OEMV Family

Installation and Operation

User Manual

OM-20000093 Rev 7

OEMV Family Installation and Operation User Manual

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Manufactured and protected under U.S. Patent:

PAC Correlator
#6,243,409 B1
#5,414,729
Narrow Correlator
#5,101,416
#5,390,207
#5,495,499
#5,809,064
GLONASS
#6,608,998 B1
GALILEO
#6,184,822 B1

Dual Frequency GPS
#5,736,961
Position for Velocity Kalman Filter
#6,664,923 B1
Anti-Jamming Technology
#5,734,674
RTK Positioning
#6,728,637 B2
#6,664,923 B1

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Notice

The following notices apply to the DL-V3, ProPak-V3, FlexPak-V2, FlexPak-V1G, FlexPak-V1, SMART-V1 and SMART-V1G. An OEMV card might not pass emissions testing by itself. For example, the ProPak-V3 passes regulatory emissions as shown in this Notice. For more information on emissions testing, please refer to the regulatory body in your geographic area. For example, in the US that is the Federal Communications Commission (FCC) and in Europe the Conformité Européenne (CE).

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.

ProPak-V3, FlexPak-V1G and FlexPak-V1 have been tested and found to comply with the radiated and conducted emission limits for a Class B digital device, while the SMART-V1, SMART-V1G, FlexPak-V2 and DL-V3 comply with Class A, for both CISPR 22 and Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment 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 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

IMPORTANT: In order to maintain compliance with the limits of a Class B digital device, it is required to 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.

WARNING!: Changes or modifications to this equipment not expressly approved by NovAtel Inc. could result in violation of Part 15 of the FCC rules and void the user’s authority to operate this equipment.

RF Exposure: When using Bluetooth, the DL-V3 device exceeds the FCC requirements for RF exposure when the antenna used for this transmitter has a separation distance of at least 20 cm from all persons.

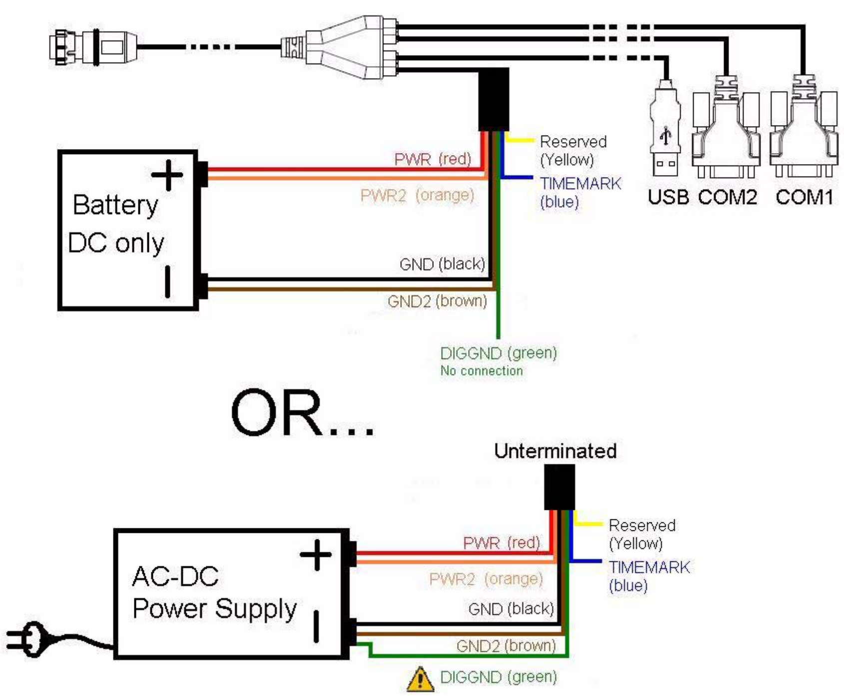
CE NOTICE

The enclosures carry the CE mark.

WARNING: This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

"Hereby, NovAtel Inc. declares that this DL-V3, ProPak-V3, FlexPak-V2, FlexPak-V1G, FlexPak-V1 SMART-V1 and SMART-V1G is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC."

SMART-V1/SMART-V1G Power Warning



When connecting power to the SMART-V1 or SMART-V1G, it is recommended that you use a battery source. In this case, it is ***important*** that you tie together the bare wires tagged as GND2 (brown) and GND (black) to the battery's negative terminal. Tie the bare wires tagged as PWR (red) and PWR2 (orange) to the battery's positive terminal.

WARNING: ***If you do not use a battery, you must tie together the bare wires tagged as GND2 (brown), GND (black) and DIGGND (green) to the DC power supply's negative ground connector.***
Failure to tie the appropriate grounds, as explained in this section, may result in your SMART-V1/SMART-V1G becoming permanently damaged and void your warranty.

Lightning Protection Notice

What is the hazard?

A lightning strike into the ground causes an increase in the earth's potential causing a high voltage potential between the centre conductor and shield of the coax cable. Voltages directly applied onto the centre conductor "roll off" and arrive after the shield pulse producing a high voltage potential between the centre conductor and shield of the coax cable.

Hazard Impact

A lightning strike causes the ground potential in the area to rise to dangerous levels resulting in personnel harm 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.

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 overvoltages 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. NovAtel recommends installing a secondary lightning protection device. The coaxial cable entering the building is connected to protective ground through the primary and secondary lightning protection.

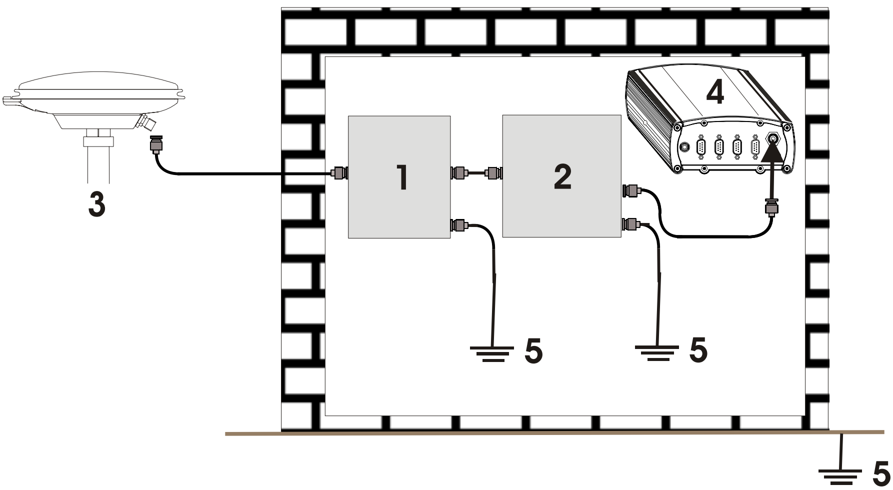


Figure 1: Primary and Secondary Lightning Protection

Reference	Description	Reference	Description
1	Primary Lightning Protection Device	4	OEMV Receiver
2	Secondary Lightning Protection Device	5	To Ground
3	External Antenna		

Electromagnetic Compatibility (EMC) and Safety

Regulatory Testing (DL-V3)

- FCC, Part 15 Radiated Emissions, Class A
- EN 55022 Emissions, Class A
- EN 55024 Immunity
    - EN 61000-4-2 Electrostatic Discharge Immunity
    - EN 61000-4-3 Radiated RF EM Field Immunity Test
    - EN 61000-4-4 Electrical Fast Transient/Burst Test
    - EN 61000-4-6 Conducted Immunity
    - EN 61000-4-8 Magnetic Field Immunity
- EN 60950 Safety of Information Technology Equipment

Regulatory Testing (ProPak-V3)

- FCC, Part 15 Radiated Emissions, Class B
- EN 55022 Radiated Emissions, Class B
- EN 61000-6-2 Generic Immunity, Industrial Environment
    - EN 61000-4-2 Electrostatic Discharge Immunity
    - EN 61000-4-3 Radiated RF EM Field Immunity Test
    - EN 61000-4-4 Electrical Fast Transient/Burst Test
    - EN 61000-4-6 Conducted Immunity
    - EN 61000-4-8 Magnetic Field Immunity
- EN 60950 Safety of Information Technology Equipment

Regulatory Testing (FlexPak-V1/FlexPak-V1G/FlexPak-V2)

- FCC, Part 15 Emissions: FlexPak-V1G and FlexPak-V1, Class B
- FCC, Part 15 Emissions: FlexPak-V2, Class A
- EN 61000-6-2 Generic Immunity, Industrial Environment
    - EN 61000-4-2 Electrostatic Discharge Immunity
    - EN 61000-4-3 Radiated RF EM Field Immunity Test
    - EN 61000-4-4 Electrical Fast Transient/Burst Test
    - EN 61000-4-5 Surge Immunity
    - EN 61000-4-6 Conducted Immunity
    - EN 61000-4-8 Magnetic Field Immunity
- EN 60950-1 Safety of Information Technology Equipment

Regulatory Testing (SMART-V1/SMART-V1G)

- FCC, Part 15 Radiated Emissions, Class A
- EN 55022 Emissions, Class A
- EN 61000-6-2 Generic Immunity, Industrial Environment
- EN 60950-1 Safety of Information Technology Equipment
- American Society of Agricultural Engineers (ASAE) Engineering Practice (EP) Vibration (Random) MIL-STD-801F 514.5 C17 and Vibration (Sine) SAE EP455
- Military Standard (MIL STD) 810 F: 7.7 g RMS Random Vibration, Shock, Sand and Dust, and Salt Spray

WEEE Notice

If you purchased your OEMV 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 recognised by their wheeled bin label ( ). [1]

RoHS Notice

The DL-V3, ProPak-V3, FlexPak-V2, FlexPak-V1G, FlexPak-V1, SMART-V1 and SMART-V1G are compliant with the European Union (EU) Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC. (The OEMV-1, OEMV-1G, OEMV-2 and OEMV-3 cards are also compliant.) [1]

1. Please visit the NovAtel website at http://www.novatel.com/support/weee.htm for more information on WEEE and RoHS.

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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

Warranty

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:

OEMV Card Receivers	One (1) Year
DL-V3, ProPak-V3, FlexPak-V2, FlexPak-V1, FlexPak-V1G, SMART-V1 and SMART-V1G	One (1) Year
GPSAntenna™ 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 obtain a Return Material Authorization (RMA) number from the point of purchase. You may also visit our website at http://www.novatel.com and select *Support | Repair Requests* from the top menu.

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

Customer Service

Firmware *upgrades* are firmware releases, which increase basic functionality of the receiver from one model to a higher level model type. When available, *upgrades* may be purchased at a price, which is the difference between the two model types on the current NovAtel Inc. Price List plus a nominal service charge.

Firmware upgrades are accomplished through NovAtel authorized dealers.

Contact your local NovAtel dealer first for more information. To locate a dealer in your area or if the problem is not resolved, contact NovAtel Inc. directly using one of the following methods:

Call the NovAtel Hotline at 1-800-NOVATEL (U.S. & 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 Service Department
1120 - 68 Avenue NE
Calgary, AB
Canada, T2E 8S5

Try our Knowledge Base at http://www.novatel.com/support/knowledgedb.htm.

Before contacting Customer Service regarding software concerns, please do the following:

1. Issue a FRESET command

2. Log the following data to a file on your PC for 30 minutes

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

3. Send the file containing the log to NovAtel Customer Service, using either the NovAtel ftp site at ftp://ftp.novatel.ca/incoming or the support@novatel.com e-mail address.

If there is a hardware problem that has not been resolved, please send a list of the troubleshooting steps you have taken and their result. See also *Chapter 8, Troubleshooting* on *Page 123*.

Foreword

Thank you for purchasing a NovAtel receiver card. Whether it is stand-alone or in an enclosure, this manual will help you get the hardware operational and provide further general information. Afterwards, the *OEMV Firmware Reference Manual* will be your primary OEMV family command and logging reference source.

Scope

The *OEMV Family Installation and Operation User Manual* contains sufficient information on the installation and operation of the OEMV-1, OEMV-1G, OEMV-2 and OEMV-3 cards to allow you to effectively integrate and fully operate them. Enclosures for the OEMV Family cards, the DL-V3, ProPak-V3, FlexPak-V2, FlexPak-V1G, FlexPak-V1 and the SMART-V1/SMART-V1G Antenna, are also described in this manual. All are RoHS compliant. Please call your distributor, or NovAtel directly, for updated information on model availability.

After the addition of accessories, user-supplied data communications equipment and a power supply, the receiver is ready to go.

The OEMV family receivers utilize a comprehensive user-interface command structure, which requires communications through its communications (COM) ports. The *OEMV Firmware Reference Manual*, lists and describes the various receiver commands and logs referenced in this manual. Please remember that since each receiver is shipped from the distributor with a customer-specific list of features, such as L-band, Satellite-Based Augmentation System (SBAS) or GLONASS availability, some commands or logs may not be applicable to your model. Other supplementary manuals may be included on CD or as quick start guides to accommodate special models and software features with unique functionality. It is recommended that you keep these documents and CDs together for easy reference.

It is beyond the scope of this manual to provide details on service or repair. Please contact your local NovAtel dealer for any customer-service related inquiries, see *Customer Service* on *Page 18*.

What's New in Rev 7 of this Manual?

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

- The SMART-V1G Antenna and the RS-422 model of the SMART-V1
- RT-20 for GPS + GLONASS models

There are also new commands and logs in the *OEMV Family Firmware Reference Manual*. Refer to its *What's New* section for more details.

The most up-to-date version of this manual and any related addendum can be downloaded from the [Documentation Updates] section of the NovAtel website at www.novatel.com.

Prerequisites

The OEMV-1, OEMV-1G, OEMV-2 and OEMV-3 are OEM products requiring the addition of an enclosure and peripheral equipment before becoming fully functional Global Navigation Satellite Systems (GNSS) receivers. The installation chapters of this document provide information concerning the installation requirements and considerations for the OEMV family cards.

Chapter 1 Introduction

1.1 Overview of the OEMV Family

The OEMV family offers single, dual and triple-frequency GNSS receivers and the first integrated L-band capability without the need for a separate board. The OEMV-based products are GLONASS-enabled and are capable of full code and real-time kinematic (RTK) positioning.

This family is a group of high-performance GNSS receivers capable of receiving and tracking different combinations of GPS L1 C/A, L2C, L2 P(Y) and L5 code and carrier, GLONASS L1 and L2 code and carrier, and L-band (CDGPS and OmniSTAR) on a maximum of 72 channels. SBAS support is standard on all OEMV family receivers. OEMV adaptability offers multi-system, frequency, and size configurations for any application requirement. Refer to the *GPS+ Reference Manual* for an overview of each of the above signal types, available from our website at http://www.novatel.com/support/docupdates.htm.

Patented Pulse Aperture Correlator (PAC) with multipath mitigation technologies, and a powerful 32-bit processor, enable the OEMV family of receivers to offer multipath-resistant processing at high data update rates. Excellent acquisition and re-acquisition times allow the receivers to operate in environments where very high dynamics and frequent interruption of signals can be expected.

The AdVance RTK engine is supported on all OEMV-based products. This means a lower ambiguity error rate, faster narrow lane convergence (even at long baseline lengths) and more fixes in a wider range of conditions.

In addition, the OEMV family offers system integrators unparalleled flexibility in areas such as configuration and specification of output data and control signals. Multiple software models are available, allowing you to better fit the receiver performance to the application while maintaining the option for a compatible upgrade path.

The RoHS-compliant OEMV family includes the OEMV-1, OEMV-1G, OEMV-2 and OEMV-3 cards, the DL-V3, ProPak-V3, FlexPak-V2, FlexPak-V1G and FlexPak-V1 enclosures, and the SMART-V1/SMART-V1G Antenna. The cards, provided as printed circuit boards, are ideal for custom integration.

1.1.1 Common Features

All OEMV family receivers have the following standard features:

- 14 L1 and 2 SBAS channels
- PAC technology, refer to the *Multipath* section of the *GPS+ Reference Manual*
- Fast reacquisition
- Fully field-upgradeable firmware
- Low power consumption
- 20 Hz raw data and position output rates
- Two mark inputs for triggering the output of logs on external events
- Auxiliary strobe signals, including a configurable PPS output for time synchronization and mark inputs

- An extensive command and log set for maximum customization
- Outputs to drive external LEDs

1.2 OEMV Cards

The OEMV family cards consist of a single printed circuit board with integrated radio frequency (RF) and digital sections. They are designed for flexibility of integration and configuration. After installation with a power source, mounting structure, GNSS, and data communications equipment, NovAtel's OEMV cards are ready for the most demanding surveying, positioning, and navigation applications.

1.2.1 OEMV-1 Card

The OEMV-1 is a compact, low-power, single frequency L1 GPS card with integrated L-band (OmniSTAR/CDGPS). In addition to the functionality given in *Section 1.1.1* on *Page 20*, the OEMV-1 offers:

- 1 Controller Area Network (CAN) Bus port (without transceiver), 1 USB 1.1 communication port and 2 LV-TTL communication ports
- Integrated L-band (OmniSTAR VBS and CDGPS)
- AdVance RTK 20 cm (RT-20) positioning capability for GPS-only, see *RT-20 Performance* starting on *Page 93*
- Auxiliary strobe signals for status and synchronization
- Software load compatibility with other OEMV family products
- Optional Application Program Interface (API) software for loading a custom application

Included with the OEMV is a wrist-grounding strap to prevent ESD damage when handling the card and a CD containing NovAtel's PC utilities and product documentation.

For technical specifications on the OEMV-1, please see *Section A.2* starting on *Page 129*.

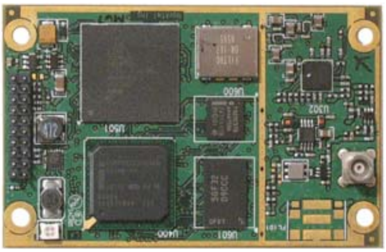


Figure 2: OEMV-1 Card

1.2.2 OEMV-1G Card

The OEMV-1G is a compact, low-power, single frequency L1 GPS + GLONASS card. In addition to the functionality given in *Section 1.1.1* on *Page 20*, the OEMV-1G offers:

- 1 Controller Area Network (CAN) Bus port (without transceiver), 1 USB 1.1 communication port and 2 LV-TTL communication ports
- 12 GLONASS L1 channels
- AdVance RTK 20 cm (RT-20) positioning capability for GPS + GLONASS, see *RT-20 Performance* starting on *Page 93*
- Auxiliary strobe signals for status and synchronization
- Software load compatibility with other OEMV family products
- Optional Application Program Interface (API) software for loading a custom application

Included with the OEMV-1G is a wrist-grounding strap to prevent ESD damage when handling the card and a CD containing NovAtel's PC utilities and product documentation.

For technical specifications on the OEMV-1G, please see *Section A.2* starting on *Page 129*.

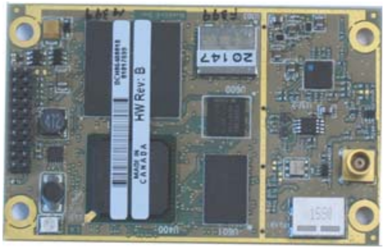


Figure 3: OEMV-1G Card

1.2.3 OEMV-2 Card

The OEMV-2 is a GPS plus GLONASS L1/L2 card that is a drop-in replacement for the OEM4-G2L. In addition to the functionality given in *Section 1.1.1* on *Page 20*, the OEMV-2 offers:

- 14 L2 P(Y) or L2C channels
- 12 GLONASS L1 channels
- 12 GLONASS L2 channels
- AdVance RTK real-time 2 cm (RT-2) positioning capability for GPS-only and GPS + GLONASS
- 2 LV-TTL, 1 RS-232 and 1 USB 1.1 communication ports
- CAN Bus (without transceiver) or a second Event line can be software configured
- An external oscillator input
- Auxiliary strobe signals for status and synchronization
- Temperature monitoring and reporting
- Software load compatibility with other OEMV family products
- Optional Application Program Interface (API) software for loading a custom application

Included with the OEMV is a wrist-grounding strap to prevent ESD damage when handling the card and a CD containing NovAtel's GPS PC utilities and product documentation.

For technical specifications on the OEMV-2, please see *Section A.4* starting on *Page 141*.

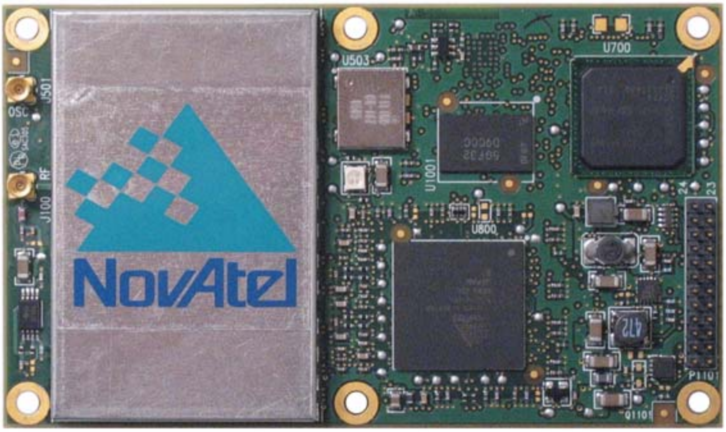


Figure 4: OEMV-2 Card

1.2.4 OEMV-3 Card

The OEMV-3 is a GPS L1/L2/L5 plus GLONASS L1/L2 card that is a drop-in replacement for the OEM4-G2. Triple-frequency capabilities will make the following possible: longer baselines in differential positioning mode due to the reduction of atmospheric errors, faster resolution of carrier-phase ambiguities when performing RTK positioning and enhanced positioning precision due to the additional measurements.

The OEMV-3 is hardware-capable for tracking L5 but requires a future firmware upgrade to enable L5 positioning. This will be available when a usable number of satellites are in orbit.

In addition to the functionality given in *Section 1.1.1* on *Page 20*, the OEMV-3 offers:

- 14 L2 P(Y) or L2C channels
- 12 GLONASS L1 channels
- 12 GLONASS L2 channels
- 6 L5 channels
- Integrated L-band (OmniSTAR VBS, HP or XP and CDGPS)
- AdVance RTK real-time 2 cm (RT-2) positioning capability for GPS-only and GPS + GLONASS
- 2 CAN Bus (including transceivers), 1 RS-232/RS-422, 1 RS-232, 1 USB 1.1 and 1 LV-TTL communication ports
- An external oscillator input
- Auxiliary strobe signals for status and synchronization

- On-board power conversion, eliminating the need for external power conditioning
- Voltage and temperature monitoring and reporting
- Software load compatibility with other OEMV family products
- Increased memory size and processor speed
- Optional Application Program Interface (API) software for loading a custom application

Included with the OEMV is a wrist-grounding strap to prevent ESD damage when handling the card and a CD containing NovAtel's PC utilities and product documentation.

For technical specifications on the OEMV-3 please see *Section A.5* starting on *Page 147*.

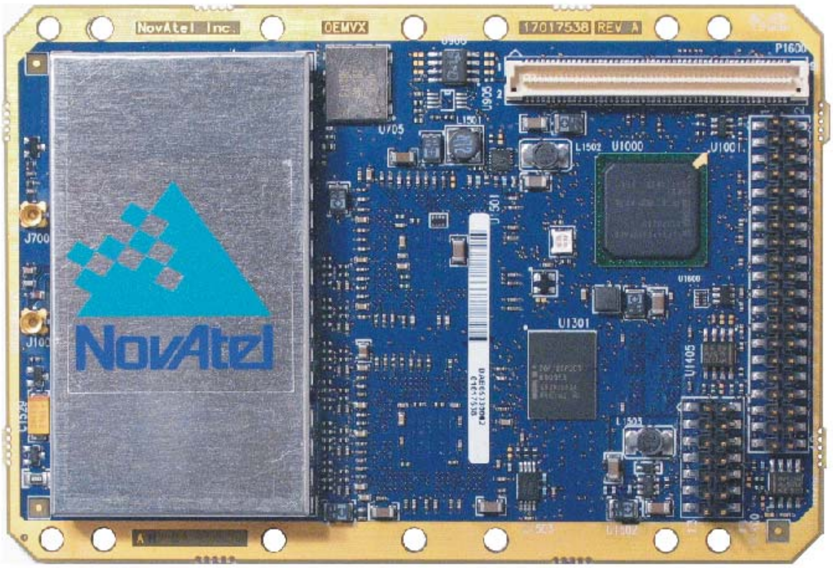


Figure 5: OEMV-3 Card

1.3 OEMV-Based Enclosures

The OEMV-3 can be housed in a DL-V3 or ProPak-V3 enclosure to provide a complete receiver solution. The OEMV-2, OEMV-1 and OEMV-1G cards can be housed in a FlexPak. The OEMV-1 card can be housed in a SMART-V1 while the OEMV-1G card can be housed in a SMART-V1G.

When connected to an antenna and a power source, the enclosure and associated OEMV card together form a fully functioning GNSS receiver.

The 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.

The table below provides a comparison between the features available on the various enclosures. The sections that follow give details on each of them.

Table 1: Enclosure Features Comparison

Feature	DL-V3	ProPak-V3	FlexPak-V2	FlexPak-V1G	FlexPak-V1	SMART-V1	SMART-V1G
OEM Card Supported	OEMV-3	OEMV-3	OEMV-2	OEMV-1G	OEMV-1	OEMV-1	OEMV-1G
Serial Ports	3 DB-9P connectors	3 DB-9P connectors	2 Deutsch connectors	2 Deutsch connectors	2 Deutsch connectors	1 Switchcraft connector	1 Switchcraft connector
USB 1.1	Yes	Yes	Yes	Yes	Yes	On select models	Yes
Ethernet	Yes	No	No	No	No	No	No
Strobe Port	DB-9S connector	DB-9S connector	Deutsch[a] connector	Deutsch[a] connector	Deutsch[a] connector	Switchcraft connector	Switchcraft connector
Input (DC) Voltage	+9 to +28 V	+9 to +18 V	+6 to +18 V	+6 to +18 V	+6 to +18 V	+9 to +28 V	+9 to +28V
L-band Differential Corrections [b]	OmniSTAR (HP, XP or VBS) and CDGPS	OmniSTAR (HP, XP or VBS) and CDGPS	Not available	Not available	OmniSTAR VBS and CDGPS	OmniSTAR VBS and CDGPS	Not available
GPS+ GLONASS Positioning	Yes	Yes	Yes	Yes	Not available	Not available	Yes
AdVance RTK	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IMU Support with SPAN Firmware Option [c]	Not available	Yes	Not available	Not available	Not available	Not available	Not available

a. If Pin# 1 on the Deutsch connector is grounded, the COM2 communications mode is set to RS-422.

b. A subscription to the OmniSTAR service, or use of the free CDGPS service, is required. Both services are regional, see *Section 5.4* starting on *Page 82*.

c. If applicable, refer also to your *SPAN for OEMV User Manual*

1.3.1 ProPak-V3 and DL-V3

The features of the OEMV-3 are available within the DL-V3 and ProPak-V3. These enclosures, see *Figure 6* below, offer GNSS integrators an effective, self-contained system for indoor applications while also providing a rugged, water, shock, and vibration resistant housing for outdoor applications. The DL-V3 is also capable of data logging (DL) using the removable Compact Flash (CF) card.

Figure 6: DL-V3 (top) and ProPak-V3 (bottom) Enclosures

DL-V3

The DL-V3 also offers the following features:

- Rugged waterproof aluminum enclosure with removable compact flash
- Auxiliary status and synchronization signals
- GNSS antenna and power ports
- Bluetooth interaction between the receiver and a user-supplied Bluetooth-equipped laptop/PDA/PC through COM3. Bluetooth is the default on COM3 but Ethernet capability is configurable. See also *Ethernet Configuration* starting on *Page 191*.

When the DL-V3 is in range, your computer can recognize it and is able to access it using this password: 0000 (four zeroes).

- External oscillator, USB, and Ethernet dedicated connectors
- LED indicators to provide power status, communication status, number of GPS satellites, CF memory, position mode, occupation time, Bluetooth status and Ethernet status

The following accessories are included with the DL-V3:

- Compact Flash Card for data storage
- Cables:
  - straight through serial
  - null modem serial
  - I/O
  - 12 V power cable
- A CD containing NovAtel's PC utilities and product documentation

For technical specifications on the DL-V3, please see *Section A.6* starting on *Page 155*.

PROPAK-V3

The ProPak-V3 also offers the following features:

- A rugged waterproof enclosure
- Auxiliary status and synchronization signals
- GNSS antenna and power ports
- Support of peripheral devices, including an Inertial Measurement Unit (IMU) for combined GPS-inertial navigation, refer to the *SPAN for OEMV User Manual*
- An external oscillator connector
- Indicators to provide power and communication status

The following accessories are included with the ProPak-V3:

- Cables:
  - straight through serial
  - null modem serial
  - USB serial
  - 12 V power cable
- A CD containing NovAtel's PC utilities and product documentation

For technical specifications on the ProPak-V3, please see *Section A.7* starting on *Page 163*.

1.3.2 FlexPak

NovAtel's FlexPak is a rugged, waterproof housing for the OEMV-2, OEMV-1G or OEMV-1 engine. As a result, the FlexPak can deliver centimeter-level positioning in a compact, lightweight enclosure. The FlexPak-V2 provides dual-frequency positioning with a USB interface and an API option for supporting custom applications. Each FlexPak receiver has two SBAS channels. FlexPak-V1G is a GPS + GLONASS model. There are also FlexPak-V1 GPS + L-band and FlexPak-V2 GPS + GLONASS models available.

The FlexPak offers the following features:

- A waterproof, shock and dust resistant enclosure
- Low power consumption
- Two serial ports (COM1 is RS-232 and COM2 is RS-232/RS-422[1])
- USB support
- PPS output
- Configurable event inputs
- Indicators for position, communication status and power

The following accessories are included with the FlexPak:

- 12 V power adapter cable
- Data cables
    - straight through serial
    - null modem serial
    - USB serial
    - 12V power adapter
- A CD containing NovAtel's PC utilities and product documentation

For technical specifications on the FlexPak, please see *Section A.8* on *Page 171*.

Figure 7: FlexPak Enclosure

1. If Pin# 1 on the Deutsch connector is grounded, the COM2 communications mode is set to RS-422.

1.3.3 SMART-V1 and SMART-V1G

NovAtel’s SMART-V1/SMART-V1G is a rugged, self-contained GNSS receiver and antenna. It is specially designed for harsh tracking environments in a number of applications.

The SMART-V1 is available in three side-mount configurations to suit your integration requirements: USB, CAN or RS-422. The SMART-V1G is available with the USB configuration.

The SMART-V1 and SMART -V1G offers the following features:

- A waterproof, shock and dust resistant enclosure
- Environmentally sealed unit is designed to meet or exceed MIL-STD 810
- Low power consumption
- USB support on USB models
- Configurable event input

The SMART-V1 offers the following features:

- Two serial ports (2 RS-232 or 1 RS-232 and 1 RS-422 on RS-422 models)
- CAN Bus support on CAN models
- Integrated L-band capability for OmniSTAR VBS and CDGPS positioning

The SMART-V1G offers the following features:

- Two serial ports (RS-232)
- Integrated GPS+GLONASS positioning

The following accessories are included with the SMART-V1 and SMART-V1G:

- Quick Start Guide
- CD containing an installation program for NovAtel’s **CDU** graphical user interface software, other PC utilities and product documentation, including user manuals

Cables are also available as optional accessories. For technical specifications on the SMART-V1/V1G, including optional cables, please see *Section A.9, SMART-V1/SMART-V1G* starting on *Page 179*.

Figure 8: SMART-V1/SMART-V1G Antenna

Chapter 2 Receiver System Overview

In addition to a NovAtel OEMV card, a complete GNSS receiver system typically contains four other major components:

- A custom enclosure and wiring harness
- A GNSS antenna (and optional LNA power supply)
- A power supply
- Data communications equipment

The overall system is represented in *Figure 9*. A brief description of the Radio Frequency (RF) and Digital Electronics sections follow the figure. The components above are also described. Details of installation and set up are provided in *Chapter 3, Installation and Set Up on Page 33*.

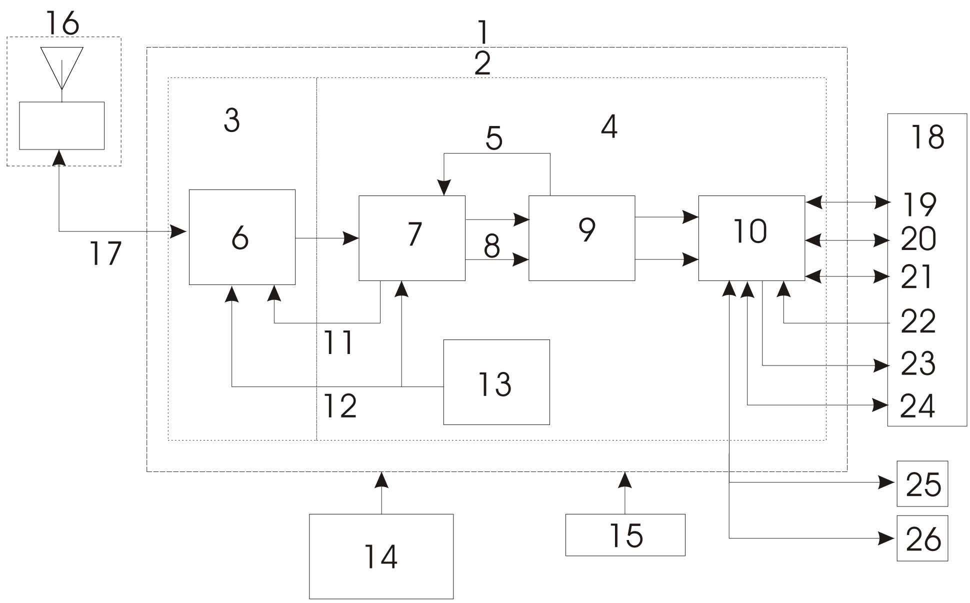


Figure 9: GNSS Receiver System Functional Diagram

Reference	Description	Reference	Description
1	Enclosure	14	Optional LNA Power
2	OEMV Card	15	Power Supply
3	RF Section	16	GNSS Antennaand LNA
4	Digital Section	17	RF, Coaxial Cable and Power
5	Controls	18	Data and Signal Processing
6	RF-IF Sections	19	COM1
7	Signal Processor	20	COM2
8	Clock	21	COM3

9	32-Bit CPU	22	Input Timing Signal
10	System I/O	23	Output Timing Signal
11	AGC	24	USB Communication
12	Clock	25	CAN Communication 1
13	VCTCXO	26	CAN Communication 2

2.1 OEMV Card

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

2.1.1 Radio Frequency (RF) Section

The receiver obtains a filtered and amplified GNSS signal from the antenna via the coaxial cable. The RF section performs the translation of the incoming RF signal to an Intermediate Frequency (IF) signal usable by the digital section. It also supplies power to the active antenna's LNA through the coaxial cable while maintaining isolation between the DC and RF paths. The RF section can reject a high level of potential interference (for example, MSAT, Inmarsat, cellular phone, and TV sub-harmonic signals).

2.1.2 Digital Electronics Section

The digital section of the receiver receives a down-converted, amplified GNSS signal which it digitizes and processes to obtain a GNSS solution (position, velocity and time). The digital section consists of an analog-to-digital converter, a 32-bit system processor, memory, control and configuration logic, signal processing circuitry, serial peripheral devices, and supporting circuitry.

The digital section performs the translations and calculations necessary to convert the IF analog signals into usable position and status information. It also handles all I/O functions, including the auxiliary strobe signals, which are described in detail in *Section 3.3.1 on Page 43*. For input and output levels please see *Appendix A, Table 31, OEMV-3 Strobes* on *Page 150, Table 29, OEMV-2 Strobes* on *Page 144* and *Table 25, OEMV-1 Strobes* on *Page 132*.

2.2 Enclosure and Wiring Harness

An enclosure is necessary to protect the OEMV card from environmental exposure and RF interference. A user-supplied wiring harness is also required to provide an interface to the OEMV card's antenna and power inputs and data and status signals.

2.3 GNSS Antenna

The purpose of the GNSS antenna is to convert the electromagnetic waves transmitted by the GNSS satellites into RF signals. An active GNSS antenna is required for the receiver to function properly. NovAtel's active antennas are recommended because of their precise phase centres and robust enclosures.

2.3.1 Optional LNA Power Supply

Power for the antenna LNA is normally supplied by the receiver but not, for example, by the OEMV-2 card. If a different type of antenna is required that is incompatible with this supply, then you could connect an external power source to the receiver. See also *Antenna LNA Power* on *Page 50*.

2.4 Principal Power Supply

A single external power supply capable of delivering the minimum receiver voltage necessary to operate the receiver. Minimum voltage varies per card, see *Table 3, Voltage Input Range for OEMV* on *Page 35* and *Appendix A, Technical Specifications* on *Page 128* for details.

WARNING: 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.

2.5 Data Communications Equipment

A PC, laptop or other data communications equipment is necessary to communicate with the receiver and, if desired, to store data generated by the receiver.

Chapter 3 Installation and Set Up

This chapter contains instructions and tips to set up your NovAtel receiver to create a GNSS receiver system similar to that described in *Chapter 2, Receiver System Overview* on *Page 30*.

3.1 Additional Equipment Required

In order for the receiver to perform optimally, the following additional equipment is required:

- An interface for power, communications, and other signals and an enclosure to protect against the environment
- A NovAtel GNSS antenna
- A quality coaxial cable (and interconnect adapter cable as necessary)
- Data communication equipment capable of serial communication
- A serial cable (if not included with the receiver)
- A power supply
- A power cable (if not included with the receiver)

CAUTION: When the OEMV family receiver is installed in a permanent location, such as in a building, it should be protected by a lightning protection device according to local building codes. See also *Warranty* on *Page 17*.

3.1.1 Selecting a GNSS Antenna

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

NovAtel offers a variety of single and dual-frequency GNSS antenna models, as indicated in *Table 2* on *Page 34*. All include band-pass filtering and an LNA. The GNSS antenna you choose will depend on your particular application. Each of these models offer exceptional phase-center stability as well as a significant measure of immunity against multipath interference. Each one has an environmentally-sealed radome. The ANT-532-C, ANT-533, ANT-534-C, ANT-536-C, ANT-537, ANT-538, GPS-702L, GPS-701-GG, GPS-702-GG, GPS-701-GGL and GPS-702-GGL are RoHS compliant.

Table 2: NovAtel GNSS Antenna Models

Models	Frequencies Supported	GPS	GLONASS
701, 511, 521, 536, 537	L1 only	✓	✗
702, 532, 533	L1 and L2	✓	✗
702L, 534	L1 and L2 plus L-band	✓	✗
701GGL, 538	L1 plus L-band	✓	✓
701GG	L1 only	✓	✓
702GGL	L1 and L2 plus L-band	✓	✓
702GG	L1 and L2	✓	✓

3.1.2 Choosing a Coaxial Cable

An appropriate coaxial cable is one that matches the impedance of the antenna and receiver being used (50 ohms), and whose line loss does not exceed 10.0 dB. If the limit is exceeded, excessive signal degradation occurs and the receiver may not be able to meet its performance specifications. NovAtel offers a variety of coaxial cables to meet your GNSS antenna interconnection requirements, including:

- 5, 15, or 30 m antenna cables with TNC male connectors on both ends (NovAtel part numbers C006, C016 and C032 respectively)
- 22 cm interconnect adapter cable between the MCX (OEMV-1/OEMV-1G) or MMCX (OEMV-2/OEMV-3) and the TNC connectors (NovAtel part #GPS-C002)

Note that a conversion is required between the female MCX connector on the OEMV-1 and OEMV-1G, the male MMCX connector on the OEMV-2, or the male MMCX connector on the OEMV-3, and the female TNC connector on NovAtel's GNSS antennas.

Your local NovAtel dealer can advise you about your specific configuration. If your application requires the use of cable longer than 30 m, refer to the application note *RF Equipment Selection and Installation* on our website at www.novatel.com, or you can obtain it directly from NovAtel.

High-quality coaxial cables should be used because a mismatch in impedance, possible with lower quality cable, produces reflections in the cable that increase signal loss. Though it is possible to use other high-quality antenna cables, the performance specifications of the OEMV family receivers are warranted only when used with NovAtel-supplied accessories.

3.1.3 Power Supply Requirements

This section contains information on the requirements for the input power to the receiver. See *Appendix A, Technical Specifications* starting on *Page 128* for more power supply specifications.

WARNING: 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.

OEMV Cards

The OEMV card contains a DC to DC converter that is very tolerant to noise and ripple at its input. A tightly regulated input supply to the OEMV-3 card is not required, as long as it falls within the given input range. A tightly regulated input supply to the OEMV-1, OEMV-1G or OEMV-2 card is required. The power supply used for any OEMV card should be capable of 5 W. The voltage input range for each the OEMV cards is given in *Table 3* on *Page 35*.

Table 3: Voltage Input Range for OEMV

OEMV Card	Power Input Range
OEMV-1	+3.3 V DC +5%/-3%
OEMV-1G	+3.3 V DC +5%/-3%
OEMV-2	+3.3 V DC +5%/-3%
OEMV-3	+4.5 to +18 V DC

All members of the OEMV family receivers are designed to prevent internal damage when subjected to a reverse polarity power connection. The OEMV also provides 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 OEMV card's requirements.

DL-V3, ProPak-V3, FlexPak or SMART Enclosures

The DL-V3, ProPak-V3, FlexPak-V2, FlexPak-V1G and FlexPak-V1 enclosures are supplied with a 12V power adapter with a built-in 3 A slow-blow fuse for use with a standard 12 V DC power outlet. In the case of the DL-V3, you can choose to press its power button or wait for the power sequence, when it will monitor the serial ports, as long as a valid voltage is present at the power supply input, see *DL-V3 Power Down and the Power Button* on *Page 40*.

If a different supply is desired, the table below provides the input range and type of connector required to mate with the enclosure's power connector. The supply should be capable of 5 W.

Table 4: Enclosure Power Requirements

Enclosure	Power Cable Connector Required	Power Input Range
DL-V3	4-pin LEMO socket connector [a] labelled *PWR*	+9 to +28 V DC
ProPak-V3	4-pin LEMO socket connector [a] labelled *PWR*	+6 to +18 V DC [b]
FlexPak-V1/V1G/V2	3-pin Deutsch socket connector [a] labelled ⏻	+6 to +18 V DC
SMART-V1/V1G	18-pin Switchcraft connector (not labelled) [c]	+9 to +28 V DC

a. See *Appendix D, Replacement Parts* on *Page 215* for connector part numbers.

b. +9 to +18 V DC when connected to an IMU. If applicable, see the *SPAN Technology User Manual* for more information.

c. Bare wires on the optional cables are labelled PWR, PWR2, GND and GND2, see also *Table 45* on *Page 186*

3.2 Installation Overview

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

1. Install the OEMV card in an enclosure with a wiring harness, as described in *Section 3.2.1* on *Page 36*.
2. Mount the GNSS antenna to a secure, stable structure, as described in *Section 3.2.3* on *Page 39*.
3. Connect the GNSS antenna to the receiver using an antenna RF cable, using the information given in *Section 3.2.4* on *Page 40*.
4. Apply power to the receiver, as described in *Section 3.2.5* on *Page 40*.
5. Connect the receiver to a PC or other data communications equipment by following the information given in *Section 3.2.6* on *Page 41*.

3.2.1 Installing an OEMV Card in a Wiring Harness and Enclosure

To install an OEMV card, begin with the following:

1. Ensure you are taking the necessary precautions against ESD, as described in this section below.
2. Mount the OEMV card in a secure enclosure to reduce environmental exposure and RF interference, as described in this section in *Mounting the Printed Circuit Board* starting below.
3. Prepare a wiring harness to interface to the receiver's data, status, and power signals using the information given in *Preparing the Data, Signal & Power Harness* starting on *Page 37*.

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. It is imperative that ESD precautions be followed when handling or installing an OEMV card. Refer to the *Anti-Static Practices* section of the *GPS+ Reference Manual* for more information on ESD precautions.

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

When you remove the OEMV card from the original packing box, it is recommended that you save the box and ESD protection for future storage or shipment purposes.

CAUTION

- **Always wear a properly grounded anti-static wrist strap when handling the OEMV card.**
- Always hold the OEMV card by its corners or the RF shield, and avoid direct contact with any of the components.
- Do not let the OEMV card come in contact with clothing at any time because the grounding strap cannot dissipate static charges from fabrics.

- Failure to follow accepted ESD handling practices could cause damage to the OEMV card.
- Warranty may be voided if equipment is damaged by ESD.

Mounting the Printed Circuit Board

The OEMV family cards are OEM products and therefore 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 the following:

- mounting of external connectors
- protection from hostile physical environments (for example, rain, snow, sand, salt, water, extreme temperatures)
- electromagnetic shielding to protect from hostile RF environments (for example, nearby transmitters)
- electromagnetic shielding so that the final product itself conforms to RF emissions specifications

Integrator note: The card can not pass emissions testing by itself. It must be in an enclosure. For example, the ProPak-V3 passes regulatory emissions as shown in the *Notice* starting on *Page 10*. For more information on emissions testing, please refer to the regulatory body in your geographic area. For example, in North America that is the Federal Communications Commission (FCC) and in Europe the Conformité Européenne (CE).

- protection from ESD (see *Appendix B, Electrostatic Discharge Control (ESD) Practices* starting on *Page 188*)

The OEMV card can be held in place by screws when used in a custom assembly. Please see *Appendix A, Technical Specifications* starting on *Page 128* for mechanical drawings.

Preparing the Data, Signal & Power Harness

The wiring harness serves the following interconnect functions:

- provide access to the serial communications ports
- provide access to input and output timing strobes
- provide power input(s)
- provide access to control signals

For all OEMV cards, the power, status, and data inputs and outputs are accessed from a single connector. Therefore, the harness must be designed to mate with this connector.

As shown in *Figures 10*, *11* and *12*, the OEMV cards use a 20, 24 or 40-pin header for the data, power, and status signals. The RF input is a female MCX connector. An external oscillator input is available on the OEMV-2 and OEMV-3 dual frequency cards where the oscillator input is also a female MMCX connector. The pin outs for these connectors are specified in *Appendix A, Technical Specifications* starting on *Page 128* for the OEMV-1, OEMV-1G, OEMV-2 and OEMV-3 while their manufacturers' part numbers are in *Section D.5* on *Page 215*.

Figure 10: OEMV-1 and OEMV-1G Connector and Indicator Locations

.Reference	Description
1	J700 power, data, and signal connector (20 pin dual row male connector with a 2 mm straight 2 x 10 header)
2	LED status indicator
3	J100 RF signal input and LNA power output (MCX female connector)

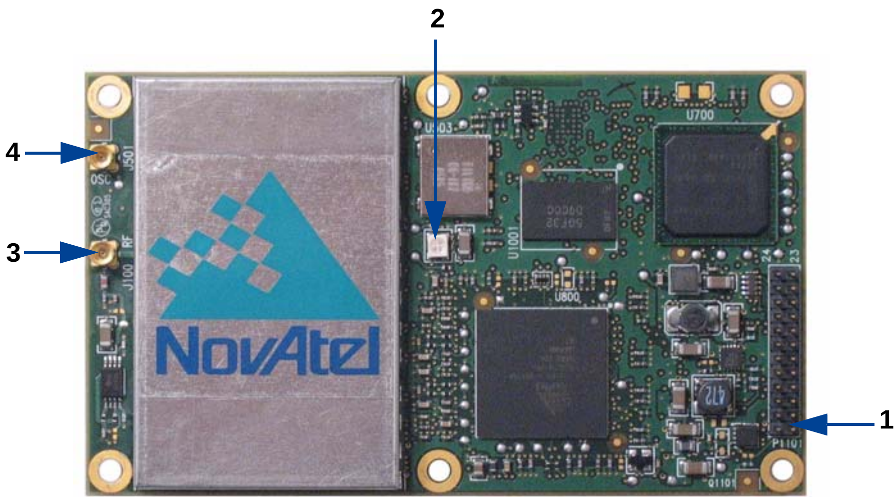


Figure 11: OEMV-2 Connector and Indicator Locations

Reference	Description
1	P1101 power, data, and signal connector (24 pin dual row male connector with a 2 mm straight 2 x 12 header)
2	LED status indicator
3	J100 RF signal input and LNA power output (MMCX female connector)
4	J501 external oscillator input (MMCX female connector)

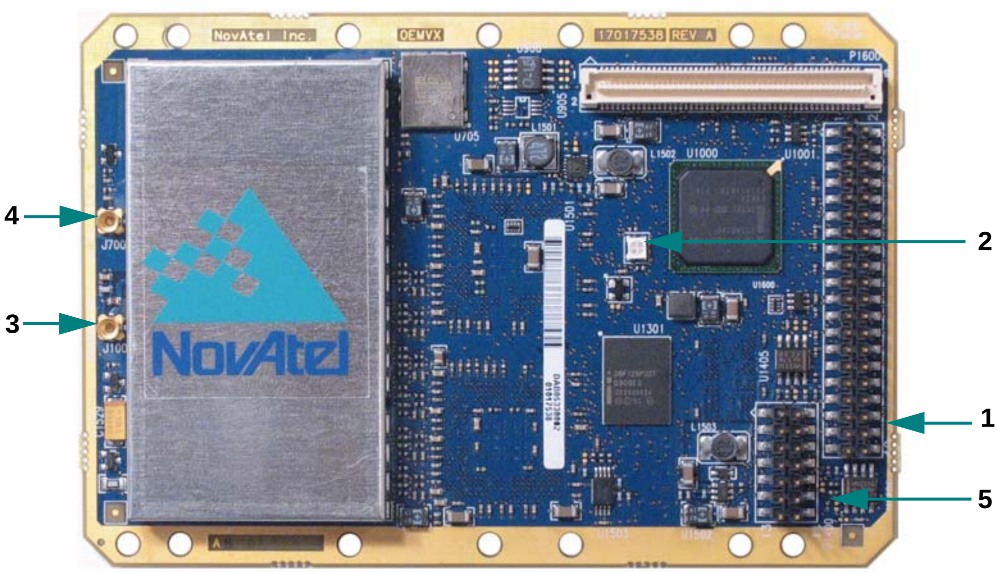


Figure 12: OEMV-3 Connector and Indicator Locations

Reference	Description
1	P1601 power, data, and signal connector (40 pin dual row male connector with 0.025” square pins and 0.1” spacing)
2	LED status indicator
3	J100 RF signal input and LNA power output (MMCX female connector)
4	J700 external oscillator input (MMCX female connector)
5	P1400 CAN Bus connector with transceiver

3.2.2 Mounting Bracket (DL-V3 and ProPak-V3 Only)

Along with the DL-V3 and ProPak-V3 enclosures, mounting kits are provided to facilitate mounting the receivers to a surface.

> ✉ The mounting kits are not designed for use in high-dynamics/vibration environments. Contact NovAtel if your application needs the DL-V3 or ProPak-V3 to be mounted in this type of environment.

To install the mounting bracket provided with the DL-V3 or ProPak-V3, refer to the instructions provided with the mounting kit. *Page 164* provides the dimension information for the bracket.

3.2.3 Mounting the GNSS Antenna

Once the OEMV card is installed in a wiring harness and enclosure, the antenna to be used with the receiver must be mounted. The GNSS receiver has been designed to operate with any of the NovAtel single-frequency or dual-frequency GNSS antenna models. See *Section 3.1.1* on *Page 33* for more information.

When installing the antenna system:

- Choose an antenna location that has a clear view of the sky so that each satellite above the horizon can be tracked without obstruction. (Refer to the *Multipath* section in the *GPS+ Reference Manual*).
- Mount the antenna on a secure, stable structure capable of safe operation in the specific environment.

3.2.4 Connecting the Antenna to the Receiver

Connect the antenna to the receiver using high-quality coaxial cable, as discussed in *Section 3.1.2* on *Page 34*.

The DL-V3, ProPak-V3 and FlexPak enclosures provide a TNC female connector, which can be connected to the antenna directly with any of NovAtel's coaxial cables. For the OEMV cards, an interconnect adapter cable is required to convert the TNC male end of the coaxial cable to the card's MCX (OEMV-1/OEMV-1G) or MMCX (OEMV-2/OEMV-3) female RF input connector. The location of the RF connector for the each of the OEMV cards is shown in *Appendix A, Technical Specifications* starting on *Page 128*.

The SMART-V1/SMART-V1G is a combined receiver and antenna, therefore no external antenna connection is necessary.

3.2.5 Applying Power to the Receiver

Connect the power supply, set to the voltage given in *Table 3, Voltage Input Range for OEMV* on *Page 35*, to the wiring harness created previously.

For a DL-V3, ProPak-V3, FlexPak-V1, FlexPak-V1G, FlexPak-V2, SMART-V1 or SMART-V1G, connect a power supply to the power port. For the DL-V3 you can choose to press its power button or wait for the power sequence, see *DL-V3 Power Down and the Power Button* starting below. See also *Table 4, Enclosure Power Requirements* on *Page 35*.

DL-V3 Power Down and the Power Button

DL-V3 incorporates a power button on its front end-cap, see *Figure 6 on Page 26*. Pressing this switch, sends a signal to the microprocessor to turn on or off the GNSS receiver.

The DL-V3 has a low-power mode called power-down mode. To enter this low-power mode, press the power button for at least three but no more than seven seconds, then release it. This is also the mode the receiver enters into after applying power. In the power-down mode, all logging is disabled.

While power consumption in power-down mode is minimal, less than 10 mA, the DL-V3 is not completely off. If power conservation is important in your application, disconnect the power source from the DL-V3 when it is not in use.

Press the power button momentarily to turn the DL-V3 back on. Also, the DL-V3 monitors its COM1 and COM2 serial ports. Power-up is triggered on these ports by a DC level of at least +5 V on either RX or TX. The receiver does not detect activity on COM3. For example, if a key is pressed on a handheld data logger that is plugged into COM1 or COM2, the time required to come on is only a few seconds. However, it may require an additional few minutes to establish an initial time and position. During power-down and power-up time, the serial ports do not process data. You must wait until the receiver outputs an RXSTATUSA log with a BOOTOK message before typing any commands. Ensure that your host application (especially Windows) does not poll these COM ports periodically to cause an accidental power-up.

The automatic power-down feature is disabled when logging is in progress. However, if the power button is pressed while the DL-V3 is logging data autonomously, the DL-V3 saves any open data files and then goes into power-down mode.

An additional function of the power button is that it resets the DL-V3 if it is held depressed for at least 10 seconds. This system reset clears stored logging parameters and reverts to a factory configuration when the power button is released.

3.2.6 Connecting Data Communications Equipment

In order to communicate with the receiver by sending commands and obtaining logs, a connection to some form of data communications equipment is required. In the case of the DL-V3, your laptop/PC can also communicate with the receiver using the Bluetooth interface. The default configuration available for each of the receiver types, except for the SMART-V1 or SMART-V1G, is given in *Table 5* on *Page 41*. Details on the SMART-V1 and SMART-V1G port can be seen in *Table 6*, at the bottom of this page, and its pin-out tables, in *Appendix A* on *Page 181*, for both US, CAN and RS-422 models.

However, if desired, on some receivers, the serial ports can be factory configured for either RS-232, RS-422, or LVTTL operation. Consult NovAtel Customer Service for more details. See *Appendix A, Technical Specifications* starting on *Page 128* for data connection details.

Table 5: Default Serial Port Configurations

Receiver	COM1	COM2	COM3	AUX
OEMV-1/ OEMV-1G	LVTTL	LVTTL	USB D+ (default)	N/A
OEMV-2	RS-232	LVTTL	LVTTL	N/A
OEMV-3	RS-232 / RS-422, see *User-Selectable Port Configuration* starting on *Page 42*	Factory-configurable RS-232 \ LVTTL	LVTTL	N/A
DL-V3	RS-232	RS-232	Bluetooth (default) or Ethernet	RS-232
ProPak-V3	Factory-configurable RS-232 \ RS-422	RS-232	Factory-configurable RS-232 \ RS-422 [a]	N/A
FlexPak-V1/V1G/V2	RS-232	RS-232 / RS-422, see *User-Selectable Port Configuration* starting on *Page 42*	Not available	N/A

a. You must use COM3 instead of AUX to send commands or request logs on the ProPak-V3 AUX port.

Table 6: SMART-V1/SMART-V1G Port Configuration

Model	Ports
USB (RS-232 only)	The single port on the USB model of the SMART-V1 or SMART-V1G can be used for COM1, COM2 or USB
CAN (RS-232 only)	The single port on the CAN model of the SMART-V1 can be used for COM1, CAN or COM3
RS-422 (RS-232 and RS-422)	The single port on the RS-422 model of the SMART-V1 can be used for RS-422 COM1, RS-232 COM2 or RS-422 COM3

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

- Data Terminal Ready (DTR)
- Clear To Send (CTS)
- Transmitted Data (TXD)
- Request To Send (RTS)
- Received Data (RXD)
- Data Carrier Detect (DCD)

On many of the receivers, extra control lines are provided on COM2 for use with modems or other differential correction data links.

The DL-V3, ProPak-V3 and FlexPak 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.

The port settings (bit rate, parity, and so on) are software-configurable. These are further described in *Chapter 4, Operation* on *Page 55*. See *Appendix A, Technical Specifications* starting on *Page 128* for further information on data communications characteristics.

The SMART-V1/SMART-V1G multi-cable is available in six configurations: two for the USB, two for the CAN (SMART-V1 only) and two for the RS-422 (SMART-V1 only) model. All 6 cables are 3 m in length. *Appendix A, Technical Specifications* starting on *Page 184* illustrates the models, their cable options, pinouts and drawings.

User-Selectable Port Configuration

The FlexPak-V1, FlexPak-V1G and FlexPak-V2 are RS-232/RS-422-selectable through pin 1 of COM2, see *Table 38* on *Page 174* and *Section A.8.2.2* on *Page 176*.

The ProPak-V3 is not user-selectable but can be factory-configured on both COM1 and COM3 for RS-232 or RS-422 operation, see *Table 36, ProPak-V3 I/O Port Pin-Out Descriptions* on *Page 165*.

The DL-V3 is RS-232 only but its COM3 port has Bluetooth/Ethernet configuration options. See *DL-V3 COM3 Configuration* starting on *Page 43*.

The OEMV-3 offers a user-selectable configuration for the COM1 port.

For OEMV-3, the configuration is selected using the USERIO1 pin. By default, RS-232 is selected as the USERIO1 input is set LOW by an internal pull-down resistor. To select RS-422 upon startup, apply 3.3 V to USERIO1. Alternatively, tie USERIO1 to pin 38 of the 40-pin connector on the OEMV-3.

Pin 38, on the 40-pin connector, is usually an ERROR indicator, and during normal OEMV card operations is set LOW, but for < 2 s during OEMV card initialization, immediately after applying power to the OEMV card, this pin is set HIGH at 3.3 Volts. It drops to LOW <2 s later when the OEMV card has been fully booted up and the [COMx] prompt is output from the OEMV card on all COM ports.

USERIO1 needs to be initialized HIGH during this initial boot-up phase in order to set up the COM1 port for RS-422 mode. Therefore, tie pin 38 to a 3.3 V source to trigger the USERIO1, to set the COM1 port to RS-422 mode.

DL-V3 COM3 Configuration

You can switch between Ethernet and Bluetooth (default) on COM3 using the APPCONTROL command. In the case of switching to Ethernet, power is automatically applied to it after switching. Bluetooth, on the other hand, may be in sleep mode. If Bluetooth operation is required, it must be put into active mode using the COMVOUT command. The ethenet requires more setup configuration steps. These involve configuring serial, and network, parameters. See also *Appendix C* starting on *Page 191* for details.

Further details on the commands above can be found in the *DL-V3 Firmware Reference Manual*.

3.3 Additional Features and Information

This section contains information on the additional features of the OEMV family receivers, which may affect the overall design of your receiver system.

3.3.1 Strobes

On OEMV family receivers, a set of inputs and outputs provide status and synchronization signals. These signals are referred to as strobes. Not all strobe signals are provided on all receivers. However, for those products for which strobes are available, you may want to design your installation to include support for these signals.

Pin-out information can also be found in *Appendix A*:

- OEMV-1 pin-out starting on *Page 134*
- OEMV-1G pin-out starting on *Page 140*
- OEMV-2 pin-out starting on *Page 146*
- OEMV-3 pin-out starting on *Page 152*
- DL-V3 port pin-out on *Page 158*
- ProPak-V3 port pin-out on *Page 165*
- FlexPak-V1/V1G/V2 port pin-out starting on *Page 173*
- SMART-V1/V1G port pin-out starting on *Page 181*

3.3.2 Universal Serial Bus (USB)

OEMV family receivers, along with the accompanying NovAtel USB drivers for Windows 2000 and Windows XP, provide three virtual serial ports over a single USB 1.1 connection using USB D(+) and USB D(-) signals, see *Table 7* below.

Table 7: Available USB Signals on Receivers

Receiver	Pins/Ports
OEMV-1/OEMV-1G	Pin 3 and Pin 4
OEMV-2	Pin 21 and Pin 22
OEMV-3	Pin 3 and Pin 5
DL-V3	Dedicated USB port labelled:
ProPak-V3	COM1 Pins 6 and 9
FlexPak-V1/V1G/V2	COM1 Pins 11 and 12 or COM2 Pins 11 and 12
SMART-V1/v1G [a]	Pins 10 and 16

a. USB model only

The three virtual serial ports, identified by the OEMV receiver as USB1, USB2, and USB3, 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 PC. For example, if a PC has COM1 and COM2 ports, the NovAtel USB drivers assign COM3 to USB1, COM4 to USB2, and COM5 to USB3.

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

The NovAtel USB Configuration Utility installed with the NovAtel USB drivers allows you to change the COM port numbers assigned to the virtual serial ports. The USB drivers, along with installation instructions, are available on the OEMV Family CD by selecting *USB Support* from the main menu. You can also check for updates to the drivers or release notes on our website at www.novatel.com.

CAUTION Do not connect USB ports if USB communications is not being used or you may risk damaging your receiver.

3.3.3 CAN Bus

A Controller Area Network Bus (CAN Bus) is a rugged differential serial bus with a protocol that provides services for processes, data and network management.

CAN Bus is a generic term, as well as referring to a specific standard for several rugged differential bus standards that provide services for processes, data, and network management. NovAtel's MINOS5 ASIC incorporates a CAN Bus controller and the GPS engine creates and interprets the physical level signals, and low-level messages, that are compatible with the appropriate sections of the J1939 and ISO11783 standards. However, the integrator must be aware that there is no single software standard for such development, and a manufacturer can specify messages that are specific to its equipment without violating the standards. Accordingly, NovAtel allows integrators to support the protocol stack they require, to interface to NovAtel's device drivers, by incorporating this protocol stack within NovAtel's Application Program Interface (API). Integrators interested in this option are advised to contact NovAtel Customer Service for further information.

On the OEMV-1, OEMV-1G and OEMV-2 cards, the CAN port is shared with the EVENT2 input, the VARF output on the OEMV-1/ OEMV-1G, and the GPIO signal on the OEMV-2. The OEMV-1, OEMV-1G and OEMV-2 require external CAN transceivers and proper bus terminations. See *Section A.2, OEMV-1 Card* on *Page 134*, or *Section A.4, OEMV-2 Card* on *Page 146*, for pin-out information.

The OEMV-3 has two CAN transceivers, CAN1 and CAN2. See *Figure 55, Top-view of 14-Pin CAN Connector on the OEMV-3* on *Page 154*. Proper bus termination is required. CAN1 is for slow speed (up to 125 Kb/s) and CAN2 is for high speed (up to 1 Mb/s). Their CAN interface can be accessed using NovAtel's API, but requires that shared signals be disabled in order to avoid conflicts. Refer to the *OEMV Firmware Reference Manual* and, see also, *Table 8* on *Page 45*.

CAN Bus signals are not available on DL-V3, ProPak-V3 or FlexPak receivers. There is a CAN Bus-capable model of the SMART-V1 with its own multi-cable.

✉ CAN Bus functionality is controlled through NovAtel's optional API software. The API header file includes documentation on using the CAN bus. For example, `oemapi.h`.

Table 8: Available CAN Signals on Receivers

Receiver	CAN	Pins/Ports
OEMV-1 and OEMV-1G (no transceiver) J700	CAN1 Tx	Pin 7
	CAN1 Rx	Pin 6
	CAN2 Tx	Pin 20
	CAN2 Rx	Pin 8
OEMV-2 (no transceiver) P1100	CAN1 Tx	Pin 19
	CAN1 Rx	Pin 7
OEMV-3 (with transceiver) P1400	CAN1H	Pin 2
	CAN1L	Pin 1
	CAN2H	Pin 6
	CAN2L	Pin 5
SMART-V1	CANH	Pin 3
	CANL	Pin 4

3.3.4 Status Indicators

OEMV family receiver cards have LED indicators that provide the status of the receiver. The OEMV cards have a single indicator, which is shown in *Figure 12 on Page 39* for the OEMV-3. The LED blinks green on and off at approximately 1 Hz to indicate normal operation. If the indicator is red, then the receiver is not working properly. The operation of this indicator is further described in *Section 7.6* on *Page 121*.

The enclosures' status indicators are shown in *Tables 9* and *10* below and on *Page 46*. The LED status indicators on the front of the DL-V3 are shown in *Section 3.3.5* starting on *Page 46*.

Table 9: ProPak-V3 Status Indicators

Indicator	Indicator Color	Status
COM1	Green	Data is being transmitted from COM1
	Red	Data is being received on COM1
COM2	Green	Data is being transmitted from COM2
	Red	Data is being received on COM2
AUX	Green	Data is being transmitted from COM3
	Red	Data is being received on COM3
PWR	Red	The receiver is powered

Table 10: FlexPak Status Indicators

Indicator	FlexPak-V1/FlexPak-V1G	FlexPak-V2
Antenna/ Position Valid	Solid **GREEN** with valid position **/** No error mode	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	Flashing **GREEN** when transmitting data from COM1 **/** Flashing **RED** when receiving data on COM1
COM2	Flashing **GREEN** when transmitting data from COM1 **/** Flashing **RED** when receiving data on COM1	Flashing **GREEN** when transmitting data from COM1 **/** Flashing **RED** when receiving data on COM1
Power	Solid **RED** when +12V applied	Solid **RED** when +12V applied

3.3.5 DL-V3 Status Indicators

The LEDs on the front of the DL-V3 represent these categories:

- Power
- Receiver Status
- COMs (COM1, COM2 and AUX)
- COM3

- Satellite Tracking
- Flash Card Memory
- Positioning Mode
- Occupation Time

Power

The power indicator glows orange when the receiver is powered and then glows green once the receiver has been turned on. See also the *DL-V3 Power Down and the Power Button* section on *Page 40*.

Status

The status indicator flashes orange when the receiver is first turned on. Under normal operation, this LED is off. If a status event occurs, the LED flashes orange again. See also *Chapter 7, Built-In Status Tests* starting on *Page 117* and the *RXSTATUS* log.

Communication Ports (excluding COM3)

The top of the COM1, COM2 and AUX LEDs flash GREEN when transmitting data while the bottom of them flash AMBER when receiving data.

COM3

The COM3 section of the LED panel on the front of the DL-V3, has two LEDs:

- 1 for Bluetooth Mode (default)
- 1 for Ethernet Mode

Only one mode may be used at a time on COM3. The active mode's LED glows (blue for Bluetooth and orange for Ethernet). See also *Appendix C, Ethernet Configuration* starting on *Page 191*.

Satellite Tracking

The LED that is glowing, and its color, corresponds to the number of GPS-only, or GLONASS and GPS-combined, satellites being tracked by the DL-V3, where the first LED to the left is #1, see *Table 11*:

Table 11: Satellite Tracking LEDs

LED#	# of SVs	LED Color
1	≤ 3	Red
2	4 or 5	Amber
3	6 or 7	Green
4	8 or 9	Green
5	≥ 10	Green

Flash Card Memory

The number of LEDs that are glowing, and their colors, correspond to the amount of memory left in the DL-V3's compact flash card, where the first LED to the left is #1, see *Table 12*.

If all 5 flash card LEDs are flashing, it can mean that there is no compact flash card in the DL-V3, or that the card in the unit is not formatted (see *Section 3.3.8, DL-V3 Removable Compact Flash Memory Card* starting on *Page 51*).

Table 12: Flash Card Memory LEDs

# of LEDs	Capacity	LED Color
1	Capacity ≤ 20%	Red [a]
2	40% ≥ Capacity > 20%	Amber
3	60% ≥ Capacity > 40%	Green
4	80% ≥ Capacity > 60%	Green
5	Capacity > 80%	Green

a. This red LED can also mean that the card was not formatted, and placed in the receiver, when the receiver was powered off.

Positioning Mode

Which LEDs are glowing, or blinking, or off, and their colors, correspond to the DL-V3's current positioning mode. *Table 13* below shows the available positioning modes and their corresponding LEDs where the first LED to the left is #1, as you look at the DL-V3, and #5 is the furthest to the right. If the table cell shows the name of a color (red, amber or green) with a solid background, that LED is glowing solidly. The table cells that appear dim, behind their color name, indicate that the LED is flashing that color. The LED may also be off.

Table 13: Positioning Mode LEDs

Position Mode	Position Mode Detail	1	2	3	4	5
Single Point	Autonomous (fixed height)	Amber	Off	Off	Off	Off
	Autonomous (3D)	Amber	Off	Off	Off	Off
Differential GPS	SBAS	Off	Green	Off	Off	Off
	CDGPS	Off	Off	Green	Off	Off
	DGPS	Off	Green	Green	Off	Off
OmniSTAR	VBS (searching)	Amber	Green	Off	Off	Off
	VBS (pulling in)	Amber	Green	Off	Off	Off
	VBS	Amber	Green	Off	Off	Off
	XP (searching)	Amber	Off	Green	Off	Off
	XP (pulling in)	Amber	Off	Green	Off	Off
	XP	Amber	Off	Green	Off	Off
	HP (searching)	Amber	Green	Green	Off	Off
	HP (pulling in)	Amber	Green	Green	Off	Off
	HP	Amber	Green	Green	Off	Off
RTK	Float (RT-20, unconverged) [a]	Amber	Off	Off	Green	Off
	Float (RT-20) [a]	Amber	Off	Off	Green	Off
	Fixed (RT-2, unconverged)	Amber	Off	Off	Off	Green
	Fixed (RT-2)	Amber	Off	Off	Off	Green

a. If you have a GPS+GLONASS model, the same LED indication used for RT-20 GPS-only is used for RT-20 GPS + GLONASS. The LEDs show the total number of satellites used in the solution (GPS or GPS + GLONASS) without making a distinction between GPS and GLONASS. Check the *Constellation* window in CDU for details on the availability of GPS and GLONASS satellites, see *Section 6.2, CDU* starting on *Page 99*.

Occupation Time

The LED that is glowing green corresponds to the DL-V3's occupation time gauge. The occupation time LEDs provide an indication of whether sufficient data has been collected for successfully post processing data for the indicated baseline. The LED that appears corresponds to the baseline length that you can process your data to, where the first LED to the left is #1. The occupation time gauge has the following values from left to right, see *Table 14:*

Table 14: Occupation Time LEDs

LED#	Baseline Length (km)	LED Color
1	≤ 5	Green
2	> 5 ≤ 10	Green
3	> 10 ≤ 15	Green
4	> 15 ≤ 20	Green
5	≥ 20	Green

3.3.6 External Oscillator (OEMV-2, OEMV-3, DL-V3 and ProPak-V3 only)

For certain applications requiring greater precision than what is possible using the on-board 20 MHz, voltage-controlled, temperature-compensated crystal oscillator (VCTCXO), you may wish to connect the OEMV to an external, high-stability oscillator. The external oscillator can be either 5 MHz or 10 MHz.

Operation consists of connecting a cable from the external oscillator to the receiver's external oscillator input connector. For the DL-V3 and ProPak-V3, the BNC external oscillator port, labelled **OSC**, is used. See *Figure 6, DL-V3 (top) and ProPak-V3 (bottom) Enclosures* on *Page 26*. For the OEMV-3, an MMCX female connector (J700) is used, as shown in *Figure 12 on Page 39*. On the OEMV-2, the external oscillator connector is J501, see *Figure 11 on Page 38*. The receiver does not have to be powered down during this procedure. If you are handling the OEMV card directly, anti-static practices must be observed.

Once the external oscillator has been installed, the EXTERNALCLOCK command must be issued to define the clock model (for example, cesium, rubidium or ovenized crystal). If the input clock rate is 5 MHz, the EXTERNALCLOCK command must be issued to change the 10 MHz default rate.

3.3.7 Antenna LNA Power

Receiver RF input gain requirements are easily met when using NovAtel antennas and coaxial cables. NovAtel antennas employ a built-in, low-noise amplifier (LNA), which typically provides 26 dB of gain to the received satellite signal. The power to the antenna LNA is provided through the center conductor of the receiver's RF port. To achieve the required input gain to the receiver, NovAtel coaxial cables have been designed to exhibit no more than 6 dB loss. Antenna supply over-current protection is provided on the OEMV cards and is limited to 100mA.

The OEMV family receivers and their LNA capabilities are listed in this section.

OEMV-3

For the OEMV-3 it is possible to supply power to the LNA of an active antenna either from the antenna port of the OEMV-3 card itself or from an external source. The internal antenna power supply of the OEMV-3 cards can produce +4.75 to +5.10 V DC at up to 100 mA; enough for NovAtel's dual-frequency GNSS antennas, so that an additional LNA power supply is not normally required.

If a different antenna is used whose LNA requires voltage capacity beyond what the receiver can produce, then the external LNA power option must be utilized. This simply requires setting an external voltage supply between +5.5 and +18 V DC, 100 mA maximum, and connecting it to pin 40 of the 40-pin connector on the OEMV-3. See also *Appendix A, OEMV-3, LNA_PWR* on *Page 153*.

In either case, the LNA power is fed to the antenna through the same coaxial cable used for the RF signals (LNA power is enabled by default). The internal LNA power source should be disabled using the ANTENNAPOWER command.

OEMV-2

The OEMV-2 card supplies power to the active antenna LNA from its internal LNA supply only.

OEMV-1 and OEMV-1G

The OEMV-1 and OEMV-1G cards use external LNA power only. Set the external voltage supply between +5.5 and +16 V DC and connect it to pin 1 of the OEMV-1, or OEMV-1G, 20-pin connector. See also *Appendix A, OEMV-1, RF Input / LNA Power Output* on *Page 130* or *OEMV-1G, Page 136*.

CAUTION NovAtel guarantees performance specifications only using NovAtel antennas.

3.3.8 DL-V3 Removable Compact Flash Memory Card

Data commands and logs can be recorded from the DL-V3 to a removable Compact Flash (CF) card. The need for a companion handheld data logger is avoided when continuous user interaction is not required, since the DL-V3 is capable of logging data according to pre-configured parameters without any user intervention. In applications when continuous user interaction is required, a simple handheld controller can be used with the DL-V3, as the controller does not require its own data logging memory. The reduced handheld data logger or controller requirement simplifies your system and reduce its total cost and power consumption. By default only a log group named *default* exists. A *powerup* group must be created to take advantage of the automatic functionality, refer to the *DL-V3 Firmware Reference Manual* for more information.

WARNING: To minimize the possibility of damage, always keep the CF card cover closed and latched except when exchanging CF cards. **Do not change the card while logging is in progress. Data will be lost.** It is not necessary to turn the receiver off before inserting or extracting a CF card if you are not logging data.

An example of a 64 MB CF card is shown in *Figure 13* below.

Figure 13: 64 MB Flash Card

When you insert a CF card into the DL-V3, enter a DISK FORMAT command using the *Console* window in NovAtel's Control and Display Unit (**CDU**) graphical user interface software. Wait a few minutes and use the DL-V3 power button to turn it off and then on again. When power is returned, the DL-V3 should be able to recognize and use the CF card. For more information on **CDU** see *Section 6.2, CDU* starting on *Page 99*.

Data Logging

See *Section 4.4, Using the DL-V3* starting on *Page 62* to begin collecting data.

Collected data can either be transmitted to a host computer over a serial port, or stored on the CF card. If you choose to log data to the CF card, each logging session is stored in a single, unique file. These files can then be transferred to a host computer, for data analysis or other types of post-processing, by one of two methods:

- Transfer the data by means of serial communications, for example, *DL Explorer* in **CDU**
- Physically remove the CF card from the DL-V3 and insert it into the host computer, provided that it is also suitably equipped with a CF card port

Refer to the *DL Explorer* chapter, and the DL-V3 commands and logs, detailed in the *DL-V3 Firmware Reference Manual*.

Access Door

From *Figure 14, Compact Flash Card Door (shown with its latch in the open position)* on *Page 53*, you can see that the CF card access door is closed with a latch (reference **1** in *Figure 14 on Page 53*). As long as the latch is secured, it provides a water and dust-resistant seal around the CF card.

To open the CF card access door, turn the latch counter-clockwise, until it releases the door.

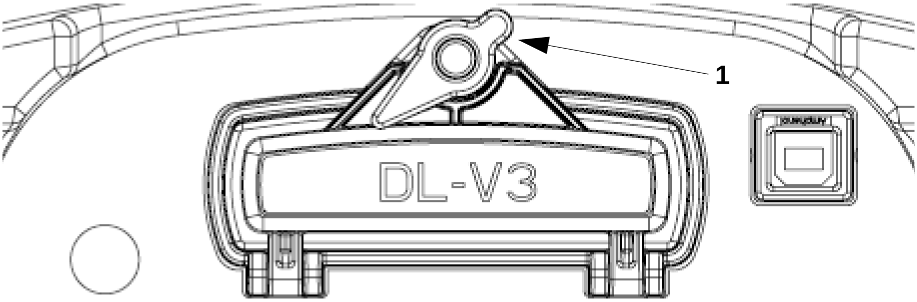


Figure 14: Compact Flash Card Door (shown with its latch in the open position)

To remove the CF card, unlock the access door. When the door is open, you can see an eject button to the left of the card. You must push this button to partially eject the card. Grasp the card and pull it all the way out.

WARNING: **Do not change the card while logging is in progress. Data will be lost.** It is not necessary to turn the receiver off before inserting or extracting a CF card if you are not logging data. See *Step 4, Stop the Data Logging* on *Page 64*.

To insert the card, ensure that it is correctly aligned before gently sliding it into the slot. When the card slides all the way in and locks in place, the eject button extends. If you attempt to insert the card incorrectly, it will not go all the way in, and the eject button will not extend. In this case, do not force the card! Remove it, orient it properly, and then insert it. After the card is locked in place, close the cover.

The data logging mechanism is designed to be robust and to endure power interruptions (and similar disruptive events) with minimum loss of data. In this situation, allow for your data to be possibly reduced by several seconds up to a maximum of five minutes. When possible, error messages are generated to identify problems as they arise. See also the RXSTATUS description in *Chapter 7, Built-In Status Tests* starting on *Page 33*.

Card Choice

You have the flexibility of choosing the CF card with the storage capacity that is the most appropriate for your needs, based on the selected logging rate. This is discussed in greater detail in *Section 4.4, Using the DL-V3* starting on *Page 62*.

Take for example the case where you have to format and use a CF card (the DL-V3 comes with a 64 MB card but up to a 2 GB card is compatible):

1. Connect your PC to COM1 of the DL-V3 at 9600 bps using a null modem cable with any simple terminal program, for example, HyperTerminal or **CDU**.
2. Power on the DL-V3 and wait until you see the BOOTOK message.
3. Type in LOG VERSION in the terminal program and press the <Enter> key to ensure you have a two-way serial connection with the DL-V3. If you do, a VERSION output message appears. For

example:

```
#VERSIONA,COM1,0,75.0,UNKNOWN,0,1608.685,004c0000,3681,2678;
3,GPSCARD,"L12LGRVA","DAB06420097","OEMV3G-3.02-2T2","3.200A10","3.000",
"2007/Feb/20","11:44:36",DB_USERAPPAUTO,"DL-V3","0","","1.000A16","",
"2007/Jan/03","17:39:23",USERINFO,"LMX9820A","0623","","","","",""
*c2605fb9
```

4. Insert the CF card.
5. Type DISK FORMAT in the terminal program and press the <Enter> key.
6. Wait a minute and power off the DL-V3.
7. Power on the DL-V3 again and the CF card is ready to use.

At least 1% of free space must be available on the CF card to open a log file. On a 64 MB disk, there is a 0.64 MB allowance for the file table.

Chapter 4 Operation

Before operating the receiver for the first time, please ensure that you have followed the installation instructions in *Chapter 3, Installation and Set Up* on *Page 33*. The following instructions are based on a configuration such as that shown in *Figure 15* below. It is assumed that a personal computer is used during initial operation and testing for greater ease and versatility.

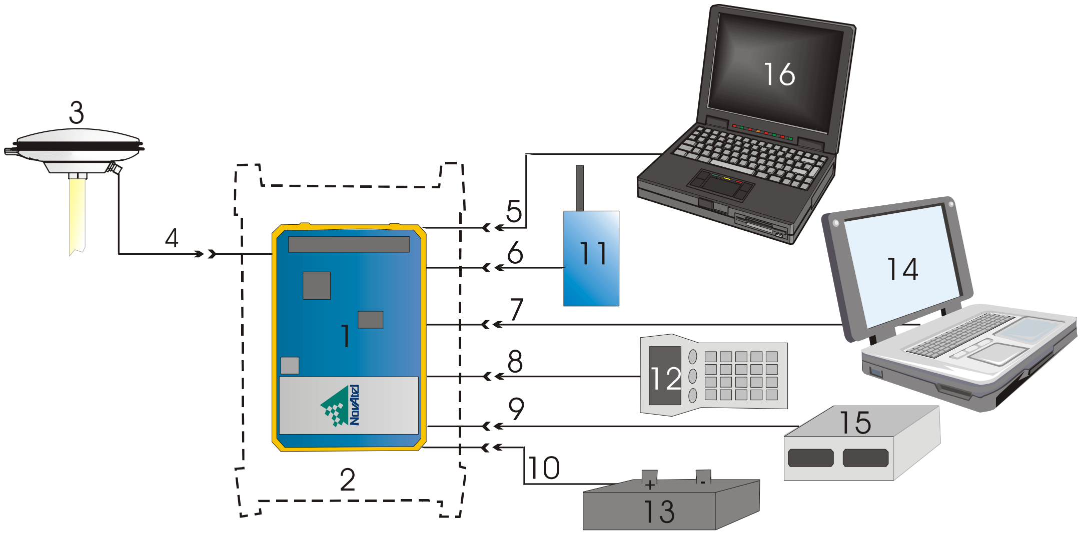


Figure 15: Available OEM Card Connection Interfaces

Reference	Description	Reference	Description
1	OEMV Card	10	Power Input
2	User-Supplied Enclosure[1]	11	User-Supplied Base Radio
3	NovAtel GNSS Antenna	12	Data Logger or Rover
4	GNSS Signal (RF Cable)	13	External DC Power Source
5	COM1 Link	14	Laptop or PC with NovAtel USB drivers installed
6	COM2 Link		
7	USB Link	15	External Oscillator
8	COM3 Link	16	PC or Base Station
9	External Oscillator Signal		

See also *Figure 16* on *Page 59* for a base/rover example.

1. Custom or NovAtel

4.1 Communications with the Receiver

Communication with the receiver typically consists of issuing commands through the communication ports from an external serial communications device. This could be either a terminal or an IBM-compatible PC that is directly connected to the receiver serial port using a null modem cable. If you are using an RTK radio it connects to the receiver's COM port by means of the radio serial cable supplied with the receiver. It is recommended that you become thoroughly familiar with the commands and logs detailed in the *OEMV Firmware Reference Manual* to ensure maximum utilization of the receiver's capabilities.

4.1.1 Serial Port Default Settings

The receiver communicates with your PC or terminal via a serial port. For communication to occur, both the receiver and the operator interface have to 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

Changing the default settings requires using the *COM* command.

The data transfer rate you choose determines how fast information is transmitted. Take for example a log whose message byte count is 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. To get 10 messages per second then requires 9600 bps. Please also remember that even if you set the bps to 9600 the actual data transfer rate is lower and depends on the number of satellites being tracked, data filters in use, and idle time. It is therefore suggested that you leave yourself a margin when choosing a data rate (115200 is recommended for most applications).

CAUTION: 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 (that is, a significant amount of information needs to be transmitted every second) but the bit rate is set too low, data will overflow the serial port buffers, cause an error condition in the receiver status and result in lost data.

4.1.2 Communicating Using a Remote Terminal

One method of communicating with the receiver is through a remote terminal. The receiver has been pre-wired to allow proper 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 optionally be used. Ensure the terminal's communications set-up matches the receiver's RS-232 protocol. In the case of the DL-V3, Bluetooth (default) and Ethernet are available.

4.1.3 Communicating Using a Personal Computer

An IBM-compatible PC can be set up to emulate a remote terminal as well as provide the added flexibility of creating multiple-command batch files and data logging storage files. Any standard communications software package that emulates a terminal can be used to establish bidirectional communications with the receiver, for example, Hyperterminal or our own graphic user interface (GUI) program, **CDU**. All data is sent as raw 8-bit binary or ASCII characters.

4.2 Getting Started

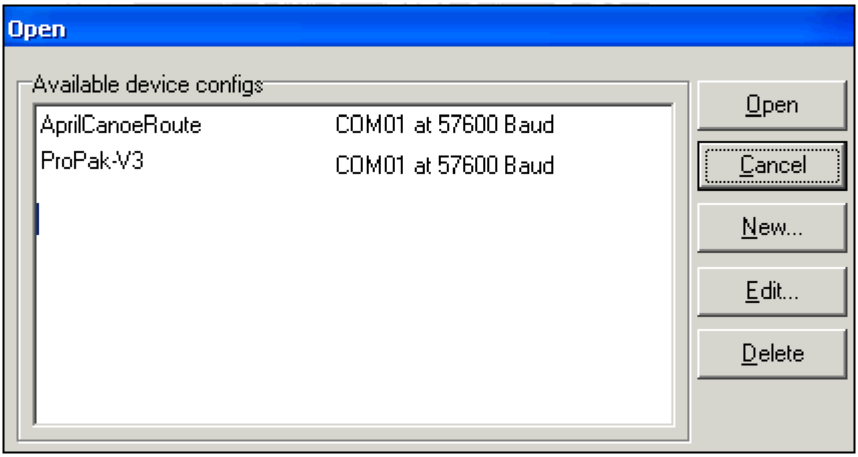
Included with your receiver are NovAtel's **CDU** and Convert programs. **CDU** is a windows-based GUI which allows you to access the receiver's many features without the need for communications protocol or to write special software. The Convert utility is a windows-based utility that allows you to convert between file formats, and strips unwanted records for data file compilation. See *Chapter 6, PC Software and Firmware* on *Page 98* for more information on these programs and their installation.

4.2.1 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 a self-test, the self-test 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 *OEMV Firmware Reference Manual* for header information. If a persistent error develops, please contact your local NovAtel dealer first. If the problem is still unresolved, please contact NovAtel directly through on of the methods listed in the *Customer Service* section at the beginning of this manual on *Page 18*.

4.2.2 Communicating with the Receiver Using CDU

Launch the **CDU** program and select *Device* | *Open* from its main menu. The *Open Configuration* window appears. The example below shows an *Open Configuration* window with two possible configurations already set up. Your configurations may be different or you may have none at all, in which case, the *Open Configuration* window is empty.



Refer to **CDU**'s Help file by selecting the *Help* | *Contents* menu. See also *Chapter 6, PC Software and Firmware* starting on *Page 98* for descriptions of the **CDU** windows available from the *View* menu. Ensure 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 above prompts indicate that the receiver is ready and waiting for command input. The screen may display other port names for other port types, for example USB1, USB2, USB3 or AUX.

1. You may also have to wait for output from receiver self tests. For example, on start-up, the OEMV family receiver is set to log the RXSTATUSEVENTA log ONNEW on all ports. See *Section 7.4, RXSTATUSEVENT Log* on *Page 118* for more details.
2. If you find that **CDU** is unable to locate your OEMV family receiver, it may be that you have previously used the SAVECONFIG command. In this case, try using a different COM port to communicate to the receiver. Once communication has been established, issue a FRESET STANDARD command. You should now be able to use your original communication port again.
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, they are not available with the COM command but may be used with other commands, such as INTERFACEMODE and LOG. Refer to the *OEMV Firmware Reference Manual* for the virtual ports available and details on the above mentioned logs.

Commands are typed at the interfacing computing device's keypad or keyboard, and executed after issuing a carriage return command which is usually the same as pressing the <Enter> key.

An example of a response to an input command is the FIX POSITION command. It can be as:

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

where [COM2] is the port prompt, followed by the command you enter from your keypad or keyboard and *[carriage return]* indicates that you should press the <Enter> key.

The above example illustrates command input to the base receiver's COM2 port which 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)*

WARNING!: **Ensure the Control Panel's Power Settings on your PC are not set to go into Hibernate or Standby modes. Data will be lost if one of these modes occurs during a logging session.**

4.3 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 which is acting as the stationary reference. It has a known position and transmits correction messages to the rover station. The rover station is the GNSS receiver which does not know its exact position and can be sent correction messages from a base station to calculate differential GNSS positions. An example of a differential setup is given in *Figure 16* below:

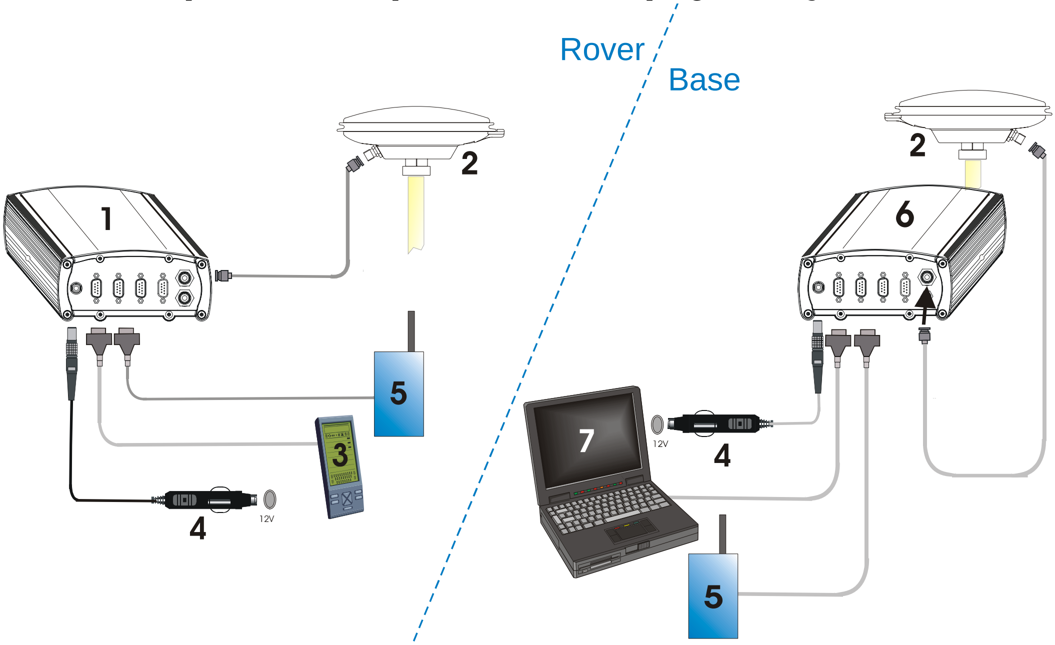


Figure 16: Basic Differential Setup

Reference	Description
1	A ProPak-V3 receiver for the rover station
2	NovAtel GNSS antenna
3	User-supplied data storage device to COM1
4	User-supplied power supply
5	User-supplied radio device to COM2
6	A ProPak-V3 receiver for the base station
7	User-supplied laptop/PC, for setting up and monitoring, to COM1

See also *Appendix C, Ethernet Configuration* starting on *Page 191* for the Bluetooth (default) and Ethernet configuration options.

Errors can be introduced by system biases, as described in *Section 5.1.1, GPS System Errors* on *Page 74*. In most cases you need to provide a data link between the base station and rover station (two NovAtel receivers) in order to receive corrections. SBAS and L-band corrections can be accomplished with one receiver and are exceptions to the base/rover concept. Generally a link capable of data throughput at a rate of 9600 bits per second, and less than 4.0 s latency, is recommended.

Once your base and rover are set up, you can configure them as shown in the configuration examples that follow in *Sections 4.3.1 - 4.3.2* starting on *Page 61*.

4.3.1 Base Station Configuration

At the base station, enter the following commands:

interfacemode port rx_type tx_type *[responses]*

fix position latitude longitude height

log port message *[trigger [period]]*

For example:

RTCA `interfacemode com2 none rtca off`

fix position 51.11358042 -114.04358013 1059.4105

log com2 rtcaobs ontime 1

log com2 rtcaref ontime 10

log com2 rtca1 ontime 5

log com2 rtcaephem ontime 10 1 *(optional)*

RTCM `interfacemode com2 none rtcm off`

fix position 51.11358042 -114.04358013 1059.4105

log com2 rtcm3 ontime 10

log com2 rtcm22 ontime 10 1

log com2 rtcm1819 ontime 1

log com2 rtcm1 ontime 5

RTCMV3 `interfacemode com2 none rtcmv3 off`

fix position 51.11358042 -114.04358013 1059.4105

log com2 rtcm1006 ontime 10

log com2 rtcm1003 ontime 1

CMR+ `interfacemode com2 none cmr off`

fix position 51.11358042 -114.04358013 1059.4105

log com2 cmrobs ontime 1

log com2 cmrplus ontime 1 *(important to use ontime 1 with cmrplus)*

CMR `interfacemode com2 none cmr off`

fix position 51.11358042 -114.04358013 1059.4105 log com2 cmrobs ontime 1

log com2 cmrref ontime 10

log com2 cmrdesc ontime 10 1

4.3.2 Rover Station Configuration

At the rover station, enter:

interfacemode port rx_type tx_type *[responses]*

For example:

RTCA	`interfacemode com2 rtca none off`	
RTCM	`interfacemode com2 rtcm none off`	
RTCMV3	`interfacemode com2 rtcmv3 none off`	
CMR+	`interfacemode com2 cmr none off`	
CMR	`interfacemode com2 cmr none off`	*(same as CMR+)*

4.3.3 Configuration Notes

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

If you wish 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 simply 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 rtcm1b ontime 2

✉ Using the receiver in this mode consumes more CPU bandwidth than using the native differential messages as shown in *Section 4.3.1, Base Station Configuration* on *Page 60*.

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

The PSRDIFFSOURCE and RTKSOURCE commands set the station ID values which identify the base stations from which to accept pseudorange or RTK corrections respectively. They are useful commands when the rover station is receiving corrections from multiple base stations. See *Section 5.2, Satellite-Based Augmentation System (SBAS)* on *Page 75* for more information on SBAS.

> ✉ All PSRDIFFSOURCE entries fall back to SBAS (even NONE) for backwards compatibility.

At the base station it is also possible to log out the contents of the standard corrections in a form that is easier to read or process. These larger variants have the correction fields broken out into standard types within the log, rather than compressed into bit fields. This can be useful if you wish to modify the format of the corrections for a non-standard application, or if you wish to look at the corrections for system debugging purposes. These variants have "DATA" as part of their names (for example, RTCADATA1, RTCMDATA1, CMRDATAOBS, and more). Refer also to the *OEMV Firmware Reference Manual*, which describes the various message formats in more detail.

> ✉ Information on how to send multiple commands and log requests using DOS or Windows, can be found on our website at http://www.novatel.com/support/knowledgedb.htm.

4.4 Using the DL-V3

A group is a set of logs for the receiver. The default software configuration for group information includes a group named *default*. A *powerup* group must be created to take advantage of the automatic logging functionality. Refer to the *DL-V3 Firmware Reference Manual* for more information on groups, commands and logs specific to the DL-V3.

Upon acquisition of coarse time, if a group named *powerup* exists, the DL-V3 executes the group automatically.

The FRESET command allows you to reset the DL-V3 to its factory default settings. SITEDEF logs, refer to the *DL-V3 Firmware Reference Manual*, contain site record information. For example:

```
#SITEDEFA,COM1,0,61.0,FINESTEERING,1420,316947.028,00180020,e40c,2678;
0,"","DL-V3ii",0,0.000000000,"",1420,1420,316890.000,316935.000,00000000,0*c56c1a5d
```

4.4.1 Log Data from a Site to a File

Consider the case of logging data at a site and appending filename and other information. The following steps apply to a base or rover site. For the base, you only need to log one file per session.

> ✉
> 1. There is no need to continually start and stop logging if you are using post-processing software, where it is dealt with automatically.
> 2. Ensure your antenna is in the correct position at the base and rover.

To log a group and update the site information

1. Select the Group
2. Edit the Site
3. Start the Data Logging
4. Stop the Data Logging

1. Select the Group

The the DL-V3 captures sets of logs using log groups. You create a group in **CDU**'s *DL Explorer* and then upload the group to the DL-V3.

CDU is available from our website at: http:// www.novatel.com/support/fwswupdates.htm.

Launch **CDU** from the *Start* menu folder specified during the installation process. The default location is Start | Programs | NovAtel OEMV | CDU. Launch **CDU** and open, or create, a DL-V3 configuration, refer to your *DL-V3 Quick Start Guide*. Select *DL Explorer* in the *Tools* menu and then select the *Edit DL Groups...* button. Within the *DL Groups* dialog, you can change a log group name by clicking on it and editing it directly. In the *Logs* tab, select the log to add from the *Name* drop-down list. Select the log format using the *Format* drop-down list (ASCII or Binary). Select the trigger for the log using the *Trigger* drop-down list. If you choose the On Time trigger, select the period for logging using the *Period* drop-down list or type it in. Select *OK* to add the new log to the log group. To log to file, select *File* from the *Port* drop-down list.

2. Edit the Site

In the *DL Explorer* dialog, select a group name from the left panel and select the *Site* tab. Check the *Automatically Log Site on Startup* and the *Include Site Information* checkboxes. Then enter a site name or number, and the height of the antenna 'lip' from the site you are measuring.

Place the tape measure from the lip to where the tip of the antenna pole touches the ground (do not measure straight down). The slant from the edge of the antenna is different than when the measurement is straight down.

Add 33 mm to the measured reading. This makes up for the distance of the antenna element to the lip on NovAtel 700-series antennas.

Click *OK* for your input to take effect and return you to the main DL Explorer window.

You can now log a site and the site information is written to the log file.

3. Start the Data Logging

Once a log group has been created, it can be uploaded to the DL-V3. The steps below provide details on uploading a group.

In the DL Explorer window, select the *Comm Params* button. 

In the *Com Parameters* dialog box, select the PC serial port the DL-V3 is connected to by clicking in its *Powered* column check box, click on its speed column to select a baud rate from the *Speed* column drop-down list and then select *Apply.*

Select the *Group Management* button. 

Select the group to upload to the DL-V3 from the list of groups in the *CDU* panel of the dialog.

Select the *UpLoad* button to copy the group.

Select a group in the *DL Groups* panel and press *Start* on the dialog's right to start logging to your CF card or COM port.

A red cross beside a log group name indicates the group is not active in the DL-V3. A green check mark indicates the group is active in the DL-V3.

Up to 5 log groups can be stored in the DL-V3 at any one time.

4. Stop the Data Logging

In the *Group Management* dialog, click on the *Stop* button to stop logging data. Once the data logging has stopped, it is no longer writing to the card. While you move the antenna, the receiver is still functioning but it is not logging data. To start a new site at a new location, repeat steps #1 to #4. Information is appended to the CF card file.

4.5 Enabling SBAS Positioning

All OEMV family receivers are capable of SBAS positioning. This positioning mode is enabled using the `SBASCONTROL` command. On a simulator, you may want to leave the *testmode* parameter off or specify NONE explicitly. The following commands are typically used to enable WAAS and other SBAS modes, for example EGNOS, respectively:

sbascontrol enable waas
sbascontrol enable egnos

See *Section 5.2, Satellite-Based Augmentation System (SBAS)* on *Page 75* for more information.

4.6 Enabling L-band (OEMV-1, OEMV-3, DL-V3 & ProPak-V3)

L-band equipped receivers allow you to achieve sub-meter accuracy. In order to use this positioning mode, you must enable L-band tracking to the Canada-Wide Differential Global Positioning System (CDGPS) or OmniSTAR signal. A subscription to OmniSTAR is required to use the OmniSTAR service. The CDGPS signal is free and available without subscription (a CDGPS coverage map is shown in *Figure 26* on *Page 84*).

To obtain an OmniSTAR subscription, contact OmniSTAR at 1-800-338-9178 or 713-785-5850. If you contact OmniSTAR, you will be asked to 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 in a terminal window or the Console window in **CDU**:

log lbandinfo

The log that is generated displays the L-band serial number in the fifth field following the log header. It is a six digit number in the range `700000` to `799999`. This log also provides the status of your subscription. Refer to the LBANDINFO command for more information.

In order 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 CDGPS frequencies are on *Page 83* and these can also be used with the `ASSIGNLBAND` command. Below are examples for using either CDGPS and OmniSTAR:

assignlband cdgps 1547547 4800
assignlband omnistar 1536782 1200

---

1. In addition to a NovAtel receiver with L-band capability, a subscription to the OmniSTAR, or use of the free CDGPS, service is required. Contact NovAtel for details.

   OmniSTAR website: http://www.omnistar.com/
   CDGPS website: http://www.cdgps.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

For example, if you are receiving CDGPS, the fifth field after the header should be 00c2:

lbandstat com1 0 43.5 finesteering 1295 149951.671 00000000 976f 34461
<1547546977 46.18 4541.0 0.00 **00c2** 00f0 0 0 0 8070 0001 0 0 0

Please refer to the LBANDSTAT command for details.

4.7 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, if available, USB port to any specified receiver COM or USB port. This capability, in conjunction with the SEND command, can allow the receiver to perform bi-directional 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** and **PASSAUX** are available on OEMV family receivers for logging through serial ports. The AUX port is available on OEMV-3-based products. Refer to the PASSCOMx log for details.

4.8 T Sync Option (OEMV-3-based products only)

This section describes the relationship constraints of the input signal phase when the Time Synchronization Modification (T Sync Mod) option has been added to an OEMV-3 card, DL-V3 or ProPak-V3.

The 5, or 10, MHz external oscillator and 1PPS signals must maintain a phase relationship as shown in *Figures 17* and *18* starting on *Page 66*. The 1PPS signal must NOT fall within 5 ns of each of the 4 positions of the 5 MHz sine wave, or within 5 ns of each of the 2 positions of the 10 MHz sine wave. These are areas of instability and should be avoided.

When an external oscillator is connected, T Sync pulses are sent through hardware on the receiver card and cannot be disabled. You must issue a time-synchronization-enabling command (refer to ADJUST1PPS TIME in the *OEMV Family Firmware Reference Manual*) for the receiver to track properly.

To adjust the phase relationship of the 5, or 10, MHz and 1PPS signals, add additional RF cable to the 5, or 10, MHz line. For example, if using RG58, each 1 meter piece will move the 5, or 10, MHz phase by approximately 5 ns.

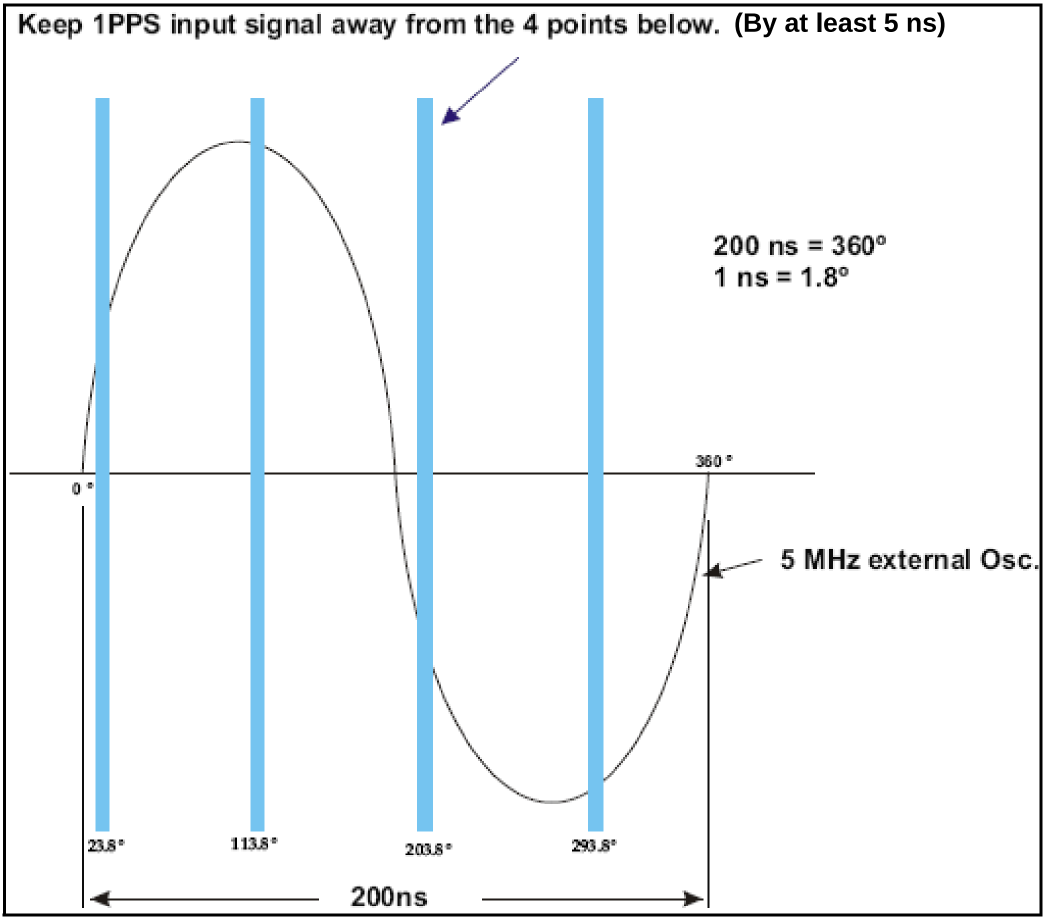


Figure 17: OEMV-3 and ProPak-V3 T Sync 5 MHz and 1PPS

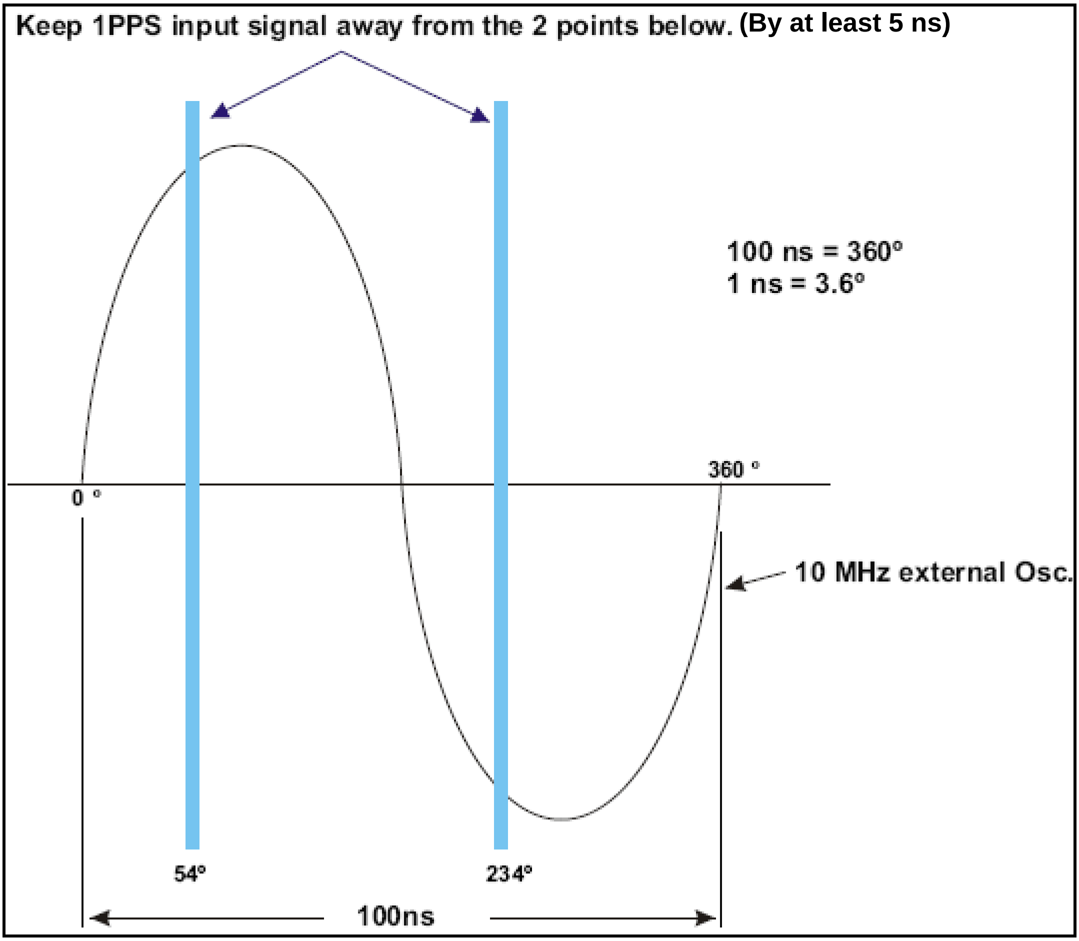


Figure 18: OEMV-3 and ProPak-V3 T Sync 10 MHz and 1PPS

4.9 Transferring Time Between Receivers

The ADJUST1PPS command is used to as part of the procedure to transfer time between receivers. The number of pulses per second (PPS) is always set to 1 Hz with this command. It is typically used when the receiver is not adjusting its own clock and is using an external reference frequency.

The TIMESYNC log is also used to synchronize time between receivers. It contains a time status field that may show COARSE or FINE for example. For a complete list of the time status values and their definitions, please refer to *Section 1.3, GPS Time Status* in the *OEMV Firmware Reference Manual*.

Section 4.9.3 starting on *Page 69* provides details on the time transfer procedure. Definition used in the procedure are in *Section 4.9.2* starting on *Page 68*. Please also refer to the ADJUSTIPPS command and the TIMESYNC log descriptions.

4.9.1 GPS to Receiver Time Synchronization

Synchronization of receiver time with GPS time does not occur until the receiver locks onto its 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 6 seconds.

✉ Although GLONASS could be used for time synchronization, OEMV receivers use GPS.

4.9.2 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	Once at least 4 satellites have been 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 is indicated by 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 OEMV family receiver that is tracking satellites, and has a receiver clock state of FINE or FINESTEERING.
Cold Clock	An OEMV family receiver that needs to have its clock synchronized with the Fine receiver. It may have any clock state including UNKNOWN.
Warm Clock	An OEMV family receiver that has its clock adjusted to better then 500 ms. Refer to the TIME log to view the clock offset.

The section that follows gives procedures for transferring time from a Fine Clock receiver to a Cold or Warm Clock receiver.

4.9.3 Procedures to Transfer Time

These procedures are 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 port from the Fine Clock to the Cold Clock (for example, COM2 on the Fine Clock receiver to COM3 on the Cold Clock receiver). Configure both ports to the same baud rate and handshaking configurations.
2. Issue this command to the Fine Clock receiver:

   log com2 timesyncb ontime 1
3. Issue this command to the Cold Clock receiver:

   adjust1pps time

When the Cold Clock receiver receives the TIMESYNC log, it sets its clock allowing for a 100 ms transfer delay.

Transfer FINE time (<50 ns) from a Fine Clock to a Cold Clock GPS receiver

1. Connect a COM port from the Fine Clock to the Cold Clock receiver (for example, COM2 on the Fine Clock receiver to COM3 on the Cold Clock receiver). Configure both ports to the same baud rate and handshaking configurations.
2. Issue this 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 this 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 it has received a valid TIMESYNC log 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 19, 1PPS Alignment* on *Page 70* below.

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.
2. Issue this 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 1 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.

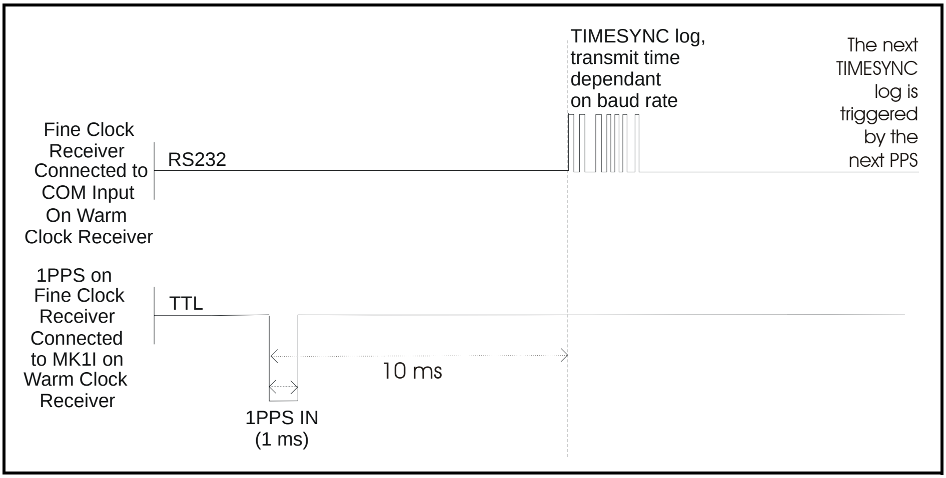


Figure 19: 1PPS Alignment

Chapter 5 Positioning Modes of Operation

NovAtel's dual frequency GNSS receivers have several important performance advantages depending on your positioning requirements. Dual frequency allows direct measurement of the signal delay through the ionosphere and is critical to fast and reliable integer ambiguity resolution when positioning using carrier measurements.

Dual frequency can improve the performance of DGPS, SBAS, and RTK positioning. Using RTCM type 15 messages allows the DGPS user to apply a local ionospheric correction to their dual frequency receiver to improve code positioning performance on larger baselines (hundreds of km). SBAS positioning is improved by applying a local correction instead of using the SBAS ionospheric grid, and RTK solutions are improved on long baselines by using an ionosphere free solution.

By default the OEMV-1, OEMV-1G, OEMV-3, DL-V3 and ProPak-V3 models with L-band software support the standard Canada-Wide Differential Global Positioning System (CDGPS) sub-meter L1/L2 service and the OmniSTAR Virtual Base Station (VBS) sub-meter L1 service. The OmniSTAR VBS service is upgradeable on the OEMV-3, DL-V3 and ProPak-V3 to the Extra Performance (XP) decimeter L1/L2 service or High Performance (HP) sub-decimeter L1/L2 service. Refer also to the AUTH command in the *OEMV Firmware Reference Manual.*

The OEMV family of receivers operate in the most accurate positioning mode possible with the signals available, and immediately drop to the next positioning mode if the current signal times out.

The following single and dual frequency modes of operation are described further in this chapter:

- Single Point
- Satellite-Based Augmentation System (SBAS)
- Pseudorange Differential
- L-band
- Carrier-Phase Differential

Refer to the *GPS Overview* section of the *GPS+ Reference Manual* for an overview of GPS positioning.

5.1 Single-Point

The NovAtel OEMV family receivers are capable of absolute 2-D single-point positioning accuracies of 1.8 meters Root Mean Square (RMS[1]) (HDOP < 2; no multipath).

The general level of accuracy available from single-point operation may be suitable for many types of positioning such as ocean going vessels, general aviation, and recreational vessels that do not require position accuracies of better than 1.8 meters RMS. However, increasingly more and more applications desire and require a much higher degree of accuracy and position confidence than is possible with single-point pseudorange positioning. This is where differential GPS (DGPS) plays a dominant role in higher accuracy real-time positioning systems (see the following sections of this chapter).

1. RMS: Root Mean Square (a probability level of 68%)

By averaging many GPS measurement epochs over several hours, it is possible to achieve a more accurate absolute position. This section attempts to explain how the position averaging function operates and to provide an indication of the level of accuracy that can be expected versus total averaging time.

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

If the maximum time is set to 1 hour or larger, positions are averaged every 10 minutes and the standard deviations reported in the AVEPOS log should be correct. If the maximum time is set to less than 1 hour, positions are averaged once per minute and the standard deviations reported in the log are not likely to be accurate; also, the optional horizontal and vertical standard deviation limits cannot be used.

If the maximum time that positions are to be measured is set to 24 hours, for example, you can then log AVEPOS with the trigger ‘onchanged’ to see the averaging status:

posave 24

log com1 avepos onchanged

If desired, you could initiate differential logging, then issue the POSAVE command followed by the SAVECONFIG command. This would cause the receiver to average positions after every power-on or reset, then invoke the FIX POSITION command to enable it to send differential corrections.

The position accuracy that may be achieved by these methods depends on many factors: average satellite geometry, sky visibility at antenna location, satellite health, time of day, and so on. The following graph summarizes the results of several examples of position averaging over different time periods. The intent is to provide an idea of the relationship between averaging time and position accuracy. All experiments were performed using a dual frequency receiver with an ideal antenna location, see *Figure 20, Single-Point Averaging (Typical Results)* on *Page 73*. *Figure 21* on *Page 73* shows the results from the same dual frequency receiver but with WAAS corrections available.

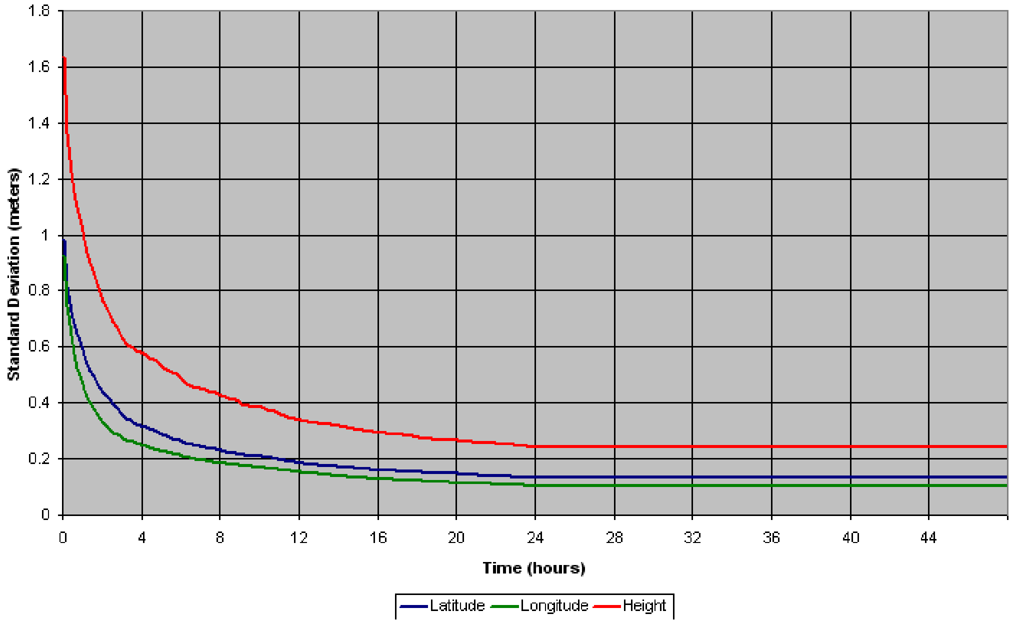


Figure 20: Single-Point Averaging (Typical Results)

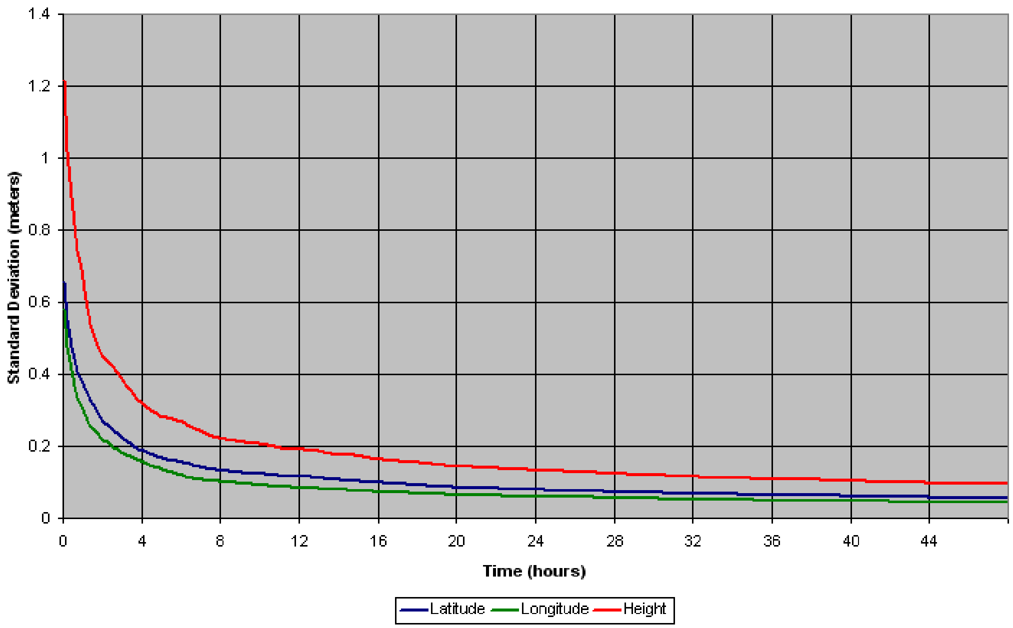


Figure 21: Single-Point Averaging (Typical Results with WAAS)

The position averaging function is useful for obtaining the WGS84 position of a point to a reasonable accuracy without having to implement differential GPS. It is interesting to note that even a six hour occupation can improve single-point GPS accuracy from over 1.5 meters to better than a meter. This improved accuracy is primarily due to the reductions of the multipath errors in the GPS signal.

Again, it is necessary to keep in mind that the resulting standard deviations of the position averaging can vary quite a bit, but improve over longer averaging times. To illustrate, the position averaging function was run for a period of 40 hours. The resulting standard deviation in latitude varied from 0.152 to 1.5589 meters. Similarly, the variation in longitude and height were 0.117 to 0.819 meters and 0.275 to 2.71 meters respectively. This degree of variation becomes larger for averaging periods of less than 12 hours due to changes in the satellite constellation. The graph provides some indication of the accuracy one may expect from single-point position averaging.

The next section deals with the type of GPS system errors that can affect accuracy in single-point operation.

5.1.1 GPS System Errors

In general, GPS SPS C/A code single-point pseudorange positioning systems are capable of absolute position accuracies of about 1.8 meters or less. This level of accuracy is really only an estimation, and may vary widely depending on numerous GPS system biases, environmental conditions, as well as the GPS receiver design and engineering quality.

There are numerous factors which influence the single-point position accuracies of any GPS C/A code receiving system. As the following list shows, a receiver's performance can vary widely when under the influences of these combined system and environmental biases.

- **Ionospheric Group Delays** — The earth's ionospheric layers cause varying degrees of GPS signal propagation delay. Ionization levels tend to be highest during daylight hours causing propagation delay errors of up to 30 meters, whereas night time levels are much lower and may be as low as 6 meters.
- **Tropospheric Refraction Delays** — The earth's tropospheric layer causes GPS signal propagation delays. The amount of delay is at the minimum (about three metres) for satellite signals arriving from 90 degrees above the horizon (overhead), and progressively increases as the angle above the horizon is reduced to zero where delay errors may be as much as 50 metres at the horizon.
- **Ephemeris Errors** — Some degree of error always exists between the broadcast ephemeris' predicted satellite position and the actual orbit position of the satellites. These errors directly affect the accuracy of the range measurement.
- **Satellite Clock Errors** — Some degree of error also exists between the actual satellite clock time and the clock time predicted by the broadcast data. This broadcast time error causes some bias to the pseudorange measurements.
- **Receiver Clock Errors** — Receiver clock error is the time difference between GPS receiver time and true GPS time. All GPS receivers have differing clock offsets from GPS time that vary from receiver to receiver by an unknown amount depending on the oscillator type and quality (TCXO versus OCXO,

and so on). However, because a receiver makes all of its single-point pseudorange measurements using the same common clock oscillator, all measurements are equally offset, and this offset can generally be modeled or quite accurately estimated to effectively cancel the receiver clock offset bias. Thus, in single-point positioning, receiver clock offset is not a significant problem.

- **Multipath Signal Reception** Multipath signal reception can potentially cause large pseudorange and carrier phase measurement biases. Multipath conditions are very much a function of specific antenna site location versus local geography and man-made structural influences. Severe multipath conditions could skew range measurements by as much as 100 meters or more. Refer to the *Multipath* section of the *GPS+ Reference Manual* for more information.

5.2 Satellite-Based Augmentation System (SBAS)

A Satellite-Based Augmentation System (SBAS) is a type of geo-stationary satellite system that improves the accuracy, integrity, and availability of the basic GPS signals. Accuracy is enhanced through the use of wide area corrections for GPS satellite orbits and ionospheric errors. Integrity is enhanced by the SBAS network quickly detecting satellite signal errors and sending alerts to receivers to not use the failed satellite. Availability is improved by providing an additional ranging signal to each SBAS geostationary satellite.

SBAS includes the Wide-Area Augmentation System (WAAS), the European Geo-Stationary Navigation System (EGNOS), and the MTSAT Satellite-Based Augmentation System (MSAS). The Chinese SNAS and Indian GAGAN systems are also planned. At the time of publication, there are three WAAS satellites over the Pacific Ocean (PRN 122, PRN 134 and PRN 135), an EGNOS satellite over the eastern Atlantic Ocean (PRN 120) and another EGNOS GEO satellite over the African mid-continent (PRN 124). SBAS data is available from any of these satellites and more satellites will be available in the future.

✉ Since July, 2003, WAAS has been certified for Class 1/ Class 2 civilian aircraft navigation.

Figure 22, SBAS and NovAtel 2006 on *Page 76* shows the regions applicable to each SBAS system mentioned in the paragraph above and how NovAtel is involved in each of them.

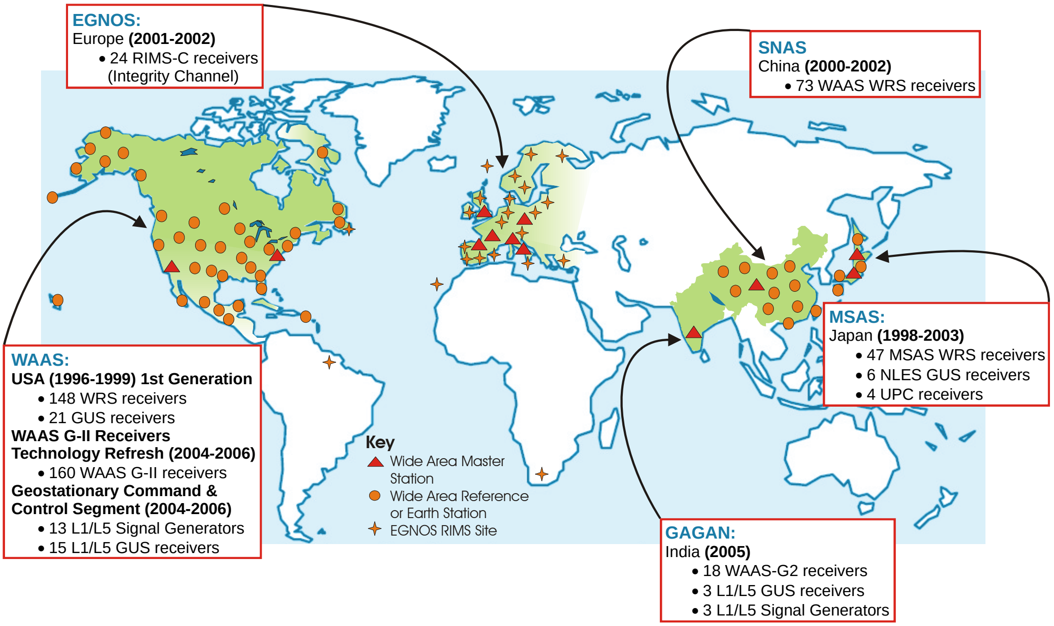


Figure 22: SBAS and NovAtel 2006

SBAS is made up of a series of Reference Stations, Master Stations, Ground Uplink Stations and Geostationary Satellites (GEOs), see *Figure 23* on *Page 77*. The Reference Stations, which are geographically distributed, pick up GPS satellite data and route it to the Master Stations where wide area corrections are generated. These corrections are sent to the Ground Uplink Stations which up-link them to the GEOs for re-transmission on the GPS L1 frequency. These GEOs transmit signals which carry accuracy and integrity messages, and which also provide additional ranging signals for added availability, continuity and accuracy. These GEO signals are available over a wide area and can be received and processed by OEMV family GPS receivers with appropriate firmware. GPS user receivers are thus able to receive SBAS data in-band and use not only differential corrections, but also integrity and residual errors information for each monitored satellite. You can set which ionospheric corrections model the receiver should use, refer to the SETIONTYPE command.

The signal broadcast via the SBAS GEOs to the SBAS users is designed to minimize modifications to standard GPS receivers. As such, the GPS L1 frequency (1575.42 MHz) is used, together with GPS-type modulation - for example, a Coarse/Acquisition (C/A) pseudorandom (PRN) code. In addition, the code phase timing is maintained close to GPS time to provide a ranging capability.

The primary functions of SBAS include:

- data collection
- determining ionospheric corrections
- determining satellite orbits
- determining satellite clock corrections
- determining satellite integrity
- independent data verification
- SBAS message broadcast and ranging
- system operations and maintenance

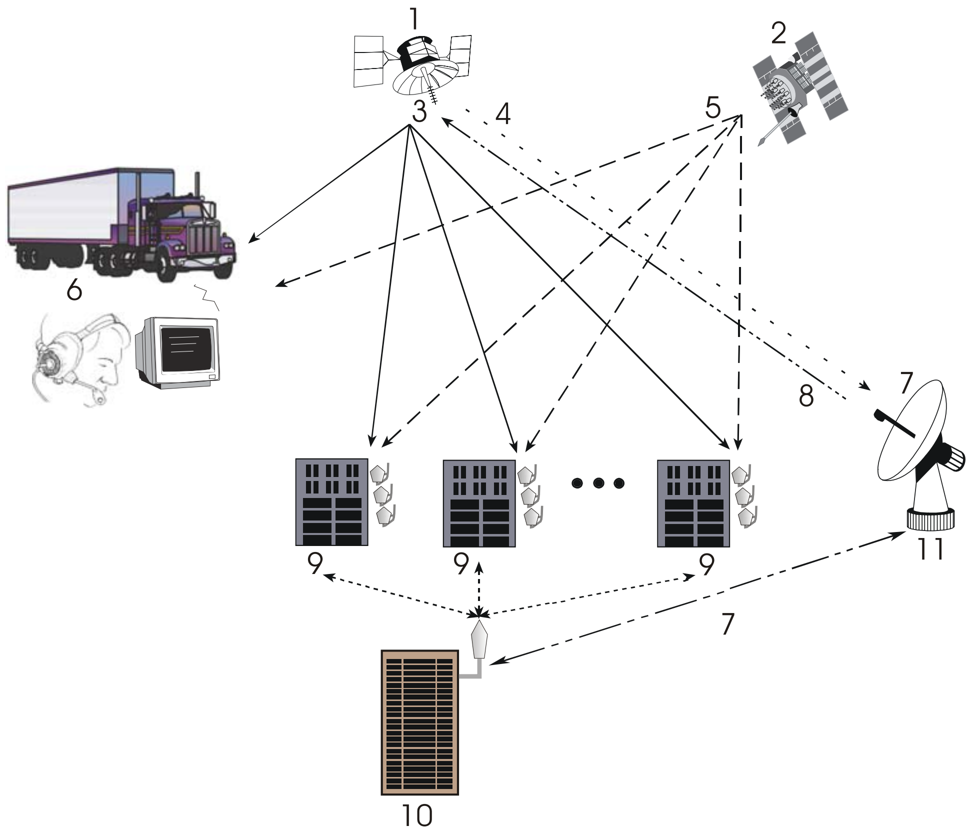


Figure 23: The SBAS Concept

Reference	Description	Reference	Description
1	Geostationary Satellite (GEO)	8	C-Band
2	GPS Satellite Constellation	9	SBAS Reference Station
3	L1	10	SBAS Master Station
4	L1 and C-Band	11	Ground Uplink Station
5	L1 and L2		
6	GPS User		
7	Integrity data, differential corrections and ranging control		

5.2.1 SBAS Receiver

All models of NovAtel OEMV receivers are equipped with SBAS capability. The ability to incorporate the SBAS corrections into the position is available in these models.

SBAS data can be output in log format (RAWWAASFRAMEA/B, WAAS0A/B-WAAS27A/B), and can incorporate these corrections to generate differential-quality position solutions. Standard SBAS data messages are analyzed based on RTCA standards for GPS/WAAS airborne equipment.

An SBAS-capable receiver permits anyone within the area of coverage to take advantage of its benefits with no subscription fee.

5.2.2 SBAS Commands and Logs

The command SBASCONTROL, enables the use of the SBAS corrections in the position filter. In order to use this command, first ensure that your receiver is capable of receiving SBAS corrections.

Several SBAS specific logs also exist and are all prefixed by the word WAAS except for the RAWWAASFRAME log.

The PSRDIFFSOURCE command sets the station ID value which identifies the base station from which to accept pseudorange corrections. All DGPS types may revert to SBAS, if enabled using the SBASCONTROL command.

Refer to the *OEMV Family Firmware Reference Manual* for more details on the SBAS commands and logs mentioned above.

5.3 Pseudorange Differential

There are two types of differential positioning algorithms: *pseudorange* and *carrier phase*. In both of these approaches, the “quality” of the positioning solution generally increases with the number of satellites which can be simultaneously viewed by both the base and rover station receivers. As well, the quality of the positioning solution increases if the distribution of satellites in the sky is favorable; this distribution is quantified by a figure of merit, the Position Dilution of Precision (PDOP), which is defined in such a way that the lower the PDOP, the better the solution. Pseudorange differential is the focus of this section. Carrier-phase algorithms are discussed in *Section 5.5, Carrier-Phase Differential* starting on *Page 87*.

5.3.1 Pseudorange Algorithms

Pseudorange algorithms correlate the pseudorandom code on the GPS signal received from a particular satellite, with a version generated within the base station receiver itself. The time delay between the two versions, multiplied by the speed of light, yields the *pseudorange* (so called because it contains several errors) between the base station and that particular satellite. The availability of four pseudoranges allows the base station receiver to compute its position (in three dimensions) and the offset required to synchronize its clock with GPS system time. The discrepancy between the base station receiver’s computed position and its known position is due to errors and biases on each pseudorange. The base station receiver calculates these errors and biases for each pseudorange, and then broadcasts these corrections to the rover station. The rover receiver applies the corrections to its own measurements; its corrected pseudoranges are then processed in a least-squares algorithm to obtain a position solution.

The “wide correlator” receiver design that predominates in the GPS industry yields accuracies of 3-5 m Spherical Error Probable (SEP[1]). NovAtel’s patented PAC technology reduces noise and multipath interference errors, yielding accuracies of 1 m SEP.

1. SEP: The radius of a sphere, centred at the user’s true location, that contains 50 percent of the individual three-dimensional position measurements made using a particular navigation system.

5.3.2 Position Solutions

Due to the many different applications for differential positioning systems, two types of position solutions are possible. NovAtel's carrier-phase algorithms can generate both *matched* and *low-latency* position solutions, while NovAtel's pseudorange algorithms generate only low-latency solutions. These are described below:

1. The *matched* position solution is computed at the rover station when the observation information for a given epoch has arrived from the base station via the data link. Matched observation set pairs are observations by both the base and rover stations which are matched by time epoch, and contain the same satellites. The matched position solution is the most accurate one available to the operator of the rover station, but it has an inherent *latency* – the sum of time delays between the moment that the base station makes an observation and the moment that the differential information is processed at the rover station. This latency depends on the computing speed of the base station receiver, the rates at which data is transmitted through the various links, and the computing speed of the rover station; the overall delay is on the order of one second. Furthermore, this position cannot be computed any more often than the observations are sent from the base station. Typically, the update rate is one solution every two seconds.

2. The *low latency* position solution is based on a prediction from the base station. Instead of waiting for the observations to arrive from the base station, a model (based on previous base station observations) is used to estimate what the observations will be at a given time epoch. These estimated base station observations are combined with actual measurements taken at the rover station to provide the position solution. Because only the base station observations are predicted, the rover station's dynamics are accurately reflected. The *latency* in this case (the time delay between the moment that a measurement is made by the rover station and the moment that a position is made available) is determined only by the rover processor's computational capacity; the overall delay is in the order of a hundred milliseconds. Low-latency position solutions can be computed more often than matched position solutions; the update rate can reach 20 solutions per second. The low-latency positions are provided for data gaps between matched positions of up to 60 seconds (for a carrier-phase solution) or 300 seconds (for a pseudorange solution, unless adjusted using the DGPSTIMEOUT command). A general guideline for the additional error incurred due to the extrapolation process is shown in *Table 15*.

Table 15: Latency-Induced Extrapolation Error

Time since last base station observation	Typical extrapolation error (RMS) rate
0-2 seconds	1 cm/s
2-7 seconds	2 cm/s
7-30 seconds	5 cm/s

5.3.3 Dual Station Differential Positioning

It is the objective of operating in differential mode to either eliminate or greatly reduce most of the errors introduced by the system biases discussed in *Section 5.1.1, GPS System Errors* starting on *Page 74*. Pseudorange differential positioning is quite effective in removing most of the biases caused by satellite clock error, ionospheric and tropospheric delays (for baselines less than 50 km), and ephemeris prediction errors. However, the biases caused by multipath reception and receiver clock offset are uncorrelated between receivers and thus cannot be cancelled by "between receiver single differencing" operation.

Differential operation requires that stations operate in pairs. Each pair consists of a base station and a rover station. A differential network could also be established when there is more than one rover station linked to a single base station.

In order for the differential pair to be effective, see *Figure 24, Typical Differential Configuration* on *Page 81*, differential positioning requires that both base and rover station receivers track and collect satellite data simultaneously from common satellites. When the two stations are in relatively close proximity (< 50 km), the pseudorange bias errors are considered to be nearly the same and can be effectively cancelled by the differential corrections. However, if the baseline becomes excessively long, the bias errors begin to decorrelate, thus reducing the accuracy or effectiveness of the differential corrections.

The Base Station

The nucleus of the differential network is the base station. To function as a base station, the GPS receiver antenna must be positioned at a control point whose position is precisely known in the GPS reference frame. Typically, the fixed position is that of a geodetic marker or a pre-surveyed point of known accuracy.

The base receiver must then be initialized to fix its position to agree with the latitude, longitude, and height of the phase centre of the base station GPS receiver antenna. Of course, the antenna offset position from the marker must be accurately accounted for.

Because the base station's position is fixed at a known location, it can now *compute* the range of its known position to the satellite. The base station now has two range measurements with which to work: *computed pseudoranges* based on its known position relative to the satellite, and *measured pseudoranges* which assumes the receiver position is unknown. Now, the base station's measured pseudorange (unknown position) is differenced against the computed range (based on known position) to derive the differential correction which represents the difference between known and unknown solutions for the same antenna. This difference between the two ranges represents the combined pseudorange measurement errors resulting from receiver clock errors, atmospheric delays, satellite clock error, and orbital errors.

The base station derives pseudorange corrections for each satellite being tracked. These corrections can now be transmitted over a data link to one or more rover stations. It is important to ensure that the base station's FIX POSITION setting be as accurate as possible, as any errors here directly bias the pseudorange corrections computed, and can cause unpredictable results depending on the application and the size of the base station position errors. As well, the base station's pseudorange measurements may be biased by multipath reception.

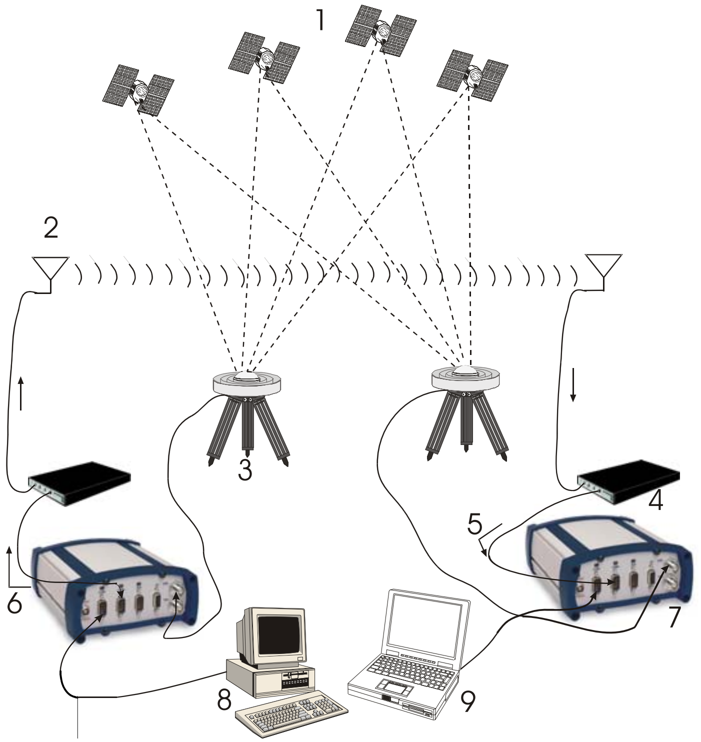


Figure 24: Typical Differential Configuration

Reference	Description	Reference	Description
1	GPS Constellation	7	GPS Receiver
2	Radio Data Link	8	Base Station
3	GPS Antenna with Choke Ring	9	Rover Station
4	Modem		
5	Differential Corrections Input		
6	Differential Corrections Output		

The Rover Station

A rover station is generally any receiver whose position is of unknown accuracy, but has ties to a base station through an established data link. If the rover station is not receiving differential corrections from the base station, it is essentially utilizing single-point positioning measurements for its position solutions, thus is subject to the various GPS system biases. However, when the rover GPS receiver is receiving a pseudorange correction from the base station, this correction is applied to the local receiver's measured pseudorange, effectively cancelling the effects of orbital and atmospheric errors (assuming baselines < 50 km), as well as eliminating satellite clock error.

The rover station must be tracking the same satellites as the base station in order for the corrections to take effect. Thus, only common satellite pseudoranges utilize the differential corrections. When the rover is able to compute its positions based on pseudorange corrections from the base station, its position accuracies approach that of the base station. Remember, the computed position solutions from the receiver are always that of its antenna's phase centre.

5.4 L-band Positioning

The transmission of OmniSTAR or CDGPS corrections are from geostationary satellites. The L-band frequency of geostationary satellites is sufficiently close to that of GPS that a common, single antenna, such as the NovAtel GPS-702L, may be used.

Both systems are portable and capable of sub-meter accuracy over their coverage areas. See also *Figure 27, L-band Concept* on *Page 86*.

The OmniSTAR system is designed for coverage of most of the world's land areas. A subscription charge by geographic area is required. The CDGPS system is a free Canada-wide DGPS service that is accessible coast-to-coast, throughout most of the continental United States, and into the Arctic.

5.4.1 Coverage

The two systems provide different coverage:

- OmniSTAR - Most of the World's Land Areas
- CDGPS - Canada/America-Wide

OmniSTAR Geographic Areas

In most world areas, a single satellite is used by OmniSTAR to provide coverage over an entire continent - or at least very large geographic areas. In North America, a single satellite is used, but it needs three separate beams to cover the continent. The three beams are arranged to cover the East, Central, and Western portions of North America. The same data is broadcast over all three beams, but the user system must select the proper beam frequency. The beams have overlaps of several hundred miles, so the point where the frequency must be changed is not critical.

The North American OmniSTAR Network currently consists of ten permanent base stations in the Continental U.S., plus one in Mexico. These eleven stations track all GPS satellites above 5 degrees elevation and compute corrections every 600 milliseconds. The corrections are sent to the OmniSTAR Network Control Center (NCC) in Houston via wire networks. At the NCC these messages are checked, compressed, and formed into packets for transmission up to the OmniSTAR satellite transponder. This occurs every few seconds. A packet contains the latest corrections from each of the North American base stations.

All of the eastern Canadian Provinces, the Caribbean Islands, Central America (south of Mexico), and South America is covered by a single satellite (AM-Sat). A single subscription is available for all the areas covered by this satellite.

OmniSTAR currently has several high-powered satellites in use around the world. They provide coverage for most of the world's land areas. Subscriptions are sold by geographic area. Any Regional OmniSTAR service center can sell and activate subscriptions for any area. They may be arranged prior to travelling to a new area, or after arrival. Contact OmniSTAR at www.omnistar.com for details.

Canada/America-Wide CDGPS

In order to enable CDGPS positioning, you must set the L-band frequency for the geographically appropriate CDGPS signal using the ASSIGNLBAND command. See also *Section 5.4.3, L-band*

Commands and Logs starting on *Page 86* for information on this command.

The CDGPS signal is broadcast on 4 different spot beams on the MSAT-1 satellite. Depending on your geographic location, there is a different frequency for the CDGPS signal as shown in *Figure 25* on *Page 83*.

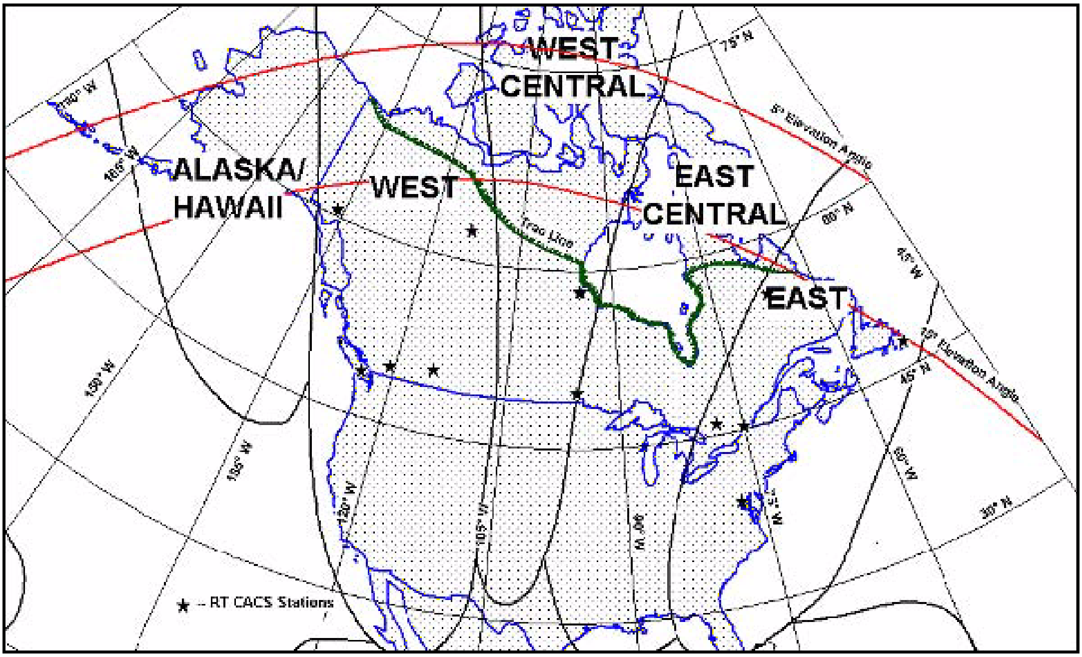


Figure 25: CDGPS Frequency Beams

The following are the spot beam names and their frequencies (in KHz or Hz):

East	1547646 or 1547646000
East-Central	1557897 or 1557897000
West-Central	1557571 or 1557571000
West	1547547 or 1547547000

✉ The CDGPS service does not include the MSAT Alaska/Hawaii beam shown in *Figure 25*.

The data signal is structured to perform well in difficult, or foliated conditions, so the service is available more consistently than other services and has a high degree of service reliability.

CDGPS features wide area technology, possible spatial integrity with all Government of Canada maps and surveys [1,2], 24-hour/7 days-a-week built-in network redundancies and an openly published broadcast protocol.

1. If the coordinates are output using the CSRS datum, refer to the DATUM command.
2. The Geological Survey of Canada website is at http://gsc.nrcan.gc.ca/index_e.php.

Figure 26 on *Page 84* is a conservative map of the coverage areas that CDGPS guarantee. The coverage may be better in your area.

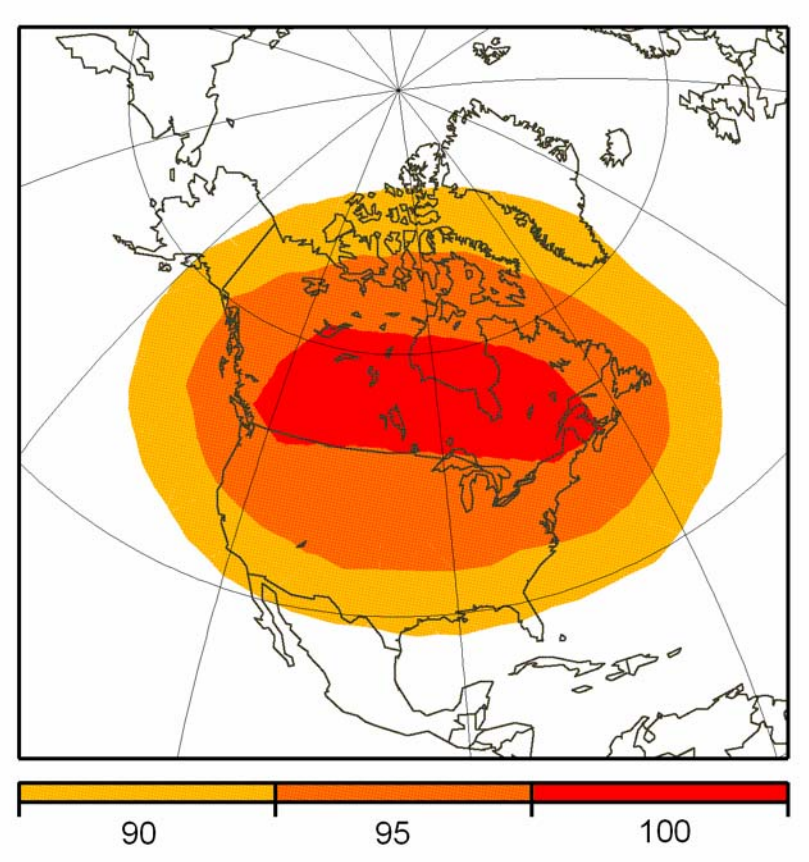


Figure 26: CDGPS Percentage (%) Coverage Map

In *Figure 26*, 100% coverage means that a correction is received for every visible satellite (at or above 10 degrees). 90% coverage means that a correction is received for 90% of visible satellites. For example, if a user views 10 satellites but has 90% coverage then there are no corrections available for one of the satellites. In that case, our firmware shows that a correction is missing for that PRN and excludes it from the position calculation.

5.4.2 L-band Service Levels

Two levels of service are available:

Standard	-	Sub-meter accuracy from OmniSTAR VBS (subscription required) and CDGPS
Extra Performance	-	Decimeter accuracy from OmniSTAR XP (subscription required)
High Performance	-	Sub-decimeter accuracy from OmniSTAR HP (subscription required)

Standard Service

The OmniSTAR VBS service uses multiple GPS base stations in a solution and reduces errors due to the GPS signals travelling through the atmosphere. It uses a wide area DGPS solution (WADGPS) and data from a relatively small number of base stations to provide consistent accuracy over large areas. A unique method of solving for atmospheric delays and weighting of distant base stations achieves sub-meter capability over the entire coverage area - regardless of your location relative to any base station.

CDGPS is able to simultaneously track two satellites, and incorporate the corrections into the position. The output is SBAS-like (see WAAS32-WAAS45 in the *OEMV Firmware Reference Manual*), and can incorporate these corrections to generate differential-quality position solutions. CDGPS allows anyone within the area of coverage to take advantage of its benefits.

CDGPS\OmniSTAR VBS services are available on OEMV-1 and OEMV-3-based products.

NovAtel's DL-V3 and ProPak-V3 provide GNSS positions with L-band corrections in one unit, using a common antenna. This means that, with CDGPS or a subscription to the OmniSTAR VBS service, the DL-V3 or ProPak-V3 are high quality receivers with sub-meter positioning capabilities. To obtain OmniSTAR VBS corrections, your receiver must have a VBS subscription from OmniSTAR.

The position from the OEMV receiver is used as the L-band system's first approximation.

After the L-band processor has taken care of the atmospheric corrections, it then uses its location versus the base station locations, in an inverse distance-weighted least-squares solution. L-band technology generates corrections optimized for the location. It is this technique that enables the L-band receiver to operate independently and consistently over the entire coverage area without regard to where it is in relation to the base stations.

High Performance Service

The OEMV-3, DL-V3 or ProPak-V3 with the software model for OmniSTAR High Performance (HP) service gives you more accuracy than with the OmniSTAR VBS or CDGPS services. OmniSTAR HP computes corrections in dual-frequency RTK float mode (within about 10 cm accuracy). The XP service is similar to HP but less accurate (15 cm) and more accurate than VBS (1 m). HP uses reference stations while XP uses clock model data from NASA's Jet Propulsion Laboratory (JPL). To obtain HP or XP corrections, your receiver must have an HP or XP subscription from OmniSTAR.

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1. For optimal performance, allow the OmniSTAR HP or XP solution to converge prior to starting any dynamic operation.
2. OmniSTAR XP is now available over a wider coverage area than previously.

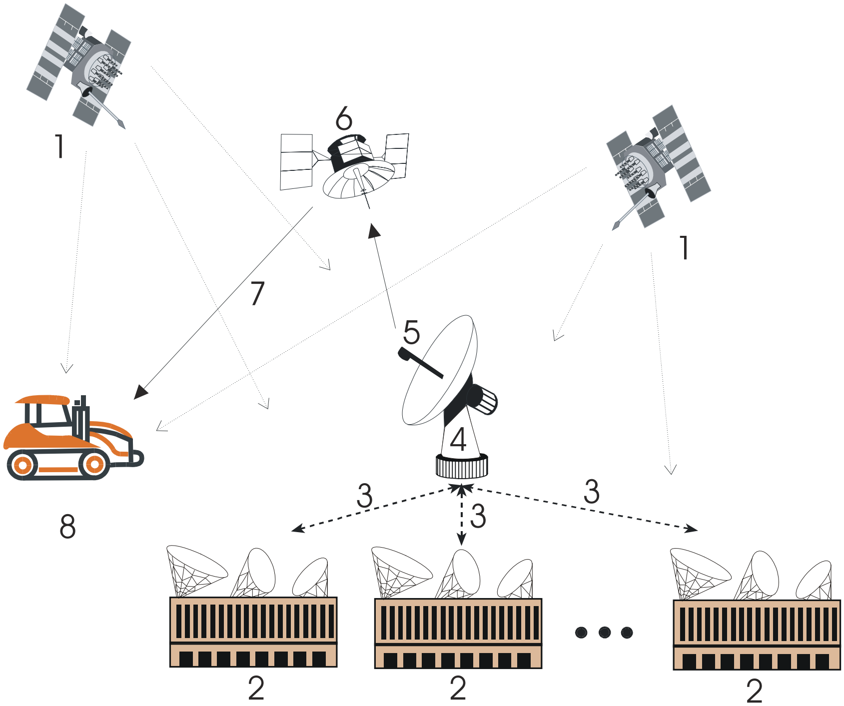

Figure 27: L-band Concept

Reference	Description
1	GPS satellites
2	Multiple L-band ground stations
3	Send GPS corrections to 4
4	Network Control Center where data corrections are checked and repackaged for uplink to 6
5	DGPS uplink
6	L-band geostationary satellite
7	L-band DGPS signal
8	Correction data are received and applied real-time

5.4.3 L-band Commands and Logs

The ASSIGNLBAND command allows you to set OmniSTAR or CDGPS base station communication parameters. It should include a relevant frequency and data rate, for example:

assignlband omnistar 1536782 1200

or,

assignlband cdgps 1547547 4800

Use the `ASSIGNLBAND OMNISTARAUTO` command for automatic beam selection if your receiver has previously stored the OmniSTAR satellite list.

The PSRDIFFSOURCE command lets you identify from which source to accept RTCA1, RTCM1, CDGPS or OmniSTAR VBS differential corrections. For example, in the PSRDIFFSOURCE command, OMNISTAR enables OmniSTAR VBS and disables other DGPS types. AUTO means the first received RTCM or RTCA message has preference over an OmniSTAR VBS or CDGPS message.

The RTKSOURCE command lets you identify from which source to accept RTK (RTCM, RTCMV3, RTCA, CMR, CMRPLUS and OmniSTAR HP) differential corrections. For example, in the RTKSOURCE command, OMNISTAR enables OmniSTAR HP or XP, if allowed, and disables other RTK types. AUTO means the NovAtel RTK filter is enabled and the first received RTCM, RTCA or CMR message is selected and the OmniSTAR HP or XP message, if allowed, is enabled. The position with the best standard deviation is used in the BESTPOS log.

The HPSEED command allows you to specify the initial position for OmniSTAR HP.

The HPSTATICINIT command allows you to speed up the convergence time of the HP or XP process when you are not moving.

The PSRDIFFSOURCE and RTKSOURCE commands are useful when the receiver is receiving corrections from multiple sources.

Several L-band specific logs also exist and are prefixed by the letters RAWLBAND, LBAND or OMNI. CDGPS corrections are output similarly to SBAS corrections. There are four SBAS fast corrections logs (WAAS32-WAAS35) and one slow corrections log (WAAS45) for CDGPS. The CDGPS PRN is 209.

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1. In addition to a NovAtel receiver with L-band capability, a subscription to the OmniSTAR, or use of the free CDGPS, service is required. Contact NovAtel for details, see *Customer Service* on *Page 18*.
2. All PSRDIFFSOURCE entries fall back to SBAS (even NONE) for backwards compatibility.

Refer to the *OEMV Firmware Reference Manual* for more details on individual L-band commands and logs.

5.5 Carrier-Phase Differential

Carrier-phase algorithms monitor the actual carrier wave itself. These algorithms are the ones used in real-time kinematic (RTK) positioning solutions - differential systems in which the rover station, possibly in motion, requires base-station observation data in real-time. Compared to pseudorange algorithms, much more accurate position solutions can be achieved: carrier-based algorithms can achieve accuracies of 1-2 cm (RMS).

Kinematic GPS using carrier-phase observations is usually applied to areas where the relation between physical elements and data collected in a moving vehicle is desired. For example, carrier-phase kinematic GPS missions have been performed in aircraft to provide coordinates for aerial photography, and in road vehicles to tag and have coordinates for highway features. This method can achieve similar accuracy to that of static carrier-phase, if the ambiguities can be fixed. However, satellite tracking is much more difficult, and loss of lock makes reliable ambiguity solutions difficult to maintain.

A carrier-phase measurement is also referred to as an *accumulated doppler range* (ADR). At the L1 frequency, the wavelength is 19 cm; at L2, it is 24 cm. The instantaneous distance between a GPS satellite and a receiver can be thought of in terms of a number of wavelengths through which the signal has propagated. In general, this number has a fractional component and an integer component (such as 124 567 967.330 cycles), and can be viewed as a pseudorange measurement (in cycles) with an initially unknown constant integer offset. Tracking loops can compute the fractional component and the change in the integer component with relative ease; however, the determination of the initial integer portion is less straight-forward and, in fact, is termed the *ambiguity*.

In contrast to pseudorange algorithms where only corrections are broadcast by the base station, carrier-phase algorithms typically “double difference” the actual observations of the base and rover station receivers. Double-differenced observations are those formed by subtracting measurements between identical satellite pairs on two receivers:

$$ADR_{\text{double difference}} = (ADR_{\text{rx A,sat i}} - ADR_{\text{rx A,sat j}}) - (ADR_{\text{rx B,sat i}} - ADR_{\text{rx B,sat j}})$$

An ambiguity value is estimated for each double-difference observation. One satellite is common to every satellite pair; it is called the *reference* satellite, and it is generally the one with the highest elevation. In this way, if there are *n* satellites in view by both receivers, then there are *n-1* satellite pairs. The difference between receivers A and B removes the correlated noise effects, and the difference between the different satellites removes each receiver’s clock bias from the solution.

In the RTK system, a floating ambiguity solution is continuously generated from a Kalman filter. When possible, fixed-integer ambiguity solutions are also computed because they are more accurate, and produce more robust standard-deviation estimates. Each possible discrete ambiguity value for an observation defines one *lane*. That is, each lane corresponds to a possible pseudorange value. There are a large number of possible lane combinations, and a receiver has to analyze each one in order to select the correct one. L2 measurements provide additional information making results faster and more reliable. In summary, NovAtel’s RTK system permits L1/L2 receivers to choose integer lanes while forcing L1-only receivers to rely exclusively on the floating ambiguity solution.

Once the ambiguities are known, it is possible to solve for the vector from the base station to the rover station. This baseline vector, when added to the position of the base station, yields the position of the rover station.

5.5.1 Real-Time Kinematic (RTK)

RT-2 (OEMV-2 and OEMV-3) and RT-20 (OEMV-1, OEMV-1G, OEMV-2 and OEMV-3), all with AdVance RTK, are real-time kinematic software products developed by NovAtel. Optimal RTK performance is achieved when both the base and rovers are NovAtel products. However, AdVance RTK will operate with equipment from other manufacturers when using RTCM messaging.

RT-2 and RT-20 are supported by GPS-only and GPS + GLONASS OEMV-based models. Also, RT-20 with GPS + GLONASS provides faster convergence.

NovAtel's RTK software algorithms utilize both carrier and code phase measurements; thus, the solutions are robust, reliable, accurate and rapid. While RT-20 and RT-2 operate along similar principles, RT-2 achieves its extra accuracy and precision due to its being able to utilize dual-frequency measurements. Dual-frequency GPS receivers have two main advantages over their single-frequency counterparts when running RTK software:

1. resolution of cycle ambiguity is possible due to the additional information
2. longer baselines are easier due to the removal of ionospheric errors

Depending on the transmitting/receiving receivers and the message content, various levels of accuracy can be obtained. Please refer to the particular accuracy as shown in the following table:

Table 16: Summary of RTK Messages and Expected Accuracy

<table>
<tr><th>Message Formats</th><th>Transmitting (Base)</th><th>Receiving (Rover)</th><th>Accuracy Expected</th></tr>
<tr><td rowspan="3">L1 and L2 RTK:
GPS-only:
RTCAOBS with RTCAREF
CMROBS with CMRREF
RTCM Types 18 and 19 with 3 and 22
RTCM Types 20 and 21 with 3 and 22
GPS + GLONASS
RTCM Types 31 and 32 with Type 3
RTCM Type 59GLO with Type 3
RTCAOBS2 with RTCAREF</td><td rowspan="2">L1/L2</td><td>L1/L2</td><td>1 cm +1 ppm RMS (RT-2)</td></tr>
<tr><td>L1</td><td>20 cm RMS (GPS-only RT-20)
10 cm RMS (GPS+GLONASS RT-20)</td></tr>
<tr><td>L1 only</td><td>L1/L2 or L1 only</td><td>20 cm RMS (GPS-only RT-20)
10 cm RMS (GPS+GLONASS RT-20)</td></tr>
<tr><td>L1 RTK:
GPS-only
RTCM Type 59 with Type 3
GPS + GLONASS
RTCM Type 59GLO with Type 3</td><td>L1 only</td><td>L1/L2 or L1 only</td><td>20 cm RMS (GPS-only RT-20)
10 cm RMS (GPS+GLONASS RT-20)</td></tr>
<tr><td>L1 Pseudorange Corrections:
RTCM Type 1
RTCA Type 1</td><td>L1/L2 or L1 only</td><td>Any differential enabled OEMV</td><td>45 cm RMS (DGPS)</td></tr>
</table>

Below are tables that show how many GPS and/or GLONASS satellites you need to obtain a fixed ambiguity solution, *Table 17* below, and how many you need to keep a fixed ambiguity solution, see *Table 18*. Note that fixed ambiguities are only provided in RT-2 mode.

Table 17: To Obtain a Fixed Ambiguity Solution

	#GPS Satellites							
#GLO Satellites	1	2	3	4	5	6	7	8
1	No	No	No	Float	**Fix**	**Fix**	**Fix**	**Fix**
2	No	No	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
3	No	Float	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
4	Float	Float	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
5	Float	Float	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
6	Float	Float	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
7	Float	Float	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
8	Float	Float	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**

Table 18: To Maintain a Fixed Ambiguity Solution

	#GPS Satellites							
#GLO Satellites	1	2	3	4	5	6	7	8
1	No	No	No	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
2	No	No	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
3	No	Fix	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
4	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
5	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
6	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
7	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**
8	Float	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**	**Fix**

The RTK system in the receiver provides two kinds of position solutions. The Matched RTK position is computed with buffered observations, so there is no error due to the extrapolation of base station measurements. This provides the highest accuracy solution possible at the expense of some latency which is affected primarily by the speed of the differential data link. The MATCHEDPOS log contains the matched RTK solution and can be generated for each processed set of base station observations. The RTKDATA log provides additional information about the matched RTK solution. The RTKDATA, RTKPOS and BESTPOS logs also show a verification flag in the "rtk info" field. It is recommended that you check this verification flag, especially in severe environments.

The Low-Latency RTK position and velocity are computed from the latest local observations and extrapolated base station observations. This supplies a valid RTK position with the lowest latency possible at the expense of some accuracy. The degradation in accuracy is reflected in the standard deviation and is summarized in *Section 5.3.2*, *Position Solutions* starting on *Page 79*. The amount of time that the base station observations are extrapolated is provided in the "differential lag" field of the position log. The Low-Latency RTK system extrapolates for 60 seconds. The RTKPOS log contains the Low-Latency RTK position when valid and an "invalid" status when a low-latency RTK solution could not be computed. The BESTPOS log contains the low-latency RTK position when it is valid, and superior to the pseudorange-based position. Otherwise, it contains the pseudorange-based position. Similarly, RTKVEL and BESTVEL contains the low-latency RTK velocity.

RT-20 solutions always use floating L1 ambiguities. When valid L2 measurements are available, RT-2 solutions have other solution types that depend on convergence time, baseline length, number of satellites, satellite geometry and the level of ionospheric activity detected.

RT-2 Performance

RT-2 software, in both static and kinematic GPS-only and GPS + GLONASS modes, provides accuracies of 1 cm +1 ppm RMS for baselines from 0 to 40 km. A plot of convergence versus baseline length is shown in *Figure 28* on *Page 92* for typical multipath, ionospheric, tropospheric, and ephemeris errors, where typical is described as follows:

- A typical multipath environment would provide no carrier-phase double-difference multipath errors greater than 2 cm or pseudorange double-difference multipath errors greater than 2 m on satellites at 11° elevation or greater. For environments where there is greater multipath, please consult NovAtel Customer Service.
- Typical unmodeled ionospheric, tropospheric and ephemeris errors must be within 2σ of their average values, at a given elevation angle and baseline length. It is assumed that the tropospheric correction is computed with standard atmospheric parameters. All performance specifications are based on a PDOP < 2 and continuous tracking of at least 5 satellites (6 preferred) at elevations of at least 11.5° on both L1 and L2.

Refer to the GPGST usage box, like this one, in the *OEMV Firmware Reference Manual* for a definition of RMS and other statistics.

RTKPOS or BESTPOS logs contain some error due to predictions from base station observations. The expected error of a RTKPOS or BESTPOS log will be that of the corresponding MATCHEDPOS log plus the appropriate error from *Table 19*.

There are no data delays for a matched log and therefore no need to add an additional error factor.

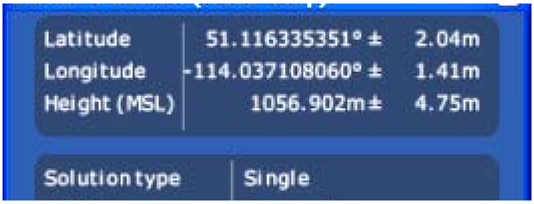
Table 19: RT-2 Degradation With Respect To Data Delay

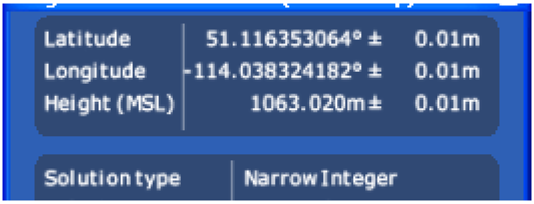
Data Delay (s)	Distance (km)	Accuracy (RMS)
0 - 2	1	+1 cm/s
2 - 7	1	+2 cm/s
7 - 30	1	+5 cm/s
>60	1	single point or pseudorange differential positioning [2]

[1] Mode = Static or Kinematic

[2] After 60 seconds reverts to pseudorange positioning (single point or differential depending on messages previously received from the base station).

The RT-2 solution can show two pronounced steps in accuracy convergence; these correspond to the single-point solution switching to the floating ambiguity solution which in turn switches to the narrow lane solution. If you were monitoring this using NovAtel's **CDU** program, the convergence might look something like this:





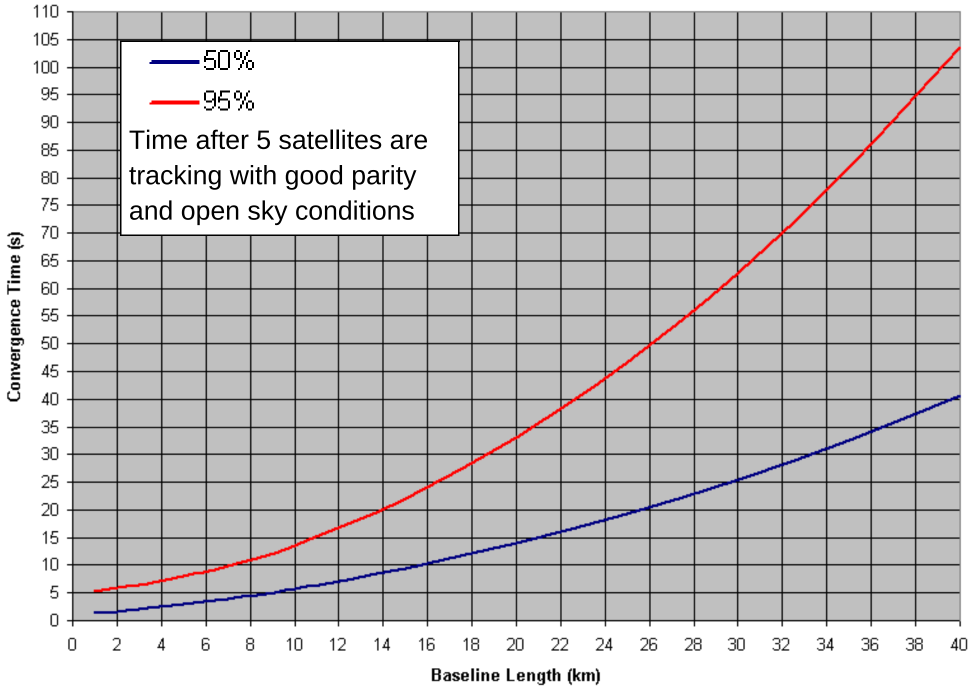


Figure 28: AdVance RTK - Time to Integer Narrowlane vs. Baseline Length

RT-20 Performance

As shown in *Table 20, RT-20 Performance* on *Page 93*, *Figure 29* on *Page 94* and *Figure 30* on *Page 94*, the RT-20 system provides nominal 20 cm accuracy (GPS-only) after 15 minutes of continuous lock in static mode. After an additional period of continuous tracking (from 10 to 20 minutes), the system typically reaches steady state. The time to steady state is about 3 times longer in kinematic mode.

RT-20 double-difference accuracies are based on PDOP < 2 and continuous tracking of at least 5 satellites (6 preferred) at elevations of at least 11.5°.

All accuracy values refer to horizontal RMS error, and are based on low-latency positions. The level of position accuracy at any time will be reflected in the standard deviations output with the position.

✉ RT-20 performance with GPS + GLONASS, converges to 20 cm accuracy faster than GPS-only. See also *Section A.1, OEMV Family Receiver Performance* on *Page 128* for details.

Table 20: RT-20 Performance

Tracking Time (s)	Mode [1]	Data Delay (s)	Distance (km)	Accuracy (RMS)
1 - 180	Static	0	1	45 to 25 cm
180 - 3000	Static	0	1	25 to 5 cm
> 3000	Static	0	1	5 cm or less [2]
1 - 600	Kinematic	0	1	45 to 25 cm
600 - 3000	Kinematic	0	1	25 to 5 cm
> 3000	Kinematic	0	1	5 cm or less [2]
	Either	0 - 2	1	+1 cm/s
	Either	2 - 7	1	+2 cm/s
	Either	7 - 30	1	+5 cm/s
	Either	> 30	1	pseudorange or single point [3]
	Either	0	0 - 10	+0.5 cm/km
	Either	0	10 - 20	+0.75 cm/km
	Either	0	20 - 50	+1.0 cm/km

1 Mode = Static or Kinematic (during initial ambiguity resolution)

2 The accuracy specifications refer to the BESTPOSA/B logs which include about 3 cm extrapolation error. MATCHEDPOSA/B logs are more accurate but have increased latency associated with them.

3 After 60 seconds reverts to pseudorange positioning (single point or differential depending on messages previously received from the base station).

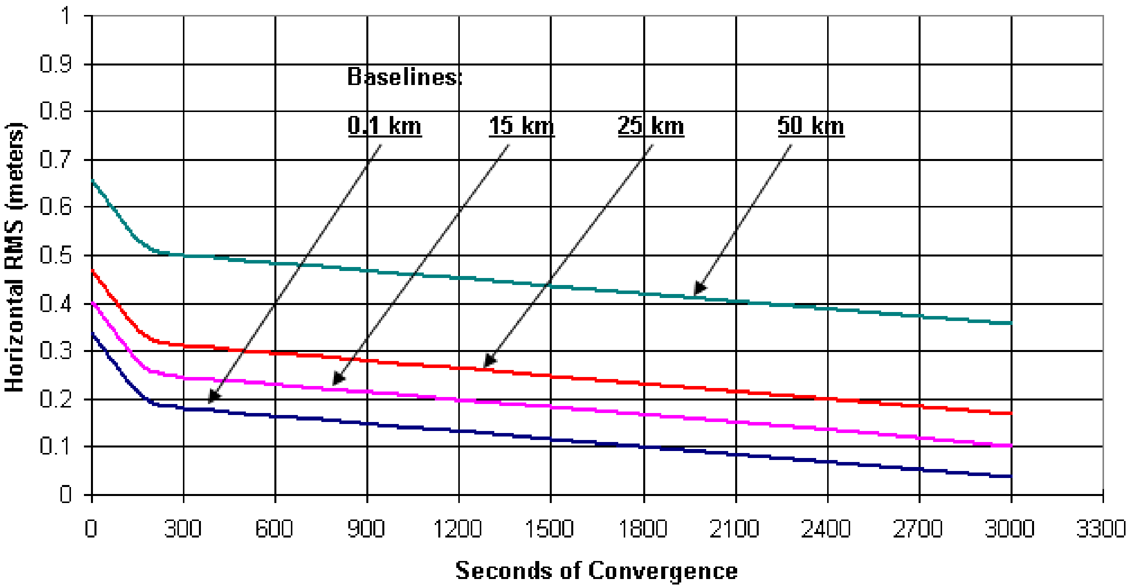


Figure 29: Typical RT-20 Convergence - Static Mode (GPS+GLONASS)

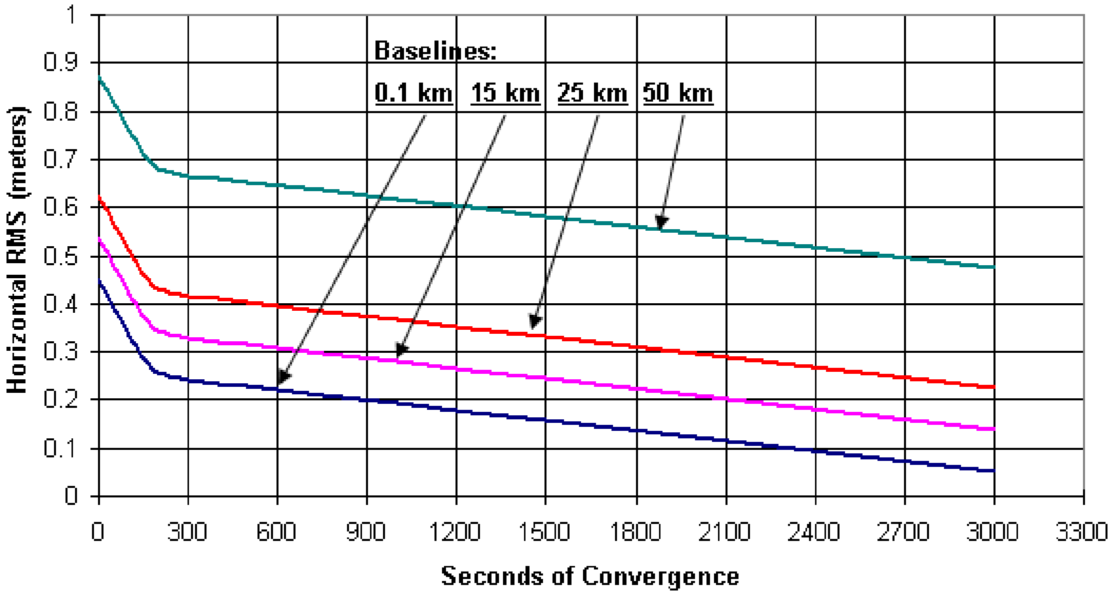


Figure 30: Typical RT-20 Convergence - Static Mode (GPS-only)

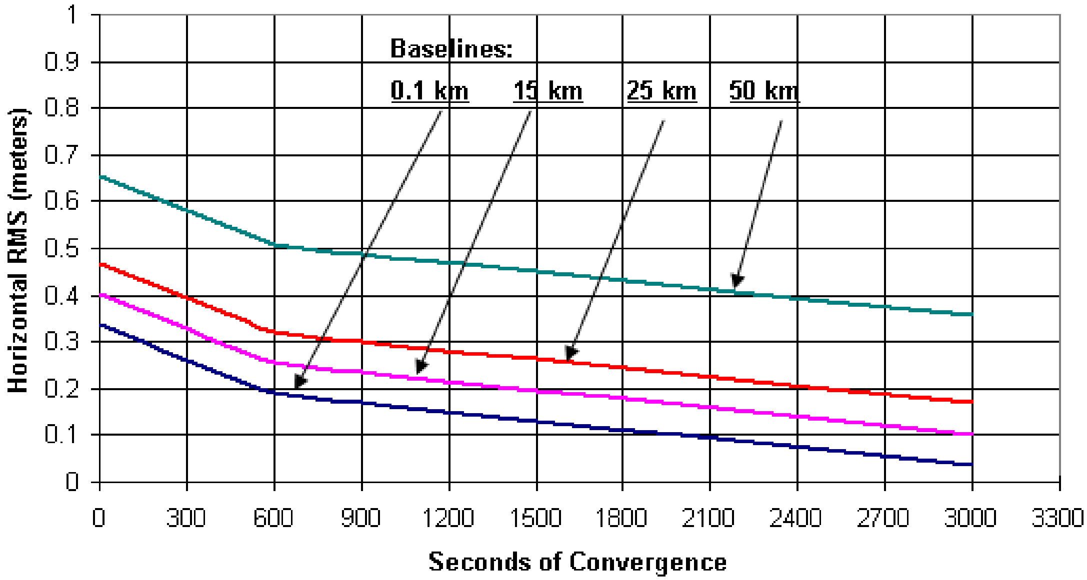


Figure 31: Typical RT-20 Convergence - Kinematic Mode (GPS + GLONASS)

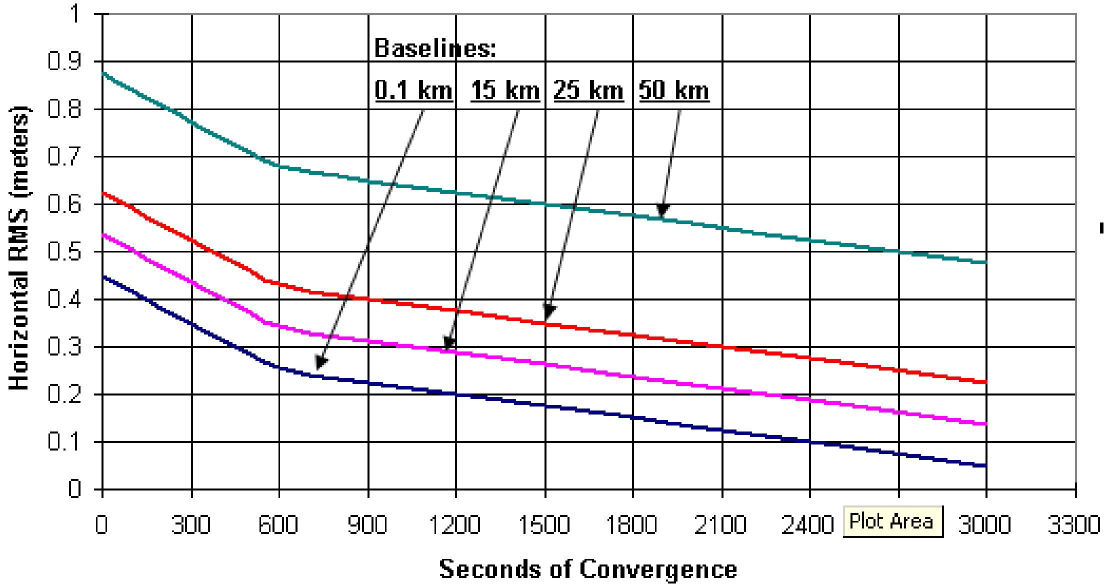


Figure 32: Typical RT-20 Convergence - Kinematic Mode (GPS-only)

Performance Considerations

When referring to the "performance" of RTK software, two factors are introduced:

1. *Baseline length*: the position estimate becomes less precise as the baseline length increases. Note that the baseline length is the distance between the *phase centres* of the two antennas. Identifying the exact position of your antenna's phase centre is essential; this information is typically supplied by the antenna's manufacturer or vendor.

   The RTK software automatically makes the transition between short and longer baselines, but the best results are obtained for baselines less than 10 km. The following are factors which are related to baseline length:

   - ephemeris errors - these produce typical position errors of 0.75 cm per 10 km of baseline length.
   - ionospheric effects - the dominant error for single-frequency GPS receivers on baselines exceeding 20 km. Differential ionospheric effects reach their peak at around 2 pm local time, being at a minimum during hours of darkness.
   - tropospheric effects - these produce typical position errors of approximately 1 cm per 20 km of baseline length. This error increases if there is a significant height difference between the base and rover stations, as well as if there are significantly different weather conditions between the two sites.

   A related issue is that of multipath interference, the dominant error on short differential baselines. Generally, multipath can be reduced by choosing the antenna's location with care, and by the use of the GPS-702 antenna (no need for a choke ring) or a L1/L2 antenna and a choke ring antenna ground plane, refer to the *Multipath* section of the *GPS+ Reference Manual*.

2. *Convergence time*: the position estimate becomes more accurate and more precise with time. However, convergence time is dependent upon baseline length: while good results are available after a minute or so for short baselines, the time required increases with baseline length. Convergence time is also affected by the number of satellites which can be used in the solution (the more satellites, the faster the convergence) and by the errors listed in *Baseline Length* above.

Performance Degradation

The performance will degrade if satellites are lost at the rover or if breaks occur in the differential correction transmission link. The degradations related to these situations are described in the following paragraphs.

Provided lock is maintained on at least 4 SVs and steady state has been achieved, the only degradation will be the result of a decrease in the geometrical strength of the observed satellite constellation. If steady state has not been achieved, then the length of time to ambiguity resolution under only 4-satellite coverage will be increased significantly.

ROVER TRACKING LOSS

If less than 4 satellites are maintained, then the RTK filter can not produce a position. When this occurs, the BESTPOS and PSRPOS logs will be generated with differential (if pseudorange differential messages are transmitted with RTK messages) or single point pseudorange solutions if possible.

DIFFERENTIAL LINK BREAKDOWN

1. Provided the system is in steady state, and the loss of observation data is for less than 60 seconds, the Low-Latency RTK positions will degrade according to the divergence of the base observation extrapolation filters. This causes a decrease in accuracy of about an order of magnitude per 10 seconds without a base station observation, and this degradation is reflected in the standard deviations of the low latency logs. Once the data link has been re-established, the accuracy will return to normal after several samples have been received.

2. If the loss of differential corrections lasts longer than 60 seconds, the RTK filter is reset and all ambiguity and base model information is lost. The timeout threshold for RTK differential corrections is 60 seconds, but for Type 1 pseudorange corrections, the default timeout is 300 seconds. Therefore, when the RTK can no longer function because of this timeout, the pseudorange filter can produce differential positions for an additional 240 seconds by default (provided pseudorange differential messages were transmitted along with the RTK messages) before the system reverts to single point positioning. Furthermore, once the link is re-established, the pseudorange filter produces an immediate differential position while the RTK filter takes several additional seconds to generate its positions. The base model must be healthy before solutions are logged to the low latency logs, so there is a delay in the use of real time carrier positioning to the user once the link has been re-established. The RTK logs, such as MATCHEDPOSA/B, use matched observations only (no extrapolated observations). These matched observations will be available after three base observations are received, but will typically have about 1.5 seconds latency associated with them, although longer latencies may occur with some slower data links.

3. The RTK system is based on a time-matched double difference observation filter. This means that observations at the rover site have to be buffered while the base station observation is encoded, transmitted, and decoded. Only 8 seconds of rover observations are saved, so the base station observation transmission process has to take less than 8 seconds if any time matches are to be made. In addition, only rover observations on even second boundaries are retained, so base station observations must also be sent on even seconds if time matches are to be made.

Chapter 6 PC Software and Firmware

Visit the Firmware and Software Updates section of the NovAtel website, www.novatel.com, for the most recent versions of the PC software and receiver firmware.

6.1 CDU/Convert Installation

The CD accompanying this manual contains the Windows applications **CDU** (Control and Display Unit) and Convert. The DL Explorer is part of CDU. They are installed via a standard Install Shield set-up application. Also included on the CD is sample source code, to aid development of software for interfacing with the receiver, and product documentation.

These applications utilize a database in their operations 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. The install set-up application does all this automatically so you have only to select where you would like the applications installed on your PC. It is strongly recommended that you close all applications before installing **CDU** and Convert. 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**, Convert and DL4Tool database.

The software operates from your PC's hard drive. You will need to install the software from the CD supplied by NovAtel or from our website:

1. Start Microsoft Windows.
2. Place the NovAtel CD in your CD-ROM drive. If the setup utility is not automatically accessible, follow these steps:
    a. Select Run from the Start menu.
    b. Select the Browse button.
    c. Locate Setup.exe on the CD drive and select Open.
    d. Select OK to run the setup utility.
3. Advance through the steps provided by the setup utility.

When the installation is complete, click on a program icon to launch the application.

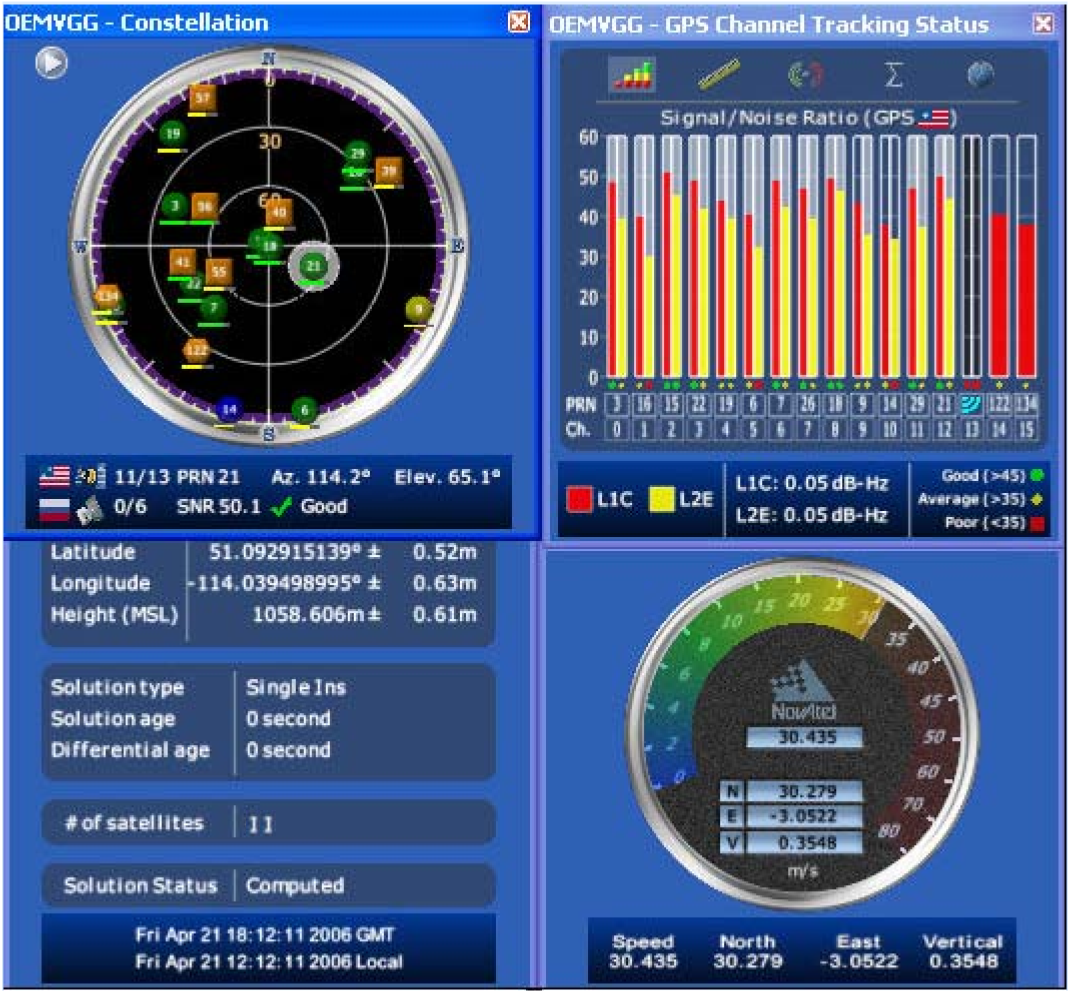
✉ **CDU** with DL Explorer (for the DL-V3) and DL4Tool (for the DL-4*plus*) is available to download from our website at http://www.novatel.com/support/fwswupdates.htm. Log groups are sets of logs used by the DL-V3. A log group can be created in **CDU**'s *DL Explorer* and then downloaded to the DL-V3. Refer to the *DL-V3 Firmware Reference Manual*, on our website at http://www.novatel.com/support/docupdates.htm, for more details on DL Explorer and its use. If applicable, refer also to your *DL-V3 Quick Start Guide*.

6.2 CDU

CDU is a 32-bit Windows application. The application provides a graphical user interface (GUI) to allow you to set-up and monitor the operation of the NovAtel receiver by providing a series of windows whose functionality is explained in this section. A help file is included with **CDU**. To access the file, select *Contents* from the *Help* menu.

See also *Section 4.2.2, Communicating with the Receiver Using CDU* starting on *Page 57*.

The rest of this section shows the **CDU** windows from the *View* menu and their descriptions.



Most windows have a popup menu accessible by right clicking on the window with the mouse. They provide a way to customize the window by changing the font or to print the window contents. Some of the windows have access to the Options dialog which contains further settings for certain windows.

- **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 via the  button.

Each of the satellites being tracked are represented with icons according to their 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 means that while the receiver is tracking 5 GLONASS satellites, none are currently used in the position solution.
- Satellite PRN number Azimuth and elevation angle values
- Signal to Noise Ratio (SNR) value and indicator

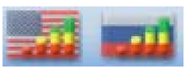
The PRN of the satellite is displayed on the icon and color-coding is used to indicate the status of the satellite or the tracking channel. Click on a satellite to display information on that satellite.

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

 Open this window by selecting Constellation Window from the View menu or by clicking its button in the Window Toolbar.

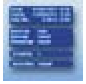
- **Channel Tracking Status Window:** The Channel Tracking Status window displays key information for each of the receiver's processing channels, including the PRN of the satellite being tracked by that channel, the Signal to Noise Ratio, Pseudorange measurements, Doppler values, Residuals measurements 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 the model of your receiver and the bars are color-keyed to indicate the frequency type on the channel.

   Open these windows by selecting Tracking Status Window GPS/GLONASS from the View menu or by selecting the American and Russian flag buttons in the Window Toolbar.

- **Position Window:** The Position window displays:
  - The receiver's latitude, longitude and height
  - The Solution Type, also known as Position Type

- The 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)


Open this window by selecting Position Window from the View menu or its button in the Window Toolbar.

Right-click in the Position window to that enables you to set the PC 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 as well as the vertical, North, and East velocity components. If necessary, the scale in the dial increases so that you have room to accelerate.


Open this window by selecting Velocity Window from the View menu or its button in the Window Toolbar.

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


Open this window by selecting Compass Window from the View menu or its button in the Window Toolbar.

- **INS Window:** If applicable, please refer to your SPAN User Manual for more on 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 indicated by an arrow on each axis.

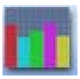

Open this window by selecting INS Window from the View menu or its button in the Window Toolbar.

- **Plan Window:** The Plan window provides real-time graphic plotting of the current position of each connected device. The latitude and longitude shown 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 this window, select Plan Window from the View menu or select its button in the Window Toolbar.

-  **Doppler Window:** A value representing the uncertainty of the position solution 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 to 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) and sent by pressing the Enter button or simply pressing <Enter> on the keyboard. The command editor has recall functionality similar to DosKey whereby pressing the up arrow on the keyboard will move backward through the previously issued commands and pressing the down arrow will move forward through the previously issued commands. This allows the user to scroll through previously issued commands and then press the <Enter> key to issue that command again.

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

WARNING!: **Ensure all other windows are closed in CDU when entering the SAVECONFIG command in the Console window.**

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

- **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 display the Logging Control window, select Logging Control Window from the Tools menu or select its button in the Window Toolbar.

WARNING!: **Ensure the Power Settings on your PC are not set to go into Hibernate or Standby modes. Data will be lost if one of these modes occurs during a logging session. Refer to CDU's online Help for more information.**

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

To display the ASCII Messages window, select ASCII Messages Window from the View menu or select its button in the Window Toolbar.

- **Wizards**: There are two wizards available: RTK and SPAN.

The Real Time Kinematic (RTK) wizard takes you through the steps needed to set up your RTK system. You must have an RTK-capable receiver model or the wizard does not continue past its opening page.

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

To display a wizard window, if you have the necessary receiver model, select SPAN Wizard or RTK Wizard from the Tools menu or select one of their buttons in the Window Toolbar.

6.3 Convert

Convert is a 32-bit Windows application and is shown in *Figure 33*. Convert will accept GPS file formats and convert them to ASCII, Binary or Rinex format. The application also allows the user to screen out particular logs by selecting the desired logs from the list of available logs. This feature is useful for screening particular logs out of large data files in either ASCII or Binary formats.

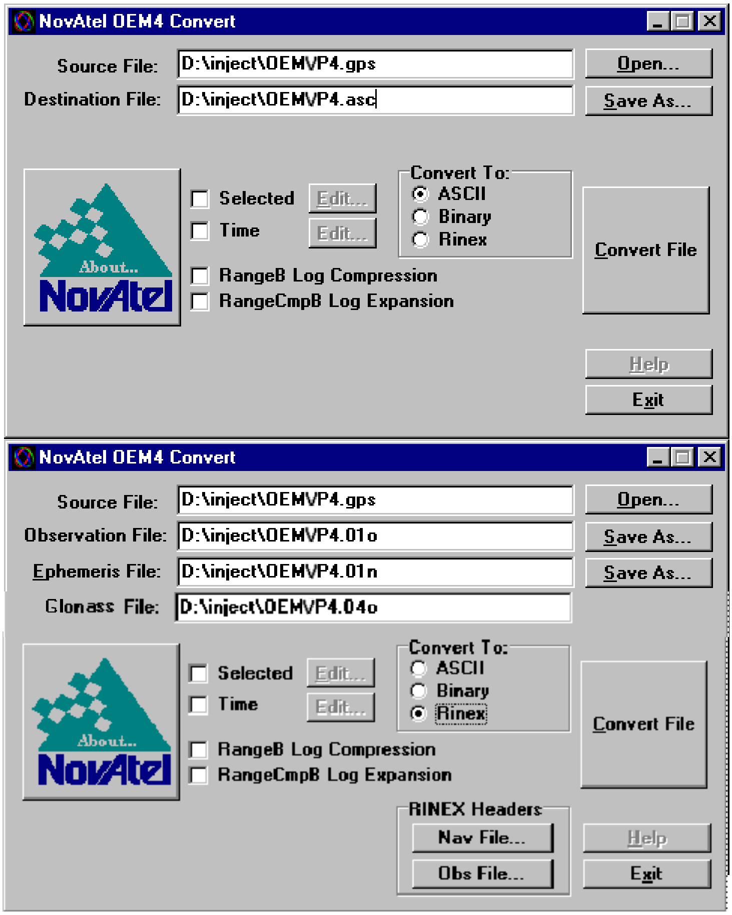


Figure 33: Convert Screen Examples

6.3.1 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.

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

The Convert4 utility can be used to produce RINEX files from NovAtel receiver data files.

✉ Although RINEX is intended to be a receiver-independent format, there are many optional records and fields. Please 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, see *Figure 33, Convert Screen Examples on Page 104*, in the Convert To section causes the:

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

For best results, the NovAtel receiver input data file should contain the logs as in *Table 21, NovAtel Logs for Rinex Conversion* on *Page 106*.

Table 21: NovAtel Logs for Rinex Conversion

NovAtel OEMV 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
SITEDEFA/B [b]	once

a. Information from this log overrides data entered into the Receiver Number, Type and Version fields using the OBS file button of the RINEX Headers section, see *Figure 33 on Page 104*

b. Available on DL-V3 receivers, refer to the *DL-V3 Firmware User Manual*. Information from this log overrides data entered into the Marker Name, Marker Number, Antenna Type and Antenna Delta H fields using the OBS file button of the RINEX Headers section

6.3.2 Convert 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 (select Accessories | Command Prompt from the Start menu). Change directory (cd) to the directory on your hard drive that Convert4 is stored. Type the following: convert4 -h

The Convert4 Command Line Arguments window appears as shown in *Figure 34*.

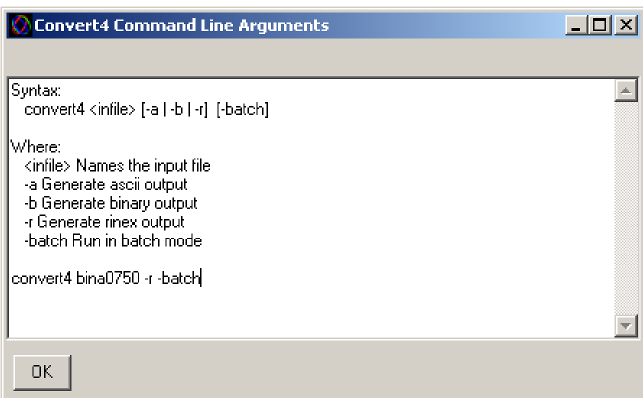


Figure 34: Convert Command Line Arguments

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 indicate the format of the data:

*.asc	for ASCII
*.bin	for binary

When converting to RINEX, the output files are named according to the RINEX Version 2.10 naming convention, see *Section 6.3.1, Rinex Format on Page 104*.

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 Convert session is used.

6.4 USB Drivers Installation

The NovAtel USB PC Driver Kit contains the following:

ngpsser.sys	This driver provides a virtual serial port for each USB port of the receiver.
ngpsusb.sys	This driver connects the virtual serial ports to the USB stack.
novatelusb.exe	This utility allows you to control which Windows COM ports are assigned to each USB port of the receiver. This utility can also be used to uninstall the drivers when newer versions are available. During installation, a shortcut is added to the Start Menu under Programs/OEMV PC Software/NovAtel USB Configuration Utility.

These drivers have not been 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 6.4.1, Windows Driver Signing* below for details.

6.4.1 Windows Driver Signing

Depending on how your administrator has configured your computer, Windows 2000 and Windows XP either ignore device drivers that are not digitally signed, display a warning when they detect device drivers that are not digitally signed (the default), or prevent you from installing device drivers without digital signatures.

Since the current version of NovAtel USB drivers are not digitally signed, the computer's policy must be either Ignore or Warn to enable the drivers to be installed.

To change the Driver Signing Policy on your computer:

1. Double-click on System in the Control Panel.
2. Select the Hardware tab.
3. Click on the Driver Signing button

4. Select either Ignore or Warn in the File signature verification box.
5. Click on OK to accept the new policy.
6. Click on 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 starting below or the *Windows 2000 Installation* section starting on *Page 110*.

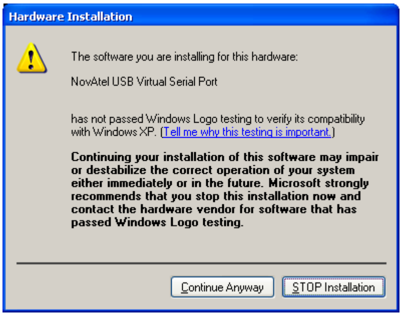
6.4.2 Windows XP Installation

If upgrading drivers, uninstall older versions using the NovAtel USB Configuration tool located in the Start Menu under Program Files | OEMV PC Software. If you have not installed NovAtel USB drivers before, the NovAtel USB Configuration tool will not be there until you install them.

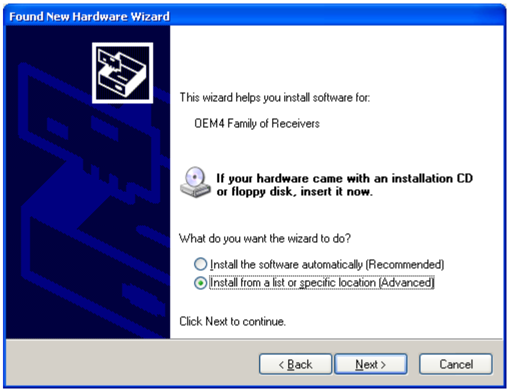
After connecting the NovAtel GPS receiver to a USB port on the PC, the Found New Hardware wizard appears.

1. The screens displayed in this section, from Windows XP, may vary from what you see and depend on your operating system.

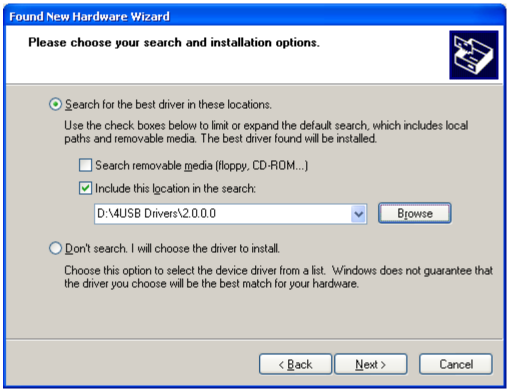
2. During the driver installation you may see a Window Logo testing warning if you skipped the steps in *Section 6.4.1,Windows Driver Signing* on *Page 107*. Our USB drivers are compatible with Microsoft Windows operating systems. Please click on *Continue Anyway* if you see a warning like this:



1. Click on *No, not this time* and then click on *Next*.
2. Select the *Install from a list or specific location (Advanced)* field and click on *Next*.



3. Clear the *Search removable media* check box, select the *Include this location in the search:* field and Browse to the USB driver install directory on the supplied OEMV family CD. Then click on *Next*.

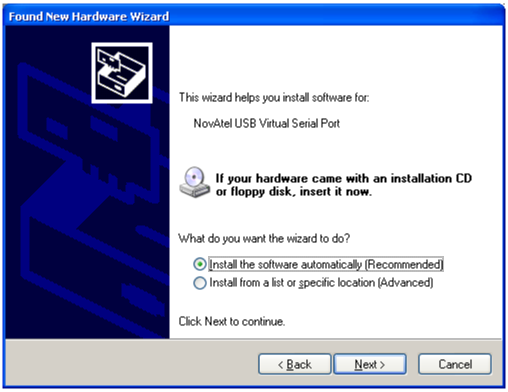


4. Click on *Finish* to complete the driver installation.

After installing the NovAtel USB driver, Windows detects the OEMV-2 or OEMV-3 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 the Install the software automatically field (recommended) and click on *Next*.



2. Click on *Finish*.

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.

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

6.4.3 Windows 2000 Installation

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

After connecting the NovAtel GPS receiver to a USB port on the PC, the Found New Hardware wizard appears. Click on *Next*. (see the example screens and notes in *Section 6.4.2, Windows XP Installation* starting on *Page 108*).

1. Select the Search for a suitable driver for my device field and click on Next.
2. Select the Specify a location field and click on Next.
3. Specify the location using the browse button, for example, on the supplied OEMV family CD: USB Drivers\Install
4. Click on OK.
5. Confirm that the driver found is, for example: \USB Drivers\Install\ngpsusb.inf

6. Click on Next.
7. Click on 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. 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.

✉ The assignment of COM port numbers is tied to the USB port on the PC. This allows you to switch receivers without Windows assigning new COM ports. However, if you connect the receiver to a different USB port, Windows detects the receiver's presence on that USB port and assign three new COM port numbers.

6.5 Firmware Upgrades

The receiver stores its program firmware in non-volatile memory, which allows you to perform firmware upgrades without having to return the receiver to the distributor. New firmware can be transferred to the receiver through COM1, and the unit will immediately be ready for operation at a higher level of performance.

The first step in upgrading your receiver is to contact your local NovAtel dealer. Your dealer will assist you in selecting the best upgrade option that suits your specific GPS needs. If your needs are still unresolved after seeing your dealer then you can contact NovAtel directly through any of the methods described in the Customer Service section, *see Page 18*, at the beginning of this manual.

When you call, be sure to have available your receiver model number, serial number, and program revision level. This information can be found by issuing the LOG VERSION command at the port prompt.

After establishing which new model/revision level would best suit your needs, and having described the terms and conditions, you will be issued an authorization code (auth-code). The auth-code is required to unlock the new features according to your authorized upgrade model type.

To upgrade to a higher performance model at the same firmware revision level (for example, upgrading from an OEMV-3-L1 to an OEMV-3-RT2 on firmware version 3.000), you can use the AUTH command with the issued auth-code.

If you are upgrading to a higher firmware revision level (for example, upgrading an OEMV-3-RT2 firmware version 3.000 to OEMV-3-RT2 firmware version 3.100), you will need to transfer new program firmware to the OEMV family receiver using the WinLoad utility program. As WinLoad and the upgrade file are generally provided in a compressed file format, you will also be given a decompression password. WinLoad and the upgrade files can be found on NovAtel's FTP site at http://www.novatel.com, or can be sent to you on disk or by e-mail.

Your local NovAtel dealer will provide you with all the information that you require to upgrade your receiver.

6.5.1 Upgrading Using the AUTH Command

The AUTH command is a special input command which authorizes the enabling or unlocking of the various model features. Use this command when upgrading to a higher performance OEMV family model available within the same revision level as your current model (for example, upgrading from an OEMV-3-L1 to an OEMV-3-RT2 on firmware version 3.000). This command only functions in conjunction with a valid auth-code assigned by Customer Service.

The upgrade can be performed directly from **CDU**'s Command Line Screen, or from any other communications program. The procedure is as follows:

1) Power-up the OEMV family receiver and establish communications over a serial port (see *Chapter 4, Operation* on *Page 55*)

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

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

Syntax:

auth auth-code

where auth is a special command which allows program model upgrades

auth-code is the upgrade authorization code, expressed as hhhh,hhhh,hhhh,hhhh,hhhh,model# where the h characters are an ASCII hexadecimal code, and the model# would be ASCII text

Example:

auth 17cb,29af,3d74,01ec,fd34,l1l2lrvrt2

Once the AUTH command has been executed, the OEMV family receiver will reboot itself. Issuing the LOG VERSION command will confirm the new upgrade model type and version number.

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

6.5.2 Updating Using the WinLoad Utility

WinLoad is required (instead of the AUTH command) when upgrading previously released firmware with a newer version of program and model firmware (for example, upgrading an OEMV-3-RT2 firmware version 3.000 to OEMV-3-RT2 firmware version 3.100). WinLoad is a Windows utility program designed to facilitate program and model upgrades. Once WinLoad is installed and running, it will allow you to select a host PC serial port, bit rate, directory path, and file name of the new program firmware to be transferred to the OEMV family receiver via its COM1, COM2 or COM3 port. The port chosen must have an RS-232 interface to the PC.

Transferring Firmware Files

To proceed with your program upgrade, you must first acquire the latest firmware revision. You will need a file with a name such as OEMXXXX.EXE (where XXXX is the firmware revision level). This file is available from NovAtel's FTP site (http://www.novatel.com), or via e-mail (support@novatel.ca). If transferring is not possible, the file can be mailed to you on floppy disk. For more information on how to contact NovAtel Customer Service please see *Page 18* at the beginning of this manual.

You will need at least 1 MB of available space on your hard drive. For convenience, you may wish to copy this file to a GPS sub-directory (for example, C:\GPS\LOADER).

The file is available in a compressed format with password protection; Customer Service will provide you with the required password. After copying the file to your computer, it must be decompressed. The syntax for decompression is as follows:

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 decompression

Example:

oem1001 12345678

A windows-based dialog box is provided for password entry.

The self-extracting archive will then generate the following files:

WinLoad.exe	WinLoad utility program
HowTo.txt	Instructions on how to use the WinLoad utility
WhatsNew.txt	Information on the changes made in the firmware since the last revision
XXXX.hex	Firmware version upgrade file, where XXXX = program version level (for example, 1001.hex)

Using the WinLoad Utility

WinLoad is a windows based program used to download firmware to OEMV family cards. The main screen is shown in *Figure 35*.

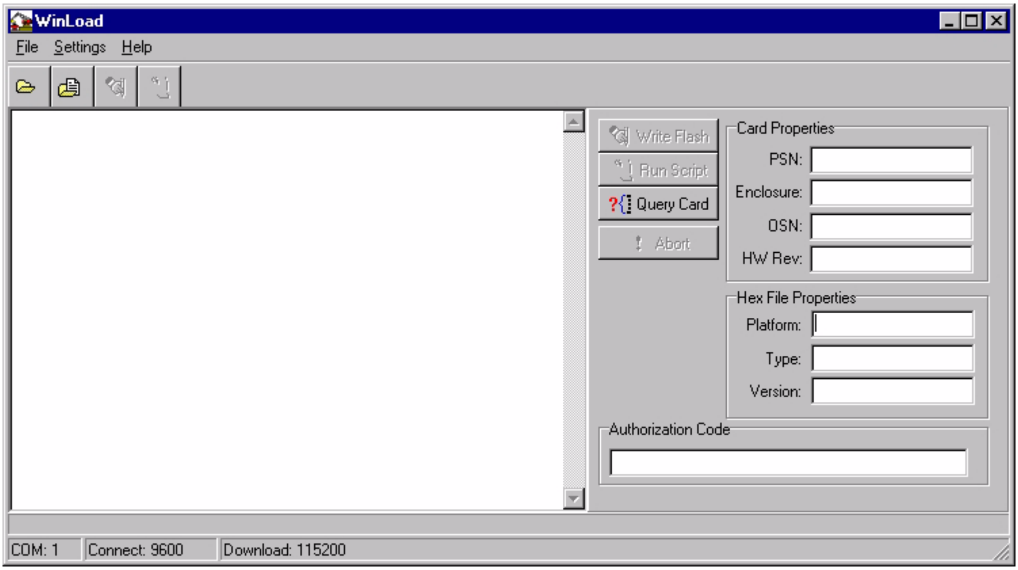


Figure 35: Main Screen of WinLoad

If you are running WinLoad for the first time you will need to make sure the file and communications settings are correct.

Open a File to Download

From the file menu choose Open. Use the Open dialog to browse for your file, see *Figure 36, WinLoad's Open Dialog on Page 114*.

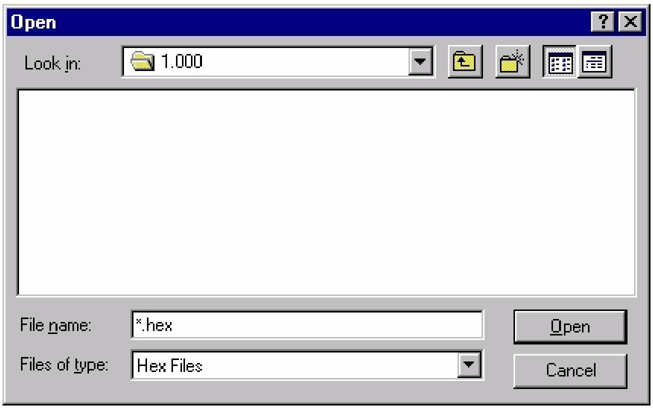


Figure 36: WinLoad's Open Dialog

Once you have selected your file, the name should appear in the main display area and in the title bar, see *Figure 37* below.

Figure 37: Open File in WinLoad

Communications Settings

To set the communications port and baud rate, select COM Settings from the Settings menu. Choose the port on your PC from the Com Port dropdown list and the baud rate from the Download Baudrate dropdown list. The baud rate should be as high as possible (the default of 115200 is preferred).

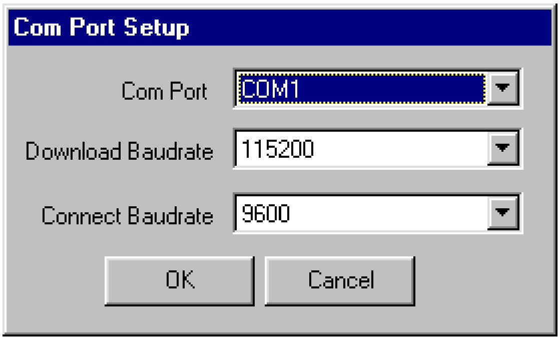


Figure 38: COM Port Setup

Downloading firmware

To download firmware follow these steps:

1. Set up the communications port as described in *Communications Settings above*.
2. Select the file to download, see *Open a File to Download* on *Page 114*.
3. Make sure the file path and file name are displayed in main display area, see *Figure 37, Open File in WinLoad on Page 115*.
4. Click on the Write Flash button to download the firmware.
5. Power down and then power up the receiver when “Searching for card” appears in the main display, see *Figure 39*.

Figure 39: Searching for Card

6. When the Authorization Code dialog opens, see *Figure 40*, enter the auth code and select OK

Figure 40: Authorization Code Dialog

7. The receiver should finish downloading and reset. The process is complete when “Done.” is displayed in the main display area, see *Figure 41*.

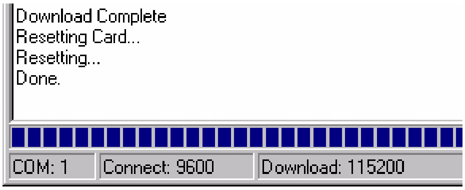


Figure 41: Upgrade Process Complete

8. Close WinLoad.

This completes the procedure required to upgrade an OEMV family receiver.

Chapter 7 Built-In Status Tests

7.1 Overview

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

1. Receiver status word (included in the header of every message)
2. ERROR strobe signal (see *Section 3.3.1, Strobes* on *Page 43*)
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. 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, in the event of 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 LED flashes red and yellow showing an error code. An RXSTATUSEVENT log is generated on all ports to show the cause of the error. Receiver tracking is disabled at this point but command and log processing continues to allow you to diagnose the error. Even if the source of the error is corrected at this point, the receiver must be reset to resume normal operation.

The above two paragraphs describe factory default behavior. Customizing is possible to better suit an individual application. RXSTATUSEVENT logs can be disabled completely using the UNLOG command. RXSTATUSEVENT logs can be generated when a receiver status bit is set or cleared by using the STATUSCONFIG SET and STATUSCONFIG CLEAR commands. Bits in the receiver status word can also be promoted to be treated just like error bits using the STATUSCONFIG PRIORITY command.

7.2 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.

The receiver gives the user the ability to determine the importance of the status bits. This is done using the priority masks. In the case of the Receiver Status, setting a bit in the priority mask will cause the condition to trigger an error. This will cause the receiver to idle all channels, turn off the antenna, and disable the RF hardware, the same as if a bit in the Receiver Error word is set. Setting a bit in an Auxiliary Status priority mask will cause that condition to set the bit in the Receiver Status word corresponding to that Auxiliary Status.

The STATUSCONFIG command is used to configure the various status mask fields in the

RXSTATUSEVENT log. These masks allow you to modify whether various status fields generate errors or event messages when they are set or cleared. This is meant to allow you to customize the operation of your OEMV family receiver for your specific needs.

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

7.3 Error Strobe Signal

The error strobe signal is one of the I/O strobes and is 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 3.3.1, Strobes* on *Page 43*.

7.4 RXSTATUSEVENT Log

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

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

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

7.5 RXSTATUS Log

7.5.1 Overview

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

The status word is the third field after the header, as shown in the example below.

```
<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 Status Word

Figure 42: Location of Receiver Status Word

Each bit in the status word indicates the status of a specific condition or function of the receiver. If the status word is 00000000, the receiver is operating normally. The numbering of the bits is shown in *Figure 43, Reading the Bits in the Receiver Status Word on Page 119* below.

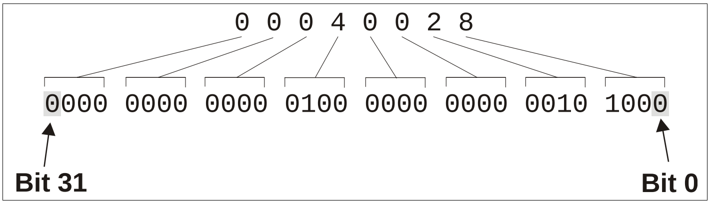


Figure 43: Reading the Bits in the Receiver Status Word

If the receiver status word indicates a problem, please also see *Section 8.1, Examining the RXSTATUS Log* on *Page 125*.

7.5.2 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 will set the error strobe line, flash the error code on the status LED, broadcast the RXSTATUSEVENT log on all ports (unless the user has unlogged it), idle all channels, turn off the antenna, and disable the RF hardware. The only way to get out of the error state is to reset the receiver.

It is also possible to have status conditions trigger event messages to be generated by the receiver. Receiver Error words automatically generate event messages. These event messages are output in RXSTATUSEVENT logs (see also *Section 7.5.6, Set and Clear Mask for all Status Code Arrays* on *Page 121*).

The error word is the first field after the log header in the RXSTATUS log, as shown in the example below, or the third from last field in the header of every log.

```
<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 44: Location of Receiver Error Word

Here is another example of a receiver error word. The numbering of the bits is shown in *Figure 45*.

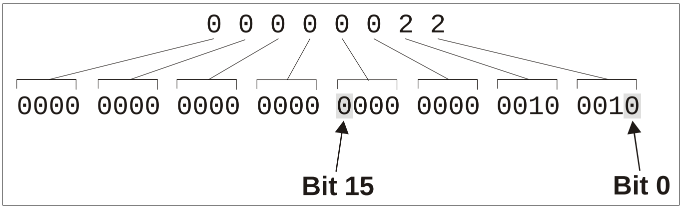


Figure 45: Reading the Bits in the Receiver Error Word

Refer to the RXSTATUS and the RXSTATUSEVENT logs in the *OEMV Firmware Reference Manual* for more detailed descriptions of these logs. If the receiver error word indicates an error, please also see *Section 8.1*, *Table 23*, *Resolving a Receiver Error Word* on *Page 125*.

7.5.3 Status Code Arrays

There are 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 4, 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.

7.5.4 Receiver Status Code

The receiver status word is included in the header of all logs. It has 32 bits, which 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 will continue to operate, unless the priority mask for the bit has been set. The priority mask bit will change that of the receiver status word into an error bit. Anything that would result from an error bit becoming active would also occur if a receiver status and its associated priority mask bits are set.

7.5.5 Auxiliary Status Codes

The auxiliary status codes are only seen in the RXSTATUS log. The three arrays representing the auxiliary status codes give indication about the receiver state for information only. The events represented by these bits typically do not cause degradation of the receiver performance. 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 *OEMV Firmware Reference Manual* for a more detailed description of this log.

7.5.6 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 which bits in the status word will result in the broadcast of the RXSTATUSEVENT log. 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 will result in the broadcast of the RXSTATUSEVENT log (unless unlogged).

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

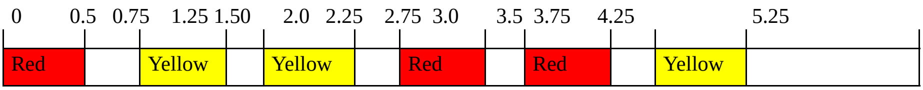
7.6 Status LEDs

7.6.1 OEMV Cards

The diagnostic LED provided on the OEMV family cards blinks green on and off at approximately 1 Hz to indicate normal operation.

Error bits and status bits that have been priority masked, as errors, will cause the LED to flash a code in a binary sequence. The binary sequence will be a 6 flash (0.5 second on and 0.25 second off per flash) sequence followed by a 1 second delay. The sequence will repeat indefinitely. If there is more than one error or status present, the lowest number will be output. The codes are ordered to have the highest priority condition output first.

The first flash in the 6 flash sequence indicates if the code that follows is an error bit or a status bit. Error bits will flash red and status bits will flash yellow. The next 5 flashes will be 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 6, the binary number is 00110 so the output sequence would be:



followed by a 1 second delay. The sequence repeats indefinitely until the receiver is reset.

In the example on *Page 122*, the first flash in the sequence is red, which means 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 7. Therefore, bit 7 of the receiver error word is set, indicating there is a problem with the supply voltage of the receiver’s power circuitry.

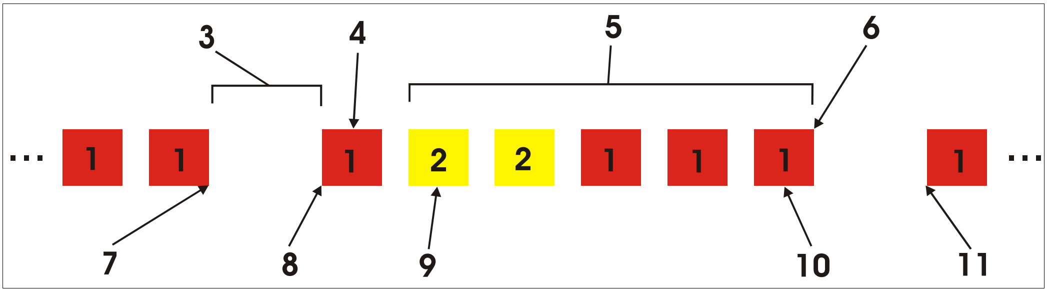


Figure 46: Status LED Flash Sequence Example

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

For a complete hexadecimal to binary conversion list, refer to the *Unit Conversion* section of the *GPS+ Reference Manual*. Refer also to the RXSTATUS log, and its tables for more details on this log and receiver error status.

7.6.2 DL-V3 Enclosure

The status LED on the front of DL-V3, with the  icon, is described in *Section 3.3.5, DL-V3 Status Indicators* on *Page 46*.

Chapter 8 Troubleshooting

When your receiver appears not to be working properly, often there are simple ways to diagnose and resolve the problem. In many cases, the issue can be resolved within a few minutes, avoiding the hassle and loss of productivity that results from having to return your receiver for repair. This chapter is designed to assist you in troubleshooting problems that occur and includes navigational instructions to bring you to the part of this manual that details resolutions to aid your receiver's operation.

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 8.1, Examining the RXSTATUS Log, Page 125*.

If the problem is not resolved after using this troubleshooting guide, or after trying our Knowledge Base at http://www.novatel.com/support/knowledgedb.htm, contact NovAtel Customer Service, see *Page 18*.

Table 22: Troubleshooting based on Symptoms

Symptom	Related Section
The receiver is not properly powered	Check for and switch a faulty power cable. See *Section 3.1.3, Power Supply Requirements, Page 34* and *Section 3.3.3, CAN Bus, Page 44*.
The receiver cannot establish communication	Check for and switch faulty serial cables and ports. See *Section 3.3.3, CAN Bus, Page 44* and *Section 7.6, Status LEDs, Page 121*. Refer also to the COMCONFIG log in the *OEMV Firmware Reference Manual*.
The receiver is not tracking satellites	Ensure you have an unobstructed view of the sky from horizon to horizon. Check for and replace a faulty antenna cable. See *Section 3.1.1, Selecting a GNSS Antenna, Page 33*, *Section 3.1.2, Choosing a Coaxial Cable, Page 34*, *Section 3.2.4, Connecting the Antenna to the Receiver, Page 40*, *Section 3.3.7, Antenna LNA Power, Page 50* and refer to the *Time to First Fix and Satellite Acquisition* section of the *GPS+ Reference Manual*.
No data is being logged	See *Section 3.3.3, CAN Bus, Page 44*, and *Section 4.1, Communications with the Receiver, Page 56*.
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 COMCONFIG log and FRESET command in the *OEMV Firmware Manual*. See also *Section 3.3.3, CAN Bus, Page 44*.

Continued on Page 124

Symptom	Related Section
A command is not accepted by the receiver	Check for correct spelling and command syntax. See *Section 4.1, Communications with the Receiver, Page 56* and refer to the FRESET command in the *OEMV Firmware Reference Manual*.
Differential mode is not working properly	See *Section 4.3, Transmitting and Receiving Corrections, Page 59* and refer to the COMCONFIG log in the *OEMV Firmware Reference Manual*.
There appears to be a problem with the receiver's memory	Refer to the NVMRESTORE command in the *OEMV 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 A, Technical Specifications* starting on *Page 128.* 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. See also *Section 4.1.1, Serial Port Default Settings, Page 56*.
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 *OEMV 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 3.1.2, Choosing a Coaxial Cable, Page 34* and the jamming symptom in this table.

8.1 Examining the RXSTATUS Log

The RXSTATUS log provides detailed status information about your receiver and can be used to diagnose problems. Please refer to the *OEMV Firmware Reference Manual* for details on this log and on how to read the receiver error word and status word. *Tables 23 and 24 on pages 125 to 127* give you actions to take when your receiver has an error flag in either of these words.

Table 23: Resolving a Receiver Error Word

Bit Set	Action to Resolve
0	Issue a FRESET command
1	Issue a FRESET command
2	Issue a FRESET command
4	Contact Customer Service as described on *Page 18*
5	Check the VERSION log
6	Issue a FRESET command
7	See *Section 3.1.3, Power Supply Requirements, Page 34*
8	Issue a NVMRESTORE command
9	Check temperature ranges in the ENVIRONMENTAL table sections of *Appendix A, Technical Specifications* starting on *Page 128*
10	Contact Customer Service as described on *Page 18*
11	
12	
13	
14	
15	Move the receiver away from any possible jamming sources

Table 24: 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 23, Resolving a Receiver Error Word* on *Page 125.*
1	Check temperature ranges in the ENVIRONMENTAL table sections of *Appendix A, , Technical Specifications* starting on *Page 128.*
2	See *Section 3.1.3, Power Supply Requirements, Page 34*.
3	See *Section 3.1.1, Selecting a GNSS Antenna, Page 33*, *Section 3.1.2, Choosing a Coaxial Cable, Page 34*, *Section 3.2.4, Connecting the Antenna to the Receiver, Page 40*, *Section 3.3.7, Antenna LNA Power, Page 50* and refer to the *Time to First Fix and Satellite Acquisition* section of the *GPS+ Reference Manual*.
4	
5	
6	
7	See *Section 4.1.1, Serial Port Default Settings, Page 56*.
8	
9	
10	
11	
14	Move the receiver away from any possible jamming sources.
15	See *Section 3.1.2, Choosing a Coaxial Cable, Page 34* and move the receiver away from any possible jamming sources.
16	Move the receiver away from any possible jamming sources.
17	See *Section 3.1.2, Choosing a Coaxial Cable, Page 34* and move the receiver away from any possible jamming sources.
18	None. Once enough time has passed 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* section of the *GPS+ Reference Manual*.
19	None. This bit only indicates if the receiver has calculated a position yet. Refer to the *Time to First Fix and Satellite Acquisition* section of the *GPS+ Reference Manual*
20	None. This bit is simply 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 *OEMV Firmware Reference Manual*.

Continued on Page 127

Bit Set	Action to Resolve
21	None. This bit simply indicates if clock steering has been manually disabled. Refer also to the FRESET command in the *OEMV Firmware Reference Manual*.
22	None. This bit only indicates if the clock model is valid. Refer also to the FRESET command in the *OEMV Firmware Reference Manual*.
23	None. This bit indicates whether or not the phase-lock-loop is locked when using an external oscillator. Refer also to the FRESET command in the *OEMV Firmware Reference Manual*.
30	None. This bit indicates if any bits in the auxiliary 2 status word are set. The auxiliary 2 word simply provides status information and does not provide any new information on problems. Refer also to the FRESET command in the *OEMV Firmware Reference Manual*.
31	None. This bit indicates if any bits in the auxiliary 1 status word are set. The auxiliary 1 word simply provides status information and does not provide any new information on problems.Refer also to the FRESET command in the *OEMV Firmware Reference Manual*.

Appendix A Technical Specifications

A.1 OEMV Family Receiver Performance

PERFORMANCE (Subject To GPS System Characteristics)		
Position Accuracy [a]	Standalone:	
	L1 only	1.8 m RMS
	L1/L2	1.5 m RMS
	WAAS:	
	L1 only	1.2 m RMS
	L1/L2	0.9 m RMS
	DGPS	0.45 m RMS
	RT-20	0.20 m RMS
	RT-2	0.01 m + 1 ppm RMS
	CDGPS:	
	L1 only	1.0 m RMS
	L1/L2	0.5 m RMS
	OmniSTAR:	
	VBS	0.7 m RMS (OEMV-1 and OEMV-3 only)
	XP	0.15 m RMS (OEMV-3 only)
	HP	0.10 m RMS (OEMV-3 only)
	Post Processed	5 mm + 1 ppm RMS
Time To First Fix	Hot: 30 s (Almanac and recent ephemeris saved and approximate position) Warm: 40 s (Almanac, approximate position and time, no recent ephemeris) Cold: 50 s (No almanac or ephemeris and no approximate position or time)	
Reacquisition	0.5 s L1 (typical)	
	1.0 s L2 (typical)	(OEMV-2 and OEMV-3 only)
Data Rates	Raw Measurements:	20 Hz
	Computed Position:	20 Hz
	OmniSTAR HP Position:	20 Hz (OEMV-3 only)
Time Accuracy [a b]	20 ns RMS	
Velocity Accuracy	0.03 m/s RMS	
Measurement Precision	C/A code phase	6 cm RMS
	L1 carrier phase:	
	Differential	0.75 mm RMS
	L2 P code	25 cm RMS (OEMV-2 and OEMV-3 only)
	L2 carrier phase:	
	Differential	2 mm RMS (OEMV-2 and OEMV-3 only)
Dynamics	Velocity	515 m/s [c]
	Height	18,288 m [c]

a. Typical values. 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. Time accuracy does not include biases due to RF or antenna delay.
c. In accordance with export licensing.

A.2 OEMV-1 Card

PHYSICAL	
Size	46 mm x 71 mm x 10.3 mm with connectors
Weight	21.5 grams
NOVATEL PART NUMBER	
Generic OEMV-1	01017533
MECHANICAL DRAWINGS	

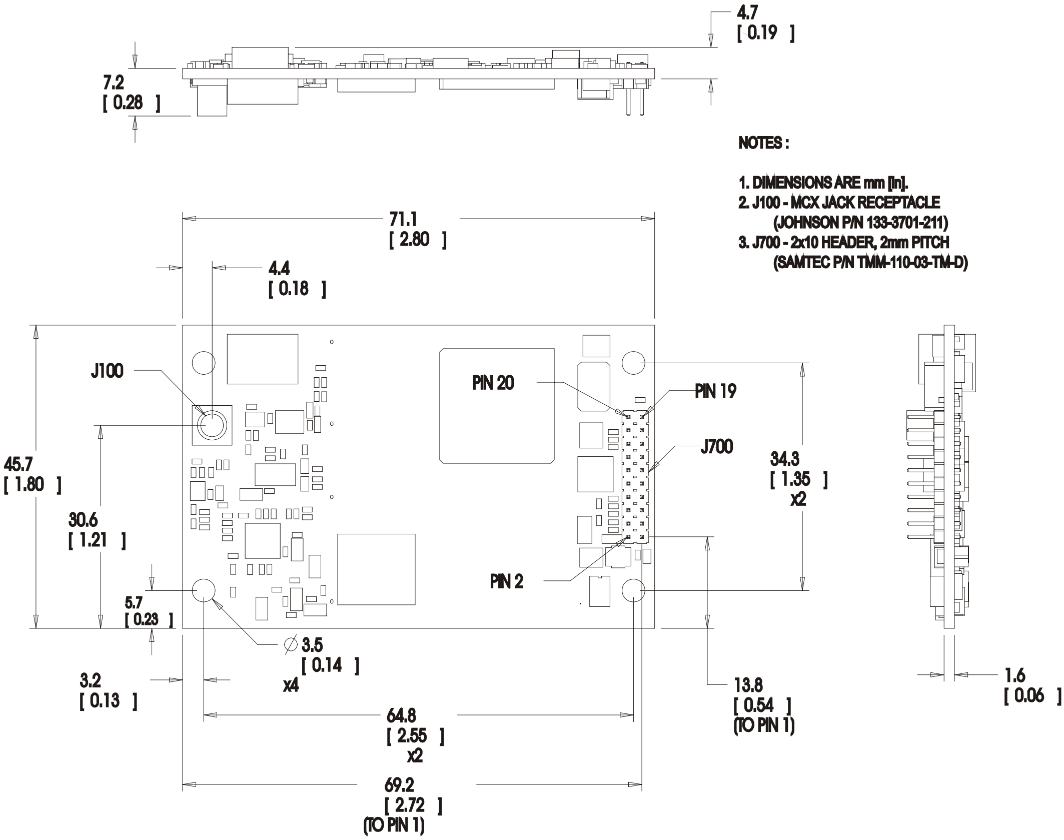


Figure 47: OEMV-1 Board Dimensions

ENVIRONMENTAL	
Operating Temperature	-40°C to +85°C
Storage Temperature	-45°C to +95°C
Humidity	Not to exceed 95% non-condensing
Random Vibe	RTCA D0-160D (4g)
Bump/Shock	MIL-STD 810F (40g)
POWER REQUIREMENTS	
Voltage	+3.3 V DC +5%/-3%
Allowable Input Voltage Ripple	100 mV p-p (max.)
Power Consumption	1.1 W (GPS only) 1.6 W (GPS + L-band) ☒ Variable values that can change due to the number of satellites in the sky and the firmware version. They are a guide for what you might expect but absolute values are not possible.
RF INPUT / LNA POWER OUTPUT	
Antenna Connector	MCX female, 50 Ω nominal impedance (See *Figure 47* on *Page 129*)
Acceptable RF Input Level	-80 to -105 dBm
RF Input Frequencies	GPS L1: 1575.42 MHz OmniSTAR or CDGPS: 1525 to 1560 MHz
LNA Power External (Optional Input) Output to antenna	(See also *Section 2.3.1* on *Page 32*) +5.5 to +16 V DC, 100 mA max. (user-supplied) +4.75 to +5.10 V DC @ 0 - 100 mA
INPUT/OUTPUT DATA INTERFACE	
COM1	
Electrical format	LVTTL
Bit rates [a]	300, 1200, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400 bps
Signals supported	COM1_Tx and COM1_Rx
COM2	
Electrical format	LVTTL
Bit rates [a]	300, 1200, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400 bps
Signals supported	COM2_Tx and COM2_Rx
COM3	
Electrical format	LVTTL [b c d]
Bit rates [a]	300, 1200, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400 bps
Signals supported	COM3_Tx and COM3_Rx

Continued on Page 131

CAN BUS [e][f][g]	
Electrical format	LVTTL (requires external CAN transceiver)
Bit rates	500 kb/s maximum. CAN Bus throughput is determined by slowest device on the bus.
Signals supported	CAN1 is on Pins 6 and 7. CAN2 is on Pins 8 and 20. [g]
USB	
Electrical format	Conforms to USB 1.1
Bit rates	5 Mb/s maximum
Signals supported	USB D (+) and USB D (-)

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.

b. Upon power-up, USB is enabled and COM3 is disabled by default. Multiplexed I/O allows you to switch between USB and COM3.

c. The receiver cannot prevent the host system from enumerating USB while using COM3 on the OEMV-1. This is due to the plug-and-play nature of USB. **Do not connect a USB cable while using COM3.**

d. Enable COM3 using the following commands:

```
INTERFACEMODE COM3 NOVATEL NOVATEL
SAVECONFIG
```

> FRESET clears this command, disabling COM3 and enabling USB (the factory default setting).

e. CAN1_RX and CAN1_TX are multiplexed with VARF and EVENT2, respectively. The default behavior is that EVENT2 is active. For VARF, refer to the FREQUENCYOUT command.

f. CAN Bus behavior must be asserted through the NovAtel API software. See *Section 3.3.3, CAN Bus* on *Page 44* for further details.

g. See also *Figure 48* on *Page 134* and its table.

Table 25: OEMV-1 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. (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 GPS 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 - 20 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 GPS Time. The polarity, period and pulsewidth 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 *OEMV Family Firmware Reference Manual*.

Table 26: OEMV-1 Strobe Electrical Specifications

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

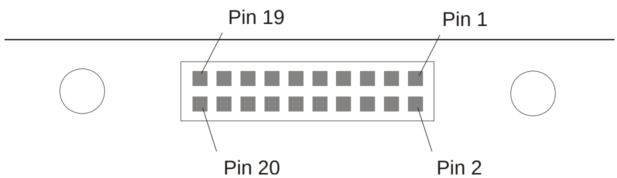


Figure 48: Top-view of 20-Pin Connector on the OEMV-1

Signal	Behavior [a]	Descriptions	Pin
LNA_PWR	Input DC	Power supply for external antenna LNA	1
V_{IN}	Input DC	DC power supply for card	2
USB D (-)	Bi-directional	USB interface data (-)	3
USB D (+) / COM3_Rx	Multiplexed	Multiplexed pin behavior default: USB D (+)	4
RESETIN	See strobes	Card reset	5
VARF / CAN1_Rx	Multiplexed	Multiplexed pin behavior, see strobes default: VARF	6
Event2 / CAN1_Tx	Multiplexed	Multiplexed pin behavior, see strobes default: Event2	7
CAN2_RX	Bi-directional	CAN Bus dedicated port	8
Event1 / COM3_Tx	Multiplexed	Multiplexed pin behavior, see strobes default: Event1	9
GND	Ground	Digital Ground	10
COM1_Tx	Output	Transmitted Data for COM 1 output	11
COM1_Rx	Input	Received Data for COM 1 input	12
GND	Ground	Digital Ground	13
COM2_Tx	Output	Transmitted Data for COM 2 output	14
COM2_Rx	Input	Received Data for COM 2 input	15
GND	Ground	Digital Ground	16
PV	See strobes	Output indicates 'good solution' or valid GPS position when high	17
GND	Ground	Digital Ground	18
PPS	See strobes	Pulse output synchronized to GPS Time	19
CAN2_TX	Bi-directional	CAN Bus dedicated port	20

a. A bi-directional Transient Voltage Suppressor (TVS) device is included between 3.3V and ground. Input/Output (I/O) lines are protected by TVS devices. Series resistance is included for the following I/O lines: COM1/COM2/COM3 Tx and Rx, RESETIN, Event1 and Event2. Lines that do not have series resistance include: CAN1_Tx, CAN1_Rx, CAN2_Tx, CAN2_Rx, USB D (+) and USB D (-).

A.3 OEMV-1G Card

PHYSICAL	
Size	46 mm x 71 mm x 9.8 mm with connectors
Weight	21.5 grams
NOVATEL PART NUMBER	
Generic OEMV-1G	01017967
MECHANICAL DRAWINGS	

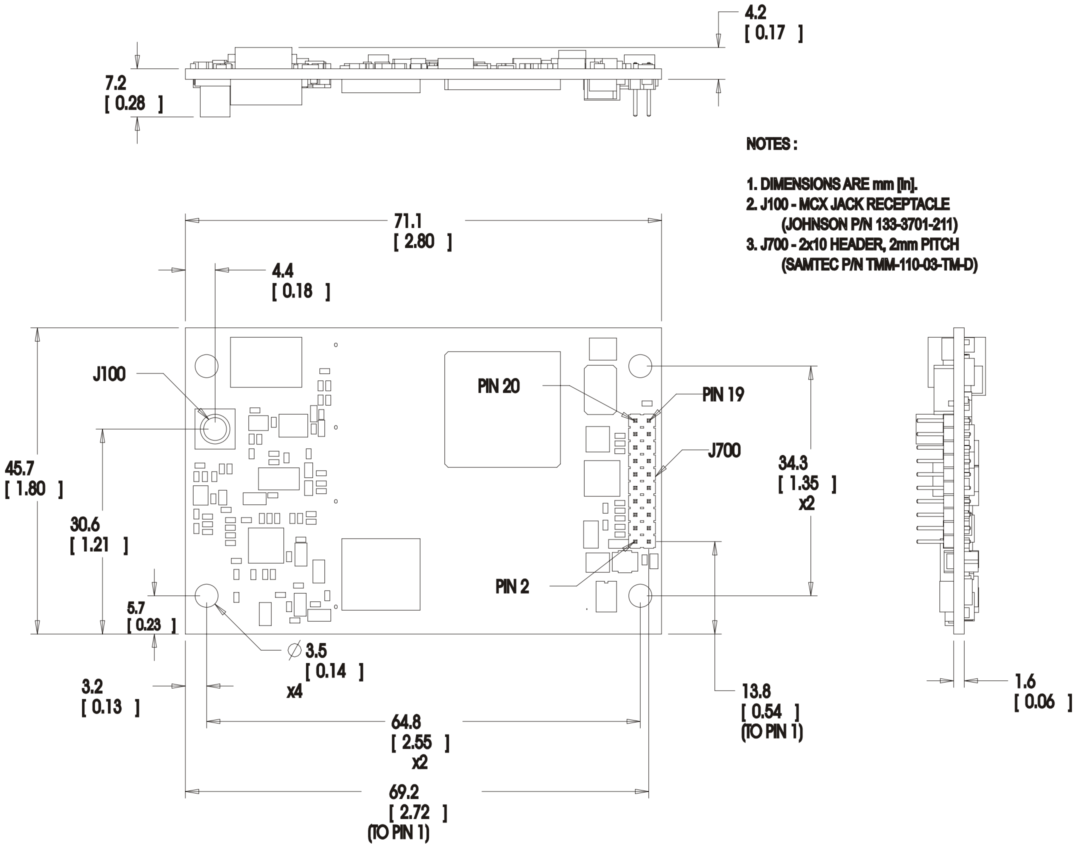


Figure 49: OEMV-1G Board Dimensions

ENVIRONMENTAL	
Operating Temperature	-40°C to +85°C
Storage Temperature	-45°C to +95°C
Humidity	Not to exceed 95% non-condensing
Random Vibe	RTCA D0-160D (4g)
Bump/Shock	MIL-STD 810F (40g)
POWER REQUIREMENTS	
Voltage	+3.3 V DC +5%/-3%
Allowable Input Voltage Ripple	100 mV p-p (max.)
Power Consumption	1.1 W (GPS + GLONASS) ☒ Variable values that can change due to the number of satellites in the sky and the firmware version. They are a guide for what you might expect but absolute values are not possible.
RF INPUT / LNA POWER OUTPUT	
Antenna Connector	MCX female, 50 Ω nominal impedance (See *Figure 49* on *Page 135*)
Acceptable RF Input Level	-80 to -105 dBm
RF Input Frequencies	GPS L1: 1575.42 MHz GLONASS L1: 1602.0 MHz for Fk=0 where k = (-7 to +13) Channel spacing 562.5 kHz
LNA Power External (Optional Input) Output to antenna	(See also *Section 2.3.1* on *Page 32*) +5.5 to +16 V DC, 100 mA max. (user-supplied) +4.75 to +5.10 V DC @ 0 - 100 mA
INPUT/OUTPUT DATA INTERFACE	
COM1	
Electrical format	LVTTL
Bit rates [a]	300, 1200, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400 bps
Signals supported	COM1_Tx and COM1_Rx
COM2	
Electrical format	LVTTL
Bit rates [a]	300, 1200, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400 bps
Signals supported	COM2_Tx and COM2_Rx
COM3	
Electrical format	LVTTL [b c d]
Bit rates [a]	300, 1200, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400 bps
Signals supported	COM3_Tx and COM3_Rx

Continued on Page 137

CAN BUS [e f g]	
Electrical format	LVTTL (requires external CAN transceiver)
Bit rates	500 kb/s maximum. CAN Bus throughput is determined by slowest device on the bus.
Signals supported	CAN1 is on Pins 6 and 7. CAN2 is on Pins 8 and 20. [g]
USB	
Electrical format	Conforms to USB 1.1
Bit rates	5 Mb/s maximum
Signals supported	USB D (+) and USB D (-)

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.

b. Upon power-up, USB is enabled and COM3 is disabled by default. Multiplexed I/O allows you to switch between USB and COM3.

c. The receiver cannot prevent the host system from enumerating USB while using COM3 on the OEMV-1G. This is due to the plug-and-play nature of USB. **Do not connect a USB cable while using COM3.**

d. Enable COM3 using the following commands:

```
INTERFACEMODE COM3 NOVATEL NOVATEL
SAVECONFIG
```

> ✉ FRESET clears this command, disabling COM3 and enabling USB (the factory default setting).

e. CAN1_RX and CAN1_TX are multiplexed with VARF and EVENT2, respectively. The default behavior is that EVENT2 is active. For VARF, refer to the FREQUENCYOUT command.

f. CAN Bus behavior must be asserted through the NovAtel API software. See *Section 3.3.3, CAN Bus* on *Page 44* for further details.

g. See also *Figure 50* on *Page 140* and its table.

Table 27: OEMV-1G 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. (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 GPS 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). 3.3 V.
VARF (Variable Frequency)	Multiplexed pin	Output	Active low	A programmable variable frequency output ranging from 0 - 20 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 GPS Time. The polarity, period and pulsewidth 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 *OEMV Family Firmware Reference Manual*.

Table 28: OEMV-1G Strobe Electrical Specifications

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

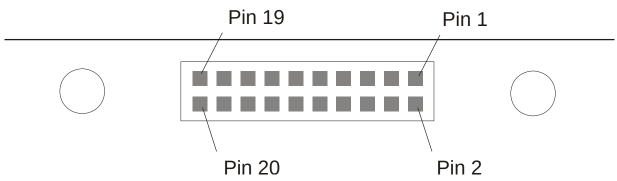


Figure 50: Top-view of 20-Pin Connector on the OEMV-1G

Signal	Behavior [a]	Descriptions	Pin
LNA_PWR	Input DC	Power supply for external antenna LNA	1
V_{IN}	Input DC	DC power supply for card	2
USB D (-)	Bi-directional	USB interface data (-)	3
USB D (+) / COM3_Rx	Multiplexed	Multiplexed pin behavior default: USB D (+)	4
RESETIN	See strobes	Card reset	5
VARF / CAN1_Rx	Multiplexed	Multiplexed pin behavior, see strobes default: VARF	6
Event2 / CAN1_Tx	Multiplexed	Multiplexed pin behavior, see strobes default: Event2	7
CAN2_RX	Bi-directional	CAN Bus dedicated port	8
Event1 / COM3_Tx	Multiplexed	Multiplexed pin behavior, see strobes default: Event1	9
GND	Ground	Digital Ground	10
COM1_Tx	Output	Transmitted Data for COM 1 output	11
COM1_Rx	Input	Received Data for COM 1 input	12
GND	Ground	Digital Ground	13
COM2_Tx	Output	Transmitted Data for COM 2 output	14
COM2_Rx	Input	Received Data for COM 2 input	15
GND	Ground	Digital Ground	16
PV	See strobes	Output indicates 'good solution' or valid GPS position when high	17
GND	Ground	Digital Ground	18
PPS	See strobes	Pulse output synchronized to GPS Time	19
CAN2_TX	Bi-directional	CAN Bus dedicated port	20

a. A bi-directional Transient Voltage Suppressor (TVS) device is included between 3.3V and ground. Input/Output (I/O) lines are protected by TVS devices. Series resistance is included for the following I/O lines: COM1/COM2/COM3 Tx and Rx, RESETIN, Event1 and Event2. Lines that do not have series resistance include: CAN1_Tx, CAN1_Rx, CAN2_Tx, CAN2_Rx, USB D (+) and USB D (-).

A.4 OEMV-2 Card

PHYSICAL	
Size	60 mm x 100 mm x 11.4 mm with connectors
Weight	56 grams
NOVATEL PART NUMBER	
Generic OEMV-2 OEMV-2G	01017646 01017647
MECHANICAL DRAWINGS	

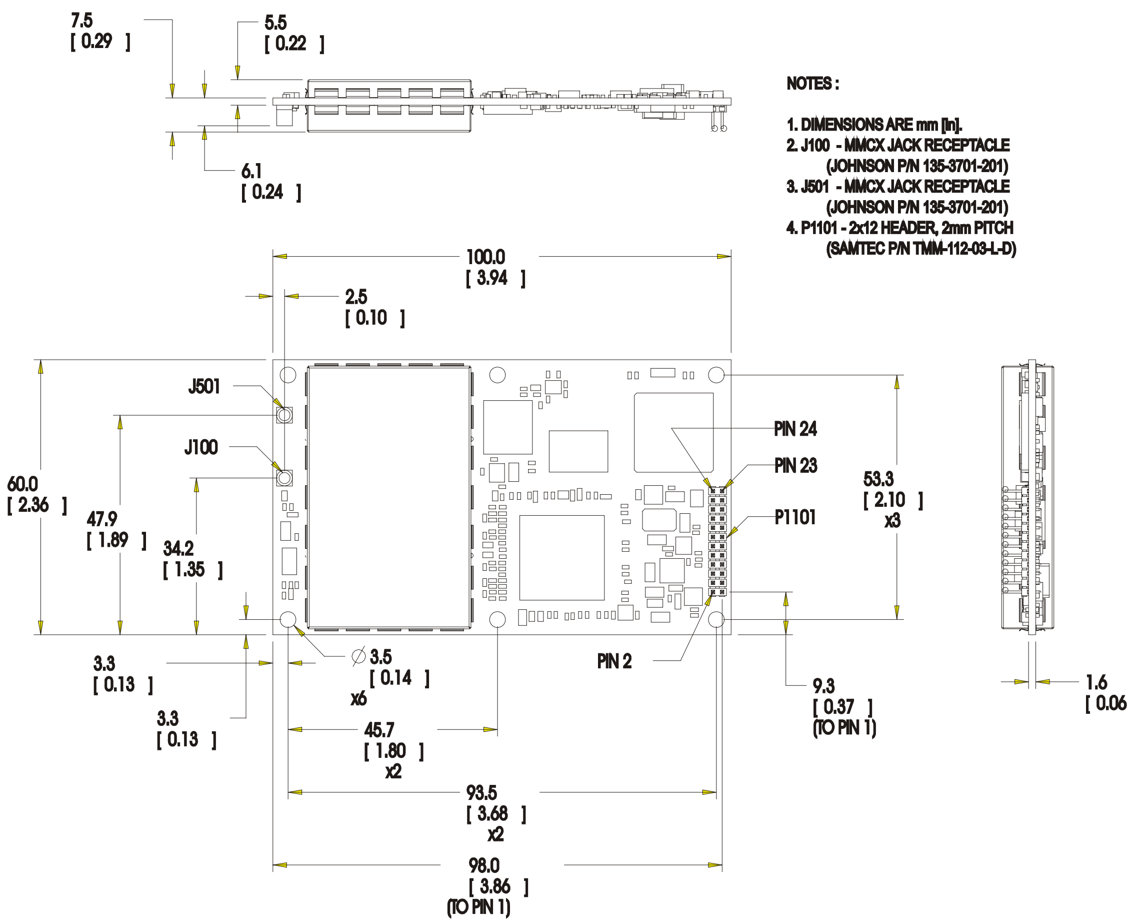


Figure 51: OEMV-2 Board Dimensions

ENVIRONMENTAL	
Operating Temperature	-40°C to +85°C
Storage Temperature	-45°C to +95°C
Humidity	Not to exceed 95% non-condensing
Random Vibe	MIL-STD 810F (7.7g)
Sine Vibe	SAEJ1211 (4g)
Bump/Shock	IEC 68-2-27 (30g)
POWER REQUIREMENTS	
Voltage	+3.3 V DC +5%/-3%
Allowable Input Voltage Ripple	100 mV p-p (max.)
Power consumption	1.2 W (GPS only) 1.6 W (GPS + GLONASS) ☒ Variable values that can change due to the number of satellites in the sky and the firmware version. They are a guide for what you might expect but absolute values are not possible.
RF INPUT / LNA POWER OUTPUT	
Antenna Connector	MMCX female, 50 Ω nominal impedance (See *Figure 51* on *Page 141*)
Acceptable RF Input Level	-80 dBm to -105 dBm
RF Input Frequencies	GPS L1: 1575.42 MHz GPS L2: 1227.60 MHz GLONASS L1: 1602.0 MHz for Fk=0 where k = (-7 to +13) Channel spacing 562.5 kHz GLONASS L2: 1246.0 MHz for Fk=0 where k= (-7 to +13) Channel spacing 437.5 kHz
LNA Power Internal	(See *Section 2.3.1* on *Page 32*) +4.75 to +5.10 V DC @ 0 - 100 mA (output from card; only option)
EXTERNAL OSCILLATOR INPUT	
Connector	MMCX female (See *Figure 53* on *Page 147)* Connections between the MMCX and an external oscillator, or interface board, must be impedance controlled. To accomplish this, use 50 ohm coaxial cable and 50 ohm connectors.
External Clock Input (Refer to the EXTERNALCLOCK command)	Frequency: 5 MHz or 10 MHz Input Impedance: 50 Ω nominal Input VSWR: < 2.0 : 1 Signal Level: 0 dBm minimum to +13.0 dBm maximum Frequency Stability: ± 0.5 ppm maximum Wave Shape: Sinusoidal

Continued on Page 143

INPUT/OUTPUT DATA INTERFACE	
COM1	
Electrical format	RS-232
Bit rates [a]	300, 1200, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400, 460800, 921600 bps
Signals supported	COM1_Tx, COM1_Rx, RTS1, CTS1
COM2	
Electrical format	LVTTL
Bit rates [a]	300, 1200, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400 bps
Signals supported	COM2_Tx, COM2_Rx, RTS2, CTS2
COM3	
Electrical format	LVTTL [b c d]
Bit rates [a]	300, 1200, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400 bps
Signals supported	COM3_Tx, COM3_Rx
***CAN BUS* [e]**	
Electrical format	LVTTL [b] (requires external CAN transceiver)
Bit rates	500 kb/s maximum. CAN Bus throughput is determined by slowest device on the bus.
Signals supported	CAN1 is on Pins 7 and 19 [f g]
USB	
Electrical format	Conforms to USB 1.1
Bit rates	5 Mb/s maximum

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.
b. COM3 is the default. COM3_Tx and COM3_Rx are multiplexed with CAN1_Tx and GPIO, AND CAN1_Rx AND EVENT2.
c. Upon power-up, COM3 (COM3_Tx and COM3_Rx) is enabled by default unless the default is overridden by a changed configuration, previously saved using the SAVECONFIG command. When COM3 is enabled, CAN1, GPIO0 and EVENT2 are not available. USB is always available.
d. Enable COM3 using the INTERFACEMODE command. GPIO on Pin 19 is configured by the MARKCONTROL command.
e. CAN Bus behavior must be asserted through the NovAtel API software. See *Section 3.3.3, CAN Bus* on *Page 44* for further details.
f. See also *Figure 52* on *Page 146* and its table.
g. Driven by an open collector source when configured as GPIO

Table 29: OEMV-2 Strobes

Strobes	Default Behavior	Input/ Output	Factory Default	Comment [a]
Event1 (Mark 1)	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 GPS 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).
VARF (Variable Frequency)	VARF0: Dedicated pin VARF1: Multiplexed pin	Output	Active low	A programmable variable frequency output ranging from 0 - 20 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 GPS Time. The polarity, period and pulsewidth can be configured using PPSCONTROL command.
ERROR	Dedicated pin	Output	Active high	See *Chapter 7, Built-In Status Tests* starting on *Page 117*

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

Table 30: OEMV-2 Strobe Specifications

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

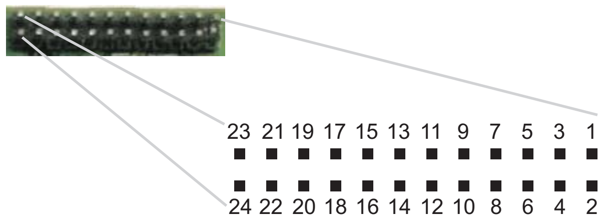


Figure 52: Top-view of 24-Pin Connector on the OEMV-2

Signal	Behavior [a]	Descriptions	Pin
GND	Ground	Digital ground	1
GPIO_USER1	Reserved	Do not use	2
VARF0	See strobes	Variable frequency out	3
PPS	See strobes	Pulse output synchronized to GPS Time	4
VCC	Input DC	Card power	5
VCC	Input DC	Card power	6
Event2, CAN1_Rx and COM3_Rx	Multiplexed	Multiplexed pin behavior, see strobes default: COM3_Rx	7
Event1	See strobes	Input trigger	8
ERROR	See strobes	Card error, see *Chapter 7, Built-In Status Tests* starting on *Page 117*	9
PV	See strobes	Output indicates valid GPS position when high	10
CTS2/VARF1	Input	Clear to Send for COM 2 input or variable frequency default: CTS2	11
RESETIN	See strobes	Card reset	12
RTS2	Output	Request to Send for COM 2 output	13
COM2_Rx	Input	Received Data for COM 2 input	14
CTS1	Input	Clear to Send for COM 1 input	15
COM2_Tx	Output	Transmitted Data for COM 2 output	16
RTS1	Output	Request to Send for COM 1 output	17
COM1_Rx	Input	Received Data for COM 1 input	18
GPIO0, CAN1_Tx and COM3_Tx	Multiplexed	Multiplexed pin behavior, see strobes default: COM3_Tx	19
COM1_Tx	Output	Transmitted Data for COM 1 output	20
USB D (-)	Bi-directional	USB interface data (-)	21
USB D (+)	Bi-directional	USB interface data (+)	22
GND	Ground	Digital Ground	23
GND	Ground	Digital Ground	24

a. There is no TVS between 3.3 V and ground. All other I/O signal lines have TVS protection. Series resistance is included for the GPIO0 and RESETIN lines.

A.5 OEMV-3 Card

PHYSICAL	
Size	85 mm x 125 mm x 14.3 mm with connectors
Weight	85 grams
NOVATEL PART NUMBER	
Generic OEMV-3	01017726
MECHANICAL DRAWINGS	

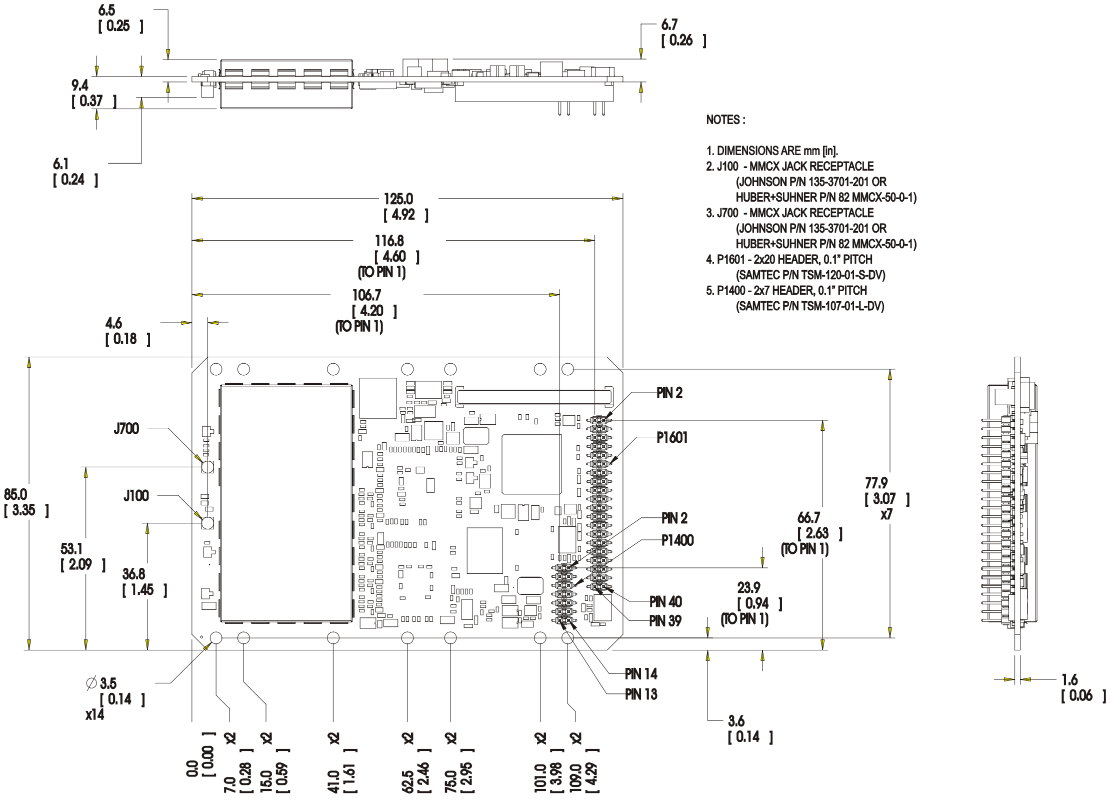


Figure 53: OEMV-3 Board Dimensions

ENVIRONMENTAL	
Operating Temperature	-40°C to +85°C
Storage Temperature	-45°C to +95°C
Humidity	Not to exceed 95% non-condensing
Random Vibe	MIL-STD 810F (7.7g)
Sine Vibe	SAEJ1211 (4g)
Bump/Shock	IEC 68-2-27 (30g)
POWER REQUIREMENTS	
Voltage	+4.5 to +18.0 V DC
Allowable Input Voltage Ripple	100 mV p-p (max.)
Power Consumption	2.1 W (GPS only), 2.4 W (GPS + L-band) 2.8 W (GPS + GLONASS), 3.1 W (GPS + GLONASS + L-band) Variable values that can change due to the number of satellites in the sky and the firmware version. They are a guide for what you might expect but absolute values are not possible.
RF INPUT / LNA POWER OUTPUT	
Antenna Connector	MMCX female, 50 Ω nominal impedance (See *Figure 53* on *Page 147*)
Acceptable RF Input Level	-80 dBm to -105 dBm
RF Input Frequencies (MHz)	GPS L1: 1575.42 MHz GPS L2: 1227.60 MHz GPS L5: 1176.45 MHz GLONASS L1: 1602.0 MHz for Fk=0 where k = (-7 to +13) Channel spacing 562.5 kHz GLONASS L2: 1246.0 MHz for Fk=0 where k= (-7 to +13) Channel spacing 437.5 kHz OmniSTAR or CDGPS: 1525 to 1560 MHz
LNA Power **Internal** External (Optional Input)	(See *Section 2.3.1* on *Page 32*) +4.75 to +5.10 V DC @ 0 - 100 mA **(output from card, default)** +5.5 to +18 V DC, 100 mA max. (user-supplied)
EXTERNAL OSCILLATOR INPUT	
Connector	MMCX female (See *Figure 53* on *Page 147)*
External Clock Input (Refer to the EXTERNALCLOCK command)	Frequency: 5 MHz or 10 MHz Input Impedance: 50 Ω nominal Input VSWR: 2.0:1 Signal Level: 0 dBm minimum to +13.0 dBm maximum Frequency Stability: ± 0.5 ppm maximum Wave Shape: Sinusoidal

Continued on Page 149

INPUT/OUTPUT DATA INTERFACE	
COM1	
Electrical format	User-selectable. Defaults to RS-232 but can be configured for RS-422. See *Page 42* for more details or GPIO if configured by the MARKCONTROL command. (Can also be factory configured for LVTTL operation)
Bit rates[a]	300, 1200, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400, 460800, 921600 bps
Signals supported	COM1_Tx, COM1_Rx, RTS1, CTS1 for RS-232 or COM1_Tx (+), COM1_Tx (-), COM1_Rx (+), COM1_Rx (-) for RS-422
COM2	
Electrical format	RS-232 (Can be factory configured for LVTTL operation)
Bit rates[a]	300, 1200, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400 bps
Signals supported	COM2_Tx, COM2_Rx, RTS2, CTS2, DTR2, DCD2
COM3	
Electrical format	LVTTL [b]
Bit rates[a]	300, 1200, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400 bps
Signals supported	COM3_Tx, COM3_Rx, RTS3, CTS3
CAN BUS [c]	
Electrical format	CANBUS [c d]
Bit rates	500 kb/s maximum. CAN Bus throughput is determined by slowest device on the bus.
CAN1 signals supported [e]	CAN Bus 1(with transceiver), see also *Figure 55, Top-view of 14-Pin CAN Connector on the OEMV-3* on *Page 154*
CAN2 signals supported [e]	CAN BUS 2 (with transceiver), see also *Figure 55* on *Page 154*
USB	
Signals supported	USB D(+), USB D(-)

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.
b. Upon power-up, EVENT2 is enabled and GPIO1 is disabled unless the default is overridden by a changed configuration, previously saved using the SAVECONFIG command. GPIO1 is configured by the MARKCONTROL command.
c. CAN Bus behavior must be asserted through the NovAtel API software. See *Section 3.3.3, CAN Bus* on *Page 44* for further details.
d. CANBUS transceivers are populated on the OEMV-3 card.
e. See also *Figure 54* on *Page 152* and its table.

Table 31: OEMV-3 Strobes

Strobes	Default Behavior	Input/ Output	Factory Default	Comment [a]
MSR (Measure Output)	Dedicated pin	Output	Active low	1 ms pulse, leading edge is synchronized with internal GNSS measurements. The MSR signal is not user-configurable. Up to 20 Hz.
Event1 (Mark 1)	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 GPS 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).
VARF (Variable Frequency)	Dedicated pin	Output	Active low	A programmable variable frequency output ranging from 0 - 20 MHz (refer to the FREQUENCYOUT command).
RESETOUT	Dedicated pin	Output	Active low	140 ms duration
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 GPS Time. The polarity, period and pulsewidth can be configured using PPSCONTROL command.
ERROR	Dedicated pin	Output	Active high	See *Chapter 7, Built-In Status Tests* starting on *Page 117*

Continued on Page 151

Strobes	Default Behavior	Input/ Output	Factory Default	Comment [a]
STATUS_RED	Dedicated pin	Output	Active high	Status output which is high, or pulses, to indicate that the OEMV-3 card is not working properly. [b]
STATUS_GREEN	Dedicated pin	Output	Active high	Status output which pulses to indicate that the OEMV-3 card is working properly. [b]

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

b. See also *Section 7.6, Status LEDs* starting on *Page 121* of this manual.

Table 32: OEMV-3 Strobe Specifications

Strobe	Sym	Min	Typ	Max	Units	Conditions
Event1 (Mark 1) Event2 (Mark2) PPS	V_{IL}			0.8	V	VDD = 3.3 V; 85°C
	V_{IH}	2.0			V	VDD = 3.3 V; 85°C
PV MSR VARF ERROR STATUS_RED STATUS_GREEN RESETOUT	V_{OL}			0.4	V	VDD = 3.3 V; 85°C
	V_{OH}	3.0			V	VDD = 3.3 V; 85°C
RESETIN	V_{IL}			0.8	V	VDD = 3.3 V; 85°C
	V_{IH}	2.3			V	VDD = 3.3 V; 85°C

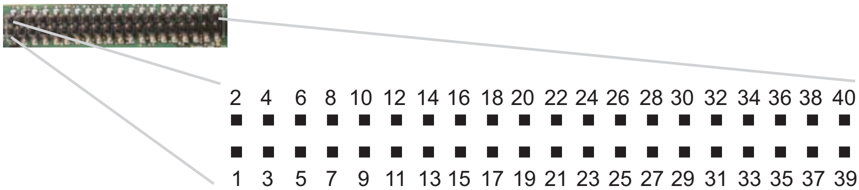


Figure 54: Top-view of 40-Pin Connector on the OEMV-3

Signal	Behavior	Descriptions	Pin
V_{IN}	Input DC	Card power	1
PV	See strobes	Output indicates a valid GPS position when high	2
USB D (+)	Bi-directional	USB interface data (+)	3
GND	Ground	Digital Ground	4
USB D (-)	Bi-directional	USB interface data (-)	5
GND	Ground	Digital Ground	6
PPS	See strobes	Pulse output synchronized to GPS Time	7
GND	Ground	Digital Ground	8
VARF	See strobes	Variable frequency out	9
GND	Ground	Digital Ground	10
Event1	See strobes	Input trigger	11
GND	Ground	Digital Ground	12
STATUS_RED	See strobes	Indicates the OEMV-3 card is not working properly when high or pulsing.	13
CTS1/ COM1_Rx (-)	See COM Ports	COM1 input Clear to Send for RS-232 / Received Data (-) for RS-422	14
COM1_Tx/ COM1_Tx (+)	See COM Ports	COM1 output Transmitted Data for RS-232 / Transmitted Data (+) for RS-422	15
RTS1/ COM1_Tx (-)	See COM Ports	COM1 output Request to Send for RS-232 / Transmitted Data (-) for RS-422	16
COM1_Rx/ COM1_Rx(+)	See COM Ports	COM1 input Received Data for RS-232 / Received Data (+) for RS-422	17
CTS3	Input	Clear to Send for COM 3	18
COM3_Tx	Output	Transmitted Data for COM 3	19
DCD2	Input	Data Carrier Detected for COM 2	20
COM3_Rx	Input	Received Data for COM 3	21
RTS3	Output	Request to Send for COM 3	22
DTR2	Output	Data Terminal Ready for COM 2	23
CTS2	Input	Clear to Send for COM 2	24
COM2_Tx	Output	Transmitted Data for COM 2	25
RTS2	Output	Request to Send for COM 2	26

Continued on Page 153

Signal	Behavior	Descriptions	Pin
COM2_Rx	Input	Received Data for COM 2	27
STATUS_GREEN	See strobes	Indicates the OEMV-3 card is working properly when pulsing at 1 Hz.	28
GPIO_USER0	Reserved	Do not use. 10 kΩ pull-down resistor internal to OEMV-3.	29
USERIO1	Input	COM1 port configuration selector. 10 kΩ pull-down resistor internal to OEMV-3. (At startup, tie high to set COM1 to RS-422 or leave open for RS-232. See *Page 42* for more details.)	30
Event2/GPIO1	See strobes	Input trigger default: EVENT2	31
MSR	See strobes	Pulse synchronized to GNSS measurements	32
RESETIN	See strobes	Card reset	33
GPAI	Analog	General purpose analog input (refer to the RXHWLEVELS log). The voltage range is 0.0 to 2.75 V DC.	34
RESETOUT	See strobes	Reset TTL signal output to external system; active low.	35
GND	Ground	Digital Ground	36
GPIO_FR	Reserved	Do not use. 10 kΩ pull-up resistor internal to OEMV-3.	37
ERROR	See strobes	Indicates fatal error when high	38
*	Reserved	Do not use.	39
LNA_PWR	Output DC	Optional external power to antenna other than a standard NovAtel GPSAntenna (see also *Antenna LNA Power* on *Page 50*).	40

☒ To create a common ground, tie together all digital grounds (GND) with the ground of the power supply.

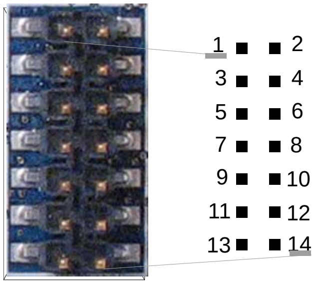


Figure 55: Top-view of 14-Pin CAN Connector on the OEMV-3

Signal	Descriptions	Pin
CAN1L	CAN1 low	1
CAN1H	CAN1 high	2
GND	Digital Ground	3
GND	Digital Ground	4
CAN2L	CAN2 low	5
CAN2H	CAN2 high	6
GND	Digital Ground	7
GND	Digital Ground	8
NC	Not Connected	9
NC	Not Connected	10
GPIO	Reserved. 10 kΩ pull-down resistor internal to OEMV-3.	11
GPIO	Reserved. 10 kΩ pull-down resistor internal to OEMV-3.	12
NC	Not Connected	13
NC	Not Connected	14

A.6 DL-V3

INPUT/OUTPUT CONNECTORS	
Antenna Input	TNC female jack, 50 Ω nominal impedance +4.75 to +5.10 V DC, 100 mA max (output from DL-V3 to antenna/LNA)
PWR	4-pin LEMO connector +9 to +28 V DC at 3.5 W (typical while logging) [a]
COM1 COM2 COM3 AUX I/O OSC	DB9P connector DB9P connector Bluetooth v1.1 interface or Ethernet [b] DB9P connector DB9S connector BNC connector (external oscillator)
NOVATEL PART NUMBER	
DL-V3	01017829

LED INDICATORS		
More details can also be found in *Section 3.3.5, DL-V3 Status Indicators* starting on *Page 46*		
Power		Orange: receiver is powered Green: receiver is turned on
Receiver Status		Orange flash: at start-up Off: normal operation Orange flash again: status event
COM1/COM2/ AUX	COM AUX	Green flash (top): transmitting Amber flash (bottom): receiving
COM3		Blue: bluetooth active (default) Orange: ethernet active
Satellite Tracking		See table below
Positioning Mode		See *Table 13, Positioning Mode LEDs* on *Page 49*

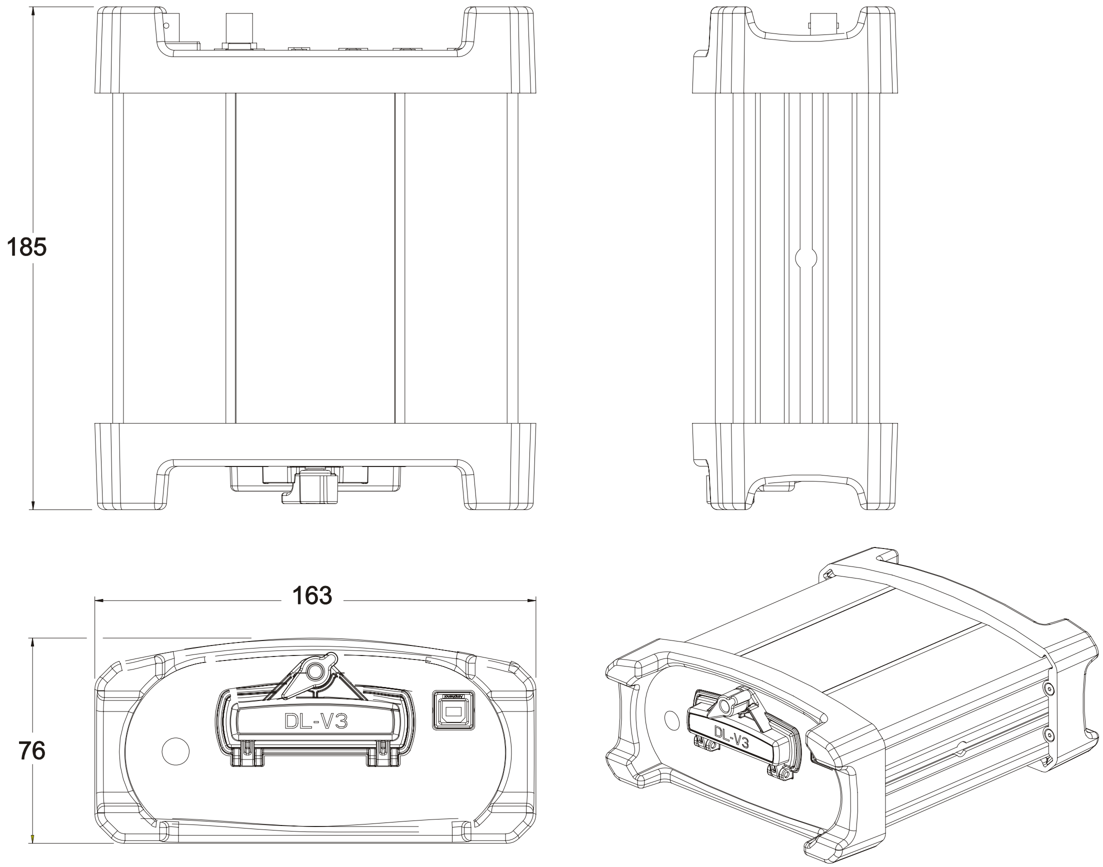
Satellite Tracking:

LED#	# of SVs	LED Color
1 (left)	≤ 3	Red
2	4 or 5	Amber
3	6 or 7	Green
4	8 or 9	Green
5 (right)	≥ 10	Green

Continued on Page 156

<table>
<tr><th colspan="3">LED INDICATORS (CONTINUED)</th></tr>
<tr><td>Flash Card Memory</td><td></td><td>
<table>
<tr><th># of LEDs</th><th>Capacity</th><th>LED Color</th></tr>
<tr><td>1</td><td>Capacity ≤ 20%</td><td>Red [a]</td></tr>
<tr><td>2</td><td>40% ≥ Capacity > 20%</td><td>Amber</td></tr>
<tr><td>3</td><td>60% ≥ Capacity > 40%</td><td>Green</td></tr>
<tr><td>4</td><td>80% ≥ Capacity > 60%</td><td>Green</td></tr>
<tr><td>5</td><td>Capacity > 80%</td><td>Green</td></tr>
</table>
a. This red LED can also mean that the card was not formatted, and placed in the receiver, when the receiver was powered off.
</td></tr>
<tr><td>Occupation Time</td><td></td><td>
<table>
<tr><th>LED#</th><th>Baseline Length (km)</th><th>LED Color</th></tr>
<tr><td>1 (left)</td><td>≤ 5</td><td>Green</td></tr>
<tr><td>2</td><td>> 5
≤ 10</td><td>Green</td></tr>
<tr><td>3</td><td>> 10
≤ 15</td><td>Green</td></tr>
<tr><td>4</td><td>> 15
≤ 20</td><td>Green</td></tr>
<tr><td>5 (right)</td><td>≥ 20</td><td>Green</td></tr>
</table>
</td></tr>
<tr><th colspan="3">PHYSICAL</th></tr>
<tr><td>Size</td><td colspan="2">185 x 163 x 76 mm</td></tr>
<tr><td>Weight</td><td colspan="2">1.3 kg maximum (including OEMV-3 card)</td></tr>
<tr><th colspan="3">ENVIRONMENTAL</th></tr>
<tr><td>Operating Temperature</td><td colspan="2">-40°C to +75°C</td></tr>
<tr><td>Storage Temperature</td><td colspan="2">-45°C to +95°C</td></tr>
<tr><td>Humidity</td><td colspan="2">Not to exceed 95% non-condensing</td></tr>
<tr><td>Vibration[c]</td><td colspan="2">Random MIL-STD-810F
Sinusoidal IEC 68-2-6
Shock IEC 68-2-27</td></tr>
</table>

a. When tracking GPS satellites
b. The DL-V3 is Bluetooth ready by default. COM3 may be configured for Ethernet but only one communication mode at a time can be used on COM3. Ethernet usage also requires a change of cable. See also the *APPCONTROL* command in the *DL-V3 Firmware Reference Manual* and *Appendix C, Ethernet Configuration* on *Page 191* of this manual.
c. See also the *Notice* section of this manual starting on *Page 10.*

DIMENSIONS
[a] [b] 

a. All dimension are in millimeters, please use the *Unit Conversion* section of the *GPS+ Reference Manual* for conversion to imperial measurements.

b. See also the ProPak-V3 *Dimensions* section, on *Page 164*, for the dimensions of the mounting bracket. The mounting bracket also has a set of instructions with it.

A.6.1 Port Pin-Outs

Table 33: DL-V3 Serial Port Pin-Out Descriptions

Connector Pin No.	COM1 RS-232	COM2 RS-232	AUX RS-232
1	N/C	N/C	N/C
2	COM1_Rx	COM2_Rx	COM3_Rx
3	COM1_Tx	COM2_Tx	COM3_Tx
4	N/C	POUT	POUT
5	GND	GND	GND
6	D (+)	N/C	N/C
7	RTS1	RTS2	RTS3
8	CTS1	CTS2	CTS3
9	D (-)	N/C	N/C

Table 34: DL-V3 I/O Port Pin-Out Descriptions

Connector Pin No.	Signal Name	Signal Descriptions
1	VARF	Variable frequency out
2	PPS	Pulse per second
3	MSR	Mark 1 output
4	EVENT1	Mark 1 input
5	PV	Valid position available
6	EVENT2	Mark 2 input, which requires a pulse longer than 150 ns is pulled up to 5V through a 47kΩ resistor in the DL-V3. Refer also to the MARKCONTROL command in the *OEMV Firmware Reference Manual*.
7	_RESETOUT	Reset TTL signal output to an external system. Active low.
8	ERROR	Indicates a fatal error when high.
9	GND	Digital ground

✉ For strobe signal descriptions, please see *Section 3.3.1*, *Strobes* on *Page 43*.

A.6.2 Cables

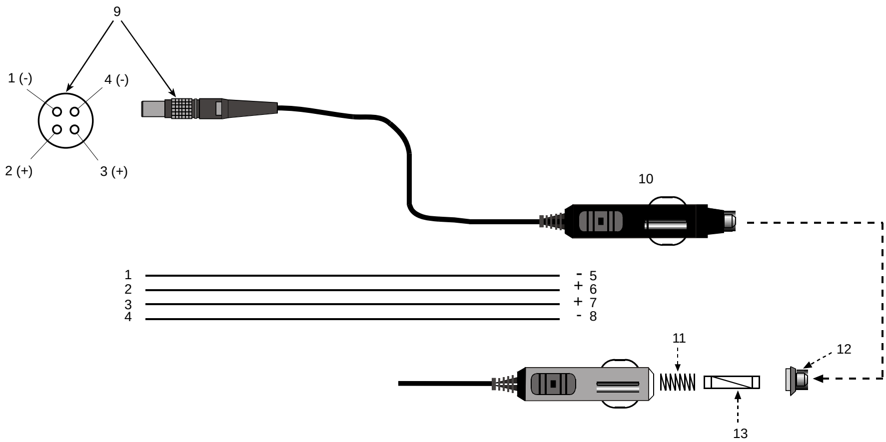
A.6.2.1 12V Power Adapter Cable (NovAtel part number 01017663)

The power adapter cable supplied with the DL-V3, see *Figure 60*, provides a convenient means for supplying +12 V DC while operating in the field.

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 back panel of the DL-V3.

This cable is RoHS compliant.

For alternate power sources please see *Section 3.1.3* on *Page 34*.



Reference	Description	Reference	Description
1	Black	5	Ground
2	Red	6	+6 to +18 V DC
3	Orange	7	+6 to +18 V DC
4	Brown	8	Ground
9	Connector key marking	12	Universal tip
10	12V adapter	13	6 Amp slow-blow fuse
11	Spring		

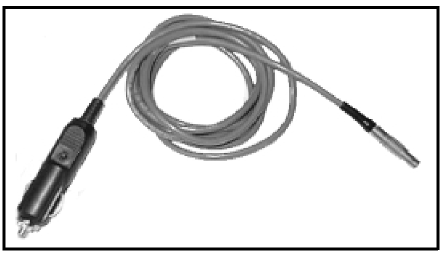
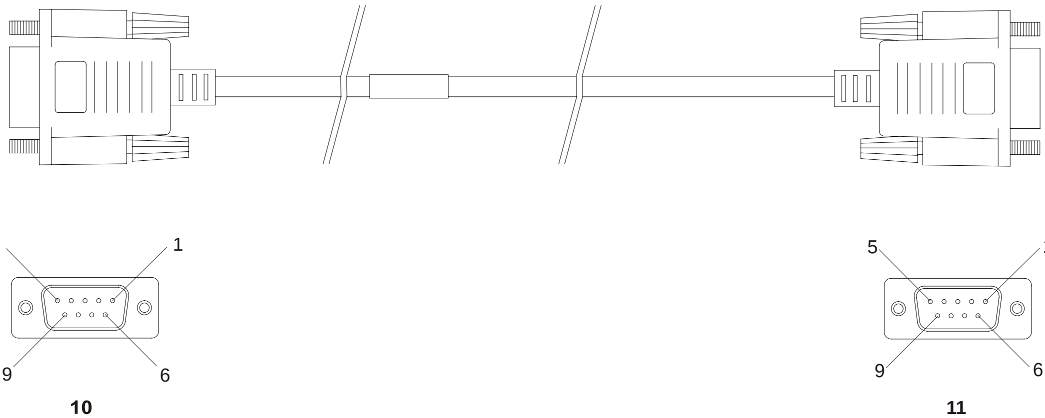


Figure 56: DL-V3 Power Cable

A.6.2.2 Null Modem Cable (NovAtel part number 01017658)

This cable supplied with the DL-V3, see *Figure 61*, 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 *COM1*, *COM2*, or *AUX* 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.



Wiring Table:

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

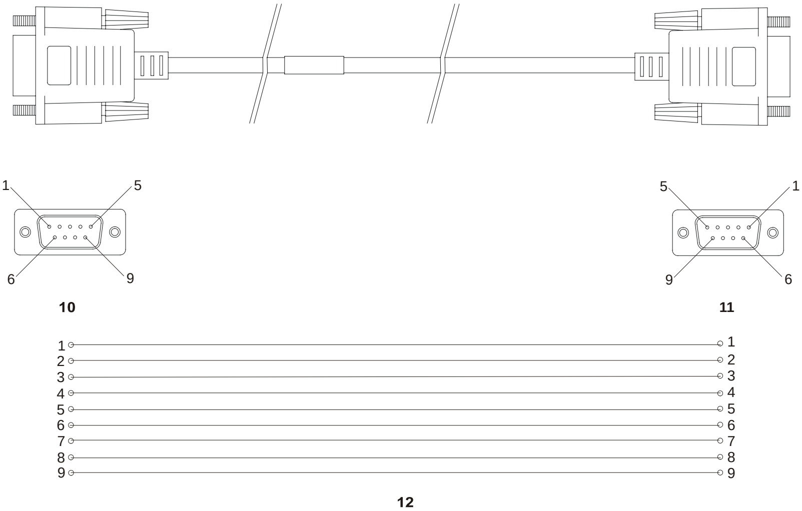
Reference	Description
10	DB9S (Female)
11	DB9S (Female)

Figure 57: DL-V3 Null Modem Cable

A.6.2.3 Straight Through Serial Cable (NovAtel part number 01017659)

This cable can be used to connect the DL-V3 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 62*.

This cable is RoHS compliant.



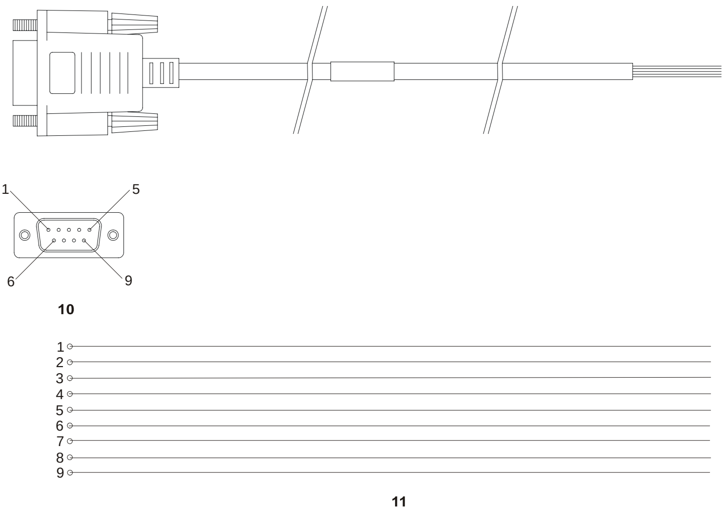
Reference	Description	Reference	Description
10	DB9P (male) connector	12	9-conductor cable
11	DB9S (female) connector		

Figure 58: DL-V3 Straight Through Serial Cable

A.6.2.4 I/O Strobe Port Cable (NovAtel part number 01017660)

The strobe lines on the DL-V3 can be accessed by inserting the male DB9 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 63*.

This cable is RoHS compliant.



Wiring Table:

I/O Port Pin	I/O Port Signal	I/O Port Cable Wire Color	I/O Port Pin	I/O Port Signal	I/O Port Cable Wire Color
1	VARF	Black	6	Event2	Green
2	PPS	Brown	7	_RESETOUT	Blue
3	MSR	Red	8	ERROR	Violet
4	Event1	Orange	9	GND	White/Grey
5	PV	Yellow			

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

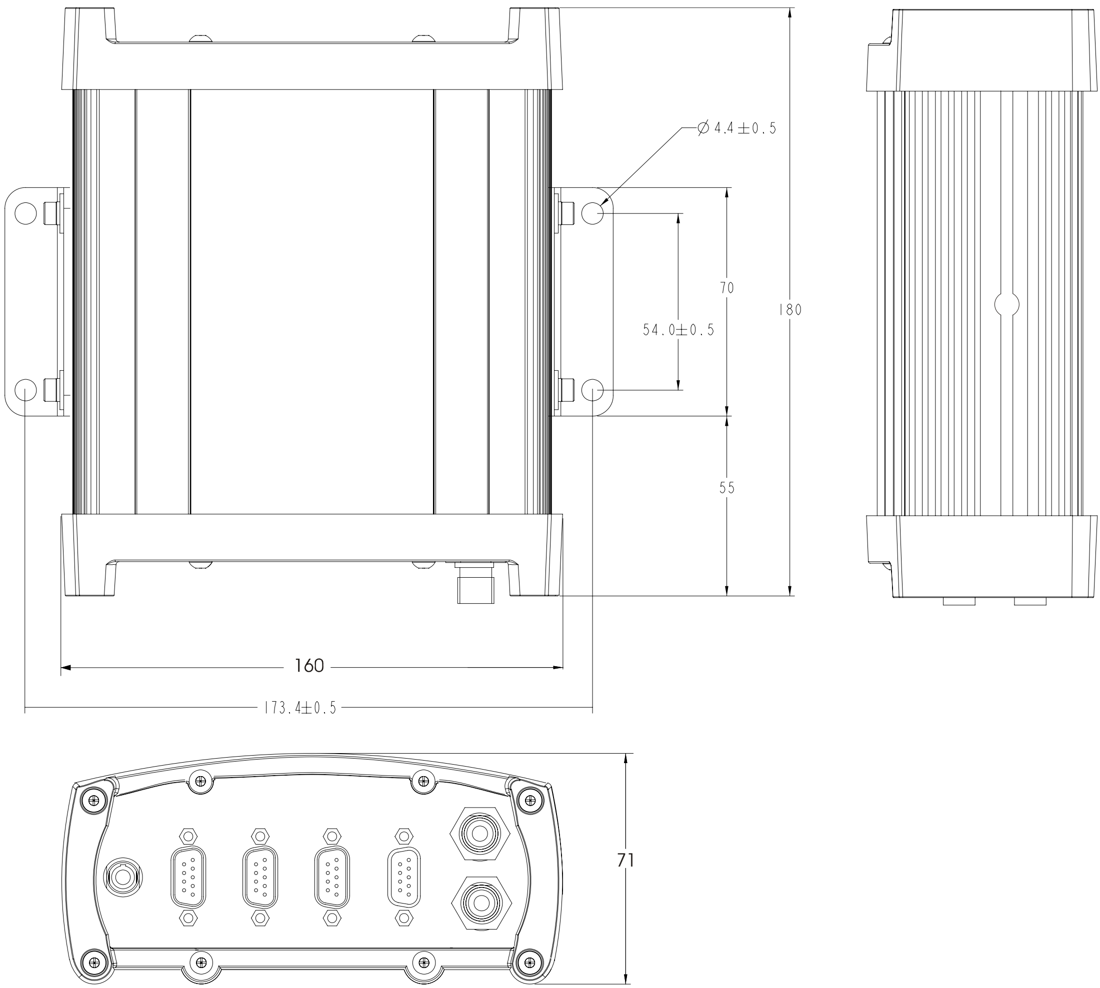
Figure 59: DL-V3 I/O Strobe Port Cable

A.7 ProPak-V3

INPUT/OUTPUT CONNECTORS	
Antenna Input	TNC female jack, 50 Ω nominal impedance +4.75 to +5.10 V DC, 100 mA max (output from ProPak-V3 to antenna/LNA)
PWR	4-pin LEMO connector +6 to +18 V DC at 2.8 W (typical) [a] [b]
COM1 COM2 AUX I/O OSC	DB9P connector DB9P connector DB9P connector [c] DB9S connector BNC connector (external oscillator)
NOVATEL PART NUMBER	
ProPak-V3	RS-232: 01017629 RS-422: 01017751
PHYSICAL	
Size	185 x 160 x 71 mm
Weight	1.0 kg maximum (including OEMV-3 card)
ENVIRONMENTAL	
Operating Temperature	-40°C to +75°C
Storage Temperature	-45°C to +95°C
Humidity	Not to exceed 95% non-condensing
Tested to these standards:	MIL-STD-810F 512.4 Procedure 1 Waterproof Immersion IEC 60529 IPX7 Waterproof MIL-STD-810F 509.4 Salt Spray MIL-STD-810F 510.4 Sand and Dust IEC 68-2-27Ea Shock (non-operating) MIL-STD-202G 214A Vibration (random) SAE J/211 4.7 Vibration (sinusoidal) FCC Part 15/ EN55022 Class B Emissions EN 61000-6-2 Immunity EN60950 Safety

a. For SPAN applications, this becomes +9 to +18 V DC
b. When tracking GPS satellites
c. The AUX port on the ProPak-V3 supports input from an IMU. If applicable, refer also to your *SPAN User Manual*. You must use COM3 instead of AUX to send commands or request logs on the ProPak-V3 AUX port.

DIMENSIONS
[a]



a. All dimension are in millimeters, please use the *Unit Conversion* section of the *GPS+ Reference Manual* for conversion to imperial measurements.

A.7.1 Port Pin-Outs

Table 35: ProPak-V3 Serial Port Pin-Out Descriptions

Connector Pin No.	COM1		COM2	AUX	
	RS-232	RS-422	RS-232 Only	RS-232	RS-422
1	Reserved	Reserved	N/C	N/C	N/C
2	COM1_Rx	COM1_Rx (+)	COM2_Rx	COM3_Rx	COM3_Rx (+)
3	COM1_Tx	COM1_Tx (+)	COM2_Tx	COM3_Tx	COM3_Tx (+)
4	N/C	N/C	POUT	POUT	POUT
5	GND	GND	GND	GND	GND
6	D (+)	D (+)	N/C	N/C	N/C
7	RTS1	COM1_Tx (-)	RTS2	RTS3	COM3_Tx (-)
8	CTS1	COM1_Rx (-)	CTS2	CTS3	COM3_Rx (-)
9	D (-)	D (-)	N/C	N/C	N/C

Table 36: ProPak-V3 I/O Port Pin-Out Descriptions

Connector Pin No.	Signal Name	Signal Descriptions
1	VARF	Variable frequency out
2	PPS	Pulse per second
3	MSR	Mark 1 output
4	EVENT1	Mark 1 input
5	PV	Valid position available
6	EVENT2	Mark 2 input, which requires a pulse longer than 150 ns. 10K ohm pull down resistor internal to the ProPak-V3. Refer also to the MARKCONTROL command in the *OEMV Firmware Reference Manual*.
7	_RESETOUT	Reset TTL signal output to an external system. Active low.
8	ERROR	Indicates a fatal error when high.
9	GND	Digital ground

For strobe signal descriptions, please see *Section 3.3.1, Strobes* on *Page 43*.

A.7.2 Cables

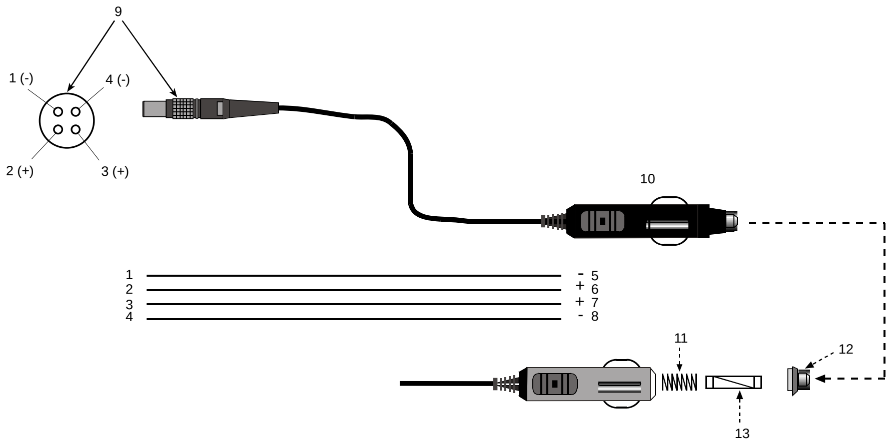
A.7.2.1 12V Power Adapter Cable (NovAtel part number 01017663)

The power adapter cable supplied with the ProPak-V3, see *Figure 60*, provides a convenient means for supplying +12 V DC while operating in the field.

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 back panel of the ProPak-V3.

This cable is RoHS compliant.

For alternate power sources please see *Section 3.1.3* on *Page 34*.



Reference	Description	Reference	Description
1	Black	5	Ground
2	Red	6	+6 to +18 V DC [1]
3	Orange	7	+6 to +18 V DC [1]
4	Brown	8	Ground
9	Connector key marking	12	Universal tip
10	12V adapter	13	6 Amp slow-blow fuse
11	Spring		

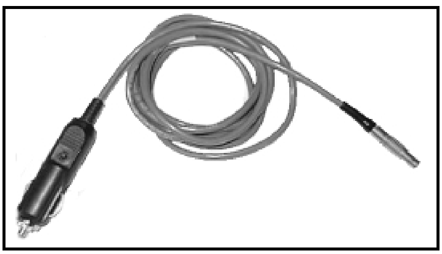


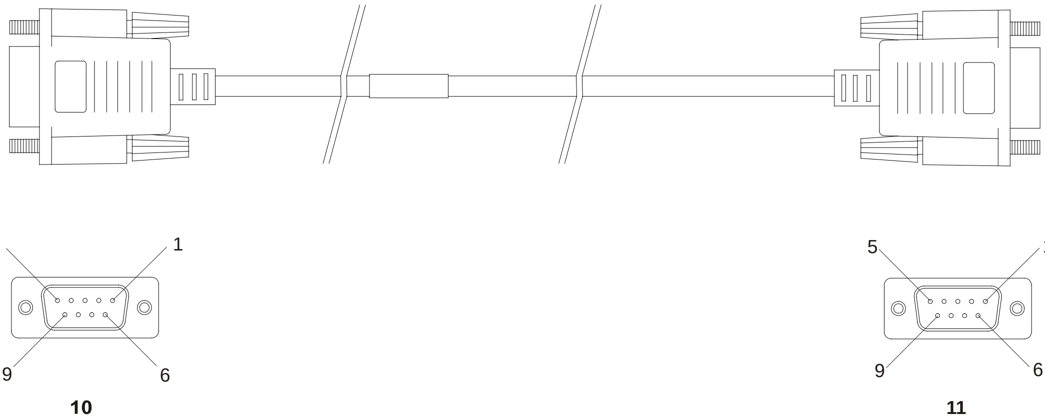
Figure 60: ProPak-V3 Power Cable

1. For SPAN applications this becomes +9 to +18 V DC

A.7.2.2 Null Modem Cable (NovAtel part number 01017658)

This cable supplied with the ProPak-V3, see *Figure 61*, 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 *COM1*, *COM2*, or *AUX* 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.



Wiring Table:

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

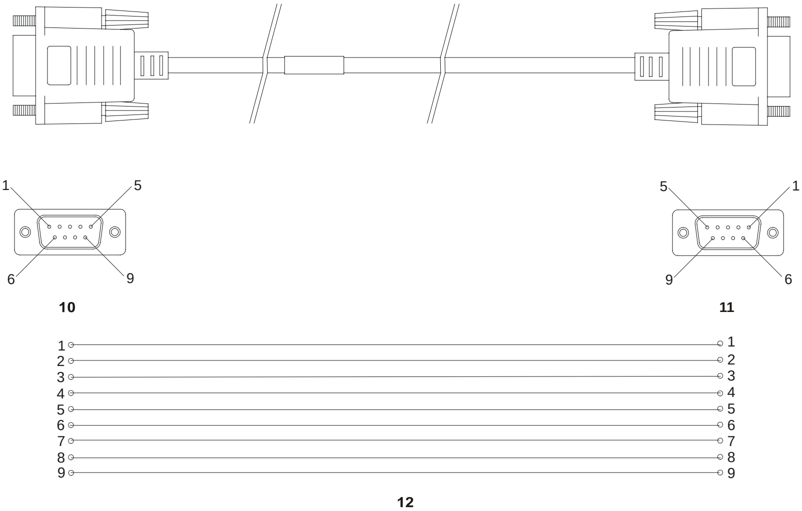
Reference	**Description**
10	DB9S (Female)
11	DB9S (Female)

Figure 61: ProPak-V3 Null Modem Cable

A.7.2.3 Straight Through Serial Cable (NovAtel part number 01017659)

This cable can be used to connect the ProPak-V3 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 62*.

This cable is RoHS compliant.



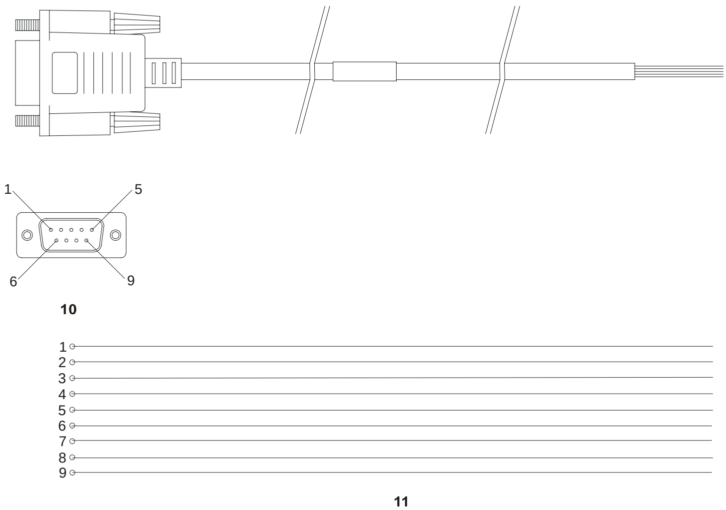
Reference	Description	Reference	Description
10	DB9P (male) connector	12	9-conductor cable
11	DB9S (female) connector		

Figure 62: ProPak-V3 Straight Through Serial Cable

A.7.2.4 I/O Strobe Port Cable (NovAtel part number 01017660)

The strobe lines on the ProPak-V3 can be accessed by inserting the male DB9 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 63*.

This cable is RoHS compliant.



Wiring Table:

I/O Port Pin	I/O Port Signal	I/O Port Cable Wire Color	I/O Port Pin	I/O Port Signal	I/O Port Cable Wire Color
1	VARF	Black	6	Event2	Green
2	PPS	Brown	7	_RESETOUT	Blue
3	MSR	Red	8	ERROR	Violet
4	Event1	Orange	9	GND	White/Grey
5	PV	Yellow			

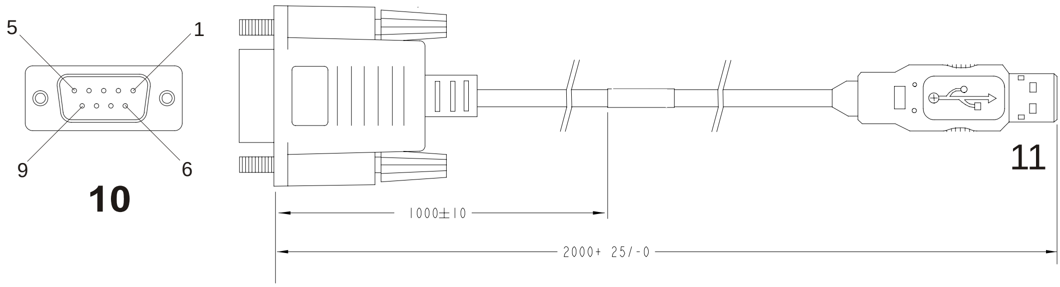
Reference	Description	Reference	Description
10	DB9P (male) connector	11	9-conductor cable

Figure 63: ProPak-V3 I/O Strobe Port Cable

A.7.2.5 USB Serial Cable (NovAtel part number 01017664)

The USB cable shown below provides a means of interfacing between the COM1 port on the ProPak-V3 and another serial communications device, such as a PC. At the ProPak-V3 end, the cable is equipped with a DB9 connector, which plugs directly into a COM port. At the other end, a USB connector is provided.

This cable is RoHS compliant.



WIRING			
DB9 CONNECTION ON RECEIVER	SIGNAL	SERIES "A" USB PLUG	WIRE COLOR
PIN 5	GND	PIN 4	BLACK
PIN 6	USB D+	PIN 3	GREEN
PIN 9	USB D-	PIN 2	WHITE
INSULATE TO PREVENT SHORT			RED

Reference	Description
10	Female DB9 connector
11	USB connector

Figure 64: USB Serial Cable

A.8 FlexPak-V1, FlexPak-V1G and FlexPak-V2

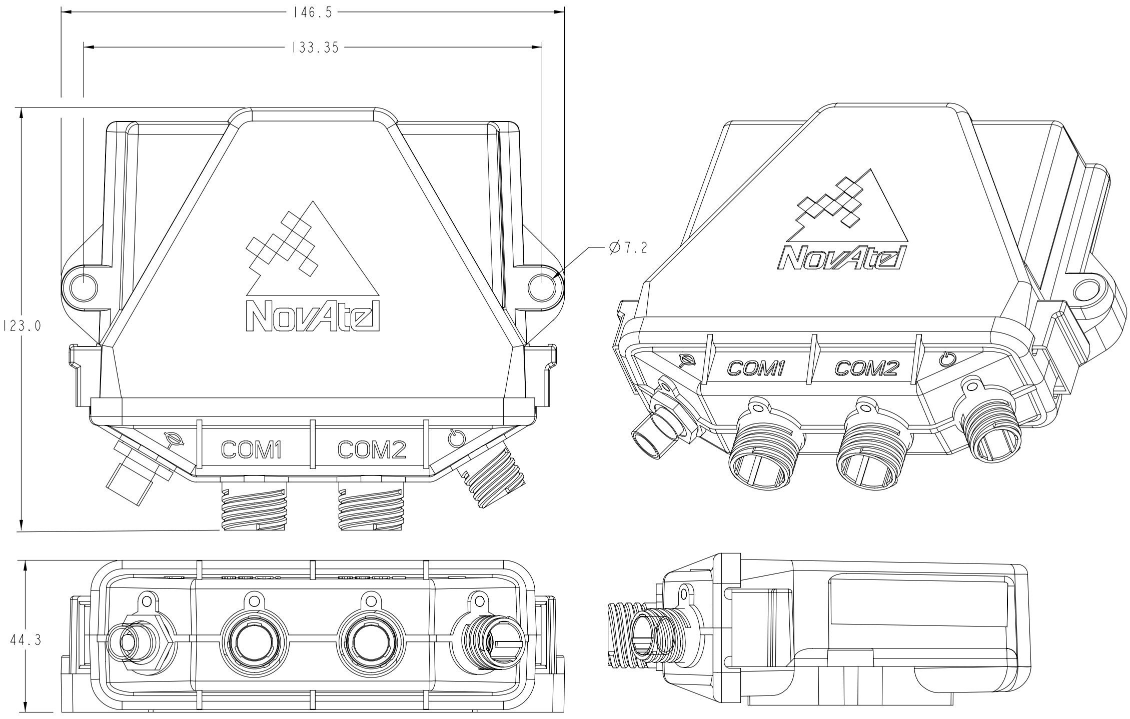
INPUT/OUTPUT CONNECTORS	
ANT	Waterproof TNC female jack, 50 Ω nominal impedance +4.75 to +5.10 V DC, 100 mA max (output from FlexPak to antenna/LNA)
PWR	3-pin waterproof Deutsch connector +6 to +18 V DC (Deutsch PN 59065-09-98PN)
COM1	13-pin waterproof Deutsch connector (Deutsch P/N 59065-11-35PF)
COM2	13-pin waterproof Deutsch connector [a] (Deutsch P/N 59065-11-35PF)
NOVATEL PART NUMBER	
FlexPak-V1 FlexPak-V1G FlexPak-V2	01017737 01017941 01017739
PHYSICAL	
Size	45 x 147 x 123 mm
Weight	350 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 +85°C
Storage Temperature	-40°C to +85°C
Humidity	Not to exceed 95% non-condensing
Waterproof	To IEC 60529 IP X7

a. Normally RS-232 but can be dynamically changed to RS-422 by grounding Pin# 1 on the COM2 Deutsch connector. You can switch between RS-232 and RS-422 by changing the state of this pin. You do not have to cycle power on the FlexPak for this change to take effect.

Pin# 1 is a No Connect (N/C) at the DB9F end of the FlexPak communication cable, see *Page 177*. There are not enough pins on the DB9F connector to accommodate this extra pin. However, if you cut the COM cable you can access wires for all the pins on the Deutsch side of the cable, including the Deutsch Pin# 1.

DIMENSIONS

[a]



a. All dimension are in millimeters, please use the *Unit Conversion* section of the *GPS+ Reference Manual* for conversion to imperial measurements.

A.8.1 Port Pin-Outs

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

Table 37: FlexPak COM1 Port Pin-Out Descriptions

Deutsch RS-232 Only	
Connector Pin No.	**Signal Name**
1	GPIO
2	COM1_Rx
3	CTS1
4	EVENT1
5	GND
6	EVENT2
7	RTS1
8	COM1_Tx
9	POUT [a]
10	PPS
11	USB D (+)
12	USB D (-)
13	ERROR

a. The current is limited to 1.5 A

See also *Section 3.3.1, Strobes* on *Page 43*.

Table 38: FlexPak COM2 Port Pin-Out Descriptions

Deutsch RS-232		Deutsch RS-422	
Pin	Function	Pin	Function
1	Select 232/ 422 Mode	1	Select 232/ 422 Mode
2	COM2_Rx	2	COM2_Rx (+)
3	CTS	3	COM2_Rx (-)
4	Event 1	4	Event 1
5	GND	5	GND
6	Event 2	6	Event 2
7	RTS2	7	COM2_Tx (+)
8	COM2_Tx	8	COM2_Tx (-)
9	POUT [a]	9	POUT [a]
10	PPS	10	PPS
11	USB D (+)	11	USB D (+)
12	USB D (-)	12	USB D (-)
13	ERROR	13	ERROR

a. The current is limited to 1.5 A

✉ The cable supplied needs to be modified to work in RS-422 mode, see *Section A.8.2.2, 13-Pin Deutsch to DB9 Null Modem Cable (NovAtel part number 01017822)* on *Page 176*.

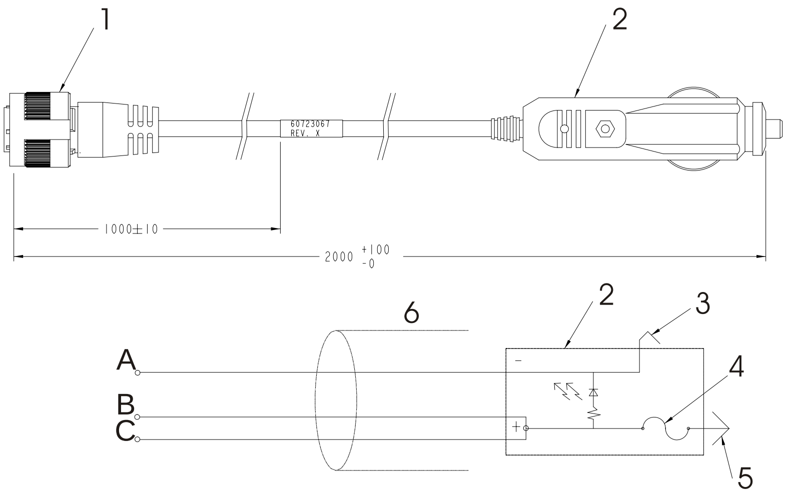
A.8.2 Cables

⌧ Deutsch cable connector pin numbers are labelled on the connectors.

A.8.2.1 12V Power Adapter Cable (NovAtel part number 01017821)

The power adapter cable supplied with the FlexPak provides a convenient means for supplying +12 V DC while operating from a 12V source (the actual voltage range for the receiver is +6 to +18 V DC). The figure below shows the cable and a wiring diagram of the 12V adapter.

The output of the power adapter uses a 3-pin Deutsch socket (Deutsch part number: 59064-09-98SN). This cable plugs directly into the PWR port on the front of the FlexPak.

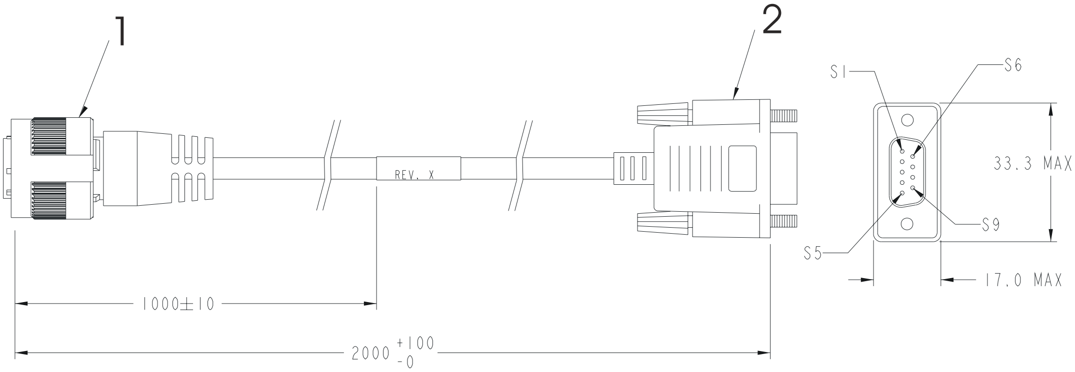


Reference	Description	Reference	Description
1	3-pin Deutsch connector	A	Black
2	12V adapter	B	Red
3	Outer contact	C	White/Natural
4	3 amp slow-blow fuse		
5	Center contact		
6	Foil shield		

Figure 65: FlexPak Power Cable

A.8.2.2 13-Pin Deutsch to DB9 Null Modem Cable (NovAtel part number 01017822)

The null modem serial cable shown below provides a means of interfacing between the COM1 or COM2 port on the FlexPak and another serial communications device, such as a PC. At the FlexPak end, the cable is equipped with a 13-pin Deutsch connector (Deutsch part number: 59064-11-35SF), which plugs directly into a COM port. At the other end, a RS-232 DB9S connector is provided. To use this cable in RS-422 mode, you must cut the DB-9 connector off and make a cable to match the COM2 port for RS-422, see *Section 38, FlexPak COM2 Port Pin-Out Descriptions* on *Page 174*. This cable looks identical to the straight through serial cable, see *Page 177*, but its use and part number differs. It is 2 meters in length.



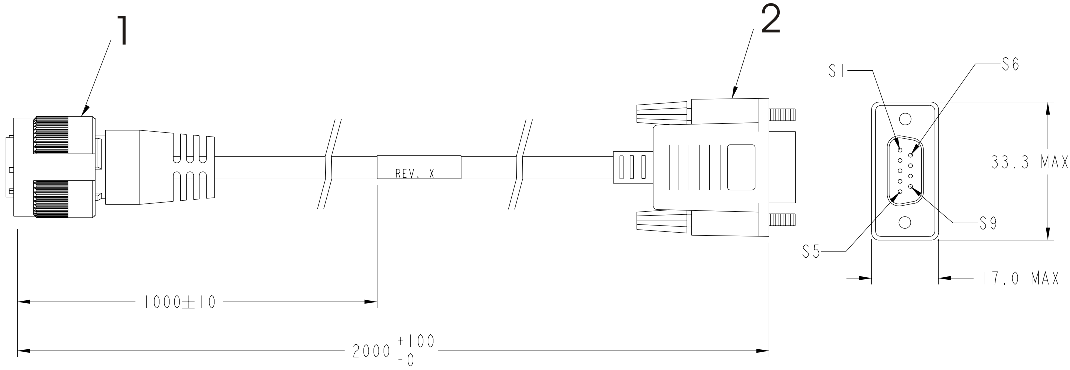
TO RECEIVER	COLOR	SIGNAL	DB-9 FEMALE TO PC
S1	BLUE/WHITE	GPIO	N/C
S2	BROWN	RXD1	S3
S3	BROWN/WHITE	CTS1	S7
S4	GREEN	EVENT1	N/C
S5	BLUE	GND	S5
S6	GREEN/BLACK	EVENT2	N/C
S7	RED	RTS1	S8
S8	RED/BLACK	TXD1	S2
S9	YELLOW/BLACK	POUT	S1,S6
S10	ORANGE	PPS	N/C
S11	WHITE	USB D+	N/C
S12	WHITE/BLACK	USB D-	N/C
S13	ORANGE/BLACK	ERROR	N/C

Reference	Description
1	13-pin Deutsch connector
2	DB9F (female) connector

Figure 66: FlexPak 13-Pin Serial Cable

A.8.2.3 13-Pin Deutsch to DB9 Straight Cable (NovAtel part number 01017823)

The straight through serial cable shown below is used to connect the FlexPak to a modem or radio transmitter to propagate differential corrections. At the FlexPak end, the cable is equipped with a 13-pin Deutsch connector (Deutsch part number: 59064-11-35SF), which plugs directly into a COM port. The female 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). This cable looks identical to the null modem serial cable, see *Page 176*, but its use and part number differs. It is 2 meters in length.



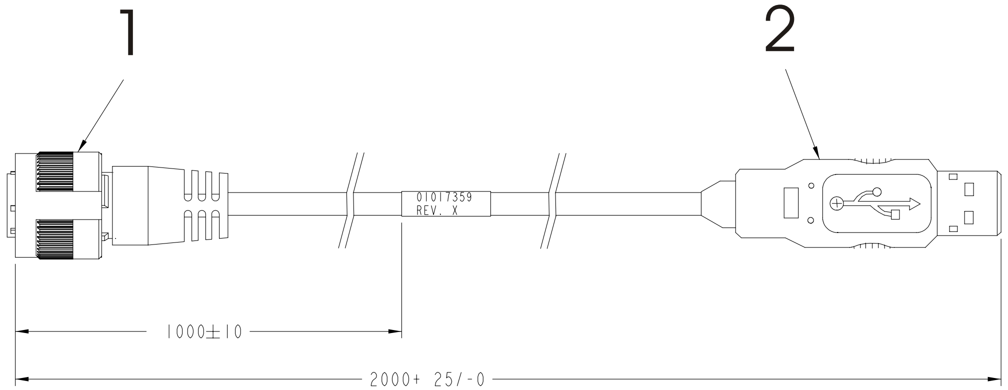
PINOUT ON RECEIVER END CONNECTOR		SIGNAL	DB-9 FEMALE
S1		GPIO	N/C
S2	PAIRED	RXD1	S2
S3		CTS1	S8
S4		EVENT1	N/C
S5		GND	S5
S6		EVENT2	N/C
S7	PAIRED	RTS1	S7
S8		TXD1	S3
S9	2 WIRES	POUT	S1
S9			S6
S10		PPS	N/C
S11	PAIRED	USB D+	N/C
S12		USB D-	N/C
S13		ERROR	N/C

Reference	Description
1	13-pin Deutsch connector
2	DB9M (male) connector

Figure 67: FlexPak 13-Pin Serial Cable

A.8.2.4 USB Serial Cable (NovAtel part number 01017820)

The USB cable shown below provides a means of interfacing between the COM1 or COM2 port on the FlexPak and another serial communications device, such as a PC. At the FlexPak end, the cable is equipped with a 13-pin Deutsch connector (Deutsch part number: 59064-11-35SF), which plugs directly into the COM2 port. See also *Section A.8.2.3, 13-Pin Deutsch to DB9 Straight Cable (NovAtel part number 01017823)* on *Page 177*. At the other end, a USB connector is provided.



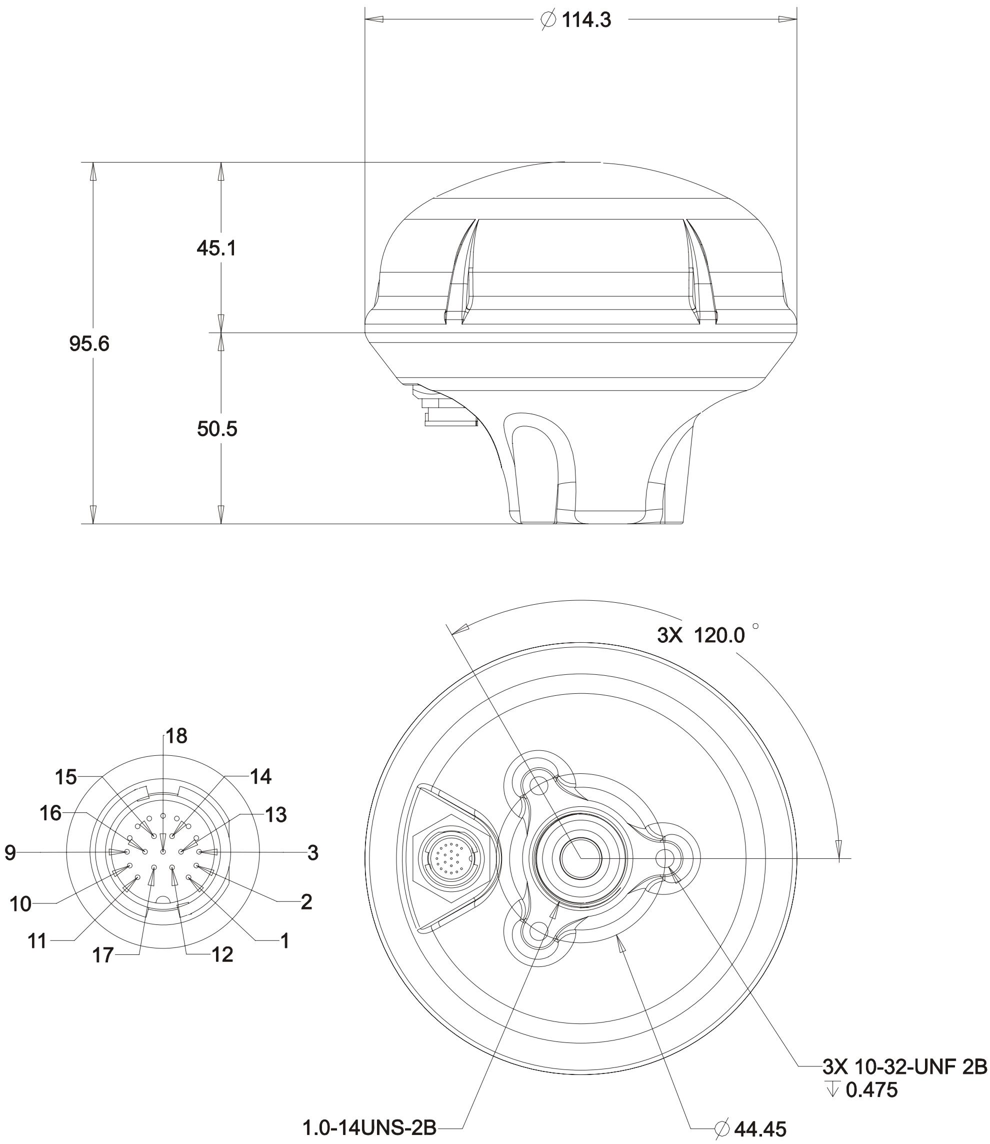
WIRING			
DEUTSCH CONN. ON RECEIVER	SIGNAL	SERIES "A" USB PLUG	WIRE COLOR
PIN 5	GND	PIN 4	BLACK
PIN 11	USB D+	PIN 3	GREEN
PIN 12	USB D-	PIN 2	WHITE
INSULATE TO PREVENT SHORT			RED

Reference	**Description**
1	Deutsch connector
2	USB connector

Figure 68: FlexPak USB Cable

A.9 SMART-V1/SMART-V1G

INPUT/OUTPUT CONNECTORS			
WARNING!: It is important that you read the ***SMART-V1/SMART-V1G Power Warning*** on ***Page 11*** of the *Notice* section.			
Switchcraft Connector Part Number: EN3P18M26 (see *Section D.5* on *Page 215* for the mating part #)			
USB model port (SMART-V1 or SMART-V1G)	18-pin Switchcraft RS-232 +9 to +28 V DC 2.5 W (typical) power consumption		
CAN model port (SMART-V1 only)	18-pin Switchcraft RS-232 +9 to +28 V DC 2.5 W (typical) power consumption		
RS-422 model port (SMART-V1 only)	18-pin Switchcraft RS-422 +9 to +28 V DC 2.5 W (typical) power consumption		
NOVATEL PART NUMBER			
SMART-V1 SMART-V1G	USB: 01017755 USB: 01018011	RS-422: 01018012	CAN: 01017756
PHYSICAL			
Size	114.3 mm Diameter x 95.6 mm Height (4.5" Diameter x 3.76" Height)		
Weight	525 g maximum excluding cable (1.16 lb.)		
Mounting System	1-14 UNS threads x 1” deep and/or 3 x 10-32 UNF screws		
ENVIRONMENTAL			
Operating Temperature	-40°C to +75°C (-40°F to +167°F)		
Storage Temperature	-55°C to +90°C (-67°F to +194°F)		
Humidity	Not to exceed 95% non-condensing		
Tested to all these standards	Waterproof/Immersion Salt Spray Sand and Dust Shock Vibration (Random) Vibration (Sine)	MIL-STD-810F 512.4 Procedure I MIL-STD-810F 509.4 MIL-STD-810F 510.4 MIL-STD-810F 516.5 MIL-STD-801F 514.5 C17 SAE EP455	

DIMENSIONS
a b 

a. All dimension are in millimeters, please use the *Unit Conversion* section of the *GPS+ Reference Manual* for conversion to imperial measurements.

b. ∅ indicates a diameter and ⊽ indicates a depth.

A.9.1 Port Pin-Outs

The pin numbering for the SMART-V1/SMART-V1G USB port followed by the SMART-V1 CAN and SMART-V1 RS-422 models, is described in the tables that follow.

Table 39: SMART-V1/SMART-V1G USB Model Port Pin-Out Descriptions

Switchcraft RS-232	
Pin	**Function**
1	PWR
2	GND
3	TX2
4	RX2
5	TX1
6	RX1
7	NC
8	NC
9	Reserved
10	USB D (-)
11	Digital GND
12	PPS
13	TX3
14	RX3
15	NC
16	USB D (+)
17	PWR2
18	GND2

See also *Section 3.3.1, Strobes* on *Page 43*.

Table 40: SMART-V1 CAN Model Port Pin-Out Descriptions

Switchcraft RS-232	
Pin	**Function**
1	PWR
2	GND
3	CAN H
4	CAN L
5	TX1
6	RX1
7	NC
8	NC
9	Reserved
10	Reserved
11	Digital GND
12	PPS
13	TX3
14	RX3
15	NC
16	NC
17	PWR2
18	GND2

Table 41: SMART-V1 RS-422 Model Port Pin-Out Descriptions

Switchcraft RS-422	
Pin	**Function**
1	PWR
2	GND
3	TX2
4	RX2
5	TX1 (-)
6	RX1 (+)
7	TX1 (+)
8	RX1 (-)
9	Reserved
10	Reserved
11	Digital GND
12	PPS
13	TX3 (-)
14	RX3 (+)
15	TX3 (+)
16	RX3 (-)
17	PWR2
18	GND2

A.9.2 Optional Cables

Each SMART-V1/SMART-V1G is available with its own multi-cable in a USB (NovAtel part number 01017893) format. The SMART-V1 is also available in CAN (NovAtel part number 01017894) or RS-422 (NovAtel part number 01018017) format. These cables are also available with no connectors at the DB-9 end (NovAtel part numbers 01017923, 01017922, or 01018024 respectively) but with tin-terminated ends. All 6 cables have an 18-pin Switchcraft connector at one end and are 3 m in length.

Section A.9.2.1 below contains SMART USB multi-cable information, *Section A.9.2.2* on *Page 185* contains SMART-V1 CAN multi-cable information while *Section A.9.2.3* on *Page 186* contains SMART-V1 RS-422 multi-cable information. *Figures 69* and *70* on *Page 187* show cable examples.

☒ Switchcraft cable connector pin numbers are labelled on the connectors.

A.9.2.1 18-Pin Switchcraft to USB Multi-Cable (NovAtel part number 01017893)

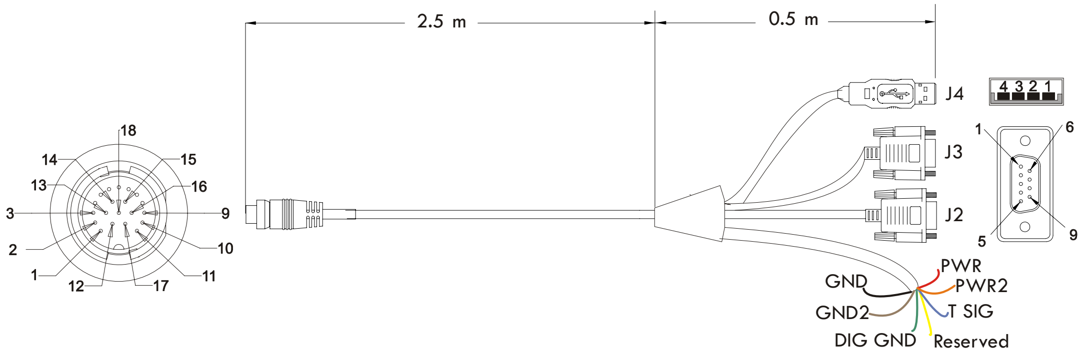


Table 42: USB Multi-Cable Connector Pin-Outs

J1 Switchcraft		J2 DB-9 socket		J3 DB-9 socket		J4 USB A	
Pin	**Signal**	**Pin**	**Signal**	**Pin**	**Signal**	**Pin**	**Signal**
1	PWR	1	N/A	1	N/A	1	N/A
2	GND	2	TX1	2	TX2	2	USB D (-)
3	TX2	3	RX1	3	RX2	3	USB D (+)
4	RX2	4	N/A	4	N/A	4	Digital GND
5	TX1 (+)	5	Digital GND	5	Digital GND		
6	RX1 (+)	6	N/A	6	N/A		
7	NC	7	N/A	7	N/A		
8	NC	8	N/A	8	N/A		
9	Reserved	9	N/A	9	N/A		
10	USB D (-)						
11	Digital GND						
12	PPS						
13	TX3 (+)						
14	RX3 (+)						
15	NC						
16	USB D (+)						
17	PWR2						
18	GND2						

☒ See also *Table 45* on *Page 186* for the optional USB cable's bare tagged wire colors.

WARNING!: It is important that you read the ***SMART-V1/SMART-V1G Power Warning*** on ***Page 11*** of the *Notice* section.

A.9.2.2 18-Pin Switchcraft to CAN Multi-Cable (NovAtel part number 01017894)

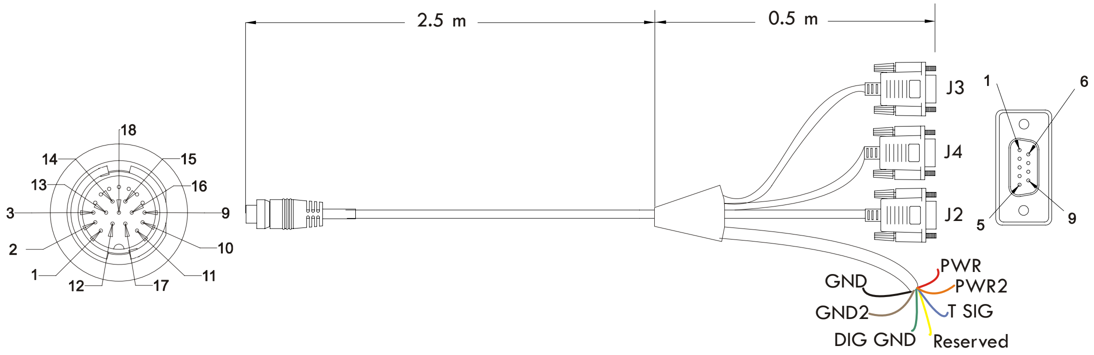


Table 43: CAN Multi-Cable Connector Pin-Outs

J1 Switchcraft		J2 DB-9 socket		J3 DB-9 plug		J4 DB-9 socket	
Pin	**Signal**	**Pin**	**Signal**	**Pin**	**Signal**	**Pin**	**Signal**
1	PWR	1	N/A	1	N/A	1	N/A
2	GND	2	TX1 (+)	2	CANH	2	TX3 (+)
3	CANH	3	RX1 (+)	3	CANL	3	RX3 (+)
4	CANL	4	N/A	4	N/A	4	N/A
5	TX1 (+)	5	Digital GND	5	N/A	5	Digital GND
6	RX1 (+)	6	N/A	6	N/A	6	N/A
7	NC	7	NC	7	N/A	7	NC
8	NC	8	NC	8	N/A	8	NC
9	Reserved	9	N/A	9	N/A	9	N/A
10	Reserved						
11	Digital GND						
12	PPS						
13	TX3 (+)						
14	RX3 (+)						
15	NC						
16	NC						
17	PWR2						
18	GND2						

See also *Table 45* below for the optional CAN cable's bare tagged wire colors.

WARNING!: It is important that you read the ***SMART-V1/SMART-V1G Power Warning*** on ***Page 11*** of the *Notice* section.

A.9.2.3 18-Pin Switchcraft to RS-422 Multi-Cable (NovAtel part number 01018017)

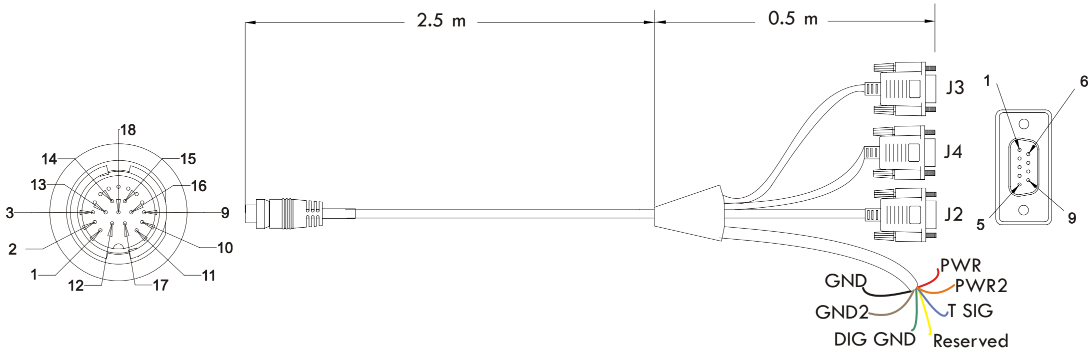


Table 44: RS-422 Multi-Cable Connector Pin-Outs

J1 Switchcraft		J2 DB-9 socket		J3 DB-9 socket		J4 DB-9 socket	
Pin	**Signal**	**Pin**	**Signal**	**Pin**	**Signal**	**Pin**	**Signal**
1	PWR	1	N/A	1	N/A	1	N/A
2	GND	2	TX1 (-)	2	CANH	2	TX3 (-)
3	TX2	3	RX1 (+)	3	CANL	3	RX3 (+)
4	RX2	4	N/A	4	N/A	4	N/A
5	TX1 (-)	5	Digital GND	5	Digital GND	5	Digital GND
6	RX1 (+)	6	N/A	6	N/A	6	N/A
7	TX1 (+)	7	TX1 (+)	7	N/A	7	TX3 (+)
8	RX1 (-)	8	RX1 (-)	8	N/A	8	RX3 (-)
9	Reserved	9	N/A	9	N/A	9	N/A
10	Reserved						
11	Digital GND						
12	PPS						
13	TX3 (-)						
14	RX3 (+)						
15	TX3 (+)						
16	RX3 (-)						
17	PWR2						
18	GND2						

✉ See also *Table 45* below for the optional RS-422 cable's bare tagged wire colors.

WARNING!: It is important that you read the ***SMART-V1/SMART-V1G Power Warning*** on ***Page 11*** of the *Notice* section.

Table 45: USB, CAN or RS-422 Multi-Cables Bare Tagged Wire Colors

Color	Function
Red	PWR
Orange	PWR2
Blue	T SIG
Yellow	Reserved
Green	Digital GND
Brown	GND2
Black	GND

Figure 69: SMART-V1/SMART-V1G Optional USB Multi-Cable

Figure 70: SMART-V1 Optional CAN or RS-422 Multi-Cable

Appendix B Electrostatic Discharge Control (ESD) Practices

B.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.

B.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.

B.3 Prime Static Accumulators

Table 46 provides some background information on static-accumulating materials.

Table 46: 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

B.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 C Ethernet Configuration

At power-up, the DL-V3 configures the COM3 multiplexer to switch to the Bluetooth device by default. In order to use the Ethernet device, the multiplexer must be switched to use Ethernet. To do this, follow one of the two methods outlined in this appendix.

C.1 Physical Set-Up

Below are the configuration methods described in this appendix and the hardware you require to set them up:

- Configuration Via Network Cable
  - DL-V3 with power cable and serial communications cable
  - User-supplied laptop with an available Ethernet port, serial port (or USB port with NovAtel serial to USB drivers) and the Lantronix software, described below, installed
  - CAT5 Ethernet cross-over cable (or use a switch with a straight through Ethernet cable)
- Configuration Via Serial and Network Parameters
  - DL-V3 with power cable
  - User-supplied laptop with the Lantronix software, described below, installed
  - Serial null-modem cable to connect from the laptop and switch between COM1 and COM2 on the DL-V3. You can avoid switching if you have two serial connections on your laptop and two null-modem cables. Also, if your laptop has only USB connectors, you need a USB to serial adaptor between the null-modem cable and the laptop's USB connector.
  - CAT5 Ethernet cross-over cable (or use a switch with a straight through Ethernet cable)

In both cases, first install the **DeviceInstaller** and **Com Port Redirector** utilities programs onto the laptop you intend to use with your DL-V3 from the Lantronix website at: http://www.lantronix.com/device-networking/utilities-tools/.

Figure 71, CAT5 Ethernet Cable Connection on *Page 192* shows the two methods of physically providing an Ethernet connection between your laptop and DL-V3. The top shows a direct connection using a CAT5 Ethernet cross-over cable and the bottom shows two straight-through CAT5 Ethernet cables with a DSS-5+ port switch in between them.

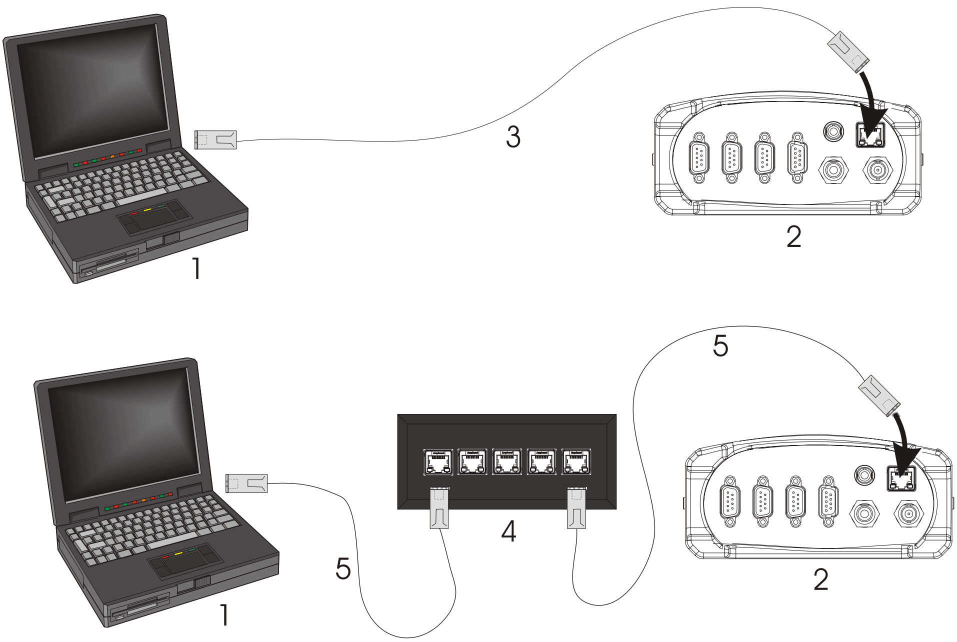


Figure 71: CAT5 Ethernet Cable Connection

Reference	Description
1	User-supplied laptop computer with Ethernet connector
2	DL-V3 (powered)
3	User-supplied CAT5 Ethernet cross-over cable
4	User-supplied DSS-5+ Port Switch
5	User-supplied CAT5 Ethernet straight-through cables

C.2 Configuration Overview

Both configuration methods are used to provide the DL-V3 with a static Internet Protocol (IP) address to be used in your personal network. To do this, your Network Administrator must assign a static IP address to you so that every time there is a receiver start-up, it has the same IP address. Otherwise, the Ethernet module in the DL-V3 is DHCP-enabled by default where DHCP is an acronym for Dynamic Host Configuration Protocol. This means that normally the Ethernet device issues a new IP address every time the receiver is started up. A static IP aids with remote work especially.

C.3 Configuration Via Network Cable

To physically connect the DL-V3 to Ethernet, follow these steps:

1. Connect a CAT5 cross-over cable to a laptop with a free Ethernet port
2. Connect the other end of the CAT5 crossover cable to the DL-V3’s Ethernet port

3. Connect the power cable to the DL-V3 and power-up the unit

C.3.1 Enable Ethernet on DL-V3 Receiver

From the laptop, connect the DL-V3 to a serial, or USB, cable. Open communication with the receiver using HyperTerminal or **CDU**. Issue the following command (to switch COM3 from Bluetooth to Ethernet operation):

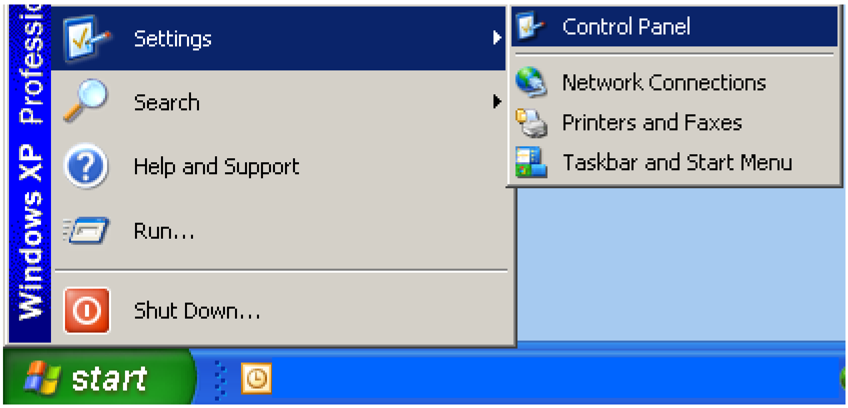
```
APPCONTROL BLUETOOTH 1
```

COM3 switches from the Bluetooth to the Ethernet device in the DL-V3. You can see this because the Ethernet LED, labelled  , on the DL-V3 now glows orange.

C.3.2 Windows XP Network Settings

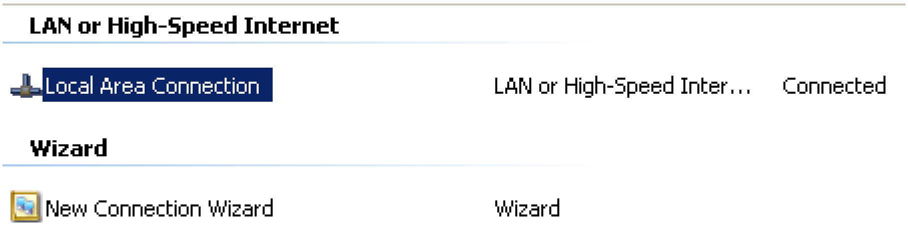
If using TCP/IP networking on a Windows XP-based PC or laptop, Windows may be configured to obtain an IP address automatically. However, an alternate IP must be configured manually rather than having an automatically generated private IP address. To do this, follow these steps:

1. Click on the *Start* button in Windows and select *Settings* | *Control Panel*.

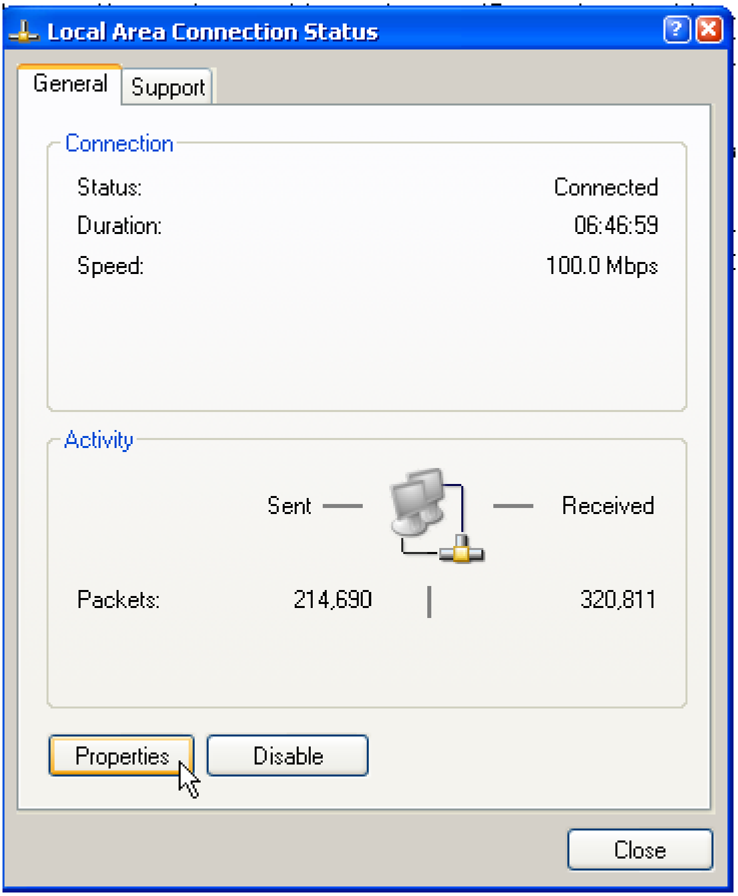


2. Select *Network Connections* in *Control Panel*, and double-click on it.

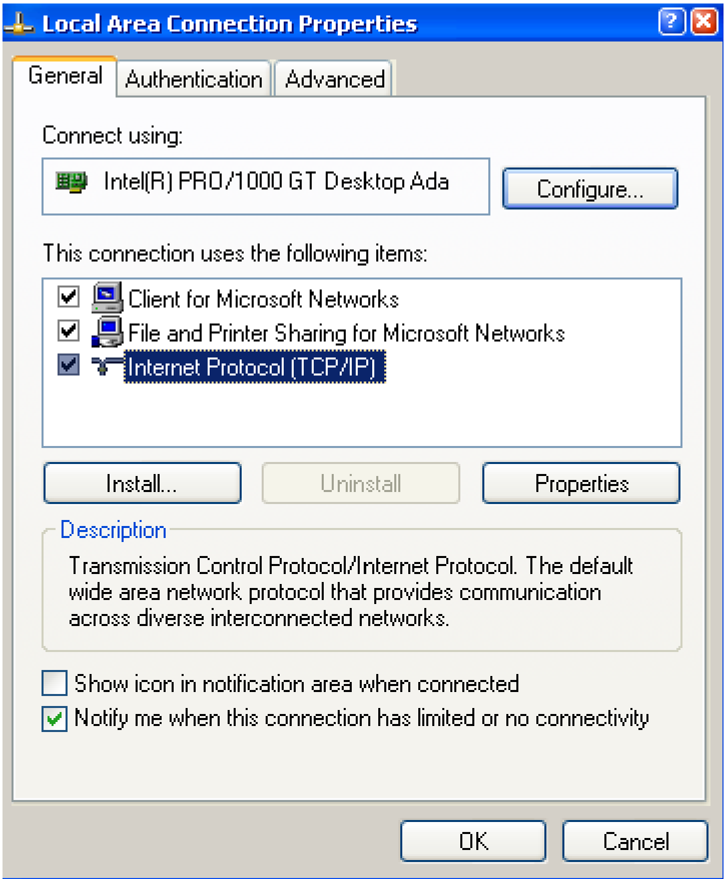
3. Highlight *Local Area Connection* and double-click on it.



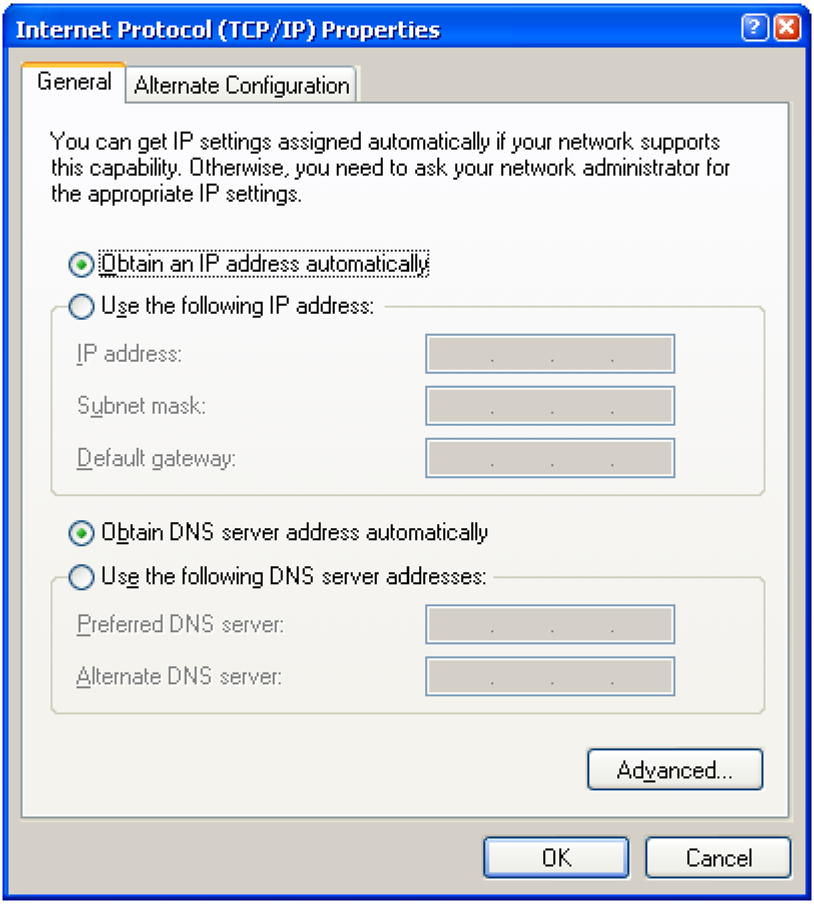
4. Click on *Properties* in the *General* tab in the *Local Area Connection* dialog that appears. The *Local Area Connection Properties* dialog appears.



5. Select *Internet Protocol (TCP/IP)* and click on the *Properties* button. The *Internet Protocol TCP/IP Properties* dialog appears.

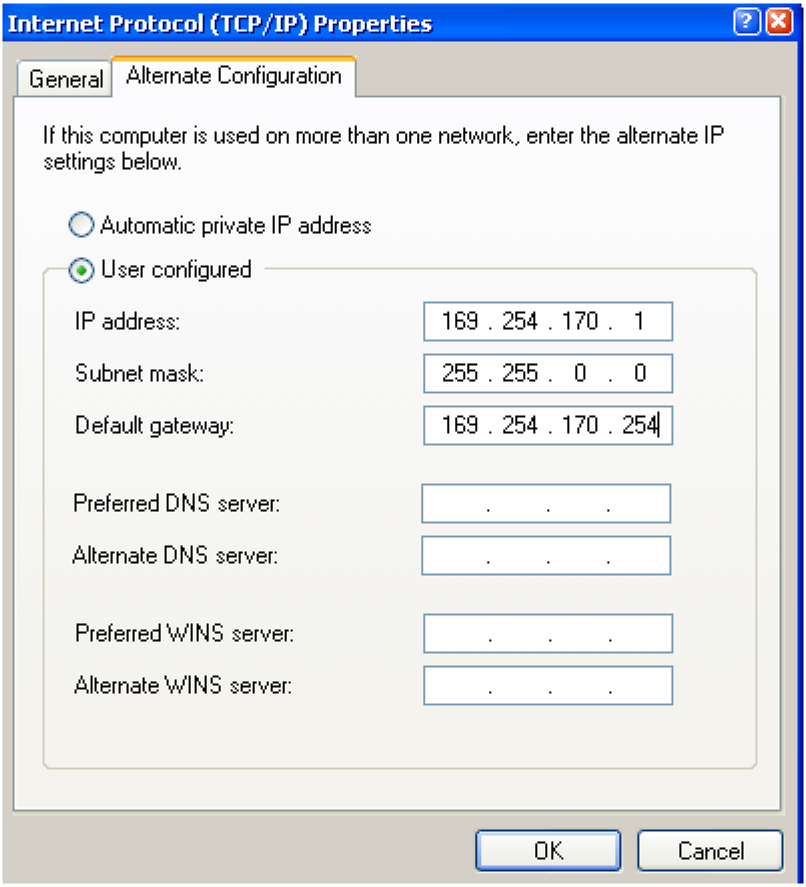


6. Ensure the *Obtain an IP address automatically* and *Obtain DNS server address automatically* radio buttons are selected in the *General* tab.



7. Select the *Alternate Configuration* tab in the *Internet Protocol (TCP/IP) Properties* dialog.

> ✉ *Step 7*, above, is very important. If the *Alternate Configuration* tab is not selected, this procedure will not work.



8. Ensure that the *User Configured* radio button is selected. Change the settings to something similar to the fictional examples shown on this page (check with your Network Administrator for details) and click *OK*.

> ✉ 1. The described IP address, and its respective submask and gateway, are for a private Auto IP, class B, designated IP address and you should obtain yours from your Network Administrator.
>
> 2. **Record your IP Address, Network Mask and Gateway numbers for future use.**

9. Click *OK* when you are returned to the *Local Area Connection Properties* dialog.

10. Click *Close* to complete the network configuration.

11. Restart the laptop for the settings to take effect.
12. Power-off and then power-on the DL-V3. The Bluetooth mode is on again by default.
13. Issue the following commands, using Hyperterminal, to switch COM3 back to Ethernet and reset the Ethernet device in the DL-V3:

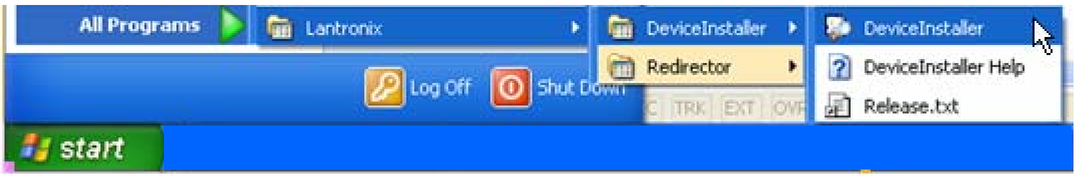
    APPCONTROL BLUETOOTH 1
    APPCONTROL OPTION 12 1

14. Restart your laptop for the settings to take effect.

C.3.3 Configuring Ethernet Serial and Network Parameters

The DL-V3's Ethernet module is DHCP-enabled by default, see *Section C.2, Configuration Overview* starting on *Page 192*.

The default serial settings are 9600 baud, 8 data bits, no stop bits, 1 parity bit, and no flow control. In order to change these settings, use the *DeviceInstaller* utility. Select and click on *DeviceInstaller* from the Start | All Programs | Lantronix | DeviceInstaller menu in Windows.



Follow these steps to use DeviceInstaller:

1. Click *No* if you see an information message asking if you would like to see a tutorial on TCP/IP.

If you click *No*, the *Lantronix DeviceInstaller* program window is visible.

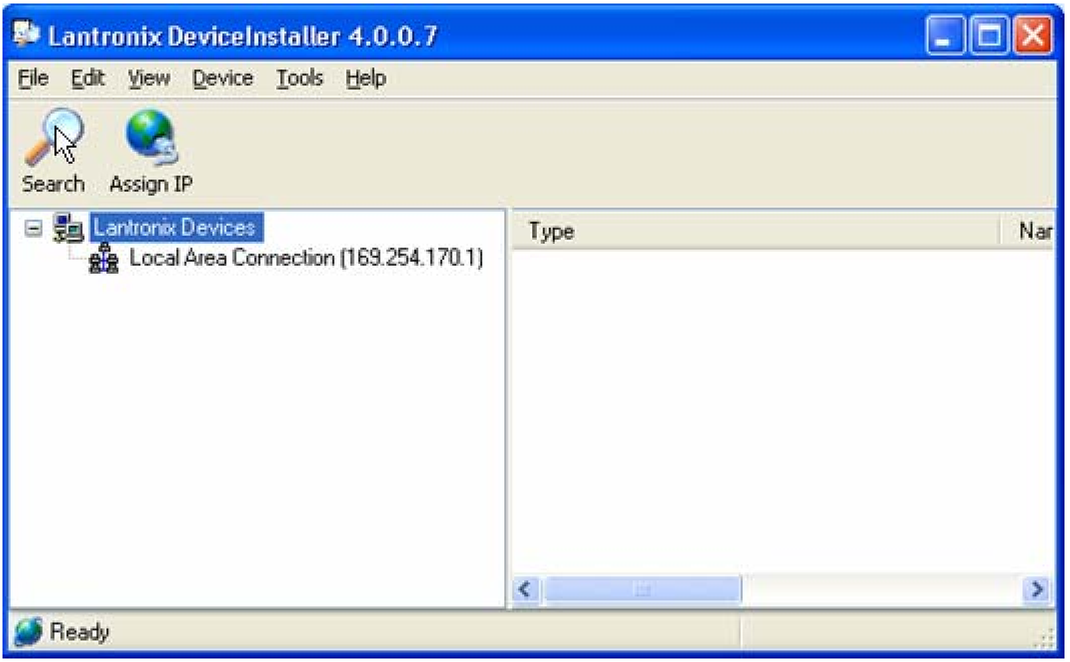
---

1. We previously went through the TCP/IP settings in *Section C.3.2, Windows XP Network Settings* starting on *Page 193*.
2. You can view the Window's TCP/IP tutorials at any time by selecting *Help and Support* from Window's *Start* menu and then using its Search engine to find TCP/IP.

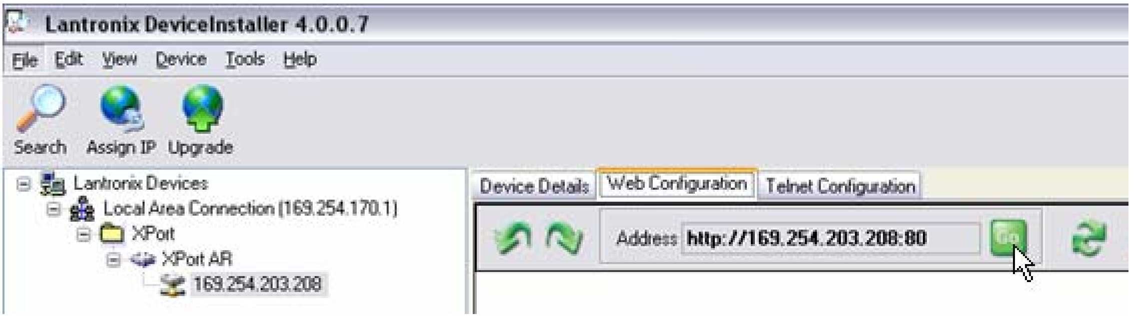
---

2. Click the *Search* button (with a magnifying glass icon) in the *Lantronix DeviceInstaller* program window to commence a search for any available Ethernet devices. If a device is found, its IP

address appears in a hierarchical tree found under Lantronix Devices.



3. Restart the laptop, select *DeviceInstaller* from the *Start* menu again and re-follow Steps *1* to *2* above. This time the *Lantronix DeviceInstaller* window should have a more detailed hierarchal tree on the left and tabs to the right.



4. Select the *Web Configuration* tab and then click on the *GO* button found beside the *Address* field.

5. Enter the *User Name* as **admin** and the *Password* as ***PASS*** in the pop-up screen that appears.

6. Click *OK* to return you to the *Lantronix DeviceInstaller* window with a new Status menu to the left of the right-side panel.

C.3.3.1 Network Settings Configuration

Select *Network| Configuration* from the *Status* menu to change to the desired network settings. Typically, the Ethernet device requires a static IP address, thus the DHCP Client is disabled. Also IP Address, Network Mask, Gateway, Hostname, Domain, and Ethernet types are changed according to the correct network values. Refer to an IT Network Administrator for further information, see also *Step 8* on *Page 197*. For instance, *Figure 72* is an example of a private IP configuration:

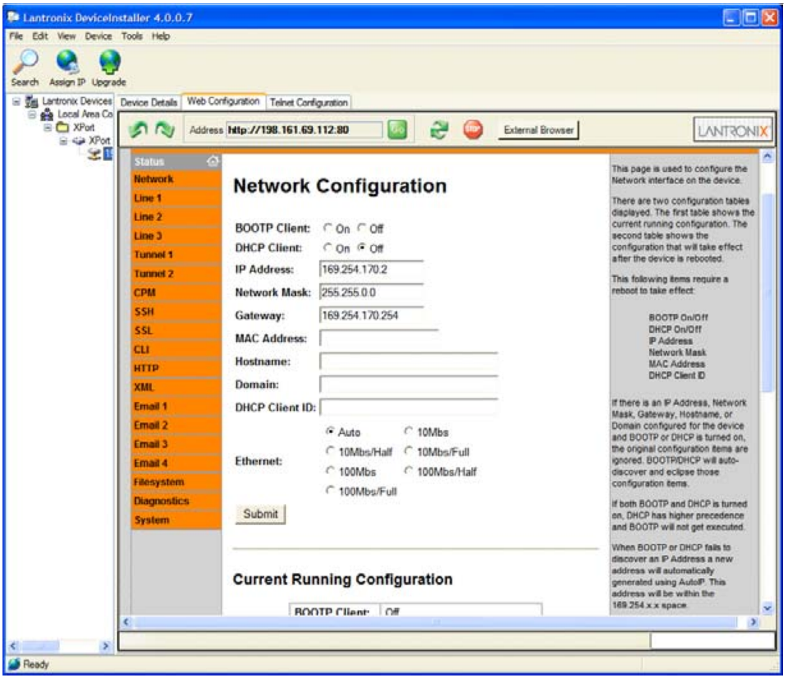


Figure 72: Lantronix Device Installer: Network Configuration

Click on the *Submit* button for the network settings to be saved to the Ethernet device's NVM.

C.3.3.2 Line 1 Configuration

Select *Line 1 | Configuration* from the *Status* menu. Line 1 refers to COM1 of the Ethernet device. This is the port that is connected to COM3 of the DL-V3. Change the settings to match COM3 of the DL-V3. The screen shown in *Figure 73* displays the new settings:

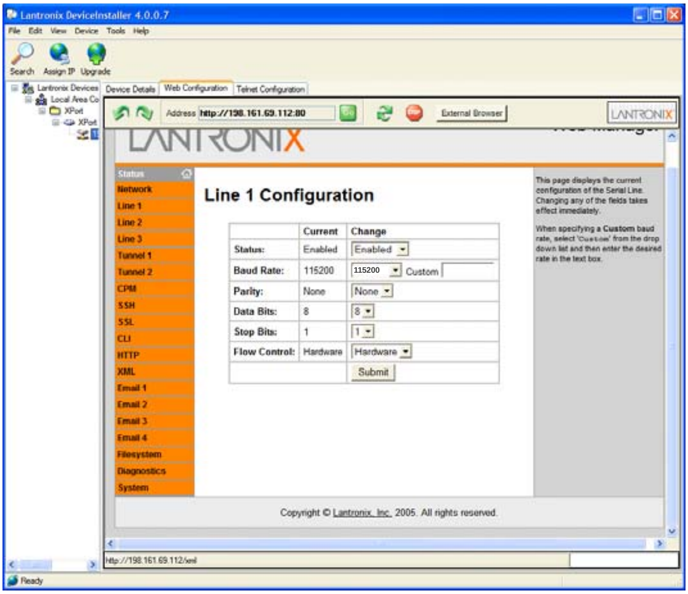


Figure 73: Lantronix Device Installer: Line 1 Configuration

Click the *Submit* button for the Line 1 configuration to be saved to the Ethernet device's NVM.

C.3.3.3 Tunnel 1 Serial Settings

Select *Tunnel 1| Serial Settings* from the *Status* menu. Tunnel 1 is associated with Line 1 and must be enabled. The screen in *Figure 74* displays the current configuration:

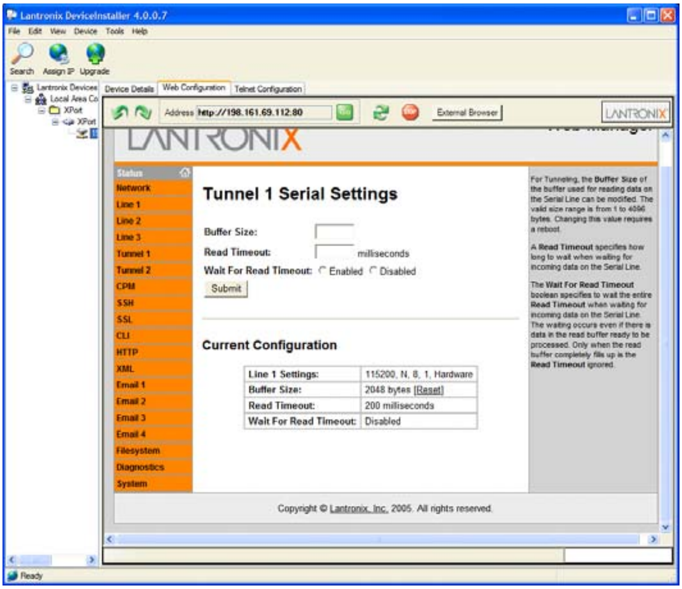


Figure 74: Lantronix Device Installer: Tunnel 1 Serial Settings

C.3.3.4 Tunnel 1 Accept Mode

Select *Tunnel 1 | Accept Mode* from the *Status* menu. In order for the Ethernet device to transfer serial data, Accept Mode must be enabled. That is, any data arriving at the Ethernet device's serial port automatically enables a TCP/IP connection. Refer to the *Lantronix XPORT-AR User Guide*, available from their website, for further information. The screen in *Figure 75* displays the Accept Mode configuration:

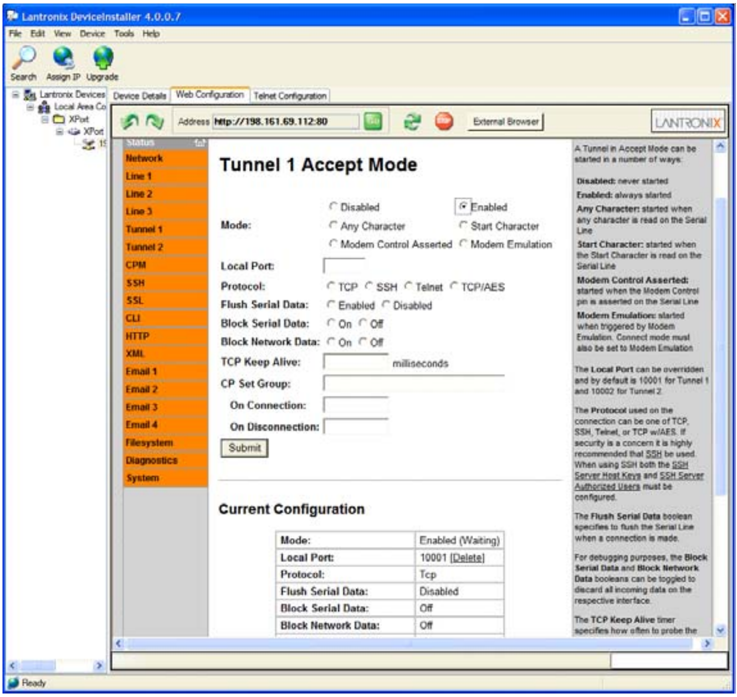


Figure 75: Lantronix Device Installer: Tunnel 1 Accept Mode

Ensure that the *Enabled* radio button is selected and click on the *Submit* button to save the Accept Mode to Ethernet device's flash memory.

A pop-up warning may appear regarding the enabling of Accept Mode. Click *OK*.

C.3.3.5 Reboot the XPORT-AR device

Select *System* from the *Status* menu. Click on the *Reboot* button to reboot the Ethernet device, and for the network and serial settings to take effect. The screen in *Figure 76* displays the system screen:

Figure 76: Lantronix Device Installer: System Screen

The Ethernet device is now ready to communicate with the DL-V3. In order for a client to communicate with the Ethernet device using existing communications tools such as HyperTerminal, the Ethernet device's IP address must be mapped to a virtual serial port within the Lantronix Port Redirector utility. *Section C.3.4*, *Lantronix Port Redirector Software*, starting below, describes the configuration process.

C.3.4 Lantronix Port Redirector Software

Run the Lantronix Port Redirector software from the *Start* | *All Programs* | *Lantronix* | *Redirector* menu.

The main *Lantronix Redirector Configuration* screen appears, see *Figure 77* on *Page 205*.

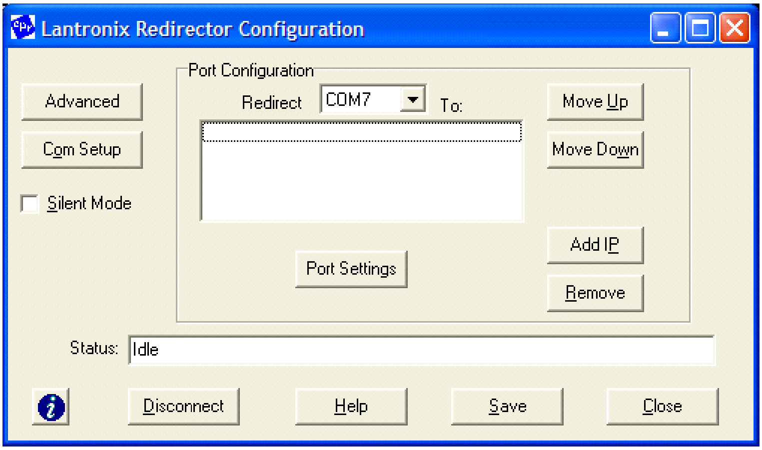


Figure 77: Lantronix Redirector Configuration Dialog

C.3.4.1 Add the DL-V3 Ethernet Device's IP Address and Port

Click on the *Add IP* button. The *IP Service Setup* screen appears. *Figure 78* is an example using the same IP address as configured in the Lantronix *DeviceInstaller* utility.

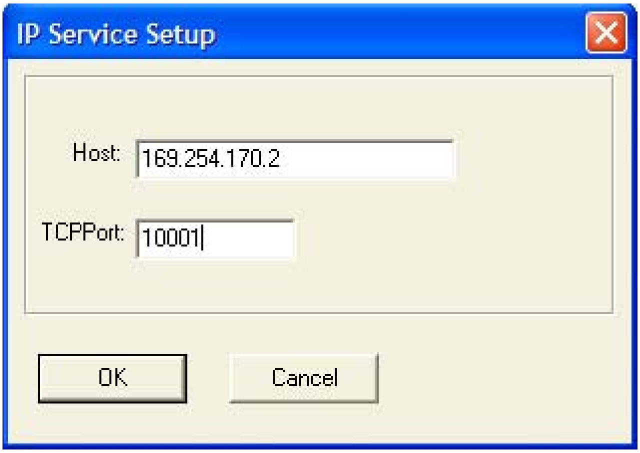


Figure 78: Lantronix Port Redirector: IP Service Setup

In the *Host* field, key in the DL-V3 Ethernet device's IP address. Since the IP address is unique for each installation, it is left up to the user to configure a valid IP address, typically static. For the port setting, in the *TCPPort* field use 10001. Click *OK* to return you to the main *Lantronix Redirector Configuration* dialog shown in *Figure 77*.

See also *Section C.3.3.1, Network Settings Configuration* on *Page 200* and *Section C.2, Configuration Overview* on *Page 192*.

C.3.4.2 Configure Port Settings

In the *Lantronix Redirector Configuration* dialog, click on the *Port Settings* button. The Port Setting dialog appears as shown in *Figure 79*. Check the *Raw Mode* check box. Click *OK* to return you to the main *Lantronix Redirector Configuration* dialog shown in *Figure 77* on *Page 205*.

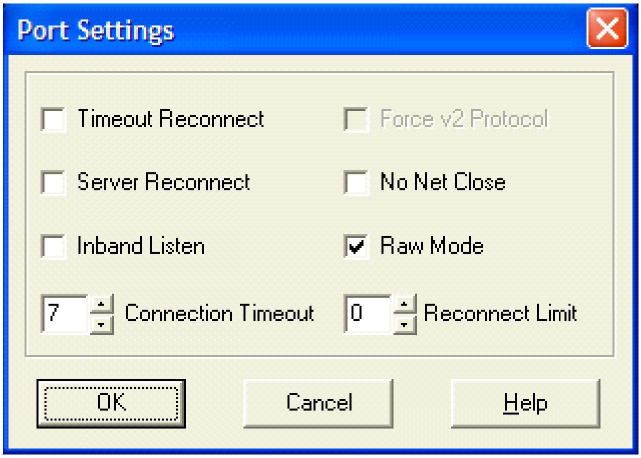


Figure 79: Lantronix Port Redirector: Port Settings Screen

C.3.4.3 Configure Virtual Serial Port

In the *Lantronix Redirector Configuration* dialog, click on the *Com Setup* button.

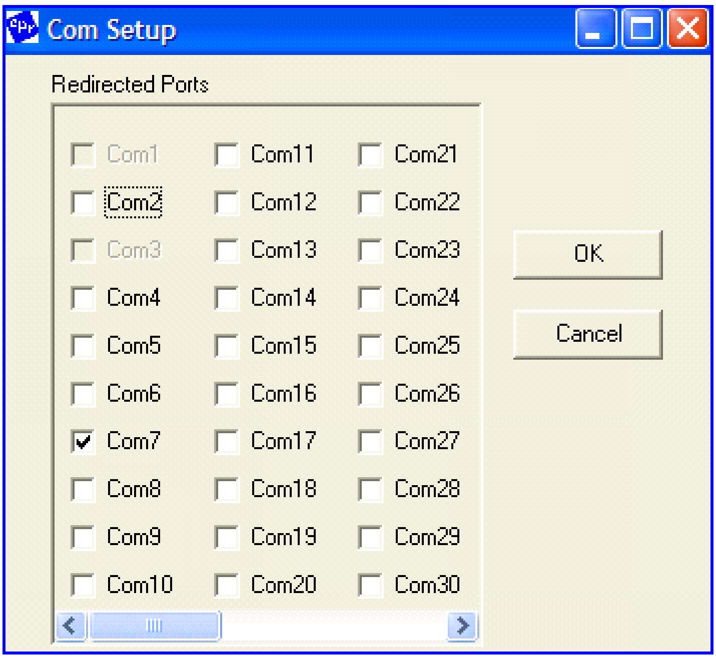


Figure 80: Lantronix Port Redirector: Com Setup Screen

The Com Setup dialog appears, see *Figure 80* on *Page 206*. Select a COM port to use as the virtual serial port for the Ethernet device. Notice that you are unable to select previously assigned ports. Click *OK* to return you to the main *Lantronix Redirector Configuration* dialog.

C.3.4.4 Redirector Configuration Completion

After completing the steps in the three sections from *Section C.3.4.1* on *Page 205* through to *Section C.3.4.3* above, click the *Save* button in the *Lantronix Redirector Configuration* dialog, shown in *Figure 77* on *Page 205*, and follow the prompts. Click the Close button to close the Redirector program. The Windows system may require a reboot when a new COM port is selected.

The system is now ready to be used with HyperTerminal, **CDU**, or other serial communications software. Ensure that the serial settings are identical to those configured for the Ethernet device, that is 115200 baud, 8 data bits, no stop bits, 1 parity bit, no flow control and the same PC COM port as selected in *Section C.3.4.3, Configure Virtual Serial Port* on *Page 206*.

C.4 Alternative Serial and Network Parameters Configuration

The DL-V3's Ethernet port is Dynamic Host Configuration Protocol DHCP-enabled by default, see *Section C.2, Configuration Overview* on *Page 192*. Also, the default serial settings are 9600 baud, 8 data bits, no stop bits, 1 parity bit, and no flow control.

Serial Command Mode is an alternative method to configure the Ethernet network and serial settings. This method is complicated by the fact that there is no direct access to the Ethernet device because it is an embedded part connected internally to COM3. The following paragraphs describe the detailed process of configuring the Ethernet via the Serial Command Mode.

C.4.1 Physical Connections

To physically connect the Ethernet to the DL-V3, follow these steps:

1. Connect a serial **null-modem** cable from your Laptop to the DL-V3 COM1 port
2. Connect a serial **null-modem** cable from your Laptop to the DL-V3 COM2 port

---

⌧ 1 serial null-modem cable may be connected from the laptop and switch between COM1 and COM2 on the DL-V3. You can avoid switching if you have two serial connections on your laptop and two null-modem cables. Also, if your laptop has only USB connectors, you need a USB to serial adaptor between the null-modem cable and the laptop's USB connector.

---

3. Connect the power cable to DL-V3 power port, power and switch on the unit with the  button on its front.

C.4.2 PC Software

HyperTerminal communications software is recommended for COM1 communications to the DL-V3. From Window's *Start* menu, select *Programs* | *Accessories* | *Communications* | *Hyperterminal*. The default communications parameters should be set to those listed in the following table in Hyperterminal:

Parameter	Setting
BAUD	9600
DATA BITS	8
PARITY	N
STOP BITS	1
FLOW CONTROL	NONE
ASCII SETTINGS	Disable echo typed characters locally

COM1 is used to tunnel to COM3 to gain direct access to the Ethernet.

COM2 is used to issue NovAtel commands to the DL-V3 using HyperTerminal communications software. The communications parameters should be set to the defaults for DL-V3 COM2. Typically, 9600, 8, N, 1, no parity and local echo on.

C.4.3 DL-V3 Commands

C.4.3.1 Switch to Ethernet Device

Once communication has been established between your laptop serial port (or USB port with a USB-to-serial port adaptor) and COM2 on the DL-V3, enter the following commands:

- LOG VERSION

> ⌧ Record the OEMV-3 part serial number (PSN) for future use (associated with the Ethernet Media Access Control (MAC) address).

- APPCONTROL BLUETOOTH 1

> ⌧ Switch COM3 peripheral to Ethernet. On the front of the DL-V3, the Bluetooth LED no longer glows blue but instead the Ethernet LED glows orange.

- LOG COMCONFIG

> ⌧ COMCONFIG shows you the current port settings (the default baud setting for COM3 is 115200). The COM commands below ensure both COM1 and COM3 are set to 9600 baud.

- COM COM1 9600 N 8 1

- COM COM3 9600 N 8 1
- LOG COMCONFIG

✉ The COMCONFIG command should verify that COM3 is now set to 9600 baud.

C.4.3.2 Establish a Communications Tunnel

Still on COM2, enter the following commands:

- INTERFACEMODE COM3 TCOM1 NONE OFF
- INTERFACEMODE COM1 TCOM3 NONE OFF

C.4.3.3 Reset Ethernet

Still on COM2, enter the following command:

- APPCONTROL OPTION 12 1

This command forces the Ethernet to reset. Wait only a second for the Ethernet to power up again.

C.4.3.4 Establish Serial Command Mode in Ethernet

Switch the null-modem cable connection on the DL-V3 from the COM2 port to the COM1 port. Follow this procedure very carefully.

1. Select *File | Properties* in the HyperTerminal menu. The *Connections Properties* dialog appears.
2. Click on the *Settings* tab in the *Connections Properties* dialog.
3. Click on the *ASCII Setup* button in the *Settings* tab. The *ASCII Setup* dialog appears.
4. Ensure that the *Echo typed characters locally* check box is unchecked. Normally it is useful to see what you are typing but for the following step we are only interested in what the Ethernet device returns to the screen.
5. Click on the *OK* buttons until you return to the main HyperTerminal window.
6. Type the character '!' and wait for a returned '!' character to appear. If it does not, repeat entering the ! and continue until a ! is returned to the screen. Immediately after observing the ! character returned, type:

    - xyz

✉ 1. Do not hit the Enter key after typing the z, simply wait for the prompt to appear

2. If the ! character never appears, go back to step *C.4.3.3*.

---

7. Follow steps 1 through 3 above again and then go on to step 8 now that we are typing commands again, and want to see characters as we type them.

8. Ensure that the *Echo typed characters locally* check box **is** checked this time.

9. Click on the *OK* buttons until you return to the main HyperTerminal window.

10. Enter the following command in the main window (that is in Command Mode)

    • enable

Figure 81 shows an example of the Ethernet communication in command mode. The xyz and enable commands can be seen near the top. The other commands that follow are shown in the next section. Refer back to *Figure 81*, as you follow the next section's instructions, to see if you get the expected results. If not return to step *C.4.3.3* and try again.

```
char *acCmds[] =
  {                               // expect:
     "xyz",                       // >
     "enable\r",                  // (enable)#
     "configure\r",               // (config)#
     "if 1\r",                    // (if-1)#
     "ip address I N",            // (if-1)#
     "no dhcp\r",                 // (if-1)#
     "speed auto\r",              // (if-1)#
     "write\r",                   // (if-1)#
     "exit\r",                    // (config)#
     "exit\r",                    // (enable)#
     "line 1\r",                  // (line-1)#
     "databits 8\r",              // (line-1)#
     "flowcontrol hardware\r",    // (line-1)#
     "speed 115200\r",            // (line-1)#
     "write\r",                   // (line-1)#
     "exit\r",                    // (enable)#
     "reload\r",                  // Are you sure (yes/no)?
     "yes\r",                     // Rebooting...
     0
  };
```

I : IP Address
Example: 193.168.1.1

N: Network Mask
Example: 255.255.255.(

At this point you must change the baud rate to 115200 for hyperterminal on COM3 and COM1

Figure 81: Command Mode Example

C.4.4 Network Configuration in Command Mode

1. Text within brackets < > denote optional parameters.
2. An IP address must be formatted in dotted quad IP address notation and be valid for the network. An example of dotted quad notation is: 192.168.0.254
3. Refer to the *Lantronix XPORT-AR User Guide* for a full command set. Lantronix website details are on *Section C.1, Physical Set-Up* on *Page 191*.

11. *(continued from Page 210)* Enter the following Ethernet command-mode commands on COM1, to configure the network settings:

    • show

1. Record the MAC address. It should appear as a set of six hexadecimal value pairs separated by colons. For example:

   00:20:4A:44:55:66
2. The show command is not shown in *Figure 81* on *Page 210*.

    • configure
    • if 1
    • ip address <IP> <network mask>
    • ip default-gateway <gateway IP address>
    • no dhcp
    • speed auto
    • exit
    • exit
    • write
    • line 1
    • databits 8
    • flowcontrol hardware
    • speed 115200

12. Change the baud rates to re-establish communications with the Ethernet device now that the Ethernet is set to 115200, but the tunneled serial ports on the DL-V3 are still at 9600 baud. In addition, HyperTerminal’s baud rate is also still set to 9600.

13. Switch the null-modem cable connection on the DL-V3 from the COM1 port to the COM2 port.

14. Enter the following commands on COM2:

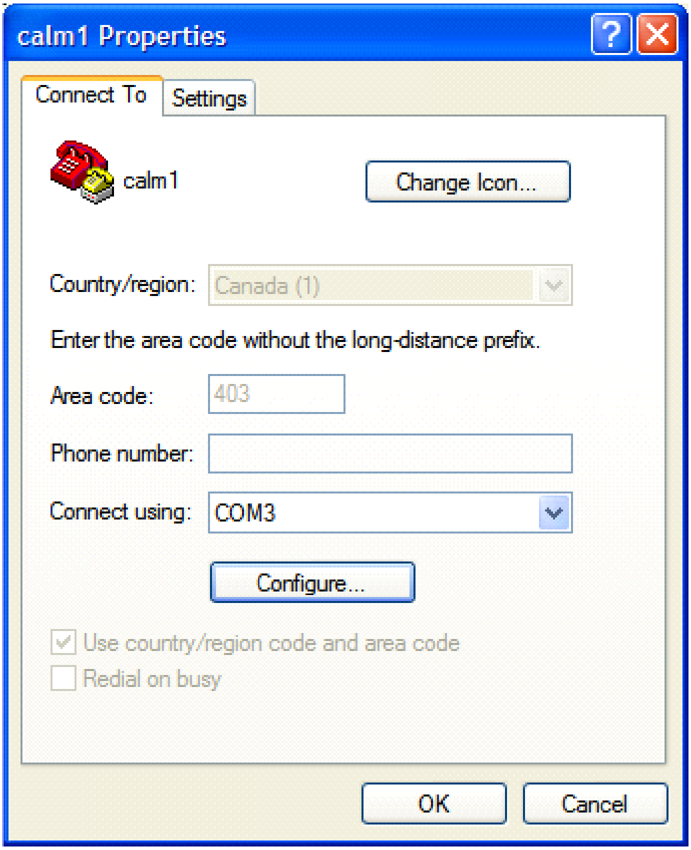
- COM COM1 115200
- COM COM3 115200
- LOG COMCONFIG

🖂 The COMCONFIG command verifies that the baud rate on COM1 and COM3 are now 115200.

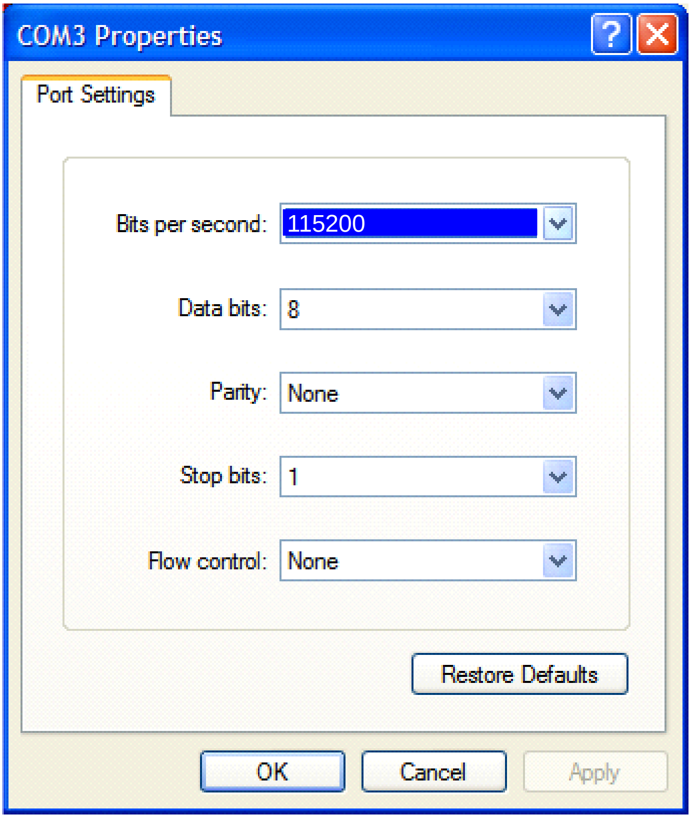
---

15. Select *Call* | *Disconnect* from the main menu to disconnect the communications so that a new baud rate can be configured.

16. Choose *File* | *Properties* from the main menu.



17. Click on the *Configure...* button in the *Properties* dialog.



18. Choose 115200 in the *Bits per second:* field.
19. Click *OK*.
20. Switch the null-modem cable connection on the DL-V3 from the COM2 port to the COM1 port.
21. Re-connect HyperTerminal and type the following commands to COM1:
    - exit

✉ Type YES when asked to reboot or reload the system. For example, after you see:
`reload\r`

- yes

22. Switch the null-modem cable connection on the DL-V3 from the COM1 port to the COM2 port
23. Type RESET on COM2, or push and hold the power button on the DL-V3 and wait for the LEDs to indicate that the unit is powering off before releasing the power button, or physically remove power from the DL-V3. This step restores COM1 and COM3 by resetting the unit.

This concludes the Ethernet configuration via Serial Command Mode. Next, see the *Lantronix Port Redirector Software* section starting on *Page 204* to configure Lantronix Port-Redirector software to configure a Lantronix virtual serial port in Windows XP.

Appendix D Replacement Parts

The following are a list of the replacement parts available for your NovAtel GPS receiver. Should you require assistance or need to order additional components, please contact your local NovAtel dealer or Customer Service representative.

D.1 DL-V3 and ProPak-V3

Part Description	NovAtel Part
I/O strobe cable (*Figure 63* on *Page 169*)	01017660
Straight through serial data cable (*Figure 62* on *Page 168*)	01017659
Null modem serial data cable (*Figure 61* on *Page 167*)	01017658
Power cable: LEMO 4-pin socket to 12V power outlet plug (*Figure 60* on *Page 166*)	01017663

D.2 ProPak-V3

Part Description	NovAtel Part
USB serial cable (*Figure 64* on *Page 170*)	01017664

D.3 FlexPak-V2, FlexPak-V1G and FlexPak-V1

Part Description	NovAtel Part
12V power adapter cable (*Figure 65* on *Page 175*)	01017821
13-pin Deutsch to DB9 null modem serial cable (*Figure 66* on *Page 176*)	01017822
13-pin Deutsch to DB9 straight through cable (*Figure 67* on *Page 177*)	01017823
13-pin Deutsch to USB connector cable (*Figure 68* on *Page 178*)	01017820

D.4 Accessories

Part Description		NovAtel Part
OEMV Family Compact Disc with PC utilities		01017716-VER1
OEMV Family Installation and Operation User Manual		OM-20000093
OEMV Family Firmware Reference Manual		OM-20000094
SMART-V1/SMART-V1G multi-cable USB (2 DB-9, 1 USB and 7 bare tagged wire ends)		01017893
SMART-V1 multi-cable CAN (3 DB-9, and 7 bare tagged wire ends)		01017894
SMART-V1 multi-cable RS-422 (3 DB-9, and 7 bare tagged wire ends)		01018017
SMART-V1/SMART-V1G multi-cable USB variant (all bare tagged-wire ends)		01017923
SMART-V1 multi-cable CAN variant (all bare tagged-wire ends)		01017922
SMART-V1 multi-cable RS-422 variant (all bare tagged-wire ends)		01018024
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 702GGL (L1/L2/GLONASS/L-band)	GPS-702-GGL

Continued on Page 215

Part Description		NovAtel Part
	Model 701GGL (L1/GLONASS/L-band)	GPS-701-GGL
	Model 538 (L1/GLONASS/L-band)	ANT-538
	Model 537 (L1)	ANT-537
	Model 536 (L1)	ANT-536-C
	Model 534 (L1/L2/L-band)	ANT-534-C
	Model 533 (L1/L2)	ANT-533
	Model 532 (L1/L2)	ANT-532-C
Optional RF Antenna Cable:	5 meters	GPS-C006
	15 meters	GPS-C016
	30 meters	GPS-C032
	22 cm interconnect adapter cable	GPS-C002
AC Adapter 120/240VAC	15 Watts, 12 V DC adapter with USA electrical chord	40023098

D.5 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
ProPak-V3/DL-V3 Power Cable (*Figure 60* on *Page 166*)	4-pin socket connector	LEMO	FGG.0B.304.CLAD52Z
FlexPak-V1/V1G/V2 Cables (*Figures 65 -68* starting on *Page 175*)	3-pin plug connector on 12V power adapter cable	DEUTSCH	59064 - 09 - 98SN
	13-pin plug connector on serial cables	DEUTSCH	59064 - 11 - 35SF
SMART-V1/V1G: USB, CAN or RS-422 Model Cables	18-pin plug connector on multi-cable	Switchcraft	EN3C18F26
OEMV-1/1G Card (*Figure 47* on *Page 129*)	J100 - MCX JACK RECEPTACLE RF signal input and LNA power output	JOHNSON	133-3701-211
	J700 - 2x10 HEADER, 2mm PITCH Power, data, and signal connector	SAMTEC	TMM-110-03-TM-D
OEMV-2 Card (*Figure 51* on *Page 141*)	J100 - MMCX JACK RECEPTACLE RF signal input and LNA power output	JOHNSON	135-3701-201
	J501 - MMCX JACK RECEPTACLE External oscillator input	JOHNSON	135-3701-201
	P1101 - 2x12 HEADER, 2mm PITCH Power, data, and signal connector	SAMTEC	TMM-112-03-L-D
OEMV-3 Card (*Figure 53* on *Page 147*) Note the alternates for J100 and J700.	J100 - MMCX JACK RECEPTACLE RF signal input and LNA power output	JOHNSON	135-3701-201
		HUBER+SUHNER	82 MMCX-50-0-1
	J700 - MMCX JACK RECEPTACLE External oscillator input	JOHNSON	135-3701-201
		HUBER+SUHNER	82 MMCX-50-0-1
	P1601 - 2x20 HEADER, 0.1" PITCH Power, data, and signal connector	SAMTEC	TSM-120-01-S-DV
	P1400 - 2x7 HEADER, 0.1" PITCH CAN Bus with transceiver	SAMTEC	TSM-107-01-L-DV

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