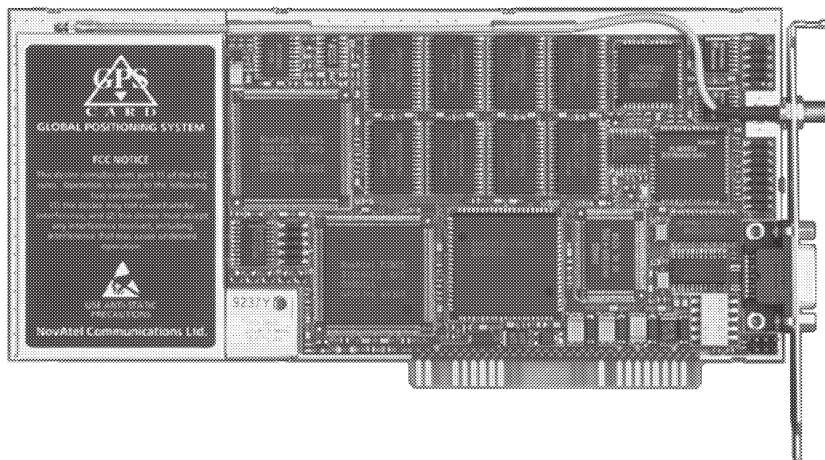


GPSCard™ *PC Series*

Installation and Operating Manual



GPSCARD™ PC SERIES

Installation and Operating Manual

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This manual is a companion to the GPSCard Command Descriptions Manual, OM-20000008.

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WARRANTY POLICY

NovAtel Communications Ltd. warrants that its Global Positioning System (GPS) products are free from defects in materials and workmanship, subject to the conditions set forth below, for the following periods of time:

GPSCard™ Series	One (1) Year
GPSAntenna™ Series	One (1) Year
Cables and Accessories	Ninety (90) Days
Software Support	One (1) Year

Date of sale shall mean the date of the invoice to the original customer for the product. NovAtel's responsibility respecting this warranty is limited solely to product replacement or product repair at an authorized NovAtel location only. Determination of replacement or repair will be made by NovAtel personnel or by technical personnel expressly authorized by NovAtel for this purpose.

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There are no user serviceable parts in the GPSCard and no maintenance is required. When the status code indicates that a unit is faulty, replace with another unit and return the faulty unit to NovAtel Communications Ltd.

You must obtain a RETURN MATERIAL AUTHORIZATION (RMA) number by calling GPS Customer Service at 1-800-280-2242 or 403-295-4900 before shipping any product to NovAtel or Dealer.

Once you have obtained an RMA number, you will be advised of proper shipping procedures to return any defective product. When returning any product to NovAtel, please return all original diskettes along with the defective product in the original packaging to avoid ESD and shipping damage.



CUSTOMER SERVICE

If you require customer service, please provide the following information along with a detailed description of the problem when you call or write:

Serial No. _____ Model No. _____

Software Release No. _____ Authorization No. _____

Date Purchased: _____

Purchased from: _____

User name: _____ Title: _____

Company: _____

Address: _____

City: _____ Prov/State: _____

Zip/Postal Code: _____ Country: _____

Phone #: _____ Fax #: _____

GPSCard interface: _____ Computer type: _____ Operating Shell: _____

Other interface used: _____

Please provide a complete description of any problems you may be experiencing, or the nature of your inquiry (attach additional sheets if needed):

You may photocopy and fax this page, call, or mail the above information to the address listed below.

For customer support, contact the NOVATEL GPS Hotline at **1-800-280-2242**, or **403-295-4900**, Fax **403-295-4901**, e-mail to **gps@novatel.ca**, or write to:

NovAtel Communications Limited
GPS Customer Service
6732 - 8th Street N.E.
Calgary, Alberta, Canada
T2E 8M4

NOTICE

This equipment has been tested and found to comply with the limits for a class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own risk.

Equipment changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

IMPORTANT: In order to maintain compliance with the limits of a Class A digital device, you are required to use properly shielded interface cables when using the Strobe Port.

CAUTION !

Handle with Care



Use Anti-Static Precautions

FOREWORD

Scope

The GPSCard™ *PC Series Installation and Operating Manual* is written for the GPSCard purchaser. In further discussions, the purchaser shall be referred to as the “user”.

This manual is dedicated to the installation and initial operation of the PC Series of GPSCard. It describes the GPSCard in sufficient detail as to allow users to effectively integrate and operate the GPSCard to its fullest potential. The manual is organized into sections, which allow easy access to appropriate information.

Accompanying this manual is the *Command Descriptions Manual*, which is intended to be a reference manual dedicated to the multitude of GPSCard commands and logs. The *Command Descriptions Manual* has been written in generic form so as to accommodate all models of GPSCard receivers, regardless of series type. Other supplementary manuals may be included to accommodate special models and software features with unique functionality. One example is the *WINSAT Graphical Interface Program*, which is separate user interface software included with all GPSCard receivers and has a separate user manual. Therefore, these manuals are to be considered as companion manuals and should be kept together at all times for easy reference from one to the other. For example, in the *Operation* section of this manual, a command or logging activity may be referred to that requires you to consult the *Command Descriptions Manual* to further understand the full contents and usage of that particular command or log.

This manual is focused on the user’s perspective for integration and operation purposes. It is beyond the scope of this manual to provide service or repair details. Please contact your NovAtel Service Centre for any customer service related inquiries.

Prerequisites

To use the NovAtel GPSCard effectively, you should be familiar with the Global Positioning System (GPS) as it applies to positioning, survey and navigation applications. For your reference, *Section 1* of the *GPSCard Command Descriptions Manual* provides a brief overview of the Global Positioning System.

The NovAtel GPSCard utilizes a comprehensive user interface command structure which requires communications through your computer console keyboard or the GPSCard’s serial COM ports. To utilize the built-in command structure to its fullest potential, it is recommended that you take some time to review and become familiar with *Sections 2* through *6* of the *GPSCard Command Descriptions Manual* before operating the GPSCard receiver.

The GPSCard PC Series of GPS receivers are capable of operating in virtually any 100% IBM-compatible desktop or laptop computer. Because of the many different makes and models of PCs available with variable levels of performance, it is difficult to clearly specify the minimum PC requirements to operate the GPSCard. The following is a list of guidelines to consider as a minimum configuration requirement before installing your GPSCard receiver.

- Any 100% IBM PC-compatible computer
- ISA 8 or 16 bit bus
- One expansion slot to install the GPSCard
- One expansion slot to accommodate the GPSCard COM2 and I/O Strobes expansion bracket (optional)
- The host computer power supply should have sufficient reserve to accommodate the GPSCard (GPSCard consumes 6 Watts nominal). Available power depends on hard drive consumption and other expansion cards already installed in your PC.
- 640K RAM or greater for DOS operation, or a minimum of 4 MB recommended for Windows and WINSAT.
- Hard drive capacity depends on the rate and duration of data logging to your hard drive files
- PC must have available at least one of the following unused hexadecimal I/O base address ranges: 150-163h, 200-213h, or 300-313h
- Must have at least one accessible IRQ 3, 5, or 7 interrupt available to be assigned to the GPSCard. (Interrupts cannot be shared.)
- Config.sys requires at least the following: Files=10 Buffers=20

If you will be using the Performance Series of GPSCard with high-rate data logging, your computer system requirements may need to be upgraded to accommodate the higher performance demands.



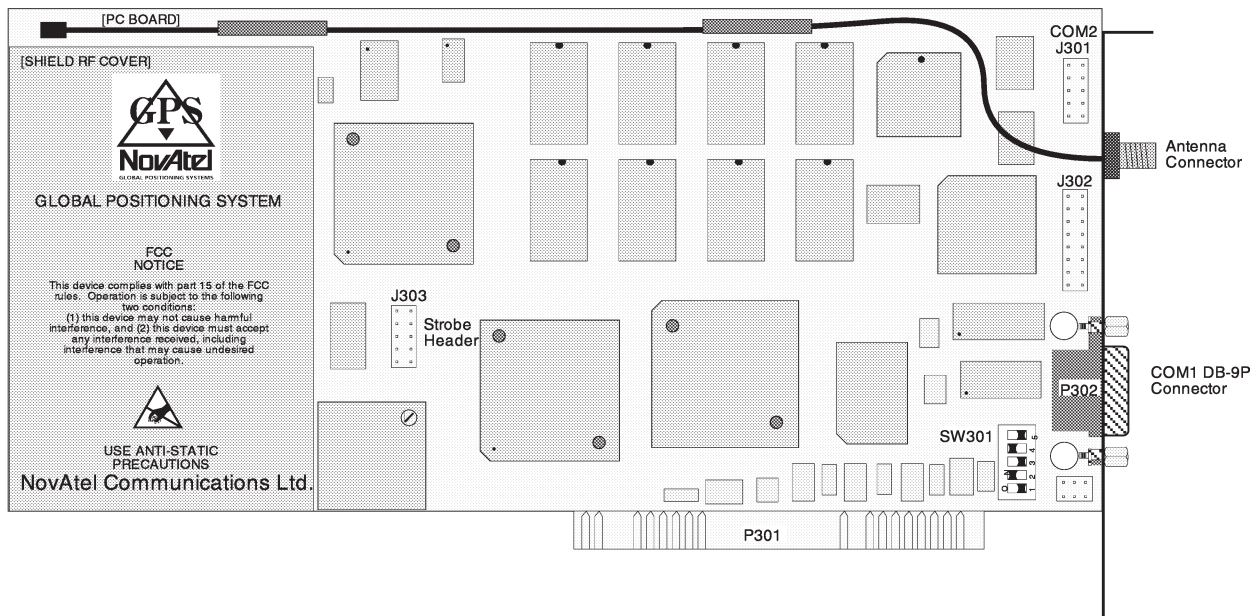
What's New in this Edition

The Features Summary Chart in Section 1 has been updated to accommodate new features added to the top-of-the-line 3951R PC Series of GPSCard. As well, the chart reflects the newest feature additions of MET (Multipath Elimination Technology) and RT-20 (RTK Carrier Phase Measurement System). The performance specifications particular to MET and RT-20 are addressed in the accompanying *Command Descriptions Manual*. As well, the summary chart includes the RTCA Standard differential data capabilities now available in GPSCards with the “R” options.

1 INTRODUCTION

The NovAtel GPSCard™ PC Series family of products are state-of-the-art multichannel GPS receivers, designed for use in a desktop or laptop PC, operating in the DOS environment. The GPSCard provides superior performance over a wide range of GPS positioning applications. Designed to allow integration into navigation systems or specific surveying applications, the GPSCard provides you with the flexibility you need.

Figure 1-1 Illustration of GPSCard – PC Series



A patented C/A code correlation technology achieves pseudorange accuracy with near P-code performance and provides the industry's most robust resistance against errors introduced by multipath signals. The improved pseudorange accuracy reduces the time required for ambiguity resolution when carrier phase measurements are being made and substantially improves the receiver's performance in differential mode.

The on-board processor measures and provides data and solutions at rates that are the highest found in the industry. Exceptional acquisition and re-acquisition times allow this receiver to operate in environments where very high dynamics and frequent interruption of signals can be expected.

NovAtel's GPSCard receiver module offers the developer unparalleled flexibility in areas such as configuration selection, remote control, and in the specification of output data and control signals. The available selection of PC models is based on a common building block, allowing the user to fit the receivers more exactly to the application while maintaining the option for a compatible upgrade path. Accessories such as a selection of antennae, and an antenna choke ring complete your system requirements.

NovAtel leads the industry in state-of-the-art GPS receiver design and we believe our GPSCard™ product line will help place your application ahead of the competition. Future products and product enhancements from NovAtel are aimed at helping you to maintain that lead.

GPSCARD DESCRIPTION OVERVIEW

The GPSCard PC Series are multi-channel parallel tracking, C/A code (Coarse Acquisition) GPS receivers operating on the L1 (1575.42 MHz) frequency. Each dedicated channel independently tracks the code and carrier phase of a GPS satellite in view and can provide a pseudorange accuracy within 10 cm. The NovAtel custom proprietary correlator chip combined with a high performance 20 MHz 32-bit CPU is capable of measuring and outputting satellite code and carrier phase data at a rate of up to 20 times per second and can compute up to 10 position solutions per second.

The GPSCard PC Series receiver is built on a 2/3 length (21.6 cm x 10.7 cm x 1.9 cm) 8-bit ISA-bus printed circuit board. It has been designed to operate inside IBM-compatible desktop or laptop computers using the host computer's expansion slots.

The GPSCard is equipped with two user configurable RS-232C serial ports, denoted by COM1 and COM2. Either port can be used as an ASCII input command port or data logger. In addition, command entries and data logging may also be accomplished using the console, that is, the screen and keyboard of the host PC.

On-board software provides a list of user friendly commands which are used to configure the system. These commands are described in the *GPSCard Command Descriptions Manual*.

OPTIONAL ACCESSORIES

The following GPSCard optional accessories are also available from NovAtel Communications Ltd.

- GPSAntenna™ (survey, aircraft, or mobile/manpack models available)
- Choke Ring Ground Plane (for GPSAntenna 501)
- 5, 15, and 30 meter antenna cable
- I/O Expansion Bracket Assembly

Please contact your NovAtel GPS Customer Service Representative for further information regarding any GPSCard options and accessories.

GPSCARD™ PC SERIES FEATURES

The GPSCard PC Series is available in numerous models with a multitude of features. *Table 1-1* summarizes the features of the top-of-the-line GPSCard PC Series models. Please feel free to contact a NovAtel GPS Customer Service Representative for further information on GPSCard models available with fewer features.

Table 1-1 PC Series Top-of-the-Line Feature Summary

General	3951RM	RT-20
Number of Dedicated Channels	12	12
Narrow Correlator Spacing	√	√
Number of Serial Ports	2	2
Personal Computer Circuit Board – 8 bit ISA	√	√
Fast Reacquisition (< 3 seconds typical)	√	√
Field-Loadable Software Upgrades	√	√
MET – Multipath Elimination Technology	√	√
< 20 cm accuracies with RTK Carrier Phase Position Solutions	—	√
Save Data Logs and Command Files to Host PC Hard Drive	√	√
Data Logging Rates (Maximum)		
<i>Computed Data:</i>		
Position/Speed/Direction/Clock Offset	10/Sec.	5/Sec.
<i>Measured Data:</i>		
Pseudorange/Carrier Phase	20/Sec.	20/Sec.
Log Formats		
NovAtel ASCII and Binary Proprietary	√	√
NMEA Standard	√	√
RTCM Standard: Types 1 and 16 (Tx/Rx)	√	√
Types 2 and 9 (Rx only)	√	√
Types 3 and 59 (Tx/Rx)	—	√
RTCA Standard: Type 1 (Tx/Rx)	√	√
Positioning Modes of Operation		
Single Point	√	√
Waypoint Navigation	√	√
Pseudorange Differential (monitor/remote)	√	√
Pseudorange/Carrier Phase Double Differencing (monitor/remote)	—	√
Receiver Control		
Serial Port Control	√	√
Datum - Table or User Definable	√	√
Magnetic Variation Correction	√	√
Undulation - Table or User Definable	√	√
Satellite Elevation Cutoff Control	√	√
Position/Height/Velocity Constraint	√	√
Satellite Lockout Control	√	√
Satellite Health Control	√	√
Almanac/Ephemeris Input-Output	√	√
Strobes		
Mark Input - Position/Time	√	√
1PPS Timing Output	√	√
Measurements Strobe	√	√
User Settable Frequency Output	√	√
Solution Status Output	√	√

2 FUNCTIONAL OVERVIEW

The GPSCard PC Series modules are composed of two major sections: an RF section and a Digital section. In order for the GPSCard PC module to function as a complete GPS positioning system, it must be installed into an IBM-compatible desktop or laptop computer and connected to an external antenna. A brief description of each section follows.

GPSAntenna™

The purpose of the antenna element is to intercept the radio waves emitted by the GPS satellites. The signal is then coupled to the low noise amplifier (LNA) where it is amplified to overcome the losses incurred by the interconnecting coaxial cable between the antenna and GPSCard.

NovAtel offers a variety of GPSAntenna models. All use low profile microstrip technology with built-in LNA and bandpass filtering. The antenna you choose will depend on your particular application, ranging from precise geodetic surveying to avionics, marine, and mobile.

GPSCARD RF/IF SECTION

The GPSCard receives the filtered and amplified RF signal from the GPSAntenna via the external interconnecting coaxial cable. The RF section of the GPSCard serves the following primary functions:

- Filters the RF signal to reduce noise and interference
- Down-converts the RF signal to an IF (intermediate frequency) range that is suitable for the A/D converter
- Amplifies the GPS signal to a level suitable to drive the A/D converter in the digital section
- Accepts automatic gain control (AGC) input from the Digital Signal Processor (DSP) to maintain the IF signal at a constant level
- Supplies DC voltage to the antenna RF input connector which is used by the GPSAntenna as power input for the LNA.

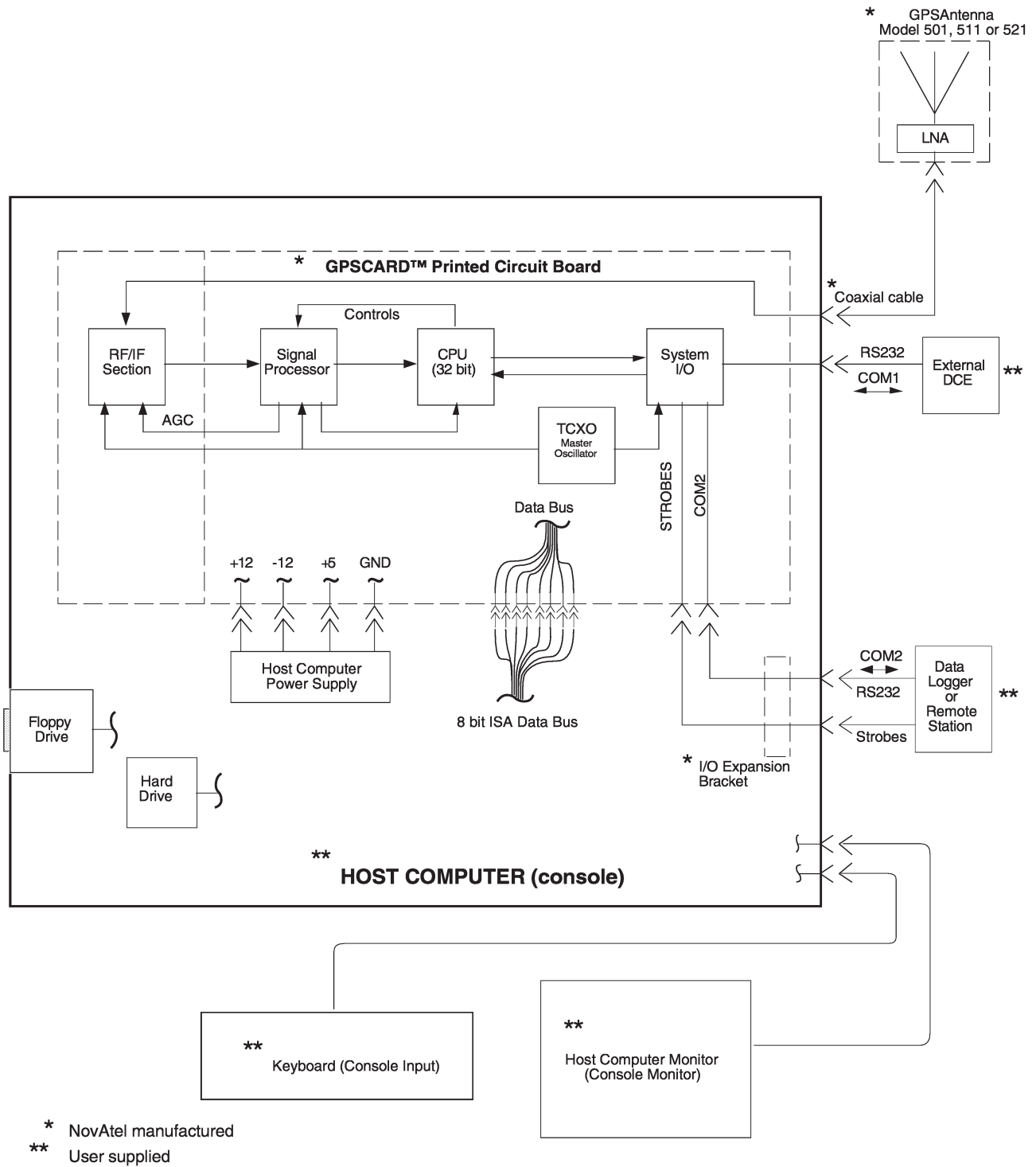
DIGITAL SECTION

The GPSCard digital section consists of three major subsections: Signal Processor, CPU, and System I/O.

The **Signal Processor** contains two NovAtel custom ASIC correlator chips, an analog to digital converter (A/D), and performs the following primary functions:

- Converts the IF signal to a digital format (A/D conversion)
- Independent satellite channel tracking (up to 12 channels)
- C/A code and carrier phase tracking

Figure 2-1 GPSCard PC Series – System Functional Block Diagram



The **CPU** is the heart of the GPSCard. All of the system control, processing, and positioning intelligence is performed in the CPU. It consists of both hardware and software components. The CPU is summarized below:

- A 32-bit microprocessor
- Custom Real Time Operating System (RTOS)
- Database management
- I/O control
- Position filtering
- Channel/loop control
- Navigation software

The **I/O** section allows two-way communications and timing strobes between outside devices and the GPSCard. Pinout descriptions for I/O connections are provided in the Hardware Installation section of this manual. A summary of I/O functions is listed below:

- Provides two serial communication ports for interfacing with outside data communications equipment (DCE)
– EIA RS 232
- Selectable baud rates up to 115.2 KBaud (defaults to 9600 baud)
- Provides input and output timing strobe lines
- Allows user command input (COM 1, COM 2, or host computer console)
- Provides a means of output logging of various data types and differential corrections

3 HARDWARE INSTALLATION

The GPSCard is a fully contained GPS receiver capable of accepting user commands, computing position information, and outputting data logs. However, to operate, the GPSCard requires that it be installed into an IBM-compatible personal computer. Because of the many different makes and models of PC's available, it is impractical to provide PC model-specific installation procedures.

The procedures that follow in this section will provide sufficient information to allow setup and preparation of the GPSCard for initial operation. *Section 4* of this manual will describe the software installation procedures required before operating the GPSCard.

MINIMUM CONFIGURATION

In order for the GPSCard to function as a complete GPS positioning system, a minimum equipment configuration is required. The recommended minimum configuration and required accessories are listed below.

- NovAtel GPSCard “PC Series”
- Any optional NovAtel GPSAntenna model
- NovAtel GPSAntenna™ coaxial antenna cable
- Any DOS-based desktop or laptop PC with the following:
 - at least one unused ISA bus port available to install the GPSCard
 - one free IRQ interrupt: 3, 5 or 7
 - one available I/O base address range: 150-163_h, 200-213_h or 300-313_h
 - hard disk size dependent on quantity of satellite data to be recorded
 - 640K RAM

The minimum configuration listed above will enable collection of GPS satellite data and computation of position solutions. Data can be logged to the COM1 port as well as to the host PC hard disk.

NOTE: If the Performance Series of GPSCard is used for high rate data logging, the computer system requirements may need to be upgraded to accommodate the higher performance demands.

OPTIONAL CONFIGURATIONS

The minimum configuration can be expanded beyond that listed in the above paragraphs. The following points should be considered.

- The I/O Expansion Bracket can be installed to provide for COM2 RS232 communications as well as timing strobe capabilities.
- It is possible to log data to the COM1 or COM2 port or receive command input through either port. This will require that external data communications equipment be connected (DCE – RS232 compatible).
- If operation using *differential corrections* is intended, the set-up will require at least two independent GPS receiver systems. Use the NovAtel XXXXR series to operate in the differential mode.
- The NovAtel WINSAT User Interface Program software is included to provide greater ease of communicating with the GPSCard.

ANTI-STATIC PRECAUTIONS

Electrostatic discharge (ESD) is the leading cause of failure of electronic equipment components and printed circuit boards containing ESD-sensitive devices and components. It is imperative that ESD precautions be followed when handling or installing the NovAtel GPSCard printed circuit board. Refer to *Appendix A* for more information on ESD precautions.



When the GPSCard is removed from the original packing box, it is recommended that the box and ESD protective plastic clamshell be saved for future storage or shipment purposes.

REMEMBER !

Always wear a properly grounded anti-static wrist strap when handling the GPSCard.

Always hold the GPSCard by its corners or the RF backplane, and avoid direct contact with any of the components or the PC bus connector.

Do not let the GPSCard come in contact with clothing at any time because the grounding strap cannot dissipate static charges from fabrics.

Failure to follow accepted ESD handling practices could cause damage to the GPSCard.

Warranty may be voided if equipment is damaged by ESD.

INSTALLATION REQUIREMENTS – MINIMUM CONFIGURATION

Ensure that all power is disconnected from the PC before any installation is attempted. Installing the GPSCard GPS receiving system requires the following steps:

- Set up the GPSCard Base Address and IRQ DIP switch selections.
- Install the GPSCard into the IBM PC compatible.
- Install the GPSAntenna™.
- Route and connect the antenna coaxial cable between the GPSAntenna and GPSCard.
- Replace the cover on the PC before turning on power.
- Install software (see *Section 4*).

BASE ADDRESS AND IRQ SELECTION

Before installing the GPSCard into the host PC, it is important to first check SW301 DIP switch for correct IRQ and Base Address settings (refer to *Figure 3-1* and *Appendix B*). The GPSCard DIP switch factory default settings are:

- Base Address = 150_h
- Interrupt Request = IRQ5

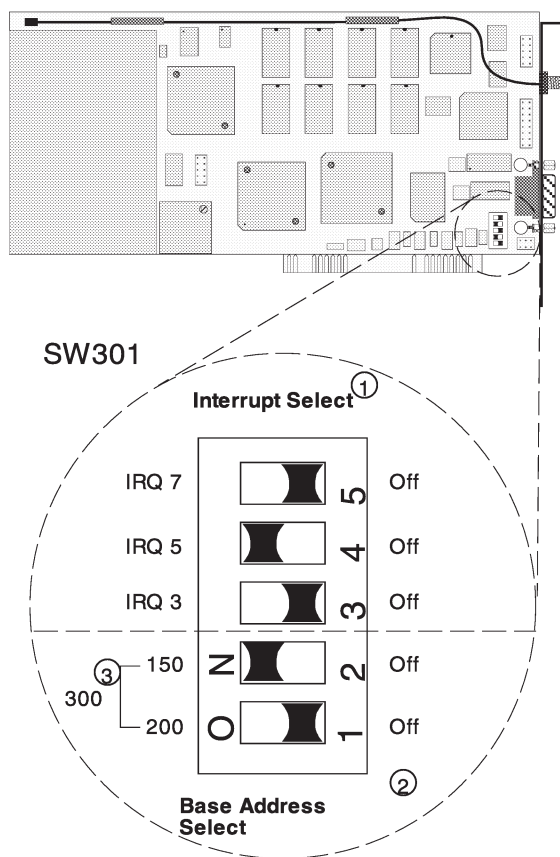
If these settings are already being used by other cards or devices in the PC, it will be necessary to change the settings of either the GPSCard or the other device.

CAUTION:

- It is important to note that any two cards or devices on the host computer cannot share common IRQ or Base Address settings. Ensure that no conflicts exist on your PC.
- Follow ESD precautions before handling the GPSCard; refer to *Appendix A*.

NOTE: After the card is installed into the computer the user can use the FINDCARD utility that is supplied on the distribution diskette. This utility reads the current settings for an installed GPSCard. If the card has been properly installed, the results will indicate hardware revision, IRQ and I/O address.

Figure 3-1 Base Address and IRQ DIP Switch Settings



- Notes:
- ① - Only one IRQ can be selected on at any one time
 - ② - Base Address is in HEXADECIMAL
 - ③ - Switches 1 and 2 must both be ON to select Base Address 300
 - ④ - Also see Appendix B

MOUNTING THE GPSCARD INTO THE HOST PC

The GPSCard is designed to be installed into any IBM-compatible PC that has at least one available expansion slot. The expansion slot chosen must not be a reserved video or memory slot. For best mechanical support, it is recommended to use an ISA slot versus an ESIA slot. Refer to *Figures 3-2* and *3-3* for installation reference. Proceed as follows:

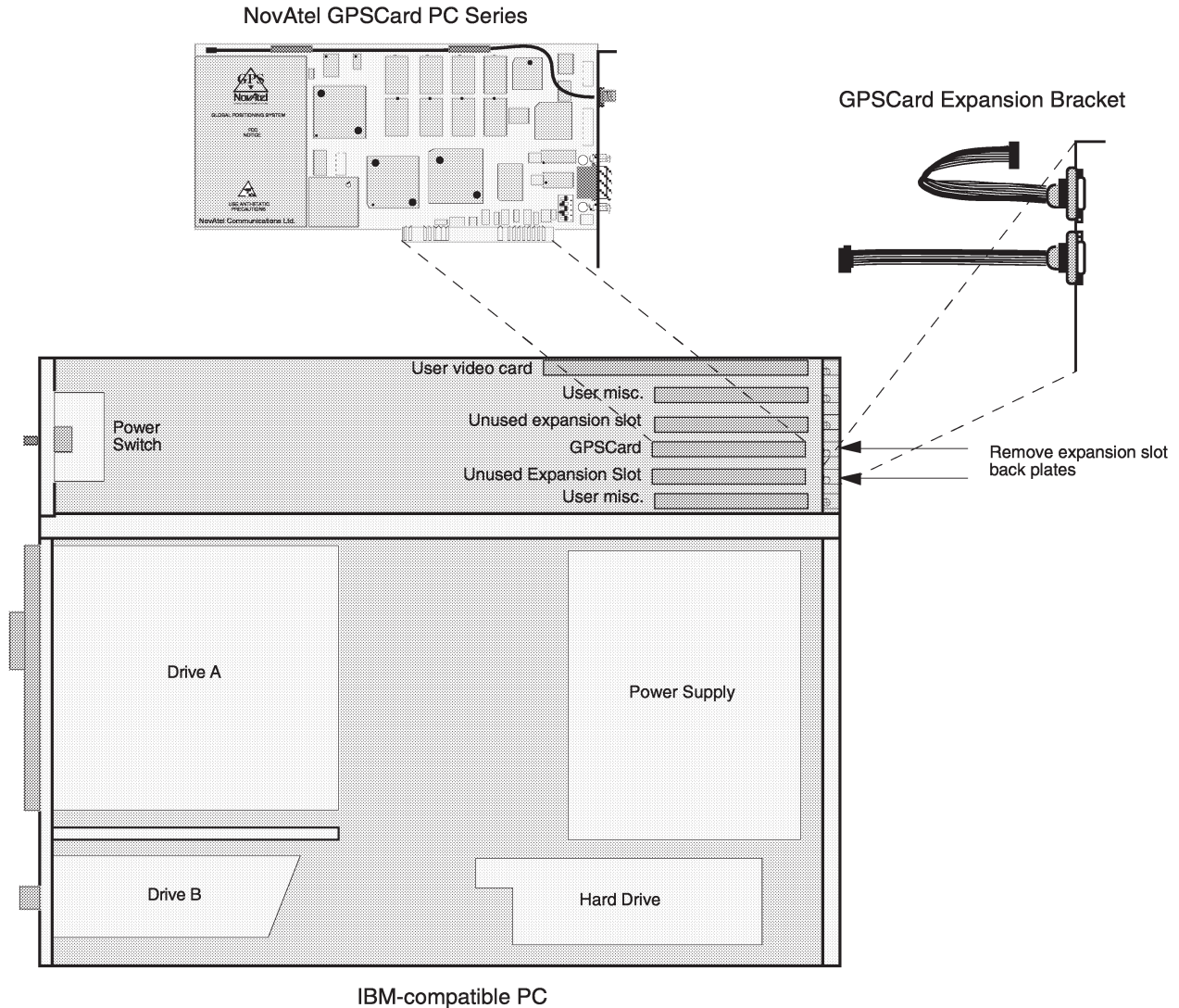
1. Ensure that all power is turned off or disconnected from the PC.
2. Remove the PC cover.
3. Ensure that you are wearing your anti-static wrist strap and that it is grounded to the PC chassis.
4. Locate an available ISA expansion slot. Remove the slot backplate and save the backplate mounting screw.
5. Insert the GPSCard into the ISA expansion slot. Use the backplate mounting screw to secure the GPSCard backplate.

IMPORTANT

If the PC and GPSCard will be operating in a high vibration environment, or if the GPSCard is left installed in the PC during transport to remote locations, it is important to ensure that the free end of the GPSCard be secured by a card guide or other securing means in the PC.

Do not install more than one GPSCard into the host PC. While it is physically possible to install more than one card, they may not operate properly. Please contact NovAtel Communications should your application require such an installation.

Figure 3-2 GPSCard Installation – PC Top View (typical)



INSTALLING THE GPSCARD I/O EXPANSION BRACKET

Some installations will require use of the GPSCard COM2 and Input/Output Strobe ports. For example, if the GPSCard is to operate as a remote station and receive differential corrections from a monitor station, COM2 may be used as the dedicated differential port while the Strobes port is being used for marking events. This would require installation of the NovAtel GPSCard I/O Expansion Bracket. Refer to *Figures 3-2, 3-3, and 3-4* for installation reference. Proceed as follows:

1. Remove the backplate of the expansion slot adjacent to the GPSCard (preferably left side – see *Figure 3-4*).
2. Connect the **COM2** 10-pin ribbon cable (female connector) to **J301** on the GPSCard. Note that the ribbon cable tracer wire connects to pin 1 of the connector and the **triangle** on the end of the connector also points to **pin 1**. The ribbon cable must be twisted 180° to connect correctly (see *Figure 3-3*).

3. Connect the Strobes 10-pin ribbon cable (female connector) to J303 on the GPSCard. Note that the ribbon cable tracer wire connects to pin 1 of the connector and the triangle on the end of the connector also points to pin 1.
4. Insert the optional GPSCard I/O Expansion Bracket into this vacant slot and secure the bracket with the backplate retaining screw.

Replace the cover on the PC and connect the antenna cable before turning on power.

Figure 3-3 GPSCard I/O Expansion Bracket

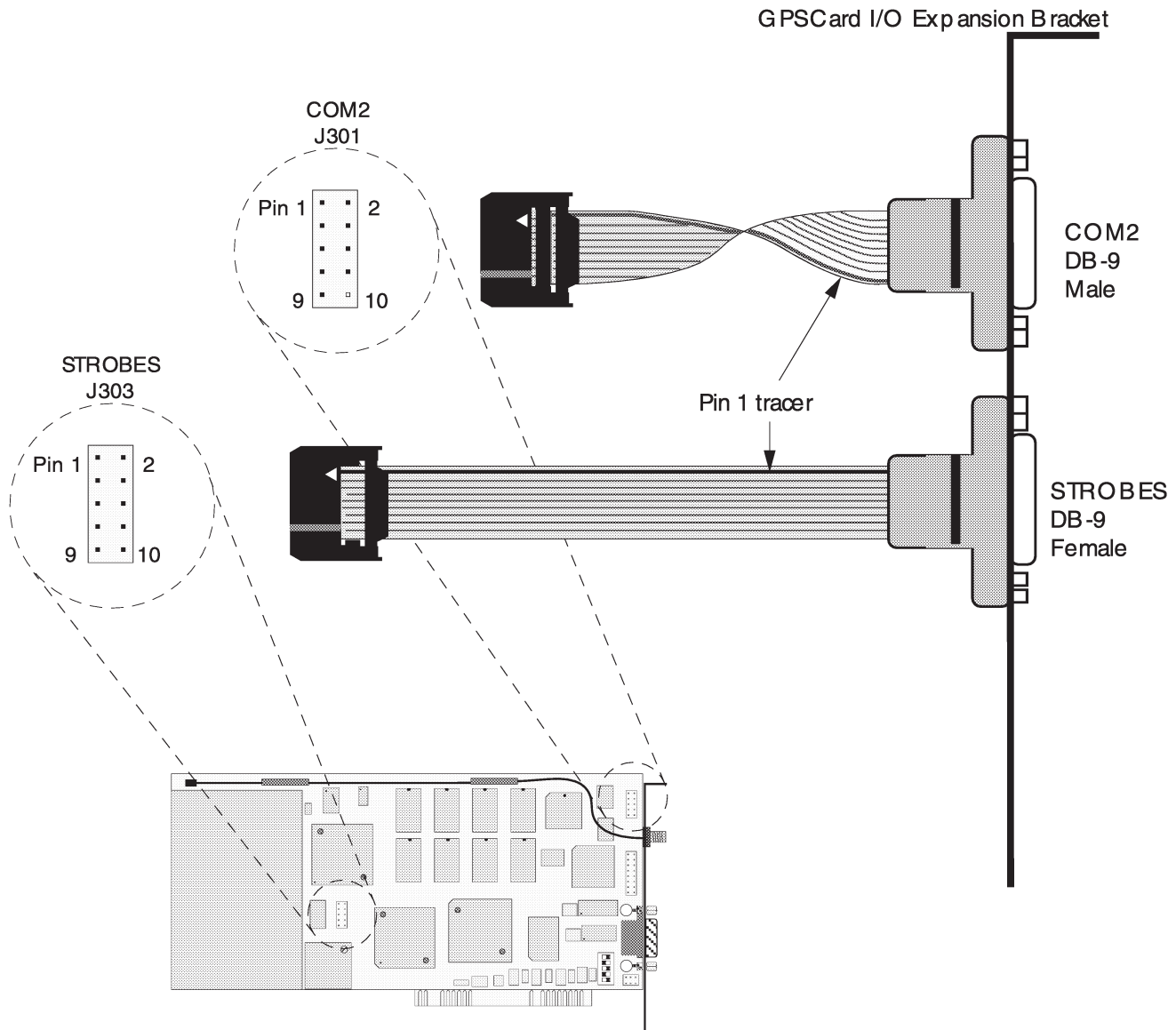
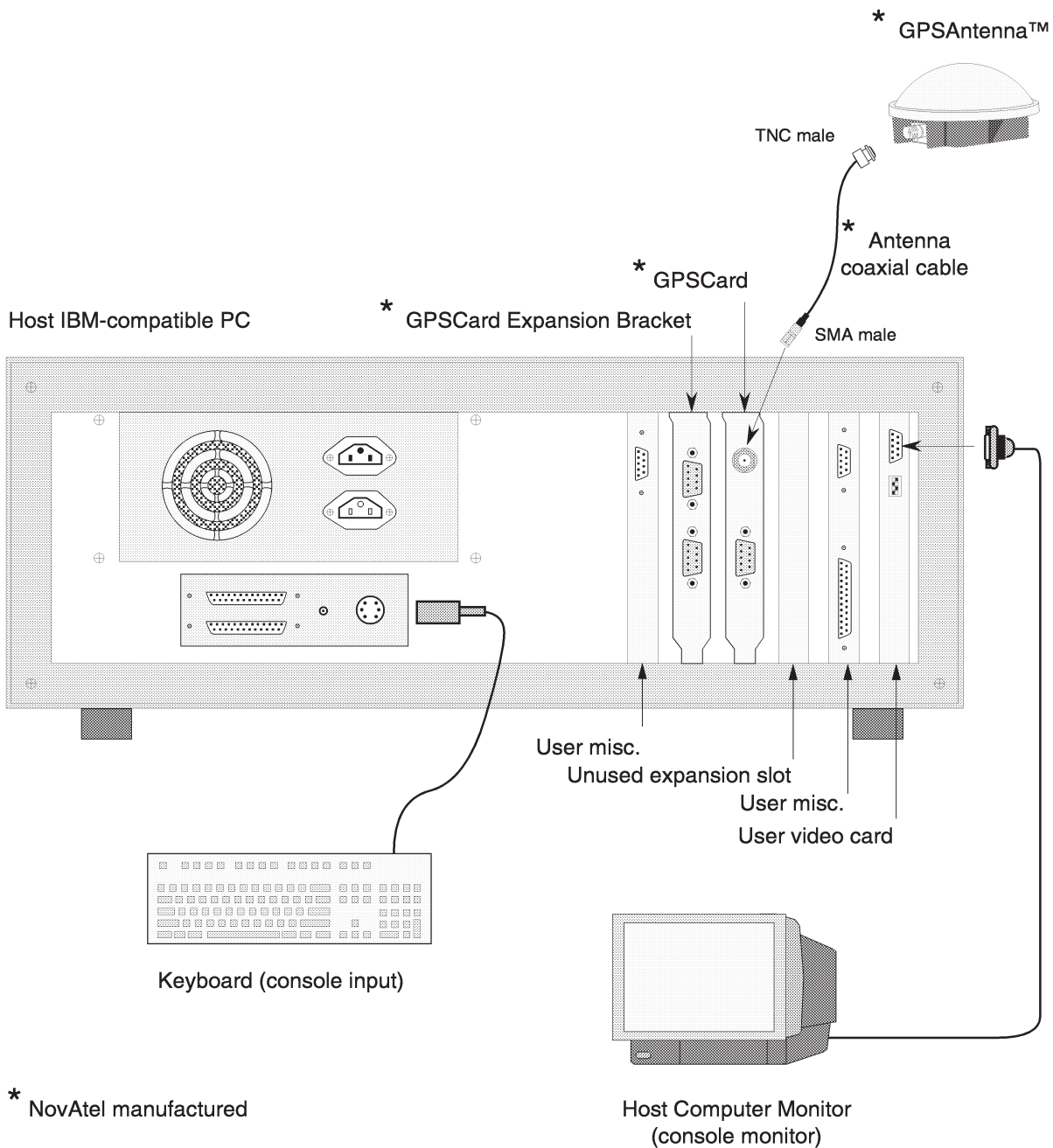


Figure 3-4 GPSCard Installation - PC Rear View (typical)



GPS ANTENNA CONSIDERATIONS

Selecting and installing an appropriate antenna system is an important step before operating your GPS receiver. The antenna you choose for your GPS system will depend on the specific positioning application, such as survey, aviation, marine, mobile, or manpack.

The GPSCard has been designed to operate with the NovAtel GPSAntenna models 501, 511, and 521. Though it is possible to operate with other GPS antennae, NovAtel only warrants operation with the above-mentioned models. For further information on GPSAntenna™ systems and extended length cable runs, contact NovAtel GPS Customer Service and ask for our "Extended-Length Antenna Cable Runs" Application Note, APN-003.

For initial testing of the GPSCard, we recommend that the GPSAntenna Model 501 be used. It offers exceptional phase center stability as well as improved immunity against multipath reception (> 10 dB rejection of left-hand circular reception). Refer to the *NovAtel GPSAntenna™ - Model 501 - User Manual* for recommended procedures when installing the Model 501 antenna.

Some important points are mentioned here to keep in mind when installing the antenna system.

- Select an antenna location with a clear view of the sky to the horizon so that each satellite above the horizon can be tracked without obstruction.
- Ensure that the antenna is mounted on a secure stable platform or structure. The mounting structure should be stable enough to withstand unexpected high wind gusts.
- If geodetic survey quality positioning is required, with reduced multipath reception, while maintaining a stable phase center, the NovAtel GPSAntenna Model 501 is recommended. If greater multipath reduction is of high importance, install the GPSAntenna on the NovAtel Choke Ring Ground Plane. Refer to the *GPSAntenna Model 501 User Manual* for more details.

ANTENNA CABLE CONSIDERATIONS

The antenna coaxial cable required will depend on the specific antenna selected and the distance between the antenna and the OEM module. The following cables are recommended for use with NovAtel GPSAntennas:

- 5 metre antenna cable (TNC/SMA)
- 15 metre antenna cable (TNC/SMA)
- 30 metre antenna cable (TNC/SMA)

Though it is possible to use other high quality antenna cables, only NovAtel supplied coaxial cables are guaranteed for use with the PC series.

REMEMBER: The coaxial cable must be connected to the antenna and GPSCard before system power is turned on. If for any reason the cable is disconnected from the antenna or GPSCard, you should turn off power before reconnecting the cable. This is to prevent the GPSCard antenna current-limiting circuit from unnecessarily activating.

INTERFACING WITH THE GPSCARD

There are basically four ways to interface with the GPSCard:

- PC Console using the ISA data bus
- COM1 port using RS232 data format
- COM2 port using RS232 data format (using I/O Expansion Bracket)
- Timing and status strobes using the Strobe port (using I/O Expansion Bracket)

PC CONSOLE

Communicating with the GPSCard using your PC console is the quickest and easiest way to initiate commands and logging when you first begin operating your GPSCard receiver. To do this, it is required that you run a user interface program. GPSCON is NovAtel's DOS-based interface program, and is described in *Section 5, Operation*. WINSAT is NovAtel's Windows-based GUI, and is outlined in the *WINSAT Graphical Interface Program User Manual* (OM-20000009).

Command input is generally initiated through the console keyboard. Command and logging response is displayed directly on your PC screen or directed to the PC disk to a specified data file. For complete information on using GPSCard commands, refer to the *Command Descriptions Manual*.

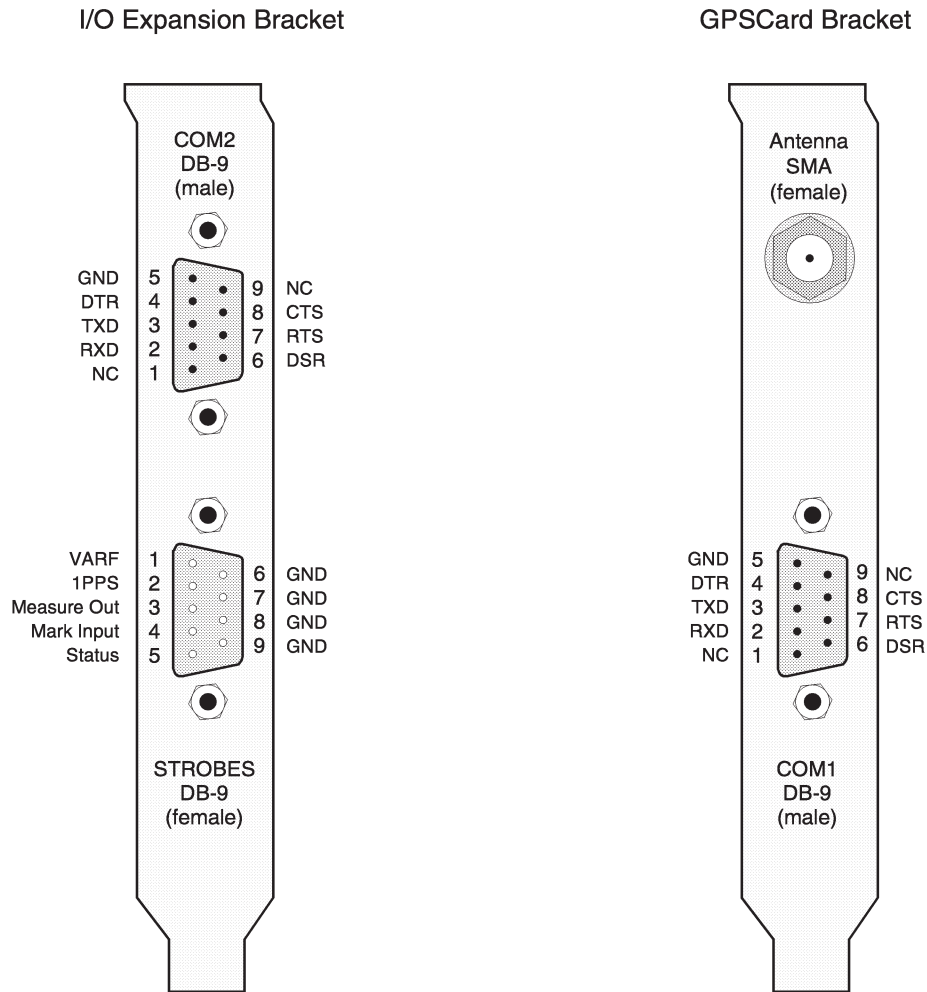
COM1 PORT

If you are operating with the minimum configuration, COM1 is available for command input, data output logging, or transferring differential corrections. COM1 is defaulted to the following RS232 protocol:

- 9600 baud
- no parity
- 8 data bits
- 1 stop bit
- no handshake
- echo off

To interface with COM1, refer to *Figure 3-5* for wiring connections.

Figure 3-5 GPSCard and I/O Expansion Bracket Pinouts



COM2 PORT

If you are operating with the I/O Expansion Bracket, COM2 port is available as well as COM1. Both ports can be used for command input, data output logging or transferring differential corrections. COM2 is defaulted to the following RS232 protocol:

- 9600 baud
- no parity
- 8 data bits
- 1 stop bit
- no handshake
- echo off

To interface with COM2, refer to *Figure 3-5* for wiring connections.

TIMING STROBES

Various strobes are available for event and time synchronization. These strobes become available at the bottom DB-9 female connector when you install the I/O Expansion Bracket with the GPSCard. *Appendix B* provides a detailed description and specifications for the I/O Strobes. To interface with the Strobes, refer to *Figure 3-5* for wiring connections.

This completes the GPSCard Hardware Installation section. Refer to *Section 4* for details on software installation and *Section 5* for operating procedures.

4 SOFTWARE INSTALLATION

When you purchase the PC Series GPSCard, it comes accompanied by a diskette containing the GPSCard software/firmware in a compressed format. Once decompressed, this software is used to run and interface with the GPSCard from your host PC hard drive. Also available on this disk is the “C” freeware source code for the utility files that accompany the GPSCard program. This manual does not discuss installation or usage of the “C” freeware source code.

As well, you are supplied with a separate disk containing the installation and operating software for the WINSAT GUI. If you have Windows and you wish to install this program, refer to the *WINSAT GUI User Manual* for further information.

The GPSCard program software resides in the host PC’s hard drive (typically C:) The GPSCard program files and utilities will need to be copied from the program disk (supplied by NovAtel) directly into the host PC’s designated operating directory. An auto-install utility is provided in the program disk (INSTALL.exe) to help make the software installation as easy as possible.

Before proceeding any further, it is recommended that you make a working backup copy of the original GPSCard program disk. This is a precaution to help prevent accidental damage to the originals.

INSTALLATION PROCEDURES

Proceed with the installation as follows:

- 1) Insert the GPSCard program disk into the appropriate drive (**A:** or **B:**)
- 2) Type the following command, then press [Enter]:
a:install or **b:install**
- 3) After a short delay the host PC screen will echo the word **INSTALL**, followed by a series of progressive white dots indicating that the utility is decompressing the files in the background.
- 4) The **MAIN MENU** will allow you to make a choice (1, 2, or 3) as to whether you want to install the “C” freeware files along with the GPSCard program files, or just the GPSCard program files. As it is not within the scope of this manual to describe usage of the “C” freeware, select choice number 2 to proceed with installation of the GPSCard program files only.
- 5) You will now be prompted to select the hard drive to which the program files will be saved; **C:** is the default. However, if your PC has other drive options available, you can select it at this time.
- 6) Define the resident directory from which the GPSCard program will operate. Install will recommend that you use the following directory structure:
C:\GPS\GPSCARD
This structure will help maintain organization within your GPS directory in the event that you may have other GPS programs such as the NovAtel WINSAT GUI programs, which would be recommended to be set up as **C:\GPS\WINSAT**. However, you do have the option to specify a directory structure other than that recommended.
After defining the directory (or just press Enter to use the default) it will only take a few moments for **INSTALL** to transfer the files to your hard drive directory.
- 7) Select menu item number four (4) to proceed with the installation **SETUP**.
- 8) At this point, you will be prompted to select the **base address** of the GPSCard; 150h is the default selection. This selection must agree with the actual DIP switch setting on your GPSCard.

- 9) Next, you are prompted to select an interrupt **IRQ** setting for the GPSCard. IRQ 5 is the GPSCard default setting. Whatever setting you select here must agree with the actual DIP switch setting on the GPSCard.

CAUTION: The base address and IRQ settings must not conflict with any other expansion card settings currently installed in your host PC.

- 10) You will now be prompted to answer yes or no to have the host PC AUTOEXEC.BAT file automatically updated. If Yes is selected, INSTALL will proceed to rename the existing autoexec file as a backup and modify the current autoexec.bat file to include the SET GPSCard=ADD,IRQ command.

If you selected No to the INSTALL prompt, your autoexec.bat file will not be modified and you must make the appropriate changes manually after the INSTALL program has completed. Please see the following section about modifying the AUTOEXEC.BAT file.

When completed, INSTALL will return to the DOS prompt and you are reminded to reboot the host PC to have the modified AUTOEXEC.BAT file commands take effect.

AUTOEXEC.BAT

The INSTALL program will modify the host PC AUTOEXEC.BAT file as required to enable proper set-up. However, should you elect not to have INSTALL modify the AUTOEXEC.BAT file or if you encounter any problems with setting-up, the following information is provided for your assistance.

MODIFYING AUTOEXEC.BAT

Before the PC Series GPSCard can be operated, it is necessary to modify the host PC's AUTOEXEC.BAT file to include "SET GPSCARD =ADD,IRQ" environment variables using the DOS SET command. Once this command has been entered into the AUTOEXEC.BAT file, it will automatically be set each time the host PC is booted-up.

It is always a good idea to back up your current AUTOEXEC.BAT file (e.g. AUTOEXEC.OLD), as this will protect your current AUTOEXEC file before you attempt to make any changes. This will allow you to recall the old AUTOEXEC file anytime in the future, if required.

The required syntax for setting the GPSCard environment variable is as follows:

Syntax: **SET GPSCARD=aaa,b**

Whereas: **aaa** = 150 or 200 or 300 (GPSCard base address in hex)
 b = 3 or 5 or 7 (GPSCard IRQ interrupt request)

Defaults: **aaa** = 150 and **b** = 5

Example: **set gpocard=150,5** [Return]

GPSCARD FILES

After you have completed the INSTALL utility, your designated GPS directory will contain the following files:

GPSLOAD.EXE	DOS bootstrap loader program; used to load MAIN.BTL.
MAIN.BTL	Firmware required to run the GPSCard. This file is <u>tagged</u> to your GPSCard and <u>cannot be interchanged</u> with other software or GPSCards.
GPSCON.EXE	DOS console program; this program enables the host PC to communicate with the GPSCard using the host keyboard or disk files
STRIP.EXE	Utility used for stripping out selected ASCII records
BIN2ASC.EXE	A utility used for converting Binary logs into ASCII logs

SOURCE	Directory containing source code for GPSCON, GPSLOAD, etc. MAKEFILE is for Borland 2 or 3C Compiler, and requires environment variable to be set before use.
README.GPS	A text file containing important information on software and manual updates.
FINDCARD.EXE	Determines the current settings for an installed GPSCard. The results will indicate hardware revision, IRQ and I/O address. This may be required for support during installation.
CHECK.EXE	Verify the link/transputer is functional on the GPSCard
MTEST.EXE	Test GPSCard system memory. Requires CHECK.EXE to pass binary file to GPSCard.
ALMANAC.TXT	Sample almanac data file. Can be loaded into GPSCard during cold boot. (Refer to <i>Section 5 – Creating or Updating the Almanac Data File</i>)

LOG FILES

When you operate the GPSCard using the GPSCON console program, data storage files are established upon start-up. The default log files are:

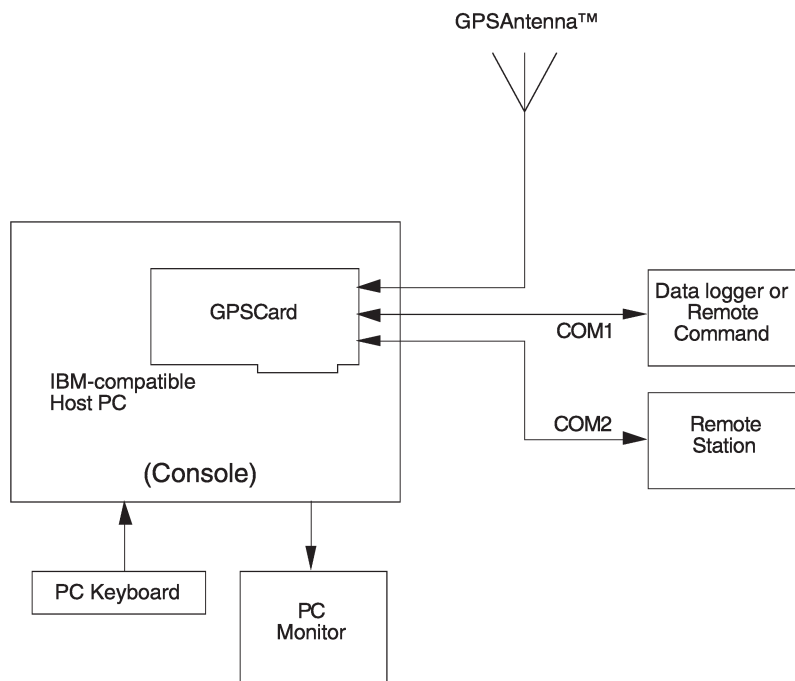
DATA.ASC	Stores all console directed ASCII logs
DATA.BIN	Stores all console directed Binary logs
USER.DEF	You can define your own file names for directing logs

Refer to *Section 5, Operation*, for more information on GPSCON and data storage files.

5 OPERATION

Once the hardware and software installations have been completed, you are now ready to begin initial operation of the GPSCard receiver. The figure below illustrates a typical operational configuration when using the GPSCard in a DOS-based system.

Figure 5-1 Typical Operational Configuration



GETTING STARTED

The firmware (MAIN.BTL) required to run and interface with the GPSCard should be resident in the GPSCard directory of your host PC hard disk. This section is dedicated to describing initial boot-up and interface with the GPSCard operating in the DOS environment. If you have Microsoft Windows and wish to utilize NovAtel's WINSAT GUI, refer to the *WINSAT Graphical Interface Program User Manual (OM-2000009)*.

REMEMBER: If you plan to track satellites upon power-up, the GPSAntenna coaxial cable should be connected to both the GPSCard and GPSAntenna before power is turned on to the PC and GPSCard. If the antenna is connected to the GPSCard after power-up, it may cause the antenna LNA power source to current-limit, shutting off power to the GPSAntenna. To restore power to the LNA, you would then be required to turn off the PC power, and then back on again.

COLD START BOOT-UP

To perform a cold start boot-up, proceed as follows.

1. Turn on the PC.
2. Move to the GPSCard directory. This directory should contain all files required to run the GPSCard. See *Section 4, Software Installation*.

e.g. C:\GPS\GPSCARD>

3. Load the GPSCard firmware (MAIN.BTL) using the DOS bootstrap loader program (GPSLOAD.EXE).

e.g. C:\GPS\GPSCARD>gpsload main.bt1 [Return]

Your PC monitor screen will display the following:

```
C:\GPS\GPSCARD>gpsload main.bt1
*****
C:\GPS\GPSCARD\GPSLOAD.EXE
Version X [Date]
GPS Products Division.
Copyright (c) 1992 ...
NovAtel Communications Systems Ltd.
6732 - 8th Street N.E.
Calgary, Alberta.
Canada.
T2E 8M4
*****
.....
.....
.....
.....

Waiting for initial prompt
Received Data From Board --> Console>

All done.

C:\GPS\GPSCARD>
```

Your GPSCard is now up and running!

At this point, it is not very obvious from your PC screen that the GPSCard is functioning. However, if you are able to observe the GPSCard inside the PC, it will be noticed that a red LED indicator on the GPSCard is flashing at a rate of once per second, if start-up proceeded normally.

If the LED is continuously on or off, it indicates an error condition has occurred. If the LED flashes at a rate other than once per second, this too indicates that an error condition was detected in *start-up self-test*.

Should any of the above error conditions exist, or if the software would not load for unknown reasons, please review the installation process to ensure that the GPSCard has been properly installed. If a problem still exists, contact the NovAtel GPS Customer Service Department for further assistance.

If you have a remote terminal connected to COM1 or COM2 of the GPSCard when you perform a cold start boot-up, the remote terminal will display one of the following prompts:

COM1> *if you are connected to COM1 port, or*

COM2> *if you are connected to COM2 port*

The GPSCard is now ready for command input from one of these two COM ports. Also see the section entitled "GPSCON" for console communications. Refer to *Sections 2 through 6* of the *GPSCard Command Descriptions Manual* for detailed information on command input and logging output.

TIP: You can use the RCSA log to monitor receiver status and self-test. Please refer to the *Command Descriptions Manual*.

COMMUNICATIONS DEFAULT SETTINGS

If you are operating with the minimum configuration, COM1 is available for command input or data output logging. If you are using the NovAtel I/O Expansion Bracket, you may want to use COM1 for command input and COM2 for logging or sending differential corrections. COM1 and COM2 are both defaulted to the following RS232 protocol:

- 9600 baud
- no parity
- 8 data bits
- 1 stop bit
- no handshake
- echo off

If you wish to change the default COM port settings, refer to the COMn command in *Section 2 of the Command Descriptions Manual*.

To interface with COM1 or COM2, refer to *Figure 3-5* in the *Hardware Installation* section for wiring connection details.

DOS AND THE GPSCARD

After the GPSCard has been booted, the PC returns to the DOS environment. You are free to perform normal DOS functions while the GPSCard tracks satellites in the background. Note that the GPSCard firmware (MAIN.BTL) is not a TSR nor will it degrade PC performance in any way. Once loaded, MAIN.BTL resides and remains resident in GPSCard RAM (as long as PC power is still applied).

USING THE GPSCARD DOS CONSOLE PROGRAM (GPSCON.EXE)

Up to this point, you have only been able to communicate, i.e., issue commands, with the GPSCard using COM1 or COM2 ports. If you wish to directly issue commands and log data with the host PC, then it is necessary to run the DOS console program (GPSCON.EXE) already resident in your GPS directory.

GPSCON

Proceed as follows.

1. Ensure that you are in the GPS directory and the GPSCard has been previously booted.
2. Start the DOS Console Program.

e.g. C:\GPS\GPSCARD> **gpscon** [Return]

Your PC monitor screen will display the following:

```

C:\GPS\GPSCARD>gpscon
*****
C:\GPS\GPSCARD\GPSCON.EXE
Version X [Date]
GPS Products Division.
Copyright (c) 1992 ...
NovAtel Communications Systems Ltd.
6732 - 8th Street N.E.
Calgary, Alberta.
Canada.
T2E 8M4
*****
Usage :  GPSCON [flags]
         flags =  /Afile      Filename for ascii output
                  /Bfile      Filename for binary output
                  /pPORT      I/O Address (default 150 hex)
                  /iINTNO     Interrupt Number (default 5)

GPSCON checks environment variable GPSCARD=150,5 for default port
settings
Ascii Output Data File -->data.asc
Binary Output Data File -->data.bin

Press Esc to close files and end.
DO NOT EXIT ANY OTHER WAY OR SYSTEM WILL CRASH !!!

```

GPSCON enables your PC to issue commands directly to the GPSCard from your host PC keyboard through the computer ISA bus, as well as store data logs to the PC disk files. See *Sections 2 through 6 of the GPSCard Command Descriptions Manual* for details on issuing commands and data logging.

When GPSCON is first loaded, you will not see the console prompt until after a command is entered, followed by the [Enter] key. For example, typically you may want to read back the VERSION information from the GPSCard when you first start GPSCON. Another example might be to enter "?" or "help" to get a list of commands.

```

example:    version [Enter]
            GPSCard-2 RT20-PC LGR94160001 HW 16 SW 3.30 Feb 01/95
            console>

```

HELP: You may find the HELP command a useful tool for listing and inquiring about all commands available with the GPSCard. See *Section 2 of the GPSCard Command Descriptions Manual* for more details.

GPSCON AND DEFAULT LOG FILES

GPSCON provides you with flexibility in specifying logging choices from your PC console. The following are the default *console logging data storage files* when GPSCON is loaded:

ASCII Logs will be directed to the file DATA.ASC in your GPS directory.

Binary Logs will be directed to the file DATA.BIN in your GPS directory.

Even if you initiate console logging from a remote command over the COM1 or COM2 ports, the console log will be stored in either DATA.ASC and DATA.BIN files (depending on the command issued).

In the example below, the log command could have been issued from the COM1 or COM2 port; in either case, the POSA log will be directed to the DATA.ASC file in your GPS directory.

```

e.g. log console posa ontime 1

```

For further information about using the LOG command, refer to *Section 2* of the *Command Descriptions Manual*.

You can exit from GPSCON at anytime by pressing the console keyboard ESC key. Do not exit any other way as this could cause your system to crash.

REMEMBER

- Anytime you direct repetitive logs to the Console files, the file will continue to accumulate data until the logs are terminated or you turn the host PC off. Ensure that you have sufficient disk space to accommodate lengthy logging sessions.
 - Any time you restart GPSCON, the specified data file (i.e. data.asc) will be cleared of all previously stored data. You may want to save these files under a different name before restarting GPSCON.
 - When you exit GPSCON by pressing the ESC key, you will be returned to the DOS environment. However, the GPSCard will continue to operate even though you have exited GPSCON. All logging directed to COM1 or COM2 will continue to log as specified before you exited GPSCON. Only logs directed to Console will continue to accumulate in the buffer until GPSCON is restarted at which time they will continue to output from the buffer.
-
-

SPECIFYING ALTERNATE CONSOLE LOG FILES

To specify an alternate file name for your ASCII or Binary Console logs, it is necessary to reload GPSCON specifying the alternate file name. Your options are specified below.

GPSCON /A

Logging to the console will be directed to the host PC *monitor screen*.

e.g. C:\GPS\GPSCARD>gpscon /a [Return]

GPSCON /A[FILENAME.EXT]

All ASCII console logs will be directed to the *specified file name*.

e.g. C:\GPS\GPSCARD>gpscon /a newdata.asc [Return]

This example restarted GPSCON and specified all ASCII logs to be directed to the file: NEWDATA.ASC

GPSCON /B[FILENAME.EXT]

All Binary console logs will be directed to the *specified file name*.

e.g. C:\GPS\GPSCARD>gpscon /b newdata.bin [Return]

This example restarted GPSCON and specified all Binary logs to be directed to the file: NEWDATA.BIN

GPSCON /A[FILENAME.EXT] /B[FILENAME.EXT] (space between A file and B file)

The following example will direct all ASCII logs to the NEWDATA.ASC file and all binary logs to the NEWDATA.BIN file.

e.g. C:\GPS\GPSCARD>gpscon /anewdata.asc /bnewdata.bin

OPERATING HINTS AND TIPS

After initial boot up, you may find the following logs useful for observing the GPSCard activities:

- Use the RCCA log to list the default command settings. After the GPSCard has been operational for a while, the RCCA log will be useful for indicating current status of all command settings.
- Use the CTSA log to monitor the channel tracking status.

- Use the SATA log to observe the satellite specific data.
- Use the POSA log to observe the current computed position solutions.
- Use the DOPA log to monitor the dilution of precision of the current satellite constellation.
- Use the RCSA log to monitor the receiver status.
- Use the HELP command to list all available commands.

CREATING OR UPDATING THE ALMANAC DATA FILE

When booting the GPSCard from a cold start, it will perform a sky-search to acquire satellites. The search time can be reduced by utilizing the ALMANAC.DAT or (ALMANAC.TXT) file as the initial boot-up almanac data. Once this data file is down-loaded to the GPSCard, the initial acquisition of satellites will be improved over a cold random search.

The almanac file can be created by logging the NovAtel ALMA log to a file called ALMANAC.DAT. Note that the ALMA log is always accompanied by the IONA and UTCA logs. Therefore, when you download the ALMANAC.DAT file, you will also be downloading the IONA and UTCA data as well.

The UTCA data will improve the time tag of the NMEA logs, until updated UTC data can be collected from the satellites. As well, the IONA information will ensure that your first fix solutions are as accurate as possible due to the availability of the recent IONA ionospheric correction data (from a cold start, it may take up to 15 minutes before almanac, UTC, and IONA data is downloaded from a satellite).

Once created, the ALMANAC.DAT file should be regularly updated to ensure current almanac data. Intervals should not exceed three months. However, as the GPS Control Segment may shift satellites without notice, it is recommended that the ALMANAC.DAT file be updated as often as once a week in order to maintain current data.

The procedure for collecting the almanac.dat file is as follows:

- 1) Load the GPSCARD program: MAIN.BTL
e.g. C:\GPS\GPSCARD>**gpsload main.btl**
- 2) Start GPSCON and designate the console monitor as the ASCII log destination.
e.g. C:\GPS\GPSCARD>**gpscon /a**
- 3) Wait approximately fifteen minutes. This will ensure that the receiver has sufficient time to acquire satellites and collect an almanac. You will know that a new almanac has been collected by observing the ALMA or GPALM logs. (At the time of this publication, typically a complete almanac consists of 25 satellite PRNs.)
e.g. C:\GPS\GPSCARD>**log console gpalm**
- 4) Exit GPSCON by pressing the keyboard [ESC] key.
- 5) Restart GPSCON and designate the ASCII destination file as ALMANAC.DAT.
e.g. C:\GPS\GPSCARD>**gpscon /aalmanac.dat**
- 6) Use the LOG command to direct the ALMA log data to the almanac.dat file. (ALMANAC.DAT was created at GPSCON bootup in step 5.)
e.g. C:\GPS\GPSCARD>**log console alma**
- 7) It is recommended that you exit (ESC) from GPSCON to prevent any further data logging to the ALMANAC.DAT file.

Your ALMANAC.DAT file should now contain the latest updated almanac data, including IONA and UTCA information. It may be a good idea to use the DOS “Edit” command to verify the contents of the ALMANAC.DAT file. A sample printout of an ALMANAC.DAT file is shown at the end of this section.

You can now use this ALMANAC.DAT file to inject the almanac data into the GPSCard any time you do a cold boot using the MAIN.BTL command file option - GPSLOAD MAIN.BTL /a[file].

e.g. C:\GPS\GPSCARD>**gpsload main.btl /aalmanac.dat**

CREATING OPTIONAL BOOT-UP COMMAND FILES

The GPSCard is capable of executing optional boot-up ASCII text command files. These command files are created using any text editor, and when saved in your GPS directory, can be used as optional start-up commands. The boot-up command file can consist of any valid GPSCard commands listed in *Section 2* of the *Command Descriptions Manual*. The procedures are as follows.

1. Use a text editor to type in any valid series of GPSCard commands the same way you would enter them through the GPSCard console keyboard.
2. Save the command file in your GPS directory under a convenient file name.

When you are ready to boot-up the GPSCard with the optional command file use the following syntax.

Syntax:

```
gpsload main.btl /a[file]
```

Example:

```
C:\GPS\GPSCARD>gpsload main.btl /abootfile.1
```

COMMAND FILE EXAMPLE – 1

When using the GPSCard, you may find it helpful to be able to monitor the functions of the receiver immediately upon start-up. The following command file could be used to provide you with receiver feedback without delay.

1. Open your text editor and type in the following GPSCard commands:

```
log console sata ontime 15 1
log console ctsa ontime 15 2
log console posa ontime 5 3
log console dopa ontime 60 4
log console rcsa ontime 60 5
log com1 sata ontime 15 1
log com1 ctsa ontime 15 2
log com1 posa ontime 5 3
log com1 dopa ontime 60 4
log com1 rcsa ontime 60 5
```

2. Save your command file in the GPS directory.

e.g. bootfile.1

3. Reboot the GPSCard with the BOOTFILE. 1.

e.g. C:\GPS\GPSCARD>**gpsload main.btl /abootfile.1**

4. Restart GPSCON and observe data on the host computer console monitor. This particular example boot file will also send logs to COM1 to be read by a remote terminal or data logger (regardless of whether GPSCON is running or not).

e.g. C:\GPS\GPSCARD>**gpscon /a**

Note that if you do not use the /a option after “gpscon”, the ASCII files directed to console will be logged to the DATA.ASC default file.

COMMAND FILE EXAMPLE – 2

Perhaps you are planning a remote site real time differential survey and want to pre-configure the monitor and remote site receivers before the units are sent into the field. It will be assumed the monitor station antenna will be positioned at a known survey marker site and the remote station is at an unknown location, and that a data link has been established for transmission of the differential corrections.

Monitor Station

To create the example monitor station command file, proceed as follows.

1. Open your text editor and type in the following GPSCard commands (of course, you may want to substitute your local lat/lon values):

```
fix position 51.11178632 -114.03919266 1055.224 1
log console posa ontime 30
log console ctsa ontime 30
log console sata ontime 30
log console dopa ontime 60
log console rgea ontime 30
log console dcsa ontime 5
com1 300,e,8,1,xon,off
log com1 dcsb ontime 5
```

2. Save your command file in the GPS directory.

e.g. C:\GPS\GPSCARD>**bootmast.er1**

3. When you are ready to boot the monitor station GPSCard, use the following syntax:

e.g. C:\GPS\GPSCARD>**gpsload main.bt1 /abootmast.er1**

After the GPSCard has rebooted and the command file has been read, the GPSCard will now be operating in Fix Position mode (monitor) and the DCSB differential log will be directed to COM1 every five seconds. Note that the COM1 port has also been set to 300 baud, even parity, etc. to support the hypothetical transmission line. Before you can store or monitor the console logs, you must now restart GPSCON program.

4. Restart GPSCON.

e.g. C:\GPS\GPSCARD>**gpscon** (console log files will be directed to the default file - DATA.ASC)

e.g. C:\GPS\GPSCARD>**gpscon /a** (console log files will be directed to the console screen)

Remote Station

To create the example remote station command file, proceed as follows.

1. Open your text editor and type in the following GPSCard commands:

```
log console posa ontime 30
log console ctsa ontime 30
log console sata ontime 30
log console dopa ontime 60
log console rgea ontime 30
com1,300,e,8,1,xon,off
log console cdsa ontime 30
accept com1 dcsb
```

2. Save your command file in the GPS directory.

e.g. C:\GPS\GPSCARD>**bootremo.tel**

3. When you are ready to boot the remote station GPSCard, use the following syntax:

e.g. C:\GPS\GPSCARD>**gpsload main.bt1 /abootremo.tel**

After the GPSCard has rebooted and the command file read, the GPSCard will now be initialized with desired receiver control information. The POSA, CTSA, SATA, DOPA, CDSA, and RGEA data logs will be directed to the console every 30 seconds.

Port 1 has been configured the same as the monitor station to be able to receive data from the data link. The CDSA log should be monitored to detect faults in the data transfer and differential decode process.

Before you can store or monitor the console logs, you must now restart the GPSCON program.

4. Restart GPSCON.

e.g. C:\GPS\GPSCARD>**gpscon** (console log files will be directed to the default file - DATA.ASC)

e.g. C:\GPS\GPSCARD>**gpscon /a** (console log files will be directed to the console screen)

COMBINING COMMAND FILES

It is possible to merge the contents of separate boot files to create one combined boot file. One example might be to append the contents of command file Example 1 above to the ALMANAC.DAT file previously described. This would enable the GPSCard to be uploaded with almanac data followed by issuing the command files of Example 1. See example below. (You will probably want to save the appended file under a new filename.)

```
$ALMA,1,3.55577E-003,32768,745,-7.8860E-009,-6.0052951E-002,-1.1824254E+000,1.67892137E+000,-1.8119E-005,-3.6379E-012,1.45854965E-004,2.65602281E+007,9.55576E-001,1,0,0*20
$ALMA,2,1.27072E-002,32768,745,-8.1603E-009,1.99116024E+000,-2.6827058E+000,-1.9146765E+000,-8.3923E-005,-3.6379E-012,1.45859691E-004,2.65596543E+007,9.54204E-001,1,0,0*2F
$ALMA,4,3.20625E-003,32768,745,-7.7717E-009,-2.1639090E+000,-1.2694458E+000,4.77871717E-001,2.28881E-005,0.00000E+000,1.45869725E-004,2.65584364E+007,9.62593E-001,1,0,0*23
$ALMA,5,2.05421E-003,32768,745,-8.1489E-009,2.00495708E+000,-2.3362789E+000,2.23796411E+000,3.62396E-005,3.63797E-012,1.45862345E-004,2.65593322E+007,9.56613E-001,1,0,0*3A
$ALMA,6,6.14500E-003,32768,745,-8.0803E-009,3.09122482E+000,3.10268436E+000,1.49695477E+000,1.04904E-004,3.27418E-011,1.46114710E-004,2.65287417E+007,9.58908E-001,1,0,0*2D
$ALMA,7,6.12783E-003,32768,745,-8.0231E-009,3.05437109E+000,-2.7149212E+000,-2.9578183E+000,6.96182E-004,0.00000E+000,1.45854550E-004,2.65602784E+007,9.62275E-001,1,0,0*2A
$ALMA,9,2.52437E-003,32768,745,-7.8860E-009,9.74000651E-001,-6.1542665E-001,1.69865826E+000,-1.6212E-005,0.00000E+000,1.45866864E-004,2.65587836E+007,9.52197E-001,1,0,0*26
$ALMA,12,1.44162E-002,32768,745,-6.5031E-009,1.31649968E+000,-1.7991916E-001,8.86189614E-001,3.05175E-005,3.63797E-012,1.45866117E-004,2.65588742E+007,1.08867E+000,0,0,0*02
$ALMA,13,0.00000E+000,0,0,0.00000E+000,0.00000000E+000,0.00000000E+000,0.00000000E+000,0.00000000E+000,0.00000E+000,0.00000E+000,0.00000E+000,0.00000000E+000,0.00000E+000,0.00000000E+000,0.00000E+000,0.60,220*35
...
...(insufficient space to show complete almanac)
...
$ALMA,25,5.80167E-003,32768,745,-7.9660E-009,9.49521374E-001,2.82805124E+000,2.64845153E+000,-5.7220E-006,0.00000E+000,1.45865164E-004,2.65589900E+007,9.45336E-001,1,0,0*03
$ALMA,26,8.21828E-003,32768,745,-7.8746E-009,-8.1900193E-002,-1.0575977E+000,-2.7968634E+000,-5.5313E-005,-3.6379E-012,1.45859235E-004,2.65597097E+007,9.58464E-001,1,0,0*0B
$ALMA,27,1.09305E-002,32768,745,-7.8974E-009,9.61584620E-001,2.37181742E+000,5.23514012E-001,2.57492E-005,0.00000E+000,1.45850819E-004,2.65607313E+007,9.49170E-001,1,0,0*1D
$ALMA,28,5.26714E-003,32768,745,-7.9660E-009,3.06158933E+000,2.88827048E+000,-4.4226283E-002,8.58306E-006,3.63797E-012,1.45858282E-004,2.65598254E+007,9.70269E-001,1,0,0*0B
$ALMA,29,5.08165E-003,32768,745,-7.9203E-009,-1.0308942E-001,-1.8326651E+000,5.19418028E-001,1.14440E-005,0.00000E+000,1.45856789E-004,2.65600066E+007,9.54396E-001,1,0,0*1A
$ALMA,31,4.90665E-003,32768,745,-8.0460E-009,3.05762855E+000,6.14527459E-001,1.69958217E+000,6.67572E-006,3.63797E-012,1.45861888E-004,2.65593876E+007,9.61664E-001,1,0,0*13
$IONA,1.0244548320770265E-008,1.4901161193847656E-008,-5.960464477539061E-008,-1.192092895507812E-007,8.8064000000000017E+004,3.2768000000000010E+004,-1.966080000000001E+005,-1.966080000000001E+005*02
$UTCA,-2.235174179077148E-008,-1.243449787580175E-014,32768,745,755,9,10,5*37
```

```
log console sata ontime 15 1
log console ctsa ontime 15 2
log console posa ontime 5 3
log console dopa ontime 60 4
log console rcsa ontime 60 5
log com1 sata ontime 15 1
log com1 ctsa ontime 15 2
log com1 posa ontime 5 3
log com1 dopa ontime 60 4
log com1 rcsa ontime 60 5
```

6 USING THE GPSCARD UTILITY FILES

The GPSCard program disk contains some useful utilities. You may find these utilities useful for converting and editing your data log files.

BIN2ASC.EXE CONVERTER

Binary data files logged to the PC Console are not directly readable from the console monitor. You can use the BIN2ASC utility to convert your binary log files to ASCII format.

It will be assumed that you have previously logged binary data to the console DATA.BIN file or your own defined binary file name. The procedure is as follows.

Syntax:

`BIN2ASC/F[file]/O[file]` (no spaces)

Syntax	Description	Example
BIN2ASC	executable name (.exe)	bin2asc
/F[file]	binary origin file to be converted	/fdata.bin
/O[file]	destination ascii converted file name	/oascdata.cnv

Example:

`bin2asc/fdata.bin/oascdata.cnv`

The above example converted the DATA.BIN binary file to ASCII and stored it as the file ASCDATA.CNV.

STRIP.EXE

The STRIP utility is a useful tool for extracting (copying) specific log types from an existing log file and placing them into a new destination file. Strip works with both ASCII and binary file types.

Syntax:

`STRIP [from file] [to file] log1 log2 log3 [etc]`

Syntax	Description	Example
STRIP		strip
from	origin file name to be stripped	data.asc
to	destination file name	data.str
log1	log type to be stripped	posa
log2	second log type to be stripped (optional)	sata
log3	third log type to be stripped (optional)	dcsa
etc	additional logs to be stripped (optional)	tm1a

Example:

`strip data.asc data.str posa sata dcsa tm1a`

The above example copied the logs POSA, SATA, DCSA, and TM1A from the file DATA.ASC and placed them into the file DATA.STR.

FINDCARD.EXE

This command will read back the current settings for an installed GPSCard. The results will indicate the card's hardware revision number, I/O address, and IRQ. This command may be helpful for support during installation.

Syntax:

```
findcard
```

An example of FINDCARD follows:

```
C:\GPS\GPSCARD>findcard
C:\GPS\GPSCARD\FINDCARD.EXE Version 1.00
NovAtel Communications Systems Ltd.
GPS Products Division
6732 - 8th Street N.E.
Calgary, Alberta
Canada T2E 8M4

A GPSCard Has Been Detected in Your System. !
Hardware Revision = "1" --> GPSCard Rev 1
I/O Address (Hex) = 0x150
Interrupt (IRQ) = 5
```

CHECK.EXE

This utility will verify that the link/transputer is functional on the GPSCard.

Syntax:

```
check
```

An example of the CHECK utility follows:

```
C:\GPS\GPSCARD>check
check 2.52

# Part rate Mb Bt [ Link0 Link1 Link2 Link3 ]
0 T805d-20 0.07 1 [ ... HOST ... ... ]
```

The above example shows the results from an operational GPSCard. "HOST" is the IBM PC interface link to the GPSCard.

If the above response was not received:

- check the GPSCard DIP switch settings and retest
- remove other cards in the system that could conflict with the GPSCard, (2nd parallel printer port, tape backup controller, etc.)
- evaluate the host PC power supply capacity (100 watts or greater)

CHECK.EXE defaults to address 150h and IRQ 5. If the address or IRQ settings are changed on the GPSCard, CHECK.EXE requires a DOS environment set command to reflect the new address or IRQ.

Examples:

```
SET LINKIRQ=X           where X = 3, 5, or 7
SET TRANSPUTER=XXX     where XXX = 150, 200, 300 (base address)
```

The CHECK command has various check options. Type **CHECK HELP** to display the command options.

Syntax:

```
check help
```

An example of the CHECK HELP command follows:

```
C:\GPS\GPSCARD>check help
```

```
check -- version 2.52 of 20 Aug 1990.
```

```
Usage:      check [/option...] [ < filename ]
```

```
            This tests the network, and optionally numbers it from filename
```

Valid options are:

- /N : do not reset the root transputer
- /R : reset the root transputer subsystem
- /C4 : read the state of all C004s found
- /CL : read the state of C004s, long form
- /CR : reset all C004s found
- /CS : set all C004s in file piped in to check
- /L <name> : use this link, else TRANSPUTER environment var
- /M <filename> : Use filename as a toolset map file
- /CFB <filename> : Use filename as a configuration binary file
- /X : Ignores any file piped in to check
- /I : Information - tells you what's happening
- /H : This help page

A ? at the end of the C004 map shows an illegal configuration.

If a C004 fails to appear (B012/B014), try MTEST on that TP.

C004a parts do not indicate whether a link is actually connected - it reports the last connection set, so often has ?. The C004 line:-

```
2 C004b (1-5 7>8 23>30 26-28 ) is an identical setting to
2 C004b [ -5---1-8 -----U --S-Q--- ]
```

However, line 1 can be very verbose with big configurations

NOTE: Ignore all references to "C004". The GPSCard does not utilize this.

MTEST.EXE

The MTEST utility is used to test the GPSCard system memory. This command works in conjunction with the CHECK command.

Syntax:

```
check | mtest
```

An example of the MTEST utility follows:

```
C:\GPS\GPSCARD>check | mtest
```

```
check 2.52 | mtest 2.52
```

```
# Part rate Mb Bt [ Link0 Link1 Link2 Link3 ] RAM,cycle
0 T805d-20 0.07 1 [ ... HOST ... ] 4K,1+1020K,4.
```

- "Host" is the IBM PC interface link to the GPSCard
- "4K,1" is the Transputer internal memory
- "1024K,4" is the GPSCard memory

The MTEST command has various test options. Type **MTEST HELP** to display the command options.

Syntax:

```
mtest help
```

An example of the MTEST HELP command follows:

```
mtest -- version 2.52 of 20 Aug 1990.
```

Usage: check | mtest [/option...]

Valid options are:

```

/C           : Include T2s with C004s on links (default - no)
/E <Kb>     : sets ceiling in Kbytes to which memory is tested
/I <iter>   : number of iterations
/L          : Log progress of testing
/T <tp>     : test processor <tp> only
/T2         : test T2s only
/T4         : test T4s and T8s only
/Q          : Quick memory sizing option
/X          : Extra information on why memory search stopped
/O         : Do not include root processor in tests
/H         : display this help page

```

terminating <;> means memory wraps,

terminating <.> means memory stops. /X switch will explain further

terminating <|> means /E ceiling reached

terminating <?> means no further messages received, probably a bus error or processor not tested

An example of MTEST using the /x option follows:

```

C:\GPS\GPSCARD>check | mtest /x
check 2.52 | mtest 2.52
# Part rate Mb Bt [ Link0 Link1 Link2 Link3 ] RAM,cycle
0 T805d-20 0.07 1 [ ... HOST ... ] 4K,1+1020K,4.
# 2K block at 80100000, bits in error FFFFFFFF, stuck bits test

```

The above example is the correct response for a good GPSCard (the card only has one Meg of memory on board and should end at 80100000). Any other response from the memory testing indicates a faulty GPSCard and should be returned for repair.

NOTE: CHECK.EXE and MTEST.EXE are supplied as freeware by INMOS. This is unsupported software.

A ANTI-STATIC PRACTICES

OVERVIEW

Static electricity is electrical energy at rest. Static-sensitive units can be permanently damaged by static discharges which are as little as 40 volts. Charges carried by the human body can be thousands of times higher than this. People may have accumulated a charge in many ways, such as friction between their shoes and carpet, tile or other non-conducting floor covering. The charge may be stored on clothing, especially in dry atmospheres, where there is friction between the body and/or various clothing layers. Synthetic materials accumulate higher charges than natural fibers. Electrostatic voltage levels generated by nonconductors may be very high, in the order of thousands of volts.

Various electrical and electronic components are vulnerable to electrostatic discharge (ESD). These include discrete components, hybrid devices, integrated circuits (ICs), and boards assembled with these devices.

RECOMMENDATIONS FOR HANDLING ESD-SENSITIVE DEVICES

ESD-sensitive devices must be handled only in static-free locations. Some recommendations for such handling practices follow:

- Handling areas must be equipped with grounded table and floor mats and grounded wrist or ankle straps.
- A relative humidity level must be maintained between 20% and 80% non-condensing.
- No ESD-sensitive board or component should be removed from its protective package, except in a static-free location.
- A static-free environment and correct static-control procedures are required at both repair stations and maintenance areas.
- ESD-sensitive devices must be handled only after personnel have grounded themselves via wrist or ankle straps and mats.
- Boards or components should never come in contact with clothing, because normal grounding cannot dissipate static charges on fabrics.
- A circuit board must be placed into an anti-static shielding bag or clamshell before being removed from the work location and must remain in the bag or clamshell until it arrives at a static-free repair/test center.
- Circuit boards must not be changed or moved needlessly. Where handles or finger holes are provided on circuit boards they must be used to remove and replace the boards, and care taken to avoid contact with the connectors and components.
- On-site repair of ESD-sensitive equipment should not be undertaken except to restore service in an emergency where spare boards are not available. Under these circumstances repair station techniques must be observed. Under normal circumstances a faulty or suspect circuit board must be sent to a repair center having complete facilities, or to the manufacturer for exchange or repair.
- Where protective measures have not been installed, a suitable alternative would be the use of a Portable Field Service Grounding Kit. This consists of a portable mat and wrist strap.
- A circuit board in a static shielding bag or clamshell may be shipped or stored in a cardboard carton, but the carton must not enter a static-free area such as a bench top or repair zone.

PRIMARY STATIC GENERATORS

Table A-1 provides some background information on static-generating materials.

Table A-1 Primary Static Generators

Work Surfaces	<ul style="list-style-type: none"> formica (waxed or highly resistive) finished wood synthetic mats writing materials, note pads, etc.
Floors	<ul style="list-style-type: none"> wax-finished vinyl
Clothes	<ul style="list-style-type: none"> common cleanroom smocks personal garments (all textiles except virgin wool) non-conductive shoes
Chairs	<ul style="list-style-type: none"> finished wood vinyl fiberglass
Packing and handling	<ul style="list-style-type: none"> common polyethylene bags, wraps, envelopes, and bubble pack pack foam common plastic trays and tote boxes
Assembly, cleaning, test and repair areas	<ul style="list-style-type: none"> spray cleaners common solder sucker common solder irons common solvent brushes (synthetic bristles) cleaning, drying and temperature chambers

STORAGE

ESD damage to unprotected sensitive devices may occur at any time. Table A-2 shows the susceptibility thresholds of such devices to ESD.

Table A-2 Susceptibility Thresholds of Devices to ESD

Devices	Minimum ESD Voltage (V)
VMOS	30
MOSFET GaAsFet EPROM	100
JFET	140
OP-AMP	190
CMOS	250
Schottky Diode Film Resistors	300
Bipolar Transistors	380
SCR	680
Schottky TTL	1000

CHANGING CIRCUIT BOARDS

Use the following procedure when it becomes necessary to install or remove a circuit board.

1. After you are connected to the grounded wrist strap, remove the circuit board from the frame and place it on a static-free surface (grounded floor or table mat).
2. Remove the replacement circuit board from the static shielding bag or clamshell and insert it into the correct slot in the frame.
3. Place the original board into the shielding bag or clamshell and seal it with a label.
4. Disconnect the wrist strap.
5. Do not put repair tags inside the shielding bag or clamshell.

B TECHNICAL SPECIFICATIONS

PHYSICAL		
Size	21.6 cm x 10.7 cm x 1.9 cm (2/3 length IBM PC card)	
Weight	220 grams	
Mounting	Installed inside an IBM-PC compatible desktop or laptop computer	
ENVIRONMENTAL		
Operating Temperature	0°C to +70°C (32°F to +158°F)	
Storage Temperature	-40°C to +85°C (-40°F to +185°F)	
Humidity	95% non-condensing	
Altitude	5,000 metres [May operate above 5,000 metres in a controlled environment, however is not certified as such.]	
VIBRATION		
The GPSCard will typically acquire and track satellites in a random vibration profile defined by the following vibration test conditions when installed in the recommended mounting configuration:		
	Frequency	Magnitude
	10 Hz	0.003 g ² /Hz
	40 Hz	0.003 g ² /Hz
	100 Hz	0.0005 g ² /Hz
	500 Hz	0.0005 g ² /Hz
	2000 Hz	0.00003 g ² /Hz
VIBRATION MOUNTING CONFIGURATION		
<ul style="list-style-type: none"> - Mount the PC card firmly using the L bracket screw. - Secure the other end of the GPSCard with a card guide. - Use anti-static rubber dampening between the guide and the GPSCard to ensure that the card does not rattle. - Ensure that the GPSCard does not rest on the ends of the motherboard card-edge-connector; use rubber dampening if necessary. 		
ACCELERATION		
Acceleration:	4g maximum (sustained tracking)	
POWER REQUIREMENTS		
Voltage	+5 VDC +5% / -2.5% +12 VDC ±5% -12 VDC ±5%	(GPSCard receives its power from the PC ISA bus edge connector.)
Power Consumption	6 watts	

PERFORMANCE (Subject To GPS System Characteristics)	
Frequency:	L1, 1575.42 MHz
Code tracked:	C/A Code (SPS)
Channels:	10 or 12 discrete channels depending on GPSCard model
Time to First Fix:	< 70 seconds typical (cold start: no initial time, almanac, or position required)
Re-acquisition:	3 seconds typical
Computed Data Update Rate:	10 solutions per second (100 msec rate) – model and configuration dependent
Measured Data Update Rate:	20 data records per second (50 msec rate) – model and configuration dependent
Pseudorange Position Accuracy: (real-time)	<p>Standalone: 15 metres CEP (SA off), GDOP < 2 40 metres CEP (SA on)</p> <p>Differential with RTCM Standard reference station: 1-5 metres CEP</p> <p>Differential between two 3900R Performance Series receivers with GDOP < 4 CEP ≤ 1.25 metres SEP < 1.85 metres</p> <p>With Choke Ring ground plane: Performance Series (Narrow Correlator) CEP 0.75 metre SEP < 1.00 metre</p> <p>RT-20 Mode < 0.20 metre CEP nominal (refer to Section 11 of the GPSCard Command Descriptions Manual for complete specifications of RT-20 mode)</p>
Pseudorange Measurement Accuracy:	10 cm RMS, 3 minutes, no multipath, C/No > 44 dBHz 25 cm RMS in multipath environment with Choke Ring
Velocity Accuracy:	0.03 m/s nominal (differential) 0.20 m/s nominal (single point)
Single Channel Phase Accuracy:	3 mm RMS, C/No >44 dBHz Loop BW = 15 Hz
Differential Channel Phase Measurement Accuracy:	0.75 mm RMS, 1 second smoothed, no multipath, C/No > 44 dBHz
Time Accuracy (relative):	50 nanoseconds (SA off) 250 nanoseconds (SA on)
Height Limit:	Up to 18,288 metres (60,000 feet) maximum [In accordance with export licensing the card is restricted to less than 60,000 feet.]
Velocity Limit:	Up to 515 metres per second maximum [In accordance with export licensing the card is restricted to less than 1000 NMi/hr. (515 m/sec)]
INPUT/OUTPUT DATA INTERFACE	
Dual RS-232C Serial:	Baud rates: 300 baud to 115.2 Kbaud (software selectable) Default: 9600 baud (COM1 and COM2)
PC - ISA Bus:	8 bits / 8 MHz

INPUT/OUTPUT STROBES (Expansion Bracket)				
VARF Output:	The VARF output provides a variable frequency output with low duty cycles. The frequency programmable is from 156 Hz to 10.23 MHz and requires two parameters to specify the frequency (refer to the FREQUENCY-OUT command for details). The high going pulse has a width of 49 nsec. The time between pulses may vary by as much as 49 ns jitter.			
1PPS Output:	A one-pulse-per-second time sync output. This is a normally low, active high pulse (200 μ s) where the rising edge is the reference.			
Measure Out:	1, 10 or 20 pulses-per-second output, normally high, active low where the pulse width is 200 μ s. The falling edge is the receiver measurement strobe. (Rate is model-dependent.)			
Mark Input:	An input mark (negative pulse > 55 nsec), time tags output log data to the time of the falling edge of the mark input pulse (refer to LOG command syntax - ONMARK). This line is TTL or contact closure compatible.			
Status Output:	Indicates a valid GPS position solution is available. A high level indicates a valid solution or fix position has been set.			
The electrical specifications of the strobe signals are as follows:				
Output:	Voltage	(High)	> 4.0 V _{DC}	
		(Low)	< 0.4 V _{DC}	
	Sink Current		24 mA	
	Source Current		-24 mA for GPSCard	
Mark Input:	Voltage	(High)	> 2.0 V _{DC} and < 5.0 V _{DC}	
		(Low)	< 0.8 V _{DC}	
	Current		< 5 mA (not to exceed 5 mA)	
INPUT/OUTPUT CONNECTORS				
COM1: DB-9P (male) (GPSCard Bracket)	Pin 1	NC	Not connected	
	Pin 2	RXD	Received data	
	Pin 3	TXD	Transmitted data	
	Pin 4	DTR	Data terminal ready	
	Pin 5	GND	Ground	
	Pin 6	DSR	Data set ready	
	Pin 7	RTS	Request to send	
and	Pin 8	CTS	Clear to send	
	Pin 9	NC	Not connected	
COM2: DB-9P (male) (Expansion Bracket)	Pin 1	NC	Not connected	
Console:	8 bit ISA edge connector			
	Strobes: DB-9S (female) (Expansion Bracket)	Pin 1	VARF	Variable Frequency output
		Pin 2	1PPS	One Pulse Per Second timing output
		Pin 3	Measure Out	Receiver measurement strobe
		Pin 4	MKI	Mark Input
		Pin 5	STATUS	Status output flag
		Pin 6	GND	Ground
		Pin 7	GND	Ground
		Pin 8	GND	Ground
	Pin 9	GND	Ground	

ANTENNA / LNA	
Connector:	SMA Female
RF Input:	1575.42 MHz
LNA Power Output:	4.0 to 5.0 Vdc, 10 to 25 mA (current limit 35 mA) Note: If the antenna connected to this port draws current below or above these limits, the GPSCard antenna sensing circuit will cause the self-test status code to be set to 0. Refer to the RCSA log for self-test status codes.

GPSCard Base Address Selection

SW1	SW2	BASE ADDRESS
OFF	OFF	Not selected
OFF	ON	150-163 _h (default)
ON	OFF	200-213 _h
ON	ON	300-313 _h

GPSCard IRQ Selection

SW3	SW4	SW5	IRQ Selected
ON	OFF	OFF	IRQ3
OFF	ON	OFF	IRQ5 (default)
OFF	OFF	ON	IRQ7
OFF	OFF	OFF	Not selected (no interrupt)

We Would Like To Hear From You...

NovAtel Communications Ltd. is committed to providing you, our valued customer, with quality products and customer service. We would like very much to hear from you.

When it is convenient for you, take a few moments to fill out the questionnaire below and mail or fax it to the NovAtel GPS Customer Service Department (403-295-4901). At NovAtel, we value your input.

- Which products have you purchased from NovAtel GPS?

GPSCard: OEM Series _____ PC Series _____ GPSAntenna: _____

Accessories: _____ Other: _____

- Are you satisfied with the performance of these products: Yes No

Please explain.

- Are you satisfied with the level of customer service provided? Yes No

Please explain.

- What influenced you to purchase NovAtel GPS products?

- Do you have any comments concerning this User Manual?

- Are there any new features or products that you would like to see from NovAtel GPS?

- Do you have any other comments or suggestions?

Your name _____ Company _____

Address/phone number _____

Notes

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