SMART6-L™
User Manual

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SMART6-L User Manual

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Warranty

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Antenna Module	One (1) Year
Cables and Accessories	Ninety (90) Days
Software Warranty	One (1) Year

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To return products, refer to the instructions found under the Return Policy Tab on the Warranty page: www.novatel.com/products/warranty/.

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#5,390,207	#6,243,409 B1	#7,250,916
#5,495,499	#6,445,354 B1	#7,738,536 B2
#5,734,674	#6,452,560 B2	#7,738,606 B2
#5,736,961	#6,608,998 B1	#7,885,317 B2
#5,809,064	#6,664,923 B1	#8,467,433 B2
#6,184,822 B1	#6,728,637 B2	#8,442,097 B2
#6,211,821 B1	#6,922,167 B2	

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Notices

The following notices apply to the SMART6-L.

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

FCC Notices

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

SMART6-L has been tested and found to comply with the emission limits for a Class B digital device. The Class B limits are designed to provide reasonable protection against harmful interference in a residential installation.

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 by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Re-orient or relocate the SMART6-L
- Increase the separation between the equipment and the SMART6-L
- Connect the equipment to an outlet on a circuit different from that to which the SMART6-L is connected
- Consult the dealer or an experienced radio/TV technician for help

In order to maintain compliance as a Class "B" digital device, shielded cables should be used for the RS-232 serial data ports (Belden 1036A or equivalent) and twisted pair cable should be used for the CAN port (shielded twisted pair will improve CAN performance in electrically harsh environments). I/O signals should be referred to signal ground (connector pin 5) and not power ground (connector pin 9). If I/O signals route to different areas of the vehicle, dedicated signal grounds for I/O should be spliced into a common connection to connector pin 5 at a point close to the SMART6-L.

Industry Canada

SMART6-L Class B digital apparatuses comply with Canadian ICES-003.
SMART6-L appareils numérique de la classe B sont conforme à la norme NMB-003 du Canada.

CE Marking

Hereby, NovAtel Inc. declares that SMART6-L is in compliance with the essential requirements (radio performance, electromagnetic compatibility and electrical safety) and other relevant provisions of Directive 1999/5/EC, EMC Directive 2004/108/EC, and the RoHS Recast Directive 2011/65/EU. Therefore the equipment is labeled with the following CE-marking.

CE1588

The Declaration of Conformity may be obtained from NovAtel Inc., 1120-68th Ave N.E., Calgary, Alberta, Canada. T2E-8S5.

E-mark

The SMART6-L has been granted EC type approval of an electric/electronic subassembly with respect to electromagnetic compatibility ECE Regulation 10.04. Therefore the equipment is labeled with the following approval marks.

10 R - 04 8644

WEEE

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

REACH

NovAtel strives to comply with the EU Directive EC 1907/2006 on chemicals and their safe use as per the Registration, Evaluation, Authorization and Restriction of Chemical substances (REACH) for its products, including the SMART6-L product. Since REACH SVHC lists are updated occasionally, please contact NovAtel Customer Support if you require further information.

Cables may contain DEHP (CAS Number 117-81-7) in concentrations above 0.1% w/w.

1.Visit the NovAtel Web site at www.novatel.com/products/weee-and-rohs/ for more information on WEEE.

Customer Service

NovAtel Knowledge Base

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

Before Contacting Customer Support

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

1. Issue the following logging commands to collect data to a file on your computer for 15 minutes:

```
LOG VERSIONA ONCE
LOG RXSTATUSA ONCHANGED
LOG RXCONFIGA ONCE
LOG RAWEPHEMA ONNEW
LOG BESTPOSA ONTIME 1
LOG RANGEA ONTIME 1
```

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

3. You can also issue a `FRESET` command to the receiver to clear any unknown settings.

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

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

Contact Information

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

Call the NovAtel Hotline at 1-800-NOVATEL (U.S. and Canada) or +1-403-295-4500 (international)	
Fax: +1-403-295-4901 E-mail: support@novatel.com website: www.novatel.com	Write:NovAtel Inc. Customer Support Department 1120 - 68 Avenue NE Calgary, AB Canada, T2E 8S5

Chapter 1 Introduction

The SMART6-L is a high performance GNSS receiver and antenna, capable of receiving and tracking different combinations of GNSS L1/L2 code and carrier signals on a maximum of 120 channels. SBAS (Satellite Based Augmentation Systems) includes WAAS (North America), EGNOS (Europe) and MSAS (Japan). SBAS support is standard. Refer to *An Introduction to GNSS* (on our website at www.novatel.com/an-introduction-to-gnss/) for an overview of each of the above signal types. The SMART6-L rear panel also features Light Emitting Diodes (LEDs) for status indication.

Once properly powered, the SMART6-L begins operating as a fully functional GNSS system. *Figure 1, SMART6-L Receiver* shows the SMART6-L without connecting cables.

Figure 1: SMART6-L Receiver

1.1 Features and Models

The main features of the SMART6-L are:

- an enhanced high performance GNSS L1/L2 receiver
- a high performance GNSS L1/L2 antenna
- a CAN port
- three (3) RS-232 COM ports
- three (3) LED status indicators
- a water and dust tight enclosure

The SMART6-L is available in several different firmware models whose configurations may include other additional features. Contact NovAtel Sates at www.novatel.com/where-to-buy/contact-us for information regarding available models, upgrading a model to increase feature/functionality or go to www.novatel.com/support/info/documents/925 to obtain product updates. Refer to *Chapter 4, NovAtel Firmware and Software* on page 32 for details.

Refer to the OEM6 Installation and Operation Manual for detailed information on receiver communications and operation.

Chapter 2 Installation and Setup

2.1 Additional Equipment Required

In order for the SMART6-L to perform optimally, the following additional equipment is required:

- A computer (user supplied)
- A cable harness for communicating and powering the SMART6-L (NovAtel cable harness 01018999 is available with three dB9 connectors, four bare cables and a SMART6-L connector) or similar
- A fused power supply (user supplied) (refer to *Table 5, Recommended Fuse and Fuse Holders* on page 48 for details)

2.1.1 SMART6-L Setup

Complete the following steps to connect and power the SMART6-LT.

1. Mount the SMART6-L on a secure, stable part of a vehicle (i.e., cab roof) with an unobstructed view of the sky from horizon to horizon (refer to *Section 2.1.4, Mounting the SMART6-L* on page 15 for details).
2. Establish a physical communication connection between the SMART6-L and the computer. Connect the COM and Power port on the back of the SMART6-L, see *Figure 2, SMART6-L Connector* below, to a DB-9 serial port on a computer or other data storage devices.

Figure 2: SMART6-L Connector

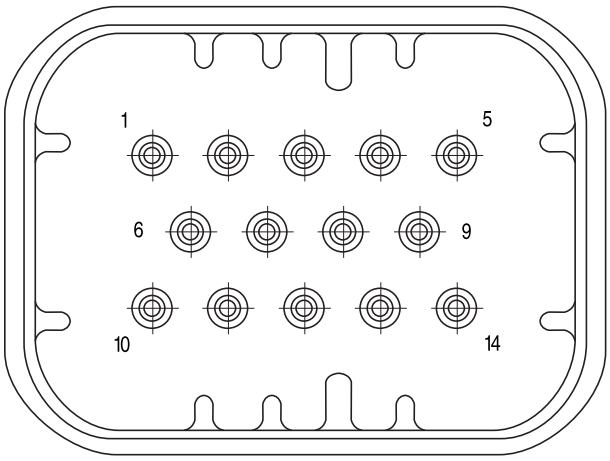


Table 1: SMART6-L Connector Pin-Out

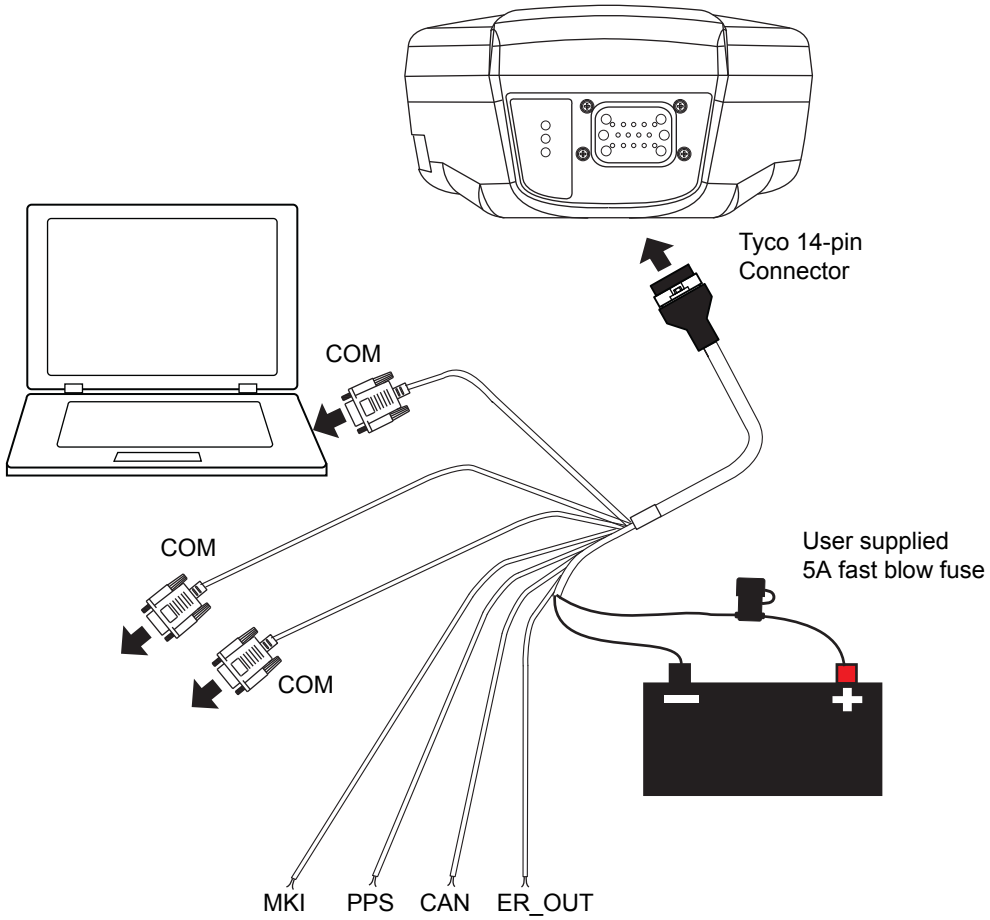
Pin	Use	Pin	Use
1	COM1 TxD	8	COM3 TxD
2	COM1 RxD	9	Power Negative/Return
3	COM2 TxD	10	ER_OUT (Emulated Radar Output)[a]
4	COM2 RxD	11	MKI (Mark Input)
5	Signal Ground (COM/MKI/PPS/ER)	12	PPS (Pulse Per Second) Output
6	CAN+	13	COM3 RxD
7	CAN-	14	Power Positive/Source

a. Emulated Radar is available only on hardware versions 3.03 or greater.

3. Turn on the power supply to the SMART6-L (the SMART6-L cable is also a power cable). The power LED on the receiver glows red when the SMART6-L is properly powered.

> Fuse/holder recommendations can be found in *Table 5, Recommended Fuse and Fuse Holders* on page 48.

Figure 3: Simplified SMART6-L Setup



> Minimum conductor size for all wiring is 0.5 mm/20 AWG. NovAtel recommends tying to ground any floating input lines.

2.1.2 Power Supply Requirements

The SMART6-L requires +8 to +36 VDC input power (refer to *Section A.2.1, SMART6-L Communication/ Power Cable (01018999)* on page 46 for additional power supply specifications).

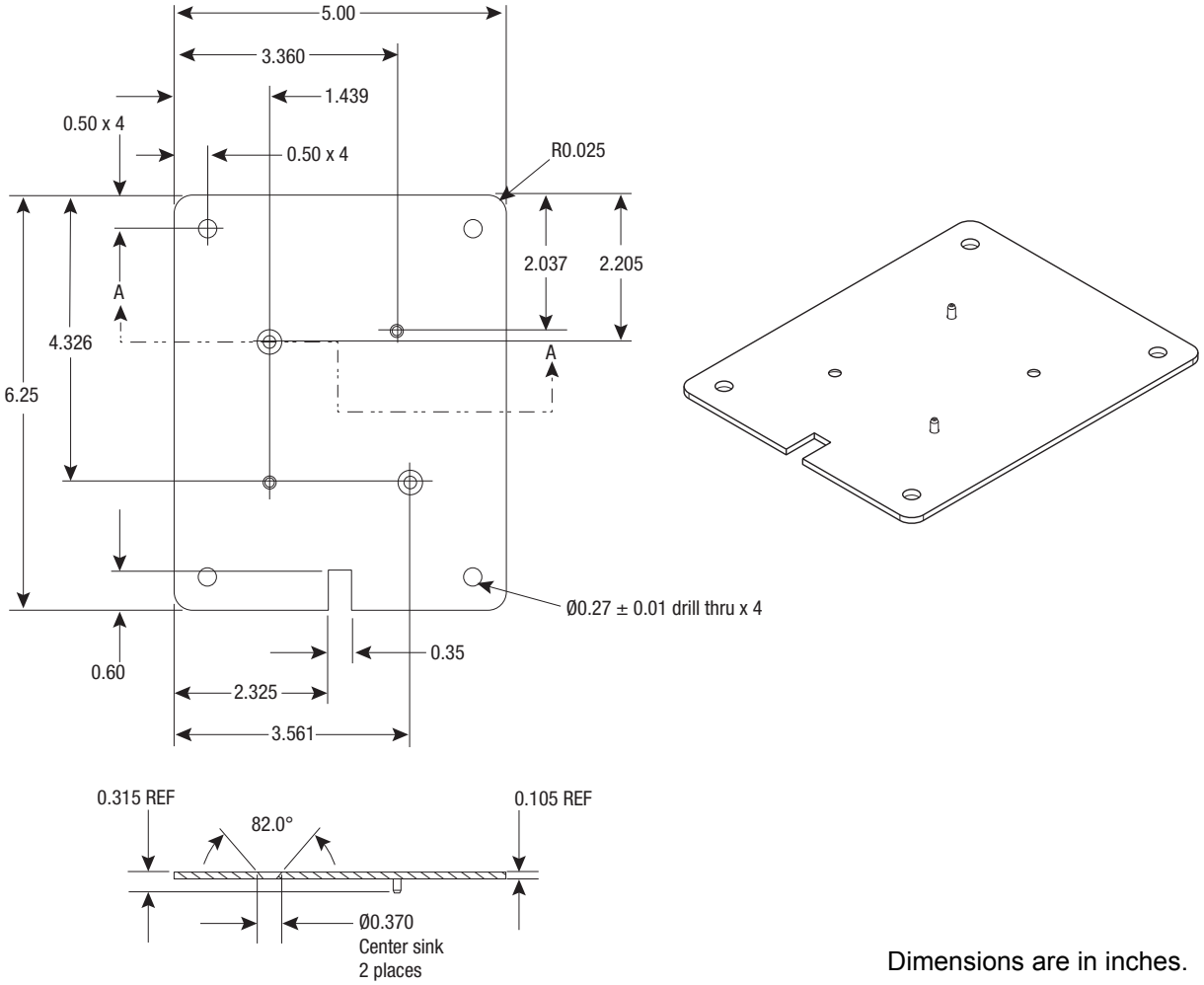
The SMART6-L cable provides power in (BATT+ and power ground (BATT-) bare wires for connecting the SMART6-L to a vehicular power system (or equivalent).

> The SMART6-L power source must be protected by a 5 A Fast Blow Fuse or damage to wiring may result (not covered by warranty). Refer to *Section A.2.1, SMART6-L Communication/Power Cable (01018999)* on page 46.

2.1.3 Mounting Plate

Two mounting plates are available to facilitate mounting the receiver: a surface mounting plate and a pole mounting plate.

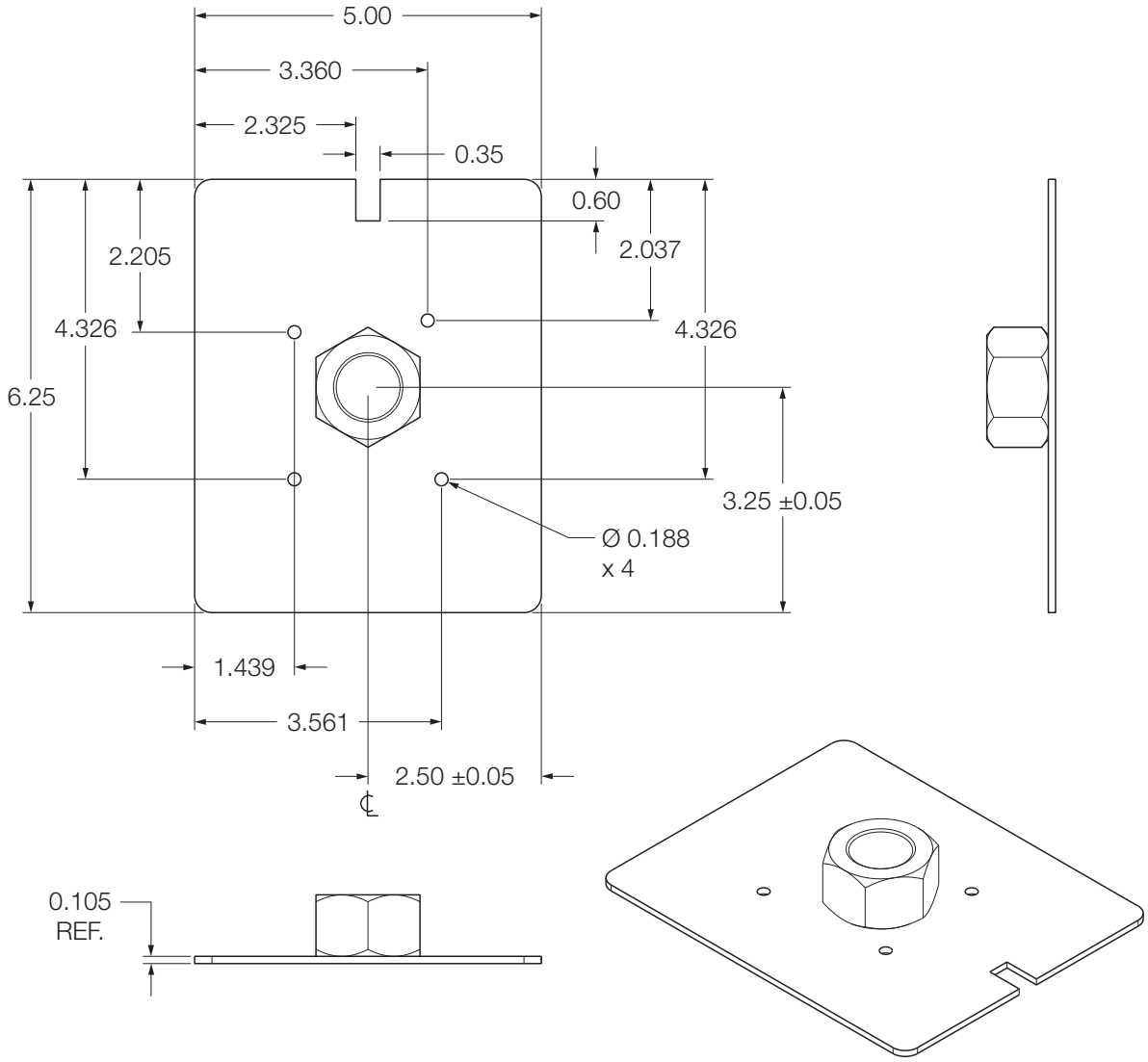
Figure 4: SMART6-L Surface Mounting Plate (01018317)



Dimensions are in inches.

To install the mounting plate, use the adhesive tape or the mounting holes at each corner of the plate.

Figure 5: SMART6 Pole Mounting Plate (01019142)



To install the pole mounting plate:

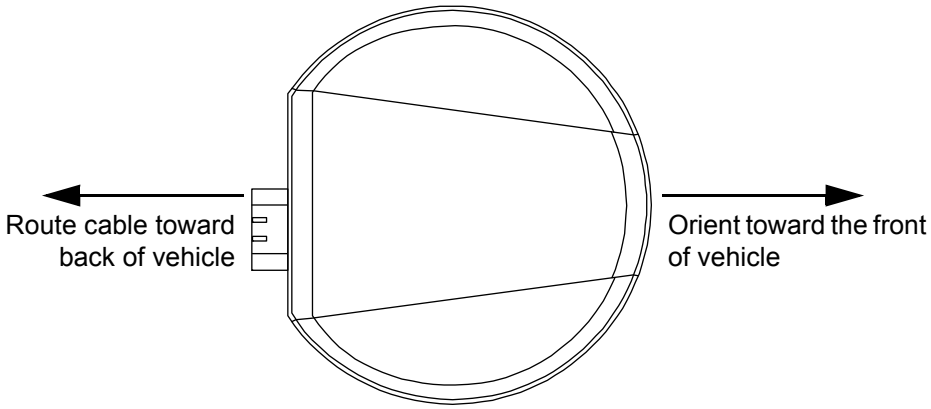
1. Use four M4 screws to connect the mounting plate to the SMART6.
2. Screw the mounting plate onto a mount, such as a range pole, tribrach, or tripod, with a 1" x 14 thread.
   A 5/8” to 1” bushing adapter is available (part number 12023275).

2.1.4 Mounting the SMART6-L

Mount on a secure, stable structure capable of safe operation in the specific environment.

- If installing on a vehicle, mount the SMART6-L on the vehicle roof, ideally close to the pivot point of the vehicle. The SMART6-L must be mounted with the connector facing the rear of the vehicle (refer to *Figure 6, SMART6-L Orientation*).

Figure 6: SMART6-L Orientation



The SMART6-L must be rigidly secured to the vehicle to avoid errors caused by vibration and motion.

- If installing in a stationary location, mount the SMART6-L in a location that has a clear view of the sky so that each satellite above the horizon can be tracked without obstruction. For more information, refer to An Introduction to GNSS.

The optimal screw penetration into the SMART6-L mounting holes is 6 mm (±1 mm) deep. When selecting screws for mounting the SMART6-L ensure the screw penetration does not exceed this specification. Using excessively long screws can damage the SMART6-L enclosure.

2.1.5 Connecting Data Communications Equipment

To communicate with the receiver for sending commands and obtaining logs, connecting to data communications equipment is required. Refer to *Table 3, SMART6-L Communication/Power Cable Pin-outs* on page 46 on for more information.

2.2 Additional Features and Information

This section contains information on the additional features of the SMART6-L, which may affect the overall design of the receiver system.

2.2.1 MKI and PPS Strobes

Mark Input (MKI) and Pulse Per Second (PPS) strobes provide status and synchronization signals. PPS is a 3.3 V CMOS output; MKI is a 5 V logic tolerant input.

Pin-out information can also be found in *Table 3, SMART6-L Communication/Power Cable Pin-outs* on page 46.

2.2.2 Status Indicators

LED indicators on the SMART6-L provide the status of the receiver. The table below shows the meaning of the LEDs.

Icon	LED Color	State	Description
✓	Green	Position Valid	Indicates a valid GNSS position solution is available
ⓘ	Yellow	Error	Receiver is in the error state and tracking is disabled Possible cause: - a fatal error - an unusual receiver status indicator, setup to act like a fatal error Note: Error status remains until the cause of the error is corrected and the receiver is reset
- +	Red	Power	Power is on

2.2.3 Emulated Radar (ER)

> Emulated Radar is available only on hardware versions 3.03 or greater.
>
> To determine the hardware version of the SMART6-L, check the product label on SMART6-L.

The SMART6-L outputs an emulated RADAR signal via the bare wires labeled ER GND and ER_OUT on the SMART6-L cable. See *Table 3, SMART6-L Communication/Power Cable Pin-outs* on page 46 for the pin-out details of this cable.

The ER outputs a logic high of supply voltage minus 0.5 V minimum and logic low of 0.5 V maximum with a rise and fall time of less than 1 ms. Its output references signal GND and provides logic low output until its speed is greater than 1 km/Hr. ER can be configured to operate at one of six distinct frequencies (10.06, 16.32, 26.11, 28.12, 34.80 or 36.11 Hz/km/Hr, with 36.11 Hz/km/Hr being the default value) and with an effective range from 1 km/Hr to 55 km/Hr for near-horizontal applications. See the RADARCONFIG command on page 55 for more information.

2.2.4 Controller Area Network (CAN)

The SMART6-L supports the following NMEA2000 Parameter Group Messages (PGN):

- PGN 129029 GNSSPositionData (1 Hz)
- PGN 129025 GNSSPositionRapidUpdate (10 Hz)
- PGN 129026 COGandSOGRapidUpdate (10 Hz)

The CAN must be activated by entering the `SETCANNAME` command (refer to *Section B.6, SETCANNAME Sets the CAN name fields* on page 59). To have the CAN set up automatically at subsequent start ups, also sends the `SAVECONFIG` command.

Table 2: Available CAN Signals on the SMART6-L

CAN	Pins
CANI+	Pin 6
CANI-	Pin 7

Details for the PGN messages can be found in the NMEA2000 specification which can be purchased directly from the National Marine Electronics Association (www.nmea.org/).

Chapter 3 Operation

Before operating the SMART6-L for the first time, ensure the installation instructions in *Chapter 2, Installation and Setup* on page 11 were followed. It is assumed that a personal computer is used during initial operation and testing for greater ease and versatility.

3.1 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 computer connected directly to the receiver serial port using a DB-9 connector on the SMART6-L communication/power cable. If using a radio, connect it to another DB-9 connector on the same communication/power cable by means of the radio serial cable supplied with the radio. It is recommended that you become thoroughly familiar with the commands and logs detailed in the OEM6 Family Firmware Reference Manual (OM-20000129) to ensure maximum utilization of the receiver's capabilities.

3.1.1 Serial Port Default Settings

The receiver communicates with the computer or terminal via an RS-232 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 `SERIALCONFIG` command. See *Section B.5, SERIALCONFIG Configure COM Port* on page 57 for details.

The data transfer rate chosen determines how fast information is transmitted. For example, outputting 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, 9600 bps is required. Also remember that even if the bps is set 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 suggested a margin is set when choosing a data rate (115200 is recommended for most applications).

Although the receiver can operate at data transfer rates as low as 300 bps, this is not desirable. For example, if several data logs are active (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, causing a warning in the receiver status and loss of data.

3.1.2 Communicating Using a Remote Terminal

One method of communicating with the receiver is through a remote terminal. The receiver is pre-wired to allow proper RS-232 interface with the data terminal. To communicate with the terminal, the receiver only requires the RX, TX and GND lines to be used. Request to Send (RTS)/Clear to Send (CTS) hardware handshaking is not available. Ensure the terminal's communications set up matches the receiver's RS-232 protocol.

3.1.3 Communicating Using a Computer

A computer 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 NovAtel's Graphical User Interface (GUI) program NovAtel Connect™. All data is sent as raw 8-bit binary or ASCII characters.

3.2 Getting Started

NovAtel Connect is a windows based GUI used to access the receiver's many features. Convert is a windows based utility that converts between file formats and strips unwanted records for data file compilation. Both are included in the NovAtel Connect PC Utilities bundle available from: www.novatel.com/support/info/documents/809.

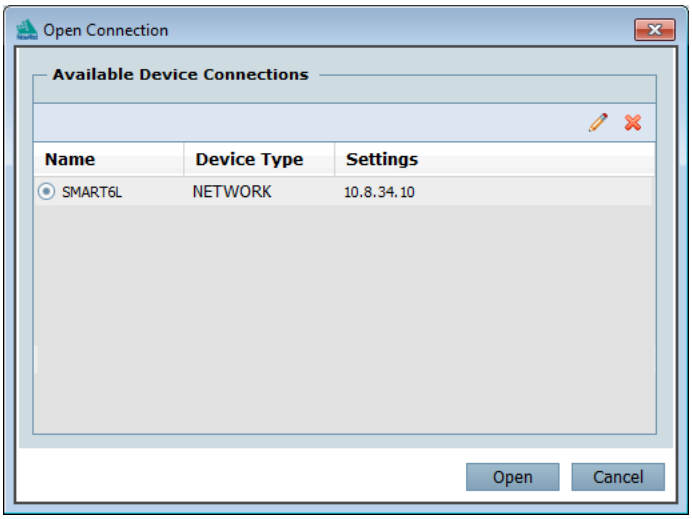
3.2.1 Starting the Receiver

When first powered, the SMART6-L undergoes a complete self-test. If an error condition is detected, the error LED lights. Details on the error can be determined by connecting to the receiver and requesting the RXSTATUS log. Refer to the OEM6 Family Firmware Reference manual (OM-20000129) for details. If a persistent error develops, contact a local NovAtel dealer first. If the problem remains unresolved, contact NovAtel directly through any of the methods listed in the *Customer Service* section on *page 9*.

3.2.2 Communicating with the Receiver Using NovAtel Connect

Launch the NovAtel Connect program and select *Device* | *Open Connect* from its main menu. The *Open Connection* window appears.

Figure 7: Open Connection Window



Refer to the NovAtel Connect help file or press F1 while the cursor is in a NovAtel Connect window. Ensure the *Console* and *ASCII Messages* windows are open 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*
or
[COM2] *if connected to COM2 port*

Any of the above prompts indicate the receiver is ready and waiting for command input.

1. You may also have to wait for output from receiver self-tests. For example, on start-up, the OEM6 family receiver, as used in SMART6-L, is set to log the RXSTATUSEVENTA log ONNEW on all ports. Refer to the OEM6 Family Firmware Reference Manual (OM-20000129) for more details.
2. If NovAtel Connect is unable to locate the OEM6 family receiver, try using a different COM port to communicate to the receiver. Once communication has been established, issue the `FRESET STANDARD` command. You should now be able to use the original communication port again.

Commands are typed at the interfacing computing device's keypad 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 entered and [Carriage Return] is a prompt to press the <Enter> key.

The example above illustrates the 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:

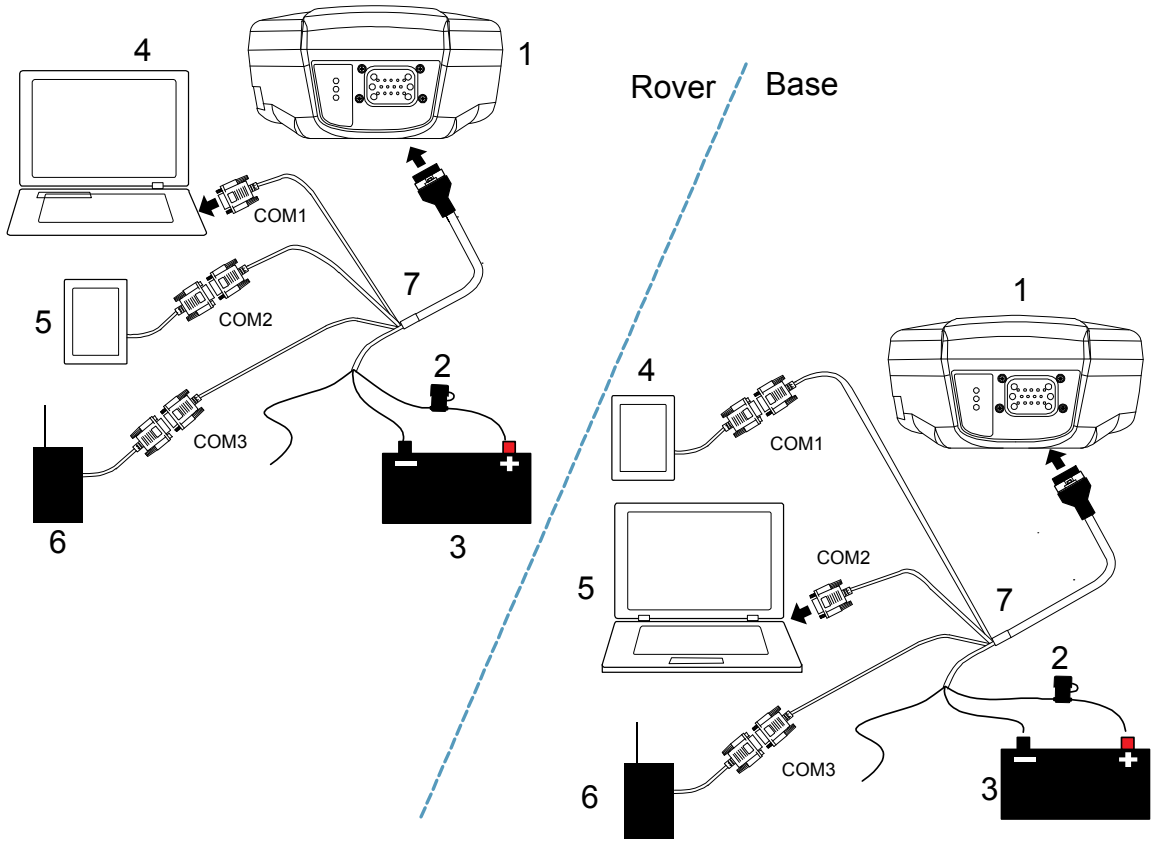
```
<Invalid Message ID
```
(or a more detailed message)

Ensure computers Control Panel's Power Settings are not set to Hibernate or Standby modes. Data is lost if one of these modes occurs during a logging session.

3.3 Transmitting and Receiving Corrections

RTK or DGPS 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. The SMART6-L can be used as a base receiver to transmit RTK or DGPS corrections or a rover to receive the same corrections. An example of a differential setup is given in *Figure 7, Open Connection Window* on page 19.

Figure 8: Basic Differential Setup



Reference	Description
1	SMART6-L receiver
2	User supplied 5 A fast blow fuse
3	User supplied power supply, for example a battery
4	User supplied device to COM1
5	User supplied device to COM2
6	User supplied device to COM3
7	User supplied cable or NovAtel 01018999 Communication/Power cable

System biases can introduce errors, refer to our *An Introduction to GNSS* found on our Web site at www.novatel.com/an-introduction-to-gnss/ for more information. In most cases, a data link between the base station and rover station (two NovAtel receivers) is required to receive corrections. SBAS 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 the base and rover are set up, configure them as shown in the configuration examples that follow in *Section 3.3.1, Base Station Configuration* on page 22 and *Section 3.3.2, Rover Station Configuration* on page 23.

3.3.1 Base Station Configuration

At the base station, enter the following commands:

```
SERIALCONFIG [port] baud
[parity[databits[stopbits[handshaking[break]]]]]
interfacemode port rx_type tx_type [responses]
fix position latitude longitude height
log port message [trigger [period]]
```

Examples of these commands include the following:

RTCA

```
serialconfig com2 9600 N 8 1 N on
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              (optional for RTK)
log com2 rtcaephem ontime 10 1       (optional)
```

RTCM

```
serialconfig com2 9600 N 8 1 N on
interfacemode com2 none rtcm off
fix position 51.11358042 -114.04358013 1059.4105
log com2 rtcm3 ontime 10       (required for RTK)
log com2 rtcm22 ontime 10 1    (optional)
log com2 rtcm1819 ontime 1
log com2 rtcm1 ontime 5
```

RTCMV3

```
serialconfig com2 9600 N 8 1 N on
interfacemode com2 none rtcmv3 off
fix position 51.11358042 -114.04358013 1059.4105
log com2 rtcm1006 ontime 10
log com2 rtcm1003 ontime 1
```

CMR+

```
serialconfig com2 9600 N 8 1 N on
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

```
serialconfig com2 9600 N 8 1 N on
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
```

3.3.2 Rover Station Configuration

At the rover station, enter:

```
SERIALCONFIG [port] baud
[parity[databits[stopbits[handhaking[break]]]]]

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+)*

3.3.3 GPS+GLONASS Base and Rover Configuration

This section shows how to set up a base and rover OEM6 GPS + GLONASS enabled receivers for GPS + GLONASS RTK operation:

Base Station:

```
fix position lat lon hgt                    (enter your own lat, lon, and hgt values)
serialconfig com2 9600 N 8 1 N on
interfacemode com2 none rtca off
log com2 rtcaref ontime 10
log com2 rtcaobs2 ontime 1
log com2 rtca1 ontime 5                     (optional, enable code-DGPS coverage)
saveconfig                                  (optional, save configuration to non-volatile memory)
```

Rover Station:

```
serialconfig com2 9600 N 8 1 N on
interfacemode com2 rtca none off
log com1 bestposa ontime 1                  (optional, view position information)
saveconfig                                  (optional, save configuration to non-volatile memory)
```

3.3.4 Configuration Notes

For compatibility with other GNSS receivers and to minimize message size, it is recommended using 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.

To mix NovAtel format messages and RTCA, RTCM, RTCMV3 or CMR messages on the same port, 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 3.3.1, Base Station Configuration* on page 22.

At the rover station, 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. These are useful commands when the rover station is receiving corrections from multiple base stations. Refer to *An Introduction to GNSS* for more information on SBAS, available from www.novatel.com/an-introduction-to-gnss/.

All PSRDIFFSOURCE entries fall back to SBAS (even NONE) for backwards compatibility (assuming SBAS was enabled).

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 to modify the format of the corrections for a non-standard application or 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 OEM6 Family Firmware Reference Manual detailed descriptions of the various message formats.

Information on how to send multiple commands and log requests using DOS or Windows can be found on our Web site at www.novatel.com/support.

3.4 GLIDE™

SMART6-L contains NovAtel's GLIDE which is a positioning algorithm for single-frequency GPS and GPS/GLONASS applications. GLIDE produces a smooth position output tuned, for applications where time relative accuracy (pass-to-pass) is more important than absolute accuracy. Because of this, it is well suited for agricultural applications.

Multipath signals tend to induce time varying biases and increase the measurement noise on the L1/L2 pseudorange measurements. Carrier phase measurements are much less susceptible to the effects of multipath. The GLIDE algorithm fuses the information from the L1 code and the L1 phase measurements into a Position Time Velocity (PVT) solution.

GLIDE includes settings for a dynamic mode, a static mode and an "auto" mode, where the filtering parameters are automatically adjusted as vehicle velocity varies between stationary and dynamic states.

3.4.1 Dual-Frequency GLIDE

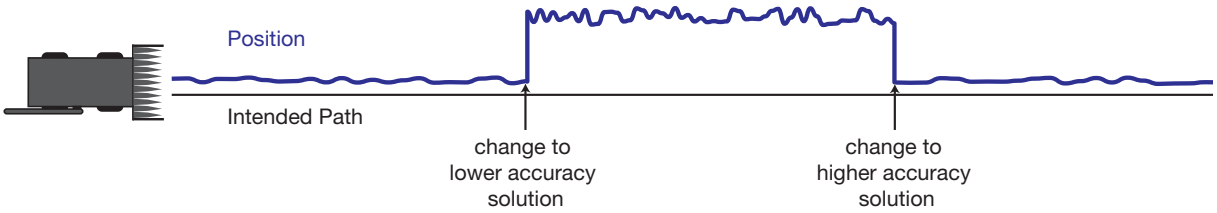
NovAtel's dual-frequency GLIDE technology adds to the superior pass-to-pass performance provided by single-frequency GLIDE. Dual-frequency GLIDE is ideal agricultural and machine guidance applications where relative positioning is critical. Using GLIDE significantly reduces the variation in position errors to less than 1 cm from one epoch to the next. Dual-frequency GLIDE improves the absolute accuracy of the GLIDE position and creates a robust solution resistant to the effects of high ionospheric activity. GLIDE works in all code positioning modes, including single point, DGNSS, SBAS and L-Band.

Refer to the NovAtel white paper on GLIDE Technology for more information on GLIDE and APN-038 Pseudorange/Delta-Phase (PDP) and GLIDE Filters along with other information available from www.novatel.com/support/search/.

3.5 Steadyline

The Steadyline functionality helps mitigate the discontinuities that often occur when a GNSS receiver changes positioning modes. The effect is especially evident when a receiver transitions from an RTK position mode solution to a lower accuracy "fall back" solution, such as NovAtel CORRECT PPP, DGPS, WAAS+GLIDE or even autonomous GLIDE (see *Figure 9, Positioning Change Without Steadyline*). Smooth transitions are particularly important for agricultural steering applications where sudden jumps are problematic.

Figure 9: Positioning Change Without Steadyline



The Steadyline feature internally monitors the position offsets between all the positioning modes present in the receiver. When the current positioning mode becomes unavailable, the receiver transitions to the next most accurate positioning mode.

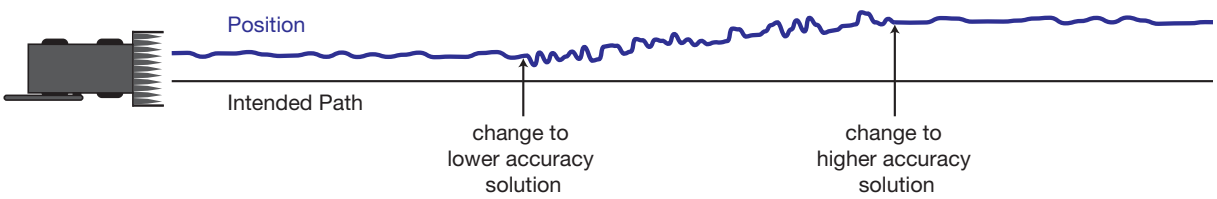
The setting in the `STEADYLINE` command determines how the receiver transitions to the next positioning mode. The following sections describe the Steadyline modes.

> For more information about the `STEADYLINE` command, refer to the OEM6 Family Firmware Reference Manual (OM-20000129).

3.5.1 Maintain

When the receiver transitions to a different positioning mode, it maintains the position offset calculated to limit a potential real position jump. The receiver continues to apply the position offset to all positions calculated in the new positioning mode.

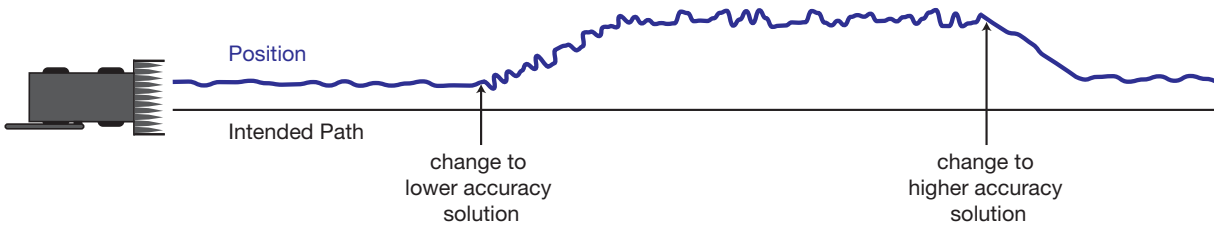
Figure 10: Steadyline Maintain



3.5.2 Transition

When the receiver transitions to a different positioning mode, the position offset is applied to the calculated position to limit a potential real position jump. The position then slowly transitions to the new reference position type over a specified period of time. This time period is specified by the Transition time parameter in the `STEADYLINE` command.

Figure 11: Steadyline Transition



3.5.3 Prefer Accuracy

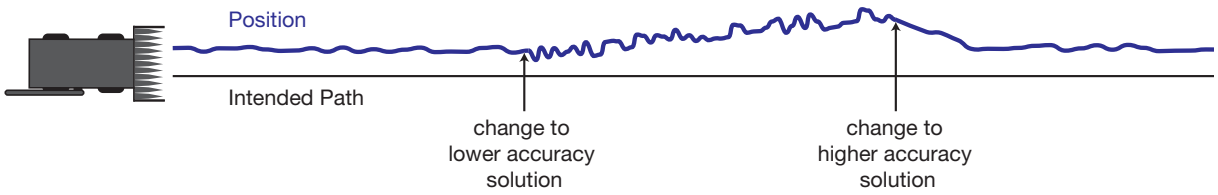
The positioning mode change depends on the accuracy level of the positioning modes.

When the position mode is changing from a more accurate mode to a less accurate mode (e.g., changing from RTK to GLIDE), the receiver uses the Maintain option.

When the position mode is changing from a less accurate mode to a more accurate mode (e.g., GLIDE to RTK), the receiver uses the Transition option.

For example, a receiver is configured to do both RTK and GLIDE. If this receiver has a fixed RTK position and experiences a loss of correction data causing the loss of the RTK solution it will immediately apply the offset between the two position modes and uses the GLIDE position stability to maintain the previous trajectory. Over time the GLIDE (or non-RTK) position will experience some drift. Once the RTK position is achieved again the receiver will start using the RTK positions for position stability and will slowly transition back to the RTK positions at a default rate of 0.005 m/s or the time specified in the `STEADYLINE` command.

Figure 12: Steadyline Prefer Accuracy



3.5.4 UAL

> UAL mode will not function unless UALCONTROL is enabled using the UALCONTROL command.

The Steadyline mode used depends on the BESTPOS and GPGGA solution types.

When the solution type is OPERATIONAL, the receiver uses the Maintain option.

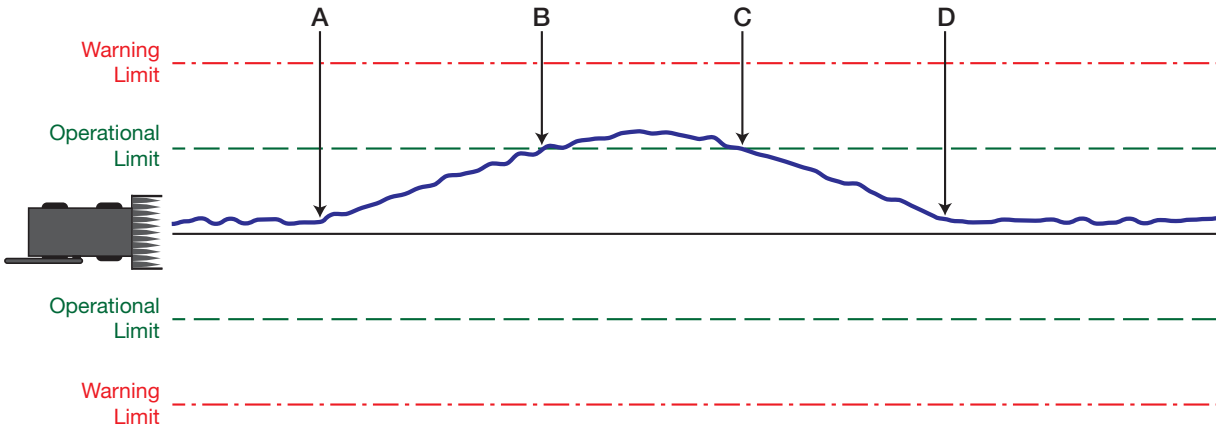
When the solution type is WARNING, the receiver uses the Transition option. When the receiver changes from WARNING to OPERATIONAL, it will continue to use the Transition option until any existing offset is gone.

When the solution type is OUT_OF_BOUNDS, the Steadyline feature is disabled.

The thresholds used to determine the solution type (OPERATIONAL, WARNING or OUT_OF_BOUNDS), can be specified using the UALCONTROL command. Refer to the OEM6 Family Firmware Reference Manual (OM-20000129) for more information.

Figure 13, Steadyline UAL- Warning Limit Example on page 27 and *Figure 14, Steadyline UAL - Out of Bounds Example* on page 28 show an examples of Steadyline using the UAL mode.

Figure 13: Steadyline UAL- Warning Limit Example



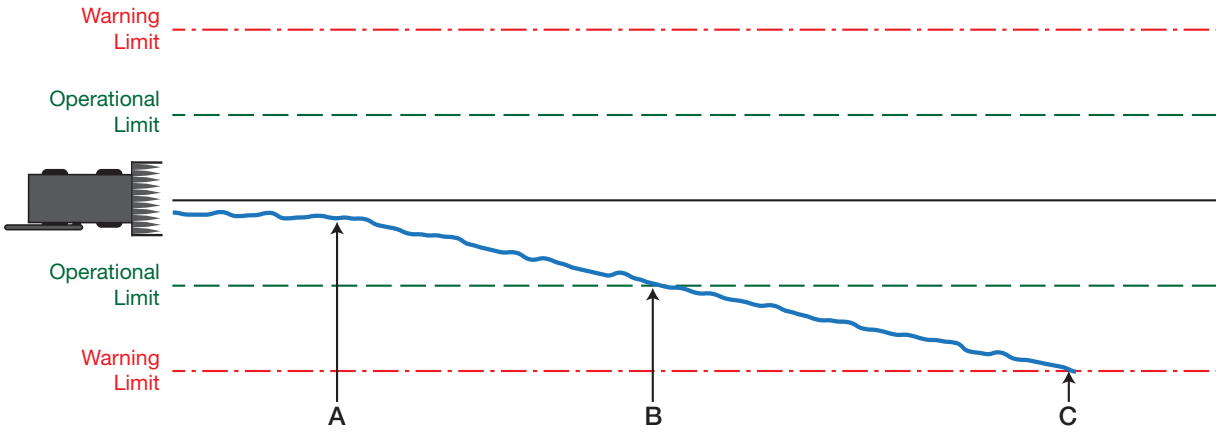
A Position type is OPERATIONAL.
Higher accuracy corrections are lost. The receiver changes to a lower accuracy solution. Steadyline operates in Maintain mode while the solution accuracy remains within the Operational limit.

B The solution accuracy exceeds the operational limit. The position type changes to WARNING. The Steadyline mode changes from Maintain to Transition.

C The solution accuracy moves back within the operational limit. The position type changes to OPERATIONAL.
The Steadyline mode remains in Transition mode.

D The solution offset is removed.
The Steadyline mode changes from Transition to Maintain.

Figure 14: Steadyline UAL - Out of Bounds Example



A The position type is OPERATIONAL.
Higher accuracy corrections are lost. The receiver changes to a lower accuracy solution.
Steadyline operates in Maintain mode while solution accuracy remains within the Operational limit.

B The solution accuracy exceeds the operational limit. The position type changes to WARNING.
The Steadyline mode changes from Maintain to Transition.

C The solution accuracy exceeds the warning limit. The position type changes to OUT_OF_BOUNDS.
Steadyline is disabled.

3.6 Enabling SBAS Positioning

The SMART6-L is capable of SBAS positioning. This positioning mode is enabled using the `SBASCONTROL` command:

```
sbascontrol enable auto
```

When the command is entered, the SMART6-L automatically tracks the SBAS that is operating in the region (e.g., WAAS or EGNOS) and applies the corrections from the service. On a simulator, leave the test mode parameter off or specify NONE explicitly. For more on SBAS, refer to application note APN-051 Positioning Modes of Operation (additional Application Notes available at www.novatel.com/support/).

3.7 Enabling L-Band

L-Band equipped receivers can achieve sub-metre position accuracy using correction data received from geostationary satellites. To use the L-Band corrections, an L-Band-capable receiver model and antenna are required (the SMART6-L is both an L-Band capable receiver and L-Band-capable antenna).

For more information on L-Band positioning, refer to:

- NovAtel Application Notes: APN-061 NovAtel CORRECT with PPP using TerraStar Corrections, APN-062 NovAtel CORRECT with Veripos (service dependent) or APN-051 Positioning Modes of Operation available from www.novatel.com/support/search/items/Application%20Note
- the OEM6 Family Firmware Reference Manual (OM-20000129) for log/command details
  and/or
- visit www.novatel.com/support
- visit www.novatel.com/solutions/novatel-correct-positioning/

TerraStar Subscriptions

A subscription is required to use the TerraStar service for land, airborne and near shore applications. Near shore applications are defined as vessels operating within 10 km of shore. To obtain a subscription, contact your local NovAtel sales representative or visit www.novatel.com/products/novatel-correct-ppp/. The receiver's TerraStar Product Activation Code (PAC) or the NovAtel product serial number (PSN) is needed to obtain a subscription. To obtain the receiver-specific PAC, enter the following command:

```
log terrastarinfo
```

This log displays the PAC in the first field following the log header and also displays the status of your subscription.

To activate a subscription, the receiver must be powered and tracking an L-Band TerraStar satellite prior to the planned activation time. Use the ASSIGNLBANDBEAM command to configure the receiver to track the TerraStar satellite.

To confirm tracking of an L-Band signal, log the L-Band tracking status information by entering the following command:

```
log lbandtrackstata
```

If receiving TerraStar service, the sixth field following the header (tracking status word) of the LBANDTRACKSTAT log will be 00c2, as shown in the following example:

```
#lbandtrackstata,com1,0,73.5,finesteering, 1769,328196.000,00000000,
29fd,12602;1,"98w",1539902500,1200,974c,00c2,0,-316.186,43.842,4.3840,
61.920,1088,2,2,138176,79,0.0001*3e43cb7d
```

The latest services and coverage can be obtained from www.terrastar.net. For additional information on TerraStar activation, contact NovAtel Customer Service at www.novatel.com/support or download the APN-061 NovAtel CORRECT with PPP using TerraStar Corrections from: www.novatel.com/support/search/items/Application%20Note.

Veripos Subscriptions

Subscriptions to the Veripos Apex and Apex^2 marine services must be obtained directly from Veripos. A unit with a marine subscription can not be switched to a land subscription and vice versa.

A subscription is required to use the Veripos services for offshore marine applications. Contact Veripos sales at www.veripos.com/support.html to obtain a Service Access License (SAL) number. To activate the service, contact the Veripos Help Desk at +44 (0) 1224 527 104 or visit www.veripos.com/support.html. Provide the SAL number and the receiver's Veripos Serial Number (VSN).To obtain the receiver-specific VSN, enter the following command:

```
log veriposinfo
```

The log displays the VSN in the first field following the log header and also displays the status of your subscription.

To activate a subscription, the receiver must be powered and tracking an L-Band Veripos satellite prior to the planned activation time. Use the ASSIGNLBANDBEAM command to configure the receiver to track the Veripos satellite.

The latest services and coverage can be obtained from www.veripos.com. For additional information on Veripos activation, contact NovAtel Customer Service at www.novatel.com/support or download the APN-062 NovAtel CORRECT with Veripos from: www.novatel.com/support/search/items/Application%20Note.

OmniSTAR®

OmniSTAR service is not supported for OEM6 products sold after October 24, 2013. If unsure whether the receiver is OmniSTAR capable, contact NovAtel Sales at www.novatel.com/where-to-buy/sales-offices, NovAtel Customer Support at www.novatel.com/support or visit www.novatel.com/solutions/novatel-correct-positioning/.

A subscription is required to use the OmniSTAR service. To obtain a subscription, contact OmniSTAR at 1-888-883-8476 or 713-785-5850. Provide the receiver's OmniSTAR serial number (which is different from the NovAtel serial number). To obtain the OmniSTAR serial number, enter the following command:

```
log lbandinfo
```

The log displays the L-Band serial number in the fifth field following the log header. The log also provides the status of your subscription. Refer to the LBANDINFO log in the OEM6 Family Firmware Reference Manual (OM-20000129) for more information.

To activate the 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 latest frequencies can be obtained from: www.omnistar.com.

Example:

```
assignlband omnistar 1557855 1200
```

To confirm tracking of an L-Band signal, log the L-Band status information by entering the following command:

```
log lbandstat
```

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

```
lbandstat com1 0 81.0 finesteering 1596 235136.000 00000000 d1c2 5968
<1557854678 48.98 1098.9 0.00 00c2 0000 153860 545 0 0000 0201 154019
68000000 00000000
```

Refer to the NovAtel application note APN-051 Positioning Modes of Operation for OmniSTAR specifics.

3.8 Emulated Radar (ER).

> Emulated Radar is available only on hardware versions 3.03 or greater.
>
> To determine the hardware version of the SMART6-L, check the product label on SMART6-L.

A typical radar sensor emits radio beams that bounce off the ground and computes ground speed based on the speed at which objects are passing in front of the sensor. The output of the sensor is a digital pulse, the frequency of which is proportional to the vehicle's ground speed. This is often used in agricultural applications such as planting and spraying. The SMART6-L eliminates the need for separate ground-sensing radar equipment by converting the GPS-derived velocity to proportional frequency output. The following emulated radar signal parameters can be configured by the customer:

- Frequency Step: Specifies how the frequency output relates to the vehicle speed.
- Signal Update Rate: Specifies how often the frequency output is updated to match the vehicle speed.
- Response Mode: Specifies how quickly changes in velocity are reflected in the frequency output. Setting a slower response mode reduces spikes (noise) in the velocity but increases latency. Setting a higher response mode reduces latency, but may result in noisier frequency output. Refer to RADARCONFIG on page 55 for more detailed information.

After it is configured using the RADARCONFIG command, Emulated Radar (ER) pulses are output through the SMART6-L cables (see *Table 3, SMART6-L Communication/Power Cable Pin-outs* on page 46) and the RADARSTATUS log (see page 62).

3.9 Recommended Configuration

The following command is recommended to enable CAN:

```
setcanname 305
```

The following command is recommended to enable SBAS (WAAS/GNOS/MSAS) corrections:

```
sbascontrol enable
```

The following commands are recommended to enable GLIDE:

```
pdpfilter enable
pdpmode relative auto
```

NovAtel has registered manufactured ID code 305 with J1939. When complete, configuration can be saved with the SAVECONFIG command. For more information about these commands, refer to the OEM6 Family Firmware Reference Manual, available at www.novatel.com/support/manuals/.

Chapter 4 NovAtel Firmware and Software

Download the most recent versions of the NovAtel firmware and receiver software from the Downloads section of www.novatel.com/support/search/.

OEM6 Firmware and Software

Refer to *Section 4.3.1, Transferring Firmware Files* on page 34 for descriptions of the Update and OEM versions.

NovAtel Connect PC Utilities Software Bundle

Bundled PC Utilities software includes:

- NovAtel Connect (a GUI interface)
- Connection Import (imports connection profiles)
- Convert (converts receiver data logs into different formats)
- USB Drivers and Window Signing

The NovAtel Connect PC Utilities bundle can be download from the Downloads section of www.novatel.com/support/search/.

Firmware and Software included

- Firmware *.shex file
- WinLoad software utility

WinLoad and SoftLoad instructions follow.

4.1 Firmware Updates and Model Upgrades

A local NovAtel dealer can provide all the information needed to upgrade or update a receiver. Refer to www.novatel.com/where-to-buy for contact information or contact sales@novatel.com or support@novatel.com directly.

4.1.1 Firmware Updates

Firmware updates are firmware releases that include fixes and enhancements to the receiver functionality. Firmware updates are released on the NovAtel web site as they become available. Firmware upgrades can be performed using the WinLoad utility, SoftLoad commands or with a custom loader application. Contact NovAtel Customer Support (support@novatel.com) for details on custom loader requirements.

4.1.2 Model Upgrades

Model upgrades enable purchased receiver features.

Contact a local NovAtel dealer to assist in selecting the upgrade options that best suit your GNSS needs at www.novatel.com/where-to-buy. Contact NovAtel Customer Support www.novatel.com/support or NovAtel Sales to request a temporary upgrade authorization code for trial purposes.

Model upgrades can be applied to the receiver with an authorization code and the AUTH command without returning the receiver to the dealer.

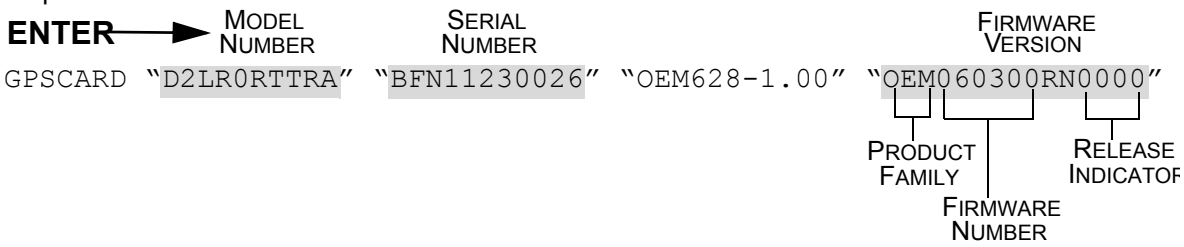
4.2 Authorization Code

An authorization code, commonly known as an auth-code, is required to upgrade a SMART6-L receiver. Auth-codes are obtained by contacting NovAtel Customer Support. Upon contact, NovAtel Customer Support requires:

- the receiver model number
- the receiver serial number
- the receiver firmware version

Enter the LOG VERSION command to determine the receiver model, serial number and firmware version.

Example:



After determining the appropriate model and firmware version the authorization code (auth-code) is issued. The auth-code is required to unlock the features on the new model type.

To upgrade to a new model with the same firmware version, use the AUTH command with the issued auth-code, as outlined in *Section 4.5, Upgrading Using the AUTH Command* on page 41.

To upgrade to a new model with a new firmware version, the new firmware needs to be loaded into the SMART6-L receiver. Refer to *Section 4.3, Updating or Upgrading Using the WinLoad Utility* on page 34 for use instructions or *Section 4.4, Updating Using SoftLoad Commands* on page 36.

There are two types of auth-codes:

- Standard auth-codes, which are tied to a model, serial number and firmware version
- Signature auth-codes, which are tied only to a model and serial number

When upgrading to a new version of firmware, the Standard auth-code for the old version of firmware will not work with the new version of firmware. Therefore, a new auth-code is required for each receiver that is upgraded.

However, Signature auth-codes work with any signed firmware image. Therefore, if a receiver has a Signature auth-code for the old version of firmware, that same auth-code will work for the new version of firmware, provided both images are digitally signed by NovAtel.

Signature auth-codes require firmware version OEM060200RN0000 (6.200) or later and boot code version OEM060100RB0000 (6.100) or later.

Signed firmware images are distributed in *.shex files, while unsigned firmware images are distributed in *.hex files.

Temporary auth-codes may be provided by NovAtel for evaluation purposes. Once the trial period has expired, a new auth-code will need to be obtained from NovAtel Customer Support (support@novatel.com).

The new download package includes a signed firmware file type that uses an extension designated as ".shex" (example OEM060200RN0000.shex), as well as the latest WinLoad utility and What's New file containing firmware update change details.

Prior to firmware version OEM060200RN0000, authorization codes depended on the software model, the firmware version and the serial number of the receiver. The authorization code changed if any of the three items changed. This is no longer the case, they are now no longer dependent on firmware version.

4.3 Updating or Upgrading Using the WinLoad Utility

WinLoad is the simplest and most common way to update or upgrade a SMART6-L receiver.

4.3.1 Transferring Firmware Files

To proceed with an update or possibly an upgrade, obtain the latest version of firmware by downloading the (OEM Version) for your product from www.novatel.com/support/firmware-downloads/.

Format of Firmware Files

All of the firmware available on the downloads website are packaged in .zip files with the following names:

- OEMXXXRN0000.zip for firmware to be installed on OEM615, OEM617, OEM617D, FlexPak6, OEM628 or SMART6-L receivers
- OMPXXXRN0000.zip for firmware to be installed on OEM638 receiver

NovAtel Customer Service may generate and provide the required authorization code. Authorization codes are obtained by contacting support@novatel.com or at www.novatel.com/Support/.

For convenience, unzip the update file to a GNSS sub-directory (for example, C:\GNSS\LOADER). If the firmware update file is password protected, NovAtel Customer Support provides the required password.

The zip archive includes the following files:

winload.exe	WinLoad utility program
howto.txt	Instructions on how to use the WinLoad utility
whatsnew.rtf	Information on the changes made in the firmware since the last revision
x..x.shex	Firmware version upgrade file, where x..x defines the product name and release (e.g., OEM060400RN0000.shex)
NovAtel Software License Agreement.rtf	License agreement for the firmware.

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

NovAtel has an online video tutorial that explains firmware uploading at: www.novatel.com/support/videos.

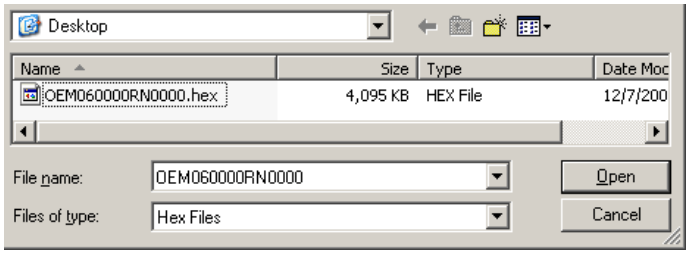
4.3.2 Using the WinLoad Utility

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

Open a File to Download

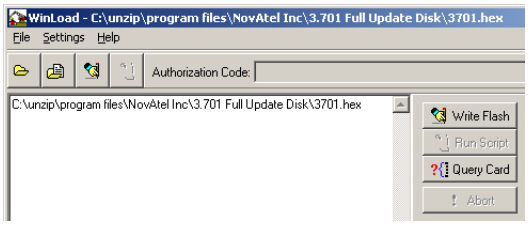
Select File |Open. Navigate to the file to open (*Figure 15)*.

Figure 15: WinLoad Open Window



When a file is selected, the `filename` appears in the main WinLoad display area and in the title bar (*Figure 16).*

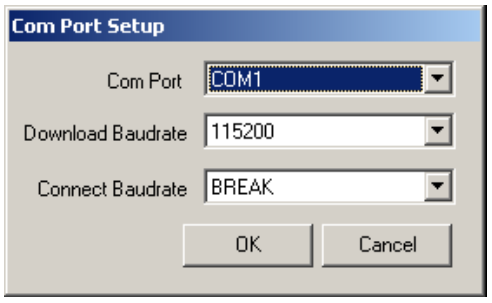
Figure 16: Open File in WinLoad



Communications Settings

To set the communications port and baud rate, select Settings | COM Settings. Choose the computer port to use from the Com Port drop down list and the baud rate from the Download Baudrate drop down list. Set the baud rate as high as possible (the default of 115200 is preferred if a higher baud rate is not available).

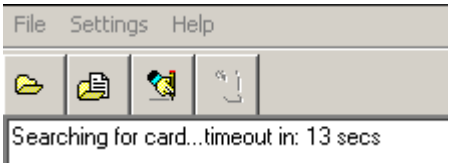
Figure 17: COM Port Setup



Downloading Firmware

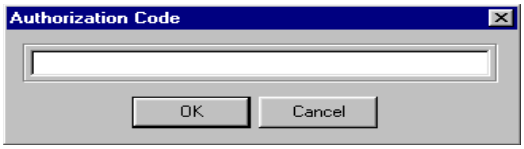
1. Select the file to download according to *Open a File to Download* on page 35.
2. Ensure the file path and name are displayed in main display area (see *Figure 16, Open File in WinLoad* on page 35).
3. Click Write Flash to download the firmware.
4. When `Searching for card` appears in the main display, power cycle the receiver.

Figure 18: Searching for Card



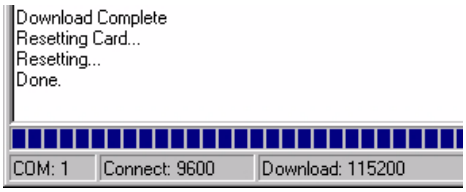
5. If the Authorization Code window appears, enter the auth-code and click **OK**. See *Section 4.2, Authorization Code* on page 33 for further information about the Authorization Code.

Figure 19: Authorization Code Window



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

Figure 20: Upgrade Process Complete



7. Close WinLoad.

4.4 Updating Using SoftLoad Commands

Firmware can be updated on a running receiver using a process called SoftLoad. Any available communication ports on the receiver can be used. The SoftLoad process is made up of a set of commands and logs that are used to send new firmware data to a receiver and check the progress of the update. Use SoftLoad if automated loading is desired.

The receiver stops tracking GNSS satellites during the SoftLoad process. Do not attempt to SoftLoad when GNSS satellite tracking on the unit is required. If the unit is connected to the NovAtel Connect utility, only the Console and ASCII Message windows may remain open in the Connect Utility.

4.4.1 SoftLoad Commands and Logs

Refer to the OEM6 Family Firmware Reference Manual (OM-20000129) for further log and command information.

Command	Description
SOFTLOADRESET	Initiate a new SoftLoad process
SOFTLOADSREC	Send an S-Record to the receiver for the SoftLoad process
SOFTLOADDATA	Send firmware image data to the receiver for the SoftLoad process
SOFTLOADCOMMIT	Complete the SoftLoad process
SOFTLOADSETUP	Send configuration information to the receiver for the SoftLoad process. This command is not required when working with a *.hex or *.shex file
Log	**Description**
SOFTLOADSTATUS	Provides status updates for the ongoing SoftLoad process

Each command and log can be used in abbreviated ASCII, ASCII or binary format, with the exception of SOFTLOADDATA, which should only be used in binary format.

File Types

Firmware data is stored in *.hex and *.shex files as ASCII data in the form of S-Records, based on the Motorola S-Record format. The *.shex file is the same as the *.hex file but includes a digital signature for the firmware.

4.4.2 Working With S-Records

Each S-Record has a header indicating the type of information contained in the record.

Records beginning with S0, S5 and S7 contain metadata about the firmware image, such as version information and which card types are supported by the firmware image.

Example S0 Record

```
S0~V~OEM060400RN0000
```

Example S5 Records

```
S50000
S503D9FE25
S5033158D5A
```

Example S7 Records

```
S70000
S70500000000FA
```

Records beginning with S3 contain the actual firmware image data. Aside from the header, each pair of characters forms the ASCII representation of binary byte. The format is as follows:

S3	LL	AAAAAAAA	DDDDDDDD...DDDDDDDD	CC
				Check Sum.
			Little Endian Data. These bytes are copied into the "data" field of the SOFTLOADDATA command	
		4 - Byte Address. Set this as the value of "offset" in the SOFTLOADDATA command		
	Length.This is the hexadecimal number of character pairs to follow in the record. This value minus 4 bytes for the address and 1 byte for the check sum is copied into the "data length" field of the SOFTLOADDATA command			
Header				

4.4.3 Sending Firmware Data

C++ source code is available to provide example code of processing S-Records and converting them to NovAtel format commands, as well as providing help with the SoftLoad process. Contact NovAtel Customer Support and ask about the srec2softload utility.

The SOFTLOADSREC and SOFTLOADDATA commands can be used to send firmware data from *.hex or *.shex files to the receiver.

S0, S5 and S7 S-Records should be sent directly to the receiver using the SOFTLOADSREC command, by enclosing the S-Record in quotation marks and issuing the command to the receiver, as follows:

```
SOFTLOADSREC "<S-RECORD>"
```

S3 records can be sent individually to the receiver using the SOFTLOADSREC command. Alternatively, the data from an S3 record can be parsed and packaged together with data from other S3 records into a binary SOFTLOADDATA command. Packaging data parsed from multiple S3 records into a binary SOFTLOADDATA command can result in improved firmware update times as each S3 record contains only a small number of bytes of firmware data. A single SOFTLOADDATA command can package up to 4096 bytes of firmware data from multiple S3 records, whereas a single SOFTLOADSREC command contains a maximum of 28 bytes of firmware data from a single S3 record.

Multiple S3 records can be packaged into a single SOFTLOADDATA command as long as the data from one S3 record follows immediately after the previous record.That is, the address from the current S3 record must equal the address from the previous S3 record plus the data length of the previous S3 record. If the data is not consecutive then the SOFTLOADDATA command can be sent with the amount of data it has packaged up to that point. Subsequent data can be packaged in a new SOFTLOADDATA command. Within the SOFTLOADDATA command, the "offset" field remains the address of the first S3 record and the "data" and "data length" are updated to include the new data. Refer to the OEM6 Family Firmware Reference Manual (OM-20000129) for more information regarding the SOFTLOADDATA command.

The *.hex and *.shex file data may contain many gaps and jumps. For example, in many NovAtel *.hex and *.shex files, data for address 0x000_00000 is stored near the very end of the file.

Example Packaging Multiple S3 Records In A SOFTLOADDATA Command

Start a new SOFTLOADDATA command

```
S32100407AD48FCA63034B80F5CE0C36507DE3D8DCC0C6C0C00515D74BCACF2F2949E1
```

Address: 0x00407AD4 Num Data Bytes: 0x21 – 0x01 – 0x04 = 0x1C

```
S32100407AF04CCA4985F0F7B081E41D9B7D806C26989AE2D4E4CCBCB47C10FBFD3E43
```

Previous Address + Previous Num Bytes = 0x00407AD4 + 0x1C = 0x00407AF0

Address: 0x00407AF0 Num Data Bytes: 0x1C

Add data to existing SOFTLOADDATA command

```
S30D00407B0CDE0400A6374D5BFFC5
```

Previous Address + Previous Num Bytes = 0x00407AF0 + 0x1C = 0x00407B0C

Address: 0x00407B0C Num Data Bytes: 0x0D – 0x01 – 0x04 = 0x08

Add data to existing SOFTLOADDATA command

```
S3210000000007F0A7F1F4060000147B4000F49217813C7BB00014493F005C00000009
```

Previous Address + Previous Num Bytes = 0x00407B0C + 0x08 = 0x00407B14

Address: 0x00000000 Num Data Bytes: 0x1C

Requires new SOFTLOADDATA command because address does not match previous address + previous number of data bytes

Send existing SOFTLOADDATA command, and start a new SOFTLOADDATA command

S3210000001C80040000E00100003000000082B0100D8060000E4060000C806000063

Address: 0x0000001C Num Data Bytes: 0x1C

Previous Address + Previous Num Bytes = 0x00000000 + 0x1C = 0x0000001C

Add data to existing SOFTLOADDATA command

The SOFTLOADDATA command must be sent as a NovAtel binary format command.

4.4.4 SoftLoad Update Method

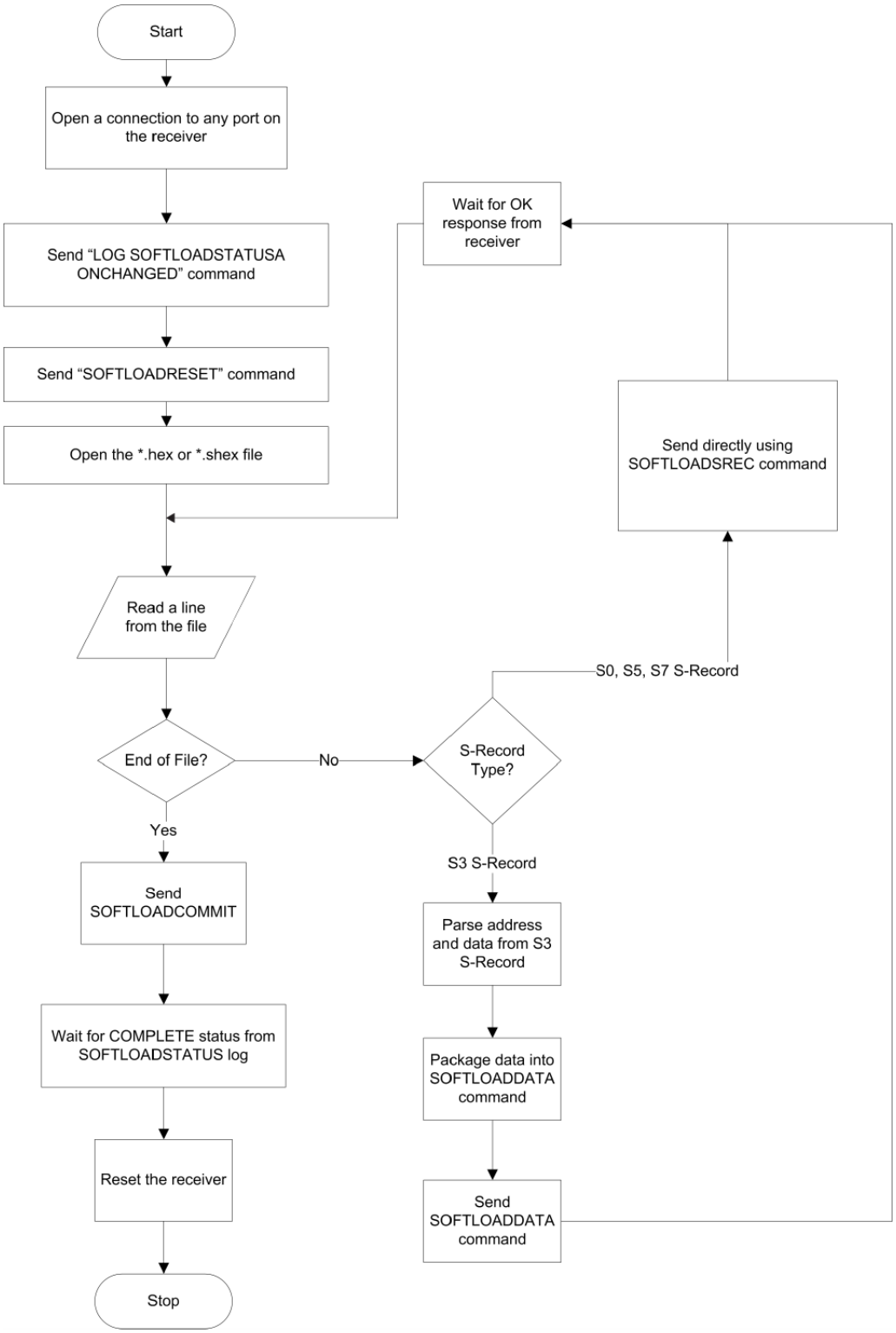
This section describes the sequence of commands that are issued to the receiver when updating using a *.hex or *.shex file.

The response for each command must be processed before sending the next command so as to determine if the command was accepted or rejected, and to wait for the receiver to complete the operation. Responses to SoftLoad commands are guaranteed to be output from the receiver within a specific time, which varies by command. Refer to the OEM6 Family Firmware Reference Manual (OM-20000129) for more information on responses, and the timeout values for SoftLoad commands.

1. Open a connection to any port on the receiver with the input and output INTERFACEMODE set to NOVATEL.
2. Request the SOFTLOADSTATUS log using the following command:
   LOG SOFTLOADSTATUSA ONCHANGED
3. Initialize SoftLoad with a SOFTLOADRESET command. This command stops all tracking on the receiver to ensure sufficient memory is available for the loading process. An RXSTATUSEVENTA log reports a SoftLoad In Progress status.
4. Open the *.hex or *.shex firmware file.
5. Read each line of the *.hex or *.shex firmware file.
   A. Send S0, S5 and S7 S-Records directly to the receiver using the SOFTLOADSREC command. The S-Record must be enclosed in quotation marks:
      SOFTLOADSREC "<S-RECORD>"
      Data within S0 records can also be sent to the receiver by converting them to SOFTLOADSETUP commands. Refer to the OEM6 Family Firmware Reference Manual (OM-20000129) for details on how to convert from S0 S-Records to SOFTLOADSETUP commands.
   B. S3 S-Records should be parsed and packaged into a SOFTLOADDATA command.
6. Send the SOFTLOADCOMMIT command after all data from the *.hex or *.shex file has been transferred to the receiver. The SOFTLOADSTATUS log reports the status of the loading process. Wait for a SOFTLOADSTATUS log to indicate the status is COMPLETE. The COMPLETE status or an error is guaranteed to be output from the receiver within 300 seconds from the time the SOFTLOADCOMMIT command was received by the receiver.
7. Send the auth code for the newly downloaded image using the AUTH command. This is only required if there is not already a signature auth code on the receiver as signature auth codes are maintained through a SoftLoad update. See *Section 4.2, Authorization Code* on page 33 for details on Auth Codes.
   AUTH ADD_DOWNLOAD <AUTH CODE>
8. Reset the receiver using any of the following methods:
   A. Enter the RESET command
   B. Enter the FRESET command
   C. Power-cycle the receiver

Once the receiver resets, the new version of firmware is active.

The SoftLoad process can be safely canceled at any time using the SOFTLOADRESET command or by otherwise resetting the receiver. Once the COMPLETE status is reported by SOFTLOADSTATUS, the new firmware image will be run after the receiver is reset.



4.4.5 SoftLoad Errors

It is possible for errors to occur during the SoftLoad update. All command responses should be checked to verify all issued commands were accepted. The SoftLoad status should also be monitored in the SOFTLOADSTATUS log. Any status enum value greater than the ERROR status indicates an error has occurred during the SoftLoad update. In the event of an error, the SoftLoad update should be restarted by issuing a SOFTLOADRESET command or normal operation can be restored by resetting the receiver.

In rare cases after a SoftLoad error, the boot code may not be able to determine which is the latest firmware to be executed. To protect against this, SoftLoad does not erase the previous valid firmware image from flash on the receiver. In such cases, the boot code will execute the old image and raise the "Safe Mode" error (see RXSTATUS log). If that error is detected, simply restart the SoftLoad process to reload the new firmware image and the error will be resolved.

4.5 Upgrading Using the AUTH Command

The AUTH command is used to upgrade to a new SMART6-L model with an authorization code that enables (unlocks) model features. This command only functions with a valid auth-code assigned by NovAtel Customer Support.

The upgrade can be performed directly through the NovAtel Connect command line or from any other communications program.

4.5.1 Upgrade Procedure

1. Power up the SMART6-L receiver and establish communications (refer to the Quick Start Guide included with the product for instructions).
2. Issue the LOG VERSION command to verify the current model, firmware version and serial number (refer to *Section 4.2, Authorization Code* on page 33 for instructions on obtaining).
3. Issue the AUTH command, followed by the auth-code and model type (refer to *Section 4.2, Authorization Code* on page 33 for details on obtaining any auth-code). The syntax is as follows:

```
auth <your auth-code here>
```

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

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

where:

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

Example:

```
auth 7WBMBK,887CB6,K5J3FH,5DF5P2,42PW8G,D1SB0GTT0,121211
```

When the AUTH command is executed, the SMART6-L receiver reboots. Issuing the LOG VERSION command confirms the new upgrade model type and firmware version number.

If communicating using NovAtel Connect, the communication path must be closed and reopened using the Device menu.

Appendix A Technical Specifications

A.1 SMART6-L Receiver Performance

PERFORMANCE[a]					
Channel Configuration	120 Channels can be configured to track: L1 GPS L2 GPS (optional) L2C GPS (optional) L1 GLONASS (optional) L2 GLONASS (optional) Galileo E1 (optional) BeiDou B1 (optional) SBAS[b] L-Band (optional)				
Horizontal Position Accuracy (RMS)[c]	Single Point	1.5 m			
	Single Point L1/L2	1.2 m			
	NovAtel CORRECT™	SBAS[c]	0.6 m		
		DGPS	0.4 m		
		PPP[d e]	4 cm		
		RT-2®	1 cm + 1ppm		
Measurement Precision (RMS)		**GPS**		**GLO**	
		Code	**Carrier**	**Code**	**Carrier**
	L1 C/A	4 cm	0.5 mm	15 cm	1.5 mm
	L2 P(Y)[f]	8 cm	1.0 mm	8 cm	1.5 mm
	L2C code[g]	8 cm	1.0 mm	8 cm	1.5 mm
Maximum Data Rate[h]	Measurements	up to 50 Hz			
	Position	up to 50 Hz			
Time to First Fix	Cold Start[i]	<50 s			
	Hot Start[j]	<35 s			
Signal Reacquisition	L1	0.5 s (typical)			
	L2	1.0 s (typical)			
Time Accuracy	20 ns RMS				
Velocity Accuracy[k]	0.03 m/s RMS				

a. Typical values. Performance specifications subject to GPS system characteristics, US DOD operational degradation, ionospheric and tropospheric conditions, satellite geometry, baseline length, multipath effects and the presence of intentional or unintentional interference sources.
b. Satellite Based Augmentation Systems (SBAS) include WAAS (North America), EGNOS (Europe) and MSAS (Japan).
c. GPS only.
d. Requires a TerraStar subscription which is available direct from NovAtel www.novatel.com/products/novatel-correct-ppp.
e. Performance dependent on local observing conditions.
f. L2 P for GLONASS.
g. L2 C/A for GLONASS.
h. Model specific.
i. Typical value. No almanac or ephemerides and no approximate position or time.
j. Typical value. Almanac and recent ephemerides saved and approximate time entered. For more information, refer to the "SETAPPROXTIME" command in the OEM6 Family Firmware Reference Manual found on our Web site at www.novatel.com/support/manuals/.
k. Export licensing restricts operation to a maximum velocity of 515 metres per second.

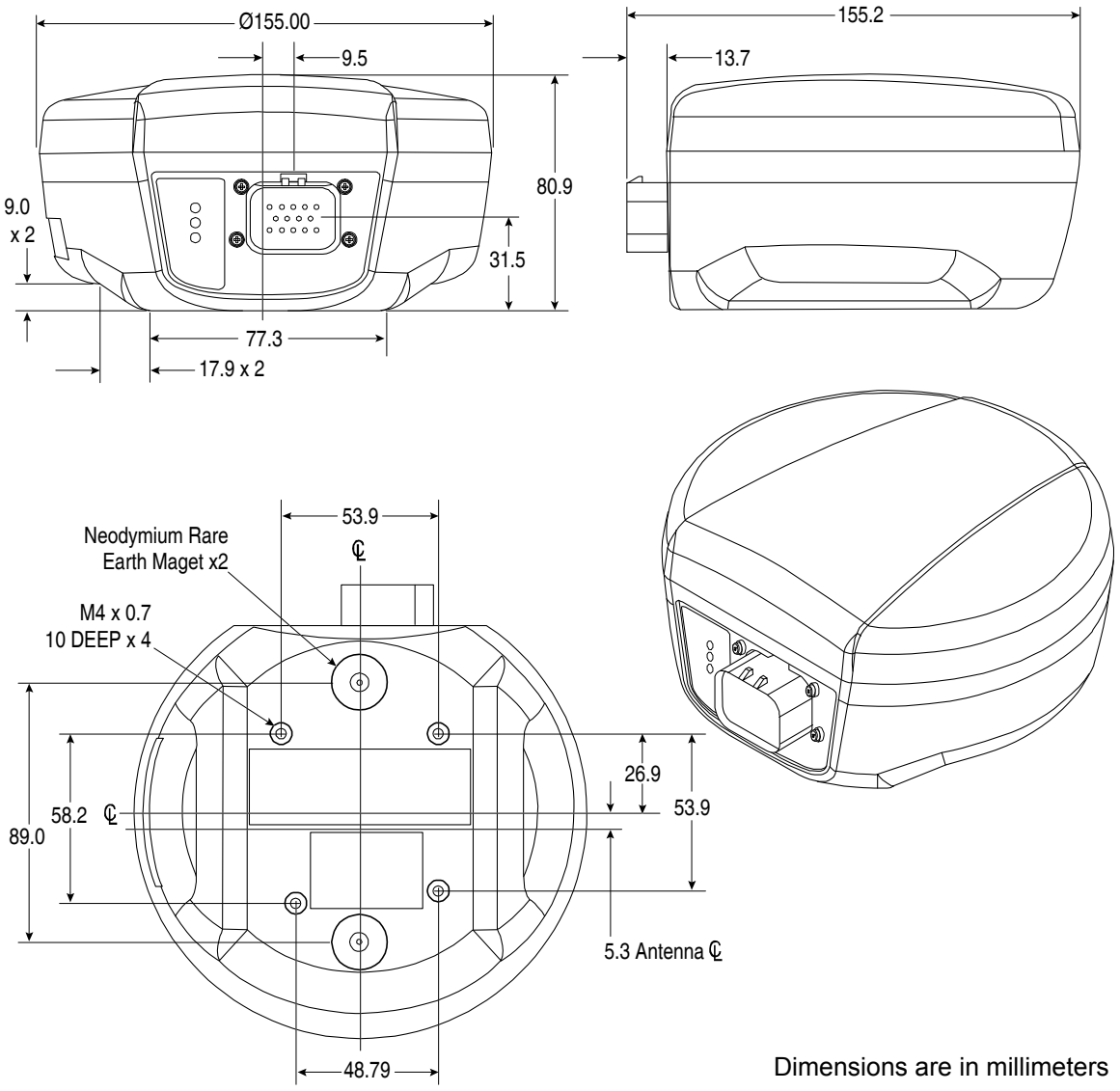
A.2 SMART6-L Specifications

PHYSICAL	
Size	80.9 x ϕ155 mm[a]
Weight	<550 g
Mounting	2 x magnetic mount
	4 x M4 screw inserts
	Optional mounting plate
ENVIRONMENTAL	
Operating Temperature	-40°C to +75°C
Storage Temperature	-55°C to +90°C
Humidity	MIL-STD-810G Method 507.5 Procedure 2
Immersion	MIL-STD-810G Method 512.5 Procedure 1
Solar Radiation	EN60950-22, Clause 8.2 MIL-STD-810G Method 505.5
Salt Fog	MIL-STD-810G, Method 509.5
Sand and Dust	MIL-STD-810G, Method 510.5
Vibration	Random: MIL-STD-810G, Method 514.6, Category 24 Sinusoidal: ASAE EP455, 5.15.2 Level 1 & 2
Shock	MIL-STD-810G Method 516.6
Ingress Protection Rating	IP67[b]
REGULATORY	
Compliance	FCC, Industry Canada, CE Marking, E-mark
POWER REQUIREMENTS	
Input Voltage	+8 to +36 V DC
Power Consumption	2.9 W [c]
14-PIN INPUT/OUTPUT CONNECTOR	
Power	+8 to +36 V DC For the cable pin-outs and drawings, see *Section A.2.1, SMART6-L Communication/Power Cable (01018999)* on page 46
Serial Com Ports	RS-232 F Compliant (Rx and Tx signals only)
CAN	SAE J1939/ ISO 11783/ ISO 11898 Compatible
Emulated Radar Output	High = Supply Voltage -0.5V Minimum Low = 0.5V Maximum Load = 3K Ohm Minimum
PPS Output	3.3 V CMOS Logic Compatible
MKI Input	3.3 V CMOS Logic/5 V Tolerant

INPUT/ OUTPUT CONNECTOR PROTECTION	
Electrical Conducted/ Coupled disturbance tolerance	ISO 7637-2:2004 Functional Class A: Pulses 2a, 3a, 3b, 4 Functional Class C: Pulses 1, 2b
LED INDICATORS	
Power, Error, Position Valid	Refer to *Section 2.2.2, Status Indicators* on page 16 for details
INPUT/OUTPUT DATA INTERFACE	
COM1	
Electrical format	RS-232
Bit rates (bps)	2400, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400, 460800 or 921600
Signals supported	TxD1, RxD1
Flow control	XON/XOFF
Features supported	Logs, Commands, Firmware Upgrade, NovAtel Connect, Baud rate reset using Break
COM2	
Electrical format	RS-232
Bit rates (bps)	2400, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400, 460800 or 921600
Signals supported	TxD2, RxD2
Flow control	XON/XOFF
Features supported	Logs, Commands, Firmware Upgrade, NovAtel Connect, Baud rate reset using Break
COM3	
Electrical format	RS-232
Bit rates (bps)	2400, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400, 460800 or 921600
Signals supported	TxD3, RxD3
Flow control	XON/XOFF
Features supported	Logs, Commands, Firmware Upgrade, NovAtel Connect, Baud rate reset using Break

a. ϕ denotes diameter, here and in the *Dimensions* graphic on *page 45.*
b. IP67 rating requires that the cable is connected to the antenna.
c. Power consumption values for GPS L1/L2.

Figure 21: SMART6-L Dimensions



Dimensions are in millimeters

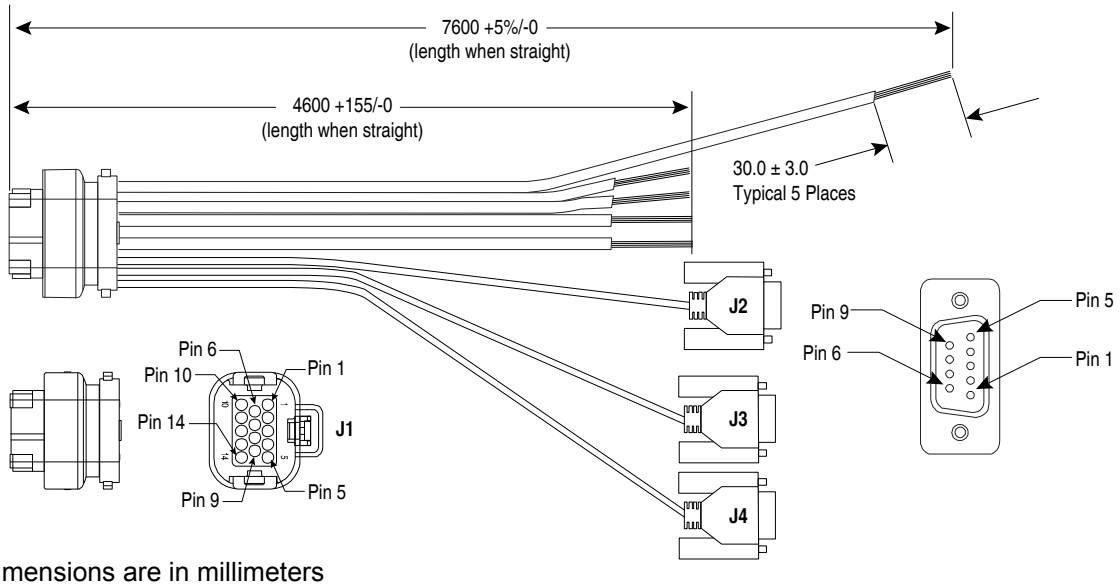
A.2.1 SMART6-L Communication/Power Cable (01018999)

The SMART6-L cable (refer to *Figure 22, SMART6-L Communication/Power Cable*), provides a means of supplying power from a battery while operating in the field. The exposed wires (red for positive and black for negative) can then be connected to a vehicular power circuit (or equivalent) protected by a 5 A fast blow fuse (user supplied). The cable has three DB-9 connectors to accommodate a computer serial (RS-232) communication port, a modem or radio transmitter to propagate differential corrections (refer to the user supplied modem or radio transmitter user guide for information on its connectors).

In addition, there are a number of bare wires where the outer insulation is cut away but the wires beneath remain intact. See *Table 3, SMART6-L Communication/Power Cable Pin-outs* on page 46 for their pin-outs. For more information on mating connectors and part numbers, see *Table 4, SMART6-L Mating Connectors* on page 47.

This cable is RoHS compliant.

Figure 22: SMART6-L Communication/Power Cable



Dimensions are in millimeters

Table 3: SMART6-L Communication/Power Cable Pin-outs

Signal Name	J1	J2	J3	J4	Label
COM1_TXD	1	2			
COM1_RXD	2	3			
COM2_TXD	3		2		
COM2_RXD	4		3		
COM3_TXD	8			2	
COM3_RXD	13			3	
COM1 GND	5	5			
COM2 GND			5		
COM3 GND				5	
MKI GND					MKI GND
EMULATED RADAR GND					ER GND
PULSE PER SECOND GND					PPS GND

Signal Name	J1	J2	J3	J4	Label
CANI+	6				CANI+
CANI-	7				CANI-
PWR RET (GND)	9				BATT-
EMULATED RADAR OUT	10				ER_OUT
EVENT MARK IN	11				MKI
PPS	12				PPS
PWR INPUT	14				BATT+

A.2.2 SMART6-L Connector and Cable Requirements

Custom cables for installing the SMART6-L can be created using he following guidelines:

- Wire size: must be 0.5 mm-1.25 mm (20-16 AWG)
- Batt+ connection must be protected by 5 A fast blow fuse
- Serial data signals (TxD, RxD, signal ground) must be run in shielded cable. Connect shields to ground at SMART6-L end only
- CAN signal conductors must be twisted (40 twists/m, 12 twists/ft)
- Use only the recommended mating connectors listed below. Use only gold plated pins

Failure to observe the given cable construction guidelines and fusing requirements in this section may result in damage to the wiring or equipment and voiding the warranty.

NovAtel recommends biasing unused inputs to their default states.

The connector used in the SMART6-L is an “AMPSEAL” dust and water sealed type produced by Tyco. The following part numbers pertain to the mating connector required to make connections to the SMART6-L. These numbers are provided for information only and are not available from NovAtel as separate parts.

Table 4: SMART6-L Mating Connectors

Product	Part Description	Company	Part Number
SMART6-L mating connector (J1 - *Figure 22, SMART6-L Communication/Power Cable* on page 46)	14-pin sealed receptacle housing-black	Tyco/AMP	776273-1
Gold plated pins (20-16 AWG) for (J1) SMART6-L connector Gold plated pins for SMART6-L connector/strip	Pins, loose piece	Tyco/AMP	770854-3
	Pins, strip (reel)	Tyco/AMP	770520-3
Seal Plug for unused pins on mating connector. (All connector positions must be populated with a pin or seal plug to achieve the IP-67 rating for the cable connection.)	Seal plug	Tyco/AMP	770678-1

Table 5, Recommended Fuse and Fuse Holders details the part numbers for recommended fuses and fuse holders. These numbers are provided for information only and are not available from NovAtel as separate parts.

Table 5: Recommended Fuse and Fuse Holders

Fuse	Recommended Fuse/Fuse Holder		
12 V System Fuse (standard size blade)	ATO Silver Blade Fuse 5 A (32 V)	Littelfuse	0287005
	Or Equivalent		
12 V System Fuse (mini size blade)	Mini Blade Fuse 5 A (32 V)	Littelfuse	0297005
	Or Equivalent		
24 V System Fuse High Reliability, Harsh Environment (standard size blade)	FKS ATO Blade Fuse 5A (80 V)	Littelfuse	166.7000.450
	Or Equivalent		
Inline Fuse Holder, (for standard size blade)	Waterproof ATO Fuse Holder	Littelfuse	FHAC0001
	Or Equivalent		
Inline Fuse Holder, (for mini size blade)	Waterproof Mini Fuse Holder	Littelfuse	0FHM0001
	Or Equivalent		

Appendix B Commands

The SMART6-L firmware implements the OEM6 family command set, documented in the OEM6 Family Firmware Reference Manual. Commonly used SMART6-L commands are summarized in *Table 6, SMART6-L Commands* and documented in this appendix.

Table 6: SMART6-L Commands

ASCII Command	Message ID	Description
FRESET	20	Factory reset (existing OEM6 commands extended to SMART6-L)
LOG	1	Request logs from the receiver
RADARCONFIG	1878	Configure the Emulated Radar output
SERIALCONFIG	1246	Configure the receiver serial port.
SETCANNAME	1091	Set the CAN name fields.

The arguments for each of these commands are described in the following sections.

For a complete listing and description of the other commands that the SMART6-L, an OEM6 based receiver, is capable of processing, refer to the OEM6 Family Firmware Reference Manual.

B.1 SYNTAX CONVENTIONS

The following rules apply when entering commands, at the command prompt, from a keyboard.

1. `Courier` font is used to illustrate program output or user input.
2. References to other commands, logs or any of their fields are shown in *italics*.
3. The commands are not case sensitive. For example, you could type either `RESET` or `reset`.
4. Except where noted, either a space or a comma can separate commands and their required entries. For example, you could type either `fix position 51.11358042 -114.04358013 1059.4105` or `fix position 51.11358042, -114.04358013, 1059.4105`.
5. At the end of a command, a carriage return is required. For example, press <Enter> or <Return> on your keyboard.
6. Responses are provided to indicate whether or not an entered command was accepted. The format of the response depends on the format of the command. Refer to the OEM6 Family Firmware Reference Manual for more information.
7. Optional parameters are indicated by square brackets (`[ ]`). For commands that contain optional parameters, the value used if the optional parameter is not specified is given in the syntax table for the command.
8. Data format definitions, as specified in the “Format” field, are detailed in the OEM6 Family Firmware Reference Manual. Note that all binary data is little-endian byte-ordered.

B.2 FRESET Clear Selected Data from NVM and Reset

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

> `FRESET STANDARD` (which is also the default) causes any commands, ephemeris, GNSS and almanac data previously saved to NVM to be erased.

Abbreviated ASCII Syntax: **Message ID: 20**

```
FRESET [target]
```

Input Example:

```
FRESET COMMAND
```

> If you are receiving no data or random data from your receiver, try the following before contacting NovAtel:
> - Verify that the receiver is tracking satellites
> - Check the integrity and connectivity of power and data cables
> - Verify the baud rate settings of the receiver and terminal device (your PC, data logger or laptop)
> - Switch COM ports
>
> Issue a `FRESET` command

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	FRESET header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively	-	H	0
2	target	See *Table 7, FRESET Target* on page 51		What data is to be reset by the receiver (default=STANDARD)	Enum	4	H

Table 7: FRESET Target

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

B.3 LOG Request Logs from the Receiver

Many different types of data can be logged using several different methods of triggering the log events. Every log element can be directed to any combination of the three COM ports. The ONTIME trigger option requires the addition of the *period* parameter. See *the* OEM6 Family Firmware Reference Manual for further information and a complete list of data log structures. The `LOG` command tables in this section show the ASCII command format.

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

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

1. The OEM6 family of receivers can handle 64 logs at a time. If it is more than 64 logs at a time, the receiver responds with an Insufficient Resources error.
2. Maximum flexibility for logging data is provided to the user by these logs. The user is cautioned, however, to recognize that each log requested requires additional CPU time and memory buffer space. Too many logs may result in lost data and degraded CPU performance. Receiver overload can be monitored using the idle time field and buffer overload bits of the Receiver Status in any log header.
3. Polled log types do not allow fractional offsets or ONTIME rates faster than 1 Hz.
4. Use the ONNEW trigger with the MARKTIME or MARKPOS logs.
5. Only the MARKPOS or MARKTIME logs and 'polled' log types are generated, on the fly, at the exact time of the mark. Synchronous and asynchronous logs output the most recently available data.
6. If the ONTIME trigger is used with asynchronous logs, the time stamp in the log does not necessarily represent the time the data was generated but rather the time when the log is transmitted.

Abbreviated ASCII Syntax: **Message ID: 1**

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

Abbreviated ASCII Example 1:

```
LOG COM1 BESTPOS ONTIME 7 0.5 HOLD
```

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

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

Abbreviated ASCII Example 2:

```
LOG COM1 BESTPOS ONCE 0.000000 0.000000 NOHOLD
```

Refer to the *Command Formats* section of the OEM6 Family Firmware Reference Manual for additional examples.

1. In NovAtel Connect there are two ways to initiate data logging to the receiver's serial ports:
   - the `LOG` command in the *Console* window or
   - use the interface provided in the *Logging Control* window.
2. Only the ASCII/Abbreviated ASCII log table is included in this manual. Refer to the `LOG` command in the OEM6 Family Firmware Reference Manual for binary log details.

Factory Default:

```
log com1 rxstatuseventa onnew 0 0 hold
log com2 rxstatuseventa onnew 0 0 hold
log com3 rxstatuseventa onnew 0 0 hold
log icom1 rxstatuseventa onnew 0 0 hold
log icom2 rxstatuseventa onnew 0 0 hold
log icom3 rxstatuseventa onnew 0 0 hold
```

Field	Field Name	ASCII Value	Description	Field Type
1	LOG (ASCII) header	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII or ASCII respectively	-
2	port	See *Table 8, Detailed Serial Port Identifiers* on page 54	Output port (default = THISPORT)	Enum
3	message	Any valid message name, with an optional A or B suffix	Message name of log to output	Char [ ]
4	trigger	ONNEW	Output when the message is updated (not necessarily changed)	Enum
		ONCHANGED	Output when the message is changed	
		ONTIME	Output on a time interval	
		ONNEXT	Output only the next message	
		ONCE	Output only the current message (default)	
		ONMARK	Output when a pulse is detected on the mark 1 input, MK1I	
5	period	Any positive double value larger than the receiver's minimum raw measurement period	Log period (for ONTIME trigger) in seconds (default = 0)	Double
6	offset	Any positive double value smaller than the period	Offset for period (ONTIME trigger) in seconds. To log data at 1 second after every minute, set the period to 60 and the offset to 1 (default = 0)	Double
7	hold	NOHOLD	Allow log to be removed by the UNLOGALL command (default)	Enum
		HOLD	Prevent log from being removed by the UNLOGALL command	

Table 8: Detailed Serial Port Identifiers

ASCII Port Name	Hex Port Value	Decimal Port Value [a]	Description
NO_PORTS	0	0	No ports specified
COM1_ALL	1	1	All virtual ports for COM port 1
COM2_ALL	2	2	All virtual ports for COM port 2
COM3_ALL	3	3	All virtual ports for COM port 3
THISPORT_ALL	6	6	All virtual ports for the current port
ALL_PORTS	8	8	All virtual ports for all ports
XCOM1_ALL	9	9	All virtual COM1 ports
XCOM2_ALL	10	10	All virtual COM2 ports
XCOM3_ALL	11	17	All virtual COM3 ports
COM1	20	32	COM port 1, virtual port 0
COM1_1	21	33	COM port 1, virtual port 1
COM1_31	3f	63	COM port 1, virtual port 31
COM2	40	64	COM port 2, virtual port 0
COM2_31	5f	95	COM port 2, virtual port 31
COM3	60	96	COM port 3, virtual port 0
COM3_31	7f	127	COM port 3, virtual port 31
THISPORT	c0	192	Current COM port, virtual port 0
THISPORT_31	df	223	Current COM port, virtual port 31
XCOM1	1a0	416	Virtual COM1 port, virtual port 0
XCOM1_1	1a1	417	Virtual COM1 port, virtual port 1
XCOM1_31	1bf	447	Virtual COM1 port, virtual port 31
XCOM2	2a0	672	Virtual COM2 port, virtual port 0
XCOM2_1	2a1	673	Virtual COM2 port, virtual port 1
XCOM2_31	2bf	703	Virtual COM2 port, virtual port 31
XCOM3	9a0	2464	Virtual COM3 port, virtual port 0
XCOM3_31	9bf	2495	Virtual COM3 port, virtual port 31

a. Decimal port values 0 through 16 are only available to the `UNLOGALL` command and cannot be used in the `UNLOG` command or in the binary message header.

For detailed information on virtual ports, refer to the `LOG` command in the OEM6 Family Firmware Reference Manual.

B.4 RADARCONFIG Configure the Emulated Radar Output

Use this command to configure the Emulated Radar (ER) output. ER is available through the SMART6-L interface cable, see *Table 3, SMART6-L Communication/Power Cable Pin-outs* on page 46 for pin-out details.

Message ID: 1878

Abbreviated ASCII Syntax

```
radarconfig switch freq_step update_rate resp_mode threshold
```

Factory Default:

```
radarconfig disable
```

ASCII Example:

```
radarconfig enable 26.11 5hz 2 3.5
```

Field	Field Type	ASCII Value	Binary Value	Description	Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary.	-	H	0
2	switch	DISABLE	0	Disables radar emulation (default = disable)	Enum	4	H
		ENABLE	1	Enables radar emulation			
3	freq_step	10.06 16.32 26.11 28.12 34.80 36.11		Frequency step per kilometer per hour. (default = 36.11 Hz/kph)	Double	8	H+4
4	update_rate	1HZ	1	Rate at which the output frequency is adjusted (default = 10HZ)[a]	Enum	4	H+12
		2HZ	2				
		5HZ	5				
		10HZ	10				
		20HZ	20				
5	resp_mode	see *Table 9, Response Modes* on page 56		Specify how responsive radar emulation is to changes in velocity (Default = 500)[a]	Integer	4	H+16
6	threshold	2 to 50 kph		The speed threshold at which to switch between response mode 1000 and response mode 500. The threshold is only applicable when the response mode is set to 2. (default = 5 kph)	Double	8	H+20

a. The number of samples used for smoothing depends on both the update_rate and resp_mode parameters. For instance, if the update_rate is 5 Hz and the resp_mode is 2000ms, the number of samples used will be 10.

Table 9: Response Modes

Mode	Description
1	Immediate. This results in the lowest latency at the cost of higher noise
2	Automatically switch between 1000 and 500 depending on speed. When speed is below the *Threshold* parameter, use *Response Mode* 500. Otherwise, use *Response Mode 1000*.
500	Signal is minimally smoothed resulting in low latency but increased noise.
1000	Output signal is smoothed over a smaller window resulting in less latency than 2000 and less noise than 500.
2000	Output signal is smoothed to reduce noise at the cost of higher latency.

B.5 SERIALCONFIG Configure COM Port

This command is used to configure the receiver's serial ports.

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

- Stop the logging of data on the current port (see UNLOGALL command in the OEM6 Family Firmware Reference Manual).
- Clear the transmit and receive buffers on the current port.
- Return the current port to its default settings
- Set the interface mode to NovAtel for both input and output (see INTERFACEMODE command in the OEM6 Family Firmware Reference Manual).

Baud rates higher than 115,200 bps are not supported by standard computer hardware. Special computer hardware may be required for higher rates, including 230400 bps, 460800 bps and 921600 bps. Also, some computers have trouble with baud rates beyond 57600 bps.

Abbreviated ASCII Syntax: **Message ID: 1246**

```
SERIALCONFIG [port] bps [parity[databits[stopbits[handshake[echo[break]]]]]]
```

Factory Default:

```
SERIALCONFIG COM1 9600 N 8 1 N OFF ON
SERIALCONFIG COM2 9600 N 8 1 N OFF ON
SERIALCONFIG COM3 9600 N 8 1 N OFF ON
```

ASCII Example:

```
SERIALCONFIG COM1 57600 N 8 1 N OFF ON
```

Use the SERIALCONFIG command before using the INTERFACEMODE command on each port.

Watch for situations where the COM ports of two receivers are connected together and the baud rates do not match. Data transmitted through a port operating at a slower baud rate may be misinterpreted as break signals by the receiving port if it is operating at a higher baud rate.

This is because data transmitted at the lower baud rate is stretched relative to the higher baud rate. In this case, configure the receiving port to have break detection disabled using the SERIALCONFIG command.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	SERIAL CONFIG header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively	-	H	0

2	port	See *Table 10, COM Serial Port Identifiers* on page 58		Port to configure. (default = THISPORT)	Enum	4	H
3	bps/baud	300, 600, 900, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, or 230400		Communication baud rate (bps). Bauds of 460800 and 921600 are also available on COM1 of OEM6 based products	ULong	4	H+4
4	parity	See *Table 11, Parity* on page 58		Parity	Enum	4	H+8
5	databits	7 or 8		Number of data bits (default = 8)	ULong	4	H+12
6	stopbits	1 or 2		Number of stop bits (default = 1)	ULong	4	H+16
7	handshake	See *Table 12, Handshaking* on page 58		Handshaking	Enum	4	H+20
8	echo	OFF	0	No echo (default)	Enum	4	H+24
		ON	1	Transmit any input characters as they are received			
9	break	OFF	0	Disable break detection	Enum	4	H+28
		ON	1	Enable break detection (default)			

Table 10: COM Serial Port Identifiers

Binary	ASCII	Description
1	COM1	COM port 1
2	COM2	COM port 2
3	COM3	COM port 3
6	THISPORT	The current COM port
8	ALL	All COM ports

Table 11: Parity

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

Table 12: Handshaking

Binary	ASCII	Description
0	N	No handshaking (default)
1	XON	XON/XOFF software handshaking

B.6 SETCANNAME Sets the CAN name fields

This command sets the CAN device name fields.

Abbreviated ASCII Syntax: **Message ID: 1091**

`SETCANNAME`

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	SETCANNAME header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively	-	H	0
2	ManufacturerCode			CAN module's Manufacturer Code	Ulong	4	H
3	IndustryGroup			Industry group number (default = 2)	Ulong	4	H+4
4	DeviceClass			11783-5 Device class (default = 0)	Ulong	4	H+8
5	DeviceClassInstance			11783-5 Device class instance (default = 0)	Ulong	4	H+12
6	Function			11783-5 Function (default = 23)	Ulong	4	H16
7	FunctionInstance			11783-5 Function instance (default = 0)	Ulong	4	H+20
8	ECUInstance			11783-5 ECU Instance (default = 0)	Ulong	4	H+24
9	PreferredAddress			Device default address on start up (default=28)	Ulong	4	H+28
10	Reserved				Ulong	4	H+32

Appendix C Logs

C.1 Position Logs

C.1.1 NMEA Logs

The NMEA logs (receiver outputs) supported by the SMART6-L are summarized in Chapter 3 of the OEM6 Family Firmware Reference Manual in section "NMEA Standard Logs". The available logs include:

- GPGGA, which outputs a log of position system fix data and undulation. There are variants of GPGGA, specifically:
  - GPGGARTK, which has greater precision than GPGGA but with the loss of the undulation field
  - GPGGALONG, which has both greater precision and the undulation field
- GPVTG, which outputs track made good and ground speed

Each of the available NMEA standard logs is described in more detail in its own section of Chapter 3 of the OEM6 Family Firmware Reference Manual.

The steps for configuring the receiver output, through the command line are:

1. Configure the communication port using the `SERIALCONFIG` command, described in *Section B.5, SERIALCONFIG Configure COM Port* on page 57. To set COM port 2 as follows:

Bit Rate	9600
Parity	none
Data Bits	8
Stop Bits	1
Handshaking	None
Echo	Off
Break	On

   enter the following string:

   ```
   serialconfig com2 9600 n 8 1 n off on
   ```

2. Select and configure the NMEA string to output. The information is described in Chapter 3 Data Logs of the OEM6 Family Firmware Reference Manual, in the section for the particular log. For example, to log gpgga (position system fix data and undulation) at 2 Hz, enter the following string:

   ```
   log gpgga ontime 0.5
   ```

You can configure the log to output at various frequencies, as described in *Section B.3, LOG Request Logs from the Receiver* on page 52.

The above command line operations can also be carried out through NovAtel Connect. Information about configuring the communication port can be found in NovAtel Connect online help. The procedure for adding a NMEA log through the Connect is summarized as follows:

1. In the **Logging control** window, click *Logging to one or more of the receiver's serial ports*. The **Add Log** window displays.
2. Beside **Select list**, select *Complete List* or *NMEA List*.
3. Beside **Log to file**, select the NMEA log you want to add.
4. Select the port.
5. Configure the remaining fields then click *Add*.

C.1.2 NovAtel Position Logs

In addition to NMEA logs, NovAtel supports a range of non-NMEA position logs, described in the OEM6 Family Firmware Reference Manual, including:

- BESTPOS: This log contains the best available position computed by the receiver, for example:

```
log bestposa ontime 0.5
```

- BESTXYZ: This log contains the receiver's best available position and velocity in ECEF coordinates, for example:

```
log bestxyza ontime 1
```

C.2 RADARSTATUS ER Signal Information

This log contains Emulated Radar (ER) signal information.

Message ID: **1877**

Log Type: **Synch**

Recommended Input:

```
log radarstatusa ontime 1
```

ASCII Example:

```
#RADARSTATUSA,COM1,0,39.0,FINESTEERING,3189,201903.000,00040020,3a93,
32768;0000000F,SOL_COMPUTED,DOPPLER_VELOCITY,5.5924,5.1682,671.842775*
9a017aff
```

Field	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	RADARSTATUS header	Log header		H	0
2	Emulated Radar status	A bit field representing the current state of radar emulation, see *Table 13, Emulated Radar Status* on page 63.	Hex	4	H
3	Solution status	Solution status as reported in the BESTVEL log, see *Table 14, Solution Status* on page 63	Enum	4	H+4
4	Velocity type	Velocity type as reported in the BESTVEL log, see *Table 15, Position or Velocity Type* on page 64	Enum	4	H+8
5	Horizontal speed	Horizontal speed over ground in metres per second	Double	8	H+12
6	Smoothed horizontal speed	Smoothed horizontal speed over ground in metres per second	Double	8	H+20
7	Frequency	Output frequency in Hz	Double	8	H+28
6	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+36
7	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Table 13: Emulated Radar Status

Bit	Mask	Description
0	0x01	Feature enabled
1	0x02	Velocity type good
2	0x04	Velocity > 1 kph
3-4	0x8	Current response mode being applied. This will equal the RADARCONFIG response mode parameter unless that parameter is 2. If the response mode was 2, then this will be either 500 or 1000, depending on speed. These bits are mapped as follows: • 00: Response mode 1 (no smoothing) • 01: Response mode 500 (500ms smoothing) • 10: Response mode 1000 (1000ms smoothing) • 11: Response mode 2000 (2000ms smoothing)
5-31	0xFFFFE700	Reserved

Table 14: Solution Status

Solution Status		Description
Binary	ASCII	
0	SOL_COMPUTED	Solution computed
1	INSUFFICIENT_OBS	Insufficient observations
2	NO_CONVERGENCE	No convergence
3	SINGULARITY	Singularity at parameters matrix
4	COV_TRACE	Covariance trace exceeds maximum (trace > 1000 m)
5	TEST_DIST	Test distance exceeded (maximum of 3 rejections if distance > 10 km)
6	COLD_START	Not yet converged from cold start
7	V_H_LIMIT	Height or velocity limits exceeded (in accordance with export licensing restrictions)
8	VARIANCE	Variance exceeds limits
9	RESIDUALS	Residuals are too large
13	INTEGRITY_WARNING	Large residuals make position unreliable
18	PENDING	When a FIX POSITION command is entered, the receiver computes its own position and determines if the fixed position is valid [a]
19	INVALID_FIX	The fixed position, entered using the FIX POSITION command, is not valid
20	UNAUTHORIZED	Position type is unauthorized - HP or XP on a receiver not authorized for it

a. PENDING implies there are not enough satellites being tracked to verify if the FIX POSITION entered into the receiver is valid. The receiver needs to be tracking two or more GPS satellites to perform this check. Under normal conditions you should only see PENDING for a few seconds on power up before the GPS receiver has locked onto its first few satellites. If your antenna is obstructed (or not plugged in) and you have entered a FIX POSITION command, then you may see PENDING indefinitely.

Table 15: Position or Velocity Type

Type (binary)	Type (ASCII)	Description
0	NONE	No solution
1	FIXEDPOS	Position has been fixed by the FIX POSITION command
2	FIXEDHEIGHT	Position has been fixed by the FIX HEIGHT/AUTO command
8	DOPPLER_VELOCITY	Velocity computed using instantaneous Doppler
16	SINGLE	Single point position
17	PSRDIFF	Pseudorange differential solution
18	WAAS	Solution calculated using corrections from an SBAS
19	PROPAGATED	Propagated by a Kalman filter without new observations
32	L1_FLOAT	Floating L1 ambiguity solution
33	IONOFREE_FLOAT	Floating ionospheric-free ambiguity solution
34	NARROW_FLOAT	Floating narrow-lane ambiguity solution
48	L1_INT	Integer L1 ambiguity solution
49	WIDE_INT	Integer wide-lane ambiguity solution
50	NARROW_INT	Integer narrow-lane ambiguity solution
68	PPP_CONVERGING[a]	Converging PPP solution
69	PPP[a]	Converged PPP solution
70	OPERATIONAL	Solution accuracy is within UAL operational limit
71	WARNING	Solution accuracy is outside UAL operational limit but within warning limit
72	OUT_OF_BOUNDS	Solution accuracy is outside UAL limits

a. NovAtel CORRECT™ with PPP requires access to a suitable correction stream, delivered either through L-Band or the Internet. For L-Band delivered TerraStar or Veripos service, an L-Band capable receiver and software model is required, along with a subscription to the desired service. Contact NovAtel for TerraStar and Veripos subscription details.

C.3 VERSION HW and SW Versions and Serial Numbers

The Component Type of the VERSION log, refer to the OEM6 Family Firmware Reference Manual, is extended to include SMART6-L information as in *Table 16, Component Type*.

Table 16: Component Type

Binary Value[a]	ASCII Value	Description
0	UNKNOWN	Unknown Component
1	GPSCARD	OEM6 GPSCard Component
3	ENCLOSURE	SMART6-L Receiver
8	USERINFO	User application information component
981073925 (0x3A7A0005)	DB_USERAPPAUTO	Auto-starting user application firmware

a. Unused numbers are reserved for future use.

```
<VERSION COM1 0 75.5 FINESTEERING 1836 244320.337 00000000 3681 13306
<     1
<        GPSCARD "D2LRPGTT0" "BFN13160106" "OEM628-2.01" "OEM060600RN0000"
"OEM060200RB0000" "2015/JAN/28" "15:27:29"
```

Appendix D Replacement Parts

The following are a list of the replacement parts available for the NovAtel SMART6-L receiver. Should assistance be required or need to order additional components, please contact your local NovAtel dealer or Customer Service representative.

D.1 SMART6-L

Table 17: SMART6-L Product

Part Description	NovAtel Part
SMART6-L	01019033
Cable: 14-pin socket to 3 DB-9 connectors, twisted CAN I/O pair, and other bare wire connectors (see *SMART6-L Communication/Power Cable (01018999)* on page 46)	01018999
Mounting Plate Kit	01018317
Pole Mount Kit	01019142

D.2 User Manuals

Table 18: Reference User Manuals

Part Description	NovAtel Part
OEM6 Family Installation and Operation User Manual	OM-20000128
OEM6 Family Firmware Reference Manual	OM-20000129

The accessories above are also available from www.novatel.com