NovAtel

SPAN® Technology for OEMV®

User Manual

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SPAN Technology for OEMV User Manual

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

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

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OEMV-3™ 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 15*).

All IMU's should only be returned 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.".

---

[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

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
RAWIMUSB onnew
INSPVASB 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:

Call the NovAtel Hotline at 1-800-NOVATEL (U.S. & Canada) or +1-403-295-4500 (international)	
Fax: +1-403-295-4501 E-mail: support@novatel.com Web site: http://www.novatel.com	Write: NovAtel Inc. Customer Support Department 1120 - 68 Avenue NE Calgary, AB Canada, T2E 8S5

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 OEMV-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 centre conductor and shield of the coaxial cable. This high voltage develops because the voltage surge induced onto the centre 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.

---

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

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 also *Figure 1, Primary and Secondary Lightning Protection* on the following page.

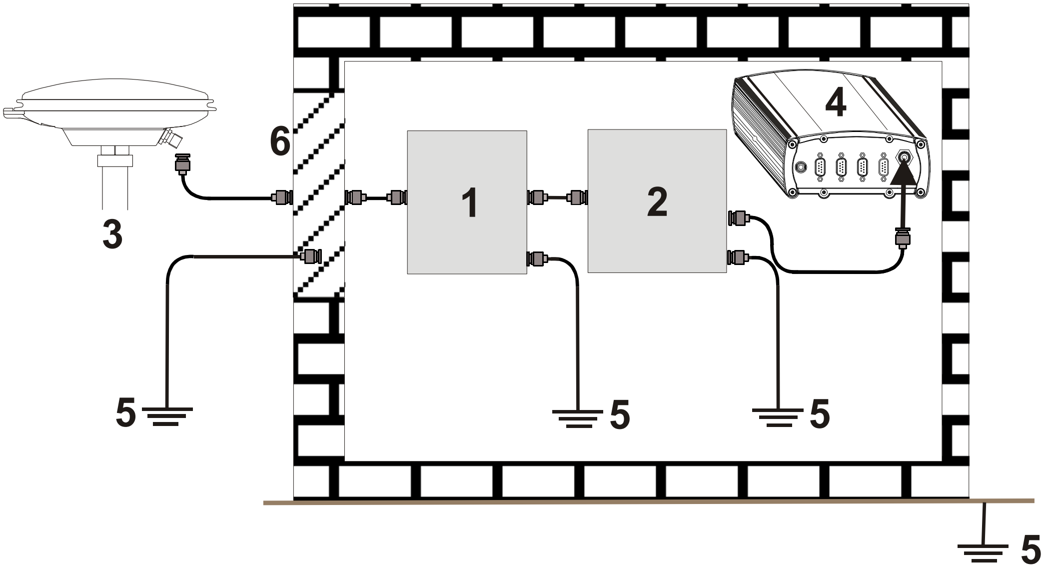


Figure 1: Primary and Secondary Lightning Protection

Ref #	Description	Ref #	Description
1	Primary lightning protection device	4	GNSS Receiver
2	Secondary lightning protection device	5	To ground
3	External antenna	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 OEMV 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 on 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*.

After the addition of accessories, an antenna and a power supply, the SPAN system is ready to go.

The OEMV-3 in the receiver utilizes a comprehensive user-interface command structure, which requires communications through its communications (COM) ports. This manual also describes the INS specific commands and logs. Other supplementary manuals are included to aid you in using the other commands and logs available with OEMV 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 98 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 usage of the program. This manual has been written with the expectation that you already have a basic familiarity with Windows.

Chapter 1 Introduction

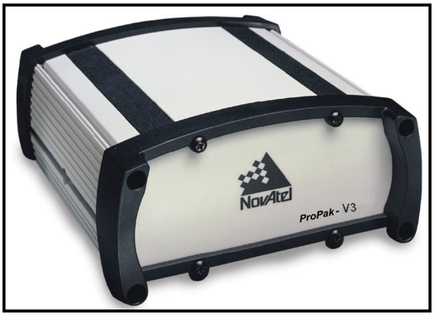


Figure 2: SPAN System Receiver

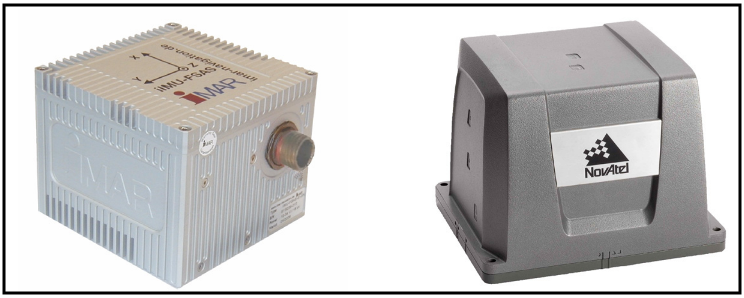


Figure 3: SPAN System IMUs

NovAtel's SPAN technology brings together two very different but complementary positioning and navigation systems namely 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 OEMV 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, and L-band (CDGPS and OmniSTAR) on a maximum of 72 channels. SBAS support is standard on all OEMV family receivers. OEMV adaptability offers multi-system, frequency, and size configurations for any application requirement. Patented Pulsed Aperture Correlator (PAC) technology combined with a powerful microprocessor make possible 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 OEMV family also supports the timing requirements of the IMU and runs the real-time INS Kalman 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 3 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 Receiver and IMU Models* on *page 27* and *Table 33, IMU Type* on *page 130*.
- 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 41*.

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

1.1 Fundamentals of GNSS/INS

GNSS positioning observes range measurements from orbiting Global Navigation Satellite System satellites. From these observations, the receiver can compute position and velocity with high accuracy. NovAtel GNSS positioning systems have been established as highly accurate positioning tools, however GNSS in general has some significant restrictions, which limit its usefulness in some situations. GNSS positioning requires line of site 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 OEMV-3 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 50*

- 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 Receiver and IMU Models

Model Name	Max. Output Rate	Compatible IMUs	SW Model
IMU-H58 IMU-H62	100 Hz	HG1700-AG58 HG1700-AG62	RT2i
IMU-LN200	200 Hz	LN-200 200 and 400 Hz models	RT2j
IMU-FSAS-EI	200 Hz	iIMU-FSAS	RT2j
IMU-H1900-CA50	100 Hz	HG1900-CA29, HG1900-CA50	RT2i
IMU-H1930-CA50	100 Hz	HG1930-AA99, HG1930-CA50	RT2c
IMU-LNDMK-LM20	100 Hz	Landmark 20	RT2c

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

Each model has the following standard features:

- Rugged shock, water, and dust-resistant enclosure
- NovAtel's advanced OEMV L1/L2 GPS and PAC technology
- Three bi-directional COM ports which support data transfer rates of up to 921,600 bits/s [1]
- A serial port capable of communication with an IMU. See also *Table 1* above.
- 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. Refer to application note *APN-046 Configure CAN for SPAN* available on our Web site at www.novatel.com through *Support | Knowledge and Training*.
- 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 *OEMV Family Installation and Operation User Manual* for further details on this topic.

SPAN currently supports the Honeywell, iMAR and Litton IMUs. When using an IMU with SPAN, it is housed in an enclosure with a PCB board to handle power, communication and data timing. See *Appendix A, Technical Specifications* starting on *page 55* for details.

---

[1] Rates higher than 115, 200 are not standard on most PCs and may require extra PC hardware

Chapter 2 SPAN Installation

2.1 Hardware Description

One hardware setup consists of an OEMV receiver (see *Figure 2 on page 25*), an IMU (see *Figure 3 on page 25*), 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 197. Another hardware set up consists of an MIC (MEMs Interface Card), an IMU and a COM and power link (refer to *Table 2.1.2.3* on *page 31* and *Table 2.1.2.4* on *page 32*).

2.1.1 SPAN System Receiver

Data storage, when using a ProPak-V3, is done using a laptop computer connected to the receiver through either the serial or USB port (if using NovAtel's DB9 to USB cable, connect to COM1 on the receiver).

The back panel of the ProPak-V3 is shown in *Figure 4*. The ProPak-V3 uses DB9 COM connectors.

Figure 4: Receiver Enclosure Back Panel

Table 2 shows a summary of the receiver's back panel port names.

> When you input a command that requires a port name referencing the third port, you **must** type in COM3 for the ProPak-V3. This is true, even if the port is labelled AUX.

Table 2: Receiver Enclosure Back Panel Labels

SPAN Enclosure	Port Label	Description
ProPak-V3	**9-18 VDC**	Supply Voltage
	COM1	COM1
	COM2	COM2
	AUX	COM3
	I/O	I/O
	GPS	Antenna
	EXT OSC	External Oscillator

2.1.2 Typical Installation Examples

2.1.2.1 LN-200 or HG1700 Set Up Example

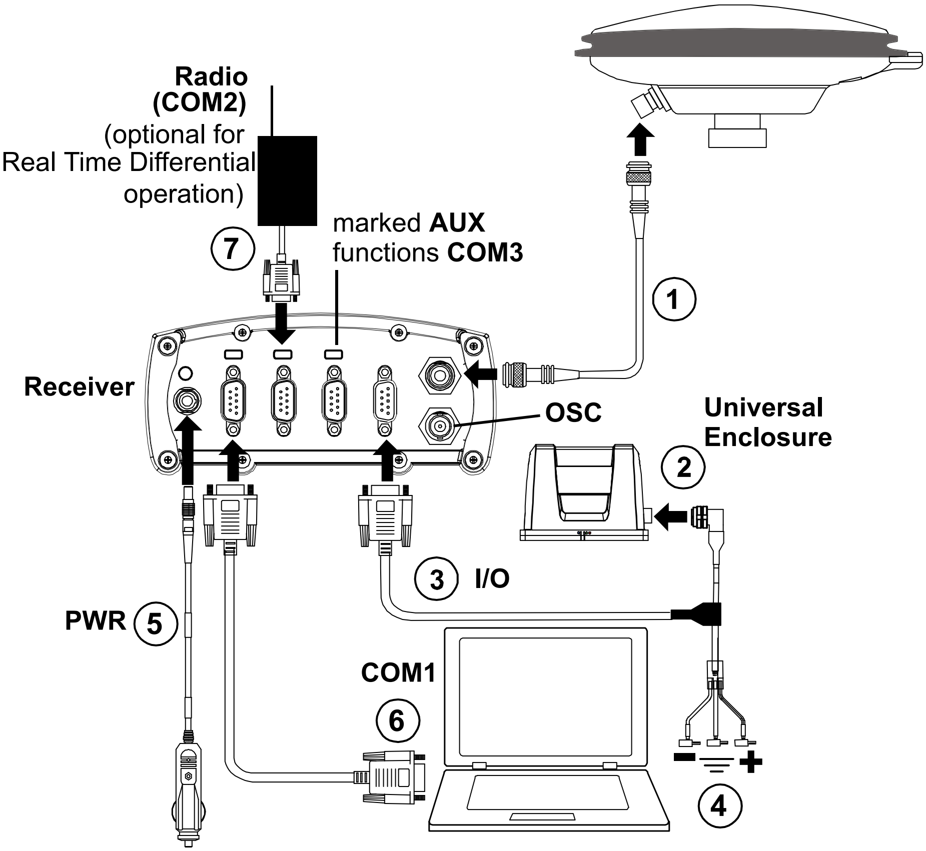


Figure 5: Basic Set Up - LN-200 or HG1700

1. Connect the antenna to the receiver.
2. Connect the interface cable to the LN-200 or HG1700 (universal enclosure).
3. Connect the DB9 connector of the interface cable to the AUX port of the receiver.
4. Connect power and ground.
5. Connect user supplied power supply (refer to *Table 3* on *page 36*).
6. Connect user supplied PC for set up and monitoring to COM1.
7. Connect user supplied radio device to COM2 (optional for real time differential operation).

2.1.2.2 IMU-FSAS Set Up Example

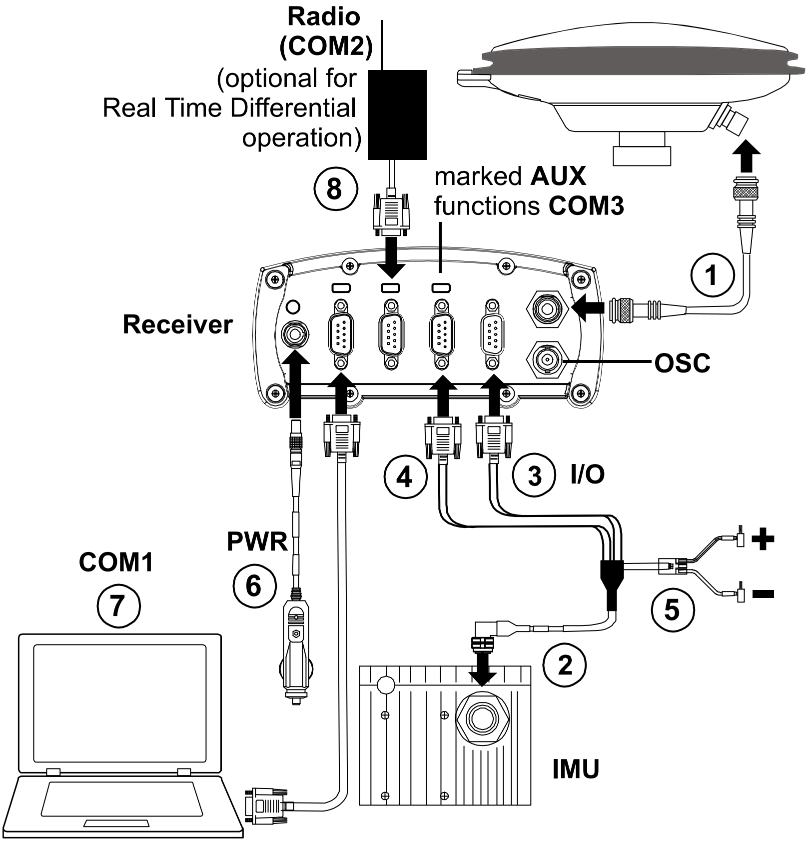


Figure 6: Basic Set Up - IMU-FSAS

1. Connect antenna to the receiver.
2. Connect interface cable to the IMU.
3. Connect the DB9 connector marked I/O of the interface cable to the I/O port of the receiver.
4. Connect the female DB9 connector of the interface cable to the AUX port of the receiver.
5. Connect power.
6. Connect user supplied power (refer to *Table 3* on *page 36*).
7. Connect user supplied PC for set up and monitoring to COM1.
8. Connect user supplied radio device to COM2 (optional for real time differential operation).

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.

2.1.2.3 MIC in Stack Up Configuration

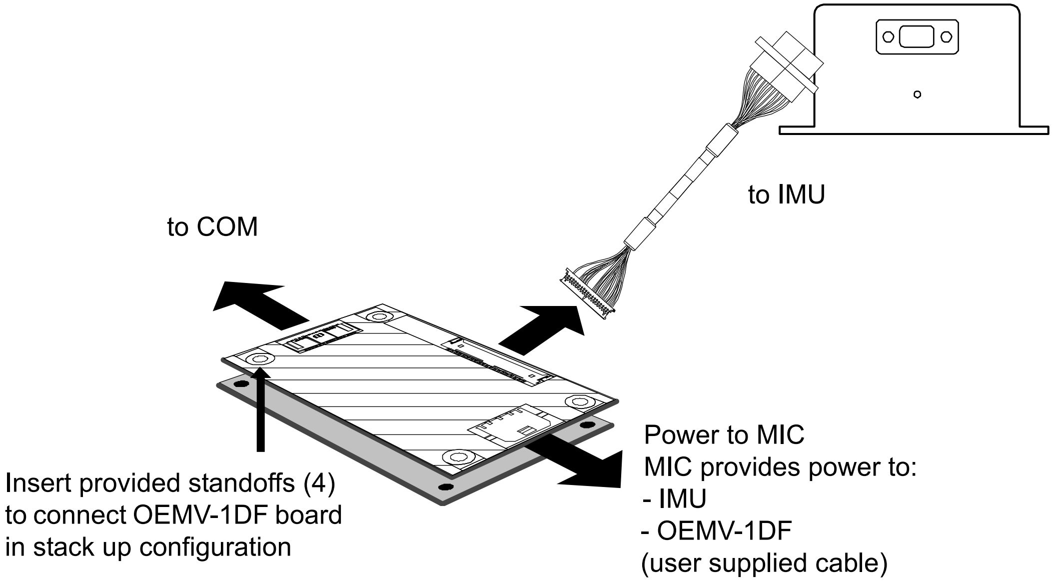


Figure 7: MIC in Stack Up Configuration

2.1.2.4 MIC in Standalone Configuration

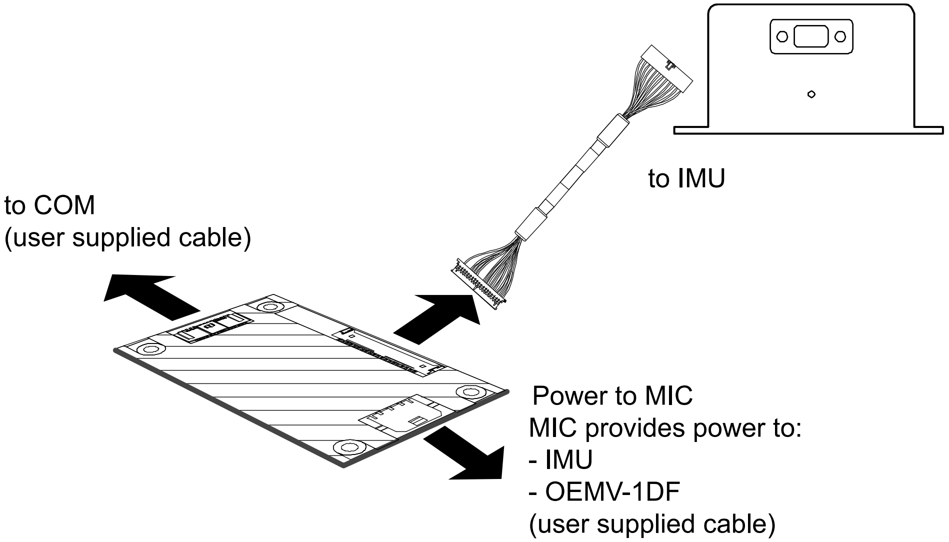


Figure 8: MIC in Standalone Configuration

2.1.3 Real Time Differential Operation

An optional static base, as shown in Figure 9, can be added. Connect a radio device using COM2 on both the base and rover radios.

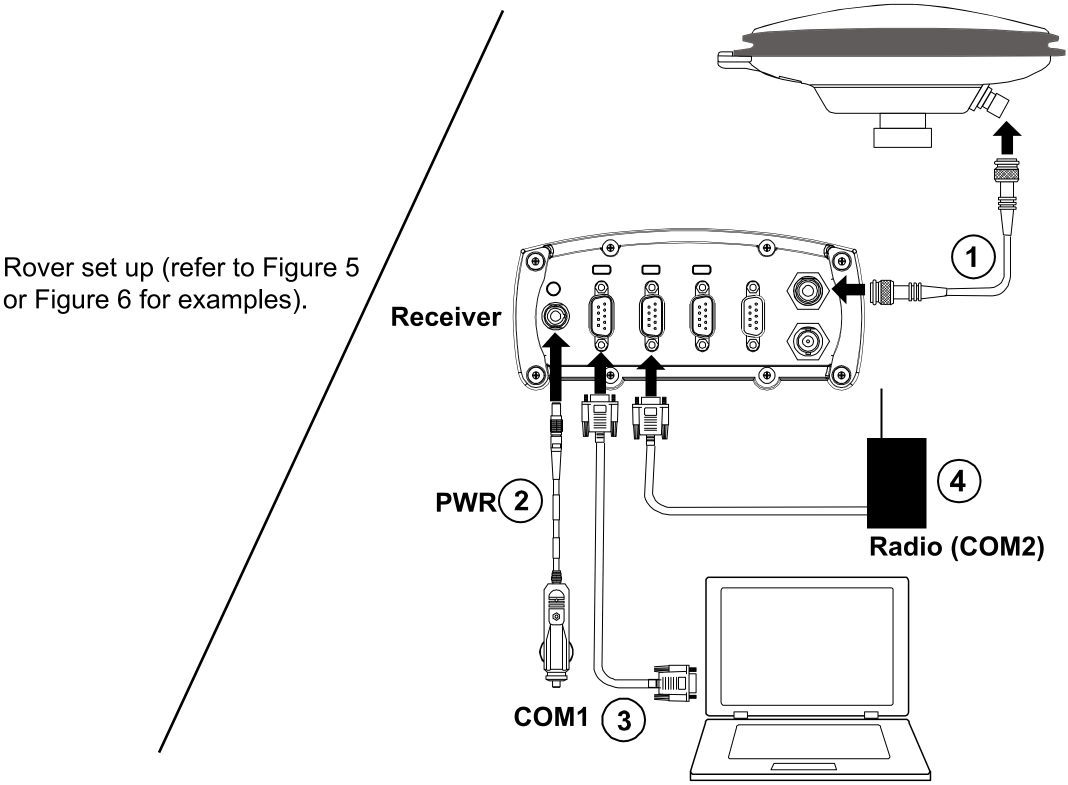


Figure 9: Typical Static Base Set Up

1. Connect antenna to the receiver.
2. Connect user supplied power (refer to *Table 3* on *page 36*).
3. Connect user supplied PC for set up and monitoring to COM1.
4. Connect user supplied radio device to COM2.

> Ensure a radio device is connected to COM2 on the rover receiver (refer to 2.1.2.1 LN-200 or HG1700 Set Up Example).

2.1.4 Cables and Ports

The sections that follows outline how to set up the system's parts and cables. See *Appendix A Technical Specifications s*tarting on *page 55*, and refer to the *OEMV Family Installation and Operation User Manual,* for the NovAtel part numbers of ProPak-V3 cables and their pinouts.

> Use a USB cable to log raw data. Serial communication is fine for configuring and monitoring the SPAN 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.

Refer to your receiver's hardware manual for more information on its ports and cables (the *OEMV 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 (number of pins) 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.

2.2 Hardware Set Up

Review this section's hardware set up subsections and follow the numbered steps, in bold, to install your SPAN system. The example graphics show the connections on the back of a ProPak-V3 receiver.

2.2.1 Mount 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 Reference Book* available from *www.novatel.com*.

1. **Mount the IMU and antenna securely to a vehicle.** Ensure they cannot move due to dynamics and that the distance and relative direction between them is fixed. See also *Section 2.3.2, SPAN IMU Configuration* starting on *page 38*.

2.2.2 Mount IMU

Mount the IMU in a fixed location where the distance from the IMU to the GNSS antenna phase centre 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 50*. See also *Appendix A, Technical Specifications* starting on *page 55* gives dimensional drawings of the IMU enclosures.

2. **Connect the IMU to the receiver using the IMU cable provided.** For the ProPak-V3 receiver, the IMU plugs into the port labelled AUX. See also *Steps 1* and *2* in the *SPAN IMU Configuration* section on *page 37*. The HG1700 and LN-200 plug directly from the ProPak-V3 to the IMU. The iIMU-FSAS has a single connector whose cable connects to the COM3 (labelled AUX) and I/O port of the ProPak-V3, and to power. See also *Step #3*'s graphic on *page 36*.

> 1. 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 GPS 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.**
> 2. 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.
> 3. The iIMU-FSAS IMU requires that COM3, labelled as AUX on the ProPak-V3, be in RS-422 mode.

2.2.3 Connect COM Cables

The ProPak-V3 receiver incorporates an I/O port. This port may 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 recorded its position whenever the shutter button was pressed.

The receivers have transistor-transistor-logic (TTL)-compatible I/O strobe lines. Typically, the I/O strobe lines can be accessed by inserting the connector of an I/O strobe port cable into the I/O port. The other end of the cable is provided without a connector so that you can provide an application-specific one. The jacket insulation is cut away slightly from the end but the insulation on each wire is intact.

Refer to the hardware manual for your receiver for more information on signals, wiring and pin-out information of the I/O port and its cable (the *OEMV Family Installation and Operation User Manual)*.

4. **Connect COM1 of the receiver to a computer COM port using a null modem cable.**

5. **Connect the antenna to the antenna port on the receiver using an appropriate coaxial cable.**

2.2.4 Connect Power

The OEM SPAN receiver products require an input supply voltage as described in Table 3. An automotive adapter is supplied but power can come from a wall outlet adapter or batteries. The receiver has an internal power module that does the following:

- 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-m wire pair represents a total wire path of 4 m. 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.

Each IMU requires its own power supply, see *Table 3* below.

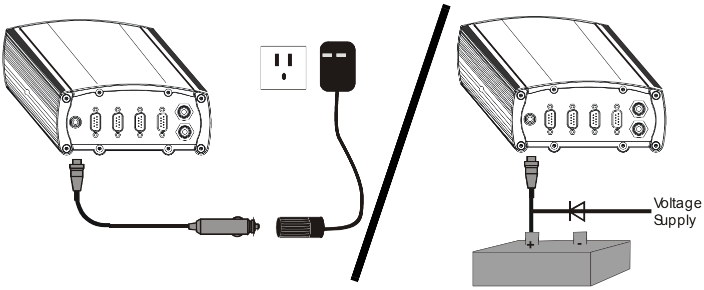
Table 3: IMU Power Supply

IMU	Power Requirement
LN-200	+12 to +28 V DC
FSAS	+10 to +34 V DC
HG1700	+12 to +28 V DC

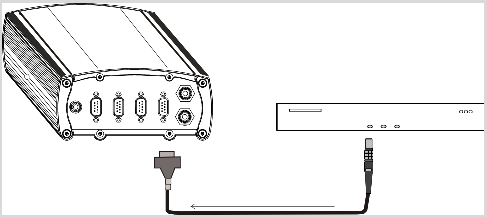
> HG1900, HG1930, Landmark 20 power must be supplied by an IMU interface card. For specifications on the MIC (refer to http://www.novatel.com/products/span-gnss-inertial-systems/span-mems).

For pin-out information on the power connector on the ProPak-V3, refer to the *OEMV Family Installation and Operation User Manual*. Details on the LN-200 power port and cables can be found in *Section A.1, Universal IMU Enclosure* starting on *page 55*.

6. **Apply power to the IMU and to the receiver.** 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 advanced users: You may also have a user point device such as video equipment. Connect the device to the receiver's I/O port using a cable that is compatible to both the receiver and the device. Refer to your device's documentation for information on its connectors and cables. The arrow along the cable in the figure indicates a MARKIN pulse, refer to the *OEMV Family Firmware Reference Manual*, from the user device on the right to the ProPak-V3 I/O port.



2.3 Software Configuration

2.3.1 GPS Configuration

The GPS configuration can be set up for different accuracy levels such as single point, SBAS, DGPS and RTK (RTCA, RTCM, RTCM V3 and CMR). ProPak-V3 receivers can also be set up for Omnistar HP, Omnistar VBS or CDGPS. Refer to the *OEMV User Manuals* 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 SPAN Configuration 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 39* to see the alternate method using NovAtel's Connect software utility:

1. **Issue the INTERFACEMODE command** to specify the receiver port connected to the IMU, see *Table 4* below and the INTERFACEMODE command on *page 115*.
2. **Issue the SETIMUTYPE command** to specify the type of IMU being used, see *Table 4* below and the SETIMUTYPE command on *page 129*.

Table 4: Enable INS Commands

IMU Type	INTERFACEMODE Command	SETIMUTYPE Command
LN-200	interfacemode comX[a] imu imu off	setimutype imu_ln200
iIMU-FSAS	interfacemode comX[a] imarimu imarimu off	setimutype imu_imar_fsas[b]
HG1700	interfacemode comX[a] imu imu off	setimutype imu_hg1700_ag11 or setimutype imu_hg1700_ag17 or setimutype imu_hg1700_ag58 or setimutype imu_hg1700_ag62
HG1900	interfacemode comX[a] imu imu off	setimutype imu_hg1900_ca29 or setimutype imu_hg1900_ca50
HG1930	interfacemode comX[a] imu imu off	setimutype imu_hg1930_aa99 or setimutype imu_hg1930_ca50
Landmark IMU	interfacemode comX[a] imu imu off	setimutype imu_gladiator_landmark20

[a] Use the COM port number that the IMU is connected to, for example, OEMV-1DF requires COM1 but an OEMV-3 ProPak can use COM1 or COM 3 for IMU communication.

[b] The iIMU-FSAS IMU uses RS-422 as its communication protocol. The OEMV-3 COM3 (can be labelled AUX on a ProPak-V3) supports either RS-232 or RS-422 as a factory configurable option.

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

> 1. A GNSS antenna must be connected and tracking satellites for operation.
> 2. Enter the INTERFACEMODE command with COM3 as the port value even if the ProPak-V3 port is labelled AUX.

3. **Issue the SETIMUTOANTOFFSET command** to enter the distance from the IMU to the GPS antenna, see *page 128*.

The offset between the antenna phase centre 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 GPS solution is accurate to a few centimeters. For the integrated INS/GPS system to have this level of accuracy, the offset must be measured to within a centimeter. 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.

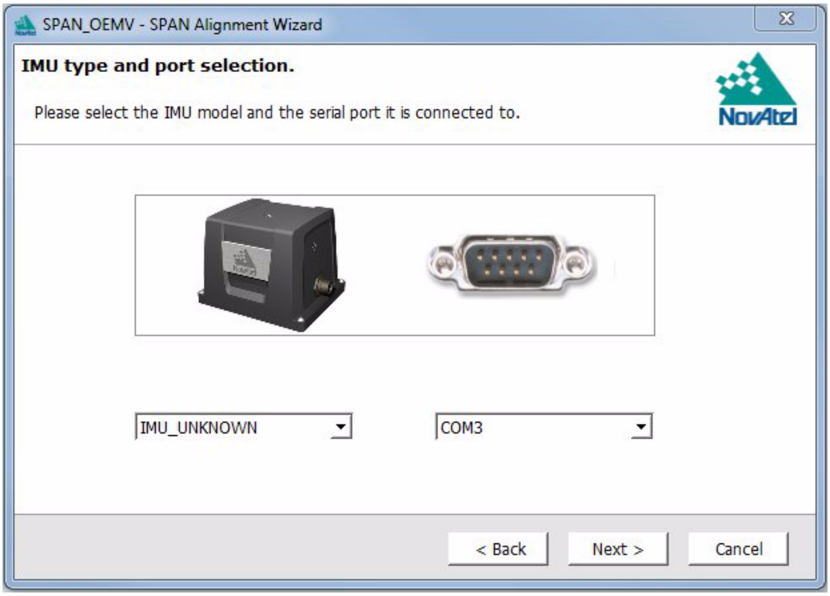
If it is impossible to measure the IMU to GPS antenna offset precisely, the offset can be estimated by carrying out the Lever Arm Calibration Routine. See *Section 3.3.4, Lever Arm Calibration Routine* on *page 50*.

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 fast alignment, select the type of IMU and configure the receiver port, connected to the IMU, to accept IMU data:



SPAN_OEMV - SPAN Alignment Wizard

IMU type and port selection.

Please select the IMU model and the serial port it is connected to.

IMU_UNKNOWN

COM3

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 fast alignment routine is available. The fast 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 47* for more details on coarse and fast alignments.

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 INTERFACEMODE command** to specify the receiver port connected to the IMU, see *Table 4* on *page 38* and the INTERFACEMODE command on *page 115*.

   ```
   interfacemode com3 imu imu off
   ```

2. **Issue the SETIMUTYPE command** to specify the type of IMU being used, see *Table 4* on *page 38* and the SETIMUTYPE command on *page 129*.

   ```
   setimutype imu_ln200
   ```

3. **Issue the SETIMUTOANTOFFSET command** to enter the distance from the IMU to the GPS antenna, see *page 128*.

   ```
   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 28.*

You can use NovAtel’s 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 NovAtel's Waypoint Products Group. Visit our Web site at www.novatel.com for details.

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

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

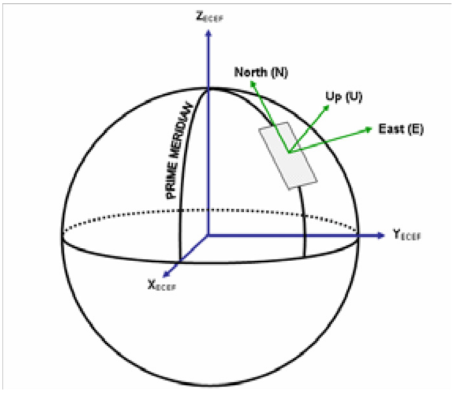


Figure 10: Local-Level Frame (ENU)

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 user has mounted the IMU
- x-axis – defined by how user has mounted the IMU

To determine your SPAN x-axis and y-axis, see *Table 32 on page 126*. 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.

This origin of this frame is not the enclosure centre, but the centre of Navigation (sensor centre).

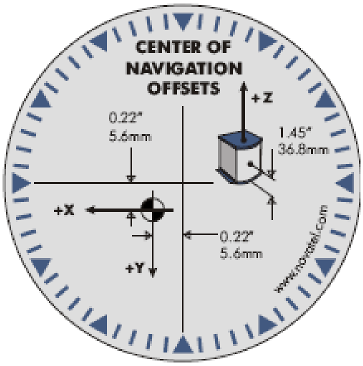


Figure 11: The Enclosure Frame

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

See the *VEHICLEBODYROTATION Vehicle to SPAN frame Rotation on page 140* for information on entering the rotation into the system and see the *RVBCALIBRATE Vehicle to Body Rotation Control on page 121* for information on calibrating this rotation.

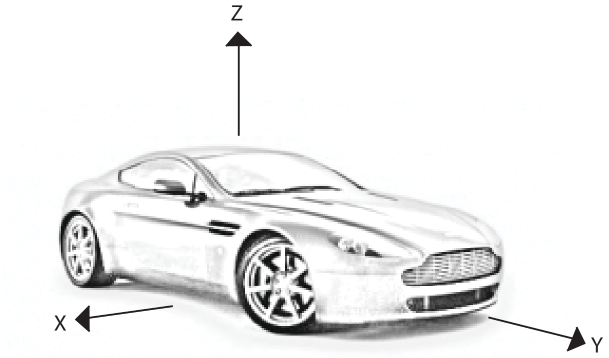


Figure 12: Vehicle Frame

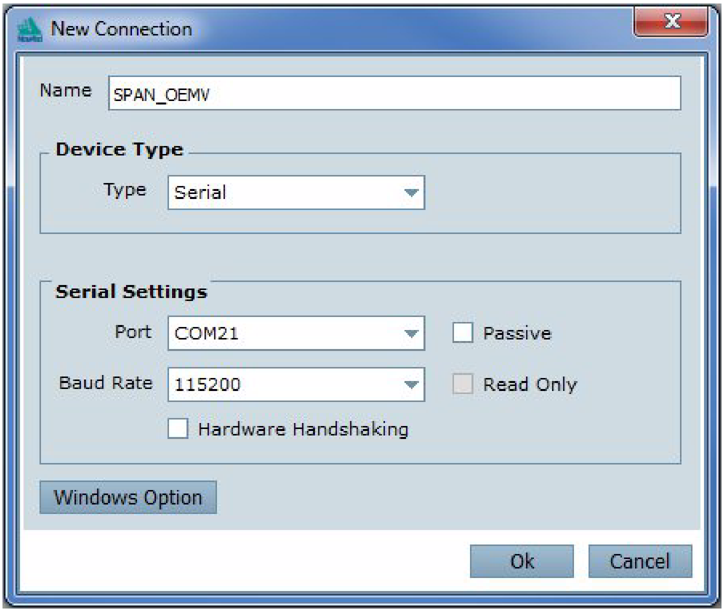
3.2 Communicating with the SPAN System

Once the receiver is connected to the PC, antenna, and power supply, install NovAtel's OEMV PC Utilities (Connect and Convert4). You can find installation instructions in your receiver's *Quick Start Guide*. (Alternatively, you can use a terminal emulator program such as HyperTerminal to communicate with the receiver.) Refer also to the Connect Help file for more details on Connect. The Help file is accessed by choosing *Help* from the main menu in Connect.

Start Connect on your PC to enable communication:

1. Launch Connect from the *Start* menu folder specified during the installation process. The default location is *Start | Programs | NovAtel OEMV | NovAtel Connect*.
2. To define a new connection, select New Connection from the *Device* menu. If a connection is already defined or if connections were imported from NovAtel Connect, choose Open Connection to use it and skip to step 8.

3. Use the New connection dialog to add a new configuration.



Name SPAN_OEMV

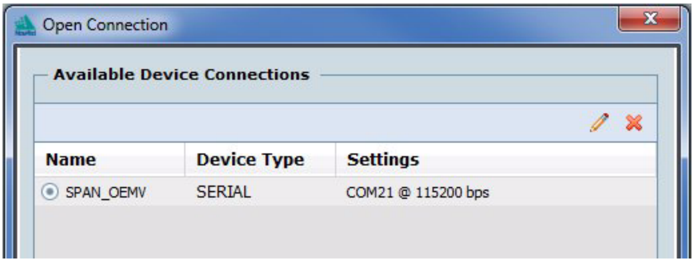
Type Serial

Port COM21 ☐ Passive

Baud Rate 115200 ☐ Read Only

☐ Hardware Handshaking

4. Select *Serial,* or *USB,* from the *Type* list and select the PC/laptop port, that the SPAN receiver is connected to, from the *Port* list.
5. Select *115200* from the *Baud Rate* list.
6. Uncheck the *Use hardware handshaking* check box.
7. Select *OK* to save the new device settings.
8. Select the new configuration from the *Available Device Connections* area of the *Open Connection* window (see below).
9. Select the *Open* button to open SPAN receiver communications.



Name	Device Type	Settings
◉ SPAN_OEMV	SERIAL	COM21 @ 115200 bps

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 Connect's on-line Help for more information.
12. Use the *Console* window to enter commands; *Section 3.4, Data Collection for Post Processing* on *page 54*.

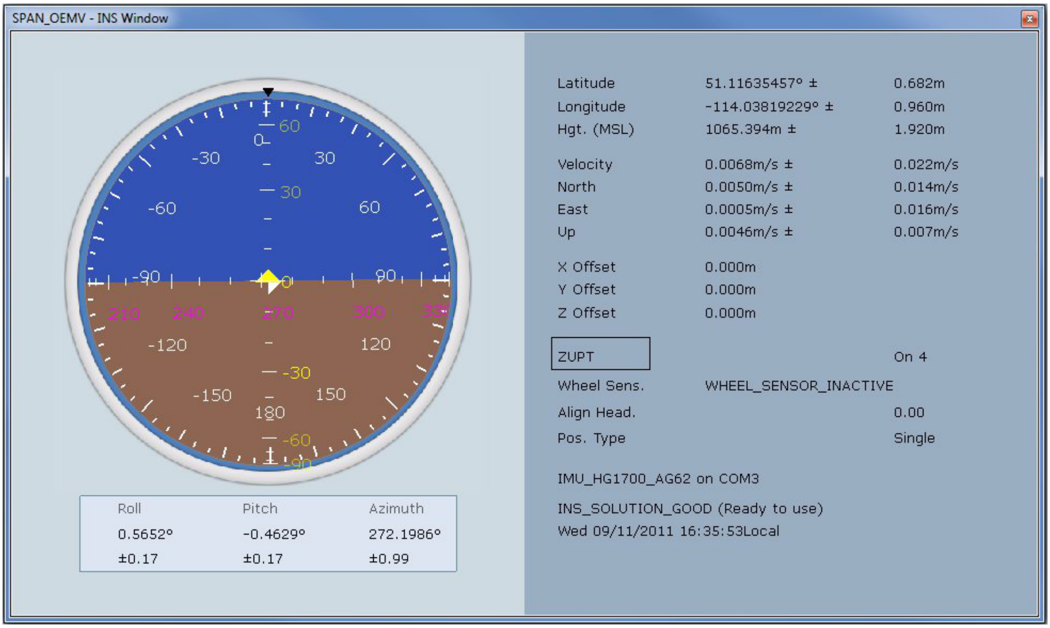
> If you have to power down your receiver, ensure that all windows, other than the Console window, are closed in Connect and then use the SAVECONFIG command.

3.2.1 INS Window in Connect

Connect is a 32 bit Windows application. The application provides a graphical user interface to allow you to set-up and monitor the operation of the SPAN system by providing a series of windows.

The INS Window in Connect is described below. Please refer to the *OEMV Family Installation and Operation User Manual* for more details on Connect and other OEMV 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 Connect's 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.



Roll	Pitch	Azimuth
0.5652°	-0.4629°	272.1986°
±0.17	±0.17	±0.99

Latitude	51.11635457° ±	0.682m
Longitude	-114.03819229° ±	0.960m
Hgt. (MSL)	1065.394m ±	1.920m
Velocity	0.0068m/s ±	0.022m/s
North	0.0050m/s ±	0.014m/s
East	0.0005m/s ±	0.016m/s
Up	0.0046m/s ±	0.007m/s
X Offset	0.000m	
Y Offset	0.000m	
Z Offset	0.000m	
ZUPT		On 4
Wheel Sens.	WHEEL_SENSOR_INACTIVE	
Align Head.		0.00
Pos. Type		Single

IMU_HG1700_AG62 on COM3

INS_SOLUTION_GOOD (Ready to use)

Wed 09/11/2011 16:35:53Local

3.3 Real-Time Operation

SPAN operates through the OEMV 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 GPS antenna is connected with a clear view of the sky.
- The Inertial solution is computed separately from the GPS solution. The GPS solution is available from the SPAN system through the GPS-specific logs even without SPAN running. The integrated INS/GPS solution is available through special INS logs documented in *Appendix C* of this manual.
- The IMU solution 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 (RAWIMUSB rather than RAWIMUB). 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, *Table 5* below.

Table 5: 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_SOLUTION_NOT_GOOD	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 GPS, 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_BAD_GPS_AGREEMENT	The INS filter is in navigation mode, and the GPS solution is suspected to be in error. This may be due to multipath or limited satellite visibility. The inertial filter has rejected the GPS 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 *#8* on *page 229*

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 to you in the RAWIMU or RAWIMUS log, see *page 179*. 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 GPS. 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_SOLUTION_NOT_GOOD.

3.3.1.1 Coarse Alignment

The coarse alignment is the default alignment routine for SPAN. The alignment starts as soon as a GPS 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 1 minute. 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 48*).

If the system is stationary for less than 1 minute, the coarse alignment finishes early, provided at least 5 stationary seconds were detected. The quality of the coarse alignment is poorer with stationary durations of less than 1 minute.

> The HG1930 and Landmark 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 *Chapter 3.3.1.2, Kinematic Alignment* starting on *page 48*.
>
> If a stationary alignment is required, refer to *Chapter 3.3.1.3, Manual Alignment* starting on *page 48*.

3.3.1.2 Kinematic Alignment

If the preferred coarse alignment routine cannot be performed because the vehicle cannot remain stationary for the length of time required, an alternate 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.

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's azimuth and pitch must match the IMU enclosure's 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 139*. 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 52*.

The kinematic alignment begins when the receiver has a good GPS position, fine time is solved, the configuration parameters have been set and a GPS 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 you know the attitude of your vehicle (roll, pitch, azimuth) you can manually enter the attitude information using the SETINITATTITUDE command. Refer to SETINITATTITUDE Set Initial Attitude of SPAN in Degrees on *page 131*.

Alternatively, if you know only the azimuth of your vehicle, you can manually enter the azimuth information using the SETINITAZIMUTH command. Refer to SETINITAZIMUTH Set Initial Azimuth and Standard Deviation on *page 133*.

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 Kalman filter. The GPS solution, phase observations and automatic zero velocity updates (ZUPTs) provide updates to the Kalman filter. When a sensor is connected to the system, wheel displacement updates are also used in the filter.

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. Three to five changes in heading should be sufficient to resolve the heading accuracy. 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_SOLUTION_NOTGOOD. 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 6* on *page 49*:

Table 6: Solution Parameters

Parameter	Log
Position	INSPOS *or* INSPOSS INSPVA *or* INSPVAS
Velocity	INSVEL *or* INSVELS INSSPD *or* INSSPDS INSPVA *or* INSPVAS
Attitude	INSATT *or* INSATTS INSPVA *or* INSPVAS
Solution Uncertainty	INSCOV *or* INSCOVS

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 GPS-only solution is still available through the GPS-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 *OEMV 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 GPS 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), GPS 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

High-rate data logging is regulated in SPAN to prevent logging of unusable data or overloading the system. Please note these 3 rules when configuring your SPAN system:

1. Only one high-rate INS log can be configured for output at a time. Once a log is selected for output at a rate faster than or equal to 100 Hz, all other log requests are limited to a maximum rate of 50 Hz. Below are examples of acceptable logging requests:

   ```
   LOG RAWIMUSB ONNEW          (100 or 200 Hz depending on the IMU)
   LOG INSPVASB ONTIME 0.02    (acceptable 50 Hz logging)
   ```

   The following is rejected because RAWIMU has already been requested at 100/200 Hz:

   ```
   LOG INSPOSSB ONTIME 0.01    (100 Hz request)
   ```

   Below is another example set of acceptable logging requests:

   ```
   LOG INSPOSSB ONTIME 0.01    (100 Hz request)
   LOG INSVELSB ONTIME 0.02    (50 Hz request)
   ```

   The following are rejected in this case because INSPOSSB has already been requested at a high rate.

   ```
   LOG RAWIMUSB ONNEW          (100 Hz request)
   LOG INSATTSB ONTIME 0.005   (200 Hz request)
   ```

2. RAWIMU and RAWIMUS logs are only available with the ONNEW or ONCHANGED trigger. These 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 log starting on *page 179.*

3. In order to collect wheel sensor information, useful in post-processing, the TIMEDWHEELDATA log should only be used with the ONNEW trigger. See also *page 191* for details on this log.

4. Only log 200 Hz logs in binary.

Specific logs need to be collected for post-processing. See *Section 3.4, Data Collection for Post Processing* on *page 54*.

To store data with a ProPak-V3, connect a laptop computer to it. The laptop computer should be equipped with a data storage device such as a Compact Flash Card, CD or MP3 disc.

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 should 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 128*. The calibration routine uses these values as the starting point for the lever arm computation.

The steps involved in the calibration are:

1. Power the receiver and the IMU, see the IMU choices and their technical specifications starting on *page 55*.
2. Configure the RTK corrections and make sure that the BESTGPSPOS log, see *page 146*, reports a good RTK solution.
3. Configure the IMU, see *Section 2.3.2, SPAN IMU Configuration* on *page 38*.
4. Set the orientation of your installed IMU using the SETIMUORIENTATION command, see *page 124*.
5. Enter the initial estimate for the lever arm using the SETIMUTOANTOFFSET command, see *page 128.*
6. Specify the limits of the calibration through the LEVERARMCALIBRATE command, see *page 118*. 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 154*, 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 also *Table 5* on *page 46*.
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.

The lever arm is saved automatically in non-volatile memory. If the IMU or GPS antenna are re-mounted, the calibration routine should be re-run to compute an accurate lever arm.

3.3.5 Vehicle to SPAN Frame Angular Offsets Calibration Routine

Kinematic fast 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 139*. 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, see the IMU choices and their technical specifications starting on *page 55*.
2. Configure the IMU, see *Section 2.3.2, SPAN IMU Configuration* on *page 38*.
3. Ensure that an accurate lever arm has been entered into the system either manually or through a lever arm calibration, see *page 50*.
4. Allow the system to complete a coarse alignment, see *page 47*.
5. Enable the vehicle to body calibration using the RVBCALIBRATE ENABLE command, see *page 121*.
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 fast alignment, the calibration stops and the VEHICLEBODYROTATION log, see *page 192*, is overwritten with the solved values. To monitor the progress of the calibration, log VEHICLEBODYROTATION using the ONCHANGED trigger.

The rotation parameters are saved in NVM for use on start-up in case a fast-alignment is required. Each time the IMU is re-mounted this calibration should be performed again. See also *Sections 3.3.1.1* and *3.3.1.2* on *page 48* for details on coarse and fast 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 47*). The angular offset values are not applied to the attitude output, unless the APPLYVEHICLEBODYROTATION command is enabled, see *page 107*.

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 38*. For HG1700 and LN-200 users, the wheel velocity commands must be created and sent to the SPAN receiver at 1 Hz. For iIMU-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 83* 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 GPS even-second boundaries. The GPS second boundary is available from the OEMV 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 142*.

ⓘ 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 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*.

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/GPS Kalman filter to perform the update. The timed data is also available through the TIMEDWHEELDATA log, see *page 191*. The TIMEDWHEELDATA log can be used for applying wheel sensor updates in post-processing.

The SPAN Kalman 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 GPS 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 193*. Information on how the wheel sensor updates are being used is available in the INSUPDATE log, see *page 173*.

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 OEMV 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.6.2, iIMU-FSAS Odometer Cabling* on *page 83*.

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 138*.

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 ONNEW

From a rover:

- RANGECMPB ONTIME 1
- RAWEPHEMB ONNEW
- RAWIMUSB ONNEW

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

> The highest rate that you should request GPS 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), GPS logs can be requested at rates up to 20 Hz.

Appendix A Technical Specifications

This appendix details the technical specifications of the IMUs. Refer to your SPAN system enclosure's hardware manual for more information on its technical specifications, performance and cables (the *OEMV Family Installation and Operation User Manual)*.

A.1 Universal IMU Enclosure

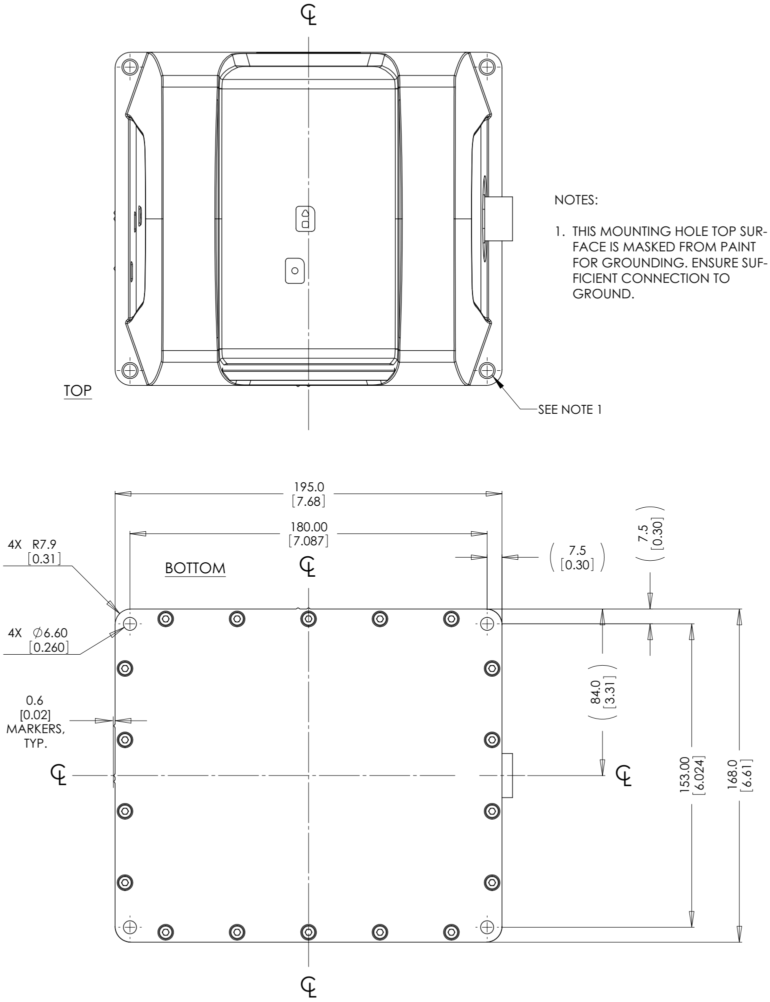
The Universal IMU enclosure is available with the HG1700 and LN200 IMU's.

Table 7: Universal IMU Enclosure Specifications

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

MECHANICAL DRAWINGS

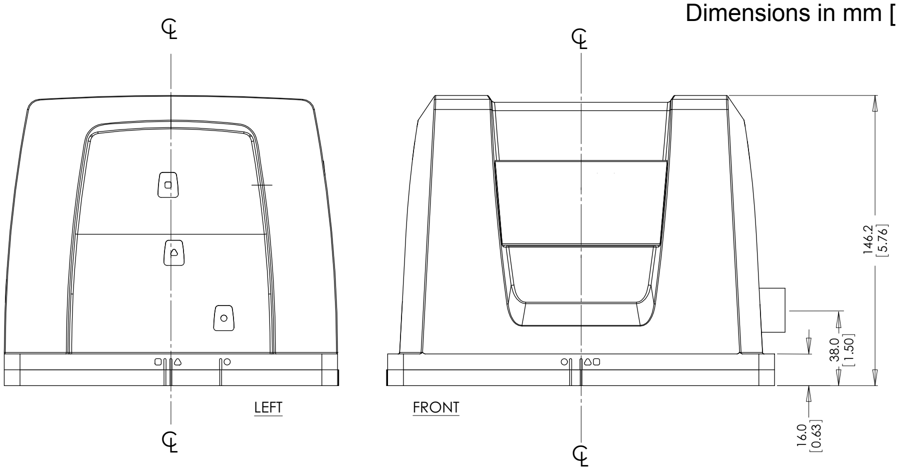
Dimensions in mm [inches]



NOTES:

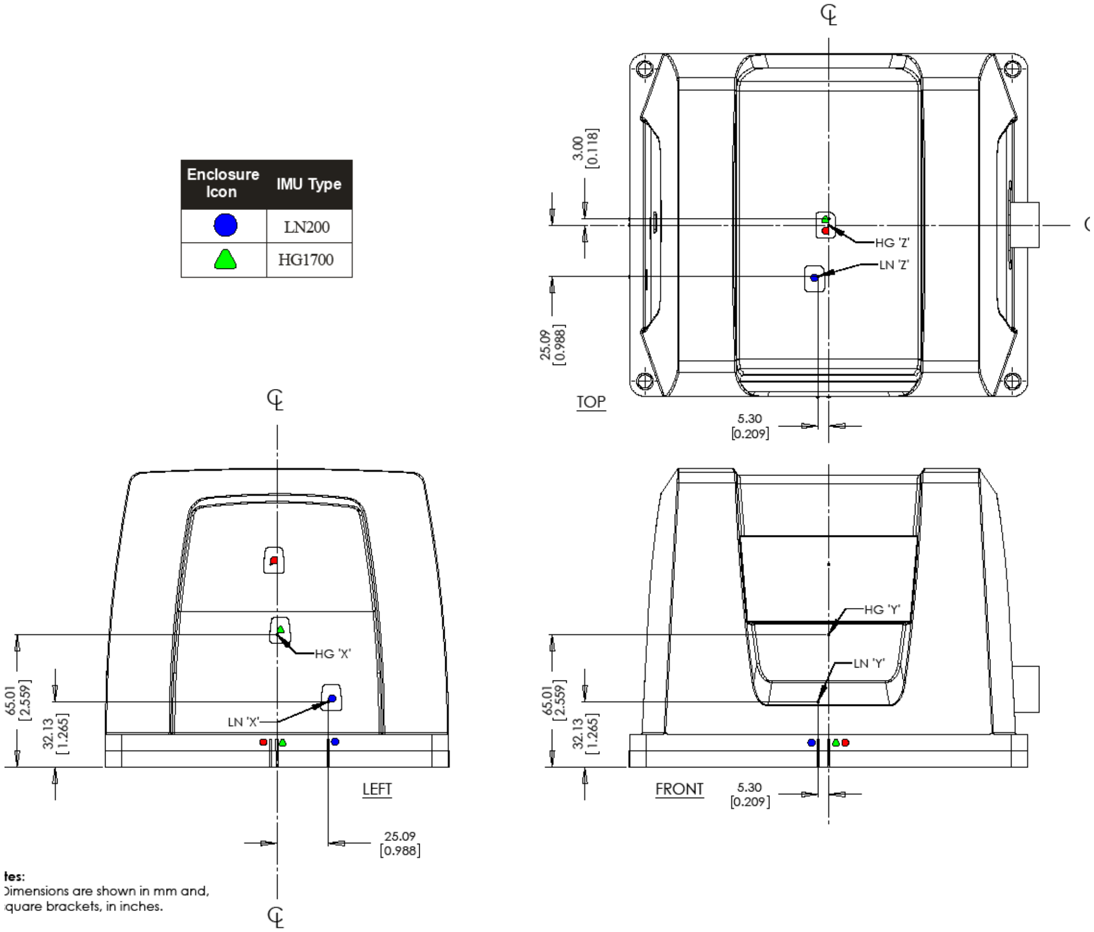
1. THIS MOUNTING HOLE TOP SURFACE IS MASKED FROM PAINT FOR GROUNDING. ENSURE SUFFICIENT CONNECTION TO GROUND.

Figure 13: Universal IMU Enclosure Top/Bottom Dimensions



Dimensions in mm [inches]

Figure 14: Universal IMU Enclosure Side Dimensions



Enclosure Icon	IMU Type
●	LN200
▲	HG1700

Figure 15: IMU Centre of Navigation

A.1.1 Universal IMU Enclosure Interface Cable

NovAtel’s part number for the Universal IMU Enclosure interface cable is 01018299 (see *Figure 16* and *Figure 17*). This cable provides power to the IMU from an external power source, and enables input and output between the receiver and the IMU.

Figure 16: Universal IMU Enclosure Interface Cable

Dimensions in millimetres.

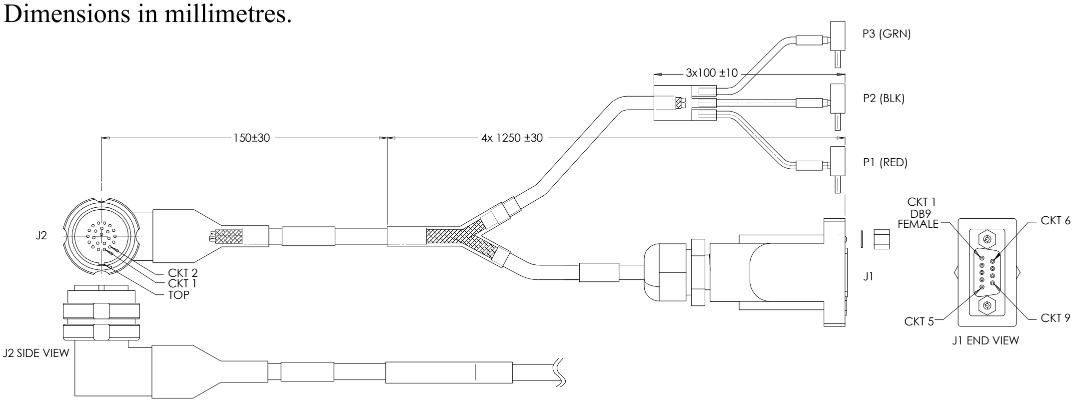


Figure 17: Universal IMU Enclosure Interface Cable

Table 8: Universal IMU Enclosure Interface Cable Pinouts

J2		REMOTE CONNECTION	
PINOUT	**FUNCTION**	**CONNECTOR**	**PIN (COLOR)**
1	V_{IN} (-) PIN 1	P2	(BLK)
22	V_{IN} (-) PIN 22		
2	Not used		
3	V_{IN} (+) PIN 3	P1	(RED)
21	V_{IN} (+) PIN 21		
4	Not used		
5	Not used		
6	Not used		

Table 8: Universal IMU Enclosure Interface Cable Pinouts (continued)

J2		REMOTE CONNECTION	
PINOUT	FUNCTION	CONNECTOR	PIN (COLOR)
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.1.2 IMU Performance

PERFORMANCE (IMU)		
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

A.1.3 Electrical and Environmental

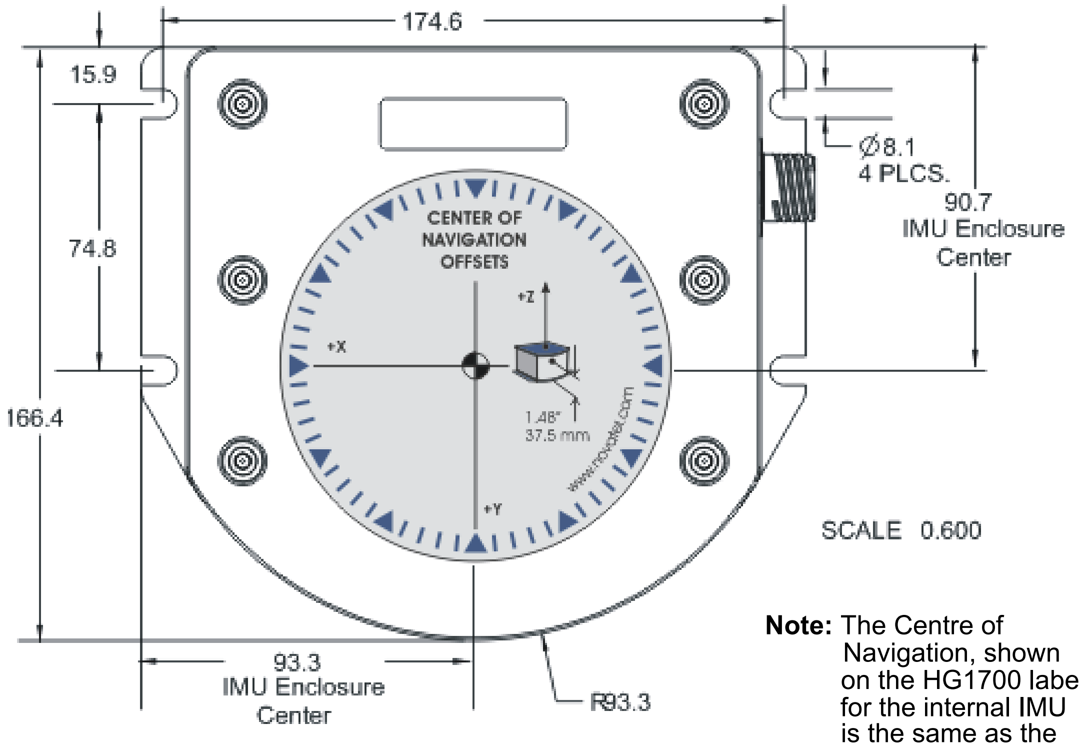
Table 9: Universal IMU Enclosure Electrical and Environmental

ELECTRICAL	
IMU Power Consumption	HG1700-AG58: 9 W (max) HG1700-AG62: 8 W (max) LN-200: 16 W (max)
IMU Input Voltage	+12 to +28 V DC (all IMU’s)
Receiver Power Consumption	2.8 W (typical, for all IMU’s)
Input/Output Connectors	MIL-C-38999-III, 22 pin (all IMU’s)
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
	LN200 Operating -30°C to +60°C Storage -45°C to +80°C
Humidity	Operates at 95% RH, non-condensing (all IMU’s)

A.2 HG1700 IMU (single-connector enclosure)

Table 10: HG1700 IMU Specifications

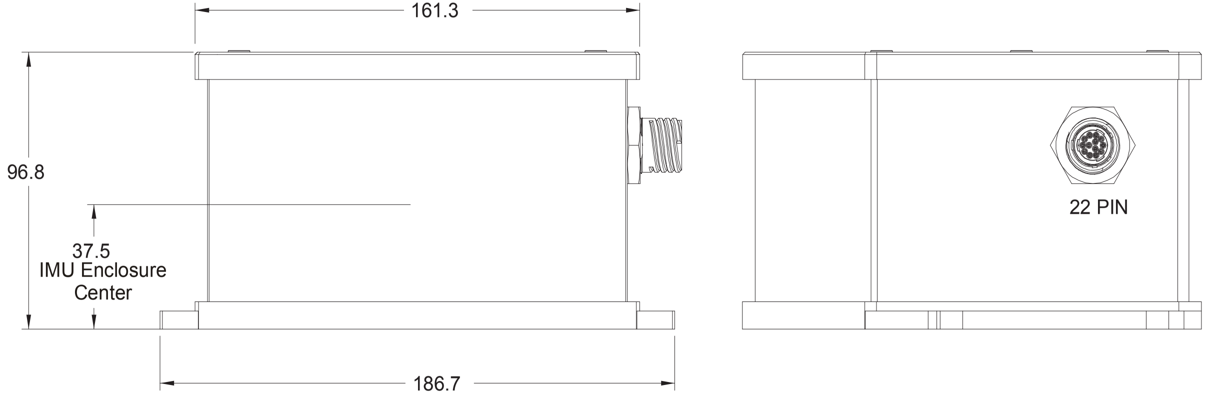
<table>
<tr><th colspan="2">PHYSICAL</th></tr>
<tr><td>IMU Enclosure Size</td><td>193 mm x 167 mm x 100 mm (7.6” x 6.6” x 3.9”)</td></tr>
<tr><td>IMU Size</td><td>160 mm x 160 mm x 100 mm (6.3” x 6.3” x 3.9”)</td></tr>
<tr><td>IMU + Enclosure Weight</td><td>3.4 kg (7.49 lb.)</td></tr>
<tr><th colspan="2">MECHANICAL DRAWINGS</th></tr>
<tr><td colspan="2">



Note: The Centre of Navigation, shown on the HG1700 label, for the internal IMU is the same as the enclosure’s centre. The enclosure centre measurements are labelled as: IMU Enclosure Centre in this figure.

Figure 18: HG1700 Top/Bottom Dimensions

</td></tr>
</table>



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

Figure 19: HG1700 Enclosure Side Dimensions

A.2.1 HG1700 IMU Interface Cable

The IMU interface cable provides power to the IMU from an external power source and enables input and output between the receiver and IMU. It is the same as the cable supplied with the Universal Enclosure, shown in *Figure 16* on *page 59*.

A.2.2 IMU Performance

PERFORMANCE *(IMU)*		
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

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	ProPak-V3 2.8 W (typical)
System Power Consumption	ProPak-V3 14.8 W (typical)
Input/Output Connectors	MIL-C-38999-III, 22 pin (all IMU's)[a]
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

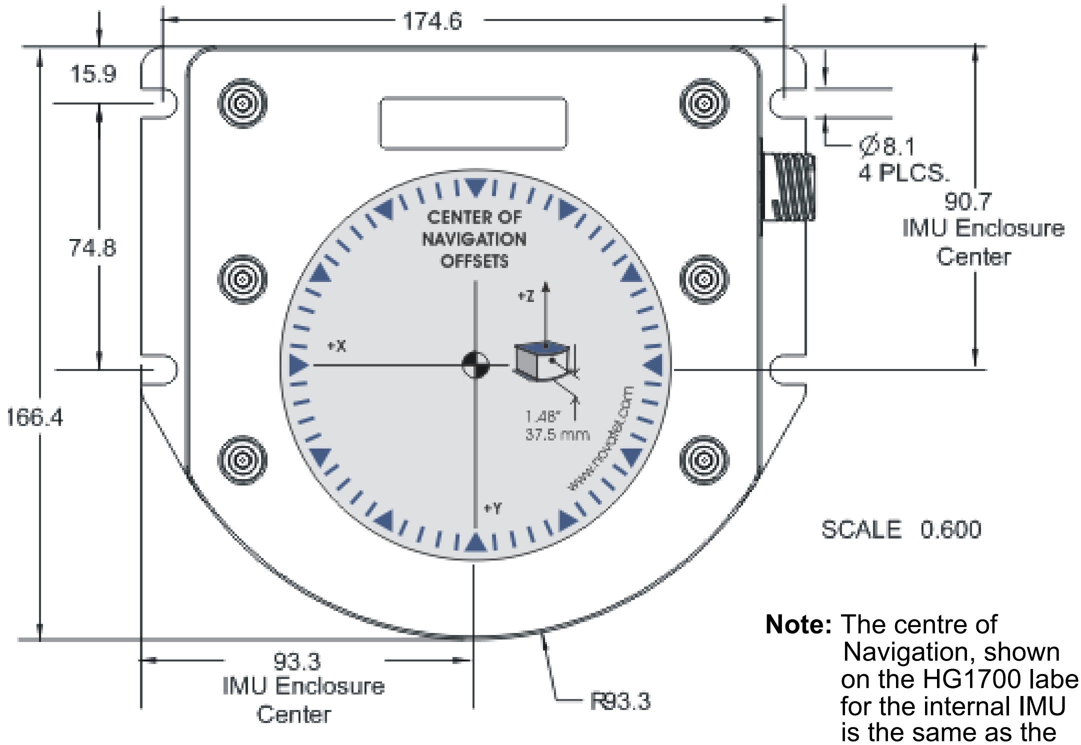
---

[a] For replacement connectors on the interface and power cables, see *Section J.3, Manufacturer's Part Numbers* on *page 231*.

A.3 HG1700 IMU (dual-connector enclosure)

Table 11: HG1700 IMU Specifications

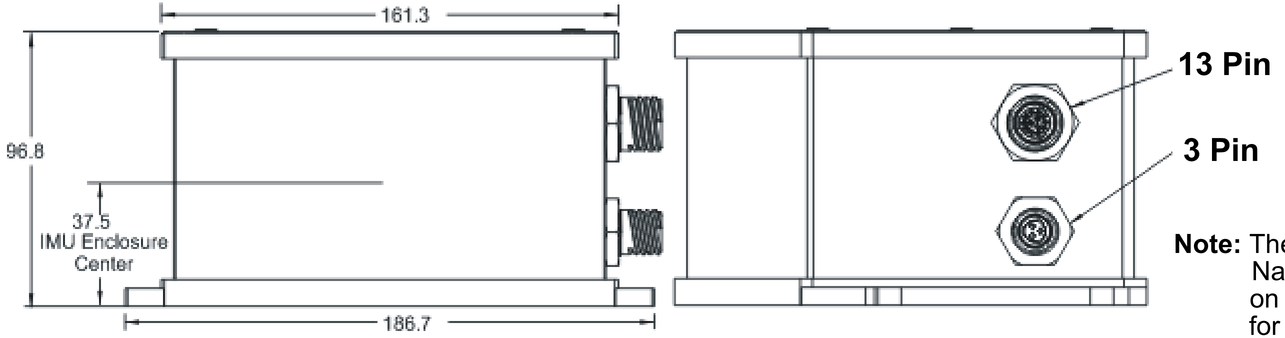
PHYSICAL	
IMU Enclosure Size	193 mm x 167 mm x 100 mm (7.6” x 6.6” x 3.9”)
IMU Size	160 mm x 160 mm x 100 mm (6.3” x 6.3” x 3.9”)
IMU Weight	3.4 kg (7.49 lb.)
MECHANICAL DRAWINGS	



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

Figure 20: HG1700 Top/Bottom Dimensions

Scale: 0.600



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

Figure 21: HG1700 Enclosure Side Dimensions

A.3.1 HG1700 IMU Interface Cable

The IMU interface cable supplied, provides power to the IMU from an external power source, and enables input and output between the receiver and IMU. It is the same as the cable supplied with the LN-200, see *Figure 26* on *page 76*.

A.3.2 IMU Performance

PERFORMANCE *(IMU)*		
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.3.3 Electrical and Environmental

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	ProPak-V3 2.8 W (typical)
System Power Consumption	ProPak-V3 14.8 W (typical)
Data Connector on Enclosure	13-pin Deutsch P/N 59065-11-35PF [a]
Power Connector on Enclosure	3-pin Deutsch P/N 59065-09-98PN [a] +6 to +18 VDC
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

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[a] For replacement connectors on the interface and power cables, see *Section J.3, Manufacturer's Part Numbers* on *page 231*.

A.4 LN-200 IMU (single-connector enclosure)

Table 12: 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	

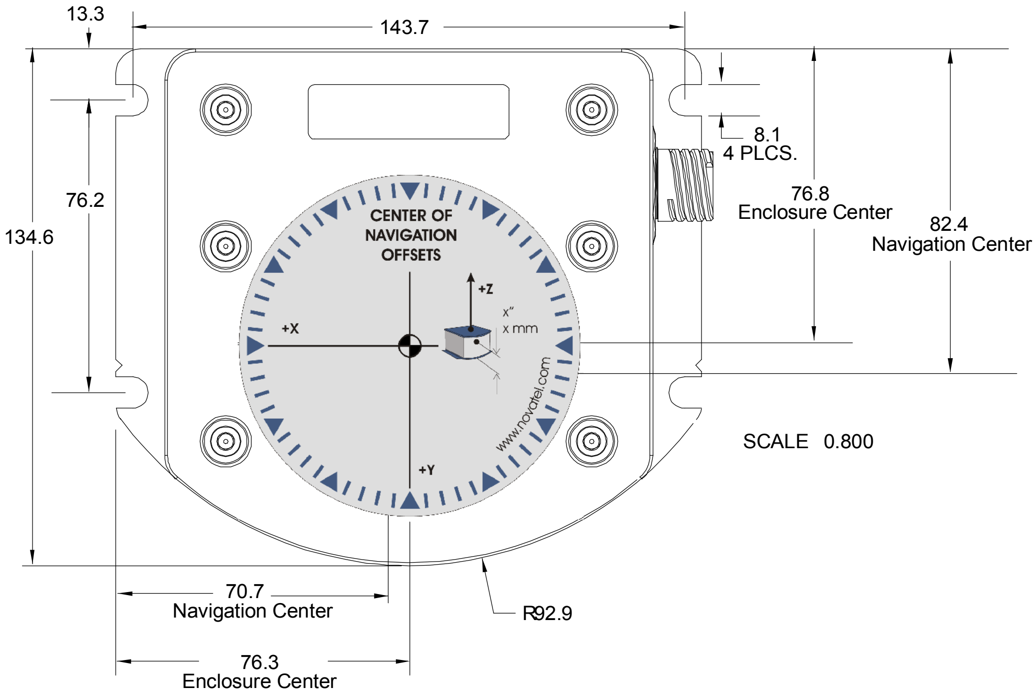
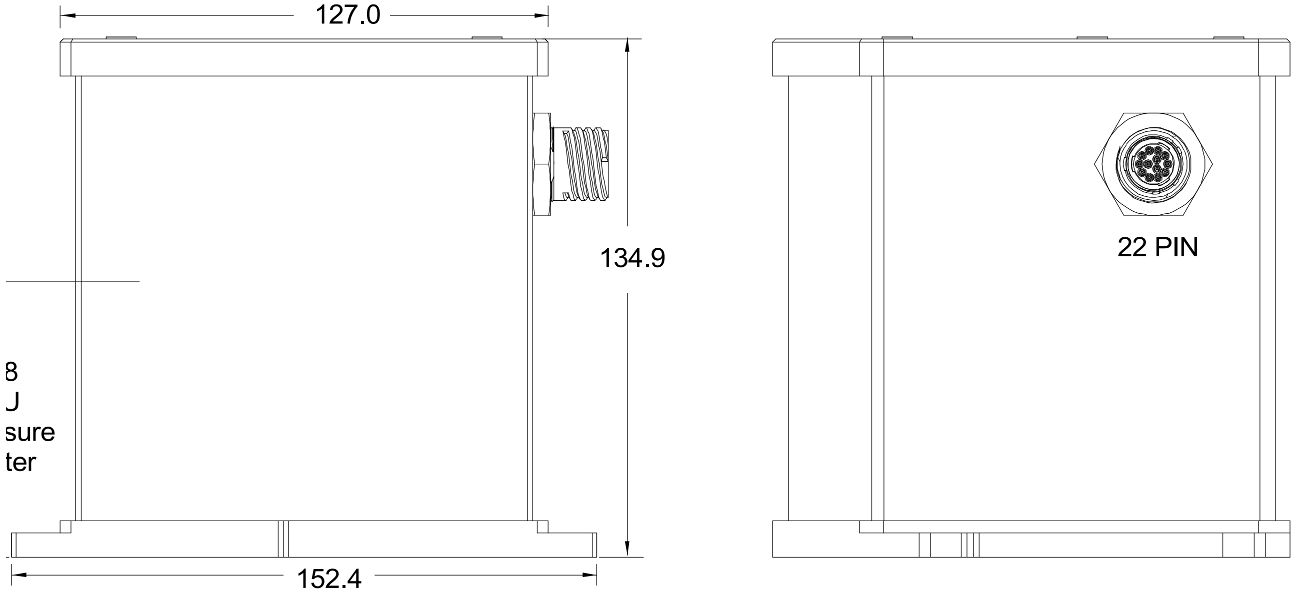


Figure 22: LN-200 IMU Enclosure Top/Bottom Dimensions and Centre of Navigation



Note: The Center of Navigation offsets, show 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 Enclosure Center in this figure and in Figure 8.

Figure 23: LN-200 Enclosure Side Dimensions

A.4.1 LN-200 IMU Interface Cable

The IMU interface cable provides power to the IMU from an external power source and enables input and output between the receiver and IMU. It is the same as the cable supplied with the Universal Enclosure, shown in *Figure 16* on *page 59*.

A.4.2 IMU Performance

PERFORMANCE *(IMU)*		
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.4.3 Electrical and Environmental

ELECTRICAL		
IMU Power Consumption	16 W (max)	
IMU Input Voltage	+12 to +28 V DC	
Receiver Power Consumption	ProPak-V3	2.8 W (typical)
System Power Consumption	ProPak-V3	14.8 W (typical)
Input/Output Connectors	MIL-C-38999-III, 22 pin (all IMU's)[a]	
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	

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[a] For replacement connectors on the interface and power cables, see *Section J.3, Manufacturer's Part Numbers* on *page 231*.

A.5 LN-200 IMU (dual-connector enclosure)

Table 13: 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	

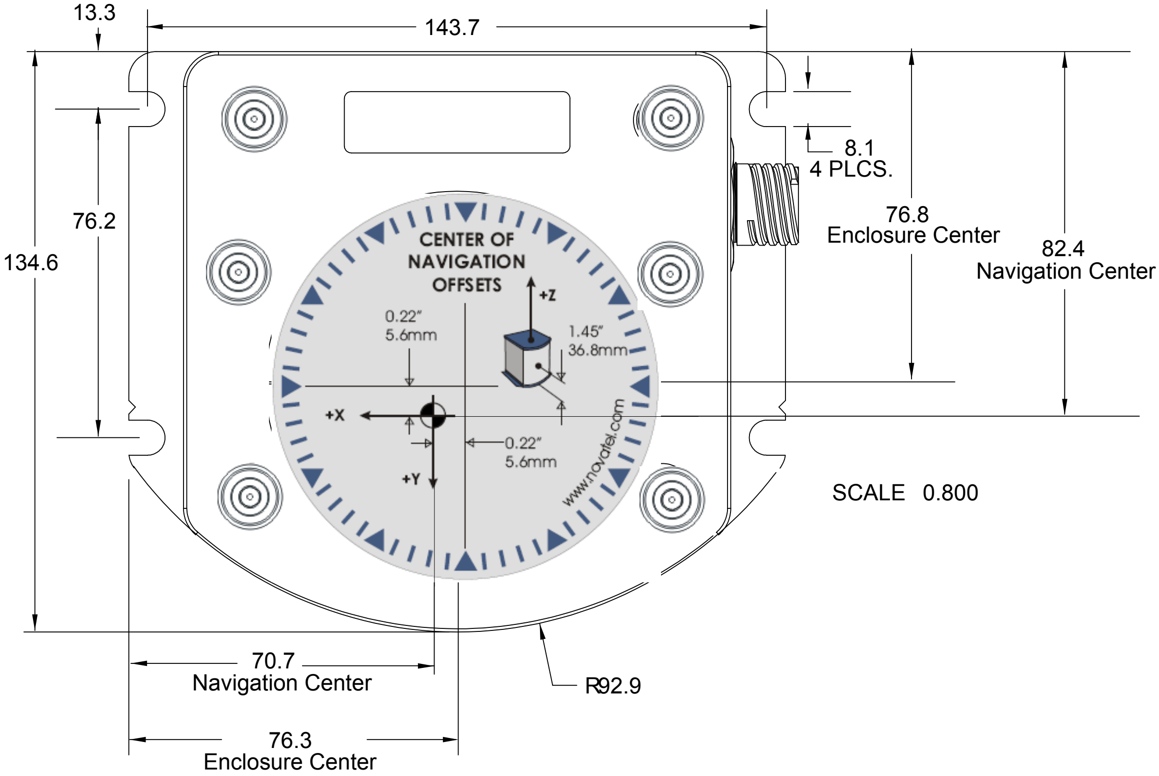
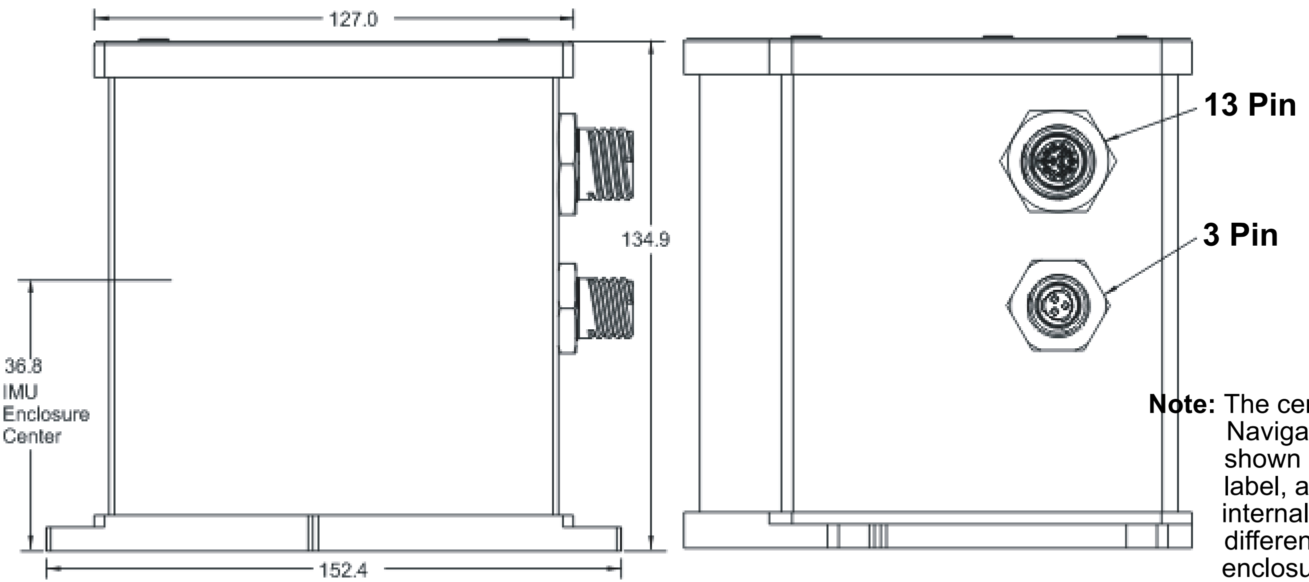


Figure 24: LN-200 IMU Enclosure Top/Bottom Dimensions and Centre of Navigation

Scale: 0.800



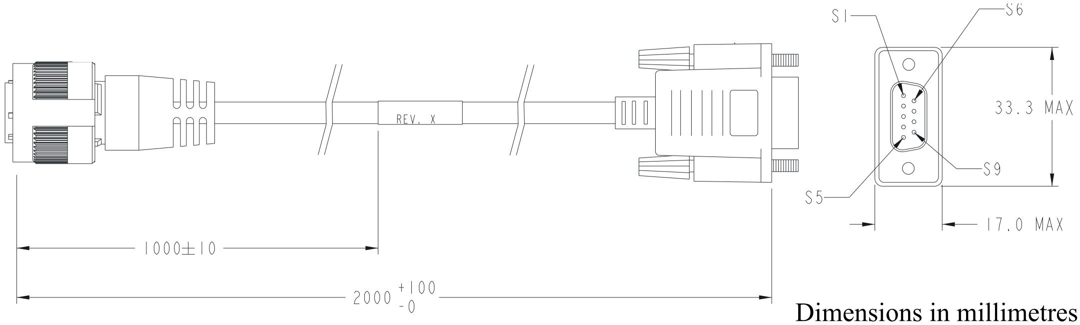
Note: The centre of Navigation offsets, shown on the LN-200 label, are for the internal IMU and are different than for the enclosure centre. The measurements for the enclosure centre are labelled as:
IMU Enclosure centre in this figure and Figure 5.

Figure 25: LN-200 Enclosure Side Dimensions

A.5.1 LN-200 IMU Interface Cable

The NovAtel part number for the LN-200 IMU interface cable is 01017375 (*Figures 26* and *27 below*). The IMU interface cable supplied enables input and output between the IMU and the receiver.

Figure 26: LN-200 Interface Cable



Dimensions in millimetres

Deutsch 13-Pin to IMU		DB-9 Female to Receiver
S1		N/C
S2	PAIRED	S3
S3		S7
S4		N/C
S5		S5
S6		N/C
S7	PAIRED	S8
S8		S2
S9	2 WIRES	S1
S9		S6
S10		N/C
S11	PAIRED	N/C
S12		N/C
S13		N/C

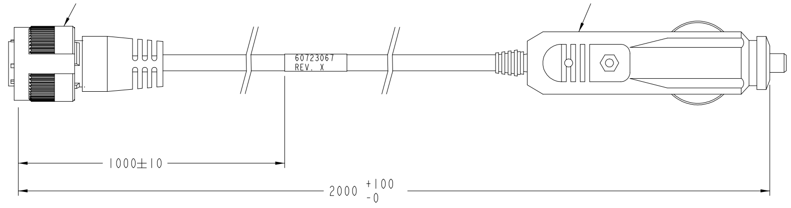
Figure 27: IMU Interface Cable Pin-Out (ProPak-V3)

A.5.2 LN-200 IMU Power Adapter Cable

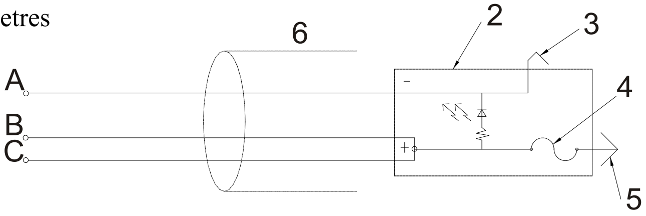
The power adapter cable, NovAtel part number 01017821, supplied with the LN-200 provides a convenient means for supplying +12 VDC while operating from a 12V source. *Figure 28* shows the cable and *Figure 29* the wiring diagram of the 12V adapter.

The output of the power adapter uses a 3-pin Deutsch socket (Deutsch part number: 59064-09-98SN). This cable plugs directly into the 3-pin port on the front of the LN-200 enclosure.

Figure 28: LN-200 Power Cable



Dimensions in millimetres



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

Figure 29: IMU Power Cable Pin-Out

A.5.3 IMU Performance

PERFORMANCE *(IMU)*		
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.5.4 Electrical and Environmental

ELECTRICAL		
IMU Power Consumption	16 W (max)	
IMU Input Voltage	+12 to +28 VDC	
Receiver Power Consumption	ProPak-V3	2.8 W (typical)
System Power Consumption	ProPak-V3	14.8 W (typical)
Data Connector on Enclosure	13-pin Deutsch P/N 59065-11-35PF [a]	
Power Connector on Enclosure	3-pin Deutsch P/N 59065-09-98PN [a] +6 to +18 VDC	
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	

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[a] For replacement connectors on the interface or power cables, see *Section J.3, Manufacturer's Part Numbers* on *page 231*.

A.6 iIMU-FSAS

Table 14: 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 [a]	

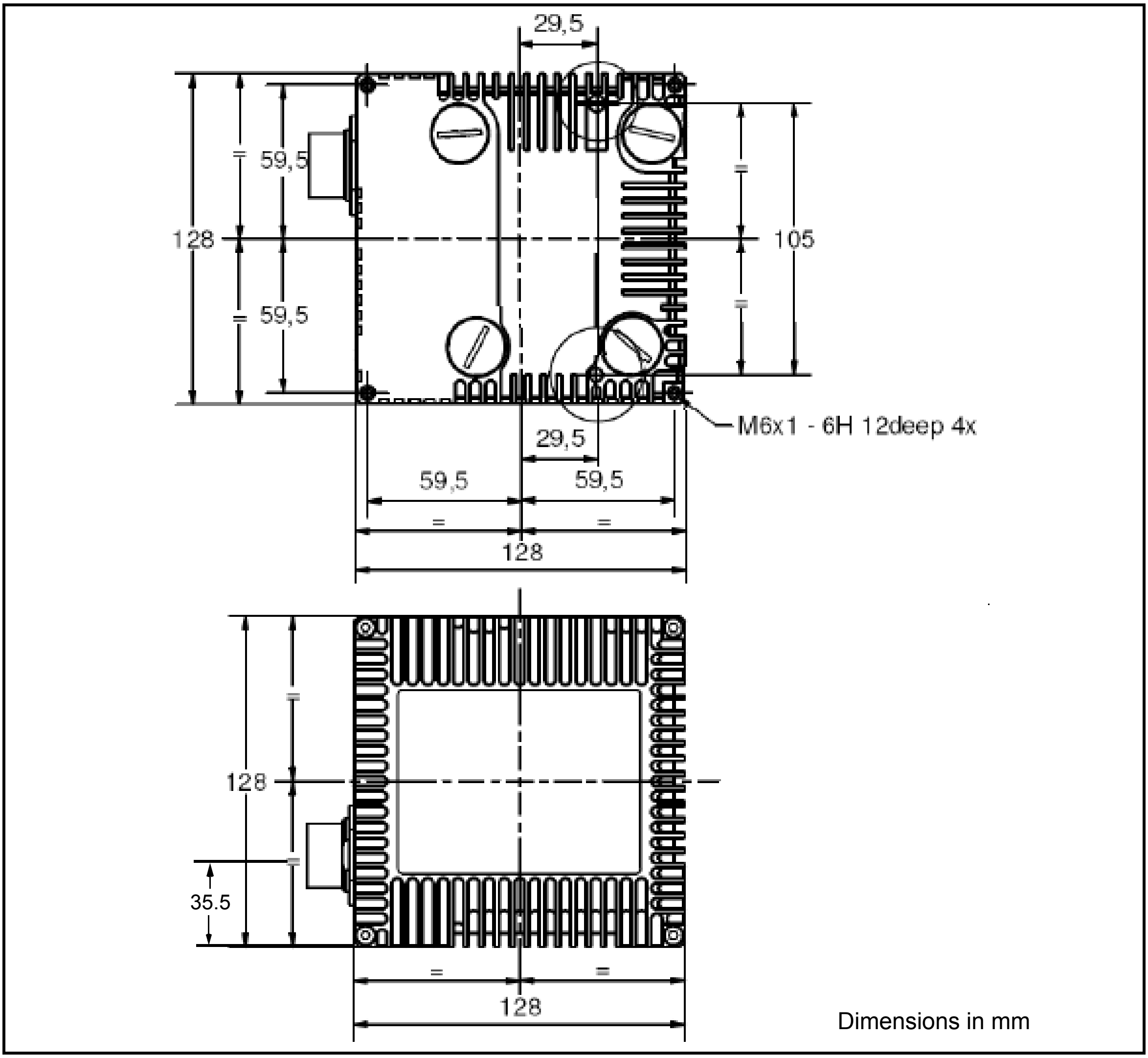

Figure 30: iIMU-FSAS Top/Bottom Dimensions

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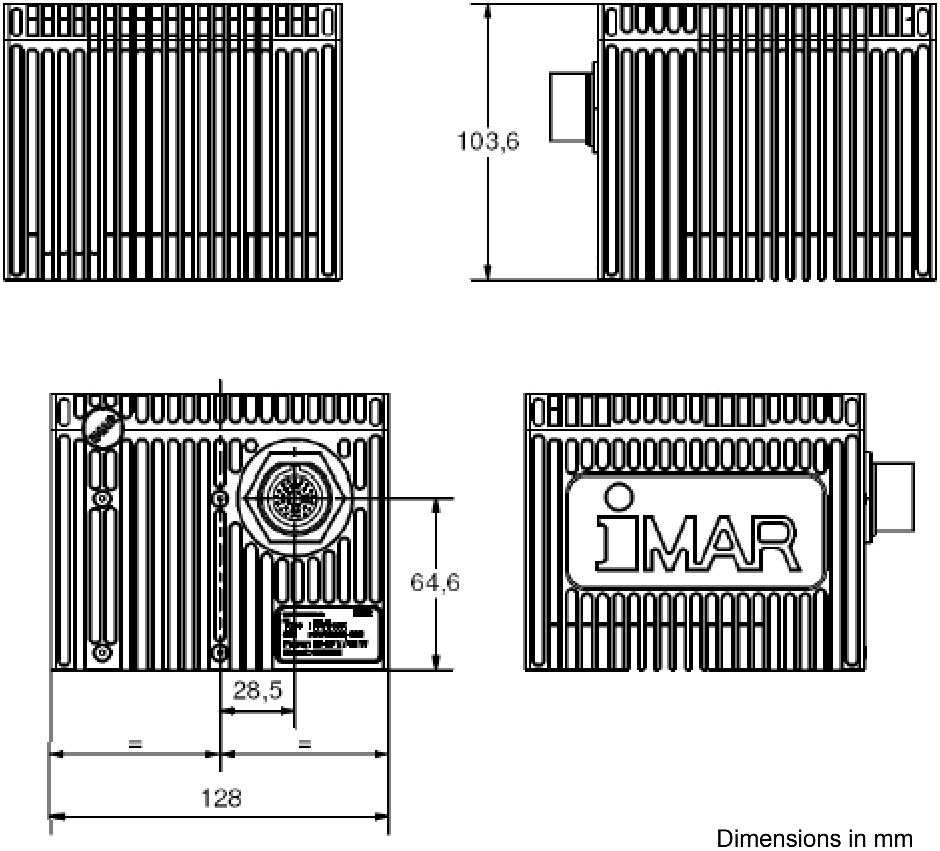
[a] See *Figure 32* on *page 81* for the centre of navigation dimensions

[b] Dimensions are in mm.



Dimensions in mm

Figure 31: iIMU-FSAS Enclosure Side Dimensions

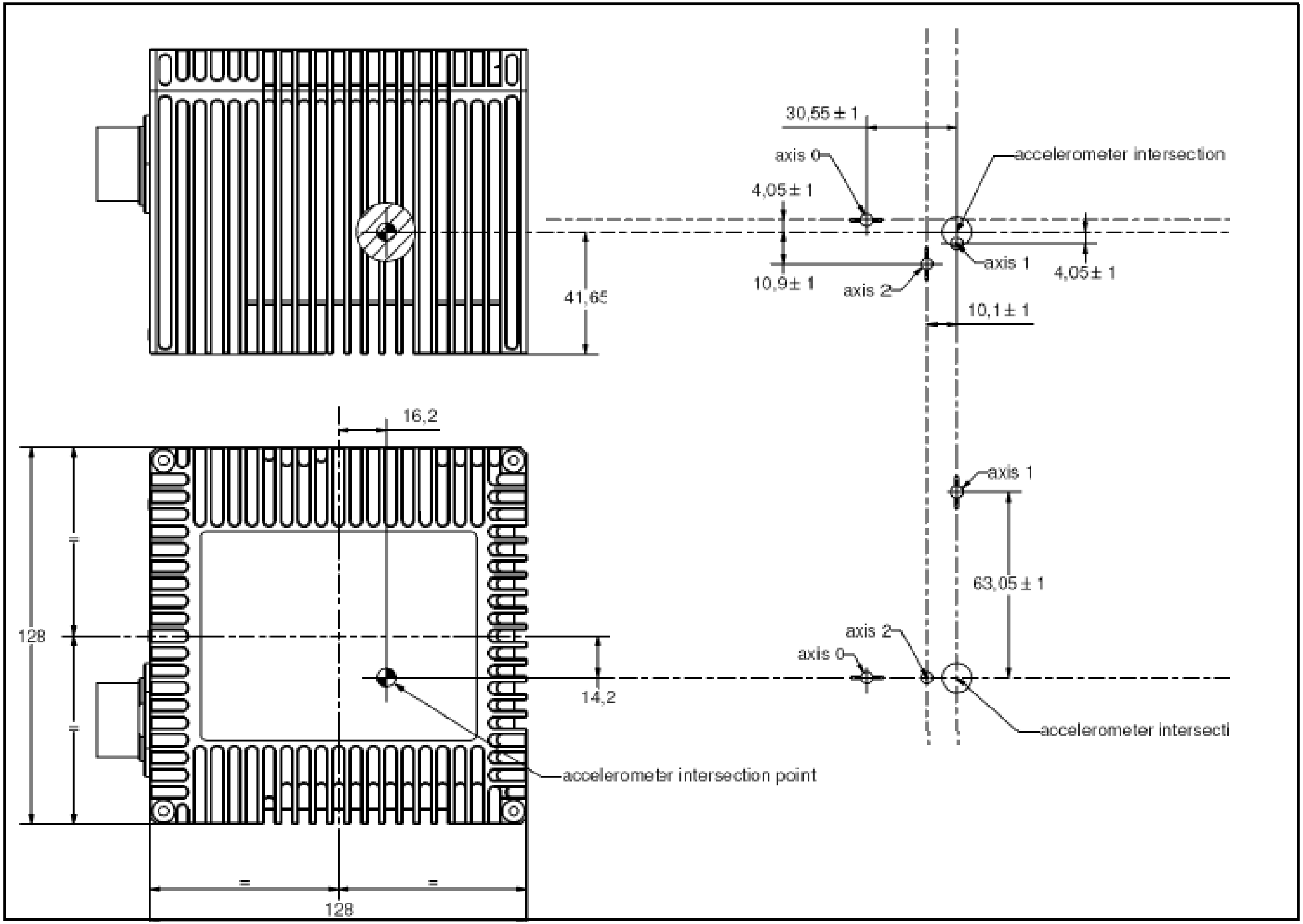


Figure 32: IMU-FSAS Centre of Navigation

A.6.1 iIMU-FSAS Interface Cable

The NovAtel part number for the 1 m iIMU-FSAS interface cable is 60723086 for the ProPak-V3 (see *Table 15* below and *Figure 35, iIMU-FSAS Interface Cable* on *page 85*). See also *Section A.6.2, iIMU-FSAS Odometer Cabling* on *page 83* if applicable.

The IMU interface cable supplied, provides power to the IMU from an external power source, and enables input and output between the receiver and IMU.

Table 15: IMU Interface Cable Pin-Out

MIL-C-38999 III Connector Pin	Function	Power 4 mm plugs	Female DB9 to COM3	Male DB9 to I/O	Male DB9 to ODO	Comments
1	PGND	Color: black Label: PGND				Power ground
2	ODO_AN				7	Odometer input A(-), opto-coupler: +2 to +6 V (RS-422 compatible)
3	V_{IN}	Color: red Label: 10-34 VDC				+10 to +34 VDC
4	ODO_A				6	Odometer input A(+), opto-coupler: +2 to +6 V (RS-422 compatible)
5-6	Reserved					
7	DAS			1 and 6		Shielded data acquisition signal (LVTTL to VARF)
8	Reserved					
9	DAS_GND			9		Shielded ground reference for data acquisition and control signals
10	Reserved					
11	DON		8			Twisted pair; serial data output signal / RS-422(-)
12	DO		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)

Continued on the following page

MIL-C-38999 III Connector Pin	Function	Power 4 mm plugs	Female DB9 to COM3	Male DB9 to I/O	Male DB9 to ODO	Comments
18	Reserved					
19	DI		3			Twisted pair; serial data in / RS-422(+)
20	DIN		7			Twisted pair; serial data in / RS-422(-)
21	SW_ON_SIG					Connected to Pin 3; switch IMU signal ON/OFF (voltage applied = ON) +4 to +34 V
22	SWON_GND					Connected to Pin 1; ground for IMU signal ON

A.6.2 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 IMU 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 34* below.
- 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 33* on *page 84*.

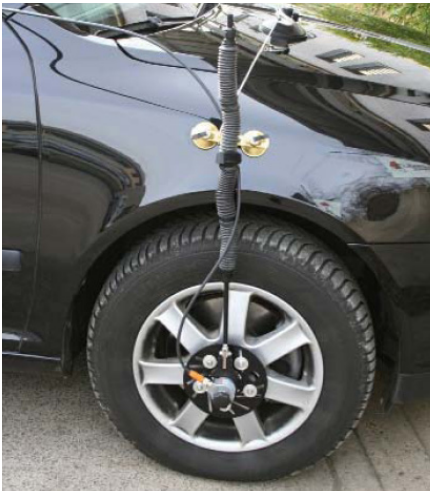


Figure 33: Corrsys Datron WPT

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.

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.

Figure 34: iMAR iMWS Pre-Installed

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.6.1* 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. Once installed, see also *SPAN Wheel Sensor Messages* on *page 53*.

1. The DMI runs only one output line (A).
2. 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 16* on *page 85*.

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

Table 16: Cable Modification for Corrsys Datron WPT

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

Figure 35: iIMU-FSAS Interface Cable

A.6.3 IMU 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

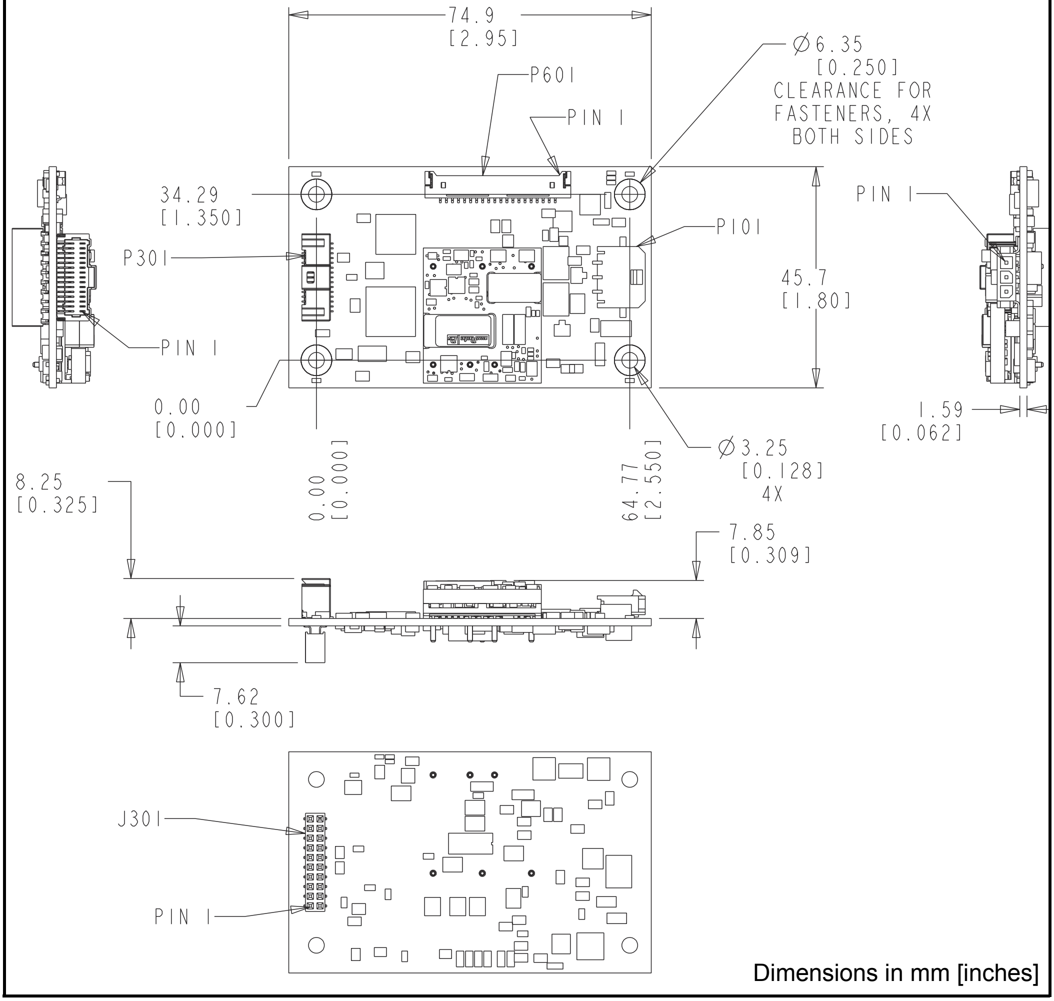
A.6.4 Electrical and Environmental

ELECTRICAL		
IMU Power Consumption	16 W (max)	
IMU Input Voltage	+10 to +34 V DC	
Receiver Power Consumption	ProPak-V3	2.8 W (typical)
System Power Consumption	ProPak-V3	14.8 W (typical)
Data Connector	MIL-C-38999-III	
Power Connector	MIL-C-38999-III (same as data connector)	
IMU Interface	RS-422	
ENVIRONMENTAL *(iIMU-FSAS)*		
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.7 MIC - MEMs Interface Card

Table 17: MIC 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	

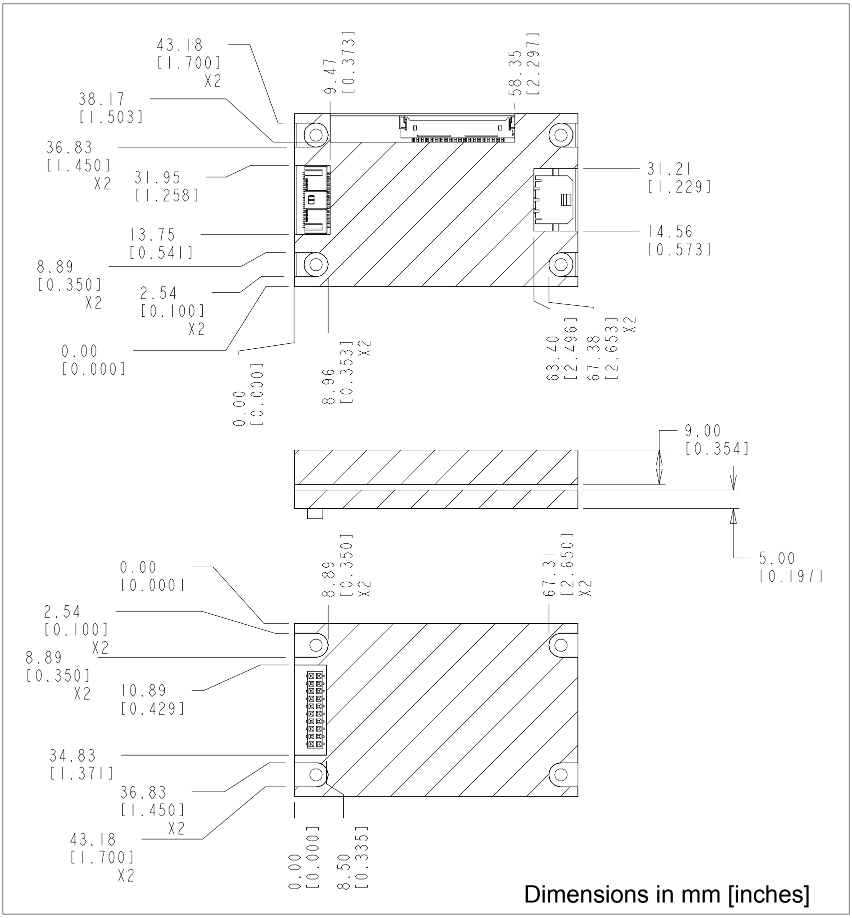


Dimensions in mm [inches]

Figure 36: MIC Top/Bottom Dimensions

Notes:

1. Dimensions are shown in millimetres [inches].
2. Connectors:
   a) P101, 43650-0313 [RoHS] Molex Electronics
   b) P301, 501571-3007 [RoHS] Molex Electronics
   c) P601, 53780-2070 [RoHS] Molex Electronics
3. Ensure adequate clearance to allow for proper mating between connectors on this printed circuit board and mating connectors.
4. This layout matches latest revision PCB design.



Dimensions in mm [inches]

Figure 37: MIC Keep-Out Zone

5. 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.7.1 Landmark IMU-to-MIC Cable Assembly

NovAtel's part number for the Landmark IMU-to-MIC interface cable is 01018826 (*Figure 38* on *page 89*). This cable provides power to the IMU and enables input and output between the MIC and the IMU.

Dimensions in millimetres

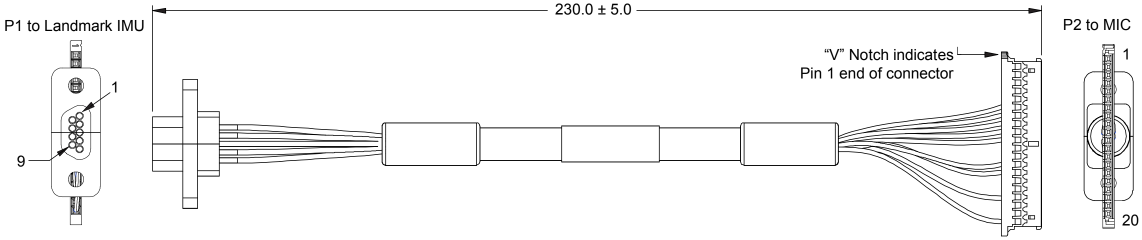


Figure 38: Landmark IMU-to-MIC Cable Assembly

Table 18: Landmark Cable Pinouts

FROM P1 MICRO-D CONNECTOR, MALE			TO P2 MIC CABLE END	
PIN	**SIGNAL NAME**		**PIN**	**SIGNAL NAME**
1	Serial Data+		13	Serial Data In+
2	Serial Data-		14	Serial Data In-
3	Power Ground		6	Power Ground
4	Reserved		7	Power Ground
5	IMU Input Power		8	IMU_VDD
			9	IMU_VDD
6	External Synch		17	Data Acquisition Signal (DAS)
7	Reserved		-	-
8	Signal Ground		10	Power Ground
			20	IMU Type indicator
9	Reserved		-	-

A.7.2 HG1930 IMU-to-MIC Cable Assembly

NovAtel's part number for the HG1930 IMU-to-MIC interface cable is 01018827 (*Figure 39* on *page 90*). This cable provides power to the IMU and enables input and output between the MIC and the IMU.

Dimensions in millimetres

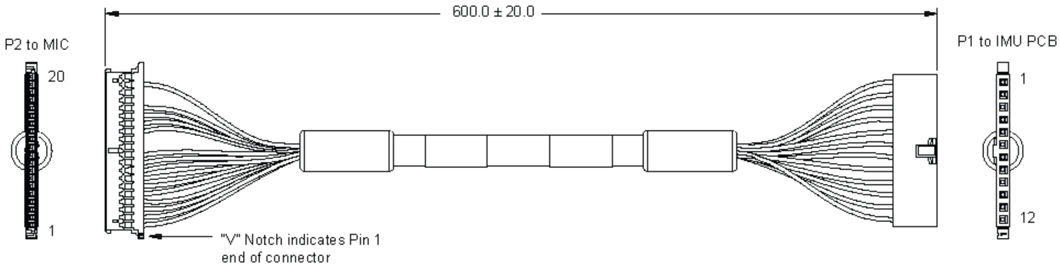


Figure 39: HG1930 IMU-to-MIC Cable Assembly

Table 19: HG1930 IMU-to-MIC Cable Assembly

FROM P1 IMU CABLE END (FCI-MINITEK)		TO P2 MIC CABLE END
PIN		PIN
1		15
2		16
3		13
4		14
5		8
7		7
6		9
8		10
11		3
		4
12		6
		19
9		5
10		1
		2

For more information, refer to the IMU documentation provided by Honeywell.

A.7.3 HG1700 and HG1900 IMU-to-MIC Cable Assembly

NovAtel's part number for the HG1700 and HG1900 IMU-to-MIC interface cable is 01018828 (*Figure 40* on *page 91*). This cable provides power to the IMU and enables input and output between the MIC and the IMU.

Dimensions in millimetres

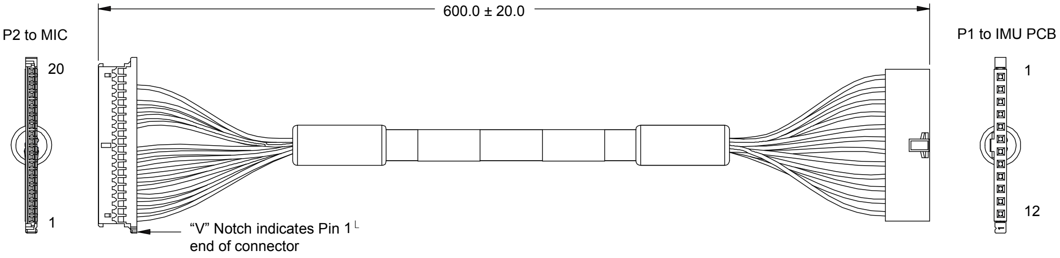


Figure 40: HG1700 and HG1900 IMU-to-MIC Cable Assembly

Table 20: HG1700 and HG1900 IMU-to-MIC Cable Assembly

FROM P1 IMU CABLE END (FCI-MINITEK)		TO P2 MIC CABLE END
PIN		PIN
1		15
2		16
3		13
4		14
5		8
7		7
6		9
8		10
11		3
		4
12		6
		18
9		5
10		1
		2

For more information, refer to the IMU documentation provided by Honeywell.

A.7.4 MIC Electrical and Environmental

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 OEMV-1DF	
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 OEMV-1DF receiver, in board stack configuration, from VIN=15 VDC at +25°C.

A.7.5 MIC Communication Ports

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

A.7.6 MIC Connectors

J301	20-pin OEMV-1DF mating connectors
P101	3-pin locking power connector
P301	30-pin locking communication connector
P601	20-pin locking IMU connector

Table 21: 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 22: 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 23: MIC Pinouts (User Interface P301)[a]

Pin	Signal	Type	Description	Comments
1	N/C			
2	N/C			
3	LED3	Output	Status LED 3 / IMU Data Status	
4	LED2	Output	Status LED 2 / GPS Time Status	
5	DGND	Power	Digital ground	
6	LED1	Output	Status LED 1 / Power Status / Self test	
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 OEMV-1DF	Only available in board stackup with OEMV-1DF In standalone, no connect
14	USB D+	Bidirectional	USB interface data (+) / Access to OEMV-1DF	Only available in board stackup with OEMV-1DF In standalone, no connect
15	RESETIN	Input	Access to OEMV-1DF reset in	Only available in board stackup with OEMV-1DF In standalone, no connect
16	VARF	Output	Access to OEMV-1DF varf	Only available in board stackup with OEMV-1DF In standalone, no connect
17	EVENT2	Input	Access to OEMV-1DF event 2	Only available in board stackup with OEMV-1DF In standalone, no connect
18	Reserved	N/A	Leave as no connect	
19	EVENT1	Input	Access to OEMV-1DF event 1	Only available in board stackup with OEMV-1DF In standalone, no connect
20	DGND	Power	Digital ground	
21	MIC TX	Output		In board stackup with OEMV-1DF, 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

Table 23: MIC Pinouts (User Interface P301)[a]

Pin	Signal	Type	Description	Comments
22	MIC RX	Input		In board stackup with OEMV-1DF, 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		
24	USER_TXD2	Output		In board stackup with OEMV-1DF, this is the access to the OEMV-1DF COM2 port In standalone, no connect
25	USER_RXD2	Input		In board stackup with OEMV-1DF, this is the access to the OEMV-1DF COM2 port In standalone, no connect
26	DGND	Power	Digital ground	
27	PV	Output	Access to OEMV-1DF position valid	Only available in board stackup with OEMV-1DF In standalone, no connect
28	DGND	Power	Digital ground	
29	1PPS	Output	Access to OEMV-1DF 1PPS	Only available in board stackup with OEMV-1DF 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 24: 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.

A.8 OEMV Family Receiver Performance

<table>
<tr><th colspan="3">Position Accuracy[a]</th></tr>
<tr><td>Standalone</td><td>L1 only</td><td>1.8 m RMS</td></tr>
<tr><td></td><td>L1/L2</td><td>1.5 m RMS</td></tr>
<tr><td>SBAS[b]</td><td></td><td>0.6 m RMS</td></tr>
<tr><td>CDGPS[b]</td><td></td><td>0.6 m RMS</td></tr>
<tr><td>DGPS</td><td></td><td>0.45 m RMS</td></tr>
<tr><td>RT-20</td><td></td><td>0.20 m RMS</td></tr>
<tr><td>RT-2</td><td></td><td>1 cm + 1 ppm RMS</td></tr>
<tr><td>OmiSTAR</td><td>VBS</td><td>0.7 m RMS (OEMV-1 and OEMV-3 only)</td></tr>
<tr><td></td><td>XP</td><td>0.15 m RMS (OEMV-3 only)</td></tr>
<tr><td></td><td>HP</td><td>0.10 m RMS (OEMV-3 only)</td></tr>
<tr><td>Post Processed</td><td></td><td>5 mm + 1 ppm RMS</td></tr>
<tr><th colspan="3">Time to First Fix</th></tr>
<tr><td colspan="3">Hot: 35 s (Almanac and recent ephemeris saved and approximate position)</td></tr>
<tr><td colspan="3">Cold: 60 s (No almanac or ephemeris and no approximate position or time)</td></tr>
<tr><th colspan="3">Reacquisition</th></tr>
<tr><td colspan="3">0.5 s L1 (typical)</td></tr>
<tr><td colspan="3">1.0 s L2 (typical) (OEMV-2 and OEMV-3 only)</td></tr>
<tr><th colspan="3">Data Rates</th></tr>
<tr><td colspan="2">Raw measurements</td><td>20 Hz (50 Hz optional)</td></tr>
<tr><td colspan="2">Computed position</td><td>20 Hz (50 Hz optional)</td></tr>
<tr><td colspan="2">OmniSTAR HP position</td><td>20 Hz (OEMV-3 only)</td></tr>
<tr><th colspan="3">Time Accuracy [a,c]</th></tr>
<tr><td colspan="3">20 ns RMS</td></tr>
<tr><th colspan="3">Velocity Accuracy</th></tr>
<tr><td colspan="3">0.03 m/s RMS</td></tr>
<tr><td colspan="3">Continued on next page</td></tr>
</table>

Measurement Precision		
C/A code phase		6 cm RMS
L1 carrier phase	Differential	0.75 mm RMS
	L2P code	25 cm RMS (OEMV-2 and OEMV-3 only)
L2 carrier phase	Differential	2 mm RMS (OEMV-2 and OEMV-3 only)
Dynamics		
	Velocity	515[d]

---

[a] Typical GPS only values. Performance specifications are subject to GPS system characteristics, U.S. DOD operation degradation ionospheric and tropospheric conditions, satellite geometry, baseline length and multipath effects.

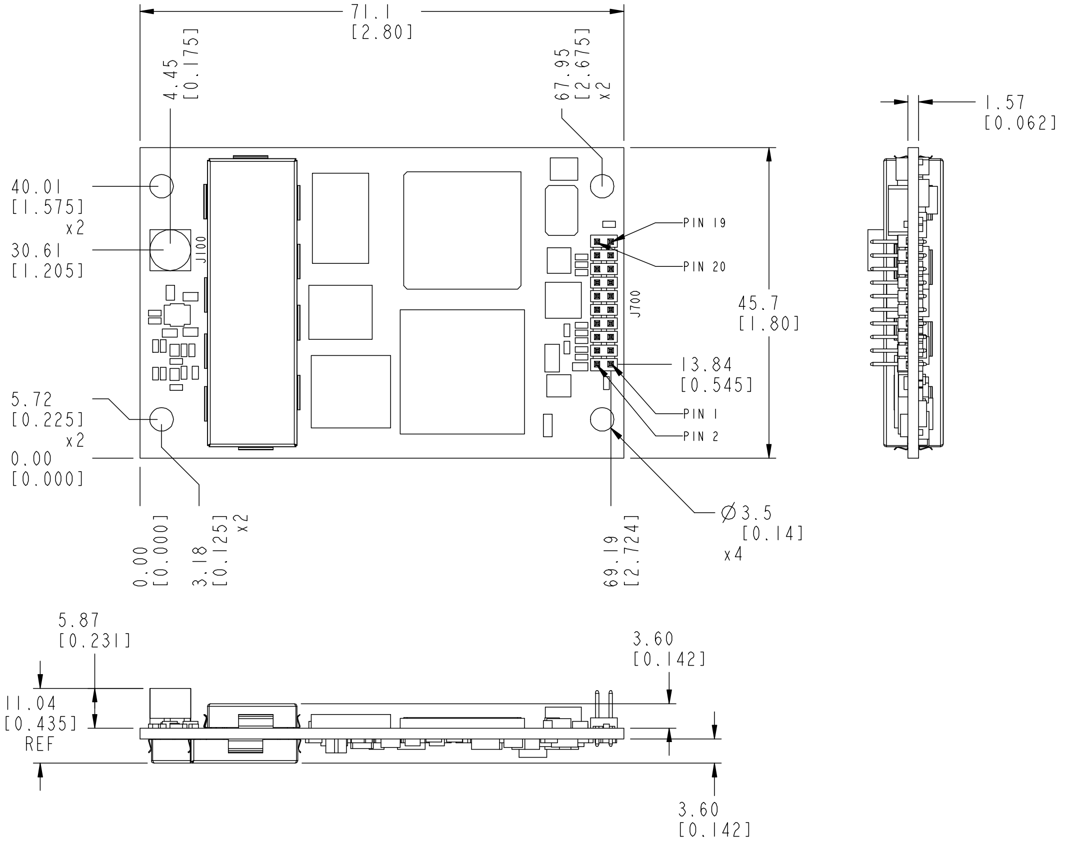
[b] GPS only.

[c] Time accuracy does not include biases due to RF or antenna delay.

[d] In accordance with export licensing.

A.9 OEMV-1DF Card

PHYSICAL	
Size	46 mm x 71 mm x 13 mm with connectors
Weight	21.5 grams
NOVATEL PART NUMBER	
Generic OEMV-1DF	01018506
MECHANICAL DRAWINGS	

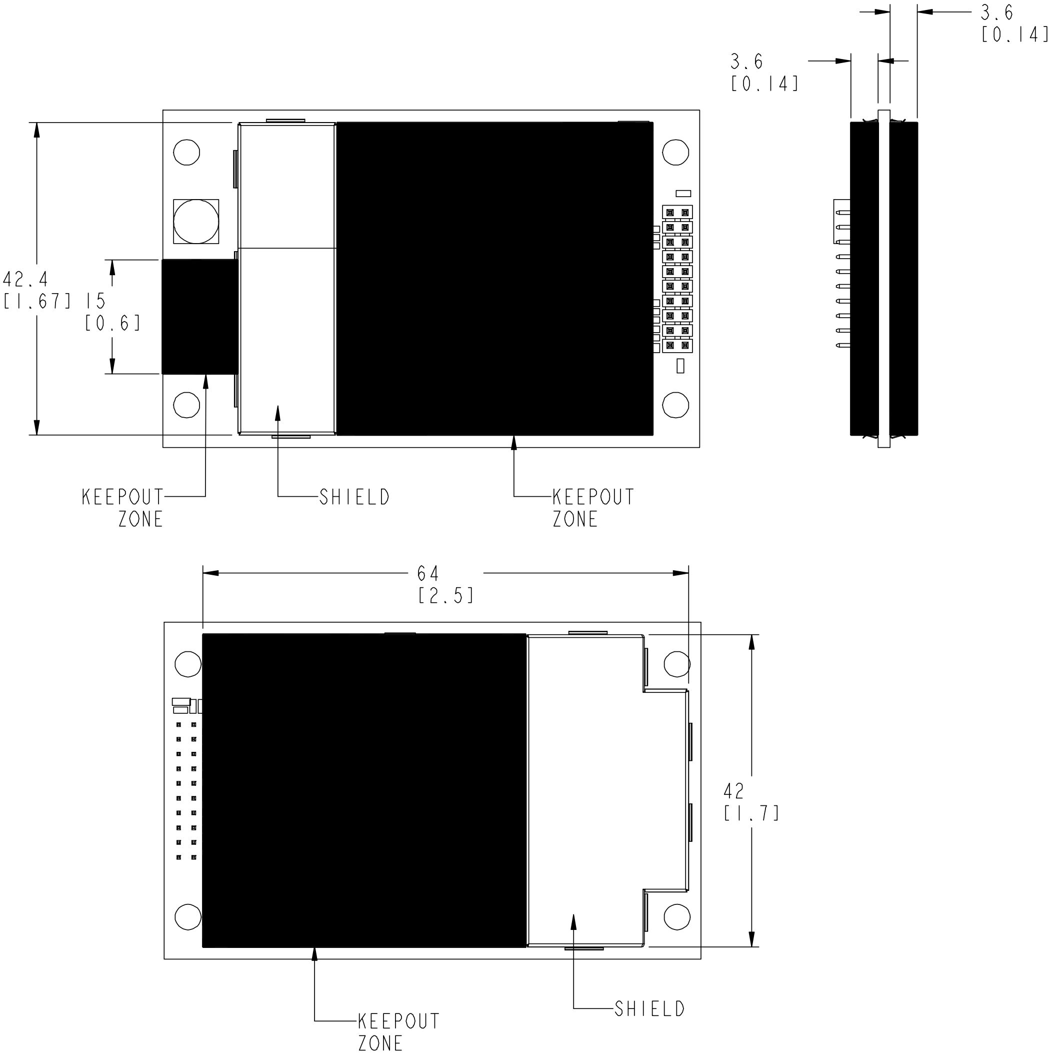


NOTES :

1. DIMENSIONS ARE SHOWN IN mm [inches].

2. CONNECTORS:
   (a) J100: MCX JACK (PLUG) RECEPTACLE
   (JOHNSON P/N 133-3711-202
   OR SAMTEC P/N MCX-J-P-H-ST
   OR EQUIVALENT)
   (b) J700: 2x12 HEADER, 2 mm PITCH
   (SAMTEC P/N TMM-110-03-G-D)

Figure 41: OEMV-1DF Board Dimensions



NOTES:

1. RECOMMENDED "KEEPOUT" AREAS ARE INTENDED FOR NOVATEL CIRCUITRY.

NOVATEL RESERVES THE RIGHT TO MODIFY COMPONENTS AND COMPONENT PLACEMENTS INSIDE SHADED KEEPOUT ZONES, WHILE MAINTAINING DESIGN FORM, FIT, AND FUNCTION.

Figure 42: OEMV-1DF Board Keep-Out Zone

ENVIRONMENTAL	
Operating Temperature	-40°C to +85°C
Storage Temperature	-45°C to +95°C
Humidity	Not to exceed 95% non-condensing
Random Vibe	MIL-STD 810G (7.7 g RMS)
Bump/Shock	MIL-STD 810G (40 g)
POWER REQUIREMENTS	
Voltage	+3.3 VDC +5%/-3%
Allowable Input Voltage Ripple	150 mV p-p (max.)
Power Consumption	1.2 W ☒ Variable values that can change due to the number of satellites in the sky and the firmware version. They are a guide for what you might expect but absolute values are not possible.
In-Rush Power Consumption	7.5 A for less than 60 μs
RF INPUT / LNA POWER OUTPUT	
Antenna Connector	MCX female, 50 Ω nominal impedance (See *Figure 41* on *page 98*)
Acceptable RF Input Level	The following levels at the receiver board input are acceptable (for tracking): 1. L1 signal power at board input -122 to -87 dBm, noise power at board input -161 to -141 dBm/Hz OEM design guidance: C/No range at board input 35 to 58 dBm/Hz 2. L2 signal power at board input -126 to -93 dBm, noise power at board input -161 to -141 dBm/Hz OEM design guidance: C/No range at board input 30 to 52 dBm/Hz The OEMV receiver series is designed to work with the following antenna/cables limits: Antenna Gain / NF / LNA-Antenna Cable Gain Nom (dB) 26.00 2.5 -6.00 Gain Max (dB) 30.00 1.5 -0.05 Gain Min (dB 22.00 3.5 -10.00 Reference Input Impedance (ohm) 50 50 Notes: a. Antenna gain includes antenna element and LNA. b. For most cases, the signals are buried under the receiver noise floor. c. Receiver potential performance could be degraded if the input conditions are not met.
RF Input Frequencies	GPS L1: 1575.42 MHz GPS L2: 1227.60 MHz

LNA Power External (Optional Input) Output to antenna	+5 to +12 V DC, 100 mA max. (user-supplied) +4.5 to +5.25 V DC @ 100 mA ☒ Apply power to the OEMV-1DF on pin 1 within the +5.5 to +12 V DC range. The card regulates a constant 5 V output on the RF connector.
INPUT/OUTPUT DATA INTERFACE	
COM1	
Electrical format	LVTTL
Bit rates [a]	300, 1200, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400, 460800, 921600 bps
Signals supported	COM1_Tx and COM1_Rx
COM2	
Electrical format	LVTTL
Bit rates [a]	300, 1200, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400 bps
Signals supported	COM2_Tx and COM2_Rx
COM3	
Electrical format	LVTTL [b,c,d]
Bit rates [a]	300, 1200, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400 bps
Signals supported	COM3_Tx and COM3_Rx
CAN BUS [e,f,g]	
Electrical format	LVTTL (requires external CAN transceiver)
Bit rates	1 Mbps maximum. CAN Bus throughput is determined by slowest device on the bus.
Signals supported	CAN1 is on Pins 6 and 7.[g]
USB	
Electrical format	Conforms to USB 1.1
Bit rate	Full speed
Signals supported	USB D (+) and USB D (-)

---

[a] Baud rates higher than 115,200 bps are not supported by standard PC hardware. Special PC hardware may be required for higher rates.

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

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

d. Enable COM3 using the following commands:

```
MARKCONTROL MARK1 DISABLE
INTERFACEMODE COM3 NOVATEL NOVATEL
SAVECONFIG
```

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

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

f. CAN Bus behavior must be asserted through the NovAtel API software. Refer to Section 3.3.3 CAN Bus in the OEMV Family Installation and Operation manual available at www.novatel.com for further details.

g. See also *Figure 43* on *page 105* and its table.

Table 25: OEMV-1DF Strobes

Strobes	Default Behavior	Input/ Output	Factory Default	Comment [a]
Event1 (Mark 1)	Multiplexed pin	Input Leading edge triggered	Active low	An input mark for which a pulse greater than 150 ns triggers certain logs to be generated. (Refer to the MARKPOS and MARKTIME logs and ONMARK trigger.) Polarity is configurable using the MARKCONTROL command. The mark inputs have 10K pull-up resistors to 3.3 V
Event2 (Mark 2)	Multiplexed pin	Input Leading edge triggered	Active low	An input mark for which a pulse greater than 150 ns triggers certain logs to be generated. (Refer to the MARK2POS and MARK2TIME logs.) Polarity is configurable using the MARKCONTROL command. The mark inputs have 10K pull-up resistors to 3.3 V.
PV (Position Valid)	Dedicated pin	Output	Active high	Indicates a valid GPS position solution is available. A high level indicates a valid solution or that the FIX POSITION command has been set (refer to the FIX POSITION command). 3.3 V.
VARF (Variable Frequency)	Multiplexed pin	Output	Active low	A programmable variable frequency output ranging from 0 -20 MHz (refer to the FREQUENCYOUT command).
RESETIN	Dedicated pin	Input	Active low	Reset LVTTL signal input from external system; active low, > 20 μs duration
PPS	Dedicated pin	Output	Active low	A time synchronization output. This is a pulse where the leading edge is synchronized to receiver-calculated GPS Time. The polarity, period and pulse width can be configured using PPSCONTROL command.

---

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

Table 26: OEMV-1DF Strobe Electrical Specifications

Strobe	Sym	Min (V)	Typ (V)	Max (V)	Current (mA)	Conditions
Event1 (Mark 1) Event2 (Mark2) PPS	V_{IL}			0.8	4	VDD = 3.3 V; 85°C
	V_{IH}	2.0			12	VDD = 3.3 V; 85°C
PV VARF	V_{OL}			0.4	4	VDD = 3.3 V; 85°C
	V_{OH}	3.0			12	VDD = 3.3 V; 85°C
RESETIN	V_{IL}			0.8	4	VDD = 3.3 V; 85°C
	V_{IH}	2.3			13.8	VDD = 3.3 V; 85°C

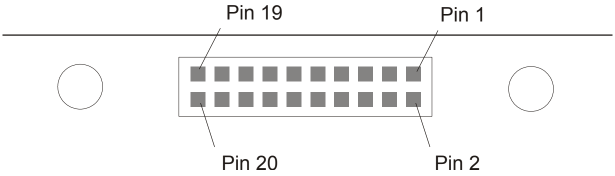


Figure 43: Top-view of 20-Pin Connector on the OEMV-1DF

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

---

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

Appendix B INS Commands

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

For information on other available commands, refer to the *OEMV 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 OEMV Family feature). INS-specific commands may be in Abbreviated ASCII, ASCII or Binary format.

Consider the *lockout* command (refer to the *OEMV 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 GPS 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), GPS 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 *OEMV Family Firmware Reference Manual* for a complete list of commands categorized by function and then detailed in alphabetical order.

B.2.1 APPLYVEHICLEBODYROTATION Enable Vehicle to Body Rotation

This command allows you to apply the vehicle to body rotation to the output attitude (that was entered from the VEHICLOBODYROTATION command, see *page 139*). This rotates the SPAN body frame output in the INSPVA, INSPVAS and INSATT logs to the vehicle frame. APPLYVEHICLEBODYROTATION is disabled by default.

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

APPLYVEHICLEBODYROTATION [switch]

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. default = disable	Enum	4	H
		Enable	1				

Input Example:

APPLYVEHICLEBODYROTATION ENABLE

B.2.2 CANCONFIG Configure the CAN Interface for SPAN

Use the CANCONFIG command to configure the CAN interface for SPAN. For further information, contact NovAtel Customer Support as outlined on page *17*.

Abbreviated ASCII Syntax: **Message ID: 884**

CANCONFIG port switch [bit rate] [base tx] [mask] [source]

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	CAN1	1	Specify the CAN port	Enum	4	H
		CAN2	2				
3	Switch	Disable	0	Enable/disable CAN configuration on the chosen port	Enum	4	H+4
		Enable	1				
4	Bit rate			CAN bit rate (kbps). See Table 27 on page 109.	Enum	4	H+8
5	Base	0 (default) to 65535	0x0000 to 0xFFFF	Base address. Refer to application note APN-046 for further information.	Ulong	4	H+12
6	Tx mask	0 (default) to 65535	0x0000 to 0xFFFF	Transmit activation mask. Refer to application note APN-046 for further information.	Ulong	4	H+16
7	Source	INSGPS (default)	0	CAN source from either the INS/GPS solution of the GPS-only solutions.	Enum	4	H+20
		GPS	1				

Abbreviated ASCII Example:

```
CANCONFIG CAN1 ENABLE 1M 1000 3 INSGPS
```

Table 27: CAN Bit Rate (per second)

Binary	ASCII
0	10K
1	20K
2	50K
3	100K (default)
4	125K
5	250K
6	500K
7	800K
8	1M

B.2.3 FRESET Factory Reset

This command clears data which 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]

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 28*		What data is to be reset by the receiver.	Enum	4	H

Input Example:

FRESET COMMAND

Table 28: 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
22	VEHICLE_BODY_R	Resets stored vehicle to body rotations
24	INS_LEVER_ARM	Resets the GPS antenna to IMU lever arm

B.2.4 INSCOMMAND INS Control Command

This command allows you to enable or disable INS positioning. When INS positioning is disabled, no INS position, velocity or attitude is output. Also, INS aiding of RTK initialization and 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 47*

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

INSCOMMAND action

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 GPS/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)			

Abbreviated ASCII Example:

INSCOMMAND ENABLE

B.2.5 INSPHASEUPDATE INS Phase Update Control

This command allows you to control the INS phase updates.

When enabled, raw GPS phase measurements are used to control errors in the inertial filter. In a typical INS/GPS integration, GPS positions are used to control inertial drifts. Some features of phase updates include:

- updates can be performed even when too few satellites are available to compute a GPS solution
- as few as 2 satellites must be in view to perform a precise update
- system performance is significantly improved in conditions challenging to GPS such as urban canyons and foliage.

Abbreviated ASCII Syntax: **Message ID: 639**

INSPHASEUPDATE switch

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	Disable INS delta-phase updates.	Enum	4	H
		ENABLE	1	Enable INS delta-phase updates. (default)			

Abbreviated ASCII Example:

INSPHASEUPDATE ENABLE

B.2.6 INSZUPT Request Zero Velocity Update

This command allows you 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 GPS/INS.

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

```
INSZUPT
```

B.2.7 INSZUPTCONTROL INS Zero Velocity Update Control

This command allows you 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

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)			

Abbreviated ASCII Example:

```
INSZUPTCONTROL DISABLE
```

B.2.8 INTERFACEMODE Set Interface Type for a Port

This command allows the user 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, please see *Section 2.3.2, SPAN IMU Configuration* starting on *page 38*.

As another 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 *OEMV 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]

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 30, COM Serial Port Identifiers,* on *page 117*		Serial port identifier (default = THISPORT)	Enum	4	H
3	Rxtype	See *Table 29, Serial Port Interface Modes,* on *page 116*		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)			

ASCII Example:

INTERFACEMODE COM1 RTCA NOVATEL ON

Table 29: 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
8	RTCMNOCR	RTCM with no CR/LF appended [a]
9	CDGPS	The port accepts GPS*C data [b]
10-13	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.

---

[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.

[b] CDGPS has three options for output of differential corrections - NMEA, RTCM, and GPS*C. If you have a ProPak-V3 receiver, you do not need to use the INTERFACEMODE command with CDGPS as the argument. The CDGPS argument is for use with obsolete external non-NovAtel CDGPS receivers. These receivers use GPS*C (NavCanada's proprietary format differential corrections from the CDGPS service).

Table 30: 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.2.9 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 centre of each marked IMU side to the phase centre of the antenna. See also *Section B.2.16, SETIMUTOANTOFFSET Set IMU to Antenna Offset* starting on *page 128* and *Section 3.3.4, Lever Arm Calibration Routine* starting on *page 50*.

The calibration runs for the time specified or until the specified uncertainty is met. The BESTLEVERARM log outputs the lever arm calculations once the calibration is complete, see also *"BESTLEVERARM IMU to Antenna Lever Arm" on Page 154*.

> 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]

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	Offset along the IMU X axis	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

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 `alignment_complete`. The example's 600 s 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 s 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.

B.2.10 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, GPGST, 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 GPS+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 and IN according to the position type given in position logs.

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 GPS position output. For example, GPGSV is for information on GPS satellites and its output always uses the GP ID. *Table 31* shows the NMEA logs and whether they use GP or GP + IN IDs with `nmeatalker auto`.

Table 31: NMEA Talkers

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

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	NMEA-TALKER 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 and/or Inertial (IN)			

B.2.11 RVBCALIBRATE Vehicle to Body Rotation Control

The RVBCALIBRATE command is used 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 192*. 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 47*). 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

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Log 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				

Abbreviated ASCII Example:

```
RVBCALIBRATE reset
```

B.2.12 SETALIGNMENTVEL Set the Minimum Kinematic Alignment Velocity

This command allows the user 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]

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)		This field permits setting of the minimum velocity required to kinematically align.	Double	8	H

Abbreviated ASCII Example

```
SETALIGNMENTVEL 5.0
```

B.2.13 SETHEAVEWINDOW Set Heave Filter Length

This command allows user control over 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

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 – 300s) (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

Abbreviated ASCII Example

SETHEAVEWINDOW 35

B.2.14 SETIMUORIENTATION Set IMU Orientation

The SETIMUORIENTATION command is used 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 fast alignment routine, see *Section 3.3.1.2, Kinematic Alignment* on *page 48*.

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 32 on page 126*. 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 55*. The example from the LN-200 is shown in *Figure 44*.

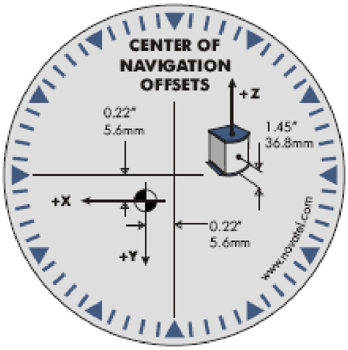


Figure 44: Frame of Reference

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

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

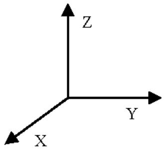
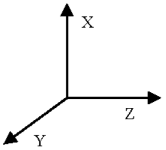
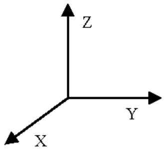
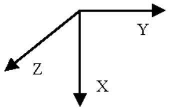
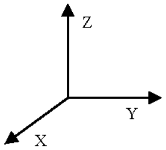
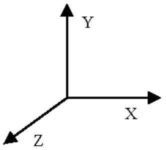
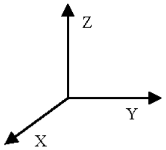
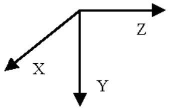
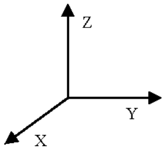
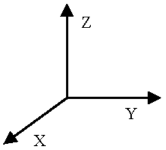
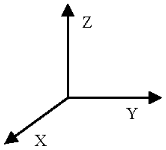
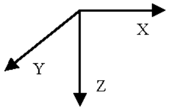
SETIMUORIENTATION switch

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Log 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**			

Abbreviated ASCII Example:

```
SETIMUORIENTATION 1
```

Table 32: 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.2.15 SETIMUSPECS Specify Error Specifications and Data Rate

The SETIMUSPECS command is used 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 AA99/CA50
Honeywell HG1900 CA29/CA50
Gladiator Landmark 20

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

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

Field	Field Type	Value Range	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	Log 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-MPPC. 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

Abbreviated ASCII Example: (iMAR-FSAS Specs)

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

B.2.16 SETIMUTOANTOFFSET Set IMU to Antenna Offset

It is recommended that you mount the IMU as close as possible to the GPS antenna, particularly in the horizontal plane. This command is used to enter the offset between the IMU and the GPS 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 centre 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).

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

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

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

Abbreviated ASCII Example:

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

B.2.17 SETIMUTYPE Set IMU Type

The SETIMUTYPE command is used to specify the type of IMU connected to the receiver. The IMU type can be saved using the SAVECONFIG command so that on startup, the receiver does not have to detect the type of IMU connected

> 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.

Abbreviated ASCII Syntax: **Message ID: 569**

SETIMUTYPE switch

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Log 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	See *Table 33, IMU Type,* on *page 130*		IMU Type	Enum	4	H

Table 33: IMU Type

Binary	ASCII	Description
0	IMU_UNKNOWN	Unknown IMU type (default)
1	IMU_HG1700_AG11	Honeywell HG1700 AG11/AG58
2-3	Reserved	
4	IMU_HG1700_AG17	Honeywell HG1700 AG17/AG62
5	IMU_HG1900_CA29	Honeywell HG1900 CA29/CA50
6-7	Reserved	
8	IMU_LN200	Litton LN-200 (200 Hz model)
9	IMU_LN200_400HZ	Litton LN-200 (400 Hz model)
10	Reserved	Reserved
11	IMU_HG1700_AG58	Honeywell HG1700 AG58
12	IMU_HG1700_AG62	Honeywell HG1700 AG62
13	IMU_IMAR_FSAS	iMAR_iIMU_FSAS
14-16	Reserved	
17	IMU_GLADIATOR_LANDMARK20	Gladiator Landmark20
18-19	Reserved	
20	IMU-HG1930_AA99	Honeywell HG1930 AA99/CA50
21-25	Reserved	
26	Reserved	
27	IMU_HG1900_CA50	Honeywell HG1900 CA50
28	IMU_HG1930_CA50	Honeywell HG1930 CA50

Abbreviated ASCII Example:

```
SETIMUTYPE IMU_IMAR_FSAS
```

B.2.18 SETINITATTITUDE Set Initial Attitude of SPAN in Degrees

This command allows you 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, see *page 124,* unless you have your IMU mounted with the z axis not pointing up. Then use the tables in the SETIMURIENTATION command, on *pages 125-126*, to determine the azimuth axis that SPAN is using.

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

SETINITATTITUDE pitch roll azimuth pitchSTD rollSTD azSTD

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.

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 (see the SETINITAZIMUTH example on *page 133*), also with a 5 degrees standard deviation.

B.2.19 SETINITAZIMUTH Set Initial Azimuth and Standard Deviation

This command allows you to start SPAN operation with a previously known azimuth. Azimuth is the weakest component of a coarse alignment, and is also the easiest to know from an external source (i.e. like the azimuth of roadway). When using this command, SPAN operation through alignment will appear the same as with a usual coarse alignment. Roll and pitch will be determined using averaged gyro and accelerometer measurements. The input azimuth will be used rather than what is computed by the normal coarse alignment routine.

- This alignment takes the same amount of time as the usual coarse alignment.
- Input azimuth values must be accurate for good system performance.
- Sending SETINITAZIMUTH resets the SPAN filter. The alignment will take approximately 1 minute, but some time and vehicle dynamics are required for the SPAN filter to converge. Bridging performance will be poor before filter convergence.
- The azimuth angle is 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 what is marked 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 azimuth with respect to the transformed axis. See SETIMUORIENTATION on *page 124*, for a description of the axes mapping that occurs when the IMU is mounted differently from z pointing 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, see *page 124,* unless you have your IMU mounted with the z axis not pointing up. Then, use the tables in the SETIMURIENTATION command, on *pages 125-126*, to determine the azimuth axis that SPAN is using.

Abbreviated ASCII Syntax: **Message ID: 863**

SETINITAZIMUTH azimuth azSTD

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	Azimuth	-360° to +360°		Input azimuth angle in degrees	Double	8	H
3	azSTD	0.000278°[a] to 180°		Input azimuth standard deviation angle in degrees	Double	8	H+8

---

[a] 0.000278° is equal to 1 arc second.

Abbreviated ASCII Example:

```
SETINITAZIMUTH 90 5
```

In this example, the initial azimuth has been set to 90 degrees. This means that the SPAN system y axis is pointing due East, within a standard deviation of 5 degrees. Note that if you have mounted your SPAN system with the positive z axis (as marked on the enclosure) not pointing up, please refer to the SETIMUORIENTATION command to determine the SPAN frame axes mapping that SPAN automatically applies.

B.2.20 SETINSOFFSET Set INS Offset

The SETINSOFFSET command is used 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, INSVEL, INSVELS, 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

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

Abbreviated ASCII Example:

```
SETINSOFFSET 0.15 0.15 0.25
```

B.2.21 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

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

Abbreviated ASCII Example:

SETMARK1OFFSET -0.324 0.106 1.325 0 0 0

B.2.22 SETMARK2OFFSET Set Mark2 Offset

Set the offset to the Mark2 trigger event.

> This command is not immediately available to iIMU-FSAS users. If you are an iIMU-FSAS user, and wish to use the Mark2 event trigger, contact NovAtel Customer Support. Contact information is on *page 17*.

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

SETMARK2OFFSET xoffset yoffset zoffset αoffset βoffset γoffset

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

Abbreviated ASCII Example:

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

B.2.23 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). The tick spacing of the iMAR iMWS was 0.025 m, as of September 2006 testing, however, refer to the iMAR iMWS documentation for its specifications.

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

SETWHEELPARAMETERS ticks circ spacing

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.

Abbreviated ASCII Example:

SETWHEELPARAMETERS 58 1.96 0.025

> 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.2.24 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**

Field #	Field Type	ASCII Value	Binary Value	Description	Format	Bytes	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

Abbreviated ASCII Example:

```
TAGNEXTMARK MARK1 1234
```

B.2.25 VEHICLEBODYROTATION Vehicle to SPAN frame Rotation

Only Mark 1 is available for the SPAN-CPT.

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 52* for more details. For more information on reference frames, see *Section 3.1, Definition of Reference Frames Within SPAN* starting on *page 41*. RVBCALIBRATE command information is on *page 121*.

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, 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 GPS into the SPAN frame of the IMU during the kinematic alignment. If you use the APPLYVEHICLEBODYROTATION command on *page 107*, the reported attitude in INSPVA or INSATT 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. Imagine a frame coincident with the vehicle frame.
2. Rotate your imagined frame about the vehicle Z-axis so that the Y-axis of your frame is approximately aligned (coplanar) with the assumed Y-axis of the IMU enclosure, as defined by your IMU orientation in Table 32 on page 126. This angle is the gamma-angle in the command and follows the right-hand rule for sign correction.
3. Rotate about the vehicle X-axis. This angle is the alpha-angle in the command.
4. Finally, rotate about the vehicle Y-axis. This angle is the beta-angle in the command. Your imagined frame should now be coincident with the assumed IMU enclosure frame.

> 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.2.1, APPLYVEHICLEBODYROTATION Enable Vehicle to Body Rotation* starting on *page 107*.

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

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

Structure: **Message ID: 642**
Log Type: Asynch

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)	-	-	-

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*.

Abbreviated ASCII Example: VEHICLEBODYROTATION 0 0 90 0 0 5

B.2.26 WHEELVELOCITY Wheel Velocity for INS Augmentation

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

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

WHEELVELOCITY latency ticks/rev wheel vel Rsrvd fwheel vel Rsrvd Rsrvd ticks/s

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	Wheel vel			Short wheel velocity in ticks/s	Ushort	2	H+4
5	Reserved				Ushort	2	H+6
6	Fwheel vel			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*.

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. 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.

Appendix C INS Logs

The INS-specific logs follow the same general logging scheme as normal OEMV 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 *OEMV Family Firmware Reference Manual*.

One difference from the standard OEMV 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 OEMV-3 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 144*.
2. The highest rate that you should request GPS 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), GPS logs can be requested at rates up to 20 Hz.

Please also refer to the *OEMV 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 5, Inertial Solution Status on *page 46* 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.

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 34 and 35*). For the message header structure of OEMV-3 regular Binary and ASCII logs, please refer to the *OEMV Family Firmware Reference Manual*.

Table 34: 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	GPS week number
4	Milliseconds	Ulong	Milliseconds from the beginning of the GPS week

Table 35: Short Binary Message Header Structure

Field #	Field Type	Field Type	Description	Binary Bytes	Binary Offset
1	Sync	Char	Hex 0xAA	1	0
2	Sync	Char	Hex 0x44	1	1
3	Sync	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	GPS week number	2	6
7	Milliseconds	Ulong	Milliseconds from the beginning of the GPS 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, 2, 3, 5, 10, 15, 20, 30 or 60 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 *OEMV 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

High-rate data logging is regulated in SPAN to prevent logging of unusable data or overloading the system. Please note these 4 rules when configuring your SPAN system:

1. Only one high-rate INS log can be configured for output at a time. Once a log is selected for output at a rate faster than or equal to 100 Hz, all other log requests are limited to a maximum rate of 50 Hz. Below are examples of acceptable logging requests:

   LOG RAWIMUSB ONNEW (100 or 200 Hz depending on the IMU)
   LOG INSPVASB ONTIME 0.02 (acceptable 50 Hz logging)

   The following is rejected because RAWIMU has already been requested at 100/200 Hz:
   LOG INSPOSSB ONTIME 0.01 (100 Hz request)

   Below is another example set of acceptable logging requests:
   LOG INSPOSSB ONTIME 0.01 (100 Hz request)
   LOG INSVELSB ONTIME 0.02 (50 Hz request)

   The following are rejected in this case because INSPOSSB has already been requested at a high rate.
   LOG RAWIMUSB ONNEW (100 Hz request)
   LOG INSATTSB ONTIME 0.005 (200 Hz request)

2. RAWIMU and RAWIMUS logs are only available with the ONNEW or ONCHANGED trigger. These 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 log starting on *page 179*.
3. In order to collect wheel sensor information, useful in post-processing, the TIMEDWHEELDATA log should only be used with the ONNEW trigger. See also *page 191* for details on this log.
4. Only log 200 Hz logs in binary.

C.2.1 BESTPOS Best Position and BESTGPSPOS Best GPS Position

This log contains the best available GPS 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 300 seconds after loss of the data link, though a different value can be set using the DGPSTIMEOUT command, refer to the *OEMV Family Firmware Reference Manual.*

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

Structure: **BESTGPSPOS Message ID: 423**

BESTPOS Message ID: 42

Log Type: Synch

Table 36: 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]

Continued on the following page

Position Type (binary)	Position Type (ASCII)	Description
21-31	Reserved	
32	L1_FLOAT	Floating L1 ambiguity solution
33	IONOFREE_FLOAT	Floating ionospheric-free ambiguity solution
34	NARROW_FLOAT	Floating narrow-lane ambiguity solution
48	L1_INT	Integer L1 ambiguity solution
49	WIDE_INT	Integer wide-lane ambiguity solution
50	NARROW_INT	Integer narrow-lane ambiguity solution
51	RTK_DIRECT_INS	RTK status where the RTK filter is directly initialized from the INS filter. [b]
52	INS	INS calculated position corrected for the antenna [2]
53	INS_PSRSP	INS pseudorange single point solution - no DGPS corrections [2]
54	INS_PSRDIFF	INS pseudorange differential solution [2]
55	INS_RTKFLOAT	INS RTK floating point ambiguities solution [2]
56	INS_RTKFIXED	INS RTK fixed ambiguities solution [2]
57	INS_OMNISTAR	INS OmniSTAR VBS position (L1 sub-meter) [1]
58	INS_OMNISTAR_HP	INS OmniSTAR high precision solution [1]
59	INS_OMNISTAR_XP	INS OmniSTAR extra precision solution [1]
64	OMNISTAR_HP	OmniSTAR high precision [1]
65	OMNISTAR_XP	OmniSTAR extra precision [1]
66	CDGPS	Position solution using CDGPS corrections [1]

---

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

b. These types appear in position logs such as BESTPOS

Table 37: 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 GPS satellites to perform this check. Under normal conditions you should only see PENDING for a few seconds on power up before the GPS receiver has locked onto its first few satellites. If your antenna is obstructed (or not plugged in) and you have entered a FIX POSITION command, then you may see PENDING indefinitely

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	header	Log header	-	H	0
2	Sol Status	Solution status, see *Table 37* on *page 148*	Enum	4	H
3	Pos Type	Position type, see *Table 36 on page 146*	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 *OEMV 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)	-	-	-

Recommended Input:

log bestgpsposa ontime 1

ASCII Example:

```
#BESTGPSPOSA,COM1,0,62.5,FINESTEERING,1036,484878.000,00000028,63e2,0;
SOL_COMPUTED,SINGLE,51.11629893124,-114.03820302746,1052.3434,
-16.271287293,61,19.6934,13.1515,23.8561,"",0.0,60.000,10,10,0,0,
0,0,0,0*1051ada9
```

Table 38: 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 39: 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.

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	BESTPOS header	Log header		H	0
2	sol stat	Solution status, see *Table 37* on *page 148*	Enum	4	H
3	pos type	Position type, see *Table 36* on *page 146*	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
16	#solnSVs	Number of satellite vehicles used in solution	Uchar	1	H+65
17	#ggL1	Number of GPS andGLONASS 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 39, Extended Solution Status* on *page 150*)	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 38* on *page 150*)	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.2.2 BESTGPSVEL Best Available GPS Velocity Data

This log contains the best available GPS 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 BESTGPSVEL 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 BESTGPSVEL or BESTGPSPOS 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.

Structure: **Message ID: 506**

Log Type: Synch

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	header	Log header	-	H	0
2	Sol Status	Solution status, see *Table 37, Solution Status* on *page 148*	Enum	4	H
3	Vel Type	Velocity type, see *Table 36, Position or Velocity Type* on *page 146*	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)	-	-	-

Recommended Input:

```
log bestgpsvela ontime 1
```

ASCII Example:

```
#BESTGPSVELA,COM1,0,62.5,FINESTEERING,1049,247755.000,00000128,f7e3,0;
SOL_COMPUTED,SINGLE,0.250,0.000,0.1744,333.002126,0.3070,6.0082*dfdc635c
```

C.2.3 BESTLEVERARM IMU to Antenna Lever Arm

This log contains the distance between the IMU's centre of navigation and the GPS phase centre in the IMU enclosure frame and its associated uncertainties. If the you enter the lever arm through the SETIMUTOANTOFFSET command, see *page 128*, these values are reflected in this log. When the lever arm calibration is complete, see the LEVERARMCALIBRATE command on *page 118*, the solved values are also output in this log.

The default X (pitch), Y (roll) and Z (azimuth) directions of the IMU enclosure frame are clearly marked on the IMU, see *Figure 44* on *page 124*.

Structure: **Message ID: 674**

Log Type: Asynch

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 32, Full Mapping Definitions* on *page 126*	Integer	4	H+48
9	xxxx	32-bit CRC	Hex	4	H+52
10	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

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
```

C.2.4 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.

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 41 and the SETIMUORIENTATION command on page 124. If the APPLYVEHICLEBODYROTATION command has been enabled (see page 107), 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	GPS week	Ulong	4	H+
3	Seconds	GPS 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.2.5 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.

Structure:

Message ID: 1382
Log Type: Asynch

Recommended Input:

log heavea onnew

Example:

```
#HEAVEA,USB1,0,38.5,FINESTEERING,1630,232064.599,00000000,a759,6696;1630,2320
64.589885392,0.086825199*93392cb4
```

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 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.2.6 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.

Abbreviated ASCII Syntax: **Message ID: 1270**

[COM1]log imutoantoffsets

Log Type: Asynch

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 33, IMU Type* on *page 130*	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 40, Lever Arm Type* on *page 160*.	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 41, Lever Arm Source* on *page 160* 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 40: 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

Table 41: 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
5	LEVER_ARM_RESET	If the current IMU orientation does not match the value restored from NVM then the lever arm will be reset to zero with this status.

C.2.7 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 34* and *Section 2.3.2, SPAN IMU Configuration* starting on *page 38* 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.

Structure: **Message ID: 263**

Log Type: Synch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS 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 5* on *page 46*	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)	-	-	-

Recommended Input:

```
log insatta ontime 1
```

ASCII Example:

```
#INSATTA,USB2,0,14.5,FINESTEERING,1541,487970.000,00040000,5b35,37343;1541,48
7970.000549050,1.876133508,-4.053672765,328.401460897,INS_SOLUTION_GOOD*
ce4ac533
```

C.2.8 INSATTS Short INS Attitude

This is a short header version of the *INSATT* log on *page 161*.

Structure: **Message ID: 319**

Log Type: Synch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS 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 5* on *page 46.*	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)	-	-	-

Recommended Input:

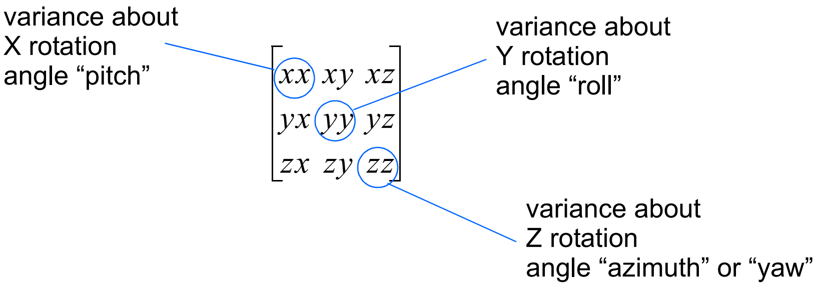
log insattsa ontime 1

ASCII Example:

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

C.2.9 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 only available after alignment. See also *Section 3.3.1, System Start-Up and Alignment Techniques* starting on *page 47*.

Structure: **Message ID: 264**

Log Type: Asynch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS 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)	-	-	-

Recommended Input:

log inscova onchanged

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
```

C.2.10 INSCOVS Short INS Covariance Log

This is a short header version of the *INCOV* log on *page 163*. These values are also computed once per second.

Structure:

Message ID: 320

Log Type: Asynch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS 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 *163* 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)	-	-	-

Recommended Input:

log inscovsa onchanged

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
```

C.2.11 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 centre, unless you issue the SETINSOFFSET command, see *page 135*.

Structure: **Message ID: 265**

Log Type:Synch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS 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 5 on page 46*	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)	-	-	-

Recommended Input:

log insposa ontime 1

ASCII Example:

```
#INSPOSA,USB2,0,18.0,FINESTEERING,1541,487977.000,00040000,17cd,37343;1541,48
7977.000549050,51.121315135,-114.042311349,1038.660737046,INS_SOLUTION_GOOD
*2fffd557
```

C.2.12 INSPOSS Short INS Position

This is a short header version of the *INSPOS* log on *page 166*.

Structure: **Message ID: 321**

Log Type:Synch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS 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 5 on page 46*	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)	-	-	-

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
```

C.2.13 INSPOSSYNC Time Synchronised INS Position

This log contains the time synchonised INS position. It is synchronised with GPS each second.

Structure: **Message ID: 322**

Log Type: Asynch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Sec	Age of synchronised INS solution (s)	Double	8	H
3	X	ECEF X coordinate	Double	8	H+8
4	Y	ECEF Y coordinate	Double	8	H+16
5	Z	ECEF Z coordinate	Double	8	H+24
6	Cov	ECEF covariance matrix (a 3 x 3 array of length 9). Refer also to the CLOCKMODEL log in the *OEMV Family Firmware Reference Manual*.	Double[9]	72	H+32
7	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+104
8	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Recommended Input:

log inspossynca onchanged

ASCII Example:

```
#INSPOSSYNCA,COM1,0,47.5,FINESTEERING,1332,484154.042,00000000,c98c,34492;
484154.000000000,-1634523.2463,-3664620.7609,4942494.6795,
1.8091616236414247,0.0452272887760925,-0.7438098675219428,
0.0452272887760925,2.9022554471257266,-1.5254793710104819,
-0.7438098675219428,-1.5254793710104819,4.3572293495804546*9fcd6ce1
```

C.2.14 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 161*, for an explanation of how the SPAN frame may differ from the IMU enclosure frame.

Structure: **Message ID: 507**

Log Type: Synch

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	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 5 on page 46*	Enum	4	H+84
14	xxxx	32-bit CRC	Hex	4	H+88
15	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

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
```

C.2.15 INSPVAS Short 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 161*, for an explanation of how the SPAN frame may differ from the IMU enclosure frame.

Structure: **Message ID: 508**

Log Type: Synch

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	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 5 on page 46*	Enum	4	H+84
14	xxxx	32-bit CRC	Hex	4	H+88
15	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

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
```

C.2.16 INSSPD INS Speed

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

Structure: **Message ID: 266**

Log Type: Synch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS 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 5 on page 46*	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)	-	-	-

Recommended Input:

log insspda ontime 1

ASCII Example:

```
#INSSPDA,USB2,0,20.0,FINESTEERING,1541,487969.000,00040000,7832,37343;1541,48
7969.000549050,329.621116190,14.182070674,-0.126606551,INS_SOLUTION_GOOD
*c274fff2
```

C.2.17 INSSPDS Short INS Speed

This is a short header version of the *INSSPD* log on *page 171*.

Structure: **Message ID: 323**

Log Type: Synch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS 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 5 on page 46*	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)	-	-	-

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
```

C.2.18 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.

Structure: **Message ID: 757**

Log Type: Asynch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Solution Type	Type of GPS solution used for the last update, see *Table 36* on *page 146*	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 42* below	Ulong	4	H+18
8	Reserved		Ulong	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)	-	-	-

Recommended Input:

log insupdate onchanged

ASCII Example:

```
#INSUPDATEA,UNKNOWN,0,32.5,FINESTEERING,1379,339642.042,00040040,3670,2431;
SINGLE,0,6,0,FALSE,WHEEL_SENSOR_UNSYNCED,0*fb5df08b
```

Table 42: 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

C.2.19 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.

Structure: **Message ID: 267**

Log Type:Synch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS 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 5 on page 46*	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)	-	-	-

Recommended Input:

log insvela ontime 1

ASCII Example:

```
#INSVELA,USB1,0,19.0,FINESTEERING,1543,236173.000,00000000,9c95,37343;1543,23
6173.002500000,14.139471871,-0.070354464,-0.044204369,INS_SOLUTION_GOOD
*3c37c0fc
```

C.2.20 INSVELS Short INS Velocity

This is a short header version of the *INSVEL* log on *page 174*.

Structure: **Message ID: 324**

Log Type:Synch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS 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 5 on page 46*	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)	-	-	-

Recommended Input:

```
log insvelsa ontime 1
```

ASCII Example:

```
%INSVELSA,USB2,0,18.5,FINESTEERING,1541,487942.000,00040000,9c95,37343;1541,4
87942.000549050,12.656120921,-3.796947104,-0.100024422,INS_SOLUTION_GOOD
*407d82ba
```

C.2.21 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.

Structure: **Message ID: 1067**

Log Type: Synch

Field	Field Type	Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS 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 Degrees clockwise from North at Mark1	Double	8	H+76
13	Status	INS Status, see *Table 5 on page 46* at Mark1	Enum	4	H+84
14	xxxx	32-bit CRC	Hex	4	H+88
15	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

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
```

C.2.22 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.

> This log and the SETMARK2OFFSET command are not immediately available to iMU-FSAS users. If you are an iIMU-FSAS user, and wish to use the Mark2 event trigger, contact NovAtel Customer Support. Contact information is on *page 17*.

Structure: **Message ID: 1068**

Log Type: Synch

Field	Field Type	Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS 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 5 on page 46* at Mark2	Enum	4	H+84
14	xxxx	32-bit CRC	Hex	4	H+88
15	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

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
```

C.2.23 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 *OEMV 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.

Structure:

Message ID: 1177

Log TypeSynch

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]

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
```

C.2.24 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 187*.

Structure: **Message ID: 268**

Log Type: Asynch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS 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 of the iIMU-FSAS, see *Table 43.* For the raw IMU status of the HG1700 and the LN-200 IMUs, see *Table 44*. Also refer to *Table 45, HG1900 and HG1930 Status* on *page 183* or *Table 46, Landmark Status* on *page 185*. Also refer to the Interface Control Documentation as provided by Honeywell and Northrop Grumman, respectively.	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 47* on *page 188*. Multiply the scale factor in *Table 47,* by the count in this field, for the velocity increments. See also *Table 1* on *page 27* 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 47* on *page 188*. Multiply the appropriate scale factor in *Table 47,* 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 the Landmark20; 200 Hz iMAR-FSAS and LN200).

Table 43: 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	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

Continued on next page

Nibble #	Bit #	Mask	Description	Range Value
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 44: HG1700 and LN200 Status

Nibble Number	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

Continued on next page

Nibble Number	Bit #	Mask	HG1700 Description	LN200 Description	
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	

Continued on next page

Nibble Number	Bit #	Mask	HG1700 Description		LN200 Description	
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 45: HG1900 and HG1930 Status

Nibble Number	Bit #	Mask	Description	Range Value
N0	0	0x00000001	Reserved	
	1	0x00000002		
	2	0x00000004		
	3	0x00000008		
N1	4	0x00000010	IMU Status	Passed: 0, Failed: 1
	5	0x00000020	IMU Status	Passed: 0, Failed: 1
	6	0x00000040	IMU Status	Passed: 0, Failed: 1
	7	0x00000080	IMU Status	Passed: 0, Failed: 1
N2	8	0x00000100	Reserved	
	9	0x00000200		
	10	0x00000400		
	11	0x00000800		

Continued on next page

				Range Value
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	IMU Status	Passed: 0, Failed: 1
	25	0x02000000	Reserved	
	26	0x04000000	IMU Status	Passed: 0, Failed: 1
	27	0x08000000	IMU Status	Passed: 0, Failed: 1
N7	28	0x10000000	IMU Status	Passed: 0, Failed: 1
	29	0x20000000	IMU Status	Passed: 0, Failed: 1
	30	0x40000000	IMU Status	Passed: 0, Failed: 1
	31	0x80000000	Reserved	

Table 46: Landmark Status

Nibble Number	Bit #	Mask	Status Description		Settings Description
N0	0	0x00000001	Cal/Test mode	Passed = 0, Failed = 1	Gyro Range Select Bit 2 [a]
	1	0x00000002	Sync	Passed = 1, Failed = 0	Accel Range Select Bit 2 [b]
	2	0x00000004	Reserved		Accel Range Bit 0 [b]
	3	0x00000008	Flash checksum error	Passed = 0, Failed = 1	Accel Range Bit 1 [b]
N1	4	0x00000010	Software error	Passed = 0, Failed = 1	Gyro Range Bit 0 [a]
	5	0x00000020	Software timing error	Passed = 0, Failed = 1	Gyro Range Bit 1 [a]
	6	0x00000040	Status/Settings Byte Select (0 = Bits 2-5, 7 are Status. 1 = Bits 2-5, 7 are Settings) [c]		
	7	0x00000080	Self-Test	Passed = 0, Failed = 1	Reserved
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	Reserved		
	25	0x02000000			
	26	0x04000000			
	27	0x08000000			
N7	28	0x10000000	Reserved		
	29	0x20000000			
	30	0x40000000			
	31	0x80000000			

a LandMark IMUs support multiple gyroscope scale factors, depending on measurement range. Currently all LandMark IMUs have common gyroscope scale factors, and these bits can be ignored.

b LandMark IMUs support multiple accelerometer scale factors, depending on measurement range. The exact range definitions can be found in the Gladiator LandMark IMU user's guide. If your accelerometer range bits are not 010 (Accel Range Bit 0 = 0, Accel Range Bit 1 = 1, Accel Range Select Bit 2 = 0), contact NovAtel Customer Support, as outlined in "Contact Information", on page 18 of this manual.

c LandMark IMUs provide two different diagnostic bytes. The type of byte (Status or Settings) is defined by bit 6 of the message. Under normal operation with NovAtel SPAN, these bytes will alternate between each RAWIMU log.

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
```

C.2.25 RAWIMUS Short Raw IMU Data

This is a short header version of the *RAWIMU* log on *page 179*.

Structure: **Message ID: 325**

Log Type: Asynch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS 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 of the iIMU-FSAS, see *Table 43, iIMU-FSAS Status* on *page 180.* For the raw IMU status of the HG1700 and the LN-200 IMUs, see *Table 44*. Also refer to *Table 45, HG1900 and HG1930 Status* on *page 183* or “Landmark Status” on Page 185.Also refer to the Interface Control Documentation as provided by Honeywell and Northrop Grumman, respectively.	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 47* on *page 188*. 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 a Landmark20; 200 Hz iMAR-FSAS and LN200). See also *Table 1* on *page 27* 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 47* on *page 188*. Multiply the appropriate scale factor in *Table 47,* by the count in this field, for the angle increments in radians.

Recommended Input:

log rawimusa onnew

ASCII Example:

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

Table 47: Raw IMU Scale Factors

IMU Scale	HG1700-AG11 HG1700-AG58 HG1900-CA29/ CA50 HG1930-AA99/ CA50	HG1700-AG17 HG1700-AG62	LN-200	iIMU-FSAS
Gyroscope Scale Factor	2.0^{-33} rad/LSB	2.0^{-33} rad/LSB	2^{-19} rad/LSB	$0.1x\ 2^{-8}$ arcsec/LSB
Acceleration Scale Factor	2.0^{-27} ft/s/LSB	2.0^{-26} ft/s/LSB	2^{-14} m/s/LSB	0.05×2^{-15} m/s/LSB

IMU Scale	Landmark 20
Gyroscope Scale Factor	1.0×10^{-4} deg/LSB
Acceleration Scale Factor	$9.80665 \times 5.0 \times 10^{6}$ m/s/LSB

Landmark IMUs have variable scale factors according to their data range. If the scale factors for your IMU differ from the values here, please contact NovAtel Customer support as outlined in see ”Contact Information” on page 17 section of this manual.

C.2.26 TAGGEDMARK1PVA

TAGGEDMARK1PVA is identical to MARK1PVA but with a 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.

Structure:

Message ID: 1258
Log Type: Synch

Field #	Field Type	Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log Header	-	H	0
2	Week	GPS Week at Mark 1 request	Ulong	4	H
3	Seconds	GPS Seconds at Mark1 request	Double	8	H+
4	Latitude	Latitude at Mark 1 request	Double	8	H+
5	Longitude	Longitude at Mark 1 request	Double	8	H+
6	Height	Height at Mark 1 request	Double	8	H+
7	North Velocity	North Velocity at Mark 1 request	Double	8	H+
8	East Velocity	East Velocity at Mark1 request	Double	8	H+
9	Up Velocity	Up Velocity at Mark 1 request	Double	8	H+
10	Roll	Roll at Mark1 request	Double	8	H+
11	Pitch	Pitch at Mark1 request	Double	8	H+
12	Azimuth	Azimuth at Mark1 request	Double	8	H+
13	Status	INS Status at Mark 1 request	Enum	4	H+
14	Tag	Tag ID from TAGNEXTMARK Cmd. If Any.	Ulong	4	H+
15	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+92
16	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

C.2.27 TAGGEDMARK2PVA

TAGGEDMARK2PVA is identical to MARK2PVA but with a 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.

Structure:

Message ID: 1259
Log Type: Synch

Field #	Field Type	Description	Format	Bytes	Offset
1	Log Header	Log Header	-	H	0
2	GpsWeek	GPS Week at Mark2 request	Ulong	4	H
3	GpsSeconds	GPS Seconds at Mark2 request	Double	8	H+
4	Latitude	Latitude at Mark2 request	Double	8	H+
5	Longitude	Longitude at Mark2 request	Double	8	H+
6	Height	Height at Mark2 request	Double	8	H+
7	North Velocity	North Velocity at Mark2 request	Double	8	H+
8	East Velocity	East Velocity at Mark2 request	Double	8	H+
9	UpVelocity	Up Velocity at Mark2 request	Double	8	H+
10	Roll	Roll at Mark2 request	Double	8	H+
11	Pitch	Pitch at Mark2 request	Double	8	H+
12	Azimuth	Azimuth at Mark2 request	Double	8	H+
13	Status	INS Status at Mark2 request	Insstatus	4	H+
14	Tag	Tag ID from TAGNEXTMARK Cmd. If Any.	Ulong	4	H+
15	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+92
16	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

C.2.28 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 53*.

> 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 *142*, 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.

Structure: **Message ID: 622**

Log Type: Asynch

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)	-	-	-

Recommended Input:

```
log timedwheeldataa onnew
```

ASCII Example:

This example is from the iMAR iMWS wheel sensor:

```
%TIMEDWHEELDATAA,1393,411345.001;58,0,215.814910889,0,0,1942255*3b5fa236
```

C.2.29 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 124*. 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.

See the syntax table in *Section B.2.24, TAGNEXTMARK* starting on *page 139* for more information.

Recommended Input:

```
log vehiclebodyrotationa onchanged
```

ASCII Example:

```
#VEHICLEBODYROTATIONA,COM1,0,36.5,FINESTEERING,1264,144170.094,00000000,bcf2,
1541;1.5869999997474209,2.6639999995760122,77.6649999876392343,2.000000000000
0000,2.0000000000000000,5.0000000000000000*25f886cc
```

C.2.30 WHEELSIZE Wheel Size

This log contains wheel sensor information.

The inertial Kalman 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.

Structure: **Message ID: 646**

Log Type: Asynch

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)	-	-	-

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
```

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's 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.

Example:

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's appropriately configured COM1 serial port is connected to the receiver's COM1 serial port, and where a rover terminal is connected to the receiver's 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 PC 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:\GPS\BOOT1.TXT) and exit the text editor.
3. Use the DOS *copy* command to direct the contents of the BOOT1.TXT file to the PC's COM1 serial port:

```
C:\GPS>copy boot1.txt com1
1 file(s) copied
C:\GPS>
```

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's COM1 serial port is connected to the receiver's COM1 serial port, and that a rover terminal is connected to the receiver's 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:\GPS\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:\GPS\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's 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's 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 its COM2 serial port.

Appendix E

HG1700 IMU in SPAN HG Enclosure

The following procedure, detailed in this appendix, 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.

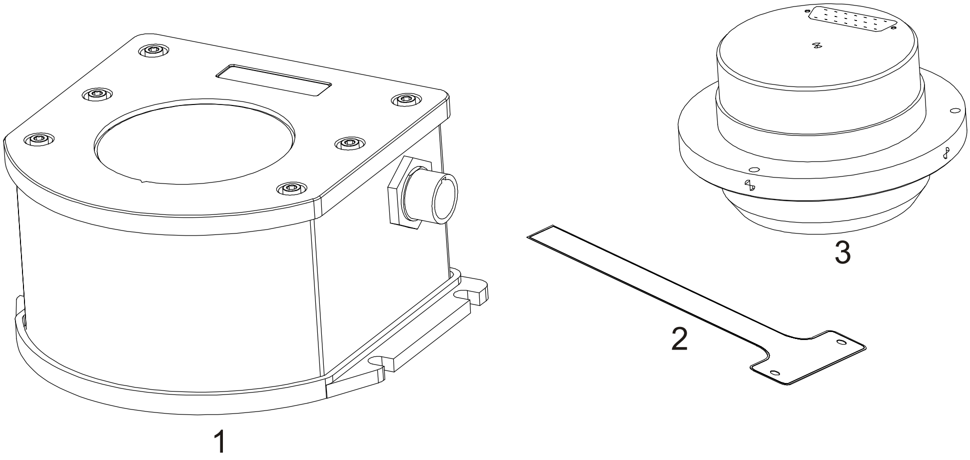


Figure 45: Required Parts

Reference	Description
1	SPAN IMU Enclosure
2	HG1700 Flex Cable
3	HG1700 Sensor Unit

E.1 Disassemble the SPAN IMU Enclosure

The SPAN IMU disassembly steps are as follows:

1. Remove the top cover's six bolts using a hex key, as shown in *Figure 46*:

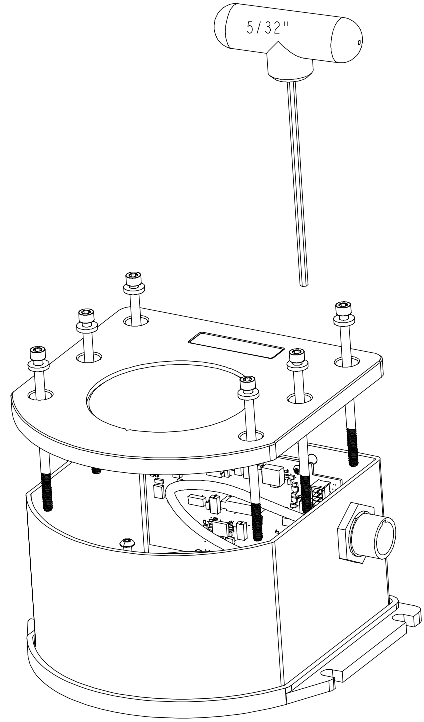


Figure 46: Bolts and Hex Key

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 47* on *page 199*.
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.

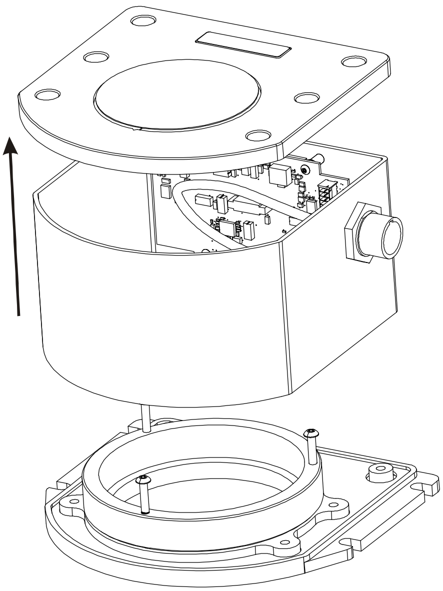


Figure 47: Lift Top Cover, Tube Body and 3 Ring Spacer Screws

E.2 Install the HG1700 Sensor Unit

To re-assemble the SPAN IMU with the HG1700 sensor, see *Figure 48* 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.

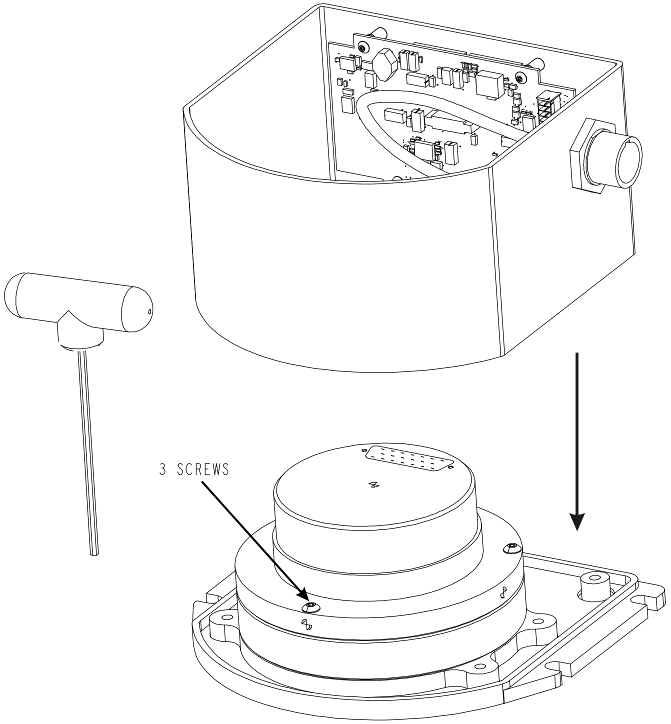


Figure 48: SPAN IMU Re-Assembly

E.3 Make the Electrical Connections

To make the electrical connections you will need a 3/32” hex key, the flex cable and the partially assembled SPAN IMU from *Section E.2, Install the HG1700 Sensor Unit* on *page 200*. 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 49*.

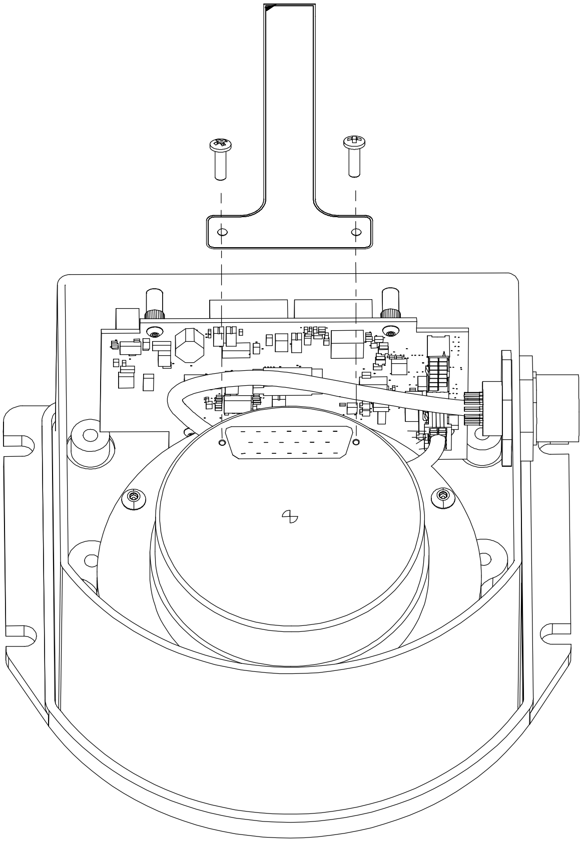


Figure 49: Attach Flex Cable

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 49*.
4. Check that the flex cable is locked in place.
5.

▼ *Figure E.4* shows an incorrect installation of the flex cable where it is bowed in the middle. It will not operate properly in this position. *Figure 50* shows the proper installation of the flex cable. Notice how the flex cable sits flush against the IMU surface.

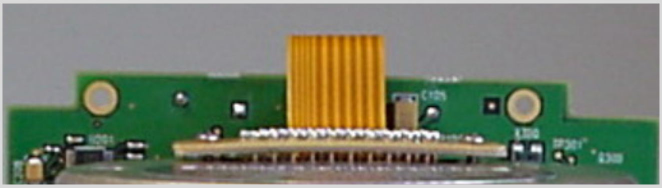


Figure 50: Incorrect (Bowed) Flex Cable Installation

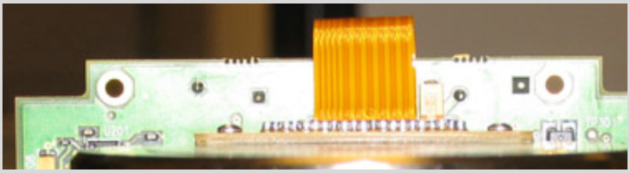


Figure 51: Correct (Flat) Flex Cable Installation

E.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 46* on *page 198*. 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 52*.

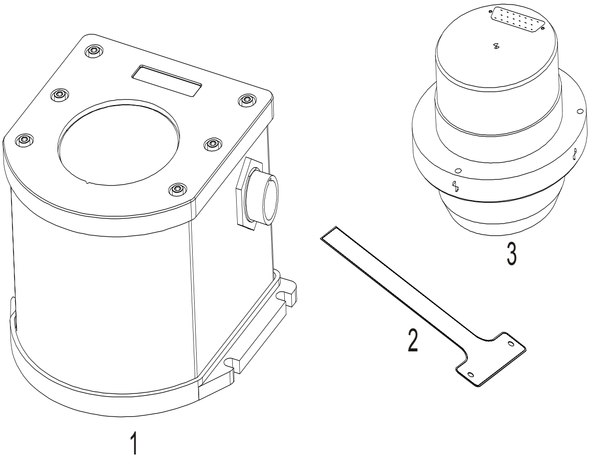


Figure 52: HG1700 SPAN IMU

Appendix F LN-200 IMU in SPAN IMU Enclosure

The following procedure, detailed in this appendix, 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.

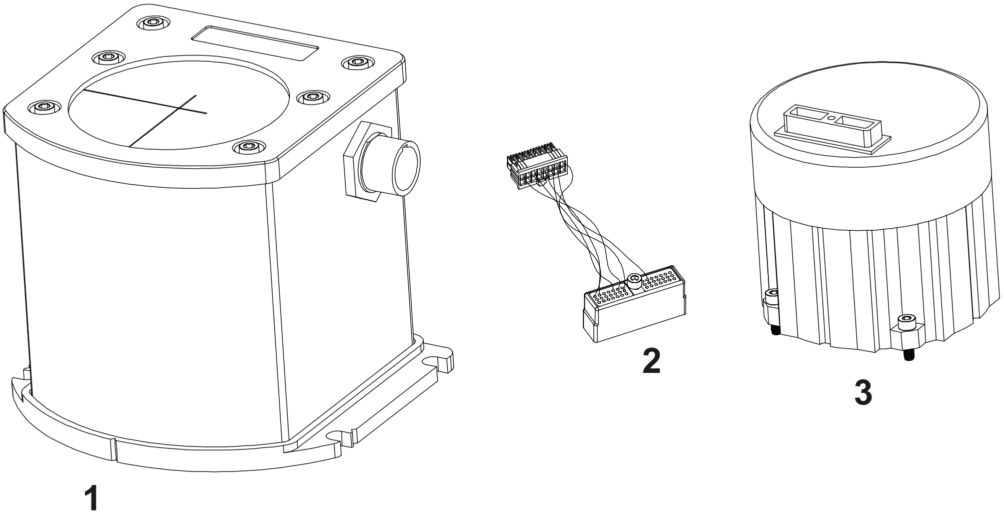


Figure 53: Required Parts

Reference	Description
1	SPAN IMU Enclosure
2	LN-200 Wiring Harness
3	LN-200 Sensor Unit

F.1 Disassemble the SPAN IMU Enclosure

The SPAN IMU disassembly steps are as follows:

1. Remove the top cover's six bolts using a hex key, as shown in *Figure 54*:

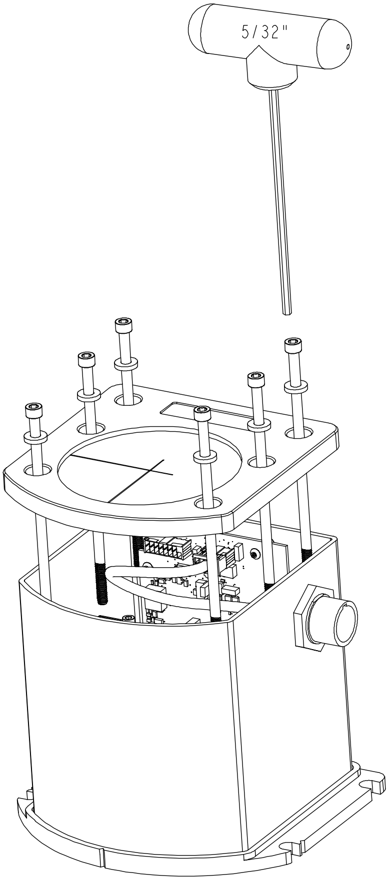


Figure 54: Bolts and Hex Key

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 55* on *page 205*.

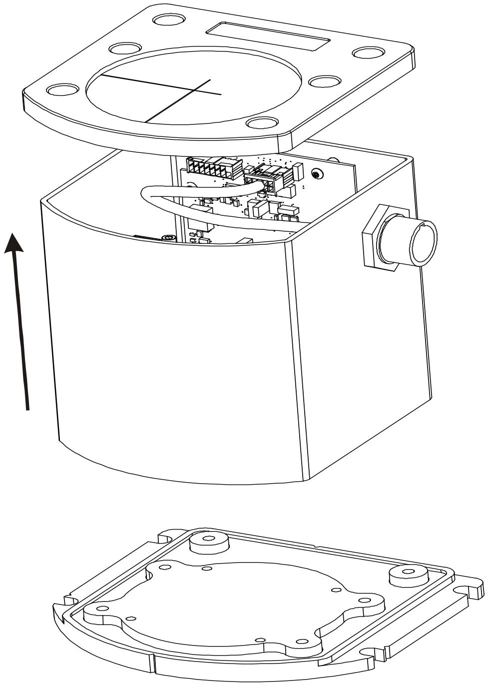


Figure 55: Lift Top Cover and Tube Body

F.2 Install the LN-200 Sensor Unit

To re-assemble the SPAN IMU with 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.

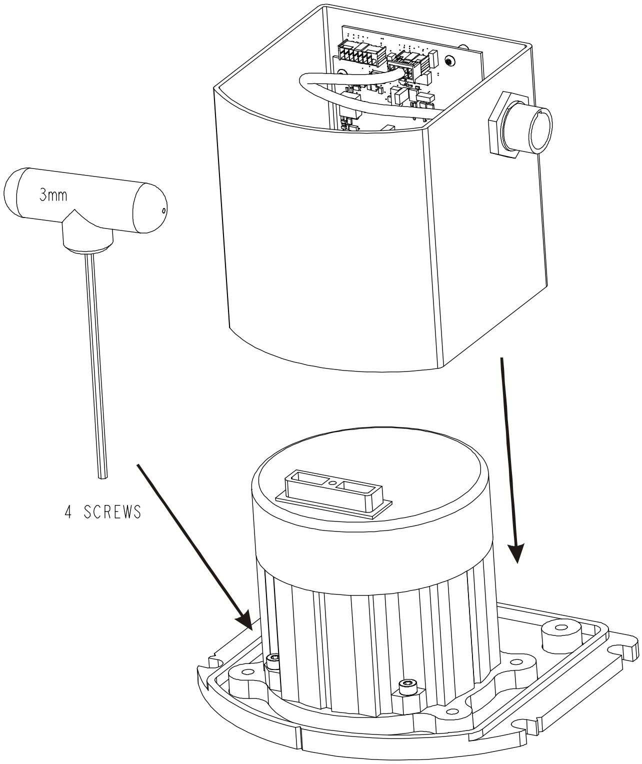


Figure 56: SPAN IMU Re-Assembly

F.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 F.2, Install the LN-200 Sensor Unit* on *page 206*. 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 57* on *page 207*.

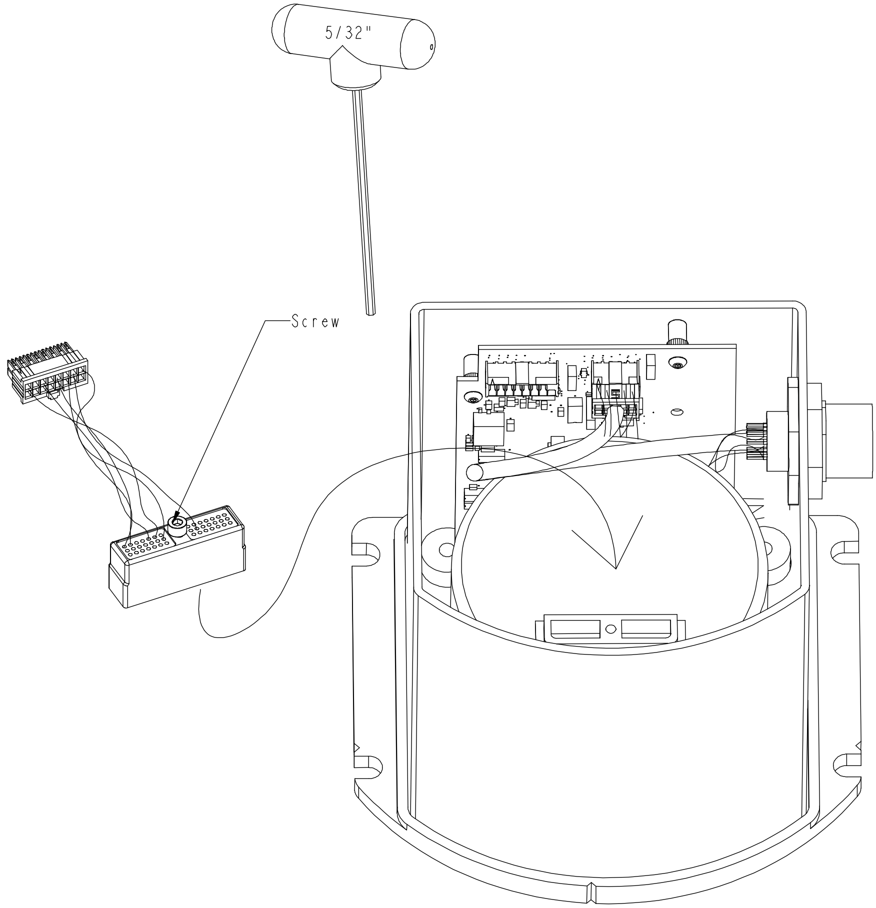


Figure 57: Attach Wiring Harness

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 58*. Ensure that the connector is locked in place.

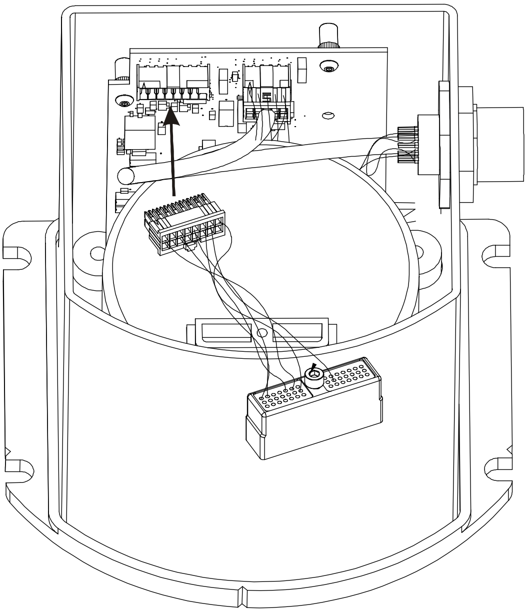


Figure 58: Attach Samtec Connector

F.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 54* on *page 204*. 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 59.*

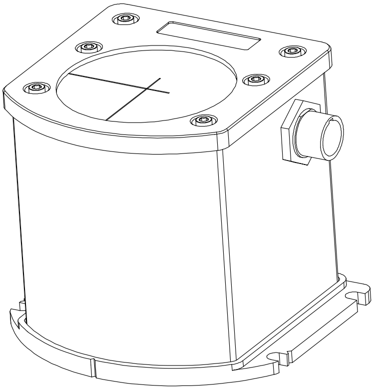


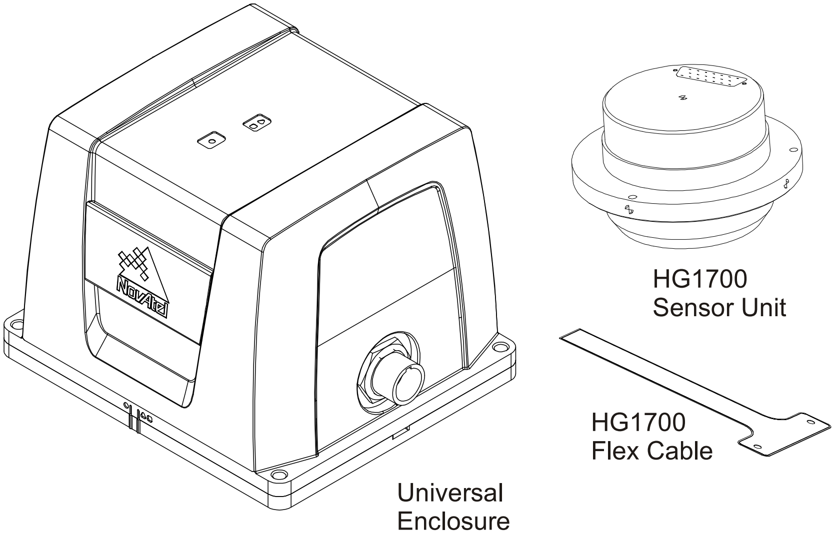
Figure 59: LN-200 SPAN IMU

Appendix G 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



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)

G.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 60*. Ensure the O-rings come with the base when it is removed, and that they are not damaged.

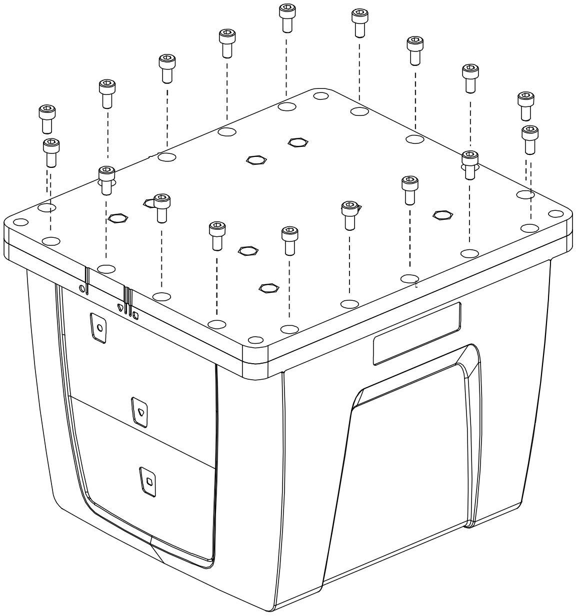


Figure 60: Remove Base

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.

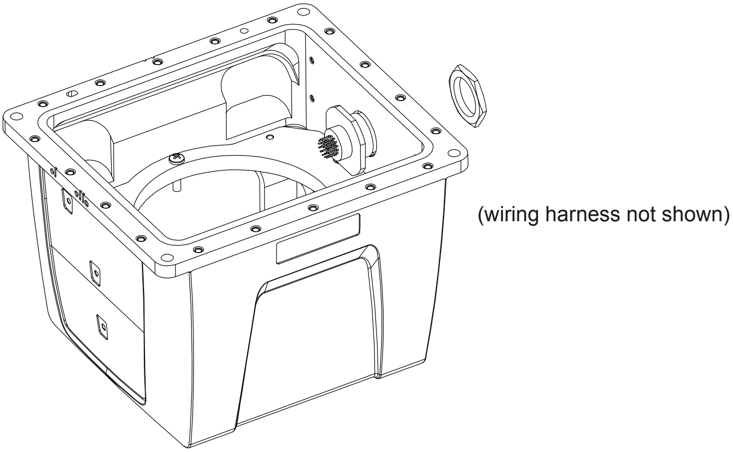


Figure 61: Disconnect Wiring Harness from Enclosure Body

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 62*:

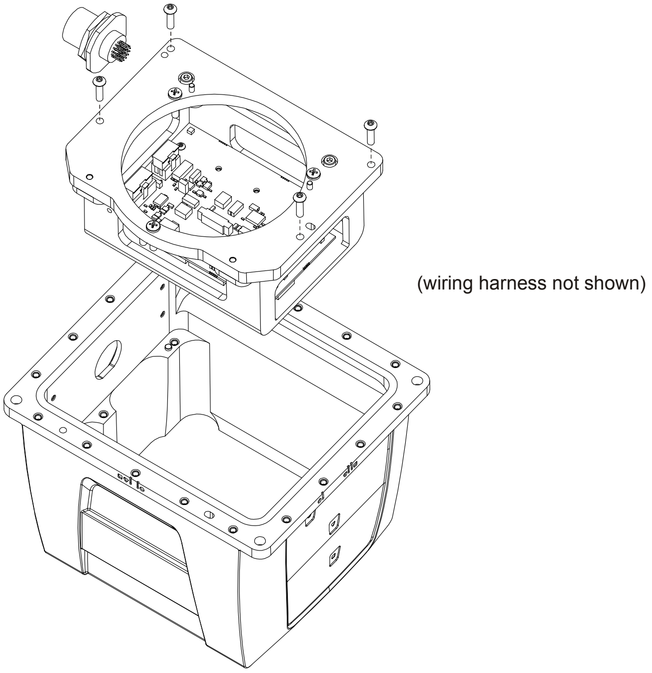


Figure 62: Remove IMU Mounting Plate and Bracket

G.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 63*:

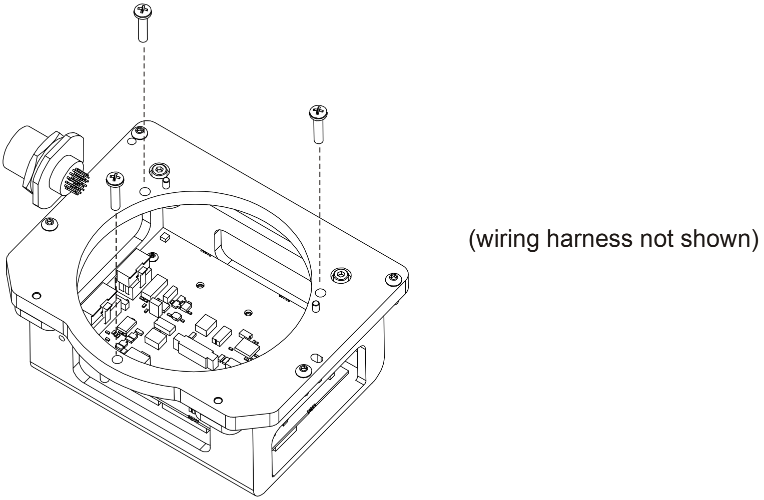


Figure 63: Remove IMU Mounting Screws

2. Check the connection of the internal cable harness to the board assembly and route as shown in *Figure 64*. 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.

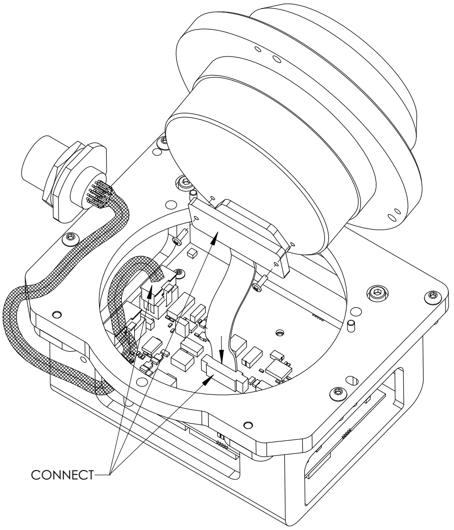


Figure 64: Connect IMU to IMU Mounting Plate

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 65*.

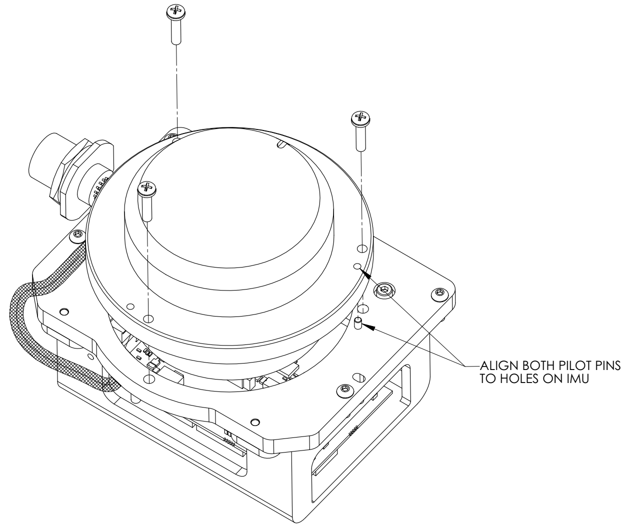


Figure 65: Installing IMU to Mounting Plate

4. Starting with the round pilot hole, shown in *Figure 66*, 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.

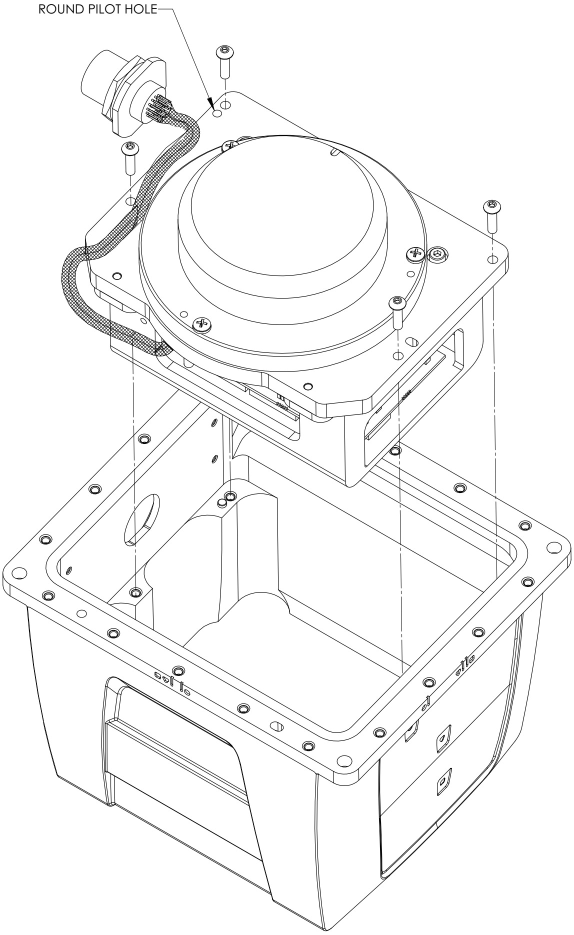


Figure 66: Assemble Into Enclosure Body

5. Connect the internal cable harness to the enclosure body, as shown in *Figure 67*. 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).

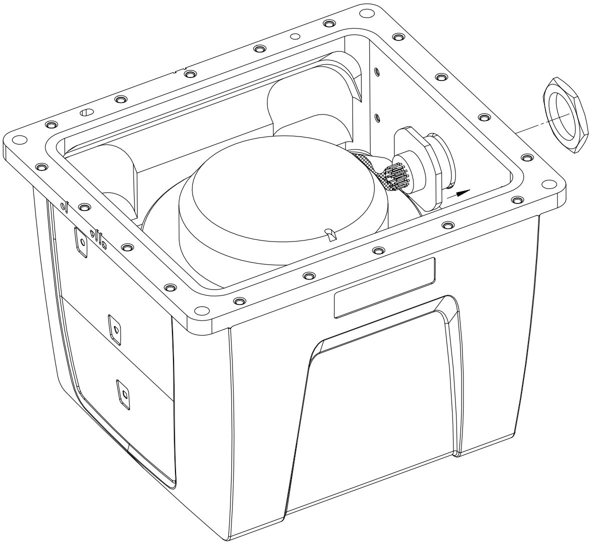


Figure 67: Fasten Internal Cable Harness

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 68*, 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.

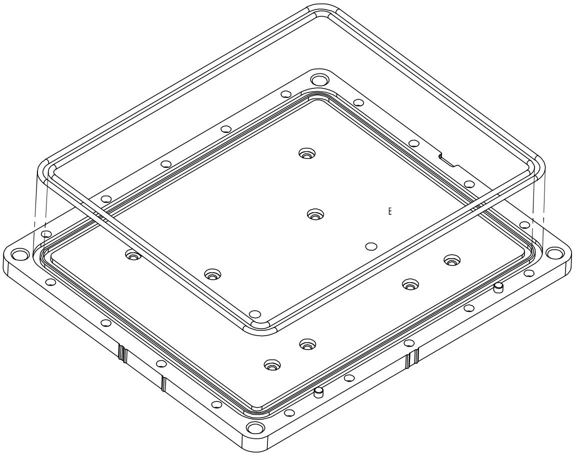


Figure 68: Install O-rings

7. Clean the surface of the enclosure body, where it mates with the O-rings, using isopropyl alcohol. As shown in *Figure 69*, 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 69*.

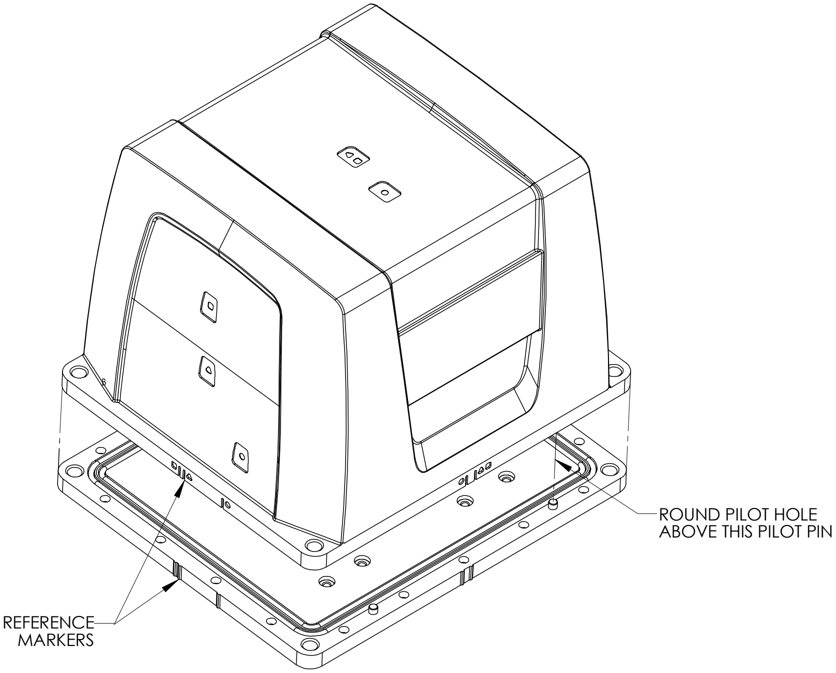


Figure 69: Install Enclosure Body on the Base

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 70*. 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.

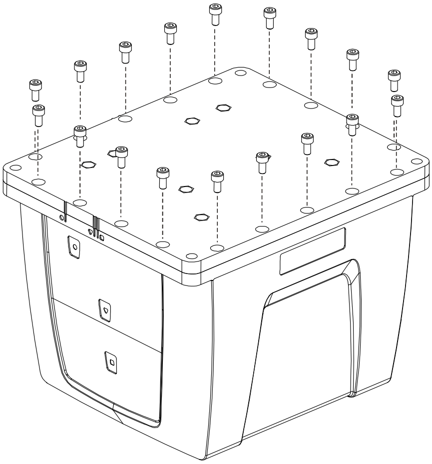


Figure 70: Screw Enclosure Base to Body

9. Ensure the product identification label, the logo plate and the centre of navigation labels are properly affixed and contain the correct information. The final assembled unit will be similar to that shown in *Figure 71*:

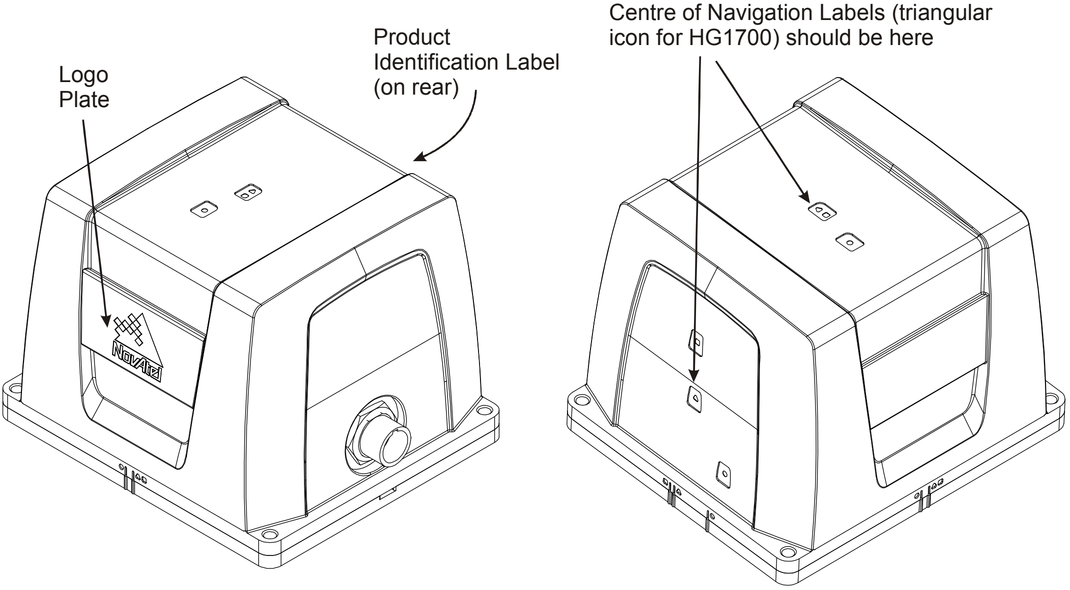


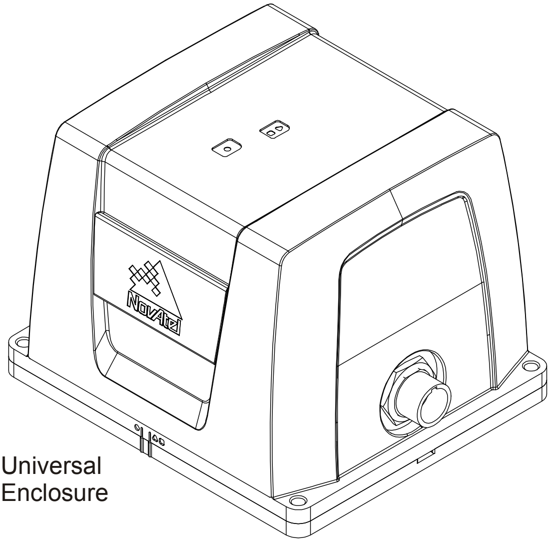
Figure 71: Final Assembly

Appendix H LN-200 IMU in Universal Enclosure

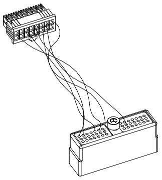
Important! Assemble in accordance with applicable industry standards. Ensure all ESD measures are in place, in particular, use a ground strap before exposing or handling any electronic items, including the IMU. Take care to prevent damaging or marring painted surfaces, O-rings, sealing surfaces, and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

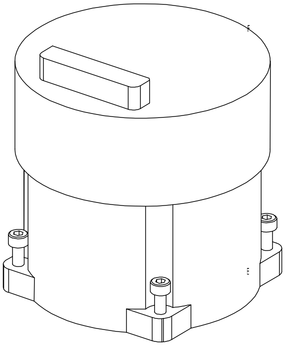
- Disassemble the Universal Enclosure
- Install the LN-200 Sensor Unit
- Reassemble the Universal Enclosure



Universal Enclosure



LN-200 Wiring Harness



LN-200 Sensor Unit

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)

H.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 72*.

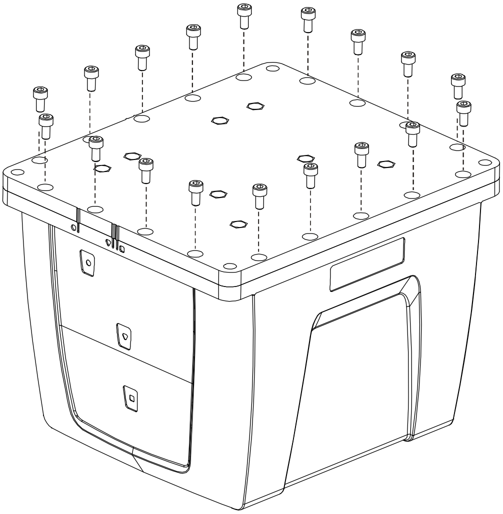


Figure 72: Remove Base

2. While squeezing and holding the assembly tightly together, carefully turn the assembly over and set it down as shown in *Figure 73*. Raise the enclosure body, and disconnect the internal cable harness at the SDLC board, as shown. Ensure the O-rings remain with the base when it is removed, and that they are not damaged.

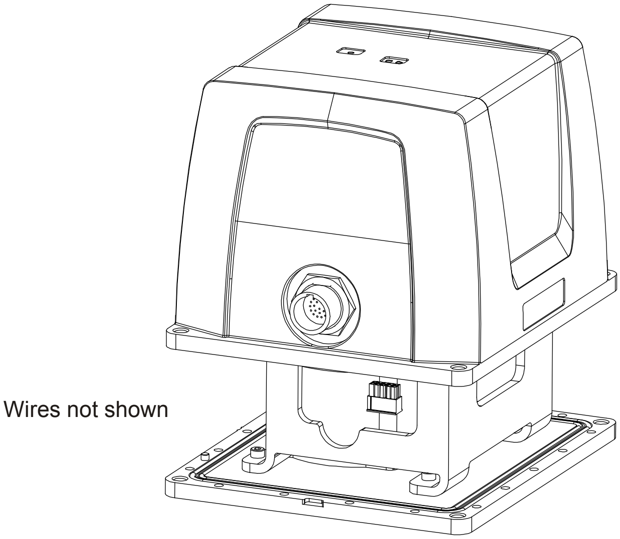


Figure 73: Disconnect Wiring Harness from SDLC Card

3. Lift the enclosure lid off the assembly to expose the IMU bracket, shown in *Figure 74*. Disconnect the harness at the SDLC card and remove.

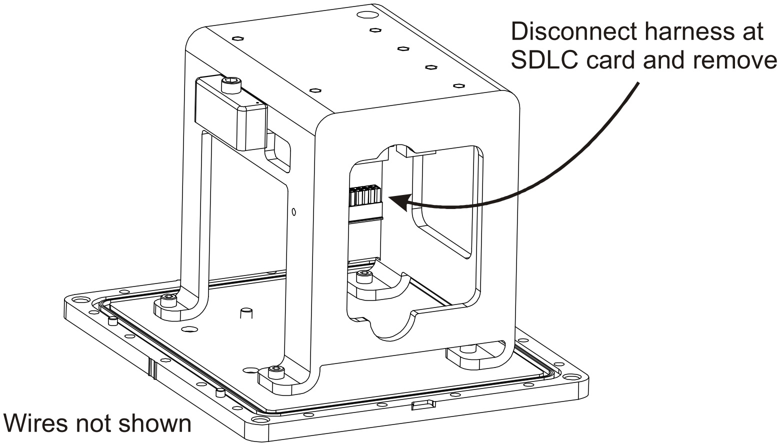


Figure 74: IMU Bracket

4. Using a 3 mm hex bit, unscrew 4 mm screws and remove the IMU bracket with SDLC, as shown in *Figure 75*.

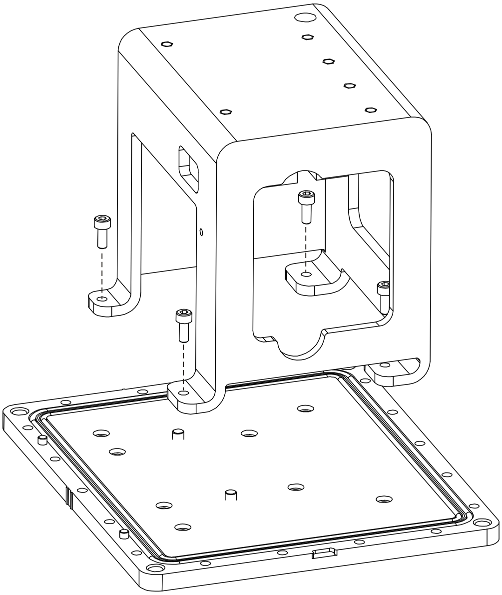


Figure 75: Remove IMU Bracket/SDLC

H.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 76*. Use thread-locking fluid on each screw.

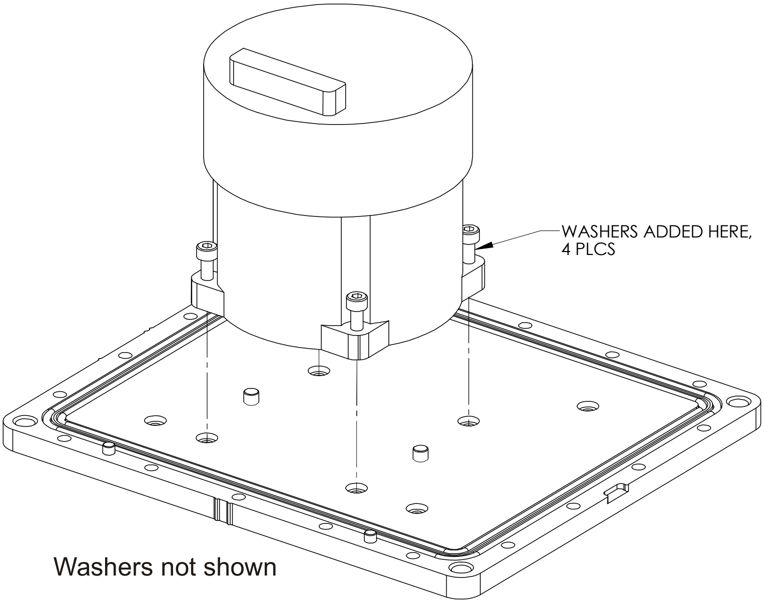


Figure 76: Install LN-200 IMU to Base

2. Using a long 3 mm hex bit, install the IMU bracket/SDLC to the base, as shown in *Figure 77*. Use thread-locking fluid on each M4 screw.

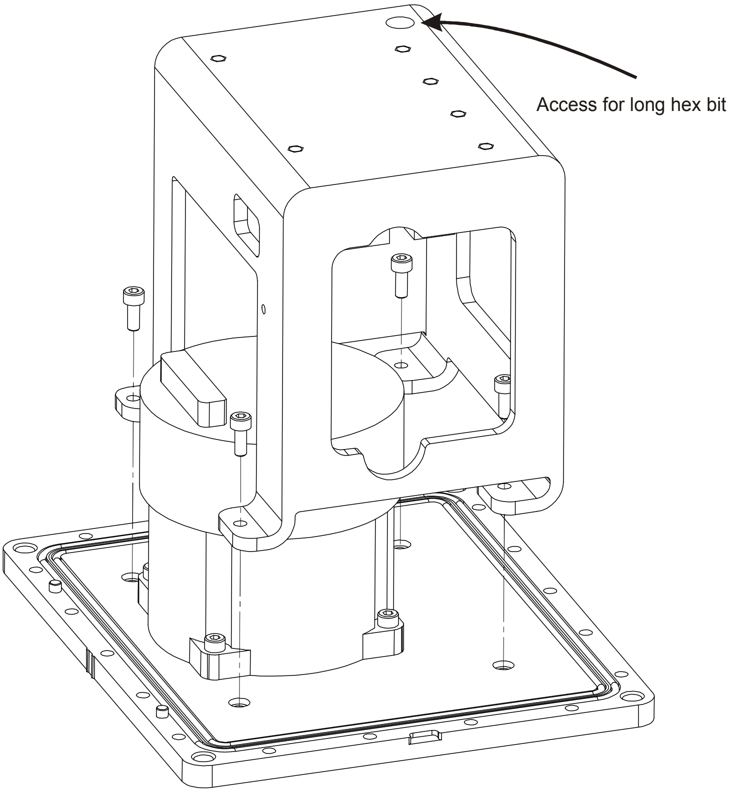
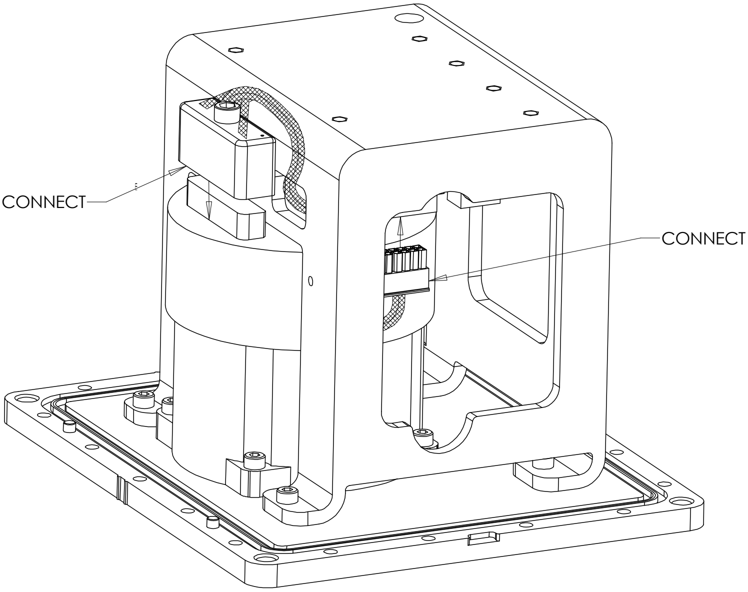


Figure 77: Install Bracket to Base

3. Connect the cable harness to the board assembly and IMU, routing it as shown in *Figure 78*. 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.



> ⓘ Make sure the tape of the harness is positioned for maximum protection.

Figure 78: Making Connections

4. While carefully holding the body over the bracket, connect the internal cable harness to the board assembly, as shown in *Figure 79*.

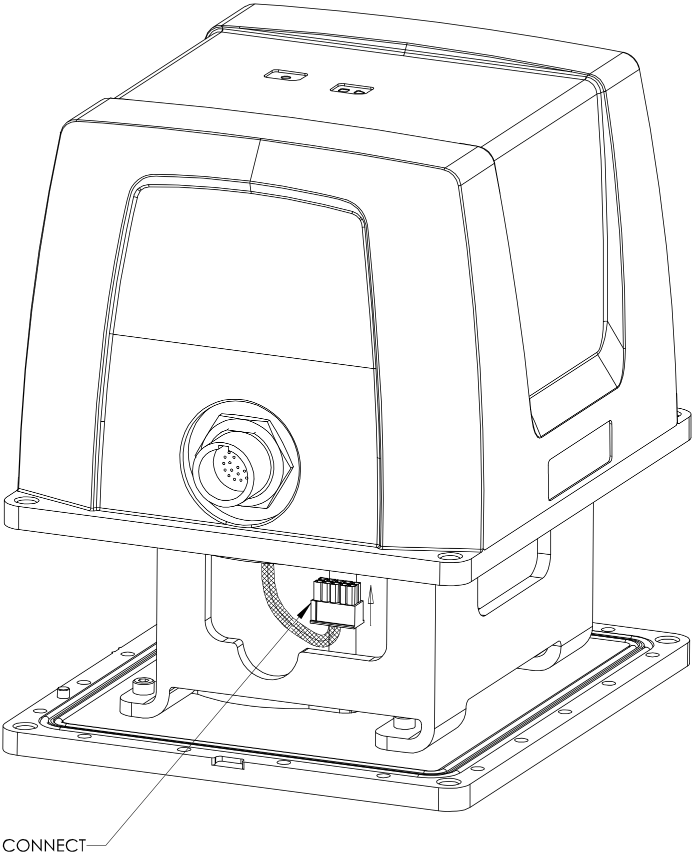


Figure 79: Connect Internal Cable Harness

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 80*, then press the assembly into place.

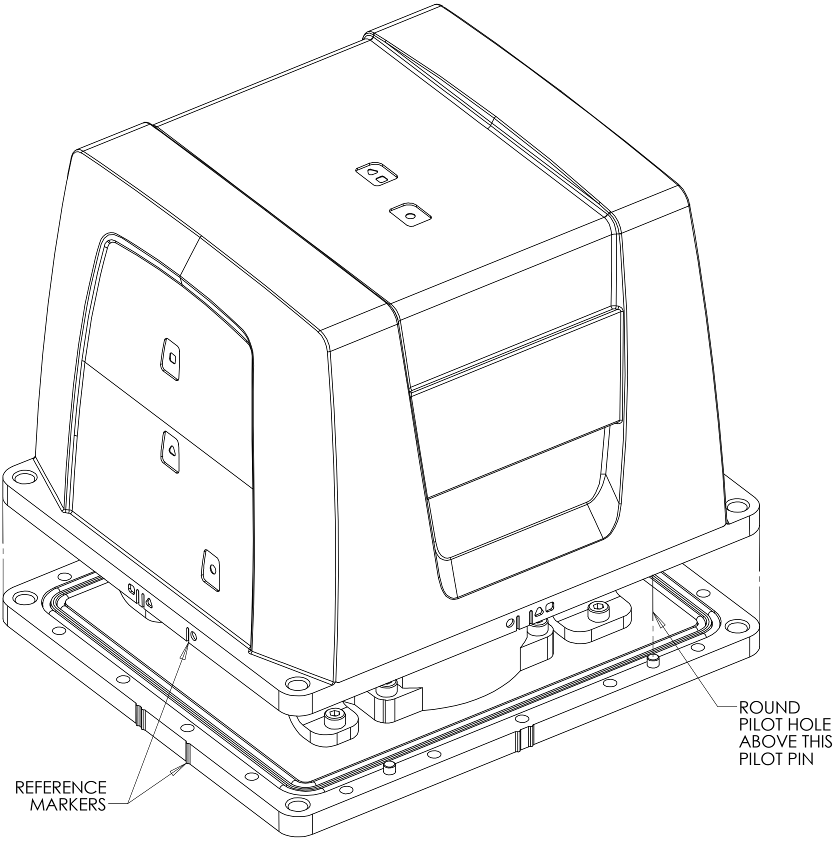


Figure 80: Installing the Enclosure Body to the Base

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 81*. 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.

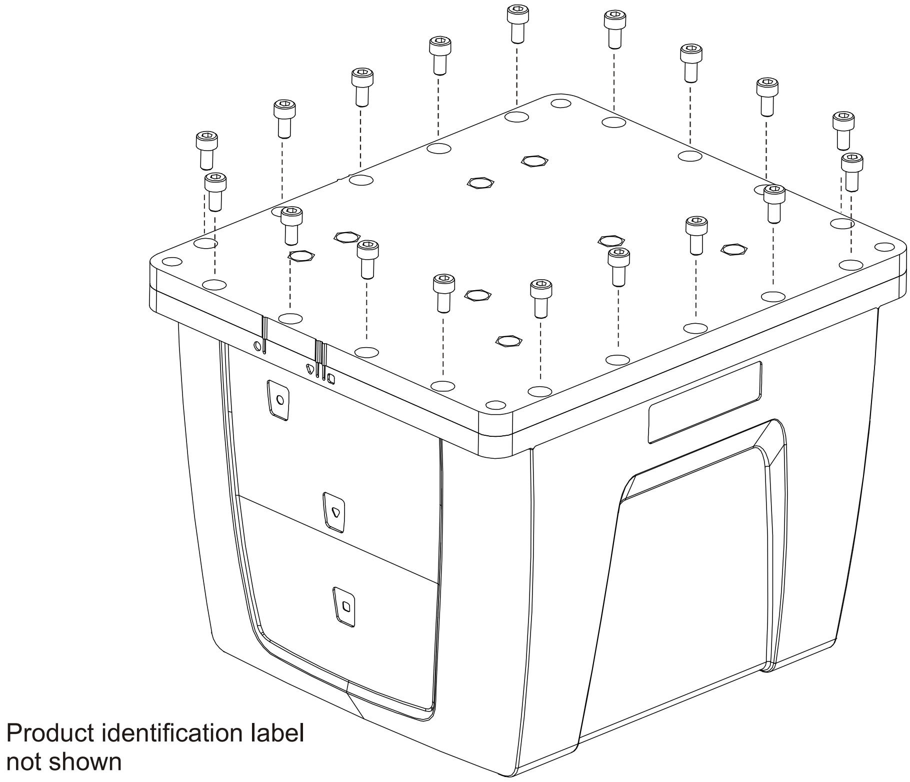


Figure 81: Screw Enclosure Base to Body

7. Ensure the product identification label, the logo plate and the centre of navigation labels are properly affixed and contain the correct information. The final assembled unit is shown in *Figure 82*.

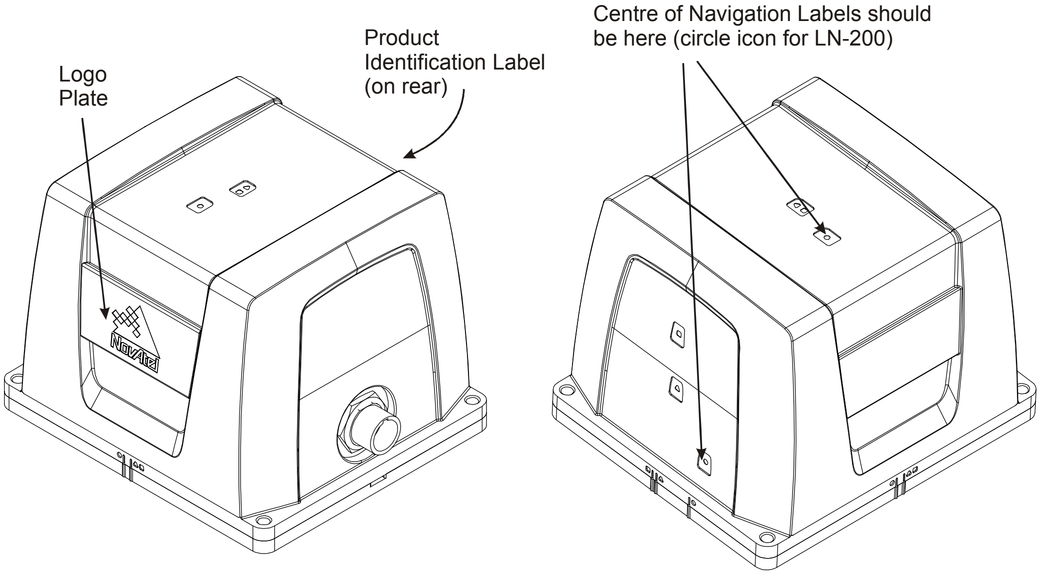


Figure 82: Final Assembly

Appendix I Frequently Asked Questions

1. *How do I know if my hardware is connected properly?*
   When powered, the HG1700 IMU will make a noticeable humming sound.

2. *I don't hear any sound from my IMU. Why?*
   a. The LN-200 and iIMU-FSAS do not make noise. Check that the IMU interface cable is connected to the AUX port on the Propak-V3.
   b. 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 AUX port on the Propak-V3.
   c. 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,* starting on *page 197* or *Appendix F,* starting on *page 203* for more details.
   d. 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.

3. *What system configuration do I need to do to get the system running?*
   a. Set the interface of the receiver port being used for IMU communication using the INTERFACEMODE command, see *page 115*.

   ```
   INTERFACEMODE COM3 IMU IMU OFF
   ```

   b. Set the IMU type using the SETIMUTYPE command, see *page 129*.

4. *What types of IMUs are supported?*
   a. SPAN currently supports the HG1700 IMU family from Honeywell, the LN-200 from Litton and the iIMU-FSAS from iMAR. Use the SETIMUTYUPE command to specify the type of IMU used (see *page 129*).

5. *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.

6. *How can I access the inertial solution?*
   The INS/GPS 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 143*.

7. *Can I still access the GPS-only solution while running SPAN?*

   The GPS only solution used when running the OEMV receiver without the IMU is still available when running SPAN. Logs such as PSRPOS, RTKPOS and OMNIPOS are still available. 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 143* should be logged at rates higher than 5 Hz when running SPAN.

8. *What will happen to the INS solution when I lose GPS satellite visibility?*

   When GPS tracking is interrupted, the INS/GPS 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 GPS 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 GPS 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 163*.

9. *What does it mean if my IMUCARD version string looks like this: < GPSCARD "L12LRVI" "DAB10340175" "OEMV3G-5.01-X2T" "SPAN3.630S3" "3.000" "2010/Dec/ 2" "09:38:01" < 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 Receiver and IMU Models* on *page 27* for details)	IMU-H58 IMU-H62 IMU-LN200 IMU-FSAS-EI UIMU-H58 UIMU-H62 UIMU-LN200
Receivers (see *Table 1, SPAN-Compatible Receiver and IMU Models* on *page 27* for details)	ProPak-V3
Universal Enclosure external cable harness, see *Figure 16* on *page 59*	01018299
ProPak-V3 to iIMU-FAS IMU interface cable, see *Table 15* on *page 82*	60723086
OEMV, Connect and Convert4 disk (see *page 41* of this manual and refer to the *OEMV Family Installation and Operation User Manual*)	01017827
SPAN Technology For OEMV User Manual	OM-20000104
OEMV Family Installation and Operation User Manual	OM-20000093
OEMV Family Firmware Reference Manual	OM-20000094

J.2 Accessories and Options

Part Description		NovAtel Part
Optional NovAtel GPSAntennas:	Model 532 (for aerodynamic applications)	GPS-532
	Model 702 (for high-accuracy applications)	GPS-702
	Model 702L (for L-band applications)	GPS-702L
	Model 533 (for high-performance base station applications)	GPS-533
Optional Alignment RF Antenna Cable:	5 meters	C006
	15 meters	C016

J.3 Manufacturer’s Part Numbers

The following original manufacturer’s part numbers (and equivalents), for the IMU interface cables, are provided for information only and are not available from NovAtel as separate parts:

Part Description	LEMO Part	Deutsch Part	MIL Part
10-pin LEMO plug connector on the HG1700 interface cables	FGG.1K.310.CLAC60Z	-	-
Deutsch (or MIL equivalent) 13-pin connector on the LN-200 interface cable Deutsch (or MIL equivalent) 3-pin connector on the LN-200 power cable	- -	59064-11-35SF 59064-09-98SN	D38999/26B35SF D38999/26A98SN
MIL 22-pin connector on the iIMU-FSAS interface cable	-	-	D38999/26WC35SA
Amphenol (or MIL equivalent) 22-pin connector on the Universal Enclosure interface cable	TV-06-RW-13-35-S-A	-	MIL-DTL-38999

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