ashtech

ProFlex™ Lite Series

Reference Manual

Copyright Notice

P/N 631643, Revision C, April 2011

Trademarks

CAUTION!

Risk of explosion if battery is incorrectly replaced. Replace only with the same or equivalent type recommended by the manufacturer. Dispose of used batteries according to the manufacturer's instructions.

Ashtech Products - Limited Warranty (North, Central and South America)

Ashtech warrants their GPS receivers and hardware accessories to be free of defects in material and workmanship and will conform to our published specifications for the product for a period of one year from the date of original purchase. THIS WARRANTY APPLIES ONLY TO THE ORIGINAL PURCHASER OF THIS PRODUCT.

In the event of a defect, Ashtech will, at its option, repair or replace the hardware product with no charge to the purchaser for parts or labor. The repaired or replaced product will be warranted for 90 days from the date of return shipment, or for the balance of the original warranty, whichever is longer. Ashtech warrants that software products or software included in hardware products will be free from defects in the media for a period of 30 days from the date of shipment and will substantially conform to the then-current user documentation provided with the software (including updates thereto). Ashtech's sole obligation shall be the correction or replacement of the media or the software so that it will substantially conform to the then- current user documentation. Ashtech does not warrant the software will meet purchaser's requirements or that its operation will be uninterrupted, error-free or virus-free. Purchaser assumes the entire risk of using the software.

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To obtain warranty service the purchaser must obtain a Return Materials Authorization (RMA) number prior to shipping by calling 1-800-229-2400 (North America) or 1-408-572-1134 (International) and leaving a voice mail at option 3, or by submitting a repair request on-line at: http://ashtech.com (fill out the RMA request from under the Support tab). The purchaser must return the product postpaid with a copy of the original sales receipt to the address provided by Ashtech with the RMA number. Purchaser's return address and the RMA number must be clearly printed on the outside of the package.

Ashtech reserves the right to refuse to provide service free-of-charge if the sales receipt is not provided or if the information contained in it is incomplete or illegible or if the serial number is altered or removed. Ashtech will not be responsible for any losses or damage to the product incurred while the product is in transit or is being shipped for repair. Insurance is recommended. Ashtech suggests using a trackable shipping method such as UPS or FedEx when returning a product for service.

EXCEPT AS SET FORTH IN THIS LIMITED WARRANTY, ALL OTHER EXPRESSED OR IMPLIED WARRANTIES, INCLUDING THOSE OF FITNESS FOR ANY PARTICULAR PURPOSE, MERCHANTABILITY OR NON-INFRINGEMENT, ARE HEREBY DISCLAIMED AND IF APPLICABLE, IMPLIED WARRANTIES UNDER ARTICLE 35 OF THE UNITED NATIONS CONVENTION ON CONTRACTS FOR THE INTERNATIONAL SALE OF GOODS. Some national, state, or local laws do not allow limitations on implied warranty or how long an implied warranty lasts, so the above limitation may not apply to you.

The following are excluded from the warranty coverage: (1) periodic maintenance and repair or replacement of parts due to normal wear and tear; (2) batteries and finishes; (3) installations or defects resulting from installation; (4) any damage caused by (i) shipping, misuse, abuse, negligence, tampering, or improper use; (ii) disasters such as fire, flood, wind, and lightning; (iii) unauthorized attachments or modification; (5) service performed or attempted by anyone other than an authorized Ashtechs Service Center; (6) any product, components or parts not manufactured by Ashtech; (7) that the receiver will be free from any claim for infringement of any patent, trademark, copyright or other proprietary right, including trade secrets; and (8) any damage due to accident, resulting from inaccurate satellite transmissions. Inaccurate transmissions can occur due to changes in the position, health or geometry of a satellite or modifications to the receiver that may be required due to any change in the GPS. (Note: Ashtech GPS receivers use GPS or GPS+GLONASS to obtain position, velocity and time information. GPS is operated by the U.S. Government and GLONASS is the Global Navigation Satellite System of the Russian Federation, which are solely responsible for the accuracy and maintenance of their systems. Certain conditions can cause inaccuracies which could require modifications to the receiver. Examples of such conditions include but are not limited to changes in the GPS or GLONASS transmission.) Opening, dismantling or repairing of this product by anyone other than an authorized Ashtech Service Center will void this warranty.

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This written warranty is the complete, final and exclusive agreement between Ashtech and the purchaser with respect to the quality of performance of the goods and any and all warranties and representations. This warranty sets forth all of Ashtech's responsibilities regarding this product. This limited warranty is governed by the laws of the State of California, without reference to its conflict of law provisions or the U.N. Convention on Contracts for the International Sale of Goods, and shall benefit Ashtech, its successors and assigns.

This warranty gives the purchaser specific rights. The purchaser may have other rights which vary from locality to locality (including Directive 1999/44/EC in the EC Member States) and certain limitations contained in this warranty, including the exclusion or limitation of incidental or consequential damages may not apply.

For further information concerning this limited warranty, please call or write:

Ashtech LLC., El Camino Real 451, Suite 210, Santa Clara, CA 95050, Phone: +1 408 572 1103, Fax: +1 408 572 1199 or

Ashtech - ZAC La Fleuriaye - BP 433 - 44474 Carquefou Cedex - France Phone: +33 (0)2 28 09 38 00, Fax: +33 (0)2 28 09 39 39.

Ashtech Products Limited Warranty (Europe, Middle East, Africa)

All Ashtech global positioning system (GPS) receivers are navigation aids, and are not intended to replace other methods of navigation. Purchaser is advised to perform careful position charting and use good judgment. READ THE USER GUIDE CAREFULLY BEFORE USING THE PRODUCT.

1. ASHTECH WARRANTY

Ashtech warrants their GPS receivers and hardware accessories to be free of defects in material and workmanship and will conform to our published specifications for the product for a period of one year from the date of original purchase or such longer period as required by law. THIS WARRANTY APPLIES ONLY TO THE ORIGINAL PURCHASER OF THIS PRODUCT.

In the event of a defect, Ashtech will, at its option, repair or replace the hardware product with no charge to the purchaser for parts or labor. The repaired or replaced product will be warranted for 90 days from the date of return shipment, or for the balance of the original warranty, whichever is longer. Ashtech warrants that software products or software included in hardware products will be free from defects in the media for a period of 30 days from the date of shipment and will substantially conform to the then-current user documentation provided with the software (including updates thereto). Ashtech's sole obligation shall be the correction or replacement of the media or the software so that it will substantially conform to the then- current user documentation. Ashtech does not warrant the software will meet purchaser's requirements or that its operation will be uninterrupted, error-free or virus-free. Purchaser assumes the entire risk of using the software.

2. PURCHASER'S REMEDY

PURCHASER'S EXCLUSIVE REMEDY UNDER THIS WRITTEN WARRANTY OR ANY IMPLIED WARRANTY SHALL BE LIMITED TO THE REPAIR OR REPLACEMENT, AT ASHTECH'S OPTION, OF ANY DEFECTIVE PART OF THE RECEIVER OR ACCESSORIES WHICH ARE COVERED BY THIS WARRANTY. REPAIRS UNDER THIS WARRANTY SHALL ONLY BE MADE AT AN AUTHORIZED ASHTECH SERVICE CENTER. ANY REPAIRS BY A SERVICE CENTER NOT AUTHORIZED BY ASHTECH WILL VOID THIS WARRANTY.

3. PURCHASER'S DUTIES

To obtain service, contact and return the product with a copy of the original sales receipt to the dealer from whom you purchased the product.

Ashtech reserves the right to refuse to provide service free-of-charge if the sales receipt is not provided or if the information contained in it is incomplete or illegible or if the serial number is altered or removed. Ashtech will not be responsible for any losses or damage to the product incurred while the product is in transit or is being shipped for repair. Insurance is recommended. Ashtech suggests using a trackable shipping method such as UPS or FedEx when returning a product for service.

4. LIMITATION OF IMPLIED WARRANTIES

EXCEPT AS SET FORTH IN ITEM 1 ABOVE, ALL OTHER EXPRESSED OR IMPLIED WARRANTIES, INCLUDING THOSE OF FITNESS FOR ANY PARTICULAR PURPOSE OR MERCHANTABILITY, ARE HEREBY DISCLAIMED AND IF APPLICABLE, IMPLIED WARRANTIES UNDER ARTICLE 35 OF THE UNITED NATIONS CONVENTION ON CONTRACTS FOR THE INTERNATIONAL SALE OF GOODS.

Some national, state, or local laws do not allow limitations on implied warranty or how long an implied warranty lasts, so the above limitation may not apply to you.

5. EXCLUSIONS

The following are excluded from the warranty coverage:

(1) periodic maintenance and repair or replacement of parts due to normal wear and tear;

(2) batteries;

(3) finishes;

(4) installations or defects resulting from installation;

(5) any damage caused by (i) shipping, misuse, abuse, negligence, tampering, or improper use; (ii) disasters such as fire, flood, wind, and lightning; (iii) unauthorized attachments or modification;

(6) service performed or attempted by anyone other than an authorized Ashtechs Service Center;

(7) any product, components or parts not manufactured by Ashtech,

(8) that the receiver will be free from any claim for infringement of any patent, trademark, copyright or other proprietary right, including trade secrets

(9) any damage due to accident, resulting from inaccurate satellite transmissions. Inaccurate transmissions can occur due to changes in the position, health or geometry of a satellite or modifications to the receiver that may be required due to any change in the GPS. (Note: Ashtech GPS receivers use GPS or GPS+GLONASS to obtain position, velocity and time information. GPS is operated by the U.S. Government and GLONASS is the Global Navigation Satellite System of the Russian Federation, which are solely responsible for the accuracy and maintenance of their systems. Certain conditions can cause inaccuracies which could require modifications to the receiver. Examples of such conditions include but are not limited to changes in the GPS or GLONASS transmission.).

Opening, dismantling or repairing of this product by anyone other than an authorized Ashtech Service Center will void this warranty.

6. EXCLUSION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES

ASHTECH SHALL NOT BE LIABLE TO PURCHASER OR ANY OTHER PERSON FOR ANY INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES WHATSOEVER, INCLUDING BUT NOT LIMITED TO LOST PROFITS, DAMAGES RESULTING FROM DELAY OR LOSS OF USE, LOSS OF OR DAMAGES ARISING OUT OF BREACH OF THIS WARRANTY OR ANY IMPLIED WARRANTY EVEN THOUGH CAUSED BY NEGLIGENCE OR OTHER FAULT OFASHTECH OR NEGLIGENT USAGE OF THE PRODUCT. IN NO EVENT WILL ASHTECH BE RESPONSIBLE FOR SUCH DAMAGES, EVEN IF ASHTECH HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

Some national, state, or local laws do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

7. COMPLETE AGREEMENT

This written warranty is the complete, final and exclusive agreement between Ashtech and the purchaser with respect to the quality of performance of the goods and any and all warranties and representations. THIS WARRANTY SETS FORTH ALL OF Ashtech'S RESPONSIBILITIES REGARDING THIS PRODUCT.

THIS WARRANTY GIVES YOU SPECIFIC RIGHTS. YOU MAY HAVE OTHER RIGHTS WHICH VARY FROM LOCALITY TO LOCALITY (including Directive 1999/44/EC in the EC Member States) AND CERTAIN LIMITATIONS CONTAINED IN THIS WARRANTY MAY NOT APPLY TO YOU.

8. CHOICE OF LAW.

This limited warranty is governed by the laws of France, without reference to its conflict of law provisions or the U.N. Convention on Contracts for the International Sale of Goods, and shall benefit Ashtech, its successors and assigns.

THIS WARRANTY DOES NOT AFFECT THE CUSTOMER'S STATUTORY RIGHTS UNDER APPLICABLE LAWS IN FORCE IN THEIR LOCALITY, NOR THE CUSTOMER'S RIGHTS AGAINST THE DEALER ARISING FROM THEIR SALES/PURCHASE CONTRACT (such as the guarantees in France for latent defects in accordance with Article 1641 et seq of the French Civil Code).

For further information concerning this limited warranty, please call or write:

Ashtech - ZAC La Fleuriaye - BP 433 - 44474 Carquefou Cedex - France.

Phone: +33 (0)2 28 09 38 00, Fax: +33 (0)2 28 09 39 39.

How to Use this Manual

This manual is organized as follows:

- **Chapter 1** is a technical introduction to the ProFlex Lite and ProFlex Lite Duo. The following information is presented: list of shippable items (basic and optional), front panel description, indicator lights, installation instructions, power requirements, technical specifications, MB 500 technical specifications and port pinout.
- **Chapter 2** reviews a selection of the typical applications of the ProFlex Lite (single-board configuration). Only the key configuration steps are listed. Refer to chapters 5-8 for more information on all applicable commands and data output messages.
- **Chapter 3** describes the UHF option for use with ProFlex Lite.
- **Chapter 4** reviews a selection of the typical applications of the ProFlex Lite Duo (dual-board configuration). Only the key configuration steps are listed. Refer to chapters 5-8 for more information on all applicable commands and data output messages.

The last five chapters focus on the MB 500 board alone. They are in fact repaginated excerpts from the MB 500 Reference Manual. These are intended to give you a more general view of the board so you can optimize its use in the ProFlex and ProFlex Lite Duo.

- **Chapter 5** includes an introduction to serial commands and reviews the different configuration steps for the MB 500 board: antenna & receiver parameters, position computation mode, heading function, managing data messages (differential data, raw data, NMEA and NMEA-like data). This chapter also provides in-depth information about differential data messages.
- **Chapter 6** provides an exhaustive description of all the set commands applicable to the MB 500 board.
- **Chapter 7** provides an exhaustive description of all the query commands applicable to the MB 500 board.
- **Chapter 8** provides a description of the raw data messages in Ashtech proprietary format.
- **Chapter 9** gives an explanation of the possible antenna height transformations performed by the board and provides the list of predefined anten1as.

April 2011 Release Note

Compared to the June 2010 release of this manual, the current release contains the following changes:

- Chapter 1: Clarification on the definition of the [V] firmware option (page 5); List of items updated to include the new ASH-66x antennas (page 6).
- Chapter 4: Use of the ProFlex Lite Duo. In the previous release of the manual, board #2 was given the heading or vector function, which was in contradiction with the factory settings. The manual now describes the two MB 500 boards with their real functions.
- Chapters 6-9 revised following the release of the new MB500 firmware.

Table of Contents

Chapter 1. Introduction

What are ProFlex Lite and ProFlex Lite Duo?

ProFlex Lite and ProFlex Lite Duo are state-of-the-art GNSS receivers intended for general-purpose, real-time, high-accuracy, absolute positioning applications, with additionally accurate heading measurements and relative positioning for ProFlex Lite Duo.

Both products share the same weatherproof, lightweight, small-sized and rugged enclosure capable of accommodating either one GNSS MB 500 board (ProFlex Lite) or two GNSS MB 500 boards (ProFlex Lite Duo).

ProFlex Lite and ProFlex Lite Duo have each a built-in power supply extending the input voltage range to between 9 and 36 V DC while maintaining a power consumption at less than 7 W (in dual-board configuration) regardless of the power input voltage.

Built in a weatherproof, rugged and small-size unit, the ProFlex Lite and ProFlex Lite Duo can be operated in harsh environments while requiring a minimum of space for their installation.

As lightweight units, ProFlex Lite and ProFlex Lite Duo are also compatible with airborne applications for which weight considerations are critical.

ProFlex Lite and ProFlex Lite Duo are smart GNSS receivers because the heart of these receivers uses the GPS/GLONASS/SBAS, single- or dual-frequency MB 500 board recently introduced in the market. Embedded BLADE™ technology in the MB 500 board ensures powerful performance and a patented way to use multiple GNSS constellations for high-accuracy positioning solutions:

- Fast initialization and accuracy at long-range,
- Patented multi-constellation signal processing,
- Advanced multi-path mitigation and robust signal tracking,
- RTK solution maintained if data link is briefly dropped,

- Interoperability with any vendor's reference station transmitting GPS+GLONASS L1/L2 signals.

The typical applications of the ProFlex Lite (single-board configuration) are:

- “Office” GNSS base station, used in conjunction with RTDS software or equivalent.
- “Field” base station connected to an external radio transmitter and a battery.
- On-board standalone GNSS rover used in SBAS DGPS mode.
- On-board GNSS rover connected to its internal UHF option or an external communication device (radio, GPRS, CDMA) and used in DGPS, Flying RTK or RTK mode.

The typical applications of the ProFlex Lite Duo (dual-board configuration) are:

- GNSS heading measurements for marine, military and civil (antenna pointing) applications, possibly combined with the delivery of an absolute RTK position.
- Relative positioning, delivering the accurate components of the baseline vector, possibly combined with the delivery of an absolute RTK position (machine guidance and control).
- Relative movement monitoring, heave compensation, wing deformation, etc.

List of Items

The tables below give an overview of the different items that may be delivered with your equipment. Depending on your purchase, only some of the listed items may have been shipped. Please refer to the packing list for an accurate description of the items that were ordered.

Ashtech reserves the right to make changes to the list of items given below without prior notice.

ProFlex Lite

Basic Supply:

Item	Part No.	Picture
ProFlex Lite (single-board configuration): • L1 GPS/GLONASS: • L1/L2 GPS: • L1/L2 GPS/GLONASS: Each of the above three items includes the following accessories: • AC/DC power unit • Serial data cable • Mounting parts (consists of two sliding bars) • Transport bag • ProFlex Lite Documentation CD	 990626-01 990626-02 990626-03	

Pre-installed Firmware:

Pre-installed Firmware	ProFlex Lite L1 GPS/GLONASS	ProFlex Lite L1/L2 GPS	ProFlex Lite L1/L2 GPS/GLONASS
[C]: Advanced multipath mitigation	•	•	•
[E]: Event marker	•	•	•
[G]: GLONASS	•		•
[K]: RTK Base	•	•	•
[L]: 1 PPS	•	•	•
[T]: 10-Hz output rate	•	•	•
[Y]: SBAS tracking	•	•	•
[P]+[S]: Dual-frequency tracking		•	•

Firmware Options:

Firmware Options	Part No.	ProFlex Lite L1 GPS/GLONASS	ProFlex Lite L1/L2 GPS	ProFlex Lite L1/L2 GPS/GLONASS
[J]+[V]+[H]	680585	•	•	•
[G]	680557		•	
[W]	680562	•	•	•
[P]+[S]	680574	•		

Where:

- [J]+[V]+[H]: Full RTK rover, i.e. RTK rover [J], Moving base [V] and Heading [H].
- [G]: GLONASS tracking.
- [W]: 20-Hz position/raw data update rate.
- [P]+[S]: GPS/GLONASS dual-frequency tracking

U-Link Rx Kit (built-in UHF Radio Receiver Option):

Item	Part Number	Picture
U-Link Rx, 12.5 kHz channel bandwidth (includes half-wave whip antenna).	802126-10 (410-430MHz) 802126-30 (430-450 MHz) 802126-50 (450-470 MHz)	(internal part)

U-Link TRx (External UHF Radio Transmitter Option):

Item	Part Number	Picture
U-Link TRx, 12.5-kHz channel bandwidth	Transmitter: 802127-10 (0.5/2/4W; 410-430 MHz) 802127-30 (0.5/2/4W; 430-450 MHz) 802127-50 (0.5/2/4W; 450-470 MHz) Each P/N includes a half-wave whip antenna, and an antenna bracket. The Y-shaped power/data cable is an integral part of the transmitter (no connector on transmitter side). The data end of the cable is fitted with a DB9 connector. The other end (power) has no connector (bare wires)	 Picture of transmitter with its cable

Hardware/Firmware Upgrade Kits:

Item	Part No.
ProFlex Lite L1 GPS/GLONASS to ProFlex Lite Duo L1 GPS/GLONASS	
ProFlex Lite L1/L2 GPS to ProFlex Lite Duo L1/L2 GPS	
ProFlex Lite L1/L2 GPS/GLONASS to ProFlex Lite Duo L1/L2 GPS/GLONASS	

For more information on these kits, please contact your local Ashtech dealer.

ProFlex Lite Duo

Basic Supply:

Item	Part No.	Picture
ProFlex Lite Duo (dual-board configuration): • L1 GPS/GLONASS: • L1/L2 GPS: • L1/L2 GPS/GLONASS: Each of the above three items includes the following accessories: • AC/DC power block • Two serial data cables • Mounting parts (consists of two sliding bars) • Transport bag • ProFlex Lite Documentation CD	 990626-11 990626-22 990626-33	

Pre-installed Firmware:

Pre-installed Firmware	ProFlex Lite Duo L1 GPS/GLONASS		ProFlex Lite Duo L1/L2 GPS		ProFlex Lite Duo L1/L2 GPS/GLONASS	
	Board#1	Board#2	Board#1	Board#2	Board#1	Board#2
[C]: Multipath	•	•	•	•	•	•
[E]: Event marker	•		•		•	
[G]: GLONASS	•	•			•	•
[H]: Heading	•		•		•	
[J]: RTK rover	•		•		•	
[K]: RTK base	•	•	•	•	•	•
[L]: 1PPS	•		•		•	
[T]: 10-Hz output	•	•	•	•	•	•
[V]: Moving base*	•		•		•	
[Y]: SBAS	•	•	•	•	•	•
[P]+[S]: Dual-freq			•	•	•	•

*Note: * The "Moving base" option ([V]) gives the board the capability to deliver accurate vector measurements, through the VEC message for example. This option should not be confused with the possibility given to the user, with the $PASHS,POS,MOV command, to declare a board as a "moving base", which means the board is assumed to be moving, i.e. delivering a moving reference position, not a static one.*

Firmware Options:

Firmware Options	ProFlex Lite Duo L1 GPS/GLONASS		ProFlex Lite Duo L1/L2 GPS		ProFlex Lite Duo L1/L2 GPS/GLONASS	
	Board#1	Board#2	Board#1	Board#2	Board#1	Board#2
[J]+[V]+[H]		•		•		•
[G]: GLONASS			•	•		
[P]+[S]: Dual freq.	•	•				
[W]: 20-Hz output	•	•	•	•	•	•

Where:
- [J]+[V]+[H] give board #2 the RTK+Heading capability.
- [G]: GLONASS tracking.
- [P]+[S]: GPS/GLONASS dual-frequency option
- [W]: 20-Hz position/raw data update rate.

Firmware Options	Part No.
[J]+[V]+[H]	680585

Firmware Options	Part No.
[G]: GLONASS	680557
[P]+[S]: Dual freq.	680574
[W]: 20-Hz output	680562

Antennas and Accessories

The following antennas and accessories can be ordered for use with any of the ProFlex Lite models:

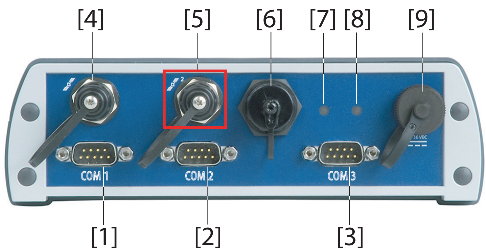
Item	Part No.	Picture
ASH-661 L1/L2/L5 GNSS antenna, gain: 38 dB	802135	
ASH-660 L1 GNSS antenna, gain: 38 dB	802133	
GNSS antenna & L band, 38 dB, 4.2-15 V DC	111407	
10-meter TNC-TNC coaxial cable	700439	
V-shaped data cable	702471	

Software Utility

A software utility called “Ashtech Communicator” is available from Ashtech to help you perform the required settings on your unit. To download this software, go to ftp://ftp.ashtech.com/OEM,%20Sensor%20&%20ADU/Utility%20Software/Ashcom/.

Equipment Description & Basic Functions

Front Panel



[1]: COM 1 (RS232).

[2]: COM 2 (RS232).

[3]: COM 3: Not used as a port, but may be used to provide DC power to an external device (please call Ashtech technical support).

WARNING! In the first units (P/N 802102 Xn) shipped by Ashtech, the locations of COM 1 and COM 3 on the front panel are inverted compared to the present description. Also on these first units, the port labels are simply “1”, “2” and “3” and printed above the SubD connectors. All more recent units (from P/N 802102 rev A, then rev B, etc.) comply, or will comply, with the present description.

[4] : GNSS input #1 (TNC-f connector, fitted with protective cap, to be used to maintain watertightness when the connection is not used).

[5] 2 : GNSS input #2 (ProFlex Lite Duo only), a TNC-f connector, fitted with a protective cap. For ProFlex Lite only, **[5]** is also the RF input for the internal UHF option, where to connect the coaxial cable to the whip antenna.

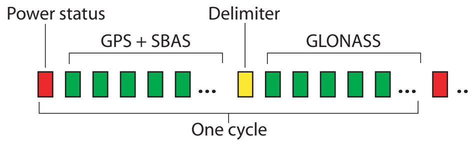
[6]: Standard USB 2.0 port in a protective circular connector

[7] and **[8]**: GNSS indicator lights allowing you to monitor the power status and constellations of satellites for the one or two GNSS boards used. **[7]** refers to board #1 (GNSS input #1) and **[8]** to board #2 (GNSS input #2).

- The indicator lights use different colors within one cycle of monitoring:

Color	Meaning
Red	Power
Green	GNSS reception

Color	Meaning
Yellow	Delimiter between GPS/SBAS and GLONASS



- The sequence of red, green and yellow flashes describes the following:
  1. One red flash: Means the board is powered properly.
  2. Green flashes: The number of green flashes is equal to the number of GPS and SBAS satellites tracked and locked.
  3. One yellow flash: Ends the first sequence of green flashes (GPS+SBAS).
  4. Green flashes: The number of green flashes is equal to the number of GLONASS satellites tracked and locked.

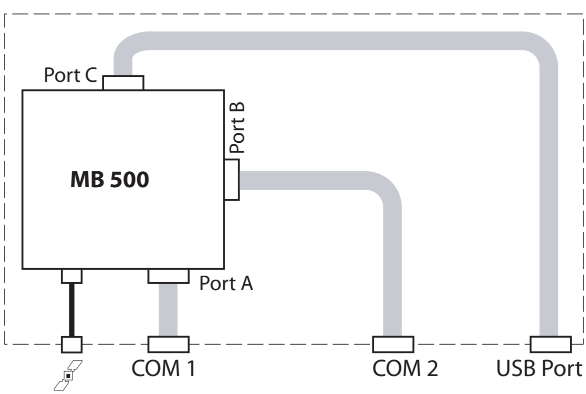
     One red flash: Ends the second sequence of green flashes (GLONASS) and resumes the whole of the above sequence of flashes from the beginning.

[9]: DC input (9-36 V DC)

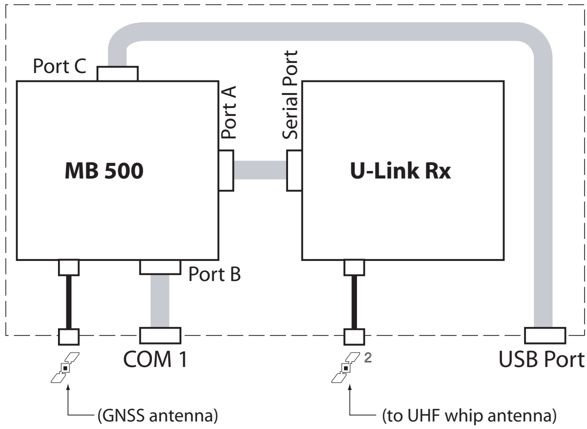
Internal Connections

The allocation of the front panel ports depends on whether a single- or dual-board configuration is provided. The diagrams below give the internal structure and connections for each of the two configurations.

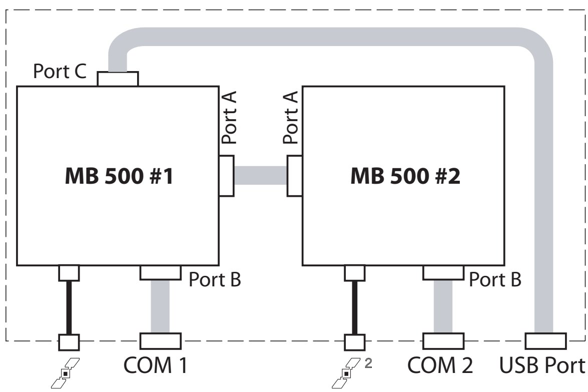
ProFlex Lite (single-board configuration):



ProFlex Lite (single-board configuration with UHF option):



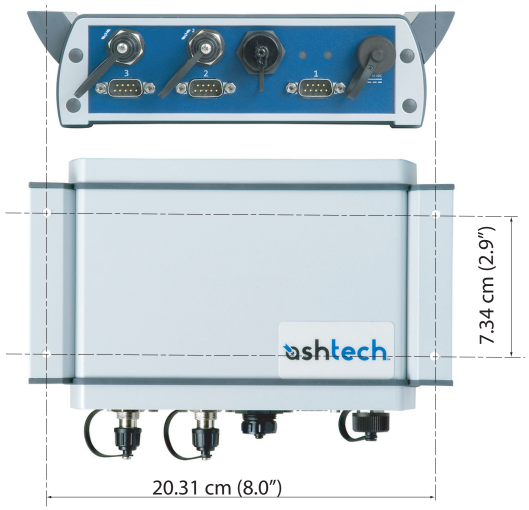
ProFlex Lite Duo (dual-board configuration):



Installation Instructions

The ProFlex Lite or ProFlex Lite Duo can be mounted onto any flat support after you have secured the provided wall fitting kit onto the case. The kit consists of two identical sliding bars.

Prepare the support by drilling the required four holes (dia.). The four holes form a rectangle of 20.31 cm in width and 7.34 cm in depth (see diagram below).

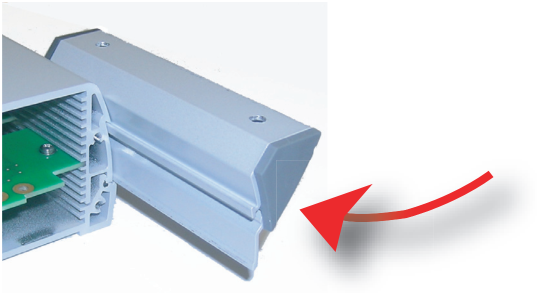


To secure the wall fitting kit onto the case, do the following:

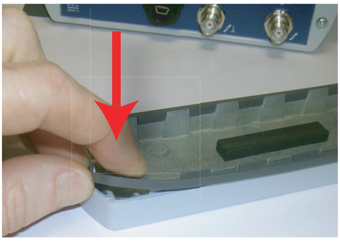
- Eject the four black plastic caps from the rear panel using a sharp tool. This unveils the four screws used to secure the rear panel to the case.

- Loosen these four screws using a torque screwdriver and unfasten the rear panel from the case.
- Remove the two dark-grey rubber strips located on either side of the case.

- Insert one sliding bar into the groove on one side of the case, as shown on the picture below.



- Do the same on the other side using the other sliding bar.
- Make sure the gasket is correctly inserted into the inner edges of the rear panel.



- Put the rear panel back in place, making sure the gasket keeps in position during this operation.
- Tighten the four screws using the torque screwdriver (torque: xx)
- You can insert the rubber strips in the two sliding bars, as shown below, or put them away in a safe place.

- Secure the case on its support using the appropriate screws, nuts and washers (not provided).

Applying Power to the ProFlex Lite or ProFlex Lite Duo

Whatever the power source used, always use the power cable provided. The cable end fitted with a 4-pin plug should be connected to the DC power input on the ProFlex Lite or ProFlex Lite Duo. Fully tightening the plug onto the DC power input will make the power connection waterproof.

If you are using the power line, simply connect the other end of the power cable to the end of the cable coming out of the AC/DC power unit. Then connect the AC/DC power unit to the power line.

If you are using another external DC power source, like a battery for example, you may not need the connector fitted at this end of the cable. Get rid of it by simply shortening the cable using pliers. Then strip the wires and connect them to the type of connector you wish to use (alligator clips or banana pins for example).

In all cases, it is advisable to fit the power source used with a circuit breaker (1-A fuse).

Applying Serial Commands

Serial commands can be applied from your personal computer through any of the available serial ports, including the USB port (for MB500 board #1 only) and the appropriate data cable.

The first time you connect the ProFlex Lite or ProFlex Lite Duo to your computer through a USB link, you will be asked to install the MB500 USB driver. This driver can be found on the ProFlex Lite Series CD.

With ProFlex Lite Duo, **your commands should necessarily be sent directly to the concerned board**, through one of its ports available on the ProFlex Lite Duo front panel. None of the two boards can be used to forward a command from your computer to the other board.

On your computer, use a communication tool to type and send your serial commands. For example you may use “Ashtech Communicator” (this software can be downloaded from the Support column on the Ashtech website), or any other terminal emulation program, such as HyperTerminal (a standard Windows communication accessory).

When using HyperTerminal, perform the following settings after creating a new connection and before typing your first command:

- In the HyperTerminal menu bar, select **File>Properties**.
- Click on the **Settings** tab.
- Click on the **ASCII Setup** button.
- Enable the following two options: **Send line ends with line feeds** and **Echo typed characters locally**. This will automatically complete all your command lines with <cr><lf> characters and allow you to see in real time the commands you are typing.
- Click **OK** twice to close the Properties window.

ProFlex Lite & ProFlex Lite Duo Specifications

Physical Characteristics (sliding bars included):

- Overall dimensions (W x H x D): 221.5 x 58 x 160 mm (8.72 x 2.28 x 6.3")
- Weight:
  - ProFlex Lite: 1.332 kg (2.93 lb)
  - ProFlex Lite Duo: 1.421 kg (3.133 lb)

Environmental characteristics:

- Operating temperature: -30° to +60°C (-22° to +140°F)
- Storage temperature: -40° to +70°C (-40° to +158°F)
- Humidity: 100% condensing
- Sealing: IP67
- Shock: MIL-STD 810F, Fig. 516.5-10 (40 g, 11 ms, sawtooth)
- Vibration: MIL-STD 810F, Fig. 514.5C -17

Power requirements:

- Input voltage range: 9-36 V DC (must be SELV, for "Safety External Low Voltage")
- Power input protected from overvoltages (70 Volts max.)
- Protected from accidental polarity reversal
- Protected against electrical disturbances of vehicles with 12V and 24V supply voltages (ISO 7637 standard)
- Overall power consumption (with GNSS antenna connected): 1 Amp DC current max.
  - ProFlex Lite: < 3.5 W
  - ProFlex Lite with UHF option (U-Link Rx): < 4.2 W
  - ProFlex Lite Duo: < 7.0 W
- GNSS antenna(s) powered from 5 V DC (±10%); DC current: 100 mA max., 5 mA min.
- AC/DC power unit: GLOBTEK, model GTM41060-2512
  Input rated 100-240 V, 50-60 Hz, 0.6 A
  Output rated 12 V DC, 2.08 A.

Recommended Antennas:

- GNSS survey antenna (38 dB gain)
- GNSS machine/marine antenna (38 dB gain)
- GNSS choke ring antenna (ProFlex Lite)

Configuration Tools:

- Ashtech Communicator, a free GNSS utility for evaluation and configuration
- ConfRadio for ProFlex Lite End User, a free PC-running utility for modifying radio settings.

UHF Options:

- Embedded U-Link Rx (receiver)
- External U-Link TRx (transmitter)

Allowable baud rate on RS232 ports: 921.6 kbits/s max.

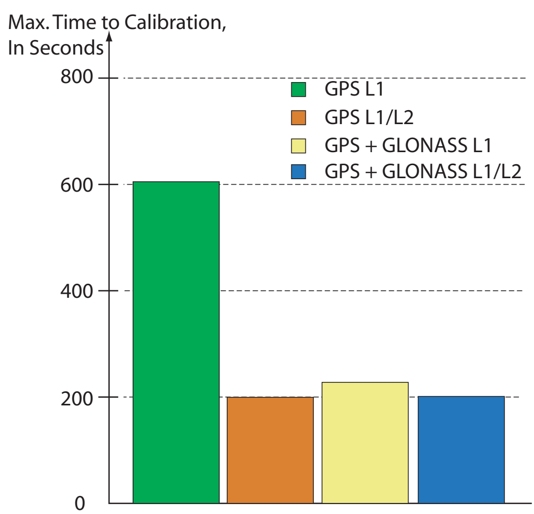
USB port: Serial emulation, up to 12 Mbits/sec.

1PPS output and **Event Marker input**.

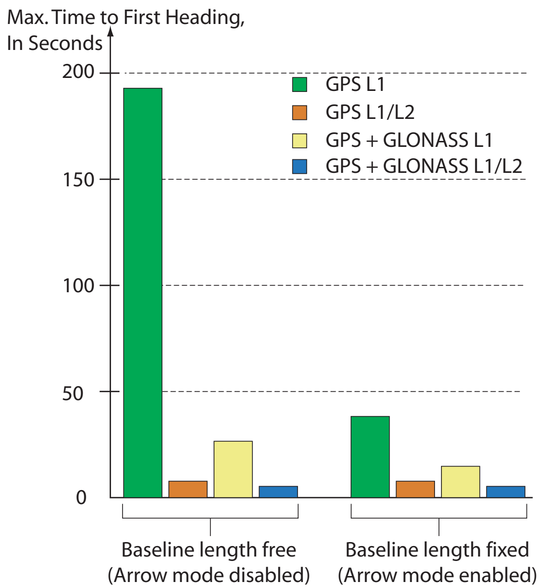
RF input connector type: TNC female.

ProFlex Lite Duo performance figures:

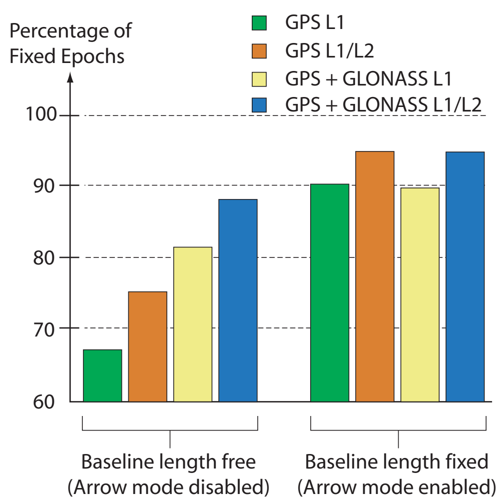
- Maximum Time to first calibration:



- Time to first heading:



- Heading Availability:



MB500 Board Specifications

GNSS Characteristics

- 75 channels:
  - GPS L1 C/A, L1/L2 P-code, L2C, L1/L2 full wavelength carrier
  - GLONASS L1 C/A, L2 C/A code, L1/L2 full wavelength carrier
  - SBAS L1 code & carrier (WAAS/EGNOS/MSAS)
  - Quick signal detection engines for fast acquisition and re-acquisition of GPS/GLONASS/SBAS signals
  - Fully independent code and phase measurements
- Ashtech BLADE™ technology for optimal performance
- Advanced multipath mitigation
- Up to 20 Hz raw data and position output
- RTK base and rover modes.

RTK Base

- DBEN type 0 (observations), type 1 (location)
- RTCM 2.3
- RTCM 3.1
- CMR
- CMR+
- ATOM™ (Ashtech proprietary format)

RTK Rover

- BLADE technology
- Up to 20 Hz Fast RTK
- RTCM 2.3
- RTCM 3.1
- CMR
- CMR+
- ATOM, DBEN & TOPAZE (Ashtech proprietary format)
- Networks: VRS, FKP, MAC
- Hot Standby RTK (Backup RTK)
- NMEA 0183 messages output

Accuracy

All mentioned values are RMS. See (i)

SBAS

i.Accuracy and TTFF specifications may be affected by atmospheric conditions, signal multipath, and satellite geometry. Position accuracy specifications are for horizontal positioning. Vertical error is typically < horizontal error x 2.

- Horizontal < 50 cm typical

DGPS

- Horizontal < 30 cm typical
- 95%: 90 cm (2.95 ft)

Flying RTK™

- Within 50 km of baseline: 5 cm + 1 ppm (ii)(iii)
- Beyond 50 km of baseline: 20 cm + 1 ppm (ii)(iv)

RTK

- Horizontal: 1 cm + 1 ppm
- Vertical: 2 cm + 1 ppm

Heading, Pitch/Roll

- Heading: 0.2 deg/baseline (m) (ii)(v)
- Pitch/roll: 0.4 deg/baseline (m) (ii)(v)

Velocity

- 95%: 0.1 knots (i)

Real-Time Performance

Instant-RTK® Initialization

- Typically 2-second initialization for baselines < 20 km
- 99.9% reliability

RTK initialization range

- > 40 km

Port Pinouts

Power In

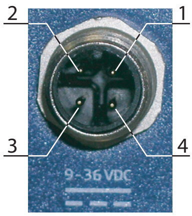
4-C Connector, type 99-3431-601-04, fitted with a sealing cap.

ii.Performance values assume minimum of five satellites, following the procedures recommended in the product manual. High multi-path areas, high PDOP values and periods of severe atmospheric conditions may degrade performance.

iii.Steady state value for baselines < 50 km after sufficient convergence time.

iv.Typical values after 3 minutes of convergence for baselines < 50 km.

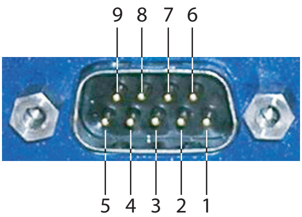
v.Typical values for properly installed antenna on vehicle body.



Pin	Description
1	Ground
2	Power Input (9-36 V DC)
3	Power Input (9-36 V DC)
4	Ground

Serial Data Ports

Ports #1, #2 and #3. Three waterproof DB9 connectors, type 4STD09PBU99R40X.



RS232 Configuration (all ports):

Pin	COM 1	COM 2	COM 3
1	NC	NC	NC
2	Receive Data (RX)	Receive Data (RX)	-
3	Transmit Data (TX)	Transmit Data (TX)	-
4	NC	NC	DC Out (see NOTE)
5	Ground	Ground	Ground
6	NC		NC
7	Request To Send (RTS)	Request To Send (RTS)	NC
8	Clear To Send (CTS)	Clear To Send (CTS)	NC
9	PPS	External Event	NC

NOTE: The DC input power voltage may be made available on this pin. Please contact the Ashtech Technical Support for more information.

1PPS Signal Output:

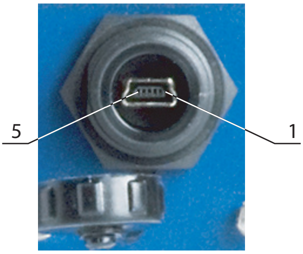
- On ProFlex Lite, the 1PPS signal is available on pin 9, COM 1.
- On ProFlex Lite Duo, the 1PPS signal from MB 500 #1 is available on pin 9, COM 1.

External Event Signal Input:

- On ProFlex Lite, the External Event input is located on pin 9, COM 2.
- On ProFlex Lite Duo, the External Event input, applied to MB 500 #1, is located on pin 9, COM 2.

USB Port, Device

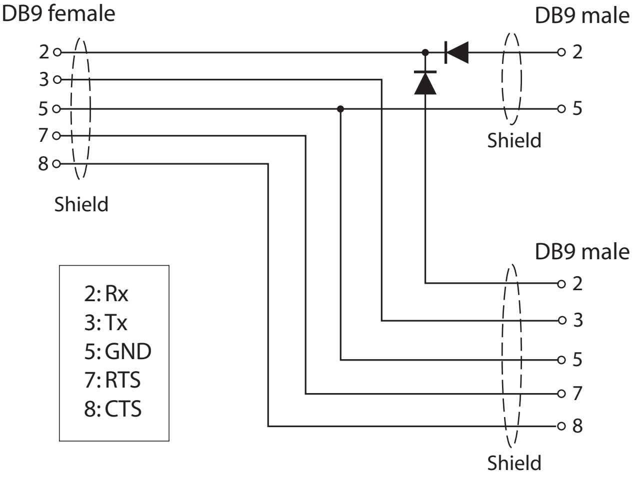
USB Mini-B, 5 contacts, type PX0446, embedded in a protective circular connector, fitted with a sealing cap.



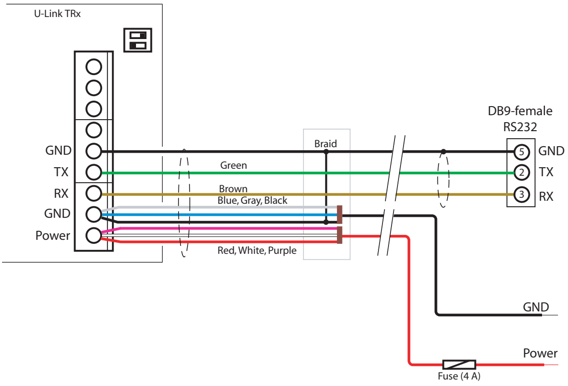
Pin	Signal Name
1	NC
2	D-
3	D+
4	NC
5	Ground

NOTE: Pin 1 is usually dedicated to carrying a +5 VDC power voltage for the USB device. In the ProFlex Lite or ProFlex Lite Duo, the USB port is powered from the unit itself, thus making useless the need for providing an external +5 VDC via this pin.

V-Shaped Data Cable



U-Link TRx Cable Pinout



Typical Setups With V-Shaped Data Cable

This accessory should be regarded as an extension to the COM connectors available on the ProFlex Lite front panel.

The two ends of this accessory are fitted with DB9 connectors of the male type, with intentionally limited pins so that one of these connectors can only carry the Rx signal (for incoming data, seen from the ProFlex Lite) whereas the other one, with its Tx and Rx signals, allows bidirectional communication with another device, typically a computer.

Below are three typical uses of this V-shaped data cable.

Fig. 1. ProFlex Lite with External Source of Corrections and Use of Two Computers

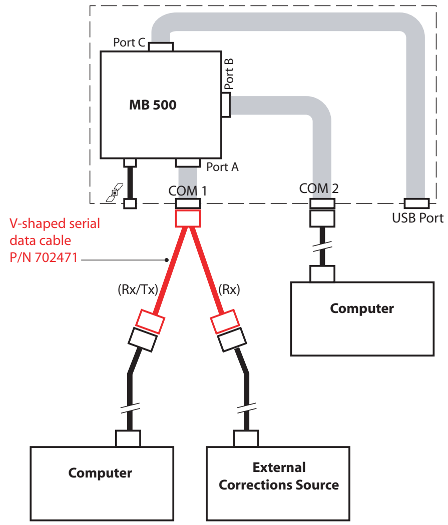


Fig. 2. ProFlex Lite Duo with External Source of Corrections and Use of Two Computers

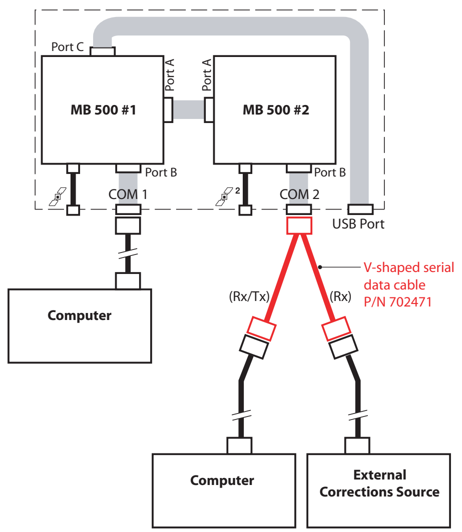
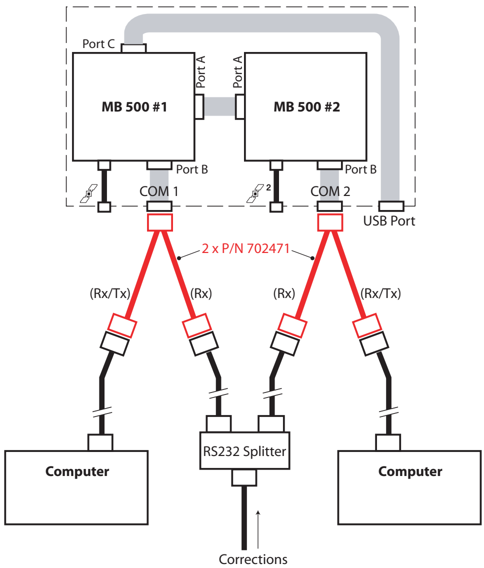
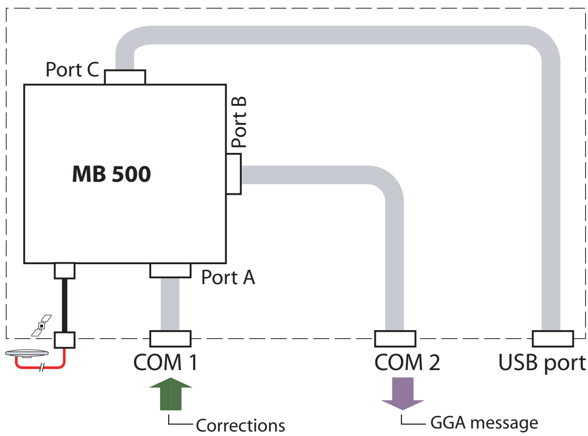


Fig. 3. ProFlex Lite Duo Providing Two Independent RTK Solutions from a Single External Source of Corrections and Using Two Computers and an RS232 Splitter (not provided)



Chapter 2. Using ProFlex Lite

Rover Delivering RTK Position



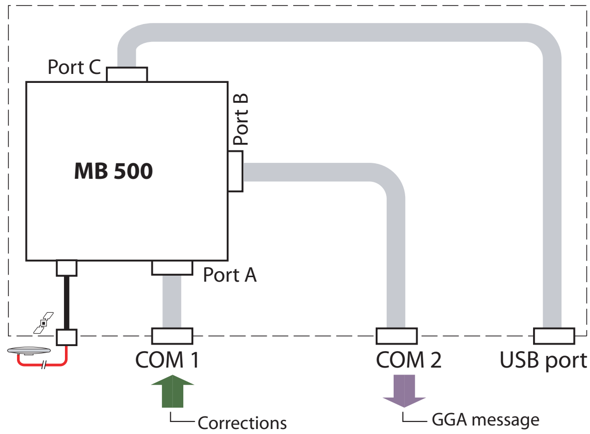
1. Run the following command to choose COM 1 (internal port A) as the port acquiring incoming differential corrections (this is the case by default).

   $PASHS,DIF,PRT,A

2. Feed the corrections stream (in RTCM 2, RTCM 3, ATOM, CMR, CMR+, DBEN or LRK -TOPAZE- format) into the ProFlex Lite through COM 1 (A).
3. Run the following command to enable the output of the position result on COM 2 (B) as a standard NMEA GGA message, at 10 Hz for example:

   $PASHS,NME,GGA,B,ON,0.1

Rover Delivering Flying RTK Position



1. Run the following command to choose COM 1 (internal port A) as the port acquiring incoming differential corrections (this is the case by default).

   $PASHS,DIF,PRT,A

2. Feed the corrections stream (in RTCM 2, RTCM 3, ATOM, CMR, CMR+, DBEN or LRK -TOPAZE- format) into the ProFlex Lite through COM 1 (A).
3. Run the following command to ask the board to indefinitely deliver a float solution of the “Flying RTK” type:

   $PASHS,CPD,AFP,0

4. Run the following command to enable the output of the position result on COM 2 (B) as a standard NMEA GGA message, at 10 Hz for example:

   $PASHS,NME,GGA,B,ON,0.1

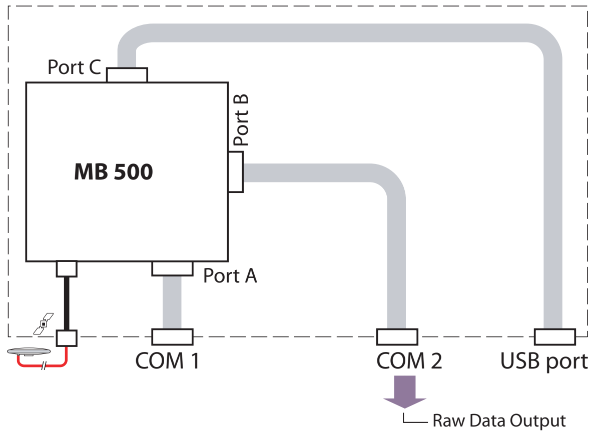
NOTE: In this application, the baseline length can be as long as 1000 km without affecting the decimetric accuracy and reliability accuracy of the position solution. Flying RTK is a powerful alternative to L-band solutions without additional costs, provided a cellular connection can be implemented through an external modem connected locally to the ProFlex Lite.

Rover Delivering Raw Data

GNSS raw data can be output in three different ways:

- Legacy Ashtech raw messages
- Ashtech proprietary ATOM messages
- Standardized RTCM 3 messages

The resulting files can then be converted into legacy Ashtech B- or E-files, and RINEX format.



Raw Data Output in Legacy Ashtech Format

Run the series of commands below to enable the output of raw data messages in the legacy Ashtech format on COM 2 (internal port B):

$PASHS,RAW,PBN,B,ON
$PASHS,RAW,MPC,B,ON
$PASHS,RAW,SNV,B,ON
$PASHS,RAW,SNG,B,ON
$PASHS,RAW,SNW,B,ON
$PASHS,RAW,ION,B,ON

To disable all these messages, run the following command:

$PASHS,RAW,ALL,B,OFF

Raw Data Output in Ashtech Proprietary ATOM Format

Run the series of commands below to enable the output of raw data messages in the Ashtech proprietary ATOM format on COM 2 (internal port B):

$PASHS,ATM,MES,B,ON
$PASHS,ATM,NAV,B,ON
$PASHS,ATM,ATR,B,ON

To disable all these messages, run the following command:

$PASHS,ATM,ALL,B,OFF

Raw Data Output in Standardized RTCM 3 Format

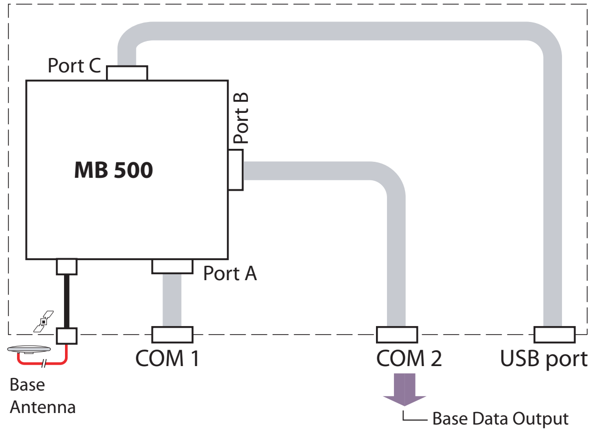
Run the series of commands below to enable the output of raw data messages in standardized RTCM 3 format on COM 2 (internal port B):

$PASHS,RT3,1004,B,ON
$PASHS,RT3,1006,B,ON
$PASHS,RT3,1012,B,ON
$PASHS,RT3,1013,B,ON
$PASHS,RT3,1019,B,ON
$PASHS,RT3,1020,B,ON
$PASHS,RT3,1033,B,ON

To disable all these messages, run the following command:

$PASHS,RT3,ALL,B,OFF

Setting ProFlex Lite as an RTK Base



Enter the receiver's known position using the $PASHS,POS command. For example, run this command if your position is lat 55°39.358908'N, lon 37°31.607218' E and height 268.26 m:

$PASHS,POS,5539.358908,N,3731.607218,E,268.26

Then the ProFlex Lite can be configured as:

- RTCM 2.3 base
- RTCM 3.1 base
- ATOM base

- CMR base
- CMR+ base

Setting up the ProFlex Lite as an RTCM 2.3 Base

Run the series of commands below to enable the output of the required RTCM 2.3 messages on COM 2 (B):

$PASHS,RT2,18,B,ON
$PASHS,RT2,19,B,ON
$PASHS,RT2,24,B,ON,13
$PASHS,RT2,23,B,ON,31

Remember that disabling all these messages (if for some reason you need to do so) can be done through the following single command:

$PASHS,RT2,ALL,B,OFF

Setting up the ProFlex Lite as an RTCM 3.0 Base

Run the series of commands below to enable the output of the required RTCM 3.0 messages on COM 2 (B):

$PASHS,RT3,1004,B,ON
$PASHS,RT3,1012,B,ON
$PASHS,RT3,1006,B,ON,13
$PASHS,RT3,1033,B,ON,31

Remember that disabling all these messages (if for some reason you need to do so) can be done through the following single command:

$PASHS,RT3,ALL,B,OFF

Setting up the ProFlex Lite as an ATOM Base

Run the series of commands below to enable the output of the required ATOM messages on COM 2 (B):

$PASHS,ATM,RNX,B,ON
$PASHS,ATM,ATR,B,ON

For the base to generate super-compact ATOM data, run the following commands:

$PASHS,ATM,ATR,B,ON,31
$PASHS,ATM,RNX,B,ON,&SCN,101

Remember that disabling all these messages (if for some reason you need to do so) can be done through the following single command:

$PASHS,ATM,ALL,B,OFF

Setting up the ProFlex Lite as a CMR Base

Run the series of commands below to enable the output of the required CMR messages on COM 2 (B):

$PASHS,CMR,0,B,ON
$PASHS,CMR,3,B,ON
$PASHS,CMR,1,B,ON,13
$PASHS,CMR,2,B,ON,31

Remember that disabling all these messages (if for some reason you need to do so) can be done through the following single command:

$PASHS,CMR,ALL,B,OFF

Setting up the ProFlex Lite as a CMR+ Base

Run the series of commands below to enable the output of the required CMR+ messages on COM 2 (B):

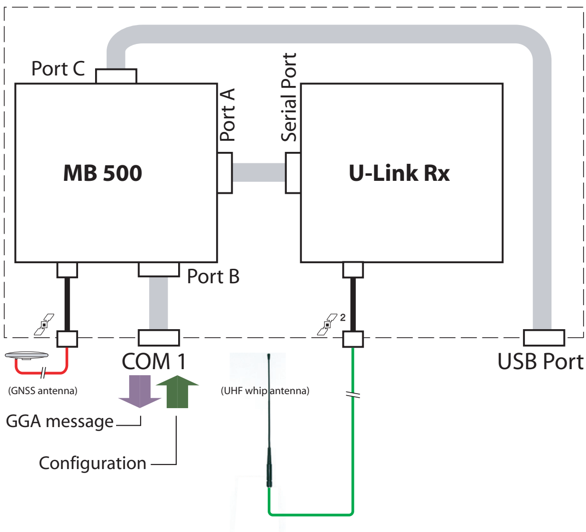
$PASHS,CMP,0,B,ON
$PASHS,CMP,3,B,ON

Remember that disabling all these messages (if for some reason you need to do so) can be done through the following single command:

$PASHS,CMP,ALL,B,OFF

Chapter 3. Adding UHF Option to ProFlex Lite

Rover Using Internal UHF Option



When delivered with its built-in UHF option, the ProFlex Lite has been configured to meet your radio requirements. However, you are allowed to change a few radio parameters such as reception channel, airlink speed, sensitivity and protocol. This can be done using the software application provided on the CD (“ConfRadio for ProFlex Lite End User”). For more details refer to *Changing U-Link Rx Settings through COM 1 on page 34*.

Note: Rather than use Ashtech’s “ConfRadio for ProFlex Lite End User”, some integrators may want to perform the authorized radio changes through their own software application. In this case, please contact the Ashtech Technical Support for more information on how *to implement the proprietary AT commands to allow your software to communicate with the radio.*

Complete the configuration of the ProFlex Lite so that it can deliver RTK positions:

1. Allow corrections from U-Link Rx to enter the MB 500 by setting port A on the MB 500 to 38400 Bd:

   $PASHS,SPD,A,7

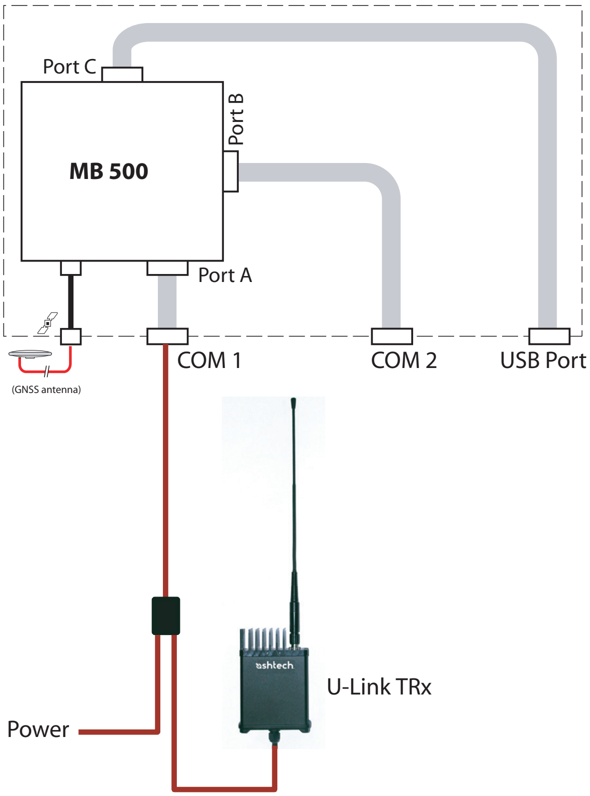
   This setting is mandatory because U-Link Rx's serial port can only work at this speed.

   By default, ProFlex Lite has its MB 500 port A set to operate at 38400 Bd, but remember this setting will be different if for some reason, you have had to run $PASHS,INI or $PASHS,RST. That is why at this stage, and as a safety measure, it is always a good idea to run this command.

   The MB 500 will automatically decode the type of corrections received on its port A so there is no need to tell the board which type of corrections it is expected to process.
2. Enable the output of the position result on COM 1 (B), for example as a standard NMEA GGA message at 10 Hz:

   $PASHS,NME,GGA,B,ON,0.1

Base Using External Radio Transmitter



The external transmitter has normally been configured to meet your radio requirements. However, you are allowed to change a few radio parameters such as transmission channel, airlink speed, sensitivity and protocol. This can be done using the software application provided on the CD ("ConfRadio for ProFlex Lite End User"). For more details refer to *Changing U-Link TRx Settings on page 36*.

To allow U-Link TRx to broadcast corrections, COM1 on ProFlex Lite should be configured to operate at 38400 Bd, using the following command:

$PASHS,SPD,A,7

Using "ConfRadio For ProFlex Lite End User" to Program The Radios

Installing ConfRadio for ProFlex Lite End User

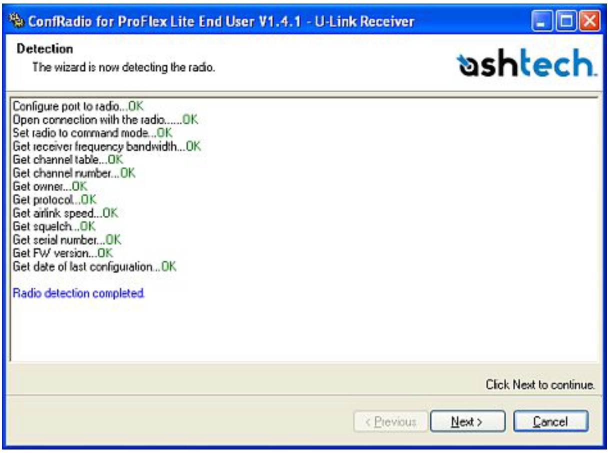
- Insert the Ashtech ProFlex Lite CD in your PC. This automatically launches the autorun file.
- Look up **Install ConfRadio for ProFlex Lite End User** in the menu and click on it. This launches the installation program for which Microsoft .NET FrameWork 2.0 is needed on your computer. The procedure will automatically install this application if it is missing (installing this component may take a couple of minutes).
- Then follow the instructions on the screen to complete the installation.

Changing U-Link Rx Settings through COM 1

- Run **ConfRadio for ProFlex Lite End User** on your computer. This opens the main window.
- Select "ProFlex Lite" as the unit where to connect to. As a result, "U-Link Receiver" is automatically selected as the radio on which to perform changes.
- Click **Next>**. Proceed as instructed:
  1. Make sure the UHF option has been installed in the ProFlex Lite. If so, a label can be seen on the rear panel giving the type, part number and central frequency of the radio.
  2. Connect a serial data cable between COM 1 on the ProFlex Lite and a serial port on your PC.
  3. Apply DC power to the ProFlex Lite using the AC/DC adapter provided.
- Select the port used on computer side to communicate with ProFlex Lite.
- Click on **Settings** and check that this port is configured as follows.

Parameter	Setting
Speed	115200
Stop bits	One
Data bits	8
Parity	None

- Click on **Next>**. The program starts communicating with the internal radio. Each of these communication steps are reported on the screen.



- Click on **Next>**. The program now shows the current radio settings.

  On the left are the different radio parameters. Those in black characters are the ones you can modify:

  – **Channel number** (0 to 15 max.)

  – **Airlink Speed**. Possible choices: 4800, 7200 or 9600 bps

  – **Squelch**. Possible choices: High, Medium or Low. “Medium” is recommended.

  – **Protocol**. Possible choices: DSNP or Transparent.

  The greyed ones are those that have been set at the factory or entered by a certified Ashtech dealer. They are displayed but cannot be modified.

  All the preset channels are shown on the right. None of them can be changed and no new channel can be added. The channel number you select on the left should be one of those for which a reception frequency has been defined.

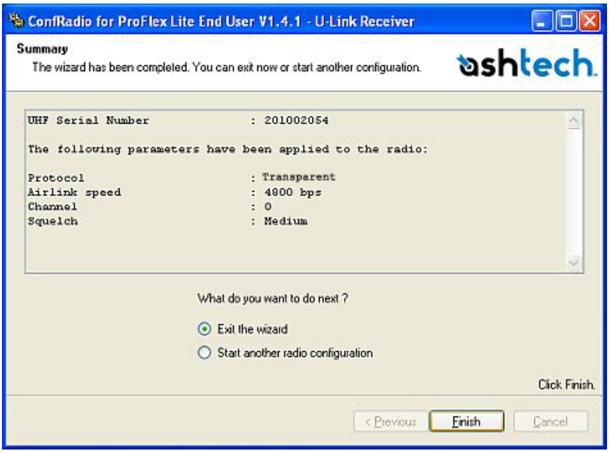
  For the **Airlink Speed** and **Protocol** parameters, Ashtech recommends you use respectively “4800” and “Transparent”.

  There are also three buttons on this screen:

  – **Reset to default:** Use this button to reset each of the parameters listed on the left to its default value.

- **Load settings**: Use this button to load a radio configuration saved earlier as an RCF file. Only the parameters that are user- modifiable are overwritten with the corresponding parameters read from the RCF file.
- **Save settings**: Use this button to save a radio configuration as an RCF file. A radio configuration consists of all the parameters shown on the screen.

- Click on **Next>**. The program automatically starts writing the new configuration parameters into the radio. The different steps of this sequence are reported on the screen.
- Click on **Next>**. The program returns a report of the configuration step you have just performed and suggests that you quit the program or start a new configuration.



- Click on **Finish** to quit the program.

Changing U-Link TRx Settings

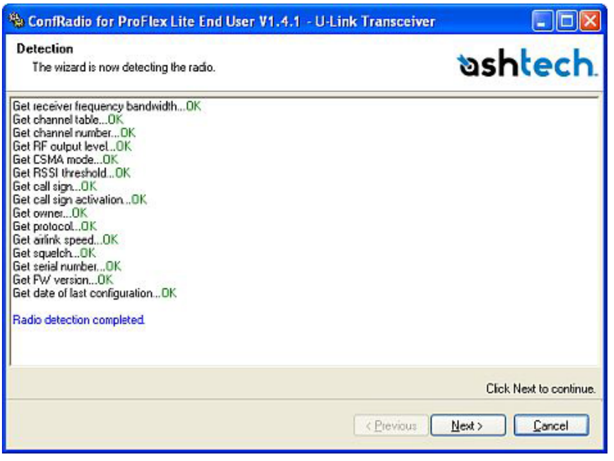
- Run **ConfRadio for ProFlex Lite End User** on your computer. This opens the main window.
- Select “None (Direct to Radio)” as the unit where to connect to. As a result, “U-Link Transceiver” is automatically selected as the radio on which to perform changes.
- Click **Next>**. Proceed as instructed:

1. Make sure the data cable of your radio transmitter is fitted with a DB9 connector and the serial line is in RS23 mode.
2. Connect this DB9 connector to a serial port on your PC.
3. Apply DC power to the transmitter by connecting its power cable to a 12-V DC power source.

- Select the port used on computer side to communicate with the transmitter.
- Click on **Settings** and check that this port is configured as follows.

Parameter	Setting
Speed	115200
Stop bits	One
Data bits	8
Parity	None

- Click on **Next>**. The program starts communicating with the radio transmitter. Each of these communication steps are reported on the screen.



- Click on **Next>**. The program now shows the current radio settings.

  On the left are the different radio parameters. Those in black characters are the ones you can modify:

  – **Channel number** (0 to 15 max.)

  – **Airlink Speed**. Possible choices: 4800, 7200 or 9600 bps

- **Squelch**. Possible choices: High, Medium or Low. "Medium" is recommended.
- **Protocol**. Possible choices: DSNP or Transparent.

The greyed ones are those that have been set at the factory or entered by a certified Ashtech dealer. They are displayed but cannot be modified.

For the **Airlink Speed** and **Protocol** parameters, Ashtech recommends you use respectively "4800" and "Transparent".

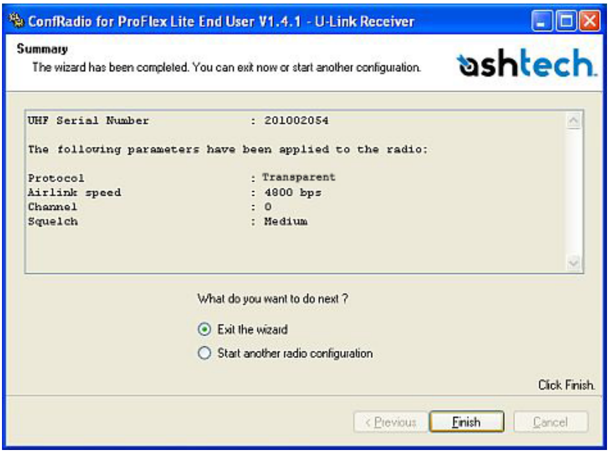
All the preset channels are shown on the right. None of them can be changed and no new channel can be added. The channel number you select on the left should be one of those for which a transmission frequency has been defined.

There are also three buttons on this screen:

- **Reset to default**: Use this button to reset each of the parameters listed on the left to its default value.
- **Load settings**: Use this button to load a radio configuration saved earlier as an RCF file. Only the parameters that are user- modifiable are overwritten with the corresponding parameters read from the RCF file.
- **Save settings**: Use this button to save a radio configuration as an RCF file. A radio configuration consists of all the parameters shown on the screen.

• Click on **Next>**. The program automatically starts writing the new configuration parameters into the radio. The different steps of this sequence are reported on the screen.

• Click on **Next>**. The program returns a report of the configuration step you have just performed and suggests that you quit the program or start a new configuration.



- Click on **Finish** to quit the program.

Installing UHF Antennas

Consider the following about the omnidirectional, half-wave, TNC-m fitted, UHF whip antennas delivered with U-Link Rx and U-Link TRx.

- For best performance, antennas should always be installed in vertical position.
- For best coverage, antennas should always be installed as high as possible:
  – For the embedded UHF option (U-Link Rx), this means the whip antenna should never be connected directly to the front panel connector, but through a standard coaxial cable, with a maximum length of 5 meters, in order to limit signal loss in the cable.

    For longer distances, a low-loss coaxial cable should be used. Choosing the appropriate bracket to securely install this antenna is left to the user's responsibility.
  – For the external radio transmitter (U-Link TRx), the whip antenna should always be connected directly to the transmitter to optimize the level of power radiated by the antenna.

    Generally speaking, the U-Link TRx and its antenna will be installed at a top of a mast, using the total length of data cable available (5 meters) to raise the transmitter and its antenna. The U-Link TRx is fitted with a fixing lug allowing easy installation on a mast.

- Special care should be taken in the choice of the site where the ProFlex Lite base and its U-Link TRx transmitter will be installed. The purpose is to optimize the radio coverage in the directions in which ProFlex Lite rovers will have to pick up the corrections from the U-Link TRx. Prefer locations overhanging the working area with no, or a minimum of obstructions along the direct propagation path.

  In fact, the requirements in terms of installation site for best radio performance and coverage are normally those that also offer the best GNSS reception conditions for the base.

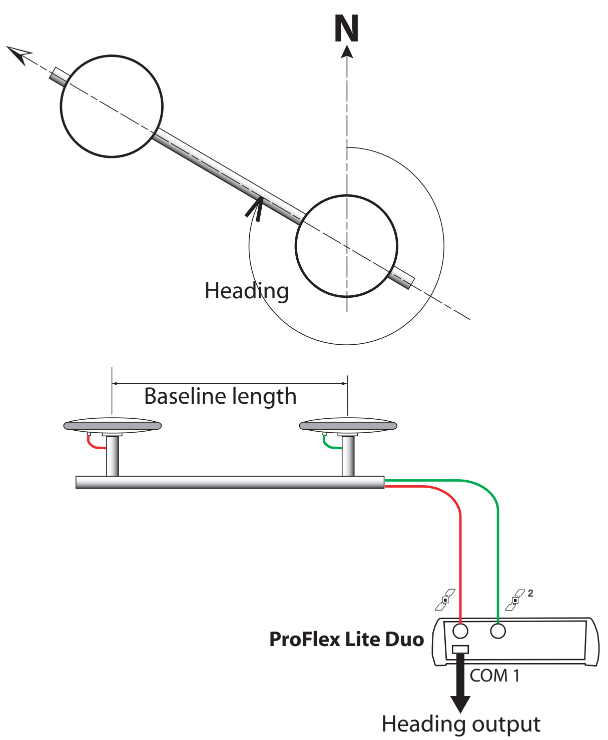
Chapter 4. Using ProFlex Lite Duo

Delivering Heading Measurements

Introduction

In this application, the ProFlex Lite Duo is used to determine the heading of the axis formed by the two GNSS antennas connected to it. The current value of heading may be provided as an HDT message.

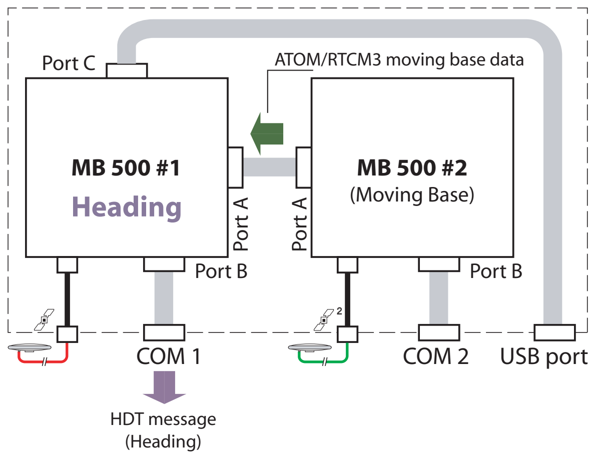
The two GNSS antennas are mounted on the same support, giving them the same height. The baseline has a fixed length and is accurately known. The two antennas used are connected to the ProFlex Lite Duo as shown below.



Typically, this application can be used on board a ship or a land vehicle to perform real-time heading measurements. The way the two antennas are oriented and the accurate knowledge of the baseline length are critical to the good performance of the system.

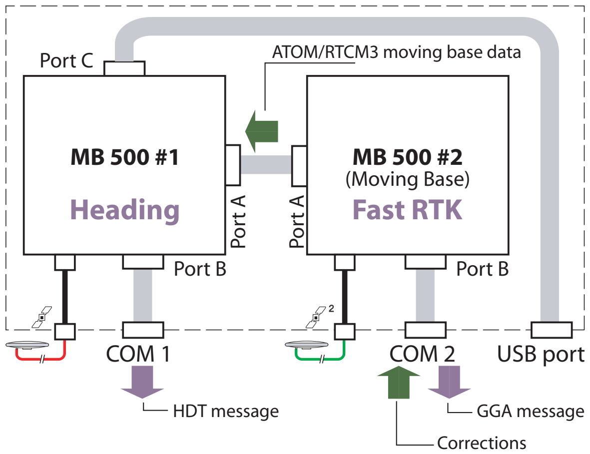
Implementation

The diagram below shows the data flow allowing the ProFlex Lite Duo to determine and output heading measurements.



MB 500 #2 needs to be configured as a moving base delivering the data (in RTCM3 or ATOM format) required by MB 500 #1 to determine the heading angle.

Additionally and if necessary, the ProFlex Lite Duo can also provide a real-time, fast-rate RTK position, with centimeter accuracy, for the GNSS antenna connected to MB 500 #2. This position can be made available as a GGA message.



MB 500 #2 has in this case two additional functions:

- Receiving RTK corrections from a static base. The base corrections are provided by an external device connected to ProFlex Lite Duo COM 2.
- Delivering the real-time position of the GNSS antenna connected to it through a GGA message, available on its B port (COM 2 on the front panel).

Setting MB 500 #2 as a Moving RTK Base

1. By default, port A has been set to 115200 Bd. Keep this setting. If the baud rate has been changed in the meantime, use the following command to restore this setting:

   $PASHS,SPD,A,9

2. By default, port B has been set to 115200 Bd. Change this value to 9600 Bd using the following command:

   $PASHS,SPD,B,6

3. Allow MB 500 #2 to use a moving position as the reference position, thus making it a moving base. This is achieved using the following command sent to this board:

   $PASHS,POS,MOV

4. MB 500 #2 can then be set in one of the following configurations, at user's choice:
   - RTCM-3.1 moving base
   - ATOM moving base

To ask MB 500 #2 to generate **RTCM3.1 base data at an output rate of 10 Hz on its port A**, run the following commands:

$PASHS,RT3,1004,A,ON,0.1
$PASHS,RT3,1012,A,ON,0.1
$PASHS,RT3,1006,A,ON,0.1
$PASHS,RT3,1033,A,ON,31

(1004 for GPS data, 1012 for GLONASS data, 1006 for antenna reference point and 1033 for receiver antenna description.)

Remember that disabling all these messages (if for some reason you need to do so) can be done through the following single command:

$PASHS,RT3,ALL,A,OFF

To ask MB 500 #2 to generate **ATOM base data at 10 Hz on its port A**, run the following commands:

$PASHS,ATM,ATR,A,ON,31
$PASHS,ATM,RNX,A,ON,0.1,&SCN,204

(ATR for ATOM attribute data at 31 s and RNX for GPS/GLONASS data at 10 Hz.)

Remember that disabling all these messages (if for some reason you need to do so) can be done through the following single command:

$PASHS,ATM,ALL,A,OFF

5. Additionally, you can ask MB500 #2 to deliver an RTK position. See *Additional Settings To Let MB 500 #2 Deliver RTK Position on page 49*.

   NOTE: At any time, you can restart the RTK process through the following command:

   $PASHS,CPD,RST

Setting MB 500 #1 to Deliver Heading Measurements

Prerequisites: MB 500 #2 has been set up as a moving RTK base. Make sure you are sending your commands directly to MB 500 #1 through one of its serial ports. Using the $PASHQ,RIO command, make sure the [H] heading option has been installed in MB 500 #1.

1. By default, port A has been set to 115200 Bd. Keep this setting. If the baud rate has been changed in the meantime, use the following command to restore this setting:

   $PASHS,SPD,A,9

2. By default, port B has been set to 115200 Bd. Change this value to 9600 Bd using the following command:

   $PASHS,SPD,B,6

3. Make sure port A has been set to be the port receiving incoming differential corrections (this is the case by default):

   $PASHS,DIF,PRT,A

4. Let MB 500 #1 know that it is using data from a moving base by running the following command:

   $PASHS,CPD,BAS,1

5. When base data from a moving base are used, it's better not to have the Fast CPD mode on. Consequently, run the following command to turn this mode off in MB 500 #1:

   $PASHS,CPD,FST,OFF

6. You may need to use the $PASHS,CPD,ARR,OFS command if the two GNSS antennas are not at the same height and/or they are not aligned with, or perpendicular to the vehicle axis. See *CPD,ARR,OFS - CP2,ARR,OFS: Setting Heading and Elevation Offsets on page 89*. See also NOTES below.
7. Enable the heading mode in MB 500 #1:

   $PASHS,CPD,ARR,MOD,ON

8. Follow one of the procedures below, depending on whether the baseline length is known or not:
   - If the baseline length is accurately known (for example 1.585 m), just type the following command and then the MB 500 #1 board will automatically start delivering heading measurements, provided output messages have been defined (see next step):

     (Example with baseline length= 1.585 m):
     $PASHS,CPD,ARR,LEN,1.585

   - If the baseline is unknown, or known but with not enough accuracy, an auto-calibration process should be run to allow MB 500 #1 to determine the baseline length prior to delivering heading measurements.

     First, set the maximum error permitted in the determination of the baseline length. The recommended value is 0.01 m. Use the following command to set this parameter:

     (Example with tolerated baseline length error= 0.01 m):
     $PASHS,CPD,ARR,PAR,,0.01

     Then start the auto-calibration process by simply running the following command:

$PASHS,CPD,ARR,LEN,0

Through this command, the baseline length is forced to “0” thus starting the auto-calibration process. The two antennas should remain static throughout the auto-calibration process.

On completion of the auto-calibration phase, the MB 500 #1 board will automatically start delivering real-time heading measurements. See also *Description of the Auto-Calibration Sequence on page 47*.

Remember this process should be run every time you need to change the baseline length while the arrow mode is on.

9. Define the output messages you would like MB 500 #1 to deliver. Typically, in heading mode, you will want to output the ATT (attitude), HDT (heading) or VEC (vector) message, depending on your application:

   $PASHS,NME,ATT,A,ON[,x]
   $PASHS,NME,HDT,A,ON[,x]
   $PASHS,NME,VEC,B,ON[,x]

   Where “x” is the output rate. See NOTES below for more information about “x”.

NOTES:

- The ATT message is output for all epochs and includes an RTK “fixed/float” flag. The HDT message is output only for fixed ambiguity epochs.
- The ATT message includes heading and pitch or heading and roll. The HDT message only includes heading.
- If the baseline elevation and azimuth offset with respect to the vehicle center line are known, the user can enter these values, in which case vehicle attitude, instead of baseline attitude, will be output. See *CPD,ARR,OFS - CP2,ARR,OFS: Setting Heading and Elevation Offsets on page 89*
- If “x” is omitted, HDT and ATT are output at a 1-Hz rate (default). “x” should preferably be equal to the moving base data interval.
- The heading determination process can be restarted at any time in MB 500 #1 using the $PASHS,CPD,RST command

Description of the Auto-Calibration Sequence

When setting the baseline length to "0" through the $PASHS,CPD,ARR,LEN,0 command, au auto-calibration sequence is run as explained below:

- A series of minimum three RTK initializations are run automatically to determine the distance between the two GNSS antennas (baseline length) with the required level of accuracy (baseline length determined to within ± 1cm). Each new RTK initialization takes place after a given period of time (typically 60 seconds).
- If the reception conditions are good, three RTK initializations are usually enough to determine the baseline length.
- In more difficult conditions of reception, more RTK initializations may be required until the baseline length is determined with the required accuracy. The auto-calibration sequence will consequently be longer than 3 minutes.
- **What can you do to detect the end of the auto-calibration process?** The best way is to regularly send the following query command to MB 500 #2:

  $PASHQ,PAR,RTK

  As long as in the response to that query, you get "CALIBRATING" after the value of baseline length, the auto-calibration process is still ongoing. When this word is replaced with "CALIBRATED", auto-calibration is complete.

  You can also monitor the value of "baseline RMS error" (**f6** field) provided in the ATT output message. For close monitoring, this message should be output at the same rate as, or faster than, the HDT message.

  After $PASHS,CPD,ARR,MOD has been set to "ON" and as long as **f6** in the ATT message stays strictly equal to 0.000, you can be sure the auto-calibration process is still in progress.

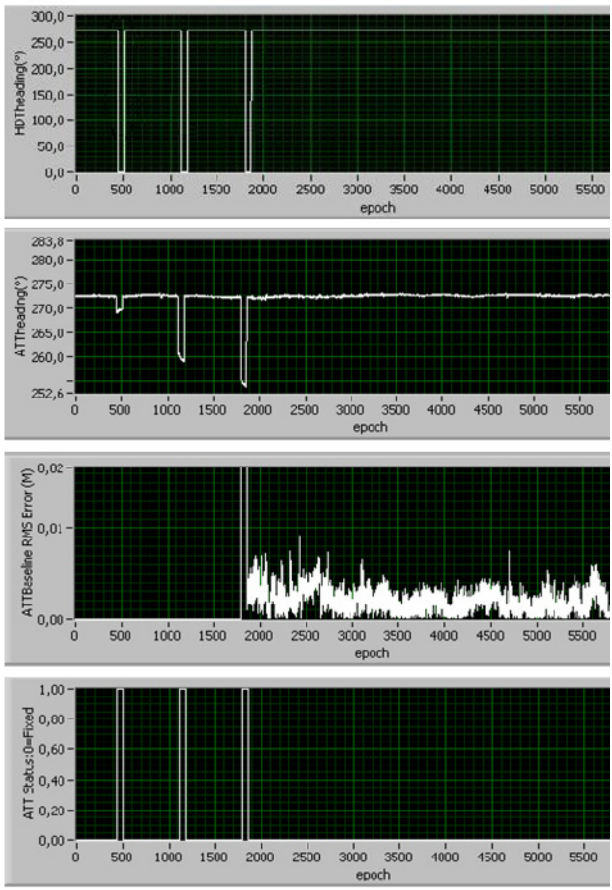
  As soon as **f6** is output with a different value, this means the auto-calibration is complete and the value of heading delivered by the HDT message is valid.

  Warning! The HDT message delivers invalid heading measurements during the auto-calibration process.

  From the RTK initialization time to the ambiguity fixing time, the heading value is zero, then an estimated value of heading is provided until the next RTK initialization takes place, and so forth until the end of the auto-calibration process (see diagram below).

The diagram below is an example of a sequence of auto-calibration, for which the following output data are shown, from top to bottom:

– Heading output in HDT message
– Heading output in ATT message
– Baseline RMS in ATT message. This data clearly shows the end of the auto-calibration sequence.
– Fixed/float status in ATT message (Fixed: 0)



Auto-Calibration at Power-Up

After a cold start, for which all the default settings are used, auto-calibration is started by simply running the following command:

$PASHS,CPD,ARR,MOD,ON

The same applies after initializing MB 500 #2 through one of the following commands:

$PASHS,RST
$PASHS,INI,x,y,1

After a warm or hot start, because a back-up battery preserves the last entered or calibrated value of baseline length while power is off, there is no need for a new auto-calibration. The ProFlex Lite Duo will rapidly deliver valid heading measurements once power has been re-applied.

Additional Settings To Let MB 500 #2 Deliver RTK Position

Make sure you are sending your commands directly to MB 500 #2 through one of its serial ports. Assuming MB 500 #2 is also receiving corrections on its port B (via ProFlex Lite Duo COM 2) from a static base, do the following:

- To accept incoming corrections on MB500#2's port B, use the following command:

  $PASHS,DIF,PRT,B

- Let MB 500 #2 know that it is using data from a static base by running the following command:

  $PASHS,CPD,BAS,0

- Define the output messages you would like MB 500 #2 to deliver on its port B (ProFlex Lite Duo COM 2). Typically, you will want to output the GGA message,:

  $PASHS,NME,GGA,B,ON[,x]

  Where "x" is the output rate. If "x" is omitted, GGA is output at a 1-Hz rate (default).

Ignoring GGA Message from MB 500 #1

In this particular application of the ProFlex Lite Duo, asking the first board (MB 500 #1) to deliver a GGA message is quite useless, if not inadvisable. The reasons are the following:

- It should be quite clear that MB500 #1 will always deliver a DGPS position, not an RTK position. This will always be true, even when MB500 #2 is also configured to deliver an RTK position.
- On MB 500 #1, the Position Type field in the GGA message is used in this particular case to report the status of the heading measurement, not that of the position measurement.

  In other words, when the "fixed" status ("4") is reported in this message, this simply means the heading measurement is valid. This does not mean that an RTK position is available.

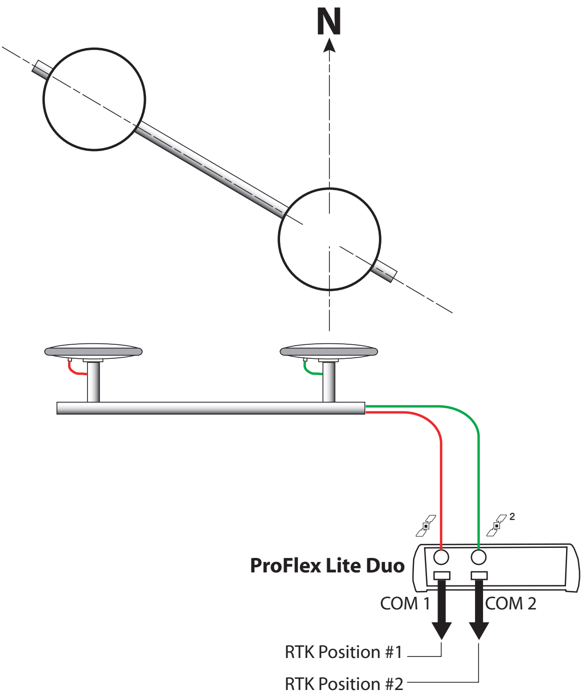
Because of this particular use of the Position Type field in the GGA message from MB 500 #1, which incidentally is in disagreement with the NMEA standard, we recommend you do not set MB 500 #1 to output this message. Doing without a position that would only exhibit decimetric accuracy should not be a problem anyway.

Delivering Two Independent Fast RTK Outputs for Further Heading Determination

Introduction

This is a particular case of heading measurements in which the ProFlex Lite Duo user already has an external and standalone heading determination system and wants to use it.

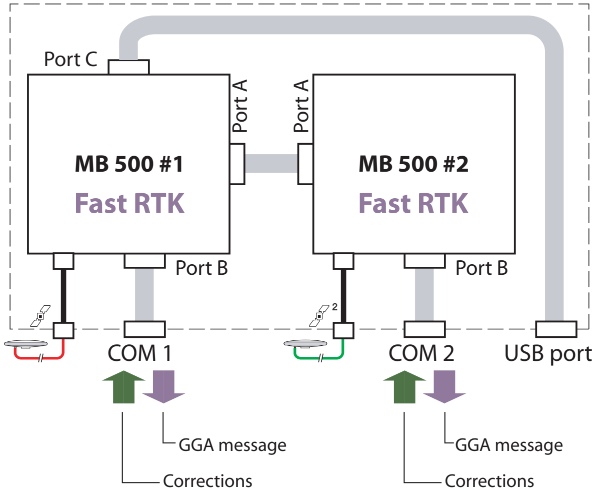
What is therefore necessary in this case is feed the system with the two centimeter-accurate positions from the ProFlex Lite Duo. From these two positions, the system will be able to compute the heading value.



Like in *Delivering Heading Measurements on page 41*, the two GNSS antennas connected to the ProFlex Lite Duo are mounted on a horizontal pole. The baseline has a fixed value and is accurately known.

Implementation

In this application, the two MB 500 boards of the ProFlex Lite Duo work separately. The serial line between their internal "A" ports is in fact not used. The base corrections are provided by an external device connected to the ProFlex Lite Duo via its ports #1 and #2.



Setting Each MB 500 to Deliver RTK Position

Each MB 500 board receiving corrections on its port B from the same static base, do the following for each board (the USB board can be used for MB 500 #1):

- Make sure you are sending your commands directly to the concerned MB 500 board through one of its serial ports.
- Run $PASHS,DIF,PRT,B to choose port B as the port receiving incoming differential corrections.
- Define the output messages you would like the MB 500 to deliver on its port B. Typically, you will want to output the GGA message,:

  $PASHS,NME,GGA,B,ON[,x]

  Where “x” is the output rate. If “x” is omitted, GGA is output at a 1-Hz rate (default).
- Make sure the corrections received from the external static base via a local corrections receiver are applied to the right ports.

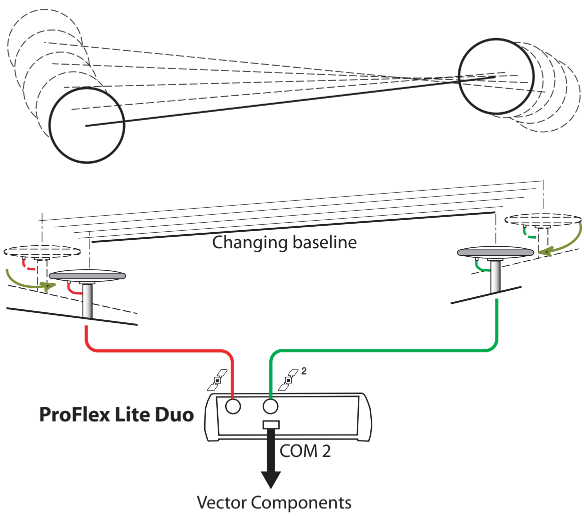
Delivering Vector Measurements

Introduction

In this application, the ProFlex Lite Duo provides the three components of a changing vector between the two GNSS antennas connected to the ProFlex Lite Duo (relative positioning). From these three measurements, both the module and direction of the vector can accurately be determined.

Obviously, because the two antennas are connected to the same system, they can only have limited movements with respect to each other (less than one meter up to several tens of meters).

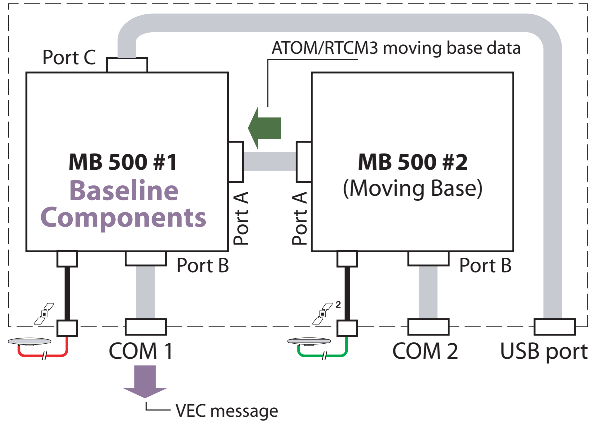
The two antennas are connected to the ProFlex Lite Duo as shown below.



This kind of setup can be used in machine control for example to constantly monitor the distance and direction between two separate tools installed on the same machine or vehicle.

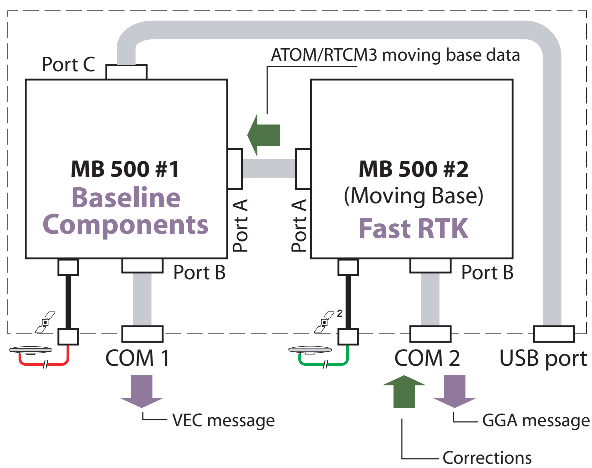
Implementation

The diagram below shows the data flow allowing the ProFlex Lite Duo to determine and output the vector components.



MB 500 #2 delivers the data (in RTCM3 or ATOM format) required by MB 500 #1 to determine the vector.

Additionally and if necessary, the ProFlex Lite Duo can also provide a real-time, fast-rate RTK position, with centimeter accuracy, for the GNSS antenna connected to MB 500 #2. This position can be made available as a GGA message.



MB 500 #2 has in this case two additional functions:

- Receiving RTK corrections from the base used, at an update rate of 1 Hz. The base corrections are provided by an external device connected to ProFlex Lite Duo COM 2.

- Delivering the real-time position of the GNSS antenna connected to it through a GGA message, available on its B port (COM 2 on the front panel).

Setting MB 500 #2 as a Moving RTK Base

1. By default, port A has been set to 115200 Bd. Keep this setting. If the baud rate has been changed in the meantime, use the following command to restore this setting:

   $PASHS,SPD,A,9

2. By default, port B has been set to 115200 Bd. Change this value to 9600 Bd using the following command:

   $PASHS,SPD,B,6

3. Allow MB 500 #2 to use a moving position as the reference position, thus making it a moving base. This is achieved using the following command sent to this board:

   $PASHS,POS,MOV

4. MB 500 #2 can then be set in one of the following configurations, at user's choice:
   - RTCM-3.1 moving base
   - ATOM moving base

   To ask MB 500 #2 to generate **RTCM3.1 base data at an output rate of 10 Hz on its port A**, run the following commands:

   $PASHS,RT3,1004,A,ON,0.1
   $PASHS,RT3,1012,A,ON,0.1
   $PASHS,RT3,1006,A,ON,0.1
   $PASHS,RT3,1033,A,ON,31
   (1004 for GPS data, 1012 for GLONASS data, 1006 for antenna reference point and 1033 for receiver antenna description.)
   Remember that disabling all these messages (if for some reason you need to do so) can be done through the following single command:
   $PASHS,RT3,ALL,A,OFF

   To ask MB 500 #2 to generate **ATOM base data at 10 Hz on its port A**, run the following commands:

   $PASHS,ATM,ATR,A,ON,31
   $PASHS,ATM,RNX,A,ON,0.1,&SCN,204
   (ATR for ATOM attribute data at 31 s and RNX for GPS/GLONASS data at 10 Hz.)
   Remember that disabling all these messages (if for some reason you need to do so) can be done through the following single command:
   $PASHS,ATM,ALL,A,OFF

5. Additionally, you can ask MB500 #2 to deliver an RTK position. See *Additional Settings To Let MB 500 #2 Deliver RTK Position on page 49*.

   NOTE: At any time, you can restart the RTK process through the following command:

   $PASHS,CPD,RST

Setting MB 500 #1 to Deliver Baseline Components

Prerequisites: MB 500 #2 has been set up as a moving RTK base. Make sure you are sending your commands directly to MB 500 #1 through one of its serial ports. Using the $PASHQ,RIO command, make sure the [H] heading option has been installed in MB 500 #1.

- By default, port A has been set to 115200 Bd. Keep this setting. If the baud rate has been changed in the meantime, use the following command to restore this setting:

  $PASHS,SPD,A,9

- By default, port B has been set to 115200 Bd. Change this value to 9600 Bd using the following command:

  $PASHS,SPD,B,6

- Make sure port A has been set to be the port receiving incoming differential corrections (this is the case by default):

  $PASHS,DIF,PRT,A

- Let MB 500 #1 know that it is using data from a moving base by running the following command:

  $PASHS,CPD,BAS,1

- When base data from a moving base are used, it's better not to have the Fast CPD mode on. Consequently, run the following command to turn this mode off in MB 500 #1:

  $PASHS,CPD,FST,OFF

- Define the output messages you would like MB 500 #1 to deliver. Typically, you will want to output the VEC (vector) message:

  $PASHS,NME,VEC,B,ON[,x]

  Where "x" is the output rate. See NOTES below for more information about "x".

NOTES:

- The accuracy on the components of the baseline vector (VEC) is almost independent of the accuracy of the moving reference position.
- If “x” is omitted, VEC is output at a 1-Hz rate (default). “x” should preferably be equal to the moving base data interval.

Additional Settings To Let MB 500 #2 Deliver RTK Position

Make sure you are sending your commands directly to MB 500 #2 through one of its serial ports. Assuming MB 500 #2 is also receiving corrections on its port B (via ProFlex Lite Duo COM 2) from a static base, do the following:

- To accept incoming corrections on MB500#2’s port B, use the following command:

  $PASHS,DIF,PRT,B

- Let MB 500 #2 know that it is using data from a static base by running the following command:

  $PASHS,CPD,BAS,0

- Define the output messages you would like MB 500 #2 to deliver on its port B (ProFlex Lite Duo COM 2). Typically, you will want to output the GGA message,:

  $PASHS,NME,GGA,B,ON[,x]

  Where “x” is the output rate. If “x” is omitted, GGA is output at a 1-Hz rate (default).

Ignoring GGA Message from MB 500 #1

In this particular application of the ProFlex Lite Duo, asking the first board (MB 500 #1) to deliver a GGA message is quite useless, if not inadvisable. The reasons are the following:

- It should be quite clear that MB500 #1 will always deliver a DGPS position, not an RTK position. This will always be true, even when MB500 #2 is also configured to deliver an RTK position.
- On MB 500 #1, the Position Type field in the GGA message is used in this particular case to report the status of the vector measurement, not that of the position measurement.

  In other words, when the “fixed” status (“4”) is reported in this message, this simply means the vector measurement is valid. This does not mean that an RTK position is available.

Because of this particular use of the Position Type field in the GGA message from MB 500 #1, which incidentally is in disagreement with the NMEA standard, we recommend you do not set MB 500 #1 to output this message. Doing without a position that would only exhibit decimetric accuracy should not be a problem.

Chapter 5. Configuring the MB 500

Introduction to Serial Commands

Serial commands allow you to communicate directly with the receiver in its proprietary command language. Serial commands can be used for various purposes such as:

- Changing default settings
- Monitoring different receiver statuses (internal operation, constellations, etc.)
- Outputting messages on request

Serial commands fall into two categories:

- *Set* commands ($PASHS,...), used to set or modify the receiver's internal parameters.
- *Query* commands ($PASHQ,...), used to interrogate the receiver.

If you wish to change some internal settings in the receiver or modify the operating mode, then use the available set of $PASHS commands.

If you want to read the instant status of the receiver, use the set of $PASHQ commands. The receiver responds to $PASHQ commands by returning one of the following, depending on which $PASHQ command is sent:

- ASCII or binary formatted $PASHR sentences, for your reading or/and automatic parsing.
- Non-formatted responses, like for example ASCII tables, only for your reading (not intended for automatic parsing).

If you want to program the receiver so that it delivers its results at regular intervals, then you should also use the set of available $PASHS commands. The receiver will respond by delivering messages at the specified output rate. Messages fall into different groups:

- NME (standardized NMEA messages and NMEA-like Ashtech proprietary messages)
- RAW (Ashtech legacy binary data)
- ATM (Ashtech proprietary ATOM binary data)

- RT2 (Standardized RTCM-2 messages)
- RT3 (Standardized RTCM-3 messages)
- CMR (Widely used TRIMBLE CMR messages)
- CMP (Widely used TRIMBLE CMR+ messages)

A three-letter identifier is part of the $PASHS command header clearly identifying which group of data the command deals with. For example, "$PASHS,NME,GGA,A,ON,1" will enable the GGA NMEA message on port A at an output rate of 1 second.

In general, all the messages of a given group are output inside a dedicated transport layer. For example, NMEA-like and RAW data are output using the Ashtech legacy $PASHR frame, whereas ATM and RT3 data are output using the standardized RTCM-3 transport protocol. For more convenience, using the $PASHS,ENC command, you can ask the receiver firmware to output all the groups via the same port and using the same frame (e.g. $PASHR).

The few conventions used to describe the serial commands in this manual are summarized in the table below.

String or sign	Description
$PASHS	Header for set commands (Whole line shown in bold characters)
$PASHQ	Header for query commands (Whole line shown in bold characters)
$PASHR	Receiver response line, in normal characters.
$--	Header prefix for all standard NMEA messages delivered by the receiver.
[ ]	Optional field or parameter
,	Field delimiter
.	Decimal point (used in f-type fields)
c..	One-character string
d..	Integer
f..	Real number, with decimal places
h..	Parameter in hexadecimal notation
m..	Denotes specific data format used, such as angles (e.g. ddmm.mmm) or time (e.g. hhmmss.sss)
n	Used in the syntax of responses to query commands to indicate that a sequence of parameters will be repeated "n" times in the response. For example, n(f1,f2,f3) means the response will include the sequence "f1,f2,f3,f1,f2,f3,f1,f2,f3...". The value of n is specific to each command.
s..	Character string
*cc	Checksum

In response to a well recognized and properly executed set command, the receiver will return the message:

$PASHR,ACK*3D

A set command is said to be "NAKed" when it is not accepted or acknowledged. The following message is then returned:

$PASHR,NAK*30

If this happens, check that the command has been typed correctly and the number and format of parameters are correct. In some cases, the execution of a set command may be contingent upon the prior activation of the corresponding firmware option.

Checksum Calculation: The checksum is computed by "exclusive-ORing" all of the bytes in the message between, but not including, the "$" and the "*". The result is "*hh" where h is a hexadecimal character.

Coordinate Transformations: The receiver is not designed to perform internally coordinate transformations. So all the positions the receiver delivers refer to a "default" datum.

The cartesian coordinates the receiver delivers (for example through the PBN message) are expressed on the following datum:

- Current ITRF realization used in broadcast ephemeris data (to date IGS05)
- Datum of reference position (applicable only for DGNSS and RTK modes)

A priori and generally speaking, the receiver does not know anything about the datum used by the local corrections provider to express the reference position it receives from that provider. As a result, the standalone position the receiver determines is tagged to the IGS05 and the differential position is the sum of the reference position (on whichever datum it is expressed) and the baseline estimate (on the IGS05 datum).

For internal transformations from cartesian (e.g. PBN) to geographical (e.g. POS) coordinates, the receiver uses the IGS05 (WGS-84 ellipsoid model).

Special Warning

⚠ Some legacy **GPS only** receivers (like Ashtech DG14 or Trimble 5800) *cannot* process incoming corrections containing GPS+GLONASS data *inside some protocols*.

It is therefore highly recommended to run the $PASHS,GLO,OFF command in any MB 500 base used by such GPS-only rovers.

Setting the Antenna & Receiver Parameters

Query or Set Command	Description
ANTENNA	
$PASHS,ANT/ANH	Antenna Reference Point With Respect to Ground Mark
$PASHS,ANP,DEL	Deleting User-Defined Antenna
$PASHS,ANP,OUT	Enabling/Disabling Raw Data Reduction for a Specific Antenna
$PASHS,ANP,OWN/REF	Naming Local and Reference Antennas
$PASHS,ANP,PCO..	Entering Offset Values to User-Defined Antennas
$PASHS,POS	Setting the Antenna Position
$PASHQ,ANP	Antenna Parameters
RECEIVER	
$PASHS,AGB	Enable/disable GLONASS bias adjustments
$PASHS,CRR	Code Correlator Mode
$PASHS,GLO	Enabling/disabling GLONASS Tracking
$PASHS,GNS,CFG	Selecting a GNSS mode
$PASHS,INI	Resetting Receiver to Preferences
$PASHS,LCS	Enabling/disabling use of local coord system
$PASHS,POP	Setting Internal Update Rates for Measurement and PVT
$PASHS,RCP,GBx	GLONASS Carrier Phase Biases for User-Defined Receiver
$PASHS,RCP,OWN/REF	Naming Local and Reference Receivers
$PASHS,REF	Enabling/Disabling Ext. Reference Clock
$PASHS,RST	Default Settings
$PASHS,SBA	Enabling/Disabling SBAS Tracking
$PASHS,SMI	Code Measurement Smoothing
$PASHS,ZDA	Setting Date & Time
$PASHQ,PAR	Receiver Parameters
$PASHQ,RID	Receiver Identification
$PASHQ,RIO	Receiver Options
OBSERVATION & ELEVATION MASKS	
$PASHS,ELM	Setting Elevation Mask for Raw Data Output

Query or Set Command	Description
$PASHS,SOM,CTT	Cumulative tracking time mask
$PASHS,SOM,NAV	Navigation data mask
$PASHS,SOM,SNR	Signal-to-noise ratio mask
$PASHS,SOM,WRN	Channel warnings mask
I/O SETTINGS	
$PASHS,PHE	Setting Active Edge of Event Marker Pulse
$PASHS,PIN	Setting programmable pin on I/O connector
$PASHS,PPS	Setting PPS Pulse Properties
$PASHS,SPD	Setting Baud Rates for Ports A and B
$PASHQ,PRT	Baud Rate Settings
OTHER	
$PASHS,ENC	Setting Transport Mode for Differential Data
$PASHS,MSG	Entering User Data for Insertion into Standard Messages
$PASHS,NME,MSG	Requesting Rover to Output Differential Message from Base
$PASHS,SIT	Defining a Site Name
RECEIVER TEST MODE	
$PASHS,PFL,TST	Switching Receiver to Test Mode

Setting the Position Computation Mode

Use the following set of commands to set the position computation mode used in the receiver.

Set Command	Description
$PASHS,CPD,AFP	Setting the Confidence Level of Ambiguity Fixing
$PASHS,CP2,AFP	Setting the Confidence Level of Ambiguity Fixing, second RTK engine
$PASHS,CPD,BAS	Setting Static or Moving Base Mode
$PASHS,CP2,BAS	Setting Static or Moving Base Mode, second RTK engine
$PASHS,CPD,NET	Network Corrections
$PASHS,CP2,MOD	Operating mode for second RTK engine
$PASHS,DIF,PRT	Choosing an Input Port for Differential Corrections to Primary RTK Engine
$PASHS,DI2,PRT	Choosing an Input Port for Differential Corrections to Second RTK Engine
$PASHS,DYN	Receiver Dynamics
$PASHS,CPD,FST	Fast RTK Output Mode
$PASHS,CPD,RST	RTK Process Reset
$PASHS,CP2,RST	RTK Process Reset, second RTK engine
$PASHS,CPD,VRS	VRS Assumption Mode
$PASHS,KPI	Known Point Initialization
$PASHS,PEM	Setting the Position Elevation Mask
$PASHS,SVM	Setting the Maximum Number of Observations in the PVT
$PASHS,UTS	Synchronizing onto GPS Time

Set Command	Description
$PASHS,UDP	User-Defined Dynamic Model Parameters
$PASHQ,BPS	Base position message
$PASHQ,CPD,REF	Querying Rover for Base Position Used

Setting Differential Data Messages

Differential Data Messages Generated by the MB 500

The following messages can be generated by the MB 500:

- RTCM-3.1 message types 1001-1013, 1019, 1020, 1029, 1033
- RTCM-2.3 message types 1, 3, 9, 16, 18, 19, 20, 21, 22, 23, 24, 31, 32, 34, 36
- CMR message types 0, 1, 2, 3
- CMR+ message types 0, 3
- ATOM messages of types 4 and 7

  For each protocol, some default configurations can be recommended.

As a reminder, the content of some typical differential data messages are listed below:

- RTCM-3.1 message types 1001-1004 generate GPS and SBAS data.
- RTCM-3.1 message types 1009-1012 generate GLONASS data.
- RTCM-2.3 message types 18, 19, 20, 21 generate GPS and GLONASS data.
- CMR message types 0, 1, 2, 3 generate GPS observation, location, description and GLONASS observation data.
- CMR+ message type 0 generates GPS observation, location and description data.
- CMR+ message type 3 generates GLONASS observation data.
- CMR/CMR+ message type 3 is compatible with similar Leica/Topcon/Novatel messages described in the official Leica White Paper entitled “A GLONASS Observation Message Compatible With The Compact Measurement Record Format.”
- ATOM messages contain GPS,GLONASS,SBAS observation, location and description data.

Data Transport Modes

The data transport mode is controlled by the $PASHS,ENC command. The different data formats available can be output using the following transport modes:

- RTCM-3.1 messages can be output in native (RTCM-3 standard) or ASH transport mode.
- RTCM-2.3 messages can be output in native (RTCM-2 standard), RT3 or ASH transport mode.
- CMR messages can be output in native (CMR standard), RT3 or ASH transport mode.
- CMR+ messages can be output in native (CMP standard), RT3 or ASH transport mode.
- ATOM messages can be output in native (RT3) or ASH transport mode.

Setting ATOM Messages

Use the following set of commands to control the output of ATOM data messages.

Set Command	Description
$PASHS,ATM	Enabling/Disabling ATOM Messages
$PASHQ,PAR,ATM	ATOM Data Generation Settings
$PASHS,ATM,ALL	Disabling All ATOM Messages

For more information on the ATOM protocol and data, refer to the *ATOM Reference Manual*.

Setting RTCM Messages

Use the following set of commands to control the output of RTCM data messages.

Set Command	Description
$PASHS,RT2	Enabling/Disabling RTCM 2.3 Messages
$PASHS,RT2,ALL	Disabling All RTCM 2.3 Messages
$PASHS,RT3	Enabling/Disabling RTCM 3.1 Messages
$PASHS,RT3,ALL	Disabling All RTCM 3.1 Messages

Setting CMR and CMR+ Messages

Use the following set of commands to control the output of CMR or CMR+ data messages.

Set Command	Description
$PASHS,CMR	Enabling/Disabling CMR Messages
$PASHS,CMR,ALL	Disabling All CMR Messages
$PASHS,CMP	Enabling/Disabling CMR+ Messages
$PASHS,CMP,ALL	Disabling All CMR+ Messages

Understanding How MB 500 Generates Differential Data Messages

All differential data messages may be output independently (if requested). The MB 500 may support a different output rate for each message.

However, because some messages include some others, there is no need to output them all (e.g. message type 1002 may not be output if message type 1004 is, because all data in message type 1002 are also included in message type 1004).

The order in which messages are output cannot be changed. Regardless of the order in which these are requested, the MB 500 will always keep the following order within each epoch:

1. Location messages (e.g. 1006)
2. Data messages (e.g. 1004,1012)
3. Description messages (e.g. 1033)

Location messages should go first for more effective support of the moving base RTK mode.

As recommended by the RTCM, for each epoch, GPS data go first (e.g. 1004), then GLONASS (e.g. 1012).

GPS and GLONASS data are output for the same physical time (the only exception can be for differential message types 1 and 31).

When the CMR or CMR+ format is used, GLONASS data always go first, owing to backward compatibility problems.

The intervals of time between messages cannot be chosen arbitrarily.

- For “fast” messages, only the following intervals are valid: 0.05, 0.1, 0.2, and 0.5 seconds.

  The phase of these messages is chosen in such a way that messages are output at an integer number of seconds of GPS time.
- For “slow” messages, time intervals of entire seconds are admissible. However, for data messages such as 1001-1004 or 1009-1012, only the following time intervals are recommended: 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60 seconds and an integer number of minutes.

  The phase of these messages is chosen in such a way that messages are output at an integer number of minutes of GPS week time.

These intervals and time shifts are recommended in the RTCM-2 standard and “kept in mind” in all the other standards. For “slow” location/description messages however, where exact time tagging is not important, any time interval with an integer number of seconds is permissible (e.g. a 31-second interval is recommended fro message type 1033).

All messages (except ephemeris message types 1019 and 1020) are output on an "on-time" basis, i.e. they strictly comply with the requested time intervals. However, outputting these ephemeris messages follows the same philosophy as when outputting SNV and SNG messages, which means they are output independently and there can't be more than one 1019 and one 1020 message for each epoch.

There can be three types of output requirements:

- *On new*: messages start to be output only after they've been requested.
- *On change*: messages are output only when their contents have changed (e.g. new IODE).
- *On time*: messages are output at regular intervals of time whether or not their contents are changing.

All differential data messages can serve two different receiver modes:

- *Base mode*, when data are generated to be sent to a remote receiver (rover).
- *Data collection mode*, when data are recorded for further post-processing.

While almost the same data are used in both receiver modes, some setup differences may exist:

- When the RTCM or CMR (CMR+) format is used in base mode, the reference position inserted in differential data messages is a stationary position entered externally (either by specifying the exact coordinates of this position or through $PASHS,POS,CUR). The message rate is typically 10 to 30 seconds. There is no need to generate ephemeris data, because this information is available on the rover side.
- When the RTCM or CMR (CMR+) format is used in data collection mode, the position inserted in differential data messages is the one currently computed for the receiver position (cf. $PASHS,POS,MOV). It is desirable to generate the messages with the same rate as the one used for observations.

  To use recorded data effectively in post-processing, there is a need to record ephemeris data if the format allows it (e.g. RTCM-3). Rough position and ephemeris are very desirable in this mode, because many of the messages (e.g. CMR Type 0) require that an integer value of milliseconds of ambiguity in pseudo-range and carrier data be restored.

Differential Data Messages Received by the MB 500

The MB 500 can receive the following reference data:

- RTCM-3.1 message types 1001-1017, 1019-1023, 1029-1033
- RTCM-2.3 message types 1, 3, 9, 16, 18, 19, 20, 21, 22, 23, 24, 31, 32, 34, 36, 59.adv (FKP)
- CMR message types 0, 1, 2, 3
- CMR+ message types 0, 3
- ATOM message types 4 and 7
- DBEN message types 0 (GPS observations) and 1 (location)
- TOPAZE messages (single-frequency GPS/WAAS/EGNOS pseudo-ranges in satellite time, and dual-frequency GPS pseudo-ranges in satellite time).

The $PASHS,DIF,PRT command can be used to specify the port dedicated to receiving the differential data stream (the differential decoder is then requested to “listen to” only one port).

To minimize decoder workload in the case of high-speed incoming data, the same command also allows you to specify the differential protocol used.

Differential decoders and processors do not make any *a priori* assumptions about the sequence of messages that follow and their intervals.

Why There is No Need for Specifying Base or Rover Mode

By default, the MB 500 starts operating as a rover as soon as a differential data stream is detected according to the settings of the $PASHS,DIF,PRT command.

Operating the MB 500 in base mode results from the simple fact that commands are executed in the MB 500 that enable the generation of differential data messages.

So in no case does the base or rover mode in the MB 500 result from a specific command that would be applied to the board.

All generated differential data messages can be used not only to support the RTK base mode, but also to allow their further post-processing (if they are also recorded). In that respect, all available differential data formats (ATOM, RTCM, CMR) are equivalent to legacy MPC (etc.) messages.

Setting Raw Data Messages

Use the following set of commands to control the output of raw data messages.

Set or Query Command	Description
$PASHS,RAW	Enabling/Disabling Raw Data Messages in Ashtech Format
$PASHS,RAW,ALL	Disabling All Raw Data Messages
$PASHQ,<message_name> Where <message_name>: ION, MCA, MPC, PBN, SNV, SNG, SNW, SAL, SAG, SAW or SBD.	Asking for the Output of the Requested Raw Data Message

Setting the NMEA and NMEA-Like Data Messages

Use the following set of commands to control the output of NMEA and NMEA-like data messages.

Enable/Disable Commands:

Query Command	Description
$PASHS,NME	Enabling/Disabling NMEA and NMEA-like Messages
$PASHS,NME,ALL	Disabling All NMEA and NMEA-Like Messages

NMEA Messages:

Query Command	Description	Resulting NMEA Message
$PASHQ,ALM	Almanac Message	$GPALM
$PASHQ,GGA	GNSS Position Message	$GPGGA
$PASHQ,GLL	Geographic Position - Latitude/ Longitude	$GPGLL
$PASHQ,GRS	GNSS Range Residuals	$GPGRS, $GLGRS or $GNGRS
$PASHQ,GSA	GNSS DOP and Active Satellites	$GPGSA, $GLGSA or $GNGSA
$PASHQ,GST	GNSS Pseudo-Range Error Statistics	$GPGST, $GLGST or $GNGST
$PASHQ,GSV	GNSS Satellites in View	$GPGSV or $GLGSV
$PASHQ,HDT	True Heading	$GPHDT
$PASHQ,RMC	Recommended Minimum Specific GNSS Data	$GPRMC
$PASHQ,VTG	Course Over Ground and Ground Speed	$GPVTG
$PASHQ,ZDA	Time & Date	$GPZDA

NMEA-like Messages:

Query Command	Description	Resulting NMEA-Like Message
$PASHQ,ATT	Heading, Roll and Pitch	$PASHR,ATT
$PASHQ,LTN	Latency	$PASHR,LTN
$PASHQ,POS	Computed Position Data	$PASHR,POS
$PASHQ,PTT	PPS Time Tag	$PASHR,PTT
$PASHQ,SAT	Satellites Status	$PASHR,SAT
$PASHQ,VEC	Vector & Accuracy Data	$PASHR,VEC
(External Event Signal)	Event Marker	$PASHR,TTT

Setting the Heading Function

Use the following set of commands to set the heading mode in the receiver.

Set Command	Description
$PASHS,CPD,ARR,LEN	Setting the Baseline Length in Heading Mode
$PASHS,CPD,ARR,MOD	Enabling/Disabling the Heading Mode
$PASHS,CPD,ARR,OFS	Setting Heading and Elevation Offsets
$PASHS,CPD,ARR,PAR	Setting Upper Limits in Heading Mode

Chapter 6. Set Command Library

AGB: Enabling/Disabling GLONASS Bias Adjustments

Function

This command is used to enable or disable the adjustment of L1 & L2 GLONASS carrier biases in the receiver so that the GLONASS Double-Difference carrier residuals between the receiver and the *golden Ashtech receiver* are equal to zero (± noise errors).

MB 500 is considered as the golden Ashtech receiver.

After activating the adjustment function, the receiver name provided by any message supposed to deliver that name (e.g. RTCM-3 MT 1033) will appear in the form:

ASHTECH<space><name>

Where <space> is a space character between the two words and <name> is the receiver name entered through the $PASHS,RCP,OWN command.

Command Format

Syntax

$PASHS,AGB,s1[*cc]

Parameters

Parameter	Description	Range	Default
s1	Enabling (ON) or disabling (OFF) adjustment of GLONASS biases	ON, OFF	OFF
*cc	Optional checksum	*00-*FF	

Example

Enabling adjustment of GLONASS biases:

$PASHS,AGB,ON*1C

ANP,DEL: Delete User-Defined Antenna

Function

This command allows you to delete the definition of a user-defined antenna.

Command Format

Syntax

$PASHS,ANP,DEL,s1[*cc]

Parameters

Parameter	Description	Range
s1	User-defined antenna name (case-sensitive)	31 characters max.
*cc	Optional checksum	*00-*FF

Example

Deleting RZ510A antenna definition:

$PASHS,ANP,DEL,RZ510A*1A

ANP,OUT: Defining a Virtual Antenna

Function

This command allows you to specify the name of an antenna that raw data will be adjusted to. By specifying the name of a virtual antenna, you ask the receiver to correct (“reduce”) the raw and differential data it generates from the received GNSS signals to make them available as if they had been received through *that* antenna.

Command Format

Syntax

$PASHS,ANP,OUT[,s1][*cc]

Parameters

Parameter	Description	Range
s1	Virtual antenna name (case-sensitive). Running this command with s1 omitted means that no virtual antenna is used (data reduction disabled).	31 characters max.
*cc	Optional checksum	*00-*FF

Examples

Setting the ADVNULLANTENNA as the virtual antenna:

$PASHS,ANP,OUT,ADVNULLANTENNA*73

Disabling the use of the virtual antenna:

$PASHS,ANP,OUT*48

Comments

- By default, the receiver observables are not corrected for the type of GNSS antenna used. It's only by providing separately the name of the GNSS antenna used (declared as the OWN antenna) that the antenna corrections can be performed when processing the receiver observables. Now precisely, the ANP,OUT command allows you to directly generate the raw and differential observables for the type of antenna you specify in the command (e.g. ADVNULLANTENNA).
- Be aware that the raw data reduction process is possible only if the name of the antenna physically used by the receiver has been specified through the $PASHS,ANP, OWN command and declared in the receiver's antenna database as one of the default or user-defined antennas. Otherwise, the command will be NAKed.
- Raw data reduction will not be performed on data from any satellite located below the elevation mask.
- When raw data reduction is effective, any antenna name messages generated by the receiver will include the name of the virtual antenna, and not the antenna serial number or the setup ID.
- If no reference position has been entered in the receiver, raw data reduction is performed in such a way that the location of the L1 phase center is left unchanged.
- If a reference position has been specified through the $PASHS,POS command, raw data reduction is performed in such a way that this reference position is left unchanged. If the reference position is explicitly given for the L1 phase center or the ARP, raw data reduction is made in such a way that the location of respectively the L1 phase center or the ARP is left unchanged.

See Also $PASHS,ANP,OWN

ANP,OWN: Naming Local Antenna

Function This command is used to enter the name of the antenna connected to the receiver (local antenna).

Command Format

Syntax

$PASHS,ANP,OWN,s1[,s2[,d3]][*cc]
or
$PASHS,ANP,OWN,s1,,d3[*cc]

Parameters

Parameter	Description	Range
s1	User-defined antenna name (case-sensitive). There is no default name (s1 empty). The command will be "NAKed" if s1 consists of more than 31 characters.	31 characters max.
s2	Antenna serial number	31 characters max.
d3	Antenna setup ID	0-255
*cc	Optional checksum	*00-*FF

Comments

- The antenna name must be chosen to be consistent with the built-in antenna database, which is a hard-coded database. The firmware has the capability to extract numerical values from the parameters entered under a given antenna name.
- Parameters s2 and d3 have little interest for a rover (that's why they are optional). If however they are specified, they should be inserted in such RTCM messages as type 1008 or 1033, in which room is reserved for these parameters.
- With the receiver used as an RTK base, the s1 parameter (and also the s2 and d3 parameters if available) are inserted into antenna name messages (e.g. RTCM 23 or RTCM 1007, 1008 or 1033). If needed, the receiver performs the transformation of the entered base position from ARP to APC, or vice versa.
- With the receiver used as an RTK rover, the numerical values corresponding to the s1 parameter are used to appropriately correct the local antenna data.

Example

Entering "ASH111661" as the name of the receiver antenna:

$PASHS,ANP,OWN,ASH111661*26

ANP,REF: Naming Reference Antenna

Function

This command is used to enter the name of the antenna used by the reference station the receiver is working with.

Command Format

Syntax

$PASHS,ANP,REF,s1[,d2][*cc]

Parameters

Parameter	Description	Range
s1	User-defined antenna name (case-sensitive). There is no default name (s1 is empty)	31 characters max.
d2	Antenna name preference (see note below)	0 (default) or 1
*cc	Optional checksum	*00-*FF

Comments

- Antenna names must be chosen to be consistent with the built-in antenna database, which is a hard-coded database. The firmware has the capability to extract numerical values from the parameters entered under a given antenna name.
- With the receiver used as an RTK rover, the numerical values corresponding to the s1 parameter are used to correct the data from the reference antenna.
- When the receiver is used as an RTK rover and d2=0, the antenna name (s1) will be ignored if the incoming reference data contain the reference antenna name.

  Reciprocally, in the same context and with d2=1, the antenna name entered as s1 will be used, and the antenna name decoded from the incoming reference data will be ignored.

Example

Entering "ASH802111" as the name of the reference antenna (ignored if messages from base include reference antenna name):

$PASHS,ANP,REF,ASH802111*2A

ANP,PCO/EDx: Entering Offset Values to User-Defined Antennas

Function

These commands are used to enter offset values to the definition of a given user-defined antenna.

Up to 5 user-defined antennas can be added to the existing antenna list. Being kept in the Battery Backup Unit (BBU), the list is preserved after a usual power cycle but can however be deleted through a receiver cold reset.

Command Format

Syntax

$PASHS,ANP,PCO,s1,f2,f3,f4,f5,f6,f7[,F8][*cc]

$PASHS,ANP,ED1,s1,f2,f3,f4,... ,f20[*cc]

$PASHS,ANP,ED2,s1,f2,f3,f4,... ,f20[*cc]

Parameters

ANP,PCO

Parameter	Description	Range
Headers	ANP stands for Antenna Parameters PCO stands for Phase Center Offset	-
s1	User-defined antenna name (case-sensitive).	31 characters max.
f2, f3, f4	North/East/Up phase center offset for L1, in mm (with respect to Antenna Reference Point)	Full range of real variable allowed
f5, f6, f7	North/East/Up phase center offset for L2, in mm (with respect to Antenna Reference Point)	Full range of real variable allowed
f8	Antenna class: • 0: High-grade antenna (default) • 1: Low-grade antenna	0, 1
*cc	Optional checksum	*00-*FF

ANP,ED1 and ANP,ED2

Parameter	Description	Range
Headers	ANP stands for Antenna Parameters ED1 (ED2) stands for Elevation Dependent for L1 (L2)	-
s1	User-defined antenna name (case-sensitive).	31 characters max.
f2 to f20	Elevation-dependent delays for L1 (L2) in mm. These parameters correspond to elevations from 90 degrees to 0 degrees in 5-degree steps.	Full range of real variable allowed
*cc	Optional checksum	*00-*FF

Comments

- Applying either of these commands to an existing antenna name causes the firmware to modify the corresponding parameters of this antenna accordingly and save them to backup memory. All other predefined parameters of the antenna not addressed by the command will be left unchanged.
- You may not apply the three commands necessarily for a given antenna name. The firmware will assume that the parameters corresponding to the non-applied commands

will be all zero, if it's a newly created antenna name, or all as predefined if it's an already existing antenna name.

- Each antenna record kept in the database has an additional indicator to tell whether the antenna is a high- or low-grade class antenna.

  When a user-defined antenna is specified using the above commands, defining the antenna grade class is recommended. In most cases, all antennas used are of the high-grade class type. However, if you wish to integrate an Ashtech GNSS board into a handheld device fitted with a cheap antenna element, then specifying this antenna as of the low-grade type is recommended. Usually such an antenna does not provide high SNR and is more affected by multipath errors. In this case, it is better for the algorithms of the internal GNSS board to be informed that the board is working with a low-grade class antenna.

Example

Entering offset parameters for "LEIAT504 LEIS" antenna:

$PASHS,ANP,PCO,LEIAT504 LEIS,2.5,1.3,106.5,-0.7,1.3,125.4*0C
$PASHS,ANP,ED1,LEIAT504 LEIS,0.0,0.0,-0.3,-0.8,-1.1,-1.4,-1.6,-1.8,-1.9,-1.9,-1.9,-1.8,-1.6,-1.4,-1.2,-1.0,-0.7,-0.3,0.0*4A
$PASHS,ANP,ED2,LEIAT504 LEIS,0.0,0.0,0.8,0.5,0.2,0.0,-0.1,-0.2,-0.2,-0.1,-0.1,0.0,0.1,0.1,0.2,0.2,0.2,0.1,0.0*6C

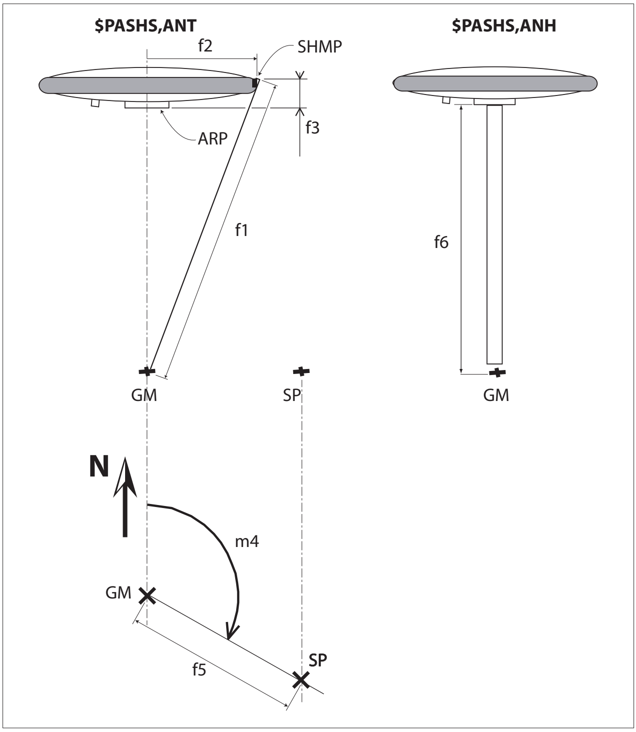
ANT & ANH: Antenna Reference Point With Respect to Ground Mark

Function

These two commands allow you to define the 3D location of the Antenna Reference Point (ARP) with respect to the survey point.

The offset parameters entered through ANT allow the receiver to deduce the position of the ARP from the entered reference position for the survey point (SP). The antenna offset parameters are never used to correct internally the computed receiver position, unless this position is generated as a reference position in differential protocol. The value entered for the vertical offset can also be included in some reference data messages.

When the antenna is placed just above the survey point and the vertical distance to the ARP is known, this distance can be entered through the more straightforward ANH command.



You will necessarily choose only one of these commands to define the ARP and discard the other. Whether the last command run is ANT or ANH, it will in any case supersede the settings made with the ANT or ANH command run previously.

Command Format

Syntax

$PASHS,ANT,f1,f2,f3,m4,f5[*cc]
or
$PASHS,ANH,f6[*cc]

Parameters

See also the above two diagrams for reference.

Parameter	Description	Range
f1	Slant height measurement, from ground mark (GM) to antenna edge (SHMP).	0-6.5535 m
f2	Antenna radius: horizontal distance from ARP to SHMP (antenna edge).	0-6.5535 m

Parameter	Description	Range
f3	Vertical offset from ARP to SHMP, negative if SHMP is above ARP, positive otherwise. See also comments below.	-3.2768 to 3.2767 m
m4	Horizontal azimuth [dddmm.mm] for the horizontal line connecting the ground mark (GM) to the survey point (SP), measured with respect to WGS84 North.	0-35959.99 (from 0° to 359° 59.99”)
f5	Horizontal offset from the ground mark (GM) to the survey point (SP).	0-6.5535 m
*cc	Optional checksum	*00-*FF
f6	Antenna height from ARP to ground mark (GM).	0-6.5535 m
*cc	Optional checksum	*00-*FF

Example

Entering the vertical measurement (2 m) of a rover antenna:

$PASHS,ANH,2.0000*02

Comments

- The ground mark (GM) is defined as the vertical projection of the ARP to the ground.
- The vertical height from ARP to ground mark can also be entered through the ANT command, which in this case should be used as follows:
  - Set **f1** to “0.0”
  - Enter the antenna height from ARP to ground mark as **f3** (which by the way in this case is equal to **f6**). Only when **f1**=0.0 can you define **f3** this way.

ATL: Debug Messages

Function

This command allows you to enable or disable the output of the binary ATL message on the specified port. The ATL message is output at its own output rate (not user-settable). ATL messages report useful data flowing in, and generated by the receiver for debugging purposes.

After you have disabled the output of ATM messages, you should save all the messages collected by the connected device (e.g. Hyperterminal running on a computer) as a file, typically named “atl.log”.

Normally you don’t have to enable this message but the Ashtech Technical Support may ask you to do so if a problem occurs in your receiver and Technical Support needs to analyze the resulting log file (atl.log) to fix the problem.

The content of the atl.log file can only be analyzed by Ashtech as the ATL message uses a proprietary, undisclosed data format, which in addition is subject to change without notice.

Command Format

Syntax

$PASHS,ATL,s1[*cc]

Parameters

Parameter	Description	Range	Default
s1	ID of port on which the ATL message is output or “OFF” to disable data recording and close the file.	A, B, C, OFF	OFF
*cc	Optional checksum	*00-*FF	

Example

Enabling the ATL message on port A:

$PASHS,ATL,A*41

Disabling the ATL message:

$PASHS,ATL,OFF*4F

Comments

- The ATL message is in binary format. Only the header (**$ATL**) of the message appears in plain format for easy recognition of the data stream.
- The ATL message can only be output on a single port at a time. If you need to change the output port (e.g. from A to B), then you should first stop the message on port A and re-enable the output on port B.
- The ATL setting is not affected by power cycles. If the output of ATL messages is enabled when the receiver is turned off, it will still be enabled when the receiver is turned back on (and reciprocally).
- The ATL message can be output on a given port without affecting the messages you have programmed on this port. This is because ATL uses a specific format, different from the one used for all the other output messages. See however the recommendations below.

Although normally ALT messages will not interfere with your own messages on the same port, here are a few recommendations for best use of the ATL command:

- Use a specific output port for ATL messages whenever possible.

- The size of ATL messages may vary significantly, depending on internal receiver settings (CGF, POP, etc.) and the availability of corrections data (see throughput requirement estimates below). Ashtech recommends you set the port accordingly, in order to have sufficient data throughput assuring ATL data and your other messages to be output uncorrupted. It is therefore advisable to use the highest possible baud rate for the port delivering the ATL messages.
- You should ask for ATL messages only after the receiver has been set in the configuration that needs debugging, otherwise ATL messages will be of little help to Technical Support.

ATL messages should be enabled only when you think that the receiver is not operating as expected. With some heavy user configurations (e.g. 20 Hz RTK + 10 Hz heading, numerous data outputs enabled), enabling ATL messages may to some extent affect data output (corrupted data, missing epochs, increased latency), especially if they are output on the same port as user data.

On the other hand, ATL messages will have no impact whatsoever on the internal receiver algorithms.

Below are rough estimates of the data throughput requirements for typical receiver operating modes. These are averaged figures. The instant figures may vary by as much as ±50% depending on the operating conditions.

Receiver Operating Mode	Data Throughput (bytes/second)
Standalone, POP,10	2,500
Standalone, POP,20	3,000
Fast RTK (10-Hz corrections input), POP,10	9,000
Fast RTK (10-Hz corrections input), POP,20	10,000

ATM: Enabling/Disabling ATOM Messages

Function

This command allows you to enable or disable ATOM messages on the specified port. For more details about the ATOM format, please refer to the *AshTech Optimized Messaging (ATOM) Reference Manual*.

Command Format

Syntax

$PASHS,ATM,s1,c2,s3[,f4][*cc]

Parameters

Parameter	Description	Range
s1	ATOM message type	MES, PVT, TT1, TT2, ATR, NAV, DAT, RNX, EVT, STA
c2	Port ID	A, B, C
s3	Enable (ON) or disable (OFF) this ATOM message type.	ON, OFF
f4	Output rate, in seconds.	See ATOM Reference Manual
*cc	Optional checksum	*00-*FF

Examples

Enabling ATOM message type PVT on serial port A at a 1-second output rate:

$PASHS,ATM,PVT,A,ON,1*0E

Enabling ATOM message type RNX on serial port A :

$PASHS,ATM,RNX,A,ON*05

Comments

Defining output rates for ATOM messages should follow the rules presented in *Understanding How MB 500 Generates Differential Data Messages on page 66*.

ATM,ALL: Disabling All ATOM Messages

Function

This command disables all ATOM messages currently enabled on the specified port.

Command Format

Syntax

$PASHS,ATM,ALL,c1,OFF[*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Example

Disabling all ATOM messages on port A:

$PASHS,ATM,ALL,A,OFF*4E

CMR: Enabling/Disabling CMR Messages

Function

This command is used to enable or disable the continuous output of CMR messages.

Command Format

Syntax

$PASHS,CMR,d1,c2,s3[,f4][*cc]

Parameters

Parameter	Description	Range	Default
d1	Data message	See table below	-
c2	Port ID	A, B, C	-
s3	Enabling/disabling command	ON, OFF	OFF
f4	Output interval, in seconds	See table below.	1
*cc	Optional checksum	*00-*FF	-

The list of supported data messages is the following:

Data	Description	f4 Range
0	GPS observations	0.05, 0.1, 0.2, 0.5, 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60, 120, etc. integer minutes, up to 960.
1	Reference WGS84 position (location) tagged to L1 phase center	0.05, 0.1, 0.2, 0.5, 1, 2, 3, 4, 5, etc. integer seconds, up to 999.
2	Reference site description (as entered through $PASHS,MSG)	0.05, 0.1, 0.2, 0.5, 1, 2, 3, 4, 5, etc. integer seconds, up to 999.
3	GLONASS observations	0.05, 0.1, 0.2, 0.5, 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60, 120, etc. integer minutes, up to 960.

Example

Setting default CMR messages at a base:

$PASHS,POS,<coordinates of position>
or
$PASHS,POS,CUR*51

$PASHS,CMR,0,A,ON,1*68
$PASHS,CMR,1,A,ON,13*5A
$PASHS,CMR,2,A,ON,31*59
$PASHS,CMR,3,A,ON,1*6B

Comments Defining output rates for CMR messages should follow the rules presented in *Understanding How MB 500 Generates Differential Data Messages on page 66*.

CMR,ALL: Disabling All CMR Messages

Function This command is used to disable all the CMR messages currently enabled on the specified port.

Command Format

Syntax

$PASHS,CMR,ALL,c1,OFF[*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Example

Disabling all CMR messages on port A:

$PASHS,CMR,ALL,A,OFF*4A

CMP: Enabling/Disabling CMR+ Messages

Function This command is used to enable or disable the continuous output of CMR+ messages.

Command Format

Syntax

$PASHS,CMP,d1,c2,s3[,f4][*cc]

Parameters

Parameter	Description	Range	Default
d1	Data message	See table below	-
c2	Port ID	A, B, C	-
s3	Enabling/disabling command	ON, OFF	OFF
f4	Output interval, in seconds	0.05, 0.1, 0.2, 0.5, 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60, 120 etc., integer minutes, up to 960	1
*cc	Optional checksum	*00-*FF	-

The list of supported data messages is the following:

Data	Description
0	GPS observations, location, description
3	GLONASS observations

Comments

- The output interval refers to the time interval between observations.
- Location and description data are spread over a number of consecutive observation epochs regardless of the output interval.
- The number of epochs required to output the complete message depends on the length of the description data. If there is no description data, then this number is 7 epochs, which means the complete location information has a fixed period of 7 epochs.

Example

Setting default CMR+ messages at a base:

$PASHS,POS,<coordinates of position>
or
$PASHS,POS,CUR*51

$PASHS,CMP,0,A,ON,1*6A
$PASHS,CMP,3,A,ON,1*69

Comments

Defining output rates for CMP messages should follow the rules presented in *Understanding How MB 500 Generates Differential Data Messages on page 66*.

CMP,ALL: Disabling All CMR+ Messages

Function

This command is used to disable all the CMR+ messages currently enabled on the specified port.

Command Format

Syntax

$PASHS,CMP,ALL,c1,OFF[*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Example

Disabling all CMR+ messages on port A:

$PASHS,CMP,ALL,A,OFF*48

CPD,AFP - CP2,AFP: Setting the Confidence Level of Ambiguity Fixing

Function

This command is used to set the confidence level required of the ambiguity fixing process. The higher the confidence level, the more likely the ambiguities are fixed correctly, but the longer the time it takes to fix them.

Command Format

Syntax

For primary RTK engine:

$PASHS,CPD,AFP,f1[*cc]

For second RTK engine:

$PASHS,CP2,AFP,f1[*cc]

Parameters

Parameter	Description	Range	Default
f1	Confidence level, in percent, required of ambiguity fixing process. Choosing “0” means the receiver will not try to fix ambiguities but instead will stay indefinitely in Float mode.	0, 95.0, 99.0 or 99.9	99.0
*cc	Optional checksum	*00-*FF	-

Example

Setting the confidence level to 99.9% for primary RTK engine:

$PASHS,CPD,AFP,99.9*62

CPD,ARR,LEN - CP2,ARR,LEN: Setting the Baseline Length in Arrow Mode

Function

This command is used to set the baseline length between the base and the rover in arrow mode.

Command Format

Syntax

For the primary RTK engine:

$PASHS,CPD,ARR,LEN,f1[*cc]

For the second RTK engine:

$PASHS,CP2,ARR,LEN,f1[*cc]

Parameters

Parameter	Description	Range	Default
f1	Baseline length in meters. When setting f1 to"0" and the arrow mode is ON, the receiver switches to calibration mode. Once the baseline length is determined, the receiver automatically switches from calibration to arrow operating mode.	0 or 0.05 to 1000 m	0
*cc	Optional checksum	*00-*FF	-

Example

Setting the baseline length to 2.5 meters for the primary RTK engine:

$PASHS,CPD,ARR,LEN,2.5*21

CPD,ARR,MOD - CP2,ARR,MOD: Enabling/Disabling the Arrow Mode

Function

This command is used to enable or disable the arrow mode in the receiver. The arrow mode is defined as a special RTK mode primarily used when the receiver (whether a base or a rover) is mounted on a solid body (e.g. a vehicle) and the baseline length is constant, to determine the vehicle's heading and pitch or roll.

Command Format

Syntax

In the primary RTK engine:

$PASHS,CPD,ARR,MOD,s1[*cc]

In the second RTK engine:

$PASHS,CP2,ARR,MOD,s1[*cc]

Parameters

Parameter	Description	Range	Default
s1	Enabling/disabling command.	ON, OFF	OFF
*cc	Optional checksum	*00-*FF	-

Example

Turning on the arrow mode in the primary RTK engine:

$PASHS,CPD,ARR,MOD,ON*08

Comments

- If the baseline length has not been set yet (using $PASHS,CPD,ARR,LEN) when the $PASHS,CPD,ARR,MOD command is run, the receiver automatically switches to the arrow calibration mode. Only after the baseline length has been determined (or entered through $PASHS,CPD,ARR,LEN) will the receiver switch to the arrow operating mode.
- As the arrow mode uses an extra baseline constraint, the resulting solution is provided with higher availability and reliability.
- Since in most of the heading applications the base is moving, the $PASHS,CPD,BAS,1 command also needs to be run when enabling the arrow mode.

CPD,ARR,OFS - CP2,ARR,OFS: Setting Heading and Elevation Offsets

Function

This command is used to set the heading and elevation offsets from the vehicle centerline.

Command Format

Syntax

For the primary RTK engine:

$PASHS,CPD,ARR,OFS,f1[,f2][*cc]
or
$PASHS,CPD,ARR,OFS,,f2[*cc]

For the second RTK engine:

$PASHS,CP2,ARR,OFS,f1[,f2][*cc]
or
$PASHS,CP2,ARR,OFS,,f2[*cc]

Parameters

Parameter	Description	Range	Default
f1	Baseline azimuth offset angle.	0° to 359.99°	0°
f2	Baseline elevation offset angle	-90° to +90°	0°
*cc	Optional checksum	*00-*FF	-

Comments

- The default value for f2 is applicable only if the baseline length is user entered. It is not applicable if the baseline length results from a calibration process.

- It is recommended to use a baseline elevation offset as close as possible to zero and a baseline heading offset as close as possible to n×90 degrees.
- If the azimuth offset is close to 0 or 180°, then the vehicle's pitch and heading will be estimated and output.
- If the azimuth offset is close to 90 or 270°, then the vehicle's roll and heading will be estimated and output.
- If the heading offset from either North, South, West or East exceeds 15 degrees, then the receiver delivers the heading component of attitude, but does not output pitch and roll.
- If the elevation offset is greater than 45 degrees or less than -45 degrees, then the receiver considers installation to be invalid and does not output any attitude information (i.e. no pitch, no roll and no heading).
- The specified values of offsets have an effect only when the rover is operating in arrow mode.
- Sending the command without f1 or f2 will not change the corresponding offset value currently used, which will stay either that entered previously through a valid CPD,ARR, OFS command, or 0° (default value) if no such command was run.

Example

Setting the baseline offsets to 90° azimuth and 2° elevation for the primary RTK engine:

$PASHS,CPD,ARR,OFS,90,2*02

CPD,ARR,PAR - CP2,ARR,PAR: Setting Upper Limits in Arrow Mode

Function

This command is used to set the upper limits of baseline elevation and expected maximum error in the entered baseline length.

Command Format

Syntax

For the primary RTK engine:

$PASHS,CPD,ARR,PAR,d1[,f2][*cc]
or
$PASHS,CPD,ARR,PAR,,f2[*cc]

For the second RTK engine:

$PASHS,CP2,ARR,PAR,d1[,f2][*cc]

or

$PASHS,CP2,ARR,PAR,,f2[*cc]

Parameters

Parameter	Description	Range	Default
d1	Maximum value of expected baseline elevation (absolute value), in degrees. Parameter d1 only affects the arrow operating mode and is not applied during baseline length auto-calibration.	0° to 90°	15
f2	Maximum value of tolerated baseline length error, in meters.	0.001 to 10	0.01
*cc	Optional checksum	*00-*FF	-

Comments

Sending the command without d1 or f2 will not change the corresponding limit currently used, which will stay either that entered previously through a valid CPD,ARR,PAR command, or the default value if no such command was run.

The default value for f2 is applicable only if the baseline length is user entered. It is not applicable if the baseline length results from a calibration process.

Example

Setting the limits to 10° for elevation and 0.02 m for baseline length error for the primary RTK engine:

$PASHS,CPD,ARR,PAR,10,0.02*3D

CPD,BAS - CP2,BAS: Setting Static or Moving Base Mode

Function

This command is used to set the operating mode for the receiver with either a static or moving base.

Command Format

Syntax

Primary RTK engine:

$PASHS,CPD,BAS,d1[*cc]

Second RTK engine:

$PASHS,CP2,BAS,d1[*cc]

Parameters

Parameter	Description	Range	Default
d1	=0: Base is assumed to be static =1: Base is assumed to be moving	0, 1	0
*cc	Optional checksum	*00-*FF	-

Example

Setting the receiver to operate with a moving base (primary RTK engine):

$PASHS,CPD,BAS,1*43

Comments

- The [V] firmware option is required for this command to work.
- When setting the receiver to operate with a moving base (primary RTK engine), it is advisable to choose the time-tagged RTK mode, rather than the Fast RTK mode, using $PASHS,CPD,FST,OFF.

CPD,FST: RTK Output Mode

Function

This command enables or disables the fast RTK output mode (Fast CPD mode). By default, the Fast CPD mode is enabled. When working with a moving base, Ashtech recommends you turn off the Fast CPD output mode.

Command Format

Syntax

$PASHS,CPD,FST,s1[*cc]

Parameters

Parameter	Description	Range	Default
s1	Enables (ON) or disables (OFF) the fast RTK output mode	ON, OFF	ON
*cc	Optional checksum	*00-*FF	-

Example

Enabling the fast RTK output mode:

$PASHS,CPD,FST,ON

CP2,MOD: Operating Mode for Second RTK Engine

Function

This command is used to set the operating mode in the second RTK engine.

Command Format

Syntax

$PASHS,CP2,MOD,s1[*cc]

Parameters

Parameter	Description	Range	Default
s1	Choice of operating mode for second RTK engine	HED, BKP, OFF; See table below.	OFF
*cc	Optional checksum	*00-*FF	

s1 parameter	Description
HED	Switches second RTK engine to heading mode.
BKP	Switches second RTK engine to backup mode.
OFF	Turns off second RTK engine.

Example

Enabling backup mode (Hot Standby RTK) in second RTK engine:

$PASHS,CP2,MOD,BKP*4B

Comments

- Whether s1=HED or BKP, the resulting output for the second RTK engine is controlled by the ATM,TT2 command. The output data are available as an extra ATM,PVT message, the header of which clearly identifies the second RTK engine as the provider of the position solution. Being wrapped into Ashtech transport, this message is provided to end users as a $PASHR,TT2 message.
- Using s1=BKP is recommended in all cases where the receiver can potentially get two independent corrections streams (usually acquired at 1 Hz each) from different static bases and entering the receiver through different physical or virtual ports.

  In this mode, the position delivered by the receiver (through messages ATM,PVT or GGA, or other) is the best of the two solutions provided by the two RTK engines used (the primary and backup ones).

  Determining which solution is the best is done by the receiver itself, taking into account all the internal parameters and indicators at its disposal. At any given time, users can identify the RTK engine from which the delivered position originates by reading the base station ID provided in the position message.

When used in Backup mode (s1=BKP), the second RTK engine will only accept time-tagged reference data determined for integer seconds of time.

- Using s1=HED is possible when the receiver is fed with two independent corrections streams, entering the receiver through different physical or virtual ports.

  The primary stream usually comes from a remote static base at 1-Hz rate and should serve the conventional RTK function.

  The secondary stream typically comes from a nearby sensor (at a rate usually greater than 1 Hz) and should serve the heading function.

  In this mode, the position delivered by the receiver (through messages ATM,PVT or GGA, or other) will always originate from the primary RTK engine. The heading result, delivered by the second RTK engine, can be read by enabling the ATM,TT2 output message.

  Still in heading mode, the second RTK engine will only provide a time-tagged solution, at an update rate of up to 10 Hz, matching the update rate of the incoming corrections. It is recommended to set “POP,10” in this case. The position and heading are then available at an output rate no greater than 10 Hz each. It is still possible to work with “POP,20” but in this case, there may be a noticeable percentage of missing epochs with a number of tracked satellites greater than about 16.

  Setting the second RTK engine to operate in heading mode affects the way the primary RK engine works: It can still provide Fast RTK solutions at up to 20 Hz, but can only provide time-tagged solutions at maximum 1 Hz.

  Since in most heading applications the base is moving, then the following command should be run additionally when enabling the heading mode:

  $PASHS,CP2,BAS,1

- If the base and rover are fixed on a solid body, i.e. the baseline length is fixed and constant in time, the second RTK engine can advantageously be set to Arrow mode. See CP2,ARR,MOD.

  In this case, different heading and elevation offsets can be introduced. See CP2,ARR,OFS.

  See also DIF,PRT and DI2,PRT.

CPD,NET: Network Corrections

Function

This command sets the behavior of the receiver with relation to network corrections, i.e. RTK correction data delivered by a network. When using master base data (and only in this case), ignoring network corrections means ignoring MAC and FKP corrections.

Command Format

Syntax

$PASHS,CPD,NET,d1[,d2][*cc]

Parameters

Parameter	Description	Range	Default
d1	RTK network operating mode relative to GPS corrections: • 0: GPS corrections from network are not used. • 1: FKP/MAC GPS corrections from network are used when available and healthy, otherwise they are rejected.	0-1	1
d2	RTK network operating mode relative to GLONASS corrections: • 0: GLONASS corrections from network are not used. • 1: FKP/MAC GLONASS corrections from network are used when available and healthy, otherwise they are rejected.	0-1	0
*cc	Optional checksum	*00-*FF	

Example

Setting the receiver to process GPS and GLONASS network corrections:

$PASHS,CPD,NET,1,1*51

Comments

This command is NAKed if the [J] firmware option is not installed.

CPD,RST - CP2,RST: RTK Process Reset

Function

This command resets the RTK processing.

Command Format

Syntax

In the primary RTK engine:

$PASHS,CPD,RST[*cc]

In the second RTK engine:

$PASHS,CP2,RST[*cc]

Parameters

None.

Example

Resetting the RTK processing in the primary RTK engine:

$PASHS,CPD,RST*5B

CPD,VRS: VRS Assumption Mode

Function

This command is used specifically to set the receiver (a rover) to operate in the so-called “compulsory VRS mode” through which it is forced to consider that the differential corrections it receives are always VRS corrections (this impacts the way corrections are processed internally).

When not operated in this mode, the receiver will automatically detect whether the received corrections are, or are not, VRS corrections (Automatic detection).

Command Format

Syntax

$PASHS,CPD,VRS,d[*cc]

Parameters

Parameter	Description	Range	Default
d	VRS assumption mode: • 0: Automatic detection • 1: Compulsory VRS mode • 2: Never switches to VRS mode	0, 1, 2	0
*cc	Optional checksum	*00-*FF	

Example

Enabling the compulsory VRS mode:

$PASHS,CPD,VRS,1*44

CRR: Code Correlator Mode

Function

This command is used to select the type of code correlator used for multipath mitigation.

Command Format

Syntax

$PASHS,CRR,c1[*cc]

Parameters

Parameter	Description	Range	Default
c1	Code correlator type: • E: Edge correlator • S: Strobe correlator	E, S	See below
*cc	Optional checksum	*00-*FF	-

Example

Selecting the strobe correlator type:

$PASHS,CRR,S*49

Comments

- The [C] firmware option (Advanced Multipath Mitigation) is required for this command to work.
- The Ashtech multipath mitigation technique can generally reduce the code multipath error.
- The default setting depends on whether the [C] option is enabled or not:
  – "Edge correlator" is used if option [C] is disabled.
  – "Strobe correlator" is used if option [C] is enabled.

DIF,PRT: Choosing an Input Port for Differential Corrections to Primary RTK Engine

Function

This command is used to choose the input port (and protocol) of the incoming differential corrections for use in the primary RTK engine.

Command Format

Syntax

$PASHS,DIF,PRT,c1[,s2][*cc]

Parameters

Parameter	Description	Range	Default
c1	Input port ID Physical port: A, B or C (Virtual port: V, W, X, Y or Z)	A, B, C, (V, W, X, Y, Z)	A
s2	Protocol	ALL, ATM, CMR, DBN, RT2, RT3, TPZ	ALL
*cc	Optional checksum	*00-*FF	

Example

Choosing port A and protocol RT3 for the incoming differential corrections:

$PASHS,DIF,PRT,A,RT3*30

Comments

- If s2 is omitted or set to ALL, then any of the possible differential protocols received on the specified port (c1) will be decoded.
- Specifying the protocol, if known a priori, will improve the throughput of the differential decoder. The choice of a protocol, and implicitly of the corresponding differential decoder, will indeed result in disabling all the other differential decoders.
- Both the CMR and CMR+ protocols are detected if CMR is specified.
- When the requested differential protocol is received on the specified port and detected, the corresponding differential messages are decoded and, when requested, the $PASHR,DDM message is output.
- When the requested differential protocol is received on the specified port, the resulting corrections are fed to the primary RTK engine. These may be RTK corrections or DGPS corrections, in which case a code-differential position will be determined.
- Whatever differential stream is applied to another port, it will be ignored and so will not be fed to the primary RTK engine.
- Choosing a protocol on the specified port implies that any other protocol received on that port will be ignored.
- For more information on virtual ports, see ATOM,DAT,EXT message in the *ATOM Reference Manual*.

DIF,PRT,OFF: Disabling Differential Corrections on the Primary RTK Engine

Function

This command is used to disable all differential decoders through which corrections are normally applied to the primary RTK engine.

Command Format

Syntax

$PASHS,DIF,PRT,OFF[*cc]

Parameters

None.

Example

Disabling differential decoders:

$PASHS,DIF,PRT,OFF*27

DI2,PRT: Choosing an Input Port for Differential Corrections to Second RTK Engine

Function

This command is used to choose the input port (and protocol) of the incoming differential corrections for use in the second RTK engine.

Command Format

Syntax

$PASHS,DI2,PRT,c1[,s2][*cc]

Parameters

Parameter	Description	Range	Default
c1	Input port ID Physical port: A, B or C (Virtual port: V, W, X, Y or Z)	A, B, C, (V, W, X, Y, Z)	A
s2	Protocol	ALL, ATM, CMR, DBN, RT2, RT3, TPZ	ALL
*cc	Optional checksum	*00-*FF	

Example

Choosing port A and protocol RT3 for the incoming differential corrections:

$PASHS,DI2,PRT,A,RT3*44

Comments

- If s2 is omitted or set to ALL, then any of the possible differential protocols received on the specified port (c1) will be decoded.
- Specifying the protocol, if known a priori, will improve the throughput of the differential decoder. The choice of a protocol, and implicitly of the corresponding differential decoder, will indeed result in disabling all the other differential decoders.
- Both the CMR and CMR+ protocols are detected if CMR is specified.
- When the requested differential protocol is received on the specified port and detected, the corresponding differential messages are decoded and, when requested, the $PASHR,DDM message is output.
- When the requested differential protocol is received on the specified port, and the second RTK engine has been enabled through $PASHS,CP2,MOD, then these corrections are fed to the second RTK engine.
- If $PASHS,DIF,PRT and $PASHS,DI2,PRT specify the same port and same protocol, then $PASHR,DDM messages will be output twice when requested.
- Whatever differential stream is applied to another port, it will be ignored and so will not be fed to the second RTK engine.
- Choosing a protocol on the specified port implies that any other protocol received on that port will be ignored.
- For more information on virtual ports, see ATOM,DAT,EXT message in the *ATOM Reference Manual*.

DI2,PRT,OFF: Disabling Differential Corrections on the Second RTK Engine

Function

This command is used to disable all differential decoders through which corrections are normally applied to the scond RTK engine.

Command Format

Syntax

$PASHS,DI2,PRT,OFF[*cc]

Parameters

None.

Example

Disabling differential decoders:

$PASHS,DI2,PRT,OFF*53

DSY: Daisy Chain

Function

This command is used to redirect all the characters flowing through a given serial port (source port) to another (destination port), without interpreting the flow of redirected data.

Once the daisy chain mode is on, only the command used to discontinue this mode can be interpreted on the source port.

Redirection can be in both directions, in which case two DSY commands, instead of one, are required to allow bidirectional data flow.

Command Format

Syntax

Redirecting data from a source port to a destination port:

$PASHS,DSY,c1,c2[,d3][*cc]

Discontinuing the daisy chain mode from a specified source port:

$PASHS,DSY,c1,OFF[*cc]

Discontinuing the daisy chain mode for all source ports:

$PASHS,DSY,OFF[*cc]

Parameters

Parameter	Description	Range
c1	Source port ID	A, B, C
c2	Destination port ID	A, B, C
d3	Mode: • 0: Raw (default) • 1: Block	0,1
*cc	Optional checksum	*00-*FF

Examples

Redirecting port B to port A:

$PASHS,DSY,B,A*38

Redirecting port B to port A and port A to port B:

$PASHS,DSY,B,A*38
$PASHS,DSY,A,B*38
For a connection to the board through port A, enter $PASHS,DSY,B,A first.
For a connection to the board through port B, enter $PASHS,DSY,A,B first.

Discontinuing the daisy chain mode from port A:

$PASHS,DSY,A,OFF*35

Discontinuing the daisy chain mode from all source ports:

$PASHS,DSY,OFF*58

DYN: Receiver Dynamics

Function

This command allows you to define the receiver dynamics. The chosen number best represents the receiver motion.

Command Format

Syntax

$PASHS,DYN,d1[*cc]

Parameters

Parameter	Description	Range	Default
d1	Receiver dynamics: • 1: Static • 2: Quasi-static • 3: Walking • 4: Ship • 5: Automobile • 6: Aircraft • 7: Unlimited • 8: Adaptive • 9: User-defined	1-9	8
*cc	Optional checksum	*00-*FF	

Example

Setting rover dynamics to “Walking”:

$PASHS,DYN,3*39

Comments

- If the receiver is set as an RTK rover using a moving base mode, then the DYN setting will be ignored. The “8” option (adaptive) will always be used instead. If the receiver is set as an RTK rover using a moving base mode, it is recommended to use d1=8 (Adaptive).

- In the adaptive mode (8), the receiver analyzes its own motion and automatically chooses one of the dynamic models that is the most suitable. The possible dynamic models are those corresponding to the other choices in the command (i.e. 2 to 7, but not 1 or 9). Using the adaptive mode rejects the possible use of the user-defined dynamic model.

ELM: Setting the Elevation Mask for Raw Data Output

Function

This command is used to set the minimum satellite elevation for the output of raw and differential measurement data. The following data are impacted: MPC, MCA, RT2, RT3, CMR, CMR+, ATM regardless of their use (i.e. as input protocol for differential data or in raw data recording).

Command Format

Syntax

$PASHS,ELM,d1[*cc]

Parameters

Parameter	Description	Range	Default
d1	Elevation mask, in degrees.	0-90°	5
*cc	Optional checksum	*00-*FF	

Example

Setting the elevation mask to 10 degrees:

$PASHS,ELM,10*1C

ENC: Setting Transport Mode for Differential Data

Function

This command defines the transport mode used for every differential data message flowing through the specified port.

Command Format

Syntax

$PASHS,ENC,c1,s2[*cc]

Parameters

Parameter	Description	Range	Default
c1	Port ID.	A, B, C	-
s2	Transport identifier.	See table below	NTV
*cc	Optional checksum	*00-*FF	

The list of transport identifiers is the following:

Data	Description
ASH	$PASHR transport used for encapsulation of all non-Ashtech messages
RT3	Standardized RTCM-3 transport for encapsulation of all non-RT3 messages.
NTV	NaTiVe transport, i.e. no encapsulation for all output messages.

Example

Setting the data encapsulation mode to “NTV” for port A:

$PASHS,ENC,A,NTV*30

Comments

When a differential data message flowing through a given port has a native transport mode different from the one defined for the port, then its data are *encapsulated* to comply with the transport mode selected for the port.

The table below lists the message formats that are encapsulated depending on the transport mode selected for the port. A bullet point means the data are encapsulated. A blank cell means the transport mode selected for the port corresponds to the native transport mode of the message and so the message data will not be encapsulated.

Message Format	ASH	RT3	NTV
RTCM 3.1	•		
RTCM 2.3	•	•	
CMR	•	•	
CMR+	•	•	
ATOM	•		
DBEN		•	

GLO: GLONASS Tracking

Function

This command is used to enable or disable GLONASS tracking. It is valid only if the GLONASS option has been activated in the receiver. See also $PASHS,GNS,CFG.

Command Format

Syntax

$PASHS,GLO,s1[*cc]

Parameters

Parameter	Description	Range	Default
s1	Enables (ON) or disables (OFF) GLONASS tracking.	ON, OFF	ON
*cc	Optional checksum	*00-*FF	

Example

Enabling GLONASS:

$PASHS,GLO,ON*1C

GNS,CFG: Selecting a GNSS Mode

Function

This command allows you to select the GNSS mode that the receiver should use. The GNSS mode refers to the constellations and frequencies used.

Command Format

Syntax

$PASHS,GNS,CFG,d1[*cc]

Parameters

Parameter	Description	Range
d1	GNSS mode: • 0: GPS L1 • 1: GPS L1 & GLONASS L1 • 2: GPS L1/L2P • 3: GPS L1/L2C • 4: GPS L1/L2P & GLONASS L1/L2 • 5: GPS L1/L2C & GLONASS L1/L2	0, 1, 2, 3, 4, 5
*cc	Optional checksum	*00-*FF

Default Setting

The default setting depends on the firmware options installed:

	[G] Option Enabled	No [G] option
[P] Option Enabled	4	2
No [P] Option	1	0

Example

Setting the receiver GNSS mode to GPS L1/L2P & GLONASS L1/L2:

$PASHS,GNS,CFG,4*59

Comments

- Changing the GNSS mode setting causes GNSS reception to be reset (the number of received/used satellites drops to 0 straight away and then rapidly comes back to normal).
- The command will be NAKed if the firmware option corresponding to the requested change has not been activated.
  - Modes “1”, “4” and “5” will be NAKed as long as the [G] option (GLONASS) is kept inactive.
  - Modes “2”, “3”, “4” and “5” will be NAKed as long as the [P] option (L2) is kept inactive.
  - Modes “3” and “5” will be NAKed as long as the [S] option (L2CS) is kept inactive.
- When GLONASS is disabled (mode 0, 2 or 3), the following actions will be NAKed:
  - Attempt to run $PASHS,GLO
  - Attempt to set the following messages: SNG, SAG, RTCM-3 MT 1009-1012 and CMR/CMR+ MT3

INI: Resetting Receiver According to Your Preferences

Function

This command resets the receiver processor and memory according to the different options you choose.

Command Format

Syntax

$PASHS,INI,d1,d2,d3[*cc]

Parameters

Parameter	Description	Range
d1	Port A baud rate code	2-15 See “Baud Rate Codes“ table below.
d2	Port B baud rate code	2-11 See “Baud Rate Codes” table below
d3	Memory reset code: • 0: No memory reset • 1: Cold start • 5: Warm start (ephemeris data cleared, but almanac and position/time data preserved)	0, 1, 5 See Memory Reset Codes table below
*cc	Optional checksum	*00-*FF

Baud Rate Codes:

Code	Baud Rate	Code	Baud Rate	Code	Baud Rate	Code	Baud Rate
2	1 200	6	19 200	10	230 400	14	2 500 000
3	2 400	7	38 400	11	460 800	15	5 000 000
4	4 800	8	57 600	12	921 600		
5	9 600	9	115 200	13	1 428 571		

Memory Reset Codes:

Reset Code:	0	1	5
Clear receiver parameters in BBU		•	
Clear ephemeris data		•	•
Clear almanac data		•	
Clear latest position		•	
Clear RTC time		•	
Reset channels	•	•	•
Restart processor	•	•	•
Clear receiver parameters in RAM		•	•

Example

Resetting ports A and B to115 200 Bd and asking for a cold start:

$PASHS,INI,9,9,1*26

KPI: Known Point Initialization

Function

This command is used to force the receiver to perform PVT initialization on a point with known geographical coordinates (expressed in the ITRF model used).

Command Format

Syntax

$PASHS,KPI,m1,c2,m3,c4,f5[,f6,f7,f8][,c9][*cc]

Parameters

Parameter	Description	Range	Default
m1	Latitude in degrees, decimal minutes (ddmm.mmmmmmm)	0-90	-
c2	North (N) or South (S)	N,S	-
m3	Longitudes in degrees, decimal minutes (dddmm.mmmmmmm)	0-180	-
c4	East (E) or West (W)	E,W	-
f5	Height in meters	±9999.9999	-
f6	Accuracy (rms) in lat direction	0-99.999 m	0.01
f7	Accuracy (rms) in lon direction	0-99.999 m	0.01
f8	Accuracy (rms) in alt direction	0-99.999 m	0.01
c9	Position attribute	PC1,ARP,SPT See table below	PC1
*cc	Optional checksum	*00-*FF	-

Position Attributes:

Parameter	Description
PC1	Position is referenced to L1 phase center.
ARP	Position is referenced to ARP.
SPT	Position is referenced to survey point.

Example

Forcing the receiver to initialize from lat 37°22.2912135’ N, lon 121° 59.7998217’ W, height 15.25 m:

$PASHS,KPI,3722.2912135,N,12159.7998217,W,15.25

Comments

- Obviously, the KPI command should be used only for a static receiver occupying the specified point. The receiver can however start moving a few seconds after it has accepted the command.

- On receiving the KPI command, the receiver performs automatic PVT reset and initialization against the specified point.
- Any attempt to assign a value less than “0.001 m” to f6, f7 or f8 will be rejected. The firmware will automatically assign the value “0.001” instead.
- To prevent the receiver from bad initialization, it is your responsibility to provide the exact coordinates of the point where initialization takes place, and also to make a sensible assessment of the accuracy figures you provide in the command.

  In fact, when the KPI command is executed, an internal watchdog routine protects the receiver from obviously wrong initialization. The routine checks that:
  - An internally computed receiver position is available.
  - The difference between internal receiver position and KPI position is less than 100 meters for each component.

  If at least one of the two conditions above is not met, then the KPI command is NAKed.

LCS: Enabling/Disabling Use of Local Coordinate System

Function

This command is used to enable or disable the use of the local coordinate system in the receiver. Having the receiver using a local coordinate system requires that it receives RTCM 3.1 message type 1021-1027 from the base.

Command Format

Syntax

$PASHS,LCS,s1[*cc]

Parameters

Parameter	Description	Range	Default
s1	ON: Local coordinate system used if RTCM 3.1 messages received. OFF: Coordinate system used is WGS84.	ON, OFF	OFF
*cc	Optional checksum	*00-*FF	-

Example

Enabling the use of the local coordinate system in the receiver:

$PASHS,LCS,ON*04

Comments

When this command is set to ON, the board is allowed to decode RTCM-3 MT 1021 to 1027 and further process MT 1021 to 1023, which are currently generated by some SAPOS networks. The processing of message types 1024 to 1027 is currently not supported.

All legacy position messages (e.g. GGA, POS, PBN, or ATM,PVT,COO) are not affected by coordinate transformation messages. When this command is set to ON, local coordinates are delivered in extra-block ATM,PVT,LDP.

"LDP" stands for Local Datum Position. The extra-block is output only if the receiver considers that the transformation parameters are valid and match the ATM,PVT,COO position.

Positions in ATM,PVT,COO and ATM,PVT,LDP always refer to the same position, but are expressed in a different datum. The LDP block also provides information on the name of the local datum.

MSG: Defining a User Message

Function

This command is used to define a user message to be generated "as is" or for insertion into one or more of the following standard messages:

- ATOM,ATR,UEM, if requested
- RTCM message type 16, 36 or 1029
- CMR type 2
- CMR+ type 0

Any new MSG command you send to the receiver overwrites the user message previously defined through the same command.

Command Format

Syntax

$PASHS,MSG,[c1],s2[*cc]

Parameters

Parameter	Description	Range	Default
c1	Message interpreter (provision for future uses): • 0: ASCII message generated periodically. If c1 is omitted, this is interpreted as c1=0	0	0
s2	User message	100 characters max.	"MB500" (receiver name)
*cc	Optional checksum	*00-*FF	

Example

Sending ASCII message "going to stop at 11pm" periodically:

$PASHS,MSG,0,going to stop at 11pm*5F

Comments

Warning! Only the first 90 characters from the user message will actually be transferred through RTCM-2 message types 16 and 36.

NME: Enabling/Disabling NMEA Messages

Function

This command is used to enable or disable NMEA messages and Ashtech NMEA-like messages.

Command Format

Syntax

$PASHS,NME,s1,c2,s3[,f4][*cc]

Parameters

Parameter	Description	Range
s1	Data message type	See tables below
c2	Port ID	A, B, C
s3	Enables (ON) or disables (OFF) the message. OFF by default.	ON, OFF
f4	Output rate, in seconds. Default is 1 second.	See tables below
*cc	Optional checksum	*00-*FF

NMEA messages:

Data	Description	f4 Range
ALM	GPS almanac data	1, 2, 3, 4, 5, etc. any integer second up to 999

Data	Description	f4 Range
GBS	GNSS Satellite Fault Detection	0.05, 0.1, 0.2, 0.5, 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60, 120 s, etc. any integer minute up to 960 s (16 min).
GGA	GPS fix data	
GLL	Geographic position - Latitude / Longitude	
GRS	GNSS range residual	
GSA	GNSS DOP and active satellites	
GST	GNSS pseudo-range error statistics	
GSV	GNSS satellites in view	
HDT	True heading	
RMC	Recommended minimum specific GNSS data	
VTG	Course over ground and ground speed	
ZDA	Time and date	

Ashtech NMEA-like messages:

Data	Description	f4 range
ATT	Heading, roll and pitch	0.05, 0.1, 0.2, 0.5, 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60, 120, etc. (integer minutes up to 960)
BPS	Base position	1, 2, 3, 4, 5, etc. (integer seconds up to 999). Default: 30 seconds
DDM	Differential decoder message	Not Applicable
LTN	Latency	0.05, 0.1, 0.2, 0.5, 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60, 120, etc. (integer minutes up to 960)
POS	Position	0.05, 0.1, 0.2, 0.5, 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60, 120, etc. (integer minutes up to 960)
PTT	1 PPS time tag	Not Applicable
SAT	Satellite status	0.05, 0.1, 0.2, 0.5, 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60, 120, etc. (integer minutes up to 960)
TTT	Event marker	Not Applicable
VEC	Baseline vector	0.05, 0.1, 0.2, 0.5, 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60, 120, etc. (integer minutes up to 960)

Example

Setting GGA message on USB port at 1-second output rate:

$PASHS,NME,GGA,C,ON,1*01

Comments

- For ALM messages, the f4 parameter can only take an integer value of seconds (by default 3600) and refers to the interval between messages related to the same satellite and with the same content.
- For a given satellite, the ALM messages are therefore renewed every "x" seconds (x=f4), or following a change in the message content ("on change"), whichever occurs first.
- ALM messages cannot be output more than once over a given period of 1 second.

NME,MSG: Requesting Rover to Output Differential Message from Base

Function

This command is used in a rover to output the incoming differential stream as a user-readable message. The message is available on the specified port at the same output rate.

The incoming differential stream may enter the rover through any of its ports but the resulting output message can only be the one defined through DIF,PRT (and not DI2,PRT).

Command Format

Syntax

Activating message output:

$PASHS,NME,MSG,c1,ON[,f1][*cc]

Deactivating message output:

$PASHS,NME,MSG,c1,OFF[,f1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
f1	For future use	
*cc	Optional checksum	*00-*FF

Example

Enabling message on port A:

$PASHS,NME,MSG,A,ON*06

Response Format

The message delivered on the specified port is in the form:

$PASHR,MSG,message[*cc]

Where “message” can be one of the following decoded data:

- RTCM3 MT 1029
- RTCM2 MT 16 or 36
- ATOM,ATR MT UEM

Example:

$PASHR,MSG,ProMark500

See Also

$PASHQ,DDM

This command can be used to read all the differential streams, and not only the one defined by DIF,PRT.

NME,ALL: Disabling All NMEA and NMEA-Like Messages

Function

This command is used to disable all NMEA messages and Ashtech NMEA-like messages currently enabled on the specified port.

Command Format

Syntax

$PASHS,NME,ALL,c1,OFF[*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Example

Disabling all NMEA and NMEA-like messages on port A:

$PASHS,NME,ALL,A,OFF*50

PEM: Setting the Position Elevation Mask

Function

This command is used to set the elevation mask used in the position processing.

Command Format

Syntax

$PASHS,PEM,d1[*cc]

Parameters

Parameter	Description	Range	Default
d1	Elevation mask angle, in degrees	0-90°	5
*cc	Optional checksum	*00-*FF	

Example

Setting the elevation mask for position processing to 15 degrees:

$PASHS,PEM,15*05

PFL,TST: Switching Receiver to Test Mode

Function

This command is used to switch the receiver in test mode. The receiver then automatically performs a series of tests (see below).

- Digital section tests:
  - Internal communications (UARTs, HPI) test
  - Fast UART test
  - SDRAM tests
  - Backup SRAM test
  - NOR Flash test
  - Real Time Clock test
  - MMU test
- RF section tests:
  - P/S voltages test
  - GPS L1/L2 and GLONASS L1/L2 AGC voltages test
  - LO2 control voltage test
  - Antenna LNA current consumption test
  - PLLs lock test

At the end of the tests, the receiver returns a test report (see below) and is then re-started (cold start).

Command Format

Syntax

$PASHS,PFL,TST[*cc]

Parameters

None.

Response Format

Example

```
$PASHR,WAT,250000*1D
$PASHR,ACK*3D
$PASHR,DGT,TST,00000000*70
$PASHR,ACK*3D
$PASHR,ADC,0,1023*02
$PASHR,ADC,1,699*35
$PASHR,ADC,2,1023*00
$PASHR,ADC,3,691*3F
$PASHR,ADC,4,551*37
$PASHR,ADC,5,627*34
$PASHR,ADC,6,594*3C
$PASHR,ADC,7,815*39
$PASHR,ADC,8,597*31
$PASHR,ADC,9,29*00
$PASHR,APW,OK*1A
$PASHR,LCK,3*2F
$PASHR,ACK*3D
$PASHR,RID,DG34,G100*59
```

All zeros in $PASHR,DGT,TST mean that all digital section tests were performed and the receiver passed them all.

PHE: Setting the Active Edge of the Event Marker Pulse

Function

This command is used to set the active edge (rising or falling) of the event marker pulse used in photogrammetry time-tagging. The Event Marker firmware option [E] must be installed for this command to work.

Command Format

Syntax

$PASHS,PHE,c1[*cc]

Parameters

Parameter	Description	Range	Default
c1	Active edge code: • "R" for rising edge • "F" for falling edge	R, F	R
*cc	Optional checksum	*00-*FF	

Example

Making the falling edge active:

$PASHS,PHE,F*42

PIN: Assigning Function to Programmable Pin on I/O Connector

Function

This command is used to assign a specific function to the programmable pin on the board's I/O connector.

Command Format

Syntax

$PASHS,PIN,d1,s2,d3[*cc]

Parameters

Parameter	Description	Range	Default
d1	Programmable pin ID (0: TIOA1)	0	-
s2	Function: • OFF: no function assigned • PAV: Position available (see comment 1) • RSP: Radar simulated pulse (see comment 2)	OFF, PAV or RSP	OFF
d3	Depends on s2 value: • s2=OFF: d3 should be omitted • s2= PAV: d3 is the number of consecutive seconds while position is not computed that causes the signal on the pin to switch to low level. • s2= RSP: d3 should be set to "1" to make Radar Simulated Pulse output available on the pin.	Omitted 1-3600 1	-
*cc	Optional checksum	*00-*FF	

Example

Assigning the PAV function to the programmable pin and asking for a low-level signal on that pin after 60 seconds of position unavailability:

$PASHS,PIN,0,PAV,60*7F

Comment

1. By default, the programmable pin provides a high-level signal. When the PAV function is assigned to the pin, a low level will occur on the pin in the following cases:
   - Immediately after the $PASHS,PIN,d1,PAV command has been executed and the position has not been computed yet at that time.

- If for any reason, the position has not been computed for more than the time specified as d3.
- After running the $PASHS,INI,x,y,0 or $PASHS,INI,x,y,5 command.
- After running the POP and GNS,CFG commands following a re-start of the board.

High level is restored on the pin right after the board has re-started computing the position.

2. By default, the programmable pin is at a high level.

   After the $PASHS,PIN,d1,RSP,1 command has been accepted, and if the ground speed is within the range 0.8 to 322 km/hr, an LV-TTL pulse signal with a 50% duty cycle is made available on the pin. The frequency conversion is then 94 Hz/(m/s).

   If the ground speed is out of range, the pin level is kept at a high level.

POP: Setting Internal Update Rates for Measurement and PVT

Function

This command allows you to set the updates rates used internally in the measurement and position processing.

Command Format

Syntax

$PASHS,POP,f1[*cc]

Parameters

Parameter	Description	Range	Default
f1	Internal update rate, in Hz, for measurement.	1, 2, 5, 10, 20	Firmware option dependent (see below)
*cc	Optional checksum	*00-*FF	

Example

Setting both update rates to 20 Hz:

$PASHS,POP,20*14

Comments

- When f1 is changed, the receiver is reset in the same way as it would be if you used $PASHS,INI,d1,d2,0, where d1 and d2 would keep their current values.
- Changing the POP setting causes all the update rates of the output messages to be reset to their default values. It

is therefore recommended to set these update rates only after having run the $PASHS,POP command.

- The default POP setting depends on which firmware option has been installed:
  - Default is “10 Hz” with the [T] option
  - Default is “20 Hz” with the [W] option

POS: Setting the Antenna Position

Function

This command is used to enter the position of the receiver (geographical coordinates expressed in the ITRF model used). The command is either used in a rover to speed up the receiver start-up, in which case the entered position may be very approximate (to within a few kilometers), or on the contrary, it is used to enter the accurate coordinates of a base, coordinates that will be inserted in all ATM, RTCM or CMR data messages.

Command Format

Syntax

To set receiver’s position (estimate in a rover, reference position in a base):
$PASHS,POS,m1,c2,m3,c4,f5[,s6][*cc]
or, to set the computed position as a reference position:
$PASHS,POS,s7[*cc]

Parameters

Parameter	Description	Range
m1	Latitude in degrees and minutes with 7 decimal places (ddmm.mmmmmmm)	0-90
c2	North (N) or South (S)	N, S
m3	Longitude in degrees, minutes with 7 decimal places (ddmm.mmmmmmm)	0-180
c4	West (W) or East (E)	W, E
f5	Height in meters	±0-9999.9999
s6	Position attribute (see table below)	PC1, ARP, SPT
*cc	Optional checksum	*00-*FF
s7	=CUR: Position is equal to the currently computed position at the moment the command is issued. After this, the reference position is kept constant. =MOV: Position is always equal to the receiver's computed position and can change arbitrarily as the receiver moves. This computed position may be standalone or DGPS position, but never RTK position.	CUR, MOV
*cc	Optional checksum	*00-*FF

Position Attributes:

Parameter	Description
PC1	Position is referenced to L1 phase center (default).
ARP	Position is referenced to ARP.
SPT	Position is referenced to survey point.

Examples

Setting the antenna position to 37°22.2912135'N, 121°59.7998217'W and 15.25 m:

$PASHS,POS,3722.2912135,N,12159.7998217,W,15.25*1F

Defining the computed position as the reference position:

$PASHS,POS,CUR*51

Comments

- You can enter a reference position tagged to either of the points (PC1, ARP or SP) on the antenna.

  If the local antenna name (OWN) is known, the receiver will be able to re-compute internally the reference position entered, from SP to ARP or vice versa.

If the ANT/ANH parameters are known, the receiver will be able to re-compute internally the reference position entered, from SP to ARP or vice versa.

Before entering the coordinates of a reference position using $PASHS,POS, you should be aware that depending on the protocol you will use to let the base generate its differential data, the reference position needs to be expressed exclusively on one of these points. For example, the reference position in RTCM-3 protocol needs to be tagged to ARP whereas in CMR, this position should be tagged to PC1.

- The reference position inserted in RTCM, CMR or ATM messages is either the position you entered manually, or a position resulting from $PASHS,POS,CUR or $PASHS,POS,MOV, whichever was issued last.
- If no position was entered manually and no $PASHS,POS, CUR is applied, then the receiver operates as if $PASHS,POS,MOV had been applied. The RTCM, CMR or ATM messages will be generated accordingly.
- The reference position generated in RTCM, CMR and ATM messages is either entered manually, or defined as a “CUR” or “MOV” position, whichever of these actions occurred last. If no position was entered manually and the position is defined as a “CUR” position, then the MOV mode is applied to the data generated in all RTCM, CMR and ATM messages.
- The reference position generated in ATM,RNX messages using scenario SCN 1, 2, 3, 4, 100 or 101 should be entered either manually or through $PASHS,POS,CUR, whichever occurs last.

  If no such command has been issued, or the last position has been specified as a “MOV” not a “CUR” position, then the moving position will be used for these messages.

  Please note, that ATOM super-compact is designed for static reference receivers only. It is therefore the user’s responsibility to ensure that a correct position is entered. The reference position generated in ATM,RNX messages SCN 0, 201, 202, 203, 204 and 300 is always a “MOV” position.

PPS: Setting PPS Pulse Properties

Function

This command is used to set the period, offset and GPS synchronized edge (rising or falling) of the PPS pulse.

Command Format

Syntax

$PASHS,PPS,f1,f2,c3[*cc]

Parameters

Parameter	Description	Range	Default
f1	PPS time period, a multiple or fraction of 1 second. • 0: 1 PPS disabled	0, 0.05, 0.1, 0.2, 0.5, 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 or 60	0
f2	Time offset in milliseconds.	± 999.9999	0
c3	GPS-synchronized edge code: • "R" for rising edge • "F" for falling edge	R, F	R
*cc	Optional checksum	*00-*FF	

Example

Setting the PPS signal to a period of 2 seconds, with an offset of 500 ms and a GPS-synchronized rising edge:

$PASHS,PPS,2,+500,R*74

Comment

- The PPS time period (f1) cannot be less than the internal update rate (see $PASHS,POP).
- The 1PPS sifgnal is not output until the receiver time scale is corrected to GPS time.

PWR,OFF: Powering Off the Receiver

Function

This command is used to prepare the board before it is turned off. Using this command allows all the settings and parameters to be saved in the non-volatile memory. This command DOES NOT switch off the on-board power supply.

Command Format

Syntax

$PASHS,PWR,OFF[*cc]

Parameters

None.

Example

Preparing the board to be turned off:

$PASHS,PWR,OFF*43

Relevant Query Command

None.

RAW: Enabling/Disabling Raw Data Messages in Legacy Ashtech Format

Function

This command is used to enable or disable the standard, continuous output of raw data in legacy Ashtech format.

Command Format

Syntax

$PASHS,RAW,s1,c2,s3[,f4][*cc]

Parameters

Parameter	Description	Range	Default
s1	Raw data message type	See table below	
c2	Port ID	A, B, C	-
s3	Enables (ON) or disables (OFF) the raw data message	ON, OFF	OFF
f4	Output rate in seconds.	See table below	1
*cc	Optional checksum	*00-*FF	

Raw data message types:

Data	Description	f4 range
MCA	GPS/GLONASS/SBAS C/A code measurements	0.05, 0.1, 0.2, 0.5, 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60, 120 sec., etc.(integer minutes up to 960 sec.)
MPC	GPS/GLONASS/SBAS raw data	
DPC	Compact GPS raw data	
RPC	DBEN messages	
PBN	Position information	
SNV	GPS ephemeris data	1, 2, 3, 4, 5, etc. (integer seconds up to 999 sec.)
SNG	GLONASS ephemeris data	
SNW	SBAS ephemeris data	
SAL	GPS almanac data	
SAG	GLONASS almanac data	
SAW	SBAS almanac data	
ION	Ionospheric parameters	
SBD	SBAS data message	Not applicable

Examples

Enabling output of MPC message type on port A to 1 second:

$PASHS,RAW,MPC,A,ON,1*1E

Enabling output of SNV message type on port A to 300 seconds:

$PASHS,RAW,SNV,A,ON,300*09

Comments

- For each of the SNV, SNG, SNW, SAL, SAG, SAW and ION messages, the f4 parameter can only take an integer value of seconds and refers to the interval between messages related to the same satellite and with the same content.

  For a given satellite, each of these messages is therefore renewed every x seconds (where x=f4), or following a change in the message content ("on change"), whichever occurs first.

  Each of these messages cannot be output more than once over a given period of 1 second.
- By default, f4 is set as follows:

Output message	f4 Default Value
SNV, SNG, ION	900
SAL, SAG	3600
SNW	120
SAW	300

- The SBD message output rate is always 1 second (as decoded). Parameter f4 is ignored.

RAW,ALL: Disabling All Raw Data Messages

Function This command is used to disable all the currently active raw data messages on the specified port.

Command Format

Syntax

$PASHS,RAW,ALL,c1,OFF[*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Example

Disabling all raw data messages on port A:

$PASHS,RAW,ALL,A,OFF*52

RCP,DEL: Deleting User-Defined Receiver Name

Function This command is used to delete a user-defined receiver name.

Command Format

Syntax

$PASHS,RCP,DEL,s1[*cc]

Parameters

Parameter	Description	Range
s1	Receiver name you want to delete (case sensitive)	31 characters max.
*cc	Optional checksum	*00-*FF

Example

Deleting receiver name “MyReceiver”:

$PASHS,RCP,DEL,MyReceiver*74

RCP,GBx: GLONASS Carrier Phase Biases for User-Defined Receiver

Function This set of two commands is used to define GLONASS carrier phase biases for a given receiver. One command deals with the GLONASS L1 band and the other with the GLONASS L2 band.

Command Format

Syntax

For the L1 band:

$PASHS,RCP,GB1,s1,f2,f3,f4,f5,f6,f7,f8,f9,f10,f11,f12,f13,f14,f15,f16,f17[*cc]

For the L2 band:

$PASHS,RCP,GB2,s1,f2,f3,f4,f5,f6,f7,f8,f9,f10,f11,f12,f13,f14,f15,f16[*cc]

Parameters

Parameter	Description	Range
s1	Name of user-defined receiver for which GLONASS biases must be defined (case sensitive)(12 characters max. recommended)	31 characters max.
f2	When a linear pattern is assumed for GLONASS biases, f2 represents the delta bias between two adjacent GLONASS frequency numbers (cycle of local L1 [or L2] frequency).	Full range of Real variables allowed
f3-f16	When an arbitrary pattern is assumed for GLONASS biases, f3-f16 represent biases for GLONASS frequency numbers from -7 to 6(cycle of local L1 [or L2] frequency).	Full range of Real variables allowed
f17	Mean pseudo-range bias (in meters) between L1 [or L2] GPS and L1 [or L2] GLONASS constellations.	
*cc	Optional checksum	*00-*FF

Comments

- **Only fractional parts of GLONASS carrier phase biases are of practical importance**.
- Running one of these commands on a receiver already stored in the list of user-defined receivers will save all the submitted parameters to permanent memory and keep all the others unchanged.
- You may not run the two commands (GB1 and GB2) for a given user-defined receiver. If you run just one of them, then the parameters corresponding to the other command will all be assumed to be invalid (i.e unknown). All user-defined receivers created from this receiver will also inherit these invalid parameters.
- The board will interpret any missing parameter in a command as a parameter for which there is currently no known valid value for this parameter.

RCP,OWN and RCP,REF: Naming Local and Reference Receivers

Function These commands are used to enter the receiver's own name as well as the reference receiver name.

Command Format

Syntax

$PASHS,RCP,OWN,s1[,s2[,s3]][*cc]
or
$PASHS,RCP,OWN,s1,,s3[*cc]

$PASHS,RCP,REF,s1[,d2][*cc]

Parameters

Parameter	Description	Range	Default
s1	Receiver name (case-sensitive).	31 characters max.	“MB500” for local receiver, Empty field for reference receiver
s2	Receiver firmware version	31 characters max.	
s3	Receiver serial number	31 characters max.	
d2	Receiver name preference	0 or 1	0
*cc	Optional checksum	*00-*FF	

Comments

- With the receiver used as an RTK base, the s1 parameter is inserted into receiver name messages (e.g. RTCM-1033).
- When the receiver is used as an RTK rover, it will use the bias values corresponding to the entered local and receiver names to correct the local and reference data accordingly.
- When the receiver is used as an RTK rover and d2=0, the receiver name (s1) will be ignored if the incoming reference data contain the base receiver name.

  Reciprocally, in the same context and with d2=1, the receiver name entered as s1 will be used, and the receiver name decoded from the incoming reference data will be ignored.
- Because the RINEX format reserves only 20 characters for receiver names, including the 8 characters used when the $PASHS,AGB command is set to “ON”, Ashtech recommends you specify receiver names in 12 characters max. so that they can be converted to RINEX format without being truncated.

Example

Entering “Unknown” as the name of the local receiver:

$PASHS,RCP,OWN,UNKNOWN*2A

REF: Enabling/Disabling External Reference Clock

Function

This command is used to enable or disable the external reference clock mode. By default, the external reference clock is disabled and the internal clock is used.

Command Format

Syntax

$PASHS,REF,ON[,d1][*cc]
$PASHS,REF,OFF[*cc]

Parameters

Parameter	Description	Range	Default
d1	Frequency, in MHz, of the external reference clock	5, 10, 20	20
*cc	Optional checksum	*00-*FF	-

Examples

Enabling a 20-MHz external reference clock:

$PASHS,REF,ON,20*27

Disabling the external reference clock:

$PASHS,REF,OFF*47

RST: Default Settings

Function

This command is used to reset the receiver parameters to their default values. All parameters are reset except:

- Ephemeris data
- Almanac data
- Position
- GPS time

Command Format

Syntax

$PASHS,RST[*cc]

Parameters

None.

Example

Resetting the receiver:

$PASHS,RST*20

RT2: Enabling/Disabling RTCM 2.3 Messages

Function

This command is used to individually enable or disable RTCM 2.3 message types on the specified port.

Command Format

Syntax

$PASHS,RT2,s1,c2,s3[,f4][*cc]

Parameters

Parameter	Description	Range	Default
s1	RTCM 2.3 message type	See table below	-
c2	Port ID	A, B, C	-
s3	Enables (ON) or disables (OFF) RTCM 2.3 message type	ON, OFF	OFF
f4	Output rate in seconds	See table below	1
*cc	Optional checksum	*00-*FF	-

Supported Data Messages:

Data	Description	f4 range
1, 9	GPS corrections	0.05, 0.1, 0.2, 0.5, 1, 2, 3, 4, 5 sec., etc. (integer seconds up to 999
24	Geographical coordinates (ITRF) tagged to ARP for reference position	
3, 22	Geographical coordinates (ITRF) tagged to L1 phase center for reference position	
23	Antenna name	
18, 19	GPS and GLONASS raw observations	0.05, 0.1, 0.2, 0.5, 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60, 120 sec., etc. (integer minutes up to 960 sec.)
20, 21	GPS and GLONASS RTK corrections	
16, 36	User messages (those entered through $PASHS,MSG)	0.05, 0.1, 0.2, 0.5, 1, 2, 3, 4, 5 sec., etc. (integer seconds up to 999 sec.)
31, 34	GLO corrections	
32	Reference PZ 90 position	

Example

Setting the default RTCM 2.3 configuration in a base:

$PASHS,POS,<position coordinates> or $PASHS,POS,CUR*51
$PASHS,RT2,18,A,ON,1*39
$PASHS,RT2,19,A,ON,1*38
$PASHS,RT2,24,A,ON,13*05
$PASHS,RT2,23,A,ON,31*02

[$PASHS,RT2,16,A,ON,59*0A]

Comments

- With RTCM 2.3, the last command (bracketed) in the above example is the only way a rover can be informed of the base receiver name (provided the corresponding $PASHS,MSG is used on the base). However, the RTCM 2 standard only allows message type 16 to be used for viewing purposes, and not in further automatic processing steps.
- Defining output rates for RTCM 2.3 messages should follow the rules presented in *Understanding How MB 500 Generates Differential Data Messages on page 66*.

RT2,ALL: Disabling All RTCM 2.3 Messages

Function

This command is used to disable all the currently active RTCM 2.3 data messages on the specified port.

Command Format

Syntax

$PASHS,RT2,ALL,c1,OFF[*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Example

Disabling all RTCM 2.3 messages on port A:

$PASHS,RT2,ALL,A,OFF*22

RT3: Enabling/Disabling RTCM 3.1 Messages

Function

This command is used to individually enable or disable RTCM 3.1 message types on the specified port.

Command Format

Syntax

$PASHS,RT3,s1,c2,s3[,f4][*cc]

Parameters

Parameter	Description	Range	Default
s1	RTCM 3.1 message type	See table below	-
c2	Port ID	A, B, C	-
s3	Enables (ON) or disables (OFF) RTCM 3.1 message type	ON, OFF	OFF
f4	Output rate in seconds	See table below	1
*cc	Optional checksum	*00-*FF	-

Supported Data Messages:

Data	Description	f4 range
1001-1004	GPS+SBAS raw observations	0.05, 0.1, 0.2, 0.5, 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60, 120 sec, etc. (integer minutes up to 960 sec.)
1005-1006	ITRF coordinates of reference position, tagged to ARP	0.05, 0.1, 0.2, 0.5, 1, 2, 3, 4, 5 sec., etc. (integer seconds up to 999 sec.)
1007-1008	Antenna name	
1009-1012	GLONASS raw observations	0.05, 0.1, 0.2, 0.5, 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60, 120 sec., etc. (integer minutes up to 960 sec.)
1013	System information	0.05, 0.1, 0.2, 0.5, 1, 2, 3, 4, 5 sec., etc. (integer seconds up to 999 sec.)
1019	GPS ephemeris data	
1020	GLONASS ephemeris data	
1029	User unicode message (as entered through $PASHS,MSG)	
1033	Antenna and receiver names	

Examples

Setting the default RTCM 3.1 configuration to serve the base mode:

$PASHS,POS,<position coordinates> or $PASHS,POS,CUR*51
$PASHS,RT3,1004,A,ON,1*34
$PASHS,RT3,1012,A,ON,1*33
$PASHS,RT3,1006,A,ON,13*05
$PASHS,RT3,1033,A,ON,31*03

Setting the default RTCM 3.1 configuration to serve the raw data collection mode:

$PASHS,POS,MOV*41
$PASHS,RT3,1004,A,ON,1*3
$PASHS,RT3,1012,A,ON,1*33
$PASHS,RT3,1006,A,ON,1*36
$PASHS,RT3,1013,A,ON,61*04
$PASHS,RT3,1033,A,ON,300*32

$PASHS,RT3,1019,A,ON,600*3F
$PASHS,RT3,1020,A,ON,600*35

Comments

Defining output rates for RTCM 3.1 messages should follow the rules presented in *Understanding How MB 500 Generates Differential Data Messages on page 66*.

RT3,ALL: Disabling All RTCM 3.1 Messages

Function

This command is used to disable all the currently active RTCM 3.1 data messages on the specified port.

Command Format

Syntax

$PASHS,RT3,ALL,c1,OFF[*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Example

Disabling all RTCM 3.1 messages on port A:

$PASHS,RT3,ALL,A,OFF*23

SBA: Enabling/Disabling SBAS Tracking

Function

This command is used to enable or disable SBAS tracking.

Command Format

Syntax

$PASHS,SBA,s1[*cc]

Parameters

Parameter	Description	Range	Default
s1	Enables (ON) or disables (OFF) SBAS tracking	ON, OFF	ON
*cc	Optional checksum	*00-*FF	

Example

Enabling SBAS tracking:

$PASHS,SBA,ON*08

SIT: Defining a Site Name

Function

This command is used to define the site name occupied by the receiver.

Command Format

Syntax

$PASHS,SIT,s1[*cc]

Parameters

Parameter	Description	Range
s1	Site name, a 4-character string where alphanumeric symbols are allowed.	See tables below
*cc	Optional checksum	*00-*FF

Example

Defining site name "1001":

$PASHS,SIT,1001

Comments

- In rover mode, the site name can be set "on line" in the field to name occupation points. The site name appears in the PBN raw data message, and in the ATM,PVT message, and probably in some other messages. Historically, "????" refers to an unknown site name or a kinematic sequence in progress.
- In base mode, the site name refers to the reference station ID. The table below lists the permitted range of values for the reference station ID, depending on the message format used to route this information.

Message format	Permitted range of reference station ID
CMR/CMR+	0000-0031
RTCM 2	0000-1023
RTCM 3	0000-4095

The resulting reference station ID may be different from s1 if s1 does not fall within the permitted range. The table below lists the resulting values of the reference station ID, depending on which s1 value was entered through

$PASHS,SIT, and depending on the message format carrying the reference station ID information.

s1 value set to:	RTCM 3	RTCM 2	CMR/ CMR+	ATOM 2, 4, 5, 6, 7, 14	ATOM 3 PBN
Default (not set)	31	31	31	31	????
0017	17	17	17	17	0017
0123	123	123	31	123	0123
1666	1666	31	31	1666	1666
5000	31	31	31	31	5000
A5CD	31	31	31	31	A5CD

SMI: Code Measurement Smoothing

Function

This command is used to set the smoothing interval in code measurements.

Command Format

Syntax

$PASHS,SMI,d1[,d2[,d3]][*cc]
or
$PASHS,SMI,d1,,d3[*cc]
or
$PASHS,SMI,,,d3[*cc]

Parameters

Parameter	Description	Range	Default
d1	Time constant in seconds for the simplest first-order smoothing, when there is no L1-L2 smoothing applied. “0” means no smoothing applied.	0-100	100
d2	Time constant in seconds for the second-order smoothing, when there is no L1-L2 smoothing applied. “0” means no 2nd-order smoothing applied.	0 100-600	600
d3	Time constant in seconds for the first-order L1-L2 smoothing. “0” means no L1-L2 smoothing applied.	0-3600	1800
*cc	Optional checksum	*00-*FF	-

Example

Setting code measurement smoothing to 100 seconds:

$PASHS,SMI,100

Comments

- The smoothing correction is provided in the MCA/MPC raw data message along with the smoothing count. If the internal smoothing count is greater than 255, then the smoothing count in the MCA/MPC message is set to 255.
- Sending the command without d1, d2 or d3 will not change the corresponding value currently used, which will stay either that entered previously through a valid SMI command, or the default value if no such command was run.

SOM,CTT: Cumulative Tracking Time Mask

Function

This command is used to mask the signal observations that do not meet the minimum continuous tracking time you specify. This means that only the observations meeting this requirement will be output (all the others will be rejected).

Command Format

Syntax

$PASHS,SOM,CTT,d1[,d2][*cc]

Parameters

Parameter	Description	Range	Default
d1	Minimum continuous tracking time for differential data, in seconds. "0" means no mask.	0-255	10
d2	Minimum continuous tracking time for raw data, in seconds. If d2 is omitted, then the receiver will assume d2=d1. "0" means no mask.	0-255	10
*cc	Optional checksum	*00-*FF	

Raw Data Masked by d2	Differential Data Masked by d1
MCA MPC DPC ATM,MES ATM,RNX,SCN,0	All other messages

Comments

- "Continuous" tracking means tracking "without cycle slips".
- This command can only mask some particular signal data. If however at the same time the L1CA data are disabled, then ALL the satellite observations, and not only the masked ones, will be rejected.

- This command equally affects all GNSS and their signals.

Examples

Setting CTT masks for differential and raw data to 20 s:

$PASHS,SOM,CTT,20*65

Enabling all signal observations to be output regardless of the continuous tracking time requirement (no CTT mask):

$PASHS,SOM,CTT,0*57

SOM,NAV: Navigation Data Mask

Function

This command is used to mask the signal observations that are not consistent with the relevant navigation data. This means that only the observations meeting this requirement will be output (all the others will be rejected).

Command Format

Syntax

$PASHS,SOM,NAV,s1[,s2][*cc]

Parameters

Parameter	Description	Range	Default
s1	Differential data mask	ON, OFF	ON
s2	Raw data mask. If s2 is omitted, then the receiver will assume s2=s1	ON, OFF	OFF
*cc	Optional checksum	*00-*FF	

Raw Data Masked by s2	Differential Data Masked by s1
MCA MPC DPC ATM,MES ATM,RNX,SCN,0	All other messages

Comments

- Stating that signal observations are consistent with the corresponding navigation data means the following:
  - GNSS time, receiver position and receiver clock offsets are available and valid.
  - L1CA pseudo-range for a given satellite is measured and valid.
  - The corresponding satellite navigation data are available and valid.

– The L1CA pseudo-range and computed range are in agreement with each other.
– Elevation and azimuth angles are available and valid.

If at least one of the above requirements is not met, then signal observations are found to be not consistent with navigation data.

- The $PASHS,SOM,NAV command will mask all signals (all observables) corresponding to a given satellite, even if some other pseudo-ranges (e.g. L2C) can be consistent with the navigation data.
- The $PASHS,SOM,NAV command equally affects all GNSS systems.

Examples

Setting NAV masks for both differential and raw data:

$PASHS,SOM,NAV,ON*7C

Enabling all signal observations to be output regardless of whether they are consistent with navigation data or not (no NAV mask):

$PASHS,SOM,NAV,OFF*32

SOM,SNR: Signal-to-Noise Ratio Mask

Function

This command is used to mask the signal observations that do not meet the minimum signal-to-noise ratio you specify. This means that only the observations meeting this requirement will be output (all the others will be rejected).

Command Format

Syntax

$PASHS,SOM,SNR,f1[,f2][*cc]

Parameters

Parameter	Description	Range	Default
f1	Differential data mask. “0” means no mask.	0-60 dBHz	28
f2	Raw data mask. If s2 is omitted, then the receiver will assume s2=s1. “0” means no mask.	0-60 dBHz	28
*cc	Optional checksum	*00-*FF	

Raw Data Masked by f2	Differential Data Masked by f1
MCA MPC DPC ATM,MES ATM,RNX,SCN,0	All other messages

Comments

- The $PASHS,SOM,SNR command can only mask particular signal data for which the SNR does not meet your requirement. If however at the same time the L1CA data are disabled, then all the satellite observations will also be masked.
- The $PASHS,SOM,SNR command equally affects all GNSS systems and their signals, except GPS L1P(Y) and L2P(Y). For these two signals, a hard-coded SNR threshold is applied.

Examples

Setting SNR masks for both differential and raw data to 30 dBHz:

$PASHS,SOM,SNR,30*68

Enabling all signal observations to be output regardless of the signal-to-noise ratio:

$PASHS,SOM,SNR,0*5B

SOM,WRN: Channel Warnings Mask

Function

This command is used to mask the signal observations for those signals flagged with channel warnings (MPC/MCA warning bits are counted from 1 to 8). This means that only the observations from non-flagged signals will be output (all the others will be rejected).

Command Format

Syntax

$PASHS,SOM,WRN,s1[,s2][*cc]

Parameters

Parameter	Description	Range	Default
s1	Differential data mask	ON, OFF	ON
s2	Raw data mask. If s2 is omitted, then the receiver will assume s2=s1	ON, OFF	OFF
*cc	Optional checksum	*00-*FF	

Raw Data Masked by s2	Differential Data Masked by s1
MCA MPC DPC ATM,MES ATM,RNX,SCN,0	All other messages

Comments

- A signal is considered as flagged in at least one of the following cases:
  - Carrier phase tracking is not stable (Bit 3 of MPC/MCA warning is set).
  - Pseudo-range data quality is bad (Bit 5 of MPC/MCA warning is set).
  - Polarity is not resolved (MPC/MCA Phase Tracking Polarity flag is set to 0).
- The $PASHS,SOM,WRN command will mask only some particular signal data (e.g. L1CA or L2P) corresponding to a given satellite. If at the same time the L1CA data are disabled, then ALL the satellite observations, and not only those masked, will be rejected.
- The $PASHS,SOM,WRN command equally affects all GNSS systems.

Examples

Setting WRN masks for both differential and raw data:

$PASHS,SOM,WRN,ON*6E

Enabling all signal observations to be output regardless of whether some signals are flagged or not (no WRN mask):

$PASHS,SOM,WRN,OFF*20

SPD: Setting Baud Rates for Ports A and B

Function

This command is used to set the baud rates of ports A and B individually.

Command Format

Syntax

$PASHS,SPD,c1,d2[*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B
d2	Baud rate code	2-15 (port A) (Default: 9) 2-11 (port B) (Default: 9) See Baud Rate Codes in table below
*cc	Optional checksum	*00-*FF

Baud Rate Codes:

Code	Baud Rate	Code	Baud Rate	Code	Baud Rate	Code	Baud Rate
2	1 200	6	19 200	10	230 400	14	2 500 000
3	2 400	7	38 400	11	460 800	15	5 000 000
4	4 800	8	57 600	12	921 600		
5	9 600	9	115 200	13	1 428 571		

Example

Setting port A and B to 19 200 Bd:

$PASHS,SPD,A,6*45

Comments

If the baud rate chosen for a port is too slow to meet the volume of data output requested on this port, then the following message is output on the port, after the board has detected that data messages were skipped:

$PASHR,SKP*3C

SVM: Setting the Maximum Number of Observations in the PVT

Function:

This function is used to set the maximum number of code and doppler observations used in the PVT calculation.

Command Format

Syntax

$PASHS,SVM,d1[*cc]

Parameters

Parameter	Description	Range	Default
d1	Maximum number of observations	0-26	14
*cc	Optional checksum	*00-*FF	-

Example

Setting the number of observations to 25:

$PASHS,SVM,25*16

Comments This setting affects all the positioning modes, except for the time-tagged RTK mode for which this limit is hardware coded and set to 14 satellites.

UDP: User-Defined Dynamic Model Parameters

Function This command is used to set the upper limits of the dynamic model (velocity, acceleration).

Command Format

Syntax

$PASHS,UDP,f1,f2,f3,f4[*cc]

Parameters

Parameter	Description	Range	Default
f1	Maximum expected horizontal velocity in m/s.	0-100 000	100 000
f2	Maximum expected horizontal accelera-tion in m/s/s.	0-100	100
f3	Maximum expected vertical velocity in m/s.	0-100 000	100 000
f4	Maximum expected vertical acceleration in m/s/s.	0-100	100
*cc	Optional checksum	*00-*FF	-

Example

Setting the dynamic model:

$PASHS,UDP,10,1,2,0.5*1D

Comments

The user-defined dynamic model is activated by the $PASHS,DYN,9 command. Note that when the adaptive dynamic mode (DYN,8) is selected, the user-defined model is automatically excluded from the possible models that could best describe the current receiver dynamics.

UTS: Synchronizing Onto GPS Time

Function: This function is used to enable or disable a clock steering mechanism that synchronizes measurements and coordinates with the GPS system time rather than with the local (receiver) clock.

Command Format

Syntax

$PASHS,UTS,s1[*cc]

Parameters

Parameter	Description	Range	Default
s1	Enabling (ON) or disabling (OFF) synchronization with GPS time	ON, OFF	ON
*cc	Optional checksum	*00-*FF	-

Example

Enabling synchronization:

$PASHS,UTS,ON*0A

Comments

- All output data, except for legacy MPC, MCA, DPC and RPC, are always clock steered.
- Legacy MPC, MCA, DPC and RPC data appear as steered or not steered depending on the last $PASHS,UTS command run.
- The PBN message contains internal clock and clock drift estimates when UTS is OFF and reports zeros for these estimates when UTS is ON.
- The ATOM,RNX message with scenario 0 contains original clock and clock drift estimates that can be used on decoding side to restore the original (not steered) observables, if needed.

ZDA: Setting Date & Time

Function

This command is used to set the date and time in the receiver.

Command Format

Syntax

$PASHS,ZDA,m1,d2,d3,d4[*cc]

Parameters

Parameter	Description	Range
m1	UTC time (hhmmss.ss)	000000.00-235959.99
d2	Current day	01-31
d3	Current month	01-12
d4	Current year	0000-9999
*cc	Optional checksum	*00-*FF

Example

$PASHS,ZDA,151145.00,13,03,2008*0A

Chapter 7. Query Command Library

ALM: Almanac Message

Function

This command allows you to output the latest GPS almanac data on the specified port, or on the port on which the query is made if no port is specified. Each response line describes the almanac data from a given GPS satellite.

Command Format

Syntax

$PASHQ,ALM[,c1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$GPALM,d1,d2,d3,d4,h5,h6,h7,h8,h9,h10,h11,h12,h13,h14,h15*cc

Parameters

Parameter	Description	Range
d1	Total number of messages	01-32
d2	Number of this message	01-32
d3	Satellite PRN number	01-32
d4	GPS week	4 digits
h5	SV health (in ASCII hex)	2 bytes
h6	e: Excentricity (in ASCII hex)	4 bytes
h7	toe: Almanac reference time, in seconds (ASCII hex)	2 bytes
h8	Io: Inclination angle, in semicircles (ASCII hex)	4 bytes
h9	OMEGADOT: Rate of ascension, in semicircles/second (ASCII hex)	4 bytes
h10	A1/2: Square root of semi-major axis, in meters 1/2 (ASCII hex)	6 bytes
h11	OMEGA: Argument of perigee, in semicircles (ASCII hex)	6 bytes

Parameter	Description	Range
h12	OMEGA0: Longitude of ascension mode, in semicircles (ASCII hex)	6 bytes
h13	Mo: Mean anomaly, in semi-circles (ASCII hex)	6 bytes
h14	af0: Clock parameter, in seconds (ASCII hex)	3 bytes
h15	af1: Clock parameter, in seconds/second (ASCII hex)	3 bytes
*cc	Checksum	*00-*FF

Example

$PASHQ,ALM

$GPALM,31,1,01,65535,00,39A8,4E,1FEA,FD65,A10C8C,B777FE,935A86,C994BE,0C6,001*73
$GPALM,31,2,02,65535,00,4830,4E,00D9,FD49,A10D24,64A66D,3B6857,E6F2A3,0BA,001*7A
$GPALM,31,3,03,65535,00,552B,4E,F572,FD3B,A10CE1,20E624,0CD7E1,D10C32,0CA,001*0D
$GPALM,31,4,04,65535,00,4298,4E,0069,FD46,A10D5C,0EE3DC,3C2E3E,51DDF9,FF0,FFF*0A
...

Automatic Output of ALM Messages

This is a reminder on how to output ALM messages at regular intervals of time: Use the $PASHS,NME command with the syntax below:

$PASHS,NME,ALM,<port_ID>,ON,<Rate>

For more details on the $PASHS,NME command, refer to the *Set Command Library* Chapter.

As an example, the command below will output ALM messages on port A at a rate of 15 seconds:

$PASHS,NME,ALM,A,ON,15

ANP: Antenna Parameters

Function

This command allows you to read the antenna parameters of the specified antenna name, or of the complete antenna database if no antenna name is specified.

Command Format

Syntax

$PASHQ,ANP[,s1][,c2][*cc]

Parameters

Parameter	Description	Range
s1	Antenna name (case sensitive)	31 characters max.
c2	ID of the port through which the receiver provides the reply line. If no port ID is specified, the reply is sent to the port routing the query command.	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

Example

$PASHQ,ANP,ProMark500

```
BEGIN ANTENNA
ProMark500
L1 N: -000.80 E: -001.40 U: +101.8
L1 PAE:+000.0 +000.9 +001.9 +002.8 +003.7 +004.7 +005.4 +006.0 +006.4 +006.5
      +006.3 +005.8 +004.8 +003.2 +001.1 -001.6 -005.1 +000.0 +000.0
L2 N: +000.80 E: -001.10 U: +086.20
L2 PAE:+000.0 -000.9 -001.1 -000.6 +000.2 +001.1 +002.0 +002.7 +003.0 +003.0
      +002.6 +001.7 +000.5 -001.1 -003.0 -004.9 -006.8 +000.0 +000.0
END ANTENNA
```

ATT: Heading, Roll and Pitch

Function

This command allows you to output the heading, roll and pitch message on the specified port, or on the port routing the query command if no output port is specified.

Command Format

Syntax

$PASHQ,ATT[,c1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$PASHR,ATT,f1,f2,f3,f4,f5,f6,d7*cc

Parameters

Parameter	Description	Range
f1	Week time in seconds.	000000.00-604799.99
f2	True heading angle in degrees.	000.00-359.99
f3	Pitch angle in degrees.	±90.00
f4	Roll angle in degrees.	±90.00
f5	Carrier measurement RMS error, in meters.	Full range of real variables
f6	Baseline RMS error, in meters.	Full range of real variables
d7	Integer ambiguity is “Fixed” or “Float”: • 0: Fixed • >0: Float	0, >0
*cc	Optional checksum	*00-*FF

Comments

- The command is NAKed if the [H] option is not installed.
- With the heading mode disabled, but the Heading option [H] still installed, this command will provide baseline azimuth (instead of heading) and baseline elevation (instead of pitch)
- When the heading mode is disabled, or it’s enabled but baseline calibration is in progress, the baseline RMS error field (f6) stays equal to zero. This field is indicative of a baseline calibration currently in progress.

Example

Querying the heading and roll/pitch message on the current port:

$PASHQ,ATT
$PASHR,ATT,310080.0,248.57,+04.22,,0.0027,0.0000,0*2B

Automatic Output of ATT Messages

This is a reminder on how to output ATT messages at regular intervals of time: Use the $PASHS,NME command with the syntax below:

$PASHS,NME,ATT,<port_ID>,ON,<Rate>

For more details on the $PASHS,NME command, refer to the *Set Command Library* Chapter.

As an example, the command below will output ATT messages on port A at a rate of 0.5 second:

$PASHS,NME,ATT,A,ON,0.5

BPS: Base Position Message

Function

This command returns the base position message on the specified port, or on the port routing the query command if no output port is specified. The command will be “NAKed” if the RTK Base option [K] is not installed.

Command Format

Syntax

$PASHQ,BPS[,c1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

Syntax

The base station position message is transmitted along with the DBEN RPC message.

This message contains the base station’s coordinates, always tagged to the L1 phase center of the antenna. When generating the response to this command, the receiver always ignores the optional tagging parameter set in $PASHS,POS and the antenna offset parameters (between f5 and s11) are all unconditionally set to zero.

The BPS response message is in the form below

$PASHR,BPS,m1,c2,m3,c4,f5,0.0000,0.0000,00.0000,00000.00,00.0000,s11*cc

Parameters

Parameter	Description	Range
m1	Latitude, in degrees and decimal minutes	0-90° 00-59.9999999’
c2	Direction of latitude	N, S
m3	Longitude, in degrees and decimal minutes	0-180° 00-59.9999999’
c4	Direction of longitude	E, W
f5	Altitude, in meters	±99999.9999
s11	Status byte in hexadecimal notation	See table below
*cc	Checksum	*00-*FF

Bit	Description
1 (LSB)	Coordinates of base station not entered
2	Not used
3	Base station is not computing position from raw pseudo-ranges
4	Entered coordinates for base are more than 500 meters away (in each direction) from the computed position, based on raw pseudo-ranges.
5	Base station is not tracking satellites properly
6, 7, 8	Not used

Example

$PASHQ,BPS
$PASHR,BPS,5539.3790930,N,03731.5553470,E,+00268.4450,0.0000,0.0000,00.0000,00000.00,00.0000,00*0E

Automatic Output of BPS Messages

This is a reminder on how to output BPS messages at regular intervals of time: Use the $PASHS,NME command with the syntax below:

$PASHS,NME,BPS,<port_ID>,ON,<Rate>

For more details on the $PASHS,NME command, refer to the *Set Command Library* Chapter.

As an example, the command below will output BPS messages on port A at a rate of 30 seconds:

$PASHS,NME,BPS,A,ON,30

CPD,REF: Querying Rover for Base Position Used

Function

This command returns the base position, as available from a rover that uses it or will use it when possible. The reply is returned on the specified port, or on the port routing the query command if no output port is specified.

The base position can be returned “as is” or tagged to some specified point (L1 phase center or ARP) if the rover knows about the antenna used at the base (through the antenna name).

If the base antenna name is unknown, then no coordinate transformation will be possible and the receiver will assume the L1 phase center and the ARP of the base antenna are physically the same point in space.

Command Format

Syntax

$PASHQ,CPD,REF[,s1][,c2][*cc]

Parameters

Parameter	Description	Range
s1	Requested base position: • ORG: Original base position (as originally presented in decoded differential message) • PC1: Base position tagged to L1 phase center • ARP: Base position tagged to ARP Omitting s1 is equivalent to using ORG for this parameter.	ORG, PC1, ARP
c2	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$PASHR,CPD,REF,f1,f2,f3,m4,c5,m6,c7,f8,s9,s10,s11*cc

Parameters

Parameter	Description	Range
f1	X component, in meters	±99999999.9999
f2	Y component, in meters	±99999999.9999
f3	Z component, in meters	±99999999.9999
m4	Latitude in degrees, decimal minutes (ddmm.mmmmmmm)	0-90
c5	North (N) or South (S)	N, S
m6	Longitude in degrees, decimal minutes (dddmm.mmmmmmm)	0-180
c7	East (E) or West (W)	E, W
f8	Ellipsoidal height, in meters	±9999.9999
s9	Position attribute: • PC1: Reference position tagged to L1 phase center • ARP: Reference position tagged to ARP	PC1, ARP, SPT
s10	Position source: • REC: Received via a differential message. May be referenced to a local datum, depending on the differential data provider. • ENT: As entered in the rover. Refers to the current ITRF. • CPT: As computed by the rover. May refer to the current ITRF.	REC, ENT, CPT
s11	Reference base station ID	
*cc	Checksum	*00-*FF

Comments

- The coordinates refer to the original datum on which the reference position of the base is expressed.

  In response to the CPD,REF command, and although most often providers only send cartesian coordinates expressed on an unknown local datum, the receiver will return both the cartesian and geographical coordinates of the reference position. The IGS05 realization (WGS-84 ellipsoid model) will be used in the receiver to transform the cartesian coordinates into geographical coordinates.
- In most cases, the reference position of the base is that decoded from the incoming differential data (REC), e.g. from RTCM-3 MT 1006. But with **further firmware versions**, using the s10 parameter, there will be a possibility to either enter base coordinates on the rover (ENT), or compute approximate base coordinates (CPT) directly from the received base observations. If the three types of base positions are available from the rover, then the command will only return the one with the highest internal priority (i.e. the one currently used or the one that will be used when this is possible).
- If there is no reference base position available from a rover, then the command will only return empty fields.
- Most of the known differential protocols (RTCM-2, RTCM-3, CMR/CMR+) generate reference position tagged either to the ARP or to the L1 phase center (PC1).

  Some proprietary protocols, such as Ashtech DBEN, transmit reference coordinates tagged to some survey point (SVP) that differ from the ARP in both the vertical and horizontal directions.

  Usually these protocols contain internally offset values allowing the original SVP position to be transformed into ARP.

  Since only PC1 tagging and ARP tagging are currently supported, for such proprietary protocols, the command will automatically return the ARP position when the s1 parameter is omitted or the ORG position is implicitly requested.

Example

$PASHQ,CPD,REF,ARP*32

$PASHR,CPD,REF,2860347.6069,2196947.3233,5243149.9374,5539.35890
84,N,03731.6072193,E,268.158,ARP,REC,0031*64

DDM: Differential Decoder Message

Function

This command returns a report about the decoded differential messages on the specified port, or on the port routing the query command if no output port is specified.

The report may refer to several types of differential messages that the built-in Differential Decoder gets from different receiver ports.

If the second RTK engine is enabled, the DD2 message is output as well.

Command Format

Syntax

$PASHQ,DDM[,c1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$PASHR,DDM,c1,s2,s3,d4,s5,f6,f7,s8*cc

If the second RTK engine is enabled, the response also includes the following:

$PASHR,DD2,c1,s2,s3,d4,s5,f6,f7,s8*cc

Parameters

Parameter	Description	Range
c1	Port receiving corrections	A, B, C
s2	Message transport	RT2, RT3, CMR, CMP, DBN, TPZ or ATM
s3	Message number/identifier	e.g. 1004 for RT3, RNX for ATM, etc.
d4	Counter of decoded messages	0-9999
s5	Base ID (empty if Base ID not available)	
f6	Time tag, in seconds, as read from the decoded message	
f7	Age of corrections, in seconds	
s8	Attribute	60 characters max.
*cc	Checksum	*00-*FF

Comments

- Corrections can come from more than one receiver port.
- Parameter d4 counts the number of decoded messages modulo 10000. It is incremented by one each time a new message is decoded.

  Each receiver port has its own counter. All counters are initialized to 0 after the $PASHS,RST or $PASHS,INI command has been issued. Counters are very useful to check if some DDM messages are lost at the output.
- Parameter f6 is the time tag, in seconds, as read from the decoded message. Regardless of its original presentation, the time tag provided in the DDM message is always expressed in GPS time, within the GPS week.

  For example the time tag from message RTCM-3 MT 1012 (referring to GLONASS time) will be transformed to a GPS time tag in the DDM message.

  Another example is the time tag from message RTCM-2 MT 18. It is originally presented modulo 3600 seconds, but appears as a complete time tag in the DDM message.

  If the decoded message does not contain any time tag (e.g. RT3 1005), the f6 field is empty.
- The age of corrections is defined as the difference, in seconds, between the receiver time at the end of the decoding process and the time tag read from the decoded message. If no tag time is provided in the message (e.g. RT3 1005), the f7 field is empty.
- Parameter s8 holds some vital attributes from the decoded message. It contains a number of parameters delimited by “slash” characters (/). It may also be empty.
- Although controlled by the $PASHS,NME,DDM command, the DDM message is independent of the NMEA period. It is output every time a new differential message is decoded.

Example

Eanbling the receiver to output the DDM message on port A:

$PASHS,NME,DDM,A,ON*12

Generating the differential decoder message on port A:

$PASHQ,DDM,A*57

$PASHR,DDM,A,RT2,18,6832,0000,461334.0,0.5,G:1/S:8/L:0/M:1*5A

GBS: GNSS Satellite Fault Detection

Function

This command returns the GBS message supporting RAIM (Receiver Autonomous Integrity Monitoring) on the specified port, or on the port routing the query command if no output port is specified.

Command Format

Syntax

$PASHQ,GBS[,c1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

The response complies with the *Standard for Interactive Marine Electronic Devices – NMEA 0183 3.00.*The message header is in the form:

$--GBS

If only GPS satellites are used in the position solution, the message header is:

$GLGBS

If only GLONASS satellites are used in the position solution, the message header is:

$GPGBS

If several types of satellites are used in the position solution, the message header is:

$GNGBS

While the receiver is operated in RTK mode, the delivered GBS messages will only consist of empty fields.

Syntax

$--GBS,m1,f2,f3,f4,d5,f6,f7,f8*cc

Parameters

Parameter	Description	Range
m1	UTC time of the GGA or GNS fix associated with this message (hhmmss.ss)	000000.00-235959.99
f2	Expected error in latitude, in meters, due to bias, with noise= 0	-

Parameter	Description	Range
f3	Expected error in longitude, in meters, due to bias, with noise= 0	-
f4	Expected error in altitude, in meters, due to bias, with noise= 0	-
d5	ID number of most likely failed satellite	1-32 for GPS 33-64 for SBAS 65-96 for GLONASS
f6	Probability of missed detection for most likely failed satellite	-
f7	Estimate of bias, in meters, on most likely failed satellite	-
f8	Standard deviation of bias estimate	-
*cc	Checksum	*00-*FF

Automatic Output of GBS Messages

This is a reminder on how to output GBS messages at regular intervals of time: Use the $PASHS,NME command with the syntax below:

$PASHS,NME,GBS,<port_ID>,ON,<Rate>

For more details on the $PASHS,NME command, refer to the *Set Command Library* Chapter.

As an example, the command below will output GBS messages on port A at a rate of 120 seconds:

$PASHS,NME,GBS,A,ON,120

GGA: GNSS Position Message

Function

This command is used to output a GGA message containing the last computed position on the specified port, or on the port on which the query is made if no port is specified. If no position is computed, the message will be output anyway, but with some blank fields.

Command Format

Syntax

$PASHQ,GGA[,c1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$GPGGA,m1,m2,c3,m4,c5,d6,d7,f8,f9,M,f10,M,f11,d12*cc

Parameters

Parameter	Description	Range
m1	Current UTC time of position (hhmmss.ss)	000000.00- 235959.99
m2	Latitude of position (ddmm.mmmmmm)	0-90 0-59.999999
c3	Direction of latitude	N, S
m4	Longitude of position (dddmm.mmmmmm)	0-180 0-59.999999
c5	Direction of longitude	E,W
d6	Position type: • 0: Position not available or invalid • 1: Autonomous position • 2: RTCM Differential (or SBAS Differential) • 3: Not used • 4: RTK fixed • 5: RTK float • 9: SBAS Differential. See comment.	0-5, 9
d7	Number of GNSS Satellites being used in the position computation	0-26
f8	HDOP	0-99.9
f9,M	Altitude, in meters, above mean seal level. “M” for meters	± 99999.999,M
f10,M	Geoidal separation in meters. “M” for meters. Based on the official NATO's standard mean-sea-level algorithm (5-degree grid of height).	± 999.999,M
f11	Age of differential corrections, in seconds	0-600
d12	Base station ID (RTCM only)	0-4095
*cc	Checksum	*00-*FF

Example

$PASHQ,GGA
$GPGGA,131745.00,4717.960847,N,00130.499476,W,4,10,0.8,35.655,M,
47.290,M,3.0,1000*61

Comment

The code allotted to a position solution of the SBAS differential type is either “1” or “9”, depending on the last $PASHS,NPT command run.

Automatic Output of GGA Messages

This is a reminder on how to output GGA messages at regular intervals of time: Use the $PASHS,NME command with the syntax below:

$PASHS,NME,GGA,<port_ID>,ON,<Rate>

For more details on the $PASHS,NME command, refer to the *Set Command Library* Chapter.

As an example, the command below will output GGA messages on port A at a rate of 0.5 second:

$PASHS,NME,GGA,A,ON,0.5

GLL: Geographic Position - Latitude/Longitude

Function

This command is used to output a GLL message containing the last computed position. The message is output on the specified port, or on the port on which the query is made if no port is specified. If no position is computed, the message will be output anyway, but all position-related fields will be blank.

Command Format

Syntax

$PASHQ,GLL[*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$GPGLL,m1,c2,m3,c4,m5,c6,c7*cc

Parameters

Parameter	Description	Range
m1	Latitude of position (ddmm.mmmmmm)	0-90 0-59.999999
c2	Direction of latitude	N, S
m3	Longitude of position (dddmm.mmmmmm)	0-180 0-59.999999
c4	Direction of longitude	E,W
m5	Current UTC time of position (hhmmss.ss)	000000.00- 235959.99

Parameter	Description	Range
c6	Status • A: Data valid • V: Data not valid	A, V
c7	Mode indicator: • A: Autonomous mode • D: Differential mode • N: Data not valid	A, D, N
*cc	Checksum	*00-*FF

Example

$PASHQ,GLL
$GPGLL,4717.960853,N,00130.499473,W,132331.00,A,D*7D

Automatic Output of GLL Messages

This is a reminder on how to output GLL messages at regular intervals of time: Use the $PASHS,NME command with the syntax below:

$PASHS,NME,GLL,<port_ID>,ON,<Rate>

For more details on the $PASHS,NME command, refer to the *Set Command Library* Chapter.

As an example, the command below will output GLL messages on port A at a rate of 0.5 second:

$PASHS,NME,GLL,A,ON,0.5

GRS: GNSS Range Residuals

Function

This command is used to output a GRS message containing the satellite range residuals. The message is output on the specified port, or on the port on which the query is made if no port is specified. No message will be output if there is no position computed.

Command Format

Syntax

$PASHQ,GRS[,c1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$--GRS,m1,d2,n(f3)*cc

Parameters

Parameter	Description	Range
"$--GRS" Header	$GPGRS: Only GPS satellites are used. $GLGRS: Only GLONASS satellites are used. $GNGRS: Several constellations (GPS, SBAS, GLONASS) are used.	$GPGRS, $GLGRS, $GNGRS
m1	Current UTC time of position (hhmmss.ss)	000000.00-235959.99
d2	Mode used to compute range residuals	Always "1"
f3	Range residual for satellite used in position computation (repeated "n" times, where n is the number of satellites used in position computation). Residuals are listed in the same order as the satellites in the GSV message so that each residual provided can easily be associated with the right satellite.	±999.999
*cc	Checksum	*00-*FF

Example

$PASHQ,GRS
$GNGRS,141003.50,1,1.14,-0.48,0.26,0.20,-0.94,-0.28,-1.18*61
$GNGRS,141003.50,1,-0.20*4F

Automatic Output of GRS Messages

This is a reminder on how to output GRS messages at regular intervals of time: Use the $PASHS,NME command with the syntax below:

$PASHS,NME,GRS,<port_ID>,ON,<Rate>

For more details on the $PASHS,NME command, refer to the *Set Command Library* Chapter.

As an example, the command below will output GRS messages on port A at a rate of 0.5 second:

$PASHS,NME,GRS,A,ON,0.5

GSA: GNSS DOP and Active Satellites

Function

This command is used to output a GSA message containing data related to DOP values and satellites used in the position solution. The message is output on the specified port, or on the port on which the query is made if no port is specified.

Command Format

Syntax

$PASHQ,GSA[,c1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$--GSA,c1,d2,d3,d4,d5,d6,d7,d8,d9,d10,d11,d12,d13,d14,f15,f16,f17*cc

Parameters

Parameter	Description	Range
"$--GSA" Header	$GPGSA: Only GPS satellites are used. $GLGSA: Only GLONASS sats are used. $GNGSA: Several constellations (GPS, SBAS, GLONASS) are used.	$GPGSA, $GLGSA, $GNGSA
c1	Output mode: • M: Manual • A: Automatic	M, A
d2	Position indicator: • 1: No position available • 2: 2D position • 3: 3D position	1-3
d3-d14	Satellites used in the position solution (blank fields for unused channels)	GPS: 1-32 GLONASS: 65-96 SBAS: 33-64
f15	PDOP	0-9.9
f16	HDOP	0-9.9
f17	VDOP	0-9.9
*cc	Checksum	*00-*FF

Example

$PASHQ,GSA
$GNGSA,A,3,20,11,13,23,17,04,31,,,,,,1.6,0.9,1.3*21
$GNGSA,A,3,81,83,68,,,,,,,,,,1.6,0.9,1.3*2C

Automatic Output of GSA Messages

This is a reminder on how to output GSA messages at regular intervals of time: Use the $PASHS,NME command with the syntax below:

$PASHS,NME,GSA,<port_ID>,ON,<Rate>

For more details on the $PASHS,NME command, refer to the *Set Command Library* Chapter.

As an example, the command below will output GSA messages on port A at a rate of 0.5 second:

$PASHS,NME,GSA,A,ON,0.5

GST: GNSS Pseudo-Range Error Statistics

Function

This command is used to output a GST message containing standard deviations relevant to the position solution. The message is output on the specified port, or on the port on which the query is made if no port is specified.

Command Format

Syntax

$PASHQ,GST[,c1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$--GST,m1,f2,f3,f4,f5,f6,f7,f8*cc

Parameters

Parameter	Description	Range
"$--GST" Header	$GPGST: Only GPS satellites are used. $GLGST: Only GLONASS satellites are used. $GNGST: Several constellations (GPS, SBAS, GLONASS) are used.	$GPGST, $GLGST, $GNGST
m1	Current UTC time of position (hhmmss.ss)	000000.00-235959.99
f2	RMS value of standard deviation of range inputs (DGNSS corrections included), in meters	0.000-99.999
f3	Standard deviation of semi-major axis of error ellipse, in meters	0.000-99.999
f4	Standard deviation of semi-minor axis of error ellipse, in meters	0.000-99.999
f5	Orientation of semi-major axis of error ellipse, in degrees from true North	0.000-99.999
f6	Standard deviation of latitude error, in meters	0.000-99.999
f7	Standard deviation of longitude error, in meters	0.000-99.999
f8	Standard deviation of altitude error, in meters	0.000-99.999
*cc	Checksum	*00-*FF

Example

$PASHQ,GST
$GNGST,154013.80,0.642,1.746,1.303,27.197,1.663,1.407,2.456*79

Automatic Output of GST Messages

This is a reminder on how to output GST messages at regular intervals of time: Use the $PASHS,NME command with the syntax below:

$PASHS,NME,GST,<port_ID>,ON,<Rate>

For more details on the $PASHS,NME command, refer to the *Set Command Library* Chapter.

As an example, the command below will output GST messages on port A at a rate of 0.5 second:

$PASHS,NME,GST,A,ON,0.5

GSV: GNSS Satellites in View

Function

This command is used to output a GSV message containing information on the satellites in view. The message is output on the specified port, or on the port on which the query is made if no port is specified.

Command Format

Syntax

$PASHQ,GSV[,c1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$--GSV,d1,d2,d3,n(d4,d5,d6,f7)*cc

The set of parameters (d4,d5,d6,f7) can be repeated up to 4 times in a single response line, corresponding to the description of 4 different satellites. The number of response lines is therefore dependent on the number of satellites in view (e.g. three response lines if between 9 and 12 satellites are visible).

Parameters

Parameter	Description	Range
"$--GSV" Header	$GPGSV: GPS and SBAS satellites. $GLGSV: GLONASS satellites	$GPGSV, $GLGSV
d1	Total number of messages	1-4
d2	Message number	1-4
d3	Total number of satellites in view	1-15
d4	Satellite PRN	GPS: 1-32 GLONASS: 65-96 SBAS: 33-64
d5	Elevation in degrees	0-90
d6	Azimuth in degrees	0-359
f7	SNR in dB.Hz	30.0-60.0
*cc	Checksum	*00-*FF

Example

$PASHQ,GSV
$GPGSV,2,1,07,20,61,066,50,11,30,146,36,13,41,200,50,23,73,134,52*7C
$GPGSV,2,2,07,33,34,198,42,17,40,242,50,04,37,304,48*47
$GLGSV,1,1,04,77,29,098,46,84,19,332,46,83,49,276,52,68,57,300,52*67

Automatic Output of GSV Messages

This is a reminder on how to output GSV messages at regular intervals of time: Use the $PASHS,NME command with the syntax below:

$PASHS,NME,GSV,<port_ID>,ON,<Rate>

For more details on the $PASHS,NME command, refer to the *Set Command Library* Chapter.

As an example, the command below will output GSV messages on port A at a rate of 10 seconds:

$PASHS,NME,GSV,A,ON,10

HDT: True Heading

Function

This command is used to output an HDT message (last computed true heading in degrees) on the specified port, or on the port on which the query is made if no port is specified.

Command Format

Syntax

$PASHQ,HDT[,c1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$GPHDT,f1,T*cc

Parameters

Parameter	Description	Range
f1,T	Last computed heading value, in degrees "T" for "True".	0-359.9°
*cc	Optional checksum	*00-*FF

Example

$PASHQ,HDT
$GPHDT,121.2,T*35

Automatic Output of HDT Messages

This is a reminder on how to output HDT messages at regular intervals of time: Use the $PASHS,NME command with the syntax below:

$PASHS,NME,HDT,<port_ID>,ON,<Rate>

For more details on the $PASHS,NME command, refer to the *Set Command Library* Chapter.

As an example, the command below will output HDT messages on port A at a rate of 1 second:

$PASHS,NME,HDT,A,ON,1

LTN: Latency

Function

This command returns the current value of latency on the specified port, or on the port routing the query command if no output port is specified.

Command Format

Syntax

$PASHQ,LTN[,c1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$PASHR,LTN,d1*cc

Parameters

Parameter	Description	Range
d1	Latency in milliseconds.	Typically less than 100 ms in FAST RTK mode
*cc	Optional checksum	*00-*FF

Example

Querying the value of latency:

$PASHQ,LTN
$PASHR,LTN,60*08

Comments

Latency refers to the time it takes for the receiver to compute a position from the measurement time tag and prepare data to be transmitted through the serial port. The value of latency depends on the number of locked satellites.

In time-tagged mode, the value of latency also includes the time required for the correction stream to go through the data communication link before arriving at the receiver.

Automatic Output of LTN Messages

This is a reminder on how to output LTN messages at regular intervals of time: Use the $PASHS,NME command with the syntax below:

$PASHS,NME,LTN,<port_ID>,ON,<Rate>

For more details on the $PASHS,NME command, refer to the *Set Command Library* Chapter.

As an example, the command below will output LTN messages on port A at a rate of 10 seconds:

$PASHS,NME,LTN,A,ON,10

PAR: Receiver Parameters

Function

This command lists the currently used parameters for the specified type of receiver settings. The response is returned through the specified port, or on the port routing the query command if no output port is specified.

Command Format

Syntax

$PASHQ,PAR[,[s1][,c2]][*cc]

Parameters

Parameter	Description	Range
s1	Type of receiver settings. If s1 is omitted, the response lists the parameters for all types of settings.	See table below.
c2	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Type	Description
INP	Input information.
OUT	Output information.
RCV	Receiver settings.
RTK	RTK and ARROW settings.
STA	Status information.

Response Format

Examples

Querying receiver parameters for output information settings:

$PASHQ,PAR,OUT

```
==============================+================================
 OUTPUT INFORMATION           |
------------------------------|
PORTS: A:9,NTV B:9,NTV C:0,NTV
ATL:OFF
NME:
     LTN ZDA GLL GGA RMC VTG GST GBS GSA GSV GRS ALM MSG HDT POS SAT BPS ATT VEC TTT PTT DDM
A:   OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
B:   OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF ON  OFF OFF OFF OFF OFF OFF OFF
C:   OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
ATM:
     PVT RNX MES TT2 TT1 ATR NAV DAT EVT STA
A:   OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
B:   OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
C:   OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
RT3:
     1005 1006 1001 1002 1003 1004 1009 1010 1011 1012 1007 1008 1033 1029 1019 1020 1013
A:   OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF
B:   OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF
C:   OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF  OFF
RT2:
     3   22  24  32  18  19  20  21  1   9   31  34  23  16  36
A:   OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
B:   OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
C:   OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF
CMR:
     1   3   0   2
A:   OFF OFF OFF OFF
B:   OFF OFF OFF OFF
C:   OFF OFF OFF OFF
CMP:
     3   0
A:   OFF OFF
B:   OFF OFF
C:   OFF OFF
RAW:
```

etc.

NOTE: When running the $PASHQ,PAR,OUT command, the returned parameters should be interpreted as follows:

- "OFF" means the message is currently not output.
- "ON" means it is currently output with the default output rate.
- A specified output rate means this rate was user-set through the appropriate command.

Querying receiver parameters for input information settings:

$PASHQ,PAR,INP

```
==============================+================================
 INPUT INFORMATION            |
------------------------------|
 RTK1 CORR SOURCE             | A,ALL
 RTK2 CORR SOURCE             | OFF,ALL
 RTK3 CORR SOURCE             | OFF,ALL
 PORTS SPEED                  | A:9 B:9 C:0
==============================+================================
```

Omitting s1 in the command is equivalent to asking for all receiver parameters, one type after the other. A typical response is given below.

$PASHQ,PAR

```
==============================+================================
 STATUS INFORMATION           |
------------------------------|
 STORED POSITION              | 5539.358898,N,03731.606905,E,267.567 (
 DATE (dd.mm.yyyy)            | 16.09.2010
 UTC TIME (hhmmss.ms)         | 133135.30
 GPS TIME SCALE               | 1601(4):394310300(7)
 GLO TIME SCALE               | 5372(4):59495300(7)
 SVS TRACKED                  | 21 (GPS:12 SBA:2 GLO:7)
 SVS USED                     | 14 (GPS:8 SBA:0 GLO:6)
 SOLUTION STATUS              | 1
 EXTERNAL ANTENNA STATUS      | SHORTED
==============================+================================
==============================+================================
 COMMON SETTINGS:             |
------------------------------|
 INTERNAL RECEIVER NAME       | MB500
 FIRMWARE VERSION             | Gh23
 REFERENCE CLOCK              | INTERNAL
 GNSS CONFIGURATION           | 4
 GPS ALLOWED TO TRACK         | ON
 GLO ALLOWED TO TRACK         | ON
 SBA ALLOWED TO TRACK         | ON
 INTERNAL UPDATE PERIOD [msec]| 50
 CHANNELS-SVS ASSIGNMENT      | AUT
 DYNAMIC                      | ADAPTIVE
 USER DYNAMIC PARAMETERS      | 100000.0,100.0,100000.0,100.0
 CLOCK STEERING               | ON
 OUTPUT ADJUSTMENT TO ANTENNA |
 CODE CORRELATOR MODE         | STROBE CORRELATOR
 CODE SMOOTHING INTERVAL [sec]| 100,600,1800
 ADJUST GLONASS BIASES        | OFF
 POSITION ELEVATION MASK [deg]| 05
 MAX SVS IN PVT               | 14
 PPS PERIOD [sec]             | 1
 PPS OFFSET [msec]            | 0
 PPS SYNCHRONIZED EDGE        | RISING
 EVENT MARKER EDGE            | RISING
------------------------------+--------------------------------
 DIFF GENERATOR SETTINGS:     |
------------------------------|
 OWN ANTENNA NAME             |
 OWN RECEIVER NAME            | MB500
 SITE NAME                    | ????
 TEXT MESSAGE                 | MB500
```

etc.

PAR,ATM: ATOM Data Generation Settings

Function

This command lists the currently used settings to generate ATOM messages. The response is returned through the specified port, or on the port routing the query command if no output port is specified.

Command Format

Syntax

$PASHQ,PAR,ATM[,[s1][,c2]][*cc]

Parameters

Parameter	Description	Range
s1	ATOM message type. If s1 is omitted, the response lists the settings for all the ATOM messages.	MES, PVT, TT1, TT2, ATR, NAV, DAT, RNX, EVT, STA
c2	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Data	Description
MES	Settings for generating ATOM, MES messages
PVT	Settings for generating ATOM, PVT messages (best RTK)
TT1	Settings for generating ATOM, PVT messages (first RTK)
TT2	Settings for generating ATOM, PVT messages (second RTK)
ATR	Settings for generating ATOM, ATR messages
NAV	Settings for generating ATOM, NAV messages
DAT	Settings for generating ATOM, DAT messages
RNX	Settings for generating ATOM, RNX messages
EVT	Settings for generating ATOM, EVT messages
STA	Settings for generating ATOM, STA messages

Response Format

The response is in a user-readable format. See *ATOM Reference Manual*.

PIN: Programmable Pin

Function

This command returns the current settings of the specified programmable pin on the I/O connector. The response is returned on the port routing the query command.

Command Format

Syntax

$PASHQ,PIN[,d1][*cc]

Parameters

Parameter	Description	Range
d1	Identification of the programmable pin ID. If d1 is not specified, the response will include information about all the available programmable pins.	0
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$PASHR,PIN,d1,s2[,d3]*cc

Parameters

Parameter	Description	Range
d1	Programmable pin ID recalled in this field (0: TIOA1)	0
s2	Pin function status: • OFF: no function assigned • PAV: Position available • RSP: Radar simulated pulse	OFF, PAV or RSP
d3	If s2=PAV, d3 is the number of consecutive seconds while position is not computed that causes the signal on the pin to switch to low level. If s2=RSP, d3 has been set to “1” to make Radar Simulated Pulse output available on the pin. if s2=OFF, d3 has been omitted	1-3600 or 1
*cc	Optional checksum	*00-*FF

Example

$PASHQ,PIN,0,A*51 (or $PASHQ,PIN*20)
$PASHR,PIN,0,PAV,60*7E
or
$PASHR,PIN,0,OFF*5C

POS: Computed Position Data

Function

This command allows you to query the computed position. The message is output on the specified port, or on the port on which the query is made if no port is specified.

Command Format

Syntax

$PASHQ,POS[,c1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$PASHR,POS,d1,d2,m3,m4,c5,m6,c7,f8,f9,f10,f11,f12,f13,f14,f15,f16,s17*cc

Parameters

Parameter	Description	Range
d1	Position mode: • 0: Autonomous • 1: RTCM code differential • 2: RTK float • 3: RTK fixed • 5: Extrapolated	0-3 or 5
d2	Count of satellites used in position computation	0-26
m3	Current UTC time of position (hhmmss.ss)	000000.00-235959.99
m4	Latitude of position (ddmm.mmmmmm)	0-90° 00-59.999999 minutes
c5	North (N) or South (S)	N, S
m6	Longitude of position (ddmm.mmmmmm)	0-180° 00--59.999999 minutes
c7	East (E) or West (W)	E, W
f8	Altitude above the WGS84 ellipsoid	±9999.000
f9	Age of Differential data, in seconds	0.0-600.0
f10	True Track/Course Over Ground, in degrees	0.0-359.9
f11	Speed Over Ground, in knots	0.0-999.9
f12	Vertical velocity in dm/s	±999.9
f13	PDOP	0-99.9
f14	HDOP	0-99.9
f15	VDOP	0-99.9
f16	TDOP	0-99.9
s17	Firmware version ID	4-char. string
*cc	Checksum	*00-*FF

Example

$PASHQ,POS

$PASHR,POS,3,10,151858.00,4717.960848,N,00130.499487,W,82.972,,0.0,0.0,-0.0,2.0,1.1,1.7,1.3,G010*49

Automatic Output of POS Messages

This is a reminder on how to output POS messages at regular intervals of time: Use the $PASHS,NME command with the syntax below:

$PASHS,NME,POS,<port_ID>,ON,<Rate>

For more details on the $PASHS,NME command, refer to the *Set Command Library* Chapter.

As an example, the command below will output POS messages on port A at a rate of 0.2 second:

$PASHS,NME,POS,A,ON,0.2

PRT: Baud Rate Settings

Function

This command is used to query the baud rate setting for port A or B. The message is output on the specified port, or on the port on which the query is made if no port is specified.

Command Format

Syntax

$PASHQ,PRT[,c1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$PASHR,PRT,c1,d2*cc

Parameters

Parameter	Description	Range
c1	Queried port ID	A, B
d2	Baud rate code	2-15 for port A 2-11 for port B (see table below)
*cc	Checksum	*00-*FF

Code	Baud Rate	Code	Baud Rate	Code	Baud Rate	Code	Baud Rate
2	1 200	6	19200	10	230400	14	2500000
3	2 400	7	38400	11	460800	15	5000000
4	4 800	8	57600	12	921600		
5	9 600	9	115200	13	1428571		

Example

$PASHQ,PRT,A

$PASHR,PRT,A,6*55

PTT: PPS Time Tag

Function

This command asks for the PPS time tag message to be output on the specified port, or on the port on which the query is made if no port is specified.

Command Format

Syntax

$PASHQ,PTT[,c1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$PASHR,PTT,d1,m2*cc

Parameters

Parameter	Description	Range
d1	Day of week: • 1: Sunday • 7: Saturday	1-7
m2	GPS time tag in hours, minutes, seconds	0-23:59:59.9999999
*cc	Checksum	*00-*FF

Example

Enabling the receiver to output the PTT message on port A:

$PASHS,NME,PTT,A,ON

Generating the PPS time tag message on port A:

$PASHQ,PTT,A
$PASHR,PTT,6,20:41:02.0000000*2D

Comments

- The response to this command will be sent out once, right after the next PPS pulse is generated.
- The response contains the GPS time at which the PPS pulse was sent, including the offset if an offset was set when the PPS pulse was enabled.
- This message is not output unless the PPS pulse is enabled and the PPS option [L] is activated in the receiver. Being set to a periodical output by the $PASHS,NME,PTT command, this message is

independent of the NMEA period. It is only linked to the PPS period.

Asking for the Output of a Raw Data Message

Function

This command is used to output the specified raw data message on the specified port, or on the port on which the query is made if no port is specified.

Command Format

Syntax

$PASHQ,s1[,c2][*cc]

Parameters

Parameter	Description	Range
s1	Raw data message identification	See table below
c2	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Data	Description
MCA	GPS/GLONASS/SBAS L1 CA data
MPC	GPS/GLONASS/SBAS measurements
DPC	Compact GPS raw data
PBN	Position information
SNV	GPS ephemeris data
SNG	GLONASS ephemeris data
SNW	SBAS ephemeris data
SAL	GPS almanac data
SAG	GLONASS almanac data
SAW	SBAS almanac data
ION	Ionospheric parameters
SBD	SBAS data message

Response Format

See detailed description of each of these messages in the chapter *Raw Data Messages in Ashtech Proprietary Format on page 189*.

RCP: Receiver Parameters

Function

This command returns the parameters of the receiver whose case-sensitive name is specified in the command. The response is returned through the specified port, or on the port routing the query command if no output port is specified.

Command Format

Syntax

$PASHQ,RCP[,[s1][,c2]][*cc]

Parameters

Parameter	Description	Range
s1	Name of the receiver (case sensitive). If s1 is omitted, the parameters for all the receivers described in the database are listed.	31 characters max.
c2	ID of the port returning the response	A, B, C
*cc	Checksum	*00-*FF

Response Format

The response is in user-readable form. Only fractional parts of the GLONASS carrier phase biases are of practical importance.

Below is an example of a response to this command:

$PASHQ,RCP,ProMark500
RECEIVER:
ProMark500:
L1 BIAS: +0.000,+0.000 +0.000 +0.000 +0.000 +0.000 +0.000 +0.000 +0.000
+0.000 +0.000 +0.000 +0.000 +0.000 +0.000
L2 BIAS: +0.000,+0.000 +0.000 +0.000 +0.000 +0.000 +0.000 +0.000 +0.000
+0.000 +0.000 +0.000 +0.000 +0.000 +0.000

For pre-defined receivers, only receiver names are provided. For user-defined receivers, all bias parameters are provided as well. Examples:

$PASHQ,RCP,MyReceiver
PREDEFINED RECEIVER LIST (1):
BEGIN RECEIVER
MyReceiver:
L1 BIAS: +0.059,+0.613 +0.671 +0.729 +0.786 +0.829 +0.898 +0.949
+0.000 +0.059 +0.112 +0.182 +0.253 +0.312 +0.373
L2 BIAS: +0.049,+0.667 +0.714 +0.761 +0.808 +0.849 +0.893 +0.947
+0.000 +0.044 +0.102 +0.153 +0.201 +0.254 +0.292
END RECEIVER

$PASHQ,RCP
PREDEFINED RECEIVER LIST (13):
BEGIN RECEIVER
ASHTECH:
END RECEIVER
BEGIN RECEIVER
ProMark500:
END RECEIVER
BEGIN RECEIVER

ProFlex500:
END RECEIVER
BEGIN RECEIVER
MB500:
END RECEIVER
BEGIN RECEIVER
MMapper100:
END RECEIVER
BEGIN RECEIVER
ProMark200:
END RECEIVER
BEGIN RECEIVER
MB100:
END RECEIVER
BEGIN RECEIVER
NOVATEL:
END RECEIVER
BEGIN RECEIVER
TRIMBLE:
END RECEIVER
BEGIN RECEIVER
SEPTENTRIO:
END RECEIVER
BEGIN RECEIVER
TOPCON:
END RECEIVER
BEGIN RECEIVER
MyReceiver:
L1 BIAS: +0.059,+0.613 +0.671 +0.729 +0.786 +0.829 +0.898 +0.949
+0.000 +0.059 +0.112 +0.182 +0.253 +0.312 +0.373
L2 BIAS: +0.049,+0.667 +0.714 +0.761 +0.808 +0.849 +0.893 +0.947
+0.000 +0.044 +0.102 +0.153 +0.201 +0.254 +0.292
END RECEIVER

RID: Receiver Identification

Function This command allows you to read the receiver identification parameters. The message is sent through the specified port, or through the port where the query is made if no port is specified.

Command Format

Syntax

$PASHQ,RID[,c1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$PASHR,RID,s1,s2*cc

Parameters

Parameter	Description	Range
s1	Receiver type	GNSS
s2	GNSS board firmware version. The firmware version contains one letter to identify the type of firmware and 3 characters for the version number (e.g. V1.00=G100)	Gxxx (4 characters)
*cc	Checksum	*00-*FF

Example

$PASHQ,RID*28

$PASHR,RID,GNSS,G100*59

RIO: Receiver Options

Function

This command returns the receiver identification and options on the specified port, or on the port on which the query is made if no port is specified.

Command Format

Syntax

$PASHQ,RIO[,c1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$PASHR,RIO,s1,s2,s3,s4,s5*cc

Parameters

Parameter	Description	Range
s1	Receiver type (i.e. "GNSS")	GNSS
s2	GNSS board firmware version: Gxxx	4 characters
s3	Reserved field	Empty
s4	Options list (see table below)	13 characters
s5	Receiver serial number (see table below)	16 characters
*cc	Optional checksum	*00-*FF

Firmware Options List (always listed in the order given below):

Option	Description	Impacted Commands If Not Installed
[T] [W]	Position/raw data update rate: [T]: 10 Hz [W]: 20 Hz	$PASHS,POP $PASHS,ATM $PASHS,RAW $PASHS,RT2 $PASHS,RT3 $PASHS,CMR $PASHS,CMP
[J]	RTK rover	All CPD commands $PASHQ,ATT $PASHQ,HDT $PASHQ,VEC
[K]	RTK base	$PASHS,RT2 $PASHS,RT3 $PASHS,CMR $PASHS,CMP
[L]	Timing Pulse Output (PPS)	$PASHS,PPS $PASHQ,PPS $PASHQ,PTT $PASHS,NME,PTT
[E]	Photogrammetry event marker	$PASHS,PHE $PASHQ,PHE $PASHS,NME,TTT
[Y]	SBAS tracking	$PASHS,SBA $PASHS,RAW (SNW, SAW, SBD)
[G]	GLONASS tracking	$PASHS,GLO $PASHS,RAW (SNG, SAG) $PASHS,RT3 (1009-1012) $PASHS,CMR (3) $PASHS,CMP (3) $PASHS,GNS,CFG (1, 4, 5)
[S]	GPS L2CS tracking. Requires the [P] option to be installed as well.	$PASHS,GNS,CFG
[V]	RTK with moving base. Requires the [J] option to be installed as well.	$PASHS,CPD,BAS

Option	Description	Impacted Commands If Not Installed
[H]	Heading function. Requires the [J] and [V] options to be installed as well.	All $PASHS,CPD,ARR commands, $PASHQ,HDT $PASHQ,ATT
[C]	Advanced multipath mitigation	$PASHS,CRR
[P]	GPS/GLONASS L2 frequency tracking	$PASHS,GNS,CFG
[I]	RAIM	$PASHS,NME,GBS $PASHQ,GBS
*cc	Optional checksum	

Serial Number format: PNPNPN V YYYY WW ZZZ

Field	Definition	Range
PNPNPN	Part number (702100)	6 digits
V	Hardware version index (e.g. B for version B)	1 character
YYYY	Year of manufacturing (e.g. 2008)	4 characters
WW	Week of manufacturing	01-52 (two digits)
ZZZ	Defines the board as the ZZZth board manufactured in the week.	(1-999)

Example

$PASHQ,RIO
$PASHR,RIO,GNSS,G100,,WJKLEYG-VH-PI,702100B200820004*4F

Comments

- Each option is represented by a letter. The presence of a given option is indicated by the presence of the corresponding letter. A dash ("-") indicates that the option is not installed.
- Options are always listed in the same order (see table above).

RMC: Recommended Minimum Specific GNSS Data

Function

This command is used to output an RMC message containing the last computed position as well as navigation-related data. The message is output on the specified port, or on the port on which the query is made if no port is specified.

Command Format

Syntax

$PASHQ,RMC[,c1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$GPRMC,m1,c2,m3,c4,m5,c6,f7,f8,d9,f10,c11,c12*cc

Parameters

Parameter	Description	Range
m1	Current UTC time of position (hhmmss.ss)	000000.00- 235959.99
c2	Status • A: Data valid • V: Data not valid	A, V
m3	Latitude of position (ddmm.mmmmmm)	0-90 0-59.999999
c4	Direction of latitude	N, S
m5	Longitude of position (dddmm.mmmmmm)	0-180 0-59.999999
c6	Direction of longitude	E,W
f7	Speed Over Ground, in knots	000.0-999.9
f8	Course Over Ground, in degrees (true)	000.0-359.9
d9	Date (ddmmyy)	010100-311299
f10	Magnetic variation, in degrees	0.00-99.9
c11	Direction of variation	E, W
c12	Mode indicator: • A: Autonomous mode • D: Differential mode • N: Data not valid	A, D, N
*cc	Checksum	*00-*FF

Example

$PASHQ,RMC

$GPRMC,160324.50,A,4717.959275,N,00130.500805,W,0.0,0.0,250208,1.9,
W,A*3D

Automatic Output of RMC Messages

This is a reminder on how to output RMC messages at regular intervals of time: Use the $PASHS,NME command with the syntax below:

$PASHS,NME,RMC,<port_ID>,ON,<Rate>

For more details on the $PASHS,NME command, refer to the *Set Command Library* Chapter.

As an example, the command below will output RMC messages on port A at a rate of 0.5 second:

$PASHS,NME,RMC,A,ON,0.5

SAT: Satellites Status

Function

This command allows you to read the status of the different satellite constellations used. The message is output through the specified port, or through the port on which the query is made if no port is specified.

Command Format

Syntax

$PASHQ,SAT[,c1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$PASHR,SAT,d1,n(d2,d3,d4,f5,c6)*cc

Parameters

Parameter	Description	Range
d1	Number of satellites locked	0-26
d2	SV PRN number	1-32: GPS 33-51: SBAS 65-88: GLONASS
d3	SV azimuth, in degrees	0-359
d4	SV elevation angle, in degrees	0-90
f5	SV signal-noise ratio, in dB.Hz	30.0-60.0
c6	SV used in computation or not • U: SV used • Any other character: SV not used	U, other character
*cc	Checksum	*00-*FF

Example

$PASHQ,SAT

$PASHR,SAT,13,20,092,32,44.0,U,13,206,78,50.0,U,23,056,55,48.0,U,33,198,34,44.0,-,17,218,13,42.0,U,25,152,34,38.0,U,04,276,65,50.0,U,02,308,31,48.0,U,77,052,37,48.0,U,84,294,33,48.0,U,83,234,23,48.0,U,78,124,42,46.0,U,68,034,65,48.0,U*35

Automatic Output of SAT Messages

This is a reminder on how to output SAT messages at regular intervals of time: Use the $PASHS,NME command with the syntax below:

$PASHS,NME,SAT,<port_ID>,ON,<Rate>

For more details on the $PASHS,NME command, refer to the *Set Command Library* Chapter.

As an example, the command below will output SAT messages on port A at a rate of 60 seconds:

$PASHS,NME,SAT,A,ON,60

TTT: Event Marker

Function

This message provides the GPS time of the external event. The time is provided with an accuracy of ± 50 nanoseconds.

Response Format

Syntax

$PASHR,TTT,d1,m2*cc

Parameters

Parameter	Description	Range
d1	Day of week: • 1: Sunday • 7: Saturday	1-7
m2	GPS time tag in hours, minutes, seconds	0-23:59:59.9999999
*cc	Optional checksum	*00-*FF

Example

$PASHR,TTT,3,18:01:33.1200417*AC

Comments

- Issuing this output message is tied to the prior execution of the appropriate $PASHS,NME,TTT command (see *NME: Enabling/Disabling NMEA Messages on page 111*), the detection of a signal at the board's external event input and the activation of the [E] event marker firmware option. There is no query command associated with the output of the TTT message.
- This message is independent of the NMEA period. It can be output faster or slower than the NMEA period, depending on the period of the event.

VEC: Vector & Accuracy Data

Function

This command is used to ask the receiver to return vector and accuracy data on the specified port, or on the port on which the query is made if no port is specified.

Command Format

Syntax

$PASHQ,VEC[,c1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$PASHR,VEC,m1,d2,d3,d4,d5,d6,d7,d8,f9,d10,f11,d12,f13,f14,f15,f16,f17,f18,f19,f20,f21*cc

Parameters

Parameter	Description	Range
m1	UTC time (hhmmss.ss)	000000.00-235959.99
d2	Source of base coordinates: • 0: No base • 1: Computed base • 2: Received base • 3: Entered base	0-3
d3	Type of baseline estimate: • 0: No baseline • 1: Time-tagged RTK estimate • 2: FAST RTK estimate	0-2
d4	Baseline reset flag: • 0: Updated • >0: Initialized	0, >0
d5	Internal RTK ambiguity flag: • 0: Float • 1: Fixed	0-1

Parameter	Description	Range
d6	Number of SVs ready for use in the RTK processing (L1 portion) on rover side.	0-26
d7	Number of SVs received from the base.	0-26

Parameter	Description	Range
d8	Number of SVs used in the baseline computation (L1 portion).	0-26
f9	Age of last received base data, in seconds.	Real number (no limit)
d10	Overall baseline estimate latency, in milliseconds.	Integer, no limit
f11	Interval of base L1 carrier data interpolation to rover time tag.	Real number (no limit)
d12	Coordinate frame flag defining the meaning of the next six fields: • 1: ENU centered on rover.	1
f13	First (East) component of baseline, in meters.	Real number (no limit)
f14	Second (North) component of baseline, in meters.	Real number (no limit)
f15	Third (Up) component of baseline, in m	Real number (no limit)
f16	RMS error for x1 component, in m.	Real number (no limit)
f17	RMS error for x2 component, in m.	Real number (no limit)
f18	RMS error for x3 component, in m.	Real number (no limit)
f19	Scaled norm of L1 carrier residuals, in meters(0 if carriers were not processed).	Real number (no limit)
f20	Scaled norm of L1 code residuals, in meters(0 if codes were not processed).	Real number (no limit)
f21	Internal ambiguity ratio (0 if the ambiguity search is not called).	Real number (no limit)
*cc	Optional checksum	*00-*FF

Example

$PASHQ,VEC

$PASHR,VEC,140746.00,2,1,0,1,,,05,,,0,1,-68.467,-26.867,5.428,
0.011,0.010,0.020,0.003 ,0.390,0.000,*25

Automatic Output of VEC Messages

This is a reminder on how to output VEC messages at regular intervals of time: Use the $PASHS,NME command with the syntax below:

$PASHS,NME,VEC,<port_ID>,ON,<Rate>

For more details on the $PASHS,NME command, refer to the *Set Command Library* Chapter.

As an example, the command below will output VEC messages on port A at a rate of 0.2 second:

$PASHS,NME,VEC,A,ON,0.2

VTG: Course Over Ground and Ground Speed

Function

This command is used to output a VTG message. The message is output through the specified port, or through the port on which the query is made if no port is specified. The message is output with blank fields until a valid position is computed.

Command Format

Syntax

$PASHQ,VTG[,c1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$GPVTG,f1,T,f2,M,f3,N,f4,K,c5*cc

Parameters

Parameter	Description	Range
f1,T	COG (with respect to True North) T for "True" North: COG orientation	000.00-359.99
f2,M	COG (with respect to Magnetic North) M for "Magnetic" North: COG orientation	000.00-359.99
f3,N	SOG (Speed Over Ground) N for "knots": SOG unit	000.00-999.99
f4,K	SOG (Speed Over Ground) K for "km/hr": SOG unit	000.00-999-99
c5	Mode indicator: • A: Autonomous mode • D: Differential mode • N: Data not valid	A, D, N
*cc	Checksum	*00-*FF

Comments

The magnetic table used is the WMM-2005 (published Dec 2004), which is the standard model of the US Department of Defense (WMM for "World Magnetic Model").

Example

$PASHQ,VTG
$GPVTG,128.00,T,129.92,M,0.17,N,0.31,K,A*2D

Automatic Output of VTG Messages

This is a reminder on how to output VTG messages at regular intervals of time: Use the $PASHS,NME command with the syntax below:

$PASHS,NME,VTG,<port_ID>,ON,<Rate>

For more details on the $PASHS,NME command, refer to the *Set Command Library* Chapter.

As an example, the command below will output VTG messages on port A at a rate of 0.5 second:

$PASHS,NME,VTG,A,ON,0.5

ZDA: Time & Date

Function

This command returns the receiver date & time. The message is output through the specified port, or through the port on which the query is made if no port is specified.

Command Format

Syntax

$PASHQ,ZDA[,c1][*cc]

Parameters

Parameter	Description	Range
c1	Port ID	A, B, C
*cc	Optional checksum	*00-*FF

Response Format

Syntax

$GPZDA,ZDA,m1,d2,d3,d4,d5,d6*cc

Parameters

Parameter	Description	Range
m1	UTC time (hhmmss.ss)	000000.00-235959.99
d2	Current day	01-31
d3	Current month	01-12
d4	Current year	0000-9999
d5	Local zone offset from UTC time (hour)	-13 to +13
d6	Local zone offset from UTC time (minutes)	00-59
*cc	Checksum	*00-*FF

Example

$PASHQ,ZDA

$GPZDA,162256.27,25,02,2008,+00,00*43

NOTE: The time offset is always reported as null (d5= d6= 0).

Automatic Output of ZDA Messages

This is a reminder on how to output ZDA messages at regular intervals of time: Use the $PASHS,NME command with the syntax below:

$PASHS,NME,ZDA,<port_ID>,ON,<Rate>

For more details on the $PASHS,NME command, refer to the *Set Command Library* Chapter.

As an example, the command below will output ZDA messages on port A at a rate of 60 seconds:

$PASHS,NME,ZDA,A,ON,60

Chapter 8. Raw Data Messages in Ashtech Proprietary Format

Output Order

In most cases, the order in which messages are output by the receiver is the same as that in which they are listed in the response to $PASHQ,PAR,OUT, i.e. from left to right and top to bottom.

For example, LTN comes first in the NME group while RNX, in the ATM group, comes earlier than MCA (in the RAW group). Still in the tabular response to the $PASHQ, PAR,OUT command, the output rate for each enabled message is provided. When this parameter is set to OFF, this means the message is disabled.

Within each group, the receiver relies on the following concept to organize the data output:

- Position first,
- Then observables,
- And finally attributes.

There are however exceptions:

- Messages generated according to the “on change” or “on event” principle (such as SNV and TTT respectively) cannot be tagged exactly to an epoch. That is why in somes cases they will appear at different locations in the output stream.
- LTN and ZDA come earlier than GLL and GGA in the NME group. This is because of the highest importance of latency and time-tagging information in some applications.
- PBN is not of prime importance in the RAW group. It is there for legacy reasons.
- TT1 or TT2 comes after RNX or MES. This is because TT1 and TT2 messages contain time-tagged RTK results that are not synchronized with the current receiver time tag. Also, when the receiver is configured in time-tagged RTK

mode, the output of some messages may present unusual behavior, due to local delays in the data link used.

Coordinate Transformations: The receiver is not designed to perform internally coordinate transformations. So all the positions the receiver delivers refer to a “default” datum. This requires some clarifications.

The cartesian coordinates the receiver delivers (for example through the PBN message) are expressed on the following datum:

- Current ITRF realization used in broadcast ephemeris data (to date IGS05)
- Datum of reference position (applicable only for DGNSS and RTK modes)

A priori and generally speaking, the receiver does not know anything about the datum used by the local corrections provider to express the reference position it receives from that provider. As a result, the standalone position the receiver determines is tagged to the IGS05 and the differential position is the sum of the reference position (on whichever datum it is expressed) and the baseline estimate (on the IGS05 datum).

For internal transformations from cartesian (e.g. PBN) to geographical (e.g. POS) coordinates, the receiver uses the IGS05 (WGS-84 ellipsoid model).

The board firmware uses the geoid model referred to as the “NATO STANAG 4294 Navstar Global Positioning System (GPS) System Characteristics-ED 2”. This model is used to determine the height above the geoid in GGA messages (or similar).

The board firmware applies the Magnetic table corresponding to model WMM-2005 (published 12/2004). This model is used in position/velocity transformations required by some NMEA messages.

When no other models (e.g. SBAS) are available, the board firmware uses the default ionosphere model, as extracted from the GPS navigation stream (Klobuchar model).

The board firmware uses proprietary troposphere models.

User positions reported in all messages are tagged to the antenna L1 phase center. There may be an exception however for reference positions generated inside correcting data streams: These can be tagged to either the L1 phase center or the ARP, according to the standard they have to comply with.

The receiver can internally compute different positions at the same time. The reported user positions are always the “best” positions, depending on the currently available corrections data. The only exception is for PBN messages, in which only a standalone, SBAS or DGNSS position can be reported. In no case can PBN messages deliver RTK positions.

Being all centimeter-level accurate, RTK positions are very sensitive to the slightest change in the parameters used. They can for example skip by a few centimeters if you change the antenna names. Changing the local and reference antenna names will indeed result in the use of new PCO parameters (antenna offset values).

If the receiver clock steering procedure is applied (UTS set to ON), this affects not only the appearance of some receiver raw data (RAW group) but also the reported position in the case of high receiver dynamics, when this position is extrapolated forward or backward for periods of time of up to 1 ms.

DPC: Compact GPS Measurements

This message contains the L1/L2 measurements from all tracked GPS satellites for one epoch.

The message is as follows:

$PASHR,DPC,<structure>

The message's binary structure is described in the table below.

Type*	Size in bits	Resolution	Contents
Unsigned short	16		Message length. Number of bytes in the <packed data> section.
PACKED DATA			
Double	32	1 msec	Receiver time in GPS milliseconds of week
Char[4]	32		Receiver's four-character ID
Unsigned long	32		Mask representing satellites that are contributors to the message content. This is a bitwise indication: Starting from the least significant bit, bit1 corresponds to SV PRN#1, bit2 corresponds to SV PRN#2, and so on. Bit value "1" for a given SV PRN means the corresponding satellite is a data contributor to this message, "0" otherwise.
The data that follow are repeated for each satellite presented in the satellite mask			
Unsigned char	1		Satellite health ("0" means Sat is unhealthy)
Unsigned char	7	1 degree	Satellite elevation
Unsigned char	1		RAIM status (always zero)
Unsigned char	7	1 dBHz	SNR of L1CA observation
#L1 Data Block (L1CA in all cases)			
Double	31	0.1 nsec	Raw range in 0.1 nsec (range is smoothed by carrier). "0" means bad raw range data.
Unsigned char	1		Warning flag ("1" means bad carrier phase with possible cycle slips)
Unsigned char	1		Sign of total carrier phase ("1": negative; "0":positive)
Double	28	1 cycle	Integer part of total carrier phase in cycles
Double	11	0.0005 cycles	Fractional part of phase in 0.0005 cycles
Double	24	0.002 Hz	Doppler in units of 0.002 Hz
#L2 Data Block (L2P for CFG,2&4 and L2C for CFG,3&5) Content and data packing scheme is the same as for L1 Data			
CHECKSUM			
Unsigned short	16		Cumulative unsigned short sum of the <packed data>, after <message length> and before <checksum>

The data in this message are packed in bits rather than bytes. So the presented types of fields are just for the sake of giving a meaningful description of the original data packing.

NOTES:

- Most of the fields found in the DPC and DBEN data outputs are similar.

- DPC data are affected by the last $PASHS,UTS command run. By default, this command is set to “ON”.
- DPC data are affected by the last $PASHS,ANP,OUT command run.
- DPC data can be made available on several ports simultaneously.
- DPC data can be output at a rate of up to 20 Hz, but the throughput compared to RTCM-3, CMR and ATOM may be quite higher.
- DPC data are not considered to be used as a differential protocol, i.e. they are simply generated, and so not processed to become corrections.

Reminder on How to Output DPC Messages

Use the $PASHS,RAW command with the syntax below:

```
$PASHS,RAW,DPC,<port_ID>,ON,<Rate>
```

For more details on the $PASHS,RAW command, refer to the *Set Command Library* Chapter.

As an example, the command below will output DPC messages on port A at a rate of 1 second:

$PASHS,RAW,DPC,A,ON,1

ION: Ionosphere Parameters

This message contains the ionosphere and GPS-to-UTC data conversion parameters.

The message is as follows:

$PASHR,ION,<structure>

The message's binary structure is described in the table below.

Type	Name	Size	Contents
Float	a0	4	Ionospheric parameter (seconds)
Float	a1	4	Ionospheric parameter (seconds/semi-circle)
Float	a2	4	Ionospheric parameter (seconds/semi-circle)
Float	a3	4	Ionospheric parameter (seconds/semi-circle)
Float	b0	4	Ionospheric parameter (seconds)
Float	b1	4	Ionospheric parameter (seconds/semi-circle)
Float	b2	4	Ionospheric parameter (seconds/semi-circle)
Float	b3	4	Ionospheric parameter (seconds/semi-circle)
Double	A1	8	First order terms of polynomial
Double	A0	8	Constant terms of polynomial
Unsigned long	Tot	4	Reference time for UTC data
Short	Wnt	4	UTC reference week number
Short	DtLS	2	GPS-UTC differences at reference time
Short	WnLSF	2	Week number when leap second became effective
Short	DN	2	Day number when leap second became effective
Short	DtLSF	2	Delta time between GPS and UTC after correction
Short	Wn	2	GPS week number
Unsigned long	Tow	4	Time of the week (in seconds)
Short	bulwn	2	GPS week number when message was read
Unsigned long	bultow	4	Time of the week when message was read
Unsigned short	Check-sum	2	The checksum is computed by breaking the structure into 37 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
Total		76	

The GPS broadcast ionosphere model (Klobuchar) is used.

Reminder on How to Output ION Messages

Use the $PASHS,RAW command with the syntax below:

$PASHS,RAW,ION,<port_ID>,ON,<Rate>

For more details on the $PASHS,RAW command, refer to the *Set Command Library* Chapter.

As an example, the command below will output ION messages on port A at a rate of 5 seconds:

$PASHS,RAW,ION,A,ON,5

MCA: C/A Code Measurements

This message contains the GPS/GLONASS/SBAS L1 C/A data of one satellite for one epoch.

The message is as follows:

$PASHR,MCA,<structure>

The message's binary structure is described in the table below.

Type	Size	Contents
Unsigned short	2	Sequence tag (unit: 50 ms) modulo 30 minutes
Unsigned char	1	Number of remaining MCA messages to be sent for current epoch
Unsigned char	1	Satellite index number GPS: 1-32 SBAS: 33-51 GLONASS: 65-88
Unsigned char	1	Satellite elevation angle (degree)
Unsigned char	1	Satellite azimuth angle (2-degree increments)
Unsigned char	1	Channel ID not duplicated for the current epoch
	29	**C/A code data** block (29 bytes)
Unsigned char	1	Warning flag Bit1, Bit2: 0,0: Code and/or carrier phase measured, but measurement was not used to compute position. 1,0: Code and/or carrier phase measured, navigation message was obtained and measurement was used to compute position, but position wasn't finally computed. 0,1: Code and/or carrier phase measured, navigation message was obtained, measurement was used to compute position and position was computed successfully. Bit3: Carrier phase questionable Bit4: Code phase (range) questionable Bit5: Range not precise (code phase loop not settled) Bit6: Z tracking mode Bit7: Possible cycle slip Bit8: Loss of lock since last epoch

Type	Size	Contents
Unsigned char	1	Indicates quality of the position measurement (good/ bad) 0: Measurement not available and no additional data will be sent 23: Code and/or carrier phase measured, navigation message was obtained and measurement was used to compute position but position wasn't finally computed. 24: Code and/or carrier phase measured, navigation message was obtained, measurement was used to compute position and position was computed successfully. Other state: measurement was not used to compute position.
Unsigned char	1	Polarity of the phase tracking 0: Polarity unknown 5: Polarity known
Unsigned char	1	Signal-to-noise ratio for satellite observation (db.Hz)
Unsigned char	1	Always 0. Not used.
Double	8	Full carrier phase measurements in cycles
Double	8	Raw range to SV (in seconds), i.e. receive time - raw range = transit time
Long	4	Doppler (10^{-4} Hz)
Long	4	Smoothing Bits 0-22: magnitude of smooth correction in centimeters Bit 23: sign of smooth correction Bits 24-31: smooth count, unsigned, as follows: 0=unsmoothed 1=least smoothed 255=most smoothed
Unsigned char	1	Checksum, a bytewise exclusive OR (XOR)
Total of bytes	37	

Reminder on How to Output MCA Messages

Use the $PASHS,RAW command with the syntax below:

$PASHS,RAW,MCA,<port_ID>,ON,<Rate>

For more details on the $PASHS,RAW command, refer to the *Set Command Library* Chapter.

As an example, the command below will output MCA messages on port A at a rate of 1 second:

$PASHS,RAW,MCA,A,ON,1

MPC: GNSS Measurements

This message contains the measurement of one satellite for one epoch.

The message is as follows:

$PASHR,MPC,<structure>

The message's binary structure is described in the table below.

Type	Size	Contents
Unsigned short	2	Sequence tag (unit: 50 ms) modulo 30 minutes
Unsigned char	1	Number of remaining structure to be sent for current epoch
Unsigned char	1	Satellite index number GPS: 1-32 SBAS: 33-51 GLONASS: 65-88
Unsigned char	1	Satellite elevation angle (degree)
Unsigned char	1	Satellite azimuth angle (2-degree increments)
Unsigned char	1	Channel ID not duplicated for the current epoch
	29	C/A code data block (29 bytes)
Unsigned char	1	Warning flag Bit1, Bit2: 0,0: Code and/or carrier phase measured but measurement was not used to compute position. 1,0: Code and/or carrier phase measured, navigation message was obtained and measurement was used to compute position but position wasn't finally computed. 0,1: Code and/or carrier phase measured, navigation message was obtained, measurement was used to compute position and position was computed successfully. Bit3: Carrier phase questionable Bit4: Code phase (range) questionable Bit5: Range not precise (code phase loop not settled) Bit6: Z tracking mode Bit7: Possible cycle slip Bit8: Loss of lock since last epoch

Type	Size	Contents
Unsigned char	1	Indicates quality of the position measurement (good/ bad) 0: Measurement not available and no additional data will be sent. 23: Code and/or carrier phase measured, navigation message was obtained and measurement was used to compute position but position wasn't finally computed. 24: Code and/or carrier phase measured, navigation message was obtained, measurement was used to compute position and position was computed success-fully. Other state: measurement was not used to compute position.
Unsigned char	1	Polarity of the phase tracking 0: Polarity unknown 5: Polarity known
Unsigned char	1	Signal-to-noise ratio for satellite observation (db.Hz)
Unsigned char	1	Always 0. Not used.
Double	8	Full carrier phase measurements in cycles
Double	8	Raw range to SV (in seconds), i.e. receive time - raw range = transit time
Long	4	Doppler (10^{-4} Hz)
Long	4	Smoothing Bits 0-22: magnitude of smooth correction in centime-ters Bit 23: sign of smooth correction Bits 24-31: smooth count, unsigned, as follows: 0=unsmoothed 1=least smoothed 255=most smoothed
	29	**L1 block**, same format as C/A code data block (see note below)
	29	**L2 block**, same format as C/A code data block (see note below)
Unsigned char	1	Checksum, a bytewise exclusive OR (XOR)
Total of bytes	95	

NOTES:

- The sequence tag for GLONASS satellites is x seconds less than the sequence tag for GPS satellites, due to the difference between the UTC (used for GLONASS) and GPS system time scales.
- The raw range for GLONASS satellites contains a time shift of x seconds, i.e. x seconds more than for GPS satellites in the same conditions. “x” is as defined in the previous note.

- In case of GPS L1/L2P tracking mode, the **L1 block** contains L1P data. In case of GPS L2CS tracking mode, the **L1 block** contains zero data. In case of GLONASS-M satellites, the **L1 block** contains zero data.
- In case of GPS L1/L2P, the **L2 block** contains L2P data. In case of GPS L2CS tracking mode, the **L2 block** contains L2CS data. In case of GLONASS-M satellites, the **L2 block** contains C/A data on the L2 frequency

Reminder on How to Output MPC Messages

Use the $PASHS,RAW command with the syntax below:

```
$PASHS,RAW,MPC,<port_ID>,ON,<Rate>
```

For more details on the $PASHS,RAW command, refer to the *Set Command Library* Chapter.

As an example, the command below will output MPC messages on port A at a rate of 1 second:

```
$PASHS,RAW,MPC,A,ON,1
```

PBN: Position Information

This message contains position information in binary format.

The message is as follows:

$PASHR,PBN,<structure>

The message's binary structure is described in the table below.

Type	Name	Size	Contents
Long	pbentime	4	GPS time when data was received (ms of week)
Char	sitename	4	Site name
Double	navx	8	Station position: ECEF-X (m)
Double	navy	8	Station position: ECEF-Y (m)
Double	navz	8	Station position: ECEF-Z (m)
Float	navt	4	Clock offset (m)
Float	navxdot	4	Velocity in ECEF-X (m/s)
Float	navydot	4	Velocity in ECEF-Y (m/s)
Float	navzdot	4	Velocity in ECEF-Z (m/s)
Float	navtdot	4	Clock drift (m/s)
Unsigned short	pdop	2	PDOP multiplied by 100
Unsigned short	checksum	2	The checksum is computed by breaking the structure into 27 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
Total of bytes		56	

When for example after a cold start, the receiver has no correct time tag, the PBN message is output with a fixed "zero" time tag.

Unlike all the other position messages, the position provided in a PBN message *cannot* be an RTK position. It can only be a standalone, SBAS or DGNSS position.

Reminder on How to Output PBN Messages

Use the $PASHS,RAW command with the syntax below:

$PASHS,RAW,PBN,<port_ID>,ON,<Rate>

For more details on the $PASHS,RAW command, refer to the *Set Command Library* Chapter.

As an example, the command below will output PBN messages on port A at a rate of 1 second:

$PASHS,RAW,PBN,A,ON,1

RPC: DBEN Messages

This message contains the L1/L2 measurements from all tracked GPS satellites for one epoch. The data are tagged to the location of the antenna L1 phase center, as reported by $PASHQ,BPS.

The message is as follows:

$PASHR,RPC,<structure>

The binary structure consists of the following:

<structure> = <message length><packed data><checksum>

The message's binary structure is described in the table below.

Type*	Size in bits	Resolution	Contents
Unsigned short	16		Message length. Number of bytes in the <packed data> section.
PACKED DATA			
Double	30	1 msec	Receiver time in GPS milliseconds of week
Char[4]	32		Receiver's four-character ID (as entered using $PASHS,SIT)
Unsigned long	32		Satellite Mask. Mask representing satellites that are contributors to the message content. This is a bitwise indication: Starting from the least significant bit, bit1 corresponds to SV PRN#1, bit2 corresponds to SV PRN#2, and so on. Bit value "1" for a given SV PRN means the corresponding satellite is a data contributor to this message, "0" otherwise.
The data that follow are repeated for each satellite presented in the satellite mask			
#L1 Data Block (L1CA in all cases)			
Double	31	0.1 nsec	Raw range in 0.1 nsec (range is smoothed by carrier). "0" means bad raw range data.
Unsigned char	1		Warning flag ("1" means bad carrier phase with possible cycle slips)
Unsigned char	1		Sign of total carrier phase ("1": negative; "0":positive)
Double	28	1 cycle	Integer part of total carrier phase, in cycles
Double	11	0.0005 cycles	Fractional part of phase, in 0.0005 cycles
#L2 Data Block (L2P for CFG,2&4 and L2C for CFG,3&5) Content and data packing scheme is the same as for L1 Data			
CHECKSUM			
Unsigned short	16		Cumulative unsigned short sum of the <packed data>, after <message length> and before <checksum>

The data in this message are packed in bits rather than bytes. So the presented types of fields are just for the sake of giving a meaningful description of the original data packing.

NOTES:

- RPC data are affected by the last $PASHS,UTS command run. By default, this command is set to “ON”.
- RPC data are affected by the last $PASHS,ANP,OUT command run.
- RPC data can be made available on several ports simultaneously.
- Regardless of the entered station ID on base side (using $PASHS,SIT), the base ID in messages generated by a rover (e.g. GGA - DDM - CPD,REF) is always reported to be “1010”.

Reminder on How to Output RPC Messages

Use the $PASHS,RAW command with the syntax below:

$PASHS,RAW,RPC,<port_ID>,ON,<Rate>

For more details on the $PASHS,RAW command, refer to the *Set Command Library* Chapter.

As an example, the command below will output RPC messages on port A at a rate of 1 second:

$PASHS,RAW,RPC,A,ON,1

SAG: GLONASS Almanac Data

This message contains almanac data for one GLONASS satellite.

The message is as follows:

$PASHR,SAG,<structure>

The message's binary structure is described in the table below.

Type	Name	Size	Contents
Short	prn	2	Satellite number 1-24
Short	frq	2	Satellite GLONASS frequency number [-7,…,6]
Short	health	2	Satellite health 0=bad, 1=good
Float	e	4	Eccentricity
Long		4	Reference day number (days in range 1 to 1461)
Float		4	Correction to inclination (semicircles)
Float	w0	4	Longitude of first ascending node (semicircles)
Float		4	Reference time of longitude of first node (seconds)
w	Float	4	Argument of perigee (semicircles)
Float	Af0	4	Correction to mean value (43200 s) of Draconic period
Float	Af1	4	Af1=d(Af0)/dt(sec/sec)
Float		4	Satellite clock offset (seconds)
Unsigned short	Checksum	2	The checksum is computed by breaking the structure into 21 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
Total		44	

Reminder on How to Output SAG Messages

Use the $PASHS,RAW command with the syntax below:

$PASHS,RAW,SAG,<port_ID>,ON,<Rate>

For more details on the $PASHS,RAW command, refer to the *Set Command Library* Chapter.

As an example, the command below will output SAG messages on port A at a rate of 15 seconds:

$PASHS,RAW,SAG,A,ON,15

SAL: GPS Almanac Data

This message contains almanac data for one GPS satellite.

The message is as follows:

$PASHR,SAL,<structure>

The message's binary structure is described in the table below.

Type	Name	Size	Contents
Short	prn	2	Satellite PRN number minus 1 (0-31)
Short	health	2	Satellite health
Float	e	4	Eccentricity
Long	toe	4	Reference time for orbit (sec)
Float	i0	4	Inclination angle at reference time (semi-circles)
Float	w dot	4	Rate of right ascension (semi-circles/sec)
Double	A1/2	8	Square root of semi-major axis (meters1/2)
Double	w0	8	Longitude of ascending node (semicircles)
Double	w	8	Argument of perigee (semicircles)
Double	M0	8	Mean anomaly at reference time (semi-circle)
Float	Af0	4	Clock correction (sec)
Float	Af1	4	Clock correction (sec/sec)
Short	wna	2	Almanac week number
Short	wn	2	GPS week number
Long		4	Seconds of GPS week
Unsigned short	Check-sum	2	The checksum is computed by breaking the structure into 34 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
Total		70	

Reminder on How to Output SAL Messages

Use the $PASHS,RAW command with the syntax below:

$PASHS,RAW,SAL,<port_ID>,ON,<Rate>

For more details on the $PASHS,RAW command, refer to the *Set Command Library* Chapter.

As an example, the command below will output SAL messages on port A at a rate of 15 seconds:

$PASHS,RAW,SAL,A,ON,15

SAW: SBAS Almanac Data

This message contains almanac data for one SBAS satellite. The message is as follows:

$PASHR,SAW,<structure>

The message's binary structure is described in the table below.

Type	Name	Size	Contents
char	Id	1	Data ID
char	Health	1	Satellite Health&Status bitwise meaning is: Bit0 – Ranging On(0), Off(1) Bit1 – Corrections On(0), Off(1) Bit2 – Broadcast Integrity On(0), Off(1) Bit3 – Reserved Bit4-7 – SBAS provider ID (0-15): 0 – WAAS, 1 – EGNOS, 2 – MSAS, 3-13 – Not assigned yet, 14-15 – Reserved
long	T0	4	Almanac data reference time within the day expressed in the SBAS time scale (seconds)
float		3*4	Satellite ECEF X,Y,Z coordinates (meters)
float		3*4	Satellite ECEF velocity X', Y', Z' coordinates (m/s)
long	Tow	4	Time within week in GPS time scale when SBAS almanac was received
char	Wn	1	Week number in GPS time scale modulo 256 when SBAS almanac was received
char	Prn	1	Satellite number (33 to 51)
Unsigned short	Check-sum	2	The checksum is computed by breaking the structure into 18 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
Total		38	

Reminder on How to Output SAW Messages

Use the $PASHS,RAW command with the syntax below:

$PASHS,RAW,SAW,<port_ID>,ON,<Rate>

For more details on the $PASHS,RAW command, refer to the *Set Command Library* Chapter.

As an example, the command below will output SAW messages on port A at a rate of 15 seconds:

$PASHS,RAW,SAW,A,ON,15

SBA,DAT: SBAS Data Message

Provided the command below has been run beforehand,

$PASHS,RAW,SBD,<port_ID>,ON

... the SBA,DAT message is output in response to:

$PASHQ,SBD, <port_ID>

...and is in the form:

$PASHR,SBA,DAT,d1,m2,d3,d4,s5*cc

Where:

Parameter	Description	Range
d1	SBAS SV ID number	33-51
m2	Time tag: hhmmss.hh The SBA,DAT message contains the time tag of the beginning of WAAS message transmission (WAAS message transmission time is 1 second)	000000.00-235959.99
d3	RTCA message ID	0-63
d4	Error flags (in HEX): bit0-preamble error, bit1-parity error	0-2
s5	RTCA message: 250 bit in 63 HEX numbers. The data lie from left to right and from high-order to low-order bits. The two low-order bits in the 63rd number are not used.	
*cc	Checksum, computed by "exclusive-ORing" all of the bytes in the message between, but not including, the "$" and the "*". The result is "*cc" where c is a hexadecimal character.	*00-*FF

SNG: GLONASS Ephemeris Data

This message contains the GLONASS ephemeris data for one satellite.

The message is as follows:

$PASHR,SNG,<structure>

The message's binary structure is described in the table below.

Type	Name	Size	Contents
Long		4	Start time of 30-second frame in satellite time scale tk from which the ephemeris data is derived; time modulo one day (seconds)
Short		2	Day number of 30-second frame; modulo four-year period counting from beginning of last leap year, which corresponds to parameter tb (tb is set within this day number). This parameter varies within the range 1 to 1461. If day number=0, the day number is unknown (absent in navigation frame)
Long		4	Ephemeris data reference time within the day expressed in GLONASS system time scale = UTC + 3 hours (seconds)
Float		4	Frequency offset gh of the on-board frequency standard at tb (dimensionless)
Float		4	Bias tn between satellite time scale and GLONASS system time scale at tb (seconds)
Double		3*8	Satellite ECEF (PZ-90) X, Y, Z coordinates (km)
Float		3*4	Satellite ECEF (PZ-90) velocity X', Y', Z' (km/sec)
Float		3*4	Satellite perturbation acceleration X", Y", Z" due to moon and sun (km/sec/sec).
Double		8	Bias between GLONASS system time scale and UTC + 3 hours time scale tc (seconds)
Char		1	Age of ephemeris parameter En (interval from moment when ephemeris data was last uploaded to tb)
Char		1	Combined 3-bit flag (contains Ï1, Ï 2, Ï 3)
Char		1	Satellite health status flag (0=good, 1=bad)
Char		1	Satellite frequency channel number [-7,…,6]
Short		2	Satellite system number (satellite number [1,…,24])

Type	Name	Size	Contents
Unsigned short	Check-sum	2	The checksum is computed by breaking the structure into 40 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
Total		82	

Reminder on How to Output SNG Messages

Use the $PASHS,RAW command with the syntax below:

$PASHS,RAW,SNG,<port_ID>,ON,<Rate>

For more details on the $PASHS,RAW command, refer to the *Set Command Library* Chapter.

As an example, the command below will output SNG messages on port A at a rate of 15 seconds:

$PASHS,RAW,SNG,A,ON,15

SNV: GPS Ephemeris Data

This message contains the GPS ephemeris data for one satellite.

The message is as follows:

$PASHR,SNV,<structure>

The message's binary structure is described in the table below.

Type	Name	Size	Contents
Short	Wn	2	GPS week number
Long	Two	4	Seconds in GPS week
Float	Tgd	4	Group delay (sec)
Long	Aodc	4	Clock data issue
Long	Toc	4	Clock data reference time (sec)
Float	af2	4	Clock correction (sec/sec^2)
Float	af1	4	Clock correction (sec/sec)
Float	af0	4	Clock correction (sec)
Long	Aode	4	Orbit data issue
Float	Dn	4	Mean anomaly correction (semicircles/sec)
Double	M0	8	Mean anomaly at reference time (semicircles)
Double	e	8	Eccentricity
Double	$A^{1/2}$	8	Square root of semi-major axis (meters $^{1/2}$)
Long	toe	4	Reference time for orbit (sec)
Float	cic	4	Harmonic correction term (radians)
Float	crc	4	Harmonic correction term (meters)
Float	cis	4	Harmonic correction term (radians)
Float	crs	4	Harmonic correction term (meters)
Float	cuc	4	Harmonic correction term (radians)
Float	cus	4	Harmonic correction term (meters)
Double	omega0	8	Longitude of ascending node (semicircles)
Double	omega	8	Argument of perigee (semicircles)
Double	i0	8	Inclination angle (semicircles)
Float	omega dot	4	Rate of right ascension (semicircles/sec)
Float	I dot	4	Rate of inclination (semicircles/sec)
Short	Accuracy	2	User range accuracy
Short	Health	2	Satellite health
Short	fit	2	Curve fit interval
Char	prn	1	Satellite PRN number minus 1 (0-31)
Char		1	Reserved byte
Unsigned short	Checksum	2	The checksum is computed by breaking the structure into 37 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
Total		76	

Reminder on How to Output SNV Messages

Use the $PASHS,RAW command with the syntax below:

$PASHS,RAW,SNV,<port_ID>,ON,<Rate>

For more details on the $PASHS,RAW command, refer to the *Set Command Library* Chapter.

As an example, the command below will output SNV messages on port A at a rate of 15 seconds:

$PASHS,RAW,SNV,A,ON,15

SNW: SBAS Ephemeris Data

This message contains the SBAS ephemeris data for one satellite.

The message is as follows:

$PASHR,SNW,<structure>

The message's binary structure is described in the table below.

Type	Name	Size	Contents
char	-	1	Spare field
char	accuracy	1	Accuracy
long	T0	4	Ephemeris data reference time within the day expressed in the SBAS time scale (seconds)
double		3*8	Satellite ECEF X,Y,Z coordinates (meters)
float		3*4	Satellite ECEF velocity X', Y', Z' coordinates (m/s)
float		3*4	Satellite ECEF acceleration X",Y",Z" (m/s2)
float	aGf0	4	Time offset between satellite time scale and SBAS system time scale (seconds)
float	aGf1	4	Time drift between satellite time scale and SBAS system time scale (seconds)
long	tow	4	Time within week in GPS time scale when SBAS ephemeris was received
char	wn	1	Week number in GPS time scale when SBAS ephemeris was received
char	prn	1	Satellite number (33 to 51)
Unsigned short	Checksum	2	The checksum is computed by breaking the structure into 34 unsigned shorts, adding them together, and taking the least significant 16 bits of the result.
Total		70	

Reminder on How to Output SNW Messages

Use the $PASHS,RAW command with the syntax below:

$PASHS,RAW,SNW,<port_ID>,ON,<Rate>

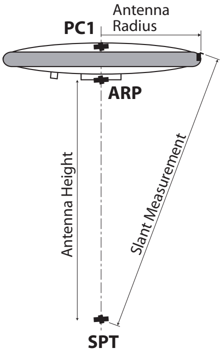
For more details on the $PASHS,RAW command, refer to the *Set Command Library* Chapter.

As an example, the command below will output SNW messages on port A at a rate of 15 seconds:

$PASHS,RAW,SNW,A,ON,15

Chapter 9. Appendices

Base Antenna Issues



The firmware has to deal internally with positions tagged to different points on the antenna:

- The L1 Phase Center (PC1)
- The Antenna Reference Point (ARP)
- The ground mark, or Survey PoinT (SPT)

By default, the software assumes that PC1, ARP and SPT are the same point.

Through the $PASHS,POS command, you can enter the exact position of the base and tell the firmware if it is tagged to PC1, ARP or SPT. The position you enter through this command is the one that will be transmitted to rovers, along with RTK differential messages.

To allow the firmware to determine the position of the other two points, starting from the one you enter, antenna phase offset parameters are required. These parameters include antenna height, slant measurement and radius for SPT.

ARP and SPT are related to each other through commands $PASHS,ANH and $PASHS,ANP.

PC1 and ARP are related to each other via the Phase Center Offset table (PCO table), referring to the specified antenna name.

Whenever a position is entered using $PASHS,POS, the firmware re-calculates the positions of the other two points, using the current antenna name, as entered using the $PASHS,ANP,OWN command. If the antenna name is unknown (the antenna name field has been left blank), then the firmware assumes that the three points (PC1, ARP, SPT) are physically the same point in space.

Whenever you change the antenna name, using $PASHS,ANP,OWN, or antenna parameters, using *$PASHS,ANP,<name>,<parameters>*, the firmware re-calculates the other two points, keeping the user-entered position unchanged. For example, if the position entered through $PASHS,POS is that of PC1, then ARP will be re-calculated. Conversely, PC1 will be re-calculated if the entered position is that of the ARP.

Depending on the protocol and message set used, the transmitted reference position will be tagged to a specific point. See table below.

Message Type	PC1	ARP	SPT
RTCM2.3 messages 3+22	•		
RTCM2.3 message 24		•	
RTCM3.1 messages 1005 or 1006		•	
CMR	•		
ATOM,RNX		•	
DBEN			•
TOPAZE	•		

All the raw and differential data the firmware generates are always fully consistent with the reference position, the antenna name and, for DBEN, with the antenna offset parameters.

Rover Antenna Issues

Antenna information is vital for RTK operation, because not only does it contain the information for PC1-ARP transformation, but also the PC2 offset (PC2= L2 Phase Center) and the PCV (Elevation Dependent Phase Center Variations). Not making this information available to the rover may lead to a noticeable degradation of the position determination or the inability to reliably fix the ambiguities.

Since both rover and base data are involved in RTK operation, in which single-differencing is performed (i.e. subtracting base correction from rover data), it is essential that the parameters of both the reference antenna (REF) used at the base and the rover antenna (OWN) be known to the rover.

As the BLADE™ internal RTK engine always works on the PC1 position, any position received by the differential processor will be transformed to PC1, using base antenna parameters. Base antenna parameters are retrieved from hard-coded or user-defined antenna lists, using the antenna name decoded from the differential stream.

Unfortunately, only a few protocols provide the antenna name. These are listed below:

- RTCM2.3 message type 23
- RTCM3.1 message types 1007, 1008 and 1033
- Set of ATOM ATR messages

If the name of the antenna used at the base (reference antenna) is not available in the differential stream, you should use the $PASHS,ANP,REF command in the rover to specify that name. Since this command does not carry a default reference antenna name (by default, the corresponding field is empty), the rover will assume that PC1, PC2 and ARP at the base are all the same point in space, and the elevation-dependent biases are all zero. Besides, the rover will use either the entered or received reference antenna name, whichever is available last.

Even if the differential stream conveys a PC1-tagged position, which is needed for RTK, the antenna name remains a fundamental parameter, especially if the reference antenna has a noticeable L1-L2 phase center offset and/or a noticeable PCV.

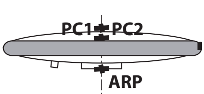
“Virtual Antenna” Concept

Experience has shown that a lot of rovers from other manufacturers do not know the PCO parameters of the antennas used by Ashtech base receivers (PCO= Phase Center Offset). As a result, these rovers cannot fully benefit from the streams of reference data delivered by Ashtech bases.

However, as there are a few antennas the names of which are well known to most vendors (e.g. ADVNULLANTENNA), Ashtech has implemented a special feature in its firmware allowing the owner of an Ashtech base to modify the complete flow of raw and differential data, as if they had been collected by a well known antenna, rather than the one actually used. This summarizes the concept of “virtual antenna”.

To enable this feature in a base, you should specify an antenna name for the truly used reference antenna (OWN), as well as a virtual antenna name (OUT) using the $PASHS, ANP,OUT command. Looking up the antenna name in the hard-coded or user-defined list of antennas, the base will then be able to make the following corrections:

- Virtual ARP coordinates= True ARP coordinates.



- Virtual PC1 coordinates: Deduced from the true ARP coordinates and the antenna parameters retrieved from the virtual (OUT) antenna name.
- Raw data: Adjusted to match the virtual antenna, i.e. L1 data will be centered on virtual PC1 and L2 data on virtual PC2. The adjusted raw data include both code and carrier L1 and L2, GPS and GLONASS.

Every time you modify any vital parameter through $PASHS,POS or $PASHS,ANP, the firmware will do the following automatically:

- Re-calculating the true ARP and/or the true PC1, using the data from the POS and OWN antenna names
- Calculating virtual PC1, using the true ARP and the data from the antenna name
- Adjusting raw data using data from the OWN and OUT antenna names

This mechanism guarantees the consistency of the position, observables/corrections and antenna name transmitted, regardless of the differential protocol and message set used.

This leads to a rover being able to calculate a correct RTK position, provided it has been able to decode the antenna name provided in the differential stream (or use the antenna name entered through the $PASHS,ANP,REF command) and retrieve the parameters of this antenna from its list of antenna names.

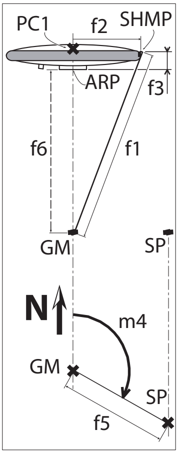
Antenna Height Transformations

The entered reference position may be defined as:

- The position of the surveyed point (SP),
- The position of the Antenna Reference Point (ARP).
- The position of the antenna L1 Phase Center (PC1).

The ground mark is defined as the vertical projection of the ARP to the ground.

The board firmware must be able to convert the originally entered position, first into ARP position, and then into L1 phase center position. To determine the ARP position, the firmware uses the data entered through either the ANT or ANH command, whichever was run last, to perform the required conversions.



- If the ANH command was the last run, the firmware will deduce that SP and GM are the same point. Then the firmware will use the entered antenna height (**f6**) to determine the ARP position, expressed in local ENU coordinates:

$$ARP(North) = GM(North) = SP(North)$$
$$ARP(East) = GM(East) = SP(East)$$
$$ARP(Up) = GM(Up) = f6$$

- If the ANT command was the last run, the firmware will use the entered parameters (**f1**, **f2**, **f3**, **m4** and **f5**) to determine the ARP position, expressed in local ENU coordinates:

$$GM(North) = SP(North) - f5 \times cos(m4)$$
$$GM(East) = SP(East) - f5 \times sin(m4)$$
$$GM(Up) = SP(Up)$$

$$ARP(North) = GM(North)$$
$$ARP(East) = GM(East)$$
$$ARP(Up) = GM(Up) + [\sqrt{f1^2 - f2^2}] + f3$$

Remember the vertical offset (**f3**) is entered as a negative value if the SHMP is above the ARP. It is otherwise positive.

With a known antenna name, the APC (Antenna Phase Center) positions for both L1 and L2 may be deduced from the ARP, using L1 and L2 3D offsets available from the hard-coded IGS antenna table:

$$APC(North)_{L1} = ARP(North) + L1Offset(North)$$
$$APC(East)_{L1} = ARP(East) + L1Offset(East)$$
$$APC(Up)_{L1} = ARP(Up) + L1Offset(Up)$$

$$APC(North)_{L2} = ARP(North) + L2Offset(North)$$
$$APC(East)_{L2} = ARP(East) + L2Offset(East)$$
$$APC(Up)_{L2} = ARP(Up) + L2Offset(Up)$$

How a Rover Reacts Dynamically to a Change of Base ID or Antenna Name

- Whenever the rover decodes a new base ID in the differential stream, all base-dependent parameters are reset to their default state in the rover. Through this reset, the default antenna name is made unknown (the corresponding field is made empty). This way, no previously received antenna name or reference position can be used.
- While the base ID is kept unchanged, a change of protocol will not cause any reset. The new position received through the new protocol will be processed normally, just as a new message including the reference position.
- Whenever a rover decodes a new antenna name, or a new antenna name is entered through the appropriate $PASH command, PC1 is re-calculated (if position received is tagged to ARP). The antenna parameters are also retrieved from the list of antennas for use in the processing run by the RTK engine.
- With a base declared as “static”, any change in the coordinates of the reference position provided by the differential stream will be interpreted by the rover as a true change in the base installation, or a change in the base setup.

  If however the difference between the new and old coordinates are greater than 10 km, the RTK engine is reset (similar to a base ID change). If the difference is between 1 km and 10 km, only the baseline estimate is reset. The baseline is otherwise simply adjusted, without any RTK reset.
- With the RTCM2.3 protocol, the reference position can be provided either in message type 3+22 or message type 24?. This means the reference position received is either tagged to PC1 or ARP. Usually the positions provided by message types 3+22 and 24 refer to the same antenna and their relationship is as described in the antenna PCO table.

  If both messages are received, message type 3+22 (PC1-tagged position) has the priority. If message type 24 is received after message type 3+22, it will therefore be rejected, unless the difference between the two positions is greater than 25 meters, in which case???.

Asynchronous Serial Communication

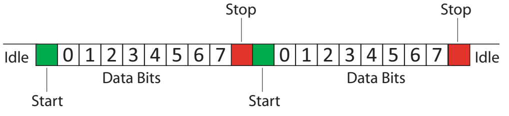
RS 232 ports and LV-UARTs are asynchronous serial communication interfaces used to transfer data bytes in series.

A start signal is sent prior to transferring each byte and a stop signal is sent after the byte has been transferred.

The start signal is used to prepare the receiving mechanism for byte reception and saving.

The stop signal puts the receiving mechanism back to idle state, making it ready for the reception of a new byte.

The diagram below shows a typical bit sequence used in an asynchronous serial communication to transfer two bytes.



Each byte consists of a start bit (green), followed by eight data bits (0-7, LSB first), and one stop bit (red). (There is no parity bit.). The overall transmission for one byte therefore represents a 10-bit character frame (8N1 configuration).

The stop bit is in fact a “wait” period of time, which cannot be shorter than a specified amount of time, usually the duration of one or two data bits.

The “wait” time for the transmitter may be arbitrarily long. The receiver requires a shorter wait time than the transmitter.

After transferring a complete byte, the receiver stops briefly, waiting for the next start bit. It is through the insertion of the stop bit in the sequence that the transmitter and the receiver keep synchronized.

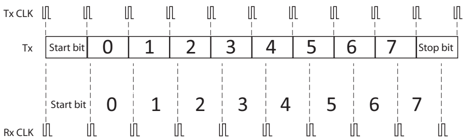
The nominal values of commonly used bit rates are 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800 and 921600 bits per second (bps or baud).

The exact bit rate on each port depends on the internal processor clock and the transmission/reception of the bit sequence. It is recommended not to work with an error greater than 5%.

The table below gives real bit rates and calculated errors for the MB 500.

Port	Real Bit Rate, in bps	Nominal Bit Rate, in bps	Error, in%
B	227272.73	230400	-1.36
B	454545.45	460800	-1.36
A	232558.14	230400	0.94
A	454545.45	460800	-1.36
A	909090.91	921600	-1.36

The diagram below shows the impact of clock frequencies on transmitter side and receiver side that differ from each other by more than 5%.



The Receive clock frequency being 6.5% less than the Transmit clock frequency, the time required for receiving each bit is 6.25% longer than the time used to transmit it. As a result, bit 7 is likely to be corrupted on receiver side.

Preset Antenna List

As listed when running the $PASHQ,ANP command.

UNKNOWN

L1 N: +000.00 E: +000.00 U: +000.00

L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

L2 N: +000.00 E: +000.00 U: +000.00

L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

MAG111406

L1 N: -000.90 E: +001.40 U: +078.30

L1 PAE:+000.0 +000.1 +000.8 +001.9 +003.1 +004.4 +005.6 +006.5 +007.1 +007.2
+006.8 +005.8 +004.3 +002.2 -000.5 -003.7 -007.4 +000.0 +000.0

L2 N: -001.30 E: +001.00 U: +068.50

L2 PAE:+000.0 -000.1 +000.2 +000.8 +001.5 +002.2 +002.8 +003.3 +003.5 +003.5
+003.3 +002.7 +001.9 +000.9 -000.3 -001.5 -002.7 +000.0 +000.0

MAG111406+CR

L1 N: -000.80 E: +000.00 U: +088.40

L1 PAE:+000.0 -000.1 -000.5 -000.5 -000.4 +000.0 +000.1 +000.2 +000.3 +000.4
+000.3 +000.2 +000.2 +000.0 -000.3 -000.1 +000.1 +000.1 +000.0
L2 N: +002.30 E: +000.10 U: +092.10
L2 PAE:+000.0 -000.4 -000.5 -000.6 -000.6 -000.2 -000.3 -000.2 +000.0 +000.1
+000.2 +000.5 +000.4 +000.7 +000.4 +000.4 +000.0 -000.1 -000.1
MAG990596
L1 N: -000.80 E: -001.40 U: +101.80
L1 PAE:+000.0 +000.9 +001.9 +002.8 +003.7 +004.7 +005.4 +006.0 +006.4 +006.5
+006.3 +005.8 +004.8 +003.2 +001.1 -001.6 -005.1 +000.0 +000.0
L2 N: +000.80 E: -001.10 U: +086.20
L2 PAE:+000.0 -000.9 -001.1 -000.6 +000.2 +001.1 +002.0 +002.7 +003.0 +003.0
+002.6 +001.7 +000.5 -001.1 -003.0 -004.9 -006.8 +000.0 +000.0
ProMark500
L1 N: -000.80 E: -001.40 U: +101.80
L1 PAE:+000.0 +000.9 +001.9 +002.8 +003.7 +004.7 +005.4 +006.0 +006.4 +006.5
+006.3 +005.8 +004.8 +003.2 +001.1 -001.6 -005.1 +000.0 +000.0
L2 N: +000.80 E: -001.10 U: +086.20
L2 PAE:+000.0 -000.9 -001.1 -000.6 +000.2 +001.1 +002.0 +002.7 +003.0 +003.0
+002.6 +001.7 +000.5 -001.1 -003.0 -004.9 -006.8 +000.0 +000.0
DORNE MARGOLIN T
L1 N: +000.00 E: +000.00 U: +110.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
AOAD/M_T
L1 N: +000.00 E: +000.00 U: +110.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
AOAD/M_TA_NGS
L1 N: +000.00 E: +000.00 U: +110.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
DORNE MARGOLIN B
L1 N: +000.00 E: +000.00 U: +078.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +096.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
AOAD/M_B
L1 N: +000.00 E: +000.00 U: +078.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +096.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
DORNE MARGOLIN R
L1 N: +000.00 E: +000.00 U: +078.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +096.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
JPLD/M_R
L1 N: +000.00 E: +000.00 U: +078.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +096.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
JPLD/M_RA_SOP
L1 N: +000.00 E: +000.00 U: +078.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +096.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
TRM23903.00
L1 N: +001.20 E: +000.40 U: +077.00
L1 PAE:+000.0 +004.8 +009.3 +013.1 +016.4 +018.8 +020.5 +021.5 +021.7 +021.3
+020.3 +018.9 +017.2 +015.6 +014.2 +013.4 +013.4 +000.0 +000.0

L2 N: +000.50 E: +004.00 U: +075.60
L2 PAE:+000.0 +000.1 +000.5 +001.1 +001.7 +002.2 +002.7 +003.0 +003.1 +003.0
+002.8 +002.4 +001.9 +001.3 +000.8 +000.5 +000.4 +000.0 +000.0
TRM29659.00
L1 N: +000.00 E: +000.00 U: +110.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
TRM33429.00+GP
L1 N: -000.20 E: +001.20 U: +074.00
L1 PAE:+000.0 +003.9 +007.6 +011.1 +014.1 +016.5 +018.3 +019.2 +019.5 +019.1
+018.1 +016.6 +014.9 +013.0 +011.5 +010.4 +010.2 +000.0 +000.0
L2 N: +000.60 E: +000.90 U: +070.30
L2 PAE:+000.0 +000.6 +001.4 +002.4 +003.4 +004.4 +005.1 +005.6 +005.8 +005.7
+005.3 +004.7 +003.9 +003.0 +002.1 +001.4 +000.9 +000.0 +000.0
TRM33429.20+GP
L1 N: -000.40 E: -001.00 U: +072.90
L1 PAE:+000.0 +004.8 +009.3 +013.3 +016.6 +019.3 +021.2 +022.3 +022.7 +022.5
+021.8 +020.6 +019.3 +018.0 +016.9 +016.4 +016.7 +000.0 +000.0
L2 N: -000.40 E: -001.30 U: +075.00
L2 PAE:+000.0 +000.3 +000.9 +001.6 +002.2 +002.9 +003.4 +003.8 +004.0 +004.1
+003.9 +003.6 +003.2 +002.7 +002.2 +001.8 +001.5 +000.0 +000.0
DORNE MARGOLIN TRIM
L1 N: +000.00 E: +000.00 U: +110.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
4000ST L1/L2 GEOD
L1 N: +000.00 E: -003.00 U: +078.00
L1 PAE:+000.0 +001.1 +003.1 +006.3 +010.2 +013.7 +015.7 +016.4 +016.3 +015.8
+014.6 +013.0 +011.4 +010.2 +008.5 +007.3 +007.0 +000.0 +000.0
L2 N: -003.10 E: -001.30 U: +074.40
L2 PAE:+000.0 +000.1 +000.5 +000.7 +001.2 +002.2 +003.4 +004.2 +004.2 +003.9
+003.6 +003.3 +002.7 +002.0 +001.5 +001.0 +000.2 +000.0 +000.0
TRM14177.00
L1 N: +000.00 E: -003.00 U: +078.00

L1 PAE:+000.0 +001.1 +003.1 +006.3 +010.2 +013.7 +015.7 +016.4 +016.3 +015.8
+014.6 +013.0 +011.4 +010.2 +008.5 +007.3 +007.0 +000.0 +000.0
L2 N: -003.10 E: -001.30 U: +074.40
L2 PAE:+000.0 +000.1 +000.5 +000.7 +001.2 +002.2 +003.4 +004.2 +004.2 +003.9
+003.6 +003.3 +002.7 +002.0 +001.5 +001.0 +000.2 +000.0 +000.0
TRM14532.00
L1 N: +000.00 E: -003.00 U: +078.00
L1 PAE:+000.0 +001.1 +003.1 +006.3 +010.2 +013.7 +015.7 +016.4 +016.3 +015.8
+014.6 +013.0 +011.4 +010.2 +008.5 +007.3 +007.0 +000.0 +000.0
L2 N: -003.10 E: -001.30 U: +074.40
L2 PAE:+000.0 +000.1 +000.5 +000.7 +001.2 +002.2 +003.4 +004.2 +004.2 +003.9
+003.6 +003.3 +002.7 +002.0 +001.5 +001.0 +000.2 +000.0 +000.0
TRM14532.10
L1 N: -001.60 E: +000.90 U: +096.00
L1 PAE:+000.0 +000.0 +000.7 +001.7 +003.0 +004.3 +005.6 +006.6 +007.3 +007.5
+007.3 +006.6 +005.3 +003.6 +001.3 -001.4 -004.5 +000.0 +000.0
L2 N: +001.60 E: +004.10 U: +094.40
L2 PAE:+000.0 -001.0 -001.3 -001.1 -000.6 +000.2 +000.9 +001.6 +002.1 +002.3
+002.1 +001.6 +000.6 -000.8 -002.6 -004.8 -007.3 +000.0 +000.0
TR GEOD L1/L2 GP
L1 N: +001.50 E: -001.20 U: +075.10
L1 PAE:+000.0 +001.8 +004.6 +008.1 +011.7 +014.5 +016.1 +016.9 +016.9 +016.2
+014.9 +013.4 +011.9 +010.4 +009.0 +007.9 +008.2 +000.0 +000.0
L2 N: -001.10 E: +001.70 U: +069.20
L2 PAE:+000.0 +000.3 +000.9 +001.8 +003.0 +004.1 +004.9 +005.4 +005.6 +005.6
+005.3 +004.5 +003.6 +002.8 +002.1 +001.2 +000.1 +000.0 +000.0
TRM22020.00+GP
L1 N: +001.50 E: -001.20 U: +075.10
L1 PAE:+000.0 +001.8 +004.6 +008.1 +011.7 +014.5 +016.1 +016.9 +016.9 +016.2
+014.9 +013.4 +011.9 +010.4 +009.0 +007.9 +008.2 +000.0 +000.0
L2 N: -001.10 E: +001.70 U: +069.20
L2 PAE:+000.0 +000.3 +000.9 +001.8 +003.0 +004.1 +004.9 +005.4 +005.6 +005.6
+005.3 +004.5 +003.6 +002.8 +002.1 +001.2 +000.1 +000.0 +000.0
TR GEOD L1/L2 W/O GP
L1 N: +003.10 E: +000.90 U: +086.60
L1 PAE:+000.0 +000.2 +000.4 +001.2 +002.5 +003.6 +004.5 +005.1 +005.6 +005.8
+005.5 +005.0 +004.2 +002.7 +000.6 -001.5 -002.6 +000.0 +000.0
L2 N: +001.20 E: -000.10 U: +081.70
L2 PAE:+000.0 +000.0 +000.5 +001.2 +002.0 +002.9 +003.5 +003.9 +004.3 +004.7

+004.9 +004.5 +003.5 +002.2 +001.0 -001.1 -004.8 +000.0 +000.0
TRM22020.00-GP
L1 N: +003.10 E: +000.90 U: +086.60
L1 PAE:+000.0 +000.2 +000.4 +001.2 +002.5 +003.6 +004.5 +005.1 +005.6 +005.8
+005.5 +005.0 +004.2 +002.7 +000.6 -001.5 -002.6 +000.0 +000.0
L2 N: +001.20 E: -000.10 U: +081.70
L2 PAE:+000.0 +000.0 +000.5 +001.2 +002.0 +002.9 +003.5 +003.9 +004.3 +004.7
+004.9 +004.5 +003.5 +002.2 +001.0 -001.1 -004.8 +000.0 +000.0
TRM41249.00
L1 N: +000.30 E: +000.50 U: +071.40
L1 PAE:+000.0 +000.6 +001.4 +002.3 +003.2 +004.1 +004.9 +005.6 +006.1 +006.4
+006.4 +006.1 +005.5 +004.5 +003.1 +001.3 -000.9 +000.0 +000.0
L2 N: -000.40 E: +000.10 U: +068.20
L2 PAE:+000.0 -000.5 -000.6 -000.5 -000.2 +000.1 +000.5 +000.8 +001.0 +001.1
+001.0 +000.9 +000.6 +000.2 -000.2 -000.6 -000.8 +000.0 +000.0
TRM55971.00
L1 N: +001.60 E: +000.70 U: +085.00
L1 PAE:+000.0 +000.7 +001.6 +002.8 +003.9 +004.9 +005.9 +006.6 +007.0 +007.2
+006.8 +006.2 +005.2 +003.7 +001.8 -000.5 -003.2 +000.0 +000.0
L2 N: +000.80 E: +001.20 U: +070.10
L2 PAE:+000.0 -000.1 -000.1 +000.1 +000.4 +000.7 +001.0 +001.2 +001.4 +001.5
+001.4 +001.1 +000.8 +000.2 -000.4 -001.3 -002.2 +000.0 +000.0
TRM55971.00 TZGD
L1 N: +001.10 E: +000.90 U: +085.60
L1 PAE:+000.0 +000.9 +001.9 +003.0 +004.0 +005.0 +005.8 +006.4 +006.8 +006.9
+006.7 +006.0 +005.0 +003.5 +001.6 -000.9 -003.8 +000.0 +000.0
L2 N: +000.70 E: +000.90 U: +070.00
L2 PAE:+000.0 -000.4 -000.5 -000.3 +000.0 +000.4 +000.7 +001.0 +001.2 +001.3
+001.2 +000.9 +000.4 -000.2 -001.1 -002.0 -003.1 +000.0 +000.0
END ANTENNA
BEGIN ANTENNA
700228
L1 N: +000.50 E: +000.30 U: +079.90
L1 PAE:+000.0 +000.1 +000.5 +001.2 +001.8 +002.1 +002.1 +002.4 +003.0 +003.3
+003.0 +002.8 +002.6 +002.3 +001.5 +000.7 +000.9 +000.0 +000.0
L2 N: -001.20 E: +000.80 U: +079.20
L2 PAE:+000.0 +000.4 +001.1 +001.5 +001.6 +001.8 +002.2 +002.3 +002.1 +002.0
+001.9 +001.7 +001.5 +001.8 +002.4 +001.6 -001.8 +000.0 +000.0
ASH700228A
L1 N: +000.50 E: +000.30 U: +079.90

L1 PAE:+000.0 +000.1 +000.5 +001.2 +001.8 +002.1 +002.1 +002.4 +003.0 +003.3
+003.0 +002.8 +002.6 +002.3 +001.5 +000.7 +000.9 +000.0 +000.0
L2 N: -001.20 E: +000.80 U: +079.20
L2 PAE:+000.0 +000.4 +001.1 +001.5 +001.6 +001.8 +002.2 +002.3 +002.1 +002.0
+001.9 +001.7 +001.5 +001.8 +002.4 +001.6 -001.8 +000.0 +000.0
ASH700228B
L1 N: +000.50 E: +000.30 U: +079.90
L1 PAE:+000.0 +000.1 +000.5 +001.2 +001.8 +002.1 +002.1 +002.4 +003.0 +003.3
+003.0 +002.8 +002.6 +002.3 +001.5 +000.7 +000.9 +000.0 +000.0
L2 N: -001.20 E: +000.80 U: +079.20
L2 PAE:+000.0 +000.4 +001.1 +001.5 +001.6 +001.8 +002.2 +002.3 +002.1 +002.0
+001.9 +001.7 +001.5 +001.8 +002.4 +001.6 -001.8 +000.0 +000.0
ASH700228C
L1 N: +000.50 E: +000.30 U: +079.90
L1 PAE:+000.0 +000.1 +000.5 +001.2 +001.8 +002.1 +002.1 +002.4 +003.0 +003.3
+003.0 +002.8 +002.6 +002.3 +001.5 +000.7 +000.9 +000.0 +000.0
L2 N: -001.20 E: +000.80 U: +079.20
L2 PAE:+000.0 +000.4 +001.1 +001.5 +001.6 +001.8 +002.2 +002.3 +002.1 +002.0
+001.9 +001.7 +001.5 +001.8 +002.4 +001.6 -001.8 +000.0 +000.0
ASH700228D
L1 N: +000.50 E: +000.30 U: +079.90
L1 PAE:+000.0 +000.1 +000.5 +001.2 +001.8 +002.1 +002.1 +002.4 +003.0 +003.3
+003.0 +002.8 +002.6 +002.3 +001.5 +000.7 +000.9 +000.0 +000.0
L2 N: -001.20 E: +000.80 U: +079.20
L2 PAE:+000.0 +000.4 +001.1 +001.5 +001.6 +001.8 +002.2 +002.3 +002.1 +002.0
+001.9 +001.7 +001.5 +001.8 +002.4 +001.6 -001.8 +000.0 +000.0
700228 NOTCH
L1 N: -000.20 E: -001.00 U: +080.80
L1 PAE:+000.0 +000.7 +001.3 +001.7 +002.1 +002.4 +002.6 +002.9 +003.0 +003.1
+003.0 +002.8 +002.4 +001.8 +001.0 -000.3 -002.0 +000.0 +000.0
L2 N: -001.90 E: +003.80 U: +077.80
L2 PAE:+000.0 -001.7 -002.5 -002.8 -002.6 -002.3 -002.0 -001.7 -001.5 -001.6
-001.8 -002.1 -002.5 -002.9 -003.1 -003.0 -002.3 +000.0 +000.0
700228 RINGS
L1 N: -002.20 E: +000.00 U: +086.00
L1 PAE:+000.0 +001.7 +003.0 +004.0 +004.8 +005.3 +005.7 +005.9 +005.9 +005.9
+005.7 +005.3 +004.8 +004.0 +003.0 +001.7 -000.1 +000.0 +000.0
L2 N: -003.70 E: +003.20 U: +078.20
L2 PAE:+000.0 -001.7 -002.5 -002.7 -002.5 -002.0 -001.6 -001.2 -001.0 -001.0
-001.2 -001.6 -002.1 -002.7 -003.1 -003.1 -002.6 +000.0 +000.0
700578

L1 N: -001.20 E: -001.00 U: +079.50
L1 PAE:+000.0 -000.2 -000.1 +001.1 +002.7 +003.2 +002.7 +002.5 +003.4 +004.2
+004.0 +003.5 +003.3 +002.7 +001.4 +000.9 +003.0 +000.0 +000.0
L2 N: -004.60 E: +001.60 U: +078.30
L2 PAE:+000.0 +000.5 +001.4 +001.6 +001.4 +001.5 +002.0 +002.1 +001.9 +002.1
+002.5 +002.2 +001.3 +001.2 +002.3 +002.0 -002.4 +000.0 +000.0
700718
L1 N: +003.40 E: +001.00 U: +087.30
L1 PAE:+000.0 +001.3 +002.9 +004.6 +006.2 +007.7 +008.8 +009.4 +009.6 +009.2
+008.4 +007.1 +005.4 +003.5 +001.4 -000.6 -002.4 +000.0 +000.0
L2 N: +003.10 E: -001.30 U: +063.40
L2 PAE:+000.0 -002.4 -004.0 -005.2 -005.9 -006.4 -006.8 -007.0 -007.2 -007.3
-007.4 -007.3 -007.0 -006.3 -005.2 -003.5 -000.8 +000.0 +000.0
ASH700699.L1
L1 N: +000.00 E: +000.00 U: +051.50
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +000.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
ASH700718A
L1 N: +003.40 E: +001.00 U: +087.30
L1 PAE:+000.0 +001.3 +002.9 +004.6 +006.2 +007.7 +008.8 +009.4 +009.6 +009.2
+008.4 +007.1 +005.4 +003.5 +001.4 -000.6 -002.4 +000.0 +000.0
L2 N: +003.10 E: -001.30 U: +063.40
L2 PAE:+000.0 -002.4 -004.0 -005.2 -005.9 -006.4 -006.8 -007.0 -007.2 -007.3
-007.4 -007.3 -007.0 -006.3 -005.2 -003.5 -000.8 +000.0 +000.0
ASH700718B
L1 N: +003.40 E: +001.00 U: +087.30
L1 PAE:+000.0 +001.3 +002.9 +004.6 +006.2 +007.7 +008.8 +009.4 +009.6 +009.2
+008.4 +007.1 +005.4 +003.5 +001.4 -000.6 -002.4 +000.0 +000.0
L2 N: +003.10 E: -001.30 U: +063.40
L2 PAE:+000.0 -002.4 -004.0 -005.2 -005.9 -006.4 -006.8 -007.0 -007.2 -007.3
-007.4 -007.3 -007.0 -006.3 -005.2 -003.5 -000.8 +000.0 +000.0
700829
L1 N: -000.70 E: +000.40 U: +092.00
L1 PAE:+000.0 +001.5 +003.3 +005.3 +007.1 +008.7 +010.0 +010.8 +011.0 +010.7
+009.9 +008.6 +006.8 +004.8 +002.6 +000.5 -001.5 +000.0 +000.0
L2 N: -000.10 E: -000.80 U: +060.10
L2 PAE:+000.0 -002.5 -004.2 -005.4 -006.1 -006.6 -006.9 -007.1 -007.1 -007.1
-007.0 -006.8 -006.3 -005.5 -004.2 -002.4 +000.3 +000.0 +000.0
DORNE MARGOLIN ASH
L1 N: +000.00 E: +000.00 U: +110.00

L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

ASH701933A_M

L1 N: +000.00 E: +000.00 U: +110.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

ASH701933B_M

L1 N: +000.00 E: +000.00 U: +110.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

ASH701933C_M

L1 N: +000.00 E: +000.00 U: +110.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

ASH701941.1

L1 N: -000.20 E: +000.10 U: +108.00
L1 PAE:+000.0 -000.3 -000.5 -000.5 -000.4 -000.3 -000.2 -000.1 +000.0 +000.1
+000.1 +000.0 +000.0 -000.1 -000.2 -000.2 -000.2 +000.0 +000.0
L2 N: -000.30 E: +000.20 U: +126.70
L2 PAE:+000.0 -002.2 -003.3 -003.5 -003.3 -002.9 -002.5 -002.2 -002.1 -002.2
-002.5 -002.9 -003.2 -003.2 -002.7 -001.3 +001.3 +000.0 +000.0

ASH701941.2

L1 N: -000.20 E: +000.10 U: +108.00
L1 PAE:+000.0 -000.3 -000.5 -000.5 -000.4 -000.3 -000.2 -000.1 +000.0 +000.1
+000.1 +000.0 +000.0 -000.1 -000.2 -000.2 -000.2 +000.0 +000.0
L2 N: -000.30 E: +000.20 U: +126.70
L2 PAE:+000.0 -002.2 -003.3 -003.5 -003.3 -002.9 -002.5 -002.2 -002.1 -002.2
-002.5 -002.9 -003.2 -003.2 -002.7 -001.3 +001.3 +000.0 +000.0

ASH701941.A

L1 N: -000.20 E: +000.10 U: +108.00
L1 PAE:+000.0 -000.3 -000.5 -000.5 -000.4 -000.3 -000.2 -000.1 +000.0
+000.1
+000.1 +000.0 +000.0 -000.1 -000.2 -000.2 -000.2 +000.0 +000.0
L2 N: -000.30 E: +000.20 U: +126.70
L2 PAE:+000.0 -002.2 -003.3 -003.5 -003.3 -002.9 -002.5 -002.2 -002.1 -002.2
-002.5 -002.9 -003.2 -003.2 -002.7 -001.3 +001.3 +000.0 +000.0
ASH701941.B
L1 N: -000.20 E: +000.10 U: +108.00
L1 PAE:+000.0 -000.3 -000.5 -000.5 -000.4 -000.3 -000.2 -000.1 +000.0
+000.1
+000.1 +000.0 +000.0 -000.1 -000.2 -000.2 -000.2 +000.0 +000.0
L2 N: -000.30 E: +000.20 U: +126.70
L2 PAE:+000.0 -002.2 -003.3 -003.5 -003.3 -002.9 -002.5 -002.2 -002.1 -002.2
-002.5 -002.9 -003.2 -003.2 -002.7 -001.3 +001.3 +000.0 +000.0
ASH701945B_M
L1 N: +000.00 E: +000.00 U: +110.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0L2
N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
ASH701945.02B
L1 N: +000.00 E: +000.00 U: +110.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
ASH701945C_M
L1 N: +000.00 E: +000.00 U: +110.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
ASH701945E_M
L1 N: +000.00 E: +000.00 U: +110.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

ASH701945E_M SCIS
L1 N: -000.10 E: +000.50 U: +107.80
L1 PAE:+000.0 -000.2 -000.5 -000.8 -000.9 -001.3 -001.4 -001.6 -001.6 -001.6
-001.6 -001.4 -001.4 -001.3 -001.1 -001.1 -001.1 +000.0 +000.0
L2 N: -000.50 E: +000.60 U: +126.90
L2 PAE:+000.0 -000.3 -000.5 -000.7 -000.8 -000.8 -000.8 -000.8 -000.9 -001.0
-001.0 -001.0 -001.1 -001.0 -000.9 -000.7 -000.3 +000.0 +000.0
ASH701945G_M
L1 N: +000.00 E: +000.00 U: +110.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
ASH701946.022
L1 N: +000.60 E: +000.80 U: +109.80
L1 PAE:+000.0 -000.1 -000.2 -000.2 -000.1 -000.1 +000.0 +000.1 +000.2
+000.2
+000.2 +000.2 +000.3 +000.2 +000.2 +000.1 +000.1 +000.0 +000.0
L2 N: +000.70 E: +001.40 U: +128.40
L2 PAE:+000.0 -000.2 -000.3 -000.3 -000.3 -000.3 -000.3 -000.3 -000.2 -000.2
-000.2 -000.3 -000.3 -000.3 -000.2 -000.2 +000.0 +000.0 +000.0
ASH701946.012
L1 N: +000.60 E: +000.80 U: +109.80
L1 PAE:+000.0 -000.1 -000.2 -000.2 -000.1 -000.1 +000.0 +000.1 +000.2
+000.2
+000.2 +000.2 +000.3 +000.2 +000.2 +000.1 +000.1 +000.0 +000.0
L2 N: +000.70 E: +001.40 U: +128.40
L2 PAE:+000.0 -000.2 -000.3 -000.3 -000.3 -000.3 -000.3 -000.3 -000.2 -000.2
-000.2 -000.3 -000.3 -000.3 -000.2 -000.2 +000.0 +000.0 +000.0
ASH701946.2
L1 N: +000.60 E: +000.80 U: +109.80
L1 PAE:+000.0 -000.1 -000.2 -000.2 -000.1 -000.1 +000.0 +000.1 +000.2
+000.2
+000.2 +000.2 +000.3 +000.2 +000.2 +000.1 +000.1 +000.0 +000.0
L2 N: +000.70 E: +001.40 U: +128.40
L2 PAE:+000.0 -000.2 -000.3 -000.3 -000.3 -000.3 -000.3 -000.3 -000.2 -000.2
-000.2 -000.3 -000.3 -000.3 -000.2 -000.2 +000.0 +000.0 +000.0
ASH701946.3
L1 N: +000.60 E: +000.80 U: +109.80
L1 PAE:+000.0 -000.1 -000.2 -000.2 -000.1 -000.1 +000.0 +000.1 +000.2
+000.2
+000.2 +000.2 +000.3 +000.2 +000.2 +000.1 +000.1 +000.0 +000.0
L2 N: +000.70 E: +001.40 U: +128.40
L2 PAE:+000.0 -000.2 -000.3 -000.3 -000.3 -000.3 -000.3 -000.3 -000.2 -000.2
-000.2 -000.3 -000.3 -000.3 -000.2 -000.2 +000.0 +000.0 +000.0
ASH700936A_M
L1 N: +000.00 E: +000.00 U: +110.00

L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

ASH700936B_M

L1 N: +000.00 E: +000.00 U: +110.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

ASH700936C_M

L1 N: +000.00 E: +000.00 U: +110.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

ASH700936D_M

L1 N: +000.00 E: +000.00 U: +110.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

ASH700936E_C

L1 N: +000.00 E: +000.00 U: +110.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

ASH700936F_C

L1 N: +000.00 E: +000.00 U: +110.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
ASH700936E
L1 N: +000.00 E: +000.00 U: +110.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
700936 RADOM
L1 N: +000.00 E: +000.00 U: +110.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
ASH701073.1
L1 N: +000.00 E: +000.00 U: +110.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
ASH701073.3
L1 N: +000.00 E: +000.00 U: +110.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +128.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
ASH701975.01A
L1 N: -002.10 E: -004.10 U: +056.40
L1 PAE:+000.0 +001.0 +002.0 +003.1 +004.2 +005.1 +005.9 +006.5 +006.9
+007.1
+007.0 +006.6 +005.9 +005.0 +003.8 +002.4 +000.7 +000.0 +000.0
L2 N: -001.70 E: -003.20 U: +062.20
L2 PAE:+000.0 -000.3 -000.2 +000.2 +000.8 +001.5 +002.3 +002.9 +003.3
+003.6
+003.7 +003.4 +002.8 +002.0 +000.8 -000.7 -002.5 +000.0 +000.0
ASH701975.01Agp
L1 N: -002.00 E: -003.30 U: +056.00
L1 PAE:+000.0 +003.5 +007.1 +010.5 +013.5 +016.1 +018.1 +019.5 +020.2
+020.3
+019.7 +018.8 +017.4 +015.9 +014.2 +012.9 +011.9 +000.0 +000.0

L2 N: -002.00 E: -002.70 U: +046.10
L2 PAE:+000.0 -001.7 -002.9 -003.8 -004.5 -004.9 -005.4 -005.6 -005.9 -006.0
-006.1 -006.1 -005.9 -005.5 -004.8 -003.6 -001.8 +000.0 +000.0
JPSREGANT_DD_E
L1 N: +001.10 E: +000.20 U: +113.10
L1 PAE:+000.0 +000.5 +001.3 +002.1 +003.0 +003.8 +004.6 +005.2 +005.6 +005.8
+005.8 +005.5 +005.0 +004.3 +003.4 +002.3 +001.1 +000.0 +000.0
L2 N: +001.00 E: +001.30 U: +118.60
L2 PAE:+000.0 -000.2 +000.0 +000.4 +001.0 +001.6 +002.1 +002.5 +002.7 +002.8
+002.7 +002.3 +001.9 +001.3 +000.7 +000.2 -000.2 +000.0 +000.0
JPSREGANT_SD_E
L1 N: +001.00 E: -001.10 U: +106.00
L1 PAE:+000.0 +000.8 +001.6 +002.3 +003.1 +003.7 +004.3 +004.7 +005.0 +005.2
+005.3 +005.1 +004.8 +004.4 +003.8 +002.9 +002.0 +000.0 +000.0
L2 N: +001.40 E: +000.50 U: +119.60
L2 PAE:+000.0 -000.3 -000.3 +000.1 +000.6 +001.1 +001.7 +002.1 +002.3 +002.4
+002.3 +002.1 +001.7 +001.2 +000.7 +000.2 -000.2 +000.0 +000.0
LEIAT504
L1 N: +000.30 E: -000.30 U: +109.30
L1 PAE:+000.0 +000.0 -000.1 -000.1 +000.0 +000.0 +000.0 +000.1 +000.1 +000.1
+000.1 +000.2 +000.2 +000.3 +000.4 +000.5 +000.6 +000.0 +000.0
L2 N: +001.10 E: +001.10 U: +128.20
L2 PAE:+000.0 -000.1 -000.1 -000.1 +000.0 +000.0 +000.0 +000.0 +000.0 -000.1
-000.2 -000.2 -000.3 -000.3 -000.2 -000.1 +000.3 +000.0 +000.0
LEIAT504 LEIS
L1 N: +002.50 E: +001.30 U: +106.50
L1 PAE:+000.0 -000.3 -000.7 -001.0 -001.2 -001.4 -001.6 -001.8 -001.9 -001.9
-001.9 -001.8 -001.6 -001.4 -001.1 -000.8 -000.3 +000.0 +000.0
L2 N: -000.70 E: +001.30 U: +125.40
L2 PAE:+000.0 +000.1 +000.2 +000.2 +000.2 +000.1 +000.1 +000.0 -000.1 -000.1
-000.2 -000.2 -000.1 +000.0 +000.2 +000.5 +000.8 +000.0 +000.0
INTERNAL
L1 N: +003.10 E: -000.20 U: +113.10
L1 PAE:+000.0 +000.5 +001.0 +002.0 +003.3 +004.5 +005.7 +007.1 +008.5 +009.0
+008.3 +007.0 +005.8 +004.7 +003.4 +001.8 +000.8 +000.0 +000.0
L2 N: +001.30 E: -003.50 U: +117.20
L2 PAE:+000.0 +000.2 +000.4 +000.8 +001.5 +002.6 +003.6 +004.2 +004.5 +005.0
+005.3 +005.0 +003.8 +002.5 +001.4 -000.8 -005.1 +000.0 +000.0
LEISR299_INT
L1 N: +003.10 E: -000.20 U: +113.10
L1 PAE:+000.0 +000.5 +001.0 +002.0 +003.3 +004.5 +005.7 +007.1 +008.5 +009.0

+008.3 +007.0 +005.8 +004.7 +003.4 +001.8 +000.8 +000.0 +000.0
L2 N: +001.30 E: -003.50 U: +117.20
L2 PAE:+000.0 +000.2 +000.4 +000.8 +001.5 +002.6 +003.6 +004.2 +004.5 +005.0
+005.3 +005.0 +003.8 +002.5 +001.4 -000.8 -005.1 +000.0 +000.0
LEISR399_INT
L1 N: +003.10 E: -000.20 U: +113.10
L1 PAE:+000.0 +000.5 +001.0 +002.0 +003.3 +004.5 +005.7 +007.1 +008.5 +009.0
+008.3 +007.0 +005.8 +004.7 +003.4 +001.8 +000.8 +000.0 +000.0
L2 N: +001.30 E: -003.50 U: +117.20
L2 PAE:+000.0 +000.2 +000.4 +000.8 +001.5 +002.6 +003.6 +004.2 +004.5 +005.0
+005.3 +005.0 +003.8 +002.5 +001.4 -000.8 -005.1 +000.0 +000.0
EXTERNAL WITHOUT GP
L1 N: +000.50 E: +000.10 U: +068.50
L1 PAE:+000.0 +001.2 +002.6 +004.3 +005.8 +006.5 +007.1 +008.3 +010.3 +011.8
+011.1 +008.6 +006.2 +005.6 +005.6 +002.9 -003.8 +000.0 +000.0
L2 N: +000.30 E: -001.90 U: +052.10
L2 PAE:+000.0 -000.2 -000.7 -000.9 -000.9 -001.1 -001.4 -001.2 -000.4 +000.6
+001.0 +000.9 +000.9 +000.6 -001.2 -005.5 -012.0 +000.0 +000.0
LEIAT202-GP
L1 N: +000.50 E: +000.10 U: +068.50
L1 PAE:+000.0 +001.2 +002.6 +004.3 +005.8 +006.5 +007.1 +008.3 +010.3 +011.8
+011.1 +008.6 +006.2 +005.6 +005.6 +002.9 -003.8 +000.0 +000.0
L2 N: +000.30 E: -001.90 U: +052.10
L2 PAE:+000.0 -000.2 -000.7 -000.9 -000.9 -001.1 -001.4 -001.2 -000.4 +000.6
+001.0 +000.9 +000.9 +000.6 -001.2 -005.5 -012.0 +000.0 +000.0
LEIAT302-GP
L1 N: +000.50 E: +000.10 U: +068.50
L1 PAE:+000.0 +001.2 +002.6 +004.3 +005.8 +006.5 +007.1 +008.3 +010.3 +011.8
+011.1 +008.6 +006.2 +005.6 +005.6 +002.9 -003.8 +000.0 +000.0
L2 N: +000.30 E: -001.90 U: +052.10
L2 PAE:+000.0 -000.2 -000.7 -000.9 -000.9 -001.1 -001.4 -001.2 -000.4 +000.6
+001.0 +000.9 +000.9 +000.6 -001.2 -005.5 -012.0 +000.0 +000.0
LEIAT303
L1 N: +001.00 E: -000.50 U: +078.20
L1 PAE:+000.0 +001.4 +002.4 +003.2 +003.8 +004.2 +004.4 +004.6 +004.7 +004.8
+004.7 +004.5 +004.2 +003.7 +003.0 +002.0 +000.7 +000.0 +000.0
L2 N: +001.80 E: +000.80 U: +093.90
L2 PAE:+000.0 +000.6 +001.1 +001.5 +001.9 +002.3 +002.5 +002.7 +002.8 +002.9
+002.7 +002.5 +002.2 +001.7 +001.0 +000.1 -000.9 +000.0 +000.0
EXTERNAL WITH GP
L1 N: +004.80 E: +001.90 U: +049.20
L1 PAE:+000.0 +000.0 +000.4 +001.7 +003.4 +004.4 +004.6 +004.9 +005.9 +006.7

+006.6 +005.6 +004.6 +003.7 +002.6 +001.7 +001.9 +000.0 +000.0
L2 N: +003.40 E: -005.20 U: +041.80
L2 PAE:+000.0 -000.2 -000.6 -000.8 -000.6 -000.2 +000.1 +000.1 +000.0 +000.0
+000.2 +000.7 +000.9 +000.5 -000.6 -001.8 -002.5 +000.0 +000.0

LEIAT202+GP

L1 N: +004.80 E: +001.90 U: +049.20
L1 PAE:+000.0 +000.0 +000.4 +001.7 +003.4 +004.4 +004.6 +004.9 +005.9 +006.7
+006.6 +005.6 +004.6 +003.7 +002.6 +001.7 +001.9 +000.0 +000.0
L2 N: +003.40 E: -005.20 U: +041.80
L2 PAE:+000.0 -000.2 -000.6 -000.8 -000.6 -000.2 +000.1 +000.1 +000.0 +000.0
+000.2 +000.7 +000.9 +000.5 -000.6 -001.8 -002.5 +000.0 +000.0

LEIAT302+GP

L1 N: +004.80 E: +001.90 U: +049.20
L1 PAE:+000.0 +000.0 +000.4 +001.7 +003.4 +004.4 +004.6 +004.9 +005.9 +006.7
+006.6 +005.6 +004.6 +003.7 +002.6 +001.7 +001.9 +000.0 +000.0
L2 N: +003.40 E: -005.20 U: +041.80
L2 PAE:+000.0 -000.2 -000.6 -000.8 -000.6 -000.2 +000.1 +000.1 +000.0 +000.0
+000.2 +000.7 +000.9 +000.5 -000.6 -001.8 -002.5 +000.0 +000.0

LEIAX1202

L1 N: +002.80 E: -000.70 U: +083.40
L1 PAE:+000.0 +000.9 +002.0 +003.2 +004.4 +005.6 +006.7 +007.5 +008.1 +008.3
+008.1 +007.4 +006.2 +004.4 +002.1 -000.8 -004.4 +000.0 +000.0
L2 N: -000.90 E: -000.30 U: +076.90
L2 PAE:+000.0 -001.1 -001.3 -001.0 -000.3 +000.6 +001.4 +002.1 +002.6 +002.8
+002.6 +002.0 +001.1 -000.2 -001.8 -003.5 -005.2 +000.0 +000.0

MACROMETER X-DIPOLE

L1 N: +002.20 E: -008.20 U: +163.10
L1 PAE:+000.0 -003.7 -003.3 -000.3 +003.9 +008.5 +012.3 +015.0 +015.9 +014.8
+011.6 +006.6 +000.1 -007.4 -015.1 -022.0 -027.0 +000.0 +000.0
L2 N: +004.30 E: +002.00 U: +091.30
L2 PAE:+000.0 -003.0 -002.9 -000.9 +002.1 +005.4 +008.3 +010.6 +011.9 +012.2
+011.6 +010.3 +008.8 +007.6 +007.6 +009.6 +014.8 +000.0 +000.0

MAC4647942

L1 N: +002.20 E: -008.20 U: +163.10
L1 PAE:+000.0 -003.7 -003.3 -000.3 +003.9 +008.5 +012.3 +015.0 +015.9 +014.8
+011.6 +006.6 +000.1 -007.4 -015.1 -022.0 -027.0 +000.0 +000.0
L2 N: +004.30 E: +002.00 U: +091.30
L2 PAE:+000.0 -003.0 -002.9 -000.9 +002.1 +005.4 +008.3 +010.6 +011.9 +012.2
+011.6 +010.3 +008.8 +007.6 +007.6 +009.6 +014.8 +000.0 +000.0

TOP700779A

L1 N: +003.40 E: +001.00 U: +087.30
L1 PAE:+000.0 +001.3 +002.9 +004.6 +006.2 +007.7 +008.8 +009.4 +009.6 +009.2
+008.4 +007.1 +005.4 +003.5 +001.4 -000.6 -002.4 +000.0 +000.0
L2 N: +003.10 E: -001.30 U: +063.40
L2 PAE:+000.0 -002.4 -004.0 -005.2 -005.9 -006.4 -006.8 -007.0 -007.2 -007.3
-007.4 -007.3 -007.0 -006.3 -005.2 -003.5 -000.8 +000.0 +000.0
72110
L1 N: -003.90 E: +007.30 U: +147.10
L1 PAE:+000.0 -001.1 -001.1 -000.3 +000.9 +002.3 +003.7 +004.8 +005.3 +005.3
+004.5 +002.9 +000.3 -003.2 -007.6 -012.9 -019.0 +000.0 +000.0
L2 N: -004.40 E: +006.50 U: +127.80
L2 PAE:+000.0 -000.5 -000.7 -000.8 -000.7 -000.6 -000.5 -000.5 -000.6 -001.0
-001.6 -002.5 -003.7 -005.3 -007.3 -009.7 -012.5 +000.0 +000.0
TOP72110
L1 N: -003.90 E: +007.30 U: +147.10
L1 PAE:+000.0 -001.1 -001.1 -000.3 +000.9 +002.3 +003.7 +004.8 +005.3 +005.3
+004.5 +002.9 +000.3 -003.2 -007.6 -012.9 -019.0 +000.0 +000.0
L2 N: -004.40 E: +006.50 U: +127.80
L2 PAE:+000.0 -000.5 -000.7 -000.8 -000.7 -000.6 -000.5 -000.5 -000.6 -001.0
-001.6 -002.5 -003.7 -005.3 -007.3 -009.7 -012.5 +000.0 +000.0
TOPCR3_GGD
L1 N: +000.10 E: +000.00 U: +080.50
L1 PAE:+000.0 +000.8 +001.3 +001.6 +001.7 +001.8 +001.8 +001.8 +001.8 +001.8
+001.9 +002.0 +002.0 +001.8 +001.5 +000.9 -000.1 +000.0 +000.0
L2 N: +000.70 E: +000.80 U: +103.50
L2 PAE:+000.0 -000.5 -000.5 -000.2 +000.2 +000.7 +001.1 +001.5 +001.8 +001.8
+001.7 +001.5 +001.1 +000.7 +000.2 -000.1 -000.3 +000.0 +000.0
TPSCR3_GGD
L1 N: +000.10 E: +000.00 U: +080.50
L1 PAE:+000.0 +000.8 +001.3 +001.6 +001.7 +001.8 +001.8 +001.8 +001.8 +001.8
+001.9 +002.0 +002.0 +001.8 +001.5 +000.9 -000.1 +000.0 +000.0
L2 N: +000.70 E: +000.80 U: +103.50
L2 PAE:+000.0 -000.5 -000.5 -000.2 +000.2 +000.7 +001.1 +001.5 +001.8 +001.8
+001.7 +001.5 +001.1 +000.7 +000.2 -000.1 -000.3 +000.0 +000.0
TPSCR3_GGD CONE
L1 N: +000.20 E: +000.10 U: +080.30
L1 PAE:+000.0 +001.2 +001.9 +002.4 +002.6 +002.6 +002.6 +002.5 +002.5 +002.4
+002.4 +002.4 +002.4 +002.4 +002.3 +002.1 +001.6 +000.0 +000.0
L2 N: +000.40 E: +000.60 U: +102.70
L2 PAE:+000.0 -000.8 -001.0 -000.7 -000.1 +000.5 +001.1 +001.7 +002.0 +002.1
+001.9 +001.6 +001.1 +000.5 +000.0 -000.4 -000.5 +000.0 +000.0
M-PULSE L1/L2 SURVEY

L1 N: +000.00 E: +000.00 U: +079.60
L1 PAE:+000.0 +000.4 +000.4 +000.9 +002.1 +003.1 +003.5 +003.6 +003.9 +003.8
+003.0 +002.2 +001.8 +001.7 +000.9 +000.9 +002.6 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +093.20
L2 PAE:+000.0 +000.1 +000.1 +000.0 +000.0 +000.6 +001.3 +001.7 +001.5 +001.2
+000.9 +000.7 +000.6 +000.7 +000.7 -000.6 -004.1 +000.0 +000.0

MPLL1/L2_SURV

L1 N: +000.00 E: +000.00 U: +079.60
L1 PAE:+000.0 +000.4 +000.4 +000.9 +002.1 +003.1 +003.5 +003.6 +003.9 +003.8
+003.0 +002.2 +001.8 +001.7 +000.9 +000.9 +002.6 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +093.20
L2 PAE:+000.0 +000.1 +000.1 +000.0 +000.0 +000.6 +001.3 +001.7 +001.5 +001.2
+000.9 +000.7 +000.6 +000.7 +000.7 -000.6 -004.1 +000.0 +000.0

MPLL1/L2SURV

L1 N: +000.00 E: +000.00 U: +079.60
L1 PAE:+000.0 +000.4 +000.4 +000.9 +002.1 +003.1 +003.5 +003.6 +003.9 +003.8
+003.0 +002.2 +001.8 +001.7 +000.9 +000.9 +002.6 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +093.20
L2 PAE:+000.0 +000.1 +000.1 +000.0 +000.0 +000.6 +001.3 +001.7 +001.5 +001.2
+000.9 +000.7 +000.6 +000.7 +000.7 -000.6 -004.1 +000.0 +000.0

2200

L1 N: +000.80 E: -001.70 U: +095.40
L1 PAE:+000.0 +001.3 +002.7 +004.4 +006.0 +007.2 +008.0 +009.1 +010.2 +010.4
+009.4 +008.3 +007.8 +007.4 +006.3 +004.6 +003.7 +000.0 +000.0
L2 N: +000.40 E: +000.10 U: +073.90
L2 PAE:+000.0 -000.3 -001.7 -003.9 -005.8 -006.3 -006.1 -006.4 -007.3 -007.8
-007.5 -006.9 -006.0 -004.1 -001.7 -001.7 -006.4 +000.0 +000.0

AERAT2775_43

L1 N: +002.30 E: -000.60 U: +088.30
L1 PAE:+000.0 +000.1 +000.6 +001.3 +002.0 +002.7 +003.4 +003.8 +004.1 +004.2
+004.0 +003.7 +003.2 +002.6 +002.1 +001.6 +001.3 +000.0 +000.0
L2 N: -000.20 E: +000.20 U: +094.10
L2 PAE:+000.0 -000.7 -001.0 -001.2 -001.3 -001.3 -001.3 -001.4 -001.4 -001.6
-001.7 -001.7 -001.7 -001.4 -000.8 +000.3 +001.8 +000.0 +000.0

3S-02-TSADM

L1 N: +001.70 E: +003.60 U: +272.50
L1 PAE:+000.0 +000.0 +000.2 +000.5 +001.0 +001.5 +002.0 +002.5 +002.9 +003.3
+003.6 +003.9 +004.2 +004.5 +004.9 +005.4 +006.0 +000.0 +000.0
L2 N: +000.80 E: +004.20 U: +291.60
L2 PAE:+000.0 +000.1 +000.3 +000.4 +000.6 +000.9 +001.1 +001.5 +001.8 +002.2
+002.5 +002.9 +003.3 +003.6 +003.9 +004.2 +004.3 +000.0 +000.0

3S-02-TSATE
L1 N: +000.00 E: +000.00 U: +171.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +171.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
NOV503+CR
L1 N: +002.30 E: -001.40 U: +086.50
L1 PAE:+000.0 +000.3 +000.8 +001.5 +002.3 +003.0 +003.7 +004.2 +004.5 +004.6
+004.6 +004.2 +003.7 +003.0 +002.3 +001.6 +001.0 +000.0 +000.0
L2 N: -000.10 E: +000.30 U: +092.30
L2 PAE:+000.0 -001.5 -002.3 -002.5 -002.6 -002.5 -002.3 -002.2 -002.1 -002.2
-002.3 -002.5 -002.5 -002.4 -001.8 -000.8 +001.0 +000.0 +000.0
NOV503+CR SPKE
L1 N: +002.00 E: -002.60 U: +087.10
L1 PAE:+000.0 -000.1 +000.5 +001.4 +002.4 +003.4 +004.4 +005.1 +005.6 +005.6
+005.5 +005.0 +004.2 +003.3 +002.4 +001.5 +000.9 +000.0 +000.0
L2 N: -000.80 E: -000.20 U: +094.60
L2 PAE:+000.0 -001.1 -001.7 -001.9 -001.8 -001.5 -001.3 -001.0 -000.8 -000.8
-000.9 -000.9 -001.1 -001.1 -000.9 -000.5 +000.5 +000.0 +000.0
NOV600
L1 N: -001.30 E: +000.30 U: +090.50
L1 PAE:+000.0 +000.7 +001.6 +002.7 +004.0 +005.2 +006.2 +007.1 +007.8 +008.1
+008.1 +007.6 +006.7 +005.4 +003.6 +001.4 -001.2 +000.0 +000.0
L2 N: +000.20 E: -000.40 U: +091.80
L2 PAE:+000.0 -000.6 -000.6 -000.2 +000.5 +001.4 +002.2 +002.9 +003.3 +003.6
+003.5 +003.1 +002.4 +001.4 +000.2 -001.2 -002.7 +000.0 +000.0
NULLANTENNA
L1 N: +000.00 E: +000.00 U: +000.00
L1 PAE:+000.0 +000.3 +001.2 +002.6 +004.4 +006.4 +008.6 +010.6 +012.4 +013.8
+014.8 +015.5 +015.6 +015.4 +014.6 +013.0 +010.7 +007.6 +003.9
L2 N: +000.00 E: +000.00 U: +000.00
L2 PAE:+000.0 +000.2 +000.6 +001.4 +002.3 +003.4 +004.5 +005.6 +006.7 +007.6
+008.1 +008.2 +007.9 +007.3 +006.4 +005.3 +003.7 +001.4 -001.7
ADVNULLANTENNA
L1 N: +000.00 E: +000.00 U: +000.00
L1 PAE:+000.0 +000.3 +001.2 +002.6 +004.4 +006.4 +008.6 +010.6 +012.4 +013.8
+014.8 +015.5 +015.6 +015.4 +014.6 +013.0 +010.7 +007.6 +003.9
L2 N: +000.00 E: +000.00 U: +000.00
L2 PAE:+000.0 +000.2 +000.6 +001.4 +002.3 +003.4 +004.5 +005.6 +006.7 +007.6

+008.1 +008.2 +007.9 +007.3 +006.4 +005.3 +003.7 +001.4 -001.7

GPP_NULLANTENNA

L1 N: +000.00 E: +000.00 U: +000.00

L1 PAE:+000.0 +000.3 +001.2 +002.6 +004.4 +006.4 +008.6 +010.6 +012.4 +013.8

+014.8 +015.5 +015.6 +015.4 +014.6 +013.0 +010.7 +007.6 +003.9

L2 N: +000.00 E: +000.00 U: +000.00

L2 PAE:+000.0 +000.2 +000.6 +001.4 +002.3 +003.4 +004.5 +005.6 +006.7 +007.6

+008.1 +008.2 +007.9 +007.3 +006.4 +005.3 +003.7 +001.4 -001.7

GPPNULLANTENNA

L1 N: +000.00 E: +000.00 U: +000.00

L1 PAE:+000.0 +000.3 +001.2 +002.6 +004.4 +006.4 +008.6 +010.6 +012.4 +013.8

+014.8 +015.5 +015.6 +015.4 +014.6 +013.0 +010.7 +007.6 +003.9

L2 N: +000.00 E: +000.00 U: +000.00

L2 PAE:+000.0 +000.2 +000.6 +001.4 +002.3 +003.4 +004.5 +005.6 +006.7 +007.6

+008.1 +008.2 +007.9 +007.3 +006.4 +005.3 +003.7 +001.4 -001.7

THA_ZMAX

L1 N: +003.80 E: -002.30 U: +000.00

L1 PAE:+000.0 -001.7 -002.2 -001.7 -000.7 +000.5 +001.6 +002.6 +003.2 +003.4

+003.0 +002.0 +000.7 -001.1 -003.2 -005.2 -007.1 +000.0 +000.0

L2 N: +003.80 E: -000.80 U: -004.90

L2 PAE:+000.0 +000.6 +000.9 +001.1 +001.3 +001.5 +001.8 +002.1 +002.6 +003.0

+003.3 +003.3 +003.0 +002.0 +000.2 -002.7 -007.0 +000.0 +000.0

110454

L1 N: +000.00 E: +000.00 U: +069.00

L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

L2 N: +000.00 E: +000.00 U: +000.00

L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

NAP100

L1 N: +000.00 E: +000.00 U: +073.00

L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

L2 N: +000.00 E: +000.00 U: +000.00

L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

AT1675-20W

L1 N: +001.50 E: -001.90 U: +098.70

L1 PAE:+000.0 +000.1 +000.7 +001.7 +002.8 +003.9 +004.9 +005.6 +005.9 +005.8

+005.4 +004.6 +003.4 +001.9 +000.3 -001.3 -002.6 +000.0 +000.0

L2 N: +000.10 E: +000.30 U: +104.30
L2 PAE:+000.0 -000.1 -000.1 -000.1 +000.0 +000.0 +000.1 +000.1 +000.2 +000.2
+000.2 +000.1 +000.1 +000.1 -000.1 -000.1 -000.2 +000.0 +000.0

AERAT1675_182
L1 N: +000.00 E: -002.40 U: +050.00
L1 PAE:+000.0 +000.7 +001.6 +002.8 +004.0 +005.3 +006.4 +007.4 +008.1 +008.4
+008.3 +007.5 +006.2 +004.1 +001.1 -002.7 -007.7 +000.0 +000.0
L2 N: -001.90 E: -001.40 U: +033.10
L2 PAE:+000.0 +000.3 +000.9 +001.6 +002.2 +002.9 +003.4 +003.7 +003.9 +003.9
+003.7 +003.3 +002.8 +002.1 +001.4 +000.8 +000.3 +000.0 +000.0

AERAT1675_32
L1 N: -000.40 E: -002.60 U: +050.40
L1 PAE:+000.0 +000.7 +001.6 +002.7 +003.8 +005.0 +006.1 +007.0 +007.7 +007.9
+007.8 +007.1 +005.8 +003.7 +000.7 -003.1 -008.0 +000.0 +000.0
L2 N: -001.80 E: -002.50 U: +032.40
L2 PAE:+000.0 +000.9 +001.7 +002.4 +003.1 +003.7 +004.2 +004.5 +004.7 +004.7
+004.5 +004.2 +003.8 +003.3 +002.6 +001.8 +000.9 +000.0 +000.0

ASH802111
L1 N: +000.00 E: +000.00 U: +000.00
L1 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +000.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

ASH111660
L1 N: +000.30 E: -000.70 U: +075.40
L1 PAE:+000.0 +000.7 +001.7 +002.8 +004.1 +005.3 +006.3 +007.2 +007.7 +007.8
+007.6 +006.9 +005.6 +003.7 +001.2 -001.9 -005.7 +000.0 +000.0
L2 N: +000.00 E: +000.00 U: +000.00
L2 PAE:+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0
+000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0 +000.0

ASH111661
L1 N: -000.50 E: -001.40 U: +075.40
L1 PAE:+000.0 +000.6 +001.5 +002.6 +003.8 +005.0 +006.0 +006.9 +007.5 +007.7
+007.4 +006.6 +005.3 +003.4 +000.8 -002.5 -006.5 +000.0 +000.0
L2 N: -002.20 E: -001.00 U: +071.90

L2 PAE:+000.0 -000.7 -000.8 -000.3 +000.4 +001.2 +002.0 +002.6 +002.9 +003.0
+002.7 +002.1 +001.1 -000.2 -001.8 -003.5 -005.3 +000.0 +000.0

ASH802129
L1 N: -002.00 E: +000.70 U: +103.00
L1 PAE:+000.0 +001.0 +002.1 +003.5 +004.8 +006.0 +006.9 +007.7 +008.0 +008.1
+007.7 +006.9 +005.8 +004.3 +002.5 +000.5 -001.6 +000.0 +000.0
L2 N: -003.40 E: -002.20 U: +100.80
L2 PAE:+000.0 -000.6 -000.6 +000.0 +000.9 +001.8 +002.7 +003.3 +003.8 +004.0
+003.7 +003.0 +002.0 +000.6 -001.1 -003.1 -005.2 +000.0 +000.0

Symbols

ProFlex™ Lite Series

Reference Manual

Survey Solutions Contact Information:
In USA +1 408 572 1103 ▪ Fax +1 408 572 1199
In South America +1 305 726 7813
Email surveysales@ashtech.com

In France +33 2 28 09 38 00 ▪ Fax +33 2 28 09 39 39
In Russia +7 495 980 5400 ▪ Fax +7 495 981 4840
Email surveysalesemea@ashtech.com

In Singapore +65 9838 4229 ▪ Fax +65 6777 9881
In China +86 10 5802 5174 ▪ Fax +86 10 5802 5135
Email surveysalesapac@ashtech.com
www.ashtech.com

ashtech™