ashtech
A TRIMBLE COMPANY

# ADU800


## Reference Manual

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# Introduction to the ADU800

ADU800 is a precise, GNSS-based, three-dimensional RTK position and attitude determination system, providing real-time heading, pitch and roll measurements, with accurate position and velocity, at a standard update rate of up to 20 Hz, for static and dynamic platforms.

The ADU800 can be used in such GNSS applications as gyrocompass calibration, open-pit mining, seismic exploration and oceanographic research.

GNSS attitude determination is based on differential carrier phase measurements between three antennas connected to the ADU800. Accuracy is basically 0.2° ($1\sigma$) per meter of baseline for the three attitude parameters when antennas are set up as explained in this manual.

The ADU800 is housed in a weatherproof, lightweight, small-sized and rugged enclosure accommodating three GNSS boards (1 x MB800 + 2 x MB100). It is fitted with a built-in power supply extending the input voltage range to between 9 and 36 V DC while maintaining a low power consumption regardless of the power input voltage.

Built in a weatherproof, rugged and small-size unit, the ADU800 can be operated in harsh environments while requiring a minimum of space for its installation.

As a lightweight unit, the ADU800 is also compatible with airborne applications for which weight considerations are critical.

The ADU800 receiver is built around the GPS/GLONASS/SBAS MB100 and MB800 boards recently introduced in the market. Embedded Z-Blade™ technology 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,
- “GNSS-centric” operation.

A choice of antennas allows you to customize the ADU800 system to best meet the requirements of your application.

# List of Items

The table below gives 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.

## ADU800 Receiver

### Basic Supply

| Item | Part No. | Picture |
|---|---|---|
| **ADU800**, includes:<br>• Receiver enclosure (pictured) containing one MB800 board and two MB100 boards.<br>• Standard accessories (see *Standard Accessories on page 3*).<br>• Pre-installed firmware options in the MB800:<br>– [W]: 20-Hz output rate<br>– [J ]: RTK Rover<br>– [K]: RTK Base<br>– [L]: 1PPS output<br>– [E]: External event (event marker input)<br>– [Y]: SBAS tracking<br>– [G]: GLONASS tracking<br>– [S]: GPS L2CS tracking<br>– [V ]: RTK with Moving Base<br>– [H ]: Heading function<br>– [C]: Advanced multipath mitigation<br>– [P]: GPS/GLONASS L2 tracking<br>– [F]: Flying RTK<br>– [A]: Attitude<br>– [N]: GPS tracking<br>• Pre-installed firmware options in each MB100:<br>– [W]: 20-Hz output rate<br>– [K]: RTK Base<br>– [L]: 1PPS output<br>– [E]: External event (event marker input)<br>– [Y]: SBAS tracking<br>– [G]: GLONASS tracking<br>– [S]: GPS L2CS tracking<br>– [C]: Advanced multipath mitigation<br>– [P]: GPS/GLONASS L2 tracking<br>– [N]: GPS tracking | 91857 |  |

## Recommended Antennas

| Item | Part No. | Picture |
|---|---|---|
| ASH-660 L1 GNSS antenna, gain: 38 dB | 802133-INT |  |
| ASH-661 L1/L2/L5 GNSS antenna, gain: 38 dB | 802135-INT |  |
| AV59 Trimble antenna, L1/L2/L5 GNSS + Omnistar aviation/marine/machine, not TSO certified, 39 dB gain | C02992 |  |
| LV59 Trimble antenna, L1/L2/L5 GNSS + Omnistar aviation/marine/machine, not TSO certified, 5/8” mount, 39 dB gain | C03167 |  |
| AV34 Trimble antenna, L1/L2 GNSS compact aviation/marine/machine, 43 dB gain | 86362 |  |
| AV33 Trimble antenna, L1 GNSS compact aviation/marine/machine, 43 dB gain | 83553 |  |
| AV33/34 antenna bracket | 84902 |  |

## Standard Accessories

The items listed below are provided as standard with the ADU800 receiver.

| Item | Picture |
|---|---|
| AC/DC power kit |  |
| Receiver-to-PC RS232 cable (x 3) |  |
| Mounting parts (consists of two sliding bars) |  |

| Item | Picture |
|---|---|
| Transport bag |  |
| Battery power kit, includes primary SAE-terminated power cable + choice of two cable extensions to battery terminals, one with alligator clips, the other with screw terminals; both equipped with in-line, car type, 5-A fuse. |  |

## Optional Accessories

The items listed below are made available as options for the ADU800.

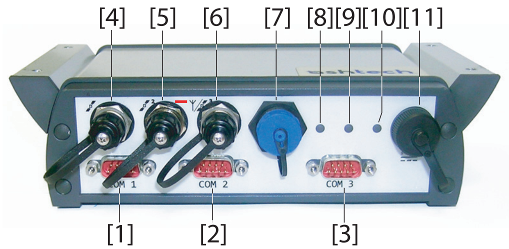
| Item | Part No. | Picture |
|---|---|---|
| Receiver-to-PC RS232 cable | 730049 |  |
| 2-meter, USB/mini-B, USB/A waterproof cable | 111632 |  |

| Item | Part No. |
|---|---|
| Antenna cable (RG58, double-shielded), TNC-m, right angle, to TNC-m, straight, 5 meters in length. | 58957-05-INT |
| Antenna cable (RG58, double-shielded), TNC-m, right angle, to TNC-m, straight, 10 meters in length. | A02500 |
| Antenna cable (LMR400), TNC-m, right angle, to TNC-m, straight, 30 meters in length. | A02501 |

## Software Utility

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

## Front Panel




**[1]**: Serial port COM 1, internally connected to MB800 board, port A

**[2]**: Serial port COM 2, internally connected to MB100 board #1, port B

**[3]**: Serial port COM 3, internally connected to MB100 board #2, port B.

**[4]** : GNSS input #1 (TNC-f connector with protective cap).

**[5]** : GNSS input #2 (TNC-f connector with protective cap).

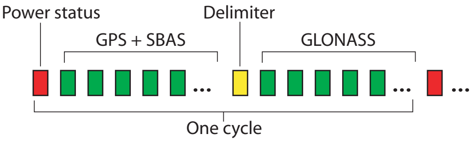
**[6]** : GNSS input #3 (TNC-f connector with protective cap).

**[7]**: Standard USB 2.0 port in a protective circular connector, connected internally to MB800 board, port C.

**[8]**, **[9]** and **[10]**: GNSS indicator lights allowing you to monitor the power status and constellations of satellites for the three GNSS boards used. **[8]** refers to the MB800 (GNSS input #1), **[9]** to MB100 board #1 (GNSS input #2) and **[10]** to MB100 board #2 (GNSS input #3).

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

| Color | Meaning |
|---|---|
| Red | Power |
| Green | GNSS reception |
| Yellow | Delimiter between GPS/SBAS and GLONASS |



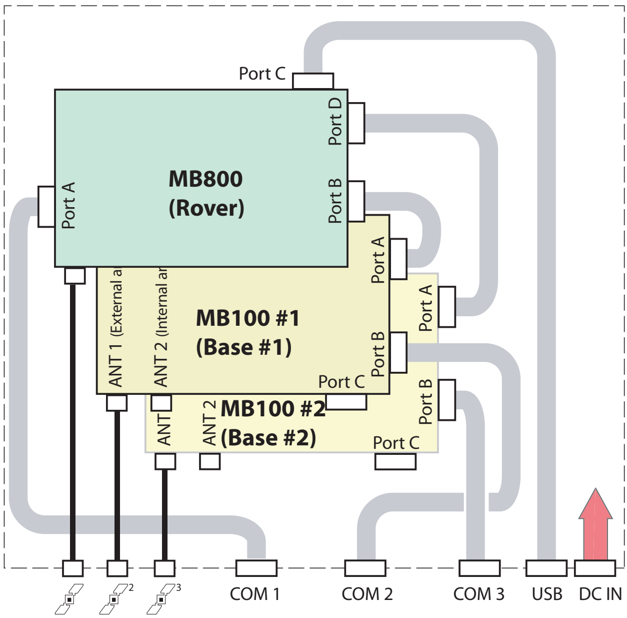

- The sequence of red, green and yellow flashes describes the following:
  1. One red flash: Means the board is powered properly.
  2. Green flashes: The number of green flashes is equal to the number of GPS and SBAS satellites tracked and locked.
  3. One yellow flash: Ends the first sequence of green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

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

## Internal Connections

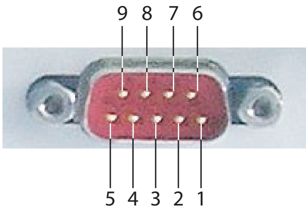
The diagram below gives the internal connections in the ADU800.




## Port Pinouts

### Serial Data Ports

COM 1, COM 2 and COM 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) | Receive Data (RX) |
| 3 | Transmit Data (TX) | Transmit Data (TX) | Transmit Data (TX) |

| Pin | COM 1 | COM 2 | COM 3 |
|---|---|---|---|
| 4 | NC | NC | NC |
| 5 | Ground | Ground | Ground |
| 6 | NC | NC | NC |
| 7 | Request To Send (RTS) | Request To Send (RTS) | NC |
| 8 | Clear To Send (CTS) | Clear To Send (CTS) | NC |
| 9 | 1PPS / 5V DC | Ext. Event input / 5 V DC | NC / 5 V DC |

NOTE: Pin 9 on the three ports may alternately be used to deliver 5 V DC. This requires the use of a jumper on each port. Please contact the Ashtech Technical Support for more information. Inserting the jumper relevant to COM1 means you remove the 1PPS output from this port. Inserting the jumper relevant to COM2 means you remove the external event input from this port. When the 5 V DC is made available on either of these ports, remember the total DC current taken from the 5 V DC should not exceed 1 Amp. If for example, the device connected to COM 1 consumes 700 mA, then only 300 mA can be shared between the other two ports.

**1PPS Signal Output**:

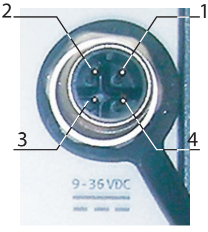
- Available on COM 1, pin 9.
- Provided by the MB800 board.

**External Event Signal Input**:

- Located on COM 2, pin 9.
- Applied to MB100 board #1

## Power In

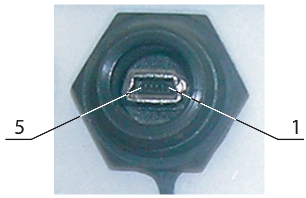
4-C Connector, type 99-3431-601-04, fitted with a sealing cap.




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

### USB Port, Device

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



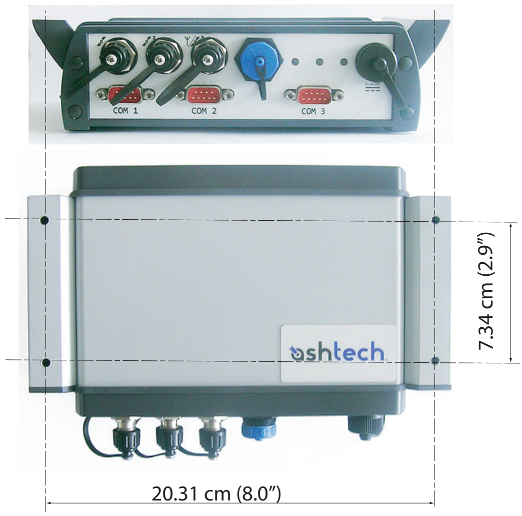

| Pin | Signal Name |
|---|---|
| 1 | NC |
| 2 | D- |
| 3 | D+ |
| 4 | NC |
| 5 | Ground |

NOTE: Pin 1 is usually dedicated to carrying a +5 VDC power voltage for the USB device. In the ADU800 receiver, the USB port is powered from the unit itself, thus making useless the need for providing an external +5 VDC via this pin.

## ADU800 Receiver

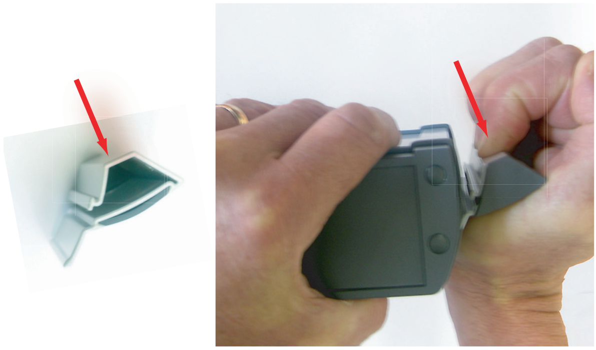
The ADU800 receiver can be mounted onto any flat support after you have secured the provided wall fitting kit onto the case. The kit consists of two identical sliding bars.

Prepare the support by drilling the required four holes (dia. 4 mm). The four holes form a rectangle of 20.31 cm in width and 7.34 cm in depth (see diagram below).




To secure each of the two sliding bars onto the case, turn the slide to the case as shown on the picture below, inserting the lower part first into the groove, then just push the bar against the case. This will securely fasten the bar onto the side of the case.

If for some reason you need to remove a bar, squeeze it as shown on the picture below. By squeezing the bar, you temporarily deform the aluminum plate thus releasing it from the case.



## Installing the Three Antennas

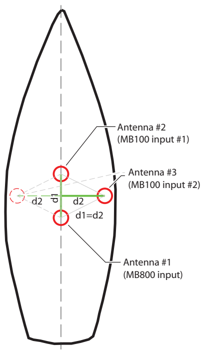
Consider the following criteria:

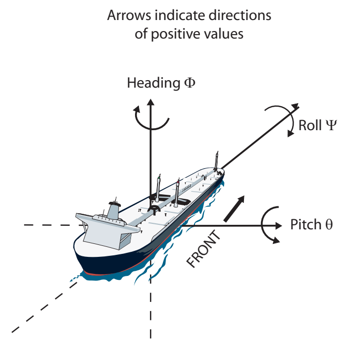
1. **Antenna Location and Spacing**: Avoid placing antennas on wing tips of aircraft. Due to excessive wing-flex of the antenna baseline, the attitude computation algorithm becomes unreliable.

   The ADU800 requires that the antennas be separated from each other by at least 50 centimeters (see next criterion).

2. **Geometrical Configuration**: The diagram below shows how to install the three antennas with respect to the vehicle’s centerline and direction of forward movement (see below left; shown for a ship).

   Using this setup, the ADU800 will measure the three angles of attitude (heading, roll and pitch) as shown on the diagram below (right):




   Antenna #3 may be installed either to the right or to the left of the Antenna #1-to-Antenna #2 baseline. This has no impact on how the heading, roll and pitch angles are measured.

   The distance (d1) between antennas #1 and #2 should be chosen in the range 0.5-1,000 meters. So should be d2.

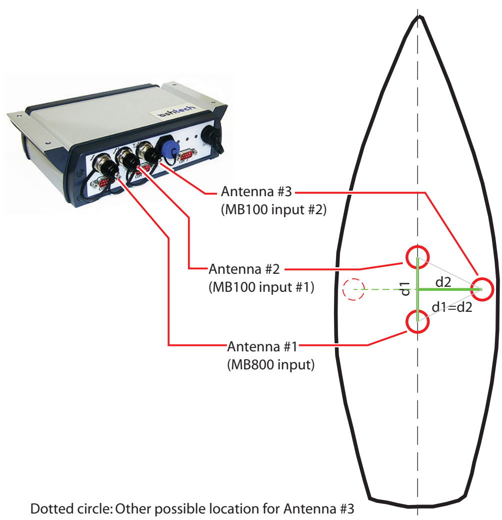
   The three antennas should preferably be installed at the same elevation. However azimuth offsets and elevation offsets may be used at non-zero values to compensate for vertical an horizontal deviations (see *Special Cases of Elevation and Azimuth Offsets on page 14*). All offsets are measured from Antenna #1 and may be different for Antenna #2 and Antenna #3.

   When a single L1/L2 GNSS antenna is used (combined with two L1 GNSS antennas), then this L1/L2 GNSS antenna should necessarily be used as antenna #1.

3. **Accuracy**: The further the antennas are spaced from each other, the greater the potential attitude measurement accuracy provided by the ADU800. But the longer the time required to calibrate the system.

   The same level of accuracy will be achieved for the three values of attitude when the three antennas are installed at the vertices of an isosceles triangle in which the perpendicular bisector (**d2**) is equal to the base of the triangle (**d1**). See **d1=d2** in the above diagram.

4. **Multipath Mitigation**: The reliability of the phase ambiguity resolution and the attitude accuracy is degraded by multipath signals. The antennas should be located on top of the vehicle (or platform) to minimize the possibility of satellite signals reflecting off metal objects near the antennas.
5. **Stability**: The ADU800 behavior depends upon the stability of the three-antenna setup. This means that the selected antenna mounting locations should not move in any direction (up/down, left/right) relative to the other antennas. If the vehicle (or platform) moves, the entire antenna system should move in the same manner. Use care in mounting antennas on flexible structures such as the mast of a ship or the wing tips of an airplane.
6. **Maximum Length**: The supplied cables have a maximum length for the particular type of cable. Do not extend the cables beyond 30 meters without an in-line amplifier, provided as an option, since the radio frequency (RF) signal presented to the ADU800 will be degraded.



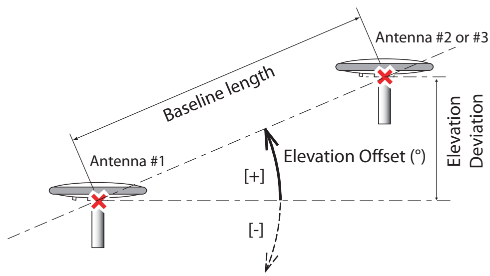

Use only the cables provided. Avoid bending the cables too much as this might spoil the cable and deteriorate its RF performance.

## Special Cases of Elevation and Azimuth Offsets

To enter the elevation and azimuth offsets into the ADU800, refer to *Entering Elevation and Azimuth Offsets on page 29*.

### Elevation Offset

Ideally, the three antennas should be installed at the same elevation. You may however be facing some installation constraints on your vehicle/ship compelling you to install the antennas at different elevations. If that is the case, this is how you should calculate the elevation offset between Antenna #1 and Antenna #2 or/and Antenna #1 and Antenna #3 after measuring the elevation deviation and the baseline length. The sign of the elevation offset is also provided on the diagram below (elevation offset positive if Antenna #1 is lower than Antenna #2/Antenna #3, negative otherwise.




$$\left|Elevation\ Offset\ (°)\right| = arcsin\ \frac{Elevation\ Deviation\ (m)}{Baseline\ Length\ (m)}$$

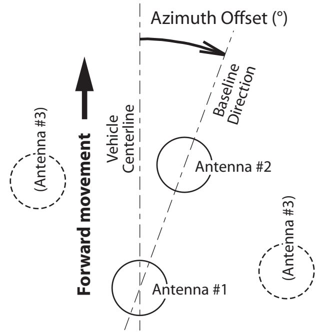
⚠ **The elevation offset should not be greater than 45 degrees (or less than -45 degrees)**, or the receiver will consider the antenna setup to be invalid and so will not deliver any heading, roll or pitch measurements.

### Azimuth Offset

Ideally, Antenna #1 and Antenna #2 should be installed to generate a baseline strictly parallel or perpendicular to the vehicle centerline. However, you may also be facing some installation constraints on your vehicle compelling you to install the antennas differently.

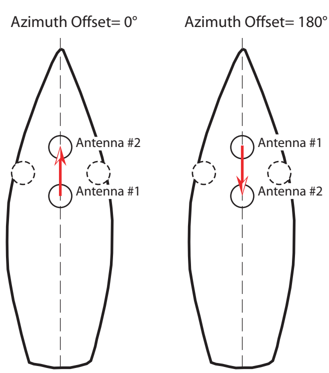
The azimuth offset describes the non-alignment of the Antenna #1-Antenna #2 baseline with the vehicle centerline. When the baseline is strictly parallel to the centerline and the baseline is oriented in the direction of forward movement, the azimuth offset is zero.

In all other cases, the offset is non-zero and should be measured as shown in the diagram below.




## Correlation Between Azimuth Offset, Antenna Setup & Heading Measurement Made

Consider the following two setups before installing your antennas. A ship is shown in the examples but this could be any other type of vehicle.




(Red arrow indicates the direction for which heading is measured.)
(Antenna #3 occupies the location of one of the dotted circles.)

## Applying Power

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 ADU800 receiver. 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).

## Using Serial Commands

You will need to use serial commands ($PASHS.., $PASHQ,..) sent from a personal computer to control or monitor your receiver. Commands may be sent via any of the available receiver ports –including the USB port– using the appropriate data cable. However, using COM1 is recommended.

The first time you connect your ADU800 receiver to a computer through a USB link, you will be asked to install the USB driver. This driver can be found on the Ashtech-oem web site (www.ashtech-oem.com).

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 Ashtech-oem web site as well), 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.

## Precautions to Be Taken at Power-Off

Whenever you send a $PASHS command (set command) to your ADU800 receiver, you must be aware that the resulting change is not saved to backup memory instantly, but only after a certain delay, which is estimated to be not greater than 120 seconds. There is a requirement behind this operating mode, which is to extend the chip's life cycle as much as possible by reducing the number of write operations in the memory chip.

Because the $PASHS commands causing the receiver to restart (i.e. INI, RTS, CFG, POP, PWR, etc.) are also part of the "delayed" commands (seen from the backup memory), it is therefore recommended that you run $PASHS,PWR,OFF about 2 to 3 seconds before you turn off the receiver or you initiate a power cycle or reset:

**$PASHS,PWR,OFF*43**

This command is used to prepare the receiver to be powered off by saving all your recent settings and parameters to the non-volatile memory. This command DOES NOT switch off the receiver.

After $PASHS commands have been applied to the three boards, then the $PASHS,PWR,OFF command should be run in each of them.

The ADU800 can be used in two different configurations:

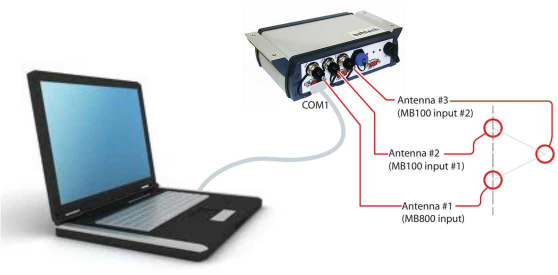
- Attitude sensor delivering real-time heading, roll and pitch measurements.
- Attitude sensor, as above, + RTK position output for Antenna #1 location.

By default, the ADU800 is configured to operate as a pure attitude sensor.

When first using the ADU800 with its three-antenna setup, you will need to calibrate the system and define output messages.

## Attitude Sensor

1. Power on the ADU800.
2. Connect a computer to COM1 on the ADU800 using the Receiver-to-PC RS232 cable provided.




3. Turn on the computer, then run a utility of your choice (see *Controlling the ADU800 Receiver from a Computer on page 17*) so you can send $PASH commands from the computer keyboard.
4. Send the following command to configure the ADU800 as an attitude sensor:

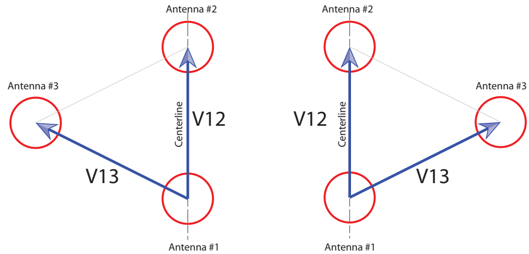
   **$PASHS,ABX,10,2+0**

   The ADU800 will return the following response:

   $PASHR,ACK*3D

   In this configuration, the ADU800 accurately determines two vectors from which attitude measurements are made.

(See diagrams below; vectors V12 and V13 are shown in the possible two geometrical configurations for the antenna setup.)




5. Allow the ADU800 to output attitude measurements through one or more NMEA (or NMEA-like) messages on port COM1 (MB800 port A). Choose to run one or more of the commands below to output the messages you need.

   **1) Attitude Message**: Run the command below to enable the delivery of attitude messages on port COM1:

   **$PASHS,NME,ATT,A,ON,<output_rate>**

   For an output rate of 2 Hz for example, send the following command:
   **$PASHS,NME,ATT,A,ON,0.5**

   Once calibration is complete (see below how to initiate calibration), the ADU800 will start delivering ATT messages. See *ATT Message Format on page 28* for more information.

   **2) Heading Message**: Run the command below to enable the delivery of heading messages on port COM1:

   **$PASHS,NME,HDT,A,ON,<output_rate>**
   OR
   **$PASHS,NME,THS,A,ON,<output_rate>**

   For an output rate of 5 Hz for example, send the following command:
   **$PASHS,NME,HDT,A,ON,0.2**
   OR
   **$PASHS,NME,THS,A,ON,0.2**

   Once calibration is complete (see below how to initiate calibration), the ADU800 will start delivering HDT (or THS) messages. See *HDT or THS Message Format on page 28* for more information.

6. The ADU800 needs to be calibrated the first time you use it. Send the following command to start calibration:

   **$PASHS,3DF,CLB**

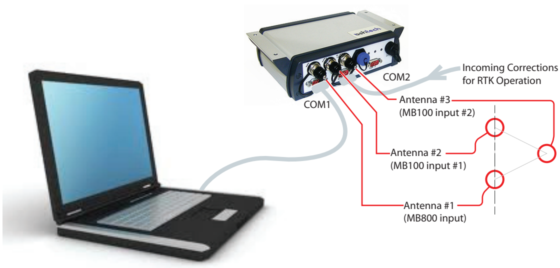
   The ADU800 will return the following response:

   $PASHR,ACK*3D

   **Important!** This operation will also be needed every time you change the antenna setup. As long as the same antenna setup is used, and once the calibration has been done, you don't need to re-calibrate the ADU800 at every system power up.
7. After calibration has been started, unplug the computer.
8. Connect COM1 to the peripheral in charge of collecting the output messages delivered by the ADU800. Heading/attitude measurements will be delivered as soon as calibration is complete.

## Attitude Sensor + RTK Position for Antenna #1

1. Power on the ADU800.
2. Connect a computer to COM1 on the ADU800 using the Receiver-to-PC RS232 cable provided.
3. Connect the source of corrections to port COM2.



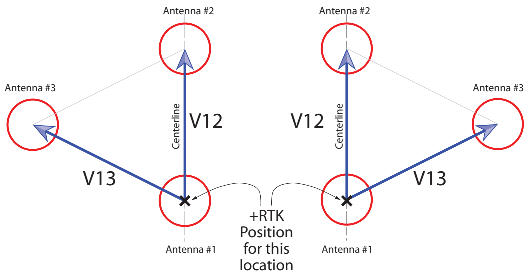

4. Turn on the computer, then run a utility of your choice (see *Controlling the ADU800 Receiver from a Computer on page 17*) so you can send $PASH commands from the computer keyboard.
5. Send the following command to configure the ADU800 as an attitude sensor, and delivering the RTK position of Antenna #1.

   **$PASHS,3DF,ABX,10,2+1**

   The ADU800 will return the following response:

   $PASHR,ACK*3D

In this configuration, the ADU800 accurately determines two vectors (V12, V13) from which attitude measurements are made. It also delivers an RTK position solution for the location of Antenna #1, using corrections applied to ADU800, port COM2. (See also diagrams below; vectors V12 and V13 are shown in the possible two geometrical configurations for the antenna setup.)




6. Run this series of commands so that the incoming corrections applied to COM2 be processed correctly inside the ADU800.
   - Run the following command on COM1:

     **$PASHS,DIF,PRT,Z**

   - Run the following commands on COM2:

     **$PASHS,ATM,DAT,A,ON,&EXT**
     **$PASHS,P2P,B,Z**
     **$PASHS,SPD,B,<baud rate code>**

   NOTE: Baud Rate Codes:

| Code | Baud Rate | Code | Baud Rate | Code | Baud Rate |
|---|---|---|---|---|---|
| 2 | 1 200 | 7 | 38 400 | 12 | 921 600 |
| 3 | 2 400 | 8 | 57 600 | 13 | 1 428 471 |
| 4 | 4 800 | 9 | 115 200 | 14 | 2 500 000 |
| 5 | 9 600 | 10 | 230 400 | 15 | 5 000 000 |
| 6 | 19 200 | 11 | 460 800 | | |

7. Allow the ADU800 to output attitude measurements and RTK position through one or more NMEA (or NMEA-like) messages on port COM1 (MB800 port A). Choose to run one or more of the commands below to output the messages you need.

**1) Attitude Message**: Run the command below to enable the delivery of attitude messages on port COM1:

**$PASHS,NME,ATT,A,ON,<output_rate>**

For an output rate of 2 Hz for example, send the following command:
**$PASHS,NME,ATT,A,ON,0.5**

Once calibration is complete (see below how to initiate calibration), the ADU800 will start delivering ATT messages. See *ATT Message Format on page 28* for more information.

**2) Heading Message**: Run the command below to enable the output of heading messages on port COM1:

**$PASHS,NME,HDT,A,ON,<output_rate>**
OR
**$PASHS,NME,THS,A,ON,<output_rate>**

For an output rate of 5 Hz for example, send the following command:
**$PASHS,NME,HDT,A,ON,0.2**
OR
**$PASHS,NME,THS,A,ON,0.2**

Once calibration is complete (see below how to initiate calibration), the ADU800 will start delivering HDT (or THS) messages. See *HDT or THS Message Format on page 28* for more information.

**3) RTK Position Message**: The NMEA GGA message is typically used to output position solutions. Run the following command to enable the output of GGA messages on port COM1:

**$PASHS,NME,GGA,A,ON,<output_rate>**

For an output rate of 20 Hz for example, send the following command:
**$PASHS,NME,GGA,A,ON,0.05**

Once calibration is complete (see below how to initiate calibration), the ADU800 will start delivering GGA messages. See *GGA Message Format on page 29* for more information.

8. The ADU800 needs to be calibrated the first time you use it. Send the following command to start calibration:

   **$PASHS,3DF,CLB**

   The ADU800 will return the following response:

   $PASHR,ACK*3D

**Important!** This operation will also be needed every time you change the antenna setup. As long as the same antenna setup is used, and once the calibration has been done, you don't need to re-calibrate the ADU800 at every system power up.

9. After calibration has been started, unplug the computer.
10. Connect COM1 to the peripheral in charge of collecting the output messages delivered by the ADU800. Heading/attitude/position measurements will be delivered as soon as calibration is complete.

    You can read the result of the calibration using the command below:

    **$PASHQ,PAR,3DF**

## GNSS Characteristics

- 210 (120 + 2x45) channels:
  - GPS L1 C/A, L1/L2 P-code, L2C, L5
  - GLONASS L1 C/A, L2 C/A code
  - GALILEO E1 and E5
  - SBAS L1 (WAAS/EGNOS/MSAS/GAGAN)
  - QZSS
- Z-Blade™ technology (Ashtech GNSS centric algorithm) for optimal GNSS performance (1)
- Quick signal detection engine for fast acquisition and re-acquisition of GNSS signals
- Fast and stable RTK solution + attitude solution
- Up to 20 Hz real-time raw data, position and heading output
- Advanced multipath mitigation technique

## Real-Time Accuracy

All mentioned values are HRMS. See (2) and (3)

**SBAS (WAAS/EGNOS/MSAS)**

- < 50 cm (1.64 ft)

**DGPS**

- 25 cm (0.82 ft) + 1 ppm (4)

**RTK**

- 1 cm (0.033 ft) + 1 ppm (4)

**Flying RTK™**

- 5 cm (0.165 ft) + 1 ppm for baselines up to 1,000 km

**Velocity**

- 95%: 0.1 knots (2)

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1.All available GNSS signals are processed equally and combined to improve performance in harsh environment.

2.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 less than horizontal error x 2.

3.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.

4.Steady state value for baselines less than 50 km after sufficient convergence time.

## Real-Time Attitude Accuracy

**1-meter Antenna Separation** (1)

- Heading: 0.2° rms
- Pitch/roll: 0.4 ° rms

**3-meter Antenna Separation**

- Heading: 0.06° rms
- Pitch/roll: 0.12 ° rms

**10-meter Antenna Separation**

- Heading: 0.02° rms
- Pitch/roll: 0.04 ° rms

## Real-Time Performance

**Instant-RTK Initialization**

- Typically 2-second initialization for baselines < 20 km
- Up to 99.9% reliability (user-configurable)

**RTK Initialization Range**

- > 40 km

**Time to First Fix** (2)

- Re-acquisition: 3 sec
- Hot start: 15 sec
- Warm start: 35 sec
- Cold start: 45 sec
- < 1-minute cold start to first attitude data

## RTK Rover

- Up to 20 Hz Fast RTK
- RTCM 2.3 & RTCM 3.1
- CMR & CMR+
- DBEN, LRK & ATOM (Ashtech formats)
- Networks: VRS, FKP, MAC
- NMEA 0183 messages output
- RTK with moving base operation.
- Heading and pitch or roll determination with auto-calibration.

## I/O Interface

- 3 x RS232
- 1 x USB 2.0 port

---

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

2.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 less than horizontal error x 2.

- 1 x PPS output
- 1 x Event Marker Input
- 3 x TNC-f antenna connectors
- 5-V power output on RS232 pin 9 (hardware jumper)

**Physical Characteristics**

- Size (W x H x D): 190 x 58 x 160 mm (7.48 x 2.28 x 6.3”) With sliding bars, width is 221.5 mm (8.72”)
- Weight: 1.4 kg (3.08 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
- IP67
- Shock: MIL-STD 810F, Fig 516.5-10 (40g, 11 ms, sawtooth)
- Vibration: MIL-STD-810F, Fig 514.5C-175
- Speed (max.): 514 m/s (1,000 knots)
- Altitude (max.): 18,287 meters (60,000 feet)

**Power Characteristics**

- 9-36 V DC DC input
- Power input protected from over-voltages (70 Volts max.)
- Protected from accidental polarity reversal
- Protected against electrical disturbances of vehicles with 12 V and 24 V supply voltages (ISO 7637 standard)
- Typical power consumption with 12-V DC input: 5.5 W
- GNSS antenna(s) powered from 5 V DC (±10%); DC current: 100 mA max., 5 mA min.

**Recommended Antennas**

- Compact GNSS machine/Marine/Aviation antennas: Trimble AV33 & AV34
- GNSS Machine/Marine/Aviation antennas: Trimble LV59 & AV59

**Configuration Tool**

Ashtech Communicator is a GNSS utility for evaluation and configuration.

- Preset of commands
- Real-time data logging
- Real-time data visualization

## ATT Message Format

ATT messages are formatted as described below.

$PASHR,ATT,f1,f2,f3,f4,f5,f6,d7*cc

Where:

| 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":<br>• 0: Fixed<br>• >0: Float | 0, >0 |
| *cc | Checksum | *00-*FF |

## HDT or THS Message Format

HDT or THS messages are formatted as described below.

$GPHDT,f1,T*cc
OR
$GPTHS,f1,T*cc

Where:

| Parameter | Description | Range |
|---|---|---|
| f1,T | Last computed heading value, in degrees<br>"T" for "True". | 0-359.9° |
| *cc | Checksum | *00-*FF |

## GGA Message Format

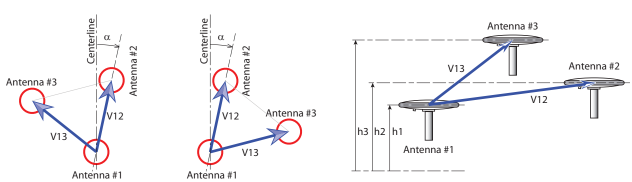
GGA messages are formatted as described below.

$GPGGA,m1,m2,c3,m4,c5,d6,d7,f8,f9,M,f10,M,f11,d12*cc

| Parameter | Description | Range |
|---|---|---|
| m1 | Current UTC time of position (hhmmss.ss) | 000000.00-<br>235959.99 |
| m2 | Latitude of position (ddmm.mmmmmm) | 0-90<br>0-59.999999 |
| c3 | Direction of latitude | N, S |
| m4 | Longitude of position (dddmm.mmmmmm) | 0-180<br>0-59.999999 |
| c5 | Direction of longitude | E,W |
| d6 | Position type:<br>• 0: Position not available or invalid<br>• 1: Autonomous position<br>• 2: RTCM Differential (or SBAS Differential)<br>• 3: Not used<br>• 4: RTK fixed<br>• 5: RTK float<br>• 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 |

## Entering Elevation and Azimuth Offsets

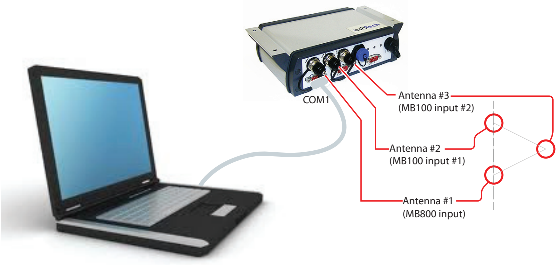
If Antenna #1 and Antenna #2 are not parallel to the vehicle centerline, you need to measure the azimuth offset ($\alpha$) by your own means.




If Antenna #2 and/or Antenna #3 are not at the same elevation as Antenna #1, you need to measure the elevation offset by your own means for each antenna. (See *Special Cases of Elevation and Azimuth Offsets on page 14* to calculate the elevation offset).

Once you have measured these offsets, follow the procedure below to enter their values into the ADU800:

- Power on the ADU800.
- Connect a computer to COM1 on the ADU800 using the Receiver-to-PC RS232 cable provided.




- Turn on the computer, then run a utility of your choice (see *Controlling the ADU800 Receiver from a Computer on page 17*) so you can send $PASH commands from the computer keyboard.
- Send the following command to enter the elevation and azimuth offsets of Antenna #2:

  **$PASHS,CP2,ARR,OFS,<azimuth_offset>,<elevation_offset>**
  With azimuth offset = 5.2°and elevation offset = -0.56 m, you would type:
  **$PASHS,CP2,ARR,OFS,5.2,-0.56**

- Send the following command to enter the elevation azimuth of Antenna #3 (the notion of azimuth offset is irrelevant to Antenna #3):

  **$PASHS,CP3,ARR,OFS,,<elevation_offset>**
  With elevation offset = 0.27 m, you would type:
  **$PASHS,CP3,ARR,OFS,,0.27**

# ADU800

Reference Manual

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