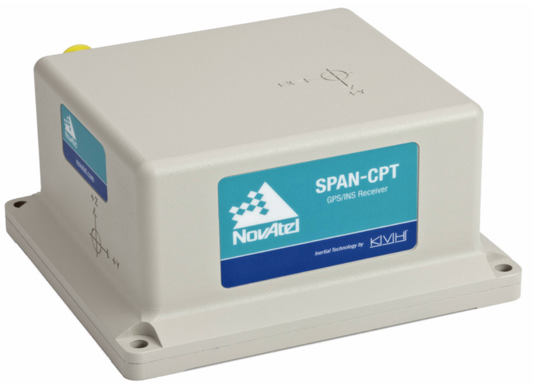

SPAN-CPT™

User Manual

OM-20000122 Rev 6

SPAN-CPT Receiver User Manual

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Revision Level: Rev 6
Revision Date: 2012/02/07

This manual reflects SPAN-CPT Firmware Version CPT3.910.

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Table of Contents

Figures

Tables

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

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

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2. PAYMENT: Terms are prepayment unless otherwise agreed in writing. Interest shall be charged on overdue accounts at the rate of 18% per annum (1.5% per month) from due date. To expedite payment by wire transfer to NovAtel Inc.: Bank - HSBC Bank of Canada

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

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

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

SPAN-CPT Unit	One (1) Year
GPSAntenna™ Series	One (1) Year
Cables and Accessories	Ninety (90) Days
Computer Discs	Ninety (90) Days
Software Warranty	One (1) Year

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

Determination of replacement or repair will be made by NovAtel personnel or by technical personnel expressly authorized by NovAtel for this purpose (*warranty continued on page14*).

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

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

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

Customer Support

NovAtel Knowledge Base

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

Before Contacting Customer Support

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

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

```
RXSTATUSB once
RAWEPHEMB onchanged
RANGECMPB ontime 1
BESTPOSB ontime 1
RXCONFIGA once
VERSIONA once
RAWIMUSB onnew
INSPVASB ontime 1
INSUPDATEB onchanged
```

2. Send the file containing the log to NovAtel Customer Support, using either the NovAtel FTP site at *ftp.novatel.com/incoming* on the NovAtel Web site at www.novatel.com or through the support@novatel.com e-mail address.
3. You can also issue a FRESET command to the receiver to clear any unknown settings.

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

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

Contact Information

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

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

Firmware Updates and Model Upgrades

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

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

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

Notices

The following notices apply to the SPAN-CPT.

FCC Notices

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

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

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

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

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

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

CE Notice

The enclosures carry the CE mark.

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

WEEE Notice

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

Lightning Protection Installation and Grounding Procedure

What is the hazard?

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

Hazard Impact

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

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

Actions to Mitigate Lightning Hazards

1. Do not install antennas or antenna coaxial cables outside the building during a lightning storm.
2. It is not possible to avoid over-voltages caused by lightning, but a lightning protection device may be used to shunt a large portion of the transient energy to the building ground reducing the over-voltage condition as quickly as possible.
3. Primary lightning protection must be provided by the operator/customer according to local building codes as part of the extra-building installation.

---

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

4. To ensure compliance with clause 7 "Connection to Cable Distribution Systems" of EN 60950-1, Safety for Information Technology Equipment, a secondary lightning protection device must be used for in-building equipment installations with external antennas. The following device has been approved by NovAtel Inc.:

   Polyphaser - Surge Arrestor DGXZ+24NFNF-A

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

   - UL listed, or equivalent, in country of installation (for example, TUV, VDE and so on) for lightning surge protection
   - The primary device must be capable of limiting an incoming surge to 10kV

5. The shield of the coaxial cable entering the building should be connected at a grounding plate at the building's entrance. The lightning protection devices should have their chassis grounded to the same ground near to the building's entrance.

6. The primary and secondary lightning protections should be as close to the building's entrance as possible. Where feasible they should be mounted onto the grounding plate itself. See also *Figure 1, Primary and Secondary Lightning Protection* on the following page.

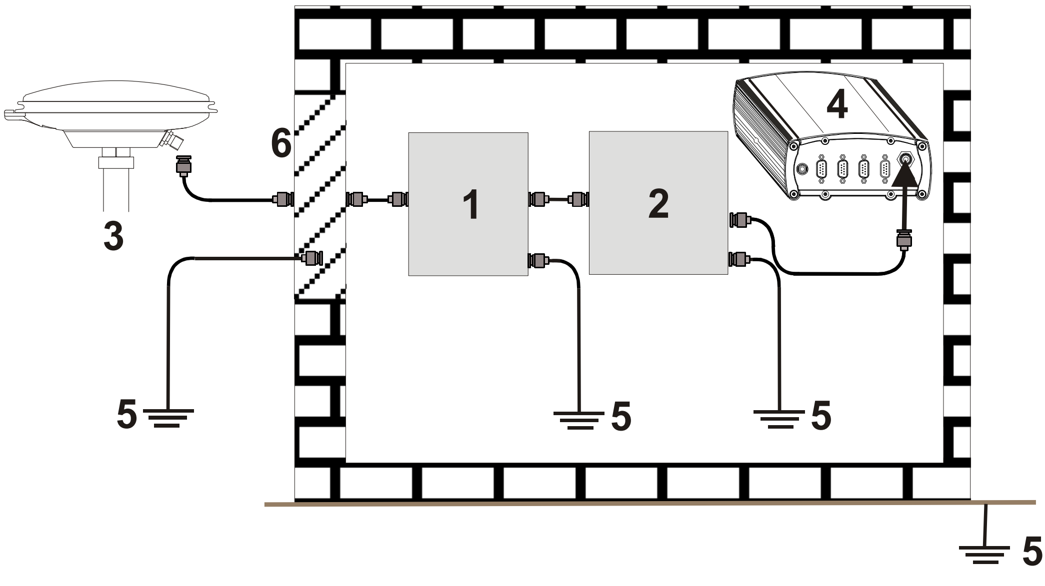


Figure 1: Primary and Secondary Lightning Protection

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

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

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

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

Foreword

Congratulations!

Congratulations on purchasing your SPAN-CPT GPS/INS receiver. SPAN (Synchronized Position Attitude Navigation) Technology features tight integration of a NovAtel GPS receiver and an Inertial Measurement Unit (IMU). SPAN provides continuous navigation information, using an Inertial Navigation System (INS), to bridge short Global Position System (GPS) outages. Designed for dynamic applications, SPAN provides precise position, velocity and attitude information. SPAN-CPT (Compact, Portable, and Tightly Coupled) combines the GPS and IMU hardware inside one enclosure for simple installation and operation. Commercial components have been chosen for integration into SPAN-CPT in order to offer the same benefits of other SPAN products but with fewer export restrictions.

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

NovAtel's OEMV-3™ receiver is the processing engine of SPAN-CPT and the IMU components are manufactured by KVH Industries.

Scope

This manual contains sufficient information on the installation and operation of the SPAN-CPT 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; as outlined in *Customer Support* on *page 15*. After accessories, an antenna and a power supply, the SPAN-CPT system is ready to go.

The OEMV-3 in the receiver utilizes a comprehensive user-interface command structure, which requires communications through its communication (COM) ports. This manual describes the INS-specific commands and logs. Other supplementary manuals are available to aid you in using the other commands and logs available with OEMV® family products. It is recommended that these documents be kept together for easy reference.

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

Download manuals at: http://www.novatel.com/support/firmware-software-and-manuals/product-manuals-and-doc-updates/oemv-family.

Prerequisites

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

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

- Microsoft Windows user interface (Windows 2000 or higher)
- Pentium Microprocessor (or faster) recommended
- VGA Display
- Windows compatible mouse or pointing device

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

Chapter 1 Introduction

Figure 2: SPAN-CPT System

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

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

An INS uses forces and rotations measured by an IMU to calculate position, velocity and attitude. This capability is embedded in the firmware of the SPAN-CPT. 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-CPT system's combined GPS/INS solution integrates the raw inertial measurements with all available GPS information to provide the optimum solution possible in any situation. By using the high accuracy GPS solution, the IMU errors can be modeled and mitigated. Conversely, the continuity and relative accuracy of the INS solution enables faster GPS signal reacquisition and RTK solution convergence.

The advantages of using SPAN-CPT technology are its ability to:

- Provide a full attitude solution (roll, pitch and azimuth)
- Provide continuous solution output (in situations when a GPS-only solution is impossible)
- Provide faster signal reacquisition and RTK solution resolution (over stand-alone GPS because of the tightly integrated GPS and INS filters)
- Output high-rate (up to 100 Hz) position, velocity and attitude solutions for high-dynamic applications, see also *Logging Restriction Important Notice* on *page 95*.
- Use raw phase observation data (to constrain INS solution drift even when too few satellites are available for a full GPS solution)

1.1 System Components

The SPAN-CPT system consists of the following components:

- **SPAN-CPT Integrated INS/GPS unit.** This unit has 3 accelerometers, 3 gyroscopes (gyros) and a NovAtel OEMV3 Receiver. 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.
- **PC software**. Real-time data collection, status monitoring and receiver configuration is possible through NovAtel's Connect software utility, see *SPAN-CPT Configuration with NovAtel Connect* on *page 35.*

Chapter 2 SPAN-CPT Installation

2.1 Hardware Description

The hardware setup consists of a SPAN-CPT enclosure containing the GPS and IMU components (see *Figure 2* on *page 23*) a GPS antenna, power and a radio link (if your application requires real time differential operation).

2.1.1 SPAN-CPT Hardware

The SPAN-CPT receiver contains the OEMV-3 GPS receiver and an IMU containing 3 accelerometers and 3 gyroscopes. Communication is done using either the com ports or USB through the multi-I/O connector.

Figure 3: SPAN-CPT Enclosure

The sections that follows outline how to set up the system's parts and cables. See *Appendix A Technical Specifications s*tarting on *page 53*.

> Use a USB cable to log raw data. Serial communication is sufficient for configuring and monitoring the unit through Hyperterminal or NovAtel Connect. USB is required if you have a post-processing application requiring 100 Hz IMU data. We also recommend you use NovAtel Connect to collect the data. Refer to *3.4 on Page 46* and 3.5 on Page 48 for instructions.

2.1.2 Typical Installation Example

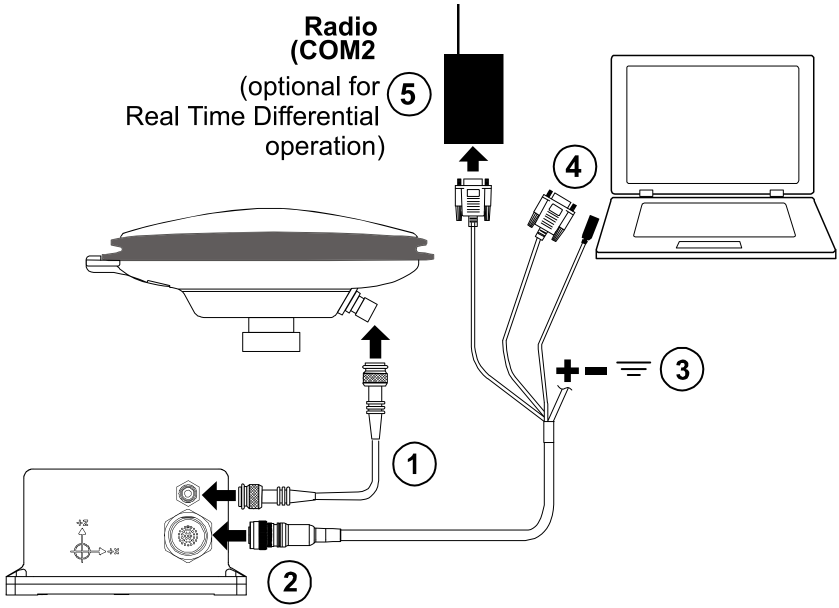


Figure 4: Typical SPAN-CPT Set Up

1. Connect the antenna to the receiver.
2. Connect the interface cable to the SPAN-CPT.
3. Connect power and ground.
4. Connect user supplied PC for set up and monitoring. Recommend using USB cable to accommodate high data rates.
5. Connect user supplied radio device (optional for real time differential operation).

2.1.3 Real Time Differential Operation

An optional static base, as shown in Figure 5, can be added. Connect a radio device using COM2 on both the base and rover radios. .

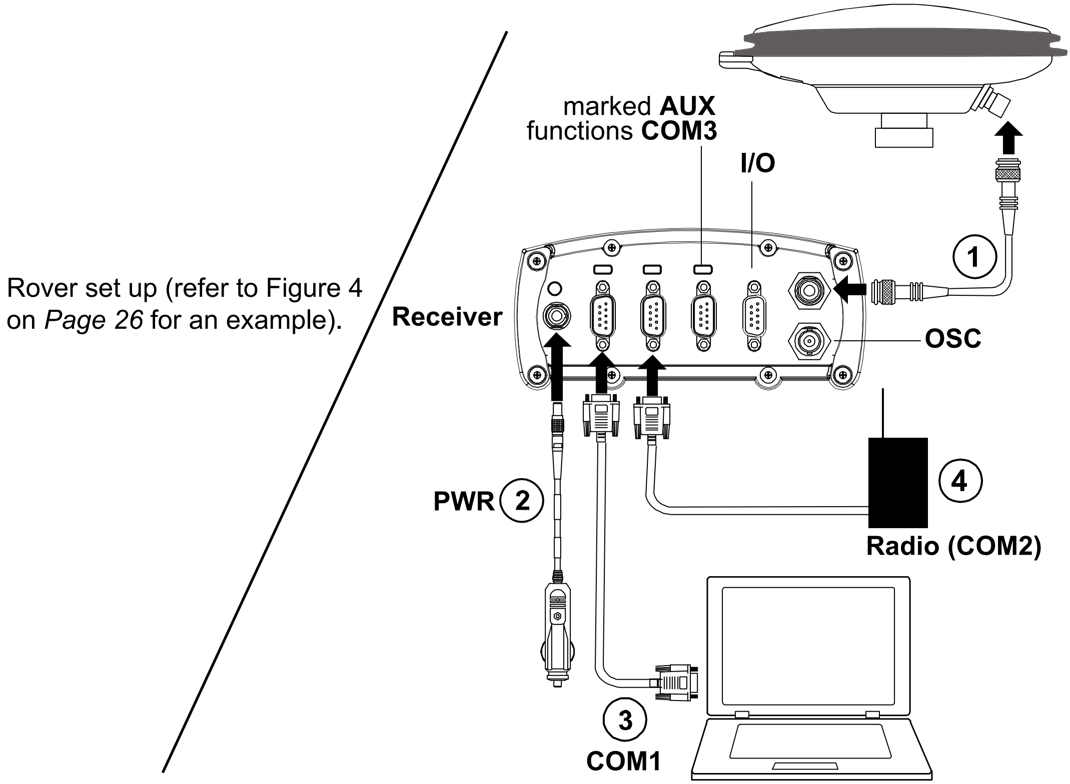


Figure 5: Typical Static Base Set Up

1. Connect antenna to the receiver.
2. Connect user supplied power (+9 to +18 V).
3. Connect user supplied PC for set up and monitoring to COM1.
4. Connect user supplied radio device to COM2.

> Ensure a radio device is connected to COM2 on the rover receiver (refer to 2.1.2, Typical Installation Example on Page 26).

2.2 Hardware Set-Up

Review this section's hardware set-up subsections and follow the numbered steps to install your SPAN system.

2.2.1 Mount Antenna

For maximum positioning precision and accuracy, as well as to minimize the risk of damage, ensure that the antenna is securely mounted on a stable structure that will not sway or topple. Where possible, select a location with a clear view of the sky to the horizon so that each satellite above the horizon can be tracked without obstruction. The location should also be one that minimizes the effect of multipath interference.

2.2.2 Mount SPAN-CPT

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

> For greatest ease of use, the SPAN-CPT should be mounted such that the positive Z-axis marked on the SPAN-CPT enclosure points up and the Y-axis points forward through the front of the vehicle, in the direction of track.

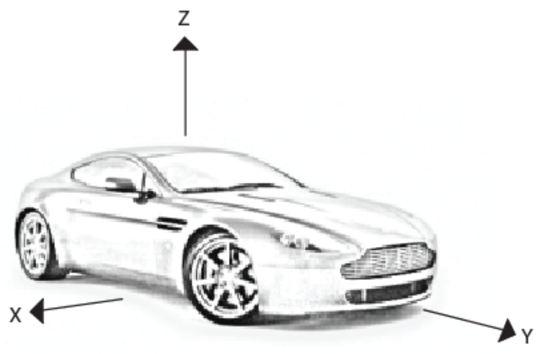


Figure 6: SPAN-CPT Enclosure Mounting

1. **Mount the SPAN-CPT enclosure and antenna securely to a vehicle**. Ensure they cannot move due to dynamics and that the distance and relative direction between them is fixed.
2. **Measure the lever arm offsets from the SPAN-CPT navigation centre to the antenna phase centre in the SPAN-CPT enclosure frame**.

Also, it is important to measure the distance from the SPAN-CPT to the antenna (the Antenna Lever Arm) after each installation, according to the axis defined on the SPAN-CPT enclosure. See *Appendix A, Technical Specifications* .

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

2.2.3 Connect COM Cables

SPAN-CPT has one multi-purpose I/O connector that contains pins for the RS232 com ports, USB ports, PPS signals and event input triggers. Refer to Appendix A for port pin definitions.

3. **Connect the USB port of the SPAN-CPT to a computer USB port.** Alternatively, connect the COM 1 port of the SPAN-CPT to the computer COM port via a null modem cable.
4. **Connect the antenna to the antenna port on the enclosure using an appropriate coaxial cable**.

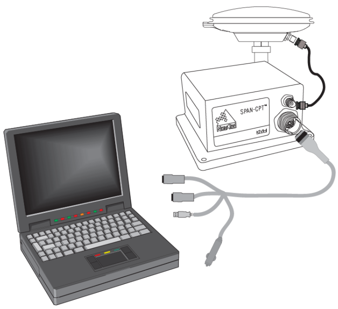


Figure 7: Connect the antenna to the antenna port

2.2.4 Connect Power

The SPAN-CPT system receiver requires an input supply voltage between +9 VDC and +18 VDC. The receiver has an internal power module that does the following:

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

Power input pins are located on the multi-purpose I/O connector. Be sure to connect the power with the correct polarity and ensure the power source is within specifications. See *Appendix A Technical Specifications* for power input requirements.

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-CPT system. A paired wire run represents a feed and return line. Therefore, a 2-m wire pair represents a total wire path of 4 m. For a SPAN-CPT 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.

> The power supply used to power the SPAN-CPT must be monotonic during power on to ensure internal logic blocks are initialized appropriately and proceed to valid operating states. If the power supply is not monotonic during power on, the accelerometer status in the IMU status may show a failure and the accelerometer measurements in the RAWIMUS log (see the RAWIMUS log description starting on *page 131*) will be zero. Power cycling with a monotonic power up clears this error state.

5. **Apply power to the SPAN-CPT**. See Figure 8.

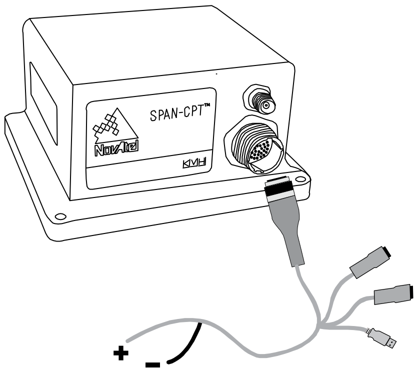


Figure 8: Apply Power to the SPAN-CPT

> It is recommended that you place a back-up battery between the SPAN-CPT and its voltage supply as a power buffer if installed in a vehicle. When a vehicle engine is started, power can dip to 9.6 VDC or cut-out ancillary equipment (see Figure 9).

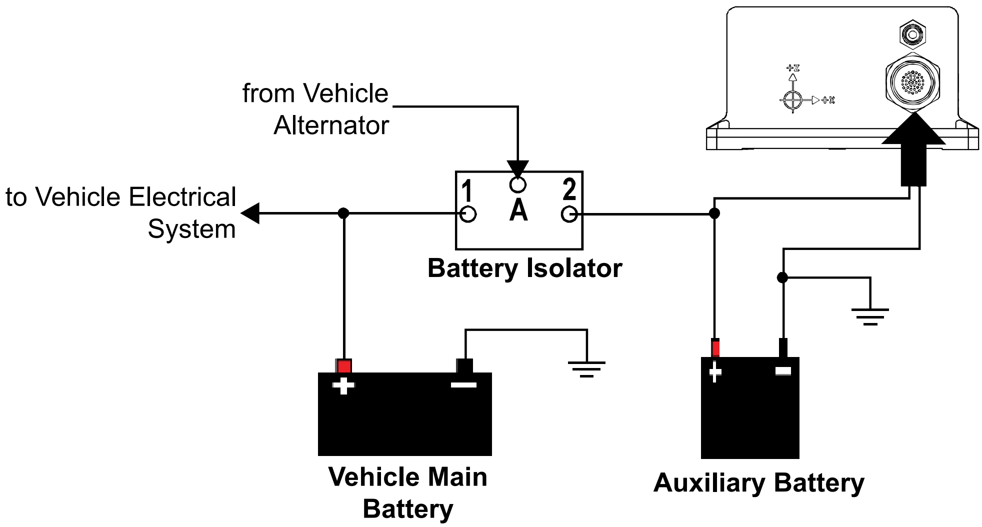


Figure 9: Battery Isolator Installation

Chapter 3 SPAN-CPT Operation

Before operating your SPAN-CPT system, ensure that you have followed the installation and setup instructions in *Chapter 2, SPAN-CPT Installation* starting on *page 25*.

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

SPAN-CPT system output is compatible with post-processing software from NovAtel's Waypoint Products Group. For information about Waypoint, visit our Web site at www.novatel.com through *Products | Waypoint Software*.

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

3.1 Definition of Reference Frames Within SPAN

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

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

3.1.1 The Local-Level Frame (ENU)

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

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

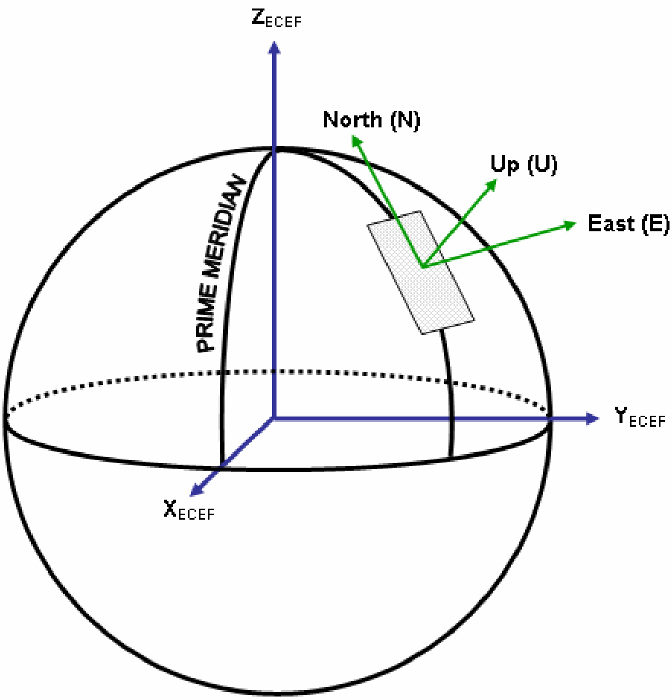


Figure 10: Local-Level Frame (ENU)

3.1.2 The SPAN Body Frame

The definition of the SPAN body frame is as follows:

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

To determine your SPAN x-axis and y-axis, see *Table 11* on *page 79*. This frame is also known as the computation frame and is the frame where all the mechanization equations are computed.

3.1.3 The Enclosure Frame

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

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

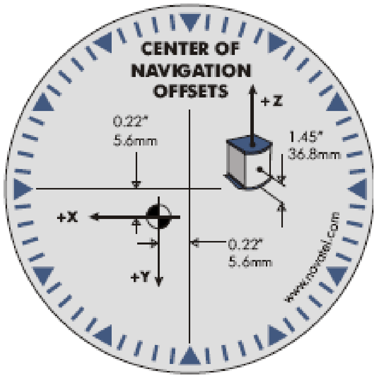


Figure 11: The Enclosure Frame

3.1.4 The Vehicle Frame

The definition of the vehicle frame is as follows:

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

See the VEHICLEBODYROTATION command on *page 136* for information on entering the rotation into the system and see the RVBCALIBRATE command on *page 74* for information on calculating this rotation.

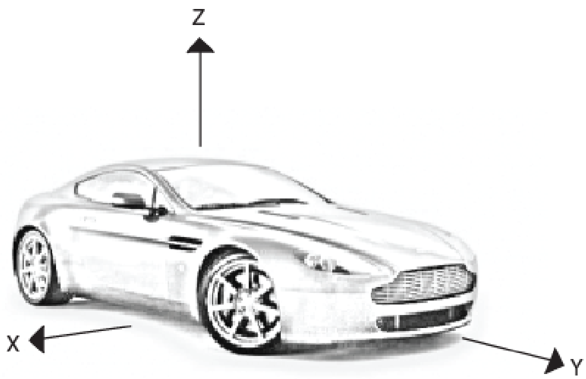


Figure 12: Vehicle Frame

3.2 Communicating with the SPAN-CPT System

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

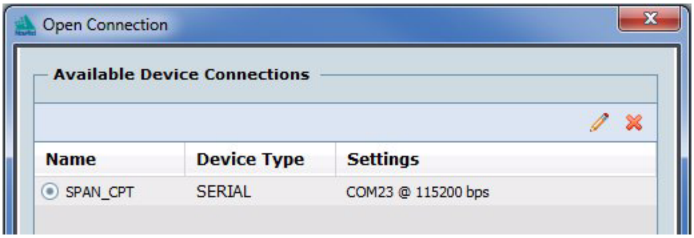
Start NovAtel Connect on your PC to enable communication:

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

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

4. Select *Serial* from the *Type* list and select the PC/laptop port, that the SPAN-CPT is connected to, from the *Port* list.
5. Select *115200* from the *Baud Rate* list.
6. Uncheck the *Hardware handshaking* checkbox.

7. Select *OK* to save the new device settings.
8. Select the new configuration from the *Available Device Connections* area of the *Open Connection* dialog.
9. Select the *Open* button to open SPAN-CPT communications.



10. As NovAtel Connect establishes the communication session with the receiver, a progress box is displayed.
11. Select *Tools* | *Logging Control* from the NovAtel Connect main menu to control the receiver's logging to files and serial ports. Refer to NovAtel Connect's on-line Help for more information.
12. Use the *Console* window to enter commands.

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

3.2.1 SPAN-CPT 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 Connect version.

3.2.1.1 SPAN-CPT basic configuration:

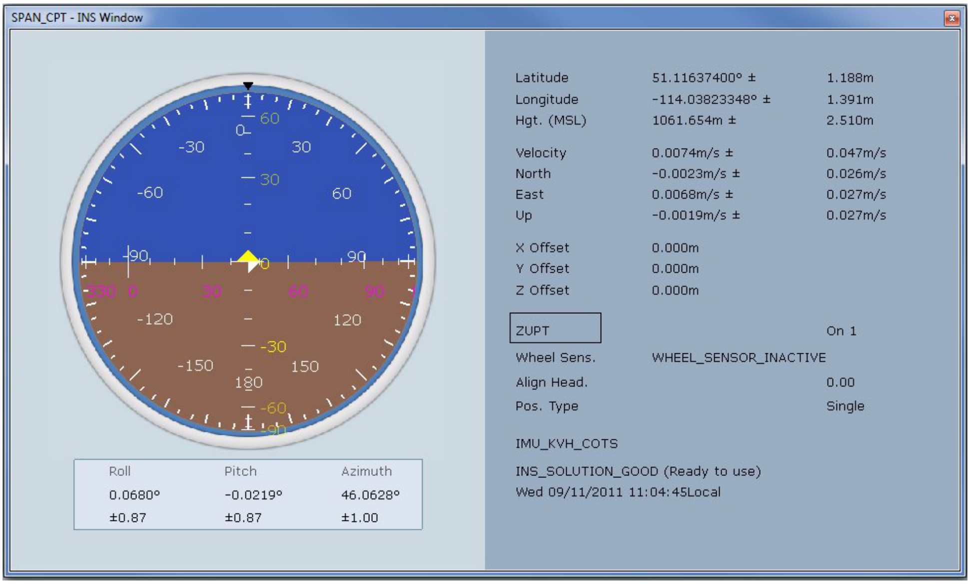
Select *Wizards*| *SPAN Alignment* from the NovAtel Connect toolbar. This wizard takes you through the steps to complete a coarse or fast alignment, select the type of IMU and configure the receiver port, connected to the IMU, to accept IMU data.

3.2.2 INS Window in NovAtel Connect

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

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

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



3.2.3 SPAN-CPT Configuration using Command Line

3.2.3.1 GPS Configuration

The GPS configuration can be set up for different accuracy levels such as single point, SBAS, DGPS and RTK (RTCA, RTCM, RTCM V3, CMR, and CMR Plus). The SPAN-CPT can also be set up for OmniStar HP, OmniStar XP, OmniStar VBS or CDGPS. Refer to the *OEMV User Manuals* for details on DGPS, RTK, L-band or SBAS setup and operation.

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

3.2.3.2 INS Configuration

Once communication has been established to the receiver, issue the SETIMUTOANTOFFSET command to enter the distance from the SPAN-CPT to the GPS antenna, see *page 80*. The offset between the antenna phase centre and the IMU navigation centre must remain constant and be known accurately. The X, Y and Z positive directions are clearly marked on the SPAN-CPT enclosure. The SETIMUTOANTOFFSET parameters are [in metres]:

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

The standard deviation fields are optional and the distances are measured from the IMU navigation centre to the Antenna Phase Centre.

A typical RTK GPS solution is accurate to a few centimeters. For the SPAN-CPT system to have this level of accuracy, the offset must be measured to within a centimeter. Any offset error between the two systems will directly affect in the output position. For example, a 10 cm error recording this offset will result in at least a 10 cm error in the output.

NovAtel Connect can also be used to configure the SPAN-CPT. See *Section 3.2.1, SPAN-CPT Configuration with NovAtel Connect* on *page 35*.

3.3 Real-Time Operation

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

Real-time operation notes:

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

Status of the inertial solution can be monitored using the inertial status field in the INS logs, *Table 1* below.

Table 1: 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. When in this status, the user can move to initiate the kinematic alignment or send a SETINITAZIMUTH command. This status also shows if the IMU status is not valid. The IMU status is given in the RAWIMU and RAWIMUS logs. See *Section B.2.18* on *page 84.*
2	INS_SOLUTION_NOT_GOOD	The INS solution is still being computed but the azimuth solution uncertainty has exceed 2 degrees. The solution is still valid but you should monitor the solution uncertainty in the INSCOV log. You may encounter this state during times when the GPS, used to aid the INS, is absent.
3	INS_SOLUTION_GOOD	The INS filter is in navigation mode and the INS solution is good.
6	INS_BAD_GPS_AGREEMENT	The INS filter is in navigation mode, and the GPS solution is suspected to be in error. This may be due to multipath or limited satellite visibility. The inertial filter has rejected the GPS position and is waiting for the solution quality to improve.
7	INS_ALIGNMENT_COMPLETE	The INS filter is in navigation mode, but not enough vehicle dynamics have been experienced for the system to be within specifications.

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. The time status in the log headers will indicate FINESTEERING when this happens
4. Raw IMU measurements begin to be timed by the receiver and are available to the INS filter. They are also available to you in the RAWIMUS log, *see "RAWIMUS Short Raw IMU Data" on page 131.*. The INS Status field reports INS_INACTIVE.
5. The inertial alignment routine starts and the INS Status field reports INS_ALIGNING. At this point there are three options for completing the alignment. See the following sections for the options.
6. Alignment is complete and the INS Status field changes to INS_ALIGNMENT_COMPLETE. The system transitions to navigation mode. The GPS/INS solution is available at this point.
7. The solution is refined using updates from GPS. Once the system is operating within specifications, after some vehicle movement, the INS Status field changes to INS_SOLUTION_GOOD. This indicates that the estimated azimuth standard deviation is below 2°. If it increases above 2°, the status changes to INS_SOLUTON_NOT_GOOD.

3.3.1.1 Default Kinematic Alignment

The Fast or Kinematic alignment is the default alignment routine for SPAN-CPT.

If the system is mounted as recommended with the Z axis pointing up and the Y axis aligned with the forward direction of the vehicle, then no additional configuration is required to complete a moving alignment.

Once the INS status reaches "INS_ALIGNING," the moving alignment will happen once the vehicle velocity reaches 1.15m/s (~4km/h) and the INS status will change to "INS_ALIGNMENT_COMPLETE". The moving alignment transfers the GPS course over ground pitch and azimuth to the attitude of the IMU. This alignment routine is best suited for ground vehicles where the direction of travel is coincident with the forward axis of the vehicle, and the roll of the vehicle is close to zero. The fast alignment routine may not be suitable for some marine or airborne where the direction of travel may be different from the forward axis of the vehicle because of factors like a crab angle.

If SPAN-CPT is installed with the IMU axes NOT aligned with the vehicle, then additional configuration is needed to complete the moving alignment. These settings can be set graphically using the INS configuration wizard in the NovAtel Connect interface program or through the command interface by issuing the following commands:

1. Specify which IMU axis is most closely aligned with gravity using the SETIMUORIENTATION command. See *page 77* for a description of this command, and table with the number

corresponding to each orientation. For example, if the Z-axis of your SPAN-CPT is pointing up, you would send this command:

SETIMUORIENTATION 5

2. Specify the angular offset from the vehicle frame to the SPAN frame (known as the vehicle/body rotation or RVB) using the VEHICLEBODYROTATION command, see *page 90*. Following the example started above, if the IMU is installed rotated so that the Y axis points out the right hand side of the vehicle instead of forward, then you would then enter this command:

    VEHICLEBODYROTATION 0 0 -90

> Angular rotations are difficult to visualize, so if you have complex rotations or some other axis that +Z pointing up, use the NovAtel Connect SPAN wizard for assistance with these settings.

The accuracy of the initial attitude will depend on the dynamics of the vehicle and the accuracy of the angles input in the VEHICLEBODYROTATION command. The alignment is only an estimate of the attitude of the vehicle and as the vehicle experiences dynamics, the accuracy of the attitude solution will improve. Once the attitude accuracy has converged the INS status will change to "INS_SOLUTION_GOOD".

3.3.1.2 Manual Alignment

If you know the attitude of your vehicle (roll, pitch, azimuth) you can manually enter the attitude information using the SETINITATTITUDE command. Details of this command start on *see "SETINITATTITUDE Set Initial Attitude of SPAN in Degrees" on page 82.*

3.3.1.3 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-CPT Dual Antenna* starting on *page 49* for details.

3.3.2 Navigation Mode

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

SPAN-CPT computes the solution by accumulating velocity and rotation increments from the IMU to generate position, velocity and attitude. SPAN-CPT models system errors by using a Kalman filter. The GPS solution, phase observations and automatic zero velocity updates (ZUPTs) provide updates to the Kalman filter. When a wheel sensor is connected to the system, wheel displacement updates are also used in the filter.

Following the alignment the attitude is coarsely defined, especially in heading. Vehicle dynamics, specifically turns, stops and starts, allow the system to observe the heading error and allows the heading accuracy to converge. Three to five changes in heading should be sufficient to resolve the heading accuracy. The INS Status field changes to INS_SOLUTION_GOOD once convergence is complete. If the attitude accuracy decreases, the INS Status field changes to INS_SOLUTION_NOT_GOOD. When the accuracy converges again, the INS status continues as INS_SOLUTION_GOOD.

3.3.3 Vehicle to SPAN-CPT Frame Angular Offsets Calibration Routine

Kinematic fast alignment requires that the angular offset between the vehicle and the SPAN-CPT frame is known approximately. If the angles are simple (that is, a simple rotation about one axis) the values can easily be entered manually through the VEHICLEBODYROTATION command, see *page 90*. If the angular offset is more complex (rotation is about 2 or 3 axis), then the calibration routine may provide a more accurate estimation of the values. The steps for the calibration routine are:

1. Apply power to the SPAN-CPT, see the *SPAN-CPT Technical Specifications* starting on *page 53*.
2. Configure the SPAN-CPT, see *SPAN-CPT Configuration with NovAtel Connect* on *page 35*.
3. Ensure that an accurate lever arm has been entered into the system.
4. Allow the system to complete a coarse alignment using the SETINITAZIMUTH command. See Coarse Alignment on *page 41* for procedures.
5. Enable the vehicle to body calibration using the RVBCALIBRATE ENABLE command, see *page 74*.
6. Start to move the system under good GPS conditions. Movement of the system under good GPS conditions is required for the observation of the angular offsets.

Vehicle speed must be greater than 5 m/s (18 km/hour) for the calibration to complete. Drive straight on a level surface if possible.

7. When the solved angles are verified (after approximately 30 seconds), the calibration stops and the VEHICLEBODYROTATION log will provide the solved values, *see Page 90.* Log VEHICLEBODYROTATION using the ONNEW trigger to monitor the progress of the calibration.

The rotation parameters are saved in NVM for use on start-up in case a fast-alignment is required. Each time the SPAN-CPT is re-mounted this calibration should be performed again. See *Section 3.3.1.1,* on *page 40 3.3.1.2*and *Section 3.3.1.2,* on *page 41* for details on fast and coarse 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 SPAN-CPT and vehicle frames. The offsets are used when aligning the system while in motion (see *Section 3.3.1, System Start-Up and Alignment Techniques* starting on *page 40*). The angular offset values are not applied to the attitude output, unless the APPLYVEHICLEBODYROTATION command is enabled, see *page 63*.

3.3.4 SPAN-CPT Wheel Sensor

The SPAN-CPT system supports wheel sensor inputs, integrated via the SPAN-CPT. The SPAN-CPT accepts TTL- level input pulses from a wheel sensor through the multi-pin connector. See *Appendix A* on *page 53* for specifications on the wheel sensor interface.

3.3.4.1 Wheel Sensor Update Logic

The wheel sensor information is sent to the SPAN-CPT along with the raw IMU data. The Corrsys Datron wheel pulse transducer is used as an example, see *Section A.1.1,* on *page 55*.

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

The modeled wheel circumference is available in the WHEELSIZE log, see *page 137*. Information on how the wheel sensor updates are being used is available in the INSUPDATE log, see *page 125*.

3.3.4.2 Odometer Requirements

SPAN-CPT is compatible with any wheel sensor meeting the following requirements:

- Input range less than or equal to 45 KHz
- Input duty cycle is symmetric 40%-60%
- Active input voltage is greater than or equal to 2.5 VDC with a max input voltage of 50 VDC
- Inactive voltage is less than or equal to 1 VDC
- Input current is approximately 3.5 mA at 5 VDC with a maximum of 5 mA at 50 VDC
- Ensure input current does not exceed 5 mA. There is a current limiting diode that can dissipate 800 mW on the input opto-isolator
- Quadrature, pulse and direction type odometers are compatible

An example of a SPAN-CPT compatible odometer is the WPT (Wheel Pulse Transducer) from Corrsys Datron. (www.corrsys-datron.com)

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.

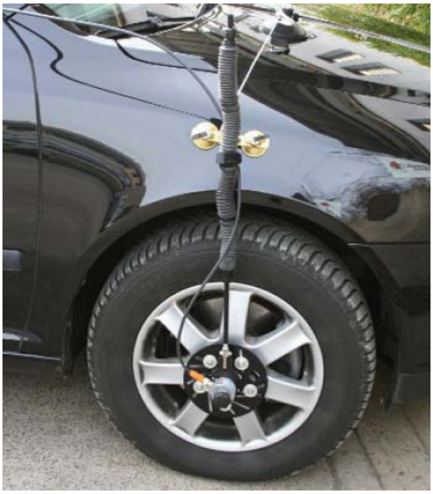


Figure 13: Corrsys Datron WPT

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

SPAN-CPT will power the odometer. See *Appendix A* on *page 53* for the pin outs of the SPAN-CPT cable. Connect the appropriate pins to your chosen odometer. If you chose the Corrsys-Datron WPT, first modify the cable at the WPT end. The cable modification is shown in *Table 2* and *Table 3* on *page 45*.

Table 2: Cable Modification for Corrsys-Datron WPT

8-pin M12 connector on the Corrsys-Datron cable [a, b]			Female DB9 connector
Pin 1	GND	White	5
Pin 2	$+U_B$ (Input Power)	Brown	9
Pin 3	Signal A	Green	6
Pin 4	Signal A inverted	Yellow	7
Pin 5	Signal B	Grey	3
Pin 6	Signal B inverted	Pink	1
Pin 7	Reserved		No change
Pin 8			

a. Pin 2 is wired to a red banana plug (Power in) and Pin 1 is wired to a black banana plug (Power return) so the WPT needs power to operate (+10 to +30 V). Solder the shield on the WPT cable to the female DB9 housing.
b. This modification is for the Corrsys Datron WPT 8-pin M12-plug cable number 14865.

Table 3: Cable Modification for CPT Odometer Input

Male DB9 Connector	Pin Wires on SPAN-CPT-KVH Terminated or Unterminated Cable		
Pin 1	18	ODO SIGNAL B INV	White
Pin 2	NONE		
Pin 3	17	ODO SIGNAL B	Black
Pin 4	NONE		
Pin 5	14	GND	Black
Pin 6	15	ODO SIGNAL A	Black
Pin 7	16	ODO SIGNAL A INV	White
Pin 8	NONE		
Pin 9	13	INPUT POWER	White

3.4 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 4* on *page 46*:

Table 4: Solution Parameters

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

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

The inertial solution is available up to the rate of 100 Hz. Data can be requested at a specific rate up to the maximum IMU output rate, or can be triggered by the mark input trigger at rates up to 20 Hz.

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

The highest rate that you should request GPS logs (RANGE, BESTPOS, RTKPOS, PSRPOS, and so on) while in INS operation is 5 Hz. If the receiver is not running INS, GPS 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.

Specific logs need to be collected for post-processing. See *Section 3* on *page 45*.

To store data from a SPAN-CPT, connect a laptop computer. The laptop computer should be equipped with a data storage device such as a Compact Flash Card, CD or USB stick.

Logging Restriction Important Notice

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

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

   LOG RAWIMUSB ONNEW (100 Hz)
   LOG INSPVASB ONTIME 0.02 (acceptable 50 Hz logging)

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

   LOG INSPOSSB ONTIME 0.01 (100 Hz request)

   Below is another example set of acceptable logging requests:

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

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

   LOG RAWIMUSB ONNEW (100 Hz request)
   LOG INSATTSB ONTIME 0.01 (100 Hz request)

2. RAWIMU and RAWIMUS logs are only available with the ONNEW or ONCHANGED trigger. These logs are not valid with the ONTIME trigger. The raw IMU observations contained in these logs are sequential changes in velocity and rotation. As such, you can only use them for navigation if they are logged at their full rate. See details of these log starting on *see "RAWIMUS Short Raw IMU Data" on page 131*.

3. In order to collect wheel sensor information, useful in post-processing, the TIMEDWHEELDATA log should only be used with the ONNEW trigger.

3.5 Data Collection for Post Processing

Some operations such as aerial measurement systems do not require real-time information from SPAN-CPT. 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
- BESTPOSB ONTIME1 (optional)

From a rover:

- RANGECMPB ONTIME 1
- RAWEPHEMB ONCHANGED
- RAWIMUSB ONNEW
- BESTLEVERARMB ONNEW (optional)
- BESTPOSB ONTIME 1 (optional)

Post processing is performed through the Waypoint Inertial Explorer software package available from from NovAtel's Waypoint Products Group. For information, visit our Web site at www.novatel.com through *Products* | *Waypoint Software*.

> The highest rate that you should request GPS logs (RANGE, BESTPOS, RTKPOS, PSRPOS, and so on) while in INS operation is 5 Hz. If the receiver is not running INS, GPS logs can be requested at rates up to 20 Hz.

Chapter 4 SPAN-CPT Dual Antenna

4.1 Overview

NovAtel's ALIGN heading technology generates distance and bearing information between a “master” and one or more “rover” receivers. This feature is ideal for customers wanting relative directional heading, separation heading between two objects, or heading information with moving base and pointing applications. Heading applications can be applied over various markets, including machine control, unmanned vehicles, marine and agricultural markets.

SPAN-CPT Dual Antenna provides the hardware necessary to run an ALIGN baseline with an IMU and a second receiver. From any of the SPAN-CPT COM ports, the ALIGN baseline solution can be logged along with the standard OEMV logs.

> SPAN-CPT dual antenna operation will require the dedicated use of the COM2 port for communication between receivers.

With the SPAN-CPT, the ALIGN GPS 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 SPAN-CPT if the heading drifts due to slow or constant dynamics.

ALIGN is capable of a 1 Hz heading output rate when integrated with SPAN-CPT.

4.2 Installation

The hardware for SPAN-CPT 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 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 COM2 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.

The SPAN-CPT and the FlexPak need to be set up as shown in the example in *Figure 14*:

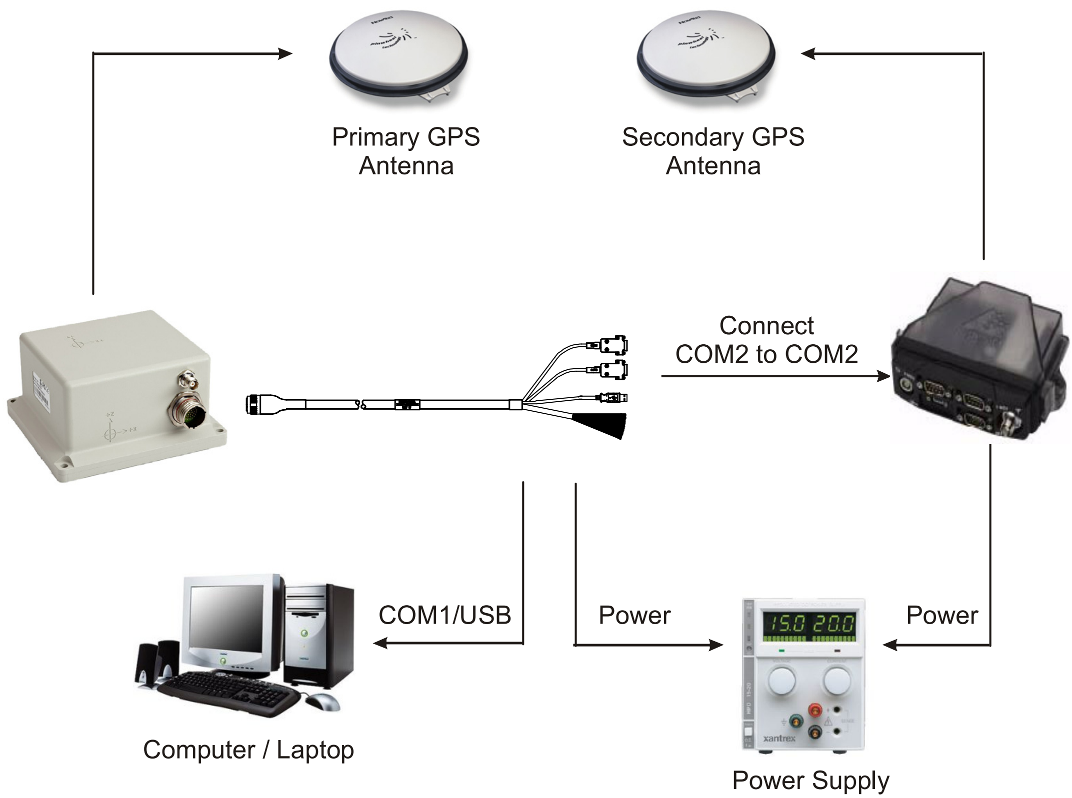


Figure 14: SPAN-CPT - Dual Antenna Installation

4.3 Configuring ALIGN with SPAN-CPT

Before configuring the ALIGN solution, the SPAN-CPT and OEMV-2 receiver (FlexPak-G2™, for example) MUST both be powered on and connected directly between COM2 of the SPAN-CPT and COM2 of the OEMV2 through either a null modem cable or an appropriate radio connection.

Check the model of your external OEMV-2. It must be an ALIGN-capable Z model such as Z12Z running the latest released OEMV firmware version, for example, 3.900.

The ALIGN solution will automatically be configured between the SPAN-CPT and the OEMV-2 when either:

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

We recommend entering the lever arms rather than entering the angular offset as this is easier to measure and will lead to better overall accuracy. Refer to *Appendix B* on *page 62* for syntax of the above commands.

The OEMV-2 needs to be started in default COM mode (NOVATEL mode) for the startup commands to be sent. Issues might arise if the COM2 on the OEMV-2 is not set to the default. The easiest way to ensure the OEMV-2 is in the default mode, is to issue a FRESET command through another port (COM or USB) of the OEMV-2.

As with all ALIGN-capable products, the baseline solution is available from the GPHDT and HEADING logs; however, for the SPAN-CPT, the maximum available rate is limited to 1 Hz.

4.4 Configuring SPAN with ALIGN on SPAN-CPT

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-CPT) 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 OEMV2) using the SETIMUTOANTOFFSET2 command.

   Abbreviated ASCII example:

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

The SPAN-CPT 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 the default kinematic alignment cannot be guaranteed, so a different alignment routine will be required.

The different alignment routines are described in the following sections:

4.4.1 Alignment on a Moving Vessel - Aided Transfer Alignment

This alignment routine is the preferred dual antenna alignment method. It will be used if the alignment mode has been set to AIDED_TRANSFER using the ALIGNMENTMODE command, and can be used if the alignment mode is set to AUTOMATIC (the default for dual antenna).

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 will happen instantaneously once the receiver establishes communication with the IMU and computes a verified, fixed integer, ALIGN solution. The INS status will change 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
```

4.4.2 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 will run given the initial azimuth value. As with the transfer alignment, the first verified fixed RTK solution will be used to provide the alignment seed after which the 60 second coarse alignment (INS_ALIGNING) will begin. After the 60 seconds, the INS status will change to INS_ALIGNMENT_COMPLETE. Once the attitude accuracy has converged, the INS status will change 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
```

4.4.3 Unaided Alignment

The unaided alignment is the default setting for any SPAN-CPT receiver that has not been configured for dual antenna operation. This returns the SPAN system to its single antenna alignment options. In the case of a SPAN-CPT, the default alignment mode is a kinematic alignment.

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

```
ALIGNMENTMODE UNAIDED
```

4.4.4 Automatic Alignment Mode - Automatic Alignment (default)

Automatic Alignment Mode Selection is the default setting for a SPAN-CPT configured for dual antenna operation. 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 51*); a kinematic alignment (Default Kinematic Alignment on *page 40*); or a manual alignment (Manual Alignment on *page 41*).

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, the alignment mode must be selected manually. No additional configuration is required to use this alignment routine.

4.5 SPAN ALIGN Attitude Updates

The INS heading updates are used to help constrain the azimuth drift of the INS solution whenever possible. This will be 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 *INSUPDATE* on *page 125*.

Appendix A Technical Specifications

This appendix details the technical specifications of the SPAN-CPT.

A.1 SPAN-CPT Technical Specifications

Table 5: Technical HW Specs for SPAN-CPT

PHYSICAL	
SPAN-CPT Enclosure Size	152.0 mm L X 168.0 mm W X 89.0 mm H
SPAN-CPT Weight	2.36 kg
MECHANICAL DRAWINGS	

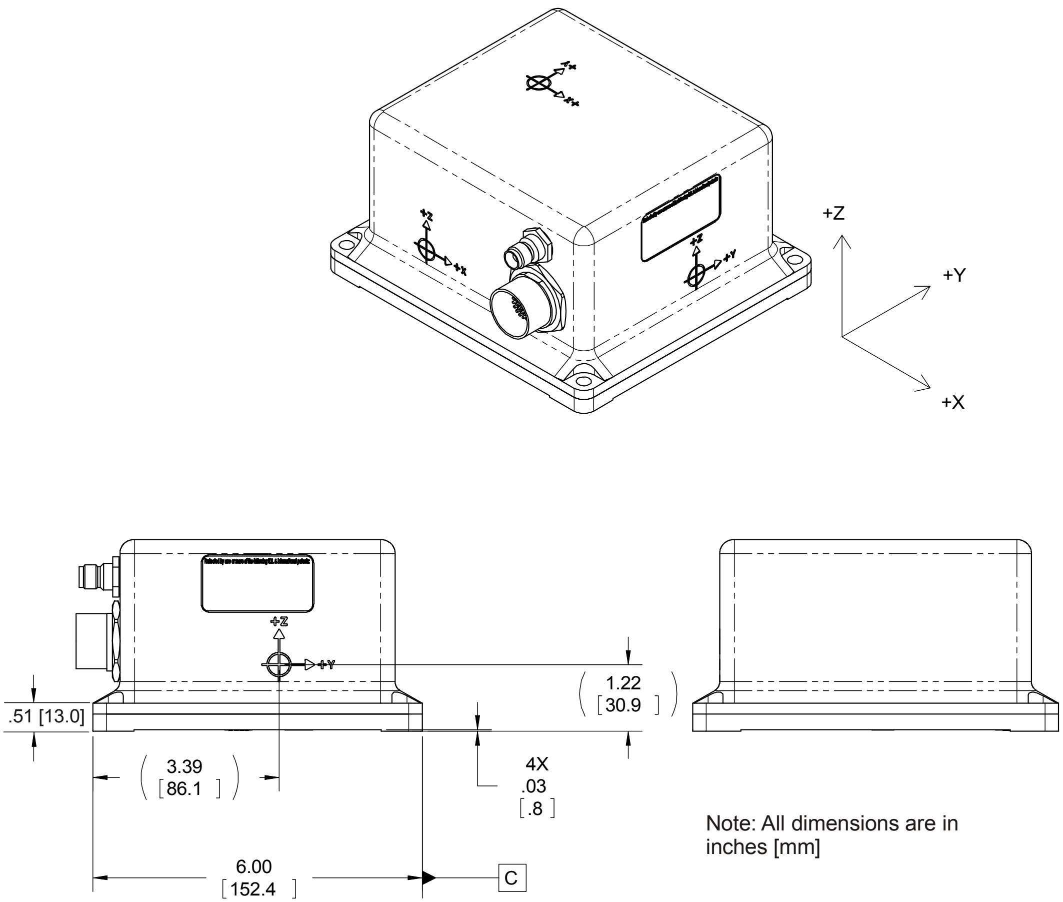


Figure 15: SPAN-CPT - Side and Perspective View

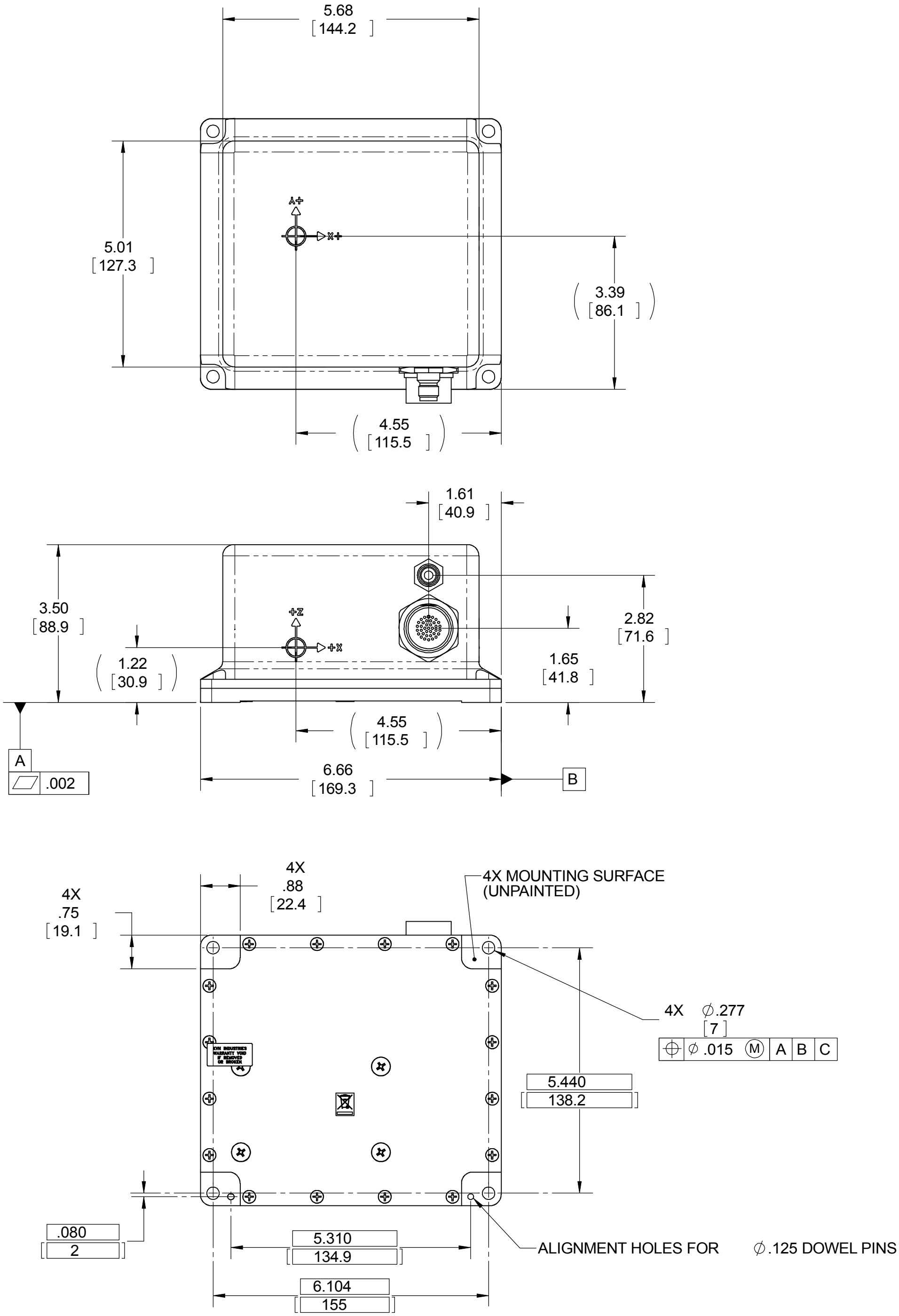


Figure 16: SPAN-CPT Top, Front and Bottom View

A.1.1 SPAN-CPT Cable

The NovAtel part numbers for the SPAN-CPT cable are:

- KVH Development Terminated Cable - 60723108
- KVH Standard Unterminated Cable - 60723107

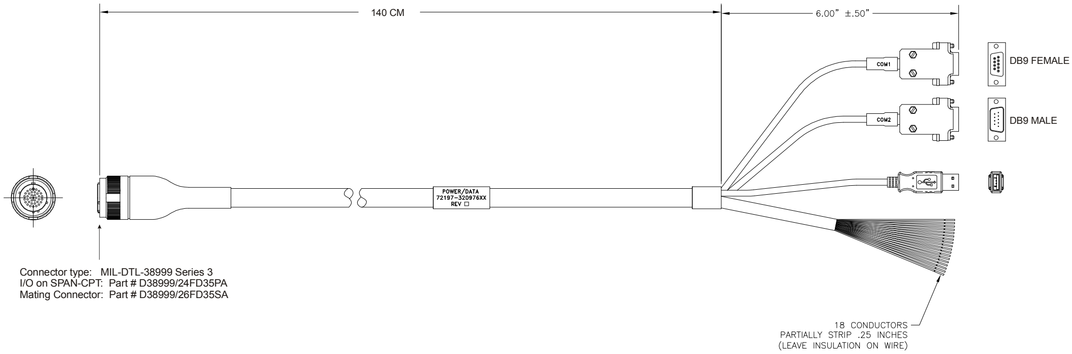


Figure 17: SPAN-CPT Development Terminated Cable

> The SPAN-CPT cable also has a green ground line that is not shown in this drawing. The green ground line is grounded to the SPAN-CPT connector and enclosure.

Table 6: SPAN-CPT 60723107 - KVH Standard Un-terminated Cable Pin-Out

Pin No.	Function	Wire Pair	Wire Colour	Female DB9 to COM1	Male DB9 to COM2	USB	Comments
1	Power Return	White / Black	White				
2	9-18 VDC Power Input		Black				
3	COM1 RS422 TX (+) / RS232 TX From OEMV-3 Module	White / Black	Black				
4	COM1 RS422 TX (-) / RS232 RTS From OEMV-3 Module		White				
5	COM1 RS422 RX (+) / RS232 RX To OEMV-3 Module	White / Black	Black				
6	COM1 RS422 RX (-) / RS232 CTS To OEMV-3 Module		White				
7	RS422 Select In		White				
8	RS422 Select Out		White				
9	COM1 Signal Ground		White				
10	OEMV-3 USB D (+)	White / Black	Black				
11	OEMV-3 USB D (-)		White				
12	OEMV-3 USB SIGNAL GND		White				

13	Odometer Power	White / Black	White				
14	Odometer Power Return		Black				
15	ODO SIGA	White / Black	Black				
16	ODO SIGA Inverted		White				
17	ODO SIGB	White / Black	Black				
18	ODO SIGB Inverted		White				
19	COM2 RS232 TX from OEMV-3 Module		White				
20	COM2 RS232 RX to OEMV-3 Module		White				
21	COM2 RS232 RTS from OEMV-3 Module		White				
22	COM2 RS232 CTS to OEMV-3 Module		White				
23	COM2 RS232 DTR from OEMV-3 Module		White				
24	COM2 RS232 DCD to OEMV-3 Module		White				
25	COM2 Signal GND		White				
26	IMU RS232 TX Diagnostics		White				
27	IMU RS232 RX Diagnostics		White				
28	IMU RS232 Diagnostics signal ground		White				
29	PPS from OEMV-3	White / Black	White				
30	EVENT1 to OEMV-3		Black				
31	OEMV-3 Signal GND		White				
32	CAN2L OEMV-3	White / Black	White				
33	CAN2H OEMV-3		Black				
34	CAN2 SIGNAL GND		White				
35	N/C						
36	N/C						
37	Chassis GND		White				

Table 7: SPAN-CPT 60723108 - KVH Development Terminated Cable Pin-Out

Pin No.	Function	Wire Pair	Wire Colour	Female DB9 to COM1	Male DB9 to COM2	USB	Comments
1	Power Return	Red / Green	Green				
2	9-18 VDC Power Input		Red				
3	COM1 RS422 TX (+) / RS232 TX From OEMV-3 Module	Red / Black	Red	2			
4	COM1 RS422 TX (-) / RS232 RTS From OEMV-3 Module		Black	8			
5	COM1 RS422 RX (+) / RS232 RX To OEMV-3 Module	White / Black	White	3			
6	COM1 RS422 RX (-) / RS232 CTS To OEMV-3 Module		Black	7			
7	RS422 Select In	White / Violet	White				Tie together with pin number 8 to select RS422
8	RS422 Select Out		Violet				Tie together with pin number 7 to select RS422
9	COM1 Signal Ground		Grey	5			
10	OEMV-3 USB D (+)	Blue / Black	Blue			3	
11	OEMV-3 USB D (-)		Black			2	
12	OEMV-3 USB SIGNAL GND		Violet			4	
13	Odometer Power	White-Red / White-Black	White-Red				
14	Odometer Power Return		White-Black				
15	ODO SIGA	White-Brown / White-Black	White-Brown				
16	ODO SIGA Inverted		White-Black				
17	ODO SIGB	White-Orange / White-Black	White-Orange				
18	ODO SIGB Inverted		White-Black				
19	COM2 RS232 TX from OEMV-3 Module		Red		3		
20	COM2 RS232 RX to OEMV-3 Module		White		2		

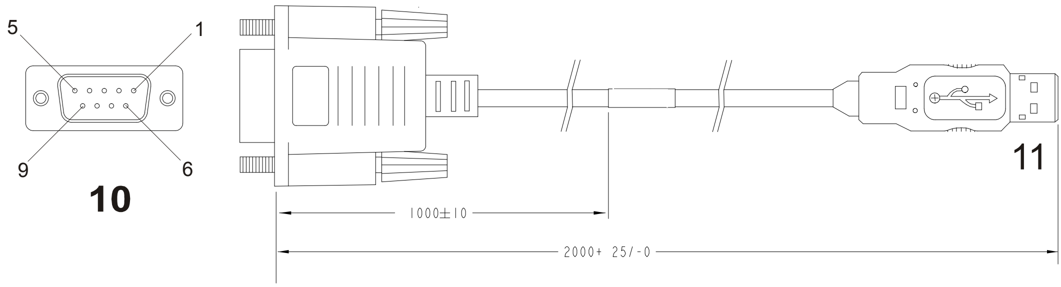
Continued on next page

21	COM2 RS232 RTS from OEMV-3 Module		Orange		7		
22	COM2 RS232 CTS to OEMV-3 Module		Brown		8		
23	COM2 RS232 DTR from OEMV-3 Module		Yellow		4		
24	COM2 RS232 DCD to OEMV-3 Module		Blue		6		
25	COM2 Signal GND		Black		5		
26	IMU RS232 TX Diagnostics		White-Orange				
27	IMU RS232 RX Diagnostics		White-Yellow				
28	IMU RS232 Diagnostics signal ground		White-Blue				
29	PPS from OEMV-3		White-Red				
30	EVENT1 to OEMV-3		White-Brown				
31	OEMV-3 Signal GND		White-Black				
32	CAN2L OEMV-3	Black / Green	Black				
33	CAN2H OEMV-3		Green				
34	CAN2 SIGNAL GND		White-Green				
35	N/C						
36	N/C						
37	Chassis GND		Green				

A.1.1.1 USB Serial Cable (NovAtel part number 01017664)

The USB cable provides a means of interfacing between the COM1 port on the ProPak-V3 and another serial communications device, such as a PC. At the ProPak-V3 end, the cable is equipped with a DB9 connector, which plugs directly into a COM port. At the other end, a USB connector is provided.

This cable is RoHS compliant.



WIRING			
DB9 CONNECTION ON RECEIVER	SIGNAL	SERIES "A" USB PLUG	WIRE COLOR
PIN 5	GND	PIN 4	BLACK
PIN 6	USB D+	PIN 3	GREEN
PIN 9	USB D-	PIN 2	WHITE
INSULATE TO PREVENT SHORT			RED

Reference	Description
10	Female DB9 connector
11	USB connector

A.1.2 KVH IMU Sensor Specifications

***PERFORMANCE* - FIBER OPTIC GYROS**		
Bias Offset	± 20	°/hr
Turn On To Turn On Bias Repeatability (Compensated)	± 3	°/hr
In Run Bias Variation, At Constant Temperature	1	°/hr @ 1σ
Scale Factor Error (Total)	1500	ppm, 1σ
Scale Factor Linearity	1000	ppm, 1σ
Temperature Dependent SF Variation	500	ppm, 1σ
Angular Random Walk	0.0667	°/√hr @ 1σ
Max Input	± 375	°/sec

***PERFORMANCE* - ACCELEROMETERS**		
Bias Offset	± 50	mg
Turn On To Turn On Bias Repeatability	± 0.75	mg
In Run Bias Variation, At Constant Temperature	0.25	mg @ 1σ
Temperature Dependent Bias Variation	0.5	mg/°C @ 1σ
Scale Factor Error (Total)	4000	ppm, 1σ
Temperature Dependent SF Variation	1000	ppm, 1σ
Accel Noise	55	µg/√Hz @ 1σ
Bandwidth	50	Hz
Max Input	±10	g

A.1.3 Electrical and Environmental

CONNECTORS	
Power and I/O	MIL-DTL-38999 Series 3
RF Antenna Connector	TNC Female
ELECTRICAL	
Input Power	9 - 18 VDC
Power consumption	15 W (Max)
Start-Up Time (Valid Data)	< 5 secs
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.1.4 Power

POWER	
Vin Ripple	0.5 V pk-pk Max
I in-rush	5 A Max for duration; no longer than 2 ms @12 V
I steady-state	1.3 A typical @ 12 V
Chassis GND (pin-37)	connect to system chassis
Voltage	should rise monotonically to nominal level with 10 ms
Odometer Power	9 to 18 Vdc @ 0-100 mA (output from Pin 13 and Pin 14)

Appendix B INS Commands

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

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

B.1 Using a Command as a Log

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

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

lockout prn

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

log com1 lockouta once

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

The highest rate that you should request GPS logs (RANGE, BESTPOS, RTKPOS, PSRPOS, and so on) while in INS operation is 5 Hz. If the receiver is not running INS, GPS logs can be requested at rates up to 20 Hz depending on the software model.

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

B.2 INS-Specific Commands

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

B.2.1 ALIGNMENTMODE Set the Alignment Mode

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

ALIGNMENTMODE mode

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

The default ALIGNMENTMODE for the SPAN-CPT is UNAIDED, when ALIGN solution is configured (by entering the primary and secondary lever arms), the ALIGMENTMODE will automatically change to AUTOMATIC. Sending this command manually will override these default selections.

Abbreviated ASCII Example:

```
ALIGNMENTMODE AIDED_TRANSFER
```

B.2.2 APPLYVEHICLEBODYROTATION Enable Vehicle to Body Rotation

This command allows you to apply the vehicle to body rotation to the output attitude (that was entered from the VEHICLEBODYROTATION command, see *page 90*). This rotates the SPAN body frame output in the INSPVA, INSPVAS and INSATT logs to the vehicle frame. APPLYVEHICLEBODYROTATION is disabled by default.

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

APPLYVEHICLEBODYROTATION [switch]

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

Input Example:

```
APPLYVEHICLEBODYROTATION ENABLE
```

B.2.3 CANCONFIG Configure the CAN Interface for SPAN

Use the CANCONFIG command to configure the CAN interface for SPAN. All of its fields are mandatory (there are no optional fields). For further information, refer to our application note *APN-046 Configure CAN for SPAN* on the NovAtel Web site at www.novatel.com through *Support | Knowledge and Learning*.

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

CANCONFIG port switch bit rate base tx mask source

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	Port	CAN1	1	Specify the CAN port	Enum	4	H
		CAN2	2				
3	Switch	DISABLE	0	Enable/disable CAN configuration on the chosen port	Enum	4	H+4
		ENABLE	1				
4	Bit rate			CAN bit rate (kbps). See Table 8 on *page 66*.	Enum	4	H+8
5	Base	0 to 65535	0x0000 to 0xFFFF	Base address. Refer to application note APN-046 for further information.	Ulong	4	H+12
6	Tx mask	0 to 65535	0x0000 to 0xFFFF	Transmit activation mask. Refer to application note APN-046 for further information.	Ulong	4	H+16
7	Source	0	INSGPS	CAN source from either the INS/GPS solution of the GPS-only solutions.	Enum	4	H+20
		1	GPS				

Abbreviated ASCII Example:

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

Table 8: CAN Bit Rate (per second)

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

B.2.4 EXTHDGOFFSET Set the Angular Offset

The EXTHDGOFFSET command can be used to specify the angular offset from the dual antenna baseline to the SPAN computation frame. It is highly recommended that these offsets be entered by entering a lever arm to both antennas as the measurement errors will be lower (see *Section 4.4, Configuring SPAN with ALIGN on SPAN-CPT* on *page 51*). However this command can be used to enter the offsets directly if necessary.

> EXTHDGOFFSET is also available as a log, when both lever arms are entered. Refer to *Section C.2.5, EXTHDGOFFSET Log the Angular Offset* on *page 105*.

Abbreviated ASCII Syntax: **Message ID: 1204**

EXTHDGOFFSET heading headingSTD [pitch] [pitchSTD]]

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header			This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively	-	H	0
2	Heading	0 to 360.0		Angular offset for the azimuth, or heading between the external aiding source and the IMU forward axis. Input in degrees.	Double	8	H
3	HeadingSTD	0 to 10.0		Input heading offset standard deviation. Input in degrees.	Double	8	H+8
4	Pitch	-90.0 to 90.0		Angular offset for the pitch between the external aiding source and the IMU forward axis. Input in degrees. Default = 0.0	Double	8	H+16
5	PitchSTD	0 to 10.0		Input pitch offset standard deviation. Input in degrees. Default = 0.0	Double	8	H+24

Abbreviated ASCII Example:

EXTHDGOFFSET 0.5 1.0 -0.23 1.0

B.2.5 FRESET Factory Reset

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

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

FRESET [target]

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	Header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	Target	See *Table 9*		What data is to be reset by the receiver.	Enum	4	H

Input Example:

```
FRESET COMMAND
```

Table 9: FRESET Target

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

B.2.6 INSCOMMAND INS Control Command

This command allows you to enable or disable INS positioning. When INS positioning is disabled, no INS position, velocity or attitude is output. Also, INS aiding of RTK initialization and tracking reacquisition is disabled. If the command is used to disable INS and then re-enable it, the INS system has to go through its alignment procedure (equivalent to issuing a RESET command). See also *Section 3.3.1, System Start-Up and Alignment Techniques* starting on *page 40*

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

INSCOMMAND action

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

Abbreviated ASCII Example:

```
INSCOMMAND ENABLE
```

B.2.7 INSPHASEUPDATE INS Phase Update Control

This command allows you to control the INS phase updates.

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

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

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

INSPHASEUPDATE switch

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

Abbreviated ASCII Example:

```
INSPHASEUPDATE ENABLE
```

B.2.8 INSZUPT Request Zero Velocity Update

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

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

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

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

```
INSZUPT
```

B.2.9 INSZUPTCONTROL INS Zero Velocity Update Control

This command allows you to control whether ZUPTs are performed by the system.

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

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

INSZUPTCONTROL switch

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

Abbreviated ASCII Example:

```
INSZUPTCONTROL DISABLE
```

B.2.10 NMEATALKER Set the NMEA Talker ID

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

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

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

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

NMEATALKER [ID]

Factory Default:

nmeatalker gp

ASCII Example:

```
NMEATALKER AUTO
```

> This command only affects NMEA logs that are capable of a GPS position output. For example, GPGSV is for information on GPS satellites and its output always uses the GP ID. *Table 10* shows the NMEA logs and whether they use GP or GP + IN IDs with `nmeatalker auto`.

Table 10: NMEA Talkers

Log	GPGLL	GPGST	GPRMB	GPRMC	GPVTG
Talker IDs	GP/IN	GP/IN	GP/IN	GP/IN	GP/IN

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

B.2.11 RVBCALIBRATE Vehicle to Body Rotation Control

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

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

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

> The solved rotation values are used only for a rough estimate of the angular offsets between the SPAN-CPT and vehicle frames. The offsets are used when aligning the system while in motion (see *Section 3.3.1, System Start-Up and Alignment Techniques* starting on *page 40*). The angular offset values are not applied to the attitude output, unless the APPLYVEHICLEBODYROTATION command is enabled.

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

RVBCALIBRATE reset

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

Abbreviated ASCII Example:

```
RVBCALIBRATE reset
```

B.2.12 SETALIGNMENTVEL Set the Minimum Kinematic Alignment Velocity

This command allows the user to adjust the minimum required velocity for a kinematic alignment.

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

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

SETALIGNMENTVEL [velocity]

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

Abbreviated ASCII Example

SETALIGNMENTVEL 5.0

B.2.13 SETHEAVEWINDOW Set Heave Filter Length

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

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

SETHEAVEWINDOW filterlength

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

Abbreviated ASCII Example

SETHEAVEWINDOW 35

B.2.14 SETIMUORIENTATION Set IMU Orientation

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

> 1. The default SPAN-CPT axis definitions are:
>
>   Y - forward
>   Z - up
>
>   X - out the right hand side.
>
>   It is strongly recommended that you mount your SPAN-CPT in this way with respect to the vehicle.
>
> 2. You only need to use this command if the system is to be aligned while in motion using the fast alignment routine, see *Section 3.3.1.1, Default Kinematic Alignment* on *page 40*.

> 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.

This orientation command serves to transform the incoming SPAN-CPT signals in such a way that a 5 mapping is achieved, see *Table 11* on *page 79*. For example, if the SPAN-CPT is mounted with the X-axis pointing UP and a mapping of 1 is specified then this transformation of the raw SPAN-CPT data is done:

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

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

The X (pitch), Y (roll) and Z (azimuth) directions of the inertial enclosure frame are clearly marked on the SPAN-CPT, see the technical specifications starting on *page 53*.

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

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

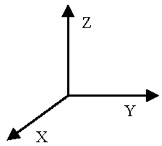
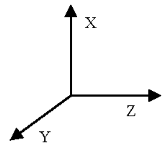
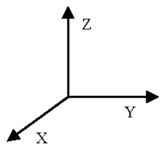
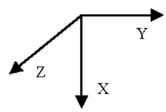
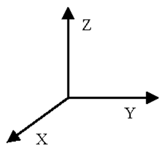
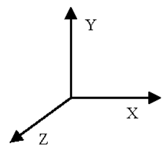
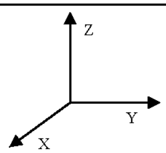
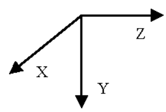
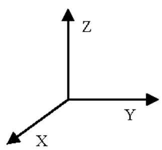
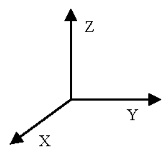
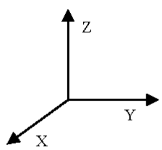
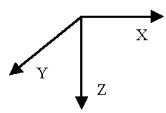
SETIMUORIENTATION switch

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

Abbreviated ASCII Example:

```
SETIMUORIENTATION 1
```

Table 11: Full Mapping Definitions

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

B.2.15 SETIMUTOANTOFFSET Set IMU to Antenna Offset

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

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

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

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

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

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

Abbreviated ASCII Example:

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

B.2.16 SETIMUTOANTOFFSET2 Set IMU to Antenna Offset 2

Set the lever arm for the secondary antenna. Preferably the primary antenna will be set up behind the IMU forward axis and the secondary antenna will be set up ahead of the IMU forward axis. Entering both lever arms will automatically compute the angular offset between the heading vector of the ALIGN antennas and the SPAN computational frame axes. However, the SETIMUTOANTOFFSET2 parameter should be input with respect to the IMU enclosure frame, as it is for the SETIMUTOANTOFFSET command.

The format of this command is identical to the SETIMUTOANTOFFSET command, as outlined on *page 80*.

B.2.17 SETINITATTITUDE Set Initial Attitude of SPAN in Degrees

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

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

1. Azimuth is positive in a clockwise direction when looking towards the z-axis origin.

2. You do not have to use the SETIMUORIENTATION command, see *page 77,* unless you have your SPAN-CPT mounted with the z axis not pointing up. Then use the tables in the SETIMURIENTATION command, on *Pages 78-79*, to determine the azimuth axis that SPAN is using.

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

SETINITATTITUDE pitch roll azimuth pitchSTD rollSTD azSTD

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

Abbreviated ASCII Example:

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

In this example, the initial roll and pitch has been set to zero degrees, with a standard deviation of 5 degrees for both. This means that the SPAN-CPT system is very close to level with respect to the local gravity field. The azimuth is 90 degrees (see the SETINITAZIMUTH example on *page 84*), also with a 5 degrees standard deviation.

B.2.18 SETINITAZIMUTH Set Initial Azimuth and Standard Deviation

This command allows you to start SPAN operation with a previously known azimuth. Azimuth is the weakest component of a coarse alignment, and is also the easiest to know from an external source (i.e. like the azimuth of roadway). This command is needed to perform a coarse alignment. Roll and pitch will be determined using averaged gyro and accelerometer measurements.

- This command is needed to perform a coarse alignment.
- Input azimuth values must be accurate for good system performance.
- Sending SETINITAZIMUTH resets the SPAN filter. The alignment will take approximately 1 minute, but some time and vehicle dynamics are required for the SPAN filter to converge. Bridging performance will be poor before filter convergence.
- The azimuth angle is with respect to the SPAN frame. If the SPAN-CPT enclosure is mounted with the z axis pointing upwards, the SPAN frame is the same as what is marked on the enclosure. If the SPAN-CPT is mounted in another way, SPAN transforms the SPAN frame axes such that z points up for SPAN computations. You must enter the azimuth with respect to the transformed axis. See SETIMUORIENTATION on *page 77*, for a description of the axes mapping that occurs when the SPAN-CPT is mounted differently from z pointing up.

> 1. Azimuth is positive in a clockwise direction when looking towards the z-axis origin.
>
> 2. You do not have to use the SETIMUORIENTATION command, see *page 77,* unless you have your SPAN-CPT mounted differently from the z axis pointing up. Then, use the tables in the SETIMURIENTATION command, on *pages 78-79*, to determine the azimuth axis that SPAN is using.

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

SETINITAZIMUTH azimuth azSTD

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	azimuth	-360° to +360°		Input azimuth angle in degrees	Double	8	H
3	azSTD	0.000278° to +180°		Input azimuth standard deviation angle in degrees	Double	8	H+8

Abbreviated ASCII Example:

```
SETINITAZIMUTH 90 5
```

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

B.2.19 SETINSOFFSET Set INS Offset

The SETINSOFFSET command is used to specify an offset from the SPAN-CPT for the output position and velocity of the INS solution. This command shifts the position and velocity in the INSPOS, INSPOSS, INSVEL, INSVELS, INSSPD, INSSPDS, INSPVA and INSPVAS logs by the amount specified in metres with respect to the SPAN-CPT enclosure frame axis.

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

SETINSOFFSET xoffset yoffset zoffset

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

Abbreviated ASCII Example:

```
SETINSOFFSET 0.15 0.15 0.25
```

B.2.20 SETMARK1OFFSET Set Mark1 Offset

Set the offset to the Mark1 trigger event.

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

SETMARK1OFFSET xoffset yoffset zoffset αoffset βoffset γoffset

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

Abbreviated ASCII Example:

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

B.2.21 SETWHEELPARAMETERS Set Wheel Parameters

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

Usage of the SETWHEELPARAMETERS command depends on what wheel sensor you are using.

The SETWHEELPARAMETERS command allows you to set the number of ticks per revolution that is correct for your wheel installation (the default is 58).

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

SETWHEELPARAMETERS ticks circ spacing

Field	Field Type	ASCII Value	Binary Value	Description	Binary Format	Binary Bytes	Binary Offset
1	header	-	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII, ASCII or binary, respectively.	-	H	0
2	ticks	1-10 000		Number of ticks per revolution (default = 58)	Ushort	4 [a]	H
3	circ	0.1-100		Wheel circumference (m) (default = 1.96 m)	Double	8	H+4
4	spacing	0.001-1000		Spacing of ticks, or resolution of the wheel sensor (m)	Double	8	H+12

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

Abbreviated ASCII Example:

```
SETWHEELPARAMETERS 58 1.96 0.025
```

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

B.2.22 TAGNEXTMARK

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

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

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

Abbreviated ASCII Example:

```
TAGNEXTMARK MARK1 1234
```

Only Mark 1 is available for the SPAN-CPT.

B.2.23 VEHICLEBODYROTATION Vehicle to SPAN frame Rotation

Use the VEHICLEBODYROTATION command to set angular offsets between the vehicle frame (direction of travel) and the SPAN body frame (direction that the SPAN-CPT computational frame is pointing). If you estimate the angular offsets using the RVBCALIBRATE command, the VEHICLEBODYROTATION command values are used as the initial values. The uncertainty values are optional (defaults = 0.0). Please see *Section 3.3.3, Vehicle to SPAN-CPT Frame Angular Offsets Calibration Routine* starting on *page 42* for more details. RVBCALIBRATE command information is on *page 74*.

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

If you use the APPLYVEHICLEBODYROTATION command, the reported attitude in the INSPVA or INSATT logs are in the vehicle frame. Otherwise, the reported attitude is in the SPAN computational frame.

The vehicle frame is as follows:

- Vehicle Z Axis - points up through the roof of the vehicle perpendicular to the ground
- Vehicle Y Axis - points out the front of the vehicle in the direction of travel
- Vehicle X Axis - completes the right-handed system (out the right-hand side of the vehicle when facing forward)

The rotation values are used during kinematic alignment. The rotation is used to transform the vehicle frame attitude estimates from GPS into the SPAN computational frame during kinematic alignment.

The uncertainty values report the accuracy of the angular offsets.

> If your SPAN-CPT 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.

Follow these steps to measure the rotation angles in the order and direction required for input in the VEHICLEBODYROTATION command:

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

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

To apply the vehicle to body rotation angles, the APPLYVEHICLEBODYROTATION needs to be enabled. Please see *page* 63 for more information.

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

VEHICLEBODYROTATION alpha beta gamma [σ alpha] [σ beta] [σ gamma]

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

Abbreviated ASCII Example:

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

Appendix C INS Logs

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

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

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

1. Each log ends with a hexadecimal number preceded by an asterisk and followed by a line termination using the carriage return and line feed characters, for example, `*1234ABCD[CR][LF]`. This value is a 32-bit CRC of all bytes in the log, excluding the '#' or '%' identifier and the asterisk preceding the four checksum digits. See also *Section C.1, Description of ASCII and Binary Logs with Short Headers* on *page 94*.

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

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

Table 1, Inertial Solution Status on *page 39* shows the status values included in the INS position, velocity and attitude output logs. If you think you have an IMU unit hooked up properly and you are not getting a good status value, something is wrong and the hardware setup must be checked out. This situation can be recognized in the RAWIMU data by observing accelerometer and gyro values which are not changing with time.

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

These logs are set up in the same way normal ASCII or binary logs are, except that a normal ASCII or binary header is replaced with a short header (see *Tables 12 and 13*). For the message header structure of OEMV-3 regular Binary and ASCII logs, please refer to the *OEMV Family Firmware Reference Manual*.

Table 12: Short ASCII Message Header Structure

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

Table 13: Short Binary Message Header Structure

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

C.2 INS-Specific Logs

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

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

Logging Restriction Important Notice

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

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

    LOG RAWIMUSB ONNEW (100 Hz)

    LOG INSPVASB ONTIME 0.02 (acceptable 50 Hz logging)

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

    LOG INSPOSSB ONTIME 0.01 (100 Hz request)

    Below is another example set of acceptable logging requests:

    LOG INSPOSSB ONTIME 0.01 (100 Hz request)

    LOG INSVELSB ONTIME 0.02 (50 Hz request)

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

    LOG RAWIMUSB ONNEW (100 Hz request)

    LOG INSATTSB ONTIME 0.01 (100 Hz request)

2. RAWIMUS logs are only available with the ONNEW or ONCHANGED trigger. These logs are not valid with the ONTIME trigger. The raw IMU observations contained in these logs are sequential changes in velocity and rotation. As such, you can only use them for navigation if they are logged at their full rate. See details of these log starting on *page 130*.

3. In order to collect wheel sensor information, useful in post-processing, the TIMEDWHEELDATA log should only be used with the ONNEW trigger. See also *page 135* for details on this log.

The periods available when you use the ONTIME trigger are 0.01 (100 Hz), 0.02 (50 Hz), 0.05, 0.1, 0.2, 0.25, 0.5, 1, 2, 3, 5, 10, 15, 20, 30 or 60 seconds.

The highest rate that you should request GPS logs (RANGE, BESTPOS, RTKPOS, PSR-POS, and so on) while in INS operation is 5 Hz. If the receiver is not running INS, GPS logs can be requested at rates up to 20 Hz depending on the software model.

C.2.1 BESTGPSPOS Best GPS Position

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

With the system operating in an RTK mode, this log reflects the latest low-latency solution for up to 60 seconds after reception of the last base station observations. After this 60 second period, the position reverts to the best solution available; the degradation in accuracy is reflected in the standard deviation fields. If the system is not operating in an RTK mode, pseudo range differential solutions continue for 300 seconds after loss of the data link, though a different value can be set using the DGPSTIMEOUT command, refer to the *OEMV Family Firmware Reference Manual.*

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

Structure: **Message ID: 423**

Log Type: Synch

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Sol Status	Solution status, see *Table 15, Solution Status* on *page 99*	Enum	4	H
3	Pos Type	Position type, see *Table 14, Position or Velocity Type* on *page 97*	Enum	4	H+4
4	Lat	Latitude	Double	8	H+8
5	Lon	Longitude	Double	8	H+16
6	Hgt	Height above mean sea level	Double	8	H+24
7	Undulation	Undulation	Float	4	H+32
8	Datum ID	Datum ID (refer to the DATUM command in the *OEMV Family Firmware Reference Manual*)	Enum	4	H+36
9	Lat s	Latitude standard deviation	Float	4	H+40
10	Lon s	Longitude standard deviation	Float	4	H+44
11	Hgt s	Height standard deviation	Float	4	H+48
12	Stn ID	Base station ID	Char[4]	4	H+52
13	Diff_age	Differential age	Float	4	H+56
14	Sol_age	Solution age in seconds	Float	4	H+60
15	#obs	Number of observations tracked	Uchar	1	H+64
16	#GPSL1	Number of GPS L1 ranges used in computation	Uchar	1	H+65

Continued on next page

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
17	#L1	Number of GPS L1 ranges above the RTK mask angle	Uchar	1	H+66
18	#L2	Number of GPS L2 ranges above the RTK mask angle	Uchar	1	H+67
19	Reserved		Uchar	1	H+68
20			Uchar	1	H+69
21			Uchar	1	H+70
22			Uchar	1	H+71
23	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+72
24	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Recommended Input:

log bestgpsposa ontime 1

ASCII Example:

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

Table 14: Position or Velocity Type

Position Type (binary)	Position Type (ASCII)	Description
0	NONE	No solution
1	FIXEDPOS	Position has been fixed by the FIX POSITION command or by position averaging
2	FIXEDHEIGHT	Position has been fixed by the FIX HEIGHT, or FIX AUTO, command or by position averaging
3	Reserved	
4	FLOATCONV	Solution from floating point carrier phase ambiguities
5	WIDELANE	Solution from wide-lane ambiguities
6	NARROWLANE	Solution from narrow-lane ambiguities
7	Reserved	
8	DOPPLER_VELOCITY	Velocity computed using instantaneous Doppler
9-15	Reserved	

Continued on next page

Position Type (binary)	Position Type (ASCII)	Description
16	SINGLE	Single point position
17	PSRDIFF	Pseudorange differential solution
18	WAAS	Solution calculated using corrections from an SBAS
19	PROPOGATED	Propagated by a Kalman filter without new observations
20	OMNISTAR	OmniSTAR VBS position (L1 sub-meter) [a]
21-31	Reserved	
32	L1_FLOAT	Floating L1 ambiguity solution
33	IONOFREE_FLOAT	Floating ionospheric-free ambiguity solution
34	NARROW_FLOAT	Floating narrow-lane ambiguity solution
48	L1_INT	Integer L1 ambiguity solution
49	WIDE_INT	Integer wide-lane ambiguity solution
50	NARROW_INT	Integer narrow-lane ambiguity solution
51	RTK_DIRECT_INS	RTK status where the RTK filter is directly initialized from the INS filter. [b]
52	INS	INS calculated position corrected for the antenna [b]
53	INS_PSRSP	INS pseudorange single point solution - no DGPS corrections [b]
54	INS_PSRDIFF	INS pseudorange differential solution [b]
55	INS_RTKFLOAT	INS RTK floating point ambiguities solution [b]
56	INS_RTKFIXED	INS RTK fixed ambiguities solution [b]
57	INS_OMNISTAR	INS OmniSTAR VBS position (L1 sub-meter) [ab]
58	INS_OMNISTAR_HP	INS OmniSTAR high precision solution [ab]
59	INS_OMNISTAR_XP	INS OmniSTAR extra precision solution [ab]
64	OMNISTAR_HP	OmniSTAR high precision [a]
65	OMNISTAR_XP	OmniSTAR extra precision [a]
66	CDGPS	Position solution using CDGPS corrections [a]

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

b. These types appear in position logs such as BESTPOS. Please refer to your *OEMV Family Firmware Reference Manual.*

Table 15: Solution Status

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

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

C.2.2 BESTGPSVEL Best Available GPS Velocity Data

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

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

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

Structure: **Message ID: 506**

Log Type: Synch

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Sol Status	Solution status, see *Table 15, Solution Status* on *page 99*	Enum	4	H
3	Vel Type	Velocity type, see *Table 14, Position or Velocity Type* on *page 97*	Enum	4	H+4
4	Latency	A measure of the latency in the velocity time tag in seconds. It should be subtracted from the time to give improved results.	Float	4	H+8
5	Age	Differential age	Float	4	H+12
6	Hor Spd	Horizontal speed over ground, in metres per second	Double	8	H+16
7	Trk Gnd	Actual direction of motion over ground (track over ground) with respect to True North, in degrees	Double	8	H+24
8	Vert Spd	Vertical speed, in metres per second, where positive values indicate increasing altitude (up) and negative values indicate decreasing altitude (down)	Double	8	H+32
9	Reserved		Float	4	H+40
10	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+44
11	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Recommended Input:

log bestgpsvela ontime 1

ASCII Example:

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

C.2.3 BESTLEVERARM/BESTLEVERARM2 IMU to Antenna Lever Arm

The BESTLEVERARM log contains the distance between the IMU's centre of navigation and the primary GPS antenna phase centre in the IMU enclosure frame and its associated uncertainties. If the you enter the lever arm through the SETIMUTOANTOFFSET command, shown on *page 80*, these values are reflected in this log.

The BESTLEVERARM2 log contains the distance between the IMU's centre of navigation and the secondary GPS antenna phase centre in the IMU enclosure frame. Currently the secondary lever arm cannot be calibrated so must be entered using the SETIMUTOANTOFFSET2 command.

The values in the BESTLEVERARM and BESTLEVERARM2 logs are also available (*IMUTOANTOFFSETS IMU to Antenna(s) Lever Arm* on *page 110)*.

The default X (pitch), Y (roll) and Z (azimuth) directions of the IMU enclosure frame are clearly marked on the IMU, see *Figure 39* on *page 155*.

Structure: **BESTLEVERARM Message ID: 674**

BESTLEVERARM2 Message ID: 1256

Log Type: Asynch

Field	Field Type	Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log Header	-	H	0
2	X Offset	IMU Enclosure Frame (m)	Double	8	H
3	Y Offset	IMU Enclosure Frame (m)	Double	8	H+8
4	Z Offset	IMU Enclosure Frame (m)	Double	8	H+16
5	X Uncertainty	IMU Enclosure Frame (m)	Double	8	H+24
6	Y Uncertainty	IMU Enclosure Frame (m)	Double	8	H+32
7	Z Uncertainty	IMU Enclosure Frame (m)	Double	8	H+40
8	iMapping	See *Table 33, Full Mapping Definitions* on *page 157*	Integer	4	H+48
9	xxxx	32-bit CRC	Hex	4	H+52
10	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

Recommended Input:

log bestleverarma onchanged

ASCII Example:

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

C.2.4 CORRIMUDATA/CORRIMUDATAS Corrected IMU measurements

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

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

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

> Since the CORRIMUDATA values are instantaneous, if you log at a rate less than full data rate of the IMU, you will receive the corrected IMU data at the epoch closest to the requested time interval.

If your IMU is mounted with the z axis, as marked on the enclosure, pointed up, the SPAN computation frame is the same as the IMU enclosure frame. The x, y, and z axes referenced in this log are of the SPAN computational frame by default. For more information on how the SPAN computational frame relates to the IMU enclosure frame, see *Section 3.1, page 31*, and the SETIMUORIENTATION command on *page 77*. If the APPLYVEHICLEBODYROTATION command has been enabled (see *page 63*), the values in CORRIMUDATA(S) logs will be in the vehicle frame, not the SPAN computation frame.

Message ID: 812 and 813

Log Type: Synch

Recommended Input:
log corrimudatab ontime 0.01

Example log:

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

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

C.2.5 EXTHDGOFFSET Log the Angular Offset

The EXTHDGOFFSET message will be available on the system after you enter both lever arms (refer to *Section 4.4* on *page 51*). The angular offsets between the dual antenna baseline and the SPAN computation frame will be computed internally and be available for output via the EXTHDGOFFSET log. For message structure, refer to *Section B.2.4* on *page 67*.

C.2.6 GPHDT NMEA Heading Log

This log provides actual vessel heading in degrees True (from True North). Refer also to information in the HEADING log on *page 107*. You can also set a standard deviation threshold for this log, as outlined in HDTOUTTHRESHOLD command section of the Firmware Reference Manual.

You must have an ALIGN-capable receiver to use this log. For further information, refer to the *Model Designators* table in the *Version* section of the *Data Logs* chapter in the *OEMV Family Firmware Reference Manual*.

Message ID: 1045
Log Type:Asynch

Recommended Input:

log gphdt onchanged

Example (GPS only):

```
$GPHDT,75.5664,T*36
```

Field	Structure	Field Description	Symbol	Example
1	$GPHDT	Log header		$GPHDT
2	heading	Heading in degrees	x.x	75.5554
3	True	Degrees True	T	T
4	*xx	Checksum	*hh	*36
5	[CR][LF]	Sentence terminator		[CR][LF]

C.2.7 HEADING Heading Information

The heading is the angle from True North of the base to rover vector in a clockwise direction.

Message ID: 971
Log Type: Asynch

Recommended Input:

log headinga onchanged

ASCII Example:

```
#HEADINGA,COM1,0,77.0,FINESTEERING,1481,418557.000,00000000,3663,36137;
SOL_COMPUTED,L1_INT,5.913998127,75.566444397,-0.152066842,0.0,0.104981117,
0.222061798,"AAAA",13,10,10,0,0,00,0,11*481a5bab
```

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header		H	0
2	sol stat	Solution status (see the *Solution Status* table in the VERSION log section of the *OEMV Firmware Manual*)	Enum	4	H
3	pos type	Position type (see the *Position or Velocity Type* table in the VERSION log section of the *OEMV Firmware Manual*)	Enum	4	H+4
4	length	Baseline length (m)	Float	4	H+8
5	heading	Heading in degrees (0 to 360.0 degrees)	Float	4	H+12
6	pitch	Pitch (±90 degrees)	Float	4	H+16
7	Reserved		Float	4	H+20
8	hdg std dev	Heading standard deviation in degrees	Float	4	H+24
9	ptch std dev	Pitch standard deviation in degrees	Float	4	H+28
10	stn ID	Station ID string	Char[4]	4	H+32
11	#SVs	Number of observations tracked	Uchar	1	H+36
12	#solnSVs	Number of satellites in solution	Uchar	1	H+37
13	#obs	Number of satellites above the elevation mask angle	Uchar	1	H+38
14	#multi	Number of satellites above the mask angle with L2	Uchar	1	H+39
15	Reserved		Uchar	1	H+40
16	ext sol stat	Extended solution status (see the *Extended Solution Status* table in the VERSION log section of the *OEMV Firmware Manual*)	Uchar	1	H+41
17	Reserved		Uchar	1	H+42
18	sig mask	Signals used mask - if 0, signals used in solution are unknown (see the *Signal-Used Mask* table in the VERSION log section of the *OEMV Firmware Manual*)	Uchar	1	H+43
19	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+44
20	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

C.2.8 HEAVE Heave Filter Log

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

You must have an inertial solution to use this log.

Structure: **Message ID: 1382**
Log Type: Asynch

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

Recommended Input:

log heavea onnew

Example:

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

C.2.9 IMUTOANTOFFSETS IMU to Antenna(s) Lever Arm

This log contains the distance between the IMU and the GNSS antenna(s) in the IMU enclosure frame and its associated uncertainties. The number of lever arms supported will equal the number of antennas supported in the model. For example, one for single antenna. This log contains the same information as the BESTLEVERARM or BESTLEVERARM2 logs for each lever arm, but is intended as a single source for all lever arm information available on the system.

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

log imutoantoffsets **Log Type: Asynch**

Example log:

```
<OK
[COM1]<IMUTOANTOFFSETS COM1 0 98.5 FINESTEERING 1581 339209.733 60000041 0000 
265
<     0 2
<          LEVER_ARM_PRIMARY -0.326000000 0.126000000 1.285000000 0.032600000 
0.012600000 0.128500000 LEVER_ARM_FROM_COMMAND
<          LEVER_ARM_SECONDARY -0.325000000 -1.155000000 1.287000000 
0.032500000 0.115500000 0.128700000 LEVER_ARM_FROM_COMMAND
[COM1]
```

Recommended Input:

log imutoantoffsetsa onchanged

ASCII Example:

```
#IMUTOANTOFFSETSA,COM1,0,98.5,FINESTEERING,1581,339209.733,60000041,0000,265;
0,2,LEVER_ARM_PRIMARY,-0.326000000,0.126000000,1.285000000,0.032600000,0
.012600000,0.128500000,LEVER_ARM_FROM_COMMAND,LEVER_ARM_SECONDARY,-
0.325000000,-
1.155000000,1.287000000,0.032500000,0.115500000,0.128700000,LEVER_ARM_FROM_
COMMAND*8f0f90b5
```

Field	Field Type	Description	Binary Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	IMU Orientation	See *Table 33, Full Mapping Definitions* on *page 157*	ULong	4	H
3	Number of Entries	Number of stored lever arms	ULong	4	H+4
4	Lever Arm Type	Type of lever arm (refer to the two following tables)	Enum	4	H+8
5	X Offset	IMU Enclosure Frame (m)	Double	8	H+12
6	Y Offset	IMU Enclosure Frame (m)	Double	8	H+20
7	Z Offset	IMU Enclosure Frame (m)	Double	8	H+28
8	X Uncertainty	IMU Enclosure Frame (m)	Double	8	H+36
9	Y Uncertainty	IMU Enclosure Frame (m)	Double	8	H+44
10	Z Uncertainty	IMU Enclosure Frame (m)	Double	8	H+52
11	Lever Arm Source	Source of the lever arm (refer to the two following tables)	Enum	4	H+60
12…	Next component offset = H + 8 + (#comp * 56)				
variable	XXXX	32-bit CRC (ASCII and Binary only)	Hex	4	H+8+ (#comp * 56)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

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

Value (binary)	Lever Arm Source (ASCII)	Description
0	LEVER_ARM_NONE	No lever arm exists
1	LEVER_ARM_FROM_NVM	Lever arm restored from NVM
2	LEVER_ARM_CALIBRATING	Lever arm currently calibrating
3	LEVER_ARM_CALIBRATED	Lever arm computed from calibration routine
4	LEVER_ARM_FROM_COMMAND	Lever arm entered via command
5	LEVER_ARM_RESET	If the current IMU orientation does not match the value restored from NVM then the lever arm will be reset to zero with this status.

C.2.10 INSATT INS Attitude

This log, and the INSATTS log, contains the most recent attitude measurements corresponding to the SPAN frame axis according to the installation instructions provided in *Section 2.2, Hardware Set-Up* starting on *page 28* and *INS Window in NovAtel Connect* on *page 36* of this manual. The attitude measurements may not correspond to other definitions of the terms pitch, roll and azimuth. If your SPAN-CPT's z-axis (as marked on the enclosure) is not pointing up, the output attitude will be with respect to the SPAN computational frame, and not the frame marked on the enclosure. See the SETIMUORIENTATION command to determine what the SPAN computation frame will be, given how the IMU is mounted.

Structure: **Message ID: 263**

Log Type: Synch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	Roll	Right handed rotation from local level around y-axis in degrees.	Double	8	H+12
5	Pitch	Right handed rotation from local level around x-axis in degrees.	Double	8	H+20
6	Azimuth	Left handed rotation around z-axis. Degrees clockwise from North.	Double	8	H+28
7	Status	INS status, see *Table 1* on *page 39*	Enum	4	H+36
8	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+40
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Recommended Input:

log insatta ontime 1

ASCII Example:

```
#INSATTA,COM1,0,40.5,FINESTEERING,1660,504255.000,00000000,5b35,7033;1660,504
255.003257800,-
0.641863008,0.927187599,27.366445668,INS_SOLUTION_GOOD*aaff276f
```

C.2.11 INSATTS Short INS Attitude

This is a short header version of the *INSATT* log on *page 113*.

Structure: **Message ID: 319**

Log Type: Synch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	Roll	Right handed rotation from local level around y-axis in degrees.	Double	8	H+12
5	Pitch	Right handed rotation from local level around x-axis in degrees.	Double	8	H+20
6	Azimuth	Left handed rotation around z-axis. Degrees clockwise from North.	Double	8	H+28
7	Status	INS status, see *Table 1* on *page 39.*	Enum	4	H+36
8	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+40
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Recommended Input:

log insattsa ontime 1

ASCII Example:

```
%INSATTSA,1660,504312.000;1660,504312.003257800,-
0.645462004,0.929949944,27.412387110,INS_SOLUTION_GOOD*1b1471b9
```

C.2.12 INSCOV INS Covariance Matrices

The position, attitude, and velocity matrices in this log each contain 9 covariance values, with respect to the local level frame. The attitude variables are given in the SPAN computational frame with respect to the local level.

variance about
SPAN Frame X rotation
angle “pitch”

$$\begin{bmatrix} xx & xy & xz \\ yx & yy & yz \\ zx & zy & zz \end{bmatrix}$$

variance about
SPAN Frame Y rotation
angle “roll”

variance about
Z rotation
angle “azimuth” or “yaw”

and are displayed within the log output as:

…,xx,xy,xz,yx,yy,yz,zx,zy,zz,…

These values are computed once per second and are only available after alignment. See also *Section 3.3.1, System Start-Up and Alignment Techniques* starting on *page 40*.

Structure: **Message ID: 264**

Log Type: Asynch

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

Recommended Input:

log inscova onchanged

ASCII Example:

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

C.2.13 INSCOVS Short INS Covariance Log

This is a short header version of the *INSCOV* log on *page 115*. These values are also computed once per second.

Structure: **Message ID: 320**

Log Type: Asynch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	Position Covariance	Position covariance matrix in local level frame. (Meters squared) xx,xy,xz,yx,yy,yz,zx,zy,zz	List of 9 Doubles	72	H+12
5	Attitude Covariance (sse *page 115* for example)	Attitude covariance matrix in local level frame. (Degrees squared - rotation around the given axis) xx,xy,xz,yx,yy,yz,zx,zy,zz	List of 9 Doubles	72	H+84
6	Velocity Covariance	Velocity covariance matrix in local level frame. (Meters/second squared) xx,xy,xz,yx,yy,yz,zx,zy,zz	List of 9 Doubles	72	H+156
7	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+228
8	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Recommended Input:

log inscovsa onchanged

ASCII Example:

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

C.2.14 INSPOS INS Position

This log contains the most recent position measurements in WGS84 coordinates and includes an INS status indicator. The log reports the position at the IMU centre, unless you issue the SETINSOFFSET command, see *page 86*.

Structure: **Message ID: 265**

Log Type:Synch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	Latitude	Latitude (WGS84)	Double	8	H+12
5	Longitude	Longitude (WGS84)	Double	8	H+20
6	Height	Ellipsoidal Height (WGS84 [m])	Double	8	H+28
7	Status	INS status, see *Table 1* on *page 39*	Enum	4	H+36
8	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+40
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Recommended Input:

log insposa ontime 1

ASCII Example:

```
#INSPOSA,COM1,0,48.0,FINESTEERING,1660,504399.000,00000000,17cd,7033;1660,504
399.003257800,51.116345818,-
114.038198958,1042.375106399,INS_SOLUTION_GOOD*fab67120
```

C.2.15 INSPOSS Short INS Position

This is a short header version of the *INSPOS* log on *Page 118*.

Structure: **Message ID: 321**

Log Type:Synch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	Latitude	Latitude (WGS84)	Double	8	H+12
5	Longitude	Longitude (WGS84)	Double	8	H+20
6	Height	Ellipsoidal Height (WGS84) [m]	Double	8	H+28
7	Status	INS status, see *Table 1* on *page 39*	Enum	4	H+36
8	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+40
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Recommended Input:

log inspossa ontime 1

ASCII Example:

```
%INSPOSSA,1660,504446.000;1660,504446.003257800,51.116345837,-
114.038199274,1042.377363896,INS_SOLUTION_GOOD*72243ba2
```

C.2.16 INSPOSSYNC Time Synchronised INS Position

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

Structure: **Message ID: 322**

Log Type: Asynch

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

Recommended Input:

log inspossynca onchanged

ASCII Example:

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

C.2.17 INSPVA INS Position, Velocity and Attitude

This log allows INS position, velocity and attitude, with respect to the SPAN frame, to be collected in one log, instead of using three separate logs. See the INSATT log, on *page 113*, for an explanation of how the SPAN frame may differ from the IMU enclosure frame.

Structure: **Message ID: 507**

Log Type: Synch

Field	Field Type	Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS Week	Ulong	4	H
3	Seconds	Seconds from week start	Double	8	H+4
4	Latitude	Latitude (WGS84)	Double	8	H+12
5	Longitude	Longitude (WGS84)	Double	8	H+20
6	Height	Ellipsoidal Height (WGS84) [m]	Double	8	H+28
7	North Velocity	Velocity in a northerly direction (a -ve value implies a southerly direction) [m/s]	Double	8	H+36
8	East Velocity	Velocity in an easterly direction (a -ve value implies a westerly direction) [m/s]	Double	8	H+44
9	Up Velocity	Velocity in an up direction [m/s]	Double	8	H+52
10	Roll	Right handed rotation from local level around y-axis in degrees	Double	8	H+60
11	Pitch	Right handed rotation from local level around x-axis in degrees	Double	8	H+68
12	Azimuth	Left handed rotation around z-axis Degrees clockwise from North	Double	8	H+76
13	Status	INS Status, see *Table 1* on *page 39*	Enum	4	H+84
14	xxxx	32-bit CRC	Hex	4	H+88
15	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

Recommended Input:

log inspvaa ontime 1

ASCII Example:

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

C.2.18 INSPVAS Short INS Position, Velocity and Attitude

This is a short header version of the INSPVA log on *page 121*.

Structure: **Message ID: 508**

Log Type: Synch

Field	Field Type	Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS Week	Ulong	4	H
3	Seconds	Seconds from week start	Double	8	H+4
4	Latitude	Latitude (WGS84)	Double	8	H+12
5	Longitude	Longitude (WGS84)	Double	8	H+20
6	Height	Ellipsoidal Height (WGS84) [m]	Double	8	H+28
7	North Velocity	Velocity in a northerly direction (a -ve value implies a southerly direction) [m/s]	Double	8	H+36
8	East Velocity	Velocity in an easterly direction (a -ve value implies a westerly direction) [m/s]	Double	8	H+44
9	Up Velocity	Velocity in an up direction [m/s]	Double	8	H+52
10	Roll	Right handed rotation from local level around y-axis in degrees	Double	8	H+60
11	Pitch	Right handed rotation from local level around x-axis in degrees	Double	8	H+68
12	Azimuth	Left handed rotation around z-axis Degrees clockwise from North	Double	8	H+76
13	Status	INS Status, see *Table 1* on *page 39*	Enum	4	H+84
14	xxxx	32-bit CRC	Hex	4	H+88
15	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

Recommended Input:

log inspvasa ontime 1

ASCII Example:

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

C.2.19 INSSPD INS Speed

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

Structure: **Message ID: 266**

Log Type: Synch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	Trk gnd	Actual direction of motion over ground (track over ground) with respect to True North, in degrees	Double	8	H+12
5	Horizontal Speed	Magnitude of horizontal speed in m/s where a positive value indicates you are moving forward and a negative value indicates you are reversing.	Double	8	H+20
6	Vertical Speed	Magnitude of vertical speed in m/s where a positive value indicates speed upward and a negative value indicates speed downward.	Double	8	H+28
7	Status	INS status, see *Table 1* on *page 39*	Enum	4	H+36
8	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+40
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Recommended Input:

log insspda ontime 1

ASCII Example:

```
#INSSPDA,COM3,0,0.0,EXACT,1105,425385.000,00040000,efce,0;
1105,425384.996167250,223.766800423,0.019769837,
-0.024795257,INS_SOLUTION_GOOD*15b864f4
```

C.2.20 INSSPDS Short INS Speed

This is a short header version of the *INSSPD* log on *Page 123*.

Structure: **Message ID: 323**

Log Type: Synch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	Trk gnd	Track over ground	Double	8	H+12
5	Horizontal Speed	Horizontal speed in m/s	Double	8	H+20
6	Vertical Speed	Vertical speed in m/s	Double	8	H+28
7	Status	INS status, see *Table 1* on *page 39*	Enum	4	H+36
8	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+40
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Recommended Input:

log insspdsa ontime 1

ASCII Example:

```
%INSSPDSA,1105,425385.000;
1105,425384.996167250,223.766800423,0.019769837,
-0.024795257,INS_SOLUTION_GOOD*15b864f4
```

C.2.21 INSUPDATE INS Update

The INSUPDATE message has been modified for this mode of operation. The reserved field at the end of the message has been filled with an enumeration regarding the status of the heading updates.

Structure: **Message ID: 757**

Log Type: Asynch (1 Hz maximum)

Field	Field Type	ASCII Value	Binary Value	Data Description	Binary Format	Binary Bytes	Binary Offset
1	Log Header	-		Log header	-	H	0
2	Solution Type	See *Table 14* on *page 97*		Type of GPS solution used for the last update	Enum	4	H
3	Reserved	-		-	Long	4	H+4
4	#Phase	0 to maximum GPS L1 channels - 1		Number of raw phase observations used in the last INS filter update	Long	4	H+8
5	Reserved	-		-	Long	4	H+12
6	ZUPT	True/False		A zero velocity update was performed during the last INS filter update	Boolean	4	H+16
7	Wheel Status	See *Table 16* on *page 126*.		Status of a wheel sensor during the last INS filter update	Enum	4	H+20
8	HEADING_UPDATE_INACTIVE	See *Table 17* on *page 126*		Status of the heading update during the last INS update	Enum	H+24	8

Recommended Input:

log insupdate onchanged

ASCII Example:

```
#INSUPDATEA,FILE,0,0.0,FINESTEERING,1549,165116.006,00000000,4289,0;SINGLE,0,
0,0,FALSE,WHEEL_SENSOR_INACTIVE,HEADING_UPDATE_USED*5a16ecba
```

The Heading Update enums are shown when:

- When the heading updates are running but the epoch is not used as an update then it will be marked HEADING_UPDATE_ACTIVE. When all other rejection criteria pass, a heading update will still only be applied once every 5 seconds (20 seconds when stationary).
- HEADING_UPDATE_HIGH_ROTATION means the last 1 second recorded a turn of over 5 degrees/second.
- HEADING_UPDATE_HIGH_STD_DEV means the standard deviation of the update failed a 3 sigma check against the inertial standard deviation (azimuth checked only). It is normal to see this status after the INS solution has converged. It simply means that the inertial attitude solution is significantly better than the ALIGN solution so no updates need to be applied.
- HEADING_UPDATE_BAD_MISC means that the difference between the ALIGN heading and the INS heading failed a 3 sigma check with the inertial standard deviation.
- HEADING_UPDATE_USED means we took the update for that epoch.

Table 16: Wheel Status

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

Table 17: Heading Update

Binary	ASCII
0	HEADING_UPDATE_INACTIVE
1	HEADING_UPDATE_ACTIVE
2	HEADING_UPDATE_USED
3	HEADING_UPDATE_HIGH_STD_DEV
4	HEADING_UPDATE_HIGH_ROTATION
5	HEADING_UPDATE_BAD_MISC

C.2.22 INSVEL INS Velocity

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

Structure: **Message ID: 267**

Log Type:Synch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	North Velocity	Velocity North in m/s	Double	8	H+12
5	East Velocity	Velocity East in m/s	Double	8	H+20
6	Up Velocity	Velocity Up in m/s	Double	8	H+28
7	Status	INS status, see *Table 1 on page 39*	Enum	4	H+36
8	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+40
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Recommended Input:

log insvela ontime 1

ASCII Example:

```
#INSVELA,COM3,0,0.0,EXACT,1105,425385.000,00040000,7d4a,0;
1105,425384.996167250,-0.014277009,-0.013675287,
-0.024795257,INS_SOLUTION_GOOD*2f3fe011
```

C.2.23 INSVELS Short INS Velocity

This is a short header version of the *INSVEL* log on *Page 127*.

Structure: **Message ID: 324**

Log Type:Synch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	North Velocity	Velocity North m/s	Double	8	H+12
5	East Velocity	Velocity East m/s	Double	8	H+20
6	Up Velocity	Velocity Up m/s	Double	8	H+28
7	Status	INS status, see *Table 1* on *page 39*	Enum	4	H+36
8	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+40
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Recommended Input:

log insvelsa ontime 1

ASCII Example:

```
%INSVELSA,1105,425385.000;
1105,425384.996167250,-0.014277009,-0.013675287,
-0.024795257,INS_SOLUTION_GOOD*2f3fe011
```

C.2.24 MARK1PVA Position, Velocity and Attitude at Mark1

This log outputs position, velocity and attitude information of the system, with respect to the SPAN frame, when an event was received on the Mark 1 input.

Structure: **Message ID: 1067**

Log Type: Synch

Field	Field Type	Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS Week at Mark1 request	Ulong	4	H
3	Seconds	Seconds from week at Mark1	Double	8	H+4
4	Latitude	Latitude (WGS84) at Mark1	Double	8	H+12
5	Longitude	Longitude (WGS84) at Mark1	Double	8	H+20
6	Height	Height (WGS84) at Mark1 [m]	Double	8	H+28
7	North Velocity	Velocity in a northerly direction (a -ve value implies a southerly direction) at Mark1 [m/s]	Double	8	H+36
8	East Velocity	Velocity in an easterly direction (a -ve value implies a westerly direction) at Mark1 [m/s]	Double	8	H+44
9	Up Velocity	Velocity in an up direction at Mark1 [m/s]	Double	8	H+52
10	Roll	Right handed rotation from local level around y-axis in degrees at Mark1	Double	8	H+60
11	Pitch	Right handed rotation from local level around x-axis in degrees at Mark1	Double	8	H+68
12	Azimuth	Left handed rotation around z-axis Degrees clockwise from North at Mark1	Double	8	H+76
13	Status	INS Status, see *Table 1* on *page 39* at Mark1	Enum	4	H+84
14	xxxx	32-bit CRC	Hex	4	H+88
15	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

Recommended Input:

log mark1pva onnew

Abbreviated ASCII Example:

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

C.2.25 PASHR NMEA, fix and position data

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

Structure:

Message ID: 1177

Log TypeSynch

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

Recommended Input:

log pashr ontime 1

Example:

```
$PASHR,,,,,,,,,,0*68 (empty)

$PASHR,195124.00,305.30,T,+0.05,-0.13,,0.180,0.185,4.986,1*2B
```

C.2.26 RAWIMUS Short Raw IMU Data

This log contains an IMU status indicator and the measurements from the accelerometers and gyros with respect to the IMU enclosure frame. This log contains the short header version to reduce the amount of data.

Structure: **Message ID: 325**

Log Type: Asynch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Week	GPS Week	Ulong	4	H
3	Seconds into Week	Seconds from week start	Double	8	H+4
4	IMU Status	The status of the IMU. This field is given in a fixed length (n) array of bytes in binary but in ASCII or Abbreviated ASCII is converted into 2 character hexadecimal pairs. [a] For more information, *Table 18, SPAN-CPT Status* on *page 132*.	Long	4	H+12
5	Z Accel Output	Change in velocity count along z axis [a]	Long	4	H+16
6	- (Y Accel Output)	- (Change in velocity count along y axis) [a, b]	Long	4	H+20
7	X Accel Output	Change in velocity count along x axis [a]	Long	4	H+24
8	Z Gyro Output	Change in angle count around z axis [c] Right-handed	Long	4	H+28
9	- (Y Gyro Output)	- (Change in angle count around y axis) [b, c] Right-handed	Long	4	H+32
10	X Gyro Output	Change in angle count around x axis [c] Right-handed	Long	4	H+36
11	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+40
12	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a. The change in velocity (acceleration) scale factor for each IMU type can be found in *Table 20* on *page 133*. Multiply the scale factor in *Table 20,* by the count in this field, for the velocity increments in m/s.
b. A negative value implies that the output is along the positive Y-axis marked on the IMU. A positive value implies that the change is in the direction opposite to that of the Y-axis marked on the IMU.
c. The change in angle (gyro) scale factor can be found in *Table 20* on *page 133*. Multiply the appropriate scale factor in *Table 20,* by the count in this field, for the angle increments in radians. To obtain acceleration in m/s^2, multiply the velocity increments by the output rate of the IMU (eg. 100Hz for HG1700, IMU-CPT, 200Hz iMAR-FSAS, LN200 and LCI).

Table 18: SPAN-CPT Status

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

Recommended Input:

log rawimusa onnew

ASCII Example:

```
%RAWIMUSA,1105,425384.180;
1105,425384.156166800,00000077,43088060,430312,-3033352,
-132863,186983,823*5aa97065
```

Table 18 shows how to change the bolded field, IMU Status, in the SPAN-CPT example above into it's binary equivalent, and then how to read *Table 19: SPAN-CPT Status Example*.

Table 19: SPAN-CPT Status Example

Nibble#	N7				N6				N5				N4			
0x	0				0				0				0			
Bit #	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Binary	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Data	Unused								Unused							
Value																

Nibble#	N3				N2				N1				N0			
0x	0				0				7				7			
Bit #	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Binary	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	1
Data	Unused									Accelerometer Z Status	Accelerometer Y Status	Accelerometer X Status		Gyro Z Status	Gyro Y Status	Gyro X Status
Value									Unused	Valid	Valid	Valid	Unused	Valid	Valid	Valid

Table 20: Raw SPAN-CPT Scale Factors

Gyroscope Scale Factor	$\frac{0.1}{(3600.0x256.0)}$ rad/LSB
Acceleration Scale Factor	$0.05/2^{15}$ m/s/LSB

C.2.27 TAGGEDMARK1PVA

> TAGGEDMARK1PVA is identical to MARK1PVA but with a tag.

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

Structure: **Message ID: 1258**
Log Type: Synch

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

C.2.28 TIMEDWHEELDATA Timed Wheel Data

This log contains wheel sensor data. The time stamp in the header is the time of validity for the wheel data, not the time the TIMEDWHEELDATA log was output.

See also *SPAN-CPT Wheel Sensor* on *page 43*.

Structure: **Message ID: 622**

Log Type: Asynch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Ticks Per Rev	Number of ticks per revolution	Ushort	2	H
3	Wheel Vel	Wheel velocity in counts/s	Ushort	2	H+2
4	fWheel Vel	Float wheel velocity in counts/s	Float	4	H+4
5	Reserved		Ulong	4	H+8
6			Ulong	4	H+12
7	Ticks Per Second	Cumulative number of ticks per second	long	4	H+16
8	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+20
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	

Recommended Input:

log timedwheeldataa innew

ASCII Example:

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

C.2.29 VEHICLEBODYROTATION Vehicle to SPAN frame Rotation

The VEHICLEBODYROTATION log reports the angular offset from the vehicle frame to the SPAN frame. The SPAN frame is defined by the transformed IMU axis with Z pointing up, see the SETIMUORIENTATION on *page 77*.

The VEHICLEBODYROTATION command, see *page 90*, sets the initial estimates for the angular offset. The uncertainty values are optional. Also refer to the Syntax table under VEHICLEBODYROTATION Vehicle to SPAN frame Rotation on *page 90*.

> If your SPAN-CPT 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.

Message ID: 642

Log Type: Asynch

Recommended Input:

log vehiclebodyrotationa onchanged

ASCII Example:

```
#VEHICLEBODYROTATIONA,COM1,0,36.5,FINESTEERING,1264,144170.094,
00000000,bcf2,1541;1.5869999997474209,2.6639999995760122,77.649999876392343,
2.0000000000000000,2.0000000000000000,5.0000000000000000*25f886cc
```

C.2.30 WHEELSIZE Wheel Size

This log contains wheel sensor information.

The inertial Kalman filter models the size of the wheel to compensate for changes in wheel circumference due to hardware or environmental changes. The default wheel size is 1.96 m. A scale factor to this default size is modeled in the filter and this log contains the current estimate of the wheel size.

Structure: **Message ID: 646**

Log Type: Asynch

Field #	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	Log Header	Log header	-	H	0
2	Scale	Wheel sensor scale factor	Double	8	H
3	Circumference	Wheel circumference (m)	Double	8	H+8
4	Variance	Variance of circumference (m^2)	Double	8	H+16
5	xxxx	32-bit CRC (ASCII, Binary and Short Binary only)	Hex	4	H+24
6	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Recommended Input:

log wheelsizea onnew

ASCII Example:

```
#WHEELSIZEA,COM3,0,44.0,EXACT,0,0.000,00000000,85f8,33738;
1.025108123,2.009211922,0.000453791*157fd50b
```

Appendix D Command Prompt Interface

When the SPAN system turns on, no activity information is transmitted from the serial ports except for the port prompt. A terminal connected to the receiver display a messages on its monitor. For example:

[COM1] *if connected to COM1 port*

The COM port can be COM1, COM2, USB1, USB2 or USB3. Commands are typed at the interfacing terminal's keyboard, and sent after pressing the terminal's <↵> or <Enter> key.

> Most valid commands do produce a visible response on the screen. The indication that they have been accepted is a return of the port prompt from the receiver.

Example:

An example of no echo response to an input command is the SETIMUTOANTOFFSET command. It can be entered as follows:

```
[COM2]setimutoantoffset .33 0.1 1.2 0.01 0.01 0.01[Return]
[COM2]
```

The above example illustrates command input to the receiver COM2 serial port, which sets the antenna to IMU offset. However, your only confirmation that the command was actually accepted is the return of the [COM2] prompt.

If a command is incorrectly entered, the receiver responds with "Invalid Command Name" (or a more detailed error message) followed by the port prompt.

D.1 DOS

One way to initiate multiple commands and logging from the receiver is to create DOS command files relating to specific functions. This minimizes the time required to set up duplicate test situations. Any convenient text editor can be used to create command text files.

Example:

For this example, consider a situation where a laptop computer's appropriately configured COM1 serial port is connected to the receiver's COM1 serial port, and where a rover terminal is connected to the receiver's COM2 serial port. If you wish to monitor the SPAN system activity, the following command file could be used to do this.

1. Open a text editor on the PC and type in the following command sequences:

   ```
   log com2 satvisa ontime 15
   log com2 trackstata ontime 15
   log com2 rxstatusa ontime 60 5
   log com2 bestposa ontime 15
   log com2 psrdopa ontime 15
   ```

2. Save this with a convenient file name (e.g. C:\GPS\BOOT1.TXT) and exit the text editor.
3. Use the DOS *copy* command to direct the contents of the BOOT1.TXT file to the PC's COM1 serial port:

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

4. The SPAN system is now initialized with the contents of the BOOT1.TXT command file, and logging is directed from the receiver's COM2 serial port to the rover terminal.

D.2 WINDOWS

As any text editor or communications program can be used for these purposes, the use of Windows 98 is described only as an illustration. The following example shows how Windows 98 accessory programs *Notepad* and *HyperTerminal* can be used to create a hypothetical waypoint navigation file on a laptop computer, and send it to the receiver. It is assumed that the laptop computer's COM1 serial port is connected to the receiver's COM1 serial port, and that a rover terminal is connected to the receiver's COM2 serial port.

Example:

1. Open *Notepad* and type in the following command text:

```
setnav 51.111 -114.039 51.555 -114.666 0 start stop
magvar -21
log com1 bestposa ontime 15
log com1 psrvela ontime 15
log com1 navigatea ontime 15
log com2 gprmb ontime 15 5
log com2 gpvtg ontime 15 5
log com2 rxconfiga ontime 60
```

2. Save this with a convenient file name (e.g. C:\GPS\BOOTNAV1.TXT) and exit *Notepad*.
3. Ensure that the *HyperTerminal* settings are correctly set up to agree with the receiver communications protocol; these settings can be saved (e.g. C:\GPS\OEMSETUP.HT) for use in future sessions. You may wish to use XON / XOFF handshaking to prevent loss of data.
4. Select Transfer | Send Text File to locate the file that is to be sent to the receiver. Once you double-click on the file or select Open, *HyperTerminal* sends the file to the receiver.

The above example initializes the SPAN system with origin and destination waypoint coordinates and sets the magnetic variation correction to -21 degrees. The BESTPOSA, PSRVELA, and NAVIGATEA logs have been set to output from the receiver's COM1 serial port at intervals of once every 15 seconds, whereas the GPRMB and GPVTG NMEA logs have been set to be logged out of the receiver's COM2 serial port at intervals of 15 seconds and offset by five seconds. The RXCONFIGA log has been set to output every 60 seconds from its COM2 serial port.

Appendix E Replacement Parts

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

E.1 SPAN-CPT System

Part Description	NovAtel Part
KVH Enclosure	80023524
KVH Standard Unterminated Cable	60723107
KVH Development Terminated Cable	60723108
SPAN-CPT Quickstart Guide	GM-14915081
OEMV, NovAtel Connect and Convert disk (refer to *page 34* of this manual and to the *OEMV Family Installation and Operation User Manual*)	01017827
SPAN-CPT User Manual	OM-20000122
OEMV Family Installation and Operation User Manual	OM-20000093
OEMV Family Firmware Reference Manual	OM-20000094

E.2 Accessories and Options

Part Description	NovAtel Part
Optional NovAtel GPSAntennas:	
Model 532 (for aerodynamic applications)	ANT-A72GA-TW-N
Model 702 (for high-accuracy applications)	GPS-702
Model 702L (for L-band applications)	GPS-702L
Model 533 (for high-performance base station applications)	ANT-C2GA-TW-N
Optional RF Antenna Cable:	
5 meters	GPS-C006
15 meters	GPS-C016

Appendix F Frequently Asked Questions

1 *Why don't I hear any sound from my SPAN-CPT?*

a. The SPAN-CPT does not make noise. Check that the multi-purpose I/O cable is connected properly.
b. Check the input power supply. A minimum of 12V should be supplied to the system for stable SPAN-CPT performance. The supply should also be able to output at least 12W over the entire operating temperature range.

2 *Why don't I have any INS logs?*

On start-up, the INS logs are not available until the system has solved for time. This requires that an antenna is attached, and satellites are visible, to the system. You can verify that time is solved by checking the time status in the header of any standard header SPAN log such as BESTPOS. When the time status reaches FINESTEERING, the inertial filter starts and INS messages are available.

3 *How can I access the inertial solution?*

The INS/GPS solution is available from a number of specific logs dedicated to the inertial filter. The INSPOS, INSPVA, INSVEL, INSSPD, and INSATT logs are the most commonly used logs for extracting the INS solution. These logs can be logged at any rate up to the rate of the IMU data (100 Hz). Further details on these logs are available in Appendix C, INS Logs starting on Page 65.

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

The GPS only solution used when running the OEMV receiver without the IMU is still available when running SPAN. Logs such as PSRPOS, RTKPOS and OMNIPOS are still available. Any non-INS logs should be logged at a maximum rate of 5 Hz when running SPAN. Only INS-specific logs documented in Appendix C, INS Logs starting on Page 65 should be logged at rates higher than 5 Hz when running SPAN.

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

When GPS tracking is interrupted, the INS/GPS solution bridges through the gaps with what is referred to as free-inertial navigation. The IMU measurements are used to propagate the solution. Errors in the IMU measurements accumulate over time to degrade the solution accuracy. For example, after one minute of GPS outage, the horizontal position accuracy is approximately 8.4 m. The SPAN solution continues to be computed for as long as the GPS outage lasts, but the solution uncertainty increases with time. This uncertainty can be monitored using the INSCOV log, see *page 115*.

6 *All the accels measurements in my RAWIMUS logs are zero and the IMU status shows one or all accels are failing. What is wrong?*

Ensure a monotonic power supply on power up of your SPAN-CPT unit. See *Connect Power* on *page 29* for more information.

Index

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