NovAtel

A Precise Positioning Technology Company

SPAN® Technology for OEM6™

User Manual

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SPAN Technology for OEM6 User Manual

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#6,664,923 B1
#6,721,657 B2
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10. <u>Customer Support</u>: 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,

Web site: http://www.novatel.com or write to:

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

Terms and Conditions

Standard Terms and Conditions of Sales

1. PRICES: All prices are Firm Fixed Price, FCA 1120 - 68th Avenue N.E., Calgary, Alberta. All prices include standard commercial packing for domestic shipment. All transportation, insurance, special packing costs and expenses, and all Federal, provincial and local excise, duties, sales, and other similar taxes are the responsibility of the Purchaser.

2. PAYMENT: Terms are prepayment unless otherwise agreed in writing. Interest shall be charged on overdue accounts at the rate of 18% per annum (1.5% per month) from due date.

3. DELIVERY: Purchaser shall supply shipping instructions with each order. (Ship to and bill to address, NovAtel Quotation #, Preferred carrier and account #, Custom broker/freight forwarder including name and contact #) In the absence of specific instructions, NovAtel may select a carrier and insure Products in transit and charge Purchaser accordingly. NovAtel shall not be responsible for any failure to perform due to unforeseen circumstances or causes beyond its ability to reasonably control. Risk of loss, damage or destruction shall pass to Purchaser upon delivery to carrier. Goods are provided solely for incorporation into the Purchaser’s end product and shall not be onward delivered except as incorporated in the Purchaser’s end product.

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5. GENERAL PROVISIONS: All Purchase Orders are subject to approval and acceptance by NovAtel. Any Purchase Order or other form from the Purchaser, which purports to expand, alter or amend these terms and conditions, is expressly rejected and is and shall not become a part of any agreement between NovAtel and the Purchaser. This agreement shall be interpreted under the laws of the Province of Alberta.

6. LIMITED WARRANTY AND LIABILITY: Warranty Period: Products - 1 year; Accessories - 90 days (in each case from the date of invoice). NovAtel warrants that during the Warranty Period that (a) the Product will be free from defects in material and workmanship and conform to NovAtel specifications; (b) the software will be free from error which materially affect performance; and (c) if applicable as defined in the User’s Manual, be eligible for access to post contract support and software updates when available. **THESE WARRANTIES ARE EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. NOVATEL SHALL IN NO EVENT BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES OF ANY KIND OR NATURE DUE TO ANY CAUSE.**

Purchaser’s exclusive remedy for a claim under this warranty shall be limited to the repair or replacement at NovAtel’s option and at NovAtel’s facility, of defective or nonconforming materials, parts or components or in the case of software, provision of a software revision for implementation by the Buyer. All material returned under warranty shall be returned to NovAtel prepaid by the Buyer and returned to the Buyer, prepaid by NovAtel. 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, (vi) service or repair of Product by the Purchaser without prior written consent from NovAtel, (vii) Products designated by NovAtel as beta site test samples, experimental, developmental, preproduction, sample, incomplete or out of specification Products, (viii) returned Products if the original identification marks have been removed or altered or (ix) Services or research activities.

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Warranty Policy

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

OEM6™ Receivers	One (1) Year
IMU Units (return to manufacturer) [1]	One (1) Year
GPSAntenna™ Series	One (1) Year
Cables and Accessories	Ninety (90) Days
Computer Discs	Ninety (90) Days
Software Warranty	One (1) Year

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

Determination of replacement or repair will be made by NovAtel personnel or by technical personnel expressly authorized by NovAtel for this purpose (*continued on page 16*).

> **Only return an IMU to the point of purchase (NovAtel, Dealer or Manufacturer)**.
>
> **If the IMU was purchased through NovAtel, contact Customer Service to begin the Return Material Authorization (RMA) process**.

When returning a Litton or Honeywell IMU from outside the U.S., follow these steps:

a) Include a copy of the original U.S. export permit with it.

b) Send the unit to Litton or Honeywell, with the following wording on the documentation: "Shipped in accordance with 22 CFR 123.4 (a) (1)", using air transport and not a carrier service. The repaired or replaced device will be returned to you under this same CFR exemption.

c) Identify the paperwork with the value of the hardware ($), the country of origin as U.S. and the Incoterms if applicable (for example, FOB, FAS, CIF Ex-Works).

d) Lastly, please clearly note on the paperwork to notify, upon receipt, Honeywell's customs broker, "EXPIDITORS", or for Litton, "FOR CUSTOMS CLEARANCE BY: FedEx Trade Networks, 19601 Hamilton Ave. Torrance, CA 90502-1309, U.S.A.".

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1. Litton: Northrop Grumman/Litton Systems, Inc.
Navigation Systems Division (NSD)
21240 Burbank Blvd.
Woodland Hills, CA 91367

iMar: iMAR GmbH
Im Reihersbruch 3
D-66386 St. Ingbert
Germany

KVH: KVH IMUs should be returned to NovAtel for repair.
Contact Customer Support for detailed information.

Honeywell: Honeywell International Inc.
2600 Ridgway Parkway (Ridgway is really not spelled with an 'e')
Minneapolis, MN 55413

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

> Before shipping any material to NovAtel or Dealer, please obtain a Return Material Authorization (RMA) number from the point of purchase.

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

Customer Support

NovAtel Knowledge Base

If you have a technical issue, browse to the NovAtel Web site at www.novatel.com then select *Support | Helpdesk and Solutions | Search Known Solutions.* Through this page, you can search for general information about GNSS and other technologies, information about NovAtel hardware and software, and installation and operation issues.

Before Contacting Customer Support

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

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

    RXSTATUSB once

    RAWEPHEMB onchanged

    RANGEB ontime 1

    BESTPOSB ontime 1

    RXCONFIGA once

    VERSIONB once

    RAWIMUSXB onnew

    INSPVASB ontime 1

    INSCOVSB ontime 1

    INSUPDATEB onchanged

2. Send the file containing the log to NovAtel Customer Support, using either the NovAtel FTP site at *Support | Firmware/Software and Manuals | Access FTP Site* on the NovAtel Web site at www.novatel.com or through the support@novatel.com e-mail address.

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

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

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

Contact Information

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

<table>
<tr><td colspan="2">Call the NovAtel Hotline at 1-800-NOVATEL (U.S. & Canada)
or +1-403-295-4900 (international)</td></tr>
<tr><td>Fax: +1-403-295-4901
E-mail: support@novatel.ca
Web site: http://www.novatel.com</td><td>Write: NovAtel Inc.
Customer Support Department
1120 - 68 Avenue NE
Calgary, AB
Canada, T2E 8S5</td></tr>
</table>

Firmware Updates and Model Upgrades

Firmware *updates* are firmware releases, which include fixes and enhancements to the receiver functionality. Firmware updates are released on the Web site as they become available. Model *upgrades* enable features on the receiver and may be purchased through NovAtel authorized dealers.

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

> Firmware updates can only be done through serial COM port connections.

Notices

The following notices apply to the SPAN devices.

FCC Notices

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

This SPAN device complies with the radiated and conducted emission limits for a Class B digital device. The Class B limits are designed to provide reasonable protection against harmful interference in a residential installation.

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

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

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

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

CE Notice

The enclosures carry the CE mark.

"Hereby, NovAtel Inc. declares that this OEM6-SPAN is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC."

WEEE Notice

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

Lightning Protection Installation and Grounding Procedure

What is the hazard?

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

Hazard Impact

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

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

Actions to Mitigate Lightning Hazards

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

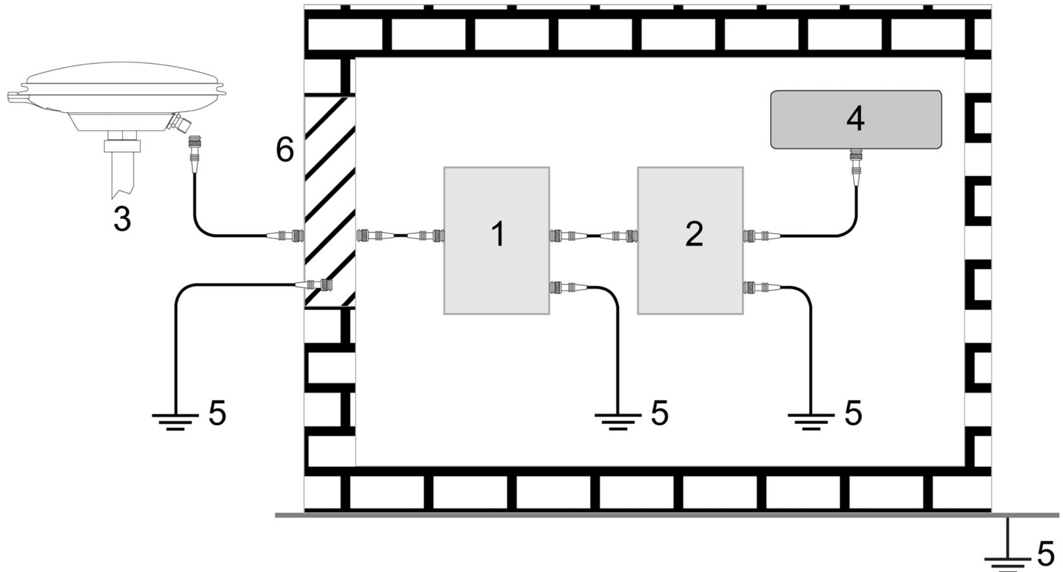
    Polyphaser - Surge Arrestor DGXZ+24NFNF-A

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

    - UL listed, or equivalent, in country of installation (for example, TUV, VDE and so on) for lightning surge protection
    - The primary device must be capable of limiting an incoming surge to 10kV
5. The shield of the coaxial cable entering the building should be connected at a grounding plate at the building's entrance. The lightning protection devices should have their chassis grounded to the same ground near to the building's entrance.
6. The primary and secondary lightning protections should be as close to the building's entrance as possible. Where feasible they should be mounted onto the grounding plate itself. See *Figure 1, Primary and Secondary Lightning Protection*.

1. Please visit the NovAtel Web site at www.novatel.comthrough *Products* | *WEEE and RoHS* for more information.

Figure 1: Primary and Secondary Lightning Protection



Ref #	Description
1	Primary lightning protection device
2	Secondary lightning protection device
3	External antenna
4	GNSS Receiver
5	To ground
6	Grounding plate or grounding point at the building's entrance

Acceptable choices for Earth Grounds, for central buildings, are:

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

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

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

Foreword

Congratulations!

Congratulations on purchasing your Synchronized Position Attitude Navigation (SPAN) Technology system. SPAN features a tight integration of a NovAtel GNSS receiver and an Inertial Measurement Unit (IMU). SPAN provides continuous navigation information, using an Inertial Navigation System (INS), to bridge short GNSS outages. Designed for dynamic applications, SPAN provides precise position, velocity and attitude information.

By complementing GNSS with inertial measurements, SPAN Technology provides robust positioning in challenging conditions where GNSS alone is less reliable. During short periods of GNSS outage, or when less than four satellites are received, SPAN Technology offers uninterrupted position and attitude output. The tight coupling of inertial technology with GNSS also provides the benefits of faster satellite reacquisition and faster RTK initialization after outages.

NovAtel's OEM6 receivers are the processing engines of the SPAN Technology system. Separate GNSS and IMU enclosures provide a simple modular system. This allows the IMU mounting at the most suitable location, while the GNSS receiver is mounted where it is most convenient. System modularity also allows GNSS-only users to upgrade to GNSS/INS. In conditions where GNSS alone is desired, the SPAN receiver can be operated independently. As a result, SPAN Technology provides a robust GNSS and Inertial solution as well as a portable, high-performance GNSS receiver in one system.

Scope

This manual contains sufficient information about the installation and operation of the SPAN system. It is beyond the scope of this manual to provide details on service or repair. Contact your local NovAtel dealer for any customer-service related inquiries, see *Customer Support on Page 17*.

A SPAN system requires the addition of accessories, an antenna and a power supply.

The OEM6 receiver utilizes a comprehensive user-interface command structure, which requires communications through its communications ports. This manual describes the INS specific commands and logs. Other supplementary manuals are included to aid you in using the other commands and logs available with OEM6 family products. It is recommended that these documents be kept together for easy reference.

SPAN system output is compatible with post-processing software from NovAtel's Waypoint Products Group. Visit our Web site at www.novatel.com for details.

Prerequisites

The installation chapters of this document provide information concerning the installation requirements and considerations for the different parts of the SPAN system.

To run the SPAN system software, your personal computer must meet or exceed this minimum configuration:

- Microsoft® Windows® user interface (Windows XP or higher)
- Pentium microprocessor recommended
- VGA Display
- Windows compatible mouse or pointing device

Although previous experience with Windows is not necessary to use the SPAN system software, familiarity with certain actions that are customary in Windows will assist in the using of the program. This manual has been written with the expectation that you already have a basic familiarity with Windows.

Chapter 1 Introduction

NovAtel's SPAN technology brings together two very different but complementary positioning and navigation systems namely Global Navigation Satellite System (GNSS) and an Inertial Navigation System (INS). By combining the best aspects of GNSS and INS into one system, SPAN technology is able to offer a solution that is more accurate and reliable than either GNSS or INS could provide alone. The combined GNSS/INS solution has the advantage of the absolute accuracy available from GNSS and the continuity of INS through traditionally difficult GNSS conditions.

The SPAN system consists of the following components:

- NovAtel OEM6 receivers - These receivers are capable of receiving and tracking different combinations of GPS L1 C/A, L2C, L2 P(Y) and L5 code and carrier, GLONASS L1 and L2 code and carrier, Galileo E1/E5a/E5b/Alt-BOC, Compass signals and L-band (OmniSTAR) on a maximum of 120 channels. SBAS support is standard on all OEM6 family receivers. OEM6 adaptability offers multi-system, frequency, and size configurations for any application requirement. Patented Pulsed Aperture Correlator (PAC) technology combined with a powerful microprocessor enable multipath-resistant processing. Excellent acquisition and re-acquisition times allow this receiver to operate in environments where very high dynamics and frequent interruption of signals can be expected. The OEM6 family also supports the timing requirements of the IMU and runs the real-time INS filter.
- IMU Enclosure - The Inertial Measurement Unit (IMU) is housed in the IMU enclosure that provides a steady power supply to the IMU, and decodes and times the IMU output data. The IMU itself consists of three accelerometers and three gyroscopes (gyros) so that accelerations along specific axis and angular rotations can be measured. Several IMU types are supported and are listed in *Table 1, SPAN-Compatible IMU Models* on *page 25* and *Table 41, IMU Type* on *page 99*.
- PC Software - Real-time data collection, status monitoring and receiver configuration is possible through NovAtel's Connect software utility, see *Section 3.1* on *page 36*.
- A GNSS antenna

Figure 2: SPAN System Receivers

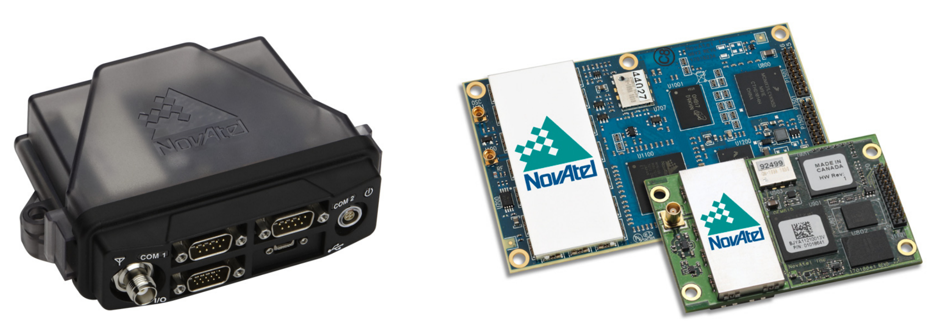


Figure 3: SPAN System IMUs

The GNSS receiver is connected to the IMU enclosure with an RS-232 or RS-422 serial link. A NovAtel GNSS antenna must also be connected to the receiver to track GNSS signals. After the IMU enclosure, GNSS antenna and appropriate power supplies are attached, and a few simple configuration commands are entered, the SPAN system will be ready to navigate.

1.1 Fundamentals of GNSS/INS

GNSS positioning observes range measurements from orbiting GNSS satellites. From these observations, the receiver can compute position and velocity with high accuracy. NovAtel GNSS positioning systems are highly accurate positioning tools. However, GNSS in general has some restrictions which limit its usefulness in some situations. GNSS positioning requires line of sight view to at least four satellites simultaneously. If these criteria are met, differential GNSS positioning can be accurate to within a few centimetres. If however, some or all of the satellite signals are blocked, the accuracy of the position reported by GNSS degrades substantially, or may not be available at all.

In general, an INS uses forces and rotations measured by an IMU to calculate position, velocity and attitude. This capability is embedded in the firmware of OEM6 series receivers. Forces are measured by accelerometers in three perpendicular axes within the IMU and the gyros measure angular rotation rates around those axes. Over short periods of time, inertial navigation gives very accurate acceleration, velocity and attitude output. The INS must have prior knowledge of its initial position, initial velocity, initial attitude, Earth rotation rate and gravity field. Since the IMU measures changes in orientation and acceleration, the INS determines changes in position and attitude, but initial values for these parameters must be provided from an external source. Once these parameters are known, an INS is capable of providing an autonomous solution with no external inputs. However, because of errors in the IMU measurements that accumulate over time, an inertial-only solution degrades with time unless external updates such as position, velocity or attitude are supplied.

The SPAN system's combined GNSS/INS solution integrates the raw inertial measurements with all available GNSS information to provide the optimum solution possible in any situation. By using the high accuracy GNSS solution, the IMU errors can be modeled and mitigated. Conversely, the continuity and relative accuracy of the INS solution enables faster GNSS signal reacquisition and RTK solution convergence.

The advantages of using SPAN technology are its ability to:

- Provide a full attitude solution (roll, pitch and azimuth)
- Provide continuous solution output (in situations when a GNSS-only solution is impossible)
- Provide faster signal reacquisition and RTK solution resolution (over stand-alone GNSS because of the tightly integrated GNSS and INS filters)
- Output high-rate (up to 100 or 200 Hz depending on your IMU model and other logging selections) position, velocity and attitude solutions for high-dynamic applications, see also *Logging Restriction Important Notice* on *page 44*
- Use raw phase observation data (to constrain INS solution drift even when too few satellites are available for a full GNSS solution)

1.2 Models and Features

All SPAN system receivers are factory configurable for L1/L2 RTK capability and are compatible with an IMU. See *Table 1* for firmware model details.

Table 1: SPAN-Compatible IMU Models

Model Name	Maximum Output Rate	Compatible IMUs	SW Model
IMU-H58 UIMU-H58	100 Hz	HG1700-AG58	S2
IMU-H62 UIMU-H62	100 Hz	HG1700-AG62	S2
IMU-LN200	200 Hz	LN-200	S3
IMU-FSAS-EI	200 Hz	iIMU-FSAS	S3
UIMU-LCI	200 Hz	Litef LCI-1	S3
IMU-CPT	100 Hz	IMU-CPT	S1
IMU-H1900-CA50	100 Hz	HG1900-CA50	S2
IMU-H1930-CA50	100 Hz	HG1930-CA50	S1

Each model is capable of multiple positioning modes of operation. For a discussion on GNSS positioning and receiver details, refer to the *OEM6 Family Installation and Operation User Manual.*

Each model has the following standard features:

- Rugged shock, water, and dust-resistant enclosure (FlexPak6)
- NovAtel's advanced OEM6 L1/L2/L5 GPS, L1/L2 GLONASS and PAC technology
- Two[1] bidirectional COM ports which support data transfer rates of up to 921,600 bits/s[2].
  One of these serial ports is capable of communication with an IMU.
- One USB 2.0 port.
- One Ethernet port (not available on the OEM615).
- A Controller Area Network Bus (CAN Bus) which is a rugged differential serial bus with a protocol that provides services for processes, data and network management.
- Field-upgradeable firmware (program software). What makes one model different from another is software, not hardware. This unique feature means that the firmware can be updated any time, anywhere, without any mechanical procedures whatsoever. For example, a model with L1/L2-only capabilities can be upgraded to a model with L1/L2 RT-2™ in only a few minutes in your office (instead of the days or weeks that would be required if the receiver had to be sent to a service depot). All that is required to unlock the additional features is a special authorization code. Refer to the *OEM6 Family Installation and Operation User Manual* for further details on this topic.

Some of the IMUs used with SPAN are housed in an enclosure with a PCB board to handle power, communication and data timing. See *Appendix A, Technical Specifications* starting on *page 64* for details.

1. A third COM port is available on the OEM615 and OEM628 receivers.
2. Rates higher than 115,200 are not standard on most computers and may require extra computer hardware.

Chapter 2 SPAN Installation

2.1 Hardware Description

One hardware setup consists of an OEM6 receiver (see *Figure 2 on page 23*), an IMU (see *Figure 3 on page 23*), a GNSS antenna, power and a radio link (if your application requires real time differential operation). If your IMU enclosure and IMU were supplied separately, additional installation instructions for installing the IMU can be found in the Appendix specific to your IMU starting on page 205. Another hardware set up consists of an MIC (MEMS Interface Card), an IMU and a COM and power link (refer to *Section 2.1.2.3, MIC in Stack Up Configuration* on *Page 29* and *Section 2.1.2.4, MIC in Standalone Configuration* on *Page 29*).

2.1.1 SPAN System Receiver

Data storage is done using a computer connected to the receiver through either the USB, serial or Ethernet port.

For information about accessing the ports on an OEM6 receiver board, see the *OEM6 Family Installation and Operation User Manual*.

The connectors available on the FlexPak6 are shown in *Figure 4*. The FlexPak6 provides DB9, DB-HD15, USB, power and antenna connectors.

Figure 4: FlexPak6 Receiver Connectors

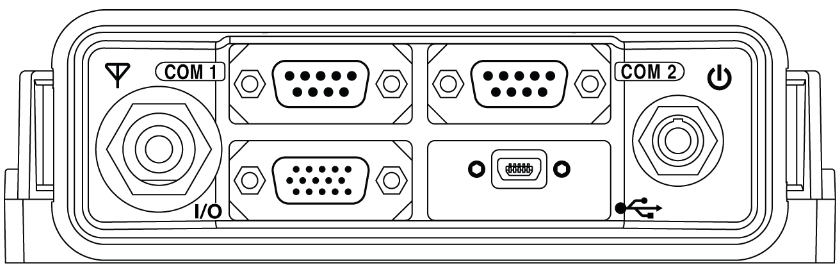


Table 2 shows a summary of the receiver port names available on the FlexPak6.

Table 2: FlexPak6 Receiver Port Labels

Port Label	Description
COM 1	Serial communications port 1
COM 2	Serial communications port 2
I/O	Input and output port for additional signals such as Ethernet and CAN Bus signals.
	Supply voltage
	USB communications port
	Antenna port

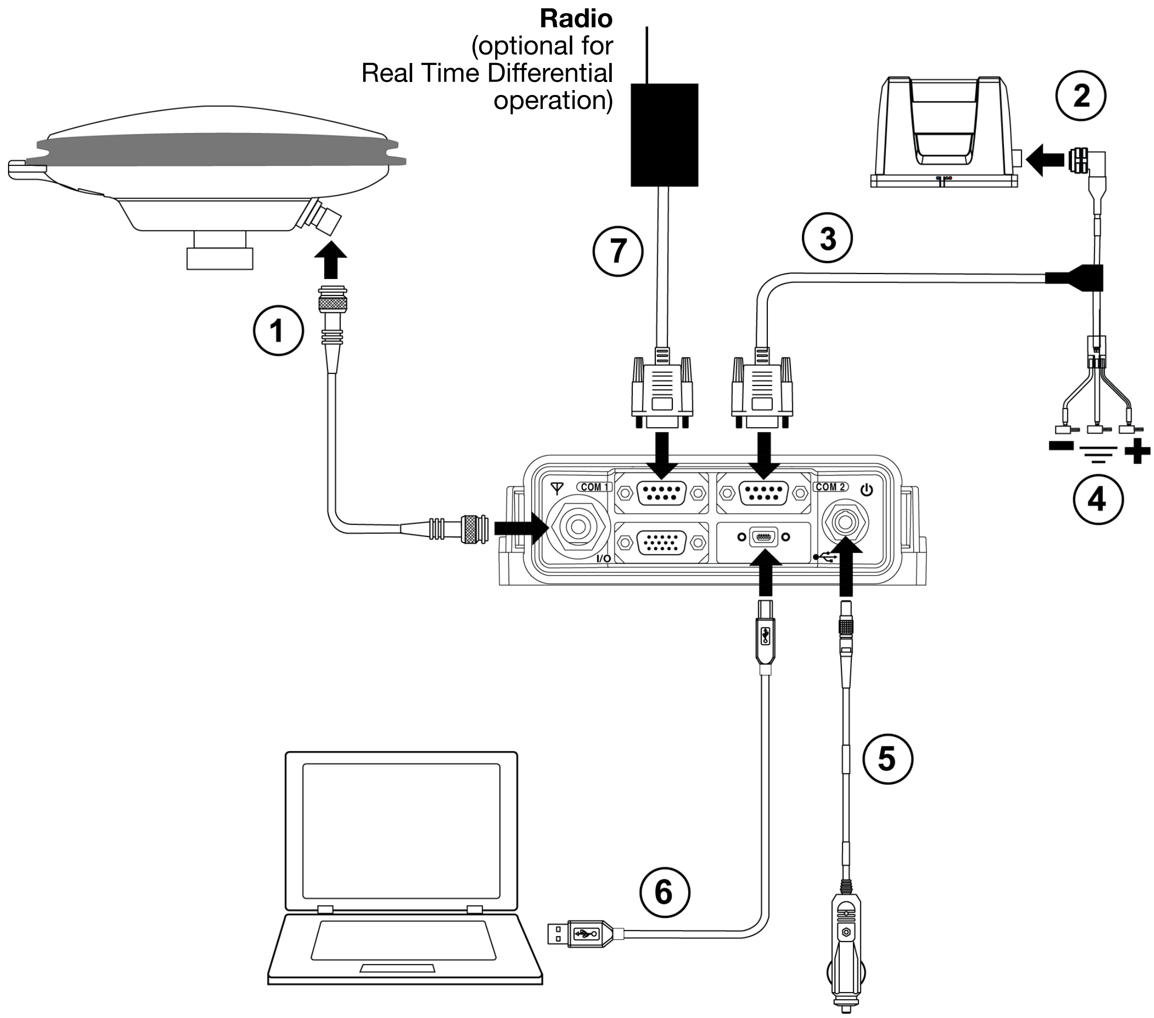
For information about the FlexPak6 ports and cables, see the *OEM6 Family Installation and Operation User Manual*.

2.1.2 Typical Installation Examples

The following examples show the connections for a FlexPak6 receiver. If you are using an OEM6 receiver card (such as an OEM615 or OEM628), you need a wiring harness to connect the receiver to the other components of the SPAN system. See the *OEM6 Family Installation and Operation User Manual* for information about preparing the data, signal and power wiring harness.

2.1.2.1 LN-200, HG1700 or LCI-1 Set Up Example

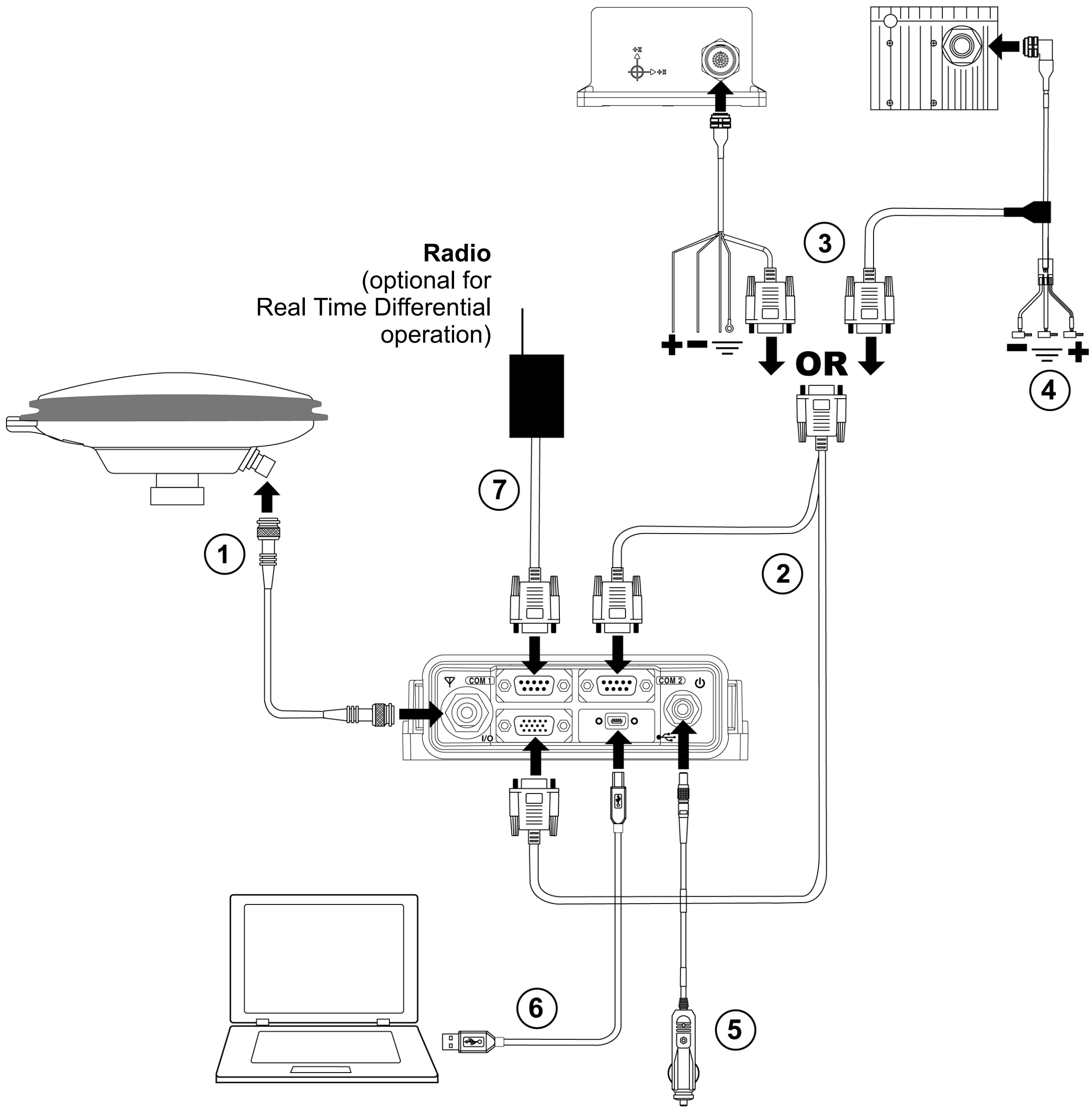
Figure 5: Basic Set Up – LN-200, HG1700 or LCI-1



1. Connect the antenna to the receiver.
2. Connect the interface cable to the LN-200, HG1700 or LCI-1 (universal enclosure).
3. Connect the DB9 connector of the interface cable to the *COM 2* port of the receiver.
4. Connect the IMU power and ground to the IMU interface cable.
5. Connect a user supplied power supply (refer to *Table 5* on *page 33*) to the receiver.
6. Connect a user supplied computer for set up and monitoring to the USB port.
7. Connect a user supplied radio device to *COM 1* (optional for real time differential operation).

2.1.2.2 IMU-FSAS or IMU-CPT Set Up Example

Figure 6: Basic Set Up – IMU-FSAS or IMU-CPT

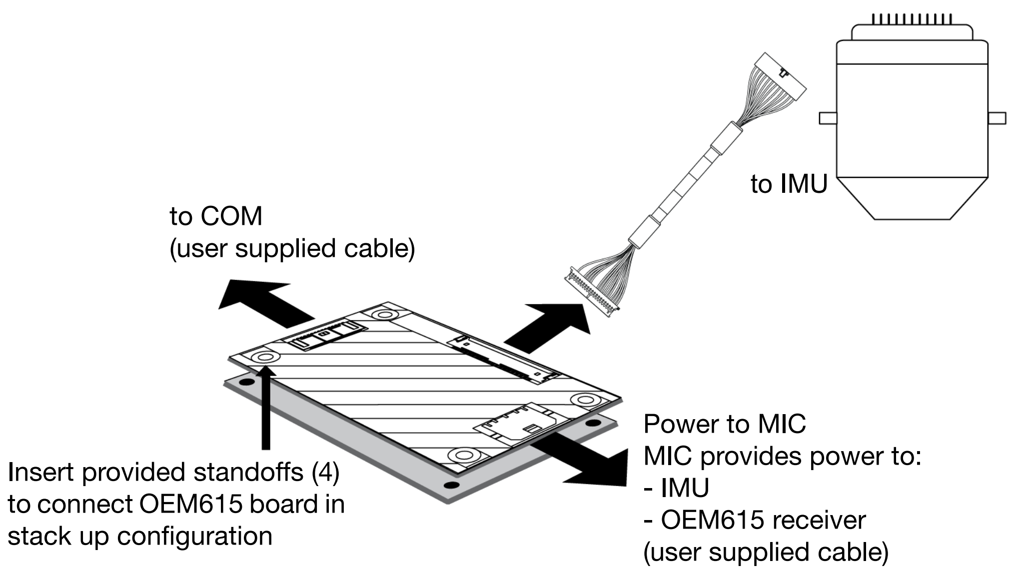


1. Connect the antenna to the receiver.
2. Connect the FlexPak Y Adapter cable to the COM 2 and I/O ports on the receiver.
3. Connect the IMU interface cable to the IMU and the FlexPak Y Adapter cable.
4. Connect power and ground to the IMU interface cable.
5. Connect a user supplied power supply (refer to *Table 5* on *page 33*) to the receiver.
6. Connect a user supplied computer for set up and monitoring to COM1.
7. Connect a user supplied radio device to COM 1 (optional for real time differential operation).

2.1.2.3 MIC in Stack Up Configuration

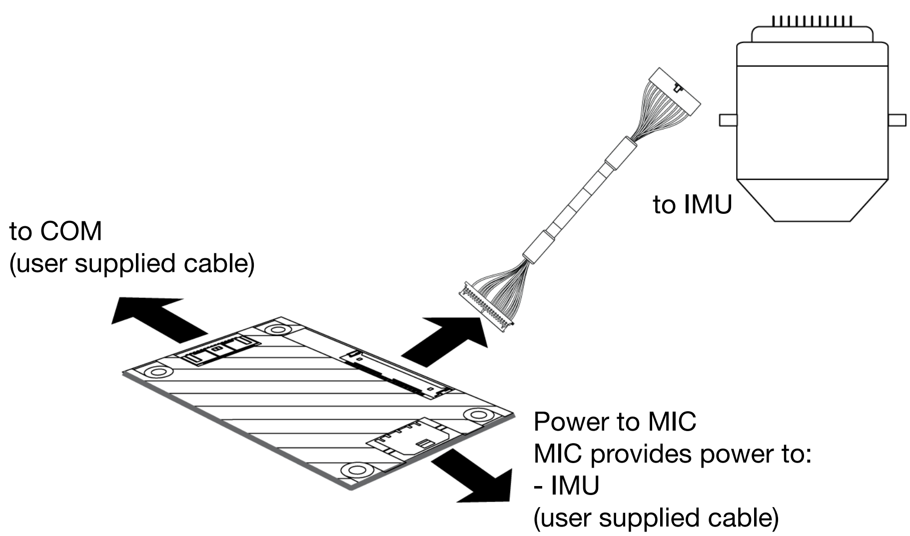
> ***Important!*** Assemble in accordance with applicable industry standards. Ensure all ESD measures are in place, in particular, use a ground strap before exposing or handling any electronic items, including the IMU. Take care to prevent damaging or marring painted surfaces, O-rings, sealing surfaces and the IMU.

Figure 7: MIC in Stack Up Configuration



2.1.2.4 MIC in Standalone Configuration

Figure 8: MIC in Standalone Configuration



2.1.3 SPAN Cables

This section outlines the cables used to connect the receiver to the IMU. For information about the other cables for OEM6 receivers, refer to the *OEM6 Family Installation and Operation User Manual*.

Each connector can be inserted in only one way, to prevent damage to both the receiver and the cables. Furthermore, the connectors used to mate the cables to the receiver require careful insertion and removal. Observe the following when handling the cables.

- To insert a cable, make certain to use the appropriate cable for the port - the serial cable has a different connector than the power cable.
- Insert the connector until it is straight on and secure.
- To remove a cable, grasp it by the connector.

> Do not pull directly on the cable.

The cables you need to connect the receiver to the IMU depends on the type of IMU you are using. Table 3 lists the cables required to connect the IMU to the receiver.

Table 3: Receiver to IMU Interface Cables

	SPAN-SE SPAN-MPPC[a]	FlexPak6 OEM615[a], OEM628[a]	ProPak-V3 OEMV-1[a], OEMV-2[a], OEMV-3[a]
IMU-LCI	**01018299** See *Universal IMU Cable* on page 66	**01018299** See *Universal IMU Cable* on page 66	OEMV receivers do not support this IMU
UIMU-LN200 **IMU-LN200** **(includes -L)**	**01018299** See *Universal IMU Cable* on page 66	**01018299** See *Universal IMU Cable* on page 66	**01018299** See *Universal IMU Cable* on page 66
IMU-FSAS	**01018299** See *Universal IMU Cable* on page 66	**01018299**[b] See *Universal IMU Cable* on page 66	**01018222** IMU-FSAS Interface Cable
UIMU-HG1700 AG58 **UIMU-HG1700 AG62** **IMU-HG1700 AG58** **IMU-HG1700 AG62**	**01018299** See *Universal IMU Cable* on page 66	**01018299** See *Universal IMU Cable* on page 66	**01018299** See *Universal IMU Cable* on page 66
IMU-CPT	**60723114** IMU-CPT Interface cable	**01018966**[b] See *IMU-CPT Cable* on page 85	OEMV receivers do not support this IMU

a. Receiver cards require modification to the standard cable. Refer to *OEM6 Family Installation and Operation User Manual* for information about the modification needed.

b. A FlexPak Y Adapter Cable (01018948) is required to connect a FlexPak6 receiver to this IMU.

Table 4 lists the cables required to connect an IMU to the MIC.

Table 4: MEMS Interface Card (MIC) Interface Cables

IMU	Cable
IMU-HG1900	01018828, see *HG1700 and HG1900 IMU-to-MIC Cable Assembly* on page 90
IMU-HG1930	01018827, see *HG1930 IMU-to-MIC Cable Assembly* on page 89

2.2 Hardware Set Up

Complete the following steps to set up your NovAtel SPAN system.

1. Mount the GNSS antenna, as described in *Section 2.2.1, Mount the Antenna* on *page 31*.
2. Mount the IMU, as described in *Section 2.2.2, Mount the IMU* on *page 31*.
3. Mount the receiver, as described in *Section 2.2.3, Mount the OEM6 Receiver* on *page 31*.
4. Connect the GNSS antenna to the OEM6 receiver, as described in *Section 2.2.4, Connect the Antenna to the OEM6 Receiver* on *page 32*.
5. Connect the IMU to the OEM6 receiver, as described in *Section 2.2.5, Connect the IMU to the OEM6 Receiver* on *Page 32*.
6. Connect the I/O strobe signals (optional), as described in *Section 2.2.6, Connect I/O Strobe Signals* on *page 32*.
7. Connect power to the IMU and receiver, as described in *Section 2.2.7, Connect Power* on *page 32*.

2.2.1 Mount the Antenna

For maximum positioning precision and accuracy, as well as to minimize the risk of damage, ensure that the antenna is securely mounted on a stable structure that will not sway or topple. Where possible, select a location with a clear view of the sky to the horizon so that each satellite above the horizon can be tracked without obstruction. The location should also be one that minimizes the effect of multipath interference. For a discussion on multipath, please refer to the *GNSS Book* available from www.novatel.com/support/knowledge-and-learning/.

Ensure the antenna cannot move due to dynamics.

2.2.2 Mount the IMU

Mount the IMU in a fixed location where the distance from the IMU to the GNSS antenna phase center is constant. Ensure that the orientation with respect to the vehicle and antenna is also constant.

For attitude output to be meaningful, the IMU should be mounted such that the positive Z-axis marked on the IMU enclosure points up and the Y-axis points forward through the front of the vehicle, in the direction of track.

Also, it is important to measure the distance from the IMU to the antenna (the Antenna Lever Arm), on the first usage, on the axis defined on the IMU enclosure. See *Section 3.3.4, Lever Arm Calibration Routine* starting on *page 44*. See also *Appendix A, Technical Specifications* starting on *page 64* for dimensional drawings of the IMU enclosures.

Ensure the IMU cannot move due to dynamics and that the distance and relative direction between the antenna and the IMU is fixed. See also *Section 2.3.2, SPAN IMU Configuration* starting on *page 34*.

- The closer the antenna is to the IMU, the more accurate the position solution. Also, your measurements when using the SETIMUTOANTOFFSET command must be as accurate as possible, or at least more accurate than the GNSS positions being used. **For example, a 10 cm error in recording the antenna offset will result in at least a 10 cm error in the output. Millimeter accuracy is preferred.**
- The offset from the IMU to the antenna, and/or a user point device, must remain constant especially for RTK or DGPS data. Ensure the IMU, antenna and user point device are bolted in one position perhaps by using a custom bracket.

2.2.3 Mount the OEM6 Receiver

The steps required to mount the OEM6 receiver vary depending on the type of OEM6 receiver (card or enclosure) you are using. See the *OEM6 Family Installation and Operation User Manual* for information about mounting an OEM6 receiver.

2.2.4 Connect the Antenna to the OEM6 Receiver

Connect the GNSS antenna to the receiver using a high-quality coaxial cable.

- For a FlexPak6 receiver, connect the antenna cable from the connector on the antenna to the Antenna port on the FlexPak6. See *Figure 5, Basic Set Up – LN-200, HG1700 or LCI-1* on page 27 or *Figure 6, Basic Set Up – IMU-FSAS or IMU-CPT* on page 28.
- For OEM6 receiver cards, an RF adapter is required to connect the antenna cable to the receiver card. See the *OEM6 Family Installation and Operation User Manual* for more information.

2.2.5 Connect the IMU to the OEM6 Receiver

Connect the IMU to the receiver using the IMU interface cable.

- For a system with a FlexPak6 receiver and an IMU in the Universal IMU Enclosure, connect the IMU interface cable from the IMU to the COM 2 port on the FlexPak6. See *Figure 5, Basic Set Up – LN-200, HG1700 or LCI-1* on page 27.
- For a system with a FlexPak6 receiver and the IMU-FSAS or IMU-CPT, connect a FlexPak Y Adapter cable to the COM 2 and I/O ports on the FlexPak6 receiver. Then, connect the IMU interface cable from the IMU to the FlexPak Y Adapter cable. See *Figure 6, Basic Set Up – IMU-FSAS or IMU-CPT* on page 28.
- For a system with a OEM6 receiver card, a wiring harness is required between the receiver card and the IMU interface cable. For more information, see the *OEM6 Family Installation and Operation User Manual*.

See *Table 3, Receiver to IMU Interface Cables* on page 30 for information about which interface cable is appropriate for your SPAN system.

2.2.6 Connect I/O Strobe Signals

The OEM6 receivers have several I/O strobe signals that enable it to be part of an interconnected system composed of devices that need to be synchronized with each other. For example, you could connect the SPAN system to an aerial camera in such a way that the SPAN system records its position whenever the shutter button is pressed.

The I/O strobe lines are accessed from the multi-pin connectors on receiver cards or the I/O port on the FlexPak6. Refer to the *OEM6 Family Installation and Operation User Manual* for more information on signals, wiring and pin-out information of the receiver card connectors and the FlexPak6 I/O port.

2.2.7 Connect Power

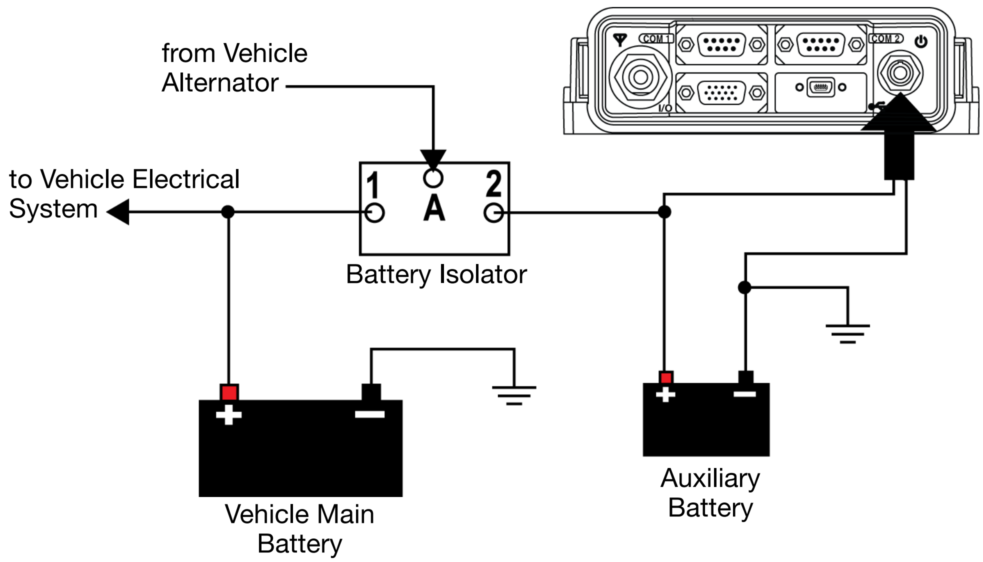
OEM6 receiver cards require 3.3 VDC ±5% with less than 100 mV ripple. For information about connecting power to an OEM6 receiver card, see the *OEM6 Family Installation and Operation User Manual*.

The FlexPak6 receiver requires an input voltage of +6 to +36 VDC. An automotive adaptor is supplied with the FlexPak6, but any appropriate DC power source can be used. The FlexPak6 has an internal power module that:

- filters and regulates the supply voltage
- protects against over-voltage, over-current, and high-temperature conditions
- provides automatic reset circuit protection

There is always a drop in voltage between the power source and the power port due to cable loss. Improper selection of wire gauge can lead to an unacceptable voltage drop at the SPAN system. A paired wire run represents a feed and return line. Therefore, a 2 metre wire pair represents a total wire path of 4 metres. For a SPAN system operating from a 12 V system, a power cable longer than 2.1 m (7 ft.) should not use a wire diameter smaller than 24 AWG.

It is recommended that a back-up battery is placed between the receiver and its voltage supply to act as a power buffer if installed in a vehicle. When a vehicle engine is started, power can dip to 9.6 VDC or cut-out to ancillary equipment causing the receiver and IMU to lose lock and calibration settings.



For pin-out information on the power connector on the FlexPak6, refer to the *OEM6 Family Installation and Operation User Manual*.

In addition to the receiver power supply, a power supply is needed for the IMU. See *Table 5* for the voltage requirements for each IMU. The same power supply can be used for the receiver and the IMU, if the power supply meets the power requirements of both devices.

Table 5: IMU Power Supply

IMU	Power Requirement
LN-200	+12 to +28 V DC
HG1700	+12 to +28 V DC
LCI-1	+12 to +28 V DC
iIMU-FSAS	+10 to +34 V DC
IMU-CPT	+9 to +18 V DC

> For HG1900 and HG1930 IMUs, power must be supplied by an IMU interface card. For specifications on the MIC (refer to http://www.novatel.com/products/span-gnss-inertial-systems/span-mems).

Details about the IMU ports and cables can be found in *Appendix A, Technical Specifications* starting on *page 64*.

2.3 Software Configuration

2.3.1 GNSS Configuration

The GNSS configuration can be set up for different accuracy levels such as single point, SBAS, DGPS and RTK (RTCA, RTCM, RTCM V3 and CMR). FlexPak6 and OEM628 receivers can also be set up for OmniSTAR VBS, XP or HP. Refer to the *OEM6 Family Installation and Operation User Manual* for details on DGPS, RTK, L-band or SBAS setup and operation.

With no additional configuration, the system operates in single point mode.

2.3.2 SPAN IMU Configuration

2.3.2.1 Configure SPAN Manually

Follow these steps to enable INS as part of the SPAN system using software commands or see *Section 2.3.2.2, SPAN Configuration with Connect* on *page 35* for the alternate method using NovAtel's Connect software utility:

> A GNSS antenna must be connected and tracking satellites for operation.

1. Issue the **CONNECTIMU** command to specify the type of IMU being used and the receiver port connected to the IMU, see *Table 6* below and the CONNECTIMU command on *page 99*.

Table 6: Enable INS Commands

IMU Type	CONNECTIMU command
HG1700 AG11	CONNECTIMU COMx[a] IMU_HG1700_AG11
HG1700 AG17	CONNECTIMU COMx[a] IMU_HG1700_AG17
HG1700 AG58	CONNECTIMU COMx[a] IMU_HG1700_AG58
HG1700 AG62	CONNECTIMU COMx[a] IMU_HG1700_AG62
HG1900 CA50	CONNECTIMU COMx[a] IMU_HG1900_CA50
HG1930 CA50	CONNECTIMU COMx[a] IMU_HG1930_CA50
iIMU-FSAS	CONNECTIMU COMx[b] IMU_IMAR_FSAS
IMU-CPT	CONNECTIMU COMx[b] IMU_KVH_COTS
LCI-1	CONNECTIMU COMx[a] IMU_LITEF_LCI1
LN-200	CONNECTIMU COMx[a] IMU_LN200

a. Use the COM port number the IMU is connected to.
COM2 is the recommended serial port for the IMU, however you can use COM1 or COM2 for these IMUs.
If you are using the OEM615+MIC board stack, you must use COM1.

b. If you are using a FlexPak6, you must use COM 2 for the iIMU-FSAS and IMU-CPT.
This is to accommodate the RS-422 protocol used for these IMUs.

Basic configuration of the SPAN system is now complete. The inertial filter starts after the GNSS solution is solved and the IMU is connected.

2. Issue the **SETIMUTOANTOFFSET** command to enter the distance from the IMU to the GNSS antenna, see *Section B.2.20, SETIMUTOANTOFFSET Set IMU to Antenna Offset* on *Page 118*.

The offset between the antenna phase center and the IMU axis must remain constant and be known accurately (m). The X (pitch), Y (roll) and Z (azimuth) directions are clearly marked on the IMU enclosure. The SETIMUTOANTOFFSET parameters are (where the standard deviation fields are optional and the distances are measured from the IMU to the Antenna):

```
x_offset y_offset z_offset [x_stdev] [y_stdev] [z_stdev]
```

A typical RTK GNSS solution is accurate to a few centimetres. For the integrated INS/GNSS system to have this level of accuracy, the offset must be measured to within a centimetre. Any offset error between the two systems shows up directly in the output position. For example, a 10 cm error in recording this offset will result in at least a 10 cm error in the output.

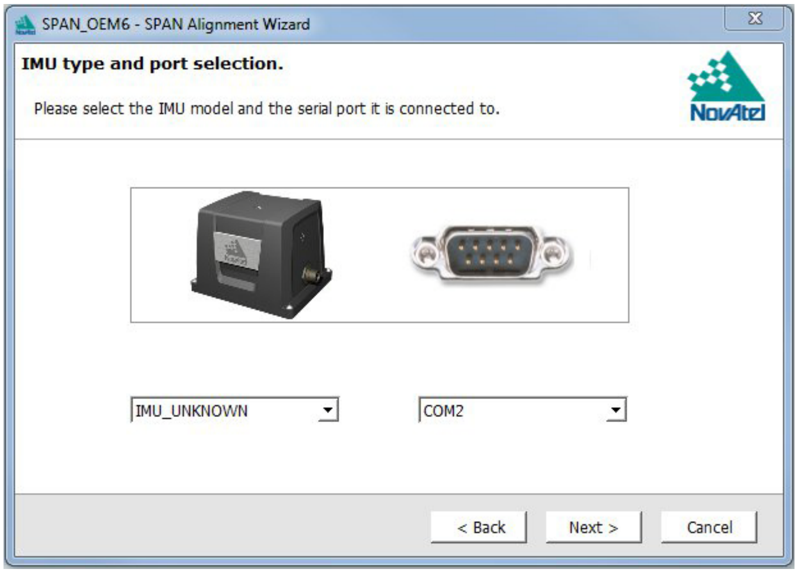
If it is impossible to measure the IMU to GNSS antenna offset precisely, the offset can be estimated by carrying out the Lever Arm Calibration Routine. See *Section 3.3.4, Lever Arm Calibration Routine* on *page 44*.

2.3.2.2 SPAN Configuration with Connect

Follow these steps to enable INS as part of the SPAN system using the NovAtel Connect software utility:

> The NovAtel Connect screen shots in this manual may differ from your version of NovAtel Connect.

1. **SPAN basic configuration**: Select *Wizards | SPAN Alignment* from the Connect toolbar. This wizard takes you through the steps to complete a coarse or kinematic alignment, select the type of IMU and configure the receiver port, connected to the IMU, to accept IMU data:



2.3.2.3 Configuration for Alignment

A coarse alignment routine requires the vehicle to remain stationary for at least 1 minute. If that is not possible, an alternate kinematic alignment routine is available. The kinematic or moving alignment is performed by estimating the attitude from the GPS velocity vector and injecting it into the SPAN filter as the initial system attitude. See also *Section 3.3.1, System Start-Up and Alignment Techniques* starting on *page 41* for more details on coarse and kinematic alignments.

> The IMU-CPT and HG1930 IMUs cannot perform coarse alignments, as these IMUs cannot accurately measure Earth rotation. For these IMUs the default alignment routine is the kinematic alignment. Refer to *Section 3.3.1.2, Kinematic Alignment* on *Page 42*.
>
> If a stationary alignment is required, refer to *Section 3.3.1.3, Manual Alignment* on *Page 42*.

2.3.3 Configuration Command Summary

This section gives a brief recap of the commands necessary to get the SPAN system running.

1. Issue the **CONNECTIMU** command to specify the type of IMU and receiver port being used, see *Table 6* on *page 34* and the CONNECTIMU command on *page 99*.

```
connectimu com2 imu_ln200
```

2. Issue the **SETIMUTOANTOFFSET** command to enter the distance from the IMU to the GNSS antenna, see *page 118*.

```
setimutoantoffset 0.1 0.1 0.1 0.01 0.01 0.01
```

Chapter 3 SPAN Operation

Before operating your SPAN system, ensure that you have followed the installation and setup instructions in *Chapter 2, SPAN Installation* starting on *page 26.*

You can use the NovAtel Connect software to configure receiver settings and to monitor data in real-time, between a rover SPAN system and base station.

SPAN system output is compatible with post-processing software from the NovAtel Waypoint Products Group. Visit our Web site at www.novatel.com for details.

> Ensure the Control Panel Power Settings on your computer are not set to go into Hibernate or Standby modes. Data will be lost if one of these modes occurs during a logging session.

3.1 Definition of Reference Frames Within SPAN

The reference frames that are most frequently used throughout this manual are the following:

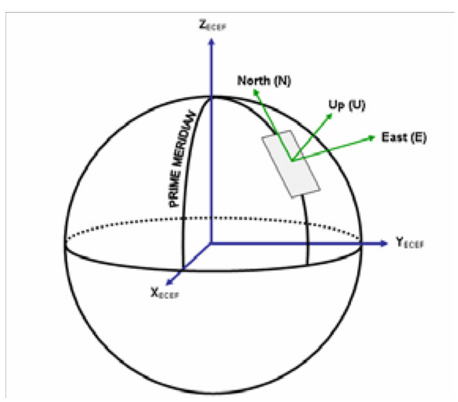
- the Local-Level Frame
- the SPAN Body Frame
- the Enclosure Frame
- the Vehicle Frame

3.1.1 The Local-Level Frame (ENU)

The definition of the local level coordinate frame is as follows:

- z-axis – pointing up (aligned with gravity)
- y-axis – pointing north
- x-axis – pointing east

Figure 9: Local-Level Frame (ENU)



3.1.2 The SPAN Body Frame

The definition of the SPAN body frame is as follows:

- z-axis – pointing up (aligned with gravity)
- y-axis – defined by how the IMU is mounted
- x-axis – defined by how the IMU is mounted

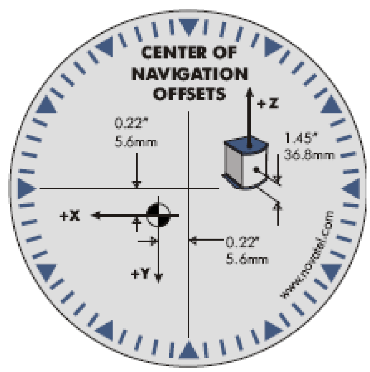
To determine your SPAN x-axis and y-axis, see *Table 46, Full Mapping Definitions, on Page 116*. This frame is also known as the computation frame and is the frame where all the mechanization equations are computed.

3.1.3 The Enclosure Frame

The definition of the enclosure frame is defined on the IMU and represents how the sensors are mounted in the enclosure. If the IMU is mounted with the z-axis (as marked on the IMU enclosure) pointing up, the IMU enclosure frame is the same as the SPAN frame.

The origin of this frame is not the enclosure center, but the center of Navigation (sensor center).

Figure 10: The Enclosure Frame

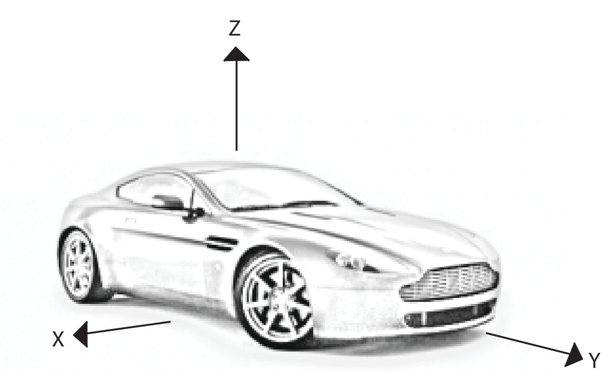


3.1.4 The Vehicle Frame

The definition of the vehicle frame is as follows:

- z-axis – points up through the roof of the vehicle perpendicular to the ground
- y-axis – points out the front of the vehicle in the direction of travel
- x-axis – completes the right-handed system (out the right-hand side of the vehicle when facing forward

Figure 11: Vehicle Frame



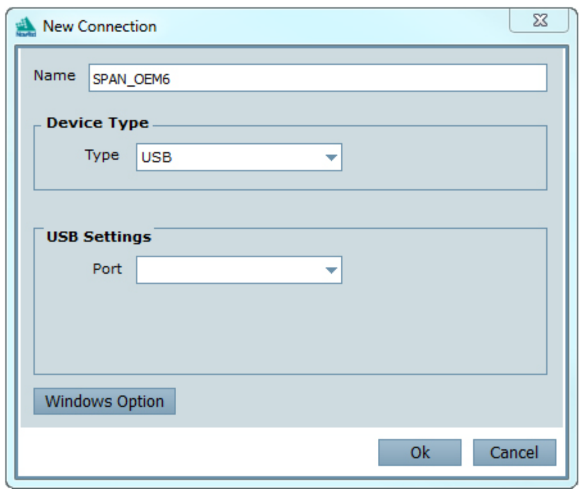
3.2 Communicating with the SPAN System

Install the NovAtel OEM6 PC Utilities (Connect and Convert4) on the computer you intend to use to configure and monitor the SPAN system. You can find installation instructions in the *Quick Start Guide* for your receiver. (Alternatively, you can use a terminal emulator program such as HyperTerminal to communicate with the receiver.) Refer to the Connect Help file for more details on Connect. The Help file is accessed by choosing *Help* from the main menu in Connect.

This procedure describes communicating with the SPAN system using a serial or USB connection. For information about communicating with the SPAN system using an Ethernet connection, see *Section 5, Ethernet Configuration* on *page 52*.

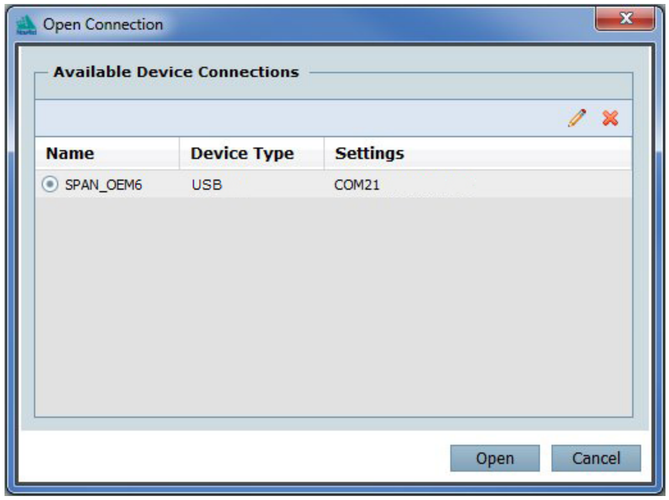
To enable communication from your computer to the SPAN system using Connect:

1. Launch Connect from the *Start* menu folder specified during the installation process. The default location is *Start | Programs | NovAtel OEM6 | NovAtel Connect*.
2. To define a new connection, select *New Connection* from the *Device* menu.
   The New Connection window appears.
   If a connection is already defined for the SPAN system, choose *Open Connection* and skip to step 8.



3. Select *Serial* or *USB* from the *Type* list.
4. Select the computer port that the SPAN system is connected to from the *Port* list.
5. If you selected *Serial*, select *115200* from the *Baud Rate* list.
6. If you selected *Serial*, clear the *Use hardware handshaking* check box.
7. Click the *OK* button to save the new device settings.

8. Select the SPAN receiver from the *Available Device Connections* area of the *Open Connection* window.



9. Click the *Open* button to open SPAN receiver communications.
10. As Connect establishes the communication session with the receiver, a progress box is displayed.
11. Select *Tools* | *Logging Control Window* from the Connect main menu to control the receiver's logging to files and serial ports. Refer to the Connect on-line Help for more information.
12. Use the *Console* window to enter commands. See *Section 3.4, Data Collection for Post Processing* on *page 47*.

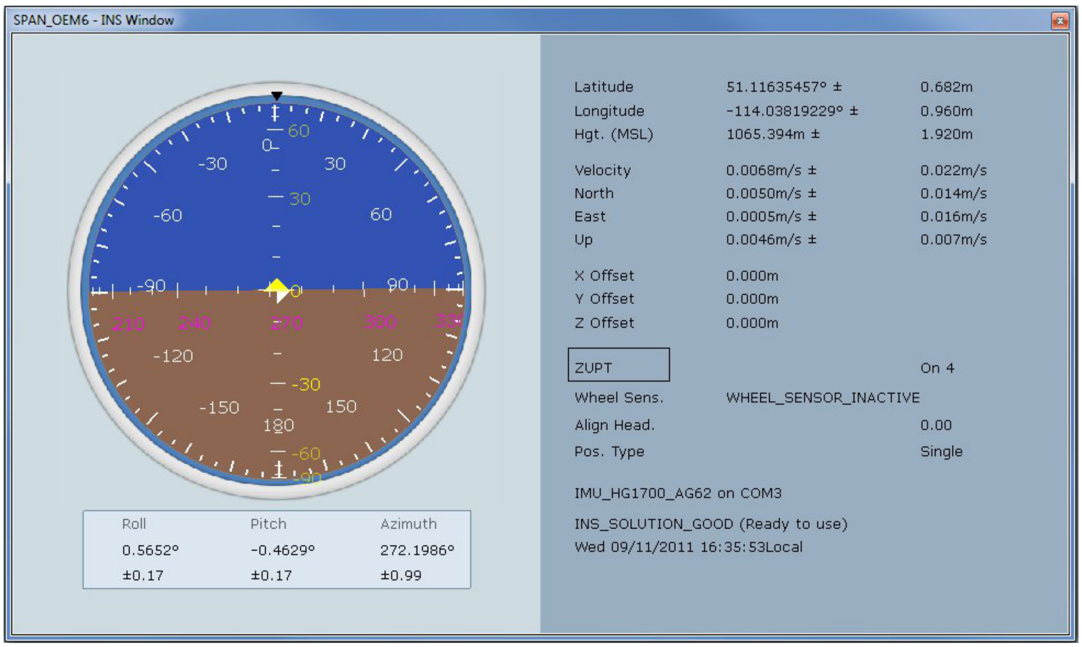
> If you want to save your receiver's configuration to NVM, ensure that all windows, other than the Console window, are closed in Connect and then use the SAVECONFIG command.

3.2.1 INS Window in Connect

Connect provides a graphical user interface to allow you to monitor the operation of the SPAN system.

The INS Window in Connect is described below. Refer to the *OEM6 Family Installation and Operation User Manual* for more details on Connect and other OEM6 Family PC software programs.

INS Window: The Position, Velocity and Attitude (roll, pitch and azimuth) sections display data from the INSPVA log along with standard deviations calculated from the INSCOV log. Information in the ZUPT (Zero Velocity Update) section reflects the current INSZUPT command setting. The receiver uses the *X*, *Y* and *Z Offset* fields to specify an offset from the IMU, for the output position and velocity of the INS solution, as specified by the SETINSOFFSET command or the Connect SPAN wizard. The *INS Configuration/Status* section displays the IMU type, IMU Status and local date/time information. The dial is a graphical display of the Roll, Pitch and Azimuth values indicated by an arrow on each axis.



3.3 Real-Time Operation

SPAN operates through the OEM6 command and log interface. Commands and logs specifically related to SPAN operation are documented in *Appendices B* and *C* of this manual respectively.

Real-time operation notes:

- Inertial data does not start until time is set and therefore, the SPAN system does not function unless a GNSS antenna is connected with a clear view of the sky.
- The inertial solution is computed separately from the GNSS solution. The GNSS solution is available from the SPAN system through the GNSS-specific logs, even without SPAN running. The integrated INS/GNSS solution is available through special INS logs documented in *Appendix C* of this manual.
- The IMU raw data is available at the maximum rate of output of the IMU (100 or 200 Hz). Because of this high data rate, a shorter header format was created. These shorter header logs are defined with an S (RAWIMUSXB rather than RAWIMUXB). We recommend you use these logs instead of the standard header logs to save throughput on the COM port.

Status of the inertial solution can be monitored using the inertial status field in the INS logs, see *Table 7*.

Table 7: Inertial Solution Status

Binary	ASCII	Description
0	INS_INACTIVE	IMU logs are present, but the alignment routine has not started; INS is inactive.
1	INS_ALIGNING	INS is in alignment mode.
2	INS_HIGH_VARIANCE	The INS solution is still being computed but the azimuth solution uncertainty has exceed 2 degrees. The solution is still valid but you should monitor the solution uncertainty in the INSCOV log. You may encounter this state during times when the GNSS, used to aid the INS, is absent. [a]
3	INS_SOLUTION_GOOD	The INS filter is in navigation mode and the INS solution is good.
6	INS_SOLUTION_FREE	The INS filter is in navigation mode and the GNSS solution is suspected to be in error. This may be due to multipath or limited satellite visibility. The inertial filter has rejected the GNSS position and is waiting for the solution quality to improve.
7	INS_ALIGNMENT_COMPLETE	The INS filter is in navigation mode, but not enough vehicle dynamics have been experienced for the system to be within specifications.

a. See also the *Frequently Asked Question* appendix, question #7 on *page 216.*

3.3.1 System Start-Up and Alignment Techniques

The system requires an initial attitude estimate to start the navigation filter. This is called system alignment. On start-up the system has no position, velocity or attitude information. When the system is first powered up, the following sequence of events happens:

1. The first satellites are tracked and coarse time is solved.
2. Enough satellites are tracked to compute a position.
3. Receiver “fine time” is solved, meaning the time on board the receiver is accurate enough to begin timing IMU measurements.
4. Raw IMU measurements begin to be timed by the receiver and are available to the INS filter. They are also available in the RAWIMU, RAWIMUS, RAWIMUX, and RAWIMUSX logs, see *page 168*. The INS Status field reports INS_INACTIVE.
5. The inertial alignment routine starts and the INS Status field reports INS_ALIGNING.
6. Alignment is complete and the INS Status field changes to INS_ALIGNMENT_COMPLETE. The system transitions to navigation mode.
7. The solution is refined using updates from GNSS. Once the system is operating within specifications and after some vehicle movement, the INS Status field changes to INS_SOLUTION_GOOD. This indicates that the estimated azimuth standard deviation is below 2°. If it increases above 2°, the status changes to INS_HIGH_VARIANCE.

3.3.1.1 Coarse Alignment

The coarse alignment is the default alignment routine for SPAN. The alignment starts as soon as a GNSS solution is available, the receiver has computed fine time and the IMU is connected and configured. The vehicle must remain stationary for the alignment to happen. During the coarse alignment, accelerometer and gyro measurements are averaged over a period of time to measure Earth rotation and gravity. From these averaged measurements, initial estimates of roll, pitch and heading are computed. Because the coarse alignment uses averaged sensor output, the vehicle must remain stationary for the duration of the alignment, which is approximately 30 seconds. The attitude estimates solved by the alignment are larger than the system specified attitude accuracy and vary upon the characteristics of the sensor and the geographic latitude of the system. Attitude accuracy converges with motion after the coarse alignment is complete (see *Section 3.3.2, Navigation Mode* on *page 43*).

> The IMU-CPT and HG1930 IMUs cannot perform coarse alignments, as these IMUs cannot accurately measure Earth rotation. For these IMUs, the default alignment routine is the kinematic alignment. Refer to *Section 3.3.1.2, Kinematic Alignment* on *page 42*.
>
> If a stationary alignment is required, refer to *Section 3.3.1.3, Manual Alignment* on *page 42*.

3.3.1.2 Kinematic Alignment

An alternate form of aligning the SPAN system is a kinematic alignment. A kinematic alignment can be used for any SPAN system, but must be used for lower performance sensors (IMU-CPT and HG1930). The kinematic or moving alignment is performed by estimating the attitude from the GNSS velocity vector and injecting it into the SPAN filter as the initial system attitude.

Currently, this alignment routine is meant only for ground-based vehicles. The assumptions used for the alignment may not hold for marine or airborne applications. For the kinematic alignment routine to work optimally, the course-over-ground azimuth and pitch must match the IMU enclosure azimuth and pitch. (For example, a plane being blown in the wind has a a large ‘crab angle’ and the course-over ground trajectory will not match the direction the IMU is pointing.)

Additional configuration parameters are necessary to enable the kinematic alignment. In order to simplify this configuration it is strongly suggested that you mount the IMU in parallel to the vehicle frame. The Y axis marked on the IMU enclosure, should point in the direction of travel.

Specify which IMU axes are most closely aligned with gravity using the SETIMUORIENTATION command. If the IMU is mounted with the Z-axis up and the Y-axis pointing in the direction of travel, then the command would be:

```
SETIMUORIENTATION 5
```

Specify the angular offsets between the SPAN frame and the vehicle frame (known as vehicle/body rotation or RVB) using the VEHICLEBODYROTATION command, see *page 126*. If the IMU is mounted coincidentally with the vehicle frame (defined as z up and y pointing in the direction of travel), then the command would be:

```
VEHICLEBODYROTATION 0 0 0
```

Alternatively, solve the vehicle to IMU frame angular offsets using the RVBCALIBRATE routine. See also *Section 3.3.5, Vehicle to SPAN Frame Angular Offsets Calibration Routine* on *page 45*.

The kinematic alignment begins when the receiver has a good GNSS position, fine time is solved, the configuration parameters have been set and a GNSS velocity of at least 1.15 m/s (~ 4 km/h) is observed. During kinematic alignment, keep the vehicle roll at less then 10°. Straight line driving is best.

The accuracy of the initial attitude of the system following the kinematic alignment varies and depends on the dynamics of the vehicle and the accuracy of the RVB estimates. The attitude accuracy will converge to within specifications once some motion is observed by the system. This transition can be observed by monitoring the INS Status field in the INS logs.

3.3.1.3 Manual Alignment

If the initial attitude (roll, pitch, azimuth) of the IMU is known, it can be entered manually using the SETINITATTITUDE command. Refer to *SETINITATTITUDE Set Initial Attitude of SPAN in Degrees* on *page 120*.

3.3.2 Navigation Mode

Once the alignment routine has successfully completed, SPAN enters navigation mode.

SPAN computes the solution by accumulating velocity and rotation increments from the IMU to generate position, velocity and attitude. SPAN models system errors by using a filter. The GNSS solution, phase observations and automatic zero velocity updates (ZUPTs) provide updates to the filter. Peripheral updates can also be supplied; wheel sensor for displacement updates or an external receiver for heading updates.

Following the alignment, the attitude is coarsely defined, especially in heading. Vehicle dynamics, specifically turns, stops and starts, allow the system to observe the heading error and allows the heading accuracy to converge. The amount of dynamics required for filter convergence vary by the alignment quality, IMU quality, and maneuvers performed. The INS Status field changes to INS_SOLUTION_GOOD once convergence is complete. If the attitude accuracy decreases, the INS Status field changes to INS_HIGH_VARIANCE. When the accuracy converges again, the INS status continues as INS_SOLUTION_GOOD.

3.3.3 Data Collection

The INS solution is available in the INS-specific logs with either a standard or short header. Other parameters are available in the logs shown in *Table 8* on *page 43*:

Table 8: Solution Parameters

Parameter	Logs	
Position	INSPOS *or* INSPOSS INSPVA *or* INSPVAS	INSPOSX or INSPVAX[a]
Velocity	INSVEL *or* INSVELS INSSPD *or* INSSPDS INSPVA *or* INSPVAS	INSVELX or INSPVAX[a]
Attitude	INSATT *or* INSATTS INSPVA *or* INSPVAS	INSATTX or INSPVAX[a]
Solution Uncertainty	INSCOV *or* INSCOVS	

a. These logs contain variance information and are therefore large logs. Use a low logging rate (<20 Hz) only.

Note that the position, velocity and attitude are available together in the INSPVA and INSPVAS logs.

The inertial solution is available up to the rate of the IMU data. Data can be requested at a specific rate up to the maximum IMU output rate, or can be triggered by the mark input trigger at rates up to 20 Hz.

The GNSS-only solution is still available through the GNSS-only logs such as RTKPOS, PSRPOS and OMNIHPPOS. When running SPAN, rates of non-INS logs should be limited to a maximum rate of 5 Hz. Refer to the *OEM6 Family Firmware Reference Manual* for more details on these logs. INS-only data logging and output can be at rates of up to the rate of the IMU data.

> The highest rate that you should request GNSS logs (RANGE, BESTPOS, RTKPOS, PSRPOS, and so on) while in INS operation is 5 Hz. If the receiver is not running INS (no IMU is attached), GNSS logs can be requested at rates up to 20 Hz.

> Ensure that all windows, other than the Console, are closed in Connect and then use the SAVECONFIG command to save settings in NVM. Otherwise, unnecessary data logging occurs and may overload your system.

> **Logging Restriction Important Notice**
>
> Logging excessive amounts of high rate data can overload the system. When configuring the output for SPAN, NovAtel recommends that only one high rate (>50 Hz) message be configured for output at a time. It is possible to log more than one message at high rates, but doing so could have negative impacts on the system. Also, if logging 100/200 Hz data, always use the binary format and, if possible, the short header binary format (available on most INS logs).
>
> For optimal performance, log only one high rate output at a time. These logs could be:
>
> - Raw data for post processing
>   RAWIMUXSB ONNEW (100 or 200 Hz depending on IMU)
>   - RAWIMU logs are not valid with the ONTIME trigger. The raw IMU observations contained in these logs are sequential changes in velocity and rotation. As such, you can only use them for navigation if they are logged at their full rate. See details of these logs starting on *page 176.*
> - Real time INS solution
>   INSPVASB ONTIME 0.01 or 0.005 (maximum rate equals the IMU rate)
>   - Other possible INS solution logs available at high rates are: INSPOSSB, INSVELSB, INSATTSB

Specific logs need to be collected for post-processing. See *Section 3.4, Data Collection for Post Processing* on *page 47*.

To store data from an OEM6 receiver, connect the receiver to a computer running NovAtel Connect or other terminal program capable of recording data.

3.3.4 Lever Arm Calibration Routine

Each time the system is re-mounted on a vehicle, or the IMU or antenna is moved on the vehicle, the lever arm must be redefined either through manual measurement or through calibration.

> We recommend that you measure the lever arm using survey methodology and equipment, for example, a total station. Only use calibrations when precise measurement of the lever arm is not possible.

The lever arm calibration routine can only be used when the receiver is operating in RTK mode. Initial estimates and uncertainties for the lever arm are entered using the SETIMUTOANTOFFSET command, see *page 118*. The calibration routine uses these values as the starting point for the lever arm computation.

The steps involved in the calibration are:

1. Apply power to the receiver and the IMU.
2. Configure the RTK corrections and make sure that the BESTGNSSPOS log, see *page 131*, reports a good RTK solution.
3. Configure the IMU, see *Section 2.3.2, SPAN IMU Configuration* on *page 34*.
4. Set the orientation of your installed IMU using the SETIMUORIENTATION command, see *page 114*.
5. Enter the initial estimate for the lever arm using the SETIMUTOANTOFFSET command, see *page 118.*
6. Specify the limits of the calibration through the LEVERARMCALIBRATE command, see *page 108*. The calibration can be limited by time or accuracy of the lever arm. It is recommended that the calibration is limited by a minimum of 300 seconds.
7. To monitor the calibration, log BESTLEVERARM, see *page 135*, using the ONCHANGED trigger.

8. Remain stationary long enough for the coarse alignment to finish. The alignment is complete when the INS status changes to INS_ALIGNMENT_COMPLETE. See *Table 7* on *page 41*.
9. Start to move the system. The lever arm is not observable while the system is stationary. Immediately, drive a series of manoeuvres such as figure eights. The turns should alternate between directions, and you should make an equal number of turns in each direction. Some height variation in the route is also useful for providing observability in the Z-axis. When the calibration is complete, either because the specified time has passed or the accuracy requirement has been met, the BESTLEVERARM log outputs the solved lever arm.

To save a calibrated lever arm for subsequent start ups, issue the SAVECONFIG command after calibration is complete. If the IMU or GNSS antenna are re-mounted, re-run the calibration routine to compute an accurate lever arm.

3.3.5 Vehicle to SPAN Frame Angular Offsets Calibration Routine

Kinematic alignment requires that the angular offset between the vehicle and SPAN frame is known approximately. If the angles are simple (that is, a simple rotation about one axis) the values can easily be entered manually through the VEHICLEBODYROTATION command, see *page 126*. If the angular offset is more complex (that is, rotation is about 2 or 3 axis), then the calibration routine provides a more accurate estimation of the values. As with the lever arm calibration, the vehicle to SPAN frame angular offset calibration requires RTK GPS. The steps for the calibration routine are:

1. Apply power to the receiver and IMU.
2. Configure the IMU, see *Section 2.3.2, SPAN IMU Configuration* on *page 34*.
3. Ensure that an accurate lever arm has been entered into the system either manually or through a lever arm calibration, see *page 44*.
4. Allow the system to complete a coarse alignment, see *page 41*.
5. Enable the vehicle to body calibration using the RVBCALIBRATE ENABLE command, see *page 110*.
6. Start to move the system. As with the lever arm calibration, movement of the system is required for the observation of the angular offsets.

   Drive a series of manoeuvres such as figure eights if the driving surface is not level, or a straight course if on level ground (remember that most roads have a crown resulting in a constant roll of a few degrees). Avoid driving on a surface with a constant, non-zero, slope to prevent biases in the computed angles. Vehicle speed must be greater than 5 m/s (18 km/hr) for the calibration to complete.
7. When the uncertainties of the offsets are low enough to be used for a kinematic alignment, the calibration stops and the VEHICLEBODYROTATION log, see *page 185*, is overwritten with the solved values. To monitor the progress of the calibration, log VEHICLEBODYROTATION using the ONCHANGED trigger.

To save a calibrated rotation for subsequent start ups, issue the SAVECONFIG command after calibration is complete. Each time the IMU is re-mounted this calibration should be performed again. See also *Section 3.3.1.1, Coarse Alignment* on *page 42* and *Section 3.3.1.2, Kinematic Alignment* on *page 42* for details on coarse and kinematic alignment.

> After the RVBCALIBRATE ENABLE command is entered, there are no vehicle-body rotation parameters present and a kinematic alignment is NOT possible. Therefore this command should only be entered after the system has performed either a static or kinematic alignment and has a valid INS solution.

> The solved rotation values are used only for a rough estimate of the angular offsets between the IMU and vehicle frames. The offsets are used when aligning the system while in motion (see *Section 3.3.1, System Start-Up and Alignment Techniques* starting on *page 41*). The angular offset values are not applied to the attitude output, unless the APPLYVEHICLEBODYROTATION command is enabled, see *page 97*.

3.3.6 SPAN Wheel Sensor Messages

The SPAN system supports wheel sensor inputs. Wheel sensor information is input to the receiver through the WHEELVELOCITY message in either ASCII or binary format. The message is sent with the port interface mode set to NovAtel. See the INTERFACEMODE command examples in *Section 2.3.2, SPAN IMU Configuration* on *page 34*. For most IMUs, the wheel velocity commands must be created and sent to the SPAN receiver at 1 Hz. For IMU-FSAS users, the wheel sensor is integrated via the FSAS IMU, and wheel velocity commands are not required. See also *iIMU-FSAS Odometer Cabling* on *page 79* of the *Technical Specifications* appendix.

3.3.6.1 Measurement Timing and Frequency

Typical wheel sensor hardware accumulates wheel ticks constantly as the wheel rotates. The SPAN interface is configured to expect wheel sensor tick counts at a rate of 1Hz, aligned with the GNSS even-second boundaries. The GNSS second boundary is available from the OEM6 1PPS pulse. This pulse should be used to trigger the wheel sensor hardware to send the accumulated tick count back to the receiver through the WHEELVELOCITY message, see *page 128*.

> SPAN does not accumulate raw measurement ticks from a wheel sensor device. Additional hardware is required to accumulate the tick counts and pass the accumulated count to the SPAN system at 1Hz, triggered by the 1PPS. Refer to our application note *APN-036 Using a Wheel Sensor with SPAN*, available on our Web site at www.novatel.com through *Support | Knowledge and Learning*.

3.3.6.2 Wheel Sensor Update Logic

The SPAN system uses the WHEELVELOCITY command to apply a time to the message based on the time of the last 1PPS pulse and the latency reported in the log. This timed data is passed to the INS/GNSS filter to perform the update. The timed data is also available through the TIMEDWHEELDATA log, see *page 182*. The TIMEDWHEELDATA log can be used for applying wheel sensor updates in post-processing.

The SPAN filter uses sequential TIMEDWHEELDATA logs to compute a distance traveled between update intervals (1Hz). This information can be used to constrain free-inertial drift during times of poor GNSS visibility. The filter also contains a state for modeling the circumference of the wheel as it may change due to hardware changes or environmental conditions.

The modeled wheel circumference is available in the WHEELSIZE log, see *page 186*. Information on how the wheel sensor updates are being used is available in the INSUPDATE log, see *page 160*.

3.3.6.3 iMAR Wheel Sensor Interface for iIMU-FSAS users

If you have the iMAR iMWS (Magnetic Wheel Speed Sensor and Convertor), the wheel sensor information is sent to the OEM6 along with the raw IMU data. You can integrate other wheel sensor hardware with the iIMU-FSAS. The Corrsys Datron wheel pulse transducer is used as an example, see *Section A.4.3, iIMU-FSAS Odometer Cabling* on *page 79*.

The accumulated wheel sensor counts are available by logging the timed wheel data log with the onchanged trigger:

```
log timedwheeldatab onnew
```

Set parameters for your installation using the SETWHEELPARAMETERS command, see *page 124*.

3.4 Data Collection for Post Processing

Some operations, such as aerial measurement systems, do not require real-time information from SPAN. These operations are able to generate the position, velocity or attitude solution post-mission in order to generate a more robust and accurate solution than is possible in real-time.

In order to generate a solution in post-processing, data must be simultaneously collected at a base station and each rover. The following logs must be collected in order to successfully post process data

From a base:

- RANGECMPB ONTIME 1
- RAWEPHEMB ONCHANGED
- GLOEPHEMERISB ONCHANGED (if using GLONASS)

From a rover:

- RANGECMPB ONTIME 1
- RAWEPHEMB ONCHANGED
- GLOEPHEMERISB ONCHANGED (if using GLONASS)
- RAWIMUSXB ONNEW
- IMUTOANTOFFSETSB ONCHANGED
- VEHICLEBODYROTATIONB ONCHANGED

Post processing is performed through the Waypoint Inertial Explorer software package available from the NovAtel Waypoint Products Group. Visit our Web site at www.novatel.com for details.

> The highest rate that you should request GNSS logs (RANGE, BESTPOS, RTKPOS, PSRPOS, and so on) while in INS operation is 5 Hz. If the receiver is not running INS (no IMU is attached), GNSS logs can be requested at rates up to 20 Hz.

Chapter 4 SPAN for OEM6 Dual Antenna

NovAtel's ALIGN® heading technology generates distance and bearing information between a "master" and one or more "rover" receivers. This information can be used by SPAN to update the inertial error estimates and improve attitude accuracy. This is particularly useful in applications with reduced motion.

SPAN for OEM6 Dual Antenna provides the hardware necessary to run an ALIGN baseline with an IMU and a second receiver.

With SPAN for OEM6, the ALIGN GNSS baseline can be used to assist the initial alignment of the SPAN solution. In addition, the ALIGN baseline solution will aid the heading solution from the receiver if the heading drifts due to slow or constant dynamics.

ALIGN is capable of a 10 Hz heading output rate when integrated with the OEM6 receiver.

4.1 Installation

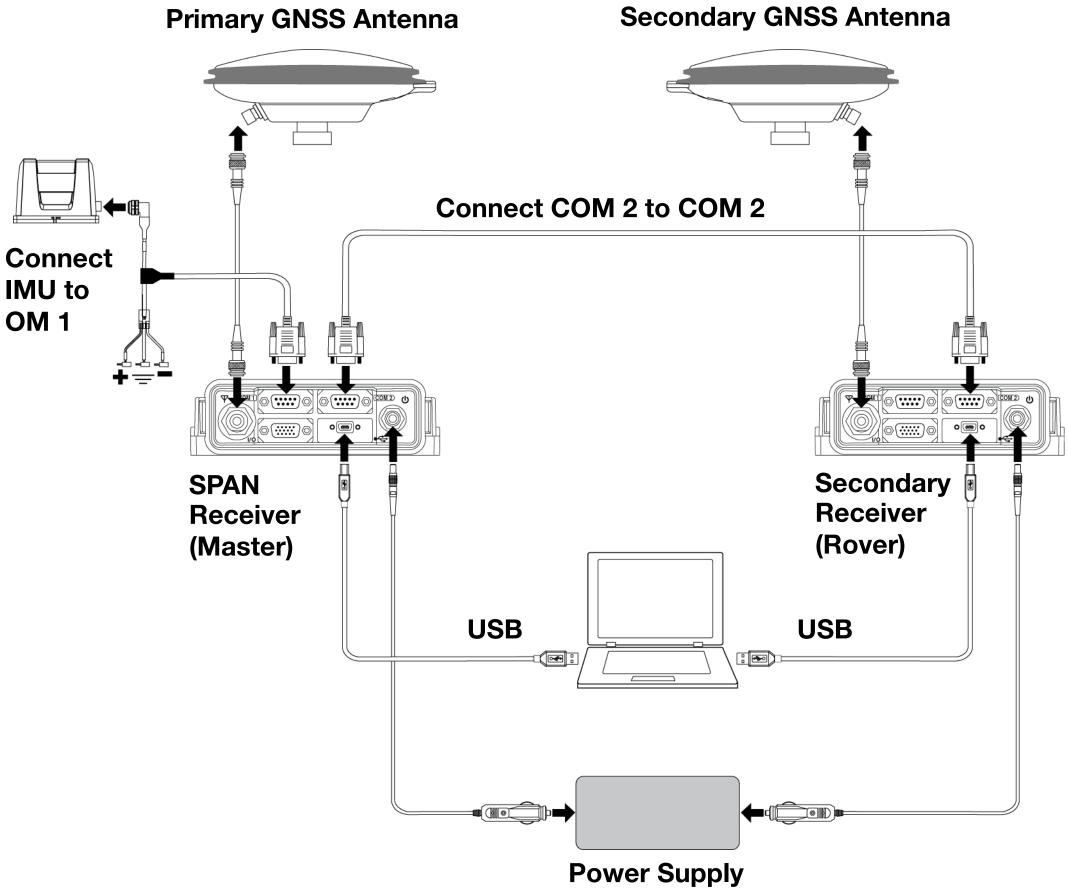
The hardware for SPAN for OEM6 Dual Antenna is installed in a manner similar to other SPAN systems. Some points to consider during your installation are:

1. Install the IMU and the two antennas in the vehicle such that the relative distance between them is fixed.
2. The antennas should be mounted where the view of the satellites will not be obstructed by any part of the vehicle. As heading accuracy is dependent on baseline length, mount the antennas as far apart as possible. A minimum separation distance of 1 metre is recommended.
3. The lever arms or distance from the IMU to the antennas needs to be fixed and accurately measured using the coordinate axes defined on the outside of the IMU. The baseline between the two antennas does NOT need to be aligned with the vehicle axes or with the axes of the IMU.
4. Both receivers need to be powered and connected to each other via COM 2 before sending any configuration commands. It does not matter which receiver is powered on first, or how long they are both powered before sending any commands.

> SPAN for OEM6 Dual Antenna operation requires the dedicated use of the COM 2 port for communication between receivers. If an IMU (iMAR-FSAS or IMU-CPT) that requires COM 2 is connected, COM 1 can be used on the master station. However the rover must always use COM 2.
>
> Use the USB port to connect the receiver to the computer used to send commands and receive logs.

The two receivers need to be set up as shown in the example in Figure 12.

Figure 12: SPAN for OEM6 - Dual Antenna Installation



4.2 Configuring ALIGN with SPAN for OEM6

Before configuring the ALIGN solution, the two receivers MUST both be powered on and connected directly between COM 2 of the SPAN receiver and COM 2 of the second receiver through either a null modem cable or an appropriate radio connection.

> The rover receiver must be an ALIGN-capable model, such as D2S-Z00-000, running the latest OEM6 firmware version.

The ALIGN solution will automatically be configured between the SPAN receiver and the second receiver when either:

1. The lever arms to both antennas are entered via the SETIMUTOANTOFFSET and SETIMUTOANTOFFSET2 commands, or
2. The angular offset between the dual-antenna baseline (from Primary GNSS antenna to Secondary GNSS antenna) and the IMU frame forward axis is entered directly via the EXTHDGOFFSET command.

We recommend entering the lever arms rather than entering the angular offset as this is easier to measure and will lead to better overall accuracy. Refer to *Appendix B, INS Commands on page 95* for the syntax of the above commands.

As with all ALIGN-capable products, the baseline solution is available from the GPHDT and HEADING logs.

4.3 Configuring SPAN with ALIGN

To enable the dual-antenna ALIGN solution to aid the INS alignment and provide heading updates, the offset between the antennas and the IMU must be known. This is achieved by entering lever arms to both antennas, using the SETIMUTOANTOFFSET and SETIMUTOANTOFFSET2 commands.

To configure SPAN with ALIGN Aiding:

1. Enter the lever arm from the IMU to the primary antenna (primary antenna is connected to the SPAN receiver) using the SETIMUTOANTOFFSET command.

Abbreviated ASCII example:

```
SETIMUTOANTOFFSET 0.54 0.32 1.20 0.03 0.03 0.05
```

2. Enter the lever arm from the IMU to the secondary antenna (secondary antenna is connected to the second receiver) using the SETIMUTOANTOFFSET2 command.

Abbreviated ASCII example:

```
SETIMUTOANTOFFSET2 0.54 2.32 1.20 0.03 0.03 0.05
```

The SPAN receiver can be configured for different alignment routines depending on the motion conditions experienced during the alignment period. For example, in marine applications, the dynamics required for either a coarse or kinematic alignment cannot be guaranteed, so a different alignment routine will be required.

The different alignment routines are described in the following sections:

4.3.1 Alignment on a Moving Vessel - Aided Transfer Alignment

This alignment routine is the preferred dual antenna alignment method. It is used if the alignment mode is set to AIDED_TRANSFER using the ALIGNMENTMODE command, and can be used if the alignment mode is set to AUTOMATIC.

If your vehicle is not stationary during the alignment, such as may be the case on a ship, use the Aided Transfer Alignment routine. This alignment method uses the ALIGN baseline solution to perform an instantaneous alignment of the vehicle attitude.

The alignment happens instantaneously after the receiver establishes communication with the IMU and computes a verified, fixed integer, ALIGN solution. The INS status changes to INS_ALIGNMENT_COMPLETE or INS_SOLUTION_GOOD, depending on the variances of the ALIGN solution, and the measured lever arm/external heading offset.

To guarantee the use of this alignment mode, the configuration command ALIGNMENTMODE must be sent to the receiver:

```
ALIGNMENTMODE AIDED_TRANSFER
```

4.3.2 Alignment on a Stationary Vehicle - Aided Static Alignment

An alternative to the aided transfer alignment, the ALIGN heading can be used as a seed for a coarse static alignment. In this mode, the standard coarse alignment routine runs given the initial azimuth value. As with the transfer alignment, the first verified fixed RTK solution is used to provide the alignment seed after which the coarse alignment (INS_ALIGNING) begins. After the coarse alignment is complete, the INS status changes to INS_ALIGNMENT_COMPLETE. After the attitude accuracy has converged, the INS status changes to INS_SOLUTION_GOOD. This alignment mode is useful if the initial vehicle roll is more than 20 degrees.

To use this alignment mode, the configuration command ALIGNMENTMODE must be sent to the receiver.

```
ALIGNMENTMODE AIDED_STATIC
```

4.3.3 Unaided Alignment

The unaided alignment sets the SPAN system to use only single antenna alignment options (static, kinematic or manual alignment).

To use this alignment mode, the configuration command ALIGNMENTMODE must be sent to the receiver.

```
ALIGNMENTMODE UNAIDED
```

4.3.4 Automatic Alignment Mode - Automatic Alignment (default)

Automatic Alignment Mode Selection is the default setting for a SPAN receiver. This mode is designed to allow alignment of the system as quickly as possible, using either an aided transfer alignment (*Section 4.3.1, Alignment on a Moving Vessel - Aided Transfer Alignment* on *Page 50*); a kinematic alignment (*Section 3.3.1.2, Kinematic Alignment* on *Page 42*); or a manual alignment (*Section 3.3.1.3, Manual Alignment* on *Page 42*).

The first available technique will be used, regardless of its relative quality. If you wish to guarantee a specific technique is used, or use an aided static alignment, you must select the desired alignment mode manually. No additional configuration is required to use this alignment routine.

4.4 SPAN ALIGN Attitude Updates

The INS heading updates are used to help constrain the azimuth drift of the INS solution whenever possible. This is of the greatest value with lower-quality IMUs and in environments with low dynamics where the attitude error is less observable. Slow moving marine or train applications are good examples of the intended use. By providing an external heading source, the solution drift can be constrained in these environments.

You can monitor the heading update status as outlined in *Section C.2.24, INSUPDATE INS Update* on *Page 160*.

Chapter 5 Ethernet Configuration

An Ethernet connection can be used to send commands to and obtain logs from Ethernet capable OEM6 receivers. An Ethernet connection can also be used to connect two receivers in a base/rover configuration.

This chapter describes how to configure the Ethernet port on an OEM6 receiver. It provides the step-by-step process for connecting to the OEM6 receiver through the Ethernet interface, setting up a base/rover configuration through Ethernet connectivity, and utilizing the NTRIP interface. The Ethernet port connections for a computer connected to the receiver are also described for both Windows XP (with SP3) and Windows 7 operating systems.

5.1 Required Hardware

The following hardware is required to setup an Ethernet interface to an OEM6 receiver:

- a user supplied computer with an available Ethernet, serial and USB port
- an Ethernet capable OEM6 receiver, such as an OEM628 or FlexPak6

> For OEM628 receivers, you also need an OEM628 Development Kit, power cable and serial communication cable.

- an RS-232 null modem cable or USB cable
- one or two CAT5 Ethernet cables
- a user supplied Ethernet network, hub or wired router (optional)
- one or two GNSS antennas
- one or two standard 5 meter 50 ohm TNC-to-TNC antenna cables

5.2 Static IP Address Configuration

For a static IP address configuration, unique IP addresses are assigned to both the OEM6 receiver and the computer. TCP/IP is used for the connection in this simple network. This configuration can also be used in a bench test environment to confirm Ethernet functionality.

Figure 13, Cross-Over Ethernet Cable Configuration—OEM628 on page 53 and *Figure 14, Cross-Over Ethernet Cable Configuration—FlexPak6* on page 53 show the connections when an OEM6 receiver uses a static IP address configuration.

Figure 13: Cross-Over Ethernet Cable Configuration—OEM628

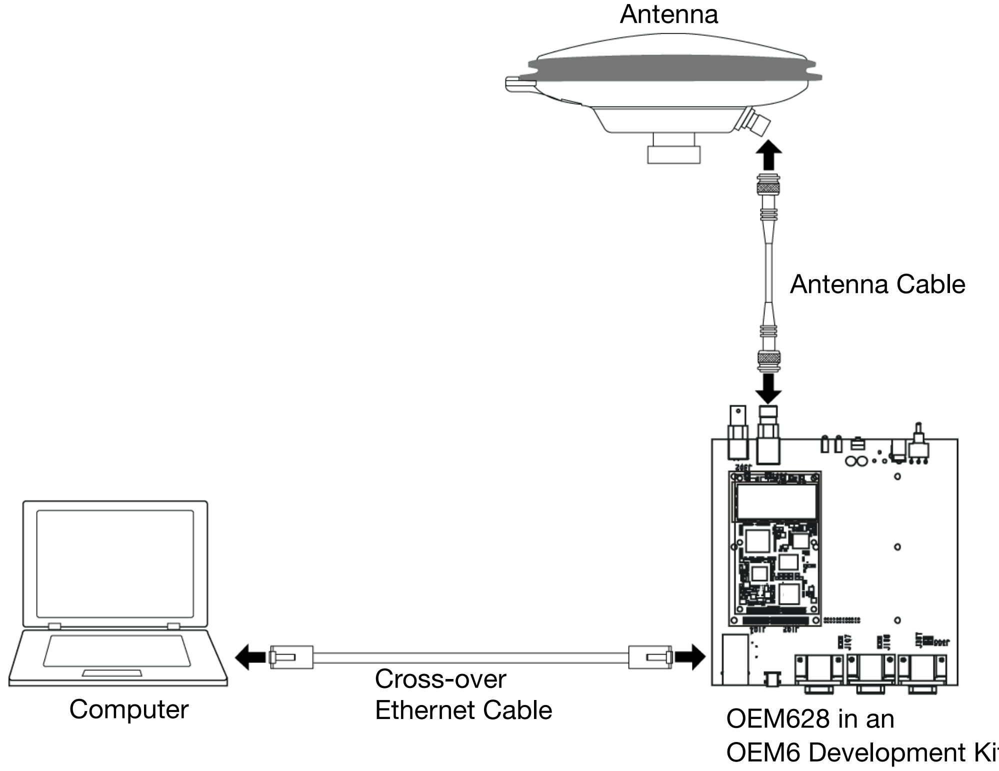
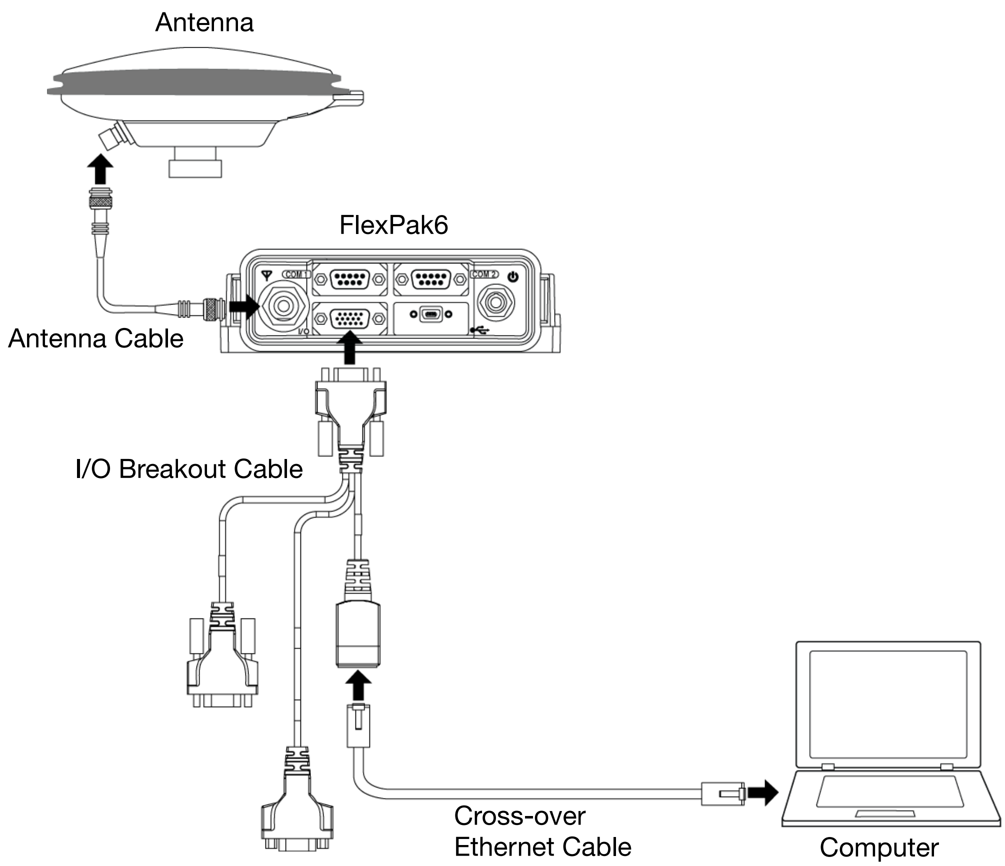


Figure 14: Cross-Over Ethernet Cable Configuration—FlexPak6



5.2.1 Static IP Address Configuration—Receiver

Follow these steps to set up a static IP address on the OEM6 receiver:

1. Connect your computer to the OEM6 receiver using a null modem serial cable or USB cable.
2. Establish a connection to the receiver using either NovAtel **Connect** or another terminal program such as Windows HyperTerminal. This connection is used to send the commands in this procedure to the receiver.

   For information about making a connection using NovAtel **Connect**, see *Section 3.2, Communicating with the SPAN System* on *Page 38*.
3. Enable the Ethernet port on the receiver.

   ```
   ETHCONFIG ETHA AUTO AUTO AUTO AUTO
   ```
4. Assign the TCP/IP port number used for the connection.

   ```
   ICOMCONFIG ICOM1 TCP :2000
   ```
5. Assign the receiver IP address, subnet mask and default gateway.

   ```
   IPCONFIG ETHA STATIC 192.168.74.10 255.255.255.0 192.168.74.1
   ```

> This command assigns the following values to the OEM6 receiver:
>
> ```
> IP address = 192.168.74.10
> Subnet mask = 255.255.255.0
> Gateway = 192.168.74.1
> ```
>
> These settings are examples only. The settings appropriate to your system may be different.

6. Save the new Ethernet settings.

   ```
   SAVECONFIG
   ```
7. Log the IPCONFIG command and confirm the TCP/IP configuration.

   ```
   LOG IPCONFIG ONCE
   ```
8. Configure your computer with a static IP address.
   For a computer using Windows XP Service Pack 3, follow the steps in *Section 5.2.2, Static IP Address Configuration—Windows XP with SP3* on *Page 54*.
   For a computer using Windows 7, follow the steps in *Section 5.2.3, Static IP Address Configuration—Windows 7* on *Page 55*.

5.2.2 Static IP Address Configuration—Windows XP with SP3

Follow these steps to set up a static IP address on your computer:

1. Click *START | Settings | Network Connections*.
   The Network Connections window appears.
2. Right click on *Local Area Connection* and select *Properties*.
   The Local Area Connection Properties window appears.
3. Click *Internet Protocol (TCP/IP)* and then click the *Properties* button.
   The Internet Protocol (TCP/IP) Properties window appears.
4. Select the *Use the following IP address* radio button.

5. Enter the *IP address*, *Subnet mask* and *Default gateway* for the Ethernet port on the computer.

> Make sure the Ethernet settings you use for the computer are compatible with the Ethernet settings on the OEM6 receiver.
>
> For example, the following settings are compatible with the OEM6 receiver settings used in *Section 5.2.1, Static IP Address Configuration—Receiver* on *Page 54*:
>
> ```
> IP address = 192.168.74.11
> Subnet mask = 255.255.255.0
> Gateway = 192.168.74.1
> ```

6. Click the *OK* button.
   The Local Area Connection Properties window appears.
7. Click the *Close* button.
8. Proceed to *Section 5.2.4, Confirming Ethernet Setup* on *Page 56*.

5.2.3 Static IP Address Configuration—Windows 7

Follow these steps to set up a static IP address on your computer:

1. Click *Start* | *Control Panel*.
2. Click *View network status and tasks* under *Network and Internet*.
3. Click the *Local Area Connection* link.
   The Local Area Connection Status window appears.
4. Click the *Properties* button.
   The Local Area Connection Properties window appears.
5. Select *Internet Protocol Version 4 (TCP/IPv4)* and then click the *Properties* button.
   The Internet Protocol Version 4 (TCP/IPv4) Properties window appears.
6. Enter the *IP address*, *Subnet mask* and *Default gateway* for the Ethernet port on the computer.

> Make sure the Ethernet settings you use for the computer are compatible with the Ethernet settings on the OEM6 receiver.
>
> For example, the following settings are compatible with the OEM6 receiver settings used in *Section 5.2.1, Static IP Address Configuration—Receiver* on *Page 54*:
>
> ```
> IP address = 192.168.74.11
> Subnet mask = 255.255.255.0
> Gateway = 192.168.74.1
> ```

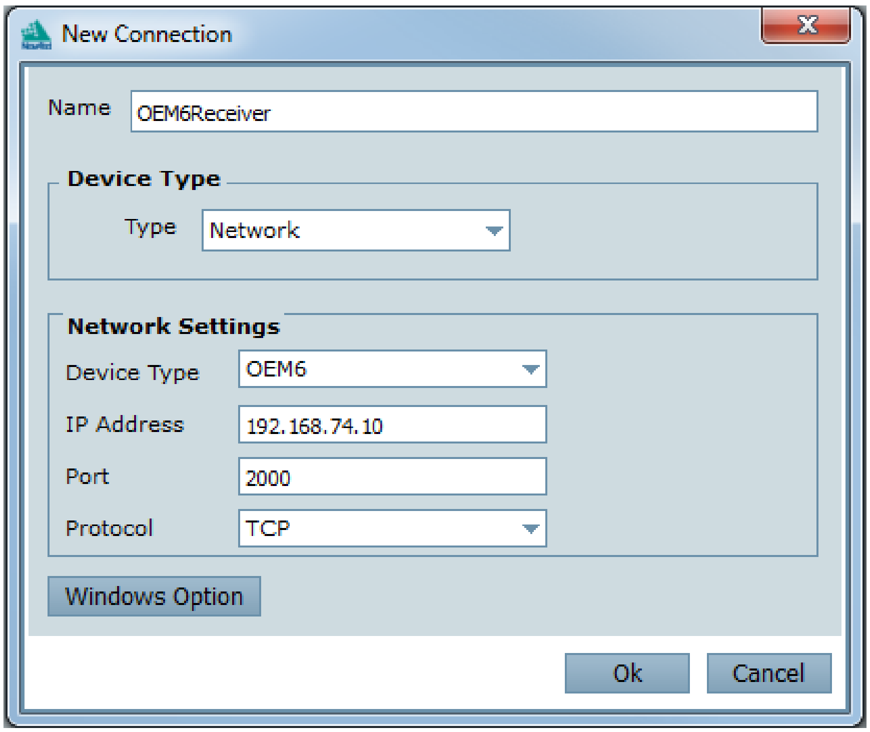
7. Click the *OK* button.
   The Local Area Connection Properties window appears.
8. Click the *Close* button.
   The Local Area Connection Status window appears.
9. Click the *Close* button.
10. Proceed to *Section 5.2.4, Confirming Ethernet Setup* on *Page 56*.

5.2.4 Confirming Ethernet Setup

1. Connect the computer to your OEM6 receiver using an Ethernet cross-over cable.
   See *Figure 13, Cross-Over Ethernet Cable Configuration—OEM628* on page 53 or *Figure 14, Cross-Over Ethernet Cable Configuration—FlexPak6* on page 53.

2. Connect to the receiver using NovAtel **Connect** or any third party terminal program that supports TCP/IP connections. Use the static IP address and port number you assigned to the OEM6 receiver in *Section 5.2.1, Static IP Address Configuration—Receiver* on *Page 54*.

   The figure below shows the *New Connection* window in NovAtel **Connect** with the example Ethernet settings used in *Section 5.2.1,* on *page 54*.



For information about establishing a connection and using NovAtel **Connect**, refer to the **Connect** Help.

5.3 Dynamic IP Address Configuration

For this configuration, a direct connection is made from the OEM6 receiver to a Dynamic Host Communication Protocol (DHCP) network and into a computer. The DHCP server automatically assigns IP addresses to the OEM6 receiver, based on its predetermined available IP addresses. You can use this configuration in a bench test environment to confirm Ethernet functionality.

Figure 15, Dynamic IP Address Configuration through a DHCP Server—OEM628 on page 57 and *Figure 16, Dynamic IP Address Configuration through a DHCP Server—FlexPak6* on page 58 show the connections when an OEM6 receiver uses a dynamic IP address configuration.

Figure 15: Dynamic IP Address Configuration through a DHCP Server—OEM628

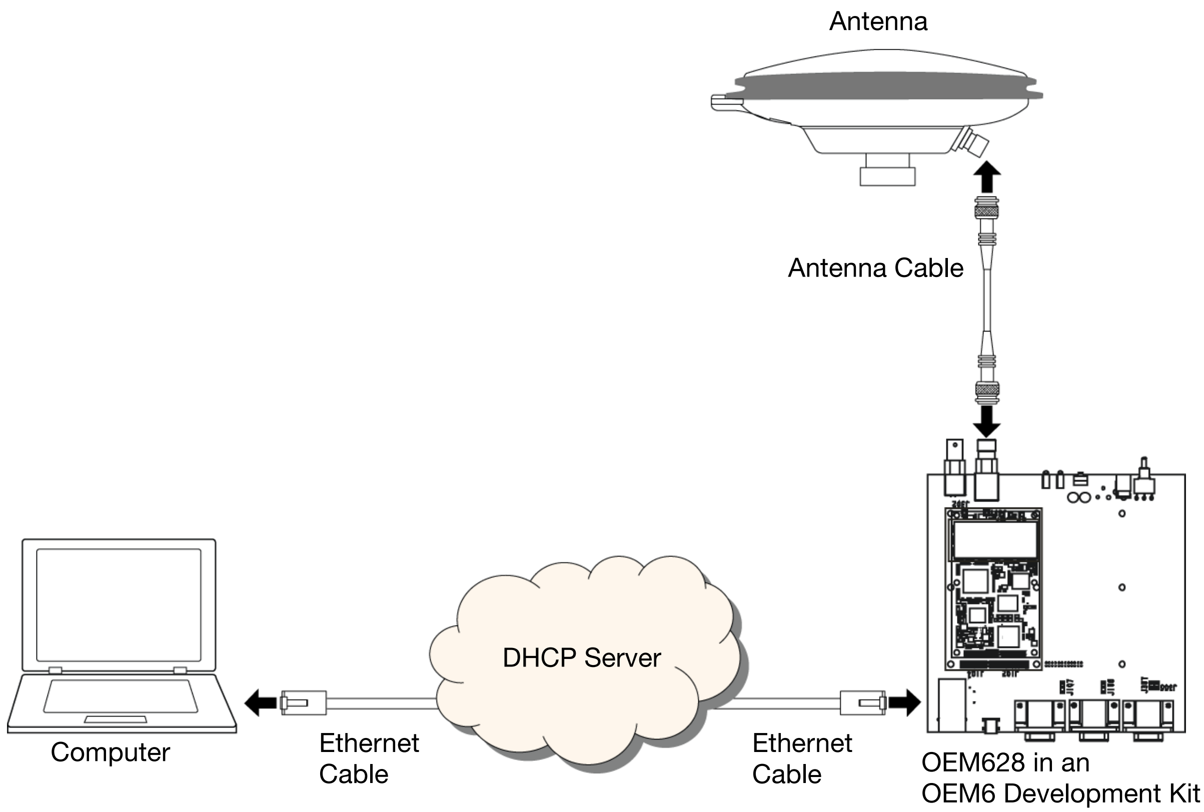
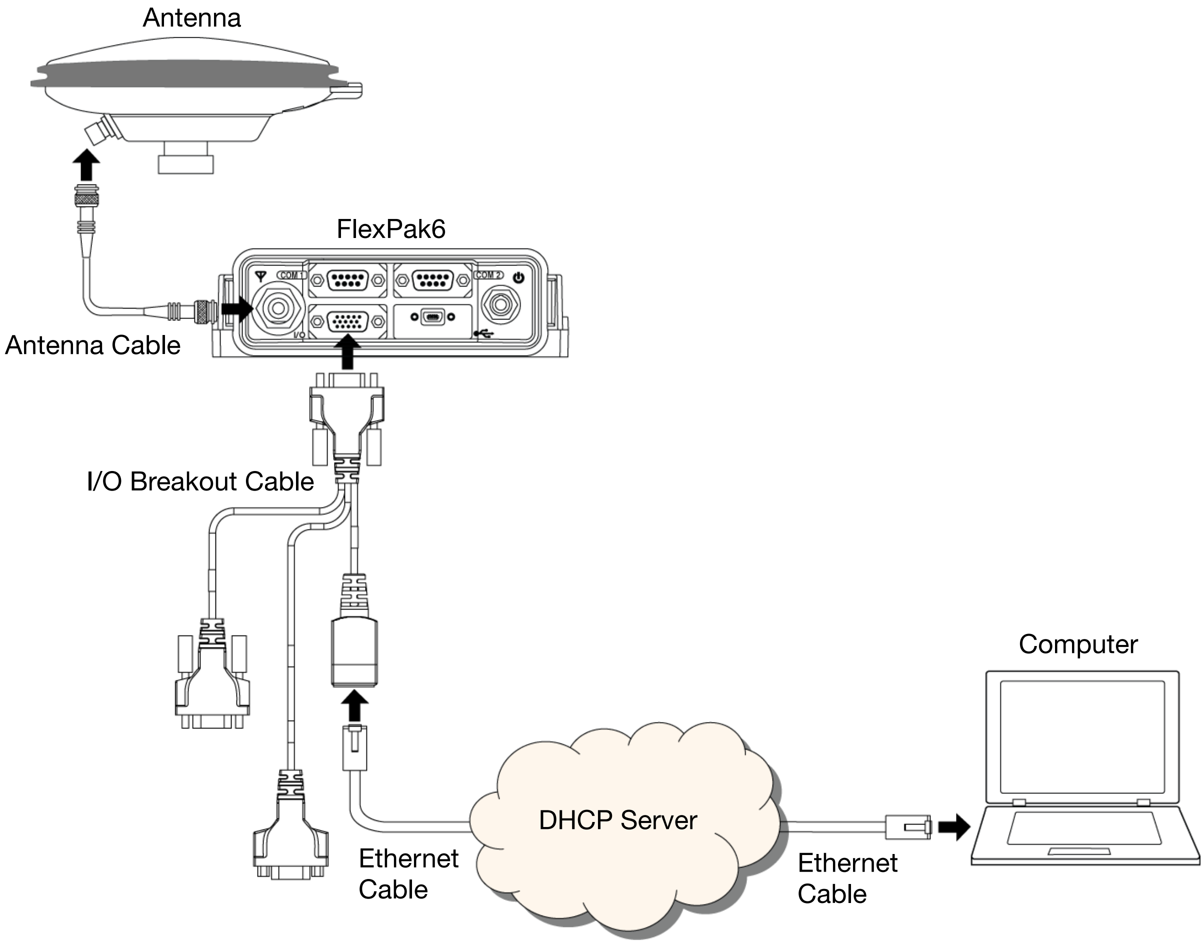


Figure 16: Dynamic IP Address Configuration through a DHCP Server—FlexPak6



To set up a dynamic IP address configuration, follow these steps:

1. Connect your computer to the OEM6 receiver using a null modem serial cable or USB cable.
2. Establish a connection to the receiver using either NovAtel **Connect** or another terminal program such as Windows HyperTerminal. This connection is used to send the commands in this procedure to the receiver.

   For information about making a connection using NovAtel **Connect**, see *Section 3.2, Communicating with the SPAN System* on *Page 38*.
3. Enable the Ethernet port.

   ```
   ETHCONFIG ETHA AUTO AUTO AUTO AUTO
   ```
4. Obtain the IP address assigned to the OEM6 receiver by the DHCP server.

   ```
   LOG IPSTATUS ONCE
   ```

> Make a note of the IP address returned with this log. This value is used later in this procedure.

5. Confirm that DHCP is enabled.

   ```
   LOG IPCONFIG ONCE
   ```
6. Assign the TCP/IP port number.

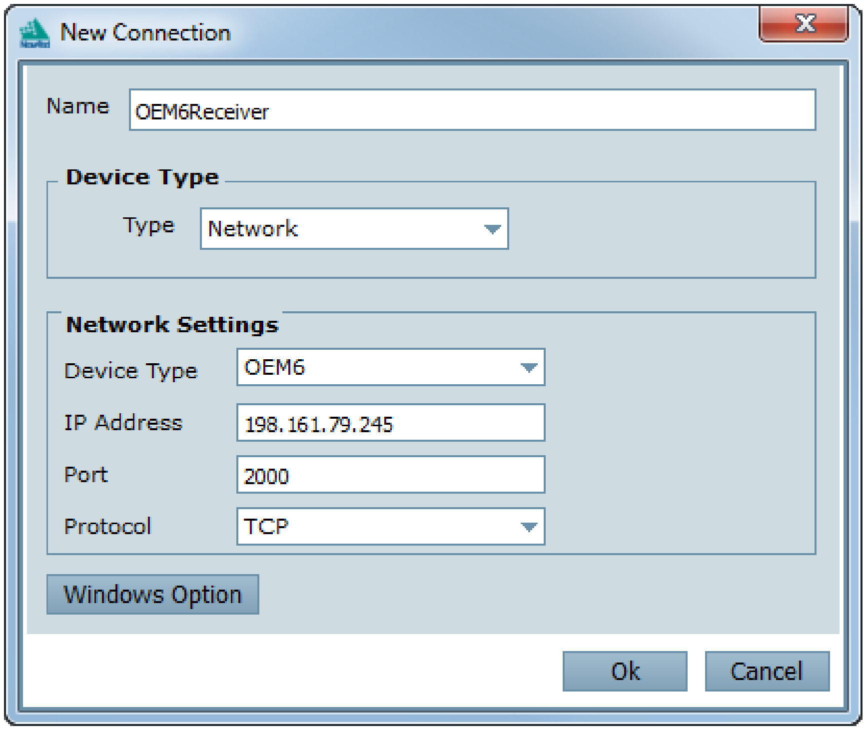
   ```
   ICOMCONFIG ICOM1 TCP :2000
   ```

7. Confirm the port number assigned to ICOM1.

```
LOG ICOMCONFIG ONCE
```

8. Connect to the receiver using NovAtel **Connect** or any third party terminal program that supports TCP/IP connections. Use the IP address you obtained from the IPSTATUS log in Step 4 and port number you assigned in Step 6.

   The figure below shows the *New Connection* window in NovAtel **Connect** with the Ethernet settings from Step 4.



For information about establishing a connection and using NovAtel **Connect**, refer to the **Connect** Help.

5.4 NovAtel Base/Rover Configuration through Ethernet Connectivity

You can use an Ethernet connection to provide communication between a base and rover receiver.

Figure 17, Base/Rover Ethernet Setup—OEM628 on page 60 and *Figure 18, Base/Rover Ethernet Setup—FlexPak6* on page 61 show the connections when a base and rover OEM6 receiver are connected using Ethernet.

Figure 17: Base/Rover Ethernet Setup—OEM628

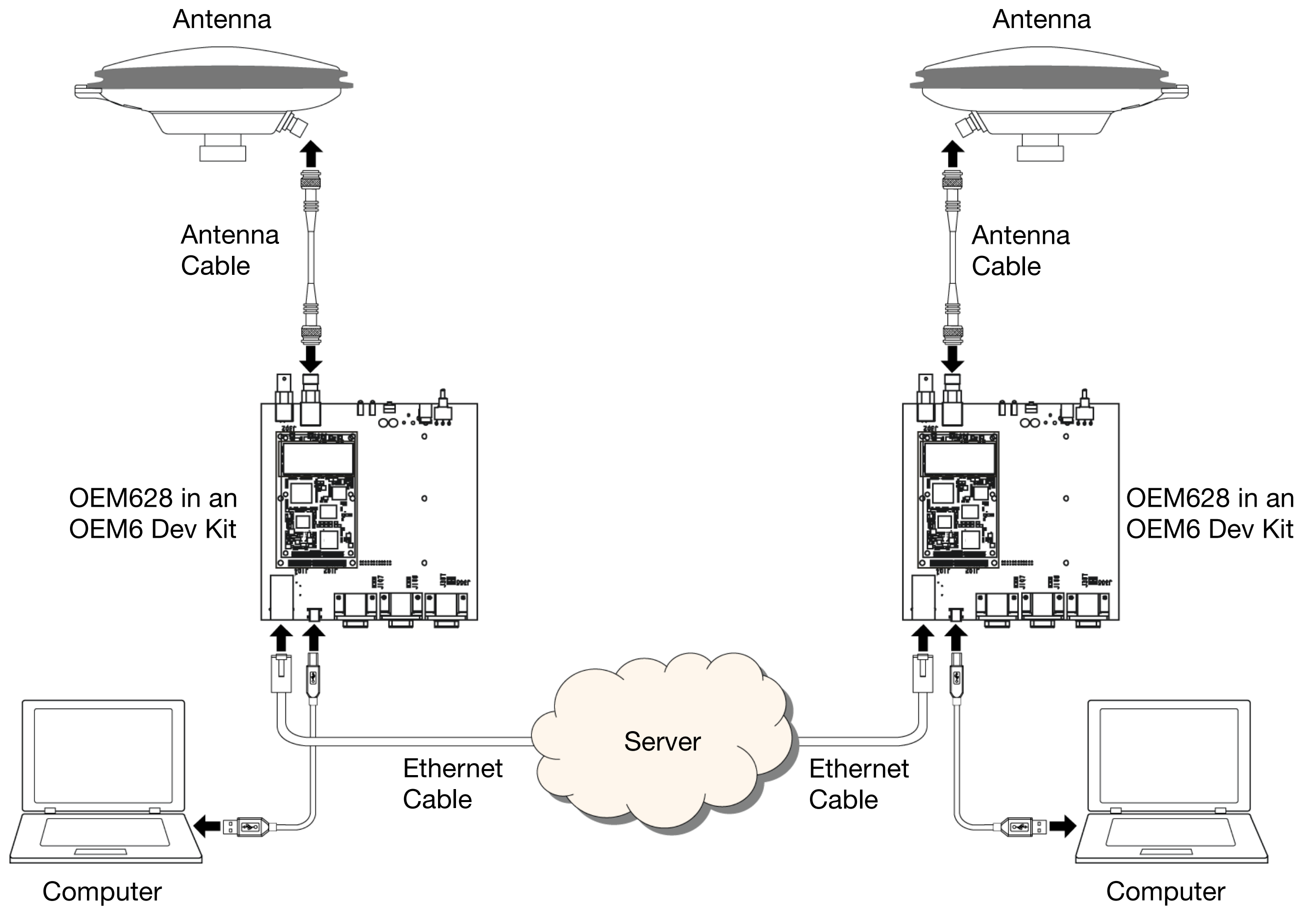
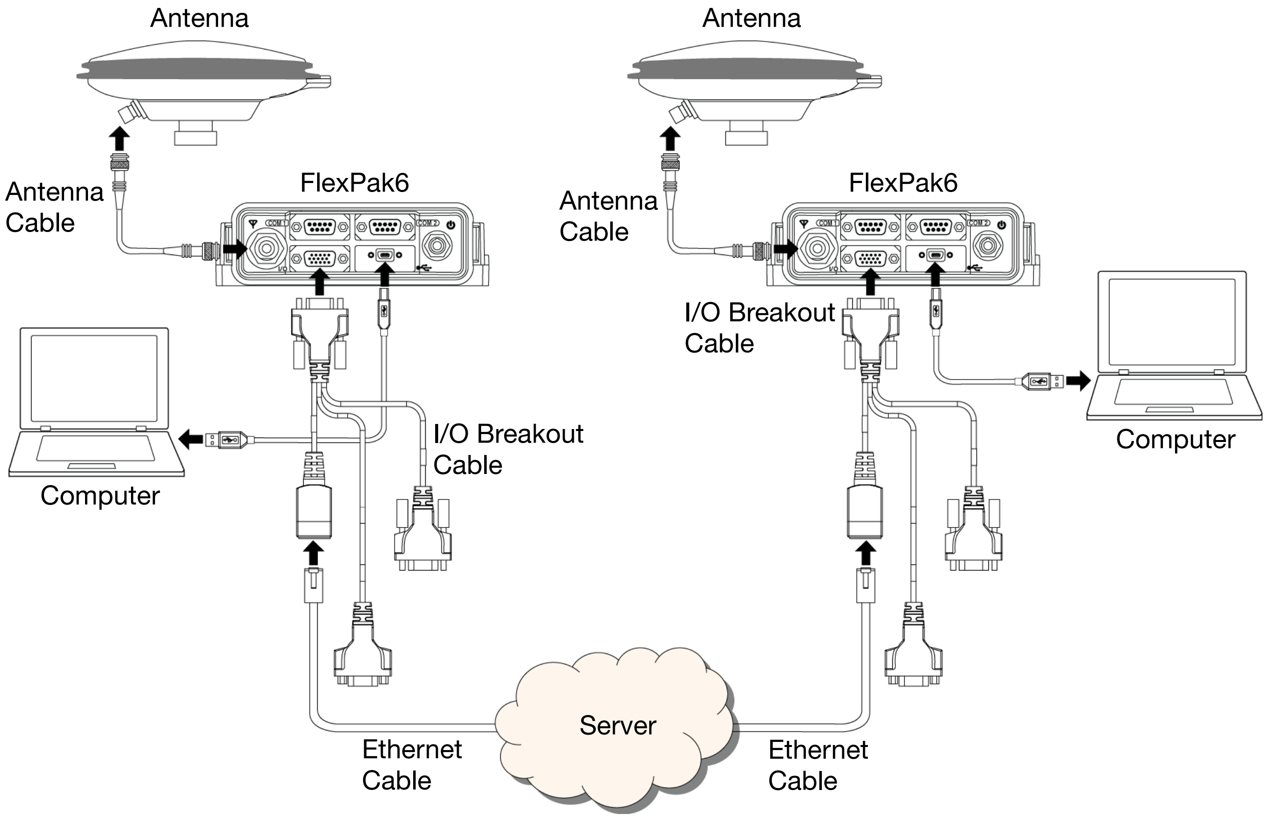


Figure 18: Base/Rover Ethernet Setup—FlexPak6



1. Connect your computer to both OEM6 receivers using null modem serial cables or USB cables.
2. Establish a connection to the receiver using either NovAtel **Connect** or another terminal program such as Windows HyperTerminal. This connection is used to send the commands in this procedure to the receivers.

   For information about making a connection using NovAtel **Connect**, see *Section 3.2, Communicating with the SPAN System* on *Page 38*.
3. Connect the power cables to both of the OEM6 receivers and apply power to the receivers.
4. Connect the Ethernet cables to the Ethernet ports on both OEM6 receivers.
5. Establish your Ethernet connection, either static or dynamic configurations. Refer to *Section 5.2, Static IP Address Configuration* on *Page 52* or *Section 5.3, Dynamic IP Address Configuration* on *Page 57* for more information.
6. Send the following commands to each receiver either through serial or USB ports:

   Base:

   ```
   FIX POSITION <lat> <long> <height>
   INTERFACEMODE ICOM1 NONE RTCA off
   LOG ICOM1 RTCAOBS2 ONTIME 1
   LOG ICOM1 RTCAREF ONTIME 10
   LOG ICOM1 RTCA1 ONTIME 5
   SAVECONFIG
   ```

   Rover:

   ```
   ICOMCONFIG ICOM1 TCP <base ip address>:<base port #>
   INTERFACEMODE ICOM1 RTCA NONE OFF
   LOG BESTPOSA ONTIME 1 (optional)
   SAVECONFIG
   ```

   Use the BESTPOS log to confirm that the OEM6 rover is in RTK mode.

5.5 Large Com Port Data Throughput

For high data rate Ethernet logging using TCP/IP, disable Windows DAA (Delayed Ack Algorithm) for complete data logging. If you do not disable DAA, there will be data gaps due to the Windows Ethernet buffer.

> **Caution: Proceed at your own risk.**
> If done incorrectly, changing the Windows Registry may impair the operation of your computer. Editing the Windows Registry is for advanced Microsoft Windows users only. NovAtel Inc. is not able to provide any technical support for any actions you take regarding information found in Microsoft's Knowledge Base.

Windows XP (SP3) and Windows Server 2003:

http://support.microsoft.com/kb/328890

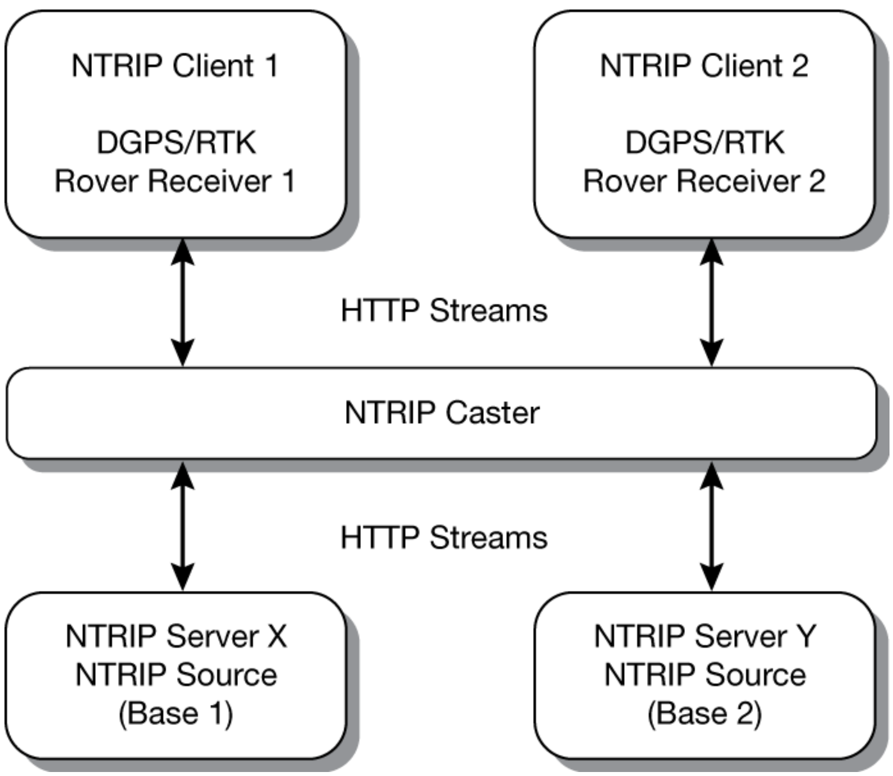
http://support.microsoft.com/kb/815230

5.6 NTRIP Configuration

NTRIP (Network Transport of RTCM via Internet Protocol) is an application protocol used to stream GNSS differential correction data over the internet.

You can configure a OEM6 receiver as either an NTRIP server or an NTRIP client. For more information about NovAtel's NTRIP, refer to our NTRIP Product Sheet on our website at http://www.novatel.com/assets/Documents/Papers/Ethernet_NTRIP.pdf

Figure 19: NTRIP System



The NTRIP caster is an HTTP internet service that acts as a communication medium between NTRIP servers and NTRIP clients. The NTRIP caster is provided by third party sources. For a full list of NTRIP casters, refer to the following link: http://www.rtcm-ntrip.org/home.

The following procedure describes how to configure a NovAtel base and a NovAtel rover through a third party NTRIP caster. This configuration is recommended for optimal RTK performance.

1. Establish a connection to the receiver using either NovAtel **Connect** or another terminal program such as Windows HyperTerminal. This connection is used to send the commands in this procedure to the receiver.

   For information about making a connection using NovAtel **Connect**, see *Section 3.2, Communicating with the SPAN System* on *Page 38*.

2. Connect the Ethernet cable to the Ethernet ports on both OEM6 receivers. For this setup, use a cross-over Ethernet cable.

3. Establish a static or dynamic Ethernet connection.
   For information about creating the connection, refer to *Section 5.2, Static IP Address Configuration* on *Page 52* or *Section 5.3, Dynamic IP Address Configuration* on *Page 57*.

4. Use the following commands to enable the base receiver as an NTRIP Server:

```
NTRIPCONFIG NCOM1 SERVER V2 <endpoint> <mountpoint> <username>
<password> ETHA
INTERFACEMODE NCOM1 NONE RTCA OFF
FIX POSITION <lat> <long> <height>
LOG NCOM1 RTCAOBS2 ONTIME 1
LOG NCOM1 RTCAREF ONTIME 10
LOG NCOM1 RTCA1 ONTIME 1
SAVECONFIG
```

5. Use the following commands to enable the rover receiver as an NTRIP Client:

```
ETHCONFIG ETHA AUTO AUTO AUTO AUTO
NTRIPCONFIG NCOM1 CLIENT V1 <endpoint> <mountpoint> <username>
<password > ETHA
```

> If you are using a specific Network RTK system, certain NMEA strings are required to be sent from the rover back to the RTK network. For example, if you are connected to the VRS mount point, the rover is required to send its position to the network in a standard NMEA (National Marine Electronics Association) GGA message. This can be achieved by issuing the following command: LOG NCOMx GPGGA ONTIME 5, until data is received by the caster. For more information about Network RTK options and properties, refer to our *Application Note on Network RTK for OEMV Receivers* found on our website at http://www.novatel.com/support/knowledge-and-learning/published-papers-and-documents/application-notes/.

The following is an NTRIP Client configuration example without the use of a Network RTK system:

```
INTERFACEMODE NCOM1 RTCA NONE OFF
RTKSOURCE AUTO ANY
PSRDIFFSOURCE AUTO ANY
LOG BESTPOS ONTIME 1 (optional)
SAVECONFIG
```

Appendix A Technical Specifications

This appendix details the technical specifications of the IMUs. For information about the technical specifications, performance and cables of the SPAN receiver, refer to the *OEM6 Family Installation and Operation User Manual*.

A.1 Universal IMU Enclosure

The Universal IMU Enclosure is available with the HG1700, LN-200 and LCI-1 IMUs.

Table 9: Universal IMU Enclosure Specifications

PHYSICAL	
IMU Enclosure Size	168 mm x 195 mm x 146 mm
IMU Enclosure Weight	4.25 kg
MECHANICAL DRAWINGS	

Figure 20: Universal IMU Enclosure Side Dimensions

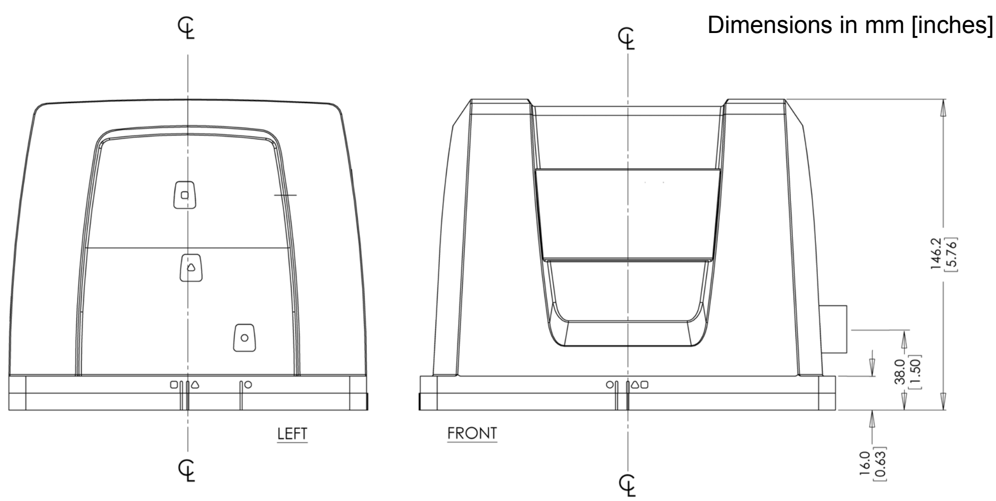


Figure 21: Universal IMU Enclosure Top/Bottom Dimensions

Dimensions in mm [inches]

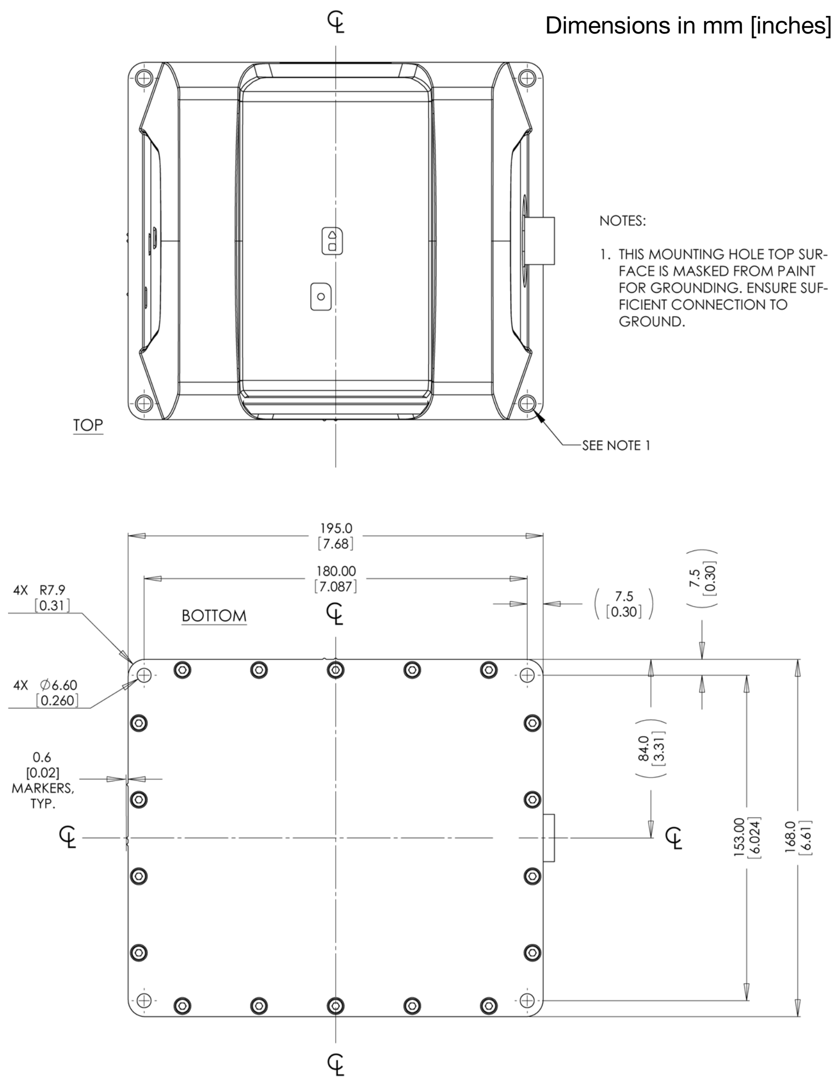
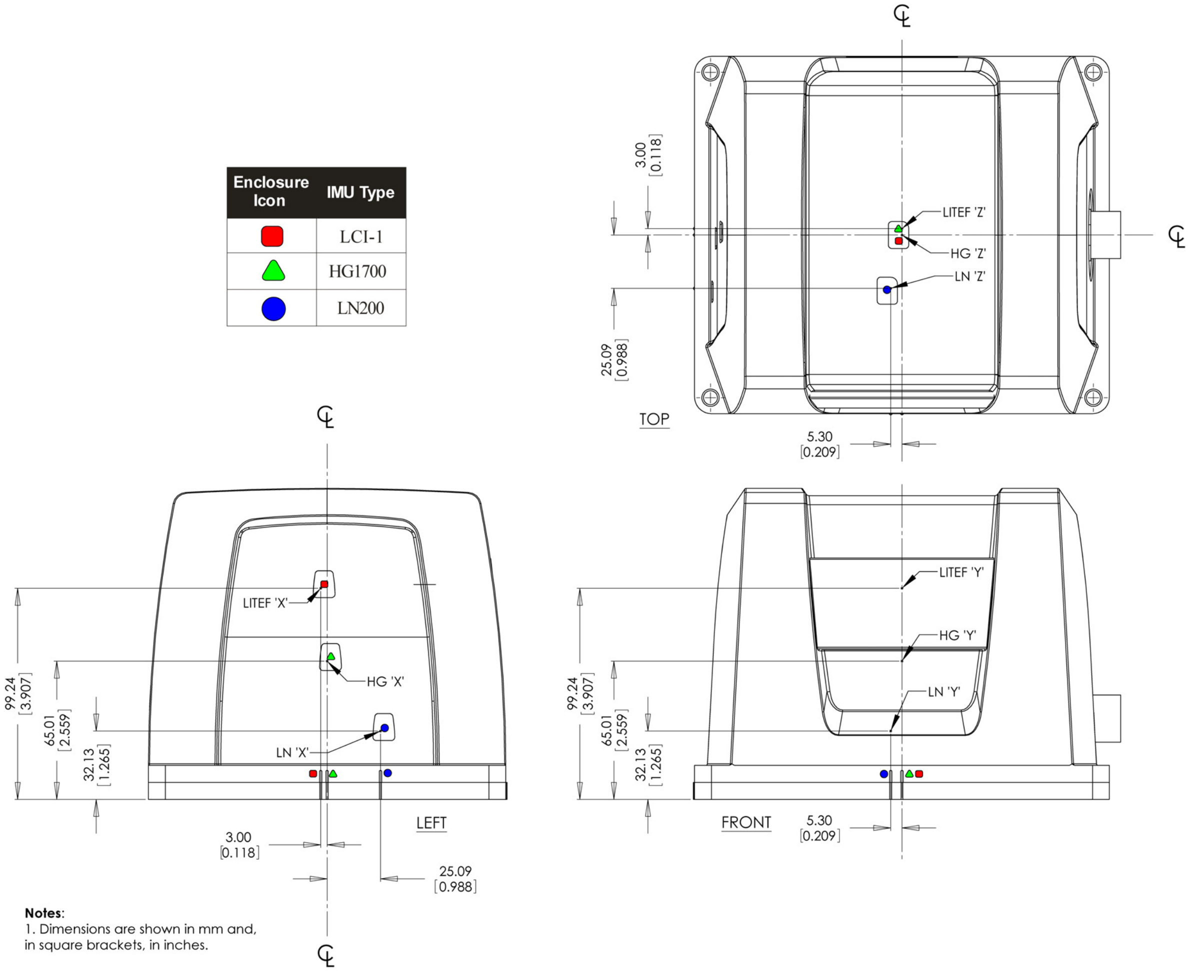


Figure 22: IMU Center of Navigation



Enclosure Icon	IMU Type
Red square	LCI-1
Green triangle	HG1700
Blue circle	LN200

A.1.1 Interface Cable for the Universal IMU Enclosure

The IMU interface cable provides power to the IMU from an external power source and enables input and output between the IMU and the receiver. IMUs in the Universal IMU Enclosure use the Universal IMU cable (see *Section A.1.2, Universal IMU Cable* on *page 66*).

A.1.2 Universal IMU Cable

The NovAtel part number for the Universal IMU cable is 01018299 (see *Figure 23*). This cable provides power to the IMU from an external power source, and enables communication between the receiver and the IMU.

Figure 23: Universal IMU Enclosure Interface Cable

Dimensions in millimetres.

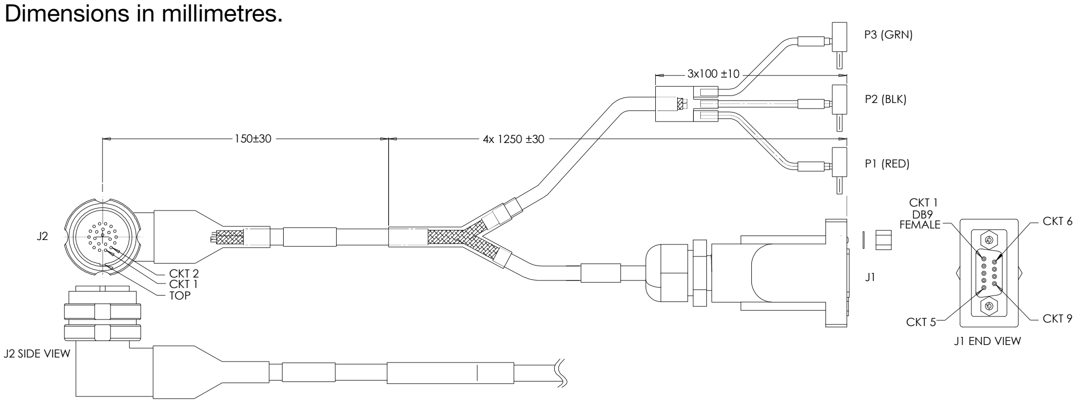


Table 10: Universal IMU Enclosure Interface Cable Pinouts

J2 Pinout	Function	Connector	Pin (Color)
1	V_{IN} (-)	P2	(BLK)
22	V_{IN} (-)		
2	Not used		
3	V_{IN} (+)	P1	(RED)
21	V_{IN} (+)		
4	Not used		
5	Not used		
6	Not used		
7	DAS (+)	J1	1
8	Not used		
9	DAS GND (-)	J1	5
10	Not used		
11	OEM_CTS/Rx-	J1	8
12	OEM_Rx/Rx+	J1	2
13	Not used		
14	DGND	J1	5
15	DGND	J1	5
16	Not used		
17	Not used		
18	Not used		
19	OEM_Tx/Tx+	J1	3
20	OEM_RTS/Tx-	J1	7
	Shield	P3	(GRN)

A.1.3 IMU Performance

Table 11: Universal IMU Enclosure IMU Performance

PERFORMANCE		
HG1700-AG58	Gyro Input Range	±1000 deg/sec
	Gyro Rate Bias	1.0 deg/hr
	Gyro Rate Scale Factor	150 ppm
	Angular Random Walk	0.125 deg/rt-hr
	Accelerometer Range	±50 g
	Accelerometer Linearity	500 ppm
	Accelerometer Scale Factor	300 ppm
	Accelerometer Bias	1.0 mg
HG1700-AG62	Gyro Input Range	±1000 deg/sec
	Gyro Rate Bias	5.0 deg/hr
	Gyro Rate Scale Factor	150 ppm
	Angular Random Walk	0.5 deg/rt-hr
	Accelerometer Range	±50 g
	Accelerometer Linearity	500 ppm
	Accelerometer Scale Factor	300 ppm
	Accelerometer Bias	3.0 mg
LN-200	Gyro Input Range	±1000 deg/sec
	Gyro Rate Bias	1.0 deg/hr
	Gyro Rate Scale Factor	100 ppm
	Angular Random Walk	0.07 deg/rt-hr
	Accelerometer Range	±40 g
	Accelerometer Linearity	-
	Accelerometer Scale Factor	300 ppm
	Accelerometer Bias	0.3 mg
LCI-1	Gyro Input Range	±800 deg/sec
	Gyro Rate Bias	< 1.0 deg/hr
	Gyro Rate Scale Factor	< 500 ppm
	Angular Random Walk	< 0.15 deg/rt-hr
	Accelerometer Range	±40 g
	Accelerometer Linearity	-
	Accelerometer Scale Factor	< 1000 ppm
	Accelerometer Bias	< 1.0 mg

A.1.4 Electrical and Environmental

Table 12: Universal IMU Enclosure Electrical and Environmental Specifications

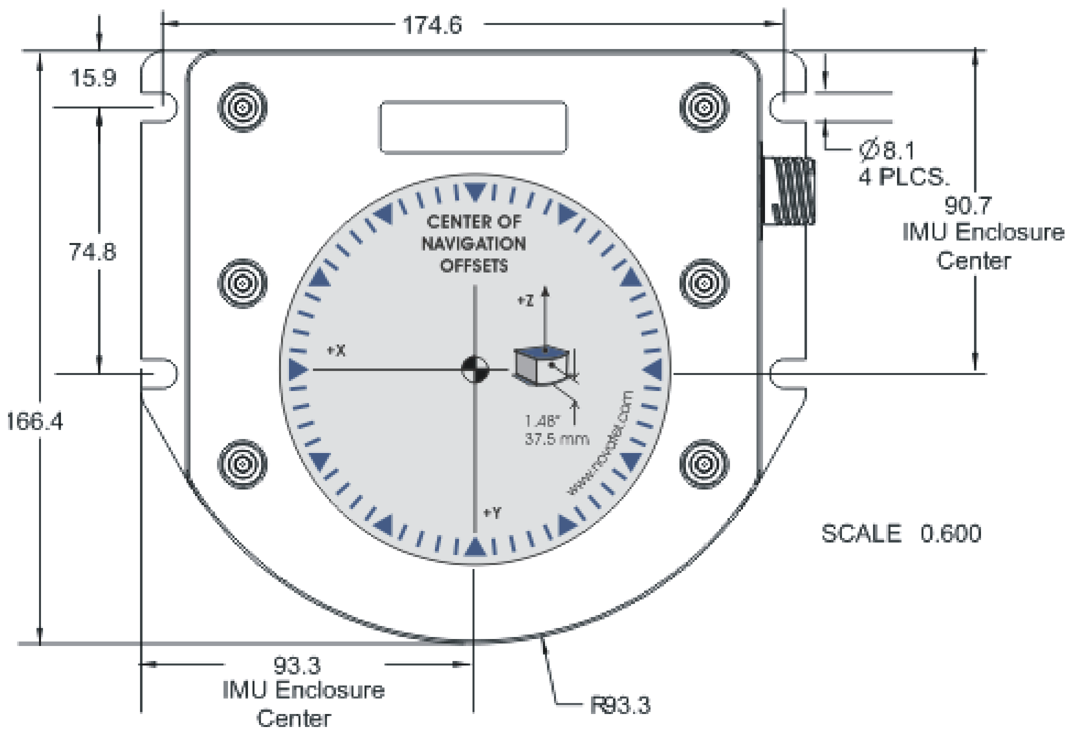
ELECTRICAL	
IMU Power Consumption	HG1700-AG58: 9 W (max) HG1700-AG62: 8 W (max) LN-200: 16 W (max) LCI-1: 16W (typical)
IMU Input Voltage	+12 to +28 V DC (all IMUs)
Receiver Power Consumption	1.8 W (typical, for all IMUs)
Input/Output Connectors	MIL-C-38999-III, 22 pin (all IMUs)
IMU Interface	RS-232 or RS-422
ENVIRONMENTAL	
Temperature	HG1700-AG58, HG1700-AG62 Operating -30°C to +60°C Storage -45°C to +71°C
	LN-200 Operating -30°C to +60°C Storage -45°C to +80°C
	LCI-1 Operating -40°C to +60°C Storage -40°C to +71°C
Humidity	Operates at 95% RH, non-condensing (all IMUs)

A.2 HG1700 IMU (single-connector enclosure)

Table 13: HG1700 IMU Specifications

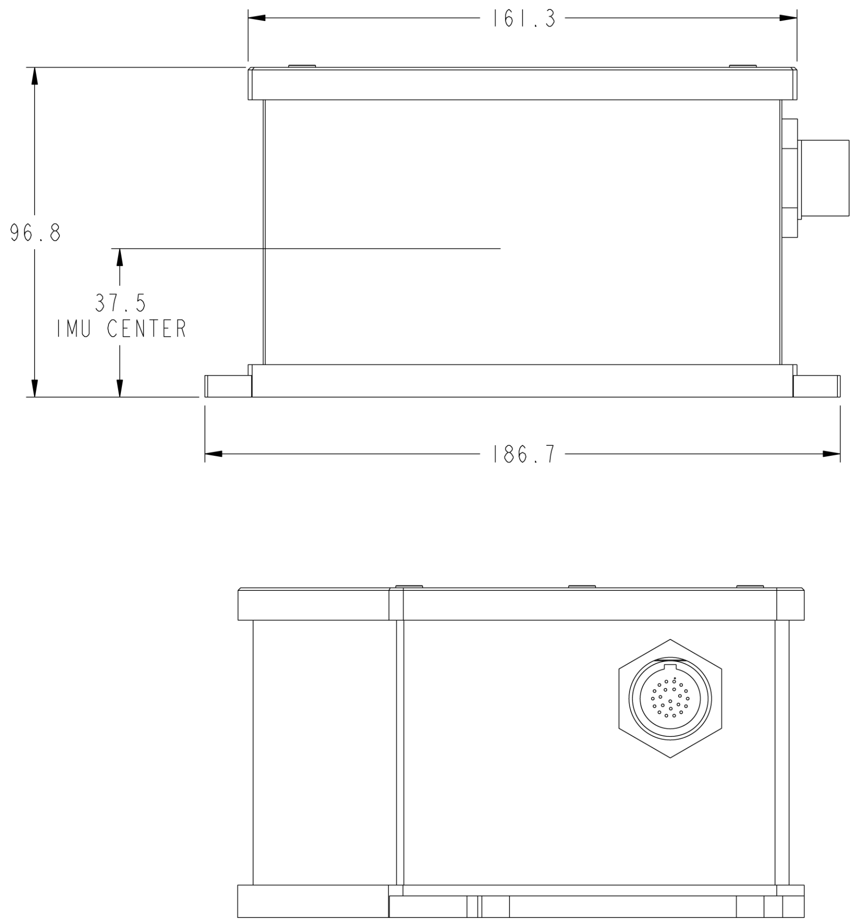
PHYSICAL	
IMU Enclosure Size	193 mm x 167 mm x 100 mm (7.6” x 6.6” x 3.9”)
IMU Size	160 mm x 160 mm x 100 mm (6.3” x 6.3” x 3.9”)
IMU + Enclosure Weight	3.4 kg (7.49 lb.)
MECHANICAL DRAWINGS	

Figure 24: HG1700 Top/Bottom Dimensions



Note: The center of Navigation, shown on the HG1700 label, for the internal IMU is the same as the enclosure center. The enclosure center measurements are labelled as *IMU Enclosure Center* in this figure.

Table 14: HG1700 Enclosure Side Dimensions



Note: The center of Navigation, shown on the HG1700 label, for the internal IMU is the same as the enclosure center. The enclosure center measurements are labelled as *IMU Center* in this figure.

A.2.1 Interface Cable for the HG1700 IMU

The IMU interface cable provides power to the IMU from an external power source and enables communication between the receiver and IMU. The HG1700 IMU uses the Universal IMU cable (see *Section A.1.2, Universal IMU Cable* on *page 66*).

A.2.2 IMU Performance

Table 15: HG1700 IMU Performance

PERFORMANCE		
IMU-H58	Gyro Input Range	± 1000 degrees/s
	Gyro Rate Bias	1.0 degree/hr
	Gyro Rate Scale Factor	150 ppm
	Angular Random Walk	0.125 degrees/rt hr
	Accelerometer Range	± 50 g
	Accelerometer Linearity	500 ppm
	Accelerometer Scale Factor	300 ppm
	Accelerometer Bias	1.0 mg
IMU-H62	Gyro Input Range	± 1000 degrees/s
	Gyro Rate Bias	5.0 degrees/hr
	Gyro Rate Scale Factor	150 ppm
	Angular Random Walk	0.5 degrees/rt-hr
	Accelerometer Range	± 50 g
	Accelerometer Linearity	500 ppm
	Accelerometer Scale Factor	300 ppm
	Accelerometer Bias	3.0 mg

A.2.3 Electrical and Environmental

Table 16: HG17000 Electrical and Environmental Specifications

ELECTRICAL	
IMU Power Consumption	IMU-H58: 9 W (max) IMU-H62: 8 W (max)
IMU Input Voltage	+12 to +28 V DC
Receiver Power Consumption	1.8 W (typical)
System Power Consumption	13.8 W (typical)
Input/Output Connectors	MIL-C-38999-III, 22 pin (all IMUs)
IMU Interface	RS-232 or RS-422
ENVIRONMENTAL (IMU)	
Temperature	Operating -30°C to +60°C (-22°F to 140°F) Storage -45°C to +80°C (-49°F to 176°F)
Humidity	95% non-condensing

A.3 LN-200 IMU (single-connector enclosure)

Table 17: LN-200 IMU Specifications

PHYSICAL	
IMU Enclosure Size	135 mm x 153 mm x 130 mm (5.315" x 6.024" x 5.118")
IMU Size	89 mm D x 85 mm H (3.504" D x 3.346" H)
IMU Weight	~3 kg (6.6 lb.)
MECHANICAL DRAWINGS	

Figure 25: LN-200 IMU Enclosure Top/Bottom Dimensions and Center of Navigation

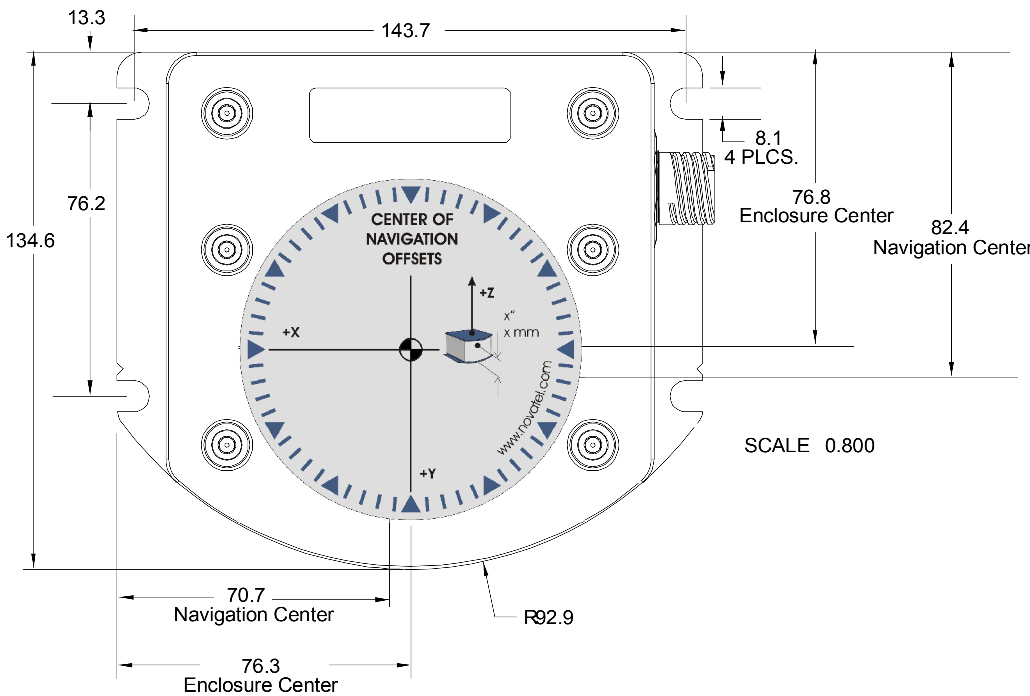
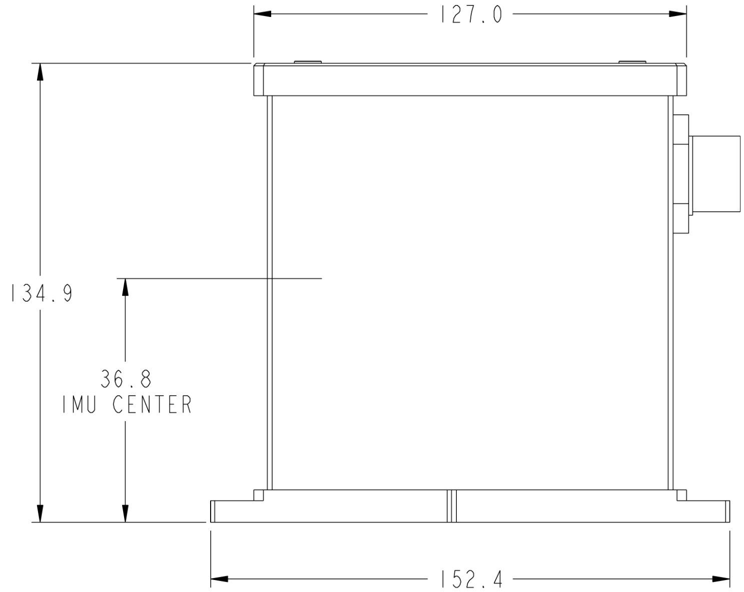
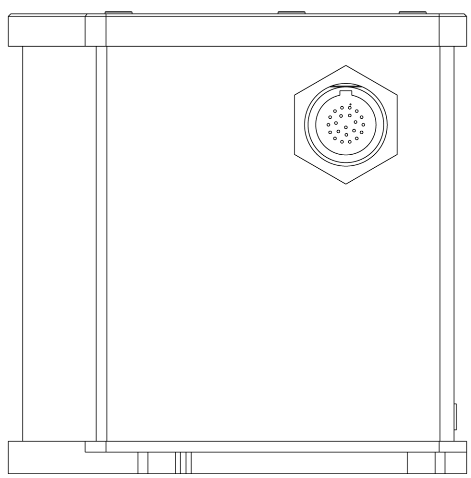


Figure 26: LN-200 Enclosure Side Dimensions





Note: The Center of Navigation offsets, shown on the LN-200 label, are for the internal IMU and are different than for the enclosure center. The enclosure center is labelled as *IMU Center* in this figure.

A.3.1 Interface Cable for the LN-200 IMU

The IMU interface cable provides power to the IMU from an external power source and enables communication between the receiver and IMU. The LN-200 IMU uses the Universal IMU cable (see *Section A.1.2, Universal IMU Cable* on *page 66*).

A.3.2 IMU Performance

Table 18: LN-200 IMU Performance

PERFORMANCE		
IMU-LN200	Gyro Input Range	± 1000 degrees/s
	Gyro Rate Bias	1°/hr
	Gyro Rate Scale Factor	100 ppm
	Angular Random Walk	0.07 degrees/rt-hr
	Accelerometer Range	± 40 g
	Accelerometer Linearity	-
	Accelerometer Scale Factor	300 ppm
	Accelerometer Bias	0.3 mg

A.3.3 Electrical and Environmental

Table 19: LN-200 Electrical and Environmental Specifications

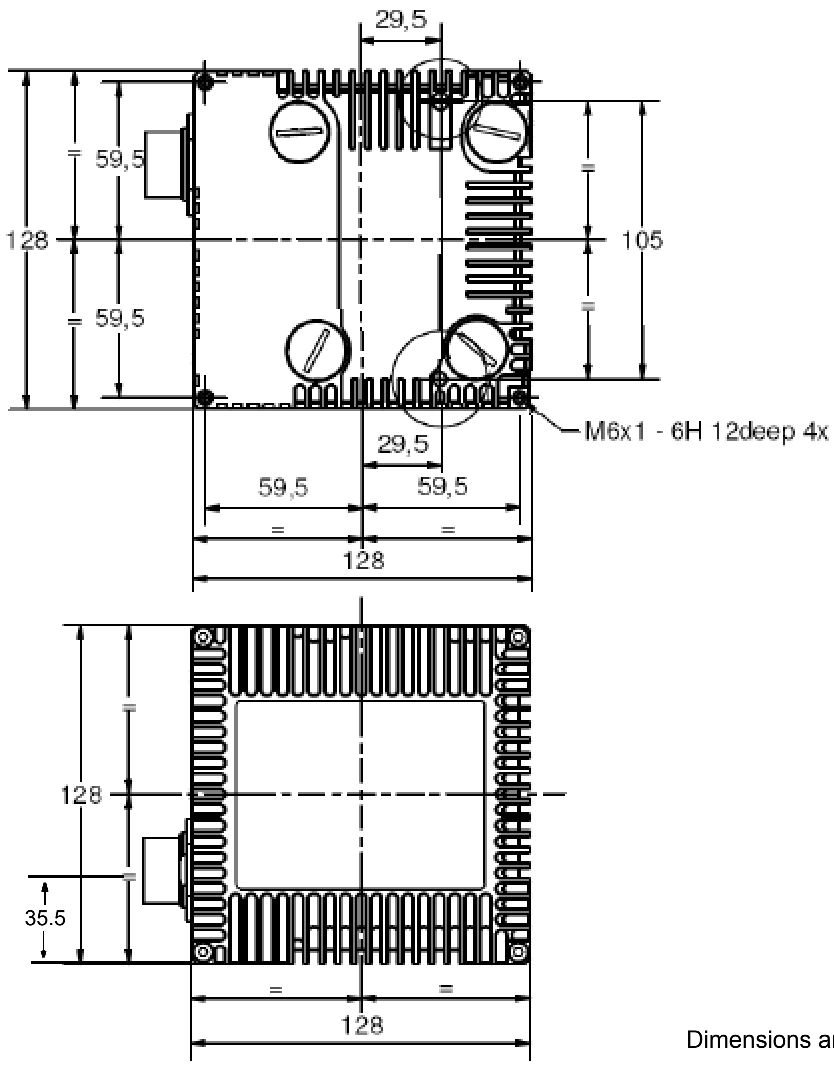
ELECTRICAL		
IMU Power Consumption	16 W (max)	
IMU Input Voltage	+12 to +28 V DC	
Receiver Power Consumption	1.8 W (typical)	
System Power Consumption	13.8 W (typical)	
Input/Output Connectors	MIL-C-38999-III, 22 pin (all IMUs)	
IMU Interface	RS-232 or RS-422	
ENVIRONMENTAL (LN-200 IMU)		
Temperature	Operating	-30°C to +60°C (-22°F to 140°F)
	Storage	-45°C to +80°C (-49°F to 176°F)
Humidity	95% non-condensing	

A.4 iIMU-FSAS

Table 20: iIMU-FSAS Specifications

PHYSICAL	
IMU Size	128 mm x 128 mm x 104 mm (5.04” x 5.04” x 4.09”)
IMU Weight	2.1 kg (4.63 lb.)
MECHANICAL DRAWINGS	

Figure 27: iIMU-FSAS Top/Bottom Dimensions



Dimensions are in mm

Figure 28: iIMU-FSAS Enclosure Side Dimensions

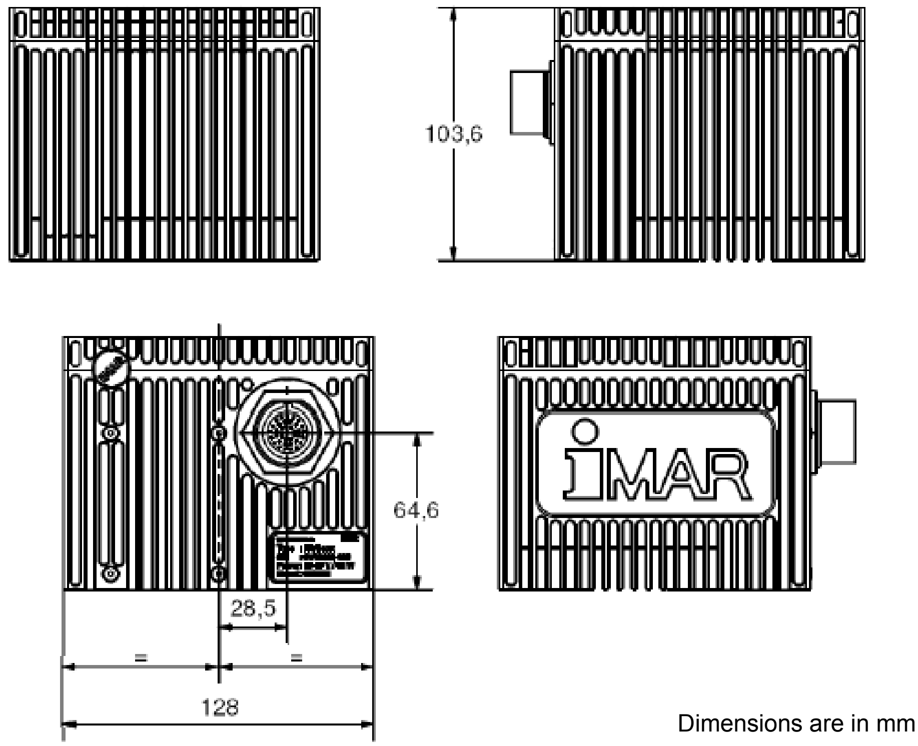
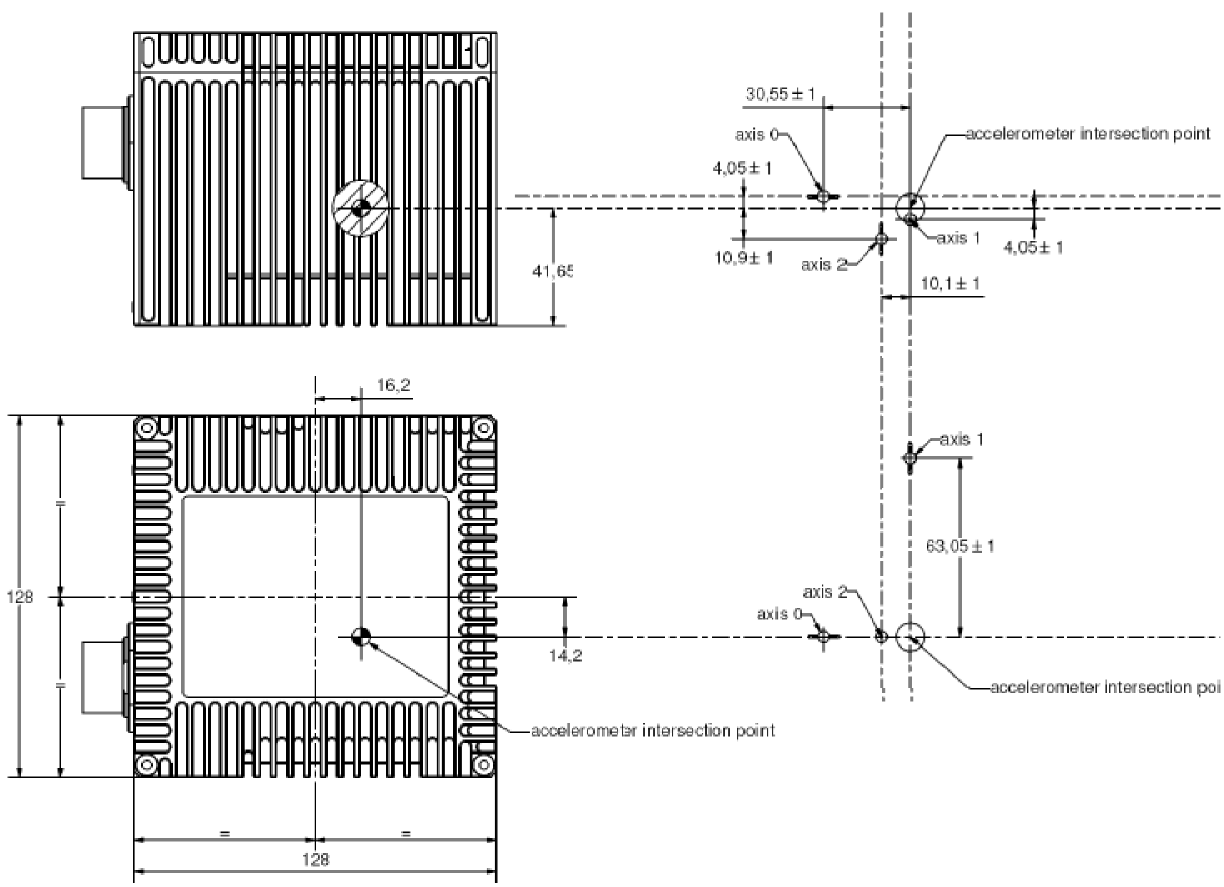


Figure 29: IMU-FSAS Center of Navigation



A.4.1 Interface Cable for the IMU-FSAS

The iIMU-FSAS connects to the FlexPak6 receiver using a FlexPak Y Adapter cable and an IMU interface cable (see *Figure 6, Basic Set Up – IMU-FSAS or IMU-CPT* on *page 28*).

For a drawing and pinout of the FlexPak Y Adapter cable, see *Section A.4.4, FlexPak Y Adapter Cable* on *page 81*.

The IMU interface cable can be one of the following cables:

Cable	NovAtel Part Number	Comment	For more information
Universal IMU cable	01018299	For standard pinout enclosures.	See *Section A.1.2, Universal IMU Cable* on *page 66*
IMU-FSAS cable with ODO	01018388	For standard pinout enclosures. Includes an additional connector for odometer cabling.	See *Section A.4.2, IMU-FSAS cable with Odometer* on *page 78*

A.4.2 IMU-FSAS cable with Odometer

The NovAtel part number for the IMU-FSAS cable with Odometer is 01018388 (see *Figure 30*). This cable:

- provides power to the IMU from an external power source
- enables input and output between the receiver and the IMU
- enables input from an optional odometer

See also *Section A.4.3, iIMU-FSAS Odometer Cabling* on *page 79*.

Figure 30: IMU-FSAS Interface Cable with Odometer

Dimensions in millimetres.

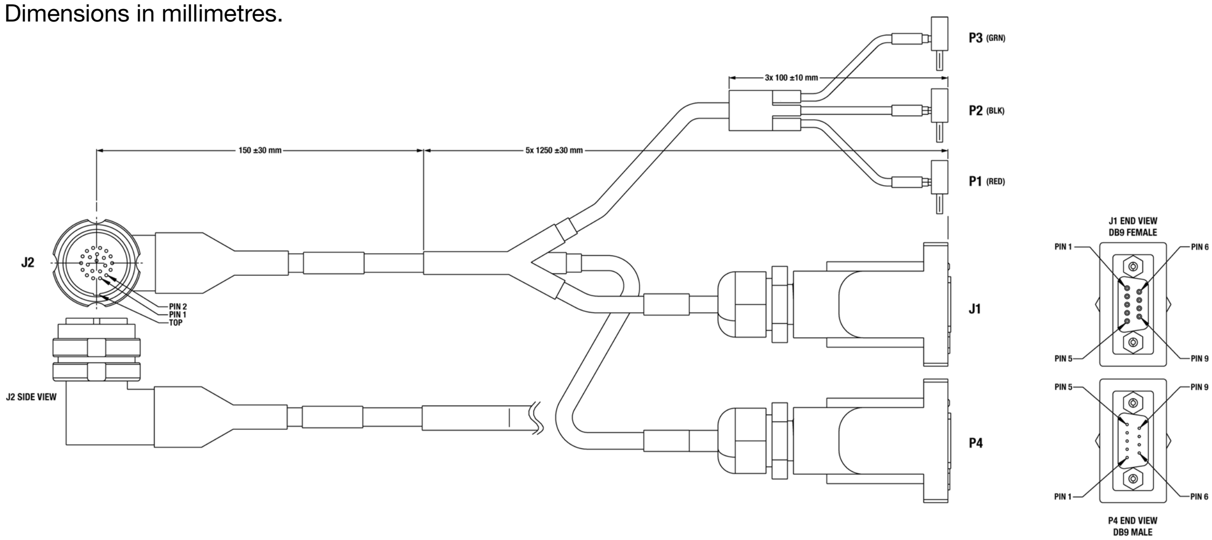


Table 21: IMU-FSAS Cable with Odometer Pinout

MIL-C-38999 III Connector Pin	Function	Power 4 mm plugs	J1 Female DB9	P4 Male DB9	Comments
1	Vin(-)	Color: black Label: Vin (-)			Power ground
22	Vin(-)				
2	ODO_AN			7	Odometer input A(-), opto-coupler: +2 to +6 V (RS-422 compatible)
4	ODO_A			6	Odometer input A(+), opto-coupler: +2 to +6 V (RS-422 compatible)
3	Vin(+)	Color: red Label: Vin (+)			+11 to +34 VDC
21	Vin(+)				
5-6	Not used				
7	DAS(+)		1		Shielded data acquisition signal (LVTTL to VARF)
9	DAS GND(-)		5		Shielded ground reference for data acquisition and control signals
8	Reserved				
10	Reserved				
11	OEM_CTS/Rx-		8		Twisted pair; serial data output signal / RS-422(-)
12	OEM_Rx/Rx+		2		Twisted pair; serial data output signal / RS-422(+)
13	Reserved				
14	DGND		5		Digital ground
15	DGND		5		Digital ground
16	ODO_B			3	Odometer input B(+), opto-coupler: +2 to +6 V (RS-422 compatible)
17	ODO_BN			1	Odometer input B(-), opto-coupler: +2 to +6 V (RS-422 compatible)
18	Reserved				
19	OEM_Tx/Tx+		3		Twisted pair; serial data in / RS-422(+)
20	OEM_RTS/Tx-		7		Twisted pair; serial data in / RS-422(-)

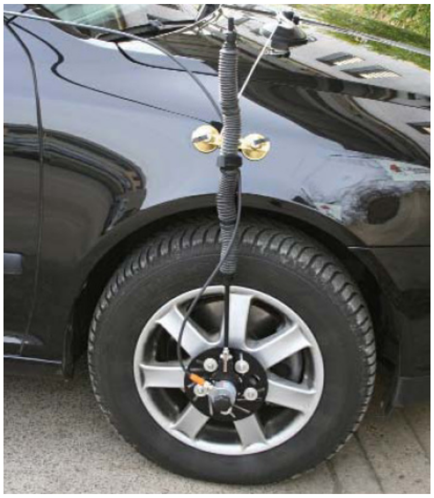
A.4.3 iIMU-FSAS Odometer Cabling

The iIMU-FSAS with the –O wheel sensor option provides wheel sensor input from the Distance Measurement Instrument (DMI) through the DB-9 connector labelled “ODO” on the IMU interface cable. The DMI data goes through the IMU and then into the SPAN receiver through the serial communication line.

There are two DMI products that are compatible with the iIMU-FSAS system:

- iMWS-V2 (Magnetic Wheel Sensor) from iMAR
  - A magnetic strip and detector are installed inside the wheel. The signal then goes through a box that translates the magnetic readings into pulses that are then passed through the cable into the ODO connector on the IMU cable. See also *Figure 32* on *page 80*.
- WPT (Wheel Pulse Transducer) from Corrsys Datron
  - A transducer traditionally fits to the outside of a non-drive wheel. A pulse is then generated from the transducer which is fed directly to the ODO connector on the IMU cable. See also *Figure 31* on *page 80*.

Figure 31: Corrsys Datron WPT



The WPT mounts to the wheel lug nuts via adjustable mounting collets. The torsion protection rod, which maintains rotation around the wheel axis, affixes to the vehicle body with suction cups. Refer to the Corrsys Datron WPT user manual for mounting instructions.

Figure 32: iMAR iMWS Pre-Installed

The iMAR iMWS-V2 sensor is on the inside of the wheel so that all you can see in the vehicle is the grey signal converter box.

iMAR provides a sensor that operates with a magnetic strip glued inside the rim of a non-drive wheel and a special detector (iRS) mounted on the inside of the wheel (the disk of the wheel suspension, brake cover or brake caliper holder). Details are shown in the installation hints delivered with the system.

The NovAtel IMU interface cable with ODO, is the same as that in *Section A.4.1* but with some of the reserved pins having odometer uses. It still provides power to the IMU from an external source, and enables input and output between the receiver and IMU. See also *SPAN Wheel Sensor Messages* on *page 46*.

> The DMI runs only one output line (A).
> SPAN specifies that the maximum pulse frequency for a wheel sensor input to SPAN is 1 MHz.

You can use our interface cable with the ODO connector to plug directly into the iMWS. With the WPT, first modify the cable at the WPT end. The cable modification is shown in *Table 22* on *page 80*.

> Connect the female DB9 connector to the male ODO end of the iMU-FSAS interface cable.

Table 22: Cable Modification for Corrsys Datron WPT

8-pin M12 connector on the Corrsys Datron cable [a] [b]		Female DB9 connector
Pin 1	GND	No change
Pin 2	$+U_B$ (Input Power)	
Pin 3	Signal A	6
Pin 4	Signal A inverted	7
Pin 5	Signal B	3
Pin 6	Signal B inverted	1
Pin 7	Reserved	No change
Pin 8		

a. Pin 2 is wired to a red banana plug (Power in) and Pin 1 is wired to a black banana plug (Power return) so the WPT needs power to operate (+10 to +30 V). Solder the shield on the WPT cable to the female DB9 housing.

b. This modification is for the Corrsys Datron WPT 8-pin M12-plug cable number 14865.

A.4.4 FlexPak Y Adapter Cable

The NovAtel part number for the FlexPak Y Adapter cable is 01018948. This cable connects from the FlexPak6 to the IMU interface cable (see *Figure 6, Basic Set Up – IMU-FSAS or IMU-CPT* on *page 28*). The FlexPak Y Adapter cable allows the IMU to access receiver signals from both the COM 2 port and the I/O port.

Figure 33: FlexPak Y Adapter Cable

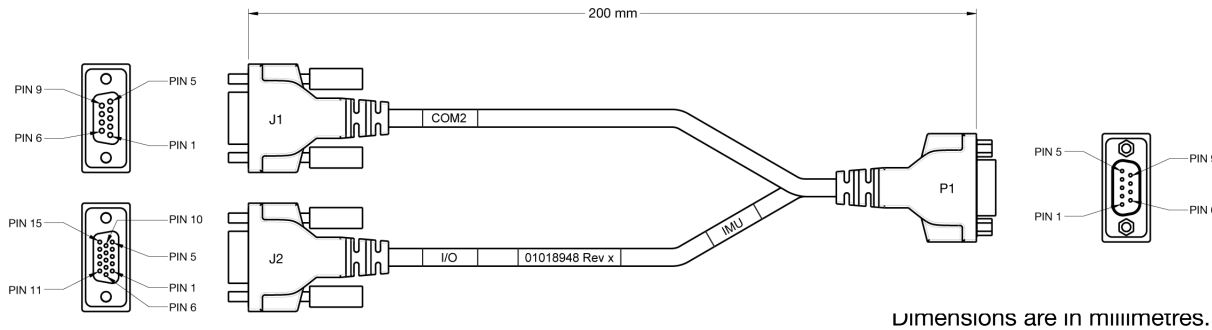


Table 23: FlexPak Y Adapter Cable Pinouts

P1 Connector DB9 to IMU Pin #	Function	J1 Connector DB9 to COM 2 Pin #	J2 Connector DB15 to I/O Pin #
1	VARF		12
2	RXD_IMU / Rx +	2	
3	TXD_IMU / Tx +	3	
4	Not Used		
5	GROUND	5	5
			9
6	Not Used		
7	RTS_IMU / Tx-	7	
8	CTS_IMU / Rx -	8	
9	Not Used		

A.4.5 IMU Performance

Table 24: iIMU-FSAS Performance

PERFORMANCE (IMU)		
iIMU-FSAS	Gyro Input Range	± 500 degrees/s
	Gyro Rate Bias	0.75°/hr
	Gyro Rate Scale Factor	300 ppm
	Angular Random Walk	0.1 degrees/sq rt hr
	Accelerometer Range	± 5 g (± 20 g optional)
	Accelerometer Linearity	-
	Accelerometer Scale Factor	400 ppm
	Accelerometer Bias	1.0 mg

A.4.6 Electrical and Environmental

Table 25: iIMU-FSAS Electrical and Environmental Specifications

ELECTRICAL		
IMU Power Consumption	16 W (max)	
IMU Input Voltage	+10 to +34 V DC	
Receiver Power Consumption	1.8 W (typical)	
System Power Consumption	13.8 W (typical)	
Data Connector	MIL-C-38999-III	
Power Connector	MIL-C-38999-III (same as data connector)	
IMU Interface	RS-422	
ENVIRONMENTAL		
Temperature	Operating	-40°C to +71°C (-40°F to 160°F)
	Storage	-40°C to +85°C (-40°F to 185°F)
Humidity	95% non-condensing	

A.5 IMU-CPT

Table 26: IMU-CPT Specifications

PHYSICAL	
IMU-CPT Enclosure Size	168 mm W X 152 mm L X 89 mm H
IMU-CPT Weight	2.29 kg
MECHANICAL DRAWINGS	

Figure 34: IMU-CPT - Side and Perspective View

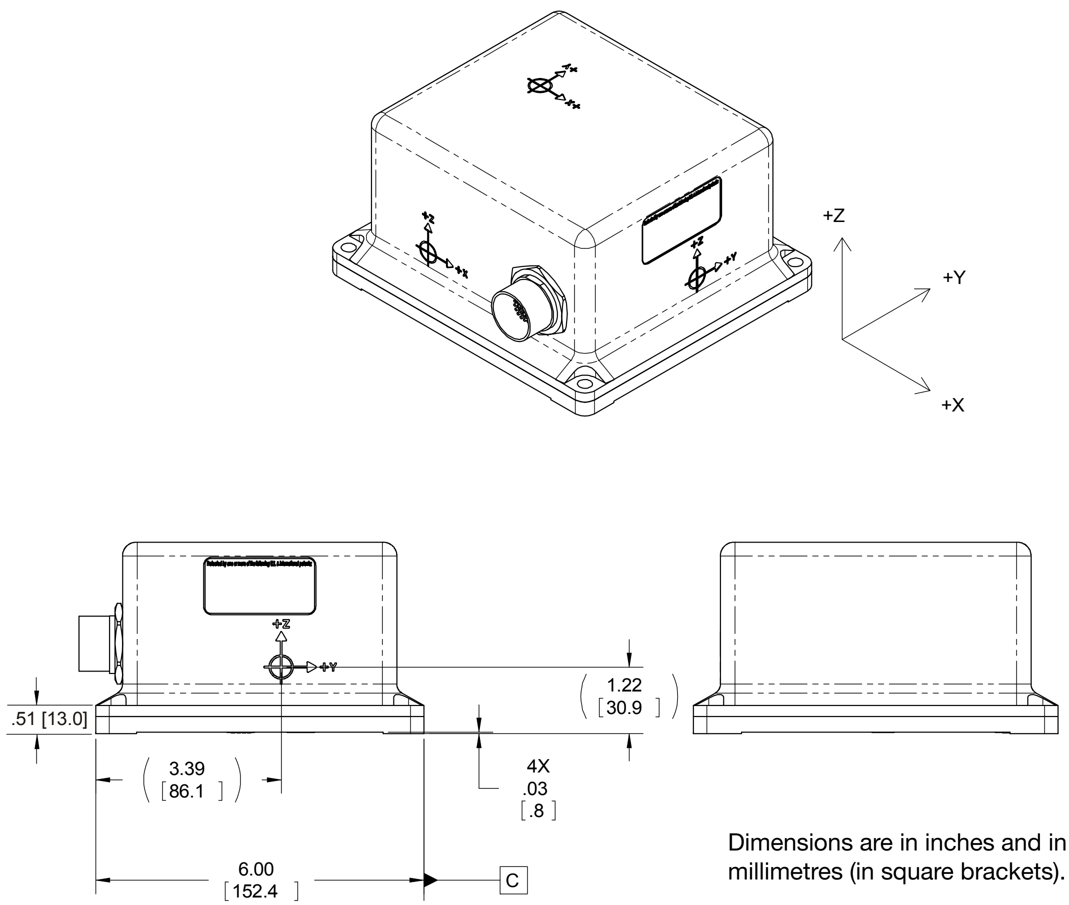
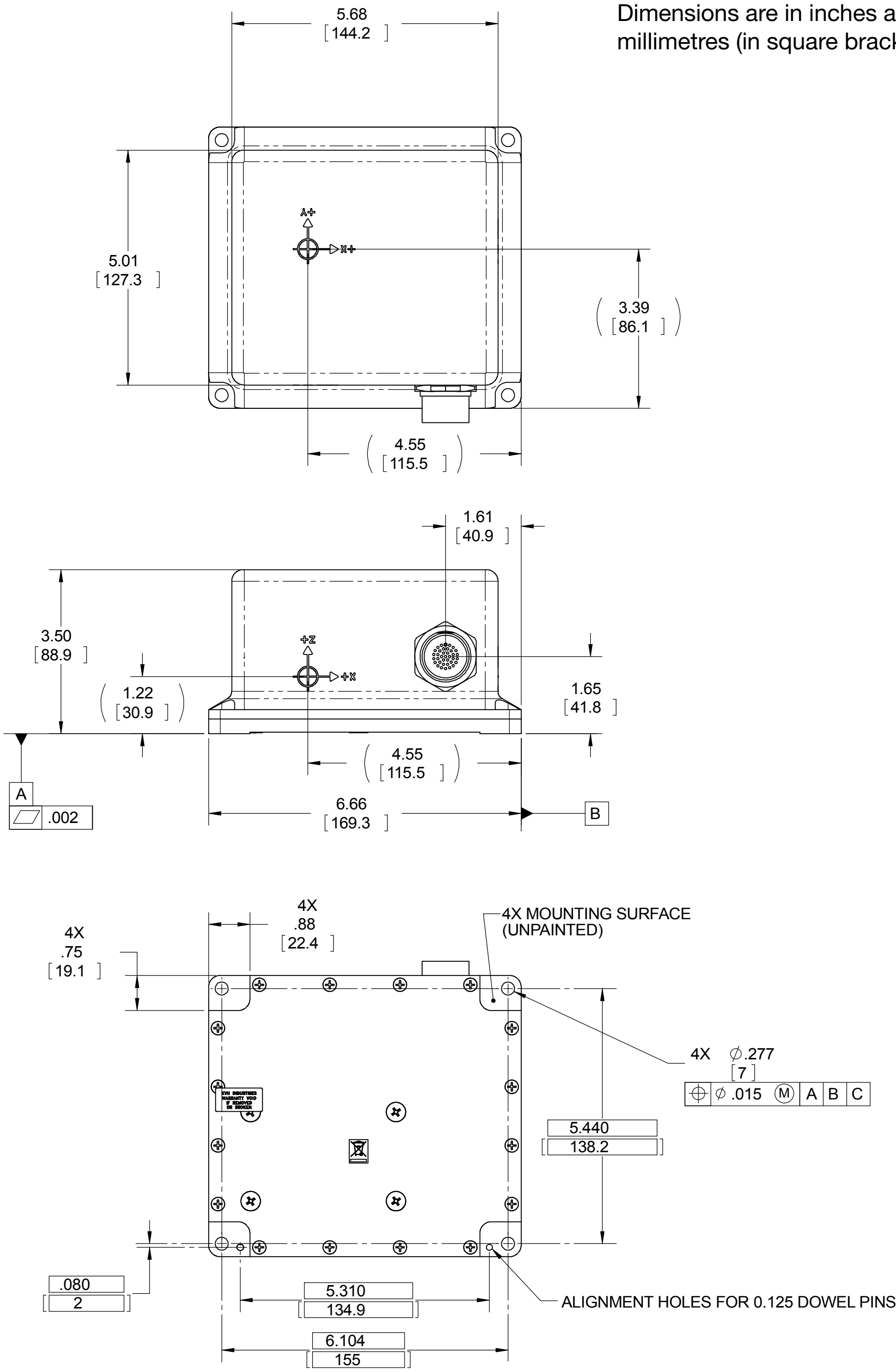


Figure 35: IMU-CPT Top, Front and Bottom View

Dimensions are in inches and in millimetres (in square brackets).

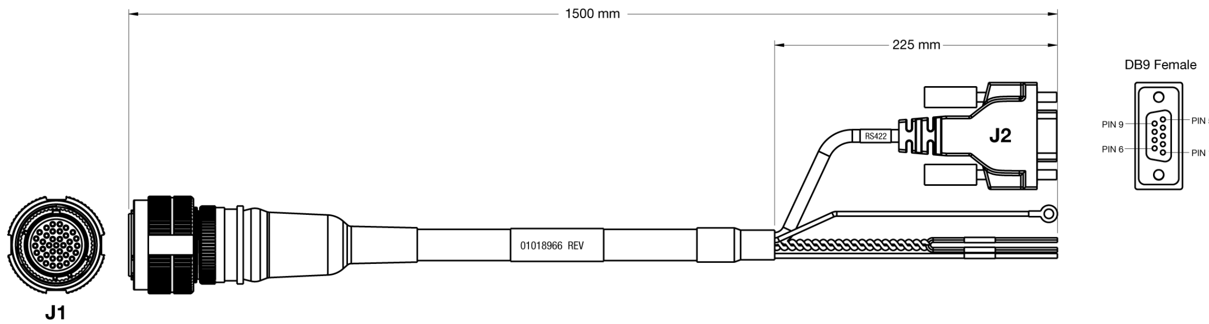


A.5.1 IMU-CPT Cable

The NovAtel part number for the IMU-CPT cable is 01018966. This cable provides power to the IMU from an external power source and enables communication between the receiver and the IMU.

A FlexPak Y Adapter cable is required between the FlexPak6 receiver and the IMU-CPT cable (see *Figure 6, Basic Set Up – IMU-FSAS or IMU-CPT* on *page 28*). Also see *Section A.4.4, FlexPak Y Adapter Cable* on *page 81*.

Figure 36: IMU-CPT Development Terminated Cable



The IMU-CPT cable has a green ground line terminated in a ring lug, as shown in *Figure 36*, that is grounded to the IMU-CPT connector body and enclosure.

Table 27: IMU-CPT Connector Pin-Out Descriptions

J1 Pin #	Function	J2 (Female DB9) Pin #	Bare Connectors
1	Power Return		Labelled Pin 1
2	9-16 VDC Power Input		Labelled Pin 2
3-20	Reserved		
21	IMU RS422 TX+	2	
22	IMU RS422 TX-	8	
23-24	Reserved		
25	IMU RS422 Signal Ground	5	
26-34	Reserved		
35	TOV Output	9	
36	External Clock Input	1	
37	Chassis GND		Labelled Pin 37
	Chassis GND		Ring lug

A.5.2 IMU-CPT Sensor Specifications

Table 28: IMU-CPT Performance

***PERFORMANCE* - FIBER OPTIC GYROS**	
Bias Offset	± 20 °/hr
Turn On To Turn On Bias Repeatability (Compensated)	± 3 °/hr
In Run Bias Variation, At Constant Temperature	1 °/hr @ 1σ
Scale Factor Error (Total)	1500 ppm, 1σ
Scale Factor Linearity	1000 ppm, 1σ
Temperature Dependent SF Variation	500 ppm, 1σ
Angular Random Walk	0.0667 °/√hr @ 1σ
Max Input	± 375 °/sec
***PERFORMANCE* - ACCELEROMETERS**	
Bias Offset	± 50 mg
Turn On To Turn On Bias Repeatability	± 0.75 mg
In Run Bias Variation, At Constant Temperature	0.25 mg @ 1σ
Temperature Dependent Bias Variation	0.5 mg/°C @ 1σ
Scale Factor Error (Total)	4000 ppm, 1σ
Temperature Dependent SF Variation	1000 ppm, 1σ
Accel Noise	55 µg/√Hz @ 1σ
Bandwidth	50 Hz
Max Input	±10 g

A.5.3 IMU-CPT Electrical and Environmental

Table 29: IMU-CPT Electrical and Environmental Specifications

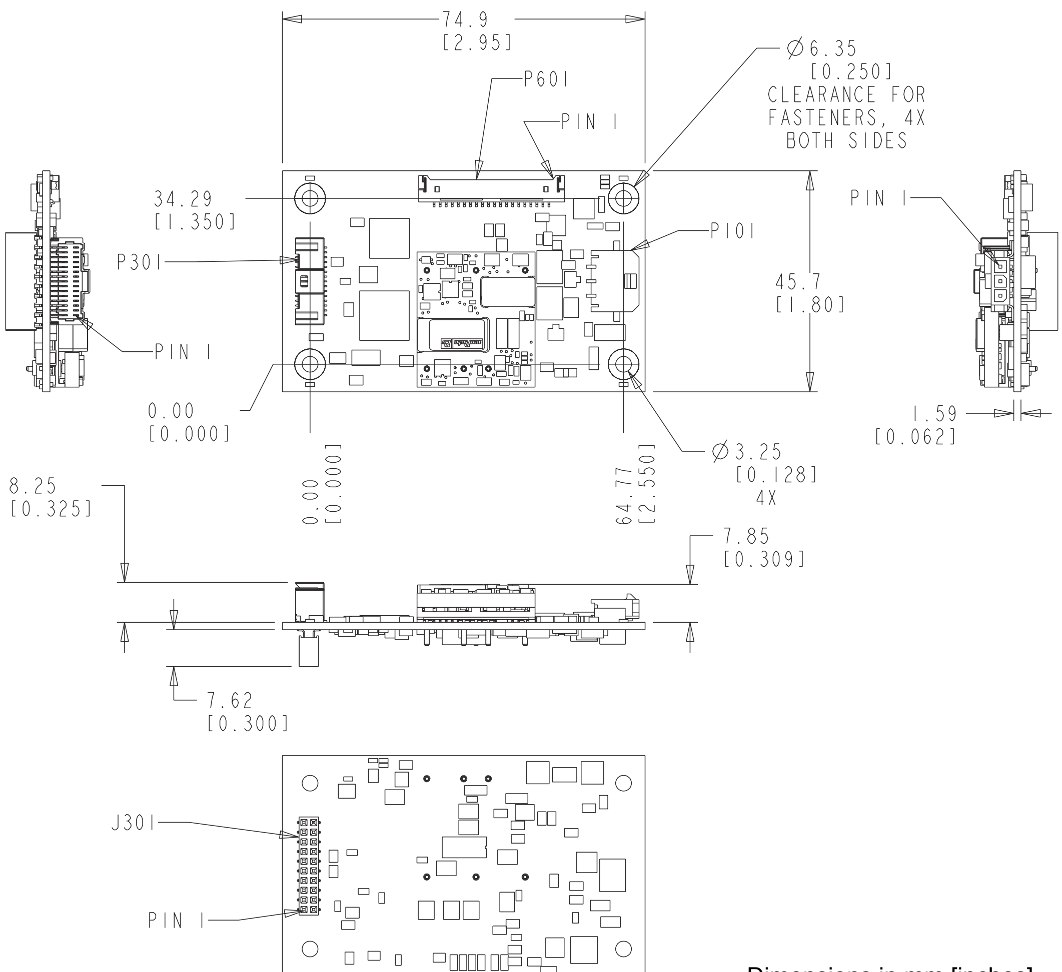
CONNECTORS	
Power and I/O	MIL-DTL-38999 Series 3
RF Antenna Connector	TNC Female
ELECTRICAL	
Input Power	9 - 18 VDC
Power consumption	15 W (Max)
Start-Up Time (Valid Data)	< 5 seconds
ENVIRONMENTAL	
Temperature, operational	-40°C to +65°C
Temperature, non-operational	-50°C to +80°C
Vibration, operational	6 g rms, 20 Hz -2 KHz
Vibration, non-operational	8 g rms, 20 Hz -2 KHz
Shock, operational	7g 6-10 msec, 1/2 sine
Shock, non-operational	60 g 6-10 msec, 1/2 sine
Altitude	-1000 to 50,000 ft.
Humidity	95% at 35°C, 48 hrs
MTBF	≥ 10,500 hours

A.6 MIC - MEMS Interface Card

Table 30: MEMS Interface Card Specifications

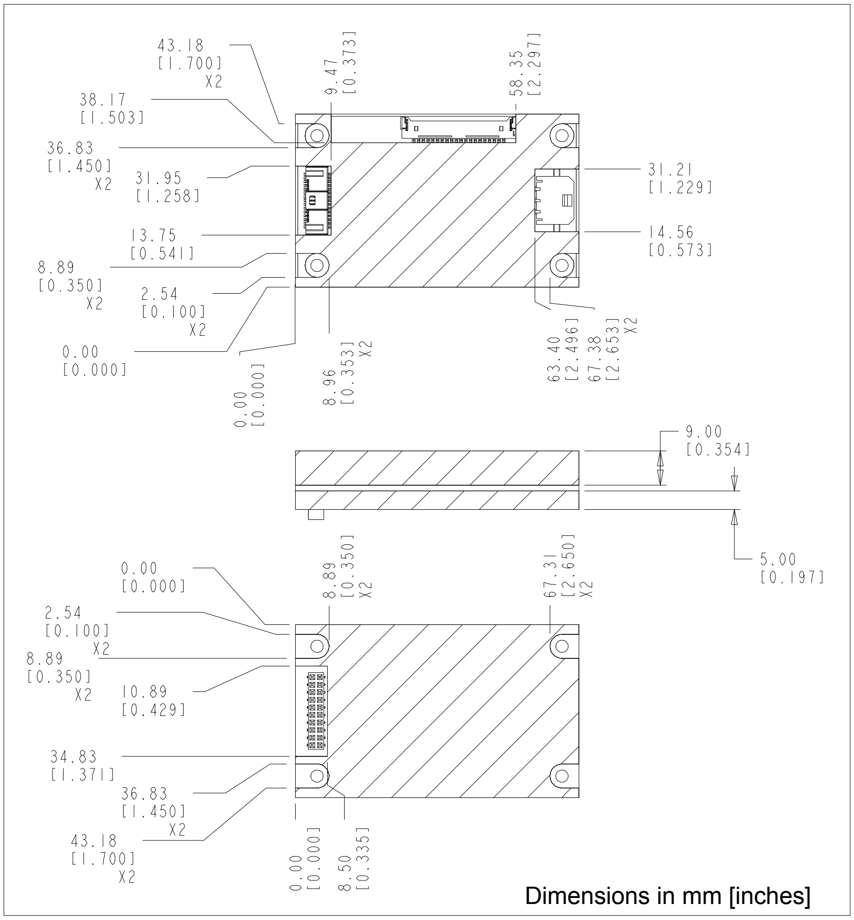
PHYSICAL	
MIC Size	74.9 mm x 45.7 mm x 19.5 mm (2.94" x 1.80" x 0.76")
MIC Weight	31 g (0.0683 lb)
MECHANICAL DRAWINGS	

Figure 37: MIC Top/Bottom Dimensions



Dimensions in mm [inches]

Figure 38: MIC Keep-Out Zone



Cross hatched areas indicate "keepout" areas intended for NovAtel circuitry. NovAtel reserves the right to modify components and component placements inside cross hatched keepout zones, while maintaining design, form, fit and function.

A.6.1 HG1930 IMU-to-MIC Cable Assembly

The NovAtel part number for the HG1930 IMU-to-MIC interface cable is 01018827 (*Figure 39* on *page 89*). This cable provides power to the IMU and enables communication between the MIC and the IMU.

Figure 39: HG1930 IMU-to-MIC Cable Assembly

Dimensions in millimetres

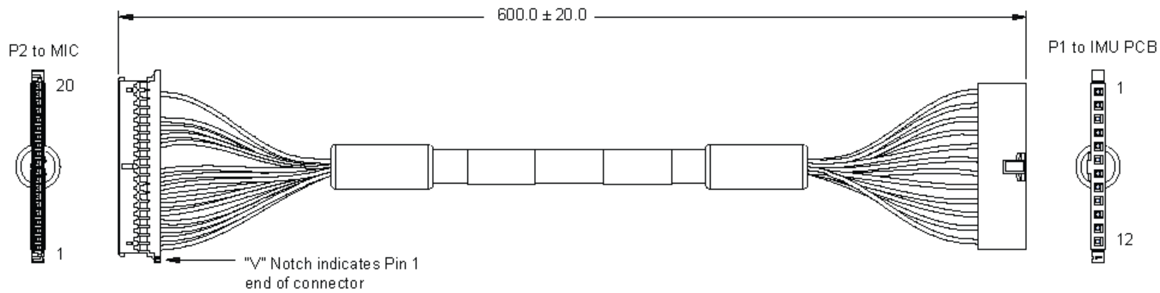


Table 31: HG1930 IMU-to-MIC Cable Assembly

P1 IMU Cable End (FCI-MINITEK)			P2 MIC Cable End	
Pin			Pin	Signal Name
1	Serial Data Cock+		15	Serial Clock Out+
2	Serial Data Clock-		16	Serial Clock Out-
3	Serial Data Out+		13	Serial Data In+
4	Serial Data Out-		14	Serial Data In-
5	5 VDC		8	IMU VDD
7	Ground		7	Ground
6	5 VDC		9	IMU VDD
8	Ground		10	Ground
11	+15 VDC		3	+15 V0
			4	+15 V0
12	Ground		6	Ground
			19	IMU Type indicator
9	-15 VDC		5	-15 V0
10	Chassis ground		1	Chassis ground
			2	Chassis ground

A.6.2 HG1700 and HG1900 IMU-to-MIC Cable Assembly

The NovAtel part number for the HG1700 and HG1900 IMU-to-MIC interface cable is 01018828 (*Figure 40* on *page 90*). This cable provides power to the IMU and enables communication between the MIC and the IMU.

Figure 40: HG1700 and HG1900 IMU-to-MIC Cable Assembly

Dimensions in millimetres

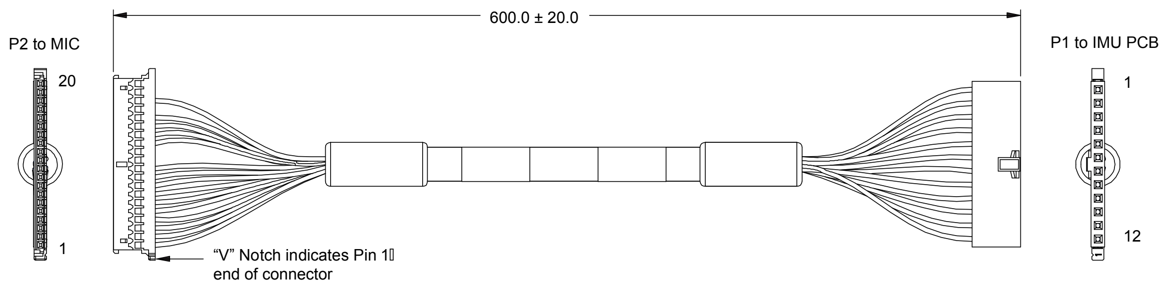


Table 32: HG1700 and HG1900 IMU-to-MIC Cable Assembly

P1 IMU Cable End (FCI-MINITEK)			P2 MIC Cable End	
Pin	**Signal Name**		**Pin**	**Signal Name**
1	Serial Data Clock+		15	Serial Clock Out+
2	Serial Data Clock-		16	Serial Clock Out-
3	Serial Data Out+		13	Serial Data In+
4	Serial Data Out-		14	Serial Data In-
5	5 VDC		8	IMU VDD
7	Ground		7	Ground
6	5 VDC		9	IMU VDD
8	Ground		10	Ground
11	+15 VDC		3	+15 V0
			4	+15 V0
12	Ground		6	Ground
			18	IMU Type Indicator
9	-15 VDC		5	-15 V0
10	Chassis ground		1	Chassis ground
			2	Chassis ground

A.6.3 MIC Electrical and Environmental

Table 33: MIC Electrical and Environmental Specifications

ELECTRICAL		
MIC Input Voltage	10 VDC-30 VDC	
Power Consumption[a]	+5 VDC @ 1 Amp for IMU +3.3 VDC @ 1 Amp for IMU +15 VDC @ 0.5 Amp for IMU -15 VDC @ 0.08 Amp for IMU +3.3 VDC @ 0.6 Amp for OEM628	
IMU Data Interfaces	UART and SDLC over RS-422	
ENVIRONMENTAL		
Temperature	Operating Storage	-40°C to +75°C (-40°F to 167°F) -55°C to +90°C (-67°F to 194°F)
VIBRATION		
Random Vibe	MIL-STD 810G (Cat 24, 7.7 g RMS)	
Sine Vibe	IEC 60068-2-6	
BUMP		
IEC 68-2-29 (25 g)		
SHOCK		
MIL-STD-810G (40 g)		

a. Sample system power consumption: 5.7 W when powering an HG1900 IMU and OEM628 receiver, in board stack configuration, from VIN=15 VDC at +25°C.

A.6.4 MIC Communication Ports

Table 34: MIC COM1 Port Specifications

INPUT/OUTPUT DATA INTERFACE—COM1	
Electrical format	LVTTL
Baud rates	115200
Signals supported	COM1_TX and COM1_RX

A.6.5 MIC Connectors

Table 35: MIC Connectors

Connector	Description
J301	20-pin OEM628 mating connectors
P101	3-pin locking power connector
P301	30-pin locking communication connector
P601	20-pin locking IMU connector

Table 36: MIC Pinouts (Power P101)

Pin	Signal	Type	Description	Comments
1	VIN+	Power	Power input	+10 VDC to +30 VDC
2	VIN-	Power	Power return	Connect to negative terminal of battery
3	GND	Power	Chassis ground	

Table 37: MIC Pinouts (IMU P601)

Pin	Signal	Type	Description	Comments
1	GND		Chassis ground	
2	GND		Chassis ground	
3	15V	Output Power	Positive 15 VDC supply	Enabled/disabled depending on the IMU type detected
4	15V	Output Power	Positive 15 VDC supply	Enabled/disabled depending on the IMU type detected
5	-15V	Output Power	Negative 15 VDC supply	Enabled/disabled depending on the IMU type detected
6	DGND		Digital ground	Enabled/disabled depending on the IMU type detected
7	DGND		Digital ground	Enabled/disabled depending on the IMU type detected
8	IMU VDD	Output Power	Positive voltage supply for IMU logic circuits	IMU_VDD can be +3.3 VDC or +5 VDC depending on the IMU type detected
9	IMU VDD	Output Power	Positive voltage supply for IMU logic circuits	
10	DGND	Power	Digital ground	
11	Tx Data+	Output	Serial data out+	Non-inverting
12	Tx Data-	Output	Serial data out-	Inverting
13	RX Data+	Input	Serial data in+	Non-inverting RS-422 data input
14	RX Data-	Input	Serial data in-	Inverting RS-422 data input
15	CLK+	Bidirectional	Serial data clock+	Non-inverting portion of RS-422 link
16	CLK-	Bidirectional	Serial data clock-	Inverting portion of RS-422 link
17	IMU DAS	Bidirectional	Data acquisition signal	Provides synchronization for IMU data (LVTTL level)
18	IMUTYPE0	Input	detect IMU type	LVTTL level, not 5V tolerant
19	IMUTYPE1	Input	detect IMU type	LVTTL level, not 5V tolerant
20	IMUTYPE2	Input	detect IMU type	LVTTL level, not 5V tolerant

Table 38: MIC Pinouts (User Interface P301)[a]

Pin	Signal	Type	Description	Comments
1	N/C			
2	N/C			
3	LED3	Output	Status LED 3 / Self-test	
4	LED2	Output	Status LED 2 / GPS Time Status	
5	DGND	Power	Digital ground	
6	LED1	Output	Status LED 1 / IMU Data Status	
7	Reserved	N/A	Leave as no connect	
8	DGND	Power	Digital ground	
9	Reserved	N/A	Leave as no connect	
10	Reserved	N/A	Leave as no connect	
11	N/C	N/A		
12	N/C	N/A		
13	USB D-	Bidirectional	USB interface data (-) / Access to OEM6 receiver	Only available in board stackup with OEM6 receiver In standalone, no connect
14	USB D+	Bidirectional	USB interface data (+) / Access to OEM6 receiver	Only available in board stackup with OEM6 receiver In standalone, no connect
15	RESETIN	Input	Access to OEM6 receiver reset in	Only available in board stackup with OEM6 receiver In standalone, no connect
16	VARF	Output	Access to OEM6 receiver varf	Only available in board stackup with OEM6 receiver In standalone, no connect
17	EVENT2	Input	Access to OEM6 receiver event 2	Only available in board stackup with OEM6 receiver In standalone, no connect
18	Reserved	N/A	Leave as no connect	
19	EVENT1	Input	Access to OEM6 receiver event 1	Only available in board stackup with OEM6 receiver In standalone, no connect
20	DGND	Power	Digital ground	
21	MIC TX	Output		In board stackup with OEM6 receiver, this pin is for firmware download In standalone use, this pin can be used for either firmware download and/or for IMU data communication to a SPAN receiver
22	MIC RX	Input		In board stackup with OEM6 receiver, this pin is for firmware download In standalone use, this pin can be used for either firmware download and/or for IMU data communication to a SPAN receiver
23	DGND	Power		

Table 38: MIC Pinouts (User Interface P301)[a]

Pin	Signal	Type	Description	Comments
24	USER_TXD2	Output		In board stackup with OEM6 receiver, this is the access to the OEM6 receiver COM2 port In standalone, no connect
25	USER_RXD2	Input		In board stackup with OEM6 receiver, this is the access to the OEM6 receiver COM2 port In standalone, no connect
26	DGND	Power	Digital ground	
27	PV	Output	Access to OEM6 receiver position valid	Only available in board stackup with OEM6 receiver In standalone, no connect
28	DGND	Power	Digital ground	
29	1PPS	Output	Access to OEM6 receiver 1PPS	Only available in board stackup with OEM6 receiver In standalone, no connect
30	Reserved	N/A	Leave as no connect	

a. All signal I/O with the exception of USB port are at LVTTL levels.

Table 39: MIC LED Indicator Drivers

Board State	Status LED 1	Status LED 2	Status LED 3
Bootup	Toggles at 2 Hz Self-test	Off	On
Normal Operation	On	Toggles at 2 Hz GPS Time	Toggles at 2 Hz IMU Data
No IMU Connected	Toggles t 1 Hz Error	Toggles at 2 Hz GPS Time	Toggles at 1 Hz Error

When the MIC boots up, it requires approximately 10 seconds to perform a self-test.

If a software update has been performed, the board can take up to 70 seconds at startup to complete the reprogramming.

Appendix B INS Commands

The INS-specific commands are described further in this chapter.

For information on other available commands, refer to the *OEM6 Family Firmware Reference Manual*.

B.1 Using a Command as a Log

All NovAtel commands may be used for data input, as normal, or used to request data output (a unique OEM6 Family feature). INS-specific commands may be in Abbreviated ASCII, ASCII or Binary format.

Consider the *lockout* command (refer to the *OEM6 Family Firmware Reference Manual*) with the syntax:

```
lockout prn
```

You can put this command into the receiver to de-weight an undesirable satellite in the solution, or you can use the *lockout* command as a log to see if there is a satellite PRN that has already been locked out. In ASCII, this might be:

```
log com1 lockouta once
```

Notice the 'a' after *lockout* to signify you are looking for ASCII output.

> The highest rate that you should request GNSS logs (RANGE, BESTPOS, RTKPOS, PSRPOS, and so on) while in INS operation is 5 Hz. If the receiver is not running INS (no IMU is attached), GNSS logs can be requested at rates up to 20 Hz depending on the software model.

> Ensure that all windows, other than the Console, are closed in Connect and then use the SAVECONFIG command to save settings in NVM. Otherwise, unnecessary data logging occurs and may overload your system.

B.2 INS-Specific Commands

Please refer to the *OEM6 Family Firmware Reference Manual* for a complete list of commands categorized by function and then detailed in alphabetical order.

B.2.1 ALIGNMENTMODE Set the Alignment Mode

Abbreviated ASCII Syntax: **Message ID: 1214**

```
ALIGNMENTMODE mode
```

Abbreviated ASCII Example:

```
ALIGNMENTMODE AIDED_TRANSFER
```

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively	-	H	0
2	mode	UNAIDED	0	Regular SPAN static coarse or kinematic alignment mode.	Enum	4	H
		AIDED_ STATIC	1	Seed the static coarse alignment with an initial azimuth.			
		AIDED_ TRANSFER	2	Seed the full attitude from an ALIGN solution. Pitch and Heading taken from ALIGN, Roll will be assumed 0.			
		AUTOMATIC (Default)	3	Seed the full attitude from ALIGN or perform a regular coarse or kinematic alignment, whichever is possible first.			

The default ALIGNMENTMODE is AUTOMATIC. In this mode, the first available method to align is used. If the receiver is in single antenna operation only the UNAIDED option is available.

Sending the ALIGNMENTMODE command manually will override the AUTOMATIC setting and allow a specific method to be used.

B.2.2 APPLYVEHICLEBODYROTATION Enable Vehicle to Body Rotation

Use this command to apply the vehicle to body rotation to the output attitude (that was entered using the VEHICLEBODYROTATION command, see *page 126*). This rotates the SPAN body frame output in the INSPVA, INSPVAS, INSATT, INSATTS and INSATTX logs to the vehicle frame. APPLYVEHICLEBODYROTATION is disabled by default.

Abbreviated ASCII Syntax: **Message ID: 1071**

```
APPLYVEHICLEBODYROTATION [switch]
```

Input Example:

```
APPLYVEHICLEBODYROTATION ENABLE
```

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	switch	Disable	0	Enable/disable vehicle body rotation using values entered in the vehiclebodyrotation command. The default value is Disable	Enum	4	H
		Enable	1				

B.2.3 ASYNCHINSLOGGING Enable Asynchronous INS Logs

Use this command to enable or disable the asynchronous INS logs (IMURATECORRIMUS and IMURATEPVAS).

> The asynchronous INS logs are highly advanced logs for users of SPAN on OEM6. The rate controls that limit the output of logs are not applicable to these logs, allowing the user to drive the idle time to zero.
>
> Users of the IMURATECORRIMUS or IMURATEPVAS logs should be limited to those who must have full rate INS solution data, or full rate corrected IMU data, without possible shifts in log time that are present in the synchronous version of these logs.
>
> The asynchronous INS logs are only available at the full rate of the IMU.

Abbreviated ASCII Syntax: **Message ID: 1363**

```
ASYNCHINSLOGGING [switch]
```

Abbreviated ASCII Example:

```
ASYNCHINSLOGGING ENABLE
```

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	Switch	ENABLE DISABLE		Enable or disable the asynchronous INS logs. The default value is DISABLE.	Enum	4	H

B.2.4 CONNECTIMU Connects an IMU to a port

This command specifies the type of IMU connected to the receiver and the receiver port used by that IMU.

Abbreviated ASCII Syntax: **Message ID: 1428**

```
CONNECTIMU IMUPort IMUType
```

Abbreviated ASCII Example:

```
CONNECTIMU COM2 IMU_LN200
```

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	IMUPort	See *Table 40*		IMU Port	Enum	4	H
3	IMUType	See *Table 41*		IMU Type	Enum	4	H+4

Table 40: COM Serial Port Identifiers

Binary	ASCII	Description
1	COM1	COM port 1
2	COM2	COM port 2
3	COM3	COM port 3

Table 41: IMU Type

Binary	ASCII	Description
0	IMU_UNKNOWN	Unknown IMU type (default)
1	IMU_HG1700_AG11	Honeywell HG1700 AG11
2-3	Reserved	
4	IMU_HG1700_AG17	Honeywell HG1700 AG17
5	IMU_HG1900_CA29	Honeywell HG1900 CA29
6-7	Reserved	
8	IMU_LN200	Litton LN-200 (200 Hz model)
9-10	Reserved	
11	IMU_HG1700_AG58	Honeywell HG1700 AG58
12	IMU_HG1700_AG62	Honeywell HG1700 AG62
13	IMU_IMAR_FSAS	iMAR iIMU-FSAS
14-15	Reserved	
16	IMU_KVH_COTS	IMU-CPT
17-18	Reserved	
19	IMU_LITEF_LCI1	Northrop Grumman Litef LCI-1
20	IMU_HG1930_AA99	Honeywell HG1930 AA99
21-26	Reserved	
27	IMU_HG1900_CA50	Honeywell HG1900 CA50
28	IMU_HG1930_CA50	Honeywell HG1930 CA50

B.2.5 FRESET Factory Reset

This command clears data that is stored in non-volatile memory. Such data includes the almanac, ephemeris and any user-specific configurations. The receiver is forced to hardware reset.

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

```
FRESET [target]
```

Input Example:

```
FRESET COMMAND
```

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	Target	See *Table 42*		What data is to be reset by the receiver.	Enum	4	H

Table 42: FRESET Target

Binary	ASCII	Description
0	STANDARD	Resets commands, ephemeris, and almanac (default). Also resets all OmniSTAR related data except for the subscription information.
1	COMMAND	Resets the stored commands (saved configuration)
2	GPSALMANAC	Resets the stored almanac
3	GPSEPHEM	Resets stored ephemeris
5	MODEL	Resets the currently selected model
11	CLKCALIBRATION	Resets the parameters entered using the CLOCKCALIBRATE command
20	SBASALMANAC	Resets the stored SBAS almanac
21	LAST_POSITION	Resets the position using the last stored position

B.2.6 HEAVEFILTER Enables or Disables Heave Filtering

This command enables or disables the filter used for heave processing.

Abbreviated ASCII Syntax: **Message ID: 1427**

```
HEAVEFILTER switch
```

Abbreviated ASCII Example:

```
HEAVEFILTER ENABLE
```

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	switch	DISABLE	0	Disables the Heave filter.	Enum	4	H
		ENABLE	1	Enables the Heave filter.			

B.2.7 INPUTGIMBALANGLE Input Gimbal Angles into the Receiver

Use this command to input information about the current mount gimbal angles. Gimbal angles are the angle from the current gimbal location to the locked mount frame. They are input in the mount body frame.

Abbreviated ASCII Syntax: **Message ID: 1317**

```
INPUTGIMBALANGLE XAngle YAngle ZAngle [XUncert][YUncert][ZUncert]
```

Abbreviated ASCII Examples:

```
INPUTGIMBALANGLE 0.003 -0.1234 12.837

INPUTGIMBALANGLE 0.003 -0.1234 12.837 0.001 0.001 0.005
```

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary.	-	H	0
2	XAngle	±180		Right hand rotation from mount to gimbal plane about mount body frame X axis in degrees.	Double	8	H
3	YAngle	±180		Right hand rotation from mount to gimbal plane about mount body frame Y axis in degrees.	Double	8	H+8
4	ZAngle	±180		Right hand rotation from mount to gimbal plane about mount body frame Z axis in degrees.	Double	8	H+16
4	XUncert	0 – 180		Uncertainty of X rotation in degrees. Default is 0	Double	8	H+24
5	YUncert	0 – 180		Uncertainty of Y rotation in degrees. Default is 0	Double	8	H+32
6	ZUncert	0 – 180		Uncertainty of Z rotation in degrees. Default is 0	Double	8	H+40

B.2.8 INSCOMMAND INS Control Command

Use this command to enable or disable INS positioning. When INS positioning is disabled, no INS position, velocity or attitude is output. Also, INS aiding of tracking reacquisition is disabled. If the command is used to disable INS and then re-enable it, the INS system has to go through its alignment procedure (equivalent to issuing a RESET command). See also *Section 3.3.1, System Start-Up and Alignment Techniques* starting on *page 41*.

Abbreviated ASCII Syntax: **Message ID: 379**

```
INSCOMMAND action
```

Abbreviated ASCII Example:

```
INSCOMMAND ENABLE
```

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	Action	RESET	0	Resets the GNSS/INS alignment and restarts the alignment initialization.	Enum	4	H
		DISABLE	1	Disables INS positioning.			
		ENABLE	2	Enables INS positioning where alignment initialization starts again. (default)			

B.2.9 INSZUPT Request Zero Velocity Update

Use this command to manually perform a Zero Velocity Update (ZUPT), that is, to update the receiver when the system has stopped.

NovAtel's SPAN Technology System does ZUPTs automatically. It is not necessary to use this command under normal circumstances.

This command should only be used by advanced users of GNSS/INS.

Abbreviated ASCII Syntax: **Message ID: 382**

```
INSZUPT
```

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	Reserved This parameter is optional when using abbreviated ASCII syntax.				BOOL	4	H

B.2.10 INSZUPTCONTROL INS Zero Velocity Update Control

Use this command to control whether ZUPTs are performed by the system.

When enabled, ZUPTs allow the INS to reduce its accumulated errors. Typically, the system will automatically detect when it is stationary, and apply a ZUPT. For certain applications where it is known that the system will never be stationary, such as marine or airborne applications, ZUPTs can be disabled altogether.

Abbreviated ASCII Syntax: **Message ID: 1293**

```
INSZUPTCONTROL switch
```

Abbreviated ASCII Example:

```
INSZUPTCONTROL DISABLE
```

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	Switch	DISABLE	0	Disable INS zero velocity updates.	Enum	4	H
		ENABLE	1	Enable INS zero velocity updates (default)			

B.2.11 INTERFACEMODE Set Interface Type for a Port

Use this command to specify what type of data a particular port on the receiver can transmit and receive. The receive type tells the receiver what type of data to accept on the specified port. The transmit type tells the receiver what kind of data it can generate. For INS operation, see *Section 2.3.2, SPAN IMU Configuration* starting on *page 34*.

As an example, you could set the receive type on a port to RTCA in order to accept RTCA differential corrections.

It is also possible to disable or enable the generation or transmission of command responses for a particular port. Disabling of responses is important for applications where data is required in a specific form and the introduction of extra bytes may cause problems, for example RTCA, RTCM, RTCMV3 or CMR. Disabling a port prompt is also useful when the port is connected to a modem or other device that will respond with data the receiver does not recognize.

When INTERFACEMODE *port* NONE NONE OFF is set, the specified port is disabled from interpreting any input or output data. Therefore, no commands or differential corrections are decoded by the specified port. Data can be passed through the disabled port and be output from an alternative port using the pass-through logs PASSCOM, PASSXCOM, PASSAUX and PASSUSB. Refer to the *OEM6 Family Firmware Reference Manual*, for information on pass-through logging and the COMCONFIG log.

Abbreviated ASCII Syntax: **Message ID: 3**

```
INTERFACEMODE [port] rxtype txtype [responses]
```

ASCII Example:

```
INTERFACEMODE COM1 RTCA NOVATEL ON
```

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	Port	See *Table 44, COM Serial Port Identifiers,* on *page 107*		Serial port identifier (default = THISPORT)	Enum	4	H
3	Rxtype	See *Table 43, Serial Port Interface Modes,* on *page 106*		Receive interface mode	Enum	4	H+4
4	Txtype			Transmit interface mode	Enum	4	H+8
5	Responses	OFF	0	Turn response generation off	Enum	4	H+12
		ON	1	Turn response generation on (default)			

Table 43: Serial Port Interface Modes

Binary Value	ASCII Mode Name	Description
0	NONE	The port accepts/generates nothing.
1	NOVATEL	The port accepts/generates NovAtel commands and logs.
2	RTCM	The port accepts/generates RTCM corrections.
3	RTCA	The port accepts/generates RTCA corrections.
4	CMR	The port accepts/generates CMR corrections.
5-6	Reserved	
7	IMU	This port supports communication with a NovAtel supported IMU.

Table 43: Serial Port Interface Modes

Binary Value	ASCII Mode Name	Description
8	RTCMNOCR	This port accepts/generates RTCM with no CR/LF appended. [a]
9-13	Reserved	
14	RTCMV3	The port accepts/generates RTCM Version 3.0 corrections.
15	NOVATELBINARY	The port only accepts/generates binary messages. If an ASCII command is entered when the mode is set to binary only, the command is ignored. Only properly formatted binary messages are responded to and the response is a binary message.
19	IMARIMU	This port supports communication with an iMAR IMU.
20-22	Reserved	
23	KVHIMU	This port supports communication with a KVH IMU.
24-27	Reserved	
28	LITEFIMU	This port supports communication with a Litef LCI-1 IMU.
29-30	Reserved	

a. An output interfacemode of RTCMNOCR is identical to RTCM but with the CR/LF appended. An input interfacemode of RTCMNOCR is identical to RTCM and functions with or without the CR/LF.

Table 44: COM Serial Port Identifiers

Binary	ASCII	Description
1	COM1	COM port 1
2	COM2	COM port 2
3	COM3	COM port 3
6	THISPORT	The current COM port
8	ALL	All COM ports
9	XCOM1 [a]	Virtual COM1 port
10	XCOM2 [a]	Virtual COM2 port
13	USB1 [b]	USB port 1
14	USB2 [b]	USB port 2
15	USB3 [b]	USB port 3
16	AUX	AUX port

a. The XCOM1 and XCOM2 identifiers are not available with the COM command but may be used with other commands. For example, INTERFACEMODE and LOG.

b. The only other field that applies when a USB port is selected is the echo field. Place holders must be inserted for all other fields to use the echo field in this case.

B.2.12 LEVERARMCALIBRATE INS Calibration Command

Use the LEVERARMCALIBRATE command to control the IMU to antenna lever arm calibration.

The IMU to antenna lever arm is the distance from the center of navigation of the IMU to the phase center of the antenna. For information about the IMU center of navigation, refer to the IMU drawings in *Appendix A, Technical Specifications* or the labels on the IMU enclosure. See also *Section B.2.20, SETIMUTOANTOFFSET Set IMU to Antenna Offset* on *page 118* and *Section 3.3.4, Lever Arm Calibration Routine* on *page 44*.

The calibration runs for the time specified or until the specified uncertainty is met. The BESTLEVERARM log outputs the lever arm INS_ALIGNMENT_COMPLETE once the calibration is complete, see also *Section C.2.3, BESTLEVERARM/BESTLEVERARM2 IMU to Antenna Lever Arm* on *page 135*.

> If a SETIMUANTENNAOFFSET command is already entered (or there is a previously saved lever arm in NVM), before the LEVERARMCALIBRATE is sent, the calibration starts using initial values from SETIMUTOANTOFFSET (or NVM). Ensure the initial standard deviations are representative of the initial lever arm values.

Abbreviated ASCII Syntax: **Message ID: 675**

```
LEVERARMCALIBRATE [switch] maxtime [maxstd]
```

Abbreviated ASCII Example 1:

```
LEVERARMCALIBRATE 600
```

Given this command, the lever arm calibration runs for 600 seconds. The final standard deviation of the estimated lever arm is output in the BESTLEVERARM log.

> The calibration starts when the SPAN solution reaches INS_ALIGNMENT_COMPLETE. The example's 600 second duration is from when calibration begins and not from when you issue the command.

Abbreviated ASCII Example 2:

```
LEVERARMCALIBRATE 600 0.05
```

Given this command, the lever arm calibration runs for 600 seconds or until the estimated lever arm standard deviation is <= 0.05 m in each direction (x, y, z), whichever happens first.

Abbreviated ASCII Example 3:

```
LEVERARMCALIBRATE OFF 0
```

This command stops the calibration. The current estimate, when the command was received, is output in the BESTLEVERARM log, and used in the SPAN computations.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	Switch	OFF	0	Enable or disable lever arm calibration.	Enum	4	H
		ON (default)	1				
3	Maxtime	0 - 1000		Maximum calibration time (s)	Double	8	H+4
4	Maxstd	0.02 – 0.5		Maximum offset uncertainty (m)	Double	8	H+12

B.2.13 NMEATALKER Set the NMEA Talker ID

This command allows you to alter the behavior of the NMEA talker ID. The talker is the first 2 characters after the $ sign in the log header of the GPGLL, GPGRS, GPGSA, GPGST, GPGSV, GPRMB, GPRMC and GPVTG log outputs. The other NMEA logs are not affected by the NMEATALKER command.

> The GPGGA position is always based on the position solution from the BESTPOS log which incorporate GNSS+INS solutions as well.

The default GPS NMEA message (`nmeatalker GP`) outputs GP as the talker ID regardless of the position type given in position logs such as BESTPOS. The `nmeatalker auto` command switches the talker ID between GP, GN and IN according to the position type given in position logs.

If nmeatalker is set to auto and there are both GPS and GLONASS satellites in the solution, two sentences with the GN talker ID are output. The first sentence contains information about the GPS satellites in the solution and the second sentence contains information about the GLONASS satellites in the solution.

If nmeatalker is set to auto and there are only GLONASS satellites in the solution, the talker ID of this message is GL.

Abbreviated ASCII Syntax: **Message ID: 861**

```
NMEATALKER [ID]
```

Factory Default:

```
nmeatalker gp
```

ASCII Example:

```
nmeatalker auto
```

> This command only affects NMEA logs that are capable of a GNSS position output. For example, GPGSV is for information on GNSS satellites and its output always uses the GP ID. *Table 45* shows the NMEA logs and whether they use GP/GN or GP/GN/IN IDs with `nmeatalker auto`.

Table 45: NMEA Talkers

Log	GLMLA	GPALM	GPGGA	GPGLL	GPGRS	GPGSA	GPGST	GPGSV	GPRMB	GPRMC	GPVTG	GPZDA
Talker IDs	GL	GP	GP	GP/GN/IN	GP/GN	GP/GN	GP/GN/IN	GP/GL	GP/GN/IN	GP/GN/IN	GP/GN/IN	GP

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	ID	GP	0	GPS (GP) only	Enum	4	H
		AUTO	1	GPS, Inertial (IN) and/or GLONASS			

B.2.14 RVBCALIBRATE Vehicle to Body Rotation Control

Use the RVBCALIBRATE command to enable or disable the calculation of the vehicle to SPAN body angular offset. This command should be entered when the IMU is re-mounted in the vehicle or if the rotation angles available are known to be incorrect.

> After the RVBCALIBRATE ENABLE command is entered, there are no vehicle-body rotation parameters present and a kinematic alignment is NOT possible. Therefore this command should only be entered after the system has performed either a static or kinematic alignment and has a valid INS solution.

A good INS solution and vehicle movement are required for the SPAN system to solve the vehicle-SPAN body offset. The solved vehicle-body rotation parameters are output in the VEHICLEBODYROTATION log when the calibration is complete, see *page 185*. When the calibration is done, the rotation values are fixed until the calibration is re-run by entering the RVBCALIBRATE command again.

> The solved rotation values are used only for a rough estimate of the angular offsets between the IMU and vehicle frames. The offsets are used when aligning the system while in motion (see *Section 3.3.1, System Start-Up and Alignment Techniques* starting on *page 41*). The angular offset values are not applied to the attitude output, unless the APPLYVEHICLEBODYROTATION command is disabled.

Abbreviated ASCII Syntax: **Message ID: 641**

```
RVBCALIBRATE reset
```

Abbreviated ASCII Example:

```
RVBCALIBRATE reset
```

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	Switch	RESET	0	Control the vehicle/body rotation computation	Enum	4	H
		DISABLE	1				
		ENABLE	2				

B.2.15 SETALIGNMENTVEL Set the Minimum Kinematic Alignment Velocity

Use the SETALIGNMENTVEL command to adjust the minimum required velocity for a kinematic alignment.

Useful in such cases as helicopters, where the alignment velocity should be increased to prevent a poor alignment at low speed.

Abbreviated ASCII Syntax: **Message ID: 1397**

```
SETALIGNMENTVEL [velocity]
```

Abbreviated ASCII Example

```
SETALIGNMENTVEL 5.0
```

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	Velocity	Minimum: 1.15 m/s (default)		The minimum velocity required to kinematically align.	Double	8	H

B.2.16 SETGIMBALORIENTATION Set the Gimbal Orientation

Use this command to convert Mount Body frame to Mount Computation frame for SPAN. This is done in the same manner as for the IMU. The mapping definitions for SETGIMBALORIENTATION are the same as they are for the SETIMUORIENTATION command. However, unlike an IMU, SPAN is not be able to auto-detect the orientation of the mount used, so this command must be sent to SPAN. If the command is not sent, SPAN will assume a default mapping of 5. If 5 is not the correct mapping, the SPAN system produces bad results.

Abbreviated ASCII Syntax: **Message ID: 1318**

```
SETGIMBALORIENTATION mapping
```

Abbreviated ASCII Example:

```
SETGIMBALORIENTATION 6
```

Field	Field Type	Value Range	Description	Format	Binary Bytes	Binary Offset
1	Header	–	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary	–	H	0
2	Mapping	1	Mount **X** axis is pointing **UP**	Double [a]	8	H
		2	Mount **X** axis is pointing **DOWN**			
		3	Mount **Y** axis is pointing **UP**			
		4	Mount **Y** axis is pointing **DOWN**			
		5	Mount **Z** axis is pointing **UP** (default)			
		6	Mount **Z** axis is pointing **DOWN**			

a. See *Table 46, Full Mapping Definitions,* on *page 116* for details

B.2.17 SETHEAVEWINDOW Set Heave Filter Length

Use this command to control the length of the heave filter. This filter determines the heave (vertical displacement) of the IMU, relative to a long–term level surface.

Abbreviated ASCII Syntax: **Message ID: 1383**

```
SETHEAVEWINDOW filterlength
```

Abbreviated ASCII Example

```
SETHEAVEWINDOW 35
```

Field	Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	Filter Length	Integer (1 – 300 s) (default = 20 s)		This filter length will be used in the heave filter. Typically, set the filter length to 5 x wave period	Int	4	H

B.2.18 SETIMUORIENTATION Set IMU Orientation

Use the SETIMUORIENTATION command to specify which of the IMU axis is aligned with gravity. The IMU orientation can be saved using the SAVECONFIG command so that on start-up, the SPAN system does not have to detect the orientation of the IMU with respect to gravity. This is particularly useful for situations where the receiver is powered while in motion.

1. The default IMU axis definitions are:
   Y - forward
   Z - up
   X - out the right hand side
   It is strongly recommended that you mount your IMU in this way with respect to the vehicle.
2. You only need to use this command if the system is to be aligned while in motion using the kinematic alignment routine, see *Section 3.3.1.2, Kinematic Alignment* on *page 42*.

Ensure that all windows, other than the Console, are closed in Connect and then use the SAVECONFIG command to save settings in NVM. Otherwise, unnecessary data logging occurs and may overload your system.

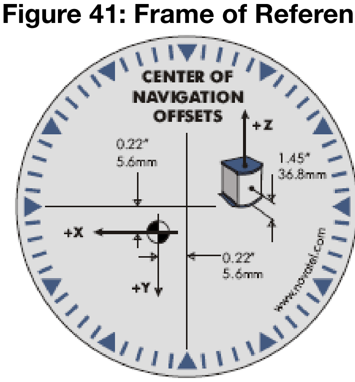
This orientation command serves to transform the incoming IMU signals in such a way that a 5 mapping is achieved, see *Table 46 on page 116*. For example, if the IMU is mounted with the X-axis pointing UP and a mapping of 1 is specified then this transformation of the raw IMU data is done:

X⇒Z, Y⇒X, Z⇒Y (where the default is X⇒X, Y⇒Y, Z⇒Z)

Notice that the X-axis observations are transformed into the Z axis, resulting in Z being aligned with gravity and a 5 mapping. The SPAN frame is defined so that Z is always pointing up along the gravity vector. If the IMU mapping is set to 1, the X axis of the IMU enclosure is mapped to the SPAN frame Z axis (pointing up), its Y axis to SPAN frame X and its Z axis to SPAN frame Y.

The X (pitch), Y (roll) and Z (azimuth) directions of the inertial enclosure frame are clearly marked on the IMU, see the IMU choices and their technical specifications starting on *page 64.* The example from the LN-200 is shown in *Figure 41*.

Figure 41: Frame of Reference



1. Azimuth is positive in a clockwise direction while yaw is positive in a counter-clockwise direction when looking down the axis center. Yaw follows the right-handed system convention where as azimuth follows the surveying convention.
2. The data in the RAWIMUSX log is never mapped. The axes referenced in the RAWIMUSX log description form the IMU enclosure frame (as marked on the enclosure).

Abbreviated ASCII Syntax: **Message ID: 567**

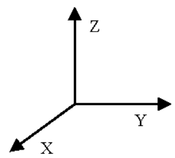
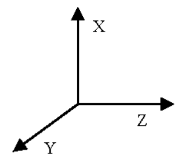
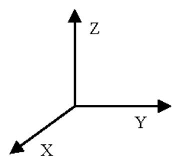
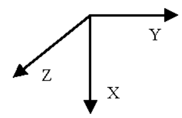
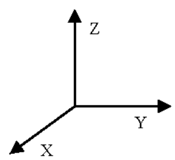
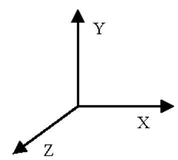
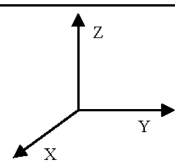
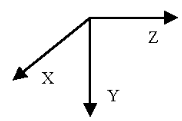
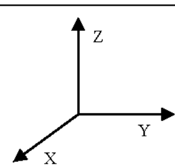
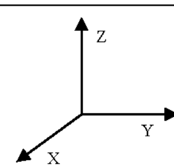
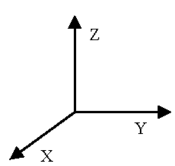
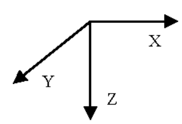
```
SETIMUORIENTATION switch
```

Abbreviated ASCII Example:

```
SETIMUORIENTATION 1
```

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	Switch	0	0	IMU determines axis orientation automatically during coarse alignment. (default)	Enum	4	H
		1	1	IMU **X** axis is pointing **UP**			
		2	2	IMU **X** axis is pointing **DOWN**			
		3	3	IMU **Y** axis is pointing **UP**			
		4	4	IMU **Y** axis is pointing **DOWN**			
		5	5	IMU **Z** axis is pointing **UP**			
		6	6	IMU **Z** axis is pointing **DOWN**			

Table 46: Full Mapping Definitions

Mapping	SPAN Frame Axes	SPAN Frame	IMU Enclosure Frame Axes	IMU Enclosure Frame
1	X		Y	
	Y		Z	
	Z		X	
2	X		Z	
	Y		Y	
	Z		-X	
3	X		Z	
	Y		X	
	Z		Y	
4	X		X	
	Y		Z	
	Z		-Y	
5 (default)	X		X	
	Y		Y	
	Z		Z	
6	X		Y	
	Y		X	
	Z		-Z	

B.2.19 SETIMUSPECS Specify Error Specifications and Data Rate

Use the SETIMUSPECS command to specify the error specifications and data rate for the desired IMU. If the default specs for the supported models are different than the unit used then this command can be used to override the default values.

This command is only available for the following IMUs:

- Honeywell HG1930 (default specifications are for the AA99/CA50 model)
- Honeywell HG1900 (default specifications are for the CA29/CA50 model)

Abbreviated ASCII Syntax: **Message ID: 1295**

```
SETIMUSPECS DataRate AccelBias AccelVRW GyroBias GyroARW
[AccelSFError] [GyroSFError] [DataLatency]
```

Abbreviated ASCII Example: (iMAR-FSAS Specs)

```
SETIMUSPECS 200 1 .0198 0.75 0.0028 300 300 2.5
```

Field	Field Type	Value Range	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	Header	-	H	0
2	Data Rate	100 Hz to 400 Hz	Data rate of the IMU	Ushort	2	H
3	Accel Bias	-	Total accelerometer bias in milli-g	Double	8	H+2
4	Accel VRW	-	Accelerometer velocity random walk in m/s/rt-hr	Double	8	H+10
5	Gyro Bias	-	Total gyroscope bias in deg/hr	Double	8	H+18
6	Gyro ARW	-	Gyroscope angular random walk in deg/rt-hr	Double	8	H+26
7	Accel Scale Factor Error	> 0	Accelerometer scale factor error in parts per million. Optional. Default = 1000 ppm.	Ulong	4	H+34
8	Gyro Scale Factor Error	> 0	Gyroscopic scale factor error in parts per million. Optional. Default = 1000 ppm.	Ulong	4	H+38
9	Data Latency	> 0	Time delay in milliseconds from the time of validity of the IMU data to the time the input pulse is received by the SPAN enabled receiver. This will include filtering delays, processing delays and transmission times. Optional. Default = 0.0.	Double	8	H+42
10	CRC	-	32-bit CRC	Hex	4	H+50

B.2.20 SETIMUTOANTOFFSET Set IMU to Antenna Offset

It is recommended that you mount the IMU as close as possible to the GNSS antenna, particularly in the horizontal plane. This command is used to enter the offset between the IMU and the GNSS antenna. The measurement should be done as accurately as possible, preferably to within millimeters especially for RTK operation. The x, y and z fields represent the vector from the IMU to the antenna phase center in the IMU enclosure frame. The a, b and c fields allow you to enter any possible errors in your measurements. If you think that your ‘x’ offset measurement is out by a centimeter for example, enter 0.01 in the ‘a’ field.

The X (pitch), Y (roll) and Z (azimuth) directions of the inertial frame are clearly marked on the IMU.

This command must be entered before or during the INS alignment mode (not after).

After changing the IMU to antenna offset, use the *SAVECONFIG* command to save the changes to non-volatile memory. For information about the *SAVECONFIG* command, see the *OEM6 Family Firmware Reference Manual*.

> If you are uncertain of the standard deviation values for the antenna offset, err on the side of a larger standard deviation.

Abbreviated ASCII Syntax: **Message ID: 383**

```
SETIMUTOANTOFFSET x y z [a] [b] [c]
```

Abbreviated ASCII Example:

```
SETIMUTOANTOFFSET 0.54 0.32 1.20 0.03 0.03 0.05
```

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	x	± 20		x offset (m)	Double	8	H
3	y	± 20		y offset (m)	Double	8	H+8
4	z	± 20		z offset (m)	Double	8	H+16
5	a	0 to +1		Uncertainty in x (m) (Defaults to 10% of the x offset to a minimum of 0.01 m)	Double	8	H+24
6	b	0 to +1		Uncertainty in y (m) (Defaults to 10% of the y offset to a minimum of 0.01 m)	Double	8	H+32
7	c	0 to +1		Uncertainty in z (m) (Defaults to 10% of the z offset to a minimum of 0.01 m)	Double	8	H+40

B.2.21 SETIMUTOANTOFFSET2 Set IMU to GNSS2 Antenna Offset

Use the SETIMUTOANTOFFSET2 command to set the lever arm for the secondary GNSS antenna. Preferable, the primary GNSS antenna will be setup behind the IMU forward axis and the secondary GNSS antenna will be set up ahead of the IMU forward axis. Entering both lever arms will automatically compute the angular offset between the ALIGN antennas and the IMU axes.

The format of this command is identical to the SETIMUTOANTOFFSET command.

Abbreviated ASCII Syntax: **Message ID: 1205**

```
SETIMUTOANTOFFSET2 x y z [a] [b] [c]
```

Abbreviated ASCII Example:

```
SETIMUTOANTOFFSET2 0.24 0.32 1.20 0.03 0.03 0.05
```

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	x	± 20		x offset (m)	Double	8	H
3	y	± 20		y offset (m)	Double	8	H+8
4	z	± 20		z offset (m)	Double	8	H+16
5	a	0 to +1		Uncertainty in x (m) (Defaults to 10% of the x offset to a minimum of 0.01 m)	Double	8	H+24
6	b	0 to +1		Uncertainty in y (m) (Defaults to 10% of the y offset to a minimum of 0.01 m)	Double	8	H+32
7	c	0 to +1		Uncertainty in z (m) (Defaults to 10% of the z offset to a minimum of 0.01 m)	Double	8	H+40

B.2.22 SETINITATTITUDE Set Initial Attitude of SPAN in Degrees

Use this command to input a known attitude to start SPAN operation, rather than the usual coarse alignment process. The caveats and special conditions of this command are listed below:

- This alignment is instantaneous based on the user input. This allows for faster system startup; however, the input values must be accurate or SPAN will not perform well.
- If you are uncertain about the standard deviation of the angles you are entering, err on the side of a larger standard deviation.
- Sending SETINITATTITUDE resets the SPAN filter. The alignment is instantaneous, but some time and vehicle dynamics are required for the SPAN filter to converge. Bridging performance is poor before filter convergence.
- The roll (about the y-axis), pitch (about the x-axis), and azimuth (about the z-axis) are with respect to the SPAN frame. If the IMU enclosure is mounted with the z axis pointing upwards, the SPAN frame is the same as the markings on the enclosure. If the IMU is mounted in another way, SPAN transforms the SPAN frame axes such that z points up for SPAN computations. You must enter the angles in SETINITATTITUDE with respect to the transformed axis. See SETIMUORIENTATION for a description of the axes mapping that occurs when the IMU is mounted differently from z up.

1. Azimuth is positive in a clockwise direction when looking towards the z-axis origin.
2. You do not have to use the SETIMUORIENTATION command, unless you have your IMU mounted with the z axis not pointing up. Then use the tables in *Section B.2.18, SETIMUORIENTATION Set IMU Orientation* on *page 114*, to determine the azimuth axis that SPAN is using.

Abbreviated ASCII Syntax: **Message ID: 862**

```
SETINITATTITUDE pitch roll azimuth pitchSTD rollSTD azSTD
```

Abbreviated ASCII Example:

```
SETINITATTITUDE 0 0 90 5 5 5
```

In this example, the initial roll and pitch has been set to zero degrees, with a standard deviation of 5 degrees for both. This means that the SPAN system is very close to level with respect to the local gravity field. The azimuth is 90 degrees, also with a 5 degrees standard deviation.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	Pitch	-360° to +360°		Input pitch angle, about the x-axis, in degrees	Double	8	H
3	Roll	-360° to +360°		Input roll angle, about the y-axis, in degrees	Double	8	H+8
4	Azimuth	-360° to +360°		Input azimuth angle, about the z-axis, in degrees	Double	8	H+16
5	PitchSTD	0.000278°[a] to 180°		Input pitch standard deviation (STD) angle in degrees	Double	8	H+24
6	RollSTD			Input roll STD angle in degrees	Double	8	H+32
7	AzSTD			Input azimuth STD angle in degrees	Double	8	H+40

a. 0.000278° is equal to 1 arc second.

B.2.23 SETINSOFFSET Set INS Offset

Use the SETINSOFFSET command to specify an offset from the IMU for the output position and velocity of the INS solution. This command shifts the position and velocity in the INSPOS, INSPOSS, INSPOSX, INSVEL, INSVELS, INSVELX, INSSPD, INSSPDS, INSPVA and INSPVAS logs by the amount specified in metres with respect to the IMU enclosure frame axis.

Abbreviated ASCII Syntax: **Message ID: 676**

```
SETINSOFFSET xoffset yoffset zoffset
```

Abbreviated ASCII Example:

```
SETINSOFFSET 0.15 0.15 0.25
```

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	X offset	± 100		Offset along the IMU enclosure frame X axis (m)	Double	8	H
3	Y offset	± 100		Offset along the IMU enclosure frame Y axis (m)	Double	8	H+8
4	Z offset	± 100		Offset along the IMU enclosure frame Z axis (m)	Double	8	H+16

B.2.24 SETMARK1OFFSET Set Mark1 Offset

Set the offset to the Mark1 trigger event.

Abbreviated ASCII Syntax: **Message ID: 1069**

```
SETMARK1OFFSET xoffset yoffset zoffset αoffset βoffset γoffset
```

Abbreviated ASCII Example:

```
SETMARK1OFFSET -0.324 0.106 1.325 0 0 0
```

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	x offset	± 360		Offset along the IMU enclosure frame X axis (m) for Mark1	Double	8	H
3	y offset	± 360		Offset along the IMU enclosure frame Y axis (m) for Mark1	Double	8	H+8
4	z offset	± 360		Offset along the IMU enclosure frame Z axis (m) for Mark1	Double	8	H+16
5	αoffset	± 360		Roll offset for Mark1 (degrees)	Double	8	H+24
6	βoffset	± 360		Pitch offset for Mark1 (degrees)	Double	8	H+32
7	γoffset	± 360		Azimuth offset for Mark1 (degrees)	Double	8	H+40

B.2.25 SETMARK2OFFSET Set Mark2 Offset

Set the offset to the Mark2 trigger event.

Abbreviated ASCII Syntax: **Message ID: 1070**

```
SETMARK2OFFSET xoffset yoffset zoffset αoffset βoffset γoffset
```

Abbreviated ASCII Example:

```
SETMARK2OFFSET -0.324 0.106 1.325 0 0 0
```

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	x offset	± 360		Offset along the IMU enclosure frame X axis (m) for Mark2	Double	8	H
3	y offset	± 360		Offset along the IMU enclosure frame Y axis (m) for Mark2	Double	8	H+8
4	z offset	± 360		Offset along the IMU enclosure frame Z axis (m) for Mark2	Double	8	H+16
5	αoffset	± 360		Roll offset for Mark2 (degrees)	Double	8	H+24
6	βoffset	± 360		Pitch offset for Mark2 (degrees)	Double	8	H+32
7	γoffset	± 360		Azimuth offset for Mark2 (degrees)	Double	8	H+40

B.2.26 SETWHEELPARAMETERS Set Wheel Parameters

The SETWHEELPARAMETERS command can be used when wheel sensor data is available. It allows you to give the filter a good starting point for the wheel size scale factor. It also gives the SPAN filter an indication of the expected accuracy of the wheel data.

Usage of the SETWHEELPARAMETERS command depends on whether you use an external wheel sensor or the iMAR iMWS wheel parameters:

1. If you have integrated an external wheel sensor, the SETWHEELPARAMETERS command can be used to override the number of ticks per revolution given in the WHEELVELOCITY command. In addition, this command supplies the resolution of the wheel sensor, which allows the filter to weight the wheel sensor data appropriately.
2. If you are using the iMAR iMWS (Magnetic Wheel Speed Sensor and Convertor), the SETWHEELPARAMETERS command allows you to set the number of ticks per revolution that is correct for your wheel installation (the default is 58). Refer to the iMAR iMWS documentation for tick spacing specifications.

Abbreviated ASCII Syntax: **Message ID: 847**

```
SETWHEELPARAMETERS ticks circ spacing
```

Abbreviated ASCII Example:

```
SETWHEELPARAMETERS 58 1.96 0.025
```

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	Ticks	1-10 000		Number of ticks per revolution	Ushort	4[a]	H
3	Circ	0.1-100		Wheel circumference (m) (default = 1.96 m)	Double	8	H+4
4	Spacing	0.001-1000		Spacing of ticks, or resolution of the wheel sensor (m)	Double	8	H+12

a. In the binary log case, an additional 2 bytes of padding are added to maintain 4-byte alignment.

> Fields 2, 3 and 4 do not have to ‘add up’. Field 4 is used to weight the wheel sensor measurement. Fields 2 and 3 are used with the estimated scale factor to determine the distance travelled.

B.2.27 TAGNEXTMARK

TAGNEXTMARK tags the next incoming mark event on the selected mark with a 32-bit number. This will be available in the TAGGEDMARKxPVA log to easily associate the PVA log with a supplied event.

Abbreviated ASCII Syntax: **Message ID: 1257**

```
TAGNEXTMARK Mark Tag
```

Abbreviated ASCII Example:

```
TAGNEXTMARK MARK1 1234
```

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	Mark	MARK1 or MARK2	Mark1=0 Mark2=1	Event line	Enum	4	H
3	Tag	-	-	Tag for next mark event	Ulong	4	H+4

B.2.28 VEHICLEBODYROTATION Vehicle to SPAN frame Rotation

Use the VEHICLEBODYROTATION command to set angular offsets between the vehicle frame (direction of travel) and the SPAN body frame (direction that the IMU computational frame is pointing). If you estimate the angular offsets using the RVBCALIBRATE command, the VEHICLEBODYROTATION command values are used as the initial values. The uncertainty values are optional (defaults = 0.0). Please see *Section 3.3.5, Vehicle to SPAN Frame Angular Offsets Calibration Routine* starting on *page 45* for more details. For more information on reference frames, see *Section 3.1, Definition of Reference Frames Within SPAN* starting on *page 36*. RVBCALIBRATE command information is on *page 110*.

> The body frame is nominally the frame as marked on the IMU enclosure. If you do not mount the IMU with the z-axis approximately up, you must check the new computational axis orientation that SPAN automatically uses, which is called the SPAN computational frame. SPAN forces z to be up in the SPAN computational frame. Output attitude (in INSPVA, INSATT, INSATTX, and so on) is with respect to the SPAN computational frame. Refer to the SETIMUORIENTATION command description to see what mapping definition applies, depending on which IMU axis most closely aligns to gravity. Essentially, this means that if you do not mount the IMU with the z-axis approximately up (as marked on the enclosure); you have a new IMU frame that defines what mapping applies. This new computational frame will not match what is marked on the IMU enclosure and will need to be determined by checking the Full Mapping Definition table documented with the SETIMUORIENTATION command. Also, in this case, begin with the SPAN computational frame aligned with the vehicle frame and record the rotations required to move from the vehicle frame to the SPAN computational frame orientation. The first rotation is around the z -axis of the vehicle frame, the second is about the x-axis of the vehicle frame, and the third and final rotation is about the y-axis of the vehicle frame.
>
> With the default mapping and with no angular offset between the vehicle frame and SPAN computational frame, the output roll is the angle of rotation about the y-axis, the output pitch is about the x-axis, and the output azimuth is about the z-axis and is measured to the y-axis. Note that azimuth is positive in the clockwise direction when looking towards the origin. However, the input vehicle to body rotation about the z-axis follows the right hand rule convention and a positive rotation is in the counterclockwise direction when looking towards the origin.
>
> For further information about extracting the vehicle's attitude with respect to the local level frame, refer to NovAtel application note *APN-037 Application Note on Vehicle Body Rotations*, available from the NovAtel Web site at www.novatel.com through *Support* | *Knowledge and Learning*.

The rotation values are used during kinematic alignment. The rotation is used to transform the vehicle frame attitude estimates from GNSS into the SPAN frame of the IMU during the kinematic alignment. If you use the APPLYVEHICLEBODYROTATION command on *page 97*, the reported attitude in INSPVA, INSATT or INSATTX will be in the vehicle frame; otherwise, the reported attitude will be in the SPAN frame. The uncertainty values report the accuracy of the angular offsets.

The VEHICLEBODYROTATION command sets the initial estimates for the angular offset. The uncertainty values are optional.

Follow these steps:

1. Start with IMU enclosure in the vehicle frame as described above.
2. Rotate about the vehicle Z-axis. This angle is the gamma-angle in the command and follows the right-hand rule for sign correction.
3. Rotate about the new X-axis to complete the transformation into the vehicle frame. This angle is the alpha-angle in the command.
4. Finally, rotate about the new Y-axis to align the X-Y plane with the vehicle frame. This angle is the beta-angle in the command.

> Enter rotation angles in degrees. We recommend entering SETIMUORIENTATION first then VEHICLEBODYROTATION.

To apply the vehicle to body rotation angles, the APPLYVEHICLEBODYROTATION command needs to be enabled, please refer to *Section B.2.2, APPLYVEHICLEBODYROTATION Enable Vehicle to Body Rotation* starting on *page 97*.

Abbreviated ASCII Syntax: **Message ID: 642**

```
VEHICLEBODYROTATION alpha beta gamma [δalpha] [δbeta] [δgamma]
```

Abbreviated ASCII Example:

```
VEHICLEBODYROTATION 0 0 90 0 0 5
```

Field	Field Type	Description	Format	Binary Bytes	Binary Offset
1	Header	header	-	H	0
2	X Angle	Right hand rotation about vehicle frame X axis, degrees	Double	8	H
3	Y Angle	Right hand rotation about vehicle frame Y axis, degrees	Double	8	H+8
4	Z Angle	Right hand rotation about vehicle frame Z axis, degrees	Double	8	H+16
5	X Uncertainty	Uncertainty of X rotation, degrees (default = 0)	Double	8	H+24
6	Y Uncertainty	Uncertainty of Y rotation, degrees (default = 0)	Double	8	H+32
7	Z Uncertainty	Uncertainty of Z rotation, degrees (default = 0)	Double	8	H+40
8	xxxx	32-bit CRC	Hex	4	H+48
9	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

Refer also to our application note *APN-037 Vehicle to Body Rotations* available on our Web site at www.novatel.com through *Support | Knowledge and Learning*.

B.2.29 WHEELVELOCITY Wheel Velocity for INS Augmentation

The WHEELVELOCITY command is used to input wheel sensor data into the OEM6 receiver.

Abbreviated ASCII Syntax: **Message ID: 504**

```
WHEELVELOCITY latency ticks/rev wheelvel Rsrvd fwheelvel Rsrvd Rsrvd
ticks/s
```

Abbreviated ASCII Example:

```
WHEELVELOCITY 123 8 10 0 0 0 0 40

WHEELVELOCITY 123 8 10 0 0 0 0 80

WHEELVELOCITY 123 8 10 0 0 0 0 120
```

The above are for a vehicle traveling at a constant velocity with these wheel sensor characteristics:

Wheel Circumference = 2 m

Vehicle Velocity (assumed constant for this example) = 10 m/s

Ticks Per Revolution = 8

Cumulative Ticks Per Second = (10 m/s)*(8 ticks/rev)/(2 m/rev) = 40

Latency between 1PPS and measurement from wheel sensor hardware = 123 ms

1. The ticks per second do not need to be computed as shown in the example above. If your hardware provides the tick count directly, it is not necessary to compute wheel velocity.
2. The wheel velocities in Fields #4 and #6 are not currently used in the SPAN filter. In Inertial Explorer post-processing, wheel velocities may be used. If you wish to use wheel velocities in post-processing, fill Fields #4 and #6 with meaningful values, otherwise, leave as zeroes.

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	Latency			A measure of the latency in the velocity time tag in ms.	Ushort	2	H
3	Ticks/rev			Number of ticks per revolution	Ushort	2	H+2
4	Wheelvel			Short wheel velocity in ticks/s	Ushort	2	H+4
5	Reserved				Ushort	2	H+6
6	Fwheelvel			Float wheel velocity in ticks/s	Float	4	H+8
7	Reserved				Ulong	4	H+12
8					Ulong	4	H+16
9	Ticks/s			Cumulative number of ticks/s	Ulong	4	H+20

Refer also to our application note *APN-036 Using a Wheel Sensor with SPAN,* available on our Web site at www.novatel.com through *Support | Knowledge and Learning*.

Appendix C INS Logs

The INS-specific logs follow the same general logging scheme as normal OEM6 Family logs. They are available in ASCII or binary formats and are defined as being either synchronous or asynchronous. All the logs in this chapter can be used only with the SPAN system.

For information on other available logs and output logging, please refer to the *OEM6 Family Firmware Reference Manual*.

One difference from the standard OEM6 Family logs is that there are two possible headers for the ASCII and binary versions of the logs. Which header is used for a given log is described in the log definitions in this chapter. The reason for having the alternate short headers is that the normal OEM6 binary header is quite long at 28 bytes. This is nearly as long as the data portion of many of the INS logs, and creates excess storage and baud rate requirements. Note that the INS-related logs contain a time tag within the data block in addition to the time tag in the header. The time tag in the data block should be considered the exact time of applicability of the data. All the described INS logs except the INSCOV, INSPOSSYNC, and INSUPDATE can be obtained at rates up to 100 or 200 Hz depending on your IMU, subject to the limits of the output baud rate. The covariance log is available once per second.

1. Each log ends with a hexadecimal number preceded by an asterisk and followed by a line termination using the carriage return and line feed characters, for example, `*1234ABCD[CR][LF]`. This value is a 32-bit CRC of all bytes in the log, excluding the '#' or '%' identifier and the asterisk preceding the four checksum digits. See also *Section C.1, Description of ASCII and Binary Logs with Short Headers* on *page 129*.
2. The highest rate that you should request GNSS logs (RANGE, BESTPOS, RTKPOS, PSRPOS, and so on) while in INS operation is 5 Hz. If the receiver is not running INS (no IMU is attached), GNSS logs can be requested at rates up to 20 Hz.

Please also refer to the *OEM6 Family Firmware Reference Manual* for information on the supplied Convert4 program that lets you change binary to ASCII data, or short binary to short ASCII data, and vice versa. Convert4 is also capable of RINEX conversions to and from ASCII or binary.

Table 7, Inertial Solution Status on *page 41* shows the status values included in the INS position, velocity and attitude output logs. If you think you have an IMU unit hooked up properly and you are not getting a good status value, something is wrong and the hardware setup must be checked out. This situation can be recognized in the RAWIMU data by observing accelerometer and gyro values which are not changing with time.

Use a USB cable to log raw data. Serial communication is acceptable for configuring and monitoring the SPAN system through Hyperterminal or NovAtel Connect. USB is required if you have a post-processing application requiring 200 Hz IMU data. We also recommend you use NovAtel Connect to collect the data.

C.1 Description of ASCII and Binary Logs with Short Headers

These logs are set up in the same way normal ASCII or binary logs are, except that a normal ASCII or binary header is replaced with a short header (see *Tables 47 and 48*). For the message header structure of OEM6 regular Binary and ASCII logs, please refer to the *OEM6 Family Firmware Reference Manual*.

Table 47: Short ASCII Message Header Structure

Field #	Field Type	Field Type	Description
1	%	Char	% symbol
2	Message	Char	This is the name of the log
3	Week Number	Ushort	GNSS week number
4	Milliseconds	Ulong	Milliseconds from the beginning of the GNSS week

Table 48: Short Binary Message Header Structure

Field #	Field Type	Field Type	Description	Binary Bytes	Binary Offset
1	Synch	Char	Hex 0xAA	1	0
2	Synch	Char	Hex 0x44	1	1
3	Synch	Char	Hex 0x13	1	2
4	Message Length	Uchar	Message length, not including header or CRC	1	3
5	Message ID	Ushort	Message ID number	2	4
6	Week Number	Ushort	GNSS week number	2	6
7	Milliseconds	Ulong	Milliseconds from the beginning of the GNSS week	4	8

The periods available when you use the ONTIME trigger are 0.005 (200Hz), 0.01 (100Hz), 0.02 (50 Hz), 0.05, 0.1, 0.2, 0.25, 0.5, 1, and any integer number of seconds.

C.2 INS-Specific Logs

The receivers are capable of generating many NovAtel-format output logs, in either Abbreviated ASCII, ASCII or binary format. Please refer to the *OEM6 Family Firmware Reference Manual* for a complete list of logs categorized by function and then detailed in alphabetical order.

INS-specific commands and logs provide attitude data such as roll, pitch and azimuth.

Logging Restriction Important Notice

Logging excessive amounts of high rate data can overload the system. When configuring the output for SPAN, NovAtel recommends that only one high rate (>50Hz) message be configured for output at a time. It is possible to log more than one message at high rates, but doing so could have negative impacts on the system. Also, if logging 100/200Hz data, always use the binary format.

For optimal performance, log only one high rate output at a time. These logs could be:

- Raw data for post processing
  RAWIMUXSB ONNEW (100 or 200Hz depending on IMU)
  - RAWIMU logs are not valid with the ONTIME trigger. The raw IMU observations contained in these logs are sequential changes in velocity and rotation. As such, you can only use them for navigation if they are logged at their full rate. See details of these logs starting on *page 176*.
- Real time INS solution
  INSPVASB ONTIME 0.01 or 0.005 (maximum rate equals the IMU rate)
  - Other possible INS solution logs available at high rates are: INSPOSSB, INSVELSB, INSATTSB

C.2.1 BESTGNSSPOS Best GNSS Position

This log contains the best available GNSS position (without INS) computed by the receiver. In addition, it reports several status indicators, including differential age, which is useful in predicting anomalous behavior brought about by outages in differential corrections. A differential age of 0 indicates that no differential correction was used.

With the system operating in an RTK mode, this log reflects the latest low-latency solution for up to 60 seconds after reception of the last base station observations. After this 60 second period, the position reverts to the best solution available; the degradation in accuracy is reflected in the standard deviation fields. If the system is not operating in an RTK mode, pseudo range differential solutions continue for the time specified in the DGPSTIMEOUT command, refer to the *OEM6 Family Firmware Reference Manual.*

Message ID: **1429**

Log Type: **Synch**

Recommended Input:

```
log bestgnssposa ontime 1
```

ASCII Example:

```
#BESTGNSSPOSA,COM1,0,92.5,FINESTEERING,1692,332119.000,00000000,8505,43521;
SOL_COMPUTED,SINGLE,51.11635530655,-114.03819448382,1064.6283,-16.9000,WGS84,1.2612,
0.9535,2.7421,"",0.000,0.000,11,11,11,11,0,06,00,03*52d3f7c0
```

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	header	Log header	-	H	0
2	Sol Status	Solution status, see *Table 49* on *page 132*	Enum	4	H
3	Pos Type	Position type, see *Table 50 on page 132*	Enum	4	H+4
4	Lat	Latitude	Double	8	H+8
5	Lon	Longitude	Double	8	H+16
6	Hgt	Height above mean sea level	Double	8	H+24
7	Undulation	Undulation	Float	4	H+32
8	Datum ID	Datum ID (refer to the DATUM command in the *OEM6 Family Firmware Reference Manual*)	Enum	4	H+36
9	Lat s	Latitude standard deviation	Float	4	H+40
10	Lon s	Longitude standard deviation	Float	4	H+44
11	Hgt s	Height standard deviation	Float	4	H+48
12	Stn ID	Base station ID	Char[4]	4	H+52
13	Diff_age	Differential age	Float	4	H+56
14	Sol_age	Solution age in seconds	Float	4	H+60
15	#obs	Number of observations tracked	Uchar	1	H+64
16	#solnSVs	Number of satellite solutions used in solution	Uchar	1	H+65
17	#L1	Number of GPS and GLONASS L1 ranges above the RTK mask angle	Uchar	1	H+66
18	#L2	Number of GPS and GLONASS L2 ranges above the RTK mask angle	Uchar	1	H+67
19	Reserved		Uchar	1	H+68
20			Uchar	1	H+69
21			Uchar	1	H+70
22			Uchar	1	H+71
23	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+72
24	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Table 49: Solution Status

Binary	ASCII	Description
0	SOL_COMPUTED	Solution computed
1	INSUFFICIENT_OBS	Insufficient observations
2	NO_CONVERGENCE	No convergence
3	SINGULARITY	Singularity at parameters matrix
4	COV_TRACE	Covariance trace exceeds maximum (trace > 1000 m)
5	TEST_DIST	Test distance exceeded (maximum of 3 rejections if distance > 10 km)
6	COLD_START	Not yet converged from cold start
7	V_H_LIMIT	Height or velocity limits exceeded (in accordance with COCOM export licensing restrictions)
8	VARIANCE	Variance exceeds limits
9	RESIDUALS	Residuals are too large
10	DELTA_POS	Delta position is too large
11	NEGATIVE_VAR	Negative variance
12-17	Reserved	
18	PENDING	When a FIX POSITION command is entered, the receiver computes its own position and determines if the fixed position is valid. [a]
19	INVALID_FIX	The fixed position, entered using the FIX POSITION command, is not valid.

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

Table 50: Position or Velocity Type

Position Type (binary)	Position Type (ASCII)	Description
0	NONE	No solution
1	FIXEDPOS	Position has been fixed by the FIX POSITION command or by position averaging
2	FIXEDHEIGHT	Position has been fixed by the FIX HEIGHT, or FIX AUTO, command or by position averaging
3	Reserved	
4	FLOATCONV	Solution from floating point carrier phase ambiguities
5	WIDELANE	Solution from wide-lane ambiguities
6	NARROWLANE	Solution from narrow-lane ambiguities
7	Reserved	
8	DOPPLER_VELOCITY	Velocity computed using instantaneous Doppler
9-15	Reserved	
16	SINGLE	Single point position
17	PSRDIFF	Pseudorange differential solution
18	WAAS	Solution calculated using corrections from an SBAS
19	PROPOGATED	Propagated by a Kalman filter without new observations
20	OMNISTAR	OmniSTAR VBS position (L1 sub-meter) [a]
21-31	Reserved	
32	L1_FLOAT	Floating L1 ambiguity solution

Position Type (binary)	Position Type (ASCII)	Description
33	IONOFREE_FLOAT	Floating ionospheric-free ambiguity solution
34	NARROW_FLOAT	Floating narrow-lane ambiguity solution
48	L1_INT	Integer L1 ambiguity solution
49	WIDE_INT	Integer wide-lane ambiguity solution
50	NARROW_INT	Integer narrow-lane ambiguity solution
51	RTK_DIRECT_INS	RTK status where the RTK filter is directly initialized from the INS filter. [b]
52	INS_SBAS	INS calculated position corrected for the antenna [b]
53	INS_PSRSP	INS pseudorange single point solution - no DGPS corrections [b]
54	INS_PSRDIFF	INS pseudorange differential solution [b]
55	INS_RTKFLOAT	INS RTK floating point ambiguities solution [b]
56	INS_RTKFIXED	INS RTK fixed ambiguities solution [b]
57	INS_OMNISTAR	INS OmniSTAR VBS position (L1 sub-meter) [a]
58	INS_OMNISTAR_HP	INS OmniSTAR high precision solution [a]
59	INS_OMNISTAR_XP	INS OmniSTAR extra precision solution [a]
64	OMNISTAR_HP	OmniSTAR high precision [a]
65	OMNISTAR_XP	OmniSTAR extra precision [a]

a. In addition to a NovAtel receiver with L-band capability, a subscription to the OmniSTAR service is required. Contact NovAtel for details.

b. These types appear in position logs such as BESTPOS.

Table 51: Signal-Used Mask

Bit	Mask	Description
0	0x01	GPS L1 used in Solution
1	0x02	GPS L2 used in Solution
2	0x04	GPS L5 used in Solution
3	0x08	Reserved
4	0x10	GLONASS L1 used in Solution
5	0x20	GLONASS L2 used in Solution
6-7	0x40-0x80	Reserved

Table 52: Extended Solution Status

Bit	Mask	Description
0	0x01	AdVance RTK Verified 0: Not Verified 1: Verified
1-3	0x0E	Pseudorange Iono Correction 0: Unknown[a] 1: Klobuchar Broadcast 2: SBAS Broadcast 3: Multi-frequency Computed 4: PSRDiff Correction 5: NovAtel Blended Iono value
4-7	0xF0	Reserved

a. Unknown can indicate that the Iono Correction type is None or that the default Klobuchar parameters are being used.

C.2.2 BESTGNSSVEL Best Available GNSS Velocity Data

This log contains the best available GNSS velocity information (without INS) computed by the receiver. In addition, it reports a velocity status indicator, which is useful in indicating whether or not the corresponding data is valid. The velocity measurements sometimes have a latency associated with them. The time of validity is the time tag in the log minus the latency value.

The velocity is typically computed from the average change in pseudorange over the time interval or the RTK Low Latency filter. As such, it is an average velocity based on the time difference between successive position computations and not an instantaneous velocity at the BESTGNSSVEL time tag. The velocity latency to be subtracted from the time tag is normally 1/2 the time between filter updates. Under default operation, the positioning filters are updated at a rate of 2 Hz. This translates into a velocity latency of 0.25 second. The latency can be reduced by increasing the update rate of the positioning filter being used by requesting the BESTGNSSVEL or BESTGNSSPOS messages at a rate higher than 2 Hz. For example, a logging rate of 10 Hz would reduce the velocity latency to 0.005 seconds. For integration purposes, the velocity latency should be applied to the record time tag.

A valid solution with a latency of 0.0 indicates that the instantaneous Doppler measurement was used to calculate velocity.

Message ID: **1430**
Log Type: **Synch**

Recommended Input:

```
log bestgnssvela ontime 1
```

ASCII Example:

```
#BESTGNSSVELA,COM1,0,91.5,FINESTEERING,1692,332217.000,00000000,00b0,43521;
SOL_COMPUTED,DOPPLER_VELOCITY,0.150,0.000,0.0168,323.193320,0.0232,0.0*159c13ad
```

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	header	Log header	-	H	0
2	Sol Status	Solution status, see *Table 49, Solution Status* on *page 132*	Enum	4	H
3	Vel Type	Velocity type, see *Table 50, Position or Velocity Type* on *page 132*	Enum	4	H+4
4	Latency	A measure of the latency in the velocity time tag in seconds. It should be subtracted from the time to give improved results.	Float	4	H+8
5	Age	Differential age	Float	4	H+12
6	Hor Spd	Horizontal speed over ground, in metres per second	Double	8	H+16
7	Trk Gnd	Actual direction of motion over ground (track over ground) with respect to True North, in degrees	Double	8	H+24
8	Vert Spd	Vertical speed, in metres per second, where positive values indicate increasing altitude (up) and negative values indicate decreasing altitude (down)	Double	8	H+32
9	Reserved		Float	4	H+40
10	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+44
11	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

C.2.3 BESTLEVERARM/BESTLEVERARM2 IMU to Antenna Lever Arm

The BESTLEVERARM log contains the distance between the IMU center of navigation and the primary GNSS antenna phase center in the IMU enclosure frame and its associated uncertainties. If the you enter the lever arm through the SETIMUTOANTOFFSET command, see *page 118*, these values are reflected in this log. When the lever arm calibration is complete, see the LEVERARMCALIBRATE command on *page 108*, the solved values are also output in this log.

The BESTLEVERARM2 log contains the distance between the IMU center of navigation and the secondary GNSS antenna phase center in the IMU enclosure frame. Currently, the second lever arm cannot be calibrated so must be entered using the SETIMUTOANTOFFSET2 command, see page 119.

The values in the BESTLEVERARM and BESTLEVERARM2 logs are also available in the IMUTOANTOFFSETS log, see page 143.

The default X (pitch), Y (roll) and Z (azimuth) directions of the IMU enclosure frame are clearly marked on the IMU, see *Figure 41* on *page 114*.

BESTLEVERARM Message ID: 674
BESTLEVERARM2 Message ID: 1256
Log Type: Asynch

Recommended Input:

```
log bestleverarma onchanged
```

ASCII Example:

```
#BESTLEVERARMA,COM1,0,83.5,UNKNOWN,0,2.983,00000008,39e4,35484;0.3934000000000000,
-1.2995000000000001,0.0105500000000000,0.0300000000000000,0.0300000000000000,
0.0300000000000000,4*876c47ad
```

Field #	Field Type	Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log Header	-	H	0
2	X Offset	IMU Enclosure Frame (m)	Double	8	H
3	Y Offset	IMU Enclosure Frame (m)	Double	8	H+8
4	Z Offset	IMU Enclosure Frame (m)	Double	8	H+16
5	X Uncertainty	IMU Enclosure Frame (m)	Double	8	H+24
6	Y Uncertainty	IMU Enclosure Frame (m)	Double	8	H+32
7	Z Uncertainty	IMU Enclosure Frame (m)	Double	8	H+40
8	iMapping	See *Table 46, Full Mapping Definitions* on *page 116*	Integer	4	H+48
9	xxxx	32-bit CRC	Hex	4	H+52
10	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

C.2.4 BESTPOS Best Position

This log contains the best available combined GNSS and Inertial Navigation System (INS - if available) position (in metres) computed by the receiver. In addition, it reports several status indicators, including differential age, which is useful in predicting anomalous behavior brought about by outages in differential corrections. A differential age of 0 indicates that no differential correction was used.

With the system operating in an RTK mode, this log reflects the latest low-latency solution for up to 60 seconds after reception of the last base station observations. After this 60 second period, the position reverts to the best solution available; the degradation in accuracy is reflected in the standard deviation fields. If the system is not operating in an RTK mode, pseudo range differential solutions continue for the time specified in the DGPSTIMEOUT command, refer to the *OEM6 Family Firmware Reference Manual.*

When in INS mode, the position is calculated at the antenna phase center.

Message ID: **42**

Log Type: **Synch**

Recommended Input:

```
log bestposa ontime 1
```

ASCII Example 1:

```
#BESTPOSA,COM1,0,83.5,FINESTEERING,1419,336148.000,00000040,6145,2724;SOL_COMPUTED,
SINGLE,51.11636418888,-114.03832502118,1064.9520,-16.2712,WGS84,1.6961,1.3636,
3.6449,"",0.000,0.000,8,8,0,0,0,06,0,03*6f63a93d
```

ASCII Example 2:

```
#BESTPOSA,COM1,0,78.5,FINESTEERING,1419,336208.000,00000040,6145,2724;SOL_COMPUTED,
NARROW_INT,51.11635910984,-114.03833105168,1063.8416,-16.2712, WGS84,0.0135,0.0084,
0.0172,"AAAA",1.000,0.000,8,8,8,8,0,01,0,03*3d9fbd48
```

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	BESTPOS header	Log header		H	0
2	sol stat	Solution status, see *Table 49, Solution Status* on *page 132*	Enum	4	H
3	pos type	Position type, see *Table 50, Position or Velocity Type* on *page 132*	Enum	4	H+4
4	lat	Latitude	Double	8	H+8
5	lon	Longitude	Double	8	H+16
6	hgt	Height above mean sea level	Double	8	H+24
7	undulation	Undulation - the relationship between the geoid and the ellipsoid (m) of the chosen datum [a]	Float	4	H+32
8	datum id#	Datum ID number	Enum	4	H+36
9	lat s	Latitude standard deviation	Float	4	H+40
10	lon s	Longitude standard deviation	Float	4	H+44
11	hgt s	Height standard deviation	Float	4	H+48
12	stn id	Base station ID	Char[4]	4	H+52
13	diff_age	Differential age in seconds	Float	4	H+56
14	sol_age	Solution age in seconds	Float	4	H+60
15	#SVs	Number of satellite vehicles tracked	Uchar	1	H+64

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
16	#solnSVs	Number of satellite vehicles used in solution	Uchar	1	H+65
17	#ggL1	Number of GPS and GLONASS L1 used in RTK solution	Uchar	1	H+66
18	#ggL1L2	Number of GPS and GLONASS L1 and L2 used in RTK solution	Uchar	1	H+67
19	Reserved		Uchar	1	H+68
20	ext sol stat	Extended solution status (see *Table 52, Extended Solution Status* on *page 133*)	Hex	1	H+69
21	Reserved		Hex	1	H+70
22	sig mask	Signals used mask - if 0, signals used in solution are unknown (see *Table 51, Signal-Used Mask* on *page 133*)	Hex	1	H+71
23	xxxx	32-bit CRC (ASCII and Binary only)	Hex	1	H+72
24	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. When using a datum other than WGS84, the undulation value also includes the vertical shift due to differences between the datum in use and WGS84

C.2.5 CORRIMUDATA/CORRIMUDATAS Corrected IMU Measurements

The CORRIMUDATA(S) log contains the RAWIMU data corrected for gravity, earth's rotation, and accelerometer and gyroscope biases. The values in this log are instantaneous, incremental values, in units of radians for the attitude rate and m/s for the accelerations. To get the full attitude rate and acceleration values, you must multiply the values in the CORRIMUDATA(S) log by the data rate of your IMU in Hz.

> The short header format, CORRIMUDATAS, is recommended, as it is for all high data rate logs.

CORRIMUDATA(S) can be logged with the ONTIME trigger, up to the full data rate of the IMU.

> Since the CORRIMUDATA values are instantaneous, if you log at a rate less than full data rate of the IMU, you will receive the corrected IMU data at the epoch closest to the requested time interval.
>
> For asynchronous, full rate data, see *Section C.2.8, IMURATECORRIMUS Asynchronous Corrected IMU Data* on *page 141*.

If your IMU is mounted with the z axis, as marked on the enclosure, pointed up, the SPAN computation frame is the same as the IMU enclosure frame. The x, y, and z axes referenced in this log are of the SPAN computational frame by default. For more information on how the SPAN computational frame relates to the IMU enclosure frame, see "Definition of Reference Frames Within SPAN" on page 36 and the SETIMUORIENTATION command on *page 114*. If the APPLYVEHICLEBODYROTATION command has been enabled (see *page 97*), the values in CORRIMUDATA(S) logs will be in the vehicle frame, not the SPAN computation frame.

Message ID: **812 & 813**

Log Type: **Synch**

Recommended Input:

```
log corrimudatab ontime 0.01
```

Example log:

```
%CORRIMUDATASA,1581,341553.000;1581,341552.997500000,-0.000000690,-0.000001549,
0.000001654,0.000061579,-0.000012645,-0.000029988*770c6232
```

Field #	Field Type	Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GNSS week	Ulong	4	H+
3	Seconds	GNSS seconds from week start	Double	8	H+4
4	PitchRate	About x axis rotation	Double	8	H+12
5	RollRate	About y axis rotation	Double	8	H+20
6	YawRate	About z axis rotation (Right Handed)	Double	8	H+28
7	LateralAcc	INS Lateral Acceleration (along x axis)	Double	8	H+36
8	LongitudinalAcc	INS Longitudinal Acceleration (along y axis)	Double	8	H+44
9	VerticalAcc	INS Vertical Acceleration (along z axis)	Double	8	H+52
10	xxxx	32-bit CRC	Hex	4	H+56
11	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

C.2.6 GIMBALLEDPVA Display gimballed position

Use the GIMBALLEDPVA log to view the re-calculated gimballed position, velocity and attitude whenever a new INPUTGIMBALANGLE command is received.

> The log is not output until the INS alignment is complete.

Message ID: **1321**
Log Type: **Asynch**

Recommended Input:

```
log gimballedpvaa onnew
```

ASCII Example:

```
#GIMBALLEDPVAA,COM1,0,93.5,FINESTEERING,1635,320568.514,00000000,0000,407;1635,
320568.514000000,51.116376614,-114.038259915,1046.112025828,-0.000291756,
-0.000578067,0.030324466,-0.243093917,-0.127718304,19.495023227,
INS_ALIGNMENT_COMPLETE*32fbb61b
```

Field	Field Type	Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log Header	-	H	0
2	Week	GPS week	Ulong	4	H
3	Seconds	Seconds from week start	Double	8	H+4
4	Latitude	WGS84 latitude in degrees	Double	8	H+12
5	Longitude	WGS84 longitude in degrees	Double	8	H+20
6	Height	WGS84 ellipsoidal height	Double	8	H+28
7	North Velocity	Velocity in a northerly direction	Double	8	H+36
8	East Velocity	Velocity in an easterly direction	Double	8	H+44
9	Up Velocity	Velocity in an upward direction	Double	8	H+52
10	Roll	Right handed rotation from local level around the Y-axis in degrees	Double	8	H+60
11	Pitch	Right handed rotation from local level around the X-axis in degrees	Double	8	H+68
12	Azimuth	Right handed rotation from local level around the Z-axis in degrees	Double	8	H+76
13	Status	INS status	Enum	4	H+84
14	xxxx	32-bit CRC	Hex	4	H+88
15	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

C.2.7 HEAVE Heave Filter Log

The log provides vessel heave computed by the integrated heave filter. Refer also to information in the SETHEAVEWINDOW command section. This log is asynchronous, but is available at approximately 10Hz.

You must have an inertial solution to use this log.

The heave filter must be enabled using the HEAVEFILTER command, see page 101, before this log is available.

Message ID: **1382**

Log Type: **Asynch**

Recommended Input:

```
log heavea onnew
```

Example:

```
#HEAVEA,USB1,0,38.5,FINESTEERING,1630,232064.599,00000000,a759,6696;1630,232064.589885392,0.086825199*93392cb4
```

Field #	Field Type	Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log Header	-	H	0
2	Week	GNSS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	Heave	Instantaneous heave in metres	Double	8	H+12
5	xxxx	32-bit CRC (ASCII, Binary, and Short Binary only)	Hex	4	H+20
6	[CR][LF]	Sentence Terminator (ASCII Only)	-	-	-

C.2.8 IMURATECORRIMUS Asynchronous Corrected IMU Data

This log provides the same information as the CORRIMUDATA log, but is available asynchronously at the full rate of the IMU.

> Using this log consumes significant system resources and should only be used by experienced users.

To use this log, you must enable asynchronous logging. See *Section B.2.3, ASYNCHINSLOGGING Enable Asynchronous INS Logs* on *page 98*.

Message ID: **1362**

Log Type: **Asynch**

Recommended Input:

```
log imuratecorrimus
```

Example log:

```
%IMURATECORRIMUSA,1581,341553.000;1581,341552.997500000,-0.000000690,-0.000001549,
0.000001654,0.000061579,-0.000012645,-0.000029988*770c6232
```

Field #	Field Type	Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GNSS week	Ulong	4	H+
3	Seconds	GNSS seconds from week start	Double	8	H+4
4	PitchRate	About x axis rotation	Double	8	H+12
5	RollRate	About y axis rotation	Double	8	H+20
6	YawRate	About z axis rotation (Right Handed)	Double	8	H+28
7	LateralAcc	INS Lateral Acceleration (along x axis)	Double	8	H+36
8	LongitudinalAcc	INS Longitudinal Acceleration (along y axis)	Double	8	H+44
9	VerticalAcc	INS Vertical Acceleration (along z axis)	Double	8	H+52
10	xxxx	32-bit CRC	Hex	4	H+56
11	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

C.2.9 IMURATEPVAS Asynchronous INS Position, Velocity and Attitude

This log provides the same information as the INSPVAS log, but is available asynchronously at the full rate of the IMU.

> Using this log consumes significant system resources and should only be used by experienced users.

To use this log, you must enable asynchronous logging. See *Section B.2.3, ASYNCHINSLOGGING Enable Asynchronous INS Logs* on *page 98*.

Message ID: **1305**

Log Type: **Asynch**

Recommended Input:

```
log imuratepvas
```

ASCII Example:

```
%IMURATEPVASA,1264,144059.000;1264,144059.002135700,51.116680071,-114.037929194,
515.286704183,277.896368884,84.915188605,-8.488207941,0.759619515,-2.892414901,
6.179554750,INS_ALIGNMENT_COMPLETE*855d6f76
```

Field #	Field Type	Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GNSS Week	Ulong	4	H
3	Seconds	Seconds from week start	Double	8	H+4
4	Latitude	Latitude (WGS84)	Double	8	H+12
5	Longitude	Longitude (WGS84)	Double	8	H+20
6	Height	Ellipsoidal Height (WGS84) [m]	Double	8	H+28
7	North Velocity	Velocity in a northerly direction (a -ve value implies a southerly direction) [m/s]	Double	8	H+36
8	East Velocity	Velocity in an easterly direction (a -ve value implies a westerly direction) [m/s]	Double	8	H+44
9	Up Velocity	Velocity in an up direction [m/s]	Double	8	H+52
10	Roll	Right handed rotation from local level around y-axis in degrees	Double	8	H+60
11	Pitch	Right handed rotation from local level around x-axis in degrees	Double	8	H+68
12	Azimuth	Left handed rotation around z-axis Degrees clockwise from North	Double	8	H+76
13	Status	INS Status, see *Table 7, Inertial Solution Status* on *page 41*	Enum	4	H+84
14	xxxx	32-bit CRC	Hex	4	H+88
15	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

C.2.10 IMUTOANTOFFSETS IMU to Antenna(s) Lever Arm

This log contains the distance between the IMU and the GNSS antenna(s) in the IMU enclosure frame and its associated uncertainties. This log contains the same information as the BESTLEVERARM logs for each lever arm, but is intended as a single source for all lever arm information available on the system.

Message ID: **1270**

Log Type: **Asynch**

Abbreviated ASCII Syntax:

```
[COM1]log imutoantoffsets
```

Example log:

```
<OK
[COM1]<IMUTOANTOFFSETS COM1 0 98.5 FINESTEERING 1581 339209.733 60000041 0000 265
<     0 1
<          LEVER_ARM_PRIMARY -0.326000000 0.126000000 1.285000000 0.032600000
0.012600000 0.128500000 LEVER_ARM_FROM_COMMAND
[COM1]
```

Recommended Input:

```
log imutoantoffsetsa onchanged
```

ASCII Example:

```
#IMUTOANTOFFSETSA,COM1,0,98.5,FINESTEERING,1581,339209.733,60000041,0000,265;0,1,
LEVER_ARM_PRIMARY,-0.326000000,0.126000000,1.285000000,0.032600000,0.012600000,
0.128500000,LEVER_ARM_FROM_COMMAND*8f0f90b5
```

Field #	Field Type	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	Log Header	-	H	0
2	IMU Orientation	See *Table 41, IMU Type* on *page 99*	ULong	4	H
3	Number of Entries	Number of stored lever arms	ULong	4	H+4
4	Lever Arm Type	Type of lever arm. See *Table 53, Lever Arm Type* on *page 144*.	Enum	4	H+8
5	X Offset	IMU Enclosure Frame (m)	Double	8	H+12
6	Y Offset	IMU Enclosure Frame (m)	Double	8	H+20
7	Z Offset	IMU Enclosure Frame (m)	Double	8	H+28
8	X Uncertainty	IMU Enclosure Frame (m)	Double	8	H+36
9	Y Uncertainty	IMU Enclosure Frame (m)	Double	8	H+44
10	Z Uncertainty	IMU Enclosure Frame (m)	Double	8	H+52
11	Lever Arm Source	Source of the lever arm. See *Table 54, Lever Arm Source* on *page 144* for the different values	Enum	4	H+60
12…	Next component offset = H + 8 + (#comp * 56)				
variable	XXXX	32-bit CRC (ASCII and Binary only)	Hex	4	H+8+ (#comp * 56)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Table 53: Lever Arm Type

Value (binary)	Lever Arm Source (ASCII)	Description
0	LEVER_ARM_INVALID	An invalid lever arm.
1	LEVER_ARM_PRIMARY	Primary lever arm entered for all SPAN systems.
2	LEVER_ARM_SECONDARY	Secondary lever arm entered for dual antenna SPAN systems.

Table 54: Lever Arm Source

Value (binary)	Lever Arm Source (ASCII)	Description
0	LEVER_ARM_NONE	No lever arm exists.
1	LEVER_ARM_FROM_NVM	Lever arm restored from NVM.
2	LEVER_ARM_CALIBRATING	Lever arm currently calibrating.
3	LEVER_ARM_CALIBRATED	Lever arm computed from calibration routine.
4	LEVER_ARM_FROM_COMMAND	Lever arm entered via command.

C.2.11 INSATT INS Attitude

This log, and the INSATTS log, contains the most recent attitude measurements corresponding to the SPAN frame axis according to the installation instructions provided in *Section 2.2, Hardware Set Up* starting on *page 31* and *Section 2.3.2, SPAN IMU Configuration* starting on *page 34* of this manual. The attitude measurements may not correspond to other definitions of the terms pitch, roll and azimuth. If your IMU's z-axis (as marked on the enclosure) is not pointing up, the output attitude will be with respect to the SPAN computational frame, and not the frame marked on the enclosure. See the SETIMUORIENTATION command to determine what the SPAN computation frame will be, given how your IMU is mounted. To output the attitude in the vehicle frame, see page 97 for information about the APPLYVEHICLEBODYROTATION command.

Message ID: **263**

Log Type: **Synch**

Recommended Input:

```
log insatta ontime 1
```

ASCII Example:

```
#INSATTA,USB2,0,14.5,FINESTEERING,1541,487970.000,00040000,5b35,37343;1541,487970.000
549050,1.876133508,-4.053672765,328.401460897,INS_SOLUTION_GOOD*ce4ac533
```

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GNSS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	Roll	Right handed rotation from local level around y-axis in degrees.	Double	8	H+12
5	Pitch	Right handed rotation from local level around x-axis in degrees.	Double	8	H+20
6	Azimuth	Left handed rotation around z-axis. Degrees clockwise from North.	Double	8	H+28
7	Status	INS status, see *Table 7, Inertial Solution Status* on *page 41*.	Enum	4	H+36
8	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+40
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

C.2.12 INSATTS Short INS Attitude

This is a short header version of the *INSATT* log on *page 145*.

Message ID: **319**

Log Type: **Synch**

Recommended Input:

```
log insattsa ontime 1
```

ASCII Example:

```
%INSATTSA,1541,487975.000;1541,487975.000549050,2.755452422,-4.127365126,
323.289778434,INS_SOLUTION_GOOD*ba08754f
```

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GNSS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	Roll	Right handed rotation from local level around y-axis in degrees.	Double	8	H+12
5	Pitch	Right handed rotation from local level around x-axis in degrees.	Double	8	H+20
6	Azimuth	Left handed rotation around z-axis. Degrees clockwise from North.	Double	8	H+28
7	Status	INS status, see *Table 7, Inertial Solution Status* on *page 41.*	Enum	4	H+36
8	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+40
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

C.2.13 INSATTX Inertial Attitude – Extended

This log includes the information from the INSATT log, as well as information about the velocity standard deviation. The position type and solution status fields indicate whether or not the corresponding data is valid.

> The INSATTX log is a large log and is not recommend for high rate logging.
> If you want to use high rate logging, log the INSATTS log at a high rate and the INVCOVS log onnew (1 Hz).

Message ID: **1457**
Log Type: **Synch**

Recommended Input:

```
log insattxa ontime 1
```

ASCII example:

```
#INSATTXA,COM1,0,81.0,FINESTEERING,1690,494542.000,00000040,5d25,43441;
INS_ALIGNMENT_COMPLETE,INS_PSRSP,1.137798832,-0.163068414,135.754208544,0.017797431,
0.017861038,3.168394804,4,0*f944b004
```

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	INSATTX Header	Log header		H	0
2	INS Status	Solution status See *Table 55, Inertial Solution Status* on *page 148*	Enum	4	H
3	Pos Type	Position type See *Table 56, Position or Velocity Type* on *page 148*	Enum	4	H+4
4	Roll	Roll in Local Level (degrees)	Double	8	H+8
5	Pitch	Pitch in Local Level (degrees)	Double	8	H+16
6	Azimuth	Azimuth in Local Level (degrees)	Double	8	H+24
7	Roll σ	Roll standard deviation (m/s)	Float	4	H+32
8	Pitch σ	Pitch standard deviation (m/s)	Float	4	H+36
9	Azimuth σ	Azimuth standard deviation (m/s)	Float	4	H+40
10	Ext sol stat	Extended solution status See *Table 57, Extended Solution Status* on *page 148*	Hex	4	H+44
11	Time Since Update	Elapsed time since the last ZUPT or position update (seconds)	Ushort	2	H+48
11	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+50
12	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Table 55: Inertial Solution Status

Binary	ASCII	Description
0	INS_INACTIVE	IMU logs are present, but the alignment routine has not started. INS is inactive.
1	INS_ALIGNING	INS is in alignment mode.
2	INS_HIGH_VARIANCE	The INS solution is still being computed, but the azimuth solution uncertainty has exceeded 2 degrees. The solution is still valid but you should monitor the solution uncertainty in the INSCOV log. You may encounter this state during times when the GNSS, used to aid the INS, is absent.
3	INS_SOLUTION_GOOD	The INS filter is in navigation mode and the INS solution is good.
6	INS_SOLUTION_FREE	The INS filter is in navigation mode and the GNSS solution is suspected to be in error. This may be due to multipath or limited satellite visibility. The inertial filter has rejected the GNSS position and is waiting for the solution quality to improve.
7	INS_ALIGNMENT_COMPLETE	The INS filter is in navigation mode, but not enough vehicle dynamics have been experienced for the system to be within specifications.

Table 56: Position or Velocity Type

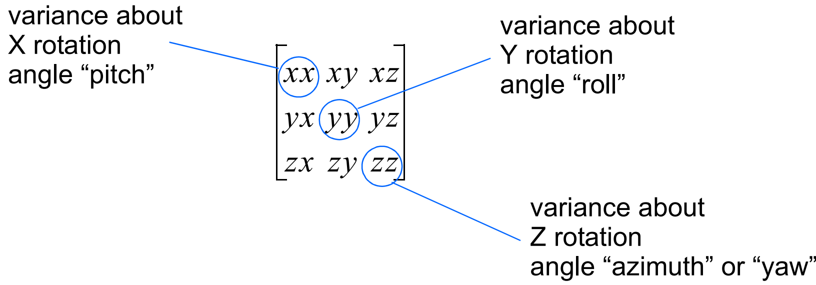
Binary	ASCII	Description
0	NONE	No Solution
1-51	Reserved	
52	INS_SBAS	INS SBAS solution
53	INS_PSRSP	INS pseudorange single point solution - no DGPS corrections
54	INS_PSRDIFF	INS pseudorange differential solution
55	INS_RTKFLOAT	INS RTK floating point ambiguities solution
56	INS_RTKFIXED	INS RTK fixed ambiguities solution
57	INS_OMNISTAR	INS OmniSTAR VBS position (L1 sub-meter)
58	INS_OMNISTAR_HP	INS OmniSTAR high precision solution
59	INS_OMNISTAR_XP	INS OmniSTAR extra precision solution

Table 57: Extended Solution Status

Bit	Mask	Description
0	0x00000001	A position update was applied in the last update epoch.
1	0x00000002	A phase update was applied in the last update epoch.
2	0x00000004	A ZUPT was applied in the last update epoch.
3	0x00000008	A wheel sensor update was applied in the last update epoch.
4	0x00000010	A heading (ALIGN) update was applied in the last update epoch.
5	0x00000020	An external position update was applied in the last update epoch.
6	0x00000040	Reserved for future use
7	0x00000080 - 0x80000000	Reserved

C.2.14 INSCOV INS Covariance Matrices

The position, attitude, and velocity matrices in this log each contain 9 covariance values, with respect to the local level frame. For the attitude angles, they are given in the SPAN computation frame, as follows:



and are displayed within the log output as:

...,xx,xy,xz,yx,yy,yz,zx,zy,zz,...

These values are computed once per second and are available before and after alignment. See also *Section 3.3.1, System Start-Up and Alignment Techniques* starting on *page 41*.

Message ID: **264**

Log Type: **Synch**

Recommended Input:

```
log inscova ontime 1
```

ASCII Example:

```
#INSCOVA,COM3,0,0.0,EXACT,1105,425385.020,00040000,c45c,0;1105,425385.000000000,
0.0997319969301073,-0.0240959791179416,-0.0133921499963209,-0.0240959791179416,
0.1538605784734939,0.0440068023663888,-0.0133921499963210,0.0440068023663887,
0.4392033415009359,0.0034190251365443,0.0000759398593357,-0.1362852812808768,
0.0000759398593363,0.0032413999569636,-0.0468473344270137,-0.1362852812808786,
-0.0468473344270131,117.5206493841025100,0.0004024901765302,-0.0000194916086028,
0.0000036582459112,-0.0000194916086028,0.0004518869575566,0.0000204616202028,
0.0000036582459112,0.0000204616202028,0.0005095575483948*1fc92787
```

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GNSS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	Position Covariance	Position covariance matrix in local level frame (Meters squared)	List of 9 Doubles	72	H+12
5	Attitude Covariance	Attitude covariance matrix in local level frame. (Degrees squared - rotation around the given axis)	List of 9 Doubles	72	H+84
6	Velocity Covariance	Velocity covariance matrix in local level frame. (Meters/second squared)	List of 9 Doubles	72	H+156
7	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+228
8	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

C.2.15 INSCOVS Short INS Covariance Log

This is a short header version of the *INSCOV* log on *page 149*. These values are also computed once per second.

Message ID: **320**

Log Type: **Synch**

Recommended Input:

```
log inscovsa ontime 1
```

ASCII Example:

```
%INSCOVSA,1105,425385.020;
1105,425385.000000000,
0.0997319969301073,-0.0240959791179416,-0.0133921499963209,-0.0240959791179416,
0.1538605784734939,0.0440068023663888,-0.0133921499963210,0.0440068023663887,
0.4392033415009359,0.0034190251365443,0.0000759398593357,-0.1362852812808768,
0.0000759398593363,0.0032413999569636,-0.0468473344270137,-0.1362852812808786,
-0.0468473344270131,117.5206493841025100,0.0004024901765302,-0.0000194916086028,
0.0000036582459112,-0.0000194916086028,0.0004518869575566,0.0000204616202028,
0.0000036582459112,0.0000204616202028,0.0005095575483948*1fc92787
```

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GNSS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	Position Covariance	Position covariance matrix in local level frame. (Meters squared) xx,xy,xz,yx,yy,yz,zx,zy,zz	List of 9 Doubles	72	H+12
5	Attitude Covariance	Attitude covariance matrix of the SPAN frame to the local level frame. See *page 149* for an example. (Degrees squared - rotation around the given axis) xx,xy,xz,yx,yy,yz,zx,zy,zz	List of 9 Doubles	72	H+84
6	Velocity Covariance	Velocity covariance matrix in local level frame. (Meters/second squared) xx,xy,xz,yx,yy,yz,zx,zy,zz	List of 9 Doubles	72	H+156
7	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+228
8	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

C.2.16 INSPOS INS Position

This log contains the most recent position measurements in WGS84 coordinates and includes an INS status indicator. The log reports the position at the IMU center, unless you issue the SETINSOFFSET command, see *page 121*.

Message ID: 265

Log Type: Synch

Recommended Input:

```
log insposa ontime 1
```

ASCII Example:

```
#INSPOSA,USB2,0,18.0,FINESTEERING,1541,487977.000,00040000,17cd,37343;1541,487977.000549050,
51.121315135,-114.042311349,1038.660737046,INS_SOLUTION_GOOD*2fffd557
```

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GNSS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	Latitude	Latitude (WGS84)	Double	8	H+12
5	Longitude	Longitude (WGS84)	Double	8	H+20
6	Height	Ellipsoidal Height (WGS84) [m]	Double	8	H+28
7	Status	INS status, see *Table 7, Inertial Solution Status* on *page 41*	Enum	4	H+36
8	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+40
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

C.2.17 INSPOSS Short INS Position

This is a short header version of the *INSPOS* log on *page 151*.

Message ID: **321**

Log Type: **Synch**

Recommended Input:

```
log inspossa ontime 1
```

ASCII Example:

```
%INSPOSSA,1541,487916.000;1541,487916.000549050,51.115797277,-114.037811065,
1039.030700122,INS_SOLUTION_GOOD*5ca30894
```

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GNSS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	Latitude	Latitude (WGS84)	Double	8	H+12
5	Longitude	Longitude (WGS84)	Double	8	H+20
6	Height	Ellipsoidal Height (WGS84) [m]	Double	8	H+28
7	Status	INS status, see *Table 7, Inertial Solution Status* on *page 41*	Enum	4	H+36
8	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+40
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

C.2.18 INSPOSX Inertial Position – Extended

This log includes the information from the INSPOS log, as well as information about the position standard deviation. The position type and solution status fields indicate whether or not the corresponding data is valid.

> The INSPOSX log is a large log and is not recommend for high rate logging.
> If you want to use high rate logging, log the INSPOSS log at a high rate and the INVCOVS log onnew (1 Hz).

Message ID: 1459
Log Type: Synch

Recommended Input:

```
log insposxa ontime 1
```

ASCII example:

```
#INSPOSXA,COM1,0,79.0,FINESTEERING,1690,493465.000,00000040,7211,43441;
INS_SOLUTION_GOOD,INS_PSRSP,51.11637750859,-114.03826206294,1049.1191,0.4883,0.4765,
0.8853,3,0*dee048ab
```

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	INSPOSX Header	Log header		H	0
2	INS Status	Solution status See *Table 55, Inertial Solution Status* on *page 148*	Enum	4	H
3	Pos Type	Position type See *Table 56, Position or Velocity Type* on *page 148*	Enum	4	H+4
4	Lat	Latitude	Double	8	H+8
5	Long	Longitude	Double	8	H+16
6	Height	Orthometric height (m)	Double	8	H+24
7	Undulation	Undulation (m)	Float	4	H+32
8	Lat σ	Latitude standard deviation	Float	4	H+36
9	Long σ	Longitude standard deviation	Float	4	H+34
10	Height σ	Height standard deviation	Float	4	H+44
11	Ext sol stat	Extended solution status See *Table 57, Extended Solution Status* on *page 148*	Hex	4	H+48
11	Time Since Update	Elapsed time since the last ZUPT or position update (seconds)	Ushort	2	H+52
12	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+54
13	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

C.2.19 INSPVA INS Position, Velocity and Attitude

This log allows INS position, velocity and attitude, with respect to the SPAN frame, to be collected in one log, instead of using three separate logs. See the INSATT log, on *page 145*, for an explanation of how the SPAN frame may differ from the IMU enclosure frame.

The attitude can be output in the vehicle frame. See *Section B.2.2, APPLYVEHICLEBODYROTATION Enable Vehicle to Body Rotation* on *page 97*.

Message ID: 507
Log Type: Synch

Recommended Input:

```
log inspvaa ontime 1
```

ASCII Example:

```
#INSPVAA,COM1,0,31.0,FINESTEERING,1264,144088.000,00040000,5615,1541;
1264,144088.002284950,51.116827527,-114.037738908,401.191547167,
354.846489850,108.429407241,-10.837482850,1.116219952,-3.476059035,
7.372686190,INS_ALIGNMENT_COMPLETE*af719fd9
```

Field #	Field Type	Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GNSS Week	Ulong	4	H
3	Seconds	Seconds from week start	Double	8	H+4
4	Latitude	Latitude (WGS84)	Double	8	H+12
5	Longitude	Longitude (WGS84)	Double	8	H+20
6	Height	Ellipsoidal Height (WGS84) [m]	Double	8	H+28
7	North Velocity	Velocity in a northerly direction (a -ve value implies a southerly direction) [m/s]	Double	8	H+36
8	East Velocity	Velocity in an easterly direction (a -ve value implies a westerly direction) [m/s]	Double	8	H+44
9	Up Velocity	Velocity in an up direction [m/s]	Double	8	H+52
10	Roll	Right handed rotation from local level around y-axis in degrees	Double	8	H+60
11	Pitch	Right handed rotation from local level around x-axis in degrees	Double	8	H+68
12	Azimuth	Left handed rotation around z-axis Degrees clockwise from North	Double	8	H+76
13	Status	INS Status, see *Table 7, Inertial Solution Status* on *page 41*	Enum	4	H+84
14	xxxx	32-bit CRC	Hex	4	H+88
15	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

C.2.20 INSPVAS Short INS Position, Velocity and Attitude

This is a short header version of the *INSPVA* log on *page 154*.

Message ID: **508**

Log Type: **Synch**

Recommended Input:

```
log inspvasa ontime 1
```

ASCII Example:

```
%INSPVASA,1264,144059.000;
1264,144059.002135700,51.116680071,-114.037929194,515.286704183,277.896368884,
84.915188605,-8.488207941,0.759619515,-2.892414901,6.179554750,INS_ALIGNMENT_COMPLETE
*855d6f76
```

Field #	Field Type	Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GNSS Week	Ulong	4	H
3	Seconds	Seconds from week start	Double	8	H+4
4	Latitude	Latitude (WGS84)	Double	8	H+12
5	Longitude	Longitude (WGS84)	Double	8	H+20
6	Height	Ellipsoidal Height (WGS84) [m]	Double	8	H+28
7	North Velocity	Velocity in a northerly direction (a -ve value implies a southerly direction) [m/s]	Double	8	H+36
8	East Velocity	Velocity in an easterly direction (a -ve value implies a westerly direction) [m/s]	Double	8	H+44
9	Up Velocity	Velocity in an up direction [m/s]	Double	8	H+52
10	Roll	Right handed rotation from local level around y-axis in degrees	Double	8	H+60
11	Pitch	Right handed rotation from local level around x-axis in degrees	Double	8	H+68
12	Azimuth	Left handed rotation around z-axis Degrees clockwise from North	Double	8	H+76
13	Status	INS Status, see *Table 7, Inertial Solution Status* on *page 41*	Enum	4	H+84
14	xxxx	32-bit CRC	Hex	4	H+88
15	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

C.2.21 INSPVAX Inertial PVA – Extended

This log includes the information from the INSPVA log, as well as information about the position standard deviation. The position type and solution status fields indicate whether or not the corresponding data is valid.

> The INSPVAX log is a large log and is not recommend for high rate logging.
> If you want to use high rate logging, log the INSPVAS log at a high rate and the INVCOVS log onnew (1 Hz).

Message ID: **1465**
Log Type: **Synch**

Recommended Input:

```
log inspvaxa ontime 1
```

ASCII example:

```
#INSPVAXA,COM1,0,73.5,FINESTEERING,1695,309428.000,00000040,4e77,43562;
INS_SOLUTION_GOOD,INS_PSRSP,51.11637873403,-114.03825114994,1063.6093,-16.9000,
-0.0845,-0.0464,-0.0127,0.138023492,0.069459386,90.000923268,0.9428,0.6688,1.4746,
0.0430,0.0518,0.0521,0.944295466,0.944567084,1.000131845,3,0*e877c178
```

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	INSPVAX Header	Log header		H	0
2	INS Status	Solution status See *Table 55, Inertial Solution Status* on *page 148*	Enum	4	H
3	Pos Type	Position type See *Table 56, Position or Velocity Type* on *page 148*	Enum	4	H+4
4	Lat	Latitude	Double	8	H+8
5	Long	Longitude	Double	8	H+16
6	Height	Orthometric height (m)	Double	8	H+24
7	Undulation	Undulation (m)	Float	4	H+32
8	North Vel	North velocity (m/s)	Double	8	H+36
9	East Vel	East velocity (m/s)	Double	8	H+44
10	Up Vel	Up velocity (m/s)	Double	8	H+52
11	Roll	Roll in Local Level (degrees)	Double	8	H+60
12	Pitch	Pitch in Local Level (degrees)	Double	8	H+68
13	Azimuth	Azimuth in Local Level (degrees)	Double	8	H+76
14	Lat σ	Latitude standard deviation	Float	4	H+84
15	Long σ	Longitude standard deviation	Float	4	H+88
16	Height σ	Height standard deviation	Float	4	H+92
17	North Vel σ	North velocity standard deviation (m/s)	Float	4	H+96
18	East Vel σ	East velocity standard deviation (m/s)	Float	4	H+100
19	Up Vel σ	Up velocity standard deviation (m/s)	Float	4	H+104
20	Roll σ	Roll standard deviation (m/s)	Float	4	H+108
21	Pitch σ	Pitch standard deviation (m/s)	Float	4	H+112
22	Azimuth σ	Azimuth standard deviation (m/s)	Float	4	H+116

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
23	Ext sol stat	Extended solution status See *Table 57, Extended Solution Status* on *page 148*	Hex	4	H+120
24	Time Since Update	Elapsed time since the last ZUPT or position update (seconds)	Ushort	2	H+124
25	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+128
26	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

C.2.22 INSSPD INS Speed

This log contains the most recent speed measurements in the horizontal and vertical directions, and includes an INS status indicator.

Message ID: **266**
Log Type: **Synch**

Recommended Input:

```
log insspda ontime 1
```

ASCII Example:

```
#INSSPDA,USB2,0,20.0,FINESTEERING,1541,487969.000,00040000,7832,37343;1541,487969.000
549050,329.621116190,14.182070674,-0.126606551,INS_SOLUTION_GOOD *c274fff2
```

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GNSS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	Trk gnd	Actual direction of motion over ground (track over ground) with respect to True North, in degrees	Double	8	H+12
5	Horizontal Speed	Magnitude of horizontal speed in m/s where a positive value indicates you are moving forward and a negative value indicates you are reversing.	Double	8	H+20
6	Vertical Speed	Magnitude of vertical speed in m/s where a positive value indicates speed upward and a negative value indicates speed downward.	Double	8	H+28
7	Status	INS status, see *Table 7, Inertial Solution Status* on *page 41*	Enum	4	H+36
8	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+40
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

C.2.23 INSSPDS Short INS Speed

This is a short header version of the *INSSPD* log on *page 158*.

Message ID: **323**

Log Type: **Synch**

Recommended Input:

```
log insspdsa ontime 1
```

ASCII Example:

```
%INSSPDSA,1541,487975.000;1541,487975.000549050,323.101450813,9.787233999,-
0.038980077,INS_SOLUTION_GOOD*105ba028
```

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GNSS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	Trk gnd	Track over ground	Double	8	H+12
5	Horizontal Speed	Horizontal speed in m/s	Double	8	H+20
6	Vertical Speed	Vertical speed in m/s	Double	8	H+28
7	Status	INS status, see *Table 7, Inertial Solution Status* on *page 41*	Enum	4	H+36
8	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+40
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

C.2.24 INSUPDATE INS Update

This log contains the most recent INS update information. It gives you information about what updates were performed in the INS filter at the last update epoch and a wheel sensor status indicator.

Message ID: **757**

Log Type: **Asynch**

Recommended Input:

```
log insupdatea onchanged
```

ASCII Example:

```
#INSUPDATEA,SPECIAL,0,48.0,FINESTEERING,1701,156566.000,00004000,6f07,10883;SINGLE,0,
12,0,FALSE,WHEEL_SENSOR_INACTIVE,HEADING_UPDATE_ACTIVE*553bef65
```

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Solution Type	Type of GNSS solution used for the last update, see *Table 50, Position or Velocity Type* on *page 132*	Enum	4	H
3	Reserved		Integer	4	H+4
4	#Phase	Number of raw phase observations used in the last INS filter update	Integer	4	H+8
5	Reserved		Integer	4	H+12
6	Zupt Flag	A zero velocity update was performed during the last INS filter update: 0 = False 1 = True	Boolean	4	H+16
7	Wheel Status	Wheel status, see *Table 58* below.	Ulong	4	H+18
8	Heading Update	Status of the heading update during the last INS filter update. See *Table 59, Heading Update Enums* on *page 161*.	Enum	4	H+22
9	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+26
10	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Table 58: Wheel Status

Binary	ASCII
0	WHEEL_SENSOR_INACTIVE
1	WHEEL_SENSOR_ACTIVE
2	WHEEL_SENSOR_USED
3	WHEEL_SENSOR_UNSYNCED
4	WHEEL_SENSOR_BAD_MISC
5	WHEEL_SENSOR_HIGH_ROTATION

Table 59: Heading Update Enums[a]

Binary	ASCII	Description
0	HEADING_UPDATE_INACTIVE	A heading update was not available.
1	HEADING_UPDATE_ACTIVE	Heading updates are running, but the epoch is not used as an update. When all other rejection criteria pass, a heading update will still only be applied once every 5 seconds (20 seconds when stationary).
2	HEADING_UPDATE_USED	The update for that epoch was taken.
3	HEADING_UPDATE_HIGH_STD_DEV	The standard deviation of the update failed a 3 sigma check against the inertial standard deviation (azimuth checked only).
4	HEADING_UPDATE_HIGH_ROTATION	The last 1 second recorded a turn of over 5 degrees/second.
5	HEADING_UPDATE_BAD_MISC	The difference between the ALIGN heading and the INS heading failed a 3 sigma check with the inertial standard deviation.

a. The heading update enums are available on the SPAN-SE-D.

C.2.25 INSVEL INS Velocity

This log contains the most recent North, East, and Up velocity vector values, with respect to the local level frame, and also includes an INS status indicator.

Message ID: **267**

Log Type: **Synch**

Recommended Input:

```
log insvela ontime 1
```

ASCII Example:

```
#INSVELA,USB1,0,19.0,FINESTEERING,1543,236173.000,00000000,9c95,37343;1543,236173.002
500000,14.139471871,-0.070354464,-0.044204369,INS_SOLUTION_GOOD *3c37c0fc
```

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GNSS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	North Velocity	Velocity North in m/s	Double	8	H+12
5	East Velocity	Velocity East in m/s	Double	8	H+20
6	Up Velocity	Velocity Up in m/s	Double	8	H+28
7	Status	INS status, see *Table 7, Inertial Solution Status* on *page 41*	Enum	4	H+36
8	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+40
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

C.2.26 INSVELS Short INS Velocity

This is a short header version of the *INSVEL* log on *page 162*.

Message ID: **324**

Log Type: **Synch**

Recommended Input:

```
log insvelsa ontime 1
```

ASCII Example:

```
%INSVELSA,USB2,0,18.5,FINESTEERING,1541,487942.000,00040000,9c95,37343;1541,487942.00
0549050,12.656120921,-3.796947104,-0.100024422,INS_SOLUTION_GOOD *407d82ba
```

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GNSS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	North Velocity	Velocity North m/s	Double	8	H+12
5	East Velocity	Velocity East m/s	Double	8	H+20
6	Up Velocity	Velocity Up m/s	Double	8	H+28
7	Status	INS status, see *Table 7, Inertial Solution Status* on *page 41*	Enum	4	H+36
8	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+40
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

C.2.27 INSVELX Inertial Velocity – Extended

This log includes the information from the INSVEL log, as well as information about the velocity standard deviation. The position type and solution status fields indicate whether or not the corresponding data is valid.

> The INSVELX log is a large log and is not recommend for high rate logging.
> If you want to use high rate logging, log the INSVELS log at a high rate and the INVCOVS log onnew (1 Hz).

Message ID: **1458**
Log Type: **Synch**

Recommended Input:

```
log insvelxa ontime 1
```

ASCII example:

```
#INSVELXA,COM1,0,80.0,FINESTEERING,1690,494394.000,00000040,1f8e,43441;INS_ALIGNMENT_
COMPLETE,INS_PSRSP,0.0086,0.0015,0.0215,0.0549,0.0330,0.0339,3,0*ec33e372
```

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	INSVELX Header	Log header		H	0
2	INS Status	Solution status See *Table 55, Inertial Solution Status* on *page 148*	Enum	4	H
3	Pos Type	Position type See *Table 56, Position or Velocity Type* on *page 148*	Enum	4	H + 4
4	North Vel	North velocity (m/s)	Double	8	H + 8
5	East Vel	East velocity (m/s)	Double	8	H + 16
6	Up Vel	Up velocity (m/s)	Double	8	H + 24
7	North Vel σ	North velocity standard deviation (m/s)	Float	4	H + 32
8	East Vel σ	East velocity standard deviation (m/s)	Float	4	H + 36
9	Up Vel σ	Up velocity standard deviation (m/s)	Float	4	H + 40
10	Ext sol stat	Extended solution status See *Table 57, Extended Solution Status* on *page 148*	Hex	4	H + 44
11	Time Since Update	Elapsed time since the last ZUPT or position update (seconds)	Ushort	2	H + 48
11	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H + 50
12	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

C.2.28 MARK1PVA Position, Velocity and Attitude at Mark1

This log outputs position, velocity and attitude information, with respect to the SPAN frame, when an event was received on the Mark1 input. If the SETMARK1OFFSET command has been entered, the MARK1PVA log will contain the solution translated, and then rotated, by the values provided in the command. See the SETMARK1OFFSET command, valid at the time, on *page 122*.

Message ID: **1067**

Log Type: **Synch**

Recommended Input:

```
log mark1pva onnew
```

Abbreviated ASCII Example:

```
MARK1PVA USB1 0 51.5 EXACT 1481 251850.001 00040000 46f4 3388 1481 251850.001000000
51.116573435 -114.037237211 1040.805671970 0.000257666 -0.003030102 -0.000089758
3.082229474 -1.019023628 89.253955744 INS_SOLUTION_GOOD
```

Field #	Field Type	Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GNSS Week at Mark1 request	Ulong	4	H
3	Seconds	Seconds from week at Mark1	Double	8	H+4
4	Latitude	Latitude (WGS84) at Mark1	Double	8	H+12
5	Longitude	Longitude (WGS84) at Mark1	Double	8	H+20
6	Height	Height (WGS84) at Mark1	Double	8	H+28
7	North Velocity	Velocity in a northerly direction (a -ve value implies a southerly direction) at Mark1	Double	8	H+36
8	East Velocity	Velocity in an easterly direction (a -ve value implies a westerly direction) at Mark1	Double	8	H+44
9	Up Velocity	Velocity in an up direction at Mark1	Double	8	H+52
10	Roll	Right handed rotation from local level around y-axis in degrees at Mark1	Double	8	H+60
11	Pitch	Right handed rotation from local level around x-axis in degrees at Mark1	Double	8	H+68
12	Azimuth	Left handed rotation around z-axis in degrees clockwise from North at Mark1	Double	8	H+76
13	Status	INS Status, see *Table 7, Inertial Solution Status* on *page 41* at Mark1	Enum	4	H+84
14	xxxx	32-bit CRC	Hex	4	H+88
15	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

C.2.29 MARK2PVA Position, Velocity and Attitude at Mark2

This log outputs position, velocity and attitude information, with respect to the SPAN frame, when an event was received on the Mark2 input. If the SETMARK2OFFSET command has been entered, the MARK2PVA log will contain the solution translated, and then rotated, by the values provided in the command. See the SETMARK2OFFSET command, valid at the time, on *page 123*.

Message ID: **1068**

Log Type: **Synch**

Recommended Input:

```
log mark2pva onnew
```

Abbreviated ASCII Example:

```
MARK2PVA USB1 0 51.5 EXACT 1481 251850.001 00040000 5b8a 3388 1481 251850.001000000
51.116573435 -114.037237211 1040.805671970 0.000257666 -0.003030102 -0.000089758
3.082229474 -1.019023628 89.253955744 INS_SOLUTION_GOOD
```

Field #	Field Type	Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GNSS Week at Mark2 request	Ulong	4	H
3	Seconds	Seconds from week at Mark2	Double	8	H+4
4	Latitude	Latitude (WGS84) at Mark2	Double	8	H+12
5	Longitude	Longitude (WGS84) at Mark2	Double	8	H+20
6	Height	Height (WGS84) at Mark2	Double	8	H+28
7	North Velocity	Velocity in a northerly direction (a -ve value implies a southerly direction) at Mark2	Double	8	H+36
8	East Velocity	Velocity in an easterly direction (a -ve value implies a westerly direction) at Mark2	Double	8	H+44
9	Up Velocity	Velocity in an up direction at Mark2	Double	8	H+52
10	Roll	Right handed rotation from local level around y-axis in degrees at Mark2	Double	8	H+60
11	Pitch	Right handed rotation from local level around x-axis in degrees at Mark2	Double	8	H+68
12	Azimuth	Left handed rotation around z-axis Degrees clockwise from North at Mark2	Double	8	H+76
13	Status	INS Status, see *Table 7, Inertial Solution Status* on *page 41* at Mark2	Enum	4	H+84
14	xxxx	32-bit CRC	Hex	4	H+88
15	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

C.2.30 PASHR NMEA, Inertial Attitude Data

The PASHR log uses a UTC time, calculated with default parameters, to output NMEA messages without waiting for a valid almanac. The UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters and sets the UTC time to VALID. For more information about NMEA, refer to the *OEM6 Firmware Reference Manual* found on our Web site. The PASHR log contains only INS derived attitude information and is only filled when an inertial solution is available.

Message ID: 1177

Log Type Synch

Recommended Input:

```
log pashr ontime 1
```

Example:

```
$PASHR,,,,,,,,,,0*68 (empty)
$PASHR,195124.00,305.30,T,+0.05,-0.13,,0.180,0.185,4.986,1*2B
```

Field #	Structure	Field Description	Symbol	Example
1	$PASHR	Log Header	---	$PASHR
2	Time	UTC Time	hhmmss.ss	195124.00
3	Heading	Heading value in decimal degrees	HHH.HH	305.30
4	True Heading	T displayed if heading is relative to true north.	T	T
5	Roll	Roll in decimal degrees. The +/- sign will always be displayed.	RRR.RR	+0.05
6	Pitch	Pitch in decimal degrees. The +/- sign will always be displayed.	PPP.PP	-0.13
7	Reserved	------	----	----
8	Roll Accuracy	Roll standard deviation in decimal degrees.	rr.rrr	0.180
9	Pitch Accuracy	Pitch standard deviation in decimal degrees.	pp.ppp	0.185
10	Heading Accuracy	Heading standard deviation in decimal degrees.	hh.hhh	4.986
11	GPS Update Quality Flag	0 = No position 1 = All non-RTK fixed integer positions 2 = RTK fixed integer position	1	1
12	Checksum	Checksum	*XX	*2B
13	[CR][LF]	Sentence terminator		[CR][LF]

C.2.31 RAWIMU Raw IMU Data

This log contains an IMU status indicator and the measurements from the accelerometers and gyros with respect to the IMU enclosure frame. If logging this data, consider the RAWIMUS log to reduce the amount of data, see *page 174*.

Message ID: **268**

Log Type: **Asynch**

Recommended Input:

```
log rawimua onnew
```

ASCII Example:

```
#RAWIMUA,COM3,0,0.0,EXACT,1105,425384.180,00040000,b8ed,0;1105,425384.156166800,111607,43088060,430312,-3033352,-132863,186983,823*5aa97065
```

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GNSS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	IMU Status	The status of the IMU. This field is given in a fixed length (n) array of bytes in binary but in ASCII or Abbreviated ASCII is converted into 2 character hexadecimal pairs. For the raw IMU status, see one of the following tables: • *Table 60, iIMU-FSAS Status* on *page 169* • *Table 61, Litef LCI-1 IMU Status* on *page 170* • *Table 63, HG1700 and LN200 Status* on *page 171* • *Table 64, IMU-CPT Status* on *page 172* • *Table 65, HG1900 and HG1930 Status* on *page 173* Also refer to Interface Control Documentation as provided by Honeywell or Northrop Grumman.	Long	4	H+12
5	Z Accel Output	Change in velocity count along z axis [a]	Long	4	H+16
6	- (Y Accel Output)	- (Change in velocity count along y axis) [a, b]	Long	4	H+20
7	X Accel Output	Change in velocity count along x axis [a]	Long	4	H+24
8	Z Gyro Output	Change in angle count around z axis [c]. Right-handed.	Long	4	H+28
9	- (Y Gyro Output)	- (Change in angle count around y axis) [b, c]. Right-handed	Long	4	H+32
10	X Gyro Output	Change in angle count around x axis [c]. Right-handed	Long	4	H+36
11	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+40
12	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. The change in velocity (acceleration) scale factor for each IMU type can be found in *Table 66, Raw IMU Scale Factors* on *page 175*. Multiply the scale factor in *Table 66,* by the count in this field, for the velocity increments. See also *Table 1, SPAN-Compatible IMU Models* on *page 25* for a list of IMU enclosures.

b. A negative value implies that the output is along the positive Y-axis marked on the IMU.
A positive value implies that the change is in the direction opposite to that of the Y-axis marked on the IMU.

c. The change in angle (gyro) scale factor can be found in *Table 66, Raw IMU Scale Factors* on *page 175*. Multiply the appropriate scale factor in *Table 66,* by the count in this field, for the angle increments in radians. To obtain acceleration in m/s^2, multiply the velocity increments by the output rate of the IMU (e.g., 100 Hz for HG1700, HG1900 and HG1930; 200 Hz iMAR-FSAS, LN200 and LCI-1).

Table 60: iIMU-FSAS Status

Nibble #	Bit #	Mask	Description	Range Value
N0	0	0x00000001	Reserved	
	1	0x00000002		
	2	0x00000004		
	3	0x00000008		
N1	4	0x00000010	Gyro warm-up	Passed = 0, Failed = 1
	5	0x00000020	Gyro self-test active	Passed = 0, Failed = 1
	6	0x00000040	Gyro status bit set	Passed = 0, Failed = 1
	7	0x00000080	Gyro time-out command interface	Passed = 0, Failed = 1
N2	8	0x00000100	Power-up built-in test (PBIT)	Passed = 0, Failed = 1
	9	0x00000200	Reserved	
	10	0x00000400	Interrupt	Passed = 0, Failed = 1
	11	0x00000800	Reserved	
N3	12	0x00001000	Warm-up	Passed = 0, Failed = 1
	13	0x00002000	Reserved	
	14	0x00004000		
	15	0x00008000	Initiated built-in test (IBIT)	Passed = 0, Failed = 1
N4	16	0x00010000	Reserved	
	17	0x00020000		
	18	0x00040000	Accelerometer	Passed = 0, Failed = 1
	19	0x00080000	Accelerometer time-out	Passed = 0, Failed = 1
N5	20	0x00100000	Reserved	
	21	0x00200000	Gyro initiated BIT	Passed = 0, Failed = 1
	22	0x00400000	Gyro self-test	Passed = 0, Failed = 1
	23	0x00800000	Gyro time-out	Passed = 0, Failed = 1
N6	24	0x01000000	Analog-to-Digital (AD)	Passed = 0, Failed = 1
	25	0x02000000	Testmode	Passed = 0, Failed = 1
	26	0x04000000	Software	Passed = 0, Failed = 1
	27	0x08000000	RAM/ROM	Passed = 0, Failed = 1
N7	28	0x10000000	Reserved	
	29	0x20000000	Operational	Passed = 0, Failed = 1
	30	0x40000000	Interface	Passed = 0, Failed = 1
	31	0x80000000	Interface time-out	Passed = 0, Failed = 1

Table 61: Litef LCI-1 IMU Status

Nibble #	Bit #	Mask	Description	Range Value	
N0	0	0x00000001	IBIT Error Flag	Normal: 0, IBIT Error: 1	
	1	0x00000002	CBIT Error Flag	Normal: 0, CBIT Error: 1	
	2	0x00000004	Calibration Status Flag	IMU Uncalibrated: 0, IMU Calibrated: 1	
	3	0x00000008	Not used		
N1	4	0x00000010	Mode Read Flag	Mode in Trans.: 0, Mode	Refer to *Table 62 on page 170*
	5	0x00000020	IMU Mode Indication 1	Not Set: 0, Set: 1	
	6	0x00000040	IMU Mode Indication 2	Not Set: 0, Set: 1	
	7	0x00000080	IMU Mode Indication 3	Not Set: 0, Set: 1	
N2	8	0x00000100	Master NoGo	Normal: 0, NoGo: 1	
	9	0x00000200	IMU NoGo	Normal: 0, NoGo: 1	
	10	0x00000400	B-290 Z NoGo	Normal: 0, NoGo: 1	
	11	0x00000800	B-290 Y NoGo	Normal: 0, NoGo: 1	
N3	12	0x00001000	B-290 X NoGo	Normal: 0, NoGo: 1	
	13	0x00002000	FORS Z NoGo	Normal: 0, NoGo: 1	
	14	0x00004000	FORS Y NoGo	Normal: 0, NoGo: 1	
	15	0x00008000	FORS X NoGo	Normal: 0, NoGo: 1	
N4	16	0x00010000	Master Warning	Normal: 0, Warning: 1	
	17	0x00020000	IMU Warning	Normal: 0, Warning: 1	
	18	0x00040000	B-290 Z Warning	Normal: 0, Warning: 1	
	19	0x00080000	B-290 Y Warning	Normal: 0, Warning: 1	
N5	20	0x00100000	B-290 X Warning	Normal: 0, Warning: 1	
	21	0x00200000	FORS Z Warning	Normal: 0, Warning: 1	
	22	0x00400000	FORS Y Warning	Normal: 0, Warning: 1	
	23	0x00800000	FORS X Warning	Normal: 0, Warning: 1	
N6	24	0x01000000	Not Used		
	25	0x02000000			
	26	0x04000000			
	27	0x08000000			
N7	28	0x10000000			
	29	0x20000000			
	30	0x40000000			
	31	0x80000000			

Table 62: Mode Indication

MDI3	MDI2	MDI1	MRF	Current IMU Mode
0	0	0	0	Power On BIT (PBIT)
0	0	0	1	Standby Mode
0	1	1	0	Initiated BIT (IBIT)
0	1	1	1	IBIT Ready
1	1	0	1	Operational Mode

Table 63: HG1700 and LN200 Status

Nibble #	Bit #	Mask	HG1700 Description		LN200 Description	
N0	0	0x00000001	Reserved		IMU Status	Passed = 0, Failed = 1
	1	0x00000002	Reserved		IMU Status	Passed = 0, Failed = 1
	2	0x00000004	Reserved		IMU Status	Passed = 0, Failed = 1
	3	0x00000008	Reserved		IMU Status	Passed = 0, Failed = 1
N1	4	0x00000010	IMU Status	Passed = 0, Failed = 1	IMU Status	Passed = 0, Failed = 1
	5	0x00000020	IMU Status	Passed = 0, Failed = 2	IMU Status	Passed = 0, Failed = 1
	6	0x00000040	IMU Status	Passed = 0, Failed = 3	IMU Status	Passed = 0, Failed = 1
	7	0x00000080	IMU Status	Passed = 0, Failed = 4	IMU Status	Passed = 0, Failed = 1
N2	8	0x00000100	Reserved		IMU Status	Passed = 0, Failed = 1
	9	0x00000200	Reserved		IMU Status	Passed = 0, Failed = 1
	10	0x00000400	Reserved		IMU Status	Passed = 0, Failed = 1
	11	0x00000800	Reserved		IMU Status	Passed = 0, Failed = 1
N3	12	0x00001000	Reserved		IMU Status	Passed = 0, Failed = 1
	13	0x00002000	Reserved		IMU Status	Passed = 0, Failed = 1
	14	0x00004000	Reserved		IMU Status	Passed = 0, Failed = 1
	15	0x00008000	Reserved		Reserved	
N4	16	0x00010000	Reserved		Reserved	
	17	0x00020000	Reserved		Reserved	
	18	0x00040000	Reserved		Reserved	
	19	0x00080000	Reserved		Reserved	
N5	20	0x00100000	Reserved		Reserved	
	21	0x00200000	Reserved		Reserved	
	22	0x00400000	Reserved		Reserved	
	23	0x00800000	Reserved		Reserved	
N6	24	0x01000000	Reserved		IMU Status	Passed = 0, Failed = 1
	25	0x02000000	Reserved		IMU Status	Passed = 0, Failed = 1
	26	0x04000000	Reserved		IMU Status	Passed = 0, Failed = 1
	27	0x08000000	IMU Status	Passed = 0, Failed = 1	IMU Status	Passed = 0, Failed = 1
N7	28	0x10000000	IMU Status	Passed = 0, Failed = 1	IMU Status	Passed = 0, Failed = 1
	29	0x20000000	IMU Status	Passed = 0, Failed = 1	Reserved	
	30	0x40000000	IMU Status	Passed = 0, Failed = 1	IMU Status	Passed = 0, Failed = 1
	31	0x80000000	IMU Status	Passed = 0, Failed = 1	Reserved	

Table 64: IMU-CPT Status

Nibble #	Bit #	Mask	Description	Range Value
N0	0	0x00000001	Gyro X Status	1: Valid, 0: Invalid
	1	0x00000002	Gyro Y Status	1: Valid, 0: Invalid
	2	0x00000004	Gyro Z Status	1: Valid, 0: Invalid
	3	0x00000008	Unused	Set to 0
N1	4	0x00000010	Accelerometer X Status	1: Valid, 0: Invalid
	5	0x00000020	Accelerometer Y Status	1: Valid, 0: Invalid
	6	0x00000040	Accelerometer Z Status	1: Valid, 0: Invalid
	7	0x00000080	Unused	Set to 0
N2	8	0x00000100	Unused	
	9	0x00000200		
	10	0x00000400		
	11	0x00000800		
N3	12	0x00001000		
	13	0x00002000		
	14	0x00004000		
	15	0x00008000		
N4	16	0x00010000		
	17	0x00020000		
	18	0x00040000		
	19	0x00080000		
N5	20	0x00100000		
	21	0x00200000		
	22	0x00400000		
	23	0x00800000		
N6	24	0x01000000		
	25	0x02000000		
	26	0x04000000		
	27	0x08000000		
N7	28	0x10000000		
	29	0x20000000		
	30	0x40000000		
	31	0x80000000		

Table 65: HG1900 and HG1930 Status

Nibble #	Bit #	Mask	Description	Range Value
N0	0	0x00000001	Reserved	
	1	0x00000002		
	2	0x00000004		
	3	0x00000008		
N1	4	0x00000010	IMU Failed	Passed: 0, Failed: 1
	5	0x00000020	Gyro Failed	Passed: 0, Failed: 1
	6	0x00000040	Accel Failed	Passed: 0, Failed: 1
	7	0x00000080	AGC Voltage	Passed: 0, Failed: 1
N2	8	0x00000100	Reserved	
	9	0x00000200		
	10	0x00000400		
	11	0x00000800		
N3	12	0x00001000	Reserved	
	13	0x00002000		
	14	0x00004000		
	15	0x00008000		
N4	16	0x00010000	Reserved	
	17	0x00020000		
	18	0x00040000		
	19	0x00080000		
N5	20	0x00100000	Reserved	
	21	0x00200000		
	22	0x00400000		
	23	0x00800000		
N6	24	0x01000000	Motor Bias Voltage	Passed: 0, Failed: 1
	25	0x02000000	Reserved	
	26	0x04000000	Processor	Passed: 0, Failed: 1
	27	0x08000000	Memory	Passed: 0, Failed: 1
N7	28	0x10000000	ASIC	Passed: 0, Failed: 1
	29	0x20000000	Gyro Frequency	Passed: 0, Failed: 1
	30	0x40000000	Accel Frequency	Passed: 0, Failed: 1
	31	0x80000000	Reserved	

C.2.32 RAWIMUS Short Raw IMU Data

This is a short header version of the *RAWIMU* log on *page 168*.

Message ID: **325**

Log Type: **Asynch**

Recommended Input:

```
log rawimusa onnew
```

ASCII Example:

```
%RAWIMUSA,1105,425384.180;1105,425384.156166800,111607,43088060,430312,
-3033352,-132863,186983,823*5aa97065
```

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GNSS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	IMU Status	The status of the IMU. This field is given in a fixed length (n) array of bytes in binary but in ASCII or Abbreviated ASCII is converted into 2 character hexadecimal pairs. For the raw IMU status, see one of the following tables: • *Table 60, iIMU-FSAS Status* on *page 169* • *Table 61, Litef LCI-1 IMU Status* on *page 170* • *Table 63, HG1700 and LN200 Status* on *page 171* • *Table 64, IMU-CPT Status* on *page 172* • *Table 65, HG1900 and HG1930 Status* on *page 173* Also refer to Interface Control Documentation as provided by Honeywell or Northrop Grumman.	Long	4	H+12
5	Z Accel Output	Change in velocity count along z axis [a]	Long	4	H+16
6	- (Y Accel Output)	- (Change in velocity count along y axis) [a, b]	Long	4	H+20
7	X Accel Output	Change in velocity count along x axis [a]	Long	4	H+24
8	Z Gyro Output	Change in angle count around z axis [c] Right-handed	Long	4	H+28
9	- (Y Gyro Output)	- (Change in angle count around y axis) [b, c] Right-handed	Long	4	H+32
10	X Gyro Output	Change in angle count around x axis [c] Right-handed	Long	4	H+36
11	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+40
12	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. The change in velocity (acceleration) scale factor for each IMU type can be found in *Table 66, Raw IMU Scale Factors* on *page 175*. Multiply the scale factor in *Table 66,* by the count in this field, for the velocity increments. See also *Table 1, SPAN-Compatible IMU Models* on *page 25* for a list of IMU enclosures.

b. A negative value implies that the output is along the positive Y-axis marked on the IMU. A positive value implies that the change is in the direction opposite to that of the Y-axis marked on the IMU.

c. The change in angle (gyro) scale factor can be found in *Table 66, Raw IMU Scale Factors* on *page 175*. Multiply the appropriate scale factor in *Table 66,* by the count in this field, for the angle increments in radians. To obtain acceleration in m/s^2, multiply the velocity increments by the output rate of the IMU (e.g., 100 Hz for HG1700, HG1900 and HG1930; 200 Hz iMAR-FSAS, LN200 and LCI-1).

Table 66: Raw IMU Scale Factors

	Gyroscope Scale Factor	Acceleration Scale Factor
HG1700-AG11 HG1700-AG58 HG1900-CA29/CA50 HG1930-AA99/CA50	2.0^{-33} rad/LSB	2.0^{-27} ft/s/LSB
HG1700-AG17 HG1700-AG62	2.0^{-33} rad/LSB	2.0^{-26} ft/s/LSB
IMU-CPT	0.1 / (3600.0x256.0) rad/LSB	$0.05/2^{15}$ m/s/LSB
iIMU-FSAS	0.1x 2^{-8} arcsec/LSB	0.05 x 2^{-15} m/s/LSB
Litef LCI-1	4 x 2^{-31} deg/LSB	2 x 2^{-31} m/s/LSB
LN-200	2^{-19} rad/LSB	2^{-14} m/s/LSB

C.2.33 RAWIMUSX IMU Data Extended

This is the short header version of the extended RAWIMUX log intended for use with post processing. The extended version includes IMU information that is used by NovAtel's Inertial Explorer post-processing software.

Message ID: **1462**

Log Type: **Asynch**

Recommended Input:

```
log rawimusxb onnew
```

ASCII example:

```
%RAWIMUSXA,1692,484620.664;00,11,1692,484620.664389000,00801503,43110635,-817242,
-202184,-215194,-41188,-9895*a5db8c7b
```

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header (short)	-	H	0
2	IMU Error	Simple IMU error flag. 1 = IMU error 0 = IMU okay. If there is an IMU error, check the IMU Status field for details.	Uchar	1	H
3	IMU Type	IMU Type identifier. See *Table 41, IMU Type* on *page 99*.	Uchar	1	H+1
4	GNSS Week	GNSS Week	Ushort	2	H+2
5	GNSS Week Seconds	Seconds from week start	Double	8	H+4
6	IMU Status	The status of the IMU. This field is given in a fixed length (n) array of bytes in binary but in ASCII or Abbreviated ASCII is converted into 2 character hexadecimal pairs. For the raw IMU status, see one of the following tables: • *Table 60, iIMU-FSAS Status* on *page 169* • *Table 61, Litef LCI-1 IMU Status* on *page 170* • *Table 63, HG1700 and LN200 Status* on *page 171* • *Table 64, IMU-CPT Status* on *page 172* • *Table 65, HG1900 and HG1930 Status* on *page 173* Also refer to Interface Control Documentation as provided by Honeywell or Northrop Grumman.	Hex	4	H+12
7	Z Accel	Change in velocity count along Z-axis. [a]	Long	4	H+16
8	-(Y Accel)	- (Change in velocity count along y-axis.) [a, b]	Long	4	H+20
9	X Accel	Change in velocity count along x axis. [a]	Long	4	H+24
10	Z Gyro	Change in angle count around z axis. [c] Right-handed	Long	4	H+28
11	-(Y Gyro)	- (Change in angle count around y axis.) [b, c] Right-handed	Long	4	H+32
12	X Gyro	Change in angle count around x axis. [c] Right-handed	Long	4	H+36
13	XXXX	32-bit CRC (ASCII, Binary, and Short Binary only)	Hex	4	H+40

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
14	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. The change in velocity (acceleration) scale factor for each IMU type can be found in *Table 66, Raw IMU Scale Factors* on *page 175*. Multiply the scale factor in *Table 66,* by the count in this field, for the velocity increments. See also *Table 1, SPAN-Compatible IMU Models* on *page 25* for a list of IMU enclosures.

b. A negative value implies that the output is along the positive Y-axis marked on the IMU.
A positive value implies that the change is in the direction opposite to that of the Y-axis marked on the IMU.

c. The change in angle (gyro) scale factor can be found in *Table 66, Raw IMU Scale Factors* on *page 175*. Multiply the appropriate scale factor in *Table 66,* by the count in this field, for the angle increments in radians. To obtain acceleration in m/s^2, multiply the velocity increments by the output rate of the IMU (e.g., 100 Hz for HG1700, HG1900 and HG1930; 200 Hz iMAR-FSAS, LN200 and LCI-1).

C.2.34 RAWIMUX IMU Data Extended

This is an extended version of the RAWIMU log intended for use with post processing. The extended version includes IMU information that is used by NovAtel's Inertial Explorer post-processing software.

Message ID: **1461**
Log Type: **Asynch**

Recommended Input:

```
log rawimuxb onnew
```

ASCII example:

```
#RAWIMUXA,COM1,0,81.5,FINESTEERING,1691,410338.819,004c0020,3fd1,43495;00,5,1691,
410338.818721000,00170705,-113836,-464281,43146813,89,11346,181*01cd06bf
```

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	IMU Error	Simple IMU error flag. 1 = IMU error 0 = IMU okay. If there is an IMU error, check the IMU Status field for details.	Uchar	1	H
3	IMU Type	IMU Type identifier. See *Table 41, IMU Type* on *page 99*.	Uchar	1	H+1
4	GNSS Week	GNSS Week	Ushort	2	H+2
5	GNSS Week Seconds	Seconds from week start	Double	8	H+4
6	IMU Status	The status of the IMU. This field is given in a fixed length (n) array of bytes in binary but in ASCII or Abbreviated ASCII is converted into 2 character hexadecimal pairs. For the raw IMU status, see one of the following tables: • *Table 60, iIMU-FSAS Status* on *page 169* • *Table 61, Litef LCI-1 IMU Status* on *page 170* • *Table 63, HG1700 and LN200 Status* on *page 171* • *Table 64, IMU-CPT Status* on *page 172* • *Table 65, HG1900 and HG1930 Status* on *page 173* Also refer to Interface Control Documentation as provided by Honeywell or Northrop Grumman.	Hex	4	H+12
7	Z Accel	Change in velocity count along Z-axis. [a]	Long	4	H+16
8	-(Y Accel)	- (Change in velocity count along y-axis.) [a, b]	Long	4	H+20
9	X Accel	Change in velocity count along x axis. [a]	Long	4	H+24
10	Z Gyro	Change in angle count around z axis. [c] Right-handed	Long	4	H+28
11	-(Y Gyro)	- (Change in angle count around y axis.) [b, c] Right-handed	Long	4	H+32
12	X Gyro	Change in angle count around x axis. [c] Right-handed	Long	4	H+36
13	XXXX	32-bit CRC (ASCII, Binary, and Short Binary only)	Hex	4	H+40

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
14	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. The change in velocity (acceleration) scale factor for each IMU type can be found in *Table 66, Raw IMU Scale Factors* on *page 175*. Multiply the scale factor in *Table 66,* by the count in this field, for the velocity increments. See also *Table 1, SPAN-Compatible IMU Models* on *page 25* for a list of IMU enclosures.

b. A negative value implies that the output is along the positive Y-axis marked on the IMU.
A positive value implies that the change is in the direction opposite to that of the Y-axis marked on the IMU.

c. The change in angle (gyro) scale factor can be found in *Table 66, Raw IMU Scale Factors* on *page 175*. Multiply the appropriate scale factor in *Table 66,* by the count in this field, for the angle increments in radians. To obtain acceleration in m/s^2, multiply the velocity increments by the output rate of the IMU (e.g., 100 Hz for HG1700, HG1900 and HG1930; 200 Hz iMAR-FSAS, LN200 and LCI-1).

C.2.35 TAGGEDMARK1PVA

TAGGEDMARK1PVA is identical to MARK1PVA but with a unique identifying number (tag).

The user specifies a TAG for the upcoming TAGGEDMARKPVA via the TAGNEXTMARK command. That tag shows up at the end of this message, which is otherwise identical to the MARK1PVA message.

Message ID: **1258**

Log Type: **Synch**

Recommended Input:

```
log taggedmark1pva onnew
```

Abbreviated ASCII Example:

```
TAGGEDMARK1PVA USB1 0 51.5 EXACT 1481 251850.001 00040000 46f4 3388 1481
251850.001000000 51.116573435 -114.037237211 1040.805671970 0.000257666 -0.003030102 -
0.000089758 3.082229474 -1.019023628 89.253955744 INS_SOLUTION_GOOD 1234 *5aa97065
```

Field #	Field Type	Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log Header	-	H	0
2	Week	GNSS Week at Mark 1 request	Ulong	4	H
3	Seconds into Week	GNSS Seconds at Mark1 request	Double	8	H+4
4	Latitude	Latitude at Mark 1 request	Double	8	H+12
5	Longitude	Longitude at Mark 1 request	Double	8	H+20
6	Height	Height at Mark 1 request	Double	8	H+28
7	North Velocity	North Velocity at Mark 1 request	Double	8	H+36
8	East Velocity	East Velocity at Mark1 request	Double	8	H+44
9	Up Velocity	Up Velocity at Mark 1 request	Double	8	H+52
10	Roll	Roll at Mark1 request	Double	8	H+60
11	Pitch	Pitch at Mark1 request	Double	8	H+68
12	Azimuth	Azimuth at Mark1 request	Double	8	H+76
13	Status	INS Status at Mark 1 request	Enum	4	H+84
14	Tag	Tag ID from TAGNEXTMARK command. If any.	Ulong	4	H+88
15	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+92
16	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

C.2.36 TAGGEDMARK2PVA

> TAGGEDMARK2PVA is identical to MARK2PVA but with a unique identifying number (tag).

The user specifies a TAG for the upcoming TAGGEDMARKPVA via the TAGNEXTMARK command. That tag shows up at the end of this message, which is otherwise identical to the MARK2PVA message.

Message ID: **1259**

Log Type: **Synch**

Recommended Input:

```
log taggedmark2pva onnew
```

Abbreviated ASCII Example:

```
TAGGEDMARK2PVA USB1 0 51.5 EXACT 1481 251850.001 00040000 46f4 3388 1481
251850.001000000 51.116573435 -114.037237211 1040.805671970 0.000257666 -0.003030102 -
0.000089758 3.082229474 -1.019023628 89.253955744 INS_SOLUTION_GOOD 1234 *5aa97066
```

Field #	Field Type	Description	Format	Bytes	Offset
1	Log Header	Log Header	-	H	0
2	Week	GNSS Week at Mark2 request	Ulong	4	H
3	Seconds into Week	GNSS Seconds at Mark2 request	Double	8	H+4
4	Latitude	Latitude at Mark2 request	Double	8	H+12
5	Longitude	Longitude at Mark2 request	Double	8	H+20
6	Height	Height at Mark2 request	Double	8	H+28
7	North Velocity	North Velocity at Mark2 request	Double	8	H+36
8	East Velocity	East Velocity at Mark2 request	Double	8	H+44
9	Up Velocity	Up Velocity at Mark2 request	Double	8	H+52
10	Roll	Roll at Mark2 request	Double	8	H+60
11	Pitch	Pitch at Mark2 request	Double	8	H+68
12	Azimuth	Azimuth at Mark2 request	Double	8	H+76
13	Status	INS Status at Mark2 request	Enum	4	H+84
14	Tag	Tag ID from TAGNEXTMARK command. If any.	Ulong	4	H+88
15	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+92
16	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

C.2.37 TIMEDWHEELDATA Timed Wheel Data

This log contains time stamped wheel sensor data. The time stamp in the header is the time of validity for the wheel data, not the time the TIMEDWHEELDATA log was output.

This log contains information from the WHEELVELOCITY command, but has the time of the wheel sensor measurement in the message header. It is primarily used to support wheel sensor information to a post-processing utility. Time in the log header is the time of the last PPS pulse plus the latency from the WHEELVELOCITY log.

See also *Section 3.3.6, SPAN Wheel Sensor Messages* on *page 46*.

> If you are using an iMAR iMWS (Magnetic Wheel Speed Sensor and Convertor), Field #4, the float wheel velocity is filled instead of Field #3, the unsigned short wheel velocity.
>
> When you send a WHEELVELOCITY command, see *page 128*, from an external wheel sensor, the TIMEDWHEELDATA log contains the same wheel velocity values, float or ushort, as those you entered.
>
> Note that neither velocity value is used by the SPAN filter. Rather, the SPAN filter uses cumulative ticks per second.
>
> If post-processing, the velocities may be used with the NovAtel Waypoint Group's Inertial Explorer software.

Message ID: 622
Log Type: Asynch

Recommended Input:

```
log timedwheeldataa onnew
```

ASCII Example:

```
%TIMEDWHEELDATAA,1393,411345.001;58,0,215.814910889,0,0,1942255*3b5fa236
```

This example is from the iMAR iMWS wheel sensor.

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header (short header)	-	H	0
2	Ticks Per Rev	Number of ticks per revolution	Ushort	2	H
3	Wheel Vel	Wheel velocity in counts/s	Ushort	2	H+2
4	fWheel Vel	Float wheel velocity in counts/s	Float	4	H+4
5	Reserved		Ulong	4	H+8
6			Ulong	4	H+12
7	Ticks Per Second	Cumulative number of ticks	Ulong	4	H+16
8	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+20
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

C.2.38 TSS1 TSS1 Protocol for Heave, Roll and Pitch

This log provides heave, roll and pitch information in TSS1 protocol.

> This message is in a different format than any other log output by the SPAN system.

Message ID: **1456**
Log Type: **Synch**

Recommended Input:

```
log tss1a ontime 1
```

Message Format:

```
:XXAAAASMHHHHQMRRRRSMPPPP<CR><LF>
```

ASCII Example:

```
:00FFCA -0003F-0325  0319
```

Field #	Field Type	Data Description	Symbol	Example
1	Log Header	Log header	-	0
2	Horizontal Acceleration	Horizontal acceleration from 0 to 9.81m/s^2. Shown as a one byte unsigned hex number where the least significant bit = 3.83 cm/s^2.	XX	00
3	Vertical Acceleration	Vertical acceleration from -20.48 to +20.48 m/s^2. Shown as a two byte hex number where the least significant bit = 0.0625 cm/s^2.	AAAA	FFCA
4	Space Character	A space delimiter.	S	
5	Heave Polarity	Space if positive. Minus sign (**-**) if negative.	M	-
6	Heave	Heave value from -99.99 to +99.99 m. Shown as a four digit integer where the least significant bit = 0.01 m.	HHHH	0003
7	Status Flag	**F** if INS Active (see *Section 3.3.2, Navigation Mode* on *page 43*). **H** if INS has not completed an alignment.	Q	F
8	Roll Polarity	Space if positive. Minus sign (**-**) if negative.	M	-
9	Roll	Roll value from -99.99 to +99.99 degrees. Shown as a four digit integer where the least significant bit = 0.01 degrees.	RRRR	0325
10	Space Character	A space delimiter.	S	
11	Pitch Polarity	Space if positive. Minus sign (**-**) if negative.	M	
12	Pitch	Pitch value from -99.99 to +99.99 degrees. Shown as a four digit integer where the least significant bit = 0.01 degrees.	PPPP	0319
13	[CR][LF]	Sentence terminator	<CR><LF>	

C.2.39 VARIABLELEVERARM Display variable lever arm details

Use this log to redisplay the re-calculated variable lever arm whenever a new INPUTGIMBALANGLE command is received.

This log is not output until the INS alignment is complete.

Message ID: **1320**

Log Type: **Asynch**

Recommended Input:

```
log variableleverarma onnew
```

ASCII Example:

```
#VARIABLELEVERARMA,SPECIAL,0,81.5,FINESTEERING,1614,495820.512,40040000,0000,320;
-0.0959421909646755,0.1226971902356540,1.1319295452903300,
0.0100057787272846,0.0122604827412661,0.1131929545290330*9611d3c6
```

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	XOffset	SPAN body frame X-axis offset	Double	8	H
3	YOffset	SPAN body frame Y-axis offset	Double	8	H+8
4	ZOffset	SPAN body frame Z-axis offset	Double	8	H+16
5	XUncert	X-axis uncertainty in degrees	Double	8+24	H
6	YUncert	Y-axis uncertainty in degrees	Double	8+32	H
7	ZUncert	Z-axis uncertainty in degrees	Double	8+40	H
8	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+24
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

C.2.40 VEHICLEBODYROTATION Vehicle to SPAN frame Rotation

The VEHICLEBODYROTATION log reports the angular offset from the vehicle frame to the SPAN frame. The SPAN frame is defined by the transformed IMU enclosure axis with Z pointing up, see the SETIMUORIENTATION command on *page 114*. If your IMU is mounted with the Z axis (as marked on the IMU enclosure) pointing up, the IMU enclosure frame is the same as the SPAN frame. This log reports whatever was entered using the VEHICLEBODYROTATION command, *page 126*, or whatever was solved for after invoking the RVBCALIBRATE command, see *page 110*.

See the syntax table in *Section B.2.28, VEHICLEBODYROTATION Vehicle to SPAN frame Rotation* starting on *page 126* for more information.

Message ID: 642

Recommended Input:

```
log vehiclebodyrotationa onchanged
```

ASCII Example:

```
#VEHICLEBODYROTATIONA,COM1,0,36.5,FINESTEERING,1264,144170.094,00000000,bcf2,1541;1.5
869999997474209,2.6639999995760122,77.6649999876392343,2.0000000000000000,2.000000000
0000000,5.0000000000000000*25f886cc
```

Field #	Field Type	Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log Header	-	H	0
2	X Angle	Right hand rotation about vehicle frame X axis, degrees	Double	8	H
3	Y Angle	Right hand rotation about vehicle frame Y axis, degrees	Double	8	H+8
4	Z Angle	Right hand rotation about vehicle frame Z axis, degrees	Double	8	H+16
5	X Uncertainty	Uncertainty of X rotation, degrees (default = 0)	Double	8	H+24
6	Y Uncertainty	Uncertainty of Y rotation, degrees (default = 0)	Double	8	H+32
7	Z Uncertainty	Uncertainty of Z rotation, degrees (default = 0)	Double	8	H+40
8	xxxx	32-bit CRC	Hex	4	H+48
9	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

C.2.41 WHEELSIZE Wheel Size

This log contains wheel sensor information.

The inertial filter models the size of the wheel to compensate for changes in wheel circumference due to hardware or environmental changes. The default wheel size is 1.96 m. A scale factor to this default size is modeled in the filter and this log contains the current estimate of the wheel size.

Message ID: **646**

Log Type: **Asynch**

Recommended Input:

```
log wheelsizea onnew
```

ASCII Example:

```
#WHEELSIZEA,COM3,0,44.0,EXACT,0,0.000,00000000,85f8,33738;
1.025108123,2.009211922,0.000453791*157fd50b
```

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Scale	Wheel sensor scale factor	Double	8	H
3	Circum	Wheel circumference (m)	Double	8	H+8
4	Var	Variance of circumference (m^2)	Double	8	H+16
5	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+24
6	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Appendix D Command Prompt Interface

When the SPAN system turns on, no activity information is transmitted from the serial ports except for the port prompt. A terminal connected to the receiver display a messages on its monitor. For example:

```
[COM2]   if connected to COM2 port
```

The COM port can be COM1, COM2, COM3, USB1, USB2, USB3, or AUX. Commands are typed at the interfacing terminal keyboard, and sent after pressing the terminal's <↵> or <Enter> key.

> Most valid commands do produce a visible response on the screen. The indication that they have been accepted is a return of the port prompt from the receiver.

An example of no echo response to an input command is the SETIMUTOANTOFFSET command. It can be entered as follows:

```
[COM2]>setimutoantoffset 0.1 0.1 0.1[Return]
[COM2]>
```

The above example illustrates command input to the receiver COM2 serial port, which sets the antenna to IMU offset. However, your only confirmation that the command was actually accepted is the return of the [COM2]> prompt.

If a command is incorrectly entered, the receiver responds with "Invalid Command Name" (or a more detailed error message) followed by the port prompt.

D.1 DOS

One way to initiate multiple commands and logging from the receiver is to create DOS command files relating to specific functions. This minimizes the time required to set up duplicate test situations. Any convenient text editor can be used to create command text files.

Example:

For this example, consider a situation where a laptop computer with an appropriately configured COM1 serial port is connected to the receiver COM1 serial port, and where a rover terminal is connected to the receiver COM2 serial port. If you wish to monitor the SPAN system activity, the following command file could be used to do this.

1. Open a text editor on the computer and type in the following command sequences:

   ```
   log com2 satvisa ontime 15
   log com2 trackstata ontime 15
   log com2 rxstatusa ontime 60 5
   log com2 bestposa ontime 15
   log com2 psrdopa ontime 15
   ```

2. Save this with a convenient file name (e.g. C:\GNSS\BOOT1.TXT) and exit the text editor.
3. Use the DOS *copy* command to direct the contents of the BOOT1.TXT file to the COM1 serial port of the computer:

   ```
   C:\GNSS>copy boot1.txt com1
   1 file(s) copied
   C:\GNSS>
   ```

4. The SPAN system is now initialized with the contents of the BOOT1.TXT command file, and logging is directed from the receiver's COM2 serial port to the rover terminal.

D.2 WINDOWS

As any text editor or communications program can be used for these purposes, the use of Windows 98 is described only as an illustration. The following example shows how Windows 98 accessory programs *Notepad* and *HyperTerminal* can be used to create a hypothetical waypoint navigation file on a laptop computer, and send it to the receiver. It is assumed that the laptop computer COM1 serial port is connected to the receiver COM1 serial port, and that a rover terminal is connected to the receiver COM2 serial port.

Example:

1. Open *Notepad* and type in the following command text:

```
setnav 51.111 -114.039 51.555 -114.666 0 start stop
magvar -21
log com1 bestposa ontime 15
log com1 psrvela ontime 15
log com1 navigatea ontime 15
log com2 gprmb ontime 15 5
log com2 gpvtg ontime 15 5
log com2 rxconfiga ontime 60
```

2. Save this with a convenient file name (e.g. C:\GNSS\BOOTNAV1.TXT) and exit *Notepad*.
3. Ensure that the *HyperTerminal* settings are correctly set up to agree with the receiver communications protocol; these settings can be saved (e.g. C:\GNSS\OEMSETUP.HT) for use in future sessions. You may wish to use XON / XOFF handshaking to prevent loss of data.
4. Select Transfer | Send Text File to locate the file that is to be sent to the receiver. Once you double-click on the file or select Open, *HyperTerminal* sends the file to the receiver.

The above example initializes the SPAN system with origin and destination waypoint coordinates and sets the magnetic variation correction to -21 degrees. The BESTPOSA, PSRVELA, and NAVIGATEA logs have been set to output from the receiver COM1 serial port at intervals of once every 15 seconds, whereas the GPRMB and GPVTG NMEA logs have been set to be logged out of the receiver COM2 serial port at intervals of 15 seconds and offset by five seconds. The RXCONFIGA log has been set to output every 60 seconds from the COM2 serial port.

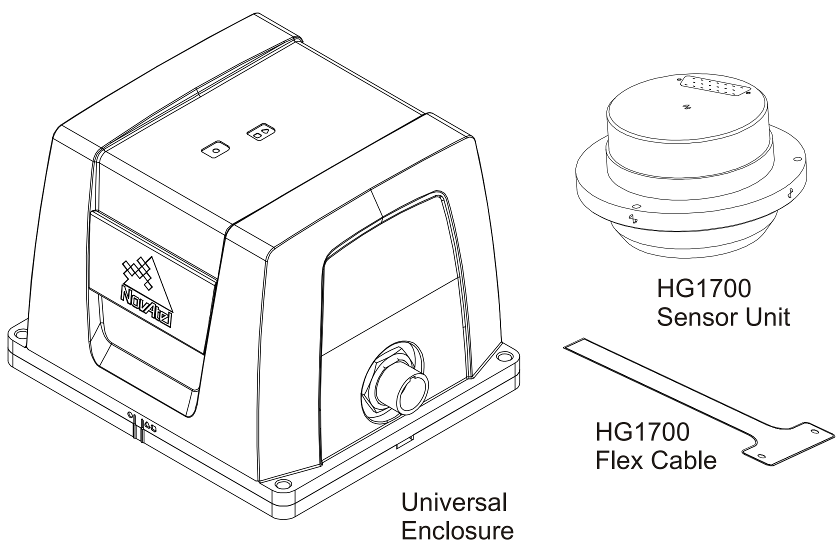
Appendix E HG1700 IMU in Universal Enclosure

Important! Assemble in accordance with applicable industry standards. Ensure all ESD measures are in place, in particular, use a ground strap before exposing or handling any electronic items, including the IMU. Take care to prevent damaging or marring painted surfaces, O-rings, sealing surfaces and the IMU.

The following procedure provides the necessary information to install the HG1700 sensor into the Universal Enclosure (NovAtel part number 01018589), both illustrated below. The steps required for this procedure are:

- Disassemble the Universal Enclosure
- Install the HG1700 Sensor Unit
- Reassemble the Universal Enclosure

Figure 42: Required Parts



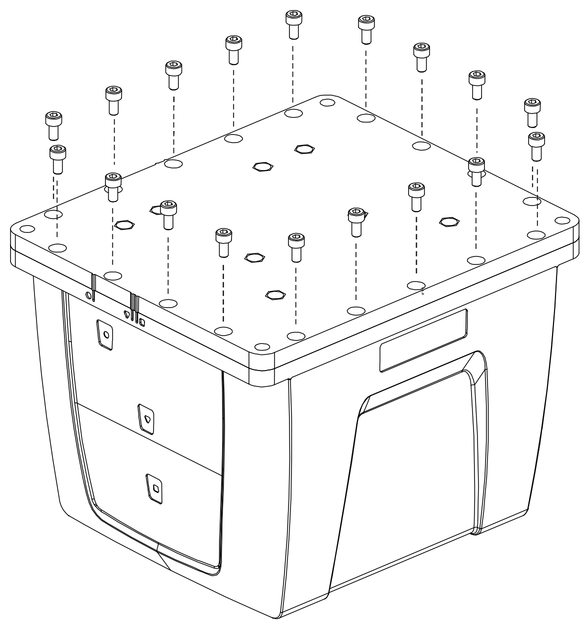
1. Use thread-locking fluid on all fasteners except for the flex cable connectors.
2. Torque values for all fasteners, including those for the flex cable, are as follows:
   Size 2-56: 0.20-0.25 N-m (1.8-2.2 lb-in) [28-35 oz/in]
   Size M4: 1.36-1.58 N-m (12.0-14.0 lb-in)
   Size 8-32: 1.55-1.70 N-m (13.7-15.0 lb-in)

E.1 Disassemble the Universal Enclosure

Disassemble the Universal Enclosure as follows:

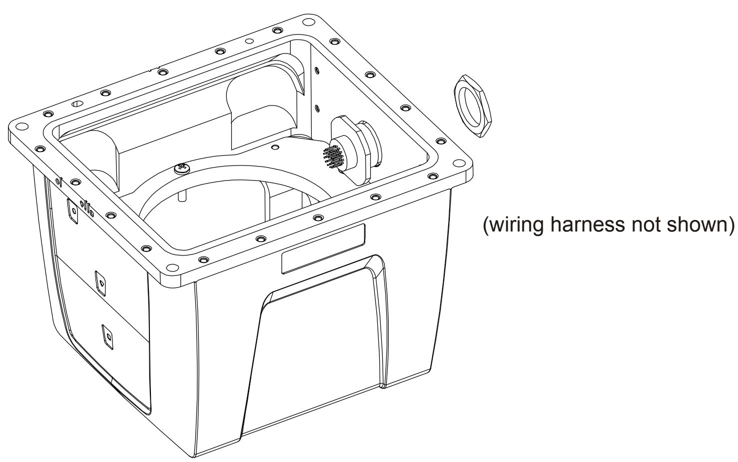
1. Using a 3 mm hex bit, remove the M4 screws (they will be reused) and the base, as shown in *Figure 43*. Ensure the O-rings come with the base when it is removed, and that they are not damaged.

Figure 43: Remove Base



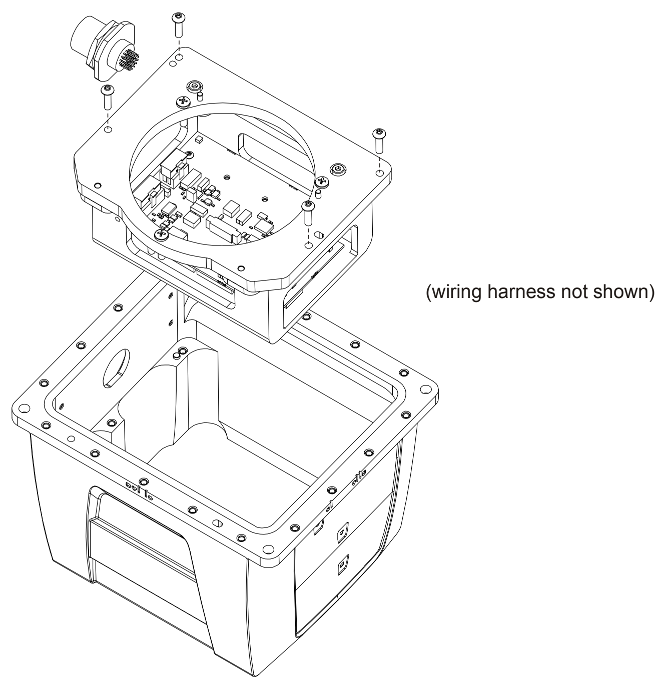
2. Using a 30 mm socket, remove the jam nut and free the wiring harness connector from the body, as shown in *Figure 2*. Retain the O-ring and the jam nut for reassembly.

Figure 44: Disconnect Wiring Harness from Enclosure Body



3. Using a 2.5 mm hex bit, unscrew the M4 screws and remove the IMU mounting plate, bracket and cable harness, as shown in *Figure 45*:

Figure 45: Remove IMU Mounting Plate and Bracket

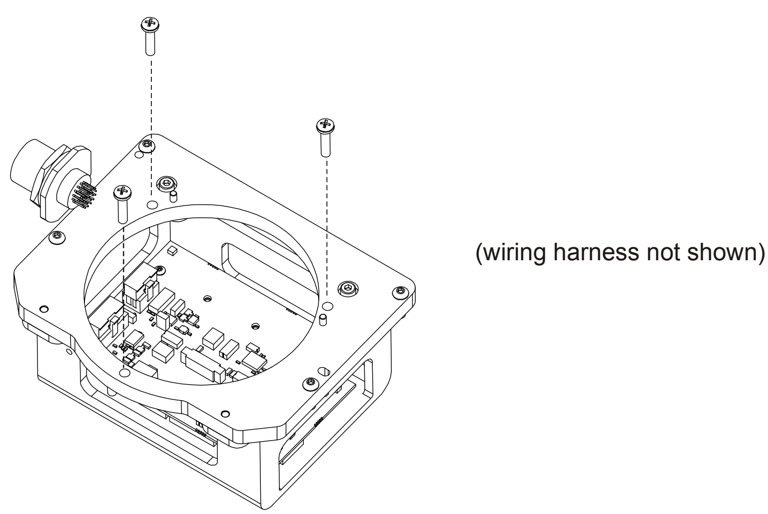


E.2 Install the HG1700 Sensor Unit

To install the HG1700 sensor unit in the Universal Enclosure:

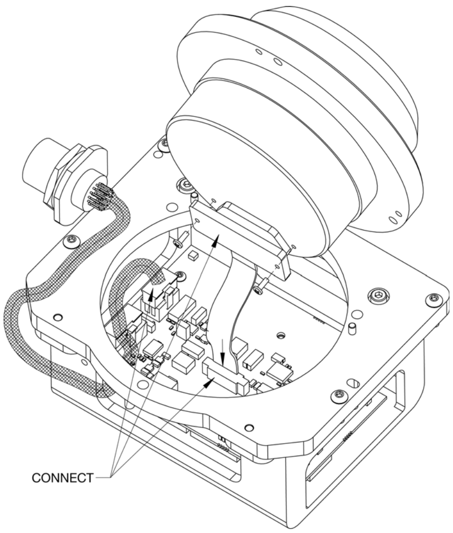
1. Using a Phillips screwdriver, remove the 8-32 IMU mounting screws from the IMU mounting plate, as shown in *Figure 46*.

Figure 46: Remove IMU Mounting Screws



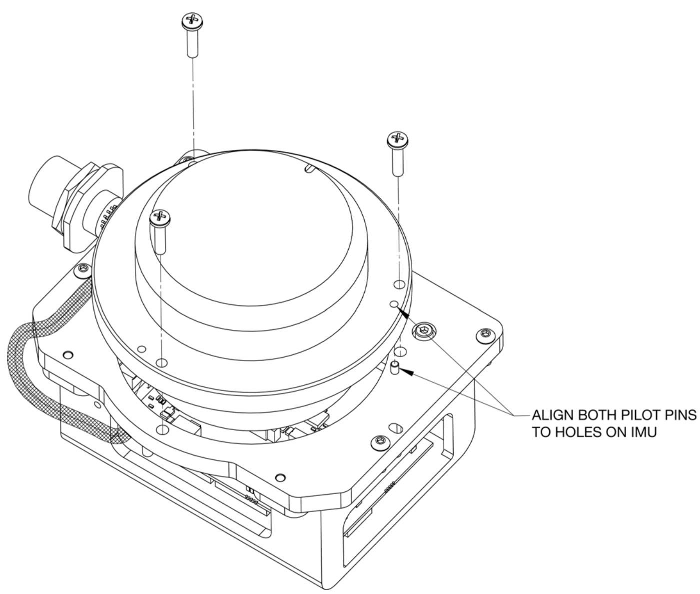
2. Check the connection of the internal cable harness to the board assembly and route as shown in *Figure 47*. Before you connect the IMU cable harness, make sure the connector on the board assembly is clicked open. Connect the IMU cable harness to the IMU (fasten the 2-56 screws but do not use thread-locking fluid), then connect to the board assembly. Ensure the cable housing latches.

Figure 47: Connect IMU to IMU Mounting Plate



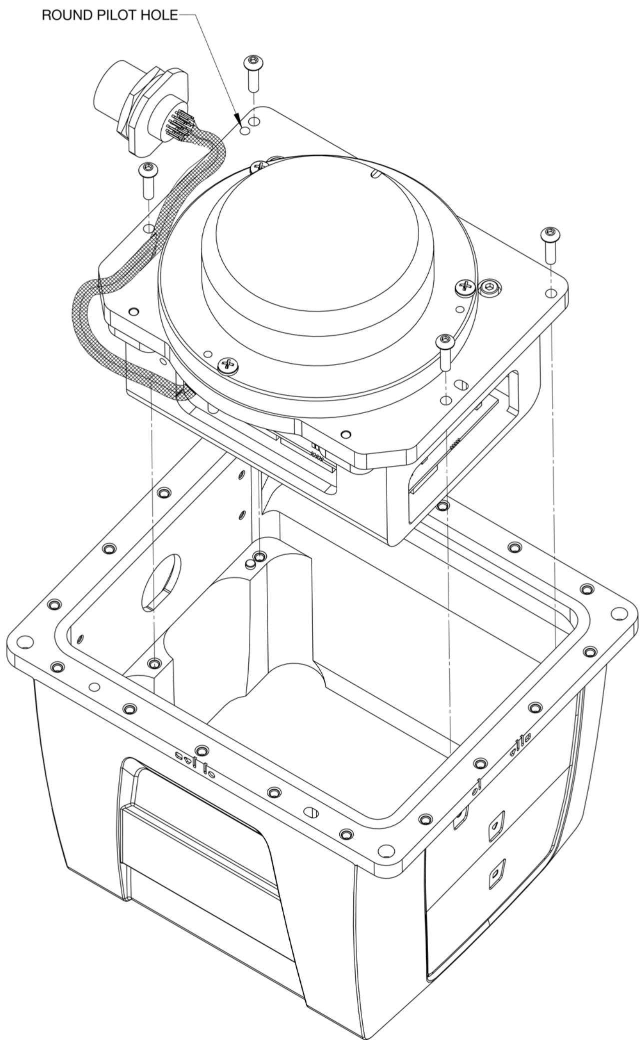
3. Being careful of the connectors and the orientation, align the pilot holes of the IMU with the pilot pins of the mounting plate. Gently place the IMU and mounting plate together, being careful not to pinch the cable harness. Screw the IMU and mounting plate together, using thread-locking fluid on the 8-32 screws, as shown in *Figure 48*.

Figure 48: Installing IMU to Mounting Plate



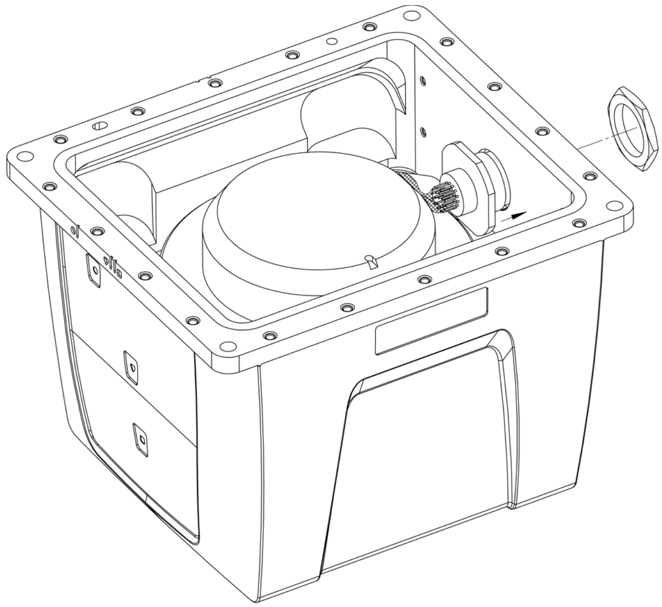
4. Starting with the round pilot hole, shown in *Figure 49*, align the pilot holes of the assembled plate (noting the orientation) with the pilot pins of the enclosure body. Lower the assembly into place, then fasten using thread-locking fluid on the M4 screws.

Figure 49: Assemble Into Enclosure Body



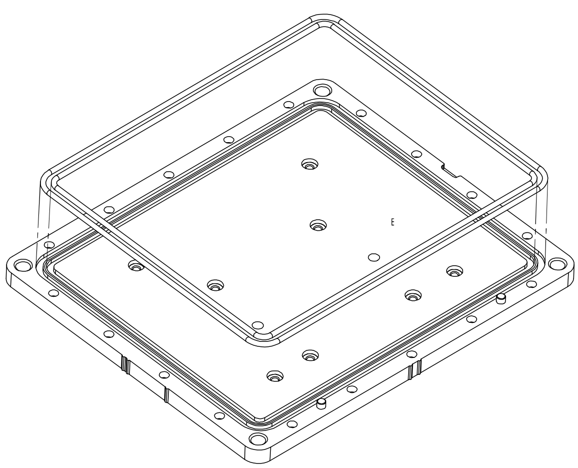
5. Connect the internal cable harness to the enclosure body, as shown in *Figure 50*. During this step, ensure the connector O-ring (supplied with the connector of the internal cable harness) remains flat within the connector's groove, and make sure the groove is clean and free of debris. Fasten the connector to the enclosure body wall using the jam nut supplied with the connector. Apply thread-locking fluid then, with a 30 mm socket, tighten the jam nut to 6.9 N-m (61 lb-in/5.1 lb-ft).

Figure 50: Fasten Internal Cable Harness



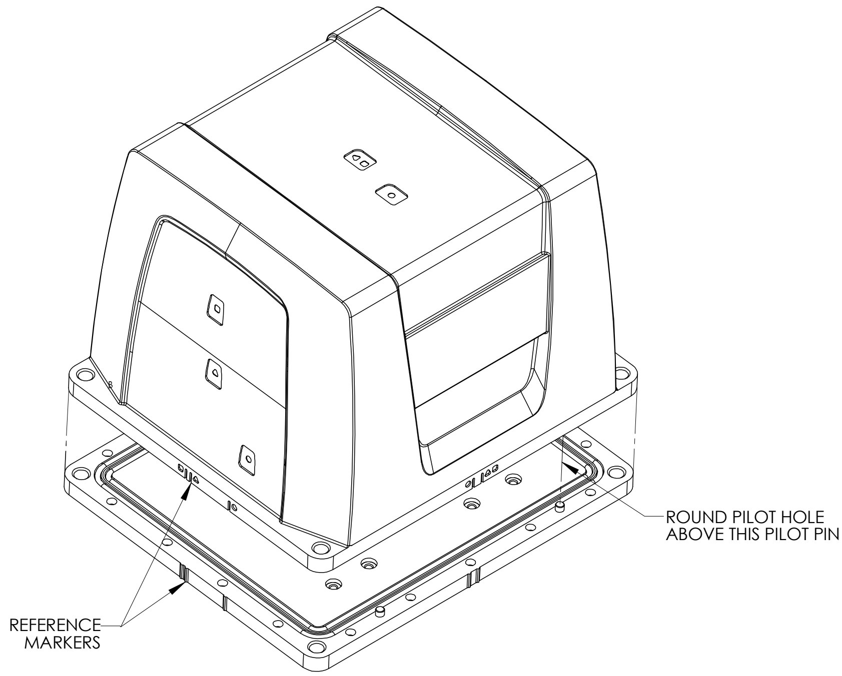
6. Ensure the O-rings are in place. If they are not, as necessary, make sure the grooves of the enclosure base are clean and free of debris, using isopropyl alcohol. As shown in *Figure 51*, install the outer environmental and inner EMI O-rings in the enclosure base, being careful not to stretch or twist them. O-rings must remain flat within the grooves during the remainder of the assembly procedure.

Figure 51: Install O-rings



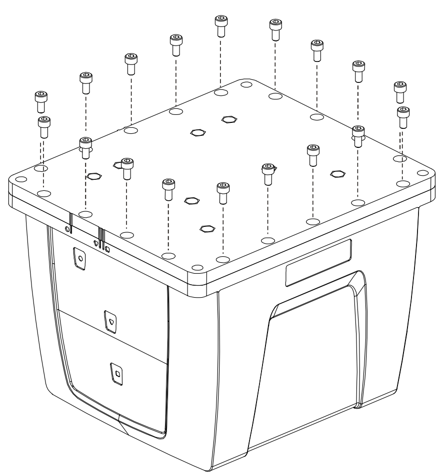
7. Clean the surface of the enclosure body, where it mates with the O-rings, using isopropyl alcohol. As shown in *Figure 52*, align the reference markers and pilot holes/pins of the enclosure body and base. Carefully lower the body onto the base, observing the O-rings and alignment of corners. Press the enclosure body into place, starting with the round pilot hole indicated in *Figure 52*.

Figure 52: Install Enclosure Body on the Base



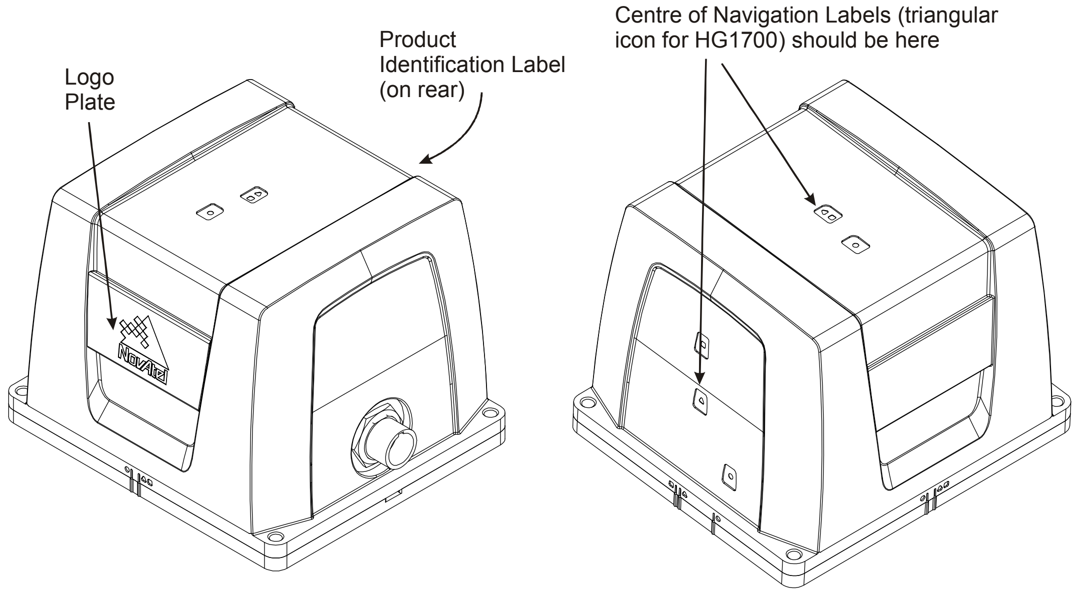
8. While squeezing and holding the enclosure body and base together to maintain tight contact, carefully turn the assembly over and place it on its top, as shown in *Figure 53*. Using a 3 mm hex bit, lightly fasten four equally spaced M4 screws to hold the parts together. Apply thread-locking fluid to each screw before inserting. Install the remaining screws in similar fashion. Tighten all screws then check all of them again for tightness. Tighten these screws to 1.36-1.58 N-m (12-14 lb-in). Do not over-tighten.

Figure 53: Screw Enclosure Base to Body



9. Ensure the product identification label, the logo plate and the center of navigation labels are properly affixed and contain the correct information. The final assembled unit will be similar to that shown in *Figure 54*.

Figure 54: Final Assembly



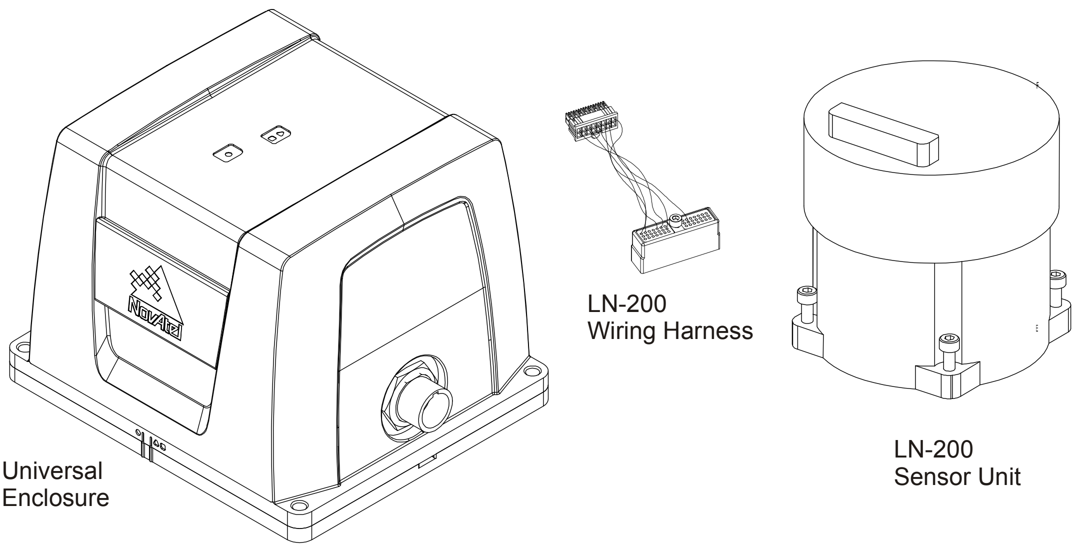
Appendix F LN-200 IMU in Universal Enclosure

> ***Important!*** Assemble in accordance with applicable industry standards. Ensure all ESD measures are in place, in particular, use a ground strap before exposing or handling any electronic items, including the IMU. Take care to prevent damaging or marring painted surfaces, O-rings, sealing surfaces, and the IMU.

The following procedure provides the necessary information to install the LN-200 sensor into the Universal Enclosure (NovAtel part number 01018590), both illustrated below. The steps required for this procedure are:

- Disassemble the Universal Enclosure
- Install the LN-200 Sensor Unit
- Reassemble the Universal Enclosure

Figure 55: Required Parts



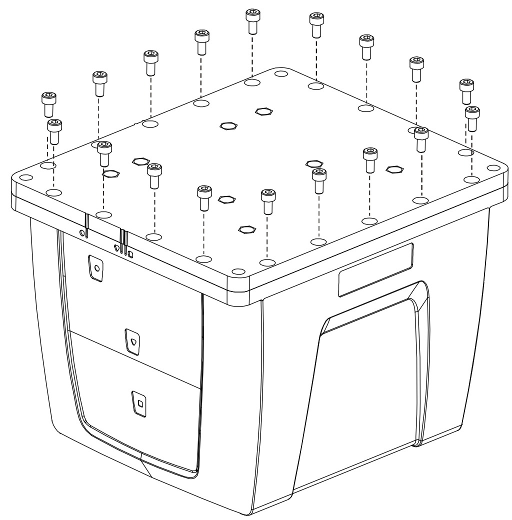
> 1. Use thread-locking fluid on all fasteners except for the cable harness connectors.
> 2. Torque values for all fasteners, including those for the cable harness screws, are as follows:
>   Size 6-32: 0.79-0.90 N-m (7.0-8.0 lb-in)
>   Size M4: 1.36-1.58 N-m (12.0-14.0 lb-in)

F.1 Disassemble the Universal Enclosure

Disassemble the Universal Enclosure as follows:

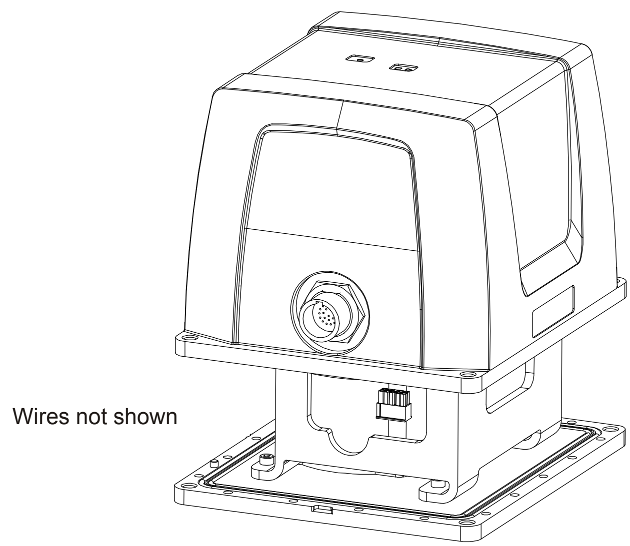
1. Using a 3 mm hex bit, remove the M4 screws (they will be reused) and the base, as shown in *Figure 56*.

Figure 56: Remove Base



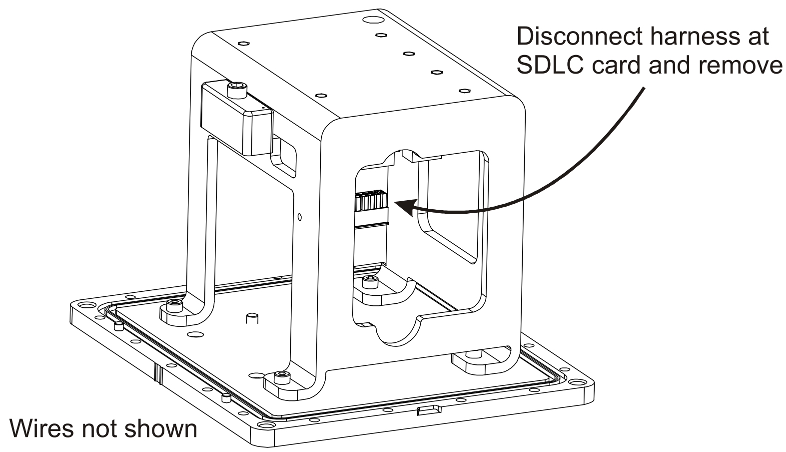
2. While squeezing and holding the assembly tightly together, carefully turn the assembly over and set it down as shown in *Figure 57*. Raise the enclosure body, and disconnect the internal cable harness at the SDLC board. Ensure the O-rings remain with the base when it is removed, and that they are not damaged.

Figure 57: Disconnect Wiring Harness from SDLC Card



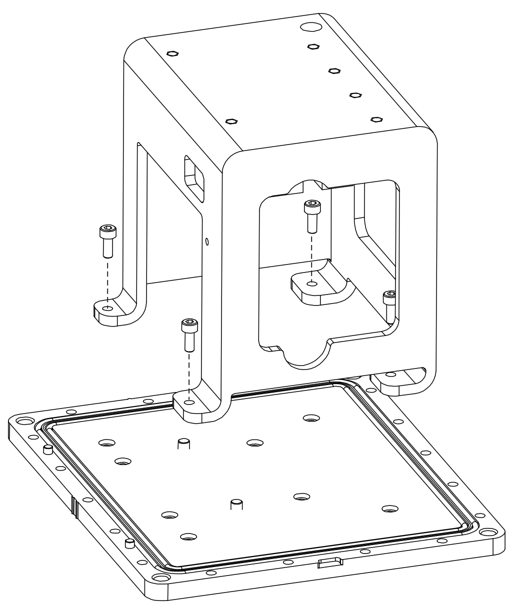
3. Lift the enclosure lid off the assembly to expose the IMU bracket, shown in *Figure 58*. Disconnect the harness at the SDLC card and remove.

Figure 58: IMU Bracket



4. Using a 3 mm hex bit, unscrew 4 mm screws and remove the IMU bracket with SDLC, as shown in *Figure 59*.

Figure 59: Remove IMU Bracket/SDLC

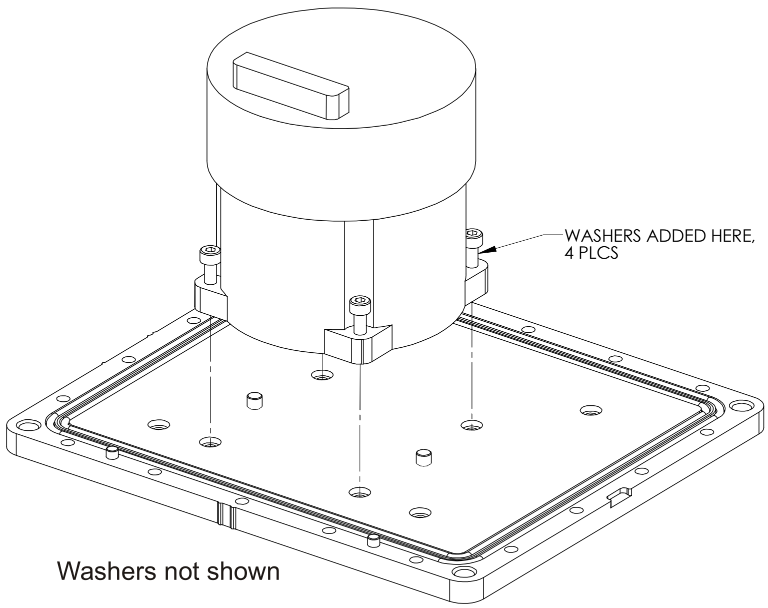


F.2 Install the LN-200 Sensor Unit

To install the LN-200 sensor unit in the Universal Enclosure:

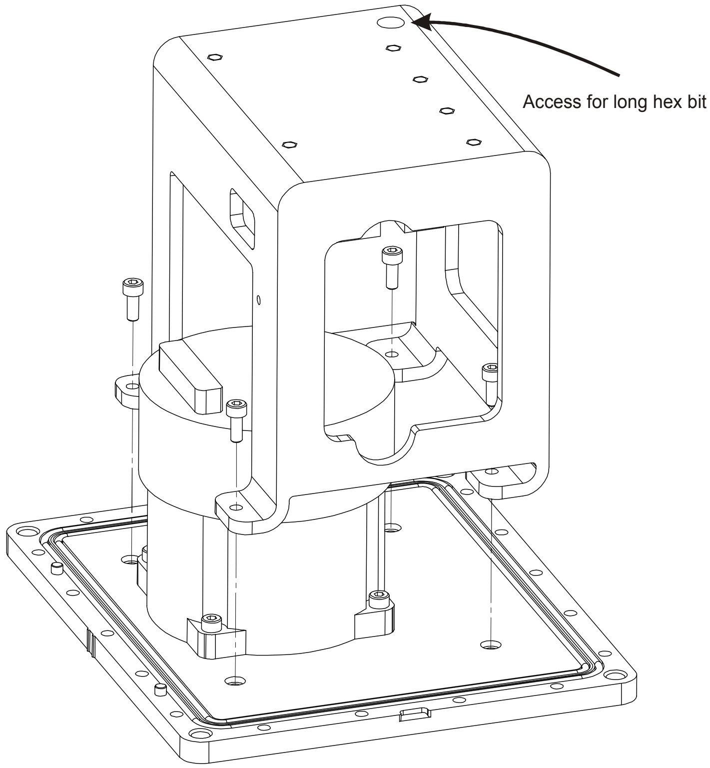
1. Using a 3 mm hex bit, remove original captive 6-32 screws and washers (4 each) from the LN-200 IMU. Add three washers under each of the original washers and fasten the IMU to the enclosure base, as shown in *Figure 60*. Use thread-locking fluid on each screw.

Figure 60: Install LN-200 IMU to Base



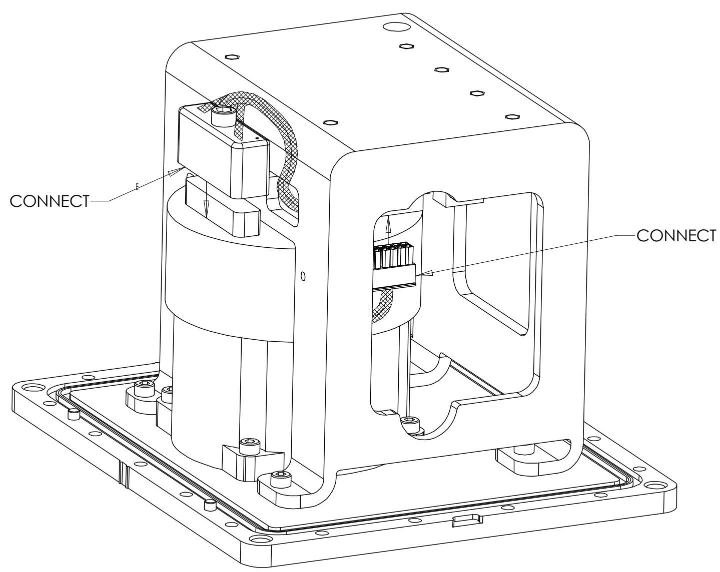
2. Using a long 3 mm hex bit, install the IMU bracket/SDLC to the base, as shown in *Figure 61*. Use thread-locking fluid on each M4 screw.

Figure 61: Install Bracket to Base



3. Connect the cable harness to the board assembly and IMU, routing it as shown in *Figure 62*. Ensure latching of the cable connector housings and fasten the 6-32 screw at the IMU end using a 5/32" hex bit. Do not use thread-locking fluid and do not overtighten.

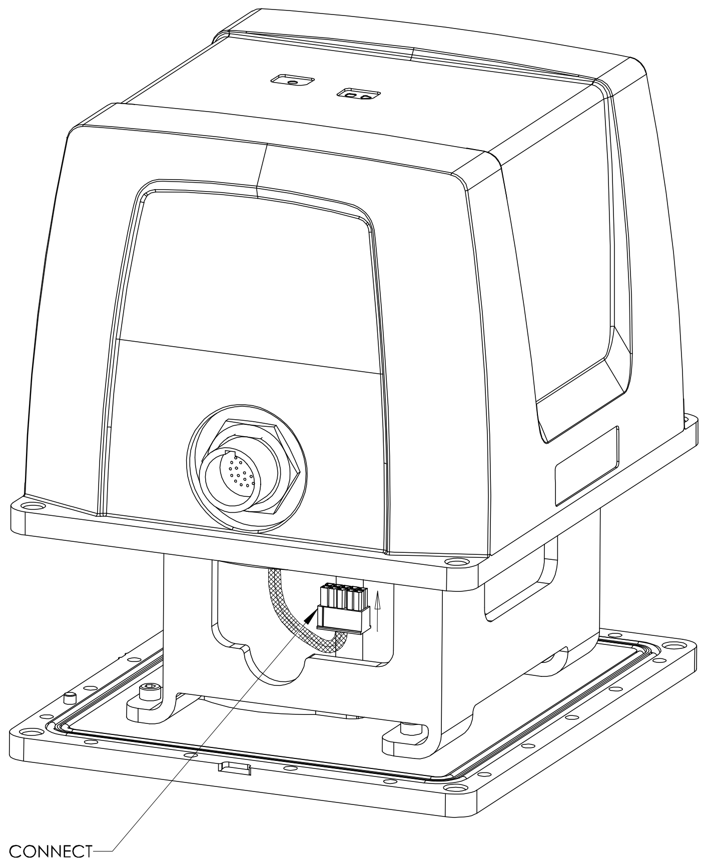
Figure 62: Making Connections



> Make sure the tape of the harness is positioned for maximum protection.

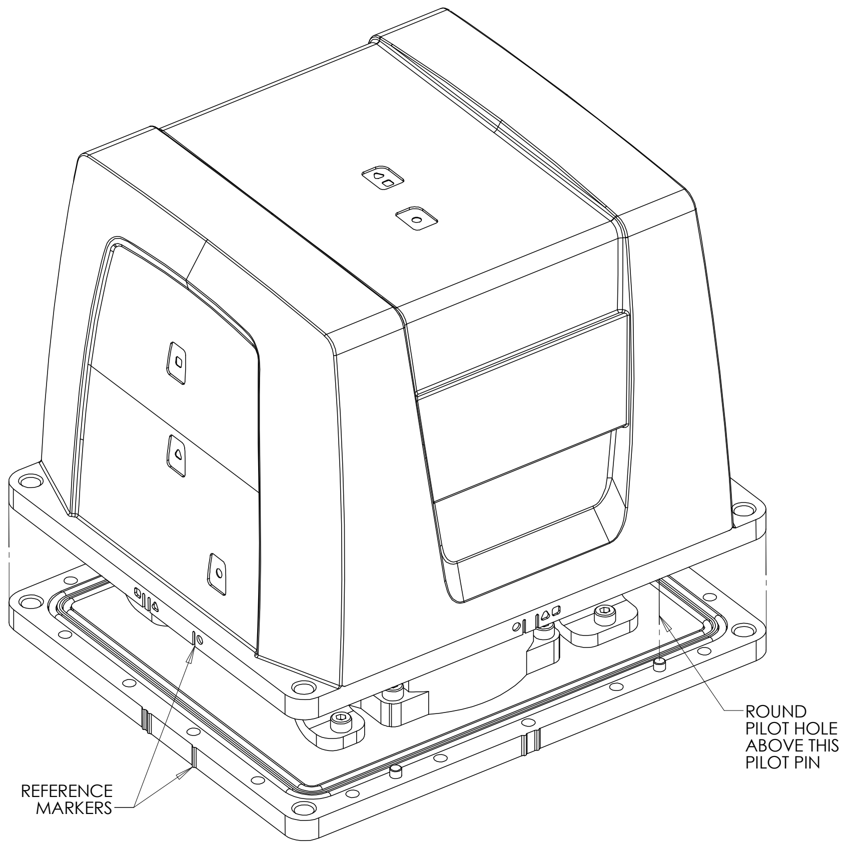
4. While carefully holding the body over the bracket, connect the internal cable harness to the board assembly, as shown in *Figure 63*.

Figure 63: Connect Internal Cable Harness



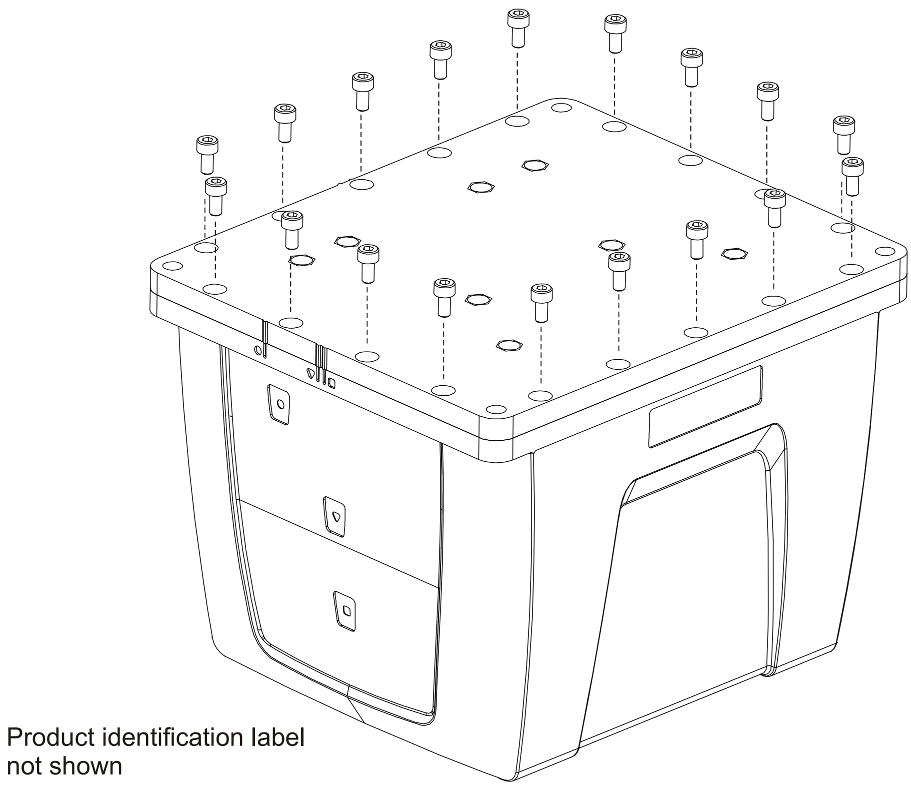
5. Clean the surface of the enclosure body, where it will mate with the O-rings, using isopropyl alcohol. While ensuring all wires will fit inside the bracket without being pinched, align the reference markers and pilot holes/ screws of the enclosure body and base, and carefully lower the body onto the base, observing the O-rings and the alignment of corners. Start with the round pilot hole indicated in *Figure 64*, then press the assembly into place.

Figure 64: Installing the Enclosure Body to the Base



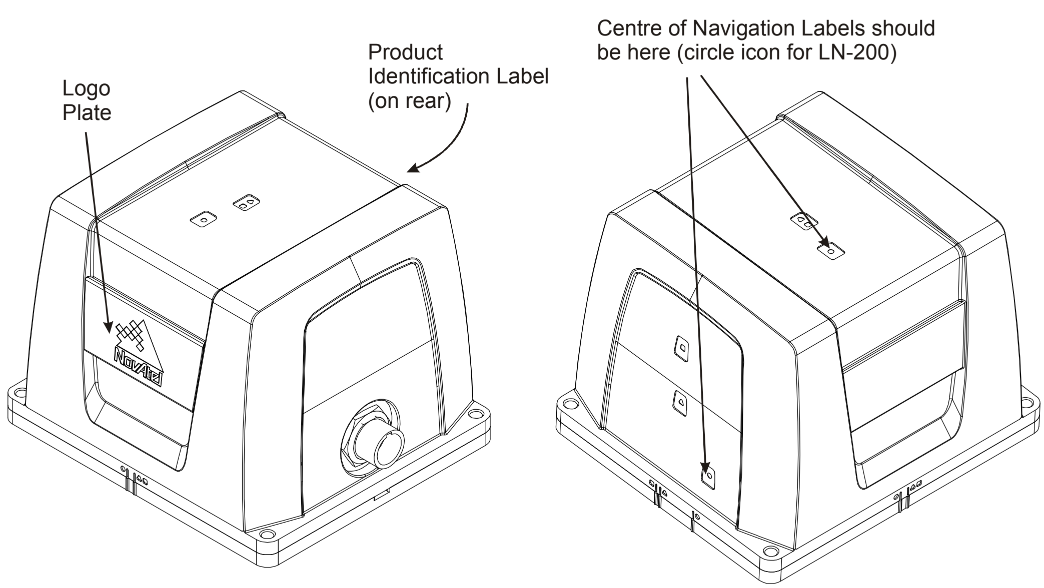
6. While squeezing and holding the enclosure body and base together to maintain tight contact, carefully turn the assembly over and place it on its top, as shown in *Figure 65*. Using a 3 mm hex bit, lightly fasten four equally spaced M4 screws to hold the parts together. Use thread-locking fluid on all screws. Install the remaining screws in similar fashion. Tighten all screws to 1.36-1.58 N-m (12-14 lb-in). Do not over-tighten.

Figure 65: Screw Enclosure Base to Body



7. Ensure the product identification label, the logo plate and the center of navigation labels are properly affixed and contain the correct information. The final assembled unit is shown in *Figure 66*.

Figure 66: Final Assembly



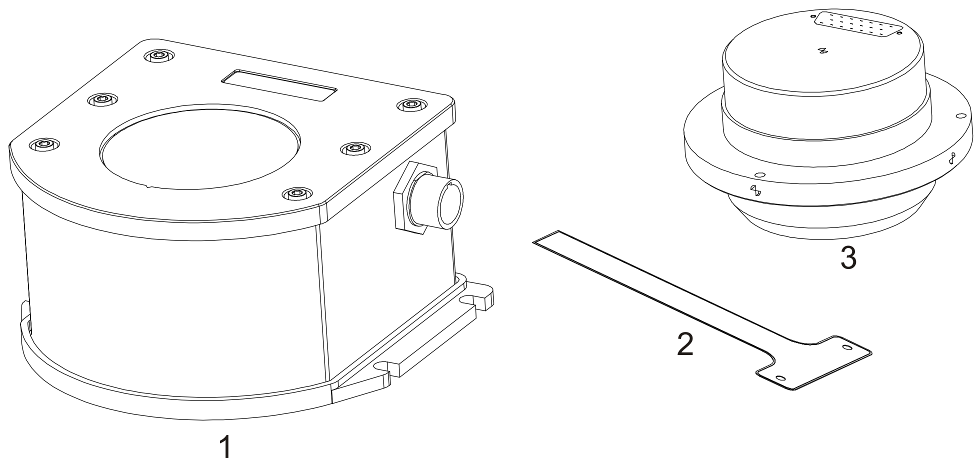
Appendix G HG1700 IMU in SPAN HG Enclosure

The following procedure provides the necessary information to install the HG1700 sensor into the SPAN HG Enclosure (NovAtel part number 01017898). The steps required for this procedure are:

- Disassemble the SPAN HG Enclosure
- Install the HG1700 Sensor Unit
- Make Electrical Connections
- Reassemble the SPAN HG Enclosure

Ensure you use a ground strap before installing the internal circuit boards. Do NOT scratch any surfaces of the unit.

Figure 67: Required Parts



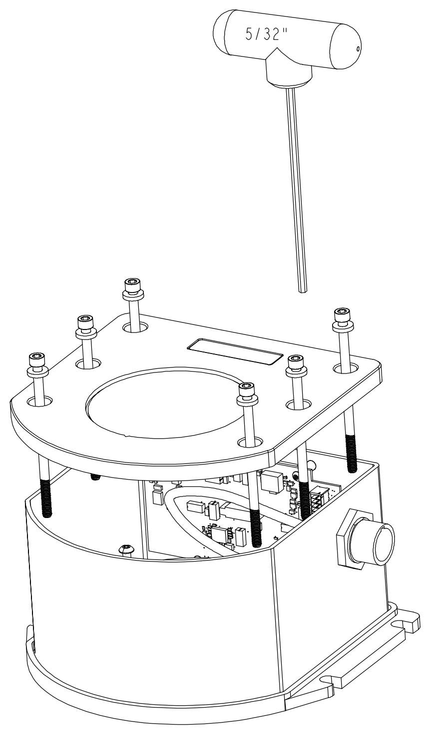
Reference	Description
1	SPAN IMU Enclosure
2	HG1700 Flex Cable
3	HG1700 Sensor Unit

G.1 Disassemble the SPAN IMU Enclosure

The SPAN IMU disassembly steps are as follows:

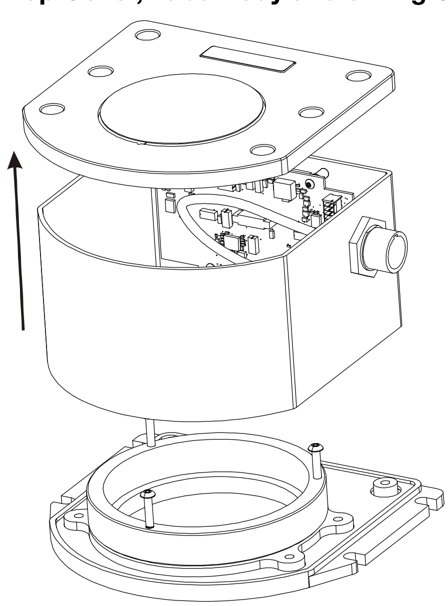
1. Remove the six bolts from the top cover using a hex key, as shown in *Figure 68*:

Figure 68: Bolts and Hex Key



2. Set aside the bolts with their sealing washers.
3. Lift the top cover off the tube body and set it aside, as shown in *Figure 69* on *page 206*.
4. Lift the tube body away from its base plate and set it aside.
5. Remove the 3 ring spacer screws and set them aside.

Figure 69: Lift Top Cover, Tube Body and 3 Ring Spacer Screws

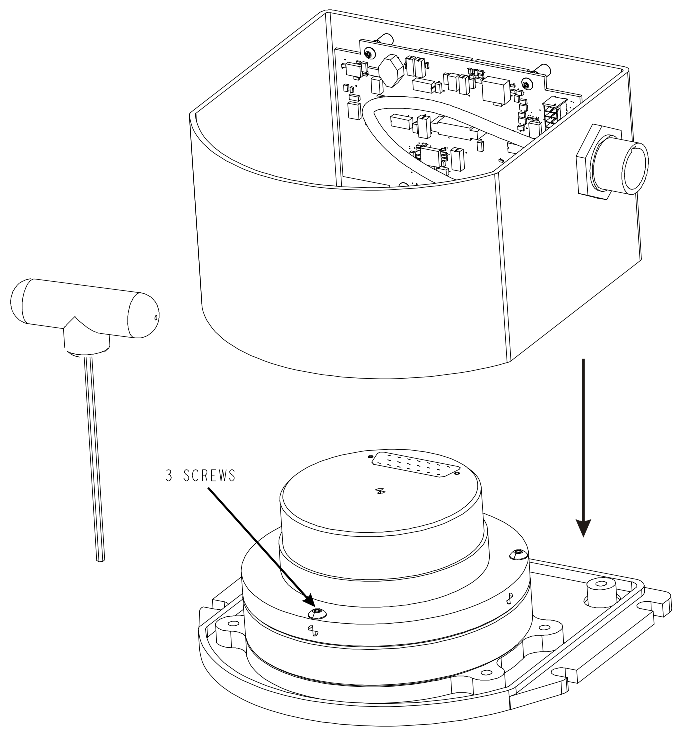


G.2 Install the HG1700 Sensor Unit

To re-assemble the SPAN IMU with the HG1700 sensor, see *Figure 70* and follow these steps:

1. Mount the HG1700 sensor with the attached #8 screws. Apply threadlock to the screw threads. Use a hex key to torque each screw to 10 in-lbs.
2. Fit the tube body over the HG1700 sensor and onto the base plate.

Figure 70: SPAN IMU Re-Assembly

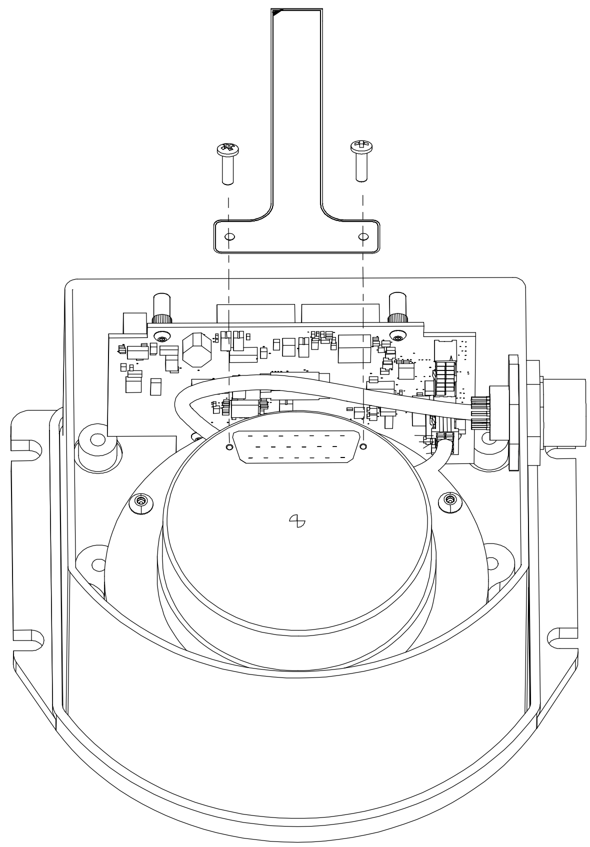


G.3 Make the Electrical Connections

To make the electrical connections you need a 3/32” hex key, the flex cable and the partially assembled SPAN IMU from *Section G.2, Install the HG1700 Sensor Unit* on *page 207*. Now follow these steps:

1. Attach the flex cable to the HG1700 sensor ensuring that all the pins are fully connected. Check also that the pins are fully seated and that the flex cable stiffener around the pins is not bent upward, see *Figure 71*.

Figure 71: Attach Flex Cable



2. Tighten the screws to 4 in-lbs.
3. Connect the opposite end of the flex cable to the corresponding connector on the IMU card ensuring that the contacts on the flex cable mate with the contacts on the connector, as shown in *Figure 71*.

4. Check that the flex cable is locked in place.

Figure 72 shows an incorrect installation of the flex cable where it is bowed in the middle. It will not operate properly in this position. *Figure 73* shows the proper installation of the flex cable. Notice how the flex cable sits flush against the IMU surface.

Figure 72: Incorrect (Bowed) Flex Cable Installation

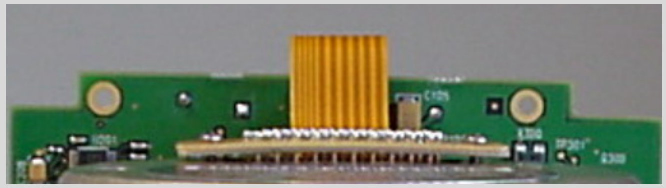
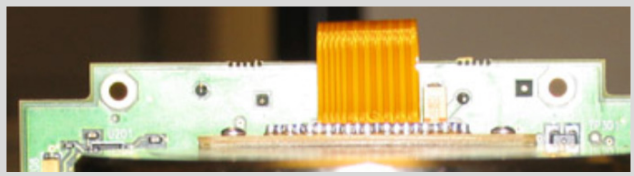


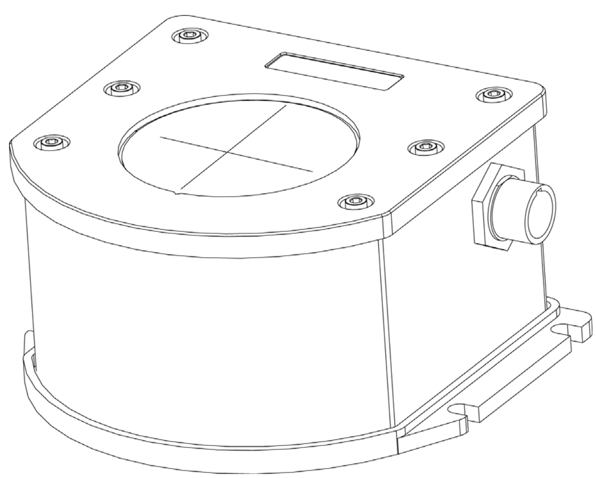
Figure 73: Correct (Flat) Flex Cable Installation



G.4 Re-Assemble the SPAN IMU Enclosure

Use a hex key to align the long bolts with the threaded holes in the base, as shown in *Figure 68* on *page 206*. Apply threadlock to threads. Finger tighten all bolts and torque them in a cross pattern to 12 in-lbs. The fully assembled IMU enclosure is shown in *Figure 74*.

Figure 74: HG1700 SPAN IMU



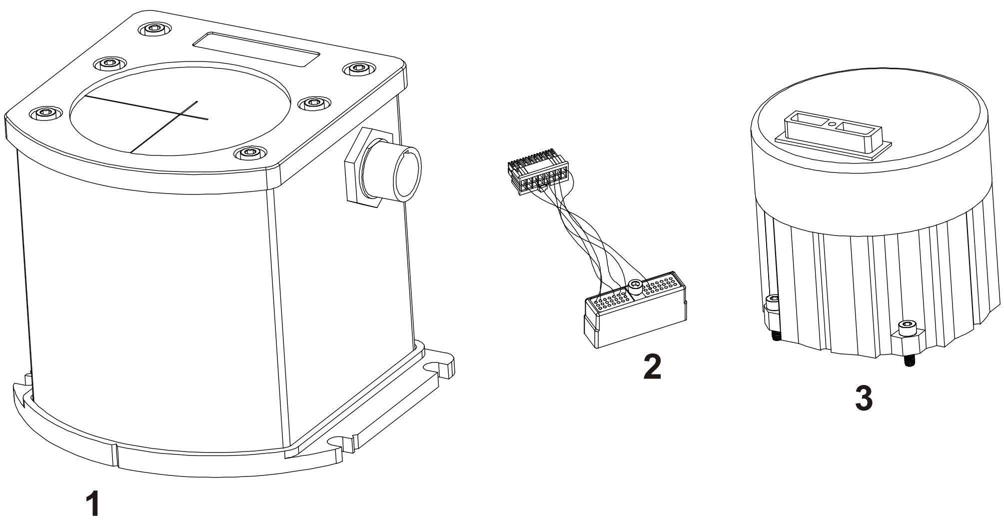
Appendix H LN-200 IMU in SPAN IMU Enclosure

The following procedure provides the necessary information to install the LN-200 sensor (NovAtel part number 80023515) into the SPAN IMU enclosure (NovAtel part number 01017656) using the LN-200 wiring harness (NovAtel part number 01017655). The steps required for this procedure are:

- Disassemble the SPAN IMU Enclosure
- Install the LN-200 Sensor Unit
- Make Electrical Connections
- Reassemble the SPAN IMU Enclosure

> ***Important!***: Ensure you use a ground strap before installing the internal circuit boards. Do NOT scratch any surfaces of the unit.

Figure 75: Required Parts



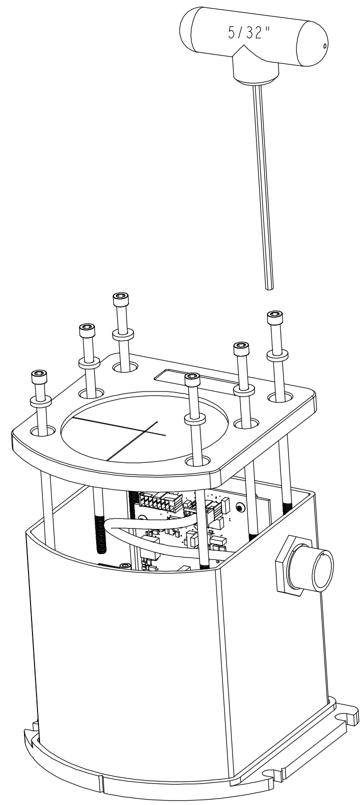
Reference	Description
1	SPAN IMU Enclosure
2	LN-200 Wiring Harness
3	LN-200 Sensor Unit

H.1 Disassemble the SPAN IMU Enclosure

The SPAN IMU disassembly steps are as follows:

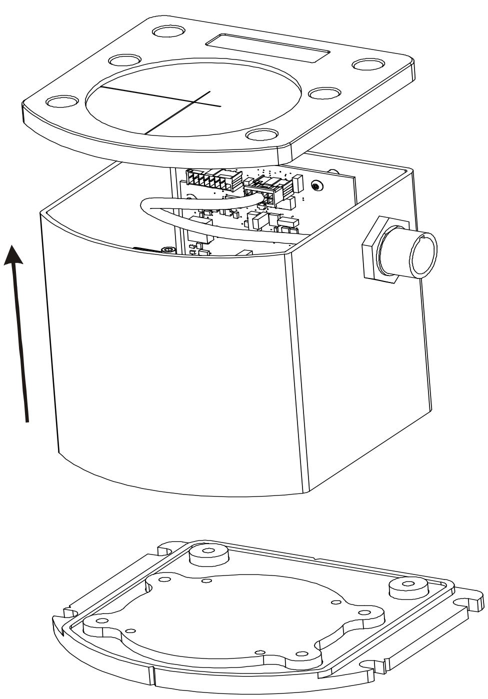
1. Remove the six bolts from the top cover using a hex key, as shown in *Figure 76*:

Figure 76: Bolts and Hex Key



2. Set aside the bolts with their sealing washers.
3. Lift the top cover off the tube body and set it aside.
4. Lift the tube body away from its base plate and set it aside, as shown in *Figure 77* on *page 211*.

Figure 77: Lift Top Cover and Tube Body

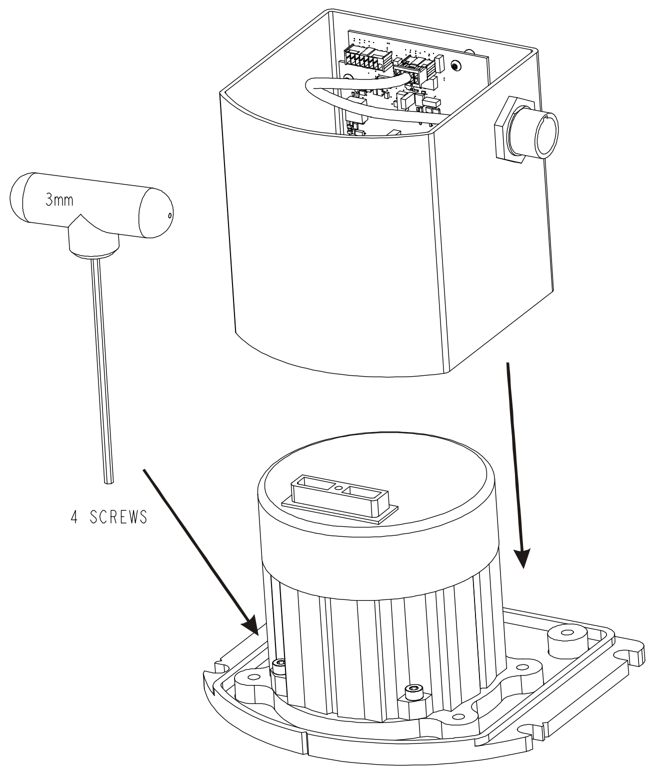


H.2 Install the LN-200 Sensor Unit

To install the LN-200 sensor, follow these steps:

1. Mount the LN-200 sensor with the attached M4 screws. Apply threadlock to the screw threads. Use a hex key to torque each screw to 10 in-lbs.
2. Fit the tube body over the LN-200 sensor and onto the base plate.

Figure 78: SPAN IMU Re-Assembly

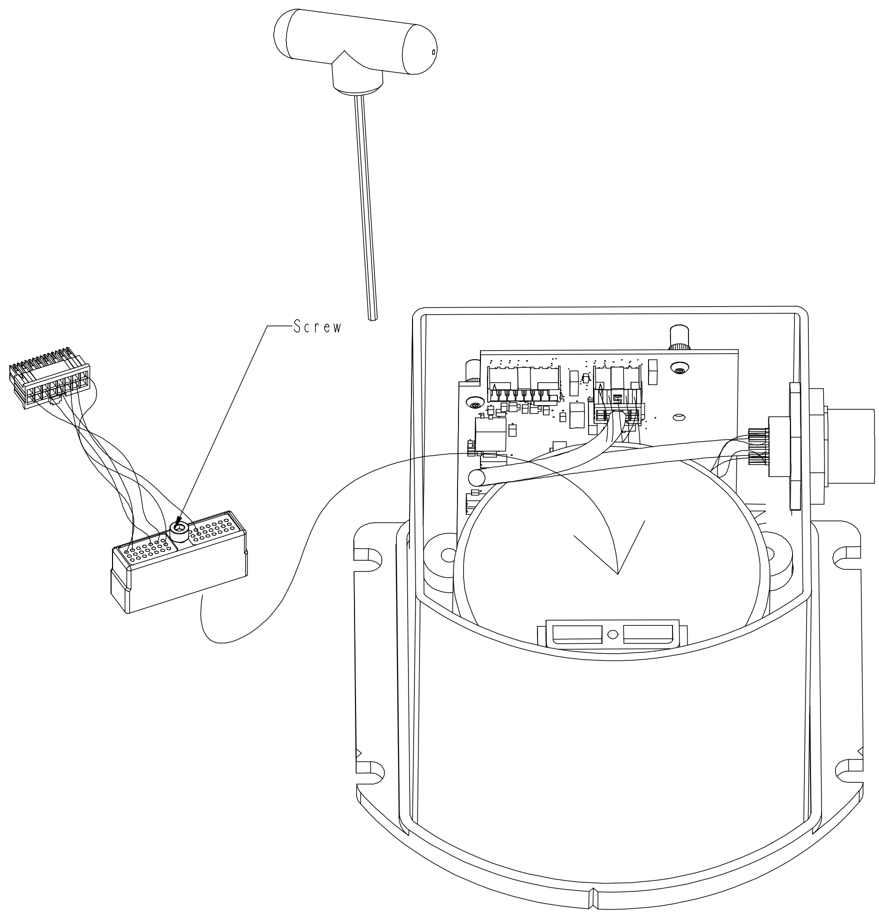


H.3 Make the Electrical Connections

To make the electrical connections you will need a 3/32" a hex key, the wiring harness and the partially assembled SPAN IMU from *Section H.2, Install the LN-200 Sensor Unit* on *page 212*. Now follow these steps:

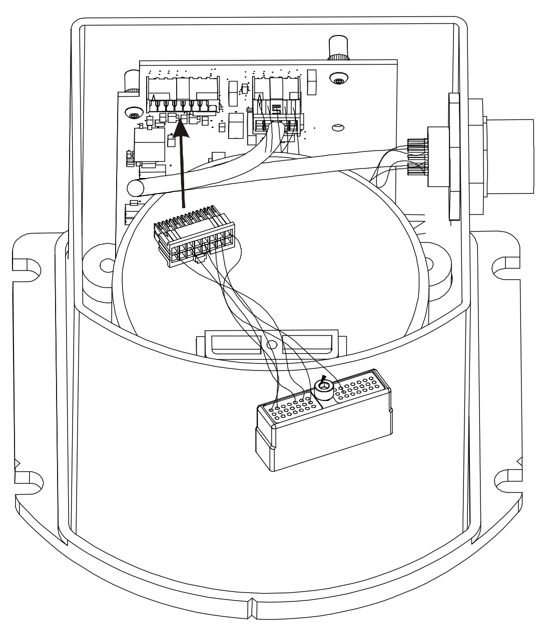
1. Attach the LN-200 wire harness to the mating connector on the LN-200. Check that the connector is fully seated, as shown in Figure 79.

Figure 79: Attach Wiring Harness



2. Connect the Samtec connector at the other end of the wiring harness to the corresponding connector on the internal IMU card, as shown in *Figure 80*. Ensure that the connector is locked in place.

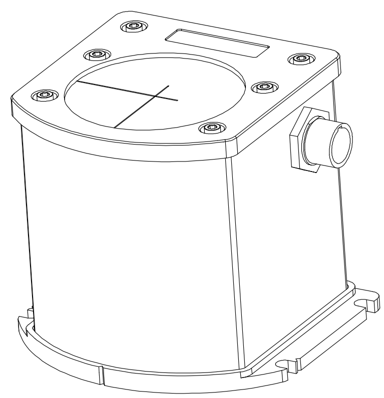
Figure 80: Attach Samtec Connector



H.4 Re-Assemble the SPAN IMU Enclosure

Use a hex key to align the long bolts with the threaded holes in the base, as shown in *Figure 76* on *page 211*. Apply threadlock to threads. Finger tighten the 6 bolts then torque them in a cross pattern to 12 in-lbs. The fully assembled IMU enclosure is shown in *Figure 81.*

Figure 81: LN-200 SPAN IMU



Appendix I Frequently Asked Questions

1. How do I know if my hardware is connected properly?
    a. When powered, some IMUs (HG1700) make a noticeable humming sound.
    b. Most IMUs (LN-200, IMU-CPT, iMAR-FSAS, Litef LCI-1, HG1900 and HG930) do not make noise. Check that the IMU interface cable is properly connected to the receiver.
    For the LN-200, check that the IMU interface cable is connected to the COM 2 port on the FlexPak6.
    For the iIMU-FSAS and IMU-CPT, check that the IMU interface cable is connected to the FlexPak Y Adapter cable and the FlexPak Y Adapter cable is connected to the COM 2 and I/O ports on the FlexPak6.
    c. When powered, the HG-1700 IMUs makes a noticeable humming sound. If no sound is heard, check that the cable between the receiver and IMU is connected properly. The cable should be connected to the COM 2 port on the FlexPak6.
    d. If the cable is connected properly and you still hear no sound from the IMU, check the flex cable mounted on top of the IMU. Refer to the instructions in this manual on proper IMU installation to ensure that the cable is seated properly on the IMU pins. See *Appendix E, HG1700 IMU in Universal Enclosure* starting on *page 189* or *Appendix F, LN-200 IMU in Universal Enclosure* starting on *page 197* for more details.
    e. Check the input power supply. A minimum of 12V should be supplied to the system for stable IMU performance. The supply should also be able to output at least 12W over the entire operating temperature range.
2. What system configuration do I need to do to get the system running?
    a. Set the IMU type using the CONNECTIMU command, see *page 99*.
3. What types of IMUs are supported?
    a. SPAN currently supports the following IMUs:
        - HG1700, HG1900 and HG1930 from Honeywell
        - LN-200 from Litton
        - iIMU-FSAS from iMAR
        - LCI-1 from Northrop Grumman LITEF
        - IMU-CPT from KVH

    Use the CONNECTIMU command to specify the type of IMU used (see *page 99*).
4. Why don't I have any INS logs?
    a. On start-up, the INS logs are not available until the system has solved for time. This requires that an antenna is attached, and satellites are visible, to the system. You can verify that time is solved by checking the time status in the header of any standard header SPAN log such as BESTPOS. When the time status reaches FINETIME, the inertial filter starts and INS messages are available.
    b. Check that the system has been configured properly. See question *3* above.
5. How can I access the inertial solution?

    The INS/GNSS solution is available from a number of specific logs dedicated to the inertial filter. The INSPOS, INSPVA, INSVEL, INSSPD, and INSATT logs are the most commonly used logs for extracting the INS solution. These logs can be logged at any rate up to the rate of the IMU data (100 or 200 Hz depending on your IMU model). These logs can also be triggered by the mark input signal by requesting the logs "ONMARK". Further details on these logs are available in *Appendix C, INS Logs* starting on *page 129*.
6. Can I still access the GNSS-only solution while running SPAN?

    The GNSS only solution used when running the OEM6 receiver without the IMU is still available when running SPAN. Logs such as PSRPOS, RTKPOS and OMNIPOS are still available. The BESTGNSSPOS log is also available to provide the best available GNSS only solution. Any non-INS logs should be logged at a maximum rate of 5 Hz when running SPAN. Only INS-specific logs documented in *Appendix C, INS Logs* starting on *page 129* should be logged at rates higher than 5 Hz when running SPAN.

7. What will happen to the INS solution when I lose GNSS satellite visibility?

   When GNSS tracking is interrupted, the INS/GNSS solution bridges through the gaps with what is referred to as free-inertial navigation. The IMU measurements are used to propagate the solution. Errors in the IMU measurements accumulate over time to degrade the solution accuracy. For example, after one minute of GNSS outage, the horizontal position accuracy is approximately 2.5 m when using an HG1700 AG58. The SPAN solution continues to be computed for as long as the GNSS outage lasts, but the solution uncertainty increases with time. This uncertainty can be monitored using the INSCOV log, see *“INSCOV INS Covariance Matrices” on Page 149*.

8. What does it mean if my IMUCARD version string looks like this: < GPSCARD "G2LR0RTT0S1" "BFN11490091" "OEM628-1.00" "OEM060210RN0000" "OEM060100RB000" "2012/Aug/03" "11:31:07" < IMUCARD "Test mode 20Hz" "" "" "r2.1.0.0" "" "Sep 13 2010" "09:34:20" ?

   The SPAN enabled receiver has detected the SDLC card and is communicating with it, however, the SDLC card is not communicating with the IMU. Check the SDLC to IMU connections to ensure that both power and communication lines are connected to the IMU.

Appendix J Replacement Parts

The following are a list of the replacement parts available. Should you require assistance, or need to order additional components, please contact your local NovAtel dealer or Customer Support.

J.1 SPAN System

Part Description	NovAtel Part
IMUs (see *Table 1, SPAN-Compatible IMU Models* on *page 25* for details)	IMU-H58 IMU-H62 IMU-LN200 IMU-FSAS-EI UIMU-H58 UIMU-H62 UIMU-LN200 IMU-LCI IMU-CPT IMU-H1900-CA50 IMU-H1930-CA50
Receivers	FlexPak6 OEM615 OEM628
Universal IMU Enclosure Interface cable	01018977
FlexPak Y Adapter cable[a]	01018948
IMU-CPT6 IMU interface cable	01018966
Universal IMU Cable	01018299
iIMU-FSAS IMU with Odometer interface cable	01018388
OEM6 Family Compact Disc with PC utilities	01018616
SPAN Technology For OEM6 User Manual	OM-20000139
OEM6 Family Installation and Operation User Manual	OM-20000128
OEM6 Family Firmware Reference Manual	OM-20000129

a. The FlexPak Y Adapter cable is required for SPAN systems with a FlexPak6 receiver and either the IMU-CPT and IMU-FSAS.

J.2 Accessories and Options

Part Description	NovAtel Part
Optional NovAtel GNSS Antennas:	
Model 702 (L1/L2)	GPS-702
Model 702L (L1/L2/L-band)	GPS-702L
Model 702GG (L1/L2/GLONASS)	GPS-702-GG
Model 702GGL (L1/L2/GLONASS/L-band)	GPS-702-GGL
Model 703GGG (L1/L2/L5/GLONASS/Galileo)	GPS-703-GGG
Model A72GA (L1/L2)	ANT-A72GA-TW-N
Model A72GLA4 (L1/L2/L-band)	ANT-A72GLA4-TW-N
Model C2GA (L1/L2)	ANT-C2GA-TW-N
Optional RF Antenna Cable:	
5 metres	GPS-C006
15 metres	GPS-C016
30 metres	GPS-C032
22 cm interconnect adapter cable	GPS-C002

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