



SUPERSTAR II

User Manual



SUPERSTAR II User Manual

Publication Number: OM-20000077
Revision Level: 6
Revision Date: 2005/06/09

Proprietary Notice

Information in this document is subject to change without notice and does not represent a commitment on the part of NovAtel Inc. The software described in this document is furnished under a licence agreement or non-disclosure agreement. The software may be used or copied only in accordance with the terms of the agreement. It is against the law to copy the software on any medium except as specifically allowed in the license or non-disclosure agreement.

No part of this manual may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, for any purpose without the express written permission of a duly authorized representative of NovAtel Inc.

The information contained within this manual is believed to be true and correct at the time of publication.

NovAtel is a registered trademark of NovAtel Inc.

SUPERSTAR, FlexPak-SSII and StarView are trademarks of NovAtel Inc.

All other brand names are trademarks of their respective holders.

© Copyright 2003-2005 NovAtel Inc. All rights reserved.

Unpublished rights reserved under International copyright laws.

Table of Contents

Software License	7
Customer Service	9
Notices	10
Warranty Policy	12
Foreword	13
1 Introduction	14
1.1 SUPERSTAR II GPS Card	14
1.2 FlexPak-SSII	15
2 Receiver Specifications	17
2.1 System Architecture	17
2.2 Physical Characteristics	17
2.2.1 Radio Frequency (RF) Section	17
2.2.2 Digital Electronics Section	17
2.3 Enclosure and Wiring Harness	18
2.4 GPS Antenna	18
2.4.1 Optional LNA Power Supply	18
2.5 Principal Power Supply	18
2.6 Data Communications Equipment	18
3 Installation	19
3.1 Electrostatic Discharge	20
3.2 Equipment Interconnection	20
3.2.1 Serial Connection	20
3.2.2 Power Connection	21
3.3 Installation Considerations	21
3.3.1 Antenna Location	21
3.3.2 Base Station Location	21
3.3.3 Data Link	22
3.3.4 Base Station and Rover Units Separation	22
3.4 Connectors and Connector Pins Assignment	22
3.4.1 J1 Interface and Power Connector	22
3.4.2 Serial Data Interface	23
3.4.3 RF Connector (J2)	23
3.4.4 Memory Back-Up	24
3.5 Protocol Selection and Non Volatile Memory	25
3.5.1 Non Volatile Memory	25
3.6 Default Configuration	26
3.7 Installation Overview	27
4 Operation	28
4.1 Communications with the Receiver	29
4.1.1 Serial Port Default Settings	29
4.2 Getting Started	29
4.2.1 Power-Up Information	30
4.2.2 Boot Information	30
4.3 Data Requests	30
4.4 Configurable Parameters	31
4.4.1 Mask Angle	31

4.4.2 GPS Antenna Position.....	31
4.5 Receiver States	31
4.5.1 Non-Operational State.....	31
4.5.2 Operational States.....	31
4.6 Built-In Status Tests.....	33
4.7 DATUM Support	33
5 Positioning Modes of Operation	34
5.1 Single-Point or Autonomous	34
5.1.1 GPS System Errors	34
5.2 Satellite-Based Augmentation System (SBAS)	35
5.2.1 SBAS Receiver.....	36
5.2.2 SBAS Messages	36
6 Troubleshooting	37
7 Updating Receiver Firmware	39
7.1 System Requirements	39
7.2 Utility Installation	39
7.3 Registration Key	39
7.4 Registration Key Accepted	40
7.5 Starting Software and Options Update	40
7.5.1 Programming Success	41

APPENDICES

A Technical Specifications	42
B FlexPak-SSII Specifications	47
C Antenna Specifications	54

Tables

1	Related Publications	13
2	Minimum J1 Connections	22
3	Use of Discretes	25
4	Non-Volatile Memory Data	25
5	Cable Lengths Vs. Gain	37
6	J1 Interfaces and Power Connector Pin Assignment	45
7	I/O Signals Voltage Limits	46
8	FlexPak Status Indicators	48
9	FlexPak COM Ports Pin-Out Descriptions	48
10	Coaxial Cable Specifications	54
11	Antenna Gain Depending on Cable Length Required	55
12	Typical Current Consumption Versus Antenna Gain	55
13	Recommended Geodetic Active Antennas	55
14	Recommended Active Antennas	56

Figures

1	SUPERSTAR II Receiver	14
2	FlexPak-SSII Enclosure	15
3	Receiver Block Diagram.....	17
4	Typical System Configuration.....	19
5	Back-Up Power	24
6	Basic Setup	27
7	Typical Operational Configuration	28
8	The SBAS Concept	36
9	Update Registration Window in DOS	39
10	Paste the Registration Key into the DOS Window	40
11	Configuration Accepted	40
12	Update Utility Activation	40
13	End of Programming Session.....	41
14	SUPERSTAR II Dimensions.....	44
15	FlexPak Power Cable.....	49
16	FlexPak 13-Pin Serial Cable	50
17	Differential GPS Setup	52
18	GPS Antenna 201-990146-716 (MCX, +12 dB)	56
19	GPS Antenna 201-990147-606 (+26 dB)	57
20	Coaxial Cable Assembly	57
21	GPS Antenna 201-990147-432 (1575 MHz) and 201-990144-807 (Pre-Amplifier).....	58

Software License

BY INSTALLING, COPYING, OR OTHERWISE USING THE SOFTWARE PRODUCT, YOU AGREE TO BE BOUND BY THE TERMS OF THIS AGREEMENT. IF YOU DO NOT AGREE WITH THESE TERMS OF USE, DO NOT INSTALL, COPY OR USE THIS ELECTRONIC PRODUCT (SOFTWARE, FIRMWARE, SCRIPT FILES, OR OTHER ELECTRONIC PRODUCT WHETHER ON A CD OR AVAILABLE ON THE COMPANY WEB SITE) (HEREINAFTER REFERRED TO AS "SOFTWARE").

1. **License:** NovAtel Inc. ("NovAtel") grants you a non-exclusive, non-transferable license (not a sale) to, where the Software will be used on NovAtel supplied hardware or in conjunction with other NovAtel supplied software, use the Software with the product(s) as supplied by NovAtel. You agree not to use the Software for any purpose other than the due exercise of the rights and licences hereby agreed to be granted to you.
2. **Copyright:** NovAtel owns, or has the right to sublicense, all copyright, trade secret, patent and other proprietary rights in the Software and the Software is protected by national copyright laws, international treaty provisions and all other applicable national laws. You must treat the Software like any other copyrighted material except that you may make one copy of the Software solely for backup or archival purposes (one copy may be made for each piece of NovAtel hardware on which it is installed or where used in conjunction with other NovAtel supplied software), the media of said copy shall bear labels showing all trademark and copyright notices that appear on the original copy. You may not copy the product manual or written materials accompanying the Software. No right is conveyed by this Agreement for the use, directly, indirectly, by implication or otherwise by Licensee of the name of NovAtel, or of any trade names or nomenclature used by NovAtel, or any other words or combinations of words proprietary to NovAtel, in connection with this Agreement, without the prior written consent of NovAtel.
3. **Patent Infringement:** NovAtel shall not be liable to indemnify the Licensee against any loss sustained by it as the result of any claim made or action brought by any third party for infringement of any letters patent, registered design or like instrument of privilege by reason of the use or application of the Software by the Licensee or any other information supplied or to be supplied to the Licensee pursuant to the terms of this Agreement. NovAtel shall not be bound to take legal proceedings against any third party in respect of any infringement of letters patent, registered design or like instrument of privilege which may now or at any future time be owned by it. However, should NovAtel elect to take such legal proceedings, at NovAtel's request, Licensee shall co-operate reasonably with NovAtel in all legal actions concerning this license of the Software under this Agreement taken against any third party by NovAtel to protect its rights in the Software. NovAtel shall bear all reasonable costs and expenses incurred by Licensee in the course of co-operating with NovAtel in such legal action.

Restrictions: You may not: (1) copy (other than as provided for in paragraph 2), distribute, transfer, rent, lease, lend, sell or sublicense all or any portion of the Software; (2) modify or prepare derivative works of the Software; (3) use the Software in connection with computer-based services business or publicly display visual output of the Software; (4) transmit the Software over a network, by telephone or electronically using any means; or (5) reverse engineer, decompile or disassemble the Software. You agree to keep confidential and use your best efforts to prevent and protect the contents of the Software from unauthorized disclosure or use.

4. **Term and Termination:** This Agreement and the rights and licences hereby granted shall continue in force in perpetuity unless terminated by NovAtel or Licensee in accordance herewith. In the event that the Licensee shall at any time during the term of this Agreement: i) be in breach of its obligations hereunder where such breach is irremediable or if capable of remedy is not remedied within 30 days of notice from NovAtel requiring its remedy; or ii) be or become bankrupt or insolvent or make any composition with its creditors or have a receiver or manager appointed of the whole or any part of its undertaking or assets or (otherwise as a solvent company for the purpose of and followed by an amalgamation or reconstruction hereunder its successor shall be bound by its obligations hereunder) commence to be wound up; or iii) be acquired or otherwise come under the direct or indirect control of a person or persons other than those controlling it, then and in any event NovAtel may forthwith by notice in writing terminate this Agreement together with the rights and licences hereby granted by NovAtel. Licensee may terminate this Agreement by providing 30 days prior written notice to NovAtel. Upon termination, for any reasons, the Licensee shall promptly, on NovAtel's request, return to NovAtel or at the election of NovAtel destroy all copies of any documents and extracts comprising or containing the Software. The Licensee shall also erase any copies of the Software residing on Licensee's computer equipment. Termination shall be without prejudice to the accrued rights of either party, including payments due to NovAtel. This provision shall survive termination of this Agreement howsoever arising.

5. Warranty:

- a. For 90 days from the date of shipment of new purchased product, NovAtel warrants that the media (for example, compact disk) on which the Software is contained will be free from defects in materials and workmanship. This warranty does not cover damage caused by improper use or neglect.
- b. NovAtel does not warrant the contents of the Software or that it will be error free. The Software is furnished "AS IS" and without warranty as to the performance or results you may obtain by using the Software. The entire risk as to the results and performance of the Software is assumed by you.

6. Indemnification: NovAtel shall be under no obligation or liability of any kind (in contract, tort or otherwise and whether directly or indirectly or by way of indemnity contribution or otherwise howsoever) to the Licensee and the Licensee will indemnify and hold NovAtel harmless against all or any loss, damage, actions, costs, claims, demands and other liabilities or any kind whatsoever (direct, consequential, special or otherwise) arising directly or indirectly out of or by reason of the use by the Licensee of the Software whether the same shall arise in consequence of any such infringement, deficiency, inaccuracy, error or other defect therein and whether or not involving negligence on the part of any person.

7. For Software UPDATES and UPGRADES, and regular customer support, contact the NovAtel GPS Hotline at 1-800-NOVATEL (U.S. or Canada only), or 403-295-4900, Fax 403-295-4901, e-mail to support@novatel.ca, website: <http://www.novatel.ca> or write to:

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

8. Disclaimer of Warranty and Limitation of Liability:

- a. THE WARRANTIES IN THIS AGREEMENT REPLACE ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. NovAtel DISCLAIMS AND EXCLUDES ALL OTHER WARRANTIES. IN NO EVENT WILL NovAtel's LIABILITY OF ANY KIND INCLUDE ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING LOST PROFITS, EVEN IF NovAtel HAS KNOWLEDGE OF THE POTENTIAL LOSS OR DAMAGE.
- b. NovAtel will not be liable for any loss or damage caused by delay in furnishing the Software or any other performance under this Agreement.
- c. NovAtel's entire liability and your exclusive remedies for our liability of any kind (including liability for negligence) for the Software covered by this Agreement and all other performance or non-performance by NovAtel under or related to this Agreement are to the remedies specified by this Agreement.

This Agreement is governed by the laws of the Province of Alberta, Canada. Each of the parties hereto irrevocably attorns to the jurisdiction of the courts of the Province of Alberta.

Customer Service

Contact Information

If you have any questions or concerns regarding your SUPERSTAR II, 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:

<i>Receiver Status, ID# 49</i>	one shot	<i>Navigation Data (ECEF), ID# 21</i>	continuous
<i>Ephemeris Data, ID# 22</i>	continuous	<i>Navigation Data (User), ID# 20</i>	continuous
<i>Measurement Block, ID# 23</i>	1 Hz	<i>Satellite Visibility, ID# 33</i>	continuous
<i>Fault Log, ID# 57</i>	one shot	<i>Channel Assignment, ID# 6</i>	continuous
<i>HW/SW Identification, ID# 45</i>	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 *Chapter 7, Updating Receiver Firmware* starting on *Page 39*.

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

The following notices apply to the SUPERSTAR II card.

The receiver operates within the performance requirements specified herein.

Electrostatic Discharge

This equipment contains components which are sensitive to damage by electrostatic discharge (ESD).

A label bearing an ESD marking appears on packaging for the card.

When cards have to be replaced or returned for service the following precautions should be observed:

1. Handle the card as little as possible. Do not touch the leads, pin or tracks while handling.
2. Keep spare cards in the ESD protective packing until they are ready for use.
3. Discharge static before handling the cards (removal or replacement) by touching a grounded metallic surface such as a rack or cabinet hardware. Use of wrist strap grounded through a one mega-ohm resistor is preferred when handling cards. (This ground should be the same as the equipment ground).
4. Do not slide static-sensitive cards over any surface.
5. Clothing must not come in contact with components or assemblies. Wear short sleeves or roll-up long sleeves.
6. Package parts properly for storage or transportation. Cards which are removed from the equipment should be placed into ESD protective packing immediately. Do not place any paper, card or other plastic inside the ESD protective packing.
7. When packing these cards for storage or transportation, keep them in the bag. Fold over and seal the mouth of the bag to keep out any static generating packing material (for example foamed polystyrene). Pack around the bag firmly to prevent motion which could generate static.

The following notices apply to the FlexPak-SSII.

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 your NovAtel dealer 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* on *Page 10*.

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

Electromagnetic Compatibility (EMC)

Common Regulatory Testing

- FCC, Part 15 Radiated Emissions, Class B
- EN 55022 (CISPR 22) Radiated and Conducted Emissions, Class B
- EN 61000-6-3 Generic Emissions, Class B
- EN 61000-6-1 Generic Immunity
- EN 61000-4-2 Electrostatic Discharge Immunity
- EN 61000-4-3 Radiated RF EM Field Immunity Test
- EN 61000-4-4 Electrical Fast Transient/Burst Test
- EN 61000-4-5 Surge Immunity
- EN 61000-4-6 Conducted Immunity
- EN 61000-4-8 Magnetic Field Immunity
- ENV 50204 Radiated Immunity, Keyed Carrier, 900 MHz Phone Band
- CSA/UL/IEC/EN 60950 Safety of Information Technology Equipment

Lightning Protection Notice

1. Do not install the external antenna lines extra-building during a lightning storm.
2. A primary lightning protection device must be provided by the operator/customer according to local building codes, as part of the extra-building installation, to ensure transient voltage levels of less than 600 V maximum.

Warranty Policy

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

SUPERSTAR II GPSCard Receiver	One (1) Year
FlexPak-SSII	One (1) Year
GPSAntenna™ Series	One (1) Year
Cables and Accessories	Ninety (90) Days
Software Support	One (1) Year

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

Determination of replacement or repair will be made by NovAtel personnel or by technical personnel expressly authorized by NovAtel for this purpose.

THE FOREGOING WARRANTIES DO NOT EXTEND TO (I) NONCONFORMITIES, DEFECTS OR ERRORS IN THE PRODUCTS DUE TO ACCIDENT, ABUSE, MISUSE OR NEGLIGENT USE OF THE PRODUCTS OR USE IN OTHER THAN A NORMAL AND CUSTOMARY MANNER, ENVIRONMENTAL CONDITIONS NOT CONFORMING TO NOVATEL'S SPECIFICATIONS, OR FAILURE TO FOLLOW PRESCRIBED INSTALLATION, OPERATING AND MAINTENANCE PROCEDURES, (II) DEFECTS, ERRORS OR NONCONFORMITIES IN THE PRODUCTS DUE TO MODIFICATIONS, ALTERATIONS, ADDITIONS OR CHANGES NOT MADE IN ACCORDANCE WITH NOVATEL'S SPECIFICATIONS OR AUTHORIZED BY NOVATEL, (III) NORMAL WEAR AND TEAR, (IV) DAMAGE CAUSED BY FORCE OF NATURE OR ACT OF ANY THIRD PERSON, (V) SHIPPING DAMAGE; OR (VI) SERVICE OR REPAIR OF PRODUCT BY THE DEALER WITHOUT PRIOR WRITTEN CONSENT FROM NOVATEL. IN ADDITION, THE FOREGOING WARRANTIES SHALL NOT APPLY TO PRODUCTS DESIGNATED BY NOVATEL AS BETA SITE TEST SAMPLES, EXPERIMENTAL, DEVELOPMENTAL, PREPRODUCTION, SAMPLE, INCOMPLETE OR OUT OF SPECIFICATION PRODUCTS OR TO RETURNED PRODUCTS IF THE ORIGINAL IDENTIFICATION MARKS HAVE BEEN REMOVED OR ALTERED. THE WARRANTIES AND REMEDIES ARE EXCLUSIVE AND ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, WRITTEN OR ORAL, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE ARE EXCLUDED. NOVATEL SHALL NOT BE LIABLE FOR ANY LOSS, DAMAGE, EXPENSE, OR INJURY ARISING DIRECTLY OR INDIRECTLY OUT OF THE PURCHASE, INSTALLATION, OPERATION, USE OR LICENSING OR PRODUCTS OR SERVICES. IN NO EVENT SHALL NOVATEL BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY KIND OR NATURE DUE TO ANY CAUSE.

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 *Registered Services* followed by *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 ESD and shipping damage.

Foreword

Congratulations!

Thank you for purchasing a SUPERSTAR II receiver. Whether you have purchased a stand alone GPS card, a packaged receiver or a development kit, this user manual defines the design, operational, physical, interface, functional and performance requirements for the receiver.

Scope

This document provides information on the SUPERSTAR II GPS OEM board and its optional FlexPak-SSII enclosure. The following sections describe functionality, mechanical and electrical characteristics of the SUPERSTAR II board. The software messages are described in the companion *SUPERSTAR II Firmware Reference Manual*, see Reference [6] below. The *GPS+ Reference Manual* also contains reference materials for you. It is available on our website at <http://www.novatel.com/Products/productmanuals.html>.

Related Publications

The related publications are listed in *Table 1*.

Table 1: Related Publications

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

- a. See the *Standards/References* section of the *GPS+ Reference Manual*, available on our website at <http://www.novatel.com/Products/productmanuals.html> for contact information.
- b. For the latest versions of these manuals, visit our website, see footnote *a* above for the link.

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.

The SUPERSTAR II, see *Figure 1* below, is a quality GPS receiver used for a variety of embedded applications. The SUPERSTAR II has robust signal tracking capability under difficult signal conditions.

The SUPERSTAR II is a complete GPS OEM sensor that provides 3D navigation on a single compact board with full differential capability. The SUPERSTAR II is a 12-channel GPS receiver that tracks all in-view satellites. It is fully autonomous such that once power is applied, the SUPERSTAR II automatically searches, acquires and tracks GPS satellites. SUPERSTAR II receivers also have a Satellite Based Augmentation System (SBAS) option, for example WAAS and EGNOS. When a sufficient number of satellites are tracked with valid measurements, the SUPERSTAR II produces a 3-D position and velocity output with an associated figure of merit (FOM).



Figure 1: SUPERSTAR II Receiver

This SUPERSTAR II receiver is available in 2 formats:

- as an OEM board
- within the FlexPak-SSII enclosure

1.1 SUPERSTAR II GPS Card

The SUPERSTAR II card is available in a 3.3 V or a 5 V model. You can tell which model of card you have by looking at its part number. Part numbers ending in -1XX, such as 245-604090-131, are 3 V while part numbers ending in -0XX, such as 245-604090-033, are 5 V.

The main features of the SUPERSTAR II are:

- Decodes differential corrections encoded in the RTCM message format
- Twelve channel correlator for all-in-view satellite tracking
- Single chip RF front end
- Active antenna support
- Single 5 V or 3.3 V power input
- Complete L1 GPS receiver and navigator on a single compact board
- Two general purpose input lines

- One general purpose input/output (GPIO) line
- Operating temperature range of -30°C to +75°C
- 1PPS output aligned on GPS Time ± 200 ns
- 1Hz measurement output aligned on GPS Time
- Support for 62 predefined datums
- Field-upgradeable firmware (stored in Flash memory) through the serial port
- Code and Carrier Phase tracking of L1 GPS frequency for increased accuracy
- Retention of satellite almanac and ephemeris data in non-volatile memory for rapid time-to-first-fix (TTFF) after power interruption
- Very fast signal re-acquisition when signal masking (obstruction or vehicle attitude) occurs
- Allows for warm start
- 1 Hz Position, Velocity and Time (PVT) output

Available Model Features¹:

- 1 Hz and 5 Hz carrier phase measurements (*Message ID# 23, Measurement Block Data* only works with these models)
- SBAS capability
- Precise timing
- 5 Hz PVT output
- RTCM DGPS Base

1.2 FlexPak-SSII

The FlexPak-SSII, see *Figure 2*, is a hardware interface between your equipment and the SUPERSTAR II GPS card. The Development Kit is an equipment set permitting easy evaluation of the receiver and includes the SUPERSTAR II GPS card in a FlexPak-SSII enclosure. It provides single-frequency positioning with two COM ports. A full description of this Development Kit and technical specifications of the FlexPak-SSII are provided in *Appendix B, FlexPak-SSII Specifications*, starting on *Page 47*.



Figure 2: FlexPak-SSII Enclosure

1. Refer to *Appendix A* of the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on *Page 13*, for models and their capabilities.

The FlexPak-SSII offers the following features:

- A shock and dust resistant enclosure
- Waterproof to IEC 60529 standards IPX4 and IPX7
- Low power consumption
- Single +3.3 V power input
- Two RS-232 serial ports
- PPS output
- Indicators for valid position, COM activity and power

If you purchased a SUPERSTAR II Development Kit, the following is also provided with your FlexPak-SSII:

- 1 Deutsch to DB-9 serial cable
- 1 Deutsch to automobile power connector cable
- 1 AC/DC adaptor
- 1 +12 dB active GPS antenna with magnetic mount and integrated RF cable
- 1 CD containing:
 - An installation program for NovAtel's GPS L1 graphical user interface software, *StarView*. See *StarView Software Installation* on Page 53, *Getting Started* on Page 29 and Reference [5] on Page 13.
 - Product documentation, including user manuals

2.1 System Architecture

Figure 3 below depicts the block diagram of the receiver assembly.

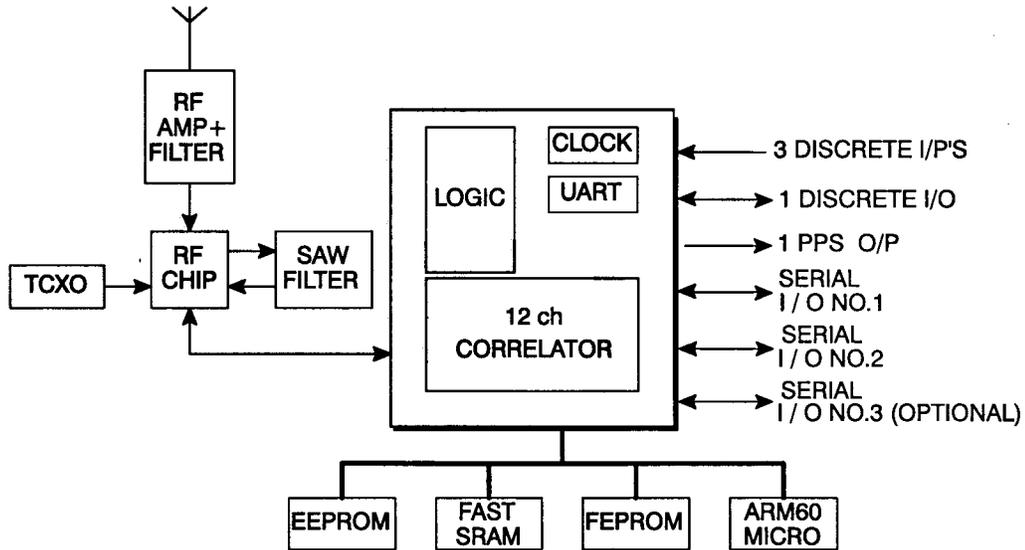


Figure 3: Receiver Block Diagram

2.2 Physical Characteristics

This section applies to the OEM board version of the receiver.

For details on the physical characteristics of the FlexPak-SSII version of the receiver, please see *Appendix B, FlexPak-SSII Specifications* starting on Page 47.

The receiver assembly consists of one printed circuit board (PCB) containing an RF section, digital and I/O sections located on both sides of the PCB, and a surface mount connector. The receiver does not require heat-sinking to a metal case.

Mechanical packaging of the receiver is designed to allow for mounting within various different configurations of OEM units.

2.2.1 Radio Frequency (RF) Section

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

2.2.2 Digital Electronics Section

The digital section of the receiver, receives a down-converted, amplified GPS signal which filtered, digitized and processed to obtain a GPS solution (position, velocity and time). The digital section consists of an analog-

to-digital converter, a 16-bit system processor, memory, control and configuration logic, signal processing circuitry, serial peripheral devices, and supporting circuitry.

The digital section performs the translations and calculations necessary to convert the IF analog signals into usable position and status information. It also handles all I/O functions, including the auxiliary strobe signals, which are described in detail in *Section 3.4, Connectors and Connector Pins Assignment* starting on *Page 22*. For input and output levels please see *Appendix A, Technical Specifications* starting on *Page 42*.

2.3 Enclosure and Wiring Harness

An enclosure is necessary to protect the GPSCard from environmental exposure and RF interference. If a FlexPak-SSII is not being used as the enclosure, a wiring harness is also required to provide an interface to the SUPERSTAR II's antenna and power inputs as well as data and status signals. *Section A.2* starting on *Page 42* for details.

2.4 GPS Antenna

The purpose of the GPS antenna is to convert the electromagnetic waves transmitted by the GPS satellites into RF signals. NovAtel's active antennas are recommended.

2.4.1 Optional LNA Power Supply

Power for the antenna LNA supplied by RF cable to J2 must be 5 V, see also *Section 3.4.3, RF Connector (J2)* starting on *Page 23*.

External LNA power is not possible with a FlexPak-SSII receiver.

2.5 Principal Power Supply

A single external power supply capable of delivering 3.3 V or 5 V, depending on the model, is necessary to operate the receiver. See *Memory Back-Up* on *Page 24* for information on power backups.

See also *Appendix A, Technical Specifications* starting on *Page 42*.



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

2.6 Data Communications Equipment

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

This section covers the installation of the receiver.

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.3, StarView Software Installation* starting on *Page 53* for its installation instructions. Details on the *StarView* program are provided in Reference [5] on *Page 13*.

The SUPERSTAR II is an OEM product designed for flexibility of integration and configuration. You are free to select an appropriate data and signal interface, power supply system and mounting structure. This allows you to custom-design your own GPS-based positioning system around the SUPERSTAR II.

A typical system configuration is shown in *Figure 4*:

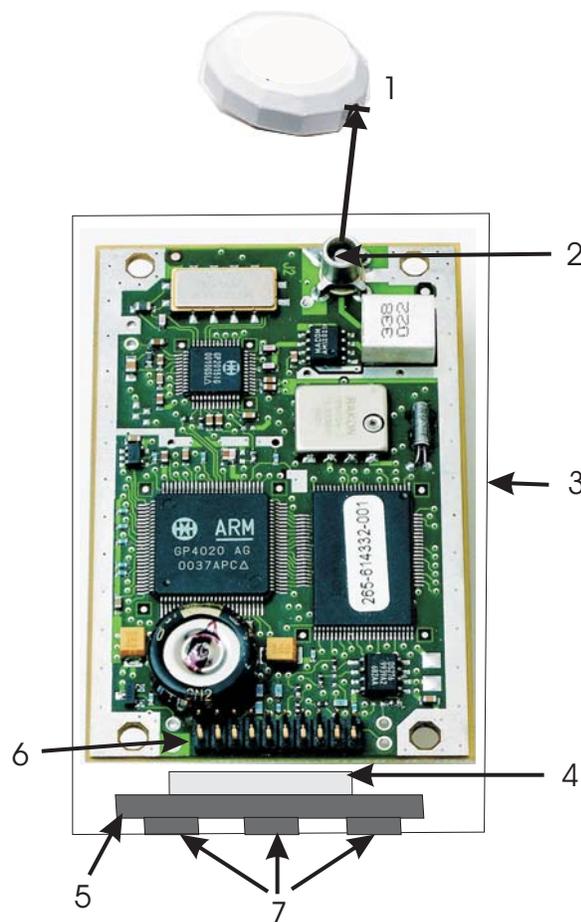


Figure 4: Typical System Configuration

Reference	Description
1	GPS antenna
2	J2
3	User-supplied enclosure, or for example, NovAtel's FlexPak enclosure
4	User-supplied power, data and signal connector to J1
5	User-supplied interface
6	J1, 20-pin digital connector
7	COM1, COM2 and power connectors

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

- NovAtel GPS antenna
- NovAtel coaxial cable
- Regulated power supply providing +3.3 V or +5 VDC depending on the model
- A wiring harness, connected to J1, as interface for power, communications and I/O signals
- Data communication equipment with serial communications

See *Appendix B, FlexPak-SSII Specifications*, starting on *Page 47* for an example of the type of enclosure equipment required for the receiver to operate.

3.1 Electrostatic Discharge

Electrostatic discharge (ESD) causes failure of electronic equipment, components and printed circuit boards containing. It is imperative that ESD precautions be followed when handling or installing the SUPERSTAR II printed circuit board. See also the electrostatic discharge notice on *Page 10* of this manual.

Store the SUPERSTAR II in its anti-static packaging when not connected in its normal operating environment. When removing the SUPERSTAR II from the ESD-protective plastic, follow accepted standard anti-static practices. Failure to do so may cause damage to the SUPERSTAR II.

When you remove the SUPERSTAR II from the original packing box, it is recommended that you save the box and ESD protective plastic for future storage or shipment purposes.

REMEMBER!

- Always wear a properly grounded anti-static wrist strap when handling the SUPERSTAR II.
 - Always hold the SUPERSTAR II by its corners or edges, and avoid direct contact with any of the components.
 - Do not let the SUPERSTAR II come in contact with clothing at any time because the grounding strap cannot dissipate static charges from fabrics.
 - Failure to follow accepted ESD handling practices will cause damage to the SUPERSTAR II.
 - Warranty may be voided if equipment is damaged by ESD.
-

3.2 Equipment Interconnection

As mentioned in *Chapter 1, Introduction*, starting on *Page 14*, the receiver can be provided either as an OEM board, or within a FlexPak-SSII enclosure. The interconnection of the OEM board format is guided by its physical and electrical specifications as detailed in *Section 3.4, Connectors and Connector Pins Assignment* starting on *Page 22*. A complete description of the FlexPak-SSII is provided in *Appendix B, FlexPak-SSII Specifications*, starting on *Page 47*.

3.2.1 Serial Connection

The receiver includes two serial communication ports. COM1 and COM2 are detailed in *Section 3.4.2, Serial Data Interface* starting on *Page 23*. Serial communication with the receiver must be performed on COM1. The maximum data transfer rate is 19200 bps. The other serial port, COM2, is used for a differential link, and its minimal data transfer rate is 9600 bps. Communication with COM1 and COM2 is through two Deutsch connectors on the FlexPak-SSII.

Please refer to the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on *Page 13*, for a discussion on the I/O protocol.

3.2.2 Power Connection

The input range for a SUPERSTAR II card is $\pm 5\%$ of either 3.3 VDC or 5 VDC depending on your model. See also *Section 1.1, SUPERSTAR II GPS Card* starting on *Page 14*. The input range required for the FlexPak-SSII is +6 to +18 VDC.

3.3 Installation Considerations

The FlexPak receiver is waterproof. The SUPERSTAR II bare card must be mounted in a dry location. Locate your receiver where it is convenient for cables to run to the power source, display device, and antenna. Form drip loops in the cables to prevent moisture from running down the cables and into the receiver.

Mount the receiver away from other radio transmission equipment.

3.3.1 Antenna Location

Many GPS reception problems can be reduced, to some degree, by careful antenna site selection. Of primary importance is to place the 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, of course, the ideal situation, which may not be possible under actual operating conditions.

1. Try to place the antenna as far as possible from obvious reflective objects, especially reflective objects that are above the antenna's radiation pattern horizon. Close-in reflections cause strong multipath signals. For a detailed discussion on multipath and site selection, see the section on *Multipath* in the *GPS+ Reference Manual* available from our website at <http://www.novatel.com/Products/productmanuals.html>.
2. Care should also be taken to avoid coiling the antenna cable around the mounting base and pinching the antenna cable in window or door jambs.

By default, the SUPERSTAR II 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*, see Reference [6] on *Page 13*, for more message details).

3.3.2 Base Station Location

☒ Your receiver must be a BASE model to act as a base station. A list of models is in *Appendix A* of the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on *Page 13*.

1. The base station must be located on a site that is above all obscuring elements on the surrounding terrain in order to have all satellites above the horizon visible at the base station's antenna. The intent is to have all satellites that are visible at the roving unit's antenna to be visible at the base station as well.
2. Multipath interference must be minimized as much as possible. Multipath is defined as the interaction of the GPS satellite signal and its reflections. This causes errors mainly on the GPS code, and less so on the GPS carrier. Even though the receiver uses carrier phase measurements, it can revert to code differential GPS operation if carrier phase differential GPS cannot be performed. Hence, the base station's antenna must be far from any reflecting elements.
3. The position of the base station's antenna must be surveyed using appropriate surveying equipment. This position must then be programmed in the base station using *Message ID# 80, Set User's Position/Operating Mode* (refer to the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on *Page 13*). Any error in the base station's position will be reflected in the roving unit's computed position.

3.3.3 Data Link

The data link for differential operation must operate at a rate of at least 9600 bps.

3.3.4 Base Station and Rover Units Separation

The operational range of carrier-phase differential measurements is limited to about 20 km, after which significant accuracy degradation can occur. If your application requires greater separations, your own base station network must be established.

3.4 Connectors and Connector Pins Assignment

The receiver has two standard connectors.

- J1 is a 20-pin connector for general input/output interfaces and power input
- J2 is a MCX type RF connector.

The minimum number of connections on J1 required for the system to operate is shown in *Table 2*.

Table 2: Minimum J1 Connections

Signal Name	J1 Pin #	Description
VCC	2	Primary power (3.3V or 5.0V -0.5 V/+0.25 V)
GND	10, 13, 16 & 18	Ground
TX_No_1	11	Serial port Tx #1
RX_No_1	12	Serial port Rx #1

If DGPS corrections are required for the application, the SUPERSTAR II can receive them on COM2:

Signal Name	J1 Pin #	Description
RX_No_2	15	Serial port Rx #2

If an active antenna is used:

Signal Name	J1 Pin #	Description
PREAMP	1	Power for active antenna (50 mA max)



CAUTION: You should use a current-limiting power source. The maximum current is 50 mA.

See *Appendix A, Technical Specifications*, starting on *Page 42* for more details.

3.4.1 J1 Interface and Power Connector

The SUPERSTAR II connector is a 2mm straight 2x10 pin header:

Suggested supplier:
On-Board connector:

Samtec
TMM-110-03-T-D.

Interface between SUPERSTAR II and customer application:

Suggested 2 inch ribbon cable:	TCS-D-10-D-2.00-01-N
or	
Suggested 12 inch ribbon cable with only one connector installed:	TCS-D-10-S-12.0-01-N
Suggested mating connector:	TCS-D-10-01-N
or	
PCB mounted connector:	SQT-110-01-L-D ¹

Connector specifications can be obtained from Samtec or other equivalent manufacturer.

3.4.2 Serial Data Interface

The receiver includes two COM ports (COM1 and COM2). Both COM ports operate independently with data transfer rates adjustable from 300 to 19200 bps.

The COM ports on the SUPERSTAR II operate at LVTTTL levels. On the FlexPak-SSII, these are RS-232 ports. The SUPERSTAR II card can be directly connected to a PC serial port but depending on the PC used, the PC serial port may download the signal level. To avoid this, level converters on the serial lines are required, such as that in the development kit's null modem cable.

COM1 supports data input (for receiver configuration and control) and output (for example, navigation results and receiver status). COM2 only supports data output if your SUPERSTAR II is a BASE model for differential correction data adhering to Reference [2] on Page 13.

☒ Your receiver must be a BASE model to act as a base station. A list of models is in Appendix A of the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on Page 13.

COM1 and COM2 support communication using the binary protocol. Through specific binary messages, the ports are re-configurable to communicate with NovAtel's PC-based user-interface *StarView* software (for extensive monitoring of SV tracking, measurements and navigation status).

The default data transfer rate is 9600 bps but can be reconfigured (refer to *Message ID# 110, Configure COM1 Port Mode* in the *SUPERSTAR II Firmware Reference Manual*). The new configuration is stored in NVM. If no default message list has been stored in NVM, the receiver will output *Message ID# 20, Navigation Data* (refer to the *SUPERSTAR II Firmware Reference Manual*) at a rate of once per second after each power up.

COM1 can be used for S/W reprogramming (please see *Chapter 7, Updating Receiver Firmware* starting on Page 39).

See also *Section A.2.3* on Page 46 for the electrical characteristics and the *Input/Output Message* rows on Page 43 for COM port details.

☒ 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 is in Appendix A of the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on Page 13.

3.4.3 RF Connector (J2)

The standard RF connector is a straight MCX jack connector.

Suggested supplier:	Johnson Comp
---------------------	--------------

1. 0.340" long standoffs will be required

On-Board connector: 133-3701-211

Interface between SUPERSTAR II and customer application:

Suggested Supplier: Omni Spectra

Supplier part number: 5831-5001-10

or

Suggested Supplier: Suhner

Supplier part number: 11MCX-50-2-10C

or

Suggested Supplier: Radiall

Supplier part number: R113082.

The center conductor provides power for an active antenna (PREAMP signal from J1-1).

3.4.3.1 Preamplifier Power Pass-Through (Antenna Supply)

The PREAMP signal is available on the I/O connector J1 Pin 1 for the host to provide power to the antenna preamplifier through the center conductor of the RF cable J2. The maximum operating voltage for an active antenna supply (PREAMP) is 5 V.



CAUTION: You should use a current-limiting power source. The maximum current on J2 is 50 mA.

3.4.3.2 RF Input

The GPS signal is received from the antenna amplifier on the J2 RF input connector. The RF input port impedance is 50 Ohms nominal.

3.4.4 Memory Back-Up

The SUPERSTAR II has a supercap device allowing a warm start, where the receiver has an approximate position, an approximate time and a valid almanac, without the need of an external power supply during a power-off state. VBATT is an external back-up source for the time keeping circuit.

A warm start is available for 1 week typically (25°C) and 3 days over a more extreme temperature range (-30 to +75°C). Therefore, VBATT can be used to extend the time retention period.

☒ An external series diode will be required between J1 and the external power source to prevent the supercap from discharging into your circuitry, see *Figure 5*.

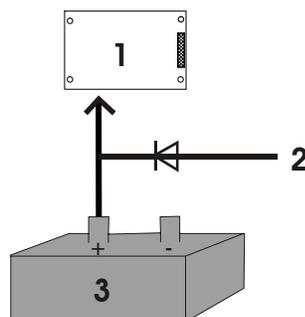


Figure 5: Back-Up Power

where 1 = SUPERSTAR II Card, 2 = Power Source and 3 = Back-Up Battery

3.5 Protocol Selection and Non Volatile Memory

Discrete IOs are available with a SUPERSTAR II card. A summary is shown in *Table 3* below.

Table 3: Use of Discretes

Discrete Name	FlexPak Equivalent Name	Use	Direction
GPIO2	IO1	Programmable Discrete I/O Pin: expansion pin for special applications	IN/OUT
GPIO3	IO2	Position Valid Output Pin	OUT
GPIO5	IP1	Reprogramming Control Input Pin: active high	IN/OUT
GPIO6	IP2	NVM Control Pin: uses the default ROM configuration instead of the configuration stored in NVM if the pin is set to ground (GND)	IN/OUT
GPIO7	IP3	NMEA Override Pin: starts up in the NMEA protocol at the 4800 baud rate if the pin is set to ground (GND)	IN/OUT

If you use NMEA, the SUPERSTAR II offers you the option of setting the I/O operating mode to NMEA through discrete input levels. Discrete inputs are also shown in byte 26 of *Message ID# 49, Receiver Status Data*, refer to the *SUPERSTAR II Firmware Reference Manual*.

3.5.1 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 4* below for a partial list of the data stored in NVM.

Table 4: Non-Volatile Memory Data

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						
LVTTTL (at the SUPERSTAR II card level) or RS-232 (with a FLEXPAK enclosure) CONFIGURATION	Contains the following configuration information: <table border="0"> <tr> <td>1. Mode of operation</td> <td>4. Time Alignment Mode State</td> </tr> <tr> <td>2. Baud Rate: 300 to 19200</td> <td>5. Mask Angle</td> </tr> <tr> <td>3. Default Binary message list</td> <td>6. Datum</td> </tr> </table>	1. Mode of operation	4. Time Alignment Mode State	2. Baud Rate: 300 to 19200	5. Mask Angle	3. Default Binary message list	6. Datum
1. Mode of operation	4. Time Alignment Mode State						
2. Baud Rate: 300 to 19200	5. Mask Angle						
3. Default Binary message list	6. Datum						

3.6 Default Configuration

Below is the SUPERSTAR II'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:	45 seconds
Default Message List:	
Binary:	Navigation Status User Coordinates (Message ID# 20) @ 1Hz
NMEA:	GGA @ 1Hz
Time Align Mode:	ON

-
- ☒ 1. The data contained in NVM is always used if the DISC_IP2 is left unconnected or tied to HI logic.
 - 2. 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 is in *Appendix A* of the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on *Page 13*.
 - 3. If DISC_IP2 is tied to LO logic, the default ROM configuration will be used and the following parameters will not be read from NVM:

Position
 Almanac
 Time
 UTC Correction and IONO Parameters
 TCXO Parameters

3.7 Installation Overview

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

1. If your receiver has been provided as a GPS card without an enclosure, install the card in an enclosure to reduce environmental exposure, RF interference and vibration effects.
2. Pre-wire your I/O harness 20-pin connector for power and communications and connect them to the J1 connector on the SUPERSTAR II. See also *Section 3.4, Connectors and Connector Pins Assignment* starting on *Page 22*.
3. Mount the GPS antenna to a secure, stable structure, as described in *Section 3.3.1 on Page 21*.
4. Connect the GPS antenna to J2 of the receiver using an antenna RF cable, using the information given in *Section 3.4.3.1, Preamplifier Power Pass-Through (Antenna Supply)*, and *Section 3.4.3.2, RF Input* starting on *Page 24*.
5. Apply power to the receiver, as described in *Section 3.2.2, Power Connection* starting on *Page 21*.
6. Connect the receiver to a PC or other data communications equipment by following the information given in *Section 3.2.1, Serial Connection* starting on *Page 20* and *3.4.2, Serial Data Interface* on *Page 23*.

Figure 6 shows a typical setup for an enclosed receiver.

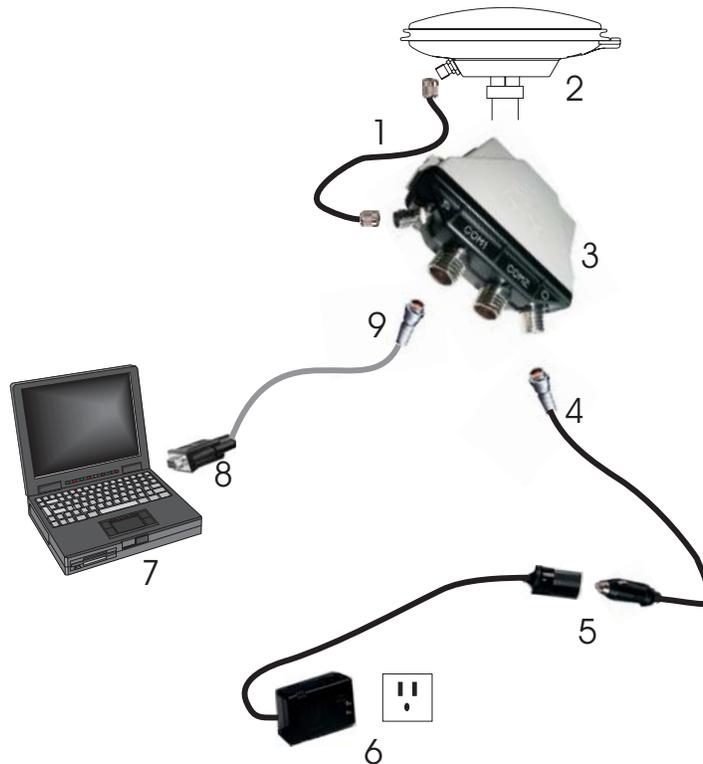


Figure 6: Basic Setup

Reference	Description	Reference	Description
1	Coaxial cable from antenna to FlexPak RF connector (⚡)	5	12 V DC Adaptor
2	Antenna	6	120 V AC power supply
3	FlexPak	7	User-supplied PC
4	To FlexPak power connector (⏻)	8	DB-9 connector to PC
		9	To FlexPak COM port (COM1)

Before operating the receiver for the first time, ensure that you have followed the installation instructions in *Chapter 3, Installation* starting on *Page 19*. The following instructions are based on a configuration such as that shown in *Figure 7*. It is assumed that a personal computer is used during the initial operation and testing for greater ease and versatility.

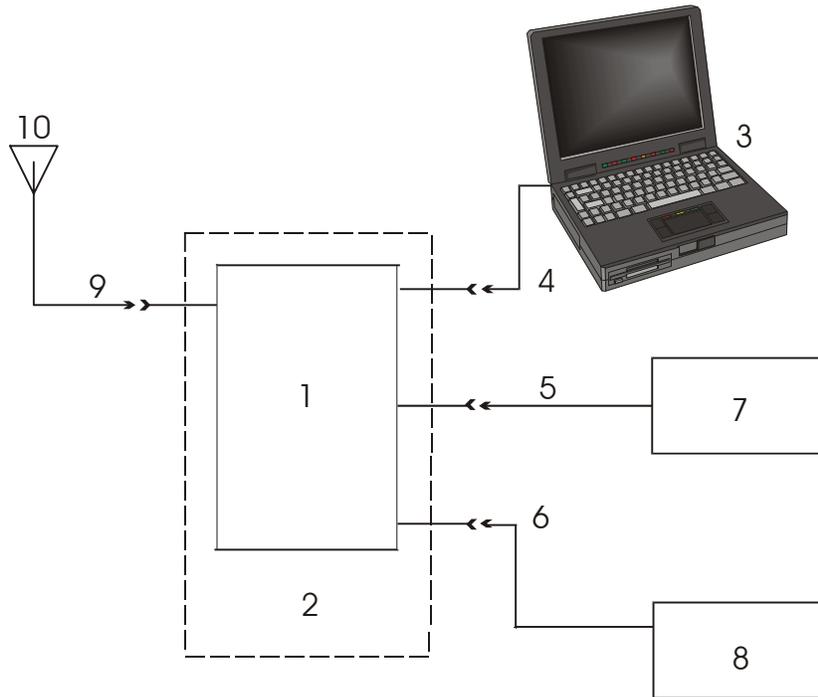


Figure 7: Typical Operational Configuration

Reference	Description
1	SUPERSTAR II card
2	OEM housing
3	User-supplied PC
4	COM1
5	COM2
6	Power
7	Radio or rover station
8	External power source(s)
9	GPS signal
10	GPS antenna

-
- ☒ 1. Your receiver must be a BASE model to act as a base station. A list of models is in *Appendix A* of the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on *Page 13*.
 - 2. We recommend that you use a level convertor on the serial line between your SUPERSTAR II card and PC. If you are using the FlexPak-SSII's null-modem cable this is not necessary.
-

4.1 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 an IBM-compatible PC that is directly connected to the COM1 serial port of the receiver using a straight serial cable. If you are using a TTL communications device such as a radio modem, connect it to the receiver's COM2 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 Reference [6] on Page 13. See also the *StarView* examples in Section 4.2, *Getting Started* starting on Page 29.

4.1.1 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 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*, see Reference [6] on Page 13. 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 model has Carrier Phase Output (CP) capability with 19200 bps as the default. A list of models is in *Appendix A* of the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on Page 13.

The data transfer rate you choose will determine how fast information is transmitted. Take for example a message whose byte count is 96. The default port settings will allow 10 bits/byte. It will therefore take 960 bits per message. To get 10 messages per second then will require 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 overflows the serial port buffers, causes an error condition in the receiver status and results in lost data.

4.2 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.

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 FlexPak-SSII 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*, see Reference [6] on Page 13, provides the available messages and parameters that the SUPERSTAR II uses. See Section B.3, *StarView Software Installation* starting on Page 53 and refer to the *StarView User Manual*, see Reference [5] on Page 13.

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 4.5.2, *Operational States* starting on Page 31. 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 9.

4.2.1 Power-Up Information

At power up, the receiver sends two categories of factory information data to COM1 at 9600 bps. The categories of information, Boot and Operational information, can be displayed on a dummy terminal.

4.2.2 Boot Information

The Boot information contains the following factory data:

GO	Go in Operational Mode
NovAtel Inc.	
S/W Version: 2.100	Software Version
CB=0x0000003F SHP	BIT Self-Test
Go to Binary @ 9600 baud.	
In Binary @ 9600 baud.	
NovAtel Inc.	
1.102-SSII	Boot S/W Version
D0	
PSN: XXXXXXXXXXXXX	Product Serial Number
UCPB: 0XXXXXXXXXX	

The Operational information contains both the factory and the current operating mode information. The current operating mode baud rate is output twice. This is useful when the operating baud rate is not 9600.

Example:

```
Go to Binary @ 19200 baud
In Binary @ 19200 baud1
```

4.3 Data Requests

Data may be requested for output by the receiver for display or logging purposes. The list of data request commands and data messages is detailed in the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on Page 13.

1. Line transmitted at the Configured Baud Rate

4.4 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 is in *Appendix A* of the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on *Page 13*.
-

4.4.1 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 provide inaccurate 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*.

4.4.2 GPS Antenna Position

For the base station, it is imperative to fix the position. 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 also set the X-Y-Z coordinates using *Message ID# 80, Set User's Position/Operating Mode*.

4.5 Receiver States

4.5.1 Non-Operational State

The receiver'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 3.5, Protocol Selection and Non Volatile Memory* starting on *Page 25* for details on retained data. A supercap allows the SUPERSTAR II to maintain data and time during OFF mode for a period of 3 days to a week.

4.5.2 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 on its host port the current operating and navigation modes.

1. Self-Test Mode

The receiver enters Self-Test mode automatically at start-up or upon request from an external source (please refer to *Message ID# 51, Initiated BIT* in the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on *Page 13*). 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.

When the receiver is in OFF mode, it will retrieve data only from NVM (cold start) or from both NVM and SRAM (warm start). Integrity checking is done on all data retrieved from the non-operating state. See also *Section 4.5.1, Non-Operational State* above.

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 2 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 will operate in Base Station Nav mode only. The receiver reports its current navigation sub-mode on its host port.

☒ Your receiver must be a BASE model to act as a base station. A list of models is in *Appendix A* of the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on *Page 13*.

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 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 4.4, Configurable Parameters* starting on *Page 31* for position initialization details.

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.

4.6 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*
- ANT LED on the FlexPak-SSII

Please refer to the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on *Page 13*, for details on the Message IDs above. See also *Section 4.5.2, Operational States* starting on *Page 31* and status LED information may be found in this manual on *Page 48*.

4.7 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*, see Reference [6] on *Page 13*. 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.

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 of the *GPS+ Reference Manual* available on our website at <http://www.novatel.com/Products/productmanuals.html> for an overview of GPS positioning.

5.1 Single-Point or Autonomous

The NovAtel SUPERSTAR II receiver is capable of absolute single-point positioning accuracies of < 5 meters CEP (GDOP < 2; no multipath).

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 also to the *GPS Overview* section of the *GPS+ Reference Manual* available on our website at <http://www.novatel.com/Products/productmanuals.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.

5.1.1 GPS System Errors

In general, GPS SPS C/A code single-point pseudorange positioning systems are capable of absolute position accuracies of about 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.

5.2 Satellite-Based Augmentation System (SBAS)

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

SBAS includes the Wide-Area Augmentation System (WAAS), the European Geo-Stationary Navigation System (EGNOS), and the MTSAT Satellite-Based Augmentation System (MSAS). 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 8, The SBAS Concept*, 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 user 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 - for example, a Coarse/Acquisition (C/A) pseudorandom (PRN) code. In addition, the code phase timing is maintained close to GPS time to provide a ranging capability.

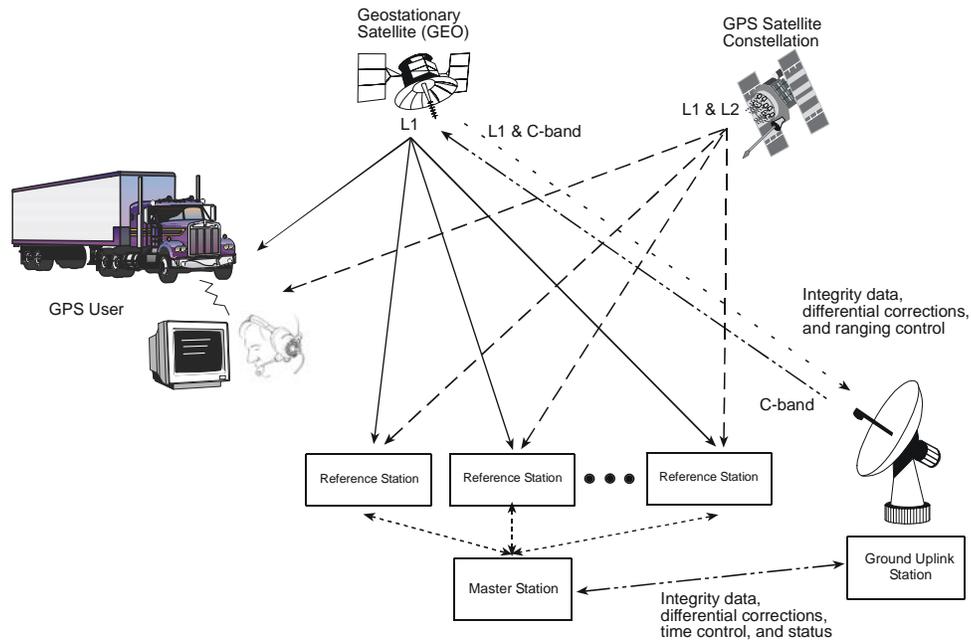


Figure 8: The SBAS Concept

5.2.1 SBAS Receiver

NovAtel SUPERSTAR II-based receivers may have the SBAS option. 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 13). The receiver uses SBAS satellites in your coverage area.

The SUPERSTAR II 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.

5.2.2 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 13.

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

When your receiver appears not to be working properly, often there may be 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* and refer to its description in the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on *Page 13*.

If the problem is not resolved after using this troubleshooting guide, contact Customer Service, see *Page 9*.

This section is intended to assist you in the use of our SUPERSTAR II product.

1. If you are having problems communicating with the SUPERSTAR II product:
 - Verify connection: look for broken pins, a misaligned connector or intermittent contact.
 - Verify power supply input is acceptable for example, 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:
 - Verify antenna connector, look for broken or poor connections on the RF signal/shield contacts.
 - If using an active antenna, verify antenna is receiving correct power from RF connector; preamp input into SUPERSTAR II is feeding a DC bias on the center conductor.
 - Verify cable length from the antenna to SUPERSTAR II; signal will be attenuated based on this length. For best performances, ensure the gain at the input of the receiver is between -3 dB and 8 dB, see *Table 5* below (for RG-58/U LLDS80 cables):

Table 5: Cable Lengths Vs. Gain

Antenna Gain	Min Cable Length (Loss)	Max Cable Length (Loss)	Signal Level at Input
0 dB	0m (0 dB)	3m (3 dB)	0 dB / -3 dB
+12 dB	5m (4 dB)	25m (15 dB)	8 dB / -3 dB
+26 dB	30m (18 dB)	54m (31 dB)	8 dB / -3 dB

- Check 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 effectiveness of your EMI / EMC shielding. Close proximity to high energy sources (both digital & RF circuitry) can affect your SUPERSTAR II's performance.
- Verify the cleanness (that is, low ripple, minimum noise spikes, voltage level variations) of the power source. Isolate the power supply of the SUPERSTAR II from the main system power.
- 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 (port #2) of the SUPERSTAR II.
 - Verify DGPS source settings are active.
 - Verify DGPS base station is actually transmitting DGPS corrections and base data is being received by the SUPERSTAR II.
4. If you are not receiving expected messages from the SUPERSTAR II:
 - Verify transmit message settings (that is, receiver's output configuration or requested message).
 - Verify hardware and software part numbers are as per expected configuration.
 - Restore default settings by sending an *Erase NVM* command (*Message ID# 99, Erase NVM*) to the SUPERSTAR II
 - Read the Reference Manual - refer to the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on *Page 13*, describing message contents.

For the problems above you may be able to isolate the suspected unit in your application:

- Substitute another SUPERSTAR II.
- Substitute another host hardware.
- Substitute another RF source (for example, antenna or cable).
- Substitute another interconnect harness.
- Substitute alternate power source or isolate main power source from auxiliary power source for SUPERSTAR II.
- Make intermittent problems more repeatable (that is, by raising operating temperature, varying power supply source, re-orienting hardware placement). Be sure to note what makes the problem worse / lessens the problem.

Having gone through the steps in this chapter and, if possible, the substitutions above, contact Customer Service (see *Page 9*).

- 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.

The software update utility is specially designed to provide an easy way to update your SUPERSTAR II 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

7.1 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

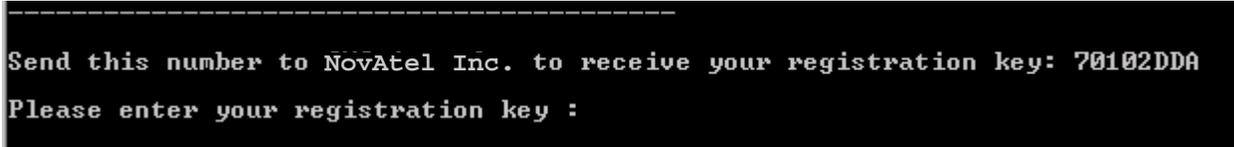
7.2 Utility Installation

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.

7.3 Registration Key



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

Figure 9: Update Registration Window in DOS

Contact NovAtel Inc. with the number that appears on your screen to obtain your registration key, see *Figure 9* above. Contact information can be found on *Page 9*. 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 10* on *Page 40*. 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.

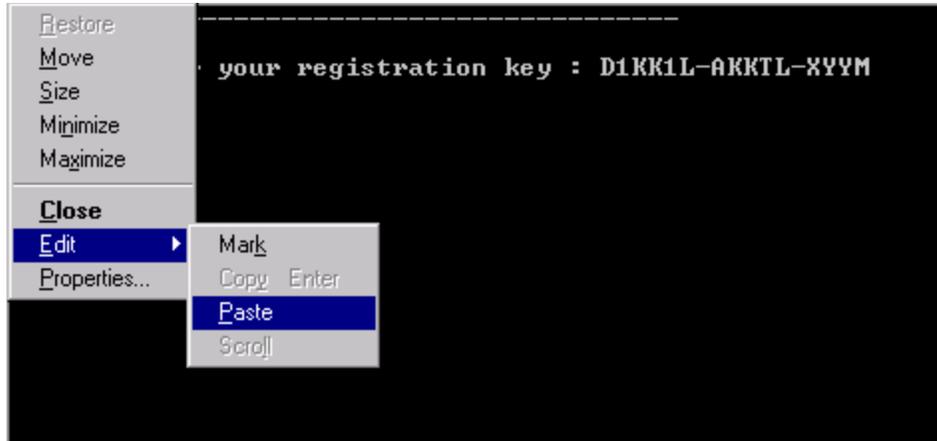


Figure 10: Paste the Registration Key into the DOS Window

7.4 Registration Key Accepted

A message confirms the Update software utility activation once the key has been entered, see *Figure 11* below. Press any key, for example <Enter>, to exit.

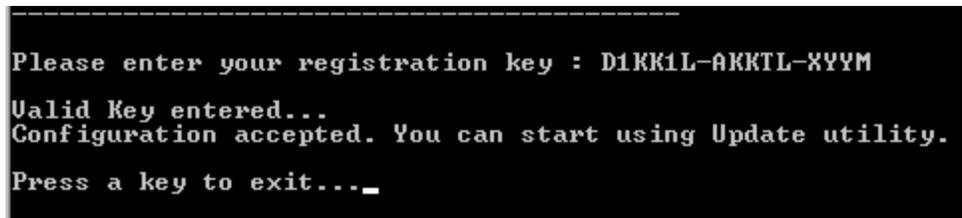


Figure 11: Configuration Accepted

7.5 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 12* below.

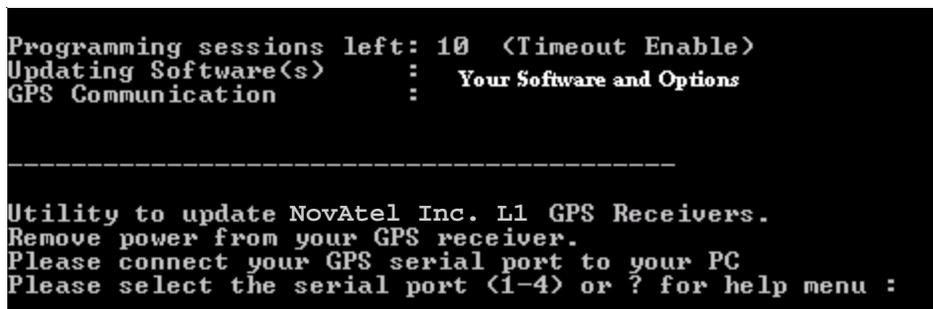


Figure 12: Update Utility Activation

7.5.1 Programming Success

The Update utility confirms programming success at the end of the programming session, see *Figure 13* below. At this point, remove power from your GPS receiver.

```
-----  
Checking GPS receiver. Please wait...  
.....  
For a final check please remove power from your GPS receiver.  
Then press Enter.  
  
Please apply power to your GPS receiver  
Configuration verification  
.....  
-----  
  
Your receiver has been updated successfully.  
Thank you.  
  
Press a key to exit..._
```

Figure 13: End of Programming Session

A.1 SUPERSTAR II Family Performance

PERFORMANCE*		
Position Accuracy:	DGPS	<1 m (CEP)
	Single Point	<5 m (CEP)
	SBAS	<1.5 m (CEP)
Velocity Accuracy:	0.05 m/s RMS	
Measurement Precision:	L1 C/A Code	75 cm RMS
	L1 Carrier Phase	1 cm RMS (differential channel)
Time to First Fix:	Hot start: 15 s typical, with current almanac, position, time and ephemeris Warm start: 45 s typical, with current almanac, position and time Cold start: 166 s typical, no almanac, no position and no time	
Signal Re-Acquisition:	< 1 s (typical) (5 second obscuration)	
Data Rate:	Measurements	5 Hz
	Position	5 Hz
Dynamics:		
Velocity:	514 m/s (limited by US and Canadian export laws)	
Acceleration:	4 G (39.2 m/s ²)	
Jerk:	2 m/s ³	
Altitude:	18 km (60,000 ft.) (limited by US and Canadian export laws)	

A.2 SUPERSTAR II GPS Card

GENERAL CHARACTERISTICS*	
12-PARALLEL "ALL-IN-VIEW" TRACKING	
L1 Frequency:	1,575.42 MHz
Minimum Tracking Sensitivity:	-135 dBm (antenna input level)
HARDWARE SPECIFICATIONS*	
Input Voltage:	+3.3 VDC or +5.0 VDC depending on model, refer to the <i>SUPERSTAR II Firmware Reference Manual</i> , see Reference [6] on Page 13. (The voltage range is $\pm 5\%$ of the input voltage)
Power Consumption	5 V version: 0.8 W typical 3.3 V version: 0.5 W typical

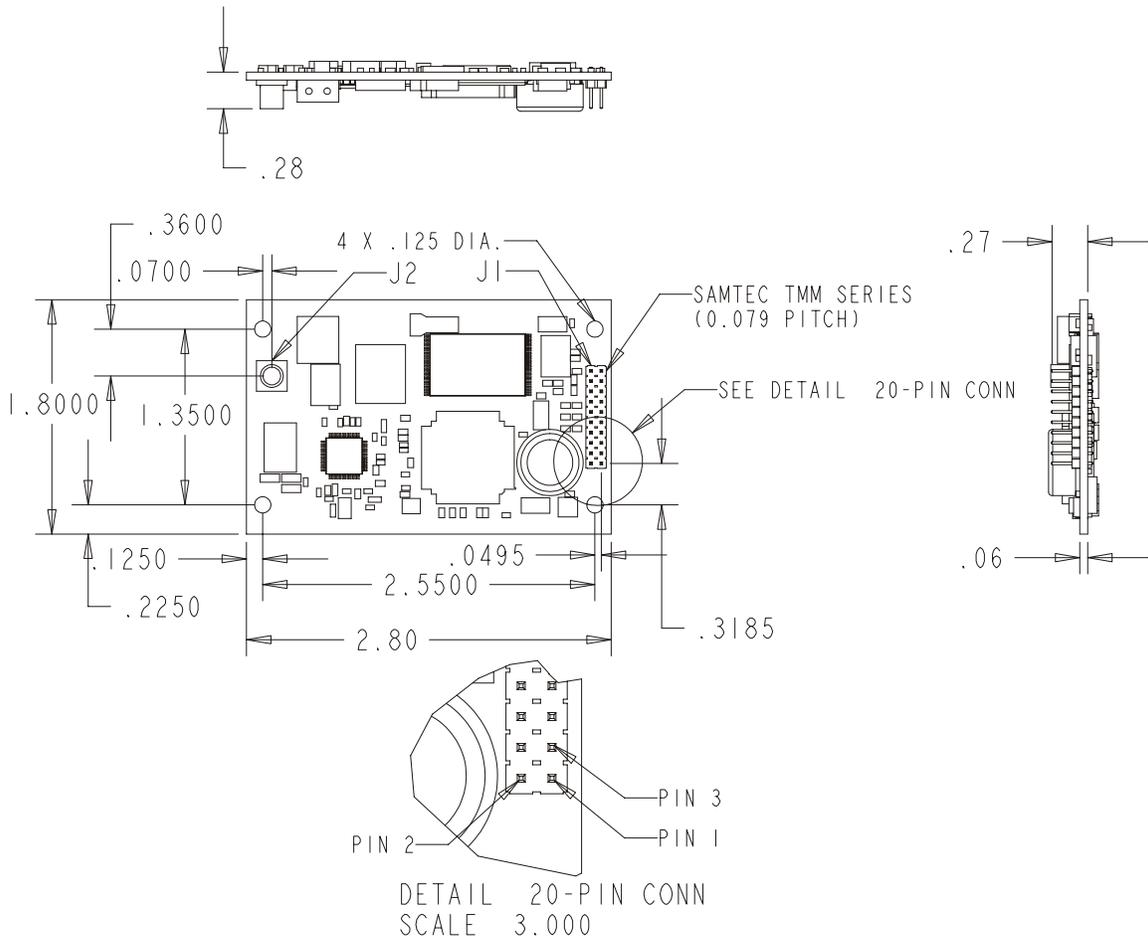
Continued on Page 43

RF Input	MCX connector, 50 Ω impedance
Operational Signal Level Input	-160 dBw to -120 dBw
“Keep Alive” Mode:	Input voltage 2.5 to 4.5 VDC Current draw < 1 mA (5V) < 50 μA (RTC only)
Serial Communications:	2 x LVTTTL level asynchronous data ports from 300 up to 19 200 bps)
Input Messages:	COM1: NMEA or proprietary binary COM2: RTCM SC-104 types 1, 2, and 9
Output Messages:	COM1: NMEA or proprietary binary (NMEA types GGA, GSA, GSV, RMC, ZDA, GLL, VTG plus proprietary messages)
Time Mark Output:	1PPS, aligned with GPS time (± 200 ns typical in absolute mode)
Discrete:	3 general purpose input/output lines
PHYSICAL AND ENVIRONMENTAL *	
Dimensions:	46 x 71 x 13 mm
Weight:	22 g
Operating Temperature:	-30°C to +75°C
Storage Temperature:	-40°C to +85°C
Humidity:	5% to 95% relative humidity, non-condensing to +60°C
SUPERSTAR II DEVELOPMENT KIT*	
Input Voltage:	+6 to +18 VDC
Waterproof Connectors:	Power: 3-pin (Deutsch part number: 58064-08-98SN) COM1: 13-pin (Deutsch part number: 59064-11-35SF) COM2: 13-pin (Deutsch part number: 59064-11-35SF) RF Input: Female TNC
Accessories Included:	A FlexPak-SSII enclosure containing a SUPERSTAR II receiver (see <i>Appendix B</i> starting on <i>Page 47</i>) A +12 dB active GPS antenna with a magnetic mount and a 6 m RF cable Power cable with an automotive adapter Null-modem serial cable with DB-9 connector

* Specifications are subject to change without notice

A.2.1 Mechanical Drawing

Figure 14 shows the SUPERSTAR II OEM board outline.



Note: All dimensions are in inches

Figure 14: SUPERSTAR II Dimensions

A.2.2 Connector Pin Assignment

Table 6 shows the Interface and Power connector J1 pin assignment.

Table 6: J1 Interfaces and Power Connector Pin Assignment

J1 PIN #	SIGNAL NAME	FUNCTION
1	PREAMP	Power for active antenna (40 mA max)
2	VCC	Primary power (3.3V or 5.0V -0.5 V/+0.25 V)
3	VBATT	Back-up battery for real-time clock device (external series diode required)
4	DISC_IO_3	Programmable discrete I/O pin (expansion pin for special applications)
5	MASTER_RESET	Reset input pin (active low)
6	DISC_IP_1	Reprogramming control input pin (active high)
7	DISC_IP_3	NMEA override pin (see Section 3.5 on Page 25)
8	DISC_IP_2	NVM control pin (see Section 3.5 on Page 25)
9	DISC_IO_1	Programmable discrete I/O pin (expansion pin for special applications)
10	GND	Ground
11	TX_NO_1	Serial port Tx #1
12	RX_NO_1	Serial port Rx #1
13	GND	Ground
14	TX_NO_2	Serial port Tx #2
15	RX_NO_2	Serial port Rx #2
16	GND	Ground
17	DISC_IO_2	Programmable discrete I/O pin (expansion pin for special applications)
18	GND	Ground
19	TIMEMARK	1PPS output
20	N/C	Not connected

A.2.3 I/O Electrical Characteristics

Table 7 shows the voltage level limits for the different I/O signals:

Table 7: I/O Signals Voltage Limits

SIGNAL NAME	TYPE	Input low max (V)	Input high min (V)	Output low max (V)	Output high min (V)
MASTER_RESET ¹	I	0.50	2.00		
DISC_IP_1, DISC_IP_2, DISC_IP_3, RX_No_1, RX_No_2	I	0.8	2.5		
DISC_IO_1	I/O	0.8	2.5	0.4	3.0 I _o ≤ 200uA
DISC_IO_2	O			0.4	3.0 I _o ≤ 200uA
TX_NO_1, TX_NO_2	O			0.4	3.0 I _o ≤ 200uA
RX_NO_3/DISC_IO_3	I/O	0.8	2.0	0.4	3.7 I _o ≤ 200uA
TIMEMARK, TX_NO_3	O			0.4	3.7 I _o ≤ 200uA

1. A LO pulse of 150 ns minimum will invoke a master reset to the receiver.

B.1 FlexPak-SSII

INPUT/OUTPUT CONNECTORS	
Antenna	Waterproof TNC female jack, 50 Ω nominal impedance Output voltage: +5 VDC Maximum Current: 50 mA
Power	3-pin waterproof Deutsch connector (Deutsch PN 59065-09-98PN) Input Voltage: +6 to +18 VDC Power Consumption: 0.9 W (typical)
COM1	13-pin waterproof connector (Deutsch P/N 59065-11-35PF) RS-232 serial to 19200 bps
COM2	13-pin waterproof connector (Deutsch P/N 59065-11-35PF) RS-232 DGPS to 19200 bps
PHYSICAL	
Size	45 x 147 x 123 mm
Weight	307 g
Mounting System	Integral flange with two 9/32" diameter mounting holes 5-1/4" apart
ENVIRONMENTAL	
Temperature	Operating: -30°C to +75°C Storage: -40°C to +85°C
Humidity	Not to exceed 95% non-condensing
Waterproof	To IEC 60529 IP X7
DIMENSIONS	
<p>The technical drawings show the device from four perspectives: a top view with dimensions 146.5 mm (width) and 133.35 mm (inner width), a side view with a height of 123.0 mm, a front view with a depth of 44.3 mm, and a rear view showing the COM1 and COM2 connectors. A hole diameter of $\phi 7.2$ mm is also indicated. The NovAtel logo is visible on the top and front panels.</p>	

a. Dimensions are in mm

B.1.1 Status Indicators

The FlexPak-SSII provides the status indicators shown in *Table 8*.

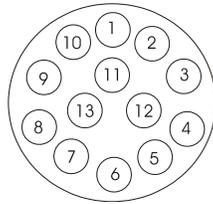
Table 8: FlexPak Status Indicators

Indicator	Indicator Color	Status
COM1	Green	Data is being transmitted from COM1
	Red	Data is being received on COM1
COM2	Green	Data is being transmitted from COM2
	Red	Data is being received on COM2
ANT	Green	Valid position computed
PWR	Red	The receiver is powered

B.1.2 Port Pin-Outs

The pin numbering for each of the ports, is described in *Table 9*. See also *Section 3.4, Connectors and Connector Pins Assignment on Page 22*.

Table 9: FlexPak COM Ports Pin-Out Descriptions



COM1 (Deutsch RS232)		COM2 (Deutsch RS232)	
Connector Pin No.	Signal Name	Connector Pin No.	Signal Name
1	Reserved	1	Reserved
2	RXD1	2	RXD2
3	Reserved	3	Reserved
4	Reserved	4	Reserved
5	GND	5	GND
6, 7	Reserved	6, 7	Reserved
8	TX1	8	TXD2
9	Reserved	9	Reserved
10		10	PPS
11		11	Reserved
12		12	DISC_IP1 ^a
13		13	Reserved

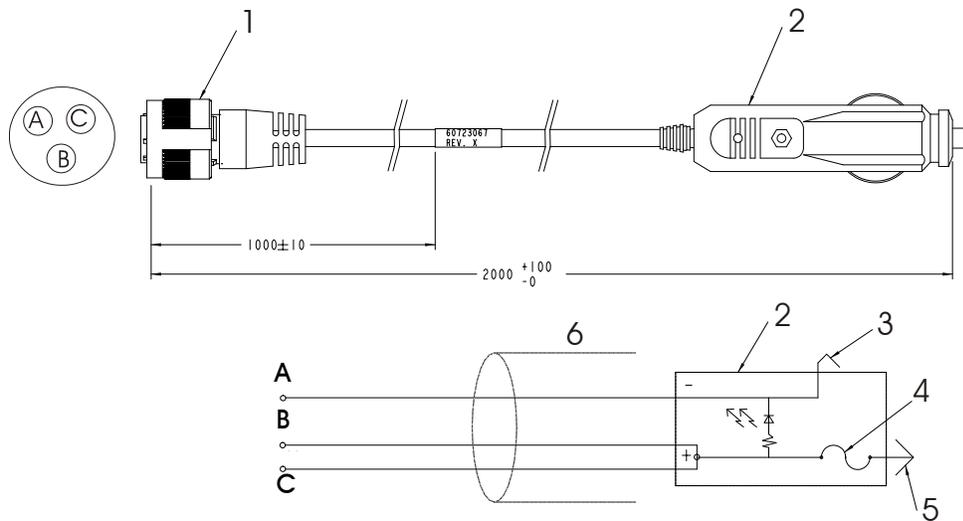
a. Leave open or tie to ground for normal operation. Set high for programming mode only.

B.1.3 Cables

B.1.3.1 Automobile Power Adapter Cable (NovAtel part number 01017374)

The power adapter cable supplied with the FlexPak provides a convenient means for supplying +12 V DC while operating from an automobile. The figure below shows the cable and a wiring diagram of the automobile adapter.

The output of the power adapter uses a 3-pin Deutsch socket (Deutsch part number: 58064-08-98SN). This cable plugs directly into the PWR port on the front of the FlexPak.



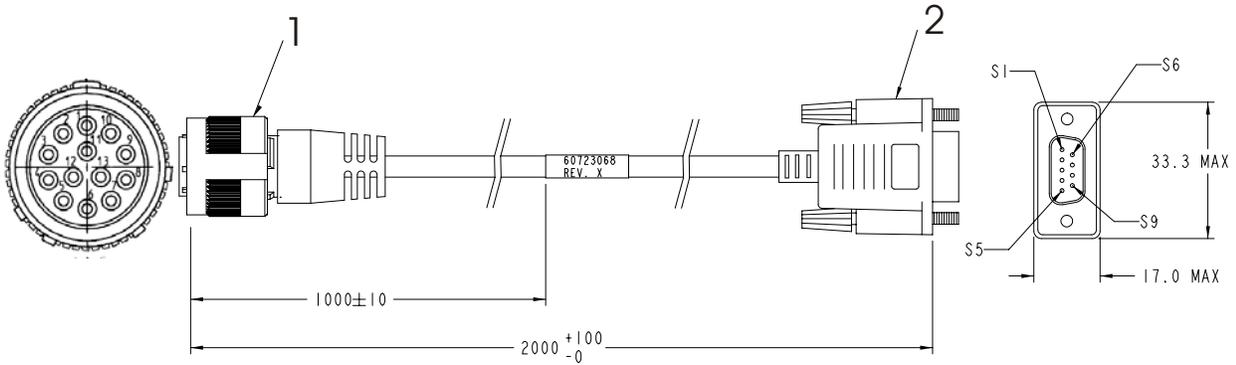
Reference	Description
1	3-pin Deutsch connector
2	Automobile adapter
3	Outer contact
4	3 amp slow-blow fuse
5	Center contact
6	Foil shield
A	Black
B	Red
C	Natural or White



Figure 15: FlexPak Power Cable

B.1.3.2 13-Pin Deutsch to DB9 Serial Cable (NovAtel part number 01017375)

The null-modem serial cable shown below provides a means of interfacing between the COM1 or COM2 port on the FlexPak and another serial communications device, such as a PC. At the FlexPak end, the cable is equipped with a 13-pin Deutsch connector (Deutsch part number: 59064-11-35SF), which plugs directly into a COM port. At the other end, a DB9S connector is provided. The cable is 2 meters in length. See also *Section B.1.2, Port Pin-Outs on Page 48*.



Deutsch Pin#	Signal
1	Reserved
2	RXD
3, 4	Reserved
5	GND
6, 7	Reserved
8	TXD
9	Reserved
10	PPS
11	Reserved
12	DISC_IP1
13	Reserved

TO RECEIVER	SIGNAL	DB-9 FEMALE TO PC
S1	GPIO	N/C
S2	RXD1	S3
S3	CTS1	S7
S4	EVENT1	N/C
S5	GND	S5
S6	EVENT2	N/C
S7	RTS1	S8
S8	TXD1	S2
S9	POUT	S1, S6
S10	PPS	N/C
S11		N/C
S12	Reserved	N/C
S13	ERROR	N/C

Reference	Description
1	13-pin Deutsch connector
2	DB9S connector



Figure 16: FlexPak 13-Pin Serial Cable

B.2 Development Kit

The SUPERSTAR II Development Kit allows you to easily evaluate the SUPERSTAR II receiver. The Development Kit implements the receiver control operation and I/O functions of the receiver using a PC, a serial cable, an external GPS antenna, and a power cable with a 120 V AC to 12 V DC power adapter. The SUPERSTAR II is contained in the FlexPak-SSII unit, with I/O connectors and status LEDs.

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 13).

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

B.2.1 Description

The Development Kit contains the following equipment:

QTY	DESCRIPTION
1	FlexPak-SSII unit with built in SUPERSTAR II receiver card
1	+12 dB active GPS antenna with 20 ft. cable, see Page 56
1	<i>StarView</i> software and receiver user manuals on CD
1	Serial cable (DB9 connector to 13-pin Deutsch connector), see Page 50
1	Automotive power cable (12 V DC power connector to 3-pin Deutsch connector) and power supply adapter 120 V AC to 12 V DC, see Page 49

B.2.2 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 is in *Appendix A* of the *SUPERSTAR II Firmware Reference Manual*, see Reference [6] on Page 13.

B.2.2.1 Normal Setup

See *Figure 6* on Page 27 when following these instructions:

1. Connect the FlexPak-SSII COM1 serial port to a PC using the serial cable provided.
2. Connect the GPS antenna to the RF port (labelled ) on the FlexPak using coaxial cable.
3. Connect the power supply to the FlexPak-SSII power port (labelled ) using the automotive power cable. When power is applied, the LED should be red. See also *Section B.1.1, Status Indicators* on Page 48.
4. Launch the *StarView* software application, see *StarView Software Installation* on Page 53. Refer also to the *StarView User Manual*, see Reference [5] on Page 13.

B.2.2.2 DGPS Setup with the FlexPak-SSII

Set up the equipment as in *Figure 17 on Page 52*, 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.2.2.1 on Page 51*. Then also connect a communications device to each FlexPak-SSII using a serial connector on the FlexPak-SSII interface cable. For example this might be a radio modem, for sending or receiving differential GPS messages.

A differential network can also be established when there is more than one rover linked to a single base station. The base receiver must be initialized to fix its position to agree with latitude, longitude and height of the phase center of the base station GPS receiver antenna and the antenna offset position from the base.

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. The computed position solutions are that of the GPS receiving antenna phase center.

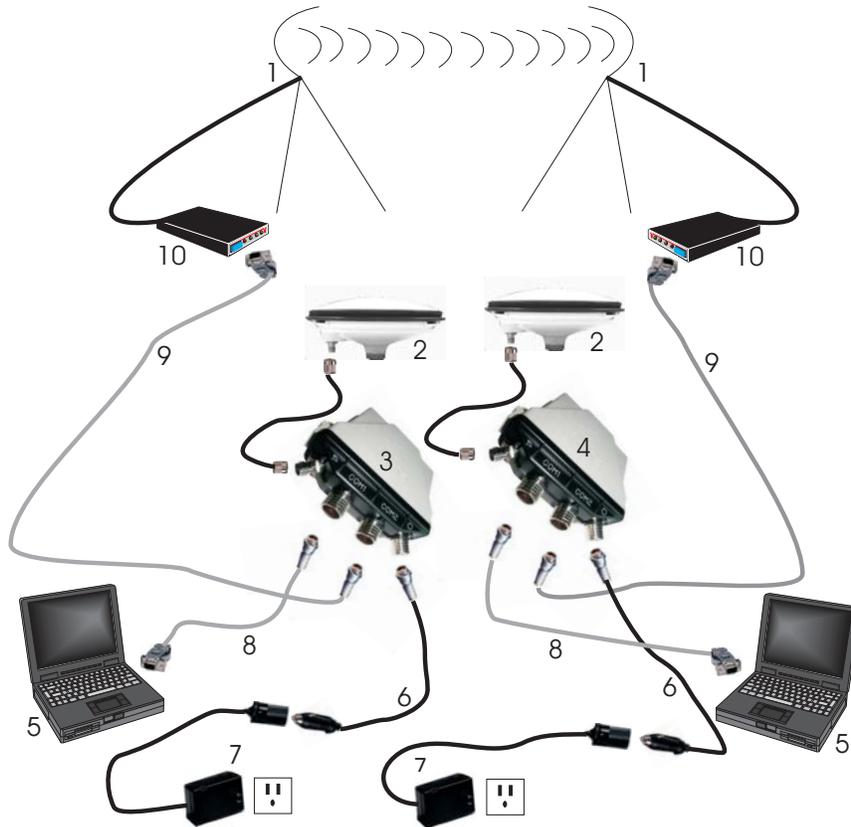


Figure 17: Differential GPS Setup

Reference	Description	Reference	Description
1	User-supplied radio data link	6	FlexPak power port to power cable
2	Antenna	7	12 V DC adaptor to 120 V AC power
3	FlexPak (base station)	8	PC to FlexPak COM1 port cable
4	FlexPak (rover station)	9	FlexPak COM2 port to modem cable
5	User-supplied PC	10	User-supplied modem

B.3 StarView Software Installation

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

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 and follow 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*. Refer also to the *StarView User Manual*, see Reference [5] on Page 13.

The GPS antenna is an important part of the total system performance and its selection should be based on your application. The SUPERSTAR II receivers include a Low Noise Amplifier (LNA) before the RF ASIC. A +12 dB up to +26 dB active GPS antenna is recommended.

This appendix is divided into characteristics for high end active geodetic and other active antennas.

We also offer the coaxial cables required between the GPS antenna and the SUPERSTAR II. You will also find in this section, different coaxial cables required in your GPS system. The end of this section includes detailed antenna drawings.

C.1 Cable Selection

The interconnecting cable between the GPS antenna and the receiver is of prime importance for the proper performance of the system. Three parameters should be considered:

1. Loss
2. Isolation
3. Outer diameter

The loss increases with the length of the cable and decreases with extra isolation. If the highest accuracy possible is not required, receivers can accept a total cable loss of 3 dB. Depending on the cable type, this could represent a cable run from 2 m up to 10 m.

Table 10 on Page 54 details the specifications of the RG-58 Low Loss Cable (RG-58/U LLDS80) used in the GPS antenna cable 217-601730-XXX. The RG-58/U LLDS80 is a custom-made low-loss coaxial cable. It is a double-shielded cable similar to Belden Type 9310 but with the improvement of having 85% minimum coverage of the second shield versus the Belden at 55% coverage. The electrical characteristics are included in Table 10.

Table 10: Coaxial Cable Specifications

Center Conductor	#20 Bare Copper wire, Resistance - 33.1 ohms per Km
Insulation	Polyethylene
Inner Shield	Aluminium Foil - 100% coverage
Outer Shield	Tinned copper braid - 85% coverage, Resistance 45.9 ohms per Km
Jacket	Black PVC
Nominal Impedance	50 ohms
Nominal Vel. of propagation	66%
Nominal Capacity	101.7 pf per meter
Attenuation	@ 1000 MHz: 44.3 dB per 100 m (or 54 dB @ 1575 MHz)

Table 11 shows the minimum and maximum cable length when using GPS antenna cable (drawing 217-601730-XXX) normally required between the receiver and the chassis case of your system. Please see Page 57 for the cable drawing.

Table 11: Antenna Gain Depending on Cable Length Required

Cable Part Numbers	Antenna Gain	Cable Type	Length ^a
217-601730-005	+12 dB	RG-58 Low Loss	5 m
217-601730-015	+12 dB	RG-58 Low Loss	15 m
217-601730-030	+26 dB	RG-58 Low Loss	30 m

a. A 1 dB loss for the coaxial cable is usually required between the RG-58 cable and the GPS Receiver MCX connector and it is included in attenuation number in parentheses. If the distance between the antenna and the GPS receiver needs to be longer than 30 m, you should select another type of coaxial cable with a lower loss per meter.

The +26 dB antenna can accept a supply voltage between 5 and 18 VDC. It is recommended to compute the drop in the coaxial cable so the active antenna will always see the minimum operating voltage of 4.5 Volt. *Table 12* lists the current taken by each of these antenna.

Table 12: Typical Current Consumption Versus Antenna Gain

Antenna Gain	Current Consumption
+12 dB	20 mA
+26 dB	35 mA

C.2 Geodetic Active Antenna

For DGPS applications where <1 m accuracy is required, it is strongly recommended you use an active geodetic GPS antenna.

Table 13: Recommended Geodetic Active Antennas

Antenna Types	Part Number
Completely sealed round disk L1 geodetic antenna with +26 dB gain, TNC connector, built-in ground plane and 1"-14 thread mounting	201-990147-606

The antenna gain should be selected depending on the cable loss between the antenna and the receiver.

C.3 Active Antenna

Lower cost antennas for higher volume applications or for more cost sensitive applications are available.

SUPERSTAR II receivers are manufactured by implementing a 20 dB LNA on board. For this reason, an active +12 dB antenna is more than adequate. An antenna with +26 dB may overdrive the RF input of the SUPERSTAR II receiver if it is used with a short cable between the antenna and the receiver. *Table 14* lists the active antennas which could be used with any of the SUPERSTAR II-based receivers.

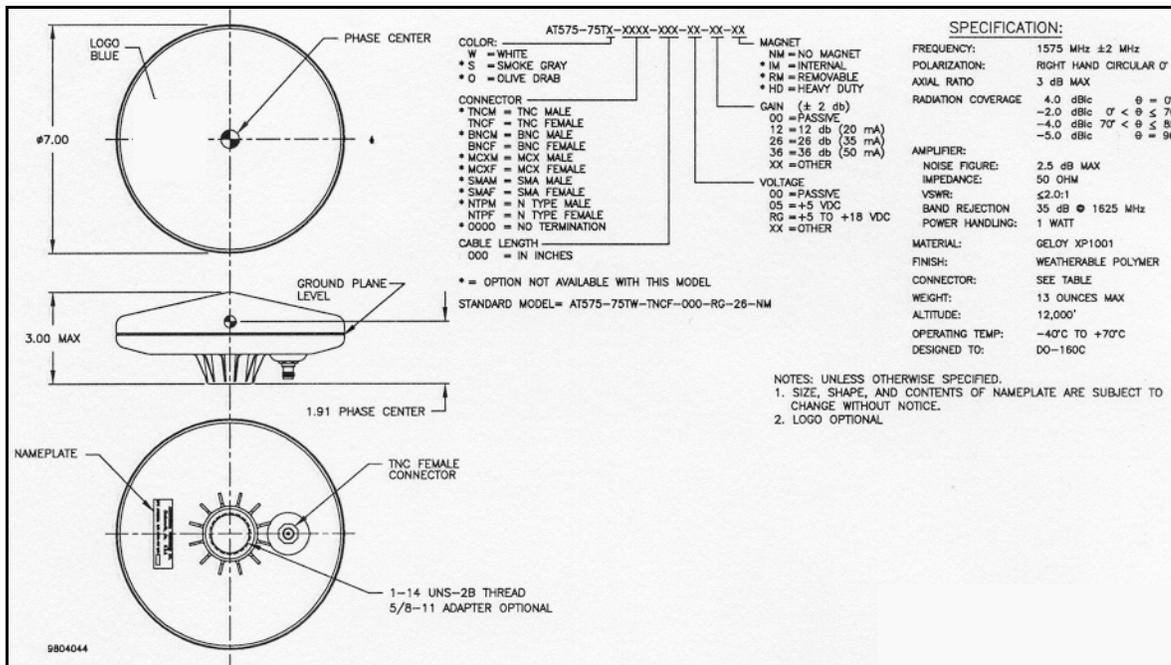


Figure 19: GPS Antenna 201-990147-606 (+26 dB)

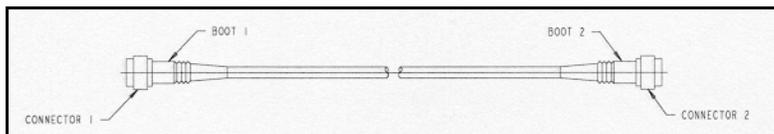


Figure 20: Coaxial Cable Assembly

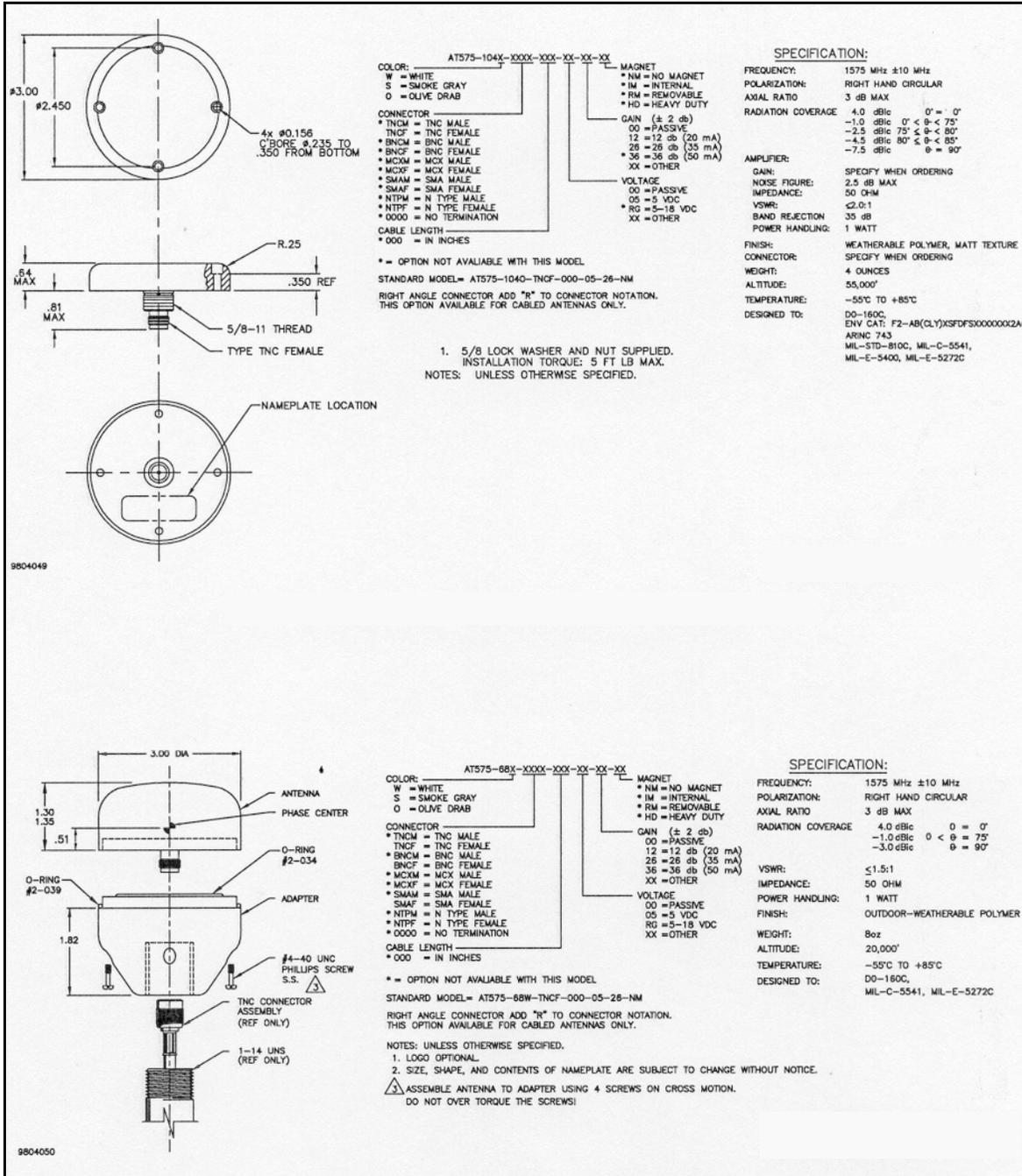


Figure 21: GPS Antenna 201-990147-432 (1575 MHz) and 201-990144-807 (Pre-Amplifier)

Index

A

accuracy, 42
 positioning, 34, 52
acquisition, 32, 42
active antenna, 22, 24
aligned mode, 26
almanac, 24–25, 32
antenna, 22
 active, 17, 22, 24, 55
 base station, 21
 gain, 54
 power, 24, 55
 site, 35
 specifications, 54–55, 57–58
anti-static, 20
architecture, system, 17

B

base, 21, 31–32, 52
baud rate, 26, 29
block diagram, 17
broadcast
 ephemeris, 34
buffer, 29

C

cables
 antenna, 54
 coaxial, 17, 57
 interface, 52
 RF, 24
 serial, 29
 warranty, 12
cautions, 29
CD, 53
coaxial, 17, 20, 54, 57
communication, 20, 29, 37–38, 43, 50–52
configuration, 19, 26, 28–29
connector, 20–24, 26–27, 45, 47–53
copyright, 2
Customer Service, 9

D

data

 link, 22
 request, 30
datum, 33
DC, 17, 47
dead-reckoning mode, 33
defaults, 26, 29
development kit, 43, 51
device, supercap, 24
DGPS, 22, 25–26
differential
 corrections, 23, 38, 52
 mode, 32
 setup, 52
dilution of precision (DOP), 34
dimensions, 43
discretes, 25
dynamics, 42

E

electrostatic discharge (ESD), 10, 20
ephemeris, 32, 34
equipment, development kit, 51
errors, 33–34

F

fault mode, 33
features, 14, 29
figure of merit (FOM), 14
firmware update, 9
fix, 52
FlexPak-SSII, 15, 30, 52
frequency, 42

G

GEO, SBAS, 35
GPS time, 35

H

handshaking, 29
humidity, 43

I

I/O, 22, 25, 46
idle time, 29
initialization, 32
input, 23–25, 38, 42–43
installation, 19

integration, 19
interface, 19, 22, 24, 45
ionosphere, 34

J

jerk, 42

K

kit, development, 43, 51

L

lightning protection, 11
LNA, *see* low noise amplifier
low noise amplifier (LNA), 18, 54

M

mask angle, 31
memory, 24, 26
merit (FOM), figure of, 14
mode
 differential, 32
 fault, 33
 operational, 31
 stand-alone nav, 32
modem, 52
multipath, 21

N

navigation
 mode, 32
NMEA, 25
non-volatile memory (NVM), 25–26
Notices, 11
notices, regulatory, 10
NovAtel Inc., 2, 9, 12

O

OCXO, *see* oscillators
operation, 28, 30–32
oscillators, 35
output, 23, 38, 43, 47

P

packaging, 17
parameter, receiver, 31
parity, 29
performance, 42
port, 20, 23, 29
position, 24–25, 42, 52
power, 42

antenna, 24
connector, 49
up, 30

preamplifier, 24
processing circuitry, 18
propagation, 34
protocol, 26
pseudorange, 34
publications, 13

R

radio frequency (RF), 18, 23–24, 43
radio modem, 52
re-acquisition, 42
receiver, sections, 17
regulatory notices, 10
revision, firmware, 1
RF, *see* radio frequency
rover, 22, 32, 52

S

satellite
 acquisition, 32
 records, number of, 29
 tracking, 14
 transmit, 18
SBAS, 35–36
scope, 13
self-test, 30–31, 33
serial
 cable, 29
 communication, 43
setup, 27, 51–52
SNR, 37
software, *StarView*, 53
stand-alone nav mode, 32
start, warm, 24
StarView software, 19, 51, 53
station, base, 21, 31–32
status, 33
supercap device, 24
support, 12
system architecture, 17

T

TCXO, *see* oscillators
technical specifications, 49
temperature, 43

time, 24
 data, 32
 -to-first-fix (TTFF), 25, 42
tracking, satellite, 14
troposphere, 34
troubleshooting, 37–38

U

update firmware, 9

V

valid almanac, 24
voltage, 46

W

warm start, 24
warnings, 11, 18
warranty, 12, 18, 20
weight, 43

