# SMART ANTENNA

**User Manual**

# SMART ANTENNA User Manual

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| | |
|---|---|
| SMART ANTENNA Receivers | One (1) Year |
| Cables and Accessories | Ninety (90) Days |
| Software Support | One (1) Year |

Date of sale shall mean the date of the invoice to the original customer for the product. NovAtel's responsibility respecting this warranty is solely to product replacement or product repair at an authorized NovAtel location only.

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

> Before shipping any material to NovAtel or Dealer, please obtain a Return Material Authorization (RMA) number from the point of purchase. You may also visit our website at http://www.novatel.com and select *Support / Repair Request* from the side menu.

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

# Customer Service

## Contact Information

If you have any questions or concerns regarding your SMART ANTENNA, please contact NovAtel Customer Service using any one of the following methods:

| | |
|---|---|
| NovAtel GPS Hotline: | **1-800-NOVATEL** (U.S. or Canada) |
| | 403-295-4900 (International) |
| Fax: | 403-295-4901 |
| E-mail: | support@novatel.ca |
| Website: | www.novatel.com |
| Write: | NovAtel Inc. Customer Service Dept. |
| | 1120 - 68 Avenue NE |
| | Calgary, Alberta, Canada |
| | T2E 8S5 |

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

1. Issue the *NVM Reset* command, *Message ID# 99*, with value 0 to reset all NVM. Your receiver automatically resets after the NVM erase has been completed.

   (For details on individual commands and logs, refer to the *SUPERSTAR II Firmware Reference Manual*)

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

| | | | |
|---|---|---|---|
| *Receiver Status, ID# 49* | one shot | *Navigation Data (ECEF), ID# 21* | continuous |
| *Ephemeris Data, ID# 22* | continuous | *Navigation Data (User), ID# 20* | continuous |
| *Measurement Block, ID# 23* | 1 Hz | *Satellite Visibility, ID# 33* | continuous |
| *Fault Log, ID# 57* | one shot | *Channel Assignment, ID# 6* | continuous |
| *HW/SW Identification, ID# 45* | one shot | | |

3. Send the file containing the log to NovAtel Customer Service, using the support@novatel.ca e-mail address.

## Firmware Updates

Firmware updates are firmware revisions to an existing model, which improves basic functionality of the GPS receiver. See also *Appendix 6, Updating Receiver Firmware on Page 32*.

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

If you need further information, please contact NovAtel using one of the methods given above.

# Notices

**⚠ WARNING:** A primary lightning protection device must be provided by the operator/customer as part of an extra-building installation to ensure transient voltage levels of less than 600 V maximum.

## FCC Notice

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

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:

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

**⚠ WARNING:** Changes or modifications to this equipment not expressly approved by NovAtel Inc. could result in violation of Part 15 of the FCC rules.

## CE Notice

The enclosures carry the CE mark.

**⚠ WARNING:** This is a Class B product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures to correct the interference. See also the *FCC Notice* above.

"Hereby, NovAtel Inc. declares that the SMART ANTENNA is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC."

## EMC Common Regulatory Testing

| | |
|---|---|
| • EN55022 | Radiated and Conducted Emissions |
| • CISPR 22 | Class B |
| • EN 50081-1 | Generic Emissions Class B |
| • EN 50082-1 | Generic Immunity Class B |
| • EN 61000-4-2 | Electrostatic Discharge Immunity |
| • EN 61000-4-3 | Radiated RF EM Field Immunity Test |
| • EN 61000-4-4 | Electrical Fast Transient/Burst Test |
| • EN 61000-4-6 | Conducted Immunity |
| • EN 61000-4-8 | Magnetic Field Immunity |

## Congratulations!

Thank you for purchasing a SMART ANTENNA. Whether you have purchased a stand alone SMART ANTENNA or a development kit, you will find this manual and other companion documentation useful. Please visit our website at www.novatel.com for a complete list of manuals that are available for download.

NovAtel's SMART ANTENNA is a rugged, self-contained GPS receiver and antenna. It is specially designed for harsh tracking environments in a number of applications. This environmentally sealed unit is designed to meet or exceed MIL-STD 810E.

The SMART ANTENNA is available in a variety of configurations to suit your integration requirements: RS-232 (to use with 7-pin or 6-pin cables up to 15 m), or RS-422 (to use with 12-pin cables over 15 m), DGPS input, 1 pulse per-second (1PPS) output, 6-, 7- or 12-pin connectors, standard mount or central cable mount, 1-14 UNS thread or 3 screws 10-32 UNF mounting.

The SMART ANTENNA is a SUPERSTAR II-based product.

## Scope

This document provides information on the SMART ANTENNA. The following sections describe functionality, mechanical and electrical characteristics of the on-board SUPERSTAR II board. The software messages are described in the companion *SUPERSTAR II Firmware Reference Manual*, NovAtel part number *OM-20000086*. There are also additional appendices with reference materials for you.

## Related Publications

**Table 1: Related Publications**

| PUBLICATION NAME | PUBLICATION NAME |
|---|---|
| [1]   ICD-GPS-200 Rev. B | NAVSTAR[a] GPS Space Segment/Navigation Interface |
| [2]   RTCM-104 version 2.1 January 1994 | Recommended Standards[a] for Differential NAVSTAR GPS Radio Technical Commission for Maritime Services |
| [3]   SAE J1211 | SAE[a] Recommended Environmental Practices for Electronic Equipment Design |
| [4]   NMEA-0183 Rev 2.20 | National Marine Electronics Association[a] Standard for Interfacing |
| [5]   STARVIEW User Manual | NovAtel[b] Part Number OM-20000081 |
| [6]   SUPERSTAR II Firmware Reference Manual | NovAtel[b] Part Number OM-20000086 |

a.   Refer to the *Standards/References* section of the *GPS+ Reference Manual* available on our website at http://www.novatel.com/Downloads/docupdates.html for contact information.
b.   For the latest versions of these manuals, visit our website at the address in footnote *a* above.

## What's New in this Revision?

New 5 Hz carrier phase (CP) models have been added to the SSII-based model set. These models are capable of 1, 2 or 5 Hz measurements.

# Chapter 1    Introduction

The SMART ANTENNA, see *Figure 1* below, is a rugged, self-contained GPS receiver and antenna designed for harsh tracking environments. It accepts DGPS correction signals to further enhance accuracy. The SMART ANTENNA provides position and velocity data for a variety of applications.

Features:

- 12-channel parallel "all in view" tracking

- L1 C/A code and carrier phase

- RTCM-104 differential corrections input

- -135 dBm minimum tracking sensitivity

- 1PPS output aligned to GPS time 200 ns (typical)

- Single +5 V power input

- Reverse polarity and SAE J1455 load dump protected

- 1 Hz position, velocity and time (PVT) output

Available Model Features[1]:

- Integrated carrier phase (CP) data (*Message ID# 23, Measurement Block Data* only works with these models): 1 Hz or 5 Hz CP

- SBAS (for example WAAS and EGNOS) support

- 5 Hz PVT output

- Precise timing

- DGPS base station software



**Figure 1: SMART ANTENNA**

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1. Refer to *Appendix A* of the *SUPERSTAR II Firmware Reference Manual* for models and their capabilities.

This section covers the installation of the SMART ANTENNA.

NovAtel's *StarView* graphical user interface software running on a PC allows you to control the receiver and to display its outputs. See *Section B.2, StarView Software Installation* starting on *Page 45* for its installation instructions. Details on the *StarView* program are provided in Reference [5] on *Page 12*.

## 2.1    Interconnections

All connections are made through a single 7-, 6- or 12-conductor cable (supplied with the development kits, otherwise available as an option). See also the cables in *Appendix A* starting on *Page 35* and the sections below.

### 2.1.1    System Components
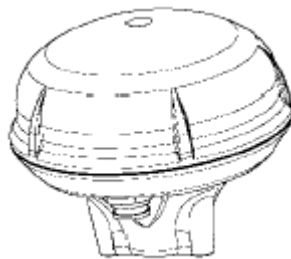


**Figure 2: Standard Mount SMART ANTENNA**

.



**Figure 3: Mounting Adapter**
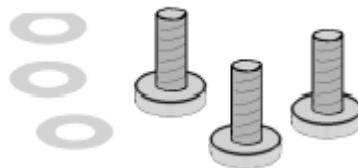


**Figure 4: 3 Mounting Screws and Washers**

The SMART ANTENNA is normally mounted using one of the following methods:

1. Using the 1"– 14 threads, mount the antenna onto a standard antenna mast or mounting adapter. *Figure 5* on *Page 15* shows the central cable mount which is also labelled as the cable exit.

2. Using three 10-32 UNF screws, mount the antenna on a flat surface with three holes on a 1.75-inch diameter circle as shown in *Figure 6* on *Page 15*.

**Figure 5: Central Cable Mount**
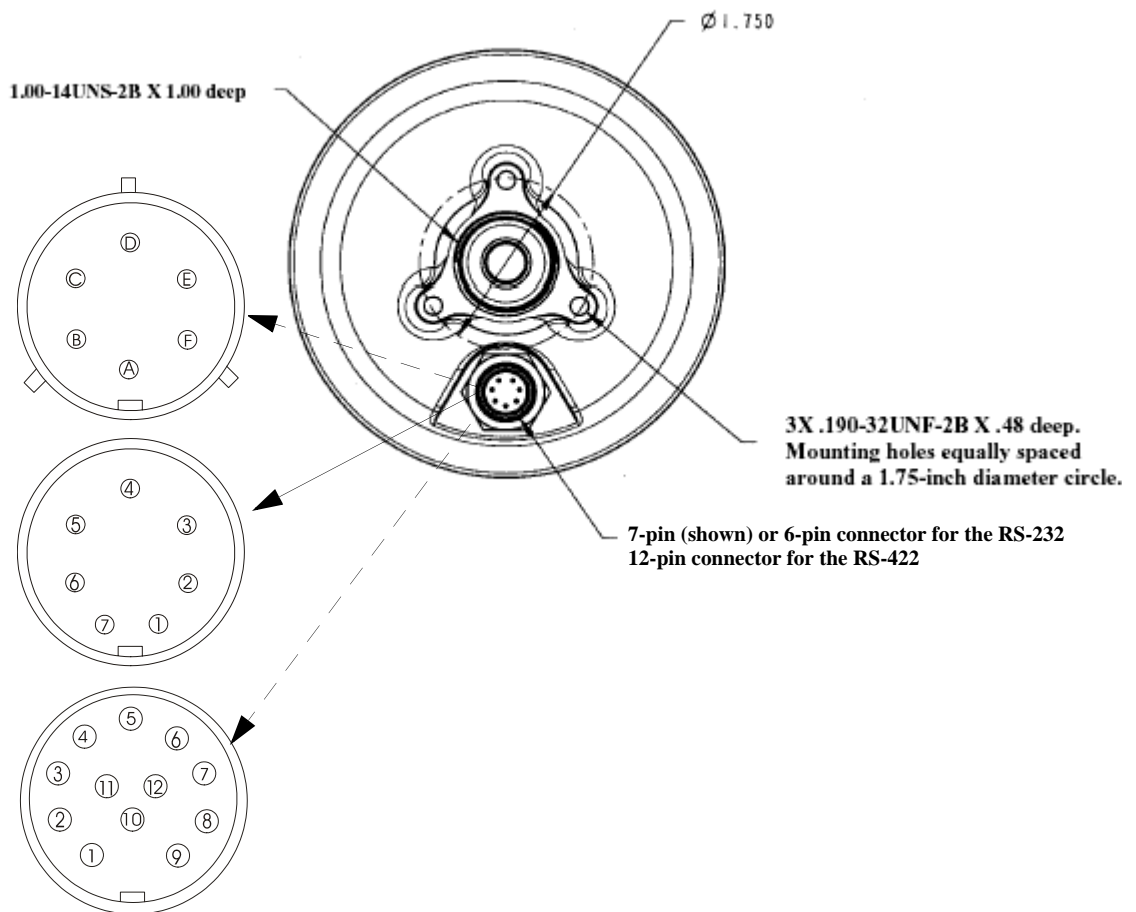


**Figure 6: Mounting Holes**

See also *Section A.3, Connector Pin Assignments* starting on *Page 38* for the connectors' pin-out descriptions.
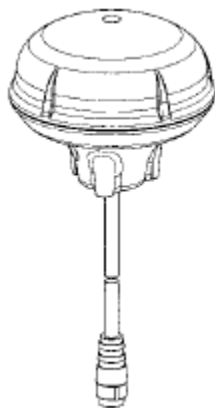
**Figure 7: Central Cable Mount**

⊠   *Figure 7* shows the SMART ANTENNA with its cable exiting from the central cable mount, see also *Figure 5*, instead of using the connector shown in *Figure 6* on *Page 15*.

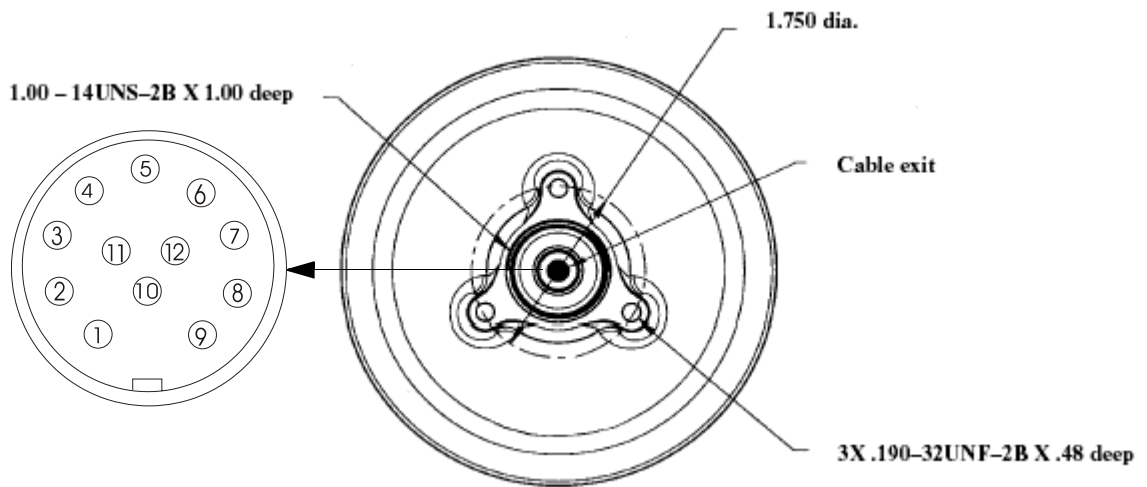Use the open-ended cable shown in *Figure 8* to connect the SMART ANTENNA to auxiliary equipment. See *Table 2* on *Page 17* for the available variations of this cable.
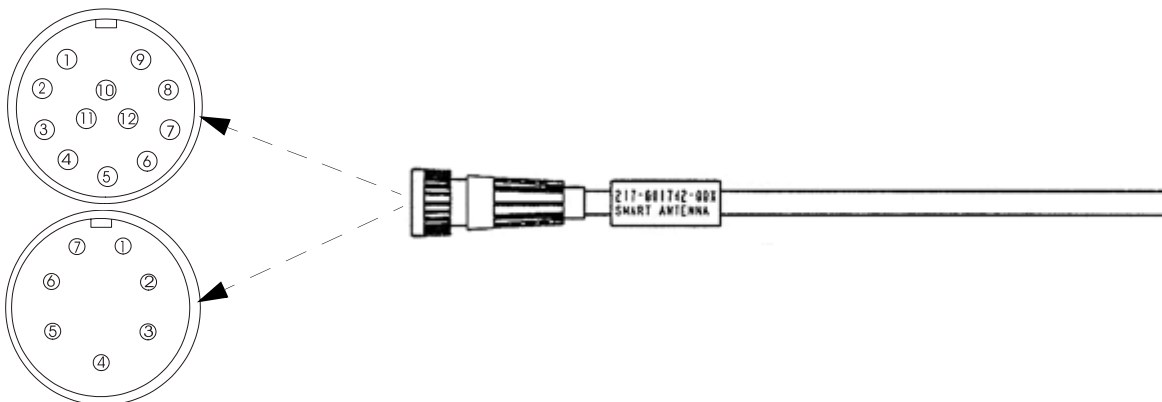


**Figure 8: Open-Ended SMART ANTENNA Cable**

The SMART ANTENNA RS-232 multi-connector cable is shown in *Figure 9* on *Page 17* and is for RS-232 models only. The receiver end of the cable connects to the 7-pin (shown in *Figure 6* on *Page 15*) or 6-pin receptacle of the RS-232 SMART ANTENNA. It provides up to three ends opposite the receiver end:

- +12 V DC automobile input power plug

- DB-9 socket connector to user-supplied PC

- open end for a user-supplied auxiliary connection

See *Table 2* on *Page 17* for the available variations of this cable.
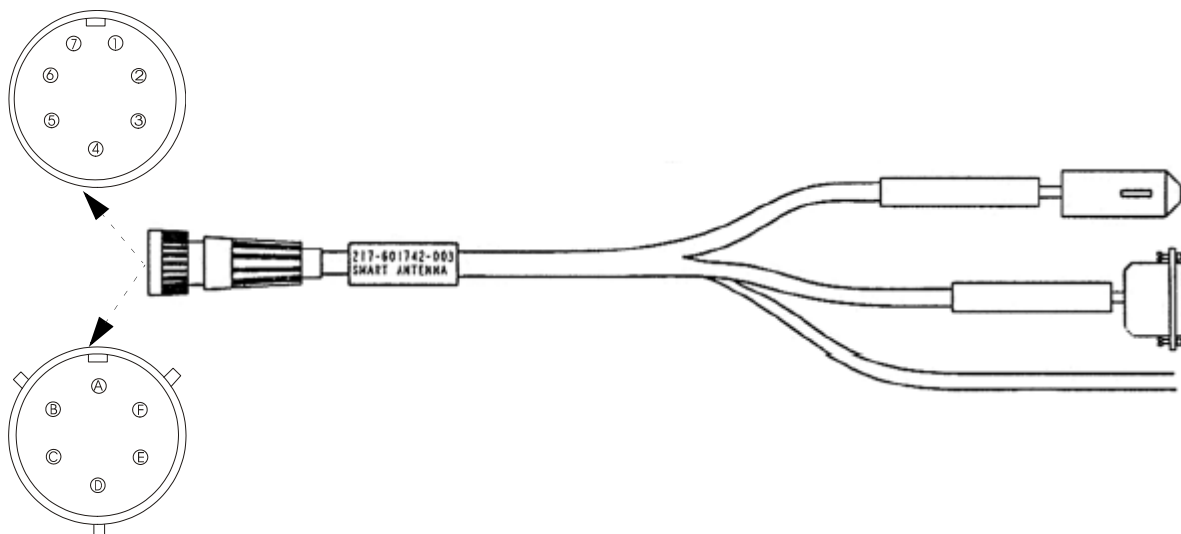
**Figure 9: Multi-Connector SMART ANTENNA Cable**

**Table 2: Cable Variations**

| Part Number | Serial Interface | Length (m) | Number of Pins at Receiver End | Connectors at Other End |
|---|---|---|---|---|
| 217-601764-001 | RS-422 | 5 | 12 | None |
| 217-601764-002 | RS-422 | 30 | 12 | None |
| 217-601764-003 | RS-422 | 15 | 12 | None |
| 217-601742-001 | RS-232 | 5 | 7 | None |
| 217-601742-003 | RS-232 | 5 | 7 | DB-9 and a +12 V DC adapter |
| 217-601798-001 | RS-232 | 5 | 6 | None |
| 217-601798-003 | RS-232 | 5 | 6 | DB-9 and a +12 V DC adapter |
| 217-601798-004 | RS-232 | 15 | 6 | DB-9 and a +12 V DC adapter |

⚠️ **CAUTION**

When installing the cable, use a tie-wrap near the antenna to hold the weight of the cable so that the connector is not stressed by the cable weight.

### 2.1.1.1    Magnetic Mount Adaptor

A magnetic mount adapter (part number 270-990146-890), see *Figure 10* on *Page 18* is available as an accessory. Use this magnetic mount accessory to thread the antenna onto a mount and position on a flat surface (for example, on top of a vehicle).

**Figure 10: Magnetic Mount Adapter**

## 2.2   Power/Communication Port

The multi-pin connector on the SMART ANTENNA (shown in *Figures 5* and *6* on *Page 15*), acts as both a communication and a power port. Power can be supplied and communication can occur simultaneously using the open-ended SMART ANTENNA cable shown in *Figure 8* on *Page 16* for the RS-422 or either of the cables shown in the previous section for the RS-232 models. See also *Appendix A, Technical Specifications*, starting on *Page 35*.
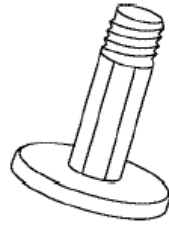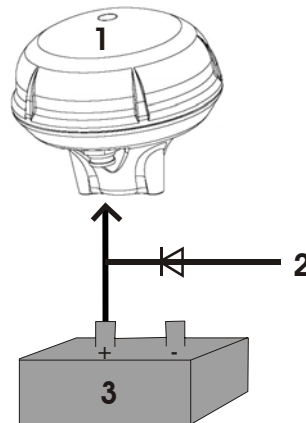
It is recommended that a back-up battery (3) is placed between the receiver (1) and its voltage supply (2) to act as a power buffer:



Normally when a vehicle engine is started, power can dip to around 9.6 VDC or even cut-out to ancillary equipment. Plug in the adapter and/or connect and turn on the power supply.

## 2.3   SMART ANTENNA Location

Many GPS reception problems can be reduced, to some degree, by careful antenna site selection. Of primary importance is to place the SMART ANTENNA so that unobstructed line-of-sight reception is possible from horizon to horizon and at all bearings and elevation angles from the antenna. This is the ideal situation, which may not be possible under actual operating conditions.

1. Try to place the SMART ANTENNA as far as possible from reflective objects, especially reflective objects that are above its radiation pattern horizon. Close-in reflections cause strong multipath signals. For a detailed discussion on multipath and site selection, refer to the section on *Multipath* in the *GPS+ Reference Manual* available on our website at http://www.novatel.com/Downloads/docupdates.html.

2. Care should also be taken to avoid coiling the SMART ANTENNA cable around the mounting base and pinching the cable in windows or doors.

By default, the SMART ANTENNA uses satellites above 4.5 degrees elevation. The mask angle can be set to use a different cut-off, as low as zero degrees (all in view), using *Message ID# 81, Set Mask Angle* (refer to the *SUPERSTAR II Firmware Reference Manual* for more message details).

## 2.4   Installation Overview

Once you have selected the appropriate equipment, set up your SMART ANTENNA and use it as in *Figure 11*.



**Figure 11: Basic Setup**

| Reference | Description | Reference | Description |
|---|---|---|---|
| 1 | SMART ANTENNA | 5 | 120 V AC power source |
| 2 | 7- or 6-pin connection | 6 | User-supplied PC |
| 3 | DB-9 connector to PC | 7 | Open-ended for user-supplied |
| 4 | 12 V DC adaptor | | connector |

*WARNING:*     **If you are using StarView, ensure the Power Settings on your PC are not set to go into Hibernate or Standby modes. Data will be lost if one of these modes occurs during a logging session.**

Before operating the receiver for the first time, ensure that you have followed the installation instructions in *Chapter 2, Installation* starting on *Page 14*. The following instructions are based on a configuration such as that shown in *Figure 12*. It is assumed that a personal computer is used during the initial operation and testing for greater ease and versatility.
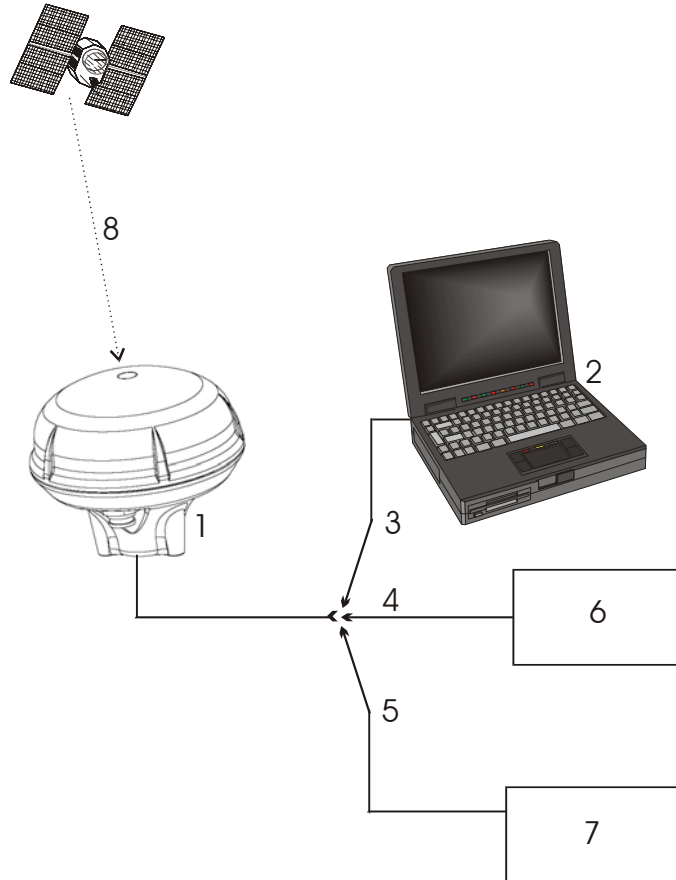
**Figure 12: Typical Operational Configuration**

| Reference | Description |
|-----------|-------------|
| 1 | SMART ANTENNA |
| 2 | User-supplied PC |
| 3 | COM1 |
| 4 | COM2 (DGPS IN) |
| 5 | Power |
| 6 | Radio or rover station |
| 7 | External power source(s) |
| 8 | GPS signal |

⊠ Your receiver must be a BASE model to act as a base station. A list of models may be found in *Appendix A* of the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on *Page 12*.

# 3.1    Communications with the Receiver

Communication with the receiver is straightforward, and consists of issuing commands through the communication ports from an external serial communications device. This could be either a terminal or a PC that is directly connected to the COM1 serial port of the receiver using a straight serial cable. If you are using an RS-232 communications device such as a radio modem, connect it to the receiver's COM2 (DGPS IN) port by means of a radio serial cable. For information about input and output messages that are useful for basic operation of the receiver, refer to the *SUPERSTAR II Firmware Reference Manual*. See also the *StarView* examples in *Section 3.2, Getting Started* starting on *Page 21*.

## 3.1.1    Serial Port Default Settings

The receiver communicates with your PC or terminal through a serial port. For communication to occur, both the receiver and the operator interface have to be configured properly. The receiver's COM1 and COM2 (DGPS IN) default port settings are as follows:

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

Changing the default baud setting requires using *Message ID# 110, Configure COM1 Port Mode*, which is described in the *SUPERSTAR II Firmware Reference Manual*. It is recommended that you become thoroughly familiar with the input and output messages detailed in the above reference manual to ensure maximum utilization of the receiver's capabilities.

---

⌧   The default data transfer rate is 9600 bps unless your receiver has Carrier Phase Output (CP) capability with 19200 bps as the default. A list of models may be found in *Appendix A* of the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on *Page 12*.

---

The data transfer rate you choose determines how fast information is transmitted. Take for example a message whose byte count is 96. The default port settings allow 10 bits/byte. It therefore takes 960 bits per message. To get 10 messages per second then requires 9600 bps. Please also remember that even if you set the bps to 9600 the actual data transfer rate will be less and depends on the number of satellites being tracked, filters in use, and idle time. It is therefore suggested that you leave yourself a margin when choosing a data rate.

---

⚠ *CAUTION:*    Although the receiver can operate at data transfer rates as low as 300 bps, this is not desirable. For example, if several data messages are active (that is, a significant amount of information needs to be transmitted every second) but the bit rate is set too low, data will overflow the serial port buffers, cause an error condition in the receiver status and result in lost data.

---

# 3.2    Getting Started

Included with your receiver is NovAtel's *StarView* program. *StarView* is a Windows-based graphical user interface which allows you to access the receiver's many features without struggling with communications protocol or writing special software. The information is displayed in windows accessed from the *Window* menu. For example, to show details of the GPS satellites being tracked, select *Satellites | Status* from the *Window* menu. Select *Navigation | LLH Solution* from the *Window* menu to display the position of the receiver in LLH (latitude, longitude and height) coordinates.

---

*WARNING:*        **If you are using StarView, ensure the Power Settings on your PC are not set to go into Hibernate or Standby modes. Data will be lost if one of these modes occurs during a logging session.**

---

The receiver is in Navigation mode whenever sufficient satellite information and measurement data is available to produce a GPS fix. When the receiver has a valid position, the *Nav Mode* field in *StarView*'s *LLH Solution*, or *XYZ Solution*, window shows Nav 2-D, Nav 3-D, Diff. 2-D or Diff. 3-D. If it shows Initialized there is no valid position yet.

The SMART ANTENNA uses a comprehensive message interface. Input messages can be sent to the receiver using the *Xmit Msg* menu in *StarView*.

The following information is important when selecting commands:

1. You can send a message request using one shot (Normal mode) or continuous (Special mode) by selecting *Xmit Msg | General Message Request* in *StarView*.

2. There is an option in *StarView* to save all messages transmitted by the receiver into a file. Select *File/Port | Save Data* after you have finished selecting messages in Step #2 above.

The *SUPERSTAR II Firmware Reference Manual* provides the available messages and parameters that the SMART ANTENNA uses. See also *Section B.2, StarView Software Installation* starting on *Page 45* and refer to the *StarView User Manual* for more information on the *StarView* program.

The receiver's software resides in read-only memory. As such, the unit "self-boots" when turned on and undergoes a complete self-test, see *Section 3.6.2, Operational States* starting on *Page 24*. If a persistent error develops, please contact your local NovAtel dealer first. If the problem is still unresolved, please contact NovAtel directly through any of the methods in the *Customer Service* section on *Page 10*.

## 3.3   Non Volatile Memory

The receiver stores different types of information used to accelerate the TTFF and to configure the I/O in NVM. See *Table 3* below for a partial list of the data stored in NVM.

| PARAMETER | NOTES |
|---|---|
| ALMANAC | The most recent almanac |
| LAST POSITION | Position in NVM is updated at different rates depending on the application. The last known position is always kept in battery back-up SRAM. |
| DGPS CONFIGURATION | Differential GPS configuration |
| RS-232 CONFIGURATION | Contains the following configuration information:<br>1. Mode of operation          4. Time Alignment Mode State<br>2. Baud Rate: 300 to 19200    5. Mask Angle<br>3. Default Binary message list   6. Datum |

**Table 3: Non-Volatile Memory Data**

## 3.4    Default Configuration

Below is the SMART ANTENNA's default configuration with no valid NVM elements:

| | |
|---|---|
| Protocol on port #1: | Binary |
| Baud Rate on port #1: | 9600 |
| Protocol on port #2: | RTCM-104 |
| Baud Rate on port #2: | 9600 |
| DGPS Correction Timeout: | 120 seconds |
| Default Message List: | |
|     Binary: | Navigation Status User Coordinates (Message ID# 20) @ 1Hz |
|     NMEA: | GGA @ 1Hz |
| 1PPS Time Align Mode: | OFF |

⊠ The default data transfer rate is 9600 bps unless your receiver model has Carrier Phase Output (CP) capability with 19200 bps as the default. A list of models may be found in *Appendix A* of the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on *Page 12*.

## 3.5    Configurable Parameters

Several parameters of the receiver and the base station are configurable and therefore, you must define them prior to operation.

⊠ Your receiver must be a BASE model to act as a base station. A list of models may be found in *Appendix A* of the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on *Page 12*.

### 3.5.1    Mask Angle

The mask angle is defined as the minimum satellite elevation angle (in degrees) above which any given satellite must be in order for it to be used in the GPS position solution. Low satellites usually do not yield accurate measurements due to weak signal reception and possible multipath. Typical mask angle values range from 5°-10°, depending on the receiver's location. This value is programmable using command *Message ID# 81, Set Mask Angle*.

### 3.5.2    SMART ANTENNA Position

For the base station, you must fix the position of the SMART ANTENNA. This can be done using either the X-Y-Z coordinates in meters within the WGS-84 reference frame, or latitude and longitude in degrees and height in meters (LLH coordinates) by selecting *Tool Setting | Set Operating Mode* in the main menu of *StarView*.

You can only set the X-Y-Z coordinates using *Message ID# 80, Set User's Position/Operating Mode*.

See also *Section 2.3, SMART ANTENNA Location* starting on *Page 18*.

## 3.6    Receiver States

### 3.6.1    Non-Operational State

The SMART ANTENNA's non-operational state is OFF mode. In OFF mode, only the data contained in the NVM is retained for use when power is re-applied. See *Section 3.3, Non Volatile Memory* starting on *Page 22* for details on retained data. If your SMART ANTENNA contains a SUPERSTAR II, its supercap allows it to maintain ephemeris, other data, and time during OFF mode for a period of 3 -7 days for a hot/quick start.

### *3.6.2    Operational States*

The receiver has 6 operating modes:

- Self-Test
- Initialization
- Acquisition
- Navigation
- Dead-Reckoning
- Fault

The receiver switches between modes automatically. The receiver reports the current operating and navigation modes on its host port.

1. **Self-Test Mode**

   The receiver enters Self-Test mode upon request from an external source (please refer to *Message ID# 51, Initiated BIT Request* in the *SUPERSTAR II Firmware Reference Manual*). The time duration spent in the Self-Test mode is no more than 15 seconds. On self-test completion, the receiver reports the BIT results on its host port through *Message ID# 51*. Self-Test mode exits to either Initialization or Fault mode.

2. **Initialization Mode**

   Upon power-up, the receiver enters Initialization mode. During this mode hardware is initialized prior to Acquisition mode entry. The Initialization mode is also initiated upon completion of the Self-Test mode, but always exits to the Acquisition mode.

   The SMART ANTENNA retrieves data from both NVM and SRAM (warm start). Integrity checking is done on all data retrieved from the non-operating state.

   During initialization, the receiver retrieves the last received valid almanac data and last user position from NVM, the current time from the low-power time source, and predicts which satellites are currently visible. This list of visible satellites is then used in Acquisition mode to program the 12 parallel correlator channels.

3. **Acquisition Mode**

   The receiver is in Acquisition mode when insufficient satellite data is available to produce an initial navigation solution. Acquisition mode is entered from Initialization or Dead-Reckoning mode and exits to Navigation or Fault mode.

   To acquire signals from the GPS satellites, the receiver uses:

   - Almanac data which describes the satellite orbits
   - Time, which in conjunction with almanac data is used to estimate the present position of satellites in their orbits
   - The approximate location of the receiver so a prediction can be made as to which satellites are visible

   The receiver then collects ephemeris data by decoding the satellite down-link data message. After each satellite in view is acquired, its measurement data set is produced. When a sufficient number of satellites are being tracked, position, velocity and time can be computed and Navigation mode entered.

   If the receiver cannot perform an acquisition due to an absence of valid almanac data or user position and/or time, it initiates a "Search the Sky" acquisition. The receiver attempts to acquire all satellites in the GPS constellation. Once a satellite has been acquired, ephemeris data is decoded

from the satellite down-link message. After sufficient satellites have been acquired, the receiver enters Navigation mode. In "Search the Sky", the TTFF is typically less than 3 minutes.

**4. Navigation Mode**

The receiver is in Navigation mode whenever sufficient satellite information and measurement data is available to produce a GPS fix. Navigation mode is entered from Acquisition or Dead-Reckoning mode and exits to Dead-Reckoning or Fault mode.

In Navigation mode, a receiver configured as a roving unit operates in 2 sub-modes: Differential and Stand-Alone Nav. Sub-mode transition occurs automatically depending on satellite data availability. A receiver which is configured as a base station unit operates in Base Station Nav mode only. The receiver reports its current navigation sub-mode on its host port.

> a. Differential (Roving Unit Only)
>
> The receiver operates in Differential mode when data from at least 4 satellites with adequate geometry and differential corrections and/or measurements exist to compute position, velocity and time outputs. This is the preferred navigation mode. Differential data is supplied to the receiver through the differential input port. Differential data can be received only on the COM2 (DGPS IN) serial data port.
>
> b. Stand-Alone Nav (Roving Unit Only)
>
> The receiver operates in Stand-Alone Nav mode when it has data from at least 4 satellites with adequate geometry, but no differential corrections or measurements exist to compute position, velocity and time outputs. This is the preferred navigation mode when insufficient differential data is available to generate a differential GPS fix.
>
> c. Base Station Nav (Base Station Unit Only)
>
> The receiver operates in Base Station Nav mode once the time has been initialized and at least 4 satellites with adequate geometry can be used for navigation purposes. Once in this mode, only a change of configuration (rover mode requested) or a reset will cause the unit to leave this navigation mode. In this mode, the unit will have the ability to transmit the DGPS messages which are requested and allowed once its position is initialized. See also *Section 3.5, Configurable Parameters* starting on *Page 23* for position initialization details.

---

✉ Your receiver must be a BASE model to act as a base station. A list of models may be found in *Appendix A* of the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on *Page 12*.

---

**5. Dead-Reckoning Mode**

The receiver enters Dead-Reckoning mode when it cannot remain in Navigation mode. The speed and direction is assumed to be constant to allow the receiver to provide an estimated position.

**6. Fault Mode**

The receiver enters Fault mode during the period of time in which the receiver outputs are affected by one or more critical system faults. This mode supersedes all others and remains active until the next power-down/power-up cycle. Fault mode is entered from any mode except Initialization.

## 3.7   Built-In Status Tests

The receiver performs self-tests and generates status information to provide an indication of the operational readiness and to facilitate maintenance actions.

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

- *Message ID# 49, Receiver Status Data*

- *Message ID# 51, Initiated BIT Result*

Please refer to the *SUPERSTAR II Firmware Reference Manual* for details on the Message IDs above.

See also *Section 3.6.2, Operational States* starting on *Page 24*.

## 3.8   DATUM Support

The receiver has the ability to provide its position in one of the 62 predefined datums. The list of the supported datum and details on *Message ID# 88, Select/Define Datum to Use* are provided in the *SUPERSTAR II Firmware Reference Manual*. The receiver can also support two user-defined datums. You must define them, prior to their use, using *Message ID# 88*. Afterwards, the desired datum, whether it is user-defined or predefined, can be selected using the above message.

# Positioning Modes of Operation

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

- Single Point or Autonomous
- Optional Satellite-Based Augmentation System (SBAS)

Refer to the *GPS Overview* section in the *GPS+ Reference Manual,* available on our website at http://www.novatel.com/Downloads/docupdates.html, for an overview of GPS positioning.

## 4.1 Single-Point or Autonomous

The SMART ANTENNA is capable of absolute single-point positioning accuracies of < 5 meters CEP (GDOP < 2 with no multipath). See also the *Performance* specifications on *Page 36* of *Appendix A*.

The general level of accuracy available from single-point operation may be suitable for many types of applications that do not require position accuracies of better than 5 m CEP. However, increasingly more and more applications desire and require a much higher degree of accuracy and position confidence than is possible with single-point pseudorange positioning. This is where differential GPS (DGPS) plays a dominant role in higher accuracy real-time positioning systems. Refer to the *GPS Overview* section in the *GPS+ Reference Manual,* available on our website at http://www.novatel.com/Downloads/docupdates.html, for an overview of GPS positioning.

By averaging many GPS measurement epochs over several hours, it is possible to achieve a more accurate absolute position.

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

### 4.1.1 GPS System Errors

In general, GPS SPS C/A code single-point pseudorange positioning systems are capable of absolute position accuracies of about 5 meters or less. This level of accuracy is really only an estimation, and may vary widely depending on numerous GPS system biases, environmental conditions, as well as the GPS receiver design and engineering quality.

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

- **Ionospheric Group Delays –** The earth's ionospheric layers cause varying degrees of GPS signal propagation delay. Ionization levels tend to be highest during daylight hours causing propagation delay errors of up to 30 meters, whereas night time levels are much lower and may be as low as 6 meters.

- **Tropospheric Refraction Delays** – The earth's tropospheric layer causes GPS signal propagation delays. The amount of delay is at the minimum (about three metres) for satellite signals arriving from 90 degrees above the horizon (overhead), and progressively increases as the angle above the horizon is reduced to zero where delay errors may be as much as 50 metres at the horizon.

- **Ephemeris Errors –** Some degree of error always exists between the broadcast ephemeris' predicted satellite position and the actual orbit position of the satellites. These errors will directly affect the accuracy of the range measurement.

- **Satellite Clock Errors** – Some degree of error also exists between the actual satellite clock time and the clock time predicted by the broadcast data. This broadcast time error will cause some bias to the pseudorange measurements.

- **Receiver Clock Errors** – Receiver clock error is the time difference between GPS receiver time and true GPS time. All GPS receivers have differing clock offsets from GPS time that vary from receiver to receiver by an unknown amount depending on the oscillator type and quality (TCXO verses OCXO and so on).

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

## 4.2   Satellite-Based Augmentation System (SBAS)

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

SBAS includes the Wide-Area Augmentation System (WAAS), the European Geo-Stationary Navigation System (EGNOS), and the MTSAT Satellite-Based Augmentation System (MSAS). At the time of publication, there are two WAAS satellites over the western Atlantic Ocean and the Pacific (PRN 122 and PRN 134 respectively) and one EGNOS satellite over the eastern Atlantic Ocean (PRN 120). SBAS data is available from any of these satellites and more satellites will be available in the future.

The primary functions of SBAS include:

- data collection

- determining ionospheric corrections

- determining satellite orbits

- determining satellite clock corrections

- determining satellite integrity

- independent data verification

- SBAS message broadcast and ranging

- system operations & maintenance

As shown in *Figure 13* on *Page 29*, the SBAS is made up of a series of Reference Stations, Master Stations, Ground Uplink Stations and Geostationary Satellites (GEOs). The Reference Stations, which are geographically distributed, pick up GPS satellite data and route it to the Master Stations where wide area corrections are generated. These corrections are sent to the Ground Uplink Stations which up-link them to the GEOs for re-transmission on the GPS L1 frequency. These GEOs transmit signals which carry accuracy and integrity messages, and which also provide additional ranging signals for added availability, continuity and accuracy. These GEO signals are available over a wide area and can be received and processed by SUPERSTAR II receivers with appropriate firmware. GPS receivers are thus able to receive SBAS data in-band and use not only differential corrections, but also integrity, residual errors and ionospheric information for each monitored satellite.

The signal broadcast through the SBAS GEOs to the SBAS users is designed to minimize modifications to standard GPS receivers. As such, the GPS L1 frequency (1575.42 MHz) is used, together with GPS-type modulation - e.g. a Coarse/Acquisition (C/A) pseudorandom (PRN) code. In addition, the code phase timing is maintained close to GPS time to provide a ranging capability.
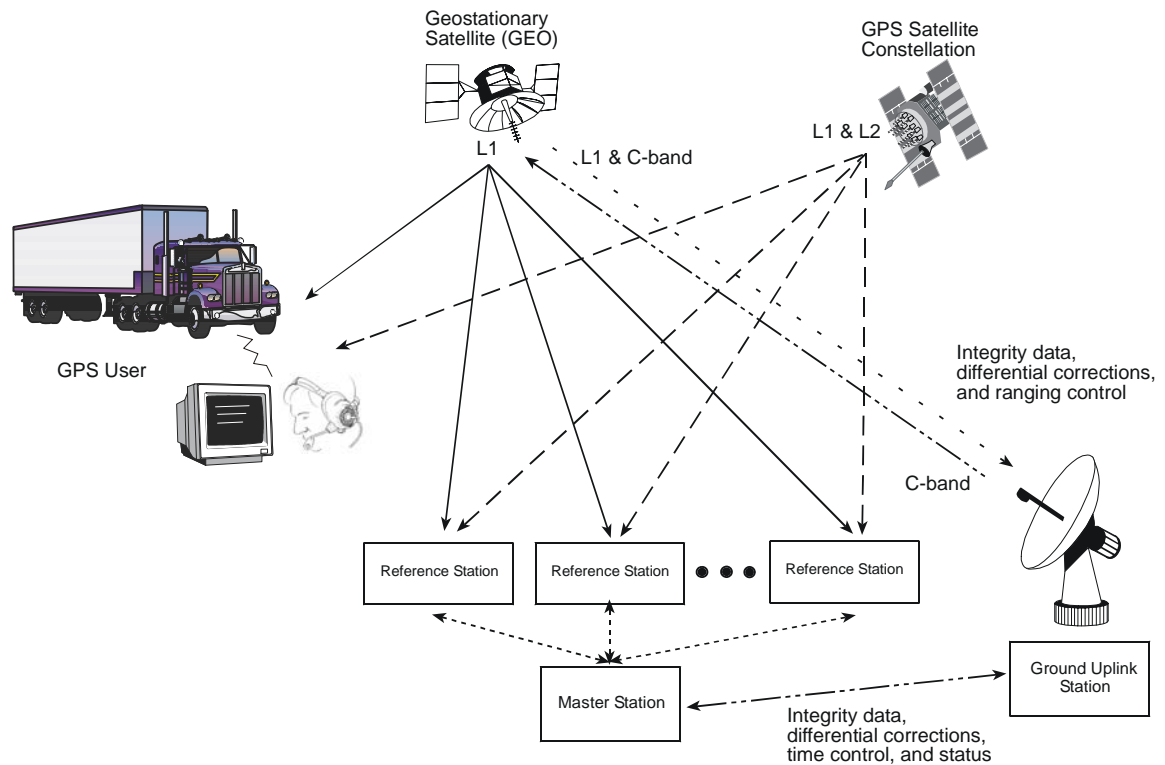
**Figure 13: The SBAS Concept**

### 4.2.1   SBAS Receiver

NovAtel SUPERSTAR II-based receivers may be equipped with an SBAS feature. The ability to simultaneously track two SBAS satellites, and incorporate the SBAS corrections into the position, is available on these models.

An SBAS-capable receiver will permit anyone within the area of coverage to take advantage of its benefits. To enable SBAS, set the DGPS mode to SBAS or Automatic (refer to *Message ID# 83, Set DGPS Configuration* in the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on *Page 12*). The receiver uses SBAS satellites in your coverage area.

The SMART ANTENNA can output the SBAS data in log format (refer to *Message ID# 67, WAAS Data* in the *SUPERSTAR II Firmware Reference Manual*), and can incorporate these corrections to generate differential-quality position solutions. SBAS data messages are analyzed based on RTCA standards for GPS/WAAS airborne equipment.

### 4.2.2   SBAS Messages

The command *Message ID# 95, Track SV*, enables the use of particular SBAS corrections in the position filter.

Two SBAS-specific messages are also available:

> *Message ID# 67, SBAS Data*
>
> *Message ID# 68, SBAS Status*

*StarView* allows you to deselect GPS and SBAS system satellites. Select *Tool Settings | Deselect | SVs* from the main menu. Refer also to the *StarView User Manual*, see Reference [5] on *Page 12*.

Refer also to *Message ID# 30, Receiver Configuration* in the *SUPERSTAR II Firmware Reference Manual*.

## Chapter 5    Troubleshooting

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

If you are unsure of the symptoms or if the symptoms do not match any of those listed, use *Message ID# 51, Initiated BIT Result* and refer to its description in the *SUPERSTAR II Firmware Reference Manual*.

If the problem is not resolved after using this troubleshooting guide, contact Customer Service, see *Page 10*.

This section is intended to assist you in the use of our SMART ANTENNA product.

1.  If you are having problems communicating with the SMART ANTENNA:
    *   Verify connection: look for broken pins, a misaligned connector or intermittent contact
    *   Verify power supply input is acceptable e.g. at a good level, low ripple, and not noisy
    *   Verify the Receive/Transmit ports are going to the correct ports on the host computer. Check signal directions and voltage levels
    *   Verify communication settings match the host computer for both protocol and baud rate

2.  If you are experiencing problems with low SNR levels:
    *   Check the SMART ANTENNA's installation, verify there is a clear view of the sky (that is, no obstructions) and there is no reflective surface nearby that may cause multipath interferences
    *   Verify the cleanness (that is, low ripple, minimum noise spikes, voltage level variations) of the power source
    *   Check digital, RF and power ground returns. Look for noise being coupled on ground return paths

3.  If you are not receiving differential corrections:
    *   Check DGPS connection on COM2 (DGPS IN) of the SMART ANTENNA
    *   Verify DGPS source settings are active
    *   Verify DGPS base station is actually transmitting DGPS corrections and base data is being received by the SMART ANTENNA

⊠   Your receiver must be a BASE model to act as a base station. A list of models may be found in *Appendix A* of the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on *Page 12*.

4.  If you are not receiving expected messages from the SMART ANTENNA:
    *   Verify transmit message settings (i.e. receiver's output configuration or requested message).
    *   Verify hardware and software part numbers are the expected configuration.
    *   Restore default settings by sending an Erase NVM command (*Message ID# 99, Erase NVM*) to the SMART ANTENNA
    *   Read the reference manual - refer to the *SUPERSTAR II Firmware Reference Manual* describing message contents.

For the problems above you may be able to isolate the suspected unit in your application:
*   Substitute another SMART ANTENNA.
*   Substitute another host hardware.
*   Substitute alternate power source or isolate main power source from auxiliary power source for SMART ANTENNA.

- Make intermittent problems more repeatable (i.e. by raising operating temperature, varying power supply source, re-orienting hardware placement). Be sure to note what makes the problem worse / lessens the problem.

---

*WARNING:* **If you are using StarView, ensure the Power Settings on your PC are not set to go into Hibernate or Standby modes. Data will be lost if one of these modes occurs during a logging session.**

---

Having gone through the steps in this chapter and, if possible, the substitutions above, contact Customer Service (see *Page 10*).

- Describe your problem, be sure to include observations, symptoms and environmental conditions for your application.
- Please supplement your problem / event descriptions with associated log files.
- Give hardware part number and software part numbers (including installed configurations).
- Customer support staff will give you instructions if the unit needs to be returned to the factory.

# Chapter 6      Updating Receiver Firmware

The software update utility is specially designed to provide an easy way to update your SMART ANTENNA software and model. The software package includes the following items:

- An update utility, usually called update.exe (may be named otherwise)
- An activation key
- An application note containing the instructions as they are in this appendix

## 6.1   System Requirements

Before you use the update utility, make sure your computer is IBM PC-compatible with the following minimum system requirements:

- Intel-compatible 486DX-66 MHz CPU or higher
- One standard serial port
- Windows 95 operating system or higher
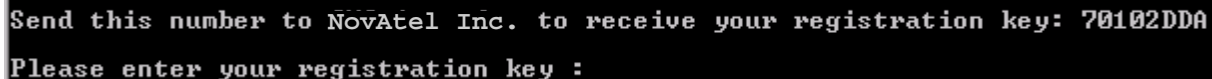
## 6.2   Utility Installation

Follow the steps below to install the Update utility:

1. Create a folder on the PC and name it "Update" for the Update utility installation. The folder name is not critical, but avoid names that are over 8 characters long.
2. Copy the Update utility executable file (update.exe for this example) into the newly created folder.
3. Select *Run* from the *Start* menu and press the *Browse* button to locate update.exe in the Update folder. Select update.exe, press the *Open* button and then *OK*.

   Alternatively, you can create a shortcut to the update.exe program on your desktop.

## 6.3   Registration Key



```
--------------------------------------------
Send this number to NovAtel Inc. to receive your registration key: 70102DDA

Please enter your registration key :
```

**Figure 14: Update Registration Window in DOS**

Contact NovAtel Inc. with the number that appears on your screen to obtain your registration key, see *Figure 14* above. Contact information can be found on *Page 10*. Follow the steps below to enter the registration key:

1. Copy and paste the registration key from a text file or the Customer Service e-mail. Right-click on the left corner of the DOS window, and select *Edit | Paste*, see *Figure 15* on *Page 33*. The registration key can also be entered manually.
2. Press <Enter>.

---

  ✉   The registration key contains your host computer information. Only the computer that originally generated the ID number that you sent to NovAtel, is able to run the update.exe program. If you have multiple updates or upgrades, you must do them all from this one computer.
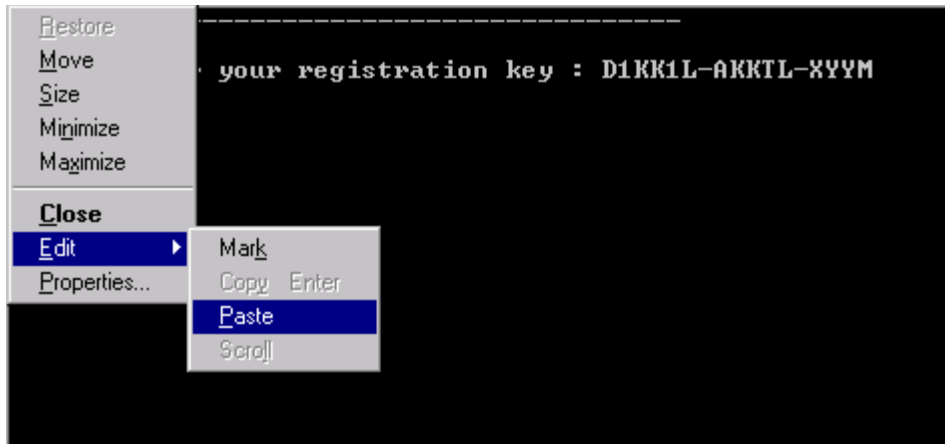
---

**Figure 15: Paste the Registration Key into the DOS Window**

## 6.4  Registration Key Accepted

A message confirms the Update software utility activation once the key has been entered, see *Figure 16* below. Press any key, for example <Enter>, to exit.
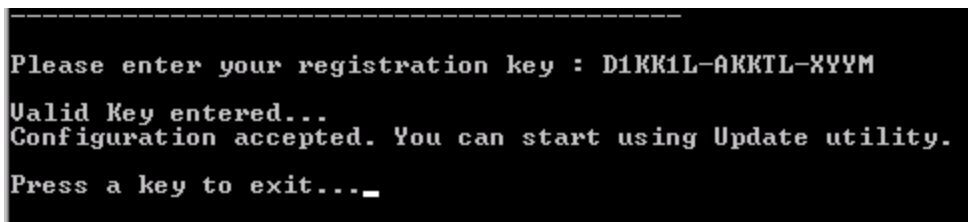


**Figure 16: Configuration Accepted**

## 6.5  Starting Software and Options Update

Once activated, the Update utility works until the date or session counter expires. Simply follow the instructions on the screen. The Update utility prompts you to remove or apply power to the GPS receiver. The sessions counter decrements every time a programming session is successfully executed. An example is shown in *Figure 17* below.
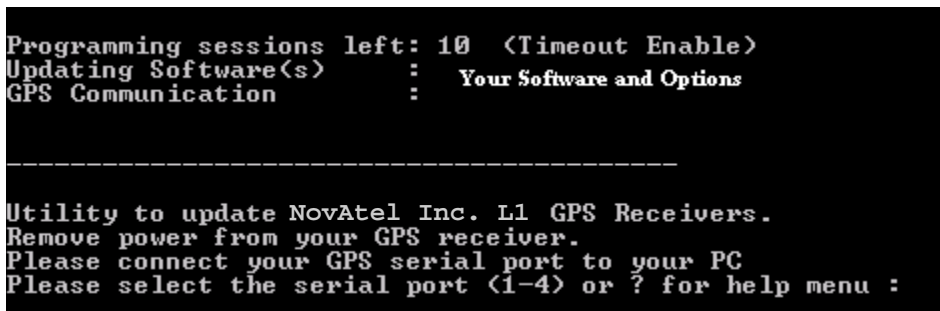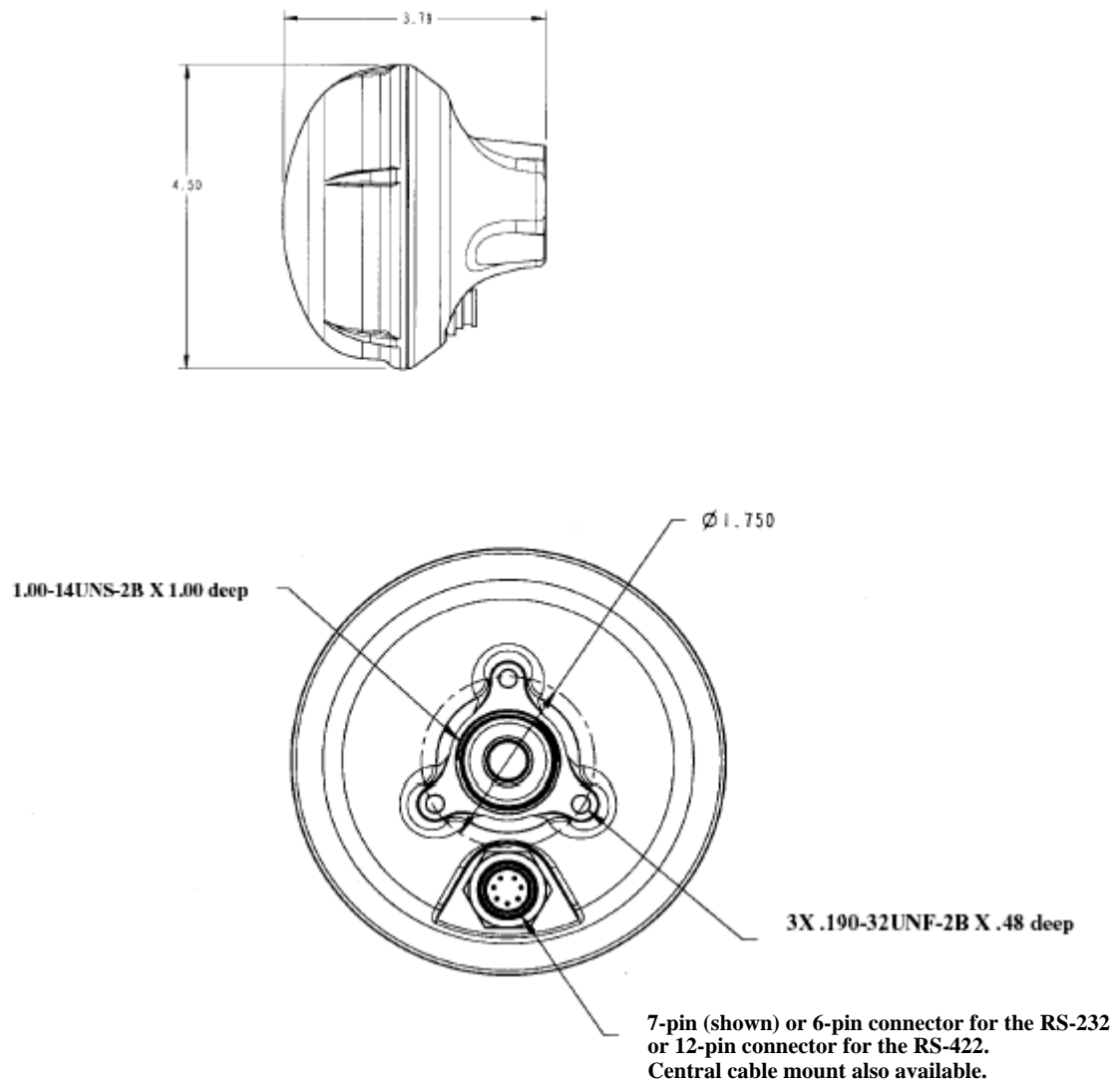


**Figure 17: Update Utility Activation**

### 6.5.1    *Programming Success*

The Update utility confirms programming success at the end of the programming session, see *Figure 18* below. At this point, remove power from your GPS receiver.



**Figure 18: End of Programming Session**

# Appendix A  Technical Specifications

## A.1  SMART ANTENNA Dimensions





✉  See also *Figures 5* and *6* on *Page 15*.

## A.2  SMART ANTENNA Specifications

| GENERAL CHARACTERISTICS |  |
| --- | --- |
| **12-PARALLEL "ALL-IN-VIEW" TRACKING** | |
| **L1 Frequency:** | 1,575.42 MHz |
| **Minimum Tracking Sensitivity:** | -135 dBm (antenna input level) |

| PERFORMANCE [a] | |
|---|---|
| **Position Accuracy:** | Single Point < 5 m (16.4') (CEP)<br>DGPS < 1 m (3.28') (CEP)<br>SBAS (for example WAAS and EGNOS) < 1.5 m (4.92')(CEP) |
| **Velocity Accuracy:** | 0.05 m/s RMS |
| **Measurement Precision:** | L1 C/A Code           75 cm RMS<br>L1 Carrier Phase      1 cm RMS (differential channel) |
| **Data Rate:** | Measurements       5 Hz<br>Position               5 Hz |
| **Time to First Fix:** | Hot start:     15 s typical, with current almanac, position, time and ephemeris<br>Warm start: 45 s typical, with current almanac, position and time but no recent ephemeris<br>Cold start:    166 s typical with no almanac, ephemeris, position or time |
| **Signal Re-Acquisition:** | < 1 s typical (5 s obscuration) |
| **Dynamics:**        **Velocity:** | 1852 km/h (514 m/s) (1151 miles/hr) [b] |
|            **Acceleration:** | 4 G (39.2 m/s$^2$) (128 feet/s$^2$) |
|                **Altitude:** | 18 km (60,000') [b] |
| INTERNAL ANTENNA | |
| **Polarization:** | Right hand circular |
| **Axial Ratio:** | 3 dB max |
| **Radiation Coverage:** | $\theta = 90°$           4 dBic<br>$15° < \theta < 90°$     -1.0 dBic<br>$10° \leq \theta < 15°$     -2.5 dBic |
| **VSWR:** | 2.0:1 |
| **Impedance:** | 50 $\Omega$ |
| HARDWARE SPECIFICATIONS | |
| **Input Voltage:** | +9 to +36 VDC (reverse polarity protected and SAE J1455 load dump protected) |
| **Power Consumption:** | 1.4 W (typical) |
| **Serial Communications:** | COM1 input/output port and DGPS input port, available with RS-232 or RS-422 interface up to 19,200 bps |
| **Message Formats:** | Input:    COM1           NMEA or proprietary binary<br>        DGPS IN [c]     RTCM-104 types 1, 2, 3, 9<br>Output: COM1           NMEA or proprietary binary (NMEA types GGA, GSA, GSV, RMC, VTG, ZDA, GLL plus proprietary messages) |

| **Time Mark Output:** | 1PPS output aligned to GPS time ± 200 ns typical |
|---|---|
| *PHYSICAL AND ENVIRONMENTAL* | |
| **Dimensions:** | 115 mm Diameter x 90 mm Height<br>(4.5" Diameter x 3.6" Height) |
| **Weight:** | 575 g maximum excluding cable (1.27 lb.) |
| **Mounting:** | 1-14 UNS threads x 1" deep and/or<br>3 x 10-32 UNF screws |
| **Connectors:** | RS-232: weathertight, 7-pin plastic or 6-pin metal<br>RS-422: weathertight, 12-pin standard or cable mount<br>See *Table 6, Connector Variations* on *Page 41* |
| **Temperature:** | Operating: -30°C to +75°C (-22°F to 167°F)<br>Storage: -40°C to +85°C (-40°F to 185°F) |
| **Humidity:** | SAE J1455/4.2 procedure I/II |
| **Waterproof:** | Sealed unit meets MIL-STD 810E method 512.3 (equivalent to 6-foot, 30-minute submersion) |
| **Shock:** | 30 g IEC 68-2-27, Test Ea (11 ms pulse) |
| **Vibration:** | Sinusoidal:  4 g SAE J1211, Figure 4, 1.5 hours/axis<br>Random:     7.5 g MIL-STD 810F method 514.5 procedure I |
| **Salt Spray:** | MIL-STD 810E method 509.3 (48 hours) |
| **Chemical Resistance:** | Compatible with chemicals encountered in the heavy-duty trucking industry |
| **Sand and Dust:** | MIL-STD 810E method 510.3 |
| **ESD:** | IEC 1000-4-2 level 2 (± 4 KV) |
| **EMI:** | FCC Class A, European CE, 89/EEC EN55022 class B, EN50082-1 |
| **Transient Protection:** | SAE J1455 4.11.2 typical vehicle transient voltage characteristic power lines (600 Watts, 1 m/s) |
| **Ultraviolet Light Protection:** | ASTM G53-88 |
| *SMART ANTENNA DEVELOPMENT KIT* | |
| **Accessories included:** | SMART ANTENNA plus:<br>   Interface cable<br>   Bushing adapter<br>   Magnetic mount<br>   AC/DC adapter<br>   CD containing *StarView* software and user manuals<br>   RS-422 to RS-232 converter (RS-422 models only) |

a. Typical values. Performance specifications are subject to GPS system characteristics, U.S. DOD operational degradation, ionospheric and tropospheric conditions, satellite geometry, baseline length and multipath effects. Assumes SA Off. Specifications subject to change without notice.

b. Limited by US and Canadian export laws

c. COM2 is also called DGPS IN

# A.3   Connector Pin Assignments

## A.3.1   RS-232

Pin numbers and signals for the 7-pin power/communication connector are shown below. There is also a 6-pin RS-232 version of the SMART ANTENNA, see *Figure 20* on *Page 39*. The orientation of these connectors on the SMART ANTENNA can be seen in *Figure 6* on *Page 15*. The most popular model (part number SA-232-07W-XXX) has the pinouts (from outside the SMART ANTENNA) shown in *Figure 19*:
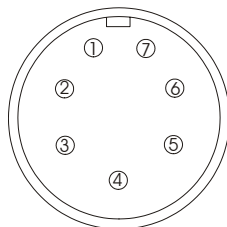


| Signal | Pin Number |
|--------|------------|
| VOLTAGE_INPUT (Vin) | 7 |
| GROUND | 6 |
| RX_2 | 2 |
| 1PPS [a] | 5 |
| TX_1 | 3 |
| RX_1 | 1 |
| GROUND | 4 |

a.  A buffer circuit operates from Vin (9 to 36 VDC).
    That is, the signal goes from Vin, down to 0 VDC
    for 1 ms, and then back up to Vin.

**Figure 19: SMART ANTENNA RS-232 7-Pin Connector Pinouts**

The SMART ANTENNA RS-232 configurations available are shown in *Table 4*:

**Table 4: SMART ANTENNA RS-232 Configurations**

| Part Number[a] | SMART ANTENNA Configuration |
|----------------|------------------------------|
| SA-232-07W-XXX | White, 7-pin plastic connector |
| SA-232-06W-XXX | White, 6-pin metal connector |
| SA-232-06G-XXX | Green, 6-pin metal connector |
| DK-SA-232-07W-XXX | Dev kit, white, 7-pin plastic connector |
| DK-SA-232-06G-XXX | Dev kit, green, 6-pin metal connector |

a.  The XXX in part numbers refers to software models. Please refer to
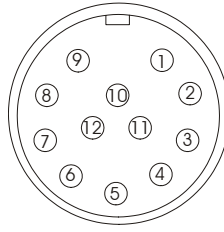    the *SUPERSTAR II Firmware Reference Manual*, see Reference [6]
    on *Page 12*.
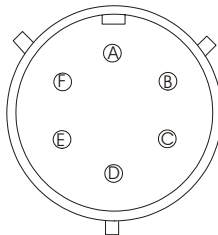
| Signal | Pin Number |
|---|---|
| GROUND | A |
| TX_1 | B |
| RX_2 | C |
| RX_1 | D |
| VOLTAGE_INPUT | E |
| 1PPS | F |

**Figure 20: SMART ANTENNA RS-232 6-Pin Connector Pinouts**

## *A.3.2   RS-422*

Pin numbers and signals for the 12-pin connector (part number 100-601910-002) from outside the SMART ANTENNA are shown below.



| Signal | Pin Number |
|---|:---:|
| POWER | 1 |
| GROUND 9 | 9 |
| RX_DATA_1- | 2 |
| RX_DATA_1+ | 3 |
| TX_DATA_1- | 4 |
| TX_DATA_1+ | 5 |
| RX_DATA_2- | 6 |
| RX_DATA_2+ | 7 |
| TX_DATA_2- [a] | 8 |
| TX_DATA_2+ [a] | 10 |
| 1PPS+ | 11 |
| 1PPS- | 12 |

a.  Alternate signal assignments on these pins (such as TX2 and an external battery connection for memory backup) are available as variations.

**Figure 21: SMART ANTENNA RS-422 12-Pin Connector Pinouts**

The SMART ANTENNA RS-422 configurations available are shown in *Table 5* on *Page 41*:

**Table 5: SMART ANTENNA RS-422 Configurations**

| Part Number [a] | SMART ANTENNA Configuration [b] |
|---|---|
| SA-422-12W-XXX | White, 12-pin plastic connector, standard cable mount |
| SA-422-CMW-XXX | White, 12-pin plastic connector, central cable mount |
| DK-SA-422-12W-XXX | Dev kit, 12-pin plastic connector, standard cable mount |

a. The XXX in part numbers refers to software models. Please refer to the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on *Page 12*.
b. For alternate signal assignments on these pins (such as TX2 and an external battery connection for memory backup), please contact NovAtel Inc. as shown in *Customer Service* on *Page 10*.

# A.4   Connections

The following connector variations are available:

**Table 6: Connector Variations**

| SMART ANTENNA | Connector Manufacturer | Connector on the SMART ANTENNA | Cable Mating Connector |
|---|---|---|---|
| RS-232 | Switchcraft | 7-pin plug: EN3P7MP | 7-contact socket: EN3C7FC |
| RS-232 | ConXall | 7-pin plug: 7281-7PG-300 | 7-contact socket: 6282-7SG-3XX |
| RS-232 | FCI | 6-pin plug: 851-07A10-6P50 | 6-contact socket: 851-06TI0-6S50 |
| RS-422 (standard mount) | Deutsch | 12-pin plug: 680023-2212P1 | 12-contact socket: MMP26C-2212S1 |
| RS-422 (central mount) | Deutsch | 12-pin plug: MMP21-2212P1 | 12-contact socket: MMP26C-2212S1 |

## A.5   Open-Ended SMART ANTENNA Cable

For the RS-232 SMART ANTENNA, this cable provides an unterminated cable end for connecting directly to other equipment. *Figure 22* shows the 6-pin version of the cable. See also *Table 2, Cable Variations* on *Page 17* and the 7-pin and 6-pin connector pin assignments on the SMART ANTENNA in *Section A.3.1, RS-232* starting on *Page 38*.

For the RS-422 SMART ANTENNA, two lengths of this cable are available. See also *Table 2* on *Page 17* and the 12-pin connector pin assignments on the SMART ANTENNA in *Section A.3.2, RS-422* on *Page 40*.

See also the *Open-Ended SMART ANTENNA Cable* on *Page 16* and *Table 6, Connector Variations* on *Page 41*.
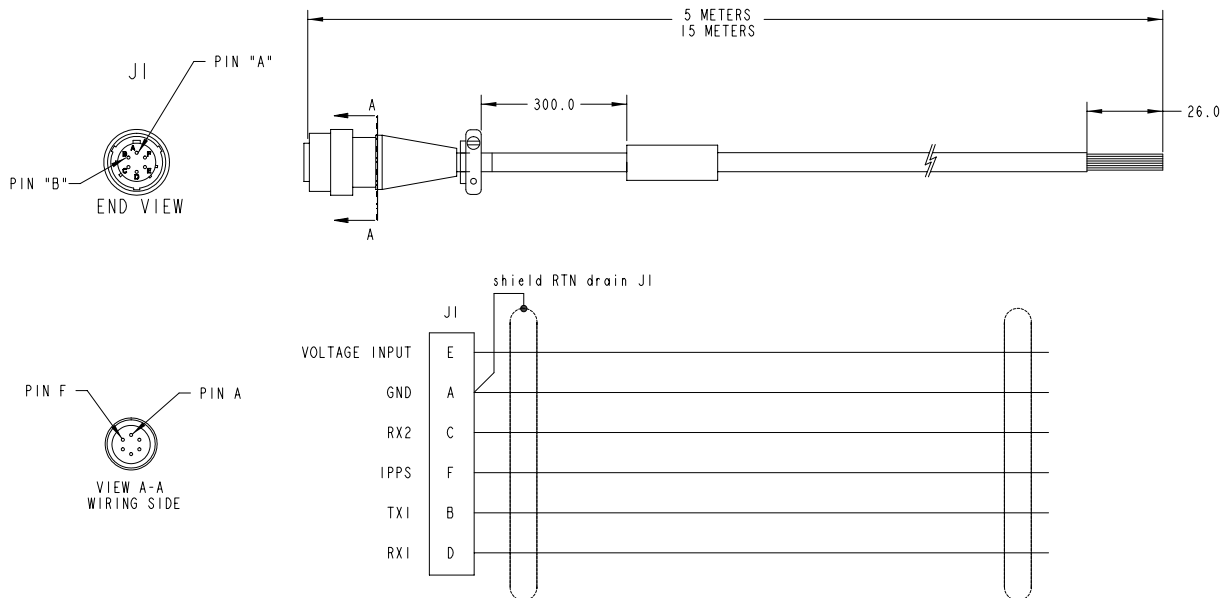
**Figure 22: RS-232 6-Pin Open-Ended SMART ANTENNA Cable**

## A.6 Multi-Connector SMART ANTENNA Cable

This multi-connector cable for the SMART ANTENNA uses separate connectors for DC power (a 12 V DC automobile input power plug), for the primary data signals (a DB-9 connector), and for auxiliary signals (unterminated wires), see *Figure 23*. The pinout for the DB-9 connector is shown in *Table 7*. See also *Table 2, Cable Variations* on *Page 17*.
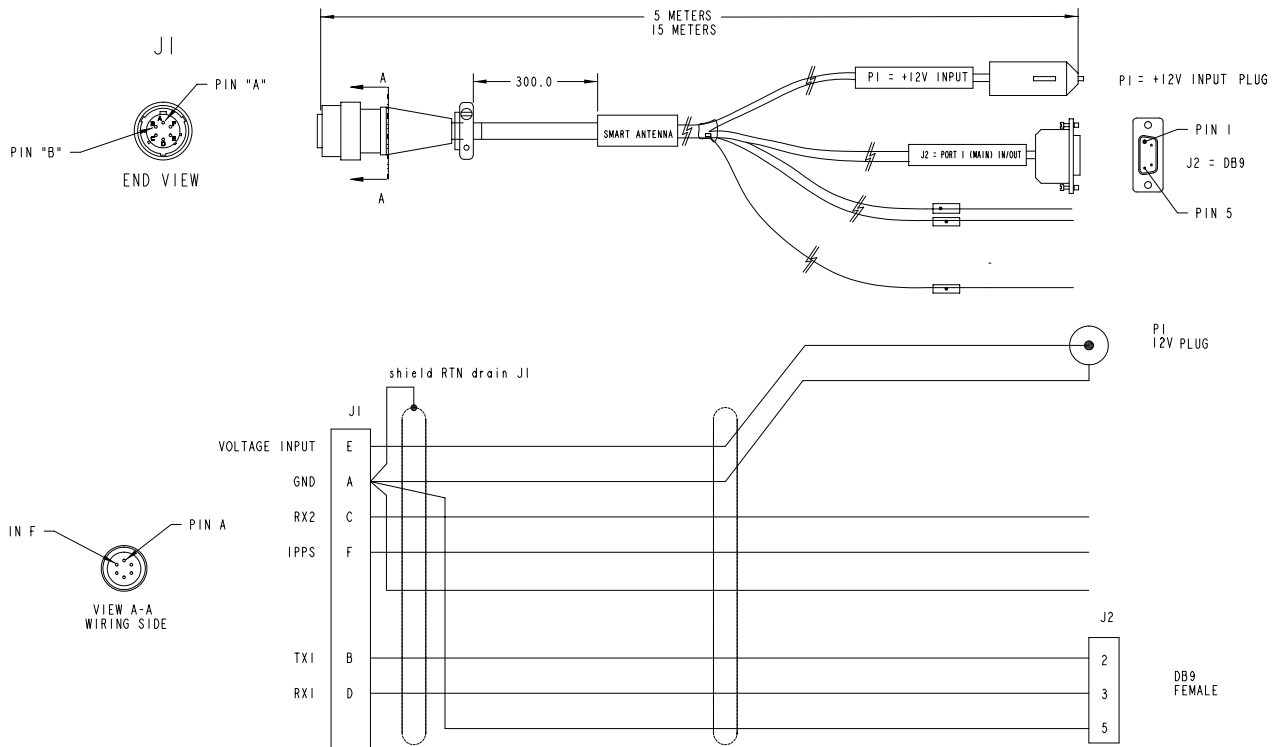
**Figure 23: RS-232 6-Pin Multi-Connector SMART ANTENNA Cable**

**Table 7: DB-9 Connector Pinout**

| Pin # | Signal | Signal Direction |
|-------|--------|------------------|
| 2 | TX1 | To host computer receive port. |
| 3 | RX1 | From host computer transmit port |
| 5 | GND | N/A |

See also the *Multi-Connector SMART ANTENNA Cable* on *Page 17* and *Table 6, Connector Variations* on *Page 41*.

✉ This multi-cable is not available for RS-422 SMART ANTENNA models.

# Appendix B    SMART ANTENNA Development Kit

## B.1    Development Kit

The SMART ANTENNA Development Kit allows you to easily evaluate the SMART ANTENNA. The Development Kit implements the receiver's operation and I/O functions using a PC, a serial/power cable with a 120 V AC to 12 V DC power adapter. The SUPERSTAR II is contained in the SMART ANTENNA unit, with an external serial/power connector.

*StarView* is a Windows application running on a PC that allows communication with the receiver. Commands and data requests can be sent through this application and received data is decoded and displayed in specific windows. A data logging facility is also provided within this tool. Details on the use of *StarView* is provided in the *StarView User Manual* (see Reference [5] on *Page 12*).

This section explains how to configure the Development Kit receiver, and how to interconnect the equipment.

See *Page 37* for a list of SMART ANTENNA Development Kit contents and *Table 4 and Table 5* starting on *Page 38* for variations in SMART ANTENNA models.

### B.1.1    Setup and Operation

⊠ The default data transfer rate is 9600 bps unless your receiver model has Carrier Phase Output (CP) capability with 19200 bps as the default.

Your receiver must be a BASE model to act as a base station.

A list of models may be found in *Appendix A* of the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on *Page 12*.

#### B.1.1.1    Normal Setup

See *Figure 11* on *Page 19* when following these instructions:

1. Connect the SMART ANTENNA to a PC using the multi-purpose cable if it is provided.

2. Connect the power supply to the SMART ANTENNA using the power connector on the multi-purpose cable.

3. Launch the *StarView* software application, see *StarView Software Installation* on *Page 45*. Refer also to the *StarView User Manual*, see Reference [5] on *Page 12*.

#### B.1.1.2    DGPS Setup with the SMART ANTENNA

Set up the equipment as in *Figure 24* on *Page 45*, for differential messages. Differential operation requires that stations operate in pairs. Each pair consists of a base station and a rover station. For each receiver, the base and the rover, follow the set-up steps in *Section B.1.1.1* on *Page 44*. Then also connect a RS-232 communications device to each SMART ANTENNA with a user-supplied connector on the multi-purpose cable's open end. For example this might connect to a radio modem, for sending or receiving differential GPS messages.

A differential network can also be established when there is more than one rover station linked to a single base station.

The base SMART ANTENNA must be initialized to fix its position (latitude, longitude and height of its phase center).

The rover station must be tracking the same satellites as the base station in order for corrections to take effect. Only common satellite pseudoranges will use the differential corrections. When the rover is able to compute its positions based on pseudorange corrections from the base station, its position accuracies will approach that of

the base station. Remember, the computed position solutions are that of the GPS receiving SMART
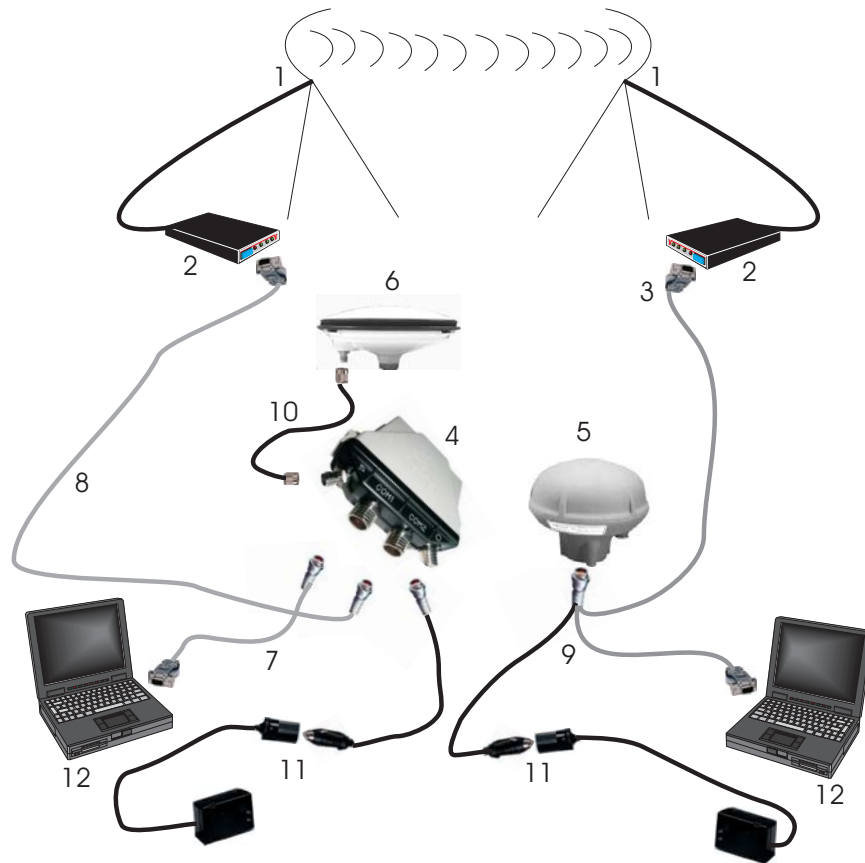ANTENNA phase center.



**Figure 24: Differential GPS Setup**

| Reference | Description | Reference | Description |
|-----------|-------------|-----------|-------------|
| 1 | User-supplied radio data link | 7 | FlexPak COM1 port to PC cable |
| 2 | User-supplied modem | 8 | FlexPak COM2 port to modem cable |
| 3 | User-supplied connector on open end of SMART multi-cable | 9 | SMART multi-cable to power, PC and modem |
| 4 | FlexPak-SSII (base station) | 10 | FlexPak ANT port to antenna cable |
| 5 | SMART ANTENNA (rover station) | 11 | Adaptor to power source cable |
| 6 | L1 GPS antenna | 12 | User-supplied PC |

## B.2   StarView Software Installation

Once the receiver is connected to the PC and power supply, install the *StarView* software. The *StarView CD is*
supplied with the development kit, otherwise *StarView* is available on our website (see *below*).

To install *StarView* from CD:

1. Start up the PC.

2. Insert the *StarView* CD in the CD-ROM drive of the computer.

3. Install the *StarView* software by following the steps on the screen. If the Setup utility is not
   automatically accessible when the CD is inserted, select *Run* from the *Start* menu and press the
   *Browse* button to locate Setup.exe on the CD drive.

4. Click on the *OK* button to install the *StarView* software and follow the steps on the screen.

From our website:

1. Start up the PC and launch your internet service program.

2. Go to our website at http://www.novatel.com/Downloads/fwswupdates.html and scroll down to the *Superstar II Family Firmware/Software* section.

3. Download the *StarView* setup program and save it in a temporary directory (for example, C:\temp).

4. Use the setup program to install the *StarView* software by following the steps on the screen.

---

⊠ After installation, *StarView* also appears in the Windows Start menu at *Start | Program Files | NovAtel L1 Software.*

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