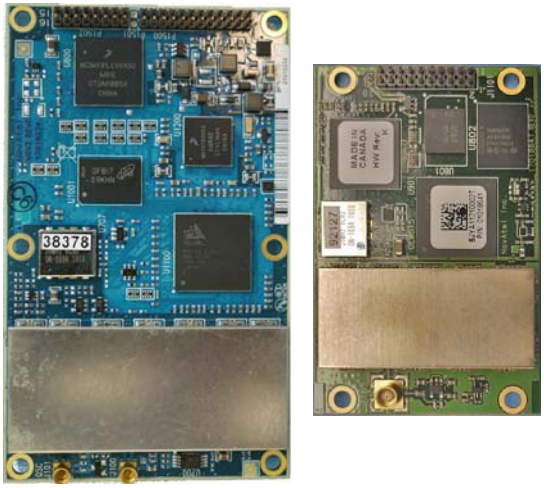
A Precise Positioning Technology Company



OEM6™ Family

Installation and Operation

User Manual

OEM6 Family - Installation and Operation User Manual

Publication Number: OM-20000128
Revision Level: 4
Revision Date: 2011/14/07

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#5,101,416
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#5,809,064
#6,184,822 B1
#6,243,409 B1
#6,445,354 B1
#6,608,998 B1
#6,664,923 B1
#7,738,536

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Notices

The following notices apply, as appropriate, to the OEM6 family products including the OEM615, OEM628 and the FlexPak6.

Changes or modifications to this equipment not expressly approved by NovAtel Inc. could result in violation of FCC, Industry Canada and CE Marking rules and void the user's authority to operate this equipment.

FCC Notices

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

The FlexPak6 has been tested and found to comply with the radiated and conducted emission limits for a Class B digital device. The Class B limits are designed to provide reasonable protection against harmful interference in a residential installation.

The equipment listed generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Re-orient or relocate the receiving antenna
- Increase the separation between the equipment and the receiver
- Connect the equipment to an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help

To maintain compliance with the limits of a Class B digital device, you must use properly shielded interface cables (such as Belden #9539 or equivalent) when using the serial data ports, and double-shielded cables (such as Belden #9945 or equivalent) when using the I/O strobe port.

Industry Canada

FlexPak6 Class B digital apparatus comply with Canadian ICES-003.

FlexPak6 appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

CE Marking

The FlexPak6 carries the CE mark.

Emissions

OEM6 family products have been designed and tested to meet regulatory emission limits. Emission levels may be higher for OEM6 family card-level operation than for integrated enclosure-level products, like the FlexPak6, using an OEM6 family card.

WEEE

If you purchased your OEM6 family product in Europe, please return it to your dealer or supplier at the end of its life. The objectives of the European Community's environment policy are, in particular, to preserve, protect and improve the quality of the environment, protect human health and utilise natural resources prudently and rationally. Sustainable development advocates the reduction of wasteful consumption of natural resources and the prevention of pollution. Waste Electrical and Electronic Equipment (WEEE) is a regulated area. Where the generation of waste cannot be avoided, it should be reused or recovered for its material or energy. WEEE products may be recognized by their wheeled bin label (). [1]

RoHS

The OEM6 family and FlexPak6 are compliant with the European Union (EU) Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

REACH

NovAtel strives to comply with the EU Directive EC 1907/2006 on chemicals and their safe use as per the Registration, Evaluation, Authorization and Restriction of Chemical substances (REACH) for its products, including the OEM6 family products. Since REACH SVHC lists are updated occasionally, please contact NovAtel Customer Support if you require further information.

Ethernet Port

The Ethernet ports are safety extra-low voltage (SELV) circuits only. and are suitable for connection within a building only. Do not connect them to telephone-network voltage (TNV) circuits.

1. See www.novatel.com | *Products* | *WEEE and RoHS* for more information.

Lightning Protection Notice

What is the hazard?

A lightning strike into the ground causes an increase in the earth's potential which results in a high voltage potential between the centre conductor and shield of the coax cable. This high voltage develops because the voltage surge induced onto the center conductor lags in time behind the voltage surge induced onto the shield.

Hazard Impact

A lightning strike causes the ground potential in the area to rise to dangerous levels resulting in harm to personnel or destruction of electronic equipment in an unprotected environment. It also conducts a portion of the strike energy down the inner conductor of the coax cable to the connected equipment.

Only qualified personnel (electricians as mandated by the governing body in the country of installation) may install lightning protection devices.

Actions to Mitigate Lightning Hazards

1. Do not install the external antenna lines extra-building during a lightning storm.
2. It is not possible to avoid over-voltages caused by lightning, but a lightning protection device may be used to shunt a large portion of the transient energy to the building ground reducing the over-voltage condition as quickly as possible.
3. Primary lightning protection must be provided by the operator/customer according to local building codes as part of the extra-building installation.
4. To ensure compliance with clause 7 "Connection to Cable Distribution Systems" of EN 60950-1, Safety for Information Technology Equipment, a secondary lightning protection device must be used for in-building equipment installations with external antennas. The following device has been approved by NovAtel Inc.:

   Polyphaser - Surge Arrestor DGXZ+24NFNF-A

   If this device is not chosen as the primary lightning protection device, the device chosen must meet the following requirements:

   - UL listed, or equivalent, in country of installation (for example, TUV, VDE and so on) for lightning surge protection
   - The primary device must be capable of limiting an incoming surge to 10kV

5. The shield of the coaxial cable entering the building should be connected at a grounding plate at the building's entrance. The lightning protection devices should have their chassis grounded to the same ground near to the building's entrance.
6. The primary and secondary lightning protections should be as close to the building's entrance as possible. Where feasible they should be mounted onto the grounding plate itself. See also *Figure 1, Primary and Secondary Lightning Protection* on the following page.

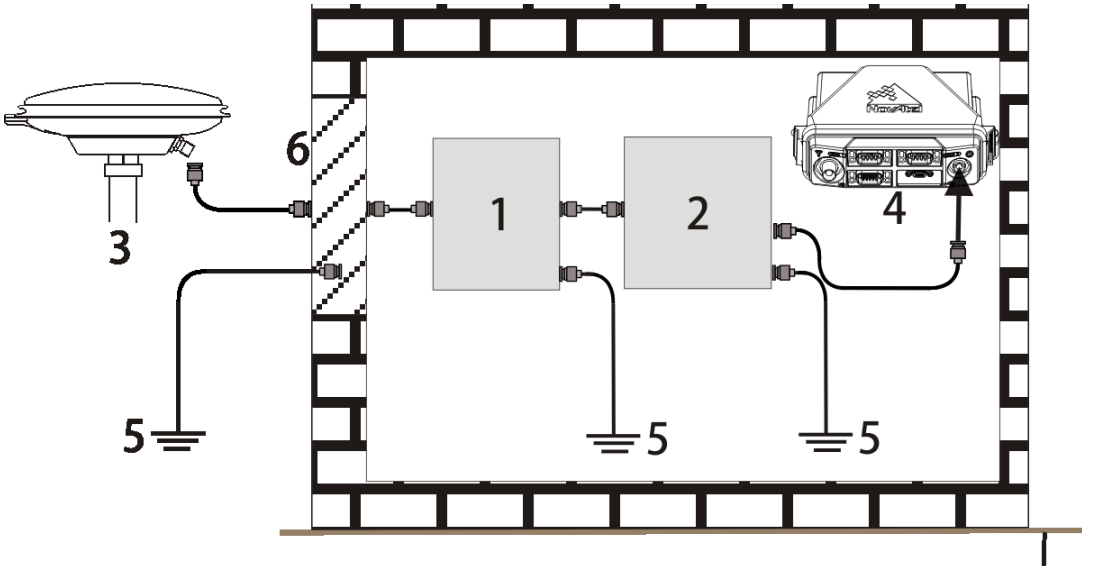

Figure 1: Primary and Secondary Lightning Protection

Reference	Description	Reference	Description
1	Primary Lightning Protection Device	4	GNSS Receiver
2	Secondary Lightning Protection Device	5	To Ground
3	External Antenna	6	Grounding plate or grounding point at the building's entrance

✉ Acceptable choices for Earth Grounds, for central buildings, are the following:

- Grounded interior metal cold water pipe within five feet (1.5 m) of the point where it enters the building
- Grounded metallic service raceway
- Grounded electrical service equipment enclosure
- Eight-foot grounding rod driven into the ground (only if bonded to the central building ground by #6, or heavier, bonding wire)

These installation instructions are the minimum requirements for receiver and antenna installations. Where applicable, follow the electrical codes for the country of installation. Examples of country codes include:

• USA	National Electrical Code (NFPA 70)
• Canada	Canadian Electrical Code (CSA C22)
• UK	British Standards Institute (BSI 7671)

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2. PAYMENT: Terms are prepayment unless otherwise agreed in writing. Interest shall be charged on overdue accounts at the rate of 18% per annum (1.5% per month) from due date. To expedite payment by wire transfer to NovAtel Inc.: Bank - HSBC Bank of Canada

Bank:	HSBC Bank of Canada	US Account number	788889-002
	407 - 8 Avenue S.W.	CDN Account number	788889-001
	Calgary, AB, Canada T2P 1E5	EURO Account number	788889-270
		Transit number	10029-016
		Swift	HKBCCATTCAL

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website: http://www.novatel.com or write to:

NovAtel Inc.
Customer Service Department
1120 - 68 Avenue NE,
Calgary, Alberta, Canada T2E 8S5

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NovAtel Inc. warrants that its products are free from defects in materials and workmanship, subject to the conditions set forth below, for the following periods of time, from the date of sale:

OEM6™ Card Receivers	One (1) Year
FlexPak6™	One (1) Year
GPS Antenna Series	One (1) Year
Cables and Accessories	Ninety (90) Days
Computer Discs	Ninety (90) Days
Software Warranty	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 solely to product replacement or product repair at an authorized NovAtel location, or in the case of software, provision of a software revision for implementation by the customer. 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 NovAtel receiver 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 Inc.

Before shipping any material to NovAtel or Dealer, please contact Customer Support. You can e-mail support@novatel.com or visit our website at www.novatel.com and log in through *Support | Helpdesk & Solutions | E-Service*.

When Customer Support confirms the faulty equipment needs to be returned, you will be referred to the repair group where you will be given an RMA number and be advised of proper shipping procedures to return any defective product..

Foreword

About this Manual

Thank you for purchasing a NovAtel OEM6 family receiver card. Whether the receiver is stand-alone or installed in an enclosure, this manual provides the information you need to integrate and operate the hardware.

Related Documents and Information

After the OEM6 hardware is operational, the *OEM6 Family Firmware and Reference Manual* becomes your primary source for command and log information. Each receiver has a specific set of features, such as L-band or GLONASS support, so some commands and logs may not be supported by your model. Refer also to the *Support* page on our website at www.novatel.com for new documents and documentation updates.

This manual does not cover OEM6 service and repair. Contact your local NovAtel dealer for any customer-service related inquiries, as outlined in *Customer Support* on *page 20*.

Conventions

The following conventions are used in this manual:

Information that supplements or clarifies text.

A caution that actions, operation or configuration may lead to incorrect or improper use of the hardware.

A warning that actions, operation or configuration may result in regulatory noncompliance, safety issues or equipment damage.

Customer Support

NovAtel Knowledge Base

If you have a technical issue, visit the NovAtel support website at *www.novatel.com* | *Support* | *Helpdesk and Solutions* | *Knowledge and Forums.* Through this page, you can search for general information about GNSS and other technologies, information about NovAtel hardware, software, installation and operation issues.

Before Contacting Customer Support

Before you contact NovAtel Customer Support about a software problem perform the following steps:

1. Log the following data to a file on your computer for 15 minutes:

```
RXSTATUSB once
RAWEPHEMB onchanged
RANGEB ontime 1
BESTPOSB ontime 1
RXCONFIGA once
VERSIONB once
```

2. Send the data file to NovAtel Customer Support, using either the NovAtel FTP site at *www.novatel.com* | *Support* | *Firmware/Software and Manuals* | *Access FTP Site* or through the support@novatel.com e-mail address.
3. You can also issue a FRESET command to the receiver to clear any unknown settings.

✉ The FRESET command will erase all user settings and perform a fac tory reset. You should know your configuration and be able to reconfigure the receiver before you send the FRESET command.

If you are having a hardware problem, send a list of the troubleshooting steps taken and the results.

Contact Information

Use one of the following methods to contact NovAtel Customer Support:

Call the NovAtel Hotline at 1-800-NOVATEL (U.S. and Canada) or +1-403-295-4900 (international)	
Fax: +1-403-295-4901 E-mail: support@novatel.ca website: http://www.novatel.com	Write: NovAtel Inc. Customer Support Department 1120 - 68 Avenue NE Calgary, AB Canada, T2E 8S5

Firmware Updates and Model Upgrades

Firmware updates are firmware releases that include fixes and enhancements to the receiver functionality. Firmware updates are released on the website as they become available. Model upgrades enable features such as RTK and ALIGN® on the receiver and may be purchased through NovAtel authorized dealers.

Contact your local NovAtel dealer for more information. To locate a dealer in your area, visit *www.novatel.com* | *Where to Buy* | *Dealers* or contact NovAtel Customer Support directly.

See *Firmware Updates and Model Upgrades* on *page 75* for instructions on using the WinLoad program to upgrade your OEM6 receiver.

Chapter 1 Introduction

1.1 Overview of the OEM6 Family

The OEM6 family offers triple-frequency GNSS receivers and integrated L-band capability. The OEM6 family supports existing and planned GPS, GLONASS, Galileo and Compass frequencies, and is capable of full code and real-time kinematic (RTK) positioning. OEM6 boards are designed for flexibility of integration and configuration.

For further information about OEM6 receiver boards, refer to the product brochures at *www.novatel.com* | *Products* | *Receivers* | *OEM Receiver Boards*.

1.2 OEM615 Receiver

The OEM615 has the same form and fit as NovAtel's OEMV-1™ receivers, with the following additional features:

- Dual frequency
- Galileo channel support
- Full-speed USB 2.0
- Dual CAN bus ports

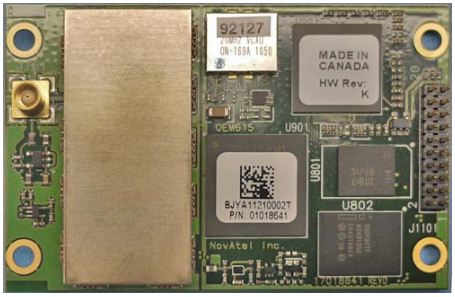


Figure 2: OEM615 Receiver Board

OEM615 technical specifications are provided in *Appendix C* on *page 125*.

1.3 OEM628 Receiver

The OEM628 has the same form and fit as NovAtel's OEMV-2™ receivers, with the following additional features:

- Triple frequency
- Galileo channel support
- Ethernet
- Full-speed USB 2.0
- Dual CAN bus ports

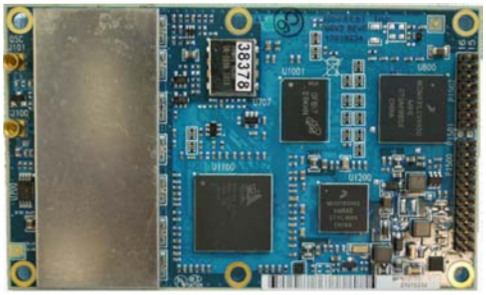


Figure 3: OEM628 Receiver Board

OEM628 technical specifications are provided in *Appendix B* on *page 97*.

1.4 OEM6 Receiver System Overview

In addition to the NovAtel OEM6 receiver board, an OEM6 receiver system requires the following:

- Enclosure and wiring harness
- GNSS antenna (and optional LNA power supply)
- Power supply
- Data communications equipment

The overall OEM6 receiver system is illustrated in *Figure 4* and described in the sections that follow.

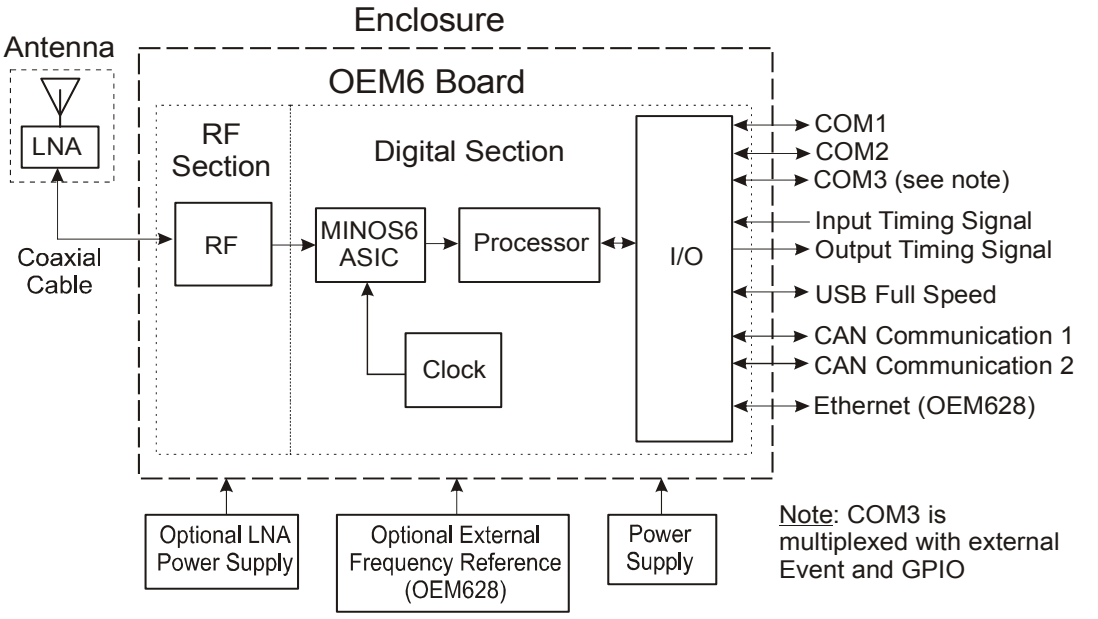


Figure 4: OEM6 Receiver System

1.4.1 OEM6 Family Card

NovAtel's OEM6 family cards consist of a radio frequency (RF) section and a digital section.

Radio Frequency (RF) Section

The receiver obtains filtered, amplified GNSS signals from the antenna. The RF section down-converts the incoming RF signals to intermediate frequency (IF) signals which are processed by the digital section. The RF section also supplies power to the active antenna LNA through the coaxial cable. The RF section has been designed to reject common sources of interference.

Digital Section

The heart of the digital section is NovAtel's MINOS6 ASIC (application-specific integrated circuit). The digital section digitizes and processes the IF signals to obtain a GNSS solution (position, velocity and time). It also processes the system I/O, shown in *Figure 4*.

1.4.2 Enclosure and Wiring Harness

An enclosure is necessary to protect the OEM6 family card from environmental extremes and high levels of RF interference. A wiring harness is required to provide the interface to the antenna, power supply and data I/O.

1.4.3 GNSS Antenna

The antenna converts electromagnetic signals transmitted by GNSS satellites into electrical signals that can be used by the receiver. An active GNSS antenna is normally required for optimal receiver performance. NovAtel's active GNSS antennas shown in *Table 2* on *page 28* provide precise phase centres and robust enclosures.

Optional LNA Power Supply

The receiver can supply power for the antenna LNA. If the antenna is not compatible with the OEM6 power supply, you may need an external LNA supply. See *Antenna LNA Power* on *page 44* for more information.

1.4.4 Power Supply

A power supply capable of delivering the minimum receiver operating voltage and power is required. See *Table 3, Voltage Input Requirement for OEM6 Family Cards* on *page 31* and *Appendix B, OEM628 Technical Specifications* on *page 97* for details.

1.4.5 Optional External Frequency Reference

Some applications may require greater precision than that provided by the OEM628 internal clock. In that case, you must connect the OEM628 to an external high-stability oscillator. See *External Oscillator* on *page 44* for more information. The OEM615 does not offer external oscillator capabilities.

1.4.6 Data Communications Equipment

A computer or other data communications device is necessary to communicate with the receiver, and to receive and store the data that the receiver provides.

1.5 OEM6 Enclosures

The OEM6 can be housed in an enclosure to provide a complete receiver solution.

Enclosures offer protection against environmental conditions and RF interference. In addition, they provides an easy-to-use interface to the card's data, power, and status signals.

1.5.1 FlexPak6

NovAtel's FlexPak6 is a housing for the OEM628 receiver that delivers centimetre-level positioning in a compact, lightweight enclosure. The FlexPak6 provides scalable high-precision positioning with Ethernet, serial, USB and CAN bus interfaces as well as an API option for supporting custom applications. The FlexPak6 receiver is capable of tracking all present and upcoming GNSS constellations and satellite signals including GPS L1/L2/L2C/L5, GLONASS L1/L2, Galileo E1/E5a/E5b/Alt-BOC and Compass signals. Table 1 lists the features available on the FlexPak6.

The Flexpak6 is not compatible with the OEM615 receiver.

Table 1: FlexPak6 Features

Feature	FlexPak6
OEM card supported	OEM628
Serial ports	2 DB9 connectors
USB 1.1	Yes
Ethernet	Yes
Strobe port	DB-HD15 connector
Input (DC) voltage	+6 to +36 V
L-band differential corrections [a]	Yes
GPS+GLONASS positioning	Yes
GL1DE	Yes
ALIGN	Yes
AdVance RTK	Yes
RAIM	Yes
NTRIP	Yes

a. A subscription to an augmentation service, like OmniSTAR, is required. Refer to the *GNSS Reference Book*, available from our website at www.novatel.com, for more details.

The following accessories are included with the FlexPak6:

- null modem serial cable
- USB cable
- 12V power adapter
- I/O Cable
- A CD containing NovAtel's PC utilities and product documentation

For technical specifications on the FlexPak6, see *Appendix B.2* on *page 115*.

Figure 5: FlexPak6

Chapter 2 Installation and Setup

This chapter provides instructions and guidelines for checking the contents of the shipping box, installing the OEM6 PC utilities on your computer, and for integrating your NovAtel receiver into a GNSS receiver system similar to that described in *Section 1.4 OEM6 Receiver System Overview on page 23*.

2.1 Opening the Shipping Box

The following items are provided:

- OEM6 family receiver card
- *OEM6 Family Receivers Quick Start Guide*
- ESD wrist strap
- NovAtel CD
- Postcard for requesting printed manuals

2.2 Installing OEM6 PC Utilities

The CD accompanying this receiver contains OEM6 PC utilities, in particular:

- CDU [Control and Display Unit] (Windows application)
- Convert4 (Windows application)
- Sample source code, to aid the development of software for interfacing with the receiver
- Product documentation

The applications use a database, so the necessary components of the Borland Database Engine (BDE) are installed as well as the necessary database tables and an alias for the database. We recommend that you close all applications before installing CDU and Convert4. You must close any applications that may be using the BDE before installing. The install set-up modifies the BDE configuration so that it can recognize the new CDU and Convert4.

1. Start Microsoft Windows.
2. Put the NovAtel CD in your CD-ROM drive. If the setup utility does not automatically run, follow these steps:
    a. Select Run from the Start menu.
    b. Browse to Setup.exe on the CD and click Open.
    c. Click OK to run the setup utility.
3. Follow the setup utility instructions.

✉ The latest CDU software can be downloaded from *www.novatel.com* | *Support* | *Firmware/Software and Manuals* | *Product Updates*.

2.3 Additional Equipment Required

For the receiver to perform optimally, the following additional equipment is required:

- Interface for power, communications, and other signals
- Enclosure to protect against the environment
- GNSS antenna (for a list of NovAtel GNSS antennas, see *Table 2* on *page 28*)
- Coaxial cable (and interconnect adapter cable, as necessary)
- Data communication equipment capable of serial, USB or Ethernet communication
- Serial, USB or Ethernet data cable (if one is not included with the receiver)
- Power supply
- Power cable (if one is not included with the receiver)

When the OEM6 family receiver is installed in a permanent location, it should be protected by a lightning protection device according to local building codes.

2.3.1 Selecting a GNSS Antenna

An active antenna with a low-noise amplifier (LNA) is required to boost the power of the incoming signal to compensate for the line loss between the antenna and the receiver.

NovAtel offers a variety of antennas, including single and dual-frequency, triple-band and wide-band reference GNSS antennas, as shown in *Table 2* on *page 28*. All of these antennas include band-pass filtering and an LNA. The GNSS antenna you choose depends on your particular application. Each model offers exceptional phase-center stability and a significant measure of immunity against multipath interference. Each antenna has an environmentally sealed radome and all meet the European Union's Restriction of Hazardous Substances (RoHS) and Waste Electrical and Electronic Equipment (WEEE).

Table 2: NovAtel GNSS Antenna Models

Models	Frequencies Supported	GPS	GLONASS	Galileo
ANT-35C1GA-TW-N ANT-26C1GA-TBW-N	L1 only	✓		
ANT-35C2GA-TW ANT-A72GA-TW-N ANT-C2GA-TW-N	L1 and L2	✓		
GPS-702L ANT-A72GLA4-TW-N ANT-A72GLA-TW-N	L1 and L2 plus L-band	✓		
GPS-701-GGL ANT-A71-GLA4-TW	L1 plus L-band	✓	✓	

Models	Frequencies Supported	GPS	GLONASS	Galileo
GPS-701-GG	L1 only	✓	✓	
GPS-702-GGL ANT-A72GOLA-TW	L1 and L2 plus L-band	✓	✓	
GPS-702-GG	L1 and L2	✓	✓	
GPS-703-GGG	L1, L2, L5, E5, E5a and E5b	✓	✓	✓

2.3.2 Choosing a Coaxial Cable

For information on selecting a coaxial cable for your application, refer to NovAtel application note APN-003 RF Equipment Selection and Installation available at *www.novatel.com* | *Support* | *Knowledge and Learning* | *Application Notes*.

An appropriate coaxial cable is one that matches the impedances of the antenna and receiver (50 ohms), and has has a line loss that does not exceed 10.0 dB. If the limit is exceeded, excessive signal degradation may occur and the receiver may not meet performance specifications. NovAtel offers several coaxial cables to meet your GNSS antenna interconnection requirements, including:

- 5, 15 and 30 m antenna cable with TNC connectors on both ends (NovAtel part numbers GPS-C006, GPS-C016 and GPS-C032)
- 22 cm interconnect adapter cable, that can be used between the MMCX and the TNC connectors (NovAtel part number GPS-C002)

A conversion is required between the OEM628's MMCX connector or the OEM615's MCX connector and the female TNC connector on NovAtel's GNSS antennas.

If your application requires the use of cable longer than 30 m, refer to application note *APN-003 RF Equipment Selection and Installation*, available at *www.novatel.com* | *Support* | *Knowledge and Learning* | *Application Notes*.

NovAtel recommends high-quality coaxial cables because an impedence mismatch, possible with lower quality cables, produces reflections in the cable that increase signal loss. Though you can use other high-quality antenna cables, the performance specifications of the OEM6 family receivers are warranted only when used with NovAtel-supplied accessories.

2.3.3 Power Supply Requirements

This section contains information on the requirements for the input power to the receiver. See *Appendix B, OEM628 Technical Specifications* starting on *page 97* and *Appendix C, OEM615 Technical Specifications* starting on *page 125* for more power supply specifications.

If the voltage supplied is below the minimum specification, the receiver will suspend operation. If the voltage supplied is above the maximum specification, the receiver may be permanently damaged, voiding your warranty.

OEM6 family cards contains a DC-to-DC converter that is tolerant to input noise and ripple. A tightly regulated input supply is not required, as long as it falls within the given input range. The power supply used for any OEM6 family card should be capable of providing the specified power requirements in *Table 3*.

Table 3: Voltage Input Requirement for OEM6 Family Cards

OEM6 Product Line	Power Input Requirement
OEM628	+3.3V DC ±5% with less than 100 mV ripple
OEM615	+3.3V DC ±5% with less than 100 mV ripple

The OEM628 is designed to prevent internal damage when subjected to reverse polarity power connection. The OEM615 does not feature reversed polarity protection.

The OEM6 family cards also provide protection for a short duration during over-voltage events. It is recommended that appropriate fuses or current limiting be incorporated as a safety precaution on all power lines used. Use a sufficient gauge of wire to ensure that the voltage at the connector is within the OEM6 family card's requirements. See *Appendix C, OEM615 Technical Specifications* starting on *page 125* or *Appendix B, OEM628 Technical Specifications* starting on *page 97* for current and voltage requirements.

2.4 Installation Overview

When you have selected the appropriate equipment, complete the following steps to set up and begin using your NovAtel GNSS receiver.

1. Install the OEM6 family card in an enclosure with a wiring harness, as described in *Section 2.4.1* on *page 32*.
2. Mount the GNSS antenna to a secure, stable structure, as described in *Section 2.4.2* on *page 36*.
3. Connect the GNSS antenna to the receiver using an antenna RF cable, using the information in *Section 2.4.3* on *page 36*.
4. Apply power to the receiver, as described in *Section 2.4.4* on *page 37*.
5. Connect the receiver to a computer or other data communications equipment by following the

information in *Section 2.4.5* on *page 37*.

2.4.1 Installing an OEM6 Family Card with Wiring Harness and Enclosure

To install an OEM6 family card:

1. Ensure that you are protected against ESD, as described in the following section.
2. Mount the OEM6 family card in a secure enclosure to reduce environmental exposure and RF interference, as described in *Mounting the Printed Circuit Board* starting on *page 33*.
3. Prepare a wiring harness to interface with the receiver's data, status, and power signals using the information in *Preparing the Data, Signal & Power Harness* starting on *page 34*.

Electrostatic Discharge (ESD) Precautions

Electrostatic discharge is a leading cause of failure of electronic equipment components and printed circuit boards containing ESD-sensitive devices and components. You must follow ESD precautions when handling or installing an OEM6 family card. See *Appendix A, Electrostatic Discharge Control (ESD) Practices* starting on *page 94* for more information on ESD precautions.

Leave the OEM6 family card in its static-shielding bag or clamshell when not connected in its normal operating environment. When removing the OEM6 family card from the ESD protection, follow accepted standard anti-static practices. Failure to do so may cause damage to the OEM6 family card.

When you remove the OEM6 family card from the original packing box, keep the box and ESD protection for future storage or shipment.

- Always wear a properly grounded anti-static wrist strap when handling an OEM6 family card.
- Always hold the OEM6 family card by its corners or the RF shield and avoid direct contact with any of the components.
- Do not let the OEM6 family card come in contact with clothing at any time. The ground strap cannot dissipate static charges from fabrics.
- Failure to follow accepted ESD handling practices could cause damage to the OEM6 family card.
- The warranty may be void if equipment is damaged by ESD.

Mounting the Printed Circuit Board

The OEM6 family cards are OEM products and the printed circuit board is provided without a housing structure. This allows flexibility in creating a mounting environment to suit particular product and marketing requirements. The mounting and enclosure should provide for the following:

- Mounting of external connectors
- Protection from hostile physical environments (rain, snow, sand, salt, water, extreme temperatures, etc)
- Electromagnetic shielding to protect from hostile RF environments (e.g:, nearby transmitters)
- Electromagnetic shielding so that the final product conforms to RF emissions specifications

The card may not pass emissions testing by itself - it may need to be installed in an enclosure. For more information on emissions testing, refer to the regulatory body in your geographic area. In the United States, contact the Federal Communications Commission (FCC) and in Europe, contact the Conformité Européenne (CE).

- Protection from ESD (see *Appendix A, Electrostatic Discharge Control (ESD) Practices* starting on *page 94*)

For proper grounding and mechanical integrity, the OEM628 is mounted with six screws and the OEM615 with four screws when used in a custom assembly. See *Appendix B, OEM628 Technical Specifications* starting on *page 97* and *Appendix C, OEM615 Technical Specifications* starting on *page 125* for mechanical drawings of each card.

Preparing the Data, Signal & Power Harness

The wiring harness provides connections to some or all of the following:

- Communication ports, including COM, Ethernet, USB and CAN (a CAN transceiver is required)
- Antenna/LNA
- Input and output timing strobes
- Power input
- Optional LNA power supply
- Optional external frequency reference

> If you are using the OEM628's Ethernet connectivity, the distance between the RJ45 connector and the magnetics must be no more than 10 inches (25.4 cm) and the distance between the device and the magnetics must be no more than 1.5 inches (3.8 cm). The OEM628 uses the Micrel KSZ8851SNLI device. Follow Micrel's recommendations for transformer selection.

For all OEM6 family cards, the power, status and data inputs and outputs are accessed from one or more connectors. Therefore, the harness must be designed to mate with this connector(s).

As shown in *Figure 6*, the OEM628 card uses 24-pin and a 16-pin headers for the data, power and status signals. The RF input is an MMCX female connector. An external oscillator input is available, also through an MMCX female connector.

The pin-outs for all connectors are specified in *Appendix B, OEM628 Technical Specifications* starting on *page 97* for the OEM628 and manufacturers' part numbers are defined in *Section D.3* on *page 138*.

The OEM615 in *Figure 7* on *page 36* uses a single 20-pin header and a MCX RF input. OEM615 pin-out information is in *Appendix C, OEM615 Technical Specifications* starting on *page 125*.

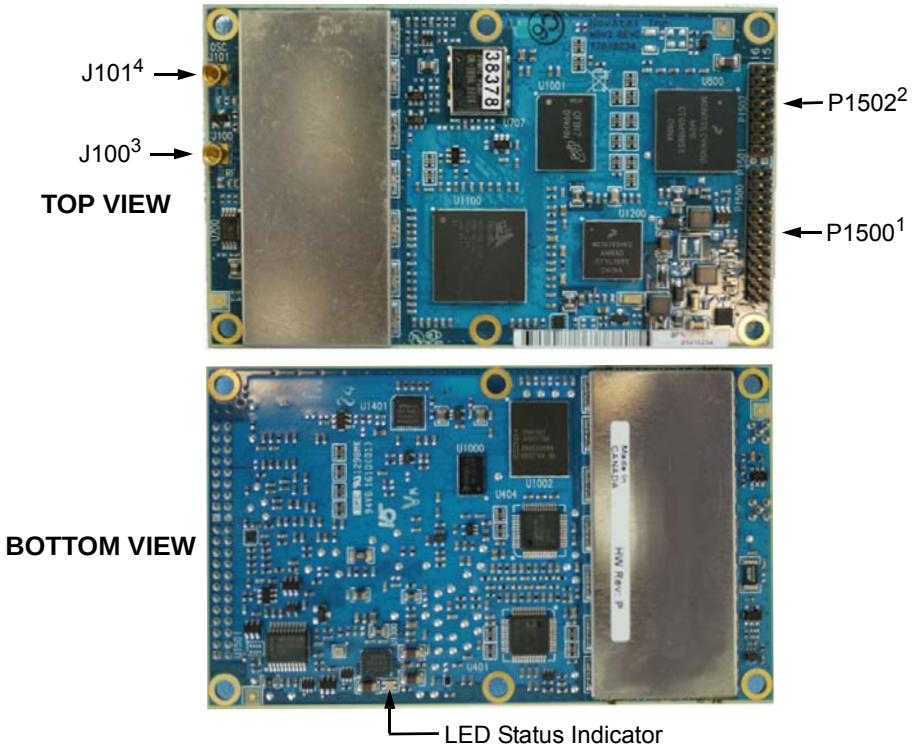


Figure 6: OEM628 Connector and Indicator Locations

Item	Description
1	P1500 24-pin dual-row male connector with a 2 mm straight 2 x 12 header, used for power, data and signal
2	P1502 16-pin dual-row male connector with a 2 mm straight 2 x 8 header
3	J100 RF signal input and LNA power output, MMCX female connector
4	J101 external clock input, MMCX female connector

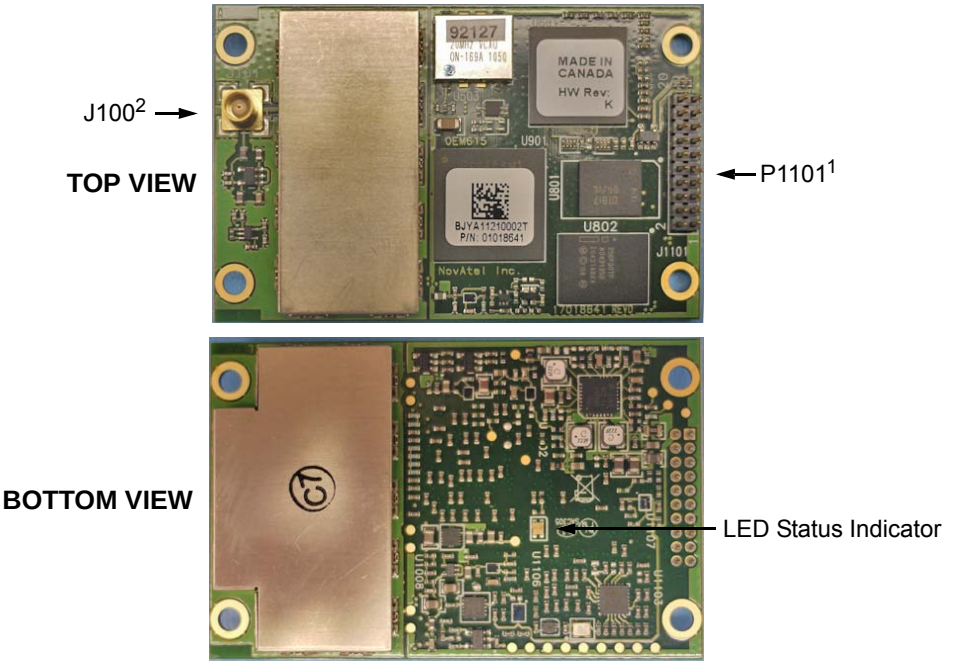


Figure 7: OEM615 Connector and Indicator Locations

Item	Description
1	P1101 20-pin dual-row male connector with a 2 mm straight 2 x 10 header, used for power, data and signal
2	J100 RF signal input and LNA power output, MCX female connector

2.4.2 Mounting the GNSS Antenna

When the OEM6 family card is installed with a wiring harness in an enclosure, the antenna can be installed and connected. The GNSS receiver is designed to operate with any of the NovAtel single, dual and triple-frequency GNSS antenna models. See *Section 2.3.1* on *page 28* for more information.

When installing the antenna:

- Choose an antenna location that has a clear view of the sky so that each satellite above the horizon can be tracked without obstruction. For more information on RF signal propagation and multipath, refer to application note *APN-008 Discussions on RF Signal Propagation and Multipath* on the Support page of our website.
- Mount the antenna on a secure, stable structure capable of safe operation in the specific environment.

2.4.3 Connecting the Antenna to the Receiver

Connect the antenna to the receiver using a high-quality coaxial cable, discussed in *Section 2.3.2* on *page 30*.

For OEM628, an interconnect adapter cable is required to convert the end of the coaxial cable to the card's MMCX female RF input connector. The RF connector location for the OEM628 is shown in *Appendix B, OEM628 Technical Specifications* starting on *page 97*.

The OEM615 uses an MCX connector, which also requires an RF adapter. See *Appendix C, OEM615 Technical Specifications* starting on *page 125* for OEM615 connector location information. A user-supplied LNA_PWR supply is internally regulated to 5 V DC and sent to the centre pin of the MCX RF connector to power an external antenna (the return is the outer conductor of the coax).

This port is capable of providing up to 100mA to a connected antenna (based on a 5V input supply. Higher input voltages should follow the derating curve shown in OM-20000128, OEM6 Family Installation and Operation User Manual for more information). The typical current draw for a NovAtel antenna is less than 40mA.

2.4.4 Applying Power to the Receiver

Set the power supply to the voltage in *Table 3, Voltage Input Requirement for OEM6 Family Cards* on *page 31*, then connect the power supply to the wiring harness.

2.4.5 Connecting Data Communications Equipment

To send commands and obtain logs, connect the receiver to a data communications device. The default configuration for OEM6 receivers is shown in *Table 4*.

On some receivers, the serial ports can be factory-configured for RS-232, RS-422 or LVTTL operation. Contact NovAtel Customer Support for more details. See *Appendix B, OEM628 Technical Specifications* starting on *page 97* and *Appendix C, OEM615 Technical Specifications* starting on *page 125* for data connection details.

Table 4: Default Serial Port Configurations

Model	COM1	COM2	COM3
OEM615	User configurable as LVTTL with no flow control	User configurable as LVTTL with no flow control	User configurable as LVTTL with no flow control
OEM628	User configurable as RS-232 with flow control or RS-422 without flow control. See *User-Selectable Port Configuration* on *page 38*.	User configurable as LVTTL with no flow control	User configurable as LVTTL with no flow control
FlexPak6	RS-232	RS-232/ RS-422. See *User-Selectable Port Configuration* on *page 38*	Not available

Each port may support some, or all, of the following signals:

- Request To Send (RTS) [COM1 and COM2]
- Clear To Send (CTS) [COM1 and COM2]
- Received Data (RX)
- Transmitted Data (TX)

Port settings (bit rate and parity, for example) are software-configurable. See *Chapter 3, Operation* on *page 46.* Also see *Appendix B, OEM628 Technical Specifications* starting on *page 97* and *Appendix C, OEM615 Technical Specifications* starting on *page 125* for further information on data communications specifications and pin assignments.

The FlexPak6 enclosures are Data Terminal Equipment (DTE) so that TXD, RTS and DTR are outputs while RXD, CTS and DCD are inputs. A null modem cable, supplied with the receiver, is required to connect to another DTE like a terminal or a PC, while a straight cable is used to connect to another receiver.

User-Selectable Port Configuration

OEM6 family cards and enclosures offer user configuration of the communication ports.

OEM615 Receiver

COM1, COM2 and COM3 are CMOS-level I/O pins only. These ports require the addition of an RS232/RS422 transceiver to provide appropriate signal levels. Most RS232 or RS422 transceivers provide adequate ESD protection.

You should use a combination of a series ferrite bead and a small-value shunt capacitor on any RS232/RS422 lines that leave the enclosure (similar to the arrangement used on the I/O ports and CAN interfaces). The TVS recommended for CMOS-level I/O is unsuitable for RS232-level I/O. Use an additional low-capacitance TVS device with a clamping voltage between 18V and 25V for RS232 lines requiring protection above what is the transceiver provides.

The OEM615 receiver has three LVTTL COM ports:

- COM1 RX is at pin 12 of the main header
- COM1 TX is at pin 11 of the main header
- COM2 RX is at pin 15 of the main header
- COM2 TX is at pin 14 of the main header
- COM3 TX is at pin 9 of the main header
- COM3 RX is at pin 4 of the main header

COM3 is multiplexed with USB and EVENT1. USB and EVENT1 are enabled by default.

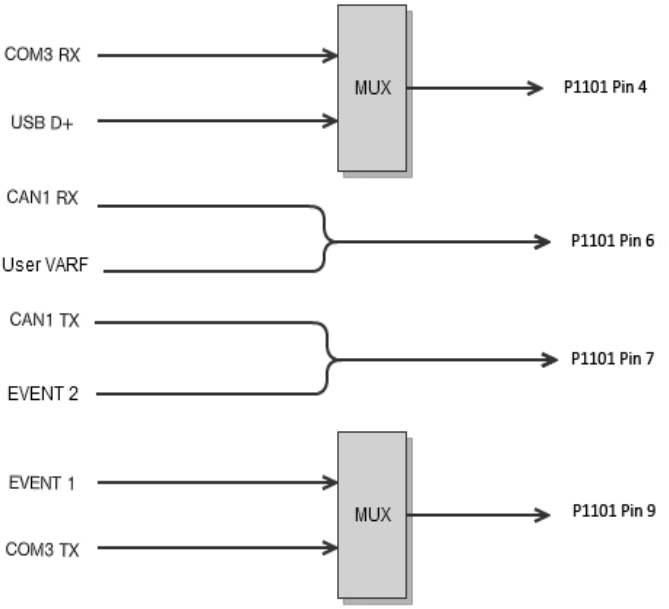

COM3 RX
USB D+
MUX
P1101 Pin 4
CAN1 RX
User VARF
P1101 Pin 6
CAN1 TX
EVENT 2
P1101 Pin 7
EVENT 1
COM3 TX
MUX
P1101 Pin 9

Figure 8: COM3 and USB multiplexed

To enable COM3, issue the following commands:

```
1. INTERFACEMODE USB1 NONE NONE
2. INTERFACEMODE USB2 NONE NONE
3. INTERFACEMODE USB3 NONE NONE
4. MARKCONTROL MARK1 DISABLE
5. INTERFACEMODE COM3 NOVATEL NOVATEL
6. SAVECONFIG (optional)
```

To enable USB, issue the following commands:

```
1. INTERFACEMODE COM3 NONE NONE
2. INTERFACEMODE USB1 NOVATEL NOVATEL
3. INTERFACEMODE USB2 NOVATEL NOVATEL
4. INTERFACEMODE USB3 NOVATEL NOVATEL
5. SAVECONFIG (optional)
```

To enable EVENT1, issue the following commands:

```
1. INTERFACEMODE COM3 NONE NONE
2. MARKCONTROL MARK1 ENABLE
3. SAVECONFIG (optional)
```

OEM628 Receiver

In the case of the OEM628 card, COM1 can be configured as either RS-232 (with hardware flow control, if the cable you are using supports it) or RS-422 (with no hardware flow control), by setting main connector pin 2 LOW or HIGH respectively.

By default, RS-232 is selected since the pin 2 input, if open, is pulled LOW by an internal pull-down resistor.

To select RS-422, apply 3.3 VDC to pin 2 during start-up. See *Figure 30* on *page 105* for pin-out details for COM1 RS-232 and RS-422 configurations.

A third serial port, COM3, is also available on pin 7 (RXD) and pin 19 (TXD). By default, COM3 is enabled. COM3 is multiplexed with both EVENT2 and USER0.

To enable COM3:

1. If a user application is running, make sure it does not initialize GPIO_USER0.
2. Issue the following command: `MARKCONTROL MARK2 DISABLE`.

3. Issue the following command: `INTERFACEMODE COM3 NOVATEL NOVATEL ON`. You can use any interface mode except NONE.

Refer to the *OEM6 Family Firmware Reference Manual* for command information.

FlexPak6

The FlexPak6 is RS-232/RS-422-selectable through pin 9 of the I/O port, see *Section B.2.1* on *page 117*.

2.5 Additional Features and Information

This section contains information on additional features of the OEM6 family receivers.

2.5.1 Strobes

OEM6 family receivers have inputs and outputs, referred to as strobes, that provide status and synchronization signals. Not all strobes are provided on all receivers.

Detailed information about OEM6 family strobes can be found in *Table 13* on *page 102* and *Table 14* on *page 104*. Detailed information about FlexPak6 strobes can be found in *Table 19* on *page 117* and *Table 20* on *page 117*.

2.5.2 Universal Serial Bus (USB)

OEM6 family receivers come with NovAtel USB drivers for Microsoft Windows 2000, Windows XP, Windows Vista and Windows 7 to provide three virtual serial ports over a single USB 2.0 full-speed connection using USB D(+) and USB D(-) signals, as shown in *Table 5*. The USB drivers are digitally signed and officially supported on Microsoft Windows XP, Windows Vista and Windows 7. They can also be installed on Microsoft Windows 2000 and Windows Server 2003, but are not WHQL signed in those applications.

Table 5: Available USB Signals on Receivers

OEM615	Pin 3 D(-) and Pin 4 D(+) on P1101 (main header)s. Pin 4 is multiplexed with COM3. See *User-Selectable Port Configuration* starting on *page 38*
OEM628	Pin 21 D(-) and Pin 22 D(+) of P1500
FlexPak6	USB mini connector

The three virtual serial ports are available to existing Windows applications which use COM ports to communicate (for example, HyperTerminal and CDU). The NovAtel USB drivers assign COM port numbers sequentially following any existing ports on the computer. For example, if a computer has COM1 and COM2 ports, the NovAtel USB drivers assign COM3 to USB1, COM4 to USB2, and COM5 to USB3.

The NovAtel USB Configuration Utility that is installed with the NovAtel USB drivers allows you to

A modern computer has several USB ports. The assignment of COM port numbers is tied to a USB port on the computer. This allows you to switch receivers without Microsoft Windows assigning new COM ports. However, if you connect the receiver to a different physical USB port, Windows detects the receiver's presence and assigns three new COM port numbers.

change the COM port numbers assigned to the virtual serial ports. The USB drivers and installation instructions are available on the OEM6 Family CD by selecting *USB Support* from the main menu. You can also check for updates to the drivers or release notes at www.novatel.com.

The USB ports are particularly sensitive to damage from Electrostatic Discharge (ESD). We recommend that conductors attached to the USB D+ and D- signal pins are terminated.

2.5.3 CAN Bus

OEM6 cards incorporate a CAN Bus controller that supports physical-layer signals and low-level messages specified in the appropriate sections of the J1939 and ISO11783 standards. Manufacturers can also create messages specific to their application without violating these standards. To facilitate manufacturer messages, NovAtel provides an Application Program Interface (API). To obtain information about this API, contact NovAtel Customer Support.

The OEM615 has two CAN ports, CAN1 and CAN2, that supports up to 1 Mbps. CAN2 is multiplexed with user VARF and EVENT2, so you must issue the following commands to enable CAN 2:

- FREQUENCYOUT DISABLE
- MARKCONTROL MARK2 DISABLE

The OEM628 card has two CAN ports, CAN1 and CAN2, both of which are brought out to the expansion connector, P1502. CAN1 and CAN2 both support applications up to 1 Mbps. Both the OEM628 and the OEM615 require CAN transceivers.

CAN interfaces can be accessed using NovAtel's API, but shared signals must be disabled to avoid conflicts. Refer to the *OEM6 Family Firmware Reference Manual* and see *Section B.1.1, Physical Description* starting on *page 98* for pin-out information.

There are no CAN transceivers on the OEM6 family boards. The cards require external CAN transceivers and proper bus terminations.

CAN Bus functionality is controlled through NovAtel's optional API software. The API header file includes documentation on using the CAN bus.

The FlexPak6 has a CAN port that support applications up to 1 Mbps, see *Section B.2* on *page 115*.

2.5.4 Status Indicator

OEM6 family receiver cards have a LED indicator that provides receiver status. See *Figure 7* on *page 36* for the OEM615 indicator location and *Figure 6* on *page 35* for the OEM628 indicator location. The LED blinks green on and off approximately once per second to indicate normal operation. If the indicator is red, then the receiver is not working properly. The indicator's operation is described in *Section 5.6* on *page 86*.

The FlexPak6 status indicators are shown in the following table:

Table 6: FlexPak6 Status Indicators

Antenna/ Position Valid	Solid **GREEN** with valid position **/** Solid **RED** indicates a board error
COM1	Flashing **GREEN** when transmitting data from COM1 **/** Flashing **RED** when receiving data on COM1
COM2	Flashing **GREEN** when transmitting data from COM2 **/** Flashing **RED** when receiving data on COM2
Power	Solid **RED** when voltage within the acceptable range is applied

2.5.5 External Oscillator

For applications requiring greater precision than what is possible using the on-board voltage-controlled, temperature-compensated crystal oscillator (VCTCXO), you may need to connect the OEM628 to an external, high-stability oscillator, at 5 MHz or 10 MHz. The OEM615 does not have an external oscillator connection.

Connect a cable from the external oscillator to the receiver's external oscillator input connector. For the OEM628, an MMCX female connector (J101) is used as shown in *Figure 6 on page 35*. The receiver does not have to be powered down during this operation. However, if you are handling an OEM628 card directly, you must observe anti-static practices.

When the external oscillator is installed, use the EXTERNALCLOCK command (refer to the *OEM6 Family Firmware Reference Manual* for details) to set the clock type (e.g.: cesium, rubidium or ovenized crystal) and frequency.

2.5.6 Antenna LNA Power

NovAtel antennas and coaxial cables meet receiver RF input gain requirements. NovAtel antennas are equipped with built-in, low-noise amplifiers (LNAs) that provide 26 dB of gain to the satellite signal received. The power to the antenna LNA is provided through the receiver's RF port center conductor. To achieve the required input gain to the receiver, NovAtel coaxial cables are designed to introduce no more than 10 dB loss. Antenna supply over-current protection limits the LNA power.

The OEM615 and OEM628 can provide +5 VDC +/- 5% at a maximum of 100 mA. In the OEM615 only, the amount of voltage that the receiver can provide depends upon the input voltage provided to pin 1 on the P1101 connector. The OEM615 output power uses the following current derating curve:

- V(LNA OUT) < 0.1W/I(LNA OUT) + 5 V

2.5.7 Ethernet

OEM628 receivers are equipped with a 10/100baseT Ethernet port that supports IPv4 Internet layer, TCP/IP transport and telnet. Users can conduct remote debugging, accept MRTCA (modified RTCA) data and download firmware. OEM6 family receivers are also equipped with NTRIP Version 2.0 (Networked Transport of RTCM via Internet Protocol) client and server capability.

There are no Ethernet magnetics or RJ45 connector on the OEM6 family receiver. If you are using the OEM6 Ethernet connectivity, the distance between the RJ45 connector and the magnetics must be no more than 10 inches (25.4 cm), and the distance between the device and the magnetics must be no more than 1.5 inches (3.8 cm).

Refer to application note *APN-057* at *www.novatel.com* | *Support* | *Knowledge and Learning* for instructions on configuring Ethernet and NTRIP.

Chapter 3 Operation

Before operating the receiver for the first time, read the installation instructions in *Chapter 2, Installation and Setup* starting on *page 27*. The following instructions are based on a configuration similar to *Figure 9*.

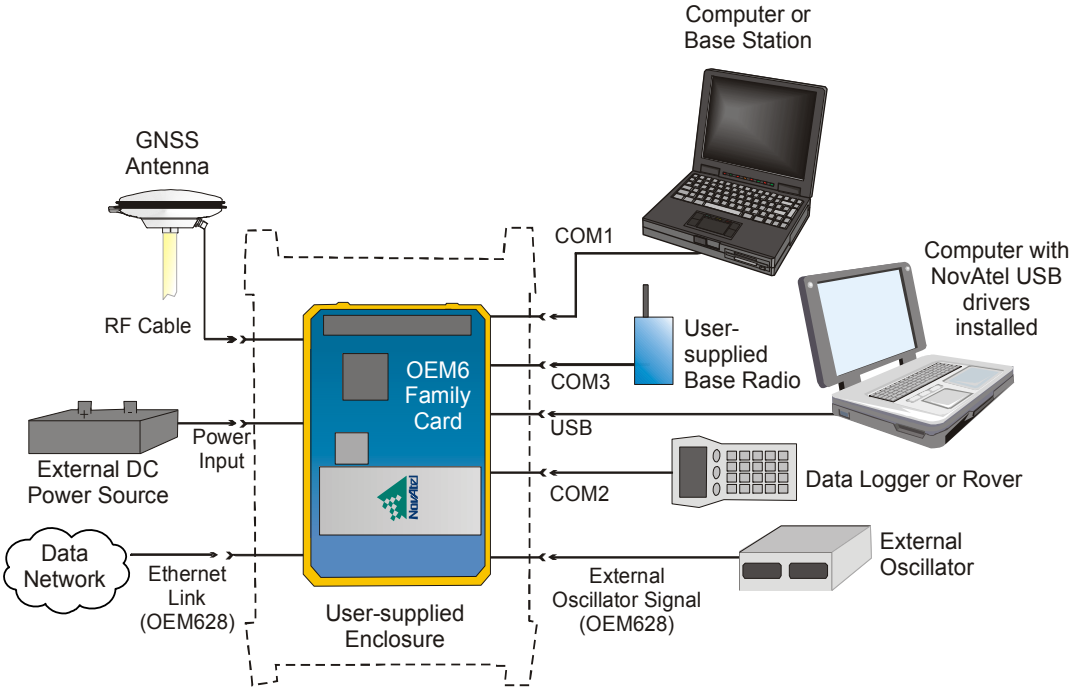


Figure 9: Basic OEM6 Family Card Connection Interfaces (example)

- See also *Figure 10* on *page 50* for a base/rover example
- Figure 9 does not show all necessary hardware

3.1 Communications with the Receiver

You can communicate with the receiver through a data terminal or computer that is connected through one of the receiver's serial port using a null-modem cable, USB or Ethernet.

When connected to the receiver, you can enter commands directly from the terminal or through terminal emulation software (such as HyperTerminal) on your computer.

To maximize the application of the receiver's capabilities, you should become familiar with the commands and logs described in the *OEM6 Family Firmware Reference Manual*.

3.1.1 Serial Port Default Settings

The receiver communicates with your computer or terminal through a serial port. For communication to occur, both the receiver and the operator interface must be configured properly. The receiver's COM1, COM2 and COM3 default port settings are as follows:

- 9600 bps, no parity, 8 data bits, 1 stop bit, no handshaking, echo off

Use the SERIALCONFIG command to change these settings, as necessary.

The data transfer rate you choose determines how fast information is transmitted. For a log with a message byte count of 96, the default port settings allows 10 bits/byte (8 data bits + 1 stop bit + 1 framing bit). It therefore takes 960 bits per message. 10 messages per second require 9600 bps. Even at a bit rate of 9600, the actual data transfer rate is lower and depends on the number of satellites being tracked, data filters in use and idle time. As a result, you should leave yourself a margin when choosing a data rate (230400 bps is recommended for most applications).

Although the receiver can operate at data transfer rates as low as 300 bps, this is not desirable. For example, if several data logs are active (meaning that a significant amount of information is being transmitted every second), but the bit rate is set too low, data will overflow the serial port buffers and cause an error condition in the receiver status that results in lost data. Refer to the RXSTATUS log in the *OEM6 Firmware Reference Manual*.

3.1.2 Communicating with a Remote Terminal

One method of communicating with the receiver is through a remote terminal. The receiver has been pre-wired to allow RS-232 interface with your data terminal. To communicate with the terminal, the receiver only requires the RX, TX, and GND lines to be used. Handshaking is not required, although it can be used optionally. Ensure that the terminal's communications set-up matches the receiver's RS-232 settings.

3.1.3 Communicating with a Computer

A computer can emulate a remote terminal as well as provide the added flexibility of supporting multiple-command batch files and data logging storage files. You can use any standard communications software package that emulates a terminal to establish bidirectional communications with the receiver. Examples include HyperTerminal or CDU, NovAtel's graphic user interface (GUI) program. All data is sent as raw 8-bit binary or ASCII characters.

3.2 Getting Started

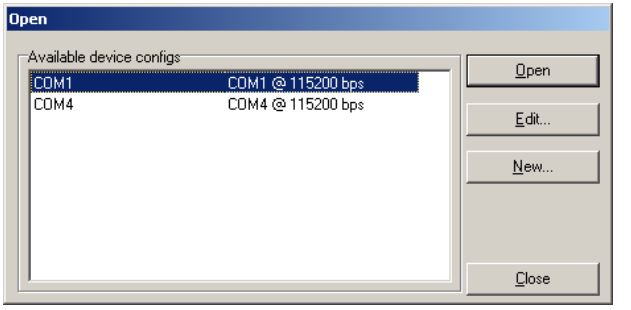
NovAtel CDU and Convert4 programs are included with your receiver. CDU is a Microsoft Windows-based GUI that you can use to access the receiver's features without special communications protocols or software. The Convert4 utility is a Microsoft Windows-based utility that allows you to convert between data formats and strip unwanted records during data-file compilation. See *Chapter 4, PC Software and Firmware* starting on *page 62* for more information on these programs and their installation.

3.2.1 Starting the Receiver

The receiver's software resides in flash memory. When first powered, it undergoes a complete self-test. If an error condition is detected during the self-test, the status word changes. This self-test status word can be viewed in the header of any data output log. Refer to the chapter on *Messages* in the *OEM6 Family Firmware Reference Manual* for header information. If a persistent error occurs, contact your local NovAtel dealer. If the dealer cannot resolve the problem, contact NovAtel Customer Support directly using one of the methods listed in *Customer Support* on *page 20*.

3.2.2 Communicating with the Receiver Using CDU

Open the CDU program and select *Device* | *Open* from the main menu. The *Open Configuration* window appears. The following example shows an *Open Configuration* window with two possible configurations already available .



Refer to CDU's Help file by selecting the *Help* | *Contents* menu. See also *Chapter 4, PC Software and Firmware* starting on *page 62* for descriptions of the CDU windows available from the *View* menu. Ensure that you can see the *Console* and *ASCII Messages* windows by selecting them from the *View* menu.

When the receiver is first turned on, no data is transmitted from the COM ports except for the port prompt. The Console window displays a port name:

[COM1] *if connected to COM1 port*

[COM2] *if connected to COM2 port*

or

[COM3] *if connected to COM3 port*

Any of the COM port prompts indicate that the receiver is ready and waiting for command input. The screen may display other port names for other port types (e.g., USB1, USB2, USB3 or AUX).

1. You may have to wait for output from receiver self tests. On start-up, the OEM6 family receiver is set to log the RXSTATUSEVENTA log ONNEW on all ports. See Section 5.4, RXSTATUSEVENT Log on page 78 for more details.
2. If CDU is unable to locate the OEM6 family receiver, you may have used the SAVECONFIG command. Try using a different COM port to communicate with the receiver. When communication has been established, issue a FRESET STANDARD command. The original communications port should be ready for use.
3. XCOM1, XCOM2 and XCOM3 virtual ports can be generated by the receiver. However, they are unlikely to appear as a port prompt as you cannot connect to these types of ports using CDU. Also, the XCOM ports are not available with the COM command but may be used with other commands, such as INTERFACEMODE and LOG. Refer to the OEM6 Family Firmware Reference Manual (OM-20000129) for details on the virtual ports.

An example of a response to an input command is the FIX POSITION command:

```
[COM2] fix position 51.11635 -114.0383 1048.2 [carriage return]
<OK
```

In this example, [COM2] is the port prompt.

This example illustrates command input to the base receiver's COM2 port that sets the position of the base station receiver for differential operation. Confirmation that the command was actually accepted is the appearance of <OK.

If a command is entered incorrectly, the receiver responds with:

```
<Invalid Message ID          (or a more detailed message)
```

Ensure that the computer does not sleep or hibernate during a logging session or data will be lost.

3.3 Transmitting and Receiving Corrections

Corrections can be transmitted from a base station to a rover station to improve position accuracy. The

base station is the GNSS receiver that acts as the stationary reference. The stationary reference has a known position and transmits correction messages to the rover station. The rover station is the GNSS receiver that does not know its exact position and requires correction messages from a base station to calculate differential GNSS positions. An example of a differential setup is shown in *Figure 10*.

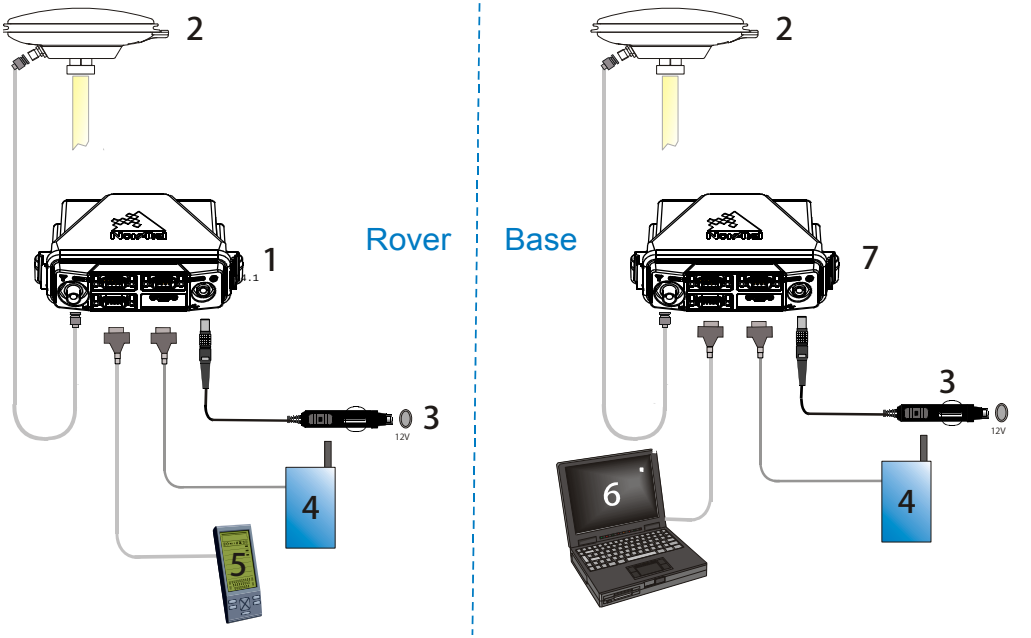


Figure 10: Basic Differential Setup

Reference	Description
1	OEM6 family enclosure for the rover station
2	NovAtel GNSS antenna
3	User-supplied power supply
4	User-supplied radio device connected to COM2
5	User-supplied data storage device connected to COM1
6	User-supplied computer, for set-up and monitoring, connected to the computer COM port
7	OEM6 family enclosure for the base station

Errors can be introduced by system biases. For more information on these system errors and the application of corrections for them, refer to application note *APN-051 Positioning Modes of Operation*, available at *www.novatel.com* | *Support* | *Knowledge and Learning* | *Application Notes*. To receive corrections with a base/rover setup, you must provide a data link between the base station and the rover station. The base and rover stations can both be NovAtel receivers, however NovAtel receivers will work with some other brands. Contact Customer Support for further details.

The data link should support a rate of at least 19200 bits per second, but a rate of 115200 bits per second with less than 4.0 s latency, is recommended. Unlike the base/rover concept, SBAS and L-band corrections can be applied directly to a single receiver.

When your base and rover are set up, configure them as shown in the configuration examples in

Sections 3.3.1 and *3.3.2*.

3.3.1 Base Station Configuration

At the base station, enter the following commands:

```
interfacemode port rx_type tx_type [responses]
fix position latitude longitude height
        (enter your own lat, lon, and hgt values)
log port message [trigger [period]]
savconfig                                   (optional)
```

For example:

RTK Automated Correction Generation

```
fix position lat lon hgt          (enter your own lat, lon, hgt)
generatertkcorrections rtca com2
```

RTCA

```
interfacemode com2 none rtca off
fix position lat lon hgt          (enter your own lat, lon, hgt)
log com2 rtcaobs2 ontime 1
                        (works with both GPS and GPS+GLONASS models)
log com2 rtcaref ontime 10
log com2 rtca1 ontime 5           (optional, enable code-dgps coverage)
log com2 rtcaephem ontime 10 1    (optional)
savconfig                         (optional)
```

RTCM V2.3

```
interfacemode com2 none rtcm off
fix position lat lon hgt          (enter your own lat, lon, hgt)
log com2 rtcm3 ontime 10
log com2 rtcm22 ontime 10 1
log com2 rtcm1819 ontime 1
log com2 rtcm1 ontime 5           (optional)
savconfig                         (optional)
```

RTCM V2.3 with GLONASS

```
interfacemode com2 none rtcm off
fix position lat lon hgt          (enter your own lat, lon, hgt)
log com2 rtcm1 ontime 5           (optional, gps psrdiff)
log com2 rtcm3 ontime 10
log com2 rtcm22 ontime 10,1
log com2 rtcm31 ontime 5,1        (optional, glonass psrdiff)
log com2 rtcm32 ontime 10,2
log com2 rtcm1819 ontime 1
savconfig                         (optional)
```

RTCM V3

```
interfacemode com2 none rtcmv3 off
fix position lat lon hgt          (enter your own lat, lon, hgt)
log com2 rtcm1002 ontime 1        (for L1 only models)
log com2 rtcm1004 ontime 1        (for L1/L2 models)
log com2 rtcm1006 ontime 10
log com2 rtcm1019 ontime 120
savconfig                         (optional)
```

RTCM V3 with GLONASS

```
interfacemode com2 none rtcmv3 off
fix position lat lon hgt          (enter your own lat, lon, hgt)
log com2 rtcm1002 ontime 1        (for L1 only models)
log com2 rtcm1004 ontime 1        (for L1/L2 models)
log com2 rtcm1010 ontime 1        (for L1 only models)
log com2 rtcm1012 ontime 1        (for L1/L2 models)
log com2 rtcm1006 ontime 10
log com2 rtcm1033 ontime 10
log com2 rtcm1019 ontime 120
log com2 rtcm1020 ontime 120
savconfig                         (optional)
```

CMRPLUS (CMR+)

```
interfacemode com2 none cmr off
fix position lat lon hgt          (enter your own lat, lon, hgt)
log com2 cmrobs ontime 1
log com2 cmrgloobs ontime 1
log com2 cmrplus ontime 1  (important to use ontime 1 with cmrplus)
savconfig                         (optional)
```

CMR

```
interfacemode com2 none cmr off
fix position lat lon hgt          (enter your own lat, lon, hgt)
log com2 cmrobs ontime 1
log com2 cmrgloobs ontime 1
log com2 cmrref ontime 10
log com2 cmrdesc ontime 10 1      (optional)
savconfig                         (optional)
```

3.3.2 Rover Station Configuration

At the rover station, enter:

```
interfacemode port rx_type tx_type [responses]
```

For example:

RTK Automated Correction Detection

```
interfacemode com2 auto none off
```

RTCA `interfacemode com2 rtca none off`

RTCAOBS2 `interfacemode com2 rtca none off`

RTCM V2.3 `interfacemode com2 rtcm none off`

RTCM V3 `interfacemode com2 rtcmv3 none off`

RTCM V3 with GLONASS

```
interfacemode com2 rtcmv3 none off
```

CMR+ `interfacemode com2 cmr none off`

CMR `interfacemode com2 cmr none off` *(same as CMR+)*

3.3.3 ALIGN® Heading Master and Remote Configurations

This section provides instructions for setting up a master station with an ALIGN-capable remote receiver for applications that require heading output. Refer to *APN-048 ALIGN Overview and Setup*, at *www.novatel.com* | *Support* | *Knowledge and Learning* | *Application Notes*.

Master:

```
interfacemode com2 none rtca off
fix position lat lon hgt                (enter your own lat, lon, and hgt values)
or movingbasestation enable
log com2 rtcaobs2 ontime 1
log com2 rtcaref ontime 1
```

Rover:

```
interfacemode com2 rtca none off
log headinga onchanged                  (heading, baseline length, pitch and other data)
log gphdt ontime 1                      (NMEA heading formatted log)
hdtoutthreshold 1.0                     (optional, controls the GPHDT log output)
```

3.3.4 PDP and GL1DE® Configurations

PDP and GL1DE position filters can be used for single-frequency single-point, WAAS, DGPS or VBS positioning.

To reset the PDP or GL1DE filter:

```
pdpfilter reset
```

To enable the PDP filter:

```
pdpfilter enable
```

Ensure that you issue the PDPFILTER command before the PDPMODE command. Set the PDP type and kinematic type according to the application. For most kinematic applications:

`pdpmode relative dynamic` *or* `pdpmode relative auto`

The rest of the setup is position type and log-dependant according to your application. For example, details of the RTKSOURCE, PSRDIFFSOURCE, INTERFACEMODE, COM and other configuration commands are outlined in the *OEM6 Family Firmware Reference Manual* available at *www.novatel.com* | *Support* | *Firmware/Software and Manuals*.

3.3.5 Configuration Notes

For compatibility with other GNSS receivers, and to minimize message size, you should use the standard form of RTCA, RTCM, RTCMV3, CMR+ or CMR corrections shown in the base and rover examples above. This requires using the INTERFACEMODE command to dedicate one direction of a serial port to one message type only. When the INTERFACEMODE command is used to change the mode from the NOVATEL default, you can no longer use NovAtel format messages.

If you want to mix NovAtel format messages and RTCA, RTCM, RTCMV3 or CMR messages on the same port, you can leave the INTERFACEMODE set to NOVATEL and log out variants of the standard correction messages with a NovAtel header. ASCII or binary variants can be requested by appending an A or B to the standard message name. For example, on the base station:

```
interfacemode com2 novatel novatel
fix position 51.11358042 -114.04358013 1059.4105
log com2 rtcaobs2b ontime 2
```

1. Interface mode must be set to *NovAtel* for the receiver to issue logs with an *A* or *B* suffix.
2. Using the receiver in this mode consumes more CPU bandwidth than using the native differential messages as shown in Section 3.3.1, Base Station Configuration on Page 51.
3. To find information on how to send multiple commands and log requests using DOS or Windows, search our knowledge database at www.novatel.com | Support | Help Desk & Solutions.

At the rover, you can leave the INTERFACEMODE default settings (`interfacemode com2 novatel novatel`). The rover recognizes the default and uses the corrections it receives with a NovAtel header.

The PSRDIFFSOURCE and RTKSOURCE commands set the station ID values that identify the base stations to accept pseudorange or RTK corrections from. They are useful commands when the rover station is receiving corrections from multiple base stations.

At the base station, you can log the contents of the standard corrections in a form that is easier to read. These larger variants have the correction fields broken out into standard types in the log, rather than compressed into bit fields. This can be useful if you want to modify the format of the corrections for a non-standard application, or if you want to look at the corrections for system debugging purposes. These variants have DATA in their names (e.g., RTCADATA1, RTCMDATA1, CMRDATAOBS). Refer to the *OEM6 Family Firmware Reference Manual* for more information.

3.4 Enabling SBAS Positioning

OEM6 family receivers are capable of SBAS positioning. This positioning mode is enabled using the `SBASCONTROL` command:

```
sbascontrol enable auto
```

When the command is entered, the OEM6 family card automatically tracks the SBAS that is operating in the region (e.g., WAAS or EGNOS) and applies the corrections from the service. On a simulator, you may want to leave the *testmode* parameter off or specify NONE explicitly. For more on SBAS, refer to application note *APN-051 Positioning Modes of Operation* at *www.novatel.com* | *Support* | *Knowledge and Learning* | *Application Notes*.

3.5 Enabling L-band

The OEM628 is an L-band equipped receiver that can achieve sub-metre accuracy. To use the L-band mode, you need an L-band-capable antenna (see *Table 2* on *page 28* for NovAtel L-band-capable antennas) and you must enable L-band tracking to the OmniSTAR signal. A subscription is required to use the OmniSTAR service. For more information on L-band positioning, refer to application note *APN-051 Positioning Modes of Operation* at *www.novatel.com* | *Support* | *Knowledge and Learning* | *Application Notes*.

To obtain an OmniSTAR subscription, contact OmniSTAR at 1-888-883-8476 or 713-785-5850. You mujst provide the receiver's OmniSTAR serial number (which is different from the NovAtel serial number). To obtain the OmniSTAR serial number, enter the following command:

```
log lbandinfo
```

The log displays the L-band serial number in the fifth field following the log header. It is a seven digit number in the range 1000000 to 9999999. The log also provides the status of your subscription. Refer to the LBANDINFO log in the *OEM6 Family Firmware Reference Manual* for more information.

To activate an OmniSTAR subscription, the receiver must be powered and tracking an L-band satellite. When advised by OmniSTAR of the appropriate satellite frequency and data link rate for your location, use the ASSIGNLBAND command to configure your receiver.

The following are the OmniSTAR frequencies as of September 17, 2010. The latest frequencies can be obtained from the OmniSTAR website at www.omnistar.com.

Coverage Area	Satellite Location (Longitude)	Frequency	Data Rate[a]	L-band	Satellite Name
Eastern U.S.	101 West	1557.8450	1200	L-band	MSV-E
Central U.S.	101 West	1557.8350	1200	L-band	MSV-C
Western U.S.	101 West	1557.8550	1200	L-band	MSV-W
North, Central, and South America, including the Caribbean	98 West	1535.1375	1200	L-band	AM-SAT
Asia, Pacific Islands	109 East	1535.1375	1200	L-band	AP-SAT
Europe, Africa, Middle East	25 East	1537.440	1200	L-band	EUSAT
Australia, Far East	160 East	1535.185	1200	L-band	OCSAT

a. A data (baud) rate of 1200 equals a symbol rate of 2438

The following is an OmniSTAR example:

```
assignlband omnistar 1557855 1200
```

1. In addition to a NovAtel receiver with L-band capability, a subscription to the OmniSTAR service is required. Contact NovAtel Customer Support for details. OmniSTAR website: http://www.omnistar.com/
2. The frequency assignment can be made in Hz or kHz. For example:

   Hz: assignlband omnistar 1536782000 1200
   kHz: assignlband omnistar 1536782 1200

   A value entered in Hz is rounded to the nearest 500 Hz.

To confirm you are tracking an L-band signal, log the L-band status information by entering the following command:

```
log lbandstat
```

If you are receiving OmniSTAR HP, the fifth field of the LBANDSTAT log should be 00c2, as shown in the following example:

```
LBANDSTAT COM1 0 81.0 FINESTEERING 1596 235136.000 00000000 d1c2 5968
<1557854678 48.98 1098.9 0.00 00c2 0000 153860 545 0 0000 0201 154019
68000000 00000000
```

Refer to the LBANDSTAT log in the *OEM6 Family Firmware Reference Manual*. For more information about L-band positioning, refer to application note *APN-051 Positioning Modes of Operation* at www.novatel.com | *Support* | *Knowledge and Learning* | *Application Notes*.

3.6 Pass-Through Logging

The pass-through logging feature enables the GNSS receiver to redirect any ASCII or binary data that is input at a specified COM port or USB port, to any specified receiver COM or USB port. This capability, in conjunction with the SEND command, allows the receiver to perform bidirectional communications with other devices such as a modem, terminal or another receiver.

There are several pass-through logs. PASSCOM1, PASSCOM2, PASSCOM3, PASSXCOM1, PASSXCOM2, PASSXCOM3, PASSUSB1, PASSUSB2, PASSUSB3, PASSICOMX, PASSNCOM and PASSAUX are available on OEM6 family receivers for logging through serial ports. Refer to the PASSCOMx log for details.

3.7 Transferring Time Between Receivers

The ADJUST1PPS command is used as part of the procedure to transfer time between receivers. The number of pulses per second (PPS) is always set to one with this command. It is typically used when the receiver is not adjusting its own clock and is using an external reference frequency.

The TIMESYNC log is also used to synchronize time between receivers. It contains a time status field that may show COARSE or FINE, among others. For a complete list of the time status values and definitions, refer to the *GPS Time Status* section in Chapter 1 of the *OEM6 Family Firmware Reference Manual*.

Section 3.7.3 starting on *page 59* provides details on the time transfer procedure. Terms used in the procedure are defined in *Section 3.7.2* starting on *page 58*. Refer also to the ADJUST1PPS command and the TIMESYNC log descriptions in the *OEM6 Family Firmware Reference Manual.*

3.7.1 GPS to Receiver Time Synchronization

Receiver time synchronization with GPS time does not occur until the receiver locks onto the first satellite. The GPS L1 signal has two main streams of data modulated on the carrier. These data streams are the C/A code (1.023 MHz rate) and the P(Y) code (10.23 MHz rate). Additionally, a navigation message (at a 50 Hz rate) contains GPS satellite data including the ephemeris, clock corrections and constellation status. This navigation message is encoded on both the C/A and P(Y) codes. The navigation message is transmitted via individual subframes and each subframe is 300 bits in length. With the 50 Hz data bit rate there is a new subframe transmitted every six seconds.

3.7.2 Time Definitions

The following are related definitions:

Coarse Time	Each subframe contains the transmit time of the next subframe in seconds of GPS time of week. After the first subframe is collected and decoded by the receiver, an approximate calculation of the receiver clock offset can be made. The receiver clock offset is the difference between GPS time and internal receiver time. The calculation is based on subframe transmit time and the approximate propagation time from the satellite signal to the receiver. The position of the satellite and receiver clock offset are used to re-initialize the seconds counter on the receiver, resulting in receiver/GPS time synchronization. The accuracy of the receiver time is expected to be within 30 milliseconds (ms) of GPS time. This initial synchronization is referred to as coarse time and is indicated by COARSE in the time status field of the TIMESYNC log.
Fine Time	When at least four satellites are acquired to calculate the antenna position, a more accurate estimate of the receiver clock offset is calculated. The new receiver clock offset is used to synchronize the receiver clock even closer to GPS time. This is referred to as fine time and appears as FINE or FINESTEERING in the time status field of the TIMESYNC log. Fine time accuracy is a function of the GPS constellation status. For the Standard Position Service (SPS) the time accuracy is specified as 300 ns (1 sigma), assuming that clock steering is enabled.
Fine Clock	An OEM6 family receiver that is tracking satellites, and has a FINE or FINESTEERING receiver clock state.
Cold Clock	An OEM6 family receiver that needs to have its clock synchronized with the Fine receiver. It may have any clock state that includes UNKNOWN.
Warm Clock	An OEM6 family receiver that has its clock adjusted to greater than 500 ms. Refer to the TIME log to view the clock offset.

3.7.3 Procedures to Transfer Time

These procedures are used to transfer time between a fine clock and a cold or warm clock GPS receiver.

Transfer COARSE time (<10 ms) from a fine clock to a cold clock GPS receiver

1. Connect a COM, USB, or Ethernet port from the fine clock receiver to the cold clock receiver (for example, COM2 on the fine clock receiver to COM3 on the cold clock receiver) as shown in *Figure 11*. Configure both ports to the same baud rate and handshaking configurations.

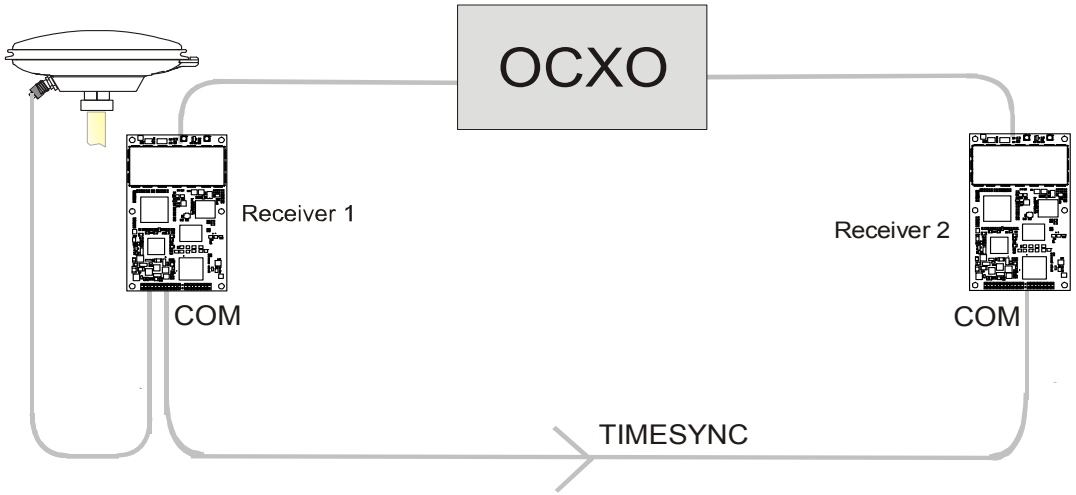


Figure 11: Transfer COARSE time from fine clock to cold clock receiver

2. Issue the following command to the fine clock receiver:

```
log com2 timesyncb ontime 1
```

3. Issue the following command to the cold clock receiver:

```
adjust1pps time
```

When the cold clock receiver receives the TIMESYNC log, it sets its clock with a 100 ms transfer delay allowance.

Transfer FINE time (<50 ns) from a fine clock to a cold clock GPS receiver

1. Connect a COM, USB, or Ethernet port from the fine clock receiver to the cold clock receiver (for example, COM2 on the fine clock receiver to COM3 on the cold clock receiver), as shown in *Figure 12*. Configure both ports to the same baud rate and handshaking configurations.

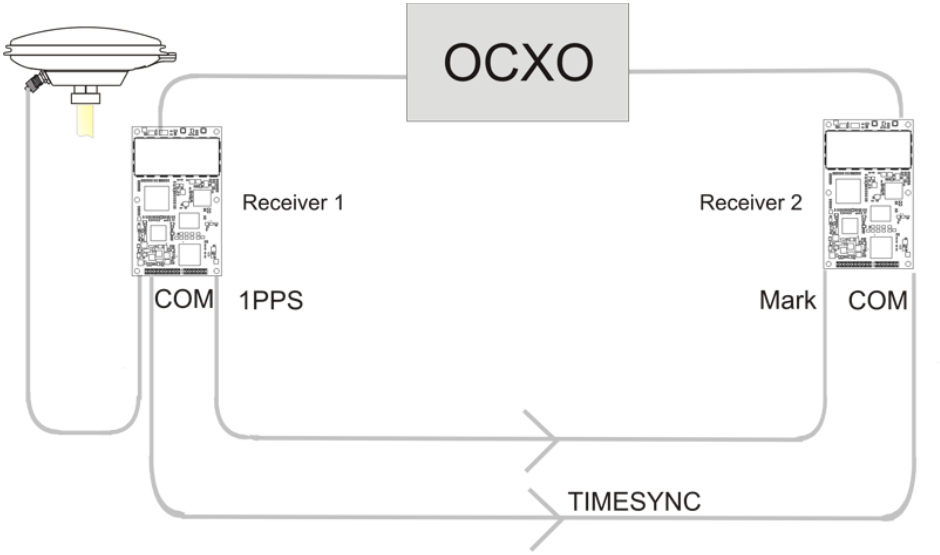


Figure 12: Transfer FINE time from fine clock to cold clock receiver

2. Issue the following command to the fine clock receiver:

```
log com2 timesyncb ontime 1
```

3. Connect the 1PPS signal of the fine clock receiver to the Mark 1 input (Event1) of the cold clock receiver.

4. Issue the following command to the cold clock receiver:

```
adjust1pps markwithtime
```

When the cold clock receiver receives the 1PPS event from the fine clock receiver, it checks to see if a valid TIMESYNC log has arrived within 200 ms of the last 1PPS event. If so, it sets the cold clock receiver clock to the time of the fine clock receiver. See *Figure 14* on *page 61*.

Transfer FINE time from a fine clock to a warm clock GPS receiver

1. Connect the 1PPS signal of the fine clock receiver to the Mark 1 input (Event1) of the warm clock receiver as shown in *Figure 13*.

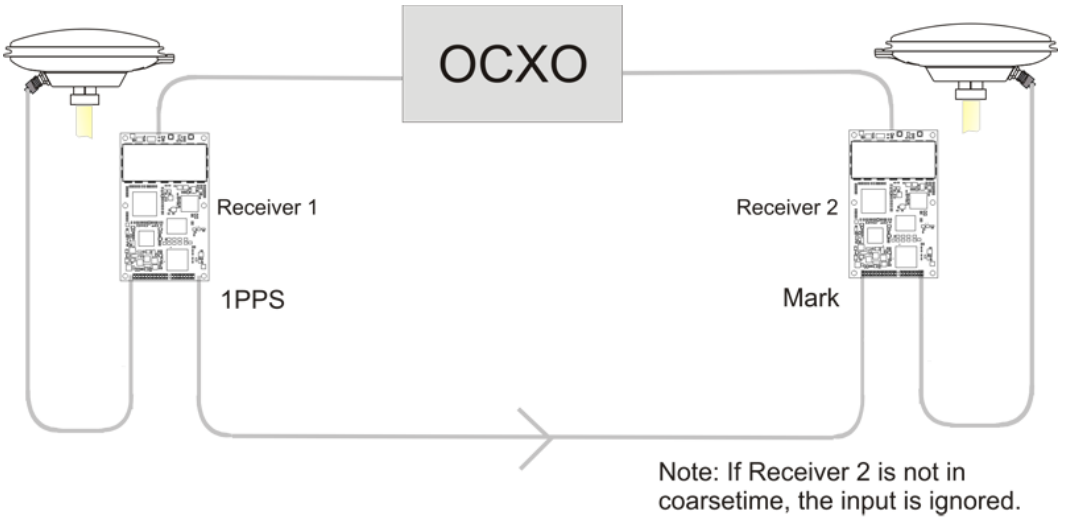


Figure 13: Transfer FINE Time from Fine Clock to Warm Clock Receiver

2. Issue the following command to the warm clock receiver:

```
adjust1pps mark
```

The phase of the warm clock receiver clock is adjusted by the fractional measurement of the fine clock receiver's 1PPS mark input event. In other words, it synchronizes the warm clock receiver's 1PPS to the incoming 1PPS of the fine clock receiver. It does not adjust the one second time of week (TOW) counter or the receiver's week number. This procedure is used to make small corrections to the warm clock receiver's clock.

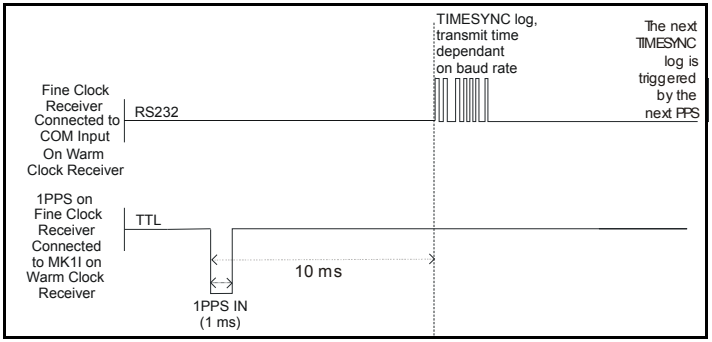


Figure 14: 1PPS Alignment

✉ The examples shown in *Figure 11*, *Figure 12* and *Figure 13* are for the transfer of time. If you need a position, your receiver must be tracking satellites and must have a valid almanac.

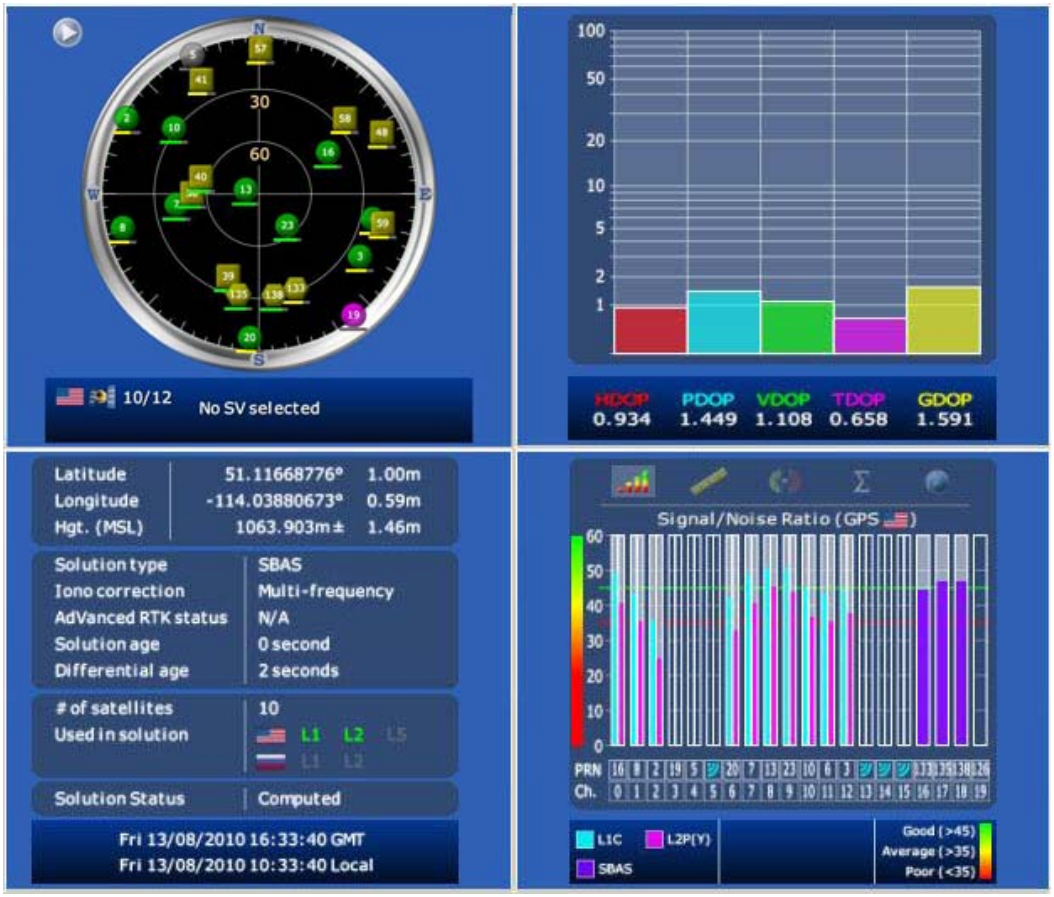
Chapter 4 PC Software and Firmware

You can download the most recent versions of the PC software and receiver firmware from the NovAtel website at *www.novatel.com* | *Support* | *Firmware/Software and Manuals*.

4.1 CDU

CDU is a 32-bit Microsoft Windows application. The application provides you with a graphical user interface (GUI) to set-up and monitor the operation of the NovAtel receiver. A help file is included with CDU and can be accessed through *Contents* from the *Help* menu.

See also *Section 3.2.2, Communicating with the Receiver Using CDU* starting on *page 48*.



Most windows have a right-click popup menu. The popup menus provide a way to customize the

window by changing the font or to print the window contents. Some windows have access to the Options dialog that contains more settings.

- **Constellation Window:** The Constellation window displays each satellite being tracked by the receiver. When you select a satellite, the window shows details of its PRN, signal-to-noise ratio (SNR), azimuth and elevation. Concentric circles from 0° to 90° represent elevations from the horizon to directly overhead, respectively. The azimuth is mapped on a compass relative to true north. The colored rings indicate the lowest elevation cut-off angles at which satellites are tracked and can be changed or viewed with the  button.

  Each satellite being tracked is represented with an icon according to its satellite system, as follows:

  - Circular for GPS
  - Square for GLONASS
  - Hexagon for SBAS

  There are also information icons and values at the bottom of the window:

  - The number of GPS/GLONASS satellites used in the solution verses the number being tracked. For example, 0/5 next to the Russian flag shows that the receiver is tracking 5 GLONASS satellites but using none in the position solution
  - The satellite PRN number, azimuth and elevation
  - The signal-to-noise ratio (SNR) value and indicator

  The PRN of the satellite is displayed on the icon and colours show the status of the satellite or the tracking channel. Click a satellite to display its information.

  When a valid position is achieved, dilution of precision (DOP) values can be viewed in the DOP window.

   To open the window, select *Constellation Window* from the *View* menu or by click the toolbar button.

- **Tracking Status Window:** The *Tracking Status* window displays key information about each of the receiver's processing channels, including the PRN of the satellite being tracked on the channel, the signal-to-noise ratio, pseudorange measurements, Doppler values, residuals measurements and lock time from the satellite.

  The TRACKSTAT log provides the data for many of the fields listed in this window. The number of channels displayed depends on your model of receiver and the bars are color-keyed to show the channel's frequency type.

   To open these windows, select *Tracking Status Window GPS/GLONASS* from the *View* menu or click the American and Russian flag toolbar buttons.

- **Position Window:** The *Position* window displays:

- Receiver's latitude, longitude and height
- Solution type, also known as position type
- Solution or differential age (number of seconds the current solution has been valid). Normally, this represents the latency in the correction data
- The number of satellites used in the solution
- The solution status
- The receiver's date and time (GMT and local)

 To open the window, select *Position Window* from the *View* menu or click the toolbar button.

Right-click the *Position* window to set the computer's clock to the receiver's time, change the font used to display the position data or set the units through the *Options* dialog box.

- **Velocity Window:** The *Velocity* window displays vertical and horizontal speed and direction. The numeric displays within the dial and the velocity values below the dial show the vector velocity and the vertical, north and east velocity components. If necessary, the scale in the dial increases so that you have room to accelerate.

 To open the window, select *Velocity Window* from the *View* menu or click the troolbar button.

- **Compass Window:** The direction dial is a compass that displays the receiver's direction of motion over ground and its elevation (both in degrees). The white arrow shows the elevation value on the vertical scale down the centre of the dial. The black arrow on the outer dial's rim shows the track over ground value. Both the track over ground and elevation angles also appear at the bottom of the Compass window.

 To open the window, select *Compass Window* from the *View* menu or click the toolbar button.

- **INS Window:** If applicable, refer to your SPAN™ User Manual for more information about INS. Information in the *INS Position, Velocity, Attitude* window is only available if you have an INS-capable receiver model.

  The dial is a graphical display of the roll, pitch and azimuth values, shown by an arrow on each axis.

 To open the window, select *INS Window* from the *View* menu or click the toolbar button.

- **Plan Window:** The *Plan* window provides real-time graphic plotting of the current position of

each connected device. The latitude and longitude at the bottom of the window indicate the receiver's reference position, which is used as the center of the grid system. The receiver's subsequent positions, shown with a yellow + marker, are given relative to this initial starting point. The current position is shown with a red + marker.

The buttons at the top of the window provide options for controlling the plan display:

- Zoom in or out of the *Plan* window
- View all configurations or center in on the active configuration
- Select a grid or circular display
- Show/hide history
- Delete all history (no undo)

 To open the window, select *Plan Window* from the *View* menu or click the toolbar button.

-  **DOP Window:** A value representing the position solution uncertainty based on the current satellite geometry. The lower the value, the greater the confidence in the solution.

  In the *DOP* window, DOP is displayed in the following forms:

• GDOP	Geometric DOP: Uncertainty of all parameters (latitude, longitude, height, clock offset)
• PDOP	Position DOP: Uncertainty of the three-dimensional parameters (latitude, longitude, height)
• HDOP	Horizontal DOP: Uncertainty of the two-dimensional parameters (latitude, longitude)
• VDOP	Vertical DOP: Uncertainty of the height
• TDOP	Time DOP: Uncertainty of the clock offset

- **Console Window:** This window allows the user to communicate directly with the receiver through the serial port. It is essentially a terminal emulator with added receiver functionality. Commands can be issued to the receiver via the command editor (at the bottom of the window).

  The command editor has recall functionality that is similar to DosKey, where pressing the up arrow on the keyboard moves backward through recent commands and pressing the down arrow moves forward through recent commands.

  Feedback from the receiver is displayed in the ASCII Messages or Console window depending on the format of the message (ASCII or Abbreviated ASCII).

> Ensure that all other CDU windows are closed when you issue the SAVECONFIG command.

 This window automatically opens when CDU is connected to a receiver. To bring the window to the front, select *Console Window* from the *View* menu or click the toolbar button.

- **Logging Control Window**: The *Logging Control* window provides a graphical interface for:
  - Initiating data logging to a file
  - Initiating logging to the receiver's serial ports
  - Specifying a time window for data logging
  - Stopping logging
  - Editing log settings

 To open the window, select *Logging Control Window* from the *Tools* menu or click the toolbar button.

 Ensure that the computer does not sleep or hibernate during a logging session or data will be lost.

- **ASCII Messages Window**: This window displays ASCII formatted NovAtel logs.

 To open the window, select *ASCII Messages Window* from the *View* menu or click the toolbar button.

- **Wizards**: Several wizards are available to assist with various receiver operations. These are available through the Tools menu or through buttons in the toolbar.

  The Position Mode wizard guides you through the steps needed to set up your RTK system. You must have an RTK-capable receiver model or the wizard will not continue past its opening page.

  The SPAN wizards take you through the steps needed to set up your Synchronized Position, Attitude and Navigation (SPAN) system. You must have a SPAN-capable receiver model, or the wizard will not continue past its opening page. The SPAN wizards help with the alignment or calibration of a SPAN system.

  The ALIGN wizard allows you to set up your remote and master so that your remote can receive heading information, if you have an ALIGN-capable receiver.

  The Troubleshooting wizard enables specific logs for 10 minutes.

  The COM Port wizard retrieves configuration information from your receiver and guides you through COM port and interface mode configurations.

4.2 Convert4

Convert4 is a 32-bit Microsoft Windows application that allows users to select, filter and convert logs from large data files, in either ASCII or binary formats. Convert4 accepts GPS file formats and converts them to ASCII, binary or RINEX format.

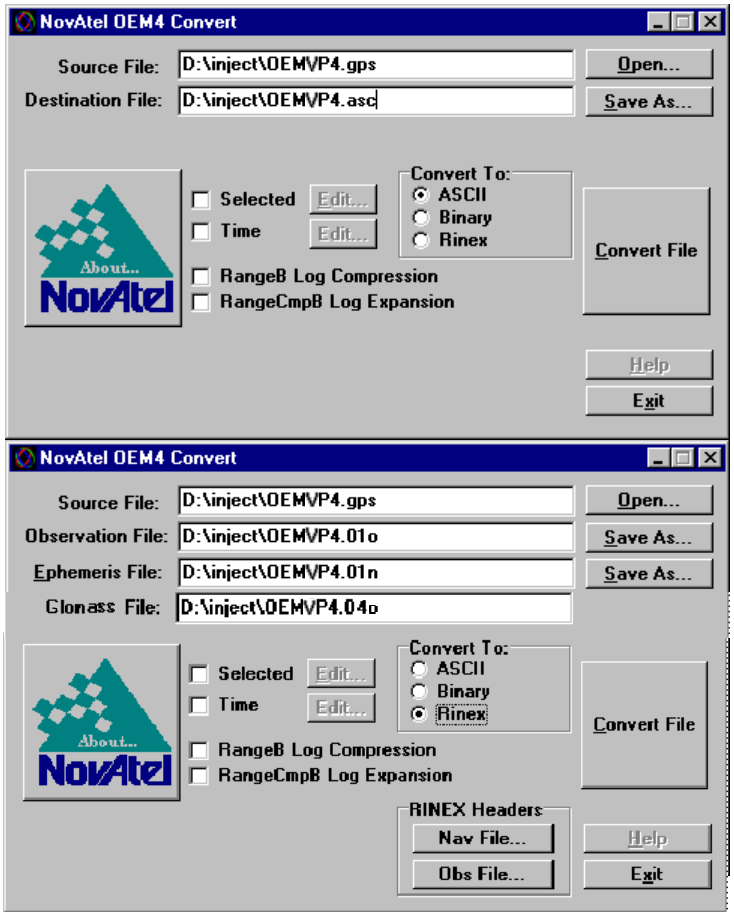


Figure 15: Convert4 Screen Examples

4.2.1 RINEX Format

The Receiver-Independent Exchange (RINEX[1]) 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.

1. For further information on RINEX Version 2.10 file descriptions, visit the U.S. National Geodetic Survey website at http://www.ngs.noaa.gov/CORS/Rinex2.html

Although RINEX is intended to be a receiver-independent format, there are many optional records and fields. Keep this in mind when combining NovAtel and non-NovAtel RINEX data.

When converting to RINEX, two files are produced: a RINEX observation file and a RINEX navigation file. A third GLONASS file is produced if the data contains GLONASS observations. The default names of these files conform to the RINEX Version 2.10 recommended naming convention of ssssdddf.yyt, where:

ssss	4 character station name. Convert4 uses the first four characters of the <infile> parameter as the station ID
ddd	day of year
f	file sequence number within the day. Convert4 sets this to zero
t	file type: o for the observation and n for the navigation file

Selecting the RINEX field in the Convert To area causes the:

1. *Destination File:* field to be replaced by the *Observation File:* and *Ephemeris File:* fields. Observation File refers to the RINEX OBS file while Ephemeris File refers to the RINEX NAV file.
2. *RINEX Headers* buttons to appear for additional information that appears in the header records of the RINEX output files (e.g., Company Name, Marker Name and Marker Number).

For best results, the NovAtel receiver input data file should contain the logs as in *Table 7, NovAtel Logs for RINEX Conversion* on *page 69*.

Table 7: NovAtel Logs for RINEX Conversion

NovAtel OEM6 Family Log	Recommended Trigger
RANGEA/B, or RANGECMPA/B	ontime 15
BESTPOSA/B, or PSRPOSA/B, or RTKPOSA/B, or MARKPOSA/B	once
IONUTCA/B	onchanged
RAWEPHEMA/B	onchanged
GLORAWEPHEMA/B	onchanged
VERSIONA/B [a]	once

a. Information from this log overrides data entered in the Receiver Number, Type and Version fields using the OBS file button of the RINEX Headers section. See *Figure 15* on *page 67.*

4.2.2 Convert4 Command Line Switches

Convert4 supports several command-line switches to facilitate batch processing. To access its Command Line Arguments window, open a command prompt window and browse to the directory where Convert4 is stored. Then, type `convert4 -h`.

The Convert4 Command Line Arguments window appears as shown in *Figure 16*.

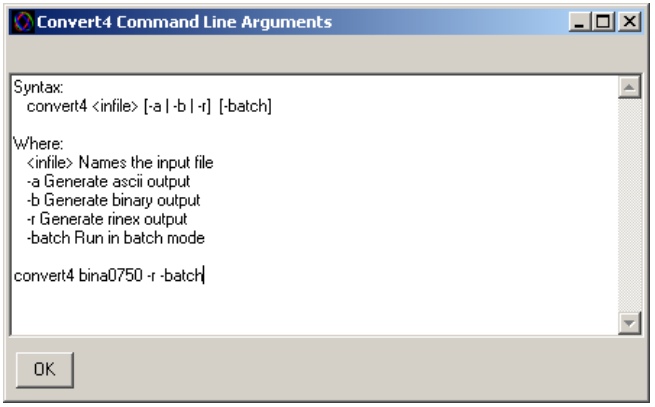


Figure 16: Convert4 Command Line Arguments

The name of the output file is the same as the input file when converting to ASCII or binary formats. The file extension, however, is altered to show the data format:

*.asc for ASCII

*.bin for binary

When converting to RINEX, the output files are named according to the RINEX Version 2.10 naming

convention, as shown in *Section 4.2.1, RINEX Format on page 67*.

The -batch arguments suppress the window display and convert the specified file automatically.

When converting to RINEX in batch mode, the navigation and observation file header information from the most recent interactive Convert4 session is used.

4.3 USB Drivers Installation

The NovAtel USB PC Driver Kit contains the following:

ngpsser.sys	Provides a virtual serial port for each USB port of the receiver.
ngpsusb.sys	Connects the virtual serial ports to the USB stack.
novatelusb.exe	This utility allows you to control the Windows COM ports that are assigned to each USB port of the receiver. This utility can also be used to uninstall the drivers when a newer version is available. During installation, a shortcut appears in the Start menu under *All Programs* | *NovAtel USB Drivers*. The latest USB driver can be found at *www.novatel.com* | *Support* | *Firmware/ Software and Manuals* | *Product Updates* | *PC Utilities*.

These drivers are certified by Microsoft's Windows Hardware Quality Lab (WHQL). Depending on your computer's Driver Signing Policy, Windows may refuse to install this driver or may display a warning. See *Section 4.3.1, Windows Driver Signing* for details.

4.3.1 Windows Driver Signing

The NovAtel USB drivers are digitally signed and officially supported on Windows XP, Windows Vista and Windows 7. They can also be installed on Windows 2000 and Windows Server 2003, but are not WHQL certified in that application. Depending on how your computer is configured, Windows may ignore device drivers that are not digitally signed, display a warning when it detects device drivers that are not digitally signed (the default) or prevent you from installing device drivers without digital signatures.

To install NovAtel USB drivers, the computer's policy must be either Ignore or Warn.

To change the Driver Signing Policy on your computer:

1. Open *System* in the *Control Panel*.
2. Select the *Hardware* tab.
3. Click *Driver Signing.*
4. Select either *Ignore* or *Warn* in the *File signature verification* box.
5. Click *OK* to accept the new policy.
6. Click *OK* again to close the *System Properties* dialog.
7. Unplug the NovAtel receiver USB cable, plug it back in and follow the installation instructions described in either the *Windows XP Installation* section or the *Windows 2000 Installation* section

starting on *page 73*.

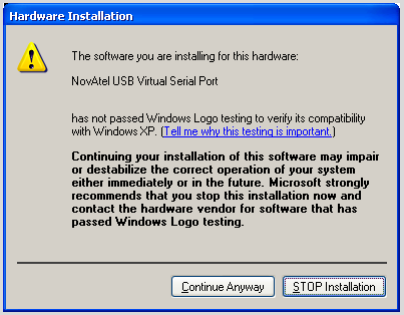
4.3.2 Windows XP Installation

If you are upgrading drivers, uninstall older versions with the NovAtel USB Configuration tool located in the Start Menu under *All Programs | NovAtel USB Drivers*. If you have not installed NovAtel USB drivers before, the NovAtel USB Utility tool will not be there until you install them.

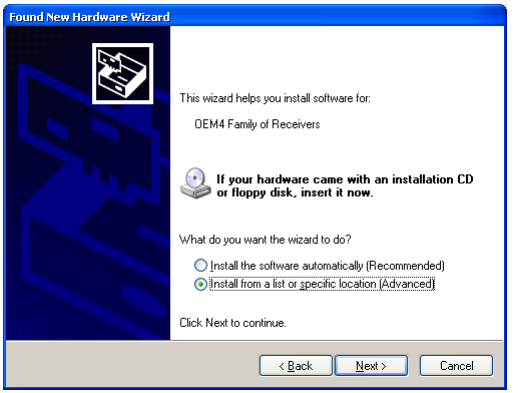
After connecting the NovAtel GNSS receiver to a USB port on the PC, the *Found New Hardware Wizard* appears.

1. Click *No, not this time* then click *Next*.

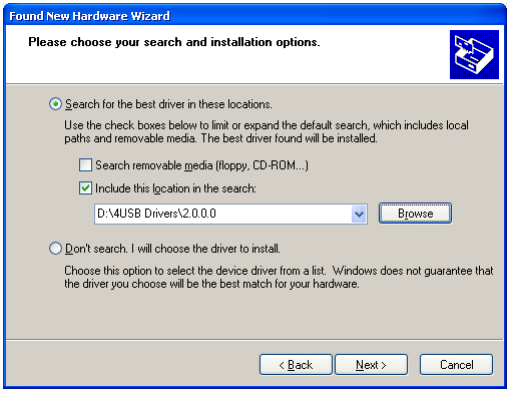
- The screens displayed in this section are from Windows XP and may vary from what you see depending on your operating system.
- During the driver installation you may see a Windows Logo testing warning if you skipped the steps in *Section 4.3.1, Windows Driver Signing* on *page 70*. Our USB drivers are compatible with Microsoft Windows operating systems. Click *Continue Anyway* if the following warning appears:



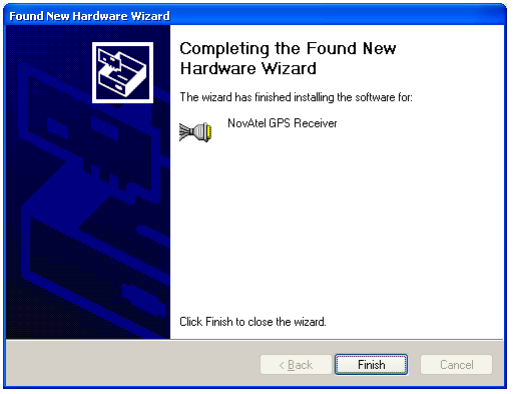
2. Select *Install from a list or specific location (Advanced)* then click *Next*.



3. Clear *Search removable media*, select *Include this location in the search:*, browse to the USB driver install directory on the supplied OEM6 family CD, then click *Next*.



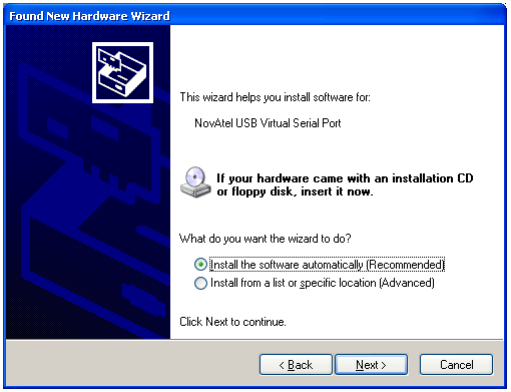
4. Click *Finish* to complete the driver installation.



After installing the NovAtel USB driver, Windows detects the OEM6 family receiver's new virtual COM ports and begins to initialize them. As each port is detected, the *Found New Hardware* wizard appears.

Complete the following steps for each port:

1. Select *Install the software automatically (recommended)* then click *Next*.



2. Click *Finish*.

The installation is complete when no more dialogs appear. The new COM ports corresponding to the receiver's USB1, USB2, and USB3 ports are numbered sequentially following the existing ports in the PC, and are ready to use with any existing application that communicates with the receiver's COM ports.

COM port number assignment is based on the computer's USB port. This allows you to switch receivers without Windows assigning new COM ports. If you connect the receiver to a different USB port, Windows detects the receiver's presence and assigns three new COM port numbers.

4.3.3 Windows 2000 Installation

If you are upgrading drivers, uninstall older version using NovAtel USB Configuration tool located in the Start Menu under *Program Files | OEM6 Family PC Software*.

After you connect the NovAtel GNSS receiver to a USB port on the PC, the Found New Hardware wizard appears. Click *Next*. (see the example screens and notes in *Section 4.3.2, Windows XP Installation* starting on *Page 71*).

1. Select *Search for a suitable driver for my device field* then click *Next*.
2. Select *Specify a location* then click *Next*.
3. Navigate to *USB Drivers\Install* on the supplied OEM6 family CD
4. Click *OK*.
5. Click *Next*.
6. Click *Finish* to complete the driver installation.

After installing the drivers, Windows detects the NovAtel receiver's new virtual COM ports and begins to initialize them. Installation is complete when no more dialogs appear. New COM ports, corresponding to the receiver's USB1, USB2, and USB3 ports, are numbered sequentially following the existing PC ports, and are ready to use with any existing application that communicates with the receiver's COM ports.

COM port number assignment is based on the computer's USB port. This allows you to switch receivers without Windows assigning new COM ports. If you connect the receiver to a different USB port, Windows detects the receiver's presence and assigns three new COM port numbers.

4.4 Firmware Updates and Model Upgrades

Firmware updates are firmware releases that include fixes and enhancements to the receiver functionality. Firmware updates are released occasionally on the NovAtel website as they become available. New firmware must be loaded into the receiver through one of the COM ports. After this is done, the receiver will reboot and start operating with the new firmware.

Model upgrades enable purchased receiver features. The receiver stores its firmware in non-volatile memory, which allows you to perform model upgrades without having to return the receiver to the dealer.

First, contact your local NovAtel dealer. Your dealer will assist you in selecting the upgrade option that best suits your GNSS needs. If your needs cannot be resolved with your dealer, contact NovAtel Customer Support directly.

When you call, be sure to have your receiver model number, serial number and firmware version. This information can be determined with the LOG VERSION command.

After determining the model and firmware version that would best suit your needs, you are issued an authorization code (auth-code). The auth-code is required to unlock the features on your new model type.

To upgrade to a new model with the same firmware version, you can use the AUTH command with the issued auth-code (if required), as outlined in *4.4.1, Updating or Upgrading Using the WinLoad Utility*.

To upgrade to a new model with a higher firmware version, you will need to load the new firmware into the OEM6 receiver using the WinLoad utility program. WinLoad and the update file are generally provided in a compressed file format, so you may also be given a decompression password. WinLoad and the update files can be found at *www.novatel.com* | *Support* | *Firmware/Software and Manuals* | *Product Updates* | *PC Utilities*.

Your local NovAtel dealer can provide you with all the information that you need to upgrade or update your receiver.

Performing updates without direct access to the serial COM ports of the OEM6 card or a way of multiplexing the COM port is an unreliable method and is not recommended.

4.4.1 Updating or Upgrading Using the WinLoad Utility

WinLoad is the simplest and most common way to update or upgrade your OEM6 card. You can upgrade to a new model and a new firmware in the same WinLoad session if you have the required auth-code.

When WinLoad is installed and running, you can select a host PC serial port, bit rate, directory path and file name for the new firmware to be transferred to the OEM6 family receiver via its COM1, COM2 or COM3 port. The port chosen must have an RS-232 interface to the computer.

Transferring Firmware Files

To proceed with the update, you must obtain the latest version of firmware from the NovAtel website at *www.novatel.com* | *Support* | *Firmware/Software and Manuals*.

The firmware update file will be one of two types:

- Update (UPDT) version - The update version includes the authorization codes for all OEM6 receivers and receiver model upgrades purchased before the cut-off date. The update version will be named UPDTXXXX.EXE, where XXXX is the firmware version. If you purchased your receiver or model upgrade after the cut-off date[1], the authorization code will not appear in the UPDT file and you must use the OEM version instead.
- OEM version - Use the OEM version if you purchased your receiver or model upgrade after the cut-off date. When you use the OEM version, NovAtel Customer Service can generate and provide you with the required authorization code. Authorization codes are also available through the NovAtel website at *www.novatel.com* | *Support* | *Helpdesk & Solutions* | *Online Services*.

  The OEM version will be named OEMXXXX.EXE, where XXXX is the firmware version.

Update files are available from NovAtel's website at *www.novatel.com* | *Support* | *Firmware/Software and Manuals*, or via e-mail at support@novatel.ca.

For convenience, you may wish to copy the update file to a GNSS sub-directory (for example, C:\GNSS\LOADER).

1. For further information and the exact cut-off date, refer to the NovAtel website at *www.novatel.com* | *Support* | *Firmware/Software and Manuals* | *Product Updates* then the page appropriate for the OEM6.

If the firmware update file is password protected, Customer Support will provide you with the required password. After copying the file to your computer, perform the following steps to extract the files:

Syntax: [filename] [password]

where filename is the name of the compressed file (but not including the .EXE extension) and password is the password required to allow extraction.

Example: OEM060000RN0000.hex

In the above example, a dialog box prompts you to enter the password.

The self-extracting archive produces the following files:

winload.exe	WinLoad utility program
howto.txt	Instructions on how to use the WinLoad utility
whatsnew.rtf	Information on the changes made in the firmware since the last revision
x..x.hex	Firmware version upgrade file, where x..x defines the product name and release (e.g., OEM060000RN0000.hex)

The files are extracted to unzip/program files/NovAtel Inc/x.xxx Full Update Disk, where x.xxx is the firmware version.

NovAtel has an online video tutorial that explains firmware uploading at *www.novatel.com* | *Support* | *Knowledge and Learning*.

Using the WinLoad Utility

If you are opening WinLoad for the first time, you must ensure that the file and communications settings are correct.

Open a File to Download

Select *File |Open*. Navigate to the file that you want to open, as shown in *Figure 17*.

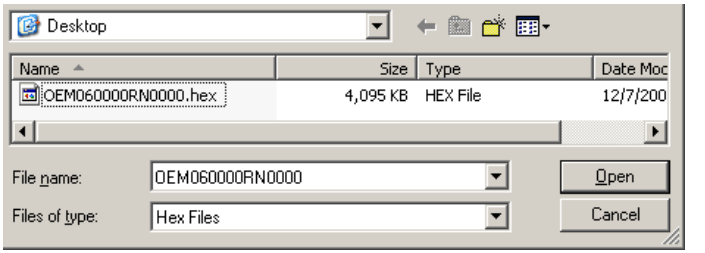


Figure 17: WinLoad's Open Dialog

When you have selected selected a file, the filename appears in the main WinLoad display area and in the title bar, as shown in *Figure 18.*

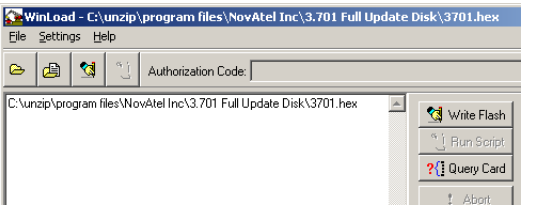


Figure 18: Open File in WinLoad

Communications Settings

To set the communications port and baud rate, select *Settings | COM Settings*. Choose the computer port to use from the *Com Port* drop-down list and the baud rate from the *Download Baudrate* drop-down list. The baud rate should be as high as possible (the default of 115200 is preferred).

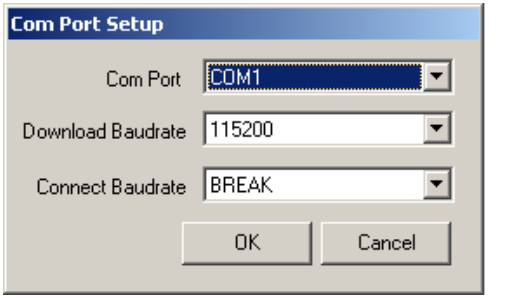


Figure 19: COM Port Setup

Downloading firmware

To download firmware:

1. Select the file to download according to *Open a File to Download* on *page 78.*
2. Ensure that the file path and name are displayed in main display area (see *Figure 18* on *page 78).*
3. Click *Write Flash* to download the firmware.
4. When *Searching for card* appears in the main display, power cycle the receiver.

Figure 20: Searching for Card

5. When the *Authorization Code* dialog opens, enter the auth-code and click *OK.* See *Section 4.4.3, Upgrading Using the AUTH Command* on *page 81* for further information about the Authorization Code.

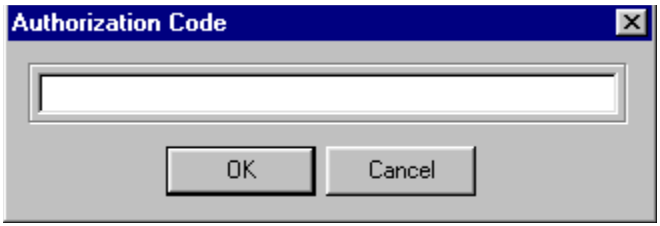


Figure 21: Authorization Code Dialog

6. The receiver finishes the download and then resets. The process is complete when *Done* appears in the main display area.

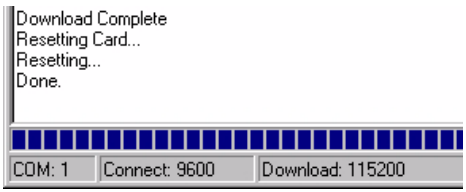


Figure 22: Upgrade Process Complete

7. Close WinLoad.

4.4.2 Updating using SoftLoad Commands

You can also use SoftLoad to update an OEM6 family receiver. SoftLoad should be used if automated loading is required or the platform used to communicate with the receiver is not supported by WinLoad.

1. Open a connection to any port on the receiver (COM, USB, Ethernet or Virtual COM port with the User API).
2. Request the SOFTLOADSTATUSA log using the following command: LOG SOFTLOADSTATUSA ONCHANGED.
3. Initialize SoftLoad with a SOFTLOADRESET command. This command stops all tracking on the receiver to ensure that sufficient memory is available for the loading process. A RXSTATUSEVENTA log reports a *SoftLoad In Progress* status.
4. Open the *.HEX firmware file.
5. Send each line of the *.HEX file to the receiver in a SOFTLOADSREC command. The S-Records must be enclosed by quotation marks: SOFTLOADSREC "<S-RECORD>"

> You can download files faster if SOFTLOADSETUP and SOFTLOADDATA binary commands are used to send the *.HEX file data rather than SOFTLOADSREC.

6. Send the SOFTLOADCOMMIT command.
7. During the loading process, SOFTLOADSTATUSA logs report the load status. You must wait for the SOFTLOADSTATUSA to indicate that loading is COMPLETE.
8. Send then new auth-code for the receiver with the following special case of the AUTH command: AUTH ADD_DOWNLOAD <auth-code>
9. Reset the receiver by RESET, FRESET or power cycling.
10. When the receiver has reset, the new version of firmware is active.

> The SoftLoad process can be cancelled safely at any time during the process using the RESET command.

4.4.3 Upgrading Using the AUTH Command

The AUTH command authorizes the enabling (unlocking) of model features. Use this command when upgrading to a new OEM6 family model that is available with the same firmware version as your current model. This command only functions in conjunction with a valid auth-code assigned by Customer Support.

The upgrade can be performed directly through the CDU command line, or from any other communications program. The procedure is as follows:

1) Power-up the OEM6 family receiver and establish communications (see *Chapter 4, Operation* on *page 55*)

2) Issue the LOG VERSION command to verify the current model, firmware version and serial number.

3) Issue the AUTH command, followed by the auth-code and model type. The syntax is as follows:

```
auth auth-code
```

where auth is a command that enables model upgrades and auth-code is the upgrade authorization code, expressed as follows:

XXXXXX,XXXXXX,XXXXXX,XXXXXX,XXXXXX,MODEL,EXPDATE

where:

1. Each X character is a case-insensitive ASCII character.
2. The MODEL string is a maximum of 15 characters long and represents the model enabled by the Auth Code.
3. The EXPDATE string is the Auth Code's expiry date, in YYMMDD format .

Example:

```
auth cndpj,zhxg4f,w3r67c,n8jjzh,xgzhxg,example
```

When the AUTH command is executed, the OEM6 family receiver reboots. Issuing the LOG VERSION command s confirm the new upgrade model type and firmware version number.

If communicating using CDU, the communication path must be closed and re-opened using the *Device* menu.

Chapter 5 Built-In Status Test

5.1 Overview

The built-in test monitors system performance and status to ensure the receiver is operating within its specifications. The test detects an exceptional condition and informs the the user through one or more indicators. The receiver status system is used to configure and monitor the indicators:

1. Receiver status word (included in the header of every message)
2. ERROR strobe signal (see *Section 2.5.1, Strobes* on *page 41*)
3. RXSTATUSEVENT log
4. RXSTATUS log
5. Status LED

In normal operation, the error strobe is driven low and the status LED on the receiver flashes green once every second. When an unusual and non-fatal event occurs (for example, there is no valid position solution), a bit is set in the receiver status word. Receiver operation continues normally, the error strobe remains off and the LED continues to flash green. When the event ends (for example, when there is a valid position solution), the bit in the receiver status word is cleared.

When a fatal event occurs (for example, a receiver hardware failure), a bit is set in the receiver error word, part of the RXSTATUS log, 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 status 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 but command and log processing continues to allow allow error diagnosis. Even if the source of the error is corrected, the receiver must be reset to resume normal operation.

These two scenarios describe factory default behavior. You can customize these behaviors to better suit an individual application. RXSTATUSEVENT logs can be disabled completely with the UNLOG command. RXSTATUSEVENT logs can be generated when a receiver status bit is set or cleared with the STATUSCONFIG SET and STATUSCONFIG CLEAR commands. Bits in the receiver status word can also be promoted to act like error bits with the STATUSCONFIG PRIORITY command.

5.2 Receiver Status Word

The receiver status word indicates the current status of the receiver. This word is found in the header of all logs and in the RXSTATUS log. In addition, the receiver status word is configurable.

You can determine the importance of the status bits with priority masks. For receiver status, setting a bit in the priority mask will cause the condition to trigger an error. The error causes the receiver to idle all channels, turn off the antenna and disable the RF hardware, just like it would if a bit in the receiver error word is set. Setting a bit in an Auxiliary Status priority mask causes the condition to set the bit in the receiver status that corresponds to the auxiliary status.a

You can use the STATUSCONFIG command configure the various status mask fields in the RXSTATUSEVENT log. You can use the masks to specify whether various status fields generate errors or event messages when they are set or cleared.

Refer to the RXSTATUS log, RXSTATUSEVENT log and STATUSCONFIG command in the *OEM6 Family Firmware Reference Manual* for more detailed descriptions of these messages.

5.3 Error Strobe Signal

The error strobe signal is one of the I/O strobes. The strobe signal driven low when the receiver is operating normally. When the receiver is in the error state and tracking is disabled, the error strobe is driven high. This can be caused by a fatal error or by an unusual receiver status indication that the user has promoted to be treated like a fatal error. Once on, the error status will remain high until the cause of the error is corrected and the receiver is reset. See also *Section 2.5.1, Strobes* on *page 41*.

5.4 RXSTATUSEVENT Log

The RXSTATUSEVENT log is used to output event messages, as indicated in the RXSTATUS log.

On start-up, the OEM6 family receiver is set to log the RXSTATUSEVENTA log ONNEW on all ports. You can remove this message with the UNLOG command.

Refer to the RXSTATUSEVENT log in the *OEM6 Family Firmware Reference Manual* for a more detailed description of this log.

5.5 RXSTATUS Log

5.5.1 Overview

The Receiver Status log (RXSTATUS) provides system status and configuration information in a series of hexadecimal words.

The status word is the third field after the header, as shown in the example in *Figure 23*.

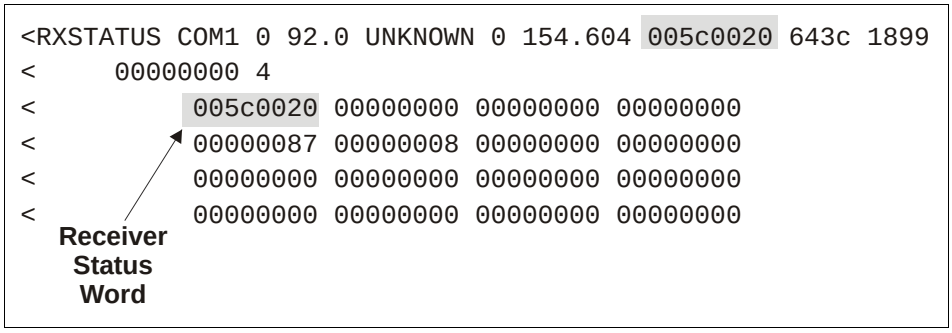


Figure 23: Location of Receiver Status Word

Each bit in the status word indicates the status of a specific receiver condition or function. If the status word is 00000000, the receiver is operating normally. The numbering of the bits is shown in *Figure 24*.

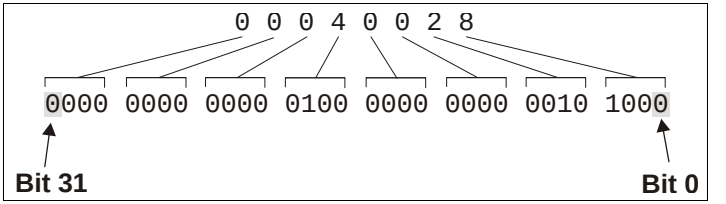


Figure 24: Reading the Bits in the Receiver Status Word

If the receiver status word indicates a problem, also see *Section 6.1, Examining the RXSTATUS Log* on *page 90*.

5.5.2 Error Word

The error field contains a 32-bit word. Each bit in the word is used to indicate an error condition. Error conditions may result in damage to the hardware or erroneous data, so the receiver is put into an error state. If any bit in the error word is set, the receiver sets the error strobe line, flashes the error code on the status LED, broadcasts the RXSTATUSEVENT log on all ports (unless the user has unlogged it), idles all channels, turns the antenna off and disables the RF hardware. The only way to get out of the error state is to reset the receiver.

You can also configure the receiver to generate event messages that are triggered by status conditions. Receiver Error words automatically generate event messages. These event messages are output in RXSTATUSEVENT logs (see also *Section 5.5.6, Set and Clear Mask for all Status Code Arrays* on *page 86*).

The error word is the first field after the log header in the RXSTATUS log, as shown in the example in *Figure 25*.

```
<RXSTATUS COM1 0 92.0 UNKNOWN 0 154.604 005c0020 643c 1899
<       00000000 4
<            005c0020 00000000 00000000 00000000
<            00000087 00000008 00000000 00000000
<            00000000 00000000 00000000 00000000
<            00000000 00000000 00000000 00000000
```

Receiver Error Word

Figure 25: Location of Receiver Error Word

Figure 26 shows an example of a receiver error word.

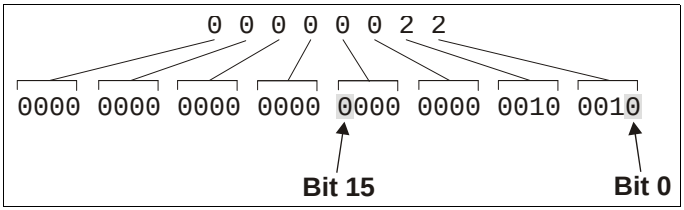


Figure 26: Reading the Bits in the Receiver Error Word

Refer to the RXSTATUS and the RXSTATUSEVENT logs in the *OEM6 Family Firmware Reference Manual* for more detailed descriptions of these logs. If the receiver error word indicates an error, See *Section 6.1, Table 9, Resolving a Receiver Error Word* on *page 90*.

5.5.3 Status Code Arrays

There are currently 4 status code arrays – the receiver status word, the auxiliary 1 status, the auxiliary 2 status and the auxiliary 3 status. Each status code array consists of four 32-bit words (the status word, a priority mask, a set mask and a clear mask). The status word is similar to the error word, with each of the 32 bits indicating a condition. The mask words are used to modify the behavior caused by a change in one of the bits in the associated status words. Each bit in any of the masks operates on the bit in the same position in the status word. For example, setting bit 3 in the priority mask changes the priority of bit 3 in the status word.

5.5.4 Receiver Status Code

The receiver status word is included in the header of all logs. It has 32 bits that indicate certain receiver conditions. If any of these conditions occur, a bit in the status word is set. Unlike the error word bits the receiver continues to operate, unless the priority mask for the bit has been set. The priority mask bit changes the receiver status word into an error bit. Anything that results from an error bit becoming active also occurs if a receiver status and its associated priority mask bits are set.

5.5.5 Auxiliary Status Codes

The auxiliary status codes are only in the RXSTATUS log. The three arrays that represent the auxiliary status codes give indication about the receiver state for information only. The events represented by these bits typically do not cause receiver performance degradation. The priority mask for the auxiliary codes does not put the receiver into an error state. Setting a bit in the auxiliary priority mask results in the corresponding bit in the receiver status code to be set if any masked auxiliary bit is set. Bit 31 of the receiver status word indicates the condition of all masked bits in the auxiliary 1 status word. Likewise, bit 30 of the receiver status word corresponds to the auxiliary 2 status word, and bit 29 to the auxiliary 3 status word.

Refer also to the RXSTATUS log in the *OEM6 Family Firmware Reference Manual* for a more detailed description of this log.

5.5.6 Set and Clear Mask for all Status Code Arrays

The other two mask words in the status code arrays operate on the associated status word in the same way. These mask words are used to configure the bits in the status word result in a RXSTATUSEVENT log broadcast. The set mask is used to turn logging on temporarily while the bit changes from the 0 to 1 state. The clear mask is used to turn logging on temporarily while the bit changes from a 1 to a 0 state. Note the error word does not have any associated mask words. Any bit set in the error word results in a RXSTATUSEVENT log broadcast (unless unlogged).

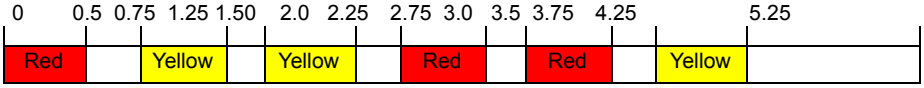
Refer also to the RXSTATUSEVENT log in the *OEM6 Family Firmware Reference Manual* for a more detailed description.

5.6 Status LED

The diagnostic LED provided on the OEM6 family cards blinks green on and off approximately once per second to indicate normal operation.

Error bits and status bits that have been priority masked as errors cause the LED to flash a code in a binary sequence. The binary sequence is a six flash (0.5 second on and 0.25 second off per flash) sequence followed by a one second delay. The sequence repeats indefinitely. If there are more than one error or status present, the lowest number appears as the flash code output. The codes are ordered to have the highest priority condition output first.

The first flash in the six flash sequence indicates if the code that follows is an error bit or a status bit. Error bits will flash red and status bits flash yellow. The next five flashes are the binary number of the code (most significant bit first). A red flash indicates a one and a yellow flash indicates a zero. For example, for an error bit six, the binary number is 00110 so the output sequence is:



followed by a one second delay. The sequence repeats indefinitely until the receiver is reset.

In the example on *page 86*, the first flash in the sequence is red, meaning that a bit is set in the receiver error word. The next five flashes give a binary value of 00111. Converting this value to decimal results in a value of seven. Therefore, bit seven of the receiver error word is set, indicating that there is a problem with the supply voltage of the receiver's power circuitry.

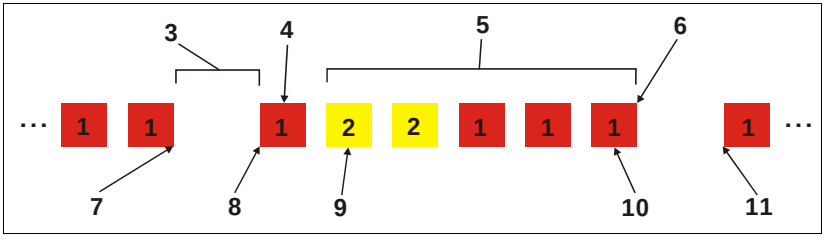


Figure 27: Status LED Flash Sequence Example

Reference	Description

1	Red
2	Yellow
3	1 Second Pause
4	Word Identifier Flash
5	Bit Identifier Flashes
6	End of Sequence
7	End of Previous Sequence
8	Beginning of Sequence
9	Most Significant Bit of Binary Value
10	Least Significant Bit of Binary Value
11	Start of Next Sequence

Refer to the RXSTATUS log and associated tables in *OEM6 Family Firmware Reference Manual* for more information about this log and receiver error status.

Chapter 6 Troubleshooting

When your receiver appears not to be working properly, there are often simple ways to diagnose and resolve the problem. In many cases, the issue can be resolved within a few minutes, avoiding the inconvenience and loss of productivity that results from having to return your receiver for repair. This chapter is designed to assist you in troubleshooting problems and includes cross-references to sections of the manual that may provide resolution information.

If you are unsure of the symptoms or if the symptoms do not match any of those listed, use the RXSTATUS log to check the receiver status and error words. See *Section 6.1, Examining the RXSTATUS Log, page 90*.

Try to resolve the problem using the troubleshooting guide in *Table 8*, then try our Knowledge Base at www.novatel.com | *Support* | *Helpdesk & Solutions* | *Search Known Solutions*. If you are still not able to resolve the problem, contact NovAtel Customer Support, as shown on *page 20*.

Table 8: Troubleshooting Based on Symptoms

Symptom	Related Section
The receiver is not properly powered	Check and replace a faulty power cable. See *Section 2.3.3, Power Supply Requirements, page 31*,
The receiver cannot establish communication	Check and replace faulty serial cables and ports. See *Section 2.5.3, CAN Bus, page 43* and *Section 5.6, Status LED, page 86*. Refer also to the COMCONFIG log in the *OEM6 Family Firmware Reference Manual*.
The receiver is not tracking satellites	Ensure that you have an unobstructed view of the sky from horizon to horizon. Check the RXSTATUS error states. See *Section 6.1, Examining the RXSTATUS Log, page 90*. If the receiver is in error mode, it will not track anything. Check for and replace a faulty antenna cable. See *Section 2.3.1, Selecting a GNSS Antenna, page 28*, *Section 2.3.2, Choosing a Coaxial Cable, page 30*, *Section 2.4.3, Connecting the Antenna to the Receiver, page 36*, *Section 2.5.6, Antenna LNA Power, page 44* and refer to the *Time to First Fix* and *Satellite Acquisition* descriptions in the *Glossary of Terms* on our website at www.novatel.com through *Support*	*Knowledge and Learning*.

Continued on the following page

Symptom	Related Section

No data is being logged	See *Section 2.5.3, CAN Bus, page 43*, and *Section 3.1, Communications with the Receiver, page 47*.
Random data is being output by the receiver, or binary data is streaming	Check the baud rate on the receiver and in the communication software. Refer to the SERIALCONFIG log and FRESET command in the *OEM6 Family Firmware Manual*. See also *Section 2.5.3, CAN Bus, page 43*.
A command is not accepted by the receiver	Check for correct spelling and command syntax. See *Section 3.1, Communications with the Receiver, page 47* and refer to the FRESET command in the *OEM6 Family Firmware Reference Manual*.
Differential mode is not working properly	See *Section 3.3, Transmitting and Receiving Corrections, page 49* and refer to the COMCONFIG log in the *OEM6 Family Firmware Reference Manual*.
There appears to be a problem with the receiver's memory	Refer to the NVMRESTORE command in the *OEM6 Family Firmware Reference Manual*.
An environmental or memory failure. The receiver temperature is out of acceptable range or the internal thermometer is not working	See the ENVIRONMENTAL sections in the tables of *Appendix B, Technical Specifications* starting on *page 97.* Move the receiver to within an acceptable temperature range or increase the baud rate.
Overload and overrun problems. Either the CPU or port buffers are overloaded	Reduce the amount of logging or reduce the baud rate. See also *Section 3.1.1, Serial Port Default Settings, page 47*.
The receiver is indicating that an invalid authorization code has been used	Refer to the Version log, VALIDMODELS log and the MODEL command in the *OEM6 Family Firmware Reference Manual*.
The receiver is being affected by jamming	Move the receiver away from any possible jamming sources.
The receiver's automatic gain control (AGC) is not working properly	See *Section 2.3.2, Choosing a Coaxial Cable, page 30* and the jamming symptom in this table.

6.1 Examining the RXSTATUS Log

The RXSTATUS log provides detailed status information about your receiver and can be used to diagnose problems. Refer to the *OEM6 Firmware Reference Manual* for details on this log and on how to read the receiver error word and status word. *Tables 9 and 10 on pages 90 to 92* give you actions to take when your receiver has an error flag in either of these words. If you are not able to resolve the condition, contact NovAtel Customer Support as described on *page 20*.

Table 9: Resolving a Receiver Error Word

Bit Set	Action to Resolve
0-2	Issue a FRESET command
4	Contact Customer Support as described on *page 20*
5	Check the VERSION log. The VERSION log will indicate "Invalid authcode". Update the auth-code as described in *Section 4.4.3, Upgrading Using the AUTH Command, page 81*.
6	Issue a FRESET command
7	See *Section 2.3.3, Power Supply Requirements, page 31*
8	This is the thermometer error bit, indicating a possible hardware or environmental condition. If you cannot resolve, contact Customer Support.
9	Check temperature ranges in the ENVIRONMENTAL table sections of *Appendix B, OEM628 Technical Specifications, starting on page 97*
10-14	Possible hardware or environmental condition. If you cannot resolve the problem, contact Customer Support as described on *page 20.*
15	Issue a FRESET command and power cycle the unit. If the bit is still present, contact Customer Support.
16	Monitor CPU idle time. Reduce number of logs or the rate of data logging.
17	Ensure that the version log is consistent with the hardware.
20	SoftLoad is in progress. See *Section 4.4.2, Updating using SoftLoad Commands, page 80*.
21	You may be exceeding the receiver's velocity limit. If so, reduce velocity. This error can only be cleared by resetting the receiver.
22	Reload firmware using WinLoad or the SoftLoad commands.
31	Possible hardware failure. Contact Customer Support.

Table 10: Resolving an Error in the Receiver Status Word

Bit Set	Action to Resolve
0	Check the Error Word in the RXSTATUS log. See also *Table 9, Resolving a Receiver Error Word* on *page 90.*
1	Check temperature ranges in the ENVIRONMENTAL table sections of *Appendix A, Technical Specifications* starting on *page 105.*
2	See *Section 3.1.3, Power Supply Requirements, page 38*.
3	See *Section 2.3.1, Selecting a GNSS Antenna, page 28*, *Section 2.3.2, Choosing a Coaxial Cable, page 30*, *Section 2.4.3, Connecting the Antenna to the Receiver, page 36*, *Section 2.5.6, Antenna LNA Power, page 44*, and refer to the *Time to First Fix* and *Satellite Acquisition* descriptions in the *Glossary of Terms* on our website at www.novatel.com through *Support* | *Knowledge and Learning*.
4	
5	
6	
7	Check the CPU idle time. Check for unnecessary logging. Check for simultaneous use of functionality, for example, API and RTK.
8	See *Section 3.1.1, Serial Port Default Settings, page 47*.
9	
10	
11	
15	See *Section 2.3.2, Choosing a Coaxial Cable, page 30* and move the receiver away from any possible jamming sources. If still a problem contact Customer Support.
17	See *Section 2.3.2, Choosing a Coaxial Cable, page 30* and move the receiver away from any possible jamming sources.
18	When the receiver has tracked GNSS satellites long enough for a valid almanac to be received, this bit will be set to 0. Also, refer to the *Time to First Fix* and *Satellite Acquisition* descriptions n the *Glossary of Terms* at *www.novatel.com* | *Support* | *Knowledge and Learning*.
19	None. This bit only indicates if the receiver has calculated a position. Refer to the *Time to First Fix* and *Satellite Acquisition* descriptions n the *Glossary of Terms* at *www.novatel.com* | *Support* | *Knowledge and Learning*.
20	None. This bit is a status bit indicating if the receiver's position has been manually fixed and does not represent a problem. Refer also to the FIX command in the *OEM6 Family Firmware Reference Manual*.

Continued on the following page

Bit Set	Action to Resolve
21	None. This bit indicates if clock steering has been manually disabled. Refer also to the FRESET command in the *OEM6 Family Firmware Reference Manual*.
22	None. This bit only indicates if the clock model is valid. Refer also to the FRESET command in the *OEM6 Family Firmware Reference Manual*.
23	None. This bit indicates if the phase-lock-loop is locked when using an external oscillator. Refer also to the FRESET command in the *OEM6 Family Firmware Reference Manual*.
24	Check the CPU idle time. Check for unnecessary logging. Check for simultaneous use of functionality, for example, API and RTK.
29	None. This bit indicates if any bits in the auxiliary 3 status word are set. The auxiliary 3 word provides status information and does not contain any new information on problems. Refer also to the FRESET command in the *OEM6 Family Firmware Reference Manual*.
30	None. This bit indicates if any bits in the auxiliary 2 status word are set. The auxiliary 2 word provides status information and does not contain any new information on problems. Refer also to the FRESET command in the *OEM6 Family Firmware Reference Manual*.
31	None. This bit indicates if any bits in the auxiliary 1 status word are set. The auxiliary 1 word provides status information and does not contain any new information on problems. Refer also to the FRESET command in the *OEM6 Family Firmware Reference Manual*.

6.2 Examining the AUX1 Status Word

Table 11 provides actions to take when your receiver has an error flag in the AUX1 status word. If you are not able to resolve the condition, contact NovAtel Customer Support as described on *page 20*.

Table 11: Resolving an Error in the AUX1 Status Word

Bit Set	Action to Resolve
0-2	(Reserved bits)
3	None. This bit indicates that Position Averaging is ON.
4-6	(Reserved bits)
7	Connect the receiver via USB.
8-10	Reduce the amount of logging on the USB ports.
11-13	(Reserved bits)
14-17	AGC error on RF1 through RF4 respectively. To resolve, ensure antenna cable is connected and signal input level is within specification.
18	Connect the receiver via Ethernet. See *Section 2.5.7 Ethernet on page 45*.
19-21	Reduce the amount of logging on the Ethernet ports.
22-24	Reduce the amount of logging on the NTRIP ports.
25-27	Reduce the amount of logging on the Virtual COM ports.
28-31	(Reserved bits)

Appendix A Electrostatic Discharge Control (ESD) Practices

A.1 Overview

Static electricity is electrical charge stored in an electromagnetic field or on an insulating body. This charge can flow as soon as a low-impedance path to ground is established. Static-sensitive units can be permanently damaged by static discharge potentials of as little as 40 volts. Charges carried by the human body, which can be thousands of times higher than this 40 V threshold, can accumulate through as simple a mechanism as walking across non-conducting floor coverings such as carpet or tile. These charges may be stored on clothing, especially when the ambient air is dry, through friction between the body and/or various clothing layers. Synthetic materials accumulate higher charges than natural fibers. Electrostatic voltage levels on insulators 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 printed circuit boards (PCBs) assembled with these devices.

A.2 Handling ESD-Sensitive Devices

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

- Handling areas must be equipped with a grounded table, floor mats, and wrist strap.
- 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-controlled location.
- A static-controlled 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 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 a static shielding bag or clamshell before being removed from the work location and must remain in the clamshell until it arrives at a static-controlled repair/test center.
- Circuit boards must not be changed or moved needlessly. Handles may be provided on circuit boards for use in their removal and replacement; care should be 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 (for example, 3M Kit #8501 or #8507). This consists of a portable mat and wrist strap which must be attached to a suitable ground.
- 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-controlled area such as a grounded or dissipative bench top or repair zone. Do not place anything else inside the bag (for example, repair tags).
- Treat all PCBs and components as ESD sensitive. Assume that you will damage the PCB or component if you are not ESD conscious.
- Do not use torn or punctured static-shielding bags. A wire tag protruding through the bag could act as a "lightning rod", funneling the entire charge into the components inside the bag.
- Do not allow chargeable plastics, such as binders, within 0.6 m of unshielded PCBs.
- Do not allow a PCB to come within 0.3 m of a computer monitor.

A.3 Prime Static Accumulators

Table 12 provides some background information on static-accumulating materials.

Table 12: Static-Accumulating Materials

Work Surfaces	• formica (waxed or highly resistive) • finished wood • synthetic mats • writing materials, note pads, and so on
Floors	• wax-finished • vinyl
Clothes	• common cleanroom smocks • personal garments (all textiles) • non-conductive shoes
Chairs	• finished wood • vinyl • fiberglass
Packing and handling	• common polyethylene bags, wraps, envelopes, and bubble pack • pack foam • common plastic trays and tote boxes
Assembly, cleaning, and repair areas	• spray cleaners • common solder sucker • common soldering irons • common solvent brushes (synthetic bristles) • cleaning, drying and temperature chambers

A.4 Handling Printed Circuit Boards

ESD damage to unprotected sensitive devices may occur at any time. ESD events can occur far below the threshold of human sensitivity. Follow this sequence 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-controlled surface (grounded floor or table mat).
2. Remove the replacement circuit board from the static-shielding bag or clamshell and insert it into the equipment.
3. Place the original board into the shielding bag or clamshell and seal it with a label.
4. Do not put repair tags inside the shielding bag or clamshell.
5. Disconnect the wrist strap.

Appendix B OEM628 Technical Specifications

B.1 OEM628 Receiver

PERFORMANCE *(Subject To GPS System Characteristics)*

Position Accuracy [a]

Standalone:

L1 only	1.5 m RMS
L1/L2	1.2 m RMS
SBAS [b]	0.6 m RMS
DGPS	0.4 m RMS
OmniSTAR:	
VBS	0.6 m RMS
XP	0.15 m RMS
HP	0.1 m RMS
RT-20®	0.2 m RMS
RT-2™	1 cm + 1 ppm RMS

Time To First Fix

Hot: 35 s (Almanac and recent ephemeris saved and approximate position and time entered)
Cold: Less than 50 s (No almanac or ephemeris and no approximate position or time)

Reacquisition

0.5 s L1 (typical)
1.0 s L2 (typical)

Data Rates

Measurements:	100 Hz
Position:	100 Hz

Time Accuracy [a c]

20 ns RMS

Velocity Accuracy [a]

0.03 m/s RMS

Measurement Precision

	GPS		GLO	
	Code	Carrier	Code	Carrier
L1 C/A	4 cm	0.5 mm	8 cm	1.0 mm
L2 P(Y) (see note 1)	8 cm	1.0 mm	8 cm	1.0 mm
L2 C (see note 2)	8 mm	0.5 mm	8 cm	1.0 mm
L5	3 cm	0.5 mm	-	-

Notes:
1. L2 P for GLONASS
2. L2 C/A for GLONASS

Dynamics

Velocity	499 m/s [d]

a. Typical values. All position and velocity RMS values are based on Horizontal position accuracy. Performance specifications are subject to GPS system characteristics, U.S. DOD operational degradation, ionospheric and tropospheric conditions, satellite geometry, baseline length and multipath effects.
b. GPS-only
c. Time accuracy does not include biases due to RF or antenna delay.
d. In accordance with export licensing.

B.1.1 Physical Description

PHYSICAL	
Size	60 mm x 100 mm x 9.11 mm
Weight	37 grams
NOVATEL PART NUMBER	
Generic Assembly OEM628	01018410
MECHANICAL DRAWINGS	

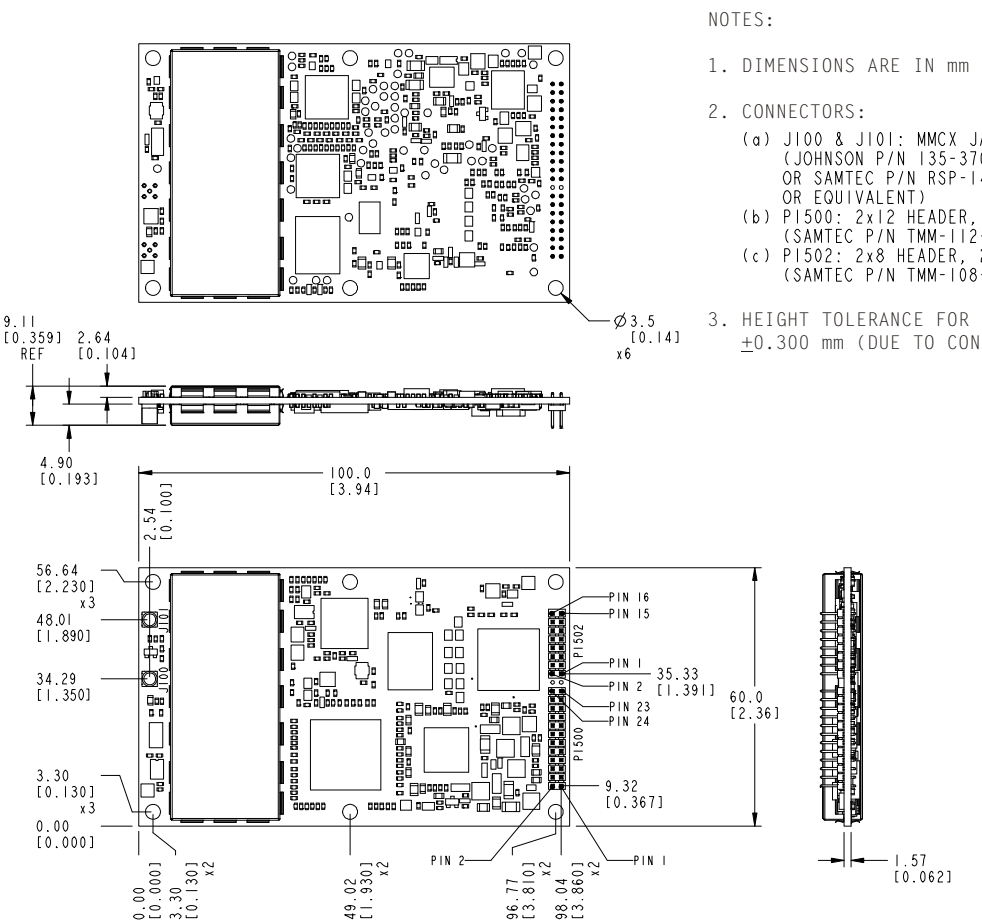
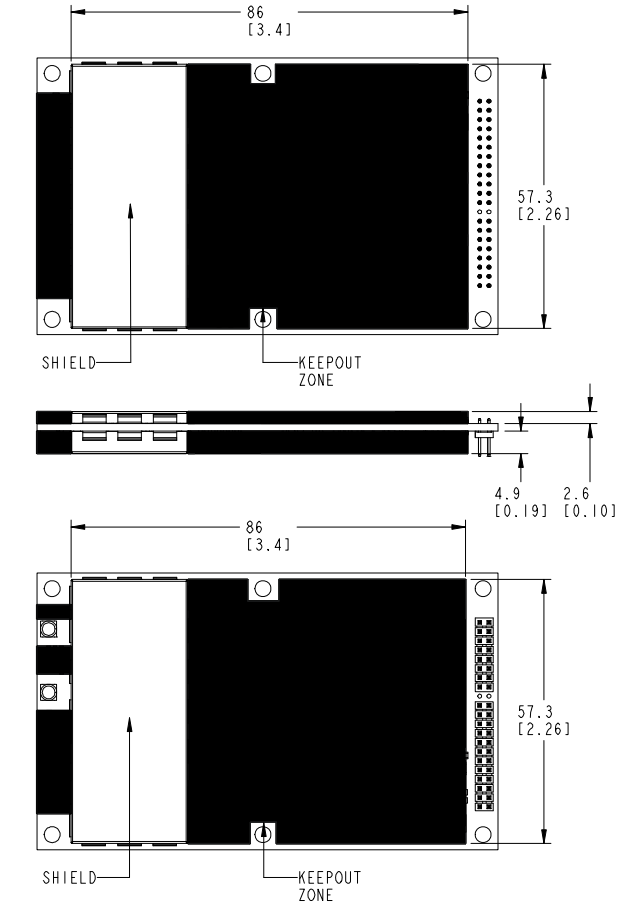


Figure 28: OEM628 Board Dimensions



NOTE:

1. RECOMMENDED "KEEPOUT" AREAS ARE INTENDED FOR NOVATEL CIRCUITRY.

   NOVATEL RESERVES THE RIGHT TO MODIFY COMPONENTS AND COMPONENT PLACEMENTS INSIDE SHADED KEEPOUT ZONES, WHILE MAINTAINING DESIGN FORM, FIT, AND FUNCTION.

Figure 29: OEM628 Keep-Out Zone

ENVIRONMENTAL	
Operating Temperature	-40°C to +85°C
Storage Temperature	-40°C to +85°C
Humidity	95% noncondensing
Random Vibe	MIL-STD 810G (category 24, 7.7 g RMS)
Sine Vibe	IEC60068-2-6
Bump	ISO 9022-31-06 (25g)

Shock	MIL-STD-810G (40g) The OEM628 undergoes additional NovAtel non-operate shock testing to 1000g/1ms

Continued on the following page

POWER REQUIREMENTS	
Voltage	+3.3 v DC ±5%
Allowable Input Voltage Ripple	100 mV p-p maximum
Power Consumption	1.3 W typical, GPS L1/L2 1.5 W typical, GPS/GLONASS L1/L2 1.81 W typical, GPS L1/L2/L5, GLONASS L1/L2, (without L-band) 1.84 W typical, GPS L1/L2, GLONASS L1/L2 (with L-band) 1.9 W typical, all on (without L-band) ✉ These power consumption values assume that Ethernet is disabled. Ethernet draws approximately 220 mw. If you require a reduced power consumption, turn off the Ethernet port as outlined in application note *APN-057*, available at www.novatel.com | *Support* | *Knowledge and Learning*, and commands described in the *OEM6 Family Firmware Reference Guide*. ✉ The above values can change with the number of satellites in view and the firmware version. Use them as a guide for what you might expect but not as absolute values.
In-Rush Power Consumption	6.6 A for less than 60 µs (typical)
RF INPUT / LNA POWER OUTPUT	
Antenna Connector	MMCX female, 50 Ω nominal impedance (See *Figure 28* on *page 98*)
Acceptable RF Input Level	L1: -122 to -87 (signal) dBm, -161 to -141 (noise) dBm/Hz L2: -126 to -93 (signal) dBm, -161 to -141 (noise) dBm/Hz L-band: -125 to -102 (signal) dBm, -161 to -151 (noise) dBm/Hz L5/E5: -119 to -84 (signal) dBm, -161 to -141 (noise) dBm/Hz
RF Input Frequencies	GPS L1: 1575.42 MHz GPS L2: 1227.60 MHz GPS L5: 1176.45 MHz GLONASS L1: 1593-1610 MHz GLONASS L2: 1237-1253 MHz Galileo E1 1575.42 MHz Galileo E5a 1176.45 MHz Galileo E5b 1207.14 MHz Galileo E5 1191.795 MHz OmniSTAR: 1525 to 1560 MHz
LNA Power	+5 v DC ±5%, 0-100 mA (supplied by card through centre conductor of RF connector)

Continued on the following page.

INPUT/OUTPUT DATA INTERFACE	
COM1	
Electrical format	RS232/RS422
Bit rates[a]	2400, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400, 460800 or 921600 bps. See *Section 3.1.1* on *page 47*.
Signals supported	COM1_Tx, COM1_Rx, RTS and CTS
Electrostatic discharge protection	Yes
COM2	
Electrical format	LVTTL
Bit rates[a]	2400, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400, 460800 or 921600 bps. See *Section 3.1.1* on *page 47*.
Signals supported	COM2_Tx, COM2_Rx, RTS and CTS
Electrostatic discharge protection	No
COM3	
Electrical format	LVTTL [b c]
Bit rates[a]	2400, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400, 460800 or 921600 bps. See *Section 3.1.1* on *page 47*.
Signals supported	COM3_Tx and COM3_Rx
Electrostatic discharge protection	No
CAN Bus[d]	
Electrical format	LVTTL (requires external CAN transceiver)
Bit rates	1 Mbps maximum. CAN Bus throughput is determined by slowest device on the bus.
Signals supported	CAN1 and CAN2
USB	
Electrical format	Conforms to USB 2.0
Bit rates	Low (1.5 Mbps) and Full-speed (12 Mbps) USB
Signals supported	USB D (+), USB D (-)
ETHERNET	
Physical Layer	10/100BASE-T

a. 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. See *User-Selectable Port Configuration* on *page 38* for details
b. Upon power-up, COM3 is enabled by default. COM3 is multiplexed with Event 2 and GPIOH(0)
c. To enable EVENT2, issue the following commands:
```
interfacemode com3 none none
markcontrol mark2 enable
```
d. CAN Bus behavior must be asserted through the NovAtel API software. See *Section 2.5.3, CAN Bus* on *page 43* for further details. See also *Figure 30* on *page 105*

Table 13: OEM628 Strobes

Strobes	Default Behavior	Input/ Output	Factory Default	Comment [a]
Event1	Dedicated pin	Input Leading edge triggered	Active low	An input mark for which a pulse greater than 150 ns triggers certain logs to be generated. (Refer to the MARKPOS and MARKTIME logs and ONMARK trigger.) Polarity is configurable using the MARKCONTROL command. The mark inputs have 10K pull-up resistors to 3.3 V
Event2 (Mark 2)	Multiplexed pin	Input Leading edge triggered	Active low	An input mark for which a pulse greater than 150 ns triggers certain logs to be generated. (Refer to the MARK2POS and MARK2TIME logs.) Polarity is configurable using the MARKCONTROL command. The mark inputs have 10K pull-up resistors to 3.3 V.
PV (Position Valid)	Dedicated pin	Output	Active high	Indicates a valid GNSS position solution is available. A high level indicates a valid solution or that the FIX POSITION command has been set (refer to the FIX POSITION command). VDD is 3.3V.
VARF (Variable Frequency)	Dedicated pin	Output	Active low	A programmable variable frequency output ranging from 0 – 5 MHz (refer to the FREQUENCYOUT command).
RESETIN	Dedicated pin	Input	Active low	Reset LVTTL signal input from external system; active low, > 20 µs duration
PPS	Dedicated pin	Output	Active low	A time synchronization output. This is a pulse where the leading edge is synchronized to receiver-calculated GNSS Time. The polarity, period and pulse width can be configured using PPSCONTROL command.

a. The commands and logs shown in capital letters (for example, MARKCONTROL) are discussed in further detail in the *OEM6 Family Firmware Reference Manual*.

Table 14: OEM628 Strobe Electrical Specifications

Strobe	Sym	Min (V)	Typ (V)	Max (V)	Current (mA)	Conditions
Event1 (Mark 1) Event2 (Mark2) PPS	V_{IL}			0.8		VCC = 2.7 V; 85°C
	V_{IH}	2.0				VCC = 2.7 V; 85°C
PV VARF	V_{OL}			0.4	24	VCC = 2.7 V; 85°C
	V_{OH}	3.0			24	VCC = 2.7V; 85°C
RESETIN	V_{IL}			0.8		VCC = 2.7 V; 85°C
	V_{IH}	2.3				VCC = 2.7 V; 85°C

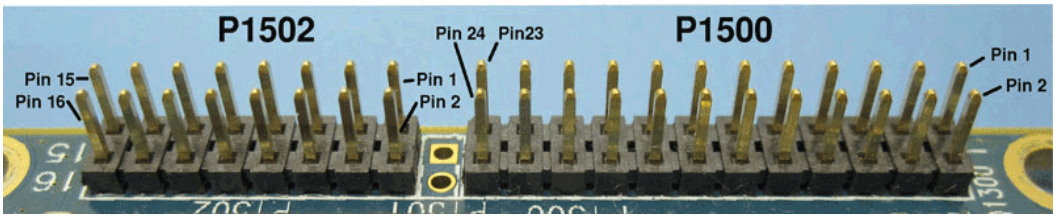


Figure 30: Top-view, P1500 Main Connector 24-Pin Header

Pin	Signal	Type	Description	Comments
1	GND	GND	Ground Reference	–
2	USER1[a]	Input/Output	General Purpose I/O	2.7 V CMOS levels, 4 mA drive (3.3 V compatible)
3	VARF	Output	Variable Frequency	2.7 V CMOS levels, 4 mA drive (3.3 V compatible)
4	PPS	Output	Time Mark Output	2.7 V CMOS levels, 4 mA drive (3.3 V compatible)
5	VCC	PWR	+3.3 V Supply Voltage	+/- 5%
6	VCC	PWR	+3.3 V Supply Voltage	+/- 5%
7	RXD3/EVENT2[b]	Input	External Event 2/COM3 Receive Data	2.7 V CMOS levels (3.3 v compatible)
8	EVENT1	Input	External Event 1	2.7 V CMOS levels (3.3 v compatible)
9	ERROR	Output	Error Detected	2.7 V CMOS levels, 4 mA drive (3.3 V compatible)
10	PVALID	Output	Position Valid	2.7 V CMOS levels, 4 mA drive (3.3 V compatible)
11	CTS2	Input	COM2 Clear to Send	2.7 V CMOS levels (3.3 V compatible)
12	RESETIN	Input	Hardware Reset	Internally pulled up. Active low reset – hold below 0.8 V for a minimum of 50 milliseconds
13	RTS2	Output	COM2 Request to Send	2.7 V CMOS levels, 4 mA drive (3.3 V compatible)
14	RXD2	Input	COM2 Receive Data	2.7 V CMOS levels (3.3 V compatible)
15	CTS1/RXD1-	Input	COM1 Clear to Send (RS-232)/ COM1 Receive Data- (RS-422)	CTS1: RS232 levels (+/-25 V tolerant) RXD1-: RS422 levels (2 V differential typical)
16	TXD2	Output	COM2 Transmit Data	2.7 V CMOS levels, 4 mA drive (3.3 V compatible)
17	RTS1/TXD1-	Output	COM1 Request to Send (RS-232)/ COM1 Transmit Data- (RS-422)	RTS1: RS232 levels (+/- 5.4 V typical) TXD1-: RS422 levels (2 V differential typical)

18	RXD1/RXD1+	Input	COM1 Receive Data (RS-232)/ COM1 Receive Data+ (RS-422)	RXD1: RS232 levels (+/- 25 V tolerant) RXD1+: RS422 levels (2 V differential typical)
19	TXD3/USER2	Input/Output	General Purpose I/O/COM3 Transmit Data	2.7 V CMOS levels, 4 mA drive (3.3 V compatible)
20	TXD1/TXD1+	Output	COM1 Transmit Data (RS-232)/ COM1 Transmit Data+ (RS-422)	TXD1: RS232 levels (+/- 25 V tolerant) TXD1+: RS422 levels (2 V differential typical)
21	D-	Input/Output	USB D-	90Ω differential pair, 5 V tolerant
22	D+	Input/Output	USB D+	
23	GND	GND	Ground Reference	–
24	GND	GND	Ground Reference	–

a. On power up, if pin 2 is set LOW or not connected, COM1 will be configured as RS-232. If pin 2 is set high then COM1 will be configured as RS-422, as described in *User-Selectable Port Configuration* on *page 38*.

b. Through firmware, COM3 RS-232 can be configured on pins 7 and 19. See table footnote "c" on *page 102* and the appropriate section of the *OEM6 Family Firmware Reference Manual.*

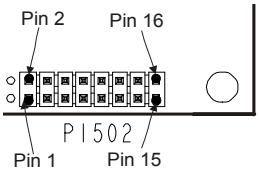


Figure 31: Top-view, P1502 Expansion 16-Pin Header

Pin	Signal	Type	Description
1	ETH_RD-	Input	Ethernet Rx-
2	ETH_RD+	Input	Ethernet Rx+
3	3V3 (for Ethernet magnetics centre tap)	Output	Rx centre tap power for Ethernet magnetics
4	ETH_TD+	Output	Ethernet Tx+
5	ETH_TD-	Output	Ethernet Tx-
6	3V3 (for Ethernet magnetics centre tap)	Output	Tx centre tap power for Ethernet magnetics
7	LED_A	Output	Ethernet Status (activity)
8	LED_B	Output	Ethernet Status (link)
9	GND	REF	GND
10	CAN1+	Input/Output	CAN1+
11	CAN1-	Input/Output	CAN1-
12	CAN2+	Input/Output	CAN2+
13	CAN2-	Input/Output	CAN2-
14	Reserved		
15	Reserved		
16	GND	REF	GND

B.1.2 CMOS Level I/O

The OEM628 provides a number of 2.7V (3.3V-compatible) CMOS-level I/O pins for status indication and timing. These I/O include:

- PPS: Pulse-Per-Second (software configurable to other rates)
- VARF: Variable Frequency (a software-configurable clock output)
- ERROR: Error indication
- PV: Position Valid (used to indicate when the receiver has calculated a valid position)
- EVENT1 and EVENT2: Event inputs (active high by default with configurable polarity)
- USERIO1 and USERIO2: User GPIO (available through NovAtel's UserApp API)

These I/O require additional ESD protection if they are routed to connectors. Some users may require additional drive strength on the PPS signal. The figure below shows a suitable buffer that may be used. R103 in the schematic may be used to limit the drive strength of the PPS output if required. This buffer has a propagation delay of approximately 5 – 6 nanoseconds.

The same ESD protection circuit shown below should be used on any OEM628 CMOS-level signal that will be routed to an enclosure connector. The ferrite bead and small-value capacitor provide some immunity to electrostatic discharge events, but also serve to reduce radiated and conducted emissions from the enclosure.

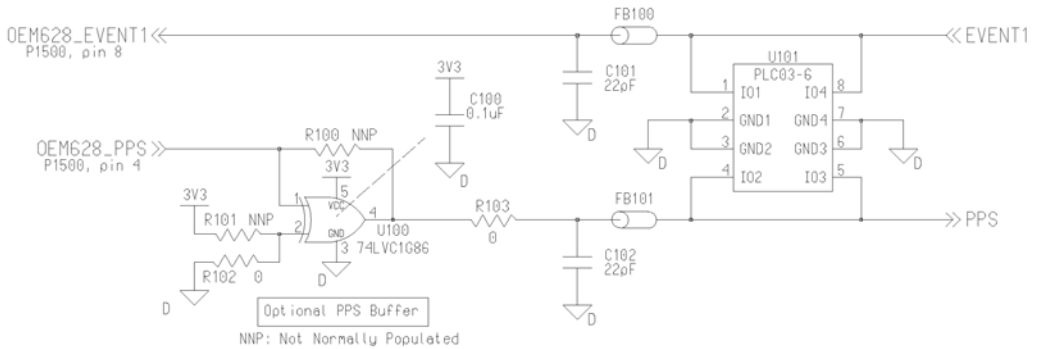


Figure 32: ESD protection for EVENT and PPS strobes

Table 15: Bill of Materials (critical components)

Designator	Manufacturer	Manufacturer part number
FFB100, FB101	TDK	MMZ1005B800C
U100	Texas Instruments	SN74LVC1G86DCK
U101	Semtech Bourns OnSemi	LC03-6.TBT CDNBS08-PLC03-6 LC03-6R2G
C101, C102	various	(22 pF 5% 50V COG 0603)

The ERROR and PV signals are generally used on enclosure products to control a status LED. These signals have low drive strengths and require a buffer to drive an LED. A simple buffer circuit is shown below:

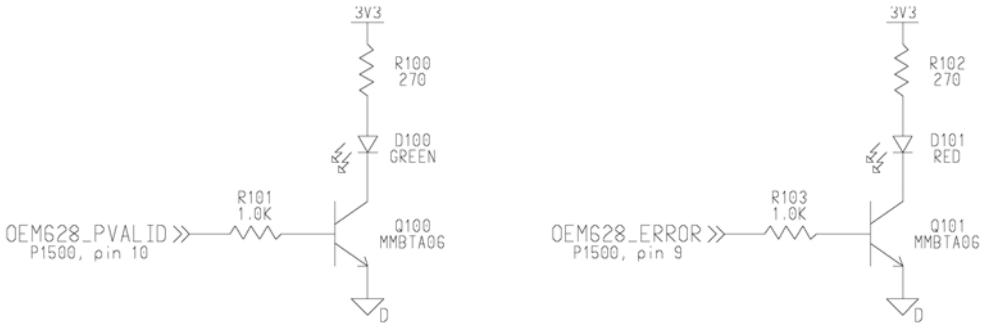


Figure 33: LED drive buffer for ERROR and PV signals

B.1.3 CAN Interface

The OEM628 provides two 2.7V (3.3V-compatible) CMOS-level CAN controller ports. An external transceiver is required. The following figure shows a typical CAN transceiver implementation.

The combination of ferrite beads and small-value capacitors are not necessarily required but may provide improved EMI performance. A low-capacitance TVS device provides ESD protection.

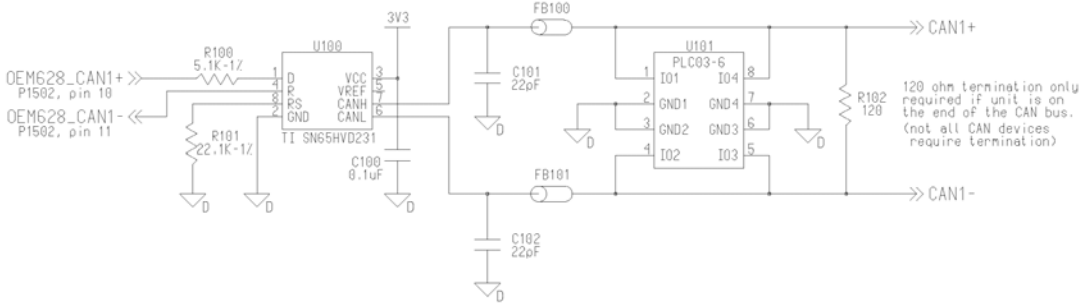


Figure 34: CAN Transceiver Implementation

Only use a 120Ω termination resistor when the CAN device is used at one end of the CAN bus. Multiple terminations along the length of the CAN bus will degrade performance for all CAN devices on that bus.

The slew rate adjustment resistor (R101) value in *Figure 34* on *page 109* sets the slew rate for applications for SAE J1939 agricultural applications. Other applications may require a different slew rate. Refer to the transceiver datasheet for more information.

Table 16: Bill of Materials (critical components)

Designator	Manufacturer	Manufacturer part number
FB100, FB101	TDK	MMZ1005B800C
U100	Texas Instruments	SN74LVC1G86DCK
U101	Semtech Bourns OnSemi	LC03-6.TBT CDNBS08-PLC03-6 LC03-6R2G
C101, C102	various	(22 pF 5% 50V COG 0603)

B.1.4 USB Interface

The OEM628 includes one USB 2.0 Full Speed (12Mbps) / Low Speed (1.5Mbps) interface.

For signal integrity and EMI reasons, route differential data traces as a 90Ω differential pair. A small-value common-mode choke (as shown in the figure below) may improve the radiated emissions performance. Small ferrite beads are shown on VBUS and UID lines as a contingency against radiated emissions.

The *OEM628_VBUS* trace should be capable of handling at least 100mA. The traces for VBUS and UID should be routed away from any high-current switching nets and high-frequency signals. The common-mode choke, ferrite beads and bypass capacitor should be placed as close as possible to the USB connector.

If the USB interface is only used as a device, the connections to OEM628 pins *VUSB* (pin 15) and *UID* (pin 14) may be omitted and a standard USB Type-B connector may be used.

Table 17: Bill of Materials (critical components)

Designator	Manufacturer	Manufacturer part number
L100	Steward / Laird	CM0805C221R-10

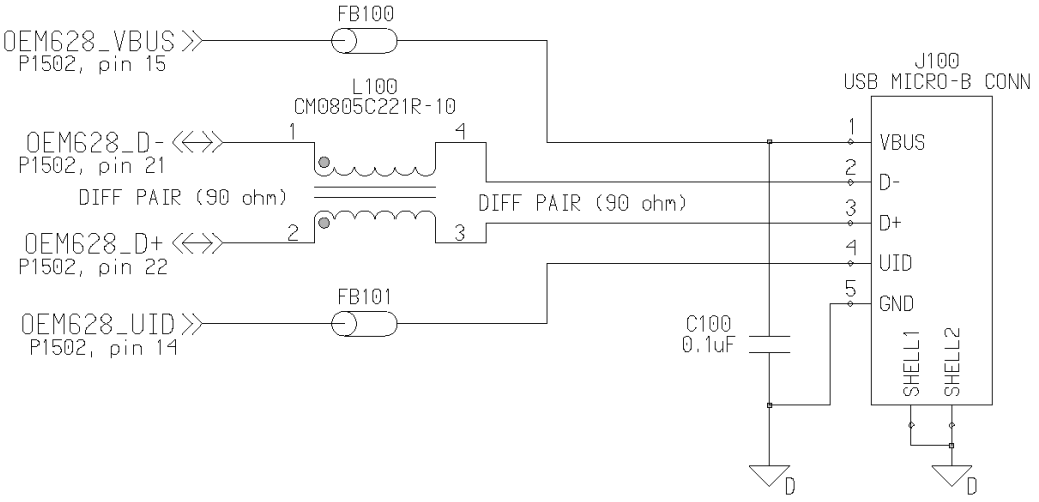


Figure 35: USB Implementation

ESD protection for the differential pair is provided by a low-capacitance TVS device located on the OEM628 card. External ESD protection for the UID and VBUS pins is required if the pins are used.

B.1.5 Ethernet Port

The OEM628 provides a 10/100 Ethernet port with auto-negotiation. The Ethernet interface is disabled by default and must be configured. See the *OEM6 Family Firmware Reference Manual* for instructions on Ethernet device configuration. The PHY layer is based on the Micrel KSZ8851 Ethernet controller.

PHY terminations are provided on the OEM628 card and a 3.3 V output is presented to bias the Ethernet magnetics. The 3.3 V power supplied by the OEM628 card is not to be used for any purposes other than biasing the Ethernet magnetics.

A reference schematic is shown below. The ferrite beads are included as an EMI de-risk contingency and may not be necessary.

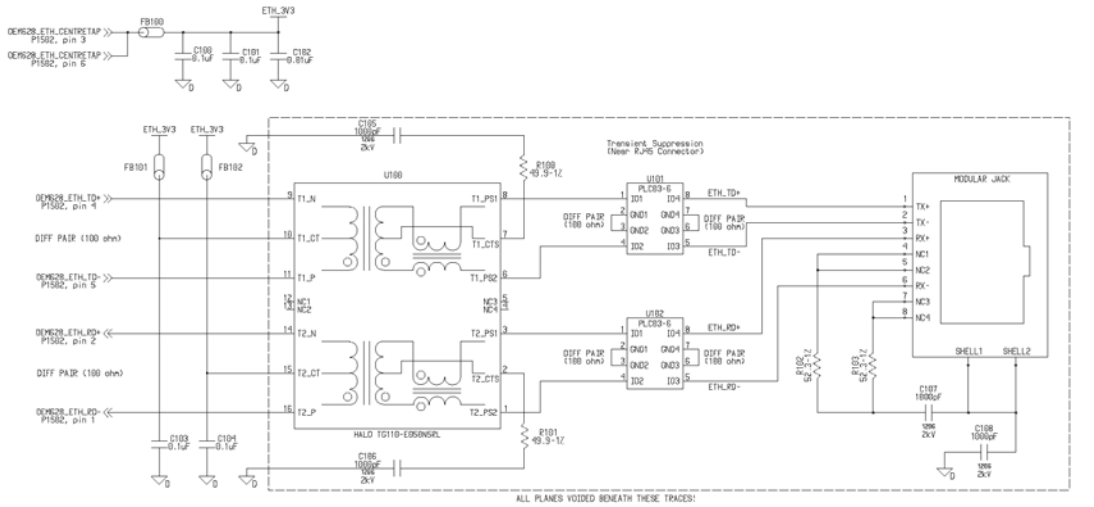


Figure 36: Ethernet reference schematic

You must provide 100Ω +/- 10% differential pairs over unbroken reference (ground) planes up to the pins on the Ethernet magnetics. Beneath and beyond the magnetics, there must be no ground plane (no copper on layers other than the traces shown here). Ensure that the Ethernet differential pairs in the voided area are also 100Ω +/- 10% (the widths/spacing are different).

The transient suppression components must be placed as close to the RJ45 jack as possible. U101 and U102 protect the OEM628 against differential-mode transients. The Ethernet magnetics provide high-voltage isolation and low-capacitance TVS devices on the OEM628 card itself protect against common-mode transients.

The spacing between receive and transmit pairs should be at least three times the width of each differential pair (both traces plus the separation distance) to minimize crosstalk. Avoid more than two layer changes (single-layer routing is best) and ensure that reference planes do not change when changing layers. If in doubt, contact your PCB vendor for appropriate dimensions for the differential pairs.

Alternately, you can use modular jacks with built-in Ethernet magnetics. In that case, you must run 100Ω differential pairs over unbroken reference planes directly to the jack. Ensure that the integrated magnetics in the jack meet the specifications in the table below. Ensure that the jack is no more than 15cm (6 inches) from the OEM6 connector. Shorter runs are better.

Keep vias on the lines to a minimum (ideally, no vias). If a layer change is required, ensure that the reference plane does not change to prevent increased radiated or conducted emissions

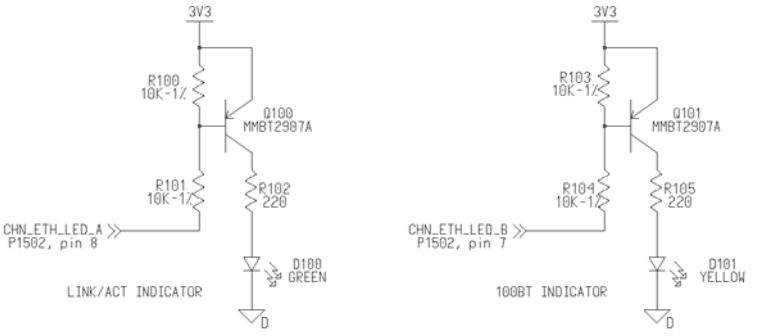
Ethernet cable type (Cat5/Cat5e/Cat6) does not affect the OEM628 emissions profile with a properly laid-out PCB. The following table gives recommended Ethernet transformer characteristics:

Parameter	Value	Test Condition
Turns ratio	1 CT : 1 CT	
Open-CCT inductance (minimum)	350 uH	100 mV, 100 kHz, 8 mA
Leakage inductance (maximum)	0.4 uH	1 MHz (minimum)
Inter-winding capacitance (minimum)	12 pF	
DC resistance (maximum)	0.9 Ω	
Insertion loss (maximum)	1.0 dB	0 MHz – 65 MHz
HIPOT (minimum)	1500 Vrms	

Table 18: Bill of Materials (critical components)

Designator	Manufacturer	Manufacturer part number
FFB100, FB101, FB102	TDK	MMZ1005B800C
U100	Halo	TG110-E050N5RL
U101, U102	Semtech Bourns OnSemi	LC03-6.TBT CDNBS08-PLC03-6 LC03-6R2G
C105, C106, C107	AVX	1206GC102KAT1A

You must buffer the OEM628 Ethernet LED control lines. The buffer structure in the figure below shows a sample LED drive circuit. Do not use the Ethernet bias 3.3V (P1502, pins 3 and 6) to drive the LEDs. The Ethernet bias should only be routed to the Ethernet magnetics.



B.2 FlexPak6

INPUT/OUTPUT CONNECTORS	
ANT	TNC female jack, 50 Ω nominal impedance +5 VDC (+5%/-5%), 100 mA max (output from FlexPak6 to antenna/ LNA)
PWR	4-pin LEMO +6 to +36 V DC In-rush power consumption: FlexPak6: 13 A for less than 80 µs
COM1	9-pin DB9
COM2	9-pin DB9 [a]
USB	mini-AB
Ethernet, CAN, I/O	DB-HD15
PHYSICAL	
Size	45 x 147 x 123 mm
Weight	337 g maximum
Mounting System	Integral flange with two 7 mm (9/32 inch) diameter mounting holes 133 mm (5.25 inches) apart
ENVIRONMENTAL	
Operating Temperature	-40°C to +75°C
Storage Temperature	-40°C to +85°C
Humidity	Not to exceed 95% non-condensing
Immersion	IEC60529 IPX7

a. COM2 can be can be dynamically changed to RS-422 by grounding I/O pin 9. You can connect pin 5 (ground) to pin 9 to switch COM2 to RS-422 mode.

DIMENSIONS

Note: All dimensions are in millimetres.

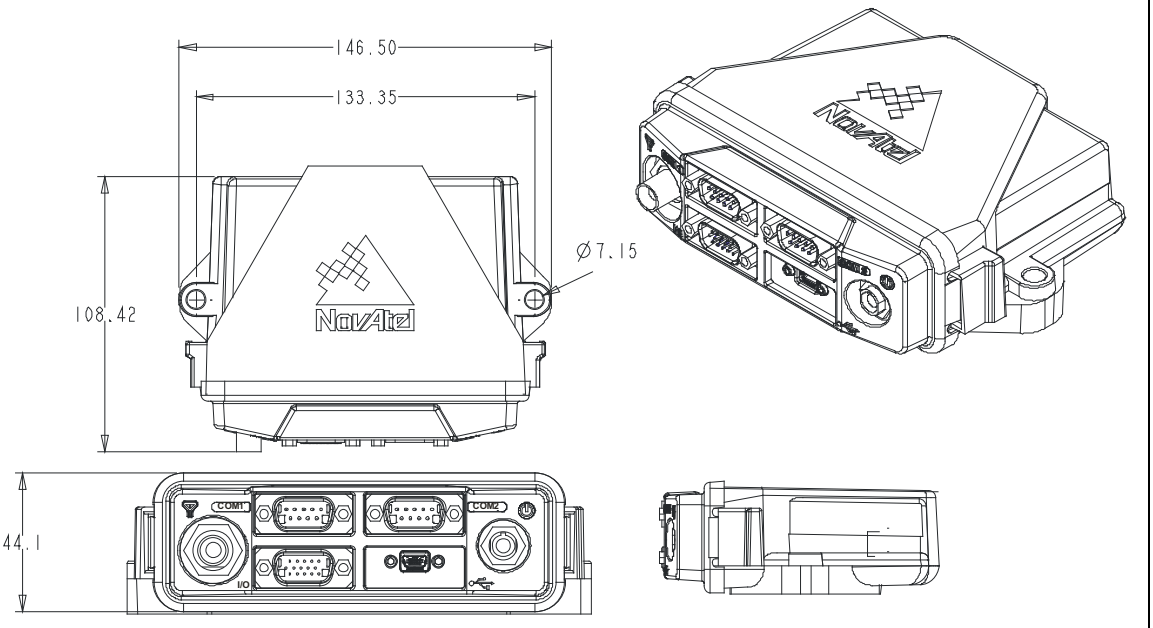


Figure 37: FlexPak6 Dimensions

B.2.1 Port Pin-Outs

The pin numbering for each of the ports, is described in the tables that follow.

Table 19: FlexPak6 Port Pin-Out Descriptions

Connector Pin No.	COM1	COM2	
	RS-232	RS-232	RS-422
1	N/C	N/C	N/C
2	Rx	Rx	Rx+
3	Tx	Tx	Tx+
4	N/C	POUT [a]	POUT[a]
5	GND	GND	GND
6	N/C	N/C	N/C
7	RTS	RTS	Tx-
8	CTS	CTS	Rx-
9	N/C	N/C	N/C

a. Current is limited to 1 A.

The FlexPak provides an output voltage on pin 4 of COM2 (POUT) that matches the voltage used to power the Flexpak.

The Flexpak can accept voltages up to 36 V DC, which is greater than the RS-232 specified maximum 25 V DC. As a result, you can damage equipment that is connected to COM2 by sending voltages higher than the RS-232 specification allows.

Table 20: FlexPak6 I/O Port Pin-Out Descriptions

Connector Pin No.	Signal Name	Signal Descriptions
1	ETH_TD+	
2	ETH_RD+	
3	CAN1+	
4	No connect	
5	GND	Digital ground

6	ETH_TD-	
7	ETH_RD-	
8	CAN1-	
9	MODE	When grounded (e.g., connected to pin 5), enables RS-422 mode. RS-232 is the unconnected default
10	EVENT2	Mark 2 input
11	EVENT1	Mark 1 input
12	VARF	Variable frequency out
13	ERROR	Indicates a fatal error when high. The antenna port LED also turns red during a fatal error
14	PV	Valid position avalable. The antenna port LED also turns green for a valid position
15	PPS	Pulse per second

Also see *Section 2.5.1, Strobes* on *page 41*.

B.2.2 Cables

B.2.2.1 I/O Breakout Cable (NovAtel part number 01018649)

The Ethernet and CAN on the FlexPak6 can be accessed by inserting the I/O breakout cable's female DB-HD15 connector into the *I/O* port. This provides a standard receptacle for Ethernet connectivity and a DB9 connector for CAN. Access to the I/O line signals (see *Table 21*) are available on the DB-HD15 male connector and the DB9 access I/O strobe port cable (see *Section B.2.2.2* on *page 121*). The breakout cable is approximately 40 cm in length (see *Figure 38*) and is RoHS compliant.

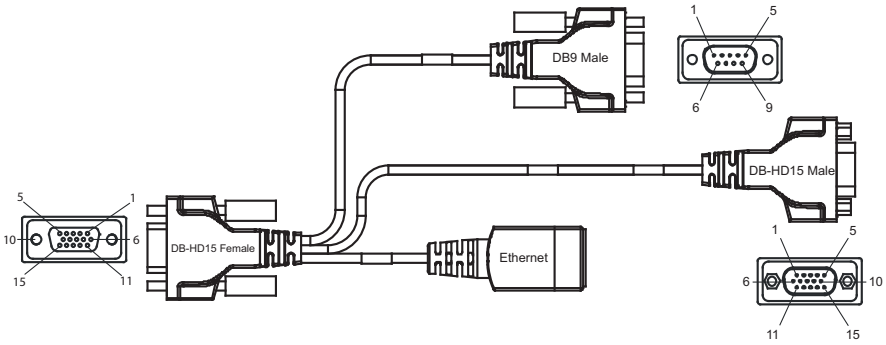


Figure 38: I/O Breakout Cable

Table 21: I/O Breakout Cable Wiring

Signal	DB-HD15 Female	DB9 Male	DB-HD15 Male	Ethernet
Signal ground	5	3, 5	5	-
CAN1-	8	2	-	-
CAN1+	3	7	-	-
ETH_TD+	1	-	-	1
ETH_RD+	2	-	-	3
ETH_TD-	6	-	-	2
ETH_RD-	7	-	-	6
No connect	4	-	-	-
MODE	9	-	9	-
EVENT2	10	-	10	-
EVENT1	11	-	11	-
VARF	12	-	12	-
ERROR	13	-	13	-

Signal	DB-HD15 Female	DB9 Male	DB-HD15 Male	Ethernet
PV	14	-	14	-
PPS	15	-	15	-

B.2.2.2 I/O DB-HD15 Strobe Port Cable (NovAtel part number 01018651)

The strobe lines on the FlexPak6 can be accessed by inserting the female DB-HD15 connector of the I/O strobe port cable into the *I/O* port. The other end of this cable is provided without a connector to provide flexibility. The jacket insulation is cut away slightly from the end but the insulation on each wire is intact. The cable is approximately 2 m in length. See *Figure 39*. This cable is RoHS compliant.

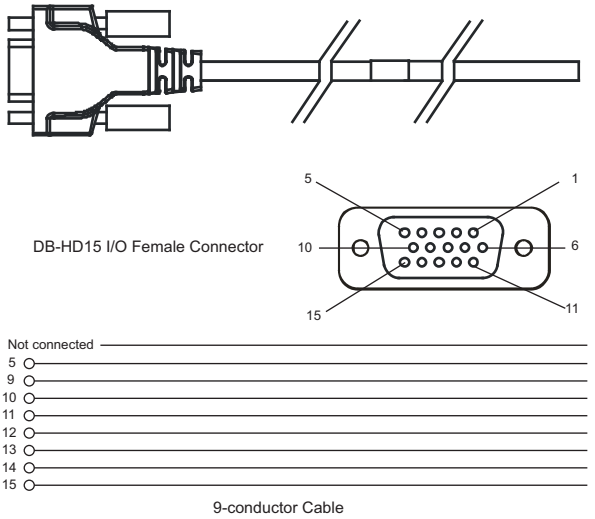


Figure 39: I/O DB-HD15 Strobe Port Cable

Table 22: I/O Strobe Port Cable Wiring

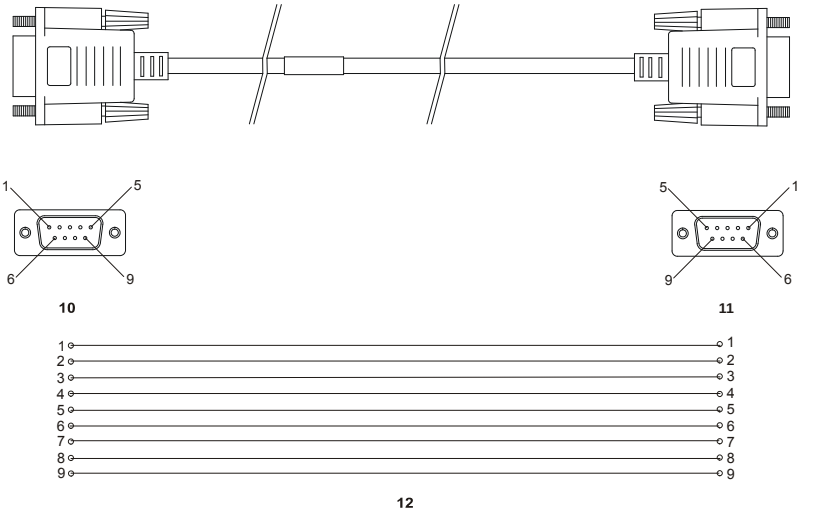
I/O Port Pin	I/O Port Signal	I/O Port Cable Wire Colour
Not connected		Blue
5	Ground	White/Grey
9	MODE	Red
10	EVENT2	Green
11	EVENT1	Orange
12	VARF	Black
13	ERROR	Violet
14	PV	Yellow
15	PPS	Brown

All unlisted pins on the cable are not connected.

B.2.2.3 Straight Through Serial Cable (NovAtel part number 01018520)

This cable can be used to connect the FlexPak6 to a modem or radio transmitter to propagate differential corrections. The cable is equipped with a female DB9 connector at the receiver end. The male DB9 connector at the other end is provided to plug into your user-supplied equipment (please refer to your modem or radio transmitter user guide for more information on its connectors). The cable is approximately 2 m in length. See *Figure 40*.

This cable is RoHS compliant.



Reference	Description
10	DB9P (male) connector
11	DB9S (female) connector
12	9-conductor cable

Figure 40: FlexPak6 Straight Through Serial Cable

B.2.2.4 Null Modem Cable (NovAtel part number 01017658)

This cable supplied with the FlexPak6, see *Figure 41*, provides an easy means of communications with a PC. The cable is equipped with a 9-pin connector at the receiver end which can be plugged into the *COM* or *COM2* port. At the PC end, a 9-pin connector is provided to accommodate a PC serial (RS-232) communication port. This cable is RoHS compliant.

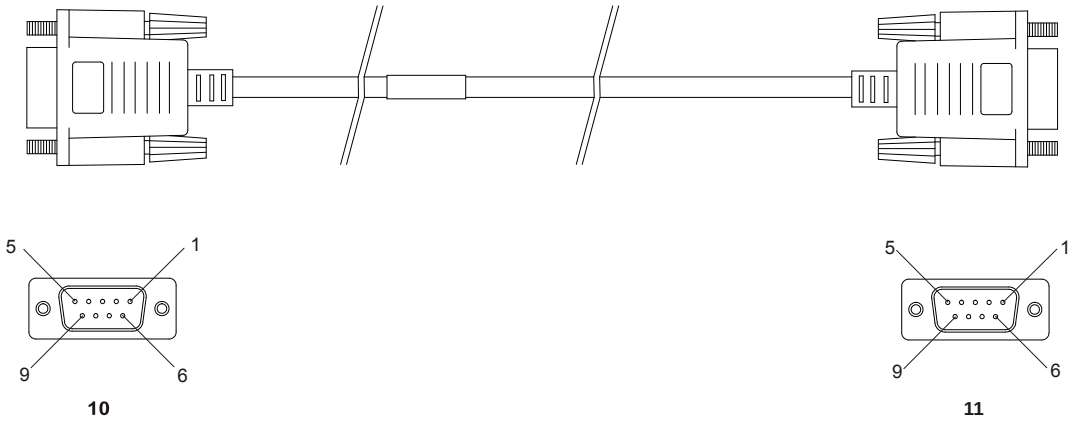


Table 23: Null Modem Cable Wiring

Connector	Pin Number						
To DB9S (10)	2	3	8	7	4	5	1 & 6
To DB9S (11)	3	2	7	8	1 & 6	5	4

Figure 41: FlexPak6 Null Modem Cable

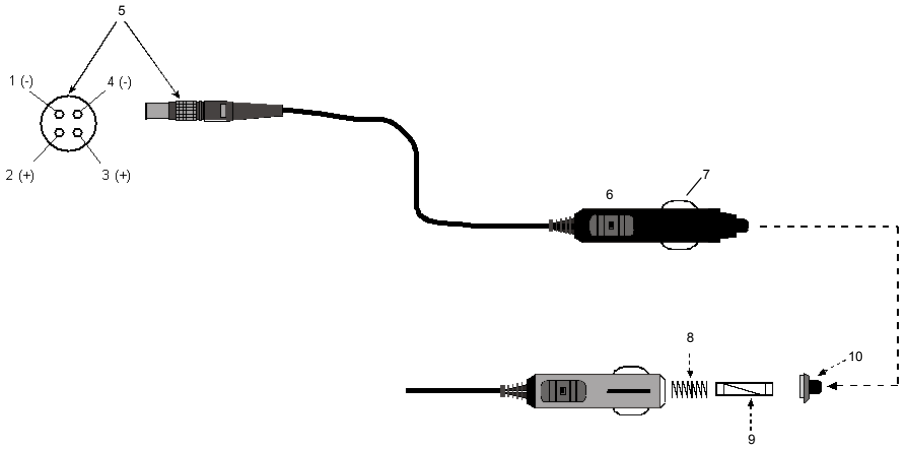
B.2.2.5 12V Power Accessory Cable (NovAtel part number 01017663)

The power accessory cable supplied with the FlexPak6, see *Figure 42*, provides a convenient means for supplying +12 V DC. While the receiver is capable of operating over a wider input voltage range, the accessory plug should not be used above +12 V. The accessory plug includes a fuse. If the accessory plug is not used, the alternative wiring must also include a fuse.

Input is provided through the standard 12V power outlet. The output from the power adapter utilizes a 4-pin LEMO connector (LEMO part number FGG.0B.304.CLAD52Z) and plugs directly into the *PWR* input located on the front of the FlexPak6.

This cable is RoHS compliant.

For alternate power sources please see *Section 3.1.3* on *page 38*.



Reference	Description	Reference	Description
1	- (black)	6	Accessory Plug
2	+ (red)	7	Ground (side tab)
3	+ (orange or green)	8	Spring
4	- (brown or white)	9	6 A slow-blow fuse
5	Connector Key Marking	10	+ Tip

Figure 42: Power Accessory Cable

Appendix C OEM615 Technical Specifications

C.1 OEM615 Receiver

***PERFORMANCE** (Subject To GPS System Characteristics)*

Position Accuracy [a]

Standalone:

L1 only	1.5 m RMS
L1/L2	1.2 m RMS
SBAS [b]	0.6 m RMS
DGPS	0.4 m RMS
OmniSTAR:	
VBS	0.6 m RMS
XP	0.15 m RMS
HP	0.1 m RMS
RT-20®	0.2 m RMS
RT-2™	1 cm + 1 ppm RMS

Time To First Fix

Hot: 35 s (Almanac and recent ephemeris saved and approximate position and time entered)
Cold: 60 s (No almanac or ephemeris and no approximate position or time)

Reacquisition

0.5 s L1 (typical)
1.0 s L2 (typical)

Data Rates

Measurements:	Up to 20 Hz
Position:	Up to 20 Hz

Time Accuracy [a c]

20 ns RMS

Velocity Accuracy [a]

0.03 m/s RMS

Measurement Precision

	GPS		GLO	
	Code	Carrier	Code	Carrier
L1 C/A	4 cm	0.5 mm	8 cm	1.0 mm
L2 P(Y) (see note 1)	8 cm	1.0 mm	8 cm	1.0 mm
L2 C (see note 2)	8 mm	0.5 mm	8 cm	1.0 mm

Notes:
1. L2 P for GLONASS
2. L2 C/A for GLONASS

Dynamics

Velocity 499 m/s [d]

a. Typical values. All position and velocity RMS values are based on Horizontal position accuracy. Performance specifications are subject to GPS system characteristics, U.S. DOD operational degradation, ionospheric and tropospheric conditions, satellite geometry, baseline length and multipath effects.
b. GPS-only
c. Time accuracy does not include biases due to RF or antenna delay.
d. In accordance with export licensing.

C.1.1 Physical Description

PHYSICAL	
Size	46 mm x 71 mm x 13 mm
Weight	23 grams
NOVATEL PART NUMBER	
Generic assembly OEM615	01018784
MECHANICAL DRAWINGS	

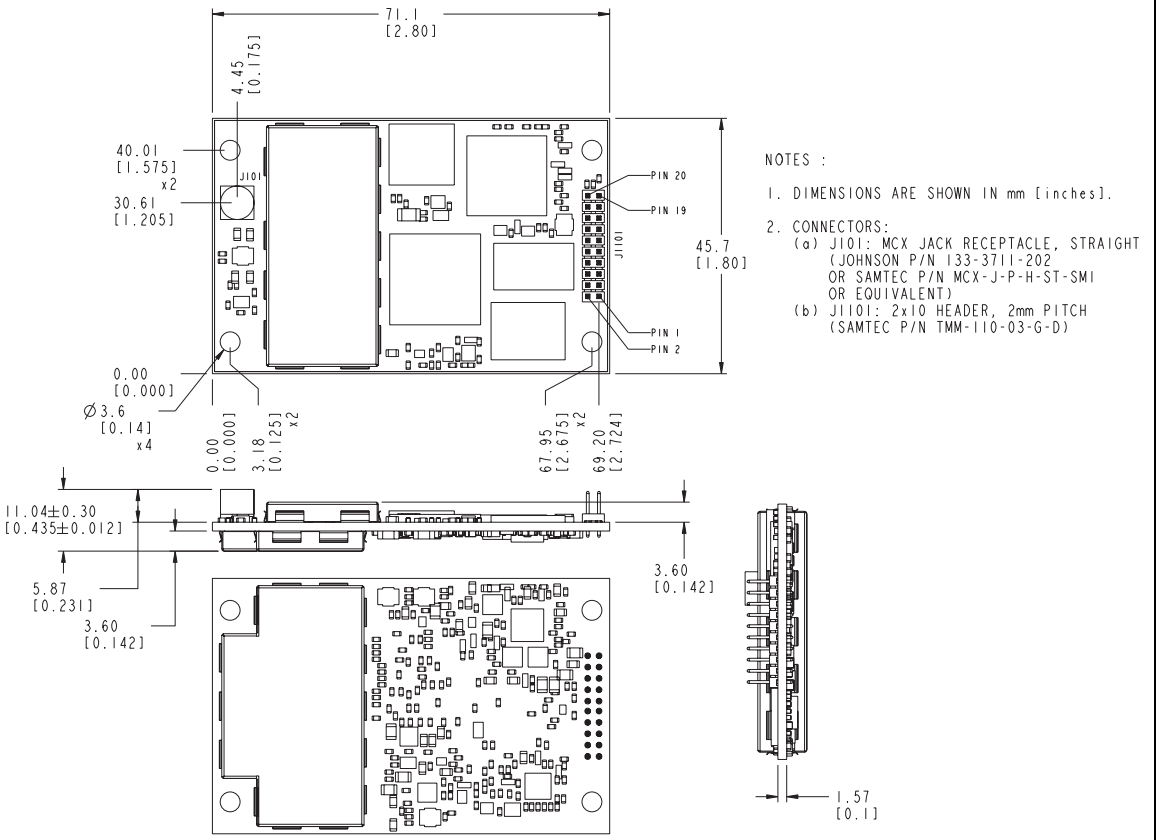


Figure 43: OEM615 Board Dimensions

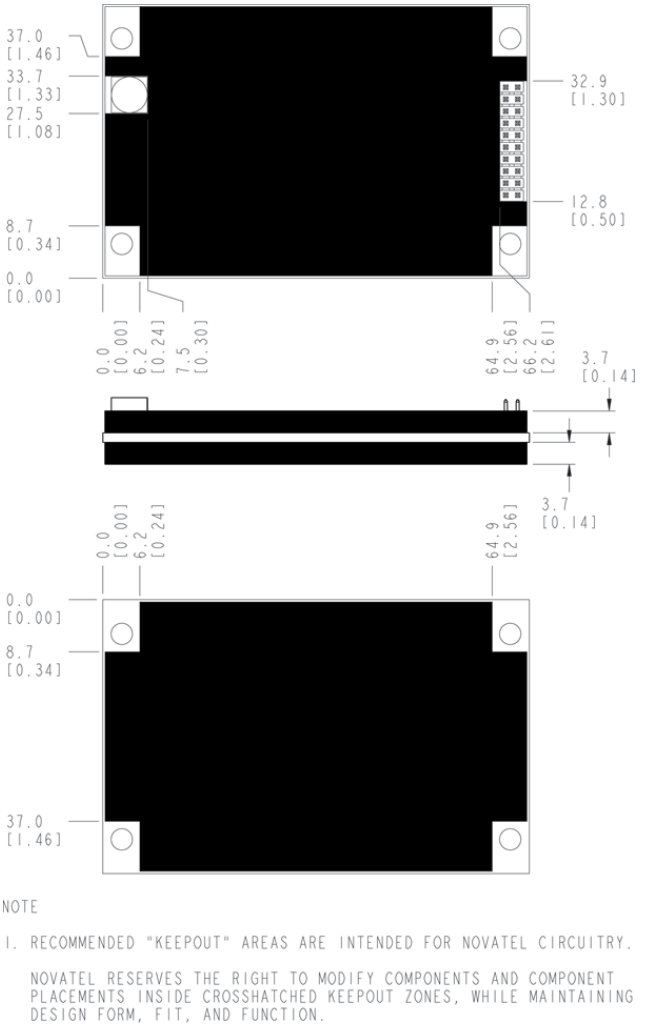


Figure 44: OEM615 Keep-Out Zone

ENVIRONMENTAL	
Operating Temperature	-40°C to +85°C
Storage Temperature	-55°C to +95°C
Humidity	95% noncondensing
Random Vibe	MIL-STD 810F (category 24, 7.7g RMS)
Sine Vibe	SAEJ1211 (4 g)
Bump / Repetative shock	IEC68-2-27 (30 g)
Shock	MIL-STD-810G (40g) Additional non-operate testing was conducted at 75g

Continued on the following page

POWER REQUIREMENTS	
Voltage	+3.3 V DC ±5%
Allowable Input Voltage Ripple	100 mV p-p maximum
Power Consumption	1.3 W typical, GPS L1/L2 1.5 W typical, GPS/GLONASS L1/L2 1.81 W typical, GPS L1/L2, GLONASS L1/L2 1.9 W typical, all on ✉ These values can change with the number of satellites in view and the firmware version. Use them as a guide for what you might expect but not as absolute values.
In-Rush Power Consumption	6.0 A for less than 60 µs (typical)
RF INPUT / LNA POWER OUTPUT	
Antenna Connector	MCX female, 50 Ω nominal impedance (See *Figure 43* on *page 126*)
Acceptable RF Input Level	L1: -122 to -87 (signal) dBm, -161 to -141 (noise) dBm/Hz L2: -126 to -93 (signal) dBm, -161 to -141 (noise) dBm/Hz
RF Input Frequencies	GPS L1: 1575.42 MHz GPS L2: 1227.60 MHz GLONASS L1: 1593-1610 MHz GLONASS L2: 1237-1253 MHz Galileo E1 1575.42 MHz
LNA Power	+5 V DC ±5%, 0-100 mA (supplied by card through centre conductor of RF connector). The amount of voltage that the receiver can provide depends upon the input voltage in the following current derating curve: • V(LNA OUT) < 0.1W/I(LNA OUT) + 5 V
INPUT/OUTPUT DATA INTERFACE	
COM1	
Electrical format	LVTTL
Bit rates[a]	2400, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400, 460800 or 921600 bps. See *Section 3.1.1* on *page 47*.
Signals supported	COM1_Tx, COM1_Rx
Electrostatic discharge protection	Yes
COM2	
Electrical format	LVTTL
Bit rates[a]	2400, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400, 460800 or 921600 bps. See *Section 3.1.1* on *page 47*.
Signals supported	COM2_Tx, COM2_Rx
Electrostatic discharge protection	No
COM3	
Electrical format	LVTTL [b c]

Bit rates[a]	2400, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400, 460800 or 921600 bps. See *Section 3.1.1* on *page 47*.	
Signals supported	COM3_Tx and COM3_Rx	
Electrostatic discharge protection	No	
CAN BUS[D]		
Electrical format	LVTTL (requires external CAN transceiver)	
Bit rates	1 Mbps maximum. CAN Bus throughput is determined by slowest device on the bus.	
Signals supported	CAN1 and CAN2	
USB		
Electrical format	Conforms to USB 2.0	
Bit rates	Full-speed USB	
Signals supported	USB D (+), USB D (-)	
ETHERNET		
Physical Layer	None	

a. Baud rates higher than 115,200 bps are not supported by standard PC hardware. Special computer hardware may be required for higher rates, including 230400 bps, 460800 bps, and 921600 bps.

b. COM3 is disabled by default. See *Section User-Selectable Port Configuration* on *page 38*

c. Event2 is enabled by default, but is multiplexed with CAN1. CAN functionality must be disabled for Event2 to work properly. See *User-Selectable Port Configuration* on *page 38* for details

d. CAN Bus behavior must be asserted through the NovAtel API software. See *Section 2.5.3 CAN Bus* on *page 43* for further details. See also *Figure 45* on *page 132*

Table 24: OEM615 Strobes

Strobes	Default Behavior	Input/ Output	Factory Default	Comment [a]
Event1 (Mark 1)	Multiplexed pin	Input Leading edge triggered	Active low	An input mark for which a pulse greater than 150 ns triggers certain logs to be generated. (Refer to the MARKPOS and MARKTIME logs and ONMARK trigger.) Polarity is configurable using the MARKCONTROL command. The mark inputs have 10K pull-up resistors to 3.3 V
Event2 (Mark 2)	Multiplexed pin	Input Leading edge triggered	Active low	An input mark for which a pulse greater than 150 ns triggers certain logs to be generated (see the MARK2POS and MARK2TIME logs). Polarity is configurable using the MARKCONTROL command. The mark inputs have 10K pull-up resistors to 3.3 V.
PV (Position Valid)	Dedicated pin	Output	Active high	Indicates a valid GNSS position solution is available. A high level indicates a valid solution or that the FIX POSITION command has been set (refer to the FIX POSITION command). VDD is 3.3V.
VARF (Variable Frequency)	Multiplexed pin	Output	Active low	A programmable variable frequency output ranging from 0 -5 MHz (refer to the FREQUENCYOUT command).
RESETIN	Dedicated pin	Input	Active low	Reset LVTTL signal input from external system; active low, > 20 µs duration
PPS	Dedicated pin	Output	Active low	A time synchronization output. This is a pulse where the leading edge is synchronized to receiver-calculated GNSS Time. The polarity, period and pulse width can be configured using PPSCONTROL command.

a. The commands and logs shown in capital letters (for example, MARKCONTROL) are discussed in further detail in the *OEM6 Family Firmware Reference Manual*.

Table 25: OEM615 Strobe Electrical Specifications

Strobe	Sym	Min (V)	Typ (V)	Max (V)	Current (mA)	Conditions
Event1 (Mark 1) Event2 (Mark2) PPS	V_{IL}			0.8		VCC = 3.3 V; 85°C
	V_{IH}	2.0				VCC = 3.3 V; 85°C
PV VARF	V_{OL}			0.4	24	VCC = 3.3 V; 85°C
	V_{OH}	3.0			24	VCC = 3.3 V; 85°C
RESETIN	V_{IL}			0.8		VCC = 3.3 V; 85°C
	V_{IH}	2.3				VCC = 3.3 V; 85°C

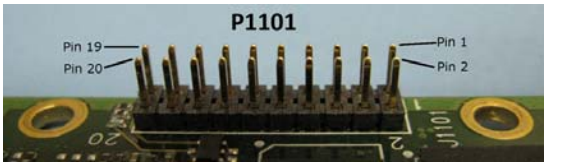


Figure 45: Top-view, P1101 Main Connector 20-Pin Header

Pin	Signal	Type	Description	Comments
1	LNA_PWR	PWR	Antenna power input	An LDO regulates the output voltage to around 5 V DC. The input voltage can be up to 12 V DC.
2	3V3	PWR	Supply voltage input	3.3 V +/- 5%
3	USB_D-	IO	USB data (-)	One-half of a differential pair (pins 3 and 4). Match lengths and route as a 90Ω differential pair if USB is required
4	USB_D+ / RXD3[a]	IO	USB data (+) / COM3 receive data	One-half of a differential pair (pins 3 and 4). Match lengths and route as a 90Ω differential pair if USB is required This pin is internally multiplexed (see *Section 2.4.5 Connecting Data Communications Equipment* on *page 37*)
5	/RESETIN	I	Reset input	Active low reset
6	USERVARF / CAN1RX	IO	Variable frequency output / CAN1 receive data	These pins are internally multiplexed (see *Section 2.4.5 Connecting Data Communications Equipment* on *page 37*)
7	EVENT2 / CAN1TX	IO	Event 2 Input / CAN1 transmit data	
8	CAN2RX	I	CAN2 receive data	
9	EVENT1 / TXD3[a]	IO	Event1 input / COM3 transmit data	This pin is internally multiplexed (see *Section 2.4.5 Connecting Data Communications Equipment* on *page 37*)
10	GND	PWR	Signal and power ground	
11	TXD1	O	COM1 transmit data	
12	RXD1	I	COM1 receive data	
13	GND	PWR	Signal and power ground	
14	TXD2	O	COM2 transmit data	
15	RXD2	I	COM2 receive data	
16	GND	PWR	Signal and power ground	
17	PV	O	Position valid indicator	Active high output

18	GND	PWR	Signal and power ground	
19	TIMEMARK	O	Timemark output	This pin has an internal 50 ohm line driver. Route as a 50Ω single-ended trace
20	CAN2TX	O	CAN2 transmit data	

a. The COM3 UART can be configured with firmware on pins 4 and 9. See OM-20000128, *OEM6 Family Installation and Operation User Manual* for more information.

C.1.2 CMOS Level I/O

The OEM615 provides a number of CMOS-level I/O pins for status indication and timing. These I/O include:

- COM1, COM2 and COM3: CMOS-level UART ports (no flow control) (3.3V I/O)
- CAN1 and CAN2: CMOS-level CAN ports (require external CAN transceivers) (2.7V I/O, 3.3V compatible levels)
- TIMEMARK: Output pulse providing time reference signal (software configurable output rate) (3.3V I/O)
- VARF: Variable Frequency output (a software-configurable clock output) (3.3V I/O)
- PV: Position Valid (Goes high when the receiver has calculated a valid position) (3.3V I/O)
- EVENT1 and EVENT2: Event inputs (Configurable polarity) (2.7V I/O, 3.3V compatible levels)

These I/O require additional ESD protection if they are routed to connectors. The same ESD protection circuit shown below should be used on any OEM615 CMOS-level signal that attaches to an enclosure connector. The ferrite bead and small-value capacitor provide some immunity to electrostatic discharge events, but also reduce radiated and conducted emissions from the enclosure.

C.1.2.1 EVENT, TIMEMARK and PV Signal Protection

Use the following circuit to create adequate protection for the EVENTx and TIMEMARK outputs in most situations.

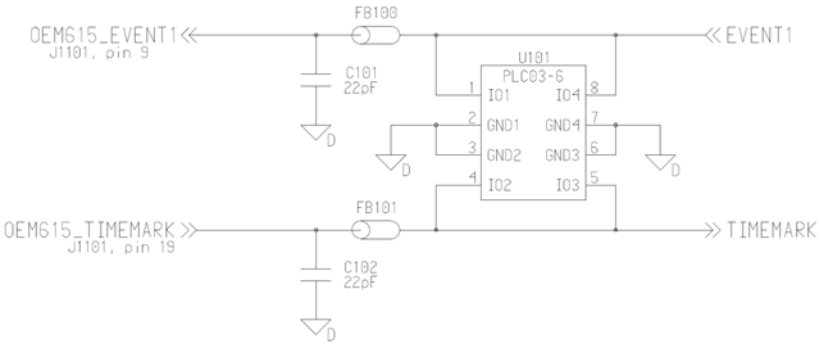


Figure 46: ESD protection for EVENT and PPS strobes

You can use the PV signal to drive an LED with the buffer circuit below. This circuit indicates that the receiver card has computed a valid position:

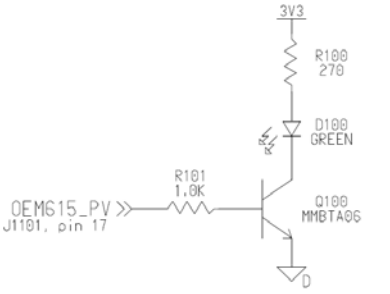


Figure 47: PV LED drive buffer

Table 26: Bill of Materials (critical components)

Designator	Manufacturer	Manufacturer part number
FB100, FB101	TDK	MMZ1005B800C
U101	Semtech Bourns OnSemi	LC03-6.TBT CDNBS08-PLC03-6 LC03-6R2G
C101, C102	various	(22 pF 5% 50 V COG 0603)

C.1.3 CAN Interface

The OEM615 provides two 2.7V (3.3V-compatible) CMOS-level CAN controller ports. An external transceiver is required. The following figure shows a typical CAN transceiver implementation.

The combination of ferrite beads and small-value capacitors are not necessarily required but may provide improved EMI performance. A low-capacitance TVS device provides ESD protection.

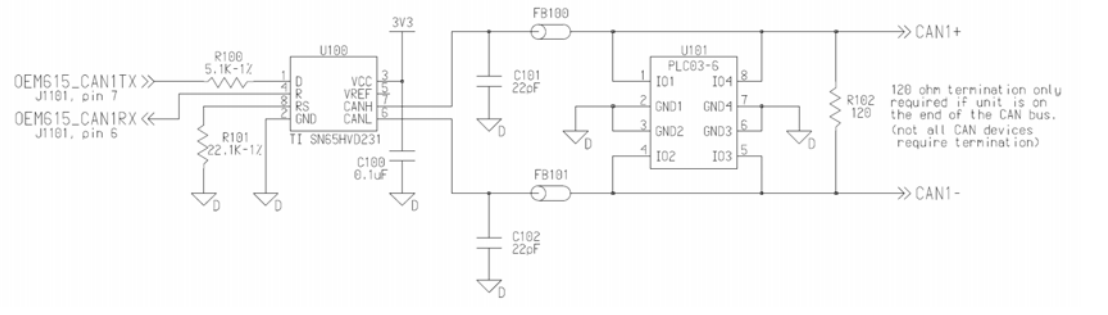


Figure 48: CAN Transceiver Implementation

Only use a 120Ω termination resistor when the CAN device is used at one end of the CAN bus. Multiple terminations along the length of the CAN bus will degrade performance for all CAN devices on the bus.

The slew rate adjustment resistor (R101) value in *Figure 48* on *page 134* sets the slew rate for applications for SAE J1939 agricultural applications. Other applications may require a different slew rate. Refer to the transceiver datasheet for more information.

Table 27: Bill of Materials (critical components)

Designator	Manufacturer	Manufacturer part number
FB100, FB101	TDK	MMZ1005B800C
U100	Texas Instruments	SN65HVD231
U101	Semtech Bourns OnSemi	LC03-6.TBT CDNBS08-PLC03-6 LC03-6R2G
C100, C101	various	(22pF 5% 50V COG 0603)

C.1.4 USB Interface

The OEM615 includes one USB 2.0 Full-Speed (12Mbps) interface.

For signal integrity and EMI reasons, route differential data traces as a 90Ω differential pair. A small-value common-mode choke (as shown in the figure below) may improve the radiated emissions performance.

The common-mode choke and ESD protection should be placed as close as possible to the USB connector.

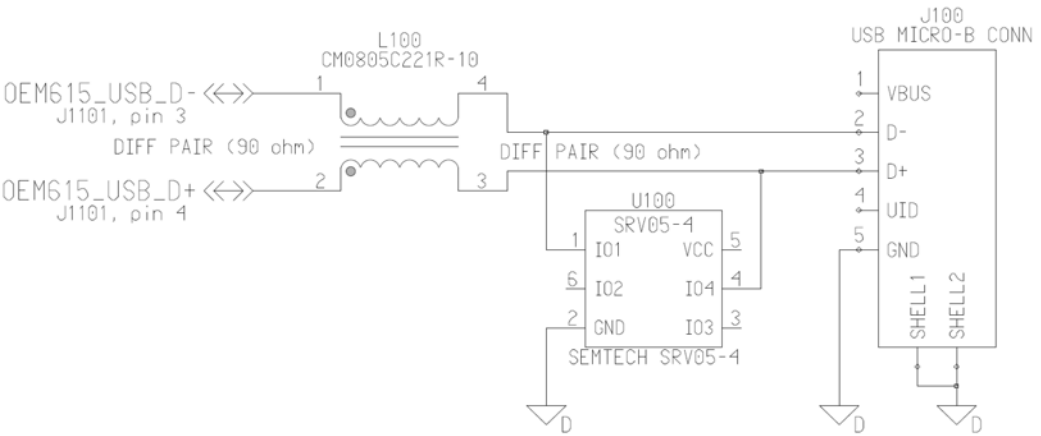


Figure 49: USB Implementation

Table 28: Bill of Materials

Designator	Manufacturer	Manufacturer part number
L100	Steward / Laird	CM805-C221R-10
U100	Semtech	SRV05-4

Appendix D Accessories and Replacement Parts

The following tables list the replacement parts available for your NovAtel OEM6 receiver.For assistance or to order additional components, contact your local NovAtel dealer or Customer Support.

D.1 FlexPak6

Part Description	NovAtel Part
I/O breakout cable (*Figure 38* on *page 119*)	01018649
I/O DB-HD15 strobe cable (*Figure 39* on *page 121*)	01018651
Straight through serial data cable (*Figure 40* on *page 122*)	01018520
Null modem serial data cable (*Figure 41* on *page 123*)	01017658
Power cable: LEMO 4-pin socket to 12V power outlet plug (*Figure 42* on *page 124*)	01017663
USB A to mini B Cable	60323078

D.2 Accessories

Part Description		NovAtel Part
OEM6 Family Compact Disc with PC utilities		01018616
OEM6 Family Installation and Operation User Manual		OM-20000128
OEM6 Family Firmware Reference Manual		OM-20000129
Optional NovAtel Antennas:	Model 702 (L1/L2)	GPS-702
	Model 701 (L1-only)	GPS-701
	Model 702L (L1/L2/L-band)	GPS-702L
	Model 702GG (L1/L2/GLONASS)	GPS-702-GG
	Model 701GG (L1/GLONASS)	GPS-701-GG
	Model 703GGG (L1/L2/L5/GLONASS/Galileo)	GPS-703-GGG
	Model 702GGL (L1/L2/GLONASS/L-band)	GPS-702-GGL
	Model 701GGL (L1/GLONASS/L-band)	GPS-701-GGL
	Model 35C50P1GLA (L1/GLONASS/L-band)	ANT-35C50P1GLA-TW-N
	Model 26C1GA (L1)	ANT-26C1GA-TBW-N
	Model 35C1GA (L1)	ANT-35C1GA-TW-N
	Model A72GLA4 (L1/L2/L-band)	ANT-A72GLA4-TW-N
	Model C2GA (L1/L2)	ANT-C2GA-TW-N
	Model A72GA (L1/L2)	ANT-A72GA-TW-N
Optional RF Antenna Cable:	5 meters	GPS-C006
	15 meters	GPS-C016
	30 meters	GPS-C032
	22 cm interconnect adapter cable	GPS-C002

D.3 Manufacturers' Part Numbers

The following original manufacturer's part numbers are provided for information only and are not available from NovAtel as separate parts.

Product	Part Description	Company	Part Number
OEM628 card (*Figure 28* on *page 98*)	J100& J101, MMCX jack receptacle	Johnson	135-3701-201
		Samtec	RSP-149374-01
	P1500, 2x12 header, 2 mm pitch	Samtec	TMM-112-03-G-D
	P1502, 2x8 header, 2 mm pitch	Samtec	TMM-108-03-G-D
OEM615 card (*Figure 43* on *page 126*)	J101, MCX jack receptacle	Samtec	MCX-J-P-H-ST-SM1
	P1101, 2 x 10 header, 2 mm pitch	Samtec	TMM-110-03-G-D

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