



SPAN™ Technology for OEMV

USER MANUAL

SPAN Technology for OEMV User Manual

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Manufactured and protected under U.S. Patent:

Narrow Correlator

#5,101,416

#5,390,207

#5,495,499

#5,809,064

PAC Correlator

#6,243,409 B1

#5,414,729

Dual Frequency GPS

#5,736,961

Anti-Jamming Technology

#5,734,674

Position for Velocity Kalman Filter

#6,664,923 B1

#7,193,559 B2

SPAN Technology

#6,721,657 B2

#6,750,816 B1

#7,346,452

10/932,497 (pending)



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

NovAtel Inc.

Customer Service Dept.

1120 - 68 Avenue NE,

Calgary, Alberta, Canada T2E 8S5

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Bank:	HSBC Bank of Canada	US Account #	788889-002
	407 - 8 Avenue S.W.	CDN Account #	788889-001
	Calgary, AB, Canada T2P 1E5	EURO Account #	788889-270
		Transit #	10029-016
		Swift	HKBCCATTCAL

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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 14*).

WARNING: Only return an IMU to its manufacturer and not to NovAtel.

-
- 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

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

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

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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 Service

Firmware Upgrades

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

Please refer to the *PC Software and Firmware* chapter in the *OEMV Installation and Operation User Manual*.

Contact Information

Firmware upgrades are accomplished through NovAtel authorized dealers.

Contact your local NovAtel dealer first for more information. To locate a dealer in your area or if the problem is not resolved, contact NovAtel Inc. directly using one of the following methods:

Call the NovAtel GPS Hotline at 1-800-NOVATEL (North America), or 403-295-4900 (international)

Fax: 403-295-4901

E-mail: support@novatel.ca

Web site: <http://www.novatel.com>

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

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

1. Issue a FRESET command
2. Send the INTERFACEMODE and SETIMUTYPE commands to re-establish communication with the IMU, see *Table 4 on Page 28*.
3. Log the following data to a file on your PC for 30 minutes:

RXSTATUSB	once
RAWEPHEMB	onchanged
RANGEB	ontime 1
BESTPOSB	ontime 1
RXCONFIGA	once
VERSIONB	once
RAWIMUSB	onnew
INSPVASB	ontime 0.1
INSCOVSB	onchanged
INSUPDATEB	onchanged
BESTGPSPOSB	ontime 1
4. Send the file containing the logs to NovAtel Customer Service using the support@novatel.com e-mail address.

Notices



CAUTION

1. This device incorporates circuitry to absorb most static discharges. However, severe static shock may cause inaccurate operation of the unit. Use anti-static precautions where possible.
2. This device is a precision instrument. It performs best when handled with care.

Congratulations!

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

By complementing GPS with inertial measurements, SPAN Technology provides robust positioning in challenging conditions where GPS alone is less reliable. During short periods of GPS outage, or when less than four satellites are received, SPAN Technology offers uninterrupted position and attitude output. The tight coupling of inertial technology with GPS 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 GPS and IMU enclosures provide a simple modular system. This allows the IMU mounting at the most suitable location, while the GPS receiver is mounted where it is most convenient. System modularity also allows GPS-only users to upgrade to GPS/INS. In conditions where GPS alone is desired, the SPAN receiver can be operated independently. As a result, SPAN Technology provides a robust GPS and Inertial solution as well as a portable, high-performance GPS 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 Service* on page 15.

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.

What's new in revision 7 of this manual?

SPAN3.620 is a feature release that provides users with AdVance RTK which was unavailable in previous SPAN on OEMV releases. SPAN3.620 is available to all customers within a post-contractual support (PCS) period.

Version 7 of this manual includes the PASHR log on *page 122*. This log provides the inertial attitude in NMEA format.

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.



Figure 1: SPAN System Receiver



Figure 2: SPAN System IMUs

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

The SPAN system consists of the following components:

- NovAtel ProPak-V3 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 (not available with SPAN) 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 21* and *Table 17, IMU Type on page 82*.
- PC Software - Real-time data collection, status monitoring and receiver configuration is possible through NovAtel's Control and Display Unit (**CDU**) software utility, see *Section 3.1 on page 33*.

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 GPS/INS

GPS positioning observes range measurements from orbiting Global Positioning System Satellites. From these observations, the receiver can compute position and velocity with high accuracy. NovAtel GPS positioning systems have been established as highly accurate positioning tools, however GPS in general has some significant restrictions, which limit its usefulness in some situations. GPS positioning requires line of site view to at least four satellites simultaneously. If these criteria are met, differential GPS 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 GPS 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 of 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 GPS/INS solution integrates the raw inertial measurements with all available GPS information to provide the optimum solution possible in any situation. By using the high accuracy GPS solution, the IMU errors can be modeled and mitigated. Conversely, the continuity and relative accuracy of the INS solution enables faster GPS 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 GPS-only solution is impossible)

- Provide faster signal reacquisition and RTK solution resolution (over stand-alone GPS because of the tightly integrated GPS 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 96*
- Use raw phase observation data (to constrain INS solution drift even when too few satellites are available for a full GPS 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	V3RT2i
IMU-LN200	200 Hz	LN-200 200 and 400 Hz models	V3RT2j
IMU-FSAS-EI	200 Hz	iIMU-FSAS	V3RT2j

Each model is capable of multiple positioning modes of operation. For a discussion on GPS 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/s¹
- 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 the *Configure CAN for SPAN* application note available on our Web site at <http://www.novatel.com/support/applicationnotes.htm> as APN-046.
- 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

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

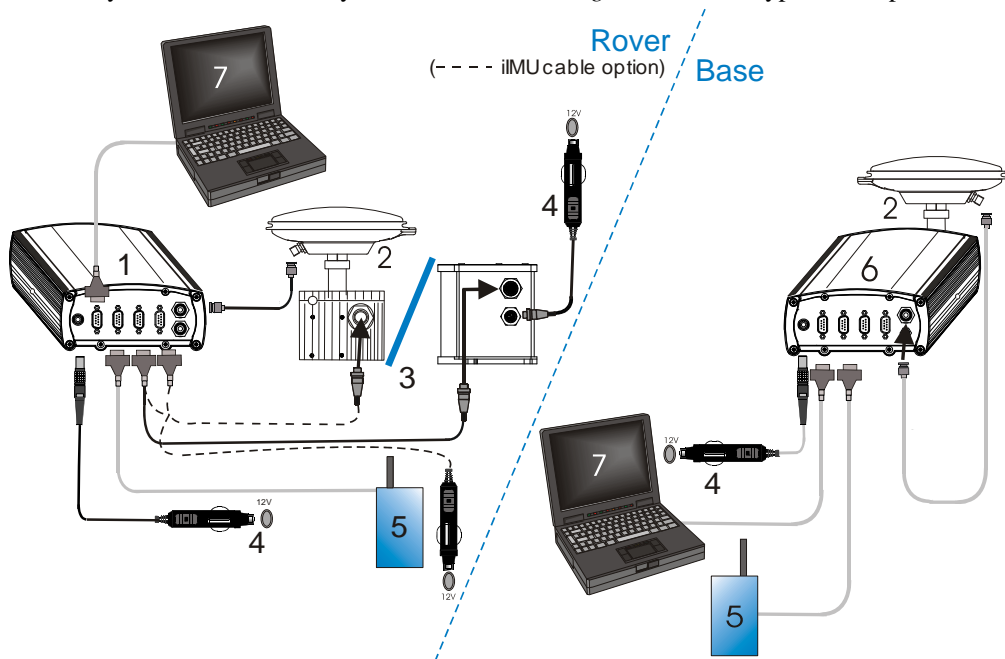
features is a special authorization code. Refer to the *OEMV Family Installation and Operation User Manual* for further details on this topic.

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 47* for details.

2.1 Hardware Description

The hardware setup consists of an OEMV receiver (see *Figure 1 on page 19*), an IMU (see *Figure 2 on page 19*), a GPS antenna, power and a radio link (if your application requires real time differential operation). If your IMU enclosure and IMU have come separately, additional installation instructions for installing the IMU can be found in *Appendix E, HG1700 IMU Installation* starting on *page 135* or *Appendix F, LN-200 IMU Installation* starting on *page 140*.

Your SPAN system receiver is ready for data collection. *Figure 3* shows a typical set-up.



Reference	Description
1	A ProPak-V3 receiver connected to a laptop for data storage
2	User-supplied NovAtel GPS antenna
3	LN-200, HG1700, or iIMU-FSAS IMU and IMU interface cable to the port labelled AUX on the Propak-V3. With the iIMU, you must also plug in the interface cable to the ProPak's I/O port and to power.
4	User-supplied power supply ProPak-V3 SPAN (1): +9 to +18 V DC ProPak-V3 base (6): +9 to +18 V DC Separate supply for IMU (3): see <i>Table 3 on page 27</i>
5	User-supplied radio device to COM2
6	User-supplied base station OEMV Family receiver
7	User-supplied PC, for setting up and monitoring, to COM1

Figure 3: Basic Set-Up

The sections that follows outline how to set up the system's parts and cables. See *Appendix A Technical Specifications* starting on page 47, 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 **CDU**. USB is required if you have a post-processing application requiring 200 Hz IMU data. We also recommend you use **CDU** to collect the data.
-

2.1.1 SPAN System Receivers

Data storage, when using a ProPak-V3, is done using a laptop computer connected to the receiver through either the serial or USB ports.

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 Cables and Ports

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 that are 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 you are using 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

WARNING: 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*.

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 28*.

2.2.2 Mount IMU

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

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

Also, it is important to measure the distance from the IMU to the antenna (the Antenna Lever Arm), on the first usage, on the axis defined on the IMU enclosure. See *Section 3.3.4, Lever Arm Calibration Routine* starting on *page 42*. See also *Appendix A, Technical Specifications* starting on *page 47* 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 28*. The HG1700 and LN-200 plug directly from the ProPak-V3 to the IMU and have a separate connector, and cable, for power. 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 26*.

-
- ☒ 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.
-

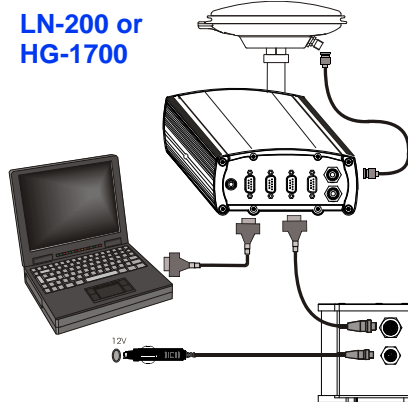
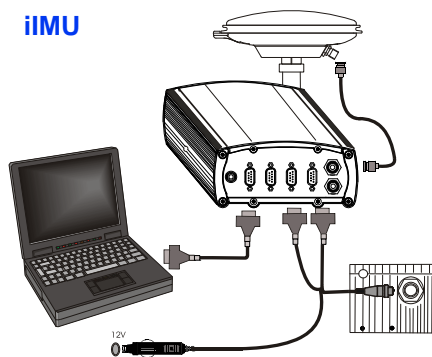
2.2.3 Connect COM Cables

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*).

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



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

2.2.4 Connect Power

The SPAN system receiver requires an input supply voltage between +12 VDC and +18 VDC. 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.

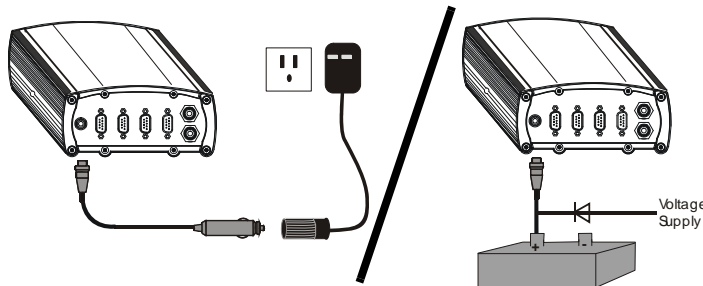
Each IMU requires its own power supply, see *Table 3* below.

Table 3: IMU Power Supply

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

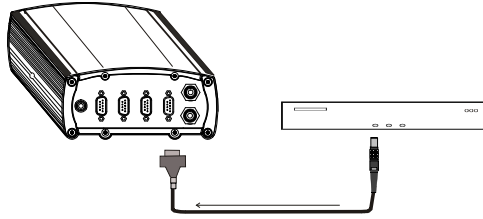
For pin-out information on the power connector on the ProPak-V3, refer to the *OEMV Family Installation and Operation User Manual*. Details on the LN-200 power port and cables can be found in *Section A.1, LN-200 IMU* starting on page 47.

- 5. 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 CDU* on page 29 to see the alternate method using NovAtel's Control and Display Unit (CDU) 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 69.
2. Issue the **SETIMUTYPE** command to specify the type of IMU being used, see *Table 4* below and the **SETIMUTYPE** command on page 81.

Table 4: Enable INS Commands

IMU Type	INTERFACEMODE Command	SETIMUTYPE Command
LN-200	interfacemode com3 imu imu off	setimutype imu_ln200
iIMU-FSAS	interfacemode com3 imarimu imarimu off	setimutype imu_imar_fsas ^a
HG1700	interfacemode com3 imu imu off	setimutype imu_hg1700_ag11, or setimutype imu_hg1700_ag17, or setimutype imu_hg1700_ag58, or setimutype imu_hg1700_ag62

- a. The iIMU-FSAS IMU requires that COM3, labelled as AUX on the ProPak-V3, be in RS-422 mode. COM3 is factory-configurable for RS-232 or RS-422 mode.

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

- ☒ 1. A GPS 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 80*.

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.

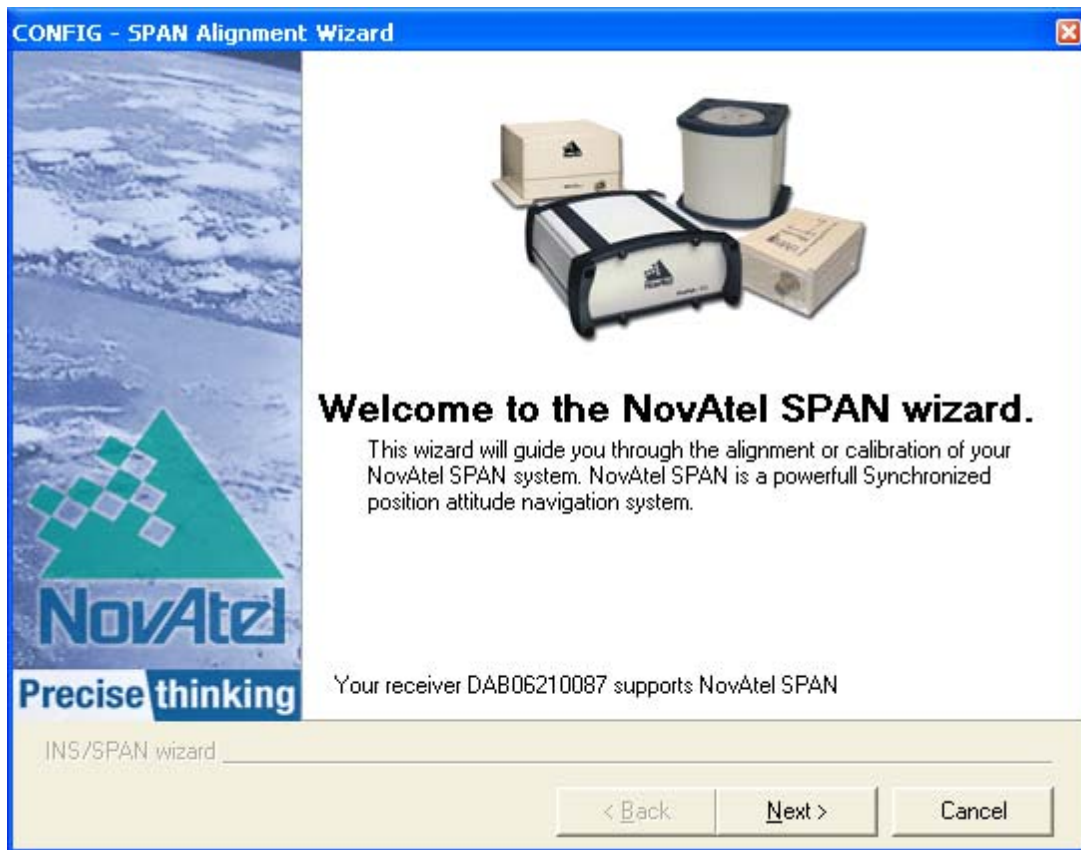
If it is impossible to measure the IMU to GPS antenna offset precisely, the offset can be estimated by carrying out the Lever Arm Calibration Routine. See *Section 3.3.4, Lever Arm Calibration Routine* on *page 42*.

2.3.2.2 SPAN Configuration with CDU

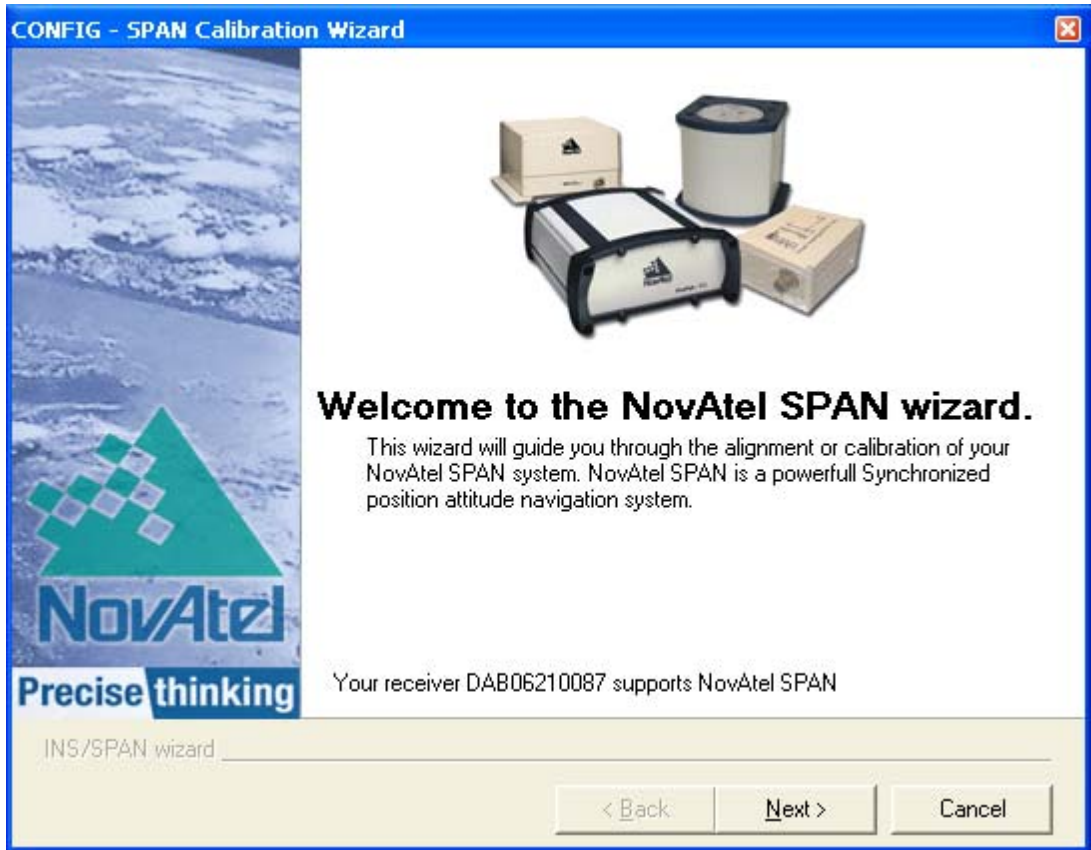
Follow these steps to enable INS as part of the SPAN system using the NovAtel **CDU** software utility:

- ☒ The **CDU** screen shots in this manual are from **CDU** Version 3.3.0.3 and may differ from your **CDU** version.
-

1. **SPAN basic configuration:** Select *Tools / SPAN Alignment Wizard* from the main menu of **CDU**. 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:



2. **Optional SPAN calibration:** Select *Tools / SPAN Calibration Wizard* from the main menu of **CDU**. The wizard takes you through the steps to calibrate your lever arm and/or vehicle to body rotation, as well as select the type of IMU and configure the receiver port connected to the IMU and to accept data:



- ☒ You need only run the Calibration Wizard if you need to calibrate the lever arm or vehicle to frame angular offsets. It is not required for the SPAN filter to run.

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 39 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 28* and the INTERFACEMODE command on *page 69*.

```
interfacemode com3 imu imu off
```

2. **Issue the SETIMUTYPE command** to specify the type of IMU being used, see *Table 4* on *page 28* and the SETIMUTYPE command on *page 81*.

```
setimutype imu_ln200
```

3. **Issue the SETIMUTOANTOFFSET command** to enter the distance from the IMU to the GPS antenna, see *page 80*.

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


Before operating your SPAN system, ensure that you have followed the installation and setup instructions in *Chapter 2, SPAN Installation* starting on page 23.

You can use NovAtel's CDU 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.

WARNING: 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

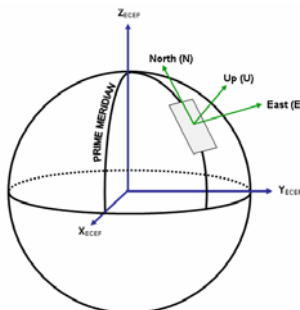


Figure 5: Local-Level Frame (ENU)

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 16 on page 79*. 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 center, but the Center of Navigation (sensor center).

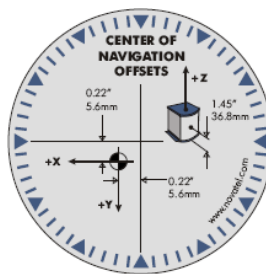


Figure 6: The Enclosure Frame

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 91* for information on entering the rotation into the system and see the *RVBCALIBRATE Vehicle to Body Rotation Control on page 76* for information on calculating this rotation.

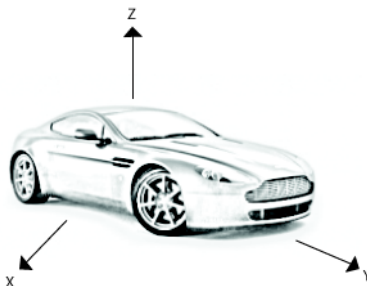


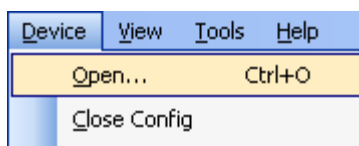
Figure 7: Vehicle Frame

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 (**CDU** and *Convert*). 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 **CDU** Help file for more details on **CDU**. The Help file is accessed by choosing *Help* from the main menu in **CDU**.




Start **CDU** on your PC to enable communication:

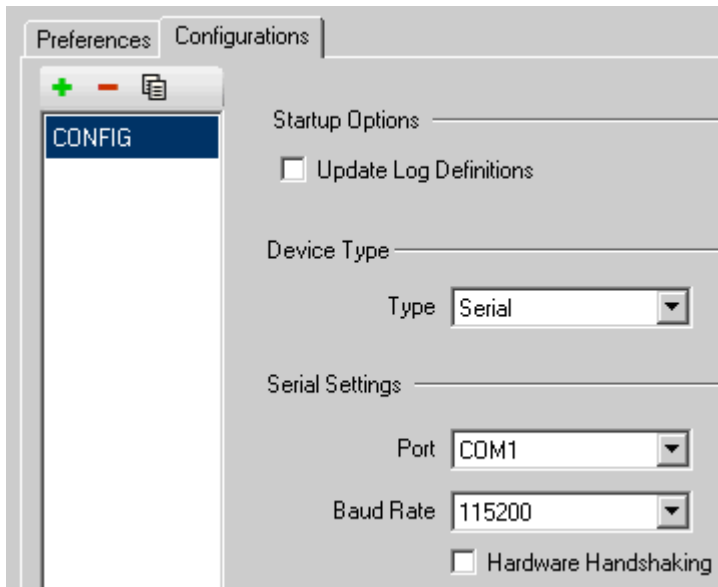
1. Launch **CDU** from the *Start* menu folder specified during the installation process. The default location is *Start | Programs | NovAtel OEMV | NovAtel CDU*.
2. Select *Open....* from the *Device* menu.



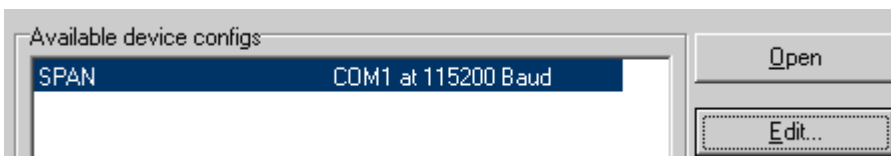
3. Select the *New...* button in the *Open* dialog box. The *Options / Configuration* dialog opens.



- Use the  button at the top of the configurations selection box to add a new configuration. To delete a configuration, select it from the list and click on the  button. To duplicate an existing configuration, click on the  button. You can select any name in the list and edit it to change it.



- 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.
- Select *115200* from the *Baud Rate* list.
- Uncheck the *Use hardware handshaking* checkbox.
- Select *OK* to save the new device settings.
- Select the new configuration from the *Available device configs* area of the *Open* dialog.
- Select the *Open* button to open SPAN receiver communications.




- As **CDU** establishes the communication session with the receiver, a progress box is displayed.
- Select *Tools / Logging Control Window* from the **CDU** main menu to control the receiver's logging to files and serial ports. Refer to **CDU**'s on-line Help for more information.
- Use the *Console* window to enter commands; *Section 3.4, Data Collection for Post Processing* on page 45.

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

3.2.1 INS Window in CDU

CDU 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 **CDU** is described below. Please refer to the *OEMV Family Installation and Operation User Manual* for more details on **CDU** 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 **CDU**'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.



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_NOTGOOD	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 146

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 123*. 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_NOTGOOD.

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 40*).

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.

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 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 91*. 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 43*.

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 (~ 4 km/h) m/s is observed. During kinematic alignment, keep the vehicle roll at less than 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

Manually enter the attitude information using the SETINITATTITUDE, or SETINITAZIMUTH, commands. Details of these commands start on *page 83*.

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 (ZUPs) 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 41*:

Table 6: Solution Parameters

Parameter	Log
Position	INSPOS or INSSPOSS 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 OMNIHPOS. 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.

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

Specific logs need to be collected for post-processing. See *Section 3.4, Data Collection for Post Processing* on *page 45*.

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.



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 123*.
 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 129* for details on this log.
-

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 80*. 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 47*.
2. Configure the RTK corrections and make sure that the BESTGPSPOS log, see *page 97*, reports a good RTK solution.
3. Configure the IMU, see *Section 2.3.2, SPAN IMU Configuration on page 28*.

4. Set the orientation of your installed IMU using the SETIMUORIENTATION command, see *page 77*.
5. Enter the initial estimate for the lever arm using the SETIMUTOANTOFFSET command, see *page 80*.
6. Specify the limits of the calibration through the LEVERARMCALIBRATE command, see *page 73*. 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 104*, 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 38*.
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 IMU 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 91*. 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 47*.
2. Configure the IMU, see *Section 2.3.2, SPAN IMU Configuration on page 28*.
3. Ensure that an accurate lever arm has been entered into the system either manually or through a lever arm calibration, see *page 42*.
4. Allow the system to complete a coarse alignment, see *page 39*.
5. Enable the vehicle to body calibration using the RVBCALIBRATE ENABLE command, see *page 76*.
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 130*, 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 39* for details on coarse and fast alignment.

WARNING: 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 39*). The angular offset values are not applied to the attitude output, unless the APPLYVEHICLEBODYROTATION command is enabled, see *page 65*.
-

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 28*. 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 56* 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 93*.

-
- ☒ 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 on *Using a Wheel Sensor with SPAN*, NovAtel part number APN-036 (available on our Web site at <http://www.novatel.com/support/applicationnotes.htm>).
-

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 129*. 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 131*. Information on how the wheel sensor updates are being used is available in the INSUPDATE log, see *page 117*.

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.2.2, iIMU-FSAS Odometer Cabling on page 56*.

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

```
log timedwheeldata onnew
```

Set parameters for your installation using the SETWHEELPARAMETERS command, see *page 90*.

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 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 LN-200 IMU

Table 7: 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	
----------------------------	--

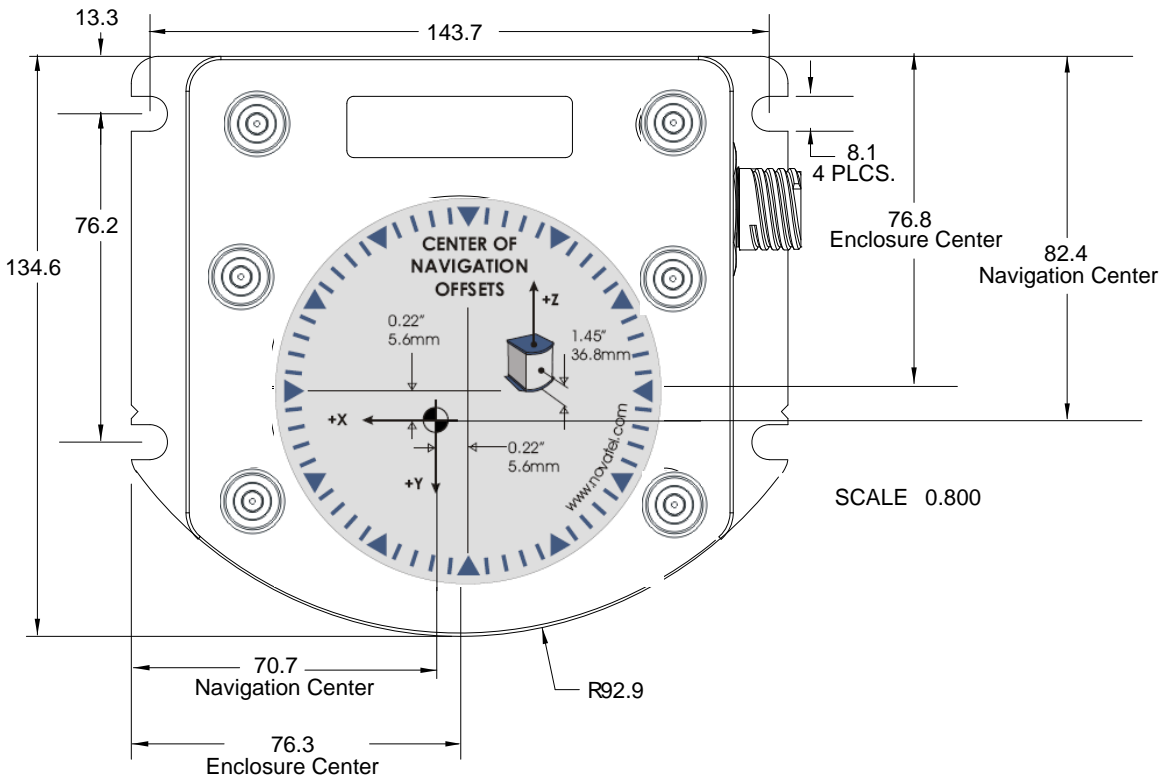


Figure 8: LN-200 IMU Enclosure Top/Bottom Dimensions and Centre of Navigation

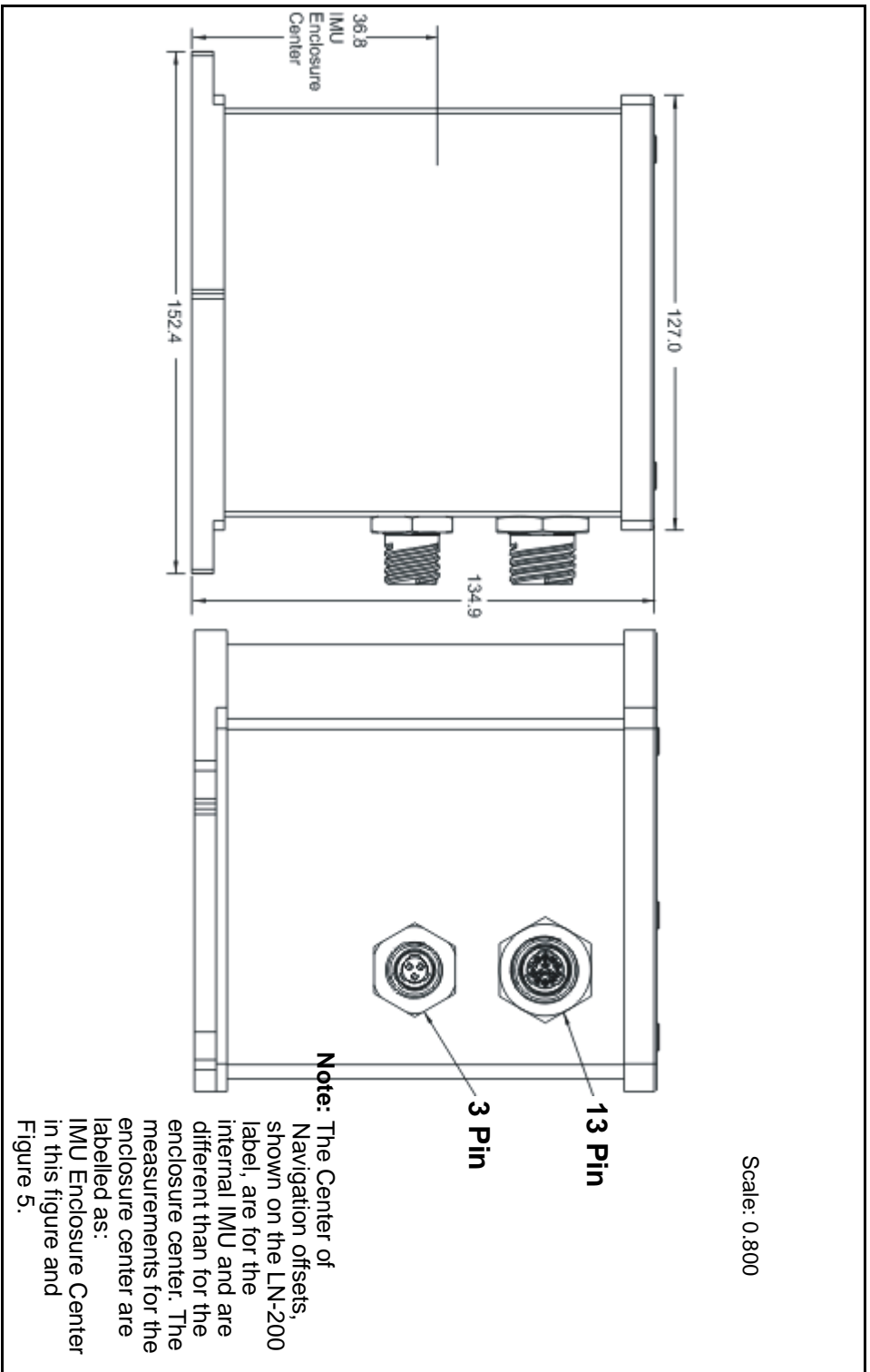


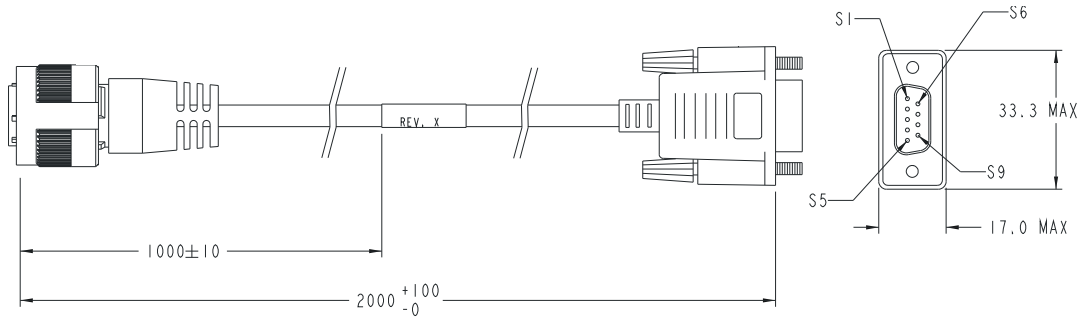
Figure 9: LN-200 Enclosure Side Dimensions

A.1.1 LN-200 IMU Interface Cable

The NovAtel part number for the LN-200 IMU interface cable is 01017375 (Figures 10 and 11 below). The IMU interface cable supplied enables input and output between the IMU and the receiver.



Figure 10: LN-200 Interface Cable



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 11: IMU Interface Cable Pin-Out (ProPak-V3)

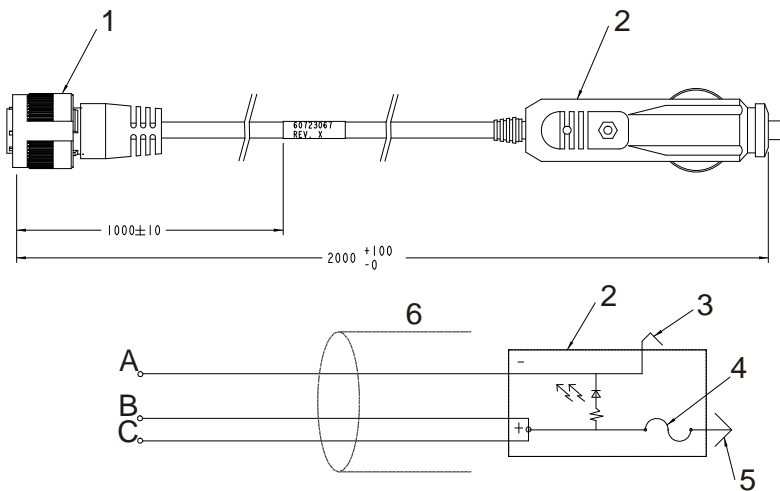
A.1.2 LN-200 IMU Power Adapter Cable

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 12* shows the cable and *Figure 13* 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 12: LN-200 Power Cable



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	Center contact		
6	Foil shield		

Figure 13: IMU Power Cable Pin-Out

A.1.3 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.1.4 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)
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	

- a. For replacement connectors on the interface or power cables, see *Section H.3, Manufacturer's Part Numbers* on page 147.

A.2 iIMU-FSAS

Table 8: 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	

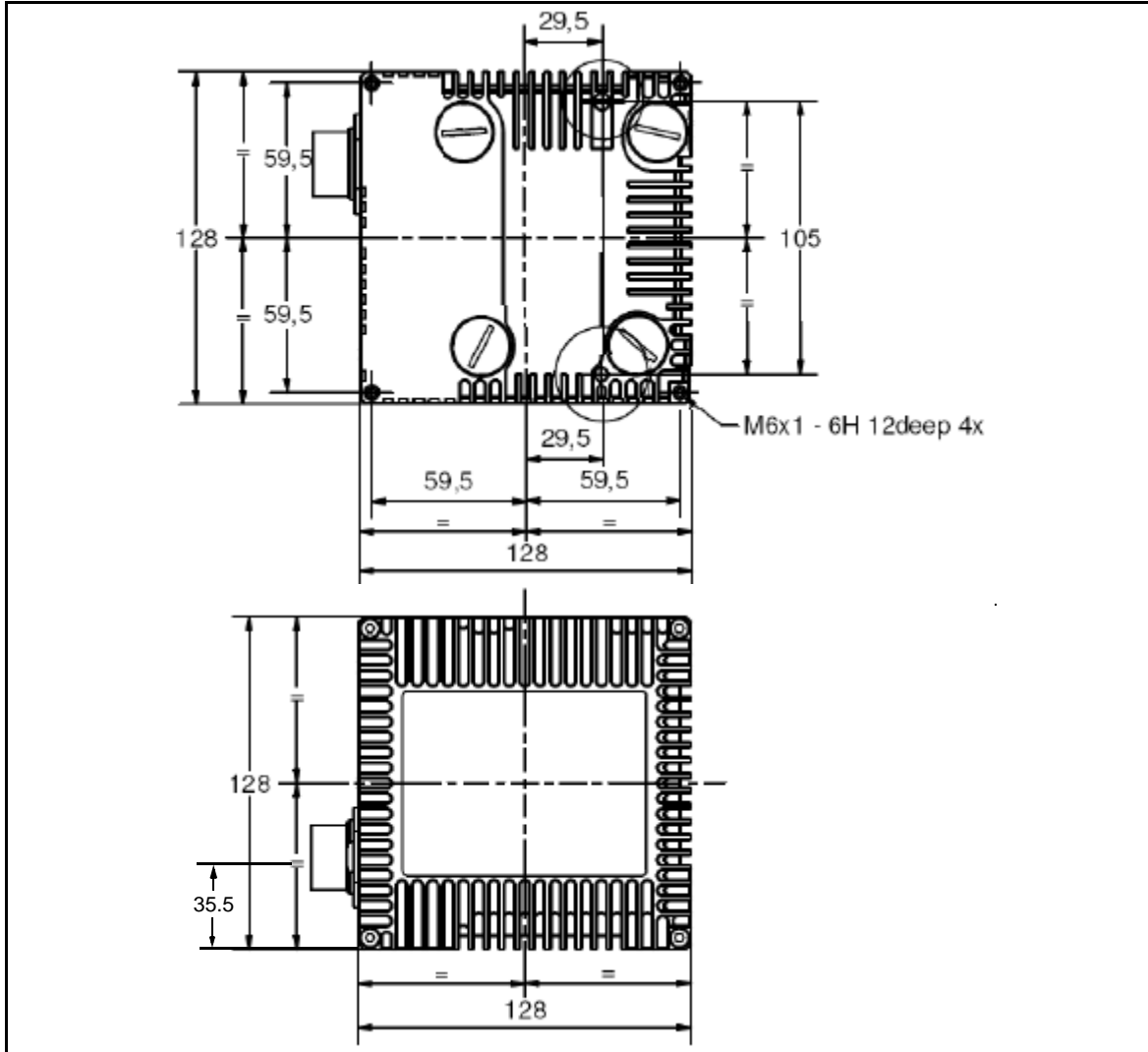


Figure 14: iIMU-FSAS Top/Bottom Dimensions

- a. See *Figure 16* on *page 54* for the centre of navigation dimensions
- b. Dimensions are in mm.

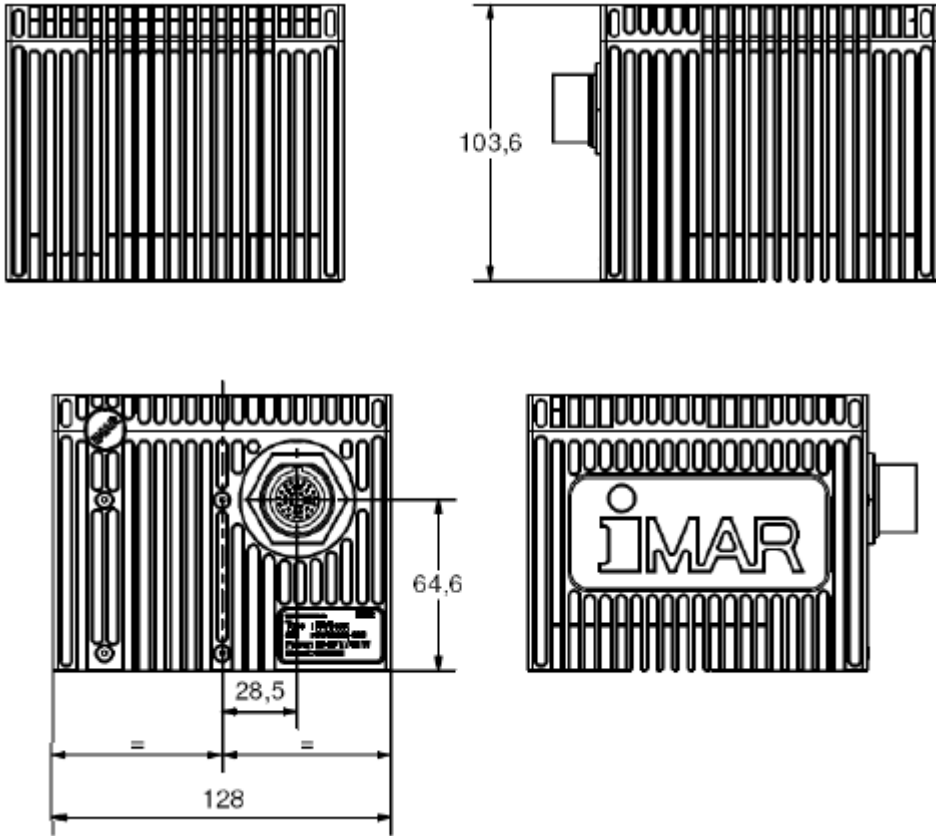


Figure 15: iIMU-FSAS Enclosure Side Dimensions

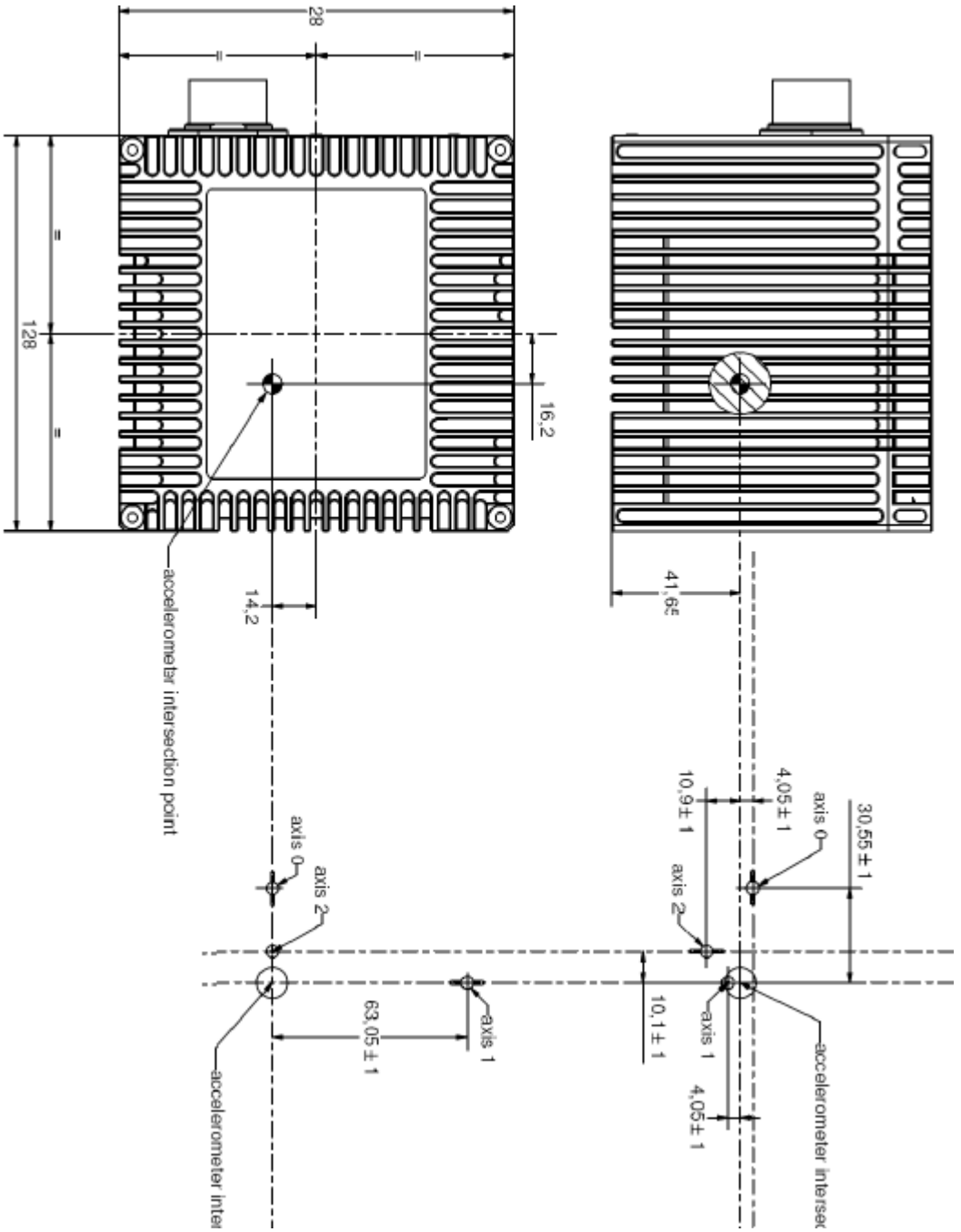


Figure 16: iIMU-FSAS Centre of Navigation

A.2.1 iIMU-FSAS Interface Cable

The NovAtel part number for the 1 m iIMU-FSAS interface cable is 60723086 for the ProPak-V3 (see Table 9 below and Figure 19, iIMU-FSAS Interface Cable on page 58). See also Section A.2.2, iIMU-FSAS Odometer Cabling on page 56 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 9: 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 (LVTTTL 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 page 56

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.2.2 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 18* 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 17* on page 57.



Figure 17: 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 NovAtel IMU interface cable, with ODO, is the same as that in *Section A.2.1* 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 44.

-
- ☒ 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 10* on page 58.

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



-
- ☒ 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 18: 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.

Table 10: 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 19: iIMU-FSAS Interface Cable

A.2.3 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.2.4 Electrical and Environmental

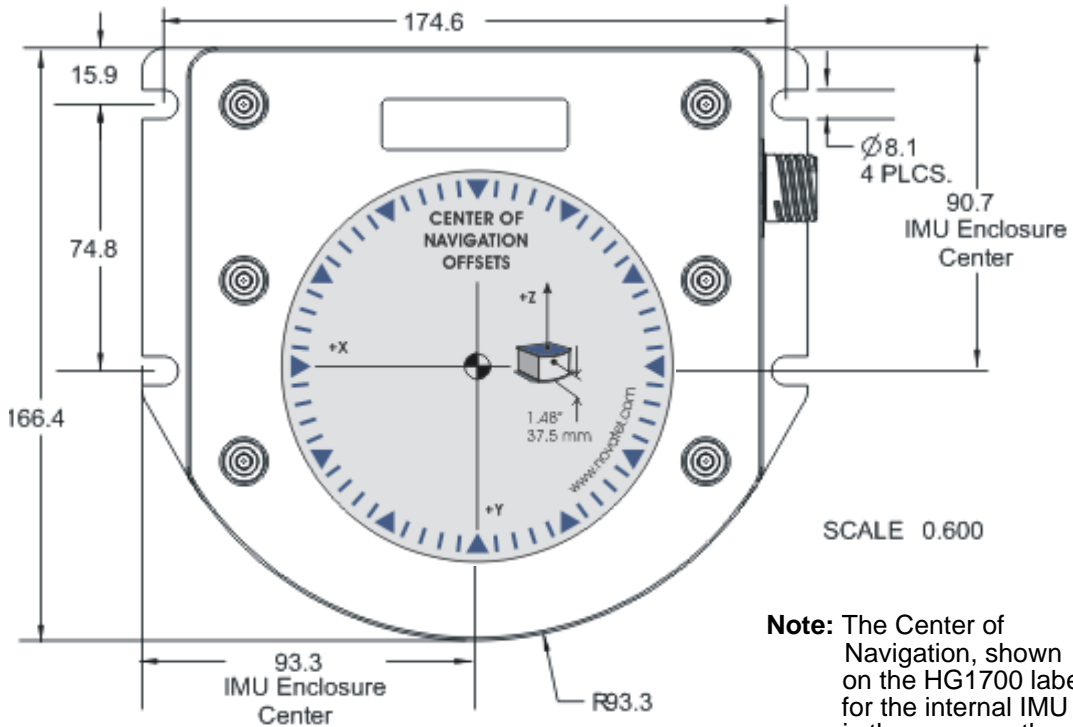
ELECTRICAL		
IMU Power Consumption	16 W (max)	
IMU Input Voltage	+10 to +34 V DC	
Receiver Power Consumption	ProPak-V3	2.8 W (typical)
System Power Consumption	ProPak-V3	14.8 W (typical)
Data Connector	MIL-C-38999-III	
Power Connector	MIL-C-38999-III (same as data connector)	
IMU Interface	RS-422	
ENVIRONMENTAL (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.3 HG1700 IMU

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 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 20: HG1700 Top/Bottom Dimensions

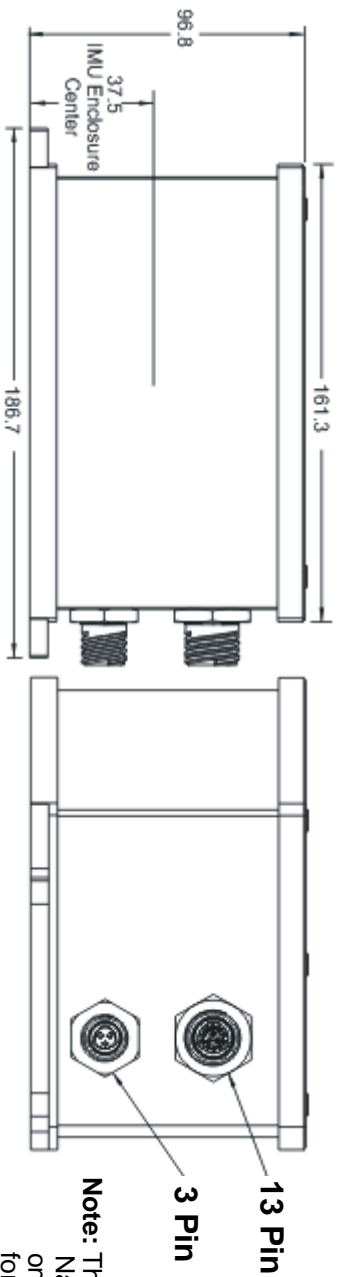


Figure 21: HG1700 Enclosure Side Dimensions

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.

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 10* on *page 49*.

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

- a. For replacement connectors on the interface and power cables, see *Section H.3, Manufacturer's Part Numbers* on page 147.

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.
-

WARNING: Ensure that all windows, other than the Console, are closed in **CDU** 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 91*). 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 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 <i>Table 12</i>		What data is to be reset by the receiver.	Enum	4	H

Input Example:

FRESET COMMAND

Table 12: 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.2.3 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 39

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.2.4 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.2.5 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 28*.

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 <i>Table 14, COM Serial Port Identifiers</i> , on <i>page 71</i>		Serial port identifier (default = THISPORT)	Enum	4	H
3	rxtype	See <i>Table 13, Serial Port Interface Modes</i> , on <i>page 70</i>		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 13: 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 14: 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.2.6 *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.

WARNING: This command should only be used by advanced users of GPS/INS.

Abbreviated ASCII Syntax:
INSZUPT

Message ID: 382

B.2.7 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.2.11, SETIMUTOANTOFFSET Set IMU to Antenna Offset* starting on page 80 and *Section 3.3.4, Lever Arm Calibration Routine* starting on page 42.

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 page 104.

-
- ☒ 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.2.8 NMEATALKER Set the NMEA talker ID V123

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 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 15* shows the NMEA logs and whether they use GP or GP + IN IDs with `nmeatalker auto`.
-

Table 15: 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.2.9 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.

WARNING: 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 130*. 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 39*). 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.2.10 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 39*.

WARNING: Ensure that all windows, other than the Console, are closed in **CDU** 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 16 on page 79*. 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:

$X \Rightarrow Z, Y \Rightarrow X, Z \Rightarrow Y$ (where the default is $X \Rightarrow X, Y \Rightarrow Y, Z \Rightarrow Z$)

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 47*. The example from the LN-200 is shown in *Figure 22*.

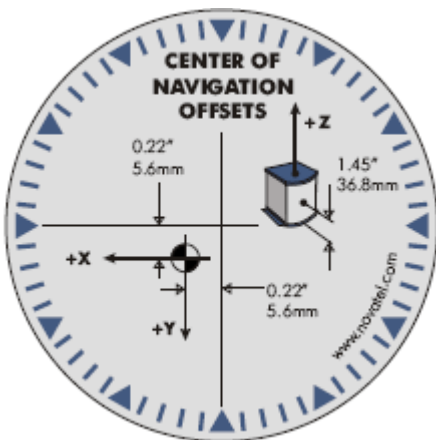


Figure 22: Frame of Reference

- ☒ 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:
SETIMUORIENTATION switch

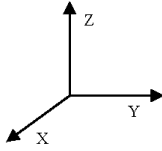
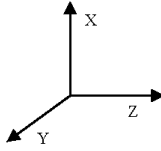
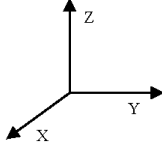
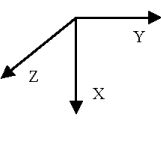
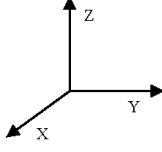
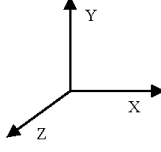
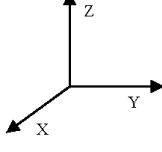
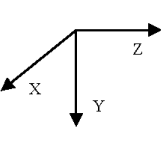
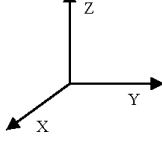
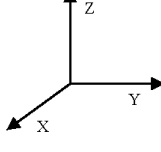
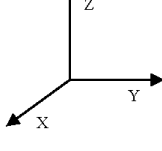
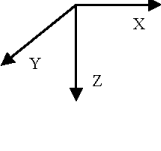
Message ID: 567

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 16: 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.2.11 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 center in the IMU enclosure frame. The a, b and c fields allow you to enter any possible errors in your measurements. If you think that your 'x' offset measurement is out by a centimeter for example, enter 0.01 in the 'a' field.

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

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

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.2.12 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.

WARNING: Ensure that all windows, other than the Console, are closed in **CDU** 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 17, IMU Type, on page 82		IMU Type	ENUM	4	H

Table 17: 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
5-7	Reserved	
8	IMU_LN200	Litton LN-200 (200 Hz model)
9	IMU_LN200_400HZ	Litton LN-200 (400 Hz model)
10	IMU_IMAR_FSAS	iMAR iIMU-FSAS
11	IMU_HG1700_AG58	Honeywell HG1700 AG58
12	IMU_HG1700_AG62	Honeywell HG1700 AG62

Abbreviated ASCII Example:

```
SETIMUTYPE IMU_IMAR_FSAS
```

B.2.13 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 77*, unless you have your IMU mounted with the z axis not pointing up. Then use the tables in the SETIMUORIENTATION command, on *pages 78-79*, to determine the azimuth axis that SPAN is using.
-

Abbreviated ASCII Syntax:

SETINITATTITUDE pitch roll azimuth pitchSTD rollSTD azSTD

Message ID: 862

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 85*), also with a 5 degrees standard deviation.

B.2.14 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 77*, 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 77*, unless you have your IMU mounted with the z axis not pointing up. Then, use the tables in the SETIMUORIENTATION command, on *pages 78-79*, to determine the azimuth axis that SPAN is using.
-

Abbreviated ASCII Syntax:

SETINITAZIMUTH azimuth azSTD

Message ID: 863

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 ^{oa} 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.2.15 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:

SETINSOFFSET xoffset yoffset zoffset

Message ID: 676

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.2.16 SETMARK1OFFSET Set Mark1 Offset

Set the offset to the Mark1 trigger event.

Abbreviated ASCII Syntax:

Message ID: 1069

SETMARK1OFFSET xoffset yoffset zoffset α offset β offset γ offset

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	α offset	± 360		Roll offset for Mark1 (degrees)	Double	8	H+24
6	β offset	± 360		Pitch offset for Mark1 (degrees)	Double	8	H+32
7	γ offset	± 360		Azimuth offset for Mark1 (degrees)	Double	8	H+40

Abbreviated ASCII Example:

SETMARK1OFFSET -0.324 0.106 1.325 0 0 0

B.2.17 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 Service. Contact information is on page 15.

Abbreviated ASCII Syntax:

Message ID: 1070

SETMARK2OFFSET xoffset yoffset zoffset α offset β offset γ offset

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	α offset	± 360		Roll offset for Mark2 (degrees)	Double	8	H+24
6	β offset	± 360		Pitch offset for Mark2 (degrees)	Double	8	H+32
7	γ offset	± 360		Azimuth offset for Mark2 (degrees)	Double	8	H+40

Abbreviated ASCII Example:

SETMARK2OFFSET -0.324 0.106 1.325 0 0 0

B.2.18 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.2.19 VEHICLEBODYROTATION Vehicle to SPAN frame Rotation

Use the VEHICLEBODYROTATION command to set angular offsets between the vehicle frame (direction of travel) and the SPAN body frame (direction that the IMU computational frame is pointing). If you estimate the angular offsets using the RVBCALIBRATE command, the VEHICLEBODYROTATION command values are used as the initial values. The uncertainty values are optional (defaults = 0.0). Please see *Section 3.3.5, Vehicle to SPAN frame Angular Offsets Calibration Routine* starting on page 43 for more details. For more information on reference frames, see *Section 3.1, Definition of Reference Frames Within SPAN* starting on page 33. RVBCALIBRATE command information is on page 76.

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

Enter rotation angles in degrees.

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 65.

Abbreviated ASCII Syntax:VEHICLEBODYROTATION alpha beta gamma [δ alpha] [δ beta] [δ gamma]**Message ID: 642****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 on *Vehicle to Body Rotations*, NovAtel part number APN-037 (available on our Web site at <http://www.novatel.com/support/applicationnotes.htm>).

Abbreviated ASCII Example:

VEHICLEBODYROTATION 0 0 90 0 0 5

B.2.20 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
9	ticks/s			Cumulative number of ticks/s	Ulong	4	H+20

Refer also to our application note on *Using a Wheel Sensor with SPAN*, NovAtel part number APN-036 (available on our Web site at <http://www.novatel.com/support/applicationnotes.htm>).

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 = $(10 \text{ m/s}) \cdot (8 \text{ ticks/rev}) / (2 \text{ m/rev}) = 40$
 Latency between 1PPS and measurement from wheel sensor hardware = 123 ms

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

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, INSSOSSH, 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 95.
 - 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 38 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 18 and 19*). For the message header structure of OEMV-3 regular Binary and ASCII logs, please refer to the *OEMV Family Firmware Reference Manual*.

Table 18: 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 19: 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

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 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 123*.
 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 129* for details on this log.
-
-

- 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.2.1 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, pseudorange 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*.

Structure:

Message ID: 423

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 <i>Table 21, Solution Status on page 101</i>	Enum	4	H
3	Pos Type	Position type, see <i>Table 20, Position or Velocity Type on page 99</i>	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 <i>OEMV Family Firmware Reference Manual</i>)	Enum	4	H+36
9	Lat σ	Latitude standard deviation	Float	4	H+40
10	Lon σ	Longitude standard deviation	Float	4	H+44
11	Hgt σ	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	#GPSL1	Number of GPS L1 ranges used in computation	Uchar	1	H+65
17	#L1	Number of GPS L1 ranges above the RTK mask angle	Uchar	1	H+66
18	#L2	Number of GPS L2 ranges above the RTK mask angle	Uchar	1	H+67

Continued on page 98

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
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 20: Position or Velocity Type

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

Continued on page 100

Position Type (binary)	Position Type (ASCII)	Description
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 ^b
53	INS_PSRSP	INS pseudorange single point solution - no DGPS corrections ^b
54	INS_PSRDIFF	INS pseudorange differential solution ^b
55	INS_RTKFLOAT	INS RTK floating point ambiguities solution ^b
56	INS_RTKFIXED	INS RTK fixed ambiguities solution ^b
57	INS_OMNISTAR	INS OmniSTAR VBS position (L1 sub-meter) ^a
58	INS_OMNISTAR_HP	INS OmniSTAR high precision solution ^a
59	INS_OMNISTAR_XP	INS OmniSTAR extra precision solution ^a
64	OMNISTAR_HP	OmniSTAR high precision ^a
65	OMNISTAR_XP	OmniSTAR extra precision ^a
66	CDGPS	Position solution using CDGPS corrections ^a

- 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. Please refer to your *OEMV Family Firmware Reference Manual*.

Table 21: 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	Reserved	
13	INTEGRITY_WARNING	Large residuals make position unreliable
14	INS_INACTIVE	INS has not started yet
15	INS_ALIGNING	INS doing its coarse alignment
16	INS_BAD	INS position is bad
17	IMU_UNPLUGGED	No IMU detected
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.

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 <i>Table 21, Solution Status on page 101</i>	Enum	4	H
3	Vel Type	Velocity type, see <i>Table 20, Position or Velocity Type on page 99</i>	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 and the GPS antenna in the IMU enclosure frame and its associated uncertainties. If you enter the lever arm through the SETIMUTOANTOFFSET command, see *page 80*, these values are reflected in this log. When the lever arm calibration is complete, see the LEVERARMCALIBRATE command on *page 73*, the solved values are also output in this log.

The default X (pitch), Y (roll) and Z (azimuth) directions of the inertial frame are clearly marked on the IMU, see *Figure 22 on page 77*.

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 <i>Table 16, Full Mapping Definitions</i> on <i>page 79</i>	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 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 25* and *Section 2.3.2, SPAN IMU Configuration* starting on *page 28* 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 <i>Table 5 on page 38</i>	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,COM3,0,0.0,EXACT,1105,425385.000,00040000,0638,0;
1105,425384.996167250,4.822147742,0.035766158,123.262113519,
INSSolutionGood*3563a760
```

The structure of the INSATT log is different in this firmware version (1.3) than in any earlier beta versions. This is because the order of the roll and pitch fields have been reversed.

C.2.5 INSATTS Short INS Attitude

This is a short header version of the *INSATT* log on *page 105*.

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 <i>Table 5</i> on <i>page 38</i> .	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
```

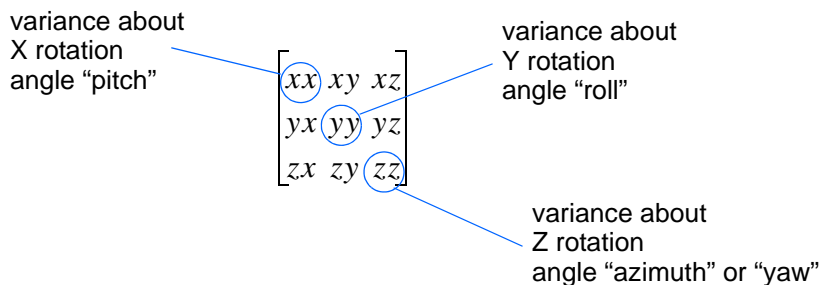
ASCII Example:

```
%INSATTSA,1105,425385.000;  
1105,425384.996167250,4.822147742,0.035766158,123.262113519,  
INSSolutionGood*3563a760
```

-
- The structure of the INSATTS log is different in this firmware version (1.3) than in any earlier beta versions. This is because the order of the roll and pitch fields have been reversed.
-

C.2.6 INSCOV INS Covariance Matrices

The position, attitude, and velocity matrices in this log each contain 9 covariance values, with respect to the SPAN frame axis, 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 39.

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.2.7 INSCOVS Short INS Covariance Log

This is a short header version of the *INCOV* log on page 107. These values are also computed once per second.

Structure:

Message ID: 320

Log Type: Async

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 in local level frame. (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.2.8 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 87*.

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)	Double	8	H+28
7	Status	INS status, see <i>Table 5 on page 38</i>	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,COM3,0,0.0,EXACT,1105,425385.000,00040000,323a,0;  
1105,425384.996167250,51.058410364,-114.065465722,  
1067.791685696,INSSolutionGood*9bfd5a12
```

C.2.9 INSPOSS Short INS Position

This is a short header version of the *INSPOS* log on page 110.

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)	Double	8	H+28
7	Status	INS status, see <i>Table 5 on page 38</i>	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,1105,425385.000;
1105,425384.996167250,51.058410364,-114.065465722,
1067.791685696,INSSolutionGood*9bfd5a12
```

C.2.10 INSPOSSYNC Time Synchronised INS Position

This log contains the time synchronised 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 <i>OEMV Family Firmware Reference Manual</i> .	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 unchanged

ASCII Example:

```
#INSPOSSYNCA,COM1,0,47.5,FINESTEERING,1332,484154.042,00000000,c98c,34492;  
484154.00000000,-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.2.11 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 105*, for an explanation of how the SPAN frame may differ from the IMU enclosure frame.

Structure:

Message ID: 507

Log Type: Synchron

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)	Double	8	H+28
7	North Velocity	Velocity in a northerly direction (a -ve value implies a southerly direction)	Double	8	H+36
8	East Velocity	Velocity in an easterly direction (a -ve value implies a westerly direction)	Double	8	H+44
9	Up Velocity	Velocity in an up direction	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 <i>Table 5 on page 38</i>	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.2.12 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 105*, 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)	Double	8	H+28
7	North Velocity	Velocity in a northerly direction (a -ve value implies a southerly direction)	Double	8	H+36
8	East Velocity	Velocity in an easterly direction (a -ve value implies a westerly direction)	Double	8	H+44
9	Up Velocity	Velocity in an up direction	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 <i>Table 5 on page 38</i>	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.2.13 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 <i>Table 5 on page 38</i>	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,COM3,0,0.0,EXACT,1105,425385.000,00040000,efce,0;
1105,425384.996167250,223.766800423,0.019769837,
-0.024795257,INSSolutionGood*15b864f4
```

C.2.14 INSSPDS Short INS Speed

This is a short header version of the *INSSPD* log on page 115.

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 <i>Table 5 on page 38</i>	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,1105,425385.000;  
1105,425384.996167250,223.766800423,0.019769837,  
-0.024795257,INSSolutionGood*15b864f4
```

C.2.15 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 <i>Table 20</i> on <i>page 99</i>	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 <i>Table 22</i> 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_UNSYNCD,0*fb5df08b
```

Table 22: Wheel Status

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

C.2.16 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 <i>Table 5 on page 38</i>	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,COM3,0,0.0,EXACT,1105,425385.000,00040000,7d4a,0;  
1105,425384.996167250,-0.014277009,-0.013675287,  
-0.024795257,INSSolutionGood*2f3fe011
```

C.2.17 *INSVELS* Short *INS* Velocity

This is a short header version of the *INSVEL* log on page 118.

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 <i>Table 5 on page 38</i>	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,1105,425385.000;  
1105,425384.996167250,-0.014277009,-0.013675287,  
-0.024795257,INSSolutionGood*2f3fe011
```

C.2.18 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 <i>Table 5 on page 38</i> 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.2.19 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 iIMU-FSAS users. If you are an iIMU-FSAS user, and wish to use the Mark2 event trigger, contact NovAtel Customer Service. Contact information is on *page 15*.

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 <i>Table 5 on page 38</i> 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.2.20 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.2.21 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 127*.

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 <i>Table 23</i> . For the raw IMU status of the HG1700 and the LN-200 IMUs, see <i>Table 24</i> . 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)	-	-	-

- The change in velocity (acceleration) scale factor for each IMU type can be found in *Table 25 on page 128*. Multiply the scale factor in *Table 25*, by the count in this field, for the velocity increments. See also *Table 1 on page 21* for a list of IMU enclosures.
- 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.
- The change in angle (gyro) scale factor can be found in *Table 25 on page 128*. Multiply the appropriate scale factor in *Table 25*, by the count in this field, for the angle increments in radians.

Table 23: iIMU-FSAS Status

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

Table 24: 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
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	

Nibble Number	Bit #	Mask	HG1700 Description		LN200 Description	
N4	16	0x00010000	Reserved		Reserved	
	17	0x00020000	Reserved		Reserved	
	18	0x00040000	Reserved		Reserved	
	19	0x00080000	Reserved		Reserved	
N5	20	0x00100000	Reserved		Reserved	
	21	0x00200000	Reserved		Reserved	
	22	0x00400000	Reserved		Reserved	
	23	0x00800000	Reserved		Reserved	
N6	24	0x01000000	Reserved		IMU Status	Passed = 0 Failed = 1
	25	0x02000000	Reserved		IMU Status	Passed = 0 Failed = 1
	26	0x04000000	Reserved		IMU Status	Passed = 0 Failed = 1
	27	0x08000000	IMU Status	Passed = 0 Failed = 1	IMU Status	Passed = 0 Failed = 1
N7	28	0x10000000	IMU Status	Passed = 0 Failed = 1	IMU Status	Passed = 0 Failed = 1
	29	0x20000000	IMU Status	Passed = 0 Failed = 1	Reserved	
	30	0x40000000	IMU Status	Passed = 0 Failed = 1	IMU Status	Passed = 0 Failed = 1
	31	0x80000000	IMU Status	Passed = 0 Failed = 1	Reserved	

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.2.22 RAWIMUS Short Raw IMU Data

This is a short header version of the RAWIMU log on page 123.

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 23. For the raw IMU status of the HG1700 and the LN-200 IMUs, see Table 24. 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 25 on page 128. Multiply the scale factor in Table 25, by the count in this field, for the velocity increments in m/s. See also Table 1 on page 21 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 25 on page 128. Multiply the appropriate scale factor in Table 25, 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 25: Raw IMU Scale Factors

IMU Scale	HG1700-AG11 HG1700-AG58	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	0.1×2^{-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

C.2.23 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 44.*

☒ If you are using an iMAR iMWS (Magnetic Wheel Speed Sensor and Converter), 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 69, 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	Ulong	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.2.24 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 77*. 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.2.19, VEHICLEBODYROTATION Vehicle to SPAN frame Rotation* starting on *page 91* for more information.

Recommended Input:

log vehiclebodyrotationa onchanged

ASCII Example:

```
#VEHICLEBODYROTATIONA,COM1,0,36.5,FINESTEERING,1264,144170.094,00000000,bcf2,1541;1.5869999997474209,2.6639999995760122,77.6649999876392343,2.0000000000000000,2.0000000000000000,5.000000000000000*25f886cc
```

C.2.25 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 displays a message 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 files(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 Installation

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), see also *Figure 23* below. 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



Important!: Ensure you use a ground strap before installing the internal circuit boards. Do NOT scratch any surfaces of the unit.

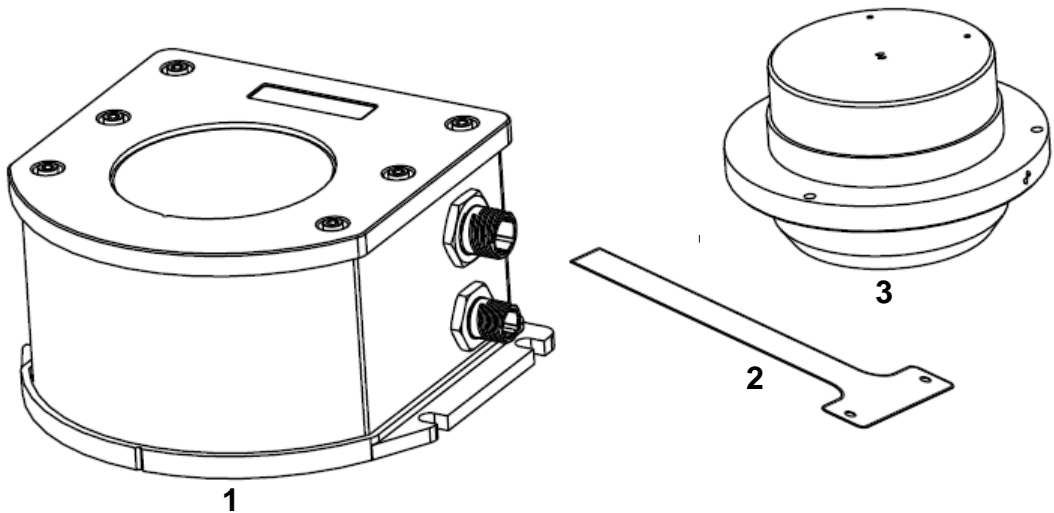


Figure 23: Required Parts

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 an allan key, see *Figure 24*:

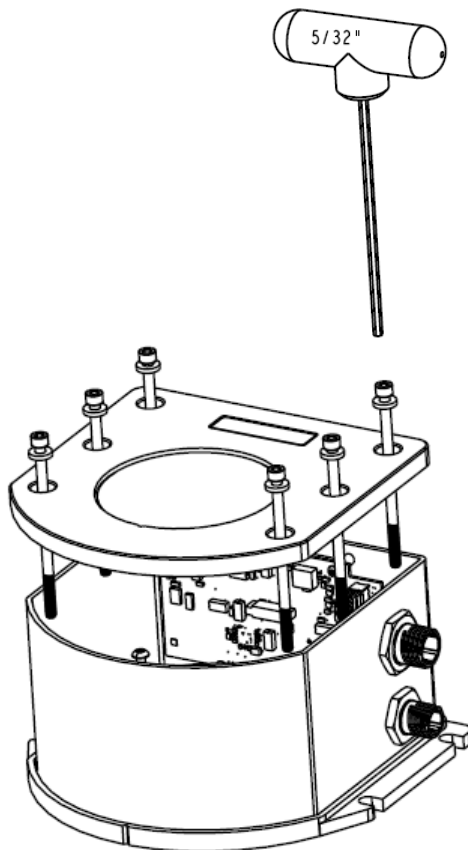


Figure 24: Bolts and Allan Key

2. Set aside the bolts with their sealing washers.
3. Lift the top cover off the tube body and set it aside, see *Figure 25* on page 137.
4. Lift the tube body away from its base plate and set it aside, see *Figure 25*.
5. Remove the 3 ring spacer screws and set aside, see *Figure 25*.

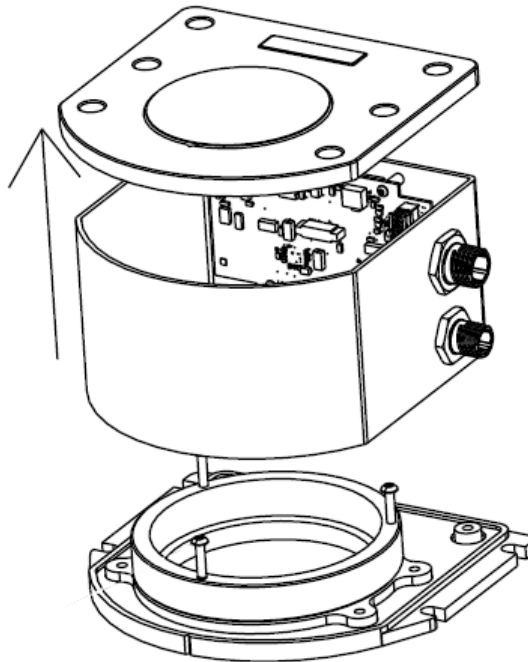


Figure 25: Lift Top Cover, Tube Body and 3 Ring Spacer Screws

E.2 Install the HG1700 Sensor Unit

To re-assemble the SPAN IMU with the HG1700 sensor, see *Figure 26* and follow these steps:

1. Mount the HG1700 sensor with the attached #8 screws. Apply threadlock to the screw threads. Use an allen key to torque each screw to 10 in-lbs.
2. Fit the tube body over the HG1700 sensor and onto the base plate.

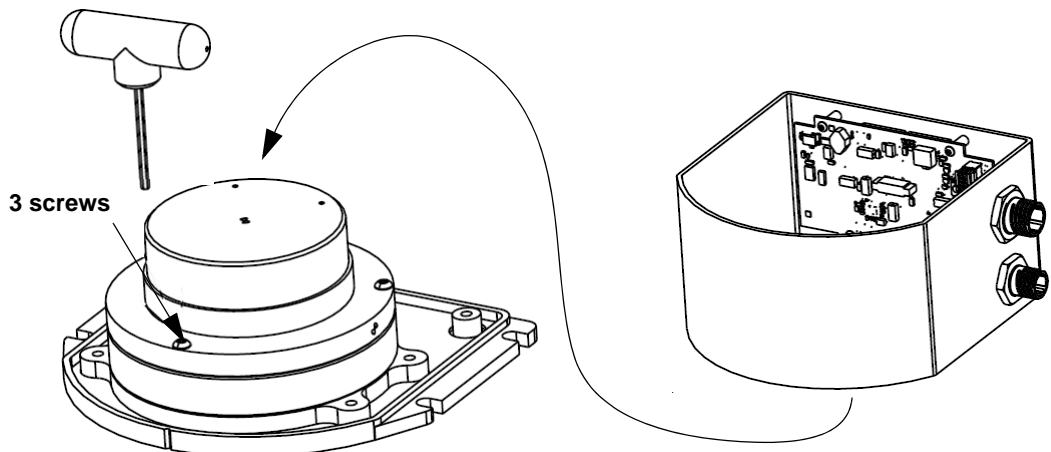


Figure 26: SPAN IMU Re-Assembly

E.3 Make the Electrical Connections

To make the electrical connections you will need a 3/32" allen key, the flex cable and the partially assembled SPAN IMU from *Section E.2, Install the HG1700 Sensor Unit on page 137*. 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 27*.

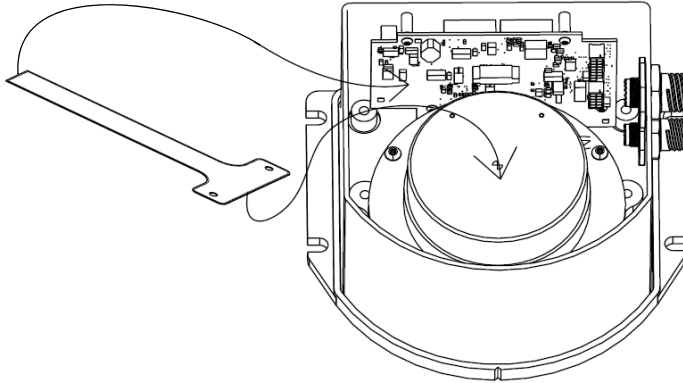


Figure 27: Attach Flex Cable

2. Tighten the screws to 4-in pounds.
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, *Figure 27*.
4. Check that the flex cable is locked in place.

Important!: *Figure 28* shows an incorrect installation of the flex cable where it is bowed in the middle. It will not operate properly in this position. *Figure 29* shows the proper installation of the flex cable. Notice how the flex cable sits flush against the IMU surface.

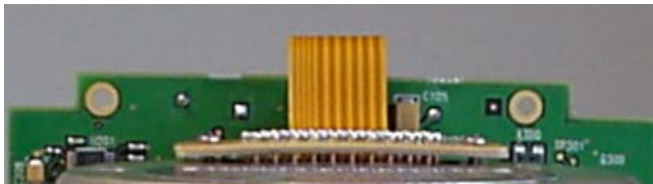


Figure 28: Incorrect (Bowed) Flex Cable Installation

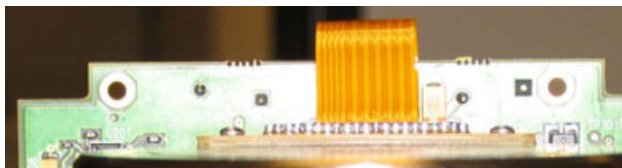


Figure 29: Correct (Flat) Flex Cable Installation

E.4 Re-Assemble the SPAN IMU Enclosure

Use an allen key to align the long bolts with the threaded holes in the base, see *Figure 24* on *page 136*. 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 30* below.



Figure 30: HG1700 SPAN IMU

Appendix F LN-200 IMU Installation

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), see also *Figure 31* below. 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.

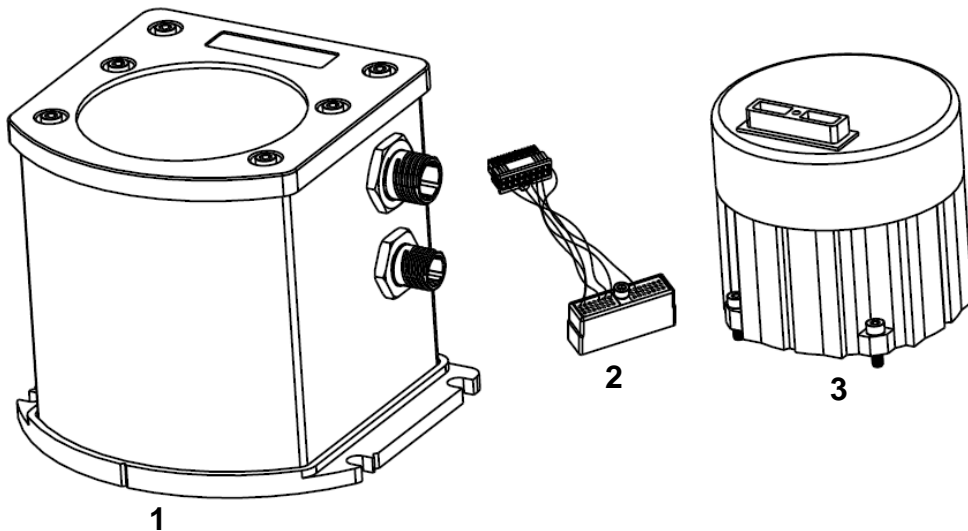


Figure 31: Required Parts

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 an allan key, see *Figure 32*:

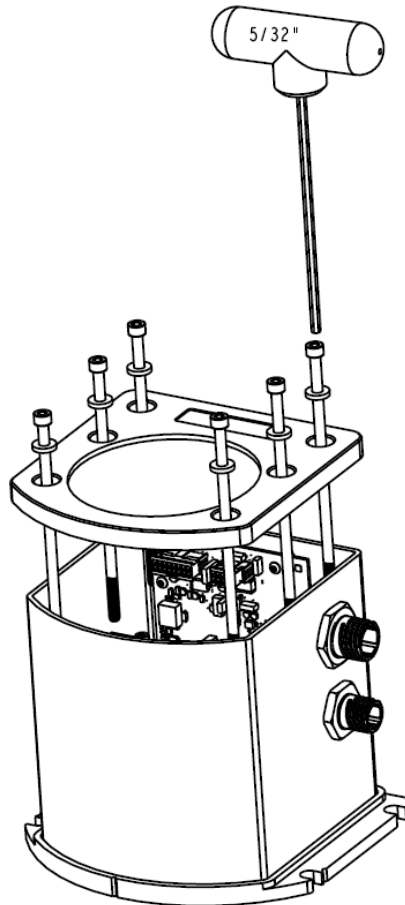


Figure 32: Bolts and Allan Key

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, see *Figure 33* on page 142.

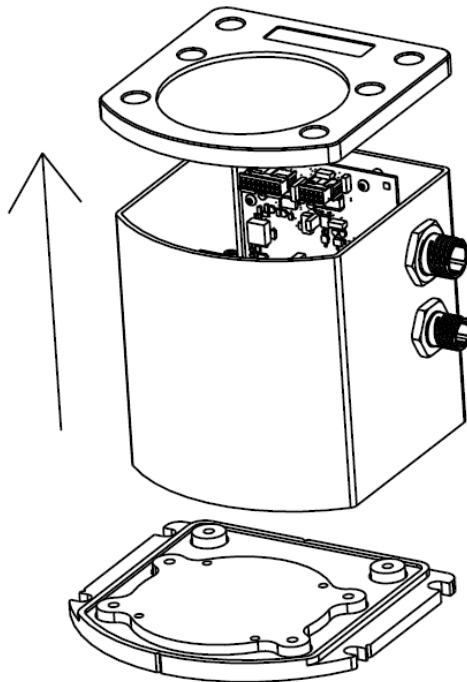


Figure 33: Lift Top Cover and Tube Body

F.2 Install the LN-200 Sensor Unit

To re-assemble the SPAN IMU with the LN-200 sensor, see *Figure 34* and follow these steps:

1. Mount the LN-200 sensor with the attached M4 screws. Apply threadlock to the screw threads. Use an allen key to torque each screw to 10 in-lbs.
2. Fit the tube body over the LN-200 sensor and onto the base plate.

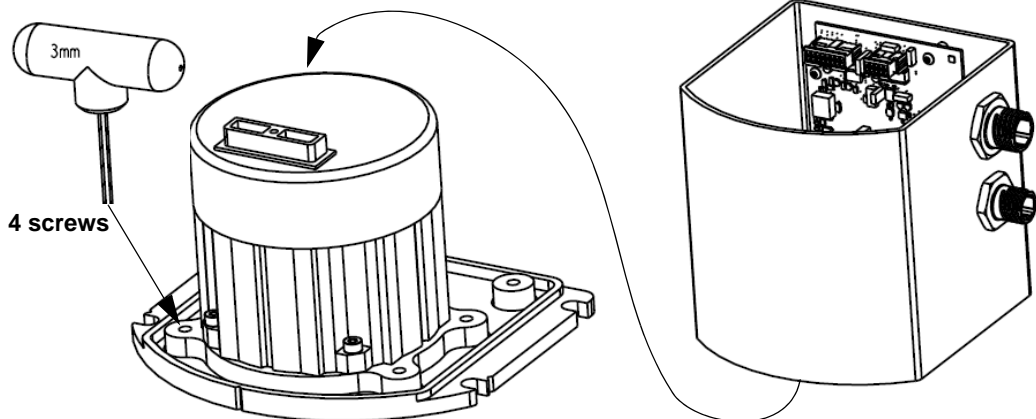


Figure 34: SPAN IMU Re-Assembly

F.3 Make the Electrical Connections

To make the electrical connections you will need a 3/32" allen key, the wiring harness and the partially assembled SPAN IMU from *Section F.2, Install the LN-200 Sensor Unit on page 142*. 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, see *Figure 35 on page 143*.

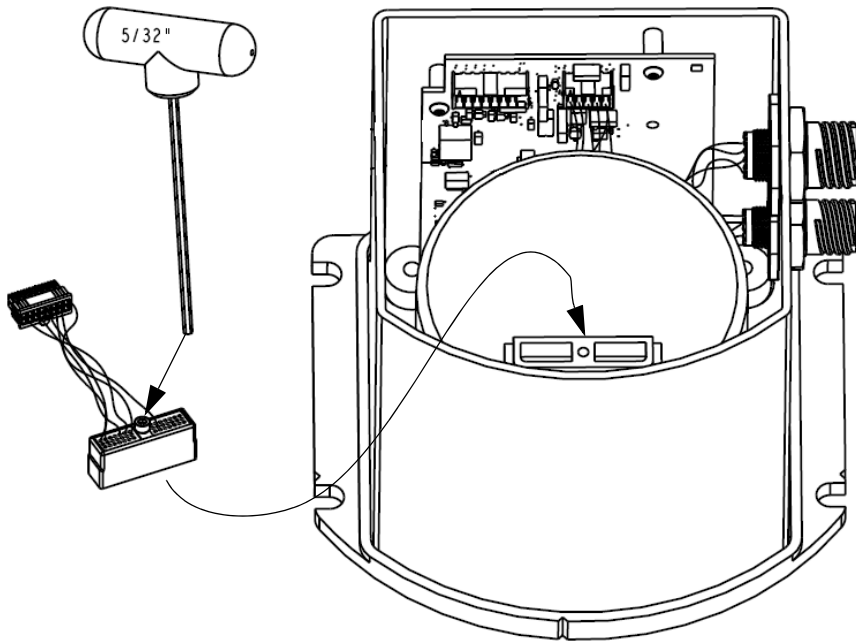


Figure 35: Attach Wiring Harness

2. Connect the Samtec connector at the other end of the wiring harness to the corresponding connector on the internal IMU card, see *Figure 36*. Ensure that the connector is locked in place.

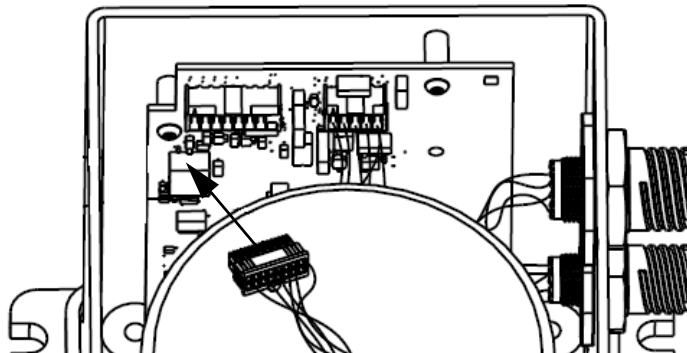


Figure 36: Attach Samtec Connector

F.4 Re-Assemble the SPAN IMU Enclosure

Use an allen key to align the long bolts with the threaded holes in the base, see *Figure 32* on *page 141*. Apply threadlock to threads. Finger tighten the 6 bolts and torque them in a cross pattern to 12 in-lbs. The fully assembled IMU enclosure is shown in *Figure 37* below.



Figure 37: LN-200 SPAN IMU

Appendix G 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 135* or *Appendix F*, starting on *page 140* 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 69*.

```
INTERFACEMODE COM3 IMU IMU OFF
```
 - b. Set the IMU type using the SETIMUTYPE command, see *page 81*.
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 81*).
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 94*.

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 94* 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 *page 107*.

Appendix H 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 Service.

H.1 SPAN System

Part Description	NovAtel Part
IMUs (see <i>Table 1, SPAN-Compatible Receiver and IMU Models on page 21</i> for details)	IMU-H58 IMU-H62 IMU-LN200 IMU-FSAS-EI
Receivers (see <i>Table 1, SPAN-Compatible Receiver and IMU Models on page 21</i> for details)	ProPak-V3
ProPak-V3 to LN-200 IMU interface cable, see <i>Figure 10 on page 49</i>	01017375
LN-200 power adapter cable, see <i>Figure 12 on page 50</i>	01017821
ProPak-V3 to iIMU-FAS IMU interface cable, see <i>Table 9 on page 55</i>	60723086
ProPak-V3 to HG1700 IMU interface cable (identical to LN-200 cable), see <i>Figure 10 on page 49</i>	01017384
OEMV, CDU and <i>Convert</i> disk (see <i>page 33</i> of this manual and refer to the <i>OEMV Family Installation and Operation User Manual</i>)	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

H.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 RF Antenna Cable:	
5 meters	C006
15 meters	C016

H.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	-	59064-11-35SF	D38999/26B35SF
Deutsch (or MIL equivalent) 3-pin connector on the LN-200 power cable	-	59064-09-98SN	D38999/26A98SN
MIL 22-pin connector on the iIMU-FSAS interface cable	-	-	D38999/26WC35SA

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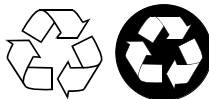
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