



Precise thinking



# OEMV Family Firmware Reference Manual

## OEMV Family of Receivers - Firmware Reference Manual

**Publication Number:** OM-20000094  
**Revision Level:** 7  
**Revision Date:** 2009/09/21

This manual reflects firmware version 3.700.

### Proprietary Notice

Information in this document is subject to change without notice and does not represent a commitment on the part of NovAtel Inc. The software described in this document is furnished under a licence agreement or non-disclosure agreement. The software may be used or copied only in accordance with the terms of the agreement. It is against the law to copy the software on any medium except as specifically allowed in the license or non-disclosure agreement.

No part of this manual may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, for any purpose without the express written permission of a duly authorized representative of NovAtel Inc.

The information contained within this manual is believed to be true and correct at the time of publication.

NovAtel, OEMV, ProPak, Narrow Correlator tracking technology and RT-2 are registered trademarks of NovAtel Inc.

**GLIDE ALIGN**, AdvVance RTK, RT-20, **CDU**, FlexPak and PAC are trademarks of NovAtel Inc.

All other brand names are trademarks of their respective holders.

Manufactured and protected under U.S. Patent:

**Narrow Correlator**

#5,101,416

#5,390,207

#5,414,729

#5,495,499

#5,809,064

**PAC Correlator**

#6,243,409 B1

**Dual Frequency GPS**

#5,736,961

**Anti-Jamming Technology**

#5,734,674

**Position and Velocity Kalman Filter**

#6,664,923 B1

#7,193,559 B2



© Copyright 2006-2009 NovAtel Inc. All rights reserved. Unpublished rights reserved under International copyright laws. Printed in Canada on recycled paper. Recyclable.

# Table of Contents

|  |           |
|--|-----------|
| <b>Foreword</b>  | <b>15</b> |
| <b>1 Messages</b>  | <b>19</b> |
| 1.1 Message Types  | 19        |
| 1.1.1 ASCII  | 21        |
| 1.1.2 Abbreviated ASCII  | 23        |
| 1.1.3 Binary   | 23        |
| 1.2 Responses  | 28        |
| 1.2.1 Abbreviated Response   | 28        |
| 1.2.2 ASCII Response   | 28        |
| 1.2.3 Binary Response  | 28        |
| 1.3 GLONASS Slot and Frequency Numbers   | 30        |
| 1.4 GPS Time Status  | 31        |
| 1.5 Message Time Stamps  | 32        |
| 1.6 Decoding of the GPS Week Number  | 33        |
| 1.7 32-Bit CRC   | 33        |
| <b>2 Commands</b>  | <b>36</b> |
| 2.1 Command Formats  | 36        |
| 2.2 Command Settings   | 36        |
| 2.3 Commands by Function   | 37        |
| 2.4 Factory Defaults   | 54        |
| 2.5 Command Reference  | 56        |
| 2.5.1 ADJUST1PPS Adjust the receiver clock <i>VI23</i>   | 56        |
| 2.5.2 ANTENNAMODEL Enter/change rover antenna model <i>VI23</i>                                    | 62        |
| 2.5.3 ANTENNAPOWER Control power to the antenna <i>V23</i>   | 64        |
| 2.5.4 ASSIGN Assign a channel to a PRN <i>VI23</i>   | 65        |
| 2.5.5 ASSIGNALL Assign all channels to a PRN <i>VI23</i>   | 68        |
| 2.5.6 ASSIGNLBAND Set L-band satellite communication parameters <i>V3_HP, VI3_VBS or VI3_CDGPS</i> | 70        |
| 2.5.7 AUTH Add authorization code for new model <i>VI23</i>  | 74        |
| 2.5.8 BASEANTENNAMODEL Enter/change base antenna model <i>VI23</i>                                 | 76        |
| 2.5.9 CDGPSTIMEOUT Set CDGPS position time out <i>VI3_CDGPS</i>                                    | 78        |
| 2.5.10 CLOCKADJUST Enable clock adjustments <i>VI23</i>  | 79        |
| 2.5.11 CLOCKCALIBRATE Adjust clock steering parameters <i>VI23</i>                                 | 81        |
| 2.5.12 CLOCKOFFSET Adjust for delay in 1PPS output <i>VI23</i>                                     | 85        |
| 2.5.13 CNOUPDATE Set the C/No update rate and resolution <i>VI23</i>                               | 86        |
| 2.5.14 COM COM port configuration control <i>VI23</i>  | 87        |
| 2.5.15 COMCONTROL Control the RS232 hardware control lines <i>VI23</i>                             | 90        |
| 2.5.16 CSMOOTH Set carrier smoothing <i>VI23</i>   | 94        |

|                                 |  |     |
|---------------------------------|--|-----|
| 2.5.17 DATUM                    | Choose a datum name type <b>VI23</b>   | 96  |
| 2.5.18 DGPSEPHMDELAY            | DGPS ephemeris delay <b>VI23_DGPS</b>  | 103 |
| 2.5.19 DGPSTIMEOUT              | Set maximum age of differential data <b>VI23_DGPS</b>                          | 105 |
| 2.5.20 DGPSTXID                 | DGPS transmit ID <b>VI23_DGPS</b>  | 106 |
| 2.5.21 DIFFCODEBIASCONTROL      | Enable or disable satellite differential code biases <b>VI23</b>               | 108 |
| 2.5.22 DYNAMICS                 | Tune receiver parameters <b>VI23</b>   | 109 |
| 2.5.23 ECUTOFF                  | Set satellite elevation cut-off <b>VI23</b>                                    | 110 |
| 2.5.24 EXTERNALCLOCK            | Set external clock parameters <b>V23</b>                                       | 112 |
| 2.5.25 FIX                      | Constrain to fixed height or position <b>VI23</b>                              | 115 |
| 2.5.26 FIXPOSDATUM              | Set position in a specified datum <b>VI23</b>                                  | 119 |
| 2.5.27 FORCEGPSL2CODE           | Force receiver to track L2 P or L2C code <b>V23_L2C</b>                        | 120 |
| 2.5.28 FREQUENCYOUT             | Set output pulse train available on VARF <b>VI23</b>                           | 121 |
| 2.5.29 FRESET                   | Clear selected data from NVM and reset <b>VI23</b>                             | 124 |
| 2.5.30 GGAQUALITY               | Customize the GP GGA GPS quality indicator <b>VI23_NMEA</b>                    | 126 |
| 2.5.31 GLOCSMOOTH               | GLONASS channel carrier smoothing <b>VIG23_G</b>                               | 128 |
| 2.5.32 GLOECUTOFF               | Set GLONASS satellite elevation cut-off <b>VIG23_G</b>                         | 129 |
| 2.5.33 HDOUTTHRESHOLD           | Control GPHDT log output <b>ALIGN</b>  | 130 |
| 2.5.34 HPSEED                   | Specify the initial OmniSTAR HP/XP position <b>V3_HP</b>                       | 131 |
| 2.5.35 HPSTATICINIT             | Set OmniSTAR HP/XP static initialization <b>V3_HP</b>                          | 133 |
| 2.5.36 INTERFACEMODE            | Set receive or transmit modes for ports <b>VI23</b>                            | 135 |
| 2.5.37 LOCALIZEDCORRECTIONDATUM | Command to set a Local Datum   | 140 |
| 2.5.38 LOCKOUT                  | Prevent the receiver from using a satellite <b>VI23</b>                        | 142 |
| 2.5.39 LOG                      | Request logs from the receiver <b>VI23</b>                                     | 143 |
| 2.5.40 MAGVAR                   | Set a magnetic variation correction <b>VI23</b>                                | 148 |
| 2.5.41 MARKCONTROL              | Control processing of mark inputs <b>VI23</b>                                  | 151 |
| 2.5.42 MODEL                    | Switch to a previously authorized model <b>VI23</b>                            | 153 |
| 2.5.43 MOVINGBASESTATION        | Set ability to use a moving base station <b>V23_RT2</b><br><b>or VI23_RT20</b> | 154 |
| 2.5.44 NMEATALKER               | Set the NMEA talker ID <b>VI23</b>   | 156 |
| 2.5.45 NVMRESTORE               | Restore NVM data after an NVM failure <b>VI23</b>                              | 158 |
| 2.5.46 PDPFILTER                | Command to enable, disable or reset the PDP filter <b>VI23</b>                 | 159 |
| 2.5.47 PDPMODE                  | Select the PDP mode and dynamics <b>VI23</b>                                   | 160 |
| 2.5.48 POSAVE                   | Implement base station position averaging <b>VI23_DGPS</b>                     | 161 |
| 2.5.49 POSTIMEOUT               | Sets the position time out <b>VI23</b>   | 163 |
| 2.5.50 PPSCONTROL               | Control the PPS output <b>VI23</b>   | 164 |
| 2.5.51 PSRDIFFSOURCE            | Set the pseudorange correction source <b>VI23_DGPS</b>                         | 166 |
| 2.5.52 PSRVELOCITYTYPE          | Specify the Doppler Source <b>VI23</b>   | 169 |
| 2.5.53 RESET                    | Perform a hardware reset <b>VI23</b>   | 170 |
| 2.5.54 RTKANTENNA               | Specify L1 phase center (PC) or ARP and enable/disable PC                      |     |

|  |            |
|--|------------|
| modelling <i>VI23_RT20 or V23_RT2</i> .....  | 171        |
| 2.5.55 RTKCOMMAND Reset or set the RTK filter to its defaults <i>VI23_RT20 or V23_RT2</i> .....      | 173        |
| 2.5.56 RTKDYNAMICS Set the RTK dynamics mode <i>VI23_RT20 or V23_RT2</i><br>174                      |            |
| 2.5.57 RTKNETWORK Specify the RTK network mode <i>VI23_RT20 or V23_RT2</i> .....                     | 175        |
| 2.5.58 RTKQUALITYLEVEL Choose an RTK quality mode <i>V23_RT2</i> .....                               | 177        |
| 2.5.59 RTKSOURCE Set the RTK correction source <i>VIG23_G, VI23_RT20, V23_RT2 or V3_HP</i> .....     | 178        |
| 2.5.60 RTKSVENTRIES Set number of satellites in corrections <i>VI23_RT20, V23_RT2 or V3_HP</i> ..... | 180        |
| 2.5.61 RTKTIMEOUT Set maximum age of RTK data <i>VI23_RT20, V23_RT2</i> .<br>181                     |            |
| 2.5.62 SAVECONFIG Save current configuration in NVM <i>VI23</i> .....                                | 182        |
| 2.5.63 SBASCONTROL Set SBAS test mode and PRN <i>VI23_SBAS</i> .....                                 | 182        |
| 2.5.64 SEND Send an ASCII message to a COM port <i>VI23</i> .....                                    | 185        |
| 2.5.65 SENDHEX Send non-printable characters in hex pairs <i>VI23</i> .....                          | 187        |
| 2.5.66 SETAPPROXPOS Set an approximate position <i>VI23</i> .....                                    | 188        |
| 2.5.67 SETAPPROXTIME Set an approximate GPS time <i>VI23</i> .....                                   | 189        |
| 2.5.68 SETBESTPOSCRITERIA Selection criteria for BESTPOS <i>VI23</i> .....                           | 191        |
| 2.5.69 SETDIFFCODEBIASES Set satellite differential code biases <i>VI23</i> .....                    | 192        |
| 2.5.70 SETIONOTYPE Enable ionospheric models <i>VI23</i> .....                                       | 193        |
| 2.5.71 SETNAV Set start and destination waypoints <i>VI23</i> .....                                  | 194        |
| 2.5.72 SETRTCM16 Enter ASCII text for RTCM data stream <i>VI23_DGPS</i> .....                        | 196        |
| 2.5.73 SETRTCM36 Enter ASCII text with Russian characters <i>VIG23_G</i> .....                       | 197        |
| 2.5.74 STATUSCONFIG Configure RXSTATUSEVENT mask fields <i>VI23</i> .....                            | 199        |
| 2.5.75 TUNNELESCAPE Break out of an established tunnel <i>VI23</i> .....                             | 201        |
| 2.5.76 UNASSIGN Unassign a previously assigned channel <i>VI23</i> .....                             | 203        |
| 2.5.77 UNASSIGNALL Unassign all previously assigned channels <i>VI23</i> .....                       | 204        |
| 2.5.78 UNDULATION Choose undulation <i>VI23</i> .....  | 205        |
| 2.5.79 UNLOCKOUT Reinstate a satellite in the solution <i>VI23</i> .....                             | 207        |
| 2.5.80 UNLOCKOUTALL Reinstate all previously locked out satellites <i>VI23</i> .....                 | 208        |
| 2.5.81 UNLOG Remove a log from logging control <i>VI23</i> .....                                     | 208        |
| 2.5.82 UNLOGALL Remove all logs from logging control <i>VI23</i> .....                               | 210        |
| 2.5.83 USERDATUM Set user-customized datum <i>VI23</i> .....   | 211        |
| 2.5.84 USEREXPDATUM Set custom expanded datum <i>VI23</i> .....                                      | 213        |
| 2.5.85 UTMZONE Set UTM parameters <i>VI23</i> .....  | 215        |
| 2.5.86 WAASECUTOFF Set SBAS satellite elevation cut-off <i>VI23_SBAS</i> .....                       | 217        |
| 2.5.87 WAASTIMEOUT Set WAAS position time out <i>VI23_SBAS</i> .....                                 | 218        |
| <b>3 Data Logs</b> .....   | <b>219</b> |
| 3.1 Log Types .....  | 219        |
| 3.1.1 Log Type Examples .....  | 220        |

|   |     |
|---|-----|
| 3.2 Logs By Function.....   | 220 |
| 3.3 Log Reference.....  | 243 |
| 3.3.1 ALMANAC Decoded Almanac <i>V123</i> .....   | 243 |
| 3.3.2 AVEPOS Position Averaging <i>V123</i> .....   | 245 |
| 3.3.3 BESTPOS Best Position <i>V123</i> .....   | 247 |
| 3.3.4 BESTUTM Best Available UTM Data <i>V123</i> .....   | 252 |
| 3.3.5 BESTVEL Best Available Velocity Data <i>V123</i> .....                                      | 255 |
| 3.3.6 BESTXYZ Best Available Cartesian Position and Velocity <i>V123</i> .....                    | 258 |
| 3.3.7 BSLNXYZ RTK XYZ Baseline <i>V23_RT2_RT2_LITE or V3_RT20_HP</i><br>262                       |     |
| 3.3.8 CLOCKMODEL Current Clock Model Status <i>V123</i> .....                                     | 265 |
| 3.3.9 CLOCKSTEERING Clock Steering Status <i>V123</i> .....                                       | 268 |
| 3.3.10 CMR Standard Logs <i>V123_RT20 or V23_RT2</i> .....  | 271 |
| 3.3.11 CMRDATADESC Base Station Description <i>V123_RT20 or V23_RT2</i> .....                     | 274 |
| 3.3.12 CMRDATAGLOOBS CMR Data GLONASS Observations <i>V123_RT20 or</i><br><i>V23_RT2</i> .....    | 276 |
| 3.3.13 CMRDATAOBS Base Station Satellite Observations <i>V123_RT20 or</i><br><i>V23_RT2</i> ..... | 279 |
| 3.3.14 CMRDATAREF Base Station Position <i>V123_RT20 or V23_RT2</i> .....                         | 282 |
| 3.3.15 CMRPLUS CMR+ Output Message <i>V123_RT20 or V23_RT2</i> .....                              | 285 |
| 3.3.16 COMCONFIG Current COM Port Configuration <i>V123</i> .....                                 | 287 |
| 3.3.17 DIFFCODEBIASES Differential code biases being applied <i>V123</i> .....                    | 289 |
| 3.3.18 EXTRXHWLEVELS Extended Receiver Hardware Levels <i>V3_G</i> .....                          | 290 |
| 3.3.19 GLMLA NMEA GLONASS Almanac Data <i>VIG23_G</i> .....                                       | 291 |
| 3.3.20 GLOALMANAC Decoded Almanac <i>VIG23_G</i> .....  | 293 |
| 3.3.21 GLOCLOCK GLONASS Clock Information <i>VIG23_G</i> .....                                    | 295 |
| 3.3.22 GLOEPHEMERIS GLONASS Ephemeris Data <i>VIG23_G</i> .....                                   | 297 |
| 3.3.23 GLORAWALM Raw GLONASS Almanac Data <i>VIG23_G</i> .....                                    | 301 |
| 3.3.24 GLORAWEPHEM Raw GLONASS Ephemeris Data <i>VIG23_G</i> .....                                | 303 |
| 3.3.25 GLORAWFRAME Raw GLONASS Frame Data <i>VIG23_G</i> .....                                    | 305 |
| 3.3.26 GLORAWSTRING Raw GLONASS String <i>VIG23_G</i> .....                                       | 307 |
| 3.3.27 GPALM Almanac Data <i>V123_NMEA</i> .....  | 308 |
| 3.3.28 GPGGA GPS Fix Data and Undulation <i>V123_NMEA</i> .....                                   | 310 |
| 3.3.29 GPGGALONG Fix Data, Extra Precision and Undulation <i>V123_NMEA</i> .<br>312               |     |
| 3.3.30 GPGGARTK Global Position System Fix Data <i>V123_NMEA</i> .....                            | 314 |
| 3.3.31 GPGLL Geographic Position <i>V123_NMEA</i> .....   | 316 |
| 3.3.32 GPGRS GPS Range Residuals for Each Satellite <i>V123_NMEA</i> .....                        | 318 |
| 3.3.33 GPGSA GPS DOP and Active Satellites <i>V123_NMEA</i> .....                                 | 320 |
| 3.3.34 GPGST Pseudorange Measurement Noise Statistics <i>V123_NMEA</i> .....                      | 322 |
| 3.3.35 GPGSV GPS Satellites in View <i>V123_NMEA</i> .....  | 324 |
| 3.3.36 GPHDT NMEA Heading Log <i>ALIGN</i> .....  | 326 |

|  |   |     |
|--|---|-----|
| 3.3.37 GPRMB                               | Navigation Information <i>VI23_NMEA</i>                             | 327 |
| 3.3.38 GPRMC                               | GPS Specific Information <i>VI23_NMEA</i>                           | 329 |
| 3.3.39 GPSEPHM                             | Decoded GPS Ephemerides <i>VI23</i>                                 | 331 |
| 3.3.40 GPVTG                               | Track Made Good And Ground Speed <i>VI23_NMEA</i>                   | 335 |
| 3.3.41 GPZDA                               | UTC Time and Date <i>VI23_NMEA</i>                                  | 337 |
| 3.3.42 HEADING                             | Heading Information <i>VI23_ALIGN</i>                               | 338 |
| 3.3.43 IONUTC                              | Ionospheric and UTC Data <i>VI23</i>                                | 339 |
| 3.3.44 LBANDINFO                           | L-band Configuration Information <i>VI3_VBS, V3_HP or VI3_CDGPS</i> | 341 |
| 3.3.45 LBANDSTAT                           | L-band Status Information <i>VI3_VBS, V3_HP or VI3_CDGPS</i>        | 344 |
| 3.3.46 LOGLIST                             | List of System Logs <i>VI23</i>                                     | 350 |
| 3.3.47 MARKPOS, MARK2POS                   | Position at Time of Mark Input Event <i>VI23</i>                    | 353 |
| 3.3.48 MARKTIME, MARK2TIME                 | Time of Mark Input Event <i>VI23</i>                                | 355 |
| 3.3.49 MASTERPOS                           | Master Position using ALIGN <i>VI23_ALIGN</i>                       | 357 |
| 3.3.50 MATCHEDPOS                          | Matched RTK Position <i>VI23_RT20, V23_RT2 or V3_HP</i>             | 359 |
| 3.3.51 MATCHEDXYZ                          | Matched RTK Cartesian Position <i>VI23_RT20, V23_RT2 or V3_HP</i>   | 361 |
| 3.3.52 NAVIGATE                            | User Navigation Data <i>VI23</i>                                    | 363 |
| 3.3.53 NMEA Standard Logs                  | <i>VI23_NMEA</i>  | 367 |
| 3.3.54 OMNIHPPOS                           | OmniSTAR HP/XP Position <i>V3_HP</i>                                | 369 |
| 3.3.55 OMNIVIS                             | Omnistar Satellite Visibility List <i>V3_HP or VI3_VBS</i>          | 371 |
| 3.3.56 PASSCOM, PASSXCOM, PASSAUX, PASSUSB | Redirect Data <i>VI23</i>   | 373 |
| 3.3.57 PDPPOS                              | PDP filter position <i>VI23</i>                                     | 377 |
| 3.3.58 PDPVEL                              | PDP filter velocity <i>VI23</i>                                     | 378 |
| 3.3.59 PDPXYZ                              | PDP filter Cartesian position and velocity <i>VI23</i>              | 379 |
| 3.3.60 PORTSTATS                           | Port Statistics <i>VI23</i>   | 381 |
| 3.3.61 PSRDOP                              | Pseudorange DOP <i>VI23</i>   | 383 |
| 3.3.62 PSRPOS                              | Pseudorange Position <i>VI23</i>                                    | 385 |
| 3.3.63 PSRTIME                             | Time Offsets from the Pseudorange Filter <i>VI23</i>                | 387 |
| 3.3.64 PSRVEL                              | Pseudorange Velocity <i>VI23</i>                                    | 388 |
| 3.3.65 PSRXYZ                              | Pseudorange Cartesian Position and Velocity <i>VI23</i>             | 390 |
| 3.3.66 RANGE                               | Satellite Range Information <i>VI23</i>                             | 393 |
| 3.3.67 RANGECMP                            | Compressed Version of the RANGE Log <i>VI23</i>                     | 398 |
| 3.3.68 RANGEGPSL1                          | L1 Version of the RANGE Log <i>VI23</i>                             | 401 |
| 3.3.69 RAWALM                              | Raw Almanac Data <i>VI23</i>  | 403 |
| 3.3.70 RAWEPHEM                            | Raw Ephemeris <i>VI23</i>   | 405 |
| 3.3.71 RAWGPSSUBFRAME                      | Raw Subframe Data <i>VI23</i>                                       | 407 |
| 3.3.72 RAWGPSWORD                          | Raw Navigation Word <i>VI23</i>                                     | 409 |
| 3.3.73 RAWLBANDFRAME                       | Raw L-band Frame Data <i>VI3_CDGPS</i>                              | 410 |
| 3.3.74 RAWLBANDPACKET                      | Raw L-band Data Packet <i>VI3_VBS or V3_HP</i>                      | 412 |

|                           |  |                    |
|---------------------------|--|--------------------|
| 3.3.75 RAWWAASFRAME       | Raw SBAS Frame Data <i>VI23_SBAS</i> .....   | 413                |
| 3.3.76 REFSTATION         | Base Station Position and Health <i>VI23_RT20 or V23_RT2</i><br>414                        |                    |
| 3.3.77 ROVERPOS.....      | ROVER Position using ALIGN V123_ALIGN416   |                    |
| 3.3.78 RTCA Standard Logs | <i>VI23_DGPS</i> .....   | 418                |
| 3.3.79 RTCADATA1          | Differential GPS Corrections <i>VI23_DGPS</i> .....  | 420                |
| 3.3.80 RTCADATAEPHEM      | Ephemeris and Time Information <i>VI23_DGPS</i>  | 423                |
| 3.3.81 RTCADATAOBS        | Base Station Observations <i>VI23_RT20 or V23_RT2</i><br>425                               |                    |
| 3.3.82 RTCADATA2OBS       | Base Station Observations 2 <i>VI23_RT20 or V23_RT2</i><br>427                             |                    |
| 3.3.83 RTCADATAREF        | Base Station Parameters <i>VI23_RT20 or V23_RT2</i>  | 430                |
| 3.3.84 RTCM Standard Logs | <i>DGPS</i> .....  | 432                |
| 3.3.85 RTCMDATA1          | Differential GPS Corrections <i>VI23_DGPS</i> .....  | 438                |
| 3.3.86 RTCMDATA3          | Base Station Parameters <i>VI23_RT20 or V23_RT2</i>  | 441                |
| 3.3.87 RTCMDATA9          | Partial Differential GPS Corrections <i>V23_DGPS</i> .....                                 | 443                |
| 3.3.88 RTCMDATA15         | Ionospheric Corrections <i>VI23_DGPS</i> .....   | 446                |
| 3.3.89 RTCMDATA16         | Special Message <i>VI23_DGPS</i> .....   | 448                |
| 3.3.90 RTCMDATA1819       | Raw Measurements <i>VI23_RT20 or V23_RT2</i> ...   | 450                |
| 3.3.91 RTCMDATA2021       | Measurement Corrections <i>VI23_RT20 or V23_RT2</i><br>456                                 |                    |
| 3.3.92 RTCMDATA22         | Extended Base Station <i>VI23_RT20 V23_RT2</i> .....                                       | 460                |
| 3.3.93 RTCMDATA22GG       | Extended Base Station for GLONASS<br><i>VIG23_G_RT20/ RT2</i> .....                        | 462                |
| 3.3.94 RTCMDATA23         | Antenna Type Definition <i>VI23_RT20 V23_RT2</i> .....                                     | 464                |
| 3.3.95 RTCMDATA24         | Antenna Reference Point (ARP) <i>VI23_RT20 V23_RT2</i><br>466                              |                    |
| 3.3.96 RTCMDATA31         | GLONASS Differential Corrections <i>VIG23_G and</i><br><i>VI23_RT20 or V23_RT2</i> .....   | 468                |
| 3.3.97 RTCMDATA32         | GLONASS Base Station Parameters <i>VIG23_G and</i><br><i>VI23_RT20 or V23_RT2</i> .....    | 470                |
| 3.3.98 RTCMDATA36         | Special Message <i>VIG23_G</i> .....   | 471                |
| 3.3.99 RTCMDATA59         | Type 59N-0 NovAtel RT20 <i>VI23_RT20 or V23_RT2</i>  | 473                |
| 3.3.100 RTCMDATA59GLO     | NovAtel Proprietary GLONASS Differential Corrections<br><i>VIG23_G and VI23_DGPS</i> ..... | 475                |
| 3.3.101 RTCMDATAACDGPS1   | ..... Localized CDGPS Corrections in RTCM1<br><i>VI3_CDGPS</i> .....                       | 477                |
| 3.3.102 RTCMDATAACDGPS9   | CDGPS Corrections in RTCM9 Format <i>VI3_CDGPS</i><br>478                                  |                    |
| 3.3.103 RTCMDATAOMNI1     | RTCM1 from OmniSTAR VBS.....   | <i>VI3_VBS</i> 480 |
| 3.3.104 RTCMV3            | RTCMV3 Standard Logs <i>VI23_RT20 V23_RT2</i> .....  | 482                |
| 3.3.105 RTCMDATA1001      | L1-Only GPS RTK Observables <i>VI23_RT20</i><br><i>V23_RT2</i> .....                       | 486                |
| 3.3.106 RTCMDATA1002      | Extended L1-Only GPS RTK Observables <i>VI23_RT20</i>                                      |                    |



|  |     |
|--|-----|
| <b>V23_RT2</b> .....   | 490 |
| 3.3.107 RTCMDATA1003 L1/L2 GPS RTK Observables <b>V123_RT20 V23_RT2</b><br>492                           |     |
| 3.3.108 RTCMDATA1004 Expanded L1/L2 GPS RTK Observables <b>V123_RT20</b><br><b>V23_RT2</b> .....         | 494 |
| 3.3.109 RTCMDATA1005 Base Station Antenna Reference Point (ARP)<br><b>V123_RT20 V23_RT2</b> .....        | 497 |
| 3.3.110 RTCMDATA1006 Base Station ARP with Antenna Height <b>V123_RT20</b><br><b>V23_RT2</b> .....       | 499 |
| 3.3.111 RTCMDATA1007 Extended Antenna Descriptor and Setup Information<br><b>V123_RT20 V23_RT2</b> ..... | 501 |
| 3.3.112 RTCMDATA1008 Extended Antenna Descriptor and Setup Information<br><b>V123_RT20 V23_RT2</b> ..... | 503 |
| 3.3.113 RTCMDATA1009 GLONASS L1-Only RTK <b>V123_RT20 V23_RT2</b> 505                                    |     |
| 3.3.114 RTCMDATA1010 Extended L1-Only GLONASS RTK <b>V123_RT20</b><br><b>V23_RT2</b> .....               | 508 |
| 3.3.115 RTCMDATA1011 GLONASS L1/L2 RTK <b>V123_RT20 V23_RT2</b> ...                                      | 510 |
| 3.3.116 RTCMDATA1012 Extended GLONASS L1/L2 RTK <b>V123_RT20</b><br><b>V23_RT2</b> .....                 | 512 |
| 3.3.117 RTCMDATA1019 GPS Ephemeris <b>V123_RT20 V23_RT2</b> .....  | 515 |
| 3.3.118 RTCMDATA1020 GLONASS Ephemeris <b>V123_RT20 V23_RT2</b> ...                                      | 519 |
| 3.3.119 RTKDATA RTK Solution Parameters <b>V123_RT20 V23_RT2</b> .....                                   | 525 |
| 3.3.120 RTKDOP DOP Values from the RTK Fast Filter <b>V123_RT20 V23_RT2</b> .<br>531                     |     |
| 3.3.121 RTKPOS RTK Low Latency Position Data <b>V123_RT20 V23_RT2</b> ...                                | 532 |
| 3.3.122 RTKVEL RTK Velocity <b>V123_RT20 V23_RT2</b> .....   | 534 |
| 3.3.123 RTKXYZ RTK Cartesian Position and Velocity <b>V123_RT20 V23_RT2</b><br>536                       |     |
| 3.3.124 RXCONFIG Receiver Configuration <b>V123</b> .....  | 539 |
| 3.3.125 RXHWLEVELS Receiver Hardware Levels <b>V3</b> .....  | 541 |
| 3.3.126 RXSTATUS Receiver Status <b>V123</b> .....   | 543 |
| 3.3.127 RXSTATUSEVENT Status Event Indicator <b>V123</b> .....   | 551 |
| 3.3.128 SATVIS Satellite Visibility <b>V123</b> .....  | 553 |
| 3.3.129 SATXYZ SV Position in ECEF Cartesian Coordinates <b>V123</b> .....                               | 555 |
| 3.3.130 TIME Time Data <b>V123</b> .....   | 557 |
| 3.3.131 TIMESYNC Synchronize Time Between GPS Receivers <b>V123</b> .....                                | 559 |
| 3.3.132 TRACKSTAT Tracking Status <b>V123</b> .....  | 560 |
| 3.3.133 VALIDMODELS Valid Model Information <b>V123</b> .....  | 563 |
| 3.3.134 VERSION Version Information <b>V123</b> .....  | 564 |
| 3.3.135 WAAS0 Remove PRN from Solution <b>V123_SBAS</b> .....  | 568 |
| 3.3.136 WAAS1 PRN Mask Assignments <b>V123_SBAS</b> .....  | 569 |
| 3.3.137 WAAS2 Fast Correction Slots 0-12 <b>V123_SBAS</b> .....  | 570 |
| 3.3.138 WAAS3 Fast Corrections Slots 13-25 <b>V123_SBAS</b> .....  | 574 |

---

|                  |   |     |
|------------------|---|-----|
| 3.3.139 WAAS4    | Fast Correction Slots 26-38 <i>VI23_SBAS</i>          | 577 |
| 3.3.140 WAAS5    | Fast Correction Slots 39-50 <i>VI23_SBAS</i>          | 580 |
| 3.3.141 WAAS6    | Integrity Message <i>VI23_SBAS</i>                    | 583 |
| 3.3.142 WAAS7    | Fast Correction Degradation <i>VI23_SBAS</i>          | 587 |
| 3.3.143 WAAS9    | GEO Navigation Message <i>VI23_SBAS</i>               | 591 |
| 3.3.144 WAAS10   | Degradation Factor <i>VI23_SBAS</i>                   | 593 |
| 3.3.145 WAAS12   | SBAS Network Time and UTC <i>VI23_SBAS</i>            | 595 |
| 3.3.146 WAAS17   | GEO Almanac Message <i>VI23_SBAS</i>                  | 597 |
| 3.3.147 WAAS18   | IGP Mask <i>VI23_SBAS</i>                             | 599 |
| 3.3.148 WAAS24   | Mixed Fast/Slow Corrections <i>VI23_SBAS</i>          | 600 |
| 3.3.149 WAAS25   | Long-Term Slow Satellite Corrections <i>VI23_SBAS</i> | 603 |
| 3.3.150 WAAS26   | Ionospheric Delay Corrections <i>VI23_SBAS</i>        | 606 |
| 3.3.151 WAAS27   | SBAS Service Message <i>VI23_SBAS</i>                 | 608 |
| 3.3.152 WAAS32   | CDGPS Fast Correction Slots 0-10 <i>VI3_CDGPS</i>     | 610 |
| 3.3.153 WAAS33   | CDGPS Fast Correction Slots 11-21 <i>VI3_CDGPS</i>    | 613 |
| 3.3.154 WAAS34   | CDGPS Fast Correction Slots 22-32 <i>VI3_CDGPS</i>    | 615 |
| 3.3.155 WAAS35   | CDGPS Fast Correction Slots 33-43 <i>VI3_CDGPS</i>    | 617 |
| 3.3.156 WAAS45   | CDGPS Slow Corrections <i>VI3_CDGPS</i>               | 619 |
| 3.3.157 WAASCORR | SBAS Range Corrections Used <i>VI23_SBAS</i>          | 621 |

**4 Responses****623**

# Figures

|    |   |     |
|----|---|-----|
| 1  | 1PPS Alignment .....                                  | 57  |
| 2  | ADJUST1PPS Connections .....                          | 59  |
| 3  | Pulse Width and 1PPS Coherency .....                  | 122 |
| 4  | Illustration of Magnetic Variation & Correction ..... | 149 |
| 5  | TTL Pulse Polarity .....                              | 151 |
| 6  | Moving Base Station 'Daisy Chain' Effect .....        | 155 |
| 7  | Using the SEND Command .....                          | 185 |
| 8  | Illustration of SETNAV Parameters .....               | 194 |
| 9  | Illustration of Undulation .....                      | 205 |
| 10 | The WGS84 ECEF Coordinate System .....                | 261 |
| 11 | Navigation Parameters .....                           | 363 |
| 12 | Pass-Through Log Data .....                           | 375 |
| 13 | 50 Hz Logging Example in CDU .....                    | 565 |

# Tables

|    |   |     |
|----|---|-----|
| 1  | Field Types .....   | 19  |
| 2  | Byte Arrangements .....   | 20  |
| 3  | ASCII Message Header Structure .....  | 22  |
| 4  | Binary Message Header Structure .....   | 24  |
| 5  | Detailed Serial Port Identifiers .....  | 26  |
| 6  | Binary Message Response Structure .....                                       | 29  |
| 7  | Binary Message Sequence .....   | 30  |
| 8  | GPS Time Status .....   | 31  |
| 9  | Communications, Control and Status Functions .....                            | 37  |
| 10 | OEMV Family Commands in Alphabetical Order .....                              | 41  |
| 11 | OEMV Commands in Numerical Order .....  | 47  |
| 12 | Channel State .....   | 65  |
| 13 | OEMV Channel Configurations .....   | 66  |
| 14 | Channel System .....  | 68  |
| 15 | L-band Mode .....   | 71  |
| 16 | Time Out Mode .....   | 78  |
| 17 | COM Serial Port Identifiers .....   | 88  |
| 18 | Parity .....  | 88  |
| 19 | Handshaking .....   | 89  |
| 20 | Tx, DTR and RTS Availability .....  | 91  |
| 21 | Reference Ellipsoid Constants .....   | 97  |
| 22 | Datum Transformation Parameters .....   | 98  |
| 23 | User Dynamics .....   | 109 |
| 24 | Clock Type .....  | 114 |
| 25 | Pre-Defined Values for Oscillators .....                                      | 114 |
| 26 | FIX Parameters .....  | 116 |
| 27 | Fix Types .....   | 117 |
| 28 | FL2 Code Type .....   | 120 |
| 29 | FRESET Target .....   | 125 |
| 30 | Seeding Mode .....  | 132 |
| 31 | Serial Port Interface Modes .....   | 137 |
| 32 | NMEA Talkers .....  | 157 |
| 33 | DGPS Type .....   | 167 |
| 34 | Pseudorange Velocity Type .....   | 169 |
| 35 | Dynamics Mode .....   | 174 |
| 36 | Network RTK Mode .....  | 176 |
| 37 | RTK Quality Mode .....  | 177 |
| 38 | System Types .....  | 183 |
| 39 | Selection Type .....  | 191 |
| 40 | Ionospheric Correction Models .....   | 193 |
| 41 | Russian Alphabet Characters (Ch) in Decimal (Dec) and Hexidecimal (Hex) ..... | 198 |
| 42 | Mask Types .....  | 200 |
| 43 | UTM Zone Commands .....   | 216 |

|    |  |     |
|----|--|-----|
| 44 | SBAS Time Out Mode .....                             | 218 |
| 45 | Log Type Triggers .....                              | 219 |
| 46 | Logs By Function .....                               | 221 |
| 47 | OEMV Family Logs in Alphabetical Order .....         | 228 |
| 48 | OEMV Family Logs in Order of their Message IDs ..... | 236 |
| 49 | Position Averaging Status .....                      | 245 |
| 50 | Position or Velocity Type .....                      | 248 |
| 51 | Solution Status .....                                | 249 |
| 52 | Signal-Used Mask .....                               | 250 |
| 53 | Extended Solution Status .....                       | 250 |
| 54 | Clock Model Status .....                             | 265 |
| 55 | Clock Source .....                                   | 268 |
| 56 | Steering State .....                                 | 269 |
| 57 | Position Accuracy .....                              | 282 |
| 58 | GLONASS Ephemeris Flags Coding .....                 | 298 |
| 59 | Bits 0 - 1: P1 Flag Range Values .....               | 298 |
| 60 | Position Precision of NMEA Logs .....                | 316 |
| 61 | NMEA Positioning System Mode Indicator .....         | 327 |
| 62 | URA Variance .....                                   | 332 |
| 63 | L-band Subscription Type .....                       | 341 |
| 64 | L-band Signal Tracking Status .....                  | 345 |
| 65 | OmniSTAR VBS Status Word .....                       | 346 |
| 66 | OmniSTAR HP/XP Additional Status Word .....          | 347 |
| 67 | OmniSTAR HP/XP Status Word .....                     | 348 |
| 68 | Navigation Data Type .....                           | 363 |
| 69 | Tracking State .....                                 | 394 |
| 70 | Correlator Type .....                                | 395 |
| 71 | Channel Tracking Example .....                       | 395 |
| 72 | Channel Tracking Status .....                        | 395 |
| 73 | Range Record Format (RANGECMP only) .....            | 399 |
| 74 | Base Station Status .....                            | 414 |
| 75 | Base Station Type .....                              | 414 |
| 76 | RTCAOBS2 Satellite Type Offsets .....                | 427 |
| 77 | RTCM1819 Data Quality Indicator .....                | 452 |
| 78 | RTCM1819 Smoothing Interval .....                    | 452 |
| 79 | RTCM1819 Multipath Indicator .....                   | 453 |
| 80 | RTCM2021 Data Quality Indicator .....                | 457 |
| 81 | RTCM2021 Multipath Indicator .....                   | 457 |
| 82 | SBAS PRN Codes .....                                 | 486 |
| 83 | Carrier Smoothing Interval of Code Phase .....       | 487 |
| 84 | Lock Time Indicator .....                            | 487 |
| 85 | GLONASS L1 and L2 Frequencies .....                  | 506 |
| 86 | SV Accuracy .....                                    | 515 |

|     |   |     |
|-----|---|-----|
| 87  | GLONASS Ephemeris Word P1 .....             | 519 |
| 88  | M-Satellite User Range Accuracy .....       | 519 |
| 89  | To Obtain a Fixed Ambiguity Solution.....   | 525 |
| 90  | To Maintain a Fixed Ambiguity Solution..... | 525 |
| 91  | Searcher Type .....                         | 527 |
| 92  | Ambiguity Type .....                        | 527 |
| 93  | RTK Information .....                       | 528 |
| 94  | Receiver Hardware Parameters .....          | 541 |
| 95  | Receiver Error .....                        | 544 |
| 96  | Receiver Status.....                        | 546 |
| 97  | Auxiliary 1 Status .....                    | 548 |
| 98  | Auxiliary 2 Status .....                    | 548 |
| 99  | Auxiliary 3 Status .....                    | 548 |
| 100 | Status Word .....                           | 552 |
| 101 | Event Type.....                             | 552 |
| 102 | Range Reject Code.....                      | 561 |
| 103 | Model Designators .....                     | 565 |
| 104 | Component Types.....                        | 566 |
| 105 | VERSION Log: Field Formats .....            | 566 |
| 106 | 50 Hz-Capable Hardware Versions .....       | 566 |
| 107 | Evaluation of UDREI .....                   | 571 |
| 108 | Evaluation of CDGPS UDREI .....             | 611 |
| 109 | Response Messages .....                     | 623 |

# Foreword

## Congratulations!

Congratulations on purchasing a NovAtel product. Whether you have bought a stand alone OEM card or a packaged receiver you will have also received companion documents to this manual. They will help you get the hardware operational. Afterwards, this text will be your primary OEMV family command and logging reference.

All OEMV products are equipped with our AdVance RTK engine for RT-2 and RT-20 (GPS-only or GPS + GLONASS). This means a lower ambiguity error rate, faster narrow lane convergence (even at long baseline lengths) and more fixes in a wider range of conditions.

## Scope

This manual describes each command and log that the OEMV family of receivers are capable of accepting or generating. Sufficient detail is provided so that you should understand the purpose, syntax, and structure of each command or log and be able to effectively communicate with the receiver, thus enabling you to effectively use and write custom interfacing software for specific needs and applications. The manual is organized into chapters which allow easy access to appropriate information about the receiver.

There is Satellite Based Augmentation System (SBAS) signal functionality on OEMV-1, OEMV-2 and OEMV-3 products. Also, OEMV-2 and OEMV-3 products support GLONASS measurements while OEMV-1 and OEMV-3 cards are L-band capable. Please refer to the *SBAS Overview* and the *Real Time Kinematic (RTK)* sections in the *OEMV Family Installation and Operation User Manual*, the *GNSS Reference Book* and the *Conventions* section below for more information. All three also support NMEA, DGPS and RTK. If you have any of these options and wish to learn more about them, please refer to *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm>, and see their associated sections in this manual. Commands and logs are tagged to be easily recognizable for cards and options. These tags are shown in more detail in the *Conventions* section starting below.

This manual does not address any of the receiver hardware attributes or installation information. Please consult the *OEMV Family Installation and Operation User Manual* for technical information on these topics. Furthermore, should you encounter any functional, operational, or interfacing difficulties with the receiver, consult the same manual for NovAtel warranty and support information.

## Conventions


This manual covers the full performance capabilities of all the OEMV family of receivers. Feature-tagging symbols have been created to help clarify which commands and logs are only available with certain cards and options. The tags are in the title of the command or log and also appear in tables where features are mentioned as footnotes. The numbering at the start of the tag indicates V followed by 1 for OEMV-1, 2 for OEMV-2 and 3 for OEMV-3 while the lettering suffix is described below:

|             |   |
|-------------|---|
| <i>V123</i> | Features available on OEMV-1, OEMV-1G, OEMV-2 or OEMV-3-based products. If a feature isn't available, its card number is omitted, for example, <i>V23</i> , <i>V13</i> or <i>V3</i> . |
|-------------|---|

|                  |  |
|------------------|--|
| <i>V123_RT20</i> | Features available only with receivers equipped with the RT-20 option  |
| <i>V23_RT2</i>   | Features available only with receivers equipped with the RT-2 option   |
| <i>V123_DGPS</i> | Feature used when operating in differential mode   |
| <i>V123_NMEA</i> | National Marine Electronics Association format   |
| <i>V123_SBAS</i> | SBAS messages available when tracking an SBAS satellite <sup>1</sup>   |
| <i>V3_HP</i>     | OmniSTAR high performance (HP), extra performance (XP) and virtual base station (VBS) available with an OmniSTAR subscription <sup>1</sup> |
| <i>V13_VBS</i>   | OmniSTAR VBS available with an OmniSTAR subscription   |
| <i>V13_CDGPS</i> | The free Canada-Wide Differential Global Positioning System (CDGPS) available without a subscription <sup>1</sup>                          |
| <i>V1G23_G</i>   | GLONASS positioning <sup>1</sup> and RT2 <b>LITE</b> available   |
| <i>V3_G</i>      | Available only on OEMV-3-based products with the GLONASS option  |
| <i>V23_L2C</i>   | Capable of receiving the L2C signal <sup>1</sup>   |
| <b>ALIGN</b>     | Available only on <b>ALIGN</b> -capable models, see also <i>Heading</i> on page 338  |

Other simple conventions are:

---

 This is a notebbox that contains important information before you use a command or log.

---



This is a usage box that contains additional information or examples.

---

- Command defaults:
  - The factory defaults for commands are shown in *Section 2.4, Factory Defaults* on Page 54. Each factory default is also shown after the syntax but before the example of each command description starting on Page 57.
  - The default values used by the OEMV family for optional fields, if you use a command without entering optional parameter values, if applicable, is given in each command table.
- The letter H in the Binary Byte or Binary Offset columns of the commands and logs tables represents the header length for that command or log, see *Section 1.1.3, Binary* on Page 23.
- The number following 0x is a hexadecimal number.
- Default values shown in command tables indicate the assumed values when optional parameters have been omitted. Default values do not imply the factory default settings, see *Chapter 2, Page 54* for a list of factory default settings.
- Command descriptions' brackets, [ ], represent the optionality of parameters.
- In tables where values are missing they are assumed to be reserved for future use.

---

1. Refer to the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm>



- Status words are output as hexadecimal numbers and must be converted to binary format (and in some cases then also to decimal). For an example of this type of conversion, please see the RANGE log, *Table 71* on *page 395*.  
Conversions and their binary or decimal results are always read from right to left. For a complete list of hexadecimal, binary and decimal equivalents, please refer to the *Unit Conversion* section of the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm>.
- ASCII log examples may be split over several lines for readability. In reality only a single [CR][LF] pair is transmitted at the end of an ASCII log.
- The terms OEMV-1, OEMV-2 and OEMV-3 will not be used in this manual unless a specific detail refers to it alone. The term receiver will infer that the text is applicable to an OEMV-1, OEMV-2 or OEMV-3, either stand-alone or in an enclosure, unless otherwise stated.
- Relevant SBAS commands and logs start with WAAS except for RAWWAASFRAME. Generally, the PRN field of the WAASx logs is common, and indicates the SBAS satellite that the message originated from. Please refer to the RTCA document *RTCA D0-229B, Appendix A Wide Area Augmentation System Signal Specification* for details.

## What's New in Rev 7 of this Manual?

This manual has been revised to include information on the following:

- RT-2 L1TE and ALIGN (single frequency) uses GPS+GLONASS satellites to assist in solution computation
- ALIGN Y-model added to output Master and Rover position and heading output at both receivers; max 10Hz output rate.
- L5 tracking capability added
- HDTOUPTHRESHOLD default is now set at 2 degrees (previously at 1 degree)
- BLCONSTRAINT command is disabled
- Support for OmniStar G2 library; **\*BETA release\*** contact customer service for activation
- HPSTATISINIT is disabled by default and should be left disabled until update from OmniStar
- Dual data input capability for OmniStar input; NTRIP and serial port was added
- Removed 20 second hold on RTCAOBS2 messages
- Fixed magnetic variation in GPRMC log

### 3.600 Enhancements:

- GPS+GLONASS L1-only RTK solution featuring centimetre-level accuracy (RT2 **L1TE**) up to 3 km from a NovAtel base, see model K in *Table 103, Model Designators* on *Page 565*.
- **ALIGN**, a heading feature that generates separation and bearing data between a base and one or multiple rovers. See also *Heading* on *page 338*.
- CMR GLONASS support, see *page 153*.

- FILE values additions to *Table 5, Detailed Serial Port Identifiers* starting on *page 26* (for DL-V3 use only).
- OmniSTAR HP 4.28 library.
- SUPERSTAR II messages 20, 21 and 33 are available with OEMV, refer to [APN-049](#)
- This manual includes enhancements and corrections that appeared in its addendum:

#### 3.400 Enhancements:

- **GLIDE** position filter, see *page 158*
- The latest High Precision (HP) library from OmniSTAR (HP4.27). This library uses the VBS position to internally seed the HP solution in order to improve convergence times. In older versions, the HP engine was seeded with an iono-free solution. In addition, outlier detection and elimination have been improved.
- CDGPS, or OmniSTAR, signals output to an existing non-L-band receiver as RTCM Type 1, or RTCM Type 9, messages, see *page 139*
- CDGPS corrections over a serial port, see *page 419*
- CMR Type 3 RTK formats, see *page 272*
- OmniSTAR external stream, see *page 135*

You can download the most up-to-date version of this manual, and any addendums, from the [support/docupdates.htm](#) section of the NovAtel Web site at [www.novatel.com](http://www.novatel.com).

## Prerequisites

As this reference manual is focused on the OEMV family commands and logging protocol, it is necessary to ensure that the receiver has been properly installed and powered up according to the instructions outlined in the companion *OEMV Family Installation and Operation User Manual* before proceeding.

## 1.1 Message Types

The receiver handles incoming and outgoing NovAtel data in three different message formats: Abbreviated ASCII, ASCII, and Binary. This allows for a great deal of versatility in the way the OEMV family receivers can be used. All NovAtel commands and logs can be entered, transmitted, output or received in any of the three formats. The receiver also supports RTCA, RTCMV3, RTCM, CMR, CMRPLUS and NMEA format messaging, see the chapter on *Message Formats* in the *OEMV Family Installation and Operation User Manual*.

When entering an ASCII or abbreviated ASCII command in order to request an output log, the message type is indicated by the character appended to the end of the message name. ‘A’ indicates that the message is ASCII and ‘B’ indicates that it is binary. No character means that the message is Abbreviated ASCII. When issuing binary commands the output message type is dependant on the bit format in the message’s binary header, see *Binary* on page 23.

Table 1, below, describes the field types used in the description of messages.

**Table 1: Field Types**

| Type   | Binary Size (bytes) | Description   |
|--------|---------------------|---|
| Char   | 1                   | The <b>char</b> type is an 8-bit integer in the range -128 to +127. This integer value may be the ASCII code corresponding to the specified character. In ASCII or Abbreviated ASCII this comes out as an actual character. |
| UChar  | 1                   | The <b>uchar</b> type is an 8-bit unsigned integer. Values are in the range from +0 to +255. In ASCII or Abbreviated ASCII this comes out as a number.  |
| Short  | 2                   | The short type is 16-bit integer in the range -32768 to +32767.   |
| UShort | 2                   | The same as Short except that it is not signed. Values are in the range from +0 to +65535.  |
| Long   | 4                   | The <b>long</b> type is 32-bit integer in the range -2147483648 to +2147483647.   |
| ULong  | 4                   | The same as Long except that it is not signed. Values are in the range from +0 to +4294967295.  |
| Double | 8                   | The <b>double</b> type contains 64 bits: 1 for sign, 11 for the exponent, and 52 for the mantissa. Its range is $\pm 1.7E308$ with at least 15 digits of precision. This is IEEE 754.                                       |

*Continued on page 20.*

| Type    | Binary Size (bytes) | Description   |
|---------|---------------------|---|
| Float   | 4                   | The <b>float</b> type contains 32 bits: 1 for the sign, 8 for the exponent, and 23 for the mantissa. Its range is $\pm 3.4E38$ with at least 7 digits of precision. This is IEEE 754.   |
| Enum    | 4                   | A 4-byte enumerated type beginning at zero (an unsigned long). In binary, the enumerated value is output. In ASCII or Abbreviated ASCII, the enumeration label is spelled out.  |
| GPSTime | 4                   | This type has two separate formats that depend on whether you have requested a binary or an ASCII format output. For binary the output is in milliseconds and is a <b>long</b> type. For ASCII the output is in seconds and is a <b>float</b> type.             |
| Hex     | n                   | Hex is a packed, fixed length (n) array of bytes in binary but in ASCII or Abbreviated ASCII is converted into 2 character hexadecimal pairs.   |
| String  | n                   | String is a variable length array of bytes that is null-terminated in the binary case and additional bytes of padding are added to maintain 4 byte alignment. The maximum byte length for each String field is shown in their row in the log or command tables. |

Table 2: Byte Arrangements

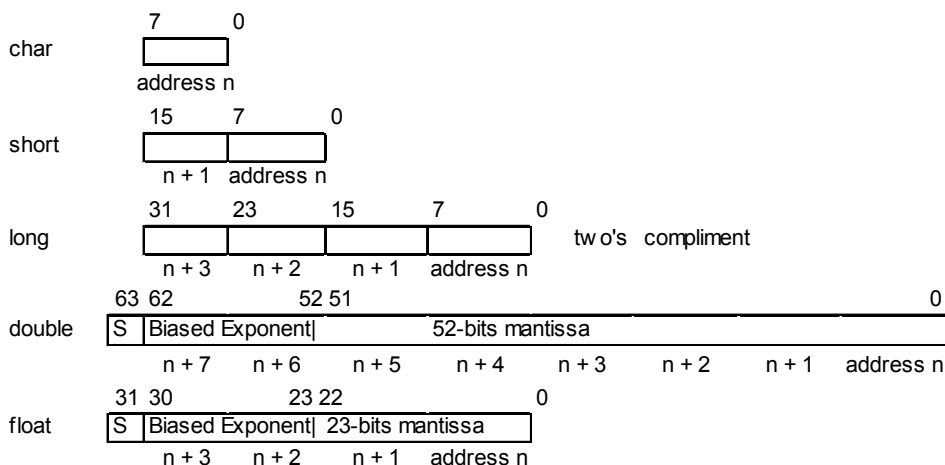


Table 2 shows the arrangement of bytes within each field type when used by IBM PC computers. All data sent to or from the OEMV family receiver, however, is read least significant bit (LSB) first, opposite to what is shown in Table 2. Data is then stored in the receiver LSB first. For example, in char type data, the LSB is bit 0 and the most significant bit (MSB) is bit 7. See Table 71, *Channel Tracking Example* on page 395 for a more detailed example.

### 1.1.1 ASCII

ASCII messages are readable by both the user and a computer. The structures of all ASCII messages follow the general conventions as noted here:

1. The lead code identifier for each record is '#'.
2. Each log or command is of variable length depending on amount of data and formats.
3. All data fields are delimited by a comma ',' with two exceptions. The first exception is the last header field which is followed by a ';' to denote the start of the data message. The other exception is the last data field, which is followed by a \* to indicate end of message data.
4. Each log ends with a hexadecimal number preceded by an asterisk and followed by a line termination using the carriage return and line feed characters, for example, \*1234ABCD[CR][LF]. This value is a 32-bit CRC of all bytes in the log, excluding the '#' identifier and the asterisk preceding the four checksum digits. See 1.7, *32-Bit CRC* on page 33 for the algorithm used to generate the CRC.
5. An ASCII string is one field and is surrounded by double quotation marks, for example, "ASCII string". If separators are surrounded by quotation marks then the string is still one field and the separator will be ignored, for example, "xxx,xxx" is one field. Double quotation marks within a string are not allowed.
6. If the receiver detects an error parsing an input message, it will return an error response message. Please see Chapter 4, *Responses* on page 623 for a list of response messages from the receiver.

#### Message Structure:



The ASCII message header structure is described in Table 3 on the next page.

**Table 3: ASCII Message Header Structure**

| Field # | Field Name           | Field Type | Description   | Ignored on Input |
|---------|----------------------|------------|---|------------------|
| 1       | Sync                 | Char       | Sync character. The ASCII message is always preceded by a single '#' symbol.  | N                |
| 2       | Message              | Char       | This is the ASCII name of the log or command (lists are in <i>Table 10, page 41</i> and <i>Table 47, page 228</i> ).  | N                |
| 3       | Port                 | Char       | This is the name of the port from which the log was generated. The string is made up of the port name followed by an _x where x is a number from 1 to 31 denoting the virtual address of the port. If no virtual address is indicated, it is assumed to be address 0. | Y                |
| 4       | Sequence #           | Long       | This is used for multiple related logs. It is a number that counts down from N-1 to 0 where 0 means it is the last one of the set. Most logs only come out one at a time in which case this number is 0.  | N                |
| 5       | % Idle Time          | Float      | The minimum percentage of time that the processor is idle between successive logs with the same Message ID.   | Y                |
| 6       | GPS Time Status      | Enum       | This value indicates the quality of the GPS time (see <i>Table 8, GPS Time Status on page 31</i> )  | Y                |
| 7       | Week                 | Ulong      | GPS week number.  | Y                |
| 8       | Seconds              | GPSec      | Seconds from the beginning of the GPS week accurate to the millisecond level.   | Y                |
| 9       | Receiver Status      | Ulong      | This is an eight digit hexadecimal number representing the status of various hardware and software components of the receiver between successive logs with the same Message ID (see <i>Table 96, Receiver Status on page 546</i> ).                                   | Y                |
| 10      | Reserved             | Ulong      | Reserved for internal use.  | Y                |
| 11      | Receiver s/w Version | Ulong      | This is a value (0 - 65535) that represents the receiver software build number.   | Y                |
| 12      | ;                    | Char       | This character indicates the end of the header.   | N                |

**Example Log:**

```
#RAWEPHEMA,COM1,0,35.0,SATTIME,1364,496230.000,00100000,97b7,2310;
30,1364,496800,8b0550a1892755100275e6a09382232523a9dc04ee6f794a0000090394ee,8b05
50a189aa6ff925386228f97eabf9c8047e34a70ec5a10e486e794a7a,8b0550a18a2effc2f80061c
2fffc267cd09f1d5034d3537affa28b6ff0eb*7a22f279
```

### 1.1.2 Abbreviated ASCII

This message format is designed to make the entering and viewing of commands and logs by the user as simple as possible. The data is represented as simple ASCII characters separated by spaces or commas and arranged in an easy to understand fashion. There is also no 32-bit CRC for error detection because it is meant for viewing by the user.

**Example Command:**

```
log com1 loglist
```

**Resultant Log:**

```
<LOGLIST COM1 0 69.0 FINE 0 0.000 00240000 206d 0
<      4
<      COM1 RXSTATUSEVENTA ONNEW 0.000000 0.000000 NOHOLD
<      COM2 RXSTATUSEVENTA ONNEW 0.000000 0.000000 NOHOLD
<      COM3 RXSTATUSEVENTA ONNEW 0.000000 0.000000 NOHOLD
<      COM1 LOGLIST ONCE 0.000000 0.000000 NOHOLD
```

As you can see the array of 4 logs are offset from the left hand side and start with '<'.

### 1.1.3 Binary

Binary messages are meant strictly as a machine readable format. They are also ideal for applications where the amount of data being transmitted is fairly high. Because of the inherent compactness of binary as opposed to ASCII data, the messages are much smaller. This allows a larger amount of data to be transmitted and received by the receiver’s communication ports. The structure of all Binary messages follows the general conventions as noted here:

1. Basic format of:

|        |  |
|--------|--|
| Header | 3 Sync bytes plus 25 bytes of header information. The header length is variable as fields may be appended in the future. Always check the header length. |
| Data   | variable   |
| CRC    | 4 bytes  |

2. The 3 Sync bytes will always be:

| Byte   | Hex | Decimal |
|--------|-----|---------|
| First  | AA  | 170     |
| Second | 44  | 68      |
| Third  | 12  | 18      |

3. The CRC is a 32-bit CRC (see 1.7, 32-Bit CRC on page 33 for the CRC algorithm) performed on all data including the header.
4. The header is in the format shown in Table 4, Binary Message Header Structure on page 24.

Table 4: Binary Message Header Structure

| Field # | Field Name     | Field Type | Description  | Binary Bytes | Binary Offset | Ignored on Input |
|---------|----------------|------------|--|--------------|---------------|------------------|
| 1       | Sync           | Char       | Hexadecimal 0xAA.  | 1            | 0             | N                |
| 2       | Sync           | Char       | Hexadecimal 0x44.  | 1            | 1             | N                |
| 3       | Sync           | Char       | Hexadecimal 0x12.  | 1            | 2             | N                |
| 4       | Header Lgth    | Uchar      | Length of the header.  | 1            | 3             | N                |
| 5       | Message ID     | Ushort     | This is the Message ID number of the log (see the log descriptions in <i>Table 48, OEMV Family Logs in Order of their Message IDs on page 236</i> for the Message ID values of individual logs).   | 2            | 4             | N                |
| 6       | Message Type   | Char       | Bits 0-4 = Reserved<br>Bits 5-6 = Format<br>00 = Binary<br>01 = ASCII<br>10 = Abbreviated ASCII, NMEA<br>11 = Reserved<br>Bit 7 = Response bit<br>(see <i>Section 1.2, page 28</i> )<br>0 = Original Message<br>1 = Response Message         | 1            | 6             | N                |
| 7       | Port Address   | Uchar      | See <i>Table 5 on page 26</i> (decimal values greater than 16 may be used) (lower 8 bits only) <sup>a</sup>  | 1            | 7             | N <sup>b</sup>   |
| 8       | Message Length | Ushort     | The length in bytes of the body of the message. This does not include the header nor the CRC.  | 2            | 8             | N                |
| 9       | Sequence       | Ushort     | This is used for multiple related logs. It is a number that counts down from N-1 to 0 where N is the number of related logs and 0 means it is the last one of the set. Most logs only come out one at a time in which case this number is 0. | 2            | 10            | N                |

Continued on the following page.



| Field # | Field Name           | Field Type | Description  | Binary Bytes   | Binary Offset | Ignored on Input |
|---------|----------------------|------------|--|----------------|---------------|------------------|
| 10      | Idle Time            | Uchar      | The time that the processor is idle in the last second between successive logs with the same Message ID. Take the time (0 - 200) and divide by two to give the percentage of time (0 - 100%).    | 1              | 12            | Y                |
| 11      | Time Status          | Enum       | Indicates the quality of the GPS time (see <i>Table 8, GPS Time Status</i> on page 31).  | 1 <sup>c</sup> | 13            | N <sup>d</sup>   |
| 12      | Week                 | Ushort     | GPS week number.   | 2              | 14            | N <sup>d</sup>   |
| 13      | ms                   | GPSe<br>c  | Milliseconds from the beginning of the GPS week.   | 4              | 16            | N <sup>d</sup>   |
| 14      | Receiver Status      | Ulong      | 32 bits representing the status of various hardware and software components of the receiver between successive logs with the same Message ID (see <i>Table 96, Receiver Status</i> on page 546). | 4              | 20            | Y                |
| 15      | Reserved             | Ushort     | Reserved for internal use.   | 2              | 24            | Y                |
| 16      | Receiver S/W Version | Ushort     | This is a value (0 - 65535) that represents the receiver software build number.  | 2              | 26            | Y                |

- The 8 bit size means that you will only see 0xA0 to 0xBF when the top bits are dropped from a port value greater than 8 bits. For example ASCII port USB1 will be seen as 0xA0 in the binary output.
- Recommended value is THISPORT (binary 192)
- This ENUM is not 4 bytes long but, as indicated in the table, is only 1 byte.
- These time fields are ignored if Field #11, Time Status, is invalid. In this case the current receiver time is used. The recommended values for the three time fields are 0, 0, 0.

**Table 5: Detailed Serial Port Identifiers**

| ASCII Port Name | Hex Port Value | Decimal Port Value <sup>a</sup> | Description                                     |
|-----------------|----------------|---------------------------------|---|
| NO_PORTS        | 0              | 0                               | No ports specified                              |
| COM1_ALL        | 1              | 1                               | All virtual ports for COM port 1                |
| COM2_ALL        | 2              | 2                               | All virtual ports for COM port 2                |
| COM3_ALL        | 3              | 3                               | All virtual ports for COM port 3                |
| THISPORT_ALL    | 6              | 6                               | All virtual ports for the current port          |
| ALL_PORTS       | 8              | 8                               | All virtual ports for all ports                 |
| XCOM1_ALL       | 9              | 9                               | All virtual COM1 ports                          |
| XCOM2_ALL       | 10             | 10                              | All virtual COM2 ports                          |
| USB1_ALL        | d              | 13                              | All virtual ports for USB port 1                |
| USB2_ALL        | e              | 14                              | All virtual ports for USB port 2                |
| USB3_ALL        | f              | 15                              | All virtual ports for USB port 3                |
| AUX_ALL         | 10             | 16                              | All virtual ports for the AUX port <sup>b</sup> |
| XCOM3_ALL       | 11             | 17                              | All virtual COM3 ports                          |
| COM1            | 20             | 32                              | COM port 1, virtual port 0                      |
| COM1_1          | 21             | 33                              | COM port 1, virtual port 1                      |
| ...             |                |                                 |   |
| COM1_31         | 3f             | 63                              | COM port 1, virtual port 31                     |
| COM2            | 40             | 64                              | COM port 2, virtual port 0                      |
| ...             |                |                                 |   |
| COM2_31         | 5f             | 95                              | COM port 2, virtual port 31                     |
| COM3            | 60             | 96                              | COM port 3, virtual port 0                      |
| ...             |                |                                 |   |
| COM3_31         | 7f             | 127                             | COM port 3, virtual port 31                     |
| USB             | 80             | 128                             | USB port, virtual port 0                        |
| ...             |                |                                 |   |
| USB_31          | 9f             | 159                             | USB port, virtual port 31                       |
| SPECIAL         | a0             | 160                             | Unknown port, virtual port 0                    |
| ...             |                |                                 |   |
| SPECIAL_31      | bf             | 191                             | Unknown port, virtual port 31                   |
| THISPORT        | c0             | 192                             | Current COM port, virtual port 0                |
| ...             |                |                                 |   |

*Continued on the following page.*

| ASCII Port Name | Hex Port Value | Decimal Port Value <sup>a</sup> | Description                                      |
|-----------------|----------------|---------------------------------|--|
| THISPORT_31     | df             | 223                             | Current COM port, virtual port 31                |
| FILE            | e0             | 224                             | User-specified file destination, 0 <sup>c</sup>  |
| FILE_1          | e1             | 225                             | User-specified file destination, 1 <sup>c</sup>  |
| ...             |                |                                 |  |
| FILE_31         | ff             | 255                             | User-specified file destination, 31 <sup>c</sup> |
| XCOM1           | 1a0            | 416                             | Virtual COM1 port, virtual port 0                |
| XCOM1_1         | 1a1            | 417                             | Virtual COM1 port, virtual port 1                |
| ...             |                |                                 |  |
| XCOM1_31        | 1bf            | 447                             | Virtual COM1 port, virtual port 31               |
| XCOM2           | 2a0            | 672                             | Virtual COM2 port, virtual port 0                |
| XCOM2_1         | 2a1            | 673                             | Virtual COM2 port, virtual port 1                |
| ...             |                |                                 |  |
| XCOM2_31        | 2bf            | 703                             | Virtual COM2 port, virtual port 31               |
| USB1            | 5a0            | 1440                            | USB port 1, virtual port 0                       |
| USB1_1          | 5a1            | 1441                            | USB port 1, virtual port 1                       |
| ...             |                |                                 |  |
| USB1_31         | 5bf            | 1471                            | USB port 1, virtual port 31                      |
| USB2            | 6a0            | 1696                            | USB port 2, virtual port 0                       |
| ...             |                |                                 |  |
| USB2_31         | 6bf            | 1727                            | USB port 2, virtual port 31                      |
| USB3            | 7a0            | 1952                            | USB port 3, virtual port 0                       |
| ...             |                |                                 |  |
| USB3_31         | 7bf            | 1983                            | USB port 3, virtual port 31                      |
| AUX             | 8a0            | 2208                            | AUX port, virtual port 0 <sup>b</sup>            |
| ...             |                |                                 |  |
| AUX_31          | 8bf            | 2239                            | AUX port, virtual port 31 <sup>b</sup>           |
| XCOM3           | 9a0            | 2464                            | Virtual COM3 port, virtual port 0                |
| ...             |                |                                 |  |
| XCOM3_31        | 9bf            | 2495                            | Virtual COM3 port, virtual port 31               |

- Decimal port values 0 through 16 are only available to the UNLOGALL command, see *page 209*, and cannot be used in the UNLOG command, *page 207*, or in the binary message header, see *Table 4 on page 24*.
- The AUX port is available on OEMV-2-based and OEMV-3-based products.
- DL-V3 only. Refer to the *DL-V3 Firmware Reference Manual* and the **CDU's** Help file.

☒ COM1\_ALL, COM2\_ALL, COM3\_ALL, THISPORT\_ALL, ALL\_PORTS, USB1\_ALL, USB2\_ALL, USB3\_ALL and AUX\_ALL are only valid for the UNLOGALL command.

## 1.2 Responses

By default, if you input a message you will get back a response. If desired, the INTERFACEMODE command can be used to disable response messages (see *page 135*). The response will be in the exact format that you entered the message (that is, binary input = binary response).

### 1.2.1 Abbreviated Response

Just the leading '<' followed by the response string, for example:

```
<OK
```

### 1.2.2 ASCII Response

Full header with the message name being identical except ending in an 'R' (for response). The body of the message consists of a 40 character string for the response string, for example:

```
#BESTPOSR,COM1,0,67.0,FINE,1028,422060.400,00000000,a31b,0;"OK" *b867caad
```

### 1.2.3 Binary Response

Similar to an ASCII response except that it follows the binary protocols, see *Table 6, Binary Message Response Structure* on *page 29*.

*Table 7, Binary Message Sequence* on *page 30* is an example of the sequence for requesting and then receiving BESTPOSB. The example is in hex format. When you enter a hex command, you may need to add a '\x' or '0x' before each hex pair, depending on your code (for example, 0xAA0x440x120x1C0x010x000x02 and so on).

Table 6: Binary Message Response Structure

|  | Field # | Field Name           | Field Type | Description   | Binary Bytes   | Binary Offset |
|--|---------|----------------------|------------|---|----------------|---------------|
| B<br>I<br>N<br>A<br>R<br>Y<br><br>H<br>E<br>A<br>D<br>E<br>R | 1       | Sync                 | Char       | Hexadecimal 0xAA.   | 1              | 0             |
|  | 2       | Sync                 | Char       | Hexadecimal 0x44.   | 1              | 1             |
|  | 3       | Sync                 | Char       | Hexadecimal 0x12.   | 1              | 2             |
|  | 4       | Header Lgth          | Uchar      | Length of the header.   | 1              | 3             |
|  | 5       | Message ID           | Ushort     | Message ID number   | 2              | 4             |
|  | 6       | Message Type         | Char       | Bit 7 = Response Bit<br>1 = Response Message  | 1              | 6             |
|  | 7       | Port Address         | Uchar      | See <i>Table 5 on page 26</i>   | 1              | 7             |
|  | 8       | Message Length       | Ushort     | The length in bytes of the body of the message (not the CRC).                                       | 2              | 8             |
|  | 9       | Sequence             | Ushort     | Normally 0  | 2              | 10            |
|  | 10      | Idle Time            | Uchar      | Idle time   | 1              | 12            |
|  | 11      | Time Status          | Enum       | <i>Table 8 on page 31</i>   | 1 <sup>a</sup> | 13            |
|  | 12      | Week                 | Ushort     | GPS week number   | 2              | 14            |
|  | 13      | ms                   | GPSec      | Milliseconds into GPS week  | 4              | 16            |
|  | 14      | Receiver Status      | Ulong      | <i>Table on page 543</i>  | 4              | 20            |
|  | 15      | Reserved             | Ushort     | Reserved for internal use   | 2              | 24            |
|  | 16      | Receiver S/W Version | Ushort     | Receiver software build number.   | 2              | 26            |
| I<br>D   | 17      | Response ID          | Enum       | <i>Table 109, Response Messages on page 623</i>   | 4              | 28            |
| H<br>E<br>X  | 18      | Response             | Hex        | String containing the ASCII response in hex coding to match the ID above (for example, 0x4F4B = OK) | variable       | 32            |

a. This ENUM is not 4 bytes long but, as indicated in the table, is only 1 byte.

**Table 7: Binary Message Sequence**

| Direction     | Sequence            | Data   |
|---------------|---------------------|--|
| To Receiver   | LOG Command Header  | AA44121C 01000240 20000000 1D1D0000 29160000<br>00004C00 55525A80  |
|               | LOG Parameters      | 20000000 2A000000 02000000 00000000 0000F03F<br>00000000 00000000 00000000   |
|               | Checksum            | 2304B3F1   |
| From Receiver | LOG Response Header | AA44121C 01008220 06000000 FFB4EE04 605A0513<br>00004C00 FFFF5A80  |
|               | Log Response Data   | 01000000 4F4B  |
|               | Checksum            | DA8688EC   |
| From Receiver | BESTPOSB Header     | AA44121C 2A000220 48000000 90B49305 B0ABB912<br>00000000 4561BC0A  |
|               | BESTPOSB Data       | 00000000 10000000 1B0450B3 F28E4940 16FA6BBE<br>7C825CC0 0060769F 449F9040 A62A82C1 3D000000<br>125ACB3F CD9E983F DB664040 00303030 00000000<br>00000000 0B0B0000 00060003 |
|               | Checksum            | 42DC4C48   |

### 1.3 GLONASS Slot and Frequency Numbers

The OEMV-1G, OEMV-2 and OEMV-3 can track GLONASS satellites. Up to 12 channels can be configured to track GLONASS signals that can be used in the solution. See also *Table 13, OEMV Channel Configurations* on page 66.

When a PRN in a log is in the range 38 to 61, then that PRN represents a GLONASS Slot where the Slot shown is the actual GLONASS Slot Number plus 37.

Similarly, the GLONASS Frequency shown in logs is the actual GLONASS Frequency plus 7.

For example:

```
#SATVISA, COM1, 0, 53.5, FINESTEERING, 1363, 234894.000, 00000000, 0947, 2277;
TRUE, TRUE, 46,
2, 0, 0, 73.3, 159.8, 934.926, 934.770,
...
43, 8, 0, -0.4, 163.7, 4528.085, 4527.929,
...
3, 0, 0, -79.9, 264.3, 716.934, 716.778*b94813d3
```

where 2 and 3 are GPS satellites and 43 is a GLONASS satellite. Its actual GLONASS Slot Number is 6. The SATVIS log shows 43 (6+ 37). Its actual GLONASS frequency is 1. The SATVIS log shows 8 (1+7). See also the SATVIS log on page 553.

Refer to the *GLONASS* section in the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm> for more information.

## 1.4 GPS Time Status

All reported receiver times are subject to a qualifying time status. This status gives you an indication of how well a time is known, see *Table 8*:

**Table 8: GPS Time Status**

| GPS Time Status (Decimal) | GPS Time Status <sup>a</sup> (ASCII) | Description   |
|---------------------------|--------------------------------------|---|
| 20                        | UNKNOWN                              | Time validity is unknown.   |
| 60                        | APPROXIMATE                          | Time is set approximately.  |
| 80                        | COARSEADJUSTING                      | Time is approaching coarse precision.   |
| 100                       | COARSE                               | This time is valid to coarse precision.   |
| 120                       | COARSESTEERING                       | Time is coarse set, and is being steered.   |
| 130                       | FREEWHEELING                         | Position is lost, and the range bias cannot be calculated.  |
| 140                       | FINEADJUSTING                        | Time is adjusting to fine precision.  |
| 160                       | FINE                                 | Time has fine precision.  |
| 180                       | FINESTEERING                         | Time is fine, set and is being steered.   |
| 200                       | SATTIME                              | Time from satellite. This is only used in logs containing satellite data such as ephemeris and almanac. |

a. See also *Section 1.5, Message Time Stamps* on *page 32*

There are several distinct states that the receiver will go through:

- UNKNOWN
- COARSE
- FREEWHEELING
- FINE
- FINESTEERING

On start up, and before any satellites are being tracked, the receiver can not possibly know the current time. As such, the receiver time starts counting at GPS week 0 and second 0.0. The time status flag is set to UNKNOWN.

If time is input to the receiver using the SETAPPROXTIME command, see *page 188*, or on receipt of an RTCAEPHEM message, see *page 423*, the time status will be APPROXIMATE.

After the first ephemeris is decoded, the receiver time is set to a resolution of  $\pm 10$  milliseconds. This state is qualified by the COARSE or COARSESTEERING time status flag depending on the state of the CLOCKADJUST switch.

Once a position is known and range biases are being calculated, the internal clock model will begin modelling the position range biases and the receiver clock offset.

Modelling will continue until the model is a good estimation of the actual receiver clock behavior. At this time, the receiver time will again be adjusted, this time to an accuracy of  $\pm 1$  microsecond. This state is qualified by the FINE time status flag.

The final logical time status flag depends on whether CLOCKADJUST is enabled or not, see *page 79*. If CLOCKADJUST is disabled, the time status flag will never improve on FINE. The time will only be adjusted again to within  $\pm 1$  microsecond if the range bias gets larger than  $\pm 250$  milliseconds. If Clock Adjust is enabled, the time status flag will be set to FINESTEERING and the receiver time will be continuously updated (steered) to minimize the receiver range bias.

If for some reason position is lost and the range bias cannot be calculated, the time status will be degraded to FREEWHEELING.

## 1.5 Message Time Stamps

All NovAtel format messages generated by the OEMV family receivers have a GPS time stamp in their header. GPS time is referenced to UTC with zero point defined as midnight on the night of January 5 1980. The time stamp consists of the number of weeks since that zero point and the number of seconds since the last week number change (0 to 604,799). GPS time differs from UTC time since leap seconds are occasionally inserted into UTC but GPS time is continuous. In addition a small error (less than 1 microsecond) can exist in synchronization between UTC and GPS time. The TIME log reports both GPS and UTC time and the offset between the two.

The data in synchronous logs (for example, RANGE, BESTPOS, TIME) are based on a periodic measurement of satellite pseudoranges. The time stamp on these logs is the receiver estimate of GPS time at the time of the measurement. When setting time in external equipment, a small synchronous log with a high baud rate will be accurate to a fraction of a second. A synchronous log with trigger ONTIME 1 can be used in conjunction with the 1PPS signal to provide relative accuracy better than 250 ns.

Other log types (asynchronous and polled) are triggered by an external event and the time in the header may not be synchronized to the current GPS time. Logs that contain satellite broadcast data (for example, ALMANAC, GPSEPHM) have the transmit time of their last subframe in the header. In the header of differential time matched logs (for example, MATCHEDPOS) is the time of the matched reference and local observation that they are based on. Logs triggered by a mark event (for example, MARKEDPOS, MARKTIME) have the estimated GPS time of the mark event in their header. In the header of polled logs (for example, LOGLIST, PORTSTATS, VERSION) is the approximate GPS time when their data was generated. However, when asynchronous logs are triggered ONTIME, the time stamp will represent the time the log was generated, not the time given in the data.



## 1.6 Decoding of the GPS Week Number

The GPS week number provided in the raw satellite data is the 10 least significant bits (or 8 least significant bits in the case of the almanac data) of the full week number. When the receiver processes the satellite data, the week number is decoded in the context of the current era and, therefore, is computed as the full week number starting from week 0 or January 6, 1980. Therefore, in all log headers and decoded week number fields, the full week number is given. Only in raw data, such as the *data* field of the RAWALM log or the *subframe* field of the RAWEPHEM log, will the week number remain as the 10 (or 8) least significant bits.

## 1.7 32-Bit CRC

The ASCII and Binary OEMV family message formats all contain a 32-bit CRC for data verification. This allows the user to ensure that the data received (or transmitted) is valid with a high level of certainty. This CRC can be generated using the following C algorithm:

```
#define CRC32_POLYNOMIAL    0xEDB88320L
/* -----
Calculate a CRC value to be used by CRC calculation functions.
----- */
unsigned long CRC32Value(int i)
{
    int j;
    unsigned long ulCRC;
    ulCRC = i;
    for ( j = 8 ; j > 0; j-- )
    {
        if ( ulCRC & 1 )
            ulCRC = ( ulCRC >> 1 ) ^ CRC32_POLYNOMIAL;
        else
            ulCRC >>= 1;
    }
    return ulCRC;
}
/* -----
Calculates the CRC-32 of a block of data all at once
----- */
unsigned long CalculateBlockCRC32(
    unsigned long ulCount,      /* Number of bytes in the data block */
    unsigned char *ucBuffer ) /* Data block */
{
    unsigned long ulTemp1;
    unsigned long ulTemp2;
    unsigned long ulCRC = 0;
    while ( ulCount-- != 0 )
```

```

    {
        ulTemp1 = ( ulCRC >> 8 ) & 0x00FFFFFFL;
        ulTemp2 = CRC32Value( ((int) ulCRC ^ *ucBuffer++ ) & 0xff );
        ulCRC = ulTemp1 ^ ulTemp2;
    }
    return( ulCRC );
}

```

- 
- ☒ The NMEA checksum is an XOR of all the bytes (including delimiters such as ', ' but excluding the \* and \$) in the message output. It is therefore an 8-bit and not a 32-bit checksum.
- 

At the time of writing, a log may not yet be available. Every effort is made to ensure that examples are correct, however, a checksum may be created for promptness in publication. In this case it will appear as '9999'.

### Example:

BESTPOSA and BESTPOSB from an OEMV family receiver.

### ASCII:

```

#BESTPOSA,COM1,0,78.0,FINESTEERING,1427,325298.000,00000000,6145,2748;
SOL_COMPUTED,SINGLE,51.11678928753,-114.03886216575,1064.3470,-16.2708,
WGS84,2.3434,1.3043,4.7300,"",0.000,0.000,7,7,0,0,0,06,0,03*9c9a92bb

```

### BINARY:

```

0xaa,0x44,0x12,0x1c 2a,0x00,0x02,0x20,0x48,0x00,0x00,0x00,0x90,0xb4,0x93,
0x05,0xb0,0xab,0xb9,0x12,0x00,0x00,0x00,0x00,0x45,0x61,0xbc,0x0a,0x00,
0x00,0x00,0x00,0x10,0x00,0x00,0x00,0x1b,0x04,0x50,0xb3,0xf2,0x8e,0x49,
0x40,0x16,0xfa,0x6b,0xbe,0x7c,0x82,0x5c,0xc0,0x00,0x60,0x76,0x9f,0x44,0x9f,
0x90,0x40,0xa6,0x2a,0x82,0xc1,0x3d,0x00,0x00,0x00,0x12,0x5a,0xcb,0x3f,0xcd,
0x9e,0x98,0x3f,0xdb,0x66,0x40,0x40,0x00,0x30,0x30,0x30,0x00,0x00,0x00,
0x00,0x00,0x00,0x00,0x0b,0x0b,0x00,0x00,0x00,0x00,0x06,0x00,0x03,
0x42,0xdc,0x4c,0x48

```

Below is a demonstration of how to generate the CRC from both ASCII and BINARY messages using the function described above.

- 
- ☒ When you pass the data into the code that follows, exclude the checksum shown in *bold italics* above.
-

**ASCII:**

```

#include <iostream.h>
#include <string.h>
void main()
{
char *i = "BESTPOSA,COM2,0,77.5,FINESTEERING,1285,160578.000,00000020,5941,11
64;
SOL_COMPUTED,SINGLE,51.11640941570,-114.03830951024,1062.6963,-16.2712,
WGS84,1.6890,1.2564,2.7826,\"\",0.000,0.000,10,10,0,0,0,0,0";
unsigned long iLen = strlen(i);
unsigned long CRC = CalculateBlockCRC32(iLen, (unsigned char*)i);
cout << hex << CRC <<endl;
}

```

**BINARY:**

```

#include <iostream.h>
#include <string.h>
int main()
{
unsigned char buffer[] = {0xAA, 0x44, 0x12, 0x1C 2A, 0x00, 0x02, 0x20, 0x48,
0x00, 0x00, 0x00, 0x90, 0xB4, 0x93, 0x05, 0xB0, 0xAB, 0xB9, 0x12, 0x00, 0x00,
0x00, 0x00, 0x45, 0x61, 0xBC, 0x0A, 0x00, 0x00, 0x00, 0x00, 0x10, 0x00, 0x00,
0x00, 0x1B, 0x04, 0x50, 0xB3, 0xF2, 0x8E, 0x49, 0x40, 0x16, 0xFA, 0x6B, 0xBE,
0x7C, 0x82, 0x5C, 0xC0, 0x00, 0x60, 0x76, 0x9F, 0x44, 0x9F, 0x90, 0x40, 0xA6,
0x2A, 0x82, 0xC1, 0x3D, 0x00, 0x00, 0x00, 0x12, 0x5A, 0xCB, 0x3F, 0xCD, 0x9E,
0x98, 0x3F, 0xDB, 0x66, 0x40, 0x40, 0x00, 0x30, 0x30, 0x30, 0x00, 0x00, 0x00,
0x00, 0x00, 0x00, 0x00, 0x00, 0x0B, 0x0B, 0x00, 0x00, 0x00, 0x06, 0x00, 0x03};
unsigned long crc = CalculateBlockCRC32(60, buffer);
cout << hex << crc <<endl;
//Please note that this hex needs to be reversed due to Big Endian order where
the most significant value in the sequence is stored first (at the lowest
storage address). For example, the two bytes required for the hex number 4F52
is stored as 524F.
}

```

## 2.1 Command Formats

The receiver accepts commands in 3 formats as described in *Chapter 1*:

- Abbreviated ASCII
- ASCII
- Binary

Abbreviated ASCII is the easiest to use for your input. The other two formats include a CRC for error checking and are intended for use when interfacing with other electronic equipment.

Here are examples of the same command in each format:

### Abbreviated ASCII Example:

```
LOG COM1 BESTPOSB ONTIME 1 [CR]
```

### ASCII Example:

```
LOGA,COM2,0,66.0,UNKNOWN,0,15.917,004c0000,5255,32858;COM1,
BESTPOSB,ONTIME,1.000000,0.000000,NOHOLD*F95592DD [CR]
```

### Binary Example:

```
AA44121C 01000240 20000000 1D1D0000 29160000 00004C00 55525A80
20000000 2A000000 02000000 00000000 0000F03F 00000000 00000000
00000000 2304B3F1
```

## 2.2 Command Settings

There are several ways to determine the current command settings of the receiver:

1. Request an RXCONFIG log, see *page 539*. This log provides a listing of all commands and their parameter settings. It also provides the most complete information, but the size and format do not make it easy to read.
2. For some specific commands, logs are available to indicate all their parameter settings. The LOGLIST log, see *page 350*, shows all active logs in the receiver beginning with the LOG command. The COMCONFIG log, see *page 287*, shows both the COM and INTERFACEMODE commands parameter settings for all serial ports.
3. Request a log of the specific command of interest to show the parameters last entered for that command. The format of the log produced is exactly the same as the format of the specific command with updated header information.

- ☒ This is very useful for most commands, but for commands that are repeated with different parameters (for example, COM, LOG, and INTERFACEMODE), this only shows the most recent set of parameters used. To see all sets of parameters try method 1 or 2 above.

**Abbreviated ASCII Example:**

```
log fix
<FIX COM1 0 45.0 FINE 1114 151898.288 00200000 dbfd 33123
<      NONE -10000.000000000000 -10000.000000000000 -10000.0000
```

## 2.3 Commands by Function

Table 9 lists the commands by function while Table 10 on page 41 is an alphabetical listing of commands (repeated in Table 11 on page 47 with the commands in the order of their message IDs). Please see 2.5, *Command Reference* on page 56 for a more detailed description of individual commands which are listed alphabetically.

**Table 9: Communications, Control and Status Functions**

| COMMANDS                           |  | DESCRIPTIONS  |  |
|------------------------------------|--|---|--|
| COMMUNICATIONS, CONTROL AND STATUS |  |   |  |
| ANTENNAPOWER                       |  | Control power to low-noise amplifier (LNA) of an active antenna |  |
| COM                                |  | Set COM port configuration                                      |  |
| COMCONTROL                         |  | Control the hardware control lines of the RS232 ports           |  |
| FREQUENCYOUT                       |  | Set the output pulse train available on VARF                    |  |
| INTERFACEMODE                      |  | Set interface type, Receive (Rx)/Transmit (Tx), for a port      |  |
| LOG                                |  | Request a log   |  |
| MARKCONTROL                        |  | Control processing of the mark inputs                           |  |
| PPSCONTROL                         |  | Control the PPS output  |  |
| SEND                               |  | Send ASCII message to a port                                    |  |
| SENDBOX                            |  | Send non-printable characters to a port                         |  |
| TUNNELESCAPE                       |  | Break out of an established tunnel                              |  |
| UNLOG, UNLOGALL                    |  | Remove one or all logs from logging control                     |  |

*Continued on the following page.*

| GENERAL RECEIVER CONTROL |   |
|--------------------------|---|
| AUTH                     | Add authorization code for new model                      |
| DYNAMICS                 | Tune receiver parameters                                  |
| RESET                    | Perform a hardware reset                                  |
| FRESET                   | Reset receiver to factory default                         |
| MODEL                    | Switch receiver to a previously AUTHed model              |
| NVMRESTORE               | Restore NVM data after a failure in NVM                   |
| SAVECONFIG               | Save current configuration                                |
| STATUSCONFIG             | Configure various status mask fields in RXSTATUSEVENT log |

| POSITION, PARAMETERS, AND SOLUTION FILTERING CONTROL |   |
|--|---|
| CSMOOTH  | Set amount of carrier smoothing                                   |
| DATUM  | Choose a DATUM name type  |
| DIFFCODEBIASCONTROL                                  | Enable or disable satellite differential code biases              |
| ECUTOFF  | Set satellite elevation cut-off for solutions                     |
| FIX  | Constrain receiver height or position                             |
| FIXPOSDATUM  | Set the position in a specified datum                             |
| GGAQUALITY   | Customize the GPGGA GPS quality indicator                         |
| HDTOUTTHRESHOLD                                      | Control the NMEA GPHDT log output                                 |
| HPSEED   | Specify the initial position for OmniSTAR HP/XP                   |
| HPSTATICINIT   | Set static initialization of OmniSTAR HP/XP                       |
| LOCALIZEDCORRECTION-DATUM                            | Set a local datum   |
| NMEATALKER   | Set the NMEA talker ID  |
| PDPFILTER  | Enable, disable or reset the Pseudorange/Delta-Phase (PDP) filter |
| PDPMODE  | Select the PDP mode and dynamics                                  |
| RTKCOMMAND   | Reset the RTK filter or set the filter to default settings        |
| RTKDYNAMICS  | Setup the RTK dynamics mode                                       |
| SBASCONTROL  | Set SBAS test mode and PRN  |

*Continued on the following page.*

| POSITION, PARAMETERS, AND SOLUTION FILTERING CONTROL |  |
|--|--|
| SETDIFFCODEBIASES                                    | Set satellite differential code biases |
| SETIONOTYPE  | Set the ionospheric corrections model  |
| UNDULATION   | Set ellipsoid-geoid separation         |
| USERDATUM  | Set user-customized datum              |
| USEREXPDATUM   | Set custom expanded datum              |
| UTMZONE  | Set UTM parameters                     |

| SATELLITE TRACKING AND CHANNEL CONTROL |   |
|--|---|
| ASSIGN                                 | Assign individual satellite channel                               |
| ASSIGNALL                              | Assign all satellite channels                                     |
| CNOUPDATE                              | C/No update rate and resolution                                   |
| DYNAMICS                               | Tune receiver parameters  |
| ECUTOFF                                | Set satellite tracking elevation cut-off                          |
| FORCEGPSL2CODE                         | Force the receiver to track L2C or P-code                         |
| GLOCSMOOTH                             | Carrier smoothing for GLONASS channels                            |
| GLOECUTOFF                             | Set the GLONASS satellite elevation cut-off angle                 |
| LOCKOUT                                | Prevent the receiver from using a satellite by specifying its PRN |
| SETAPPROXPOS                           | Set an approximate position                                       |
| SETAPPROXTIME                          | Set an approximate GPS time                                       |
| UNASSIGN                               | Unassign a previously ASSIGNED channel                            |
| UNASSIGNALL                            | Unassign all previously ASSIGNED channels                         |
| UNLOCKOUT                              | Reinstate a satellite in the solution                             |
| UNLOCKOUTALL                           | Reinstate all previously locked out satellites                    |
| WAASECUTOFF                            | Set SBAS satellite elevation cut-off                              |

*Continued on the following page.*

| WAYPOINT NAVIGATION |                                   |
|---------------------|-----------------------------------|
| MAGVAR              | Set magnetic variation correction |
| SETNAV              | Set waypoints                     |

| DIFFERENTIAL BASE STATION |   |
|---------------------------|---|
| BASEANTENNAMODEL          | Enter or change a base antenna model                          |
| DGPSEPHEMDELAY            | DGPS ephemeris delay  |
| DGPSTXID                  | DGPS transmit ID  |
| FIX                       | Constrain receiver height or position                         |
| INTERFACEMODE             | Set interface type Transmit (Tx), for a port                  |
| LOG                       | Select required differential-output log                       |
| MOVINGBASESTATION         | Set ability to use a moving base station position             |
| POSAVE                    | Set up position averaging                                     |
| FIXPOSDATUM               | Fix position in a datum                                       |
| RTKANTENNA                | Specify L1 phase center (PC) or antenna reference point (ARP) |
| RTKNETWORK                | Specify the RTK network mode                                  |
| RTKSVENTRIES              | Set the number of satellites to include in RTK corrections    |
| SETRTCM16                 | Enter ASCII message to be sent in RTCM data stream            |
| SETRTCM36                 | Enter ASCII message including Russian characters              |

| DIFFERENTIAL ROVER STATION |  |
|----------------------------|--|
| ANTENNAMODEL               | Enter or change a rover antenna model            |
| ASSIGNLBAND                | Set L-band satellite communication parameters    |
| DGPSEPHEMDELAY             | DGPS ephemeris delay                             |
| CDGPSTIMEOUT               | Set maximum age of CDGPS data accepted           |
| DGPSTIMEOUT                | Set maximum age of differential data accepted    |
| HPSEED                     | Specify the initial position for OmniSTAR HP/XP  |
| HPSTATICINIT               | Set static initialization of OmniSTAR HP/XP      |
| INTERFACEMODE              | Set interface type, Receive (Rx), for a COM port |

*Continued on the following page.*



| DIFFERENTIAL ROVER STATION |  |
|----------------------------|--|
| POSTIMEOUT                 | Set the position time out value for RTK  |
| PSRDIFFSOURCE              | Set the pseudorange correction source    |
| PSRVELOCITYTYPE            | Specific the Doppler source              |
| RTKDYNAMICS                | Set the RTK dynamics mode                |
| RTKCOMMAND                 | Issue RTK specific commands              |
| RTKQUALITYLEVEL            | Choose an RTK quality mode               |
| RTKSOURCE                  | Set the RTK correction source            |
| RTKTIMEOUT                 | Set the maximum age of RTK data accepted |
| SBASCONTROL                | Set SBAS test mode and PRN               |
| SETAPPROXPOS               | Set an approximate position              |
| SETAPPROXTIME              | Set an approximate GPS time              |
| WAASTIMEOUT                | Set maximum age of WAAS data accepted    |

| CLOCK INFORMATION, STATUS, AND TIME |  |
|-------------------------------------|--|
| ADJUST1PPS                          | Adjust the receiver clock                                    |
| CLOCKADJUST                         | Enable/disable adjustments to internal clock and 1PPS output |
| CLOCKCALIBRATE                      | Adjust the control parameters of the clock steering loop     |
| CLOCKOFFSET                         | Adjust for antenna RF cable delay in PPS output              |
| EXTERNALCLOCK                       | Set the parameters for an external clock                     |
| SETAPPROXTIME                       | Set an approximate time                                      |

**Table 10: OEMV Family Commands in Alphabetical Order**

| Command      | Message ID | Description   | Syntax  |
|--------------|------------|---|---|
| ADJUST1PPS   | 429        | Adjust the receiver clock                                 | adjust1pps mode [period] [offset]   |
| ANTENNAMODEL | 841        | Enter or change a rover antenna model                     | antennamodel name SN setupID type [L1 offset] [L1 var] [L2 offset] [L2 var] |
| ANTENNAPOWER | 98         | Control power to low-noise amplifier of an active antenna | antennapower flag   |

*Continued on the following page.*

| Command           | Message ID | Description  | Syntax  |
|-------------------|------------|--|---|
| ASSIGN            | 27         | Assign individual satellite channel to a PRN             | assign channel [state] prn [Doppler [Doppler window]]                           |
| ASSIGNALL         | 28         | Assign all satellite channels to a PRN                   | assignall [system] [state] prn [Doppler [Doppler window]]                       |
| ASSIGNLBAND       | 729        | Set L-band satellite communication parameters            | assignlband mode freq baud  |
| AUTH              | 49         | Add authorization code for new model                     | auth [state] part1 part2 part3 part4 part5 model [date]                         |
| BASEANTENNA-MODEL | 870        | Enter or change a base antenna model                     | baseantennamodel name SN setupID type [L1 offset] [L1 var] [L2 offset] [L2 var] |
| CDGPSTIMEOUT      | 850        | Set maximum age of CDGPS data accepted                   | cdgpstimeout mode [delay]   |
| CLOCKADJUST       | 15         | Enable clock adjustments                                 | clockadjust switch  |
| CLOCKCALIBRATE    | 430        | Adjust the control parameters of the clock steering loop | clockcalibrate mode [period] [width] [slope] [bandwidth]                        |
| CLOCKOFFSET       | 596        | Adjust for antenna RF cable delay in PPS output          | clockoffset offset  |
| CNOUPDATE         | 849        | C/No update rate and resolution                          | cnoupdate rate  |
| COM               | 4          | COM port configuration control                           | com [port] bps [parity [databits [stopbits [handshake [echo [break]]]]]]        |
| COMCONTROL        | 431        | Control the hardware control lines of the RS232 ports    | comcontrol port signal control  |
| CSMOOTH           | 269        | Set carrier smoothing                                    | csmooth L1time [L2time]   |
| DATUM             | 160        | Choose a DATUM name type                                 | datum datum   |

*Continued on the following page.*

| Command              | Message ID | Description   | Syntax  |
|----------------------|------------|---|---|
| DGPSEPHMDELAY        | 142        | DGPS ephemeris delay  | dgpsephemdelay delay  |
| DGPSTIMEOUT          | 127        | Set maximum age of differential data accepted   | dgpstimeout delay   |
| DGPSTXID             | 144        | DGPS transmit ID  | dgpstxid type ID  |
| DIFFCODEBIAS-CONTROL | 913        | Enable or disable satellite differential code biases  | diffcodebiascontrol switch                                    |
| DYNAMICS             | 258        | Tune receiver parameters  | dynamics dynamics   |
| ECUTOFF              | 50         | Set satellite elevation cut-off   | ecutoff angle   |
| EXTERNALCLOCK        | 230        | Set external clock parameters   | externalclock clocktype [freq] [h0 [h1 [h2]]]                 |
| FIX                  | 44         | Constrain to fixed height or position   | fix type [param1 [param2 [param3]]]                           |
| FIXPOSDATUM          | 761        | Set the position in a specified datum   | position datum [[lat [lon [height]]]                          |
| FORCEGPSL2CODE       | 796        | Force the receiver to track L2C or P-code   | forcegpsl2code L2type   |
| FREQUENCYOUT         | 232        | Sets the output pulse train available on VARF.  | frequencyout [switch] [pulsewidth] [period]                   |
| FRESET               | 20         | Clear almanac model, or user configuration data, which is stored in NVM and followed by a receiver reset. | freset [target]   |
| GGAQUALITY           | 691        | Customize the GPGGA GPS quality indicator   | ggaquality #entries [pos type1][qual1] [pos type2] [qual2]... |
| GLOCSMOOTH           | 830        | Carrier smoothing for GLONASS channels  | glocsmooth L1time [L2time]                                    |
| GLOECUTOFF           | 735        | Set the GLONASS satellite elevation cut-off angle   | gloecutoff angle  |

Continued on the following page.

| Command                    | Message ID | Description   | Syntax  |
|----------------------------|------------|---|---|
| HDTOUTTHRESHOLD            | 1062       | Control the NMEA GPHDT log output                                 | hdtoutthreshold thres                                       |
| HPSEED                     | 782        | Specify the initial position for OmniSTAR HP/XP                   | hpseed mode lat lon hgt lats lons hgts datum undulation     |
| HPSTATICINIT               | 780        | Set static initialization of OmniSTAR HP/XP                       | hpstaticinit switch   |
| INTERFACEMODE              | 3          | Set interface type, Receive (Rx)/Transmit (Tx), for ports         | interfacemode [port] rxtype txtype [responses]              |
| LOCALIZED-CORRECTION-DATUM | 947        | Set a local datum   | localizedcorrectiondatum type                               |
| LOCKOUT                    | 137        | Prevent the receiver from using a satellite by specifying its PRN | lockout prn   |
| LOG                        | 1          | Request logs from receiver  | log [port] message [trigger [period [offset [hold]]]]       |
| MAGVAR                     | 180        | Set magnetic variation correction                                 | magvar type [correction [stddev]]                           |
| MARKCONTROL                | 614        | Control the processing of the mark inputs                         | markcontrol signal switch [polarity] [timebias [timeguard]] |
| MODEL                      | 22         | Switch to a previously AUTHed model                               | model model   |
| MOVINGBASE-STATION         | 763        | Set ability to use a moving base station position                 | movingbasestation switch                                    |
| NMEATALKER                 | 861        | Set the NMEA talker ID  | nmeatalker ID   |
| NVMRESTORE                 | 197        | Restore NVM data after a failure in NVM                           | nvmrestore  |
| PDPFILTER                  | 424        | Enable, disable or reset the PDP filter                           | pdpfilter switch  |
| PDPMODE                    | 970        | Select the PDP mode and dynamics                                  | pdpmode mode dynamics                                       |

*Continued on the following page.*

| Command         | Message ID | Description   | Syntax                                     |
|-----------------|------------|---|--|
| POSAVE          | 173        | Implement position averaging for base station                 | posave [state] maxtime [maxhstd [maxvstd]] |
| POSTIMEOUT      | 612        | Sets the position time out value for RTK                      | postimeout sec                             |
| PPSCONTROL      | 613        | Control the PPS output  | ppscontrol switch [polarity] [rate]        |
| PSRDIFFSOURCE   | 493        | Set the pseudorange correction source                         | psrdiffsource type ID                      |
| PSRVELOCITYTYPE | 950        | Specify the Doppler source                                    | psrvelocitytype [source]                   |
| RESET           | 18         | Perform a hardware reset                                      | reset [delay]                              |
| RTKANTENNA      | 858        | Specify L1 phase center (PC) or antenna reference point (ARP) | rtkantenna posref [pc]                     |
| RTKCOMMAND      | 97         | Reset the RTK filter or set the filter to default settings    | rtkcommand action                          |
| RTKDYNAMICS     | 183        | Set the RTK dynamics mode                                     | rtkdynamics mode                           |
| RTKNETWORK      | 951        | Specify the RTK network mode                                  | rtknetwork mode [network#]                 |
| RTKQUALITYLEVEL | 844        | Choose an RTK quality level                                   | rtkqualitylevel mode                       |
| RTKSOURCE       | 494        | Set the RTK correction source                                 | rtksource type ID                          |
| RTKSVENTRIES    | 92         | Set the number of satellites to use in corrections            | rtksventries number                        |
| RTKTIMEOUT      | 910        | Set the maximum age of RTK data accepted                      | rtktimeout delay                           |
| SAVECONFIG      | 19         | Save current configuration in non-volatile memory             | saveconfig                                 |

*Continued on the following page.*

| Command             | Message ID | Description  | Syntax  |
|---------------------|------------|--|---|
| SBASCONTROL         | 652        | Set SBAS test mode and PRN   | sbascontrol keyword [system] [prn] [testmode]                       |
| SEND                | 177        | Send an ASCII message to any of the communications ports           | send port data  |
| SENDHEX             | 178        | Send non-printable characters in hexadecimal pairs                 | sendhex port length data  |
| SETAPPROXPOS        | 377        | Set an approximate position  | setapproxpos lat lon height   |
| SETAPPROXTIME       | 102        | Set an approximate GPS time  | setapproxtime week sec  |
| SETBESTPOS-CRITERIA | 839        | Set criteria for the BESTPOS log                                   | setbestposcriteria type delay                                       |
| SETDIFFCODE-BIASES  | 687        | Set satellite differential code biases                             | setdiffcodebiases [bias_type] [array of 40 biases (ns)]             |
| SETIONOTYPE         | 711        | Set the ionospheric corrections model                              | setionotype model   |
| SETNAV              | 162        | Set start and destination waypoints                                | setnav fromlat fromlon tolat tolon track offset from-point to-point |
| SETRTCM16           | 131        | Enter an ASCII text message to be sent out in the RTCM data stream | setrtcm16 text  |
| SETRTCM36           | 880        | Enter ASCII message including Russian characters                   | setrtcm36 extdtext  |
| STATUSCONFIG        | 95         | Configure various status mask fields in RXSTATUSEVENT log          | statusconfig type word mask   |
| TUNNELESCAPE        | 962        | Break out of an established tunnel                                 | tunnelescape [switch] [length] [esc seq]                            |
| UNASSIGN            | 29         | Unassign a previously ASSIGNED channel                             | unassign channel  |

*Continued on the following page.*

| Command      | Message ID | Description                                       | Syntax  |
|--------------|------------|---|---|
| UNASSIGNALL  | 30         | Unassign all previously ASSIGNED channels         | unassignall [system]  |
| UNDULATION   | 214        | Choose undulation                                 | undulation option [separation]  |
| UNLOCKOUT    | 138        | Reinstate a satellite in the solution computation | unlockout prn   |
| UNLOCKOUTALL | 139        | Reinstate all previously locked out satellites    | unlockoutall  |
| UNLOG        | 36         | Remove log from logging control                   | unlog [port] datatype   |
| UNLOGALL     | 38         | Remove all logs from logging control              | unlogall [port]   |
| USERDATUM    | 78         | Set user-customized datum                         | userdatum semimajor flattening dx dy dz rx ry rz scale  |
| USEREXPDATUM | 783        | Set custom expanded datum                         | userexpdatum semimajor flattening dx dy dz rx ry rz scale xvel yvel zvel xrvel yrvel zrvel scalev refdate |
| UTMZONE      | 749        | Set UTM parameters                                | utmzone command parameter   |
| WAASECUTOFF  | 505        | Set SBAS satellite elevation cut-off              | waasecutoff angle   |
| WAASTIMEOUT  | 851        | Set maximum age of WAAS data accepted             | waastimeout mode [delay]  |

**Table 11: OEMV Commands in Numerical Order**

| Message ID | Command       | Description   | Syntax  |
|------------|---------------|---|---|
| 1          | LOG           | Request logs from receiver                                | log [port] message [trigger [period [offset [hold]]]] |
| 3          | INTERFACEMODE | Set interface type, Receive (Rx)/Transmit (Tx), for ports | interfacemode [port] rxtype txtype [responses]        |

*Continued on the following page.*

| Message ID | Command     | Description   | Syntax   |
|------------|-------------|---|--|
| 4          | COM         | COM port configuration control  | com [port] bps [parity [databits [stopbits [handshake [echo [break]]]]]] |
| 15         | CLOCKADJUST | Enable clock adjustments  | clockadjust switch   |
| 18         | RESET       | Perform a hardware reset  | reset [delay]  |
| 19         | SAVECONFIG  | Save current configuration in non-volatile memory   | saveconfig   |
| 20         | FRESET      | Clear almanac model, or user configuration data, which is stored in NVM and followed by a receiver reset. | freset [target]  |
| 22         | MODEL       | Switch to a previously AUTHed model   | model model  |
| 27         | ASSIGN      | Assign individual satellite channel to a PRN  | assign channel [state] prn [Doppler [Doppler window]]                    |
| 28         | ASSIGNALL   | Assign all satellite channels to a PRN  | assignall [system] [state] prn [Doppler [Doppler window]]                |
| 29         | UNASSIGN    | Unassign a previously ASSIGNED channel  | unassign channel   |
| 30         | UNASSIGNALL | Unassign all previously ASSIGNED channels   | unassignall [system]   |
| 36         | UNLOG       | Remove log from logging control   | unlog [port] datatype  |
| 38         | UNLOGALL    | Remove all logs from logging control  | unlogall [port]  |
| 44         | FIX         | Constrain to fixed height or position   | fix type [param1 [param2 [param3]]]                                      |
| 49         | AUTH        | Add authorization code for new model  | auth [state] part1 part2 part3 part4 part5 model [date]                  |
| 50         | ECUTOFF     | Set satellite elevation cut-off   | ecutoff angle  |

*Continued on the following page.*



| Message ID | Command         | Description  | Syntax   |
|------------|-----------------|--|--|
| 78         | USERDATUM       | Set user-customized datum  | userdatum semimajor flattening dx dy dz rx ry rz scale |
| 92         | RTKSVENTRIES    | Set the number of satellites to use in corrections                 | rtksventries number                                    |
| 95         | STATUSCONFIG    | Configure various status mask fields in RXSTATUSEVENT log          | statusconfig type word mask                            |
| 97         | RTKCOMMAND      | Reset the RTK filter or set the filter to default settings         | rtkcommand action                                      |
| 98         | ANTENNAPOWER    | Control power to low-noise amplifier of an active antenna          | antennapower flag                                      |
| 102        | SETAPPROXTIME   | Set an approximate GPS time  | setapproxtime week sec                                 |
| 127        | DGPSTIMEOUT     | Set maximum age of differential data accepted                      | dgpstimeout delay                                      |
| 131        | SETRTCM16       | Enter an ASCII text message to be sent out in the RTCM data stream | SETRTCM16 text   |
| 137        | LOCKOUT         | Prevent the receiver from using a satellite by specifying its PRN  | lockout prn  |
| 138        | UNLOCKOUT       | Reinstate a satellite in the solution computation                  | unlockout prn  |
| 139        | UNLOCKOUTALL    | Reinstate all previously locked out satellites                     | unlockoutall   |
| 142        | DGPSEPHEM-DELAY | DGPS ephemeris delay   | dgpsephemdelay delay                                   |
| 144        | DGPSTXID        | DGPS transmit ID   | dgpstxid type ID                                       |
| 160        | DATUM           | Choose a DATUM name type   | datum datum  |

*Continued on the following page.*

| Message ID | Command        | Description  | Syntax  |
|------------|----------------|--|---|
| 162        | SETNAV         | Set start and destination waypoints                      | setnav fromlat fromlon tolat tolon track offset from-point to-point |
| 173        | POSAVE         | Implement position averaging for base station            | posave[state] maxtime [maxhstd [maxvstd]]                           |
| 177        | SEND           | Send an ASCII message to any of the communications ports | send port data  |
| 178        | SENDHEX        | Send non-printable characters in hexadecimal pairs       | sendhex port length data  |
| 180        | MAGVAR         | Set magnetic variation correction                        | magvar type [correction [stddev]]                                   |
| 183        | RTKDYNAMICS    | Set the RTK dynamics mode                                | rtkdynamics mode  |
| 197        | NVMRESTORE     | Restore NVM data after a failure in NVM                  | nvmrestore  |
| 214        | UNDULATION     | Choose undulation  | undulation option [separation]                                      |
| 230        | EXTERNALCLOCK  | Set external clock parameters                            | externalclock clocktype [freq] [h0 [h1 [h2]]]                       |
| 232        | FREQUENCYOUT   | Sets the output pulse train available on VARF.           | frequencyout [switch] [pulsewidth] [period]                         |
| 258        | DYNAMICS       | Tune receiver parameters                                 | dynamics dynamics   |
| 269        | CSMOOTH        | Set carrier smoothing                                    | csmooth L1time [L2time]   |
| 377        | SETAPPROXPOS   | Set an approximate position                              | setapproxpos lat lon height   |
| 424        | PDPFILTER      | Enable, disable or reset the PDP filter                  | pdpfilter switch  |
| 429        | ADJUST1PPS     | Adjust the receiver clock                                | adjust1pps mode [period] [offset]                                   |
| 430        | CLOCKCALIBRATE | Adjust the control parameters of the clock steering loop | clockcalibrate mode [period] [width] [slope] [bandwidth]            |

*Continued on the following page.*

| Message ID | Command            | Description   | Syntax  |
|------------|--------------------|---|---|
| 431        | COMCONTROL         | Control the hardware control lines of the RS232 ports | comcontrol port signal control                              |
| 493        | PSRDIFFSOURCE      | Set the pseudorange correction source                 | psrdiffsource type ID                                       |
| 494        | RTKSOURCE          | Set the RTK correction source                         | rtksource type ID   |
| 505        | WAASECUTOFF        | Set SBAS satellite elevation cut-off                  | waasecutoff angle   |
| 596        | CLOCKOFFSET        | Adjust for antenna RF cable delay                     | clockoffset offset  |
| 612        | POSTIMEOUT         | Sets the position time out                            | postimeout sec  |
| 613        | PPSCONTROL         | Control the PPS output                                | ppscontrol switch [polarity] [rate]                         |
| 614        | MARKCONTROL        | Control the processing of the mark inputs             | markcontrol signal switch [polarity] [timebias [timeguard]] |
| 652        | SBASCONTROL        | Set SBAS test mode and PRN                            | sbascontrol keyword [system] [prn] [testmode]               |
| 687        | SETDIFFCODE-BIASES | Set satellite differential code biases                | setdiffcodebiases [bias_type] [array of 40 biases (ns)]     |
| 691        | GGAQUALITY         | Customize the GPGGA GPS quality indicator             | #entries [pos type1][qual1] [pos type2] [qual2]...          |
| 711        | SETIONOTYPE        | Set the ionospheric corrections model                 | setionotype model   |
| 729        | ASSIGNLBAND        | Set L-band satellite communication parameters         | assignlband mode freq baud                                  |
| 735        | GLOECUTOFF         | Set the GLONASS satellite elevation cut-off           | gloecutoff angle  |
| 749        | UTMZONE            | Set UTM parameters                                    | utmzone command parameter                                   |
| 761        | FIXPOSDATUM        | Set the position in a specified datum                 | position datum [lat [lon [height]]]                         |

*Continued on the following page.*

| Message ID | Command             | Description   | Syntax  |
|------------|---------------------|---|---|
| 763        | MOVINGBASE-STATION  | Set ability to use a moving base station position             | movingbasestation switch  |
| 780        | HPSTATICINIT        | Set static initialization of OmniSTAR HP/XP                   | hpstaticinit switch   |
| 782        | HPSEED              | Specify the initial position for OmniSTAR HP/XP               | hpseed mode lat lon hgt lats lons hgts datum undulation   |
| 783        | USEREXPDATUM        | Set custom expanded datum                                     | userexpdatum semimajor flattening dx dy dz rx ry rz scale xvel yvel zvel xrvel yrvel zrvel scalev refdate |
| 796        | FORCEGPSL2-CODE     | Force the receiver to track L2C or P-code                     | forcegpsl2code L2type   |
| 830        | GLOCSMOOTH          | Carrier smoothing for GLONASS channels                        | glocsmooth L1time [L2time]  |
| 839        | SETBESTPOS-CRITERIA | Set criteria for the BESTPOS log                              | setbestposcriteria type delay   |
| 841        | ANTENNAMODEL        | Enter or change a rover antenna model                         | antennamodel name SN setupID type [L1 offset] [L1 var] [L2 offset] [L2 var]                               |
| 844        | RTKQUALITYLEVEL     | Choose an RTK quality level                                   | rtkqualitylevel mode  |
| 849        | CNOUPDATE           | C/No update rate and resolution                               | cnoupdate rate  |
| 850        | CDGPSTIMEOUT        | Set maximum age of CDGPS data accepted                        | cdgpstimeout mode [delay]   |
| 851        | WAASTIMEOUT         | Set maximum age of WAAS data accepted                         | waastimeout mode [delay]  |
| 858        | RTKANTENNA          | Specify L1 phase center (PC) or antenna reference point (ARP) | rtkantenna posref [pc]  |
| 861        | NMEATALKER          | Set the NMEA talker ID  | nmeatalker ID   |
| 870        | BASEANTENNA-MODEL   | Enter or change a base antenna model                          | baseantennamodel name SN setupID type [L1 offset] [L1 var] [L2 offset] [L2 var]                           |

*Continued on the following page.*

| Message ID | Command                    | Description  | Syntax                                   |
|------------|----------------------------|--|--|
| 880        | SETRTCM36                  | Enter ASCII message including Russian chars          | setrtcm36 extdtext                       |
| 910        | RTKTIMEOUT                 | Set the maximum age of RTK data accepted             | rtktimeout delay                         |
| 913        | DIFFCODEBIAS-CONTROL       | Enable or disable satellite differential code biases | diffcodebiascontrol switch               |
| 947        | LOCALIZED-CORRECTION-DATUM | Set a local datum                                    | localizedcorrectiondatum type            |
| 950        | PSRVELOCITY-TYPE           | Specify the Doppler source                           | psrvelocitytype [source]                 |
| 951        | RTKNETWORK                 | Specify the RTK network mode                         | rtknetwork mode [network#]               |
| 962        | TUNNELESCAPE               | Break out of an established tunnel                   | tunnelescape [switch] [length] [esc seq] |
| 970        | PDPMODE                    | Select the PDP mode and dynamics                     | pdpmode mode dynamics                    |
| 1062       | HDTOUT-THRESHOLD           | Control the NMEA GPHDT log output                    | hdtoutthreshold thres                    |

When the receiver is first powered up, or after a FRESET command, all commands revert to their factory default settings. The SAVECONFIG command can be used to modify the power-on defaults. Use the RXCONFIG log to determine command and log settings.

Ensure that all windows, other than the Console window, are closed in NovAtel’s Control and Display Unit (CDU) user interface before you issue the SAVECONFIG command.

- 
- ☒ FRESET STANDARD causes all previously stored user configurations saved to non-volatile memory to be erased (including Saved Config, Saved Almanac, Saved Ephemeris, and L-band-related data, excluding subscription information).
-

## 2.4 Factory Defaults

When the receiver is first powered up, or after a FRESET command (see *page 121*), all commands revert to their factory default settings. When you use a command without specifying its optional parameters, it may have a different command default than the factory default. The SAVECONFIG command (see *page 181*) can be used to save these defaults. Use the RXCONFIG log (see *page 539*) to reference many command and log settings.

The factory defaults are:

```

ADJUST1PPS OFF
ANTENNAPOWER ON
ASSIGNLBAND IDLE
CLOCKADJUST ENABLE
CLOCKOFFSET 0
COM COM1 9600 N 8 1 N OFF ON
COM COM2 9600 N 8 1 N OFF ON
COM COM3 9600 N 8 1 N OFF ON
COM AUX 9600 N 8 1 N OFF ON
COMCONTROL COM1 RTS DEFAULT
COMCONTROL COM2 RTS DEFAULT
COMCONTROL COM3 RTS DEFAULT
CSMOOTH 100 100
DATUM WGS84
DGPSEPHEMDELAY 120
DGPSTIMEOUT 300
DGPSTXID AUTO "ANY"
DYNAMICS AIR
ECUTOFF 5.0
EXTERNALCLOCK DISABLE
FIX NONE
FIXPOSDATUM NONE
FORCEGPSL2CODE DEFAULT
FREQUENCYOUT DISABLE
GLOCSMOOTH 100 100
GLOECUTOFF 5.0
HDTOUTTHRESHOLD 2.0
HPSEED RESET
HPSTATICINIT DISABLE
INTERFACEMODE COM1 NOVATEL NOVATEL ON
INTERFACEMODE COM2 NOVATEL NOVATEL ON
INTERFACEMODE COM3 NOVATEL NOVATEL ON
INTERFACEMODE AUX NOVATEL NOVATEL ON
INTERFACEMODE USB1 NOVATEL NOVATEL ON
INTERFACEMODE USB2 NOVATEL NOVATEL ON

```

```

INTERFACEMODE USB3 NOVATEL NOVATEL ON
LOG COM1 RXSTATUSEVENTA ONNEW 0 0 HOLD
LOG COM2 RXSTATUSEVENTA ONNEW 0 0 HOLD
LOG COM3 RXSTATUSEVENTA ONNEW 0 0 HOLD
LOG AUX RXSTATUSEVENTA ONNEW 0 0 HOLD
LOG USB1 RXSTATUSEVENTA ONNEW 0 0 HOLD
LOG USB2 RXSTATUSEVENTA ONNEW 0 0 HOLD
LOG USB3 RXSTATUSEVENTA ONNEW 0 0 HOLD
MAGVAR CORRECTION 0 0
MARKCONTROL MARK1 ENABLE NEGATIVE 0 0
MARKCONTROL MARK2 ENABLE NEGATIVE 0 0
MOVINGBASESTATION DISABLE
NMEATAALKER gp
POSAVE OFF
POSTIMEOUT 600
PPSCONTROL ENABLE NEGATIVE 1.0 0
PSRDIFFSOURCE AUTO "ANY"
RTKCOMMAND USE_DEFAULTS
RTKANTENNA 11pc
RTKDYNAMICS DYNAMIC
RTKQUALITYLEVEL NORMAL
RTKSVENTRIES 24
RTKSOURCE AUTO "ANY"
RTKTIMEOUT 60
SBASCONTROL DISABLE AUTO 0 NONE
SETIONOTYPE AUTO
SETNAV 90.0 0.0 90.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
STATUSCONFIG PRIORITY STATUS 0
STATUSCONFIG PRIORITY AUX1 0x00000008
STATUSCONFIG PRIORITY AUX2 0
STATUSCONFIG SET STATUS 0x00000000
STATUSCONFIG SET AUX1 0
STATUSCONFIG SET AUX2 0
STATUSCONFIG CLEAR STATUS 0x00000000
STATUSCONFIG CLEAR AUX1 0
STATUSCONFIG CLEAR AUX2 0
UNDULATION EGM96
USERDATUM 6378137.0 298.2572235628 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
USEREXPDATUM 6378137.0 298.25722356280 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
UTMZONE AUTO 0
WAASECUTOFF -5.000000000

```

## 2.5 Command Reference

When you use a command without specifying its optional parameters, it may have a different command default than the factory default. See *Section 2.4* starting on *Page 54* for the factory default settings and the individual commands in the sections that follow for their command defaults.

### 2.5.1 **ADJUST1PPS** *Adjust the receiver clock VI23*

This command is used to adjust the receiver clock or as part of the procedure to transfer time between receivers. The number of pulses per second (PPS) is always set to 1 Hz with this command. It is typically used when the receiver is not adjusting its own clock and is using an external reference frequency.

To disable the automatic adjustment of the clock, refer to the **CLOCKADJUST** command on *Page 79*. To configure the receiver to use an external reference oscillator, see the **EXTERNALCLOCK** command on *Page 112*.

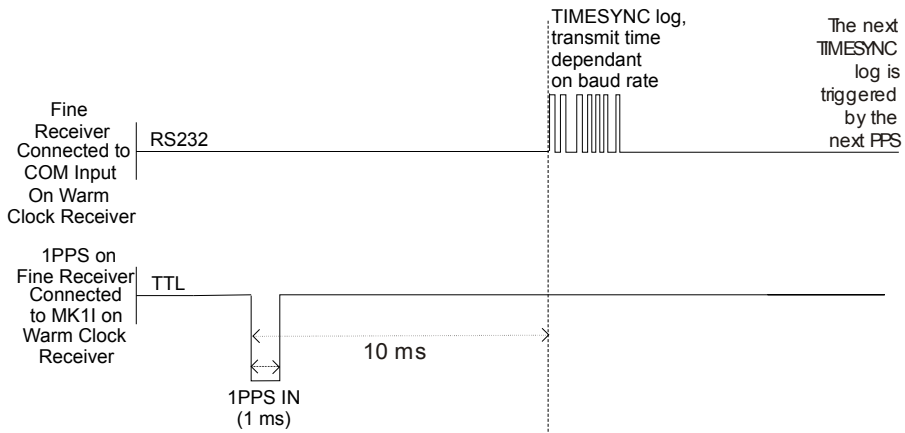
The **ADJUST1PPS** command can be used to:

1. Manually shift the phase of the clock
2. Adjust the phase of the clock so that the output 1PPS signal matches an external signal
3. Set the receiver clock close to that of another GPS receiver
4. Set the receiver clock exactly in phase of another GPS receiver

- 
- ☒ 1. The resolution of the clock synchronization is 50 ns.
  - 2. To adjust the 1PPS output when the receiver's internal clock is being used and the **CLOCKADJUST** command is enabled, use the **CLOCKOFFSET** command on *Page 85*.
  - 3. If the 1PPS rate is adjusted, the new rate does not start until the next second begins.
- 

*Figure 1* on *Page 57* shows the 1PPS alignment between a Fine and a Cold Clock receiver. See also the **TIMESYNC** log on *Page 559* and the *Transfer Time Between Receivers* section in the *OEMV Family Installation and Operation User Manual*.





**Figure 1: 1PPS Alignment**

The 1PPS is obtained from different receivers in different ways.

If you are using a:

- Bare Card            The 1PPS output strobe is on pin# 7 of the OEMV-2 or pin# 4 of the OEMV-1.
- ProPak-V3            A DB9F connector on the back of the enclosure provides external access to various I/O strobes to the internal card. This includes the 1PPS output signal, which is accessible on pin# 2 of the DB9F connector.

Alternatively, the 1PPS signal can be set up to be output on the RTS signal of COM1, COM2, or COM3, or the DTR signal of COM2 using the COMCONTROL command, see *page 90*. The accuracy of the 1PPS is less using this method, but may be more convenient in some circumstances.

---

☒ COM3 is not available on the OEMV-1 card.

---

To find out the time of the last 1PPS output signal use the TIMESYNCA/B output message, see *page 559*, which can be output serially on any available COM port, for example:

```
LOG COM1 TIMESYNCA ONTIME 1
```

**Abbreviated ASCII Syntax:**

**Message ID: 429**

ADJUST1PPS mode [period] [offset]

**Factory Default:**

adjust1pps off

**ASCII Example:**

adjust1pps mark continuous 240



You can use the ADJUST1PPS command to synchronize two OEMV cards in a primary/secondary relationship to a common external clock.

At the Primary Receiver:

```
log com2 timesynca ontime 1
clockadjust disable
externalclock ocxo (you can choose rubidium, cesium or user instead)
externalclock frequency 10 (you can choose 5 instead)
```

At the Secondary Receiver:

```
interfacemode com2 novatel novatel
clockadjust disable
adjust1pps mark (or markwithtime or time depending on your connection,
                 see Figure 2 on Page 59)
externalclock ocxo (you can choose rubidium, cesium or user instead)
externalclock frequency 10 (you can choose 5 instead)
```

Connections:

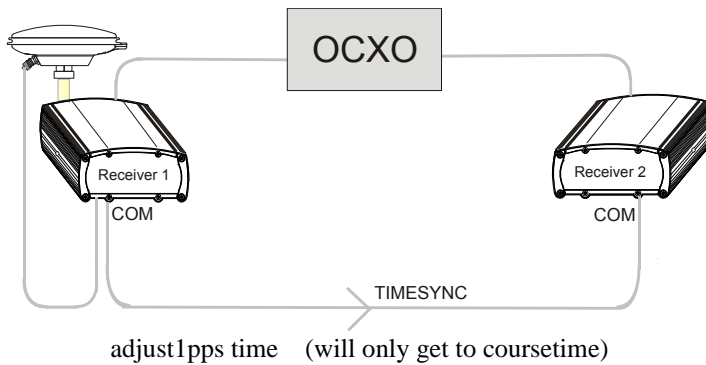
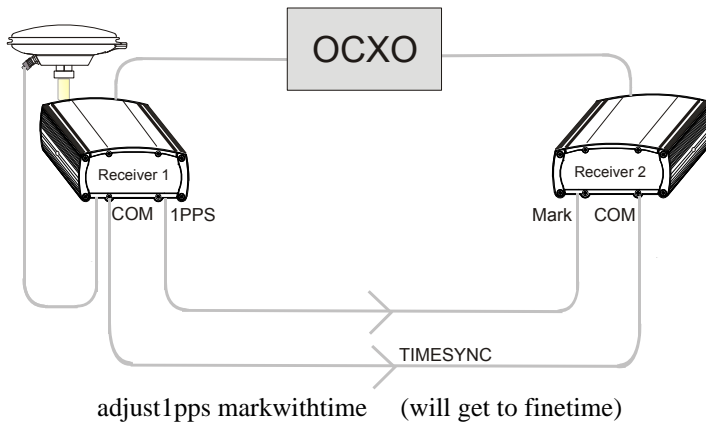
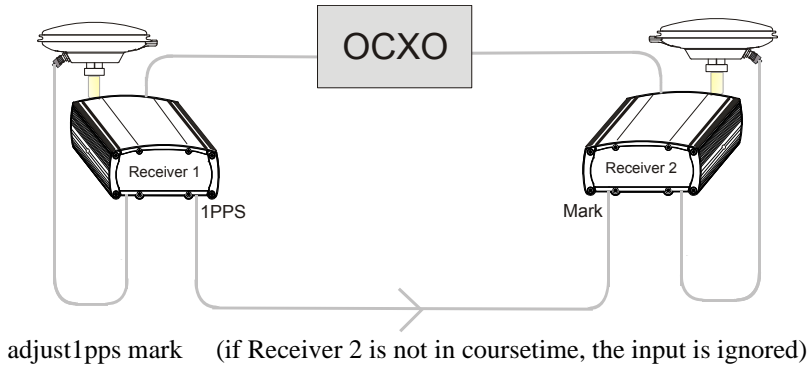
- Null modem cable connected from Primary COM2 to Secondary COM2
- OCXO signal sent through a splitter to feed both the Primary and Secondary external clock inputs
- Primary 1PPS (pin# 2) connected to Secondary MKI (Mark Input, pin# 4)

Make sure that you connect everything before you apply power. If power is applied and the OEMV receivers have acquired satellites before the OCXO and/or 1PPS = MKI is set up, the times reported by the TIMESYNC logs still diverge. We noted that after the clock model was stabilized at state 0, the time difference between the Primary and Secondary reported by the TIMESYNC log was less than 10 ns.

---

☒ In *Figure 2 on Page 59*, the examples are for the transfer of time. If you need position, you must be tracking satellites and your receiver must have a valid almanac.

---



**Figure 2: ADJUST1PPS Connections**

| Field | Field Type         | ASCII Value | Binary Value | Description                          | Binary Format | Binary Bytes | Binary Offset |
|-------|--------------------|-------------|--------------|--------------------------------------|---------------|--------------|---------------|
| 1     | ADJUST-1PPS header | -           | -            | This field contains the command name | -             | H            | 0             |

Continued on page 60.

| Field | Field Type | ASCII Value               | Binary Value | Description   | Binary Format | Binary Bytes | Binary Offset |
|-------|------------|---------------------------|--------------|---|---------------|--------------|---------------|
| 2     | mode       | OFF                       | 0            | Disables ADJUST1PPS (default).  | Enum          | 4            | H             |
|       |            | MANUAL                    | 1            | Immediately shifts the receivers time by the offset field in ns. The period field has no effect in this mode. This command does not affect the clock state  |               |              |               |
|       |            | MARK <sup>a</sup>         | 2            | Shifts the receiver time to align its 1PPS with the signal received in the MK11 port adjusted by the offset field in ns. The effective shift range is $\pm 0.5$ s.  |               |              |               |
|       |            | MARKWITHTIME <sup>b</sup> | 3            | Shifts the receiver time to align its 1PPS with the signal received in the MK11 port adjusted by the offset field in ns, and sets the receiver TOW and week number, to that embedded in a received TIMESYNC log, see <i>Page 559</i> . It also sets the receiver Time Status to that embedded in the TIMESYNC log, which must have arrived between 800 and 1000 ms prior to the MK11 event (presumably the 1PPS from the Primary), or it is rejected as an invalid message. |               |              |               |
|       |            | TIME                      | 4            | If the receiver clock is not at least COARSE adjusted, this command enables the receiver to COARSE adjust its time upon receiving a valid TIMESYNC log in any of the ports. The clock state embedded in the TIMESYNC log must be at least FINE or FINESTEERING before it is considered. The receiver does not use the MK11 event in this mode.  |               |              |               |

Continued on page 61.

| Field | Field Type | ASCII Value                | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|------------|----------------------------|--------------|--|---------------|--------------|---------------|
| 3     | period     | ONCE                       | 0            | The time is synchronized only once (default). The ADJUST1PPS command must be re-issued if another synchronization is required.   | Enum          | 4            | H+4           |
|       |            | CONTINUOUS                 | 1            | The time is continuously monitored and the receiver clock is corrected if an offset of more than 50 ns is detected.  |               |              |               |
| 4     | offset     | -2147483648 to +2147483647 |              | Allows the operator to shift the Secondary clock in 50 ns increments. In MANUAL mode, this command applies an immediate shift of this offset in ns to the receiver clock. In MARK and MARKWITHTIME mode, this offset shifts the receiver clock with respect to the time of arrival of the MK1I event. If this offset is zero, the Secondary aligns its 1PPS to that of the signal received in its MK1I port. For example, if this value was set to 50, then the Secondary would set its 1PPS 50 ns ahead of the input signal and if this | Long          | 4            | H+8           |

- a. Only the MK1I input can be used to synchronize the 1PPS signal. Synchronization cannot be done using the MK2I input offered on some receivers.
- b. It is presumed that the TIMESYNC log, see *Page 559*, was issued by a Primary GPS receiver within 1000 ms, but not less than 800 ms, of the last 1PPS event, see *Figure 1, 1PPS Alignment on Page 57*. Refer also to the *Transfer Time Between Receivers* section in the *OEMV Family Installation and Operation User Manual*.

## 2.5.2 ANTENNAMODEL *Enter/change rover antenna model V123*

This command allows you to enter or change an antenna model for a rover receiver. Setting this value changes the appropriate field in RTCM23, RTCM1007 and RTCM1008 messages. You can set the antenna set-up ID to any value from 0-255. See also BASEANTENNAMODEL, *page 76*, to set these parameters for the base, and RTKANTENNA, *page 170*.

Phase center offsets are entered as northing, easting and up. The PCV (phase center variation) entries follow the NGS standard, and correspond to the phase elevation at 5 degree increments starting at 90 degrees and decreasing to 0. All units are in mm.

- 
- ☒ L1/L2 processing should include both L1 and L2 values, or the resulting values might be incorrect. Since the phase measurement itself is corrected with the L1/L2 difference, failure to enter these values could result in bad position fixes.

For proper usage, the rover receiver needs to have both ANTENNAMODEL and BASEANTENNAMODEL data entered locally. Existing differential messaging standards do not include transmission of all data found in BASEANTENNAMODEL.

---



It is recommended that the ANTENNAMODEL, BASEANTENNAMODEL and RTKANTENNA commands are used together and only used if complete antenna model information is available. These commands are best used in high-precision static survey situations where antenna models are available for the base and rover receivers.

---

### Abbreviated ASCII Syntax:

**Message ID: 841**

ANTENNAMODEL name SN setupID type [L1 offset N] [L1 offset E] [L1 offset UP] [L1 var] [L2 offset N] [L2 offset E] [L2 offset UP] [L2 var]

### Factory Default:

antennamodel none none 0 none

### ASCII Example:

```
antennamodel 702gg nae07070025 3 user 3.0 -1.0 68.4 0.0 0.0
0.1 0.0 0.0 -0.2 -0.5 -0.8 -1.1 -1.3 -1.4 -1.7 -1.7 -1.8
-1.8 -1.4 -0.4 0.0 0.0 -0.6 -1.4 70.9 0.0 -0.9 -1.3 -1.5
-1.5 -1.5 -1.6 -1.7 -2.0 -2.2 -2.4 -2.7 -2.8 -2.9 -2.8 -2.7
-2.3 0.0 0.0
```

- 
- ☒ This example is using absolute calibration values from NGS for a NovAtel 702 Antenna.
-

| Field | Field Type           | ASCII Value | Binary Value | Description   | Binary Format | Binary Bytes          | Binary Offset |
|-------|----------------------|-------------|--------------|---|---------------|-----------------------|---------------|
| 1     | ANTENNA-MODEL header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.  | -             | H                     | 0             |
| 2     | name                 |             |              | Antenna name  | String[32]    | Variable <sup>a</sup> | H             |
| 3     | SN                   |             |              | Antenna serial number   | String[32]    | Variable <sup>a</sup> | Variable      |
| 4     | setupID              |             |              | Setup identification - setting this value changes the appropriate field in RTCM23, RTCM1007 and RTCM1008, see Pages 464, 501 and 503 respectively | Ulong         | 4                     | Variable      |
| 5     | type <sup>b</sup>    |             |              | Antenna model type<br>None = No antenna<br>1 = User antenna   | Enum          | 4                     | Variable      |
| 6     | L1 offset N          |             |              | L1 phase offsets northing (default = 0.0 0.0 0.0)   | Double [3]    | 24                    | Variable      |
| 7     | L1 offset E          |             |              | L1 phase offsets easting (default = 0.0 0.0 0.0)  | Double [3]    | 24                    | Variable      |
| 8     | L1 offset UP         |             |              | L1 phase offsets up (default = 0.0 0.0 0.0)   | Double [3]    | 24                    | Variable      |
| 9     | L1 var               |             |              | L1 phase center variations (default = 0.0 for all 19)   | Double [19]   | 152                   | Variable      |
| 10    | L2 offset N          |             |              | L1 phase offsets northing (default = 0.0 0.0 0.0)   | Double [3]    | 24                    | Variable      |
| 11    | L2 offset E          |             |              | L1 phase offsets northing (default = 0.0 0.0 0.0)   | Double [3]    | 24                    | Variable      |
| 12    | L2 offset UP         |             |              | L1 phase offsets northing (default = 0.0 0.0 0.0)   | Double [3]    | 24                    | Variable      |
| 13    | L2 var               |             |              | L1 phase center variations (default = 0.0 for all 19)   | Double [19]   | 152                   | Variable      |

- a. In the binary log case, additional bytes of padding are added to maintain 4-byte alignment
- b. This should always be a user antenna when data is being entered manually for phase center offsets and/or phase center variation arrays.

### 2.5.3 ANTENNAPOWER Control power to the antenna V23

This command enables or disables the supply of electrical power from the internal (refer to the *OEMV Family Installation and Operation User Manual* for information on supplying power to the antenna) power source of the receiver to the low-noise amplifier (LNA) of an active antenna.

There are several bits in the Receiver Status (see *Table* , *If you wish to disable all these messages without changing the bits, simply UNLOG the RXSTATUSEVENT logs on the appropriate ports. See also the UNLOG command on page 207.. on Page 543*) that pertain to the antenna. These bits indicate whether the antenna is powered (internally or externally) and whether it is open circuited or short circuited.

On start-up, the ANTENNAPOWER is set to ON.

#### Abbreviated ASCII Syntax:

Message ID: 98

ANTENNAPOWER flag

#### Factory Default:

antennapower on

#### ASCII Example:

antennapower off



For the OEMV-3 card, it is possible to supply power to the LNA of an active antenna either from the antenna port of the OEM card itself or from an external source. The internal antenna power supply of the cards can produce +4.75 to +5.10 VDC at up to 100 mA. This meets the needs of any of NovAtel's dual-frequency GPS antennas, so, in most cases, an additional LNA power supply is not required.

External LNA power is not possible with an OEMV-2. The internal antenna power supply from the OEMV-2 card can produce +4.75 to +5.10 VDC at up to 100 mA.

| Field | Field Type          | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|---------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | ANTENNAPOWER header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | flag                | OFF         | 0            | Disables internal powering of antenna.   | Enum          | 4            | H             |
|       |                     | ON          | 1            | Enables internal powering of antenna.  |               |              |               |



### 2.5.4 ASSIGN Assign a channel to a PRN V123

- 
- ☒ 1. The ASSIGN command should only be used by advanced users.
  - 2. Assigning a SV channel sets the forced assignment bit in the channel tracking status field which is reported in the RANGE and TRACKSTAT logs
  - 3. Assigning a PRN to a SV channel does not remove the PRN from the search space of the automatic searcher; only the SV channel is removed (that is, the searcher may search and lock onto this PRN on another channel). The automatic searcher only searches for PRNs 1 to 32 for GPS channels, PRNs 38 to 61 for GLONASS (where available) and PRNs 120 to 138 for SBAS channels.
- 

This command may be used to aid in the initial acquisition of a satellite by allowing you to override the automatic satellite/channel assignment and reacquisition processes with manual instructions. The command specifies that the indicated tracking channel search for a specified satellite at a specified Doppler frequency within a specified Doppler window.

The instruction remains in effect for the specified SV channel and PRN, even if the assigned satellite subsequently sets. If the satellite Doppler offset of the assigned SV channel exceeds that specified by the *window* parameter of the ASSIGN command, the satellite may never be acquired or re-acquired. If a PRN has been assigned to a channel and the channel is currently tracking that satellite, when the channel is set to *AUTO* tracking, the channel immediately idles and returns to automatic mode.

To cancel the effects of *ASSIGN*, you must issue one of the following:

- The *ASSIGN* command with the *state* set to *AUTO*
- The *UNASSIGN* command
- The *UNASSIGNALL* command

These return SV channel control to the automatic search engine immediately.

**Table 12: Channel State**

| Binary | ASCII  | Description   |
|--------|--------|---|
| 0      | IDLE   | Set the SV channel to not track any satellites                  |
| 1      | ACTIVE | Set the SV channel active (default)                             |
| 2      | AUTO   | Tell the receiver to automatically assign PRN codes to channels |
| 3      | NODATA | Tell the receiver to track without navigation data              |
| 4      | OUTPUT | Assign a channel to output the signal                           |

**Abbreviated ASCII Syntax:**

**Message ID: 27**

ASSIGN channel [state] [prn [Doppler [Doppler window]]]

**ASCII Example 1:**

```
assign 0,active,29,0,2000
```

In example 1, the first SV channel is acquiring satellite PRN 29 in a range from -2000 Hz to 2000 Hz until the satellite signal has been detected.

**ASCII Example 2:**

```
assign 11,28,-250,0
```

SV channel 11 is acquiring satellite PRN 28 at an offset of -250 Hz only.

**ASCII Example 3:**

```
assign 11,idle
```

SV channel 11 is idled and does not attempt to search for satellites.



OEMV cards have 2 assigned channels for SBAS. They automatically use the GEO satellites with the highest elevations. You can use the ASSIGN command to enter a GEO PRN manually.

**Table 13: OEMV Channel Configurations**

| Configurations              | OEMV Card                             | Channels  |
|-----------------------------|---------------------------------------|---|
| GPS/SBAS                    | OEMV-1, OEMV-1G,<br>OEMV-2 and OEMV-3 | 0 to 13 for GPS<br>14 to 15 for SBAS  |
| GPS/SBAS/L-band             | OEMV-1 and OEMV-3                     | 0 to 13 for GPS<br>14 for SBAS<br>15 for L-band                               |
| GPS/SBAS/GLONASS            | OEMV-1G, OEMV-2<br>and OEMV-3         | 0 to 13 for GPS<br>14 to 15 for SBAS<br>16 to 27 for GLONASS                  |
| GPS/SBAS/GLONASS/L-<br>band | OEMV-3                                | 0 to 13 for GPS<br>14 to 15 for SBAS<br>16 to 27 for GLONASS<br>28 for L-band |

| Field | Field Type     | ASCII Value  | Binary Value | Description   | Binary Format | Binary Bytes | Binary Offset |
|-------|----------------|--|--------------|---|---------------|--------------|---------------|
| 1     | ASSIGN header  | -  | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively (see 1.1, <i>Message Types</i> on page 19).           | -             | H            | 0             |
| 2     | channel        | See Table 13, <i>OEMV Channel Configurations</i> on Page 66        |              | Desired SV channel number where channel 0 is the first SV channel. The last channel depends on your model configuration. <sup>a</sup>   | ULong         | 4            | H             |
| 3     | state          | See Table 12, <i>Channel State</i> on Page 65                      |              | Set the SV channel state.   | Enum          | 4            | H+4           |
| 4     | prn            | GPS: 1-37<br>SBAS: 120-138<br>GLONASS: see Section 1.3 on Page 30. |              | Optional satellite PRN code from 1 to 32 for GPS channels, 38 to 61 for GLONASS and 120 to 138 for SBAS channels. If not included in the command line, the state parameter must be set to IDLE.       | Long          | 4            | H+8           |
| 5     | Doppler        | -100 000 to 100 000 Hz   |              | Current Doppler offset of the satellite<br>Note: Satellite motion, receiver antenna motion and receiver clock frequency error must be included in the calculation of Doppler frequency. (default = 0) | Long          | 4            | H+12          |
| 6     | Doppler window | 0 to 10 000 Hz   |              | Error or uncertainty in the Doppler estimate above.<br>Note: This is a ± value. Example: 500 for ± 500 Hz. (default = 4 500)  | ULong         | 4            | H+16          |

a. The last channel is currently forced to the L-band signal (if available). See also Table 13, *OEMV Channel Configurations* on Page 66.

## 2.5.5 ASSIGNALL Assign all channels to a PRN V123

☒ The ASSIGNALL command should only be used by advanced users.

This command allows you to override the automatic satellite/channel assignment and reacquisition processes for all receiver channels with manual instructions.

**Abbreviated ASCII Syntax:**

**Message ID: 28**

ASSIGNALL [system][state][prn [Doppler [Doppler window]]]

**Table 14: Channel System**

| Binary | ASCII       | Description                                  |
|--------|-------------|--|
| 0      | GPSL1       | GPS L1 dedicated SV channels only            |
| 1      | GPSL1L2     | GPS L1 and L2 dedicated SV channels only     |
| 2      | NONE        | No dedicated SV channels                     |
| 3      | ALL         | All channels (default)                       |
| 4      | WAASL1      | SBAS SV channels only                        |
| 6      | GPSL1L2C    | GPS L1/L2C channels only                     |
| 7      | GPSL1L2AUTO | Automatically select GPS L1 or L2 channels   |
| 8      | GLOL1L2     | GLONASS L1 and L2 dedicated SV channels only |
| 9      | LBAND       | L-band channels only                         |
| 10     | GLOL1       | GLONASS L1 dedicated SV channels only        |

- ☒ 1. Only GLONASS satellites that are in the almanac are available to assign using a slot number in the ASSIGN command. The possible range is still 38 to 61.
2. The optional *system* field indicates the channel type the command is to use. For example, the command input `ASSIGNALL GPSL1 IDLE` idles all GPS L1 channels on the receiver (GPSL1 is the system in this case). If the receiver is not using any GPS L1 channels, the command has no effect.

The ASSIGNALL command cannot be used as a method of changing the receiver's channel configuration. For example, changing all the GPS L1 and GPS L2 channels to track L1 only. Channel configuration can only be modified by purchasing the appropriate software model.

### ASCII Example 1:

```
assignall gpsl1,active,29,0,2000
```

In example 1, all GPS L1 dedicated SV channels are set to active and trying to acquire PRN 29 in a range from -2000 Hz to 2000 Hz until the satellite signal has been detected.

**ASCII Example 2:**

```
assignall gps112,28,-250,0
```

All L1 and L2 dedicated SV channels are trying to acquire satellite PRN 28 at -250 Hz only.

**ASCII Example 3:**

```
assignall gps11,idle
```

All L1 only dedicated SV channels are idled and are not attempting to search for satellites.



This command is the same as ASSIGN except that it affects **all** SV channels.

| Field | Field Type        | ASCII Value   | Binary Value | Description   | Binary Format | Binary Bytes | Binary Offset |
|-------|-------------------|---|--------------|---|---------------|--------------|---------------|
| 1     | ASSIGN-ALL header | -   | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.  | -             | H            | 0             |
| 2     | system            | See <i>Table 14</i>   |              | System that SV channel is tracking  | Enum          | 4            | H             |
| 3     | state             | See <i>Table 12, Channel State on Page 65</i>                             |              | Set the SV channel state  | Enum          | 4            | H+4           |
| 4     | prn               | GPS: 1-37<br>SBAS: 120-138<br>GLONASS: see <i>Section 1.3 on Page 30.</i> |              | Optional satellite PRN code from 1 to 37 for GPS channels, 38 to 61 for GLONASS and 120 to 138 for SBAS channels. If not included in the command line, the state parameter must be set to idle.       | Long          | 4            | H+8           |
| 5     | Doppler           | -100 000 to 100 000 Hz  |              | Current Doppler offset of the satellite<br>Note: Satellite motion, receiver antenna motion and receiver clock frequency error must be included in the calculation of Doppler frequency. (default = 0) | Long          | 4            | H+12          |
| 6     | Doppler window    | 0 to 10 000 Hz  |              | Error or uncertainty in the Doppler estimate above. This is a ± value (for example, 500 for ± 500 Hz). (default =4500)  | ULong         | 4            | H+16          |

---

## 2.5.6 **ASSIGNLBAND** *Set L-band satellite communication parameters V3\_HP, V13\_VBS or V13\_CDGPS*

You must use this command to ensure that the receiver searches for a specified L-band satellite at a specified frequency with a specified baud rate. The factory parameter default is ASSIGNLBAND IDLE.

- 
- ☒ 1. In addition to a NovAtel receiver with L-band capability, a subscription to the OmniSTAR, or use of the free CDGPS, service is required. Contact NovAtel for details. Contact information may be found on the back of this manual or you can refer to the *Customer Service* section in the *OEMV Family Installation and Operation User Manual*.
  - 2. The frequency assignment, field #3 below, can be made in kHz or Hz. For example:  
ASSIGNLBAND OMNISTAR 1557855 1200  
A value entered in Hz is rounded to the nearest 500 Hz.
  - 3. The NAD83 (CSRS) datum is available to CDGPS users. The receiver automatically transforms the CDGPS computed coordinates into WGS84 (the default datum of the receiver). Alternatively, select any datum, including CSRS, for a specified coordinate system output. See also *Table 21, Reference Ellipsoid Constants* on Page 97.
- 

### Abbreviated ASCII Syntax:

**Message ID: 729**

ASSIGNLBAND mode freq baud

### Factory Default:

assignlband idle

### ASCII Example 1:

assignlband cdgps 1547547 4800

### ASCII Example 2:

assignlband idle

**Table 15: L-band Mode**

| Binary | ASCII          | Description   |
|--------|----------------|---|
| 0      | Reserved       |   |
| 1      | OMNISTAR       | When you select OmniSTAR, enter a dedicated frequency and baud rate.  |
| 2      | CDGPS          | When you select CDGPS, enter a dedicated frequency and baud rate.   |
| 3      | IDLE           | When you select IDLE, the receiver is configured to stop tracking any L-band satellites. The 'freq' and 'baud' fields are optional so that you may select IDLE without specifying the other fields.   |
| 4      | OMNISTARAUTO   | When you select OMNISTARAUTO, the receiver automatically selects the best OmniSTAR beam to track based on the receiver's position. This requires the receiver to have a downloaded satellite list from an OmniSTAR satellite. Therefore, a manual assignment is necessary the first time an OmniSTAR satellite is assigned on a new receiver. After collection, the satellite list is stored in NVM for subsequent auto assignments. Lists are considered valid for 6 months and are constantly updated while an OmniSTAR signal is tracking. If the receiver has a valid satellite list, it is reported in a status bit in the LBANDSTAT log, see <i>page 344</i> . <sup>a</sup> |
| 5      | OMNISTARNARROW | When you select OMNISTARNARROW, enter a dedicated frequency and baud rate. For re-acquisitions of the L-band signal, the receiver uses a 1500 Hz search window and the stored TCXO offset information. To remove the TCXO offset information from NVM, use the FRESET LBAND_TCXO_OFFSET command. A standard FRESET command does not do this, see <i>page 124</i> . <sup>b</sup>   |

- a. The receiver will always track an available local beam over a global beam. The receiver constantly monitors the satellite list to ensure it is tracking the best one and automatically switches beams if it is not tracking the best one. You can view the satellite list by logging the OMNIVIS message, see *page 371*.
- b. Refer also to the *L-band Tracking and Data Output with GPS* application note available on our Web site as APN-043 at <http://www.novatel.com/support/applicationnotes.htm>.

### Beam Frequencies

You can switch between Omnistar VBS and CDGPS by using the following commands:

Use CDGPS

```
assignlband cdgps <freq> 4800
```

```
psrdiffsource cdgps
```

---

### Use OmniStar VBS

```
assignlband omnistar <freq> 1200
```

```
psrdiffsource omnistar
```

Where <freq> is determined for CDGPS or OmniStar as follows:

1. CDGPS beam frequency chart:
  - East 1547646 or 1547646000
  - East-Central 1557897 or 1557897000
  - West-Central 1557571 or 1557571000
  - West 1547547 or 1547547000
2. The OmniStar beam frequency chart can be found at <http://www.omnistar.com/chart.html>.

For example:

Eastern US (Coverage is Northern Canada to southern Mexico) 1530359 or 1530359000

---

✉ OmniSTAR has changed channels (frequencies) on the AMSC Satellite that broadcasts OmniSTAR corrections for North America. NovAtel receivers do not need a firmware change. To change frequencies, connect your receiver and issue an ASSIGNLBAND command. For example, the Western Beam frequency as stated on Omnistar's Web site is 1536.7820 MHz. Input into the receiver: `assignlband omnistar 1536782 1200`

---



A NovAtel receiver with CDGPS has many advantages over other existing wide area correction systems. Most importantly, it delivers superior correction signal penetration, high accuracy and high resolution differential GPS corrections that are critical to many dynamic positioning applications. In addition, there is no subscription cost for users of this service. These features make a NovAtel OEMV with CDGPS an ideal sub-meter positioning system for a wide range of applications including agriculture, GIS, marine, and unmanned systems.

---



| Field | Field Type         | ASCII Value                                    | Binary Value | Description   | Binary Format | Binary Bytes | Binary Offset |
|-------|--------------------|--|--------------|---|---------------|--------------|---------------|
| 1     | ASSIGNLBAND header | -  | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively (see 1.1, <i>Message Types</i> on page 19). | -             | H            | 0             |
| 2     | mode               | See Table 15                                   |              | Set the mode and enter specific frequency and baud rate values  | Enum          | 4            | H             |
| 3     | freq               | 1525000 to 1560000 or 1525000000 to 1560000000 |              | L-band service beam frequency of satellite (Hz or kHz). See also <i>Beam Frequencies</i> on Page 71. (default = 1536782 if the mode is OMNISTAR)  | Ulong         | 4            | H+4           |
| 4     | baud               | 300, 600, 1200, 2400 or 4800                   |              | Data rate for communication with L-band satellite (default = 1200)  | Ulong         | 4            | H+8           |

## 2.5.7 AUTH Add authorization code for new model V123

This command is used to add or remove authorization codes from the receiver. Authorization codes are used to authorize models of software for a receiver. The receiver is capable of keeping track of 5 authorization codes at one time. The MODEL command can then be used to switch between authorized models. The VALIDMODELS log lists the current available models in the receiver. This simplifies the use of multiple software models on the same receiver.

If there is more than one valid model in the receiver, the receiver either uses the model of the last auth code entered via the AUTH command or the model that was selected by the MODEL command, whichever was done last. Both the AUTH and MODEL commands cause a reset automatically.

- 
- ☒ Authorization codes are firmware version specific. If the receiver firmware is updated, it is necessary to acquire new authorization codes for the required models. If you wish to update the firmware in the receiver, please contact NovAtel Customer Service.
- 

---

**WARNING!:** Removing an authorization code will cause the receiver to permanently lose this information.

---

**Abbreviated ASCII Syntax:**

**Message ID: 49**

AUTH [state] part1 part2 part3 part4 part5 model [date]

**Input Examples:**

```
auth add 1234 5678 9abc def0 1234 oemv1112 990131
```

```
auth 1234 5678 9abc def0 1234 oemv1112
```



When you want to easily upgrade your receiver without returning it to the factory, our unique field-upgradeable feature allows you buy the equipment that you need today, and upgrade them without facing obsolescence.

When you are ready to upgrade from one model to another, call 1-800-NOVATEL to speak with our Customer Service/Sales Personnel, who can provide the authorization code that unlocks the additional features of your GPS receiver. This procedure can be performed at your work-site and takes only a few minutes.

---

| Field | Field Type  | ASCII Value                  | Binary Value    | Description  | Binary Format    | Binary Bytes          | Binary Offset |
|-------|-------------|------------------------------|-----------------|--|------------------|-----------------------|---------------|
| 1     | AUTH header | -                            | -               | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -                | H                     | 0             |
| 2     | state       | REMOVE                       | 0               | Remove the authcode from the system.   | Enum             | 4                     | H             |
|       |             | ADD                          | 1               | Add the authcode to the system. (default)  |                  |                       |               |
| 3     | part1       | 4 digit hexadecimal (0-FFFF) |                 | Authorization code section 1.  | ULong            | 4                     | H+4           |
| 4     | part2       | 4 digit hexadecimal (0-FFFF) |                 | Authorization code section 2.  | ULong            | 4                     | H+8           |
| 5     | part3       | 4 digit hexadecimal (0-FFFF) |                 | Authorization code section 3.  | ULong            | 4                     | H+12          |
| 6     | part4       | 4 digit hexadecimal (0-FFFF) |                 | Authorization code section 4.  | ULong            | 4                     | H+16          |
| 7     | part5       | 4 digit hexadecimal (0-FFFF) |                 | Authorization code section 5.  | ULong            | 4                     | H+20          |
| 8     | model       | Alpha numeric                | Null terminated | Model name of the receiver   | String [max. 16] | Variable <sup>a</sup> | Variable      |
| 9     | date        | Numeric                      | Null terminated | Expiry date entered as yymmdd in decimal.  | String [max. 7]  | Variable <sup>a</sup> | Variable      |

a. In the binary log case, additional bytes of padding are added to maintain 4-byte alignment

## 2.5.8 BASEANTENNAMODEL Enter/change base antenna model V123

This command allows you to enter or change an antenna model for a base receiver. Setting this value changes the appropriate field in RTCM23, RTCM1007 and RTCM1008 messages. You can set the antenna set-up ID to any value from 0-255. See also ANTENNAMODEL, *page 76*, to set these parameters at the rover, and RTKANTENNA, *page 170*.

Phase center offsets are entered as northing, easting and up. The PCV (phase center variation) entries follow the NGS standard, and correspond to the phase elevation at 5 degree increments starting at 90 degrees and decreasing to 0. All units are in mm.

---

☒ L1/L2 processing should include both L1 and L2 values, or the resulting values might be incorrect. Since the phase measurement itself is corrected with the L1/L2 difference, failure to enter these values could result in bad position fixes.

---



It is recommended that the ANTENNAMODEL, BASEANTENNAMODEL and RTKANTENNA commands are used together and only used if complete antenna model information is available. These commands are best used in high-precision static survey situations where antenna models are available for the base and rover receivers.

---

Abbreviated ASCII Syntax: Message ID: 870

BASEANTENNAMODEL name SN setupID type L1 offset N [L1 offset E] [L1 offset UP] [L1 var] [L2 offset N] [L2 offset E] [L2 offset UP] [L2 var]

### Factory Default:

baseantennamodel none none 0 none

### ASCII Example:

baseantennamodel 702 nvh05410007 1 user

| Field | Field Type                | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes          | Binary Offset |
|-------|---------------------------|-------------|--------------|--|---------------|-----------------------|---------------|
| 1     | BASE-ANTENNA-MODEL header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H                     | 0             |
| 2     | name                      |             |              | Antenna name   | String[32]    | Variable <sup>a</sup> | H             |
| 3     | SN                        |             |              | Antenna serial number  | String[32]    | Variable <sup>a</sup> | Variable      |
| 4     | setupID                   |             |              | Setup identification - setting this value changes the appropriate field in RTCM23, RTCM1007 and RTCM1008, see 464, 501 and 503 respectively      | Ulong         | 4                     | Variable      |
| 5     | type <sup>b</sup>         |             |              | Antenna model type<br>0 = No antenna<br>1 = User antenna   | Enum          | 4                     | Variable      |
| 6     | L1 offset N               |             |              | L1 phase offsets northing (default = 0.0 0.0 0.0)  | Double [3]    | 24                    | Variable      |
| 7     | L1 offset E               |             |              | L1 phase offsets easting (default = 0.0 0.0 0.0)   | Double [3]    | 24                    | Variable      |
| 8     | L1 offset UP              |             |              | L1 phase offsets up (default = 0.0 0.0 0.0)  | Double [3]    | 24                    | Variable      |
| 9     | L1 var                    |             |              | L1 phase center variations (default = 0.0 for all 19)  | Double [19]   | 152                   | Variable      |
| 10    | L2 offset N               |             |              | L1 phase offsets northing (default = 0.0 0.0 0.0)  | Double [3]    | 24                    | Variable      |
| 11    | L2 offset E               |             |              | L1 phase offsets northing (default = 0.0 0.0 0.0)  | Double [3]    | 24                    | Variable      |
| 12    | L2 offset UP              |             |              | L1 phase offsets northing (default = 0.0 0.0 0.0)  | Double [3]    | 24                    | Variable      |
| 13    | L2 var                    |             |              | L1 phase center variations (default = 0.0 for all 19)  | Double [19]   | 152                   | Variable      |

- a. In the binary log case, additional bytes of padding are added to maintain 4-byte alignment
- b. This should always be a user antenna when data is being entered manually for phase center offsets and/or phase center variation arrays.

## 2.5.9 CDGPSTIMEOUT Set CDGPS position time out V13\_CDGPS

This command is used to set the amount of time the receiver remains in a CDGPS position if it stops receiving CDGPS corrections. See the DGPSEPHEMDELAY command on *page 103* to set the ephemeris change-over delay for base stations.

**Abbreviated ASCII Syntax:**

**Message ID: 850**

CDGPSTIMEOUT mode [delay]

**Factory Default:**

cdgpstimeout auto

**ASCII Example (rover):**

cdgpstimeout set 60



When the time out mode is set to AUTO, the time out delay is 120 seconds.

| Field | Field Type           | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|----------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | CDGPS-TIMEOUT header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | mode                 | See Table   |              | Time out mode (default = auto)   | Enum          | 4            | H             |
| 3     | delay                | 2 to 1000 s |              | Maximum CDGPS age (default = 120)  | Double        | 8            | H+4           |
| 4     | Reserved             |             |              |  | Double        | 8            | H+12          |

**Table 16: Time Out Mode**

| Binary | ASCII    | Description                   |
|--------|----------|-------------------------------|
| 0      | Reserved |                               |
| 1      | AUTO     | Set the default value (120 s) |
| 2      | SET      | Set the delay in seconds      |

## 2.5.10 CLOCKADJUST Enable clock adjustments V123

All oscillators have some inherent drift. By default the receiver attempts to steer the receiver's clock to accurately match GPS time. If for some reason this is not desired, this behavior can be disabled using the CLOCKADJUST command. The TIME log can then be used to monitor clock drift.

- 
- ✉ 1. The CLOCKADJUST command should only be used by advanced users.
  - 2. If the CLOCKADJUST command is ENABLED, and the receiver is configured to use an external reference frequency (set in the EXTERNALCLOCK command, see *Page 112*, for an external clock - TCXO, OCXO, RUBIDIUM, CESIUM, or USER), then the clock steering process takes over the VARF output pins and may conflict with a previously entered FREQUENCYOUT command, see *Page 121*.
  - 3. When using the EXTERNALCLOCK and CLOCKADJUST commands together, issue the EXTERNALCLOCK command first to avoid losing satellites.
  - 4. When disabled, the range measurement bias errors continue to accumulate with clock drift.
  - 5. Pseudorange, carrier phase and Doppler measurements may jump if the CLOCKADJUST mode is altered while the receiver is tracking.
  - 6. When disabled, the time reported on all logs may be offset from GPS time. The 1PPS output may also be offset. The amount of this offset may be determined from the TIME log, see *page 555*.
  - 7. A discussion on GPS time may be found in *Section 1.4, GPS Time Status on page 31*.
- 

### Abbreviated ASCII Syntax:

**Message ID: 15**

CLOCKADJUST switch

### Factory Default:

clockadjust enable

### ASCII Example:

clockadjust disable



The CLOCKADJUST command can be used to calibrate an internal oscillator.

Disable the CLOCKADJUST mode in order find out what the actual drift is from the internal oscillator. Watch the CLOCKMODEL log to see the drift rate and adjust the oscillator until the drift stops.

---



---

| Field | Field Type         | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|--------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | CLOCKADJUST header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | switch             | DISABLE     | 0            | Disallow adjustment of internal clock  | Enum          | 4            | H             |
|       |                    | ENABLE      | 1            | Allow adjustment of internal clock   |               |              |               |



### 2.5.11 CLOCKCALIBRATE Adjust clock steering parameters V123

This command is used to adjust the control parameters of the clock steering loop. The receiver must be enabled for clock steering before these values can take effect. Refer to the CLOCKADJUST command, see *Page 79*, to enable or disable this feature.

To disable the clock steering process, issue the CLOCKADJUST DISABLE command.

The current values used by the clock steering process are listed in the CLOCKSTEERING log, see *Page 268*.

- 
- ☒ The values entered using the CLOCKCALIBRATE command are saved to non-volatile memory (NVM). To restore the values to their defaults, the FRESET CLKCALIBRATION command must be used. See *Section 2.5.29 on Page 124* for more details.
- 

**Abbreviated ASCII Syntax:**

**Message ID: 430**

CLOCKCALIBRATE mode [period] [width] [slope] [bandwidth]

**ASCII Example:**

```
clockcalibrate auto
```



The receiver by default steers its INTERNAL VCTCXO but can be commanded to control an EXTERNAL reference oscillator. Use the EXTERNALCLOCK command, see *page 112*, to configure the receiver to use an external reference oscillator. If the receiver is configured for an external reference oscillator and configured to adjust its clock, then the clock steering loop attempts to steer the external reference oscillator through the use of the VARF signal. Note that the clock steering control process conflicts with the manual FREQUENCYOUT command, see *page 121*. It is expected that the VARF signal is used to provide a stable reference voltage by the use of a filtered charge pump type circuit (not supplied).

---



---

| Field | Field Type            | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|-----------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | CLOCKCALIBRATE header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.   | -             | H            | 0             |
| 2     | mode                  | SET         | 0            | Sets the period, pulsewidth, slope, and bandwidth values into NVM for the currently selected steered oscillator (INTERNAL or EXTERNAL)   | Enum          | 4            | H             |
|       |                       | AUTO        | 1            | Forces the receiver to do a clock steering calibration to measure the slope (change in clock drift rate with a 1 bit change in pulse width), and required pulsewidth, to zero the clock drift rate. After the calibration, these values along with the period and bandwidth are entered into NVM and are then used from this point forward on the selected oscillator. |               |              |               |
|       |                       | OFF         | 2            | Terminates a calibration process currently underway  |               |              |               |
| 3     | period                | 0 to 262144 |              | Signal period in 25 ns steps.<br>Frequency Output = 40,000,000 / Period.<br>(default = 4400)   | Ulong         | 4            | H+4           |

Continued on page 83.

| Field | Field Type | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|------------|-------------|--------------|--|---------------|--------------|---------------|
| 4     | pulsewidth |             |              | The valid range for this parameter is 10% to 90% of the period.<br><br>Sets the initial pulse width that should provide a near zero drift rate from the selected oscillator being steered. The valid range for this parameter is 10% to 90% of the period. The default value is 2200. If this value is not known, (in the case of a new external oscillator) then it should be set to 1/2 the period and the mode should be set to AUTO to force a calibration.  | Ulong         | 4            | H+8           |
| 5     | slope      |             |              | This value should correspond to how much the clock drift changes with a 1 bit change in the pulsewidth m/s/bit. The default values for the slope used for the INTERNAL and EXTERNAL clocks is -2.0 and -0.01 respectively. If this value is not known, then its value should be set to 1.0 and the mode should be set to AUTO to force a calibration. Once the calibration process is complete and using a slope value of 1.0, the receiver should be recalibrated using the measured slope and pulsewidth values (see the CLOCKSTEERING log, on Page 268). This process should be repeated until the measured slope value remains constant (less than a 5% change). | Float         | 4            | H+12          |

Continued on page 84.

| Field | Field Type | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|------------|-------------|--------------|--|---------------|--------------|---------------|
| 6     | bandwidth  |             |              | This is the value used to control the smoothness of the clock steering process. Smaller values result in slower and smoother changes to the receiver clock. Larger values result in faster responses to changes in oscillator frequency and faster start-up clock pull-in. The default values are 0.03 and 0.001 Hz respectively for the INTERNAL and EXTERNAL clocks. | Float         | 4            | H+16          |

### 2.5.12 CLOCKOFFSET Adjust for delay in 1PPS output V123

This command can be used to remove a delay in the PPS output. The PPS signal is delayed from the actual measurement time due to two major factors:

- A delay in the signal path from the antenna to the receiver
- An intrinsic delay through the RF and digital sections of the receiver

The second delay is automatically accounted for by the receiver using a nominal value determined for each receiver type. However, since the delay from the antenna to the receiver cannot be determined by the receiver, an adjustment cannot automatically be made. The CLOCKOFFSET command can be used to adjust for this delay.

**Abbreviated ASCII Syntax:**

**Message ID: 596**

CLOCKOFFSET offset

**Factory Default:**

clockoffset 0

**ASCII Example:**

clockoffset -15



There may be small variances in the delays for each cable or card. The CLOCKOFFSET command can be used to characterize each setup. For example, for a cable with a delay of 10 ns, the offset can be set to -10 to remove the delay from the PPS output.

| Field | Field Type         | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|--------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | CLOCKOFFSET header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively (see 1.1, Message Types on page 19). | -             | H            | 0             |
| 2     | offset             | ±200        |              | Specifies the offset in nanoseconds  | Long          | 4            | H             |

### 2.5.13 CNOUPDATE Set the C/No update rate and resolution V123

This command allows you to set the C/No update rate and resolution.

**Abbreviated ASCII Syntax:**

**Message ID: 849**

CNOUPDATE [rate]

**Factory Default:**

cnupdate default

**ASCII Example (rover):**

cnupdate 20hz



Use the CNOUPDATE command for higher resolution C/No measurements, of the incoming GPS signals, at a higher rate. By default, the C/No values are calculated at approximately 4 Hz, but this command allows you to increase that rate to 20 Hz.

| Field | Field Type        | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|-------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | CNO-UPDATE header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | rate              | DEFAULT     | 0            | C/No update rate:<br>0 = Turn off C/No enhancement default = 4 Hz (4 bits/s)<br>1 = 20 Hz C/No updates (20 bits/s)                               | ENUM          | 4            | H             |
|       |                   | 20HZ        | 1            |  |               |              |               |

## 2.5.14 COM COM port configuration control V123

This command permits you to configure the receiver's asynchronous serial port communications drivers.

The current COM port configuration can be reset to its default state at any time by sending it two hardware break signals of 250 milliseconds each, spaced by fifteen hundred milliseconds (1.5 seconds) with a pause of at least 250 milliseconds following the second break. This will:

- Stop the logging of data on the current port (see UNLOGALL on *Page 209*)
- Clear the transmit and receive buffers on the current port
- Return the current port to its default settings (see *Page 54* for details)
- Set the interface mode to NovAtel for both input and output (see the INTERFACEMODE command on *Page 135*)

See also *Section 2.4, Factory Defaults* on *page 54* for a description of the factory defaults, and the COMCONFIG log on *Page 287*.

- 
- ☒ 1. The COMCONTROL command, see *Page 90*, may conflict with handshaking of the selected COM port. If handshaking is enabled, then unexpected results may occur.
  - 2. Baud rates higher than 115,200 bps are not supported by standard PC hardware. Special PC hardware may be required for higher rates, including 230400 bps, 460800 bps and 921600 bps. Also, some PC's have trouble with baud rates beyond 57600 bps.
- 

### Abbreviated ASCII Syntax:

**Message ID: 4**

COM [port] bps [parity[databits[stopbits[handshake[echo[break]]]]]]

### Factory Default:

```
com com1 9600 n 8 1 n off on
com com2 9600 n 8 1 n off on
com com3 9600 n 8 1 n off on
com aux 9600 n 8 1 n off on
```

### ASCII Example:

```
com com1,57600,n,8,1,n,off,on
```



Watch for situations where the COM ports of two receivers are connected together and the baud rates do not match. Data transmitted through a port operating at a slower baud rate may be misinterpreted as break signals by the receiving port if it is operating at a higher baud rate. This is because data transmitted at the lower baud rate is stretched relative to the higher baud rate. In this case, configure the receiving port to have break detection disabled using the COM command.

---



---

**WARNING!:** Use the COM command before using the INTERFACEMODE command on

each port. Turn break detection off using the COM command to stop the port from resetting because it is interpreting incoming bits as a break command.

**Table 17: COM Serial Port Identifiers**

| Binary | ASCII              | Description          |
|--------|--------------------|----------------------|
| 1      | COM1               | COM port 1           |
| 2      | COM2               | COM port 2           |
| 3      | COM3               | COM port 3           |
| 6      | THISPORT           | The current COM port |
| 8      | ALL                | All COM ports        |
| 9      | XCOM1 <sup>a</sup> | Virtual COM1 port    |
| 10     | XCOM2 <sup>a</sup> | Virtual COM2 port    |
| 13     | USB1 <sup>b</sup>  | USB port 1           |
| 14     | USB2 <sup>b</sup>  | USB port 2           |
| 15     | USB3 <sup>b</sup>  | USB port 3           |
| 16     | AUX <sup>c</sup>   | AUX port             |
| 17     | XCOM3 <sup>a</sup> | Virtual COM3 port    |

- a. The XCOM1, XCOM2 and XCOM3 identifiers are not available with the COM command but may be used with other commands. For example, INTERFACEMODE on *Page 135* and LOG on *Page 142*.
- b. The only other field that applies when a USB port is selected is the echo field. A place holder must be inserted for all other fields to use the echo field in this case.
- c. The AUX port is available on OEMV-2-based and OEMV-3-based products.

☒ The OEMV-3 AUX port does not support hardware handshaking. Only transmit and receive lines exist for the AUX port on the OEMV-3.

**Table 18: Parity**

| Binary | ASCII | Description         |
|--------|-------|---------------------|
| 0      | N     | No parity (default) |
| 1      | E     | Even parity         |
| 2      | O     | Odd parity          |



**Table 19: Handshaking**

| Binary | ASCII | Description                   |
|--------|-------|-------------------------------|
| 0      | N     | No handshaking (default)      |
| 1      | XON   | XON/XOFF software handshaking |
| 2      | CTS   | CTS/RTS hardware handshaking  |

| Field | Field Type | ASCII Value   | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|------------|---|--------------|--|---------------|--------------|---------------|
| 1     | COM header | -   | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | port       | See <i>Table 17, COM Serial Port Identifiers on Page 88</i>                   |              | Port to configure. (default = THISPORT)  | Enum          | 4            | H             |
| 3     | bps/ baud  | 300, 600, 900, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, or 230400 |              | Communication baud rate (bps). Bauds of 460800 and 921600 are also available on COM1 of OEMV-2-based products.                                   | ULong         | 4            | H+4           |
| 4     | parity     | See <i>Table 18 on page 88</i>  |              | Parity   | Enum          | 4            | H+8           |
| 5     | databits   | 7 or 8  |              | Number of data bits (default = 8)  | ULong         | 4            | H+12          |
| 6     | stopbits   | 1 or 2  |              | Number of stop bits (default = 1)  | ULong         | 4            | H+16          |
| 7     | handshake  | See <i>Table 19 on page 89</i>  |              | Handshaking  | Enum          | 4            | H+20          |
| 8     | echo       | OFF   | 0            | No echo (default)  | Enum          | 4            | H+24          |
|       |            | ON  | 1            | Transmit any input characters as they are received   |               |              |               |
| 9     | break      | OFF   | 0            | Disable break detection  | Enum          | 4            | H+28          |
|       |            | ON  | 1            | Enable break detection (default)   |               |              |               |

### 2.5.15 COMCONTROL Control the RS232 hardware control lines V123

This command is used to control the hardware control lines of the RS232 ports. The TOGGLEPPS mode of this command is typically used to supply a timing signal to a host PC computer by using the RTS or DTR lines. The accuracy of controlling the COM control signals is better than 900  $\mu$ s. The other modes are typically used to control custom peripheral devices. Also, it is possible to communicate with all three serial ports simultaneously using this command.

- 
- ☒ 1. If handshaking is disabled, any of these modes can be used without affecting regular RS232 communications through the selected COM port. However, if handshaking is enabled, it may conflict with handshaking of the selected COM port, causing unexpected results.
  - 2. The PULSEPPSLOW control type cannot be issued for a TX signal.  
Only PULSEPPSHIGH, FORCEHIGH and FORCELOW control types can be used for a TX signal.
- 

#### Abbreviated ASCII Syntax:

Message ID: 431

COMCONTROL port signal control

#### Factory Default:

```
comcontrol com1 rts default
comcontrol com2 rts default
comcontrol com3 rts default
```

#### ASCII Example 1:

```
com com1 9600 n 8 1 n (to disable handshaking)
comcontrol com1 rts forcelow
comcontrol com2 dtr togglepps
```

#### ASCII Example 2:

```
comcontrol com1 rts togglepps
comcontrol com2 rts togglepps
comcontrol com3 rts togglepps
```

#### ASCII Example 3:

OEMV-3:

To set a break condition on AUX:

```
comcontrol aux tx forcelow
```

A break condition remains in effect until it is cleared.

To clear a break condition on AUX:

```
comcontrol com1 tx default
```

or

```
comcontrol com1 tx forcehigh
```

**Table 20: Tx, DTR and RTS Availability**

|        | Tx Available On:   | DTR Available On: | RTS Available On:   |
|--------|--------------------|-------------------|---------------------|
| OEMV-1 | COM1 and COM2      | N/A               | N/A                 |
| OEMV-2 | COM1 and COM2      | N/A               | COM1 and COM2       |
| OEMV-3 | COM1, COM3 and AUX | COM2              | COM1, COM2 and COM3 |



COM1 on the OEMV-3 is user-configurable for RS-422. Refer to the *Technical Specifications* appendix and also the *User-Selectable Port Configuration* section of the *OEMV Family Installation and Operation User Manual*.

| Field | Field Type        | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|-------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | COMCONTROL header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | port              | COM1        | 1            | RS232 port to control. Valid ports are COM1, COM2, COM3 and AUX. The AUX port is only available on OEMV-3-based products.                        | Enum          | 4            | H             |
|       |                   | COM2        | 2            |  |               |              |               |
|       |                   | COM3        | 3            |  |               |              |               |
|       |                   | AUX         | 16           |  |               |              |               |
| 3     | signal            | RTS         | 0            | COM signal to control. The controllable COM signals are RTS, DTR and TX. See also <i>Table 20, Tx, DTR and RTS Availability on Page 91</i>       | Enum          | 4            | H+4           |
|       |                   | DTR         | 1            |  |               |              |               |
|       |                   | TX          | 2            |  |               |              |               |

*Continued on page 93.*

| Field | Field Type | ASCII Value  | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|------------|--------------|--------------|--|---------------|--------------|---------------|
| 4     | control    | DEFAULT      | 0            | Disables this command and returns the COM signal to its default state  | Enum          | 4            | H+8           |
|       |            | FORCEHIGH    | 1            | Immediately forces the signal high   |               |              |               |
|       |            | FORCELOW     | 2            | Immediately forces the signal low  |               |              |               |
|       |            | TOGGLE       | 3            | Immediately toggles the current state of the signal  |               |              |               |
|       |            | TOGGLEPPS    | 4            | Toggles the state of the selected signal within 900 $\mu$ s after each 1PPS event. The state change of the signal lags the 1PPS by an average value of 450 $\mu$ s. The delay of each pulse varies by a uniformly random amount less than 900 $\mu$ s. |               |              |               |
|       |            | PULSEPPSLOW  | 5            | Pulses the line low at a 1PPS event and to high 1 ms after it. Not for TX.   |               |              |               |
|       |            | PULSEPPSHIGH | 6            | Pulses the line high for 1 ms at the time of a 1PPS event  |               |              |               |

## 2.5.16 CSMOOTH Set carrier smoothing V123

This command sets the amount of carrier smoothing to be performed on the code measurements. An input value of 100 corresponds to approximately 100 seconds of smoothing. Upon issuing the command, the locktime (amount of continuous tracking in seconds) for all tracking satellites is reset to zero. From this point each code smoothing filter is restarted. The user must wait for at least the length of smoothing time for the new smoothing constant to take full effect. The optimum setting for this command is dependent on your application.

### Abbreviated ASCII Syntax:

**Message ID: 269**

CSMOOTH L1time [L2time]

### Factory Default:

csmooth 100 100

### Abbreviated ASCII Example:

csmooth 500

- 
- ✉ 1. The CSMOOTH command should only be used by advanced GPS users. The shorter the carrier smoothing the more noise there will be. If you are at all unsure please call NovAtel Customer Service Department, see the *Customer Service* section at the start of the *OEMV Family Installation and Operation User Manual*.
  - 2. It may not be suitable for every GPS application. When using CSMOOTH in differential mode, the same setting should be used at both the base and rover station, if both the base and rover stations are using the same type of receiver (both OEM4 or both OEMV family). However if the base and rover stations use different types of receivers (OEM4 and OEMV family), it is recommended that the CSMOOTH command default value is used at each receiver (CSMOOTH 100 100 and GLOCSMOOTH 100 100).
- 



There are several considerations when using the CSMOOTH command:

- The attenuation of low frequency noise (multipath) in pseudorange measurements
- The effect of time constants on the correlation of phase and code observations
- The rate of “pulling-in” of the code tracking loop (step response)
- The effect of ionospheric divergence on carrier smoothed pseudorange (ramp response)

The primary reason for applying carrier smoothing to the measured pseudoranges is to mitigate the high frequency noise inherent in all code measurements. Adding more carrier smoothing by increasing the CSMOOTH value filters out lower frequency noise, including some multipath frequencies.

There are also some adverse effects of higher CSMOOTH values on some performance aspects of the receiver. Specifically, the time constant of the tracking loop is directly proportional to the CSMOOTH value and affects the degree of dependence between the carrier phase and pseudorange information. Carrier phase smoothing of the code measurements (pseudoranges) is accomplished by introducing data from the carrier tracking loops into the code tracking system. Phase and code data collected at a sampling rate greater than about 3 time constants of the loop are correlated (the greater the sampling rate, the greater the correlation). This correlation is not relevant if only positions are logged from the receiver, but is an important consideration if the data is combined in some other process such as post-mission carrier smoothing. Also, a narrow bandwidth in a feedback loop impedes the ability of the loop to track step functions. Steps in the pseudorange are encountered during initial lock-on of the satellite and when working in an environment conducive to multipath. A low CSMOOTH value allows the receiver to effectively adapt to these situations.

Also, increased carrier smoothing may cause problems when satellite signals are strongly affected by the ionosphere. The rate of divergence between the pseudoranges and phase-derived ranges is greatest when a satellite is low in the sky since the GPS signal must travel through a much “thicker” ionosphere. The tracking error of the receiver is greatest at these times when a lot of carrier smoothing is implemented. In addition, changing periods of ionospheric activity (diurnal changes and the 11-year cycle) influences the impact of large CSMOOTH values. It is important to realize that the advantages of carrier smoothing do not come without some trade-off in receiver performance. The factory default CSMOOTH value of 100 was selected as an optimal compromise of the above considerations. For the majority of applications, this default value should be appropriate. However, the flexibility exists to adjust the parameter for specific applications by users who are familiar with the consequences.

| Field | Field Type     | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|----------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | CSMOOTH header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | L1time         | 2-2000      |              | L1 carrier smoothing time constant, in seconds   | Ulong         | 4            | H             |
| 3     | [L2time]       | 5-2000      |              | L2 carrier smoothing time constant, in seconds (default = 100)   | Ulong         | 4            | H+4           |

### 2.5.17 DATUM Choose a datum name type V123

This command permits you to select the geodetic datum for operation of the receiver. If not set, the factory default value is WGS84. See the USERDATUM command for user definable datums. The datum you select causes all position solutions to be based on that datum.

The NAD83 (CSRS) datum is available to CDGPS users. The receiver automatically transforms the CDGPS computed coordinates into WGS84 (the default datum of the receiver). Alternatively, select any datum, including CSRS, for a specified coordinate system output.

The transformation for the WGS84 to Local used in the OEMV family is the Bursa-Wolf transformation or reverse Helmert transformation. In the Helmert transformation, the rotation of a point is counter clockwise around the axes. In the Bursa-Wolf transformation, the rotation of a point is clockwise. Therefore, the reverse Helmert transformation is the same as the Bursa-Wolf.

See *Table 21* on *page 97* for a complete listing of all available predefined datums. The offsets in the table are from your local datum to WGS84.

**Abbreviated ASCII Syntax:**

**Message ID: 160**

DATUM datum

**Factory Default:**

datum wgs84

**ASCII Example:**

datum csrs

Also, as an example, you can achieve spatial integrity with Government of Canada maps and surveys if the coordinates are output using the CSRS datum (Datum ID# 64).

*Table 21* on *page 97* contains the internal ellipsoid and transformation parameters used in the receiver. The values contained in these tables were derived from the following DMA reports:

1. TR 8350.2 Department of Defence World Geodetic System 1984 and Relationships with Local Geodetic Systems - Revised March 1, 1988.
2. TR 8350.2B Supplement to Department of Defence World Geodetic System 1984 Technical Report - Part II - Parameters, Formulas, and Graphics for the Practical Application of WGS84 - December 1, 1987.
3. TR 8350.2 Department of Defense World Geodetic System 1984 National Imagery and Mapping Agency Technical Report, Third Addition, Amendment 1 - January 3, 2000



By default, NovAtel receivers output positions in WGS84, with the following additional information to consider:

|        |  |
|--------|--|
| Single | Uses WGS84   |
| WAAS   | Corrects to WGS84                                      |
| EGNOS  | Corrects to International Terrestrial Reference System |



CDGPS (ITRF) which is compatible with WGS84  
 Corrects to NAD83 and then transforms to WGS84  
 If you select the CSRS datum, the WGS84 transformation is undone and position is returned to CSRS

OmniSTAR XP/HP Corrects to ITRF which is compatible with WGS84  
 OmniSTAR VBS Corrects to ITRF which is compatible with WGS84  
 PSRDIFF and RTK Unknown, as the rover does not know how the user fixed the base position, but must be close to WGS84

**Table 21: Reference Ellipsoid Constants**

| ELLIPSOID                        | ID CODE  | a (meters)  | 1/f           | f                |
|----------------------------------|----------|-------------|---------------|------------------|
| Airy 1830                        | AW       | 6377563.396 | 299.3249646   | 0.00334085064038 |
| Modified Airy                    | AM       | 6377340.189 | 299.3249646   | 0.00334085064038 |
| Australian National              | AN       | 6378160.0   | 298.25        | 0.00335289186924 |
| Bessel 1841                      | BR       | 6377397.155 | 299.1528128   | 0.00334277318217 |
| Clarke 1866                      | CC       | 6378206.4   | 294.9786982   | 0.00339007530409 |
| Clarke 1880                      | CD       | 6378249.145 | 293.465       | 0.00340756137870 |
| Everest (India 1830)             | EA       | 6377276.345 | 300.8017      | 0.00332444929666 |
| Everest (Brunei & E.Malaysia)    | EB       | 6377298.556 | 300.8017      | 0.00332444929666 |
| Everest (W.Malaysia & Singapore) | EE       | 6377304.063 | 300.8017      | 0.00332444929666 |
| Geodetic Reference System 1980   | RF       | 6378137.0   | 298.257222101 | 0.00335281068118 |
| Helmert 1906                     | HE       | 6378200.0   | 298.30        | 0.00335232986926 |
| Hough 1960                       | HO       | 6378270.0   | 297.00        | 0.00336700336700 |
| International 1924               | IN       | 6378388.0   | 297.00        | 0.00336700336700 |
| Parameters of the Earth          | PZ-90.02 | 6378136.0   | 298.26        | 0.00335280374302 |
| South American 1969              | SA       | 6378160.0   | 298.25        | 0.00335289186924 |
| World Geodetic System 1972       | WD       | 6378135.0   | 298.26        | 0.00335277945417 |
| World Geodetic System 1984       | WE       | 6378137.0   | 298.257223563 | 0.00335281066475 |

Table 22: Datum Transformation Parameters

| Datum ID# <sup>a</sup> | NAME   | DX <sup>b</sup> | DY <sup>b</sup> | DZ <sup>b</sup> | DATUM DESCRIPTION   | ELLIPSOID           |
|------------------------|--------|-----------------|-----------------|-----------------|---|---------------------|
| 1                      | ADIND  | -162            | -12             | 206             | This datum has been updated, see ID# 65 <sup>c</sup>          | Clarke 1880         |
| 2                      | ARC50  | -143            | -90             | -294            | ARC 1950 (SW & SE Africa)                                     | Clarke 1880         |
| 3                      | ARC60  | -160            | -8              | -300            | This datum has been updated, see ID# 66 <sup>c</sup>          | Clarke 1880         |
| 4                      | AGD66  | -133            | -48             | 148             | Australian Geodetic Datum 1966                                | Australian National |
| 5                      | AGD84  | -134            | -48             | 149             | Australian Geodetic Datum 1984                                | Australian National |
| 6                      | BUKIT  | -384            | 664             | -48             | Bukit Rimpah (Indonesia)                                      | Bessel 1841         |
| 7                      | ASTRO  | -104            | -129            | 239             | Camp Area Astro (Antarctica)                                  | International 1924  |
| 8                      | CHATM  | 175             | -38             | 113             | Chatham 1971 (New Zealand)                                    | International 1924  |
| 9                      | CARTH  | -263            | 6               | 431             | Carthage (Tunisia)  | Clarke 1880         |
| 10                     | CAPE   | -136            | -108            | -292            | CAPE (South Africa)   | Clarke 1880         |
| 11                     | DJAKA  | -377            | 681             | -50             | Djakarta (Indonesia)  | Bessel 1841         |
| 12                     | EGYPT  | -130            | 110             | -13             | Old Egyptian  | Helmert 1906        |
| 13                     | ED50   | -87             | -98             | -121            | European 1950   | International 1924  |
| 14                     | ED79   | -86             | -98             | -119            | European 1979   | International 1924  |
| 15                     | GUNSG  | -403            | 684             | 41              | G. Segara (Kalimantan - Indonesia)                            | Bessel 1841         |
| 16                     | GEO49  | 84              | -22             | 209             | Geodetic Datum 1949 (New Zealand)                             | International 1924  |
| 17                     | GRB36  | 375             | -111            | 431             | <b>Do not use.</b> Use ID# 76 instead. <sup>d</sup>           | Airy 1830           |
| 18                     | GUAM   | -100            | -248            | 259             | Guam 1963 (Guam Island)                                       | Clarke 1866         |
| 19                     | HAWAII | 89              | -279            | -183            | <b>Do not use.</b> Use ID# 77 or ID# 81 instead. <sup>d</sup> | Clarke 1866         |

*Continued on the following page.*

**Table 22: Datum Transformation Parameters**

| Datum ID# | NAME   | DX   | DY   | DZ   | DATUM DESCRIPTION   | ELLIPSOID          |
|-----------|--------|------|------|------|---|--------------------|
| 20        | KAUAI  | 45   | -290 | -172 | <b>Do not use.</b> Use ID# 78 or ID# 82 instead. <sup>d</sup> | Clarke 1866        |
| 21        | MAUI   | 65   | -290 | -190 | <b>Do not use.</b> Use ID# 79 or ID# 83 instead. <sup>d</sup> | Clarke 1866        |
| 22        | OAHU   | 56   | -284 | -181 | <b>Do not use.</b> Use ID# 80 or ID# 84 instead. <sup>d</sup> | Clarke 1866        |
| 23        | HERAT  | -333 | -222 | 114  | Herat North (Afghanistan)                                     | International 1924 |
| 24        | HJORS  | -73  | 46   | -86  | Hjorsey 1955 (Iceland)  | International 1924 |
| 25        | HONGK  | -156 | -271 | -189 | Hong Kong 1963  | International 1924 |
| 26        | HUTZU  | -634 | -549 | -201 | This datum has been updated, see ID# 68 <sup>c</sup>          | International 1924 |
| 27        | INDIA  | 289  | 734  | 257  | <b>Do not use.</b> Use ID# 69 or ID# 70 instead. <sup>d</sup> | Everest (EA)       |
| 28        | IRE65  | 506  | -122 | 611  | <b>Do not use.</b> Use ID# 71 instead. <sup>d</sup>           | Modified Airy      |
| 29        | KERTA  | -11  | 851  | 5    | Kertau 1948 (West Malaysia and Singapore)                     | Everest (EE)       |
| 30        | KANDA  | -97  | 787  | 86   | Kandawala (Sri Lanka)   | Everest (EA)       |
| 31        | LIBER  | -90  | 40   | 88   | Liberia 1964  | Clarke 1880        |
| 32        | LUZON  | -133 | -77  | -51  | <b>Do not use.</b> Use ID# 72 instead. <sup>d</sup>           | Clarke 1866        |
| 33        | MINDA  | -133 | -70  | -72  | This datum has been updated, see ID# 73 <sup>c</sup>          | Clarke 1866        |
| 34        | MERCH  | 31   | 146  | 47   | Merchich (Morocco)  | Clarke 1880        |
| 35        | NAHR   | -231 | -196 | 482  | This datum has been updated, see ID# 74 <sup>c</sup>          | Clarke 1880        |
| 36        | NAD83  | 0    | 0    | 0    | N. American 1983 (Includes Areas 37-42)                       | GRS-80             |
| 37        | CANADA | -10  | 158  | 187  | N. American Canada 1927                                       | Clarke 1866        |
| 38        | ALASKA | -5   | 135  | 172  | N. American Alaska 1927                                       | Clarke 1866        |

*Continued on the following page.*

**Table 22: Datum Transformation Parameters**

| Datum ID# | NAME   | DX   | DY   | DZ   | DATUM DESCRIPTION                                    | ELLIPSOID          |
|-----------|--------|------|------|------|--|--------------------|
| 39        | NAD27  | -8   | 160  | 176  | N. American Conus 1927                               | Clarke 1866        |
| 40        | CARIBB | -7   | 152  | 178  | This datum has been updated, see ID# 75 <sup>c</sup> | Clarke 1866        |
| 41        | MEXICO | -12  | 130  | 190  | N. American Mexico                                   | Clarke 1866        |
| 42        | CAMER  | 0    | 125  | 194  | N. American Central America                          | Clarke 1866        |
| 43        | MINNA  | -92  | -93  | 122  | Nigeria (Minna)                                      | Clarke 1880        |
| 44        | OMAN   | -346 | -1   | 224  | Oman   | Clarke 1880        |
| 45        | PUERTO | 11   | 72   | -101 | Puerto Rica and Virgin Islands                       | Clarke 1866        |
| 46        | QORNO  | 164  | 138  | -189 | Qornoq (South Greenland)                             | International 1924 |
| 47        | ROME   | -255 | -65  | 9    | Rome 1940 Sardinia Island                            | International 1924 |
| 48        | CHUA   | -134 | 229  | -29  | South American Chua Astro (Paraguay)                 | International 1924 |
| 49        | SAM56  | -288 | 175  | -376 | South American (Provisional 1956)                    | International 1924 |
| 50        | SAM69  | -57  | 1    | -41  | South American 1969                                  | S. American 1969   |
| 51        | CAMPO  | -148 | 136  | 90   | S. American Campo Inchauspe (Argentina)              | International 1924 |
| 52        | SACOR  | -206 | 172  | -6   | South American Corrego Alegre (Brazil)               | International 1924 |
| 53        | YACAR  | -155 | 171  | 37   | South American Yacare (Uruguay)                      | International 1924 |
| 54        | TANAN  | -189 | -242 | -91  | Tananarive Observatory 1925 (Madagascar)             | International 1924 |
| 55        | TIMBA  | -689 | 691  | -46  | This datum has been updated, see ID# 85 <sup>c</sup> | Everest (EB)       |
| 56        | TOKYO  | -128 | 481  | 664  | This datum has been updated, see ID# 86 <sup>c</sup> | Bessel 1841        |
| 57        | TRIST  | -632 | 438  | -609 | Tristan Astro 1968 (Tristan du Cunha)                | International 1924 |
| 58        | VITI   | 51   | 391  | -36  | Viti Levu 1916 (Fiji Islands)                        | Clarke 1880        |

*Continued on the following page.*

Table 22: Datum Transformation Parameters

| Datum ID# | NAME  | DX          | DY         | DZ         | DATUM DESCRIPTION  | ELLIPSOID          |
|-----------|-------|-------------|------------|------------|--|--------------------|
| 59        | WAK60 | 101         | 52         | -39        | This datum has been updated, see ID# 67 <sup>c</sup>     | Hough 1960         |
| 60        | WGS72 | 0           | 0          | 4.5        | World Geodetic System - 72                               | WGS72              |
| 61        | WGS84 | 0           | 0          | 0          | World Geodetic System - 84                               | WGS84              |
| 62        | ZANDE | -265        | 120        | -358       | Zanderidj (Surinam)                                      | International 1924 |
| 63        | USER  | 0           | 0          | 0          | User Defined Datum Defaults                              | User <sup>a</sup>  |
| 64        | CSRS  | -0.983<br>3 | 1.90<br>82 | 0.48<br>78 | Canadian Spatial Ref. System (epoch 2005.0)              | GRS-80             |
| 65        | ADIM  | -166        | -15        | 204        | Adindan (Ethiopia, Mali, Senegal & Sudan) <sup>c</sup>   | Clarke 1880        |
| 66        | ARSM  | -160        | -6         | -302       | ARC 1960 (Kenya, Tanzania) <sup>c</sup>                  | Clarke 1880        |
| 67        | ENW   | 102         | 52         | -38        | Wake-Eniwetok (Marshall Islands) <sup>c</sup>            | Hough 1960         |
| 68        | HTN   | -637        | -549       | -203       | Hu-Tzu-Shan (Taiwan) <sup>c</sup>                        | International 1924 |
| 69        | INDB  | 282         | 726        | 254        | Indian (Bangladesh) <sup>d</sup>                         | Everest (EA)       |
| 70        | INDI  | 295         | 736        | 257        | Indian (India, Nepal) <sup>d</sup>                       | Everest (EA)       |
| 71        | IRL   | 506         | -122       | 611        | Ireland 1965 <sup>d</sup>                                | Modified Airy      |
| 72        | LUZA  | -133        | -77        | -51        | Luzon (Philippines excluding Mindanao Is.) <sup>de</sup> | Clarke 1866        |
| 73        | LUZB  | -133        | -79        | -72        | Mindanao Island <sup>c</sup>                             | Clarke 1866        |
| 74        | NAHC  | -243        | -192       | 477        | Nahrwan (Saudi Arabia) <sup>c</sup>                      | Clarke 1880        |
| 75        | NASP  | -3          | 142        | 183        | N. American Caribbean <sup>c</sup>                       | Clarke 1866        |
| 76        | OGBM  | 375         | -111       | 431        | Great Britain 1936 (Ordinance Survey) <sup>d</sup>       | Airy 1830          |
| 77        | OHAA  | 89          | -279       | -183       | Hawaiian Hawaii <sup>d</sup>                             | Clarke 1866        |
| 78        | OHAB  | 45          | -290       | -172       | Hawaiian Kauai <sup>d</sup>                              | Clarke 1866        |

*Continued on the following page.*

**Table 22: Datum Transformation Parameters**

| Datum ID# | NAME | DX   | DY   | DZ   | DATUM DESCRIPTION                                     | ELLIPSOID          |
|-----------|------|------|------|------|---|--------------------|
| 79        | OHAC | 65   | -290 | -190 | Hawaiian Maui <sup>d</sup>                            | Clarke 1866        |
| 80        | OHAD | 58   | -283 | -182 | Hawaiian Oahu <sup>d</sup>                            | Clarke 1866        |
| 81        | OHIA | 229  | -222 | -348 | Hawaiian Hawaii <sup>d</sup>                          | International 1924 |
| 82        | OHIB | 185  | -233 | -337 | Hawaiian Kauai <sup>d</sup>                           | International 1924 |
| 83        | OHIC | 205  | -233 | -355 | Hawaiian Maui <sup>d</sup>                            | International 1924 |
| 84        | OHID | 198  | -226 | -347 | Hawaiian Oahu <sup>d</sup>                            | International 1924 |
| 85        | TIL  | -679 | 669  | -48  | Timbalai (Brunei and East Malaysia) 1948 <sup>c</sup> | Everest (EB)       |
| 86        | TOYM | -148 | 507  | 685  | Tokyo (Japan, Korea and Okinawa) <sup>c</sup>         | Bessel 1841        |

- The default user datum is WGS84. See also the USERDATUM and USEREXPDATUM commands starting on *Page 210*. The following logs report the datum used according to the OEM card Datum ID column: BESTPOS, BESTUTM, MATCHEDPOS and PSRPOS.
- The DX, DY and DZ offsets are from your local datum to WGS84.
- The updated datum have the new x, y and z translation values updated to the latest numbers. The old datum values can still be used for backwards compatibility.
- Use the corrected datum only (with the higher ID#) as the old datum is incorrect.
- The original LUZON values are the same as for LUZA but the original has an error in the code.

## 2.5.18 DGPSEPHMDELAY DGPS ephemeris delay V123\_DGPS

The DGPSEPHMDELAY command is used to set the ephemeris delay when operating as a base station. The ephemeris delay sets a time value by which the base station continues to use the old ephemeris data. A delay of 120 to 300 seconds typically ensures that the rover stations have collected updated ephemeris. After the delay period is passed, the base station begins using new ephemeris data.

The factory default of 120 seconds matches the RTCM standard.

- 
- ☒ The RTCA Standard stipulates that a base station shall wait five minutes after receiving a new ephemeris before transmitting differential corrections to rover stations that are using the RTCA standard. This time interval ensures that the rover stations have received the new ephemeris, and have computed differential positioning based upon the same ephemeris. Therefore, for RTCA base stations, the recommended ephemeris delay is 300 seconds.
- 

### Abbreviated ASCII Syntax:

Message ID: 142

DGPSEPHMDELAY delay

### Factory Default:

dgpsephemdelay 120

### ASCII Example (base):

dgpsephemdelay 120



When using differential corrections, the rover receiver must use the same set of broadcast ephemeris parameters as the base station generating the corrections. The Issue of Ephemeris Data (IODE) parameter is transmitted as part of the differential correction so that the rover can guarantee that its and the base station ephemerides match. The DGPSEPHMDELAY parameter should be large enough to ensure that the base station is not using a new set of ephemerides that has not yet been received at the rover receiver.

---

| Field | Field Type           | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|----------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | DGPSEPHMDELAY header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | delay                | 0 to 600 s  |              | Minimum time delay before new ephemeris is used (default = 120 s)  | ULong         | 4            | H             |



### 2.5.19 DGPSTIMEOUT Set maximum age of differential data V123\_DGPS

This command is used to set the maximum age of pseudorange differential data to use when operating as a rover station. Pseudorange differential data received that is older than the specified time is ignored. RTK differential data is set at 60 seconds but can be changed using the RTKTIMEOUT command, see *Page 180*. See DGPSEPHMDELAY on *page 103* to set the ephemeris changeover delay for base stations.

---

☒ The RTCA Standard for SCAT-I stipulates that the maximum age of differential correction messages cannot be greater than 22 seconds. Therefore, for RTCA rover users, the recommended DGPS delay setting is 22.

---

**Abbreviated ASCII Syntax:**

**Message ID: 127**

DGPSTIMEOUT delay

**Factory Default:**

dgpstimeout 300

**ASCII Example (rover):**

dgpstimeout 60



DGPSTIMEOUT only applies to local pseudorange differential (RTCA, RTCM and OmniSTAR VBS) corrections as if they were from a local base station.

---

| Field | Field Type         | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|--------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | DGPSTIMEOUT header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | delay              | 2 to 1000 s |              | Maximum pseudorange differential age (default = 300 s)   | ULong         | 4            | H             |

## 2.5.20 DGPSTXID DGPS transmit ID V123\_DGPS

This command sets the station ID value for the receiver when it is transmitting corrections. This allows for the easy identification of which base station was the source of the data.

For example, if you want to compare RTCM and RTCMV3 corrections, you would be easily able to identify their base stations by first setting their respective DGPSTXID values.

**Abbreviated ASCII Syntax:**

**Message ID: 144**

DGPSTXID type ID

**Factory Default:**

dgpstxid auto "any"

**ASCII Examples:**

|                      |                               |
|----------------------|-------------------------------|
| dgpstxid rcm 2       | - using an rcm type and id    |
| dgpstxid cmr 30      | - using a cmr type and id     |
| dgpstxid cmr "any"   | - using the default cmr id    |
| dgpstxid rtca d36d   | - using an rtca type and id   |
| dgpstxid rtcmv3 2050 | - using an rtcmv3 type and id |



How long do I need to sit on a 10 km baseline?

How long you need to occupy stations for a 10 km baseline depends on the system you are using and what type of precision you require. There are three major categories we can look at:

- for a DGPS system using only L1 C/A-code data, all you require is a single epoch of common data. Typically, you would log a few minutes worth of data. The type of precision you can expect out of this system is in the 1 meter range.
- for a DGPS system using L1 C/A-code and carrier data, you require approximately 5 minutes of data including the initialization procedure under optimal conditions. This type of system provides you with precision in the 10 cm range. If cm-level precision is required, you need approximately 30 to 40 minutes of data, again under optimal conditions.
- for a DGPS system using L1 C/A-code and carrier data along with L2 P-code and carrier data, you require approximately 10 to 20 minutes of data under optimal conditions. This type of system provides you with precision in the cm range.

The term optimal conditions refers to observing six or more healthy satellites being tracked with a geometric dilution of precision - GDOP value of less than 5 and relatively low multi-path. Note that the above situations apply to both real-time and post-processed solutions with minor differences.

| Field | Field Type      | ASCII Value                         | Binary Value  | Description  | Binary Format   | Binary Bytes          | Binary Offset |
|-------|-----------------|-------------------------------------|---|--|-----------------|-----------------------|---------------|
| 1     | DGPSTXID header | -                                   | -   | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -               | H                     | 0             |
| 2     | type            | See Table 33, DGPS Type on Page 166 |   | ID Type  | Enum            | 4                     | H             |
| 3     | ID              | String [max. 5] or "ANY"            | ID string<br>ANY type defaults:<br>RTCM - 0<br>RTCMV3 - 0<br>RTCA - AAAA<br>CMR - 0<br>The following range values are in affect:<br>$0 \leq \text{CMR ID} \leq 31$<br>$0 \leq \text{RTCM ID} \leq 1023$<br>$0 \leq \text{RTCMV3 ID} \leq 4095$<br>RTCA: any four character string containing only alpha (a-z) or numerical characters (0-9) |  | String [max. 5] | Variable <sup>a</sup> | Variable      |

a. In the binary log case, additional bytes of padding are added to maintain 4-byte alignment

## 2.5.21 DIFFCODEBIASCONTROL *Enable or disable satellite differential code biases V123*

The purpose of the differential code biases is to correct pseudorange errors that affect the L1/L2 ionospheric corrections. This command enables/disables the biases. A set of biases is included in the firmware, and use of the biases is enabled by default. See also the SETDIFFCODEBIASES command on page 191.

**Abbreviated ASCII Syntax:**

**Message ID: 913**

DIFFCODEBIASCONTROL switch

**Factory Default:**

diffcodebiascontrol enable

**Example:**

diffcodebiascontrol disable

| Field | Field Type                   | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|------------------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | DIFFCODE-BIAS-CONTROL header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | switch                       | DISABLE     | 0            | Disable the differential code bias   | Enum          | 4            | H             |
|       |                              | ENABLE      | 1            | Enable the differential code bias (default)  |               |              |               |

### 2.5.22 DYNAMICS Tune receiver parameters V123

This command adjusts the receiver dynamics to that of your environment. It is used to optimally tune receiver parameters.

The DYNAMICS command adjusts the Tracking State transition time-out value of the receiver, see *Table 69, Tracking State on Page 394*. When the receiver loses the position solution, see *Table 51, Solution Status on Page 249*, it attempts to steer the tracking loops for fast reacquisition (5 s time-out by default). The DYNAMICS command allows you to adjust this time-out value, effectively increasing the steering time. The three states 0, 1, and 2 set the time-out to 5, 10, or 20 s respectively.

- 
- ☒ 1. The DYNAMICS command should only be used by advanced users. The default of AIR should **not** be changed except under very specific conditions.
  - 2. The DYNAMICS command affects satellite reacquisition. The constraint of its filter with FOOT is very tight and is appropriate for a user on foot. A sudden tilted or up and down movement, for example while a tractor is moving slowly along a track, may trip the RTK filter to reset and cause the position to jump. AIR should be used in this case.
- 

**Abbreviated ASCII Syntax:**

**Message ID: 258**

DYNAMICS dynamics

**Factory Default:**

dynamics air

**Example:**

dynamics foot

**Table 23: User Dynamics**

| Binary | ASCII | Description   |
|--------|-------|---|
| 0      | AIR   | Receiver is in an aircraft or a land vehicle, for example a high speed train, with velocity greater than 110 km/h (30 m/s). This is also the most suitable dynamic for a jittery vehicle at any speed. See also <i>Note #2</i> above. |
| 1      | LAND  | Receiver is in a stable land vehicle with velocity less than 110 km/h (30 m/s)  |
| 2      | FOOT  | Receiver is being carried by a person with velocity less than 11 km/h (3 m/s)   |



Qualifying North American Solar Challenge cars annually weave their way through 1000's of miles between the US and Canada. GPS keeps them on track through many intersections on secondary highways and gives the Calgary team constant intelligence on the competition's every move. In this case, with average speeds of 46 miles/hour and at times a jittery vehicle, air is the most suitable dynamic.

| Field | Field Type      | ASCII Value  | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|-----------------|--------------|--------------|--|---------------|--------------|---------------|
| 1     | DYNAMICS header | -            | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | dynamics        | See Table 23 |              | Receiver dynamics based on your environment  | Enum          | 4            | H             |

### 2.5.23 ECUTOFF Set satellite elevation cut-off V123

This command sets the elevation cut-off angle for tracked satellites. The receiver does not start automatically searching for a satellite until it rises above the cut-off angle. Tracked satellites that fall below the cut-off angle are no longer tracked unless they were manually assigned (see the ASSIGN command).

In either case, satellites below the ECUTOFF angle are eliminated from the internal position and clock offset solution computations.

This command permits a negative cut-off angle; it could be used in these situations:

- The antenna is at a high altitude, and thus can look below the local horizon
- Satellites are visible below the horizon due to atmospheric refraction

- 
- ☒ 1. Care must be taken when using ECUTOFF because the signals from lower elevation satellites are travelling through more atmosphere and are therefore degraded. Use of satellites below 5 degrees is not recommended.
2. This command does not affect the tracking of SBAS or GLONASS satellites.
- 

**Abbreviated ASCII Syntax:**

**Message ID: 50**

ECUTOFF angle

**Factory Default:**

ecutoff 5.0

**ASCII Example:**

ecutoff 10.0



A low elevation satellite is a satellite the receiver tracks "just" above the horizon. Generally, a satellite is considered low elevation if it is anywhere between 0 and 15 degrees above the horizon. Low elevation satellites are usually setting or rising.

There is no difference in the data transmitted from a low elevation satellite to that transmitted from a higher elevation satellite. However, differences in the signal path of a low elevation satellite make their use less desirable. Low elevation satellite signals are noisier due to the increased amount of atmosphere they must travel through. In addition, signals from low elevation satellites don't fit the assumption that a GPS signal travels in air nearly the same as in a vacuum. As such, using low elevation satellites in the solution results in greater position inaccuracies.

The elevation cut-off angle is specified with ECUTOFF to ensure that noisy, low elevation satellite data below the cut-off is not used in computing a position. If post-processing data, it is still best to collect all data (even that below the cut-off angle). Experimenting with different cut-off angles can then be done to provide the best results. In cases where there are not enough satellites visible, a low elevation satellite may actually help in providing a useful solution.

| Field | Field Type     | ASCII Value   | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|----------------|---------------|--------------|--|---------------|--------------|---------------|
| 1     | ECUTOFF header | -             | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | angle          | ±90.0 degrees |              | Elevation cut-off angle relative to horizon  | Float         | 4            | H             |

## 2.5.24 EXTERNALCLOCK Set external clock parameters V23

### Overview

The EXTERNALCLOCK command allows the OEMV card to operate with an optional external oscillator. You are able to optimally adjust the clock model parameters of these receivers for various types of external clocks.

- 
- ☒ 1. This command affects the interpretation of the CLOCKMODEL log.
  - 2. If the EXTERNALCLOCK command is enabled and set for an external clock (TCXO, OCXO, RUBIDIUM, CESIUM, or USER) and the CLOCKADJUST command, see *Page 79*, is ENABLED, then the clock steering process takes over the VARF output pins and may conflict with a previously entered FREQUENCYOUT command, see *Page 121*. If clocksteering is not used with the external oscillator, the clocksteering process must be disabled by using the CLOCKADJUST DISABLE command.
  - 3. When using the EXTERNALCLOCK and CLOCKADJUST commands together, issue the EXTERNALCLOCK command first to avoid losing satellites.
- 

There are three steps involved in using an external oscillator:

1. Follow the procedure outlined in the *OEMV Family Installation and Operation User Manual* to connect an external oscillator to your OEMV.
2. Using the EXTERNALCLOCK command, select a standard oscillator and its operating frequency.
3. Using the CLOCKADJUST command, disable the clocksteering process if external clocksteering is not used.

### Theory

An unsteered oscillator can be approximated by a three-state clock model, with two states representing the range bias and range bias rate, and a third state assumed to be a Gauss-Markov (GM) process representing the range bias error generated from satellite clock dither. The third state is included because the Kalman filter assumes an (unmodeled) white input error. The significant correlated errors produced by satellite clock dither are obviously not white and the Markov process is an attempt to handle this kind of short-term variation.

The internal units of the new clock model's three states (offset, drift and GM state) are meters, meters per second, and meters. When scaled to time units for the output log, these become seconds, seconds per second, and seconds, respectively. Note that the old units of the third clock state (drift rate) were meters per second per second.

The user has control over 3 process noise elements of the linear portion of the clock model. These are the  $h_0$ ,  $h_{-1}$ , and  $h_{-2}$  elements of the power law spectral density model used to describe the frequency noise characteristics of oscillators:



$$S_y(f) = \frac{h_{-2}}{f^2} + \frac{h_{-1}}{f} + h_0 + h_1 f + h_2 f^2$$

where  $f$  is the sampling frequency and  $S_y(f)$  is the clock's power spectrum. Typically only  $h_0$ ,  $h_{-1}$ , and  $h_{-2}$  affect the clock's Allan variance and the clock model's process noise elements.

## Usage

Before you use an optional external oscillator, several clock model parameters must be set. There are default settings for a voltage-controlled temperature-compensated crystal oscillator (VCTCXO), ovenized crystal oscillator (OCXO), Rubidium and Cesium standard, which are given in *Table 25* on *page 114*. You may alternatively choose to supply customized settings.



The EXTERNALCLOCK command determines whether the OEMV receiver (OEMV-2, OEMV-3, DL-V3 or ProPak-V3 only) uses its own internal temperature-compensated crystal oscillator, or that of an external oscillator, as a frequency reference. It also sets which clock model is used for an external oscillator.

To force the OEMV to use the internal oscillator, use the EXTERNALCLOCK DISABLE command and physically disconnect the external oscillator input. Do not use the EXTERNALCLOCK OCXO, CESIUM, RUBIDIUM or USER parameters if there is no external oscillator connected to the OEMV.

### Abbreviated ASCII Syntax:

**Message ID: 230**

EXTERNALCLOCK clocktype [freq] [h<sub>0</sub>[h<sub>-1</sub>[h<sub>-2</sub>]]]

### Factory Default:

externalclock disable

### ASCII Examples:

externalclock user 10mhz 1.0167e-23 6.87621e-25 8.1762e-26

externalclock tcxo 5mhz

**Table 24: Clock Type**

| ASCII    | Binary | Description   |
|----------|--------|---|
| DISABLE  | 0      | Turns the external clock input off, reverts back to the on-board VCTCXO |
| TCXO     | 1      | Sets the pre-defined values for a VCTCXO                                |
| OCXO     | 2      | Sets the pre-defined values for an OCXO                                 |
| RUBIDIUM | 3      | Sets the pre-defined values for a rubidium oscillator                   |
| CESIUM   | 4      | Sets the pre-defined values for a cesium oscillator                     |
| USER     | 5      | Defines custom process noise elements                                   |

**Table 25: Pre-Defined Values for Oscillators**

| Clock Type | $h_0$     | $h_{-1}$  | $h_{-2}$  |
|------------|-----------|-----------|-----------|
| VCTCXO     | 1.0 e-21  | 1.0 e-20  | 1.0 e-20  |
| OCXO       | 2.51 e-26 | 2.51 e-23 | 2.51 e-22 |
| Rubidium   | 1.0 e-23  | 1.0 e-22  | 1.3 e-26  |
| Cesium     | 2.0 e-20  | 7.0 e-23  | 4.0 e-29  |

| Field | Field Type           | ASCII Value              | Binary Value | Description   | Binary Format | Binary Bytes | Binary Offset |
|-------|----------------------|--------------------------|--------------|---|---------------|--------------|---------------|
| 1     | EXTERNALCLOCK header | -                        | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.  | -             | H            | 0             |
| 2     | clocktype            | See Table 24 on page 114 |              | Clock type  | Enum          | 4            | H             |
| 3     | freq                 | 0MHz                     | 0            | Optional frequency. If a value is not specified, the default is 5 MHz.  | Enum          | 4            | H+4           |
|       |                      | 5MHz                     | 1            |   |               |              |               |
|       |                      | 10MHz                    | 2            |   |               |              |               |
|       |                      | 20MHz                    | 3            |   |               |              |               |
| 4     | $h_0$                | 1.0 e-31 to 1.0 e-18     |              | Optional timing standards. These fields are only valid when the USER clocktype is selected. Do not use h values with VCTCXO, OCXO, CESIUM, or RUBIDIUM clock types. The h values for these options are fixed, see Table 25. | Double        | 8            | H+8           |
| 5     | $h_{-1}$             | 1.0 e-31 to 1.0 e-18     |              |   | Double        | 8            | H+16          |
| 6     | $h_{-2}$             | 1.0 e-31 to 1.0 e-18     |              |   | Double        | 8            | H+24          |

### 2.5.25 FIX Constrain to fixed height or position V123

This command fixes various parameters of the receiver such as height or position. For various applications, fixing these values can assist in improving acquisition times and accuracy of position or corrections. For example, fixing the position and height is a requirement for differential base stations as it provides a truth position to base the differential corrections from.

If you enter a FIXPOSDATUM command, see *page 119*, the FIX command is then issued internally with the FIXPOSDATUM command values translated to WGS84. It is the FIX command that appears in the RXCONFIG log. If the FIX or the FIXPOSDATUM command are used, their newest values overwrite the internal FIX values.

- 
- ☒ 1. NovAtel strongly recommends that the FIX POSITION entered be good to within a few meters. This level of accuracy can be obtained from a receiver using single point positioning once 5 or 6 satellites are being tracked.
  - 2. FIX POSITION should only be used for base station receivers. Applying FIX POSITION to a rover, switches it from RT20, or RT2, mode to a fixed position mode. Applying FIX POSITION to the rover does not speed up ambiguity resolution.
  - 3. Any setting other than FIX POSITION disables output of differential corrections unless the MOVINGBASESTATION command is set to ENABLE, see also *page 153*.
  - 4. You can fix the position of the receiver using latitude, longitude and height in Mean Sea Level (MSL) or ellipsoidal parameters depending on the UNDULATION setting. The factory default for the UNDULATION setting is TABLE where the height entered in the FIX command is set as MSL height. If you change the UNDULATION setting to USER 0, the height entered in the FIX command is set as ellipsoidal height. See also *page 204*.
- 

Error checking is done on the entered fixed position. If less than 3 measurements are available, the solution status indicates PENDING. While the status is PENDING, the fixed position value is not used internally (for example, for updating the clock model, or controlling the satellite signal search). Once 3 or more measurements are available, error checking is performed. If the error check passes, the solution status changes to SOL\_COMPUTED, and the fixed position is used internally. At the first level of error, when the fixed position is off by approximately 25-50 m, the output position log indicates INTEGRITY\_WARNING in the solution status field, but the fixed position value is still used internally. If the error reaches the second level, a few km, the receiver does not use the fixed position at all and indicates INVALID\_FIX in the solution status. Note that a fixed position obtained from the POSAVE function is treated the same way in the error checking as one entered manually.

#### Abbreviated ASCII Syntax:

Message ID: 44

FIX type [param1 [param2 [param3]]]

#### Factory Default:

fix none

#### ASCII Example:

fix height 4.567



In order to maximize accuracy of an RTK survey, you must fix the base station coordinates to their known position using the FIX [lat][lon][hgt] command. This ensures the accuracy of their corrections.

**Table 26: FIX Parameters**

| ASCII Type Name | Parameter 1  | Parameter 2  | Parameter 3  |
|-----------------|--|--|--|
| AUTO            | Not used   | Not used   | Not used   |
| HEIGHT          | Default MSL height <sup>a b</sup><br>(-1000 to 20000000 m)                                   | Not used   | Not used   |
| NONE            | Not used   | Not used   | Not used   |
| POSITION        | Lat (-90 to 90 degrees)<br>where a '-' sign<br>denotes south and a<br>'+' sign denotes north | Lon (-360 to 360 degrees)<br>where a '-' sign denotes<br>west and a '+' sign<br>denotes east | Default MSL height <sup>a b</sup><br>(-1000 to 20000000 m) |

- a. For a discussion on height, refer to the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm>.
- b. See also *Note #4* on page 115

**Table 27: Fix Types**

| ASCII Name  | Binary Value | Description   |
|-------------|--------------|---|
| NONE        | 0            | Unfix. Clears any previous FIX commands.  |
| AUTO        | 1            | Configures the receiver to fix the height at the last calculated value if the number of satellites available is insufficient for a 3-D solution. This provides a 2-D solution. Height calculation resumes when the number of satellites available allows a 3-D solution.  |
| HEIGHT      | 2            | <p>Configures the receiver in 2-D mode with its height constrained to a given value. This command is used mainly in marine applications where height in relation to mean sea level may be considered to be approximately constant. The height entered using this command is referenced to the mean sea level, see the BESTPOS log on <i>Page 247</i>, and is in meters. The receiver is capable of receiving and applying differential corrections from a base station while FIX HEIGHT is in effect. The FIX HEIGHT command overrides any previous FIX HEIGHT or FIX POSITION command.</p> <hr/> <p><input checked="" type="checkbox"/> This command only affects pseudorange corrections and solutions, and so has no meaning within the context of RTK.</p> <hr/>  |
| POSITION    | 3            | <p>Configures the receiver with its position fixed. This command is used when it is necessary to generate differential corrections.</p> <p>For both pseudorange and differential corrections, this command must be properly initialized before the receiver can operate as a GPS base station. Once initialized, the receiver computes differential corrections for each satellite being tracked. The computed differential corrections can then be output to rover stations by utilizing any of the following receiver differential corrections data log formats: RTCM, RTCMV3, RTCA, or CMR. See the <i>OEMV Family Installation and Operation User Manual</i> for information on using the receiver for differential applications.</p> <p>The values entered into the FIX POSITION command should reflect the precise position of the base station antenna phase centre. Any errors in the FIX POSITION coordinates directly bias the corrections calculated by the base receiver.</p> <p>The receiver performs all internal computations based on WGS84 and the datum command is defaulted as such. The datum in which you choose to operate (by changing the DATUM command) is internally converted to and from WGS84. Therefore, all differential corrections are based on WGS84, regardless of your operating datum.</p> <p>The FIX POSITION command overrides any previous FIX HEIGHT or FIX POSITION command settings.</p> |
| PENDING     | 18           | There is not enough measurements available to verify the FIX POSITION entry   |
| INVALID_FIX | 19           | The errors in the FIX POSITION entry are too large  |

| Field | Field Type | ASCII Value              | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|------------|--------------------------|--------------|--|---------------|--------------|---------------|
| 1     | FIX header | -                        | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | type       | See Table 27 on page 117 |              | Fix type   | Enum          | 4            | H             |
| 3     | param1     | See Table 26             |              | Parameter 1  | Double        | 8            | H + 4         |
| 4     | param2     |                          |              | Parameter 2  | Double        | 8            | H + 12        |
| 5     | param3     |                          |              | Parameter 3  | Double        | 8            | H + 20        |

## 2.5.26 FIXPOSDATUM Set position in a specified datum V123

This command sets the position by referencing the position parameters through a specified datum. The position is transformed into the same datum as that in the receiver’s current setting. The FIX command, see *page 115*, is then issued internally with the FIXPOSDATUM command values. It is the FIX command that appears in the RXCONFIG log. If the FIX or the FIXPOSDATUM command are used, their newest values overwrite the internal FIX values.

**Abbreviated ASCII Syntax:**

**Message ID: 761**

FIXPOSDATUM datum [lat [lon [height]]]

**Factory Default:**

fixposdatum none

**ASCII Example:**

fixposdatum user 51.11633810554 -114.03839550586 1048.2343



You can use the FIXPOSDATUM command in a survey to fix the position with values from another known datum, rather than transforming them into WGS84 yourself.

| Field | Field Type         | ASCII Value             | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|--------------------|-------------------------|--------------|--|---------------|--------------|---------------|
| 1     | FIXPOSDATUM header | -                       | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | datum              | See Table 21 on page 97 |              | Datum ID   | Enum          | 4            | H             |
| 3     | lat                | ±90                     |              | Latitude (degrees)   | Double        | 8            | H + 4         |
| 4     | lon                | ±360                    |              | Longitude (degrees)  | Double        | 8            | H + 12        |
| 5     | height             | -1000 to 20000000       |              | Mean sea level (MSL) height (m) <sup>a</sup>   | Double        | 8            | H + 20        |

- a. For a discussion on height, refer to the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm>.

## 2.5.27 FORCEGPSL2CODE Force receiver to track L2 P or L2C code V23\_L2C

This command allows you to force the receiver to track L2 P-code or L2C code. AUTO tells the receiver to use L2C code type if available and L2P-code if L2C code is not available.

- 
- There are two channels on L2 tracking, one is P and the other is C. When you set the L2 channel to P it can choose between P(Y) or P. In this case, it automatically tracks P(Y)
- 

**Abbreviated ASCII Syntax:**

**Message ID: 796**

FORCEGPSL2CODE L2type

**Factory Default:**

forcegpsl2code default

**ASCII Example:**

forcegpsl2code p

**Table 28: FL2 Code Type**

| Binary | ASCII   | Description                                   |
|--------|---------|---|
| 0      | AUTO    | Receiver uses the best L2 code type available |
| 1      | P       | L2 P-code or L2 Precise code                  |
| 2      | C       | L2C code or L2 Civilian code                  |
| 3      | DEFAULT | Set to channel default                        |



Only use this command if you want to evaluate L2C measurements and do not require a position. L2C measurements are currently not used in the position solution calculations.

---

| Field | Field Type             | ASCII Value        | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|------------------------|--------------------|--------------|--|---------------|--------------|---------------|
| 1     | FORCEGPSL2-CODE header | -                  | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | L2type                 | See Table 28 above |              | GPS L2 code type   | Enum          | 4            | H             |



## 2.5.28 **FREQUENCYOUT** Set output pulse train available on VARF V123

This command sets the output pulse train available on the variable frequency (VARF) pin. The output waveform is coherent with the 1PPS output, see the usage note and *Figure 3* below.

- 
- ☒ If the CLOCKADJUST command is ENABLED, see *Page 79*, and the receiver is configured to use an external reference frequency (set in the EXTERNALCLOCK command, see *Page 112*, for an external clock - TCXO, OCXO, RUBIDIUM, CESIUM, or USER), then the clock steering process takes over the VARF output pins and may conflict with a previously entered FREQUENCYOUT command.
- 



*Figure 3*, below, shows how the chosen pulse width is frequency locked but not necessarily phase locked.

### Abbreviated ASCII Syntax:

Message ID: 232

FREQUENCYOUT [switch] [pulsewidth] [period]

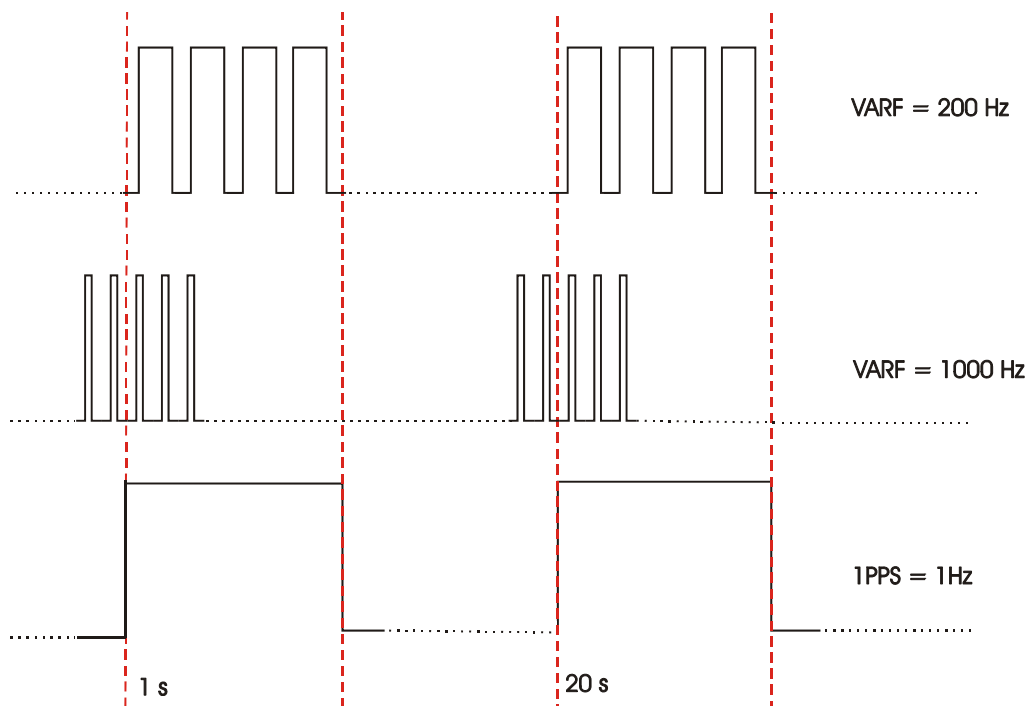
### Factory Default:

frequencyout disable

### ASCII Example:

frequencyout enable 2 4

This example generates a 50% duty cycle 10 MHz square wave.



**Figure 3: Pulse Width and 1PPS Coherency**

| Field | Field Type          | ASCII Value   | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|---------------------|---------------|--------------|--|---------------|--------------|---------------|
| 1     | FREQUENCYOUT header | -             | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.   | -             | H            | 0             |
| 2     | switch              | DISABLE       | 0            | Disable causes the output to be fixed low (default)  | Enum          | 4            | H             |
|       |                     | ENABLE        | 1            | Enables customized frequency output  |               |              |               |
| 3     | pulsewidth          | (0 to 262144) |              | <p>Number of 25 ns steps for which the output is high.</p> <p>Duty cycle = pulsewidth / period.</p> <p>Must be less than or equal to the period. (default = 0).</p> <p>If pulsewidth is the same as the period, the output is a high DC signal. If pulsewidth is 1/2 the period, then the output is a square wave.</p> | Ulong         | 4            | H+4           |
| 4     | period              | (0 to 262144) |              | <p>Signal period in 25 ns steps.</p> <p>Frequency Output = 40,000,000 / Period (default = 0)</p>   | Ulong         | 4            | H+8           |

## 2.5.29 FRESET Clear selected data from NVM and reset V123

This command clears data which is stored in non-volatile memory. Such data includes the almanac, ephemeris, and any user-specific configurations. The commands, ephemeris, almanac, and L-band related data, excluding the subscription information, can be cleared by using the STANDARD target. The model can only be cleared by using the MODEL target. The receiver is forced to hardware reset. In addition, values entered using the CLOCKCALIBRATE, or the ASSIGNLBAND OMNISTARNARROW, command can only be cleared by using the STANDARD target.

---

☒ FRESET STANDARD (which is also the default) causes any commands, ephemeris, GPS almanac and SBAS almanac data (COMMAND, GPSALMANAC, GPSEPHEM and SBASALMANAC in Table 29) previously saved to NVM to be erased.

---

### Abbreviated ASCII Syntax:

Message ID: 20

FRESET [target]

### Input Example:

freset command



If you are receiving no data or random data from your receiver, try these before contacting NovAtel:

- Verify that the receiver is tracking satellites
  - Check the integrity and connectivity of power and data cables
  - Verify the baud rate settings of the receiver and terminal device (your PC, data logger, or laptop)
  - Switch COM ports
  - Issue a FRESET command
-

**Table 29: FRESET Target**

| Binary | ASCII             | Description   |
|--------|-------------------|---|
| 0      | STANDARD          | Resets commands, ephemeris, and almanac (default). Also resets all L-band related data except for the subscription information. |
| 1      | COMMAND           | Resets the stored commands (saved configuration)  |
| 2      | GPSALMANAC        | Resets the stored GPS almanac   |
| 3      | GPSEPHEM          | Resets the stored GPS ephemeris   |
| 4      | GLOEPHEM          | Resets the stored GLONASS ephemeris   |
| 5      | MODEL             | Resets the currently selected model   |
| 11     | CLKCALIBRATION    | Resets the parameters entered using the CLOCKCALIBRATE command  |
| 20     | SBASALMANAC       | Resets the stored SBAS almanac  |
| 21     | LAST_POSITION     | Resets the position using the last stored position  |
| 31     | GLOALMANAC        | Resets the stored GLONASS almanac   |
| 38     | LBAND_TCXO_OFFSET | Removes the TCXO offset information from NVM  |

| Field | Field Type    | ASCII Value  | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|---------------|--------------|--------------|--|---------------|--------------|---------------|
| 1     | FRESET header | -            | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | target        | See Table 29 |              | What data is to be reset by the receiver   | Enum          | 4            | H             |

### 2.5.30 GGAQUALITY *Customize the GPGGA GPS quality indicator VI23\_NMEA*

This command allows you to customize the NMEA GPGGA GPS quality indicator. See also the GPGGA log on *page 310*.

**Abbreviated ASCII Syntax:**

**Message ID: 691**

GGAQUALITY #entries [pos type1][qual1] [pos type2] [qual2]...

**Input Example 1:**

```
ggaquality 1 waas 2
```

Makes the WAAS solution type show 2 as the quality indicator.

**Input Example 2:**

```
ggaquality 2 waas 2 narrow_float 3
```

Makes the WAAS solution type show 2, and the NARROW\_FLOAT solution type show 3, as their quality indicators.

**Input Example 3:**

```
ggaquality 0
```

Sets all the quality indicators back to the default.



Some solution types, see *Table 50, Position or Velocity Type on Page 248*, store a quality indicator. For example, OmniSTAR\_HP, OmniSTAR\_XP and NARROW\_FLOAT all share an indicator of 2. This command can be used to customize an application to have unique indicators for each solution type.

---

| Field | Field Type  | ASCII Value  | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|---|--|--------------|--|---------------|--------------|---------------|
| 1     | GGAQUALITY header   | -  | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | #entries  | 0-20   |              | The number of position types that are being re-mapped (20 max.)  | Ulong         | 4            | H+4           |
| 3     | pos type1   | See <i>Table 50, Position or Velocity Type on Page 248</i> |              | The 1st position type that is being re-mapped  | Enum          | 4            | H+8           |
| 4     | qual1   | See <i>page 310</i>  |              | The number that appears in the GPGGA log for the 1st position type   | Ulong         | 4            | H+12          |
| 5     | pos type2   | See <i>Table 50 on page 248</i>                            |              | The 2nd position type that is being re-mapped, if applicable   | Enum          | 4            | H+16          |
| 6     | qual2   | See <i>page 310</i>  |              | The number that appears in the GPGGA log for the 2nd solution type, if applicable  | Ulong         | 4            | H+20          |
| ...   | Next solution type and quality indicator set, if applicable |  |              |  | Variable      |              |               |

### 2.5.31 GLOCSMOOTH GLONASS channel carrier smoothing VIG23\_G

This command sets the amount of carrier smoothing to be performed on the code measurements. An input value of 100 corresponds to approximately 100 seconds of smoothing. Upon issuing the command, the locktime for continuous tracking of all GLONASS satellites is reset to zero. From this point each code smoothing filter is restarted. The user must wait for at least the length of smoothing time for the new smoothing constant to take full effect. The optimum setting for this command is dependent on your application.

#### Abbreviated ASCII Syntax:

Message ID: 830

GLOCSMOOTH L1time [L2time]

#### Factory Default:

glocsmooth 100 100

#### Abbreviated ASCII Example:

glocsmooth 200

- 
- ☒ 1. The GLOCSMOOTH command should only be used by advanced GNSS users. The shorter the carrier smoothing, the more noise there will be. If you are at all unsure please e-mail NovAtel Customer Service ([support@novatel.ca](mailto:support@novatel.ca)).
  - 2. When used in differential mode, the same setting should be used at both the base and rover stations, if both are using the same type of receiver (both OEMV). However, if the base and rover use different types of receivers (OEM4 and OEMV), use the CSMOOTH and GLOCSMOOTH command default values at each receiver.
- 



The OEMV family of receivers use the default setting of 100 s. The GLOCSMOOTH and CSMOOTH values for the OEMV are best left at their defaults (100 100) unless you are certain that your application requires different values.

---

| Field | Field Type         | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|--------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | GLO-CSMOOTH header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | L1 t const         | 2 to 2000   |              | L1 time constant   | Ulong         | 4            | H             |
| 3     | L2 t const         | 2 to 2000   |              | L2 time constant (default = 100)   | Ulong         | 4            | H+4           |



### 2.5.32 GLOECUTOFF Set GLONASS satellite elevation cut-off V1G23\_G

This command sets the elevation cut-off angle for tracked GLONASS satellites. The receiver does not start automatically searching for a satellite until it rises above the cut-off angle. Tracked satellites that fall below the cut-off angle are no longer tracked unless they were manually assigned (see the ASSIGN command).

In either case, satellites below the GLOECUTOFF angle are eliminated from the internal position and clock offset solution computations. See also the ECUTOFF command for more information on elevation cut-off commands.

---

☒ GLONASS measurements can be used for post-processed positioning solutions or in user-designed programs. NovAtel plans to offer GLONASS positioning in the future. In the meantime, OEMV-based output is compatible with post-processing software from the Waypoint Products Group, NovAtel Inc. See also [www.novatel.com](http://www.novatel.com) for details.

---

**Abbreviated ASCII Syntax:**

**Message ID: 735**

GLOECUTOFF angle

**Factory Default:**

gloecutoff 5.0

**ASCII Example:**

gloecutoff 0



Refer to the GLONASS section in the *GNSS Reference Book*, available on our Web site at <http://www.novatel.ca/support/docupdates.htm>.

| Field | Field Type         | ASCII Value   | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|--------------------|---------------|--------------|--|---------------|--------------|---------------|
| 1     | GLO-ECUTOFF header | -             | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | angle              | ±90.0 degrees |              | Elevation cut-off angle relative to horizon  | Float         | 4            | H             |

### 2.5.33 HDTOUTTHRESHOLD Control GPHDT log output ALIGN

This command controls the output of the NMEA GPHDT heading log, see *page 326*. It sets a heading standard deviation threshold. Only heading information with a standard deviation less than this threshold can be output into a GPHDT message.

**Abbreviated ASCII Syntax:**

**Message ID: 1062**

HDTOUTTHRESHOLD thresh

**Factory Default:**

hdtoutthreshold 2.0

| Field | Field Type              | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|-------------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | HDTOUT-THRESHOLD header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | thresh                  | 0.0 - 180.0 |              | Heading standard deviation threshold (degrees)   | Float         | 4            | H             |

### 2.5.34 HPSEED Specify the initial OmniSTAR HP/XP position V3\_HP

This OmniSTAR HP/XP command allows you to specify the initial position for OmniSTAR HP/XP. It allows you to specify the datum and undulation for the position entered. Position is then transformed into the datum currently set in the receiver. You can use STORE or RESTORE as a variable.

- 
- ☒ The HPSEED command does not get saved when you use the SAVECONFIG command. Rather, if STORE is issued with the HPSEED command, it stores in it NVM. The RESTORE variable re-sends the stored HPSEED command.
- 

#### Abbreviated ASCII Syntax:

**Message ID: 782**

HPSEED mode [lat lon hgt lat $\sigma$  lon $\sigma$  hgt $\sigma$  [datum undulation]]

#### Factory Default:

hpseed reset



There is more information on HP/XP seeding in the usage box starting on *page 133*.

Here are some ASCII Examples:

- To store the current HP/XP position so that it can be used as the seed in the future:  
HPSEED STORE
  - To use the stored HP/XP position as the seed:  
HPSEED RESTORE
  - To use a known position in the native datum of OmniSTAR HP/XP as the seed:  
HPSEED SET 51.11633810554 -114.03839550586 1048.2343  
0.0086,0.0090,0.0191
  - To use a known position from a datum other than the native OmniSTAR HP/XP datum as the seed:  
HPSEED SET 51.11633810554 -114.03839550586 1048.2343  
0.0086,0.0090,0.0191 CANADA EGM96
-

**Table 30: Seeding Mode**

| Binary Value | ASCII Mode Name | Description   |
|--------------|-----------------|---|
| 0            | RESET           | Clear current seed and restart HP/XP <sup>a</sup>                         |
| 1            | SET             | Specify a position and inject it into HP/XP as seed                       |
| 2            | STORE           | Store current HP/XP position in NVM for use as a future seed <sup>a</sup> |
| 3            | RESTORE         | Inject NVM-stored position into HP/XP as seed <sup>a</sup>                |

a. No further parameters are needed in the syntax

| Field | Field Type    | ASCII Value  | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|---------------|--|--------------|--|---------------|--------------|---------------|
| 1     | HPSEED header | -  | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | mode          | See Table 30 on page 132                                     |              | Seeding mode   | Enum          | 4            | H             |
| 3     | lat           | ±90  |              | Latitude (degrees)   | Double        | 8            | H+4           |
| 4     | lon           | ±360   |              | Longitude (degrees)  | Double        | 8            | H+12          |
| 5     | hgt           | -1000 to 20000000  |              | Height above mean sea level (m)  | Double        | 8            | H+20          |
| 6     | lat $\sigma$  |  |              | Latitude standard deviation (m)  | Float         | 4            | H+28          |
| 7     | lon $\sigma$  |  |              | Longitude standard deviation (m)   | Float         | 4            | H+32          |
| 8     | hgt $\sigma$  |  |              | Height standard deviation (m)  | Float         | 4            | H+36          |
| 9     | datum         | See Table 21, Reference Ellipsoid Constants on Page 97       |              | Datum ID (default = WGS84)   | Enum          | 4            | H+40          |
| 10    | undulation    | see the UNDULATION command's option field values on page 204 |              | Undulation type (default = TABLE)  | Enum          | 4            | H+44          |

### 2.5.35 HPSTATICINIT Set OmniSTAR HP/XP static initialization V3\_HP

This command enables or disables static initialization of OmniSTAR HP/XP. If the OmniSTAR HP/XP process knows that the receiver is stationary, it can converge more quickly.

- 
- ☒ If the HP/XP filter perceives receiver motion, it may abort static initialization. See the Static Initialization Mode bit in the HP/XP Status field of the LBANDSTAT log, details starting on *Page 344*, to confirm that static initialization is in progress.
- 

**Abbreviated ASCII Syntax:**

**Message ID: 780**

HPSTATICINIT switch

**Factory Default:**

hpstaticinit disable

**ASCII Example:**

hpstaticinit enable



HP/XP seeding is restarting the HP/XP filter from known coordinates with a known accuracy as a starting point such that it is already converged. This is implemented by using the HPSEED command, see *page 131*.

There are two ways of using our implementation of HP/XP seeding:

*1. Seed HP/XP from a stored HP/XP position:*

You can use this method to save the converged HP/XP position and feed it back in when your vehicle, for example, your tractor, hasn't moved since shutting down.

When HP/XP is converged and the vehicle is stopped, enter HPSEED STORE to save the current HP/XP position to NVM.

When the vehicle is restarted, enter HPSEED RESTORE to feed the previously known position into the HP/XP process so it can start from the previous accuracy.

*2. Seed HP/XP from an externally generated known position and accuracy:*

Consider the case of survey customers who enter the known antenna location with HPSEED SET <latitude> <longitude> <msl height> <lat stdev> <long stdev> <height stdev>

If the source of the position is in a different datum than the native datum of HP/XP, or if a different undulation has been used, the transformation can be specified after <height stdev> with <datum id> <undulation type>.

*Note: Initial position estimate for HP/XP and fallback when HP/XP is lost:*

When HP/XP starts up, it requests the current position to get itself started. In the start-up timeline that we have implemented, this is the first valid position available when the task running HP/XP receives its first L-band data. This may or may not be a

VBS position when VBS is also enabled. It depends on how things start up - whatever pseudorange filter position is available is used. If you want to hold off on HP/XP using the position estimate until you've confirmed that the VBS corrections have started and plenty of satellites are in the solution, you can start up with PSRDIFFSOURCE OMNISTAR and RTKSOURCE NONE, wait for the condition of the VBS position to be satisfactory and then set RTKSOURCE OMNISTAR as well. The HP/XP start-up will be waiting until you set the RTKSOURCE. This may give some minor improvement to the convergence time of HP/XP.

This is somewhat related to the position falling back to VBS when HP/XP is lost. If both PSRDIFFSOURCE OMNISTAR and RTKSOURCE OMNISTAR is set, the BESTPOS log contains the best available of the two. There is normally an offset between the HP/XP solution and VBS.

| Field | Field Type          | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|---------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | HPSTATICINIT header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | switch              | DISABLE     | 0            | The receiver is not stationary   | Enum          | 4            | H             |
|       |                     | ENABLE      | 1            | The receiver is stationary   |               |              |               |

### 2.5.36 INTERFACEMODE Set receive or transmit modes for ports V123

This command allows the user to specify what type of data a particular port on the receiver can transmit and receive. The receive type tells the receiver what type of data to accept on the specified port. The transmit type tells the receiver what kind of data it can generate. For example, you would set the receive type on a port to RTCA in order to accept RTCA differential corrections.

It is also possible to disable or enable the generation or transmission of command responses for a particular port. Disabling of responses is important for applications where data is required in a specific form and the introduction of extra bytes may cause problems, for example RTCA, RTCM, RTCMV3 or CMR. Disabling a port prompt is also useful when the port is connected to a modem or other device that responds with data the receiver does not recognize.

When INTERFACEMODE *port* NONE NONE OFF is set, the specified port are disabled from interpreting any input or output data. Therefore, no commands or differential corrections are decoded by the specified port. When GENERIC is set for a port, it is also disabled but data can be passed through the disabled port and be output from an alternative port using the pass-through logs PASSCOM, PASSXCOM, PASSAUX and PASSUSB. See *Page 373* for details on these logs and the *Operation* chapter, in the *OEMV Family Installation and Operation User Manual*, for information on pass-through logging. See also the COMCONFIG log on *Page 287*.

---

**WARNING!:** If you intend to use the COM command, ensure you do so before the INTERFACEMODE command on each port. The COM command can remove the INTERFACEMODE command setting if the baud rate is changed after the interface mode is set. You can also turn break detection off using the COM command, see *page 87*, to stop the port from resetting because it is interpreting incoming bits as a break command.

---

#### OmniSTAR External Stream

This feature allows you to use OmniSTAR VBS, HP or XP when you are not tracking an L-band signal on the OEMV. This is useful on an L-band-capable receiver where the OmniSTAR signals are unavailable. There is a new OmniSTAR option for the INTERFACEMODE command (OMNISTAR), see *Table on page 136*.

For example, set the incoming INTERFACEMODE command to OMNISTAR on COM2:

```
INTERFACEMODE COM2 OMNISTAR NONE
```

where COM2 is expecting raw OmniSTAR L-band data from an external source.

- 
- ☒ 1. OMNISTAR is not a valid setting for an INTERFACEMODE output command.
  - 2. Receiver data only comes from one source (port or L-band tracking) at a time.
- 

**Abbreviated ASCII Syntax:**

**Message ID: 3**

```
INTERFACEMODE [port] rxtype txtype [responses]
```

**Factory Default:**

```
interfacemode com1 novatel novatel on
interfacemode com2 novatel novatel on
interfacemode com3 novatel novatel on
interfacemode aux novatel novatel on
interfacemode usb1 novatel novatel on
interfacemode usb2 novatel novatel on
interfacemode usb3 novatel novatel on
```

**ASCII Example 1:**

```
interfacemode com1 rtca novatel on
```

**ASCII Example 2:**

```
interfacemode com2 mrtca none
```



Are NovAtel receivers compatible with others on the market?

All GPS receivers output two solutions: position and time. The manner in which they output them makes each receiver unique. Most geodetic and survey grade receivers output the position in electronic form (typically RS-232), which makes them compatible with most computers and data loggers. All NovAtel receivers have this ability. However, each manufacturer has a unique way of formatting the messages. A NovAtel receiver is not directly compatible with a Trimble or Ashtech receiver (which are also incompatible with each other) unless everyone uses a generic data format.

But there are several generic data formats available. For position and navigation output there is the NMEA format. Real-time differential corrections use RTCM or RTCA format. Receiver code and phase data use RINEX format. NovAtel and all other major manufacturers support these formats and can work together using them.

You must understand your post-processing and real-time software requirements. Good software supports a generic standard while poor software locks you into one brand of GPS equipment. For the most flexibility, insist on generic data format support for all hardware and software solutions.

---



**Table 31: Serial Port Interface Modes**

| Binary Value | ASCII Mode Name   | Description  |
|--------------|-------------------|--|
| 0            | NONE              | The port accepts/generates nothing. The port is disabled.  |
| 1            | NOVATEL           | The port accepts/generates NovAtel commands and logs   |
| 2            | RTCM              | The port accepts/generates RTCM corrections  |
| 3            | RTCA              | The port accepts/generates RTCA corrections  |
| 4            | CMR               | The port accepts/generates CMR corrections   |
| 5            | OMNISTAR          | The port accepts OMNISTAR corrections, see also <i>OmniSTAR External Stream</i> on Page 135  |
| 6            | Reserved          |  |
| 7            | IMU               | This port supports communication with a NovAtel supported IMU, contact Customer Service, or refer to your <i>SPAN for OEMV User Manual</i> for more information  |
| 8            | RTCMNOCR          | RTCM with no CR/LF appended <sup>a</sup>   |
| 9            | CDGPS             | The port accepts GPS*C data <sup>b</sup>   |
| 10           | TCOM1             | <p>INTERFACEMODE tunnel modes. To configure a full duplex tunnel, configure the baud rate on each port. Once a tunnel is established, the baud rate does not change. Special characters, such as a BREAK condition, do not route across the tunnel transparently and the serial port is altered, see the COM command on Page 87. Only serial ports may be in a tunnel configuration:<br/>COM1, COM2, COM3 or AUX may be used.</p> <p>For example, configure a tunnel at 115200 bps between COM1 and AUX:<br/>COM AUX 115200<br/>COM COM1 115200<br/>INTERFACEMODE AUX TCOM1 NONE OFF<br/>INTERFACEMODE COM1 TAUX NONE OFF<br/>The tunnel is fully configured to receive/transmit at a baud rate of 115200 bps.</p> |
| 11           | TCOM2             |  |
| 12           | TCOM3             |  |
| 13           | TAUX <sup>c</sup> |  |
| 14           | RTCMV3            | The port accepts/generates RTCM Version 3.0 corrections  |
| 15           | NOVATELBINARY     | The port only accepts/generates binary messages. If an ASCII command is entered when the mode is set to binary only, the command is ignored. Only properly formatted binary messages are responded to and the response is a binary message.  |
| 16-17        | Reserved          |  |

*Continued on the following page.*

**Table 31: Serial Port Interface Modes**

| Binary Value | ASCII Mode Name | Description   |
|--------------|-----------------|---|
| 18           | GENERIC         | The port accepts/generates nothing. SEND/SENDHEX commands from another port generate data on this port. Any incoming data on this port can be seen with PASSCOM logs on another port, see <i>page 373</i> . |
| 19           | Reserved        |   |
| 20           | MRTCA           | The port accepts MRTCA data to output CDGPS positions. See also <i>CDGPS Corrections Over a Serial Port on Page 419</i>   |

- a. An output interfacemode of RTCMNOCR is identical to RTCM but with the CR/LF appended. An input interfacemode of RTCMNOCR is identical to RTCM and functions with or without the CR/LF.
- b. CDGPS has three options for output of differential corrections - NMEA, RTCM, and GPS\*C. If you have a ProPak-V3 receiver, you do not need to use the INTERFACEMODE command with CDGPS as the argument. The CDGPS argument is for use with obsolete external non-NovAtel CDGPS receivers. These receivers use GPS\*C (NavCanada's proprietary format differential corrections from the CDGPS service).
- c. The AUX port, and therefore TAUX mode, is only available on OEMV-2-based and OEMV-3-based products.

| Field | Field Type           | ASCII Value   | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|----------------------|---|--------------|--|---------------|--------------|---------------|
| 1     | INTERFACEMODE header | -   | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | port                 | See Table 17, COM Serial Port Identifiers on Page 88  |              | Serial port identifier (default = THISPORT)  | Enum          | 4            | H             |
| 3     | rxtype               | See Table , You must understand your post-processing and real-time software requirements. Good software supports a generic standard while poor software locks you into one brand of GPS equipment. For the most flexibility, insist on generic data format support for all hardware and software solutions. on Page 136 |              | Receive interface mode   | Enum          | 4            | H+4           |
| 4     | txtype               |   |              | Transmit interface mode  | Enum          | 4            | H+8           |
| 5     | responses            | OFF   | 0            | Turn response generation off   | Enum          | 4            | H+12          |
|       |                      | ON  | 1            | Turn response generation on (default)  |               |              |               |

### 2.5.37 LOCALIZEDCORRECTIONDATUM Command to set a Local Datum

Use this command to select a localized correction datum before you use localized wide area corrections. The choices are World Geodetic System 84 (WGS84) and North American 1983 (NAD83) including Areas 37-42. The default is WGS84, however:

- When the receiver receives CDGPS data, and you issue a LOCALIZEDCORRECTIONDATUM NAD83 command, it bases its localized wide area corrections on CSRS
- When the receiver receives OmniSTAR data, and you issue a LOCALIZEDCORRECTIONDATUM NAD83 command, it bases its localized wide area corrections on NAD83

---

RTCM corrections are always with respect to the datum selected at the base. For example, if you set the LOCALIZEDCORRECTIONDATUM to NAD83 at a base station, the datum of the positions produced at the rover receiver using these localized corrections will be NAD83. This is true even though the datum in the rover BESTPOS log shows WGS84.

---

#### Localized Wide Area Corrections Mode

The local wide area corrections<sup>1</sup> enhancement allows a NovAtel receiver to receive CDGPS or OmniSTAR VBS corrections, compute an equivalent DGPS correction and then output it in RTCM format to any GPS receiver. You can select to output corrections in the WGS84 or NAD83 datum.

Localized CDGPS and OmniSTAR corrections are available on OEMV-1- and OEMV-3-based products with L-band capability. Supported datums provide these corrections with WGS84 as the default.

This enhancement also introduces the following logs:

RTCMCDGPS1/RTCMDATACDGPS1, see *page 477* and *CDGPS Local Wide Area Corrections on Page 436*

RTCMCDGPS9/RTCMDATACDGPS9, see *page 478* and *CDGPS Local Wide Area Corrections on Page 436*

RTCMOMNI1/RTCMDATAOMNI1, see *page 480* and *OmniSTAR Local Wide Area Corrections on Page 436*

Use the SAVECONFIG command to save local wide area corrections interface settings.

**Abbreviated ASCII Syntax:**

**Message ID: 947**

LOCALIZEDCORRECTIONDATUM type

**ASCII Example:**

```
localizedcorrectiondatum nad83
```

---

1. Refer also to our application note on *Localized Wide Area Corrections*, available on our Web site at <http://www.novatel.com/support/applicationnotes.htm> as APN-045.

| Field | Field Type                        | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|-----------------------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | LOCALIZED-CORRECTION-DATUM header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | type                              | WGS84       | 1            | Localised correction datum type  | Enum          | 4            | H             |
|       |                                   | NAD83       | 2            |  |               |              |               |

### 2.5.38 LOCKOUT Prevent the receiver from using a satellite V123

This command prevents the receiver from using a satellite by de-weighting its range in the solution computations. Note that the LOCKOUT command does not prevent the receiver from tracking an undesirable satellite. This command must be repeated for each satellite to be locked out.

See also the UNLOCKOUT and UNLOCKOUTALL commands.

**Abbreviated ASCII Syntax:**

**Message ID: 137**

LOCKOUT prn

**Input Example:**

lockout 8



The LOCKOUT command allows you to remove one or more satellites from the solution while leaving other satellites available.

| Field | Field Type     | ASCII Value   | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|----------------|---|--------------|--|---------------|--------------|---------------|
| 1     | LOCKOUT header | -   | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | prn            | GPS: 1-37<br>SBAS: 120-138<br>GLONASS: see <i>Section 1.3</i> on <i>Page 30</i> . |              | A single satellite PRN number to be locked out   | Ulong         | 4            | H             |

### 2.5.39 LOG Request logs from the receiver V123

Many different types of data can be logged using several different methods of triggering the log events. Every log element can be directed to any combination of the three COM ports and three USB ports. The ONTIME trigger option requires the addition of the *period* parameter. See *Chapter 3, Data Logs on Page 219* for further information and a complete list of data log structures. The LOG command tables in this section show the binary format followed by the ASCII command format.

The optional parameter [hold] prevents a log from being removed when the UNLOGALL command, with its defaults, is issued. To remove a log which was invoked using the [hold] parameter requires the specific use of the UNLOG command, see *page 207*. To remove all logs that have the [hold] parameter, use the UNLOGALL command with the *held* field set to 1, see *page 209*.

The [port] parameter is optional. If [port] is not specified, [port] is defaulted to the port that the command was received on.

- 
- ☒ 1. The OEMV family of receivers can handle 30 logs at a time. If you attempt to log more than 30 logs at a time, the receiver responds with an Insufficient Resources error.
  - 2. Maximum flexibility for logging data is provided to the user by these logs. The user is cautioned, however, to recognize that each log requested requires additional CPU time and memory buffer space. Too many logs may result in lost data and degraded CPU performance. Receiver overload can be monitored using the idle-time field and buffer overload bits of the Receiver Status in any log header.
  - 3. Polled log types do not allow fractional offsets or ONTIME rates faster than 1Hz.
  - 4. Use the ONNEW trigger with the MARKTIME, MARK2TIME, MARKPOS or MARK2POS logs.
  - 5. Only the MARKPOS, MARK2POS, MARKTIME or MARK2TIME logs, and ‘polled’ log types are generated ‘on the fly’ at the exact time of the mark. Synchronous and asynchronous logs output the most recently available data.
  - 6. If you do use the ONTIME trigger with asynchronous logs, the time stamp in the log does not necessarily represent the time the data was generated, but rather the time when the log is being transmitted.
- 

#### Abbreviated ASCII Syntax:

#### Message ID: 1

LOG [port] message [trigger [period [offset [hold]]]]

#### Factory Default:

```
log com1 rxstatureventa onnew 0 0 hold
log com2 rxstatureventa onnew 0 0 hold
log com3 rxstatureventa onnew 0 0 hold
log aux rxstatureventa onnew 0 0 hold
```

```
log usb1 rxstatureventa onnew 0 0 hold
log usb2 rxstatureventa onnew 0 0 hold
log usb3 rxstatureventa onnew 0 0 hold
```

**Abbreviated ASCII Example 1:**

```
log com1 bestpos ontime 7 0.5 hold
```

The above example shows BESTPOS logging to COM port 1 at 7 second intervals and offset by 0.5 seconds (output at 0.5, 7.5, 14.5 seconds and so on). The [hold] parameter is set so that logging is not disrupted by the UNLOGALL command.

To send a log only one time, the trigger option can be ignored.

**Abbreviated ASCII Example 2:**

```
log com1 bestpos once 0.000000 0.000000 nohold
```

See *Section 2.1, Command Formats* on page 36 for additional examples.



In CDU there are two ways to initiate data logging to the receiver's serial ports. You can either enter the LOG command in the *Console* window, or use the interface provided in the *Logging Control* window. Ensure the Power Settings on your PC are not set to go into Hibernate or Standby modes. Data is lost if one of these modes occurs during a logging session.

---



| Field | Field Name          | Binary Value   | Description   | Field Type | Binary Bytes | Binary Offset |
|-------|---------------------|--|---|------------|--------------|---------------|
| 1     | LOG (binary) header | (See Table 4, Binary Message Header Structure on Page 24)  | This field contains the message header.   | -          | H            | 0             |
| 2     | port                | See Table 5, Detailed Serial Port Identifiers on Page 26   | Output port   | Enum       | 4            | H             |
| 3     | message             | Any valid message ID   | Message ID of log to output   | UShort     | 2            | H+4           |
| 4     | message type        | Bits 0-4 = Reserved<br>Bits 5-6 = Format<br>00 = Binary<br>01 = ASCII<br>10 = Abbreviated ASCII, NMEA<br>11 = Reserved<br>Bit 7 = Response Bit (see page 28)<br>0 = Original Message<br>1 = Response Message | Message type of log   | Char       | 1            | H+6           |
| 5     | Reserved            |  |   | Char       | 1            | H+7           |
| 6     | trigger             | 0 = ONNEW  | Does not output current message but outputs when the message is updated (not necessarily changed) | Enum       | 4            | H+8           |
|       |                     | 1 = ONCHANGED  | Outputs the current message and then continue to output when the message is changed               |            |              |               |
|       |                     | 2 = ONTIME   | Output on a time interval   |            |              |               |
|       |                     | 3 = ONNEXT   | Output only the next message  |            |              |               |
|       |                     | 4 = ONCE   | Output only the current message   |            |              |               |
|       |                     | 5 = ONMARK   | Output when a pulse is detected on the mark 1 input, MK11 <sup>a b</sup>                          |            |              |               |
| 7     | period              | Valid values for the high rate logging are 0.05, 0.1, 0.2, 0.25 and 0.5. For logging slower than 1Hz any integer value is accepted.  | Log period (for ONTIME trigger) in seconds <sup>c</sup>   | Double     | 8            | H+12          |

Continued on page 145.

| Field | Field Name | Binary Value  | Description  | Field Type | Binary Bytes | Binary Offset |
|-------|------------|---|--|------------|--------------|---------------|
| 8     | offset     | A valid value is any integer smaller than the period. These decimal values, on their own, are also valid: 0.1, 0.2, 0.25 or 0.5 | Offset for period (ONTIME trigger) in seconds. If you wished to log data at 1 second after every minute you would set the period to 60 and the offset to 1 | Double     | 8            | H+20          |
| 9     | hold       | 0 = NOHOLD  | Allow log to be removed by the UNLOGALL command  | Enum       | 4            | H+28          |
|       |            | 1 = HOLD  | Prevent log from being removed by the default UNLOGALL command   |            |              |               |

- a. Refer to the *Technical Specifications* appendix in the *OEMV Family Installation and Operation User Manual* for more details on the MK11 pin. ONMARK only applies to MK11. Events on MK21 (if available) do not trigger logs when ONMARK is used. Use the ONNEW trigger with the MARKTIME, MARK2TIME, MARKPOS or MARK2POS logs.
- b. Once the 1PPS signal has hit a rising edge, for both MARKPOS and MARKTIME logs, a resolution of both measurements is 49 ns. As for the ONMARK trigger for other logs that measure latency, for example RANGE and position log such as BESTPOS, it takes typically 20-30 ms (50 ms maximum) for the logs to output information from the 1PPS signal. Latency is the time between the reception of the 1PPS pulse and the first byte of the associated log. See also the MARKPOS and MARKTIME logs starting on *page 353*.
- c. See *Appendix A* in the *OEMV Family Installation and Operation User Manual* for the maximum raw measurement rate to calculate the minimum period. If the value entered is lower than the minimum measurement period, the value is ignored and the minimum period is used.

| Field | Field Name         | ASCII Value   | Description  | Field Type |
|-------|--------------------|---|--|------------|
| 1     | LOG (ASCII) header | -   | This field contains the command name or the message header depending on whether the command is abbreviated ASCII or ASCII respectively.                                  | -          |
| 2     | port               | See <i>Table 17, COM Serial Port Identifiers on Page 88</i>                         | Output port (default = THISPORT)   | Enum       |
| 3     | message            | Any valid message name, with an optional A or B suffix.                             | Message name of log to output  | Char [ ]   |
| 4     | trigger            | ONNEW   | Output when the message is updated (not necessarily changed)   | Enum       |
|       |                    | ONCHANGED   | Output when the message is changed   |            |
|       |                    | ONTIME  | Output on a time interval  |            |
|       |                    | ONNEXT  | Output only the next message   |            |
|       |                    | ONCE  | Output only the current message. (default)   |            |
|       |                    | ONMARK  | Output when a pulse is detected on the mark 1 input, MK11 (see <i>Footnotes a and b on page 145</i> )  |            |
| 5     | period             | Any positive double value larger than the receiver's minimum raw measurement period | Log period (for ONTIME trigger) in seconds (default = 0) (see <i>Footnote c on page 145</i> )  | Double     |
| 6     | offset             | Any positive double value smaller than the period.                                  | Offset for period (ONTIME trigger) in seconds. If you wished to log data at 1 second after every minute you would set the period to 60 and the offset to 1 (default = 0) | Double     |
| 7     | hold               | NOHOLD  | Allow log to be removed by the UNLOGALL command (default)  | Enum       |
|       |                    | HOLD  | Prevent log from being removed by the UNLOGALL command   |            |

## 2.5.40 MAGVAR Set a magnetic variation correction V123

The receiver computes directions referenced to True North. Use this command (magnetic variation correction) if you intend to navigate in agreement with magnetic compass bearings. The correction value entered here causes the "bearing" field of the NAVIGATE log to report bearing in degrees Magnetic. The receiver computes the magnetic variation correction if you use the auto option. See *Figure 4, Illustration of Magnetic Variation & Correction on Page 148*.

The receiver calculates values of magnetic variation for given values of latitude, longitude and time using the International Geomagnetic Reference Field (IGRF) 2005 spherical harmonic coefficients and IGRF time corrections to the harmonic coefficients. The model is intended for use up to the year 2010. The receiver will compute for years beyond 2010 but accuracy may be reduced.

**Abbreviated ASCII Syntax:****Message ID: 180**

MAGVAR type [correction] [std dev]

**Factory Default:**

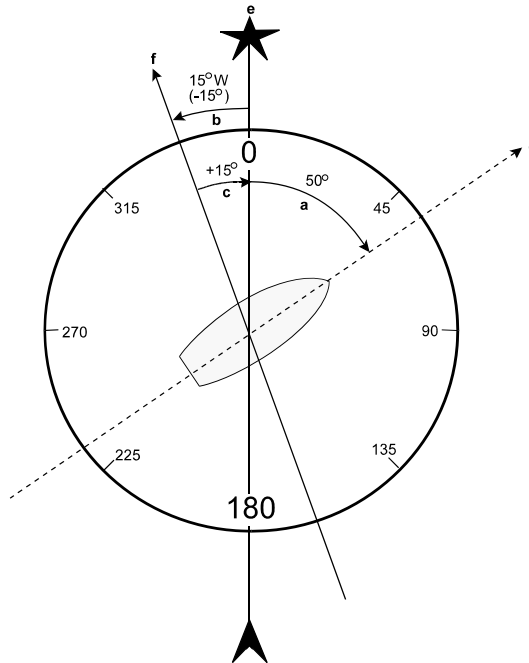
magvar correction 0 0

**ASCII Example 1:**

magvar auto

**ASCII Example 2:**

magvar correction 15 0



**Figure 4: Illustration of Magnetic Variation & Correction**

| Reference | Description   |
|-----------|---|
| a         | True Bearing  |
| b         | Local Magnetic Variation  |
| c         | Local Magnetic Variation Correction (inverse of magnetic variation) |
| a + c     | Magnetic Bearing  |
| d         | Heading: 50° True, 60° Magnetic                                     |
| e         | True North  |
| f         | Local Magnetic North  |



How does the GPS determine what Magnetic North is? Do the satellites transmit a database, or some kind of look-up chart to determine the declination for your given latitude and longitude? How accurate is it?

Magnetic North refers to the location of the Earth's Magnetic North Pole. Its position is constantly changing in various cycles over centuries, years, and days. These rates of change vary and are not well understood. However, we are able to monitor these changes.

True North refers to the earth's celestial pole, that is, at 90° north latitude or the location where the lines of longitude converge. This position is always the same and

does not vary.

The locations of these two poles do not coincide. Thus, a relationship is required between these two values for users to relate GPS bearings to their compass bearings. This value is called the magnetic variation correction or declination.

GPS does not determine where Magnetic North is nor do the satellites provide magnetic correction or declination values. However, OEMV receivers store this information internally in look-up tables so that when you specify that you want to navigate with respect to Magnetic North, this internal information is used. These values are also available from various information sources such as the United States Geological Survey (USGS). The USGS produces maps and has software which enables you to determine these correction values. By identifying your location (latitude and longitude), you can obtain the correction value. Refer to the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm> for USGS contact information.

| Field | Field Type    | ASCII Value     | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|---------------|-----------------|--------------|--|---------------|--------------|---------------|
| 1     | MAGVAR header | -               | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | type          | AUTO            | 0            | Use IGRF corrections   | Enum          | 4            | H             |
|       |               | CORRECTION      | 1            | Use the correction supplied  |               |              |               |
| 3     | correction    | ± 180.0 degrees |              | Magnitude of correction (Required field if type = Correction)  | Float         | 4            | H+4           |
| 4     | std_dev       | ± 180.0 degrees |              | Standard deviation of correction (default = 0)   | Float         | 4            | H+8           |

### 2.5.41 MARKCONTROL Control processing of mark inputs V123

This command provides a means of controlling the processing of the mark 1 (MK1I) and mark 2 (MK2I) inputs for the OEMV. Using this command, the mark inputs can be enabled or disabled, the polarity can be changed, and a time offset and guard against extraneous pulses can be added.

The MARKPOS and MARKTIME logs, see their descriptions starting on *page 353*, have their outputs (and extrapolated time tags) pushed into the future (relative to the MKI event) by the amount entered into the time bias field. In almost all cases, this value is set to 0, which is also the default setting.

**Abbreviated ASCII Syntax:**

**Message ID: 614**

MARKCONTROL signal switch [polarity] [timebias [timeguard]]

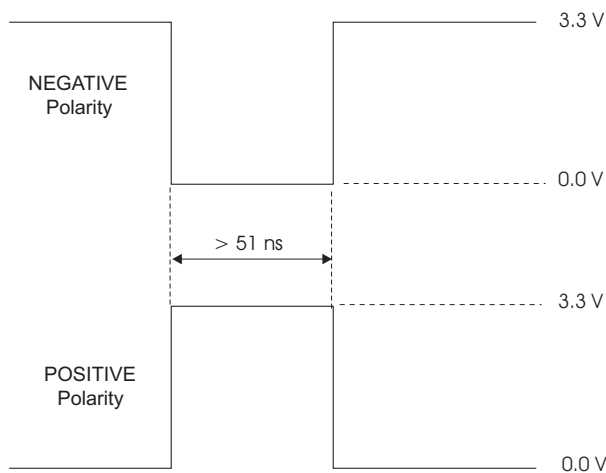
**Factory Default:**

markcontrol mark1 enable negative 0 0

markcontrol mark2 enable negative 0 0

**ASCII Example:**

markcontrol mark1 enable negative 50 100



**Figure 5: TTL Pulse Polarity**



You may have a user point device, such as a video camera device. Connect the device to the receiver's I/O port. Use a cable that is compatible to both the receiver and the device. A MARKIN pulse can be a trigger from the device to the receiver. See also the MARKPOS and MARKTIME logs starting on *Page 353*.

| Field | Field Type         | ASCII Value  | Binary Value | Description   | Binary Format | Binary Bytes | Binary Offset |
|-------|--------------------|--|--------------|---|---------------|--------------|---------------|
| 1     | MARKCONTROL header | -  | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.  | -             | H            | 0             |
| 2     | signal             | MARK1  | 0            | Specifies which mark input the command should be applied to. Set to MARK1 for the MK1I input and MARK2 for MK2I. Both mark inputs have 10K pull-up resistors to 3.3 V and are leading edge triggered. | Enum          | 4            | H             |
|       |                    | MARK2  | 1            |   |               |              |               |
| 3     | switch             | DISABLE  | 0            | Disables or enables processing of the mark input signal for the input specified. If DISABLE is selected, the mark input signal is ignored. The factory default is ENABLE.                             | Enum          | 4            | H+4           |
|       |                    | ENABLE   | 1            |   |               |              |               |
| 4     | polarity           | NEGATIVE   | 0            | Optional field to specify the polarity of the pulse to be received on the mark input. See <i>Figure 5</i> for more information. If no value is specified, the default NEGATIVE is used.               | Enum          | 4            | H+8           |
|       |                    | POSITIVE   | 1            |   |               |              |               |
| 5     | timebias           | Any valid long value   |              | Optional value to specify an offset, in nanoseconds, to be applied to the time the mark input pulse occurs. If no value is supplied, the default value of 0 is used.                                  | Long          | 4            | H+12          |
| 6     | timeguard          | Any valid ulong value larger than the receiver's minimum raw measurement period <sup>a</sup> |              | Optional field to specify a time period, in milliseconds, during which subsequent pulses after an initial pulse are ignored. If no value is supplied, the default value of 0 is used.                 | ULong         | 4            | H+16          |

- a. See *Appendix A* in the *OEMV Family Installation and Operation User Manual* for the maximum raw measurement rate to determine the minimum period. If the value entered is lower than the minimum measurement period, the value is ignored and the minimum period is used.



### 2.5.42 MODEL Switch to a previously authorized model V123

This command is used to switch the receiver between models previously added with the AUTH command. When this command is issued, the receiver saves this model as the active model. The active model is now used on every subsequent start-up. The MODEL command causes an automatic reset.

Use the VALIDMODELS log to output a list of available models for your receiver. The VALIDMODELS log is described on *Page 563*. Use the VERSION log to output the active model, see *Page 564*.

- ☒ If you switch to an expired model, the receiver will reset and enter into an error state. You will need to switch to a valid model to continue.

**Abbreviated ASCII Syntax:**

**Message ID: 22**

MODEL model

**Input Example:**

```
model rt2w
```



NovAtel receivers use the concept of models to enable different levels of functionality in the receiver firmware. For example, a receiver may be purchased with an L1 only enabled version of firmware and be easily upgraded at a later time to a more feature-intensive model. All that is required to upgrade is an authorization code for the higher model and the AUTH command (see *page 74*). Reloading the firmware or returning the receiver for service to upgrade the model is not required. Upgrades are available from NovAtel Customer Service at 1-800-NOVATEL.

| Field | Field Type   | ASCII Value  | Binary Value | Description  | Binary Format    | Binary Bytes          | Binary Offset |
|-------|--------------|--|--------------|--|------------------|-----------------------|---------------|
| 1     | MODEL header | -  | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -                | H                     | 0             |
| 2     | model        | Max 16 character null-terminated string (including the null) |              | Model name   | String [max. 16] | Variable <sup>a</sup> | Variable      |

a. In the binary log case, additional bytes of padding are added to maintain 4-byte alignment

### 2.5.43 MOVINGBASESTATION *Set ability to use a moving base station V23\_RT2 or V123\_RT20*

This command enables or disables a receiver from transmitting corrections without a fixed position.

The moving base function allows you to obtain a cm level xyz baseline estimate when the base station and possibly the rover are moving. It is very similar to normal RTK, that is, one base station and potentially more than one rover depending on the data link. Communication with each receiver is done in the usual way (refer to the *Transmitting and Receiving Corrections* section of the *Operation* chapter in the *OEMV Family Installation and Operation User Manual*). The BSLNXYZ log is an asynchronous 'matched' log that can be logged with the onchanged trigger to provide an accurate baseline between the base and rover.

At the rover, it is recommended that you only use the PSRPOS log for position when in moving base station mode. PSRPOS has normal accuracy with good standard deviations. Other position logs, for example BESTPOS, can have error levels of 10's to 100's of meters and should be considered invalid. Also, the standard deviation in these logs does not correctly reflect the error level. Other rover position logs, where accuracy and standard deviations are affected by the moving base station mode, are BESTXYZ, GPGST, MARKPOS, MARK2POS, MATCHEDPOS, MATCHEDXYZ, RTKPOS and RTKXYZ.

The MOVINGBASESTATION command must be used to allow the base to transmit messages without a fixed position.

- 
- ☒ 1. Use the PSRPOS position log at the rover. It provides the best accuracy and standard deviations when the MOVINGBASESTATION mode is enabled.
  - 2. This command now supports RTCM V2.3 messages (except RTCM2021), RTCM V3 operation and CMR GLONASS.
  - 3. RTCA, RTCM1819 and RTCM V3 support includes GPS + GLONASS operation.
  - 4. The MOVINGBASESTATION mode is functional if any of the following RTK message formats are in use: RTCAOBS, RTCAOBS2, CMROBS, RTCAREF or CMRREF.
- 

#### Abbreviated ASCII Syntax:

**Message ID: 763**

MOVINGBASESTATION switch

#### Factory Default:

movingbasestation disable

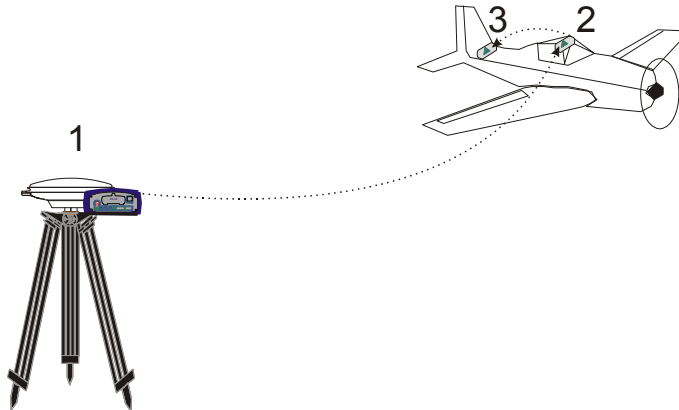
#### ASCII Example:

movingbasestation enable



1. Consider the case where there is a fixed base and an airplane flying with a moving base station near its front and a rover station at its tail end. See *Figure 6* on *Page 154*.

Corrections can be sent between the receivers in a 'daisy chain' effect where the fixed base station sends corrections to the moving base station which in turn can send corrections to the rover.



**Figure 6: Moving Base Station 'Daisy Chain' Effect**

Be cautious however when using this method as a check on the position type is only done at the fixed base station. Moving base stations will continue to operate under any conditions.

2. This command is useful for moving base stations doing RTK positioning at sea. A rover station is used to map out local areas (for marking shipping lanes, hydrographic surveying, and so on), while the base station resides on the control ship. The control ship may not move much (parked at sea), but there is a certain amount of movement due to the fact that it is floating in the ocean. By using the MOVINGBASESTATION command, the control ship is able to use RT2-level RTK positioning and move to new survey sites.

| Field | Field Type                | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|---------------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | MOVING-BASESTATION header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | switch                    | DISABLE     | 0            | Do not transmit corrections without a fixed position (default)   | Enum          | 4            | H             |
|       |                           | ENABLE      | 1            | Transmit corrections without a fixed position  |               |              |               |

## 2.5.44 NMEATALKER Set the NMEA talker ID V123

This command allows you to alter the behavior of the NMEA talker ID. The talker is the first 2 characters after the \$ sign in the log header of the GPGLL, GPGRS, GPGSA, GPGST, GPGSV, GPRMB, GPRMC, GPVTG, and GPZDA log outputs.

The default GPS NMEA messages (`nmeatalker gp`) include specific information on only the GPS satellites and have a 'GP' talker solution even when GLONASS satellites are present. The `nmeatalker auto` command changes this behaviour so that the NMEA messages include all satellites in the solution, and the talker ID changes according to those satellites.

If `nmeatalker` is set to `auto`, and there are both GPS and GLONASS satellites in the solution, two sentences with the GN talker ID are output. The first sentence contains information on the GPS, and the second sentence on the GLONASS, satellites in the solution.

If `nmeatalker` is set to `auto` and there are only GLONASS satellites in the solution, the talker ID of this message is GL.

### Abbreviated ASCII Syntax:

**Message ID: 861**

NMEATALKER [ID]

### Factory Default:

`nmeatalker gp`

### ASCII Example:

`nmeatalker auto`



The NMEATALKER command only affects NMEA logs that are capable of a GPS output. For example, GLMLA is a GLONASS-only log and its output will always use the GL talker. *Table 32 on page 156* shows the NMEA logs and whether they use GPS (GP), GLONASS (GL) or combined (GN) talkers with `nmeatalker auto`.

---

**Table 32: NMEA Talkers**

| Log   | Talker IDs |
|-------|------------|
| GLMLA | GL         |
| GPALM | GP         |
| GPGGA | GP         |
| GPGLL | GP or GN   |
| GPGRS | GP or GN   |
| GPGSA | GP or GN   |
| GPGST | GP or GN   |
| GPGSV | GP and GL  |
| GPRMB | GP or GN   |
| GPRMC | GP or GN   |
| GPVTG | GP or GN   |
| GPZDA | GP         |

| Field | Field Type         | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|--------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | NMEA-TALKER header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | ID                 | GP          | 0            | GPS only   | Enum          | 4            | H             |
|       |                    | AUTO        | 1            | GPS, GLONASS, combined and/or Inertial <sup>a</sup>  |               |              |               |

- a. Inertial only applies when using an inertial navigation system such as NovAtel's SPAN products. Please visit our Web site, refer to your *SPAN for OEMV User Manual*, or contact NovAtel for more information.

## 2.5.45 NVMRESTORE Restore NVM data after an NVM failure V123

This command restores non-volatile memory (NVM) data after a NVM Fail error. This failure is indicated by bit 13 of the receiver error word being set (see also *RXSTATUS*, Page 541 and *RXSTATUSEVENT*, Page 551). If corrupt NVM data is detected, the receiver remains in the error state and continues to flash an error code on the Status LED until the NVMRESTORE command is issued (refer to the chapter on *Built-In Status Tests* in the *OEMV Family Installation and Operation User Manual* for further explanation).

If you have more than one auth-code and the saved model is lost then the model may need to be entered using the MODEL command or it is automatically saved in NVM on the next start-up. If the almanac was lost, a new almanac is automatically saved when the next complete almanac is received (after approximately 15 minutes of continuous tracking). If the user configuration was lost it has to be re-entered by the user. This could include communication port settings.

---

✉ The factory default for the COM ports is 9600, n, 8, 1.

---

After entering the NVMRESTORE command and resetting the receiver, the communications link may have to be re-established at a different baud rate from the previous connection.

**Abbreviated ASCII Syntax:**

**Message ID: 197**

NVMRESTORE



The possibility of NVM failure is extremely remote, however, if it should occur it is likely that only a small part of the data is corrupt. This command is used to remove the corrupt data and restore the receiver to an operational state. The data lost could be the user configuration, almanac, model, or other reserved information.

---

## 2.5.46 PDPFILTER Command to enable, disable or reset the PDP filter V123

This command enables, disables or resets the Pseudorange/Delta-Phase (PDP) filter. The main advantages of the Pseudorange/Delta-Phase (PDP) implementation are:

- Smooths a jumpy position
- Bridges outages in satellite coverage (the solution is degraded from normal but there is at least a reasonable solution without gaps)

---

☒ Enable the PDP filter to output the PDP solution in BESTPOS, BESTVEL and NMEA logs.

---



Refer to the *Operation* chapter of the [OEMV Installation and Operation Manual](#) for a section on configuring your receiver for PDP or **GLIDE** operation.

---

### GLIDE Position Filter

**GLIDE** is a mode of the PDP<sup>1</sup> filter which optimizes the position for consistency over time rather than absolute accuracy. This is ideally in clear sky conditions where the user needs a tight, smooth, and consistent output. The **GLIDE** filter works best with CDGPS or WAAS. The PDP filter is smoother than a least squares fit but is still noisy in places. The **GLIDE** filter produces a very smooth solution with consistent rather than absolute position accuracy. There should be less than 1 cm difference typically from epoch to epoch. **GLIDE** also works in single point, DGPS and OmniSTAR VBS modes. See also the PDPMODE command on *page 159* and the PDPPOS, PSRVEL and PSRXYZ logs starting on *page 377*.

**Abbreviated ASCII Syntax:**

**Message ID: 424**

PDPFILTER switch

**Factory Default:**

pdpfilter disable

**ASCII Example:**

pdpfilter enable

| Field | Field Type       | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | PDPFILTER header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | switch           | DISABLE     | 0            | Enable/disable/reset the PDP filter. A reset clears the filter memory so that the pdp filter can start over.                                     | Enum          | 4            | H             |
|       |                  | ENABLE      | 1            |  |               |              |               |
|       |                  | RESET       | 2            |  |               |              |               |

---

1. Refer also to our application note on *Pseudorange/Delta-Phase (PDP)*, available on our Web site as APN-038 at <http://www.novatel.com/support/applicationnotes.htm>

## 2.5.47 PDPMODE Select the PDP mode and dynamics V123

This command allows you to select the mode and dynamics of the PDP filter.

- 
- ☒ 1. You must issue a PDPFILTER ENABLE command before the PDPMODE command. See also *Section 2.5.46 on Page 158*.
  - 2. If you choose RELATIVE mode (**GL1DE**) while in WAAS or CDGPS mode:
    - With an L1-only receiver model, you must force the iono type to GRID in the SETIONOTYPE command.
    - With an L1/L2 receiver model, you must force the iono type to L1L2 in the SETIONOTYPE command.

See also *Section 2.5.70* starting on *Page 192* for details on the SETIONOTYPE command.

---

**Abbreviated ASCII Syntax:**

**Message ID: 970**

PDPMODE mode dynamics

**Factory Default:**

pdpmode normal auto

**ASCII Example:**

pdpmode relative dynamic

| Field | Field Type     | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|----------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | PDPMODE header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.   | -             | H            | 0             |
| 2     | mode           | NORMAL      | 0            | In relative mode, <b>GL1DE</b> performance is optimized to obtain a consistent error in latitude and longitude over time periods of 15 minutes or less rather than to obtain the smallest absolute position error. See also <i>GL1DE Position Filter on Page 158</i> . | Enum          | 4            | H             |
|       |                | RELATIVE    | 1            |  |               |              |               |
| 3     | dynamics       | AUTO        | 0            | Auto detect dynamics mode  | Enum          | 4            | H+4           |
|       |                | STATIC      | 1            | Static mode  |               |              |               |
|       |                | DYNAMIC     | 2            | Dynamic mode   |               |              |               |



## 2.5.48 POSAVE Implement base station position averaging V123\_DGPS

This command implements position averaging for base stations. Position averaging continues for a specified number of hours or until the estimated averaged position error is within specified accuracy limits. Averaging stops when the time limit or the horizontal standard deviation limit or the vertical standard deviation limit is achieved. When averaging is complete, the FIX POSITION command is automatically invoked.

If you initiate differential logging, then issue the POSAVE command followed by the SAVECONFIG command, the receiver averages positions after every power-on or reset, and then invokes the FIX POSITION command to enable it to send differential corrections.

- 
- ☒ If this command is used, its command default state is ON and as such you only need to specify the state if you wish to disable position averaging (OFF). In *Example 1* below, POSAVE 24 1 2 is the same as:

```
POSAVE ON 24 1 2
```

---

### Abbreviated ASCII Syntax:

**Message ID: 173**

```
POSAVE [state] maxtime [maxhstd [maxvstd]]
```

### Factory Default:

```
posave off
```

### ASCII Example 1:

```
posave 24 1 2
```

### ASCII Example 2:

```
posave off
```



The POSAVE command can be used to establish a new base station in any form of survey or RTK data collection by occupying a site and averaging the position until either a certain amount of time has passed, or position accuracy has reached a user-specified level. User-specified requirements can be based on time, or horizontal or vertical quality of precision.

---

| Field | Field Type    | ASCII Value      | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|---------------|------------------|--------------|--|---------------|--------------|---------------|
| 1     | POSAVE header | -                | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | state         | ON               | 1            | Enable or disable position averaging (default = ON)  | Enum          | 4            | H             |
|       |               | OFF              | 0            |  |               |              |               |
| 3     | maxtime       | 0.01 - 100 hours |              | Maximum amount of time that positions are to be averaged. Only becomes optional if: State = OFF  | Float         | 4            | H+4           |
| 4     | maxhstd       | 0 - 100 m        |              | Desired horizontal standard deviation (default = 0)  | Float         | 4            | H+8           |
| 5     | maxvstd       | 0 - 100 m        |              | Desired vertical standard deviation (default = 0)  | Float         | 4            | H+12          |

### 2.5.49 POSTIMEOUT Sets the position time out V123

This commands allows you to set the RTK time out value for the position calculation in seconds.

In position logs, for example BESTPOS or PSRPOS, when the position time out expires, the *Position Type* field is set to NONE. Other field values in these logs remain populated with the last available position data. Also, the position is no longer used in conjunction with the almanac to determine what satellites are visible.

**Abbreviated ASCII Syntax:**

**Message ID: 612**

POSTIMEOUT sec

**Factory Default:**

postimeout 600

**ASCII Example:**

postimeout 1200



In performing RTK data collection in a highly dynamic environment (for example, urban canyons or in high-speed operations), you can use POSTIMEOUT to prevent the receiver from using calculated positions that are too old. Use POSTIMEOUT to force the receiver position type to NONE. This ensures that the position information being used in BESTPOS or PSRPOS logs is based on a recent calculation. All position calculations are then re-calculated using the most recent satellite information.

| Field | Field Type        | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|-------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | POSTIMEOUT header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | sec               | 0-86400     |              | Time out in seconds (default = 600 s)  | Ulong         | 4            | H             |

### 2.5.50 PPSCONTROL Control the PPS output V123

This command provides a method for controlling the polarity, rate and pulse width of the PPS output on the OEMV. You can also disable the PPS output using this command.

The leading edge of the 1PPS pulse is always the trigger/reference:

```
PPSCONTROL ENABLE NEGATIVE
```

generates a normally high, active low pulse with the falling edge as the reference, while:

```
PPSCONTROL ENABLE POSITIVE
```

generates a normally low, active high pulse with the rising edge as the reference.

In firmware versions 3.301 and higher, the pulse width is user-adjustable. The adjustable pulse width feature generates these uses for the PPS signal:

- Supporting triggers/systems that need longer, or shorter, pulse widths than the default to register the pulse
- Enabling a type of GPIO line for manipulation of external hardware control lines

**Abbreviated ASCII Syntax:**

**Message ID: 613**

```
PPSCONTROL switch [polarity] [rate] [pulse width]
```

**Factory Default:**

```
ppscontrol enable negative 1.0 0
```

**ASCII Example:**

```
ppscontrol enable positive 0.5 2000
```



This command is used to setup the PPS signal coming from the receiver. Suppose you wanted to take measurements such as temperature or pressure in synch with your GPS data. The PPS signal can be used to trigger measurements in other devices.

---

| Field | Field Type        | ASCII Value                                      | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|-------------------|--|--------------|--|---------------|--------------|---------------|
| 1     | PPSCONTROL header | -  | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.   | -             | H            | 0             |
| 2     | switch            | DISABLE  | 0            | Disables or enables output of the PPS pulse. The factory default value is ENABLE.  | Enum          | 4            | H+4           |
|       |                   | ENABLE   | 1            |  |               |              |               |
| 3     | polarity          | NEGATIVE   | 0            | Optional field to specify the polarity of the pulse to be generated on the PPS output. See <i>Figure 5</i> for more information. If no value is supplied, the default NEGATIVE is used.  | Enum          | 4            | H+8           |
|       |                   | POSITIVE   | 1            |  |               |              |               |
| 4     | rate              | 0.05, 0.1, 0.2, 0.25, 0.5, 1.0, 2.0, 3.0,...20.0 |              | Optional field to specify the period of the pulse, in seconds. If no value is supplied, the default value of 1.0 is used.  | Double        | 8            | H+12          |
| 5     | pulse width       | Any positive value less than half the period     |              | Optional field to specify the pulse width of the PPS signal in microseconds. If no value is supplied, the default value of 0 is used which refers to 1000 microseconds. This value should always be less than half the period. | ULong         | 4            | H+20          |

### 2.5.51 **PSRDIFFSOURCE** *Set the pseudorange correction source V123\_DGPS*

This command lets you identify from which base station to accept differential corrections. This is useful when the receiver is receiving corrections from multiple base stations. See also the **RTKSOURCE** command on *Page 177*.

- 
- ☒ 1. When a valid **PSRDIFFSOURCE** command is received, the current correction is removed immediately rather than in the time specified in **DGPSTIMEOUT**.
  - 2. To use L-band differential corrections, an L-band receiver and a subscription to the OmniSTAR, or use of the free CDGPS, service are required. Contact NovAtel for details, see the back of this manual or *Customer Service* in the *OEMV Installation* manual.
- 

**Abbreviated ASCII Syntax:**

**Message ID: 493**

**PSRDIFFSOURCE** type ID

**Factory Default:**

psrdiffsource auto "any"

**ASCII Examples:**

1. Enable only SBAS:  
 rtksource none  
 psrdiffsource sbas  
 sbascontrol enable auto
2. Enable OmniSTAR VBS, and HP or XP:  
 rtksource omnistar  
 psrdiffsource omnistar
3. Enable RTK and PSRDIFF from RTCM, with a fall-back to SBAS:  
 rtksource rtm any  
 psrdiffsource rtm any  
 sbascontrol enable auto
4. Disable all corrections:  
 rtksource none  
 psrdiffsource none



Since several errors affecting signal transmission are nearly the same for two receivers near each other on the ground, a base at a known location can monitor the errors and generate corrections for the rover to use. This method is called Differential GPS, and is used by surveyors to obtain millimeter accuracy.

Major factors degrading GPS signals, which can be removed or reduced with differential methods, are the atmosphere, ionosphere, satellite orbit errors and satellite clock errors. Errors not removed include receiver noise and multipath.

---

**Table 33: DGPS Type**

| Binary | ASCII                   | Description   |
|--------|-------------------------|---|
| 0      | RTCM <sup>a d</sup>     | RTCM ID:<br>0 ≤ RTCM ID ≤ 1023 <b>or</b> ANY  |
| 1      | RTCA <sup>a d</sup>     | RTCA ID:<br>A four character string containing only alpha (a-z) or numeric characters (0-9) <b>or</b> ANY   |
| 2      | CMR <sup>a b d</sup>    | CMR ID:<br>0 ≤ CMR ID ≤ 31 <b>or</b> ANY  |
| 3      | OMNISTAR <sup>c d</sup> | In the PSRDIFFSOURCE command, OMNISTAR enables OmniSTAR VBS and disables other DGPS types. OmniSTAR VBS produces RTCM-type corrections.<br>In the RTKSOURCE command, OMNISTAR enables OmniSTAR HP/XP (if allowed) and disables other RTK types. OmniSTAR HP/XP has its own filter, which computes corrections in RTK float mode or within about 10 cm accuracy.   |
| 4      | CDGPS <sup>c d</sup>    | In the PSRDIFFSOURCE command, CDGPS enables CDGPS and disables other DGPS types. CDGPS produces SBAS-type corrections.<br><b>Do not set CDGPS in the RTKSOURCE command as it can not provide carrier phase positioning and disallows all other sources of RTK information.</b>  |
| 5      | SBAS <sup>c d</sup>     | In the PSRDIFFSOURCE command, when enabled, SBAS, such as WAAS, EGNOS and MSAS, forces the use of SBAS as the pseudorange differential source. SBAS is able to simultaneously track two SBAS satellites, and incorporate the SBAS corrections into the position to generate differential-quality position solutions.<br>An SBAS-capable receiver permits anyone within the area of coverage to take advantage of its benefits.<br><b>Do not set SBAS in the RTKSOURCE command as it can not provide carrier phase positioning and disallows all other sources of RTK information.</b> |
| 10     | AUTO <sup>c d</sup>     | In the PSRDIFFSOURCE command, AUTO means the first received RTCM or RTCA message has preference over an L-band message.<br>In the RTKSOURCE command, AUTO means that both the NovAtel RTK filter and the OmniSTAR HP/XP filter (if authorized) are enabled. The NovAtel RTK filter selects the first received RTCM, RTCA, RTCMV3 or CMR message.<br>The BESTPOS log selects the best solution between NovAtel RTK and OmniSTAR HP/XP.   |
| 11     | NONE <sup>c d</sup>     | Disables all differential correction types  |
| 12     | Reserved                |   |
| 13     | RTCMV3 <sup>b</sup>     | RTCM Version 3.0 ID:<br>0 ≤ RTCMV3 ID ≤ 4095 <b>or</b> ANY  |

- a. Disables L-band Virtual Base Stations (VBS).
- b. Available only with the RTKSOURCE command, see page 177.
- c. ID parameter is ignored.
- d. All PSRDIFFSOURCE entries fall back to SBAS (except NONE).

| Field | Field Type           | ASCII Value         | Binary Value | Description  | Binary Format | Binary Bytes   | Binary Offset |
|-------|----------------------|---------------------|--------------|--|---------------|----------------|---------------|
| 1     | PSRDIFFSOURCE header | -                   | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.           | -             | H              | 0             |
| 2     | type                 | See <i>Table 33</i> |              | ID Type. All types may revert to SBAS (if enabled) or SINGLE position types. See also <i>Table 50, Position or Velocity Type on Page 248.</i> <sup>a</sup> | Enum          | 4              | H             |
| 3     | ID                   | Char [5] or ANY     |              | ID string  | Char[5]       | g <sup>b</sup> | H+4           |

- a. If you choose ANY, the receiver ignores the ID string. Specify a Type when you are using base station IDs.
- b. In the binary log case, an additional 3 bytes of padding are added to maintain 4-byte alignment



## 2.5.52 PSRVELOCITYTYPE Specify the Doppler Source V123

This command sets the Doppler source for velocities determined by the pseudorange filter.

The velocity in the PSRVEL log is determined by the pseudorange filter. Velocities from the pseudorange filter are calculated from the Doppler. The PSRVELOCITYTYPE command allows you to specify the Doppler source for pseudorange filter velocities.

In general, we recommend Doppler velocity. The exception is in cases needing a very good estimate of the latency and low latency. The delta phase velocity becomes noisier at high rates.

See also the PSRVEL log on *page 388*.

**Abbreviated ASCII Syntax:**

**Message ID: 950**

PSRVELOCITYTYPE [source]

**Factory Default:**

psrvelocitytype doppler

**Input Example:**

psrvelocitytype doppler

| Field | Field Type               | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|--------------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | PSR-VELOCITY-TYPE header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | source                   |             |              | Pseudorange velocity type, see <i>Table 34</i> below.  | Enum          | 4            | H             |

**Table 34: Pseudorange Velocity Type**

| Binary | ASCII      | Description                                 |
|--------|------------|---|
| 0      | DOPPLER    | Use observed Doppler                        |
| 1      | DELTAPHASE | Use phase differencing to calculate Doppler |

### 2.5.53 RESET Perform a hardware reset V123

This command performs a hardware reset. Following a RESET command, the receiver initiates a cold-start boot up. Therefore, the receiver configuration reverts either to the factory default, if no user configuration was saved, or the last SAVECONFIG settings. See also the FRESET and SAVECONFIG commands on *Pages 124 and 181* respectively.

The optional delay field is used to set the number of seconds the receiver is to wait before resetting.

**Abbreviated ASCII Syntax:**

**Message ID: 18**

RESET [delay]

#### Example

```
reset 120
```



The RESET command can be used to erase any unsaved changes to the receiver configuration.

| Field | Field Type   | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|--------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | RESET header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | delay        |             |              | Seconds to wait before resetting. (default = 0)  | Ulong         | 4            | H             |

---

### 2.5.54 **RTKANTENNA** Specify L1 phase center (PC) or ARP and enable/disable PC modelling V123\_RT20 or V23\_RT2

Use this command to specify whether to use L1 phase center or Antenna Reference Point (ARP) positioning.

You can also decide whether or not to apply phase center variation modeling. If there are any conditions that make a selected mode impossible, the solution status in the position logs indicate an error or warning. Status information is in the *rtk info* field of the RTKDATA log, see *page 525*.

L1 ARP offsets, L2 ARP offsets and phase center variation parameters can be entered using the ANTENNAMODEL and BASEANTENNAMODEL commands on *page 62* and *page 76* respectively.

Error states occur if either the rover does not have the necessary antenna information entered or the base is not sending sufficient information to work in the requested mode. Some examples of these error conditions are:

- RTCM Types 23 and 24 messages are received from the base and no model is available for the specified base antenna
- Phase center modeling is requested but the base is only sending RTCM Types 3 and 22
- Position reference to the ARP is requested but no rover antenna model is available

**Abbreviated ASCII Syntax:****Message ID: 858**

```
RTKANTENNA posref [pcv]
```

**Factory Default:**

```
rtkantenna 11pc
```

**ASCII Example:**

```
rtkantenna arp enable
```



This command is used for high-precision RTK positioning allowing application of antenna offset and phase centre variation parameters.

---

| Field | Field Type        | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|-------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | RTKANTENNA header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | posref            | L1PC        | 0            | L1 phase centre position reference   | Enum          | 4            | H             |
|       |                   | ARP         | 1            | ARP position reference   |               |              |               |
|       |                   | UNKNOWN     | 2            | Unknown position reference   |               |              |               |
| 3     | pcv               | DISABLE     | 0            | Disable PCV modelling (default)  | Enum          | 4            | H+4           |
|       |                   | ENABLE      | 1            | Enable PCV modelling   |               |              |               |
| 4     | Reserved          |             |              |  | Bool          | 4            | H+8           |
| 5     | Reserved          |             |              |  | Bool          | 4            | H+12          |

### 2.5.55 RTKCOMMAND *Reset or set the RTK filter to its defaults V123\_RT20 or V23\_RT2*

This command provides the ability to reset the RTK filter and clear any set RTK parameters. The RESET parameter causes the AdVance RTK algorithm to undergo a complete reset, forcing the system to restart the ambiguity resolution calculations. The USE\_DEFAULTS command executes the following commands:

```
RTKDYNAMICS DYNAMIC
RTKSVENTRIES 12
```

**Abbreviated ASCII Syntax:**

**Message ID: 97**

RTKCOMMAND action

**Factory Default:**

```
rtkcommand use_defaults
```

**ASCII Example:**

```
rtkcommand reset
```



See the descriptions for the above commands in the following pages.

| Field | Field Type        | ASCII Value  | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|-------------------|--------------|--------------|--|---------------|--------------|---------------|
| 1     | RTKCOMMAND header | -            | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | type              | USE_DEFAULTS | 0            | Reset to defaults  | Enum          | 4            | H             |
|       |                   | RESET        | 1            | Reset RTK algorithm  |               |              |               |


### 2.5.56 RTKDYNAMICS Set the RTK dynamics mode V123\_RT20 or V23\_RT2

This command provides the ability to specify how the receiver looks at the data. There are three modes: STATIC, DYNAMIC, and AUTO. The STATIC mode forces the RTK software to treat the rover station as though it were stationary, regardless of the output of the motion detector.

DYNAMIC forces the software to treat the receiver as though it were in motion. If the receiver is undergoing very slow steady motion (<2.5 cm/s for more than 5 seconds), you should use DYNAMIC mode (as opposed to AUTO) to prevent inaccurate results and possible resets.

On start-up, the receiver defaults to the DYNAMIC setting.

---

 For reliable performance the antenna should not move more than 1-2 cm when in static mode.

---

**Abbreviated ASCII Syntax:**

**Message ID: 183**

RTKDYNAMICS mode

**Factory Default:**

rtkdynamics dynamic

**ASCII Example:**

rtkdynamics static

**Table 35: Dynamics Mode**

| ASCII   | Binary | Description                            |
|---------|--------|--|
| AUTO    | 0      | Automatically determine dynamics mode. |
| STATIC  | 1      | Static mode.                           |
| DYNAMIC | 2      | Dynamic mode.                          |



Use the static option to decrease the time required to fix ambiguities and reduce the amount of noise in the position solution. If you use STATIC mode when the antenna is not static, the receiver will have erroneous solutions and unnecessary RTK resets.

| Field | Field Type         | ASCII Value  | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|--------------------|--------------|--------------|--|---------------|--------------|---------------|
| 1     | RTKDYNAMICS header | -            | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | mode               | See Table 35 |              | Set the dynamics mode  | Enum          | 4            | H             |

## 2.5.57 RTKNETWORK Specify the RTK network mode V123\_RT20 or V23\_RT2

Network RTK uses permanent base station installations, allowing kinematic GNSS users to achieve centimeter accuracies without the need of setting up a GNSS base station at a known site. This command sets the RTK network mode for a specific network. For more details on Network RTK, refer to the Network RTK application note available on our Web site as APN-041 at:

<http://www.novatel.com/support/applicationnotes.htm>.

There are several RTCM messages that accommodate network RTK. See also RTCM Types 22, 22G and 24, starting on *page 432*.

**Abbreviated ASCII Syntax:**

**Message ID: 951**

RTKNETWORK mode [network#]

**Factory Default:**

rtknetwork disabled

**Input Example:**

rtknetwork imax

| Field | Field Type         | ASCII Value | Binary Value | Description   | Binary Format | Binary Bytes | Binary Offset |
|-------|--------------------|-------------|--------------|---|---------------|--------------|---------------|
| 1     | RTK-NETWORK header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.  | -             | H            | 0             |
| 2     | mode               |             |              | RTK network mode, see <i>Table 36 on page 175</i> . The factory default is disabled where the receiver uses the standard AdVance RTK mode unless it detects FKP, then it uses FKP mode. | Enum          | 4            | H             |
| 3     | network#           |             |              | Specify a number for the network default = 0  | Ulong         | 4            | H+4           |

**Table 36: Network RTK Mode**

| Binary | ASCII    | Description  |
|--------|----------|--|
| 0      | Disabled | Standard RTK mode (or FKP mode if it is detected)  |
| 1-4    | Reserved |  |
| 5      | VRS      | <p>The virtual reference station (VRS), or virtual base station (VBS), idea, introduced by Trimble, is that a base station is artificially created in the vicinity of a rover receiver. All baseline-length-dependent errors, such as abnormal troposphere variation, ionospheric disturbances and orbital errors, are reduced for this VRS. The rover receiving VRS information has a lower level of these errors than a distant base station. The VRS is calculated for a position, supplied by the rover during communication start-up, with networking software. The VRS position can change if the rover is far away from the initial point. The format for sending the rover's position is standard NMEA format. Most rovers receive VRS data for a calculated base station that is within a couple of meters away.</p> <p>The VRS approach requires bi-directional communication for supplying the rover's position to the networking software.</p>   |
| 6      | IMAX     | <p>The iMAX idea, introduced by Leica Geosystems, is that networking software corrections, based on the rover's position, are calculated as with VRS. However, instead of calculating the base station observations for the provided position, or another position closer to the base station, original observation information is corrected with the calculated corrections and broadcast. VRS works so that although the rover is unaware of errors the VRS is taking care of, there still might be ionospheric remains in the base station observations. iMAX provides actual base station position information. The rover may assume the base station is at a distance and open its settings for estimation of the remaining ionospheric residuals. The iMAX method may trigger the rover to open its settings further than required since the networking software removes at least part of the ionospheric disturbances. However, compared to VRS above, this approach is safer since it notifies the rover when there might be baseline-length-dependent errors in the observation information.</p> <p>iMAX requires bi-directional communication to the networking software for supplying the base station observation information.</p> |
| 7-8    | Reserved |  |
| 9      | Unknown  | Use this setting if the RTK network type is unknown. Then, the receiver will use a default set of parameters for Network RTK mode.   |



### 2.5.58 RTKQUALITYLEVEL Choose an RTK quality mode V23\_RT2

**Abbreviated ASCII Syntax:**

**Message ID: 844**

RTKQUALITYLEVEL mode

**Factory Default:**

rtkqualitylevel normal

**ASCII Example:**

rtkqualitylevel extra\_safe

**Table 37: RTK Quality Mode**

| ASCII      | Binary | Description    |
|------------|--------|----------------|
| NORMAL     | 1      | Normal RTK     |
| EXTRA_SAFE | 4      | Extra Safe RTK |



The EXTRA\_SAFE command is needed in areas where the signal is partially blocked, by trees for example, and the position solution in NORMAL mode shows NARROW\_INT even though the real position solution is out by several metres. Using EXTRA\_SAFE in these types of environments means the solution will be slower getting to NARROW\_INT but it won't be erroneous.

| Field | Field Type              | ASCII Value  | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|-------------------------|--------------|--------------|--|---------------|--------------|---------------|
| 1     | RTKQUALITY-LEVEL header | -            | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | mode                    | See Table 37 |              | Set the RTK quality level mode   | Enum          | 4            | H             |

### 2.5.59 **RTKSOURCE** *Set the RTK correction source V1G23\_G, V123\_RT20, V23\_RT2 or V3\_HP*

This command lets you identify from which base station to accept RTK (RTCM, RTCMV3, RTCA, CMR and OmniSTAR (HP/XP)) differential corrections. This is useful when the receiver is receiving corrections from multiple base stations. See also the PSRDIFFSOURCE command on *Page 165*.

- 
- To use OmniSTAR HP/XP differential corrections, a NovAtel receiver with L-band capability and a subscription to the OmniSTAR service are required. Contact NovAtel for details. Contact information may be found on the back of this manual or you can refer to the *Customer Service* section in the *OEMV Family Installation and Operation User Manual*.
- 

#### Abbreviated ASCII Syntax:

**Message ID: 494**

RTKSOURCE type ID

#### Factory Default:

rtksource auto "any"

#### ASCII Examples:

1. Specify the format before specifying the base station IDs:
 

```
rtksource rtmv3 5
rtksource rtm 6
```

The RTKSOURCE command supports both RTCM and RTCMV3 while the PSRDIFFSOURCE commands supports only RTCM.
2. Select only SBAS:
 

```
rtksource none
psrdiffsource none
sbascontrol enable auto
```
3. Enable OmniSTAR HP and VBS:
 

```
rtksource omnistar
psrdiffsource omnistar
```
4. Enable RTK and PSRDIF from RTCM, with a fall-back to SBAS:
 

```
rtksource rtm any
psrdiffsource rtm any
sbascontrol enable auto
```



Consider an agricultural example where a farmer has his/her own RTCM base station set up but, either due to obstructions or radio problems, occasionally experience a loss of corrections. By specifying a fallback to SBAS, the farmer could set up his/her receiver to use transmitted RTCM corrections when available, but fall back to SBAS. Also, if he/she decided to get an OmniSTAR subscription, he could switch to the OmniSTAR corrections.

| Field | Field Type       | ASCII Value                                | Binary Value | Description  | Binary Format | Binary Bytes   | Binary Offset |
|-------|------------------|--|--------------|--|---------------|----------------|---------------|
| 1     | RTKSOURCE header | -  | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H              | 0             |
| 2     | type             | See <i>Table 33, DGPS Type on Page 166</i> |              | ID Type <sup>a</sup>   | Enum          | 4              | H             |
| 3     | ID               | Char [5] or ANY                            |              | ID string  | Char[5]       | g <sup>b</sup> | H+4           |

- a. If you choose ANY, the receiver ignores the ID string. Specify a Type when you are using base station IDs.
- b. In the binary log case, an additional 3 bytes of padding are added to maintain 4-byte alignment

## 2.5.60 RTKSVENTRIES *Set number of satellites in corrections V123\_RT20, V23\_RT2 or V3\_HP*

This command sets the number of satellites (at the highest elevation) that are transmitted in the RTK corrections from a base station receiver. Intended for RTCA, it works only with RTCAOBS or RTCAOBS2, see *Page 418*. This is useful when the amount of bandwidth available for transmitting corrections is limited.

### Abbreviated ASCII Syntax:

Message ID: 92

RTKSVENTRIES number

### Factory Default:

rtksventries 24

### ASCII Example:

rtksventries 7



GPS devices have enabled many transit and fleet authorities to provide Automatic Vehicle Location (AVL). AVL systems track the position of individual vehicles and relay that data back to a remote dispatcher location, that can store or better utilize the information. Consider the implementation of an AVL system within a police department, to automatically log and keep track of the location of each cruiser. Typically a fleet uses a 9600 bps connection where AVL data is relayed back to headquarters. The limited bandwidth of the radio must be shared amongst the AVL and other systems in multiple cruisers.

When operating with a low baud rate radio transmitter (9600 or lower), especially over a long distance, the AVL system could limit the number of satellites for which corrections are sent using the RTKSVENTRIES command.

| Field | Field Type          | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|---------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | RTKSVENTRIES header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | number              | 4-24        |              | The number of SVs to use in the solution (default = 24)  | ULong         | 4            | H             |

### 2.5.61 RTKTIMEOUT Set maximum age of RTK data V123\_RT20, V23\_RT2

This command is used to set the maximum age of RTK data to use when operating as a rover station. RTK data received that is older than the specified time is ignored.

**Abbreviated ASCII Syntax:**

**Message ID: 910**

RTKTIMEOUT delay

**Factory Default:**

rtktimeout 60

**ASCII Example (rover):**

rtktimeout 20



See the DGPSEPHMDELAY command on *Page 99* to set the ephemeris changeover delay for base stations.

| Field | Field Type        | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|-------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | RTKTIMEOUT header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | delay             | 5 to 60 s   |              | Maximum RTK data age (default = 60 s)  | ULong         | 4            | H             |

### 2.5.62 SAVECONFIG Save current configuration in NVM V123

This command saves the user's present configuration in non-volatile memory. The configuration includes the current log settings, FIX settings, port configurations, and so on. Its output is in the RXCONFIG log, see *page 539*. See also the FRESET command, *page 124*.

---



---

**WARNING!:** If you are using this command in CDU, ensure that you have all windows other than the Console window closed. Otherwise, log commands used for the various windows are saved as well. This will result in unnecessary data being logged.

---



---

**Abbreviated ASCII Syntax:**

**Message ID: 19**

SAVECONFIG

### 2.5.63 SBASCONTROL Set SBAS test mode and PRN V123\_SBAS

This command allows you to dictate how the receiver handles Satellite Based Augmentation System (SBAS) corrections. The receiver automatically switches to Pseudorange Differential (RTCM or RTCA) or RTK if the appropriate corrections are received, regardless of the current setting.

To enable the position solution corrections, you must issue the SBASCONTROL ENABLE command. The GPS receiver does not attempt to track any GEO satellites until you use the SBASCONTROL command to tell it to use either WAAS, EGNOS, or MSAS corrections.

When in AUTO mode, if the receiver is outside the defined satellite system's corrections grid, it reverts to ANY mode and chooses a system based on other criteria.

Once tracking satellites from one system in ANY or AUTO mode, it does not track satellites from other systems. This is because systems such as WAAS, EGNOS and MSAS do not share broadcast information and have no way of knowing each other are there.

The "testmode" parameter in the example is to get around the test mode of these systems. EGNOS at one time used the IGNOREZERO test mode. At the time of printing, ZEROTOTWO is the correct setting for all SBAS, including EGNOS, running in test mode. On a simulator, you may want to leave this parameter off or specify NONE explicitly.

When you use the SBASCONTROL command to direct the GPS receiver to use a specific correction type, the GPS receiver begins to search for and track the relevant GEO PRNs for that correction type only.

You can force the GPS receiver to track a specific PRN using the ASSIGN command. You can force the GPS receiver to use the corrections from a specific SBAS PRN using the SBASCONTROL command.

Disable stops the corrections from being used.

**Abbreviated ASCII Syntax:**

**Message ID: 652**

SBASCONTROL keyword [system] [prn] [testmode]

**Factory Default:**

sbascontrol disable auto 0 none

**Abbreviated ASCII Example 1:**

sbascontrol enable waas 0 zerototwo



NovAtel's OEMV receivers work with SBAS systems including EGNOS (Europe), MSAS (Japan) and WAAS (North America).

**Table 38: System Types**

| ASCII | Binary | Description   |
|-------|--------|---|
| NONE  | 0      | Don't use any SBAS satellites                             |
| AUTO  | 1      | Automatically determine satellite system to use (default) |
| ANY   | 2      | Use any and all SBAS satellites found                     |
| WAAS  | 3      | Use only WAAS satellites                                  |
| EGNOS | 4      | Use only EGNOS satellites                                 |
| MSAS  | 5      | Use only MSAS satellites                                  |

| Field | Field Type         | ASCII Value                     | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|--------------------|---------------------------------|--------------|--|---------------|--------------|---------------|
| 1     | SBASCONTROL header | -                               | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | keyword            | DISABLE                         | 0            | Receiver does not use the SBAS corrections it receives   | Enum          | 4            | H             |
|       |                    | ENABLE                          | 1            | Receiver uses the SBAS corrections it receives   |               |              |               |
| 3     | system             | See <i>Table 38 on page 182</i> |              | Choose the SBAS the receiver will use  | Enum          | 4            | H+4           |
| 4     | prn                | 0                               |              | Receiver uses any PRN (default)  | ULong         | 4            | H+8           |
|       |                    | 120-138                         |              | Receiver uses SBAS corrections only from this PRN  |               |              |               |
| 5     | testmode           | NONE                            | 0            | Receiver interprets Type 0 messages as they are intended (as do not use) (default)   | Enum          | 4            | H+12          |
|       |                    | ZEROTOTWO                       | 1            | Receiver interprets Type 0 messages as Type 2 messages   |               |              |               |
|       |                    | IGNOREZERO                      | 2            | Receiver ignores the usual interpretation of Type 0 messages (as do not use) and continues   |               |              |               |



### 2.5.64 SEND Send an ASCII message to a COM port V123

This command is used to send ASCII printable data from any of the COM or USB ports to a specified communications port. This is a one-time command, therefore the data message must be preceded by the SEND command and followed by <CR> each time you wish to send data. If the data string contains delimiters (that is, spaces, commas, tabs, and so on), the entire string must be contained within double quotation marks. Carriage return and line feed characters (for example, 0x0D, 0x0A) are appended to the sent ASCII data.

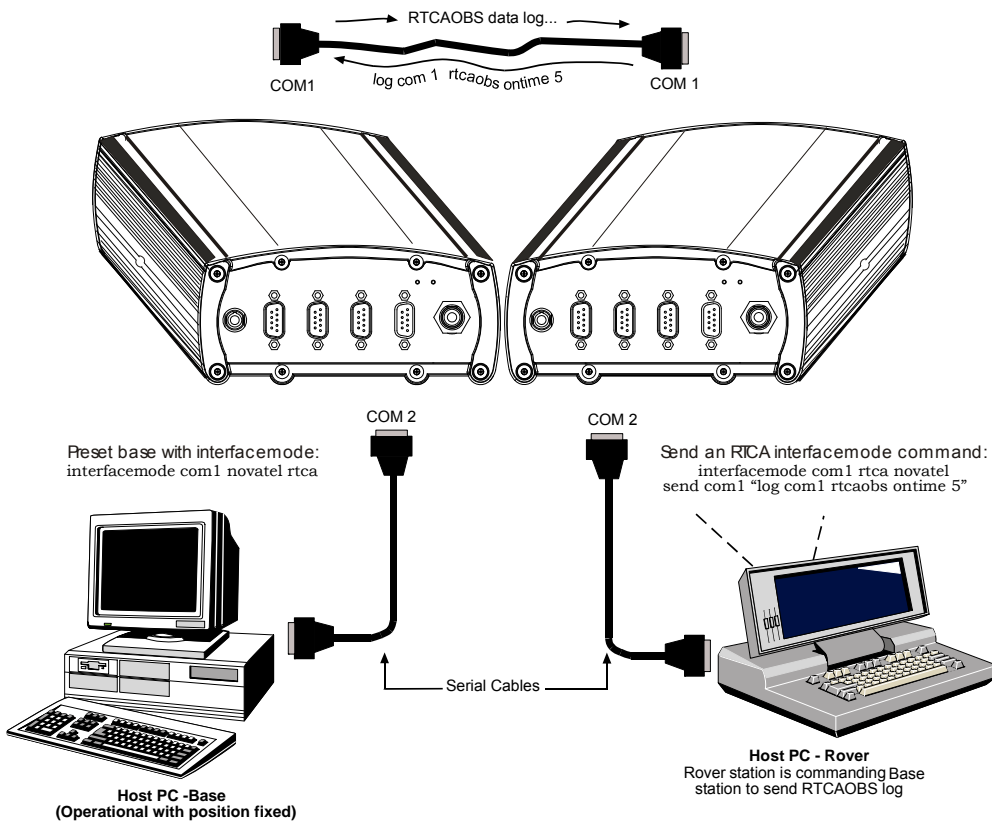
**Abbreviated ASCII Syntax:**

**Message ID: 177**

SEND port data



**Scenario:** Assume that you are operating receivers as base and rover stations. It could also be assumed that the base station is unattended but operational and you wish to control it from the rover station. From the rover station, you could establish the data link and command the base station receiver to send differential corrections.



**Figure 7: Using the SEND Command**

| Field | Field Type  | ASCII Value   | Binary Value | Description  | Binary Format     | Binary Bytes          | Binary Offset |
|-------|-------------|---|--------------|--|-------------------|-----------------------|---------------|
| 1     | SEND header | -   | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -                 | H                     | 0             |
| 2     | port        | See Table 17, COM Serial Port Identifiers on Page 88  |              | Output port  | Enum              | 4                     | H             |
| 3     | message     | Max 100 character string (99 typed visible chars and a null char added by the firmware automatically) |              | ASCII data to send   | String [max. 100] | Variable <sup>a</sup> | Variable      |

a. In the binary log case, additional bytes of padding are added to maintain 4-byte alignment

### 2.5.65 SENDHEX Send non-printable characters in hex pairs V123

This command is like the SEND command except that it is used to send non-printable characters expressed as hexadecimal pairs. Carriage return and line feed characters (for example, 0x0D, 0x0A) will **not** be appended to the sent data and so must be explicitly added to the data if needed.

**Abbreviated ASCII Syntax:**

**Message ID: 178**

SENDHEX port length data

**Input Example:**

sendhex com1 6 143ab5910d0a

| Field | Field Type     | ASCII Value  | Binary Value | Description  | Binary Format     | Binary Bytes           | Binary Offset |
|-------|----------------|--|--------------|--|-------------------|------------------------|---------------|
| 1     | SENDHEX header | -  | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -                 | H                      | 0             |
| 2     | port           | See <i>Table 17, COM Serial Port Identifiers on Page 88</i>  |              | Output port  | Enum              | 4                      | H             |
| 3     | length         | 0 - 700  |              | Number of hex pairs  | ULong             | 4                      | H+4           |
| 4     | message        | limited to a 700 maximum string (1400 pair hex) by command interpreter buffer even number of ASCII characters from set of 0-9, A-F no spaces are allowed between pairs of characters |              | Data   | String [max. 700] | Vari-able <sup>a</sup> | Vari-able     |

a. In the binary log case, additional bytes of padding are added to maintain 4-byte alignment

## 2.5.66 SETAPPROXPOS Set an approximate position V123

This command sets an approximate latitude, longitude, and height in the receiver. Estimating these parameters, when used in conjunction with an approximate time (see the SETAPPROXTIME command on *Page 188*), can improve satellite acquisition times and time to first fix. For more information about TTFF and Satellite Acquisition, please refer to the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm>.

The horizontal position entered should be within 200 km of the actual receiver position. The approximate height is not critical and can normally be entered as zero. If the receiver cannot calculate a valid position within 2.5 minutes of entering an approximate position, the approximate position is ignored.

The approximate position is not visible in any position logs. It can be seen by issuing a SETAPPROXPOS log. See also the SATVIS log on *Page 553*.

### Abbreviated ASCII Syntax:

**Message ID: 377**

SETAPPROXPOS lat lon height

### Input Example:

```
setapproxpos 51.116 -114.038 0
```



For an example on the use of this command, please see the SETAPPROXTIME command on *page 188*.

| Field | Field Type          | ASCII Value          | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|---------------------|----------------------|--------------|--|---------------|--------------|---------------|
| 1     | SETAPPROXPOS header | -                    | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | Lat                 | ± 90 degrees         |              | Approximate latitude   | Double        | 8            | H             |
| 3     | Lon                 | ± 360 degrees        |              | Approximate longitude  | Double        | 8            | H+8           |
| 4     | Height              | -1000 to +20000000 m |              | Approximate height   | Double        | 8            | H+16          |

### 2.5.67 SETAPPROXTIME Set an approximate GPS time V123

This command sets an approximate time in the receiver. The receiver uses this time as a system time until a GPS coarse time can be acquired. This can be used in conjunction with an approximate position (see the SETAPPROXPOS command on *page 187*) to improve time to first fix. For more information TTFF and Satellite Acquisition, please refer to the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm>.

The time entered should be within 10 minutes of the actual GPS time.

If the week number entered does not match the broadcast week number, the receiver resets.

See also the SATVIS log on *page 553*.

**Abbreviated ASCII Syntax:**

**Message ID: 102**

SETAPPROXTIME week sec

**Input Example:**

```
setapproxtime 1105 425384
```



Upon power-up, the receiver does not know its position or time, and therefore, cannot use almanac information to aid satellite acquisition. You can set an approximate GPS time using the SETAPPROXTIME command or RTCAEPHEM message. The RTCAEPHEM message contains GPS week and seconds and the receiver uses that GPS time if the time is not yet known. Several logs provide base station coordinates and the receiver uses them as an approximate position allowing it to compute satellite visibility. Alternately, you can set an approximate position by using the SETAPPROXPOS command.

Approximate time and position must be used in conjunction with a current almanac to aid satellite acquisition. See the table below for a summary of the OEMV family commands and logs used to inject an approximated time or position into the receiver:

| Approximate | Command       | Log                        |
|-------------|---------------|----------------------------|
| Time        | SETAPPROXTIME | RTCAEPHEM                  |
| Position    | SETAPPROXPOS  | RTCAREF or CMRREF or RTCM3 |

Base station aiding can help in these environments. A set of ephemerides can be injected into a rover station by broadcasting the RTCAEPHEM message from a base station. This is also useful in environments where there is frequent loss of lock (GPS ephemeris is three frames long within a sequence of five frames. Each frame requires 6 s of continuous lock to collect the ephemeris data. This gives a minimum of 18 s and a maximum of 36 s continuous lock time.) or, when no recent ephemerides (new or stored) are available.

| Field | Field Type           | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|----------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | SETAPPROXTIME header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | week                 | 0-9999      |              | GPS week number  | Ulong         | 4            | H             |
| 3     | sec                  | 0-604801    |              | Number of seconds into GPS week  | Double        | 8            | H+4           |

### 2.5.68 SETBESTPOSCRITERIA Selection criteria for BESTPOS V123

Use this command to set the criteria for the BESTPOS log. It allows you to select between 2D and 3D standard deviation to obtain the best position from the BESTPOS log. It also allows you to specify the number of seconds to wait before changing the position type. This delay provides a single transition that ensures position types do not skip back and forth. See also BESTPOS on *page 247*.

**Abbreviated ASCII Syntax:**

**Message ID: 839**

SETBESTPOSCRITERIA type delay

**Factory Default:**

setbestposcriteria pos3d 0

**Example:**

setbestposcriteria pos2d 5

| Field | Field Type                  | ASCII Value         | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|-----------------------------|---------------------|--------------|--|---------------|--------------|---------------|
| 1     | SET-BESTPOS-CRITERIA header | -                   | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | type                        | See <i>Table 39</i> |              | Select a 2D or 3D standard deviation type to obtain the best position from the BESTPOS log default = 3D  | Enum          | 4            | H             |
| 3     | delay                       | 0 to 100 s          |              | Set the number of seconds to wait before changing the position type default = 0  | Ulong         | 4            | 4             |

**Table 39: Selection Type**

| ASCII | Binary | Description                     |
|-------|--------|---------------------------------|
| POS3D | 0      | 3D standard deviation (default) |
| POS2D | 1      | 2D standard deviation           |

## 2.5.69 SETDIFFCODEBIASES Set satellite differential code biases V123

---



---

**WARNING!:** Changing the biases may negatively affect positioning accuracy. NovAtel recommends that only advanced users modify the biases.

---



---

Use this command to set the differential code biases that correct pseudorange errors affecting the L1/L2 ionospheric corrections. Bias values are restricted to between -3 ns and +3 ns. A set of biases is included in the firmware, and use of the biases is enabled by default. See also the DIFFCODEBIASCONTROL command on *page 108*.

The receiver uses the C/A code on L1 and the P code on L2 to calculate a dual-frequency ionospheric correction. However, the GPS clock corrections are broadcast as if the P codes on both L1 and L2 are used to calculate this correction. The biases account for the differences between the P and C/A codes on L1, and improve the estimate of the ionospheric correction.

The biases are calculated by the International GNSS Service (IGS). Calculation details, analysis, and results are available at <http://www.aiub.unibe.ch/ionosphere.html>. The most recent 30 day average bias values can be downloaded from <http://www.aiub.unibe.ch/ionosphere/p1c1.dcb>.

**Abbreviated ASCII Syntax:**

**Message ID: 687**

SETDIFFCODEBIASES

**Factory Default:**

```
SETDIFFCODEBIASES GPS_C1P1 -0.542 -0.069 -0.597 1.030 -1.289
0.089 -1.878 -0.686 0.044 -1.982 0.528 1.285 1.405 0.029
1.696 -0.838 1.237 -0.514 -2.094 -1.482 -0.543 0.473 0.629
-0.343 0.337 0.911 -0.498 -0.440 1.783 1.808 1.542 -1.031
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
```

| Field | Field Type                 | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|----------------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | SETDIFF-CODE-BIASES header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | bias_type                  | GPS_C1P1    | 0            | Code pair to which biases refer (default)  | Enum          | 4            | H             |
| 3     | biases                     |             |              | Array of 40 biases (ns)  | Float[40]     | 160          | 4             |



### 2.5.70 SETIONOTYPE Enable ionospheric models V123

Set which ionospheric corrections model the receiver should use.

L1-only models with firmware 3.301 or higher automatically use SBAS or CDGPS ionospheric grid corrections, if available. The corrections model with the previous ASCII name of BROADCAST is now called KLOBUCHAR to reflect the actual model used.

**Abbreviated ASCII Syntax:**

**Message ID: 711**

SETIONOTYPE model

**Factory Default:**

setionotype auto

**ASCII Example:**

setionotype klobuchar



For PDP or *GLIDE* positioning filters, refer to their configuration section in *Chapter 4* of the [OEMV Installation and Operation User Manual](#), available on our Web site.

| Field | Field Type         | ASCII Value               | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|--------------------|---------------------------|--------------|--|---------------|--------------|---------------|
| 1     | SETIONOTYPE header | -                         | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | model              | See <i>Table 40</i> below |              | Choose an ionospheric corrections model (default = AUTO)   | Enum          | 4            | H             |

**Table 40: Ionospheric Correction Models**

| ASCII     | Binary | Description  |
|-----------|--------|--|
| NONE      | 0      | Don't use ionospheric modelling                      |
| KLOBUCHAR | 1      | Use the broadcast Klobuchar model                    |
| GRID      | 2      | Use the SBAS/L-band model                            |
| L1L2      | 3      | Use the L1/L2 model                                  |
| AUTO      | 4      | Automatically determine the ionospheric model to use |

### 2.5.71 SETNAV Set start and destination waypoints V123

This command permits entry of one set of navigation waypoints (see *Figure 8* on *Page 193*). The origin (FROM) and destination (TO) waypoint coordinates entered are considered on the ellipsoidal surface of the current datum (default WGS84). Once SETNAV has been set, you can monitor the navigation calculations and progress by observing the NAVIGATE log messages.

Track offset is the perpendicular distance from the great circle line drawn between the FROM lat-lon and TO lat-lon waypoints. It establishes the desired navigation path, or track, that runs parallel to the great circle line, which now becomes the offset track, and is set by entering the track offset value in meters. A negative track offset value indicates that the offset track is to the left of the great circle line track. A positive track offset value (no sign required) indicates the offset track is to the right of the great circle line track (looking from origin to destination). See *Figure 8* on *Page 193* for clarification.

#### Abbreviated ASCII Syntax:

**Message ID: 162**

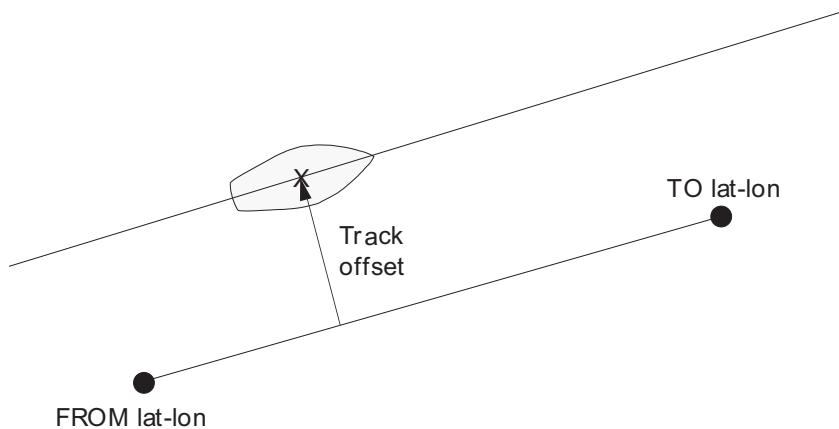
SETNAV fromlat fromlon tolat tolon track offset from-point to-point

#### Factory Default:

```
setnav 90.0 0.0 90.0 0.0 0.0 0.0 from to
```

#### ASCII Example:

```
setnav 51.1516 -114.16263 51.16263 -114.1516 -125.23 from to
```



**Figure 8: Illustration of SETNAV Parameters**



Consider the case of setting waypoints in a deformation survey along a dam. The surveyor enters the From and To point locations on either side of the dam using the SETNAV command. They then use the NAVIGATE log messages to record progress and show them where they are in relation to the From and To points.

| Field | Field Type    | ASCII Value          | Binary Value | Description   | Binary Format   | Binary Bytes          | Binary Offset |
|-------|---------------|----------------------|--------------|---|-----------------|-----------------------|---------------|
| 1     | SETNAV header | -                    | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.                          | -               | H                     | 0             |
| 2     | fromlat       | ± 90 degrees         |              | Origin latitude in units of degrees/decimal degrees. A negative sign for South latitude. No sign for North latitude.  | Double          | 8                     | H             |
| 3     | fromlon       | ± 180 degrees        |              | Origin longitude in units of degrees/decimal degrees. A negative sign for West longitude. No sign for East longitude.   | Double          | 8                     | H+8           |
| 4     | tolat         | ± 90 degrees         |              | Destination latitude in units of degrees/decimal degrees  | Double          | 8                     | H+16          |
| 5     | tolon         | ± 180 degrees        |              | Destination longitude in units of degrees/decimal degrees   | Double          | 8                     | H+24          |
| 6     | track offset  | ± 1000 km            |              | Waypoint great circle line offset (in kilometers); establishes offset track; positive indicates right of great circle line; negative indicates left of great circle line. | Double          | 8                     | H+32          |
| 7     | from-point    | 5 characters maximum |              | ASCII station name  | String [max. 5] | Variable <sup>a</sup> | Variable      |
| 8     | to-point      | 5 characters maximum |              | ASCII station name  | String [max. 5] | Variable <sup>a</sup> | Variable      |

a. In the binary log case, additional bytes of padding are added to maintain 4-byte alignment

## 2.5.72 SETRTCM16 Enter ASCII text for RTCM data stream V123\_DGPS

The RTCM type 16 message allows ASCII text to be transferred from a GPS base station to rover GPS receivers. The SETRTCM16 command is used to define the ASCII text at the base station. The text defined by the SETRTCM16 command can be verified in the RXCONFIG log. Once the ASCII text is defined it can be broadcast periodically by the base station with the command "log port RTCM16 ONTIME interval". The received ASCII text can be displayed at the rover by logging RTCM16T.

This command limits the input message length to a maximum of 90 ASCII characters. If the message string contains any delimiters (that is, spaces, commas, tabs, and so on) the entire string must be contained in double quotation marks.

**Abbreviated ASCII Syntax:**

**Message ID: 131**

SETRTCM16 text

**Input Example:**

setrtcm16 "base station will shut down in 1 hour"

| Field | Field Type       | ASCII Value                 | Binary Value | Description  | Binary Format    | Binary Bytes           | Binary Offset |
|-------|------------------|-----------------------------|--------------|--|------------------|------------------------|---------------|
| 1     | SETRTCM16 header | -                           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -                | H                      | 0             |
| 2     | text             | Maximum 90 character string |              | The text string  | String [max. 90] | Vari-able <sup>a</sup> | Vari-able     |

a. In the binary log case, additional bytes of padding are added to maintain 4-byte alignment

### 2.5.73 SETRTCM36 Enter ASCII text with Russian characters VIG23\_G

The RTCM Type 36 message is the GLONASS equivalent of the RTCM Type 16 message except that the RTCM36 message can contain characters from an extended character set including Russian characters. *Table 41 on page 197* provides the standard decimal and hex codes to use when transmitting Cyrillic characters to provide Russian language messages. Codes from 0 to 127 correspond to standard ASCII codes.

To support the 8-bit character data in the ASCII version, 8-bit characters are represented as `\xnn` (or `\dnnn`) which are the hexadecimal (or decimal) values of the characters. A `"\"` is represented as `"\"`.

In the RTCMDATA36 and RTCM36T logs, the ascii output displays the 8-bit characters in the decimal `\dnnn` representation. However, in the SETRTCM36 command, you can enter the 8-bit characters using the `\x` or `\d` prefix.

- 
- ☒ This command limits the input message length to a maximum of 90 ASCII characters. If the message string contains any delimiters (that is, spaces, commas, tabs, and so on) the entire string must be contained in double quotation marks.
- 

#### Abbreviated ASCII Syntax:

**Message ID: 880**

SETRTCM36 extdtext

#### Input Example:

To set the message “QUICK ШТОПМ”, enter any of the following commands (colour added, or grayscale in printed versions, to aid understanding):

```
setrtcm36 "quick \d166\d146\d174\d144\d140"
setrtcm36 "quick \xa6\x92\xae\x90\x8c"
setrtcm36 "\x51\x55\x49\x43\x4b\x20\xa6\x92\xae\x90\x8c"
setrtcm36 "\x51\x55\x49\x43\x4b\xa6\x92\xae\x90\x8c"
```

The corresponding RTCMDATA36A log, see *page 471*, looks like:

```
#RTCMDATA36A,COM1,0,64.5,FINESTEERING,1399,237113.869,00500000,
F9F5,35359;36,0,5189,0,0,6,11,"QUICK\D166\D146\D174\D144\D140"
*8BDEAE71
```

Similarly, the corresponding RTCM36T message, see *page 432*, looks like:

```
#RTCM36TA,COM1,0,77.5,FINESTEERING,1399,237244.454,00000000,
2E54,35359;"QUICK \D166\D146\D174\D144\D140"*4AA7F340
```



Similar to the RTCM type 16 message, the SETRTCM36 command is used to define the ASCII text at the base station and can be verified in the RXCONFIG log. Once

the ASCII text is defined it can be broadcast periodically by the base station with the command, for example "log port RTCM36 ONTIME 10". The received ASCII text can be displayed at the rover by logging RTCM36T.

**Table 41: Russian Alphabet Characters (Ch) in Decimal (Dec) and Hexidecimal (Hex)**

| Hex Code | Dec Code | Ch | Hex Code | Dec Code | Ch | Hex Code | Dec Code | Ch | Hex Code | Dec Code | Ch |
|----------|----------|----|----------|----------|----|----------|----------|----|----------|----------|----|
| 80       | 128      | А  | 90       | 144      | Р  | A0       | 160      | а  | B0       | 176      | р  |
| 81       | 129      | Б  | 91       | 145      | С  | A1       | 161      | б  | B1       | 177      | с  |
| 82       | 130      | В  | 92       | 146      | Т  | A2       | 162      | в  | B2       | 178      | т  |
| 83       | 131      | Г  | 93       | 147      | У  | A3       | 163      | г  | B3       | 179      | у  |
| 84       | 132      | Д  | 94       | 148      | Ф  | A4       | 164      | д  | B4       | 180      | ф  |
| 85       | 133      | Е  | 95       | 149      | Х  | A5       | 165      | е  | B5       | 181      | х  |
| 86       | 134      | Ж  | 96       | 150      | Ц  | A6       | 166      | ж  | B6       | 182      | ц  |
| 87       | 135      | Э  | 97       | 151      | Ч  | A7       | 167      | э  | B7       | 183      | ч  |
| 88       | 136      | И  | 98       | 152      | Ш  | A8       | 168      | и  | B8       | 184      | ш  |
| 89       | 137      | Й  | 99       | 153      | Щ  | A9       | 169      | й  | B9       | 185      | щ  |
| 8A       | 138      | К  | 9A       | 154      | Ъ  | AA       | 170      | к  | BA       | 186      | ъ  |
| 8B       | 139      | Л  | 9B       | 155      | Ы  | AB       | 171      | л  | BB       | 187      | ы  |
| 8C       | 140      | М  | 9C       | 156      | Ь  | AC       | 172      | м  | BC       | 188      | ь  |
| 8D       | 141      | Н  | 9D       | 157      | Э  | AD       | 173      | н  | BD       | 189      | э  |
| 8E       | 142      | О  | 9E       | 158      | Ю  | AE       | 174      | о  | BE       | 190      | ю  |
| 8F       | 143      | П  | 9F       | 159      | Я  | AF       | 175      | п  | BF       | 191      | я  |

| Field | Field Type       | ASCII Value                 | Binary Value | Description  | Binary Format    | Binary Bytes          | Binary Offset |
|-------|------------------|-----------------------------|--------------|--|------------------|-----------------------|---------------|
| 1     | SETRTCM36 header | -                           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -                | H                     | 0             |
| 2     | extdtext         | Maximum 90 character string |              | The RTCM36 text string   | String [max. 90] | Variable <sup>a</sup> | Variable      |

a. In the binary log case, additional bytes of padding are added to maintain 4-byte alignment

## 2.5.74 STATUSCONFIG Configure RXSTATUSEVENT mask fields V123

This command is used to configure the various status mask fields in the RXSTATUSEVENT log, see *page 551*. These masks allow you to modify whether various status fields generate errors or event messages when they are set or cleared.

Receiver Errors automatically generate event messages. These event messages are output in RXSTATUSEVENT logs. It is also possible to have status conditions trigger event messages to be generated by the receiver. This is done by setting/clearing the appropriate bits in the event set/clear masks. The set mask tells the receiver to generate an event message when the bit becomes set. Likewise, the clear mask causes messages to be generated when a bit is cleared. If you wish to disable all these messages without changing the bits, simply UNLOG the RXSTATUSEVENT logs on the appropriate ports. Refer also to the *Built in Status Tests* chapter in the *OEMV Family Installation and Operation User Manual*.

### Abbreviated ASCII Syntax:

**Message ID: 95**

STATUSCONFIG type word mask

### Factory Default:

```
statusconfig priority status 0
statusconfig priority aux1 0x00000008
statusconfig priority aux2 0
statusconfig set status 0x00000000
statusconfig set aux1 0
statusconfig set aux2 0
statusconfig clear status 0x00000000
statusconfig clear aux1 0
statusconfig clear aux2 0
```

### ASCII Example:

```
statusconfig set status 0028a51d
```



The receiver gives the user the ability to determine the importance of the status bits. In the case of the Receiver Status, setting a bit in the priority mask causes the condition to trigger an error. This causes the receiver to idle all channels, set the ERROR strobe line, flash an error code on the status LED, turn off the antenna (LNA power), and disable the RF hardware, the same as if a bit in the Receiver Error word is set. Setting a bit in an Auxiliary Status priority mask causes that condition to set the bit in the Receiver Status word corresponding to that Auxiliary Status.

**Table 42: Mask Types**

| ASCII    | Binary | Description               |
|----------|--------|---------------------------|
| PRIORITY | 0      | Replace the Priority mask |
| SET      | 1      | Replace the Set mask      |
| CLEAR    | 2      | Replace the Clear mask    |

| Field | Field Type          | ASCII Value         | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|---------------------|---------------------|--------------|--|---------------|--------------|---------------|
| 1     | STATUSCONFIG header | -                   | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | type                | See <i>Table 42</i> |              | Type of mask to replace  | Enum          | 4            | H             |
| 3     | word                | STATUS              | 1            | Receiver Status word   | Enum          | 4            | H+4           |
|       |                     | AUX1                | 2            | Auxiliary 1 Status word  |               |              |               |
| 4     | mask                | 8 digit hexadecimal |              | The hexadecimal bit mask   | Ulong         | 4            | H+8           |



## 2.5.75 TUNNELESCAPE Break out of an established tunnel V123

The tunnel escape sequence feature allows you to break out of a tunnel between two ports by sending a pre-defined sequence of bytes through the tunnel in-line with the data stream. While the Bluetooth implementation on DL-V3 products utilizes the tunnel mode of OEM receivers, the tunnel escape sequence feature is applicable to any tunneling application.

Use the TUNNELESCAPE command to specify the tunnel escape sequence. The escape sequence is applied independently to all active tunnels. Use the SAVECONFIG command to save the escape sequence in case of a power cycle.

This command allows you to define an escape sequence that, when detected in a byte stream between any two COM (or AUX) ports, resets the interface mode to NOVATEL NOVATEL on those ports. The baud rate and other port parameters remain unaffected.

The TUNNELESCAPE command accepts three parameters. The first is the *switch* parameter with ENABLE or DISABLE options. The second is the *length* parameter. It is a number from 1 to 8 and must be present if the *switch* parameter is set to ENABLE. The third parameter, *esc seq*, consists of a series of pairs of digits representing hexadecimal numbers where the number of pairs are equal to the value entered for the second parameter. The series of hexadecimal pairs of digits represent the escape sequence. The receiver detects a sequence in a tunnel exactly as it was entered.

For example, the command TUNNELESCAPE ENABLE 4 61626364 searches for the bytes representing “abcd” in a tunnel stream. TUNNELESCAPE ENABLE 3 AA4412 searches for the NovAtel binary log sync bytes.

You must first set up a tunnel. For example, create a tunnel between COM1 and COM2 by entering INTERFACEMODE COM1 TCOM2 NONE OFF. The commands can be entered in any order.

- 
- ☒ 1. All bytes, leading up to and including the escape sequence, pass through the tunnel before it is reset. Therefore, the escape sequence is the last sequence of bytes that passes through the tunnel. Configure the receiver to detect and interpret the escape sequence. For example, use this information to reset equipment or perform a shutdown process.
  - 2. The receiver detects the escape sequence in all active tunnels in any direction.
  - 3. Create tunnels using the INTERFACEMODE command, see *page 135*.
  - 4. SAVECONFIG WARNING: If you are using the SAVECONFIG command in **CDU**, ensure that you have all windows other than the *Console* window closed. Otherwise, **CDU** also saves log commands used for its various windows. This will result in unnecessary data being logged.
- 

**Abbreviated ASCII Syntax:**

**Message ID: 962**

TUNNELESCAPE [switch] [length] [esc seq]

**Factory Default:**

tunnelescape disable

**ASCII Example:**

```
tunnelescape enable
```

| Field | Field Type           | ASCII Value | Binary Value | Description   | Binary Format | Binary Bytes | Binary Offset |
|-------|----------------------|-------------|--------------|---|---------------|--------------|---------------|
| 1     | TUNNEL-ESCAPE header | -           | -            | This field contains the command name  | H             | 0            | -             |
| 2     | switch               | DISABLE     | 0            | Enable or disable the tunnel escape mode<br>default: DISABLE                    | ENUM          | 4            | H             |
|       |                      | ENABLE      | 1            |   |               |              |               |
| 3     | length               | 1 to 8      |              | Specifies the number of hexbytes to follow.                                     | ULONG         | 4            | H+4           |
| 4     | esc seq              |             |              | Escape sequence where Hex pairs are entered without spaces, for example, AA4412 | Uchar[8]      | 8            | H+8           |

### 2.5.76 UNASSIGN *Unassign a previously assigned channel V123*

This command cancels a previously issued ASSIGN command and the SV channel reverts to automatic control (the same as ASSIGN AUTO).

**Abbreviated ASCII Syntax:**

**Message ID: 29**

UNASSIGN channel

**Input Example:**

unassign 11



Issuing the UNASSIGN command to a channel that was not previously assigned by the ASSIGN command will have no effect.

| Field | Field Type      | ASCII Value   | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|-----------------|---|--------------|--|---------------|--------------|---------------|
| 1     | UNASSIGN header | -   | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | channel         | See Table 13, <i>OEMV Channel Configurations on Page 66</i> |              | Reset SV channel to automatic search and acquisition mode  | ULong         | 4            | H             |
| 3     | state           | See Table 12, <i>Channel State on Page 65</i>               |              | Set the SV channel state (currently ignored)   | Enum          | 4            | H+4           |

## 2.5.77 UNASSIGNALL *Unassign all previously assigned channels V123*

This command cancels all previously issued ASSIGN commands for all SV channels (same as ASSIGNALL AUTO). Tracking and control for each SV channel reverts to automatic mode. See ASSIGN AUTO for more details.

**Abbreviated ASCII Syntax:**

**Message ID: 30**

UNASSIGNALL [system]

**Input Example:**

```
unassignall gps11
```

---

✉ Issuing the UNASSIGNALL command has no effect on channels that were not previously assigned using the ASSIGN command.

---

| Field | Field Type         | ASCII Value                             | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|--------------------|---|--------------|--|---------------|--------------|---------------|
| 1     | UNASSIGNALL header | -                                       | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | system             | See Table 14, Channel System on Page 68 |              | System that the SV channel is tracking   | Enum          | 4            | H             |



These command examples are only applicable to specific receiver models.

1. The following command applies to receiver models tracking only L1 frequencies:

```
assignall gps11 active 29 0 2000
```

2. The following command applies to receiver models tracking both L1 and L2 frequencies:

```
assignall gps1112,28,-250,0
```

If you use the *system* field with this command and the receiver has no channels configured with that channel system, the command has no effect on the receiver's tracking state.

---

### 2.5.78 UNDULATION Choose undulation V123

This command permits you to either enter a specific geoidal undulation value or use the internal table of geoidal undulations. In the *option* field, the EGM96 table provides ellipsoid heights at a 0.25° by 0.25° spacing while the OSU89B is implemented at a 2° by 3° spacing. In areas of rapidly changing elevation, you could be operating somewhere within the 2° by 3° grid with an erroneous height. EGM96 provides a more accurate model of the ellipsoid which results in a denser grid of heights. It is more accurate because the accuracy of the grid points themselves has also improved from OSU89B to EGM96. For example, the default grid (EGM96) is useful where there are underwater canyons, steep drop-offs or mountains.

The undulation values reported in the BESTPOS, BESTUTM, MARKPOS, MATCHEDPOS, OMNIHPPPOS, PSRPOS and RTKPOS logs are in reference to the ellipsoid of the chosen datum.

**Abbreviated ASCII Syntax:**

**Message ID: 214**

UNDULATION option [separation]

**Factory Default:**

undulation egm96

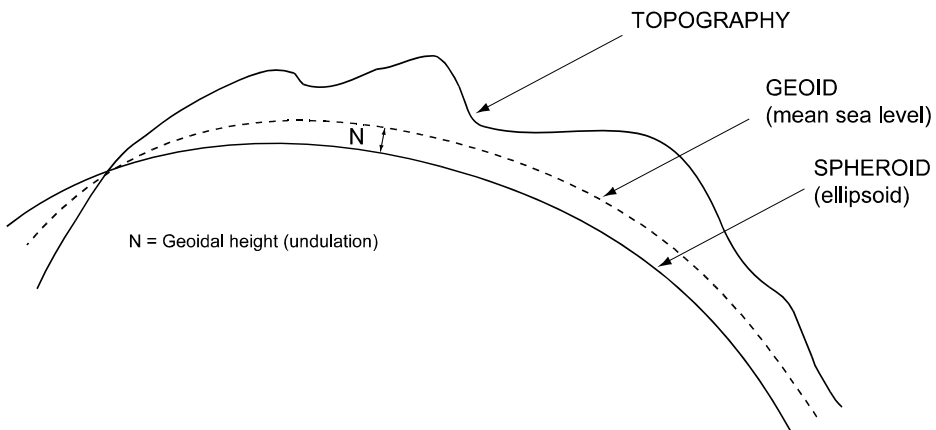
**ASCII Example 1:**

undulation osu89b

**ASCII Example 2:**

undulation user -5.599999905

Refer to the application note titled *Geoid Issue*, available on our Web site at <http://www.novatel.com/support/applicationnotes.htm>, for a description of the relationships in *Figure 9*.



**Figure 9: Illustration of Undulation**

| Field | Field Type        | ASCII Value | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|-------------------|-------------|--------------|--|---------------|--------------|---------------|
| 1     | UNDULATION header | -           | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | option            | TABLE       | 0            | Use the internal undulation table (same as EGM96)  | Enum          | 4            | H             |
|       |                   | USER        | 1            | Use the user specified undulation value  |               |              |               |
|       |                   | OSU89B      | 2            | Use the OSU89B undulation table  |               |              |               |
|       |                   | EGM96       | 3            | Use global geoidal height model EGM96 table (default)  |               |              |               |
| 3     | separation        | ± 1000.0 m  |              | The undulation value (required for the USER option)  | Float         | 4            | H+4           |

### 2.5.79 UNLOCKOUT *Reinstate a satellite in the solution V123*

This command allows a satellite which has been previously locked out (LOCKOUT command) to be reinstated in the solution computation. If more than one satellite is to be reinstated, this command must be reissued for each satellite reinstatement.

**Abbreviated ASCII Syntax:**

**Message ID: 138**

UNLOCKOUT prn

**Input Example:**

unlockout 8



The UNLOCKOUT command allows you to reinstate a satellite while leaving other locked out satellites unchanged.

| Field | Field Type       | ASCII Value  | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|------------------|--|--------------|--|---------------|--------------|---------------|
| 1     | UNLOCKOUT header | -  | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | prn              | GPS: 1-37<br>SBAS: 120-138<br>GLONASS: see Section 1.3 on Page 30. |              | A single satellite PRN number to be reinstated   | Ulong         | 4            | H             |

---

### 2.5.80 UNLOCKOUTALL Reinstates all previously locked out satellites V123

This command allows all satellites which have been previously locked out (LOCKOUT command) to be reinstated in the solution computation.

**Abbreviated ASCII Syntax:**

**Message ID: 139**

UNLOCKOUTALL

**Input Example:**

```
unlockoutall
```



The UNLOCKOUTALL command allows you to reinstate all satellites currently locked out.

---

### 2.5.81 UNLOG Remove a log from logging control V123

This command permits you to remove a specific log request from the system.

The *[port]* parameter is optional. If *[port]* is not specified, it is defaulted to the port on which the command was received. This feature eliminates the need for you to know which port you are communicating on if you want logs to be removed on the same port as this command.

**Abbreviated ASCII Syntax:**

**Message ID: 36**

UNLOG *[port]* datatype

**Input Example:**

```
unlog com1 bestposa
```

```
unlog bestposa
```



The UNLOG command allows you to remove one or more logs while leaving other logs unchanged.

---



| Field | Field Name            | Binary Value  | Description  | Field Type | Binary Bytes | Binary Offset |
|-------|-----------------------|---|--|------------|--------------|---------------|
| 1     | UNLOG (binary) header | (See Table 4, Binary Message Header Structure on Page 24)   | This field contains the message header.              | -          | H            | 0             |
| 2     | port                  | See Table 5 on page 26 (decimal values greater than 16 may be used)   | Port to which log is being sent (default = THISPORT) | Enum       | 4            | H             |
| 3     | message               | Any valid message ID  | Message ID of log to output                          | UShort     | 2            | H+4           |
| 4     | message type          | Bits 0-4 = Reserved<br>Bits 5-6 = Format<br>00 = Binary<br>01 = ASCII<br>10 = Abbreviated ASCII, NMEA<br>11 = Reserved<br>Bit 7 = Response Bit (see Section 1.2 on Page 28)<br>0 = Original Message<br>1 = Response Message | Message type of log                                  | Char       | 1            | H+6           |
| 5     | Reserved              |   |  | Char       | 1            | H+7           |

| Field | Field Type           | ASCII Value   | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|----------------------|---|--------------|--|---------------|--------------|---------------|
| 1     | UNLOG (ASCII) header | -   | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | port                 | See Table 5 on page 26 (decimal values greater than 16 may be used) |              | Port to which log is being sent (default = THISPORT)   | Enum          | 4            | H             |
| 3     | message              | Message Name  | N/A          | Message Name of log to be disabled   | ULong         | 4            | H+4           |

## 2.5.82 UNLOGALL Remove all logs from logging control V123

If [*port*] is specified this command disables all logs on the specified port only. All other ports are unaffected. If [*port*] is not specified this command defaults to the ALL\_PORTS setting.

**Abbreviated ASCII Syntax:**

**Message ID: 38**

UNLOGALL [*port*]

**Input Example:**

```
unlogall com2_15
```



The UNLOGALL command allows you to remove all log requests currently in use.

| Field | Field Type      | ASCII Value   | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|-----------------|---|--------------|--|---------------|--------------|---------------|
| 1     | UNLOGALL header | -   | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | port            | See <i>Table 5</i> on <i>page 26</i> (decimal values greater than 16 may be used) |              | Port to clear (default = ALL_PORTS)  | Enum          | 4            | H             |
| 3     | held            | FALSE   | 0            | Does not remove logs with the HOLD parameter (default)   | Enum          | 4            | H+4           |
|       |                 | TRUE  | 1            | Removes previously held logs, even those with the HOLD parameter   |               |              |               |

### 2.5.83 USERDATUM Set user-customized datum V123

This command permits entry of customized ellipsoidal datum parameters. This command is used in conjunction with the DATUM command, see *page 96*. If used, the command default setting for USERDATUM is WGS84.

When the USERDATUM command is entered, the USEREXPDATUM command, see *page 212*, is then issued internally with the USERDATUM command values. It is the USEREXPDATUM command that appears in the RXCONFIG log. If the USEREXPDATUM or the USERDATUM command are used, their newest values overwrite the internal USEREXPDATUM values.

The transformation for the WGS84 to Local used in the OEMV family is the Bursa-Wolf transformation or reverse Helmert transformation. In the Helmert transformation, the rotation of a point is counter clockwise around the axes. In the Bursa-Wolf transformation, the rotation of a point is clockwise. Therefore, the reverse Helmert transformation is the same as the Bursa-Wolf.

#### Abbreviated ASCII Syntax:

Message ID: 78

USERDATUM semimajor flattening dx dy dz rx ry rz scale

#### Factory Default:

```
userdatum 6378137.0 298.2572235628 0.0 0.0 0.0 0.0 0.0 0.0
```

#### ASCII Example:

```
userdatum 6378206.400 294.97869820000 -12.0000 147.0000 192.0000 0.0000 0.0000
0.0000 0.000000000
```



You can use the USERDATUM command in a survey to fix the position with values from another known datum so that the GPS calculated positions are reported in the known datum rather than WGS84.

| Field | Field Type       | ASCII Value             | Binary Value | Description   | Binary Format | Binary Bytes | Binary Offset |
|-------|------------------|-------------------------|--------------|---|---------------|--------------|---------------|
| 1     | USERDATUM header | -                       | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.  | -             | H            | 0             |
| 2     | semimajor        | 6300000.0 - 6400000.0 m |              | Datum Semi-major Axis (a) in meters   | Double        | 8            | H             |
| 3     | flattening       | 290.0 - 305.0           |              | Reciprocal Flattening, $1/f = a/(a-b)$  | Double        | 8            | H+8           |
| 4     | dx               | ± 2000.0                |              | Datum offsets from local to WGS84. These are the translation values between the user datum and WGS84 (internal reference).  | Double        | 8            | H+16          |
| 5     | dy               | ± 2000.0                |              |   | Double        | 8            | H+24          |
| 6     | dz               | ± 2000.0                |              |   | Double        | 8            | H+32          |
| 7     | rx               | ± 10.0 radians          |              | Datum rotation angle about X, Y and Z. These values are the rotation from your local datum to WGS84. A positive sign is for counter clockwise rotation and a negative sign is for clockwise rotation. | Double        | 8            | H+40          |
| 8     | ry               | ± 10.0 radians          |              |   | Double        | 8            | H+48          |
| 9     | rz               | ± 10.0 radians          |              |   | Double        | 8            | H+56          |
| 10    | scale            | ± 10.0 ppm              |              | Scale value is the difference in ppm between the user datum and WGS84   | Double        | 8            | H+64          |

### 2.5.84 USEREXPDATUM Set custom expanded datum V123

Like the USERDATUM command, this command allows you to enter customized ellipsoidal datum parameters. However, USEREXPDATUM literally means user expanded datum allowing you to enter additional datum information such as velocity offsets and time constraints. The 7 expanded parameters are rates of change of the initial 7 parameters. These rates of change affect the initial 7 parameters over time relative to the Reference Date provided by the user.

This command is used in conjunction with the datum command, see *Page 96*. If you use this command without specifying any parameters, the command defaults to WGS84. If you enter a USERDATUM command, see *page 210*, the USEREXPDATUM command is then issued internally with the USERDATUM command values. It is the USEREXPDATUM command that appears in the RXCONFIG log. If the USEREXPDATUM or the USERDATUM command are used, their newest values overwrite the internal USEREXPDATUM values.

#### Abbreviated ASCII Syntax:

**Message ID: 783**

```
USEREXPDATUM semimajor flattening dx dy dz rx ry rz scale xvel yvel zvel xrvel yrvel zrvel scalev
refdate
```

#### Factory Default:

```
userexpdatum 6378137.0 298.25722356280 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0
```

#### ASCII Example:

```
USEREXPDATUM 6378137.000 298.25722356280 0.000000000
0.000000000 0.000000000 0.000000000 0.000000000 0.000000000
0.000000000 0.000000000 0.000000000 0.000000000 0.0000
0.000000000 0.000000000 0.000000000 0.000000000
```



You can use the USEREXPDATUM command in a survey to fix the position with values from another known datum so that the GPS calculated positions are reported in the known datum rather than WGS84. For example, it is useful for places like Australia, where the continent is moving several centimeters a year relative to WGS84. With USEREXPDATUM you can also input the velocity of the movement to account for drift over the years.

---



---

| Field | Field Type          | ASCII Value             | Binary Value | Description   | Binary Format | Binary Bytes | Binary Offset |
|-------|---------------------|-------------------------|--------------|---|---------------|--------------|---------------|
| 1     | USEREXPDATUM header | -                       | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.  | -             | H            | 0             |
| 2     | semimajor           | 6300000.0 - 6400000.0 m |              | Datum semi-major axis (a) in meters   | Double        | 8            | H             |
| 3     | flattening          | 290.0 - 305.0           |              | Reciprocal Flattening, $1/f = a/(a-b)$  | Double        | 8            | H+8           |
| 4     | dx                  | $\pm 2000.0$ m          |              | Datum offsets from local to WGS84. These are the translation values between the user datum and WGS84 (internal reference).  | Double        | 8            | H+16          |
| 5     | dy                  | $\pm 2000.0$ m          |              |   | Double        | 8            | H+24          |
| 6     | dz                  | $\pm 2000.0$ m          |              |   | Double        | 8            | H+32          |
| 7     | rx                  | $\pm 10.0$ radians      |              | Datum rotation angle about X, Y and Z. These values are the rotation from your local datum to WGS84. A positive sign is for counter clockwise rotation and a negative sign is for clockwise rotation. | Double        | 8            | H+40          |
| 8     | ry                  | $\pm 10.0$ radians      |              |   | Double        | 8            | H+48          |
| 9     | rz                  | $\pm 10.0$ radians      |              |   | Double        | 8            | H+56          |
| 10    | scale               | $\pm 10.0$ ppm          |              | Scale value is the difference in ppm between the user datum and WGS84   | Double        | 8            | H+64          |
| 11    | xvel                | $\pm 2000.0$ m/yr       |              | Velocity vector along X-axis  | Double        | 8            | H+72          |
| 12    | yvel                | $\pm 2000.0$ m/yr       |              | Velocity vector along Y-axis  | Double        | 8            | H+80          |
| 13    | zvel                | $\pm 2000.0$ m/yr       |              | Velocity vector along Z-axis  | Double        | 8            | H+88          |
| 14    | xrvel               | $\pm 10.0$ radians/yr   |              | Change in the rotation about X over time  | Double        | 8            | H+96          |
| 15    | yrvel               | $\pm 10.0$ radians/yr   |              | Change in the rotation about Y over time  | Double        | 8            | H+104         |
| 16    | zrvel               | $\pm 10.0$ radians/yr   |              | Change in the rotation about Z over time  | Double        | 8            | H+112         |
| 17    | scalev              | $\pm 10.0$ ppm/yr       |              | Change in scale from WGS84 over time  | Double        | 8            | H+120         |
| 18    | refdate             | 0.0 year                |              | Reference date of parameters<br>Example:<br>2005.00 = Jan 1, 2005<br>2005.19 = Mar 11, 2005   | Double        | 8            | H+128         |

## 2.5.85 UTMZONE Set UTM parameters V123

This command sets the UTM persistence, zone number or meridian. Please refer to <http://earth-info.nga.mil/GandG/coordsys/grids/referencesys.html> for more information and a world map of UTM zone numbers.

- 
- ☒ 1. The latitude limits of the UTM System are 80°S to 84°N, so if your position is outside this range, the BESTUTM log outputs a northing, easting, and height of 0.0, along with a zone letter of “\*” and a zone number of 0, so that it is obvious that the data in the log is dummy data.
  - 2. If the latitude band is X, then the Zone number should not be set to 32, 34 or 36. These zones were incorporated into other zone numbers and do not exist.
- 

### Abbreviated ASCII Syntax:

Message ID: 749

UTMZONE command parameter

### Factory Default:

```
utmzone auto 0
```

### ASCII Example 1:

```
utmzone set 10
```

### ASCII Example 2:

```
utmzone current
```



The UTM grid system is displayed on all National Topographic Series (NTS) of Canada maps and United States Geological Survey (USGS) maps. On USGS 7.5-minute quadrangle maps (1:24,000 scale), 15-minute quadrangle maps (1:50,000, 1:62,500, and standard-edition 1:63,360 scales), and Canadian 1:50,000 maps the UTM grid lines are drawn at intervals of 1,000 meters, and are shown either with blue ticks at the edge of the map or by full blue grid lines. On USGS maps at 1:100,000 and 1:250,000 scale and Canadian 1:250,000 scale maps a full UTM grid is shown at intervals of 10,000 meters.

---

**Table 43: UTM Zone Commands**


| Binary | ASCII    | Description   |
|--------|----------|---|
| 0      | AUTO     | UTM zone default that automatically sets the central meridian and does not switch zones until it overlaps by the set persistence. This a spherical approximation to the earth unless you are at the equator. (default = 0) (m)              |
| 1      | CURRENT  | Same as UTMZONE AUTO with infinite persistence of the current zone. The parameter field is not used.  |
| 2      | SET      | Sets the central meridian based on the specified UTM zone. A zone includes its western boundary, but not its eastern boundary, Meridian. For example, zone 12 includes (108°W, 114°W] where $108^\circ < \text{longitude} \leq 114^\circ$ . |
| 3      | MERIDIAN | Sets the central meridian as specified in the parameter field. In BESTUTM, the zone number is output as 61 to indicate the manual setting (zones are set by pre-defined central meridians not user-set ones).                               |

| Field | Field Type     | ASCII Value               | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|----------------|---------------------------|--------------|--|---------------|--------------|---------------|
| 1     | UTMZONE header | -                         | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | command        | See <i>Table 43 above</i> |              |  | Enum          | 4            | H             |
| 3     | parameter      |                           |              |  | Enum          | 4            | H+4           |



## 2.5.86 WAASECUTOFF Set SBAS satellite elevation cut-off V123\_SBAS

This command sets the elevation cut-off angle for SBAS satellites. The receiver does not start automatically searching for an SBAS satellite until it rises above the cut-off angle. Tracked SBAS satellites that fall below the WAASECUTOFF angle are no longer tracked unless they are manually assigned (see the ASSIGN command).

 This command does not affect the tracking of GPS satellites. Similarly, the ECUTOFF command does not affect SBAS satellites.

**Abbreviated ASCII Syntax:**

**Message ID: 505**

WAASECUTOFF angle

**Factory Default:**

waasecutoff -5.000000000

**ASCII Example:**

waasecutoff 10.0



This command permits a negative cut-off angle. It could be used in these situations:

- The antenna is at a high altitude, and thus can look below the local horizon
- Satellites are visible below the horizon due to atmospheric refraction

| Field | Field Type         | ASCII Value   | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|--------------------|---------------|--------------|--|---------------|--------------|---------------|
| 1     | WAASECUTOFF header | -             | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | angle              | ±90.0 degrees |              | Elevation cut-off angle relative to horizon (default = 0.0)  | Float         | 4            | H             |

## 2.5.87 WAASTIMEOUT Set WAAS position time out V123\_SBAS

This command is used to set the amount of time the receiver remain in an SBAS position if it stops receiving SBAS corrections. See the DGPSEPHMDELAY command on *page 103* to set the ephemeris change-over delay for base stations.

**Abbreviated ASCII Syntax:**

**Message ID: 851**

WAASTIMEOUT mode [delay]

**Factory Default:**

waastimeout auto

**ASCII Example (rover):**

waastimeout set 100



When the time out mode is AUTO, the time out delay is 180 s.

| Field | Field Type          | ASCII Value               | Binary Value | Description  | Binary Format | Binary Bytes | Binary Offset |
|-------|---------------------|---------------------------|--------------|--|---------------|--------------|---------------|
| 1     | WAAS-TIMEOUT header | -                         | -            | This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively. | -             | H            | 0             |
| 2     | mode                | See <i>Table 44</i> below |              | Time out mode (default = AUTO)   | Enum          | 4            | H             |
| 3     | delay               | 2 to 1000 s               |              | Maximum SBAS position age (default = 180 s)  | Double        | 8            | H+4           |
| 4     | Reserved            |                           |              |  | Double        | 8            | H+12          |

**Table 44: SBAS Time Out Mode**

| Binary | ASCII    | Description                   |
|--------|----------|-------------------------------|
| 0      | Reserved |                               |
| 1      | AUTO     | Set the default value (180 s) |
| 2      | SET      | Set the delay in seconds      |

### 3.1 Log Types

See the LOG command on *page 143*, for details about requesting logs.

The receiver is capable of generating many different logs. These logs are divided into the following three types: Synchronous, asynchronous, and polled. The data for synchronous logs is generated on a regular schedule. Asynchronous data is generated at irregular intervals. If asynchronous logs were collected on a regular schedule, they would not output the most current data as soon as it was available. The data in polled logs is generated on demand. An example would be RXCONFIG. It would be polled because it changes only when commanded to do so. Therefore, it would not make sense to log this kind of data ONCHANGED, or ONNEW. The following table outlines the log types and the valid triggers to use:

**Table 45: Log Type Triggers**

| Type   | Recommended Trigger         | Illegal Trigger  |
|--------|-----------------------------|------------------|
| Synch  | ONTIME                      | ONNEW, ONCHANGED |
| Asynch | ONCHANGED                   | -                |
| Polled | ONCE or ONTIME <sup>a</sup> | ONNEW, ONCHANGED |

a. Polled log types do not allow fractional offsets and cannot do ontime rates faster than 1Hz.

See *Section 1.5, Message Time Stamps on page 32* for information on how the message time stamp is set for each type of log.

- 
- ✉ 1. The OEMV family of receivers can handle 30 logs at a time. If you attempt to log more than 30 logs at a time, the receiver responds with an Insufficient Resources error.
  - 2. The following logs do not support the ONNEXT trigger: GPSEPHEM, RAWEPHEM, RAWGPSSUBFRAME, RAWWAASFRAME, RXSTATUSEVENT and WAAS9.
  - 3. Asynchronous logs, such as MATCHEDPOS, should only be logged ONCHANGED. Otherwise, the most current data is not output when it is available. This is especially true of the ONTIME trigger, which may cause inaccurate time tags to result.
  - 4. Use the ONNEW trigger with the MARKTIME or MARKPOS logs.
- 



Before the output of fields for ASCII and Binary logs, there is an ASCII or binary header respectively. See also *Table 3, ASCII Message Header Structure on page 22* and *Table 4, Binary Message Header Structure on page 24*. There is no header information before Abbreviated ASCII output, see *page 23*.

---

### 3.1.1 Log Type Examples

For polled logs, the receiver only supports an offset that is:

- smaller than the logging period
- an integer

The following are valid examples for a polled log:

```
log comconfig ontime 2 1
log portstats ontime 4 2
log version once
```

For polled logs, the following examples are invalid:

```
log comconfig ontime 1 2      [offset is larger than the logging period]
log comconfig ontime 4 1.5    [offset is not an integer]
```

For synchronous and asynchronous logs, the receiver supports any offset that is:

- smaller than the logging period
- a multiple of the minimum logging period

For example, if the receiver supports 20 Hz logging, the minimum logging period is 1/20 Hz or 0.05 s. The following are valid examples for a synchronous, or asynchronous log, on a receiver that can log at rates up to 20 Hz:

```
log bestpos 0.05                [20 Hz]
log bestpos 0.1                 [10 Hz]
log bestpos 0.1 0.05
log bestpos ontime 1            [1 Hz]
log bestpos ontime 1 0.1
log bestpos ontime 1 0.90
log avepos ontime 1 0.95
log avepos ontime 2            [0.5 Hz]
log avepos ontime 2 1.35
log avepos ontime 2 1.75
```

For synchronous and asynchronous logs, the following examples are invalid:

```
log bestpos ontime 1 0.08      [offset is not a multiple of the minimum logging period]
log bestpos ontime 1 1.05      [offset is larger than the logging period]
```

## 3.2 Logs By Function

*Table 46*, starting on the following page, lists the logs by function while *Table 47* starting on *Page 228* is an alphabetical listing of logs (repeated in *Table 48* starting on *Page 236* with the logs in the order of their message IDs).

Table 46: Logs By Function

| GENERAL RECEIVER CONTROL AND STATUS                  |  |        |
|--|--|--------|
| Logs   | Descriptions   | Type   |
| COMCONFIG  | Current COM port configuration   | Polled |
| EXTRXHWLEVELS  | Extended receiver hardware levels  | Polled |
| LOGLIST  | List of system logs  | Polled |
| PASSCOM1,<br>PASSXCOM1,<br>PASSAUX,<br>PASSUSB1      | Pass-through log, also PASSCOM2, PASSCOM3,<br>PASSXCOM2, PASSXCOM3, PASSUSB2 and<br>PASSUSB3 | Asynch |
| PORTSTATS  | COM and, if applicable, USB port statistics  | Polled |
| RXCONFIG   | Receiver configuration status  | Polled |
| RXHWLEVELS   | Receiver hardware levels   | Polled |
| RXSTATUS   | Self-test status   | Asynch |
| RXSTATUSEVENT  | Status event indicator   | Asynch |
| VALIDMODELS  | Model and expiry date information for receiver   | Asynch |
| VERSION  | Receiver hardware and software version numbers   | Polled |
| POSITION, PARAMETERS, AND SOLUTION FILTERING CONTROL |  |        |
| AVEPOS   | Position averaging log   | Asynch |
| BESTPOS <sup>a</sup>                                 | Best position data   | Synch  |
| BESTUTM  | Best available UTM data  | Synch  |
| BESTXYZ  | Cartesian coordinates position data  | Synch  |
| BSLNXYZ  | RTK XYZ baseline   | Synch  |
| DIFFCODEBIASES                                       | Differential code biases being applied   | Polled |
| GPGGA  | NMEA, fix and position data  | Synch  |
| GPGGARTK   | NMEA, global position system fix data  | Synch  |
| GPGLL  | NMEA, position data  | Synch  |

*Continued on page 222.*

| POSITION, PARAMETERS, AND SOLUTION FILTERING CONTROL |  |        |
|--|--|--------|
| Logs   | Descriptions   | Type   |
| GPGRS  | NMEA, range residuals                                      | Synch  |
| GPGSA  | NMEA, DOP information                                      | Synch  |
| GPGST  | NMEA, measurement noise statistics                         | Synch  |
| GPHDT  | NMEA, heading from True North                              | Synch  |
| HEADING  | Heading information with the <b>ALIGN</b> feature          | Asynch |
| IONUTC   | Ionospheric and UTC model information                      | Asynch |
| MASTERPOS  | Displays the master position with the <b>ALIGN</b> feature | Asynch |
| MATCHEDPOS <sup>a</sup>                              | Computed position  | Asynch |
| MATCHEDXYZ   | Cartesian coordinates computed position data               | Asynch |
| MARKPOS,<br>MARK2POS                                 | Position at time of mark input event                       | Asynch |
| MARKTIME,<br>MARK2TIME                               | Time of mark input event                                   | Asynch |
| OMNIHPPOS  | OmniSTAR HP/XP position data                               | Synch  |
| PSRDOP   | DOP of SVs currently tracking                              | Asynch |
| ROVERPOS   | Displays the rover position with the <b>ALIGN</b> feature  | Asynch |
| RTKDOP   | Values from the RTK fast filter                            | Synch  |
| RTKPOS <sup>a</sup>                                  | RTK low latency position                                   | Synch  |
| RTKVEL <sup>b</sup>                                  | RTK Velocity   | Synch  |
| RTKXYZ   | RTK cartesian coordinate position                          | Synch  |

- a. The RTK system in the receiver provides two kinds of position solutions. The Matched RTK position is computed with buffered observations, so there is no error due to the extrapolation of base station measurements. This provides the highest accuracy solution possible at the expense of some latency which is affected primarily by the speed of the differential data link. The MATCHEDPOS log contains the matched RTK solution and can be generated for each processed set of base station observations. The RTKDATA log provides additional information about the matched RTK solution.

The Low-Latency RTK position is computed from the latest local observations and extrapolated base station observations. This supplies a valid RTK position with the lowest latency possible at the expense of some accuracy. The degradation in accuracy is reflected in the standard deviation and is summarized in the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm>. The amount of time that the base station observations are extrapolated is provided in the "differential age" field of the position log. The Low-Latency RTK system extrapolates for 60 seconds. The RTKPOS log contains the Low-Latency RTK position when valid, and an "invalid" status when a low-latency RTK solution could not be computed. The BESTPOS log contains either the low-latency RTK, OmniSTAR HP or XP, or pseudorange-based position, whichever has the smallest standard deviation.

- b. The RTK velocity is computed from successive low-latency RTK position solutions. The RTKVEL log contains the RTK velocity, when valid, and outputs an 'invalid' status if a low-latency RTK velocity solution cannot be computed. The BESTVEL log contains the low-latency RTK velocity when the BESTPOS log contains the low-latency RTK position.

In a BESTVEL, PSRVEL or RTKVEL log, the actual speed and direction of the receiver antenna over ground is provided. The receiver does not determine the direction a vessel, craft, or vehicle is pointed (heading), but rather the direction of motion of the GPS antenna relative to ground.

| WAYPOINT NAVIGATION  |                                 |       |
|----------------------|---------------------------------|-------|
| Logs                 | Descriptions                    | Type  |
| BESTPOS              | Best position data              | Synch |
| BESTVEL <sup>b</sup> | Velocity data                   | Synch |
| GPHDT                | NMEA, heading from True North   | Synch |
| GPRMB                | NMEA, waypoint status           | Synch |
| GPRMC                | NMEA, navigation information    | Synch |
| GPVTG                | NMEA, track made good and speed | Synch |
| NAVIGATE             | Navigation waypoint status      | Synch |
| OMNIHPPOS            | OmniSTAR HP position data       | Synch |

*Continued on the following page.*

| WAYPOINT NAVIGATION                 |  |        |
|-------------------------------------|--|--------|
| Logs                                | Descriptions   | Type   |
| PSRPOS                              | Pseudorange position                                     | Synch  |
| PSRVEL <sup>b</sup>                 | Pseudorange velocity                                     | Synch  |
| PSRXYZ                              | Pseudorange cartesian coordinate position                | Synch  |
| CLOCK INFORMATION, STATUS, AND TIME |  |        |
| CLOCKMODEL                          | Range bias information                                   | Synch  |
| CLOCKSTEERING                       | Clock steering status                                    | Asynch |
| GLOCLOCK                            | GLONASS clock information                                | Asynch |
| GPZDA                               | NMEA, UTC time and data                                  | Synch  |
| PSRTIME                             | Time offsets from the pseudorange filter                 | Synch  |
| TIME                                | Receiver time information                                | Synch  |
| TIMESYNC                            | Synchronize time between receivers                       | Synch  |
| POST PROCESSING DATA                |  |        |
| GPSEPHM                             | Decoded GPS ephemeris information                        | Asynch |
| Logs                                | Descriptions   | Type   |
| IONUTC                              | Ionospheric and UTC model information                    | Asynch |
| RAWEPHEM                            | Raw ephemeris  | Asynch |
| RANGE                               | Satellite range information                              | Synch  |
| RANGECMP                            | Compressed version of the RANGE log                      | Synch  |
| RANGGPSL1                           | L1 version of the RANGE log                              | Synch  |
| RTKDATA                             | RTK related data such as baselines and satellite counts. | Asynch |
| TIME                                | Receiver clock offset information                        | Synch  |

*Continued on the following page.*



| SATELLITE TRACKING AND CHANNEL CONTROL |                                     |        |
|--|-------------------------------------|--------|
| ALMANAC                                | Current decoded almanac data        | Asynch |
| GLMLA                                  | NMEA GLONASS almanac data           | Asynch |
| GLOALMANAC                             | GLONASS almanac data                | Asynch |
| GLOEPHEMERIS                           | GLONASS ephemeris data              | Asynch |
| GLORAWALM                              | Raw GLONASS almanac data            | Asynch |
| GLORAWEPHEM                            | Raw GLONASS ephemeris data          | Asynch |
| GLORAWFRAME                            | Raw GLONASS frame data              | Asynch |
| GLORAWSTRING                           | Raw GLONASS string data             | Asynch |
| GPALM                                  | NMEA, almanac data                  | Asynch |
| GPGSA                                  | NMEA, SV DOP information            | Synch  |
| GPGSV                                  | NMEA, satellite-in-view information | Synch  |
| GPSEPHEM                               | Decoded GPS ephemeris information   | Asynch |
| OMNIVIS                                | OmniSTAR satellite visibility list  | Synch  |
| SATELLITE TRACKING AND CHANNEL CONTROL |                                     |        |
| Logs                                   | Descriptions                        | Type   |
| PSRDOP                                 | DOP of SVs currently tracking       | Asynch |
| RANGE                                  | Satellite range information         | Synch  |
| RANGEGPSL1                             | L1 version of the RANGE log         | Synch  |
| RAWALM                                 | Raw almanac                         | Asynch |
| RAWEPHEM                               | Raw ephemeris                       | Asynch |
| RAWGPSSUBFRAME                         | Raw subframe data                   | Asynch |
| RAWGPSWORD                             | Raw navigation word                 | Asynch |
| RAWWAASFRAME                           | Raw SBAS frame data                 | Asynch |

*Continued on the following page.*

| SATELLITE TRACKING AND CHANNEL CONTROL |   |        |
|--|---|--------|
| Logs                                   | Descriptions                              | Type   |
| SATVIS                                 | Satellite visibility                      | Synch  |
| SATXYZ                                 | SV position in ECEF Cartesian coordinates | Synch  |
| TRACKSTAT                              | Satellite tracking status                 | Synch  |
| WAAS0                                  | Remove PRN from the solution              | Asynch |
| WAAS1                                  | PRN mask assignments                      | Asynch |
| WAAS2                                  | Fast correction slots 0-12                | Asynch |
| WAAS3                                  | Fast correction slots 13-25               | Asynch |
| WAAS4                                  | Fast correction slots 26-38               | Asynch |
| WAAS5                                  | Fast correction slots 39-50               | Asynch |
| WAAS6                                  | Integrity message                         | Asynch |
| WAAS7                                  | Fast correction degradation               | Asynch |
| WAAS9                                  | GEO navigation message                    | Asynch |
| WAAS10                                 | Degradation factor                        | Asynch |
| WAAS12                                 | SBAS network time and UTC                 | Asynch |
| SATELLITE TRACKING AND CHANNEL CONTROL |   |        |
| Logs                                   | Descriptions                              | Type   |
| WAAS17                                 | GEO almanac message                       | Asynch |
| WAAS18                                 | IGP mask                                  | Asynch |
| WAAS24                                 | Mixed fast/slow corrections               | Asynch |
| WAAS25                                 | Long-term slow satellite corrections      | Asynch |
| WAAS26                                 | Ionospheric delay corrections             | Asynch |
| WAAS27                                 | SBAS service message                      | Asynch |

*Continued on the following page.*

| <b>SATELLITE TRACKING AND CHANNEL CONTROL</b> |                                       |             |
|---|---------------------------------------|-------------|
| <b>Logs</b>                                   | <b>Descriptions</b>                   | <b>Type</b> |
| WAAS32  | CDGPS fast correction slots 0-10      | Asynch      |
| WAAS33  | CDGPS fast correction slots 11-21     | Asynch      |
| WAAS34  | CDGPS fast correction slots 22-32     | Asynch      |
| WAAS35  | CDGPS fast correction slots 39-50     | Asynch      |
| WAAS45  | CDGPS slow corrections                | Asynch      |
| WAASCORR                                      | SBAS range corrections used           | Synch       |
| <b>DIFFERENTIAL BASE STATION</b>              |                                       |             |
| ALMANAC                                       | Current almanac information           | Asynch      |
| BESTPOS                                       | Best position data                    | Synch       |
| BESTVEL                                       | Velocity data                         | Synch       |
| BSLNXYZ                                       | RTK XYZ baseline                      | Asynch      |
| CMRDATADESC                                   | Base station description              | Synch       |
| CMRDATAOBS                                    | Base station satellite observations   | Synch       |
| CMRDATAREF                                    | Base station position                 | Synch       |
| GPGGA   | NMEA, position fix data               | Synch       |
| GPGGARTK                                      | NMEA, global position system fix data | Synch       |
| <b>DIFFERENTIAL BASE STATION</b>              |                                       |             |
| <b>Logs</b>                                   | <b>Descriptions</b>                   | <b>Type</b> |
| LBANDINFO                                     | L-band configuration information      | Synch       |
| LBANDSTAT                                     | L-band status information             | Synch       |
| MATCHEDPOS                                    | Computed Position – Time Matched      | Asynch      |
| OMNIHPPOS                                     | OmniSTAR HP/XP position data          | Synch       |
| PSRPOS  | Pseudorange position                  | Synch       |

*Continued on the following page.*

| DIFFERENTIAL BASE STATION |   |        |
|---------------------------|---|--------|
| Logs                      | Descriptions  | Type   |
| PSRVEL                    | Pseudorange velocity                                    | Synch  |
| RANGE                     | Satellite range information                             | Synch  |
| RANGECMP                  | Compressed version of the RANGE log                     | Synch  |
| RAWLBANDFRAME             | Raw L-band frame data                                   | Asynch |
| RAWLBANDPACKET            | Raw L-band data packet                                  | Asynch |
| REFSTATION                | Base station position and health                        | Asynch |
| RTCADATA1                 | Differential GPS corrections                            | Synch  |
| RTCADATA2OBS              | Base station observations 2                             | Synch  |
| RTCADATAEPHEM             | Ephemeris and time information                          | Synch  |
| RTCADATAOBS               | Base station observations                               | Synch  |
| RTCADATAREF               | Base station parameters                                 | Synch  |
| RTKDATA                   | RTK related data such as baselines and satellite counts | Asynch |
| RTKPOS                    | RTK low latency position                                | Synch  |

RTCA, RTCM, RTCMV3 or CMR data logs, for example CMRDATADESC, RTCADATA1, RTCMDATA1 and RTCM1001.

See also *Table 47*, that follows, for a complete list of logs in alphabetical order.

**Table 47: OEMV Family Logs in Alphabetical Order**

| NovAtel Format Logs |            |                                    |
|---------------------|------------|------------------------------------|
| Datatype            | Message ID | Description                        |
| ALMANAC             | 73         | Current almanac information        |
| AVEPOS              | 172        | Position averaging                 |
| BESTPOS             | 42         | Best position data                 |
| BESTUTM             | 726        | Best available UTM data            |
| BESTVEL             | 99         | Velocity data                      |
| BESTXYZ             | 241        | Cartesian coordinate position data |

*Continued on the following page.*

| NovAtel Format Logs |            |  |
|---------------------|------------|--|
| Datatype            | Message ID | Description  |
| BSLNXYZ             | 686        | RTK XYZ baseline                                       |
| CLOCKMODEL          | 16         | Current clock model matrices                           |
| CLOCKSTEERING       | 26         | Clock steering status                                  |
| CMRDATADESC         | 389        | Base station description information                   |
| CMRDATAGLOBS        | 1003       | CMR Type 3 GLONASS observations                        |
| CMRDATAOBS          | 390        | Base station satellite observation information         |
| CMRDATAREF          | 391        | Base station position information                      |
| CMRPLUS             | 717        | CMR+ output message                                    |
| COMCONFIG           | 317        | Current COM port configuration                         |
| DIFFCODEBIASES      | 914        | Differential code biases being applied                 |
| EXTRXHWLEVELS       | 843        | Extended receiver hardware levels                      |
| GLOALMANAC          | 718        | GLONASS almanac data                                   |
| GLOCLOCK            | 719        | GLONASS clock information                              |
| GLOEPHEMERIS        | 723        | GLONASS ephemeris data                                 |
| GLORAWALM           | 720        | Raw GLONASS almanac data                               |
| GLORAWEPHEM         | 792        | Raw GLONASS ephemeris data                             |
| GLORAWFRAME         | 721        | Raw GLONASS frame data                                 |
| GLORAWSTRING        | 722        | Raw GLONASS string data                                |
| GPSEPHEM            | 7          | GPS ephemeris data                                     |
| HEADING             | 971        | Heading information with the <b>ALIGN</b> feature      |
| IONUTC              | 8          | Ionospheric and UTC model information                  |
| LBANDINFO           | 730        | L-band configuration information                       |
| LBANDSTAT           | 731        | L-band status information                              |
| LOGLIST             | 5          | A list of system logs                                  |
| MARKPOS, MARK2POS   | 181, 615   | Position at time of mark input event                   |
| MARKTIME, MARK2TIME | 231, 616   | Time of mark input event                               |
| MASTERPOS           | 1051       | Displays master position with the <b>ALIGN</b> feature |
| MATCHEDPOS          | 96         | RTK Computed Position – Time Matched                   |
| MATCHEDXYZ          | 242        | RTK Time Matched cartesian coordinate position         |
| NAVIGATE            | 161        | Navigation waypoint status                             |
| OMNIHPPPOS          | 495        | OmniSTAR HP/XP position data                           |
| OMNIVIS             | 860        | OmniSTAR satellite visibility list                     |

Continued on the following page.

| NovAtel Format Logs  |  |  |
|--|--|--|
| Datatype   | Message ID                                       | Description  |
| PASSCOM1, PASSCOM2, PASSCOM3, PASSXCOM1, PASSXCOM2, PASSXCOM3, PASSAUX, PASSUSB1, PASSUSB2, PASSUSB3 | 233, 234, 235, 405, 406, 795, 690, 607, 608, 609 | Pass-through logs                                    |
| PDPPOS   | 469  | PDP filter position                                  |
| PDPVEL   | 470  | PDP filter velocity                                  |
| PDPXYZ   | 471  | PDP filter Cartesian position and velocity           |
| PORTSTATS  | 72   | COM or USB port statistics                           |
| PSRDOP   | 174  | DOP of SVs currently tracking                        |
| PSRPOS   | 47   | Pseudorange position information                     |
| PSRTIME  | 881  | Time offsets from the pseudorange filter             |
| PSRVEL   | 100  | Pseudorange velocity information                     |
| PSRXYZ   | 243  | Pseudorange cartesian coordinate position            |
| RANGE  | 43   | Satellite range information                          |
| RANGECMP   | 140  | Compressed version of the RANGE log                  |
| RANGEGPSL1   | 631  | L1 version of the RANGE log                          |
| RAWALM   | 74   | Raw almanac  |
| RAWEPHEM   | 41   | Raw ephemeris  |
| RAWGPSSUBFRAME   | 25   | Raw subframe data                                    |
| RAWGPSWORD   | 407  | Raw navigation word                                  |
| RAWLBANDFRAME  | 732  | Raw L-band frame data                                |
| RAWLBANDPACKET   | 733  | Raw L-band data packet                               |
| RAWWAASFRAME   | 287  | Raw SBAS frame data                                  |
| REFSTATION   | 175  | Base station position and health                     |
| ROVERPOS   | 1052   | Displays over position with the <b>ALIGN</b> feature |
| RTCADATA1  | 392  | Type 1 Differential GPS Corrections                  |
| RTCADATA2OBS   | 808  | Type 7 Base Station Observations 2                   |
| RTCADATAEPHEM  | 393  | Type 7 Ephemeris and Time Information                |
| RTCADATAOBS  | 394  | Type 7 Base Station Observations                     |
| RTCADATAREF  | 395  | Type 7 Base Station Parameters                       |
| RTCMDATA1  | 396  | Type 1 Differential GPS Corrections                  |
| RTCMDATA3  | 402  | Type 3 Base Station Parameters                       |
| RTCMDATA9  | 404  | Type 9 Partial Differential GPS Corrections          |

Continued on the following page.

| NovAtel Format Logs |            |   |
|---------------------|------------|---|
| Datatype            | Message ID | Description                                       |
| RTCMDATA15          | 397        | Type 15 Ionospheric Corrections                   |
| RTCMDATA16          | 398        | Type 16 Special Message                           |
| RTCMDATA1819        | 399        | Type18 and Type 19 Raw Measurements               |
| RTCMDATA2021        | 400        | Type 20 and Type 21 Measurement Corrections       |
| RTCMDATA22          | 401        | Type 22 Extended Base Station Parameters          |
| RTCMDATA22GG        | 964        | Extend Base Station Parameters for GLONASS        |
| RTCMDATA23          | 663        | Type 23 Antenna Type Definition                   |
| RTCMDATA24          | 664        | Type 24 Antenna Reference Point (ARP)             |
| RTCMDATA31          | 868        | Type 31 GLONASS Differential Corrections          |
| RTCMDATA32          | 878        | Type 32 GLONASS Base Station Parameters           |
| RTCMDATA36          | 879        | Type 36 Special Message                           |
| RTCMDATA59          | 403        | Type 59N-0 NovAtel Proprietary: RT20 Differential |
| RTCMDATA59GLO       | 905        | NovAtel proprietary GLONASS differential          |
| RTCMDATA1001        | 784        | L1-Only GPS RTK Observables                       |
| RTCMDATA1002        | 785        | Extended L1-Only GPS RTK Observables              |
| RTCMDATA1003        | 786        | L1/L2 GPS RTK Observables                         |
| RTCMDATA1004        | 787        | Extended L1/L2 GPS RTK Observables                |
| RTCMDATA1005        | 788        | RTK Base Station ARP                              |
| RTCMDATA1006        | 789        | RTK Base Station ARP with Antenna Height          |
| RTCMDATA1007        | 856        | Extended Antenna Descriptor and Setup             |
| RTCMDATA1008        | 857        | Extended Antenna Reference Station Description    |
| RTCMDATA1009        | 897        | GLONASS L1-Only RTK                               |
| RTCMDATA1010        | 898        | Extended GLONASS L1-Only RTK                      |
| RTCMDATA1011        | 899        | GLONASS L1/L2 RTK                                 |
| RTCMDATA1012        | 900        | Extended GLONASS L1/L2 RTK                        |
| RTCMDATA1019        | 901        | GPS Ephemerides                                   |
| RTCMDATA1020        | 902        | GLONASS Ephemerides                               |
| RTCMDATAACDGPS1     | 953        | Localized CDGPS corrections in RTCM1              |
| RTCMDATAACDGPS9     | 956        | CDGPS corrections in RTCM9                        |
| RTCMDATAOMNI1       | 960        | RTCM1 from OmniSTAR                               |
| RTKDATA             | 215        | RTK specific information                          |
| RTKDOP              | 952        | Values from the RTK fast filter                   |
| RTKPOS              | 141        | RTK low latency position data                     |

Continued on the following page.

| NovAtel Format Logs |            |  |
|---------------------|------------|--|
| Datatype            | Message ID | Description                                    |
| RTKVEL              | 216        | RTK velocity                                   |
| RTKXYZ              | 244        | RTK cartesian coordinate position data         |
| RXCONFIG            | 128        | Receiver configuration status                  |
| RXHWLEVELS          | 195        | Receiver hardware levels                       |
| RXSTATUS            | 93         | Self-test status                               |
| RXSTATUSEVENT       | 94         | Status event indicator                         |
| SATVIS              | 48         | Satellite visibility                           |
| SATXYZ              | 270        | SV position in ECEF Cartesian coordinates      |
| TIME                | 101        | Receiver time information                      |
| TIMESYNC            | 492        | Synchronize time between receivers             |
| TRACKSTAT           | 83         | Satellite tracking status                      |
| VALIDMODELS         | 206        | Model and expiry date information for receiver |
| VERSION             | 37         | Receiver hardware and software version numbers |
| WAAS0               | 290        | Remove PRN from the solution                   |
| WAAS1               | 291        | PRN mask assignments                           |
| WAAS2               | 296        | Fast correction slots 0-12                     |
| WAAS3               | 301        | Fast correction slots 13-25                    |
| WAAS4               | 302        | Fast correction slots 26-38                    |
| WAAS5               | 303        | Fast correction slots 39-50                    |
| WAAS6               | 304        | Integrity message                              |
| WAAS7               | 305        | Fast correction degradation                    |
| WAAS9               | 306        | GEO navigation message                         |
| WAAS10              | 292        | Degradation factor                             |
| WAAS12              | 293        | SBAS network time and UTC                      |
| WAAS17              | 294        | GEO almanac message                            |
| WAAS18              | 295        | IGP mask                                       |
| WAAS24              | 297        | Mixed fast/slow corrections                    |
| WAAS25              | 298        | Long term slow satellite corrections           |
| WAAS26              | 299        | Ionospheric delay corrections                  |
| WAAS27              | 300        | SBAS service message                           |
| WAAS32              | 696        | CDGPS fast correction slots 0-10               |
| WAAS33              | 697        | CDGPS fast correction slots 11-21              |
| WAAS34              | 698        | CDGPS fast correction slots 22-32              |

*Continued on the following page.*



| NovAtel Format Logs           |            |  |
|-------------------------------|------------|--|
| Datatype                      | Message ID | Description                                    |
| WAAS35                        | 699        | CDGPS fast correction slots 39-50              |
| WAAS45                        | 700        | CDGPS slow corrections                         |
| WAASCORR                      | 313        | SBAS range corrections used                    |
| CMR Format Logs <sup>a</sup>  |            |  |
| CMRDESC                       | 310        | Base station description information           |
| CMRGLOOBS                     | 882        | CMR Type 3 GLONASS observations                |
| CMROBS                        | 103        | Base station satellite observation information |
| CMRREF                        | 105        | Base station position information              |
| CMRPLUS                       | 717        | CMR+ output message                            |
| RTCA Format Logs <sup>a</sup> |            |  |
| RTCA1                         | 10         | Type 1 Differential GPS Corrections            |
| RTCAEPHEM                     | 347        | Type 7 Ephemeris and Time Information          |
| RTCAOBS                       | 6          | Type 7 Base Station Observations               |
| RTCAOBS2                      | 805        | Type 7 Base Station Observations II            |
| RTCAREF                       | 11         | Type 7 Base Station Parameters                 |
| RTCM Format Logs <sup>a</sup> |            |  |
| RTCM1                         | 107        | Type 1 Differential GPS Corrections            |
| RTCM3                         | 117        | Type 3 Base Station Parameters                 |
| RTCM9                         | 275        | Type 9 Partial Differential GPS Corrections    |
| RTCM15                        | 307        | Type 15 Ionospheric Corrections                |
| RTCM16                        | 129        | Type16 Special Message                         |
| RTCM16T                       | 131        | Type16T Special Text Message                   |
| RTCM1819                      | 260        | Type18 and Type 19 Raw Measurements            |
| RTCM2021                      | 374        | Type 20 and Type 21 Measurement Corrections    |
| RTCM22                        | 118        | Type 22 Extended Base Station Parameters       |
| RTCM23                        | 665        | Type 23 Antenna Type Definition                |
| RTCM24                        | 667        | Type 24 Antenna Reference Point (ARP)          |
| RTCM Format Logs <sup>a</sup> |            |  |
| RTCM31                        | 864        | Type 31 Differential GLONASS Corrections       |
| RTCM32                        | 873        | Type 32 GLONASS Base Station Parameters        |
| RTCM36                        | 875        | Type 36 Special Message                        |
| RTCM36T                       | 877        | Type 36T Special Text Message                  |

Continued on the following page.

| RTCM Format Logs <sup>a</sup> |      |  |
|-------------------------------|------|--|
| RTCM59                        | 116  | Type 59N-0 NovAtel Proprietary: RT20                             |
| RTCM59GLO                     | 903  | NovAtel proprietary GLONASS differential                         |
| RTCMCDGPS1                    | 954  | Localized CDGPS corrections in RTCM1                             |
| RTCMCDGPS9                    | 955  | CDGPS corrections in RTCM9                                       |
| RTCMOMNI1                     | 957  | RTCM1 from OmniSTAR  |
| RTCM1001                      | 772  | L1-Only GPS RTK Observables                                      |
| RTCM1002                      | 774  | Extended L1-Only GPS RTK Observables                             |
| RTCM1003                      | 776  | L1/L2 GPS RTK Observables  |
| RTCM1004                      | 770  | Extended L1/L2 GPS RTK Observables                               |
| RTCM1005                      | 765  | RTK Base Station ARP   |
| RTCM1006                      | 768  | RTK Base Station ARP with Antenna Height                         |
| RTCM1007                      | 852  | Extended Antenna Descriptor and Setup                            |
| RTCM1008                      | 854  | Extended Antenna Reference Station Description and Serial Number |
| RTCM1009                      | 885  | GLONASS L1-Only RTK  |
| RTCM1010                      | 887  | Extended GLONASS L1-Only RTK                                     |
| RTCM1011                      | 889  | GLONASS L1/L2 RTK  |
| RTCM1012                      | 891  | Extended GLONASS L1/L2 RTK                                       |
| RTCM1019                      | 893  | GPS Ephemerides  |
| RTCM1020                      | 895  | GLONASS Ephemerides  |
| NMEA Format Logs              |      |  |
| GLMLA                         | 859  | NMEA GLONASS almanac data  |
| GPALM                         | 217  | Almanac Data   |
| GPGGA                         | 218  | GPS Fix Data and Undulation                                      |
| GPGGALONG                     | 521  | GPS Fix Data, Extra Precision and Undulation                     |
| GPGGARTK                      | 259  | GPS Fix Data with Extra Precision                                |
| GPGLL                         | 219  | Geographic Position - latitude/longitude                         |
| GPGRS                         | 220  | GPS Range Residuals for Each Satellite                           |
| GPGSA                         | 221  | GPS DOP and Active Satellites                                    |
| GPGST                         | 222  | Pseudorange Measurement Noise Statistics                         |
| GPGSV                         | 223  | GPS Satellites in View   |
| GPHDT                         | 1045 | Heading in Degrees True  |
| GPRMB                         | 224  | Generic Navigation Information                                   |
| GPRMC                         | 225  | GPS Specific Information   |

*Continued on the following page.*

---

| NMEA Format Logs |     |                                  |
|------------------|-----|----------------------------------|
| GPVTG            | 226 | Track Made Good and Ground Speed |
| GPZDA            | 227 | UTC Time and Date                |

- 
- a. CMR, RTCA, and RTCM logs may be logged with an A or B extension to give an ASCII or Binary output with a NovAtel header followed by Hex or Binary data respectively

**Table 48: OEMV Family Logs in Order of their Message IDs**

| NovAtel Format Logs |                |  |
|---------------------|----------------|--|
| Message ID          | Datatype       | Description                                    |
| 5                   | LOGLIST        | A list of system logs                          |
| 7                   | GPSEPHEM       | GPS ephemeris data                             |
| 8                   | IONUTC         | Ionospheric and UTC model information          |
| 16                  | CLOCKMODEL     | Current clock model matrices                   |
| 25                  | RAWGPSSUBFRAME | Raw subframe data                              |
| 26                  | CLOCKSTEERING  | Clock steering status                          |
| 37                  | VERSION        | Receiver hardware and software version numbers |
| 41                  | RAWEPHEM       | Raw ephemeris                                  |
| 42                  | BESTPOS        | Best position data                             |
| 43                  | RANGE          | Satellite range information                    |
| 47                  | PSRPOS         | Pseudorange position information               |
| 48                  | SATVIS         | Satellite visibility                           |
| 72                  | PORTSTATS      | COM or USB port statistics                     |
| 73                  | ALMANAC        | Current almanac information                    |
| 74                  | RAWALM         | Raw almanac                                    |
| 83                  | TRACKSTAT      | Satellite tracking status                      |
| 93                  | RXSTATUS       | Self-test status                               |
| 94                  | RXSTATUSEVENT  | Status event indicator                         |
| 96                  | MATCHEDPOS     | RTK Computed Position – Time Matched           |
| 99                  | BESTVEL        | Velocity data                                  |
| 100                 | PSRVEL         | Pseudorange velocity information               |
| 101                 | TIME           | Receiver time information                      |
| 128                 | RXCONFIG       | Receiver configuration status                  |
| 140                 | RANGECMP       | Compressed version of the RANGE log            |
| 141                 | RTKPOS         | RTK low latency position data                  |
| 161                 | NAVIGATE       | Navigation waypoint status                     |
| 172                 | AVEPOS         | Position averaging                             |
| 174                 | PSRDOP         | DOP of SVs currently tracking                  |
| 175                 | REFSTATION     | Base station position and health               |
| 181                 | MARKPOS        | Position at time of mark input event           |
| 195                 | RXHWLEVELS     | Receiver hardware levels                       |
| 206                 | VALIDMODELS    | Model and expiry date information for receiver |

*Continued on page 237.*

| NovAtel Format Logs |                                 |   |
|---------------------|---------------------------------|---|
| Message ID          | Datatype                        | Description   |
| 215                 | RTKDATA                         | RTK specific information                            |
| 216                 | RTKVEL                          | RTK velocity  |
| 231                 | MARKTIME                        | Time of mark input event                            |
| 233, 234, 235       | PASSCOM1,<br>PASSCOM2, PASSCOM3 | Pass-through logs                                   |
| 241                 | BESTXYZ                         | Cartesian coordinate position data                  |
| 242                 | MATCHEDXYZ                      | RTK Time Matched cartesian coordinate position data |
| 243                 | PSRXYZ                          | Pseudorange cartesian coordinate position           |
| 244                 | RTKXYZ                          | RTK cartesian coordinate position data              |
| 270                 | SATXYZ                          | SV position in ECEF Cartesian coordinates           |
| 287                 | RAWWAASFRAME                    | Raw SBAS frame data                                 |
| 290                 | WAAS0                           | Remove PRN from the solution                        |
| 291                 | WAAS1                           | PRN mask assignments                                |
| 292                 | WAAS10                          | Degradation factor                                  |
| 293                 | WAAS12                          | SBAS network time and UTC                           |
| 294                 | WAAS17                          | GEO almanac message                                 |
| 295                 | WAAS18                          | IGP mask  |
| 296                 | WAAS2                           | Fast correction slots 0-12                          |
| 297                 | WAAS24                          | Mixed fast/slow corrections                         |
| 298                 | WAAS25                          | Long term slow satellite corrections                |
| 299                 | WAAS26                          | Ionospheric delay corrections                       |
| 300                 | WAAS27                          | SBAS service message                                |
| 301                 | WAAS3                           | Fast correction slots 13-25                         |
| 302                 | WAAS4                           | Fast correction slots 26-38                         |
| 303                 | WAAS5                           | Fast correction slots 39-50                         |
| 304                 | WAAS6                           | Integrity message                                   |
| 305                 | WAAS7                           | Fast correction degradation                         |
| 306                 | WAAS9                           | GEO navigation message                              |
| 313                 | WAASCORR                        | SBAS range corrections used                         |
| 317                 | COMCONFIG                       | Current COM port configuration                      |
| 389                 | CMRDATADESC                     | Base station description information                |
| 390                 | CMRDATAOBS                      | Base station satellite observation information      |
| 391                 | CMRDATAREF                      | Base station position information                   |

*Continued on page 238.*

| NovAtel Format Logs |                                 |  |
|---------------------|---------------------------------|--|
| Message ID          | Datatype                        | Description  |
| 392                 | RTCADATA1                       | Type 1 Differential GPS Corrections                |
| 393                 | RTCADATAEPHEM                   | Type 7 Ephemeris and Time Information              |
| 394                 | RTCADATAOBS                     | Type 7 Base Station Observations                   |
| 395                 | RTCADATAREF                     | Type 7 Base Station Parameters                     |
| 396                 | RTCMDATA1                       | Type 1 Differential GPS Corrections                |
| 397                 | RTCMDATA15                      | Type 15 Ionospheric Corrections                    |
| 398                 | RTCMDATA16                      | Type 16 Special Message                            |
| 399                 | RTCMDATA1819                    | Type 18 and Type 19 Raw Measurements               |
| 400                 | RTCMDATA2021                    | Type 20 and Type 21 Measurement Corrections        |
| 401                 | RTCMDATA22                      | Type 22 Extended Base Station Parameters           |
| 402                 | RTCMDATA3                       | Type 3 Base Station Parameters                     |
| 403                 | RTCMDATA59                      | Type 59N-0 NovAtel Proprietary: RT20 Differential  |
| 404                 | RTCMDATA9                       | Type 9 Partial Differential GPS Corrections        |
| 405,<br>406         | PASSXCOM1,<br>PASSXCOM2         | Pass-through logs                                  |
| 407                 | RAWGPSWORD                      | Raw navigation word                                |
| 469                 | PDPPOS                          | PDP filter position                                |
| 470                 | PDPVEL                          | PDP filter velocity                                |
| 471                 | PDPXYZ                          | PDP filter Cartesian position and velocity         |
| 492                 | TIMESYNC                        | Synchronize time between receivers                 |
| 495                 | OMNIHPPOS                       | OmniSTAR HP/XP position data                       |
| 607, 608, 609       | PASSUSB1, PASSUSB2,<br>PASSUSB3 | Pass-through logs (for receivers that support USB) |
| 615                 | MARK2POS                        | Time of mark input event                           |
| 616                 | MARK2TIME                       | Position at time of mark input event               |
| 631                 | RANGEGPSL1                      | L1 version of the RANGE log                        |
| 663                 | RTCMDATA23                      | Type 23 Antenna Type Definition                    |
| 664                 | RTCMDATA24                      | Type 24 Antenna Reference Point (ARP)              |
| 686                 | BSLNXYZ                         | RTK XYZ baseline                                   |
| 690                 | PASSAUX                         | Pass-through log for AUX port                      |
| 696                 | WAAS32                          | CDGPS fast correction slots 0-10                   |
| 697                 | WAAS33                          | CDGPS fast correction slots 11-21                  |

*Continued on page 239.*

| NovAtel Format Logs |                |  |
|---------------------|----------------|--|
| Message ID          | Datatype       | Description  |
| 698                 | WAAS34         | CDGPS fast correction slots 22-32                                |
| 699                 | WAAS35         | CDGPS fast correction slots 39-50                                |
| 700                 | WAAS45         | CDGPS slow corrections   |
| 718                 | GLOALMANAC     | GLONASS almanac data   |
| 719                 | GLOCLOCK       | GLONASS clock information  |
| 720                 | GLORAWALM      | Raw GLONASS almanac data   |
| 721                 | GLORAWFRAME    | Raw GLONASS frame data   |
| 722                 | GLORAWSTRING   | Raw GLONASS string data  |
| 723                 | GLOEPHEMERIS   | GLONASS ephemeris data   |
| 726                 | BESTUTM        | Best available UTM data  |
| 730                 | LBANDINFO      | L-band configuration information                                 |
| 731                 | LBANDSTAT      | L-band status information  |
| 732                 | RAWLBANDFRAME  | Raw L-band frame data  |
| 733                 | RAWLBANDPACKET | Raw L-band data packet   |
| 784                 | RTCMDATA1001   | L1-Only GPS RTK Observables                                      |
| 785                 | RTCMDATA1002   | Extended L1-Only GPS RTK Observables                             |
| 786                 | RTCMDATA1003   | L1/L2 GPS RTK Observables  |
| 787                 | RTCMDATA1004   | Extended L1/L2 GPS RTK Observables                               |
| 788                 | RTCMDATA1005   | RTK Base Station ARP   |
| 789                 | RTCMDATA1006   | RTK Base Station ARP with Antenna Height                         |
| 792                 | GLORAWEPHEM    | Raw GLONASS ephemeris data                                       |
| 795                 | PASSXCOM3      | Pass through log   |
| 808                 | RTCADATA2OBS   | Type 7 Base Station Observations 2                               |
| 843                 | EXTRXHWLEVELS  | Extended receiver hardware levels                                |
| 856                 | RTCMDATA1007   | Extended Antenna Descriptor and Setup                            |
| 857                 | RTCMDATA1008   | Extended Antenna Reference Station Description and Serial Number |
| 860                 | OMNIVIS        | OmniSTAR satellite visibility list                               |
| 868                 | RTCMDATA31     | Type 31 GLONASS Differential Corrections                         |
| 878                 | RTCMDATA32     | Type 32 GLONASS Base Station Parameters                          |

*Continued on page 240.*

| NovAtel Format Logs          |                 |  |
|------------------------------|-----------------|--|
| Message ID                   | Datatype        | Description  |
| 879                          | RTCMDATA36      | Type 36 Special Message                                    |
| 881                          | PSRTIME         | Time offsets from the pseudorange filter                   |
| 897                          | RTCMDATA1009    | GLONASS L1-Only RTK  |
| 898                          | RTCMDATA1010    | Extended GLONASS L1-Only RTK                               |
| 899                          | RTCMDATA1011    | GLONASS L1/L2 RTK  |
| 897                          | RTCMDATA1009    | GLONASS L1-Only RTK  |
| 898                          | RTCMDATA1010    | Extended GLONASS L1-Only RTK                               |
| 899                          | RTCMDATA1011    | GLONASS L1/L2 RTK  |
| 900                          | RTCMDATA1012    | Extended GLONASS L1/L2 RTK                                 |
| 901                          | RTCMDATA1019    | GPS Ephemerides  |
| 902                          | RTCMDATA1020    | GLONASS Ephemerides  |
| 905                          | RTCMDATA59GLO   | NovAtel proprietary GLONASS differential corrections       |
| 914                          | DIFFCODEBIASES  | Differential code biases being applied                     |
| 952                          | RTKDOP          | Values from the RTK fast filter                            |
| 953                          | RTCMDATAACDGPS1 | Localized CDGPS corrections in RTCM1                       |
| 956                          | RTCMDATAACDGPS9 | CDGPS corrections in RTCM9                                 |
| 960                          | RTCMDATAOMNI1   | RTCM1 from OmniSTAR  |
| 964                          | RTCMDATA22GG    | Extended base station parameters for GLONASS               |
| 971                          | HEADING         | Heading information with the <b>ALIGN</b> feature          |
| 1051                         | MASTERPOS       | Displays the master position with the <b>ALIGN</b> feature |
| 1052                         | ROVERPOS        | Displays the rover position with the <b>ALIGN</b> feature  |
| CMR Format Logs <sup>a</sup> |                 |  |
| 103                          | CMROBS          | Base station satellite observation information             |
| 105                          | CMRREF          | Base station position information                          |
| 310                          | CMRDESC         | Base station description information                       |
| 717                          | CMRPLUS         | CMR+ output message  |
| 882                          | CMRGLOOBS       | CMR Type 3 GLONASS observations                            |
| 1003                         | CMRDATAGLOOBS   | CMR Type 3 GLONASS observations                            |

Continued on the following page.



| RTCA Format Logs <sup>a</sup>   |            |   |
|---------------------------------|------------|---|
| 6                               | RTCAOBS    | Type 7 Base Station Observations                  |
| 10                              | RTCA1      | Type 1 Differential GPS Corrections               |
| RTCA Format Logs <sup>a</sup>   |            |   |
| 11                              | RTCAREF    | Type 7 Base Station Parameters                    |
| 347                             | RTCAEPHEM  | Type 7 Ephemeris and Time Information             |
| 805                             | RTCAOBS2   | Type 7 Base Station Observations 2                |
| RTCM Format Logs <sup>a</sup>   |            |   |
| 107                             | RTCM1      | Type 1 Differential GPS Corrections               |
| 116                             | RTCM59     | Type 59N-0 NovAtel Proprietary: RT20 Differential |
| 117                             | RTCM3      | Type 3 Base Station Parameters                    |
| 118                             | RTCM22     | Type 22 Extended Base Station Parameters          |
| 129                             | RTCM16     | Type16 Special Message                            |
| 131                             | RTCM16T    | Type16T Special Text Message                      |
| 260                             | RTCM1819   | Type18 and Type 19 Raw Measurements               |
| 275                             | RTCM9      | Type 9 Partial Differential GPS Corrections       |
| 307                             | RTCM15     | Type 15 Ionospheric Corrections                   |
| 374                             | RTCM2021   | Type 20 and Type 21 Measurement Corrections       |
| 665                             | RTCM23     | Type 22 Extended Base Station Parameters          |
| 667                             | RTCM24     | Type 23 Antenna Type Definition                   |
| 864                             | RTCM31     | Type 31 Differential GLONASS Corrections          |
| 873                             | RTCM32     | Type 32 GLONASS Base Station Parameters           |
| 875                             | RTCM36     | Type 36 Special Message                           |
| 877                             | RTCM36T    | Type 36T Special Text Message                     |
| 903                             | RTCM59GLO  | NovAtel proprietary GLONASS differential NovAtel  |
| 954                             | RTCMCDGPS1 | Localized CDGPS corrections in RTCM1              |
| 955                             | RTCMCDGPS9 | CDGPS corrections in RTCM9                        |
| 957                             | RTCMOMNI1  | RTCM1 from OmniSTAR                               |
| RTCMV3 Format Logs <sup>a</sup> |            |   |
| 765                             | RTCM1005   | RTK Base Station ARP                              |
| 768                             | RTCM1006   | RTK Base Station ARP with Antenna Height          |
| 770                             | RTCM1004   | Extended L1/L2 GPS RTK Observables                |
| 772                             | RTCM1001   | L1-Only GPS RTK Observables                       |
| 774                             | RTCM1002   | Extended L1-Only GPS RTK Observables              |
| 776                             | RTCM1003   | L1/L2 GPS RTK Observables                         |

Continued on the following page.

| RTCMV3 Format Logs <sup>a</sup> |           |  |
|---------------------------------|-----------|--|
| 852                             | RTCM1007  | Extended Antenna Descriptor and Setup                            |
| 854                             | RTCM1008  | Extended Antenna Reference Station Description and Serial Number |
| RTCMV3 Format Logs <sup>a</sup> |           |  |
| 885                             | RTCM1009  | GLONASS L1-Only RTK  |
| 887                             | RTCM1010  | Extended GLONASS L1-Only RTK                                     |
| 889                             | RTCM1011  | GLONASS L1/L2 RTK  |
| 891                             | RTCM1012  | Extended GLONASS L1/L2 RTK                                       |
| 893                             | RTCM1019  | GPS Ephemerides  |
| 895                             | RTCM1020  | GLONASS Ephemerides  |
| NMEA Format Data Logs           |           |  |
| 217                             | GPALM     | Almanac Data   |
| 218                             | GPGGA     | GPS Fix Data and Undulation                                      |
| 219                             | GPGLL     | Geographic Position - latitude/longitude                         |
| 220                             | GPRGS     | GPS Range Residuals for Each Satellite                           |
| 221                             | GPGSA     | GPS DOP and Active Satellites                                    |
| 222                             | GPGST     | Pseudorange Measurement Noise Statistics                         |
| 223                             | GPGSV     | GPS Satellites in View   |
| 224                             | GPRMB     | Generic Navigation Information                                   |
| 225                             | GPRMC     | GPS Specific Information   |
| 226                             | GPVTG     | Track Made Good and Ground Speed                                 |
| 227                             | GPZDA     | UTC Time and Date  |
| 259                             | GPGGARTK  | GPS Fix Data with Extra Precision                                |
| 521                             | GPGGALONG | GPS Fix Data, Extra Precision and Undulation                     |
| 859                             | GLMLA     | NMEA GLONASS Almanac Data  |
| 1045                            | GPHDT     | Heading in Degrees True  |

- a. CMR, RTCA, RTCM and RTCMV3 logs may be logged with an A or B extension to give an ASCII or Binary output with a NovAtel header followed by Hex or Binary data respectively

## 3.3 Log Reference

### 3.3.1 ALMANAC Decoded Almanac V123

This log contains the decoded almanac parameters from Subframe four and five as received from the satellite with the parity information removed and appropriate scaling applied. Multiple messages are transmitted, one for each SV almanac collected. For more information on Almanac data, refer to the GPS SPS Signal Specification. (Refer to the *Standards and References* section in the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm>.)

The OEMV family of receivers automatically save almanacs in their non-volatile memory (NVM), therefore creating an almanac boot file is not necessary.

**Message ID:** 73  
**Log Type:** Asynch

#### Recommended Input:

log almanaca onchanged

#### ASCII Example:

```
#ALMANACA, COM1, 0, 54.0, SATTIME, 1364, 409278.000, 00000000, 06de, 2310;
29,
1, 1364, 589824.0, 6.289482e-03, -7.55460039e-09, -2.2193421e+00, -1.7064776e+00,
-7.94268362e-01, 4.00543213e-05, 3.63797881e-12, 1.45856541e-04, 2.6560037e+07,
4.45154034e-02, 1, 0, 0, FALSE,
2, 1364, 589824.0, 9.173393e-03, -8.16033991e-09, 1.9308788e+00, 1.9904300e+00,
6.60915023e-01, -1.62124634e-05, 0.00000000, 1.45860023e-04, 2.6559614e+07,
8.38895743e-03, 1, 0, 0, FALSE,
3, 1364, 589824.0, 7.894993e-03, -8.04604944e-09, 7.95206128e-01, 6.63875501e-01,
-2.00526792e-01, 7.91549683e-05, 3.63797881e-12, 1.45858655e-04, 2.6559780e+07,
-1.59210428e-02, 1, 0, 0, TRUE,
...
28, 1364, 589824.0, 1.113367e-02, -7.87461372e-09, -1.44364969e-01, -2.2781989e+00,
1.6546425e+00, 3.24249268e-05, 0.00000000, 1.45859775e-04, 2.6559644e+07,
1.80122900e-02, 1, 0, 0, FALSE,
29, 1364, 589824.0, 9.435177e-03, -7.57745849e-09, -2.2673888e+00, -9.56729511e-01,
1.1791713e+00, 5.51223755e-04, 1.09139364e-11, 1.45855297e-04, 2.6560188e+07,
4.36225787e-02, 1, 0, 0, FALSE,
30, 1364, 589824.0, 8.776665e-03, -8.09176563e-09, -1.97082451e-01, 1.2960786e+00,
2.0072936e+00, 2.76565552e-05, 0.00000000, 1.45849410e-04, 2.6560903e+07,
2.14517626e-03, 1, 0, 0, FALSE*de7a4e45
```



The speed at which the receiver locates and locks onto new satellites is improved if the receiver has approximate time and position, as well as an almanac. This allows the receiver to compute the elevation of each satellite so it can tell which satellites are visible and their Doppler offsets, improving time to first fix (TTFF).

| Field # | Field type  | Data Description  | Format | Binary Bytes | Binary Offset             |
|---------|---|---|--------|--------------|---------------------------|
| 1       | ALMANAC header                                      | Log header  |        | H            | 0                         |
| 2       | #messages   | The number of satellite PRN almanac messages to follow. Set to zero until almanac data is available.  | Long   | 4            | H                         |
| 3       | PRN   | Satellite PRN number for current message, dimensionless   | Ulong  | 4            | H+4                       |
| 4       | week  | Almanac reference week (GPS week number)  | Ulong  | 4            | H+8                       |
| 5       | seconds   | Almanac reference time, seconds into the week   | Double | 8            | H+12                      |
| 6       | ecc   | Eccentricity, dimensionless - defined for a conic section where $e = 0$ is a circle, $e = 1$ is a parabola, $0 < e < 1$ is an ellipse and $e > 1$ is a hyperbola.                 | Double | 8            | H+20                      |
| 7       | $\dot{\omega}$                                      | Rate of right ascension, radians/second   | Double | 8            | H+28                      |
| 8       | $\omega_0$  | Right ascension, radians  | Double | 8            | H+36                      |
| 9       | $\omega$  | Argument of perigee, radians - measurement along the orbital path from the ascending node to the point where the SV is closest to the Earth, in the direction of the SV's motion. | Double | 8            | H+44                      |
| 10      | $M_0$   | Mean anomaly of reference time, radians   | Double | 8            | H+52                      |
| 11      | $a_{f_0}$   | Clock aging parameter, seconds  | Double | 8            | H+60                      |
| 12      | $a_{f_1}$   | Clock aging parameter, seconds/second   | Double | 8            | H+68                      |
| 13      | N   | Corrected mean motion, radians/second   | Double | 8            | H+76                      |
| 14      | A   | Semi-major axis, meters   | Double | 8            | H+84                      |
| 15      | incl-angle  | Angle of inclination relative to $0.3 \pi$ , radians  | Double | 8            | H+92                      |
| 16      | SV config   | Satellite configuration   | Ulong  | 4            | H+100                     |
| 17      | health-prn  | SV health from Page 25 of subframe 4 or 5 (6 bits)  | Ulong  | 4            | H+104                     |
| 18      | health-alm  | SV health from almanac (8 bits)   | Ulong  | 4            | H+108                     |
| 19      | antispoof   | Anti-spoofing on?<br>0 = FALSE<br>1 = TRUE  | Enum   | 4            | H+112                     |
| 20...   | Next PRN offset = $H + 4 + (\#messages \times 112)$ |   |        |              |                           |
| 21      | xxxx  | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H + 4 + (112 x #messages) |
| 22      | [CR][LF]  | Sentence terminator (ASCII only)  | -      | -            | -                         |

### 3.3.2 AVEPOS Position Averaging V123

When position averaging is underway, the various fields in the AVEPOS log contain the parameters being used in the position averaging process. *Table 49* below shows the possible position averaging status values seen in field #8 of the AVEPOS log table on the next page.

See the description of the POSAVE command on *page 161*. Refer also to the height and pseudorange sections of the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm>.

- 
- ☒ 1. All quantities are referenced to the geoid (average height above sea level), regardless of the use of the DATUM or USERDATUM commands, except for the height parameter (field #4 in the AVEPOS log table on the next page). The relation between the geoid and WGS84 ellipsoid is the geoidal undulation, and can be obtained from the PSRPOS log, see *page 385*.
  - 2. Asynchronous logs should only be logged ONCHANGED. Otherwise, the most current data is not output when it is available. This is especially true of the ONTIME trigger, which may cause inaccurate time tags to result.
- 

**Message ID:** 172

**Log Type:** Asynch

**Recommended Input:**

log aveposa onchanged

**ASCII Example:**

```
#AVEPOSA,COM1,0,48.5,FINESTEERING,1364,492100.000,80000000,e3b4,2310;
51.11635589900,-114.03833558937,1062.216134356,1.7561,0.7856,1.7236,
INPROGRESS,2400,2*72a550c1
```

**Table 49: Position Averaging Status**

| Binary | ASCII      | Description               |
|--------|------------|---------------------------|
| 0      | OFF        | Receiver is not averaging |
| 1      | INPROGRESS | Averaging is in progress  |
| 2      | COMPLETE   | Averaging is complete     |



When a GPS position is computed, there are four unknowns being solved: latitude, longitude, height and receiver clock offset (often just called time). The solutions for each of the four unknowns are correlated to satellite positions in a complex way. Since satellites are above the antenna (none are below it) there is a geometric bias. Therefore geometric biases are present in the solutions and affect the computation of height. These biases are called DOPs (Dilution Of Precision). Smaller biases are

indicated by low DOP values. VDOP (Vertical DOP) pertains to height. Most of the time, VDOP is higher than HDOP (Horizontal DOP) and TDOP (Time DOP). Therefore, of the four unknowns, height is the most difficult to solve. Many GPS receivers output the standard deviations (SD) of the latitude, longitude and height. Height often has a larger value than the other two.

Accuracy is based on statistics, reliability is measured in percent. When a receiver says that it can measure height to one meter, this is an accuracy. Usually this is a one sigma value (one SD). A one sigma value for height has a reliability of 68%. In other words, the error is less than one meter 68% of the time. For a more realistic accuracy, double the one sigma value (one meter) and the result is 95% reliability (error is less than two meters 95% of the time). Generally, GPS heights are 1.5 times poorer than horizontal positions. See also *page 322* for CEP and RMS definitions.

| Field # | Field type    | Data Description   | Format | Binary Bytes | Binary Offset |
|---------|---------------|--|--------|--------------|---------------|
| 1       | AVEPOS header | Log header   |        | H            | 0             |
| 2       | lat           | Average WGS84 latitude (degrees)                                       | Double | 8            | H             |
| 3       | lon           | Average WGS84 longitude (degrees)                                      | Double | 8            | H+8           |
| 4       | ht            | Average height above sea level (m)                                     | Double | 8            | H+16          |
| 5       | lat $\sigma$  | Estimated average standard deviation of latitude solution element (m)  | Float  | 4            | H+24          |
| 6       | lon $\sigma$  | Estimated average standard deviation of longitude solution element (m) | Float  | 4            | H+28          |
| 7       | hgt $\sigma$  | Estimated average standard deviation of height solution element (m)    | Float  | 4            | H+32          |
| 8       | posave        | Position averaging status (see <i>Table 49</i> )                       | Enum   | 4            | H+36          |
| 9       | ave time      | Elapsed time of averaging (s)  | Ulong  | 4            | H+40          |
| 10      | #samples      | Number of samples in the average                                       | Ulong  | 4            | H+44          |
| 11      | xxxx          | 32-bit CRC (ASCII and Binary only)                                     | Hex    | 4            | H+48          |
| 12      | [CR][LF]      | Sentence terminator (ASCII only)                                       | -      | -            | -             |

### 3.3.3 BESTPOS Best Position V123

This log contains the best available combined GPS and inertial navigation system (INS - if available) position (in metres) computed by the receiver. In addition, it reports several status indicators, including differential age, which is useful in predicting anomalous behavior brought about by outages in differential corrections. A differential age of 0 indicates that no differential correction was used.

With the system operating in an RTK mode, this log reflects the latest low-latency solution for up to 60 seconds after reception of the last base station observation. After this 60 second period, the position reverts to the best solution available; the degradation in accuracy is reflected in the standard deviation fields. If the system is not operating in an RTK mode, pseudorange differential solutions continue for the time specified in the DGPSTIMEOUT command, see *page 105*.

See also the table footnote for position logs on *page 223* as well as the MATCHEDPOS, PSRPOS and RTKPOS logs, on *pages 357, 385 and 532* respectively.

**Message ID:** 42

**Log Type:** Synch

#### Recommended Input:

```
log bestposa ontime 1
```

See *Section 2.1, Command Formats* on *page 36* for more examples of log requests.

#### ASCII Example 1:

```
#BESTPOSA, COM1, 0, 83.5, FINESTEERING, 1419, 336148.000, 00000040, 6145, 2724;  
SOL_COMPUTED, SINGLE, 51.11636418888, -114.03832502118, 1064.9520, -16.2712,  
WGS84, 1.6961, 1.3636, 3.6449, "", 0.000, 0.000, 8, 8, 0, 0, 0, 06, 0, 03*6f63a93d
```

#### ASCII Example 2:

```
#BESTPOSA, COM1, 0, 78.5, FINESTEERING, 1419, 336208.000, 00000040, 6145, 2724;  
SOL_COMPUTED, NARROW_INT, 51.11635910984, -114.03833105168, 1063.8416, -16.2712,  
WGS84, 0.0135, 0.0084, 0.0172, "AAAA", 1.000, 0.000, 8, 8, 8, 8, 0, 01, 0, 03*3d9fbd48
```



Dual frequency GPS receivers offer two major advantages over single frequency equipment. 1) Ionospheric errors that are inherent in all GPS observations can be modelled and significantly reduced by combining satellite observations made on two different frequencies, and 2) Observations on two frequencies allow for faster ambiguity resolution times.

In general, dual frequency GPS receivers provide a faster, more accurate, and more reliable solution than single frequency equipment. They do, however, cost significantly more to purchase, thus it is important for potential GPS buyers to carefully consider their current and future needs.

**Table 50: Position or Velocity Type**

| Type (binary) | Type (ASCII)                | Description   |
|---------------|-----------------------------|---|
| 0             | NONE                        | No solution   |
| 1             | FIXEDPOS                    | Position has been fixed by the FIX POSITION command                         |
| 2             | FIXEDHEIGHT                 | Position has been fixed by the FIX HEIGHT/AUTO command                      |
| 8             | DOPPLER_VELOCITY            | Velocity computed using instantaneous Doppler                               |
| 16            | SINGLE                      | Single point position   |
| 17            | PSRDIFF                     | Pseudorange differential solution   |
| 18            | WAAS                        | Solution calculated using corrections from an SBAS                          |
| 19            | PROPAGATED                  | Propagated by a Kalman filter without new observations                      |
| 20            | OMNISTAR <sup>a</sup>       | OmniSTAR VBS position (L1 sub-meter)  |
| 32            | L1_FLOAT                    | Floating L1 ambiguity solution  |
| 33            | IONOFREE_FLOAT              | Floating ionospheric-free ambiguity solution                                |
| 34            | NARROW_FLOAT                | Floating narrow-lane ambiguity solution                                     |
| 48            | L1_INT                      | Integer L1 ambiguity solution   |
| 49            | WIDE_INT                    | Integer wide-lane ambiguity solution  |
| 50            | NARROW_INT                  | Integer narrow-lane ambiguity solution                                      |
| 51            | RTK_DIRECT_INS <sup>b</sup> | RTK status where the RTK filter is directly initialized from the INS filter |
| 52            | INS <sup>b</sup>            | INS calculated position corrected for the antenna                           |
| 53            | INS_PSRSP <sup>b</sup>      | INS pseudorange single point solution - no DGPS corrections                 |
| 54            | INS_PSRDIFF <sup>b</sup>    | INS pseudorange differential solution                                       |
| 55            | INS_RTKFLOAT <sup>b</sup>   | INS RTK floating point ambiguities solution                                 |
| 56            | INS_RTKFIXED <sup>b</sup>   | INS RTK fixed ambiguities solution  |
| 64            | OMNISTAR_HP <sup>a</sup>    | OmniSTAR HP position  |
| 65            | OMNISTAR_XP <sup>a</sup>    | OmniSTAR XP position  |
| 66            | CDGPS <sup>a</sup>          | Position solution using CDGPS correction                                    |

- a. In addition to a NovAtel receiver with L-band capability, a subscription to the OmniSTAR, or use of the free CDGPS, service is required. Contact NovAtel for details.
- b. Output only by the BESTPOS and BESTVEL logs when using an inertial navigation system such as NovAtel's SPAN products. Please visit our Web site, refer to your *SPAN for OEMV User Manual*, or contact NovAtel for more information.



Table 51: Solution Status

| Solution Status |   | Description   |
|-----------------|---|---|
| (Binary)        | (ASCII)                                 |   |
| 0               | SOL_COMPUTED                            | Solution computed   |
| 1               | INSUFFICIENT_OBS                        | Insufficient observations   |
| 2               | NO_CONVERGENCE                          | No convergence  |
| 3               | SINGULARITY                             | Singularity at parameters matrix  |
| 4               | COV_TRACE                               | Covariance trace exceeds maximum (trace > 1000 m)   |
| 5               | TEST_DIST                               | Test distance exceeded (maximum of 3 rejections if distance > 10 km)  |
| 6               | COLD_START                              | Not yet converged from cold start   |
| 7               | V_H_LIMIT                               | Height or velocity limits exceeded (in accordance with export licensing restrictions)   |
| 8               | VARIANCE                                | Variance exceeds limits   |
| 9               | RESIDUALS                               | Residuals are too large   |
| 10              | DELTA_POS                               | Delta position is too large   |
| 11              | NEGATIVE_VAR                            | Negative variance   |
| 12              | Reserved                                |   |
| 13              | INTEGRITY_WARNING                       | Large residuals make position unreliable  |
| 14-17           | INS solution status values <sup>a</sup> |   |
| 18              | PENDING                                 | When a FIX POSITION command is entered, the receiver computes its own position and determines if the fixed position is valid <sup>b</sup> |
| 19              | INVALID_FIX                             | The fixed position, entered using the FIX POSITION command, is not valid  |
| 20              | UNAUTHORIZED                            | Position type is unauthorized - HP or XP on a receiver not authorized for it  |
| 21              | ANTENNA_WARNING                         | One of the antenna warnings listed in the RTKANTENNA command description, see <i>page 171</i>   |

- a. Output only when using an inertial navigation system such as NovAtel's SPAN products. Please visit our Web site, refer to your *SPAN for OEMV User Manual*, or contact NovAtel for more information.
- b. PENDING implies there are not enough satellites being tracked to verify if the FIX POSITION entered into the receiver is valid. The receiver needs to be tracking two or more GPS satellites to perform this check. Under normal conditions you should only see PENDING for a few seconds on power up before the GPS receiver has locked onto its first few satellites. If your antenna is obstructed (or not plugged in) and you have entered a FIX POSITION command, then you may see PENDING indefinitely.

**Table 52: Signal-Used Mask**

| Bit | Mask      | Description                 |
|-----|-----------|-----------------------------|
| 0   | 0x01      | GPS L1 used in Solution     |
| 1   | 0x02      | GPS L2 used in Solution     |
| 2   | 0x04      | GPS L5 used in Solution     |
| 3   | 0x08      | Reserved                    |
| 4   | 0x10      | GLONASS L1 used in Solution |
| 5   | 0x20      | GLONASS L2 used in Solution |
| 6-7 | 0x40-0x80 | Reserved                    |

**Table 53: Extended Solution Status**

| Bit | Mask | Description  |
|-----|------|--|
| 0   | 0x01 | AdVance RTK Verified<br>0 = Not Verified<br>1 = Verified   |
| 1-3 | 0x0E | Pseudorange Iono Correction<br>0 = Unknown <sup>a</sup><br>1 = Klobuchar Broadcast<br>2 = SBAS Broadcast<br>3 = Multi-frequency Computed<br>4 = PSRDiff Correction<br>5 = NovAtel Blended Iono Value |
| 4-7 | 0xF0 | Reserved   |

- a. Unknown can indicate that the Iono Correction type is None or that the default Klobuchar parameters are being used.

| Field # | Field type     | Data Description   | Format  | Binary Bytes | Binary Offset |
|---------|----------------|--|---------|--------------|---------------|
| 1       | BESTPOS header | Log header   |         | H            | 0             |
| 2       | sol stat       | Solution status, see <i>Table 51 on page 249</i>   | Enum    | 4            | H             |
| 3       | pos type       | Position type, see <i>Table 50 on page 248</i>   | Enum    | 4            | H+4           |
| 4       | lat            | Latitude   | Double  | 8            | H+8           |
| 5       | lon            | Longitude  | Double  | 8            | H+16          |
| 6       | hgt            | Height above mean sea level  | Double  | 8            | H+24          |
| 7       | undulation     | Undulation - the relationship between the geoid and the ellipsoid (m) of the chosen datum <sup>a</sup> | Float   | 4            | H+32          |
| 8       | datum id#      | Datum ID number (see <i>Chapter 2, Table 21, Reference Ellipsoid Constants on page 97</i> )            | Enum    | 4            | H+36          |
| 9       | lat $\sigma$   | Latitude standard deviation  | Float   | 4            | H+40          |
| 10      | lon $\sigma$   | Longitude standard deviation   | Float   | 4            | H+44          |
| 11      | hgt $\sigma$   | Height standard deviation  | Float   | 4            | H+48          |
| 12      | stn id         | Base station ID  | Char[4] | 4            | H+52          |
| 13      | diff_age       | Differential age in seconds  | Float   | 4            | H+56          |
| 14      | sol_age        | Solution age in seconds  | Float   | 4            | H+60          |
| 15      | #SVs           | Number of satellite vehicles tracked   | Uchar   | 1            | H+64          |
| 16      | #solnSVs       | Number of satellite vehicles used in solution  | Uchar   | 1            | H+65          |
| 17      | #ggL1          | Number of GPS plus GLONASS L1 used in solution   | Uchar   | 1            | H+66          |
| 18      | #ggL1L2        | Number of GPS plus GLONASS L1 and L2 used in solution  | Uchar   | 1            | H+67          |
| 19      | Reserved       |  | Uchar   | 1            | H+68          |
| 20      | ext sol stat   | Extended solution status (see <i>Table 53, Extended Solution Status on page 250</i> )                  | Hex     | 1            | H+69          |
| 21      | Reserved       |  | Hex     | 1            | H+70          |
| 22      | sig mask       | Signals used mask - if 0, signals used in solution are unknown (see <i>Table 52 on page 250</i> )      | Hex     | 1            | H+71          |
| 23      | xxxx           | 32-bit CRC (ASCII and Binary only)   | Hex     | 1            | H+72          |
| 24      | [CR][LF]       | Sentence terminator (ASCII only)   | -       | -            | -             |

- a. When using a datum other than WGS84, the undulation value also includes the vertical shift due to differences between the datum in use and WGS84

### 3.3.4 BESTUTM Best Available UTM Data V123

This log contains the best available position computed by the receiver in UTM coordinates.

See also the UTMZONE command on *page 215* and the BESTPOS log on *page 247*.

**Message ID:** 726  
**Log Type:** Synch

---

✉ The latitude limits of the UTM System are 80°S to 84°N. If your position is outside this range, the BESTUTM log outputs a northing, easting and height of 0.0, along with a zone letter of '\*' and a zone number of 0, so that it is obvious that the data in the log is unusable.

---

#### Recommended Input:

```
log bestutma ontime 1
```

#### ASCII Example:

```
#BESTUTMA, COM1, 0, 73.0, FINESTEERING, 1419, 336209.000, 00000040, eb16, 2724;  
SOL_COMPUTED, NARROW_INT, 11, U, 5666936.4417, 707279.3875, 1063.8401, -16.2712,  
WGS84, 0.0135, 0.0084, 0.0173, "AAAA", 1.000, 0.000, 8, 8, 8, 8, 0, 01, 0, 03*a6d06321
```



Please refer to <http://earth-info.nga.mil/GandG/coordsys/grids/referencesys.html> for more information and a world map of UTM zone numbers.

| Field # | Field type     | Data Description  | Format  | Binary Bytes | Binary Offset |
|---------|----------------|---|---------|--------------|---------------|
| 1       | BESTUTM header | Log header  |         | H            | 0             |
| 2       | sol status     | Solution status, see <i>Table 51, Solution Status</i> on page 249   | Enum    | 4            | H             |
| 3       | pos type       | Position type, see <i>Table 50, Position or Velocity Type</i> on page 248   | Enum    | 4            | H+4           |
| 4       | z#             | Longitudinal zone number  | Ulong   | 4            | H+8           |
| 5       | zletter        | Latitudinal zone letter   | Ulong   | 4            | H+12          |
| 6       | northing       | Northing (m) where the origin is defined as the equator in the northern hemisphere and as a point 10000000 metres south of the equator in the southern hemisphere (that is, a 'false northing' of 10000000 m) | Double  | 8            | H+16          |
| 7       | easting        | Easting (m) where the origin is 500000 m west of the central meridian of each longitudinal zone (that is, a 'false easting' of 500000 m)  | Double  | 8            | H+24          |
| 8       | hgt            | Height above mean sea level   | Double  | 8            | H+32          |
| 9       | undulation     | Undulation - the relationship between the geoid and the ellipsoid (m) of the chosen datum <sup>a</sup>  | Float   | 4            | H+40          |
| 10      | datum id#      | Datum ID number (see <i>Chapter 2, Table 21, Reference Ellipsoid Constants</i> on page 97)  | Enum    | 4            | H+44          |
| 11      | N $\sigma$     | Northing standard deviation   | Float   | 4            | H+48          |
| 12      | E $\sigma$     | Easting standard deviation  | Float   | 4            | H+52          |
| 13      | hgt $\sigma$   | Height standard deviation   | Float   | 4            | H+56          |
| 14      | stn id         | Base station ID   | Char[4] | 4            | H+60          |
| 15      | diff_age       | Differential age in seconds   | Float   | 4            | H+64          |
| 16      | sol_age        | Solution age in seconds   | Float   | 4            | H+68          |
| 17      | #SVs           | Number of satellite vehicles tracked  | Uchar   | 1            | H+72          |
| 18      | #solnSVs       | Number of satellite vehicles used in solution   | Uchar   | 1            | H+73          |
| 19      | #ggL1          | Number of GPS plus GLONASS L1 used in solution  | Uchar   | 1            | H+74          |
| 20      | #ggL1L2        | Number of GPS plus GLONASS L1 and L2 used in solution   | Uchar   | 1            | H+75          |
| 21      | Reserved       |   | Uchar   | 1            | H+76          |

*Continued on page 254.*

| Field # | Field type   | Data Description   | Format | Binary Bytes | Binary Offset |
|---------|--------------|--|--------|--------------|---------------|
| 22      | ext sol stat | Extended solution status (see <i>Table 53, Extended Solution Status</i> on page 250)             | Hex    | 1            | H+77          |
| 23      | Reserved     |  | Hex    | 1            | H+78          |
| 24      | sig mask     | Signals used mask - if 0, signals used in solution are unknown (see <i>Table 52</i> on page 250) | Hex    | 1            | H+79          |
| 25      | xxxx         | 32-bit CRC (ASCII and Binary only)   | Hex    | 4            | H+80          |
| 26      | [CR][LF]     | Sentence terminator (ASCII only)   | -      | -            | -             |

- a. When using a datum other than WGS84, the undulation value also includes the vertical shift due to differences between the datum in use and WGS84

### 3.3.5 BESTVEL Best Available Velocity Data V123

This log contains the best available velocity information computed by the receiver. In addition, it reports a velocity status indicator, which is useful in indicating whether or not the corresponding data is valid. The velocity measurements sometimes have a latency associated with them. The time of validity is the time tag in the log minus the latency value. See also the table footnote for velocity logs on page 223.

- 
- ☒ The velocity type is from the same source that was chosen for BESTPOS. So if BESTPOS is from the pseudorange filter, the BESTVEL velocity type is the same as for PSRVEL, see page 388. If BESTPOS is from RTK, the BESTVEL velocity type is the same as for RTKVEL, see page 534. If BESTPOS is from OMNIHPPPOS, the BESTVEL velocity type is OMNISTAR\_HP or OMNISTAR\_XP.
- 

The RTK, OmniSTAR HP and OmniSTAR XP velocities are typically computed from the average change in position over the time interval or the RTK Low Latency filter. As such, it is an average velocity based on the time difference between successive position computations and not an instantaneous velocity at the BESTVEL time tag. The velocity latency to be subtracted from the time tag is normally half the time between filter updates. Under default operation, the positioning filters are updated at a rate of 2 Hz. This average velocity translates into a velocity latency of 0.25 seconds.

The latency can be reduced by increasing the update rate of the positioning filter being used by requesting the BESTVEL or BESTPOS messages at a rate higher than 2 Hz. For example, a logging rate of 10 Hz would reduce the velocity latency to 0.05 seconds. For integration purposes, the velocity latency should be applied to the record time tag.

Velocities based on delta phase are noisier at faster rates because they are derived by dividing the phase difference by the delta time (which is getting smaller at higher rates). Doppler-based velocity is not effected.

While you are standing still, your velocity may jump several centimeters per second. If the velocity in the BESTVEL log comes from the pseudorange filter, it has been computed from instantaneous doppler measurements. You know that you have an instantaneous doppler velocity solution when you see PSRDIFF, WAAS, OMNISTAR, CDGPS, or DOPPLER\_VELOCITY in field #3 (*vel type*). The instantaneous doppler velocity has low latency and is not delta position dependent. If you change your velocity quickly, you can see this in the DOPPLER\_VELOCITY solution. This instantaneous doppler velocity translates into a velocity latency of 0.15 seconds.

**Message ID:** 99  
**Log Type:** Synch

**Recommended Input:**

log bestvela ontime 1

**ASCII Example:**

```
#BESTVELA, COM1, 0, 61.0, FINESTEERING, 1337, 334167.000, 00000000, 827b, 1984;
```

---

SOL\_COMPUTED, PSRDIFF, 0.250, 4.000, 0.0206, 227.712486, 0.0493, 0.0\*0e68bf05

---



Velocity vector (speed and direction) calculations involve a difference operation between successive satellite measurement epochs and the error in comparison to the position calculation is reduced. As a result you can expect velocity accuracy approaching plus or minus 0.03 m/s, 0.07 m.p.h., or 0.06 knots assuming phase measurement capability and a relatively high measurement rate (that is, 1 Hz or better) by the GPS receiver.

Direction accuracy is derived as a function of the vehicle speed. A simple approach would be to assume a worst case 0.03 m/s cross-track velocity that would yield a direction error function something like:

$$d(\text{speed}) = \tan^{-1}(0.03/\text{speed})$$

For example, if you are flying in an airplane at a speed of 120 knots, or 62 m/s, the approximate directional error will be:

$$\tan^{-1}(0.03/62) = 0.03 \text{ degrees}$$

Consider another example applicable to hiking at an average walking speed of 3 knots or 1.5 m/s. Using the same error function yields a direction error of about 1.15 degrees.

You can see from both examples that a faster vehicle speed allows for a more accurate heading indication. As the vehicle slows down, the velocity information becomes less and less accurate. If the vehicle is stopped, a GPS receiver still outputs some kind of movement at speeds between 0 and 0.5 m/s in random and changing directions. This represents the random variation of the static position.

In a navigation capacity, the velocity information provided by your GPS receiver is as, or more, accurate than that indicated by conventional instruments as long as the vehicle is moving at a reasonable rate of speed. It is important to set the GPS measurement rate fast enough to keep up with all major changes of the vehicle's speed and direction. It is important to keep in mind that although the velocity vector is quite accurate in terms of heading and speed, the actual track of the vehicle might be skewed or offset from the true track by plus or minus 0 to 1.8 meters as per the standard positional errors.

---



| Field # | Field type     | Data Description  | Format | Binary Bytes | Binary Offset |
|---------|----------------|---|--------|--------------|---------------|
| 1       | BESTVEL header | Log header  |        | H            | 0             |
| 2       | sol status     | Solution status, see <i>Table 51, Solution Status on page 249</i>   | Enum   | 4            | H             |
| 3       | vel type       | Velocity type, see <i>Table 50, Position or Velocity Type on page 248</i>   | Enum   | 4            | H+4           |
| 4       | latency        | A measure of the latency in the velocity time tag in seconds. It should be subtracted from the time to give improved results.                         | Float  | 4            | H+8           |
| 5       | age            | Differential age in seconds   | Float  | 4            | H+12          |
| 6       | hor spd        | Horizontal speed over ground, in meters per second  | Double | 8            | H+16          |
| 7       | trk gnd        | Actual direction of motion over ground (track over ground) with respect to True North, in degrees   | Double | 8            | H+24          |
| 8       | vert spd       | Vertical speed, in meters per second, where positive values indicate increasing altitude (up) and negative values indicate decreasing altitude (down) | Double | 8            | H+32          |
| 9       | Reserved       |   | Float  | 4            | H+40          |
| 10      | xxxx           | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+44          |
| 11      | [CR][LF]       | Sentence terminator (ASCII only)  | -      | -            | -             |

### 3.3.6 BESTXYZ Best Available Cartesian Position and Velocity V123

This log contains the receiver's best available position and velocity in ECEF coordinates. The position and velocity status fields indicate whether or not the corresponding data is valid. See *Figure 10, page 261* for a definition of the ECEF coordinates.

See also the BESTPOS and BESTVEL logs, on *pages 247 and 252* respectively.

---

☒ These quantities are always referenced to the WGS84 ellipsoid, regardless of the use of the DATUM or USERDATUM commands.

---

**Message ID:** 241

**Log Type:** Synch

**Recommended Input:**

log bestxyza ontime 1

**ASCII Example:**

```
#BESTXYZA, COM1, 0, 55.0, FINESTEERING, 1419, 340033.000, 00000040, d821, 2724;
SOL_COMPUTED, NARROW_INT, -1634531.5683, -3664618.0326, 4942496.3270,
0.0099, 0.0219, 0.0115, SOL_COMPUTED, NARROW_INT, 0.0011, -0.0049, -0.0001,
0.0199, 0.0439, 0.0230, "AAAA", 0.250, 1.000, 0.000, 12, 11, 11, 11, 0, 01, 0, 33*e9eafeca
```



According to classic GPS theory, one civilian receiver operating in single point mode (no assistance from other sources) will have an accuracy of  $\pm 20$  to 30 meters horizontally. This allows hikers and recreational users to place themselves on a map with some degree of certainty, but in terms of surveying, this is not considered accurate. If Selective Availability (SA) were to return, which may be employed by the US military to intentionally degrade the user's position, the accuracy would degrade to  $\pm 100$  meters. Logging data and averaging for 24 hours may yield results in the order of 1 to 5 meters horizontally.

---

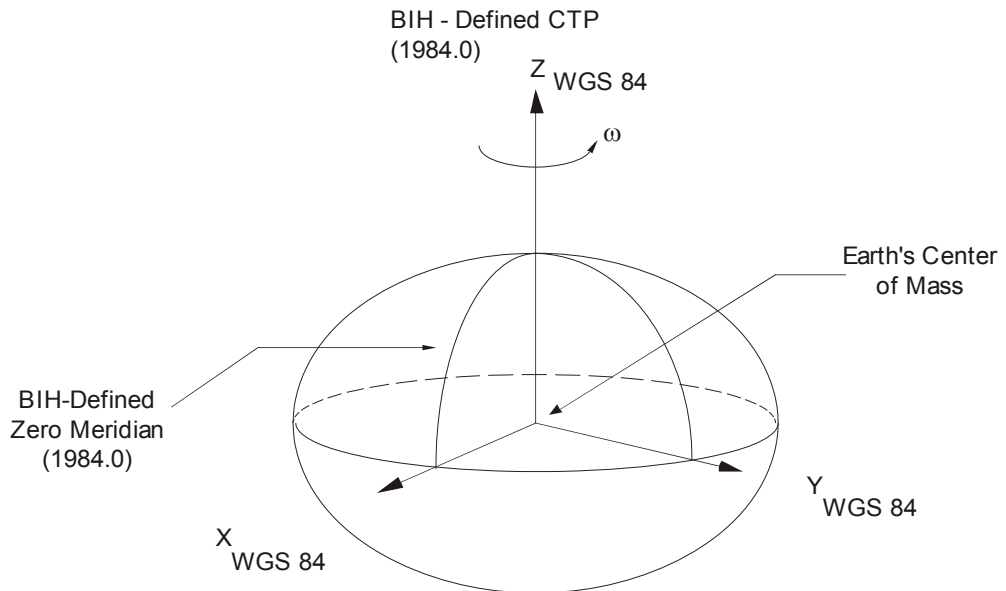
| Field # | Field type     | Data Description  | Format  | Binary Bytes | Binary Offset |
|---------|----------------|---|---------|--------------|---------------|
| 1       | BESTXYZ header | Log header  |         | H            | 0             |
| 2       | P-sol status   | Solution status, see <i>Table 51, Solution Status on page 249</i>   | Enum    | 4            | H             |
| 3       | pos type       | Position type, see <i>Table 50, Position or Velocity Type on page 248</i>   | Enum    | 4            | H+4           |
| 4       | P-X            | Position X-coordinate (m)   | Double  | 8            | H+8           |
| 5       | P-Y            | Position Y-coordinate (m)   | Double  | 8            | H+16          |
| 6       | P-Z            | Position Z-coordinate (m)   | Double  | 8            | H+24          |
| 7       | P-X $\sigma$   | Standard deviation of P-X (m)   | Float   | 4            | H+32          |
| 8       | P-Y $\sigma$   | Standard deviation of P-Y (m)   | Float   | 4            | H+36          |
| 9       | P-Z $\sigma$   | Standard deviation of P-Z (m)   | Float   | 4            | H+40          |
| 10      | V-sol status   | Solution status, see <i>Table 51, Solution Status on page 249</i>   | Enum    | 4            | H+44          |
| 11      | vel type       | Velocity type, see <i>Table 50, Position or Velocity Type on page 248</i>   | Enum    | 4            | H+48          |
| 12      | V-X            | Velocity vector along X-axis (m/s)  | Double  | 8            | H+52          |
| 13      | V-Y            | Velocity vector along Y-axis (m/s)  | Double  | 8            | H+60          |
| 14      | V-Z            | Velocity vector along Z-axis (m/s)  | Double  | 8            | H+68          |
| 15      | V-X $\sigma$   | Standard deviation of V-X (m/s)   | Float   | 4            | H+76          |
| 16      | V-Y $\sigma$   | Standard deviation of V-Y (m/s)   | Float   | 4            | H+80          |
| 17      | V-Z $\sigma$   | Standard deviation of V-Z (m/s)   | Float   | 4            | H+84          |
| 18      | stn ID         | Base station identification   | Char[4] | 4            | H+88          |
| 19      | V-latency      | A measure of the latency in the velocity time tag in seconds. It should be subtracted from the time to give improved results. | Float   | 4            | H+92          |
| 20      | diff_age       | Differential age in seconds   | Float   | 4            | H+96          |
| 21      | sol_age        | Solution age in seconds   | Float   | 4            | H+100         |
| 22      | #SVs           | Number of satellite vehicles tracked  | Uchar   | 1            | H+104         |
| 23      | #solnSVs       | Number of satellite vehicles used in solution   | Uchar   | 1            | H+105         |

*Continued on page 260.*

| Field # | Field type   | Data Description   | Format | Binary Bytes | Binary Offset |
|---------|--------------|--|--------|--------------|---------------|
| 24      | #ggL1        | Number of GPS plus GLONASS L1 used in solution   | Uchar  | 1            | H+106         |
| 25      | #ggL1L2      | Number of GPS plus GLONASS L1 and L2 used in solution  | Uchar  | 1            | H+107         |
| 26      | Reserved     |  | Char   | 1            | H+108         |
| 27      | ext sol stat | Extended solution status (see <i>Table 53, Extended Solution Status</i> on page 250)             | Hex    | 1            | H+109         |
| 28      | Reserved     |  | Hex    | 1            | H+110         |
| 29      | sig mask     | Signals used mask - if 0, signals used in solution are unknown (see <i>Table 52</i> on page 250) | Hex    | 1            | H+111         |
| 30      | xxxx         | 32-bit CRC (ASCII and Binary only)   | Hex    | 4            | H+112         |
| 31      | [CR][LF]     | Sentence terminator (ASCII only)   | -      | -            | -             |

## - Definitions - \*

- Origin = Earth's center of mass
- Z-Axis = Parallel to the direction of the Conventional Terrestrial Pole (CTP) for polar motion, as defined by the Bureau International de l'Heure (BIH) on the basis of the coordinates adopted for the BIH stations.
- X-Axis = Intersection of the WGS 84 Reference Meridian Plane and the plane of the CTP's Equator, the Reference Meridian being parallel to the Zero Meridian defined by the BIH on the basis of the coordinates adopted for the BIH stations.
- Y-Axis = Completes a right-handed, earth-centered, earth-fixed (ECEF) orthogonal coordinate system, measured in the plane of the CTP Equator,  $90^\circ$  East of the X-Axis.



\* Analogous to the BIH Defined Conventional Terrestrial System (CTS), or BTS, 1984.0.

**Figure 10: The WGS84 ECEF Coordinate System**

### 3.3.7 BSLNXYZ RTK XYZ Baseline V23\_RT2\_RT2\_LITE or V3\_RT20\_HP

This log contains the receiver's RTK baseline in ECEF coordinates. The position status field indicates whether or not the corresponding data is valid. See *Figure 10, page 261* for a definition of the ECEF coordinates.

The BSLNXYZ log comes from time-matched base and rover observations such as in the MATCHEDXYZ log on *page 361*.

- 
- Asynchronous logs, such as BSLNXYZ, should only be logged ONCHANGED. Otherwise, the most current data is not output when it is available. This is especially true of the ONTIME trigger, which may cause inaccurate time tags to result.
- 

**Message ID:** 686  
**Log Type:** Asynch

**Recommended Input:**

log bslnxyza onchanged

**ASCII Example:**

```
#BSLNXYZA, COM1, 0, 59.5, FINESTEERING, 1419, 340033.000, 00000040, 5b48, 2724;
SOL_COMPUTED, NARROW_INT, 0.0012, 0.0002, -0.0004, 0.0080, 0.0160, 0.0153,
"AAAA", 12, 12, 12, 12, 0, 01, 0, 33*1a8a1b65
```



The BSLNXYZ log contains offset values in the ECEF frame from base to rover:

Base position (in ECEF) + Offset values (in ECEF) = Rover position (in ECEF)

You can use the position information in the BESTXYZ log from the rover and subtract the offset values from the BSLNXYZ log, to yield the position information of the base in ECEF coordinates.

Be careful of where you the want vector to originate and point to. Our ECEF positions are referenced to the WGS84 ellipsoid, regardless of the use of the DATUM or USERDATUM commands.

---



Consider the impact of the base station and the roving GPS receivers being separated by large distances.

For this discussion, we assume that when we talk about large distances, we are referring to distances greater than 1000 km (600 miles). Typically, for this type of baseline length only code data is used in a differential system. Carrier-phase data is typically used for distances much shorter than 1000 kilometers. (The advantage of using carrier-phase data, to produce centimeter-level accuracies is greatly reduced when large distances are involved.)

---

GPS operates in a similar fashion as conventional surveying tools such as electronic distance measuring instruments (EDMs). This means that there is a constant and a proportional error associated with computed positions. The proportional error depends on the distance the base and rover receivers are apart. Therefore, the larger the distance, the lower the accuracy. We also have to take into account the quality of the data being received. Better receivers generally provide cleaner signals and thus better accuracy.

When operating in differential mode, you require at least four common satellites at the base and rover. The number of common satellites being tracked at large distances is less than at short distances. This is important because the accuracy of GPS and DGPS positions depend a great deal on how many satellites are being used in the solution (redundancy) and the geometry of the satellites being used (DOP). DOP stands for dilution of precision and refers to the geometry of the satellites. A good DOP occurs when the satellites being tracked and used are evenly distributed throughout the sky. A bad DOP occurs when the satellites being tracked and used are not evenly distributed throughout the sky or grouped together in one part of the sky.

Also, the principal of DGPS positioning assumes that there are common errors at the base and rover stations. These errors include: atmospheric errors, satellite clock and ephemeris errors. Typically, in a differential GPS survey, a receiver occupies a survey control marker at a known location referred to as the base station. The base station collects GPS data and computes a position. This position is then compared against the published coordinates. The difference between these two positions in the way of range errors to the satellites are your differential corrections. Usually, these corrections are then passed to your rover unit(s) for use in computing the rover's differentially corrected positions. However, the further apart the base and rover receivers are, the less their errors are in common. Thus, the differential corrections computed at your base are less applicable at your rover's location at large distances.

---

| Field # | Field type     | Data Description  | Format  | Binary Bytes | Binary Offset |
|---------|----------------|---|---------|--------------|---------------|
| 1       | BSLNXYZ header | Log header  |         | H            | 0             |
| 2       | sol status     | Solution status, see <i>Table 51, Solution Status on page 249</i>                                 | Enum    | 4            | H             |
| 3       | bsln type      | Baseline type, see <i>Table 50, Position or Velocity Type on page 248</i>                         | Enum    | 4            | H+4           |
| 4       | B-X            | X-axis offset (m)   | Double  | 8            | H+8           |
| 5       | B-Y            | Y-axis offset (m)   | Double  | 8            | H+16          |
| 6       | B-Z            | Z-axis offset (m)   | Double  | 8            | H+24          |
| 7       | B-X $\sigma$   | Standard deviation of B-X (m)   | Float   | 4            | H+32          |
| 8       | B-Y $\sigma$   | Standard deviation of B-Y (m)   | Float   | 4            | H+36          |
| 9       | B-Z $\sigma$   | Standard deviation of B-Z (m)   | Float   | 4            | H+40          |
| 10      | stn ID         | Base station identification   | Char[4] | 4            | H+44          |
| 11      | #SVs           | Number of satellite vehicles tracked  | Uchar   | 1            | H+48          |
| 12      | #solnSVs       | Number of satellite vehicles used in solution   | Uchar   | 1            | H+49          |
| 13      | #ggL1          | Number of GPS plus GLONASS L1 used in solution  | Uchar   | 1            | H+50          |
| 14      | #ggL1L2        | Number of GPS plus GLONASS L1 and L2 used in solution   | Uchar   | 1            | H+51          |
| 15      | Reserved       |   | Uchar   | 1            | H+52          |
| 16      | ext sol stat   | Extended solution status (see <i>Table 53, Extended Solution Status on page 250</i> )             | Hex     | 1            | H+53          |
| 17      | Reserved       |   | Hex     | 1            | H+54          |
| 18      | sig mask       | Signals used mask - if 0, signals used in solution are unknown (see <i>Table 52 on page 250</i> ) | Hex     | 1            | H+55          |
| 30      | xxxx           | 32-bit CRC (ASCII and Binary only)  | Hex     | 4            | H+56          |
| 31      | [CR][LF]       | Sentence terminator (ASCII only)  | -       | -            | -             |



### 3.3.8 CLOCKMODEL Current Clock Model Status V123

The CLOCKMODEL log contains the current clock-model status of the receiver.

Monitoring the CLOCKMODEL log allows you to determine the error in your receiver reference oscillator as compared to the GPS satellite reference.

All logs report GPS time not corrected for local receiver clock error. To derive the closest GPS time, subtract the clock offset from the GPS time reported. The clock offset can be calculated by dividing the value of the range bias given in field 6 of the CLOCKMODEL log by the speed of light (*c*).

The following symbols are used throughout this section:

B = range bias (m)

BR = range bias rate (m/s)

SAB = Gauss-Markov process representing range bias error due to satellite clock dither (m)

The standard clock model now used is as follows:

*clock parameters array* = [ B BR SAB]

*covariance matrix* =

$$\begin{bmatrix} \sigma_B^2 & \sigma_B \sigma_{BR} & \sigma_B \sigma_{SAB} \\ \sigma_{BR} \sigma_B & \sigma_{BR}^2 & \sigma_{BR} \sigma_{SAB} \\ \sigma_{SAB} \sigma_B & \sigma_{SAB} \sigma_{BR} & \sigma_{SAB}^2 \end{bmatrix}$$

**Table 54: Clock Model Status**

| Clock Status (Binary) | Clock Status (ASCII) | Description                                   |
|-----------------------|----------------------|---|
| 0                     | VALID                | The clock model is valid                      |
| 1                     | CONVERGING           | The clock model is near validity              |
| 2                     | ITERATING            | The clock model is iterating towards validity |
| 3                     | INVALID              | The clock model is not valid                  |
| 4                     | ERROR                | Clock model error                             |

---

**Message ID:** 16  
**Log Type:** Synch

**Recommended Input:**

log clockmodela ontime 1

**ASCII Example:**

```
#CLOCKMODELA, COM1, 0, 52.0, FINESTEERING, 1364, 489457.000, 80000000, 98f9, 2310;  
VALID, 0, 489457.000, 489457.000, 7.11142843e+00, 6.110131956e-03,  
-4.93391151e+00, 3.02626565e+01, 2.801659017e-02, -2.99281529e+01,  
2.801659017e-02, 2.895779736e-02, -1.040643538e-02, -2.99281529e+01,  
-1.040643538e-02, 3.07428979e+01, 2.113, 2.710235665e-02, FALSE*3d530b9a
```



The CLOCKMODEL log can be used to monitor the clock drift of an internal oscillator once the CLOCKADJUST mode has been disabled. Watch the CLOCKMODEL log to see the drift rate and adjust the oscillator until the drift stops.

---

| Field # | Field type        | Data Description  | Format  | Binary Bytes | Binary Offset |
|---------|-------------------|---|---------|--------------|---------------|
| 1       | CLOCKMODEL header | Log header  |         | H            | 0             |
| 2       | clock status      | Clock model status as computed from current measurement data, see <i>Table 54, Clock Model Status</i> on page 265 | Enum    | 4            | H             |
| 3       | reject            | Number of rejected range bias measurements  | Ulong   | 4            | H+4           |
| 4       | noise time        | GPS time of last noise addition   | GPSTime | 4            | H+8           |
| 5       | update time       | GPS time of last update   | GPSTime | 4            | H+12          |
| 6       | parameters        | Clock correction parameters (a 1x3 array of length 3), listed left-to-right                                       | Double  | 8            | H+16          |
| 7       |                   |   |         | 8            | H+24          |
| 8       |                   |   |         | 8            | H+32          |
| 9       | cov data          | Covariance of the straight line fit (a 3x3 array of length 9), listed left-to-right by rows                       | Double  | 8            | H+40          |
| 10      |                   |   |         | 8            | H+48          |
| 11      |                   |   |         | 8            | H+56          |
| 12      |                   |   |         | 8            | H+64          |
| 13      |                   |   |         | 8            | H+72          |
| 14      |                   |   |         | 8            | H+80          |
| 15      |                   |   |         | 8            | H+88          |
| 16      |                   |   |         | 8            | H+96          |
| 17      |                   |   |         | 8            | H+104         |
| 18      | range bias        | Last instantaneous measurement of the range bias (meters)   | Double  | 8            | H+112         |
| 19      | range bias rate   | Last instantaneous measurement of the range bias rate (m/s)   | Double  | 8            | H+120         |
| 20      | change            | Is there a change in the constellation?<br>0 = FALSE<br>1 = TRUE  | Enum    | 4            | H+128         |
| 21      | xxxx              | 32-bit CRC (ASCII and Binary only)  | Hex     | 4            | H+132         |
| 22      | [CR][LF]          | Sentence terminator (ASCII only)  | -       | -            | -             |

### 3.3.9 CLOCKSTEERING Clock Steering Status V123

The CLOCKSTEERING log is used to monitor the current state of the clock steering process. All oscillators have some inherent drift. By default the receiver attempts to steer the receiver's clock to accurately match GPS time. If for some reason this is not desired, this behavior can be disabled using the CLOCKADJUST command, see [page 79](#).

- 
- ☒ If the CLOCKADJUST command is ENABLED, and the receiver is configured to use an external reference frequency (set in the EXTERNALCLOCK command, see [page 112](#), for an external clock - TCXO, OCXO, RUBIDIUM, CESIUM, or USER), then the clock steering process takes over the VARF output pins and may conflict with a previously entered FREQUENCYOUT command, see [page 121](#).
- 

**Message ID:** 26

**Log Type:** Asynch

**Recommended Input:**

log clocksteeringa onchanged

**ASCII Example:**

```
#CLOCKSTEERINGA,COM1,0,56.5,FINESTEERING,1337,394857.051,00000000,0f61,1984;
INTERNAL,SECOND_ORDER,4400,1707.554687500,0.029999999,-2.00000000,-0.224,
0.060*0e218bbc
```



To configure the receiver to use an external reference oscillator, see the EXTERNALCLOCK command on [page 112](#).

**Table 55: Clock Source**

| Binary | ASCII    | Description  |
|--------|----------|--|
| 0      | INTERNAL | The receiver is currently steering its internal VCTCXO using an internal VARF signal     |
| 1      | EXTERNAL | The receiver is currently steering an external oscillator using the external VARF signal |

Table 56: Steering State

| Binary | ASCII                         | Description  |
|--------|-------------------------------|--|
| 0      | FIRST_ORDER                   | Upon start-up, the clock steering task adjusts the VARF pulse width to reduce the receiver clock drift rate to below 1 ms using a 1st order control loop. This is the normal start-up state of the clock steering loop.  |
| 1      | SECOND_ORDER                  | Once the receiver has reduced the clock drift to below 1 m/s, it enters a second order control loop and attempts to reduce the receiver clock offset to zero. This is the normal runtime state of the clock steering process.  |
| 2      | CALIBRATE_HIGH <sup>a</sup>   | This state corresponds to when the calibration process is measuring at the "High" pulse width setting  |
| 3      | CALIBRATE_LOW <sup>a</sup>    | This state corresponds to when the calibration process is measuring at the "Low" pulse width setting   |
| 4      | CALIBRATE_CENTER <sup>b</sup> | This state corresponds to the "Center" calibration process. Once the center has been found, the modulus pulse width, center pulse width, loop bandwidth, and measured slope values are saved in NVM and are used from now on for the currently selected oscillator (INTERNAL or EXTERNAL). |

- a. These states are only seen if you force the receiver to do a clock steering calibration using the CLOCKCALIBRATE command, see *page 81*. With the CLOCKCALIBRATE command, you can force the receiver to calibrate the slope and center pulse width, of the currently selected oscillator, to steer. The receiver measures the drift rate at several "High" and "Low" pulse width settings.
- b. After the receiver has measured the "High" and "Low" pulse width setting, the calibration process enters a "Center calibration" process where it attempts to find the pulse width required to zero the clock drift rate.

| Field # | Field type           | Data Description   | Format | Binary Bytes | Binary Offset |
|---------|----------------------|--|--------|--------------|---------------|
| 1       | CLOCKSTEERING header | Log header   |        | H            | 0             |
| 2       | source               | Clock source, see <i>Table 55, Clock Source</i> on page 268.   | Enum   | 4            | H             |
| 3       | steeringstate        | Steering state, see <i>Table 56, Steering State</i> on page 269.   | Enum   | 4            | H+4           |
| 4       | period               | Period of the FREQUENCYOUT signal used to control the oscillator, refer to the FREQUENCYOUT command. This value is set using the CLOCKCALIBRATE command.   | Ulong  | 4            | H+8           |
| 5       | pulsewidth           | Current pulse width of the FREQUENCYOUT signal. The starting point for this value is set using the CLOCKCALIBRATE command. The clock steering loop continuously adjusts this value in an attempt to drive the receiver clock offset and drift terms to zero. | Double | 8            | H+12          |
| 6       | bandwidth            | The current band width of the clock steering tracking loop in Hz. This value is set using the CLOCKCALIBRATE command.  | Double | 8            | H+20          |
| 7       | slope                | The current clock drift change in m/s/bit for a 1 LSB pulse width. This value is set using the CLOCKCALIBRATE command.   | Float  | 4            | H+28          |
| 8       | offset               | The last valid receiver clock offset computed (m). It is the same as Field # 18 of the CLOCKMODEL log, see page 262.   | Double | 8            | H+32          |
| 9       | driftrate            | The last valid receiver clock drift rate received (m/s). It is the same as Field # 19 of the CLOCKMODEL log.   | Double | 8            | H+40          |
| 10      | xxxx                 | 32-bit CRC (ASCII and Binary only)   | Hex    | 4            | H+48          |
| 11      | [CR][LF]             | Sentence terminator (ASCII only)   | -      | -            | -             |

### 3.3.10 CMR Standard Logs V123\_RT20 or V23\_RT2

|                    |  |
|--------------------|--|
| <b>CMRDESC</b>     | <b>BASE STATION DESCRIPTION INFORMATION</b>                        |
| <b>Message ID:</b> | <b>310</b>   |
| <b>CMRGLOOBS</b>   | <b>CMR DATA GLONASS OBSERVATIONS (CMR TYPE 3 MESSAGE) <u>G</u></b> |
| <b>Message ID:</b> | <b>882</b>   |
| <b>CMROBS</b>      | <b>BASE STATION SATELLITE OBSERVATION INFORMATION</b>              |
| <b>Message ID:</b> | <b>103</b>   |
| <b>CMRPLUS</b>     | <b>CMR+ OUTPUT INFORMATION</b>                                     |
| <b>Message ID:</b> | <b>717</b>   |
| <b>CMRREF</b>      | <b>BASE STATION POSITION INFORMATION</b>                           |
| <b>Message ID:</b> | <b>105</b>   |

The Compact Measurement Record (CMR) Format, is a standard communications protocol used in Real-Time Kinematic (RTK) systems to transfer GPS carrier phase and code observations from a base station to one or more rover stations.

- 
- ☒ 1. The above messages can be logged with an A or B suffix for an ASCII or Binary output with a NovAtel header followed by Hex or Binary raw data respectively.
  - 2. CMRDATA logs output the details of the above logs if they have been sent.
  - 3. No guarantee is made that the OEMV will meet its performance specifications if non-NovAtel equipment is used.
  - 4. Trimble rovers must receive CMRDESC messages from a base.
- 

The Compact Measurement Record (CMR) message format was developed by Trimble Navigation Ltd. as a proprietary data transmission standard for use in RTK applications. In 1996, Trimble publicly disclosed this standard and allowed its use by all manufacturers in the GPS industry<sup>1</sup>.

The NovAtel implementation allows a NovAtel rover receiver to operate in RTK mode while receiving pseudorange and carrier phase data via CMR messages (version 3.0) from a non-NovAtel base-station receiver. The NovAtel receiver can also transmit CMR messages (version 3.0). The station ID must be  $\leq 31$  when transmitting CMR corrections. The CMRPLUS output message distributes the base station information over 14 updates, see *page 285*.

The maximum message lengths of the four CMR messages are as follows:

$$\begin{aligned} \text{CMROBS} &= 6 \text{ (frame)} + 6 \text{ (header)} + (14 * \text{L1 channels}) + (14 * \text{L2 channels}) = (222 \text{ bytes max.}) \\ \text{CMRREF} &= 6 \text{ (frame)} + 6 \text{ (header)} + 19 = (31 \text{ bytes}) \\ \text{CMRDESC} &= 6 \text{ (frame)} + 6 \text{ (header)} + (\text{variable: } 26 \text{ to } 75) = (38 \text{ bytes minimum; } 87 \text{ bytes max.}) \\ \text{CMRPLUS} &= 6 \text{ (frame)} + 3 \text{ (header)} + 7 = (16 \text{ bytes}) \end{aligned}$$

- 
1. Talbot, N.C. (1996) "Compact Data Transmission Standard for High-Precision GPS". ION GPS-96 Conference Proceedings, Kansas, MO, Sept. 1996, Vol. I, pp. 861-871

## CMR Type 3 RTK Formats

---

☒ NovAtel CMR Type 3 messages are CMR Type 3 messages as defined by Leica and Topcon.

---

CMR Type 3 format messages are for GLONASS CMR observations. CMRGLOOBS and CMRDATAGLOOBS logs are similar to the existing CMROBS and CMRDATAOBS logs. See also *CMR Standard Logs* starting on *page 271*.

CMR Type 3 message types (CMRGLOOBS and CMRDATAGLOOBS) have their Z count stamped to GLONASS UTC time instead of GPS Time (the *epoch* field in the CMR Header part of the message).

When you use CMRGLOOBS in conjunction with CMRREF and CMROBS, you can perform GPS + GLONASS RTK positioning (provided you have a GLONASS-capable receiver model).

### CMR Type 3 Example Setup

In the example below, apply *Steps #1* and *#2* to the base, and *Step #3* to the rover:

1. Use the INTERFACEMODE command to set up the base port's receive mode as NONE and transmit mode as CMR:

```
interfacemode com2 none cmr
```

2. Log out CMRREF, CMROBS and CMRGLOOBS <sup>1</sup> messages:

```
log com2 CMRREF ontime 10
```

```
log com2 CMROBS ontime 1
```

```
log com2 CMRGLOOBS ontime 1
```

☒ We recommend that you log CMROBS and CMRGLOOBS messages out at the same rate.

3. Set up the rover receiver to use incoming CMR messages by setting the rover port's receive mode as CMR and the transmit mode as NONE:

```
interfacemode com2 CMR none
```

### Using AdvVance RTK with CMR Format Messages

To enable receiving CMR messages, follow these steps:

1. Issue the COM command, see *page 87*, to the rover receiver to set its serial port parameters to the proper bit rate, parity, and so on.
2. Issue the "INTERFACEMODE COMn CMR" command to the rover receiver, where "COMn" refers to the communication port that is connected to the data link. See also *page 135*.

---

1. These correspond to reference station data, GPS observations, and GLONASS observations respectively.



Assuming that the base station is transmitting valid data, your rover receiver begins to operate in AdVance RTK mode. To send CMR messages, periodically transmit the three following CMR messages at the base station:

- A CMROBS message that contains base station satellite observation information, and should be sent once every 1 or 2 seconds.
- A CMRREF message that contains base station position information, and should be sent once every 10 seconds. Also, the rover receiver automatically sets an approximate position from this message if it does not already have a position. Therefore, this message can be used in conjunction with an approximate time to improve TTFF, refer to the *Time to First Fix* and *Satellite Acquisition* sections of the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm>.
- A CMRDESC message that contains base station description information and should be sent once every 10 seconds. However, it should be interlinked with the CMRREF message.

- 
- ☒ 1. For CMR, the station ID must be less than 31 (refer to the DGPSTXID and RTKSOURCE commands on *pages 106* and *178* respectively).
2. CMRDESC is logged with an offset of 5 to allow interleaving with CMRREF. Note that Trimble rovers must receive CMRDESC messages from a base.
3. Novatel CMR Type 2 messages are for compatibility only. When received, a Type 2 message is discarded. For transmission, all fields are permanently set as follows:
- |                  |   |           |
|------------------|---|-----------|
| Record Length    | = | 33 bytes  |
| Short Station ID | = | "cref"    |
| COGO Code        | = | ""        |
| Long Station ID  | = | "UNKNOWN" |
- 

### Example Input:

```
interfacemode com2 none CMR
fix position 51.113 -114.044 1059.4
log com2 cmrobs ontime 1
log com2 cmrref ontime 10
log com2 cmrdesc ontime 10 5
```

### 3.3.11 CMRDATADESC Base Station Description V123\_RT20 or V23\_RT2

See Section 3.3.10, *CMR Standard Logs* starting on page 271 for information on CMR standard logs.

**Message ID:** 389

**Log Type:** Synch

**Recommended Input:**

```
log cmrdatadesca ontime 10 5
```

**ASCII Example:**

```
#CMRDATADESCA,COM1,0,76.5,FINESTEERING,1117,162906.461,00100020,b467,399;
2,0,147,39,3,0,2,
FALSE,FALSE,0,TRUE,0,180000,1,0,33,32,32,32,32,99,114,101,102,0,0,0,0,0,0,
0,0,0,0,0,0,0,0,8,85,78,75,78,79,87,78,0*482add29
```

where the bolded 33 in the example above represents the total length of the records that follow:

**Short ID:**

```
32,32,32,32,99,114,101,102, (8 bytes)
```

**COGO Code:**

```
0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0, (16 bytes)
```

**ID Length:**

```
8, (1 byte)
```

**Long ID:**

```
85,78,75,78,79,87,78,0 (8 bytes)
```



Here are some CMR terminology facts:

- In the CMR format description, the base station description log is referred to as Type 2
  - COGO is an acronym for coordinate geometry (COordinate GeOmetry)
-

| Field # | Field type          | Data Description   | Format    | Binary Bytes    | Binary Offset |
|---------|---------------------|--|-----------|-----------------|---------------|
| 1       | CMRDATA-DESC header | Log header   | -         | H               | 0             |
| 2       | CMR header          | Synch character for the message  | Ulong     | 4               | H             |
| 3       |                     | Message status   | Ulong     | 4               | H+4           |
| 4       |                     | CMR message type   | Ulong     | 4               | H+8           |
| 5       |                     | Message body length  | Ulong     | 4               | H+12          |
| 6       |                     | Version  | Ulong     | 4               | H+16          |
| 7       |                     | Station ID   | Ulong     | 4               | H+20          |
| 8       |                     | Message Type   | Ulong     | 4               | H+24          |
| 9       | battery             | Is the battery low?<br>0 = FALSE<br>1 = TRUE                                 | Enum      | 4               | H+28          |
| 10      | memory              | Is memory low?<br>0 = FALSE<br>1 = TRUE                                      | Enum      | 4               | H+32          |
| 11      | Reserved            |  | Ulong     | 4               | H+36          |
| 12      | L2                  | Is L2 enabled?<br>0 = FALSE<br>1 = TRUE                                      | Enum      | 4               | H+40          |
| 13      | Reserved            |  | Ulong     | 4               | H+44          |
| 14      | epoch               | Epoch time (milliseconds)  | Ulong     | 4               | H+48          |
| 15      | motion              | Motion state<br>0 = UNKNOWN<br>1 = STATIC<br>2 = KINEMATIC                   | Ulong     | 4               | H+52          |
| 16      | Reserved            |  | Ulong     | 4               | H+56          |
| 17      | rec length          | Record length (bytes). The length altogether of the four fields that follow. | Double    | 8               | H+60          |
| 18      | short ID            | Short station ID. A sequence of eight numbers.                               | Uchar[8]  | 8               | H+68          |
| 19      | code                | COGO code. A sequence of 16 numbers.   | Uchar[16] | 16              | H+76          |
| 20      | ID length           | Long ID length. The length of the long ID field that follows.                | Ulong     | 4               | H+92          |
| 21      | long ID             | Long station ID, variable length, see field #20                              | Uchar[50] | 52 <sup>a</sup> | H+96          |
| 22      | xxxx                | 32-bit CRC (ASCII and Binary only)   | Hex       | 4               | H+148         |
| 23      | [CR][LF]            | Sentence terminator (ASCII only)   | -         | -               | -             |

a. In the binary log case an additional 2 bytes of padding are added to maintain 4 byte alignment

### 3.3.12 CMRDATAGLOOBS *CMR Data GLONASS Observations V123\_RT20 or V23\_RT2*

See *Section 3.3.10, CMR Standard Logs* starting on page 271 for information on CMR standard logs.

**Message ID:** 1003

**Log Type:** Synch

**Recommended Input:**

```
log cmrdatagloobsa ontime 10
```

**ASCII Example:**

```
#CMRDATAGLOOBSA, COM1, 0, 69.5, FINESTEERING, 1464, 426413.000, 00100000, d9fe, 3186;
2, 0, 147, 51, 3, 0, 3, 3, 159000, 3, 0, 3,
7, FALSE, TRUE, TRUE, 6872924, 281, 6, 1, TRUE, TRUE, TRUE, TRUE, TRUE, 0, 401, 326, 11, 1,
6, FALSE, TRUE, TRUE, 10410661, -124, 4, 1, TRUE, TRUE, TRUE, TRUE, TRUE, 0, 185, -16, 11, 1,
23, FALSE, TRUE, TRUE, 11322704, 99, 4, 1, TRUE, TRUE, TRUE, TRUE, TRUE, 0, 724, -140, 11, 1
*442e2924
```

### CMRGLOOBS

This CMR Type 3 message is based closely on the CMR observables, or message 0, and is intended to allow GLONASS corrections to be broadcast using the CMR format.

---

NovAtel, Leica and Topcon support this CMR message type but it is not compatible with Trimble's unpublished GLONASS CMR messages.

---

| Field # | Field type            | Data Description  | Format        | Binary Bytes | Binary Offset |
|---------|-----------------------|---|---------------|--------------|---------------|
| 1       | CMRDATA-GLOOBS header | Log header  | -             | H            | 0             |
| 2       | CMR header            | Synch character for the message   | Ulong         | 4            | H             |
| 3       |                       | Message status  | Ulong         | 4            | H+4           |
| 4       |                       | CMR message type  | Ulong         | 4            | H+8           |
| 5       |                       | Message body length   | Ulong         | 4            | H+12          |
| 6       |                       | Version   | Ulong         | 4            | H+16          |
| 7       |                       | Station ID  | Ulong         | 4            | H+20          |
| 8       |                       | Message Type  | Ulong         | 4            | H+24          |
| 9       |                       | #sv   | Number of SVs | Ulong        | 4             |
| 10      | epoch                 | Epoch time (milliseconds)   | Ulong         | 4            | H+32          |
| 11      | clock bias            | Is clock bias valid?<br>0 = NOT VALID<br>3 = VALID                          | Ulong         | 4            | H+36          |
| 12      | clock offset          | Clock offset (nanoseconds)  | Long          | 4            | H+40          |
| 13      | # obs                 | Number of satellite observations with information to follow                 | Ulong         | 4            | H+44          |
| 14      | slot#                 | GLONASS satellite slot number   | Ulong         | 4            | H+48          |
| 15      | P code?               | Is P code collected?<br>0 = FALSE = C/A<br>1 = TRUE = P                     | Enum          | 4            | H+52          |
| 16      | L1 phase?             | Is L1 phase valid?<br>0 = FALSE<br>1 = TRUE                                 | Enum          | 4            | H+56          |
| 17      | L2?                   | Is L2 present?<br>0 = FALSE<br>1 = TRUE                                     | Enum          | 4            | H+60          |
| 18      | L1 psr                | L1 pseudorange (1/8 L1 cycles)  | Ulong         | 4            | H+64          |
| 19      | L1 carrier            | L1 carrier-code measurement (1/256 L1 cycles)                               | Long          | 4            | H+68          |
| 20      | L1 S/N <sub>0</sub>   | L1 signal-to-noise density ratio  | Ulong         | 4            | H+72          |
| 21      | L1 slip               | L1 cycle slip count (number of times that tracking has not been continuous) | Ulong         | 4            | H+76          |

Continued on page 278.

| Field #  | Field type                            | Data Description   | Format | Binary Bytes | Binary Offset |
|----------|---------------------------------------|--|--------|--------------|---------------|
| 22       | L2 code                               | Is L2 code available?<br>0 = FALSE<br>1 = TRUE   | Enum   | 4            | H+80          |
| 23       | C/A code?                             | Is C/A code collected on L2?<br>0 = FALSE = P<br>1 = TRUE = C/A                                  | Enum   | 4            | H+84          |
| 24       | L2 code?                              | Is L2 code valid?<br>0 = FALSE<br>1 = TRUE   | Enum   | 4            | H+88          |
| 25       | L2 phase?                             | Is L2 phase valid?<br>0 = FALSE<br>1 = TRUE  | Enum   | 4            | H+92          |
| 26       | phase full?                           | Is phase full?<br>0 = FALSE<br>1 = TRUE  | Enum   | 4            | H+96          |
| 27       | Reserved                              |  | Ulong  | 4            | H+100         |
| 28       | L2 r offset                           | L2 range offset (1/100 meters)   | Long   | 4            | H+104         |
| 29       | L2 c offset                           | L2 carrier offset (1/256 cycles)<br>The L2 frequency used is that of the broadcasting satellite. | Long   | 4            | H+108         |
| 30       | L2 S/N <sub>0</sub>                   | L2 signal-to-noise density ratio   | Ulong  | 4            | H+112         |
| 31       | L2 slip                               | L2 cycle slip count (number of times that tracking has not been continuous)                      | Ulong  | 4            | H+116         |
| 32...    | Next PRN offset = H+48 + (#prns x 72) |  |        |              |               |
| variable | xxxx                                  | 32-bit CRC (ASCII and Binary only)   | Hex    | 4            | variable      |
| variable | [CR][LF]                              | Sentence terminator (ASCII only)   | -      | -            | -             |

### 3.3.13 CMRDATAOBS Base Station Satellite Observations V123\_RT20 or V23\_RT2

See Section 3.3.10, *CMR Standard Logs* starting on page 271 for information on CMR standard logs.

**Message ID:** 390

**Log Type:** Synch

#### Recommended Input:

log cmrdataobsa ontime 2

#### ASCII Example:

```
#CMRDATAOBSA, COM1, 0, 74.0, FINESTEERING, 1117, 162981.000, 00100020, b222, 399;
2, 0, 147, 93, 3, 0, 0,
10, 21000, 3, 0, 10,
3, FALSE, TRUE, TRUE, 8684073, -505, 10, 1, TRUE, TRUE, TRUE, TRUE, TRUE, 0, 368, -512, 11, 1,
15, FALSE, TRUE, TRUE, 11936394, 129, 11, 1, TRUE, TRUE, TRUE, TRUE, TRUE, 0, 270, 78, 12, 1,
18, FALSE, TRUE, TRUE, 5334926, 186, 11, 1, TRUE, TRUE, TRUE, TRUE, TRUE, 0, 164, 164, 12, 1,
21, FALSE, TRUE, TRUE, 10590427, -770, 10, 1, TRUE, TRUE, TRUE, TRUE, TRUE, 0,
366, -850, 11, 1,
17, FALSE, TRUE, TRUE, 3262859, 32, 11, 1, TRUE, TRUE, TRUE, TRUE, TRUE, 0, 325, 216, 12, 1,
26, FALSE, TRUE, TRUE, 211264, 1213, 10, 1, TRUE, TRUE, TRUE, TRUE, TRUE, 0, 390, 1069, 10, 1,
23, FALSE, TRUE, TRUE, 8098, 209, 11, 1, TRUE, TRUE, TRUE, TRUE, TRUE, 0, 265, 236, 12, 1,
28, FALSE, TRUE, TRUE, 5090047, -160, 6, 1, TRUE, TRUE, TRUE, TRUE, TRUE, 0, 535, -227, 9, 1,
31, FALSE, TRUE, TRUE, 1857322, -1027, 7, 1, TRUE, TRUE, TRUE, TRUE, TRUE, 0,
513, -1063, 8, 1,
9, FALSE, TRUE, TRUE, 51623, -1245, 6, 1, TRUE, TRUE, TRUE, TRUE, TRUE, 0,
599, -1244, 9, 1*9fe706b0
```



The CMRDATAOBS log is analogous to the RTCADATAOBS logs when using RTCA messages. In the CMR format description, the CMRDATAOBS log is referred to as Type 0.

| Field # | Field type          | Data Description  | Format        | Binary Bytes | Binary Offset |
|---------|---------------------|---|---------------|--------------|---------------|
| 1       | CMRDATA-OBS header  | Log header  | -             | H            | 0             |
| 2       | CMR header          | Synch character for the message   | Ulong         | 4            | H             |
| 3       |                     | Message status  | Ulong         | 4            | H+4           |
| 4       |                     | CMR message type  | Ulong         | 4            | H+8           |
| 5       |                     | Message body length   | Ulong         | 4            | H+12          |
| 6       |                     | Version   | Ulong         | 4            | H+16          |
| 7       |                     | Station ID  | Ulong         | 4            | H+20          |
| 8       |                     | Message Type  | Ulong         | 4            | H+24          |
| 9       |                     | #sv   | Number of SVs | Ulong        | 4             |
| 10      | epoch               | Epoch time (milliseconds)   | Ulong         | 4            | H+32          |
| 11      | clock bias          | Is clock bias valid?<br>0 = NOT VALID<br>3 = VALID                          | Ulong         | 4            | H+36          |
| 12      | clock offset        | Clock offset (nanoseconds)  | Long          | 4            | H+40          |
| 13      | # obs               | Number of satellite observations with information to follow                 | Ulong         | 4            | H+44          |
| 14      | prn                 | Satellite PRN number  | Ulong         | 4            | H+48          |
| 15      | code flag           | Is code P Code?<br>0 = FALSE<br>1 = TRUE                                    | Enum          | 4            | H+52          |
| 16      | L1                  | Is L1 phase valid?<br>0 = FALSE<br>1 = TRUE                                 | Enum          | 4            | H+56          |
| 17      | L2                  | Is L2 present?<br>0 = FALSE<br>1 = TRUE                                     | Enum          | 4            | H+60          |
| 18      | L1 psr              | L1 pseudorange (1/8 L1 cycles)  | Ulong         | 4            | H+64          |
| 19      | L1 carrier          | L1 carrier-code measurement (1/256 L1 cycles)                               | Long          | 4            | H+68          |
| 20      | L1 S/N <sub>0</sub> | L1 signal-to-noise density ratio  | Ulong         | 4            | H+72          |
| 21      | L1 slip             | L1 cycle slip count (number of times that tracking has not been continuous) | Ulong         | 4            | H+76          |

Continued on page 281.



| Field #  | Field type                            | Data Description  | Format | Binary Bytes | Binary Offset |
|----------|---------------------------------------|---|--------|--------------|---------------|
| 22       | L2 code                               | Is L2 code available?<br>0 = FALSE<br>1 = TRUE                              | Enum   | 4            | H+80          |
| 23       | Code type                             | Is code X-correlation?<br>0 = FALSE<br>1 = TRUE                             | Enum   | 4            | H+84          |
| 24       | L2 c valid                            | Is L2 code valid?<br>0 = FALSE<br>1 = TRUE                                  | Enum   | 4            | H+88          |
| 25       | L2 p valid                            | Is L2 phase valid?<br>0 = FALSE<br>1 = TRUE                                 | Enum   | 4            | H+92          |
| 26       | phase full                            | Is phase full?<br>0 = FALSE<br>1 = TRUE                                     | Enum   | 4            | H+96          |
| 27       | Reserved                              |   | Ulong  | 4            | H+100         |
| 28       | L2 r offset                           | L2 range offset (1/100 meters)  | Long   | 4            | H+104         |
| 29       | L2 c offset                           | L2 carrier offset (1/256 cycles)  | Long   | 4            | H+108         |
| 30       | L2 S/N <sub>0</sub>                   | L2 signal-to-noise density ratio  | Ulong  | 4            | H+112         |
| 31       | L2 slip                               | L2 cycle slip count (number of times that tracking has not been continuous) | Ulong  | 4            | H+116         |
| 32...    | Next PRN offset = H+48 + (#prns x 72) |   |        |              |               |
| variable | xxxx                                  | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | variable      |
| variable | [CR][LF]                              | Sentence terminator (ASCII only)  | -      | -            | -             |

### 3.3.14 CMRDATAREF Base Station Position V123\_RT20 or V23\_RT2

See Section 3.3.10, *CMR Standard Logs* starting on page 271 for information on CMR standard logs. See also Figure 10 on page 261 for a definition of the ECEF coordinates.

**Message ID:** 391  
**Log Type:** Synch

**Recommended Input:**

log cmrdatarefa ontime 10

**ASCII Example:**

```
#CMRDATAREFA,COM1,0,70.0,FINESTEERING,1269,147115.000,00100000,5db6,1516;2,0,
147,25,3,0,1,FALSE,FALSE,0,TRUE,0,234000,1,0,-1634529233.1026337146759033,
0,-3664611941.5660152435302734,0,-2054717277,0,15,0*c21a9c26
```



The CMRDATAREF log is analogous to the RTCADATAREF log when using RTCA messages. In the CMR format description, the CMRDATAREF log is referred to as Type 1.

**Table 57: Position Accuracy**

| Code | Position Accuracy |
|------|-------------------|
| 0    | Unknown           |
| 1    | 5 km              |
| 2    | 1 km              |
| 3    | 500 m             |
| 4    | 100 m             |
| 5    | 50 m              |
| 6    | 10 m              |
| 7    | 5 m               |
| 8    | 1 m               |
| 9    | 50 cm             |
| 10   | 10 cm             |
| 11   | 5 cm              |
| 12   | 1 cm              |
| 13   | 5 mm              |
| 14   | 1 mm              |
| 15   | Exact             |

| Field # | Field type         | Data Description  | Format                                       | Binary Bytes | Binary Offset |
|---------|--------------------|---|--|--------------|---------------|
| 1       | CMRDATA REF header | Log header  | -  | H            | 0             |
| 2       | CMR header         | Synch character for the message                             | Ulong  | 4            | H             |
| 3       |                    | Message status  | Ulong  | 4            | H+4           |
| 4       |                    | CMR message type  | Ulong  | 4            | H+8           |
| 5       |                    | Message body length   | Ulong  | 4            | H+12          |
| 6       |                    | Version   | Ulong  | 4            | H+16          |
| 7       |                    | Station ID  | Ulong  | 4            | H+20          |
| 8       |                    | Message Type  | Ulong  | 4            | H+24          |
| 9       |                    | battery   | Is the battery low?<br>0 = FALSE<br>1 = TRUE | Enum         | 4             |
| 10      | memory             | Is memory low?<br>0 = FALSE<br>1 = TRUE                     | Enum   | 4            | H+32          |
| 11      | Reserved           |   | Ulong  | 4            | H+36          |
| 12      | L2                 | Is L2 enabled?<br>0 = FALSE<br>1 = TRUE                     | Enum   | 4            | H+40          |
| 13      | Reserved           |   | Ulong  | 4            | H+44          |
| 14      | epoch              | Epoch time (milliseconds)                                   | Ulong  | 4            | H+48          |
| 15      | motion             | Motion state:<br>0 = UNKNOWN<br>1 = STATIC<br>2 = KINEMATIC | Ulong  | 4            | H+52          |
| 16      | Reserved           |   | Ulong  | 4            | H+56          |
| 17      | ECEF-X             | Reference ECEF-X position (millimeters)                     | Double                                       | 8            | H+60          |
| 18      | ant hgt            | Antenna height (millimeters)                                | Ulong  | 4            | H+68          |
| 19      | ECEF-Y             | Reference ECEF-Y position (millimeters)                     | Double                                       | 8            | H+72          |
| 20      | e offset           | Easting offset (millimeters)                                | Ulong  | 4            | H+80          |
| 21      | ECEF-Z             | Reference ECEF-Z position (millimeters)                     | Double                                       | 8            | H+84          |
| 22      | n offset           | Northing offset (millimeters)                               | Ulong  | 4            | H+92          |

Continued on page 284.

| Field # | Field type | Data Description  | Format | Binary Bytes | Binary Offset |
|---------|------------|---|--------|--------------|---------------|
| 23      | pos acc    | Position accuracy relative to WGS84, see <i>Table 57, Position Accuracy</i> on page 282 | Ulong  | 4            | H+96          |
| 24      | Reserved   |   | Ulong  | 4            | H+100         |
| 25      | xxxx       | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+104         |
| 26      | [CR][LF]   | Sentence terminator (ASCII only)  | -      | -            | -             |

### 3.3.15 CMRPLUS CMR+ Output Message V123\_RT20 or V23\_RT2

The CMRPLUS message distributes the base station information over 14 updates. For example, if you log:

```
CMRPLUS ontime 1
```

the receiver outputs the complete base station information in 14 seconds.

Refer to the chapter on *Message Formats* in the *OEMV Family Installation and Operation User Manual* for information on CMR standard logs.

**Message ID:** 717  
**Log Type:** Asynch

**Recommended Input:**

```
log cmrplusa ontime 1
```

**ASCII Example:**

```
#CMRPLUSA,COM1,0,83.0,FINESTEERING,1317,318534.915,00180040,30aa,1855;  
2,0,148,10,0,4,14,1b,00,00,00,00,62,61*64e0c9ea
```



The CMRPLUS log can be used in place of the CMRREF log. The advantage of the CMRPLUS log is that it requires less transmission bandwidth because of the way the information is spread over 14 separate updates. This may be especially useful in difficult communication environments, for example, when a radio repeater is required.

| Field # | Field type     | Data Description                   | Format   | Binary Bytes   | Binary Offset |
|---------|----------------|------------------------------------|----------|----------------|---------------|
| 1       | CMRPLUS header | Log header                         | -        | H              | 0             |
| 2       | CMR header     | Synch character for the message    | Ulong    | 4              | H             |
| 3       |                | Message status                     | Ulong    | 4              | H+4           |
| 4       |                | CMR message type                   | Ulong    | 4              | H+8           |
| 5       |                | Message body length                | Ulong    | 4              | H+12          |
| 6       |                | Version                            | Ulong    | 4              | H+16          |
| 7       |                | Station ID                         | Ulong    | 4              | H+20          |
| 8       |                | Message Type                       | Ulong    | 4              | H+24          |
| 9       | stnID          | Station ID                         | Ulong    | 4              | H+28          |
| 10      | page           | Current page index                 | Ulong    | 4              | H+32          |
| 11      | #pages         | Maximum number of page indexes     | Ulong    | 4              | H+36          |
| 12      | data           | Data for this page                 | Uchar[7] | 8 <sup>a</sup> | H+40          |
| 13      | xxxx           | 32-bit CRC (ASCII and Binary only) | Hex      | 4              | H+104         |
| 14      | [CR][LF]       | Sentence terminator (ASCII only)   | -        | -              | -             |

a. In the binary log case, an additional byte of padding is added to maintain 4-byte alignment

---

### 3.3.16 COMCONFIG Current COM Port Configuration V123

This log outputs the current COM port configuration for each port on your receiver.

**Message ID:** 317  
**Log Type:** Polled

**Recommended Input:**

log comconfiga once

**ASCII example:**

```
#COMCONFIGA,COM1,0,57.5,FINESTEERING,1337,394947.236,00000000,85aa,1984;  
3,  
COM1,57600,N,8,1,N,OFF,ON,NOVATEL,NOVATEL,ON,  
COM2,9600,N,8,1,N,OFF,ON,RTCA,NONE,ON,  
COM3,9600,N,8,1,N,OFF,ON,NOVATEL,NOVATEL,ON*9d4b21b6
```



COM1 on the OEMV-3 is user-configurable for RS-422. Refer to the *Technical Specifications* appendix and the *User-Selectable Port Configuration* section of the *OEMV Family Installation and Operation User Manual*.

---

| Field # | Field type                              | Data Description  | Format | Binary Bytes | Binary Offset   |
|---------|---|---|--------|--------------|-----------------|
| 1       | COMCONFIG header                        | Log header  |        | H            | 0               |
| 2       | #port                                   | Number of ports with information to follow  | Long   | 4            | H               |
| 3       | port                                    | Serial port identifier, see <i>Table 17, COM Serial Port Identifiers on page 88</i>                       | Enum   | 4            | H+4             |
| 4       | baud                                    | Communication baud rate   | Ulong  | 4            | H+8             |
| 5       | parity                                  | See <i>Table 18, Parity on page 88</i>  | Enum   | 4            | H+12            |
| 6       | databits                                | Number of data bits   | Ulong  | 4            | H+16            |
| 7       | stopbits                                | Number of stop bits   | Ulong  | 4            | H+20            |
| 8       | handshake                               | See <i>Table 19, Handshaking on page 89</i>   | Enum   | 4            | H+24            |
| 9       | echo                                    | When echo is on, the port is transmitting any input characters as they are received.<br>0 = OFF<br>1 = ON | Enum   | 4            | H+28            |
| 10      | breaks                                  | Breaks are turned on or off<br>0 = OFF<br>1 = ON  | Enum   | 4            | H+32            |
| 11      | rx type                                 | The status of the receive interface mode, see <i>Table 31, Serial Port Interface Modes on page 137</i> .  | Enum   | 4            | H+36            |
| 12      | tx type                                 | The status of the transmit interface mode, <i>Table 31, Serial Port Interface Modes on page 137</i>       | Enum   | 4            | H+40            |
| 13      | response                                | Responses are turned on or off<br>0 = OFF<br>1 = ON   | Enum   | 4            | H+44            |
| 14      | next port offset = H + 4 + (#port x 44) |   |        |              |                 |
| 15      | xxxx                                    | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+4+(#port x44) |
| 16      | [CR][LF]                                | Sentence terminator (ASCII only)  | -      | -            | -               |



### 3.3.17 DIFFCODEBIASES Differential code biases being applied V123

This log outputs the differential code biases that are being applied to the L1/L2 ionospheric corrections.

**Message ID:** 914

**Log Type:** Polled

**Recommended Input:**

log diffcodebiases once

**ASCII example:**

```
#DIFFCODEBIASESA,COM1,0,61.5,UNKNOWN,0,4294967.295,004c0000,15ba,35548;
1,GPS_C1P1,-0.472,-0.006,-0.482,1.154,-1.153,0.250,-1.319,-0.535,0.119,
-1.945,0.522,1.425,1.489,0.090,0.000,-0.727,1.361,-0.416,-2.066,-1.347,
-0.380,0.543,0.414,-0.172,0.394,0.923,-0.422,-0.326,0.481,1.937,1.753,
-1.088,0.000,0.000,0.000,0.000,0.000,0.000,0.000,0.000*417eef8e0
```

| Field # | Field type   | Data Description  | Format    | Binary Bytes | Binary Offset                 |
|---------|--|---|-----------|--------------|-------------------------------|
| 1       | DIFFCODE-BIASES header                             | Log header  |           | H            | 0                             |
| 2       | #bias_sets   | Number of sets of bias code arrays                            | Long      | 4            | H                             |
| 3       | bias_type  | Bias type (there is currently only one type):<br>0 = GPS_C1P1 | Enum      | 4            | H+4                           |
| 4       | bias_array   | Array of 40 biases (ns)                                       | Float[40] | 160          | H+8                           |
| 5       | next bias_sets offset = H + 4 + (#bias_sets x 164) |   |           |              |                               |
| 6       | xxxx   | 32-bit CRC (ASCII and Binary only)                            | Hex       | 4            | H+4+<br>(#bias_sets<br>x 164) |
| 7       | [CR][LF]   | Sentence terminator (ASCII only)                              | -         | -            | -                             |

### 3.3.18 EXTRXHWLEVELS Extended Receiver Hardware Levels V3\_G

This log contains extended receiver environmental and voltage parameters. The EXTRXHWLEVELS log is for OEMV-3-based GLONASS products only. Its fields display zeroes for other receivers.

**Message ID:** 843

**Log Type:** Polled

**Recommended Input:**

log extrxhwlevels ontime 60

**Abbreviated ASCII Example:**

```
#EXTRXHWLEVELSA,COM1,0,77.0,FINESTEERING,1415,404242.050,00000020,a536,2616;
3.325,1.803,2.833,0.000,-0.031,6.104e-04,0.000,0.000,0.000,0.000*54a4d596
```



Refer also to the OEMV-3 technical specifications in *Appendix A* of the *OEMV Family Installation and Operation User Manual* for comparisons.

| Field # | Field type            | Data Description                   | Format | Binary Bytes | Binary Offset |
|---------|-----------------------|------------------------------------|--------|--------------|---------------|
| 1       | EXTRXHW-LEVELS header | Log header                         |        | H            | 0             |
| 2       | system volt           | Receiver system voltage (V)        | Float  | 4            | H             |
| 3       | MINOS volt            | MINOS chip voltage (V)             | Float  | 4            | H+4           |
| 4       | L-band volt           | L-band voltage (V)                 | Float  | 4            | H+8           |
| 5       | L5 volt               | Receiver supply voltage (V)        | Float  | 4            | H+12          |
| 6       | Reserved              |                                    | Float  | 4            | H+16          |
| 7       |                       |                                    | Float  | 4            | H+20          |
| 8       |                       |                                    | Float  | 4            | H+24          |
| 9       |                       |                                    | Float  | 4            | H+28          |
| 10      |                       |                                    | Float  | 4            | H+32          |
| 11      |                       |                                    | Float  | 4            | H+36          |
| 12      | xxxx                  | 32-bit CRC (ASCII and Binary only) | Hex    | 4            | H+40          |
| 13      | [CR][LF]              | Sentence terminator (ASCII only)   | -      | -            | -             |

### 3.3.19 GLMLA NMEA GLONASS Almanac Data VIG23\_G

This log outputs almanac data for GLONASS satellites. Multiple sentences are transmitted, one for each satellite.

---

☒ GLONASS satellites:

GLO PRN#<sub>NovAtel</sub> = GLO PRN#<sub>NMEA</sub> - 24

Slot#<sub>To match NovAtel format logs  
or GLONASS status Web site</sub> = GLO PRN#<sub>NMEA</sub> -24 -37

---

**Message ID:** 859

**Log Type:** Asynch

**Recommended Input:**

log glmlaa unchanged

**ASCII Example:**

```
$GLMLA,16,01,65,1176,07,0496,4c,5ff2,8000,34c05e,0e93e8,04b029,001fa2,099,213*68
$GLMLA,16,02,66,1176,01,12e3,4c,42cc,8000,34c08e,10fae9,02f48c,00224e,099,003*64
$GLMLA,16,03,67,1176,8c,08f6,4a,ef4d,8000,34c051,13897b,00d063,001b09,099,000*63
$GLMLA,16,04,68,1176,06,116b,48,3a00,8000,34c09d,02151f,0e49e8,00226e,099,222*63
$GLMLA,16,05,70,1176,01,140f,49,45c4,8000,34c0bc,076637,0a3e40,002214,099,036*37
$GLMLA,16,06,71,1176,05,0306,4c,5133,8000,34c025,09bda7,085d84,001f83,099,21d*6E
$GLMLA,16,07,72,1176,06,01b1,4c,4c19,8000,34c021,0c35a0,067db8,001fca,099,047*3D
$GLMLA,16,08,74,1176,84,076b,45,7995,8000,34c07b,104b6d,0e1557,002a38,099,040*35
$GLMLA,16,09,78,1176,84,066c,46,78cf,8000,34c07b,0663f0,1a6239,0029df,099,030*38
$GLMLA,16,10,79,1176,80,0afc,45,8506,8000,34c057,08de48,1c44ca,0029d7,099,000*6B
$GLMLA,16,11,82,1176,8a,12d3,0f,e75d,8000,34be85,10aea6,1781b7,00235a,099,207*6E
$GLMLA,16,12,83,1176,03,0866,0f,6c08,8000,34c009,11f32e,18839d,002b22,099,214*36
$GLMLA,16,13,85,1176,88,01a6,0d,9dc9,8000,34bff8,031887,02dale,002838,099,242*6D
$GLMLA,16,14,86,1176,8a,00e1,0e,4b15,8000,34c016,058181,010433,0027f0,099,227*6F
$GLMLA,16,15,87,1176,03,0383,0f,824c,8000,34bfda,081864,1104ea,002b04,099,00c*60
$GLMLA,16,16,88,1176,02,0821,0f,8ac8,8000,34c05b,0a8510,12dcb6,002b6f,099,020*3F
```

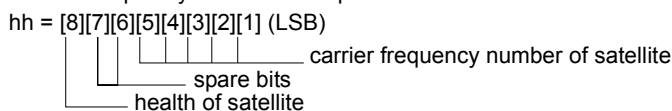


Refer to the GLONASS section of the *GNSS Reference Book*, available on our Web site at <http://www.novatel.ca/support/docupdates.htm>.

---

| Field | Structure          | Field Description  | Symbol | Example  |
|-------|--------------------|--|--------|----------|
| 1     | \$GLMLA            | Log header   |        | \$GLMLA  |
| 2     | #alm               | Number of NMEA almanac messages in the set   | x.x    | 16       |
| 3     | alm#               | Current message number   | x.x    | 13       |
| 4     | slot               | Slot number for satellite (65-96) <sup>a</sup>                                       | xx     | 85       |
| 5     | N                  | Calendar day count within the four year period from the last leap year               | x.x    | 1176     |
| 6     | hlth & freq        | Health and frequency for satellite <sup>b</sup>                                      | hh     | 88       |
| 7     | ecc                | Eccentricity <sup>c</sup>  | hhhh   | 01a6     |
| 8     | ΔTdot              | Rate of change of orbital period (s/orbital period <sup>2</sup> ) <sup>c</sup>       | hh     | 0d       |
| 9     | ω                  | Argument of perigee (PZ-90.02), in radians <sup>c</sup>                              | hhhh   | 9dc9     |
| 10    | τ <sub>16MSB</sub> | Clock offset, in seconds <sup>c</sup>  | hhhh   | 8000     |
| 11    | ΔT                 | Correction to the mean value of the Draconian period (s/orbital period) <sup>c</sup> | hhhhh  | 34bff8   |
| 12    | tλ                 | GLONASS Time of ascending node equator crossing, in seconds <sup>c</sup>             | hhhhhh | 031887   |
| 13    | λ                  | Longitude of ascending node equator crossing (PZ-90.02), in radians <sup>c</sup>     | hhhhhh | 02da1e   |
| 14    | Δi                 | Correction to nominal inclination, in radians <sup>c</sup>                           | hhhhhh | 002838   |
| 15    | τ <sub>12LSB</sub> | Clock offset, in seconds <sup>c</sup>  | hhh    | 099      |
| 16    | t                  | Course value of the time scale shift <sup>c</sup>                                    | hhh    | 242      |
| 17    | xxxx               | 32-bit CRC (ASCII and Binary only)   | Hex    | *6D      |
| 18    | [CR][LF]           | Sentence terminator (ASCII only)   | -      | [CR][LF] |

- a. The NMEA GLONASS PRN numbers are 64 plus the GLONASS slot number. Current slot numbers are 1 to 24 which give the range 65 to 88. PRN numbers 89 to 96 are available if slot numbers above 24 are allocated to on-orbit spares.
- b. Health and carrier frequency number are represented in this 2-character Hex field as:



- c. The LSB of the Hex data field corresponds to the LSB of the word indicated in the Table 4.3 of the GLONASS Interface Control Document, 1995. If the number of available bits in the Hex field is greater than the word, the MSB (upper bits) are unused and filled with zeroes.

### 3.3.20 GLOALMANAC Decoded Almanac VIG23\_G

The GLONASS almanac reference time and week are in GPS time coordinates. GLONASS ephemeris information is available through the GLMLA log.

Nominal orbit parameters of the GLONASS satellites are as follows:

- Draconian period - 11 hours 15 minutes 44 seconds (see fields 14 and 15 on *page 294*)
- Orbit altitude - 19100 km
- Inclination - 64.8 (see field 11)
- Eccentricity - 0 (see field 12)

**Message ID:** 718

**Log Type:** Asynch

#### Recommended Input:

log gloalmanaca onchanged

#### ASCII Example:

```
#GLOALMANACA, COM1, 0, 52.5, SATTIME, 1364, 410744.000, 00000000, ba83, 2310;
24,
1364, 336832.625, 1, 2, 0, 0, 2018.625000000, -2.775537500, 0.028834045, 0.001000404,
2.355427500, -2656.076171875, 0.000000000, 0.000091553,
1364, 341828.437, 2, 1, 0, 0, 7014.437500000, -3.122226146, 0.030814438, 0.004598618,
1.650371580, -2656.160156250, 0.000061035, 0.000095367,
1364, 347002.500, 3, 12, 0, 0, 12188.500000000, 2.747629236, 0.025376596, 0.002099991,
-2.659059822, -2656.076171875, -0.000061035, -0.000198364,
1364, 351887.125, 4, 6, 0, 0, 17073.125000000, 2.427596502, 0.030895332, 0.004215240,
1.438586358, -2656.167968750, -0.000061035, 0.000007629,
.
.
.
1364, 364031.187, 23, 11, 0, 1, 29217.187500000, 0.564055522, 0.030242192,
0.001178741, 2.505278248, -2655.957031250, 0.000366211, 0.000019073,
1364, 334814.000, 24, 3, 0, 1, 0.000000000, 0.000000000, 0.000000000, 0.000000000,
0.000000000, 0.000000000, 0.000000000, 0.000000000*4dc981c7
```



Refer to the GLONASS section of the *GNSS Reference Book*, available on our Web site at <http://www.novatel.ca/support/docupdates.htm>.

| Field #  | Field type                                 | Data Description  | Format | Binary Bytes | Binary Offset        |
|----------|--|---|--------|--------------|----------------------|
| 1        | GLOALMANAC header                          | Log header  |        | H            | 0                    |
| 2        | #recs                                      | The number of GLONASS almanac records to follow. Set to zero until almanac data is available. | Long   | 4            | H                    |
| 3        | week                                       | GPS Week, in weeks  | Ulong  | 4            | H+4                  |
| 4        | time                                       | GPS Time, in milliseconds (binary data) or seconds (ASCII data)                               | Ulong  | 4            | H+8                  |
| 5        | slot                                       | Slot number for satellite, ordinal  | Uchar  | 1            | H+12                 |
| 6        | frequency                                  | Frequency for satellite, ordinal (frequency channels are in the range -7 to +13)              | Char   | 1            | H+13                 |
| 7        | sat type                                   | Satellite type where<br>0 = GLO_SAT<br>1 = GLO_SAT_M (new M type)                             | Uchar  | 1            | H+14                 |
| 8        | health                                     | Almanac health where<br>0 = GOOD<br>1 = BAD   | Uchar  | 1            | H+15                 |
| 9        | TlambdaN                                   | GLONASS Time of ascending node equator crossing, in seconds                                   | Double | 8            | H+16                 |
| 10       | lambdaN                                    | Longitude of ascending node equator crossing (PZ-90.02), in radians                           | Double | 8            | H+24                 |
| 11       | deltaI                                     | Correction to nominal inclination, in radians   | Double | 8            | H+32                 |
| 12       | ecc  | Eccentricity  | Double | 8            | H+40                 |
| 13       | ArgPerig                                   | Argument of perigee (PZ-90.02), in radians  | Double | 8            | H+48                 |
| 14       | deltaT                                     | Correction to the mean value of the Draconian period (s/orbital period)                       | Double | 8            | H+56                 |
| 15       | deltaTD                                    | Rate of change of orbital period (s/orbital period <sup>2</sup> )                             | Double | 8            | H+64                 |
| 16       | tau  | Clock offset, in seconds  | Double | 8            | H+72                 |
| 17...    | Next message offset = H + 4 + (#recs x 76) |   |        |              |                      |
| variable | xxxx                                       | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H + 4 + (76 x #recs) |
| variable | [CR][LF]                                   | Sentence terminator (ASCII only)  | -      | -            | -                    |

### 3.3.21 GLOCLOCK GLONASS Clock Information VIG23\_G

This log contains the time difference information between GPS and GLONASS time as well as status flags. The status flags are used to indicate the type of time processing used in the least squares adjustment. GPS and GLONASS time are both based on the Universal Time Coordinated (UTC) time scale with some adjustments. GPS time is continuous and does not include any of the leap second adjustments to UTC applied since 1980. The result is that GPS time currently leads UTC time by 14 seconds.

GLONASS time applies leap seconds but is also three hours ahead to represent Moscow time. The nominal offset between GPS and GLONASS time is therefore due to the three hour offset minus the leap second offset. Currently this value is at 10787 seconds with GLONASS leading. As well as the nominal offset, there is a residual offset on the order of nanoseconds which must be estimated in the least squares adjustment. The GLONASS-M satellites broadcasts this difference in the navigation message.

This log also contains information from the GLONASS navigation data relating GLONASS time to UTC.

**Message ID:** 719

**Log Type:** Asynch

#### Recommended Input:

log gloclocka onchanged

#### ASCII Example:

```
#GLOCLOCKA,COM1,0,54.5,SATTIME,1364,411884.000,00000000,1d44,2310;
0,0.000000000,0.000000000,0,0,-0.000000275,792,-0.000001207,
0.000000000,0.000000000,0*437e9afaf
```



Refer to the GLONASS section of the *GNSS Reference Book*, available on our Web site at <http://www.novatel.ca/support/docupdates.htm>.

| Field # | Field type       | Data Description   | Format | Binary Bytes   | Binary Offset     |
|---------|------------------|--|--------|----------------|-------------------|
| 1       | GLOCKLOCK header | Log header   |        | H              | 0                 |
| 2       | Reserved         |  | Ulong  | 4              | H                 |
| 3       |                  |  | Double | 8              | H+4               |
| 4       |                  |  | Double | 8              | H+12              |
| 5       | sat type         | Satellite type where<br>0 = GLO_SAT<br>1 = GLO_SAT_M (new M type)  | Uchar  | 1              | H+20              |
| 6       | N <sup>4</sup>   | Four-year interval number starting from 1996   | Uchar  | 1 <sup>a</sup> | H+21 <sup>a</sup> |
| 7       | $\tau_{GPS}$     | GPS time scale correction to UTC(SU) given at beginning of day N <sup>4</sup> , in seconds                       | Double | 8              | H+24              |
| 8       | N <sup>A</sup>   | GLONASS calendar day number within a four year period beginning since the leap year, in days                     | Ushort | 2 <sup>a</sup> | H+32 <sup>a</sup> |
| 9       | $\tau_C$         | GLONASS time scale correction to UTC time, in seconds  | Double | 8              | H+36              |
| 10      | b1               | Beta parameter 1st order term  | Double | 8              | H+44              |
| 11      | b2               | Beta parameter 2nd order term  | Double | 8              | H+52              |
| 12      | Kp               | The Kp scale summarizes the global level of geomagnetic activity. A Kp of 0 to 4 is below storm levels (5 to 9). | Uchar  | 1              | H+60              |
| 13      | xxxx             | 32-bit CRC (ASCII and Binary only)   | Hex    | 4              | H+61              |
| 14      | [CR][LF]         | Sentence terminator (ASCII only)   | -      | -              | -                 |

a. In the binary log case, an additional bytes of padding are added to maintain 4-byte alignment



### 3.3.22 GLOEPHEMERIS GLONASS Ephemeris Data VIG23\_G

GLONASS ephemeris information is available through the GLOEPHEMERIS log. GLONASS ephemerides are referenced to the PZ90.02 geodetic datum. No adjustment between the GPS and GLONASS reference frames are made for positioning.

- 
- ☒ GLONASS measurements can be used for post-processed positioning solutions or in user-designed programs. NovAtel plans to offer GLONASS positioning in the future. In the meantime, OEMV-based output is compatible with post-processing software from the Waypoint Products Group, NovAtel Inc. See also [www.novatel.com](http://www.novatel.com) for details.
- 

**Message ID:** 723  
**Log Type:** Asynch

#### Recommended Input:

log gloephemerisa onchanged

#### Example:

```
#GLOEPHEMERISA, COM1, 3, 49.0, SATTIME, 1364, 413624.000, 00000000, 6b64, 2310;
43, 8, 1, 0, 1364, 413114000, 10786, 792, 0, 0, 87, 0, 9.0260864257812500e+06,
-6.1145468750000000e+06, 2.2926090820312500e+07, 1.4208841323852539e+03,
2.8421249389648438e+03, 1.9398689270019531e+02, 0.0000000000000000,
-2.79396772384643555e-06, -2.79396772384643555e-06, 2.12404876947402954e-04,
-1.396983862e-08, -3.63797880709171295e-12, 78810, 3, 15, 0, 12*a02ce18b
#GLOEPHEMERISA, COM1, 2, 49.0, SATTIME, 1364, 413626.000, 00000000, 6b64, 2310;
44, 11, 1, 0, 1364, 413116000, 10784, 792, 0, 0, 87, 13, -1.2882617187500000e+06,
-1.9318657714843750e+07, 1.6598909179687500e+07, 9.5813846588134766e+02,
2.0675134658813477e+03, 2.4769935607910156e+03, 2.79396772384643555e-06,
-3.72529029846191406e-06, -1.86264514923095703e-06, 6.48368149995803833e-05,
-4.656612873e-09, 3.63797880709171295e-12, 78810, 3, 15, 3, 28*e2d5ef15
#GLOEPHEMERISA, COM1, 1, 49.0, SATTIME, 1364, 413624.000, 00000000, 6b64, 2310;
45, 13, 0, 0, 1364, 413114000, 10786, 0, 0, 0, 87, 0, -1.1672664062500000e+07,
-2.2678505371093750e+07, 4.8702343750000000e+05, -1.1733341217041016e+02,
1.3844585418701172e+02, 3.5714883804321289e+03, 2.79396772384643555e-06,
-2.79396772384643555e-06, 0.0000000000000000, -4.53162938356399536e-05,
5.587935448e-09, -2.36468622460961342e-11, 78810, 0, 0, 0, 8*c15abfeb
#GLOEPHEMERISA, COM1, 0, 49.0, SATTIME, 1364, 413624.000, 00000000, 6b64, 2310;
59, 17, 0, 0, 1364, 413114000, 10786, 0, 0, 0, 87, 0, -2.3824853515625000e+05,
-1.6590188964843750e+07, 1.9363733398437500e+07, 1.3517074584960938e+03,
-2.2859592437744141e+03, -1.9414072036743164e+03, 1.86264514923095703e-06,
-3.72529029846191406e-06, -1.86264514923095703e-06, 7.92574137449264526e-05,
4.656612873e-09, 2.72848410531878471e-12, 78810, 0, 0, 0, 12*ed7675f5
```



Refer to the GLONASS section of the *GNSS Reference Book*, available on our Web site at <http://www.novatel.ca/support/docupdates.htm>.

**Table 58: GLONASS Ephemeris Flags Coding**

| N 0 | ←<br>← | Nibble Number |   |     |  |                               |          |
|-----|--------|---------------|---|-----|--|-------------------------------|----------|
| 4   | 3      | 2             | 1 | 0   | Bit  |                               |          |
|     |        |               |   | 1   | P1 FLAG - TIME INTERVAL BETWEEN ADJACENT ISSUE (N) VALUES                          | See Table below<br>(Table 59) | 00000001 |
|     |        |               |   | = 0 |  |                               |          |
|     |        |               |   | 1   |  |                               | 00000002 |
|     |        |               |   | 2   | P2 FLAG - ODDNESS OR EVENNESS OF ISSUE (N) VALUE                                   | 0 = even, 1 = odd             | 00000004 |
|     |        |               |   | 3   | P3 FLAG - NUMBER OF SATELLITES WITH ALMANAC INFORMATION<br>WITHIN CURRENT SUBFRAME | 0 = four, 1 = five            | 00000008 |
|     |        |               |   | 4   |  |                               |          |
|     |        |               |   | :   | RESERVED (N-1 through N-7)   |                               |          |
|     |        |               |   | 31  |  |                               |          |

**Table 59: Bits 0 - 1: P1 Flag Range Values**

| State | Description |
|-------|-------------|
| 00    | 0 minutes   |
| 01    | 30 minutes  |
| 10    | 45 minutes  |
| 11    | 60 minutes  |

| Field# | Field type           | Data Description  | Format | Binary Bytes | Binary Offset |
|--------|----------------------|---|--------|--------------|---------------|
| 1      | GLO-EPHEMERIS header | Log header  |        | H            | 0             |
| 2      | slot0                | Slot information offset - PRN identification (Slot + 37). This is also called SLOTO in CDU  | Ushort | 2            | H             |
| 3      | freq0                | Frequency channel offset for satellite in the range 0 to 20   | Ushort | 2            | H+2           |
| 4      | sat type             | Satellite type where<br>0 = GLO_SAT<br>1 = GLO_SAT_M (new M type)   | Uchar  | 1            | H+4           |
| 5      | Reserved             |   |        | 1            | H+5           |
| 6      | e week               | Reference week of ephemeris (GPS time)  | Ushort | 2            | H+6           |
| 7      | e time               | Reference time of ephemeris (GPS time) in ms  | Ulong  | 4            | H+8           |
| 8      | t offset             | Integer seconds between GPS and GLONASS time. A positive value implies GLONASS is ahead of GPS time.  | Ulong  | 4            | H+12          |
| 9      | Nt                   | Current data number. This field is only output for the new M type satellites. See example output from both satellite types (field 4) on page 297. | Ushort | 2            | H+16          |
| 10     | Reserved             |   |        | 1            | H+18          |
| 11     |                      |   |        | 1            | H+19          |
| 12     | issue                | 15-minute interval number corresponding to ephemeris reference time   | Ulong  | 4            | H+20          |
| 13     | health               | Ephemeris health where<br>0 = GOOD<br>1 = BAD   | Ulong  | 4            | H+24          |
| 14     | pos x                | X coordinate for satellite at reference time (PZ-90.02), in meters  | Double | 8            | H+28          |
| 15     | pos y                | Y coordinate for satellite at reference time (PZ-90.02), in meters  | Double | 8            | H+36          |
| 16     | pos z                | Z coordinate for satellite at reference time (PZ-90.02), in meters  | Double | 8            | H+44          |
| 17     | vel x                | X coordinate for satellite velocity at reference time (PZ-90.02), in meters/s   | Double | 8            | H+52          |
| 18     | vel y                | Y coordinate for satellite velocity at reference time (PZ-90.02), in meters/s   | Double | 8            | H+60          |

Continued on page 300.

| Field# | Field type  | Data Description   | Format | Binary Bytes | Binary Offset |
|--------|-------------|--|--------|--------------|---------------|
| 19     | vel z       | Z coordinate for satellite velocity at reference time (PZ-90.02), in meters/s  | Double | 8            | H+68          |
| 20     | LS acc x    | X coordinate for lunisolar acceleration at reference time (PZ-90.02), in meters/s/s  | Double | 8            | H+76          |
| 21     | LS acc y    | Y coordinate for lunisolar acceleration at reference time (PZ-90.02), in meters/s/s  | Double | 8            | H+84          |
| 22     | LS acc z    | Z coordinate for lunisolar acceleration at reference time (PZ-90.02), in meters/s/s  | Double | 8            | H+92          |
| 23     | tau_n       | Correction to the nth satellite time t_n relative to GLONASS time t_c, in seconds  | Double | 8            | H+100         |
| 24     | delta_tau_n | Time difference between navigation RF signal transmitted in L2 sub-band and navigation RF signal transmitted in L1 sub-band by nth satellite, in seconds | Double | 8            | H+108         |
| 25     | gamma       | Frequency correction, in seconds/second  | Double | 8            | H+116         |
| 26     | Tk          | Time of frame start (since start of GLONASS day), in seconds   | Ulong  | 4            | H+124         |
| 27     | P           | Technological parameter  | Ulong  | 4            | H+128         |
| 28     | Ft          | User range   | Ulong  | 4            | H+132         |
| 29     | age         | Age of data, in days   | Ulong  | 4            | H+136         |
| 30     | Flags       | Information flags, see <i>Table 58, GLONASS Ephemeris Flags Coding on page 298</i>   | Ulong  | 4            | H+140         |
| 31     | xxxx        | 32-bit CRC (ASCII and Binary only)   | Hex    | 4            | H+144         |
| 32     | [CR][LF]    | Sentence terminator (ASCII only)   | -      | -            | -             |

### 3.3.23 GLORAWALM Raw GLONASS Almanac Data VIG23\_G

This log contains the undecoded almanac subframes as received from the GLONASS satellite.

**Message ID:** 720  
**Log Type:** Asynch

**Recommended Input:**

log glorawalma onchanged

**Example:**

```
#GLORAWALMA, COM1, 0, 44.5, SATTIME, 1364, 419924.000, 00000000, 77bb, 2310;
1364, 419954.069, 54,
0563100000a4000000006f, 0,
0681063c457a12cc0419be, 0,
075ff807e2a69804e0040b, 0,
0882067fcd80141692d6f2, 0,
09433e1b6676980a40429b, 0,
0a838d1bfcb4108b089a8c, 0,
0bec572f9c869804f05882, 0,
.
.
.
06950201e02e13d3819564, 0,
07939a4a16fe97fe814ad0, 0,
08960561cecc13b0014613, 0,
09469a5d70c69802819466, 0,
0a170165bed413b704d416, 0,
0b661372213697fd41965a, 0,
0c18000000000000000006, 0,
0d000000000000000000652, 0,
0e000000000000000000d0, 0*b516623b
```



Refer to the GLONASS section of the *GNSS Reference Book*, available on our Web site at <http://www.novatel.ca/support/docupdates.htm>.

| Field#   | Field type  | Data Description  | Format                           | Binary Bytes | Binary Offset                      |
|----------|---|---|----------------------------------|--------------|------------------------------------|
| 1        | GLORAWALM header  | Log header  |                                  | H            | 0                                  |
| 2        | week  | GPS Week, in weeks  | Ulong                            | 4            | H                                  |
| 3        | time  | GPS Time, in milliseconds (binary data) or seconds (ASCII data) | Ulong                            | 4            | H+4                                |
| 4        | #recs   | Number of records to follow.                                    | Ulong                            | 4            | H+8                                |
| 5        | string  | GLONASS data string   | Uchar [string size] <sup>a</sup> | variable     | H+12                               |
| 6        | Reserved  |   | Uchar                            | 1            | variable                           |
| 7...     | Next record offset = H + 16 + (#recs x [string size + 1]) |   |                                  |              |                                    |
| variable | xxxx  | 32-bit CRC (ASCII and Binary only)                              | Hex                              | 4            | H + 12 + (#recs x [string size+1]) |
| variable | [CR][LF]  | Sentence terminator (ASCII only)                                | -                                | -            | -                                  |

a. In the binary log case, additional bytes of padding are added to maintain 4-byte alignment.

### 3.3.24 GLORAWEPHEM Raw GLONASS Ephemeris Data V1G23\_G

This log contains the raw ephemeris frame data as received from the GLONASS satellite.

**Message ID:** 792

**Log Type:** Asynch

**Recommended Input:**

log glorawephema onchanged

**Example:**

```
#GLORAWEPHEMA, COM1, 3, 47.0, SATTIME, 1340, 398653.000, 00000000, 332d, 2020;  
38, 9, 0, 1340, 398653.080, 4,  
0148d88460fc115dbdaf78, 0, 0218e0033667aec83af2a5, 0,  
038000b9031e14439c75ee, 0, 0404f226600000000000065, 0*17f3dd17  
...  
#GLORAWEPHEMA, COM1, 0, 47.0, SATTIME, 1340, 398653.000, 00000000, 332d, 2020;  
41, 13, 0, 1340, 398653.078, 4,  
0108d812532805bfa1cd2c, 0, 0208e0a36e8e0952b111da, 0,  
03c02023b68c9a32410958, 0, 0401fda440000000000002a, 0*0b237405
```



Refer to the GLONASS section of the *GNSS Reference Book*, available on our Web site at <http://www.novatel.ca/support/docupdates.htm>.

| Field#   | Field type  | Data Description  | Format                           | Binary Bytes | Binary Offset                      |
|----------|---|---|----------------------------------|--------------|------------------------------------|
| 1        | GLORAWEPHEM header  | Log header  |                                  | H            | 0                                  |
| 2        | sloto   | Slot information offset - PRN identification (Slot + 37). Ephemeris relates to this slot and is also called SLOTO in CDU. | Ushort                           | 2            | H                                  |
| 3        | freqo   | Frequency channel offset in the range 0 to 20   | Ushort                           | 2            | H+2                                |
| 4        | sigchan   | Signal channel number   | Ulong                            | 4            | H+4                                |
| 5        | week  | GPS Week, in weeks  | Ulong                            | 4            | 8                                  |
| 6        | time  | GPS Time, in milliseconds (binary data) or seconds (ASCII data)   | Ulong                            | 4            | 12                                 |
| 7        | #recs   | Number of records to follow   | Ulong                            | 4            | H+16                               |
| 8        | string  | GLONASS data string   | Uchar [string size] <sup>a</sup> | variable     | H+20                               |
| 9        | Reserved  |   | Uchar                            | 1            | variable                           |
| 10...    | Next record offset = H + 20 + (#recs x [string size + 1]) |   |                                  |              |                                    |
| variable | xxxx  | 32-bit CRC (ASCII and Binary only)  | Hex                              | 4            | H + 20 + (#recs x [string size+1]) |
| variable | [CR][LF]  | Sentence terminator (ASCII only)  | -                                | -            | -                                  |

a. In the binary log case, additional bytes of padding are added to maintain 4-byte alignment.



### 3.3.25 GLORAWFRAME Raw GLONASS Frame Data V1G23\_G

This log contains the raw GLONASS frame data as received from the GLONASS satellite.

**Message ID:** 721  
**Log Type:** Asynch

**Recommended Input:**

log glorawframea onchanged

**Example:**

```
#GLORAWFRAMEA, COM1, 19, 53.0, SATTIME, 1340, 398773.000, 00000000, 8792, 2020;  
3, 39, 8, 1340, 398773.067, 44, 44, 15,  
0148dc0b67e9184664cb35, 0,  
0218e09dc8a3ae8c6ba18d, 0,  
...  
0f0000000000000000000000, 0*11169f9e  
...  
#GLORAWFRAMEA, COM1, 0, 53.0, SATTIME, 1340, 398713.000, 00000000, 8792, 2020;  
1, 41, 13, 1340, 398713.077, 36, 36, 15,  
0108da12532805bfa1cdd, 0,  
0208e0a36e8e0952b111da, 0,  
03c02023b68c9a32410958, 0,  
...  
0f6efb59474697fd72c4e2, 0*0a6267c8
```



Refer to the GLONASS section of the *GNSS Reference Book*, available on our Web site at <http://www.novatel.ca/support/docupdates.htm>.

| Field#   | Field type  | Data Description  | Format                           | Binary Bytes | Binary Offset                      |
|----------|---|---|----------------------------------|--------------|------------------------------------|
| 1        | GLORAWFRAME header  | Log header  |                                  | H            | 0                                  |
| 2        | frame#  | Frame number  | Ulong                            | 2            | H                                  |
| 3        | sloto   | Slot information offset - PRN identification (Slot + 37). Ephemeris relates to this slot and is also called SLOTO in CDU. | Ushort                           | 2            | H+2                                |
| 4        | freqo   | Frequency channel offset in the range 0 to 20   | Ushort                           | 2            | H+4                                |
| 5        | week  | GPS Week, in weeks  | Ulong                            | 4            | H+6                                |
| 6        | time  | GPS Time, in milliseconds (binary data) or seconds (ASCII data)   | Ulong                            | 4            | H+10                               |
| 7        | frame decode  | Frame decoder number  | Ulong                            | 4            | H+14                               |
| 8        | sigchan   | Signal channel number   | Ulong                            | 4            | H+18                               |
| 9        | #recs   | Number of records to follow   | Ulong                            | 4            | H+22                               |
| 10       | string  | GLONASS data string   | Uchar [string size] <sup>a</sup> | variable     | H+26                               |
| 11       | Reserved  |   | Uchar                            | 1            | variable                           |
| 12...    | Next record offset = H + 26 + (#recs x [string size + 1]) |   |                                  |              |                                    |
| variable | xxxx  | 32-bit CRC (ASCII and Binary only)  | Hex                              | 4            | H + 26 + (#recs x [string size+1]) |
| variable | [CR][LF]  | Sentence terminator (ASCII only)  | -                                | -            | -                                  |

a. In the binary log case, additional bytes of padding are added to maintain 4-byte alignment.

### 3.3.26 GLORAWSTRING Raw GLONASS String VIG23\_G

This log contains the raw string data as received from the GLONASS satellite.

**Message ID:** 722

**Log Type:** Asynch

**Recommended Input:**

log glorawstringa onchanged

**Example:**

```
#GLORAWSTRINGA, COM1, 0, 51.0, SATTIME, 1340, 399113.000, 00000000, 50ac, 2020;
4, 6, 061000000000000000000004f, 0*5b215fb2
```



Refer to the GLONASS section of the *GNSS Reference Book*, available on our Web site at <http://www.novatel.ca/support/docupdates.htm>.

| Field# | Field type          | Data Description  | Format                           | Binary Bytes | Binary Offset           |
|--------|---------------------|---|----------------------------------|--------------|-------------------------|
| 1      | GLORAWSTRING header | Log header  |                                  | H            | 0                       |
| 2      | slot                | Slot identification   | Uchar                            | 2            | H                       |
| 3      | freq                | Frequency channel (frequency channels are in the range -7 to +13) | Char                             | 2            | H+2                     |
| 4      | string              | GLONASS data string   | Uchar [string size] <sup>a</sup> | variable     | H+4                     |
| 5      | Reserved            |   | Uchar                            | 1            | variable                |
| 6      | xxxx                | 32-bit CRC (ASCII and Binary only)                                | Hex                              | 4            | (H +4 + string size +1) |
| 7      | [CR][LF]            | Sentence terminator (ASCII only)                                  | -                                | -            | -                       |

a. In the binary log case, additional bytes of padding are added to maintain 4-byte alignment.

### 3.3.27 GPALM Almanac Data V123\_NMEA

This log outputs raw almanac data for each satellite PRN contained in the broadcast message. A separate record is logged for each PRN, up to a maximum of 32 records. GPALM outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then UTC time is then set to VALID. It takes a minimum of 12.5 minutes to collect a complete almanac following receiver boot-up. If an almanac was stored in NVM, the stored values are reported in the GPALM log once time is set on the receiver.

- 
- ✉ To obtain copies of ICD-GPS-200, seen in the GPALM table footnotes, refer to ARINC in the *Standards and References* section of the *GNSS Reference Book*, available on our Web site. Refer also to NMEA contact information there.
- 

**Message ID:** 217  
**Log Type:** Asynch

#### Recommended Input:

log gpalm onchanged

#### Example:

```
$GPALM,28,01,01,1337,00,305a,90,1b9d,fd5b,a10ce9,ba0a5e,2f48f1,cccb76,006,001
*27
$GPALM,28,02,02,1337,00,4aa6,90,0720,fd50,a10c5a,4dc146,d89bab,0790b6,fe4,000
*70
.
.
.
$GPALM,28,24,26,1337,00,878c,90,1d32,fd5c,a10c90,1db6b6,2eb7f5,ce95c8,00d,000
*23
$GPALM,28,25,27,1337,00,9cde,90,07f2,fd54,a10da5,adc097,562da3,6488dd,00e,000
*2F
$GPALM,28,26,28,1337,00,5509,90,0b7c,fd59,a10cc4,a1d262,83e2c0,3003bd,02d,000
*78
$GPALM,28,27,29,1337,00,47f7,90,1b20,fd58,a10ce0,d40a0b,2d570e,221641,122,006
*7D
$GPALM,28,28,30,1337,00,4490,90,0112,fd4a,a10cc1,33d10a,81dfc5,3bdb0f,178,004
*28
```



Please see the GPGGA usage box that applies to all NMEA logs on [page 310](#).

---

| Field | Structure       | Field Description   | Symbol | Example  |
|-------|-----------------|---|--------|----------|
| 1     | \$GPALM         | Log header  |        | \$GPALM  |
| 2     | # msg           | Total number of messages logged. Set to zero until almanac data is available. | x.x    | 17       |
| 3     | msg #           | Current message number  | x.x    | 17       |
| 4     | PRN             | Satellite PRN number:<br>GPS = 1 to 32  | xx     | 28       |
| 5     | GPS wk          | GPS reference week number <sup>a</sup> .                                      | x.x    | 653      |
| 6     | SV hlth         | SV health, bits 17-24 of each almanac page <sup>b</sup>                       | hh     | 00       |
| 7     | ecc             | e, eccentricity <sup>c d</sup>  | hhhh   | 3EAF     |
| 8     | alm ref time    | toa, almanac reference time <sup>c</sup>                                      | hh     | 87       |
| 9     | incl angle      | (sigma) <sub>i</sub> , inclination angle <sup>c</sup>                         | hhhh   | OD68     |
| 10    | omegadot        | OMEGADOT, rate of right ascension <sup>c</sup>                                | hhhh   | FD30     |
| 11    | rt axis         | (A) <sup>1/2</sup> , root of semi-major axis <sup>c</sup>                     | hhhhh  | A10CAB   |
| 12    | omega           | omega, argument of perigee <sup>c e</sup>                                     | hhhhh  | 6EE732   |
| 13    | long asc node   | (OMEGA) <sub>o</sub> , longitude of ascension node <sup>c</sup>               | hhhhh  | 525880   |
| 14    | M <sub>o</sub>  | Mo, mean anomaly <sup>c</sup>   | hhhhh  | 6DC5A8   |
| 15    | af <sub>0</sub> | af <sub>0</sub> , clock parameter <sup>c</sup>                                | hhh    | 009      |
| 16    | af <sub>1</sub> | af <sub>1</sub> , clock parameter <sup>c</sup>                                | hhh    | 005      |
| 17    | *xx             | Checksum  | *hh    | *37      |
| 18    | [CR][LF]        | Sentence terminator   |        | [CR][LF] |

- a Variable length integer, 4-digits maximum from (2) most significant binary bits of Subframe 1, Word 3 reference Table 20-I, ICD-GPS-200, Rev. B, and (8) least significant bits from subframe 5, page 25, word 3 reference Table 20-I, ICD-GPS-200
- b Reference paragraph 20.3.3.5.1.3, Table 20-VII and Table 20-VIII, ICD-GPS-200, Rev. B
- c Reference Table 20-VI, ICD-GPS-200, Rev. B for scaling factors and units.
- d A quantity defined for a conic section where e = 0 is a circle, e = 1 is an ellipse, 0 < e < 1 is a parabola and e > 1 is a hyperbola.
- e A measurement along the orbital path from the ascending node to the point where the SV is closest to the Earth, in the direction of the SV's motion

### 3.3.28 GPGGA GPS Fix Data and Undulation V123\_NMEA

Time, position and fix-related data of the GPS receiver. For greater precision, but with the loss of the undulation fields, use the GPGGARTK log (see *page 312*). See also *Table 60, Position Precision of NMEA Logs on page 316*.

The GPSGGA log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

**Message ID:** 218  
**Log Type** Synch

#### Recommended Input:

log gpgga ontime 1

#### Example:

```
$GPGGA,134658.00,5106.9792,N,11402.3003,W,2,09,1.0,1048.47,M,-16.27,M,08,AAAA*60
```



The NMEA (National Marine Electronics Association) has defined standards that specify how electronic equipment for marine users communicate. GPS receivers are part of this standard and the NMEA has defined the format for several GPS data logs otherwise known as 'sentences'.

Each NMEA sentence begins with a '\$' followed by the prefix 'GP' followed by a sequence of letters that define the type of information contained in the sentence. Data contained within the sentence is separated by commas and the sentence is terminated with a two digit checksum followed by a carriage return/line feed. Here is an example of an NMEA sentence that describes time, position, and fix related data:

```
$GPGGA,134658.00,5106.9792,N,11402.3003,W,2,09,1.0,1048.47,M,-16.27,M,08,AAAA*60
```

The GPGGA sentence shown above, and other NMEA logs, are output the same no matter what GPS receiver is used, providing a standard way to communicate and process GPS information.

| Field | Structure  | Field Description   | Symbol    | Example   |
|-------|------------|---|-----------|---|
| 1     | \$GPGGA    | Log header  |           | \$GPGGA   |
| 2     | utc        | UTC time of position (hours/minutes/seconds/<br>decimal seconds)  | hhmmss.ss | 202134.00   |
| 3     | lat        | Latitude (DDmm.mm)  | llll.ll   | 5106.9847   |
| 4     | lat dir    | Latitude direction (N = North, S = South)   | a         | N   |
| 5     | lon        | Longitude (DDDmm.mm)  | yyyyy.yy  | 11402.2986  |
| 6     | lon dir    | Longitude direction (E = East, W = West)  | a         | W   |
| 7     | GPS qual   | GPS Quality indicator<br>0 = fix not available or invalid<br>1 = GPS fix<br>2 = C/A differential GPS, OmniSTAR HP,<br>OmniSTAR XP, OmniSTAR VBS,<br>or CDGPS<br>4 = RTK fixed ambiguity solution (RT2), see<br>also <i>Table 90</i> on <i>page 525</i><br>5 = RTK floating ambiguity solution (RT20),<br>OmniSTAR HP or OmniSTAR XP<br>6 = Dead reckoning mode<br>7 = Manual input mode (fixed position)<br>8 = Simulator mode<br>9 = WAAS <sup>a</sup> | x         | 1   |
| 8     | # sats     | Number of satellites in use. May be different to<br>the number in view  | xx        | 10  |
| 9     | hdop       | Horizontal dilution of precision  | x.x       | 1.0   |
| 10    | alt        | Antenna altitude above/below mean sea level   | x.x       | 1062.22   |
| 11    | a-units    | Units of antenna altitude (M = meters)  | M         | M   |
| 12    | undulation | Undulation - the relationship between the geoid<br>and the WGS84 ellipsoid  | x.x       | -16.271   |
| 13    | u-units    | Units of undulation (M = meters)  | M         | M   |
| 14    | age        | Age of Differential GPS data (in seconds) <sup>b</sup>  | xx        | <i>(empty when<br/>no differential<br/>data is present)</i> |
| 15    | stn ID     | Differential base station ID, 0000-<br>1023   | xxxx      | <i>(empty when<br/>no differential<br/>data is present)</i> |
| 16    | *xx        | Checksum  | *hh       | *48   |
| 17    | [CR][LF]   | Sentence terminator   |           | [CR][LF]  |

a. An indicator of 9 has been temporarily set for WAAS (NMEA standard for WAAS not decided yet).

b. The maximum age reported here is limited to 99 seconds.

### 3.3.29 GPGGALONG *Fix Data, Extra Precision and Undulation* V123\_NMEA

Time, position, undulation and fix-related data of the GPS receiver. This is output as a GPGGA log but the GPGGALONG log differs from the normal GPGGA log by its extra precision. See also *Table 60, Position Precision of NMEA Logs* on page 316.

The GPGGALONG log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

**Message ID:** 521  
**Log Type:** Synch

#### Recommended Input:

log gpggalong ontime 1

#### Example 1:

```
$GPGGA,181126.00,5106.9802863,N,11402.3037304,W,7,11,0.9,1048.234,M,
-16.27,M,,*51
```

#### Example 2:

```
$GPGGA,134658.00,5106.9802863,N,11402.3037304,W,2,09,1.0,1048.234,M,
-16.27,M,08,AAAA
```



Please see the GPGGA usage box that applies to all NMEA logs on page 310.



| Field | Structure    | Field Description   | Symbol    | Example   |
|-------|--------------|---|-----------|---|
| 1     | \$GPGGA-LoNG | Log header  |           | \$GPGGA   |
| 2     | utc          | UTC time of position (hours/minutes/seconds/decimal seconds)  | hhmmss.ss | 202126.00   |
| 3     | lat          | Latitude (DDmm.mm)  | llll.ll   | 5106.9847029                                      |
| 4     | lat dir      | Latitude direction (N = North, S = South)   | a         | N   |
| 5     | lon          | Longitude (DDDmm.mm)  | yyyyy.yy  | 11402.2986286                                     |
| 6     | lon dir      | Longitude direction (E = East, W = West)  | a         | W   |
| 7     | GPS qual     | GPS Quality indicator<br>0 = fix not available or invalid<br>1 = GPS fix<br>2 = C/A differential GPS, OmniSTAR HP, OmniSTAR XP, OmniSTAR VBS, or CDGPS<br>4 = RTK fixed ambiguity solution (RT2), see also <i>Table 90</i> on <i>page 525</i><br>5 = RTK floating ambiguity solution (RT20), OmniSTAR HP or OmniSTAR XP<br>6 = Dead reckoning mode<br>7 = Manual input mode (fixed position)<br>8 = Simulator mode<br>9 = WAAS <sup>a</sup> | x         | 1   |
| 8     | # sats       | Number of satellites in use (00-12). May be different to the number in view   | xx        | 10  |
| 9     | hdop         | Horizontal dilution of precision  | x.x       | 1.0   |
| 10    | alt          | Antenna altitude above/below msl  | x.x       | 1062.376  |
| 11    | units        | Units of antenna altitude (M = meters)  | M         | M   |
| 12    | undulation   | Undulation - the relationship between the geoid and the WGS84 ellipsoid   | x.x       | -16.271   |
| 13    | u-units      | Units of undulation (M = meters)  | M         | M   |
| 14    | age          | Age of Differential GPS data (in seconds) <sup>b</sup>  | xx        | 10 (empty when no differential data is present)   |
| 15    | stn ID       | Differential base station ID, 0000-1023   | xxxx      | AAAA (empty when no differential data is present) |
| 16    | *xx          | Checksum  | *hh       | *48   |
| 17    | [CR][LF]     | Sentence terminator   |           | [CR][LF]  |

a. An indicator of 9 has been temporarily set for WAAS (NMEA standard for WAAS is not decided yet).

b. The maximum age reported here is limited to 99 seconds.

### 3.3.30 GPGGARTK Global Position System Fix Data V123\_NMEA

Time, position and fix-related data of the GPS receiver. This is output as a GPGGA log but the GPGGARTK log differs from the normal GPGGA log by its extra precision. In order for the position to be output with this extra precision, the undulation fields are unavailable (see the GPGGA log on page 310). See also *Table 60, Position Precision of NMEA Logs* on page 316.

The GPGGARTK log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

**Message ID:** 259  
**Log Type:** Synch

#### Recommended Input:

**log gpggartk ontime 1**

#### Example:

```
$GPGGA,135324.00,5106.9791988,N,11402.3002127,W,2,09,1.0,1047.606,M,,04,AAAA  
*1C
```



The GPGGARTK log is ideal for RTK positioning applications where mm-level position precision is required.

See also the GPGGA usage box that applies to all NMEA logs on page 310.

| Field | Structure | Field Description   | Symbol    | Example   |
|-------|-----------|---|-----------|---|
| 1     | \$GPGGA   | Log header  |           | \$GPGGA   |
| 2     | utc       | UTC time of position (hours/minutes/seconds/<br>decimal seconds)  | hhmmss.ss | 220147.50   |
| 3     | lat       | Latitude (DDmm.mm)  | llll.ll   | 5106.7194489  |
| 4     | lat dir   | Latitude direction (N = North, S = South)   | a         | N   |
| 5     | lon       | Longitude (DDDmm.mm)  | yyyyy.yy  | 11402.358902<br>0   |
| 6     | lon dir   | Longitude direction (E = East, W = West)  | a         | W   |
| 7     | GPS qual  | GPS Quality indicator<br>0 = fix not available or invalid<br>1 = GPS fix<br>2 = C/A differential GPS, OmniSTAR HP,<br>OmniSTAR XP, OmniSTAR VBS,<br>or CDGPS<br>4 = RTK fixed ambiguity solution (RT2), see<br>also <i>Table 90</i> on <i>page 525</i><br>5 = RTK floating ambiguity solution (RT20),<br>OmniSTAR HP or OmniSTAR XP<br>6 = Dead reckoning mode<br>7 = Manual input mode (fixed position)<br>8 = Simulator mode<br>9 = WAAS <sup>a</sup> | x         | 1   |
| 8     | # sats    | Number of satellites in use. May be different to<br>the number in view  | xx        | 08  |
| 9     | hdop      | Horizontal dilution of precision  | x.x       | 0.9   |
| 10    | alt       | Antenna altitude above/below mean sea level   | x.x       | 1080.406  |
| 11    | units     | Units of antenna altitude (M = meters)  | M         | M   |
| 12    | null      | (This field not available on OEMV family<br>receivers)  |           | <i>(empty when<br/>no differential<br/>data is<br/>present)</i> |
| 13    | null      | (This field not available on OEMV family<br>receivers)  |           |   |
| 14    | age       | Age of Differential GPS data (in seconds) <sup>b</sup>  | xx        |   |
| 15    | stn ID    | Differential base station ID, 0000-1023   | xxxx      |   |
| 16    | *xx       | Checksum  | *hh       | *48   |
| 17    | [CR][LF]  | Sentence terminator   |           | [CR][LF]  |

- a. An indicator of 9 has been temporarily set for WAAS. The NMEA standard for WAAS has not been decided yet.
- b. The maximum age reported here is limited to 99 seconds.

### 3.3.31 GPGLL Geographic Position V123\_NMEA

Latitude and longitude of present vessel position, time of position fix, and status.

Table 60 compares the position precision of selected NMEA logs.

The GPGLL log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

- 
- ☒ If the NMEATALKER command, see *page 156*, is set to AUTO, the talker (the first 2 characters after the \$ sign in the log header) is set to GP (GPS satellites only), GL (GLONASS satellites only), or GN (satellites from both systems). NovAtel does not support a GLONASS-only solution.
- 

**Message ID:** 219  
**Log Type:** Synch

**Recommended Input:**

log gppll ontime 1

**Example 1 (GPS only):**

```
$GPGLL,5107.0013414,N,11402.3279144,W,205412.00,A,A*73
```

**Example 2 (Combined GPS and GLONASS):**

```
$GNGLL,5107.0014143,N,11402.3278489,W,205122.00,A,A*6E
```

**Table 60: Position Precision of NMEA Logs**

| NMEA Log  | Latitude (# of decimal places) | Longitude (# of decimal places) | Altitude (# of decimal places) |
|-----------|--------------------------------|---------------------------------|--------------------------------|
| GPGGA     | 4                              | 4                               | 2                              |
| GPGGALONG | 7                              | 7                               | 3                              |
| GPGGARTK  | 7                              | 7                               | 3                              |
| GPGLL     | 7                              | 7                               | N/A                            |
| GPRMC     | 7                              | 7                               | N/A                            |



Please see the GPGGA usage box that applies to all NMEA logs on *page 310*.

---

| Field | Structure   | Field Description   | Symbol    | Example       |
|-------|-------------|---|-----------|---------------|
| 1     | \$GPGLL     | Log header  |           | \$GPGLL       |
| 2     | lat         | Latitude (DDmm.mm)  | llll.ll   | 5106.7198674  |
| 3     | lat dir     | Latitude direction<br>(N = North, S = South)                          | a         | N             |
| 4     | lon         | Longitude (DDDmm.mm)  | yyyyy.yy  | 11402.3587526 |
| 5     | lon dir     | Longitude direction<br>(E = East, W = West)                           | a         | W             |
| 6     | utc         | UTC time of position (hours/minutes/<br>seconds/decimal seconds)      | hhmmss.ss | 220152.50     |
| 7     | data status | Data status:<br>A = Data valid, V = Data invalid                      | A         | A             |
| 8     | mode ind    | Positioning system mode indicator, see<br><i>Table 61 on page 327</i> | a         | A             |
| 9     | *xx         | Checksum  | *hh       | *1B           |
| 10    | [CR][LF]    | Sentence terminator   |           | [CR][LF]      |

### 3.3.32 GPGRS GPS Range Residuals for Each Satellite V123\_NMEA

Range residuals can be computed in two ways, and this log reports those residuals. Under mode 0, residuals output in this log are used to update the position solution output in the GPGLGA message. Under mode 1, the residuals are re-computed after the position solution in the GPGLGA message is computed. The receiver computes range residuals in mode 1. An integrity process using GPGRS would also require GPGLGA (for position fix data), GPGLSA (for DOP figures), and GPGLSV (for PRN numbers) for comparative purposes.

The GPGRS log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

- 
- ✉ 1. If the range residual exceeds  $\pm 99.9$ , then the decimal part is dropped. Maximum value for this field is  $\pm 999$ . The sign of the range residual is determined by the order of parameters used in the calculation as follows:

range residual = calculated range - measured range

2. If the NMEATALKER command, see *page 156*, is set to AUTO, the talker (the first 2 characters after the \$ sign in the log header) is set to GP (GPS satellites only), GL (GLONASS satellites only), or GN (satellites from both systems). NovAtel does not support a GLONASS-only solution.
  3. There is no residual information available from the OmniSTAR HP/XP service, so the GPGRS contains the pseudorange position values when using it. For the OmniSTAR VBS or CDGPS service, residual information is available.
- 

**Message ID:** 220

**Log Type:** Synch

**Recommended Input:**

log gpgrs ontime 1

**Example 1 (GPS only):**

```
$GPGRS,142406.00,1,-1.1,-0.1,1.7,1.2,-2.0,-0.5,1.2,-1.2,-0.1,,,*67
```

**Example 2 (Combined GPS and GLONASS):**

```
$GNGRS,143209.00,1,-0.2,-0.5,2.2,1.3,-2.0,-1.3,1.3,-0.4,-1.2,-0.2,,*72
```

```
$GNGRS,143209.00,1,1.3,-6.7,,,,,,,,,,*73
```



Please see the GPGLGA usage box that applies to all NMEA logs on *page 310*.

---

| Field  | Structure | Field Description   | Symbol        | Example  |
|--------|-----------|---|---------------|--|
| 1      | \$GPGRS   | Log header  |               | \$GPGRS  |
| 2      | utc       | UTC time of position (hours/minutes/seconds/ decimal seconds)   | hhmmss.ss     | 192911.0   |
| 3      | mode      | Mode 0 =residuals were used to calculate the position given in the matching GGA line (apriori) (not used by OEMV family receiver)<br>Mode 1 =residuals were recomputed after the GGA position was computed (preferred mode) | x             | 1  |
| 4 - 15 | res       | Range residuals for satellites used in the navigation solution. Order matches order of PRN numbers in GPGSA.  | x.x,x.x,..... | -13.8,-1.9,11.4,-33.6,0.9,6.9,-12.6,0.3,0.6, -22.3 |
| 16     | *xx       | Checksum  | *hh           | *65  |
| 17     | [CR][LF]  | Sentence terminator   |               | [CR][LF]   |

### 3.3.33 GPGSA GPS DOP and Active Satellites V123\_NMEA

GPS receiver operating mode, satellites used for navigation and DOP values.

The GPGSA log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

- 
- ☒ 1. If the DOP values exceed 9999.0, or there is an insufficient number of satellites to calculate a DOP value, 9999.0 is reported for PDOP and HDOP. VDOP is reported as 0.0 in this case.
  - 2. If the NMEATALKER command, see *page 156*, is set to AUTO, the talker (the first 2 characters after the \$ sign in the log header) is set to GP (GPS satellites only), GL (GLONASS satellites only), or GN (satellites from both systems). NovAtel does not support a GLONASS-only solution.
- 

**Message ID:** 221

**Log Type:** Synch

**Recommended Input:**

log gpgsa ontime 1

**Example 1 (GPS only):**

```
$GPGSA,M,3,17,02,30,04,05,10,09,06,31,12,,,1.2,0.8,0.9*35
```

**Example 2 (Combined GPS and GLONASS):**

```
$GNGSA,M,3,17,02,30,04,05,10,09,06,31,12,,,1.2,0.8,0.9*2B
$GNGSA,M,3,87,70,,,,,,,,,1.2,0.8,0.9*2A
```



The DOPs provide a simple characterization of the user-satellite geometry. DOP is related to the volume formed by the intersection points of the user-satellite vectors, with the unit sphere centered on the user. Larger volumes give smaller DOPs. Lower DOP values generally represent better position accuracy. The role of DOP in GPS positioning, however, is often misunderstood. A lower DOP value does not automatically mean a low position error. The quality of a GPS-derived position estimate depends upon both the measurement geometry as represented by DOP values, and range errors caused by signal strength, ionospheric effects, multipath and so on.

Please see also the GPGGA usage box that applies to all NMEA logs on *page 310*.

---



| Field  | Structure | Field Description  | Symbol      | Example                                 |
|--------|-----------|--|-------------|---|
| 1      | \$GPGSA   | Log header   |             | \$GPGSA                                 |
| 2      | mode MA   | A = Automatic 2D/3D<br>M = Manual, forced to operate in 2D or 3D   | M           | M                                       |
| 3      | mode 123  | Mode: 1 = Fix not available; 2 = 2D; 3 = 3D  | x           | 3                                       |
| 4 - 15 | prn       | PRN numbers of satellites used in solution (null for unused fields), total of 12 fields<br>GPS = 1 to 32<br>SBAS = 33 to 64 (add 87 for PRN number)<br>GLO = 65 to 96 <sup>a</sup> | xx,xx,..... | 18,03,13,<br>25,16,<br>24,12,<br>20,,,, |
| 16     | pdop      | Position dilution of precision   | x.x         | 1.5                                     |
| 17     | hdop      | Horizontal dilution of precision   | x.x         | 0.9                                     |
| 18     | vdop      | Vertical dilution of precision   | x.x         | 1.2                                     |
| 19     | *xx       | Checksum   | *hh         | *3F                                     |
| 20     | [CR][LF]  | Sentence terminator  |             | [CR][LF]                                |

- a. The NMEA GLONASS PRN numbers are 64 plus the GLONASS slot number. Current slot numbers are 1 to 24 which give the range 65 to 88. PRN numbers 89 to 96 are available if slot numbers above 24 are allocated to on-orbit spares.

### 3.3.34 GPGST Pseudorange Measurement Noise Statistics V123\_NMEA

Pseudorange measurement noise statistics are translated in the position domain in order to give statistical measures of the quality of the position solution.

This log reflects the accuracy of the solution type used in the BESTPOS, see *page 247*, and GPGGA, see *page 310*, logs except for the RMS field. The RMS field, since it specifically relates to pseudorange inputs, does not represent carrier-phase based positions. Instead it reflects the accuracy of the pseudorange position which is given in the PSRPOS log, see *page 385*.

The GPGST log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

- 
- ☒ If the NMEATALKER command, see *page 156*, is set to AUTO, the talker (the first 2 characters after the \$ sign in the log header) is set to GP (GPS satellites only), GL (GLONASS satellites only), or GN (satellites from both systems). NovAtel does not support a GLONASS-only solution.
- 

**Message ID:** 222

**Log Type:** Synch

**Recommended Input:**

log gpgst ontime 1

**Example 1 (GPS only):**

```
$GPGST,141451.00,1.18,0.00,0.00,0.0000,0.00,0.00,0.00*6B
```

**Example 2 (Combined GPS and GLONASS):**

```
$GNGST,143333.00,7.38,1.49,1.30,68.1409,1.47,1.33,2.07*4A
```



1. Please see the GPGGA usage box that applies to all NMEA logs on *page 310*.
2. Accuracy is based on statistics, reliability is measured in percent. When a receiver can measure height to one meter, this is an accuracy. Usually this is a one sigma value (one SD). A one sigma value for height has a reliability of 68%, that is, the error is less than one meter 68% of the time. For a more realistic accuracy, double the one sigma value (1 m) and the result is 95% reliability (error is less than 2 m 95% of the time). Generally, GPS heights are 1.5 times poorer than horizontal positions.

As examples of statistics, the GPST message and NovAtel performance specifications use root mean square RMS. Specifications may be quoted in CEP:

- RMS: root mean square (a probability level of 68%)
- CEP: circular error probable (the radius of a circle such that 50% of a set of events occur inside the boundary)

| Field | Structure | Field Description  | Symbol    | Example   |
|-------|-----------|--|-----------|-----------|
| 1     | \$GPGST   | Log header   |           | \$GPGST   |
| 2     | utc       | UTC time of position (hours/minutes/seconds/decimal seconds)   | hhmmss.ss | 173653.00 |
| 3     | rms       | RMS value of the standard deviation of the range inputs to the navigation process. Range inputs include pseudoranges and DGPS corrections. | x.x       | 2.73      |
| 4     | smjr std  | Standard deviation of semi-major axis of error ellipse (m)   | x.x       | 2.55      |
| 5     | smnr std  | Standard deviation of semi-minor axis of error ellipse (m)   | x.x       | 1.88      |
| 6     | orient    | Orientation of semi-major axis of error ellipse (degrees from true north)  | x.x       | 15.2525   |
| 7     | lat std   | Standard deviation of latitude error (m)   | x.x       | 2.51      |
| 8     | lon std   | Standard deviation of longitude error (m)  | x.x       | 1.94      |
| 9     | alt std   | Standard deviation of altitude error (m)   | x.x       | 4.30      |
| 10    | *xx       | Checksum   | *hh       | *6E       |
| 11    | [CR][LF]  | Sentence terminator  |           | [CR][LF]  |

### 3.3.35 GPGSV GPS Satellites in View V123\_NMEA

Number of SVs in view, PRN numbers, elevation, azimuth and SNR value. Four satellites maximum per message. When required, additional satellite data sent in 2 or more messages (a maximum of 9). The total number of messages being transmitted and the current message being transmitted are indicated in the first two fields.

The GPGSV log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

- 
- ☒ 1. Satellite information may require the transmission of multiple messages. The first field specifies the total number of messages, minimum value 1. The second field identifies the order of this message (message number), minimum value 1.
  - 2. If the NMEATALKER command, see *page 156*, is set to AUTO, the talker (the first 2 characters after the \$ sign in the log header) is set to GP (GPS satellites only) or GL (GLONASS satellites only) , or GN (satellites from both systems).
  - 3. A variable number of 'PRN-Elevation-Azimuth-SNR' sets are allowed up to a maximum of four sets per message. Null fields are not required for unused sets when less than four sets are transmitted.
- 

**Message ID:** 223

**Log Type:** Synch

#### Recommended Input:

log gpgsv ontime 1

**Example** (Including GPS and GLONASS sentences):

```
$GPGSV,3,1,11,18,87,050,48,22,56,250,49,21,55,122,49,03,40,284,47*78
$GPGSV,3,2,11,19,25,314,42,26,24,044,42,24,16,118,43,29,15,039,42*7E
$GPGSV,3,3,11,09,15,107,44,14,11,196,41,07,03,173,*4D
$GLGSV,2,1,06,65,64,037,41,66,53,269,43,88,39,200,44,74,25,051,*64
$GLGSV,2,2,06,72,16,063,35,67,01,253,*66
```



The GPGSV log can be used to determine which satellites are currently available to the receiver. Comparing the information from this log to that in the GPGSA log shows you if the receiver is tracking all available satellites.

Please see also the GPGGA usage box that applies to all NMEA logs on *page 310*.

---

| Field    | Structure | Field Description  | Symbol | Example  |
|----------|-----------|--|--------|----------|
| 1        | \$GPGSV   | Log header   |        | \$GPGSV  |
| 2        | # msgs    | Total number of messages (1-9)   | x      | 3        |
| 3        | msg #     | Message number (1-9)   | x      | 1        |
| 4        | # sats    | Total number of satellites in view. May be different than the number of satellites in use (see also the GPSSGA log on <i>page 310</i> ). | xx     | 09       |
| 5        | prn       | Satellite PRN number<br>GPS = 1 to 32<br>SBAS = 33 to 64 (add 87 for PRN#s)<br>GLO = 65 to 96 <sup>a</sup>                               | xx     | 03       |
| 6        | elev      | Elevation, degrees, 90 maximum   | xx     | 51       |
| 7        | azimuth   | Azimuth, degrees True, 000 to 359  | xxx    | 140      |
| 8        | SNR       | SNR (C/No) 00-99 dB, null when not tracking  | xx     | 42       |
| ...      | ...       | Next satellite PRN number, elev, azimuth, SNR,   |        |          |
| ...      | ...       | ...  |        |          |
| ...      | ...       | Last satellite PRN number, elev, azimuth, SNR,   |        |          |
| variable | *xx       | Checksum   | *hh    | *72      |
| variable | [CR][LF]  | Sentence terminator  |        | [CR][LF] |

- a. The NMEA GLONASS PRN numbers are 64 plus the GLONASS slot number. Current slot numbers are 1 to 24 which give the range 65 to 88. PRN numbers 89 to 96 are available if slot numbers above 24 are allocated to on-orbit spares.

### 3.3.36 GPHDT NMEA Heading Log ALIGN

Actual vessel heading in degrees True (from True North). See also a description of heading on *page 338*. You can also set a standard deviation threshold for this log, see *page 130*.

You must have an **ALIGN**-capable receiver to use this log, see *Table 103* on *page 565*.

- 
- ☒ If the NMEATALKER command, see *page 156*, is set to AUTO, the talker (the first 2 characters after the \$ sign in the log header) is set to GP (GPS satellites only), GL (GLONASS satellites only), or GN (satellites from both systems). NovAtel does not support a GLONASS-only solution.
- 

**Message ID:** 1045

**Log Type:** ASynch

**Recommended Input:**

log gphdt onchanged

**Example 1 (GPS only):**

```
$GPHDT,75.5664,T*36
```

**Example 2 (Combined GPS and GLONASS):**

```
$GNHDT,75.5554,T*45
```

| Field | Structure | Field Description   | Symbol | Example  |
|-------|-----------|---------------------|--------|----------|
| 1     | \$GPHDT   | Log header          |        | \$GPHDT  |
| 2     | heading   | Heading in degrees  | x.x    | 75.5554  |
| 3     | True      | Degrees True        | T      | T        |
| 4     | *xx       | Checksum            | *hh    | *36      |
| 5     | [CR][LF]  | Sentence terminator |        | [CR][LF] |

### 3.3.37 GPRMB Navigation Information V123\_NMEA

Navigation data from present position to a destination waypoint. The destination is set active by the receiver SETNAV command.

The GPRMB log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

**Message ID:** 224  
**Log Type:** Synch

#### Recommended Input:

log gprmb ontime 1

#### Example 1 (GPS only):

```
$GPRMB,A,5.14,L,FROM,TO,5109.7578000,N,11409.0960000,W,5.1,303.0,-0.0,V,A*6F
```

#### Example 2 (Combined GPS and GLONASS):

```
$GNRMB,A,5.14,L,FROM,TO,5109.7578000,N,11409.0960000,W,5.1,303.0,-0.0,V,A*71
```

- 
- ☒ If the NMEATALKER command, see *page 156*, is set to AUTO, the talker (the first 2 characters after the \$ sign in the log header) is set to GP (GPS satellites only), GL (GLONASS satellites only), or GN (satellites from both systems). NovAtel does not support a GLONASS-only solution.
- 



Please see the GPGBGA usage box that applies to all NMEA logs on *page 310*.

---

**Table 61: NMEA Positioning System Mode Indicator**

| Mode | Indicator                       |
|------|---------------------------------|
| A    | Autonomous                      |
| D    | Differential                    |
| E    | Estimated (dead reckoning) mode |
| M    | Manual input                    |
| N    | Data not valid                  |

| Field | Structure   | Field Description  | Symbol  | Example       |
|-------|-------------|--|---------|---------------|
| 1     | \$GPRMB     | Log header   |         | \$GPRMB       |
| 2     | data status | Data status:<br>A = data valid; V = navigation receiver warning                      | A       | A             |
| 3     | xtrack      | Cross track error <sup>a</sup>   | x.x     | 5.14          |
| 4     | dir         | Direction to steer to get back on track (L/R) <sup>b</sup>                           | a       | L             |
| 5     | origin ID   | Origin waypoint ID <sup>c</sup>  | c--c    | FROM          |
| 6     | dest ID     | Destination waypoint ID <sup>c</sup>   | c--c    | TO            |
| 7     | dest lat    | Destination waypoint latitude (DDmm.mm) <sup>c</sup>                                 | IIII.II | 5109.7578000  |
| 8     | lat dir     | Latitude direction (N = North, S = South) <sup>c</sup>                               | a       | N             |
| 9     | dest lon    | Destination waypoint longitude (DDDmm.mm) <sup>c</sup>                               | YYYY.YY | 11409.0960000 |
| 10    | lon dir     | Longitude direction (E = East, W = West) <sup>c</sup>                                | a       | W             |
| 11    | range       | Range to destination, nautical miles <sup>d</sup>                                    | x.x     | 5.1           |
| 12    | bearing     | Bearing to destination, degrees True   | x.x     | 303.0         |
| 13    | vel         | Destination closing velocity, knots  | x.x     | -0.0          |
| 14    | arr status  | Arrival status:<br>A = perpendicular passed<br>V = destination not reached or passed | A       | V             |
| 15    | mode ind    | Positioning system mode indicator, see <i>Table 61</i> on <i>page 327</i>            | a       | A             |
| 16    | *xx         | Checksum   | *hh     | *6F           |
| 17    | [CR][LF]    | Sentence terminator  |         | [CR][LF]      |

- a. - If cross track error exceeds 9.99 NM, display 9.99
  - Represents track error from intended course
  - One nautical mile = 1,852 meters
- b. Direction to steer is based on the sign of the crosstrack error, that is, L = xtrack error (+);  
R = xtrack error (-)
- c. Fields 5, 6, 7, 8, 9, and 10 are tagged from the SETNAV command, see *page 188*.
- d. If range to destination exceeds 999.9 NM, display 999.9



### 3.3.38 GPRMC GPS Specific Information V123\_NMEA

Time, date, position, track made good and speed data provided by the GPS navigation receiver. RMC and RMB are the recommended minimum navigation data to be provided by a GPS receiver.

A comparison of the position precision between this log and other selected NMEA logs can be seen in *Table 60, Position Precision of NMEA Logs on page 316*.

The GPRMC log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

- 
- ☒ If the NMEATALKER command, see *page 156*, is set to AUTO, the talker (the first 2 characters after the \$ sign in the log header) is set to GP (GPS satellites only), GL (GLONASS satellites only), or GN (satellites from both systems). NovAtel does not support a GLONASS-only solution.
- 

**Message ID:** 225  
**Log Type:** Synch

#### Recommended Input:

log gprmc ontime 1

#### Example 1 (GPS):

```
$GPRMC,144326.00,A,5107.0017737,N,11402.3291611,W,0.080,323.3,210307,0.0,E,A*  
20
```

#### Example 2 (Combined GPS and GLONASS):

```
$GNRMC,143909.00,A,5107.0020216,N,11402.3294835,W,0.036,348.3,210307,0.0,E,A*  
31
```



Please see the GPGGGA usage box that applies to all NMEA logs on *page 310*.

---

| Field | Structure  | Field Description  | Symbol    | Example       |
|-------|------------|--|-----------|---------------|
| 1     | \$GPRMC    | Log header   |           | \$GPRMC       |
| 2     | utc        | UTC of position  | hhmmss.ss | 144326.00     |
| 3     | pos status | Position status:<br>A = data valid, V = data invalid                         | A         | A             |
| 4     | lat        | Latitude (DDmm.mm)   | llll.ll   | 5107.0017737  |
| 5     | lat dir    | Latitude direction<br>N = North, S = South                                   | a         | N             |
| 6     | lon        | Longitude (DDDmm.mm)   | yyyyy.yy  | 11402.3291611 |
| 7     | lon dir    | Longitude direction<br>E = East, W = West                                    | a         | W             |
| 8     | speed Kn   | Speed over ground, knots   | x.x       | 0.080         |
| 9     | track true | Track made good, degrees True  | x.x       | 323.3         |
| 10    | date       | Date: dd/mm/yy   | xxxxxx    | 210307        |
| 11    | mag var    | Magnetic variation, degrees <sup>a</sup>                                     | x.x       | 0.0           |
| 12    | var dir    | Magnetic variation direction E/W <sup>b</sup>                                | a         | E             |
| 13    | mode ind   | Positioning system mode indicator,<br>see <i>Table 61</i> on <i>page 327</i> | a         | A             |
| 14    | *xx        | Checksum   | *hh       | *20           |
| 15    | [CR][LF]   | Sentence terminator  |           | [CR][LF]      |

- a. Note that this field is the actual magnetic variation and will always be positive. The direction of the magnetic variation is always positive.
- b. Easterly variation (E) subtracts from True course and Westerly variation (W) adds to True course.

### 3.3.39 GPSEPHM Decoded GPS Ephemerides V123

A single set of GPS ephemeris parameters.

**Message ID:** 7

**Log Type:** Asynch

**Recommended Input:**

log gpsephema onchanged

**ASCII Example:**

```
#GPSEPHEMA,COM1,12,59.0,SATTIME,1337,397560.000,00000000,9145,1984;
3,397560.0,0,99,99,1337,1337,403184.0,2.656004220e+07,4.971635660e-09,
-2.752651501e+00,7.1111434372e-03,6.0071892571e-01,2.428889275e-06,
1.024827361e-05,1.64250000e+02,4.81562500e+01,1.117587090e-08,
-7.078051567e-08,9.2668266314e-01,-1.385772009e-10,-2.098534041e+00,
-8.08319384e-09,99,403184.0,-4.190951586e-09,2.88095e-05,3.06954e-12,
0.00000,TRUE,1.458614684e-04,4.00000000e+00*0f875b12
#GPSEPHEMA,COM1,11,59.0,SATTIME,1337,397560.000,00000000,9145,1984;
25,397560.0,0,184,184,1337,1337,403200.0,2.656128681e+07,4.897346851e-09,
1.905797220e+00,1.1981436634e-02,-1.440195331e+00,-1.084059477e-06,
6.748363376e-06,2.37812500e+02,-1.74687500e+01,1.825392246e-07,
-1.210719347e-07,9.5008501632e-01,2.171519024e-10,2.086083072e+00,
-8.06140722e-09,184,403200.0,-7.450580597e-09,1.01652e-04,9.09495e-13,
0.00000,TRUE,1.458511425e-04,4.00000000e+00*18080b24
.
.
.
#GPSEPHEMA,COM1,0,59.0,SATTIME,1337,397560.000,00000000,9145,1984;
1,397560.0,0,224,224,1337,1337,403200.0,2.656022490e+07,3.881233098e-09,
2.938005195e+00,5.8911956148e-03,-1.716723741e+00,-2.723187208e-06,
9.417533875e-06,2.08687500e+02,-5.25625000e+01,9.126961231e-08,
-7.636845112e-08,9.8482911735e-01,1.325055194e-10,1.162012787e+00,
-7.64138972e-09,480,403200.0,-3.259629011e-09,5.06872e-06,2.04636e-12,
0.00000,TRUE,1.458588731e-04,4.00000000e+00*97058299
```



The GPSEPHM log can be used to monitor changes in the orbits of GPS satellites.

**Table 62: URA Variance**

| Index Value | A: Standard Deviations | Variance: A <sup>2</sup> (m <sup>2</sup> ) |
|-------------|------------------------|--|
| 0           | 2.0                    | 4  |
| 1           | 2.8                    | 7.84                                       |
| 2           | 4.0                    | 16   |
| 3           | 5.7                    | 32.49                                      |
| 4           | 8                      | 56   |
| 5           | 11.3                   | 127.69                                     |
| 6           | 16.0                   | 256  |
| 7           | 32.0                   | 1024                                       |
| 8           | 64.0                   | 4096                                       |
| 9           | 128.0                  | 16384                                      |
| 10          | 256.0                  | 65536                                      |
| 11          | 512.0                  | 262144                                     |
| 12          | 1024.0                 | 1048576                                    |
| 13          | 2048.0                 | 4194304                                    |
| 14          | 4096.0                 | 16777216                                   |
| 15          | 8192.0                 | 67108864                                   |

| Field# | Field type       | Data Description  | Format | Binary Bytes | Binary Offset |
|--------|------------------|---|--------|--------------|---------------|
| 1      | GPSEPHHEM header | Log header  |        | H            | 0             |
| 2      | PRN              | Satellite PRN number  | Ulong  | 4            | H             |
| 3      | tow              | Time stamp of subframe 0 (seconds)  | Double | 8            | H+4           |
| 4      | health           | Health status - a 6-bit health code as defined in ICD-GPS-200 <sup>a</sup>  | Ulong  | 4            | H+12          |
| 5      | IODE1            | Issue of ephemeris data 1   | Ulong  | 4            | H+16          |
| 6      | IODE2            | Issue of ephemeris data 2   | Ulong  | 4            | H+20          |
| 7      | week             | GPS week number   | Ulong  | 4            | H+24          |
| 8      | z week           | Z count week number. This is the week number from subframe 1 of the ephemeris. The 'toe week' (field #7) is derived from this to account for rollover.                            | Ulong  | 4            | H+28          |
| 9      | toe              | Reference time for ephemeris, seconds   | Double | 8            | H+32          |
| 10     | A                | Semi-major axis, meters   | Double | 8            | H+40          |
| 11     | $\Delta N$       | Mean motion difference, radians/second  | Double | 8            | H+48          |
| 12     | $M_0$            | Mean anomaly of reference time, radians   | Double | 8            | H+56          |
| 13     | ecc              | Eccentricity, dimensionless - quantity defined for a conic section where $e=0$ is a circle, $e=1$ is a parabola, $0<e<1$ is an ellipse and $e>1$ is a hyperbola.                  | Double | 8            | H+64          |
| 14     | $\omega$         | Argument of perigee, radians - measurement along the orbital path from the ascending node to the point where the SV is closest to the Earth, in the direction of the SV's motion. | Double | 8            | H+72          |
| 15     | cuc              | Argument of latitude (amplitude of cosine, radians)   | Double | 8            | H+80          |
| 16     | cus              | Argument of latitude (amplitude of sine, radians)   | Double | 8            | H+88          |
| 17     | crc              | Orbit radius (amplitude of cosine, meters)  | Double | 8            | H+96          |
| 18     | crs              | Orbit radius (amplitude of sine, meters)  | Double | 8            | H+104         |
| 19     | cic              | Inclination (amplitude of cosine, radians)  | Double | 8            | H+112         |
| 20     | cis              | Inclination (amplitude of sine, radians)  | Double | 8            | H+120         |
| 21     | $l_0$            | Inclination angle at reference time, radians  | Double | 8            | H+128         |

Continued on page 334.

| Field# | Field type     | Data Description  | Format | Binary Bytes | Binary Offset |
|--------|----------------|---|--------|--------------|---------------|
| 22     | $\dot{i}$      | Rate of inclination angle, radians/second   | Double | 8            | H+136         |
| 23     | $\omega_0$     | Right ascension, radians  | Double | 8            | H+144         |
| 24     | $\dot{\omega}$ | Rate of right ascension, radians/second   | Double | 8            | H+152         |
| 25     | iodc           | Issue of data clock   | Ulong  | 4            | H+160         |
| 26     | toc            | SV clock correction term, seconds   | Double | 8            | H+164         |
| 27     | tgd            | Estimated group delay difference, seconds   | Double | 8            | H+172         |
| 28     | $a_{f0}$       | Clock aging parameter, seconds (s)  | Double | 8            | H+180         |
| 29     | $a_{f1}$       | Clock aging parameter, (s/s)  | Double | 8            | H+188         |
| 30     | $a_{f2}$       | Clock aging parameter, (s/s/s)  | Double | 8            | H+196         |
| 31     | AS             | Anti-spoofing on: 0 = FALSE<br>1 = TRUE   | Enum   | 4            | H+204         |
| 32     | N              | Corrected mean motion, radians/second   | Double | 8            | H+208         |
| 33     | URA            | User Range Accuracy variance, m <sup>2</sup> . The ICD <sup>a</sup> specifies that the URA index transmitted in the ephemerides can be converted to a nominal standard deviation value using an algorithm listed there. We publish the square of the nominal value (variance). The correspondence between the original URA index and the value output is shown in <i>Table 62</i> . | Double | 8            | H+216         |
| 34     | xxxx           | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+224         |
| 35     | [CR][LF]       | Sentence terminator (ASCII only)  | -      | -            | -             |

- a. To obtain copies of ICD-GPS-200, refer to ARINC in the *Standards and References* section of the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm>.

### 3.3.40 GPVTG Track Made Good And Ground Speed V123\_NMEA

The track made good and speed relative to the ground.

The GPVTG log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

**Message ID:** 226  
**Log Type:** Synch

#### Recommended Input:

log gpvtg ontime 1

#### Example 1 (GPS only):

```
$GPVTG,172.516,T,155.295,M,0.049,N,0.090,K,D*2B
```

#### Example 2 (Combined GPS and GLONASS):

```
$GNVTG,134.395,T,134.395,M,0.019,N,0.035,K,A*33
```

- 
- ✉ If the NMEATALKER command, see *page 156*, is set to AUTO, the talker (the first 2 characters after the \$ sign in the log header) is set to GP (GPS satellites only), GL (GLONASS satellites only), or GN (satellites from both systems). NovAtel does not support a GLONASS-only solution.
- 



Please see the GPVGA usage box that applies to all NMEA logs on *page 310*.

---

| Field | Structure  | Field Description  | Symbol | Example   |
|-------|------------|--|--------|-----------|
| 1     | \$GPVTG    | Log header   |        | \$GPVTG   |
| 2     | track true | Track made good, degrees True  | x.x    | 24.168    |
| 3     | T          | True track indicator   | T      | T         |
| 4     | track mag  | Track made good, degrees Magnetic;<br>Track mag = Track true + (MAGVAR correction)<br>See the <i>MAGVAR</i> command, page 148. | x.x    | 24.168    |
| 5     | M          | Magnetic track indicator   | M      | M         |
| 6     | speed Kn   | Speed over ground, knots   | x.x    | 0.4220347 |
| 7     | N          | Nautical speed indicator (N = Knots)   | N      | N         |
| 8     | speed Km   | Speed, kilometers/hour   | x.x    | 0.781608  |
| 9     | K          | Speed indicator (K = km/hr)  | K      | K         |
| 10    | mode ind   | Positioning system mode indicator, see <i>Table 61</i><br>on page 327  | a      | A         |
| 11    | *xx        | Checksum   | *hh    | *7A       |
| 12    | [CR][LF]   | Sentence terminator  |        | [CR][LF]  |



### 3.3.41 GPZDA UTC Time and Date V123\_NMEA

The GPZDA log outputs these messages with contents without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time is set to VALID.

**Message ID:** 227

**Log Type:** Synch

**Recommended Input:**

```
log gpzda ontime 1
```

**Example:**

```
$GPZDA,143042.00,25,08,2005,,*6E
```



Please see the GPGGA usage box that applies to all NMEA logs on page 310.

| Field | Structure | Field Description   | Symbol    | Example                                |
|-------|-----------|---|-----------|--|
| 1     | \$GPZDA   | Log header  |           | \$GPZDA                                |
| 2     | utc       | UTC time  | hhmmss.ss | 220238.00                              |
| 3     | day       | Day, 01 to 31   | xx        | 15                                     |
| 4     | month     | Month, 01 to 12   | xx        | 07                                     |
| 5     | year      | Year  | xxxx      | 1992                                   |
| 6     | null      | Local zone description - not available                      | xx        | <i>(empty when no data is present)</i> |
| 7     | null      | Local zone minutes description - not available <sup>a</sup> | xx        | <i>(empty when no data is present)</i> |
| 8     | *xx       | Checksum  | *hh       | *6F                                    |
| 9     | [CR][LF]  | Sentence terminator   |           | [CR][LF]                               |

a. Local time zones are not supported by OEMV family receivers. Fields 6 and 7 are always null.

### 3.3.42 HEADING Heading Information V123\_ALIGN

The heading is the angle from True North of the base to rover vector in a clockwise direction.

**Message ID:** 971

**Log Type:** Asynch

**Recommended Input:**

log headinga onchanged

**ASCII Example:**

```
#HEADINGA,COM1,0,77.0,FINESTEERING,1481,418557.000,00000000,3663,36137;
SOL_COMPUTED,L1_INT,5.913998127,75.566444397,-0.152066842,0.0,0.104981117,
0.222061798,"AAAA",13,10,10,0,0,00,0,11*481a5bab
```

| Field # | Field type     | Data Description  | Format  | Binary Bytes | Binary Offset |
|---------|----------------|---|---------|--------------|---------------|
| 1       | HEADING header | Log header  |         | H            | 0             |
| 2       | sol stat       | Solution status, see <i>Table 51 on page 249</i>  | Enum    | 4            | H             |
| 3       | pos type       | Position type, see <i>Table 50 on page 248</i>  | Enum    | 4            | H+4           |
| 4       | length         | Baseline length (0 to 3000 m)   | Float   | 4            | H+8           |
| 5       | heading        | Heading in degrees (0 to 360.0 degrees)   | Float   | 4            | H+12          |
| 6       | pitch          | Pitch ( $\pm 90$ degrees)   | Float   | 4            | H+16          |
| 7       | Reserved       |   | Float   | 4            | H+20          |
| 8       | hdg std dev    | Heading standard deviation in degrees   | Float   | 4            | H+24          |
| 9       | ptch std       | Pitch standard deviation in degrees   | Float   | 4            | H+28          |
| 10      | stn ID         | Station ID string   | Char[4] | 4            | H+32          |
| 11      | #SVs           | Number of observations tracked  | Uchar   | 1            | H+36          |
| 12      | #solnSVs       | Number of satellites in solution  | Uchar   | 1            | H+37          |
| 13      | #obs           | Number of satellites above the elevation mask   | Uchar   | 1            | H+38          |
| 14      | #multi         | Number of satellites above the mask angle with L2   | Uchar   | 1            | H+39          |
| 15      | Reserved       |   | Uchar   | 1            | H+40          |
| 16      | ext sol stat   | Extended solution status (see <i>Table 53, Extended Solution Status on page 250</i> )             | Uchar   | 1            | H+41          |
| 17      | Reserved       |   | Uchar   | 1            | H+42          |
| 18      | sig mask       | Signals used mask - if 0, signals used in solution are unknown (see <i>Table 52 on page 250</i> ) | Uchar   | 1            | H+43          |
| 19      | xxxx           | 32-bit CRC (ASCII and Binary only)  | Hex     | 4            | H+44          |
| 20      | [CR][LF]       | Sentence terminator (ASCII only)  | -       | -            | -             |

### 3.3.43 IONUTC Ionospheric and UTC Data V123

The Ionospheric Model parameters (ION) and the Universal Time Coordinated parameters (UTC) are provided.

**Message ID:** 8

**Log Type:** Asynch

**Recommended Input:**

log ionutca onchanged

**ASCII Example:**

```
#IONUTCA,COM1,0,58.5,FINESTEERING,1337,397740.107,00000000,ec21,1984;
1.210719347000122e-08,2.235174179077148e-08,-5.960464477539062e-08,
-1.192092895507812e-07,1.003520000000000e+05,1.146880000000000e+05,
-6.553600000000000e+04,-3.276800000000000e+05,1337,589824,
-1.2107193470001221e-08,-3.907985047e-14,1355,7,13,14,0*c1dfd456
```



The Receiver-Independent Exchange (RINEX<sup>1</sup>) format is a broadly-accepted, receiver-independent format for storing GPS data. It features a non-proprietary ASCII file format that can be used to combine or process data generated by receivers made by different manufacturers.

The Convert4 utility can be used to produce RINEX files from NovAtel receiver data files. For best results, the NovAtel receiver input data file should contain the logs as specified in the *PC Software and Firmware* chapter of the *OEMV Family Installation and Operation User Manual* including IONUTC.

---

1. Refer to the U.S. National Geodetic Survey Web site at

<http://www.ngs.noaa.gov/CORS/Rinex2.html>

| Field # | Field type    | Data Description   | Format | Binary Bytes | Binary Offset |
|---------|---------------|--|--------|--------------|---------------|
| 1       | IONUTC header | Log header   |        | H            | 0             |
| 2       | a0            | Alpha parameter constant term                                      | Double | 8            | H             |
| 3       | a1            | Alpha parameter 1st order term                                     | Double | 8            | H+8           |
| 4       | a2            | Alpha parameter 2nd order term                                     | Double | 8            | H+16          |
| 5       | a3            | Alpha parameter 3rd order term                                     | Double | 8            | H+24          |
| 6       | b0            | Beta parameter constant term                                       | Double | 8            | H+32          |
| 7       | b1            | Beta parameter 1st order term                                      | Double | 8            | H+40          |
| 8       | b2            | Beta parameter 2nd order term                                      | Double | 8            | H+48          |
| 9       | b3            | Beta parameter 3rd order term                                      | Double | 8            | H+56          |
| 10      | utc wn        | UTC reference week number  | Ulong  | 4            | H+64          |
| 11      | tot           | Reference time of UTC parameters                                   | Ulong  | 4            | H+68          |
| 12      | A0            | UTC constant term of polynomial                                    | Double | 8            | H+72          |
| 13      | A1            | UTC 1st order term of polynomial                                   | Double | 8            | H+80          |
| 14      | wn lsf        | Future week number   | Ulong  | 4            | H+88          |
| 15      | dn            | Day number (the range is 1 to 7 where Sunday = 1 and Saturday = 7) | Ulong  | 4            | H+92          |
| 16      | deltat ls     | Delta time due to leap seconds                                     | Long   | 4            | H+96          |
| 17      | deltat lsf    | Future delta time due to leap seconds                              | Long   | 4            | H+100         |
| 18      | deltat utc    | Time difference  | Ulong  | 4            | H+104         |
| 19      | xxxx          | 32-bit CRC (ASCII and Binary only)                                 | Hex    | 4            | H+108         |
| 20      | [CR][LF]      | Sentence terminator (ASCII only)                                   | -      | -            | -             |

### 3.3.44 LBANDINFO L-band Configuration Information V13\_VBS, V3\_HP or V13\_CDGPS

This log outputs configuration information for an L-band service. In the case of using the free CDGPS service, no subscription is required and therefore the subscription fields report an UNKNOWN subscription status. See also the examples below.

- 
- ☒ In addition to a NovAtel receiver with L-band capability, a subscription to the OmniSTAR, or use of the free CDGPS, service is required. Contact NovAtel for details. Contact information may be found on the back of this manual or you can refer to the *Customer Service* section in the *OEMV Family Installation and Operation User Manual*.
- 

**Message ID:** 730  
**Log Type:** Asynch

#### Recommended Input:

```
log lbandinfoa ontime 1
```

#### ASCII Example 1 (OmniSTAR HP):

```
#LBANDINFOA,COM2,0,81.5,FINESTEERING,1295,152639.184,00000240,c51d,34461;  
1547547,4800,c685,0,762640,EXPIRED,0,0,FIXEDTIME,1199,259199,0*8cc5e573
```

#### Abbreviated ASCII Example 2 (CDGPS):

```
LBANDINFO COM1 0 45.5 FINESTEERING 1297 498512.389 00000000 c51d 34486  
1547547 4800 0 0 762640 UNKNOWN 0 0 UNKNOWN 0 0 0
```

**Table 63: L-band Subscription Type**

| Binary | ASCII            | Description   |
|--------|------------------|---|
| 0      | EXPIRED          | The L-band subscription has expired or does not exist.  |
| 1      | FIXEDTIME        | The L-band subscription expires at a fixed date and time.   |
| 2      | COUNTDOWN        | The L-band subscription expires after the specified amount of running time.                           |
| 3      | COUNTDOWNOVERRUN | The COUNTDOWN subscription has expired but has entered a brief grace period. Resubscribe immediately. |
| 16     | UNKNOWN          | Unknown subscription  |



---

What is the real accuracy of the Coast Guard's DGPS as compared to the commercial DGPS? The Coast Guard claims a 10 meter accuracy for their DGPS. Some commercial DGPS vendors offer 5 m (or better) accuracy. Are the commercial vendors really supplying something more accurate than the Coast Guard signal?

The real accuracy of the Coast Guard's DGPS signal is likely better than 10 meters. However, there a number of factors which are involved in determining the accuracy of a DGPS system. These include:

- your proximity to the base station which is transmitting DGPS corrections,
- the GPS receiver used by the Coast Guard,
- the GPS receiver used by the commercial DGPS services,
- your GPS receiver, and the statistical qualifier used in conjunction with the stated accuracy.

If you were to compare the Coast Guard and commercial DGPS services under the same situations, for example, a base to user proximity of 1 km and stated accuracy at 2drms (95% confidence), you would probably find that the Coast Guard's DGPS is at least equivalent to, if not better than, commercial DGPS services.

Also of note is that the Coast Guard's DPGS service is available to all users (marine, land and air), similar to a public utility without any charge. In addition, the Coast Guard's service acts as an integrity monitor, which provides an independent check of each GPS satellite's signal and reports whether it is good or bad. Commercial DGPS vendors usually have a monthly or yearly subscription fee.

All of the previous discussions have been dealing with code data. Some commercial DGPS services are now also provide high accuracy carrier-phase data along with code data. With this type of data, depending on your equipment, you will be able to achieve decimeter and even centimeter level accuracies.

---

| Field # | Field Type       | Data Description  | Format | Binary Bytes | Binary Offset |
|---------|------------------|---|--------|--------------|---------------|
| 1       | LBANDINFO header | Log header  |        | H            | 0             |
| 2       | freq             | Selected frequency for L-band service (kHz)   | Ulong  | 4            | H             |
| 3       | baud             | Communication baud rate from L-band satellite   | Ulong  | 4            | H+4           |
| 4       | ID               | L-band signal service ID  | Ushort | 2            | H+8           |
| 5       | Reserved         |   | Ushort | 2            | H+10          |
| 6       | OSN              | L-band serial number  | Ulong  | 4            | H+12          |
| 7       | vbs sub          | L-band VBS subscription type (see <i>Table 63</i> on page 341)                        | Enum   | 4            | H+16          |
| 8       | vbs exp week     | GPS week number of L-band VBS expiration date <sup>a</sup>                            | Ulong  | 4            | H+20          |
| 9       | vbs exp secs     | Number of seconds into the GPS week of L-band VBS expiration date <sup>a</sup>        | Ulong  | 4            | H+24          |
| 10      | hp sub           | OmniSTAR HP or XP subscription type (see <i>Table 63</i> on page 341)                 | Enum   | 4            | H+28          |
| 11      | hp exp week      | GPS week number of OmniSTAR HP or XP expiration date <sup>a</sup>                     | Ulong  | 4            | H+32          |
| 12      | hp exp secs      | Number of seconds into the GPS week of OmniSTAR HP or XP expiration date <sup>a</sup> | Ulong  | 4            | H+36          |
| 13      | hp sub mode      | HP or XP subscription mode if the subscription is valid:<br>0 = HP<br>1 = XP          | Ulong  | 4            | H+40          |
| 14      | xxxx             | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+44          |
| 15      | [CR][LF]         | Sentence terminator (ASCII only)  | -      | -            | -             |

- a. If the subscription type is COUNTDOWN, see Field #7 above, the expiration week and expiration seconds into the GPS week contain the amount of running time remaining in the subscription. If the subscription type is COUNTDOWNOVERRUN, the expiration week and expiration seconds into GPS week count the amount of the overrun time.

### 3.3.45 **LBANDSTAT** *L-band Status Information V13\_VBS, V3\_HP or V13\_CDGPS*

This log outputs status information for a standard L-band, OmniSTAR XP (Extra Precision) or OmniSTAR HP (High Performance) service.

- 
- In addition to a NovAtel receiver with L-band capability, a subscription to the OmniSTAR, or use of the free CDGPS, service is required. Contact NovAtel for details. Contact information may be found on the back of this manual or you can refer to the *Customer Service* section in the *OEMV Family Installation and Operation User Manual*.
- 

**Message ID:** 731

**Log Type:** Asynch

**Recommended Input:**

log lbandstata ontime 1

**ASCII Example:**

```
#LBANDSTATA,COM1,0,73.5,FINESTEERING,1314,494510.000,00000000,c797,1846;  
1551488896,43.19,62.3,0.00,0082,0000,7235,11,0,0000,0001,7762,04000000,0  
*93f7d2af
```



In binary, the receiver outputs 48 bytes without the checksum when the LBANDSTATB log is requested.

---



**Table 64: L-band Signal Tracking Status**

| Nibble # | Bit # | Mask   | Description        | Range Value   |
|----------|-------|--------|--------------------|---|
| N0       | 0     | 0x0001 | Tracking State     | 0 = Searching, 1 = Pull-in,<br>2 = Tracking, 3 = Idle |
|          | 1     | 0x0002 |                    |   |
|          | 2     | 0x0004 | Reserved           |   |
|          | 3     | 0x0008 |                    |   |
| N1       | 4     | 0x0010 |                    |   |
|          | 5     | 0x0020 |                    |   |
|          | 6     | 0x0040 | Bit Timing Lock    | 0 = Not Locked, 1 = Locked                            |
|          | 7     | 0x0080 | Phase Locked       | 0 = Not Locked, 1 = Locked                            |
| N2       | 8     | 0x0100 | DC Offset Unlocked | 0 = Good, 1 = Warning                                 |
|          | 9     | 0x0200 | AGC Unlocked       | 0 = Good, 1 = Warning                                 |
|          | 10    | 0x0400 | Reserved           |   |
|          | 11    | 0x0800 |                    |   |
| N3       | 12    | 0x1000 |                    |   |
|          | 13    | 0x2000 |                    |   |
|          | 14    | 0x4000 |                    |   |
|          | 15    | 0x8000 | Error              | 0 = Good, 1 = Error                                   |

**Table 65: OmniSTAR VBS Status Word**

| Nibble # | Bit # | Mask   | Description                       | Bit = 0 | Bit = 1 |               |  |  |
|----------|-------|--------|-----------------------------------|---------|---------|---------------|--|--|
| N0       | 0     | 0x0001 | Subscription Expired <sup>a</sup> | False   | True    |               |  |  |
|          | 1     | 0x0002 | Out of Region <sup>a</sup>        | False   | True    |               |  |  |
|          | 2     | 0x0004 | Wet Error <sup>a</sup>            | False   | True    |               |  |  |
|          | 3     | 0x0008 | Link Error <sup>a</sup>           | False   | True    |               |  |  |
| N1       | 4     | 0x0010 | No Remote Sites                   | False   | True    |               |  |  |
|          | 5     | 0x0020 | No Almanac                        | False   | True    |               |  |  |
|          | 6     | 0x0040 | No Position                       | False   | True    |               |  |  |
|          | 7     | 0x0080 | No Time                           | False   | True    |               |  |  |
| N2       | 8     | 0x0100 | Reserved                          |         |         |               |  |  |
|          | 9     | 0x0200 |                                   |         |         |               |  |  |
|          | 10    | 0x0400 |                                   |         |         |               |  |  |
|          | 11    | 0x0800 |                                   |         |         |               |  |  |
| N3       | 12    | 0x1000 |                                   |         |         | Updating Data |  |  |
|          | 13    | 0x2000 |                                   |         |         |               |  |  |
|          | 14    | 0x4000 |                                   |         |         |               |  |  |
|          | 15    | 0x8000 |                                   |         |         |               |  |  |

- a. Contact OmniSTAR for subscription support. All other status values are updated by collecting OmniSTAR data for 20-35 minutes.

**Table 66: OmniSTAR HP/XP Additional Status Word**

| Nibble # | Bit # | Mask   | Description                       | Bit = 0    | Bit = 1      |          |  |  |
|----------|-------|--------|-----------------------------------|------------|--------------|----------|--|--|
| N0       | 0     | 0x0001 | Solution not fully converged      | False      | True         |          |  |  |
|          | 1     | 0x0002 | OmniStar satellite list available | False      | True         |          |  |  |
|          | 2     | 0x0004 | Reserved                          |            |              |          |  |  |
|          | 3     | 0x0008 |                                   |            |              |          |  |  |
| N1       | 4     | 0x0010 | HP not authorized <sup>a</sup>    | Authorized | Unauthorized |          |  |  |
|          | 5     | 0x0020 | XP not authorized <sup>a</sup>    | Authorized | Unauthorized |          |  |  |
|          | 6     | 0x0040 | Reserved                          |            |              |          |  |  |
|          | 7     | 0x0080 |                                   |            |              |          |  |  |
| N2       | 8     | 0x0100 | Reserved                          |            |              |          |  |  |
|          | 9     | 0x0200 |                                   |            |              |          |  |  |
|          | 10    | 0x0400 |                                   |            |              |          |  |  |
|          | 11    | 0x0800 |                                   |            |              |          |  |  |
| N3       | 12    | 0x1000 |                                   |            |              | Reserved |  |  |
|          | 13    | 0x2000 |                                   |            |              |          |  |  |
|          | 14    | 0x4000 |                                   |            |              |          |  |  |
|          | 15    | 0x8000 |                                   |            |              |          |  |  |

- a. This authorization is related to the receiver model and not the OmniStar subscription. To view OmniSTAR subscription information use the LBANDINFO log, see *page 341*.

Table 67: OmniSTAR HP/XP Status Word

| Nibble # | Bit # | Mask       | Description                       | Bit = 0 | Bit = 1 |
|----------|-------|------------|-----------------------------------|---------|---------|
| N0       | 0     | 0x00000001 | Subscription Expired <sup>a</sup> | False   | True    |
|          | 1     | 0x00000002 | Out of Region <sup>a</sup>        | False   | True    |
|          | 2     | 0x00000004 | Wet Error <sup>a</sup>            | False   | True    |
|          | 3     | 0x00000008 | Link Error <sup>a</sup>           | False   | True    |
| N1       | 4     | 0x00000010 | No Measurements                   | False   | True    |
|          | 5     | 0x00000020 | No Ephemeris                      | False   | True    |
|          | 6     | 0x00000040 | No Initial Position               | False   | True    |
|          | 7     | 0x00000080 | No Time Set                       | False   | True    |
| N2       | 8     | 0x00000100 | Velocity Error                    | False   | True    |
|          | 9     | 0x00000200 | No base stations                  | False   | True    |
|          | 10    | 0x00000400 | No Mapping Message                | False   | True    |
|          | 11    | Reserved   |                                   |         |         |
| N3-N5    | 12-23 | Reserved   |                                   |         |         |
| N6       | 24-25 |            |                                   |         |         |
|          | 26    |            |                                   |         |         |
|          | 27    | Reserved   |                                   |         |         |
| N7       | 28-30 | Reserved   |                                   |         |         |
|          | 31    | 0x80000000 | Updating Data                     | False   | True    |

- a. Contact OmniSTAR for subscription support. All other status values are updated by collecting the OmniSTAR data for 20-35 minutes.

| Field # | Field Type  | Data Description   | Format | Binary Bytes | Binary Offset |
|---------|---|--|--------|--------------|---------------|
| 1       | LBANDSTAT header  | Log header   |        | H            | 0             |
| 2       | freq  | Measured frequency of L-band signal (Hz)   | Ulong  | 4            | H             |
| 3       | C/No  | Carrier to noise density ratio<br>C/No = 10[log <sub>10</sub> (S/N <sub>0</sub> )] (dB-Hz) | Float  | 4            | H+4           |
| 4       | locktime  | Number of seconds of continuous tracking (no cycle slipping)                               | Float  | 4            | H+8           |
| 5       | Reserved  |  | Float  | 4            | H+12          |
| 6       | tracking  | Tracking status of L-band signal (see <i>Table 64</i> on page 345)                         | Hex    | 2            | H+16          |
| 7       | VBS status  | Status word for OmniSTAR VBS (see <i>Table 65</i> on page 346)                             | Hex    | 2            | H+18          |
| 8       | #bytes  | Number of bytes fed to the standard process  | Ulong  | 4            | H+20          |
| 9       | #good dgps  | Number of standard updates   | Ulong  | 4            | H+24          |
| 10      | #bad data   | Number of missing standard updates   | Ulong  | 4            | H+28          |
| 11      | Reserved (the <i>hp status 1</i> field is obsolete and has been replaced by the longer OmniSTAR HP Status field. The shorter legacy status here is maintained for backward compatibility) |  | Hex    | 2            | H+32          |
| 12      | hp status 2   | Additional status pertaining to the HP or XP process (see <i>Table 66</i> on page 347)     | Hex    | 2            | H+34          |
| 13      | #bytes hp   | Number of bytes fed to the HP or XP process  | Ulong  | 4            | H+36          |
| 14      | hp status   | Status from the HP or XP process (see <i>Table 67</i> on page 348)                         | Hex    | 4            | H+40          |
| 15      | Reserved  |  | Hex    | 4            | H+44          |
| 16      | xxxx  | 32-bit CRC (ASCII and Binary only)   | Hex    | 4            | H+48          |
| 17      | [CR][LF]  | Sentence terminator (ASCII only)   | -      | -            | -             |

### 3.3.46 **LOGLIST** *List of System Logs V123*

Outputs a list of log entries in the system. The following tables show the binary ASCII output. See also the RXCONFIG log on *page 539* for a list of current command settings.

**Message ID:** 5  
**Log Type:** Polled

**Recommended Input:**

log loglista once

**ASCII Example:**

```
#LOGLISTA,COM1,0,60.5,FINESTEERING,1337,398279.996,00000000,c00c,1984; 8,
COM1,RXSTATUSEVENTA,ONNEW,0.000000,0.000000,HOLD,
COM2,RXSTATUSEVENTA,ONNEW,0.000000,0.000000,HOLD,
COM3,RXSTATUSEVENTA,ONNEW,0.000000,0.000000,HOLD,
USB1,RXSTATUSEVENTA,ONNEW,0.000000,0.000000,HOLD,
USB2,RXSTATUSEVENTA,ONNEW,0.000000,0.000000,HOLD,
USB3,RXSTATUSEVENTA,ONNEW,0.000000,0.000000,HOLD,
COM1,BESTPOSA,ONTIME,10.000000,0.000000,NOHOLD,
COM1,LOGLISTA,ONCE,0.000000,0.000000,NOHOLD*5b29eed3
```

---



---

**WARNING!:** Do not use undocumented logs or commands! Doing so may produce errors and void your warranty.

---



---



Before contacting NovAtel Customer Service regarding software concerns, please do the following:

1. Issue a FRESET command
2. Log the following data to a file on your PC/laptop for 30 minutes
  - RXSTATUSB once
  - RAWEPHEMB onchanged
  - RANGEB ontime 1
  - BESTPOSB ontime 1
  - RXCONFIGA once
  - VERSIONB once

3. Send the file containing the logs to NovAtel Customer Service, using the support@novatel.com e-mail address.
-

| Field #  | Field type                             | Data Description   | Format | Binary Bytes   | Binary Offset    |
|----------|--|--|--------|----------------|------------------|
| 1        | LOGLIST (binary) header                | Log header   |        | H              | 0                |
| 2        | #logs                                  | Number of messages to follow, maximum = 30   | Long   | 4              | H                |
| 3        | port                                   | Output port, see <i>Table 5, Detailed Serial Port Identifiers on page 26</i>   | Enum   | 4              | H+4              |
| 4        | message                                | Message ID of log  | Ushort | 2              | H+8              |
| 5        | message type                           | Bits 0-4 = Reserved<br>Bits 5-6 = Format<br>00 = Binary<br>01 = ASCII<br>10 = Abbreviated ASCII, NMEA<br>11 = Reserved<br>Bit 7 = Response Bit (see <i>Section 1.2, Responses on page 28</i> )<br>0 = Original Message<br>1 = Response Message | Char   | 1              | H+10             |
| 6        | Reserved                               |  | Char   | 3 <sup>a</sup> | H+11             |
| 7        | trigger                                | 0 = ONNEW<br>1 = ONCHANGED<br>2 = ONTIME<br>3 = ONNEXT<br>4 = ONCE<br>5 = ONMARK   | Enum   | 4              | H+14             |
| 8        | period                                 | Log period for ONTIME  | Double | 8              | H+18             |
| 9        | offset                                 | Offset for period (ONTIME trigger)   | Double | 8              | H+26             |
| 10       | hold                                   | 0 = NOHOLD<br>1 = HOLD   | Enum   | 4              | H+32             |
| 11...    | Next log offset = H + 4 + (#logs x 32) |  |        |                |                  |
| variable | xxxx                                   | 32-bit CRC   | Hex    | 4              | H+4+(#logs x 32) |

a. In the binary log case, an additional 2 bytes of padding are added to maintain 4-byte alignment

| Field #  | Field type             | Data Description   | Format   |
|----------|------------------------|--|----------|
| 1        | LOGLIST (ASCII) header | Log header   |          |
| 2        | #port                  | Number of messages to follow, maximum = 30   | Long     |
| 3        | port                   | Output port, see <i>Table 5, Detailed Serial Port Identifiers on page 26</i>                               | Enum     |
| 4        | message                | Message name of log with no suffix for abbreviated ascii, an A suffix for ascii and a B suffix for binary. | Char [ ] |
| 5        | trigger                | ONNEW<br>ONCHANGED<br>ONTIME<br>ONNEXT<br>ONCE<br>ONMARK   | Enum     |
| 6        | period                 | Log period for ONTIME  | Double   |
| 7        | offset                 | Offset for period (ONTIME trigger)   | Double   |
| 8        | hold                   | NOHOLD<br>HOLD   | Enum     |
| 9...     | Next port              |  |          |
| variable | xxxx                   | 32-bit CRC   | Hex      |
| variable | [CR][LF]               | Sentence terminator  | -        |



### 3.3.47 MARKPOS, MARK2POS Position at Time of Mark Input Event V123

This log contains the estimated position of the antenna when a pulse is detected at a mark input. MARKPOS is a result of a pulse on the MK1I input and MARK2POS is generated when a pulse occurs on a MK2I input. Refer to the *Technical Specifications* appendix in the *OEMV Family Installation and Operation User Manual* for mark input pulse specifications and the location of the mark input pins.

The position at the mark input pulse is extrapolated using the last valid position and velocities. The latched time of mark impulse is in GPS weeks and seconds into the week. The resolution of the latched time is 49 ns. See also the notes on MARKPOS in the MARKTIME log on *page 355*.

**Message ID:** 181 (MARKPOS) and 615 (MARK2POS)

**Log Type:** Asynch

**Recommended Input:**

log markposa onnew

---

☒ Use the ONNEW trigger with the MARKTIME or MARKPOS logs.

---

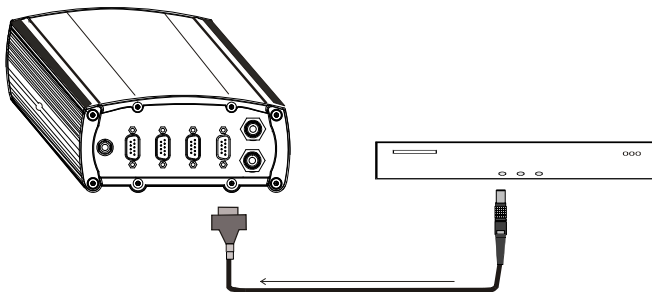
**Abbreviated ASCII Example:**

```
SOL_COMPUTED, NARROW_INT, 51.11637234389, -114.03824932277, 1063.8475, -16.2713,
WGS84, 0.0095, 0.0078, 0.0257, "AAAA", 1.000, 0.000, 17, 10, 10, 9, 0, 1, 0, 03
```



Consider the case where you have a user point device such as video equipment.

Connect the device to the receiver's I/O port using a cable that is compatible to both the receiver and the device. Refer to your device's documentation for information on its connectors and cables. The arrow along the cable in the figure below indicates a MARKIN pulse, from the user device on the right to the receiver I/O port:



| Field # | Field type                     | Data Description  | Format  | Binary Bytes | Binary Offset |
|---------|--------------------------------|---|---------|--------------|---------------|
| 1       | MARKPOS/<br>MARK2POS<br>header | Log header  |         | H            | 0             |
| 2       | sol status                     | Solution status (see <i>Table 51 on page 249</i> )  | Enum    | 4            | H             |
| 3       | pos type                       | Position type (see <i>Table 50 on page 248</i> )  | Enum    | 4            | H+4           |
| 4       | lat                            | Latitude  | Double  | 8            | H+8           |
| 5       | lon                            | Longitude   | Double  | 8            | H+16          |
| 6       | hgt                            | Height above mean sea level   | Double  | 8            | H+24          |
| 7       | undulation                     | Undulation - the relationship between the geoid and the WGS84 ellipsoid (m) <sup>a</sup>          | Float   | 4            | H+32          |
| 8       | datum id#                      | Datum ID number (see <i>Chapter 2, Table 21, Reference Ellipsoid Constants on page 97</i> )       | Enum    | 4            | H+36          |
| 9       | lat $\sigma$                   | Latitude standard deviation   | Float   | 4            | H+40          |
| 10      | lon $\sigma$                   | Longitude standard deviation  | Float   | 4            | H+44          |
| 11      | hgt $\sigma$                   | Height standard deviation   | Float   | 4            | H+48          |
| 12      | stn id                         | Base station ID   | Char[4] | 4            | H+52          |
| 13      | diff_age                       | Differential age in seconds   | Float   | 4            | H+56          |
| 14      | sol_age                        | Solution age in seconds   | Float   | 4            | H+60          |
| 15      | #SVs                           | Number of satellite vehicles tracked  | Uchar   | 1            | H+64          |
| 16      | #solnSVs                       | Number of satellite vehicles used in solution   | Uchar   | 1            | H+65          |
| 17      | #ggL1                          | Number of GPS plus GLONASS L1 used in solution  | Uchar   | 1            | H+66          |
| 18      | #ggL1L2                        | Number of GPS plus GLONASS L1 and L2 used in solution   | Uchar   | 1            | H+67          |
| 19      | Reserved                       |   | Uchar   | 1            | H+68          |
| 20      | ext sol stat                   | Extended solution status (see <i>Table 53, Extended Solution Status on page 250</i> )             | Hex     | 1            | H+69          |
| 21      | Reserved                       |   | Hex     | 1            | H+70          |
| 22      | sig mask                       | Signals used mask - if 0, signals used in solution are unknown (see <i>Table 52 on page 250</i> ) | Hex     | 1            | H+71          |
| 23      | xxxx                           | 32-bit CRC (ASCII and Binary only)  | Hex     | 4            | H+72          |
| 24      | [CR][LF]                       | Sentence terminator (ASCII only)  | -       | -            | -             |

- a. When using a datum other than WGS84, the undulation value also includes the vertical shift due to differences between the datum in use and WGS84

### 3.3.48 **MARKTIME, MARK2TIME** Time of Mark Input Event V123

This log contains the time of the leading edge of the detected mark input pulse. MARKTIME gives the time when a pulse occurs on the MK1I input and MARK2POS is generated when a pulse occurs on a MK2I input. Refer to the *Technical Specifications* appendix in the *OEMV Family Installation and Operation User Manual* for mark input pulse specifications and the location of the mark input pins. The resolution of this measurement is 49 ns.

- 
- 1. Use the ONNEW trigger with this or the MARKPOS logs.
  - 2. Only the MARKPOS logs, the MARKTIME logs, and 'polled' log types are generated 'on the fly' at the exact time of the mark. Synchronous and asynchronous logs output the most recently available data.
- 

**Message ID:** 231 (MARKTIME) and 616 (MARK2TIME)

**Log Type:** Asynch

**Recommended Input:**

log marktimea onnew

**Example:**

```
#MARKTIMEA, COM1, 0, 77.5, FINESTEERING, 1358, 422621.000, 00000000, 292e, 2214;
1358, 422621.000000500, -1.398163614e-08, 7.812745577e-08, -14.000000002,
VALID*d8502226
```



These logs allow you to measure the time when events are occurring in other devices (such as a video recorder). See also the MARKCONTROL command on [page 151](#).

---

| Field # | Field type                       | Data Description  | Format | Binary Bytes | Binary Offset |
|---------|----------------------------------|---|--------|--------------|---------------|
| 1       | MARKTIME/<br>MARK2TIME<br>header | Log header  |        | H            | 0             |
| 2       | week                             | GPS week number   | Long   | 4            | H             |
| 3       | seconds                          | Seconds into the week as measured from the receiver clock, coincident with the time of electrical closure on the Mark Input port.   | Double | 8            | H+4           |
| 4       | offset                           | Receiver clock offset, in seconds. A positive offset implies that the receiver clock is ahead of GPS Time. To derive GPS time, use the following formula:<br>GPS time = receiver time - (offset)  | Double | 8            | H+12          |
| 5       | offset std                       | Standard deviation of receiver clock offset (s)   | Double | 8            | H+20          |
| 6       | utc offset                       | This field represents the offset of GPS time from UTC time, computed using almanac parameters. UTC time is GPS time plus the current UTC offset plus the receiver clock offset.<br>UTC time = GPS time + offset + UTC offset <sup>a</sup> | Double | 8            | H+28          |
| 7       | status                           | Clock model status, see <i>Table 54, Clock Model Status</i> on page 265   | Enum   | 4            | H+36          |
| 8       | xxxx                             | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+40          |
| 9       | [CR][LF]                         | Sentence terminator (ASCII only)  | -      | -            | -             |

- a. 0 indicates that UTC time is unknown because there is no almanac available in order to acquire the UTC offset.

### 3.3.49 MASTERPOS Master Position using ALIGN V123\_ALIGN

**ALIGN** generates distance and bearing information between a “Master” and “Rover” receiver. This log outputs the position information of the master when using the **ALIGN** feature. Refer to the **ALIGN** application note on our Web site at <http://www.novatel.com/support/applicationnotes.htm>.



**ALIGN** is useful for obtaining the relative directional heading of a vessel/body, separation heading between two vessels/bodies, or heading information with moving base and pointing applications.

---

You must have an **ALIGN**-capable receiver to use this log, see *Table 103* on page 565.

- 
- ☒ The log can be output at YZ Model Rover only if it is receiving the RTCAREFEXT message from the Master. The log can be output at any Master if Master is receiving HEADINGEXTA or HEADINGEXTB from the YZ Rover.
- 

**Message ID:** 1051 (MASTERPOS)

**Log Type:** ASynch

**Recommended Input:**

log masterposa onchanged

**Example 1:**

```
#MASTERPOSA,COM1,0,21.5,FINESTEERING,1544,340322.000,00000008,5009,4655;
SOL_COMPUTED,NARROW_INT,51.11604599076,-114.03855412002,1055.7756,
16.9000,WGS84,0.0090,0.0086,0.0143,"AAAA",0.0,0.0,13,13,13,12,0,0,0,0*a72e8d3
f
```

- 
- ☒ Asynchronous logs, such as MASTERPOS, should only be logged ONCHANGED. Otherwise, the most current data is not output when it is available. This is especially true of the ONTIME trigger, which may cause inaccurate time tags to result.
-

| Field # | Field Type       | Field Description  | Binary Format | Binary Bytes | Binary Offset |
|---------|------------------|--|---------------|--------------|---------------|
| 1       | MASTERPOS header | Log Header   |               | H            | 0             |
| 2       | sol stat         | Solution Status, see <i>Table 51 on page 249</i>   | Enum          | 4            | H             |
| 3       | pos type         | Position Type see <i>Table 50 on page 248</i>  | Enum          | 4            | H+4           |
| 4       | lat              | Master WGS84 Latitude in degrees   | Double        | 8            | H+8           |
| 5       | long             | Master WGS84 Longitude in degrees  | Double        | 8            | H+16          |
| 6       | hgt              | Master MSL Height in metres  | Double        | 8            | H+24          |
| 7       | undulation       | Undulation in metres   | Float         | 4            | H+32          |
| 8       | datum id#        | WGS84 (default)  | Enum          | 4            | H+36          |
| 9       | lat $\sigma$     | Latitude Std in metres   | Float         | 4            | H+40          |
| 10      | long $\sigma$    | Longitude Std in metres  | Float         | 4            | H+44          |
| 11      | hgt $\sigma$     | Height Std in metres   | Float         | 4            | H+48          |
| 12      | stn id           | Receiver ID<br>MASTERPOS ID can be set using the DGPSTXID command, see <i>page 106</i> . | Char[4]       | 4            | H+52          |
| 13      | Reserved         |  | Float         | 4            | H+56          |
| 14      |                  |  | Float         | 4            | H+60          |
| 15      | #SVs             | Number of satellite vehicles tracked   | Uchar         | 1            | H+64          |
| 16      | #solnSVs         | Number of satellite vehicles used in solution  | Uchar         | 1            | H+65          |
| 17      | #obs             | Number of observations with information to follow  | Uchar         | 1            | H+66          |
| 18      | #multi           | Number of satellites above the mask angle with L2  | Uchar         | 1            | H+67          |
| 19      | Reserved         |  | Uchar         | 1            | H+68          |
| 20      |                  |  | Uchar         | 1            | H+69          |
| 21      |                  |  | Uchar         | 1            | H+70          |
| 22      |                  |  | Uchar         | 1            | H+71          |
| 23      | xxxx             |  | HEX           | 1            | H+72          |
| 24      | [CR][LF]         | Sentence Terminator (ASCII only)   | -             | -            | -             |

### 3.3.50 MATCHEDPOS *Matched RTK Position V123\_RT20, V23\_RT2 or V3\_HP*

This log represents positions that have been computed from time matched base and rover observations. There is no base extrapolation error on these positions because they are based on buffered measurements; they lag real time by some amount depending on the latency of the data link. If the rover receiver has not been enabled to accept RTK differential data, or is not actually receiving data leading to a valid solution, this is shown in fields #2 (*sol status*) and #3 (*pos type*).

This log provides the best accuracy in static operation. For lower latency in kinematic operation, see the RTKPOS or BESTPOS logs. The data in the logs changes only when a base observation (RTCM, RTCMV3, RTCA, CMRPLUS or CMR) changes.

A good message trigger for this log is "ONCHANGED". Then, only positions related to unique base station messages are produced, and the existence of this log indicates a successful link to the base.

- 
- ☒ Asynchronous logs, such as MATCHEDPOS, should only be logged ONCHANGED. Otherwise, the most current data is not output when it is available. This is especially true of the ONTIME trigger, which may cause inaccurate time tags to result.
- 

**Message ID:** 96  
**Log Type:** Asynch

#### Recommended Input:

log matchedposa onchanged

#### ASCII Example:

```
#MATCHEDPOSA, COM1, 0, 63.0, FINESTEERING, 1419, 340034.000, 00000040, 2f06, 2724;
SOL_COMPUTED, NARROW_INT, 51.11635908660, -114.03833102484, 1063.8400, -16.2712,
WGS84, 0.0140, 0.0075, 0.0174, "AAAA", 0.000, 0.000, 12, 12, 12, 12, 0, 01, 0, 33*feac3a3a
```



Measurement precision is different from the position computation precision. Measurement precision is a value that shows how accurately the actual code or carrier phase is measured by the GPS receiver. Position precision is a value that shows the accuracy of the position computation that is made from the code and/or carrier phase measurements. The P-code L2 measurement precision is not as good as the C/A measurement precision because the NovAtel GPS receiver is a civilian grade GPS device, and thus does not have direct access to the decrypted military L2 P(Y) code. This means that our semi-codeless P-code L2 measurements are noisier than the civilian band L1 C/A code measurements. Refer to the *OEMV Installation and Operation Manual* for the technical specification of the OEMV card.

| Field # | Field type         | Data Description  | Format  | Binary Bytes | Binary Offset |
|---------|--------------------|---|---------|--------------|---------------|
| 1       | MATCHED-POS header | Log header  |         | H            | 0             |
| 2       | sol status         | Solution status (see <i>Table 51 on page 249</i> )  | Enum    | 4            | H             |
| 3       | pos type           | Position type (see <i>Table 50 on page 248</i> )  | Enum    | 4            | H+4           |
| 4       | lat                | Latitude  | Double  | 8            | H+8           |
| 5       | lon                | Longitude   | Double  | 8            | H+16          |
| 6       | hgt                | Height above mean sea level   | Double  | 8            | H+24          |
| 7       | undulation         | Undulation - the relationship between the geoid and the WGS84 ellipsoid (m) <sup>a</sup>          | Float   | 4            | H+32          |
| 8       | datum id#          | Datum ID number (see <i>Table 21 on page 97</i> )   | Enum    | 4            | H+36          |
| 9       | lat $\sigma$       | Latitude standard deviation   | Float   | 4            | H+40          |
| 10      | lon $\sigma$       | Longitude standard deviation  | Float   | 4            | H+44          |
| 11      | hgt $\sigma$       | Height standard deviation   | Float   | 4            | H+48          |
| 12      | stn id             | Base station ID   | Char[4] | 4            | H+52          |
| 13      | Reserved           |   | Float   | 4            | H+56          |
| 14      |                    |   | Float   | 4            | H+60          |
| 15      | #SVs               | Number of satellite vehicles tracked  | Uchar   | 1            | H+64          |
| 16      | #solnSVs           | Number of satellite vehicles used in solution   | Uchar   | 1            | H+65          |
| 17      | #ggL1              | Number of GPS plus GLONASS L1 used in solution  | Uchar   | 1            | H+66          |
| 18      | #ggL1L2            | Number of GPS plus GLONASS L1 and L2 used in solution   | Uchar   | 1            | H+67          |
| 19      | Reserved           |   | Uchar   | 1            | H+68          |
| 20      | ext sol stat       | Extended solution status (see <i>Table 53, Extended Solution Status on page 250</i> )             | Hex     | 1            | H+69          |
| 21      | Reserved           |   | Hex     | 1            | H+70          |
| 22      | sig mask           | Signals used mask - if 0, signals used in solution are unknown (see <i>Table 52 on page 250</i> ) | Hex     | 1            | H+71          |
| 23      | xxxx               | 32-bit CRC (ASCII and Binary only)  | Hex     | 4            | H+72          |
| 24      | [CR][LF]           | Sentence terminator (ASCII only)  | -       | -            | -             |

- a. When using a datum other than WGS84, the undulation value also includes the vertical shift due to differences between the datum in use and WGS84



### 3.3.51 **MATCHEDXYZ** *Matched RTK Cartesian Position V123\_RT20, V23\_RT2 or V3\_HP*

This log contains the receiver's matched position in ECEF coordinates. It represents positions that have been computed from time matched base and rover observations. There is no base station extrapolation error on these positions because they are based on buffered measurements; they lag real time by some amount depending on the latency of the data link. If the rover receiver has not been enabled to accept RTK differential data, or is not actually receiving data leading to a valid solution, this is reflected by the code shown in field #2 (solution status) and #3 (position type). See *Figure 10, page 261* for a definition of the ECEF coordinates.

This log provides the best accuracy in static operation. For lower latency in kinematic operation, see the BESTXYZ or RTKXYZ logs on *pages 258 and 536* respectively. The data in the logs changes only when a base observation (RTCM, RTCMV3, RTCA, or CMR) changes.

The time stamp in the header is the time of the matched observations that the computed position is based on, not the current time.

**Message ID:** 242

**Log Type:** Asynch

#### **Recommended Input:**

log matchedxyza onchanged

- 
- ☒ Asynchronous logs, such as MATCHEDXYZ, should only be logged ONCHANGED. Otherwise, the most current data is not output when it is available. This is especially true of the ONTIME trigger, which may cause inaccurate time tags to result.
- 

#### **ASCII Example:**

```
#MATCHEDXYZA, COM1, 0, 62.5, FINESTEERING, 1419, 340035.000, 00000040, b8ed, 2724;
SOL_COMPUTED, NARROW_INT, -1634531.5703, -3664618.0321, 4942496.3280, 0.0080,
0.0159, 0.0154, "AAAA", 12, 12, 12, 12, 0, 01, 0, 33*e4b84015
```



A good message trigger for this log is "onchanged". Then, only positions related to unique base station messages are produced, and the existence of this log indicates a successful link to the base station.

---



---

| Field # | Field type        | Data Description  | Format   | Binary Bytes | Binary Offset |
|---------|-------------------|---|----------|--------------|---------------|
| 1       | MATCHEDXYZ header | Log header  |          | H            | 0             |
| 2       | P-sol status      | Solution status, see <i>Table 51, Solution Status on page 249</i>                                 | Enum     | 4            | H             |
| 3       | pos type          | Position type, see <i>Table 50, Position or Velocity Type on page 248</i>                         | Enum     | 4            | H+4           |
| 4       | P-X               | Position X-coordinate (m)   | Double   | 8            | H+8           |
| 5       | P-Y               | Position Y-coordinate (m)   | Double   | 8            | H+16          |
| 6       | P-Z               | Position Z-coordinate (m)   | Double   | 8            | H+24          |
| 7       | P-X $\sigma$      | Standard deviation of P-X (m)   | Float    | 4            | H+32          |
| 8       | P-Y $\sigma$      | Standard deviation of P-Y (m)   | Float    | 4            | H+36          |
| 9       | P-Z $\sigma$      | Standard deviation of P-Z (m)   | Float    | 4            | H+40          |
| 18      | stn ID            | Base station ID   | Char[4 ] | 4            | H+44          |
| 22      | #SVs              | Number of satellite vehicles tracked  | Uchar    | 1            | H+48          |
| 23      | #solnSVs          | Number of satellite vehicles used in solution   | Uchar    | 1            | H+49          |
| 24      | #ggL1             | Number of GPS plus GLONASS L1 used in solution  | Uchar    | 1            | H+50          |
| 25      | #ggL1L2           | Number of GPS plus GLONASS L1 and L2 used in solution   | Uchar    | 1            | H+51          |
| 26      | Reserved          |   | Char     | 1            | H+52          |
| 27      | ext sol stat      | Extended solution status (see <i>Table 53, Extended Solution Status on page 250</i> )             | Hex      | 1            | H+53          |
| 28      | Reserved          |   | Hex      | 1            | H+54          |
| 29      | sig mask          | Signals used mask - if 0, signals used in solution are unknown (see <i>Table 52 on page 250</i> ) | Hex      | 1            | H+55          |
| 30      | xxxx              | 32-bit CRC (ASCII and Binary only)  | Hex      | 4            | H+56          |
| 31      | [CR][LF]          | Sentence terminator (ASCII only)  | -        | -            | -             |

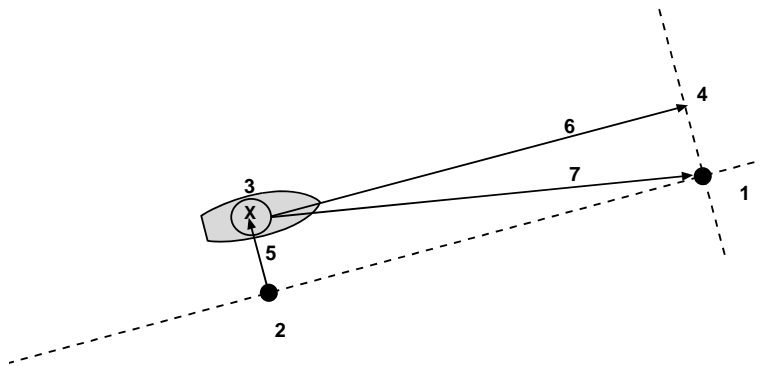
### 3.3.52 NAVIGATE User Navigation Data V123

This log reports the status of the waypoint navigation progress. It is used in conjunction with the SETNAV command, see page 188.

See Figure 11, below, for an illustration of navigation parameters.

The SETNAV command must be enabled before valid data will be reported from this log.

**Message ID:** 161  
**Log Type:** Synch



| Reference | Description                           |
|-----------|---------------------------------------|
| 1         | TO lat-lon                            |
| 2         | X-Track perpendicular reference point |
| 3         | Current GPS position                  |
| 4         | A-Track perpendicular reference point |
| 5         | X-Track (cross track)                 |
| 6         | A-Track (along track)                 |
| 7         | Distance and bearing from 3 to 1      |

**Figure 11: Navigation Parameters**

**Table 68: Navigation Data Type**

| Navigation Data Type |                  | Description   |
|----------------------|------------------|---|
| Binary               | ASCII            |   |
| 0                    | GOOD             | Navigation is good                                  |
| 1                    | NOVELOCITY       | Navigation has no velocity                          |
| 2                    | BADNAV           | Navigation calculation failed for an unknown reason |
| 3                    | FROM_TO_SAME     | “From” is too close to “To” for computation         |
| 4                    | TOO_CLOSE_TO_TO  | Position is too close to “To” for computation       |
| 5                    | ANTIPODAL_WAYPTS | Waypoints are antipodal on surface                  |

**Recommended Input:**

```
log navigatea ontime 1
```

**ASCII Example:**

```
#NAVIGATEA,COM1,0,56.0,FINESTEERING,1337,399190.000,00000000,aece,1984;  
SOL_COMPUTED,PSRDIFF,SOL_COMPUTED,GOOD,9453.6278,303.066741,133.7313,  
9577.9118,1338,349427.562*643cd4e2
```



Use the NAVIGATE log in conjunction with the SETNAV command to tell you where you currently are with relation to known To and From points. You can find a specific latitude, longitude or height knowing where you started from. A backpacker for example, could use these two commands to program a user-supplied graphical display on a digital GPS compass to show their progress as they follow a specific route.

---

| Field # | Field Type      | Data Description  | Format | Binary Bytes | Binary Offset |
|---------|-----------------|---|--------|--------------|---------------|
| 1       | NAVIGATE header | Log header  |        | H            | 0             |
| 2       | sol status      | Solution status, see <i>Table 51, Solution Status on page 249</i>   | Enum   | 4            | H             |
| 3       | pos type        | Position type, see <i>Table 50, Position or Velocity Type on page 248</i>   | Enum   | 4            | H+4           |
| 4       | vel type        | Velocity type, see <i>Table 50, Position or Velocity Type on page 248</i>   | Enum   | 4            | H+8           |
| 5       | nav type        | Navigation data type (see <i>Table 68, Navigation Data Type on page 363</i> ).  | Enum   | 4            | H+12          |
| 6       | distance        | Straight line horizontal distance from current position to the destination waypoint, in meters (see <i>Figure on page 363</i> ). This value is positive when approaching the waypoint and becomes negative on passing the waypoint.   | Double | 8            | H+16          |
| 7       | bearing         | Direction from the current position to the destination waypoint in degrees with respect to True North (or Magnetic if corrected for magnetic variation by MAGVAR command)   | Double | 8            | H+24          |
| 8       | along track     | Horizontal track distance from the current position to the closest point on the waypoint arrival perpendicular; expressed in meters. This value is positive when approaching the waypoint and becomes negative on passing the waypoint.   | Double | 8            | H+32          |
| 9       | xtrack          | The horizontal distance (perpendicular track-error) from the vessel's present position to the closest point on the great circle line that joins the FROM and TO waypoints. If a "track offset" has been entered in the SETNAV command, xtrack is the perpendicular error from the "offset track". Xtrack is expressed in meters. Positive values indicate the current position is right of the Track, while negative offset values indicate left. | Double | 8            | H+40          |
| 10      | eta week        | Estimated GPS week number at time of arrival at the "TO" waypoint along track arrival perpendicular based on current position and speed, in units of GPS weeks. If the receiving antenna is moving at a speed of less than 0.1 m/s in the direction of the destination, the value in this field is "9999".  | Ulong  | 4            | H+48          |

*Continued on page 366.*

| Field # | Field Type | Data Description  | Format | Binary Bytes | Binary Offset |
|---------|------------|---|--------|--------------|---------------|
| 11      | eta secs   | Estimated GPS seconds into week at time of arrival at destination waypoint along track arrival perpendicular, based on current position and speed, in units of GPS seconds into the week. If the receiving antenna is moving at a speed of less than 0.1 m/s in the direction of the destination, the value in this field is "0.000". | Double | 8            | H+52          |
| 12      | xxxx       | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+60          |
| 13      | [CR][LF]   | Sentence terminator (ASCII only)  | -      | -            | -             |

### 3.3.53 NMEA Standard Logs V123\_NMEA

|                  |   |
|------------------|---|
| <b>GLMLA</b>     | <b>GLONASS ALMANAC DATA</b>                           |
| <b>GPALM</b>     | <b>ALMANAC DATA</b>                                   |
| <b>GPGGA</b>     | <b>GLOBAL POSITION SYSTEM FIX DATA AND UNDULATION</b> |
| <b>GPGGALONG</b> | <b>GPS FIX DATA, EXTRA PRECISION AND UNDULATION</b>   |
| <b>GPGGARTK</b>  | <b>GPS FIX DATA</b>                                   |
| <b>GPGLL</b>     | <b>GEOGRAPHIC POSITION</b>                            |
| <b>GPGRS</b>     | <b>GPS RANGE RESIDUALS FOR EACH SATELLITE</b>         |
| <b>GPGSA</b>     | <b>GPS DOP AN ACTIVE SATELLITES</b>                   |
| <b>GPGST</b>     | <b>PSEUDORANGE MEASUREMENT NOISE STATISTICS</b>       |
| <b>GPGSV</b>     | <b>GPS SATELLITES IN VIEW</b>                         |
| <b>GPHTD</b>     | <b>NMEA HEADING LOG (<i>ALIGN</i>)</b>                |
| <b>GPRMB</b>     | <b>NAVIGATION INFORMATION</b>                         |
| <b>GPRMC</b>     | <b>GPS SPECIFIC INFORMATION</b>                       |
| <b>GPVTG</b>     | <b>TRACK MADE GOOD AND GROUND SPEED</b>               |
| <b>GPZDA</b>     | <b>UTC TIME AND DATE</b>                              |

The NMEA log structures follow format standards as adopted by the National Marine Electronics Association. The reference document used is "Standard For Interfacing Marine Electronic Devices NMEA 0183 Version 3.01". For further information, see the *Standards and References* section of the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm>. The following table contains excerpts from Table 6 of the NMEA Standard which defines the variables for the NMEA logs. The actual format for each parameter is indicated after its description.



Please see the GPGGA usage box that applies to all NMEA logs on page 310.

| Field Type            | Symbol    | Definition  |
|-----------------------|-----------|---|
| Special Format Fields |           |   |
| Status                | A         | Single character field:<br>A = Yes, Data Valid, Warning Flag Clear<br>V = No, Data Invalid, Warning Flag Set  |
| Latitude              | llll.ll   | Fixed/Variable length field:<br>degrees minutes.decimal - 2 fixed digits of degrees, 2 fixed digits of mins and a <u>variable</u> number of digits for decimal-fraction of mins. Leading zeros always included for degrees and mins to maintain fixed length. The decimal point and associated decimal-fraction are optional if full resolution is not required.  |
| Longitude             | yyyy.yy   | Fixed/Variable length field:<br>degrees minutes.decimal - 3 fixed digits of degrees, 2 fixed digits of mins and a <u>variable</u> number of digits for decimal-fraction of mins. Leading zeros always included for degrees and mins to maintain fixed length. The decimal point and associated decimal-fraction are optional if full resolution is not required   |
| Time                  | hhmmss.ss | Fixed/Variable length field:<br>hours minutes seconds.decimal - 2 fixed digits of hours, 2 fixed digits of mins, 2 fixed digits of seconds and <u>variable</u> number of digits for decimal-fraction of seconds. Leading zeros always included for hours, mins and seconds to maintain fixed length. The decimal point and associated decimal-fraction are optional if full resolution is not required. |
| Defined field         |           | Some fields are specified to contain pre-defined constants, most often alpha characters. Such a field is indicated in this standard by the presence of one or more valid characters. Excluded from the list of allowable characters are the following which are used to indicate field types within this standard:<br>"A", "a", "c", "hh", "hhmmss.ss", "llll.ll", "x", "yyyy.yy"                       |
| Numeric Value Fields  |           |   |
| Variable numbers      | x.x       | Variable length integer or floating numeric field. Optional leading and trailing zeros. The decimal point and associated decimal-fraction are optional if full resolution is not required (example: 73.10 = 73.1 = 073.1 = 73)  |
| Fixed HEX             | hh____    | Fixed length HEX numbers only, MSB on the left  |
| Information Fields    |           |   |
| Variable text         | c--c      | Variable length valid character field.  |
| Fixed alpha           | aa____    | Fixed length field of uppercase or lowercase alpha characters   |
| Fixed                 | xx____    | Fixed length field of numeric characters  |
| Fixed text            | cc____    | Fixed length field of valid characters  |

## NOTES:

- Spaces may only be used in variable text fields.
- A negative sign "-" (HEX 2D) is the first character in a Field if the value is negative. The sign is omitted if the value is positive.
- All data fields are delimited by a comma (,).
- Null fields are indicated by no data between two commas (,,). Null fields indicate invalid data or no data available.
- The NMEA Standard requires that message lengths be limited to 82 characters.



### 3.3.54 OMNIHPPPOS OmniSTAR HP/XP Position V3\_HP

Outputs L-band Extra Performance (XP) or High Performance (HP) position information.

- 
- ☒ In addition to a NovAtel receiver with L-band capability, a subscription to the OmniSTAR service is required. Contact NovAtel for details. Contact information may be found on the back of this manual or you can refer to the *Customer Service* section in the *OEMV Installation and Operation Manual*.
- 

**Message ID:** 495  
**Log Type:** Synch

**Recommended Input:**

log omnihpposa ontime 1

**ASCII Example:**

```
#OMNIHPPOSA,COM1,0,67.5,FINESTEERING,1419,320435.000,00000000,808d,2724;  
SOL_COMPUTED,OMNISTAR_HP,51.11635489609,-114.03819540112,1063.8314,-16.2713,  
WGS84,0.1258,0.2135,0.2342,"1000",8.000,0.000,13,10,10,10,0,00,0,03*e8510806
```



OmniSTAR HP/XP service is particularly useful for agricultural machine guidance and many surveying tasks. It operates in real time, and without the need for local Base Stations or telemetry links. It usually has a 2-sigma (95%) horizontal error under 10 centimeters and a 99% horizontal error of less than 15 centimeters.

---

| Field # | Field type        | Data Description  | Format  | Binary Bytes | Binary Offset |
|---------|-------------------|---|---------|--------------|---------------|
| 1       | OMNIHPPPOS header | Log header  |         | H            | 0             |
| 2       | sol status        | Solution status, see <i>Table 51 on page 249</i>  | Enum    | 4            | H             |
| 3       | pos type          | Position type, see <i>Table 50 on page 248</i>  | Enum    | 4            | H+4           |
| 4       | lat               | Latitude  | Double  | 8            | H+8           |
| 5       | lon               | Longitude   | Double  | 8            | H+16          |
| 6       | hgt               | Height above mean sea level   | Double  | 8            | H+24          |
| 7       | undulation        | Undulation - the relationship between the geoid and the WGS84 ellipsoid (m) <sup>a</sup>          | Float   | 4            | H+32          |
| 8       | datum id#         | Datum ID number (see <i>Chapter 2, Table 21, Reference Ellipsoid Constants on page 97</i> )       | Enum    | 4            | H+36          |
| 9       | lat $\sigma$      | Latitude standard deviation   | Float   | 4            | H+40          |
| 10      | lon $\sigma$      | Longitude standard deviation  | Float   | 4            | H+44          |
| 11      | hgt $\sigma$      | Height standard deviation   | Float   | 4            | H+48          |
| 12      | stn id            | Base station ID   | Char[4] | 4            | H+52          |
| 13      | diff_age          | Differential age in seconds   | Float   | 4            | H+56          |
| 14      | sol_age           | Solution age in seconds   | Float   | 4            | H+60          |
| 15      | #SVs              | Number of satellite vehicles tracked  | Uchar   | 1            | H+64          |
| 16      | #solnSVs          | Number of satellite vehicles used in solution   | Uchar   | 1            | H+65          |
| 17      | #ggL1             | Number of GPS plus GLONASS L1 used in solution  | Uchar   | 1            | H+66          |
| 18      | #ggL1L2           | Number of GPS plus GLONASS L1 and L2 used in solution   | Uchar   | 1            | H+67          |
| 19      | Reserved          |   | Uchar   | 1            | H+68          |
| 20      | ext sol stat      | Extended solution status (see <i>Table 53, Extended Solution Status on page 250</i> )             | Hex     | 1            | H+69          |
| 21      | Reserved          |   | Hex     | 1            | H+70          |
| 22      | sig mask          | Signals used mask - if 0, signals used in solution are unknown (see <i>Table 52 on page 250</i> ) | Hex     | 1            | H+71          |
| 23      | xxxx              | 32-bit CRC (ASCII and Binary only)  | Hex     | 4            | H+72          |
| 24      | [CR][LF]          | Sentence terminator (ASCII only)  | -       | -            | -             |

- a. When using a datum other than WGS84, the undulation value also includes the vertical shift due to differences between the datum in use and WGS84

### 3.3.55 OMNIVIS Omnistar Satellite Visibility List V3\_HP or V13\_VBS

This log contains OmniSTAR satellite and visibility information.

- 
- ☒ For local OmniSTAR beams, the satellite with the smallest local ellipsoid distance is the best one to use. For global beams, the satellite with the highest elevation is the best one. See also the *Usage Box* below.
- 

**Message ID:** 860  
**Log Type:** Synch

#### Recommended Input:

log omnivisa ontime 1

```
#OMNIVISA, COM1, 0, 60.5, FINESTEERING, 1419, 396070.000, 00000020, 0041, 2710;
TRUE, 8,
10, 0, "MSVW_", 0, 0.000, 1536782000, 1200, c685, -1.16, -90.00,
11, 0, "MSVC_", 0, 0.000, 1534741000, 1200, c685, 8.28, -90.00,
12, 0, "MSVE_", 0, 0.000, 1530359000, 1200, c685, 22.97, -90.00,
8, 0, "AMSAT", 0, 0.000, 1535137500, 1200, c685, 34.87, 31.09,
7, 0, "EASAT", 0, 0.000, 1535152500, 1200, c685, 91.01, -41.76,
3, 0, "AFSAT", 0, 0.000, 1535080000, 1200, c685, 110.73, -41.76,
4, 0, "APSAT", 0, 0.000, 1535137500, 1200, 2873, 185.25, -40.66,
13, 0, "OCSAT", 0, 0.000, 1535185000, 1200, 2873, 235.91, -18.57*b35c9cdf
```

#### ASCII Example 2:

```
#OMNIVISA, COM1, 0, 62.5, FINESTEERING, 1419, 334202.000, 00000020, 0041, 2710;
FALSE, 0*9e0f9078
```



**Local Beams:** When the value is negative, the user is inside the local beam footprint and a signal should be available. Beams with small positive values may be available but their availability is not guaranteed.

**Global Beams:** Any beams above 0 degrees are visible, however the tracking may be marginal for elevations less than 10 degrees.

---

| Field # | Field type                              | Data Description  | Format | Binary Bytes | Binary Offset           |
|---------|---|---|--------|--------------|-------------------------|
| 1       | OMNIVIS header                          | Log header  |        | H            | 0                       |
| 2       | valid                                   | Is the list of satellites valid?<br>0 = FALSE<br>1 = TRUE   | Bool   | 4            | H                       |
| 3       | #recs                                   | Number of records to follow   | Ulong  | 4            | H+4                     |
| 4       | link ID                                 | Satellite link ID   | Uchar  | 1            | H+8                     |
| 5       | app flag                                | Time of applicability flag:<br>0 = Valid Now<br>1 = Invalid<br>2 = Valid Until<br>3 = Valid After<br>4-7 = Reserved | Uchar  | 1            | H+9                     |
| 6       | sat name                                | Satellite name  | String | 6            | H+10                    |
| 7       | app week                                | Time of applicability week  | Ulong  | 4            | H+16                    |
| 8       | app sec                                 | Time of applicability (s into the week)   | Ulong  | 4            | H+20                    |
| 9       | freq                                    | Satellite broadcast frequency (Hz)  | Ulong  | 4            | H+28                    |
| 10      | bit rate                                | Satellite data bit rate   | Ushort | 2            | H+32                    |
| 11      | service id                              | Satellite service ID  | Hex    | 2            | H+34                    |
| 12      | ellip dist                              | Local ellipsoid distance parameter  | Float  | 4            | H+36                    |
| 13      | global elev                             | Global beam elevation (degrees)   | Float  | 4            | H+40                    |
| 14      | Next port offset = H + 8 + (#recs x 32) |   |        |              |                         |
| 15      | xxxx                                    | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+8+<br>(#recs<br>x 32) |
| 16      | [CR][LF]                                | Sentence terminator (ASCII only)  | -      | -            | -                       |

### 3.3.56 **PASSCOM, PASSXCOM, PASSAUX, PASSUSB** *Redirect Data V123*

The pass-through logging feature enables the receiver to redirect any ASCII or binary data that is input at a specified port to any specified receiver port. It allows the receiver to perform bi-directional communications with other devices such as a modem, terminal or another receiver. See also the *INTERFACEMODE* command on *page 135*.

There are several pass-through logs. PASSCOM1, PASSCOM2, PASSCOM3, PASSXCOM1, PASSXCOM2, PASSXCOM3 and PASSAUX allow for redirection of data that is arriving at COM1, COM2, COM3, virtual COM1, virtual COM2 or AUX, respectively. The AUX port is available on OEMV-2-based and OEMV-3-based products. PASSUSB1, PASSUSB2, PASSUSB3 are only available on receivers that support USB and can be used to redirect data from USB1, USB2, or USB3.

A pass-through log is initiated the same as any other log, that is, LOG [to-port] [data-type] [trigger]. However, pass-through can be more clearly specified as: LOG [to-port] [from-port-AB] [onchanged]. Now, the [from-port-AB] field designates the port which accepts data (that is, COM1, COM2, COM3, AUX, USB1, USB2, or USB3) as well as the format in which the data is logged by the [to-port] (A for ASCII or B for Binary).

When the [from-port-AB] field is suffixed with an [A], all data received by that port is redirected to the [to-port] in ASCII format and logs according to standard NovAtel ASCII format. Therefore, all incoming ASCII data is redirected and output as ASCII data. However, any binary data received is converted to a form of ASCII hexadecimal before it is logged.

When the [from-port-AB] field is suffixed with a [B], all data received by that port is redirected to the [to-port] exactly as it is received. The log header and time-tag adhere to standard NovAtel Binary format followed by the pass-through data as it was received (ASCII or binary).

Pass-through logs are best utilized by setting the [trigger] field as onchanged or onnew.

If the data being injected is ASCII, then the data is grouped together with the following rules:

- blocks of 80 characters
- any block of characters ending in a <CR>
- any block of characters ending in a <LF>
- any block remaining in the receiver code when a time-out occurs (100 ms)

If the data being injected is binary, or the port INTERFACEMODE mode is set to GENERIC, then the data is grouped as follows:

- blocks of 80 bytes
- any block remaining in the receiver code when a time-out occurs (100 ms)

If a binary value is encountered in an ASCII output, then the byte is output as a hexadecimal byte preceded by a backslash and an x. For example 0A is output as \x0A. An actual '\' in the data is output as \\ . The output counts as one pass-through byte although it is four characters.

The first character of each pass-through record is time tagged in GPS weeks and seconds.

**PASSCOM1 Message ID:233**

**PASSCOM2 Message ID:234**

**PASSCOM3 Message ID:235**

**PASSXCOM1 Message ID: 405**

**PASSXCOM2 Message ID: 406**

**PASSXCOM3 Message ID: 795**

**PASSUSB1 Message ID: 607**

**PASSUSB2 Message ID: 608**

**PASSUSB3 Message ID: 609**

**PASSAUX Message ID: 690**

**Log Type: Asynch**

**Recommended Input:**

log passcom1a onchanged

---

Asynchronous logs should only be logged ONCHANGED. Otherwise, the most current data is not output when it is available. This is especially true of the ONTIME trigger, which may cause inaccurate time tags to result.

---

### ASCII Example 1:

```
#PASSCOM2A, COM1, 0, 59.5, FINESTEERING, 1337, 400920.135, 00000000, 2b46, 1984;
80, #BESTPOSA, COM3, 0, 80.0, FINESTEERING, 1337, 400920.000, 00000000, 4ca6, 1899;
SOL_COMPUT*f9dfab46
#PASSCOM2A, COM1, 0, 64.0, FINESTEERING, 1337, 400920.201, 00000000, 2b46, 1984;
80, ED, SINGLE, 51.11636326036, -114.03824210485, 1062.6015, -16.2713, WGS84,
1.8963, 1.0674*807fd3ca
#PASSCOM2A, COM1, 0, 53.5, FINESTEERING, 1337, 400920.856, 00000000, 2b46, 1984;
49, , 2.2862, "", 0.000, 0.000, 9, 9, 0, 0, 0, 0, 0*20b24878\x0d\x0a*3eef4220
#PASSCOM1A, COM1, 0, 53.5, FINESTEERING, 1337, 400922.463, 00000000, 13ff, 1984;
17, unlog passcom2a\x0d\x0a*ef8d2508
```

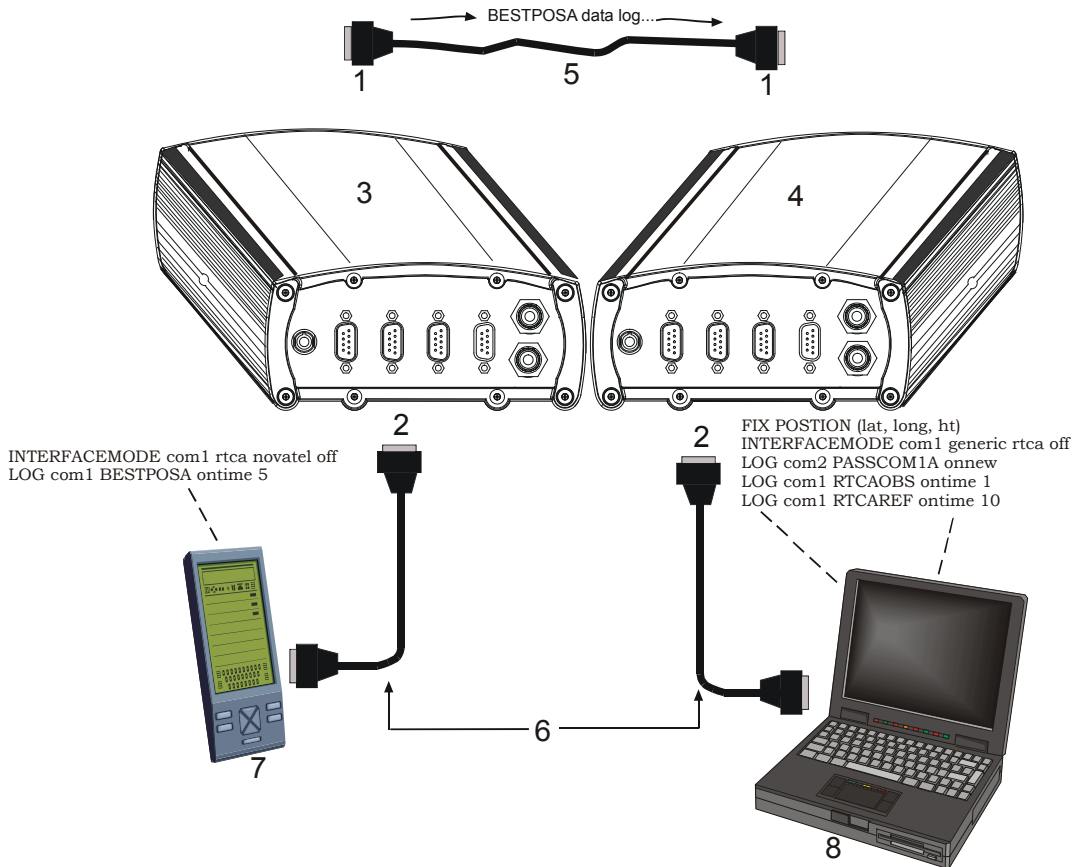
### ASCII Example 2:

```
#PASSCOM2A, COM1, 0, 53.0, FINESTEERING, 1337, 400040.151, 00000000, 2b46, 1984;
80, \x99A\x10\x04\x07yN &\xc6\xea\xf10\x00\x01\xde\x00\x00\x10\xfe\xbf\xfe1\
xfe\x9c\xf4\x03\xe2\xef\x9f\x1f\xf3\xff\xd6\xff\xc3_A~z \xaa\xfe\xbf\xf9\
xd3\xf8\xd4\xf4-\xe8kHo\xe2\x00>\xe0QOC>\xc3\x9c\x11\xff\x7f\xfa1\xf3t\
xf4'\xf4xvo\xe6\x00\x9d*dcd2e989
```

In the example, note that ‘~’ is a printable character.



For example, you could connect two OEMV family receivers together via their COM1 ports such as in the figure below (a rover station to base station scenario). If the rover station is logging BESTPOSA data to the base station, it is possible to use the pass-through logs to pass through the received BESTPOSA data to a disk file (let's call it diskfile.log) at the base station host PC hard disk.



| Reference | Description    | Reference | Description       |
|-----------|----------------|-----------|-------------------|
| 1         | To COM1        | 5         | Data link         |
| 2         | To COM2        | 6         | Serial cables     |
| 3         | Rover receiver | 7         | Pocket PC - rover |
| 4         | Base receiver  | 8         | Laptop PC - base  |

**Figure 12: Pass-Through Log Data**

Under default conditions the two receivers "chatter" back and forth with the *Invalid Command Option* message (due to the command interpreter in each receiver not recognizing the command prompts of the other receiver). This *chattering* in turn causes the accepting receiver to transmit new pass-through logs with the response

data from the other receiver. To avoid this chattering problem, use the INTERFACEMODE command on the accepting port to disable error reporting from the receiving port command interpreter.

If the accepting port's error reporting is disabled by INTERFACEMODE, the BESTPOSA data record passes through and creates two records.

The reason that two records are logged from the accepting receiver is because the first record was initiated by receipt of the BESTPOSA first terminator <CR>. Then the second record followed in response to the BESTPOSA second terminator <LF>.

Note that the time interval between the first character received and the terminating <LF> can be calculated by differencing the two GPS time tags. This pass-through feature is useful for time tagging the arrival of external messages. These messages can be any user-related data. If you are using this feature for tagging external events, it is recommended that the rover receiver be disabled from interpreting commands, so that the receiver does not respond to the messages, using the INTERFACEMODE command, see *page 135*.

If the BESTPOSB binary log data is input to the accepting port (log com2 passcom1a onchanged), the BESTPOSB binary data at the accepting port is converted to a variation of ASCII hexadecimal before it is passed through to COM2 port for logging.

| Field # | Field type     | Data Description                   | Format    | Binary Bytes | Binary Offset |
|---------|----------------|------------------------------------|-----------|--------------|---------------|
| 1       | PASSCOM header | Log header                         |           | H            | 0             |
| 2       | #bytes         | Number of bytes to follow          | Ulong     | 4            | H             |
| 3       | data           | Message data                       | Char [80] | 80           | H+4           |
| 4       | xxxx           | 32-bit CRC (ASCII and Binary only) | Hex       | 4            | H+8+(#bytes)  |
| 5       | [CR][LF]       | Sentence terminator (ASCII only)   | -         | -            | -             |



### 3.3.57 PDPPOS PDP filter position V123

The PDPPOS log contains the pseudorange position computed by the receiver with the PDP filter enabled. See also the PDPFILTER command on *page 159*.

**Message ID:** 469

**Log Type:** Synch

**Recommended Input:**

```
log pdpposa ontime 1
```

**ASCII Example:**

```
#PDPPOSA,COM1,0,75.5,FINESTEERING,1431,494991.000,00040000,a210,35548;
SOL_COMPUTED,SINGLE,51.11635010310,-114.03832575772,1065.5019,-16.9000,
WGS84,4.7976,2.0897,5.3062,"",0.000,0.000,8,8,0,0,0,0,0*3cbfa646
```

| Field # | Field type    | Data Description   | Format  | Binary Bytes | Binary Offset |
|---------|---------------|--|---------|--------------|---------------|
| 1       | PDPPOS header | Log header   |         | H            | 0             |
| 2       | sol status    | Solution status  | Enum    | 4            | H             |
| 3       | pos type      | Position type  | Enum    | 4            | H+4           |
| 4       | lat           | Latitude   | Double  | 8            | H+8           |
| 5       | lon           | Longitude  | Double  | 8            | H+16          |
| 6       | hgt           | Height above mean sea level  | Double  | 8            | H+24          |
| 7       | undulation    | Undulation - the relationship between the geoid and the WGS84 ellipsoid (m) <sup>a</sup> | Float   | 4            | H+32          |
| 8       | datum id#     | Datum ID number  | Enum    | 4            | H+36          |
| 9       | lat $\sigma$  | Latitude standard deviation  | Float   | 4            | H+40          |
| 10      | lon $\sigma$  | Longitude standard deviation   | Float   | 4            | H+44          |
| 11      | hgt $\sigma$  | Height standard deviation  | Float   | 4            | H+48          |
| 12      | stn id        | Base station ID  | Char[4] | 4            | H+52          |
| 13      | diff_age      | Differential age in seconds  | Float   | 4            | H+56          |
| 14      | sol_age       | Solution age in seconds  | Float   | 4            | H+60          |
| 15      | #sats         | Number of satellite vehicles tracked   | Uchar   | 1            | H+64          |
| 16      | #sats soln    | Number of satellites in the solution   | Uchar   | 1            | H+65          |
| 17      | Reserved      |  | Uchar   | 1            | H+66          |
| 18      |               |  | Uchar   | 1            | H+67          |
| 19      |               |  | Uchar   | 1            | H+68          |
| 20      |               |  | Uchar   | 1            | H+69          |
| 21      |               |  | Uchar   | 1            | H+70          |
| 22      |               |  | Uchar   | 1            | H+71          |
| 23      | xxxx          | 32-bit CRC (ASCII and Binary only)   | Hex     | 4            | H+72          |
| 24      | [CR][LF]      | Sentence terminator (ASCII only)   | -       | -            | -             |

- a. When using a datum other than WGS84, the undulation value also includes the vertical shift due to differences between the datum in use and WGS84

### 3.3.58 PDPVEL PDP filter velocity V123

The PDPVEL log contains the pseudorange velocity computed by the receiver with the PDP filter enabled. See also the PDPFILTER command on *page 159*.

**Message ID:** 470

**Log Type:** Synch

**Recommended Input:**

```
log pdpvela ontime 1
```

**ASCII Example:**

```
#PDPVELA,COM1,0,75.0,FINESTEERING,1430,505990.000,00000000,b886,2859;
SOL_COMPUTED,SINGLE,0.150,0.000,27.4126,179.424617,-0.5521,0.0*7746b0fe
```

| Field # | Field type    | Data Description   | Format | Binary Bytes | Binary Offset |
|---------|---------------|--|--------|--------------|---------------|
| 1       | PDPVEL header | Log header   |        | H            | 0             |
| 2       | sol status    | Solution status  | Enum   | 4            | H             |
| 3       | vel type      | Velocity type  | Enum   | 4            | H+4           |
| 4       | latency       | A measure of the latency in the velocity time tag in seconds. It should be subtracted from the time to give improved results.    | Float  | 4            | H+8           |
| 5       | age           | Differential age in seconds  | Float  | 4            | H+12          |
| 6       | hor spd       | Horizontal speed over ground, in meters per second   | Double | 8            | H+16          |
| 7       | trk gnd       | Actual direction of motion over ground (track over ground) with respect to True North, in degrees                                | Double | 8            | H+24          |
| 8       | height        | Height in meters where positive values indicate increasing altitude (up) and negative values indicate decreasing altitude (down) | Double | 8            | H+32          |
| 9       | Reserved      |  | Float  | 4            | H+40          |
| 10      | xxxx          | 32-bit CRC (ASCII and Binary only)   | Hex    | 4            | H+44          |
| 11      | [CR][LF]      | Sentence terminator (ASCII only)   | -      | -            | -             |

---

### 3.3.59 PDPXYZ PDP filter Cartesian position and velocity V123

The PDPXYZ log contains the Cartesian position in X, Y and Z coordinates as computed by the receiver with the PDP filter enabled. See also the PDPFILTER command on *page 159*.

**Message ID:** 471

**Log Type:** Synch

**Recommended Input:**

```
log pdpxyza ontime 1
```

**ASCII Example:**

```
#PDPXYZA,COM1,0,75.5,FINESTEERING,1431,494991.000,00040000,33ce,35548;  
SOL_COMPUTED,SINGLE,-1634531.8128,-3664619.4862,4942496.5025,2.9036,  
6.1657,3.0153,SOL_COMPUTED,SINGLE,-2.5588e-308,-3.1719e-308,3.9151e-308,  
0.0100,0.0100,0.0100,"",0.150,0.000,0.000,8,8,0,0,0,0,0,0*20dbd4f
```

| Field # | Field type    | Data Description  | Format  | Binary Bytes | Binary Offset |
|---------|---------------|---|---------|--------------|---------------|
| 1       | PDPXYZ header | Log header  |         | H            | 0             |
| 2       | P-sol status  | Solution status   | Enum    | 4            | H             |
| 3       | pos type      | Position type   | Enum    | 4            | H+4           |
| 4       | P-X           | Position X-coordinate (m)   | Double  | 8            | H+8           |
| 5       | P-Y           | Position Y-coordinate (m)   | Double  | 8            | H+16          |
| 6       | P-Z           | Position Z-coordinate (m)   | Double  | 8            | H+24          |
| 7       | P-X $\sigma$  | Standard deviation of P-X (m)   | Float   | 4            | H+32          |
| 8       | P-Y $\sigma$  | Standard deviation of P-Y (m)   | Float   | 4            | H+36          |
| 9       | P-Z $\sigma$  | Standard deviation of P-Z (m)   | Float   | 4            | H+40          |
| 10      | V-sol status  | Solution status   | Enum    | 4            | H+44          |
| 11      | vel type      | Velocity type   | Enum    | 4            | H+48          |
| 12      | V-X           | Velocity vector along X-axis (m)  | Double  | 8            | H+52          |
| 13      | V-Y           | Velocity vector along Y-axis (m)  | Double  | 8            | H+60          |
| 14      | V-Z           | Velocity vector along Z-axis (m)  | Double  | 8            | H+68          |
| 15      | V-X $\sigma$  | Standard deviation of V-X (m)   | Float   | 4            | H+76          |
| 16      | V-Y $\sigma$  | Standard deviation of V-Y (m)   | Float   | 4            | H+80          |
| 17      | V-Z $\sigma$  | Standard deviation of V-Z (m)   | Float   | 4            | H+84          |
| 18      | stn ID        | Base station ID   | Char[4] | 4            | H+88          |
| 19      | V-latency     | A measure of the latency in the velocity time tag in seconds. It should be subtracted from the time to give improved results. | Float   | 4            | H+92          |
| 20      | diff_age      | Differential age in seconds   | Float   | 4            | H+96          |
| 21      | sol_age       | Solution age in seconds   | Float   | 4            | H+100         |
| 22      | #sats         | Number of satellite vehicles tracked  | Uchar   | 1            | H+104         |
| 23      | #sats soln    | Number of satellite vehicles used in solution   | Uchar   | 1            | H+105         |
| 24      | Reserved      |   | Uchar   | 1            | H+106         |
| 25      |               |   | Uchar   | 1            | H+107         |
| 26      |               |   | Uchar   | 1            | H+108         |
| 27      |               |   | Uchar   | 1            | H+109         |
| 28      |               |   | Uchar   | 1            | H+110         |
| 29      |               |   | Uchar   | 1            | H+111         |
| 30      | xxxx          | 32-bit CRC (ASCII and Binary only)  | Hex     | 4            | H+112         |
| 31      | [CR][LF]      | Sentence terminator (ASCII only)  | -       | -            | -             |

### 3.3.60 PORTSTATS Port Statistics V123

This log conveys various status parameters of the receiver's COM ports and, if supported, USB ports. The receiver maintains a running count of a variety of status indicators of the data link. This log outputs a report of those indicators.

**Message ID:** 72

**Log Type:** Polled

**Recommended Input:**

```
log portstatsa once
```

**ASCII example:**

```
#PORTSTATSA,COM1,0,59.0,FINESTEERING,1337,403086.241,00000000,a872,1984;  
6,COM1,4450,58494,4450,0,1869,0,0,0,0,  
COM2,5385946,0,5385941,0,192414,0,0,5,0,  
COM3,0,1,0,0,0,0,0,0,0,  
USB1,0,0,0,0,0,0,0,0,0,  
USB2,0,0,0,0,0,0,0,0,0,  
USB3,0,0,0,0,0,0,0,0,0*F7f6ea50
```



Parity and framing errors occur for COM ports if poor transmission lines are encountered or if there is an incompatibility in the data protocol. If errors occur, you may need to confirm the bit rate, number of data bits, number of stop bits and parity of both the transmit and receiving ends. Characters may be dropped when the CPU is overloaded.

| Field # | Field type                              | Data Description   | Format | Binary Bytes | Binary Offset        |
|---------|---|--|--------|--------------|----------------------|
| 1       | PORTSTATS header                        | Log header   |        | H            | 0                    |
| 2       | #port                                   | Number of ports with information to follow   | Long   | 4            | H                    |
| 3       | port                                    | Serial port identifier, see <i>Table 17, COM Serial Port Identifiers</i> on page 88                    | Enum   | 4            | H+4                  |
| 4       | rx chars                                | Total number of characters received through this port  | Ulong  | 4            | H+8                  |
| 5       | tx chars                                | Total number of characters transmitted through this port   | Ulong  | 4            | H+12                 |
| 6       | acc rx chars                            | Total number of accepted characters received through this port   | Ulong  | 4            | H+16                 |
| 7       | dropped chars                           | Number of software overruns  | Ulong  | 4            | H+20                 |
| 8       | interrupts                              | Number of interrupts on this port  | Ulong  | 4            | H+24                 |
| 9       | breaks                                  | Number of breaks<br>(This field does not apply for a USB port and is always set to 0 for USB.)         | Ulong  | 4            | H+28                 |
| 10      | par err                                 | Number of parity errors<br>(This field does not apply for a USB port and is always set to 0 for USB.)  | Ulong  | 4            | H+32                 |
| 11      | fram err                                | Number of framing errors<br>(This field does not apply for a USB port and is always set to 0 for USB.) | Ulong  | 4            | H+36                 |
| 12      | overruns                                | Number of hardware overruns  | Ulong  | 4            | H+40                 |
| 13      | Next port offset = H + 4 + (#port x 40) |  |        |              |                      |
| 14      | xxxx                                    | 32-bit CRC (ASCII and Binary only)   | Hex    | 4            | H+4+<br>(#port x 40) |
| 15      | [CR][LF]                                | Sentence terminator (ASCII only)   | -      | -            | -                    |

### 3.3.61 PSRDOP Pseudorange DOP V123

The dilution of precision data is calculated using the geometry of only those satellites that are currently being tracked and used in the position solution by the receiver. This log is updated once every 60 seconds or whenever a change in the satellite constellation occurs. Therefore, the total number of data fields output by the log is variable and depends on the number of SVs that are being tracked.

- 
- ☒ 1. If a satellite is locked out using the LOCKOUT command, it will still be shown in the PRN list, but it will be significantly de-weighted in the DOP calculation
  - 2. The vertical dilution of precision can be calculated by:  $vdop = \sqrt{pdop^2 - hdop^2}$
- 

**Message ID:** 174

**Log Type:** Asynch

**Recommended Input:**

log psrdopa onchanged

**ASCII Example:**

```
#PSRDOPA,COM1,0,56.5,FINESTEERING,1337,403100.000,00000000,768f,1984;
1.9695,1.7613,1.0630,1.3808,0.8812,5.0,10,14,22,25,1,24,11,5,20,30,7*106de10a
```



When operating in differential mode, you require at least four common satellites at the base and rover. The number of common satellites being tracked at large distances is less than at short distances. This is important because the accuracy of GPS and DGPS positions depend a great deal on how many satellites are being used in the solution (redundancy) and the geometry of the satellites being used (DOP). DOP stands for dilution of precision and refers to the geometry of the satellites. A good DOP occurs when the satellites being tracked and used, are evenly distributed throughout the sky. A bad DOP occurs when the satellites being tracked and used are not evenly distributed throughout the sky or grouped together in one part of the sky.

---

| Field #  | Field type                            | Data Description   | Format | Binary Bytes | Binary Offset       |
|----------|---------------------------------------|--|--------|--------------|---------------------|
| 1        | PSRDOP header                         | Log header   |        | H            | 0                   |
| 2        | gdop                                  | Geometric dilution of precision - assumes 3-D position and receiver clock offset (all 4 parameters) are unknown. | Float  | 4            | H                   |
| 3        | pdop                                  | Position dilution of precision - assumes 3-D position is unknown and receiver clock offset is known.             | Float  | 4            | H+4                 |
| 4        | hdop                                  | Horizontal dilution of precision.  | Float  | 4            | H+8                 |
| 5        | htdop                                 | Horizontal position and time dilution of precision.  | Float  | 4            | H+12                |
| 6        | tdop                                  | Time dilution of precision - assumes 3-D position is known and only the receiver clock offset is unknown.        | Float  | 4            | H+16                |
| 7        | cutoff                                | Elevation cut-off angle.   | Float  | 4            | H+20                |
| 8        | #PRN                                  | Number of satellites PRNs to follow.   | Long   | 4            | H+24                |
| 9        | PRN                                   | PRN of SV PRN tracking, null field until position solution available.  | Ulong  | 4            | H+28                |
| 10...    | Next PRN offset = H + 28 + (#prn x 4) |  |        |              |                     |
| variable | xxxx                                  | 32-bit CRC (ASCII and Binary only)   | Hex    | 4            | H+28+<br>(#prn x 4) |
| variable | [CR][LF]                              | Sentence terminator (ASCII only)   | -      | -            | -                   |



### 3.3.62 PSRPOS Pseudorange Position V123

This log contains the pseudorange position (in metres) computed by the receiver, along with three status flags. In addition, it reports other status indicators, including differential age, which is useful in predicting anomalous behavior brought about by outages in differential corrections.

**Message ID:** 47  
**Log Type:** Synch

#### Recommended Input:

log psrposa ontime 1

#### ASCII Example:

```
#PSRPOSA, COM1, 0, 58.5, FINESTEERING, 1419, 340037.000, 00000040, 6326, 2724;  
SOL_COMPUTED, SINGLE, 51.11636177893, -114.03832396506, 1062.5470, -16.2712,  
WGS84, 1.8532, 1.4199, 3.3168, "", 0.000, 0.000, 12, 12, 0, 0, 0, 06, 0, 33*d200a78c
```



There are variations of DGPS which can easily be perceived as using only one receiver. For example, the US Coast Guard operates a differential correction service which broadcasts GPS differential corrections over marine radio beacons. As a user, all you need is a marine beacon receiver and a GPS receiver to achieve positioning accuracy of 1 to 5 m. In this case, the Coast Guard owns and operates the base receiver at known coordinates. Other examples of users appearing to use only one GPS receiver include FM radio station correction services, privately owned radio transmitters, and corrections carried by communication satellites. Some of the radio receivers have built-in GPS receivers and combined antennas, so they even appear to look as one self-contained unit.

The major factors degrading GPS signals which can be removed or reduced with differential methods are the atmosphere, ionosphere, satellite orbit errors, and satellite clock errors. Some errors which are not removed include receiver noise and multipath.

| Field # | Field type    | Data Description  | Format  | Binary Bytes | Binary Offset |
|---------|---------------|---|---------|--------------|---------------|
| 1       | PSRPOS header | Log header  |         | H            | 0             |
| 2       | sol status    | Solution status (see <i>Table 51, Solution Status on page 249</i> )                               | Enum    | 4            | H             |
| 3       | pos type      | Position type (see <i>Table 50, Position or Velocity Type on page 248</i> )                       | Enum    | 4            | H+4           |
| 4       | lat           | Latitude  | Double  | 8            | H+8           |
| 5       | lon           | Longitude   | Double  | 8            | H+16          |
| 6       | hgt           | Height above mean sea level   | Double  | 8            | H+24          |
| 7       | undulation    | Undulation - the relationship between the geoid and the WGS84 ellipsoid (m) <sup>a</sup>          | Float   | 4            | H+32          |
| 8       | datum id#     | Datum ID number (see <i>Table 21, Reference Ellipsoid Constants on page 97</i> )                  | Enum    | 4            | H+36          |
| 9       | lat $\sigma$  | Latitude standard deviation   | Float   | 4            | H+40          |
| 10      | lon $\sigma$  | Longitude standard deviation  | Float   | 4            | H+44          |
| 11      | hgt $\sigma$  | Height standard deviation   | Float   | 4            | H+48          |
| 12      | stn id        | Base station ID   | Char[4] | 4            | H+52          |
| 13      | diff_age      | Differential age in seconds   | Float   | 4            | H+56          |
| 14      | sol_age       | Solution age in seconds   | Float   | 4            | H+60          |
| 15      | #SVs          | Number of satellite vehicles tracked  | Uchar   | 1            | H+64          |
| 16      | #solnSVs      | Number of satellite vehicles used in solution   | Uchar   | 1            | H+65          |
| 17      | Reserved      |   | Uchar   | 1            | H+66          |
| 18      |               |   | Uchar   | 1            | H+67          |
| 19      |               |   | Uchar   | 1            | H+68          |
| 20      | ext sol stat  | Extended solution status (see <i>Table 53, Extended Solution Status on page 250</i> )             | Hex     | 1            | H+69          |
| 21      | Reserved      |   | Hex     | 1            | H+70          |
| 22      | sig mask      | Signals used mask - if 0, signals used in solution are unknown (see <i>Table 52 on page 250</i> ) | Hex     | 1            | H+71          |
| 23      | xxxx          | 32-bit CRC (ASCII and Binary only)  | Hex     | 4            | H+72          |
| 24      | [CR][LF]      | Sentence terminator (ASCII only)  | -       | -            | -             |

- a. When using a datum other than WGS84, the undulation value also includes the vertical shift due to differences between the datum in use and WGS84

### 3.3.63 PSRTIME Time Offsets from the Pseudorange Filter V123

This log contains the instantaneous receiver clock offsets calculated in the pseudorange filter for each GNSS used in the solution.

**Message ID:** 881  
**Log Type:** Synch

#### Recommended Input:

log psrtimea ontime 1

#### ASCII Example:

```
#PSRTIMEA, COM1, 0, 62.5, FINESTEERING, 1423, 231836.000, 00000000, 462f, 35520;
2,
GPS, -1.2631e-09, 7.1562e-09,
GLONASS, -7.0099e-07, 2.4243e-08*40aa2af1
```



Uses for this log include i) estimating the difference between GPS and GLONASS satellite system times and ii) estimating the difference between UTC and GLONASS system time.

| Field #  | Field type                            | Data Description                             | Format | Binary Bytes | Binary Offset |
|----------|---------------------------------------|--|--------|--------------|---------------|
| 1        | PSRTIME header                        | Log header                                   |        | H            | 0             |
| 2        | #recs                                 | Number of records to follow                  | Ulong  | 4            | H             |
| 3        | system                                | NavigationSystem<br>0 = GPS<br>1 = GLONASS   | Enum   | 4            | H+4           |
| 4        | offset                                | GNSS time offset from the pseudorange filter | Double | 8            | H+8           |
| 5        | offset stdv                           | Time offset standard deviation               | Double | 8            | H+12          |
| variable | Next binary offset = H+4+(#recs x 20) |  |        |              |               |
| variable | xxxx                                  | 32-bit CRC (ASCII and Binary only)           | Hex    | 4            | variable      |
| variable | [CR][LF]                              | Sentence terminator (ASCII only)             | -      | -            | -             |

### 3.3.64 PSRVEL Pseudorange Velocity VI23

In the PSRVEL log the actual speed and direction of the receiver antenna over ground is provided. The velocity measurements sometimes have a latency associated with them. The time of validity is the time tag in the log minus the latency value. See also the table footnote for velocity logs on *page 223*.

The velocity in the PSRVEL log is determined by the pseudorange filter. Velocities from the pseudorange filter are calculated from the Doppler. The PSRVELOCITYTYPE command, see *page 169*, allows you to specify the Doppler source for pseudorange filter velocities.

The velocity status indicates varying degrees of velocity quality. To ensure healthy velocity, the velocity sol-status must also be checked. If the sol-status is non-zero, the velocity is likely invalid. It should be noted that the receiver does not determine the direction a vessel, craft, or vehicle is pointed (heading), but rather the direction of the motion of the GPS antenna relative to the ground.

The latency of the instantaneous Doppler velocity is always 0.15 seconds. The latency represents an estimate of the delay caused by the tracking loops under acceleration of approximately 1 G. For most users, the latency can be assumed to be zero (instantaneous velocity).

**Message ID:** 100  
**Log Type:** Synch

#### Recommended Input:

```
log psrvela ontime 1
```

#### ASCII Example:

```
#PSRVELA,COM1,0,52.5,FINESTEERING,1337,403362.000,00000000,658b,1984;  
SOL_COMPUTED,PSRDIFF,0.250,9.000,0.0698,26.582692,0.0172,0.0*a94e5d48
```



Consider the case where vehicles are leaving a control centre. The control centre's coordinates are known but the vehicles are on the move. Using the control centre's position as a reference, the vehicles are able to report where they are with PSRPOS and their speed and direction with PSRVEL at any time.

---



---

| Field # | Field type    | Data Description  | Format | Binary Bytes | Binary Offset |
|---------|---------------|---|--------|--------------|---------------|
| 1       | PSRVEL header | Log header  |        | H            | 0             |
| 2       | sol status    | Solution status, see <i>Table 51, Solution Status on page 249</i>   | Enum   | 4            | H             |
| 3       | vel type      | Velocity type, see <i>Table 50, Position or Velocity Type on page 248</i>   | Enum   | 4            | H+4           |
| 4       | latency       | A measure of the latency in the velocity time tag in seconds. It should be subtracted from the time to give improved results.                         | Float  | 4            | H+8           |
| 5       | age           | Differential age in seconds   | Float  | 4            | H+12          |
| 6       | hor spd       | Horizontal speed over ground, in meters per second  | Double | 8            | H+16          |
| 7       | trk gnd       | Actual direction of motion over ground (track over ground) with respect to True North, in degrees   | Double | 8            | H+24          |
| 8       | vert spd      | Vertical speed, in meters per second, where positive values indicate increasing altitude (up) and negative values indicate decreasing altitude (down) | Double | 8            | H+32          |
| 9       | Reserved      |   | Float  | 4            | H+40          |
| 10      | xxxx          | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+44          |
| 11      | [CR][LF]      | Sentence terminator (ASCII only)  | -      | -            | -             |

### 3.3.65 PSRXYZ Pseudorange Cartesian Position and Velocity V123

This log contains the receiver's pseudorange position and velocity in ECEF coordinates. The position and velocity status field's indicate whether or not the corresponding data is valid. See *Figure 10, page 261* for a definition of the ECEF coordinates.

The velocity status indicates varying degrees of velocity quality. To ensure healthy velocity, the velocity sol-status must also be checked. If the sol-status is non-zero, the velocity is likely invalid. It should be noted that the receiver does not determine the direction a vessel, craft, or vehicle is pointed (heading), but rather the direction of the motion of the GPS antenna relative to the ground.

The latency of the instantaneous Doppler velocity is always 0.15 seconds. The latency represents an estimate of the delay caused by the tracking loops under acceleration of approximately 1 G. For most users, the latency can be assumed to be zero (instantaneous velocity).

**Message ID:** 243

**Log Type:** Synch

**Recommended Input:**

```
log psrxyza ontime 1
```

**ASCII Example:**

```
#PSRXYZA,COM1,0,58.5,FINESTEERING,1419,340038.000,00000040,4a28,2724;
SOL_COMPUTED,SINGLE,-1634530.7002,-3664617.2823,4942495.5175,1.7971,
2.3694,2.7582,SOL_COMPUTED,DOPPLER_VELOCITY,0.0028,0.0231,-0.0120,
0.2148,0.2832,0.3297,"",0.150,0.000,0.000,12,12,0,0,0,06,0,33*4fdbcd1
```



The instantaneous Doppler is the measured Doppler frequency which consists of the satellite's motion relative to the receiver (Satellite Doppler + User Doppler) and the clock (local oscillator) drift.

| Field # | Field type    | Data Description  | Format  | Binary Bytes | Binary Offset |
|---------|---------------|---|---------|--------------|---------------|
| 1       | PSRXYZ header | Log header  |         | H            | 0             |
| 2       | P-sol status  | Solution status, see <i>Table 51, Solution Status on page 249</i>   | Enum    | 4            | H             |
| 3       | pos type      | Position type, see <i>Table 50, Position or Velocity Type on page 248</i>   | Enum    | 4            | H+4           |
| 4       | P-X           | Position X-coordinate (m)   | Double  | 8            | H+8           |
| 5       | P-Y           | Position Y-coordinate (m)   | Double  | 8            | H+16          |
| 6       | P-Z           | Position Z-coordinate (m)   | Double  | 8            | H+24          |
| 7       | P-X $\sigma$  | Standard deviation of P-X (m)   | Float   | 4            | H+32          |
| 8       | P- Y $\sigma$ | Standard deviation of P-Y (m)   | Float   | 4            | H+36          |
| 9       | P-Z $\sigma$  | Standard deviation of P-Z (m)   | Float   | 4            | H+40          |
| 10      | V-sol status  | Solution status, see <i>Table 51, Solution Status on page 249</i>   | Enum    | 4            | H+44          |
| 11      | vel type      | Velocity type, see <i>Table 50, Position or Velocity Type on page 248</i>   | Enum    | 4            | H+48          |
| 12      | V-X           | Velocity vector along X-axis (m)  | Double  | 8            | H+52          |
| 13      | V-Y           | Velocity vector along Y-axis (m)  | Double  | 8            | H+60          |
| 14      | V-Z           | Velocity vector along Z-axis (m)  | Double  | 8            | H+68          |
| 15      | V-X $\sigma$  | Standard deviation of V-X (m)   | Float   | 4            | H+76          |
| 16      | V-Y $\sigma$  | Standard deviation of V-Y (m)   | Float   | 4            | H+80          |
| 17      | V-Z $\sigma$  | Standard deviation of V-Z (m)   | Float   | 4            | H+84          |
| 18      | stn ID        | Base station ID   | Char[4] | 4            | H+88          |
| 19      | V-latency     | A measure of the latency in the velocity time tag in seconds. It should be subtracted from the time to give improved results. | Float   | 4            | H+92          |
| 20      | diff_age      | Differential age in seconds   | Float   | 4            | H+96          |
| 21      | sol_age       | Solution age in seconds   | Float   | 4            | H+100         |
| 22      | #SVs          | Number of satellite vehicles tracked  | Uchar   | 1            | H+104         |
| 23      | #solnSVs      | Number of satellite vehicles used in solution   | Uchar   | 1            | H+105         |

*Continued on page 392.*

| Field # | Field type   | Data Description   | Format | Binary Bytes | Binary Offset |
|---------|--------------|--|--------|--------------|---------------|
| 24      | Reserved     |  | Char   | 1            | H+106         |
| 25      |              |  | Char   | 1            | H+107         |
| 26      |              |  | Char   | 1            | H+108         |
| 27      | ext sol stat | Extended solution status (see <i>Table 53, Extended Solution Status</i> on page 250)             | Hex    | 1            | H+109         |
| 28      | Reserved     |  | Hex    | 1            | H+110         |
| 29      | sig mask     | Signals used mask - if 0, signals used in solution are unknown (see <i>Table 52</i> on page 250) | Hex    | 1            | H+111         |
| 30      | xxxx         | 32-bit CRC (ASCII and Binary only)   | Hex    | 4            | H+112         |
| 31      | [CR][LF]     | Sentence terminator (ASCII only)   | -      | -            | -             |



### 3.3.66 RANGE Satellite Range Information V123

RANGE contains the channel measurements for the currently tracked satellites. When using this log, please keep in mind the constraints noted along with the description.

It is important to ensure that the receiver clock has been set. This can be monitored by the bits in the *Receiver Status* field of the log header. Large jumps in pseudorange as well as accumulated Doppler range (ADR) occur as the clock is being adjusted. If the ADR measurement is being used in precise phase processing, it is important not to use the ADR if the "parity known" flag in the *ch-tr-status* field is not set as there may exist a half (1/2) cycle ambiguity on the measurement. The tracking error estimate of the pseudorange and carrier phase (ADR) is the thermal noise of the receiver tracking loops only. It does not account for possible multipath errors or atmospheric delays.

If both the L1 and L2 signals are being tracked for a given PRN, two entries with the same PRN appear in the range logs. As shown in *Table 72, Channel Tracking Status on page 395*, these entries can be differentiated by bit 20, which is set if there are multiple observables for a given PRN, and bits 21-22, which denotes whether the observation is for L1 or L2. This is to aid in parsing the data.

**Message ID:** 43

**Log Type:** Synch

**Recommended Input:**

log rangea ontime 30

**ASCII Example:**

```
#RANGEA, COM1, 0, 63.5, FINESTEERING, 1429, 226979.000, 00000000, 5103, 2748;
26,
6, 0, 23359924.081, 0.078, -122757217.106875, 0.015, -3538.602, 43.3, 19967.080,
08109c04,
6, 0, 23359926.375, 0.167, -95654966.812027, 0.019, -2757.355, 36.7, 19960.461,
01309c0b,
21, 0, 20200269.147, 0.038, -106153137.954409, 0.008, -86.289, 49.5, 13397.470,
08109c44,
21, 0, 20200268.815, 0.056, -82716721.366921, 0.008, -67.242, 46.1, 13391.980,
01309c4b,
16, 0, 23945650.428, 0.091, -125835245.287192, 0.024, -2385.422, 41.9, 10864.640,
08109c64,
16, 0, 23945651.399, 0.148, -98053428.283142, 0.028, -1858.773, 37.7, 10859.980,
01309c6b,
.
.
.
44, 12, 19388129.378, 0.335, -103786179.553598, 0.012, 975.676, 36.6, 3726.656,
18119e24,
44, 12, 19388136.659, 0.167, -80722615.862096, 0.000, 758.859, 42.7, 3714.860,
10b19e2b,
43, 8, 20375687.399, 0.253, -108919708.904476, 0.012, -2781.090, 39.1, 10629.934,
18119e84,
43, 8, 20375689.555, 0.177, -84715349.232514, 0.000, -2163.074, 42.2, 10619.916,
10b19e8b*fd2d3125
```



Consider the case where you have a computer to record data at a fixed location, and another laptop in the field also recording data as you travel. Can you take the difference between the recorded location and the known location of the fixed point and use that as an error correction for the recorded data in the field?

The simple answer is yes. You can take the difference between recorded position and known location and apply this as a position correction to your field data. Then, what is the difference between pseudorange and position differencing?

The correct and more standard way of computing this correction is to compute the range error to each GPS satellite being tracked at your fixed location and to apply these range corrections to the observations at your mobile station.

The position corrections method is seldom used in industry. The drawback of this method is that computed corrections vary depending on the location of the fixed station. The geometry is not accounted for between the fixed station and the tracked satellites. Also, position corrections at the fixed site are computed with a certain group of satellites while the field station is tracking a different group of satellites. In general, when the position correction method is used, the farther the fixed and field stations are apart, the less accurate the solution.

The range corrections method is more commonly used in industry. The advantage of using this method is that it provides consistent range corrections and hence field positions regardless of the location of your fixed station. You are only able to obtain a "good" differential position if both the fixed and field stations are tracking the same four satellites at a minimum.

DGPS refers to using 1 base receiver at a known location and 1 or more rover receivers at unknown locations. As the position of the base is accurately known, we can determine the error that is present in GPS at any given instant by either of the two methods previously described. We counter the bias effects present in GPS including: ionospheric, tropospheric, ephemeris, receiver and satellite clock errors. You could choose either method depending on your application and the accuracy required.

**Table 69: Tracking State**

| State | Description                      | State | Description            |
|-------|----------------------------------|-------|------------------------|
| 0     | L1 Idle                          | 7     | L1 Frequency-lock loop |
| 1     | L1 Sky search                    | 8     | L2 Idle                |
| 2     | L1 Wide frequency band pull-in   | 9     | L2 P-code alignment    |
| 3     | L1 Narrow frequency band pull-in | 10    | L2 Search              |
| 4     | L1 Phase lock loop               | 11    | L2 Phase lock loop     |
| 5     | L1 Reacquisition                 | 19    | L2 Steering            |
| 6     | L1 Steering                      |       |                        |

**Table 70: Correlator Type**

| State | Description                           |
|-------|---------------------------------------|
| 0     | N/A                                   |
| 1     | Standard correlator: spacing = 1 chip |
| 2     | Narrow Correlator: spacing < 1 chip   |
| 3     | Reserved                              |
| 4     | Pulse Aperture Correlator (PAC)       |
| 5-6   | Reserved                              |

**Table 71: Channel Tracking Example**

|                           | N7               |    |              |    | N6         |    |             |    | N5 |    |          |    | N4               |    |                    |    | N3               |             |                 |                | N2 |    |   |                    | N1 |   |   |   | N0 |   |   |   |
|---------------------------|------------------|----|--------------|----|------------|----|-------------|----|----|----|----------|----|------------------|----|--------------------|----|------------------|-------------|-----------------|----------------|----|----|---|--------------------|----|---|---|---|----|---|---|---|
| <b>0x</b>                 | 0                |    |              |    | 8          |    |             |    | 1  |    |          |    | 0                |    |                    |    | 9                |             |                 |                | C  |    |   |                    | 0  |   |   |   | 4  |   |   |   |
| <b>Bit #</b>              | 31               | 30 | 29           | 28 | 27         | 26 | 25          | 24 | 23 | 22 | 21       | 20 | 19               | 18 | 17                 | 16 | 15               | 14          | 13              | 12             | 11 | 10 | 9 | 8                  | 7  | 6 | 5 | 4 | 3  | 2 | 1 | 0 |
| <b>Binary<sup>a</sup></b> | 0                | 0  | 0            | 0  | 1          | 0  | 0           | 0  | 0  | 0  | 0        | 1  | 0                | 0  | 0                  | 0  | 1                | 0           | 0               | 1              | 1  | 1  | 0 | 0                  | 0  | 0 | 0 | 0 | 0  | 0 | 1 | 0 |
| <b>Data</b>               | Chan. Assignment |    | Reserved (R) |    | Primary L1 | R  | Signal Type |    |    |    | Grouping | R  | Satellite System |    | Correlator Spacing |    | Code locked flag | Parity flag | Phase lock flag | Channel Number |    |    |   | Tracking State     |    |   |   |   |    |   |   |   |
| <b>Value</b>              | Automatic        |    |              |    | Primary    |    | L1 C/A      |    |    |    | Grouped  |    | GPS              |    | PAC                |    | Locked           | Known       | Locked          | Channel 0      |    |    |   | L1 Phase Lock Loop |    |   |   |   |    |   |   |   |

a. For a complete list of hexadecimal and binary equivalents please refer to the conversions section of the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm>.

**Table 72: Channel Tracking Status**

| Nibble # | Bit # | Mask       | Description       | Range Value  |
|----------|-------|------------|-------------------|--|
| N0       | 0     | 0x00000001 | Tracking state    | 0-11, see <i>Table 69, Tracking State on page 394</i>  |
|          | 1     | 0x00000002 |                   |  |
|          | 2     | 0x00000004 |                   |  |
|          | 3     | 0x00000008 |                   |  |
| N1       | 4     | 0x00000010 | SV channel number | 0-n (0 = first, n = last)<br>n depends on the receiver |
|          | 5     | 0x00000020 |                   |  |
|          | 6     | 0x00000040 |                   |  |
|          | 7     | 0x00000080 |                   |  |
|          | 8     | 0x00000100 |                   |  |
|          | 9     | 0x00000200 |                   |  |
|          | 10    | 0x00000400 | Phase lock flag   | 0 = Not locked, 1 = Locked                             |

*Continued on page 396.*

| Nibble # | Bit #      | Mask       | Description                            | Range Value  |
|----------|------------|------------|--|--|
|          | 11         | 0x00000800 | Parity known flag                      | 0 = Not known, 1 = Known   |
| N3       | 12         | 0x00001000 | Code locked flag                       | 0 = Not locked, 1 = Locked   |
|          | 13         | 0x00002000 | Correlator type                        | 0-7, see <i>Table 70, Correlator Type</i> on page 395  |
|          | 14         | 0x00004000 |  |  |
|          | 15         | 0x00008000 |  |  |
| N4       | 16         | 0x00010000 | Satellite system                       | 0 = GPS<br>1 = GLONASS<br>2 = WAAS<br>3-6 = Reserved<br>7 = Other  |
|          | 17         | 0x00020000 |  |  |
|          | 18         | 0x00040000 |  |  |
|          | 19         | 0x00080000 | Reserved                               |  |
| N5       | 20         | 0x00100000 | Grouping <sup>a</sup>                  | 0 = Not grouped, 1 = Grouped   |
|          | 21         | 0x00200000 | Signal type                            | Dependant on satellite system above:<br>GPS:                      GLONASS:<br>0 = L1 C/A              0 = L1 C/A<br>5 = L2 P                 5 = L2 P<br>9 = L2 P codeless<br>17 = L2C<br>SBAS:                    Other:<br>0 = L1 C/A              19 = OmniSTAR<br>23 = CDGPS |
|          | 22         | 0x00400000 |  |  |
|          | 23         | 0x00800000 |  |  |
| 24       | 0x01000000 |            |  |  |
| N6       | 25         | 0x02000000 |  |  |
|          | 26         | 0x04000000 | Forward Error Correction               | 0 = Not FEC, 1 = FEC   |
|          | 27         | 0x08000000 | Primary L1 channel                     | 0 = Not primary, 1 = Primary   |
| N7       | 28         | 0x10000000 | Carrier phase measurement <sup>b</sup> | 0 = Half Cycle Not Added,<br>1 = Half Cycle Added  |
|          | 29         | Reserved   |  |  |
|          | 30         | 0x40000000 | PRN lock flag <sup>c</sup>             | 0 = PRN Not Locked Out,  |
|          | 31         | 0x80000000 | Channel assignment                     | 0 = Automatic, 1 = Forced  |

- a. Grouped: Channel has an associated channel (L1/L2 pairs)
- b. This bit is zero until the parity is known and the parity known flag (bit 11) is set to 1.
- c. A PRN can be locked out using the LOCKOUT command, see also *page 142*.

| Field #  | Field type                            | Data Description   | Format | Binary Bytes | Binary Offset       |
|----------|---------------------------------------|--|--------|--------------|---------------------|
| 1        | RANGE header                          | Log header   |        | H            | 0                   |
| 2        | # obs                                 | Number of observations with information to follow <sup>a</sup>   | Long   | 4            | H                   |
| 3        | PRN/ slot                             | Satellite PRN number of range measurement (GPS: 1 to 32, SBAS: 120 to 138, and GLONASS: 38 to 61, see <i>Section 1.3</i> on <i>page 30</i> ) | UShort | 2            | H+4                 |
| 4        | glofreq                               | (GLONASS Frequency + 7), see <i>Section 1.3</i> on <i>page 30</i> .  | UShort | 2            | H+6                 |
| 5        | psr                                   | Pseudorange measurement (m)  | Double | 8            | H+8                 |
| 6        | psr std                               | Pseudorange measurement standard deviation (m)   | Float  | 4            | H+16                |
| 7        | adr                                   | Carrier phase, in cycles (accumulated Doppler range)   | Double | 8            | H+20                |
| 8        | adr std                               | Estimated carrier phase standard deviation (cycles)  | Float  | 4            | H+28                |
| 9        | dopp                                  | Instantaneous carrier Doppler frequency (Hz)   | Float  | 4            | H+32                |
| 10       | C/No                                  | Carrier to noise density ratio<br>C/No = 10[log <sub>10</sub> (S/N <sub>0</sub> )] (dB-Hz)   | Float  | 4            | H+36                |
| 11       | locktime                              | # of seconds of continuous tracking (no cycle slipping)  | Float  | 4            | H+40                |
| 12       | ch-tr-status                          | Tracking status (see 72, <i>Channel Tracking Status</i> on <i>page 395</i> and the example in <i>Table 71</i> )                              | ULong  | 4            | H+44                |
| 13...    | Next PRN offset = H + 4 + (#obs x 44) |  |        |              |                     |
| variable | xxxx                                  | 32-bit CRC (ASCII and Binary only)   | Hex    | 4            | H+4+<br>(#obs x 44) |
| variable | [CR][LF]                              | Sentence terminator (ASCII only)   | -      | -            | -                   |

a. Satellite PRNs may have two lines of observations, one for the L1 frequency and the other for L2.

### 3.3.67 RANGECMP Compressed Version of the RANGE Log V123

**Message ID:** 140  
**Log Type:** Synch

**Recommended Input:**

log rangecmpa ontime 10

**Example:**

```
#RANGECMPA, COM1, 0, 63.5, FINESTEERING, 1429, 226780.000, 00000000, 9691, 2748;
26,
049c10081857f2df1f4a130ba2888eb9600603a709030000,
0b9c3001225bf58f334a130bb1e2bed473062fa609020000,
449c1008340400e0aaa9a109a7535bac2015cf71c6030000,
4b9c300145030010a6a9a10959c2f09120151f7166030000,
...
0b9d301113c8ffefc284000c6ea051dbf3089da1a0010000,
249d1018c6b7f67fa228820af2e5e39830180ae1a8030000,
2b9d301165c4f8ffb228820a500a089f31185fe0a8020000,
449d1018be18f41f2aacad0a1a934efc40074ecf88030000,
4b9d301182b9f69f38acad0a3e3ac28841079fcb88020000,
849d101817a1f95f16d7af0a69fbeb1fa401d3fd064030000,
8b9d30112909fb2f20d7af0a9f24a687521ddece64020000,
249e1118af4e0470f66d4309a0a631cd642cf5b821320000,
2b9eb110a55903502f6e4309ee28d1ad032c7cb7e1320000,
849e1118b878f54f4ed2aa098c35558a532bde1765220000,
8b9eb110abcff71f5ed2aa09cb6ad0f9032b9d16c5220000*0eeead18
```



Consider the case where commercial vehicles are leaving a control centre. The control centre's coordinates are known but the vehicles are on the move. Using the control centre's position as a reference, the vehicles are able to report where they are at any time. Post-processed information gives more accurate comparisons.

Post-processing can provide post-mission position and velocity using raw GPS collected from the vehicles. The logs necessary for post-processing include:

```
RANGECMPB ONTIME 1
RAWEPHEMB ONNEW
```

- ☒ Above, we describe and give an example of data collection for post-processing. OEMV-based output is compatible with post-processing software from the Waypoint Products Group, Novatel Inc. See also [www.novatel.com](http://www.novatel.com) for details.

Table 73: Range Record Format (RANGECMP only)

| Data                    | Bit(s) first to last | Length (bits) | Scale Factor                                      | Units  |
|-------------------------|----------------------|---------------|---|--------|
| Channel Tracking Status | 0-31                 | 32            | see Table 72, Channel Tracking Status on page 395 | -      |
| Doppler Frequency       | 32-59                | 28            | 1/256   | Hz     |
| Pseudorange (PSR)       | 60-95                | 36            | 1/128   | m      |
| ADR <sup>a</sup>        | 96-127               | 32            | 1/256   | cycles |
| StdDev-PSR              | 128-131              | 4             | see note b  | m      |
| StdDev-ADR              | 132-135              | 4             | (n + 1)/512                                       | cycles |
| PRN/Slot <sup>c</sup>   | 136-143              | 8             | 1   | -      |
| Lock Time <sup>d</sup>  | 144-164              | 21            | 1/32  | s      |
| C/No <sup>e</sup>       | 165-169              | 5             | (20 + n)  | dB-Hz  |
| Reserved                | 170-191              | 22            |   |        |

a. ADR (Accumulated Doppler Range) is calculated as follows:

$$\text{ADR\_ROLLS} = (\text{RANGECMP\_PSR} / \text{WAVELENGTH} + \text{RANGECMP\_ADR}) / \text{MAX\_VALUE}$$

Round to the closest integer

IF (ADR\_ROLLS ≤ 0)

$$\text{ADR\_ROLLS} = \text{ADR\_ROLLS} - 0.5$$

ELSE

$$\text{ADR\_ROLLS} = \text{ADR\_ROLLS} + 0.5$$

At this point integerise ADR\_ROLLS

$$\text{CORRECTED\_ADR} = \text{RANGECMP\_ADR} - (\text{MAX\_VALUE} * \text{ADR\_ROLLS})$$

where

ADR has units of cycles

WAVELENGTH = 0.1902936727984 for GPS L1 **Note:** GLONASS satellites emit L1 and L2 carrier waves at a satellite-specific frequency, refer to the GNSS Reference Book for more on GLONASS frequencies.

WAVELENGTH = 0.2442102134246 for GPS L2

MAX\_VALUE = 8388608

| b. | Code | StdDev-PSR (m) |
|----|------|----------------|
|    | 0    | 0.050          |
|    | 1    | 0.075          |
|    | 2    | 0.113          |
|    | 3    | 0.169          |
|    | 4    | 0.253          |
|    | 5    | 0.380          |
|    | 6    | 0.570          |
|    | 7    | 0.854          |
|    | 8    | 1.281          |
|    | 9    | 2.375          |
|    | 10   | 4.750          |
|    | 11   | 9.500          |
|    | 12   | 19.000         |
|    | 13   | 38.000         |
|    | 14   | 76.000         |
|    | 15   | 152.000        |

c. GPS: 1 to 32, SBAS: 120 to 138, and GLONASS: 38 to 61, see Section 1.3 on page 30.

d. The Lock Time field of the RANGECMP log is constrained to a maximum value of 2,097,151 which represents a lock time of 65535.96875 s (2097151 ÷ 32).

- e. C/No is constrained to a value between 20-51 dB-Hz. Thus, if it is reported that C/No = 20 dB-Hz, the actual value could be less. Likewise, if it is reported that C/No = 51, the true value could be greater.

| Field #  | Field Type   | Data Description  | Format | Binary Bytes | Binary Offset               |
|----------|--|---|--------|--------------|-----------------------------|
| 1        | RANGECMP header                                    | Log header  |        | H            | 0                           |
| 2        | #obs   | Number of satellite observations with information to follow.  | Long   | 4            | H                           |
| 3        | 1st range record                                   | Compressed range log in format of <i>Table 73 on page 399</i> | Hex    | 24           | H+4                         |
| 4        | Next rangecmp offset = $H + 4 + (\#obs \times 24)$ |   |        |              |                             |
| variable | xxxx   | 32-bit CRC (ASCII and Binary only)                            | Hex    | 4            | $H + 4 + (\#obs \times 24)$ |
| variable | [CR][LF]   | Sentence terminator (ASCII only)                              | -      | -            | -                           |



### 3.3.68 RANGEGPSL1 L1 Version of the RANGE Log V123

This log is identical to the RANGE log, see *page 393*, except that it only includes L1 GPS observations.

**Message ID:** 631  
**Log Type:** Synch

#### Recommended Input:

```
log rangegpsl1a ontime 30
```

#### ASCII Example:

```
#RANGEGPSL1A, COM1, 0, 57.0, FINESTEERING, 1337, 404766.000, 00000000, 5862, 1984;
10,
14, 0, 21773427.400, 0.037, -114420590.433332, 0.006, -2408.171, 49.9, 14963.280,
18109c04,
22, 0, 24822942.668, 0.045, -130445851.055756, 0.009, -3440.031, 48.0, 22312.971,
08109c24,
25, 0, 20831000.299, 0.033, -109468139.214586, 0.006, 1096.876, 50.7, 7887.840,
08109c44,
1, 0, 20401022.863, 0.032, -107208568.887106, 0.006, -429.690, 51.1, 10791.500,
18109c64,
24, 0, 23988223.932, 0.074, -126058964.619453, 0.013, 2519.418, 43.8, 493.550,
18109c84,
11, 0, 22154466.593, 0.043, -116423014.826717, 0.007, -1661.273, 48.4, 11020.952,
08109ca4,
5, 0, 24322401.516, 0.067, -127815012.260616, 0.012, -1363.596, 44.6, 6360.282,
18109cc4,
20, 0, 22294469.347, 0.043, -117158267.467388, 0.008, 2896.813, 48.5, 4635.968,
08109ce4,
30, 0, 23267589.649, 0.051, -122271969.418761, 0.009, 822.194, 47.0, 4542.270,
08109d04,
23, 0, 24975654.673, 0.058, -131247903.805678, 0.009, 3395.097, 45.9, 406.762,
18109d24*be4b7d70
```



Since the RANGEGPSL1 log includes only L1 GPS observations, it is smaller in size than the RANGE log which contain entries for both L1 and L2. Use the RANGEGPSL1 log when data throughput is limited and you are only interested in GPS L1 range data. For L1 only models, RANGE and RANGEGPSL1 logs are identical.

| Field #  | Field type                            | Data Description  | Format | Binary Bytes | Binary Offset       |
|----------|---------------------------------------|---|--------|--------------|---------------------|
| 1        | RANGEGPSL1 header                     | Log header  |        | H            | 0                   |
| 2        | # obs                                 | Number of L1 observations with information to follow                    | Long   | 4            | H                   |
| 3        | PRN                                   | Satellite PRN number of range measurement (GPS: 1 to 32)                | UShort | 2            | H+4                 |
| 4        | Reserved                              |   | UShort | 2            | H+6                 |
| 5        | psr                                   | Pseudorange measurement (m)   | Double | 8            | H+8                 |
| 6        | psr std                               | Pseudorange measurement standard deviation (m)                          | Float  | 4            | H+16                |
| 7        | adr                                   | Carrier phase, in cycles (accumulated Doppler range)                    | Double | 8            | H+20                |
| 8        | adr std                               | Estimated carrier phase standard deviation (cycles)                     | Float  | 4            | H+28                |
| 9        | dopp                                  | Instantaneous carrier Doppler frequency (Hz)                            | Float  | 4            | H+32                |
| 10       | C/No                                  | Carrier to noise density ratio<br>$C/No = 10[\log_{10}(S/N_0)]$ (dB-Hz) | Float  | 4            | H+36                |
| 11       | locktime                              | Number of seconds of continuous tracking (no cycle slipping)            | Float  | 4            | H+40                |
| 12       | ch-tr-status                          | Tracking status (see 72, <i>Channel Tracking Status</i> on page 395)    | ULong  | 4            | H+44                |
| 13...    | Next PRN offset = H + 4 + (#obs x 44) |   |        |              |                     |
| variable | xxxx                                  | 32-bit CRC (ASCII and Binary only)                                      | Hex    | 4            | H+4+<br>(#obs x 44) |
| variable | [CR][LF]                              | Sentence terminator (ASCII only)  | -      | -            | -                   |

### 3.3.69 RAWALM Raw Almanac Data V123

This log contains the undecoded almanac subframes as received from the satellite. For more information on Almanac data, refer to the GPS SPS Signal Specification (refer to the *Standards and References* section of the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm>.)

**Message ID:** 74

**Log Type:** Asynch

**Recommended Input:**

log rawalma onchanged

**ASCII Example:**

```
#RAWALMA, COM1, 0, 56.0, SATTIME, 1337, 405078.000, 00000000, cc1b, 1984;
1337, 589824.000, 43,
3, 8b04e4839f35433a5590f5aefdf3900a10c9aaa6f40187925e50b9f03003f,
27, 8b04e483a1325b9cde9007f2fd5300a10da5562da3adc0966488dd01001a,
4, 8b04e483a1b44439979006e2fd4f00a10d15d96b3b021e6c6c5f23fef3c,
28, 8b04e483a3b05c5509900b7cfd5800a10cc483e2bfa1d2613003bd050017,
5, 8b04e483a43745351c90fcb0fd4500a10d8a800f0328067e5df8b6100031,
57, 8b04e483a6337964e036d74017509f38e13112df8dd92d040605eaaaaaaa,
6, 8b04e483a6b54633e390fa8bfd3f00a10d4facbc80b322528f62146800ba,
29, 8b04e483a8b05d47f7901b20fd5700a10ce02d570ed40a0a2216412400cb,
7, 8b04e483a935476dee90fb94fd4300a10d93aba327b7794ae853c02700ba,
.
.
.
1, 8b04e483d8b641305a901b9dfd5a00a10ce92f48f1ba0a5dccc7500003b,
25, 8b04e483dab25962259004fcfd4c00a10dc154eee5c555d7a2a5010d000d,
2, 8b04e483db37424aa6900720fd4f00a10c5ad89baa4dc1460790b6fc000f,
26, 8b04e483dd305a878c901d32fd5b00a10c902eb7f51db6b6ce95c701fff4*83cae97a
```



The OEMV family of receivers automatically saves almanacs in their non-volatile memory (NVM), therefore creating an almanac boot file is not necessary.

| Field #  | Field type                                      | Data Description                          | Format | Binary Bytes | Binary Offset             |
|----------|---|---|--------|--------------|---------------------------|
| 1        | RAWALM header                                   | Log header                                |        | H            | 0                         |
| 2        | ref week  | Almanac reference week number             | Ulong  | 4            | H                         |
| 3        | ref secs  | Almanac reference time (s)                | Ulong  | 4            | H+4                       |
| 4        | subframes                                       | Number of subframes to follow             | Ulong  | 4            | H+8                       |
| 5        | svid  | SV ID (satellite vehicle ID) <sup>a</sup> | UShort | 2            | H+12                      |
| 6        | data  | Subframe page data                        | Hex    | 30           | H+14                      |
| 7...     | Next subframe offset = H + 12 + (subframe x 32) |   |        |              |                           |
| variable | xxxx  | 32-bit CRC (ASCII and Binary only)        | Hex    | 4            | H + 12 + (32 x subframes) |
| variable | [CR][LF]  | Sentence terminator (ASCII only)          | -      | -            | -                         |

- a. A value between 1 and 32 for the SV ID indicates the PRN of the satellite. Any other values indicate the page ID. See section 20.3.3.5.1.1, *Data ID and SV ID*, of ICD-GPS-200C for more details. To obtain copies of ICD-GPS-200, see ARINC in the *Standards and References* section of the *GNSS Reference Book* found on our Web site.

### 3.3.70 RAWEPHEM Raw Ephemeris V123

This log contains the raw binary information for subframes one, two and three from the satellite with the parity information removed. Each subframe is 240 bits long (10 words - 24 bits each) and the log contains a total 720 bits (90 bytes) of information (240 bits x 3 subframes). This information is preceded by the PRN number of the satellite from which it originated. This message is not generated unless all 10 words from all 3 frames have passed parity.

Ephemeris data whose TOE (Time Of Ephemeris) is older than six hours is not shown.

**Message ID: 41**

**Log Type: Asynch**

**Recommended Input:**

log rawephema onnew

**ASCII Example:**

```
#RAWEPHEMA,COM1,15,60.5,FINESTEERING,1337,405297.175,00000000,97b7,1984;
3,1337,403184,8b04e4818da44e50007b0d9c05ee664ffbfef695df763626f00001b03c6b3,
8b04e4818e2b63060536608fd8cdaa051803a41261157ea10d2610626f3d,
8b04e4818ead0006aa7f7ef8ffda25c1a69a14881879b9c6ffa79863f9f2*0bb16ac3
.
.
.
#RAWEPHEMA,COM1,0,60.5,SATTIME,1337,405390.000,00000000,97b7,1984;
1,1337,410400,8b04e483f7244e50011d7a6105ee664ffbfef695df9e1643200001200aa92,
8b04e483f7a9e1faab2b16a27c7d41fb5c0304794811f7a10d40b564327e,
8b04e483f82c00252f57a782001b282027a31c0fba0fc525ffac84e10a06*c5834a5b
```



A way to use only one receiver and achieve 1 to 5 meter accuracy is to use precise orbit and clock files. Three types of GPS ephemeris, clock and earth orientation solutions are compiled by an elaborate network of GPS receivers around the world all monitoring the satellite characteristics. IGS rapid orbit data is processed to produce files that correct the satellite clock and orbit parameters. Since there is extensive processing involved, these files are available on a delayed schedule from the US National Geodetic Survey at: <http://www.ngs.noaa.gov/GPS/GPS.html>

Precise ephemeris files are available today to correct GPS data which was collected a few days ago. All you need is one GPS receiver and a computer to process on. Replace the ephemeris data with the precise ephemeris data and post-process to correct range values.

| Field # | Field type      | Data Description                   | Format | Binary Bytes | Binary Offset |
|---------|-----------------|------------------------------------|--------|--------------|---------------|
| 1       | RAWEPHEM header | Log header                         |        | H            | 0             |
| 2       | prn             | Satellite PRN number               | Ulong  | 4            | H             |
| 3       | ref week        | Ephemeris reference week number    | Ulong  | 4            | H+4           |
| 4       | ref secs        | Ephemeris reference time (s)       | Ulong  | 4            | H+8           |
| 5       | subframe1       | Subframe 1 data                    | Hex    | 30           | H+12          |
| 6       | subframe2       | Subframe 2 data                    | Hex    | 30           | H+42          |
| 7       | subframe3       | Subframe 3 data                    | Hex    | 30           | H+72          |
| 8       | xxxx            | 32-bit CRC (ASCII and Binary only) | Hex    | 4            | H+102         |
| 9       | [CR][LF]        | Sentence terminator (ASCII only)   | -      | -            | -             |

### 3.3.71 RAWGPSSUBFRAME Raw Subframe Data V123

This log contains the raw GPS subframe data.

A raw GPS subframe is 300 bits in total. This includes the parity bits which are interspersed with the raw data ten times in six bit chunks, for a total of 60 parity bits. Note that in Field #5, the 'data' field below, we have stripped out these 60 parity bits, and only the raw subframe data remains, for a total of 240 bits. There are two bytes added onto the end of this 30 byte packed binary array to pad out the entire data structure to 32 bytes in order to maintain 4 byte alignment.

**Message ID:** 25  
**Log Type:** Asynch

#### Recommended Input:

```
log rawgpssubframea onnew
```

#### ASCII Example:

```
#RAWGPSSUBFRAMEA,COM1,59,62.5,SATTIME,1337,405348.000,00000000,f690,1984;2,22,4,8b04e483f3b17ee037a3732fe0fc8ccf074303ebdf2f6505f5aaaaaaaa9,2*41e768e4
...
#RAWGPSSUBFRAMEA,COM1,35,62.5,SATTIME,1337,405576.000,00000000,f690,1984;4,25,2,8b04e48406a8b9fe8b364d786ee827ff2f062258840ea4a10e20b964327e,4*52d460a7
...
#RAWGPSSUBFRAMEA,COM1,0,62.5,SATTIME,1337,400632.000,00000000,f690,1984;20,9,3,8b04e4826aadff3557257871000a26fc34a31d7a300bede5ffa3de7e06af,20*55d16a4a
```



The RAWGPSSUBFRAME log can be used to receive the data bits with the parity bits stripped out. Alternately, you can use the RAWGPSWORD log to receive the parity bits in addition to the data bits.

| Field # | Field type            | Data Description                                     | Format  | Binary Bytes    | Binary Offset |
|---------|-----------------------|--|---------|-----------------|---------------|
| 1       | RAWGPSSUBFRAME header | Log header   |         | H               | 0             |
| 2       | decode #              | Frame decoder number                                 | Ulong   | 4               | H             |
| 3       | PRN                   | Satellite PRN number                                 | Ulong   | 4               | H+4           |
| 4       | subfr id              | Subframe ID  | Ulong   | 4               | H+8           |
| 5       | data                  | Raw subframe data                                    | Hex[30] | 32 <sup>a</sup> | H+12          |
| 6       | chan                  | Signal channel number that the frame was decoded on. | Ulong   | 4               | H+44          |
| 7       | xxxx                  | 32-bit CRC (ASCII and Binary only)                   | Hex     | 4               | H+48          |
| 8       | [CR][LF]              | Sentence terminator (ASCII only)                     | -       | -               | -             |

a. In the binary log case, an additional 2 bytes of padding are added to maintain 4-byte alignment



### 3.3.72 RAWGPSWORD Raw Navigation Word V123

This message contains the framed raw navigation words. Each log contains a new 30 bit navigation word (in the least significant 30 bits), plus the last 2 bits of the previous word (in the most significant 2 bits). The 30 bit navigation word contains 24 bits of data plus 6 bits of parity. The GPS time stamp in the log header is the time that the first bit of the 30 bit navigation word was received. Only navigation data that has passed parity checking appears in this log. One log appears for each PRN being tracked every 0.6 seconds if logged ONNEW or ONCHANGED.

**Message ID:** 407

**Log Type:** Asynch

#### Recommended Input:

```
log rawgpsworda onnew
```

#### ASCII Example:

```
#RAWGPSWORDA, COM1, 0, 58.5, FINESTEERING, 1337, 405704.473, 00000000, 9b16, 1984;  
14, 7ff9f5dc*8e7b8721
```

...

```
#RAWGPSWORDA, COM1, 0, 57.0, FINESTEERING, 1337, 405783.068, 00000000, 9b16, 1984;  
1, 93feff8a*6dd62c81
```

...

```
#RAWGPSWORDA, COM1, 0, 55.5, FINESTEERING, 1337, 405784.882, 00000000, 9b16, 1984;  
5, fffff8ce*a948b4de
```



The RAWGPSWORD log can be used to receive the parity bits in addition to the data bits. Alternately, you can use the RAWGPSSUBFRAME log which already has the parity bits stripped out.

| Field # | Field type        | Data Description                   | Format | Binary Bytes | Binary Offset |
|---------|-------------------|------------------------------------|--------|--------------|---------------|
| 1       | RAWGPSWORD header | Log header                         |        | H            | 0             |
| 2       | PRN               | Satellite PRN number               | Ulong  | 4            | H             |
| 3       | nav word          | Raw navigation word                | Ulong  | 4            | H+4           |
| 4       | xxxx              | 32-bit CRC (ASCII and Binary only) | Hex    | 4            | H+8           |
| 5       | [CR][LF]          | Sentence terminator (ASCII only)   | -      | -            | -             |

### 3.3.73 RAWLBANDFRAME Raw L-band Frame Data V13\_CDGPS

This log contains the raw L-band frame data if you are tracking CDGPS. The RAWLBANDPACKET is output for OmniSTAR tracking.

- 
- ☒ 1. In addition to a NovAtel receiver with L-band capability, use of the free CDGPS service is required. Contact NovAtel for details. Contact information may be found on the back of this manual or you can refer to the *Customer Service* section in the *OEMV Family Installation and Operation User Manual*.
  - 2. Please use the RAWLBANDPACKET log for raw OmniSTAR frame data, see page 412.
- 

**Message ID:** 732  
**Log Type:** Asynch

**Recommended Input:**

log rawbandframea onnew

**ASCII Example:**

```
#RAWLBANDFRAMEA,COM2,0,73.5,FINESTEERING,1295,152802.068,00000040,4f80,34461;
9,1a1e,600,f6,00,62,35,c8,cd,34,e7,6a,a1,37,44,8f,a8,24,71,90,d0,5f,94,2d,94,
3c,74,9c,f0,12,a3,4c,a7,30,aa,b6,2e,27,dd,dc,24,ba,d3,76,8d,76,d9,e7,83,1a,c8
,81,b0,62,1c,69,88,23,70,2a,06,c0,fc,f8,80,2c,72,f1,2e,6b,c2,5b,ec,03,70,d3,f
3,fe,ef,37,3d,17,37,1b,cf,be,af,d1,02,15,96,d1,f6,58,56,ac,bd,a3,11,12,d0,3d,
11,27,8a,87,28,0c,0f,52,70,b3,2f,0c,0c,62,2d,b8,69,6c,52,10,df,7d,bb,08,d6,ca
,a9,5e,77,66,96,c2,a0,63,3b,98,34,bc,d5,47,64,e0,00,37,10,4a,f7,c1,b6,83,8f,0
6,94,21,ff,b4,27,15,b0,60,40,02,b4,af,9c,9d,c2,d4,ea,95,68,86,0f,0a,9d,2d,36,
52,68,65,b8,a2,0b,00,21,80,64,8a,72,ff,59,b7,79,b9,49,fd,f5,3c,48,1c,2f,77,f1
,b2,9e,58,0a,81,05,1f,00,7b,00,1e,68,c9,a3,12,56,b8,2a,32,df,d9,ea,03,9b,16,c
6,17,2f,33,b3,5f,c4,f9,d2,97,75,64,06,52,a1,b2,3a,4b,69,e7,eb,0f,97,d3,e6,bf,
de,af,37,c6,10,13,9b,dc,c9,e3,22,80,78,3f,78,90,d5,9f,d3,5f,af,1f,7a,75,ef,77
,8e,de,ac,00,32,2e,79,fb,3f,65,f3,4f,28,77,b4,6d,f2,6f,31,24,b2,40,76,37,27,b
c,95,33,15,01,76,d5,f1,c4,75,16,e6,c6,ab,f2,fe,34,d9,c3,55,85,61,49,e6,a4,4e,
8b,2a,60,57,8a,e5,77,02,fc,9c,7d,d4,40,4c,1d,11,3c,9b,8e,c3,73,d3,3c,0d,ff,18
.
.
.
,7a,21,05,cb,12,f6,dd,c3,df,69,62,f5,70*3791693b
```



The data signal is structured to perform well in difficult, or foliated conditions, so the service is available more consistently and has a higher degree of service reliability.

| Field # | Field type           | Data Description                   | Format      | Binary Bytes | Binary Offset |
|---------|----------------------|------------------------------------|-------------|--------------|---------------|
| 1       | RAWLBANDFRAME header | Log header                         |             | H            | 0             |
| 2       | frame#               | Frame number (maximum = 9)         | Ushort      | 2            | H+2           |
| 3       | channelcode          | 10-bit channel code word           | Ushort      | 2            | H+4           |
| 4       | data                 | Raw L-band frame data              | Uchar[1200] | 1200         | H+6           |
| 5       | xxxx                 | 32-bit CRC (ASCII and Binary only) | Hex         | 4            | H+1206        |
| 6       | [CR][LF]             | Sentence terminator (ASCII only)   | -           | -            | -             |

### 3.3.74 RAWLBANDPACKET Raw L-band Data Packet V13\_VBS or V3\_HP

This log contains the raw L-band packet data. The RAWLBANDPACKET log is only output for OmniSTAR tracking. If you are tracking CDGPS, only the RAWLBANDFRAME log is output.

- 
- In addition to a NovAtel receiver with L-band capability, a subscription to the OmniSTAR service is required. Contact NovAtel for details. Contact information may be found on the back of this manual or you can refer to the *Customer Service* section in the *OEMV Family Installation and Operation User Manual*.
- 

**Message ID:** 733  
**Log Type:** Asynch

**Recommended Input:**

log rawbandpacketa onnew

**ASCII Example:**

```
#RAWLBANDPACKETA,COM2,0,77.0,FINESTEERING,1295,238642.610,01000040,c5b1,34461
;9,07,de,3a,f9,df,30,7b,0d,cb*7e5205a8
```



OmniSTAR currently has several high-powered satellites in use around the world. They provide coverage for most of the Earth's land areas. Subscriptions are sold by geographic area. Any regional OmniSTAR service center can sell and activate subscriptions for any area. They may be arranged prior to travelling to a new area, or after arrival. Contact OmniSTAR at [www.omnistar.com](http://www.omnistar.com) for further details.

---

| Field # | Field type            | Data Description                   | Format     | Binary Bytes | Binary Offset |
|---------|-----------------------|------------------------------------|------------|--------------|---------------|
| 1       | RAWLBANDPACKET header | Log header                         |            | H            | 0             |
| 2       | #recs                 | Number of records to follow        | Ulong      | 4            | H             |
| 3       | data                  | Raw L-band data packet.            | Uchar[128] | 128          | H +4          |
| 4       | xxxx                  | 32-bit CRC (ASCII and Binary only) | Hex        | 4            | H+128         |
| 5       | [CR][LF]              | Sentence terminator (ASCII only)   | -          | -            | -             |

### 3.3.75 RAWWAASFRAME Raw SBAS Frame Data V123\_SBAS

This log contains the raw SBAS frame data of 226 bits (8-bit preamble, 6-bit message type and 212 bits of data but without a 24-bit CRC). Only frame data with a valid preamble and CRC are reported.

**Message ID:** 287

**Log Type:** Asynch

#### Recommended Input:

```
log rawwaasframea onnew
```

#### ASCII Example:

```
#RAWWAASFRAMEA,COM1,0,39.0,SATTIME,1337,405963.000,00000000,58e4,1984;29,122,
10,5328360984c80130644dc53800c004b1244000000000000000000000,29*7b398c7a
#RAWWAASFRAMEA,COM1,0,43.0,SATTIME,1337,405964.000,00000000,58e4,1984;29,122,
3,9a0e9ffc035ffff5ffc00dfc008044004005ffdfbfabb9b96217b80,29*f2139bad
#RAWWAASFRAMEA,COM1,0,43.0,SATTIME,1337,405965.000,00000000,58e4,1984;29,122,
2,c608bff9ffdfbfec00bfa4019ffdfdfbfec04c0097bb9f27bb97940,29*364848b7
...
#RAWWAASFRAMEA,COM1,0,44.5,SATTIME,1337,405983.000,00000000,58e4,1984;29,122,
2,c608bff5ffdfbfec00ffa8015ffdfdfbfec804c0017bb9f27bb97940,29*a5dc4590
```



The RAWWAASFRAME log output contains all the raw data required for an application to compute its own SBAS correction parameters.

| Field # | Field type           | Data Description   | Format    | Binary Bytes    | Binary Offset |
|---------|----------------------|--|-----------|-----------------|---------------|
| 1       | RAAWWAASFRAME header | Log header   |           | H               | 0             |
| 2       | decode #             | Frame decoder number   | Ulong     | 4               | H             |
| 3       | PRN                  | SBAS satellite PRN number  | Ulong     | 4               | H+4           |
| 4       | WAASmsg id           | SBAS frame ID  | Ulong     | 4               | H+8           |
| 5       | data                 | Raw SBAS frame data. There are 226 bits of data and 6 bits of padding. | Uchar[29] | 32 <sup>a</sup> | H+12          |
| 6       | chan                 | Signal channel number that the frame was decoded on                    | Ulong     | 4               | H+44          |
| 7       | xxxx                 | 32-bit CRC (ASCII and Binary only)                                     | Hex       | 4               | H+48          |
| 8       | [CR][LF]             | Sentence terminator (ASCII only)                                       | -         | -               | -             |

a. In the binary log case, an additional 3 bytes of padding are added to maintain 4-byte alignment

### 3.3.76 REFSTATION Base Station Position and Health V123\_RT20 or V23\_RT2

This log contains the ECEF Cartesian position of the base station as received through the RTCM, RTCMV3, RTCA, or CMR message. It also features a time tag, the health status of the base station, and the station ID. This information is set at the base station using the FIX POSITION command and the DGPSTXID command. See *Figure 10, page 261* for a definition of the ECEF coordinates.

The base station health, Field #6, may be one of 8 values (0 to 7). Values 0 through 5 indicate the scale factor that multiply satellite UDRE one-sigma differential error values. Below are values 0 to 5 and their corresponding UDRE scale factors:

0: 1 (Health OK) 1: 0.75 2: 0.5 3: 0.3 4: 0.2 5: 0.1

The base station health field only applies to RTCM base stations. A value of 6 means that the base station transmission is not monitored and a value of 7 means that the base station is not working.

**Message ID:** 175  
**Log Type:** Asynch

#### Recommended Input:

log refstationa onchanged

#### ASCII Example:

```
#REFSTATIONA, COM1, 0, 66.5, FINESTEERING, 1364, 490401.124, 80000000, 4e46, 2310;  
00000000, -1634532.443, -3664608.907, 4942482.713, 0, RTCA, "AAAA"*1e2a0508
```

**Table 74: Base Station Status**

| Bit # | Mask       | Description                   | Bit = 0 | Bit = 1 |
|-------|------------|-------------------------------|---------|---------|
| 0     | 0x00000001 | Validity of the base station. | Valid   | Invalid |

**Table 75: Base Station Type**

| Base Station Type (Binary) (ASCII) | Description                      |
|------------------------------------|----------------------------------|
| 0                                  | NONE<br>Base station is not used |
| 1                                  | RTCM<br>Base station is RTCM     |
| 2                                  | RTCA<br>Base station is RTCA     |
| 3                                  | CMR<br>Base station is CMR       |
| 4                                  | RTCMV3<br>Base station is RTCMV3 |



The REFSTATION log can be used for checking the operational status of a remotely located base station. You can verify that the base station is operating properly without travelling to it. This is especially useful for RTK work on long baselines.

| Field # | Field type        | Data Description   | Format  | Binary Bytes   | Binary Offset |
|---------|-------------------|--|---------|----------------|---------------|
| 1       | REFSTATION header | Log header   |         | H              | 0             |
| 2       | status            | Status of the base station information (see <i>Table 74</i> below)     | ULong   | 4              | H             |
| 3       | x                 | ECEF X value   | Double  | 8              | H+4           |
| 4       | y                 | ECEF Y value   | Double  | 8              | H+12          |
| 5       | z                 | ECEF Z value   | Double  | 8              | H+20          |
| 6       | health            | Base station health, see the 2nd paragraph on the previous page        | Ulong   | 4              | H+28          |
| 7       | stn type          | Base station type (see <i>Table 75, Base Station Type</i> on page 414) | Enum    | 4              | H+32          |
| 8       | stn ID            | Base station ID  | Char[5] | 8 <sup>a</sup> | H+36          |
| 9       | xxxx              | 32-bit CRC (ASCII and Binary only)                                     | Hex     | 4              | H+44          |
| 10      | [CR][LF]          | Sentence terminator (ASCII only)                                       | -       | -              | -             |

a. In the binary log case, an additional 3 bytes of padding are added to maintain 4-byte alignment

### 3.3.77 ROVERPOS ROVER Position using ALIGN\_V123\_ALIGN

**ALIGN** generates distance and bearing information between a “Master” and “Rover” receiver. This log outputs the position information of the rover when using the **ALIGN** feature. Refer to the **ALIGN** application note on our Web site at <http://www.novatel.com/support/applicationnotes.htm>.



**ALIGN** is useful for obtaining the relative directional heading of a vessel/body, separation heading between two vessels/bodies, or heading information with moving base and pointing applications.

You must have an **ALIGN**-capable receiver to use this log, see *Table 103* on page 565.

- ✉ The log can be output at YZ Model Rover only if it is receiving the RTCAREFEXT message from the Master. The log can be output at any Master if Master is receiving HEADINGEXTA or HEADINGEXTB from the YZ Rover.

**Message ID:** 1052 (ROVERPOS)

**Log Type:** ASynch

**Recommended Input:**

log roverposa onchanged

**Example 1:**

```
#ROVERPOSA, COM1, 0, 21.5, FINESTEERING, 1544, 340322.000, 00000008, 7453, 4655;
SOL_COMPUTED, NARROW_INT, 51.11605565964, -114.03854655975, 1055.8559, -
16.9000, WGS84, 0.0130, 0.0122, 0.0206, "RRRR", 0.0, 0.0, 13, 12, 12, 11, 0, 0, 0, 0*635b3a1
c
```

- ✉ Asynchronous logs, such as ROVERPOS, should only be logged ONCHANGED. Otherwise, the most current data is not output when it is available. This is especially true of the ONTIME trigger, which may cause inaccurate time tags to result.



| Field # | Field Type      | Field Description                                 | Binary Format | Binary Bytes | Binary Offset |
|---------|-----------------|---|---------------|--------------|---------------|
| 1       | ROVERPOS header | Log Header  |               | H            | 0             |
| 2       | sol stat        | Solution Status, see <i>Table 51 on page 249</i>  | Enum          | 4            | H             |
| 3       | pos type        | Position Type see <i>Table 50 on page 248</i>     | Enum          | 4            | H+4           |
| 4       | lat             | Rover WGS84 Latitude in degrees                   | Double        | 8            | H+8           |
| 5       | long            | Rover WGS84 Longitude in degrees                  | Double        | 8            | H+16          |
| 6       | hgt             | Rover MSL Height in metres                        | Double        | 8            | H+24          |
| 7       | undulation      | Undulation in metres                              | Float         | 4            | H+32          |
| 8       | datum id#       | WGS84 (default)                                   | Enum          | 4            | H+36          |
| 9       | lat $\sigma$    | Latitude Std in metres                            | Float         | 4            | H+40          |
| 10      | long $\sigma$   | Longitude Std in metres                           | Float         | 4            | H+44          |
| 11      | hgt $\sigma$    | Height Std in metres                              | Float         | 4            | H+48          |
| 12      | stn id          | Receiver ID (currently, "RRRR")                   | Char[4]       | 4            | H+52          |
| 13      | Reserved        |   | Float         | 4            | H+56          |
| 14      |                 |   | Float         | 4            | H+60          |
| 15      | #SVs            | Number of satellite vehicles tracked              | Uchar         | 1            | H+64          |
| 16      | #solnSVs        | Number of satellite vehicles used in solution     | Uchar         | 1            | H+65          |
| 17      | #obs            | Number of observations with information to follow | Uchar         | 1            | H+66          |
| 18      | #multi          | Number of satellites above the mask angle with L2 | Uchar         | 1            | H+67          |
| 19      | Reserved        |   | Uchar         | 1            | H+68          |
| 20      |                 |   | Uchar         | 1            | H+69          |
| 21      |                 |   | Uchar         | 1            | H+70          |
| 22      |                 |   | Uchar         | 1            | H+71          |
| 23      | xxxx            |   | HEX           | 1            | H+72          |
| 24      | [CR][LF]        | Sentence Terminator (ASCII only)                  | -             | -            | -             |

### 3.3.78 RTCA Standard Logs V123\_DGPS

#### RTCA1 DIFFERENTIAL GPS CORRECTIONS

Message ID: 10

#### RTCAEPHEM EPHEMERIS AND TIME INFORMATION

Message ID: 347

#### RTCAOBS BASE STATION OBSERVATIONS V123\_RT20 or V23\_RT2

Message ID: 6

#### RTCAOBS2 BASE STATION OBSERVATIONS 2 V123\_RT20 or V23\_RT2

Message ID: 805

#### RTCAREF BASE STATION PARAMETERS V123\_RT20 or V23\_RT2

Message ID: 11

- 
- ☒ 1. The above messages can be logged with an A or B suffix for an ASCII or Binary output with a NovAtel header followed by Hex or Binary raw data respectively.
  - 2. When you plan to send both RTCAOBS2 and RTCAOBS messages, ensure you send the RTCAOBS2 message first, before RTCAOBS.
  - 3. RTCADATA logs output the details of the above logs if they have been sent.
- 

The RTCA (Radio Technical Commission for Aviation Services) Standard is being designed to support Differential Global Navigation Satellite System (DGNSS) Special Category I (SCAT-I) precision instrument approaches. The RTCA Standard is in a preliminary state. Described below is NovAtel's current support for this standard. It is based on "Minimum Aviation System Performance Standards DGNSS Instrument Approach System: Special Category I (SCAT-I)".<sup>1</sup>

NovAtel has defined four proprietary RTCA Standard Type 7 binary-format messages, RTCAOBS, RTCAOBS2, RTCAREF and RTCAEPHEM for base station transmissions. These can be used with either single or dual-frequency NovAtel receivers. The RTCA message format outperforms the RTCM format in the following ways, among others:

- a more efficient data structure (lower overhead)
- better error detection
- allowance for a longer message, if necessary

RTCAREF and RTCAOBS, respectively, correspond to the RTCM Type 3 and Type 59 logs used in single-frequency-only measurements. Both are NovAtel-proprietary RTCA Standard Type 7 messages with an 'N' primary sub-label.

Refer to the *Receiving and Transmitting Corrections* section in the *OEMV Installation and Operation*

---

1. For further information on RTCA Standard messages, you may wish to refer to:

*Minimum Aviation System Performance Standards - DGNSS Instrument Approach System: Special Category I (SCAT-I)*, Document No. RTCA/DO-217 (April 19, 1995); Appx A, Pg 21

---

*Manual* for more information on using these message formats for differential operation.

### **Input Example**

```
interfacemode com2 none RTCA
fix position 51.1136 -114.0435 1059.4
log com2 rtcaobs2 ontime 1
log com2 rtcaobs ontime 1
log com2 rtcaref ontime 10
log com2 rtca1 ontime 5
log com2 rtcaephem ontime 10 1
```

### **CDGPS Corrections Over a Serial Port**

This feature allows any OEMV receiver to receive Modified RTCA (MRTCA) corrections via a serial port to obtain a CDGPS position. This is useful on a receiver, such as the OEMV-2, that does not have the necessary RF components to track the CDGPS signal directly. Currently, you must use this feature in combination with a CDGPS-capable receiver like an OEMV-1 or OEMV-3, which can access the CDGPS signals and then re-broadcast them to MRTCA corrections.

Use the interface mode called MRTCA. If the corrections are input on COM2, enter:

```
INTERFACEMODE COM2 MRTCA NONE
```

for the receiver to output a CDGPS position.

Refer also to the INTERFACEMODE command on *page 135*.

### 3.3.79 RTCADATA1 Differential GPS Corrections V123\_DGPS

See Section 3.3.78 starting on page 418 for information on RTCA standard logs.

**Message ID:** 392  
**Log Type:** Synch

**Recommended Input:**

```
log rtcadata1a ontime 10 3
```

**ASCII Example:**

```
#RTCADATA1A,COM1,0,60.0,FINESTEERING,1364,493614.000,00100000,606b,2310;
414.000000000,0,9,
30,-6.295701472,111,-0.019231669,1.000000000,
2,-4.720861644,60,-0.021460577,1.000000000,
6,-11.464165041,182,-0.015610195,1.000000000,
4,-6.436236222,7,-0.021744921,1.000000000,
5,-5.556760025,39,0.003675566,1.000000000,
10,-14.024430156,181,-0.013904139,1.000000000,
7,-5.871886130,48,-0.016165427,1.000000000,
25,-22.473942049,59,-0.003024942,1.000000000,
9,-28.422760762,130,-0.048257797,1.000000000*56d5182f
```

## RTCA1

This log enables transmission of RTCA Standard format Type 1 messages from the receiver when operating as a base station. Before this message can be transmitted, the receiver FIX POSITION command must be set, see *page 115*. The RTCA log is accepted by a receiver operating as a rover station over a COM port after an INTERFACEMODE port RTCA command is issued, see *page 135*.

The RTCA Standard for SCAT-I stipulates that the maximum age of differential correction (Type 1) messages accepted by the rover station cannot be greater than 22 seconds. See the DGPSTIMEOUT command on *page 105* for information regarding DGPS delay settings.

The RTCA Standard also stipulates that a base station shall wait five minutes after receiving a new ephemeris before transmitting differential corrections. Refer to the DGPSEPHMDELAY command on *page 103* for information regarding ephemeris delay settings.

The basic SCAT-I Type 1 differential correction message is as follows:

**Format:** Message length = 11 + (6\*obs): (83 bytes maximum)

| Field Type    | Data                                  | Scaling   | Bits | Bytes   |
|---------------|---------------------------------------|-----------|------|---------|
| SCAT-I header | – Message block identifier            | -         | 8    | 6       |
|               | – Base station ID                     | -         | 24   |         |
|               | – Message type                        | -         | 8    |         |
|               | – Message length                      | -         | 8    |         |
| Type 1 header | – Modified z-count                    | 0.2 s     | 13   | 2       |
|               | – Acceleration error bound            | -         | 3    |         |
| Type 1 data   | – Satellite ID                        | -         | 6    | 6 * obs |
|               | – Pseudorange correction <sup>a</sup> | 0.02 m    | 16   |         |
|               | – Issue of data                       | -         | 8    |         |
|               | – Range rate correction <sup>a</sup>  | 0.002 m/s | 12   |         |
|               | – UDRE                                | 0.2 m     | 6    |         |
| CRC           | Cyclic redundancy check               | -         |      | 3       |

- a. The pseudorange correction and range rate correction fields have a range of  $\pm 655.34$  meters and  $\pm 4.049$  m/s respectively. Any satellite which exceeds these limits are not included.



At the base station it is possible to log out the contents of the standard corrections in a form that is easier to read or process. These larger variants have the correction fields broken out into standard types within the log, rather than compressed into bit fields. This can be useful if you wish to modify the format of the corrections for a non-standard application, or if you wish to look at the corrections for system debugging purposes. These variants have "DATA" as part of their names (for example, RTCADATA1).

| Field #  | Field type                            | Data Description  | Format | Binary Bytes   | Binary Offset |
|----------|---------------------------------------|---|--------|----------------|---------------|
| 1        | RTCADATA1 header                      | Log header  | -      | H              | 0             |
| 2        | z-count                               | Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris. | Double | 8              | H             |
| 3        | AEB                                   | Acceleration Error Bound  | Uchar  | 4 <sup>a</sup> | H+8           |
| 4        | #prn                                  | Number of satellite corrections with information to follow  | Ulong  | 4              | H+12          |
| 5        | PRN/slot                              | Satellite PRN number of range measurement (GPS: 1-32 and SBAS: 120 to 138.)                         | Ulong  | 4              | H+16          |
| 6        | range                                 | Pseudorange correction (m)  | Double | 8              | H+20          |
| 7        | IODE                                  | Issue of ephemeris data   | Uchar  | 4 <sup>a</sup> | H+28          |
| 8        | range rate                            | Pseudorange rate correction (m/s)   | Double | 8              | H+32          |
| 9        | UDRE                                  | User differential range error   | Float  | 4              | H+40          |
| 10...    | Next prn offset = H+16 + (#prns x 28) |   |        |                |               |
| variable | xxxx                                  | 32-bit CRC (ASCII and Binary only)  | Hex    | 4              | variable      |
| variable | [CR][LF]                              | Sentence terminator (ASCII only)  | -      | -              | -             |

a. In the binary log case, an additional 3 bytes of padding are added to maintain 4-byte alignment

### 3.3.80 RTCADATAEPHEM Ephemeris and Time Information V123\_DGPS

See Section 3.3.78 starting on page 418 for information on RTCA standard logs.

#### RTCAEPHEM Type 7

An RTCAEPHEM (RTCA Satellite Ephemeris Information) message contains raw satellite ephemeris information. It can be used to provide a rover receiver with a set of GPS ephemerides. Each message contains a complete ephemeris for one satellite and the GPS time of transmission from the base. The message is 102 bytes (816 bits) long. This message should be sent once every 5-10 seconds (The faster this message is sent, the quicker the rover station receives a complete set of ephemerides). Also, the rover receiver automatically sets an approximate system time from this message if time is still unknown. Therefore, this message can be used in conjunction with an approximate position to improve time to first fix (TTFF).

**Message ID:** 393

**Log Type:** Synch

#### Recommended Input:

```
log rtcadataephema ontime 10 7
```

#### ASCII Example:

```
#RTCADATAEPHEMA,COM1,0,49.0,FINESTEERING,1364,494422.391,00100000,d869,2310;
78,2,340,494422,4,0,
8b0550a0f0a455100175e6a09382232523a9dc04f307794a00006415c8a98b0550a0f12a070b1
2394e4f991f8d09e903cd1e4b0825a10e669c794a7e8b0550a0f1acffe54f81e9c0004826b947
d725ae063beb05ffa17c07067d*c9dc4f88
```



A hot position is when the receiver has a saved almanac, saved recent ephemeris data and an approximate position.

A hot position aids the time to first fix (TTFF). The TTFF is the actual time required by a GPS receiver to achieve a position solution.

---



---

| Field # | Field type           | Data Description                   | Format  | Binary Bytes    | Binary Offset |
|---------|----------------------|------------------------------------|---------|-----------------|---------------|
| 1       | RTCADATAEPHEM header | Log header                         | -       | H               | 0             |
| 2       | des                  | NovAtel designator                 | Uchar   | 1               | H             |
| 3       | subtype              | RTCA message subtype               | Uchar   | 3 <sup>a</sup>  | H+1           |
| 4       | week                 | GPS week number (weeks)            | Ulong   | 4               | H+4           |
| 5       | sec                  | Seconds into the week (seconds)    | Ulong   | 4               | H+8           |
| 6       | prn                  | PRN number                         | Ulong   | 4               | H+12          |
| 7       | Reserved             |                                    | Uchar   | 4 <sup>b</sup>  | H+16          |
| 8       | raw data             | Raw ephemeris data                 | Hex[90] | 92 <sup>a</sup> | H+20          |
| 9       | xxxx                 | 32-bit CRC (ASCII and Binary only) | Hex     | 4               | H+112         |
| 10      | [CR][LF]             | Sentence terminator (ASCII only)   | -       | -               | -             |

- a. In the binary log case an additional 2 bytes of padding are added to maintain 4 byte alignment
- b. In the binary log case an additional 3 bytes of padding are added to maintain 4 byte alignment



### 3.3.81 RTCADATAOBS Base Station Observations V123\_RT20 or V23\_RT2

See Section 3.3.78 starting on page 418 for information on RTCA standard logs.

#### RTCAOBS Type 7

An RTCAOBS (RTCA Base-Station Satellite Observations) message contains base station satellite observation information. It is used to provide range observations to the rover receiver, and should be sent every 1 or 2 seconds.

- 
- Do not log RTCADATAOBS or RTCA2DATAOBS with an offset. A period of 1 or 2 seconds, as stated above, is acceptable. See also the LOG command starting on page 143.
- 

This log is made up of variable-length messages up to 255 bytes long. The maximum number of bits in this message is  $[140 + (92 \times N)]$ , where  $N$  is the maximum number of satellite record entries transmitted. Using the RTKSVENTRIES command, see page 180, you can define  $N$  to be anywhere from 4 to 12; the default value is 12.

**Message ID:** 394  
**Log Type:** Synch

#### Recommended Input:

```
log rtcadataobsa ontime 2
```

#### ASCII Example:

```
#RTCADATAOBSA, COM1, 0, 47.0, FINESTEERING, 1364, 494469.000, 00100000, 9025, 2310;
78,
1, 2.0270986000000000e+07, 69.000000000, 0, 8, 2,
3, 3, 4.000000000, -3.500000000, 0.241999999, 0.207000002, TRUE, 180,
5, 3, 3, 569234.000000000, -1.750000000, 0.717999995, 1.340999961, TRUE, 180,
7, 3, 3, 756774.600000000, -1.250000000, 0.054000001, -0.119999997, TRUE, 180,
30, 3, 3, 445544.200000000, -1.250000000, 0.140000001, 0.344999999, TRUE, 180,
4, 3, 3, 1897221.200000000, -0.750000000, 0.361999989, 1.179000020, TRUE, 180,
6, 3, 3, 2883369.000000000, -0.500000000, -0.751999974, -1.922999978, TRUE, 180,
10, 3, 3, 2860119.800000000, -0.250000000, -0.546000004, -1.944000006, TRUE,
180, 25, 3, 3, 4734110.200000000, -0.750000000, 0.474000007, 2.013000011,
TRUE, 180*dd9699f5
```



Transmission of the base station observations is necessary for the highest precision applications. The base station observations are used by the rover for carrier phase ambiguity resolution.

---

| Field #  | Field type                          | Data Description  | Format | Binary Bytes   | Binary Offset |
|----------|-------------------------------------|---|--------|----------------|---------------|
| 1        | RTCADATAOBS header                  | Log header  | -      | H              | 0             |
| 2        | des                                 | NovAtel designator  | Uchar  | 1              | H             |
| 3        | subtype                             | RTCA message subtype  | Uchar  | 3 <sup>a</sup> | H+1           |
| 4        | min psr                             | Minimum pseudorange   | Double | 8              | H+4           |
| 5        | sec                                 | Seconds into the GPS week                                     | Float  | 4              | H+12          |
| 6        | Reserved                            |   | Long   | 4              | H+16          |
| 7        | #ids                                | Number of Transmitter IDs with information to follow          | Ulong  | 4              | H+20          |
| 8        | trans ID                            | Transmitter ID  | Uchar  | 1              | H+24          |
| 9        | L1 lock                             | L1 lock flag  | Uchar  | 1              | H+25          |
| 10       | L2 lock                             | L2 lock flag  | Uchar  | 2 <sup>b</sup> | H+26          |
| 11       | L1 psr                              | L1 pseudorange offset (2/10 m)                                | Double | 8              | H+28          |
| 12       | L2 psr                              | L2 pseudorange offset (1/4 m)                                 | Double | 8              | H+36          |
| 13       | L1 ADR                              | L1 carrier phase offset, accumulated Doppler range (2/1000 m) | Float  | 4              | H+44          |
| 14       | L2 ADR                              | L2 carrier phase offset, accumulated Doppler range (3/1000 m) | Float  | 4              | H+48          |
| 15       | L2 encrypt                          | L2 not encrypted?<br>0 = FALSE<br>1 = TRUE                    | Enum   | 4              | H+52          |
| 16       | Reserved                            |   | Long   | 4              | H+56          |
| 17...    | Next id offset = H+24 + (#ids x 36) |   |        |                |               |
| variable | xxxx                                | 32-bit CRC (ASCII and Binary only)                            | Hex    | 4              | variable      |
| variable | [CR][LF]                            | Sentence terminator (ASCII only)                              | -      | -              | -             |

- a. In the binary log case, an additional 2 bytes of padding are added to maintain 4-byte alignment
- b. In the binary log case, an additional 1 byte of padding is added to maintain 4-byte alignment

### 3.3.82 RTCADATA2OBS Base Station Observations 2 V123\_RT20 or V23\_RT2

See Section 3.3.78 starting on page 418 for information on RTCA standard logs.

#### RTCAOBS2 Type 7

An RTCAOBS2 (RTCA Base-Station Satellite Observations subtype 2) message supports GPS, GLONASS and L1/L2 RTK differential operation. It contains base station satellite observation information. It is used to provide range observations to the rover receiver, and should be sent every 1 or 2 seconds. See also the RTCADATAOBS notebox on page 425.

This log is made up of variable-length messages up to 255 bytes long. The maximum number of bits in this message is  $[128 + (108 \times N)]$ , where  $N$  is the maximum number of satellite record entries transmitted.

The RTCAOBS2 message is the same as the RTCAOBS message except for the determination of the L1 pseudorange offset for each transmitter. The L1 ADR, L2 PSR and L2 ADR are all calculated the same as RTCAOBS. Instead of determining the minimum pseudorange, as in RTCAOBS, RTCAOBS2 relies on a constellation specific nominal offset and the receiver GPS time bias. The nominal offset values for some different satellite types are shown in Table 76 below.

**Table 76: RTCAOBS2 Satellite Type Offsets**

| Satellite Type | Nominal Offset |
|----------------|----------------|
| GPS            | 23,000 km      |
| GLONASS        | 22,000 km      |
| Pseudolite     | 0 km           |

**Message ID:** 808

**Log Type:** Synch

#### Recommended Input:

log rtcadata2obsa ontime 2

#### ASCII Example:

```
#RTCADATA2OBSA, COM1, 0, 63.5, FINESTEERING, 1416, 508872.000, 00140008, e0c5, 2690;
78, 3, 0.000000000, 72.000000000, 0, 13,
44, 135, 0, -2809276.000000000, -0.102000000, 5.877472455e-39, 0.000000000, TRUE, 43,
21, 131, 0, -2763150.200000000, -0.016000000, 5.877472455e-39, 0.000000000, TRUE, 19,
18, 227, 0, -2284827.400000000, 0.090000000, 5.877472455e-39, 0.000000000, TRUE, 84,
60, 118, 0, -1049837.400000000, 0.074000000, 5.877472455e-39, 0.000000000, TRUE, 201,
26, 30, 0, -1406884.400000000, 0.062000000, 5.877472455e-39, 0.000000000, TRUE, 184,
43, 30, 0, -984645.600000000, 0.040000000, 5.877472455e-39, 0.000000000, TRUE, 184,
22, 217, 0, -651966.600000000, -0.002000000, 5.877472455e-39, 0.000000000, TRUE, 23,
24, 0, 0, -205779.800000000, 0.070000000, 5.877472455e-39, 0.000000000, TRUE, 0,
3, 223, 0, -407386.400000000, -0.048000000, 5.877472455e-39, 0.000000000, FALSE, 60,
45, 114, 0, -53743.200000000, -0.088000000, 5.877472455e-39, 0.000000000, TRUE, 176,
7, 126, 0, 263919.200000000, -0.020000000, 5.877472455e-39, 0.000000000, TRUE,
```

```
250,6,34,0,1336444.200000000,-0.102000000,5.877472455e-39,0.000000000,
TRUE,209,
19,206,0,1943816.400000000,-0.048000000,5.877472455e-39,0.000000000,TRUE,217
*afe9ae2e
```



Transmission of the base station observations is necessary for the highest precision applications. The base station observations are used by the rover for carrier phase ambiguity resolution.

| Field #  | Field type                          | Data Description  | Format | Binary Bytes   | Binary Offset |
|----------|-------------------------------------|---|--------|----------------|---------------|
| 1        | RTCADATA2-OBS header                | Log header  | -      | H              | 0             |
| 2        | des                                 | NovAtel designator  | Uchar  | 1              | H             |
| 3        | subtype                             | RTCA message subtype  | Uchar  | 3 <sup>a</sup> | H+1           |
| 4        | GPStimebias                         | Receiver GPS time bias  | Double | 8              | H+4           |
| 5        | sec                                 | Seconds into the GPS week                                     | Float  | 4              | H+12          |
| 6        | Reserved                            |   | Long   | 4              | H+16          |
| 7        | #ids                                | Number of Transmitter IDs with information to follow          | Ulong  | 4              | H+20          |
| 8        | trans ID                            | Transmitter ID  | Uchar  | 1              | H+24          |
| 9        | L1 lock                             | L1 lock flag  | Uchar  | 1              | H+25          |
| 10       | L2 lock                             | L2 lock flag  | Uchar  | 2 <sup>b</sup> | H+26          |
| 11       | L1 psr                              | L1 pseudorange offset (2/10 m)                                | Double | 8              | H+28          |
| 12       | L2 psr                              | L2 pseudorange offset (1/4 m)                                 | Double | 8              | H+36          |
| 13       | L1 ADR                              | L1 carrier phase offset, accumulated Doppler range (2/1000 m) | Float  | 4              | H+44          |
| 14       | L2 ADR                              | L2 carrier phase offset, accumulated Doppler range (3/1000 m) | Float  | 4              | H+48          |
| 15       | L2 encrypt                          | L2 not encrypted?<br>0 = FALSE<br>1 = TRUE                    | Enum   | 4              | H+52          |
| 16       | Reserved                            |   | Long   | 4              | H+56          |
| 17...    | Next id offset = H+24 + (#ids x 36) |   |        |                |               |
| variable | xxxx                                | 32-bit CRC (ASCII and Binary only)                            | Hex    | 4              | variable      |
| variable | [CR][LF]                            | Sentence terminator (ASCII only)                              | -      | -              | -             |

- a. In the binary log case, an additional 2 bytes of padding are added to maintain 4-byte alignment
- b. In the binary log case, an additional 1 byte of padding is added to maintain 4-byte alignment

### 3.3.83 RTCADATAREF Base Station Parameters V123\_RT20 or V23\_RT2

See Section 3.3.78 starting on page 418 for information on RTCA standard logs.

#### RTCAREF Type 7

An RTCAREF (RTCA Base Station Position Information) message contains base station position information, and should be sent once every 10 seconds. Each message is 24 bytes (192 bits) long.

If RTCA-format messaging is being used, the optional *station id* field that is entered using the DGPSTXID command, see page 106, can be any 4-character string combining numbers and upper-case letters, and enclosed in double quotation marks (for example, "RW34"). The station ID is reported at the rover receiver, in its position log.

**Message ID:** 395

**Log Type:** Synch

#### Recommended Input:

```
log rtcadatarefa ontime 10
```

#### ASCII Example:

```
#RTCADATAREFA,COM1,0,47.5,FINESTEERING,1364,494600.601,00100000,44de,2310;
78,0,-1634531.401490912,-3664616.874355976,4942495.215668959,0*646a495c
```



The rover receiver automatically sets an approximate position from the RTCADATAREF message if it does not already have a position. Therefore this message can be used in conjunction with an approximate time to improve TTFF. Refer to the time to first fix and satellite acquisition sections of the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm> for more information on TTFF.

| Field # | Field type         | Data Description                        | Format | Binary Bytes   | Binary Offset |
|---------|--------------------|---|--------|----------------|---------------|
| 1       | RTCADATAREF header | Log header                              | -      | H              | 0             |
| 2       | des                | NovAtel designator.                     | Uchar  | 1              | H             |
| 3       | subtype            | RTCA message subtype                    | Uchar  | 3 <sup>a</sup> | H+1           |
| 4       | X pos              | Base station X coordinate position (mm) | Double | 8              | H+4           |
| 5       | Y pos              | Base station Y coordinate position (mm) | Double | 8              | H+12          |
| 6       | Z pos              | Base station Z coordinate position (mm) | Double | 8              | H+20          |
| 7       | Reserved           |   | Uchar  | 4 <sup>b</sup> | H+28          |
| 8       | xxxx               | 32-bit CRC (ASCII and Binary only)      | Hex    | 4              | H+32          |
| 9       | [CR][LF]           | Sentence terminator (ASCII only)        | -      | -              | -             |

- a. In the binary log case an additional 2 bytes of padding are added to maintain 4 byte alignment
- b. In the binary log case an additional 3 bytes of padding are added to maintain 4 byte alignment

### 3.3.84 RTCM Standard Logs DGPS

- RTCM1**      **DIFFERENTIAL GPS CORRECTIONS**    *V123\_DGPS*  
Message ID: 107
- RTCM3**      **BASE STATION PARAMETERS**    *V123\_RT20 or V23\_RT2*  
Message ID: 117
- RTCM9**      **PARTIAL DIFFERENTIAL GPS CORRECTIONS**    *V23\_DGPS*  
MESSAGE ID: 275 (OEMV-2 with external oscillator or OEMV-3)
- RTCM15**     **IONOSPHERIC CORRECTIONS**    *V123\_DGPS*  
Message ID: 307
- RTCM16**     **SPECIAL MESSAGE**    *V123\_DGPS*  
Message ID: 129
- RTCM16T**    **SPECIAL TEXT MESSAGE**, see also *page 196*    *V123\_DGPS*  
Message ID: 131
- RTCM1819**   **RAW MEASUREMENTS**    *V123\_RT20 or V23\_RT2*  
Message ID: 260
- RTCM2021**   **MEASUREMENT CORRECTIONS**    *V123\_RT20 or V23\_RT2*  
Message ID: 374
- RTCM22**     **EXTENDED BASE STATION**    *V123\_RT20 or V23\_RT2*  
Message ID: 118
- RTCM23**     **ANTENNA TYPE DEFINITION**    *V123\_RT20 or V23\_RT2*  
Message ID: 665
- RTCM24**     **ANTENNA REFERENCE POINT (ARP)**    *V123\_RT20 or V23\_RT2*  
Message ID: 667
- RTCM31**     **DIFFERENTIAL GLONASS**    *VIG23\_G, V123\_DGPS and V123\_RT20 or V23\_RT2*  
Message ID: 864
- RTCM32**     **GLONASS BASE PARAMETERS**    *VIG23\_G, V123\_DGPS and V123\_RT20 or V23\_RT2*  
Message ID: 873
- RTCM36**     **SPECIAL EXTENDED MESSAGE**    *VIG23\_G*  
Message ID: 875
- RTCM36T**    **SPECIAL EXTENDED MESSAGE**, see also *page 197*    *VIG23\_G*  
Message ID: 877
- RTCM59**     **TYPE 59N-0 PROPRIETARY DIFFERENTIAL**    *V123\_RT20 or V23\_RT2*  
Message ID: 116



**RTCM59GLO PROPRIETARY GLONASS DIFFERENTIAL V1G23\_G and V123\_DGPS****Message ID: 903****RTCMCDGPS1 LOCALIZED CDGPS CORRECTIONS IN RTCM1 V13\_CDGPS****Message ID: 954****RTCMCDGPS9 CDGPS CORRECTIONS IN RTCM9 V13\_CDGPS****Message ID: 955****RTCMOMNI1 RTCM1 FROM OMNISTAR VBS V13\_CDGPS****Message ID: 957**

- 
- ☒ 1. The RTCM messages can be logged with an A or B suffix for an ASCII or Binary output with a NovAtel header followed by Hex or Binary raw data respectively.
  - 2. Combinations of integer offsets and fractional offsets are not supported for RTCM logs. See also the LOG command starting on *page 143* for more details on offsets.
  - 3. RTCMDATA logs output the details of the above logs if they have been sent.
- 

The Radio Technical Commission for Maritime Services (RTCM) was established to facilitate the establishment of various radio navigation standards, which includes recommended GPS differential standard formats. Refer to the *Receiving and Transmitting Corrections* section in the *OEMV Installation and Operation Manual* for more information on using these message formats for differential operation.

The standards recommended by the Radio Technical Commission for Maritime Services Special Committee 104, Differential GPS Service (RTCM SC-104, Washington, D.C.), have been adopted by NovAtel for implementation into the receiver. Because the receiver is capable of utilizing RTCM formats, it can easily be integrated into positioning systems around the globe.

As it is beyond the scope of this manual to provide in-depth descriptions of the RTCM data formats, it is recommended that anyone requiring explicit descriptions of such, should obtain a copy of the published RTCM specifications. Refer to the *Standards and References* section of the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm> for information.

RTCM SC-104<sup>1</sup> Type 3 & 59 messages can be used for base station transmissions in differential systems. However, since these messages do not include information on the L2 component of the GPS signal, they cannot be used with RT-2 positioning. Regardless of whether single or dual-frequency receivers are used, the RT-20 positioning algorithm is used. This is for a system in which both the base and rover stations utilize NovAtel receivers.

Note that the error-detection capability of an RTCM-format message is less than that of an RTCA-format message. The communications equipment that you use may have an error-detection capability of its own to supplement that of the RTCM message, although at a penalty of a higher overhead.

- 
- 1. For further information on RTCM SC-104 messages, you may wish to refer to:  
RTCM Recommended Standards for Differential GNSS (Global Navigation Satellite Systems) Service, Version 2.3 at <http://www.rtc.org/overview.php>.

Consult the radio vendor's documentation for further information.

If RTCM-format messaging is being used, the optional *station id* field that is entered using the FIX POSITION command can be any number within the range of 0 - 1023 (for example, 119). The representation in the log message is identical to what was entered.

The NovAtel logs which implement the RTCM Standard Format for Type 1, 3, 9, 16, 18, 19, 22, 31, 32 and 36 messages are known as the RTCM1, RTCM3, RTCM9, RTCM16, RTCM18, RTCM19, RTCM22, RTCM23, RTCM24, RTCM31, RTCM32 and RTCM36 logs, respectively, while Type 59N-0 messages are listed in the RTCM59 log.

All receiver RTCM standard format logs adhere to the structure recommended by RTCM SC-104. Thus, all RTCM message are composed of 30 bit words. Each word contains 24 data bits and 6 parity bits. All RTCM messages contain a 2-word header followed by 0 to 31 data words for a maximum of 33 words (990 bits) per message.

| Message Frame Header | Data   | Bits |
|----------------------|--|------|
| Word 1               | – Message frame preamble for synchronization | 8    |
|                      | – Frame/message type ID                      | 6    |
|                      | – Base station ID                            | 10   |
|                      | – Parity                                     | 6    |
| Word 2               | – Modified z-count (time tag)                | 13   |
|                      | – Sequence number                            | 3    |
|                      | – Length of message frame                    | 5    |
|                      | – Base health                                | 3    |
|                      | – Parity                                     | 6    |

Version 3.0, also developed by the RTCM SC-104, consists primarily of messages designed to support real-time kinematic (RTK) operations. It provides messages that support GPS and GLONASS RTK operations, including code and carrier phase observables, antenna parameters, and ancillary system parameters. Version 3.1 adds RTCM messages containing transformation data and information about Coordinate Reference Systems.<sup>1</sup>

The remainder of this section provides further information concerning receiver commands and logs that utilize the RTCM data formats.

### Example Input:

- For further information on RTCM SC-104 messages, you may wish to refer to:  
RTCM Recommended Standards for Differential GNSS (Global Navigation Satellite Systems) Service, Version 3.0 and Version 3.1 at <http://www.rtcn.org/overview.php>.

---

```
interfacemode com2 none RTCM
fix position 51.1136 -114.0435 1059.4
log com2 rtm3 ontime 10
log com2 rtm22 ontime 10 1
log com2 rtm1819 ontime 1
log com2 rtm31 ontime 2
log com2 rtm32 ontime 2
log com2 rtm1 ontime 5
```

## CDGPS Local Wide Area Corrections

CDGPS corrections can be output as RTCM Type 1 and RTCM Type 9 messages for input into receivers that are not able to accept CDGPS corrections directly. RTCM Type 9 messages do not require the use of an external clock when generated from CDGPS corrections. The generated RTCM Type 9 messages contain a maximum of three pseudorange corrections per message.

The positioning performance using CDGPS local wide area corrections meets the standard CDGPS code differential performance specifications. Pseudorange corrections include tropospheric corrections, calculated using the UNB4 model, and ionospheric corrections, calculated using the CDGPS iono grid, regardless of the availability of L1 or L2 corrections. Pseudorange correction also include CDGPS test and slow corrections.

If the base receiver loses the correction source, it continues to generate pseudorange corrections based on the current settings in the CDGPSTIMEOUT command. The base station ID in the RTCM Type 1 and 9 messages is 209. The range rate correction (RRC) fields in the RTCM Type 1 and 9 messages are set to zero.

Enable the output of CDGPS corrections in RTCM messages by using the following commands:

```
INTERFACEMODE COM2 NOVATEL RTCM OFF
ASSIGNLBAND CDGPS <frequency> <bps>
PSRDIFFSOURCE CDGPS
LOG COM2 RTCMCDGPS1 ONTIME 1
```

or

```
LOG COM2 RTCMCDGPS9 ONTIME 1
```

---

There is no need to fix a position when using the above localised wide area corrections method.

---

The CDGPS RTCM model outputs RTCM corrections at a rate of up to 1 Hz. This new model does not include position or raw measurement output.

## OmniSTAR Local Wide Area Corrections

RTCM Type 1 messages are generated from OmniSTAR VBS corrections.

The positioning performance using OmniSTAR local wide area corrections meets the standard OmniSTAR VBS code differential performance specifications.

Unless otherwise noted, values in the RTCM Type 1 messages are unchanged from what is provided by the VBS library (for example, RRC, UDRE, station ID) apart from necessary unit scaling. An RTCM1 message is generated and output each time the VBS library provides updated corrections (about every 6 s). The receiver no longer outputs corrections when the L-band signal is lost and the VBS library stops generating corrections. The output is for the same set of satellites provided by the VBS library (above 5° elevation at the current position).

Enable the output of OmniSTAR VBS corrections in RTCM messages by using the following commands:

```
INTERFACEMODE COM2 NOVATEL RTCM OFF  
ASSIGNLBAND OMNISTAR <frequency> <bps> or ASSIGNLBAND OMNISTARAUTO  
PSRDIFFSOURCE OMNISTAR  
LOG COM2 RTCMOMNI1 ONCHANGED
```

The RTCMOMNI1 log is asynchronous.

The OmniSTAR RTCM model outputs RTCM corrections at a rate of up to 0.2 Hz. This new model does not include position or raw measurement output.

### 3.3.85 RTCMDATA1 Differential GPS Corrections V123\_DGPS

See Section 3.3.84 starting on page 432 for information on RTCM standard logs.

**Message ID:** 396  
**Log Type:** Synch

**Recommended Input:**

```
log rtcmdata1a ontime 10 3
```

**ASCII Example:**

```
#RTCMDATA1A,COM1,0,68.5,FINESTEERING,1420,506618.000,00180020,d18a,1899;
1,0,4363,0,0,6,
9,
0,0,26,22569,-2,231,
0,0,19,-3885,-36,134,
0,0,3,-14036,-23,124,
0,0,24,1853,-36,11,
0,0,18,5632,15,6,
0,0,21,538,-26,179,
0,0,9,12466,3,4,
0,0,14,-21046,17,27,
0,0,22,-7312,16,238*35296338
```

## RTCM1

This is the primary RTCM log used for pseudorange differential corrections. This log follows the RTCM Standard Format for a Type 1 message. It contains the pseudorange differential correction data computed by the base station generating this Type 1 log. The log is of variable length depending on the number of satellites visible and pseudoranges corrected by the base station. Satellite specific data begins at word 3 of the message.

**Structure:**

Type 1 messages contain the following information for each satellite in view at the base station:

- Satellite ID
- Pseudorange correction
- Range-rate correction
- Issue of Data (IOD)

When operating as a base station, the receiver must be in FIX POSITION mode and have the INTERFACEMODE command set before the data can be correctly logged. When operating as a rover station, the receiver COM port receiving the RTCM data must have its INTERFACEMODE command set. Refer to the *Receiving and Transmitting Corrections* section in the *OEMV Installation and Operation Manual* for more information on using these commands and RTCM message formats.



**REMEMBER:** Upon a change in ephemeris, base stations transmit Type 1 messages based on the old ephemeris for a period of time defined by the DGPSEPHMDELAY command, see *page 103*. After the time out, the base station begins to transmit the Type 1 messages based on the new ephemeris.

RTCMDATA logs provide you with the ability to monitor the RTCM messages, being used by the NovAtel receiver, in an easier to read format than the RTCM standard format. You can also use the RTCMDATA logs as a diagnostic tool to identify when the receivers are operating in the required modes.

---

| Field #  | Field type                            | Data Description   | Format                                    | Binary Bytes | Binary Offset |
|----------|---------------------------------------|--|---|--------------|---------------|
| 1        | RTCMDATA1 header                      | Log header   | -   | H            | 0             |
| 2        | RTCM header                           | RTCM message type  | Ulong                                     | 4            | H             |
| 3        |                                       | Base station ID  | Ulong                                     | 4            | H+            |
| 4        |                                       | Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris | Ulong                                     | 4            | H+8           |
| 5        |                                       | Sequence number  | Ulong                                     | 4            | H+12          |
| 6        |                                       | Length of frame  | Ulong                                     | 4            | H+16          |
| 7        |                                       | Base station health, see <i>REFSTATION</i> on page 414   | Ulong                                     | 4            | H+20          |
| 8        |                                       | #prn   | Number of PRNs with information to follow | Ulong        | 4             |
| 9        | scale                                 | Scale where<br>0 = 0.02 m and 0.002 m/s<br>1 = 0.32 m and 0.032 m/s                                | Ulong                                     | 4            | H+28          |
| 10       | UDRE                                  | User differential range error  | Ulong                                     | 4            | H+32          |
| 11       | PRN/slot                              | Satellite PRN number of range measurement (GPS: 1-32 and SBAS: 120 to 138.)                        | Ulong                                     | 4            | H+36          |
| 12       | psr corr                              | Scaled pseudorange correction (meters)   | Long                                      | 4            | H+40          |
| 13       | rate corr                             | Scaled range rate correction   | Long                                      | 4            | H+44          |
| 14       | IOD                                   | Issue of data  | Long                                      | 4            | H+48          |
| 15...    | Next PRN offset = H+28 + (#prns x 24) |  |   |              |               |
| variable | xxxx                                  | 32-bit CRC (ASCII and Binary only)   | Hex                                       | 4            | variable      |
| variable | [CR][LF]                              | Sentence terminator (ASCII only)   | -   | -            | -             |



### 3.3.86 RTCMDATA3 Base Station Parameters V123\_RT20 or V23\_RT2

See Section 3.3.84 starting on page 432 for information on RTCM standard logs.

**Message ID:** 402  
**Log Type:** Synch

**Recommended Input:**

log rtcmdata3a ontime 10

**ASCII Example:**

```
#RTCMDATA3A, COM1, 0, 72.0, FINESTEERING, 1420, 506793.276, 00180020, 61e6, 1899;  
3, 0, 4655, 0, 0, 6, -163496421.7426230311393738, -366468552.3169214129447937,  
494229879.5281358957290649*0F343499
```



Use this log to see what base station information is being received by your rover receivers.

### RTCM3 Base Station Parameters (RTK)

This log contains the GPS position of the base station expressed in rectangular ECEF coordinates based on the center of the WGS-84 ellipsoid. It follows the RTCM SC-104 Standard for a Type 3 message. This log uses four RTCM data words following the two-word header, for a total frame length of six 30-bit words (180 bits maximum). This message must be sent at least once every 30 seconds, although it is recommended that it is sent once every 10 seconds.

Also, the rover receiver automatically sets an approximate position from this message if it does not already have a position. Therefore, this message can be used in conjunction with an approximate time to improve TTFF, refer to the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm>.

**Structure:**

Type 3 messages contain the following information:

- Scale factor
- ECEF X-coordinate
- ECEF Y-coordinate
- ECEF Z-coordinate

The receiver only transmits the RTCM Type 3 when the position is fixed by the FIX POSITION command, see page 115.

☒ This log is intended for use when operating in RTK mode.

| Field # | Field type        | Data Description  | Format | Binary Bytes | Binary Offset |
|---------|-------------------|---|--------|--------------|---------------|
| 1       | RTCM DATA3 header | Log header  | -      | H            | 0             |
| 2       | RTCM header       | RTCM message type   | Ulong  | 4            | H             |
| 3       |                   | Base station ID   | Ulong  | 4            | H+4           |
| 4       |                   | Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris. | Ulong  | 4            | H+8           |
| 5       |                   | Sequence number   | Ulong  | 4            | H+12          |
| 6       |                   | Length of frame   | Ulong  | 4            | H+16          |
| 7       |                   | Base station health, see <i>REFSTATION</i> on page 414  | Ulong  | 4            | H+20          |
| 8       | ECEF-X            | Base station ECEF X-coordinate (1/100 m)  | Double | 8            | H+24          |
| 9       | ECEF-Y            | Base station ECEF Y-coordinate (1/100 m)  | Double | 8            | H+32          |
| 10      | ECEF-Z            | Base station ECEF Z-coordinate (1/100 m)  | Double | 8            | H+40          |
| 11      | xxxx              | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+48          |
| 12      | [CR][LF]          | Sentence terminator (ASCII only)  | -      | -            | -             |

### 3.3.87 RTCMDATA9 Partial Differential GPS Corrections V23\_DGPS

See Section 3.3.84 starting on page 432 for information on RTCM standard logs. This log is the same as the RTCMDATA1 log but there are only corrections for a maximum of 3 satellites.

**Message ID:** 404  
**Log Type:** Synch

#### Recommended Input:

```
log rtcmdata9a ontime 10
```

#### ASCII Example:

```
#RTCMDATA9A, COM1, 0, 68.5, FINESTEERING, 1420, 506833.000, 00180020, 37f9, 1899;  
9, 0, 4721, 0, 0, 6,  
3,  
0, 0, 26, 22639, 11, 231,  
0, 0, 19, -4387, -22, 134,  
0, 0, 3, -14572, -27, 124*6016236c
```

### RTCM9 Partial Satellite Set Differential Corrections

RTCM Type 9 messages follow the same format as Type 1 messages. However, unlike a Type 1 message, Type 9 does not require a complete satellite set. This allows for much faster differential correction data updates to the rover stations, thus improving performance and reducing latency.

Type 9 messages should give better performance with slow or noisy data links.

- 
- ☒ The base station transmitting Type 9 corrections with an OEMV-2 must be operating with a high-stability clock to prevent degradation of navigation accuracy due to the unmodeled clock drift that can occur between Type 9 messages. Only OEMV-2 receivers with an external oscillator or OEMV-3 receivers, with or without an external oscillator, can generate Type 9 messages. All OEMV family receivers can accept Type 9 messages.
- 

**NovAtel recommends a high-stability clock whose 2-sample (Allan) variance meets the following stability requirements:**

**$3.24 \times 10^{-24} \text{ s}^2/\text{s}^2$  between 0.5 - 2.0 seconds, and**  
 **$1.69 \times 10^{-22} \text{ T s}^2/\text{s}^2$  between 2.0 - 100.0 seconds**

**An external clock, such as an OCXO, requires approximately 10 minutes to warm up and become fully stabilized after power is applied. Do not broadcast RTCM Type 9 corrections during this warm-up period.**

#### Structure:

Type 9 messages contain the following information for a group of three satellites in view at the base station:

- Scale factor
- User Differential Range Error
- Satellite ID
- Pseudorange correction
- Range-rate correction
- Issue of Data (IOD)



A base station transmitting RTCM Type 9 corrections must be operating with a high-stability clock to prevent degradation of navigation accuracy due to the unmodeled clock drift that can occur between Type 9 messages.

NovAtel recommends a high-stability clock such as a PIEZO model whose 2-sample (Allan) variance meets the following stability requirements:

- $3.24 \times 10^{-24} \text{ s}^2/\text{s}^2$  between 0.5 - 2.0 seconds  
and
- $1.69 \times 10^{-22} \text{ T s}^2/\text{s}^2$  between 2.0 - 100.0 seconds

An external clock such as an OCXO requires approximately 10 minutes to warm up and become fully stabilized after power is applied. Do not broadcast RTCM Type 9 corrections during this warm-up period. See also the EXTERNALCLOCK command on *page 112*.

---

| Field #  | Field type                            | Data Description  | Format   | Binary Bytes | Binary Offset |
|----------|---------------------------------------|---|--|--------------|---------------|
| 1        | RTCMDATA9 header                      | Log header  | -  | H            | 0             |
| 2        | RTCM header                           | RTCM message type   | Ulong  | 4            | H             |
| 3        |                                       | Base station ID   | Ulong  | 4            | H+4           |
| 4        |                                       | Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris.                         | Ulong  | 4            | H+8           |
| 5        |                                       | Sequence number   | Ulong  | 4            | H+12          |
| 6        |                                       | Length of frame   | Ulong  | 4            | H+16          |
| 7        |                                       | Base station health, see <i>REFSTATION</i> on page 414  | Ulong  | 4            | H+20          |
| 8        |                                       | #prn  | Number of PRNs with information to follow (maximum of 3) | Ulong        | 4             |
| 9        | scale                                 | Scale where<br>0 = 0.02 m and 0.002 m/s<br>1 = 0.32 m and 0.032 m/s   | Ulong  | 4            | H+28          |
| 10       | UDRE                                  | User differential range error   | Ulong  | 4            | H+32          |
| 11       | PRN/slot                              | Satellite PRN number of range measurement (GPS: 1-32 and SBAS: 120 to 138. For GLONASS, see <i>Section 1.3</i> on page 30.) | Ulong  | 4            | H+36          |
| 12       | psr corr                              | Scaled pseudorange correction (m)   | Long   | 4            | H+40          |
| 13       | rate corr                             | Scaled range rate correction  | Long   | 4            | H+44          |
| 14       | IOD                                   | Issue of data   | Long   | 4            | H+48          |
| 15...    | Next PRN offset = H+28 + (#prns x 24) |   |  |              |               |
| variable | xxxx                                  | 32-bit CRC (ASCII and Binary only)  | Hex  | 4            | variable      |
| variable | [CR][LF]                              | Sentence terminator (ASCII only)  | -  | -            | -             |

### 3.3.88 RTCMDATA15 Ionospheric Corrections VI23\_DGPS

See Section 3.3.84 starting on page 432 for information on RTCM standard logs.

**Message ID:** 397  
**Log Type:** Synch

**Recommended Input:**

log rtcmdata15a ontime 10

**ASCII Example:**

```
#RTCMDATA15A, COM1, 0, 74.5, FINESTEERING, 1117, 160783.000, 00100020, 9601, 399;
15, 0, 3971, 7799968, 5163500, 6,
10,
0, 0, 3, 1631, 445,
0, 0, 15, 1423, -222,
0, 0, 18, 1275, -334,
0, 0, 21, 1763, -334,
0, 0, 17, 1454, -556,
0, 0, 6, 2063, 0,
0, 0, 26, 1579, 222,
0, 0, 23, 1423, -111,
0, 0, 28, 1874, 445,
0, 0, 22, 2146, -445*19ed193f
```



This data message provides data to continually enable you to remove ionospheric components from received pseudorange corrections. The *ion rate* and *ion delay* fields can be added just like Type 1 corrections to provide “iono-free” data collection.

### RTCM15 Ionospheric Corrections

RTCM Type 15 messages support the broadcast of ionospheric delay and rate of change measurements for each satellite as determined by the base station receiver. They are used to improve the ionospheric de-correlation that would otherwise be experienced by a rover at a long distance from the base. This log works in conjunction with Type 1 messages using dual frequency receivers. Type 15 messages are broadcast every 5-10 minutes and follow the RTCM standard for Type 15 messages.

Type 15 messages enable the rover to continuously remove the ionospheric component from received pseudorange corrections. The delay and rate terms are added like Type 1 corrections to provide the total ionospheric delay at a given time, which is then subtracted from the pseudorange corrections. The resulting corrections are then “iono-free”. The rover subtracts its measurements (or estimates) of ionospheric delay from its own pseudorange measurements and applies the iono-free corrections.

**Structure:**

Type 15 messages contain the following information for each satellite in view at the base station:

- Satellite ID
- Ionospheric delay
- Iono rate of change

When operating as a base station, the receiver must be in FIX POSITION mode and have the INTERFACEMODE command set before the data can be correctly logged. You must also log the RTCM Type 1 corrections. See *pages 115 and 135* respectively.

When operating as a rover station, the receiver COM port receiving the RTCM data must have its INTERFACEMODE command set.

| Field #  | Field type                            | Data Description   | Format                                    | Binary Bytes | Binary Offset |
|----------|---------------------------------------|--|---|--------------|---------------|
| 1        | RTCMDATA15 header                     | Log header   | -   | H            | 0             |
| 2        | RTCM header                           | RTCM message type  | Ulong                                     | 4            | H             |
| 3        |                                       | Base station ID  | Ulong                                     | 4            | H+4           |
| 4        |                                       | Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris.              | Ulong                                     | 4            | H+8           |
| 5        |                                       | Sequence number  | Ulong                                     | 4            | H+12          |
| 6        |                                       | Length of frame  | Ulong                                     | 4            | H+16          |
| 7        |                                       | Base station health, see <i>REFSTATION</i> on <i>page 414</i>  | Ulong                                     | 4            | H+20          |
| 8        |                                       | #prn   | Number of PRNs with information to follow | Ulong        | 4             |
| 9        | Reserved                              |  | Ulong                                     | 4            | H+28          |
| 10       | sat type                              | Satellite type where<br>0 = GPS<br>1 = GLONASS   | Ulong                                     | 4            | H+32          |
| 11       | PRN/slot                              | Satellite PRN number of range measurement (GPS: 1 to 32, SBAS: 120 to 138 and for GLONASS, see <i>page 30</i> .) | Ulong                                     | 4            | H+36          |
| 12       | ion delay                             | Ionospheric delay (cm)   | Ulong                                     | 4            | H+40          |
| 13       | ion rate                              | Ionospheric rate (0.05 cm / min.)  | Long                                      | 4            | H+44          |
| 14...    | Next PRN offset = H+28 + (#prns x 20) |  |   |              |               |
| variable | xxxx                                  | 32-bit CRC (ASCII and Binary only)   | Hex                                       | 4            | variable      |
| variable | [CR][LF]                              | Sentence terminator (ASCII only)   | -   | -            | -             |

### 3.3.89 RTCMDATA16 Special Message V123\_DGPS

See Section 3.3.84 starting on page 432 for information on RTCM standard logs.

**Message ID:** 398  
**Log Type:** Synch

**Recommended Input:**

```
log rtcmdata16a once
```

**ASCII Example:**

```
#RTCMDATA16A, COM1, 0, 65.0, FINESTEERING, 1420, 507147.000, 00180020, 2922, 1899;  
16, 0, 5245, 0, 0, 6, 37, "base station will shut down in 1 hour"*ac5ee822
```

### RTCM16 Special Message

This log contains a special ASCII message that can be displayed on a printer or cathode ray tube. The base station wishing to log this message out to rover stations that are logged onto a computer, must use the SETRTCM16T command to set the required ASCII text message. Once set, the message can then be issued at the required intervals with the “LOG port RTCM16 interval” command. The Special Message setting can be verified in the RXCONFIGA log, see page 539. The received ASCII text can be displayed at the rover by logging RTCM16T ONNEW.

The RTCM16 data log follows the RTCM Standard Format. Words 1 and 2 contain RTCM header information followed by words 3 to  $n$  (where  $n$  is variable from 3 to 32) which contain the special message ASCII text. Up to 90 ASCII characters can be sent with each RTCM Type 16 message frame.



---

Message Type 16 is a special ASCII message capable of being displayed on a printer or CRT. The message can be up to 90 characters long.

---



| Field #  | Field type                             | Data Description   | Format | Binary Bytes   | Binary Offset |
|----------|--|--|--------|----------------|---------------|
| 1        | RTCM DATA16 header                     | Log header   | -      | H              | 0             |
| 2        | RTCM header                            | RTCM message type  | Ulong  | 4              | H             |
| 3        |  | Base station ID  | Ulong  | 4              | H+4           |
| 4        |  | Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris | Ulong  | 4              | H+8           |
| 5        |  | Sequence number  | Ulong  | 4              | H+12          |
| 6        |  | Length of frame  | Ulong  | 4              | H+16          |
| 7        |  | Base station health, see <i>REFSTATION</i> on page 414   | Ulong  | 4              | H+20          |
| 8        | #chars                                 | Number of characters to follow   | Ulong  | 4              | H+24          |
| 9        | character                              | Character  | Char   | 4 <sup>a</sup> | H+28          |
| 10...    | Next char offset = H+28 + (#chars x 4) |  |        |                |               |
| variable | xxxx                                   | 32-bit CRC (ASCII and Binary only)   | Hex    | 4              | variable      |
| variable | [CR][LF]                               | Sentence terminator (ASCII only)   | -      | -              | -             |

a. In the binary log case, an additional 3 bytes of padding are added to maintain 4-byte alignment

### 3.3.90 RTCMDATA1819 Raw Measurements V123\_RT20 or V23\_RT2

See Section 3.3.84 starting on page 432 for information on RTCM standard logs.

**Message ID:** 399

**Log Type:** Synch

**Recommended Input:**

log rtcmdata1819a ontime 2

**ASCII Example:**

```
#RTCMDATA1819A, COM1, 1, 80.0, FINESTEERING, 1415, 317696.000, 00140040, f337, 2616;
18, 1000, 1493, 0, 0, 6,
2, 0, 200000, 5,
1, 1, 0, 2, 0, 1, 7017922,
1, 1, 0, 30, 0, 1, 12485535,
1, 1, 0, 4, 0, 1, -8421345,
1, 1, 0, 5, 0, 1, 4072787,
1, 1, 0, 12, 0, 1, 3227209,
19, 1000, 1493, 0, 0, 6,
2, 0, 200000, 5,
1, 1, 0, 2, 2, 3, 1025891090,
1, 1, 0, 30, 2, 3, 1098334724,
1, 1, 0, 4, 2, 3, 1051480779,
1, 1, 0, 5, 2, 3, 1028271427,
1, 1, 0, 12, 2, 3, 1029484966*dce6f781
```

### RTCM18 and RTCM19 Raw Measurements (RTK)

RTCM18 provides uncorrected carrier phase measurements and RTCM19 provides uncorrected pseudorange measurements. The measurements are not corrected by the ephemerides contained in the satellite message.

The messages have similar formats. Word 3, the first data word after the header, contains a GPS TIME OF MEASUREMENT field which is used to increase the resolution of the MODIFIED Z-COUNT in the header. Word 3 is followed by pairs of words containing the data for each satellite observed. Appropriate flags are provided to indicate L1 C/A or P-code or L2 cross correlated or P-code measurements. The carrier smoothing interval for pseudoranges and pseudorange corrections is also furnished, for a total frame length of six 30 bit words (180 bits maximum).

RTCM18 and RTCM19 messages follow the RTCM SC-104 Standard for Type 18 and Type 19 messages.

For RTK, you may periodically transmit a set of RTCM Type 18 and RTCM Type 19 together with an RTCM Type 3 message and an RTCM Type 22 message.



RTCM DATA1819 and RTCM2021 logs contain data useful for surveying and highly accurate positioning and/or navigation.

This data provides support for RTK applications using real-time interferometric techniques to resolve integer ambiguities. (An interferometer is, in aerospace for example, an instrument that utilizes the interference of waves for precise determinations.)

RTCM Message Type 18 provides carrier phase measurements, while RTCM Message Type 19 provides pseudorange measurements.

RTCM Message Types 20 and 21 contain the same data as Types 18 and 19 except that the values of Types 20 and 21 are corrected by the ephemerides contained in the satellite message.

---

**Table 77: RTCM1819 Data Quality Indicator**

| Code | Pseudorange Error |
|------|-------------------|
| 0    | $\leq 0.020$ m    |
| 1    | $\leq 0.030$ m    |
| 2    | $\leq 0.045$ m    |
| 3    | $\leq 0.066$ m    |
| 4    | $\leq 0.099$ m    |
| 5    | $\leq 0.148$ m    |
| 6    | $\leq 0.220$ m    |
| 7    | $\leq 0.329$ m    |
| 8    | $\leq 0.491$ m    |
| 9    | $\leq 0.732$ m    |
| 10   | $\leq 1.092$ m    |
| 11   | $\leq 1.629$ m    |
| 12   | $\leq 2.430$ m    |
| 13   | $\leq 3.625$ m    |
| 14   | $\leq 5.409$ m    |
| 15   | $> 5.409$ m       |

**Table 78: RTCM1819 Smoothing Interval**

| Code | Smoothing Interval (Minutes) |
|------|------------------------------|
| 0    | 0 to 1                       |
| 1    | 1 to 5                       |
| 2    | 5 to 15                      |
| 3    | Undefined smoothing interval |

**Table 79: RTCM1819 Multipath Indicator**

| Code | Multipath Error        |
|------|------------------------|
| 0    | $\leq 0.100$ m         |
| 1    | $\leq 0.149$ m         |
| 2    | $\leq 0.223$ m         |
| 3    | $\leq 0.332$ m         |
| 4    | $\leq 0.495$ m         |
| 5    | $\leq 0.739$ m         |
| 6    | $\leq 1.102$ m         |
| 7    | $\leq 1.644$ m         |
| 8    | $\leq 2.453$ m         |
| 9    | $\leq 3.660$ m         |
| 10   | $\leq 5.460$ m         |
| 11   | $\leq 8.145$ m         |
| 12   | $\leq 12.151$ m        |
| 13   | $\leq 18.127$ m        |
| 14   | $> 18.127$ m           |
| 15   | Undetermined multipath |

| Field # | Field type               | Data Description   | Format  | Binary Bytes | Binary Offset |
|---------|--------------------------|--|---|--------------|---------------|
| 1       | RTCMDATA-1819 header     | Log header   | -   | H            | 0             |
| 2       | RTCM header (for RTCM18) | RTCM message type  | Ulong   | 4            | H             |
| 3       |                          | Base station ID  | Ulong   | 4            | H+4           |
| 4       |                          | Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris   | Ulong   | 4            | H+8           |
| 5       |                          | Sequence number  | Ulong   | 4            | H+12          |
| 6       |                          | Length of frame  | Ulong   | 4            | H+16          |
| 7       |                          | Base station health, see <i>REFSTATION</i> on page 414   | Ulong   | 4            | H+20          |
| 8       |                          | freq   | Frequency indicator where<br>0 = L1<br>2 = L2<br>(1 is reserved for future use) | Ulong        | 4             |
| 9       | Reserved                 |  | Ulong   | 4            | H+28          |
| 10      | GNSS time                | Global Navigation Satellite System (GNSS) time of measurement (microseconds)   | Long  | 4            | H+32          |
| 11      | #obs                     | Number of observations with information to follow  | Long  | 4            | H+36          |
| 12      | multi bit                | Multiple message indicator   | Ulong   | 4            | H+40          |
| 13      | code                     | Is code P Code?<br>0 = FALSE<br>1 = TRUE   | Ulong   | 4            | H+44          |
| 14      | sat type                 | Satellite type<br>0 = GPS<br>1 = GLONASS   | Ulong   | 4            | H+48          |
| 15      | PRN/slot                 | PRN number for GPS satellites (satellite number 32 is indicated by 0); slot number for GLONASS satellites, see also <i>Section 1.3</i> on page 30. | Ulong   | 4            | H+52          |
| 16      | quality                  | Data quality indicator, see <i>Table 77, RTCM1819 Data Quality Indicator</i> on page 452   | Ulong   | 4            | H+56          |
| 17      | continuity               | Cumulative loss of continuity indicator with a loss of lock counter  | Ulong   | 4            | H+60          |
| 18      | phase                    | Carrier phase (1/256 cycles)   | Long  | 4            | H+64          |

Continued on page 455.

| Field #     | Field type  | Data Description   | Format | Binary Bytes | Binary Offset |
|-------------|---|--|--------|--------------|---------------|
| 19...       | Next RTCM18 observation offset = H+40 + (#obs x 28) |  |        |              |               |
| variable    | RTCM header (for RTCM19)                            | RTCM message type  | Ulong  | 4            | variable      |
|             |   | Base station ID  | Ulong  | 4            |               |
|             |   | Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris | Ulong  | 4            |               |
|             |   | Sequence number  | Ulong  | 4            |               |
|             |   | Length of frame  | Ulong  | 4            |               |
|             |   | Base station health, see <i>REFSTATION</i> on page 414   | Ulong  | 4            |               |
| variable    | freq  | Frequency indicator where<br>0 = L1<br>2 = L2<br>(1 is reserved for future use)                    | Ulong  | 4            | variable      |
|             | smooth  | Smoothing interval, see <i>Table 78, RTCM1819 Smoothing Interval</i> on page 452                   | Ulong  | 4            |               |
|             | GNSS time   | GNSS time of measurement ( $\mu$ s)  | Long   | 4            |               |
|             | #obs  | Number of observations with information to follow  | Ulong  | 4            |               |
| variable    | multi bit   | Multiple message indicator   | Ulong  | 4            | variable      |
|             | code  | Is code P Code?<br>0 = FALSE<br>1 = TRUE   | Ulong  | 4            |               |
|             | sat type  | Satellite type<br>0 = GPS<br>1 = GLONASS   | Ulong  | 4            |               |
|             | prn   | Satellite PRN/slot number  | Ulong  | 4            |               |
|             | quality   | Data quality indicator, see <i>Table 77, RTCM1819 Data Quality Indicator</i> on page 452           | Ulong  | 4            |               |
|             | multipath   | Multipath indicator, see <i>Table 79, RTCM1819 Multipath Indicator</i> on page 453                 | Ulong  | 4            |               |
|             | range   | Pseudorange (2/100 m)  | Ulong  | 4            |               |
| variable... | Next RTCM19 observation offset = variable           |  |        |              |               |
| variable    | xxxx  | 32-bit CRC (ASCII and Binary only)   | Hex    | 4            | variable      |
| variable    | [CR][LF]  | Sentence terminator (ASCII only)   | -      | -            | -             |

### 3.3.91 RTCMDATA2021 Measurement Corrections V123\_RT20 or V23\_RT2

See Section 3.3.84 starting on page 432 for information on RTCM standard logs.

**Message ID:** 400  
**Log Type:** Synch

**Recommended Input:**

log rtcmdata2021a ontime 10

**ASCII Example:**

```
#RTCMDATA2021A, COM1, 1, 84.0, FINESTEERING, 1415, 317796.000, 00140040, ade1, 2616;
20, 1000, 1660, 0, 0, 6,
0, 0, 0, 6,
0, 0, 0, 2, 0, 1, 2, 221,
0, 0, 0, 4, 0, 1, 129, 244,
0, 0, 0, 5, 0, 1, 208, 108,
0, 0, 0, 30, 0, 1, 227, 196,
0, 0, 0, 12, 0, 1, 73, 269,
0, 0, 0, 24, 0, 1, 13, 130,
21, 1000, 1660, 0, 0, 6,
0, 0, 0, 6,
0, 0, 0, 2, 0, 0, 0, 3, 2, 136,
0, 0, 0, 0, 4, 0, 0, 0, 3, 129,
226, -1, 0, 0, 0, 5, 0, 0, 0, 3,
208, -195, 1, 0, 0, 0, 30, 0, 0, 0,
3, 227, -55, 1, 0, 0, 0, 12, 0, 0,
0, 3, 73, 1, 1, 0, 0, 0, 24, 0, 0, 0, 3, 13, -1309, 8*e1b9072c
```

### RTCM20 and RTCM21 Measurement Corrections (RTK)

RTCM20 provides carrier phase corrections and RTCM21 provides pseudorange corrections. Types 20 and 21 are corrected by the ephemerides contained in the satellite message and are therefore referred to as ‘corrections’.

Message Type 21 is very similar to the standard Type 1 message, but has additional measurement quality information, and can be used to support cross-correlation receivers. Message Type 21 is also useful in non-kinematic applications requiring high accuracy and integrity.

See the section above for the message format of the Type 18 and 19 messages that are similar to the Type 20 and 21 messages.



RTCM Message Types 20 and 21 contain the same data as Types 18 and 19 except that the values of Types 20 and 21 are corrected by the ephemerides contained in the satellite message. See also the usage box for Types 18 and 19 on page 451.



**Table 80: RTCM2021 Data Quality Indicator**

| Code | Pseudorange Error |
|------|-------------------|
| 0    | $\leq 0.1$ m      |
| 1    | $\leq 0.25$ m     |
| 2    | $\leq 0.5$ m      |
| 3    | $\leq 1.0$ m      |
| 4    | $\leq 2.0$ m      |
| 5    | $\leq 3.5$ m      |
| 6    | $\leq 5$ m        |
| 7    | $> 5$             |

**Table 81: RTCM2021 Multipath Indicator**

| Code | Multipath Error        |
|------|------------------------|
| 0    | $\leq 0.1$ m           |
| 1    | $\leq 0.25$ m          |
| 2    | $\leq 0.5$ m           |
| 3    | $\leq 1.0$ m           |
| 4    | $\leq 2.5$ m           |
| 5    | $\leq 5$ m             |
| 6    | $> 5$ m                |
| 7    | Undetermined multipath |

| Field # | Field type  | Data Description   | Format | Binary Bytes | Binary Offset |
|---------|---|--|--------|--------------|---------------|
| 1       | RTCMDATA-2021 header                                | Log header   | -      | H            | 0             |
| 2       | RTCM header (for RTCM20)                            | RTCM message type  | Ulong  | 4            | H             |
| 3       |   | Base station ID  | Ulong  | 4            | H+4           |
| 4       |   | Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris   | Ulong  | 4            | H+8           |
| 5       |   | Sequence number  | Ulong  | 4            | H+12          |
| 6       |   | Length of frame  | Ulong  | 4            | H+16          |
| 7       |   | Base station health, see <i>REFSTATION</i> , page 414  | Ulong  | 4            | H+20          |
| 8       | freq  | Frequency indicator<br>0 = L1<br>2 = L2  | Ulong  | 4            | H+24          |
| 9       | Reserved  |  | Ulong  | 4            | H+28          |
| 10      | GNSS time   | Global Navigation Satellite System (GNSS) time of measurement ( $\mu$ s)   | Long   | 4            | H+32          |
| 11      | #obs  | Number of observation with information to follow   | Long   | 4            | H+36          |
| 12      | multi bit   | Multiple message indicator   | Ulong  | 4            | H+40          |
| 13      | code  | Is code P Code?<br>0 = FALSE<br>1 = TRUE   | Ulong  | 4            | H+44          |
| 14      | sat type  | Satellite type<br>0 = GPS<br>1 = GLONASS   | Ulong  | 4            | H+48          |
| 15      | PRN/slot  | PRN number for GPS satellites (satellite number 32 is indicated by 0); slot number for GLONASS satellites, see also <i>Section 1.3</i> on page 30. | Ulong  | 4            | H+52          |
| 16      | quality   | Data quality indicator, see <i>Table 80, RTCM2021 Data Quality Indicator</i> on page 457   | Ulong  | 4            | H+56          |
| 17      | continuity  | Cumulative loss of continuity indicator with a loss of lock counter  | Ulong  | 4            | H+60          |
| 18      | IODE  | Issue of ephemeris data  | Ulong  | 4            | H+64          |
| 19      | phase   | Carrier phase correction (1/256 cycles)  | Long   | 4            | H+68          |
| 20...   | Next RTMC20 observation offset = H+40 + (#obs x 32) |  |        |              |               |

Continued on page 459.

| Field #  | Field type                                | Data Description  | Format | Binary Bytes | Binary Offset |
|----------|---|---|--------|--------------|---------------|
| variable | RTCM header (for RTCM21)                  | RTCM message type   | Ulong  | 4            | variable      |
|          |   | Base station ID   | Ulong  | 4            |               |
|          |   | Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris. | Ulong  | 4            |               |
|          |   | Sequence number   | Ulong  | 4            |               |
|          |   | Length of frame   | Ulong  | 4            |               |
|          |   | Base station health, see <i>REFSTATION</i> , page 414   | Ulong  | 4            |               |
| variable | freq                                      | Frequency indicator   | Ulong  | 4            | variable      |
|          | Reserved                                  |   | Ulong  | 4            |               |
|          | GNSS time                                 | GNSS time of measurement  | Long   | 4            |               |
|          | #obs                                      | Number of observations to follow  | Ulong  | 4            |               |
| variable | multi bit                                 | Multiple message indicator  |        |              | variable      |
|          | code                                      | Is code P Code?<br>0 = FALSE<br>1 = TRUE  | Ulong  | 4            |               |
|          | sat type                                  | Satellite type<br>0 = GPS<br>1 = GLONASS  | Ulong  | 4            |               |
|          | prn                                       | Satellite PRN/slot number   | Ulong  | 4            |               |
|          | corr scale                                | Pseudorange correction scale factor<br>0 = 0.02<br>1 = 0.32   | Ulong  | 4            |               |
|          | rate scale                                | Pseudorange rate correction scale factor<br>0 = 0.002<br>1 = 0.032                                  | Ulong  | 4            |               |
|          | quality                                   | Data quality indicator, see <i>Table 80, Page 457</i>   | Ulong  | 4            |               |
|          | multipath                                 | Multipath indicator, see <i>Table 81, Page 457</i>  | Ulong  | 4            |               |
|          | IODE                                      | Issue of ephemeris data   | Ulong  | 4            |               |
|          | range corr                                | Pseudorange correction (scaled)   | Long   | 4            |               |
|          | range rate                                | Pseudorange range correction rate (scaled)  | Long   | 4            |               |
| variable | Next RTCM21 observation offset = variable |   |        |              |               |
| variable | xxxx                                      | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | variable      |
| variable | [CR][LF]                                  | Sentence terminator (ASCII only)  | -      | -            | -             |

### 3.3.92 RTCMDATA22 Extended Base Station V123\_RT20 V23\_RT2

See Section 3.3.84 starting on page 432 for information on RTCM standard logs.

This message accommodates Network RTK. However, it is not specific to Network RTK and may be used in other applications. For more details, refer to the Network RTK application note available from our Web site as APN-041 at <http://www.novatel.com/support/applicationnotes.htm>.

**Message ID:** 401  
**Log Type:** Synch


#### Recommended Input:

log rtcmdata22a ontime 10

#### ASCII Example:

```
#RTCMDATA22GGA,COM1,0,68.5,FINESTEERING,1450,231012.566,00100000,28b0,35794;  
22,0,1020,0,0,6,-24,-122,82,1,0,0,0,0,TRUE,174762,1,0,0,0*2846ab0c
```

---

 Only use the RTCMDATA22 log with GPS-only receiver models.

---

### RTCM22 RTCM Extended Base Station Parameters (RTK)

Message Type 22 provides firstly, a means of achieving sub-millimeter precision for base station coordinates, and secondly, base station antenna height above a base, which enables mobile units to reference measured position to the base directly in real time.

The first data word of message Type 22 provides the corrections to be added to each ECEF coordinate. Note that the corrections may be positive or negative.

The second data word, which may not be transmitted, provides the antenna L1 phase center height expressed in integer and fractional centimeters, and is always positive. It has the same resolutions as the corrections. The range is about 10 meters. The spare bits can be used if more height range is required.



RTCM Message Type 22 can be used to achieve sub-millimeter precision for base station coordinates in kinematic applications.

Further, if a base station antenna is for example, above a monument, it can be used to provide height. This enables mobile units (rovers) to reference measured positions to the monument directly in real time.

---

| Field #  | Field type        | Data Description   | Format                                   | Binary Bytes | Binary Offset |
|----------|-------------------|--|--|--------------|---------------|
| 1        | RTCMDATA22 header | Log header   | -  | H            | 0             |
| 2        | RTCM header       | RTCM message type  | Ulong                                    | 4            | H             |
| 3        |                   | Base station ID  | Ulong                                    | 4            | H+4           |
| 4        |                   | Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris | Ulong                                    | 4            | H+8           |
| 5        |                   | Sequence number  | Ulong                                    | 4            | H+12          |
| 6        |                   | Length of frame  | Ulong                                    | 4            | H+16          |
| 7        |                   | Base station health, see <i>REFSTATION</i> on page 414.  | Ulong                                    | 4            | H+20          |
| 8        |                   | L1 ECEF-X  | L1 ECEF $\Delta X$ correction (1/256 cm) | Long         | 4             |
| 9        | L1 ECEF-Y         | L1 ECEF $\Delta Y$ correction (1/256 cm)   | Long                                     | 4            | H+28          |
| 10       | L1 ECEF-Z         | L1 ECEF $\Delta Z$ correction (1/256 cm)   | Long                                     | 4            | H+32          |
| 11       | #L1 recs          | Number of GPS L1 records to follow   | Ulong                                    | 4            | H+36          |
| 12       | spare             | Spare bits   | Ulong                                    | 4            | H+40          |
| 13       | height stat       | No height flag where<br>0 = FALSE<br>1 = TRUE  | Enum                                     | 4            | H+44          |
| 14       | phase center      | Antenna L1 phase center height (1/256 cm)  | Ulong                                    | 4            | H+48          |
| variable | #L2 recs          | Number of GPS L2 records to follow   | Ulong                                    | 4            | variable      |
| variable | L2 ECEF-X         | L2 ECEF $\Delta X$ correction (1/256 cm)   | Long                                     | 4            | variable      |
| variable | L2 ECEF-Y         | L2 ECEF $\Delta Y$ correction (1/256 cm)   | Long                                     | 4            | variable      |
| variable | L2 ECEF-Z         | L2 ECEF $\Delta Z$ correction (1/256 cm)   | Long                                     | 4            | variable      |
| variable | xxxx              | 32-bit CRC (ASCII and Binary only)   | Hex                                      | 4            | variable      |
| variable | [CR][LF]          | Sentence terminator (ASCII only)   | -  | -            | -             |

---

### 3.3.93 **RTCMDATA22GG** *Extended Base Station for GLONASS VIG23\_G\_RT20/\_RT2*

See *Section 3.3.84* starting on *page 432* for information on RTCM standard logs. See also RTCMDATA22 for GPS-only receivers starting on *page 460*.

This message accommodates Network RTK. However, it is not specific to Network RTK and may be used in other applications. For more details, refer to the Network RTK application note available from our Web site as APN-041 at <http://www.novatel.com/support/applicationnotes.htm>.

**Message ID:** 964  
**Log Type:** Synch

#### **Recommended Input:**

log rtcmdata22gga ontime 10

#### **ASCII Example:**

```
#RTCMDATA22GGA, COM1, 0, 68.5, FINESTEERING, 1450, 231012.566, 00100000, 28b0, 35794;  
22, 0, 1020, 0, 0, 6, -24, -122, 82, 1, 0, 0, 0, 0, TRUE, 174762, 1, 0, 0, 0*2846ab0c
```

| Field #  | Field type           | Data Description   | Format                                   | Binary Bytes | Binary Offset |
|----------|----------------------|--|--|--------------|---------------|
| 1        | RTCMDATA-22GG header | Log header   | -  | H            | 0             |
| 2        | RTCM header          | RTCM message type  | Ulong                                    | 4            | H             |
| 3        |                      | Base station ID  | Ulong                                    | 4            | H+4           |
| 4        |                      | Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris | Ulong                                    | 4            | H+8           |
| 5        |                      | Sequence number  | Ulong                                    | 4            | H+12          |
| 6        |                      | Length of frame  | Ulong                                    | 4            | H+16          |
| 7        |                      | Base station health  | Ulong                                    | 4            | H+20          |
| 8        |                      | L1 ECEF-X  | L1 ECEF $\Delta X$ correction (1/256 cm) | Long         | 4             |
| 9        | L1 ECEF-Y            | L1 ECEF $\Delta Y$ correction (1/256 cm)   | Long                                     | 4            | H+28          |
| 10       | L1 ECEF-Z            | L1 ECEF $\Delta Z$ correction (1/256 cm)   | Long                                     | 4            | H+32          |
| 11       | #L1recs              | Number of GPS/GLONASS L1 records to follow   | Ulong                                    | 4            | H+36          |
| 12       | spare                | Spare bits   | Ulong                                    | 4            | H+40          |
| 13       | constellation        | Constellation  | Ulong                                    | 4            |               |
| 14       | ant type             | Antenna type   | Ulong                                    | 4            |               |
| 15       | ant ref pt           | Antenna reference point  | Ulong                                    | 4            |               |
| 16       | height stat          | No height flag where<br>0 = FALSE<br>1 = TRUE  | Enum                                     | 4            | H+44          |
| 17       | phase center         | Antenna L1 phase center height (1/256 cm)  | Ulong                                    | 4            | H+48          |
| variable | #L2recs              | Number of GPS/GLONASS L2 records to follow   | Ulong                                    | 4            | variable      |
| variable | L2 ECEF-X            | L2 ECEF $\Delta X$ correction (1/256 cm)   | Long                                     | 4            | variable      |
| variable | L2 ECEF-Y            | L2 ECEF $\Delta Y$ correction (1/256 cm)   | Long                                     | 4            | variable      |
| variable | L2 ECEF-Z            | L2 ECEF $\Delta Z$ correction (1/256 cm)   | Long                                     | 4            | variable      |
| variable | xxxx                 | 32-bit CRC (ASCII and Binary only)   | Hex                                      | 4            | variable      |
| variable | [CR][LF]             | Sentence terminator (ASCII only)   | -  | -            | -             |

### 3.3.94 RTCMDATA23 Antenna Type Definition V123\_RT20 V23\_RT2

See Section 3.3.84 starting on page 432 for information on RTCM standard logs.

**Message ID:** 663  
**Log Type:** Synch

**Recommended Input:**

log rtcmdata23a ontime 5

**ASCII Example:**

```
#RTCMDATA23A, COM1, 0, 80.5, COARSESTEERING, 1399, 253488.880, 005c0002, 3188, 35143;
23, 0, 2481, 0, 0, 6, 0, 0, 1, 9, "arbitrary", 1, 0, 6, "values"*f84ed3a0
```

#### RTCM23 RTCM Antenna Type Definition Record (RTK)

Message Type 23 provides information on the antenna type used at the base station. The RTCM commission uses an equipment-naming downloadable table from the International GPS Service Central Bureau (IGS CB): [ftp://igscb.jpl.nasa.gov/igscb/station/general/rcvr\\_ant.tab](ftp://igscb.jpl.nasa.gov/igscb/station/general/rcvr_ant.tab). This table provides a unique antenna descriptor for antennas used for high-precision surveying type applications.

The service provider uses the *setup ID* parameter to indicate the particular base station-antenna combination. "0" for this value means that the values of a standard model type calibration should be used. A non-zero value specifies a particular setup, or calibration, table for the specific antenna in use at the base station. Increase the number whenever a change occurs at the station that affects the antenna phase center variations. Depending on the change of the phase center variations due to a setup change, a change in the *setup ID* would mean that you should check with the service provider to see if the antenna phase center variation in use is still valid. The provider must make appropriate information available to users.

The *ant ser#* field is the individual antenna serial number as issued by the manufacturer of the antenna. A possible duplication of the antenna serial number is not possible, because together with the antenna descriptor, only one antenna with the particular number is available. In order to avoid confusion, the antenna serial number should be omitted when the record is used together with reverse reduction to model type calibration values, because it cannot be allocated to a real physical antenna.



In order to produce RTCM23 or RTCM24 messages from a base receiver, the receiver must have a fixed position (or be properly set to operate as a moving base station). The receiver must also have a BASEANTENNAMODEL command sent to it, see page 76. Provided these conditions are met, you can log RTCM23 and RTCM24 from the base station. If an RTCM24 log, or request for an RTCM24 log, is detected at the base, the rover station ARP parameter is set to 1. Otherwise it is set to 0.

---



| Field # | Field type        | Data Description   | Format     | Binary Bytes    | Binary Offset |
|---------|-------------------|--|------------|-----------------|---------------|
| 1       | RTCMDATA23 header | Log header   | -          | H               | 0             |
| 2       | RTCM header       | RTCM message type  | Ulong      | 4               | H             |
| 3       |                   | Base station ID  | Ulong      | 4               | H+4           |
| 4       |                   | Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris | Ulong      | 4               | H+8           |
| 5       |                   | Sequence number  | Ulong      | 4               | H+12          |
| 6       |                   | Length of frame  | Ulong      | 4               | H+16          |
| 7       |                   | Base station health, see <i>REFSTATION</i> on page 414   | Ulong      | 4               | H+20          |
| 8       |                   | Reserved   |            | Ulong           | 4             |
| 9       | ARP               | Antenna Reference Point  | Ulong      | 4               | H+28          |
| 10      | ser flag          | Serial flag  | Ulong      | 4               | H+32          |
| 11      | #chars            | Length of antenna descriptor (number of characters)  | Ulong      | 4               | H+36          |
| 12      | ant descrp        | Antenna descriptor   | Uchar [31] | 32 <sup>a</sup> | H+40          |
| 13      | setup ID          | Setup ID   | Ulong      | 4               | H+72          |
| 14      | Reserved          |  | Ulong      | 4               | H+76          |
| 15      | #chars2           | Length of antenna serial number (characters)   | Ulong      | 4               | H+80          |
| 16      | ant ser#          | Antenna serial number  | Uchar [31] | 31              | H+84          |
| 17      | xxxx              | 32-bit CRC (ASCII and Binary only)   | Hex        | 4               | variable      |
| 18      | [CR][LF]          | Sentence terminator (ASCII only)   | -          | -               | -             |

a. In the binary log case, additional bytes of padding may be added to maintain 4-byte alignment.

### 3.3.95 RTCMDATA24 Antenna Reference Point (ARP) V123\_RT20 V23\_RT2

See *Section 3.3.84* starting on *page 432* for information on RTCM standard logs.

This message accommodates Network RTK. However, it is not specific to Network RTK and may be used in other applications. For more details, refer to the Network RTK application note available from our Web site as APN-041 at <http://www.novatel.com/support/applicationnotes.htm>.

**Message ID:** 664  
**Log Type:** Synch

#### Recommended Input:

log rtcmdata24a ontime 5

#### ASCII Example:

```
#RTCMDATA24A, COM1, 0, 71.0, FINESTEERING, 1450, 237173.950, 00100000, 0625, 35794;  
24, 0, 5289, 0, 0, 6, -1.634526570929836e+10, 0, -3.664616764707576e+10,  
0, 4.942495013223856e+10, 0, 1, 1, 0, 0*530c8b71
```



In the example, log RTCM24 from the base before you log RTCMDATA24 at a rover:

```
interfacemode com2 none rtc (Set the COM2 interface mode to RTCM)  
log com2 RTCM24 ontime 5.0 (Output RTCM24 messages from COM2 every 5 s)
```

### RTCM24 RTCM Antenna Reference Point Parameter (RTK)

Message 24 replaced messages 3 and 22 for RTK operation. The L1 phase center is not a point in space that can be used as a standard reference but rather, depends on the antenna setup and calibration. The location of the L1 phase center may vary between different calibration tables for the same antenna model. Message Type 24 solves this using ARP, used throughout the International GPS Service (IGS).

Message 24 contains the coordinates of the installed antenna's ARP in the GNSS coordinate system Earth-Center-Earth-Fixed (ECEF) coordinates. Local datums are not supported. The coordinates refer to a physical point on the antenna (typically the bottom of the antenna mounting surface).

BASEANTENNA\_MODEL and ANTENNA\_MODEL commands set the data, see *pages 76* and *62* respectively. ECEF coordinates correspond to the currently calculated base station coordinates with the L1 phase centre offsets applied and will soon reflect the ARP, calculated from the base and rover sets of user antenna model parameters.

Reserved fields are set to 0, the *sys ind* field defaults to GPS, and the *ant ht* field is set to 0 by default. This follows current implementation of RTCM22 messages.

RTCM24 data can be viewed at the base by requesting the RTCMDATA24 log.

- ☒ If a rover receives RTCM24, RTCM1005, or RTCM1006 data, containing antenna offset information but does not have the same antenna type as the base station, the position is offset.

Provided the two receivers have matching antenna models, the output rover positions reflect the position of the ARP.

| Field # | Field type        | Data Description   | Format                                | Binary Bytes | Binary Offset |
|---------|-------------------|--|---------------------------------------|--------------|---------------|
| 1       | RTCMDATA24 header | Log header   | -                                     | H            | 0             |
| 2       | RTCM header       | RTCM message type  | Ulong                                 | 4            | H             |
| 3       |                   | Base station ID  | Ulong                                 | 4            | H+4           |
| 4       |                   | Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris | Ulong                                 | 4            | H+8           |
| 5       |                   | Sequence number  | Ulong                                 | 4            | H+12          |
| 6       |                   | Length of frame  | Ulong                                 | 4            | H+16          |
| 7       |                   | Base station health, see <i>REFSTATION</i> on page 414   | Ulong                                 | 4            | H+20          |
| 8       |                   | ECEF_X   | ECEF $\Delta X$ correction (1/256 cm) | Double       | 8             |
| 9       | Reserved          |  | Ulong                                 | 4            | H+32          |
| 10      | ECEF_Y            | ECEF $\Delta Y$ correction (1/256 cm)  | Double                                | 8            | H+36          |
| 11      | Reserved          |  | Ulong                                 | 4            | H+44          |
| 12      | ECEF_Z            | ECEF $\Delta Z$ correction (1/256 cm)  | Double                                | 8            | H+48          |
| 13      | sys ind           | System indicator   | Ulong                                 | 4            | H+56          |
| 14      | ant ht flag       | Antenna height flag  | Ulong                                 | 4            | H+60          |
| 15      | #recs             | Number of antenna records to follow  | Ulong                                 | 4            | H+64          |
| 16      | ant ht            | Antenna height   | Ulong                                 | 4            | H+68          |
| 16      | Reserved          |  | Ulong                                 | 4            | H+72          |
| 17      | xxxx              | 32-bit CRC (ASCII and Binary only)   | Hex                                   | 4            | H+76          |
| 18      | [CR][LF]          | Sentence terminator (ASCII only)   | -                                     | -            | -             |

---

### 3.3.96 RTCMDATA31 GLONASS Differential Corrections VIG23\_G and V123\_RT20 or V23\_RT2

See Section 3.3.84 starting on page 432 for information on RTCM standard logs.

**Message ID:** 868

**Log Type:** Synch

**Recommended Input:**

log rtcmdata31a ontime 2

**ASCII Example:**

```
#RTCMDATA31A, COM1, 0, 59.5, FINESTEERING, 1417, 171572.000, 00140000, 77c0, 2698;  
31, 1000, 3953, 0, 0, 6, 4, 0, 0, 4, -506, -6, 1, 77, 0, 0, 2, -280, -9, 1, 77, 0, 0, 18, -645,  
-4, 1, 77, 0, 0, 19, -660, -6, 1, 77*29664bf3
```

#### RTCM31 Differential GLONASS Corrections (RTK)

Message Type 31 provides differential GLONASS corrections.

- 
- ☒ The Type 31 format complies with the tentative RTCM 2.3 standard but is subject to change as the RTCM specifications change. It currently matches the Type 59GLO format, but unlike Type 31 which may change, Type 59GLO will stay in the same format.
-

| Field # | Field type         | Data Description   | Format                      | Binary Bytes | Binary Offset |
|---------|--------------------|--|-----------------------------|--------------|---------------|
| 1       | RTCM DATA31 header | Log header   | -                           | H            | 0             |
| 2       | RTCM header        | RTCM message type  | Ulong                       | 4            | H             |
| 3       |                    | Base station ID  | Ulong                       | 4            | H+4           |
| 4       |                    | Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris | Ulong                       | 4            | H+8           |
| 5       |                    | Sequence number  | Ulong                       | 4            | H+12          |
| 6       |                    | Length of frame  | Ulong                       | 4            | H+16          |
| 7       |                    | Base station health, see <i>REFSTATION</i> on page 414   | Ulong                       | 4            | H+20          |
| 8       |                    | #recs  | Number of records to follow | Ulong        | 4             |
| 9       | scale              | Scale factor   | Long                        | 4            | H+28          |
| 10      | udre               | User differential range error  | Ulong                       | 4            | H+32          |
| 11      | prn                | Satellite ID   | Ulong                       | 4            | H+36          |
| 12      | cor                | Correction   | Int                         | 4            | H+40          |
| 13      | cor rate           | Correction rate  | Int                         | 4            | H+44          |
| 14      | change             | Change bit   | Ulong                       | 4            | H+48          |
| 15      | $\tau_K$           | Time of day  | Ulong                       | 4            | H+52          |
| 16      | xxxx               | 32-bit CRC (ASCII and Binary only)   | Hex                         | 4            | variable      |
| 17      | [CR][LF]           | Sentence terminator (ASCII only)   | -                           | -            | -             |

### 3.3.97 RTCMDATA32 GLONASS Base Station Parameters VIG23\_G and V123\_RT20 or V23\_RT2

See Section 3.3.84 starting on page 432 for information on RTCM standard logs.

**Message ID:** 878

**Log Type:** Synch

**Recommended Input:**

log rtcmdata32a ontime 2

**ASCII Example:**

```
#RTCMDATA32A, COM1, 0, 41.0, FINESTEERING, 1417, 159021.845, 00140000, 4231, 2698;
32, 1000, 1036, 0, 0, 6, -109917613.9246512502431870,
-164379942.4939256608486176, 247124922.7021482884883881*3d24c470
```

### RTCM31 GLONASS Base Station Parameters (RTK)

Message Type 32 provides GLONASS base station parameters in ECEF coordinates.

| Field # | Field type        | Data Description   | Format                               | Binary Bytes | Binary Offset |
|---------|-------------------|--|--------------------------------------|--------------|---------------|
| 1       | RTCMDATA32 header | Log header   | -                                    | H            | 0             |
| 2       | RTCM header       | RTCM message type  | Ulong                                | 4            | H             |
| 3       |                   | Base station ID  | Ulong                                | 4            | H+4           |
| 4       |                   | Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris | Ulong                                | 4            | H+8           |
| 5       |                   | Sequence number  | Ulong                                | 4            | H+12          |
| 6       |                   | Length of frame  | Ulong                                | 4            | H+16          |
| 7       |                   | Base station health, see <i>REFSTATION</i> on page 414   | Ulong                                | 4            | H+20          |
| 8       |                   | ECEF-X   | ECEF $\Delta X$ correction (1/100 m) | Double       | 8             |
| 9       | ECEF-Y            | ECEF $\Delta Y$ correction (1/100 m)   | Double                               | 8            | H+32          |
| 10      | ECEF-Z            | ECEF $\Delta Z$ correction (1/100 m)   | Double                               | 8            | H+40          |
| 17      | xxxx              | 32-bit CRC (ASCII and Binary only)   | Hex                                  | 4            | H+48          |
| 18      | [CR][LF]          | Sentence terminator (ASCII only)   | -                                    | -            | -             |

### 3.3.98 RTCMDATA36 Special Message V1G23\_G

See Section 3.3.84 starting on page 432 for information on RTCM standard logs.

**Message ID:** 879

**Log Type:** Synch

**Recommended Input:**

log rtcmdata36a once

**ASCII Example:**

```
#RTCMDATA36A, COM1, 0, 64.5, FINESTEERING, 1399, 237113.869, 00500000,
f9f5, 35359; 36, 0, 5189, 0, 0, 6, 11, "QUICK\d166\d146\d174\d144\d140"
*8bdeae71
```

#### RTCM36 Special Message Including Russian Characters

This log contains a special ASCII message that can be displayed on a printer or terminal. The base station wishing to log this message out to rover stations that are logged onto a computer, must use the SETRTCM36T command to set the required ASCII text message. Once set, the message can then be issued at the required intervals with the “LOG *port* RTCM36 *interval*” command. The Special Message setting can be verified in the RXCONFIGA log, see page 539. The received ASCII text can be displayed at the rover by logging RTCM36T ONNEW.

The RTCM36 data log follows the RTCM Standard Format. Words 1 and 2 contain RTCM header information followed by words 3 to *n* (where *n* is variable from 3 to 32) which contain the special message ASCII text. Up to 90 ASCII characters, including an extended ASCII set as shown in Table 41 on page 198, can be sent with each RTCM Type 36 message frame.



The ASCII extended character set includes Cyrillic characters to provide, for example, Russian language messages.

| Field #  | Field type                             | Data Description   | Format | Binary Bytes   | Binary Offset |
|----------|--|--|--------|----------------|---------------|
| 1        | RTCM DATA36 header                     | Log header   | -      | H              | 0             |
| 2        | RTCM header                            | RTCM message type  | Ulong  | 4              | H             |
| 3        |  | Base station ID  | Ulong  | 4              | H+4           |
| 4        |  | Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris | Ulong  | 4              | H+8           |
| 5        |  | Sequence number  | Ulong  | 4              | H+12          |
| 6        |  | Length of frame  | Ulong  | 4              | H+16          |
| 7        |  | Base station health, see <i>REFSTATION</i> on page 414   | Ulong  | 4              | H+20          |
| 8        | #chars                                 | Number of characters to follow   | Ulong  | 4              | H+24          |
| 9        | character                              | Character  | Char   | 4 <sup>a</sup> | H+28          |
| 10...    | Next char offset = H+28 + (#chars x 4) |  |        |                |               |
| variable | xxxx                                   | 32-bit CRC (ASCII and Binary only)   | Hex    | 4              | variable      |
| variable | [CR][LF]                               | Sentence terminator (ASCII only)   | -      | -              | -             |

a. In the binary log case, an additional 3 bytes of padding are added to maintain 4-byte alignment



### 3.3.99 RTCMDATA59 Type 59N-0 NovAtel RT20 V123\_RT20 or V23\_RT2

See Section 3.3.84 starting on page 432 for information on RTCM standard logs.

**Message ID:** 403

**Log Type:** Synch

**Recommended Input:**

log rtcmdata59a ontime 10

**ASCII Example:**

```
#RTCMDATA59A, COM1, 0, 71.0, FINESTEERING, 1420, 506996.000, 00180020, 7dc7, 1899;
59, 0, 4993, 0, 0, 6, 78, 20506229, 2, 0, 8, 26, 3, 39864503, -167, 19, 3, 20437804, -40,
3, 3, 16170184, -41, 18, 3, 1213739, -123, 21, 3, 13601473, -50, 9, 3, 23627155, -171,
14, 3, 26086086, -151, 22, 3, 5, -182*9c414d63
```

### RTCM59 Type 59N-0 NovAtel Proprietary Message (RTK)

RTCM Type 59 messages are reserved for proprietary use by RTCM base station operators.

Each message is variable in length, limited only by the RTCM maximum of 990 data bits (33 words maximum). The first eight bits in the third word (the word immediately following the header) serve as the message identification code, in the event that the base station operator wishes to have multiple Type 59 messages.

NovAtel has defined only a Type 59N-0 message to date; it is used for operation in receivers capable of operating in RT-20 Carrier Phase Differential Positioning Mode. This log is primarily used by a base station to broadcast its RT-20 observation data (delta pseudorange and accumulated Doppler range) to rover RT-20 – capable receivers. Type 59N messages should be sent once every 2 seconds.

- 
- ☒ 1. The PORTSTATS log, see *page 381*, is very useful for monitoring the serial data link, as well as differential data decode success.
  - 2. This log is intended for use when operating in RT-20 mode.
- 



RTCM Message Type 59 is a message type reserved for private use by operators who communicate proprietary information.

NovAtel receivers make use of this Message Type 59 for RT20 differential positioning. The RTCMDATA59 log can be used to observe data being used by a rover that is performing RT-20 level positioning and RTCM corrections.

For example, the German SAPOS (Satellitenpositionierungsdienst der Deutschen Landesvermessung) and ASCOS (Satelliten-Referenzdienst der E.ON Ruhrgas AG) correction networks send their FKP RTK correction parameters (using their own message format) through RTCM message Type 59. FKP is an acronym for Flachen Korrektur Parameter (Plane Correction Parameter).

---

| Field #  | Field type                            | Data Description  | Format | Binary Bytes   | Binary Offset |
|----------|---------------------------------------|---|--------|----------------|---------------|
| 1        | RTCM DATA -59 header                  | Log header  | -      | H              | 0             |
| 2        | RTCM header                           | RTCM message type   | Ulong  | 4              | H             |
| 3        |                                       | Base station ID   | Ulong  | 4              | H+4           |
| 4        |                                       | Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris.                                 | Ulong  | 4              | H+8           |
| 5        |                                       | Sequence number   | Ulong  | 4              | H+12          |
| 6        |                                       | Length of frame   | Ulong  | 4              | H+16          |
| 7        |                                       | Base station health, see <i>REFSTATION</i> , page 414   | Ulong  | 4              | H+20          |
| 8        | subtype                               | Message subtype   | Char   | 4 <sup>a</sup> | H+24          |
| 9        | min psr                               | Minimum pseudorange (m)   | Long   | 4              | H+28          |
| 10       | time offset                           | Time difference between the Z-count time and the measurement time where Z-count time from subframe 1 of the ephemeris (0.1 s / lsb) | Long   | 4              | H+32          |
| 10       | Reserved                              |   | Ulong  | 4              | H+36          |
| 11       | #prn                                  | Number of PRNs with information to follow   | Ulong  | 4              | H+40          |
| 12       | PRN/slot                              | Satellite PRN number of range measurement (GPS: 1-32 and SBAS: 120 to 138. For GLONASS, see <i>Section 1.3</i> on page 30.)         | Ulong  | 4              | H+44          |
| 13       | lock                                  | Lock time:<br>0 = <20 seconds<br>1 = 20-40 seconds<br>2 = 40-80 seconds<br>3 = >80 seconds  | Ulong  | 4              | H+48          |
| 14       | psr                                   | Pseudorange correction (1/10 m)   | Ulong  | 4              | H+52          |
| 15       | adr                                   | Accumulated Doppler (ADR) correction (1/1000 m)   | Long   | 4              | H+56          |
| 16...    | Next PRN offset = H+44 + (#prns x 16) |   |        |                |               |
| variable | xxxx                                  | 32-bit CRC (ASCII and Binary only)  | Hex    | 4              | variable      |
| variable | [CR][LF]                              | Sentence terminator (ASCII only)  | -      | -              | -             |

a. In the binary log case, an additional 3 bytes of padding are added to maintain 4-byte alignment

---

### 3.3.100 RTCMDATA59GLO *NovAtel Proprietary GLONASS Differential Corrections V1G23\_G and V123\_DGPS*

See Section 3.3.84 starting on page 432 for information on RTCM standard logs.

**Message ID:** 905  
**Log Type:** Synch

**Recommended Input:**

```
log rtcmdata59gloa ontime 2
```

**ASCII Example:**

```
#RTCMDATA59GLOA,COM1,0,71.5,FINESTEERING,1420,509339.000,00100008,e896,2733;  
59,10,2898,0,0,6,110,2,0,0,19,-459,-9,0,56,0,0,4,570,-7,1,56*00dee641
```

- 
- ☒ The Type 31 format, see page 468, currently matches the Type 59GLO format, but unlike Type 31 which may change, Type 59GLO will stay in the same format. The Type 31 format complies with the tentative RTCM 2.3 standard but is subject to change as the RTCM specifications change.
- 

#### RTCM59GLO Differential GLONASS Corrections (DGPS)

Message Type 59GLO provides differential GLONASS corrections.

| Field # | Field type             | Data Description   | Format          | Binary Bytes | Binary Offset  |
|---------|------------------------|--|-----------------|--------------|----------------|
| 1       | RTCM DATA-59GLO header | Log header   | -               | H            | 0              |
| 2       | RTCM header            | RTCM message type  | Ulong           | 4            | H              |
| 3       |                        | Base station ID  | Ulong           | 4            | H+4            |
| 4       |                        | Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris | Ulong           | 4            | H+8            |
| 5       |                        | Sequence number  | Ulong           | 4            | H+12           |
| 6       |                        | Length of frame  | Ulong           | 4            | H+16           |
| 7       |                        | Base station health, see <i>REFSTATION</i> on page 414   | Ulong           | 4            | H+20           |
| 8       |                        | subtype  | Message subtype | Uchar        | 4 <sup>a</sup> |
| 9       | #recs                  | Number of records to follow  | Ulong           | 4            | H+28           |
| 10      | scale                  | Scale factor   | Long            | 4            | H+32           |
| 11      | udre                   | User differential range error  | Ulong           | 4            | H+36           |
| 12      | prn                    | Satellite ID   | Ulong           | 4            | H+40           |
| 13      | cor                    | Correction   | Int             | 4            | H+44           |
| 14      | cor rate               | Correction rate  | Int             | 4            | H+48           |
| 15      | change                 | Change bit   | Ulong           | 4            | H+52           |
| 16      | $\tau_K$               | Time of day  | Ulong           | 4            | H+56           |
| 17      | xxxx                   | 32-bit CRC (ASCII and Binary only)   | Hex             | 4            | variable       |
| 18      | [CR][LF]               | Sentence terminator (ASCII only)   | -               | -            | -              |

a. In the binary log case, an additional 3 bytes of padding are added to maintain 4-byte alignment.

---

### 3.3.101 RTCMDATACDGPS1 Localized CDGPS Corrections in RTCM1 V13\_CDGPS

See Section 3.3.84 starting on page 432 for information on RTCM standard logs. See also *CDGPS Local Wide Area Corrections* on page 436.

**Message ID:** 953

**Log Type:** Synch

**Recommended Input:**

```
log rtcmdatcdgps1a ontime 10
```

**ASCII Example:**

```
#RTCMDATACDGPS1A,COM1,0,51.5,FINESTEERING,1464,423863.023,00000000,ad02,3144;  
1,209,4438,0,0,0,10,0,1,21,-384,0,64,0,1,18,-412,0,9,0,1,24,-423,0,81,0,1,6,  
-361,0,2,0,1,26,-461,0,59,0,1,16,-88,0,5,0,1,22,-734,0,48,0,1,3,-695,0,73,  
0,2,10,-1007,0,77,0,3,8,-1342,0,63*c6bfd557
```

#### RTCMCDGPS1

The RTCMCDGPS1 message is an RTCM Type 1 message that the receiver generates from CDGPS corrections. See also the RTCMDATAOMNI1 log table starting on page 481 that reflects an RTCM1 output and the RTCMDATACDGPS1 output example above.

### 3.3.102 RTCMDATACDGPS9 CDGPS Corrections in RTCM9 Format VI3\_CDGPS

See *Section 3.3.84* starting on *page 432* for information on RTCM standard logs. See also the RTCMDATACDGPS9 output example below, the RTCMDATACDGPS9 log table on *page 479*, and *CDGPS Local Wide Area Corrections* on *page 436*.

**Message ID:** 956

**Log Type:** Synch

**Recommended Input:**

```
log rtcmdatacdgps9a ontime 10
```

**ASCII Example:**

```
#RTCMDATACDGPS9A,COM1,0,54.0,FINESTEERING,1464,423903.023,00000000,0e6c,3144;  
9,209,4505,0,0,0,3,0,1,3,-687,0,73,0,2,10,-1025,0,77,0,3,8,-1335,0,63  
*1ed7bcc9
```

#### RTCMCDGPS9

The RTCMCDGPS9 message is an RTCM Type 9 message that the receiver generates from CDGPS corrections. To use this log, you must have an OEMV-3 based receiver capable of receiving L-band. See also the log table on *page 479* that reflects an RTCM9 output and the RTCMDATACDGPS9 output example in the next section.

Type 9 messages follow the same format as Type 1 messages. However, unlike a Type 1 message, Type 9 does not require a complete satellite set. This allows for much faster differential correction data updates to the rover stations that improves performance and reduces latency.

OEMV-3 receivers, with or without an external oscillator, can generate Type 9 messages. All OEMV family receivers can accept Type 9 messages. Also, Type 9 messages give better performance with slow or noisy data links.

| Field #  | Field type                            | Data Description   | Format   | Binary Bytes | Binary Offset |
|----------|---------------------------------------|--|--|--------------|---------------|
| 1        | RTCMDATA-<br>CDGPS9<br>header         | Log header   | -  | H            | 0             |
| 2        | RTCM header                           | RTCM message type  | Ulong  | 4            | H             |
| 3        |                                       | Base station ID  | Ulong  | 4            | H+4           |
| 4        |                                       | Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris | Ulong  | 4            | H+8           |
| 5        |                                       | Sequence number  | Ulong  | 4            | H+12          |
| 6        |                                       | Length of frame  | Ulong  | 4            | H+16          |
| 7        |                                       | Base station health, see <i>REFSTATION</i> on page 414   | Ulong  | 4            | H+20          |
| 8        |                                       | #prn   | Number of PRNs with information to follow (maximum of 3) | Ulong        | 4             |
| 9        | scale                                 | Scale where<br>0 = 0.02 m and 0.002 m/s<br>1 = 0.32 m and 0.032 m/s                                | Ulong  | 4            | H+28          |
| 10       | UDRE                                  | User differential range error  | Ulong  | 4            | H+32          |
| 11       | PRN/slot                              | Satellite PRN number (GPS: 1-32, SBAS: 120 to 138) or GLONASS slot                                 | Ulong  | 4            | H+36          |
| 12       | psr corr                              | Scaled pseudorange correction (m)  | Long   | 4            | H+40          |
| 13       | rate corr                             | Scaled range rate correction   | Long   | 4            | H+44          |
| 14       | IOD                                   | Issue of data  | Long   | 4            | H+48          |
| 15...    | Next PRN offset = H+28 + (#prns x 24) |  |  |              |               |
| variable | xxxx                                  | 32-bit CRC (ASCII and Binary only)   | Hex  | 4            | variable      |
| variable | [CR][LF]                              | Sentence terminator (ASCII only)   | -  | -            | -             |

### 3.3.103 RTCMDATAOMNI1 RTCM1 from OmniSTAR VBS V13\_VBS

See Section 3.3.84 starting on page 432 for information on RTCM standard logs. See also *OmniSTAR Local Wide Area Corrections* on page 436.

**Message ID:** 960

**Log Type:** Asynch

**Recommended Input:**

log rtcmdataomni1a onchanged

**ASCII Example:**

```
#RTCMDATAOMNI1A,COM1,0,74.0,FINESTEERING,1464,424276.151,00000000,405e,35912;
1,100,5119,0,0,0,0,12,
0,0,6,-313,0,2,0,0,3,-570,0,73,0,0,10,-1116,0,77,0,0,15,-339,0,0,
0,0,16,-527,0,5,0,0,18,-29,0,9,0,0,21,-306,0,64,0,0,22,-586,0,48,
0,0,24,-362,0,81,0,0,26,-394,0,59,0,0,29,-487,0,37,0,0,8,-1242,0,63*f128cbd2
```

### RTCMOMNI1 RTCM from OmniSTAR

The RTCMOMNI1 message is an RTCM Type 1 message that the receiver generates from OmniSTAR VBS corrections.



| Field #  | Field type             | Data Description   | Format | Binary Bytes | Binary Offset |
|----------|------------------------|--|--------|--------------|---------------|
| 1        | RTCM DATA-OMNI1 header | Log header   | -      | H            | 0             |
| 2        | type                   | RTCM message type  | Ulong  | 4            | H             |
| 3        | baseID                 | Base station ID  | Ulong  | 4            | H+4           |
| 4        | Z                      | Modified Z count where the Z count week number is the week number from subframe 1 of the ephemeris | Ulong  | 4            | H+8           |
| 5        | seq#                   | Sequence number  | Ulong  | 4            | H+12          |
| 6        | frame length           | Length of frame  | Ulong  | 4            | H+16          |
| 7        | health                 | Base station health  | Ulong  | 4            | H+20          |
| 8        | Mhealth                | Message health   | Ulong  | 4            | H+24          |
| 9        | #recs                  | Number of records to follow  | Ulong  | 4            | H+28          |
| 10       | scale                  | Scaling for the correction and correction rate   | Ulong  | 4            | H+32          |
| 11       | UDRE                   | User differential range error  | Ulong  | 4            | H+36          |
| 12       | prn                    | Satellite PRN (1-32)   | Ulong  | 4            | H+40          |
| 13       | corr                   | Correction   | Int    | 4            | H+44          |
| 14       | corr rate              | Correction rate  | Int    | 4            | H+48          |
| 15       | IODE                   | Issue of ephemeris data  | Ulong  | 4            | H+52          |
| variable | xxxx                   | 32-bit CRC (ASCII and Binary only)   | Hex    | 4            | variable      |
| variable | [CR][LF]               | Sentence terminator (ASCII only)   | -      | -            | -             |

### 3.3.104 RTCMV3 *RTCMV3 Standard Logs V123\_RT20 V23\_RT2*

**RTCM1001** L1-ONLY GPS RTK OBSERVABLES *V123\_RT20 V23\_RT2*

**Message ID: 772**

**RTCM1002** EXTENDED L1-ONLY GPS RTK OBSERVABLES *V123\_RT20 V23\_RT2*

**Message ID: 774**

**RTCM1003** L1 AND L2 GPS RTK OBSERVABLES *V123\_RT20 V23\_RT2*

**Message ID: 776**

**RTCM1004** EXTENDED L1 AND L2 GPS RTK OBSERVABLES *V123\_RT20 V23\_RT2*

**Message ID: 770**

**RTCM1005** STATIONARY RTK BASE STATION ANTENNA REFERENCE  
POINT (ARP) *V123\_RT20 V23\_RT2*

**Message ID: 765**

**RTCM1006** STATIONARY RTK BASE STATION ARP WITH ANTENNA  
HEIGHT *V123\_RT20 V23\_RT2*

**Message ID: 768**

**RTCM1007** EXTENDED ANTENNA DESCRIPTOR AND SETUP INFORMATION  
*V123\_RT20 V23\_RT2*

**Message ID: 852**

**RTCM1008** EXTENDED ANTENNA REFERENCE STATION DESCRIPTION AND  
SERIAL NUMBER *V123\_RT20 V23\_RT2*

**Message ID: 854**

**RTCM1009** GLONASS L1-ONLY RTK *V123\_RT20 V23\_RT2*

**Message ID: 885**

**RTCM1010** EXTENDED GLONASS L1-ONLY RTK *V123\_RT20 V23\_RT2*

**Message ID: 887**

**RTCM1011** GLONASS L1/L2 RTK *V123\_RT20 V23\_RT2*

**Message ID: 889**

**RTCM1012** EXTENDED GLONASS L1/L2 RTK *V123\_RT20 V23\_RT2*

**Message ID: 891**

**RTCM1019** GPS EPHEMERIDES *V123\_RT20 V23\_RT2*

**Message ID: 893**

**RTCM1020** GLONASS EPHEMERIDES *V123\_RT20 V23\_RT2*

**Message ID: 895**

- 
- ☒ 1. At the base station, choose to send either an RTCM1005 or RTCM1006 message to the rover station. Then select one of the observable messages (RTCM1001, RTCM1002, RTCM1003 or RTCM1004) to send from the base.
  - 2. RTCM1007 and RTCM1008 data is set using the BASEANTENNAMODEL command, see *page 76*. If you have set a base station ID, it is detected and set. Other values are also taken from a previously entered BASEANTENNAMODEL command.
  - 3. In order to set up logging of RTCM1007 or RTCM1008 data, it is recommended to first use the INTERFACEMODE command to set the interface mode of the port transmitting RTCMV3 messages to RTCMV3, see *page 135*. Providing the base has a fixed position, see FIX on *page 115*, and its BASEANTENNAMODEL command set, you can log out RTCM1007 messages.
  - 4. The RTCM messages can be logged with an A or B suffix for an ASCII or Binary output with a NovAtel header followed by Hex or Binary raw data respectively.
  - 5. RTCMDATA logs output the details of the above logs if they have been sent.
- 

RTCM SC-104 is a more efficient alternative to the documents entitled "RTCM Recommended Standards for Differential NAVSTAR GPS Service, Version 2.x". Version 3.0, consists primarily of messages designed to support real-time kinematic (RTK) operations. The reason for this emphasis is that RTK operation involves broadcasting a lot of information, and thus benefits the most from a more efficient data format.

The RTCM SC-104 standards have been adopted by NovAtel for implementation into the receiver. The receiver can easily be integrated into positioning systems around the globe because it is capable of utilizing RTCM Version 3.0 formats.

The initial Version 3.0 document describes messages and techniques for supporting GPS. However, the format accommodates modifications to these systems (for example, new signals), and to new satellite systems that are under development. In addition, augmentation systems that utilize geostationary satellites with transponders operating in the same frequency bands are now in the implementation stages. Generically they are called Satellite-Based Augmentation Systems (SBAS), and they have been designed to be interoperable (for example WAAS, EGNOS, MSAS).

Message types contained in the current Version 3.0 standard have been structured in different groups. Transmit at least one message type from each of Groups 1 to 3:

Group 1 - Observations:

|          |                              |
|----------|------------------------------|
| RTCM1001 | L1-Only GPS RTK              |
| RTCM1002 | Extended L1-Only GPS RTK     |
| RTCM1003 | L1 And L2 GPS RTK            |
| RTCM1004 | Extended L1and L2 GPS RTK    |
| RTCM1009 | L1-Only GLONASS RTK          |
| RTCM1010 | Extended L1-Only GLONASS RTK |
| RTCM1011 | L1/L2 GLONASS RTK            |
| RTCM1012 | Extended L1/L2 GLONASS RTK   |

## Group 2 - Base Station Coordinates:

- RTCM1005     RTK Base Antenna Reference Point (ARP)
- RTCM1006     RTK Base ARP with Antenna Height

## Group 3 - Antenna Description:

- RTCM1007     Extended Antenna Descriptor and Setup Information
- RTCM1008     Extended Antenna Reference Station Description and Serial Number

## Group 4 - Auxiliary Operation Information:

- RTCM1019     GPS Ephemerides
- RTCM1020     GLONASS Ephemerides

**Example Input:**

```
interfacemode com2 none RTCMV3
fix position 51.1136 -114.0435 1059.4
baseantennamodel 702 NVH05410007 1 user
log com2 rtc1005 ontime 3
log com2 rtc1002 ontime 5
log com2 rtc1006 ontime 1
log com2 rtc1007 ontime 10
log com2 rtc1008 ontime 10
```

**RTCM1001-RTCM1004GPS RTK Observables *V123\_RT20 V23\_RT2***

RTCM1001, RTCM1002, RTCM1003 and RTCM1004 are GPS real-time kinematic (RTK) messages, which are based on raw data. From these data, valid RINEX files can be obtained. As a result, this set of messages offers a high level of interoperability and compatibility with standard surveying practices. Refer also to the *PC Software and Firmware* section of the *OEMV Installation and Operation Manual* for details on the logs that Convert4 converts to RINEX.

The Type 1001 Message supports single-frequency RTK operation. It does not include an indication of the satellite carrier-to-noise ratio as measured by the base station.

The Type 1002 Message supports single-frequency RTK operation, and includes an indication of the satellite carrier-to-noise (C/No) as measured by the base station. Since the C/No does not usually change from measurement to measurement, this message type can be mixed with the Type 1001, and used primarily when a satellite C/No changes, thus saving broadcast link throughput.

The Type 1003 Message supports dual-frequency RTK operation, but does not include an indication of the satellite carrier-to-noise (C/No) as measured by the base station.

The Type 1004 Message supports dual-frequency RTK operation, and includes an indication of the satellite carrier-to-noise (C/No) as measured by the base station. Since the C/No does not usually change from measurement to measurement, this message type can be mixed with the Type 1003, and used only when a satellite C/No changes, thus saving broadcast link throughput.

---

## RTCM1005 & RTCM1006 RTK Base Antenna Reference Point (ARP)

Message Type 1005 provides the earth-centered, earth-fixed (ECEF) coordinates of the antenna reference point (ARP) for a stationary base station. No antenna height is provided.

Message Type 1006 provides all the same information as Message Type 1005, but additionally provides the height of the ARP.

These messages are designed for GPS operation, but are equally applicable to future satellite systems, and system identification bits are reserved for them.

Message Types 1005 and 1006 avoid any phase center problems by utilizing the ARP, which is used throughout the International GPS Service (IGS). They contain the coordinates of the installed antenna's ARP in Earth-Center-Earth-Fixed (ECEF) coordinates - datum definitions are not yet supported. The coordinates always refer to a physical point on the antenna, typically the bottom of the antenna mounting surface.

## RTCM1007 & RTCM1008 Extended Antenna Descriptions

Message Type 1007 provides an ASCII descriptor of the base station antenna. The International GPS Service (IGS) Central Bureau convention is used most of the time, since it is universally accessible.

Message Type 1008 provides the same information, plus the antenna serial number, which removes any ambiguity about the model number or production run.

IGS limits the number of characters to 20 at this time. The antenna setup ID is a parameter for use by the service provider to indicate the particular base station-antenna combination. "0" for this value means that the values of a standard model type calibration should be used. The antenna serial number is the individual antenna serial number as issued by the manufacturer of the antenna.

## RTCM1009-RTCM1012 GLONASS RTK Observables

Message Types 1009 through 1012 provide the contents of the GLONASS RTK messages, which are based on raw data. You can obtain complete RINEX files from this data. This set of messages offers a high level of interoperability and compatibility with standard surveying practices. When using these messages, you should also use an ARP message (Type 1005 or 1006) and an Antenna Descriptor message (Type 1007 or 1008). If the time tags of the GPS and GLONASS RTK data are synchronized, the Synchronized GNSS flag can be used to connect the entire RTK data block.

## RTCM1019-RTCM1020 GPS and GLONASS Ephemerides

Message Type 1019 contains GPS satellite ephemeris information. Message Type 1020 contains GLONASS ephemeris information. These messages can be broadcast in the event that an anomaly in ephemeris data is detected, requiring the base station to use corrections from previously good satellite ephemeris data. This allows user equipment just entering the differential system to use corrections being broadcast from that ephemeris. Broadcast this message (Type 1019 or 1020) every 2 minutes until the satellite broadcast is corrected, or until the satellite drops below the coverage area of the base station.

These messages can also be used to assist receivers to quickly acquire satellites. For example, if you access a wireless service with this message, it can utilize the ephemeris information immediately rather than waiting for a satellite to be acquired and its almanac data processed.

### 3.3.105 RTCMDATA1001 L1-Only GPS RTK Observables V123\_RT20 V23\_RT2

This log is available at the base station. See *Section 3.3.104* starting on page 482 for information on RTCM Version 3.0 standard logs.

**Message ID:** 784  
**Log Type:** Synch

**Recommended Input:**

log rtcmdata1001a ontime 10 3

**ASCII Example:**

```
#RTCMDATA1001A,COM1,0,82.0,FINESTEERING,1317,239228.000,00180040,c279,1855;
0,0,239228000,0,8,0,0,8,21,0,14513926,8707,127,2,0,3705361,5040,127,16,0,
7573721,3555,124,29,0,5573605,-11078,127,26,0,2996771,-17399,99,6,0,9341652,
-329,127,10,0,13274623,2408,127,30,0,3355111,18860,127*ec698c2a
```



Message Type 1001 contains the shortest version of a message for GPS observations, namely L1-only observables. Message Type 1002 contains additional information that enhances performance. If throughput is not limited and the additional information is available, it is recommended to use the longer version of messages.

**Table 82: SBAS PRN Codes**

| SBAS Code | GPS/GLONASS Satellite ID | SBAS Code | GPS/GLONASS Satellite ID |
|-----------|--------------------------|-----------|--------------------------|
| 120       | 40                       | 130       | 50                       |
| 121       | 41                       | 131       | 51                       |
| 122       | 42                       | 132       | 52                       |
| 123       | 43                       | 133       | 53                       |
| 124       | 44                       | 134       | 54                       |
| 125       | 45                       | 135       | 55                       |
| 126       | 46                       | 136       | 56                       |
| 127       | 47                       | 137       | 57                       |
| 128       | 48                       | 138       | 58                       |
| 129       | 49                       |           |                          |

**Table 83: Carrier Smoothing Interval of Code Phase**

| Indicator |        | Smoothing Interval           |
|-----------|--------|------------------------------|
| ASCII     | Binary |                              |
| 0         | 000    | No smoothing                 |
| 1         | 001    | < 30 s                       |
| 2         | 010    | 30-60 s                      |
| 3         | 011    | 1-2 min.                     |
| 4         | 100    | 2-4 min.                     |
| 5         | 101    | 4-8 min.                     |
| 6         | 110    | >8 min.                      |
| 7         | 111    | Unlimited smoothing interval |

**Table 84: Lock Time Indicator**

| Indicator (j) <sup>a</sup> | Minimum Lock Time (s) | Range of Indicated Lock Times     |
|----------------------------|-----------------------|-----------------------------------|
| 0-23                       | i                     | $0 \leq \text{lock time} < 24$    |
| 24-47                      | $i \cdot 2 - 24$      | $24 \leq \text{lock time} < 72$   |
| 48-71                      | $i \cdot 4 - 120$     | $72 \leq \text{lock time} < 168$  |
| 72-95                      | $i \cdot 8 - 408$     | $168 \leq \text{lock time} < 360$ |
| 96-119                     | $i \cdot 16 - 1176$   | $360 \leq \text{lock time} < 744$ |
| 120-126                    | $i \cdot 32 - 3096$   | $744 \leq \text{lock time} < 937$ |
| 127                        | ---                   | $\text{lock time} \geq 937$       |

- a. Determining Loss of Lock: In normal operation, a cycle slip is evident when the Minimum Lock Time (s) has decreased in value. For long time gaps between messages, such as from a radio outage, extra steps should be taken on the rover to safeguard against missed cycle slips.

| Field # | Field type                 | Data Description   | Format                                    | Binary Bytes | Binary Offset |
|---------|----------------------------|--|---|--------------|---------------|
| 1       | RTCMDATA1001 header        | Log header   | -   | H            | 0             |
| 2       | RTCMV3 observations header | Message number   | Ushort                                    | 2            | H             |
| 3       |                            | Base station ID  | Ushort                                    | 2            | H+2           |
| 4       |                            | GPS epoch time in ms from the beginning of the GPS week, which begins at midnight GMT on Saturday night/Sunday morning, measured in GPS time (as opposed to UTC)   | Ulong                                     | 4            | H+4           |
| 5       |                            | GNSS message flag:<br>0 = No further GNSS observables referenced to the same epoch time. The receiver begins to process data immediately after decoding the message.<br>1 = The next message contains observables from another GNSS source referenced to the same epoch time                     | Uchar                                     | 1            | H+8           |
| 6       |                            | Number of GPS satellite signals processed (the number of satellites in the message and not necessarily equal to the number of satellites visible to the base station)  | Uchar                                     | 1            | H+9           |
| 7       |                            | Smoothing indicator<br>0 = Divergence-free smoothing not used<br>1 = Divergence-free smoothing used  | Uchar                                     | 1            | H+10          |
| 8       |                            | Smoothing interval, see <i>Table 83 on page 487</i> . This is the integration period over which base station pseudorange code phase measurements are averaged using carrier phase information. Divergence-free smoothing may be continuous over the entire period that the satellite is visible. | Uchar                                     | 1            | H+11          |
| 9       |                            | #prns  | Number of PRNs with information to follow | Ulong        | 4             |
| 10      | PRN                        | PRN #, for SBAS see <i>Table 82, page 486</i>  | Uchar                                     | 1            | H+16          |
| 11      | code-ind                   | GPS L1 code indicator<br>0 = C/A code<br>1 = P(Y) code direct  | Uchar                                     | 1            | H+17          |
| 12      | psr                        | GPS L1 pseudorange (m) in 0.02 m units   | Ulong                                     | 4            | H+18          |

Continued on page 489.



| Field #  | Field type                            | Data Description  | Format | Binary Bytes   | Binary Offset |
|----------|---------------------------------------|---|--------|----------------|---------------|
| 13       | phase-pseudo                          | GPS L1 (phaserange - pseudorange) in 0.0005 m units<br>Range: $\pm 262.1435$ m  | Long   | 4              | H+22          |
| 14       | locktime-ind                          | GPS L1 continuous tracking lock time indicator, see <i>Table 84</i> on page 487 | Uchar  | 2 <sup>a</sup> | H+26          |
| 15...    | Next PRN offset = H+16 + (#prns x 12) |   |        |                |               |
| variable | xxxx                                  | 32-bit CRC (ASCII and Binary only)  | Hex    | 4              | variable      |
| variable | [CR][LF]                              | Sentence terminator (ASCII only)  | -      | -              | -             |

- a. In the binary log case, a variable number of additional bytes of padding are added, depending on the number of satellites, to maintain 4-byte alignment.

---

### 3.3.106 RTCMDATA1002 *Extended L1-Only GPS RTK Observables* *V123\_RT20 V23\_RT2*

This log is available at the base station. See *Section 3.3.104* starting on *page 482* for information on RTCM Version 3.0 standard logs.

**Message ID:** 785  
**Log Type:** Synch

**Recommended Input:**

log rtcmdata1002a ontime 7

**ASCII Example:**

```
#RTCMDATA1002A,COM1,0,79.0,FINESTEERING,1317,239318.000,00180040,adb2,1855;  
0,0,239318000,0,9,0,0,9,21,0,12261319,-9236,127,0,202,  
2,0,6623657,4517,127,0,171,16,0,5632627,1876,127,0,179,  
29,0,3064427,-10154,127,0,177,26,0,14721908,-21776,105,0,164,  
6,0,9384778,1113,127,0,205,18,0,9594701,-1176,27,0,184,  
10,0,14876991,8629,127,0,202,30,0,6417059,20243,127,0,195*e7d3c54d
```



Message Type 1002 contains additional information to Message Type 1001, see *page 486*, that enhances performance. If throughput is not limited and the additional information is available, it is recommended to use the longer version of messages.

---

| Field #  | Field type  | Data Description   | Format | Binary Bytes   | Binary Offset |
|----------|---|--|--------|----------------|---------------|
| 1        | RTCM DATA1002 header  | Log header   | -      | H              | 0             |
| 2        | RTCMV3 observations header, see the RTCM-DATA1001 log on page 486 for details | Message number   | Ushort | 2              | H             |
| 3        |   | Base station ID  | Ushort | 2              | H+2           |
| 4        |   | GPS epoch time (ms)  | Ulong  | 4              | H+4           |
| 5        |   | GNSS message flag  | Uchar  | 1              | H+8           |
| 6        |   | Number of GPS satellite signals processed (0-31)   | Uchar  | 1              | H+9           |
| 7        |   | Smoothing indicator  | Uchar  | 1              | H+10          |
| 8        |   | Smoothing interval, see Table 83 on page 487.  | Uchar  | 1              | H+11          |
| 9        | #prns   | Number of PRNs with information to follow  | Ulong  | 4              | H+12          |
| 10       | prn#  | PRN #, for SBAS see Table 82, page 486   | Uchar  | 1              | H+16          |
| 11       | code-ind  | GPS L1 code indicator<br>0 = C/A code<br>1 = P(Y) code direct  | Uchar  | 1              | H+17          |
| 12       | psr   | GPS L1 pseudorange (m) in 0.02 m units   | Ulong  | 4              | H+18          |
| 13       | phase-pseudo  | GPS L1 (phaserange - pseudorange) in 0.0005 m units<br>Range: ±262.1435 m  | Long   | 4              | H+22          |
| 14       | locktime-ind  | GPS L1 continuous tracking lock time indicator, see Table 84 on page 487   | Uchar  | 1              | H+26          |
| 15       | amb   | GPS L1 PSR modulus ambiguity (m). The integer number of full pseudorange modulus divisions (299,792.458 m) of the raw L1 pseudorange measurement.              | Uchar  | 1              | H+27          |
| 16       | C/No  | GPS L1 carrier-to-noise ratio (dBHz). The base station's estimate of the satellite's signal. A value of 0 indicates that the C/No measurement is not computed. | Uchar  | 4 <sup>a</sup> | H+28          |
| 17...    | Next PRN offset = H+16 + (#prns x 16)   |  |        |                |               |
| variable | xxxx  | 32-bit CRC (ASCII and Binary only)   | Hex    | 4              | variable      |
| variable | [CR][LF]  | Sentence terminator (ASCII only)   | -      | -              | -             |

- a. In the binary log case, a variable number of additional bytes of padding are added, depending on the number of satellites, to maintain 4-byte alignment.

### 3.3.107 RTCMDATA1003 L1/L2 GPS RTK Observables V123\_RT20 V23\_RT2

This log is available at the base station. See *Section 3.3.104* starting on *page 482* for information on RTCM Version 3.0 standard logs.

**Message ID:** 786  
**Log Type:** Synch

**Recommended Input:**

log rtcmdata1003a ontime 7

**ASCII Example:**

```
#RTCMDATA1003A,COM1,0,79.0,FINESTEERING,1317,239386.000,00180040,a38c,1855;
0,0,239386000,0,9,0,0,9,
21,0,10569576,-8901,127,0,-176,-7752,127,
2,0,8831714,3717,127,0,-163,7068,127,
16,0,4189573,-1118,127,0,-108,-1273,127,
29,0,1181151,-10116,127,0,-61,-11354,127,
26,0,12256552,-15107,109,0,24,-18232,109,
6,0,9442835,1961,127,0,-116,2536,127,
18,0,7145333,-3326,54,0,-17,-304,54,
10,0,1125215,13933,127,0,-148,12353,127,
30,0,8737848,20418,127,0,-48,19592,127*2286a5ab
```



Message Type 1003 provides minimum data for L1/L2 operation, while Message Type 1004 provides the full data content. The longer observation messages do not change very often, and can be sent less often.

| Field #  | Field type   | Data Description   | Format                                    | Binary Bytes   | Binary Offset |
|----------|--|--|---|----------------|---------------|
| 1        | RTCM DATA1003 header   | Log header   | -   | H              | 0             |
| 2        | RTCM V3 observations header, see the RTCM-DATA1001 log on page 486 for details | Message number   | Ushort                                    | 2              | H             |
| 3        |  | Base station ID  | Ushort                                    | 2              | H+2           |
| 4        |  | GPS epoch time (ms)  | Ulong                                     | 4              | H+4           |
| 5        |  | GNSS message flag  | Uchar                                     | 1              | H+8           |
| 6        |  | Number of GPS satellite signals  | Uchar                                     | 1              | H+9           |
| 7        |  | Smoothing indicator  | Uchar                                     | 1              | H+10          |
| 8        |  | Smoothing interval: <i>Table 83 on page 487</i>  | Uchar                                     | 1              | H+11          |
| 9        |  | #prns  | Number of PRNs with information to follow | Ulong          | 4             |
| 10       | prn#   | PRN #, for SBAS see <i>Table 82, page 486</i>  | Uchar                                     | 1              | H+16          |
| 11       | L1code-ind   | GPS L1 code indicator<br>0 = C/A code<br>1 = P(Y) code direct  | Uchar                                     | 1              | H+17          |
| 12       | L1psr  | GPS L1 pseudorange (m) in 0.02 m units   | Ulong                                     | 4              | H+18          |
| 13       | L1 phase-pseudo  | GPS L1 (phaserange - pseudorange) in 0.0005 m units<br>Range: $\pm 262.1435$ m   | Long                                      | 4              | H+22          |
| 14       | L1locktime-ind   | GPS L1 lock time indicator, see <i>Table 84 on page 487</i>  | Uchar                                     | 1              | H+26          |
| 15       | L2code-ind   | GPS L2 code indicator<br>0 = C/A or L2C code<br>1 = P(Y) code direct<br>2 = P(Y) code cross-correlated<br>3 = Correlated P/Y | Uchar                                     | 1              | H+27          |
| 16       | L1L2psrdiff  | GPS L2-L1 pseudorange difference (m) in 0.02 m units<br>Range: $\pm 163.82$ m  | Short                                     | 2              | H+28          |
| 17       | L2phase-L1pseudo   | GPS L2 phaserange - L1 pseudorange in 0.005 m units<br>Range: $\pm 262.1435$ m   | Long                                      | 4              | H+30          |
| 18       | L1L2 locktime-ind  | GPS L2 continuous tracking lock time indicator, see <i>Table 84 on page 487</i>  | Uchar                                     | 2 <sup>a</sup> | H+34          |
| 19...    | Next PRN offset = H+16 + (#prns x 20)  |  |   |                |               |
| variable | xxxx   | 32-bit CRC (ASCII and Binary only)   | Hex                                       | 4              | variabl       |
| variable | [CR][LF]   | Sentence terminator (ASCII only)   | -   | -              | -             |

- a. In the binary log case, a variable number of additional bytes of padding are added, depending on the number of satellites, to maintain 4-byte alignment.

### 3.3.108 RTCMDATA1004 Expanded L1/L2 GPS RTK Observables V123\_RT20 V23\_RT2

This log is available at the base station. See *Section 3.3.104* starting on *page 482* for information on RTCM Version 3.0 standard logs.

**Message ID:** 787

**Log Type:** Synch

**Recommended Input:**

log rtcmdata1004a ontime 7

**ASCII Example:**

```
#RTCMDATA1004A, COM1, 0, 83.5, FINESTEERING, 1317, 238497.000, 00180040, 5500, 1855;
0, 0, 238497000, 0, 7, 0, 0, 7,
21, 0, 3492634, 1536, 98, 0, 202, 0, -169, 1904, 96, 175,
2, 0, 10314064, -3500, 99, 0, 195, 0, -192, -1385, 96, 165,
16, 0, 9713480, 7187, 65, 0, 164, 0, -80, 6159, 65, 148,
29, 0, 11686252, 1601, 95, 0, 163, 0, -24, 932, 94, 164,
6, 0, 10511647, 3261, 99, 0, 206, 0, -115, 3375, 96, 188,
10, 0, 1964375, 2688, 99, 0, 200, 0, -120, 2779, 96, 178,
30, 0, 9085068, 4078, 98, 0, 190, 0, -50, 2990, 96, 167*f91c8c6d
```



Message Type 1004 provides fuller data content than Message Type 1003, see *page 492*. The longer observation messages do not change very often, and can be sent less often.

| Field # | Field type   | Data Description   | Format                                    | Binary Bytes   | Binary Offset |
|---------|--|--|---|----------------|---------------|
| 1       | RTCM DATA1004 header   | Log header   | -   | H              | 0             |
| 2       | RTCM V3 observations header, see the RTCM-DATA1001 log on page 486 for details | Message number   | Ushort                                    | 2              | H             |
| 3       |  | Base station ID  | Ushort                                    | 2              | H+2           |
| 4       |  | GPS epoch time (ms)  | Ulong                                     | 4              | H+4           |
| 5       |  | GNSS message flag  | Uchar                                     | 1              | H+8           |
| 6       |  | Number of GPS satellite signals processed (0-31)   | Uchar                                     | 1              | H+9           |
| 7       |  | Smoothing indicator  | Uchar                                     | 1              | H+10          |
| 8       |  | Smoothing interval, see Table 83 on page 487   | Uchar                                     | 1              | H+11          |
| 9       |  | #prns  | Number of PRNs with information to follow | Ulong          | 4             |
| 10      | prn#   | PRN #, for SBAS see Table 82, page 486   | Uchar                                     | 1              | H+16          |
| 11      | L1code-ind   | GPS L1 code indicator<br>0 = C/A code<br>1 = P(Y) code   | Uchar                                     | 1              | H+17          |
| 12      | L1psr  | GPS L1 pseudorange (m) in 0.02 m units   | Ulong                                     | 4              | H+18          |
| 13      | L1 phase-pseudo  | GPS L1 (phaserange - pseudorange) in 0.0005 m units<br>Range: $\pm 262.1435$ m   | Long                                      | 4              | H+22          |
| 14      | L1lcktm-ind  | GPS L1 lock time indicator, see Table 84 on page 487   | Uchar                                     | 1              | H+26          |
| 15      | L1amb  | GPS L1 PSR modulus ambiguity (m). The integer number of full pseudorange modulus divisions (299,792.458 m) of the raw L1 pseudorange.                          | Uchar                                     | 1              | H+27          |
| 16      | L1C/No   | GPS L1 carrier-to-noise ratio (dBHz). The base station's estimate of the satellite's signal. A value of 0 indicates that the C/No measurement is not computed. | Uchar                                     | 1              | H+28          |
| 17      | L2code-ind   | GPS L2 code indicator:<br>0 = C/A or L2C code<br>1 = P(Y) code direct<br>2 = P(Y) code cross-correlated<br>3 = Correlated P(Y)                                 | Uchar                                     | 1              | H+29          |
| 18      | L1L2psrdiff  | GPS L2-L1 pseudorange difference (m) in 0.02 m units; Range: $\pm 163.82$ m  | Short                                     | 4 <sup>a</sup> | H+30          |

Continued on page 496.

| Field #  | Field type                            | Data Description   | Format | Binary Bytes | Binary Offset |
|----------|---------------------------------------|--|--------|--------------|---------------|
| 19       | L2phase-L1pseudo                      | GPS L2 phaserange - L1 pseudorange in 0.0005 m units<br>Range: $\pm 262.1435$ m  | Long   | 4            | H+34          |
| 20       | L2lcktm-ind                           | GPS L2 lock time indicator, see <i>Table 84</i> on <i>page 487</i>   | Uchar  | 1            | H+38          |
| 21       | L2 C/No                               | GPS L2 carrier-to-noise ratio (dBHz). The base station's estimate of the satellite's signal. A value of 0 indicates that the C/No measurement is not computed. | Uchar  | 1            | H+39          |
| 22...    | Next PRN offset = H+16 + (#prns x 24) |  |        |              |               |
| variable | xxxx                                  | 32-bit CRC (ASCII and Binary only)   | Hex    | 4            | variable      |
| variable | [CR][LF]                              | Sentence terminator (ASCII only)   | -      | -            | -             |

- a. In the binary log case, a variable number of additional bytes of padding are added, depending on the number of satellites, to maintain 4-byte alignment



### 3.3.109 RTCMDATA1005 Base Station Antenna Reference Point (ARP) V123\_RT20 V23\_RT2

This log is available at the base station. See *Section 3.3.104* starting on *page 482* for information on RTCM Version 3.0 standard logs.

In order to produce RTCM1005 or RTCM1006 messages from a base receiver, it must have a fixed position (or be properly set to operate as a moving base station). However, the RTCM1005 or RTCM1006 message only incorporate antenna offsets if a BASEANTENNAMODEL command has been sent to the receiver. Once a BASEANTENNAMODEL command has been set, the ARP values are reflected in the RTCM1005 and RTCM1006 logs.

See also the BASEANTENNAMODEL command on *page 76* and the MOVINGBASESTATION command on *page 154*.

- 
- ✉ If a rover receives RTCM24, RTCM1005, or RTCM1006 data, containing antenna offset information but does not have the same antenna type as the base station, the position is offset. Provided the two receivers have matching antenna models, the output rover positions reflect position of the ARP.
- 

**Message ID:** 788  
**Log Type:** Synch

#### Recommended Input:

log rtcmdata1005a ontime 3

#### ASCII Example:

```
#RTCMDATA1005A, COM1, 0, 84.5, FINESTEERING, 1317, 238322.885, 00180040, 0961, 1855;  
0, 0, 0, 1, 0, 0, 0, -16349783637, 0, -36646792121, 0, 49422987955*7dbd6160
```



Message Types 1005 and 1006 are designed for GPS operation, but are equally applicable to GLONASS and the future Galileo.

---

| Field # | Field type          | Data Description   | Format | Binary Bytes   | Binary Offset |
|---------|---------------------|--|--------|----------------|---------------|
| 1       | RTCMDATA1005 header | Log header   | -      | H              | 0             |
| 2       | msg#                | Message number   | Ushort | 2              | H             |
| 3       | ID                  | Base station ID  | Ushort | 2              | H+2           |
| 4       | Reserved            |  | Uchar  | 1              | H+4           |
| 5       | GPSind              | GPS indicator<br>0 = No GPS service supported<br>1 = GPS service supported             | Uchar  | 1              | H+5           |
| 6       | GLOind              | GLONASS indicator<br>0 = No GLONASS service supported<br>1 = GLONASS service supported | Uchar  | 1              | H+6           |
| 7       | GALind              | Galileo indicator<br>0 = No Galileo service supported<br>1 = Galileo service supported | Uchar  | 1              | H+7           |
| 8       | Reserved            |  | Uchar  | 1              | H+8           |
| 9       | ECEF-X              | Base station ECEF X-coordinate<br>(1/10000 m)  | Double | 8              | H+9           |
| 10      | Reserved            |  | Uchar  | 1              | H+17          |
| 11      | ECEF-Y              | Base station ECEF Y-coordinate<br>(1/10000 m)  | Double | 8              | H+18          |
| 12      | Reserved            |  | Uchar  | 2 <sup>a</sup> | H+26          |
| 13      | ECEF-Z              | Base station ECEF Z-coordinate<br>(1/10000 m)  | Double | 8              | H+28          |
| 14      | xxxx                | 32-bit CRC (ASCII and Binary only)   | Hex    | 4              | H+36          |
| 15      | [CR][LF]            | Sentence terminator (ASCII only)   | -      | -              | -             |

a. In the binary log case, an additional byte of padding is added to maintain 4-byte alignment

### 3.3.110 RTCMDATA1006 Base Station ARP with Antenna Height V123\_RT20 V23\_RT2

This log is available at the base station. See *Section 3.3.104* starting on *page 482* for information on RTCM Version 3.0 standard logs.

In order to produce RTCM1005 or RTCM1006 messages from a base receiver, it must have a fixed position (or be properly set to operate as a moving base station). However, the RTCM1005 or RTCM1006 message only incorporate antenna offsets if a BASEANTENNAMODEL command has been sent to the receiver. Once a BASEANTENNAMODEL command has been set, the ARP values are reflected in the RTCM1005 and RTCM1006 logs.

See also the BASEANTENNAMODEL command on *page 76* and the MOVINGBASESTATION command on *page 154*.

- 
- ✉ If a rover receives RTCM24, RTCM1005, or RTCM1006 data, containing antenna offset information but does not have the same antenna type as the base station, the position is offset. Provided the two receivers have matching antenna models, the output rover positions reflect position of the ARP.
- 

**Message ID:** 789  
**Log Type:** Synch

#### Recommended Input:

log rtcmdata1006a ontime 3

#### ASCII Example:

```
#RTCMDATA1006A, COM1, 0, 80.5, FINESTEERING, 1317, 239459.744, 00180040, 7583, 1855
; 0, 0, 0, 1, 0, 0, 0, -16349783637, 0, -36646792121, 0, 49422987955, 0*5a466fb5
```



Message Types 1005 and 1006 are designed for GPS operation, but are equally applicable to GLONASS and the future Galileo.

---

| Field # | Field type          | Data Description   | Format | Binary Bytes   | Binary Offset |
|---------|---------------------|--|--------|----------------|---------------|
| 1       | RTCMDATA1006 header | Log header   | -      | H              | 0             |
| 2       | msg#                | Message number   | Ushort | 2              | H             |
| 3       | ID                  | Base station ID  | Ushort | 2              | H+2           |
| 4       | Reserved            |  | Uchar  | 1              | H+4           |
| 5       | GPSind              | GPS indicator<br>0 = No GPS service supported<br>1 = GPS service supported             | Uchar  | 1              | H+5           |
| 6       | GLOind              | GLONASS indicator<br>0 = No GLONASS service supported<br>1 = GLONASS service supported | Uchar  | 1              | H+6           |
| 7       | GALind              | Galileo indicator<br>0 = No Galileo service supported<br>1 = Galileo service supported | Uchar  | 1              | H+7           |
| 8       | Reserved            |  | Uchar  | 1              | H+8           |
| 9       | ECEF-X              | Base station ECEF X-coordinate<br>(1/10000 m)  | Double | 8              | H+9           |
| 10      | Reserved            |  | Uchar  | 1              | H+17          |
| 11      | ECEF-Y              | Base station ECEF Y-coordinate<br>(1/10000 m)  | Double | 8              | H+18          |
| 12      | Reserved            |  | Uchar  | 2 <sup>a</sup> | H+26          |
| 13      | ECEF-Z              | Base station ECEF Z-coordinate<br>(1/10000 m)  | Double | 8              | H+28          |
| 14      | anthgt              | Antenna height   | Ushort | 4 <sup>b</sup> | H+36          |
| 15      | xxxx                | 32-bit CRC (ASCII and Binary only)   | Hex    | 4              | H+40          |
| 16      | [CR][LF]            | Sentence terminator (ASCII only)   | -      | -              | -             |

- a. In the binary log case, an additional byte of padding is added to maintain 4-byte alignment  
b. In the binary log case, an additional 2 bytes of padding are added to maintain 4-byte alignment

### 3.3.111 RTCMDATA1007 *Extended Antenna Descriptor and Setup Information V123\_RT20 V23\_RT2*

RTCM1007 information is set using the BASEANTENNAMODEL command, see *page 76*. If you have set a base station ID, it is detected and set. Other values are also taken from a previously entered BASEANTENNAMODEL command.

Message Type 1007 provides information on the antenna type used at the base station. The RTCM commission uses an equipment-naming downloadable table from the International GPS Service Central Bureau (IGS CB): [ftp://igscb.jpl.nasa.gov/igscb/station/general/rcvr\\_ant.tab](ftp://igscb.jpl.nasa.gov/igscb/station/general/rcvr_ant.tab). This table provides a unique antenna descriptor for antennas used for high-precision surveying type applications.

The service provider uses the *setup ID* parameter to indicate the particular base station-antenna combination. "0" for this value means that the values of a standard model type calibration should be used. A non-zero value specifies a particular setup, or calibration, table for the specific antenna in use at the base station. Increase the number whenever a change occurs at the station that affects the antenna phase center variations. Depending on the change of the phase center variations due to a setup change, a change in the *setup ID* would mean that you should check with the service provider to see if the antenna phase center variation in use is still valid. The provider must make appropriate information available to users.

---

☒ In order to set up logging of RTCM1007 data, it is recommended to first use the INTERFACEMODE command to set the interface mode of the port transmitting RTCMV3 messages to RTCMV3, see *page 135*. Providing the base has a fixed position, see FIX on *page 115*, and its BASEANTENNAMODEL command is set, you can log out RTCM1007 messages.

---

**Message ID:** 856  
**Log Type:** Synch

**Recommended Input:**

```
log rtcmdata1007a ontime 10
```

**ASCII Example:**

```
#RTCMDATA1007A, COM1, 0, 73.5, FINESTEERING, 1423, 309496.883, 00180000, 1d56, 2748;  
0, 0, 3, "702", 1*c6f5de3d
```

| Field # | Field type           | Data Description                                    | Format   | Binary Bytes    | Binary Offset |
|---------|----------------------|---|----------|-----------------|---------------|
| 1       | RTCM DATA1007 header | Log header  | -        | H               | 0             |
| 2       | msg#                 | Message number                                      | Ushort   | 2               | H             |
| 3       | base ID              | Base station ID                                     | Ushort   | 2               | H+2           |
| 4       | #chars               | Length of antenna descriptor (number of characters) | Ulong    | 4               | H+4           |
| 5       | ant descrp           | Antenna descriptor                                  | Char[31] | 31 <sup>a</sup> | H+8           |
| 6       | setupID              | Setup identification                                | Uchar    | 1               | H+39          |
| 7       | xxxx                 | 32-bit CRC (ASCII and Binary only)                  | Hex      | 4               | H+40          |
| 8       | [CR][LF]             | Sentence terminator (ASCII only)                    | -        | -               | -             |

a. Additional bytes of padding may be added to maintain 4-byte alignment

### 3.3.112 RTCMDATA1008 *Extended Antenna Descriptor and Setup Information V123\_RT20 V23\_RT2*

RTCM1008 information is set using the BASEANTENNAMODEL command, see *page 76*. If you have set a base station ID, it is detected and set. Other values are also taken from a previously entered BASEANTENNAMODEL command.

Message Type 1008 provides information on the antenna type used at the base station. The RTCM commission uses an equipment-naming downloadable table from the International GPS Service Central Bureau (IGS CB): [ftp://igs.cb.jpl.nasa.gov/igs/scb/station/general/rcvr\\_ant.tab](ftp://igs.cb.jpl.nasa.gov/igs/scb/station/general/rcvr_ant.tab). This table provides a unique antenna descriptor for antennas used for high-precision surveying type applications.

The service provider uses the *setup ID* parameter to indicate the particular base station-antenna combination. "0" for this value means that the values of a standard model type calibration should be used. A non-zero value specifies a particular setup, or calibration, table for the specific antenna in use at the base station. Increase the number whenever a change occurs at the station that affects the antenna phase center variations. Depending on the change of the phase center variations due to a setup change, a change in the *setup ID* would mean that you should check with the service provider to see if the antenna phase center variation in use is still valid. The provider must make appropriate information available to users.

---

☒ In order to set up logging of RTCM1008 data, it is recommended to first use the INTERFACEMODE command to set the interface mode of the port transmitting RTCMV3 messages to RTCMV3, see *page 135*. Providing the base has a fixed position, see FIX on *page 115*, and its BASEANTENNAMODEL command is set, you can log out RTCM1007 messages.

---

**Message ID:** 857  
**Log Type:** Synch

**Recommended Input:**

```
log rtcmdata1008a ontime 10
```

**ASCII Example:**

```
#RTCMDATA1008A,COM1,0,69.0,FINESTEERING,1423,309565.095,00180000,d8c6,2748;  
0,0,3,"702",1,11,"NVH05410007"*e89f1a17
```

| Field # | Field type          | Data Description                                    | Format    | Binary Bytes    | Binary Offset |
|---------|---------------------|---|-----------|-----------------|---------------|
| 1       | RTCMDATA1008 header | Log header  | -         | H               | 0             |
| 2       | msg#                | Message number                                      | Ushort    | 2               | H             |
| 3       | base ID             | Base station ID number                              | Ushort    | 2               | H+2           |
| 4       | #chars              | Length of antenna descriptor (number of characters) | Ulong     | 4               | H+4           |
| 5       | ant descrp          | Antenna descriptor                                  | Char[31]  | 32 <sup>a</sup> | H+8           |
| 6       | setupID             | Setup identification                                | Uchar     | 1               | H+40          |
| 7       | #chars2             | Length of antenna serial number (characters)        | Ulong     | 4               | H+41          |
| 8       | ant ser#            | Antenna serial number                               | Char [31] | 31              | H+45          |
| 9       | xxxx                | 32-bit CRC (ASCII and Binary only)                  | Hex       | 4               | H+76          |
| 10      | [CR][LF]            | Sentence terminator (ASCII only)                    | -         | -               | -             |

a. Additional bytes of padding may be added to maintain 4-byte alignment



---

### 3.3.113 RTCMDATA1009 GLONASS L1-Only RTK V123\_RT20 V23\_RT2

This log is available at the base station. See *Section 3.3.104* starting on page 482 for information on RTCM Version 3.0 standard logs.

**Message ID:** 897  
**Log Type:** Synch

**Recommended Input:**

```
log rtcmdata1009a ontime 3
```

**ASCII Example:**

```
#RTCMDATA1009A, COM1, 0, 68.5, FINESTEERING, 1432, 313977.000, 00100000, 58cf, 35602;  
0, 0, 65563000, 0, 4, 0, 0,  
4,  
7, 0, 12, 3853223, 295, 96,  
21, 0, 15, 22579496, -8, 95,  
6, 0, 8, 28671345, -9, 97,  
14, 0, 11, 10195220, -403, 96*4ea61d07
```



RTCM1009 supports single-frequency RTK operation, but does not include an indication of the satellite carrier-to-noise (C/No) as indicated by the base station.

---

**Table 85: GLONASS L1 and L2 Frequencies**

| Frequency Indicator | Channel # | L1 Frequency, MHz | L2 Frequency, MHz |
|---------------------|-----------|-------------------|-------------------|
| 0                   | -07       | 1598.0625         | 1242.9375         |
| 1                   | -06       | 1598.6250         | 1243.3750         |
| 2                   | -05       | 1599.1875         | 1243.8125         |
| 3                   | -04       | 1599.7500         | 1244.2500         |
| 4                   | -03       | 1600.3125         | 1244.6875         |
| 5                   | -02       | 1600.8750         | 1245.1250         |
| 6                   | -01       | 1601.4375         | 1245.5625         |
| 7                   | 00        | 1602.0            | 1246.0            |
| 8                   | 01        | 1602.5625         | 1246.4375         |
| 9                   | 02        | 1603.125          | 1246.875          |
| 10                  | 03        | 1603.6875         | 1247.3125         |
| 11                  | 04        | 1604.25           | 1247.75           |
| 12                  | 05        | 1604.8125         | 1248.1875         |
| 13                  | 06        | 1605.375          | 1248.625          |
| 14                  | 07        | 1605.9375         | 1249.0625         |
| 15                  | 08        | 1606.5            | 1249.5            |
| 16                  | 09        | 1607.0625         | 1249.9375         |
| 17                  | 10        | 1607.625          | 1250.375          |
| 18                  | 11        | 1608.1875         | 1250.8125         |
| 19                  | 12        | 1608.75           | 1251.25           |
| 20                  | 13        | 1609.3125         | 1251.6875         |

| Field #  | Field type  | Data Description   | Format | Binary Bytes | Binary Offset |
|----------|---|--|--------|--------------|---------------|
| 1        | RTCM DATA1009 header  | Log header   | -      | H            | 0             |
| 2        | RTCMV3 observations header, see the RTCM-DATA1001 log on page 486 for details | Message number   | Ushort | 2            | H             |
| 3        |   | Base station ID  | Ushort | 2            | H+2           |
| 4        |   | GPS epoch time (ms)  | Ulong  | 4            | H+4           |
| 5        |   | GNSS message flag  | Uchar  | 1            | H+8           |
| 6        |   | Number of GLONASS satellite signals processed                                  | Uchar  | 1            | H+9           |
| 7        |   | Smoothing indicator  | Uchar  | 1            | H+10          |
| 8        |   | Smoothing interval, see Table 83 on page 487.                                  | Uchar  | 1            | H+11          |
| 9        | #rec  | Number of records with information to follow                                   | Ulong  | 4            | H+12          |
| 10       | satID   | GLONASS satellite ID (slot# 1-24)  | Uchar  | 1            | H+16          |
| 11       | GLOcode   | GLONASS code indicator<br>0 = L1 C/A code<br>1 = L2 P code                     | Uchar  | 1            | H+17          |
| 12       | GLOfreq   | GLONASS frequency indicator (0-20), see Table 85 on page 506                   | Uchar  | 1            | H+18          |
| 13       | GLOpsr  | GLONASS L1 pseudorange in 0.02 m units<br>Range: 0 to +599584.92 m             | Ulong  | 4            | H+19          |
| 14       | phase-pseudo  | GLONASS L1 phaserange - L1 pseudorange in 0.0005 m units<br>Range: ±262.1435 m | Long   | 4            | H+23          |
| 15       | locktime-ind  | GLONASS L1 continuous tracking lock time indicator, see Table 84 on page 487   | Uchar  | 1            | H+27          |
| 16...    | Next record offset = H+16 + (#recs x 12)                                      |  |        |              |               |
| variable | xxxx  | 32-bit CRC (ASCII and Binary only)   | Hex    | 4            | variable      |
| variable | [CR][LF]  | Sentence terminator (ASCII only)   | -      | -            | -             |

### 3.3.114 RTCMDATA1010 Extended L1-Only GLONASS RTK V123\_RT20 V23\_RT2

This log is available at the base station. See *Section 3.3.104* starting on *page 482* for information on RTCM Version 3.0 standard logs.

**Message ID:** 898

**Log Type:** Synch

**Recommended Input:**

log rtcmdata1010a ontime 3

**ASCII Example:**

```
#RTCMDATA1010A, COM1, 0, 63.5, FINESTEERING, 1432, 313982.000, 00100000, 3b2a, 35602;  
0, 0, 65568000, 0, 4, 0, 0,  
4,  
7, 0, 12, 3689203, 306, 96, 39, 175,  
21, 0, 15, 22641632, 35, 96, 33, 192,  
6, 0, 8, 28599532, 9, 97, 32, 194,  
14, 0, 11, 10250494, -433, 96, 37, 179*b9747504
```



Message Type 1010 supports single-frequency RTK operation, and includes an indication of the satellite C/No measured by the base. Since C/No does not usually change from measurement to measurement, this message type can be mixed with Type 1009 and used only when a satellite C/No changes, saving broadcast link throughput.

---

| Field #  | Field type  | Data Description   | Format | Binary Bytes   | Binary Offset |
|----------|---|--|--------|----------------|---------------|
| 1        | RTCM DATA1010 header  | Log header   | -      | H              | 0             |
| 2        | RTCMV3 observations header, see the RTCM-DATA1001 log on page 486 for details | Message number   | Ushort | 2              | H             |
| 3        |   | Base station ID  | Ushort | 2              | H+2           |
| 4        |   | GPS epoch time (ms)  | Ulong  | 4              | H+4           |
| 5        |   | GNSS message flag  | Uchar  | 1              | H+8           |
| 6        |   | Number of GLONASS satellite signals  | Uchar  | 1              | H+9           |
| 7        |   | Smoothing indicator  | Uchar  | 1              | H+10          |
| 8        |   | Smoothing interval, see <i>Table 83, page 487</i>  | Uchar  | 1              | H+11          |
| 9        | #recs   | Number of GLONASS records to follow  | Ulong  | 4              | H+12          |
| 10       | satID   | GLONASS satellite ID (slot# 1-24)  | Uchar  | 1              | H+16          |
| 11       | GLOcode   | GLONASS code indicator<br>0 = L1 C/A code<br>1 = L2 P code   | Uchar  | 1              | H+17          |
| 12       | GLOfreq   | GLONASS frequency indicator (0-20), see <i>Table 85 on page 506</i>  | Ulong  | 4              | H+18          |
| 13       | GLOpsr  | GLONASS L1 pseudorange in 0.02 m units<br>Range: 0 to +599584.92 m   | Long   | 4              | H+22          |
| 14       | phase-pseudo  | GLONASS L1 phaserange - L1 pseudorange in 0.0005 m units; Range: ±262.1435   | Long   | 4              | H+26          |
| 15       | locktime-ind  | GLONASS L1 continuous tracking lock time indicator, see <i>Table 84 on page 487</i>  | Uchar  | 1              | H+30          |
| 16       | amb   | GLONASS L1 PSR modulus ambiguity. The full pseudorange modulus divisions integer (599584.916 m) of the raw L1 pseudorange measurement. Range: 0 to +76147284.332                     | Uchar  | 1              | H+31          |
| 17       | C/No  | GLONASS L1 carrier-to-noise ratio. The base station's estimate of the satellite's signal. A value of 0 indicates that the C/No measurement is not computed. Range: 0 to +63.75 dB-Hz | Uchar  | 4 <sup>a</sup> | H+32          |
| 17...    | Next record offset = H+16 + (#recs x 20)                                      |  |        |                |               |
| variable | xxxx  | 32-bit CRC (ASCII and Binary only)   | Hex    | 4              | variable      |
| variable | [CR][LF]  | Sentence terminator (ASCII only)   | -      | -              | -             |

- a. In the binary log case, a variable number of additional bytes of padding are added, depending on the number of satellites, to maintain 4-byte alignment

### 3.3.115 RTCMDATA1011 GLONASS L1/L2 RTK V123\_RT20 V23\_RT2

This log is available at the base station. See *Section 3.3.104* starting on *page 482* for information on RTCM Version 3.0 standard logs.

**Message ID:** 899

**Log Type:** Synch

**Recommended Input:**

log rtcmdata1011a ontime 3

**ASCII Example:**

```
#RTCMDATA1011A, COM1, 0, 70.5, FINESTEERING, 1432, 313985.000, 00100000, 35bd, 35602;  
0, 0, 65571000, 0, 4, 0, 0,  
4,  
7, 0, 12, 3590806, 357, 96, 0, -2, 361, 94,  
21, 0, 15, 22679016, 35, 96, 0, 74, 154, 94,  
6, 0, 8, 28556501, -9, 97, 0, -185, -126, 94,  
14, 0, 11, 10283759, -463, 97, 0, 171, -824, 95*5e265573
```



The RTCM Type 1011 Message supports dual-frequency RTK operation but does not include an indication of the satellite C/No measured by the base station.

---

| Field #  | Field type   | Data Description  | Format | Binary Bytes | Binary Offset |
|----------|--|---|--------|--------------|---------------|
| 1        | RTCM DATA1011 header   | Log header  | -      | H            | 0             |
| 2        | RTCM V3 observations header, see the RTCM-DATA1001 log on page 486 for details | Message number  | Ushort | 2            | H             |
| 3        |  | Base station ID   | Ushort | 2            | H+2           |
| 4        |  | GPS epoch time (ms)   | Ulong  | 4            | H+4           |
| 5        |  | GNSS message flag   | Uchar  | 1            | H+8           |
| 6        |  | Number of GLONASS satellite signals (0-31)  | Uchar  | 1            | H+9           |
| 7        |  | Smoothing indicator   | Uchar  | 1            | H+10          |
| 8        |  | Smoothing interval, see <i>Table 83, page 487</i>                                   | Uchar  | 1            | H+11          |
| 9        | #rec   | Number of records with information to follow  | Ulong  | 4            | H+12          |
| 10       | satID  | GLONASS satellite ID (slot# 1-24)   | Uchar  | 1            | H+16          |
| 11       | GLOcode  | GLONASS code indicator<br>0 = L1 C/A code<br>1 = L2 P code                          | Uchar  | 1            | H+17          |
| 12       | GLOfreq  | GLONASS frequency indicator (0-20), see <i>Table 85 on page 506</i>                 | Ulong  | 4            | H+18          |
| 13       | GLOpsr   | GLONASS L1 pseudorange in 0.02 m units<br>Range: 0 to +599584.92 m                  | Long   | 4            | H+22          |
| 14       | phase-pseudo   | GLONASS L1 phaserange - L1 pseudorange in 0.0005 m units<br>Range: ±262.1435 m      | Uchar  | 1            | H+26          |
| 15       | locktime-ind   | GLONASS L1 continuous tracking lock time indicator, see <i>Table 84 on page 487</i> | Uchar  | 1            | H+27          |
| 16       | GLOcodeL2  | GLONASS L2 code indicator<br>0 = C/A code<br>1 = P code                             | Uchar  | 1            | H+28          |
| 17       | L1L2psrdiff  | GLONASS L2-L1 pseudorange difference in 0.02 m units; Range: ±163.82 m              | Short  | 2            | H+29          |
| 18       | L2phase-L1pseudo   | GLONASS L2 phaserange - L1 pseudorange in 0.0005 m units; Range: ±262.1435 m        | Long   | 4            | H+31          |
| 19       | L2locktime-ind   | GLONASS L2 continuous tracking lock time indicator, see <i>Table 84 on page 487</i> | Uchar  | 1            | H+35          |
| 20...    | Next record offset = H+16 + (#recs x 20)                                       |   |        |              |               |
| variable | xxxx   | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | variable      |
| variable | [CR][LF]   | Sentence terminator (ASCII only)  | -      | -            | -             |

### 3.3.116 RTCMDATA1012 Extended GLONASS L1/L2 RTK V123\_RT20 V23\_RT2

This log is available at the base station. See *Section 3.3.104* starting on *page 482* for information on RTCM Version 3.0 standard logs.

**Message ID:** 900

**Log Type:** Synch

**Recommended Input:**

log rtcmdata1012a ontime 3

**ASCII Example:**

```
#RTCMDATA1012A, COM1, 0, 52.5, FINESTEERING, 1432, 407880.000, 00000000, ee92, 35602;  
0, 0, 73066000, 0, 5, 0, 0,  
5,  
7, 0, 12, 421564, 185, 108, 34, 193, 0, -35, 33, 108, 176, 0,  
8, 0, 13, 22564562, 69, 108, 32, 193, 0, 150, -100, 108, 188, 0,  
1, 0, 14, 5214900, 271, 107, 38, 135, 0, 189, 886, 106, 161, 0,  
24, 0, 9, 21406829, 160, 109, 36, 187, 0, 139, 84, 108, 159, 0,  
10, 0, 11, 18616094, 202, 109, 35, 186, 0, 215, 329, 108, 181, 0*4b04eeeb
```



Message Type 1012 supports dual-frequency RTK operation, and includes an indication of the satellite C/No as measured by the base station.



| Field # | Field type   | Data Description  | Format | Binary Bytes   | Binary Offset |
|---------|--|---|--------|----------------|---------------|
| 1       | RTCM DATA1012 header   | Log header  | -      | H              | 0             |
| 2       | RTCM V3 observations header, see the RTCM-DATA1001 log on page 486 for details | Message number  | Ushort | 2              | H             |
| 3       |  | Base station ID   | Ushort | 2              | H+2           |
| 4       |  | GPS epoch time (ms)   | Ulong  | 4              | H+4           |
| 5       |  | GNSS message flag   | Uchar  | 1              | H+8           |
| 6       |  | Number of GLONASS satellite signals processed   | Uchar  | 1              | H+9           |
| 7       |  | Smoothing indicator   | Uchar  | 1              | H+10          |
| 8       |  | Smoothing interval, see Table 83 on page 487.   | Uchar  | 1              | H+11          |
| 9       | #recs  | Number of records with information to follow  | Ulong  | 4              | H+12          |
| 10      | satID  | GLONASS satellite ID (slot# 1-24)   | Uchar  | 1              | H+16          |
| 11      | GLOcode  | GLONASS code indicator<br>0 = L1 C/A code<br>1 = L2 P code  | Uchar  | 1              | H+17          |
| 12      | GLOfreq  | GLONASS frequency indicator (0-20), see Table 85 on page 506  | Uchar  | 2 <sup>a</sup> | H+18          |
| 13      | GLOpsr   | GLONASS L1 pseudorange<br>Range: 0 to +599584.92 m  | ULong  | 4              | H+20          |
| 14      | phase-pseudo   | GLONASS L1 phaserange - L1 pseudorange<br>Range: ±262.1435 m  | Long   | 4              | H+24          |
| 15      | locktime-ind   | GLONASS L1 continuous tracking lock time indicator, see Table 84 on page 487  | Uchar  | 1              | H+28          |
| 16      | amb  | GLONASS L1 PSR modulus ambiguity. The full pseudorange modulus divisions integer (599584.916 m) of the raw L1 pseudorange measurement. Range: 0 to +76147284.332                        | Uchar  | 1              | H+29          |
| 17      | C\No   | GLONASS L1 carrier-to-noise ratio. The base station's estimate of the satellite's signal. A value of 0 indicates that the C/No measurement is not computed.<br>Range: 0 to +63.75 dB-Hz | Uchar  | 1              | H+30          |

Continued on page 514.

| Field #  | Field type                               | Data Description   | Format | Binary Bytes   | Binary Offset |
|----------|--|--|--------|----------------|---------------|
| 18       | GLOcodeL2                                | GLONASS L2 code indicator<br>0 = C/A code<br>1 = P code  | Uchar  | 1              | H+31          |
| 19       | L1L2psrdiff                              | GLONASS L2-L1 pseudorange difference in 0.02 m units; Range: $\pm 163.82$ m  | Short  | 4 <sup>b</sup> | H+32          |
| 20       | L2phase-L1pseudo                         | GLONASS L2 phaserange - L1 pseudorange in 0.0005 m units; Range: $\pm 262.1435$ m  | Long   | 4              | H+36          |
| 21       | L2locktime-ind                           | GLONASS L2 continuous tracking lock time indicator, see <i>Table 84</i> on <i>page 487</i>   | Uchar  | 1              | H+40          |
| 22       | GLO L2 C/No                              | GLONASS L2 carrier-to-noise ratio. The base station's estimate of the satellite's signal. A value of 0 indicates that the C/No measurement is not computed. Range: 0 to +63.75 dB-Hz | Uchar  | 1              | H+41          |
| 23       | Reserved                                 |  | UShort | 2              | H+42          |
| 24...    | Next record offset = H+16 + (#recs x 28) |  |        |                |               |
| variable | xxxx                                     | 32-bit CRC (ASCII and Binary only)   | Hex    | 4              | variable      |
| variable | [CR][LF]                                 | Sentence terminator (ASCII only)   | -      | -              | -             |

- a. In the binary log case, an additional byte of padding is added to maintain 4-byte alignment
- b. In the binary log case, an additional 2 bytes of padding are added to maintain 4-byte alignment

### 3.3.117 RTCMDATA1019 GPS Ephemeris V123\_RT20 V23\_RT2

This log is available at the base station. See *Section 3.3.104* starting on *page 482* for information on RTCM Version 3.0 standard logs.

All data fields have the same number of bits, scale factors and units as defined in the GPS SPS Signal Specification, Sections 2.4.3 and 2.4.4.

**Message ID:** 901  
**Log Type:** Synch

#### Recommended Input:

```
log rtcmdata1019a ontime 3
```

#### ASCII Example:

```
#RTCMDATA1019A, COM1, 0, 70.5, FINESTEERING, 1432, 313994.864, 00100000, f837, 3560
2;
1019, 3, 408, 0, 1, 775, 112, 19800, 0, 48, 161191, 112, 516, 14603, 1364270492, 428,
80926891, 4761, 2702050848, 19800, -109, -991856009, -60, 632629735, 6099,
504327378, -23427, -9, 0, 0, 0*dba8a7f4
```



Message Type 1019 contains only GPS ephemeris information, see Message Type 1020 starting on *page 519* for GLONASS ephemeris information.

**Table 86: SV Accuracy**

| Index Value (m) | Standard Deviations (m) | Index Value (m) | Standard Deviations (m) |
|-----------------|-------------------------|-----------------|-------------------------|
| 0               | 2.0                     | 8               | 64.0                    |
| 1               | 2.8                     | 9               | 128.0                   |
| 2               | 4.0                     | 10              | 256.0                   |
| 3               | 5.7                     | 11              | 512.0                   |
| 4               | 8                       | 12              | 1024.0                  |
| 5               | 11.3                    | 13              | 2048.0                  |
| 6               | 16.0                    | 14              | 4096.0                  |
| 7               | 32.0                    | 15              | 8192.0                  |

| Field # | Field type           | Data Description  | Scale Factor     | Format | Binary Bytes   | Binary Offset |
|---------|----------------------|---|------------------|--------|----------------|---------------|
| 1       | RTCMDATA-1019 header | Log header  | -                | -      | H              | 0             |
| 2       | message#             | Message number<br>Range: 0 to 4095  | -                | Ushort | 2              | H             |
| 3       | PRN#                 | Satellite PRN#, for SBAS see<br><i>Table 82, page 486</i><br>Range: 1 to 63 | -                | Uchar  | 2 <sup>a</sup> | H+2           |
| 4       | week                 | GPS week number<br>Range: 0 to 1023   | 1 week           | Ushort | 2              | H+4           |
| 5       | SV accur index       | SV Accuracy (m), see <i>Table 86 on page 515</i>                            | -                | Uchar  | 1              | H+6           |
| 6       | GPSCodeOnL2          | GPS code on L2<br>0 = Reserved<br>1 = P code<br>2 = C/A code<br>3 = L2C     | 1                | Uchar  | 1              | H+7           |
| 7       | IDOT                 | Rate of inclination angle,<br>semi-circles/second                           | 2 <sup>-43</sup> | Short  | 2              | H+8           |
| 8       | IODE                 | Issue of ephemeris data<br>Range: 0-255 (unitless)                          | 1                | Uchar  | 2 <sup>a</sup> | H+10          |
| 9       | TOC                  | SV clock correction term<br>Maximum: 604784 s                               | 2 <sup>4</sup>   | Ushort | 2              | H+12          |
| 10      | AF2                  | Clock aging parameter, s/s <sup>2</sup>                                     | 2 <sup>-55</sup> | Char   | 2 <sup>a</sup> | H+14          |
| 11      | AF1                  | Clock aging parameter, s/s  | 2 <sup>-43</sup> | Short  | 4 <sup>b</sup> | H+16          |
| 12      | AF0                  | Clock aging parameter,<br>seconds   | 2 <sup>-31</sup> | Long   | 4              | H+20          |
| 13      | IODC                 | Issue of data, clock<br>Range: 0-1023 (unitless)                            | 1                | Ushort | 2              | H+24          |
| 14      | Crs                  | Orbit radius (amplitude of<br>sine, meters)                                 | 2 <sup>-5</sup>  | Short  | 2              | H+26          |
| 15      | ΔN                   | Mean motion difference, semi-<br>circles/second                             | 2 <sup>-43</sup> | Short  | 4 <sup>b</sup> | H+28          |
| 16      | M <sub>0</sub>       | Mean anomaly of reference<br>time, semi-circles                             | 2 <sup>-31</sup> | Long   | 4              | H+32          |
| 17      | Cuc                  | Argument of latitude<br>(amplitude of cosine, radians)                      | 2 <sup>-29</sup> | Short  | 4 <sup>b</sup> | H+36          |

Continued on page 517.

| Field # | Field type         | Data Description   | Scale Factor | Format | Binary Bytes   | Binary Offset |
|---------|--------------------|--|--------------|--------|----------------|---------------|
| 18      | ecc                | Eccentricity, dimensionless - quantity defined for a conic section where $e = 0$ is a circle, $e = 1$ is a parabola, $0 < e < 1$ is an ellipse and $e > 1$ is a hyperbola. (unitless)  | $2^{-33}$    | Ulong  | 4              | H+40          |
| 19      | Cus                | Argument of latitude (amplitude of sine, radians)  | $2^{-29}$    | Short  | 4 <sup>b</sup> | H+44          |
| 20      | (A) <sup>1/2</sup> | Square root of the semi-major axis   | $2^{-19}$    | Ulong  | 4              | H+48          |
| 21      | toe                | Reference time for ephemeris, seconds  | $2^4$        | Ushort | 2              | H+52          |
| 22      | Cic                | Inclination (amplitude of cosine, radians)   | $2^{-29}$    | Short  | 2              | H+54          |
| 23      | $\omega_0$         | Right ascension, radians   | $2^{-31}$    | Long   | 4              | H+56          |
| 24      | Cis                | Inclination (amplitude of sine, radians)   | $2^{-29}$    | Short  | 4 <sup>b</sup> | H+60          |
| 25      | $l_0$              | Inclination angle at reference time, radians   | $2^{-31}$    | Long   | 4              | H+64          |
| 26      | Crc                | Orbit radius (amplitude of cosine, meters)   | $2^{-5}$     | Short  | 4 <sup>b</sup> | H+68          |
| 27      | $\omega$           | Argument of perigee, radians - measurement along the orbital path from the ascending node to the point where the SV is closest to the Earth, in the direction of the SV's motion.  | $2^{-31}$    | Long   | 4              | H+72          |
| 28      | $\dot{\omega}$     | Rate of right ascension, radians/second  | $2^{-43}$    | Long   | 4              | H+76          |
| 29      | tgd                | Estimated group delay difference, seconds  | $2^{-31}$    | Char   | 1              | H+80          |
| 30      | SV health          | The six-bit health indication given by bits 17 through 22 of word three refers to the transmitting satellite. The MSB indicates a summary of the health of the navigation data, where:<br>0 = all navigation data is OK<br>1 = some or all navigation data is not OK | 1            | Uchar  | 1              | H+81          |

Continued on page 518.

| Field #  | Field type   | Data Description   | Scale Factor | Format | Binary Bytes | Binary Offset |
|----------|--------------|--|--------------|--------|--------------|---------------|
| 31       | L2Pflag      | GPS L2 P flag, subframe 1, word 4, bit 1:<br>0 = L2 P-code NAV data ON<br>1 = L2 P-code NAV data OFF                         | 1            | Uchar  | 1            | H+82          |
| 32       | fit interval | GPS fit interval, subframe 2, word 10, bit 17:<br>0 = Curve-fit interval is 4 hours<br>1 = Curve-fit is greater than 4 hours | 1            | Uchar  | 1            | H+83          |
| variable | xxxx         | 32-bit CRC (ASCII and Binary only)   | -            | Hex    | 4            | variable      |
| variable | [CR][LF]     | Sentence terminator (ASCII only)   | -            | -      | -            | -             |

- a. In the binary log case, an additional byte of padding is added to maintain 4-byte alignment
- b. In the binary log case, two additional bytes of padding are added to maintain 4-byte alignment

### 3.3.118 RTCMDATA1020 GLONASS Ephemeris V123\_RT20 V23\_RT2

This log is available at the base station. See *Section 3.3.104* starting on *page 482* for information on RTCM Version 3.0 standard logs.

All data fields have the same number of bits, scale factors and units defined in the 5th edition of the GLONASS ICD, which contains the most recent information about GLONASS-M navigation data.

**Message ID:** 902  
**Log Type:** Synch

#### Recommended Input:

log rtcmdata1020a ontime 3

#### ASCII Example:

```
#RTCMDATA1020A, COM1, 0, 71.0, FINESTEERING, 1432, 313998.350, 00100000, 48c9, 35602;
1020, 6, 8, 0, 0, 0, 2329, 0, 1, 73, 2911974, -27323203, 0, -379009, -15756135, 0, 1761261,
41395090, -2, 1, -2, 3, 0, 227246, -15, 0, 1, 15, 1267, 1, 1, 1267, -2958, 3, -1032, 0, 0
*cfbf1816
```



Message Type 1020 contains only GLONASS ephemeris information, see Message Type 1019 starting on *page 515* for GPS ephemeris information.

**Table 87: GLONASS Ephemeris Word P1**

| Word P1 | Time Interval <sup>a</sup> |
|---------|----------------------------|
| 00      | 0                          |
| 01      | 30                         |
| 10      | 45                         |
| 11      | 60                         |

a. Time interval between adjacent values of  $t_b$  in minutes

**Table 88: M-Satellite User Range Accuracy**

| $F_T$ | Accuracy $\sigma$ (m) | $F_T$ | Accuracy $\sigma$ (m) | $F_T$ | Accuracy $\sigma$ (m) |
|-------|-----------------------|-------|-----------------------|-------|-----------------------|
| 0     | 1                     | 6     | 10                    | 12    | 128                   |
| 1     | 2                     | 7     | 12                    | 13    | 256                   |
| 2     | 2.5                   | 8     | 14                    | 14    | 512                   |
| 3     | 4                     | 9     | 16                    | 15    | Reserved              |
| 4     | 5                     | 10    | 32                    |       |                       |
| 5     | 7                     | 11    | 64                    |       |                       |

| Field # | Field type           | Data Description   | Scale Factor | Format | Binary Bytes   | Binary Offset |
|---------|----------------------|--|--------------|--------|----------------|---------------|
| 1       | RTCMDATA-1020 header | Log header   |              | -      | H              | 0             |
| 2       | message#             | Message number<br>Range: 0 to 4095   | -            | Ushort | 2              | H             |
| 3       | satID                | GLONASS sateliite ID (slot# 1-24)  | -            | Uchar  | 1              | H+2           |
| 4       | GLOfreq              | GLONASS frequency indicator (0-20), see <i>Table 85</i> on <i>page 506</i>   | 1            | Uchar  | 1              | H+3           |
| 5       | alm health           | GLONASS almanac health:<br>0 = non-operability of satellite.<br>1 = operability of satellite   | -            | Uchar  | 1              | H+4           |
| 6       | alm health ind       | Almanac health availability indicator (depends on whether an almanac has been received yet or not):<br>0 = Almanac health is not available<br>1 = Almanac health is available  | -            | Uchar  | 1              | H+5           |
| 7       | P1                   | Word P1 is a data updating flag. It indicates a time interval between two adjacent values of the <i>tb</i> parameter (in minutes) in both current and previous frames as indicated in <i>Table 87</i> on <i>page 519</i> .   | -            | Uchar  | 2 <sup>a</sup> | H+6           |
| 8       | Tk                   | Time of frame start (since start of GLONASS day). The number of hours elapsed occupies the 5 MSB, the minutes occupies the next 6 bits and the number of thirty-second intervals occupies the LSB:<br>Bits 11 to 17: 0 - 23 (hours)<br>Bits 6 to 1 : 0 - 59 (minutes)<br>Bit 0 : 0 - 1 (30-second intervals) | -            | Ushort | 2              | H+8           |
| 9       | Bn MSB               | Word Bn is the health flag:<br>0 = GOOD<br>1 = BAD<br><br>Both the second and third bits of this word are not used.  | -            | Uchar  | 1              | H+10          |
| 10      | P2                   | Word P2 is a flag of oddness (1) or evenness (0) of the value of <i>tb</i> (for intervals of 30 or 60 minutes)   | -            | Uchar  | 1              | H+11          |

*Continued on page 521.*



| Field # | Field type | Data Description  | Scale Factor                    | Format | Binary Bytes   | Binary Offset |
|---------|------------|---|---------------------------------|--------|----------------|---------------|
| 11      | tb         | Time to which GLONASS navigation data are referenced.<br>Range: 1 - 95 (minutes)                          | 15 mins.                        | Uchar  | 4 <sup>b</sup> | H+12          |
| 12      | Xn(tb)1    | GLONASS ECEF-X component of satellite velocity vector in PZ-90 datum<br>Range: $\pm 4.3$ km/s             | $\pm 2^{-20}$ km/s              | Long   | 4              | H+16          |
| 13      | Xn(tb)     | GLONASS ECEF-X component of satellite coordinates in PZ-90 datum<br>Range: $\pm 27000$ km                 | $\pm 2^{-11}$ km                | Long   | 4              | H+20          |
| 14      | Xn(tb)2    | GLONASS ECEF-X component of satellite acceleration in PZ-90 datum<br>Range: $\pm 6.2 \times 10^{-9}$ km/s | $\pm 2^{-30}$ km/s <sup>2</sup> | Char   | 4 <sup>b</sup> | H+24          |
| 15      | Yn(tb)1    | GLONASS ECEF-Y component of satellite velocity vector in PZ-90 datum<br>Range: $\pm 4.3$ km/s             | $\pm 2^{-20}$ km/s              | Long   | 4              | H+28          |
| 16      | Yn(tb)     | GLONASS ECEF-Y component of satellite coordinates in PZ-90 datum<br>Range: $\pm 27000$ km                 | $\pm 2^{-11}$ km                | Long   | 4              | H+32          |
| 17      | Yn(tb)2    | GLONASS ECEF-Y component of satellite acceleration in PZ-90 datum<br>Range: $\pm 6.2 \times 10^{-9}$ km/s | $\pm 2^{-30}$ km/s <sup>2</sup> | Char   | 4 <sup>b</sup> | H+36          |
| 18      | Zn(tb)1    | GLONASS ECEF-Z component of satellite velocity vector in PZ-90 datum<br>Range: $\pm 4.3$ km/s             | $\pm 2^{-20}$ km/s              | Long   | 4              | H+40          |
| 19      | Zn(tb)     | GLONASS ECEF-Z component of satellite coordinates in PZ-90 datum<br>Range: $\pm 27000$ km                 | $\pm 2^{-11}$ km                | Long   | 4              | H+44          |
| 20      | Zn(tb)2    | GLONASS ECEF-Z component of satellite acceleration in PZ-90 datum<br>Range: $\pm 6.2 \times 10^{-9}$ km/s | $\pm 2^{-30}$ km/s <sup>2</sup> | Char   | 1              | H+48          |

Continued on page 522.

| Field # | Field type           | Data Description   | Scale Factor | Format | Binary Bytes   | Binary Offset |
|---------|----------------------|--|--------------|--------|----------------|---------------|
| 21      | P3                   | The Word P3 flag indicates the number of satellites the almanac is transmitting within the given frame:<br>1 = five satellites<br>0 = four satellites  | -            | Uchar  | 1              | H+49          |
| 22      | $\gamma$ (tb)        | GLONASS relative deviation of predicted satellite carrier frequency from the nominal value. Range: $\pm 2^{-30}$   | $2^{-40}$    | Short  | 2              | H+50          |
| 23      | M P                  | Word P for the GLONASS-M satellite is a technological parameter that indicates the satellite operation mode in respect of time parameters <sup>c</sup> :<br>0 = $\tau_C$ parameter relayed from control segment, $\tau_{GPS}$ parameter relayed from control segment<br>1 = $\tau_C$ parameter relayed from control segment, $\tau_{GPS}$ parameter calculated on-board the GLONASS-M satellite<br>2 = $\tau_C$ parameter calculated on-board the GLONASS-M satellite, $\tau_{GPS}$ parameter relayed from control segment<br>3 = $\tau_C$ parameter calculated on-board the GLONASS-M satellite, $\tau_{GPS}$ parameter calculated on-board the GLONASS-M satellite | -            | Uchar  | 1              | H+52          |
| 24      | M I <sub>n</sub> 3rd | GLONASS-M 3rd string Word I <sub>n</sub> :<br>0 = the nth satellite is healthy<br>1 = the nth satellite is not healthy   | -            | Uchar  | 3 <sup>d</sup> | H+53          |
| 25      | $\tau_{tb}$          | GLONASS correction time relative to GLONASS system time. Range: $\pm 2^{-9}$ s   | $2^{-30}$    | Long   | 4              | H+56          |
| 26      | M $\Delta\tau$       | GLONASS time difference between the navigation RF signal transmitted in L2 sub-band and navigation RF signal transmitted in L1 sub-band. Range: $\pm 13.97 \times 10^{-9}$ s   | $2^{-30}$    | Char   | 1              | H+60          |
| 27      | E                    | The age of GLONASS navigation data. Range: 0 to 31 days  | 1 day        | Uchar  | 1              | H+61          |

Continued on page 523.

| Field # | Field type       | Data Description  | Scale Factor    | Format | Binary Bytes   | Binary Offset |
|---------|------------------|---|-----------------|--------|----------------|---------------|
| 28      | M P4             | Word P4 for the GLONASS-M satellite is a flag to show that ephemeris parameters are present.<br>1 = Updated ephemeris or frequency/time parameters have been uploaded by the control segment<br>0 = No parameters have been uploaded by the control segment | -               | Uchar  | 1              | H+62          |
| 29      | M F <sub>T</sub> | GLONASS-M predicted satellite user range at time $t_b$ .<br>Range: 0 to 15, see <i>Table 88</i> on <i>page 519</i>  | -               | Uchar  | 1              | H+63          |
| 30      | M Nt             | GLONASS-M current data number<br>Range: 1 to 1461 days  | 1 day           | Ushort | 2              | H+64          |
| 31      | M type?          | Type of GLONASS satellite<br>1 = Valid GLONASS-M data<br>0 = Not valid GLONASS-M data and may contain arbitrary values  | -               | Uchar  | 1              | H+66          |
| 32      | GLOavail         | This flag determines the availability of additional GLONASS data fields 132-136:<br>1 = Available<br>0 = Unavailable  | -               | Uchar  | 1              | H+67          |
| 33      | N <sup>A</sup>   | GLONASS calendar day within a four-year period to which $\tau_C$ is referenced<br>Range: 1 to 1461  | 1 day           | Ushort | 4 <sup>d</sup> | H+68          |
| 34      | $\tau_C$         | $\tau_C$ is the difference between GLONASS time and UTC time. This parameter is referenced to the beginning of the day N <sup>A</sup> . Range: $\pm 1$ s  | $2^{-31}$       | Long   | 4              | H+72          |
| 35      | M N4             | GLONASS four-year interval number starting from 1996<br>Range: 1 to 31  | 4-year interval | Uchar  | 4 <sup>b</sup> | H+76          |
| 36      | M $\tau_{GPS}$   | GLONASS-M $\tau_{GPS}$ is the correction to GPS time relative to GLONASS time.<br>Range: $\pm 1.9 \times 10^{-3}$ s   | $2^{-31}$       | Long   | 4              | H+80          |

Continued on page 524.

| Field #  | Field type           | Data Description   | Scale Factor | Format | Binary Bytes | Binary Offset |
|----------|----------------------|--|--------------|--------|--------------|---------------|
| 37       | M I <sub>n</sub> 5th | GLONASS-M 5th string Word I <sub>n</sub> :<br>0 = the nth satellite is healthy<br>1 = the nth satellite is not healthy | -            | Uchar  | 1            | H+84          |
| 38       | Reserved             |  | -            | Char   | 1            | H+85          |
| variable | xxxx                 | 32-bit CRC (ASCII and Binary only)   | -            | Hex    | 4            | variable      |
| variable | [CR][LF]             | Sentence terminator (ASCII only)   | -            | -      | -            | -             |

- a. In the binary log case, an additional byte of padding is added to maintain 4-byte alignment
- b. In the binary log case, an additional 3 bytes of padding are added to maintain 4-byte alignment
- c.  $\tau_C$  is the GLONASS time scale correction to UTC(SU) time.  $\tau_{GPS}$  is the correction to GPS time relative to GLONASS time:  $T_{GPS} - T_{GLO} = \Delta T + \tau_{GPS}$  where  $\Delta T$  is the integer part, and  $\tau_{GPS}$  is the fractional part of the difference between the system time scales expressed in seconds.
- d. In the binary log case, an additional 2 bytes of padding are added to maintain 4-byte alignment

### 3.3.119 RTKDATA RTK Solution Parameters V123\_RT20 V23\_RT2

This is the “RTK output” log, and it contains miscellaneous information regarding the RTK solution. It is based on the matched update. Note that the length of the log messages vary depending on the number of common satellites (on both rover and base stations) in the solution, a quantity represented by #sv in the field numbers.

To see how many GPS and/or GLONASS satellites you need to obtain a fixed ambiguity solution, see *Table 89*, and how many you need to keep a fixed ambiguity solution, see *Table 90*.

**Table 89: To Obtain a Fixed Ambiguity Solution**

| # GLO Satellites | # GPS Satellites |       |     |     |     |     |     |
|------------------|------------------|-------|-----|-----|-----|-----|-----|
|                  | 2                | 3     | 4   | 5   | 6   | 7   | 8   |
| 2                | No               | Float | Fix | Fix | Fix | Fix | Fix |
| 3                | Float            | Float | Fix | Fix | Fix | Fix | Fix |
| 4                | Float            | Float | Fix | Fix | Fix | Fix | Fix |
| 5                | Float            | Float | Fix | Fix | Fix | Fix | Fix |
| 6                | Float            | Float | Fix | Fix | Fix | Fix | Fix |
| 7                | Float            | Float | Fix | Fix | Fix | Fix | Fix |
| 8                | Float            | Float | Fix | Fix | Fix | Fix | Fix |

**Table 90: To Maintain a Fixed Ambiguity Solution**

| #GLO Satellites | # GPS Satellites |     |     |     |     |     |     |
|-----------------|------------------|-----|-----|-----|-----|-----|-----|
|                 | 2                | 3   | 4   | 5   | 6   | 7   | 8   |
| 2               | No               | Fix | Fix | Fix | Fix | Fix | Fix |
| 3               | Fix              | Fix | Fix | Fix | Fix | Fix | Fix |
| 4               | Fix              | Fix | Fix | Fix | Fix | Fix | Fix |
| 5               | Fix              | Fix | Fix | Fix | Fix | Fix | Fix |
| 6               | Fix              | Fix | Fix | Fix | Fix | Fix | Fix |
| 7               | Fix              | Fix | Fix | Fix | Fix | Fix | Fix |
| 8               | Fix              | Fix | Fix | Fix | Fix | Fix | Fix |

See also the BESTPOS log (the best available position computed by one receiver) and the MATCHEDPOS log (positions that have been computed from time matched base and rover observations), on *pages 247 and 353* respectively.

See *Figure 10, page 261* for a definition of the ECEF coordinates

**Message ID:** 215  
**Log Type:** Asynch

**Recommended Input:**

log rtkdataa onchanged

---

☒ Asynchronous logs should only be logged ONCHANGED. Otherwise, the most current data is not output when it is available. This is especially true of the ONTIME trigger, which may cause inaccurate time tags to result.

---

**ASCII Example:**

```
#RTKDATAA, COM1, 0, 61.0, FINESTEERING, 1419, 340038.000, 00000040, d307, 2724;
SOL_COMPUTED, NARROW_INT, 00000103, 12, 12, 12, 12, 0, 01, 0, 33, HNAV, 0,
6.3126e-05, 5.3089e-05, -4.4002e-05,
5.3089e-05, 2.5408e-04, -4.2023e-05,
-4.4002e-05, -4.2023e-05, 2.3526e-04,
0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000,
22, 12,
1, NARROW_INT, -0.000102415,
3, NARROW_INT, 0.000007917,
9, NARROW_INT, 0.000485239,
11, NARROW_FLOAT, -0.001025980,
14, NARROW_INT, 0.000196952,
18, NARROW_INT, 0.000621116,
19, NARROW_INT, -0.000129004,
21, NARROW_INT, 0.002786725,
39, NARROW_FLOAT, -0.003358357,
56, NARROW_FLOAT, -0.002554488,
22, REFERENCE, 0.000000000,
41, REFERENCE, 0.000000000*6fe4101f
```



Consider the appropriate observation times when using dual frequency receivers.

One primary advantage of dual frequency equipment is the ability to observe baselines using much shorter occupation times. It is difficult to state exactly what this occupation time should be since every observation session is different. Keep the following factors in mind when determining how long a station should be occupied (occupation time refers to the simultaneous observation time at both base and rover):

- The distance between rover and base station. As the distance between the base and rover receivers increases, the occupation times should also increase.
- Sky visibility at each of the base and rover receiver. The accuracy and reliability of differential GPS is proportional to the number of common satellites that are visible at the base and rover. Therefore, if the sky visibility at either station is

poor, you might consider increasing the occupation times. This condition is best measured by monitoring the number of visible satellites during data collection along with the PDOP value (a value less than 3 is ideal). See also the SATVIS log on *page 553*.

- Time of day. The location and number of satellites in the sky is constantly changing. As a result, some periods in the day are slightly better for GPS data collection than others. Use the SATVIS log to monitor the satellite constellation at a particular place and time.
- Station environment. It is good practice to observe the site conditions surrounding the station to be occupied. Water bodies, buildings, trees, and nearby vehicles can generate noise in the GPS data. Any of these conditions may warrant an increased occupation time.

**Table 91: Searcher Type**

| Searcher Type (binary) | Searcher Type (ASCII) | Description        |
|------------------------|-----------------------|--------------------|
| 0-4                    | Reserved              |                    |
| 5                      | HNAV                  | AdVance RTK Engine |

**Table 92: Ambiguity Type**

| Ambiguity Type (binary) | Ambiguity Type (ASCII) | Description  |
|-------------------------|------------------------|--|
| 0                       | UNDEFINED              | Undefined ambiguity  |
| 1                       | L1_FLOAT               | Floating L1 ambiguity  |
| 2                       | IONOFREE_FLOAT         | Floating ionospheric-free ambiguity  |
| 3                       | NARROW_FLOAT           | Floating narrow-lane ambiguity   |
| 4                       | NLF_FROM_WL1           | Floating narrow-lane ambiguity derived from integer wide-lane ambiguity  |
| 5                       | L1_INT                 | Integer L1 ambiguity   |
| 6                       | WIDE_INT               | Integer wide-lane ambiguity  |
| 7                       | NARROW_INT             | Integer narrow-lane ambiguity  |
| 8                       | IONOFREE_DISCRETE      | Discrete ionospheric-free ambiguity  |
| 9-10                    | Reserved               |  |
| 11                      | REFERENCE              | Double-difference reference satellite (There are two references if GLONASS is being used. The residuals of the references are always 0.0.) |

**Table 93: RTK Information**

| Bit # | Mask        | Description  | Bit = 0      | Bit = 1  |
|-------|-------------|--|--------------|----------|
| 0     | 0x00000001  | RTK dynamics   | Static       | Dynamic  |
| 1     | 0x00000002  | RTK dynamics mode  | Auto         | Forced   |
| 2     | 0x00000004  | Severe differential ionosphere detected                        | No           | Yes      |
| 8     | 0x00000100  | Verification flag for AdVance RTK, see also the note box below | Not verified | Verified |
| 3-31  | 0xFFFFFFFF8 | Reserved   |              |          |

- ☒ The verification flag is shown in the 8th bit of Field #4 where a 1 means the AdVance RTK narrow-lane ambiguity is verified and a 0 means it has not yet been verified.

To achieve the best reliability, particularly when operating in difficult environments such as high foliage, longer baselines or unstable atmospheric conditions, the user should wait for the verified status. The verification flag provides an extra level of assurance that the ambiguity resolutions are correct.



| Field # | Field type     | Data Description  | Format | Binary Bytes | Binary Offset |
|---------|----------------|---|--------|--------------|---------------|
| 1       | RTKDATA header | Log header  |        | H            | 0             |
| 2       | sol status     | Solution status (see Table 51, <i>Solution Status</i> on page 249)  | Enum   | 4            | H             |
| 3       | pos type       | Position type (see Table 50, <i>Position or Velocity Type</i> on page 248)  | Enum   | 4            | H+4           |
| 4       | rtk info       | RTK information (see Table 93, <i>RTK Information</i> on page 528)  | Ulong  | 4            | H+8           |
| 5       | #SVs           | Number of satellite vehicles tracked  | Uchar  | 1            | H+12          |
| 6       | #solnSVs       | Number of satellite vehicles used in solution   | Uchar  | 1            | H+13          |
| 7       | #ggL1          | Number of GPS plus GLONASS L1 used in solution  | Uchar  | 1            | H+14          |
| 8       | #ggL1L2        | Number of GPS plus GLONASS L1 and L2 used in solution   | Uchar  | 1            | H+15          |
| 9       | Reserved       |   | Uchar  | 1            | H+16          |
| 10      | ext sol stat   | Extended solution status (see Table 53, <i>Extended Solution Status</i> on page 250)  | Hex    | 1            | H+17          |
| 11      | Reserved       |   | Hex    | 1            | H+18          |
| 12      | sig mask       | Signals used mask - if 0, signals used in solution are unknown (see Table 52 on page 250)   | Hex    | 1            | H+19          |
| 13      | search stat    | Searcher status, normally ANAV (see Table 91, <i>Searcher Type</i> on page 527)   | Enum   | 4            | H+20          |
| 14      | Reserved       |   | Ulong  | 4            | H+24          |
| 15-23   | [C]            | The $C_{xx}, C_{xy}, C_{xz}, C_{yx}, C_{yy}, C_{yz}, C_{zx}, C_{zy}$ and $C_{zz}$ components in (meters) <sup>2</sup> , of the ECEF position covariance matrix (3x3). | Float  | 36           | H+28          |
| 24      | Reserved       |   | Double | 8            | H+64          |
| 25      |                |   | Double | 8            | H+72          |
| 26      |                |   | Double | 8            | H+80          |
| 27      |                |   | Float  | 4            | H+88          |
| 28      |                |   | Float  | 4            | H+92          |
| 29      |                |   | Float  | 4            | H+96          |
| 30      | ref PRN        | Base PRN  | Ulong  | 4            | H+100         |

Continued on page 530.

| Field #  | Field type                            | Data Description   | Format | Binary Bytes | Binary Offset      |
|----------|---------------------------------------|--|--------|--------------|--------------------|
| 31       | # SV                                  | Number of SVs to follow  | Long   | 4            | H+104              |
| 32       | PRN                                   | Satellite PRN number of range measurement                        | Ulong  | 4            | H+108              |
| 33       | amb                                   | Ambiguity type (see <i>Table 92, Ambiguity Type</i> on page 527) | Enum   | 4            | H+112              |
| 34       | res                                   | Residual (m)   | Float  | 4            | H+116              |
| 35...    | Next SV offset = H + 108 + (obs x 12) |  |        |              |                    |
| variable | xxxx                                  | 32-bit CRC (ASCII and Binary only)                               | Hex    | 4            | H+108+<br>(12xobs) |
| variable | [CR][LF]                              | Sentence terminator (ASCII only)                                 | -      | -            | -                  |

### 3.3.120 RTKDOP DOP Values from the RTK Fast Filter V123\_RT20 V23\_RT2

This log contains the DOP values calculated by the RTK fast filter.

The RTKDOP log contains single-point DOPs, calculated using only the satellites used in the fast RTK solution, that is, those used for the RTKPOS position. Calculation of the RTK DOPs are limited to once a second.

The calculation of the RTK DOP is different than that for the pseudorange DOP. In the pseudorange filter, new DOPs are calculated every 60s, or when the satellites used in the solution change. The RTK DOP is calculated at the rate requested, and regardless of a change in satellites. However, the DOP is only calculated when the RTKDOP log is requested.

**Message ID:** 952

**Log Type:** Synch

#### Recommended Input:

```
log rtkdopa ontime 10
```

#### ASCII Example:

```
#RTKDOPA,COM1,0,60.0,FINESTEERING,1449,446982.000,00000008,b42b,3044;2.3386,  
1.9856,0.9407,1.5528,1.2355,10.0,11,21,58,6,7,10,16,18,24,26,29,41*85f8338b
```

| Field # | Field type    | Data Description                         | Format       | Binary Bytes | Binary Offset |
|---------|---------------|--|--------------|--------------|---------------|
| 1       | RTKDOP header | Log header                               |              | H            | 0             |
| 2       | GDOP          | Geometric DOP                            | Float        | 4            | H             |
| 3       | PDOP          | Position DOP                             | Float        | 4            | H+4           |
| 4       | HDOP          | Horizontal DOP                           | Float        | 4            | H+8           |
| 5       | HTDOP         | Horizontal and Time DOP                  | Float        | 4            | H+12          |
| 6       | TDOP          | Time DOP                                 | Float        | 4            | H+16          |
| 7       | elev mask     | Elevation mask angle                     | Float        | 4            | H+20          |
| 8       | #sats         | Number of satellites to follow           | Ulong        | 4            | H+24          |
| 9       | sats          | Satellites in use at time of calculation | Ulong[#sats] | 4x(#sats)    | H+28          |
| 10      | xxxx          | 32-bit CRC (ASCII and Binary only)       | Hex          | 4            | variable      |
| 11      | [CR][LF]      | Sentence terminator (ASCII only)         | -            | -            | -             |

### 3.3.121 RTKPOS RTK Low Latency Position Data V123\_RT20 V23\_RT2

This log contains the low latency RTK position computed by the receiver, along with two status flags. In addition, it reports other status indicators, including differential age, which is useful in predicting anomalous behavior brought about by outages in differential corrections. This log is recommended for kinematic operation. Better accuracy can be obtained in static operation with the MATCHEDPOS log.

With the system operating in an RTK mode, this log reflects if the solution is a good RTK low latency solution (from extrapolated base station measurements) or invalid. A valid RTK low latency solution is computed for up to 60 seconds after reception of the last base station observation. The degradation in accuracy, due to differential age, is reflected in the standard deviation fields, and is summarized in the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm>. See also the DGPSTIMEOUT command on *page 105*.

**Message ID:** 141  
**Log Type:** Synch

#### Recommended Input:

log rtkposa ontime 1

#### ASCII Example:

```
#RTKPOSA, COM1, 0, 54.5, FINESTEERING, 1419, 340040.000, 00000040, 176e, 2724;  
SOL_COMPUTED, NARROW_INT, 51.11635911294, -114.03833103654, 1063.8336, -16.2712,  
WGS84, 0.0179, 0.0096, 0.0174, "AAAA", 1.000, 0.000, 12, 11, 11, 11, 0, 01, 0, 33*0adb3e47
```



Consider the case of a racing car on a closed circuit requiring RTK operation. In this situation, you would have to send live data to the pits using a radio link.

RTK operation enables live cm-level position accuracy. When answers are required right in the field, the base station must transmit its information to the rover in real-time. For RTK operation, extra equipment such as radios are required to be able to transmit and receive this information. The base station has a corresponding base radio and the rover station has a corresponding rover radio.

Post-processing can provide post-mission position and velocity data using raw GPS collected from the car. The logs necessary for post-processing include:

```
RANGECMPB ONTIME 1  
RAWEPHEMB ONNEW
```

- ☒ Above, we describe and give examples of data collection for post-processing, and real-time operation. OEMV-based output is compatible with post-processing software from the Waypoint Products Group, NovAtel Inc. See also [www.novatel.com](http://www.novatel.com).

| Field # | Field type    | Data Description  | Format  | Binary Bytes | Binary Offset |
|---------|---------------|---|---------|--------------|---------------|
| 1       | RTKPOS header | Log header  |         | H            | 0             |
| 2       | sol status    | Solution status (see <i>Table 51 on page 249</i> )  | Enum    | 4            | H             |
| 3       | pos type      | Position type (see <i>Table 50 on page 248</i> )  | Enum    | 4            | H+4           |
| 4       | lat           | Latitude  | Double  | 8            | H+8           |
| 5       | lon           | Longitude   | Double  | 8            | H+16          |
| 6       | hgt           | Height above mean sea level   | Double  | 8            | H+24          |
| 7       | undulation    | Undulation - the relationship between the geoid and the WGS84 ellipsoid (m) <sup>a</sup>          | Float   | 4            | H+32          |
| 8       | datum id#     | Datum ID number (see <i>Table 21, Reference Ellipsoid Constants on page 97</i> )                  | Enum    | 4            | H+36          |
| 9       | lat $\sigma$  | Latitude standard deviation   | Float   | 4            | H+40          |
| 10      | lon $\sigma$  | Longitude standard deviation  | Float   | 4            | H+44          |
| 11      | hgt $\sigma$  | Height standard deviation   | Float   | 4            | H+48          |
| 12      | stn id        | Base station ID   | Char[4] | 4            | H+52          |
| 13      | diff_age      | Differential age in seconds   | Float   | 4            | H+56          |
| 14      | sol_age       | Solution age in seconds   | Float   | 4            | H+60          |
| 15      | #SVs          | Number of satellite vehicles tracked  | Uchar   | 1            | H+64          |
| 16      | #solnSVs      | Number of satellite vehicles used in solution   | Uchar   | 1            | H+65          |
| 17      | #ggL1         | Number of GPS plus GLONASS L1 used in solution  | Uchar   | 1            | H+66          |
| 18      | #ggL1L2       | Number of GPS plus GLONASS L1 and L2 used in solution   | Uchar   | 1            | H+67          |
| 19      | Reserved      |   | Uchar   | 1            | H+68          |
| 20      | ext sol stat  | Extended solution status (see <i>Table 53, Extended Solution Status on page 250</i> )             | Hex     | 1            | H+69          |
| 21      | Reserved      |   | Hex     | 1            | H+70          |
| 22      | sig mask      | Signals used mask - if 0, signals used in solution are unknown (see <i>Table 52 on page 250</i> ) | Hex     | 1            | H+71          |
| 23      | xxxx          | 32-bit CRC (ASCII and Binary only)  | Hex     | 4            | H+72          |
| 24      | [CR][LF]      | Sentence terminator (ASCII only)  | -       | -            | -             |

- a. When using a datum other than WGS84, the undulation value also includes the vertical shift due to differences between the datum in use and WGS84

### 3.3.122 RTKVEL RTK Velocity V123\_RT20 V23\_RT2

This log contains the RTK velocity information computed by the receiver. In addition, it reports a velocity status indicator, which is useful in indicating whether or not the corresponding data is valid and differential age, which is useful in predicting anomalous behavior brought about by outages in differential corrections. The velocity measurements sometimes have a latency associated with them. The time of validity is the time tag in the log minus the latency value. See also the table footnote for velocity logs on *page 223*.

---

Velocities from the RTK filter are calculated from the delta-position. In RTKVEL, the velocity type is the same as the position type.

---

With the system operating in an RTK mode, this log reflects if the solution is a good RTK Low Latency solution (from extrapolated base station measurements) or invalid. A valid RTK Low Latency solution is computed for up to 60 seconds after reception of the last base station observation.

The velocity is computed from consecutive RTK low latency updates. As such, it is an average velocity based on the time difference between successive position computations and not an instantaneous velocity at the RTKVEL time tag. The velocity latency to be subtracted from the time tag is normally 1/2 the time between filter updates. Under default operation, the RTK low latency filter is updated at a rate of 2 Hz. This translates into a velocity latency of 0.25 seconds. The latency can be reduced by increasing the update rate of the RTK low latency filter by requesting the BESTVEL, RTKVEL, BESTPOS or RTKPOS messages at a rate higher than 2 Hz. For example, a logging rate of 10 Hz would reduce the velocity latency to 0.05 seconds. For integration purposes, the velocity latency should be applied to the record time tag.

**Message ID:** 216

**Log Type:** Synch

**Recommended Input:**

log rtkvela ontime 1

**ASCII Example:**

```
#RTKVELA, COM1, 0, 43.5, FINESTEERING, 1364, 496137.000, 00100000, 71e2, 2310;
SOL_COMPUTED, NARROW_INT, 0.250, 1.000, 0.0027, 207.645811, 0.0104, 0.0*f551cc42
```



Consider the case of an unmanned aircraft. A differential base station must send data to the remote aircraft. In this type of application, the aircraft's radio may pass differential data, for example RTKVEL, to the positioning system so it can process it and generate precise position information for the flight controls.

---

| Field # | Field type    | Data Description  | Format | Binary Bytes | Binary Offset |
|---------|---------------|---|--------|--------------|---------------|
| 1       | RTKVEL header | Log header  |        | H            | 0             |
| 2       | sol status    | Solution status, see <i>Table 51, Solution Status on page 249</i>   | Enum   | 4            | H             |
| 3       | vel type      | Velocity type, see <i>Table 50, Position or Velocity Type on page 248</i>   | Enum   | 4            | H+4           |
| 4       | latency       | A measure of the latency in the velocity time tag in seconds. It should be subtracted from the time to give improved results.                         | Float  | 4            | H+8           |
| 5       | age           | Differential age in seconds   | Float  | 4            | H+12          |
| 6       | hor spd       | Horizontal speed over ground, in meters per second  | Double | 8            | H+16          |
| 7       | trk gnd       | Actual direction of motion over ground (track over ground) with respect to True North, in degrees   | Double | 8            | H+24          |
| 8       | vert spd      | Vertical speed, in meters per second, where positive values indicate increasing altitude (up) and negative values indicate decreasing altitude (down) | Double | 8            | H+32          |
| 9       | Reserved      |   | Float  | 4            | H+40          |
| 10      | xxxx          | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+44          |
| 11      | [CR][LF]      | Sentence terminator (ASCII only)  | -      | -            | -             |

### 3.3.123 RTKXYZ RTK Cartesian Position and Velocity V123\_RT20 V23\_RT2

This log contains the receiver's low latency position and velocity in ECEF coordinates. The position and velocity status field's indicate whether or not the corresponding data is valid. See *Figure 10, page 261* for a definition of the ECEF coordinates.

The velocity measurements sometimes have a latency associated with them. The time of validity is the time tag in the log minus the latency value.

With the system operating in an RTK mode, this log reflects if the solution is a good RTK Low Latency solution (from extrapolated base station measurements) or invalid. A valid RTK Low Latency solution is computed for up to 60 seconds after reception of the last base station observation. The degradation in accuracy due to differential age is reflected in the standard deviation fields, and is summarized in the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm>. See also the DGPSTIMEOUT command on *page 105*.

The velocity is computed from consecutive RTK low latency updates. As such, it is an average velocity based on the time difference between successive position computations and not an instantaneous velocity at the RTKVEL time tag. The velocity latency to be subtracted from the time tag is normally 1/2 the time between filter updates. Under default operation, the RTK low latency filter is updated at a rate of 2 Hz. This translates into a velocity latency of 0.25 seconds. The latency can be reduced by increasing the update rate of the RTK low latency filter by requesting the BESTXYZ message at a rate higher than 2 Hz. For example, a logging rate of 10 Hz would reduce the velocity latency to 0.05 seconds. For integration purposes, the velocity latency should be applied to the record time tag.

See also the BESTXYZ and MATCHEDXYZ logs, on *Pages 258 and 361* respectively.

**Message ID:** 244  
**Log Type:** Synch

**Recommended Input:**

log rtkxyza ontime 1

**ASCII Example:**

```
#RTKXYZA,COM1,0,56.0,FINESTEERING,1419,340041.000,00000040,3d88,2724;
SOL_COMPUTED,NARROW_INT,-1634531.5666,-3664618.0291,4942496.3230,0.0099,
0.0219,0.0115,SOL_COMPUTED,NARROW_INT,0.0030,0.0003,-0.0016,0.0198,0.0438,
0.0230,"AAAA",0.250,1.000,0.000,12,11,11,11,0,01,0,33*0497d146
```



| Field # | Field type    | Data Description  | Format  | Binary Bytes | Binary Offset |
|---------|---------------|---|---------|--------------|---------------|
| 1       | RTKXYZ header | Log header  |         | H            | 0             |
| 2       | P-sol status  | Solution status, see <i>Table 51, Solution Status on page 249</i>   | Enum    | 4            | H             |
| 3       | pos type      | Position type, see <i>Table 50, Position or Velocity Type on page 248</i>   | Enum    | 4            | H+4           |
| 4       | P-X           | Position X-coordinate (m)   | Double  | 8            | H+8           |
| 5       | P-Y           | Position Y-coordinate (m)   | Double  | 8            | H+16          |
| 6       | P-Z           | Position Z-coordinate (m)   | Double  | 8            | H+24          |
| 7       | P-X $\sigma$  | Standard deviation of P-X (m)   | Float   | 4            | H+32          |
| 8       | P-Y $\sigma$  | Standard deviation of P-Y (m)   | Float   | 4            | H+36          |
| 9       | P-Z $\sigma$  | Standard deviation of P-Z (m)   | Float   | 4            | H+40          |
| 10      | V-sol status  | Solution status, see <i>Table 51, Solution Status on page 249</i>   | Enum    | 4            | H+44          |
| 11      | vel type      | Velocity type, see <i>Table 50 on page 248</i>  | Enum    | 4            | H+48          |
| 12      | V-X           | Velocity vector along X-axis (m)  | Double  | 8            | H+52          |
| 13      | V-Y           | Velocity vector along Y-axis (m)  | Double  | 8            | H+60          |
| 14      | V-Z           | Velocity vector along Z-axis (m)  | Double  | 8            | H+68          |
| 15      | V-X $\sigma$  | Standard deviation of V-X (m)   | Float   | 4            | H+76          |
| 16      | V-Y $\sigma$  | Standard deviation of V-Y (m)   | Float   | 4            | H+80          |
| 17      | V-Z $\sigma$  | Standard deviation of V-Z (m)   | Float   | 4            | H+84          |
| 18      | stn ID        | Base station identification   | Char[4] | 4            | H+88          |
| 19      | V-latency     | A measure of the latency in the velocity time tag in seconds. It should be subtracted from the time to give improved results. | Float   | 4            | H+92          |
| 20      | diff_age      | Differential age in seconds   | Float   | 4            | H+96          |
| 21      | sol_age       | Solution age in seconds   | Float   | 4            | H+100         |
| 22      | #SVs          | Number of satellite vehicles tracked  | Uchar   | 1            | H+104         |
| 23      | #solnSVs      | Number of satellite vehicles used in solution   | Uchar   | 1            | H+105         |
| 24      | #ggL1         | Number of GPS plus GLONASS L1 used in solution  | Uchar   | 1            | H+106         |

*Continued on page 538.*

| Field # | Field type   | Data Description  | Format | Binary Bytes | Binary Offset |
|---------|--------------|---|--------|--------------|---------------|
| 25      | #ggL1L2      | Number of GPS plus GLONASS L1 and L2 used in solution   | Uchar  | 1            | H+107         |
| 26      | Reserved     |   | Char   | 1            | H+108         |
| 27      | ext sol stat | Extended solution status (see <i>Table 53, Extended Solution Status on page 250</i> )             | Hex    | 1            | H+109         |
| 28      | Reserved     |   | Hex    | 1            | H+110         |
| 29      | sig mask     | Signals used mask - if 0, signals used in solution are unknown (see <i>Table 52 on page 250</i> ) | Hex    | 1            | H+111         |
| 30      | xxxx         | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+112         |
| 31      | [CR][LF]     | Sentence terminator (ASCII only)  | -      | -            | -             |

### 3.3.124 RXCONFIG Receiver Configuration V123

This log is used to output a list of all current command settings. When requested, an RXCONFIG log is output for each setting. See also the LOGLIST log on *page 350* for a list of currently active logs.

**Message ID:** 128  
**Log Type:** Polled

#### Recommended Input:

```
log rxconfiga once
```

#### ASCII Example<sup>1</sup>:

```
#RXCONFIGA, COM1, 71, 47.5, APPROXIMATE, 1337, 333963.260, 00000000, f702, 1984;
#ADJUST1PPSA, COM1, 71, 47.5, APPROXIMATE, 1337, 333963.260, 00000000, f702, 1984;
OFF, ONCE, 0*ba85a20b*91f89b07
#RXCONFIGA, COM1, 70, 47.5, APPROXIMATE, 1337, 333963.398, 00000000, f702, 1984;
#ANTENNAPOWERA, COM1, 70, 47.5, APPROXIMATE, 1337, 333963.398, 00000000, f702, 1984;
ON*d12f6135*8f8741be
#RXCONFIGA, COM1, 69, 47.5, APPROXIMATE, 1337, 333963.455, 00000000, f702, 1984;
#CLOCKADJUSTA, COM1, 69, 47.5, APPROXIMATE, 1337, 333963.455, 00000000, f702, 1984;
ENABLE*0af36d92*b13280f2
...
#RXCONFIGA, COM1, 7, 47.5, APPROXIMATE, 1337, 333966.781, 00000000, f702, 1984;
#STATUSCONFIGA, COM1, 7, 47.5, APPROXIMATE, 1337, 333966.781, 00000000, f702, 1984;
CLEAR, AUX2, 0*a6141e28*d0bba9f2
#RXCONFIGA, COM1, 2, 47.5, APPROXIMATE, 1337, 333967.002, 00000000, f702, 1984;
#WAASECUTOFFA, COM1, 2, 47.5, APPROXIMATE, 1337, 333967.002, 00000000, f702, 1984;
-5.00000000*b9b11096*2e8b77cf
#RXCONFIGA, COM1, 1, 47.5, FINESTEERING, 1337, 398382.787, 00000000, f702, 1984;
#LOGA, COM1, 1, 47.5, FINESTEERING, 1337, 398382.787, 00000000, f702, 1984;
COM1, MARKPOSA, ONNEW, 0.000000, 0.000000, NOHOLD*a739272d*6692c084
#RXCONFIGA, COM1, 0, 47.5, FINESTEERING, 1337, 400416.370, 00000000, f702, 1984;
#LOGA, COM1, 0, 47.5, FINESTEERING, 1337, 400416.370, 00000000, f702, 1984;
COM2, PASSCOM2A, ONCHANGED, 0.000000, 0.000000, NOHOLD*55fc0c62*17086d18
```

---



---

**WARNING!:** Do not use undocumented commands or logs! Doing so may produce errors and void your warranty.

---



---

1. The embedded CRCs are flipped to make the embedded messages recognizable to the receiver. For example, consider the first embedded message above.

```
91f89b07: 10010001111110001001101100000111
11100000110110010001111110001001:e0d91f89
```

Its CRC is really e0d91f89.



The RXCONFIG log can be used to ensure that your receiver is set up correctly for your application.

| Field # | Field type      | Data Description  | Format | Binary Bytes | Binary Offset |
|---------|-----------------|---|--------|--------------|---------------|
| 1       | RXCONFIG header | Log header  | -      | H            | 0             |
| 2       | e header        | Embedded header   | -      | h            | H             |
| 3       | e msg           | Embedded message  | Varied | a            | H + h         |
| 4       | e xxxx          | Embedded (inverted) 32-bit CRC (ASCII and Binary only). The embedded CRC is inverted so that the receiver does not recognize the embedded messages as messages to be output but continues with the RXCONFIG message. If you wish to use the messages output from the RXCONFIG log, simply flip the embedded CRC around for individual messages. | Long   | 4            | H+ h + a      |
| 5       | xxxx            | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+ h + a + 4  |
| 6       | [CR][LF]        | Sentence terminator (ASCII only)  | -      | -            | -             |

### 3.3.125 RXHWLEVELS Receiver Hardware Levels V3

This log contains the receiver environmental and voltage parameters. *Table 94* provides some of the minimum, maximum and typical parameters of OEMV-3-based products.

☒ This log outputs null fields from OEMV-1-based and OEMV-2-based products.

**Message ID:** 195  
**Log Type:** Polled

**Recommended Input:**

log rxhwlevels ontime 60

**ASCII Example:**

```
#RXHWLEVELSA, COM1, 0, 82.5, FINESTEERING, 1364, 490216.808, 00000008, 863c, 2310;  
31.563, 0.000, 1.352, 11.763, 4.996, 0.000, 0.000, 0.000, 0.000, 0.000*76927cb1
```



Refer also to the OEMV-3 technical specifications in *Appendix A* of the *OEMV Family Installation and Operation User Manual* for comparisons.

**Table 94: Receiver Hardware Parameters**

|                | Temp.<br>(°C)    | Antenna<br>Current | Core<br>Voltage <sup>a</sup> | Supply<br>Voltage | RF<br>Voltage | Internal<br>LNA<br>Voltage | GPAI | LNA<br>Voltage |
|----------------|------------------|--------------------|------------------------------|-------------------|---------------|----------------------------|------|----------------|
| <b>Min</b>     | -40              | 0                  | 1.30                         | 4.5               | 4.55          | 4.55                       | 0    | 0              |
| <b>Max</b>     | 100 <sup>b</sup> | 0.10               | 1.65                         | 18                | 5.25          | 5.25                       | 2.5  | 30             |
| <b>Typical</b> | 40               | 0.04               | 1.37                         | 12                | 5             | 5                          | 0    | 5              |

- The shown voltage levels are for OEMV-3 cards.
- The board temperature is about 15°C higher than the ambient temperature. Bit 1, in *Table* , *If you wish to disable all these messages without changing the bits, simply UNLOG the RXSTATUSEVENT logs on the appropriate ports. See also the UNLOG command on page 207.. on page 543*, turns on as a warning when the board temperature is above 100°C and a hazardous temperature error message is generated at 110°C.

| Field # | Field type        | Data Description                         | Format | Binary Bytes | Binary Offset |
|---------|-------------------|--|--------|--------------|---------------|
| 1       | RXHWLEVELS header | Log header                               |        | H            | 0             |
| 2       | temp              | Board temperature (degrees celsius)      | Float  | 4            | H             |
| 3       | ant current       | Approximate internal antenna current (A) | Float  | 4            | H+4           |
| 4       | core volt         | CPU core voltage (V)                     | Float  | 4            | H+8           |
| 5       | supply volt       | Receiver supply voltage (V)              | Float  | 4            | H+12          |
| 6       | rf volt           | 5V RF supply voltage (V)                 | Float  | 4            | H+16          |
| 7       | int lna volt      | Internal LNA voltage level (V)           | Float  | 4            | H+20          |
| 8       | GPAI              | General purpose analog input (V)         | Float  | 4            | H+24          |
| 9       | Reserved          |  | Float  | 4            | H+28          |
| 10      |                   |  | Float  | 4            | H+32          |
| 11      | lna volt          | LNA voltage (V) at OEM card output       | Float  | 4            | H+36          |
| 12      | xxxx              | 32-bit CRC (ASCII and Binary only)       | Hex    | 4            | H+40          |
| 13      | [CR][LF]          | Sentence terminator (ASCII only)         | -      | -            | -             |

### 3.3.126 RXSTATUS Receiver Status V123

This log conveys various status parameters of the GPS receiver system. These include the Receiver Status and Error words which contain several flags specifying status and error conditions. If an error occurs (shown in the Receiver Error word) the receiver idles all channels, turns off the antenna, and disables the RF hardware as these conditions are considered to be fatal errors. The log contains a variable number of status words to allow for maximum flexibility and future expansion.

The receiver gives the user the ability to determine the importance of the status bits. In the case of the Receiver Status, setting a bit in the priority mask causes the condition to trigger an error. This causes the receiver to idle all channels, turn off the antenna, and disable the RF hardware, the same as if a bit in the Receiver Error word is set. Setting a bit in an Auxiliary Status priority mask causes that condition to set the bit in the Receiver Status word corresponding to that Auxiliary Status. See also the STATUSCONFIG command on *page 199*.

- 
- ☒ 1. Field #4, the receiver status word as represented in *Table* , is also in Field #8 of the header. See the *ASCII Example* below and *Table* on *page 543* for clarification.
  - 2. Refer also to the chapter on *Built-In Status Tests* in the *OEMV Family Installation and Operation User Manual*.
- 

**Message ID:** 93

**Log Type:** Asynch

**Recommended Input:**

log rxstatusa onchanged

**ASCII Example:**

```
#RXSTATUSA,COM1,0,43.5,FINESTEERING,1337,407250.846,00000000,643c,1984;
00000000,4,00000000,00000000,00000000,00000000,00000083,00000008,00000000,
00000000,00000000,00000000,00000000,00000000,00000000,00000000,00000000,
00000000*ba27dfae
```



Receiver errors automatically generate event messages. These event messages are output in RXSTATUSEVENT logs. It is also possible to have status conditions trigger event messages to be generated by the receiver. This is done by setting/clearing the appropriate bits in the event set/clear masks. The set mask tells the receiver to generate an event message when the bit becomes set. Likewise, the clear mask causes messages to be generated when a bit is cleared. See the STATUSCONFIG command on *page 199* for details.

If you wish to disable all these messages without changing the bits, simply UNLOG the RXSTATUSEVENT logs on the appropriate ports. See also the UNLOG command on *page 208*.

---

**Table 95: Receiver Error**

| Nibble # | Bit # | Mask       | Description  | Bit = 0 | Bit = 1 |
|----------|-------|------------|--|---------|---------|
| N0       | 0     | 0x00000001 | Dynamic Random Access Memory (DRAM) status <sup>a</sup>    | OK      | Error   |
|          | 1     | 0x00000002 | Invalid firmware   | OK      | Error   |
|          | 2     | 0x00000004 | ROM status   | OK      | Error   |
|          | 3     | Reserved   |  |         |         |
| N1       | 4     | 0x00000010 | Electronic Serial Number (ESN) access status               | OK      | Error   |
|          | 5     | 0x00000020 | Authorization code status                                  | OK      | Error   |
|          | 6     | 0x00000040 | Slow ADC status  | OK      | Error   |
|          | 7     | 0x00000080 | Supply voltage status                                      | OK      | Error   |
| N2       | 8     | 0x00000100 | Thermometer status   | OK      | Error   |
|          | 9     | 0x00000200 | Temperature status (as compared against acceptable limits) | OK      | Error   |
|          | 10    | 0x00000400 | MINOS5 status  | OK      | Error   |
|          | 11    | 0x00000800 | PLL RF1 hardware status - L1                               | OK      | Error   |
| N3       | 12    | 0x00001000 | PLL RF2 hardware status - L2                               | OK      | Error   |
|          | 13    | 0x00002000 | RF1 hardware status - L1                                   | OK      | Error   |
|          | 14    | 0x00004000 | RF2 hardware status - L2                                   | OK      | Error   |
|          | 15    | 0x00008000 | NVM status   | OK      | Error   |
| N4       | 16    | 0x00010000 | Software resource limit                                    | OK      | Error   |
|          | 17    | 0x00020000 | Model not valid for this receiver                          | OK      | Error   |
|          | 18    | 0x00040000 | Reserved   |         |         |
|          | 19    | 0x00080000 |  |         |         |

*Continued on page 545.*



**Table 95: Receiver Error**

| Nibble # | Bit # | Mask       | Description              | Bit = 0                    | Bit = 1 |
|----------|-------|------------|--------------------------|----------------------------|---------|
| N5       | 20    | 0x00100000 | Remote loading has begun | No                         | Yes     |
|          | 21    | 0x00200000 | Export restriction       | OK                         | Error   |
|          | 22    | 0x00400000 | Reserved                 |                            |         |
|          | 23    | 0x00800000 |                          |                            |         |
| N6       | 24    | 0x01000000 |                          |                            |         |
|          | 25    | 0x02000000 |                          |                            |         |
|          | 26    | 0x04000000 |                          |                            |         |
|          | 27    | 0x08000000 |                          |                            |         |
| N7       | 28    | 0x10000000 |                          |                            |         |
|          | 29    | 0x20000000 |                          |                            |         |
|          | 30    | 0x40000000 |                          |                            |         |
|          | 31    | 0x80000000 |                          | Component hardware failure | OK      |

- a. RAM failure on an OEMV card may also be indicated by a flashing red LED.

Table 96: Receiver Status

| Nibble # | Bit # | Mask       | Description   | Bit = 0               | Bit = 1     |
|----------|-------|------------|---|-----------------------|-------------|
| N0       | 0     | 0x00000001 | Error flag, see <i>Table</i> , If you wish to disable all these messages without changing | No error              | Error       |
|          | 1     | 0x00000002 | Temperature status  | Within specifications | Warning     |
|          | 2     | 0x00000004 | Voltage supply status   | OK                    | Warning     |
|          | 3     | 0x00000008 | Antenna power status<br>See <i>ANTENNAPOWER</i> on Page 64                                | Powered               | Not powered |
| N1       | 4     | 0x00000010 | Reserved  |                       |             |
|          | 5     | 0x00000020 | Antenna open flag <sup>a</sup>  | OK                    | Open        |
|          | 6     | 0x00000040 | Antenna shorted flag <sup>a</sup>   | OK                    | Shorted     |
|          | 7     | 0x00000080 | CPU overload flag <sup>a</sup>  | No overload           | Overload    |
| N2       | 8     | 0x00000100 | COM1 buffer overrun flag  | No overrun            | Overrun     |
|          | 9     | 0x00000200 | COM2 buffer overrun flag  | No overrun            | Overrun     |
|          | 10    | 0x00000400 | COM3 buffer overrun flag  | No overrun            | Overrun     |
|          | 11    | 0x00000800 | USB buffer overrun flag <sup>b</sup>  | No overrun            | Overrun     |
| N3       | 12    | 0x00001000 | Reserved  |                       |             |
|          | 13    | 0x00002000 |   |                       |             |
|          | 14    | 0x00004000 |   |                       |             |
|          | 15    | 0x00008000 | RF1 AGC status  | OK                    | Bad         |
| N4       | 16    | 0x00010000 | Reserved  |                       |             |
|          | 17    | 0x00020000 | RF2 AGC status  | OK                    | Bad         |
|          | 18    | 0x00040000 | Almanac flag/UTC known  | Valid                 | Invalid     |
|          | 19    | 0x00080000 | Position solution flag  | Valid                 | Invalid     |
| N5       | 20    | 0x00100000 | Position fixed flag, see <i>FIX</i> on page 115   | Not fixed             | Fixed       |
|          | 21    | 0x00200000 | Clock steering status   | Enabled               | Disabled    |
|          | 22    | 0x00400000 | Clock model flag  | Valid                 | Invalid     |
|          | 23    | 0x00800000 | OEMV card external oscillator flag  | Disabled              | Enabled     |

Continued on page 546.

Table 96: Receiver Status

| Nibble # | Bit #      | Mask       | Description                   | Bit = 0  | Bit = 1 |
|----------|------------|------------|-------------------------------|----------|---------|
| N6       | 24         | 0x01000000 | Software resource             | OK       | Warning |
|          | 25         | 0x02000000 | Reserved                      |          |         |
|          | 26         | 0x04000000 |                               |          |         |
|          | 27         | 0x08000000 |                               |          |         |
| 28       | 0x10000000 |            |                               |          |         |
| N7       | 29         | 0x20000000 | Auxiliary 3 status event flag | No event | Event   |
|          | 30         | 0x40000000 | Auxiliary 2 status event flag | No event | Event   |
|          | 31         | 0x80000000 | Auxiliary 1 status event flag | No event | Event   |
|          |            |            |                               |          |         |

- a. This flag is only available on OEMV-3 products (not on OEMV-1 or OEMV-2 where it is set to 0).
- b. This flag indicates if any of the three USB ports (USB1, USB2, or USB3) are overrun. See the auxiliary status word for the specific port for which the buffer is overrun.

**Table 97: Auxiliary 1 Status**

| Nibble # | Bit # | Mask       | Description              | Bit = 0    | Bit = 1       |
|----------|-------|------------|--------------------------|------------|---------------|
| N0       | 0     | 0x00000001 | Reserved                 |            |               |
|          | 1     | 0x00000002 |                          |            |               |
|          | 2     | 0x00000004 |                          |            |               |
|          | 3     | 0x00000008 | Position averaging       | Off        | On            |
| N1       | 4     | 0x00000010 | Reserved                 |            |               |
|          | 5     | 0x00000020 |                          |            |               |
|          | 6     | 0x00000040 |                          |            |               |
|          | 7     | 0x00000080 | USB connection status    | Connected  | Not connected |
| N2       | 8     | 0x00000100 | USB1 buffer overrun flag | No overrun | Overrun       |
|          | 9     | 0x00000200 | USB2 buffer overrun flag | No overrun | Overrun       |
|          | 10    | 0x00000400 | USB3 buffer overrun flag | No overrun | Overrun       |
|          | 11    | 0x00000800 | Reserved                 |            |               |

**Table 98: Auxiliary 2 Status**

| Nibble # | Bit # | Mask       | Description | Bit = 0 | Bit = 1 |
|----------|-------|------------|-------------|---------|---------|
| N0       | 0     | 0x00000001 | Reserved    |         |         |

**Table 99: Auxiliary 3 Status**

| Nibble # | Bit # | Mask       | Description | Bit = 0 | Bit = 1 |
|----------|-------|------------|-------------|---------|---------|
| N0       | 0     | 0x00000001 | Reserved    |         |         |

| Field # | Field type      | Data Description   | Format | Binary Bytes | Binary Offset |
|---------|-----------------|--|--------|--------------|---------------|
| 1       | RXSTATUS header | Log header   |        | H            | 0             |
| 2       | error           | Receiver error (see <i>Table 95, Receiver Error on page 544</i> ). A value of zero indicates no errors.  | ULong  | 4            | H             |
| 3       | # stats         | Number of status codes (including Receiver Status)   | ULong  | 4            | H+4           |
| 4       | rxstat          | Receiver status word (see <i>Table 96, Receiver Status on page 546</i> )                                 | ULong  | 4            | H+8           |
| 5       | rxstat pri      | Receiver status priority mask, which can be set using the STATUSCONFIG command ( <i>page 199</i> )       | ULong  | 4            | H+12          |
| 6       | rxstat set      | Receiver status event set mask, which can be set using the STATUSCONFIG command ( <i>page 199</i> )      | ULong  | 4            | H+16          |
| 7       | rxstat clear    | Receiver status event clear mask, which can be set using the STATUSCONFIG command ( <i>page 199</i> )    | ULong  | 4            | H+20          |
| 8       | aux1stat        | Auxiliary 1 status word (see <i>Table 97, Auxiliary 1 Status on page 548</i> )                           | ULong  | 4            | H+24          |
| 9       | aux1stat pri    | Auxiliary 1 status priority mask, which can be set using the STATUSCONFIG command ( <i>page 199</i> )    | ULong  | 4            | H+28          |
| 10      | aux1stat set    | Auxiliary 1 status event set mask, which can be set using the STATUSCONFIG command ( <i>page 199</i> )   | ULong  | 4            | H+32          |
| 11      | aux1stat clear  | Auxiliary 1 status event clear mask, which can be set using the STATUSCONFIG command ( <i>page 199</i> ) | ULong  | 4            | H+36          |
| 12      | aux2stat        | Auxiliary 2 status word (see <i>Table 98, Auxiliary 2 Status on page 548</i> )                           | ULong  | 4            | H+40          |
| 13      | aux2stat pri    | Auxiliary 2 status priority mask, which can be set using the STATUSCONFIG command ( <i>page 199</i> )    | ULong  | 4            | H+44          |
| 14      | aux2stat set    | Auxiliary 2 status event set mask, which can be set using the STATUSCONFIG command                       | ULong  | 4            | H+48          |
| 15      | aux2stat clear  | Auxiliary 2 status event clear mask, which can be set using the STATUSCONFIG command                     | ULong  | 4            | H+52          |

Continued on page 550.

| Field #  | Field type                                       | Data Description   | Format | Binary Bytes | Binary Offset     |
|----------|--|--|--------|--------------|-------------------|
| 16       | aux3stat   | Auxiliary 3 status word (see <i>Table 99, Auxiliary 3 Status</i> on page 548)                            | ULong  | 4            | H+56              |
| 17       | aux3stat pri                                     | Auxiliary 3 status priority mask, which can be set using the STATUSCONFIG command (see <i>page 199</i> ) | ULong  | 4            | H+60              |
| 18       | aux3stat set                                     | Auxiliary 3 status event set mask, which can be set using the STATUSCONFIG command                       | ULong  | 4            | H+64              |
| 19       | aux3stat clear                                   | Auxiliary 3 status event clear mask, which can be set using the STATUSCONFIG command                     | ULong  | 4            | H+68              |
| 20...    | Next status code offset = H + 8 + (# stats x 16) |  |        |              |                   |
| variable | xxxx   | 32-bit CRC (ASCII and Binary only)   | Hex    | 4            | H+8+(#stats x 64) |
| variable | [CR][LF]   | Sentence terminator (ASCII only)   | -      | -            | -                 |

### 3.3.127 RXSTATUSEVENT Status Event Indicator V123

This log is used to output event messages as indicated in the RXSTATUS log. An event message is automatically generated for all receiver errors, which are indicated in the receiver error word. In addition, event messages can be generated when other conditions, which are indicated in the receiver status and auxiliary status words, are met. Whether or not an event message is generated under these conditions is specified using the STATUSCONFIG command, which is detailed starting on *page 199*.

On start-up, the receiver is set to log the RXSTATUSEVENTA log ONNEW on all ports. You can remove this message by using the UNLOG command, see *page 208*.

---

☒ See also the chapter on *Built-In Status Tests* in the *OEMV Family Installation and Operation User Manual*.

---

**Message ID:** 94

**Log Type:** Asynch

#### Recommended Input:

log rxstatuseventa onchanged

#### ASCII Example 1:

```
#RXSTATUSEVENTA,COM1,0,17.0,FREEWHEELING,1337,408334.510,00480000,b967,1984;
STATUS,19,SET,"No Valid Position Calculated"*6de945ad
```

#### ASCII Example 2:

```
#RXSTATUSEVENTA,COM1,0,41.0,FINESTEERING,1337,408832.031,01000400,b967,1984;
STATUS,10,SET,"COM3 Transmit Buffer Overrun"*5b5682a9
```



When a fatal event occurs (for example, in the event of a receiver hardware failure), a bit is set in the receiver error word, part of the RXSTATUS log on *page 541*, to indicate the cause of the problem. Bit 0 is set in the receiver status word to show that an error occurred, the error strobe is driven high, and the LED flashes red and yellow showing an error code. An RXSTATUSEVENT log is generated on all ports to show the cause of the error. Receiver tracking is disabled at this point but command and log processing continues to allow you to diagnose the error. Even if the source of the error is corrected at this point, the receiver must be reset to resume normal operation.

---

**Table 100: Status Word**

| Word (binary) | Word (ASCII) | Description  |
|---------------|--------------|--|
| 0             | ERROR        | Receiver Error word, see <i>Table</i> on page 543        |
| 1             | STATUS       | Receiver Status word, see <i>Table</i> on page 543       |
| 2             | AUX1         | Auxiliary 1 Status word, see <i>Table 97</i> on page 548 |
| 3             | AUX2         | Auxiliary 2 Status word see <i>Table 98</i> on page 548  |
| 4             | AUX3         | Auxiliary 3 Status word see <i>Table 99</i> on page 548  |

**Table 101: Event Type**

| Event (binary) | Event (ASCII) | Description     |
|----------------|---------------|-----------------|
| 0              | CLEAR         | Bit was cleared |
| 1              | SET           | Bit was set     |

| Field # | Field type           | Data Description  | Format   | Binary Bytes | Binary Offset |
|---------|----------------------|---|----------|--------------|---------------|
| 1       | RXSTATUSEVENT header | Log header  |          | H            | 0             |
| 2       | word                 | The status word that generated the event message (see <i>Table 100</i> , above)   | Enum     | 4            | H             |
| 3       | bit position         | Location of the bit in the status word (see <i>Table 96</i> , <i>Receiver Status</i> on page 546 or the <i>Auxiliary Status</i> tables on page 548) | Ulong    | 4            | H+4           |
| 4       | event                | Event type (see <i>Table 101</i> above)   | Enum     | 4            | H+8           |
| 3       | description          | This is a text description of the event or error  | Char[32] | 32           | H+12          |
| 5       | xxxx                 | 32-bit CRC (ASCII and Binary only)  | Hex      | 4            | H+44          |
| 6       | [CR][LF]             | Sentence terminator (ASCII only)  | -        | -            | -             |



### 3.3.128 SATVIS *Satellite Visibility* V123

Satellite visibility log with additional satellite information.

- 
- ✉ 1. The SATVIS log is meant to provide a brief overview. The satellite positions and velocities used in the computation of this log are based on Almanac orbital parameters, not the higher precision Ephemeris parameters.
  - 2. In the SATVIS log output there may be double satellite number entries. These are GLONASS antipodal satellites that are in the same orbit plane separated by 180 degrees latitude. Refer also to the *GLONASS* chapter of the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm>.
- 

**Message ID:** 48

**Log Type:** Synch

**Recommended Input:**

log satvisa ontime 60

**ASCII Example:**

```
#SATVISA, COM1, 0, 46.5, FINESTEERING, 1363, 238448.000, 00000000, 0947, 2277;
TRUE, TRUE, 61,
7, 0, 0, 86.1, 77.4, -69.495, -69.230,
2, 0, 0, 66.3, 70.7, -1215.777, -1215.512,
58, 7, 1, 64.7, 324.5, 1282.673, 1282.939,
58, 12, 0, 64.7, 324.5, 1283.808, 1284.074,
30, 0, 0, 60.8, 267.7, 299.433, 299.699,
5, 0, 0, 58.1, 205.5, -1783.823, -1783.557,
42, 7, 1, 53.0, 79.0, 17.034, 17.300,
42, 9, 1, 53.0, 79.0, 20.108, 20.373,
...
19, 0, 0, -86.8, 219.3, 88.108, 88.373*a0b7cc0b
```



Consider sky visibility at each of the base and rover receivers in a differential setup.

The accuracy and reliability of differential messages is proportional to the number of common satellites that are visible at the base and rover. Therefore, if the sky visibility at either station is poor, you might consider increasing the occupation times. This condition is best measured by monitoring the number of visible satellites during data collection along with the PDOP value (a value less than 3 is ideal). Also, the location and number of satellites in the sky is constantly changing. As a result, some periods in the day are slightly better for data collection than others. Use the SATVIS log to monitor satellite visibility. The PSRDOP log, see *page 383*, can be used to monitor the PDOP values.

Site conditions surrounding the station that may affect satellite visibility and can generate noise in the data are water bodies, buildings, trees and nearby vehicles.

| Field #  | Field type                                   | Data Description   | Format | Binary Bytes | Binary Offset        |
|----------|--|--|--------|--------------|----------------------|
| 1        | SATVIS header                                | Log header   |        | H            | 0                    |
| 2        | sat vis                                      | Is satellite visibility valid?<br>0 = FALSE<br>1 = TRUE  | Enum   | 4            | H                    |
| 3        | comp alm                                     | Was complete GPS almanac used?<br>0 = FALSE<br>1 = TRUE  | Enum   | 4            | H+4                  |
| 4        | #sat   | Number of satellites with data to follow   | Ulong  | 4            | H+8                  |
| 5        | PRN/slot                                     | Satellite PRN number of range measurement (GPS: 1-32 and SBAS: 120 to 138. For GLONASS, see <i>Section 1.3</i> on <i>page 30</i> )   | Short  | 2            | H+12                 |
| 6        | glofreq                                      | (GLONASS Frequency + 7), see <i>Section 1.3</i> on <i>page 30</i>  | Short  | 2            | H+14                 |
| 7        | health                                       | Satellite health <sup>a</sup>  | Ulong  | 4            | H+16                 |
| 8        | elev   | Elevation (degrees)  | Double | 8            | H+20                 |
| 9        | az   | Azimuth (degrees)  | Double | 8            | H+28                 |
| 10       | true dop                                     | Theoretical Doppler of satellite - the expected Doppler frequency based on a satellite's motion relative to the receiver. It is computed using the satellite's coordinates and velocity, and the receiver's coordinates and velocity. (Hz) | Double | 8            | H+36                 |
| 11       | app dop                                      | Apparent Doppler for this receiver - the same as Theoretical Doppler above but with clock drift correction added. (Hz)   | Double | 8            | H+44                 |
| 12       | Next satellite offset = H + 12 + (#sat x 40) |  |        |              |                      |
| variable | xxxx   | 32-bit CRC (ASCII and Binary only)   | Hex    | 4            | H+12+<br>(#sat x 40) |
| variable | [CR][LF]                                     | Sentence terminator (ASCII only)   | -      | -            | -                    |

- a. Satellite health values may be found in ICD-GPS-200. To obtain copies of ICD-GPS-200, refer to ARINC in the *Standards and References* section of the *GNSS Reference Book*, available on our Web site at <http://www.novatel.com/support/docupdates.htm>.

### 3.3.129 SATXYZ SV Position in ECEF Cartesian Coordinates V123

When combined with a RANGE log, this data set contains the decoded satellite information necessary to compute the solution: satellite coordinates (ECEF WGS84), satellite clock correction, ionospheric corrections and tropospheric corrections. See the calculation examples in the usage box below. Only those satellites that are healthy are reported here. See also *Figure 10* on page 261.

**Message ID:** 270

**Log Type:** Synch

**Recommended Input:**

log satxyz ontime 1

**ASCII Example:**

```
#SATXYZA,COM1,0,45.5,FINESTEERING,1337,409729.000,00000000,6f3c,1984;0.0,11,
1,8291339.5258,-17434409.5059,18408253.4923,1527.199,2.608578998,
3.200779818,0.000000000,0.000000000,
...
14,18951320.4329,-16297117.6697,8978403.7764,-8190.088,4.139015349,
10.937283220,0.000000000,0.000000000*8a943244
```



The OEMV family use positive numbers for ionospheric and tropospheric corrections.

A positive clock offset indicates that the clock is running ahead of the reference time. Positive ionospheric and tropospheric corrections are added to the geometric ranges or subtracted from the measured pseudoranges. For example:

$$P = p + pd + c(dt - dt) + d(\text{ion}) + d(\text{trop}) + E_p$$

is equivalent to

$$P - c(dt - dt) - d(\text{ion}) - d(\text{trop}) = p + pd + E_p$$

where

P = measured pseudorange

p = geometric range

pd = orbit error

dt = satellite clock offset

dT = receiver clock offset

d(ion) = ionospheric delay

d(trop) = tropospheric delay

c = speed of light

$E_p$  = noise and multipath.

| Field #  | Field type                                   | Data Description  | Format | Binary Bytes | Binary Offset        |
|----------|--|---|--------|--------------|----------------------|
| 1        | SATXYZ header                                | Log header  |        | H            | 0                    |
| 2        | Reserved                                     |   | Double | 8            | H                    |
| 3        | #sat   | Number of satellites with Cartesian information to follow   | Ulong  | 4            | H+8                  |
| 4        | PRN/slot                                     | Satellite PRN number of range measurement (GPS: 1-32 and SBAS: 120 to 138. For GLONASS, see <i>Section 1.3</i> on <i>page 30</i> .) | Ulong  | 4            | H+12                 |
| 5        | x  | Satellite X coordinates (ECEF, m)   | Double | 8            | H+16                 |
| 6        | y  | Satellite Y coordinates (ECEF, m)   | Double | 8            | H+24                 |
| 7        | z  | Satellite Z coordinates (ECEF, m)   | Double | 8            | H+32                 |
| 8        | clk corr                                     | Satellite clock correction (m)  | Double | 8            | H+40                 |
| 9        | ion corr                                     | Ionospheric correction (m)  | Double | 8            | H+48                 |
| 10       | trop corr                                    | Tropospheric correction (m)   | Double | 8            | H+56                 |
| 11       | Reserved                                     |   | Double | 8            | H+64                 |
| 12       |  |   | Double | 8            | H+72                 |
| 13       | Next satellite offset = H + 12 + (#sat x 68) |   |        |              |                      |
| variable | xxxx   | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+12+<br>(#sat x 68) |
| variable | [CR][LF]                                     | Sentence terminator (ASCII only)  | -      | -            | -                    |

### 3.3.130 TIME Time Data V123

This log provides several time related pieces of information including receiver clock offset and UTC time and offset. It can also be used to determine any offset in the PPS signal relative to GPS time.

To find any offset in the PPS signal, log the TIME log 'ontime' at the same rate as the PPS output. For example, if the PPS output is configured to output at a rate of 0.5 seconds, see the PPSCONTROL command on *page 164*, log the TIME log 'ontime 0.5' as follows:

```
log time ontime 0.5
```

The TIME log offset field can then be used to determine any offset in PPS output relative to GPS time.

**Message ID:** 101  
**Log Type:** Synch

**Recommended Input:**

```
log timea ontime 1
```

**ASCII Example:**

```
#TIMEA, COM1, 0, 50.5, FINESTEERING, 1337, 410010.000, 00000000, 9924, 1984;  
VALID, 1.953377165e-09, 7.481712815e-08, -12.99999999492, 2005, 8, 25, 17,  
53, 17000, VALID*e2fc088c
```



Consider the case where you used the ADJUST1PPS command, see *page 56*, to synchronize two receivers in a primary/secondary relationship to a common external clock. You can use the TIME log after the clock model has stabilized at state 0, to monitor the time difference between the Primary and Secondary receivers.



The header of the TIME log gives you the GPS time (the week number since January 5th, 1980) and the seconds into that week. The TIME log outputs the UTC offset (offset of GPS time from UTC time) and the receiver clock offset from GPS time.

If you want the UTC time in weeks and seconds, take the week number from the header. Then take the seconds into that week, also from the header, and add the correction to the seconds using the 2 offsets. Ensure you take care of going negative or rollover (going over the total number of seconds, 604800, in a week. In the case of rollover, add a week and the left over seconds become the seconds into this new week. If negative, subtract a week and the remainder from the seconds of that week.

For example:

```
TIME COM1 0 73.5 FINESTEERING 1432 235661.000 00000000 9924 2616  
VALID -0.000000351 0.000000214 -14.00000000106 2007 6 19 17 27 27000 VALID
```

From the time information above:

GPS time = 1432 (GPS week), 235661.000 (GPS seconds) from the header.

From the UTC offset row in the TIME log description on *page 558*:

UTC time = GPS time + offset + UTC offset

UTC time

= week 1432, 235661.000 s - 0.000000351 (offset) - 14.00000000106 (UTC offset)

= week 1432, seconds 235646.99999964794

| Field # | Field type   | Data Description  | Format | Binary Bytes | Binary Offset |
|---------|--------------|---|--------|--------------|---------------|
| 1       | TIME header  | Log header  |        | H            | 0             |
| 2       | clock status | Clock model status (not including current measurement data), see <i>Table 54 on page 265</i>  | Enum   | 4            | H             |
| 3       | offset       | Receiver clock offset, in seconds from GPS time. A positive offset implies that the receiver clock is ahead of GPS time. To derive GPS time, use the following formula: GPS time = receiver time - offset | Double | 8            | H+4           |
| 4       | offset std   | Receiver clock offset standard deviation.   | Double | 8            | H+12          |
| 5       | utc offset   | The offset of GPS time from UTC time, computed using almanac parameters. UTC time is GPS time plus the current UTC offset plus the receiver clock offset: UTC time = GPS time + offset + UTC offset       | Double | 8            | H+20          |
| 6       | utc year     | UTC year  | Ulong  | 4            | H+28          |
| 7       | utc month    | UTC month (0-12) <sup>a</sup>   | Uchar  | 1            | H+32          |
| 8       | utc day      | UTC day (0-31) <sup>a</sup>   | Uchar  | 1            | H+33          |
| 9       | utc hour     | UTC hour (0-23)   | Uchar  | 1            | H+34          |
| 10      | utc min      | UTC minute (0-59)   | Uchar  | 1            | H+35          |
| 11      | utc ms       | UTC millisecond (0-60999) <sup>b</sup>  | Ulong  | 4            | H+36          |
| 12      | utc status   | UTC status<br>0 = Invalid<br>1 = Valid<br>2 = Warning <sup>c</sup>  | Enum   | 4            | H+40          |
| 13      | xxxx         | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+44          |
| 14      | [CR][LF]     | Sentence terminator (ASCII only)  | -      | -            | -             |

a. If UTC time is unknown, the values for month and day are 0.

b. Maximum of 60999 when leap second is applied.

c. Indicates that the leap seconds value is used as a default due to the lack of an almanac.

### 3.3.131 TIMESYNC Synchronize Time Between GPS Receivers V123

The TIMESYNC log is used in conjunction with the ADJUST1PPS command, see *page 56*, to synchronize the time between GPS receivers.

Refer also to the *Transfer Time Between Receivers* section in the *OEMV Family Installation and Operation User Manual*.

**Message ID:** 492  
**Log Type:** Synch

#### Recommended Input:

```
log timesynca ontime 1
```

#### ASCII Example:

```
#TIMESYNCA,COM1,0,46.0,FINESTEERING,1337,410095.000,00000000,bd3f,1984;  
1337,410095000,FINESTEERING*aa2025db
```



The time data embedded in this log represents the time of the most recent 1PPS signal. This log should be issued from a communications port within 200 ms, of the last 1PPS event. See *Figure 1, 1PPS Alignment* on *page 57* for an illustration.

| Field # | Field type      | Data Description   | Format | Binary Bytes | Binary Offset |
|---------|-----------------|--|--------|--------------|---------------|
| 1       | TIMESYNC header | Log header   |        | H            | 0             |
| 2       | week            | GPS week number  | Ulong  | 4            | H             |
| 3       | ms              | Number of milliseconds into the GPS week                               | Ulong  | 4            | H+4           |
| 4       | time status     | GPS Time Status, see <i>Table 8, GPS Time Status</i> on <i>page 31</i> | Enum   | 4            | H+8           |
| 5       | xxxx            | 32-bit CRC (ASCII and Binary only)                                     | Hex    | 4            | H+12          |
| 6       | [CR][LF]        | Sentence terminator (ASCII only)                                       | -      | -            | -             |

### 3.3.132 TRACKSTAT Tracking Status V123

This log provides channel tracking status information for each of the receiver parallel channels.

If both the L1 and L2 signals are being tracked for a given PRN, two entries with the same PRN appear in the tracking status log. As shown in *Table 72, Channel Tracking Status on page 395* these entries can be differentiated by bit 20, which is set if there are multiple observables for a given PRN, and bits 21-22, which denote whether the observation is for L1 or L2. This is to aid in parsing the data.

**Message ID:** 83  
**Log Type:** Synch

#### Recommended Input:

log trackstata ontime 1

#### ASCII Example:

```
#TRACKSTATA,COM1,0,49.5,FINESTEERING,1337,410139.000,00000000,457c,1984;
SOL_COMPUTED,PSRDIFF,5.0,30,
1,0,18109c04,21836080.582,-2241.711,50.087,1158.652,0.722,GOOD,0.973,
1,0,11309c0b,21836083.168,-1746.788,42.616,1141.780,0.000,OBSL2,0.000,
30,0,18109c24,24248449.644,-2588.133,45.237,939.380,-0.493,GOOD,0.519,
30,0,11309c2b,24248452.842,-2016.730,38.934,939.370,0.000,OBSL2,0.000,
...
14,0,18109da4,24747286.206,-3236.906,46.650,1121.760,-0.609,GOOD,0.514,
14,0,11309dab,24747288.764,-2522.270,35.557,1116.380,0.000,OBSL2,0.000,
0,0,0c0221c0,0.000,0.000,0.047,0.000,0.000,NA,0.000,
0,0,0c0221e0,0.000,0.000,0.047,0.000,0.000,NA,0.000*255a732e
```



The OEMV-3 with L-band and HP/XP requires the following minimum number of satellites for the following operations:

- single point = 4 GPS satellites
- RTK, including HP/XP = 5 GPS satellites

Extra satellites provide additional redundancy, which is good to have. Note that the default cut-off angle is 5 degrees, and single point positioning utilizes all available GPS satellites in the position solution.

RTK solutions, including HP/XP, only use GPS satellites that are above the RTK elevation angle, (usually 12.5 degrees). So, although there could be more than 5 GPS satellites in view, if there are not at least 5 GPS satellites above 12.5 degrees then an RTK solution may not be possible.



Table 102: Range Reject Code

| Reject Code (binary) | Reject Code (ASCII) | Description  |
|----------------------|---------------------|--|
| 0                    | GOOD                | Observation is good  |
| 1                    | BADHEALTH           | Bad satellite health is indicated by ephemeris data                                  |
| 2                    | OLDEPHEMERIS        | Old ephemeris due not being updated during the last 3 hours                          |
| 3                    | ECCENTRICANOMALY    | Eccentric anomaly error during computation of the satellite's position               |
| 4                    | TRUEANOMALY         | True anomaly error during computation of the satellite's position                    |
| 5                    | SATCOORDINATE-ERROR | Satellite coordinate error during computation of the satellite's position            |
| 6                    | ELEVATIONERROR      | Elevation error due to the satellite being below the cut-off angle                   |
| 7                    | MISCLOSURE          | Misclosure too large due to excessive gap between estimated and actual positions     |
| 8                    | NODIFFCORR          | No compatible differential correction is available for this particular satellite     |
| 9                    | NOEPHEMERIS         | Ephemeris data for this satellite has not yet been received                          |
| 10                   | INVALIDIODE         | Invalid IODE (Issue Of Data Ephemeris) due to mismatch between differential stations |
| 11                   | LOCKEDOUT           | Locked out: satellite is excluded by the user (LOCKOUT command)                      |
| 12                   | LOWPOWER            | Low power: satellite is rejected due to low carrier/noise ratio                      |
| 13                   | OBSL2               | L2 observation is ignored and not used in the pseudorange solution                   |
| 16                   | NOIONOCORR          | No compatible ionospheric correction is available for this particular satellite      |
| 17                   | NOTUSED             | Observation is ignored and not used in the solution                                  |
| 99                   | NA                  | No observation (a reject code is not applicable)                                     |
| 100                  | BAD_INTEGRITY       | The integrity of the pseudorange is bad  |

| Field #  | Field Type                               | Data Description  | Format | Binary Bytes | Binary Offset             |
|----------|--|---|--------|--------------|---------------------------|
| 1        | TRACKSTAT header                         | Log header  |        | H            | 0                         |
| 2        | sol status                               | Solution status (see <i>Table 51, Solution Status on page 249</i> )   | Enum   | 4            | H                         |
| 3        | pos type                                 | Position type (see <i>Table 50, Position or Velocity Type on page 248</i> )   | Enum   | 4            | H+4                       |
| 4        | cutoff                                   | Tracking elevation cut-off angle  | Float  | 4            | H+8                       |
| 5        | # chans                                  | Number of hardware channels with information to follow  | Long   | 4            | H+12                      |
| 6        | PRN/slot                                 | Satellite PRN number of range measurement (GPS: 1-32 and SBAS: 120 to 138. For GLONASS, see <i>Section 1.3 on page 30</i> )   | Short  | 2            | H+16                      |
| 7        | glfreq                                   | (GLONASS Frequency + 7), see <i>Section 1.3 on page 30</i>  | Short  | 2            | H+18                      |
| 8        | ch-tr-status                             | Channel tracking status (see <i>Table 72, Channel Tracking Status on page 395</i> )   | ULong  | 4            | H+20                      |
| 9        | psr                                      | Pseudorange (m) - if this field is zero but the channel tracking status in the previous field indicates that the card is phase locked and code locked, the pseudorange has not been calculated yet. | Double | 8            | H+24                      |
| 10       | Doppler                                  | Doppler frequency (Hz)  | Float  | 4            | H+32                      |
| 11       | C/No                                     | Carrier to noise density ratio (dB-Hz)  | Float  | 4            | H+36                      |
| 12       | locktime                                 | Number of seconds of continuous tracking (no cycle slips)   | Float  | 4            | H+40                      |
| 13       | psr res                                  | Pseudorange residual from pseudorange filter (m)  | Float  | 4            | H+44                      |
| 14       | reject                                   | Range reject code from pseudorange filter (see <i>Table 102, Range Reject Code on page 561</i> )  | Enum   | 4            | H+48                      |
| 15       | psr weight                               | Pseudorange filter weighting  | Float  | 4            | H+52                      |
| 16...    | Next PRN offset = H + 16 + (#chans x 40) |   |        |              |                           |
| variable | xxxx                                     | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+16+<br>(#chans<br>x 40) |
| variable | [CR][LF]                                 | Sentence terminator (ASCII only)  | -      | -            | -                         |

### 3.3.133 VALIDMODELS Valid Model Information V123

This log gives a list of valid authorized models available and expiry date information.

If a model has no expiry date it reports the year, month and day fields as 0, 0 and 0 respectively.

**Message ID:** 206  
**Log Type:** Polled

#### Recommended Input:

log validmodelsa once

#### ASCII Example:

```
#VALIDMODELSA,COM1,0,54.0,FINESTEERING,1337,414753.310,00000000,342f,1984;
1,"ME3",0,0,0*16c0b1a3
```



Use the VALIDMODELS log to output a list of available models for the receiver. You can use the AUTH command, see [page 74](#), to add a model and the MODEL command, see [page 153](#), to change the currently active model. See the VERSION log on [page 564](#) for the currently active model.

| Field #  | Field type  | Data Description                            | Format           | Binary Bytes          | Binary Offset       |
|----------|---|---|------------------|-----------------------|---------------------|
| 1        | VALIDMODELS header                                      | Log header                                  |                  | H                     | 0                   |
| 2        | #mod  | Number of models with information to follow | Ulong            | 4                     | H                   |
| 3        | model   | Model name                                  | String [max. 16] | Variable <sup>a</sup> | Variable            |
| 4        | expyear   | Expiry year                                 | Ulong            | 4                     | Variable Max: H+20  |
| 5        | expmonth  | Expiry month                                | Ulong            | 4                     | Variable Max: H+24  |
| 6        | expday  | Expiry day                                  | Ulong            | 4                     | Variable: Max: H+28 |
| 7...     | Next model offset = H + 4 + (#mods x variable [max:28]) |   |                  |                       |                     |
| variable | xxxx  | 32-bit CRC (ASCII and Binary only)          | Hex              | 4                     | Variable            |
| variable | [CR][LF]  | Sentence terminator (ASCII only)            | -                | -                     | -                   |

a. In the binary log case, additional bytes of padding are added to maintain 4-byte alignment

### 3.3.134 VERSION Version Information V123

This log contains the version information for all components of a system. When using a standard receiver, there is only one component in the log.

A component may be hardware (for example, a receiver or data collector) or firmware in the form of applications or data (for example, data blocks for height models or user applications). See *Table 105, VERSION Log: Field Formats* on page 566 for details on the format of key fields.

See also the VALIDMODELS log on page 563.

**Message ID:** 37  
**Log Type:** Polled

#### Recommended Input:

log versiona once

#### ASCII Example:

```
#VERSIONA,COM1,0,71.5,FINESTEERING,1362,340308.478,00000008,3681,2291;
1,GPSCARD,"L12RV","DZZ06040010","OEMV2G-2.00-2T","3.000A19","3.000A9",
"2006/Feb/ 9","17:14:33"*5e8df6e0
```

- 
- ☒ 1. Unlike the OEM4 family, there is no need for an extra OmniSTAR Interface Board (I-Board) on L-band capable OEMV receivers. If you have an OmniSTAR subscription and the receiver is tracking an OmniSTAR satellite, the OmniSTAR serial number can be found in the LBANDINFO log, see *page 341*.
  - 2. Model Z is not available with K or R models, see *Table 103* on page 565.
- 



The VERSION log is a useful log as a first communication with your receiver. Once connected, using CDU or HyperTerminal, log VERSION and check that the output makes sense. Also, ensure that you have the receiver components you expected.

---

### 50 Hz Output Rate for GPS-only F Models

The 50 Hz feature allows the receiver to support a 50 Hz output rate on OEM-V1/V1G/V2/V3-based products. It also introduces the F model option.

This feature increases the CPU speed to 400 MHz for the newer hardware versions of OEM-V1/V1G/V2-based receivers, see *Table 106* on page 566. The CPU speed for OEM-V3-based receivers is still 400 MHz.

- 
- ☒ The periods available when you use the ONTIME trigger are 0.02 (50 Hz), 0.05, 0.1, 0.2, 0.25, 0.5, 1, 2, 3, 5, 10, 15, 20, 30, 60 seconds.
-



Figure 13: 50 Hz Logging Example in CDU

Table 103: Model Designators

| Designator | Description  |
|------------|--|
| G          | 12 L1 or 12 L1/L2 GLONASS channels, frequencies to match GPS configuration   |
| R          | Receive RT2 and/or RT20 corrections  |
| I          | Synchronized Position Attitude Navigation (SPAN)   |
| J          | SPAN supporting 200 Hz IMUs and IGI higher rate IMU (256.144 Hz)   |
| S          | Reduces positions and measurement rates to 5 Hz, disables VARF and EVENT signals   |
| A          | Application Program Interface (API)  |
| B          | 1 L-band channel with CDGPS and OmniSTAR VBS capability  |
| L          | 1 L-band channel with CDGPS and OmniSTAR HP/XP capability  |
| NL         | 1 L-band channel with OmniSTAR enabled and no position, velocity, time (PVT) or raw data output  |
| F          | 50 Hz output   |
| Z          | <b>ALIGN:</b> This heading feature generates separation and bearing data between a base and one or multiple rovers.  |
| K          | Receiver RT2 <b>LITE:</b> The L1 GG RTK feature is a fixed integer GPS+GLONASS L1-only RTK solution that works with RTCAOBS and RTCAOBS2 correction types. Centimeter-level (RT2 <b>LITE</b> ) accuracy is possible with fix times in the order of 60 s, depending on visibility, number of satellites, and so on. Since it is an L1-only solution, the operational baseline is limited to 3 km to minimize ionospheric errors. Outside of the baseline threshold (3 km), the receiver outputs RT20 instead. |

**Table 104: Component Types**

| Binary                 | ASCII          | Description                             |
|------------------------|----------------|---|
| 0                      | UNKNOWN        | Unknown component                       |
| 1                      | GPSCARD        | OEMV family component                   |
| 2                      | CONTROLLER     | Data collector                          |
| 3                      | ENCLOSURE      | OEM card enclosure                      |
| 4-6                    | Reserved       |   |
| 7                      | IMUCARD        | IMU card                                |
| 981073920 (0x3A7A0000) | DB_HEIGHTMODEL | Height/track model data                 |
| 981073921 (0x3A7A0001) | DB_USERAPP     | User application firmware               |
| 981073925 (0x3A7A0005) | DB_USERAPPAUTO | Auto-starting user application firmware |

- a. Please refer to the Acronyms section of the *GNSS Reference Book*, available from our Web site at <http://www.novatel.com/support/docupdates.htm>.

**Table 105: VERSION Log: Field Formats**

| Field Type                     | Field Format (ASCII) | Description  |
|--------------------------------|----------------------|--|
| hw version                     | P-RS-CCC             | P = hardware platform (for example, OEMV)<br>R = hardware revision (for example, 3.00)<br>S = processor revision (for example, A) <sup>a</sup><br>CCC = COM port configuration (for example, 22T) <sup>b</sup> |
| sw version,<br>boot<br>version | VV.RRR[Xxxx]         | VV = major revision number<br>RRR = minor revision number<br>X = Special (S), Beta (B), Internal Development (D, A)<br>xxx = number  |
| comp date                      | YYYY/MM/DD           | YYYY = year<br>MM = month<br>DD = day (1 - 31)   |
| comp time                      | HH:MM:SS             | HH = hour<br>MM = minutes<br>SS = seconds  |

- a. This field may be empty if the revision is not stamped onto the processor
- b. One character for each of the COM ports 1, 2, and 3. Characters are: 2 for RS-232, 4 for RS-422, T for LV-TTL, and X for user-selectable (valid for COM1 of the OEMV-2 only). Therefore, the example is for a receiver that uses RS-232 for COM 1 and COM 2 and LV-TTL for COM 3.

**Table 106: 50 Hz-Capable Hardware Versions**

| Receiver      | Version           |
|---------------|-------------------|
| OEM-V1-based  | Rev 3.01 or later |
| OEM-V1G-based | Rev 1.01 or later |
| OEM-V2-based  | Rev 3.01 or later |
| OEMV-3-based  | All               |

| Field #  | Field type                                    | Data Description   | Format   | Binary Bytes | Binary Offset      |
|----------|---|--|----------|--------------|--------------------|
| 1        | VERSION header                                | Log header   |          | H            | 0                  |
| 2        | # comp  | Number of components (cards, and so on)  | Long     | 4            | H                  |
| 3        | type  | Component type (see <i>Table 104, Component Types</i> on page 566)   | Enum     | 4            | H+4                |
| 4        | model   | A base model name plus designators where there are 4 possible base names:<br>L12: 20 Hz positions and measurements, RT2/20 base, 14 GPS L1/L2 and 2 SBAS channels<br>L1: 20 Hz positions and measurements, RT20 base, 14 GPS L1 and 2 SBAS channels<br>N12: 20 Hz positions, no measurements, 14 GPS L1/L2 and 2 SBAS channels<br>N1: 20 Hz positions, no measurements, 14 GPS L1 and 2 SBAS channels<br>The model designators are shown in <i>Table 103</i> on Page 565 | Char[16] | 16           | H+8                |
| 5        | psn   | Product serial number  | Char[16] | 16           | H+24               |
| 6        | hw version                                    | Hardware version, see <i>Table 105, VERSION Log: Field Formats</i> on page 566   | Char[16] | 16           | H+40               |
| 7        | sw version                                    | Firmware software version, see <i>Table 105</i>  | Char[16] | 16           | H+56               |
| 8        | boot version                                  | Boot code version, see <i>Table 105</i>  | Char[16] | 16           | H+72               |
| 9        | comp date                                     | Firmware compile date, see <i>Table 105</i>  | Char[12] | 12           | H+88               |
| 10       | comp time                                     | Firmware compile time, see <i>Table 105</i>  | Char[12] | 12           | H+100              |
| 11...    | Next component offset = H + 4 + (#comp x 108) |  |          |              |                    |
| variable | xxxx  | 32-bit CRC (ASCII and Binary only)   | Hex      | 4            | H+4+ (#comp x 108) |
| variable | [CR][LF]                                      | Sentence terminator (ASCII only)   | -        | -            | -                  |

### 3.3.135 WAAS0 Remove PRN from Solution V123\_SBAS

This message tells you, when you are using SBAS messages, not to use a specific PRN message for a period of time outlined in the SBAS signal specification.

See how the WAAS0 message relates to the SBAS testing modes in the SBASCONTROL command on *page 182*.

**Message ID:** 290  
**Log Type:** Asynch

#### Recommended Input:

log WAAS0a onchanged

#### ASCII Example:

```
#WAAS0A, COM1, 0, 68.5, SATTIME, 1093, 161299.000, 00040020, 7d6a, 209;122*e9a5ab08
```



Although the WAAS was designed for aviation users, it supports a wide variety of non-aviation uses including agriculture, surveying, recreation, and surface transportation, just to name a few. The WAAS signal has been available for non safety-of-life applications since August 24, 2000. Today, there are many non-aviation WAAS-enabled GPS receivers in use.

| Field # | Field type   | Data Description                         | Format | Binary Bytes | Binary Offset |
|---------|--------------|--|--------|--------------|---------------|
| 1       | WAAS0 header | Log header                               |        | H            | 0             |
| 2       | prn          | Source PRN message - also PRN not to use | Ulong  | 4            | H             |
| 3       | xxxx         | 32-bit CRC (ASCII and Binary only)       | Hex    | 4            | H+4           |
| 4       | [CR][LF]     | Sentence terminator (ASCII only)         | -      | -            | -             |



### 3.3.136 WAAS1 PRN Mask Assignments V123\_SBAS

The PRN mask is given in WAAS1. The transition of the PRN mask to a new one (which will be infrequent) is controlled with the 2-bit IODP, which sequences to a number between 0 and 3. The same IODP appears in the applicable WAAS2, WAAS3, WAAS4, WAAS5, WAAS7, WAAS24 and WAAS25 messages (WAAS32, WAAS33, WAAS34, WAAS35 and WAAS45 for CDGPS). This transition would probably only occur when a new satellite is launched or when a satellite fails and is taken out of service permanently. A degraded satellite may be flagged as a don't use satellite temporarily.

**Message ID:** 291

**Log Type:** Asynch

**Recommended Input:**

log WAAS1a onchanged

**ASCII Example:**

```
#WAAS1A, COM1, 0, 24.5, SATTIME, 1337, 415802.000, 00000000, 5955, 1984;
134, ffeffffe000000000000000000000000004004000000000000000000, 2*3633cf7b
```



Each raw WAAS frame gives data for a specific frame decoder number. The WAAS1 message can be logged to view the data breakdown of WAAS frame 1 which contains information on the PRN mask assignment.

| Field # | Field type | Data Description                   | Format    | Binary Bytes    | Binary Offset |
|---------|------------|------------------------------------|-----------|-----------------|---------------|
| 1       | header     | Log header                         |           | H               | 0             |
| 2       | prn        | Source PRN of message              | Ulong     | 4               | H             |
| 3       | mask       | PRN bit mask                       | Uchar[27] | 28 <sup>a</sup> | H+4           |
| 4       | iodp       | Issue of PRN mask data             | Ulong     | 4               | H+32          |
| 5       | xxxx       | 32-bit CRC (ASCII and Binary only) | Hex       | 4               | H+36          |
| 6       | [CR][LF]   | Sentence terminator (ASCII only)   | -         | -               | -             |

- a. In the binary log case, an additional 1 byte of padding is added to maintain 4-byte alignment

### 3.3.137 WAAS2 Fast Correction Slots 0-12 VI23\_SBAS

WAAS2 are fast corrections for slots 0-12 in the mask of WAAS1. This message may or may not come when SBAS is in testing mode (see the SBASCONTROL command on *page 182* for details).

**Message ID:** 296

**Log Type:** Asynch

**Recommended Input:**

log WAAS2a onchanged

**ASCII Example:**

```
#WAAS2A, COM1, 0, 29.0, SATTIME, 1337, 415925.000, 00000000, e194, 1984;  
134, 2, 2, 3, -3, 5, 1, 2047, -2, 2047, 2047, 2047, 2047, 2047, -3, 2, 5, 11, 7,  
8, 14, 8, 14, 14, 14, 14, 14, 14, 6, 12*8d8d2e1c
```



Each raw WAAS frame gives data for a specific frame decoder number. The WAAS2 message can be logged to view the data breakdown of WAAS frame 2 which contains information on fast correction slots 0-12.

**Table 107: Evaluation of UDREI**

| UDREI <sup>a</sup> | UDRE meters   | $\sigma^2_{i.udre}$ meters <sup>2</sup> |
|--------------------|---------------|---|
| 0                  | 0.75          | 0.0520                                  |
| 1                  | 1.0           | 0.0924                                  |
| 2                  | 1.25          | 0.1444                                  |
| 3                  | 1.75          | 0.2830                                  |
| 4                  | 2.25          | 0.4678                                  |
| 5                  | 3.0           | 0.8315                                  |
| 6                  | 3.75          | 1.2992                                  |
| 7                  | 4.5           | 1.8709                                  |
| 8                  | 5.25          | 2.5465                                  |
| 9                  | 6.0           | 3.3260                                  |
| 10                 | 7.5           | 5.1968                                  |
| 11                 | 15.0          | 20.7870                                 |
| 12                 | 50.0          | 230.9661                                |
| 13                 | 150.0         | 2078.695                                |
| 14                 | Not Monitored | Not Monitored                           |
| 15                 | Do Not Use    | Do Not Use                              |

- a. The  $\sigma^2_{UDRE}$  broadcast in WAAS2, WAAS3, WAAS4, WAAS5, WAAS6 and WAAS24 applies at a time prior to or at the time of applicability of the associated corrections.

| Field # | Field type   | Data Description  | Format | Binary Bytes | Binary Offset | Scaling |
|---------|--------------|---|--------|--------------|---------------|---------|
| 1       | WAAS2 header | Log header  |        | H            | 0             |         |
| 2       | prn          | Source PRN of message   | Ulong  | 4            | H             | -       |
| 3       | iodf         | Issue of fast corrections data  | Ulong  | 4            | H+4           | -       |
| 4       | iodp         | Issue of PRN mask data  | Ulong  | 4            | H+8           | -       |
| 5       | prc0         | prc(i):<br>Fast corrections (-2048 to +2047) for the prn in slot i (i = 0-12) | Long   | 4            | H+12          | -       |
| 6       | prc1         |   | Long   | 4            | H+16          | -       |
| 7       | prc2         |   | Long   | 4            | H+20          | -       |
| 8       | prc3         |   | Long   | 4            | H+24          | -       |
| 9       | prc4         |   | Long   | 4            | H+28          | -       |
| 10      | prc5         |   | Long   | 4            | H+32          | -       |
| 11      | prc6         |   | Long   | 4            | H+36          | -       |
| 12      | prc7         |   | Long   | 4            | H+40          | -       |
| 13      | prc8         |   | Long   | 4            | H+44          | -       |
| 14      | prc9         |   | Long   | 4            | H+48          | -       |
| 15      | prc10        |   | Long   | 4            | H+52          | -       |
| 16      | prc11        |   | Long   | 4            | H+56          | -       |
| 17      | prc12        |   | Long   | 4            | H+60          | -       |

Continued on page 573.

| Field # | Field type | Data Description   | Format | Binary Bytes | Binary Offset | Scaling  |
|---------|------------|--|--------|--------------|---------------|--|
| 18      | udre0      | udre(i):<br>User differential range error indicator for the prn in slot i (i = 0-12) | Ulong  | 4            | H+64          | See Table 107, Evaluation of UDREI on page 571 |
| 19      | udre1      |  | Ulong  | 4            | H+68          |  |
| 20      | udre2      |  | Ulong  | 4            | H+72          |  |
| 21      | udre3      |  | Ulong  | 4            | H+76          |  |
| 22      | udre4      |  | Ulong  | 4            | H+80          |  |
| 23      | udre5      |  | Ulong  | 4            | H+84          |  |
| 24      | udre6      |  | Ulong  | 4            | H+88          |  |
| 25      | udre7      |  | Ulong  | 4            | H+92          |  |
| 26      | udre8      |  | Ulong  | 4            | H+96          |  |
| 27      | udre9      |  | Ulong  | 4            | H+100         |  |
| 28      | udre10     |  | Ulong  | 4            | H+104         |  |
| 29      | udre11     |  | Ulong  | 4            | H+108         |  |
| 30      | udre12     |  | Ulong  | 4            | H+112         |  |
| 31      | xxxx       | 32-bit CRC (ASCII and Binary only)   | Hex    | 4            | H+116         | -  |
| 32      | [CR][LF]   | Sentence terminator (ASCII only)   | -      | -            | -             | -  |

---

### 3.3.138 WAAS3 Fast Corrections Slots 13-25 V123\_SBAS

WAAS3 are fast corrections for slots 13-25 in the mask of WAAS1. This message may or may not come when SBAS is in testing mode (see the SBASCONTROL command on *page 182* for details).

**Message ID:** 301  
**Log Type:** Asynch

**Recommended Input:**

log WAAS3a onchanged

**ASCII Example:**

```
#WAAS3A,COM1,0,17.0,SATTIME,1337,415990.000,00000000,bff5,1984;  
134,1,2,2047,0,2047,2047,-21,-4,2047,2047,-1,0,2,2047,6,14,5,  
14,14,11,5,14,14,5,7,5,14,8*a25aebc5
```



Each raw WAAS frame gives data for a specific frame decoder number. The WAAS3 message can be logged to view the data breakdown of WAAS frame 3 which contains information on fast correction slots 13-25.

---

| Field # | Field type   | Data Description  | Format | Binary Bytes | Binary Offset | Scaling |
|---------|--------------|---|--------|--------------|---------------|---------|
| 1       | WAAS3 header | Log header  |        | H            | 0             |         |
| 2       | prn          | Source PRN of message   | Ulong  | 4            | H             | -       |
| 3       | iodf         | Issue of fast corrections data  | Ulong  | 4            | H+4           | -       |
| 4       | iodp         | Issue of PRN mask data  | Ulong  | 4            | H+8           | -       |
| 5       | prc13        | prc(i):<br>Fast corrections (-2048 to +2047)<br>for the prn in slot i (i = 13-25) | Long   | 4            | H+12          | -       |
| 6       | prc14        |   | Long   | 4            | H+16          | -       |
| 7       | prc15        |   | Long   | 4            | H+20          | -       |
| 8       | prc16        |   | Long   | 4            | H+24          | -       |
| 9       | prc17        |   | Long   | 4            | H+28          | -       |
| 10      | prc18        |   | Long   | 4            | H+32          | -       |
| 11      | prc19        |   | Long   | 4            | H+36          | -       |
| 12      | prc20        |   | Long   | 4            | H+40          | -       |
| 13      | prc21        |   | Long   | 4            | H+44          | -       |
| 14      | prc22        |   | Long   | 4            | H+48          | -       |
| 15      | prc23        |   | Long   | 4            | H+52          | -       |
| 16      | prc24        |   | Long   | 4            | H+56          | -       |
| 17      | prc25        |   | Long   | 4            | H+60          | -       |

*Continued on page 576.*

| Field # | Field type | Data Description  | Format | Binary Bytes | Binary Offset | Scaling  |
|---------|------------|---|--------|--------------|---------------|--|
| 18      | udre13     | udre(i):<br>User differential range error indicator for the prn in slot i (i = 13-25) | Ulong  | 4            | H+64          | See Table 107, Evaluation of UDREI on page 571 |
| 19      | udre14     |   | Ulong  | 4            | H+68          |  |
| 20      | udre15     |   | Ulong  | 4            | H+72          |  |
| 21      | udre16     |   | Ulong  | 4            | H+76          |  |
| 22      | udre17     |   | Ulong  | 4            | H+80          |  |
| 23      | udre18     |   | Ulong  | 4            | H+84          |  |
| 24      | udre19     |   | Ulong  | 4            | H+88          |  |
| 25      | udre20     |   | Ulong  | 4            | H+92          |  |
| 26      | udre21     |   | Ulong  | 4            | H+96          |  |
| 27      | udre22     |   | Ulong  | 4            | H+100         |  |
| 28      | udre23     |   | Ulong  | 4            | H+104         |  |
| 29      | udre24     |   | Ulong  | 4            | H+108         |  |
| 30      | udre25     |   | Ulong  | 4            | H+112         |  |
| 31      | xxxx       | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+116         | -  |
| 32      | [CR][LF]   | Sentence terminator (ASCII only)  | -      | -            | -             | -  |



---

### 3.3.139 WAAS4 Fast Correction Slots 26-38 VI23\_SBAS

WAAS4 are fast corrections for slots 26-38 in the mask of WAAS1. This message may or may not come when SBAS is in testing mode (see the SBASCONTROL on *page 182* command for details).

**Message ID:** 302

**Log Type:** Asynch

**Recommended Input:**

log WAAS4a onchanged

**ASCII Example:**

```
#WAAS4A, COM1, 0, 58.0, SATTIME, 1093, 163399.000, 00000020, b4b0, 209;  
122, 0, 3, 2047, 3, -1, 2047, 2047, 2047, -3, -1, 5, 3, 3,  
2047, 2, 14, 3, 3, 14, 14, 14, 6, 3, 4, 5, 4, 14, 3*2e0894b1
```



Each raw WAAS frame gives data for a specific frame decoder number. The WAAS4 message can be logged to view the data breakdown of WAAS frame 4 which contains information on fast correction slots 26-38.

---

| Field # | Field type   | Data Description  | Format | Binary Bytes | Binary Offset | Scaling |
|---------|--------------|---|--------|--------------|---------------|---------|
| 1       | WAAS4 header | Log header  |        | H            | 0             |         |
| 2       | prn          | Source PRN of message   | Ulong  | 4            | H             | -       |
| 3       | iodf         | Issue of fast corrections data                                      | Ulong  | 4            | H+4           | -       |
| 4       | iodp         | Issue of PRN mask data  | Ulong  | 4            | H+8           | -       |
| 5       | prc26        | prc(i):   | Long   | 4            | H+12          | -       |
| 6       | prc27        | Fast corrections (-2048 to +2047) for the prn in slot i (i = 26-38) | Long   | 4            | H+16          | -       |
| 7       | prc28        |   | Long   | 4            | H+20          | -       |
| 8       | prc29        |   | Long   | 4            | H+24          | -       |
| 9       | prc30        |   | Long   | 4            | H+28          | -       |
| 10      | prc31        |   | Long   | 4            | H+32          | -       |
| 11      | prc32        |   | Long   | 4            | H+36          | -       |
| 12      | prc33        |   | Long   | 4            | H+40          | -       |
| 13      | prc34        |   | Long   | 4            | H+44          | -       |
| 14      | prc35        |   | Long   | 4            | H+48          | -       |
| 15      | prc36        |   | Long   | 4            | H+52          | -       |
| 16      | prc37        |   | Long   | 4            | H+56          | -       |
| 17      | prc38        |   | Long   | 4            | H+60          | -       |

*Continued on page 579.*

| Field # | Field type | Data Description  | Format | Binary Bytes | Binary Offset | Scaling  |
|---------|------------|---|--------|--------------|---------------|--|
| 18      | udre26     | udre(i):<br>User differential range error indicator for the prn in slot i (i = 26-38) | Ulong  | 4            | H+64          | See Table 107, Evaluation of UDREI on page 571 |
| 19      | udre27     |   | Ulong  | 4            | H+68          |  |
| 20      | udre28     |   | Ulong  | 4            | H+72          |  |
| 21      | udre29     |   | Ulong  | 4            | H+76          |  |
| 22      | udre30     |   | Ulong  | 4            | H+80          |  |
| 23      | udre31     |   | Ulong  | 4            | H+84          |  |
| 24      | udre32     |   | Ulong  | 4            | H+88          |  |
| 25      | udre33     |   | Ulong  | 4            | H+92          |  |
| 26      | udre34     |   | Ulong  | 4            | H+96          |  |
| 27      | udre35     |   | Ulong  | 4            | H+100         |  |
| 28      | udre36     |   | Ulong  | 4            | H+104         |  |
| 29      | udre37     |   | Ulong  | 4            | H+108         |  |
| 30      | udre38     |   | Ulong  | 4            | H+112         |  |
| 31      | xxxx       | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+116         | -  |
| 32      | [CR][LF]   | Sentence terminator (ASCII only)  | -      | -            | -             | -  |

---

### 3.3.140 WAAS5 Fast Correction Slots 39-50 VI23\_SBAS

WAAS5 are fast corrections for slots 39-50 in the mask of WAAS1. This message may or may not come when SBAS is in testing mode (see the SBASCONTROL command on *page 182* for details).

**Message ID:** 303  
**Log Type:** Asynch

**Recommended Input:**

log WAAS5a onchanged

**ASCII Example:**

```
#WAAS5A,COM1,0,72.5,SATTIME,1093,161480.000,00040020,31d4,209;122,1,3,  
-7,2047,2047,2047,-4,2047,2047,2047,9,2047,2047,-3,-2,11,14,14,14,4,14,14,14,  
5,14,14,4,2*2bf0109b
```



Each raw WAAS frame gives data for a specific frame decoder number. The WAAS5 message can be logged to view the data breakdown of WAAS frame 5 which contains information on fast correction slots 39-50.

---

| Field # | Field type                  | Data Description  | Format | Binary Bytes | Binary Offset | Scaling |
|---------|-----------------------------|---|--------|--------------|---------------|---------|
| 1       | WAAS5 header                | Log header  |        | H            | 0             |         |
| 2       | prn                         | Source PRN of message   | Ulong  | 4            | H             | -       |
| 3       | iodf                        | Issue of fast corrections data  | Ulong  | 4            | H+4           | -       |
| 4       | iodp                        | Issue of PRN mask data  | Ulong  | 4            | H+8           | -       |
| 5       | prc39                       | prc(i):<br>Fast corrections (-2048 to +2047)<br>for the prn in slot i (i = 39-50) | Long   | 4            | H+12          | -       |
| 6       | prc40                       |   | Long   | 4            | H+16          | -       |
| 7       | prc41                       |   | Long   | 4            | H+20          | -       |
| 8       | prc42                       |   | Long   | 4            | H+24          | -       |
| 9       | prc43                       |   | Long   | 4            | H+28          | -       |
| 10      | prc44                       |   | Long   | 4            | H+32          | -       |
| 11      | prc45                       |   | Long   | 4            | H+36          | -       |
| 12      | prc46                       |   | Long   | 4            | H+40          | -       |
| 13      | prc47                       |   | Long   | 4            | H+44          | -       |
| 14      | prc48                       |   | Long   | 4            | H+48          | -       |
| 15      | prc49                       |   | Long   | 4            | H+52          | -       |
| 16      | prc50                       |   | Long   | 4            | H+56          | -       |
| 17      | prc51 (Invalid, do not use) |   | Long   | 4            | H+60          | -       |

*Continued on page 582.*

| Field # | Field type                   | Data Description  | Format | Binary Bytes | Binary Offset | Scaling  |
|---------|------------------------------|---|--------|--------------|---------------|--|
| 18      | udre39                       | udre(i):<br>User differential range error indicator for the prn in slot i (i = 39-50) | Ulong  | 4            | H+64          | See Table 107, Evaluation of UDREI on page 571 |
| 19      | udre40                       |   | Ulong  | 4            | H+68          |  |
| 20      | udre41                       |   | Ulong  | 4            | H+72          |  |
| 21      | udre42                       |   | Ulong  | 4            | H+76          |  |
| 22      | udre43                       |   | Ulong  | 4            | H+80          |  |
| 23      | udre44                       |   | Ulong  | 4            | H+84          |  |
| 24      | udre45                       |   | Ulong  | 4            | H+88          |  |
| 25      | udre46                       |   | Ulong  | 4            | H+92          |  |
| 26      | udre47                       |   | Ulong  | 4            | H+96          |  |
| 27      | udre48                       |   | Ulong  | 4            | H+100         |  |
| 28      | udre49                       |   | Ulong  | 4            | H+104         |  |
| 29      | udre50                       |   | Ulong  | 4            | H+108         |  |
| 30      | udre51 (Invalid, do not use) |   | Ulong  | 4            | H+112         |  |
| 31      | xxxx                         | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+116         | -  |
| 32      | [CR][LF]                     | Sentence terminator (ASCII only)  | -      | -            | -             | -  |

### 3.3.141 WAAS6 Integrity Message V123\_SBAS

WAAS6 is the integrity information message. Each message includes an IODF for each fast corrections message. The  $\sigma^2_{UDRE}$  information for each block of satellites applies to the fast corrections with the corresponding IODF.

**Message ID:** 304

**Log Type:** Asynch

**Recommended Input:**

log WAAS6a onchanged

**ASCII Example:**

```
#WAAS6A, COM1, 0, 57.5, SATTIME, 1093, 273317.000, 00000020, 526a, 209;
122, 3, 3, 3, 3, 9, 14, 14, 2, 3, 10, 2, 14, 14, 3, 14, 14, 5, 14, 14, 7, 14, 14, 14, 14, 14, 3, 3,
14, 14, 14, 14, 3, 15, 11, 11, 15, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0*925a2a9b
```



Each raw WAAS frame gives data for a specific frame decoder number. The WAAS6 message can be logged to view the data breakdown of WAAS frame 6 which contains information on the integrity message.

| Field # | Field type   | Data Description   | Format | Binary Bytes | Binary Offset | Scaling  |
|---------|--------------|--|--------|--------------|---------------|--|
| 1       | WAAS6 header | Log header   |        | H            | 0             | -  |
| 2       | prn          | Source PRN of message  | Ulong  | 4            | H             | -  |
| 3       | iodf2        | Issue of fast corrections data   | Ulong  | 4            | H+4           | -  |
| 4       | iodf3        | Issue of fast corrections data   | Ulong  | 4            | H+8           | -  |
| 5       | iodf4        | Issue of fast corrections data   | Ulong  | 4            | H+12          | -  |
| 6       | iodf5        | Issue of fast corrections data   | Ulong  | 4            | H+16          | -  |
| 7       | udre0        | udre(i):<br>User differential range error indicator for the prn in slot i (i = 0-50) | Ulong  | 4            | H+20          | See Table 107, Evaluation of UDREI on page 571 |
| 8       | udre1        |  | Ulong  | 4            | H+24          |  |
| 9       | udre2        |  | Ulong  | 4            | H+28          |  |
| 10      | udre3        |  | Ulong  | 4            | H+32          |  |
| 11      | udre4        |  | Ulong  | 4            | H+36          |  |
| 12      | udre5        |  | Ulong  | 4            | H+40          |  |
| 13      | udre6        |  | Ulong  | 4            | H+44          |  |
| 14      | udre7        |  | Ulong  | 4            | H+48          |  |
| 15      | udre8        |  | Ulong  | 4            | H+52          |  |
| 16      | udre9        |  | Ulong  | 4            | H+56          |  |
| 17      | udre10       |  | Ulong  | 4            | H+60          |  |
| 18      | udre11       |  | Ulong  | 4            | H+64          |  |
| 19      | udre12       |  | Ulong  | 4            | H+68          |  |
| 20      | udre13       |  | Ulong  | 4            | H+72          |  |
| 21      | udre14       |  | Ulong  | 4            | H+76          |  |
| 22      | udre15       |  | Ulong  | 4            | H+80          |  |
| 23      | udre16       |  | Ulong  | 4            | H+84          |  |
| 24      | udre17       | Ulong  | 4      | H+88         |               |  |

Continued on page 585.



| Field # | Field type | Data Description   | Format | Binary Bytes | Binary Offset | Scaling  |
|---------|------------|--|--------|--------------|---------------|--|
| 25      | udre18     | udre(i):<br>User differential range error indicator for the prn in slot i (i = 0-50) | Ulong  | 4            | H+92          | See Table 107, Evaluation of UDREI on page 571 |
| 26      | udre19     |  | Ulong  | 4            | H+96          |  |
| 27      | udre20     |  | Ulong  | 4            | H+100         |  |
| 28      | udre21     |  | Ulong  | 4            | H+104         |  |
| 29      | udre22     |  | Ulong  | 4            | H+108         |  |
| 30      | udre23     |  | Ulong  | 4            | H+112         |  |
| 31      | udre24     |  | Ulong  | 4            | H+116         |  |
| 32      | udre25     |  | Ulong  | 4            | H+120         |  |
| 33      | udre26     |  | Ulong  | 4            | H+124         |  |
| 34      | udre27     |  | Ulong  | 4            | H+128         |  |
| 35      | udre28     |  | Ulong  | 4            | H+132         |  |
| 36      | udre29     |  | Ulong  | 4            | H+136         |  |
| 37      | udre30     |  | Ulong  | 4            | H+140         |  |
| 38      | udre31     |  | Ulong  | 4            | H+144         |  |
| 39      | udre32     |  | Ulong  | 4            | H+148         |  |
| 40      | udre33     |  | Ulong  | 4            | H+152         |  |
| 41      | udre34     |  | Ulong  | 4            | H+156         |  |
| 42      | udre35     |  | Ulong  | 4            | H+160         |  |
| 43      | udre36     |  | Ulong  | 4            | H+164         |  |
| 44      | udre37     |  | Ulong  | 4            | H+168         |  |
| 45      | udre38     |  | Ulong  | 4            | H+172         |  |
| 46      | udre39     |  | Ulong  | 4            | H+176         |  |
| 47      | udre40     |  | Ulong  | 4            | H+180         |  |
| 48      | udre41     |  | Ulong  | 4            | H+184         |  |
| 49      | udre42     |  | Ulong  | 4            | H+188         |  |
| 50      | udre43     |  | Ulong  | 4            | H+192         |  |
| 51      | udre44     |  | Ulong  | 4            | H+196         |  |
| 52      | udre45     |  | Ulong  | 4            | H+200         |  |

Continued on page 586.

| Field # | Field type                   | Data Description   | Format | Binary Bytes | Binary Offset | Scaling  |
|---------|------------------------------|--|--------|--------------|---------------|--|
| 53      | udre46                       | udre(i):<br>User differential range error indicator for the prn in slot i (i = 0-50) | Ulong  | 4            | H+204         | See Table 107, Evaluation of UDREI on page 571 |
| 54      | udre47                       |  | Ulong  | 4            | H+208         |  |
| 55      | udre48                       |  | Ulong  | 4            | H+212         |  |
| 56      | udre49                       |  | Ulong  | 4            | H+216         |  |
| 58      | udre50                       |  | Ulong  | 4            | H+220         |  |
| 58      | udre51 (Invalid, do not use) |  | Ulong  | 4            | H+224         |  |
| 59      | xxxx                         | 32-bit CRC (ASCII and Binary only)   | Hex    | 4            | H+228         | -  |
| 60      | [CR][LF]                     | Sentence terminator (ASCII only)   | -      | -            | -             | -  |

### 3.3.142 WAAS7 Fast Correction Degradation V123\_SBAS

The WAAS7 message specifies the applicable IODP, system latency time and fast degradation factor indicator for computing the degradation of fast and long-term corrections.

**Message ID:** 305

**Log Type:** Asynch

#### Recommended Input:

log WAAS7a onchanged

#### ASCII Example:

```
#WAAS7A, COM1, 0, 36.5, SATTIME, 1337, 416367.000, 00000000, 12e3, 1984;
122, 1, 2, 0, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15,
15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0*827a7364
```



Each raw WAAS frame gives data for a specific frame decoder number. The WAAS7 message can be logged to view the data breakdown of WAAS frame 7 which contains information on fast correction degradation.

| Field # | Field type   | Data Description  | Format | Binary Bytes | Binary Offset |
|---------|--------------|---|--------|--------------|---------------|
| 1       | WAAS7 header | Log header  |        | H            | 0             |
| 2       | prn          | Source PRN of message   | Ulong  | 4            | H             |
| 3       | latency      | System latency  | Ulong  | 4            | H+4           |
| 4       | iodp         | Issue of PRN mask data  | Ulong  | 4            | H+8           |
| 5       | spare bits   | Unused spare bits   | Ulong  | 4            | H+12          |
| 6       | al(0)        | al(i):<br>Degradation factor indicator for the prn in slot i (i = 0-50) | Ulong  | 4            | H+16          |
| 7       | al(1)        |   | Ulong  | 4            | H+20          |
| 8       | al(2)        |   | Ulong  | 4            | H+24          |
| 9       | al(3)        |   | Ulong  | 4            | H+28          |
| 10      | al(4)        |   | Ulong  | 4            | H+32          |
| 11      | al(5)        |   | Ulong  | 4            | H+36          |
| 12      | al(6)        |   | Ulong  | 4            | H+40          |
| 13      | al(7)        |   | Ulong  | 4            | H+44          |
| 14      | al(8)        |   | Ulong  | 4            | H+48          |
| 15      | al(9)        |   | Ulong  | 4            | H+52          |
| 16      | al(10)       |   | Ulong  | 4            | H+56          |
| 17      | al(11)       |   | Ulong  | 4            | H+60          |
| 18      | al(12)       |   | Ulong  | 4            | H+64          |
| 19      | al(13)       |   | Ulong  | 4            | H+68          |
| 20      | al(14)       |   | Ulong  | 4            | H+72          |
| 21      | al(15)       |   | Ulong  | 4            | H+76          |
| 22      | al(16)       |   | Ulong  | 4            | H+80          |
| 23      | al(17)       |   | Ulong  | 4            | H+84          |
| 24      | al(18)       |   | Ulong  | 4            | H+88          |
| 25      | al(19)       |   | Ulong  | 4            | H+92          |
| 26      | al(20)       |   | Ulong  | 4            | H+96          |

Continued on page 589.

| Field # | Field type | Data Description  | Format | Binary Bytes | Binary Offset |
|---------|------------|---|--------|--------------|---------------|
| 27      | al(21)     | al(i):<br>Degradation factor indicator for the prn in slot i (i = 0-50) | Ulong  | 4            | H+100         |
| 28      | al(22)     |   | Ulong  | 4            | H+104         |
| 29      | al(23)     |   | Ulong  | 4            | H+108         |
| 30      | al(24)     |   | Ulong  | 4            | H+112         |
| 31      | al(25)     |   | Ulong  | 4            | H+116         |
| 32      | al(26)     |   | Ulong  | 4            | H+120         |
| 33      | al(27)     |   | Ulong  | 4            | H+124         |
| 34      | al(28)     |   | Ulong  | 4            | H+128         |
| 35      | al(29)     |   | Ulong  | 4            | H+132         |
| 36      | al(30)     |   | Ulong  | 4            | H+136         |
| 37      | al(31)     |   | Ulong  | 4            | H+140         |
| 38      | al(32)     |   | Ulong  | 4            | H+144         |
| 39      | al(33)     |   | Ulong  | 4            | H+148         |
| 40      | al(34)     |   | Ulong  | 4            | H+152         |
| 41      | al(35)     |   | Ulong  | 4            | H+156         |
| 42      | al(36)     |   | Ulong  | 4            | H+160         |
| 43      | al(37)     |   | Ulong  | 4            | H+164         |
| 44      | al(38)     |   | Ulong  | 4            | H+168         |
| 45      | al(39)     |   | Ulong  | 4            | H+172         |
| 46      | al(40)     |   | Ulong  | 4            | H+176         |
| 47      | al(41)     |   | Ulong  | 4            | H+180         |
| 48      | al(42)     |   | Ulong  | 4            | H+184         |
| 49      | al(43)     |   | Ulong  | 4            | H+188         |
| 50      | al(44)     |   | Ulong  | 4            | H+192         |
| 51      | al(45)     |   | Ulong  | 4            | H+196         |
| 52      | al(46)     |   | Ulong  | 4            | H+200         |
| 53      | al(47)     |   | Ulong  | 4            | H+204         |
| 54      | al(48)     |   | Ulong  | 4            | H+208         |

Continued on page 590.

| Field # | Field type                   | Data Description   | Format | Binary Bytes | Binary Offset |
|---------|------------------------------|--|--------|--------------|---------------|
| 55      | al(49)                       | al(i):<br>Degradation factor indicator for the<br>prn in slot i (i = 0-50) | Ulong  | 4            | H+212         |
| 56      | al(50)                       |  | Ulong  | 4            | H+216         |
| 57      | al(51) (Invalid, do not use) |  | Ulong  | 4            | H+220         |
| 58      | xxxx                         | 32-bit CRC (ASCII and Binary only)   | Hex    | 4            | H+224         |
| 59      | [CR][LF]                     | Sentence terminator (ASCII only)   | -      | -            | -             |

### 3.3.143 WAAS9 GEO Navigation Message V123\_SBAS

WAAS9 provides the GEO navigation message representing the position, velocity and acceleration of the geostationary satellite, in ECEF coordinates and its apparent clock time and frequency offsets.

Also included is the time of applicability, an issue of data (IOD) and an accuracy exponent (URA) representing the estimated accuracy of the message. The time offset and time drift are with respect to SBAS Network Time. Their combined effect is added to the estimate of the satellite's transmit time.

**Message ID:** 306  
**Log Type:** Asynch

#### Recommended Input:

log WAAS9a onchanged

#### ASCII Example:

```
#WAAS9A, COM1, 0, 38.0, SATTIME, 1337, 416426.000, 00000000, b580, 1984;
122, 175, 70848, 2, 24802064.1600, -34087313.9200, -33823.2000,
1.591250000, 0.107500000, 0.6080000, -0.0000750, -0.0001125,
0.000187500, -2.235174179e-08, 9.094947018e-12*636051d2
```



Each raw WAAS frame gives data for a specific frame decoder number. The WAAS9 message can be logged to view the data breakdown of WAAS frame 9 which contains the GEO navigation message.

| Field # | Field type      | Data Description                   | Format | Binary Bytes | Binary Offset |
|---------|-----------------|------------------------------------|--------|--------------|---------------|
| 1       | WAAS9 header    | Log header                         |        | H            | 0             |
| 2       | prn             | Source PRN of message              | Ulong  | 4            | H             |
| 3       | iodn            | Issue of GEO navigation data       | Ulong  | 4            | H+4           |
| 4       | t <sub>0</sub>  | Time of applicability              | Ulong  | 4            | H+8           |
| 5       | ura             | URA value                          | Ulong  | 4            | H+12          |
| 6       | x               | ECEF x coordinate                  | Double | 8            | H+16          |
| 7       | y               | ECEF y coordinate                  | Double | 8            | H+24          |
| 8       | z               | ECEF z coordinate                  | Double | 8            | H+32          |
| 9       | xvel            | X rate of change                   | Double | 8            | H+40          |
| 10      | yvel            | Y rate of change                   | Double | 8            | H+48          |
| 11      | zvel            | Z rate of change                   | Double | 8            | H+56          |
| 12      | xaccel          | X rate of rate change              | Double | 8            | H+64          |
| 13      | yaccel          | Y rate of rate change              | Double | 8            | H+72          |
| 14      | zaccel          | Z rate of rate change              | Double | 8            | H+80          |
| 15      | a <sub>f0</sub> | Time offset                        | Double | 8            | H+88          |
| 16      | a <sub>f1</sub> | Time drift                         | Double | 8            | H+96          |
| 17      | xxxx            | 32-bit CRC (ASCII and Binary only) | Hex    | 4            | H+104         |
| 18      | [CR][LF]        | Sentence terminator (ASCII only)   | -      | -            | -             |



---

### 3.3.144 WAAS10 Degradation Factor V123\_SBAS

The fast corrections, long-term corrections and ionospheric corrections are all provided in the WAAS10 message.

**Message ID:** 292

**Log Type:** Asynch

**Recommended Input:**

log WAAS10a onchanged

**ASCII Example:**

```
#WAAS10A, COM1, 0, 35.5, SATTIME, 1337, 416469.000, 00000000, c305, 1984;  
122, 54, 38, 76, 256, 152, 100, 311, 83, 256, 6, 0, 300, 292, 0, 1,  
000000000000000000000000*8884d248
```



Each raw WAAS frame gives data for a specific frame decoder number. The WAAS10 message can be logged to view the data breakdown of WAAS frame 10 which contains information on degradation factors.

---

| Field # | Field type             | Data Description  | Format | Binary Bytes | Binary Offset | Scaling  |
|---------|------------------------|---|--------|--------------|---------------|----------|
| 1       | WAAS10 header          | Log header  |        | H            | 0             | -        |
| 2       | prn                    | Source PRN of message   | Ulong  | 4            | H             | -        |
| 3       | b <sub>rcc</sub>       | Estimated noise and round off error parameter                                 | Ulong  | 4            | H+4           | 0.002    |
| 4       | c <sub>lrc_ls</sub>    | Maximum round off due to the least significant bit (lsb) of the orbital clock | Ulong  | 4            | H+8           | 0.002    |
| 5       | c <sub>lrc_vl</sub>    | Velocity error bound  | Ulong  | 4            | H+12          | 0.00005  |
| 6       | i <sub>lrc_vl</sub>    | Update interval for v=1 long term   | Ulong  | 4            | H+16          | -        |
| 7       | c <sub>lrc_v0</sub>    | Bound on update delta   | Ulong  | 4            | H+20          | 0.002    |
| 8       | i <sub>lrc_v1</sub>    | Minimum update interval v = 0   | Ulong  | 4            | H+24          | -        |
| 9       | c <sub>geo_ls</sub>    | Maximum round off due to the lsb of the orbital clock                         | Ulong  | 4            | H+28          | 0.0005   |
| 10      | c <sub>geo_v</sub>     | Velocity error bound  | Ulong  | 4            | H+32          | 0.00005  |
| 11      | i <sub>geo</sub>       | Update interval for GEO navigation message                                    | Ulong  | 4            | H+36          | -        |
| 12      | c <sub>er</sub>        | Degradation parameter   | Ulong  | 4            | H+40          | 0.5      |
| 13      | c <sub>iono_step</sub> | Bound on ionospheric grid delay difference                                    | Ulong  | 4            | H+44          | 0.001    |
| 14      | i <sub>iono</sub>      | Minimum ionospheric update interval   | Ulong  | 4            | H+48          | -        |
| 15      | c <sub>iono_ramp</sub> | Rate of ionospheric corrections change  | Ulong  | 4            | H+52          | 0.000005 |
| 16      | rss <sub>udre</sub>    | User differential range error flag  | Ulong  | 4            | H+56          | -        |
| 17      | rss <sub>iono</sub>    | Root sum square flag  | Ulong  | 4            | H+60          | -        |
| 18      | spare bits             | Spare 88 bits, possibly GLONASS   | Ulong  | 4            | H+64          | -        |
| 19      | xxxx                   | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+68          | -        |
| 20      | [CR][LF]               | Sentence terminator (ASCII only)  | -      | -            | -             | -        |

---

### 3.3.145 WAAS12 SBAS Network Time and UTC V123\_SBAS

WAAS12 contains information bits for the UTC parameters and UTC time standard from which an offset is determined. The UTC parameters correlate UTC time with the SBAS network time rather than with GPS time.

**Message ID:** 293

**Log Type:** Asynch

**Recommended Input:**

log WAAS12a onchanged

**ASCII Example:**

Not available at time of print.



Each raw WAAS frame gives data for a specific frame decoder number. The WAAS12 message can be logged to view the data breakdown of WAAS frame 12 which contains information on time parameters.

---

| Field # | Field type                              | Data Description  | Format   | Binary Bytes    | Binary Offset |
|---------|---|---|----------|-----------------|---------------|
| 1       | WAAS12 header                           | Log header  |          | H               | 0             |
| 2       | prn                                     | Source PRN of message   | Ulong    | 4               | H             |
| 3       | A <sub>1</sub>                          | Time drift (s/s)  | Double   | 8               | H+4           |
| 4       | A <sub>0</sub>                          | Time offset (s)   | Double   | 8               | H+12          |
| 5       | seconds                                 | Seconds into the week (s)   | Ulong    | 4               | H+20          |
| 6       | week                                    | Week number   | Ushort   | 4               | H+24          |
| 7       | dt <sub>ls</sub>                        | Delta time due to leap seconds  | Short    | 2               | H+28          |
| 8       | wn <sub>lsf</sub>                       | Week number, leap second future   | Ushort   | 2               | H+30          |
| 9       | dn                                      | Day of the week (the range is 1 to 7 where Sunday = 1 and Saturday = 7) | Ushort   | 2               | H+32          |
| 10      | dt <sub>lsf</sub>                       | Delta time, leap second future  | Short    | 2               | H+34          |
| 11      | utc id                                  | UTC type identifier   | Ushort   | 2               | H+36          |
| 12      | gpstow                                  | GPS time of the week  | Ulong    | 2               | H+38          |
| 13      | gpswn                                   | GPS de-modulo week number   | Ulong    | 2               | H+40          |
| 14      | glo indicator                           | Is GLONASS information present?<br>0 = FALSE<br>1 = TRUE                | Enum     | 4               | H+42          |
| 15      | Reserved array of hexabytes for GLONASS |   | Char[10] | 12 <sup>a</sup> | H+46          |
| 16      | xxxx                                    | 32-bit CRC (ASCII and Binary only)                                      | Hex      | 4               | H+58          |
| 17      | [CR][LF]                                | Sentence terminator (ASCII only)  | -        | -               | -             |

- a. In the binary log case, an additional 2 bytes of padding are added to maintain 4-byte alignment

### 3.3.146 WAAS17 GEO Almanac Message V123\_SBAS

Almanacs for all GEOs are broadcast periodically to alert you of their existence, location, the general service provided, status, and health.

---

✉ Unused almanacs have a PRN number of 0 and should be ignored, see *ASCII Example* below.

---

**Message ID:** 294

**Log Type:** Asynch

**Recommended Input:**

log WAAS17a onchanged

**ASCII Example:**

```
#WAAS17A,COM1,0,33.5,SATTIME,1337,416653.000,00000000,896c,1984;
122,3,
0,134,0,-42138200,1448200,26000,0,0,0,
0,122,0,24801400,-34088600,-26000,0,0,0,
0,0,0,0,0,0,0,0,0,70848*22d9a0eb
```



Each raw WAAS frame gives data for a specific frame decoder number. The WAAS17 message can be logged to view the data breakdown of WAAS frame 17 which contains GEO almanacs.

---



---

| Field #  | Field type                      | Data Description                                     | Format | Binary Bytes   | Binary Offset      | Scaling |
|----------|---------------------------------|--|--------|----------------|--------------------|---------|
| 1        | WAAS17 header                   | Log header   |        | H              | 0                  | -       |
| 2        | prn                             | Source PRN of message                                | Ulong  | 4              | H                  | -       |
| 3        | #ents                           | Number of almanac entries with information to follow | Ulong  | 4              | H+4                | -       |
| 4        | data id                         | Data ID type   | Ushort | 2              | H+8                | -       |
| 5        | entry prn                       | PRN for this entry                                   | Ushort | 2              | H+10               | -       |
| 6        | health                          | Health bits  | Ushort | 4 <sup>a</sup> | H+12               | -       |
| 7        | x                               | ECEF x coordinate                                    | Long   | 4              | H+16               | -       |
| 8        | y                               | ECEF y coordinate                                    | Long   | 4              | H+20               | -       |
| 9        | z                               | ECEF z coordinate                                    | Long   | 4              | H+24               | -       |
| 10       | x vel                           | X rate of change                                     | Long   | 4              | H+28               | -       |
| 11       | y vel                           | Y rate of change                                     | Long   | 4              | H+32               | -       |
| 12       | z vel                           | Z rate of change                                     | Long   | 4              | H+36               | -       |
| 13...    | Next entry = H+8 + (#ents x 32) |  |        |                |                    | -       |
| variable | t0                              | Time of day in seconds (0 to 86336)                  | Ulong  | 4              | H+8+ (#ents x 32)  | 64      |
| variable | xxxx                            | 32-bit CRC (ASCII and Binary only)                   | Hex    | 4              | H+12+ (#ents x 32) | -       |
| variable | [CR][LF]                        | Sentence terminator (ASCII only)                     | -      | -              | -                  | -       |

a. In the binary log case, an additional 2 bytes of padding is added to maintain 4-byte alignment

### 3.3.147 WAAS18 IGP Mask V123\_SBAS

The ionospheric delay corrections are broadcast as vertical delay estimates at specified ionospheric grid points (IGPs), applicable to a signal on L1. The predefined IGPs are contained in 11 bands (numbered 0 to 10). Bands 0-8 are vertical bands on a Mercator projection map, and bands 9-10 are horizontal bands on a Mercator projection map. Since it is impossible to broadcast IGP delays for all possible locations, a mask is broadcast to define the IGP locations providing the most efficient model of the ionosphere at the time.

**Message ID:** 295

**Log Type:** Asynch

#### Recommended Input:

log WAAS18a onchanged

#### ASCII Example:

```
#WAAS18A,COM1,0,33.0,SATTIME,1337,417074.000,00000000,f2c0,1984;
122,4,2,2,0000ffc0007fc0003ff0000ff80007fe0007fe0003ff0000ff80,0*b1ed353e
```



Each raw WAAS frame gives data for a specific frame decoder number. The WAAS18 message can be logged to view the data breakdown of WAAS frame 18 which contains information on ionospheric grid points.

| Field # | Field type    | Data Description   | Format    | Binary Bytes    | Binary Offset |
|---------|---------------|--|-----------|-----------------|---------------|
| 1       | WAAS18 header | Log header   |           | H               | 0             |
| 2       | prn           | Source PRN of message  | Ulong     | 4               | H             |
| 3       | #bands        | Number of bands broadcast  | Ulong     | 4               | H+4           |
| 4       | band num      | Specific band number that identifies which of the 11 IGP bands the data belongs to | Ulong     | 4               | H+8           |
| 5       | iodi          | Issue of ionospheric data  | Ulong     | 4               | H+12          |
| 6       | igp mask      | IGP mask   | Uchar[26] | 28 <sup>a</sup> | H+16          |
| 7       | spare bit     | One spare bit  | Ulong     | 4               | H+44          |
| 8       | xxxx          | 32-bit CRC (ASCII and Binary only)   | Hex       | 4               | H+48          |
| 9       | [CR][LF]      | Sentence terminator (ASCII only)   | -         | -               | -             |

- a. In the binary log case, an additional 2 bytes of padding are added to maintain 4-byte alignment

### 3.3.148 WAAS24 Mixed Fast/Slow Corrections VI23\_SBAS

If there are 6 or fewer satellites in a block, they may be placed in this mixed correction message. There is a fast data set for each satellite and a UDRE indicator. Each message also contains an IODP indicating the associated PRN mask.

The fast correction (PRC) has a valid range of -2048 to +2047. If the range is exceeded a don't use indication is inserted into the user differential range error indicator (UDREI) field, see *Table 107* on *page 571*. You should ignore extra data sets not represented in the PRN mask.

The time of applicability (T0) of the PRC is the start of the epoch of the WNT second that is coincident with the transmission at the GEO satellite of the first bit of the message block.

**Message ID:** 297

**Log Type:** Asynch

**Recommended Input:**

log WAAS24a onchanged

**ASCII Example:**

```
#WAAS24A,COM1,0,34.0,SATTIME,1337,417108.000,00000000,0a33,1984;
134,2047,2047,2047,2047,-1,-2,14,14,14,14,11,14,2,2,0,0,1,0,0,0,
0,0,0,0,0,0,0,0,0,0,0*76ff954b
```



Each raw WAAS frame gives data for a specific frame decoder number. The WAAS24 message can be logged to view the data breakdown of WAAS frame 24 which contains mixed fast/slow corrections.



| Field # | Field type       | Data Description  | Format | Binary Bytes | Binary Offset | Scaling                         |
|---------|------------------|---|--------|--------------|---------------|---------------------------------|
| 1       | WAAS24 header    | Log header  |        | H            | 0             | -                               |
| 2       | prn              | Source PRN of message   | Ulong  | 4            | H             | -                               |
| 3       | prc0             | prc(i):<br>Fast corrections (-2048 to +2047)<br>for the prn in slot i<br>(i = 0-5)        | Long   | 4            | H+4           | -                               |
| 4       | prc1             |   | Long   | 4            | H+8           | -                               |
| 5       | prc2             |   | Long   | 4            | H+12          | -                               |
| 6       | prc3             |   | Long   | 4            | H+16          | -                               |
| 7       | prc4             |   | Long   | 4            | H+20          | -                               |
| 8       | prc5             |   | Long   | 4            | H+24          | -                               |
| 9       | udre0            | udre(i):<br>User differential range error<br>indicator for the prn in slot i<br>(i = 0-5) | Ulong  | 4            | H+28          | See Table<br>107 on<br>page 571 |
| 10      | udre1            |   | Ulong  | 4            | H+.32         |                                 |
| 11      | udre2            |   | Ulong  | 4            | H+36          |                                 |
| 12      | udre3            |   | Ulong  | 4            | H+40          |                                 |
| 13      | udre4            |   | Ulong  | 4            | H+44          |                                 |
| 14      | udre5            |   | Ulong  | 4            | H+48          |                                 |
| 15      | iodp             | Issue of PRN mask data  | Ulong  | 4            | H+52          | -                               |
| 16      | block id         | Associated message type   | Ulong  | 4            | H+56          |                                 |
| 17      | iodf             | Issue of fast corrections data  | Ulong  | 4            | H+60          | -                               |
| 18      | spare            | Spare value   | Ulong  | 4            | H+64          | -                               |
| 19      | vel              | Velocity code flag  | Ulong  | 4            | H+68          | -                               |
| 20      | mask1            | Index into PRN mask (Type 1)  | Ulong  | 4            | H+72          | -                               |
| 21      | iode1            | Issue of ephemeris data   | Ulong  | 4            | H+76          | -                               |
| 22      | dx1              | Delta x (ECEF)  | Long   | 4            | H+80          | 0.125                           |
| 23      | dy1              | Delta y (ECEF)  | Long   | 4            | H+84          | 0.125                           |
| 24      | dz1              | Delta z (ECEF)  | Long   | 4            | H+88          | 0.125                           |
| 25      | da <sup>f0</sup> | Delta a <sup>f0</sup> clock offset  | Long   | 4            | H+92          | 2 <sup>-31</sup>                |
| 26      | mask2            | Second index into PRN mask (Type 1)   | Ulong  | 4            | H+96          | -                               |

Continued on page 602.

| Field # | Field type       | Data Description                             | Format | Binary Bytes | Binary Offset | Scaling   |
|---------|------------------|--|--------|--------------|---------------|-----------|
| 27      | iode2            | Second issue of ephemeris data               | Ulong  | 4            | H+100         | -         |
| 28      | ddx              | Delta delta x (ECEF)                         | Long   | 4            | H+104         | $2^{-11}$ |
| 29      | ddy              | Delta delta y (ECEF)                         | Long   | 4            | H+108         | $2^{-11}$ |
| 30      | ddz              | Delta delta z (ECEF)                         | Long   | 4            | H+112         | $2^{-11}$ |
| 31      | da <sup>f1</sup> | Delta a <sup>f1</sup> clock offset           | Long   | 4            | H+116         | $2^{-39}$ |
| 32      | t <sub>0</sub>   | Applicable time of day                       | Ulong  | 4            | H+120         | 16        |
| 33      | iodp             | Issue of PRN mask data                       | Ulong  | 4            | H+124         | -         |
| 34      | corr spare       | Spare value when velocity code is equal to 0 | Ulong  | 4            | H+128         | -         |
| 35      | xxxx             | 32-bit CRC (ASCII and Binary only)           | Hex    | 4            | H+132         | -         |
| 36      | [CR][LF]         | Sentence terminator (ASCII only)             | -      | -            | H+136         | -         |

---

### 3.3.149 WAAS25 Long-Term Slow Satellite Corrections V123\_SBAS

WAAS25 provides error estimates for slow varying satellite ephemeris and clock errors with respect to WGS-84 ECEF coordinates.

**Message ID:** 298

**Log Type:** Asynch

**Recommended Input:**

log WAAS25a onchanged

**ASCII Example:**

```
#WAAS25A, COM1, 0, 37.5, SATTIME, 1337, 417193.000, 00000000, b8ff, 1984;  
134, 1, 19, 25, -1, -3, 0, -15, 0, 0, 0, 1, -1, -2, 4465, 2, 0, 1, 0, 0, 0, 0, 0, 0, 0,  
0, 0, 0, 0, 0, 0*81685317
```



Each raw WAAS frame gives data for a specific frame decoder number. The WAAS25 message can be logged to view the data breakdown of WAAS frame 25 which contains long-term slow satellite corrections.

---

| Field # | Field type               | Data Description   | Format | Binary Bytes | Binary Offset | Scaling          |
|---------|--------------------------|--|--------|--------------|---------------|------------------|
| 1       | WAAS25 header            | Log header   |        | H            | 0             | -                |
| 2       | prn                      | Source PRN of message  | Ulong  | 4            | H             | -                |
| 3       | 1st half vel             | Velocity code flag (0 or 1)  | Ulong  | 4            | H+4           | -                |
| 4       | 1st half mask1           | Index into PRN mask (Type 1)   | Ulong  | 4            | H+8           | -                |
| 5       | 1st half iode1           | Issue of ephemeris data  | Ulong  | 4            | H+12          | -                |
| 6       | 1st half dx1             | Delta x (ECEF)   | Long   | 4            | H+16          | 0.125            |
| 7       | 1st half dy1             | Delta y (ECEF)   | Long   | 4            | H+20          | 0.125            |
| 8       | 1st half dz1             | Delta z (ECEF)   | Long   | 4            | H+24          | 0.125            |
| 9       | 1st half a <sup>f0</sup> | Delta a <sup>f0</sup> clock offset   | Long   | 4            | H+28          | 2 <sup>-31</sup> |
| 10      | 1st half mask2           | Second index into PRN mask (Type 1)<br>Dummy value when velocity code = 1  | Ulong  | 4            | H+32          | -                |
| 11      | 1st half iode2           | Second issue of ephemeris data<br>Dummy value when velocity code = 1   | Ulong  | 4            | H+36          | -                |
| 12      | 1st half ddx             | Delta delta x (ECEF) when velocity code = 1<br>Delta x (dx) when velocity code = 0                                     | Long   | 4            | H+40          | 2 <sup>-11</sup> |
| 13      | 1st half ddy             | Delta delta y (ECEF) when velocity code = 1<br>Delta y (dy) when velocity code = 0                                     | Long   | 4            | H+44          | 2 <sup>-11</sup> |
| 14      | 1st half ddz             | Delta delta z (ECEF) when velocity code = 1<br>Delta z (dz) when velocity code = 0                                     | Long   | 4            | H+48          | 2 <sup>-11</sup> |
| 15      | 1st half a <sup>f1</sup> | Delta a <sup>f1</sup> clock offset when velocity code = 1<br>Delta a <sup>f0</sup> clock offset when velocity code = 0 | Long   | 4            | H+52          | 2 <sup>-39</sup> |
| 16      | 1st half t <sub>0</sub>  | Applicable time of day<br>Dummy value when velocity code = 0   | Ulong  | 4            | H+56          | 16               |
| 17      | 1st half iodp            | Issue of PRN mask data   | Ulong  | 4            | H+60          | -                |
| 18      | 1st half corr spare      | Spare value when velocity code = 0<br>Dummy value when velocity code = 1   | Ulong  | 4            | H+64          | -                |

Continued on page 605.

| Field # | Field type               | Data Description   | Format | Binary Bytes | Binary Offset | Scaling          |
|---------|--------------------------|--|--------|--------------|---------------|------------------|
| 19      | 2nd half vel             | Velocity code flag (0 or 1)  | Ulong  | 4            | H+68          | -                |
| 20      | 2nd half mask1           | Index into PRN mask (Type 1)   | Ulong  | 4            | H+72          | -                |
| 21      | 2nd half iode1           | Issue of ephemeris data  | Ulong  | 4            | H+76          | -                |
| 22      | 2nd half dx1             | Delta x (ECEF)   | Long   | 4            | H+80          | 0.125            |
| 23      | 2nd half dy1             | Delta y (ECEF)   | Long   | 4            | H+84          | 0.125            |
| 24      | 2nd half dz1             | Delta z (ECEF)   | Long   | 4            | H+88          | 0.125            |
| 25      | 2nd half a <sup>f0</sup> | Delta a <sup>f0</sup> clock offset   | Long   | 4            | H+92          | 2 <sup>-31</sup> |
| 26      | 2nd half mask2           | Second index into PRN mask (Type 1)<br>Dummy value when velocity code = 1  | Ulong  | 4            | H+96          | -                |
| 27      | 2nd half iode2           | Second issue of ephemeris data<br>Dummy value when velocity code = 1   | Ulong  | 4            | H+100         | -                |
| 28      | 2nd half ddx             | Delta delta x (ECEF) when velocity code = 1<br>Delta x (dx) when velocity code = 0                                     | Long   | 4            | H+104         | 2 <sup>-11</sup> |
| 29      | 2nd half ddy             | Delta delta y (ECEF) when velocity code = 1<br>Delta y (dy) when velocity code = 0                                     | Long   | 4            | H+108         | 2 <sup>-11</sup> |
| 30      | 2nd half ddz             | Delta delta z (ECEF) when velocity code = 1<br>Delta z (dz) when velocity code = 0                                     | Long   | 4            | H+112         | 2 <sup>-11</sup> |
| 31      | 2nd half a <sup>f1</sup> | Delta a <sup>f1</sup> clock offset when velocity code = 1<br>Delta a <sup>f0</sup> clock offset when velocity code = 0 | Long   | 4            | H+116         | 2 <sup>-39</sup> |
| 32      | 2nd half t <sub>0</sub>  | Applicable time of day<br>Dummy value when velocity code = 0   | Ulong  | 4            | H+120         | 16               |
| 33      | 2nd half iodp            | Issue of PRN mask data   | Ulong  | 4            | H+124         | -                |
| 34      | 2nd half corr spare      | Spare value when velocity code = 0<br>Dummy value when velocity code = 1   | Ulong  | 4            | H+128         | -                |
| 35      | xxxx                     | 32-bit CRC (ASCII and Binary only)   | Hex    | 4            | H+132         | -                |
| 36      | [CR][LF]                 | Sentence terminator (ASCII only)   | -      | -            | H+136         | -                |

### 3.3.150 WAAS26 Ionospheric Delay Corrections V123\_SBAS

WAAS26 provides vertical delays (relative to an L1 signal) and their accuracy at geographically defined IGP's identified by the BAND NUMBER and IGP number. Each message contains a band number and a block ID, which indicates the location of the IGP's in the respective band mask.

**Message ID:** 299

**Log Type:** Asynch

**Recommended Input:**

log WAAS26a onchanged

**ASCII Example:**

```
#WAAS26A,COM1,0,38.0,SATTIME,1337,417243.000,00000000,ec70,1984;  
134,1,2,15,27,11,25,11,23,11,19,11,16,11,16,12,15,13,16,13,29,14,  
30,13,27,11,27,11,24,11,19,11,16,12,2,0*3b6d6806
```



Each raw WAAS frame gives data for a specific frame decoder number. The WAAS26 message can be logged to view the data breakdown of WAAS frame 26 which contains ionospheric delay corrections.

| Field #  | Field type                            | Data Description                                 | Format | Binary Bytes | Binary Offset       | Scaling |
|----------|---------------------------------------|--|--------|--------------|---------------------|---------|
| 1        | WAAS26 header                         | Log header                                       |        | H            | 0                   | -       |
| 2        | prn                                   | Source PRN of message                            | Ulong  | 4            | H                   | -       |
| 3        | band num                              | Band number                                      | Ulong  | 4            | H+4                 | -       |
| 4        | block id                              | Block ID   | Ulong  | 4            | H+8                 | -       |
| 5        | #pts                                  | Number of grid points with information to follow | Ulong  | 4            | H+12                | -       |
| 6        | igp <sub>vde</sub>                    | IGP vertical delay estimates                     | Ulong  | 4            | H+16                | 0.125   |
| 7        | givei                                 | Grid ionospheric vertical error indicator        | Ulong  | 4            | H+20                | -       |
| 8...     | Next #pts entry = H + 16 + (#pts x 8) |  |        |              |                     |         |
| variable | iodi                                  | Issue of data - ionosphere                       | Ulong  | 4            | H+16+<br>(#pts x 8) |         |
| variable | spare                                 | 7 spare bits                                     | Ulong  | 4            | H+20+<br>(#pts x 8) | -       |
| variable | xxxx                                  | 32-bit CRC (ASCII and Binary only)               | Hex    | 4            | H+24+<br>(#pts x 8) | -       |
| variable | [CR][LF]                              | Sentence terminator (ASCII only)                 | -      | -            | -                   | -       |

---

### 3.3.151 WAAS27 SBAS Service Message V123\_SBAS

WAAS27 messages apply only to the service provider transmitting the message. The number of service messages indicates the total number of unique WAAS27 messages for the current IODS. Each unique message for that IODS includes a sequential message number. The IODS is incremented in all messages, each time that any parameter in any WAAS27 message is changed.

**Message ID:** 300

**Log Type:** Asynch

**Recommended Input:**

log WAAS27a onchanged

**ASCII Example:**

Not available at time of print.



Each raw WAAS frame gives data for a specific frame decoder number. The WAAS27 message can be logged to view the data breakdown of WAAS frame 27 which contains information on SBAS service messages.

---



| Field #  | Field type                             | Data Description                             | Format | Binary Bytes | Binary Offset        | Scaling |
|----------|--|--|--------|--------------|----------------------|---------|
| 1        | WAAS27 header                          | Log header                                   |        | H            | 0                    | -       |
| 2        | prn                                    | Source PRN of message                        | Ulong  | 4            | H                    | -       |
| 3        | iods                                   | Issue of slow corrections data               | Ulong  | 4            | H+4                  | -       |
| 4        | #messages                              | Low-by-one count of messages                 | Ulong  | 4            | H+8                  | -       |
| 5        | message num                            | Low-by-one message number                    | Ulong  | 4            | H+12                 | -       |
| 6        | priority code                          | Priority code                                | Ulong  | 4            | H+16                 | -       |
| 7        | dudre inside                           | Delta user differential range error - inside | Ulong  | 4            | H+20                 | -       |
| 8        | dudre outside                          | Delta user differential range error -outside | Ulong  | 4            | H+24                 | -       |
| 9...     | #reg                                   | Number of regions with information to follow | Ulong  | 4            | H+28                 | -       |
| variable | lat1                                   | Coordinate 1 latitude                        | Long   | 4            | H+32                 | -       |
| variable | lon1                                   | Coordinate 1 longitude                       | Long   | 4            | H+36                 | -       |
| variable | lat2                                   | Coordinate 2 latitude                        | Long   | 4            | H+40                 | -       |
| variable | lon2                                   | Coordinate 2 longitude                       | Long   | 4            | H+44                 | -       |
| variable | shape                                  | Shape where: 0 = triangle<br>1 = square      | Ulong  | 4            | H+48                 | -       |
| variable | Next #reg entry = H + 32 + (#reg x 20) |  |        |              |                      |         |
| variable | t <sub>0</sub>                         | Time of applicability                        | Ulong  | 4            | H+32+<br>(#reg x 20) | 16      |
| variable | xxxx                                   | 32-bit CRC (ASCII and Binary only)           | Hex    | 4            | H+36+<br>(#reg x 20) | -       |
| variable | [CR][LF]                               | Sentence terminator (ASCII only)             | -      | -            | -                    | -       |

### 3.3.152 WAAS32 CDGPS Fast Correction Slots 0-10 VI3\_CDGPS

WAAS32 are fast corrections for slots 0-10 in the mask of WAAS1 for CDGPS, see page 569.

**Message ID:** 696

**Log Type:** Asynch

**Recommended Input:**

log WAAS32a onchanged

**ASCII Example:**

```
#WAAS32A,COM2,0,70.5,FINE,1295,153284.000,00000240,18e9,34461;209,0,0,  
-8097,0,0,0,0,-947,0,-2128,0,2570,14,0,14,14,14,14,0,14,0,14,0*58778ae5
```



The CDGPS data signal is structured to perform well in difficult, or foliated conditions, so the service is available more consistently. The network has a high degree of service reliability. The corrections signal has been structured around an open broadcast protocol so that additional hardware and software developers can easily extend the value of the data. The service is available on a cost-free basis.

For example, when tree harvesting, a boom operator can know exactly where he is in the forest at any given time of the day or night. In one application, the position of the antenna is shown on a screen and has a buffer ring around it which corresponds to the reach of the boom. The operator knows how close he can go to the boundary without crossing it. As well, he is able to flag obstacles or danger points in the harvest area for reference later and by other operators. The data is downloadable for post-processing and analysis later.

---

**Table 108: Evaluation of CDGPS UDREI**

| UDREI | UDRE meters   |
|-------|---------------|
| 0     | 0.01          |
| 1     | 0.02          |
| 2     | 0.03          |
| 3     | 0.05          |
| 4     | 0.10          |
| 5     | 0.15          |
| 6     | 0.20          |
| 7     | 0.25          |
| 8     | 0.30          |
| 9     | 0.35          |
| 10    | 0.40          |
| 11    | 0.45          |
| 12    | 0.50          |
| 13    | 0.60          |
| 14    | Not Monitored |
| 15    | Do Not Use    |

| Field # | Field type    | Data Description   | Format | Binary Bytes | Binary Offset | Scaling  |
|---------|---------------|--|--------|--------------|---------------|--|
| 1       | WAAS32 header | Log header   |        | H            | 0             |  |
| 2       | prn           | Source PRN of message  | Ulong  | 4            | H             | -  |
| 3       | iodp          | Issue of PRN mask data   | Ulong  | 4            | H+4           | -  |
| 4       | prc0          | prc(i):<br>Fast corrections (-2048 to +2047) for the prn in slot i (i = 0-10)        | Long   | 4            | H+8           | -  |
| 5       | prc1          |  | Long   | 4            | H+12          | -  |
| 6       | prc2          |  | Long   | 4            | H+16          | -  |
| 7       | prc3          |  | Long   | 4            | H+20          | -  |
| 8       | prc4          |  | Long   | 4            | H+24          | -  |
| 9       | prc5          |  | Long   | 4            | H+28          | -  |
| 10      | prc6          |  | Long   | 4            | H+32          | -  |
| 11      | prc7          |  | Long   | 4            | H+36          | -  |
| 12      | prc8          |  | Long   | 4            | H+40          | -  |
| 13      | prc9          |  | Long   | 4            | H+44          | -  |
| 14      | prc10         |  | Long   | 4            | H+48          | -  |
| 15      | udre0         | udre(i):<br>User differential range error indicator for the prn in slot i (i = 0-10) | Ulong  | 4            | H+52          | See Table 108, Evaluation of CDGPS UDREI on page 611 |
| 16      | udre1         |  | Ulong  | 4            | H+56          |  |
| 17      | udre2         |  | Ulong  | 4            | H+60          |  |
| 18      | udre3         |  | Ulong  | 4            | H+64          |  |
| 19      | udre4         |  | Ulong  | 4            | H+68          |  |
| 20      | udre5         |  | Ulong  | 4            | H+72          |  |
| 21      | udre6         |  | Ulong  | 4            | H+76          |  |
| 22      | udre7         |  | Ulong  | 4            | H+80          |  |
| 23      | udre8         |  | Ulong  | 4            | H+84          |  |
| 24      | udre9         |  | Ulong  | 4            | H+88          |  |
| 25      | udre10        |  | Ulong  | 4            | H+92          |  |
| 26      | xxxx          | 32-bit CRC (ASCII and Binary only)   | Hex    | 4            | H+96          | -  |
| 27      | [CR][LF]      | Sentence terminator (ASCII only)   | -      | -            | -             | -  |

---

### 3.3.153 WAAS33 CDGPS Fast Correction Slots 11-21 VI3\_CDGPS

WAAS33 are fast corrections for slots 11-21 in the mask for CDGPS.

**Message ID:** 697

**Log Type:** Asynch

**Recommended Input:**

log WAAS33a onchanged

**ASCII Example:**

```
#WAAS33A,COM2,0,47.5,FINE,1295,158666.000,01000240,b23e,34461;209,0,0,-3343,0,0,0,-533,0,0,0,0,0,14,0,14,14,14,0,14,14,14,14,14*6d890f5f
```



Each raw CDGPS mask frame gives data for a specific frame decoder number. The WAAS33 message can be logged to view the data breakdown of WAAS frame 33 which contains information on CDGPS fast correction slots 11-21.

---

| Field # | Field type    | Data Description  | Format | Binary Bytes | Binary Offset | Scaling  |
|---------|---------------|---|--------|--------------|---------------|--|
| 1       | WAAS33 header | Log header  |        | H            | 0             |  |
| 2       | prn           | Source PRN of message   | Ulong  | 4            | H             | -  |
| 3       | iodp          | Issue of PRN mask data  | Ulong  | 4            | H+4           | -  |
| 4       | prc11         | prc(i):<br>Fast corrections (-2048 to +2047) for the prn in slot i (i = 11-21)        | Long   | 4            | H+8           | -  |
| 5       | prc12         |   | Long   | 4            | H+12          | -  |
| 6       | prc13         |   | Long   | 4            | H+16          | -  |
| 7       | prc14         |   | Long   | 4            | H+20          | -  |
| 8       | prc15         |   | Long   | 4            | H+24          | -  |
| 9       | prc16         |   | Long   | 4            | H+28          | -  |
| 10      | prc17         |   | Long   | 4            | H+32          | -  |
| 11      | prc18         |   | Long   | 4            | H+36          | -  |
| 12      | prc19         |   | Long   | 4            | H+40          | -  |
| 13      | prc20         |   | Long   | 4            | H+44          | -  |
| 14      | prc21         |   | Long   | 4            | H+48          | -  |
| 15      | udre11        | udre(i):<br>User differential range error indicator for the prn in slot i (i = 11-21) | Ulong  | 4            | H+52          | See Table 108, Evaluation of CDGPS UDREI on page 611 |
| 16      | udre12        |   | Ulong  | 4            | H+56          |  |
| 17      | udre13        |   | Ulong  | 4            | H+60          |  |
| 18      | udre14        |   | Ulong  | 4            | H+64          |  |
| 19      | udre15        |   | Ulong  | 4            | H+68          |  |
| 20      | udre16        |   | Ulong  | 4            | H+72          |  |
| 21      | udre17        |   | Ulong  | 4            | H+76          |  |
| 22      | udre18        |   | Ulong  | 4            | H+80          |  |
| 23      | udre19        |   | Ulong  | 4            | H+84          |  |
| 24      | udre20        |   | Ulong  | 4            | H+88          |  |
| 25      | udre21        |   | Ulong  | 4            | H+92          |  |
| 26      | xxxx          | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+96          | -  |
| 27      | [CR][LF]      | Sentence terminator (ASCII only)  | -      | -            | -             | -  |

---

### 3.3.154 WAAS34 CDGPS Fast Correction Slots 22-32 V13\_CDGPS

WAAS34 are fast corrections for slots 22-32 in the mask of WAAS1 for CDGPS, see *page 569*.

**Message ID:** 698

**Log Type:** Asynch

**Recommended Input:**

log WAAS34a onchanged

**ASCII Example:**

```
#WAAS34A,COM2,0,73.0,FINE,1295,226542.000,00000040,1be8,34461;209,0,5879,0,0,  
0,0,2687,0,10922,10922,10922,10922,0,14,14,14,14,0,14,15,15,15,15*3aeb74be
```



Each raw CDGPS mask frame gives data for a specific frame decoder number. The WAAS34 message can be logged to view the data breakdown of WAAS frame 34 which contains information on CDGPS fast correction slots 22-32.

---

| Field # | Field type    | Data Description  | Format | Binary Bytes | Binary Offset | Scaling   |
|---------|---------------|---|--------|--------------|---------------|---|
| 1       | WAAS34 header | Log header  |        | H            | 0             |   |
| 2       | prn           | Source PRN of message   | Ulong  | 4            | H             | -   |
| 3       | iodp          | Issue of PRN mask data  | Ulong  | 4            | H+4           | -   |
| 4       | prc22         | prc(i):<br>Fast corrections (-2048 to +2047)<br>for the prn in slot i (i = 22-32)           | Long   | 4            | H+8           | -   |
| 5       | prc23         |   | Long   | 4            | H+12          | -   |
| 6       | prc24         |   | Long   | 4            | H+16          | -   |
| 7       | prc25         |   | Long   | 4            | H+20          | -   |
| 8       | prc26         |   | Long   | 4            | H+24          | -   |
| 9       | prc27         |   | Long   | 4            | H+28          | -   |
| 10      | prc28         |   | Long   | 4            | H+32          | -   |
| 11      | prc29         |   | Long   | 4            | H+36          | -   |
| 12      | prc30         |   | Long   | 4            | H+40          | -   |
| 13      | prc31         |   | Long   | 4            | H+44          | -   |
| 14      | prc32         |   | Long   | 4            | H+48          | -   |
| 15      | udre22        | udre(i):<br>User differential range error<br>indicator for the prn in slot i<br>(i = 22-32) | Ulong  | 4            | H+52          | See Table<br>108,<br>Evaluation<br>of CDGPS<br>UDREI on<br>page 611 |
| 16      | udre23        |   | Ulong  | 4            | H+56          |   |
| 17      | udre24        |   | Ulong  | 4            | H+60          |   |
| 18      | udre25        |   | Ulong  | 4            | H+64          |   |
| 19      | udre26        |   | Ulong  | 4            | H+68          |   |
| 20      | udre27        |   | Ulong  | 4            | H+72          |   |
| 21      | udre28        |   | Ulong  | 4            | H+76          |   |
| 22      | udre29        |   | Ulong  | 4            | H+80          |   |
| 23      | udre30        |   | Ulong  | 4            | H+84          |   |
| 24      | udre31        |   | Ulong  | 4            | H+88          |   |
| 25      | udre32        |   | Ulong  | 4            | H+92          |   |
| 26      | xxxx          | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+96          | -   |
| 27      | [CR][LF]      | Sentence terminator (ASCII only)  | -      | -            | -             | -   |



---

### 3.3.155 WAAS35 CDGPS Fast Correction Slots 33-43 V13\_CDGPS

WAAS35 are fast corrections for slots 33-43 in the mask of WAAS1 for CDGPS, see *page 569*.

**Message ID:** 699

**Log Type:** Asynch

**Recommended Input:**

log WAAS35a unchanged

**ASCII Example:**

This message is not being broadcast by CDGPS at the time of publication.



Each raw CDGPS mask frame gives data for a specific frame decoder number. The WAAS35 message can be logged to view the data breakdown of WAAS frame 35 which contains information on CDGPS fast correction slots 33-43.

---

| Field # | Field type    | Data Description  | Format | Binary Bytes | Binary Offset | Scaling   |
|---------|---------------|---|--------|--------------|---------------|---|
| 1       | WAAS35 header | Log header  |        | H            | 0             |   |
| 2       | prn           | Source PRN of message   | Ulong  | 4            | H             | -   |
| 3       | iodp          | Issue of PRN mask data  | Ulong  | 4            | H+4           | -   |
| 4       | prc33         | prc(i):<br>Fast corrections (-2048 to +2047)<br>for the prn in slot i (i = 33-43)           | Long   | 4            | H+8           | -   |
| 5       | prc34         |   | Long   | 4            | H+12          | -   |
| 6       | prc35         |   | Long   | 4            | H+16          | -   |
| 7       | prc36         |   | Long   | 4            | H+20          | -   |
| 8       | prc37         |   | Long   | 4            | H+24          | -   |
| 9       | prc38         |   | Long   | 4            | H+28          | -   |
| 10      | prc39         |   | Long   | 4            | H+32          | -   |
| 11      | prc40         |   | Long   | 4            | H+36          | -   |
| 12      | prc41         |   | Long   | 4            | H+40          | -   |
| 13      | prc42         |   | Long   | 4            | H+44          | -   |
| 14      | prc43         |   | Long   | 4            | H+48          | -   |
| 15      | udre33        | udre(i):<br>User differential range error<br>indicator for the prn in slot i<br>(i = 33-43) | Ulong  | 4            | H+52          | See Table<br>108,<br>Evaluation<br>of CDGPS<br>UDREI on<br>page 611 |
| 16      | udre34        |   | Ulong  | 4            | H+56          |   |
| 17      | udre35        |   | Ulong  | 4            | H+60          |   |
| 18      | udre36        |   | Ulong  | 4            | H+64          |   |
| 19      | udre37        |   | Ulong  | 4            | H+68          |   |
| 20      | udre38        |   | Ulong  | 4            | H+72          |   |
| 21      | udre39        |   | Ulong  | 4            | H+76          |   |
| 22      | udre40        |   | Ulong  | 4            | H+80          |   |
| 23      | udre41        |   | Ulong  | 4            | H+84          |   |
| 24      | udre42        |   | Ulong  | 4            | H+88          |   |
| 25      | udre43        |   | Ulong  | 4            | H+92          |   |
| 26      | xxxx          | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+96          | -   |
| 27      | [CR][LF]      | Sentence terminator (ASCII only)  | -      | -            | -             | -   |

### 3.3.156 WAAS45 CDGPS Slow Corrections V13\_CDGPS

Each WAAS45 message contains a 2-bit IODP indicating the associated PRN mask.

The time of applicability (T0) of the PRC is the start of the epoch of the WNT second that is coincident with the transmission at the CDGPS satellite (PRN 209) of the first bit of the message block.

**Message ID:** 700  
**Log Type:** Asynch

#### Recommended Input:

log WAAS45a onchanged

#### ASCII Example:

```
#WAAS45A,COM2,0,73.0,FINE,1295,228498.000,00000040,c730,34461;209,23,32,197,  
-116,206,-1,-6,-3,-5546,3488,25,148,262,-312,867,4,3,0,2513,3488,0*02d6e0d5
```



Each raw CDGPS mask frame gives data for a specific frame decoder number. The WAAS45 message can be logged to view the data breakdown of WAAS frame 45 which contains information on CDGPS slow corrections.

| Field # | Field type         | Data Description                    | Format | Binary Bytes | Binary Offset | Scaling   |
|---------|--------------------|-------------------------------------|--------|--------------|---------------|-----------|
| 1       | WAAS45 header      | Log header                          |        | H            | 0             | -         |
| 2       | prn                | Source PRN of message               | Ulong  | 4            | H             | -         |
| 3       | mask1              | Index into PRN mask (Type 1)        | Ulong  | 4            | H+4           | -         |
| 4       | iode1              | Issue of ephemeris data             | Ulong  | 4            | H+8           | -         |
| 5       | dx1                | Delta x (ECEF)                      | Long   | 4            | H+12          | 0.125     |
| 6       | dy1                | Delta y (ECEF)                      | Long   | 4            | H+16          | 0.125     |
| 7       | dz1                | Delta z (ECEF)                      | Long   | 4            | H+20          | 0.125     |
| 8       | ddx                | Delta delta x (ECEF)                | Long   | 4            | H+24          | $2^{-11}$ |
| 9       | ddy                | Delta delta y (ECEF)                | Long   | 4            | H+28          | $2^{-11}$ |
| 10      | ddz                | Delta delta z (ECEF)                | Long   | 4            | H+32          | $2^{-11}$ |
| 11      | da <sup>f0</sup> 1 | Delta a <sup>f0</sup> clock offset  | Long   | 4            | H+36          | $2^{-31}$ |
| 12      | t <sub>0</sub> 1   | Applicable time of day              | Ulong  | 4            | H+40          | 16        |
| 13      | mask2              | Second index into PRN mask (Type 1) | Ulong  | 4            | H+44          | -         |
| 14      | iode2              | Second issue of ephemeris data      | Ulong  | 4            | H+48          | -         |
| 15      | dx1                | Delta x (ECEF)                      | Long   | 4            | H+52          | 0.125     |
| 16      | dy1                | Delta y (ECEF)                      | Long   | 4            | H+56          | 0.125     |
| 17      | dz1                | Delta z (ECEF)                      | Long   | 4            | H+60          | 0.125     |
| 18      | ddx                | Delta delta x (ECEF)                | Long   | 4            | H+64          | $2^{-11}$ |
| 19      | ddy                | Delta delta y (ECEF)                | Long   | 4            | H+68          | $2^{-11}$ |
| 20      | ddz                | Delta delta z (ECEF)                | Long   | 4            | H+72          | $2^{-11}$ |
| 21      | da <sup>f0</sup> 2 | Delta a <sup>f0</sup> clock offset  | Long   | 4            | H+76          | $2^{-31}$ |
| 22      | t <sub>0</sub> 2   | Applicable time of day              | Ulong  | 4            | H+80          | 16        |
| 23      | iodp               | Issue of PRN mask data              | Ulong  | 4            | H+84          | -         |
| 24      | xxxx               | 32-bit CRC (ASCII and Binary only)  | Hex    | 4            | H+88          | -         |
| 25      | [CR][LF]           | Sentence terminator (ASCII only)    | -      | -            | -             | -         |

### 3.3.157 WAASCORR SBAS Range Corrections Used V123\_SBAS

The information is updated with each pseudorange position calculation. It has an entry for each tracked satellite. Satellites that are not included in an SBAS corrected solution have 0.0 in both the 'psr corr' and 'corr stdv' fields.

The 'psr corr' is the combined fast and slow corrections and is to be added to the pseudorange. Ionospheric and tropospheric corrections are not included and should be applied separately.

**Message ID:** 313  
**Log Type:** Synch

#### Recommended Input:

log waascorra ontime 1

#### ASCII Example:

```
#WAASCORRA,COM1,0,40.5,FINESTEERING,1337,417485.000,01000000,3b3b,1984;
20,
3,101,0.0000,0.0000,3,0,0.0000,0.0000,
2,133,0.0000,0.0000,2,0,0.0000,0.0000,
23,48,0.0000,0.0000,23,0,0.0000,0.0000,
4,55,0.0000,0.0000,4,0,0.0000,0.0000,
16,197,0.0000,0.0000,16,0,0.0000,0.0000,
20,25,0.0000,0.0000,20,0,0.0000,0.0000,
27,26,0.0000,0.0000,27,0,0.0000,0.0000,
25,186,0.0000,0.0000,25,0,0.0000,0.0000,
13,85,0.0000,0.0000,13,0,0.0000,0.0000,
122,0,0.0000,0.0000,134,0,0.0000,0.0000*0af4c14d
```



The SBAS pseudorange corrections can be added to the raw pseudorange for a more accurate solution in applications that compute their own solutions.

| Field #  | Field type                         | Data Description  | Format | Binary Bytes | Binary Offset    |
|----------|------------------------------------|---|--------|--------------|------------------|
| 1        | WAASCORR header                    | Log header  |        | H            | 0                |
| 2        | #sat                               | Number of satellites with information to follow         | Ulong  | 4            | H                |
| 3        | prn                                | Satellite PRN   | Ulong  | 4            | H+4              |
| 4        | iode                               | Issue of ephemeris data for which the corrections apply | Ulong  | 4            | H+8              |
| 5        | psr corr                           | SBAS pseudorange correction (m)                         | Float  | 4            | H+12             |
| 6        | corr stdv                          | Standard deviation of pseudorange correction (m)        | Float  | 4            | H+16             |
| 7...     | Next sat entry = H+4 + (#sat x 16) |   |        |              |                  |
| variable | xxxx                               | 32-bit CRC (ASCII and Binary only)                      | Hex    | 4            | H+4+ (#sat x 16) |
| variable | [CR][LF]                           | Sentence terminator (ASCII only)                        | -      | -            | -                |

The receiver is capable of outputting several responses for various conditions. Most of these responses are error messages to indicate when something is not correct.

The output format of the messages is dependant on the format of the input command. If the command is input as abbreviated ASCII, the output will be abbreviated ASCII. Likewise for ASCII and binary formats. *Table 109* outlines the various responses.

**Table 109: Response Messages**

| ASCII Message                         | Binary Message ID | Meaning  |
|---------------------------------------|-------------------|--|
| OK                                    | 1                 | Command was received correctly.  |
| REQUESTED LOG DOES NOT EXIST          | 2                 | The log requested does not exist.  |
| NOT ENOUGH RESOURCES IN SYSTEM        | 3                 | The request has exceeded a limit (for example, the maximum number of logs are being generated).                    |
| DATA PACKET DOESN'T VERIFY            | 4                 | Data packet is not verified  |
| COMMAND FAILED ON RECEIVER            | 5                 | Command did not succeed in accomplishing requested task.   |
| INVALID MESSAGE ID                    | 6                 | The input message ID is not valid.   |
| INVALID MESSAGE. FIELD = X            | 7                 | Field x of the input message is not correct.   |
| INVALID CHECKSUM                      | 8                 | The checksum of the input message is not correct. This only applies to ASCII and binary format messages.           |
| MESSAGE MISSING FIELD                 | 9                 | A field is missing from the input message.   |
| ARRAY SIZE FOR FIELD X EXCEEDS MAX    | 10                | Field x contains more array elements than allowed.   |
| PARAMETER X IS OUT OF RANGE           | 11                | Field x of the input message is outside the acceptable limits.   |
| TRIGGER X NOT VALID FOR THIS LOG      | 14                | Trigger type x is not valid for this type of log.  |
| AUTHCODE TABLE FULL - RELOAD SOFTWARE | 15                | Too many authcodes are stored in the receiver. The receiver firmware must be reloaded.                             |
| INVALID DATE FORMAT                   | 16                | This error is related to the inputting of authcodes. It indicates that the date attached to the code is not valid. |

*Continued on Page 624*

| ASCII Message                           | Binary Message ID | Meaning   |
|---|-------------------|---|
| INVALID AUTHCODE ENTERED                | 17                | The authcode entered is not valid.                  |
| NO MATCHING MODEL TO REMOVE             | 18                | The model requested for removal does not exist.     |
| NOT VALID AUTH CODE FOR THAT MODEL      | 19                | The model attached to the authcode is not valid.    |
| CHANNEL IS INVALID                      | 20                | The selected channel is invalid.                    |
| REQUESTED RATE IS INVALID               | 21                | The requested rate is invalid.                      |
| WORD HAS NO MASK FOR THIS TYPE          | 22                | The word has no mask for this type of log.          |
| CHANNELS LOCKED DUE TO ERROR            | 23                | Channels are locked due to error.                   |
| INJECTED TIME INVALID                   | 24                | Injected time is invalid                            |
| COM PORT NOT SUPPORTED                  | 25                | The COM or USB port is not supported.               |
| MESSAGE IS INCORRECT                    | 26                | The message is invalid.                             |
| INVALID PRN                             | 27                | The PRN is invalid.                                 |
| PRN NOT LOCKED OUT                      | 28                | The PRN is not locked out.                          |
| PRN LOCKOUT LIST IS FULL                | 29                | PRN lockout list is full.                           |
| PRN ALREADY LOCKED OUT                  | 30                | The PRN is already locked out.                      |
| MESSAGE TIMED OUT                       | 31                | Message timed out.                                  |
| UNKNOWN COM PORT REQUESTED              | 33                | Unknown COM or USB port requested.                  |
| HEX STRING NOT FORMATTED CORRECTLY      | 34                | Hex string not formatted correctly.                 |
| INVALID BAUD RATE                       | 35                | The baud rate is invalid.                           |
| MESSAGE IS INVALID FOR THIS MODEL       | 36                | This message is invalid for this model of receiver. |
| COMMAND ONLY VALID IF IN NVM FAIL MODE  | 40                | Command is only valid if NVM is in fail mode        |
| INVALID OFFSET                          | 41                | The offset is invalid.                              |
| MAXIMUM NUMBER OF USER MESSAGES REACHED | 78                | Maximum number of user messages has been reached.   |
| GPS PRECISE TIME IS ALREADY KNOWN       | 84                | GPS precise time is already known.                  |



# Index

## A

A model, 565

abbreviated ascii, 19, 23

accumulated doppler range (ADR), 393, 473

accuracy

    correction, 115

    degradation, 247

    limit, 161

    navigation, 443

    position, 115

    RTK solution, 223

    time, 32

acquisition, 65, 115, 203, 394

ADJUST1PPS command, 56

adjustable PPS, 164

ADR, *see* accumulated doppler range

age

    differential

        RTK, 223, 532, 534

        velocity, 257, 259, 389, 391, 537

        xyz coordinates, 259, 391, 537

    solution

        at mark input, 354

        ECEF coordinates, 259, 391, 537

        OmniSTAR HP/XP, 370

        position, 251, 386

        RTK, 533

        UTM coordinates, 253

agriculture, 179, 369, 568

aircraft, 109, 256, 534

almanac

    complete, 554

    data, 189, 308

    GEO, 597

    GLONASS, 291, 293

    log, 225, 227, 243

    lost, 158

    raw data, 403

    reset, 124

    stored, 125

    time status, 31

ALMANAC log, 243

along track, 363, 365

ambiguity

    half cycle, 393

    type, 530

anomaly, 244, 561

antenna

    active, 64

    altitude, 110, 311, 313, 315

    base station, 76

    delay, 85

    high altitude, 217

    motion, 67, 69, 174

    phase center, 117, 463

    position, 353

    receiver status, 543

    reference point, 463

    reference point (ARP), 484-485, 497

    rover station, 62

    speed, 365

    type, 463

ANTENNAMODEL command, 62

ANTENNAPOWER command, 64

anti-spoofing (AS), 244

ascii

    display, 448, 471

    message, 21, 40

    overview, 21

    printable data, 185

    redirect, 373

    response, 28

    send, 185

    text message, 196-197

    transfer, 196

assign

    cancel, 203

    channel, 39, 65

    cut-off angle, 110, 129, 217

ASSIGN command, 65

ASSIGNALL command, 68

ASSIGNLBAND command, 70

asterisk, 21

asynchronous log, 219

atmospheric

- delay, 393
- noise, 111
- refraction, 110, 217
- AUTH command, 74
- authorization, 38, 74-75
- AUX port
  - break condition, 90
  - identifier, 26-27, 88
  - interface mode, 138
  - pass-through log, 238, 373
  - RS-232 port control, 92
- AVEPOS log, 245
- averaging, position, 40, 161, 245
- azimuth, 324, 554
  
- B**
- B model, 565
- bandwidth, 180
- base station
  - aiding, 189
  - antenna model, 76
  - basic, 263
  - command, 40
  - common to rover, 375, 383
  - distance from rover, 262
  - ephemeris, 103
  - health, 463, 481
  - height, 460
  - ID, 463, 481
  - L-band, 436
  - log, 227-228
  - moving, 154
  - network RTK, 175
  - observations, 176
  - parameter, 441
  - parameters, 460
  - position, 430-431
  - radio, 534
  - satellite visibility, 553
  - send data, 185, 534
  - standard corrections, 421
  - status, 414
  - unique messages, 361
  - virtual, 176
- BASEANTENNA\_MODEL command, 76
- baseline
  - dual frequency, 526
  - length, 262
  - RTK, 224, 228, 414
- baseline
  - heading, 338
- battery, 275
- baud rate, *see* bps
- beam frequency, 72
- bearing, 148-149, 328, 363, 365
- BESTPOS log, 247
- BESTUTM log, 252
- BESTVEL log, 252
- BESTXYZ log, 258
- bias, 79
- bi-directional communication, 373
- binary
  - overview, 23
  - raw ephemeris, 405
  - redirect, 373
  - response, 28
  - RTCA, 418
- bit rate, *see* bps
- Bluetooth, 201
- boom operator, 610
- bps, 89, 158
- break, 87, 89-90, 138, 382
- bridge, 159
- broadcast
  - almanac, 308
  - correction, 443
  - observation data, 473
- BSLNXYZ log, 262
- buffer, 143
- Built-In Status Test (BIT), 543
- Bursa-Wolf transformation, 96
- byte, 20, 24, 29
  
- C**
- C/No, *see* carrier to noise density ratio
- cable
  - delay, 85
  - external device, 151, 353
  - integrity, 124
  - null modem, 58
  - serial, 375
- car, 532
- carrier phase, ??-402
  - jump, 79

- RTK, 271, 426, 428, 451, 473
- carrier to noise density ratio (C/No), 86, 325, 349, 397-402, 562
- CDGPS, 140, 477-478, 565
  - assign, 70-71
  - configure, 341
  - datum, 96
  - fast corrections, 610, 613-618
  - frame data, 410
  - network, 610
  - NMEA, 318
  - prn mask, 569
  - slow corrections, 619
  - status, 344-345
- CDGPSTIMEOUT command, 78, 436
- CDU, *see* Control and Display Unit
- celestial pole, 149
- central processing unit (CPU) speed, 564
- channel, 298
  - assign, 65, 67, 69
  - control, 39, 225-227
  - dedicate, 68
  - range measurement, 393
  - raw subframe data, 408, 413
  - tracking, 298
  - tracking status, 395, 399, 560
  - unassign, 203
- chatter, 375-376
- checksum, 21, 23
- clock
  - adjust, 79, 393
  - age, 244
  - bias, 79
  - calibrate, 81
  - command, 41
  - dither, 112, 265
  - drift, 79, 266, 444
  - error, 67, 69, 79, 265
  - external, 58, 443
  - internal, 32
  - model, 265, 267
  - offset, 110, 129, 224, 356, 384
  - parameter, 112
  - phase, 56
  - precise, 405
  - receiver, 558
  - set, 393
  - shift, 56, 60
  - status, 224, 265, 356
  - steer, 79, 81
  - validity, 265
- CLOCKADJUST command, 79
- CLOCKCALIBRATE command, 81
- CLOCKMODEL log, 262
- CLOCKOFFSET command, 85
- CLOCKSTEERING log, 268
- CMR
  - analogous to RTCA, 279, 282
  - bandwidth, 285
  - base station, 414
  - dgps type, 167
  - interface mode, 138
  - log, 271
- CMR messages, 272, 277-278
- CMRDATADESC log, 274
- CMRDATAAGLOOBS log, 276
- CMRDATAOBS log, 279
- CMRDATAAREF log, 282
- CMRPLUS log, 285
- CNOUPDATE command, 86
- Coast Guard, 342, 385
- COM command, 87
- COM port, 144, 185, 287, 381
- COMCONFIG log, 279
- COMCONTROL command, 90
- command response messages, 623
- communication, 37, 473
- compass, 364
- configuration, 565
  - non-volatile memory, 124
  - port, 37, 87, 287
  - receiver, 170, 221, 539, 543
  - reset, 53, 170
  - RXCONFIG log, 448, 471
  - save, 182
  - status mask, 199
- constellation, 267, 383
- constraint, 393
- control
  - automatic, 203
  - centre, 388, 398
  - channel, 39
  - command, 37
  - filtering, 221
  - receiver, 38, 221
- Control and Display Unit (CDU), 53, 144,

- 201, 564
  - convention, 15
  - Convert4, 339
  - coordinate geometry (COGO), 274
  - coordinated universal time (UTC)
    - log, 222, 224, 337
    - offset, 356
    - position, 311, 313, 315, 323
    - status, 558
  - copyright, 2
  - correction
    - accuracy, 115
    - bias, 117
    - magnetic, 149
    - magnitude of, 150
    - mean motion, 244
    - RTCA, 138
    - RTK, 176, 180, 565
  - CPU, 143, 381, 542
  - CRC, *see* cyclic redundancy check
  - cross track, 256, 363, 365
  - CSMOOTH command, 94
  - Customer Service, 124, 153, 350
  - cut-off angle
    - command, 111
    - DOP, 384
    - GLONASS, 129
    - negative, 217
    - range reject code, 561
    - SBAS, 217
  - cyclic redundancy check (CRC), 21, 23-24, 29, 33
  - Cyrillic characters, 197
- D**
- data link, 185
  - datum, 98-102
    - best position, 251
    - command, 38, 94, 117, 128
    - current, 194
    - customized, 211
    - expanded, 213
    - fix position, 119
    - mark position, 354
    - matched position, 360
    - OmniSTAR HP, 370
    - pseudorange position, 386
    - RTK, 533
    - transformation parameters, 98-102
    - UTM, 253
  - DATUM command, 94
  - declination, 150
  - default
    - factory, 38, 54, 96, 103, 170
  - delay, antenna, 85
  - destination, 194, 365
  - device, user point, 151, 164, 355
  - de-weighting, 142, 383
  - DGPS command, 78, 103, 105-106, 135, 323
  - DGPSTIMEOUT command, 105, 181
  - DGPSTXID command, 106
  - DIFFCODEBIASCONTROL command, 108
  - DIFFCODEBIASES log, 289
  - differential correction
    - accept, 135
    - age, 257, 259
    - DGPS, 105
    - OmniSTAR HP/XP, 370
    - position, 247, 251, 354
    - pseudorange, 385, 389
    - pseudorange position, 391
    - RTK, 223, 532-533, 535, 537
    - UTM, 253
  - DGPS, 342
  - error reduction, 385
  - fix position, 115, 117
  - method, 166
  - none available, 561
  - outage, 179, 247, 385, 532, 534
  - positioning, 103
  - satellite visibility, 553
  - send, 161, 185
  - set, 443
  - station, 117, 166, 178, 227-228, 561
  - transmit RTCA, 103
- differential GPS (DGPS), 140
  - dilution of precision (DOP), 311-315, 531
    - differential, 263
    - NMEA, 320
    - position averaging, 245
    - pseudorange, 383
    - volume, 320
  - direction
    - accuracy, 256

- bearing, 365
  - communication, 176
  - over ground, 388
  - referenced to True North, 148
  - report, 388
  - static position, 256
  - tunnel, 201
  - dispatcher, 180
  - distance
    - exceeded, 249
    - straight line, 365
    - track offset, 194
  - dither, 265
  - DL-V3, 201
  - DOP, *see* dilution of precision
  - Doppler, 169, 397
    - accumulated, 393, 399-402, 426, 428, 473-474
    - assign, 65, 67-68
    - instantaneous, 390, 397, 402
    - jump, 79
    - offsets, 243
    - range record, 399
    - satellite visibility, 554
    - tracking status, 562
  - drift, 79
  - dual frequency, 247, 526
  - dynamic, 38, 109, 163, 174
  - dynamics, 160
  - DYNAMICS command, 109
- E**
- earth-centered earth-fixed (ECEF), 258, 414, 441
  - earth-centred-earth-fixed (ECEF), 463
  - eccentricity, 244, 333, 517
  - ECEF, *see* earth-centered earth-fixed
  - echo, 89
  - ECUTOFF command, 110
  - EGNOS (European SBAS), 183
  - electronic distance measuring instrument (EDM), 263
  - elevation, 531
    - cut-off, 110-111, 217, 384
    - error, 561
    - GLONASS, 129
    - highest, 180
    - satellite visibility, 324, 554
    - set, 38
    - tracking status, 562
  - ellipsoid, 441
    - constants, 97
    - customized, 211
    - navigation, 194
    - parameter, 96, 98-102, 213
    - surface, 194
    - undulation, 39, 205
  - environmental parameter, 290, 541
  - ephemeris
    - change in, 439
    - collect, 189
    - decoded, 224
    - delay, 103-104, 420
    - GLONASS, 297
    - health, 561
    - log, 225
    - raw data, 224, 405, 424
    - RTK, 423
    - time status, 31-32
  - error
    - averaged position, 161
    - clock, 79, 112, 265
    - common from base and rover, 263
    - extrapolation, 359, 361
    - fatal, 551
    - flag, 543
    - framing, 381
    - in fixed coordinates, 117
    - messages, 543
    - multipath, 393
    - non-volatile memory, 158
    - parity, 381-382
    - proportional to baseline, 263
    - range reject code, 561
    - response message, 623
    - statistics, 246, 323
    - status, 199
    - text description, 552
    - tracking, 393
  - escape, tunnel, 201-202
  - event
    - fatal, 551
    - message, 199, 543, 552
    - text description, 552
    - type, 552

expiry date, 563  
external  
    oscillator, 112, 443  
    reference frequency, 56  
EXTERNALCLOCK command, 112  
extrapolation error, 359, 361  
EXTRXHWLEVELS log, 290

## F

F model, 565  
factory default  
    datum, 96  
    ephemeris delay, 103  
    modify, 182  
    reset, 38, 53, 170  
    setting, 54, 87  
fallback to SBAS, 179  
field type, 19  
field upgrade, 74  
filter, 159-160, 169, 377, 531  
    control, 38  
    pseudorange, 562  
    RTK, 38, 173  
    solution log, 221  
    update, 536  
fine time, 32  
fix  
    command, 115  
    data, 310, 312, 314  
    position, 316  
    save setting, 182  
    solution, 173  
FIX command, 115  
FIXPOSDATUM command, 119  
flag  
    antenna, 64  
    error, 543  
    parity, 393  
    status, 385, 543  
flattening, 214  
fleet, 180  
flight controls, 534  
float solution, 173  
foliage, 410, 610  
FORCEGPSL2CODE command, 120  
forest, 610  
format, 21, 23, 33, 36, 367

frame decoder number, WAAS, 569  
framing error, 381  
frequency, 121, 418  
FREQUENCYOUT command, 121  
FRESET command, 124

## G

G model, 565  
Galileo and RTCM Version 3.0, 497, 499  
gaps, 159  
generic data formats, 136, 339  
geodetic datum, *see* datum  
geoid, 39, 205, 245  
geometric bias, 245  
GGAQUALITY command, 126  
GLIDE, 160  
GLMLA log, 291  
GLOALMANAC log, 290  
GLOCLOCK log, 295  
GLOCSMOOTH command, 128  
GLOECUTOFF command, 129  
GLOEPHEMERIS log, 297  
GLONASS, 272  
    almanac, 291, 293  
    base station, 470  
    elevation cut-off, 129  
    logs, 291-307  
    RTCM, 197, 459, 468, 470, 475  
    RTCM V3, 458, 497-500  
    SBAS, 594, 596  
GLORAWALM log, 301  
GLORAWEPHEM log, 303  
GLORAWFRAME log, 305  
GLORAWSTRING log, 307  
GNSS Reference Book, 15, 243  
GPALM log, 308  
GPGGA log, 312  
GPGGALONG log, 312  
GPGGARTK log, 310  
GPGLL log, 316  
GPGRS log, 318  
GPGSA log, 320  
GPGST log, 322  
GPGSV log, 324  
GPHDT log, 326  
GPRMB log, 327  
GPRMC log, 329

GPS overview, 31, 33  
 GPSEPHM log, 331  
 GPVTG log, 335  
 GPZDA log, 337  
 graphical display, 364  
 great circle line, 194-195, 365

## H

handshaking, 89-90  
 hardware, 564
 

- parameter, 290, 541
- reset, 38, 170
- version, 221, 567

 harvesting, 610  
 HDOP, *see* dilution of precision  
 HDTOUTTHRESHOLD command, 130  
 header
 

- ascii, 21-22, 28
- binary, 19
- convention, 16
- log, 393

 heading
 

- and velocity, 223, 256
- information, 338
- magnetic variation, 149
- NMEA, 130, 326

 HEADING log, 338  
 health
 

- almanac, 309
- base station, 228, 414
- satellite, 244, 554, 561
- status, 333

 height, 463
 

- approximate, 188
- base antenna, 460
- calculate, 117, 205
- fix, 38, 115, 117
- limit, 249
- position, 251, 386
  - mark, 354
  - match, 360
  - OmniSTAR HP/XP, 132, 370
  - RTK, 533

 Helmert transformation, 96  
 Hertz (Hz), 564-566  
 hexadecimal, 16, 20-21, 24, 29, 187, 200  
 hibernate mode, PC, 144

hiking, 256, 258  
 hold, 143, 146-147, 351-352  
 horizon, 111, 129, 217  
 hot position, 423  
 HP/XP seed, 133  
 HP/XP, OmniSTAR, 369, 560
 

- expiration date, 343
- position or velocity type, 248
- status, 347, 349
- tracking state, 345

 HPSEED command, 131  
 HPSTATICINIT command, 133  
 hydrographic survey, 155

## I

I model, 565  
 identifier
 

- ascii message, 21
- serial port, 26, 139, 288, 382

 iMAX mode, 176  
 inclination angle, 244  
 instantaneous Doppler, 390  
 integer ambiguities, 451  
 interface, 37, 40, 139  
 INTERFACEMODE command, 135, 419  
 interferometric techniques, 451  
 interrupt, 382  
 ionosphere, 95, 176, 436
 

- carrier smoothing, 95
- delay, 606
- grid points, 599
- log, 339
- positive integers, 555
- remove, 446

 IONUTC log, 339  
 island, 213

## J

J model, 565

## K

K model, 565  
 kinematic, 175, 460  
 known site, 175

**L**

L model, 565  
 L1-only observables, 486  
 laptop, 144, 375, 394  
 latched time, 353  
 latency
 

- data link, 359, 361
- position, 223, 247, 536
- reduction, 443, 478
- velocity, 259, 391, 536-537

 latitude/longitude
 

- approximate, 188
- fix data, 311, 313, 315
- GPS specific, 330
- position, 251, 386
  - mark, 354
  - match, 360
  - NMEA, 316
  - OmniSTAR HP/XP, 132, 370
  - RTK, 533
- set navigation waypoint, 195

 L-band, 70, 166, 341, 344, 565  
 LBANDINFO log, 341  
 LBANDSTAT log, 344  
 LED, 551  
 library, OmniSTAR, 436  
 link, 185, 381  
 LNA, *see* low noise amplifier  
 local horizon, 110  
 localized wide area corrections, 140  
 LOCALIZEDCORRECTIONDATUM  
 command, 140  
 lock
 

- command, 142
- out, 383, 561
- reinststate, 207
- time, 562

 LOCKOUT command, 142  
 locktime
 

- current, 397, 402
- L-band, 349
- reset to zero, 94, 128
- RTK, 489, 491, 493, 507, 509, 511, 513

 log
 

- list, 350
- response messages, 623
- RTCA, 418

RTCM, 418, 434  
 trigger, 219  
 type, 219  
 LOG command, 143  
 LOGLIST log, 350  
 loss of lock, 189  
 low noise amplifier (LNA), 37, 64, 542  
 LSB, 21

**M**

machine guidance, 369  
 magnetic variation, 40, 148-149, 330, 365  
 MAGVAR command, 148  
 map, 155, 215, 258, 599  
 mark
 

- event, 60, 152, 222
- input pulse, 353, 355

 MARKCONTROL command, 151  
 MARKPOS log, 353  
 MARKTIME log, 355  
 mask
 

- event, 543
- priority, 549-550
- WAAS PRN, 569

 matched update, 525  
 MATCHEDPOS log, 357, 416  
 MATCHEDXYZ log, 361  
 matrix, 265  
 mean sea level
 

- fix, 117, 311, 313, 315
- position, 251, 253, 386
- mark, 354
- match, 360
- OmniSTAR HP/XP, 132, 370
- RTK, 533

 memory, 275
 

- buffer space, 143
- non-volatile
  - erase, 53, 124
  - restore, 158
  - save
    - almanac, 243
    - configuration, 182

 meridian, UTM, 215  
 message
 

- almanac, 243
- ascii, 21



- base station, 414
- format, 19, 23, 33
- ID, 351-352
- length, 196-197
- navigation, 194
- response, 28, 623
- send, 185
- time stamp, 32
- trigger, 145, 147
- mode
  - 2-D, 321
  - 3-D, 321
  - dynamic, 174
  - interface, 135, 139
  - operating, 320
  - RTK, 247
  - static, 174
- model
  - active, 563
  - authorization, 38, 74-75, 153
  - card, 153
  - clock, 265, 267, 356
  - expiry date, 221, 563
  - ionospheric, 339
  - log, 222
  - lost, 158
  - switch, 153
  - valid, 563
  - version, 563
- MODEL command, 153
- models, 564
- modem, 373
- Modified RTCA (MRTCA), 139, 419
- month, 558, 566
- monument height, 460
- motion
  - detector, 174
  - island, 213
  - mean, 244, 334
- moving base stations, 155
- MOVINGBASESTATION command, 154
- MSAS (Japanese SBAS), 183
- MSB, 21
- multipath
  - carrier smoothing, 94
  - example, 95, 385
  - indicator, 453, 457
  - NMEA, 320
  - RTK, 455, 459
- N**
- National Topographic Series (NTS), 215
- NAVIGATE log, 363
- navigation, 565
  - accuracy, 443
  - command, 40
  - data, 320, 329
  - information, 326-327
  - log, 363-364
  - magnetic compass, 148
  - path, 194
  - satellite system, 418
  - standard, 433
  - status, 328, 365
  - waypoint, 194, 223
  - word, 409
- network RTK, 175, 466
- NGS, *see* US National Geodetic Survey
- NL model, 565
- NMEA
  - fix data, 315
  - generic format, 136
  - log list, 367
  - position, 317
  - pseudorange measurement noise statistics, 322
  - satellite range residuals, 318-319
  - satellite type, 156
  - standards, 310
- NMEATALKER command, 156
- node, 309
- noise
  - oscillator, 112
  - statistic, 322
  - thermal, 393
  - time of, 267
- non-printable character, 37, 187
- non-volatile memory (NVM), 53
  - automatic, 403
  - reset, 124
  - restore, 158
  - save
    - almanac, 243
    - configuration, 182
- north pole, 149

## note

- antenna motion, 174
- authorization code, 74
- channel assignment, 68
- clock adjustment, 79
- differential correction, 103, 105
- elevation cut-off angle, 110
- ephemeris delay, 103
- factory default, 158
- logging, 143
- navigation, 363
- range residual, 318
- reset, 53, 124
- satellite, 383
- status, 551
- WGS84, 245

NovAtel Inc., 2

NTS, *see* National Topographic Series

NVMRESTORE command, 158

**O**

## observation

- base station, 275

observations, 526

obstacles, 610

ocean, 155

## offset

- clock, 356
- Doppler, 65
- ECUTOFF effect, 110, 129
- oscillator clock, 112
- receiver clock, 384, 558
- track, 194, 365

OMNIHPPOS log, 369

OmniSTAR, 135, 140, 341, 436, 480, 565

OmniSTAR subscription, 412

OMNIVIS log, 371

one pulse per second (1PPS), 41

- adjust, 56
- control, 164
- delay, 85
- frequency, 121
- obtain, 57
- offset, 79
- time, 79, 559

on-foot, 256, 258, 364

operating mode, 320

optionality, 16

orbit, 405

origin, 194

## oscillator

- clock drift, 79, 266
- error, 265
- external, 112, 268, 444
- with an RTCM Type 9 message, 443

outages, 159

output pulse, 121

overload, 143

**P**

parity, 88-89

- errors, 381
- flag, 393
- port, 272, 382
- receive, 409
- removed, 405, 407
- RTCM word, 434

PASSAUX log, 373

PASSCOMx logs, 373

pass-through log, 373, 375-376

PASSUSBx logs, 373

PC, 144

PC or laptop, 144, 375, 394

PDOP, *see* dilution of precision

PDPFILTER command, 159

PDPMODE command, 160

PDPPOS log, 377

PDPVEL log, 378

PDPXYZ log, 379-380

perigee, 244

period, 143, 145, 147, 351-352

perpendicular distance, 194, 365-366

persistence, UTM, 215

phase difference, 169

phase lock loop (PLL), 394-395, 544

PLL, *see* phase lock loop

polled log, 219

## port

- ascii header, 22
- communication, 23, 420
- configuration, 37, 87, 89, 182, 287
- identifier, 26, 88
- interrupt, 382
- log request, 144

- output, 145, 147, 351-352
  - parameters, 201
  - pass-through, 373
  - RS232, 90
  - RTCM, 438
  - send data, 185
  - serial, 135, 138-139, 381
  - statistic, 221
  - status, 381, 551
  - unlog, 210
  - PORTSTATS log, 381
  - POSAVE command, 161
  - position, 377
    - 3-D, 384
    - accuracy, 115
    - approximate, 189, 243, 430
    - at time of mark, 354
    - averaging, 40, 161, 245
    - base station, 228, 414, 431
    - best, 247, 252, 258, 525
    - calculation, 163
    - command, 38
    - current, 363, 365
    - datum, 96
    - fix, 38, 117
    - four unknowns, 245, 263, 383, 394
    - hot, 423
    - log, 221, 223
    - matched, 359, 361
    - precision, 314, 425, 428
    - pseudorange, 227, 385
    - single point, 258
    - solution, 110, 129, 383
    - static, 256
    - time out, 163
    - type, 354
    - xyz coordinates, 259, 362, 390-391, 537
  - POSTIMEOUT command, 163
  - post-process
    - application example, 398, 532, 610
    - carrier smoothing, 95
    - differential, 106
    - elevation angle, 111
    - ephemeris data, 405
    - generic software, 136
    - Waypoint, a NovAtel Precise Positioning Company, 398
  - power, 64, 561
  - PPSCONTROL command, 164
  - prerequisite, 18
  - pressure, 164
  - processing, 22, 25, 224, 393
  - proprietary information, 473
  - pseudorange, 621
    - correction, 117, 438, 444
    - error estimate, 393
    - jump, 79, 393
    - measurement, 322, 397, 399, 402, 451
    - noise statistic, 322
    - position, 224, 227
    - raw, 621
    - solution, 117, 247
    - tracking status, 562
    - velocity, 227, 388
  - pseudorange/delta-phase (PDP), 159-160, 169, 377-378, 436
  - PSRDIFFSOURCE command, 166
  - PSRDOP log, 383
  - PSRPOS log, 385
  - PSRTIME log, 387
  - PSRVEL log, 388
  - PSRVELOCITYTYPE command, 169
  - PSRXYZ log, 390
  - pulse, 121, 353, 355
- ## Q
- quality
    - NMEA, 126, 315, 322
  - quotation mark, 21, 185, 196-197
- ## R
- R model, 565
  - radio, 180, 285, 385, 532, 534
  - range
    - bias, 32, 267
    - compressed, 400
    - corrections, 394
    - errors, 263
    - measurement, 79, 393, 401
    - reject code, 562
    - residual, 318
    - satellite information, 142
  - RANGE log, 393
  - range rate correction (RRC), 436
  - RANGECMP log, 398-399

- RANGEGPSL1 log, 401
- rate of right ascension, 244
- raw almanac, 308
- RAWALM log, 401
- RAWEPHEM log, 405
- RAWGPSSUBFRAME log, 407
- RAWGPSWORD log, 409
- RAWLBANDFRAME log, 410
- RAWLBANDPACKET log, 412
- RAWWAASFRAME log, 413
- reacquisition, 65, 68, 394
- receiver
  - character, 382
  - clock offset, 245
  - components, 564
  - dual frequency, 247
  - errors, 543
  - independent exchange (RINEX), 339
  - interface, 37, 40, 135
  - set up, 540
  - status, 143, 543, 546
  - time, 60
- recent satellite information, 163
- reference station, *see* base station
- references and standards, 243, 403
- REFSTATION log, 414
- reinstate satellite, 207
- relative pseudorange/delta phase, 160
- remote station, *see* rover station
- reset, 201
  - after error, 551
  - average positions after, 161
  - complete, 173
  - hardware, 38, 124, 170
- RESET command, 170
- residual, 318, 530, 562
- resolution, 173
- response, 28, 135, 139, 623
- RF delay, 85
- RINEX, *see* receiver independent exchange
- root mean square (RMS), 323
- route, 364
- rover station
  - antenna model, 62
  - basic, 263
  - carrier phase ambiguity resolution, 425, 428
  - command, 40
  - common to base, 383
  - data age, 105, 181
  - data from base, 441
  - distance from base, 262
  - faster data update to, 443, 478
  - format messages, 433
  - satellite visibility, 553
  - to base scenario, 375
- ROVERPOS, 222
- RS-422, 91
- RTCA
  - age, 105, 420
  - base station, 427
  - base station type, 414
  - DGPS type, 167
  - ephemeris delay, 103
  - interface mode, 135, 138
  - log list, 418
  - station ID, 430
- RTCADATA1 log, 420
- RTCADATA2OBS log, 427
- RTCADATAEPHEM log, 423
- RTCADATAOBS log, 425, 427
- RTCADATAREF log, 430
- RTCM
  - and L-band, 140, 436-437
  - base station, 414, 441
  - DGPS type, 167
  - ephemeris delay, 103
  - example, 435
  - header, 459
  - interface mode, 138
  - log list, 432
  - measurement corrections, 456
  - messages, 463, 480-481
  - multipath indicator, 453, 457
  - P Code, 455
  - proprietary message, 473
  - quality indicator, 452
  - RTCA comparison, 418
- RTCMDATA log, 439
- RTCMDATA1 log, 438
- RTCMDATA1001 log, 486
- RTCMDATA1002 log, 490
- RTCMDATA1003 log, 492
- RTCMDATA1004 log, 494
- RTCMDATA1005 log, 497
- RTCMDATA1006 log, 499

- RTCMATA1009 log, 505
  - RTCMATA1010 log, 508
  - RTCMATA1011 log, 510
  - RTCMATA1012 log, 512
  - RTCMATA1019 log, 515
  - RTCMATA1020 log, 519
  - RTCMATA15 log, 446
  - RTCMATA16 log, 448
  - RTCMATA1819 log, 450
  - RTCMATA2021 log, 456
  - RTCMATA22 log, 460
  - RTCMATA22GG log, 462
  - RTCMATA23 log, 464
  - RTCMATA24 log, 466
  - RTCMATA3 log, 441
  - RTCMATA31 log, 468
  - RTCMATA32 log, 470
  - RTCMATA36 log, 471
  - RTCMATA59 log, 473
  - RTCMATA59GLO log, 475
  - RTCMATA9 log, 443
  - RTCMATAACDGPS1 log, 477
  - RTCMATAACDGPS9 log, 478
  - RTCMATAOMNI1 log, 480
  - RTCMV3
    - antenna setup, 501, 503
    - base station, 414-519
    - DGPS type, 167
    - ephemeris, 515, 519
    - example input, 484
    - GLONASS, 505, 508, 510, 512
    - interface mode, 138
    - locktime, 487
    - station ID, 107
  - RTK
    - baseline, 224
    - command, 41
    - convention, 15
    - correction, 180
    - data, 228, 525
    - DOP, 531
    - filter, 173
    - low latency position, 222, 228, 532
    - mode, 247, 536
    - network, 175-176
    - position, 223, 247, 359, 361, 532
    - satellite count, 224
    - solution, 525
    - transfer, 271
    - velocity, 534
  - RTKANTENNA command, 171
  - RTKCOMMAND command, 173
  - RTKDOP log, 531
  - RTKDYNAMICS command, 174
  - RTKNETWORK command, 175
  - RTKPOS log, 532
  - RTKQUALITYLEVEL command, 177
  - RTKSOURCE command, 178
  - RTKSVENTRIES command, 180
  - RTKTIMEOUT command, 181
  - RTKVEL log, 534
  - RTKXYZ log, 536
  - Russian characters, 197
  - RXCONFIG log, 539
  - RXHWLEVELS log, 541
  - RXSTATUS log, 543
  - RXSTATUSEVENT log, 551
- ## S
- S model, 565
  - satellite
    - acquisition, 65, 189, 243
    - active, 320
    - almanac, 243
    - availability, 117, 324
    - channel, 69
    - clock dither, 112
    - command, 39
    - common, 525
    - count, 224, 228
    - coverage, 159
    - DGNSS, 418
    - elevation, 110, 217, 243
    - error, 561
    - geometry, 263, 383
    - GLONASS, 129
    - group, 383
    - ID, 438, 444
    - in view, 324
    - lock, 142, 383
    - low, 95, 111
    - motion, 390
    - number of, 384, 400, 531
    - range, 318
    - raw, 403, 405, 408-409

- recent, 163
- record, number of, 425
- redundancy, 263, 560
- reinstate, 208
- RTK, 40, 180, 525, 531
- SBAS, 217
- search, 69
- tracking, 225-227, 393
- unassign, 203
- unlock, 207
- visibility, 189, 226, 553
- SATVIS log, 553
- SATXYZ log, 555
- SAVECONFIG command, 182
- SBAS
  - channel, 68
  - control, 182
  - degradation factor, 590
  - differential, 166
  - fallback, 179
  - fast correction slots, 570
  - integrity message, 583-586
  - mixed fast/slow corrections, 600
  - navigation, 591
  - PRN, 67, 69, 568-569
  - range corrections used, 621
  - raw frame data, 413
  - service message, 608
  - system type, 183
- SBASCONTROL command, 182
- scaling
  - almanac, 243
  - factor, 399
- scope, 15
- self-test, 143
- semi-major axis, 214, 244
- send, 185, 187
- SEND command, 185
- SENDHEX command, 187
- serial port, 138-139, 288, 382
- SETAPPROXPOS command, 188
- SETAPPROXTIME command, 189
- SETBESTPOSCRITERIA command, 191
- SETDIFFCODEBIASES command, 192
- SETIONOTYPE command, 193
- SETNAV command, 188
- SETRTCM16, 196
- SETRTCM36 command, 197
- setting, command, 36
- shipping lanes, 155
- signal
  - 1PPS, 57, 164
  - CDGPS, 72
  - control, 93
  - DC, 123
  - elevation cut-off, 110
  - error, 95, 166
  - external, 56
  - mark, 152
  - oscillator, 58
  - path, 85, 111
  - period, 123
  - search, 115
  - structure, 410
  - timing, 90
- single point mode, 258
- sky, 553
- smooth, 159
- smoothing
  - carrier phase, 94-95, 128
  - indicator, 488
  - interval, 452, 455, 487
  - pseudorange, 450
- software version, 221
- solar cars, 109
- solution
  - status, 354
  - type, 126
- speed
  - current, 365
  - data, 223, 329
  - over ground, 257, 330, 336, 389, 535
- standard positioning service (SPS), 243, 403
- standards and references, 243, 403
- standby mode, PC, 144
- static mode, 133, 160, 174, 275, 361
- station ID, 106, 414, 434
- stationary, 134
- statistics, 246, 323, 342, 369
- status
  - arrival, 328
  - base station health, 414
  - channel tracking, 395, 397, 399, 402, 560
  - clock model, 356
  - COM port, 381

- command, 37
  - data, 316
  - event, 551
  - flag, 385, 543
  - indicator, 247, 255, 258, 390, 536
  - mask, 199
  - receiver, 22, 143, 221, 543, 546
  - self-test, 221
  - solution, 354
  - time, 22
  - trigger, 543
  - velocity, 258, 534
  - word, 552
  - STATUSCONFIG command, 199
  - steer
    - clock, 79, 81
    - time, 31-32, 79
  - subframe, 225, 243, 403-405
  - survey
    - base station, 161
    - control ship, 155
    - datum, 119, 211, 213
    - grade receivers, 136
    - HP/XP seed, 133
    - hydrographic, 155
    - navigate, 194
    - WAAS, 568
  - synchronize, 56, 58, 557
  - synchronous log, 219
- T**
- tag external event, 376
  - Technical Specifications, 353, 355
  - temperature, 164
  - text, transfer, 196
  - throughput, 486
  - time
    - 1PPS, 57, 559
    - acquisition, 115
    - almanac reference, 404
    - anomaly, 244
    - approximate, 243, 430
    - clock adjustment, 79
    - coarse/fine, 31
    - CPU, 143
    - delay, 104
    - difference, 58, 557
    - dilution of precision, 384
    - embedded, 559
    - ephemeris, 103, 405
    - event, 355
    - fine, 32
    - GPS, 265, 376, 558
    - interval, 145, 147
    - latched, 353
    - limit, 161
    - log, 224
    - matched position, 227, 361
    - observation, 526
    - occupation, 553
    - of mark in event, 356
    - of position fix, 316
    - out, 105, 181
    - precision, 31
    - receiver clock offset, 245
    - stamp, 32, 361
    - status, 22, 31-32
    - steering, 31, 79
    - tag, 373, 414, 536
    - to first fix (TTFF), 189, 243, 423, 430
    - transfer, 56
    - UTC, 311, 313, 315, 337
    - validity, 31
  - TIME log, 555
  - TIMESYNC log, 559
  - track
    - made good, 329, 335
    - over ground, 257, 389, 535
  - tracking
    - assign, 65
    - automatic, 204
    - channel, 393, 560
    - continuous, 349, 397, 402, 562
    - cut-off angle, 110
    - disabled, 551
    - fix position, 117
    - GLONASS, 129
    - loop, 393
    - satellite, 39, 225-227, 383
    - status, 560
    - undesirable, 142
  - TRACKSTAT log, 560
  - transfer
    - ASCII text, 196
    - RTK, 271

time, 56  
 transformation parameter, 96  
 transit, 180  
 transmit, 37, 40, 89, 135, 382  
 travel, 394  
 trigger
 

- error, 543
- event message, 199
- log, 143, 219, 351-352, 359-360
- option, 144

 troposphere, 436, 555  
 true north
 

- direction of motion, 257, 389
- magnetic variation, 148-149
- pseudorange error orientation, 323
- to waypoint, 365
- track over ground, 535

 TTFF, *see* time to first fix  
 tunnel escape sequence, 201-202  
 tunnel, serial port, 138  
 TUNNELESCAPE command, 201  
 type, field, 19

## U

UNASSIGN command, 203  
 UNASSIGNALL command, 203  
 undulation
 

- best position, 251, 253, 370
- command, 205
- illustration, 205
- position, 245, 354, 360, 386, 533
- type, 132

 UNDULATION command, 205  
 United States Geological Survey (USGS), 150, 215  
 universal time coordinated (UTC), 272  
 unknown network, 176  
 UNLOCKOUT command, 207  
 UNLOCKOUTALL command, 207  
 UNLOG command, 208  
 UNLOGALL command, 210  
 upgrade, 74, 153  
 US National Geodetic Survey (NGS), 405  
 USB port, 88  
 user point device, 151, 164, 355  
 USERDATUM command, 211  
 USEREXPDATUM command, 213

USGS, *see* United States Geological Survey  
 UTM coordinates, 252  
 UTMZONE, 215  
 UTMZONE command, 215

## V

validity
 

- base station, 414, 536
- clock model, 265
- receiver model, 563-564
- time tag, 536

 VALIDMODELS log, 563  
 VBS, OmniSTAR
 

- DGPS type, 167
- HP/XP, 134, 349
- initiate, 71
- position or velocity type, 248
- subscription, 343

 VCTCXO, *see* oscillator  
 VDOP, *see* dilution of precision  
 vehicle, 532
 

- application example, 155, 180, 256, 398
- dynamics, 109
- HP/XP seed, 133
- moving base station, 155
- velocity, 256

 velocity, 169, 378
 

- accuracy, 256
- average, 536
- best, 255, 258
- closing, 328
- island, 213
- latency, 536-537
- limit, 249
- log, 223
- offset, 213
- pseudorange, 227
- report, 388
- RTK, 534
- vector, 256
- via radio, 532
- xyz coordinates, 214, 259, 390-391, 537

 version, 2, 74, 221, 564
 

- hardware, 564

 VERSION log, 564  
 video camera device, 151



virtual address, 22  
 virtual base station (VBS), 176, 436  
 visibility, satellite, 226, 553  
 voltage, 290, 542  
 VRS (Virtual Reference Station), 176

## W

WAAS (North American SBAS), 183  
 WAAS0 log, 568  
 WAAS1 log, 569  
 WAAS10 log, 593  
 WAAS12 log, 595  
 WAAS17 log, 597  
 WAAS18 log, 599  
 WAAS2 log, 570  
 WAAS24 log, 600  
 WAAS25 log, 603  
 WAAS26 log, 606  
 WAAS27 log, 608  
 WAAS3 log, 574  
 WAAS32 log, 610  
 WAAS33 log, 613  
 WAAS34 log, 615  
 WAAS35 log, 617  
 WAAS4 log, 577  
 WAAS45 log, 619  
 WAAS5 log, 580  
 WAAS6 log, 583  
 WAAS7 log, 587  
 WAAS9 log, 591  
 WAASCORR log, 621  
 WAASECUTOFF command, 217  
 WAASTIMEOUT command, 218  
 warning, 74, 350, 539  
 warranty, 15  
 waypoint  
   destination, 327, 365  
   navigation, 40, 194, 223, 363-364  
   setting, 194  
   track offset, 194-195  
 Waypoint Products Group, 129, 297, 398, 532  
 week  
   decoding, 33  
   future, 340  
   GPS, 333, 365  
   reference, 406

weighting, pseudorange filter, 562  
 WGS84  
   base station, 441  
   default datum, 96, 211  
   differential corrections, 117, 258  
   waypoint navigation, 194  
 word  
   error, 158  
   raw ephemeris, 405  
   status, 543, 552  
   week number, 309

## X

xyz coordinates, 258, 390, 414

## Y

year, 558, 566

## Z

Z count, 272, 463, 481  
 Z model, 565  
 zone number, UTM, 215





Recyclable



Printed in Canada on recycled paper