SPAN® on OEM6®

User Manual

OM-20000139 Rev 12 February 2017

SPAN on OEM6 User Manual

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Warranty

NovAtel Inc. warrants that its GNSS products are free from defects in materials and workmanship, subject to the conditions set forth on our web site: www.novatel.com/products/warranty/ and for the following time periods:

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

Return instructions

To return products, refer to the instructions at the bottom of the warranty page: www.novatel.com/products/warranty/.

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Table of Contents

Figures

Tables

Customer Support

NovAtel Knowledge Base

If you have a technical issue, browse to the NovAtel website at www.novatel.com/support/ and search for general information about GNSS and other technologies, information about NovAtel hardware, software, installation and operation issues.

Before Contacting Customer Support

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

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

```
RXSTATUSB once
RAWEPHEMB onchanged
GLORAWEPHEMB onchanged
RANGECMPB ontime 1
BESTPOSB ontime 1
RXCONFIGA once
VERSIONA once
RAWIMUSXB onnew
INSPVAXB ontime 1
INSUPDATEB onchanged
IMUTOANTOFFSETSB onchanged
VEHICLEBODYROTATIONA once
```

2. Send the data file to NovAtel Customer Support, using either the NovAtel FTP site at ftp://ftp.novatel.ca/ or through the support@novatel.com e-mail address.
3. You can also issue a `FRESET` command to the receiver to clear any unknown settings.

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

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

Contact Information

Log a support request with NovAtel Customer Support using one of the following methods:

Log a Case and Search Knowledge:
Website: www.novatel.com/support

Log a Case, Search Knowledge and View Your Case History: (login access required)
Web Portal: https://novatelsupport.force.com/community/login

E-mail:
support@novatel.com

Telephone:

U.S. and Canada:	1-800-NOVATEL (1-800-668-2835)
International:	+1-403-295-4900

Notices

The following notices apply to the SPAN devices.

FCC

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

Class B digital devices

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

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

Class A digital devices

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

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

> Changes or modifications to this equipment, not expressly approved by NovAtel Inc., could void the user’s authority to operate this equipment.

Industry Canada

SPAN Class B and Class A digital apparatuses comply with Canadian ICES-003.

SPAN appareils numérique de la classe B et classe A sont conforme à la norme NMB-003 du Canada.

European Union (EU)

Hereby, NovAtel Inc. declares that the SPAN IMU-(model #) is in conformity with the relevant union harmonized legislation: EMC Directive 2014/30/EU.

The full text of the EU Declaration may be obtained from the NovAtel website at: www.novatel.com/products/compliance/eu-declaration-of-conformity/.

WEEE

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

RoHS

SPAN products are in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

REACH

SPAN products are in compliance with Regulation (EC) No 1907/2006 OF THE EUROPEAN PARLIAMENT AND THE COUNCIL of 18 December 2006 concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH). The Candidate List of Substances of Very High Concern (SVHC) published by the European Chemical Agency (ECHA) is updated occasionally and available at https://echa.europa.eu/candidate-list-table.

> Cables may contain DEHP (CAS Number 117-81-7) in concentrations above 0.1% w/w.

1. Visit the NovAtel Web site at www.novatel.com/products/weee-and-rohs/ for more information.

Chapter 1 Introduction

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

The SPAN system consists of the following components:

- NovAtel OEM6 receiver
  These receivers are capable of receiving and tracking different combinations of GPS, GLONASS, Galileo and BeiDou signals on a maximum of 120 or 240 channels. OEM6 family receivers can also allocate channels for the reception of correction service signals from SBAS (standard) and NovAtel Correct™ with PPP (optional). OEM6 adaptability offers multi-system, frequency, and size configurations for any application requirement. Patented Pulsed Aperture Correlator (PAC) technology combined with a powerful microprocessor enable multipath-resistant processing. Excellent acquisition and re-acquisition times allow this receiver to operate in environments where very high dynamics and frequent interruption of signals can be expected. The OEM6 family also supports the timing requirements of the IMU and runs the real-time INS filter.
- IMU
  The Inertial Measurement Unit (IMU) consists of three accelerometers and three gyroscopes (gyros) so that accelerations along specific axis and angular rotations can be measured. Several IMU types are supported and are listed in *Table 1, SPAN-Compatible IMU Models* on page 18.
- GNSS antenna
- Computer Software
  Real-time data collection, status monitoring and receiver configuration is possible through the NovAtel Connect™ software utility, see *SPAN Configuration with NovAtel Connect* on page 54.

Figure 1: SPAN System IMUs

Figure 2: SPAN System Receivers

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

1.1 Fundamentals of GNSS+INS

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

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

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

The advantages of using SPAN technology are its ability to:

- Provide a full attitude solution (roll, pitch and azimuth)
- Provide continuous solution output (in situations when a GNSS-only solution is impossible)
- Provide faster signal reacquisition and RTK solution resolution (over stand-alone GNSS because of the tightly integrated GNSS and INS filters)
- Output high-rate (up to 100, 125 or 200 Hz depending on your IMU model and logging selections) position, velocity and attitude solutions for high-dynamic applications, see also *Logging Restriction Important Notice* on page 67
- Use raw phase observation data (to constrain INS solution drift even when too few satellites are available for a full GNSS solution)

1.2 Models and Features

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

Table 1: SPAN-Compatible IMU Models

Model Name	Maximum Output Rate	Compatible IMUs	SW Model
IMU-CPT	100 Hz	IMU-CPT	S1
IMU-FSAS-EI	200 Hz	iIMU-FSAS	S3
IMU-H1900-CA50	100 Hz	HG1900-CA50	S2
IMU-H1930-CA50	100 Hz	HG1930-CA50	S1
IMU-H58	100 Hz	HG1700-AG58	S2
IMU-H62	100 Hz	HG1700-AG62	S2
IMU-IGM-A1	200 Hz	IMU-IGM-A1	S1
IMU-IGM-S1	125 Hz	IMU-IGM-S1	S1
IMU-ISA-100C	200 Hz	ISA-100C	S3
IMU-ISA-100C (400 Hz)	400 Hz	ISA-100C (400 Hz)	S3
IMU-KVH1725	200 Hz	KVH-1725	S2
IMU-KVH1750	200 Hz	KVH-1750	S2
IMU-LN200	200 Hz	LN-200	S3
IMU-µIMU	200 Hz	Litef µIMU	S2
OEM-IMU-ADIS-16488	200 Hz	OEM-IMU-ADIS-16488	S1
OEM-IMU-ISA-100C	200 Hz	OEM-IMU-ISA-100C	S3
OEM-IMU-ISA-100C (400 Hz)	400 Hz	OEM-IMU-ISA-100C (400 Hz)	S3
OEM-IMU-STIM300	125 Hz	OEM-IMU-STIM300	S1
UIMU-H58	100 Hz	HG1700-AG58	S2
UIMU-H62	100 Hz	HG1700-AG62	S2
UIMU-LCI	200 Hz	Litef LCI-1	S3

Each model is capable of multiple positioning modes of operation. For a discussion on GNSS positioning and receiver details, refer to the OEM6 Family Installation and Operation User Manual (OM-20000129).

Each model has the following standard features:

- Rugged shock, water and dust-resistant enclosure (FlexPak6™ and ProPak6™)
- NovAtel's advanced OEM6 L1/L2/L5 GPS, L1/L2 GLONASS and PAC technology
- Bidirectional COM ports which support data transfer rates of up to 921,600 bits/s[1]. One of these serial ports is capable of communication with an IMU.
- USB 2.0 port.
- Ethernet port (not available on the OEM615).
- Controller Area Network Bus (CAN Bus) which is a rugged differential serial bus with a protocol that provides services for processes, data and network management.
- Field-upgradeable firmware (program software). This unique feature means that the firmware can be updated any time, anywhere, without any mechanical procedures whatsoever. Firmware upgrades can include changes in the software model to enable additional features or signals. For example, a model with L1/L2-only capabilities can be upgraded to a model with L1/L2 and NovAtel CORRECT with RTK™ in only a few minutes in your office (instead of the days or weeks that would be required if the receiver had to be sent to a service depot). All that is required to unlock the additional features is a special authorization code. Refer to the OEM6 Family Installation and Operation User Manual (OM-20000128) for further details on this topic.

Some of the IMUs used with SPAN are housed in an enclosure with a PCB board to handle power, communication and data timing. See *Appendix A, Technical Specifications* on page 84 for details.

1.3 Related Documents and Information

This manual contains sufficient information about the installation and operation of the SPAN system. It is beyond the scope of this manual to provide details on service or repair. Contact your local NovAtel dealer for any customer service related inquiries, see *Customer Support* on page 13.

The OEM6 receiver utilizes a comprehensive user-interface command structure, which requires communications through its communications ports. The SPAN specific commands and logs are described in the SPAN on OEM6 Firmware Reference Manual (OM-20000144). For descriptions of the other commands and logs available with OEM6 family products, refer to the OEM6 Family Firmware Reference Manual (OM-20000129) available on the NovAtel website at www.novatel.com/support/. It is recommended that these documents be kept together for easy reference.

For more information about the OEM6 family receiver cards or the FlexPak6 receiver, refer to the OEM6 Family Installation and Operation User Manual (OM-20000128). For more information about the ProPak6 receiver, refer to the ProPak6 User Manual (OM-20000148).

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.

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

1.4 Conventions

The following conventions are used in this manual:

	Information that supplements or clarifies text.
	A caution that actions, operation or configuration may lead to incorrect or improper use of the hardware.
	A warning that actions, operation or configuration may result in regulatory noncompliance, safety issues or equipment damage.

Chapter 2 SPAN Installation

2.1 Hardware Description

One hardware setup consists of an OEM6 receiver (see *Figure 2, SPAN System Receivers* on page 17), an IMU (see *Figure 1, SPAN System IMUs* on page 16), a GNSS antenna, power and a communication link (if your application requires real time differential operation). If your IMU enclosure and IMU were supplied separately, additional installation instructions for installing the IMU can be found in the Appendix specific to your IMU starting on page 202.

Another hardware set up consists of a receiver, an IMU, an IMU interface card and a COM and power link. The IMU interface card can be a MEMS Interface Card (MIC) (refer to *MIC Set Up* on page 40) or a Universal IMU Controller (UIC) (refer to *UIC Set Up* on page 49).

2.1.1 SPAN System Receiver

Data storage is done using a computer connected to the receiver through either the USB, serial or Ethernet port. The OEM638 and ProPak6 receivers also have on board data storage.

For information about accessing the ports on an OEM6 receiver card, see the OEM6 Family Installation and Operation User Manual (OM-20000128).

The connectors available on the FlexPak6 are shown in *Figure 3, FlexPak6 Receiver Connectors*. The FlexPak6 provides DB9, DB-15HD, USB, power and antenna connectors.

Figure 3: FlexPak6 Receiver Connectors

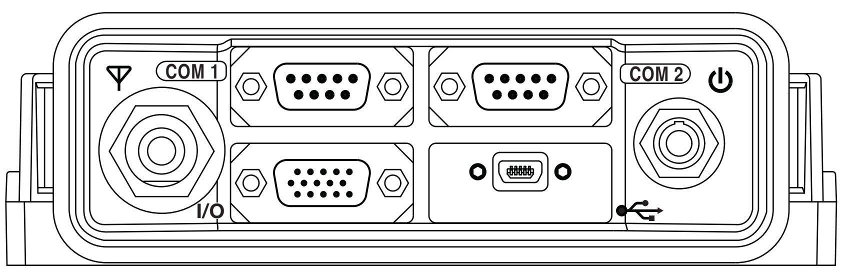


Table 2, FlexPak6 Receiver Port Labels shows a summary of the receiver port names available on the FlexPak6.

Table 2: FlexPak6 Receiver Port Labels

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

For information about the FlexPak6 ports and cables, see the OEM6 Family Installation and Operation User Manual (OM-20000128).

The connectors available on the ProPak6 are shown in *Figure 4, ProPak6 Receiver Connectors*. The ProPak6 provides DB9, USB, Ethernet, expansion, power and antenna connectors.

Figure 4: ProPak6 Receiver Connectors

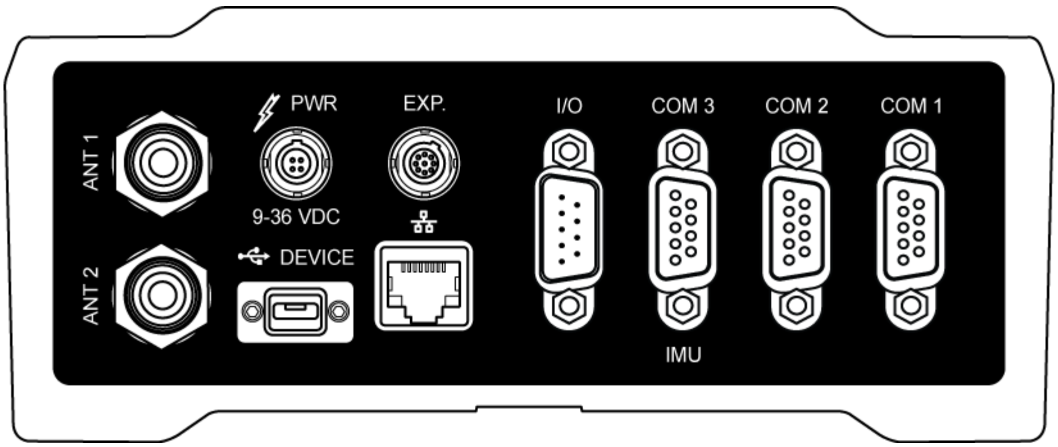


Table 3, ProPak6 Receiver Port Labels shows a summary of the receiver port names available on the ProPak6.

Table 3: ProPak6 Receiver Port Labels

Port Label	Description
COM1	Serial communications port 1
COM2	Serial communications port 2
COM3/IMU	Serial communications port 3 The IMU must be connected to this port.
I/O	Input and output port for additional signals (PPS, Event Inputs and Event Outputs)
EXP	Expansion port for CAN Bus ports 1 and 2 and additional COM ports (COM7, COM8, COM9, COM10)
	Ethernet port
PWR	Supply voltage
Device	USB communications port
ANT or ANT 1	Antenna port
OSC or ANT 2	External oscillator input or Secondary antenna port (Dual antenna model)

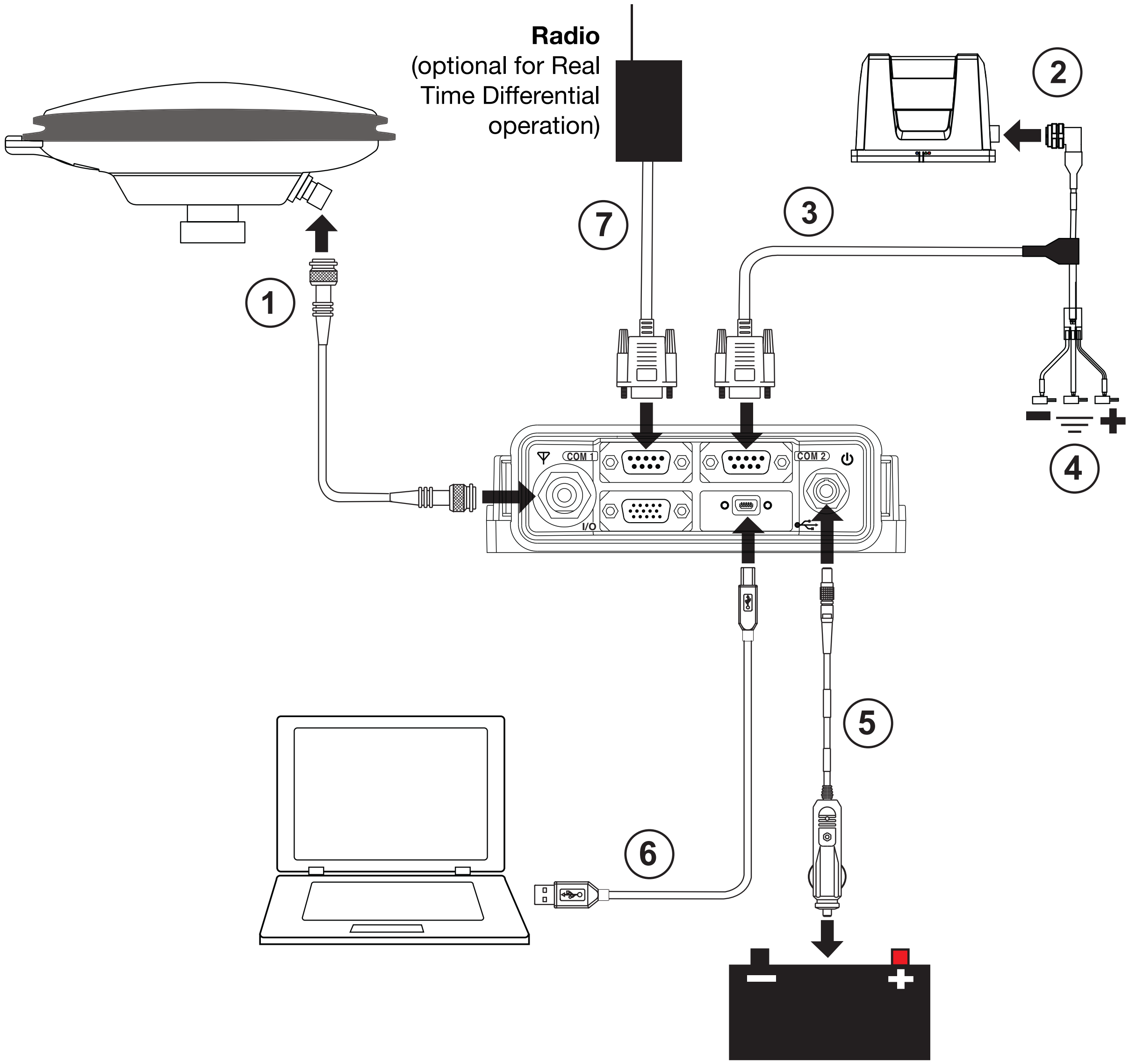
For information about the ProPak6 ports and cables, see the ProPak6 User Manual (OM-20000148).

2.1.2 Typical Installation Examples

The following examples show the connections for a FlexPak6 receiver. If you are using an OEM6 receiver card (such as an OEM615, OEM628 or OEM638), you need a wiring harness to connect the receiver to the other components of the SPAN system. See the OEM6 Family Installation and Operation User Manual (OM-20000128) for information about preparing the data, signal and power wiring harness.

2.1.2.1 FlexPak6 to Universal IMU Enclosure (LN-200, HG1700 or LCI-1) Set Up Example

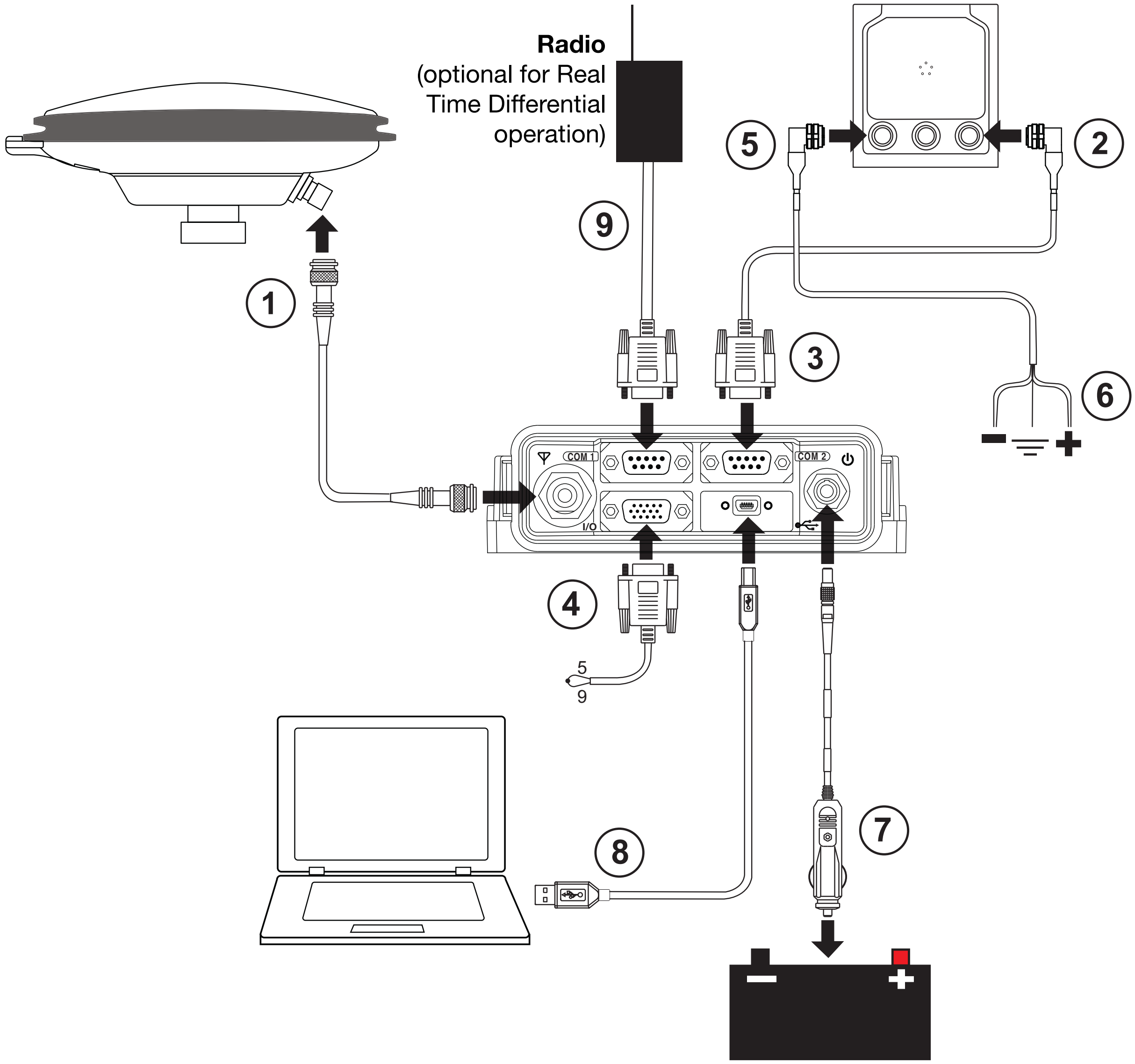
Figure 5: Basic Set Up – FlexPak6 to Universal IMU Enclosure (LN-200, HG1700 or LCI-1)



1. Connect the antenna to the receiver.
2. Connect the interface cable to the LN-200, HG1700 or LCI-1 (Universal IMU Enclosure).
3. Connect the DB9 connector of the interface cable to the *COM 2* port of the receiver.
4. Connect the IMU power and ground to the IMU interface cable (refer to *Table 8, IMU Power Supply* on page 39).
5. Connect a user supplied power supply to the receiver.
6. Connect a user supplied computer for set up and monitoring to the USB port.
7. Connect a user supplied radio device to *COM 1* (optional for real time differential operation).

2.1.2.2 FlexPak6 to IMU Enclosure (HG1900, ISA-100C, LN200 or µIMU) Set Up Example

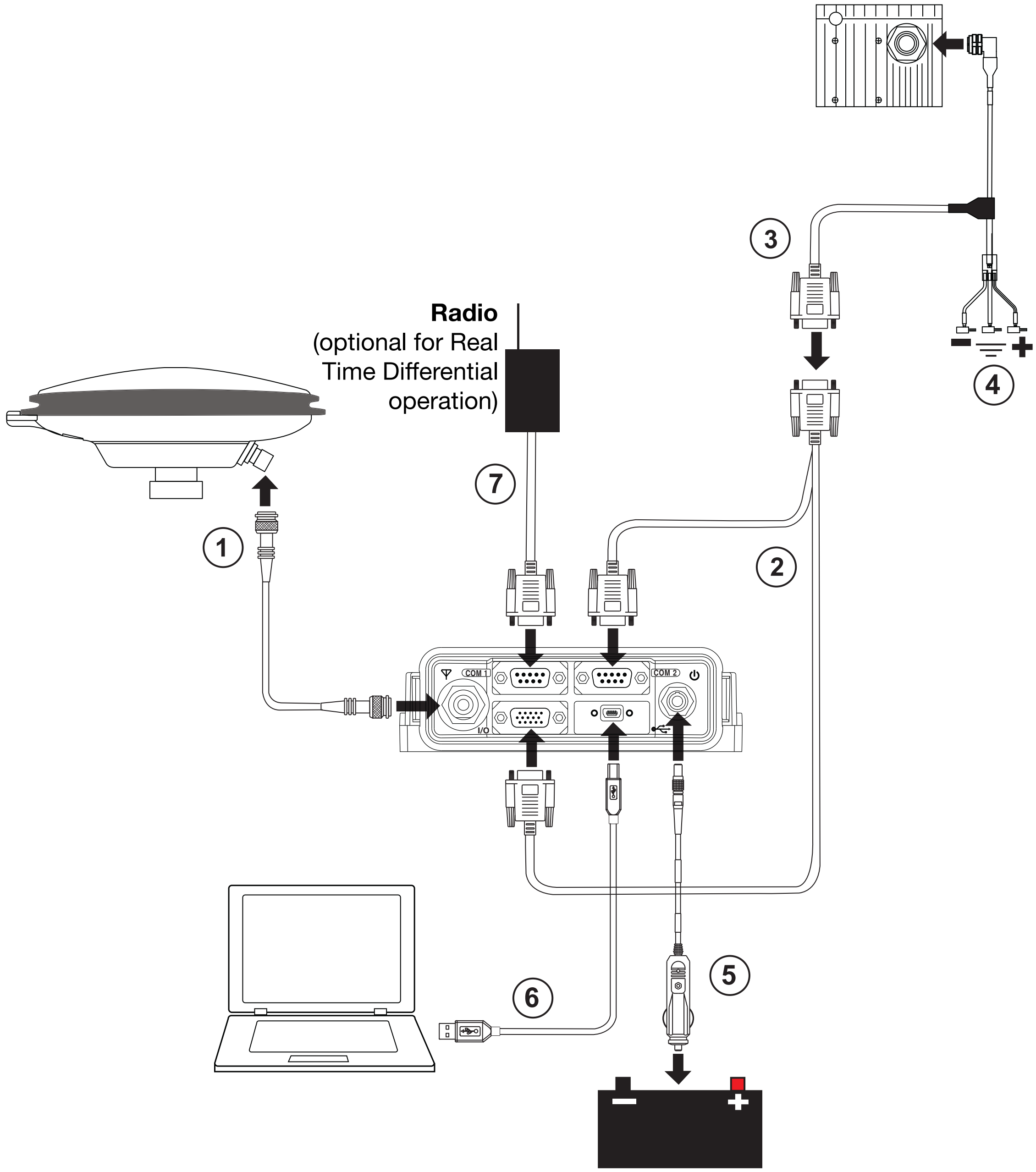
Figure 6: Basic Set Up – FlexPak6 to IMU Enclosure (HG1900, ISA-100C, LN200 or µIMU)



1. Connect the antenna to the receiver.
2. Connect the M12 connector (male, 5 pin) of the interface cable to the HG1900, ISA-100C, LN200 or µIMU (IMU Enclosure).
3. Connect the DB9 connector of the interface cable to the *COM 2* port of the receiver.
4. Connect pin 5 to pin 9 on the I/O port of the FlexPak6. This changes the COM2 protocol to RS-422.
5. Connect the M12 connector (female, 5 pin) of the IMU power cable to the power connector (- +) on the IMU.
6. Connect a user supplied power supply to the IMU power cable (refer to *Table 8, IMU Power Supply* on page 39).
7. Connect a user supplied power supply to the receiver.
8. Connect a user supplied computer for set up and monitoring to the USB port.
9. Connect a user supplied radio device to *COM 1* (optional for real time differential operation).

2.1.2.3 FlexPak6 to IMU-FSAS Set Up Example

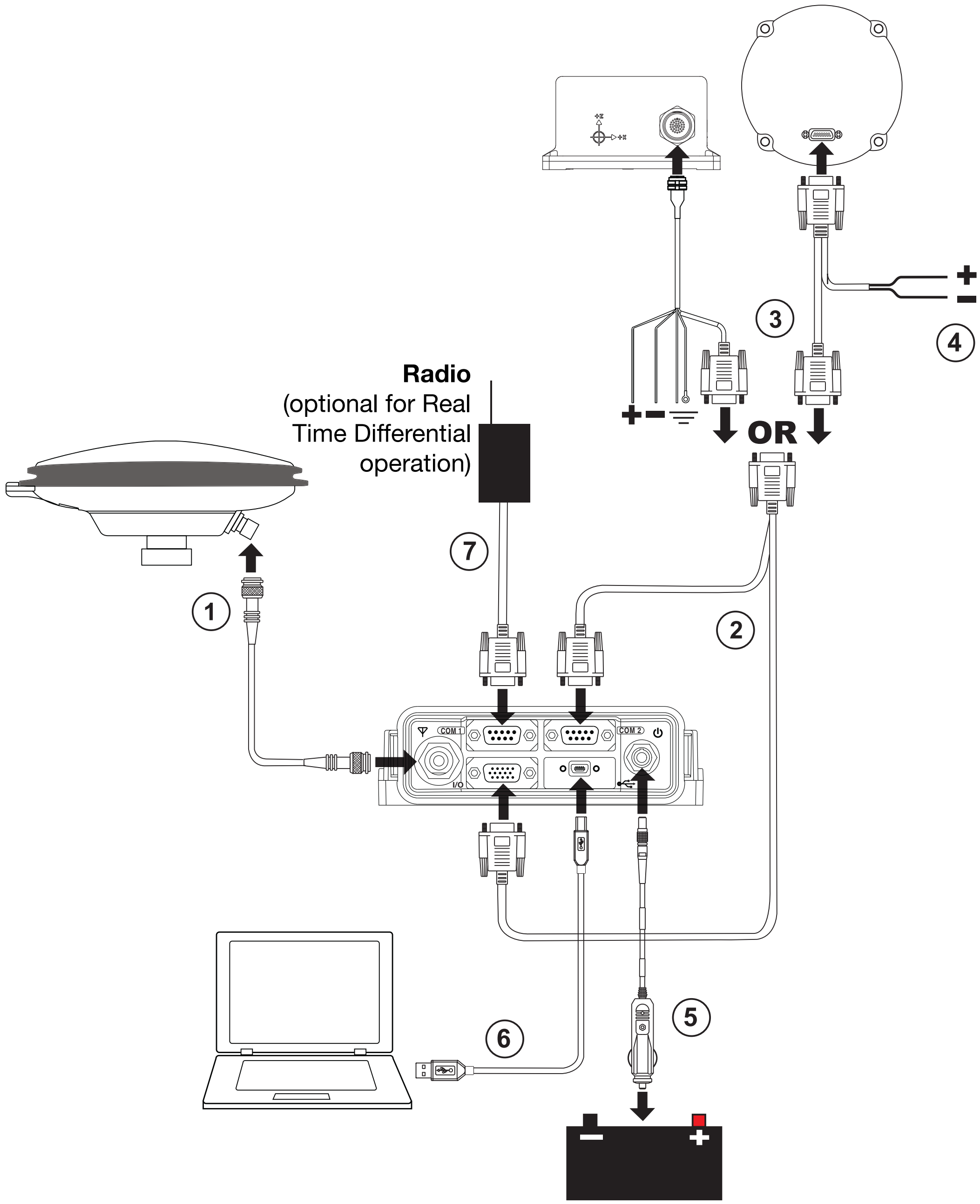
Figure 7: Basic Set Up – FlexPak6 to IMU-FSAS



1. Connect the antenna to the receiver.
2. Connect the FlexPak Y Adapter cable to the COM 2 and I/O ports on the receiver.
3. Connect the IMU interface cable to the IMU and the FlexPak Y Adapter cable.
4. Connect power and ground to the IMU interface cable (refer to *Table 8, IMU Power Supply* on page 39).
5. Connect a user supplied power supply to the receiver.
6. Connect a user supplied computer for set up and monitoring to the USB port.
7. Connect a user supplied radio device to COM 1 (optional for real time differential operation).

2.1.2.4 FlexPak6 to IMU-CPT or IMU-KVH1750 Set Up Example

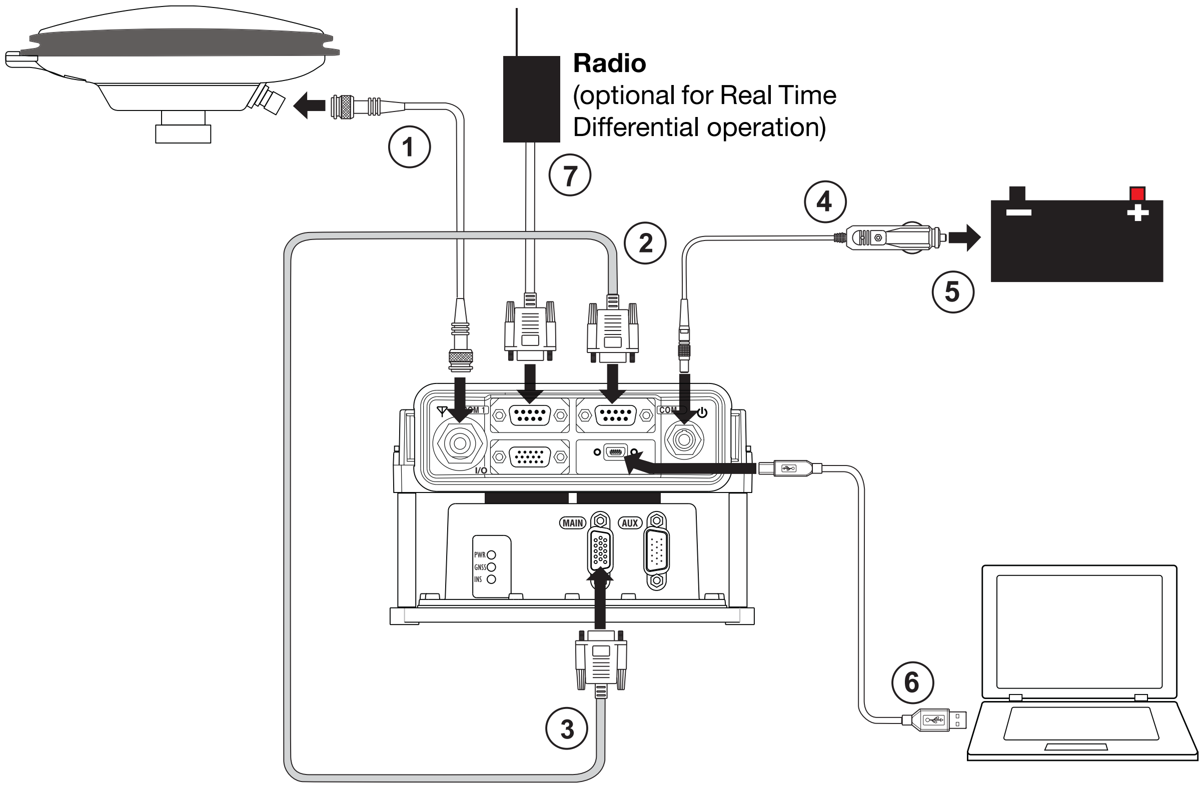
Figure 8: Basic Set Up – FlexPak6 to IMU-CPT or IMU-KVH1750



1. Connect the antenna to the receiver.
2. Connect the FlexPak Y Adapter cable to the COM 2 and I/O ports on the receiver.
3. Connect the IMU interface cable to the IMU and the FlexPak Y Adapter cable.
4. Connect power and ground to the IMU interface cable (refer to *Table 8, IMU Power Supply* on page 39).
5. Connect a user supplied power supply to the receiver.
6. Connect a user supplied computer for set up and monitoring to the USB port.
7. Connect a user supplied radio device to COM 1 (optional for real time differential operation).

2.1.2.5 FlexPak6 to IMU-IGM Set Up Example

Figure 9: Basic Set Up – FlexPak6 to IMU-IGM

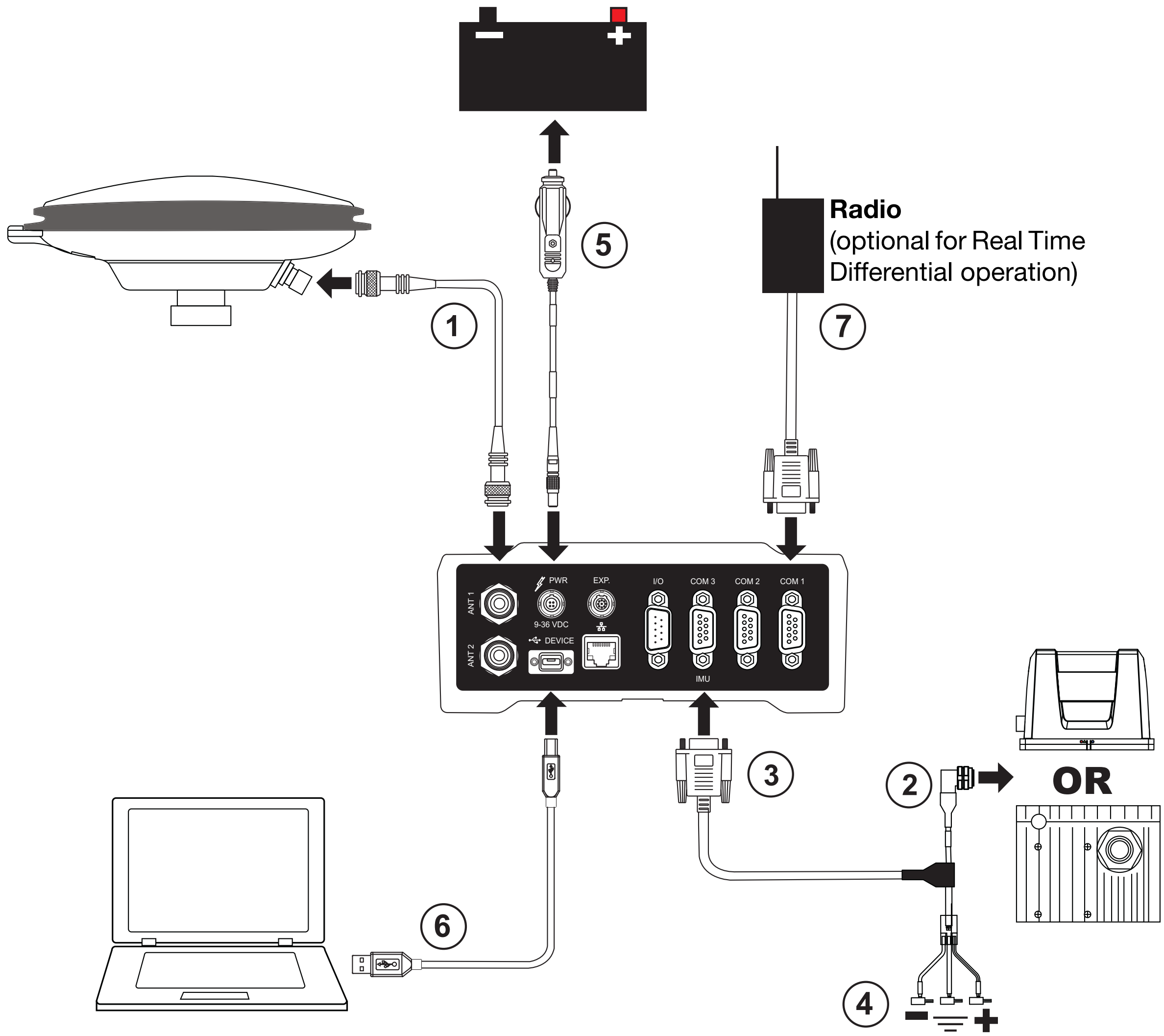


1. Connect the antenna to the receiver.
2. Connect the DB-15HD connector of the interface cable to the *MAIN* connector on the IMU-IGM.
3. Connect the DB9 connector of the interface cable to the *COM 2* port of the receiver.
4. Connect a user supplied power supply to the receiver.
5. Connect a user supplied power supply (refer to *Table 8, IMU Power Supply* on page 39) to the IMU. This step is not required if you are using the IMU-IGM Stack Up Cable (01019013). Power from the FlexPak6 is supplied to the IMU-IGM through the Stack Up Cable
6. Connect a user supplied computer for set up and monitoring to the USB port.
7. Connect a user supplied radio device to *COM 1* (optional for real time differential operation).

> In *Figure 9, Basic Set Up – FlexPak6 to IMU-IGM*, the FlexPak6 is mounted on IMU-IGM using the optional Bracket Kit (01019040).

2.1.2.6 ProPak6 to Universal IMU Enclosure (LN-200, HG1700, LCI-1) or IMU-FSAS Set Up Example

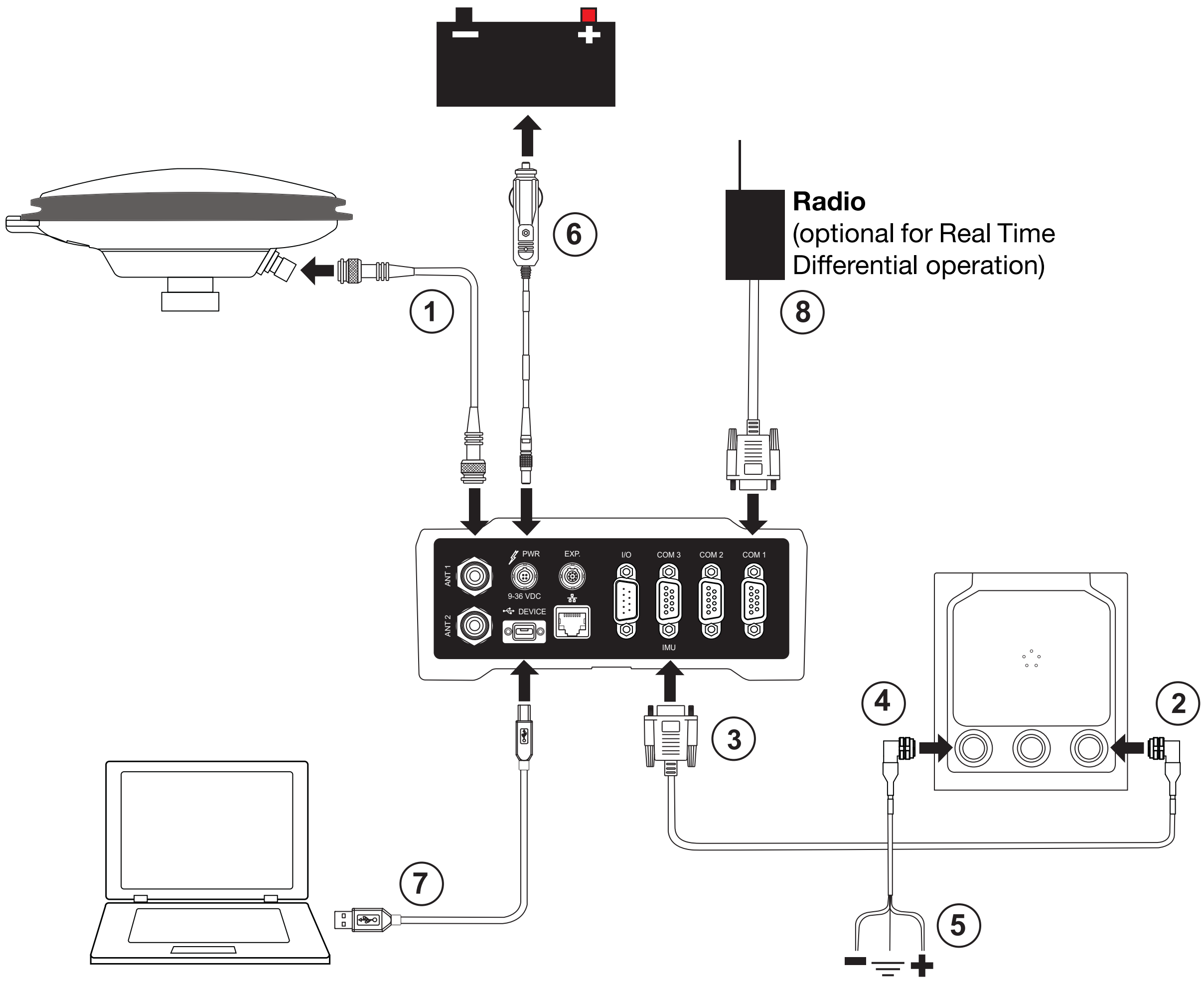
Figure 10: Basic Set Up – ProPak6 to Universal IMU Enclosure (LN-200, HG1700, LCI-1) or IMU-FSAS



1. Connect the antenna to the receiver.
2. Connect the interface cable to the LN-200, HG1700 or LCI-1 (Universal IMU Enclosure) or the IMU-FSAS.
3. Connect the DB9 connector of the interface cable to the *COM3/IMU* port of the receiver.
4. Connect the IMU power and ground to the IMU interface cable (refer to *Table 8, IMU Power Supply* on page 39).
5. Connect a user supplied power supply to the receiver.
6. Connect a user supplied computer for set up and monitoring to the USB port.
7. Connect a user supplied radio device to *COM1* (optional for real time differential operation).

2.1.2.7 ProPak6 to IMU Enclosure (HG1900, ISA-100C, LN200 or µIMU) Set Up Example

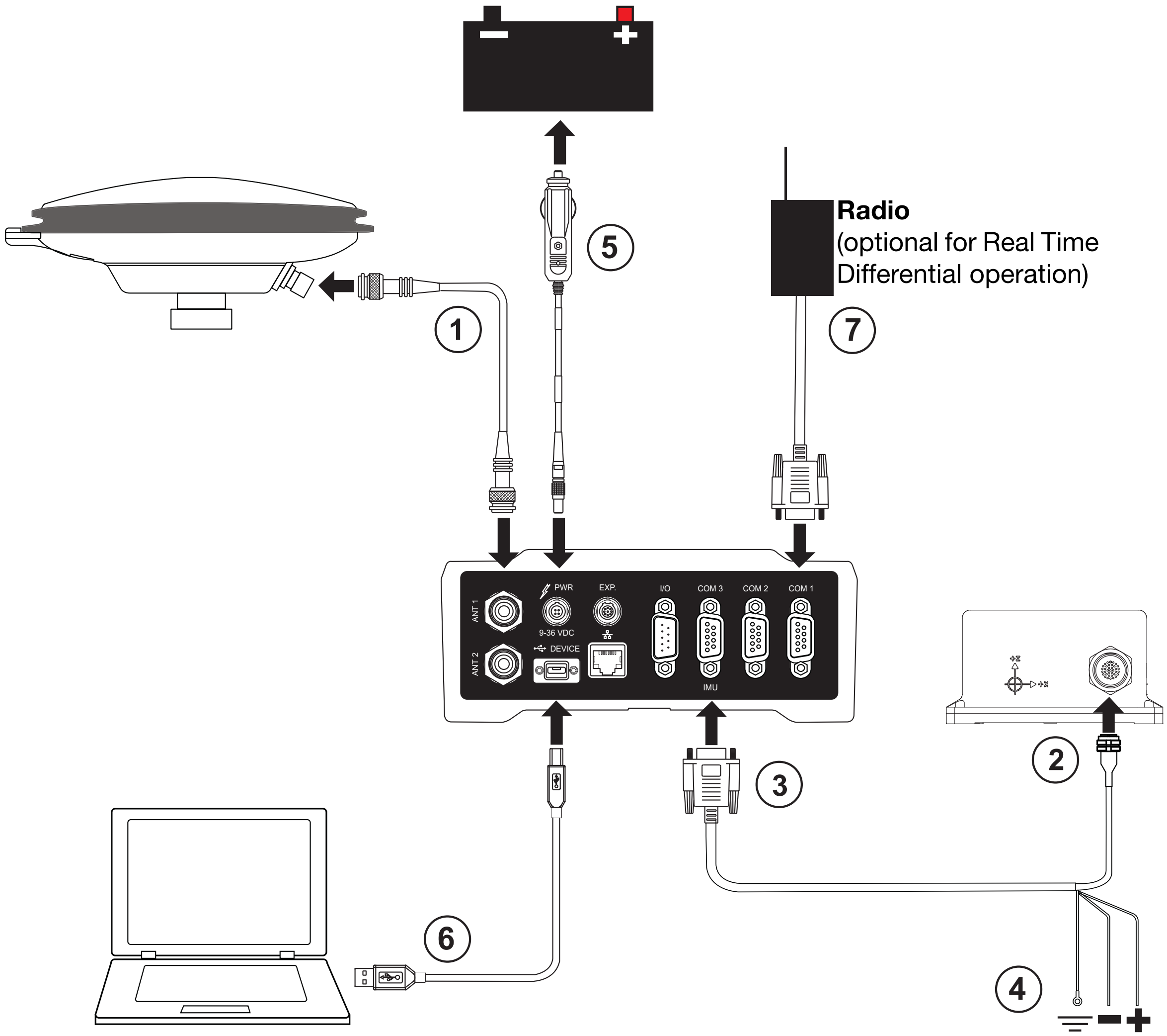
Figure 11: Basic Set Up – ProPak6 to IMU Enclosure (HG1900, ISA-100C, LN200 or µIMU)



1. Connect the antenna to the receiver.
2. Connect the M12 connector (male, 5 pin) of the interface cable to the HG1900, ISA-100C, LN200 or µIMU (IMU Enclosure).
3. Connect the DB9 connector of the interface cable to the *COM3/IMU* port of the receiver.
4. Connect the M12 connector (female, 5 pin) of the IMU power cable to the power connector ( ) on the IMU.
5. Connect a user supplied power supply to the IMU power cable (refer to *Table 8, IMU Power Supply* on page 39).
6. Connect a user supplied power supply to the receiver.
7. Connect a user supplied computer for set up and monitoring to the USB port.
8. Connect a user supplied radio device to *COM1* (optional for real time differential operation).

2.1.2.8 ProPak6 to IMU-CPT Set Up Example

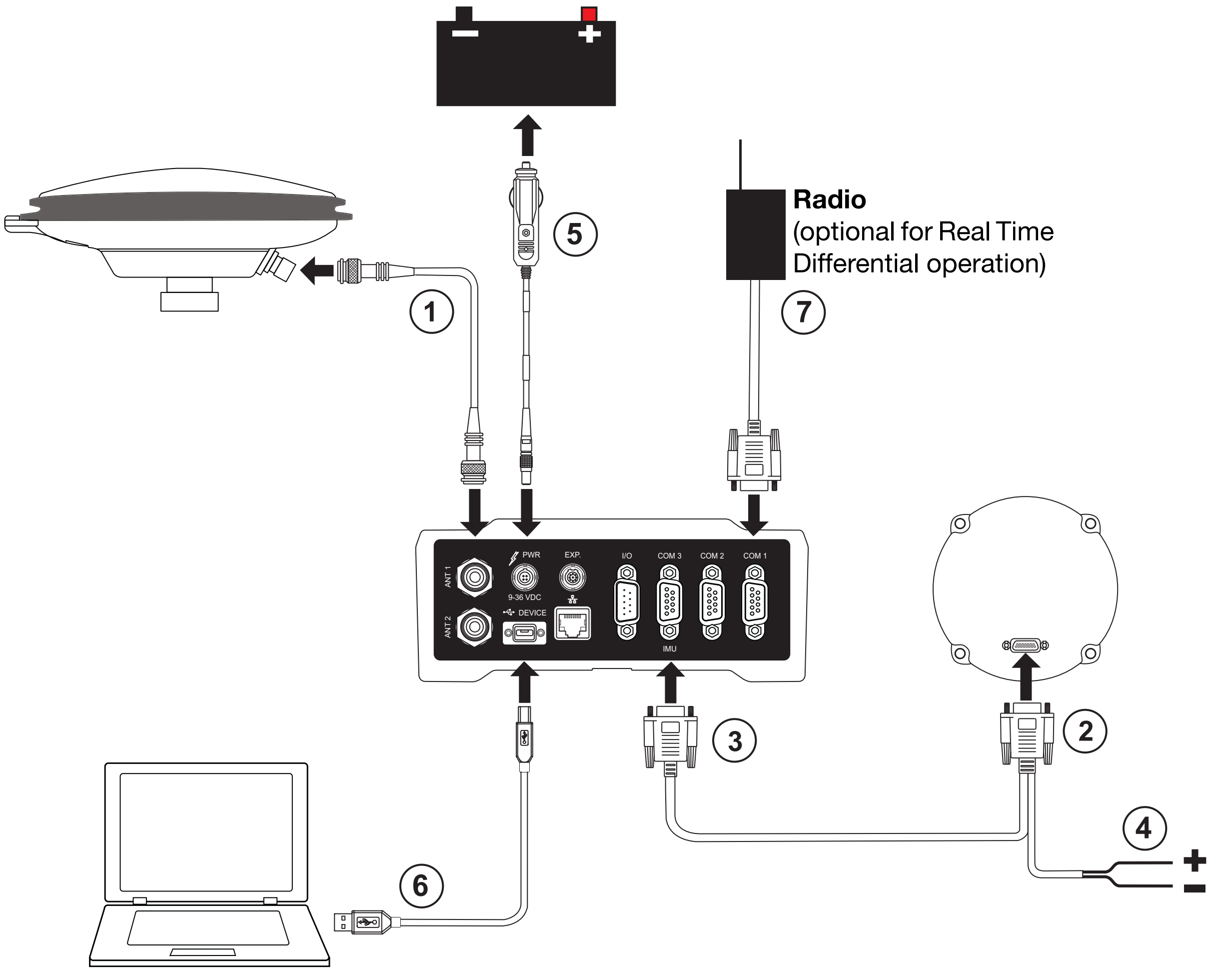
Figure 12: Basic Set Up – ProPak6 to IMU-CPT



1. Connect the antenna to the receiver.
2. Connect the interface cable to the IMU-CPT.
3. Connect the DB9 connector of the interface cable to the *COM3/IMU* port of the receiver.
4. Connect the IMU power and ground to the IMU interface cable (refer to *Table 8, IMU Power Supply* on page 39).
5. Connect a user supplied power supply to the receiver.
6. Connect a user supplied computer for set up and monitoring to the USB port.
7. Connect a user supplied radio device to *COM1* (optional for real time differential operation).

2.1.2.9 ProPak6 to IMU-KVH1750 Set Up Example

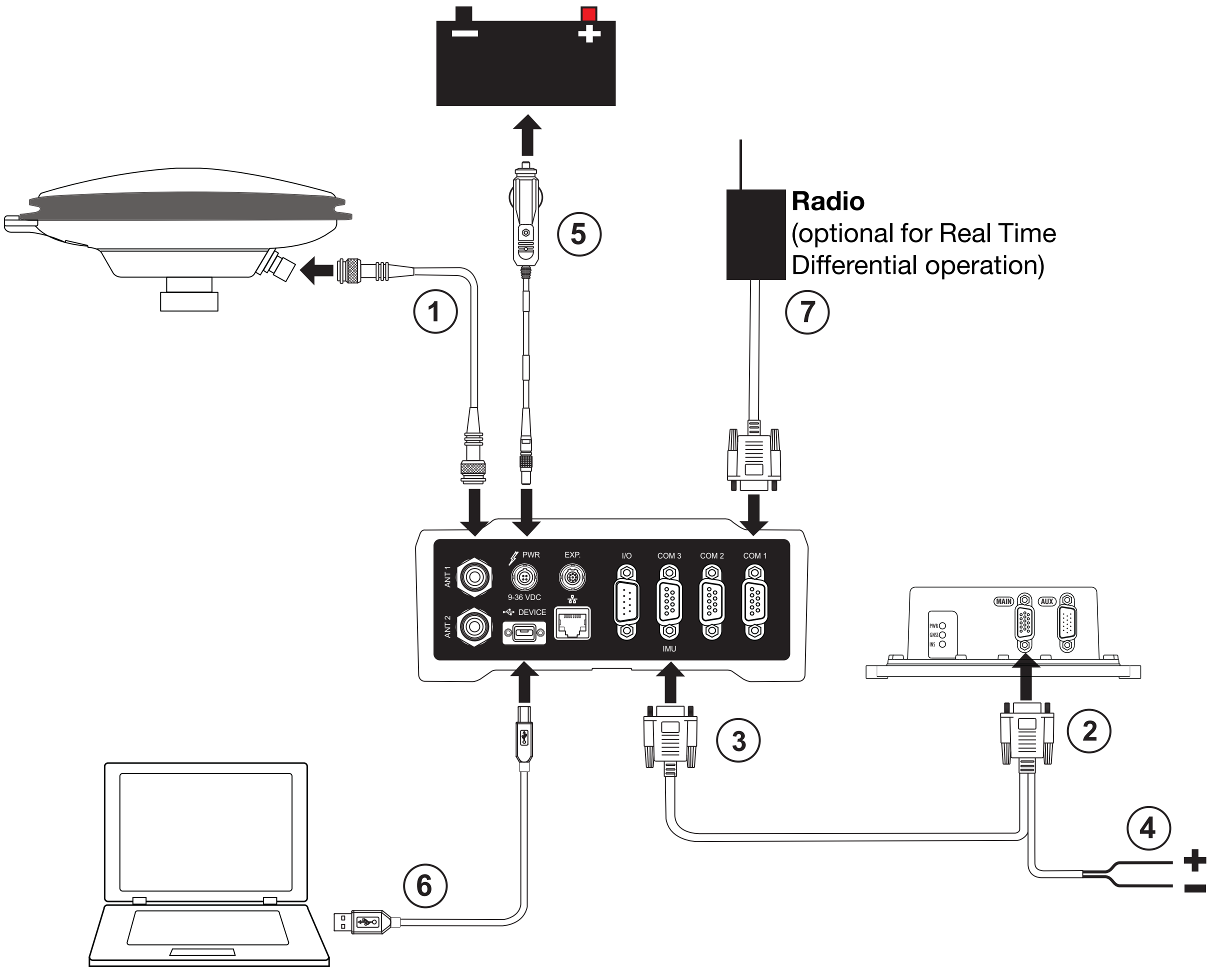
Figure 13: Basic Set Up – ProPak6 to IMU-KVH1750



1. Connect the antenna to the receiver.
2. Connect the 15-pin Micro-D connector of the interface cable to the *MAIN* connector on the IMU-KVH1750.
3. Connect the DB9 connector of the interface cable to the *COM3/IMU* port of the receiver.
4. Connect the IMU power to the IMU interface cable (refer to *Table 8, IMU Power Supply* on page 39).
5. Connect a user supplied power supply to the receiver.
6. Connect a user supplied computer for set up and monitoring to the USB port.
7. Connect a user supplied radio device to *COM1* (optional for real time differential operation).

2.1.2.10 ProPak6 to IMU-IGM Set Up Example

Figure 14: Basic Set Up – ProPak6 to IMU-IGM



1. Connect the antenna to the receiver.
2. Connect the DB-15HD connector of the interface cable to the *MAIN* connector on the IMU-IGM.
3. Connect the DB9 connector of the interface cable to the *COM3/IMU* port of the receiver.
4. Connect the IMU power to the IMU interface cable (refer to *Table 8, IMU Power Supply* on page 39).
5. Connect a user supplied power supply to the receiver.
6. Connect a user supplied computer for set up and monitoring to the USB port.
7. Connect a user supplied radio device to *COM1* (optional for real time differential operation).

2.1.3 SPAN Cables

This section outlines the cables used to connect the receiver to the IMU. For information about the other cables for OEM6 receivers, refer to the OEM6 Family Installation and Operation User Manual (OM-20000128).

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

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

> Do not pull directly on the cable.

The cables you need to connect the receiver to the IMU depends on the type of IMU you are using. *Table 4, Receiver to IMU Interface Cables* lists the cables required to connect the IMU to the receiver. *Table 5, MIC Interface Cables* on page 34 lists the cables required to connect an IMU to the MIC. *Table 6, UIC Interface Cables* on page 34 lists the cables required to connect an IMU to the UIC. For information about these cables see *Appendix A, Technical Specifications* on page 84.

> Receiver cards (such as the OEM615, OEM628 and OEM638) require modification to the standard cable. Refer to OEM6 Family Installation and Operation User Manual (OM-20000128) for information about the modifications needed.

Table 4: Receiver to IMU Interface Cables

	FlexPak6	ProPak6
IMU-LCI	01018977 Universal IMU Enclosure Interface Cable	01018977 Universal IMU Enclosure Interface Cable
HG1900 IMU-ISA-100C LN200 μIMU	01019319 IMU Enclosure Interface Cable	01019319 IMU Enclosure Interface Cable
UIMU-LN200 (includes -L)	01018977 Universal IMU Enclosure Interface Cable	01018977 Universal IMU Enclosure Interface Cable
IMU-FSAS	01018977 Universal IMU Enclosure Interface Cable[a] or 01018388 IMU-FSAS Interface Cable with Odometer[a]	01018977 Universal IMU Enclosure Interface Cable or 01018388 IMU-FSAS Interface Cable with Odometer
UIMU-HG1700 AG58 UIMU-HG1700 AG62 IMU-HG1700 AG58 IMU-HG1700 AG62	01018977 Universal IMU Enclosure Interface Cable	01018977 Universal IMU Enclosure Interface Cable
IMU-CPT	01018966 IMU-CPT Cable[a]	01018966 IMU-CPT Cable
IMU-KVH1750	01019211 IMU-KVH1750 Interface Cable[a]	01019211 IMU-KVH1750 Interface Cable
IMU-IGM	01019016 IMU-IGM Interface Cable or 01019013 IMU-IGM Stack Up Cable	01019016 IMU-IGM Interface Cable

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

Table 5: MIC Interface Cables

IMU	Cable
OEM-HG1900	01018828, see *HG1700 and HG1900 IMU-to-MIC Cable Assembly* on page 176
OEM-HG1930	01018827, see *HG1930 IMU-to-MIC Cable Assembly* on page 175
OEM-ADIS-16488	01019008, see *ADIS-16488 IMU-to-MIC Cable Assembly* on page 154
OEM-STIM300	01019161, see *STIM300 IMU-to-MIC Cable Assembly* on page 163

Table 6: UIC Interface Cables

IMU	Cable
OEM-ISA-100C	01019393, see *OEM-IMU-ISA-100C IMU to UIC Cable Assembly* on page 158
OEM-HG1900	01019762, see *HG1900 IMU to UIC Cable Assembly* on page 182
OEM-LN200	01019763, see *LN200 IMU to UIC Cable Assembly* on page 183
OEM-µIMU	01019760, see *µIMU to UIC Cable Assembly* on page 167

2.2 Hardware Set Up

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

1. Mount the GNSS antenna, as described in *Mount the Antenna* on page 34.
2. Mount the IMU, as described in *Mount the IMU* on page 35.
3. Mount the receiver, as described in *Mount the OEM6 Receiver* on page 35.
4. Connect the GNSS antenna to the OEM6 receiver, as described in *Connect the Antenna to the OEM6 Receiver* on page 35.
5. Connect the IMU to the OEM6 receiver, as described in *Connect the IMU to the OEM6 Receiver* on page 36.
6. Connect the I/O strobe signals (optional), as described in *Connect I/O Strobe Signals* on page 37.
7. Connect power to the IMU and receiver, as described in *Connect Power* on page 37.

> NovAtel recommends biasing unused inputs to their default states. See *Appendix A, Technical Specifications* on page 84 for information about the devices in the system.

2.2.1 Mount the Antenna

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

Ensure the antenna cannot move due to dynamics.

2.2.2 Mount the IMU

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

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

Also, it is important to measure the distance from the IMU to the antenna (the Antenna Lever Arm), on the first usage, on the axis defined on the IMU enclosure. See *Lever Arm Calibration Routine* on page 68. See also *Appendix A, Technical Specifications* on page 84 for dimensional drawings of the IMU enclosures.

Ensure the IMU cannot move due to dynamics and that the distance and relative direction between the antenna and the IMU is fixed. See *SPAN IMU Configuration* on page 53.

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

2.2.3 Mount the OEM6 Receiver

The steps required to mount the OEM6 receiver vary depending on the type of OEM6 receiver (card or enclosure) you are using. See the OEM6 Family Installation and Operation User Manual (OM-20000128) or ProPak6 User Manual (OM-20000148) for information about mounting an OEM6 receiver.

2.2.4 Connect the Antenna to the OEM6 Receiver

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

- For a ProPak6 receiver, connect the antenna cable from the connector on the antenna to the ANT (or ANT1) port on the ProPak6. See *Figure 10, Basic Set Up – ProPak6 to Universal IMU Enclosure (LN-200, HG1700, LCI-1) or IMU-FSAS* on page 28, *Figure 11, Basic Set Up – ProPak6 to IMU Enclosure (HG1900, ISA-100C, LN200 or μIMU)* on page 29, *Figure 12, Basic Set Up – ProPak6 to IMU-CPT* on page 30 or *Figure 14, Basic Set Up – ProPak6 to IMU-IGM* on page 32.
- For a FlexPak6 receiver, connect the antenna cable from the connector on the antenna to the Antenna port on the FlexPak6. See *Figure 5, Basic Set Up – FlexPak6 to Universal IMU Enclosure (LN-200, HG1700 or LCI-1)* on page 23, *Figure 6, Basic Set Up – FlexPak6 to IMU Enclosure (HG1900, ISA-100C, LN200 or μIMU)* on page 24, *Figure 7, Basic Set Up – FlexPak6 to IMU-FSAS* on page 25 or *Figure 9, Basic Set Up – FlexPak6 to IMU-IGM* on page 27.
- For OEM6 receiver cards, an RF adapter is required to connect the antenna cable to the receiver card. See the OEM6 Family Installation and Operation User Manual (OM-20000128) for more information.

For best performance, use a high-quality coaxial cable. An appropriate coaxial cable is one that matches the impedances of the antenna and receiver (50 ohms), and has a line loss that does not exceed 10.0 dB. If the limit is exceeded, excessive signal degradation may occur and the receiver may not meet performance specifications.

> NovAtel offers several coaxial cables to meet your GNSS antenna interconnection requirements, including 5, 15 and 30 m antenna cable with TNC connectors on both ends (NovAtel part numbers GPS-C006, GPS-C016 and GPS-C032).

If your application requires the use of a cable longer than 30 m, refer to application note APN-003 RF Equipment Selection and Installation, available at www.novatel.com/support/search/.

2.2.5 Connect the IMU to the OEM6 Receiver

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

For a system with a ProPak6 receiver:

- Connect the IMU interface cable from the IMU to the COM3/IMU port on the ProPak6 receiver.
  See *Figure 10, Basic Set Up – ProPak6 to Universal IMU Enclosure (LN-200, HG1700, LCI-1) or IMU-FSAS* on page 28, *Figure 11, Basic Set Up – ProPak6 to IMU Enclosure (HG1900, ISA-100C, LN200 or µIMU)* on page 29, *Figure 12, Basic Set Up – ProPak6 to IMU-CPT* on page 30, *Figure 13, Basic Set Up – ProPak6 to IMU-KVH1750* on page 31 or *Figure 14, Basic Set Up – ProPak6 to IMU-IGM* on page 32.

> The COM3/IMU port should be used to connect to the IMU.

For a system with a FlexPak6 receiver and an IMU in a Universal IMU Enclosure (LN-200, HG1700 or LCI-1):

- Connect the IMU interface cable from the IMU to the COM 1 or COM 2 port on the FlexPak6.
  See *Figure 5, Basic Set Up – FlexPak6 to Universal IMU Enclosure (LN-200, HG1700 or LCI-1)* on page 23.

For a system with a FlexPak6 receiver and an IMU in an IMU Enclosure (HG1900, ISA-100C, LN200 or µIMU):

- Connect the IMU interface cable from the IMU to the COM 2 port on the FlexPak6.
  See *Figure 6, Basic Set Up – FlexPak6 to IMU Enclosure (HG1900, ISA-100C, LN200 or µIMU)* on page 24.

> To use an IMU-HG1900, IMU-ISA-100C, IMU-LN200 or IMU-µIMU with the FlexPak6 COM2 port, you must short pin 5 to pin 9 on the FlexPak6 I/O port. This changes the COM2 protocol to RS-422.

For a system with a FlexPak6 receiver and an IMU-FSAS, IMU-CPT or IMU-KVH1750:

- Connect a FlexPak Y Adapter cable to the COM 2 and I/O ports on the FlexPak6 receiver. Then, connect the IMU interface cable from the IMU to the FlexPak Y Adapter cable. See *Figure 7, Basic Set Up – FlexPak6 to IMU-FSAS* on page 25 or *Figure 8, Basic Set Up – FlexPak6 to IMU-CPT or IMU-KVH1750* on page 26.

For a system with a FlexPak6 receiver and an IMU-IGM:

- Connect the IMU interface cable (01019016) from the MAIN connector on the IMU-IGM to the COM 2 port on the FlexPak6. See *Figure 9, Basic Set Up – FlexPak6 to IMU-IGM* on page 27.
  If the IMU-IGM is connected to the FlexPak6 using a Stack Up Cable (01019013), you must connect the cable to the COM 2 port.

For a system with a OEM6 receiver card:

- A wiring harness is required between the receiver card and the IMU interface cable. For more information, see the OEM6 Family Installation and Operation User Manual (OM-20000128).

> For systems with an OEM638 receiver, the COM6 port should be used to connect to the IMU.

See *Table 4, Receiver to IMU Interface Cables* on page 33 for information about which interface cable is appropriate for your SPAN system.

2.2.6 Connect I/O Strobe Signals

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

The I/O strobe lines are accessed from the multi-pin connectors on receiver cards or the I/O port on the FlexPak6 and ProPak6. Refer to the OEM6 Family Installation and Operation User Manual (OM-20000128) for more information on signals, wiring and pinout information of the receiver card connectors and the FlexPak6 I/O port. Refer to the ProPak6 User Manual (OM-20000148) for more information on signals, wiring and pinout information of the ProPak6.

2.2.7 Connect Power

> If you are using a MEMS OEM IMU (ADIS-16488, HG1900, HG1930, STIM300) and a MIC, see *MIC Set Up* on page 40 for information about connecting and powering the MIC and IMU.
>
> If you are using an OEM IMU (ISA-100C, HG1900, LN200 or µIMU) and a UIC, see *UIC Set Up* on page 49 for information about connecting and powering the UIC and IMU.

2.2.7.1 Receiver Power

The power requirements for the OEM6 family receiver cards are shown in *Table 7*. For information about connecting power to an OEM6 receiver card, see the OEM6 Family Installation and Operation User Manual (OM-2000128).

Table 7: OEM6 Family Receiver Card Power Requirements

Receiver	Power Requirements
OEM615	+3.3 VDC ±5% (<100 mV p-p ripple)
OEM617	+3.3 VDC +5%/-3% (<100 mV p-p ripple)
OEM617D	+3.3 VDC +5%/-3% (<100 mV p-p ripple)
OEM628	+3.3 VDC ±5% (<100 mV p-p ripple)
OEM638	+3.3 VDC +5%/-3% (<100 mV p-p ripple) or +4.5 to +36 VDC

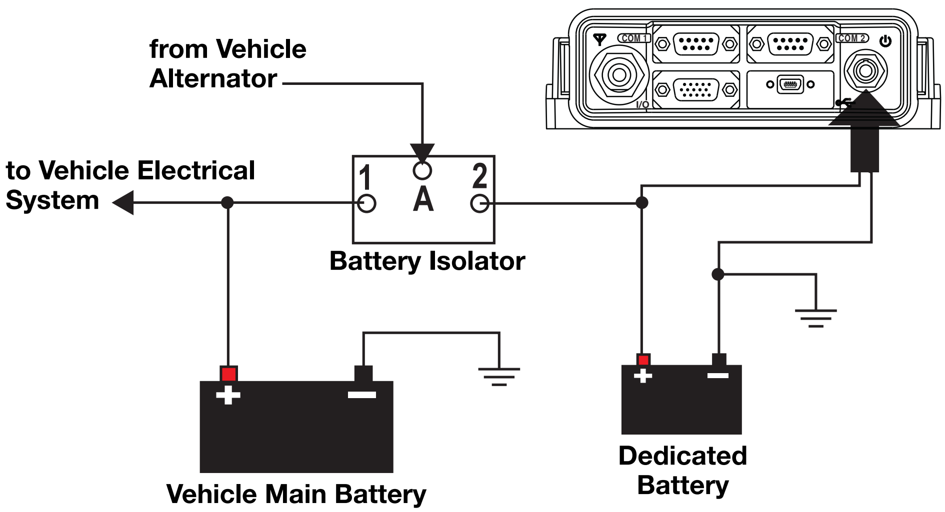
The FlexPak6 receiver requires an input voltage of +6 to +36 VDC. The ProPak6 receiver requires an input voltage of +9 to +36 VDC. A 12 V automotive adapter is supplied with the FlexPak6 and ProPak6, but any appropriate DC power source can be used. The FlexPak6 and ProPak6 have an internal power module that:

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

> The 12 V automotive adapter contains a 6 A fuse. If an alternate power connection is used, a user supplied 6 A slow blow fuse, in a suitable holder, must be used to protect both the power supply and your warranty. See the OEM6 Family Installation and Operation User Manual (OM-20000128) or ProPak6 User Manual (OM-20000148) for details. The car adapter is not recommended for use if your power source is greater than 12 V.

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

If the receiver is installed in a vehicle, it is recommended that a dedicated battery be provided for the receiver that is isolated from the engine starter battery. When a vehicle engine is started, the voltage on the starter battery can dip to 9.6 VDC or cut-out to ancillary equipment causing the receiver and IMU to lose lock and calibration settings.



For pinout information about the power connector on the FlexPak6, refer to the OEM6 Family Installation and Operation User Manual (OM-20000128). For pinout information about the power connect on the ProPak6, refer to the ProPak6 User Manual (OM-20000148).

2.2.7.2 IMU Power

In addition to the receiver power supply, a power supply is needed for the IMU. See *Table 8, IMU Power Supply* for the voltage requirements for each IMU. The same power supply can be used for the receiver and the IMU, if the power supply meets the power requirements of both devices.

> If the SPAN system has an IMU-IGM connected to the COM2 port on a FlexPak6 using the Stack Up Cable (01019013), power for the IMU-IGM is provided by the FlexPak6 through the Stack Up Cable.

Table 8: IMU Power Supply

IMU	Power Requirement
IMU-CPT	+9 to +18 V DC
iIMU-FSAS	+10 to +34 V DC
IMU-HG1900	+10 to +34 V DC
IMU-IGM	+10 to +30 V DC
IMU-ISA-100C	+10 to +34 V DC
IMU-LN200	+10 to +34 V DC
IMU-μIMU	+10 to +34 V DC
UIMU-HG1700 (AG58 or AG62)	+12 to +28 V DC
IMU-KVH1725	+9 to +36 V DC
IMU-KVH1750	+9 to +36 V DC
UIMU-LCI	+12 to +28 V DC
UIMU-LN200	+12 to +28 V DC

For most IMUs, connect the power leads on the IMU interface cable to the IMU power supply.
For an IMU in the IMU Enclosure (IMU-HG1900, IMU-ISA-100C, IMU-LN200 or IMU-μIMU), connect the IMU Power Cable (NovAtel part # 60723136) from the IMU to the IMU power supply.

Details about the IMU ports and cables can be found in *Appendix A, Technical Specifications* on page 84.

2.2.8 Connect the Additional Communication Ports on a ProPak6

In addition to the three COM ports (COM1, COM2 and COM3/IMU) on the back of the ProPak6, there are four additional COM ports available from the EXP port. To access these ports, connect the ProPak6 Expansion Cable (01019154) to the EXP port. For more information about this cable, see the ProPak6 User Manual.

2.2.9 Connect the CAN Bus

OEM6 family receivers incorporate a CAN Bus controller that supports physical layer signals and low level messages specified in the appropriate sections of the J1939 and ISO11783 standards. Manufacturers can also create messages specific to their application without violating these standards. To facilitate manufacturer messages, NovAtel provides an Application Program Interface (API). To obtain information about this API, contact NovAtel Customer Support.

The OEM6 family receiver cards have two CAN Bus ports, CAN1 and CAN2, which are available on the multi-pin connectors. See the OEM6 Family Installation and Operation User Manual (OM-20000128) for pinout descriptions of the multi-pin connectors.

The FlexPak6 receiver has one CAN Bus port, CAN1, which is available on the I/O port. See the OEM6 Family Installation and Operation User Manual (OM-20000128) for pinout descriptions of the I/O port.

The ProPak6 receiver has two CAN Bus ports, CAN1 and CAN2, which are available on the EXP port. To access these signals, use the ProPak6 Expansion Cable (01019154). For information about the EXP port and the ProPak6 Expansion Cable, see the ProPak6 User Manual (OM-2000148).

2.3 MIC Set Up

OEM6 family receiver cards connect to Micro Electromechanical Systems (MEMS) IMUs using the MEMS Interface Card (MIC).

> IMUs have different interface requirements. Use a MIC to connect MEMS IMUs (ADIS-16488, HG-1700, HG-1900, HG-1930 or STIM-300) to an OEM6 family receiver. For other supported OEM IMUs (e.g. ISA100C, LN200, HG-1900 or μIMU), use a Universal IMU Controller (UIC). See *UIC Set Up* on page 49.

There are two MIC configurations: stack up and standalone. In a stack up configuration, the MIC card is mounted on an OEM615 receiver. In a standalone configuration, the MIC is mounted separately from the receiver.

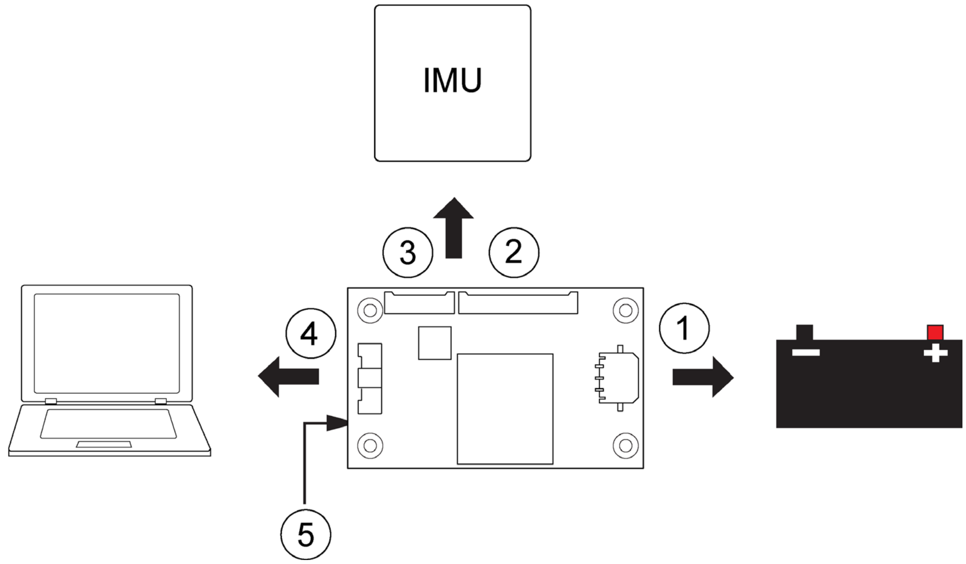
> The MIC supports OEM6 family receiver cards for communications. The OEM615 is the only OEM6 family receiver card that can be directly integrated and powered by the MIC.

2.3.1 Install a MIC in a Stack Up Configuration

In a stack up configuration, the MIC is connected to an OEM615 receiver using the 20-pin header on the OEM615. Power and communications connections to the receiver are made through the MIC.

> ***Important!*** Assemble in accordance with applicable industry standards. Ensure all Electrostatic Discharge (ESD) measures are in place, in particular, use a ground strap before exposing or handling any electronic items, including the MIC, receiver and IMU. Take care to prevent damaging or marring painted surfaces, O-rings, sealing surfaces and the IMU.
>
> For more information about ESD practices, see the OEM6 Family Installation and Operation User Manual (OM-20000128).

Figure 15: Basic Set Up – MIC in Stack Up Configuration



Ref	Connector	Part Number	Mating Connector	Description
1	P101	43650-0313 (Molex)	43645-0300 (Molex)	Connects to the MIC power supply. This connection provides power to the MIC and the OEM615 receiver. (user supplied cable)
2	P601	53780-2070 (Molex)	51146-2000 (Molex)	Connects to HG1700, HG1900, HG1930 and STIM300 IMUs. (NovAtel supplied cable kit)
3	P701	53780-1070 (Molex)	51146-1000 (Molex)	Connects to ADIS-16488 IMUs. (NovAtel supplied cable kit)
4	P301	501571-3007 (Molex)	501189-3010 (Molex)	Connects the MIC and OEM615 communication signals to the user system. (user supplied cable)
5	J301	ASP-163577-01 (Samtec)	N/A	Connects to the main connector (P1101) on an OEM615 receiver. J301 is on the bottom of the MIC card

2.3.1.1 Mount the OEM615 Receiver and MIC

1. Mount the GNSS antenna. See *Mount the Antenna* on page 34.
2. Use the standoffs supplied with the MIC card to secure the OEM615 to its mounting location. See *Figure 16, Mount the MIC on the OEM615* on page 42. See the OEM6 Family Installation and Operation User Manual (OM-20000128) for information about mounting printed circuit boards.

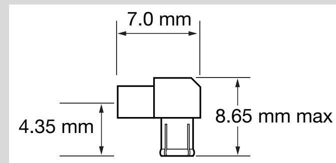
> The part number for the recommended standoffs is RAF-M21073005AL7 (Irwin Industrial).
>
> If alternate standoffs are selected, use equivalent parts with a minimum height of 12 mm.

> Ensure all standoffs are properly installed and the mounting location is level.
>
> The amount of board deflection (bow and twist) must not exceed 0.75%. For example, on the OEM615 which is 71 mm long and 46 mm wide, the deflection along the length must not exceed 0.53 mm and the deflection along the width must not exceed 0.34 mm.

3. Connect the antenna cable to the antenna jack on the OEM615.
   The antenna cable must have a right angle MCX connector on the end that connects to the OEM615.

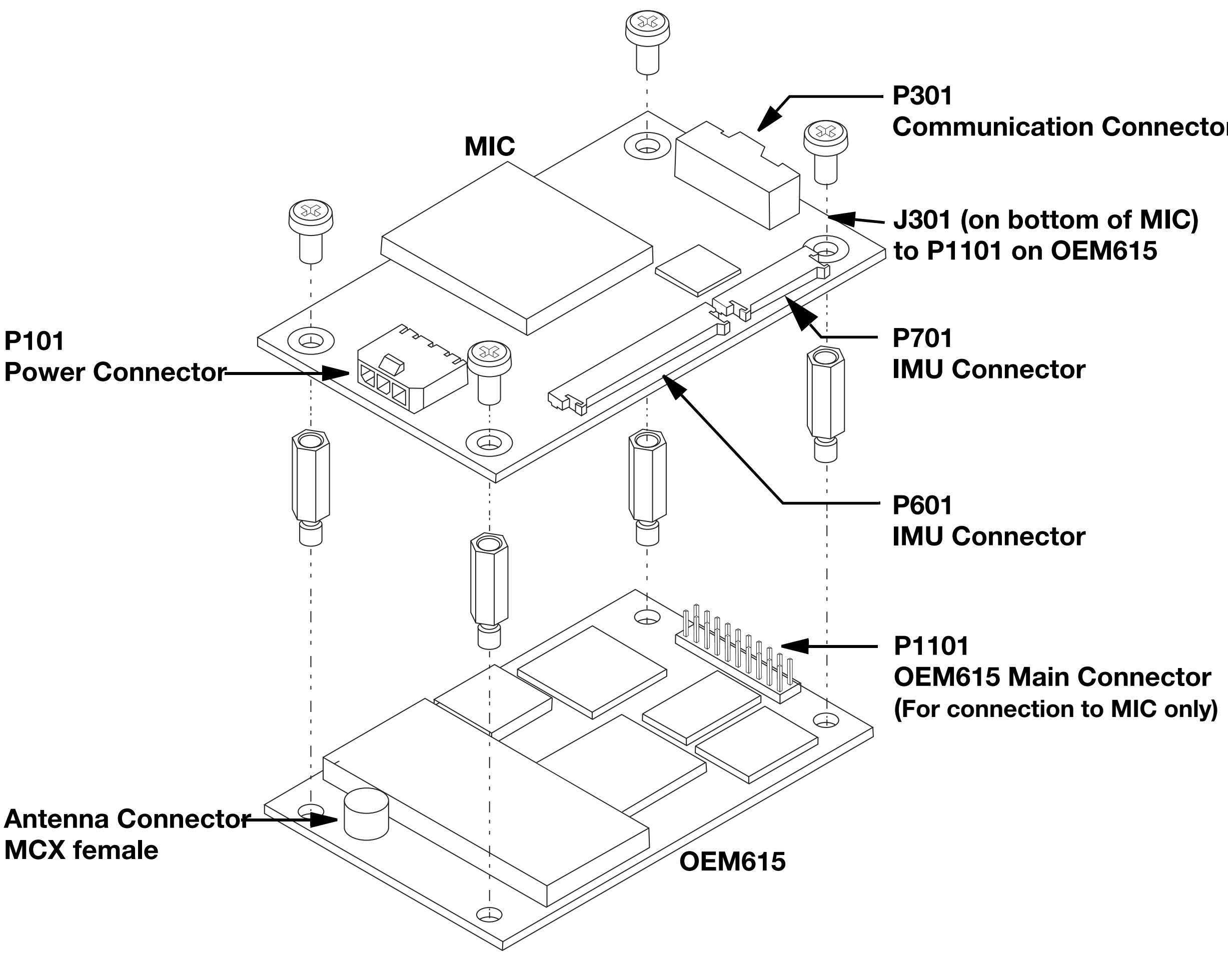
> ***Warning!*** Do not apply power to the cards until the antenna cable is attached.

> The part number for the recommended MCX connector is M1051-110 (ShinA Telecom). If an alternate part is used, it should meet the dimensions shown in the diagram.
>
> The space between the OEM615 and the MIC is limited. The height of the MCX connector **must not** exceed 8.65 mm.



4. Align the OEM615 mating connector (J301) on the MIC with the 20-pin header (P1101) on the OEM615.
   Make sure all of the pins on the header are aligned with the holes in the mating connector.
   Press down on the MIC to seat the connector on the header.
5. Use the four screws supplied with MIC to secure the MIC card to the OEM615.

Figure 16: Mount the MIC on the OEM615



2.3.1.2 Connect the IMU to the MIC

1. Attach the IMU mounting Printed Circuit Board (PCB) to the IMU.
   Ensure all the pins on the header are aligned with the holes on the mating connector.

> An IMU mounting PCB is not used with the STIM300 IMU.

2. Mount the IMU. See *Mount the IMU* on page 35.
3. Connect the IMU-to-MIC interface cable to the IMU.
4. Connect the IMU-to-MIC interface cable to the IMU connector on the MIC.
   - Use the 10 pin locking connector (P701) for the ADIS IMUs.
     See *Figure 17, Connect the ADIS IMU to the MIC (OEM Cable Kit: 01019007)* on page 43.
   - Use the 20 pin locking connector (P601) for the HG1700, HG1900, HG1930 or STIM300 IMU.
     See *Figure 18, Connect the HG1700 IMU to the MIC (OEM Cable Kit: 01018868)* on page 43, *Figure 19, Connect the HG1900 IMU to the MIC (OEM Cable Kit: 01018871)* on page 44, *Figure 20, Connect the HG1930 IMU to the MIC (OEM Cable Kit: 01018869)* on page 44 or *Figure 21, Connect the STIM300 IMU to the MIC (OEM Cable Kit: 01019174)* on page 44.

Figure 17: Connect the ADIS IMU to the MIC (OEM Cable Kit: 01019007)

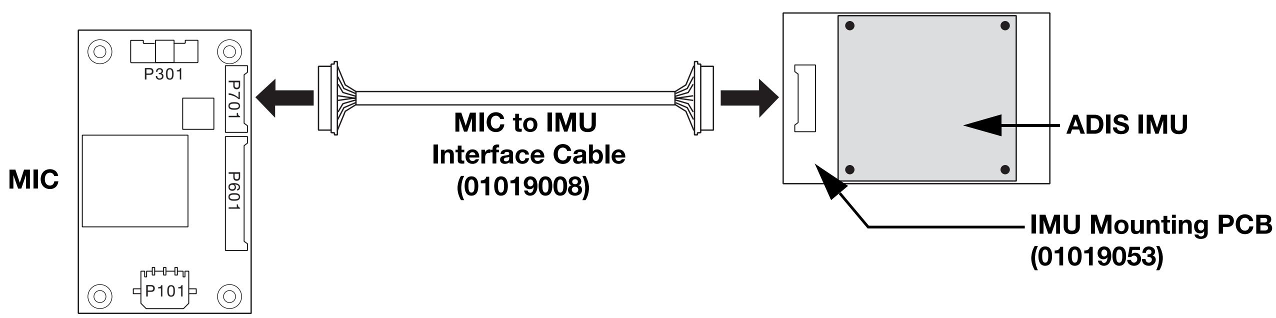


Figure 18: Connect the HG1700 IMU to the MIC (OEM Cable Kit: 01018868)

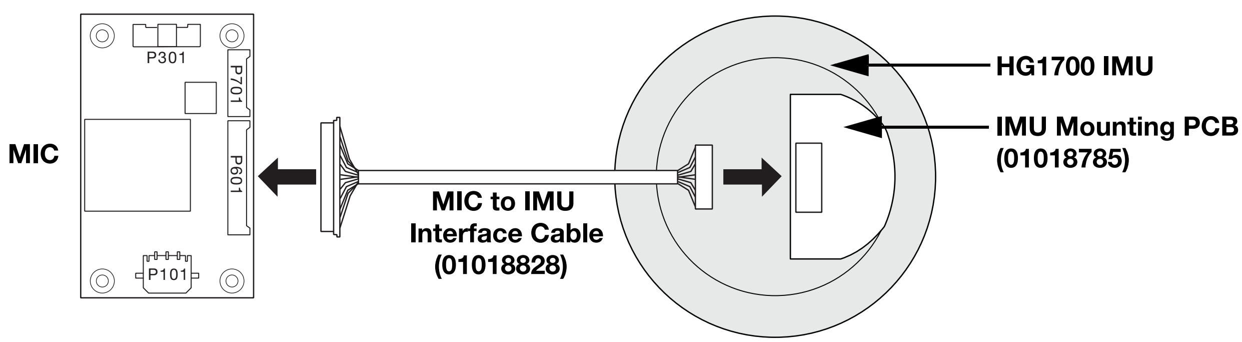


Figure 19: Connect the HG1900 IMU to the MIC (OEM Cable Kit: 01018871)

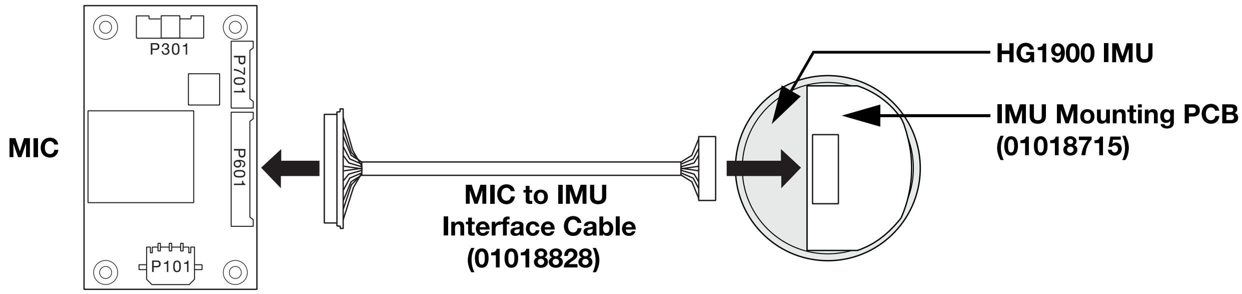


Figure 20: Connect the HG1930 IMU to the MIC (OEM Cable Kit: 01018869)

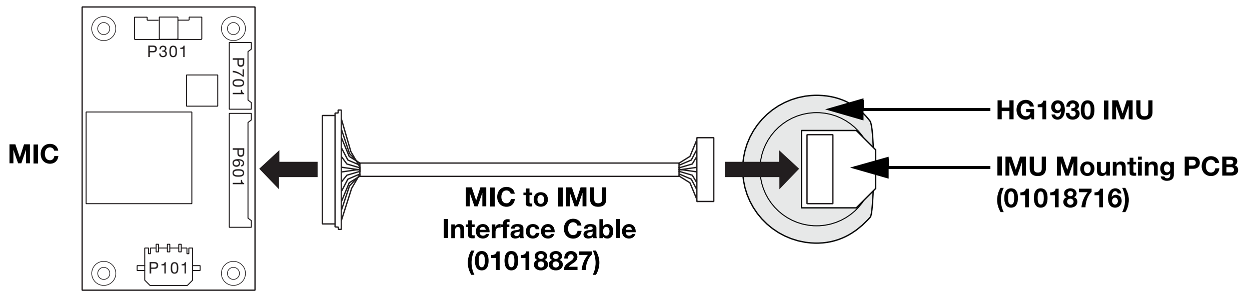
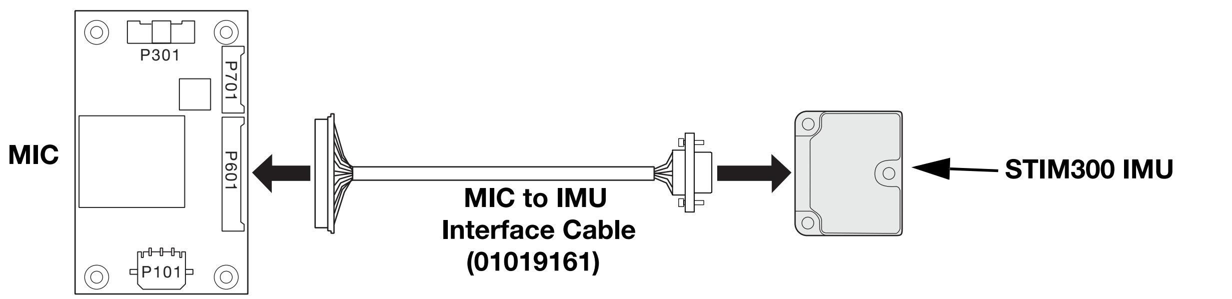


Figure 21: Connect the STIM300 IMU to the MIC (OEM Cable Kit: 01019174)



2.3.1.3 Connect Power to the MIC

Connect a +10 to +30 V DC power supply to the power connector (P101) on the MIC. See *MIC Connectors* on page 170 for pinout information for the power connector.

> This connection provides power to the MIC and the OEM615.

2.3.1.4 Connect the Input and Output Signals

All of the communication connections to the MIC and the OEM615 receiver are available on the communications connector (P601) on the MIC. These connections include:

- MIC serial port
- OEM615 serial port (COM2)
- USB port
- Event1 trigger input
- Event2 trigger input
- 1 PPS (Pulse Per Second) output
- VARF (Variable Frequency) output
- Reset input
- Position Valid output

See *MIC Connectors* on page 170 for the pinouts of the communications connector.

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

To connect the MIC to devices that use other signals levels, such as a computer with an RS-232 serial port, an interface circuit that converts LVTTL to the other signal level must be used.

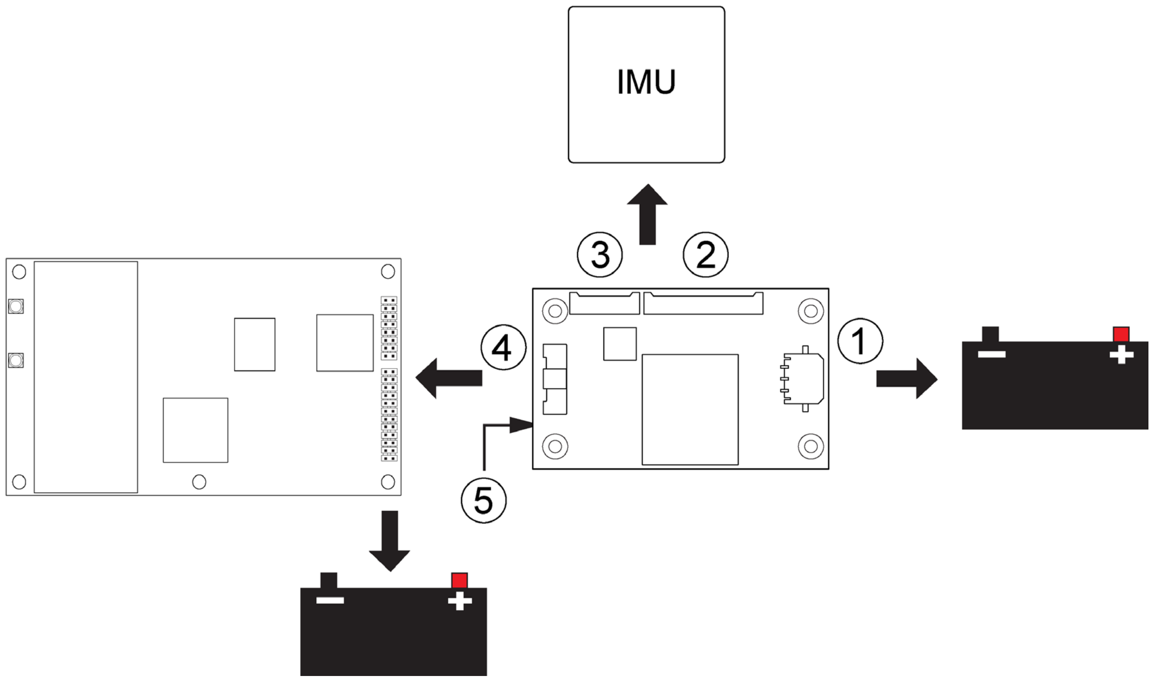
Use a twisted pair for the USB port connection and keep the wires as short as possible.

2.3.2 Install a MIC in a Standalone MIC Set Up

In a standalone configuration, the MIC is mounted separately from the OEM6 receiver.

> ***Important!*** Assemble in accordance with applicable industry standards. Ensure all Electrostatic Discharge (ESD) measures are in place, in particular, use a ground strap before exposing or handling any electronic items, including the IMU. Take care to prevent damaging or marring painted surfaces, O-rings, sealing surfaces and the IMU.
>
> For more information about ESD practices, see the <u>OEM6 Family Installation and Operation User Manual</u> (OM-20000128).

Figure 22: Basic Set Up – MIC in Standalone Configuration



Ref	Connector	Part Number	Mating Connector	Description
1	P101	43650-0313 (Molex)	43645-0300 (Molex)	Connects to the MIC power supply. (user supplied cable)
2	P601	53780-2070 (Molex)	51146-2000 (Molex)	Connects to HG1700, HG1900, HG1930 and STIM300 IMUs. (NovAtel supplied cable)
3	P701	53780-1070 (Molex)	51146-1000 (Molex)	Connects to ADIS-16488 IMUs. (NovAtel supplied cable)
4	P301	501571-3007 (Molex)	501189-3010 (Molex)	Connects the MIC serial port to the OEM6 receiver. (user supplied cable)
5	J301	ASP-163577-01 (Samtec)	N/A	This connector is not used in a standalone configuration.

> For information about the OEM6 receiver card connectors and pinouts, refer to the <u>OEM6 Family Installation and Operation User Manual</u> (OM-20000128).

> **OEM628 Recommendations**
> - Use COM1 for connection to a computer. COM1 uses RS-232 levels and can be connected to a computer without additional interface circuitry.
> - Use COM2 for connection to the MIC serial port. Both the MIC serial port and COM2 use LVTTL levels and can be connected without additional interface circuitry.

> **OEM638 Recommendations**
> - Use COM1 or COM2 for connection to a computer. COM1 and COM2 use RS-232 levels and can be connected to a computer without additional interface circuitry.
> - Use COM3 for connection to the MIC serial port. This COM port and the MIC serial port use LVTTL levels and can be connected without additional interface circuitry.

2.3.2.1 Mount the OEM6 receiver and MIC

1. Mount the antenna. See *Mount the Antenna* on page 34.
2. Mount OEM6 receiver. See the OEM6 Family Installation and Operation User Manual (OM-20000128) for information about installing an OEM6 receiver.
3. Use the screws supplied with the MIC card to secure the MIC to its mounting location. See *MIC - MEMS Interface Card* on page 168 for the MIC dimensions.

> Ensure all standoffs are properly installed and the mounting location is level.
>
> The amount of board deflection (bow and twist) must not exceed 0.75%. For example, on the MIC which is 75 mm long and 46 mm wide, the deflection along the length must not exceed 0.56 mm and the deflection along the width must not exceed 0.34 mm.

2.3.2.2 Connect the IMU to the MIC

1. Attach the IMU mounting Printed Circuit Board (PCB) to the IMU.
   Ensure all the pins on the header are aligned with the holes on the mating connector.

> An IMU mounting PCB is not used with the STIM300 IMU.

2. Mount the IMU. See *Mount the IMU* on page 35.
3. Connect the IMU-to-MIC interface cable supplied with the MIC to the IMU.
4. Connect the IMU-to-MIC interface cable to the IMU connector on the MIC.
   - Use the 10 pin locking connector (P701) for ADIS IMUs.
     See *Figure 17, Connect the ADIS IMU to the MIC (OEM Cable Kit: 01019007)* on page 43.
   - Use the 20 pin locking connector (P601) for the HG1700, HG1900, HG1930 or STIM300 IMU.
     See *Figure 18, Connect the HG1700 IMU to the MIC (OEM Cable Kit: 01018868)* on page 43, *Figure 19, Connect the HG1900 IMU to the MIC (OEM Cable Kit: 01018871)* on page 44, *Figure 20, Connect the HG1930 IMU to the MIC (OEM Cable Kit: 01018869)* on page 44 or *Figure 21, Connect the STIM300 IMU to the MIC (OEM Cable Kit: 01019174)* on page 44.

2.3.2.3 Connect Power to the MIC and OEM6 receiver

> In a standalone configuration, a separate power supply is required for the OEM6 family receiver. For information about the power supply requirements, refer to the Technical Specifications appendix for the receiver card in the OEM6 Family Installation and Operation User Manual (OM-20000128).

1. Connect a +10 to +30 V DC power supply to the power connector (P101) on the MIC. See *MIC Connectors* on page 170 for pinout information for the power connector.
2. Connect power to the OEM6 receiver. See the OEM6 Family Installation and Operation User Manual (OM-2000128) for information about connecting power to the receiver.

2.3.2.4 Connect the MIC to a receiver

Use the MIC serial port to connect the MIC to the OEM6 receiver. The MIC serial port is available on the communications connector (P301) of the MIC. See *MIC Connectors* on page 170 for the pinouts of the communications connector. See the OEM6 Family Installation and Operation User Manual (OM-20000128) for information about connecting a serial port to the receiver.

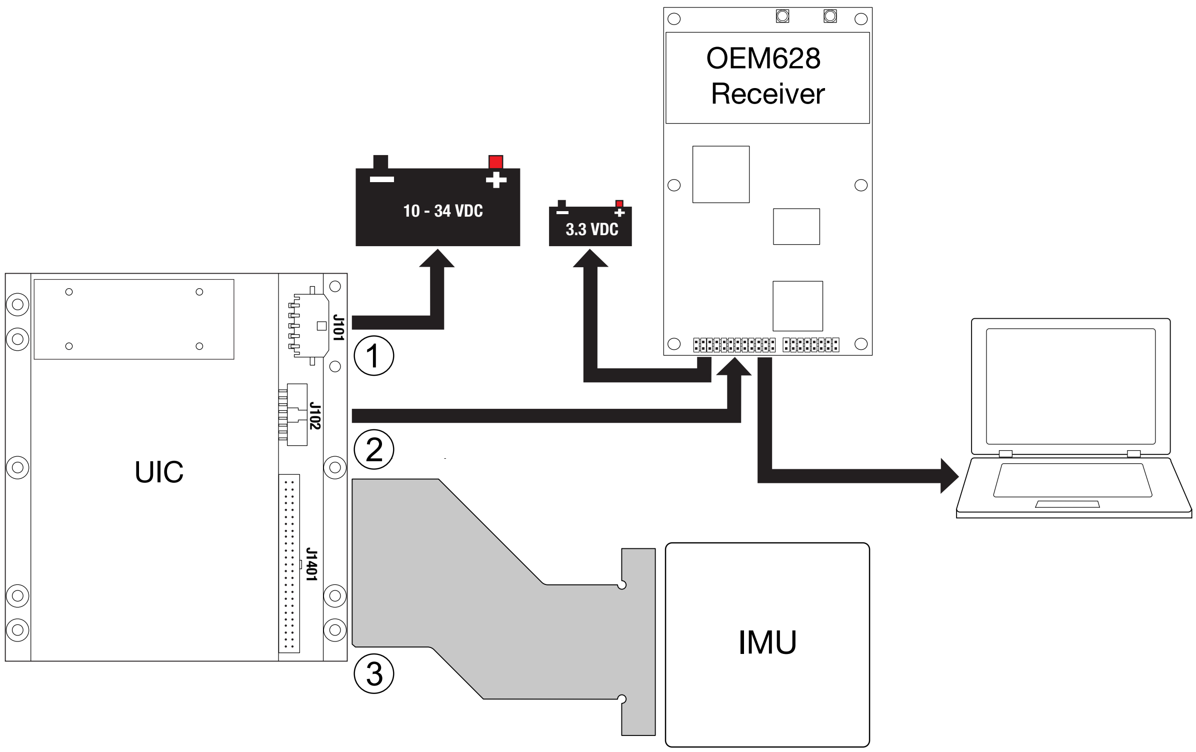
> All signal I/O on the MIC, with the exception of the USB port, are at LVTTL levels.
>
> To connect the MIC to devices that use other signals levels, such as a computer with an RS-232 serial port, an interface circuit that converts LVTTL to the other signal level must be used.

2.4 UIC Set Up

For IMUs that are not mounted inside a NovAtel IMU enclosure (e.g. OEM-IMU-ISA-100C), an interface card is required to connect the IMU to the OEM6 family receiver. The Universal IMU Controller (UIC) provides the connection between OEM6 family receiver cards and IMUs.

IMUs have different interface requirements. Use a UIC to connect OEM IMUs (ISA-100C, LN200, HG-1900 or µIMU) to an OEM6 receiver. Use a MEMS Interface Card (MIC) to connect MEMS OEM IMUs (ADIS-16488, HG-1700, HG-1900, HG-1930 or STIM-300) to an OEM6 family receiver. See *Section 2.3, MIC Set Up* on page 40.

Figure 23: Basic UIC Set Up



Ref	Connector	Part Number	Mating Connector	Description
1	J101	43650-0513 (Molex)	43645-0500 (Molex)	Connects to the UIC power supply. (user supplied cable)
2	J102	98464-G61-16LF (FCI)	90311-016LF (FCI)	Connects the UIC serial port to the OEM6 receiver (user supplied cable)
3	J1401	LTMM-125-02-L-D (Samtec)	SQT-125-01-L-D (Samtec)	Connects to the IMU. (NovAtel supplied cable)

For information about the UIC connectors and pinouts, see *Section A.17.3, UIC Connectors* on page 179.

For information about the OEM6 receiver card connectors and pinouts, refer to the OEM6 Family Installation and Operation User Manual (OM-20000128).

> ***Important!*** Ensure all Electrostatic Discharge (ESD) measures are in place, in particular, use a ground strap before exposing or handling any electronic items, including the IMU. Take care to prevent damaging the UIC, receiver or IMU.
>
> For more information about ESD practices, see the OEM6 Family Installation and Operation User Manual (OM-20000128).

2.4.1 Mount the SPAN System Components

1. Mount the antenna. See *Mount the Antenna* on page 34.
2. Mount OEM6 receiver. See the OEM6 Family Installation and Operation User Manual (OM-20000128) for information about installing an OEM6 receiver.
3. Mount the IMU. See *Mount the IMU* on page 35.
4. Install the UIC in a secure enclosure to reduce environmental exposure and RF interference. If there is sufficient space, the UIC can reside in the same enclosure as the receiver.
   Use M3 pan head stainless steel screws to secure the UIC to its mounting location. See *UIC - Universal IMU Controller* on page 177 for the UIC dimensions.

> Ensure the UIC is mounted close enough to the IMU so the interface cable can reach both devices. For the length of the interface cable, refer to the specifications for the IMU in *Appendix A, Technical Specifications* on page 84.

> Ensure the mounting location provides at least 5 mm of clearance below the board to allow for components on the bottom of the UIC.
>
> Ensure all standoffs are properly installed and the mounting location is flat.
>
> The amount of board deflection (bow and twist) must not exceed 0.75%. For example, on the UIC which is 100 mm long and 113 mm wide, the deflection along the length must not exceed 0.75 mm and the deflection along the width must not exceed 0.85 mm.

2.4.2 Connect the IMU to the UIC

1. If using an ISA-100C, attach the screw kit to the IMU to UIC interface cable.
2. Connect the IMU to UIC interface cable supplied with the UIC to the IMU. For IMU cables with screws, secure the cable to the IMU using the screws.
3. Connect the IMU to UIC interface cable to the IMU connector (J1401) on the UIC.

2.4.3 Connect the UIC to a receiver

1. Using a customer supplied wiring harness, connect the UIC serial port to a serial port on the OEM6 receiver. See *Section A.17.3, UIC Connectors* on page 179 for pinout information for the communications connector (J102).

> The serial port on the UIC uses RS-422 levels.
>
> To connect the UIC to devices that use other signals levels, such as an LVTTL COM port on the GNSS receiver, an interface circuit that converts to and from RS-422 must be used.

Table 9: COM Port Recommendations

OEM615 OEM617	• All of the COM ports on these receivers use LVTTL levels. An interface circuit that converts to and from RS-422 levels is required for the port connected to the UIC.
OEM628	• COM1 on the OEM628 receiver can use RS-232 levels (default) or RS-422 levels. To use COM1 for connection to the UIC, configure the COM1 port to use RS-422 levels. Refer to the OEM6 Family Installation and Operation User Manual for information about changing COM1 to RS-422 levels. • COM2 and COM3 on the OEM628 receiver use LVTTL levels. To use COM2 or COM3 for connection to the UIC serial port, an interface circuit that converts to and from RS-422 levels is required.
OEM638	• Use COM1 or COM2 for connection to a computer. COM1 and COM2 use RS-232 levels and can be connected to a computer without additional interface circuitry. • Use COM6 for connection to the UIC serial port. To use COM6, the port must be changed to RS-422 levels. Refer to the OEM6 Family Installation and Operation User Manual for information about changing COM6 to RS-422 levels.

For information about the OEM6 receiver card connectors and pinouts, refer to the OEM6 Family Installation and Operation User Manual.

2. Connect a computer (for monitoring and configuration) to the OEM6 receiver.
   Refer to the OEM6 Family Installation and Operation User Manual for information about connecting data communications equipment to an OEM6 receiver.

2.4.4 Connect Power to the UIC and OEM6 receiver

OEM615, OEM617 and OEM628

A separate power supply is required for the OEM6 family receiver.
For information about the power supply requirements, refer to the Technical Specifications appendix for the receiver card in the OEM6 Family Installation and Operation User Manual (OM-20000128).

OEM638, FlexPak6 and ProPak6

The same power supply can be used for the UIC and the receiver if the power supply provides +10 to +34 V DC and can provide enough power for both devices.
For information about the power supply requirements, refer to the Technical Specifications appendix for the receiver in the OEM6 Family Installation and Operation User Manual (OM-20000128) or the ProPak6 User Manual (OM-20000148).

1. Using a customer supplied wiring harness, connect a +10 to +34 V DC power supply to the power connector (J101) on the UIC.
   See *UIC Connectors* on page 179 for pinout information for the power connector.

2. Using a customer supplied wiring harness, connect power to the OEM6 receiver. See the OEM6 Family Installation and Operation User Manual (OM-2000128) for information about connecting power to the receiver.

2.4.5 UIC Status LEDs

The LEDs on the UIC provide basic status information.

Figure 24: UIC Status LEDs

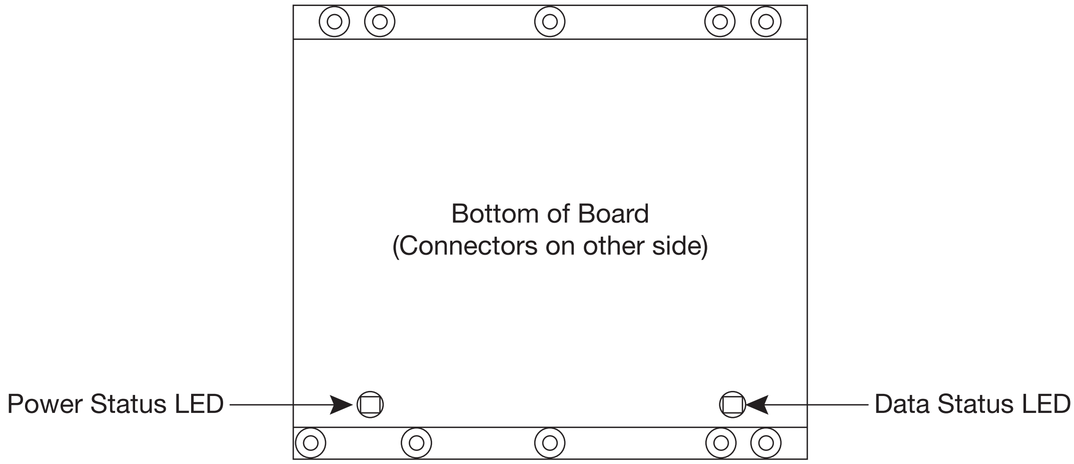


Table 10: UIC Status LEDs

LED	Off	On (Red)	On (Green)	Flash Slow (Yellow, 1 Hz)	Flash Fast (Yellow, 3 Hz)
Power	No power to UIC.	An error occurred during boot up or initialization.	UIC is powered on with no errors detected during boot up or initialization.	Boot up and IMU initialization.	N/A
Data	No communication between UIC and GNSS receiver.	N/A	UIC is transmitting and receiving data without errors.	UIC is receiving data from the receiver, but not transmitting data.	UIC is transmitting data to the receiver, but not receiving data.

2.5 Software Configuration

2.5.1 GNSS Configuration

The GNSS configuration can be set up for different accuracy levels such as single point, SBAS, DGPS and RTK (RTCA, RTCM, RTCM V3 and CMR). ProPak6, FlexPak6, OEM638 and OEM628 receivers can also be set up for L-Band corrections. Refer to the OEM6 Family Installation and Operation User Manual (OM-2000128) for details on DGPS, RTK, L-Band or SBAS setup and operation.

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

2.5.2 SPAN IMU Configuration

2.5.2.1 Configure SPAN Manually

Follow these steps to enable INS as part of the SPAN system using software commands or see *SPAN Configuration with NovAtel Connect* on page 54 for the alternate method using the NovAtel Connect software utility:

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

1. Issue the **CONNECTIMU** command to specify the type of IMU being used and the receiver port connected to the IMU, see *Table 11, Enable INS Commands* on page 53 and the CONNECTIMU command.

Table 11: Enable INS Commands

IMU Type	CONNECTIMU command
ADIS-16488	CONNECTIMU COMx[a] IMU_ADIS16488
HG1700 AG11	CONNECTIMU COMx[a] IMU_HG1700_AG11
HG1700 AG17	CONNECTIMU COMx[a] IMU_HG1700_AG17
HG1700 AG58	CONNECTIMU COMx[a] IMU_HG1700_AG58
HG1700 AG62	CONNECTIMU COMx[a] IMU_HG1700_AG62
HG1900 CA50	CONNECTIMU COMx[a] IMU_HG1900_CA50
HG1930 CA50	CONNECTIMU COMx[a] IMU_HG1930_CA50
iIMU-FSAS	CONNECTIMU COMx[b] IMU_IMAR_FSAS
IMU-CPT	CONNECTIMU COMx[b] IMU_KVH_COTS
IMU-IGM-A1	CONNECTIMU COMx[a] IMU_ADIS16488
IMU-IGM-S1	CONNECTIMU COMx[a] IMU_STIM300
IMU-ISA-100C	CONNECTIMU COMx[b] IMU_ISA100C
IMU-ISA-100C (400 Hz)	CONNECTIMU COMx[b] IMU_ISA100C_400HZ
IMU-KVH1725	CONNECTIMU COMx[b] IMU_KVH_1725
IMU-KVH1750	CONNECTIMU COMx[b] IMU_KVH_1750
IMU-µIMU	CONNECTIMU COMx[b] IMU_LITEF_MICROIMU
LCI-1	CONNECTIMU COMx[a] IMU_LITEF_LCI1
LN-200	CONNECTIMU COMx[a] IMU_LN200
STIM300	CONNECTIMU COMx[a] IMU_STIM300

a. Use the COM port number the IMU is connected to.
For SPAN systems with a ProPak6 receiver, the IMU must use COM3/IMU.
For SPAN systems with an OEM638 receiver, the IMU must use COM6.
If you are using the OEM615+MIC board stack, you must use COM1.
For SPAN systems with a FlexPak6 or OEM628 receiver, COM2 is the recommended serial port for the IMU, however you can use any available port for these IMUs

b. If you are using a FlexPak6, you must use COM2 for the IMU-CPT, IMU-FSAS, IMU-ISA-100C, IMU-KVH1725. IMU-KVH1750, IMU-LN200 or IMU-µIMU. This is to accommodate the RS-422 protocol used for these IMUs.
For SPAN systems with a ProPak6 receiver, the IMU must use COM3/IMU.
For SPAN systems with an OEM638 receiver, the IMU must use COM6.

2. If the SPAN system uses an OEM-HG1900 IMU connected to a MIC card, issue the following command.

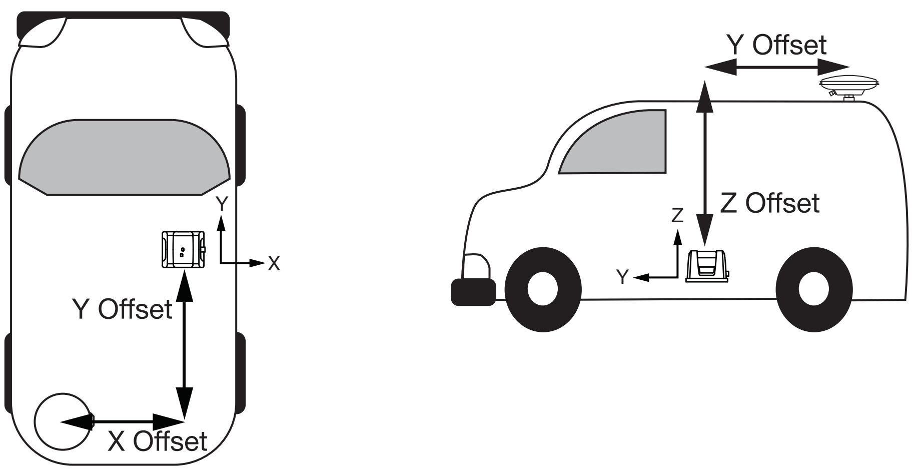
```
SETIMUPORTPROTOCOL RS232
```

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

3. Issue the **SETIMUTOANTOFFSET** command to enter the distance from the IMU to the GNSS antenna. See the SPAN on OEM6 Firmware Reference Manual (OM-20000144) for information about the SETIMUTOANTOFFSET command.

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

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



> This example assumes a default mounting configuration with a -X offset, -Y offset and +Z offset.

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

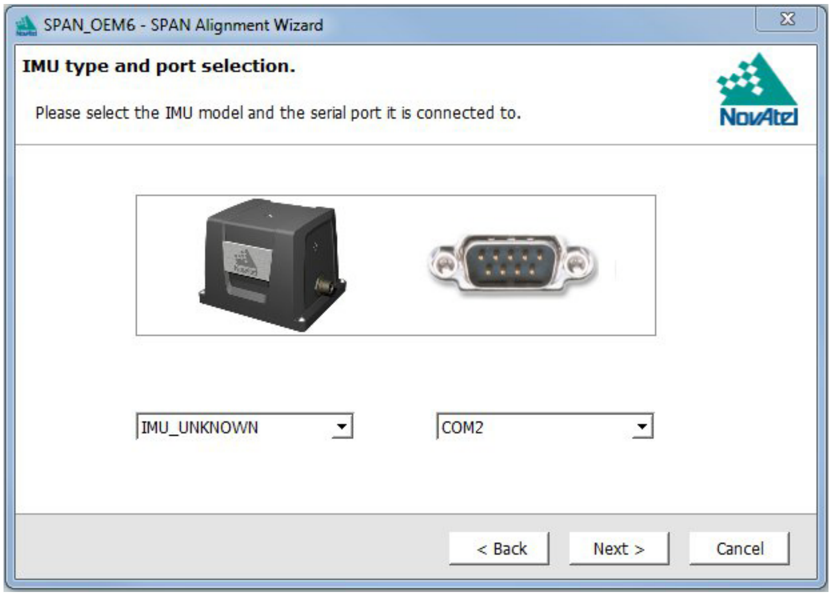
If it is impossible to measure the IMU to GNSS antenna offset precisely, the offset can be estimated by carrying out the Lever Arm Calibration Routine. See *Lever Arm Calibration Routine* on page 68.

2.5.2.2 SPAN Configuration with NovAtel Connect

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

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

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



2.5.2.3 Configuration for Alignment

A coarse alignment routine requires the vehicle to remain stationary for at least 1 minute. If that is not possible, an alternate kinematic alignment routine is available. The kinematic or moving alignment is performed by estimating the attitude from the GNSS velocity vector and injecting it into the SPAN filter as the initial system attitude. See also *System Start-Up and Alignment Techniques* on page 64 for more details on coarse and kinematic alignments.

> The ADIS-16488, IMU-CPT, IMU-IGM, HG1930 and STIM300 IMUs cannot perform coarse alignments, as these IMUs cannot accurately measure Earth rotation. For these IMUs, the default alignment routine is the kinematic alignment. Refer to *Kinematic Alignment* on page 64.
>
> If a stationary alignment is required, refer to *Manual Alignment* on page 65.

2.6 IMU LEDs

The IMU-IGM and IMU Enclosure (IMU-HG1900, IMU-ISA-100C, IMU-LN200, IMU-μIMU) have LEDs that provide the IMUs basic status information.

Table 12: IMU-IGM LEDs

LED	Off	On	Flashing Slow (1Hz)	Flashing Fast (>1Hz)
Power (Red)	No power to unit	Unit is powered on	UNKNOWN or UNSUPPORTED IMU	Programming error
GNSS[a] (Green)	Waiting for GPS time	Time Status FINE or FINESTEERING	Time status COARSE, COARSESTEERING or FREEWHEELING	N/A
INS[a] (Green)	Not connected to IMU	Connected to IMU	N/A	Bootup or loading firmware

a. The IMU-IGM must be connected to a GNSS receiver before the state of these LEDs can change to On.

Table 13: IMU Enclosure LEDs

LED	Off	On (Red)	On (Green)	Flash Slow (Yellow, 1 Hz)	Flash Fast (Yellow, 3 Hz)
Power	No power to IMU Enclosure.	An error occurred during boot up or initialization.	IMU Enclosure is powered on with no errors detected during boot up or initialization.	Boot up and IMU initialization.	N/A
COM	No communication between IMU Enclosure and GNSS receiver.	N/A	IMU Enclosure is transmitting and receiving data without errors.	IMU Enclosure is receiving data from the receiver, but not transmitting data.	IMU Enclosure is transmitting data to the receiver, but not receiving data.

Chapter 3 SPAN Operation

Before operating your SPAN system, ensure that you have followed the installation and setup instructions in *Chapter 2, SPAN Installation* on page 21.

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

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

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

3.1 Definition of Reference Frames Within SPAN

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

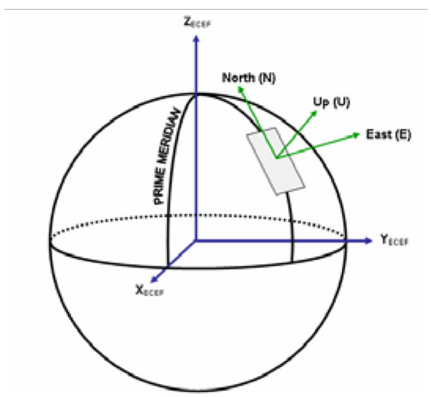
- the Local-Level Frame
- the SPAN Body Frame
- the Enclosure Frame
- the Vehicle Frame

3.1.1 *The Local-Level Frame (ENU)*

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

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

Figure 25: Local-Level Frame (ENU)



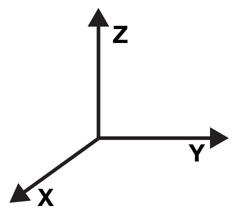
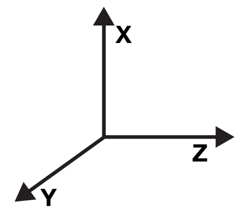
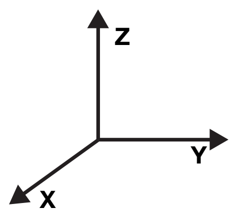
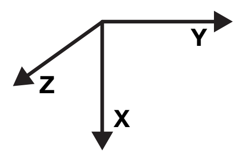
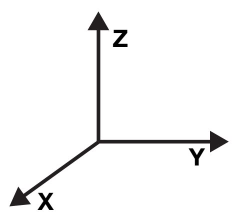
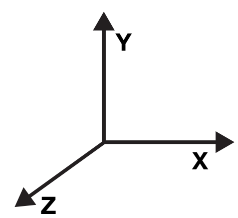
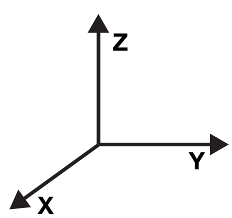
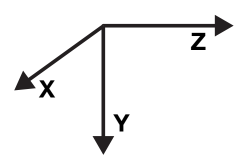
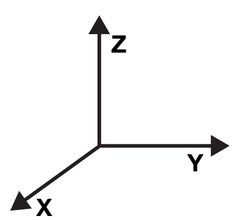
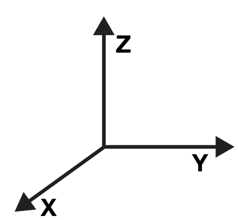
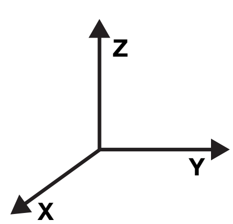
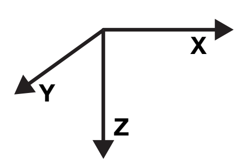
3.1.2 *The SPAN Body Frame*

The definition of the SPAN body frame is as follows:

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

To determine your SPAN x-axis and y-axis, see *Table 14, Full Mapping Definitions* on page 58. This frame is also known as the computation frame and is the frame where all the mechanization equations are computed.

Table 14: Full Mapping Definitions

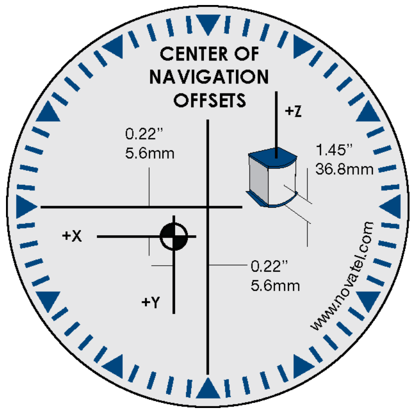
Mapping	SPAN Frame Axis	SPAN Frame	IMU Enclosure Frame Axis	IMU Enclosure Frame
1	X		Y	
	Y		Z	
	Z		X	
2	X		Z	
	Y		Y	
	Z		-X	
3	X		Z	
	Y		X	
	Z		Y	
4	X		X	
	Y		Z	
	Z		-Y	
5 (default)	X		X	
	Y		Y	
	Z		Z	
6	X		Y	
	Y		X	
	Z		-Z	

3.1.3 The Enclosure Frame

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

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

Figure 26: The Enclosure Frame

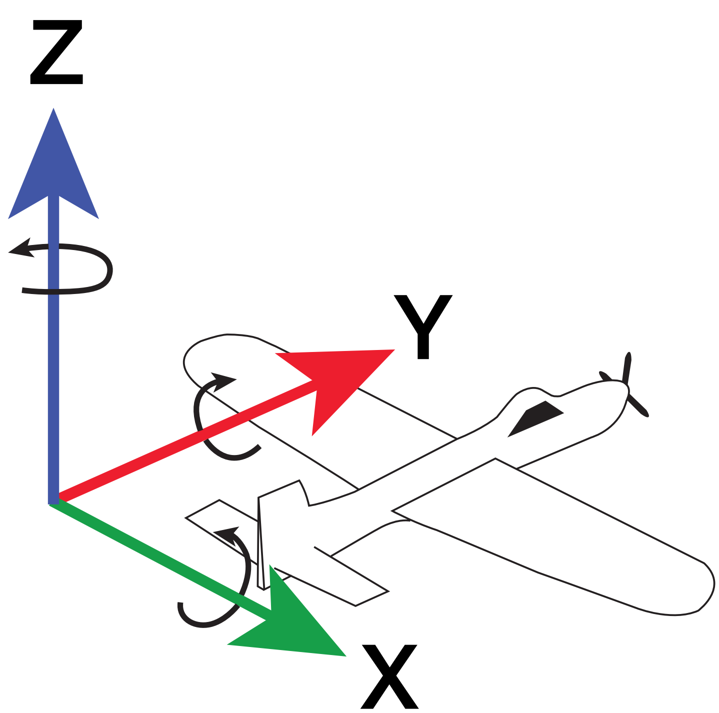


3.1.4 The Vehicle Frame

The definition of the vehicle frame is as follows:

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

Figure 27: Vehicle Frame



3.2 Communicating with the SPAN System

Install the NovAtel OEM6 PC Utilities (NovAtel Connect and Convert4) on the computer you intend to use to configure and monitor the SPAN system. (Alternatively, you can use a terminal emulator program such as HyperTerminal to communicate with the receiver.)

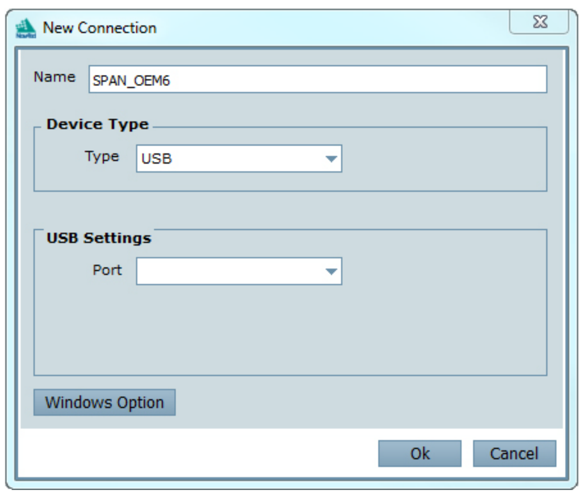
> To access and download the most current version of the NovAtel Connect PC Utilities, go to the NovAtel website at www.novatel.com/support/search/items/PC%20Software.

Refer to the NovAtel Connect Help file for more details on NovAtel Connect. The Help file is accessed by choosing *Help* from the main menu in NovAtel Connect.

This procedure describes communicating with the SPAN system using a serial or USB connection. For information about communicating with the SPAN system using an Ethernet connection, see the OEM6 Family Installation and Operation User Manual (OM-20000128).

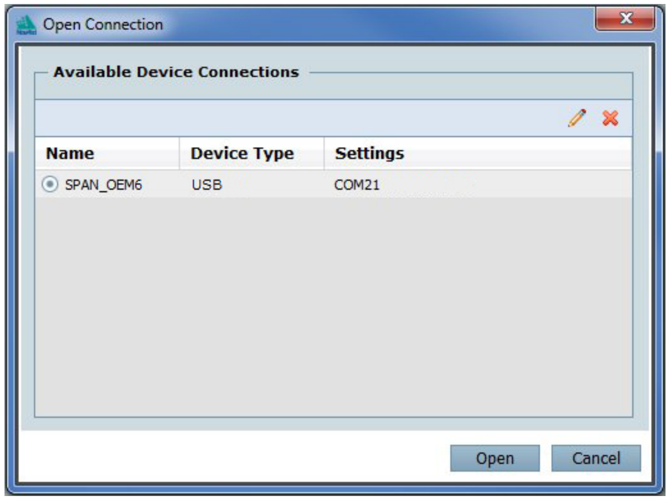
To enable communication from your computer to the SPAN system using NovAtel Connect:

1. Launch NovAtel Connect from the **Start** menu folder specified during the installation process. The default location is Start | Programs | NovAtel Connect | NovAtel Connect.
2. To define a new connection, select **New Connection** from the **Device** menu.
   The New Connection window appears.
   If a connection is already defined for the SPAN system, choose **Open Connection** and skip to step 9.



3. Enter a name for the connection.
4. Select **Serial** or **USB** from the **Type** drop down list.
5. Select the computer port that the SPAN enabled OEM6 receiver is connected to from the **Port** drop down list.
6. If you selected **Serial**, select **115200** from the **Baud Rate** drop down list.
7. If you selected **Serial**, clear the **Use hardware handshaking** check box.
8. Click the **OK** button to save the new device settings.

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



10. Click the **Open** button to open SPAN receiver communications.
11. As NovAtel Connect establishes the communication session with the receiver, a progress box is displayed.
12. Select Tools | Logging Control Window from the NovAtel Connect main menu to control the receiver's logging to files and serial ports. Refer to the NovAtel Connect on-line Help for more information.
13. Use the Console window to enter commands. See *Data Collection for Post Processing* on page 76.

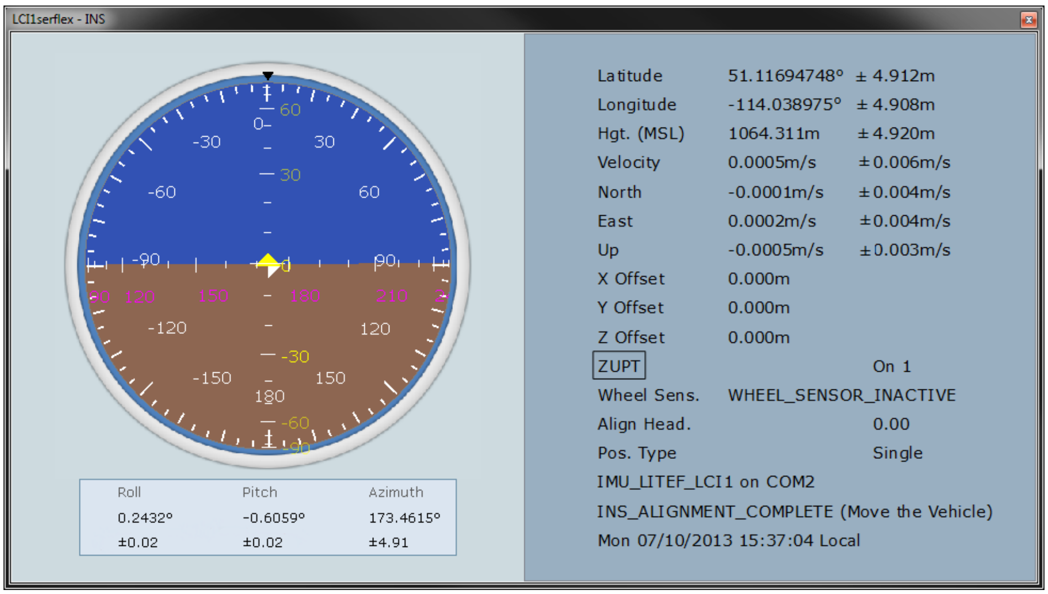
> If you want to save your receiver's configuration to NVM, ensure that all windows, other than the Console window, are closed in NovAtel Connect and then use the SAVECONFIG command.

3.2.1 INS Window in NovAtel Connect

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

The INS Window in NovAtel Connect is described below. Refer to the NovAtel Connect help file for more details on NovAtel Connect.

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



3.3 Real-Time Operation

SPAN operates through the OEM6 command and log interface. Commands and logs specifically related to SPAN operation are documented in the SPAN on OEM6 Firmware Reference Manual (OM-2000144).

Real-time operation notes:

- Inertial data does not start until time is set and therefore, the SPAN system does not function unless a GNSS antenna is connected with a clear view of the sky.
- The inertial solution is computed separately from the GNSS solution. The GNSS solution is available from the SPAN system through the GNSS-specific logs, even without SPAN running. The integrated GNSS+INS solution is available through special INS logs documented in the SPAN on OEM6 Firmware Reference Manual (OM-20000144).
- The IMU raw data is available at the maximum rate of output of the IMU (100, 125 or 200 Hz). Because of this high data rate, a shorter header format was created. These shorter header logs are defined with an S (RAWIMUSXB rather than RAWIMUXB). We recommend you use these logs instead of the standard header logs to save throughput on the COM port.

Status of the inertial solution can be monitored using the inertial status field in the INS logs, see *Table 15, Inertial Solution Status* on page 63.

Table 15: Inertial Solution Status

Binary	ASCII	Description
0	INS_INACTIVE	IMU logs are present, but the alignment routine has not started; INS is inactive.
1	INS_ALIGNING	INS is in alignment mode.
2	INS_HIGH_VARIANCE	The INS solution is still being computed but the azimuth solution uncertainty has exceeded the threshold. The default threshold is IMU dependent.[a] The solution is still valid but you should monitor the solution uncertainty in the INSCOV log. You may encounter this state during times when the GNSS, used to aid the INS, is absent.[b]
3	INS_SOLUTION_GOOD	The INS filter is in navigation mode and the INS solution is good.
6	INS_SOLUTION_FREE	The INS filter is in navigation mode and the GNSS solution is suspected to be in error. This may be due to multipath or limited satellite visibility. The inertial filter has rejected the GNSS position and is waiting for the solution quality to improve.
7	INS_ALIGNMENT_COMPLETE	The INS filter is in navigation mode, but not enough vehicle dynamics have been experienced for the system to be within specifications.
8	DETERMINING_ORIENTATION	INS is determining the IMU axis aligned with gravity.
9	WAITING_INITIALPOS	The INS filter has determined the IMU orientation and is awaiting an initial position estimate to begin the alignment process.

a. This value is configured using the INSTHRESHOLDS command. See the SPAN on OEM6 Firmware Reference Manual (OM-20000144) for more information.

b. See also question #7 in *Appendix F, Frequently Asked Questions* on page 213.

The INS LED on the front of the ProPak6 also indicates the status of the inertial solution.

Table 16: INS LED States

LED State	Description
Off	INS disabled (GNSS only) or INS enabled- no IMU detected
Red (solid)	INS inactive (IMU detected-no error)
Red (blinking)	IMU error (INS state not applicable)
Red/Amber (alternating)	INS determining orientation (IMU good)
Red/Amber (alternating)	INS waiting initial position
Green/Amber (alternating)	INS solution free
Amber (solid)	INS is aligning
Amber (blinking)	INS high variance
Green (solid)	INS solution good
Green (blinking)	INS alignment complete

3.3.1 System Start-Up and Alignment Techniques

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

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

3.3.1.1 Coarse Alignment

The coarse alignment is the default alignment routine for SPAN. The alignment starts as soon as a GNSS solution is available, the receiver has computed fine time and the IMU is connected and configured. The vehicle must remain stationary for the alignment to happen. During the coarse alignment, accelerometer and gyro measurements are averaged over a period of time to measure Earth rotation and gravity. From these averaged measurements, initial estimates of roll, pitch and heading are computed. Because the coarse alignment uses averaged sensor output, the vehicle must remain stationary for the duration of the alignment, which is approximately 45 seconds. The attitude estimates solved by the alignment are larger than the system specified attitude accuracy and vary upon the characteristics of the sensor and the geographic latitude of the system. Attitude accuracy converges with motion after the coarse alignment is complete (see *Navigation Mode* on page 66).

> The ADIS-16488, IMU-CPT, IMU-IGM, HG1930 and STIM300 IMUs cannot perform coarse alignments, as these IMUs cannot accurately measure Earth rotation. For these IMUs, the default alignment routine is the kinematic alignment. Refer to *Kinematic Alignment* on page 64.
>
> If a stationary alignment is required, refer to *Manual Alignment* on page 65.

3.3.1.2 Kinematic Alignment

An alternate form of aligning the SPAN system is a kinematic alignment. A kinematic alignment can be used for any SPAN system and is the best alignment alternative for lower performance sensors (ADIS-16488, IMU-CPT, IMU-IGM, HG1930 and STIM300). The kinematic or moving alignment is performed by estimating the attitude from the GNSS velocity vector and injecting it into the SPAN filter as the initial system attitude.

This method for alignment assumes that the roll and pitch of the vehicle are near to zero. This should be kept in mind when attempting to do this in airborne or marine environments as these assumptions may not hold causing a poor initial solution.

For the kinematic alignment routine to work optimally, the course-over-ground azimuth and pitch must match the IMU enclosure azimuth and pitch. (For example, a plane being blown in the wind has a a large 'crab angle' and the course-over ground trajectory will not match the direction the IMU is pointing.)

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

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

```
SETIMUORIENTATION 5
```

> The INS filter is reset anytime the `SETIMUORIENTATION` command is sent, regardless of whether the orientation is changed.

Specify the angular offsets between the SPAN frame and the vehicle frame (known as vehicle/body rotation or RVB) using the VEHICLEBODYROTATION command. 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 *Vehicle to SPAN Frame Angular Offsets Calibration Routine* on page 69.

> Regardless of system configuration and IMU orientation, the `SETIMUORIENTATION` and `VEHICLEBODYROTATION` commands must be sent to the receiver before starting a kinematic alignment.

The kinematic alignment begins when the receiver has a good GNSS position, fine time is solved, the configuration parameters have been set and a GNSS velocity of at least 5 m/s (~ 18 km/h) is observed. During kinematic alignment, keep the vehicle roll at less then 10°. Straight line driving is best.

> 5 m/s is the default alignment velocity. If a different alignment velocity is required, it can be changed using the `SETALIGNMENTVEL` command. See the SPAN on OEM6 Firmware Reference Manual (OM-20000144) for more information.

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

3.3.1.3 Manual Alignment

If the initial attitude (roll, pitch, azimuth) of the IMU is known, it can be entered manually using the `SETINITATTITUDE` command. Refer the SPAN on OEM6 Firmware Reference Manual (OM-20000144) for more information about the `SETINITATTITUDE` command.

3.3.1.4 Dual Antenna Alignment

SPAN can also use information available from a NovAtel Dual Antenna ALIGN solution to perform an alignment. Refer to *Chapter 4, SPAN on OEM6 Dual Antenna* on page 78 for details.

3.3.2 Navigation Mode

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

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

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

3.3.3 Data Collection

The INS solution is available in the INS-specific logs with either a standard or short header. Other parameters are available in the logs shown in *Table 17, Solution Parameters*:

Table 17: Solution Parameters

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

a. These logs contain variance information and are therefore large logs.
Use a low logging rate (<20 Hz) only.
These logs contain solution uncertainty in standard deviation format.

Note that the position, velocity and attitude are available together in the INSPVA, INSPVAS and INSPVAX 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 200 Hz.

The GNSS-only solution is still available through the GNSS-only logs such as RTKPOS and PSRPOS. When running SPAN, rates of non-INS logs should be limited to a maximum rate of 5 Hz. Refer to the OEM6 Family Firmware Reference Manual (OM-2000128) for more details on these logs. INS-only data logging and output can be at rates of up to the rate of the IMU data.

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

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

Logging Restriction Important Notice

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

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

- Raw data for post processing
  RAWIMUXSB ONNEW (output rate depends on IMU see *Table 1, SPAN-Compatible IMU Models* on page 18)
  - RAWIMU logs are not valid with the ONTIME trigger. The raw IMU observations contained in these logs are sequential changes in velocity and rotation. As such, you can only use them for navigation if they are logged at their full rate. See details of these logs in the SPAN on OEM6 Firmware Reference Manual (OM-2000144).
- Real time INS solution
  IMURATEPVA ONNEW or IMURATEPVAS ONNEW
  (These logs require asynchronous logging to be enabled. See `ASYNCHINSLOGGING` in the SPAN on OEM6 Firmware Reference Manual (OM-2000144))
  - Other possible INS solution logs available at high rates are: INSPVASB, INSPOSSB, INSVELSB, INSATTSB

Specific logs need to be collected for post-processing. See *Data Collection for Post Processing* on page 76.

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

3.3.3.1 Onboard Data Logging

SPAN systems with an OEM638 or ProPak6 receiver contain 4 GB of memory for onboard data storage. Data can be logged to internal memory and downloaded for post-processing at a later time. For information about logging information to the onboard memory and retrieving data from the onboard memory, refer to the OEM6 Family Installation and Operation User Manual (OM-20000128) or the ProPak6 User Manual (OM-20000148).

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.

Initial estimates and uncertainties for the lever arm may be entered using the `SETIMUTOANTOFFSET` command. The calibration routine uses these values as the starting point for the lever arm computation.

> The Lever Arm Calibration routine is not available for the IMU-CPT, HG-1930, ADIS-16488, IMU-IGM or STIM300.

The steps involved in the calibration are:

1. Apply power to the receiver and the IMU.
2. Configure the IMU, see *SPAN IMU Configuration* on page 53.
3. Set the orientation of your installed IMU using the SETIMUORIENTATION command.
4. Enter the initial estimate for the lever arm using the SETIMUTOANTOFFSET command.
   Ensure the standard deviation values entered for the antenna offset are not overly optimistic (i.e, err on the side of a larger standard deviation).
5. Specify the limits of the calibration through the LEVERARMCALIBRATE command.
   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 600 seconds.
6. To monitor the calibration, log BESTLEVERARM using the ONCHANGED trigger.
7. Perform an initial system alignment using one of the methods described in *System Start-Up and Alignment Techniques* on page 64.
8. Start to move the system. The lever arm is not observable while the system is stationary.
   Immediately, drive a series of maneuverer such as figure eights. The turns should alternate between directions, and you should make an equal number of turns in each direction. Some height variation in the route is also useful for providing observability in the Z-axis. When the calibration is complete, either because the specified time has passed or the accuracy requirement has been met, the BESTLEVERARM log outputs the solved lever arm.

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

> For information about the logs and commands used in this procedure, refer to the [SPAN on OEM6 Firmware Reference Manual] (OM-20000144).

3.3.5 Vehicle to SPAN Frame Angular Offsets Calibration Routine

Kinematic alignment requires that the angular offset between the vehicle and SPAN frame is known approximately. If the angles are simple (that is, a simple rotation about one axis) the values can easily be entered manually through the VEHICLEBODYROTATION command. 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. The steps for the calibration routine are:

1. Apply power to the receiver and IMU.
2. Configure the IMU, see *SPAN IMU Configuration* on page 53.
3. Ensure that an accurate lever arm has been entered into the system either manually or through a lever arm calibration, see *Lever Arm Calibration Routine* on page 68.
4. Allow the system to complete an alignment, see *System Start-Up and Alignment Techniques* on page 64.
5. Enable the vehicle to body calibration using the RVBCALIBRATE ENABLE command.
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 straight course on level ground (remember that most roads have a crown resulting in a constant roll of a few degrees). Avoid driving on a surface with a constant, non-zero, slope to prevent biases in the computed angles. Vehicle speed must be greater than 5 m/s (18 km/hr) for the calibration to complete.
7. When the uncertainties of the offsets are low enough to be used for a kinematic alignment, the calibration stops and the VEHICLEBODYROTATION log is overwritten with the solved values. To monitor the progress of the calibration, log VEHICLEBODYROTATION using the ONCHANGED trigger.

To save a calibrated rotation for subsequent start ups, issue the SAVECONFIG command after calibration is complete. Each time the IMU is re-mounted this calibration should be performed again. See also *Coarse Alignment* on page 64 and *Kinematic Alignment* on page 64 for details on coarse and kinematic alignment.

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

> The solved rotation values are used only for a rough estimate of the angular offsets between the IMU and vehicle frames. The offsets are used when aligning the system while in motion (see *System Start-Up and Alignment Techniques* on page 64). The angular offset values are not applied to the attitude output, unless the APPLYVEHICLEBODYROTATION command is enabled.

3.4 Synchronizing External Equipment

A SPAN system allows you to synchronize with external equipment in two ways:

1. SPAN systems with an OEM638 and ProPak6 receiver have configurable output strobes. Each strobe is synchronous with GNSS time and can be configured for pulse length and polarity.
2. All SPAN receivers accept input pulses (events). Each event signal can be configured for positive or negative polarity. Time, or a solution (position, velocity, attitude), can be generated and output with each input pulse.

3.4.1 Configuring a Synchronous Output Pulse

The `EVENTOUTCONTROL` command (see the OEM6 Family Firmware Reference Manual (OM-20000129)) is used to configure an output strobe. The ProPak6 has three output strobe lines (MARK1 through MARK3) and the OEM638 has seven output strobe lines (MARK1 through MARK7). Each of these output strobe lines can be configured independently. The event strobes toggle between 3.3 V and 0 V. Each strobe can supply 24 mA.

The pulse consists of two states: an active state and a not-active state. The start of the active state is synchronized with the top of the GNSS time second and the polarity of the signal indicates whether the active period is 3.3 V or 0 V. The not-active period immediately follows the active period and has the alternate voltage.

Each output strobe can be configured in the following ways:

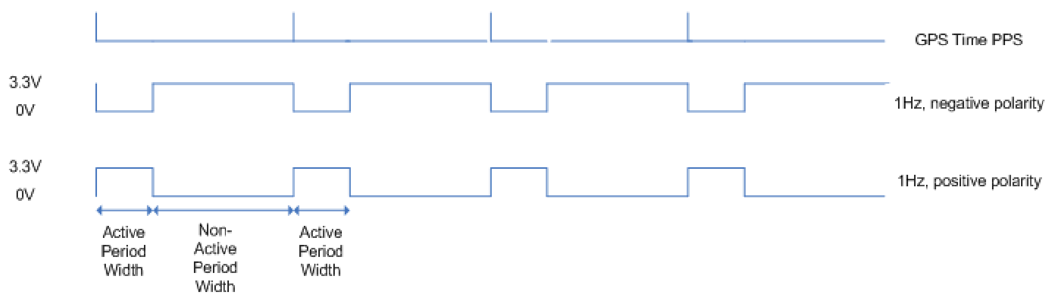
Polarity:	The polarity defines the signal state of the active portion of the signal. A positive polarity dictates that the active portion of the signal is in a high state (3.3 V).
Active Period Width:	The active period starts at the GNSS time synchronized edge (rising for negative polarity and falling for positive polarity). The time length of this period is specified in nanoseconds (ns).
Not-Active Period Width:	The not-active period immediately follows the active period. The width of this period is specified in ns.

Rules Governing Period Widths:

- The minimum period is 10 ns. The maximum period is 999 999 990 ns.
- The sum of the active and not-active periods must be a factor of 1 s. That is:

  K (active + not-active) = 1 000 000 000, where K = 1, 2, 3, ..., 500 000

Figure 28: Event Out



3.4.2 Configuring an Input Strobe

SPAN systems with OEM615, OEM628 and FlexPak6 receivers have two available input strobes. SPAN systems with OEM638 and ProPak6 receivers have four available input strobes. The input strobes apply an accurate GNSS time to the rising, or falling, edge of an input pulse called an event. For each event, an accurate position, velocity or attitude solution is also available. Each input strobe is usually associated with a separate device, therefore different solution output lever arm offsets can be applied to each strobe.

Each input strobe can be configured using the EVENTINCONTROL command (see the OEM6 Family Firmware Reference Manual (OM-20000129)) for the following parameters:

Polarity:	When polarity is set to positive, events trigger on the rising edge. When polarity is set to negative, events trigger on the falling edge.
Time Bias (t_bias):	A constant time bias in ns can be applied to each event pulse. Typically this is used to account for a transmission delay.
Time Guard (t_guard):	The time guard specifies the minimum number of milliseconds between pulses. This is used to coarsely filter the input pulses.

The time of the input pulses is available from the MARK*x*TIME logs (see the OEM6 Family Firmware Reference Manual (OM-20000129)). The solution synchronous with the event pulses is available from the MARK*x*PVA logs (see the SPAN on OEM6 Firmware Reference Manual (OM-20000144)). The logs required for input strobes are:

`LOG MARK1TIMEB ONNEW`	Output time for every pulse received.
`LOG MARK1PVAB ONNEW`	Output time, position, velocity and attitude for every pulse received at the location specified by the `SETMARK1OFFSET` command.

The above example is for the MARK1 event input. The input signal levels are 3.3 V to 0 V. Signal voltages outside these bounds damage the receiver. The minimum detectable pulse duration must be greater than or equal to 1 microsecond.

3.4.2.1 Using the Input Strobe to Accumulate Counts

An input strobe line can also count the number of pulses over one second and report the total at the top of each second by setting the input event line to `COUNT` mode.

```
EVENTINCONTROL MARK1 COUNT
```

When in COUNT mode, the polarity, time bias and time guard entries in the `EVENTINCONTROL` log are ignored. The maximum signal frequency for the count mode is 50 kHz.

When an input strobe is configured for `COUNT` mode, the totals are available by logging the `MARKxCOUNT` logs (see the SPAN on OEM6 Firmware Reference Manual (OM-20000144)). For example, the following gives the total pulses on event strobe 1 every second:

```
LOG MARK1COUNTA ONNEW
```

3.5 Adding Timed Sensor Triggers

Use the EVENT IN and EVENT OUT connections to attach up to three sensor devices to an OEM6 receiver and then trigger the sensors based upon GPS time.

In this context a 'sensor' is any external device. The 'sensor' reference in the receiver is an object consisting of an Event_In and Event_Out pair of system strobes all linked by a sensor identifier.

You can send multiple trigger events marked with a user-specified ID and a GPS time to trigger the sensor. At the requested trigger time, the receiver outputs a user-specified LVTTL level pulse to the sensor and waits for a response pulse to indicate a sensor measurement (i.e. camera exposure). When this response is received, the SPAN system outputs a log with the inertial position/velocity/attitude and the ID of the event.

> This feature is available only on the OEM638 or ProPak6.

3.5.1 Configuring the Hardware

A sensor's trigger input is connected to a valid Event_Out and the sensor's response output is connected to a valid Event_In. Three sensor slots are available for use, but may be limited to less depending on the hardware platform used.

Table 18: Valid Event Inputs and Outputs for Timed Sensor Triggers

Valid Event Outputs	Valid Event Inputs
MARK1	MARK1
MARK2	MARK2
MARK3	MARK3
MARK4	MARK4
MARK5 (bare OEM638 only)	
MARK6 (bare OEM638 only)	

3.5.2 Configuring the Software

Sensor objects are defined by using the `SETUPSENSOR` command. This command allows the Event_In and Event_Out lines to be specified as well as some parameters for the outgoing and incoming signals.

> After configuring a sensor using the `SETUPSENSOR` command, any other commands that affect the selected event lines will disturb this functionality. For example, if MARK4 Out is selected for a sensor, but later the `EVENTOUTCONTROL` command is sent, the `EVENTOUTCONTROL` command will reconfigure the properties of the MARK4 line.

3.5.3 Using Timed Event Pulses

When sensors have been connected and configured, use the `TIMEDEVENTPULSE` command to queue events on the system. `TIMEDEVENTPULSE` specifies the sensors that are affected, the GPS time for the desired event (in weeks and seconds), and an event ID. You can queue 10 unprocessed events at a time. Any time input specified via this command must occur at least 1 second after the command is entered.

The timing accuracy of the `TIMEDEVENTPULSE` output is 2 milliseconds.

3.5.4 Recording Incoming Sensor Events

After a `TIMEDEVENTPULSE` is sent, the system can be configured to accept an incoming pulse from the sensor in order to produce a time and ID tagged inertial solution associated to that event. This is optional and useful if a sensor provides a measurement TOV pulse. The produced log is a TAGGEDxMARKPVA where the 'x' is the Event_In line associated with that sensor (via the `SETUPSENSOR` command).

For example, if the `SETUPSENSOR` command specifies SENSOR1 to use MARK1 in as the input event then a TAGGEDMARK1PVA log will be produced when any pulses on that line are observed. In this case the TAGGEDMARK1PVA log should be requested ONNEW to capture the data.

3.6 SPAN Wheel Sensor Configuration

A wheel sensor is used to measure the distance traveled by counting the number of revolutions of a ground vehicle wheel. Typical wheel sensor hardware outputs a variable frequency pulse that varies linearly with speed. If the pulses are accumulated and the size of the wheel known, a displacement of the wheel over time can be calculated. The SPAN system takes in a wheel sensor input and applies a displacement update to the GNSS+INS Kalman filter in order to constrain the position error growth during GNSS outages. SPAN also automatically estimates the size of the wheel to mitigate small changes in the size of the wheel due to hardware changes or environmental conditions.

Wheel sensor information can be input into the system using one of two separate methods:

- The wheel sensor is connected directly to one of the event input lines available on the SPAN receiver (available only on ProPak6 receivers).
- The wheel sensor ticks are accumulated by the IMU and then passed on to the SPAN receiver.
  - For IMU-FSAS and IMU-CPT users, the wheel sensor is integrated via the IMU and wheel velocity commands are not required. See also *iIMU-FSAS Odometer Cabling* on page 126.
  - For IMU Enclosure users (IMU-HG1900, IMU-ISA-100C, IMU-LN200 or IMU-μIMU), the wheel sensor is connected to the Wheel Sensor port using the optional Wheel Sensor Cable (60723137) or a custom cable. See *A.4.7, IMU Enclosure Wheel Sensor Cable* on page 105 for information about the Wheel Sensor Cable and the Wheel Sensor port pinout.
  - For IMU-IGM-A1 and IMU-IGM-S1 users, the wheel sensor can be connected to the AUX port on the enclosure using the Auxiliary Interface Cable (01019015).

3.6.1 Wheel Sensor Updates Using the Event Input Lines

> This section applies only to systems with OEM638 and ProPak6 receivers.

The event input lines on the SPAN receiver can be configured to accept a wheel sensor signal directly. Any of available event input lines can be used, but only one can be used at a time – the system does not support multiple wheel sensors. This method only supports A mode (directionless) and not A/B (directional) mode of operation for the wheel sensor. The receiver automatically accumulates the wheel sensor ticks, calculates a distance traveled and applies the constraint information in the SPAN GNSS+INS filter.

To connect the wheel sensor to the SPAN system, connect Signal A from the wheel sensor to one of the event input lines on the SPAN receiver. For information about the event input lines, refer to the OEM6 Family Installation and Operation User Manual (OM-20000128) or the ProPak6 User Manual (OM-20000148).

The event input line must be configured for wheel sensor input using the `SETWHEELSOURCE` command and the size of the wheel and the number of ticks per revolution must be set using the `SETWHEELPARAMETERS` command. For example if you have your wheel sensor connected to event input 2 with a 2 m circumference wheel and 2000 pulses per revolution, the configuration commands would be:

```
SETWHEELSOURCE MARK2 POSITIVE
SETWHEELPARAMETERS 2000 2.0 0.001
```

For information about the `SETWHEELSOURCE` command, see the SPAN on OEM6 Firmware Reference Manual. (OM-20000144).

3.6.2 Wheel Sensor Data Collected on IMU

3.6.2.1 Wheel Sensor Update Logic

The SPAN system uses the wheel sensor data passed in and timed through the IMU-CPT, iMAR FSAS, IMU-IGM, IMU-HG1900, IMU-ISA-100C, IMU-LN200 or IMU-μIMU. This timed data is passed to the GNSS+INS filter to perform the update. The timed data is also available through the TIMEDWHEELDATA log. The TIMEDWHEELDATA log can be used for applying wheel sensor updates in post-processing.

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

The modeled wheel circumference is available in the WHEELSIZE log. Information on how the wheel sensor updates are being used is available in the INSUPDATE log. Refer to the SPAN on OEM6 Firmware Reference Manual (OM-20000144) for information about these logs.

3.6.2.2 iMAR Wheel Sensor Interface for iIMU-FSAS and IMU-CPT Users

If you have the iMAR iMWS (Magnetic Wheel Speed Sensor and Converter), the wheel sensor information is sent to the OEM6 along with the raw IMU data. You can integrate other wheel sensor hardware with the iIMU-FSAS. The Kistler Wheel Pulse Transducer CWPTA411 (WPT) is used as an example, see *iIMU-FSAS Odometer Cabling* on page 126.

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

```
log timedwheeldatab onnew
```

Set parameters for your installation using the SETWHEELPARAMETERS command. Refer to the SPAN on OEM6 Firmware Reference Manual (OM-20000144) for information about this command.

3.6.2.3 Wheel Sensor Interface for IMU-IGM Users

IMU-IGM accepts TTL level input pulses from a wheel sensor through the AUX connector. For information about the connections available on the AUX connector, see *IMU-IGM Ports* on page 146.

To enable wheel sensor data on an IMU-IGM, see the `ENCLOSUREWHEELSENSOR` command in the SPAN on OEM6 Firmware Reference Manual (OM-20000144).

> The SPAN-IGM Auxiliary Port interface cable (01019015) can be used to connect the wheel sensor inputs to the IMU-IGM.
>
> However, when this cable is used with an IMU-IGM, only the wheel sensor inputs are available. The other connectors on this cable do not have connections to the IMU or receiver.

3.6.2.4 Wheel Sensor Interface for IMU Enclosure Users

On SPAN systems with an IMU in an IMU Enclosure (IMU-ISA-100C, IMU-HG1900, IMU-LN200 or IMU-μIMU), send the following command to enable the collection of wheel sensor data.

```
ENCLOSUREWHEELSENSOR ENABLE
```

See the SPAN on OEM6 Firmware Reference Manual (OM-20000144) for information about the `ENCLOSUREWHEELSENSOR` command.

3.7 Azimuth Sources on a SPAN System

The SPAN system use three different methods to calculate the azimuth.

- Course Over Ground
- Inertial Azimuth
- ALIGN Azimuth

3.7.1 Course Over Ground

The course over ground azimuth is determined using the position delta between two position solutions computed by the OEM receiver. This is the simplest way to compute an azimuth and is done using either the GNSS solution or the INS solution. This method does not work when the vehicle is stationary as any position difference is due to position error and the computed azimuth is meaningless.

Course over ground azimuth is of greatest advantage in aerial or marine environments where the actual direction of travel may not match the forward axis of the aircraft/boat due to winds or currents. This effect is known as the crab angle. Course over ground azimuth is a great way to compute the offset if another means of computing the vehicle azimuth is available.

Course over ground azimuths are available in several different velocity logs. See *Table 19, Logs with Azimuth data* on page 76.

3.7.2 Inertial Azimuth

The inertial azimuth computed by the SPAN inertial navigation filter. It uses the sensors in the IMU to compute the azimuth of the IMU (this can be rotated to another reference if desired). For more information, see the `APPLYVEHICLEBODYROATION` and `VEHICLEBODYROTATION` commands in the SPAN on OEM6 Firmware Reference Manual (OM-20000144).

This azimuth is the one provided in the majority of the INS logs available to a SPAN user. See *Table 19, Logs with Azimuth data* on page 76.

3.7.3 ALIGN Azimuth

On SPAN systems with dual antennas, an azimuth is available from the dual antenna baseline. This is the same azimuth that is used as an update to the SPAN solution. It is noisier than the inertial azimuth and is available at a much lower rate, but will have a stable mean. This azimuth is computed from the master antenna to the rover antenna based on how the antennas are oriented on the vehicle.

There is a specific subset of logs that output this azimuth. See *Table 19, Logs with Azimuth data* on page 76.

Table 19: Logs with Azimuth data

Log	Log Format	Azimuth Source
INSPVA / INSPVAS / INSPVAX	NovAtel	Inertial
INSATT / INSATTS / INSATTX	NovAtel	Inertial
PASHR	NMEA	Inertial
INSSPD	NovAtel	Course Over Ground Computed using the INS solution only
BESTVEL	NovAtel	Course Over Ground From the best system solution which could be either GNSS or INS
GPVTG	NMEA	Course Over Ground From the best system solution which could be either GNSS or INS
HEADING	NovAtel	ALIGN
GPHDT	NMEA	ALIGN

3.8 Data Collection for Post Processing

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

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

From a base:

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

From a rover:

- RANGECMPB ONTIME 1
- RAWEPHEMB ONCHANGED
- GLOEPHEMERISB ONCHANGED (if using GLONASS)
- RAWIMUSXB ONNEW
- IMUTOANTOFFSETSB ONCHANGED
- VEHICLEBODYROTATIONB ONCHANGED
- HEADINGB ONNEW (if using ALIGN dual antenna solution)

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

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

3.9 Firmware Updates and Model Upgrades

Firmware updates are firmware releases which include fixes and enhancements to the receiver functionality. Firmware updates are released on the web site as they become available.

Model upgrades enable features on the receiver and may be purchased through NovAtel authorized dealers.

Contact your local NovAtel dealer first for more information. To locate a dealer in your area visit Where to Buy | Dealer Network on the NovAtel web site at www.novatel.com/where-to-buy/sales-offices/ or contact NovAtel Customer Support directly.

For information about how to install firmware updates or model upgrades, refer to the OEM6 Family Installation and Operation User Manual (OM-20000128).

3.10 Variable Lever Arm

The variable lever arm concept arose to support applications in which the IMU is no longer rigidly fixed to the vehicle, but rather on a gimballed mount. This creates an issue where the input lever arm offsets to the GNSS antenna are no longer correct, because the IMU can rotate on its mount, while the antenna remains fixed.

The use of the variable lever arm functionality requires that the device to which the IMU is attached be able to send its gimbal rotation angles back to SPAN. These angles are used to re-calculate the lever arm at the rate that they are received. SPAN will also be able to output a gimballed solution at the rate the gimbal angles are received.

See the SPAN on OEM6 Firmware Reference Manual (OM-20000144) or more information.

3.11 Relative INS

The Relative INS feature generates a position, velocity and full attitude vector between two SPAN systems. Unlike an RTK system, where the master receiver is stationary and the rover receiver is moving, in a Relative INS system both the master receiver and rover receiver are moving.

See the SPAN on OEM6 Firmware Reference Manual (OM-20000144) or more information.

Chapter 4 SPAN on OEM6 Dual Antenna

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

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

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

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

4.1 Installation

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

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

> SPAN on OEM6 Dual Antenna operation requires the dedicated use of the COM 2 port for communication between receivers. If an IMU (ISA-100C, HG1900, LN200 (with UIC), iMAR-FSAS, IMU-CPT or IMU-KVH1750 with a FlexPak6) that requires COM 2 is connected, COM 1 can be used on the master station. However the rover must always use COM 2.
>
> Use the USB port to connect the receiver to the computer used to send commands and receive logs.

The two receivers need to be set up as shown in the example in *Figure 29, SPAN on OEM6 - Dual Antenna Installation* on page 79.

The ProPak6 Dual Antenna receiver contains the hardware necessary to provide an ALIGN solution without an additional receiver. Set up a SPAN system with a ProPak6 Dual Antenna receiver as shown in *Figure 30, SPAN on OEM6 - ProPak6 Dual Antenna Installation* on page 80.

> In a SPAN system with a ProPak6 Dual Antenna receiver, the antenna connected to the ANT1 port is the Primary GNSS Antenna and the antenna connected to the ANT2 port is the Secondary GNSS Antenna.

Figure 29: SPAN on OEM6 - Dual Antenna Installation

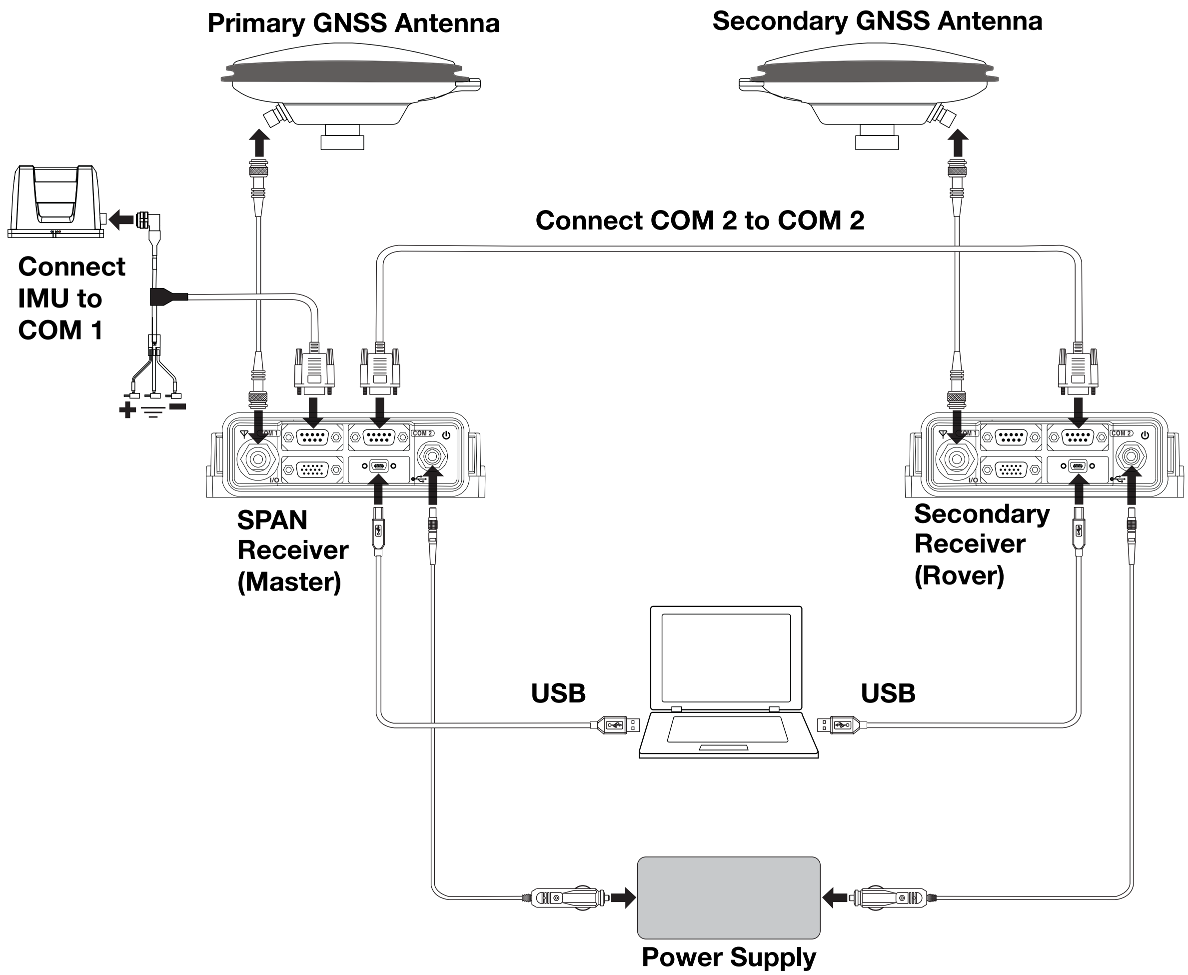
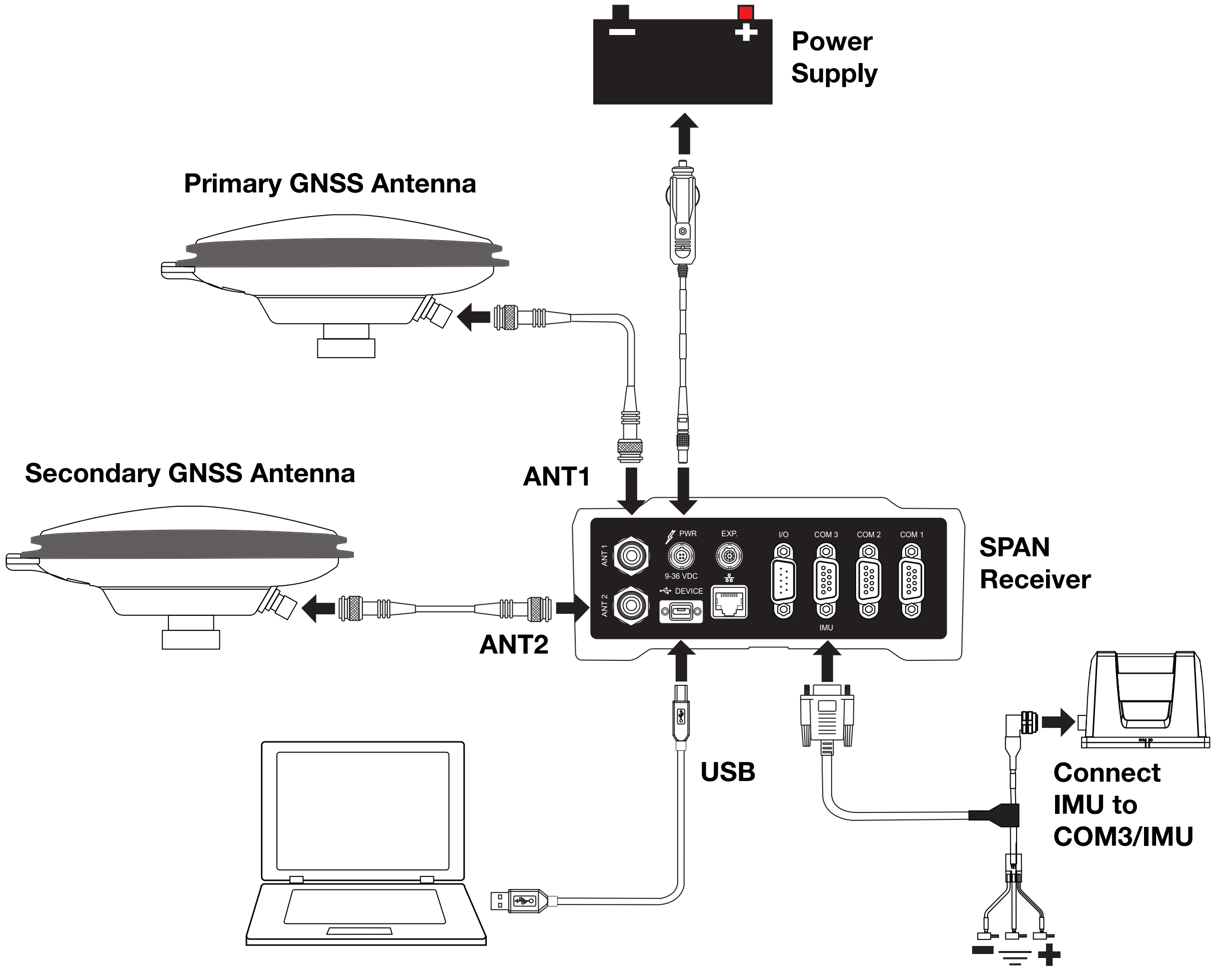


Figure 30: SPAN on OEM6 - ProPak6 Dual Antenna Installation



The ALN LED on the front panel of the ProPak6 indicates the ALIGN heading status.

Table 20: ALN (ALIGN) LED States

LED State	Description
Off	ALIGN is not operational - Dual card is disabled or unavailable - Tracking <4 satellites - Heading log not received/updated in 30 seconds
Amber (solid)	ALIGN has FLOAT solution - SOLTYPE_L1_FLOAT - SOLTYPE_NARROW_FLOAT or - SOLTYPE_WIDE_FLOAT
Green (solid)	ALIGN has fixed solution - SOLTYPE_L1_INT - SOLTYPE_NARROW_INT

4.2 Configuring ALIGN with SPAN on OEM6

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

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

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

To configure SPAN with ALIGN Aiding:

1. Enter the lever arm from the IMU to the primary antenna (primary antenna is connected to the SPAN receiver or the ANT1 port on a ProPak6) using the SETIMUTOANTOFFSET command.

   Abbreviated ASCII example:

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

2. Enter the lever arm from the IMU to the secondary antenna (secondary antenna is connected to the second receiver or the ANT2 port on a ProPak6) using the SETIMUTOANTOFFSET2 command.

   Abbreviated ASCII example:

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

Alternately, the angular offset between the dual-antenna baseline (from primary GNSS antenna to secondary GNSS antenna) and the IMU frame forward axis is entered directly via the `EXTHDGOFFSET` command.

> We recommend entering the lever arms rather than entering the angular offset as this is easier to measure and will lead to better overall accuracy.

Refer to the SPAN on OEM6 Firmware Reference Manual (OM-20000144) for the syntax of the above commands.

As with all ALIGN-capable products, the GNSS baseline solution is available from the GPHDT and HEADING logs. For INS heading, use INSATT or INSPVA.

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

The different alignment routines are described in the following sections.

4.3 Configuring SPAN with ALIGN

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

> If the ALIGNMENTMODE selected can use a kinematic alignment (UNAIDED or AUTOMATIC), the `SETIMUORIENTATION` and `VEHICLEBODYROTATION` commands must be sent to the receiver regardless of system configuration and IMU orientation.

The different alignment routines are described in the following sections:

4.3.1 Alignment on a Moving Vessel - Aided Transfer Alignment

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

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

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

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

```
ALIGNMENTMODE AIDED_TRANSFER
```

4.3.2 Alignment on a Stationary Vehicle - Aided Static Alignment

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

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

```
ALIGNMENTMODE AIDED_STATIC
```

4.3.3 Unaided Alignment

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

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

```
ALIGNMENTMODE UNAIDED
```

4.3.4 Automatic Alignment Mode - Automatic Alignment (default)

Automatic Alignment Mode Selection is the default setting for a SPAN receiver. This mode is designed to allow alignment of the system as quickly as possible, using either an aided transfer alignment (*Alignment on a Moving Vessel - Aided Transfer Alignment* on page 82); a kinematic alignment (*Kinematic Alignment* on page 64); or a manual alignment (*Manual Alignment* on page 65).

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

4.4 SPAN ALIGN Attitude Updates

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

You can monitor the heading update status as outlined in the INSUPDATE command in the SPAN on OEM6 Firmware Reference Manual (OM-20000144).

Appendix A Technical Specifications

This appendix details the technical specifications of the IMUs. For information about the technical specifications, performance and cables of the SPAN receiver, refer to the OEM6 Family Installation and Operation User Manual (OM-20000128).

A.1 Universal IMU Enclosure

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

Table 21: Universal IMU Enclosure Physical Specifications

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

A.1.1 Universal IMU Enclosure Mechanical Drawings

Figure 31: Universal IMU Enclosure Side Dimensions

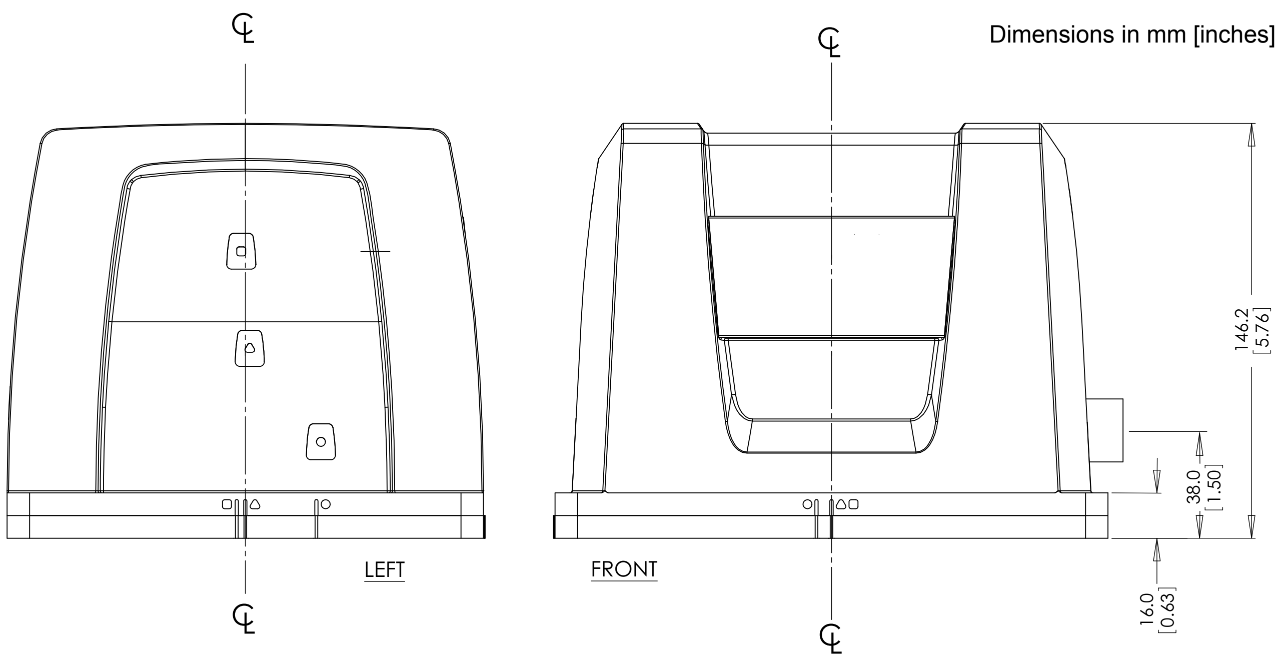


Figure 32: Universal IMU Enclosure Top/Bottom Dimensions

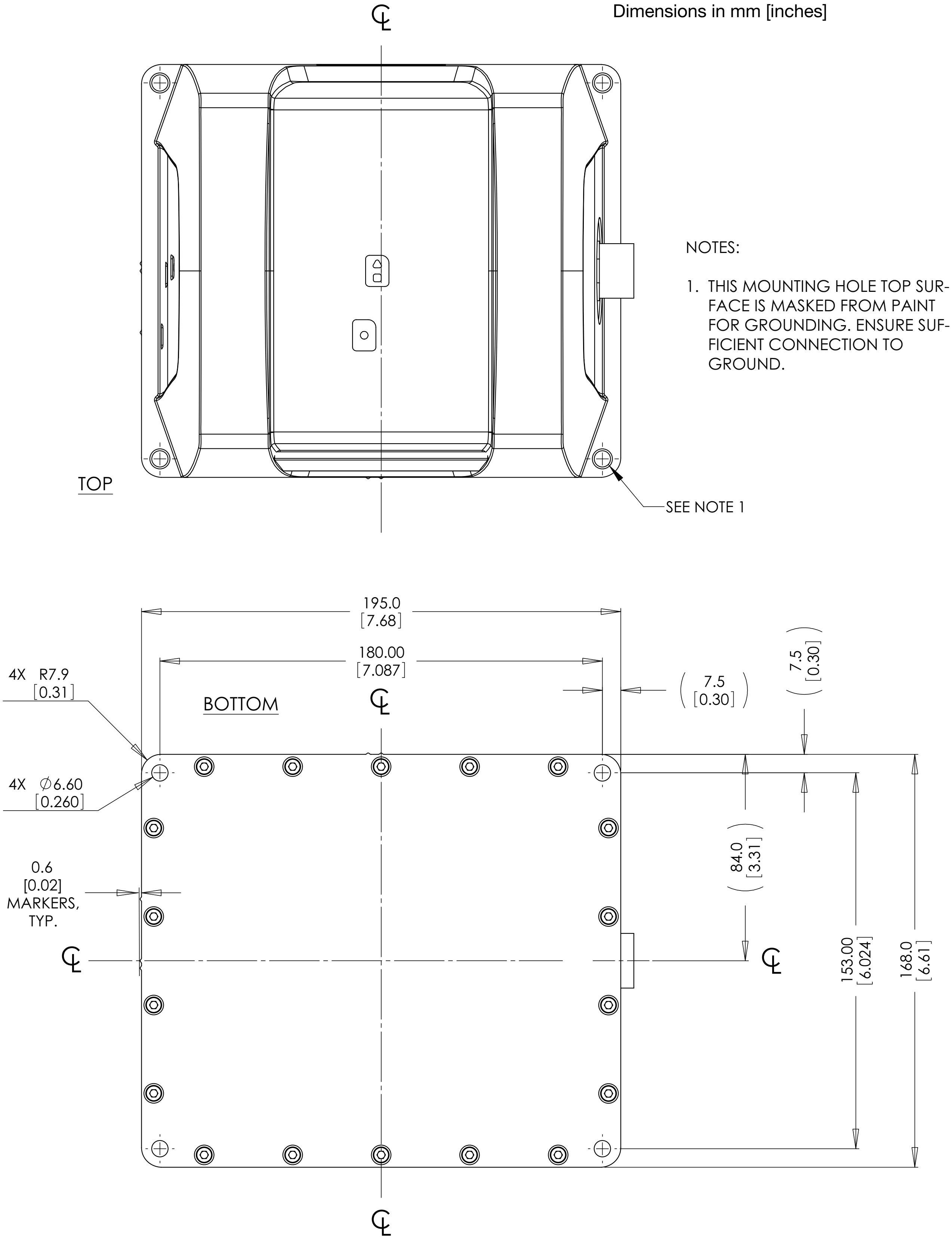
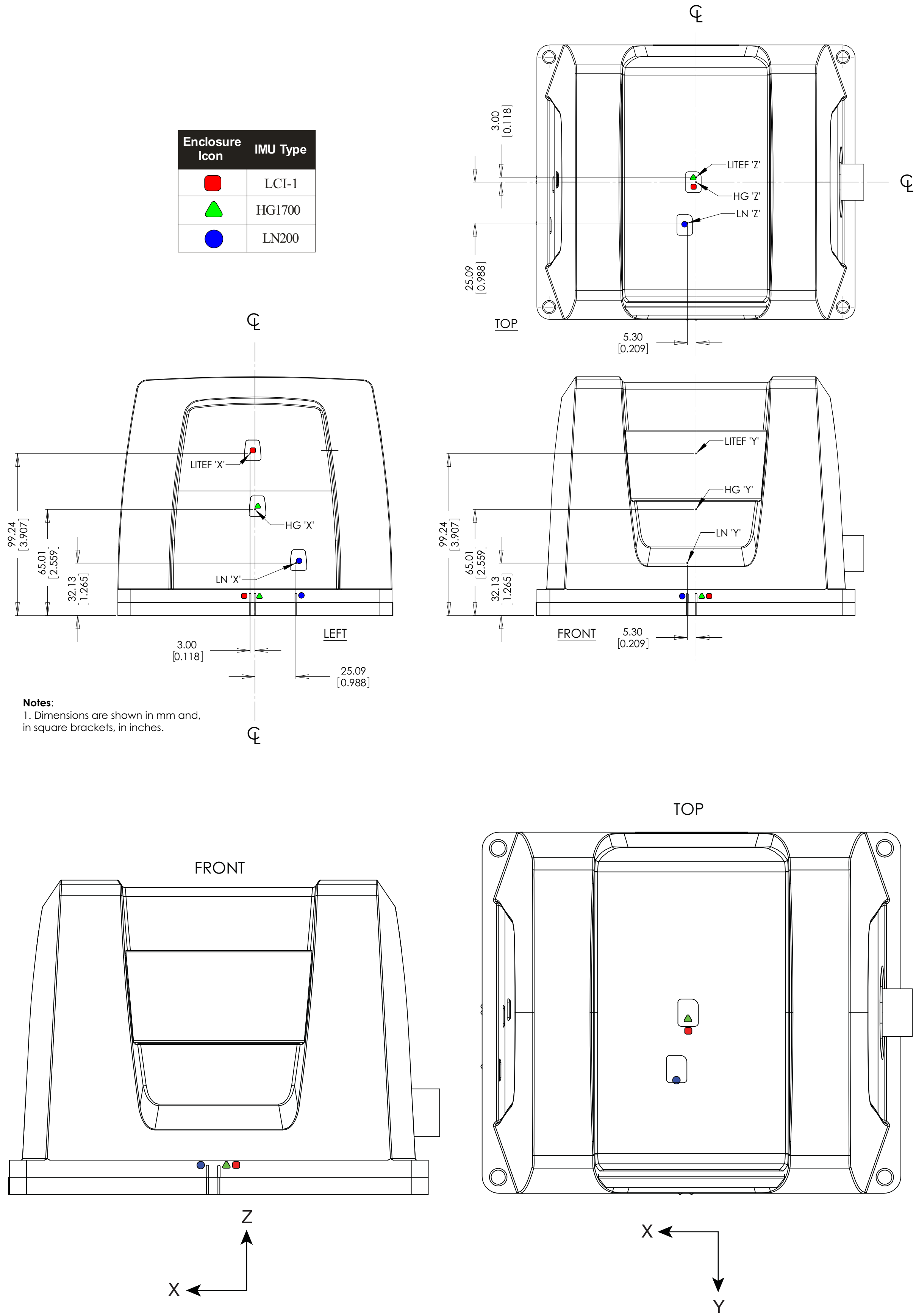


Figure 33: IMU Center of Navigation



A.1.2 IMU Performance

Table 22: HG1700-AG58 IMU Performance

GYROSCOPE PERFORMANCE	
Gyro Input Range	±1000 deg/sec
Gyro Rate Bias	1.0 deg/hr
Gyro Rate Scale Factor	150 ppm
Angular Random Walk	0.125 deg/rt-hr
ACCELEROMETER PERFORMANCE	
Accelerometer Range	±50 g
Accelerometer Linearity	500 ppm
Accelerometer Scale Factor	300 ppm
Accelerometer Bias	1.0 mg
DATA RATE	
IMU Measurement	100 Hz

Table 23: HG1700-AG62 IMU Performance

GYROSCOPE PERFORMANCE	
Gyro Input Range	±1000 deg/sec
Gyro Rate Bias	5.0 deg/hr
Gyro Rate Scale Factor	150 ppm
Angular Random Walk	0.5 deg/rt-hr
ACCELEROMETER PERFORMANCE	
Accelerometer Range	±50 g
Accelerometer Linearity	500 ppm
Accelerometer Scale Factor	300 ppm
Accelerometer Bias	2.0 mg
DATA RATE	
IMU Measurement	100 Hz

Table 24: LN200 IMU Performance

GYROSCOPE PERFORMANCE	
Gyro Input Range	±1000 deg/sec
Gyro Rate Bias	1.0 deg/hr
Gyro Rate Scale Factor	100 ppm
Angular Random Walk	0.07 deg/rt-hr
ACCELEROMETER PERFORMANCE	
Accelerometer Range	±40 g
Accelerometer Linearity	150 ppm
Accelerometer Scale Factor	300 ppm
Accelerometer Bias	0.3 mg
DATA RATE	
IMU Measurement	200 Hz

Table 25: LCI-1 IMU Performance

GYROSCOPE PERFORMANCE	
Gyro Input Range	±800 deg/sec
Gyro Rate Bias	< 1.0 deg/hr
Gyro Rate Scale Factor	100 ppm (typical)
Angular Random Walk	< 0.05 deg/rt-hr
ACCELEROMETER PERFORMANCE	
Accelerometer Range	±40 g
Accelerometer Scale Factor	250 ppm (typical)
Accelerometer Bias	< 1.0 mg
DATA RATE	
IMU Measurement	200 Hz

A.1.3 Electrical and Environmental

Table 26: Universal IMU Enclosure Electrical Specifications

ELECTRICAL	
IMU Power Consumption	HG1700-AG58: 9 W (max) HG1700-AG62: 8 W (max) LN-200: 16 W (typical) LCI-1: 16W (typical)
IMU Input Voltage	+12 to +28 V DC (all IMUs)
Receiver Power Consumption	1.8 W (typical, for all IMUs)
Input/Output Connectors	MIL-C-38999-III, 22 pin (all IMUs)
IMU Interface	RS-232 or RS-422

Table 27: Universal IMU Enclosure Environmental Specifications

ENVIRONMENTAL		
Temperature	HG1700-AG58, HG1700-AG62	
	Operating	-30°C to +60°C
	Storage	-45°C to +80°C
	LN-200	
	Operating	-30°C to +60°C
	Storage	-45°C to +80°C
	LCI-1	
	Operating	-40°C to +60°C
	Storage	-40°C to +71°C
Humidity	Operates at 95% RH, non-condensing (all IMUs)	

A.1.4 Universal IMU Enclosure Interface Cable

The NovAtel part number for the Universal IMU Enclosure interface cable is 01018977 (see *Figure 34, Universal IMU Enclosure Interface Cable*). This cable provides power to the IMU from an external power source and enables communication between the receiver and the IMU.

Figure 34: Universal IMU Enclosure Interface Cable

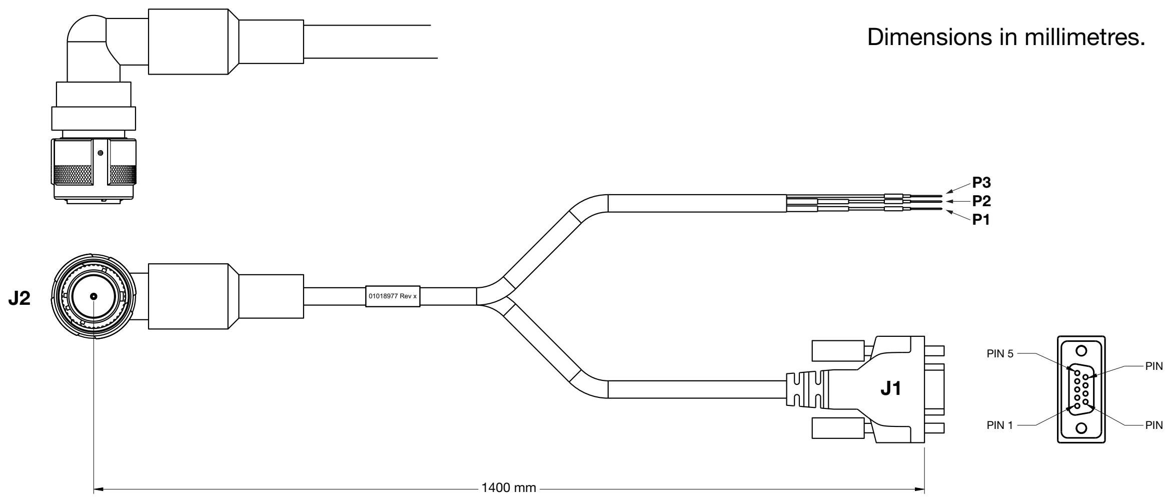


Table 28: Universal IMU Enclosure Interface Cable Pinouts

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

A.1.4.1 Custom Cable Recommendations

The tables below provide recommendations for creating custom cables to replace the Universal IMU Enclosure interface cable (01018977).

Table 29: Connectors

Connector	Description
J1	DB-9, female
J2	MIL-DTL-38999 III, plug

Table 30: Maximum Cable Length

IMU	RS-232	RS-422
HG1700, LN-200, LCI-1	< 2.0 metres	< 50 metres
iIMU-FSAS	N/A	< 1.5 metres

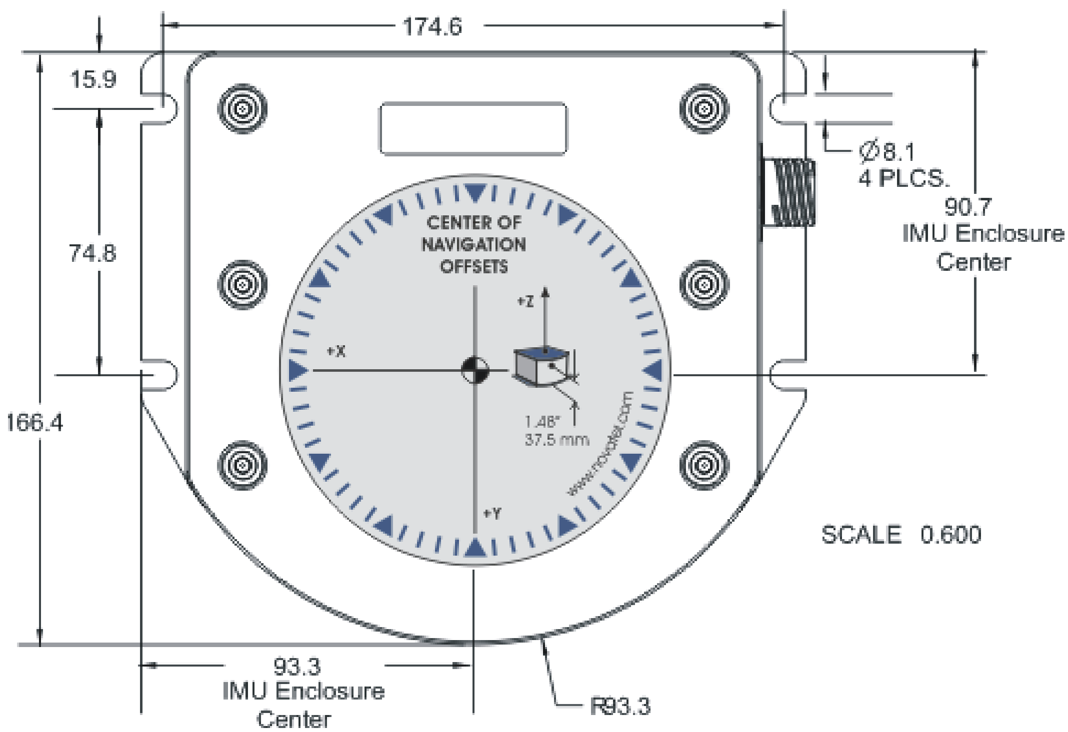
A.2 HG1700 IMU (single-connector enclosure)

Table 31: HG1700 IMU Physical Specifications

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

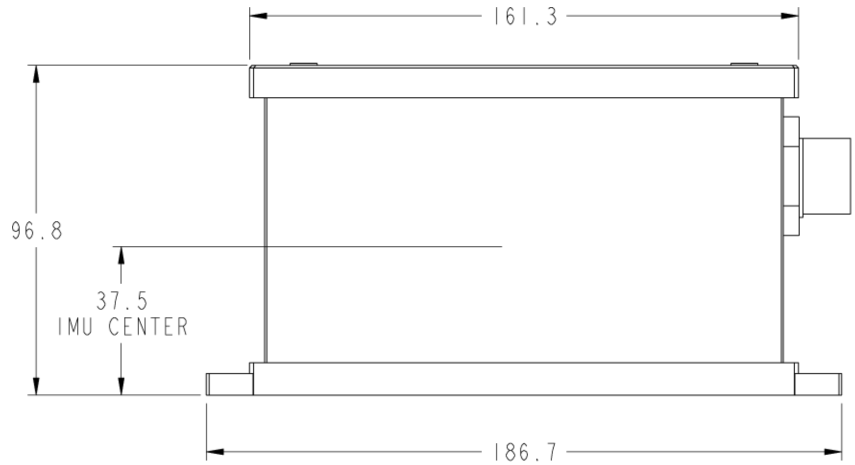
A.2.1 HG1700 IMU Mechanical Drawings

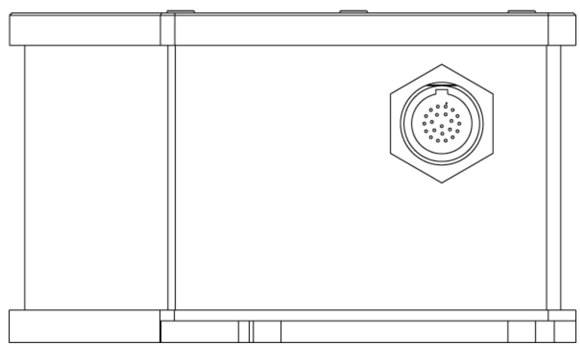
Figure 35: HG1700 Top/Bottom Dimensions



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

Table 32: HG1700 Enclosure Side Dimensions





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

A.2.2 HG1700 IMU Performance

Table 33: HG1700-AG58 IMU Performance

GYROSCOPE PERFORMANCE	
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 PERFORMANCE	
Accelerometer Range	±50 g
Accelerometer Linearity	500 ppm
Accelerometer Scale Factor	300 ppm
Accelerometer Bias	1.0 mg
DATA RATE	
IMU Measurement	100 Hz

Table 34: HG1700-AG62 IMU Performance

GYROSCOPE PERFORMANCE	
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 PERFORMANCE	
Accelerometer Range	±50 g
Accelerometer Linearity	500 ppm
Accelerometer Scale Factor	300 ppm
Accelerometer Bias	2.0 mg
DATA RATE	
IMU Measurement	100 Hz

A.2.3 HG1700 Electrical and Environmental

Table 35: HG17000 Electrical Specifications

ELECTRICAL	
IMU Power Consumption	IMU-H58: 9 W (max) IMU-H62: 8 W (max)
IMU Input Voltage	+12 to +28 V DC
Receiver Power Consumption	1.8 W (typical)
System Power Consumption	13.8 W (typical)
Input/Output Connectors	MIL-C-38999-III, 22 pin (all IMUs)
IMU Interface	RS-232 or RS-422

Table 36: HG17000 Environmental Specifications

ENVIRONMENTAL (IMU)		
Temperature	Operating Storage	-30°C to +60°C (-22°F to 140°F) -45°C to +80°C (-49°F to 176°F)
Humidity	95% non-condensing	

A.2.4 Interface Cable for the HG1700 IMU

The IMU interface cable provides power to the IMU from an external power source and enables communication between the receiver and IMU. The HG1700 IMU uses the Universal IMU Enclosure Interface cable (see *Universal IMU Enclosure Interface Cable* on page 90).

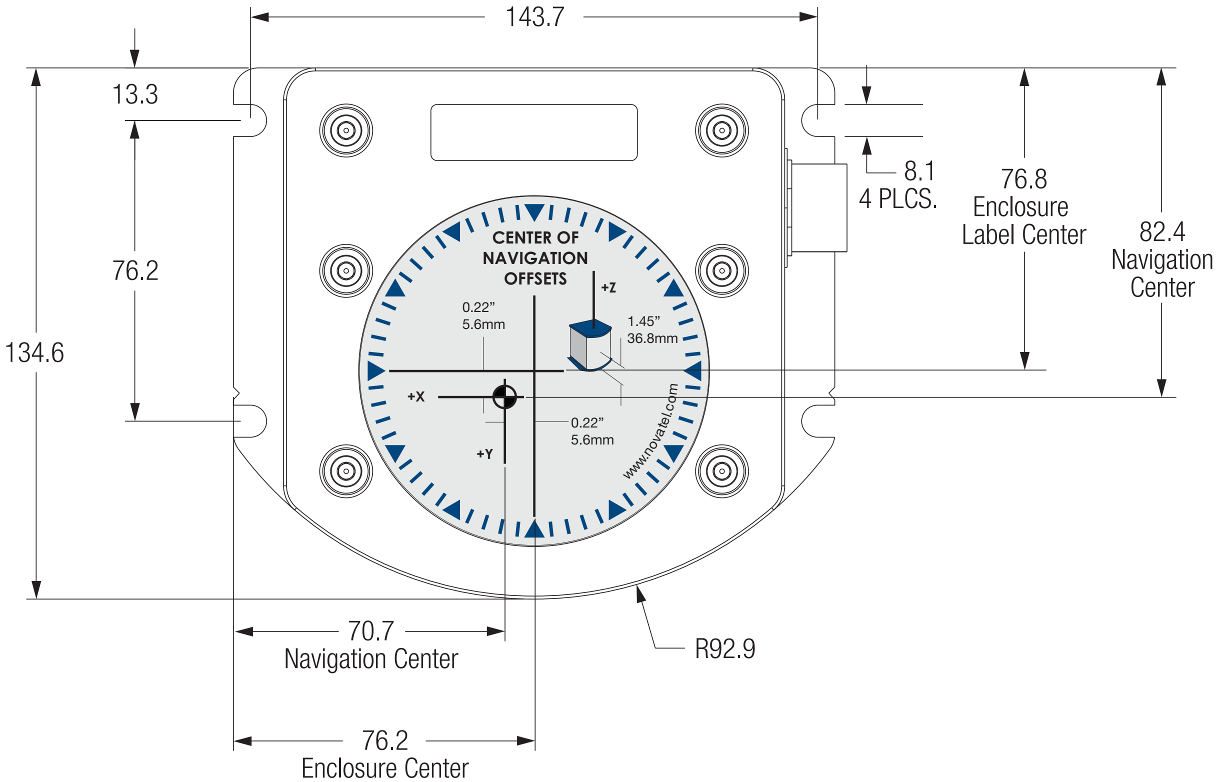
A.3 LN-200 IMU (single-connector enclosure)

Table 37: LN-200 IMU Physical 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	3.19 kg (7.02 lb.)

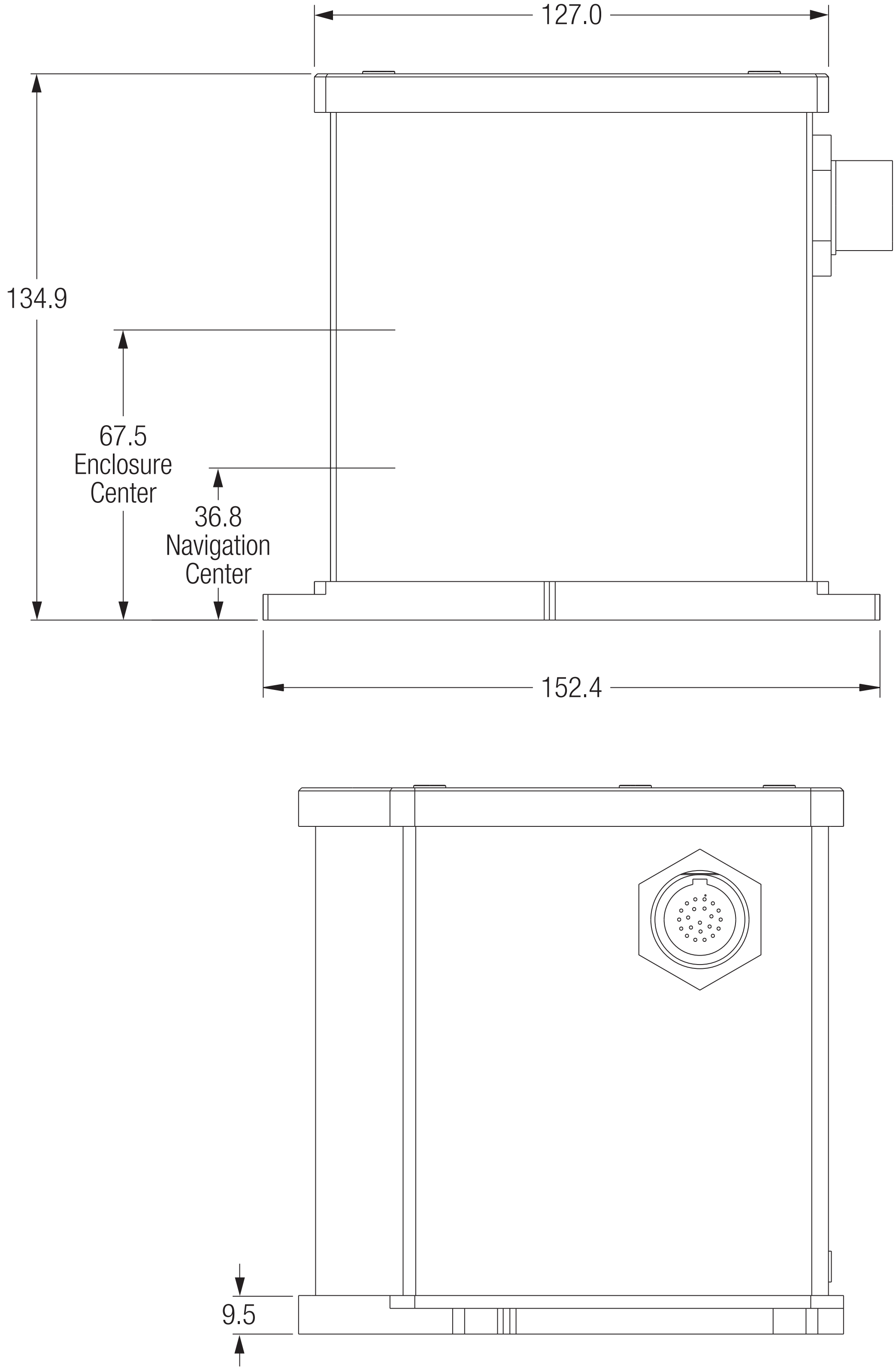
A.3.1 LN-200 IMU Mechanical Drawings

Figure 36: LN-200 IMU Enclosure Top/Bottom Dimensions and Center of Navigation



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

Figure 37: LN-200 Enclosure Side Dimensions



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

A.3.2 LN-200 IMU Performance

Table 38: LN-200 IMU Performance

GYROSCOPE PERFORMANCE	
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 PERFORMANCE	
Accelerometer Range	±40 g
Accelerometer Linearity	150 ppm
Accelerometer Scale Factor	300 ppm
Accelerometer Bias	0.3 mg
DATA RATE	
IMU Measurement	200 Hz

A.3.3 LN-200 Electrical and Environmental

Table 39: LN-200 Electrical Specifications

ELECTRICAL	
IMU Power Consumption	16 W (max)
IMU Input Voltage	+12 to +28 V DC
Receiver Power Consumption	1.8 W (typical)
System Power Consumption	13.8 W (typical)
Input/Output Connectors	MIL-C-38999-III, 22 pin (all IMUs)
IMU Interface	RS-232 or RS-422

Table 40: LN-200 Environmental Specifications

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.3.4 Interface Cable for the LN-200 IMU

The IMU interface cable provides power to the IMU from an external power source and enables communication between the receiver and IMU. The LN-200 IMU uses the Universal IMU Enclosure Interface cable (see *Universal IMU Enclosure Interface Cable* on page 90).

A.4 IMU-ISA-100C

The IMU-ISA-100C contains an ISA-100C IMU.

Table 41: IMU-ISA-100C Physical Specifications

PHYSICAL	
IMU Enclosure Size	180 mm x 150 mm x 137 mm
IMU Enclosure Weight	5.0 kg

A.4.1 IMU-ISA-100C Mechanical Drawings

Figure 38: IMU-ISA-100C Dimensions

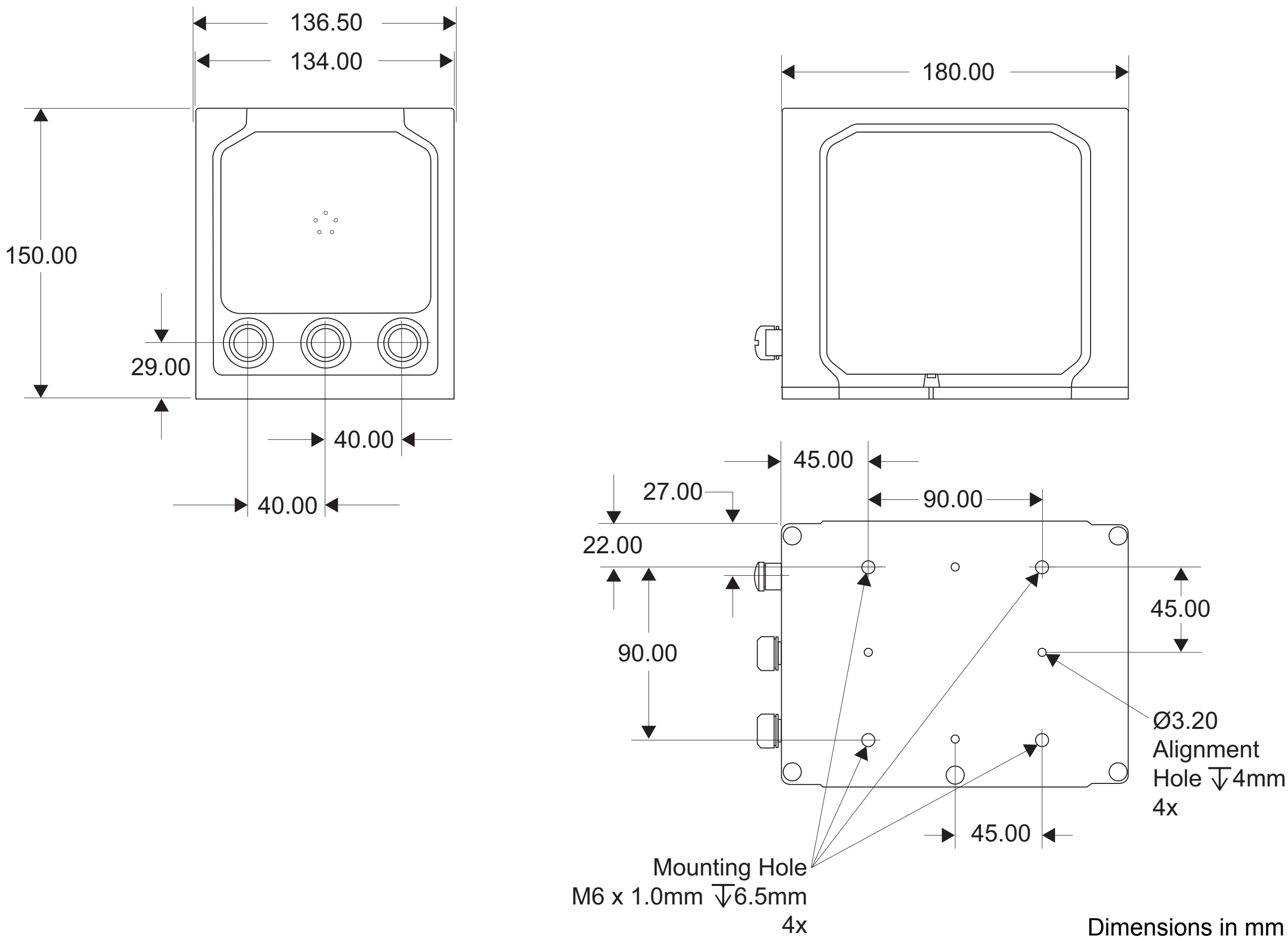
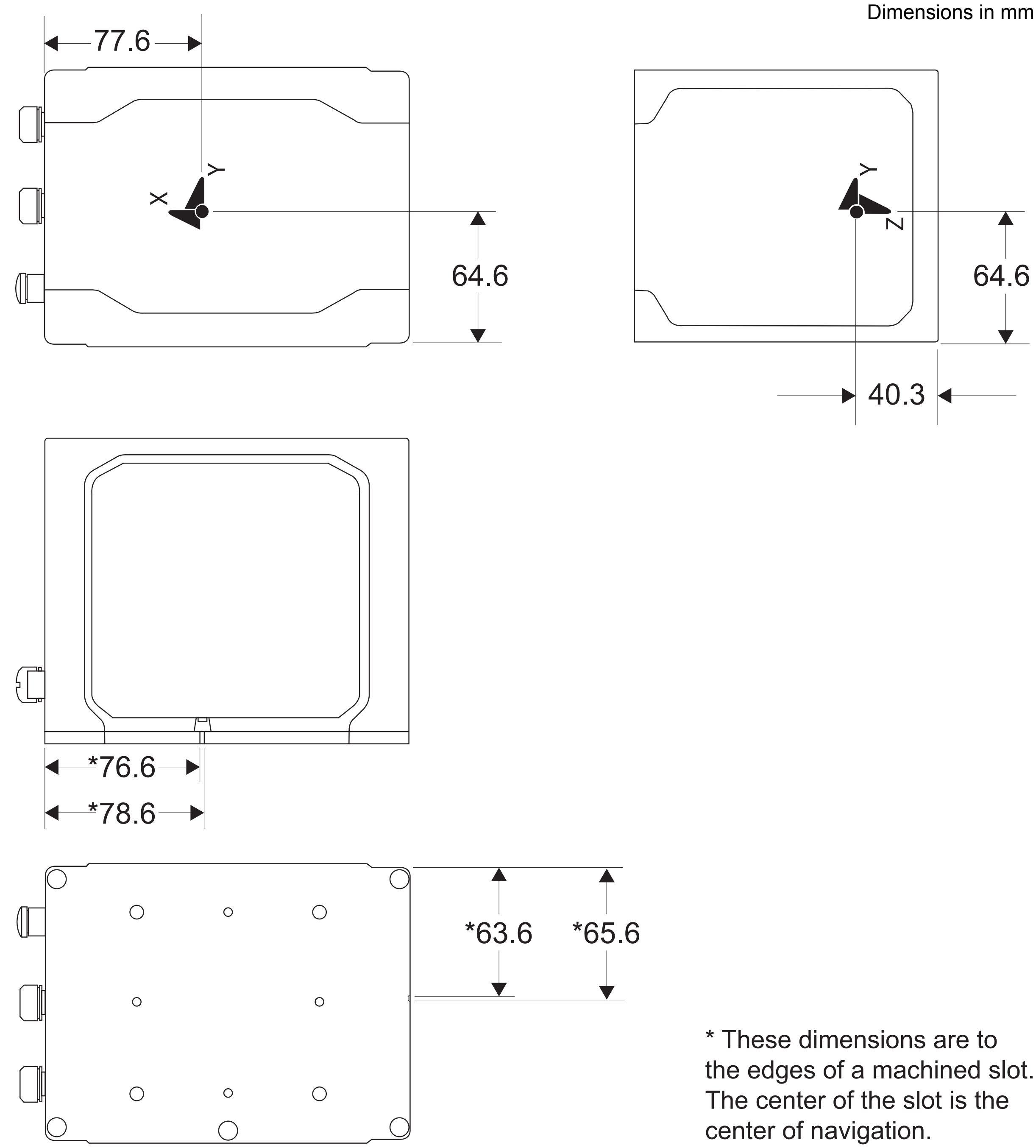


Figure 39: IMU-ISA-100C Center of Navigation



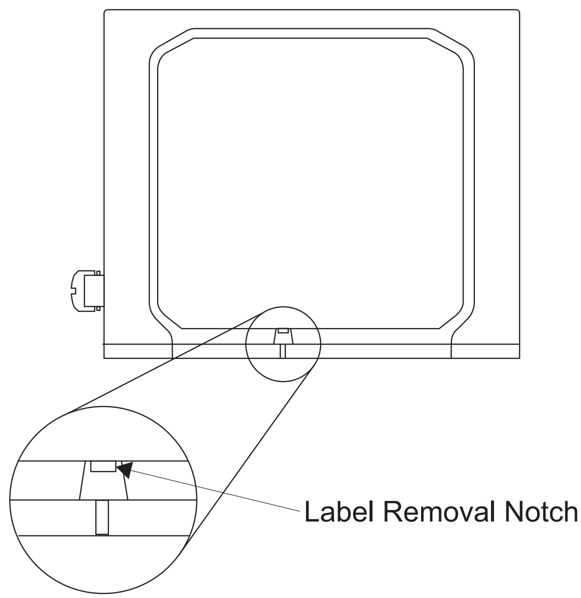
* These dimensions are to the edges of a machined slot. The center of the slot is the center of navigation.

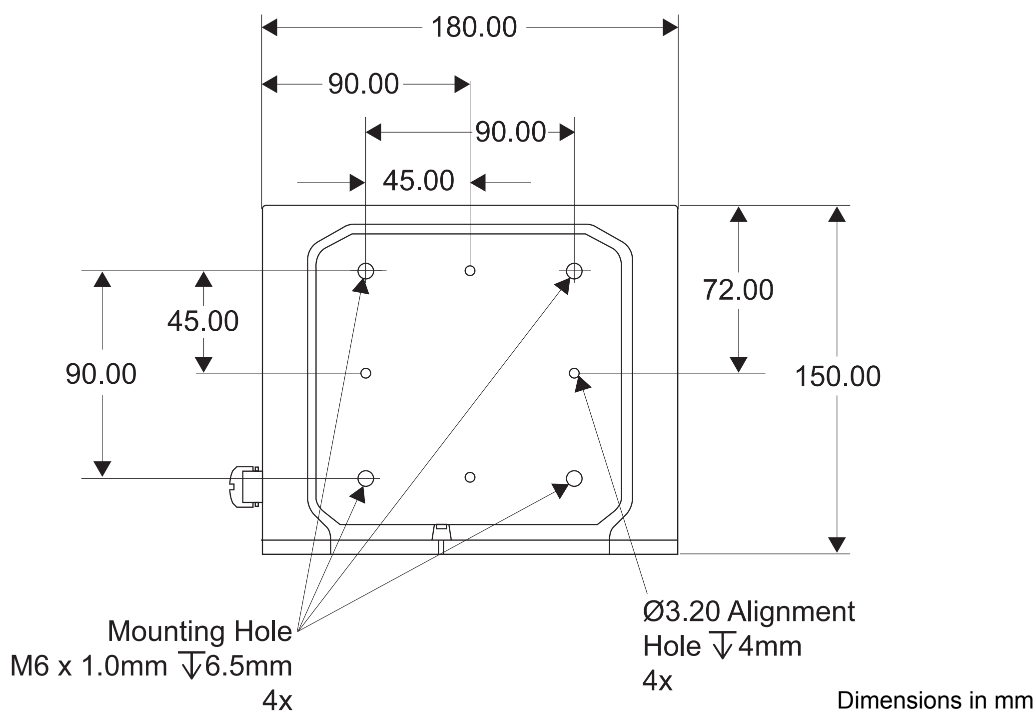
A.4.2 Optional Side Mounting Holes

There are mounting and alignment holes on both sides of the IMU enclosure to allow the IMU to be mounted on its side. These holes have the same pattern and spacing as the mounting and alignment holes on the bottom of the IMU enclosure.

To access these holes, the NovAtel label must be removed from the side of the enclosure. A small notch on the side of enclosure allows you to insert a small flat blade screw under the label to start lifting the label.

Figure 40: Optional Side Mounting Holes





A.4.3 IMU-ISA-100C Performance

Table 42: IMU-ISA-100C IMU Performance

GYROSCOPE PERFORMANCE	
Input range	±495 deg/sec
In-run bias stability	≤0.05 deg/hr
Scale factor repeatability	≤100 ppm
Scale factor non-linearity	≤100 ppm
Angular random walk	0.012 deg/√hr
ACCELEROMETER PERFORMANCE	
Range	±10 g
In-run bias stability	≤100 μg
1 year scale factor repeatability	≥1250 μg
Scale factor non-linearity	≤100 ppm
Velocity random walk	≤100 μg/√Hz
DATA RATE	
IMU Measurement	200 Hz[a]

a. A maximum data rate of 400 Hz is available on specific models of IMU-ISA-100C.

A.4.4 Electrical and Environmental

Table 43: IMU-ISA-100C Electrical Specifications

ELECTRICAL	
IMU Power Consumption	18 W (typical)
IMU Input Voltage	+10 to +34 V DC
IMU Interface	RS-422
CONNECTORS	
Power	SAL M12, 5 pin, male
Data	SAL M12, 5 pin, female
Wheel Sensor	SAL M12, 8 pin, male

Table 44: IMU-ISA-100C Environmental Specifications

ENVIRONMENTAL	
Operating Temperature	-40°C to +55°C
Storage Temperature	-40°C to +85°C
Humidity	MIL-STD-810G, Method 507.5
Water Ingress	MIL-STD-810G. Method 512.5

A.4.5 IMU Enclosure Interface Cable

The NovAtel part number for the IMU-ISA-100C interface cable is 01019319 (see *Figure 41, IMU Enclosure Interface Cable*). This cable enables communication between the receiver and the IMU.

> This cable is used for all versions of the IMU Enclosure (IMU-ISA-100C, IMU-LN200, IMU-HG1900 and IMU-µIMU).

Figure 41: IMU Enclosure Interface Cable

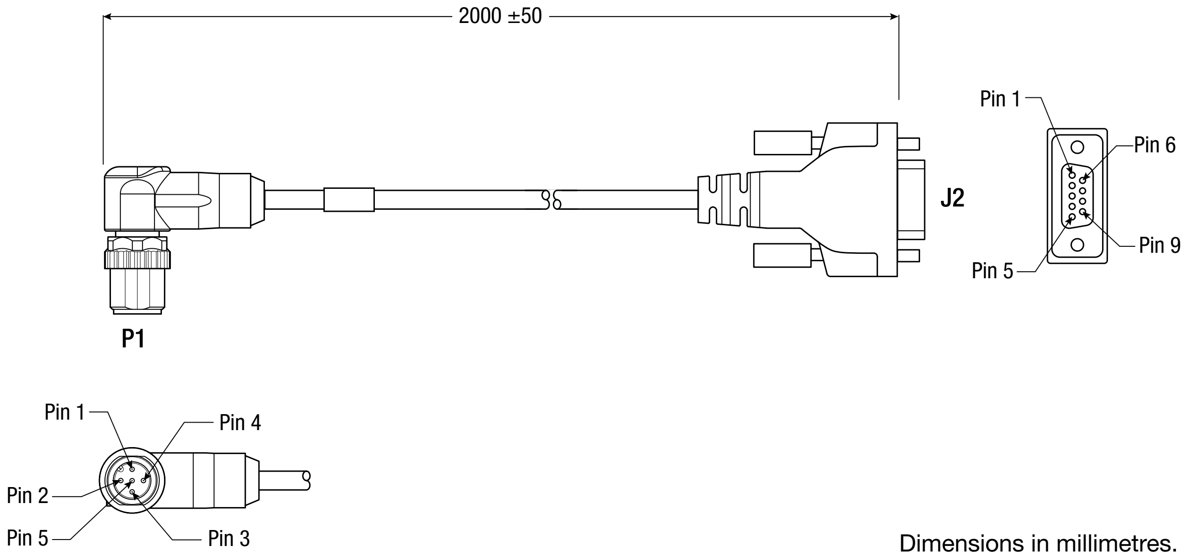


Table 45: IMU Enclosure Interface Cable Pinouts

P1 Pinout (M12)	Function	J2 Pinout (DB9)
1	TX+	2
2	RX+	3
3	TX-	8
4	RX-	7
5	GND	5
Shield	Shield	Shield

A.4.5.1 Custom Cable Recommendations

The tables below provide recommendations for creating custom cables to replace the IMU Enclosure Interface Cable (01019319).

Table 46: Connectors

Connector	Description
P1	M12x1, 5 position, male
J2	DB-9, female

Table 47: Maximum Cable Length

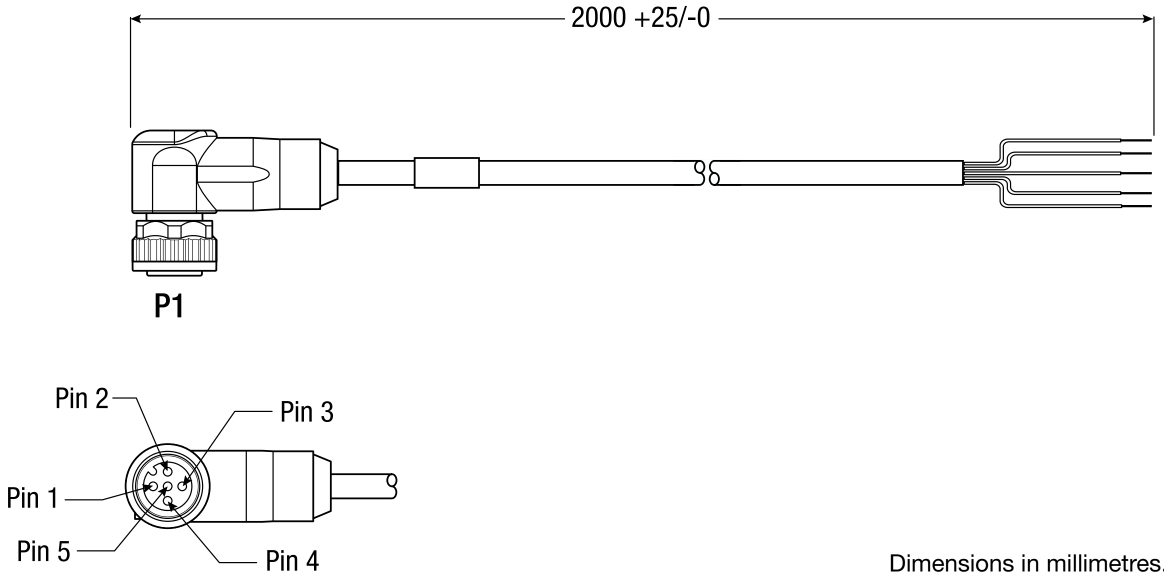
IMU	RS-422
IMU-ISA-100C	< 50 metres

A.4.6 IMU Enclosure Power Cable

The NovAtel part number for the IMU Enclosure Power Cable is 60723136 (see *Figure 42, IMU Enclosure Power Cable*). This cable provides power to the IMU from an external power source.

> This cable is used for all versions of the IMU Enclosure (IMU-ISA-100C, IMU-LN200, IMU-HG1900 and IMU-µIMU).

Figure 42: IMU Enclosure Power Cable



Dimensions in millimetres.

Table 48: IMU Enclosure Power Cable Pinouts

P1 Pinout (M12)	Function	Bare Wire Color
1	VIN-	Brown
2	VIN+	White
3	VIN+	Blue
4	VIN-	Black
5	Chassis Ground	Grey

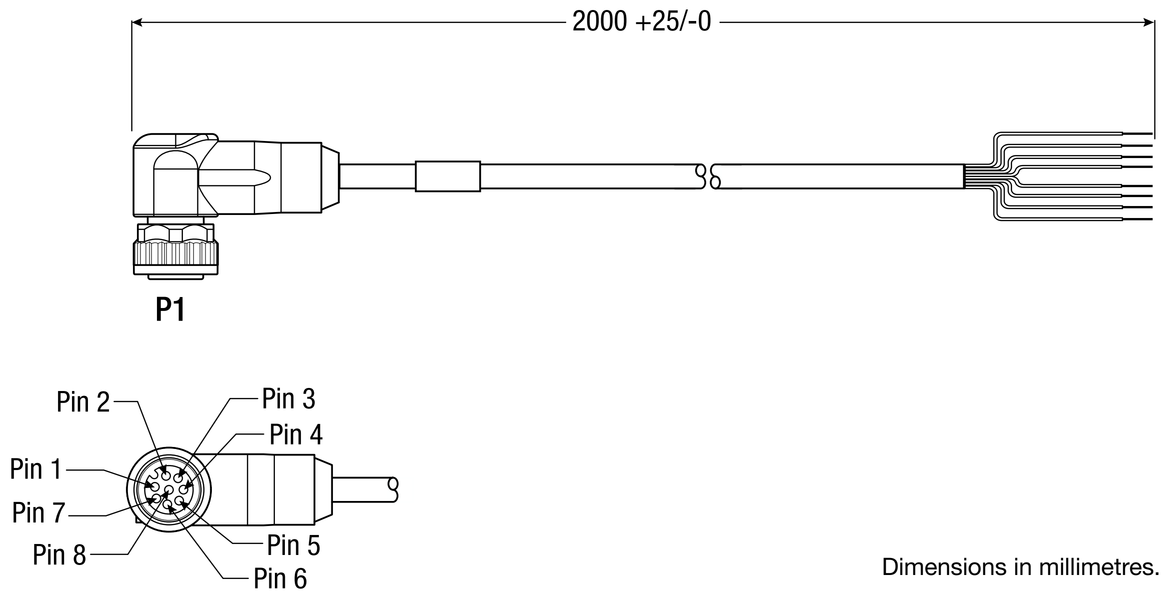
> This cable uses a M12x1, 5 position, female connector.

A.4.7 IMU Enclosure Wheel Sensor Cable

The NovAtel part number for the IMU Enclosure Wheel Sensor Cable is 60723137 (see *Figure 43, IMU Enclosure Wheel Sensor Cable*). This cable enables communication between the IMU and the wheel sensor.

> This cable is used for all versions of the IMU Enclosure (IMU-ISA-100C, IMU-LN200, IMU-HG1900 and IMU-µIMU).

Figure 43: IMU Enclosure Wheel Sensor Cable



Dimensions in millimetres.

Table 49: IMU Enclosure Wheel Sensor Cable Pinouts

P1 Pinout (M12)	Function	Bare Wire Color
1	A+	White
2	B+	Brown
3	Chassis Ground	Green
4	A-	Yellow
5	B-	Grey
6	Chassis Ground	Pink
7	Reserved	Blue
8	Reserved	Red

One of the wheel sensors compatible with the IMU-ISA-100C is the Kistler WPT (see *Figure 55, Kistler WPT* on page 126). *Table 50, Kistler to NovAtel Wheel Sensor Cable Connections* on page 106 shows connections required between the Kistler cable and the IMU-ISA-100C wheel sensor cable.

Table 50: Kistler to NovAtel Wheel Sensor Cable Connections

M12 Connector on Kistler Cable[a] Pin	Signal	M12 Connector on NovAtel Cable Pin	Bare Wire Color
1	GND	External[b]	
2	+U_B (Input Power)		
3	Signal A	1	White
4	Signal A Inverted	4	Yellow
5	Signal B	2	Brown
6	Signal B Inverted	5	Grey
7	Reserved	No Connection	
8			

a. This modification is for the Kistler WPT 8-pin M12-plug cable number 14865.

b. The WPT requires power to operate, which is not supplied through the P1 connector on the IMU-ISA-100C interface cable. Pins 1 and 2 should therefore be connected to an external power supply (+10 to +30 VDC).

A.4.7.1 Custom Cable Recommendations

The tables below provide recommendations for creating custom cables to replace the IMU Enclosure Wheel Sensor Cable (60723137).

Table 51: Connectors

Connector	Description
P1	M12x1, 8 position, female

Table 52: Maximum Cable Length

IMU	RS-422
IMU-ISA-100C	< 50 metres

A.5 IMU-LN200

The IMU-LN200 contains an LN200 or LN200C IMU.

Table 53: IMU-LN200 Physical Specifications

PHYSICAL	
IMU Enclosure Size	150 mm x 134 mm x 134 mm
IMU Enclosure Weight	<3.4 kg

A.5.1 IMU-LN200 Mechanical Drawings

Figure 44: IMU-LN200 Dimensions

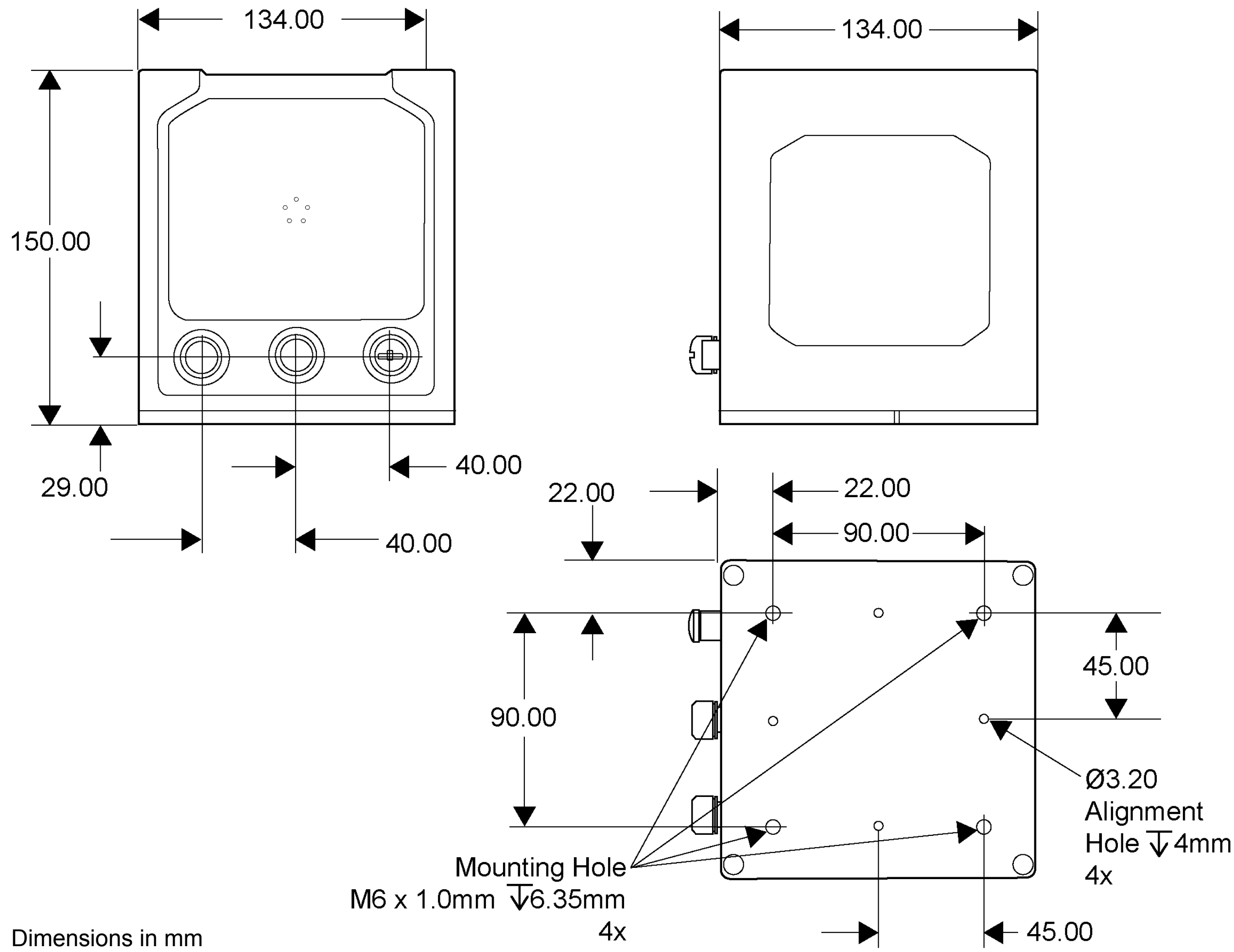
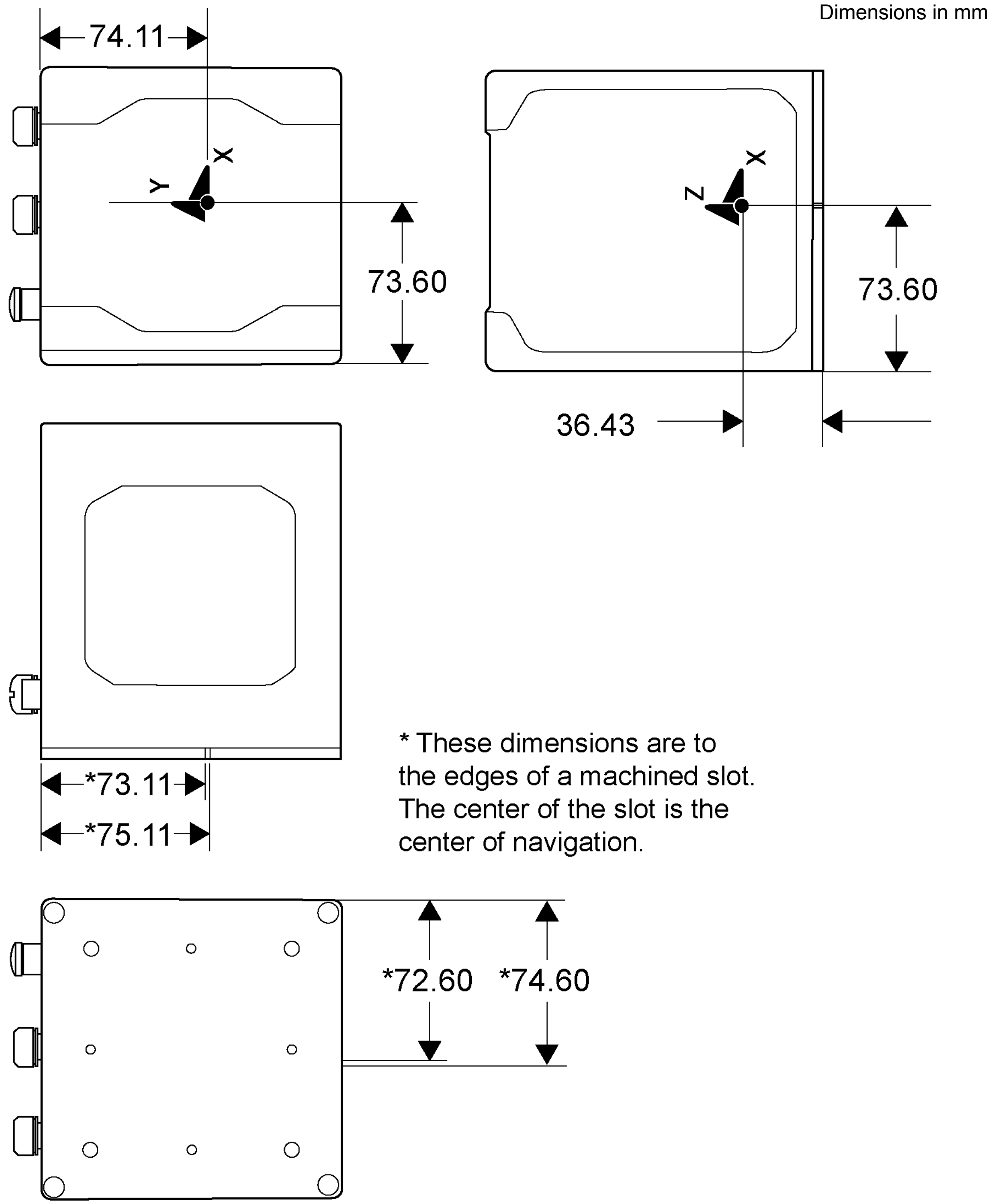


Figure 45: IMU-LN200 Center of Navigation



A.5.2 IMU-LN200 Performance

Table 54: IMU-LN200C IMU Performance

GYROSCOPE PERFORMANCE	
Input range	±490 deg/sec
Rate bias	1.0 deg/hr
Scale factor error	100 ppm
Angular random walk	0.07 deg/√hr
ACCELEROMETER PERFORMANCE	
Input range	±15 g
Scale factor asymmetry	150 ppm
Scale factor error	300 ppm
Bias	1.0 mg
DATA RATE	
IMU Measurement	200 Hz

Table 55: IMU-LN200 IMU Performance

GYROSCOPE PERFORMANCE	
Input range	±1000 deg/sec
Rate bias	1.0 deg/hr
Scale factor error	100 ppm
Angular random walk	0.07 deg/√hr
ACCELEROMETER PERFORMANCE	
Range	±40 g
Scale factor asymmetry	150 ppm
Scale factor error	300 ppm
Bias	0.3 mg
DATA RATE	
IMU Measurement	200 Hz

A.5.3 Electrical and Environmental

Table 56: IMU-LN200 Electrical Specifications

ELECTRICAL	
IMU Power Consumption	14 W (typical)
IMU Input Voltage	+10 to +34 V DC
IMU Interface	RS-422
CONNECTORS	
Power	SAL M12, 5 pin, male
Data	SAL M12, 5 pin, female
Wheel Sensor	SAL M12, 8 pin, male

Table 57: IMU-LN200 Environmental Specifications

ENVIRONMENTAL	
Operating Temperature	-40°C to +55°C
Storage Temperature	-40°C to +80°C
Humidity	MIL-STD-810G, Method 507.5
Random Vibe	MIL-STD-810G. Method 514.6 (2.0 g)
Environment	IEC 60529 IP67

A.5.4 IMU-LN200 Interface Cable

The IMU-LN200 uses the IMU Enclosure Interface Cable. Refer to *IMU Enclosure Interface Cable* on page 103 for details about this cable.

A.5.5 IMU-LN200 Power Cable

The IMU-LN200 uses the IMU Enclosure Power Cable. Refer to *IMU Enclosure Power Cable* on page 104 for details about this cable.

A.5.6 IMU-LN200 Wheel Sensor Cable

The IMU-LN200 uses the IMU Enclosure Wheel Sensor Cable. Refer to *IMU Enclosure Wheel Sensor Cable* on page 105 for details about this cable.

A.6 IMU-HG1900

The IMU-HG1900 contains a Honeywell HG1900 IMU.

Table 58: IMU-HG1900 Physical Specifications

PHYSICAL	
IMU Enclosure Size	130 mm x 130 mm x 125 mm
IMU Enclosure Weight	2.34 kg

A.6.1 IMU-HG1900 Mechanical Drawings

Figure 46: IMU-HG1900 Dimensions

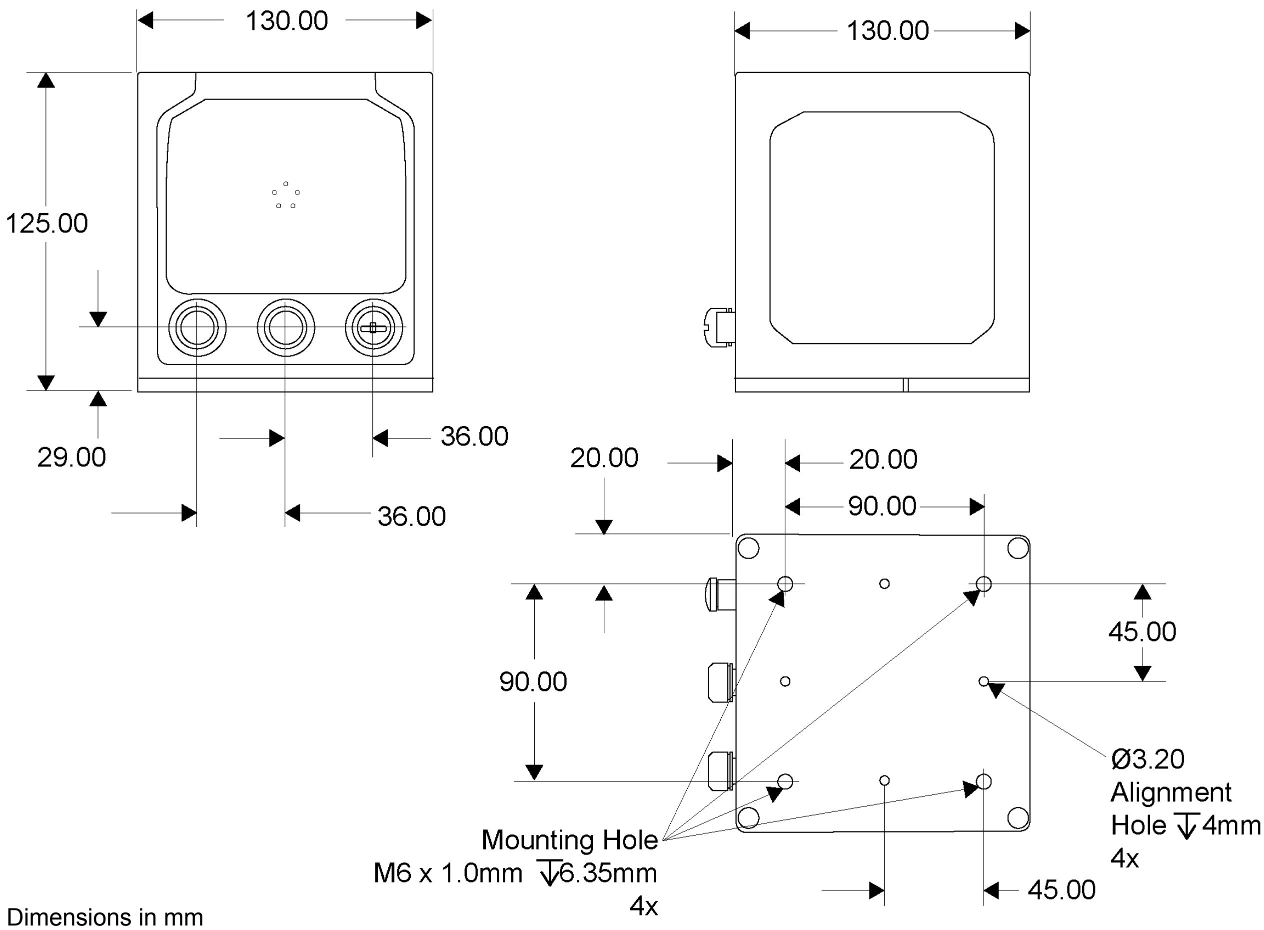
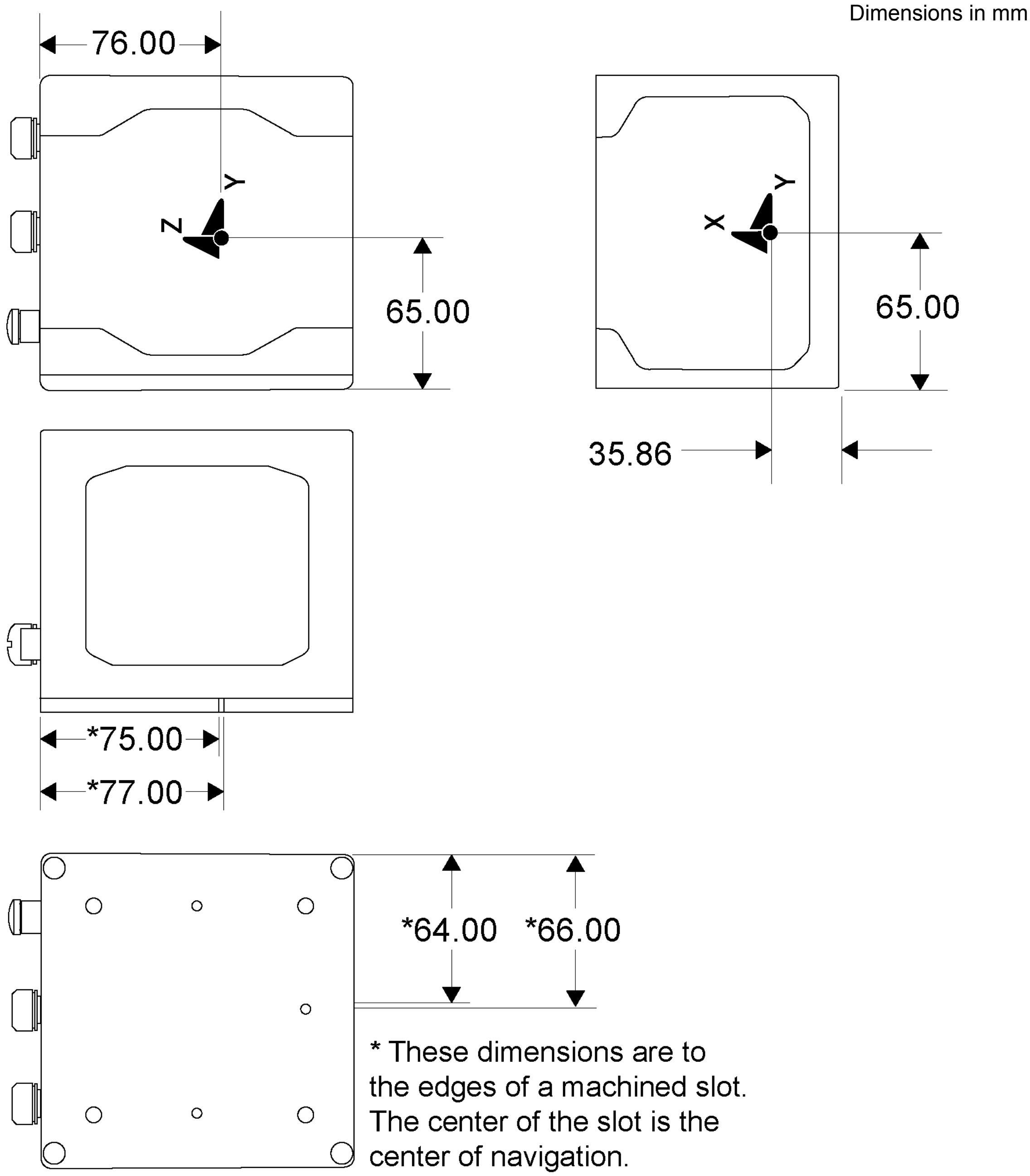


Figure 47: IMU-HG1900 Center of Navigation



A.6.2 IMU-HG1900 Performance

Table 59: IMU-HG1900 IMU Performance

GYROSCOPE PERFORMANCE	
Input range	±1000 deg/sec
Rate bias	5 deg/hr
In-run bias stability	1 deg/hr
Rate scale factor	150 ppm
Angular random walk	0.09 deg/√hr
ACCELEROMETER PERFORMANCE	
Range	±30 g
Linearity	500 ppm
Scale factor	300 ppm
Bias repeatability	1 mg
Bias in-run stability	0.7 mg
DATA RATE	
IMU Measurement	100 Hz

A.6.3 Electrical and Environmental

Table 60: IMU-HG1900 Electrical Specifications

ELECTRICAL	
IMU Power Consumption	7.5 W (typical)
IMU Input Voltage	+10 to +34 V DC
IMU Interface	RS-422
CONNECTORS	
Power	SAL M12, 5 pin, male
Data	SAL M12, 5 pin, female
Wheel Sensor	SAL M12, 8 pin, male

Table 61: IMU-HG1900 Environmental Specifications

ENVIRONMENTAL	
Operating Temperature	-40°C to +55°C
Storage Temperature	-40°C to +80°C
Humidity	MIL-STD-810G, Method 507.5
Random Vibe	MIL-STD-810G. Method 514.6 (2.0g)
Environment	IEC 60529 IP 67

A.6.4 IMU-HG1900 Interface Cable

The IMU-HG1900 uses the IMU Enclosure Interface Cable. Refer to *IMU Enclosure Interface Cable* on page 103 for details about this cable.

A.6.5 IMU-HG1900 Power Cable

The IMU-HG1900 uses the IMU Enclosure Power Cable. Refer to *IMU Enclosure Power Cable* on page 104 for details about this cable.

A.6.6 IMU-HG1900 Wheel Sensor Cable

The IMU-HG1900 uses the IMU Enclosure Wheel Sensor Cable. Refer to *IMU Enclosure Wheel Sensor Cable* on page 105 for details about this cable.

A.7 IMU-µIMU

The IMU-µIMU contains a Litef µIMU.

Table 62: IMU-µIMU Physical Specifications

PHYSICAL	
IMU Enclosure Size	130 mm x 130 mm x 115 mm
IMU Enclosure Weight	2.57 kg

A.7.1 IMU-µIMU Mechanical Drawings

Figure 48: IMU-µIMU Dimensions

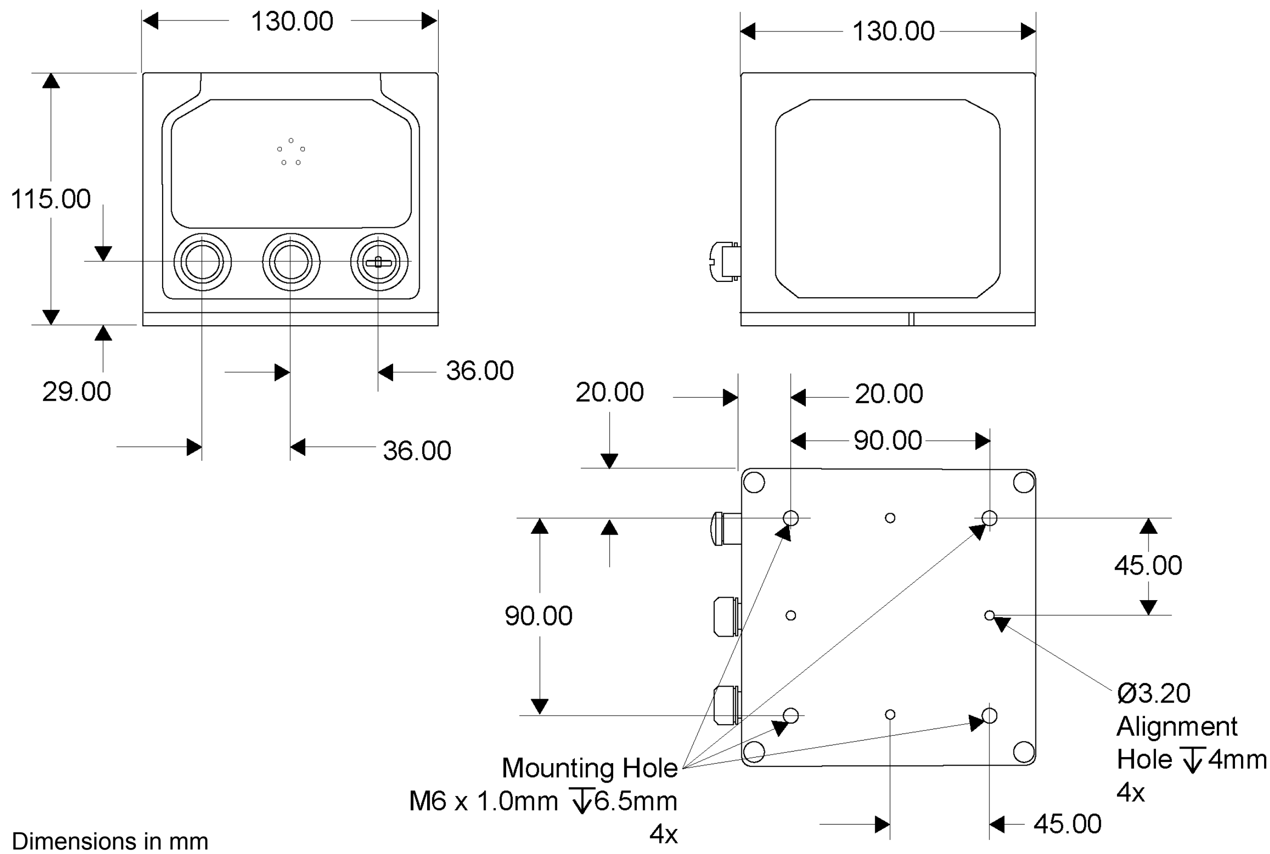
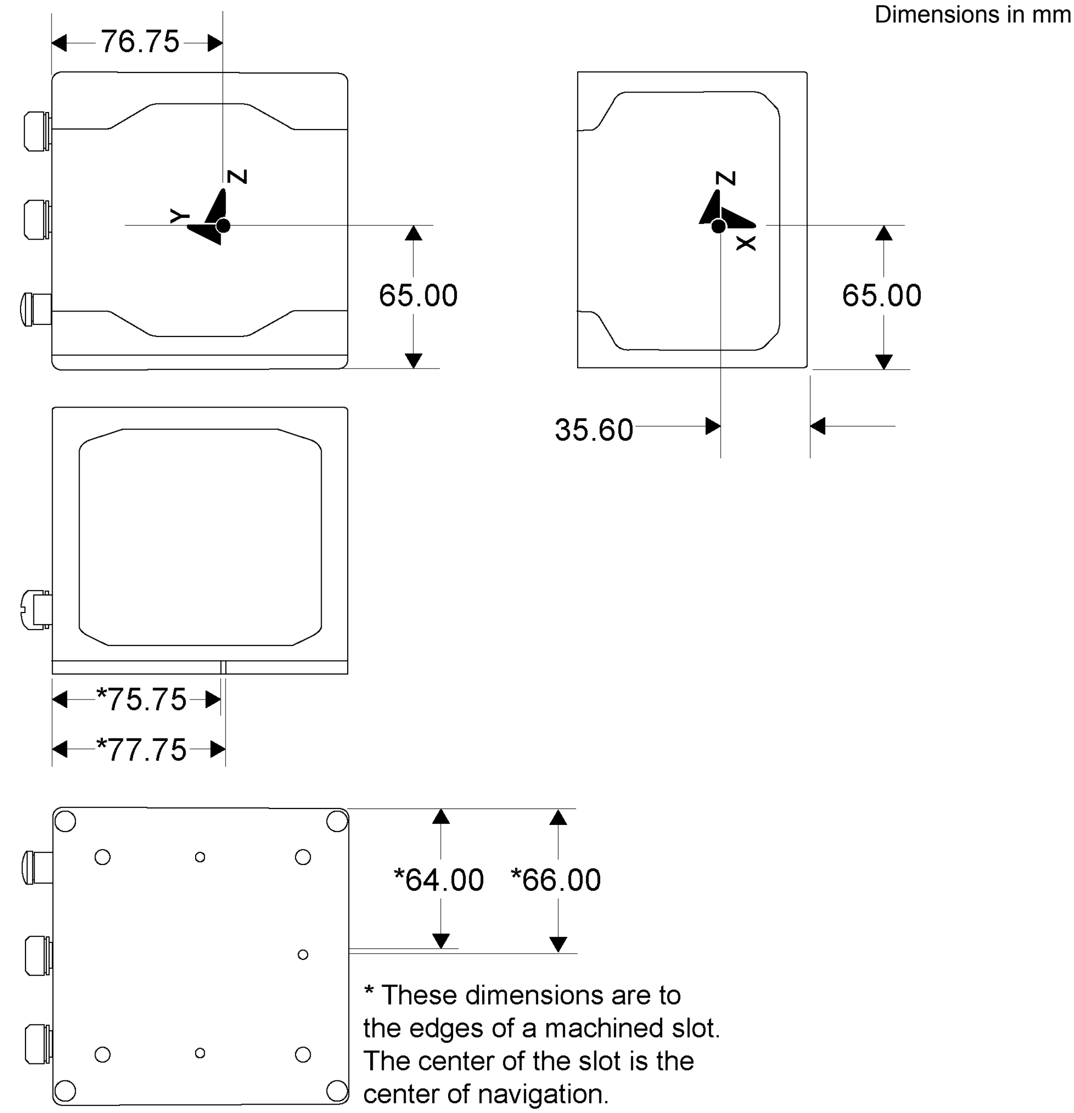


Figure 49: IMU-µIMU Center of Navigation



A.7.2 IMU-µIMU Performance

Table 63: IMU-µIMU IMU Performance

GYROSCOPE PERFORMANCE	
Input range	±499 deg/sec
Bias stability	≤6 deg/hr
Scale factor error	≤1400 ppm
Angular random walk	0.3 deg/√hr
ACCELEROMETER PERFORMANCE	
Range	±15 g
Bias repeatability	≤3 mg
Scale factor error	≤1500 ppm
Velocity random walk	≤0.25 mg/√Hz
DATA RATE	
IMU Measurement	200 Hz

A.7.3 Electrical and Environmental

Table 64: IMU-µIMU Electrical Specifications

ELECTRICAL	
IMU Power Consumption	11 W (typical)
IMU Input Voltage	+10 to +34 V DC
IMU Interface	RS-422
CONNECTORS	
Power	SAL M12, 5 pin, male
Data	SAL M12, 5 pin, female
Wheel Sensor	SAL M12, 8 pin, male

Table 65: IMU-µIMU Environmental Specifications

ENVIRONMENTAL	
Operating Temperature	-40°C to +55°C
Storage Temperature	-40°C to +80°C
Humidity	MIL-STD-810G, Method 507.5
Random Vibe	MIL-STD-810G. Method 514.6 (2.0g)
Environment	IEC 60529 IP67

A.7.4 IMU-µIMU Interface Cable

The IMU-µIMU uses the IMU Enclosure Interface Cable. Refer to *IMU Enclosure Interface Cable* on page 103 for details about this cable.

A.7.5 IMU-µIMU Power Cable

The IMU-µIMU uses the IMU Enclosure Power Cable. Refer to *IMU Enclosure Power Cable* on page 104 for details about this cable.

A.7.6 IMU-µIMU Wheel Sensor Cable

The IMU-µIMU uses the IMU Enclosure Wheel Sensor Cable. Refer to *IMU Enclosure Wheel Sensor Cable* on page 105 for details about this cable.

A.8 iIMU-FSAS

Table 66: iIMU-FSAS Physical 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.)

A.8.1 iIMU-FSAS Mechanical Drawings

Figure 50: iIMU-FSAS Top Dimensions

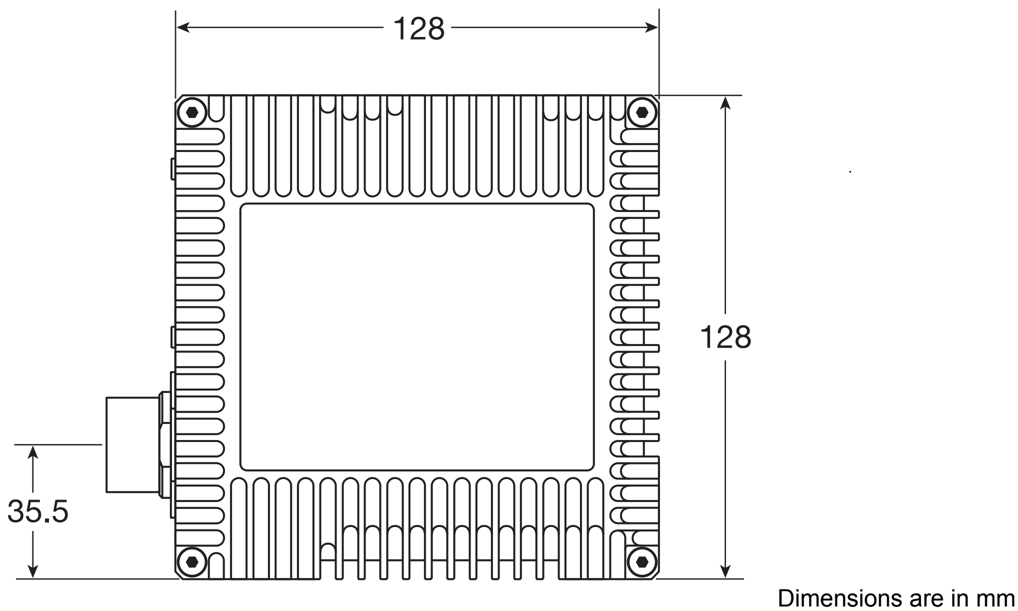


Figure 51: iIMU-FSAS Bottom Dimensions

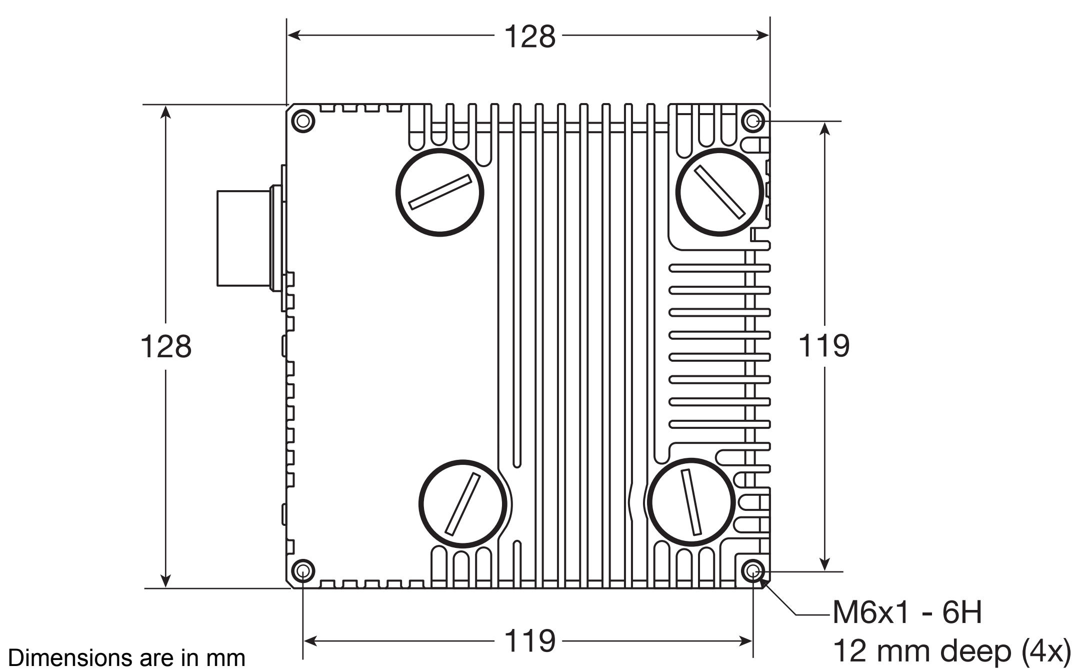


Figure 52: iIMU-FSAS Enclosure Side Dimensions

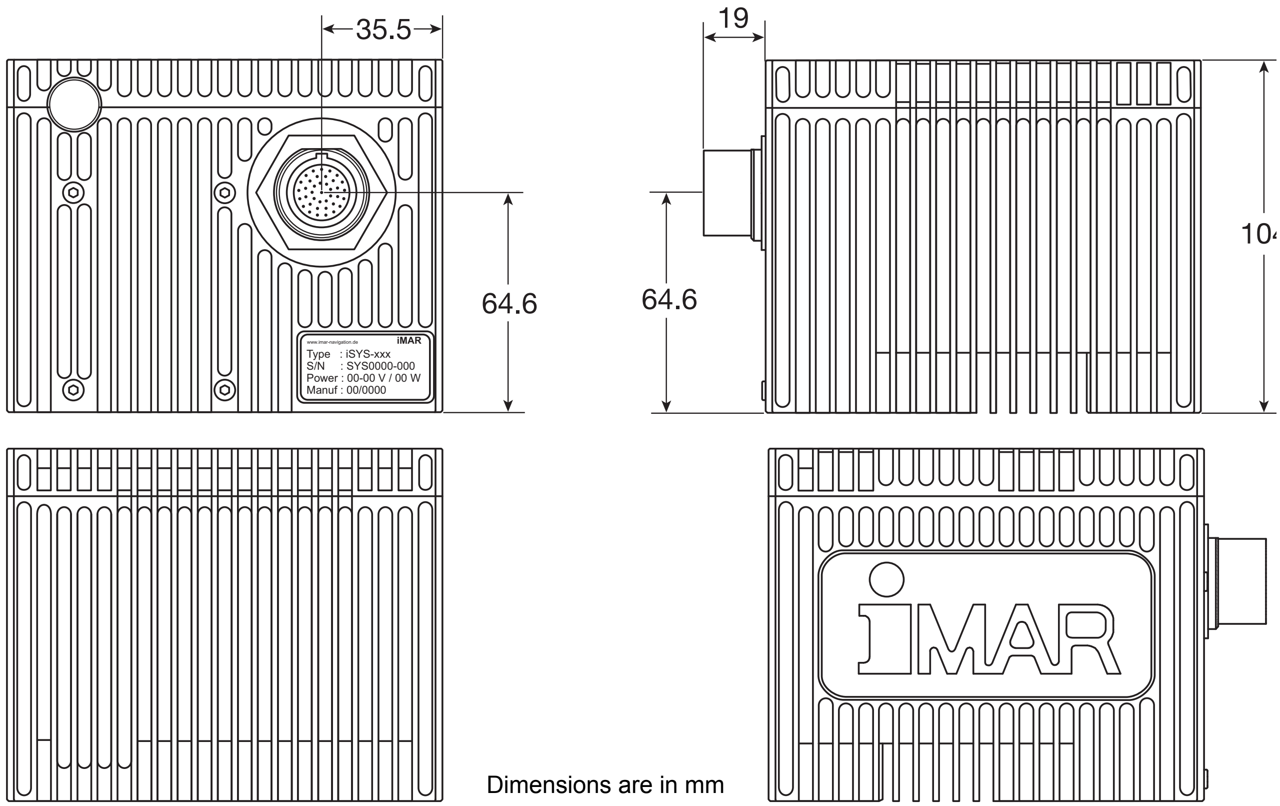
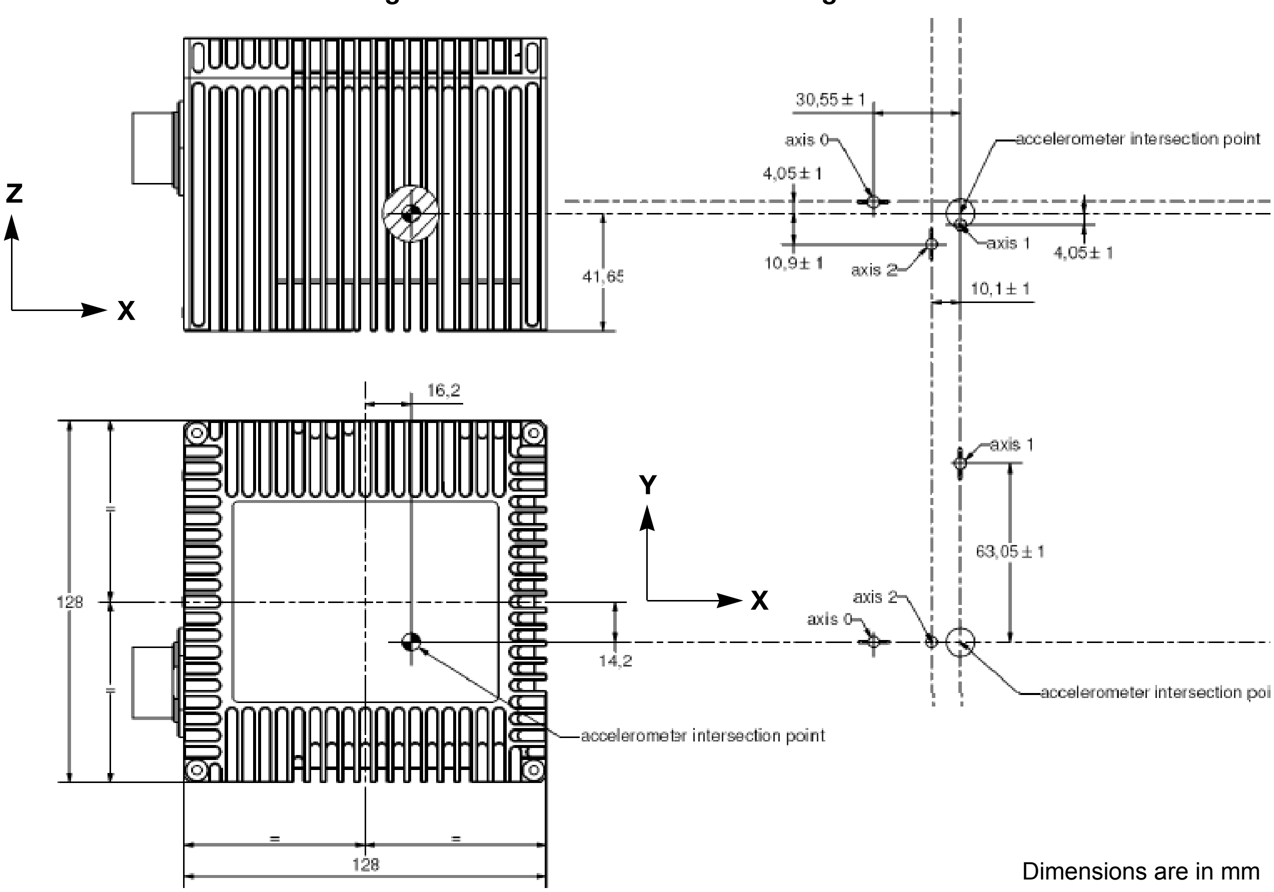


Figure 53: iIMU-FSAS Center of Navigation



A.8.2 iIMU-FSAS Performance

Table 67: iIMU-FSAS Performance

GYROSCOPE PERFORMANCE	
Gyro Input Range	±450 degrees/s
Gyro Rate Bias	<0.75°/hr
Gyro Rate Scale Factor	300 ppm
Angular Random Walk	0.1 degrees/sq rt hr
ACCELEROMETER PERFORMANCE	
Accelerometer Range	±5 g (±20 g optional)
Accelerometer Scale Factor	300 ppm
Accelerometer Bias	1.0 mg
DATA RATE	
IMU Measurement	200 Hz

A.8.3 iIMU-FSAS Electrical and Environmental

Table 68: iIMU-FSAS Electrical Specifications

ELECTRICAL	
IMU Power Consumption	16 W (max)
IMU Input Voltage	+10 to +34 V DC
Receiver Power Consumption	1.8 W (typical)
System Power Consumption	13.8 W (typical)
Data Connector	MIL-C-38999-III
Power Connector	MIL-C-38999-III (same as data connector)
IMU Interface	RS-422

Table 69: iIMU-FSAS Environmental Specifications

ENVIRONMENTAL	
Operating Temperature	-40°C to +71°C (-40°F to 160°F)
Storage Temperature	-40°C to +85°C (-40°F to 185°F)
Humidity	95% non-condensing

A.8.4 Interface Cable for the IMU-FSAS

The iIMU-FSAS connects to the FlexPak6 receiver using a FlexPak Y Adapter cable and an IMU interface cable (see *Figure 7, Basic Set Up – FlexPak6 to IMU-FSAS* on page 25).

For a drawing and pinout of the FlexPak Y Adapter cable, see *FlexPak Y Adapter Cable (for IMU-FSAS, IMU-CPT or IMU-KVH1750)* on page 128.

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

Cable	NovAtel Part Number	Comment	For more information
Universal IMU Enclosure Interface cable	01018977	For standard pinout enclosures. FlexPak6 compatible connectors	See *Universal IMU Enclosure Interface Cable* on page 90
IMU-FSAS cable with ODO	01018388	For standard pinout enclosures. Includes an additional connector for odometer cabling.	See *IMU-FSAS cable with Odometer* on page 123

A.8.5 IMU-FSAS cable with Odometer

The NovAtel part number for the IMU-FSAS cable with Odometer is 01018388 (see *Figure 54, IMU-FSAS Interface Cable with Odometer*). This cable:

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

See also *iIMU-FSAS Odometer Cabling* on page 126.

Figure 54: IMU-FSAS Interface Cable with Odometer

Dimensions in millimetres.

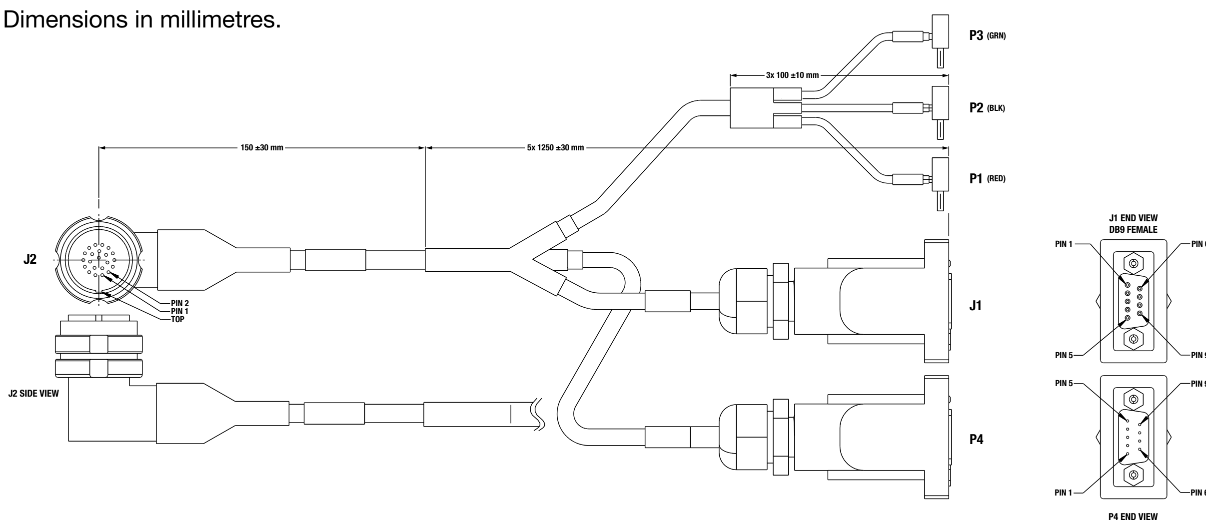


Table 70: IMU-FSAS Cable with Odometer Pinout

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

A.8.5.1 Custom Cable Recommendations

The tables below provide recommendations for creating custom cables to replace the IMU-FSAS cable with Odometer (01018388).

Table 71: Connectors

Connector	Description
J1	DB-9, female
J2	MIL-DTL-38999 III, plug
P4	DB-9, male

Table 72: Maximum Cable Length

IMU	RS-422
iIMU-FSAS	< 1.5 metres

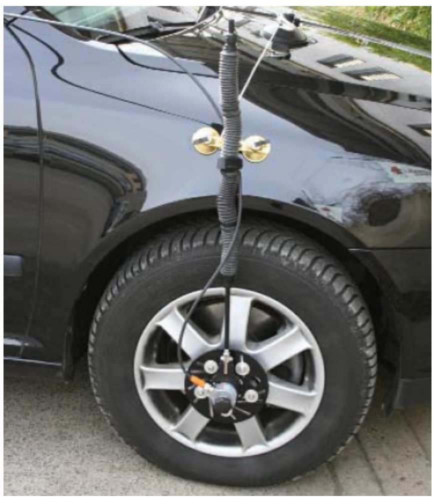
A.8.6 iIMU-FSAS Odometer Cabling

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

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

- iMWS-V2 (Magnetic Wheel Sensor) from iMAR
  - A magnetic strip and detector are installed inside the wheel. The signal then goes through a box that translates the magnetic readings into pulses that are then passed through the cable into the ODO connector on the IMU cable. See also *Figure 56, iMAR iMWS Pre-Installed* on page 126.
- Wheel Pulse Transducer CWPTA411 (WPT) from Kistler
  - 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 55, Kistler WPT* on page 126.

Figure 55: Kistler 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 Kistler WPT (part number CWPTA411) user manual for mounting instructions.

Figure 56: iMAR iMWS Pre-Installed

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

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

The NovAtel IMU interface cable with ODO, is the same as that in *Interface Cable for the IMU-FSAS* on page 123 but with some of the reserved pins having odometer uses. It still provides power to the IMU from an external source, and enables input and output between the receiver and IMU. See also *SPAN Wheel Sensor Configuration* on page 73.

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

You can use our interface cable with the ODO connector to plug directly into the iMWS. With the WPT, first modify the cable provided with the WPT. The cable modification is shown in *Table 73, Cable Modification for Kistler WPT*.

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

Table 73: Cable Modification for Kistler WPT

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

a. This modification is for the Kistler WPT 8-pin M12-plug cable number 14865.

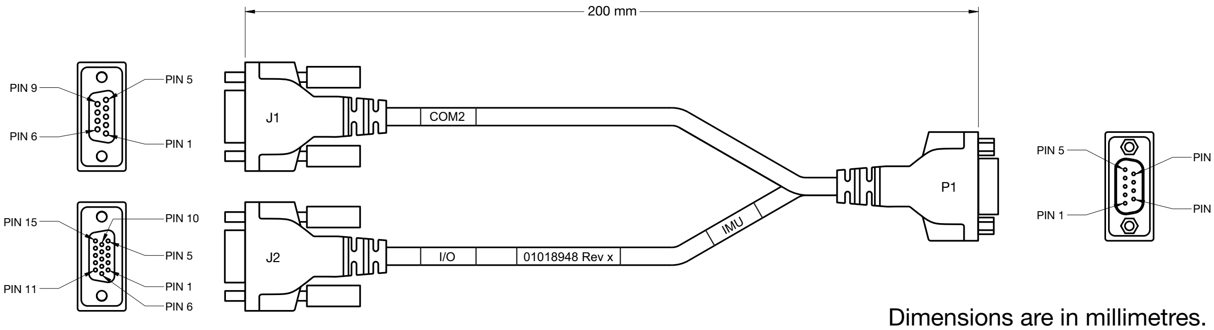
b. The WPT requires power to operate, which is not supplied through the P4 connector on the IMU-FSAS interface cable. Pins 1 and 2 should therefore be connected to an external power supply (+10 to +30 VDC).

Kistler provides an M12 to DB9 cable for use with the WPT. However, certain revisions of this cable to do not bring through all four signal inputs. The IMU-FSAS odometer interface requires all four signal inputs to operate correctly. See your WPT documentation for cable details.

A.8.7 FlexPak Y Adapter Cable (for IMU-FSAS, IMU-CPT or IMU-KVH1750)

The NovAtel part number for the FlexPak Y Adapter cable is 01018948. This cable connects from the FlexPak6 to the IMU interface cable (see *Figure 7, Basic Set Up – FlexPak6 to IMU-FSAS* on page 25). The FlexPak Y Adapter cable allows the IMU to access receiver signals from both the COM 2 port and the I/O port.

Figure 57: FlexPak Y Adapter Cable



Dimensions are in millimetres.

Table 74: FlexPak Y Adapter Cable Pinouts

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

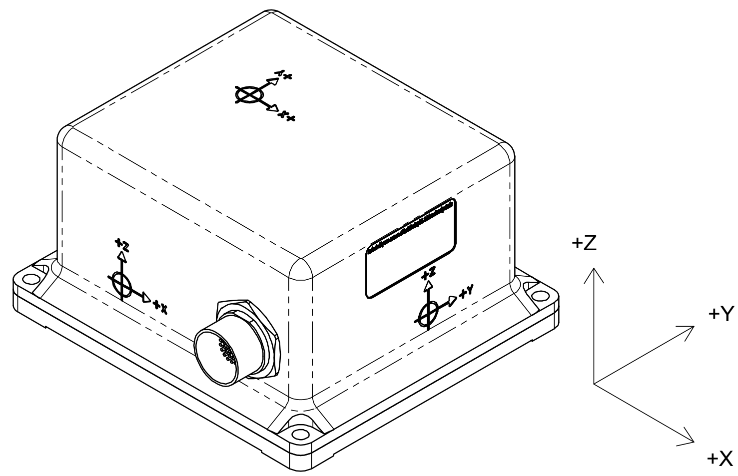
A.9 IMU-CPT

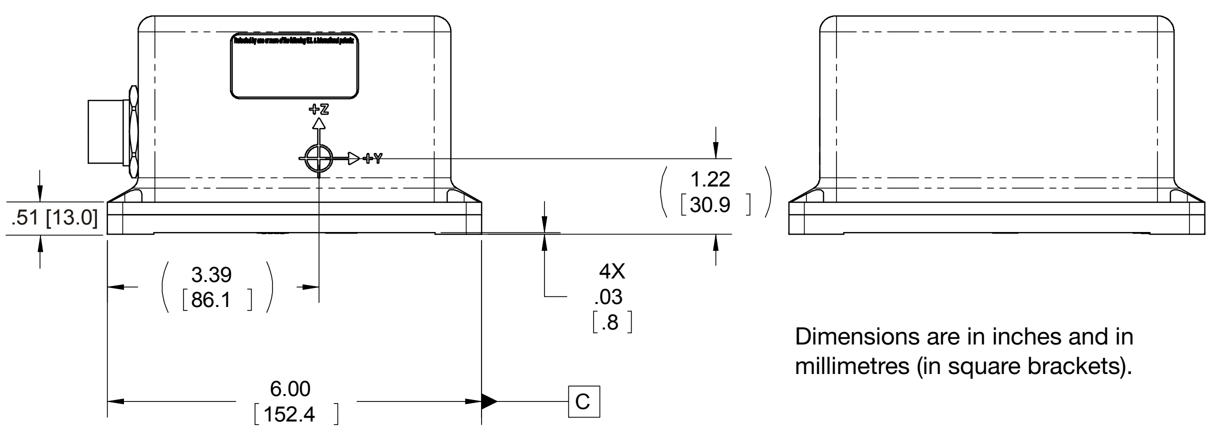
Table 75: IMU-CPT Physical Specifications

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

A.9.1 IMU-CPT Mechanical Drawings

Figure 58: IMU-CPT - Side and Perspective View

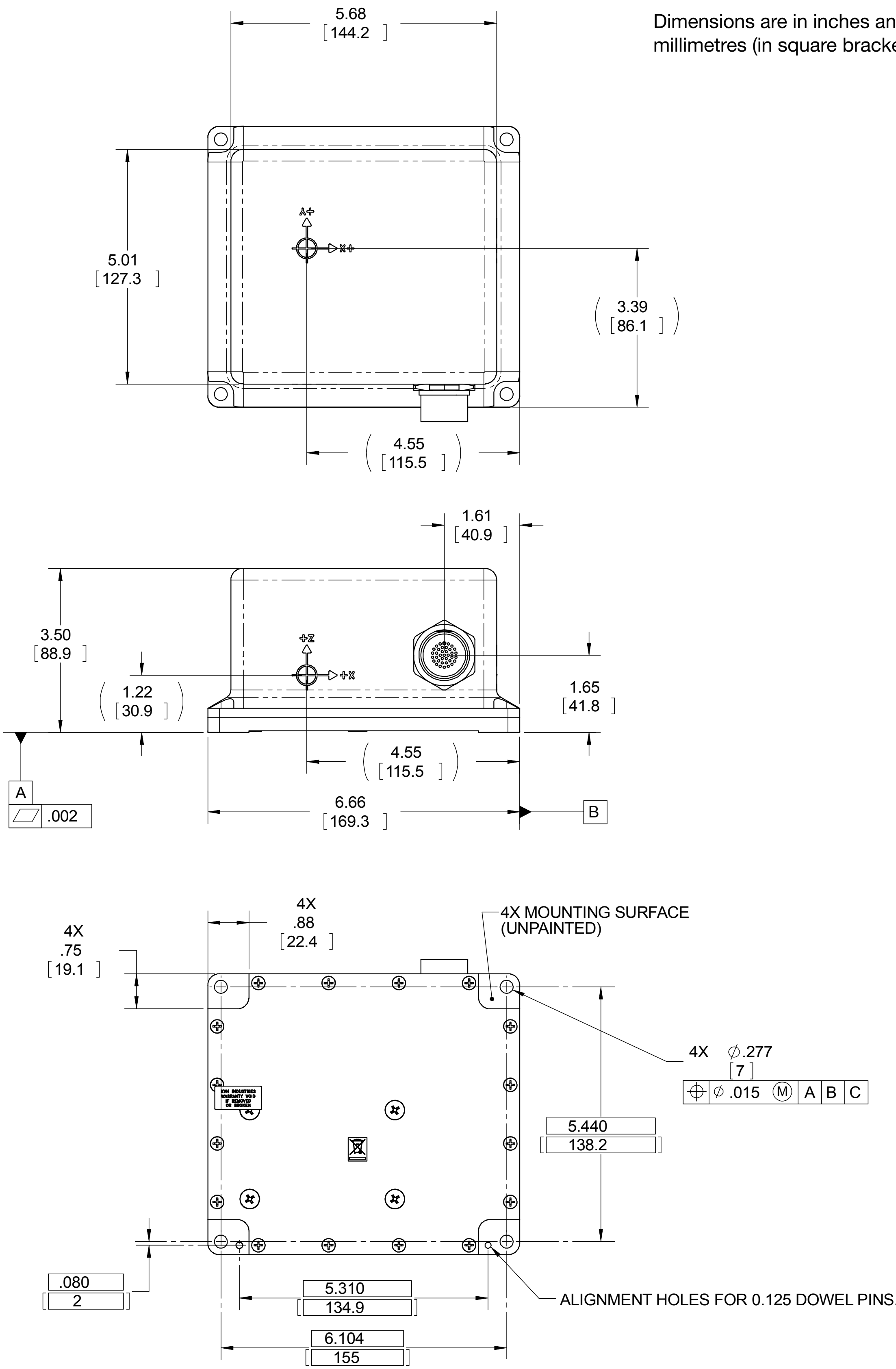




Dimensions are in inches and in millimetres (in square brackets).

Figure 59: IMU-CPT Top, Front and Bottom View

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



A.9.2 IMU-CPT Sensor Specifications

Table 76: IMU-CPT Performance

GYROSCOPE PERFORMANCE	
Bias Offset	±20 °/hr
Turn On To Turn On Bias Repeatability (Compensated)	±3 °/hr
In Run Bias Variation, At Constant Temperature	1 °/hr @ 1σ
Scale Factor Error (Total)	1500 ppm, 1σ
Scale Factor Linearity	1000 ppm, 1σ
Temperature Dependent SF Variation	500 ppm, 1σ
Angular Random Walk	0.0667 °/√hr @ 1σ
Max Input	±375 °/sec
ACCELEROMETER PERFORMANCE	
Bias Offset	±50 mg
Turn On To Turn On Bias Repeatability	±0.75 mg
In Run Bias Variation, At Constant Temperature	0.25 mg @ 1σ
Temperature Dependent Bias Variation	0.5 mg/°C @ 1σ
Scale Factor Error (Total)	4000 ppm, 1σ
Temperature Dependent SF Variation	1000 ppm, 1σ
Accelerometer Noise	55 μg/√Hz @ 1σ
Bandwidth	50 Hz
Max Input	±10 g
DATA RATE	
IMU Measurement	100 Hz

A.9.3 IMU-CPT Electrical and Environmental

Table 77: IMU-CPT Electrical and Environmental Specifications

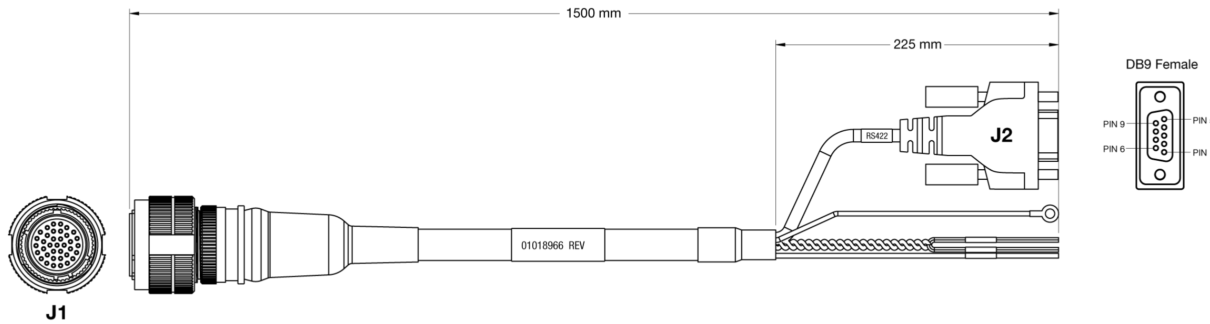
CONNECTORS	
Power and I/O	MIL-DTL-38999 Series 3
ELECTRICAL	
Input Power	9 - 18 VDC
Power consumption	13 W (max)
Start-Up Time (Valid Data)	< 5 seconds
ENVIRONMENTAL	
Temperature, operational	-40°C to +65°C
Temperature, non-operational	-50°C to +80°C
Vibration, operational	6 g rms, 20 Hz -2 KHz
Vibration, non-operational	8 g rms, 20 Hz -2 KHz
Shock, operational	7g 6-10 msec, 1/2 sine
Shock, non-operational	60 g 6-10 msec, 1/2 sine
Altitude	-1000 to 50,000 ft.
Humidity	95% at 35°C, 48 hrs
MTBF	≥ 10,500 hours

A.9.4 IMU-CPT Cable

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

A FlexPak Y Adapter cable is required between the FlexPak6 receiver and the IMU-CPT cable (see *Figure 7, Basic Set Up – FlexPak6 to IMU-FSAS* on page 25). Also see *FlexPak Y Adapter Cable (for IMU-FSAS, IMU-CPT or IMU-KVH1750)* on page 128.

Figure 60: IMU-CPT Development Terminated Cable



> The IMU-CPT cable has a green ground line terminated in a ring lug, as shown in *Figure 60, IMU-CPT Development Terminated Cable*, that is grounded to the IMU-CPT connector body and enclosure.

Table 78: IMU-CPT Connector Pinout Descriptions

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

A.9.4.1 Custom Cable Recommendations

The tables below provide recommendations for creating custom cables to replace the IMU-CPT cable is (01018966).

Table 79: Connectors

Connector	Description
J1	MIL-DTL 38999, 37 connector, plug
J2	DB-9, female

Table 80: Maximum Cable Length

IMU	RS-422
IMU-CPT	< 1.5 metres

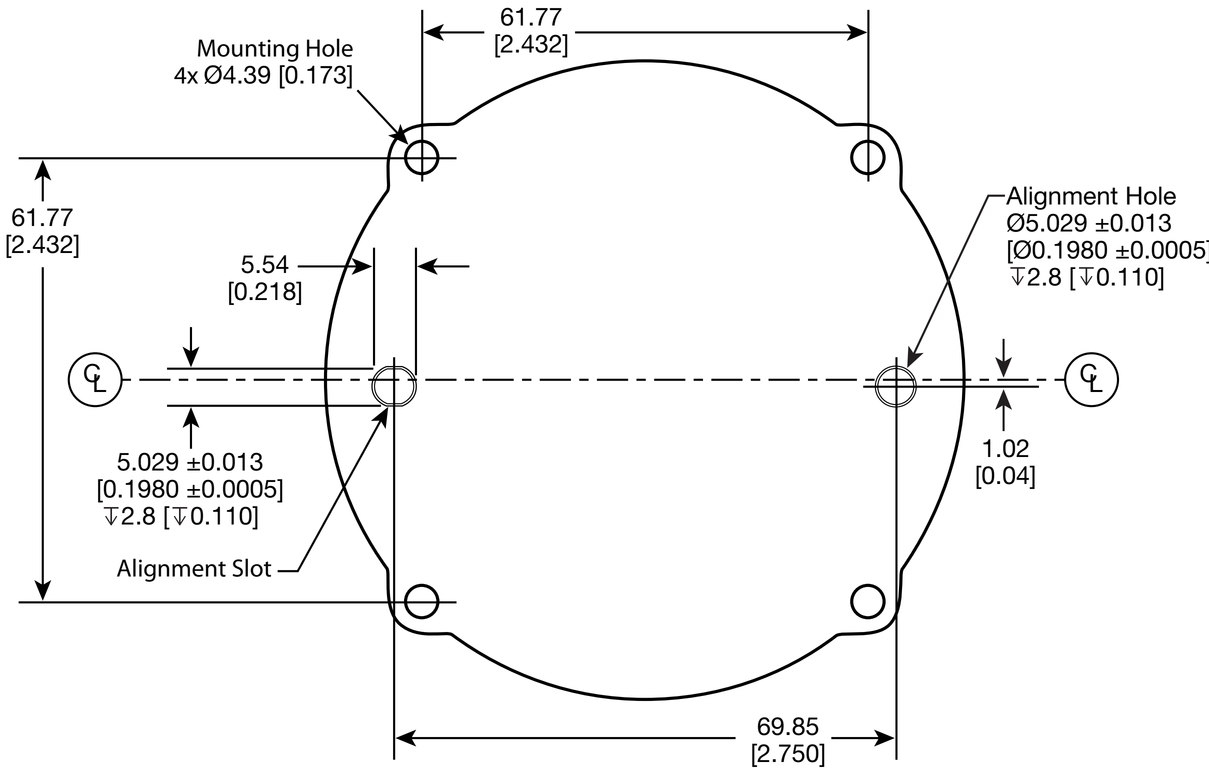
A.10 IMU-KVH1750 / IMU-KVH1725

Table 81: IMU-KVH1750 / IMU-KVH-1725 Physical Specifications

PHYSICAL	
Enclosure Size	88.9 mm X 73.7 mm
Weight	<0.7 kg

A.10.1 IMU-KVH1750 / IMU-KVH1725 Mechanical Drawings

Figure 61: IMU-KVH1750 / IMU-KVH1725 Bottom view



Dimensions are in millimetres [inches]

Figure 62: IMU-KVH1750 / IMU-KVH1725 - Top View

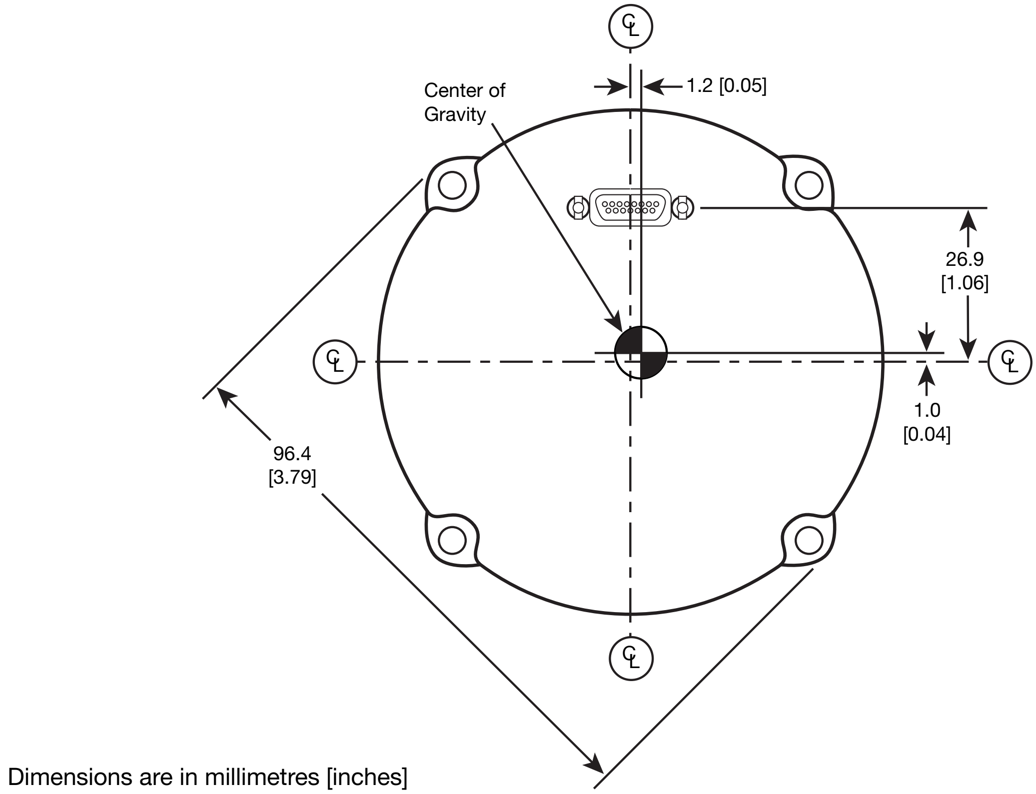


Figure 63: IMU-KVH1750 / IMU-KVH1725 Side View

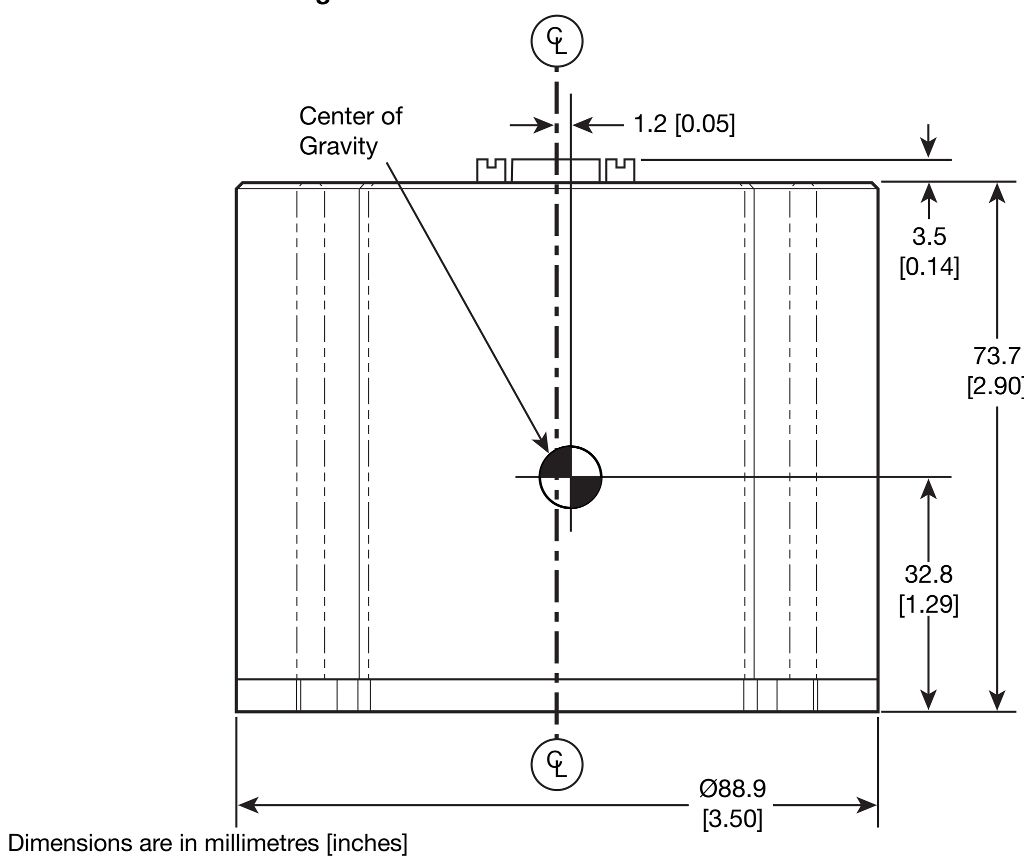
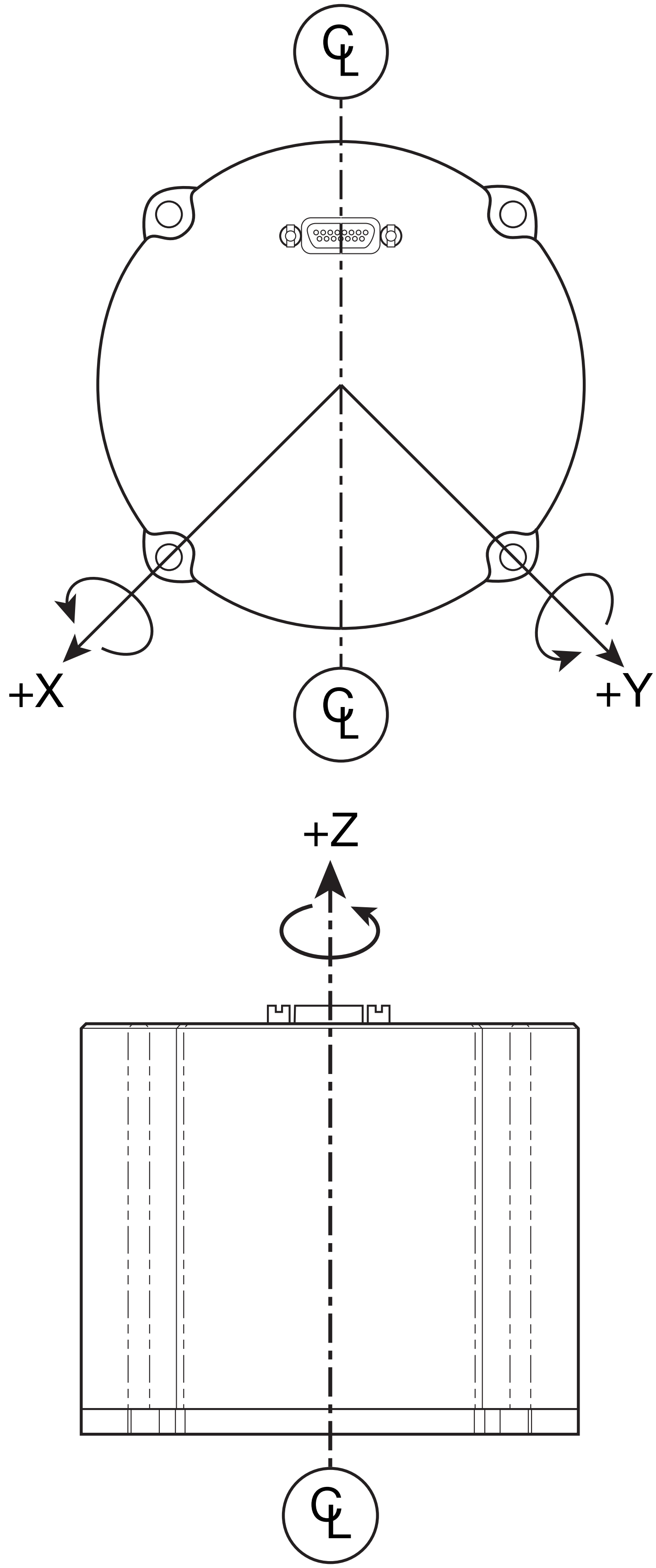


Figure 64: IMU-KVH1750 / IMU-KVH1725 Gyro Axes



A.10.2 IMU-KVH1750 / IMU-KVH1725 Sensor Specifications

Table 82: IMU-KVH1750 Performance

GYROSCOPE PERFORMANCE	
Maximum Input Rate	±490 °/second
Bias Stability (constant temperature)	0.05°/hr (typical) 0.1°/hr (max)
Bias Temperature Sensitivity (full temp.)	0.7°/hr (typical) 1°/hr (max)
Bias Offset (at 25° C)	±2°/hr
Scale Factor (nominal)	1 ±0.2%
Scale Factor Non-linearity (at 25° C)	≤50 ppm
Scale Factor Temperature Sensitivity	≤200 ppm
Angular Random Walk	≤0.012 °/√hr
Input Axis Misalignment	±0.4 mrad
ACCELEROMETER PERFORMANCE	
Maximum Input	±10 g
Bias Stability (at 25° C)	≤0.05 mg
Scale Factor Temperature Sensitivity	≤100 ppm/°C (typical) 250 ppm/°C (max)
Velocity Random Walk	0.12 mg/√Hz
Input Axis Misalignment	±1.0 mrad
DATA RATE	
IMU Measurement	200 Hz

Table 83: IMU-KVH1725 Performance

GYROSCOPE PERFORMANCE	
Maximum Input Rate	±490 °/second
Bias Stability (constant temperature)	≤0.1°/hr
Bias Temperature Sensitivity (full temp.)	≤4°/hr
Bias Offset (at 25° C)	±5°/hr
Scale Factor (nominal)	1 ±0.2%
Scale Factor Non-linearity (at 25° C)	≤200 ppm
Scale Factor Temperature Sensitivity	≤300 ppm
Angular Random Walk	≤0.017 °/√hr
Input Axis Misalignment	±0.4 mrad
ACCELEROMETER PERFORMANCE	
Maximum Input	±10 g
Bias Stability (at 25° C)	≤0.1 mg
Scale Factor Temperature Sensitivity	≤100 ppm/°C (typical) 250 ppm/°C (max)
Velocity Random Walk	≤0.12 mg/√Hz
Input Axis Misalignment	±1.0 mrad
DATA RATE	
IMU Measurement	200 Hz

A.10.3 IMU-KVH1750 / IMU-KVH1725 Electrical and Environmental

Table 84: IMU-KVH1750 / IMU-KVH1725 Electrical and Environmental Specifications

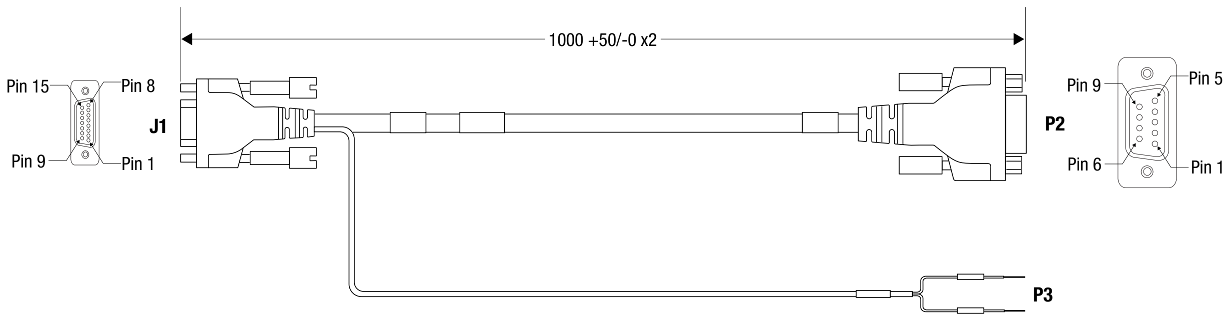
CONNECTORS	
Power and I/O	15-pin Micro-D (male)
ELECTRICAL	
Input Voltage	9 - 36 VDC
Power Consumption	5W (typical), 8W (max)
Turn-On Time (room temp.)	≤1.25 seconds
Full Performance Time (room temp.)	≤60 seconds
IMU Interface	RS-422
ENVIRONMENTAL	
Temperature, operational	-40°C to +75°C
Temperature, non-operational	-50°C to +85°C
Vibration, operational	8 g rms, 20 Hz -2 kHz
Vibration, non-operational	12 g rms, 20 Hz -2 kHz
Shock, operational	9 g (11 ms, sawtooth)
Shock, non-operational	40 g (11 ms, sawtooth)

A.10.4 IMU-KVH1750 / IMU-KVH1725 Cable

The NovAtel part number for the IMU-KVH1750 / IMU-KVH1725 cable is 01019211. This cable provides power to the IMU from an external power source and enables communication between the receiver and the IMU.

A FlexPak Y Adapter cable is required between the FlexPak6 receiver and the IMU-KVH1750 / IMU-KVH1725 cable (see *Figure 7, Basic Set Up – FlexPak6 to IMU-FSAS* on page 25). Also see *FlexPak Y Adapter Cable (for IMU-FSAS, IMU-CPT or IMU-KVH1750)* on page 128.

Figure 65: IMU-KVH1750 / IMU-KVH1725 Cable



Dimensions are in millimetres.

Table 85: IMU-KVH1750 / IMU-KVH1725 Connector Pinout Descriptions

J1 (15 Pin Micro D Female)		P2 (Female DB9)		P3
Pin #	**Signal Name**	**Pin #**	**Signal Name**	**Labels**
1	TX+	2	RX+	
2	TX-	8	RX-	
3	RX-	7	TX-	
4	RX+	3	TX+	
5	Reserved			
6	Reserved			
7	Reserved			
8	Reserved			
9	Power Return			PWR-
10	VDC Power			PWR+
11	MSync	1	IMU Event Out (Sync)	
12	TOV-Out	9	Event In	
13	Reserved			
14	Reserved			
15	Signal Ground	5	Signal Ground	
Shell	Chassis Ground	Shell	Chassis Ground	

A hardware change by KVH regarding KVH1750 IMUs (manufactured after November 2015) expect a differential MSYNC signal input (J1 (15 pin micro D female) of the IMU: Pin 11 MSync+, Pin 7 MSync-). This was previously a single ended input signal on Pin 11 only. The NovAtel VARF signal used to provide the MSYNC to the IMU remains single ended, however significant testing has been completed with the existing IMU-KVH1750 Cable (01019211) in safe environments (no interference sources). No issues or failures have been observed. There are no plans to modify NovAtel cables at this time. However, for any custom or OEM cable solutions, it is recommended to follow KVH guidelines in providing a differential MSYNC signal, converting the VARF to differential and properly shielding for optimal reliability.

A.10.4.1 Custom Cable Recommendations

The tables below provide recommendations for creating custom cables to replace the IMU-KVH1750 / IMU-KVH1725 cable (01019211).

Table 86: Connectors

Connector	Description
J1	Micro-D, 15-pin, female
J2	DB-9, female

Table 87: Maximum Cable Length

IMU	RS-422
IMU-KVH1750	< 1.5 metres

A.11 IMU-IGM

This section contains the specifications for both the IMU-IGM-A1 and IMU-IGM-S1.

A.11.1 IMU-IGM Physical Specifications

Table 88: IMU-IGM-A1 Physical Specifications

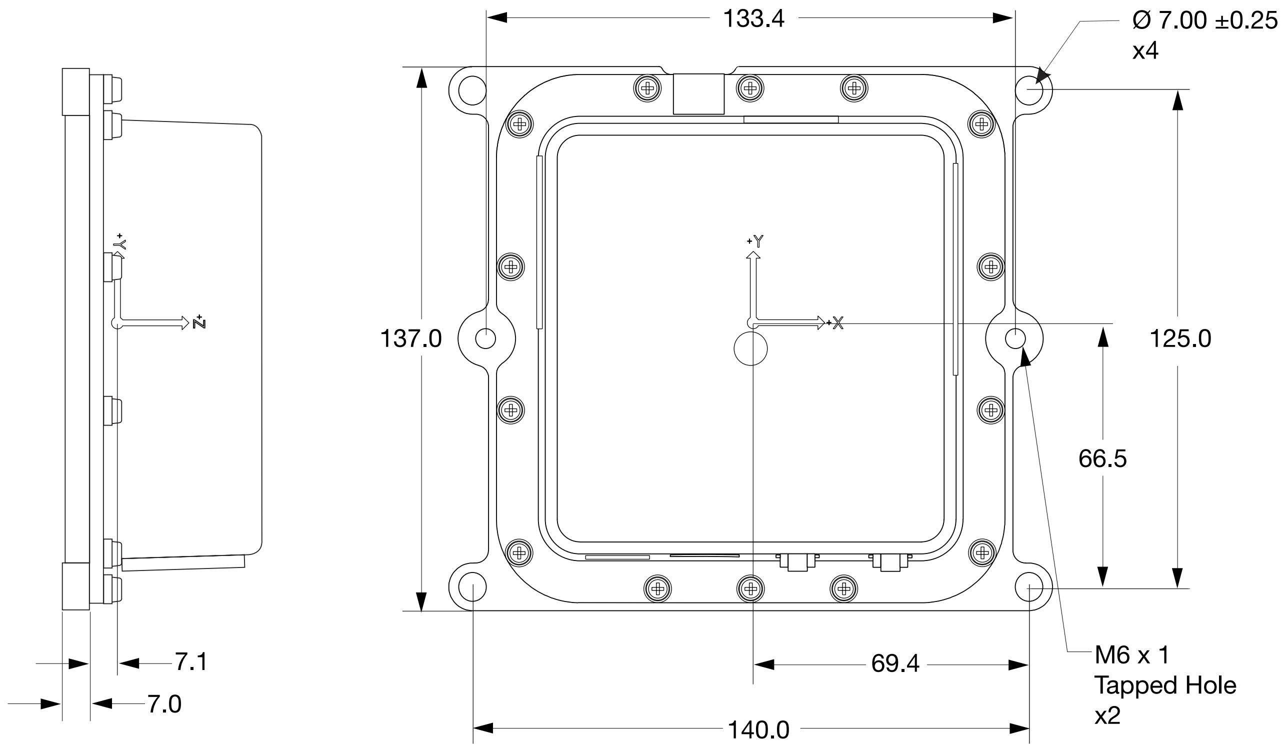
PHYSICAL	
Enclosure Size	152.0 mm x 137.0 mm x 50.5 mm
Weight	475 g
CONNECTORS	
MAIN	DB-15HD Female
AUX	DB-15HD Male

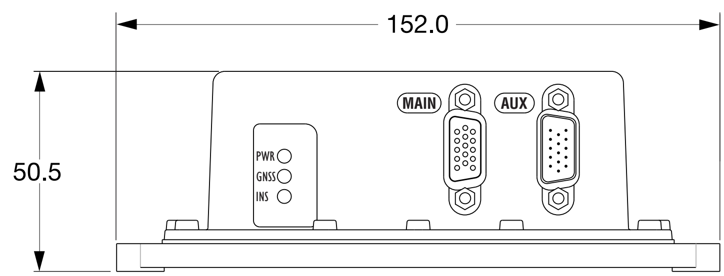
Table 89: IMU-IGM-S1 Physical Specifications

PHYSICAL	
Enclosure Size	152.0 mm x 137.0 mm x 50.5 mm
Weight	500 g
CONNECTORS	
MAIN	DB-15HD Female
AUX	DB-15HD Male

A.11.2 IMU-IGM Mechanical Drawings

Figure 66: IMU-IGM-A1 Dimensions

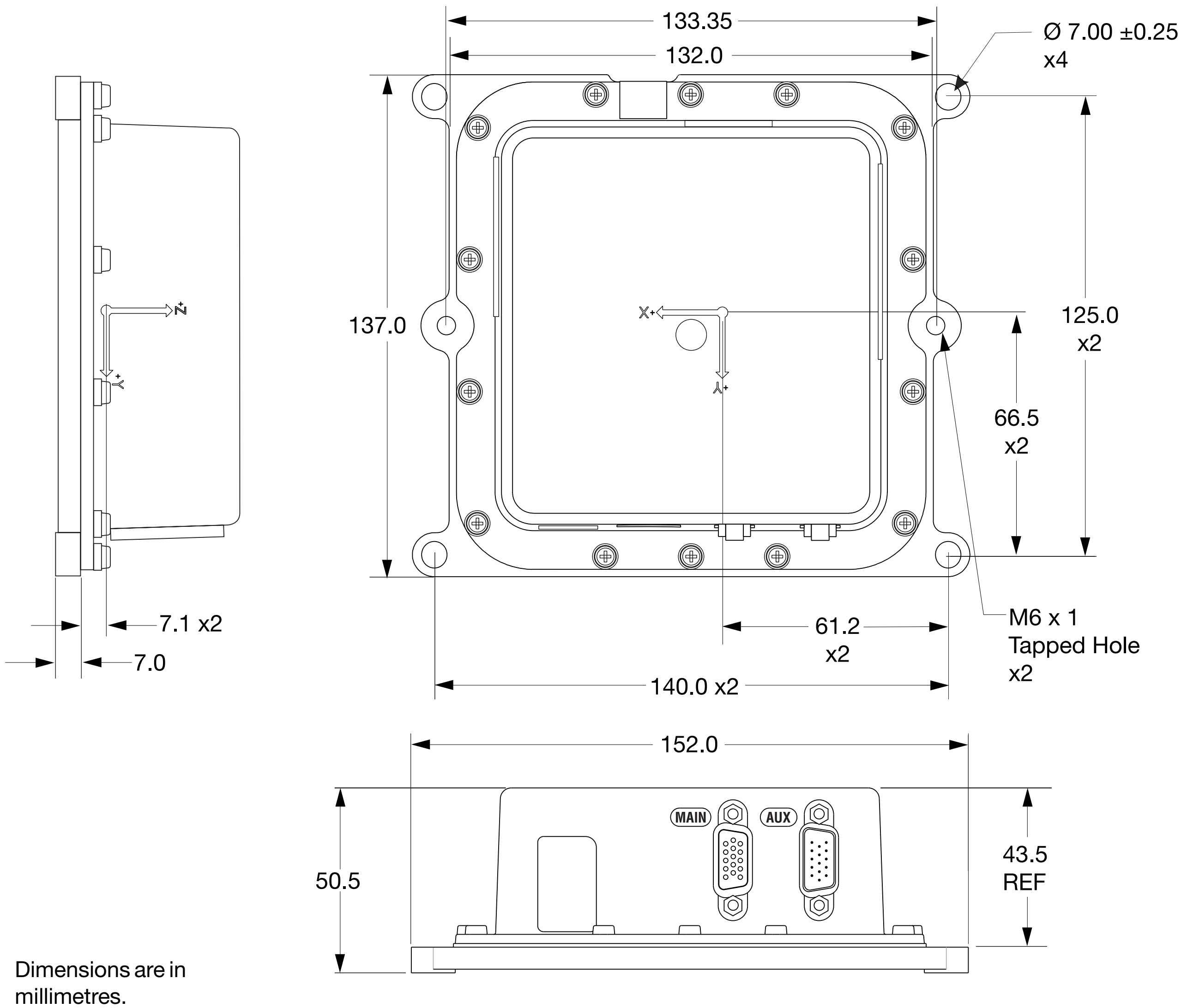




Dimensions are in millimetres.

The center of navigation is at the location marked by the axis labels on the enclosure and indicated on the drawing above. It is not at the depression in the enclosure cover.

Figure 67: IMU-IGM-S1 Dimensions



The center of navigation is at the location marked by the axis labels on the enclosure and indicated on the drawing above. It is not at the depression in the enclosure cover.

A.11.3 IMU-IGM Ports

Table 90: IMU-IGM Main Port Pinout

Pin #	Label	Description
1	MIC_TX/MIC_TX+	MODE2 high or open: MIC port transmit (RS-232) MODE2 low: MIC port transmit positive (RS-422)
2	MIC_TX-	MODE2 high or open: No connection MODE2 low: MIC port transmit negative (RS-422)
3	DGND	Digital ground
4	V+	IMU-IGM power supply input, positive
5	V-	IMU-IGM power supply input, negative
6	MIC_RX/ MIC_RX+	MODE2 high or open: MIC port receiver (RS-232) MODE2 low: MIC port receive positive (RS-422)
7	MIC_RX-	MODE2 high or open: No connection MODE2 low: MIC port receive negative (RS-422)
8	DGND	Digital ground
9	Reserved	Reserved
10	Reserved	Reserved
11	DGND	Digital ground
12	Reserved	Reserved
13	MODE2	Mode 2 input, controls MIC port standard
14	Reserved	Reserved
15	Reserved	Reserved

Table 91: IMU-IGM AUX Port Pinout

Pin #	Label	Description
1	ODM_A+	Odometer input A positive
2	ODM_B+	Odometer input B positive (No connection on IMU-IGM-S1)
3	Reserved	Reserved
4	WS_VOUT	Wheel sensor output voltage (12 VDC)
5	DGND	Digital ground
6	ODM_A-	Odometer input A negative
7	ODM_B-	Odometer input B negative (No connection on IMU-IGM-S1)
8	Reserved	Reserved
9	DGND	Digital ground
10	Reserved	Reserved
11	Reserved	Reserved
12	Reserved	Reserved
13	Reserved	Reserved
14	Reserved	Reserved
15	DGND	Digital ground

A.11.4 IMU-IGM Sensor Specifications

Table 92: IMU-IGM-A1 IMU Performance

GYROSCOPE PERFORMANCE	
Gyro Input Range	± 450 °/second
In Run Gyro Rate Bias Stability	6.25 °/hour
Angular Random Walk	0.3 °/√hour
ACCELEROMETER PERFORMANCE	
Accelerometer Range	± 18 g
In Run Accelerometer Bias Stability	0.1 mg
Velocity Random Walk	0.029 m/s/√hr
DATA RATE	
IMU Measurement	200 Hz

Table 93: IMU-IGM-S1 IMU Performance

GYROSCOPE PERFORMANCE	
Gyro Input Range	± 400 °/second
In Run Gyro Rate Bias Stability	0.5 °/hour
Angular Random Walk	0.15 °/√hour
ACCELEROMETER PERFORMANCE	
Accelerometer Range	± 10 g
In Run Accelerometer Bias Stability	0.05 mg
Velocity Random Walk	0.07 m/s/√hr
DATA RATE	
IMU Measurement	125 Hz

A.11.5 IMU-IGM Electrical and Environmental

Table 94: IMU-IGM-A1 Electrical Specifications

ELECTRICAL	
Input Voltage	10 - 30 VDC[a]
Power consumption	2.5 W (typical)[b]

a. A system with a FlexPak6 requires 11 VDC if using the FlexPak6 to power the IMU-IGM.
b. A system with a FlexPak6 requires 5 W (typical).

Table 95: IMU-IGM-A1 Environmental Specifications

ENVIRONMENTAL	
Temperature, operational	-40°C to +65°C
Temperature, storage	-50°C to +80°C
Humidity	95% Non-condensing

Table 96: IMU-IGM-S1 Electrical Specifications

ELECTRICAL	
Input Voltage	10 - 30 VDC[a]
Power consumption	<4.6 W (typical)[b]

a. A system with a FlexPak6 requires 11 VDC if using the FlexPak6 to power the IMU-IGM.
b. A system with a FlexPak6 requires 7 W (typical).

Table 97: IMU-IGM-S1 Environmental Specifications

ENVIRONMENTAL	
Temperature, operational	-40°C to +65°C
Temperature, storage	-50°C to +80°C
Humidity	95% Non-condensing

A.11.6 IMU-IGM Interface Cable

The NovAtel part number for the IMU-IGM interface cable is 01019016. This cable provides power to the IMU-IGM and communication signals between the IMU-IGM and the OEM6 family receiver.

Figure 68: IMU-IGM Interface Cable

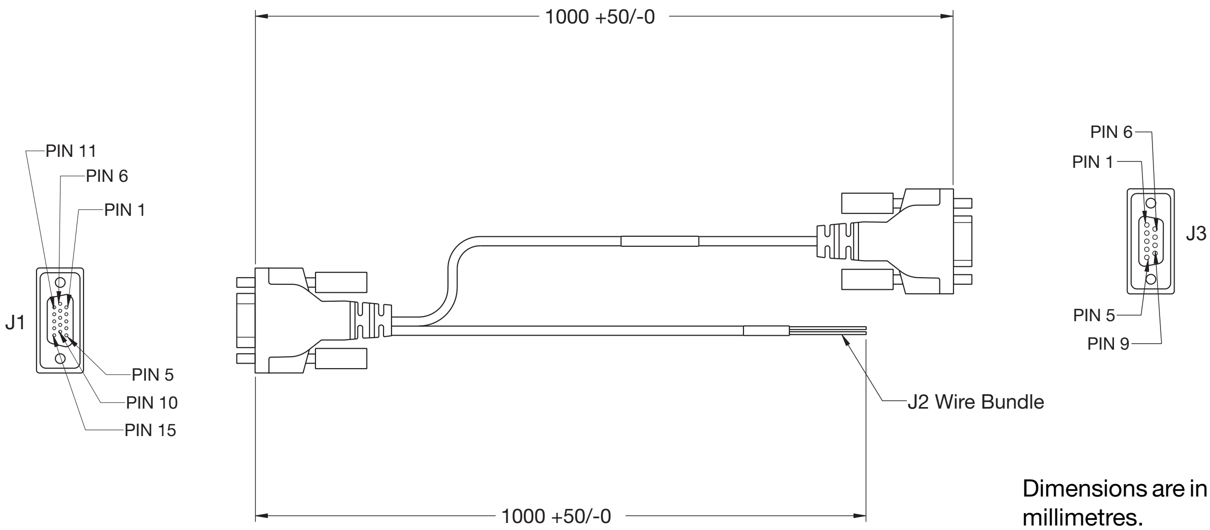


Table 98: IMU-IGM Interface Cable Pinout Descriptions

J1 MAIN Pin #	Function	J2 Wire Bundle Label	J3 MIC Port Pin #
1	MIC Port Transmit/Transmit+ (RS-422)		2
2	MIC Port Transmit- (RS-422)		8
3	Digital Ground		
4	Battery +	BATT+	
5	Digital Ground	BATT-	
6	MIC Port Receive/Receive+ (RS-422)		3
7	MIC Port Receive- (RS-422)		7
8	Digital Ground		5
9	Reserved		
10	Reserved		
11	Digital Ground		
12	Reserved		
13	MODE 2	MODE 2	
14	Reserved		
15	Reserved		

The MIC port can operate as either an RS-232 or RS-422 serial port.

- To set the MIC port to RS-232, leave MODE 2 pin open/unconnected.
- To set the MIC port to RS-422, tie the MODE 2 pin low.

A.11.6.1 Custom Cable Recommendations

The tables below provide recommendations for creating custom cables to replace the IMU-IGM interface cable (01019016).

Table 99: Connectors

Connector	Description
J1	DB-15HD, male
J3	DB-9, female

Table 100: Maximum Cable Length

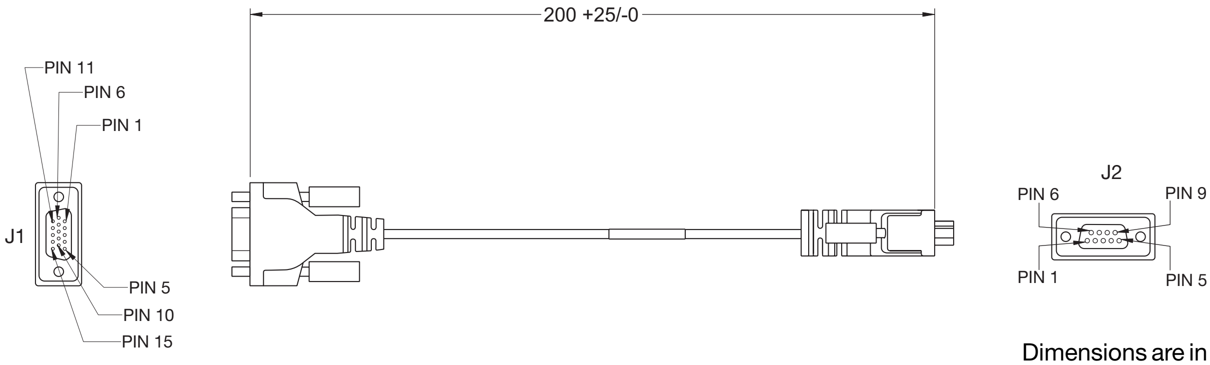
IMU	RS-232	RS-422
IMU-IGM-A1, IMU-IGM-S1	< 1.2 metres	< 50 metres

A.11.7 IMU-IGM Stack Up Cable

The NovAtel part number for the IMU-IGM stack up cable is 01019013. This cable provides power to the IMU-IGM and communication signals between the IMU-IGM and the FlexPak6 receiver.

Use the stack up cable when the IMU-IGM is connected to a FlexPak6 receiver in a stack up configuration. You must connect this cable to COM 2 on FlexPak6.

Figure 69: IMU-IGM Stack Up Cable



Dimensions are in millimetres.

Table 101: IMU-IGM Stack Up Cable Pinout Descriptions

J1 MAIN Pin #	Function	J2 COM 2 Pin #
1	MIC Port Transmit/Transmit+ (RS-422)	2
3	Digital Ground	5
4	Battery +	4
5	Digital Ground	5
6	MIC Port Receive/Receive+ (RS-422)	3

A.12 OEM-IMU-ADIS-16488

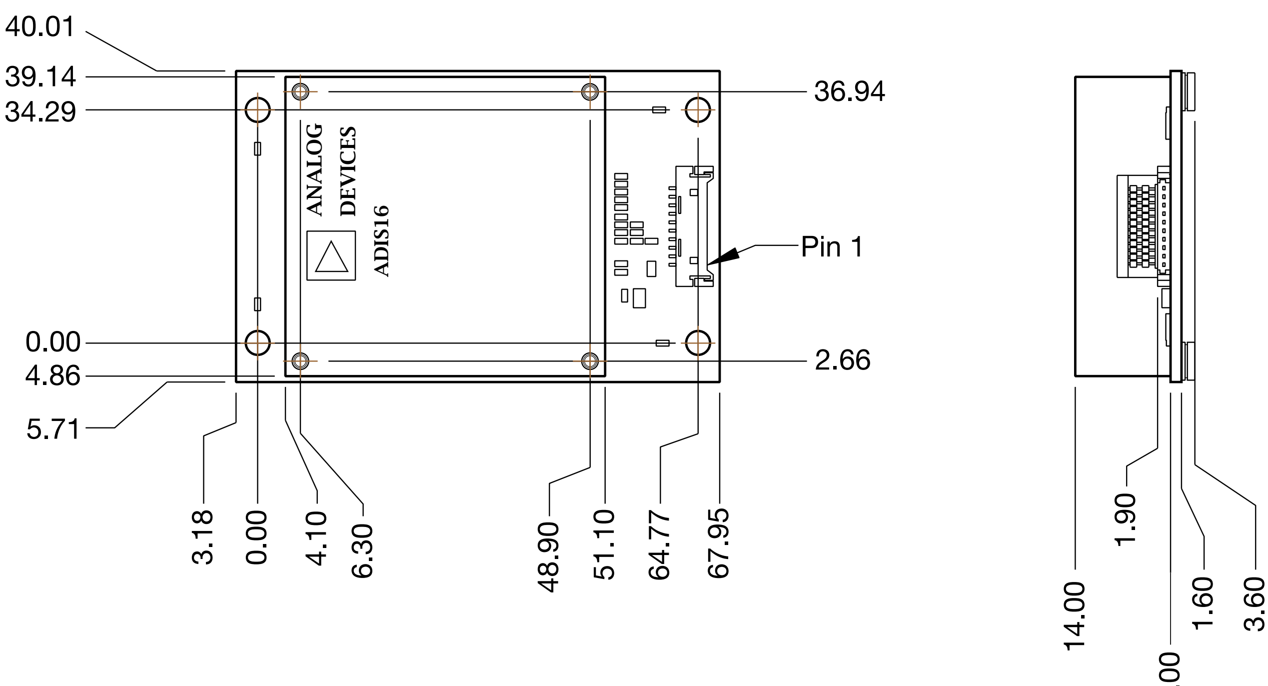
> The OEM-IMU-ADIS-16488 requires a MEMS Interface Card to connect to a NovAtel receiver.
> See *MIC - MEMS Interface Card* on page 168.

Table 102: OEM-IMU-ADIS-16488 Physical Specifications

PHYSICAL	
IMU Size	47 mm x 44 mm x 14 mm
IMU Weight	48 g
IMU with mounting PCB size	71.1 mm x 45.7 mm x 17.6 mm

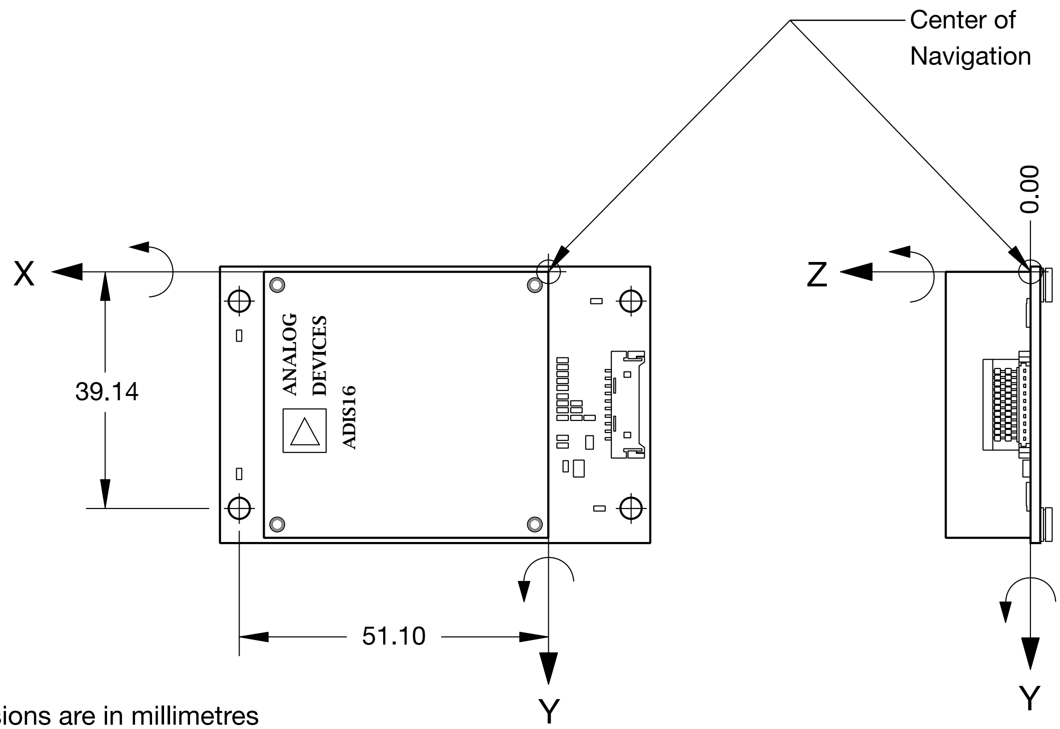
A.12.1 Mechanical Drawings

Figure 70: ADIS-16488 Dimensions



Dimensions are in millimetres

Figure 71: ADIS-16488 Center of Navigation



A.12.2 OEM-IMU-ADIS-16488 Sensor Specifications

Table 103: OEM-IMU-ADIS-16488 Performance

GYROSCOPE PERFORMANCE	
Gyro Input Range	±450°/second
In-run Gyro Rate Bias Stability	6.25°/hour
Angular Random Walk	0.30°/√hour
ACCELEROMETER PERFORMANCE	
Accelerometer Range	±18 g
In-run Accelerometer Bias Stability	0.1 mg
Velocity Random Walk	0.029 m/s√hour
DATA RATE	
IMU Measurement	200 Hz

A.12.3 OEM-IMU-ADIS-16488 Electrical and Environmental

Table 104: OEM-IMU-ADIS-16488 Electrical Specifications

ELECTRICAL	
Input Power	+3.0 to + + 3.6 V DC +3.3 V DC typical
Power consumption	254 mA typical
IMU Interface	SPI

Table 105: OEM-IMU-ADIS-16488 Environmental Specifications

ENVIRONMENTAL	
Temperature, operational	-40°C to +85°C
Temperature, non-operational	-40°C to +105°C

A.12.4 ADIS-16488 IMU-to-MIC Cable Assembly

The NovAtel part number for the ADIS-16488 IMU-to-MIC interface cable is 01019008 (*Figure 72, ADIS-16488 IMU-to-MIC Cable Assembly*). This cable provides power to the IMU and enables communication between the MIC and the IMU.

Figure 72: ADIS-16488 IMU-to-MIC Cable Assembly

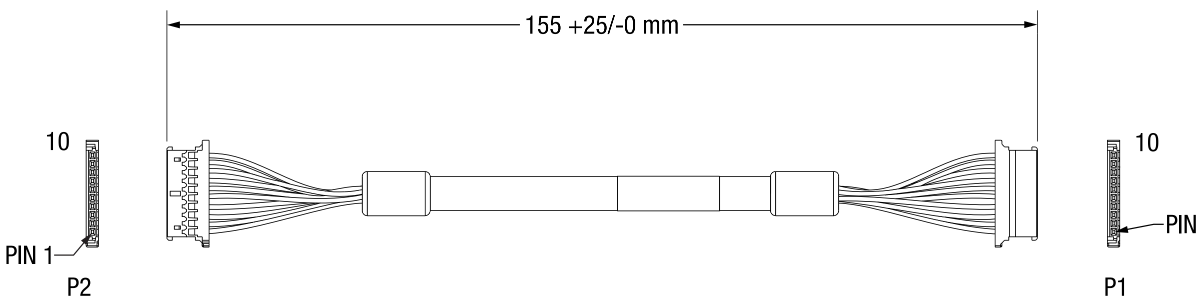


Table 106: ADIS-16488 IMU-to-MIC Cable Pinout

P2 Pin	Signal Name	P1 Pin
1	IMU_VDD	1
2	IMU_VDD	2
3	SPI_NSS	3
4	SPI_CLK	4
5	Ground	5
6	SPI_MOSI	6
7	SPI_MISO	7
8	Ground	8
9	ADIS_IMU_DIO1	9
10	ADIS_IMU_DIO2	10

A.13 OEM-IMU-ISA-100C

> The OEM-IMU-ISA-100C requires a Universal IMU Controller Card to connect to a NovAtel receiver. See *UIC - Universal IMU Controller* on page 177.

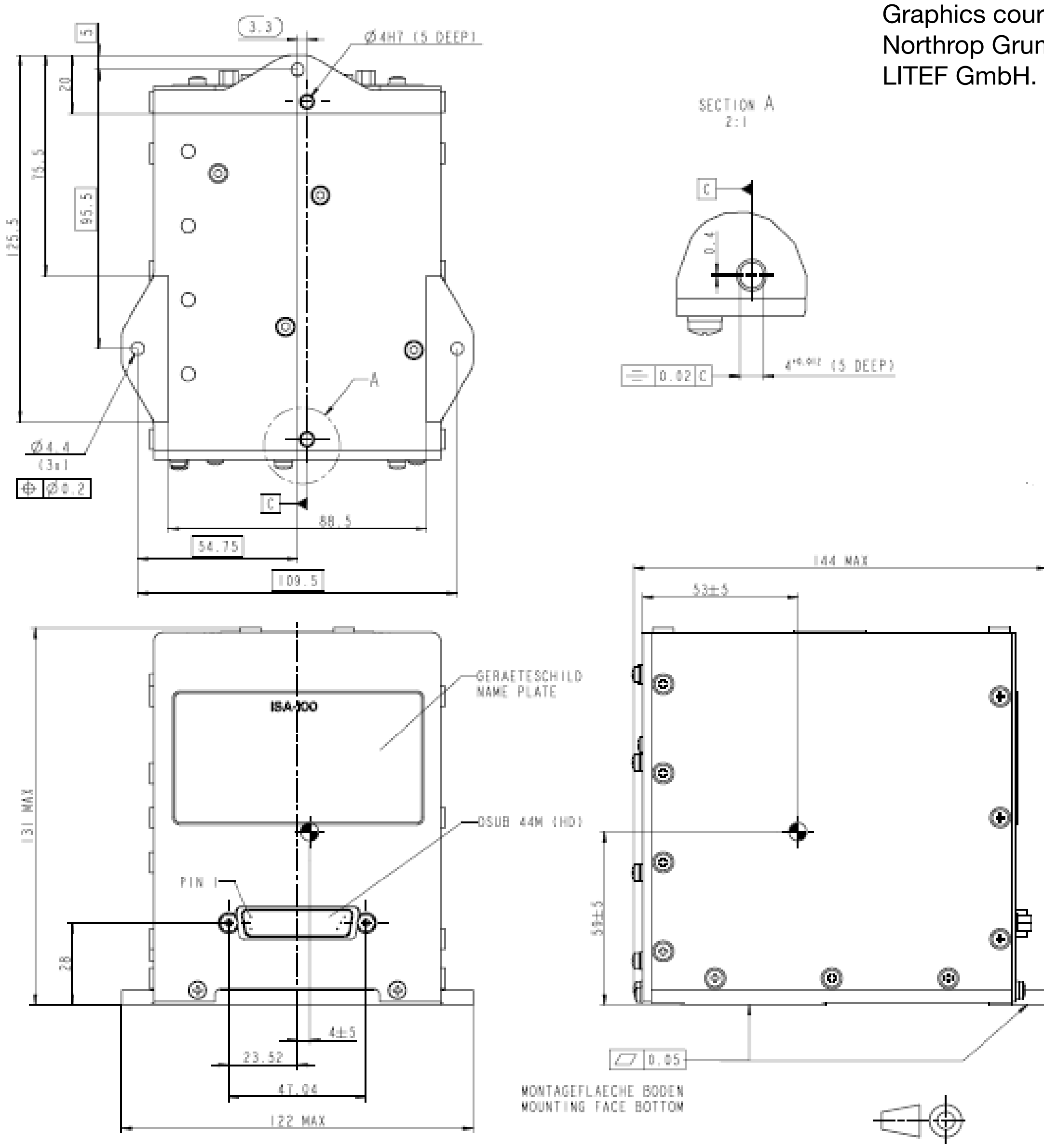
Table 107: OEM-IMU-ISA-100C Physical Specifications

PHYSICAL	
IMU Size	100 mm x 130 mm x 125 mm
IMU Weight	2 kg

A.13.1 Mechanical Drawings

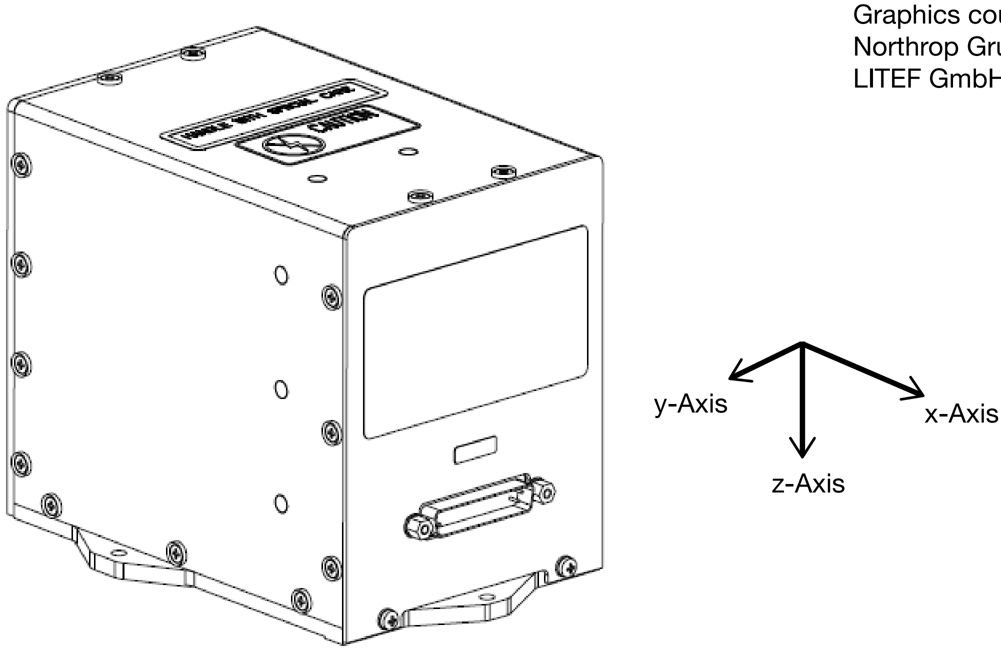
Figure 73: ISA-100C Dimensions

Graphics courtesy of Northrop Grumman LITEF GmbH.



Dimensions are in millimetres

Figure 74: ISA-100C Coordinate Axis



Graphics courtesy of Northrop Grumman LITEF GmbH.

A.13.2 OEM-IMU-ISA-100C Sensor Specifications

Table 108: OEM-IMU-ISA-100C IMU Performance

GYROSCOPE PERFORMANCE	
Input range	±495 deg/sec
In-run bias stability	≤0.05 deg/hr
Scale factor repeatability	≤100 ppm
Scale factor non-linearity	≤100 ppm
Angular random walk	0.012 deg/√hr
ACCELEROMETER PERFORMANCE	
Range	±10 g
In-run bias stability	≤100 μg
1 year scale factor repeatability	≥1250 μg
Scale factor non-linearity	≤100 ppm
Velocity random walk	≤100 μg/√Hz
DATA RATE	
IMU Measurement	200 Hz[a]

a. A maximum data rate of 400 Hz is available on specific models of OEM-IMU-ISA-100C.

A.13.3 OEM-IMU-ISA-100C Electrical and Environmental

Table 109: OEM-IMU-ISA-100C Electrical Specifications

ELECTRICAL	
Input Power	+3.3 V, ±5.25 V, ±15 V, -15 V (optional)
Power consumption	≤10 W (typical) 16 W (maximum)
Connector	44 pin HD D-Sub, male

Table 110: OEM-IMU-ISA-100C Environmental Specifications

ENVIRONMENTAL	
Temperature, operational	-40°C to +71°C

A.13.4 OEM-IMU-ISA-100C IMU to UIC Cable Assembly

The NovAtel part number for the OEM-IMU-ISA-100C IMU to UIC interface cable is 01019393 (*Figure 75, OEM-IMU-ISA-100C IMU to UIC Cable Assembly*). This cable provides power to the IMU and enables communication between the UIC and the IMU.

Figure 75: OEM-IMU-ISA-100C IMU to UIC Cable Assembly

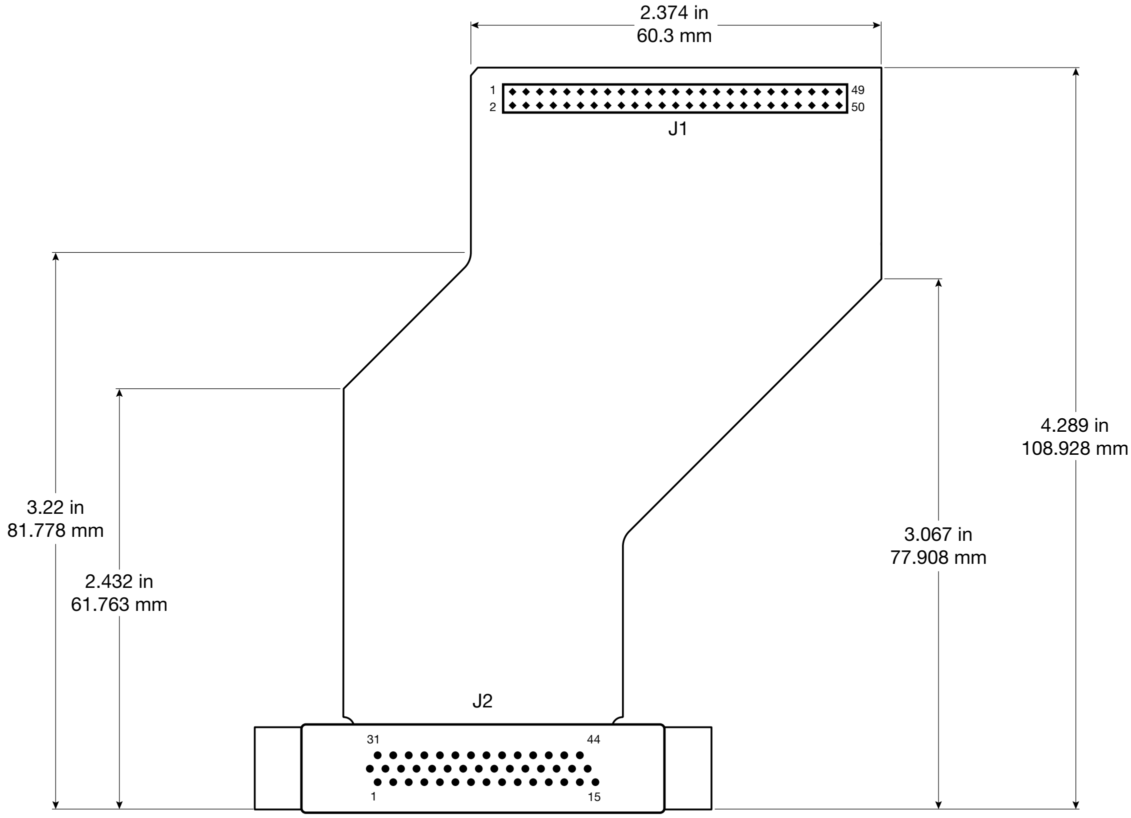


Table 111: OEM-IMU-ISA-100C IMU to UIC Cable Pinout

J2 Pin (ISA-100C)	Signal	J1 Pin (UIC)
1	GND	9
2	3.3 V	1
3	GND	4
4	GND	5
5	GND	6
6	GND	8
7	GND	10
8	GND	15
9	GND	16
10	GND	21
11	GND	22
12	5.25 V	43
13	-5.25 V	49

<table>
<tr><th>J2 Pin
(ISA-100C)</th><th>Signal</th><th>J1 Pin
(UIC)</th></tr>
<tr><td>14</td><td>-5.25 V</td><td rowspan="2">50</td></tr>
<tr><td>15</td><td>-5.25 V</td></tr>
<tr><td>16</td><td>15 V</td><td>7</td></tr>
<tr><td>17</td><td>3.3 V</td><td>3</td></tr>
<tr><td>18</td><td>GND</td><td>28</td></tr>
<tr><td>19</td><td>–</td><td>–</td></tr>
<tr><td>20</td><td>–</td><td>–</td></tr>
<tr><td>21</td><td>NOGOx</td><td>18</td></tr>
<tr><td>22</td><td>–</td><td>–</td></tr>
<tr><td rowspan="2">23</td><td>GND</td><td>29</td></tr>
<tr><td>GND</td><td>35</td></tr>
<tr><td>24</td><td>TXC+</td><td>32</td></tr>
<tr><td>25</td><td>SYNC-</td><td>34</td></tr>
<tr><td>26</td><td>GND</td><td>41</td></tr>
<tr><td>27</td><td>TXD+</td><td>40</td></tr>
<tr><td>28</td><td>–</td><td>–</td></tr>
<tr><td>29</td><td>GND</td><td>42</td></tr>
<tr><td>30</td><td>5.25 V</td><td>44</td></tr>
<tr><td>31</td><td>3.3 V</td><td rowspan="2">2</td></tr>
<tr><td>32</td><td>3.3 V</td></tr>
<tr><td>33</td><td>PWRDOWNx</td><td>12</td></tr>
<tr><td>34</td><td>RESETIMUx</td><td>14</td></tr>
<tr><td>35</td><td>–</td><td>–</td></tr>
<tr><td>36</td><td>GND</td><td>45</td></tr>
<tr><td>37</td><td>–</td><td>–</td></tr>
<tr><td>38</td><td>TXC-</td><td>30</td></tr>
<tr><td>39</td><td>GND</td><td>48</td></tr>
<tr><td>40</td><td>SYNC+</td><td>36</td></tr>
<tr><td>41</td><td>TXD-</td><td>38</td></tr>
<tr><td>42</td><td>–</td><td>–</td></tr>
<tr><td>43</td><td>GND</td><td>48</td></tr>
<tr><td>44</td><td>5.25 V</td><td>46</td></tr>
</table>

A.14 OEM-IMU-STIM300

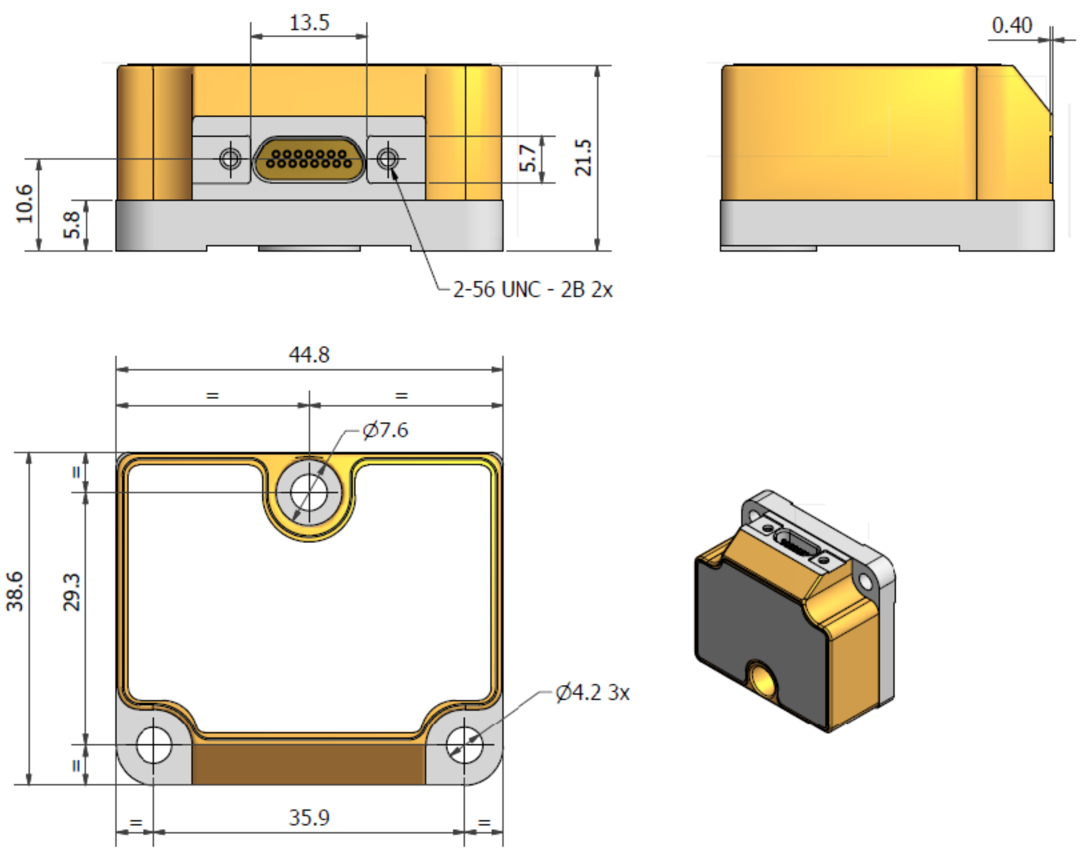
> The OEM-IMU-STIM300 requires a MEMS Interface Card to connect to a NovAtel receiver. See *MIC - MEMS Interface Card* on page 168.

Table 112: OEM-IMU-STIM300 Physical Specifications

PHYSICAL	
IMU Size	45 mm x 39 mm x 22 mm
IMU Weight	55 g

A.14.1 Mechanical Drawings

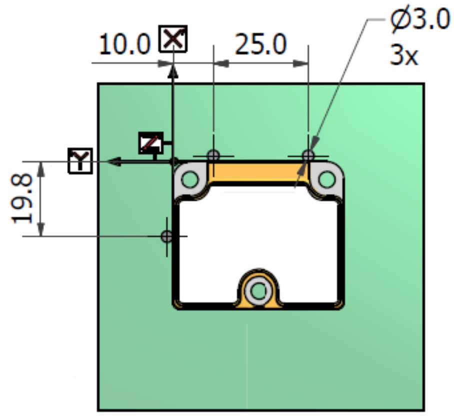
Figure 76: STIM300 Dimensions



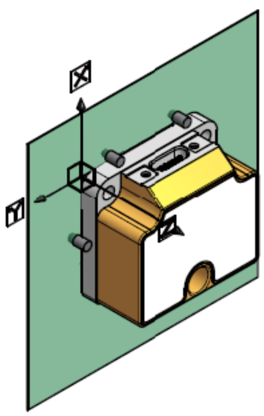
Dimensions are in millimetres

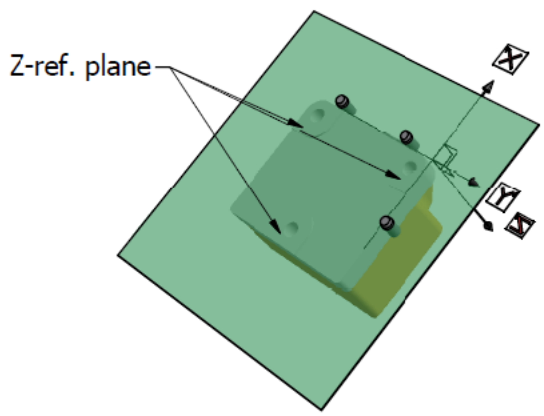
Graphics courtesy of Sensonor AS.

Figure 77: STIM300 Center of Navigation



Graphics courtesy of Sensonor AS.





A.14.2 OEM-IMU-STIM300 Sensor Specifications

Table 113: OEM-IMU-STIM300 Performance

GYROSCOPE PERFORMANCE	
Gyro Input Range	±400°/second
In-run Gyro Rate Bias Stability	0.5°/hour
Angular Random Walk	0.15°/√hour
ACCELEROMETER PERFORMANCE	
Accelerometer Range	±10 g
In-run Accelerometer Bias Stability	0.05 mg
Velocity Random Walk	0.07 m/s√hour
DATA RATE	
IMU Measurement	125 Hz

A.14.3 OEM-IMU-STIM300 Electrical and Environmental

Table 114: OEM-IMU-STIM300 Electrical Specifications

ELECTRICAL	
Input Power	+4.5 to + 5.5 V DC +5.0 V DC typical
Power consumption	1.5 W nominal
Connector	15 pin Micro-D, female

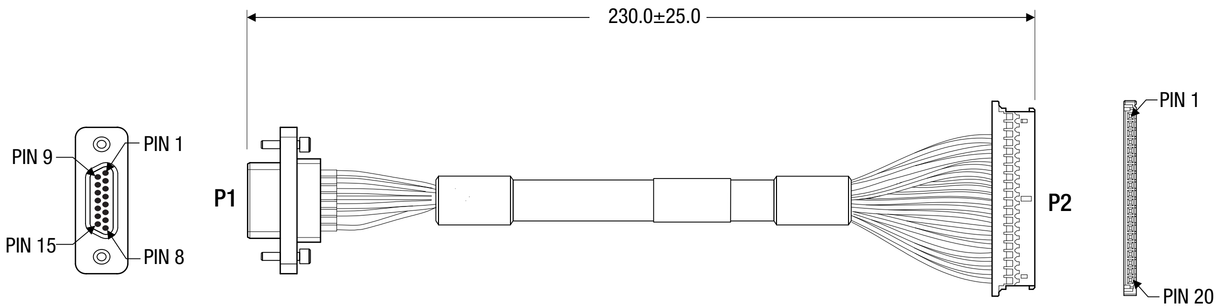
Table 115: OEM-IMU-STIM300 Environmental Specifications

ENVIRONMENTAL	
Temperature, operational	-40°C to +85°C
Temperature, non-operational	-55°C to +90°C

A.14.4 STIM300 IMU-to-MIC Cable Assembly

The NovAtel part number for the STIM300 IMU-to-MIC interface cable is 01019161 (*Figure 78, STIM300 IMU-to-MIC Cable Assembly*). This cable provides power to the IMU and enables communication between the MIC and the IMU.

Figure 78: STIM300 IMU-to-MIC Cable Assembly



Dimensions are in millimetres

Table 116: STIM300 IMU-to-MIC Cable Pinout

P2 Pin (MIC)	Signal	P1 Pin (STIM300)
1	No connection	–
2	No connection	–
3	No connection	–
4	No connection	–
5	No connection	–
6	Ground	12
7	Ground	13
8	VSUP (5V input)	8
9	VSUP (5V input)	
10	Ground	15
11	Transmit Data+	10
12	Transmit Data-	2
13	Receive Data+	9
14	Receive Data-	1
15	No connection	–
16	No connection	–
17	IMU DAS	4
18	No connection	–
19	IMUTYPE1	15
20	No connection	–

A.15 OEM-IMU-μIMU

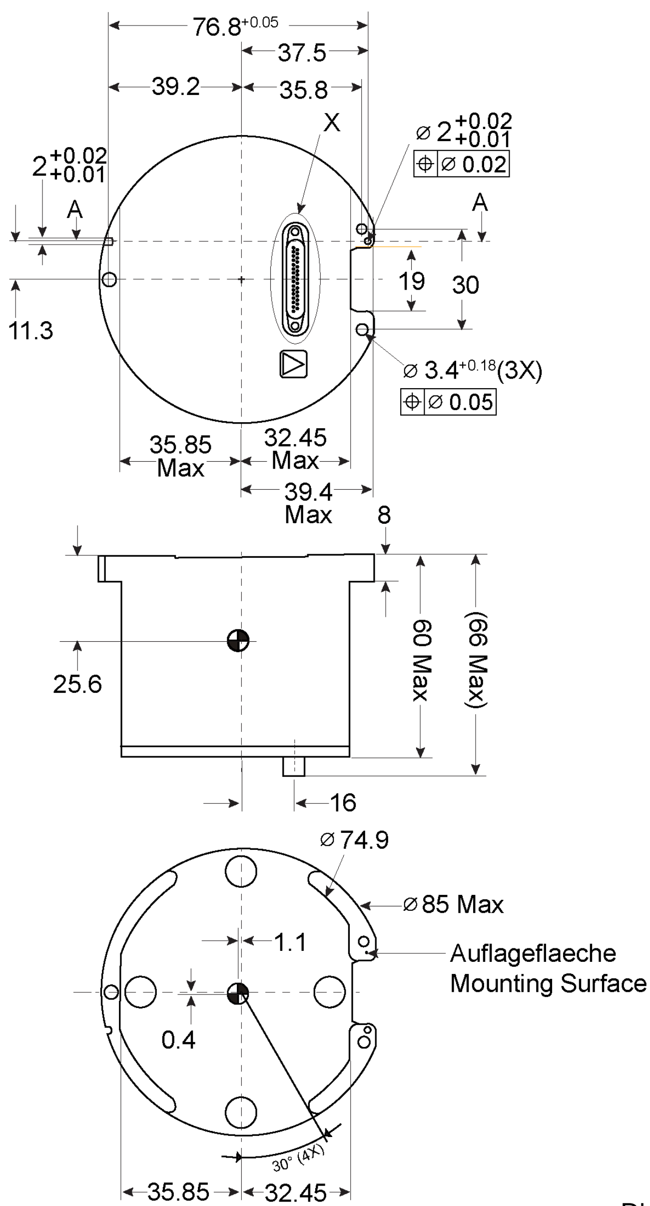
The OEM-IMU-μIMU requires a Universal IMU Controller to connect to a NovAtel receiver. See *UIC - Universal IMU Controller* on page 177.

Table 117: OEM-IMU-μIMU Physical Specifications

PHYSICAL	
IMU Size (Ø x H)	85 mm x 60 mm
IMU Weight	0.68 kg

A.15.1 Mechanical Drawings

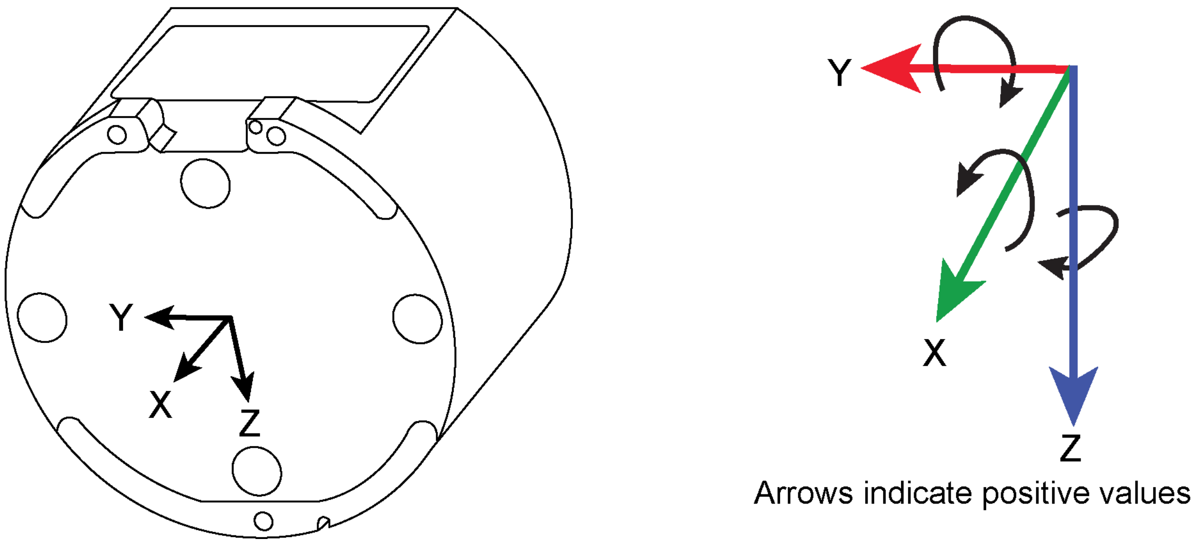
Figure 79: μIMU Dimensions



Graphics courtesy of Northrop Grumman LITEF GmbH.

Dimensions are in millimetres

Figure 80: µIMU Coordinate Axis



Graphics courtesy of
Northrop Grumman
LITEF GmbH.

A.15.2 OEM-IMU-µIMU Sensor Specifications

Table 118: OEM-IMU-µIMU Performance

GYROSCOPE PERFORMANCE	
Input range	±499 deg/sec
Bias stability	≤6 deg/hr
Scale factor error	≤1400 ppm
Angular random walk	0.3 deg/√hr
ACCELEROMETER PERFORMANCE	
Range	±15 g
Bias repeatability	≤3 mg
Scale factor error	≤1500 ppm
Velocity random walk	≤0.25 mg/√Hz
DATA RATE	
IMU Measurement	200 Hz

A.15.3 OEM-IMU-μIMU Electrical and Environmental

Table 119: OEM-IMU-μIMU Electrical Specifications

ELECTRICAL	
Input Power	+5.0 V DC
Power consumption	<8 W
Connector	31 pin Micro-D, plug

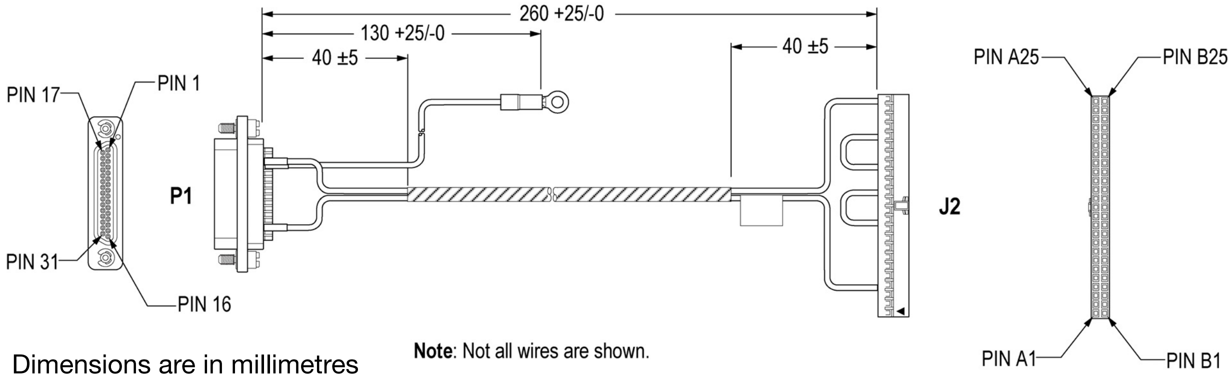
Table 120: OEM-IMU-μIMU Environmental Specifications

ENVIRONMENTAL	
Temperature, operational	-55°C to +71°C

A.15.4 µIMU to UIC Cable Assembly

The NovAtel part number for the µIMU to UIC interface cable is 01019760 (*Figure 81, µIMU to UIC Cable Assembly*). This cable provides power to the IMU and enables communication between the UIC and the IMU.

Figure 81: µIMU to UIC Cable Assembly



Dimensions are in millimetres

Table 121: µIMU to UIC Cable Pinout

P1 Pin (µIMU)	Signal	J2 Pin (UIC)
1	Ground	B2
2	Ground	A3
3	Transmit Data+	B20
4	Transmit Data-	B19
5	Transmit Clock-	B15
6	Transmit Clock+	B16
7	Ground	B3
8	Ground	B4
13	NOGO	B9
16	SYNC-	B17
17	IMU_5V25	A22
18	IMU_5V25	B22
19	IMU_5V25	B23
20	Ground	A21 B21
21	Ground	B5 B11
22	Ground	A23 B24
26	Lug Ring	-
27	IMU_PDWARN	B6
30	IMU_RESET	B7
31	SYNC+	B18
	IMU_TYPE_3	A15 to A18
	IMU_TYPE_1	A13 to A11

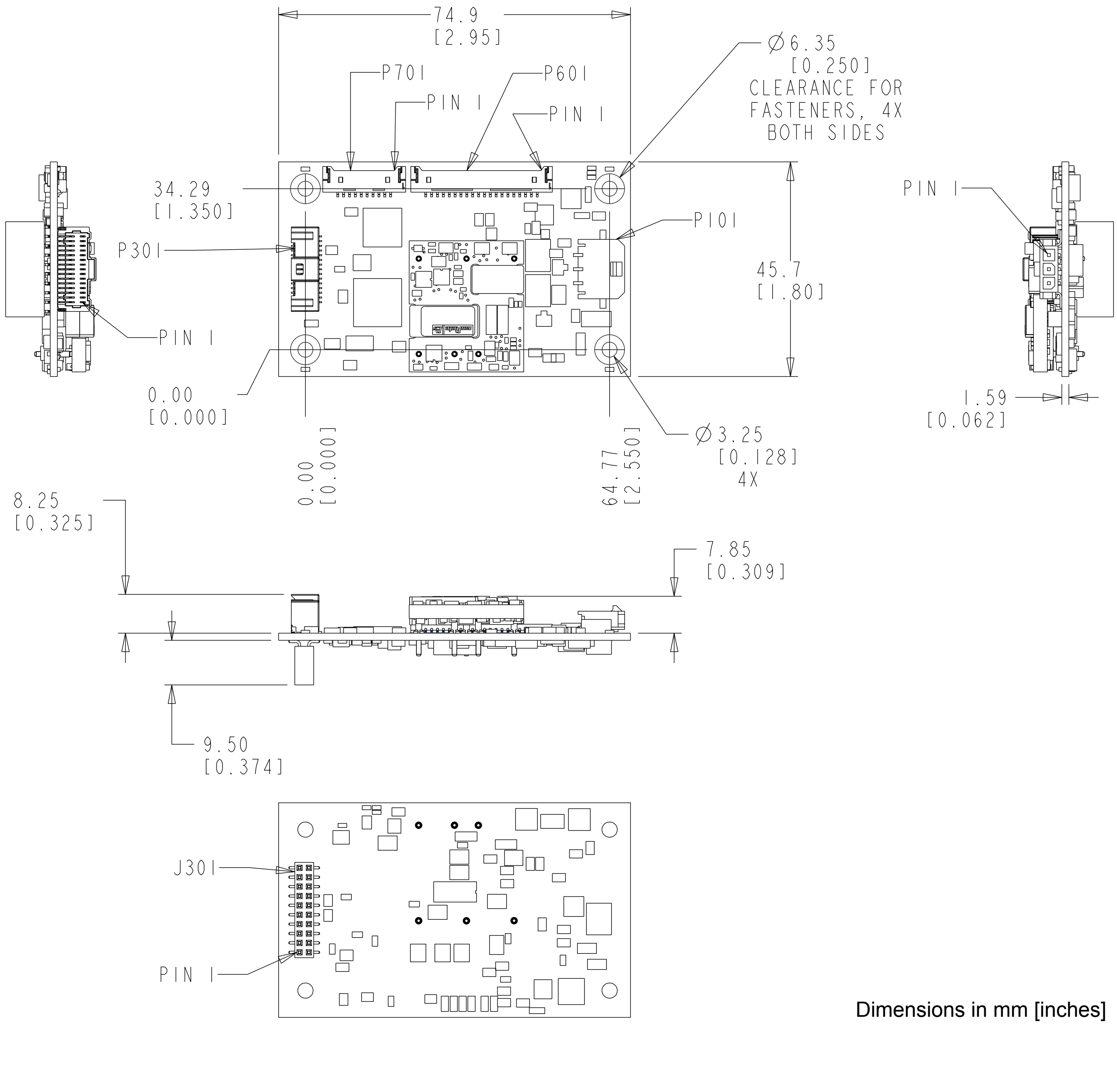
A.16 MIC - MEMS Interface Card

Table 122: MEMS Interface Card Physical Specifications

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

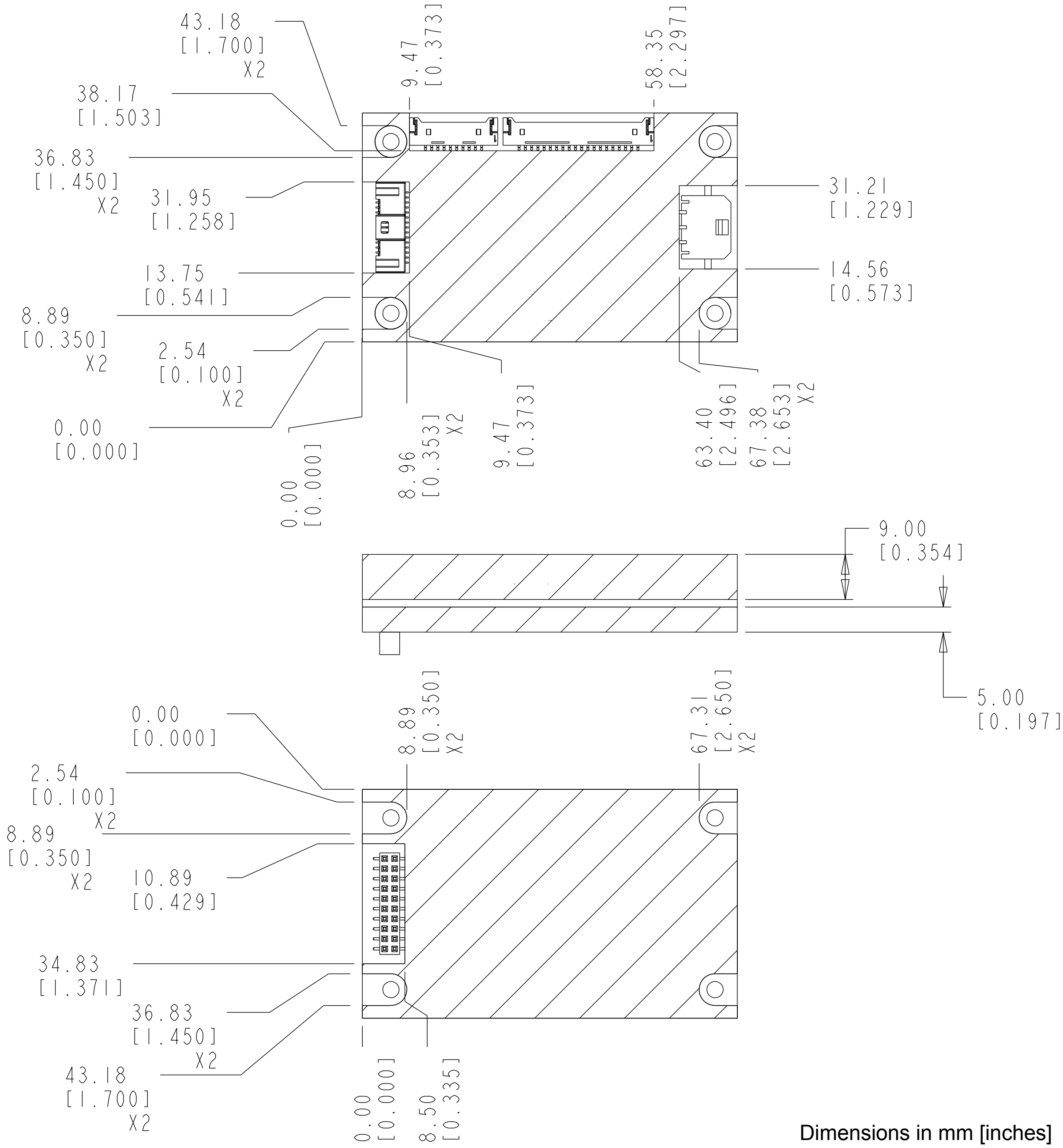
A.16.1 MIC Mechanical Drawings

Figure 82: MIC Top/Bottom Dimensions



Dimensions in mm [inches]

Figure 83: MIC Keep-Out Zone



Dimensions in mm [inches]

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

A.16.2 MIC Electrical and Environmental

Table 123: MIC Electrical Specifications

ELECTRICAL	
MIC Input Voltage	10 VDC to 30 VDC
Power Consumption[a]	+5 VDC @ 1 Amp for IMU +3.3 VDC @ 1 Amp for IMU +15 VDC @ 0.5 Amp for IMU -15 VDC @ 0.08 Amp for IMU +3.3 VDC @ 0.6 Amp for OEM615
IMU Data Interfaces	UART and SDLC over RS-422

a. Sample system power consumption: 5.7 W when powering an HG1900 IMU and OEM615 receiver, in board stack configuration, from VIN=15 VDC at +25°C.

Table 124: MIC Electrical and Environmental Specifications

ENVIRONMENTAL	
Operating Temperature	-40°C to +75°C (-40°F to 167°F)
Storage Temperature	-55°C to +90°C (-67°F to 194°F)
Random Vibe	MIL-STD 810G (Cat 24, 7.7 g RMS)
Sine Vibe	IEC 60068-2-6
Bump	IEC 68-2-29 (25 g)
Shock	MIL-STD-810G (40 g)

A.16.3 MIC Connectors

Table 125: MIC Connectors

Connector	Description	Part Number	Mating Connector Part number
J301	20-pin OEM615 mating connector	501189-3010 Molex Electronics	Connects only to OEM615 receiver.
P101	3-pin locking power connector	43650-0313 Molex Electronics	43645-0300 Molex Electronics
P301	30-pin locking communication connector	501571-3007 Molex Electronics	501189-3010 Molex Electronics
P601	20-pin locking IMU connector for Honeywell and Sensonor IMUs	53780-2070 Molex Electronics	51146-2000 Molex Electronics
P701	10-pin locking IMU connector for ADIS IMUs	53780-1070 Molex Electronics	51146-1000 Molex Electronics

Table 126: Pinouts for Power Connector (P101)

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

Table 127: Pinouts for User Interface Connector (P301)

Pin	Signal[a]	Type	Description	Comments
1	N/C			
2	N/C			
3	LED3	Output	Status LED 3 / Self-test	
4	LED2	Output	Status LED 2 / GPS Time Status	
5	DGND	Power	Digital ground	
6	LED1	Output	Status LED 1 / IMU Data Status	
7	Reserved	N/A	Leave as no connect	
8	DGND	Power	Digital ground	
9	Reserved	N/A	Leave as no connect	
10	Reserved	N/A	Leave as no connect	
11	N/C	N/A		
12	N/C	N/A		
13	USB D-	Bidirectional	USB interface data (-)	Only available in board stackup with OEM615 In standalone, no connect
14	USB D+/ COM3 RX[b c]	Bidirectional	USB interface data (+)/ COM3 receive data	Only available in board stackup with OEM615 In standalone, no connect
15	RESETIN	Input	OEM615 reset in	Only available in board stackup with OEM615 In standalone, no connect
16	VARF/ CAN1RX[d]	Output/ Input	Variable frequency output/ CAN1 receive data	Only available in board stackup with OEM615 In standalone, no connect
17	EVENT2/ CAN1TX[e]	Input/ Output	Event2 input/ CAN1 transmit data	Only available in board stackup with OEM615 In standalone, no connect
18	CAN2RX	Input	CAN2 receive data	Only available in board stackup with OEM615 In standalone, no connect
19	EVENT1/ COM3 TX[c f]	Input	Event1 input/ COM3 transmit data	Only available in board stackup with OEM615 In standalone, no connect
20	DGND	Power	Digital ground	

Pin	Signal[a]	Type	Description	Comments
21	MIC TX	Output		In board stackup with OEM615, this pin is for firmware download In standalone use, this pin can be used for either firmware download and/or for IMU data communication to a SPAN receiver
22	MIC RX	Input		In board stackup with OEM615, this pin is for firmware download In standalone use, this pin can be used for either firmware download and/or for IMU data communication to a SPAN receiver
23	DGND	Power		
24	USER_TXD2	Output		In board stackup with OEM615, this is the access to the OEM615 COM2 port In standalone, no connect
25	USER_RXD2	Input		In board stackup with OEM615, this is the access to the OEM615 COM2 port In standalone, no connect
26	DGND	Power	Digital ground	
27	PV	Output	Access to OEM615 position valid	Only available in board stackup with OEM615 In standalone, no connect
28	DGND	Power	Digital ground	
29	1PPS	Output	Access to OEM615 1PPS	Only available in board stackup with OEM615 In standalone, no connect
30	CAN2TX	Output	CAN2 transmit data	Only available in board stackup with OEM615 In standalone, no connect

a. All signal I/O with the exception of USB port are at LVTTL levels.
b. The USB port is enabled by default and the COM3 port is disabled by default. If you enable the COM3 port, the USB port is disabled.
c. To switch to COM3 send the following commands:
```
MARKCONTROL mark1 disable
INTERFACEMODE com3 novatel novatel
```
d. The VARF output is enabled by default and the CAN1RX input is disabled by default. If you disable VARF, the CAN1RX input is enabled.
e. The Event2 input is enabled by default and the CAN1TX output is disabled by default. If you disable EVENT2, the CAN1TX output is enabled.
f. The Event1 input is enabled by default and the COM3 port is disabled by default. If you enable the COM3 port, the Event1 input is disabled.

Table 128: Pinouts for IMU Connector (P601)

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

a. All signal I/O are at LVTTL levels.

Table 129: Pinouts for IMU Connector (P701)

Pin	Signal	Type	Description	Comments
1	IMU_VDD	Output Power	Positive voltage supply for IMU logic circuits	IMU_VDD must be +3.3 VDC
2	IMU_VDD	Output Power	Positive voltage supply for IMU logic circuits	
3	SPI_NSS		Slave Select	LVTTL level, not 5V tolerant
4	SPI_SCK	Output	Serial Clock	LVTTL level, not 5V tolerant
5	DGND		Digital Ground	
6	SPI_MOSI	Output	Master Output / Slave Input	LVTTL level, not 5V tolerant
7	SPI_MISO	Input	Master Input / Slave Output	LVTTL level, not 5V tolerant
8	DGND		Digital Ground	
9	IMU_DIO1	Bidirectional		LVTTL level, not 5V tolerant
10	IMU_DIO2	Bidirectional		LVTTL level, not 5V tolerant

Table 130: MIC LED Indicator Drivers

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

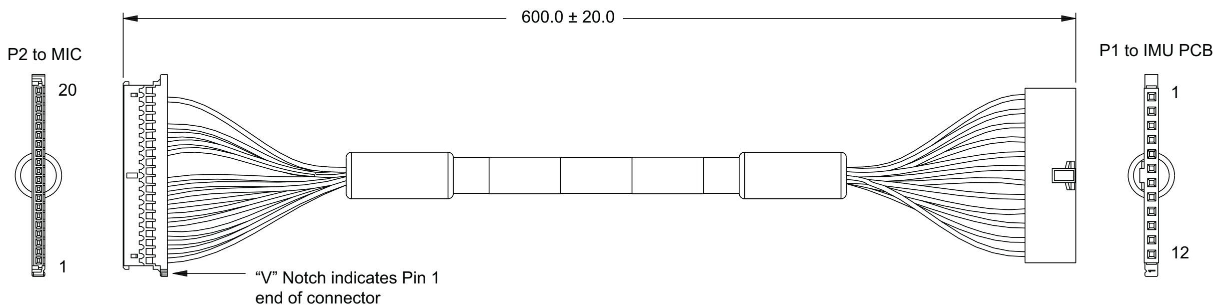
When the MIC boots up, it requires approximately 10 seconds to perform a self-test.

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

A.16.4 HG1930 IMU-to-MIC Cable Assembly

The NovAtel part number for the HG1930 IMU-to-MIC interface cable is 01018827 (*Figure 84, HG1930 IMU-to-MIC Cable Assembly*). This cable provides power to the IMU and enables communication between the MIC and the IMU.

Figure 84: HG1930 IMU-to-MIC Cable Assembly



Dimensions in millimetres

Table 131: HG1930 IMU-to-MIC Cable Assembly

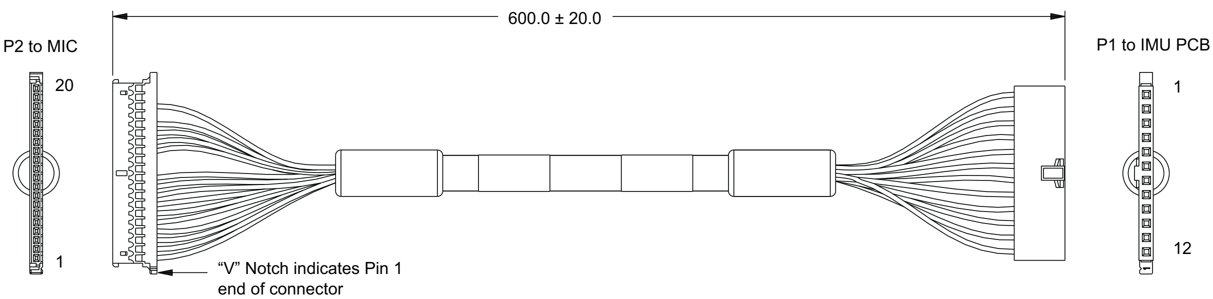
P1 IMU Cable End (FCI-MINITEK) Pin		P2 MIC Cable End Pin
1		15
2		16
3		13
4		14
5		8
7		7
6		9
8		10
11		3
		4
12		6
		19
9		5
10		1
		2

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

A.16.5 HG1700 and HG1900 IMU-to-MIC Cable Assembly

The NovAtel part number for the HG1700 and HG1900 IMU-to-MIC interface cable is 01018828 (*Figure 85, HG1700 and HG1900 IMU-to-MIC Cable Assembly*). This cable provides power to the IMU and enables communication between the MIC and the IMU.

Figure 85: HG1700 and HG1900 IMU-to-MIC Cable Assembly



Dimensions in millimetres

Table 132: HG1700 and HG1900 IMU-to-MIC Cable Assembly

P1 IMU Cable End (FCI-MINITEK) Pin		P2 MIC Cable End Pin
1		15
2		16
3		13
4		14
5		8
7		7
6		9
8		10
11		3
		4
12		6
		18
9		5
10		1
		2

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

A.17 UIC - Universal IMU Controller

Table 133: UIC Physical Specifications

PHYSICAL	
UIC Size	100 mm x 113 mm x 17.54 mm (3.94” x 4.45” x 0.69”)
UIC Weight	125 g (0.28 lb)

A.17.1 UIC Mechanical Drawings

Figure 86: UIC Dimensions and Keep Out Zones

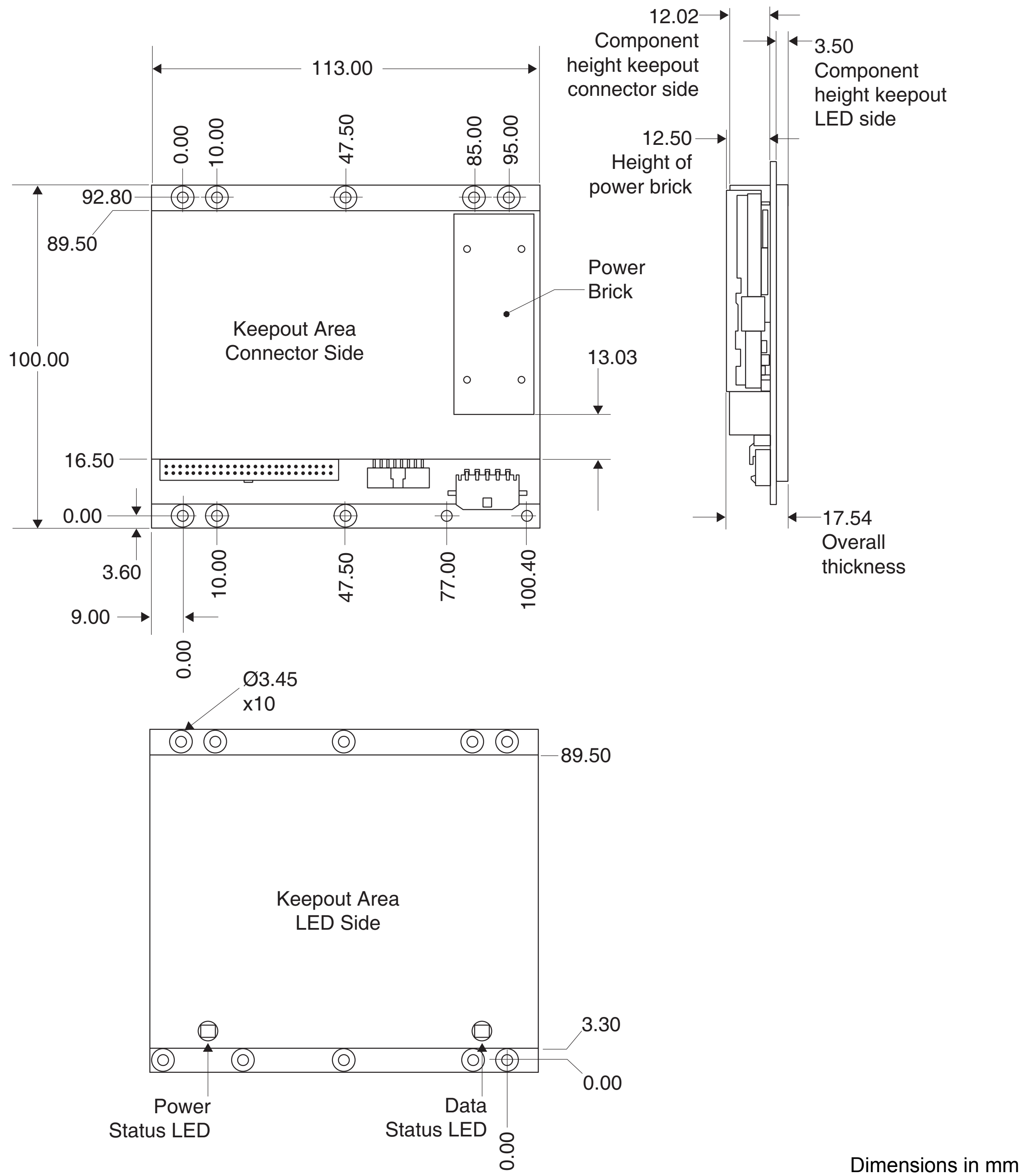
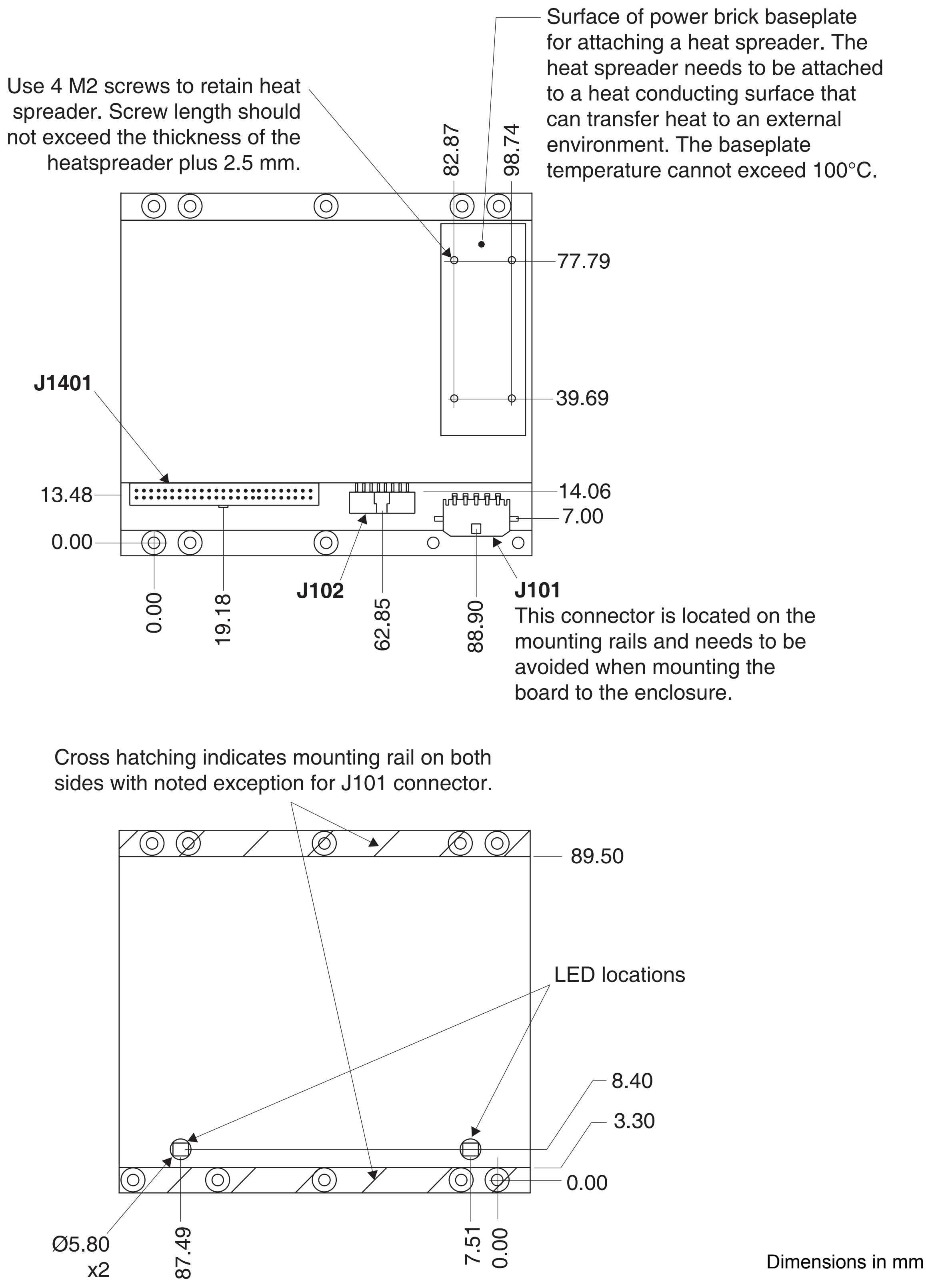


Figure 87: UIC Connectors, LEDs and Heat Sink Details



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

A.17.2 UIC Electrical and Environmental

Table 134: UIC Electrical Specifications

ELECTRICAL	
UIC Input Voltage	10 VDC-34 VDC
Power Consumption	4 W[a]
IMU Data Interfaces	UART and SDLC over RS-422

a. At 12 VDC input.

Table 135: UIC Electrical and Environmental Specifications

ENVIRONMENTAL	
Operating Temperature	-40°C to +75°C (-40°F to 167°F)
Storage Temperature	-55°C to +90°C (-67°F to 194°F)
Random Vibe	MIL-STD 810G (Cat 24, 7.7 g RMS)
Sine Vibe	IEC 60068-2-6
Bump	IEC 68-2-29 (25 g)
Shock	MIL-STD-810G (40 g)

A.17.3 UIC Connectors

Table 136: UIC Connectors

Connector	Description	Part Number	Mating Connector Part number
J101	5-pin UIC power connector[a]	43650-0513 Molex Electronics	43645-0500 Molex Electronics
J102	16-pin UIC to receiver communication connector[b]	98464-G61-16LF FCI Electronics	90311-016LF FCI Electronics
J1401	50-pin UIC to IMU communication connector	LTMM-125-02-L-D (Samtec)	SQT-125-01-L-D (Samtec)

a. A filter module (similar to Delta FL 75L07) in series with the power cable maybe needed to pass conducted emission.

b. A tubular ferrite bead (similar to Laird Technologies 28B0375-300) maybe attached to the data cable to reduce radiated emissions.

Table 137: Pinouts for Power Connector (J101)

Pin	Signal	Type	Description	Comments
1	VIN+	Power	Power input	+10 VDC to +34 VDC
2	VIN+	Power	Power input	+10 VDC to +34 VDC
3	VIN-	Power	Power return	Connect to negative terminal of battery
4	VIN-	Power	Power return	Connect to negative terminal of battery
5	GND	Power	Chassis ground	

Table 138: Pinouts for UIC to Receiver Communications Connector (J102)

Pin	Signal[a]	Type	Description	Comments
A1	UIC_RX+	Input	RS-422 serial data in+	RS-422 serial port for UIC to receiver communication
A2	UIC_RX-	Input	RS-422 serial data in-	
A3	UIC_TX+	Output	RS-422 serial data out+	
A4	UIC_TX-	Output	RS-422 serial data out+	
A5	A+	Input	Odometer input A (+)	Connects to the wheel sensor.
A6	A-	Input	Odometer input A (-)	Connects to the wheel sensor.
A7	Reserved			
A8	Reserved			
B1	Reserved			
B2	Reserved			
B3	EVENT_OUT+	Output	Event output (+)	
B4	EVENT_OUT-	Output	Event output (-)	
B5	B+	Input	Odometer input B (+)	Connects to the wheel sensor.
B6	B-	Input	Odometer input B (-)	Connects to the wheel sensor.
B7	Reserved (do not connect)			
B8	CGND	Power	Chassis ground	

a. All signal I/O are at LVTTL levels (not 5V tolerant).

Table 139: Pinouts for UIC to IMU Communications Connector (J1401)

Pin	Signal[a]	Type	Description
1	3.3V	Output Power	Positive 3.3 VDC supply
2	3.3V	Output Power	Positive 3.3 VDC supply
3	3.3V	Output Power	Positive 3.3 VDC supply
4	GND	Power	Digital ground
5	GND	Power	Digital ground
6	GND	Power	Digital ground
7	15V	Output Power	Positive 15 VDC supply
8	GND	Power	Digital ground
9	-15V	Output Power	Negative 15 VDC supply
10	GND	Power	Digital ground
11	NSS		SPI Slave Select
12	PWRDOWNx	Output	Power down warning
13	SCK	Output	SPI Serial Clock
14	RESETIMUx	Output	Reset IMU
15	GND	Power	Digital ground

Pin	Signal[a]	Type	Description
16	GND	Power	Digital ground
17	MISO	Input	SPI Master Input / Slave Output
18	NOGOx		
19	MOSI	Output	SPI Master Output / Slave Input
20	DIO2		
21	GND	Power	Digital ground
22	GND	Power	Digital ground
23	IMU_TYPE0	Input	Detect IMU type 0
24	IMU_EVENT_IN		
25	IMU_TYPE1	Input	Detect IMU type 1
26	IMU_EVENT_OUT		
27	IMU_TYPE2	Input	Detect IMU type 2
28	GND	Power	Digital ground
29	IMU_TYPE3	Input	Detect IMU type 3
30	TXC-		
31	IMU_DATA_OUT1-		
32	TXC+		
33	IMU_DATA_OUT1+		
34	SYNC-		
35	GND	Power	Digital ground
36	SYNC+		
37	IMU_DATA_OUT2-		
38	TXD-		
39	IMU_DATA_OUT2+		
40	TXD+		
41	GND	Power	Digital ground
42	GND	Power	Digital ground
43	5.25V	Output Power	Positive 5.25 VDC supply
44	5.25V	Output Power	Positive 5.25 VDC supply
45	GND	Power	Digital ground
46	5.25V	Output Power	Positive 5.25 VDC supply
47	GND	Power	Digital ground
48	GND	Power	Digital ground
49	-5.25V	Output Power	Negative 5.25 VDC supply
50	-5.25V	Output Power	Negative 5.25 VDC supply

a. All signal I/O are at LVTTL levels (not 5V tolerant).

A.17.4 HG1900 IMU to UIC Cable Assembly

The NovAtel part number for the HG1900 IMU to UIC interface cable is 01019762 (*Figure 88, OEM-IMU-HG1900 IMU to UIC Cable Assembly*). This cable provides power to the IMU and enables communication between the MIC and the IMU.

Figure 88: OEM-IMU-HG1900 IMU to UIC Cable Assembly

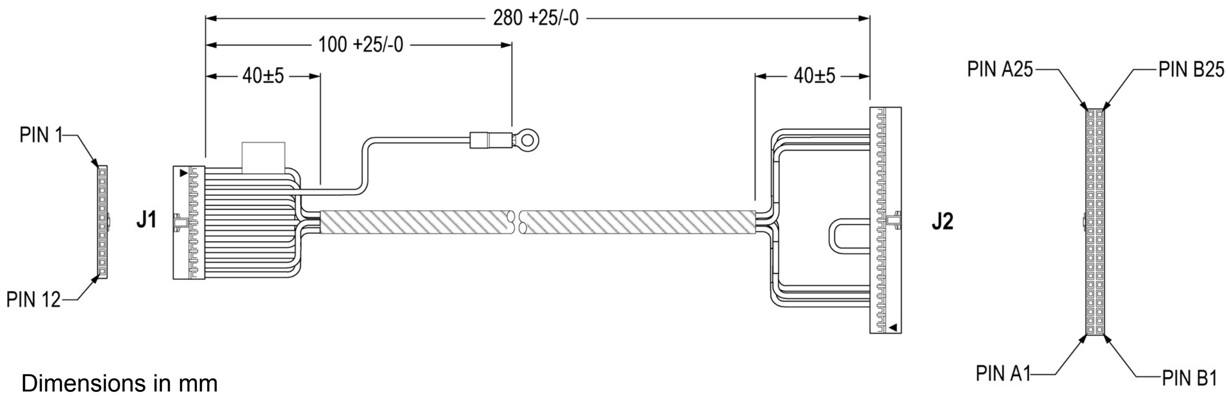


Table 140: OEM-IMU-HG1900 IMU to UIC Cable Pinout

J1 Pins (to HG1900)		J2 Pins (to UIC)
1		A3 B5
2		A4
3		Lug Ring
4		A5
5		A23
6		B21
7		B22
8		A22
9		B19
10		B20
11		A16
12		A17
		A11 to A12

A.17.5 LN200 IMU to UIC Cable Assembly

The NovAtel part number for the LN200 IMU to UIC interface cable is 01019763 (*Figure 89, OEM-IMU-LN200 IMU to UIC Cable Assembly*). This cable provides power to the IMU and enables communication between the MIC and the IMU.

Figure 89: OEM-IMU-LN200 IMU to UIC Cable Assembly

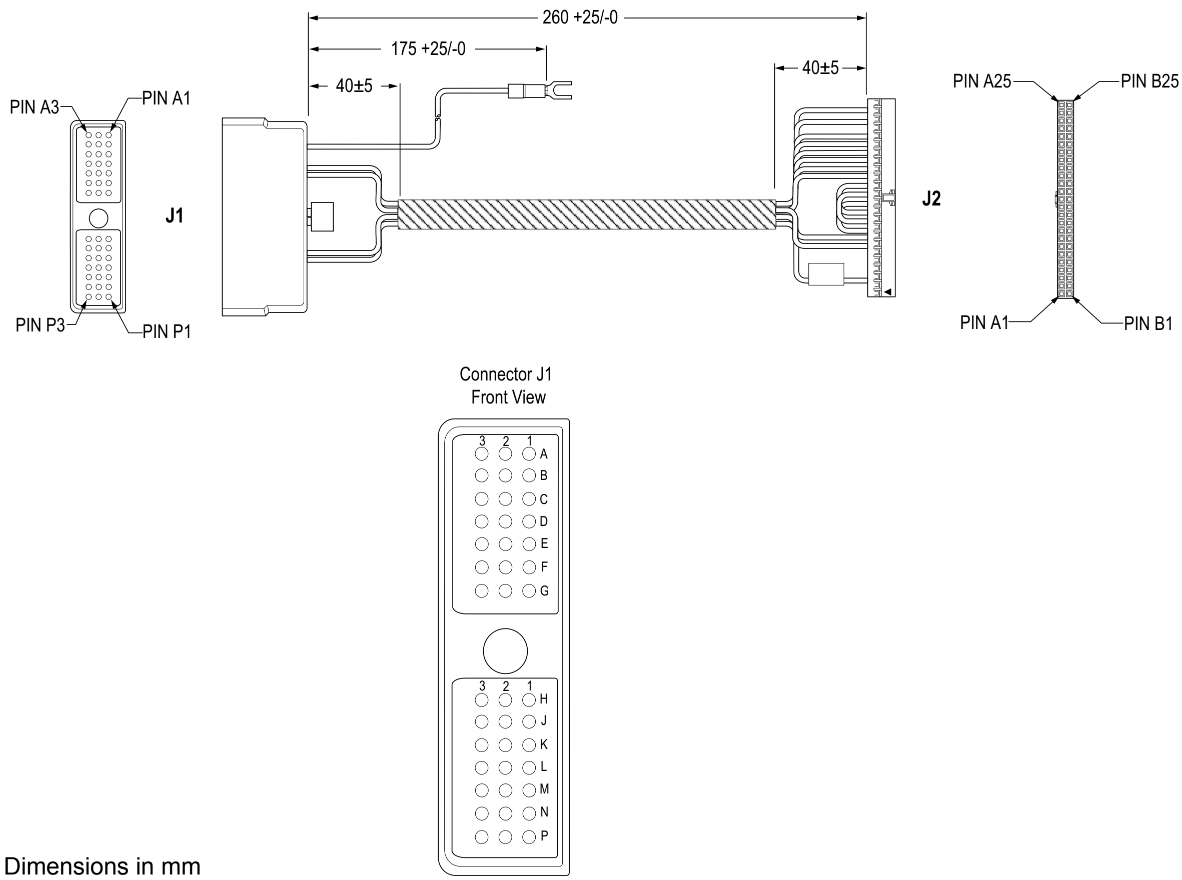


Table 141: OEM-IMU-LN200 IMU to UIC Cable Pinout

J1 Pins (to LN200)		J2 Pins (to UIC)
A2		B19
A3		B15
B1		B20
B2		B16
C1		A3 B14
D1		A24 B24
D2		A21 B21
D3		Lug Fork

J1 Pins (to LN200)		J2 Pins (to UIC)
E1		A22
E2		B22
E3		B23
F3		A4
G2		A5
K1		B4 B5
L2		B18
L3		B17
		A8 to A13
		A11 to 12
		A15 to A18

A.18 Receivers

For technical specifications for the OEM615, OEM617, OEM628, OEM638 and FlexPak6, see the OEM6 Family Installation and Operation User Manual.

For technical specifications for the ProPak6, see the ProPak6 User Manual.

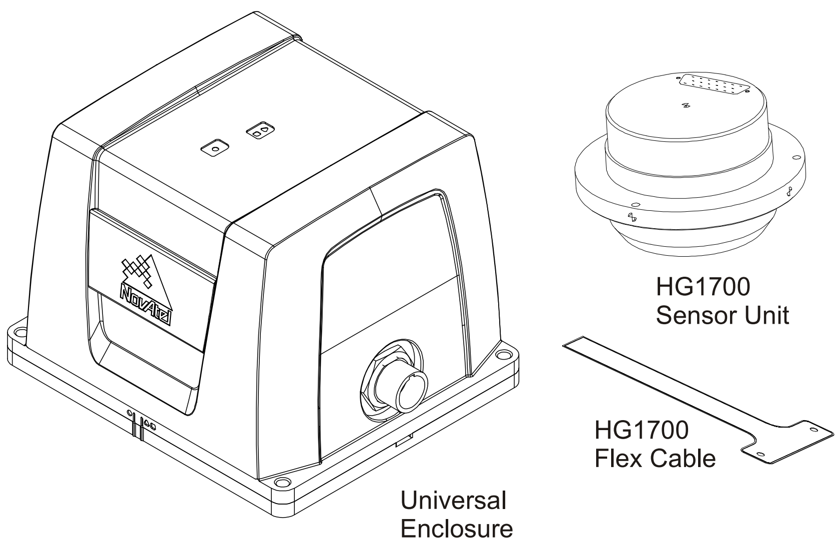
Appendix B HG1700 IMU in Universal Enclosure

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

The following procedure provides the necessary information to install the HG1700 sensor into the Universal Enclosure (NovAtel part number 01018589), both illustrated below. The steps required for this procedure are:

- Disassemble the Universal Enclosure
- Install the HG1700 Sensor Unit
- Reassemble the Universal Enclosure

Figure 90: Required Parts



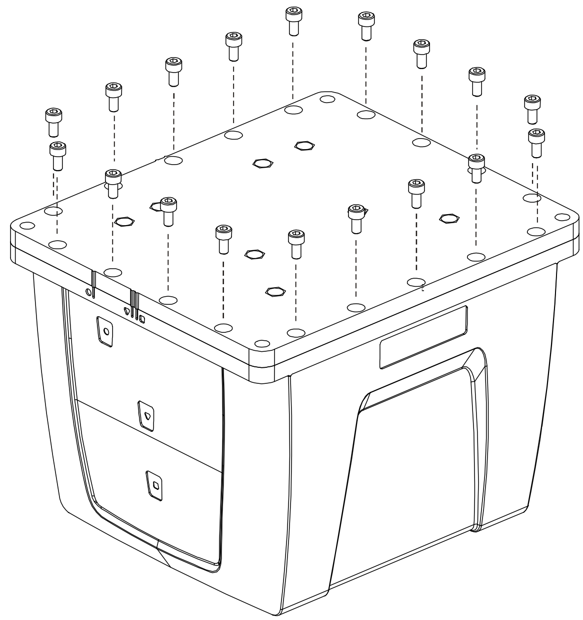
> 1. Use thread-locking fluid on all fasteners except for the flex cable connectors.
> 2. Torque values for all fasteners, including those for the flex cable, are as follows:
>   Size 2-56: 0.20-0.25 N-m (1.8-2.2 lb-in) [28-35 oz/in]
>   Size M4: 1.36-1.58 N-m (12.0-14.0 lb-in)
>   Size 8-32: 1.55-1.70 N-m (13.7-15.0 lb-in)

B.1 Disassemble the Universal Enclosure

Disassemble the Universal Enclosure as follows:

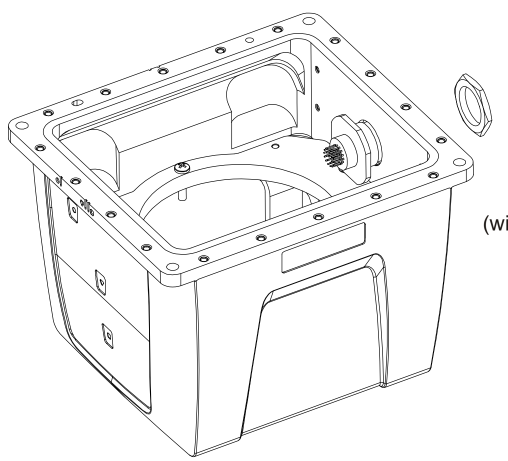
1. Using a 3 mm hex bit, remove the M4 screws (they will be reused) and the base, as shown in *Figure 91, Remove Base*. Ensure the O-rings come with the base when it is removed, and that they are not damaged.

Figure 91: Remove Base



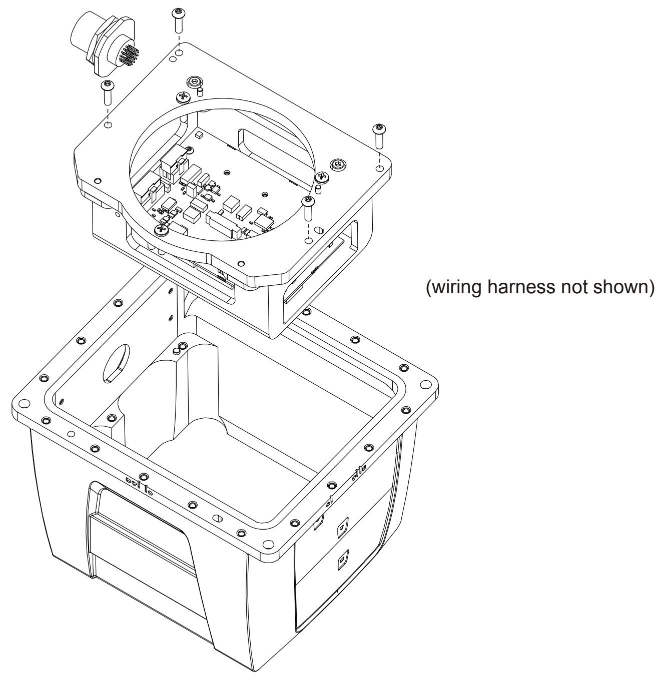
2. Using a 30 mm socket, remove the jam nut and free the wiring harness connector from the body, as shown in *Figure 92, Disconnect Wiring Harness from Enclosure Body*. Retain the O-ring and the jam nut for reassembly.

Figure 92: Disconnect Wiring Harness from Enclosure Body



3. Using a 2.5 mm hex bit, unscrew the M4 screws and remove the IMU mounting plate, bracket and cable harness, as shown in *Figure 93, Remove IMU Mounting Plate and Bracket*:

Figure 93: Remove IMU Mounting Plate and Bracket

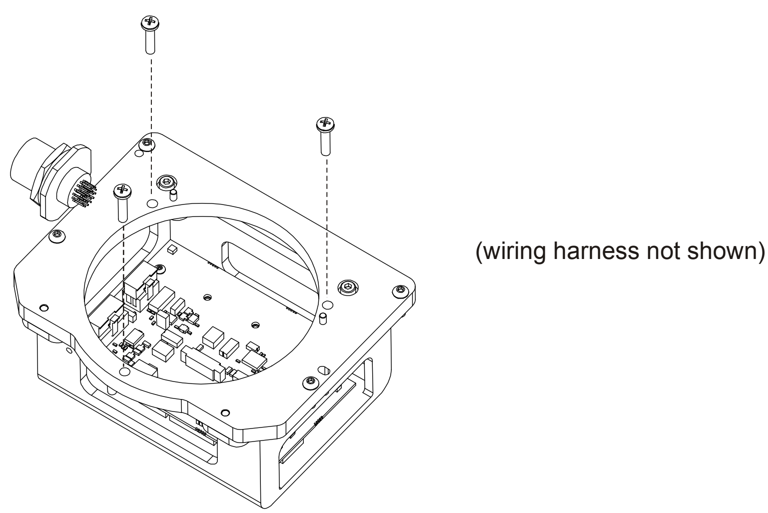


B.2 Install the HG1700 Sensor Unit

To install the HG1700 sensor unit in the Universal Enclosure:

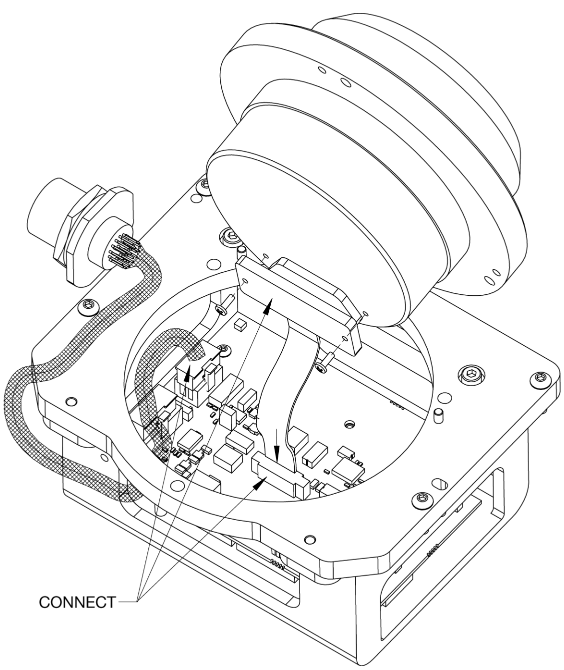
1. Using a Phillips screwdriver, remove the 8-32 IMU mounting screws from the IMU mounting plate, as shown in *Figure 94, Remove IMU Mounting Screws*.

Figure 94: Remove IMU Mounting Screws



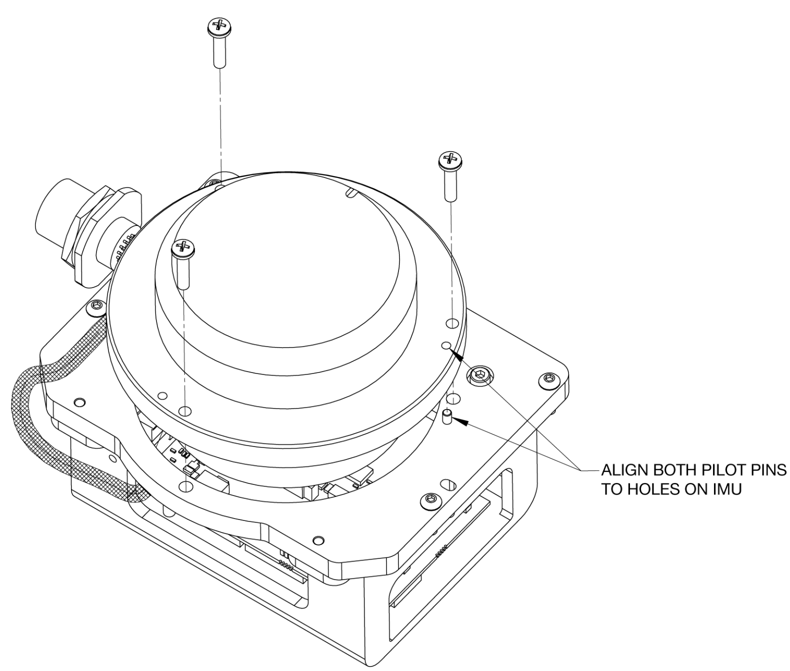
2. Check the connection of the internal cable harness to the board assembly and route as shown in *Figure 95, Connect IMU to IMU Mounting Plate*. Before you connect the IMU cable harness, make sure the connector on the board assembly is clicked open. Connect the IMU cable harness to the IMU (fasten the 2-56 screws but do not use thread-locking fluid), then connect to the board assembly. Ensure the cable housing latches.

Figure 95: Connect IMU to IMU Mounting Plate



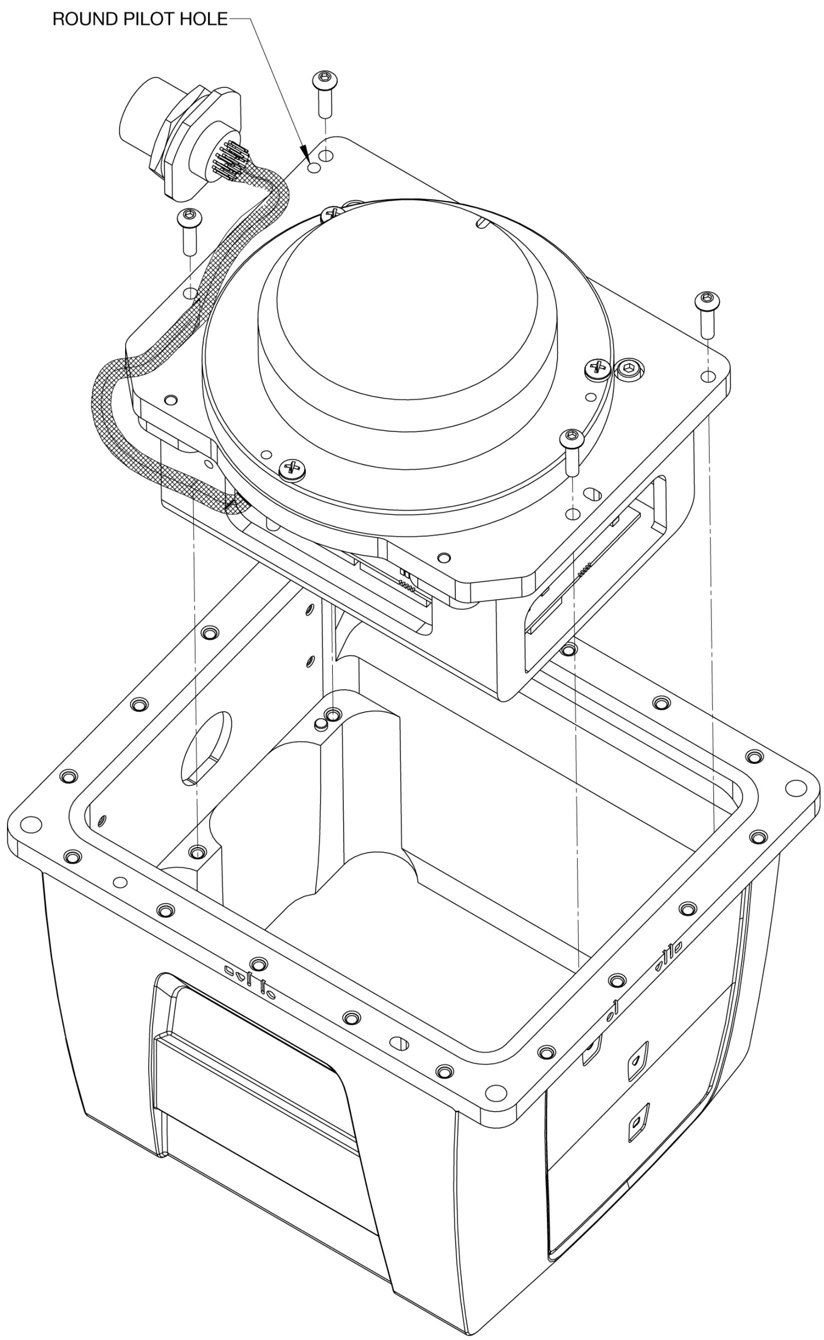
3. Being careful of the connectors and the orientation, align the pilot holes of the IMU with the pilot pins of the mounting plate. Gently place the IMU and mounting plate together, being careful not to pinch the cable harness. Screw the IMU and mounting plate together, using thread-locking fluid on the 8-32 screws, as shown in *Figure 96, Installing IMU to Mounting Plate*.

Figure 96: Installing IMU to Mounting Plate



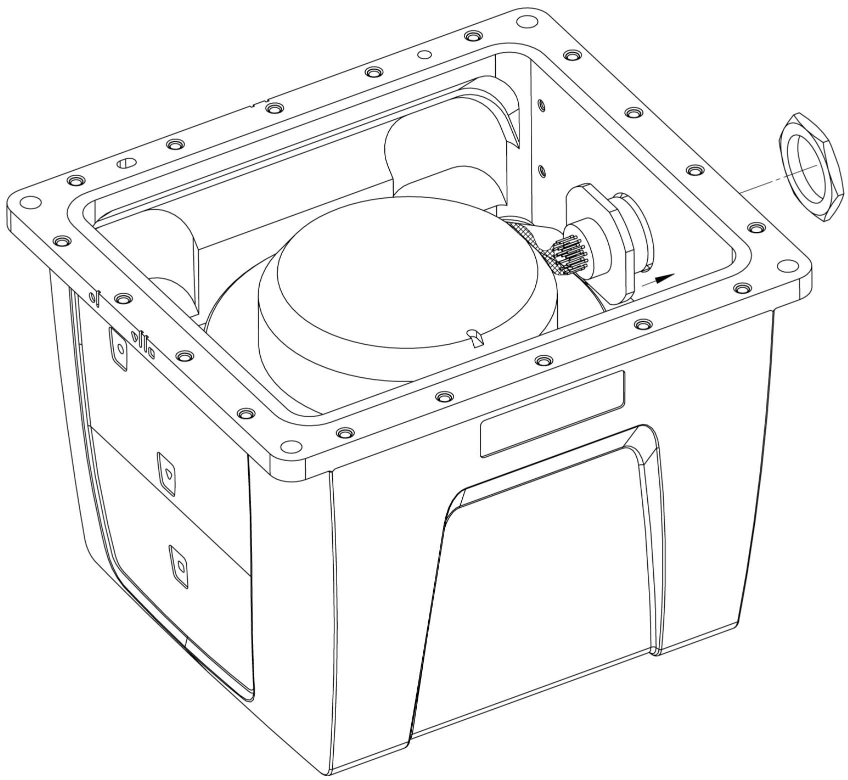
4. Starting with the round pilot hole, shown in *Figure 97, Assemble Into Enclosure Body*, align the pilot holes of the assembled plate (noting the orientation) with the pilot pins of the enclosure body. Lower the assembly into place, then fasten using thread-locking fluid on the M4 screws.

Figure 97: Assemble Into Enclosure Body



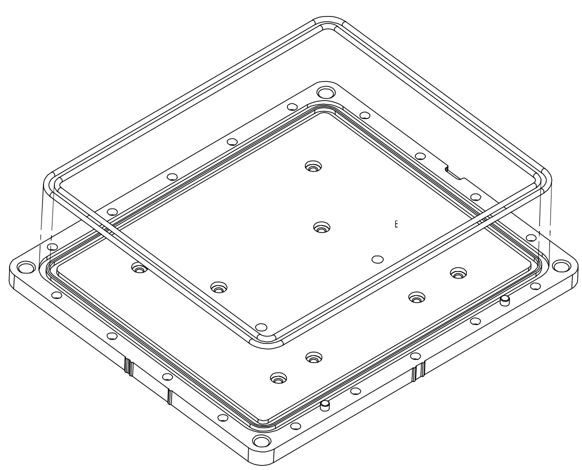
5. Connect the internal cable harness to the enclosure body, as shown in *Figure 98, Fasten Internal Cable Harness*. During this step, ensure the connector O-ring (supplied with the connector of the internal cable harness) remains flat within the connector's groove, and make sure the groove is clean and free of debris. Fasten the connector to the enclosure body wall using the jam nut supplied with the connector. Apply thread-locking fluid then, with a 30 mm socket, tighten the jam nut to 6.9 N-m (61 lb-in/5.1 lb-ft).

Figure 98: Fasten Internal Cable Harness



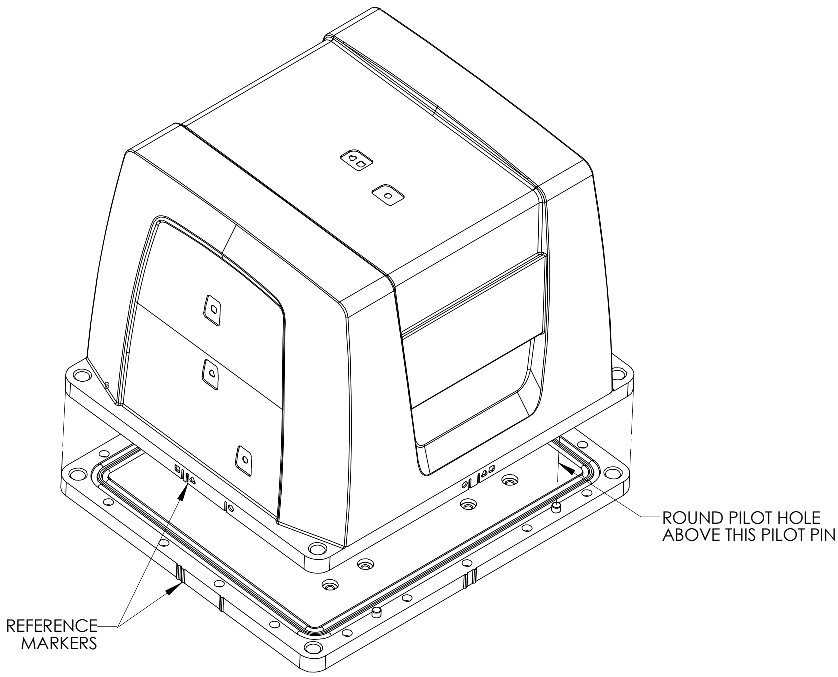
6. Ensure the O-rings are in place. If they are not, as necessary, make sure the grooves of the enclosure base are clean and free of debris, using isopropyl alcohol. As shown in *Figure 99, Install O-rings*, install the outer environmental and inner EMI O-rings in the enclosure base, being careful not to stretch or twist them. O-rings must remain flat within the grooves during the remainder of the assembly procedure.

Figure 99: Install O-rings



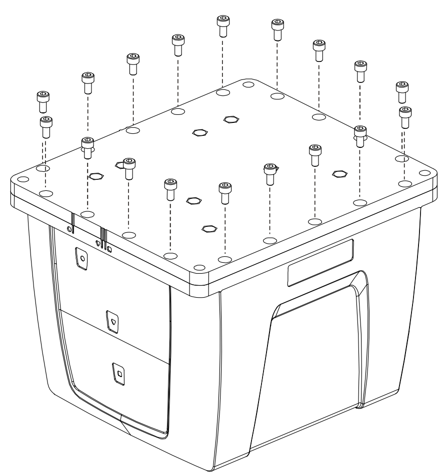
7. Clean the surface of the enclosure body, where it mates with the O-rings, using isopropyl alcohol. As shown in *Figure 100, Install Enclosure Body on the Base*, align the reference markers and pilot holes/pins of the enclosure body and base. Carefully lower the body onto the base, observing the O-rings and alignment of corners. Press the enclosure body into place, starting with the round pilot hole indicated in *Figure 100, Install Enclosure Body on the Base*.

Figure 100: Install Enclosure Body on the Base



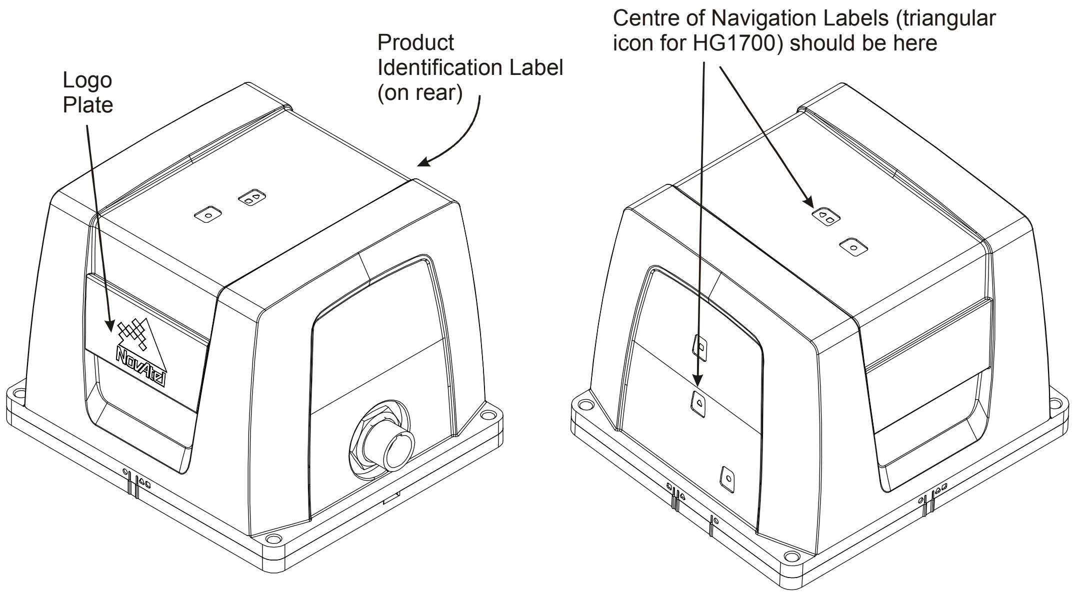
8. While squeezing and holding the enclosure body and base together to maintain tight contact, carefully turn the assembly over and place it on its top, as shown in *Figure 101, Screw Enclosure Base to Body*. Using a 3 mm hex bit, lightly fasten four equally spaced M4 screws to hold the parts together. Apply thread-locking fluid to each screw before inserting. Install the remaining screws in similar fashion. Tighten all screws then check all of them again for tightness. Tighten these screws to 1.36-1.58 N-m (12-14 lb-in). Do not over-tighten.

Figure 101: Screw Enclosure Base to Body



9. Ensure the product identification label, the logo plate and the center of navigation labels are properly affixed and contain the correct information. The final assembled unit will be similar to that shown in *Figure 102, Final Assembly*.

Figure 102: Final Assembly



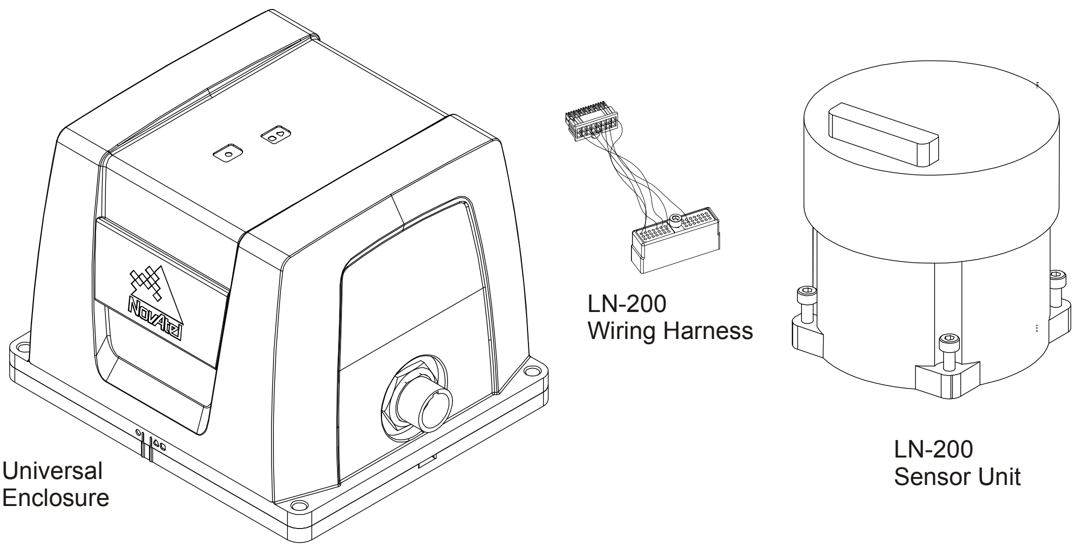
Appendix C LN-200 IMU in Universal Enclosure

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

The following procedure provides the necessary information to install the LN-200 sensor into the Universal Enclosure (NovAtel part number 01018590), both illustrated below. The steps required for this procedure are:

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

Figure 103: Required Parts



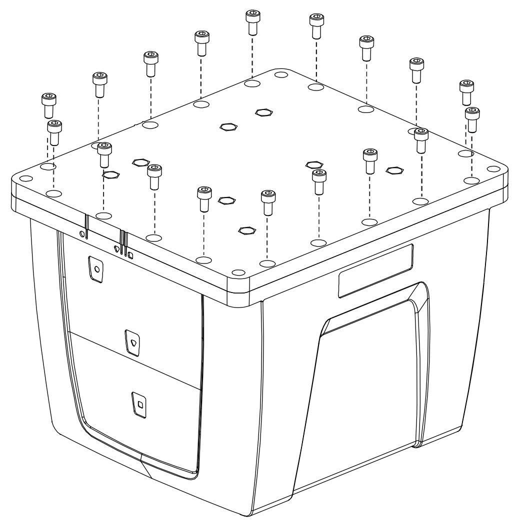
> 1. Use thread-locking fluid on all fasteners except for the cable harness connectors.
> 2. Torque values for all fasteners, including those for the cable harness screws, are as follows:
>   Size 6-32: 0.79-0.90 N-m (7.0-8.0 lb-in)
>   Size M4: 1.36-1.58 N-m (12.0-14.0 lb-in)

C.1 Disassemble the Universal Enclosure

Disassemble the Universal Enclosure as follows:

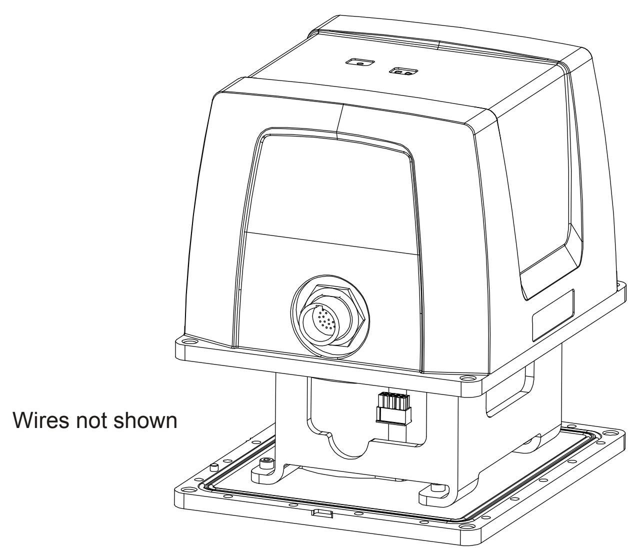
1. Using a 3 mm hex bit, remove the M4 screws (they will be reused) and the base, as shown in *Figure 104, Remove Base*.

Figure 104: Remove Base



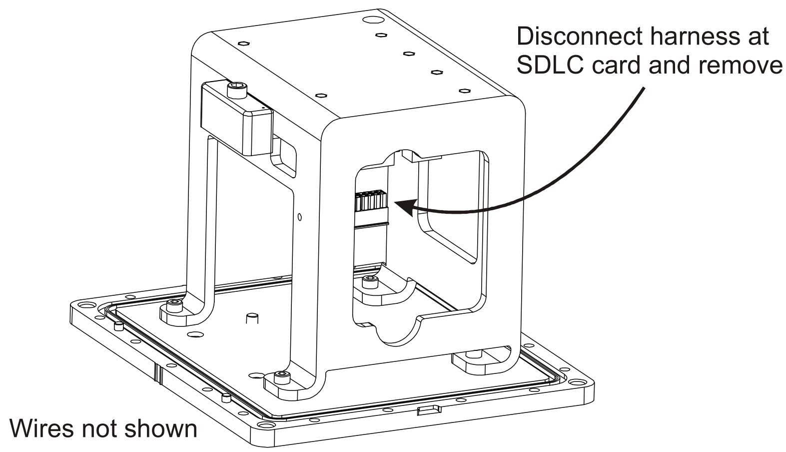
2. While squeezing and holding the assembly tightly together, carefully turn the assembly over and set it down as shown in *Figure 105, Disconnect Wiring Harness from SDLC Card*. Raise the enclosure body, and disconnect the internal cable harness at the SDLC board. Ensure the O-rings remain with the base when it is removed, and that they are not damaged.

Figure 105: Disconnect Wiring Harness from SDLC Card



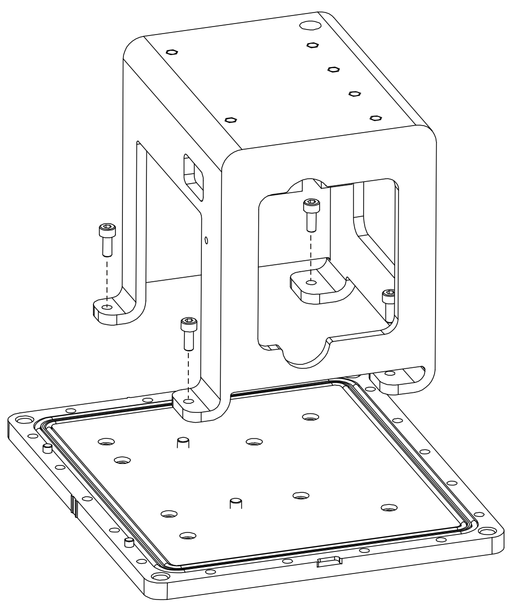
3. Lift the enclosure lid off the assembly to expose the IMU bracket, shown in *Figure 106, IMU Bracket*. Disconnect the harness at the SDLC card and remove.

Figure 106: IMU Bracket



4. Using a 3 mm hex bit, unscrew 4 mm screws and remove the IMU bracket with SDLC, as shown in *Figure 107, Remove IMU Bracket/SDLC*.

Figure 107: Remove IMU Bracket/SDLC

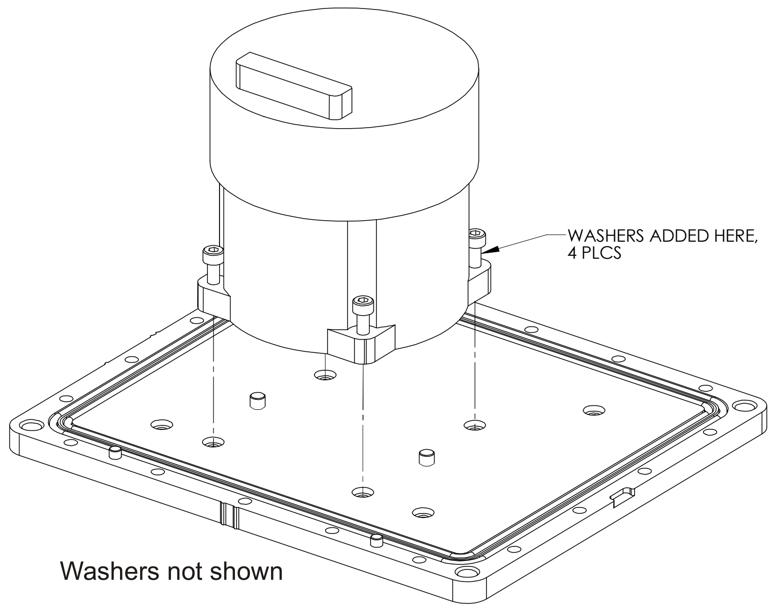


C.2 Install the LN-200 Sensor Unit

To install the LN-200 sensor unit in the Universal Enclosure:

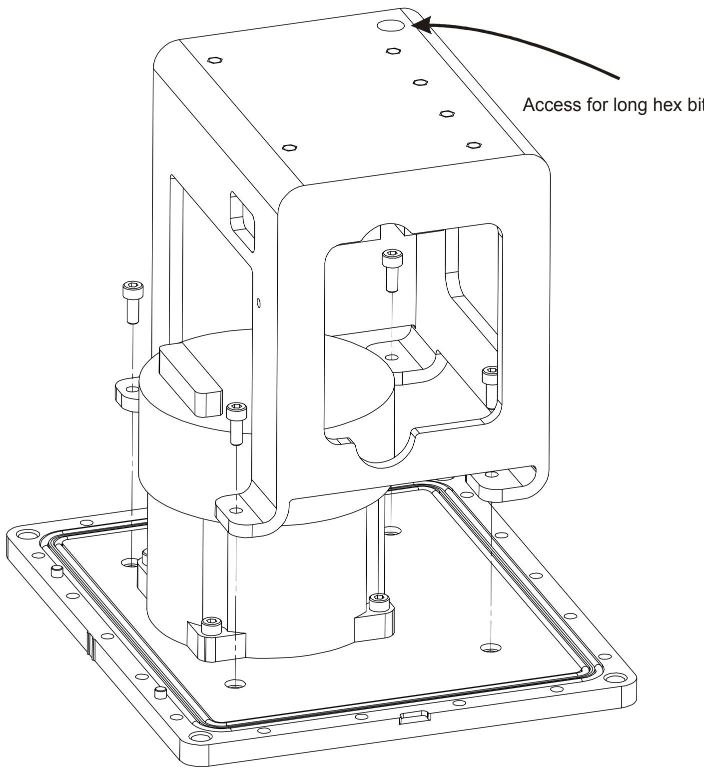
1. Using a 3 mm hex bit, remove original captive 6-32 screws and washers (4 each) from the LN-200 IMU. Add three washers under each of the original washers and fasten the IMU to the enclosure base, as shown in *Figure 108, Install LN-200 IMU to Base*. Use thread-locking fluid on each screw.

Figure 108: Install LN-200 IMU to Base



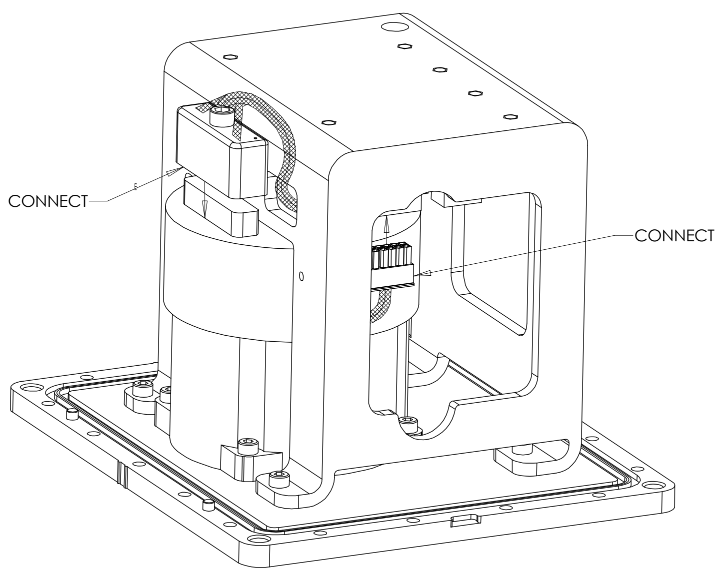
2. Using a long 3 mm hex bit, install the IMU bracket/SDLC to the base, as shown in *Figure 109, Install Bracket to Base*. Use thread-locking fluid on each M4 screw.

Figure 109: Install Bracket to Base



3. Connect the cable harness to the board assembly and IMU, routing it as shown in *Figure 110, Making Connections*. Ensure latching of the cable connector housings and fasten the 6-32 screw at the IMU end using a 5/32” hex bit. Do not use thread-locking fluid and do not overtighten.

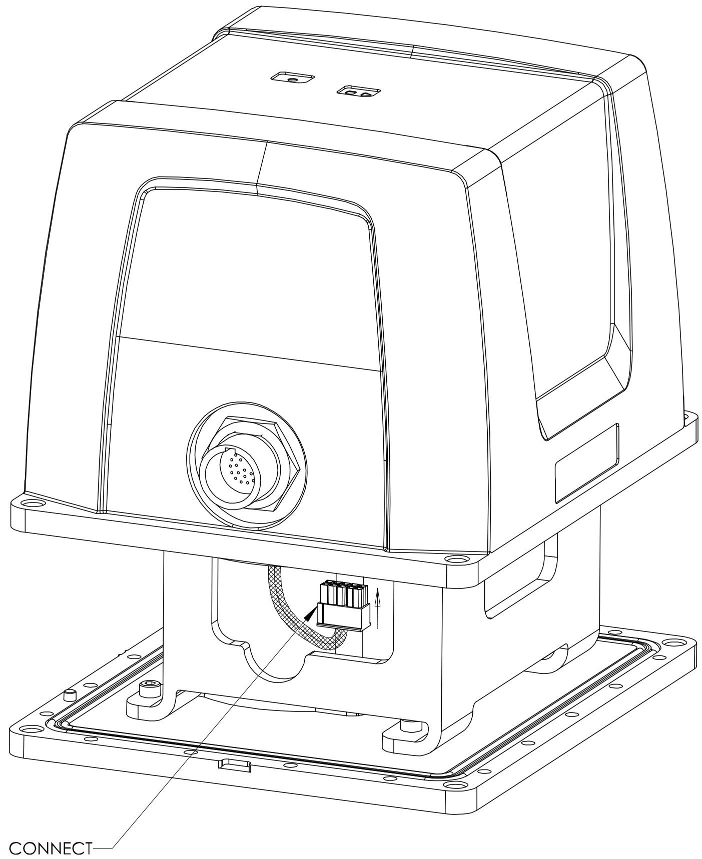
Figure 110: Making Connections



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

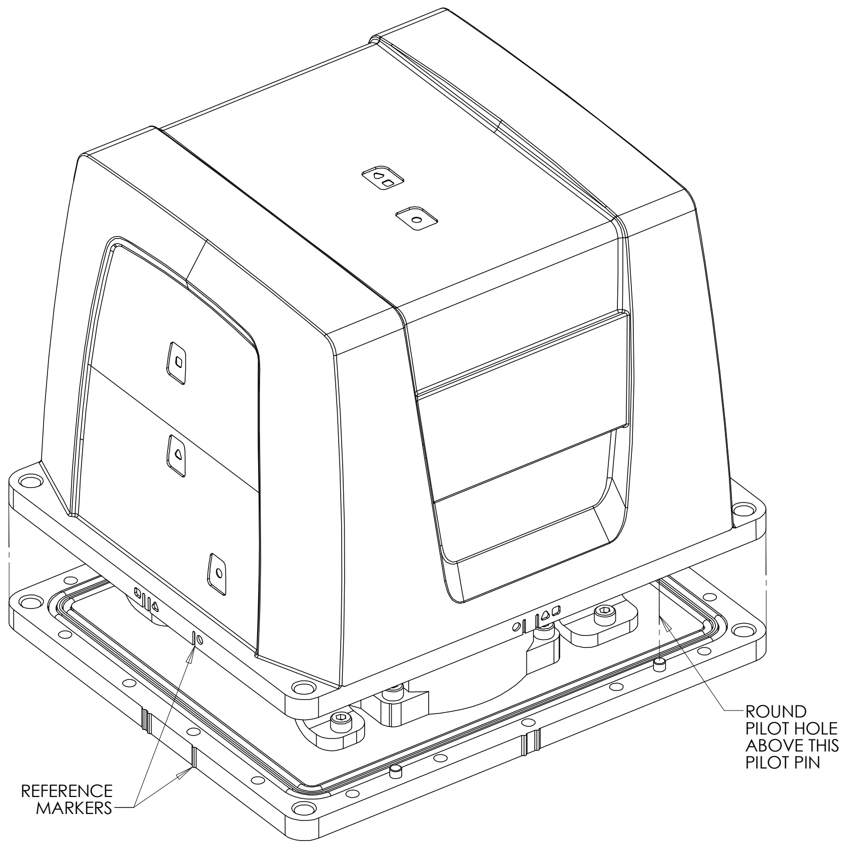
4. While carefully holding the body over the bracket, connect the internal cable harness to the board assembly, as shown in *Figure 111, Connect Internal Cable Harness*.

Figure 111: Connect Internal Cable Harness



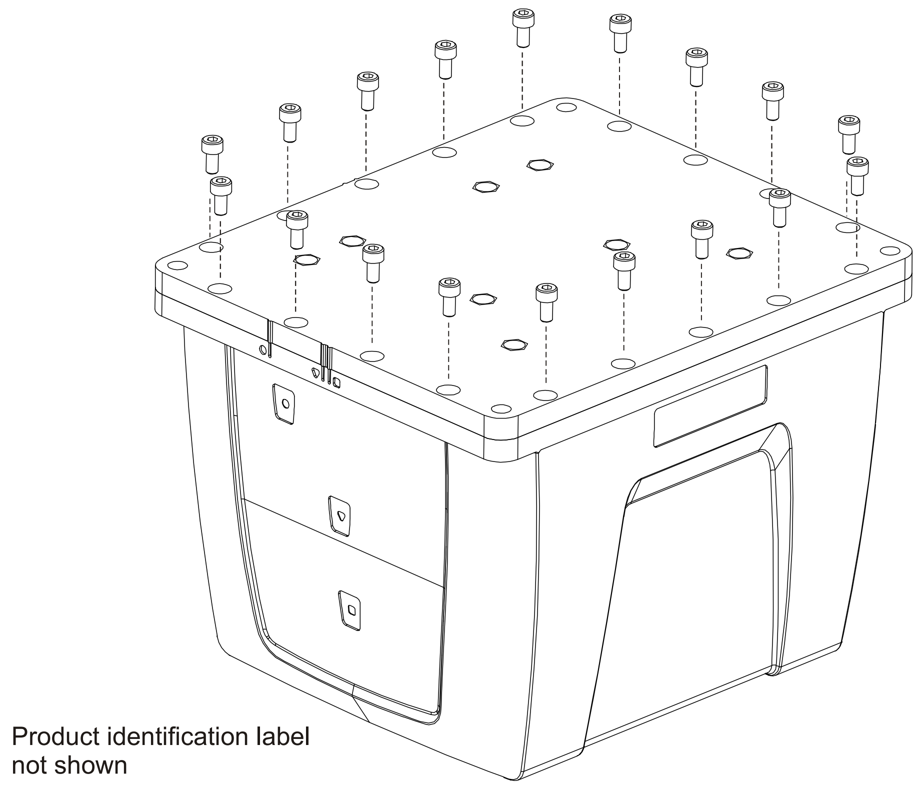
5. Clean the surface of the enclosure body, where it will mate with the O-rings, using isopropyl alcohol. While ensuring all wires will fit inside the bracket without being pinched, align the reference markers and pilot holes/screws of the enclosure body and base, and carefully lower the body onto the base, observing the O-rings and the alignment of corners. Start with the round pilot hole indicated in *Figure 112, Installing the Enclosure Body to the Base*, then press the assembly into place.

Figure 112: Installing the Enclosure Body to the Base



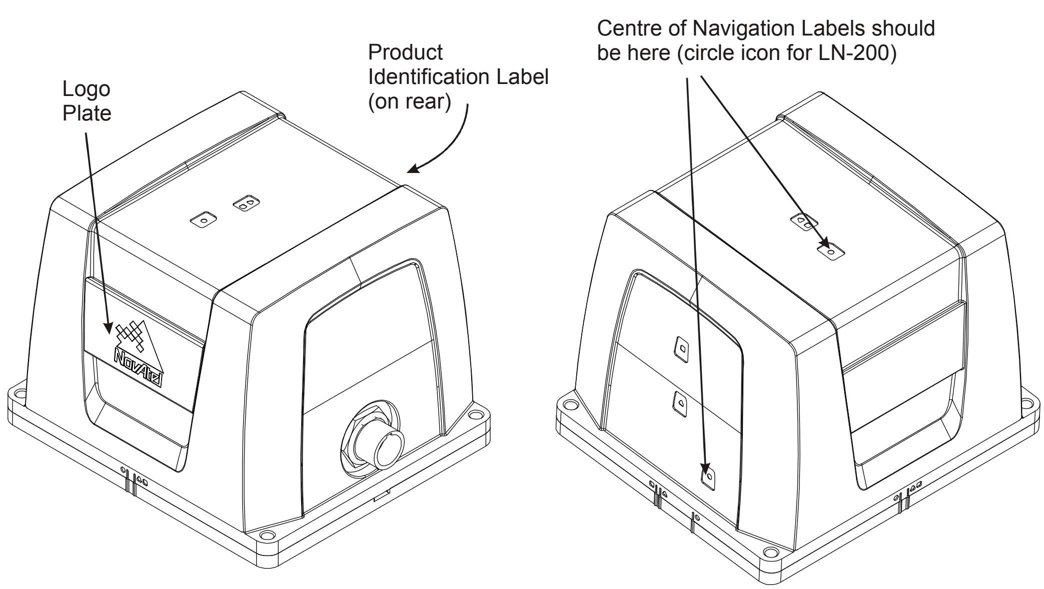
6. While squeezing and holding the enclosure body and base together to maintain tight contact, carefully turn the assembly over and place it on its top, as shown in *Figure 113, Screw Enclosure Base to Body*. Using a 3 mm hex bit, lightly fasten four equally spaced M4 screws to hold the parts together. Use thread-locking fluid on all screws. Install the remaining screws in similar fashion. Tighten all screws to 1.36-1.58 N-m (12-14 lb-in). Do not over-tighten.

Figure 113: Screw Enclosure Base to Body



7. Ensure the product identification label, the logo plate and the center of navigation labels are properly affixed and contain the correct information. The final assembled unit is shown in *Figure 114, Final Assembly*.

Figure 114: Final Assembly



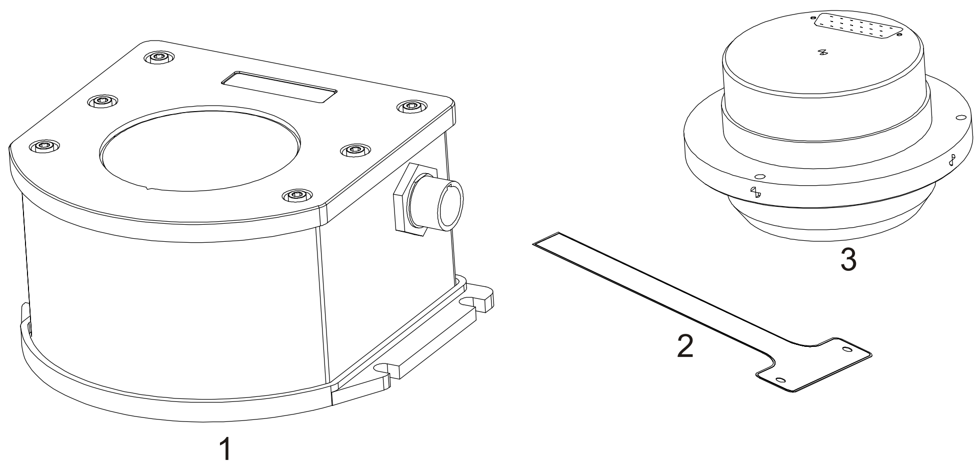
Appendix D HG1700 IMU in SPAN HG Enclosure

The following procedure provides the necessary information to install the HG1700 sensor into the SPAN HG Enclosure (NovAtel part number 01017898). The steps required for this procedure are:

- Disassemble the SPAN HG Enclosure
- Install the HG1700 Sensor Unit
- Make Electrical Connections
- Reassemble the SPAN HG Enclosure

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

Figure 115: Required Parts



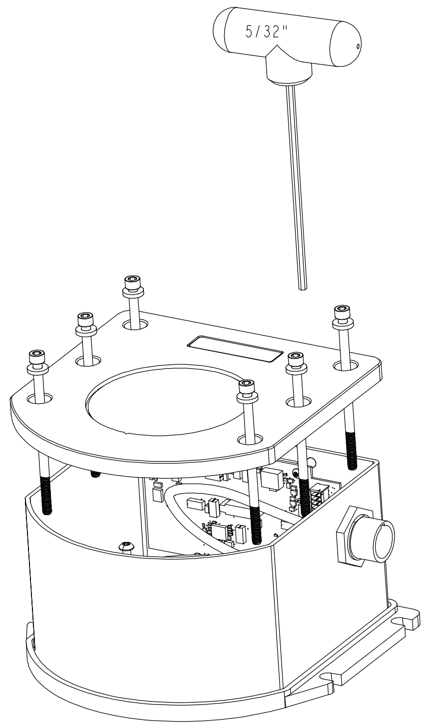
Reference	Description
1	SPAN IMU Enclosure
2	HG1700 Flex Cable
3	HG1700 Sensor Unit

D.1 Disassemble the SPAN IMU Enclosure

The SPAN IMU disassembly steps are as follows:

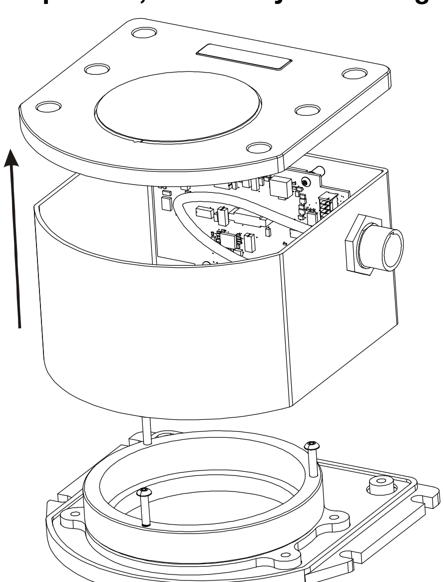
1. Remove the six bolts from the top cover using a hex key, as shown in *Figure 116, Bolts and Hex Key*:

Figure 116: Bolts and Hex Key



2. Set aside the bolts with their sealing washers.
3. Lift the top cover off the tube body and set it aside, as shown in *Figure 117, Lift Top Cover, Tube Body and 3 Ring Spacer Screws* on page 203.
4. Lift the tube body away from its base plate and set it aside.
5. Remove the 3 ring spacer screws and set them aside.

Figure 117: Lift Top Cover, Tube Body and 3 Ring Spacer Screws

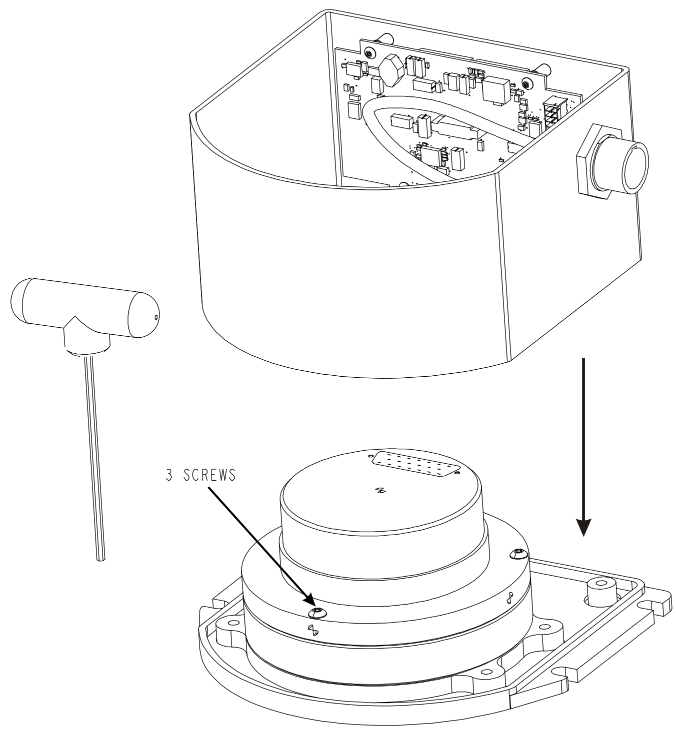


D.2 Install the HG1700 Sensor Unit

To re-assemble the SPAN IMU with the HG1700 sensor, see *Figure 118, SPAN IMU Re-Assembly* on page 204 and follow these steps:

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

Figure 118: SPAN IMU Re-Assembly

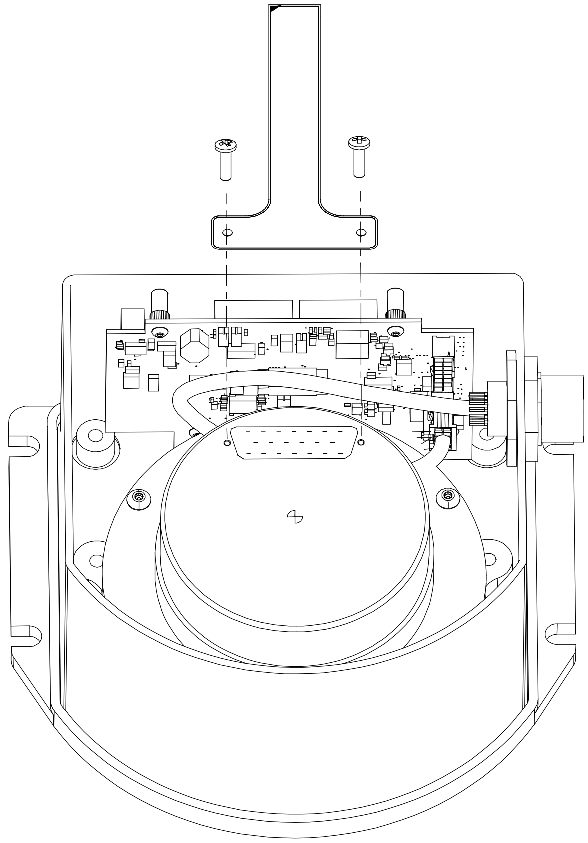


D.3 Make the Electrical Connections

To make the electrical connections you need a 3/32” hex key, the flex cable and the partially assembled SPAN IMU from *Section D.2, Install the HG1700 Sensor Unit* on page 204. 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 119, Attach Flex Cable*.

Figure 119: Attach Flex Cable



2. Tighten the screws to 4 in-lbs.
3. Connect the opposite end of the flex cable to the corresponding connector on the IMU card ensuring that the contacts on the flex cable mate with the contacts on the connector, as shown in *Figure 119, Attach Flex Cable* on page 205.
4. Check that the flex cable is locked in place.

Figure 120, Incorrect (Bowed) Flex Cable Installation shows an incorrect installation of the flex cable where it is bowed in the middle. It will not operate properly in this position. *Figure 121, Correct (Flat) Flex Cable Installation* shows the proper installation of the flex cable. Notice how the flex cable sits flush against the IMU surface.

Figure 120: Incorrect (Bowed) Flex Cable Installation

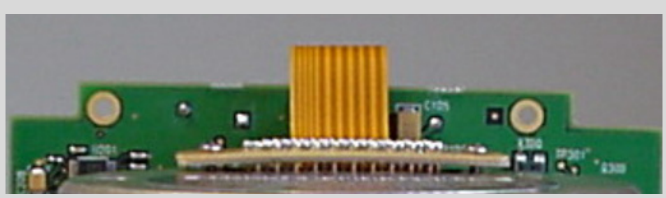
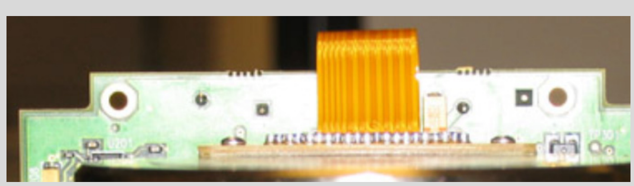


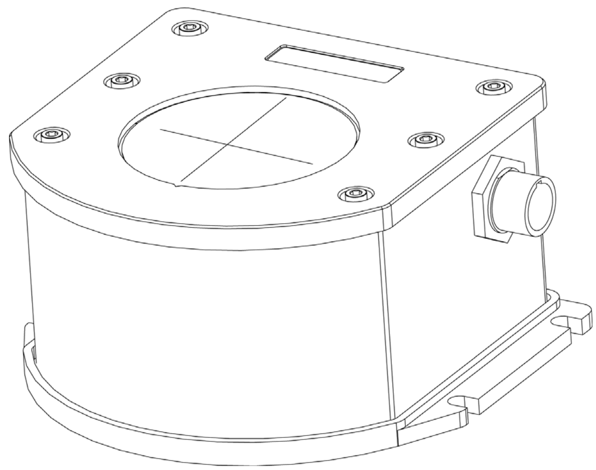
Figure 121: Correct (Flat) Flex Cable Installation



D.4 Re-Assemble the SPAN IMU Enclosure

Use a hex key to align the long bolts with the threaded holes in the base, as shown in *Figure 116, Bolts and Hex Key* on page 203. 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 122, HG1700 SPAN IMU.*

Figure 122: HG1700 SPAN IMU



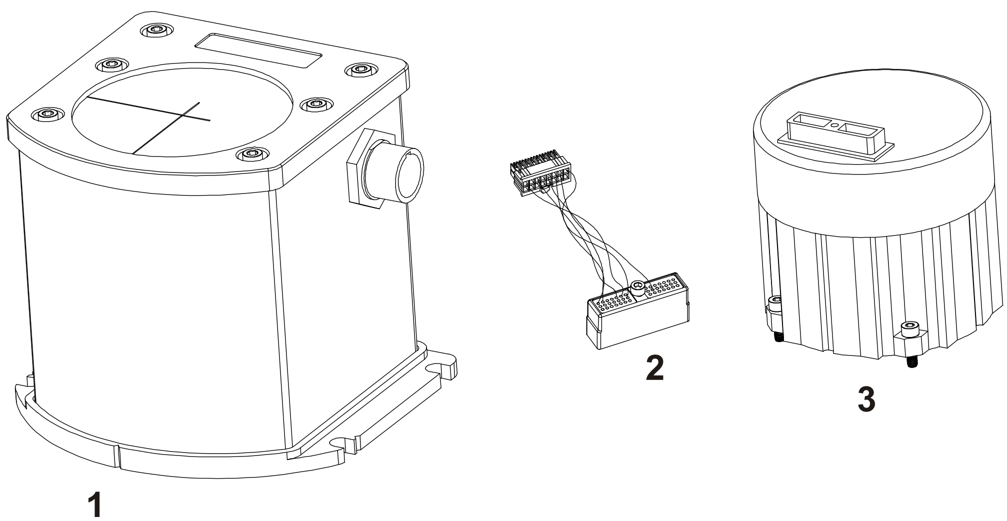
Appendix E LN-200 IMU in SPAN IMU Enclosure

The following procedure provides the necessary information to install the LN-200 sensor (NovAtel part number 80023515) into the SPAN IMU enclosure (NovAtel part number 01017656) using the LN-200 wiring harness (NovAtel part number 01017655). The steps required for this procedure are:

- Disassemble the SPAN IMU Enclosure
- Install the LN-200 Sensor Unit
- Make Electrical Connections
- Reassemble the SPAN IMU Enclosure

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

Figure 123: Required Parts



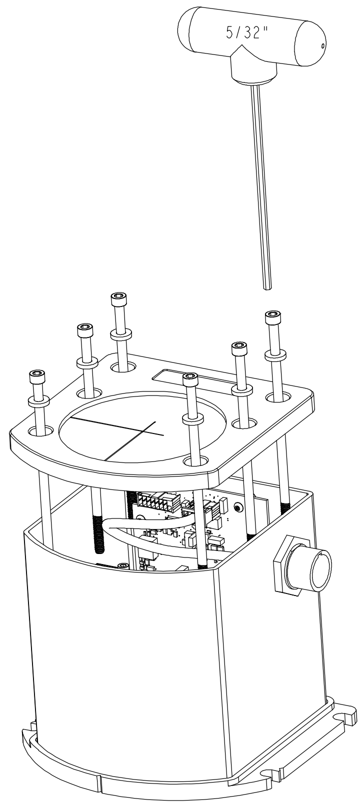
Reference	Description
1	SPAN IMU Enclosure
2	LN-200 Wiring Harness
3	LN-200 Sensor Unit

E.1 Disassemble the SPAN IMU Enclosure

The SPAN IMU disassembly steps are as follows:

1. Remove the six bolts from the top cover using a hex key, as shown in *Figure 124, Bolts and Hex Key* on page 208:

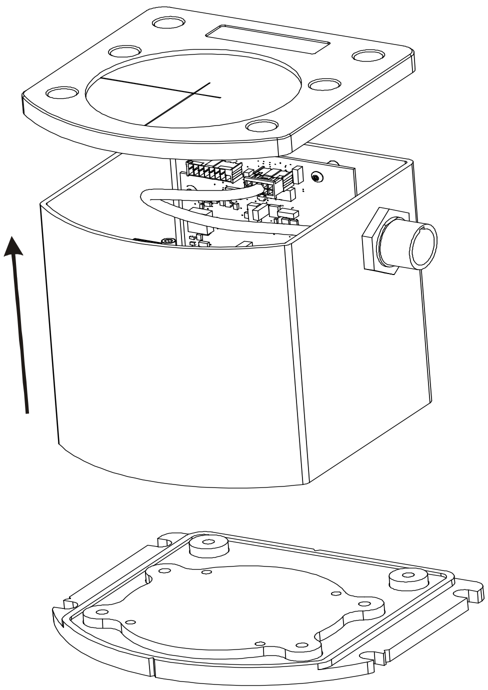
Figure 124: Bolts and Hex Key



2. Set aside the bolts with their sealing washers.
3. Lift the top cover off the tube body and set it aside.

4. Lift the tube body away from its base plate and set it aside, as shown in *Figure 125, Lift Top Cover and Tube Body* on page 209.

Figure 125: Lift Top Cover and Tube Body

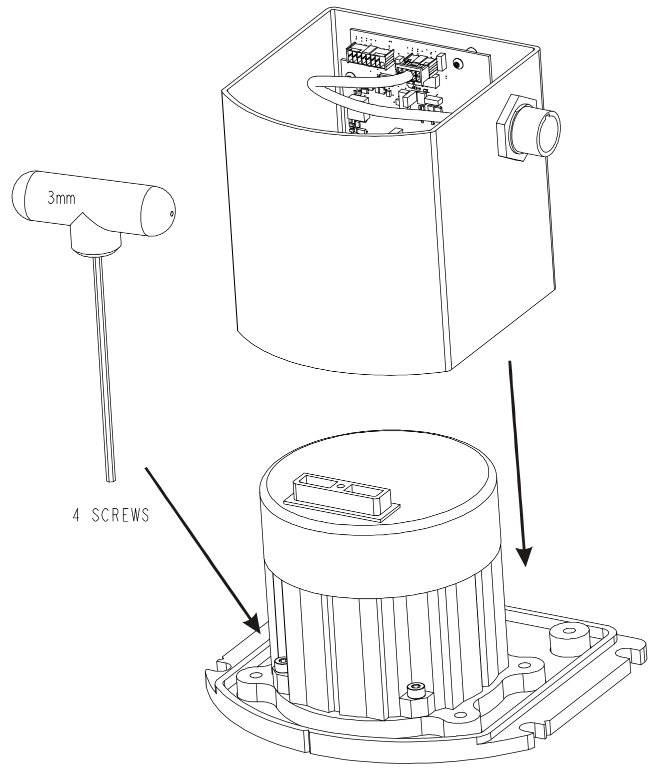


E.2 Install the LN-200 Sensor Unit

To install the LN-200 sensor, follow these steps:

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

Figure 126: SPAN IMU Re-Assembly

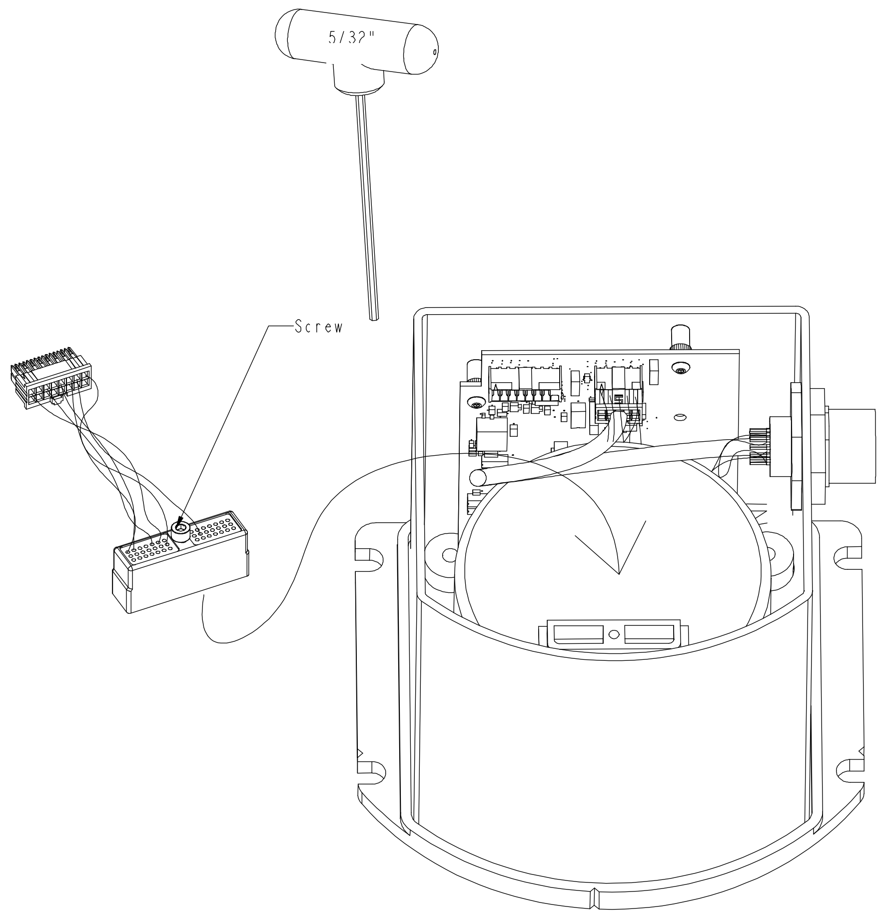


E.3 Make the Electrical Connections

To make the electrical connections you will need a 3/32" a hex key, the wiring harness and the partially assembled SPAN IMU from *Section E.2, Install the LN-200 Sensor Unit* on page 210. Now follow these steps:

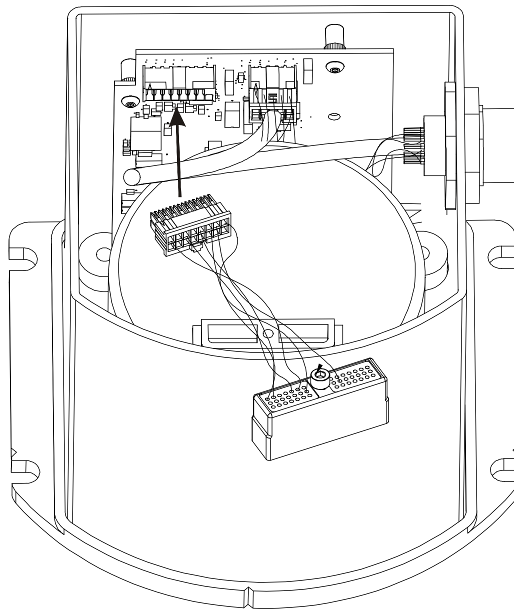
1. Attach the LN-200 wire harness to the mating connector on the LN-200. Check that the connector is fully seated, as shown in *Figure 127, Attach Wiring Harness* on page 211.

Figure 127: Attach Wiring Harness



2. Connect the Samtec connector at the other end of the wiring harness to the corresponding connector on the internal IMU card, as shown in *Figure 128, Attach Samtec Connector* on page 212. Ensure that the connector is locked in place.

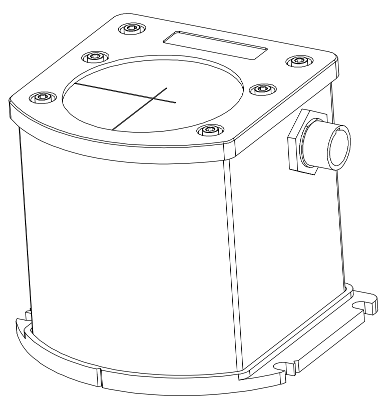
Figure 128: Attach Samtec Connector



E.4 Re-Assemble the SPAN IMU Enclosure

Use a hex key to align the long bolts with the threaded holes in the base, as shown in *Figure 124, Bolts and Hex Key* on page 208. Apply threadlock to threads. Finger tighten the 6 bolts then torque them in a cross pattern to 12 in-lbs. The fully assembled IMU enclosure is shown in *Figure 129, LN-200 SPAN IMU.*

Figure 129: LN-200 SPAN IMU



Appendix F Frequently Asked Questions

1. How do I know if my hardware is connected properly?

   a. When powered, the HG-1700 IMU makes a noticeable humming sound. If no sound is heard, check that the cable between the receiver and IMU is connected properly. The cable should be connected to the COM 2 port on the FlexPak6, COM3/IMU on a ProPak6 or COM6 on an OEM638.

   b. Most IMUs (LN-200, ISA-100C, ADIS-16488, IMU-IGM, IMU-CPT, IMU-KVH1750, iMAR-FSAS, Litef LCI-1, HG1900, HG930 and STIM300) do not make noise. Check that the IMU interface cable is properly connected to the receiver.
   For the IMU-FSAS, IMU-CPT and IMU-KVH1750, check that the IMU interface cable is connected to the FlexPak Y Adapter cable and the FlexPak Y Adapter cable is connected to the COM 2 and I/O ports on the FlexPak6.
   For the IMU-ISA-100C, IMU-FSAS, IMU-CPT and IMU-KVH1750, ensure the IMU interface cable is connected to an RS-422 capable port (COM2 on the FlexPak6 or COM3/IMU on the ProPak6) and the port is configured to use RS-422.
   On the ProPak6 (for all IMUs), check that the IMU interface cable is connected to the COM3/IMU port.

   c. If the cable is connected properly, 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 B, HG1700 IMU in Universal Enclosure* on page 186 or *Appendix C, LN-200 IMU in Universal Enclosure* on page 194 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.

2. What system configuration do I need to do to get the system running?

   a. Set the IMU type using the CONNECTIMU command.

3. What types of IMUs are supported?

   a. SPAN currently supports the following IMUs:
      - HG1700, HG1900 and HG1930 from Honeywell
      - LN-200 from Litton
      - iIMU-FSAS from iMAR
      - ISA-100C and µIMU from Northrop Grumman LITEF
      - IMU-CPT and IMU-KVH1750 from KVH
      - ADIS-16488 from Analog Devices
      - STIM300 from Sensonor

   Use the CONNECTIMU command to specify the type of IMU used.

4. Why don't I have any INS data?

   a. By default, the raw IMU data begins flowing at system start up. If there is no INS data, check that the system has been configured properly. See question *3* above.

   b. If the `INSCOMMAND` command has been set to `START_FINE_TIME`, or for firmware versions prior to OEM6.600, the RAWIMU 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 IMU data is available.

5. How can I access the inertial solution?

   The GNSS+INS 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, 125 or 200 Hz depending on your IMU model). The solution can also be triggered by the mark input signal by requesting the MARKxPVA logs. Further details on these logs are available in the SPAN on OEM6 Firmware Reference Manual (OM-20000144).

6. Can I still access the GNSS-only solution while running SPAN?

   The GNSS only solution used when running the OEM6 receiver without the IMU is still available when running SPAN. Logs such as PSRPOS and RTKPOS are still available. The BESTGNSSPOS log is also available to provide the best available GNSS only solution. Any non-INS logs should be logged at a maximum rate of 5 Hz when running SPAN. Only INS-specific logs documented in the SPAN on OEM6 Firmware Reference Manual (OM-20000144) should be logged at rates higher than 5 Hz when running SPAN.

7. What will happen to the INS solution when I lose GNSS satellite visibility?

   When GNSS tracking is interrupted, the INS solution bridges through the gaps with what is referred to as free-inertial navigation. The IMU measurements are used to propagate the solution. Errors in the IMU measurements accumulate over time to degrade the solution accuracy. For example, after one minute of GNSS outage, the horizontal position accuracy is approximately 2.5 m when using an HG1700 AG58. The SPAN solution continues to be computed for as long as the GNSS outage lasts, but the solution uncertainty increases with time. This uncertainty can be monitored using the INSCOV log.

8. What does it mean if my IMUCARD version string looks like this: < GPSCARD "G2LR0RTT0S1" "BFN11490091" "OEM628-1.00" "OEM060210RN0000" "OEM060100RB000" "2012/Aug/03" "11:31:07" < IMUCARD "Test mode 20Hz" "" "" "r2.1.0.0" "" "Sep 13 2010" "09:34:20" ?

   The SPAN enabled receiver has detected the SDLC card and is communicating with it, however, the SDLC card is not communicating with the IMU. Check the SDLC to IMU connections to ensure that both power and communication lines are connected to the IMU.

9. Why can SPAN not align with my IMU-KVH1750?

   SPAN requires that the IMU-KVH1750 be configured with non-default settings. If you have obtained your IMU-KVH1750 directly from KVH, or have manually changed the IMU configuration, you need to use the `IMUCONFIGURATION` command to restore the configuration that SPAN requires. See the SPAN on OEM6 Firmware Reference Manual (OM-20000144) for details on this command.

Appendix G Replacement Parts

The following are a list of the replacement parts available. Should you require assistance, or need to order additional components, contact your local NovAtel dealer or Customer Support.

G.1 SPAN System

Part Description	NovAtel Part
IMUs (see *Table 1, SPAN-Compatible IMU Models* on page 18 for details)	IMU-CPT IMU-FSAS-EI IMU-H1900-CA50 IMU-H1930-CA50 IMU-H58 IMU-H62 IMU-IGM-A1 IMU-IGM-S1 IMU-ISA-100C IMU-ISA-100C (400 Hz) IMU-KVH1725 IMU-KVH1750 IMU-LCI IMU-LN200 IMU-μIMU OEM-IMU-ADIS-16488 OEM-IMU-HG1900 OEM-IMU-ISA-100C OEM-IMU-ISA-100C (400 Hz) OEM-IMU LN200 OEM-IMU-STIM300 OEM-IMU-μIMU UIMU-H58 UIMU-H62 UIMU-LN200
Receivers	OEM615 OEM617 OEM628 OEM638 FlexPak6 ProPak6
MEMS Interface Card (MIC) for MEMS IMUs	OEM-IMU-ADIS-MIC OEM-IMU-STIM-MIC
Universal IMU Controller (UIC) for OEM-IMU-ISA-100C	OEM-IMU-ISA-UIC

iIMU-FSAS IMU with Odometer interface cable	01018388
FlexPak Y Adapter cable[a]	01018948
IMU-CPT6 IMU interface cable	01018966
Universal IMU Enclosure Interface cable	01018977
ADIS IMU Cable Kit	01019007
IMU-IGM Stack Up Cable	01019013
SPAN-IGM Auxiliary Port Interface Cable	01019015
IMU-IGM Interface Cable	01019016
SPAN-IGM/IMU-IGM Bracket Kit	01019040
ProPak6 Expansion Cable	01019154
OEM-IMU-STIM300 Cable	01019174
IMU-KVH1750 Interface Cable	01019211
IMU Enclosure Interface Cable	01019319
UIC to ISA-100C Interface Cable	01019393
UIC to µIMU Interface Cable	01019760
UIC to HG1900 Interface Cable	01019762
UIC to LN200 Interface Cable	01019763
IMU Enclosure Power Cable	60723136
IMU Enclosure Wheel Data Cable	60723137
SPAN on OEM6 User Manual	OM-20000139
SPAN on OEM Firmware Reference Manual	OM-20000144
SPAN on OEM6 Quick Start Guide	GM-14915112
MEMS Interface Card Quick Start Guide	GM-14915118
Universal IMU Controller Quick Start Guide	GM-14915134
OEM6 Family Installation and Operation User Manual	OM-20000128
OEM6 Family Firmware Reference Manual	OM-20000129
ProPak6 User Manual	OM-20000148

a. The FlexPak Y Adapter cable is required for SPAN systems with a FlexPak6 receiver and either the IMU-CPT, IMU-KVH1750 or IMU-FSAS.

G.2 Accessories and Options

Part Description	NovAtel Part
Optional NovAtel GNSS Antennas:	
High Performance Antenna GPS L1/L2, GLONASS L1/L2, Galileo E1/E5b, BeiDou B1/B2, L-Band	GNSS-502
High Performance Antenna GPS L1/L2, GLONASS L1/L2, Galileo E1, BeiDou B1	GNSS-802
High Performance Antenna GPS L1/L2, GLONASS L1/L2, Galileo E1, BeiDou B1, L-Band	GNSS-802L
High Performance Antenna GPS L1/L2, GLONASS L1/L2, Galileo E1/E5b, BeiDou B1/B2	GNSS-804
High Performance Antenna GPS L1/L2, GLONASS L1/L2, Galileo E1/E5b, BeiDou B1/B2, L-Band	GNSS-804L
High Performance Antenna GPS L1/L2/L5, GLONASS L1/L2/L3, Galileo E1/E5a/E5b/E6, BeiDou B1/B2/B3, L-Band	GNSS-850
Compact L1/L2 Antenna	42G1215A-XT-1-Cert
Compact L1/L2/L-Band Antenna	42G1215A-XT-1-3-Cert
Compact L1/L2/GLONASS/L-Band Antenna	42G0XX16A4-XT-1-1-Cert
Optional RF Antenna Cable:	
5 metres	GPS-C006
15 metres	GPS-C016
30 metres	GPS-C032
22 cm interconnect adapter cable	GPS-C002