User Guide

Acutime™ GG

Multi-GNSS Smart Antenna

For use with:

Acutime GG multi-GNSS smart antenna (P/N 92626-XX)

Acutime GG Starter Kit (P/N 92636-XX)

Version 1.0
Revision G
November 2014
Part Number 89996-00

Legal Notices

Corporate Office

Trimble Navigation Limited
Component Technologies
935 Stewart Drive
Sunnyvale, CA 94085
U.S.A.
1-800-767-4822 (toll-free in the USA)

+1-408-481-7921 www.trimble.com

Email: trimble_support@trimble.com

Copyright and Trademarks

Release Notice

This is the November 2014 release (Revision G) of the *Acutime™ GG multi- GNSS smart antenna User Guide*, part number 89996-00.

LIMITED WARRANTY TERMS AND CONDITIONS

Product Limited Warranty

Subject to the following terms and conditions, Trimble Navigation Limited (“Trimble”) warrants that for a period of one (1) year from date of purchase this Trimble product (the “Product”) will substantially conform to Trimble's publicly available specifications for the Product and that the hardware and any storage media components of the Product will be substantially free from defects in materials and workmanship.

Product Software

Product software, whether built into hardware circuitry as firmware, provided as a standalone computer software product, embedded in flash memory, or stored on magnetic or other media, is licensed solely for use with or as an integral part of the Product and is not sold. If accompanied by a separate end user license agreement (“EULA”), use of any such software will be subject to the terms of such end user license agreement (including any differing limited warranty terms, exclusions, and limitations), which shall control over the terms and conditions set forth in this limited warranty.

Software Updates

During the limited warranty period you will be entitled to receive such updates to the Product software that Trimble releases and makes commercially available and for which it does not charge separately, subject to the procedures for delivery to purchasers of Trimble products generally. If you have purchased the Product from an authorized Trimble dealer rather than from Trimble directly, Trimble may, at its option, forward the software Fix to the Trimble dealer for final distribution to you. Minor Updates, Major Upgrades, new products, or substantially new software releases, as identified by Trimble, are expressly excluded from this update process and limited warranty. Receipt of software updates or other enhancements shall not serve to extend the limited warranty period.

For purposes of this warranty the following definitions shall apply: (1) “Fix(es)” means an error correction or other update created to fix a previous software version that does not substantially conform to its Trimble specifications; (2) “Minor Update” occurs when enhancements are made to current features in a software program; and (3) “Major Upgrade” occurs when significant new features are added to software, or when a new product containing new features replaces the further development of a current product line. Trimble reserves the right to determine, in its sole discretion, what constitutes a Fix, Minor Update, or Major Upgrade.

Warranty Remedies

If the Trimble Product fails during the warranty period for reasons covered by this limited warranty and you notify Trimble of such failure during the warranty period, Trimble will repair OR replace the nonconforming Product with new, equivalent to new, or reconditioned parts or Product, OR refund the Product purchase

price paid by you, at Trimble’s option, upon your return of the Product in accordance with Trimble's product return procedures then in effect.

How to Obtain Warranty Service

To obtain warranty service for the Product, please contact your local Trimble representative or distributor. Alternatively, you may contact Trimble to request warranty service by sending an email tsgsupport@trimble.com, including the following information:

- your name, address, and telephone numbers
- proof of purchase
- a copy of this Trimble warranty
- a description of the nonconforming Product including the model number
- an explanation of the problem

The customer service representative may need additional information from you depending on the nature of the problem.

Warranty Exclusions and Disclaimer

This Product limited warranty shall only apply in the event and to the extent that (a) the Product is properly and correctly installed, configured, interfaced, maintained, stored, and operated in accordance with Trimble's applicable operator's manual and specifications, and; (b) the Product is not modified or misused. This Product limited warranty shall not apply to, and Trimble shall not be responsible for, defects or performance problems resulting from (i) the combination or utilization of the Product with hardware or software products, information, data, systems, interfaces, or devices not made, supplied, or specified by Trimble; (ii) the operation of the Product under any specification other than, or in addition to, Trimble's standard specifications for its products; (iii) the unauthorized installation, modification, or use of the Product; (iv) damage caused by: accident, lightning or other electrical discharge, fresh or salt water immersion or spray (outside of Product specifications); or exposure to environmental conditions for which the Product is not intended; (v) normal wear and tear on consumable parts (e.g., batteries); or (vi) cosmetic damage. Trimble does not warrant or guarantee the results obtained through the use of the Product, or that software components will operate error free.

NOTICE REGARDING PRODUCTS EQUIPPED WITH TECHNOLOGY CAPABLE OF TRACKING SATELLITE SIGNALS FROM SATELLITE BASED AUGMENTATION SYSTEMS (SBAS) (WAAS/EGNOS, AND MSAS), OMNISTAR, GPS, MODERNIZED GPS OR GLONASS SATELLITES, OR FROM IALA BEACON SOURCES: TRIMBLE IS NOT RESPONSIBLE FOR THE OPERATION OR FAILURE OF OPERATION OF ANY SATELLITE BASED POSITIONING SYSTEM OR THE AVAILABILITY OF ANY SATELLITE BASED POSITIONING SIGNALS.

THE FOREGOING LIMITED WARRANTY TERMS STATE TRIMBLE’S ENTIRE LIABILITY, AND YOUR EXCLUSIVE REMEDIES, RELATING TO THE TRIMBLE PRODUCT. EXCEPT AS OTHERWISE EXPRESSLY PROVIDED HEREIN, THE PRODUCT, AND ACCOMPANYING DOCUMENTATION AND MATERIALS ARE PROVIDED “AS-IS” AND WITHOUT EXPRESS OR IMPLIED WARRANTY OF ANY KIND, BY EITHER TRIMBLE OR ANYONE WHO HAS BEEN INVOLVED IN ITS CREATION, PRODUCTION, INSTALLATION, OR DISTRIBUTION, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, TITLE, AND NONINFRINGEMENT. THE STATED EXPRESS WARRANTIES ARE IN LIEU OF ALL OBLIGATIONS OR LIABILITIES ON THE PART OF TRIMBLE ARISING OUT OF, OR IN CONNECTION WITH, ANY PRODUCT. BECAUSE SOME STATES AND JURISDICTIONS DO NOT ALLOW LIMITATIONS ON DURATION OR THE EXCLUSION OF AN IMPLIED WARRANTY, THE ABOVE LIMITATION MAY NOT APPLY OR FULLY APPLY TO YOU.

Limitation of Liability

TRIMBLE'S ENTIRE LIABILITY UNDER ANY PROVISION HEREIN SHALL BE LIMITED TO THE AMOUNT PAID BY YOU FOR THE PRODUCT. TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, IN NO EVENT SHALL TRIMBLE OR ITS SUPPLIERS BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGE WHATSOEVER UNDER ANY CIRCUMSTANCE OR LEGAL THEORY RELATING IN ANYWAY TO THE PRODUCTS, SOFTWARE AND ACCOMPANYING DOCUMENTATION AND MATERIALS, (INCLUDING, WITHOUT LIMITATION, DAMAGES FOR LOSS OF BUSINESS PROFITS, BUSINESS INTERRUPTION, LOSS OF DATA, OR ANY OTHER PECUNIARY LOSS), REGARDLESS OF WHETHER TRIMBLE HAS BEEN ADVISED OF THE POSSIBILITY OF ANY SUCH LOSS AND REGARDLESS OF THE COURSE OF DEALING WHICH DEVELOPS OR HAS DEVELOPED BETWEEN YOU AND TRIMBLE. BECAUSE SOME STATES AND JURISDICTIONS DO NOT ALLOW THE EXCLUSION OR LIMITATION OF LIABILITY FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES, THE ABOVE LIMITATION MAY NOT APPLY OR FULLY APPLY TO YOU.

PLEASE NOTE: THE ABOVE TRIMBLE LIMITED WARRANTY PROVISIONS WILL NOT APPLY TO PRODUCTS PURCHASED IN THOSE JURISDICTIONS (E.G., MEMBER STATES OF THE EUROPEAN ECONOMIC AREA) IN

WHICH PRODUCT WARRANTIES ARE THE RESPONSIBILITY OF THE LOCAL TRIMBLE AUTHORIZED DEALER FROM WHOM THE PRODUCTS ARE ACQUIRED. IN SUCH A CASE, PLEASE CONTACT YOUR LOCAL TRIMBLE AUTHORIZED DEALER FOR APPLICABLE WARRANTY INFORMATION.

Official Language

THE OFFICIAL LANGUAGE OF THESE TERMS AND CONDITIONS IS ENGLISH. IN THE EVENT OF A CONFLICT BETWEEN ENGLISH AND OTHER LANGUAGE VERSIONS, THE ENGLISH LANGUAGE SHALL CONTROL.

Notices

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

– Reorient or relocate the receiving antenna.

– Increase the separation between the equipment and the receiver.

– Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

– Consult the dealer or an experienced radio/TV technician for help.

Changes and modifications not expressly approved by the manufacturer or registrant of this equipment can void your authority to operate this equipment under Federal Communications Commission rules.

Canada

This digital apparatus does not exceed the Class B limits for radio noise emissions from digital apparatus as set out in the radio interference regulations of the Canadian Department of Communications, ICES-003.

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de Classe B prescrites dans le règlement sur le brouillage radioélectrique édicté par le Ministère des Communications du Canada, ICES-003.

Europe

This product has been tested and found to comply with the requirements for a Class B device pursuant to European Council Directive 89/336/EEC on EMC, thereby satisfying the requirements for CE Marking and sale within the European Economic Area (EEA). These requirements are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential or commercial environment.

Notice to Our European Union Customers

For product recycling instructions and more information, please go to www.trimble.com/ev.shtml.

Recycling in Europe: To recycle Trimble WEEE (Waste Electrical and Electronic Equipment, products that run on electrical power.), Call +31 497 53 24 30, and ask for the "WEEE Associate". Or, mail a request for recycling instructions to:

Trimble Europe BV

c/o Menlo Worldwide Logistics

Meerheide 45

5521 DZ Eersel, NL

Declaration of Conformity

We, Trimble Navigation Limited,

935 Stewart Drive
Sunnyvale, CA 94085-3913
United States
+1-408-481-8000

declare under sole responsibility that the product: Acutime™ GG multi-GNSS Smart Antenna Starter Kit complies with Part 15B of FCC Rules.

Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Safety Information

Warnings and Cautions

An absence of specific alerts does not mean that there are no safety risks involved. Always follow the instructions that accompany a Warning or Caution. The information they provide is intended to minimize the risk of personal injury and/or damage to the equipment. In particular, observe safety instructions that are presented in the following formats:

WARNING – A Warning alerts you to a likely risk of serious injury to your person and/or damage to the equipment.

CAUTION – A Caution alerts you to a possible risk of damage to the equipment and/or loss of data.

Operation and storage

WARNING – Operating or storing the Acutime GG multi-GNSS smart antenna outside the specified temperature range can damage it. For more information, see the product specifications on the data sheet.

Routing any cable

CAUTION – Be careful not to damage the cable. Take care to avoid sharp bends or kinks in the cable, hot surfaces (for example, exhaust manifolds or stacks), rotating or reciprocating equipment, sharp or abrasive surfaces, door and window jambs, and corrosive fluids or gases.

Contents

CHAPTER

1

Introduction

In this chapter:

The *Acutime™ GG multi-GNSS smart antenna User Guide* describes how to install, setup and use the Trimble® Acutime™ GG multi-GNSS smart antenna and timing receiver (“Acutime GG”)

The Acutime GG integrates the latest multi-GNSS technology into a rugged, self-contained antenna unit that provides optimal GPS timing performance, in all weather conditions, with continuous operation, long- term reliability, ease of operation, and simple installation.

The Acutime GG provides an accurate one pulse-per-second (PPS) output to synchronize and time broadband wireless, cellular base stations, Time Difference of Arrival (TDOA) applications, and many other Supervisory and Data Acquisition (SCADA) applications.

For more information on GPS, go to http://www.trimble.com/gps/index.shtml.

Features of the Acutime GG multi-GNSS smart antenna

Hardware features

The Acutime GG contains the following in a sealed, weatherproof housing:

- An active patch multi-GNSS antenna with a proprietary pre-amp design and integrated band-pass filtering providing excellent performance against jamming signals.
- A 32-channel, parallel-tracking multi-GNSS receiver, able to convert both GPS and GLONASS frequencies.
- A connector that supports both the power and data interface connection.
- Two user-configurable RS-422 I/O communication ports.

The Acutime GG operates with a 5 to 36 VDC power supply with protection against reverse polarity. Internal circuitry reduces the power to operate the receiver at 3.3 VDC.

When power is applied, the Acutime GG initializes by itself, acquires satellite signals, and begins a self-survey, which culminates in a transition from the Positioning Mode to an Over-determined Clock Mode.)

Interface protocols

You can select the protocol for the Acutime GG. There are two options:

- Trimble Standard Interface Protocol (TSIP) is a binary packet protocol that allows the system designer maximum configuration control over the GNSS receiver for optimum performance in timing applications. TSIP supports multiple commands and their associated response packets for use in configuring the Acutime GG receiver to meet your requirements. See Appendix A, Trimble Standard Interface Protocol.
- NMEA 0183 (National Marine Electronics Association) is an industry standard protocol common to marine applications. It provides direct compatibility with other NMEA- capable devices such as chart plotters and radar. The Acutime GG supports the ZDA NMEA message for GPS timing. You can select other NMEA messages and output rates as required. See Appendix B, NMEA 0183.

Standard timing software features

- Automatic self-survey
- Over-determined (OD) Clock Mode
- Single-satellite Timing Mode
- Timing Superpackets
- Timing Receiver Autonomous Integrity Monitoring (T-RAIM)
- Position integrity (P-RAIM). When the receiver detects a position difference greater than 1000 meters from its stored position, it will restart the self-survey.
- Cable delay compensation

Operation

When the Acutime GG is turned on, it runs a self-survey process and then switches into the Over-determined Clock Mode. In this mode, the reference position from the self-survey is retained in memory and the receiver solves only for clock error and clock bias. This mode also provides for T-RAIM, which allows the receiver to remove a satellite that provides incorrect information from the timing solution. If a receiver is moved more than

1000 meters from its surveyed location, a new self-survey ensures position integrity by automatically initiating and correcting the reference location.

The first time that the Acutime GG is turned on, it searches for satellites from a cold start with no almanac, time, ephemeris, or stored position. The Acutime GG begins to compute position and time solutions within the first 46 seconds, but it must track satellites continuously for approximately 15 minutes to download a complete almanac and ephemeris. ***Do not interrupt the initialization process.***

The Acutime GG generates a 1 PPS output, synchronized to GPS or Coordinated Universal Time (UTC) or GLONASS time within 15 ns (one sigma). This level of accuracy is obtained using an Over-determined Clock solution and T-RAIM. The 1 PPS output and data signals conform to the RS-422 standard and support very long cable runs.

Note – *The delay inherent in the cable from the antenna to the receiver can be overcome by determining the length of the cable and then entering the offset based on information from the cable manufacturer about the specific cable type.*

Starter kit

The Acutime GG Starter Kit contains all the components required for a high-performance, cost-effective reference time source that uses GPS technology to precisely synchronize computers, servers and Internet applications for evaluation and engineering purposes. It is quick and easy to install.

Use and care

The Acutime GG is a high-precision electronic instrument and should be treated with reasonable care.

If a problem arises with the unit, an amber indicator appears in the Trimble GPS Studio application. Contact Trimble for technical direction and repair.

CAUTION – There are no user-serviceable parts inside the Acutime GG and any modification to the unit by the user voids the warranty.

Related information

An electronic copy of this manual is available in portable document format (PDF). Use Adobe Reader to view the file.

Contact your local sales representative or Trimble Support for more information about the support agreement contracts for software and firmware

Technical assistance

If you have a problem and cannot find the information you need in the product documentation, contact the Trimble Technical Assistance Center at 800-767-4822 or email tsgsupport@trimble.com.

CHAPTER

2

Setting up the Acutime GG

In this chapter:

Trimble recommends that you install the Trimble GPS Studio software before setting up the Acutime GG, as this will enable you to monitor the acquisition of satellites once you start up the multi-GNSS antenna.

A starter kit is available for testing, evaluation, and engineering purposes. This section describes the components of the starter kit, and how to set it up.

The hardware integration is described in Chapter 3, Hardware integration

System requirements

Hardware

- For evaluation or engineering purposes:
  - The Trimble Acutime GG multi-GNSS smart antenna starter kit, see page 17
- For permanent installation:
  - Trimble Acutime GG multi-GNSS smart antenna
  - Interface cable with DB-25 connector
  - Universal Interface Module

Computer

- An office computer running a version of the Microsoft® Windows® operating system (Windows XP or later)

System software

- Trimble GPS Studio software. This is used to monitor the Acutime GG's performance and to assist system integrators in developing a software interface for the smart antenna. The software is compatible with the Windows® operating systems. See Trimble GPS Studio software.
- Trimble Standard Interface Protocol (TSIP). This consists of command packets and report packets. See Appendix A Trimble Standard Interface Protocol.
- NMEA-0183. See Appendix B NMEA 0183.

Installing and using the software

All software programs for the Acutime GG starter kit are available online from the Trimble website at http://www.trimble.com/timing.shtml. These programs enable you to monitor the Acutime GG and change its settings.

Tip *– Install and set up the monitor program before turning on the Acutime GG—this allows you to watch the timing process, from start up to fully functioning*.

Trimble GPS Studio software

CAUTION – Use only the Trimble GPS Studio software with this product. Previous software versions may not be compatible

To install the Trimble GPS Studio software from the website:

1. Go to http://www.trimble.com/timing/acutime_GG.aspx and then select *Support for TGS /Installation Files.*
2. Select and then download Trimble GPS Studio.exe to the computer's hard drive.
3. To run the application, double-click the file. The *Trimble GPS Studio* screen appears.
4. To specify the communications port and protocol for your office computer, right-click in the bottom right of the *Trimble GPS Studio* screen and then select the required COM port and settings.
5. Connect the Acutime GG antenna to the Universal Interface Module using the provided antenna interface cable. Connect the 12-pin connector to the antenna, and the DB-25 connector to the Universal Interface Module.
6. Connect one end of the USB cable to the USB port of the universal interface module.
7. Connect the other end of the cable to the USB port of your computer.
8. Turn on the DC power source or plug in the AC/DC converter and then turn on the power.

   The Tx and Rx in the lower left of the status bar indicate the following:
   - If the Tx blinks, the computer is transmitting commands to the receiver.
   - If the Rx blinks, the computer is receiving reports from the receiver.
9. The Acutime GG automatically begins its self-survey. When this is complete and the receiver achieves a position fix, the following information appears:
   - position
   - time
   - satellites tracked
   - GPS receiver status

Note – *The receiver sends a health report every few seconds, even if satellites are not being tracked.*

Data fields

If the Trimble GPS Studio software displays a question mark (?) in a data field, the receiver has not reported a status for this field. If the question mark stays in place, the Acutime GG may not be communicating with the computer. Check the interface cable connections and verify the serial port selection and settings.

If the communication fails, call the Trimble Technical Assistance Center (TAC) at

1 (800) 767-4822.

TSIP

The Trimble Standard Interface Protocol (TSIP) consists of command packets and report packets, see Appendix A Trimble Standard Interface Protocol.

The TSIP is installed by factory default.

NMEA-0813

To convert to the NMEA protocol, please refer to and use the Trimble GPS Studio software for serial port protocol, Input/Output, message type output, and baud rate configuration

Acutime GG starter kit

Acutime GG Multi-GNSS Smart Antenna

Universal Interface Module
(RS-422 to USB converter)

Power converter (24VDC to AC)

Power pin adapters

100 feet of interface cable
with DB-25 connector

USB Cable

Universal Interface Module (UIM)

The UIM that is included with the starter kit makes it easy to evaluate and develop software when it is connected to the Acutime GG. It has a Type 2 USB interface to the Acutime GG that is compatible with most computers.

- Network power (5 to 36 VDC) is supplied through the power connector on the front of the module.
- The USB connector and interface cable allows for easy connection to a PC USB port.

Note – *The Acutime GG is a dual port receiver—it requires power separate from the USB.*

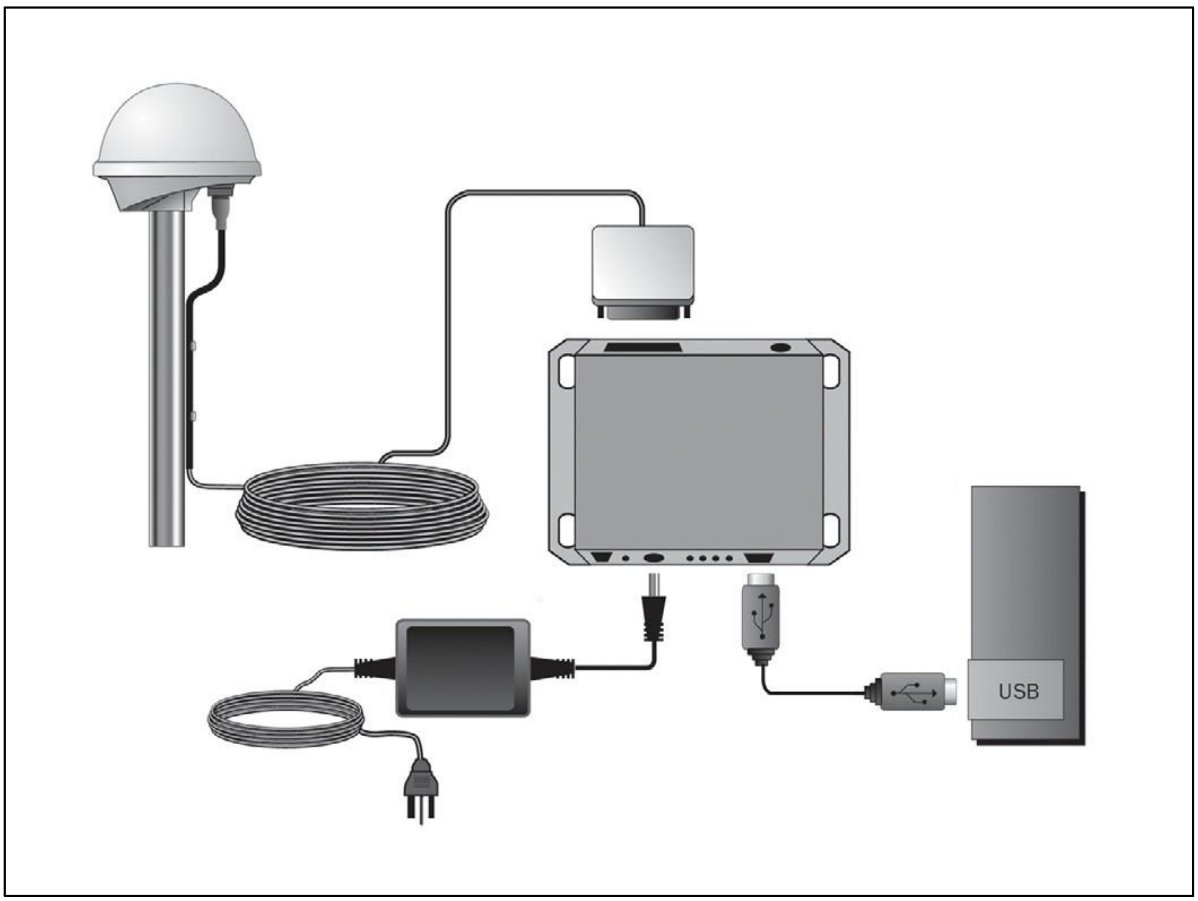
- The motherboard has a switching power supply, which converts the prime voltage input to the 24 V that is required to power the receiver over most available cable lengths.
- Connect the output device to the 1 PPS connector on the rear of the unit.

Power converter (AC/DC)

The AC/DC power converter provides an alternative power source for the interface unit and enables you to run the module from network power.

It converts 110 or 220 VAC to a regulated +24 VDC that is compatible with the UIM. The AC/DC power converter output cable is terminated with a standard DC power connector that is compatible with the power connector on the metal enclosure.

Setting up the starter kit



1. Mount the Acutime GG on a 1" OD marine pipe or 3/4" ID pipe, with 14 threads per inch.

2. Connect the antenna cable to the Acutime GG. Allow for the cable to maintain a "drip-loop" to prevent water intrusion and to allow for flex on the antenna to cable connector.
3. Place the Acutime GG so that it has the fullest possible view of the sky to ensure that the maximum number of satellites is available.
4. Use the DB-25 connector to connect the antenna cable to the rear of the UIM.

CAUTION – Be careful not to damage the cable. Take care to avoid sharp bends or kinks in the cable, hot surfaces (for example, exhaust manifolds or stacks), rotating or reciprocating equipment, sharp or abrasive surfaces, door and window jambs, routing near high EMI / EMF (Electro-Magnetic Induction / Field) transformers or equipment, and corrosive fluids or gases.

---

5. When using the TSIP protocol, connect one end of the USB interface cable to the USB port of the interface unit. Connect the other end of the cable to USB port on a computer.

Note – *The receiver supports the TSIP or NMEA protocols. Dual ports support either the input/output of TSIP messages or the output of NMEA messages.*

6. To connect the power connector to the UIM, do one of the following:
   – Use the DC power cable. Connect the terminated end of the power cable to the power connector on the UIM. Connect the red lead to DC positive voltage (+12 VDC to +24 VDC) and the black power lead to DC ground. The yellow wire is not used.
   – Use the AC/DC power converter. Connect the output cable of the converter to the power connector on the UIM. Use the appropriate 3-pin power adapters to connect the converter to mains power (110 VAC or 220 VAC).
7. Switch on the DC power source or turn on the mains power.

To integrate the multi-GNSS smart antenna, into your system, see Chapter 3, Hardware integration.

Starter kit components

The Acutime GG is available as part of the starter kit, or as an individual item. The starter kit includes all the components necessary to quickly test and integrate the receiver.

Product	Part Number
Acutime GG multi-GNSS timing module (Default mode: GPS only)	92626-00

Product	Part Number
Acutime GG multi-GNSS timing module (Default mode: multi-GNSS)	92626-05
100’ Acutime GG cable	60155 (included in Starter kit)
Acutime GG Universal Interface Module	Available with SK only
AC/DC power supply module	Available with SK only
Interface cable (USB/USB)	Available with SK only

***Note –** Part numbers are subject to change. Confirm part numbers with your Trimble representative when placing your order.*

Page intentionally left blank.

CHAPTER

3

Hardware integration

In this chapter:

The setup procedures for the Acutime GG multi-GNSS Smart antenna are described in Chapter 2, Setting up and Running the Acutime GG.

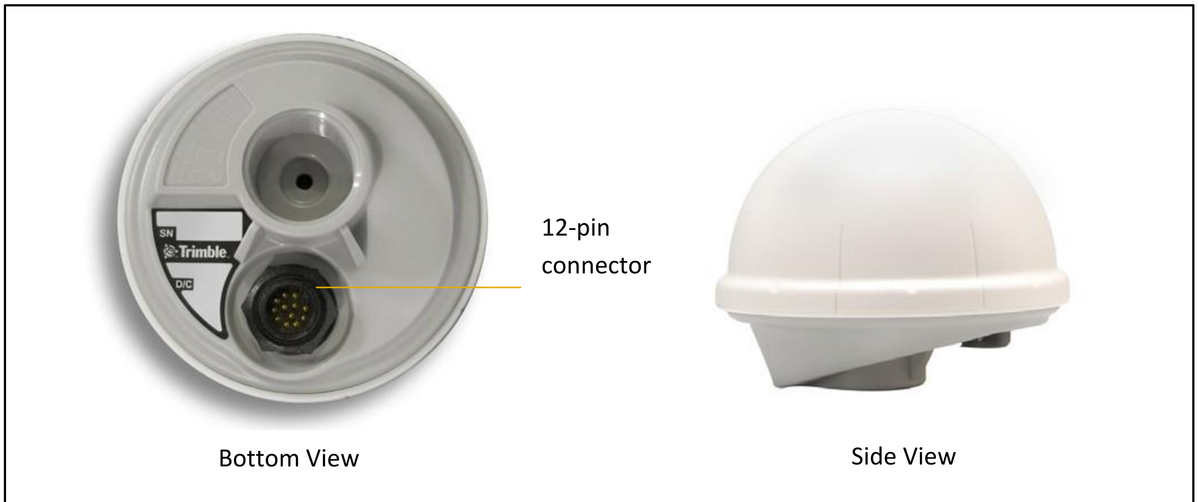
This chapter describes the hardware components, to assist you when you integrate the Acutime GG into a system.

To integrate the Acutime GG multi-GNSS Smart antenna into your system you must:

- Connect to a standard serial interface port on the host system
- Design a circuit to read the electrical 1PPS
- Develop a software interface

The setup procedures for the Acutime GG multi-GNSS Smart antenna starter kit are described in chapter 2.

Acutime GG multi-GNSS smart antenna



Performance Specifications

General	GPS / GLONASS frequencies, CA/code (SPS), continuous tracking receiver, static Over-determined Clock Mode
Update rate	1 Hz
Accuracy horizontal position	<6 meters (50%) <9 meters (90%)
Accuracy altitude position	<11 meters (50%) <18 meters (90%)
Velocity	0.06 m/sec
Time to first fix	No stored position: <46 s (50%), <50 s (90%) Stationary with stored position (for example, recovery after a power outage): <14 s (50%), <18 s (90%)
Reacquisition after 60s signal loss	<2 s (90%)
Dynamics	Velocity: 500 m/s maximum Acceleration: 4 g (39.2 m/sec2) Jerk: 20 m/s3
PPS output	Physical interface: RS-422 Width: 10 microseconds (default); user programmable from 10 microseconds to 500 milliseconds On-time edge: Rising edge on time (default); user programmable rising or falling Resolution:<32 nanoseconds (quantization error reported through TSIP)

	Accuracy: UTC 15 nanoseconds (static), UTC 90 nanoseconds (dynamic, TDOP ≤ 3)
Minimum pulse width	10 microseconds, rising edge-on-edge
Reporting mechanism	TSIP packet

Environmental specifications

Operating temperature	-40 °C to +85 °C (-40 °F to 185 °F)	
Storage temperature	-55 °C to +105 °C (-67 °F to 221 °F)	
Vibration	0.008 g2/Hz	5 Hz to 20 Hz
	0.05 g2/Hz	20 Hz to 100 Hz
	-3 dB/octave	100 Hz to 900 Hz
Operating humidity	95% RH, non-condensing at 60 °C (140 °F) EMC	
EMC	CE, FCC Class B	
Ingress protection	IP 67	

Physical characteristics

Power consumption	50 mA @ 12 V 0.6 W (typical), < 1 W maximum
Dimensions	95 mm (depth) x 72.5 mm (height) (3.74" x 2.85")
Connector	12-pin round, waterproof
Weight	154 g (5.4 oz)
Mounting	1” - 14” straight thread or 3/4” pipe thread

Interface cables

The Acutime interface cable is twisted-pair technology, 22 American Wire Gauge (AWG), 6 pair/12 conductors, shielded, and protected with a PVC-U/V outer sheath.

Acutime GG interface cables are available in the following standard lengths:

- 15 m (50 feet)
- 30 m (100 feet)
- 60 m (200 feet)
- 120 m (400 feet)

For custom-length cables of up to 550 m (1800 feet), contact Trimble.

All cables are terminated on the antenna end.

For a list of part numbers, see http://www.trimble.com/timing/acutime-GG.aspx.

Power requirements

The Acutime GG multi-GNSS receiver is designed for static timing applications and requires a nominal +12 VDC to +24 VDC input (a range of +5 VDC to +36 VDC is possible). You can apply power to the Universal Interface Monitor using one of two options: the DC power cable, or the AC/DC power converter.

Tip – Some voltage drop will occur over the cable run. If feed voltage is limited to +5 VDC, the cable length is limited to 30 feet. When the cable is 100 feet or longer, the feed voltage must be at least +12 VDC. Trimble recommends +24 VDC for most runs.

The red wire (Acutime GG pin 1) and the black wire (Acutime GG pin 9) on the interface cable support power and ground connections, respectively. The Acutime GG features a linear power supply, which supports +5 to +36 VDC. The Acutime GG is protected against reverse polarity and brief over voltage conditions, however, extended over-voltage conditions may cause permanent damage.
Power consumption of the Acutime GG is less than 70 mA at 12 VDC.

Serial port interfaces

The pin-out descriptions and color codes for the standard un-terminated cables and DB-25 interface cable are as follows:

Acutime GG Connector	Wire Color	Function	DB-25 Interface	Protocol
Pin 1	Red	DC Power	Pin 1	+5 VDC to +36 VDC
Pin 2	Violet	Port B: Receive -	Pin 25	TSIP RS-422
Pin 3	Orange	Port B: Receive +	Pin 13	TSIP RS-422
Pin 4	Brown	Port B: Transmit -	Pin 11	TSIP RS-422
Pin 5	Yellow	Port B: Transmit +	Pin 23	TSIP RS-422
Pin 6	White	Port A: Receive -	Pin 24	Not Used
Pin 7	Gray	Port A: Receive +	Pin 12	Not Used
Pin 8	Green	Port A: Transmit -	Pin 10	NMEA / TSIP RS-422
Pin 9	Black	DC Ground	Pin 7	Ground
Pin 10	Blue	Port A: Transmit +	Pin 22	NMEA / TSIP RS-422
Pin 11	Orange w/ white stripe	1 PPS Transmit +	Pin 21	RS-422
Pin 12	Black w/ white stripe	1PPS Transmit -	Pin 9	RS-422

Pulse-Per-Second (PPS)

The Acutime GG provides a 1.0 microsecond wide, RS-422, Pulse-Per-Second (PPS) on antenna connector pins 11 and 12. The pulse is sent once per second and the leading edge of the pulse is synchronized to UTC, GPS, or GLONASS time.

The pulse shape is affected by the distributed capacitance of the attached cabling and input circuit. The pulse's trailing edge should not be used for timing applications. An accurate timing pulse is available only when the Acutime GG is operating in the static

Over-determined Clock Mode with a timing accuracy of <15 nanoseconds (one sigma) to UTC, GPS, or GLONASS time.

The PPS output can be programmed to provide an even-second output using TSIP packet 0x8F-4E.

Timing pulse connections

The Acutime GG outputs a timing pulse for timing and synchronization applications. The timing pulse is generated using an RS-422 line driver circuit (connector pins 11 and 12). The leading edge of the PPS output pulse is synchronized to UTC. The width of the pulse's leading edge is 20 nanoseconds or less. The exact width and shape of the pulse depends upon the distributed capacitance of the interface cable.

Serial ports

The Acutime GG has two RS-422 communication ports. The functions of these ports (B and A) are described below.

Port B

Port B is the primary serial port for the Acutime GG. Using this port, you can:

- Send commands and receive command responses.
- Query for and receive satellite data (for example, ephemeris, tracking information, and signal levels).
- Receive timing packets that are synchronized with the PPS output.
- Enable TSIP timing packets 0x8F-AB and 0x8F-AC (which output automatically after the self-survey has been completed) or 0x8F-AD using command packet 0x8E-A5.
- Configure Port B to transmit NMEA packets.

The Acutime GG automatically sends a range of satellite data packets on Port B. You may not need these data packets—to disable them, use command packet 0x8E-A5. This ensures that only the timing packets are sent. You can also choose to receive the timing packets on Port A , and use Port B to only send commands and receive satellite data.

Port A

Port A serves as a dedicated transmit port for timing packets.

The user can select NMEA output on port A, with TSIP in / TSIP out on port B.

CHAPTER

4

System Operation

In this chapter:

The Acutime GG receives the amplified GNSS signals through the antenna feed line connector and passes them to the RF down-converter. A highly stable crystal reference oscillator is used by the down-converter to produce the signals used by the digital signal processor (DSP). The DSP tracks the GNSS signals and extracts the carrier code information as well as the navigation data at 50 bits per second.

Operation of the tracking channels is controlled by the navigation processor. The software tracking channels track the highest twelve satellites above the horizon. The navigation processor then uses the optimum satellite combination to compute a position. The navigation processor also manages the ephemeris and almanac data for all of the satellites, and performs the data I/O.

Operation

Start-up

On startup the receiver automatically runs a self-survey process and then provides an over-determined timing solution.

The first time that the Acutime GG is turned on, it begins searching for satellites from a cold start with no almanac, time, ephemeris, or stored position. The receiver starts computing position and time solutions within the first 46 seconds, but the receiver must continuously track satellites for approximately 15 minutes to download a complete almanac and ephemeris. ***Do not interrupt the initialization process.***

During the satellite acquisition phase, the Acutime GG outputs periodic TSIP messages on Port B. These status messages confirm that the receiver is working.

Note – *the Acutime GG has no provision for external backup power and always begins operation from a cold start unless a warm start is forced by uploading almanac data and time*.

Timing receiver performance

The receiver and patch antenna contained in the Acutime GG are in a single board format. The board has been adapted for timing applications where reliability, performance, and ease of integration are required.

The receiver features Trimble's improved signal processing code, a high-gain RF section, and RS-422 line drivers to deliver a differentially driven 1 PPS output for timing and synchronization applications.

Timing applications are assumed to be static. The specialized timing software used within the Acutime GG configures the unit into an automatic self-survey mode at start up. The receiver will average position fixes for a specified time (one per second) and at the end of this period, this reference location is used to solve for time. The receiver goes into an Over- determined Clock Mode and no longer solves for position but only for clock error and clock bias using all of the available satellites. This procedure will provide an accuracy of less than 15 ns (one sigma) to GPS, UTC, or GLONASS time for the 1 PPS output.

To change the default port parameters and NMEA settings, issue the appropriate TSIP command and then store the settings in the receiver's non-volatile (flash) memory. The settings are retained when mains power is removed, without the need for battery backup. The factory default setting for Port B, the primary I/O port, is bi-directional TSIP at 9600 baud, 8 data bits, odd parity, and 1 stop bit.

Note – *When customizing port assignments or characteristics, confirm that your changes do not affect your ability to communicate with the receiver.*

Communicating with the receiver

Communication with the receiver is through an RS-422 compatible serial port. The port characteristics can be modified to accommodate your application requirements. Port parameters are stored in flash memory, which does not require back-up power. The default port characteristics are:

Parameter	Factory Default
Input baud rate	9600
Output baud rate	9600
Parity	Odd
Data bits	8
Stop bits	1
Input protocol	TSIP input
Output protocol	TSIP output

Note – *The Acutime GG also supports the NMEA message protocol.*

Port B configuration

The factory default protocol on Port B is TSIP in and out at 9600-odd-8-1.

The serial port can be changed and stored in flash memory. The receiver protocol can be re-configured using TSIP command packet 0xBC, Timing Receiver, Trimble GPS Studio software, or a user-written serial interface program.

C-source code examples for TSIP commands are also provided in Appendix A Trimble Standard Interface Protocol. When used as software design templates, this source code can significantly speed up code development.

The protocol settings and options are stored in Random Access Memory (RAM). They can be saved into the flash memory using command packet 0x8E-26.

Port A configuration

Port A is a dedicated port for outputting comprehensive timing packets. The factory default setting is TSIP, output only, at 9600-8-odd-1.

The host system receives both the PPS and the time packet identifying each pulse. Use packet 0x8E-A5 to determine which Timing Superpacket to output on this port.

Automatic operation

When the Acutime GG has acquired and locked onto a set of satellites that pass the mask criteria listed below, and has obtained a valid ephemeris for each tracked satellite, it performs a self-survey. After a number of position fixes (configurable), the self-survey is complete. At that time, the Acutime GG automatically switches to a time-only mode (Over-determined Clock mode).

Satellite masks

Satellite masks are only operable when the receiver is in over-determined mode. By default the masks are disabled and all usable satellites are included in the solution.

The Acutime GG continuously tracks and uses up to 32 satellites in an over-determined clock solution. The satellites must pass the mask criteria to be included in the solution.

The following table lists the default satellite masks used by the Acutime GG. These masks serve as the screening criteria for satellites used in fix computations and ensure that solutions meet a minimum level of accuracy. The satellite masks can be adjusted using the TSIP protocol described in Appendix A, Trimble Standard Interface Protocol

Mask	Setting	Notes
Elevation	10°	SV elevation above horizon
AMU	4	Signal strength
DOP	8	Self-survey only

Elevation mask

Generally, signals from low-elevation satellites are of poorer quality than signals from higher elevation satellites. These signals travel farther through the ionospheric and tropospheric layers and undergo distortion due to these atmospheric conditions

SNR mask

Low SNR values can result from low-elevation satellites, partially obscured signals (for example, dense foliage), or multi-reflected signals (multipath).

Multi-reflected signals, also known as multipath, can degrade the position and timing solution. Multipath is most commonly found in urban environments with many tall buildings and a preponderance of mirrored glass. Multi-reflected signals tend to be weak (low SNR value), since each reflection diminishes the signal.

If the Acutime GG antenna has a clear view of the sky (outdoor antenna placement), an SNR mask of 35 is recommended for optimal results. However, for indoor use or operation with an obscured view of the sky, the mask must be low enough to allow valid weak signals to be used. For indoor operation, an SNR mask of 4 AMU is recommended.

PDOP mask

Position Dilution of Precision (PDOP) is a measure of the error caused by the geometric relationship of the satellites used in the position solution. Satellite sets that are tightly clustered or aligned in the sky have a high PDOP and contribute to lower position accuracy. For most applications, a PDOP mask of 8 offers a satisfactory trade-off between accuracy and GPS coverage.

Note – PDOP is applicable only during self-survey or whenever the receiver is performing position fixes.

Operating modes

The Acutime GG operates in one of the following: Main modes:

- Self-survey mode (position fix operating mode)
- Over-determined Clock mode

After establishing a reference position in Self-Survey mode, the Acutime GG automatically switches to Over-determined (OD) Clock mode

Self-survey mode

At power-on, the Acutime GG performs a self-survey by averaging 2000 position fixes. The number of position fixes until survey completion is configurable using the 8E-A9 command.

The default mode during self-survey is 2D/3D Automatic, where the receiver must obtain a 3-D solution. If fewer than four conforming satellites are visible, the Acutime GG suspends the self-survey. 3-D mode may not be achieved when the receiver is subjected to frequent obscuration or when the geometry is poor due to an incomplete constellation.

Over-determined Clock mode

Over-determined Clock Mode is used only in stationary timing applications. This is the default mode for the Acutime GG once a surveyed (or user input) position is determined. After the receiver self-surveys its static reference position, it automatically switches to Over-determined Clock Mode and determines the clock solution. The timing solution is qualified by a Time-Receiver Autonomous Integrity Monitoring algorithm, which automatically detects and rejects faulty satellites from the solution.

Using the default Anti Jamming setting, a minimum of two satellites is required for a fix in Over-determined Clock mode. When you power-up the receiver, or after a long fix outages (longer than nine minutes), three satellites are required for the first fix.

In this mode, the Acutime GG does not navigate or update positions and velocities, but maintains the PPS output, solving only for the receiver clock error (bias) and error rate (bias rate). If the Anti Jamming setting is disabled, only one satellite is required for a fix. To set Anti Jamming, see Command Packet 0xBB: Set Receiver Configuration.

PPS output options

The PPS (Pulse Per Second) output is the primary timing output generated by the Acutime GG and is provided through an RS-422 differential driver. Although an RS-422 differential receiver provides the best noise immunity, you can use only one side of the differential signal for single-ended applications.

To program the characteristics of the PPS, use the following TSIP packets:

- To set an accuracy criterion for the generation of the PPS signal, based on the number of usable satellites, use packet 0x8E-4E.

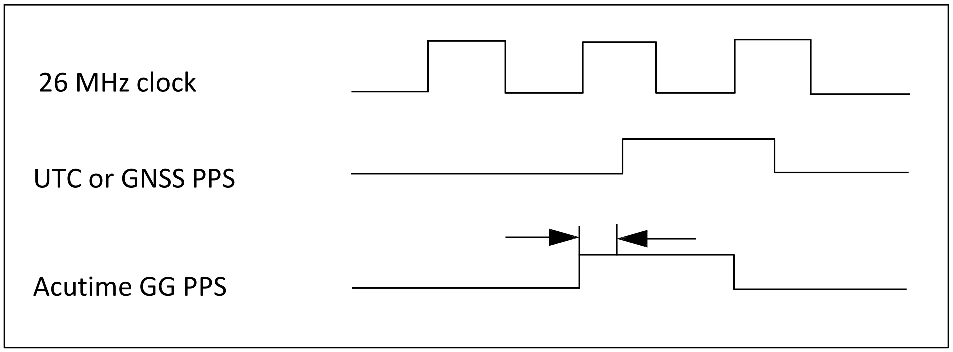
  The accuracy of the PPS output depends to some degree on the number of satellites used in the solution that determine the placement of the PPS output. In some systems it is preferable to have the PPS generated only when it meets the highest levels of accuracy and to leave it off if these accuracy levels are not met.

- To set the width of the PPS from 10 µs to 500 ms, use packet 0x8E-4F

PPS quantization error

The Acutime GG uses a high-precision, fixed frequency oscillator as the timing source to down-convert and decode the GNSS signal and to generate the PPS output signal. Since a fixed-frequency oscillator is used, the Acutime GG must place the PPS output on the clock edge that it determines is closest to UTC, GPS, or GLONASS. This situation results in a quantization error on the placement of the PPS whose magnitude is equal to one-half the period of the fixed frequency oscillator. The oscillator frequency is 26 MHz, which is equivalent to a period just under 80 nanoseconds. Since both clock edges are used, the quantization error on the PPS output is between ±20 ns.

The quantization error is illustrated below..



- The top waveform represents the 26 MHz clock. The Acutime GG output must be placed on one of the edges of this clock.
- The middle waveform represents the UTC/GPS on-time mark as determined by the receiver's electronics.
- The bottom waveform represents the Acutime GG PPS output which is output on the clock edge closest to the actual UTC/GPS on-time mark

The amount of quantization error present on each PPS output pulse is reported in packet 0x8F-AC. This quantization error information can be used to reduce the effective amount of jitter on the PPS pulse.

Serial data communication

The Acutime GG outputs TSIP Superpackets or NMEA messages.

On start-up, the Acutime GG outputs TSIP packets 0x8F-AB, 0x8F-AC, and PPS. To enable or disable timing packets and automatic output packets, use packet 0x8E-A5.

The factory default port setting is 9600-odd-8-1 (in/out). To change the serial port setting and store it in flash memory, use the appropriate TSIP command. The port can also be configured to transmit timing packets, using packet 0x8E-A5.

GNSS timing

For many timing applications, such as time/frequency standards, site synchronization systems, and wireless voice and data networks, the Acutime GG can be used to steer a local reference oscillator. The steering algorithm combines the short-term stability of the oscillator with the long-term stability of the GNSS PPS. An accurate GNSS PPS allows the use of cost-effective crystal oscillators, which have less stability than expensive, high- quality oscillators, such as Oven Controlled Crystal Oscillators (OCXO).

The GNSS system consists of several GPS, GLONASS, and other constellation orbiting satellites. Unlike most telecommunications satellites, GNSS satellites are not geostationary, so satellites in view are constantly changing. Each GNSS satellite contains four highly-stable atomic clocks, which are continuously monitored and corrected by the GPS control segment. Consequently, the GPS constellation can be considered a set of 24 orbiting "clocks" with worldwide 24-hour coverage.

A Trimble multi-GNSS receiver uses the signals from the GPS satellites to correct its internal clock, which is not as stable or accurate as the GPS atomic clocks. The Acutime GG outputs a highly accurate timing pulse (PPS) generated by its internal clock, which is constantly corrected using the GPS or GLONASS clocks. This timing pulse is synchronized to GPS/UTC/GLONASS time within 15 ns (one sigma) after the survey is complete.

Note: *- GLONASS time is supported when the unit is operating in GLONASS only mode.*

In addition to serving as highly-accurate stand-alone time sources, GNSS timing receivers are used to synchronize distant clocks in communication or data networks. This is possible because all GNSS satellites are corrected to a common master clock. Therefore, the relative clock error is the same, regardless of which satellites are used. For synchronization applications requiring a common clock, GNSS is the ideal solution.

An accurate reference position is critical. A position error of 100 meters corresponds to a time error of approximately 333 ns.

The GNSS receiver's clocking rate and software affect PPS accuracy. The Acutime GG has a clocking rate of 26 MHz, which enables a steering resolution of 40 ns (±20 ns). Using both the rising edge and falling edge of the pulse enables a steering resolution of ±20 ns. Using software algorithms such as an Over-determined Clock solution, the Acutime GG mitigates the effects of clock error to achieve a PPS accuracy within 15 ns (one sigma) to GPS/GLONASS/UTC after the survey is complete..

Timing operation

The Acutime GG automatically outputs a PPS and time tag. With an accurate reference position, the receiver automatically switches to an over-determined clock mode, activates its TRAIM algorithm and outputs a precise PPS. Using a simple voting scheme based on pseudo-range residuals, the Acutime GG integrity algorithm automatically removes the worst satellite with the highest residual from the solution set if that satellite's residual is above a certain threshold.

In addition to TRAIM, Acutime GG implements position integrity checking on startup, in case the receiver has been moved to a new location. When the receiver power up with a surveyed (or user input) position in memory, it will compare fixes computed from the GNSS satellites to the surveyed position. If it finds that the surveyed position is off by more than 100 meters horizontally or vertically in the first 60 consecutive GNSS fixes, it will delete the surveyed position from memory (including non-volatile storage) and restart the self-survey provided the self-survey is enabled, and the "position save flag" is set to 1 using the 0x8E-A9 command.

The Acutime GG's default configuration provides optimal timing accuracy. The only item under user or host control that can affect the receiver's absolute PPS accuracy is the delay introduced by the antenna cable. For long cable runs, this delay can be significant (1.8 ns per foot). TSIP packet 8Ex4A sets the cable delay parameter, which is stored in non-volatile memory. For the best absolute PPS accuracy, adjust the cable delay to match the installed cable length (check with your cable manufacturer for the delay for a specific cable type). Generally, the cable delay is about 1.8 nanoseconds per foot of cable. To compensate for the cable delay, use a negative offset to advance the PPS output.

***Note** – GPS time differs from UTC (Universal Coordinated Time) by a small, sub- microsecond offset and an integer-second offset. The small offset is the steering offset between the GPS DoD clock ensemble and the UTC (NIST) clock ensemble. The large offset is the cumulative number of leap seconds since 1 January 1980, which, on 30 June.2012 was increased from 15 to 16 seconds. Historically, the offset increases by one second approximately every 18—24 months, usually just before midnight on 30 June or 31 December. System designers should note whether the output time is UTC or GPS time.*

Customizing operations

The Acutime GG provides a number of user configurable parameters that allow you to customize the operation of the unit. These parameters are stored in non-volatile memory (Flash) to be retained during loss of power and through resets. At reset or power-up, the receiver configures itself based on the parameters stored in Flash. You can change the values of these parameters to achieve the desired operations using a variety of TSIP packets. The Acutime GG configures itself based on the new parameter immediately, but the new parameter value is not automatically saved to Flash. You must direct the receiver to save the parameters to Flash.

To change the parameter values stored in Flash memory, send packet 0x8E-26 to direct the Acutime GG to save the current parameter values to the Flash. To save or delete the stored position, use command packet 0x8E-A6. You can also direct the receiver to set the parameter values to their factory default settings (and to erase the stored position) with packet 0x1E.

In brief, to customize the Acutime GG multi-GNSS smart antenna operations for your application:

- Configure the receiver using TSIP command packets until the desired operation is achieved.

- Use TSIP packet 0x8E-26 to save the settings in nonvolatile memory (Flash).
- If the position was not automatically saved during the self-survey or if it was manually entered, the position can be saved to flash memory using TSIP packet 8E-A6.

The new settings will control receiver operations whenever it is reset or power cycled

Configuration parameters

The following tables list the user configurable parameters. Each table lists the parameter name, its factory default value, and the TSIP packet that sets or reads the parameter value (typically, one TSIP packet sets or reads several related parameters).

Parameter	Factory Default
Operating dimension	4 (Full Position 3D)
Dynamic code	1 (land)
Elevation mask	0.175 radians (10°)
Signal level mask	4.0 AMU
PDOP mask	8.0
PDOP switch	6.0
Foliage mode	0 (never)
Have reference altitude flag	False
Reference altitude (meters)	0.0

Configuration parameters

Parameter	Factory Default
Datum index	WGS 84 Ellipsoid
Position	0x12
Velocity	0x02
Time	0x01
Auxiliary	0x02
Superpackets output mask (byte 1)	0x32
Superpackets output mask (byte 2)	0x21
Auto TSIP output mask	0xFFFFFFC0

Port A and B Configuration

Parameter	Factory Default
Input baud rate	9600
Output baud rate	9600
Parity	Odd
Data bits	8
Stop bits	1
Input protocol	TSIP input
Output protocol	TSIP output

PPS Configuration

Parameter	Factory Default
PPS enabled switch	Enabled
PPS timebase	UTC
Polarity	True
PPS offset	0.0 seconds
Bias uncertainty threshold	300 meters
PPS width	$10e^{-6}$ seconds
PPS driver switch	3 (at least 1SV)

Position information

Parameter	Factory Default
XYZ coordinates	Such that LLA coordinates are all zeros
Have position flag	False

Self-survey configuration

Parameter	Factory Default
Survey enable flag	True
Survey length	2000
Survey save flag	False
Survey operating dimension	Full Position 3D

NMEA 0183 protocol and data output options

The National Marine Electronics Association (NMEA) protocol is an industry standard data protocol, which was developed for the marine industry. Trimble has chosen to adhere stringently to the NMEA 0183 data specification as published by the NMEA. The Acutime GG multi-GNSS smart antenna also adheres to the NMEA 0183, Version 3.0 specification.

NMEA data is output in standard ASCII sentence formats. Message identifiers signify what data is contained in each sentence. Commas within the NMEA sentence separate data fields. In the Acutime GG GNSS receiver, NMEA is an output-only protocol.

The receiver is shipped from the factory with the TSIP protocol configured on Port A and B. Port A can be reconfigured for NMEA output through Port B using TSIP command packet 0xBC, in conjunction with the Trimble GPS Studio software, or a user-written serial-interface program.

The NMEA output messages selection and message output rate can be set using TSIP command packet 0x7A. The default setting is to output the ZDA message at a 1-second interval, when the receiver output protocol is configured to NMEA, using packet 0xBC.

To use NMEA permanently, use TSIP command 0x8E-26 to store the protocol configuration (0xBC) and NMEA message output setting (0x7A) in the flash memory.

The industry standard port characteristics for NMEA are:

- Baud rate: 115 kbps
- Data bits: 8
- Parity: None
- Stop bits:1
- No flow control

Any standard serial communications program, such as Windows HyperTerminal or PROCOMM, can be used to view the NMEA output messages.

TSIP is a binary protocol; it outputs raw binary serial data that cannot be read when using the Windows HyperTerminal or PROCOMM applications.

CAUTION – When you use the TSIP protocol to change port assignments or settings, confirm that your changes do not affect the ability to communicate with the receiver. For example, that you have not inadvertently selected PC COM port settings that do not match the receiver settings, or changed the output protocol to TSIP if you are not using the Trimble GPS Studio software

---

APPENDIX

A

Trimble Standard Interface Protocol

In this chapter:

The Trimble Standard Interface Protocol (TSIP) provides commands that the system designer can use to configure a GNSS receiver for optimum performance in a variety of applications, and to customize the configuration of a GNSS module to meet the requirements of a specific application.

TSIP is a simple bidirectional, binary packet protocol used in a wide variety of Trimble GNSS receivers. TSIP offers a broad range of command packets and report packets that provide the GNSS user with maximum control over the Acutime GG receiver.

This appendix describes how to use the powerful TSIP features, enhance overall system performance, and reduce the total development time. The reference tables help you determine which packets apply to your application. For those applications requiring customization, see Customizing receiver operations, for a detailed description of the key setup parameters. Application guidelines are provided for each TSIP command packet.

Introduction

TSIP is a powerful and compact interface protocol which has been designed to allow the system developer a great deal of flexibility in interfacing to a Trimble product. Many TSIP data packets are common to all products which use TSIP. An example would be a single precision position output packet. Other packets may be unique to a product. Custom packets are only used in the products for which they have been created.

Interface scope

The Acutime GG GNSS smart antenna has one configurable serial I/O communication port, which is a bi-directional control and data port utilizing a Trimble Standard Interface Protocol (TSIP). The data I/O port characteristics and other options are user programmable and stored in non-volatile memory (Flash memory).

The TSIP protocol is based on the transmission of packets of information between the user equipment and the GPS receiver. Each packet includes an identification code (1 byte, representing 2 hexadecimal digits) that identifies the meaning and format of the data that follows. Each packet begins and ends with control characters.

Packet structure

TSIP packet structure is the same for both commands and reports. The packet format is:

<DLE> <id> <data string bytes> <DLE> <ETX>

Where:

<DLE>	is the byte 0x10
<ETX>	is the byte 0x03
<id>	is a packet identifier byte, which can have any value excepting
<ETX>	and
<DLE>	The bytes in the data string can have any value. To prevent confusion with the frame sequences <DLE> <id> and <DLE> <ETX>, every <DLE> byte in the data string is preceded by an extra <DLE> byte ('stuffing'). These extra <DLE> bytes must be added ('stuffed') before sending a packet and removed after receiving the packet.

Note – *A simple <DLE> <ETX> sequence does not necessarily signify the end of the packet, as these can be bytes in the middle of a data string. The end of a packet is <ETX> preceded by an odd number of <DLE> bytes.*

Multiple-byte numbers (integer, float, and double) follow the ANSI / IEEE Std. 754 IEEE Standard for binary Floating-Point Arithmetic. They are sent most-significant byte first. ***You must switch the byte order on Intel-based machines*.**

The data types used in the Acutime GG TSIP are as follows:

Data type	Description
U8	An 8- bit unsigned number (0 to 255)
S8	An 8-bit signed number (-128 to 127)
I16	A 16-bit unsigned number (0 to 65,535)
S16	An 16-bit signed number (-32,768 to 32,767)
U32	A 32-bit unsigned number (0 to 4,294,967,295)
S32	A 32-bit signed number (-2,147,483,648 to 2,147,483,647
	Single - Float (4 bytes) (3.4x10-38 to 1.7x1038) (24 bit precision)
	Double - Float (8 bytes) (1.7x10-308 to 3.4x10308) (53 bit precision)

Note – Default settings are 9600-8-odd-1

Physical interface characteristics

The Acutime GG uses high-quality serial I/O components to drive the available serial transmit and receive channels.

The Acutime GG is available in an RS-422 configuration. This section explains the capabilities of each receiver.

Nomenclature

As with previous Multi-GNSS Smart antennas by Trimble, including the Acutis™, Acutime, and Palisade™ products, the Acutime GG ports are referenced as "A" and "B", and conform to standards established by the Palisade product line.

Function	Label	Internal
TSIP	Port B	Port 0
Timing	Port A	Port 1

Protocol capabilities

The I/O ports of the Acutime GG are highly configurable. Port settings are stored in flash memory, and are retained after power failures.

For systems with minimal bandwidth for processing serial data streams, the receivers can be configured as silent devices, which generate I/O only when polled. The Acutime GG receiver can be configured to output various automatic report packets and protocols to satisfy demanding real-time update requirements of complex monitoring systems.

Primary port features – port B

The Acutime GG features a primary bi-directional port, which is factory configured for TSIP input and output.

Secondary port features – port A

The Acutime GG has a bi-directional, programmable secondary port that is designated as the Timing port.

Packets output at startup

The following messages are output by the receiver at startup. After completing its self- survey, the receiver automatically outputs a series of packets that indicate the initial operating condition of the receiver. Messages are output in the following order. Upon output of packet 0x84, the sequence is complete and the receiver is ready to accept commands.

Output ID	Description	Notes
0x46	Receiver health	
0x4B	Machine code / status	
0x45	Software version	
0x83	Double precision XYZ position	If single precision is selected, packet 0x42 is output
0x84	Double precision LLA position	If single precision is selected, packet 0x4A is output

Receiver warm-start

Once the Acutime GG has completed its internal initialization and has output packet 0x84 (see Packets output at startup), you can send the following commands to restart it

Output ID	Description
0x2B/23	Initial position (LLA/ECEF)
0x2E	Initial time
0x38 (type 2)	GPS almanac (for each SV)
0x38 (type 3)	GPS almanac health
0x38 (type 4)	Ionosphere page
0x38 (type 5)	UTC correction
0x38 (type 6)	GPS ephemeris
0x38 (type 7)	GLONASS almanac
0x38 (type 8)	GLONASS ephemeris

Default background packets (Port B)

Output ID	Description	Notes
0x41	GPS time	Output approximately every 1.6 minutes if the receiver's GNSS clock is set and the receiver is not outputting positions. Output approximately every 2.5 minutes if the receiver is doing position fixes.
0x46	Receiver health	Output approximately every 16 seconds, if the receiver is not doing fixes. Output approximately every 30 seconds if the receiver is doing position fixes. Whenever any bit in the health message changes, receiver health is automatically output.
0x6C	Mode packet	Output approximately every 30 seconds or when a constellation change occurs.

Note – *The background packets listed in this table are automatically output. Background packets can be turned off. See also* Command Packet 0x8E-4D: Automatic Packet Output Mask.

Default automatic position and velocity reports

The Acutime GG automatically outputs position and velocity reports at set intervals. Report intervals are controlled by packet 0x35.

Output ID	Description
0x42	Single precision XYZ position
0x83	Double precision XYZ position
0x4A	Single precision LLA position
0x84	Double precision LLA position
0x43	Velocity fix (XYZ ECEF)
0x54	Bias and bias rate[1]
0x56	Velocity fix (ENU)

[1]When the receiver is in the Manual or Over-determined Clock Mode, it outputs packet 0x54 to provide the computed clock-only solution.

Automatic primary and supplemental timing reports

Timing Packets 0x8F-AB and 0x8F-AC are automatically output at 1 Hz when enabled by packet 0x8E-A5. These packets are part of the low-latency packet series 0x8F-AB/AC/AD/OB.

Low-latency timing packets

The Acutime GG features a sequence of high-priority Timing Superpackets, which are output within a bounded period of time after the PPS.

The Superpackets that meet the LLTP criteria are shown below. Output of each packet can be turned on/off by using the mask in packet 0x8E-A5, but the output order cannot be changed.

The packets may also be requested; please refer to the specific packet documentation for details

LLT Packet ID	Description	Request packet ID
0x8F-AB	Primary Timing	0x8E-AB
0x8F-AC	Supplemental Timing	0x8E-AC
0x8E-AD	Primary UTC	0x8E-AD
0x8F-0B	Comprehensive Time & Position	0x8E-0B

The receiver will output all other TSIP packets after the transmission of LLT packet sequence is complete.

Satellite data packets

Input ID	Description	Output ID
0x20	Request almanac	0x40
0x27	Request signal levels	0x47
0x28	Request GPS system message	0x48
0x29	Request almanac health page	0x49
0x2F	Request UTC parameters	0x4F
0x38	Request/load satellite system data	0x58
0x39	Set/request satellite disable or ignore health	0x59
0x3A	Request last raw measurement	0x5A
0x3B	Request satellite ephemeris status	0x5B
0x3C	Request tracking status	0x5C

Customizing receiver operations

Customizing receiver output for the application

Input ID	Description	Output ID
0x23	Set Initial position (XYZ Cartesian ECEF)	
0x24	Request receiver position fix mode	0x6C
0x26	Request receiver health	0x46 and 0x4B
0x27	Request satellite signal levels	0x47
0x2A	Set Altitude for 2-D mode	0x4A
0x2B	Set Initial position (LLA)	
0x2E	Set GPS time	0x4E
0x35	Set input/output options	0x55
0x7A	Set/request NMEA interval and message mask	0x7B
0xBB	Set/request receiver configuration	0xBB
0xBC	Set/request port configuration	0xBC
0x8E-4A	Set/request PPS characteristics	0x8F-4A
0x8E-A5	Set/request packet broadcast mask	0x8F-A5
0x8E-A6	Issue self-survey command	0x8F-A6

***Note –** Output is determined by packet 0x35 settings (see Command Packet 0x35: I/O Option Flags Command).*

Customizing receiver operation

Input ID	Description	Output ID
0x1E	Clear memory reset	[1]
0x25	Soft reset and self-test	[1]
0x2D	Request oscillator offset	0x4D
0x39	Satellite disable or ignore health	0x59[2]
0xBB	Set receiver configuration parameters	0xBB
0x8E-4A	Set PPS characteristics	0x8F-4A
0x8E-4E	Set PPS output option	0x8F-4E
0x8E-4F	Set PPS Width (Acutime GG only)	0x8F-4F
0x8E-20	Set Fixed Point Superpacket Output	0x8F-20

[1]Output is determined by packet 35 settings. For packets 0x1E and 0x25, see Packets output at startup to determine which packets are output at power-up.
[2]Not all modes of packet 0x39 cause a reply (see the description for packet 0x39).

Command Packets: User to Acutime GG

The table below summarizes the packets that can be input by the user. The table includes the input packet ID, a short description of each packet, and the associated output packet.

Input ID	Packet Description	Output ID
0x1C-01	firmware version	0x1C-81
0x1C-03	hardware component information	0x1C-83
0x1E	initiate cold reset or factory reset	[1]
0x1F	software version	0x45
0x20	Almanac	0x40
0x21	Current GPS time	0x41
0x22	Fix Mode select	[2]
0x23	Initial position (XYZ)	
0x24	request GPS satellite selection	0x6C
0x25	Soft reset and self-test	0x45
0x26	Receiver health	0x46, 0x4B
0x27	request signal levels	0x47
0x29	Almanac health page	0x49
0x2A	Altitude for 2D mode	0x4A
0x2B	initial position (LLA)	0x2B
0x2D	Oscillator offset	0x4D
0x2E	set GPS time	0x4E
0x2F	UTC parameters	0x4F
0x31	Accurate initial position (XYZ Cartesian ECEF)	0x31
0x32	set accurate initial position (lat, long, Alt)	0x32
0x35	set/request I/O options	0x55
0x37	status and values of last position and velocity	0x57 [3]
0x38	load or request satellite system data	0x58
0x39	Satellite enable/disable and health heed/ignore	0x59 [4]
0x3A	request last raw measurement	0x5A
0x3B	Satellite ephemeris status	0x5B
0x3C	request current satellite tracking status	0x5C
0x3D	Timing port configuration	0x3D
0x7A	NMEA Set/Request	0x7B
0xBB	set receiver configuration	0xBB
0xBC	set port configuration	0xBC
0x8E-0B	Request or configure superpacket output	0x8F-0B/0x8F-A5

Input ID	Packet Description	Output ID
0x8E-15	Current datum values	0x8F-15
0x8E-20	Last fix (fixed point)	0x8F-20
0x8E-26	save configuration	
0x8E-41	request manufacturing parameters	0x8F-41
0x8E-42	request production parameters	0x8F-42
0x8E-4A	set PPS characteristics	0x8F-4A
0x8E-4D	Packet Output Mask	0x8F-4D
0x8E-4E	PPS output option	0x8F-4E
0x8E-4F	Set PPS width	0x8F-4F
0x8E-A2	UTC/GPS timing	0x8F-A2
0x8E-A5	packet broadcast mask	0x8F-A5
0x8E-A6	self-survey commands	0x8F-A6
0x8E-A9	self-survey parameters	0x8F-A9
0x8E-AB	Set/request primary timing packet	0x8F-AB
0x8E-AC	Set/request supplemental timing packet	0x8F-AC
0x8E-AD	0x8F-AD output configuration	0x8F-A5 / 0x8F-AD

[1]Output is determined by packet 0x35 settings. See Packets output at startup, page 44 to determine which messages are output at power-up.
[2]Entering 1SV mode initiates automatic output of packet 0x54.
[3]Output is determined by packet 0x35 settings.
[4]Not all packet 0x39 operations have a response. See packet 0x39 description

Report packets: Acutime GG to User

The table below summarizes the packets output by the Acutime GG. The table includes the output packet ID, a short description of each packet, and the associated input packet. In some cases, the response packets depend on user-selected options.

Output ID	Packet Description	Input ID
0x13	unparsable packet	error
0x1C-81	firmware version	0x1C-01
0x1C-83	hardware component information	0x1C-03
0x3D	Timing port configuration	0x3D
0x40	Almanac data for one satellite	0x20
0x41	GPS time	0x21
0x42	single precision XYZ ECEF position fix	0x35
0x43	velocity fix (XYZ ECEF)	0x37, auto

Output ID	Packet Description	Input ID
0x45	software version	0x1E,0x1F, power up
0x46	Health of receiver	0x26
0x47	signal level for all satellites	0x27
0x49	Almanac health for all satellites	0x29
0x4A	single precision LLA position	0x37, auto
0x4B	Machine code/status	0x26
0x4D	Oscillator offset	0x2D
0x4E	set GPS time	0x2E
0x4F	UTC parameters	0x2F
0x54	One-satellite bias and bias rate	0x54
0x55	I/O options	0x35
0x56	velocity fix (ENU)	0x37, auto
0x57	status and values of last position and velocity	0x37
0x58	GPS system data acknowledge	0x38
0x59	Satellite enable/disable and health heed/ignore	0x39
0x5A	last raw measurement	0x3A
0x5B	Satellite ephemeris status	0x3B
0x5C	current satellite tracking status	0x3C
0x6C	All-in-view satellite selection	0x24
0x7B	NMEA message output	0x7A
0x83	double precision XYZ	0x37, auto
0x84	double precision LLA	0x37, auto
0xBB	receiver configuration	0xBB
0xBC	port configuration	0xBC
0x8F-0B	Comprehensive time	Auto
0x8F-20	Last fix with extra information (fixed point)	0x8E-20
0x8F-26	save configuration	0x8E-26
0x8F-41	stored manufacturing parameters	0x8E-41
0x8F-42	stored production parameters	0x8E-42
0x8F-4A	set PPS characteristics	0x8E-4A
0x8F-4D	Automatic packet output mask	0x8E-4D
0x8F-4E	PPS output option	0x8E-4E
0x8F-4F	Set PPS width	0x8E-4F
0x8F-A2	UTC/GPS timing	0x8E-A2
0x8F-A5	packet broadcast mask	0x8E-A5
0x8F-A6	self-survey commands	0x8E-A6

Output ID	Packet Description	Input ID
0x8F-A9	self-survey parameters	0x8E-A9
0x8F-AB	primary timing packet	auto
0x8F-AC	supplemental timing packet	Auto
0x8F-AD	UTC event time	Event / Auto

Packet descriptions

Command packets are sent from an external device, such as a computer or terminal, to the receiver when requesting report packets, setting receiver parameters, or performing receiver command operations such as resetting the receiver. Many command packets have a corresponding report packet, which is sent to the external device in response to the command packet. Some commands perform discrete operations and have no matching report packet

Command Packet 0x1C: Firmware Version 01

The command packet 0x1C: 01 may be issued to obtain the firmware version. The product name is *Acutime GG*. The packet format is defined in the following table:

Byte	Item	Type	Value	Meaning
0	Packet ID	U8	0x1C	Packet ID 0x1C
1	Sub-code	U8	0x01	Sub-code 0x01 for software component version information request

Report Packet 0x1C: 81

Byte	Item	Type	Value	Meaning
0	Packet ID	U8	0x1C	Packet ID 0x1C
1	Sub-code	U8	0x81	Sub-code 0x81 for software
2	Reserved	U8	Any	Reserved
3	Major version	U8	Any	Firmware major version
4	Minor version	U8	Any	Firmware minor version
5	Build number	U8	Any	Firmware build number
6	Month	U8	1-12	Firmware build month
7	Day	U8	1-31	Firmware build day
8…9	Year	I16	Any	Firmware build year
10	Length of first module name	U8	Any	The length of the product name (L1)
11… (10+L1)	Product name	U8	String	Product name in ASCII

Command Packet 0x1C: 03 – hardware component version information

- The command packet 0x1C: 03 may be issued to obtain the hardware component version information.
- The report packet is of variable length, depending on the length of the hardware ID.
- The serial number, build date fields, and the hardware ID are programmed into the Acutime GG at production.
- The hardware code for the Acutime GG is 3016.
- ID for Acutime GG is Acutime GG.

The packet format is defined in the following table:

Byte	Item	Type	Value	Meaning
0	Packet ID	U8	0x1C	Packet ID 0x1C
1	Sub-code	U8	0x03	Sub-code 0x03 for hardware component version information request

Report Packet 0x1C: 83 – hardware component version information

Byte	Item	Type	Value	Meaning
0	Packet ID	U8	0x1C	Packet ID 0x1C
1	Sub-code	U8	0x83	Sub-code 0x83 for hardware component version information report
2 – 5	Serial number	U32	Any	Board serial number
6	Build day	U8	1-31	Day of the board's build date
7	Build month	U8	1-12	Month of the board's build date
8…9	Build year	I16	Any	Year of the board's build date
10	Build hour	U8	0-23	Hour of the board's build date
11…12	Hardware code	I16	Any	Hardware code associated with Hardware ID
13	Length of Hardware ID	U8	Any	The length of the Hardware ID (L)
14... (13+L)	Hardware ID	U8	String	Hardware ID string in ASCII

Command Packet 0x1E: Initiate Cold or Factory Reset

This packet commands the Acutime GG to perform either a cold reset, or a factory reset:

- A cold reset will clear the GNSS data (almanac, ephemeris, etc.) stored in RAM and is equivalent to a power cycle.
- A factory reset will additionally restore the factory defaults of all configuration parameters stored in flash memory.

Byte	Item	Type	Value	Response
0	Reset	U8	’K’ (0x4B)	Cold reset
			’F’ (0x46)	Factory reset
			’C’ (0x43)	Compatibility re-start for the Palisade
			’N’ (0x4E)	Clear navigation data in EEPROM and
			‘R’ (0x52)	Set configuration parameters in

Note – The factory reset command will delete the stored position and cause self-survey to restart.

Command Packet 0x1F: Request Software Version

This packet requests information about the version of software in the Acutime GG. This packet contains no data. The GNSS receiver returns packet 0x45.

Command Packet 0x20: Almanac Request

This packet requests almanac data for one satellite from the GNSS receiver. This packet contains one data byte specifying the satellite PRN number. The GNSS receiver returns packet 0x40 hex.

Command Packet 0x21: Current Time Request

This packet requests current GNSS time. This packet contains no data. The GNSS receiver returns packet 0x41 hex.

Command Packet 0x22: Request GPS Satellite Selection

Command Packet 0x22 configures the receiver to operate in a specific position fix mode and stores the new mode setting in memory. One data byte is included in the packet to select the position fix mode.

Byte	Item	Type	Value	Meaning
1	Position Fix Mode	BYTE	Flag	Position fix mode: 0 Automatic 2D/3D (default) 1……Time only (0D) 3…..Horizontal (2D) 4…..Full position (3D) 10…..Over determined Clock mode

Command Packet 0x23: Initial Position (XYZ Cartesian ECEF) Command

This packet provides the GNSS receiver with an approximate initial position in XYZ coordinates. This packet is useful if you have moved more than about 1000 meters since the previous fix.

***Note** – The GNSS receiver can initialize without any data from the user; this packet merely reduces the time required for initialization.*

This packet is ignored if the receiver is already calculating positions.

The origin is the earth's center. The X-axis points toward the intersection of the equator and the Greenwich meridian, the Y-axis points toward the intersection of the equator and the 90° meridian, and the Z-axis points toward the North Pole. The cold-start default LLA (not XYZ) position is 0, 0, 0.

Byte	Item	Type	Units
0-3	X	Single	Meters
4-7	Y	Single	Meters
8-11	Z	Single	Meters

Command Packet 0x24: Request GPS Satellite Selection

This packet requests a list of satellites used for the current position/time fix. This packet contains no data. The GNSS receiver returns packet 0x6C.

Command Packet 0x25: Initiate Soft Reset / Self-Test Command

This packet commands the GNSS receiver to perform a soft reset, causing the receiver to perform the equivalent of powering off and then on. The receiver performs a self-test during the reset routine. Command Packet 0x25 contains no data bytes.

***Note** – The GNSS receiver sends packet 0x45 only on power-up and reset (or on request). If packet 0x45 appears unrequested, either the GNSS receiver power was cycled or the GNSS receiver was reset.*

Command Packet 0x26: Health Request

This packet requests health and status information from the GNSS receiver. This packet contains no data. The GNSS receiver returns packets 0x46 and 0x4B.

Command Packet 0x27: Request Signal Levels

This packet requests signal levels for all satellites currently being tracked. This packet contains no data. The GNSS receiver returns packet 0x47 hex.

Command Packet 0x29: Almanac Health Page Request

This packet requests the health page from the almanac. This packet contains no data. The GNSS receiver returns packet 0x49.

Command Packet 0x2A: Altitude for 2-D Mode Command

This packet provides the altitude to be used for 2-dimensional navigation mode. This packet contains one SINGLE number (4 bytes) specifying the altitude in meters, using the WGS-84 model of the earth or MSL geoid altitude, depending on I/O options (set by packet 0x35). The GNSS receiver returns packet 0x4A. Trimble recommends that you upload the reference altitude before the receiver starts doing position fixes.

If an altitude is not provided, the receiver uses the altitude of the previous 3-D fix (altitude-hold mode). Sending packet 0x2A with one data byte equal to 0xFF cancels altitude-set mode and returns the reference altitude to 0. The altitude setting is stored in flash memory. You can use packet 0x8E-26 to write receiver configurations to EEPROM.

To use the fixed altitude survey mode, the receiver must be configured to Manual 2-D navigation mode using packet 0xBB. The reference altitude is used in 2-D surveys from both warm and cold starts

Note – If the receiver altitude is set above 18,000 m, the receiver is forced to reset each time it acquires satellites. This is implemented to conform to the COCOM industry standard.

Command Packet 0x2B: Initial Position (Latitude, Longitude, Altitude)

This packet provides the GNSS receiver with an approximate initial position in latitude and longitude coordinates (WGS-84). This packet is useful if the user has moved more than about 1,000 miles since the previous fix. The GNSS receiver returns report packet 0x2B, which indicates if the position was accepted by the receiver.

Note *– The GNSS receiver can initialize itself without any data from the user; this packet merely reduces the time required for initialization.*

This packet is ignored if the receiver is already calculating positions. The data format is shown in the table below.

Byte	Item	Type	Units
0-3	Latitude	Single	Radians, north
4-7	Longitude	Single	Radians, east
8-11	Altitude	Single	Meters

Command Packet 0x2D: Oscillator Offset Request

This packet requests the calculated offset of the GNSS receiver master oscillator. This packet contains no data. The GNSS receiver returns packet 0x4D hex. This packet is used mainly for service.

Command Packet 0x2E: Set GPS Time

This packet provides the approximate GNSS time of week and the week number to the GNSS receiver. The GNSS receiver returns Packet 0x4E. The GPS week number reference is Week #0, starting on 6 January 1980. The seconds count begins at midnight on each Sunday morning. This packet is usually not required when the battery back-up voltage is applied as the internal clock keeps time to sufficient accuracy. *This packet is ignored if the receiver has already calculated the time from tracking a GNSS satellite*.

***Note** – See report Packet 41 for information on the Extended GPS week number.*

Byte	Item	Type	Units
0-3	GPS time of week	Single	Seconds
4-5	Extended GNSS week number	I16	Weeks

Command Packet 0x2F: UTC Parameters Request

This packet requests the current UTC-GPS time offset (leap seconds). The packet has no data. The receiver returns packet 0x4F.

Command Packet 0x31: Accurate Initial Position (XYZ Cartesian ECEF) Command

This packet is identical in content to packet 0x23; it provides an initial position to the GNSS receiver in XYZ coordinates. However, the GNSS receiver assumes the position provided in this packet to be accurate. This packet is used for satellite acquisition aiding in systems where another source of position is available and in time transfer (one-satellite mode) applications. For acquisition aiding, the position provided by the user to the GNSS receiver in this packet should be accurate to a few kilometers. For high-accuracy time transfer, position should be accurate to a few meters. T-RAIM flags come on if this position is not accurate enough.

Entering an accurate position sets the self-survey completion state to 100%. The uploaded position is not stored in EEPROM unless it is stored with command packet 0x8E-26. The input position is reported by packet 0x8F-AC.

Command Packet 0x32: Accurate Initial Position (Latitude, Longitude, Altitude)

This packet provides an accurate initial position to the GNSS receiver in latitude, longitude, and altitude coordinates. Either the single precision or the double precision version of this packet may be used, however, we recommend using the double precision version for greatest accuracy. The GNSS receiver returns report packet 0x32, which indicates if the position was accepted by the receiver. The GNSS receiver uses this position for performing time-only fixes. If a survey is in progress when this command is issued, the survey is aborted, and this position data is used immediately. The coordinates entered must be in the WGS-84 datum. The Acutime GG will automatically switch to the over-determined timing mode. Note that this position is not automatically saved to flash memory. If you want to save this position, first set the position, wait at least 2 seconds and then use packet 8E-A6 to save the position.

Note – When converting from degrees to radians use the following value for PI:
3.1415926535898

Single precision data format

Byte	Item	Type	Units
0-3	Latitude	Single	Radians, north
4-7	Longitude	Single	Radians, east
8-11	Altitude	Single	Meters

Double precision data format

Byte	Item	Type	Units
0-7	Latitude	Double	Radians, north
8-15	Longitude	Double	Radians, east
16-23	Altitude	Double	Meters

Command Packet 0x35: Set or Request I/O Options

This packet requests the current I/O option states and allows the I/O option states to be set as desired.

To request the option states without changing them, the user sends this packet with no data bytes. To change any option states, the user includes 4 data bytes with the values. The I/O options, their default states, and the byte values for all possible states are shown below. These options can be set into non-volatile memory (flash ROM) with the 0x8E-26 command. The GPS receiver returns packet 0x55.

These abbreviations apply to the following table:
ALT (Altitude)

ECEF (Earth-centered, Earth-fixed) XYZ (Cartesian coordinates)
LLA (latitude, longitude, altitude)
HAE (height above ellipsoid)
WGS-84 (Earth model (ellipsoid))
MSL geoid (Earth (mean sea level) mode) UTC (coordinated universal time)

Byte	Data Type	Bit	Default	Value	Meaning	Associated Packet
0	Position	0	0	0	ECEF off	0x42 or 0x83
				1	ECEF on	
		1	1	0	LLA off	0x4A or 0x84
				1	LLA on	
		2	0	0	HAE (datum)	0x4A or 0x84
				1	MSL geoid (Note 1)	
		3	0	0	reserved	
		4	1	0	single-precision position	0x42 / 4A 0x83 / 84
				1	double-precision position	
		5:7	0		reserved	
1	velocity	0	0	0	ECEF off	0x43
				1	ECEF on	
		1	1	0	ENU off	0x56
				1	ENU on	
		2:7	0		reserved	
2	timing	0	0	0	GPS time reference	0x42, 0x43, 0x4A, 0x83,
				1	UTC time reference	0x84, 0x56,
3	Reserved	0:7	reserved		reserved	

***Note** – When using the MSL altitude output, the current datum must be set to WGS-84.*

Command Packet 0x37: Request Status and Values of Last Position

This packet requests information regarding the last position fix (normally used when the GNSS receiver is not automatically outputting fixes). The GNSS receiver returns the position/velocity auto packets specified in the 0x35 message as well as message 0x57. This packet contains no data.

Command Packet 0x38: Request/Load Satellite System Data

This packet requests current satellite data (almanac, ephemeris, and so on) or permits loading initialization data from an external source (for example, by extracting initialization data from an operating GNSS receiver unit through a data logger or computer and then using that data to initialize a second GNSS receiver unit). The GNSS receiver returns packet 0x58.

Note *– The GNSS receiver can initialize itself without any data from the user; it merely requires more time.*

To request data without loading data, use only bytes 0 through 2; to load data, use all bytes. Before loading data, observe the caution notice below. The data formats are located in Report Packet 0x58.

Byte	Item	Type	Value	Meaning
0	Operation	U8	1	Request data from GPS receiver
			2	Load data into GPS receiver
1	Type of data	U8	2	Almanac
			3	Health page, T_oa, WN_oa
			4	Ionosphere
			5	UTC
			6	Ephemeris
2	Sat PRN#	U8	02	Data that is not satellite - ID specific
			1-32	Satellite PRN number
3	Length (n)	U8		Number of bytes of data to be loaded
4 to n+3	Data	U8		Satellite data

WARNING – Loading all satellite data at once sends a lot of bytes to the unit, which could overwhelm the unit's serial receive buffer. Always wait for the acknowledge packet before sending the next data block.

Command Packet 0x39: Satellite Attribute Database Command

Normally, the GNSS receiver selects only healthy satellites (based on transmitted values in the ephemeris and almanac) that satisfy all mask values for use in the position solution. This packet allows you to override the internal logic and force the receiver to either unconditionally disable a particular satellite or to ignore a bad health flag. The GNSS receiver returns packet 0x59 for operation modes 3 and 6 only.

Byte	Item	Type	Value	Meaning
0	Operation	BYTE	1	Enable for selection (default)
			2	Disable for selection
			3	Request enable or disable status of all 32 satellites
			4	Heed health on satellite (default)

			5	Ignore health on satellite
			6	Request heed or ignore health on all 32 satellites
1	Satellite #	BYTE	0	All 32 satellites
			1-32	Any one satellite PRN number

At power-on and after a reset, the default values are set for all satellites.

Command Packet 0x3A: Request last raw Measurement

This packet requests the most recent raw measurement data for one specified satellite. The GNSS receiver returns packet 0x5A if data is available.

Command Packet 0x3B: Satellite Ephemeris Status Request

This packet requests the current status of satellite ephemeris data. The GNSS receiver returns packet 0x5B, if data is available.

Byte	Item	Type	Value	Meaning
1	Satellite #	BYTE	0	All satellites for which ephemeris data is available
			1-32	Required satellite

Command Packet 0x3C: Request Current Satellite Tracking Status

This packet requests the current satellite tracking status. The GNSS receiver returns packet 0x5C if data is available.

Byte	Item	Type	Value	Meaning
1	Satellite #	BYTE	0	All satellites in the current tracking set
			1-32	Required satellite

Command Packet 0x3D: Timing Port Configuration Command

This packet is superseded by 0xBC.

Report Packet 0x32: Accurate Initial Position (Latitude, Longitude, Altitude)

This packet is sent in response to command packet 0x32. The packet indicates if the receiver accepted the accurate initial position.

Byte	Item	Type	Value	Description
0	Status	U8	0	Position accepted
			1	Position not accepted
1	Reserved	U8	0	Reserved

Report Packet 0x40: Almanac Data Page Report

This packet provides almanac data for a single satellite. The GNSS receiver sends this packet on request (packet 0x20 hex) and optionally, when the data is received from a satellite.

Byte	Item	Type	Units
0	satellite	Byte	(identification number)
1-4	T_zc	Single	seconds
5-6	week number	Integer	weeks
7-10	eccentricity	Single	(dimensionless)
11-14	T_oa	Single	seconds
15-18	i_o	Single	radians
19-22	OMEGA_dot	Single single	radians/second
23-26	square_root_A	Single	√meters
27-30	OMEGA_0	Single	radians
31-34	Omega	Single	radians
35-38	M_0	Single	radians

T_zc is normally positive However, if no almanac data is available for this satellite, then T_zc is negative. T_zc and the week number in this packet refer to the Z-count time and week number at the time the almanac was received. The remaining items are described in the ICD-GPS-200.

Report Packet 0x41: GPS Time Report

This packet provides the current GPS time of week and the week number. The GNSS receiver sends this packet in response to packet 0x21 and during an update cycle, which occurs approximately every 16 seconds when not doing fixes and approximately every 150 seconds when doing fixes.

Byte	Item	Type	Units
0-3	GPS time of week	Single	Seconds
4-5	GPS week number	Integer	Weeks
6-9	GPS/UTC offset	Single	seconds

Report Packet 0x42: Single-precision Position Fix

This packet provides current GNSS position fix in XYZ ECEF coordinates. If the I/O "position" option is set to "XYZ ECEF" and the I/O "Precision-of-Position output" is set to single-precision, then the GNSS receiver sends this packet each time a fix is computed and at start-up. The data format is shown below.

Byte	Item	Type	Units
0-3	X	Single	meters
4-7	Y	Single	meters
8-11	Z	Single	meters
12-15	Time of fix	Single	seconds

The time-of-fix is in GNSS time or UTC as selected by the I/O "timing" option in command packet 0x35. Packet 0x83 provides a double-precision version of this information.

Report Packet 0x43 Velocity Fix, XYZ ECEF

This packet provides current GNSS velocity fix in XYZ ECEF coordinates. If the I/O "velocity" option (packet 0x35) is set to "XYZ ECEF", then the GNSS receiver sends this packet each time a fix is computed or in response to packet 0x37. The data format is shown below. The time-of-fix is in GPS, GLONASS or UTC as selected by the I/O "timing" option.

Byte	Item	Type	Units
0-3	X velocity	Single	meters/second
4-7	Y velocity	Single	meters/second
8-11	Z velocity	Single	meters/second
12-15	bias rate	Single	meters/second
16-19	time-of-fix	Single	seconds

Report Packet 0x45: Software Version Information

This packet provides information about the version of software in the Acutime GG. The GNSS receiver sends this packet after power-on and in response to packet 0x1F.

Byte	Item	Type
0	Major version number of application	U8
1	Minor version number	U8
2	Month	U8
3	Day	U8
4	Year number minus 2000	U8
5	Major revision number of GPS core	U8
6	Minor revision number	U8
7	Month	U8
8	Day	U8

9	Year number minus 2000	U8

***Note** – Bytes 0 through 4 are part of the application layer of the firmware, while bytes 5 through 9 are part of the GNSS core layer of the firmware.*

Report Packet 0x46: Health of Receiver Report

This packet provides information about the satellite tracking status and the operational health of the receiver. The receiver sends this packet after power-on or software-initiated resets, in response to packet 0x26, during an update cycle, when a new satellite selection is attempted, and when the receiver detects a change in its health. Packet 0x4B is always sent with this packet. The data format is shown below:

Byte	Item	Type	Value	Meaning
0	Status code	Byte	00 hex	Doing position fixes
			01 hex	Do not have GPS time yet
			03 hex	PDOP is too high
			08 hex	No usable satellites
			09 hex	Only 1 usable satellite
			0A hex	Only 2 usable satellites
			0B hex	Only 3 usable satellites
			0C hex	The chosen satellite is unusable
			BB hex	Have GPS time fix (OD mode)
1	Error codes	Byte		See Report Packet 0x46

The error codes in Byte 1 of packet 0x46 are encoded into individual bits within the byte. The bit positions and their meanings are shown below:

Error code bit position	Meaning if bit value = 1
0 (LSB)	Unused
1	Unused
2	Unused
3	Unused
4	Antenna feed line fault (open or short)
5	Antenna is shorted
6	Unused
7 (MSB)	unused

Report Packet 0x47: Signal Level for All Satellites Tracked

This packet provides received signal levels for all satellites currently being tracked or on which tracking is being attempted (i.e., above the elevation mask and healthy according to the almanac). The receiver sends this packet only in response to packet 0x27. The data format is shown below. Up to 14 satellite number/signal level pairs may be sent, indicated by the count field. Signal level is normally positive. If it is zero then that satellite has not yet been acquired. The absolute value of signal level field is the last known signal level of that satellite.

Byte	Item	Type
0	count	U8
1	satellite number 1	U8
2- 5	signal level 1	Single
6	satellite number 2	U8
7-10	signal level 2	Single
(etc.)	(etc.)	(etc.)

Note – The signal level provided in this packet is a linear measure of the signal strength after correlation or de-spreading. Units are in dBHz.

Report Packet 0x49: Almanac Health Page Report

This packet provides health information on all 32 satellites. Packet data consists of 32 bytes, each of which contains the 6-bit health from almanac page 25. The first byte is for satellite #1, and so on. The receiver sends this packet in response to packet 0x29 and when this data is received from a satellite.

Byte	Item
0	Health of satellite #1
1	Health of satellite #2
-…-	-…-
31	Health of satellite #31

In each data byte of this packet, a value “0” indicates that the satellite is healthy; all other values indicate that the satellite is unhealthy.

Report Packet 0x4A: Single Precision LLA Position Fix

The packet provides current GNSS position fix in LLA (latitude, longitude, and altitude) coordinates. If the I/O position option is set to "LLA" and the I/O precision of position output is set to single precision, then the receiver sends this packet each time a fix is computed. The data format is shown below:

Byte	Item	Type	Units
0-3	latitude	Single	radians: + for north, - for south
4-7	longitude	Single	radians: + for east, - for west
8-11	altitude	Single	meters
12-15	clock Bias	Single	meters (always relative to GPS)
16-19	time of fix	Single	seconds

The LLA conversion is done according to the datum selected; the default is WGS-84. Altitude is referred to the datum or the MSL Geoid, depending on which I/O LLA altitude option is selected with packet 0x35. The time of fix is in GPS, GLONASS time or UTC, depending on which I/O timing option is selected.

CAUTION – When converting from radians to degrees, significant and readily visible errors will be introduced by use of an insufficiently precise approximation for the constant π (pi). The value of a constant π as specified in ICDGPS-200 is 3.1415926535898.

CAUTION – The MSL option is only valid with the WGS-84 datum. Do not use other datums**.**

Report Packet 0x4B: Machine/Code ID and Additional Status Report

The receiver transmits this packet in response to packets 0x25 and 0x26 and following a change in state. This packet identifies the receiver and may present error messages. Packet

0x46 is always sent with this packet. The machine ID can be used by equipment communicating with the receiver to determine the type of receiver to which the equipment is connected. Then the interpretation and use of packets can be adjusted accordingly.

Byte	Item	Type	Meaning
0	Machine ID	BYTE	97
1	Status 1	BYTE	See below for the Status 1 codes
2	Status 2	BYTE	Superpackets are supported

The status codes are encoded into individual bits within the bytes:

Status 1 Bit Position	Meaning if bit value = 1

0 (LSB)	Not used
1	Not used
2	Not used
3	The Almanac stored in the receiver is not complete & current
4-7	Not used

Report Packet 0x4D: Oscillator Offset

This packet provides the current value of the receiver master oscillator offset in Hertz at carrier. This packet contains one SINGLE number (4 bytes). The receiver sends this packet in response to packet 0x2D

Report Packet 0x4E: Response to Set GPS Time

Indicates whether the receiver accepted the time given in a Set GNSS time packet. The receiver sends this packet in response to Packet 0x2E. This packet contains one byte.

Value	Meaning
ASCII “Y”	The receiver accepts the time entered via Packet 2E. The receiver has not yet received the time from a satellite.
ASCII “N”	The receiver does not accept the time entered via Packet 2E. The receiver has received the time from a satellite and uses that time. The receiver disregards the time in Packet 0x2E

Report Packet 0x4F: UTC Parameters Report

This packet is sent in response to command packet 0x2F and contains 26 bytes. It reports the UTC information broadcast by the GPS system. For details on the meanings of the following parameters, consult ICD-200, Sections 20.3.3.5.2.4, 20.3.3.5.1.8, and Table 20-IX.

On the simplest level, to get UTC time from GPS time, subtract ΔTLS seconds. The other information contained in this packet indicates when the next leap second is scheduled to occur.

Byte	Value	Type
0-7	A0	Double
8-11	A1	Single
12-13	ΔT_{LS}	Integer
14-17	T_{OT}	Single
18-19	WN_T	Integer
20-21	WN_{LSF}	Integer

Byte	Value	Type
22-23	DN	Integer
24-25	ΔT_{LSF}	Integer

Report Packet 0x54: Bias and Bias Rate Report

The receiver sends this packet to provide the computed clock-only solution when the receiver is in the manual or automatic Over-determined Clock Mode or Time Only (1-SV) Mode.

Byte	Item	Type	Units
0-3	Bias	Single	Meters
4-7	Bias rate	Single	Meters/second
8-11	Time of fix	Single	seconds

The bias is the offset of the receiver internal time clock from GPS time. Bias is expressed as meters of apparent range from the satellites, and corrects the 1 PPS output. Bias rate is the frequency error of the receiver internal oscillator. It is expressed as apparent range rate. Time-of-fix is in GPS or UTC time as selected by the I/O “timing” option in packet 0x35.

CAUTION – For accurate interpretation of the propagation delay, the precise constant for the speed of light must be used. The ICD-200 value for the speed of light is 299,792,458 m/s**.**

Report Packet 0x55 I/O Options

This packet provides the current I/O option states in response to packet 0x35 request. The data format is the same as for packet.

Report Packet 0x56: Velocity Fix, East-North-Up (ENU)

If East-North-Up (ENU) coordinates have been selected for the I/O "velocity" option, the receiver sends this packet under the following conditions:

- Each time that a fix is computed
- In response to packet 0x37 (last known fix) The data format is shown below.

Byte	Item	Type	Units
0-3	East Velocity	Single	m/s; + for east, - for west
4-7	North Velocity	Single	m/s; + for north, - for south
8-11	up velocity	Single	m/s; + for up, - for down
12-15	clock bias rate	Single	m/s
16-19	time-of-fix	Single	seconds

Note – The time-of-fix is in GPS, GLONASS or UTC time as selected by the I/O "timing" option.

Report Packet 0x57: Information about Last Computed Fix

This packet provides information concerning the time and origin of the previous position fix. The receiver sends this packet, among others, in response to packet 0x37. The data format is shown below.

Byte	Item	Type	Value	Meaning
0	source of info	U8	0	none
			1	regular fix initialization
1	Tracking mode	U8	0	No previous fix
			1	Time only -SV
			2	2D clock hold
			3	2D
			4	3D
			5	over-determined clock
			6	DGPS reference
2-5	time of last fix	Single		seconds GPS time
6-7	week of last fix	U16		weeks

Report Packet 0x58: Satellite System Data/Acknowledge from Receiver

This packet provides GNSS data (almanac, ephemeris, and so on). The receiver sends this packet in response to Packet 0x38 (acknowledging the loading of data). The data format is shown below.

Data Format

Byte	Item	Type	Value	Definition
0	Operation	Byte	1	Acknowledgement
			2	Data Out
1	Type of data	Byte	1	Not used
			2	Almanac
			3	Health page, T_oa, WN_oa
			4	Ionosphere
			5	UTC
			6	GPS Ephemeris
			7	GLONASS Almanac
			8	GLONASS Ephemeris

Byte	Item	Type	Value	Definition
2	Sat PRN #	Byte	0	Data that is not satellite ID-specific
			1 to 32	Satellite PRN number
3	Length (n)	Byte		Byte count
4 to n+3	Data	nBytes		

Almanac parameters

Byte	Item	Type	Definition / ICD-GPS-200
4	t_oa_raw	U8	Sec 20.3.3.5.1.2
5	SV_HEALTH	U8	Sec 20.3.3.5.1.2
6-9	e	Single	Sec 20.3.3.5.1.2
10-13	t_oa	Single	Sec 20.3.3.5.1.2
14-17	i_o	Single	Sec 20.3.3.5.1.2
18-21	OMEGADOT	Single	Sec 20.3.3.5.1.2
22-25	sqrt_A	Single	Sec 20.3.3.5.1.2
26-29	OMEGA_0	Single	Sec 20.3.3.5.1.2
30-33	OMEGA	Single	Sec 20.3.3.5.1.2
34-37	M_0	Single	Sec 20.3.3.5.1.2
38-41	a_f0	Single	Sec 20.3.3.5.1.2
42-45	a_f1	Single	Sec 20.3.3.5.1.2
46-49	Axis	Single	Sec 20.3.3.5.1.2
50-53	n	Single	Sec 20.3.3.5.1.2
54-57	OMEGA_n	Single	Sec 20.3.3.5.1.2
58-61	ODOT_n	Single	Sec 20.3.3.5.1.2
62-65	t_zs	U16	Sec 20.3.3.5.1.2, see Note 2.
66-67	weeknum	U16	Sec 20.3.3.5.1.2
68-69	WN_oa	U16	Sec 20.3.3.5.1.2

Note – All angles are in radians. If data is not available, t_zc is set to -1.0.

Satellite health

Byte	Item	Type	Definition / ICD-GPS-200
4	week number for health	U8	Sec 20.3.3.5.1.3
5-36	SV health	U8	Sec 20.3.3.5.1.3
37	t_oa for health	U8	Sec 20.3.3.5.1.3
38	current t_oa	U8	units = seconds/2048
39-40	current week #	I16	

Ionosphere parameters

Byte	Item	Type	Definition / ICD-GPS-200
4-11	not used		
12-15	α0	Single	Sec 20.3.3.5.1.9
16-19	α1	Single	Sec 20.3.3.5.1.9
20-23	α2	Single	Sec 20.3.3.5.1.9
24-27	α3	Single	Sec 20.3.3.5.1.9
28-31	β0	Single	Sec 20.3.3.5.1.9
32-35	β1	Single	Sec 20.3.3.5.1.9
36-39	β2	Single	Sec 20.3.3.5.1.9
40-43	β3	Single	Sec 20.3.3.5.1.9

UTC parameters

Byte	Item	Type	Meaning
4-16	not used		
17-24	A0	Double	Sec 20.3.3.5.1.8
25-28	A1	Single	Sec 20.3.3.5.1.8
29-30	ΔtLS	S16	Sec 20.3.3.5.1.8
31-34	tot	Single	Sec 20.3.3.5.1.8
35-36	WNt	U16	Sec 20.3.3.5.1.8
37-38	WNLSF	U16	Sec 20.3.3.5.1.8
39-40	DN	U16	Sec 20.3.3.5.1.8
41-42	ΔtLSf	S16	Sec 20.3.3.5.1.8

Ephemeris data

Byte	Item	Type	Meaning
4	SV number	U8	SV PRN number
5-8	t_ephem	Single	time of collection (note, if data is missing or invalid, t_ephem will be negative)
9-10	week number	U16	GPS week number 0 thru 1023
11	codeL2		Sec 20.3.3.3, Table 20-I
12	L2Pdata		Sec 20.3.3.3, Table 20-I
13	SV accuracy raw	U8	Sec 20.3.3.3, Table 20-I
14	SV health	U8	Sec 20.3.3.3, Table 20-I
15-16	IODC	U16	Sec 20.3.3.3, Table 20-I

Byte	Item	Type	Meaning
17-20	tGD	Single	Sec 20.3.3.3, Table 20-I
21-24	toc	Single	Sec 20.3.3.3, Table 20-I
25-28	af2	Single	Sec 20.3.3.3, Table 20-I
29-32	af1	Single	Sec 20.3.3.3, Table 20-I
33-36	afo	Single	Sec 20.3.3.3, Table 20-I
37-40	SV accuracy	Single	Sec 20.3.3.3, Table 20-I
41	IODE	U8	Sec 20.3.3.4
42	fit_interval	U8	Sec 20.3.3.4
43-46	Crs	Single	Sec 20.3.3.4
47-50	Δn	Single	Sec 20.3.3.4
51-58	M0	Double	Sec 20.3.3.4
59-62	Cuc	Single	Sec 20.3.3.4, radians
63-70	e	Double	Sec 20.3.3.4
71-74	CUS	Single	Sec 20.3.3.4, radians
75-82	sqrt(A)	Double	Sec 20.3.3.4
83-86	toe	Single	Sec 20.3.3.4
87-90	Cic	Single	Sec 20.3.3.4
91-98	OMEGA_0	Double	Sec 20.3.3.4
99-102	Cis	Single	Sec 20.3.3.4
103-110	io	Double	Sec 20.3.3.4
111-114	Crc	Single	Sec 20.3.3.4
115-122	OMEGA	Double	Sec 20.3.3.4
123-126	OMEGADOT	Single	Sec 20.3.3.4
127-130	IDOT	Single	Sec 20.3.3.4
131-138	Axis	Double	= (sqrt_A)2
139-146	n	Double	derived from delta_n
147-154	r1me2	Double	= sqrt (1.0-e2)
155-162	OMEGA_n	Double	derived from OMEGA_0, OMEGADOT
163-170	ODOT_n	Double	derived from OMEGADOT

Report Packet 0x59: Satellite Attributes Database Report

This packet is returned in response to packet 0x39 if operation mode 3 or 6 is used with packet 0x39.

Normally the GNSS receiver selects only healthy satellites (based on transmitted values in the ephemeris and almanac) that satisfy all mask values, for use in the position solution.

Packet 0x59 indicates whether or not each satellite is allowed to be selected for use in the position solution, and whether each satellite's health is to be heeded or ignored.

***Note** – When viewing the satellite disabled list, the satellites are not numbered but are in numerical order. The disabled satellites are signified by a 1 and enabled satellites are signified by a 0.*

Byte	Item	Type	Value	Meaning
0	Operation	Byte	3	The remaining bytes tell whether receiver is allowed to select each satellite
			6	The remaining bytes tell whether the receiver heeds or ignores each satellite's health as a criterion for selection
1-32	Satellite #	32 Byte		1 byte per satellite (depends on byte 0 value)
			0	Enable satellite selection or heed satellite's health.
			1	Disable satellite selection or ignore satellite's health

Report Packet 0x5A: Raw Data Measurement Data

Packet 0x5A provides raw GNSS measurement data. If the packet 0x35 auxiliary option byte bit 1 is set, this packet is sent automatically as measurements are taken.

Byte	Item	Type	Units
0	SV PRN number	U8	
1-4	sample length	single	milliseconds
5-8	signal level	single	dB/Hz
9-12	code phase	single	1/16th chip
13-16	doppler	single	Hertz @ L1
17-24	time of measurement	double	seconds

Note – The sample length is the number of milliseconds over which the sample was averaged.

Note – The code phase value is the average delay over the sample interval of the received C/A code, and is measured with respect to the receiver's millisecond timing reference.

Signal level

The Signal Level (byte 5) is a linear approximation of C/N0 which is stated in antenna amplitude measurement units (AMUs), a Trimble devised unit.
The C/N0 is affected by five basic parameters:

- signal strength from the GPS satellite
- receiver/antenna gain
- pre-amplifier noise figure
- receiver noise bandwidth
- accumulator sample rate and statistics

Codephase

The codephase (byte 9) value is the average delay over the sample interval of the received C/A code and is measured with respect to the receiver's millisecond timing reference. Thus, it includes all receiver, satellite, and propagation biases and errors. It is expressed in 1/16th of a C/A code chip.

Doppler

The Doppler (byte 13) value is apparent carrier frequency offset averaged over the sample interval. It is measured with respect to the nominal GPS L1 frequency of 1575.42 MHz, referenced to the receiver's internal oscillator. Thus, it includes all receiver and satellite clock frequency errors. It is expressed in Hertz at the L1 carrier.

Time of measurement

The time of measurement (Byte 17) is the center of the sample interval adjusted by adding the receiver-supplied codephase (modulo mS) to a user-determined integer number of mS between receiver and satellite.

The receiver codephase resolution is 1/16th of a C/A code chip. This corresponds to:

1/16 × C/A code chip ≈ 977.517ns/16 ≈ 61.0948 ns

≈ 61.0948 × speed of light, m/s

≈ 18.3158 meters

The integer millisecond portion of the pseudo-range must then be derived by utilizing the approximate receiver and satellite positions. Rough receiver position (within a few hundred kilometers) must be known; the satellite position can be found in its almanac/ephemeris data. Each mS integer corresponds to:

C/A code epoch × speed of light = 1 ms × speed of light m/s

≈ 300 km (approximate)

≈ 299.792458 km (precise)

The satellite time-of-transmission for a measurement can be reconstructed using the code phase, the time of measurement, and the user-determined integer number of milliseconds.

Report Packet 0x5B: Satellite Ephemeris Status Report

This packet is sent in response to packet 0x3B and optionally, when a new ephemeris (based on IODE) is received. It contains information on the status of the ephemeris in the receiver for a given satellite.

Byte	Item	Type	Units
0	Satellite PRN number	Byte	
1-4	Time of Collection	Single	seconds
5	Health	Byte	
6	IODE	Byte	
7-10	toe	Single	seconds
11	Fit Interval Flag	Byte	
12-15	SV Accuracy (URA)	Single	meters

The satellite PRN number is in the range 1–32. Time of Collection is the GPS time when this ephemeris data was collected from the satellite. Health is the 6-bit ephemeris health. IODE, toe, and Fit Interval Flag are as described in ICD-GPS-200. SV Accuracy (URA) is converted to meters from the 4-bit code as described in ICD-GPS-200.

Report Packet 0x5C: Satellite Tracking Status

The receiver sends this packet in response to command packet 0x3C.

Byte	Bit	Item	Type	Value	Meaning
0		SV PRN number	U8	1-32	GPS
				65-97	GLONASS
1	3-7	channel number	bit field	1-32	Channels 1-32
2		acquisition flag	UNIT8	0	never acquired
				1	acquired
				2	re-opened search
3		ephemeris flag	UNIT8	0	flag not set
				>0	good ephemeris
4-7		signal level	single		dBHz
8-11		time of last measurement	single	secs	GPS time of week
12- 15		elevation angle	single		radians
16- 19		azimuth angle	single		radians

Byte	Bit	Item	Type	Value	Meaning
20		old measurement flag	U8	0	measurement is current
				>0	measurement is old
21		reserved	U8	0	reserved
22		reserved	U8	0	reserved
23		reserved	U8	1	reserved

Report Packet 0x6C: All-in-View Satellite Selection

This packet provides a list of satellites used for position or time only fixes by the GNSS receiver. The packet also provides the PDOP, HDOP, and VDOP of that set and provides the current mode (automatic or manual, 3-D or 2-D, over-determined, clock, etc.). This packet has variable length equal to 17+nsvs where "nsvs" is the number of satellites used in the solution.

The GNSS receiver sends this packet in response to packet 0x24 when the selection list is updated. If enabled with packet 8E-A5, the receiver will send this packet whenever the selection is updated. The data format is shown below.

Byte	Bit	Item	Type	Value	Meaning
0	0-2	fix dimension	bit field	3	2D fix
				4	3D fix
				5	OD clock fix
	3	fix mode	bit field	0	auto
				1	manual
1-4		PDOP	Single		PDOP
5-8		HDOP	Single		HDOP
9-12		VDOP	Single		VDOP
13-16		TDOP	Single		TDOP
17		No. of SV in fix	U8		Count
18 - n		SV PRN	S8	±(1- 32)	PRN

Command Packet 0x7A: Set or Request NMEA Interval and Message Mask

The NMEA message determines whether or not a given NMEA message will be output. If the bit for a message is set, the message will be sent every "interval" seconds. To determine the NMEA interval and message mask, use the values shown below. While fixes are being generated the output order is: ZDA, GGA, GLL, VTG, GSA, GSV, RMC.

Byte	Bit	Item	Type	Value	Meaning
0		Subcode	U8	0	

Byte	Bit	Item	Type	Value	Meaning
1		Interval	U8	1-225	Fix interval in seconds
2		Reserved	U8	0	
3		Reserved	U8	0	
4	0	RMC	Bit	0	Off
				1	On
5	1-7	Reserved	Bit	0	
5	0	GGA	Bit	0	Off
				1	On
5	1	GGL	Bit	0	Off
				1	On
5	2	VTG	Bit	0	Off
				1	On
5	3	GSV	Bit	0	Off
				1	On
5	4	GSA	Bit	0	Off
				1	On
5	5	ZDA	Bit	0	Off
				1	On
5	6-7	Reserved	Bit	0	

Report Packet 0x7B: Set NMEA Message Output

This packet is sent in response to command packet 7A and has the same data format as packet 7A.

Report Packet 0x83: Double Precision XYZ

This packet provides current GNSS position fix in XYZ ECEF coordinates. If the I/O "position" option is set to "XYZ ECEF" and the I/O double position option is selected, the receiver sends this packet each time a fix is computed. The data format is shown below.

Byte	Item	Type	Units
0-7	X	Double	meters
8-15	Y	Double	meters
16-23	Z	Double	meters
24-31	clock bias	Double	meters
32-35	time-of-fix	Single	seconds

***Note** – The time-of-fix is in GPS, GLONASS time or UTC, as selected by the I/O "timing" option. Packet 0x42 provides a single-precision version of this information.*

Report Packet 0x84: Double Precision LLA Position Fix and Bias Information

This packet provides current GNSS position fix in LLA coordinates. If the I/O "position" option is set to "LLA" and the double position option is selected (see packet 0x35), the receiver sends this packet each time a fix is computed.

Byte	Item	Type	Units
0-7	latitude	Double	radians; + for north, - for south
8-15	longitude	Double	radians; + for east, - for west
16-23	altitude	Double	meters
24-31	clock bias	Double	meters (always relative to GPS)
32-35	time-of-fix	Single	seconds

***Note** – The time-of-fix is in GPS, GLONASS time or UTC time as selected by the I/O "timing" option.*

CAUTION – When converting from radians to degrees, significant and readily visible errors will be introduced by use of an insufficiently precise approximation for the constant p (PI). The value of the constant PI as specified in ICDGPS-200 is 3.1415926535898.

Command Packet 0xBB: Set Receiver Configuration

In query mode, packet 0xBB is sent with a single data byte and returns report packet

0xBB in the format shown below:

Data Format (Query Only)

Byte	Item	Type	Value	Meaning	Default
0	Subcode	U8	0	Query mode	

TSIP packet 0xBB is used to set GNSS Processing options. The table below lists the individual fields within the 0xBB packet.

Report Packet 0 x BB Data Format

Byte	Item	Type	Value	Meaning	Default

Byte	Item	Type	Value	Meaning	Default
0	Subcode	U8	0x00	Receiver configuration block	
1	Receiver mode	U8	0	Automatic	#0
			1	Time only (1SV)	
			3	Horizontal (2D)	
			4	Full Position (3D)	
			5	Reserved	
			6	2D clock hold	
			7	Over Determined Clock	
2	reserved	U8		N/A	
3	reserved	U8		N/A	
4	reserved	U8		N/A	
5-8	Elevation Mask	Single	0-π/2	Lowest satellite elevation for fixes only when the receiver is operating the Over Determined Clock mode.	0 degrees
9-12	AMU Mask	Single	0 - 55	Min. signal level for fixes. Used when receiver is operating in OD mode.	4.0
13-16	PDOP Mask	Single		Maximum PDOP for fixes	8
17-20	PDOP Switch	Single		Selects 2D/3D mode	6
21	reserved	U8		N/A	
22	Anti-jamming	U8	0	Disabled	
	mode		1	Enabled	1
23	reserved	U8		N/A	
24	reserved	U8		N/A	
25	Measurement rate	U8	0	1 Hertz	1Hz
26	Position Fix rate	U8	0	1 Hertz	1Hz
27	Constellation	Bit	1	GPS	See note
			2	GLONASS	
28-39	reserved	U8		N/A	

Note – Byte 27 is used for constellation setting. For GPS only mode 1st bit position is set to 1 (0001), for GLONASS only mode 2nd bit position is set to 1 (eg. 0010) and for GPS & GLONASS mode both 1st and 2nd bits are set to 1 (0011).

CAUTION – The operation of the Acutime GG can be affected adversely if incorrect data is entered in the fields associated with packet 0xBB. Know what you are doing.

Note *– When sending packet 0xBB, fields that are specified as "do not alter" or if you do not want to alter a specific field, send a value of 0xFF for U8 types and a value of - 1.0 for floating point types. The Acutime GG will ignore these values.*

Command Packet 0xBC: Set Port Configuration

TSIP packet 0xBC is used to set and query the port characteristics. In query mode, packet 0xBC is sent with a single data byte and returns report packet 0xBC:

Note – The input and output baud rates must be the same.

Byte	Item	Type	Value	Meaning
0	Port Number	U8	0	Port A (standard)
			1	Port B
			FF	Current Port

Field data format

The table below lists the individual fields within the packet 0xBC when used in the set mode and when read in the query mode:

Byte	Item	Type	Value	Meaning
0	Port to Change	U8	0	Port A (standard)
			1	Port B
			0xFF	Current port
1	Input Baud Rate	U8	6	4800 bps
			7	9600 bps
			8	19200 bps
			9	38400 bps
			10	57600 bps
			11	115200 bps
2	Output Baud Rate	U8	As above	As above
3	# Data Bits	U8	2	7 bits
			3	8 bits
4	Parity	U8	0	None
			1	Odd
			2	Even
5	# Stop Bits	U8	0	1 bit
			1	2 bits

Byte	Item	Type	Value	Meaning
6	Flow Control	U8	0	none
7	Input Protocols	U8	2	TSIP
			4	NMEA
8	Output Protocols	U8	2	TSIP
			4	NMEA
9	Reserved	U8	0	

TSIP Superpackets

Several packets have been added to the core TSIP protocol to provide additional capability for the receivers. In packets 0x8E and their 0x8F responses, the first data byte is a subcode which indicates the superpacket type. For example, in packet 0x8E-15, 15 is the subcode that indicates the superpacket type. Therefore the ID code for these packets is 2 bytes long followed by the data.

Command Packet 0x8E-0B: Request or Configure Superpacket Output

The 0x8E-0B packet is identical in function to the 0x8E-AD packet. If the 0x8E-0B byte sequence is sent with no data, the receiver will return a 0x8F-0B packet on Port B. The time reported by the 0x8F-0B packet on Port B is always the beginning of the current second.

Command Packet 0x8E-15: Request current Datum values

This packet contains only the subpacket ID, 0x15. The response to this packet is 0x8F-15.

Command Packet 0x8E-20: Request Last Fix with Extra Information

This packet requests packet 0x8F-20 or marks it for automatic output. If only the first byte (20) is sent, a 0x8F-20 report containing the last available fix will be sent immediately. If two bytes are sent, the packet is marked / unmarked for auto report according to the value of the second byte.

Byte	Item	Type	Units
0	Sub-packet ID	BYTE	0x20
1	Mark for Auto-	BYTE	0 = do not auto-report
			1 = auto-report

***Note** – Auto-report requires that Superpacket output is enabled. See Command Packet 0x35: I/O Option Flags Command. This packet must also be enabled with packet0x8E-4D.*

Command Packet 0x8E-26: Write Receiver Configuration to Non-volatile Memory (Flash)

This command packet causes the current configuration settings to be written to non- volatile storage. This packet contains only a single byte: the sub-packet ID. Upon receiving the command, the receiver will write the configuration and send a report packet 0x8F-26 when the operation is completed. It typically takes about 1 second to write the user configuration.

CAUTION – If the user application needs to power down the receiver after issuing this command, it must wait until 0x8F-26 report packet is received.

Command Packet 0x8E-41: Request Manufacturing Parameters

This packet is used to request the manufacturing parameters stored in nonvolatile memory. Send this packet with no data bytes (don't forget the subcode) to request packet 0x8F-41.

Command Packet 0x8E-42: Stored Production Parameters

This packet is used to request the production parameters stored in nonvolatile memory. Send this packet with no data bytes (don't forget the subcode) to request packet 0x8F-42.

Command Packet 0x8E-4A: Set PPS Characteristics

This packet allows the user to query (by sending the packet with no data bytes) or set the Acutime GG PPS characteristics. The Acutime GG responds to a query or set command with packet 8F-4A.

Byte	Item	Type	Value	Meaning
0	Subcode	U8	0x4A	Always
1	PPS driver switch	U8	0	off
			1	on
2	Time Base	U8	0	GPS
			1	UTC
3	PPS polarity	U8	0	positive
			1	negative

4-11	PPS offset or cable delay	Double		seconds
12-15	Bias uncertainty threshold	Single	0	meter

***Note** – Negative offset values advance the PPS, and are normally used to compensate for cable delay.*

Command Packet 0x8E-4D: Automatic Packet Output Mask

This packet is used to disable automatic output of packets on Port B.

- To request the current mask, send this packet with no data bytes except the subcode byte. The receiver returns packet 0x8F-4D.
- To set the automatic packet output mask , send this packet with 4 data bytes. This mask only disables automatic packet output. Packets generated in response to TSIP set or query commands will always be output by the receiver.

Bit	Output packet	Default A2K	When output	Meaning
0 (LSB)	0x40	0	After Decode	Almanac data collected from satellite.
1	0x58, 0x5B	0	After Decode	Ephemeris data collected from satellite.
2	0x4F	0	After Decode	UTC data collected from satellite.
23	0x58	0	After Decode	Ionospheric data collected from satellite.
4	0x48	0	After Decode	GPS Message.
5	0x49	0	After Decode	Almanac health page collected from satellite.
6	Reserved	1		Reserved
7	Reserved	1		Reserved
8	0x41	1	New Fix	Partial and full fix complete and packet output timer has expired.
9	Reserved	1		Reserved
10	Reserved	1		Reserved
11	6D, 46, 4B,	1	Constellation	New satellite selection
12-29	Reserved	1		Reserved
30	42, 43, 4A, 54, 56, 83, 84, 8F-20	1	New Fix Update	Kinetic and Timing information. Output must be enabled using I/O options
31	5A	1	New Fix	Raw Measurement Data Output must be enabled using I/O options

Command Packet 0x8E-4E: Set PPS output option

This command packet sets the PPS driver switch to one of the values listed in Table A-52. The current driver switch value can be requested by sending the packet with no data bytes except the subcode byte. The response packet is 0x8F-4E.

Driver switch values 3 and 4 only make sense in Over-determined Timing mode. In any position fix mode the effective choices are always on or during fixes which you get if you set the driver switch to 3 or 4.

The Acutime GG can also be configured to generate an Even Second pulse in place of the PPS pulse by setting the value as shown in the table below.

Byte	Item	Type	Value	Meaning
0	Subcode	U8	0x4E	
1	PPS driver switch	U8	2	PPS is always on. PPS is generated every second
			3	PPS is output when at least one satellite is tracking. PPS is generated every second
			4	PPS is output when at least three satellites are tracking. PPS is generated every second
			130	PPS is always on. PPS is generated every even second PPS is output when at least one satellite is tracking. PPS is generated every even second
			131	PPS is output when at least three satellites are tracking
			132	PPS is generated every even second

Command Packet 0x8E-4F: Set PPS Width

This command packet sets the PPS width to a value in the range of 10 microseconds to 500 milliseconds. The receiver returns packet 0x8F-4F. The current PPS width can be requested by sending this packet with no data bytes except the subcode byte.

Byte	Item	Type	Value	Meaning
0	Subcode	U8	0x4F	
1-8	PPS width	U16		seconds

Command Packet 0x8E-A2: UTC/GNSS Timing

Command packet 8E-A2 sets the UTC/GNSS timing mode (time and date fields) in packet 0x8F-AB, and the temporal location of the Acutime GG output PPS. Send packet 8E-A2 with no data to request the current settings. The Acutime GG replies with response packet 8F-A2.

Byte	Bit	Item	Type	Value	Meaning

0		Subcode	U8	0xA2	
1	0	UTC/GPS time	bit field	0	GPS time/date in packet 0x8F-AB
				1	UTC time/date in packet 0x8F-AB
	1			0	PPS referenced to GPS time
				1	PPS referenced to UTC time
	2	GLONASS time	Bit field	0	Time base as indicated in Bit 0
				1	GLONASS time /date
	3			0	PPS reference as indicated in Bit 1
				1	PPS referenced to GLONASS time

Command Packet 0x8E-A5: Packet Broadcast Mask

Use command packet 8E-A5 to set the packet broadcast masks or to request the current mask settings. The Acutime GG replies to requests with response packet

8F-A5. The broadcast mask is bitwise encoded to allow the user to turn on and off the broadcast of certain packets. For those broadcast packets that have multiple format, the Acutime GG will broadcast only one of the formats. If more than one of the formats is masked on for broadcast, then the format with the greatest precision of content masked on will be sent and the rest will not. For each bit in the mask that is used, the coding is as follows:

0: Turn off broadcast of this packet

1: Turn on broadcast of this packet

Byte	Bit	Item	Type	Description
0		Subcode	U8	0xA5
1-2	0	Mask 0	bit field	8F-AB, Primary Timing Information
	1			Reserved
	2			8F-AC, Supplemental Timing Information
	3			Reserved
	4			Reserved
	5			Reserved
	6			Automatic Output Packets
3-4		Mask 2	bit field	reserved

Command Packet 0x8E-A6: Self-Survey Command

Use command packet 8E-A6 to issue a self-survey command, to save the current position in flash or to delete the position saved in flash. The GNSS receiver returns report packet 0x8F-A6, which indicates the result of the requested operation.

Byte	Item	Type	Value	Meaning
0	Subcode	U8	0xA6	
1	Self-survey command	U8	0	Restart self-survey
			1	Save position to Flash
			2	Delete position from Flash

Command Packet 0x8E-A9: Self-Survey Parameters

Use command packet 8E-A9 to set the self-survey parameters or to request the current settings. The Acutime GG replies to requests with response packet 8F-A9.

Data fields

- Self-Survey Enable: Use this field to enabled or disabled the self-survey mechanism.
  0: Disable the self-survey mechanism
  1: Enable the self-survey mechanism
- Position Save Flag: Use this field to tell the self-survey mechanism to automatically save (or to not save) the self-surveyed position at the end of the self-survey procedure.
  0: Don't automatically save the surveyed position when the self-survey is complete
  1: Automatically save the surveyed position when the self-survey is complete.
- Self-Survey Length: Use this field to specify the number of position fixes that are to be averaged together to form the self-surveyed position used for clock-only fixes.
  Limits: 1 to (232 - 1) fixes

Byte	Item	Type	Value	Description
0	Subcode	U8	0xA9	
1	Self-Survey Enable	U8	0	Disabled
			1	Enabled
2	Position Save Flag	U8	0	Don't save position
			1	Save self-surveyed position at the end of the survey
3-6	Self-Survey Length	UINT3 2	see above	Number of fixes
7-10	Reserved	UINT3 2	0	0

Command Packet 0x8E-AB: Request Primary Timing Packet

Use this command packet to request the Primary Timing packet 0x8F-AB. By default, the Acutime GG automatically sends packet 0x8F-AB once per second so it is not necessary to request it. To receive 0x8F-AB information by request only, use packet0x8E-A5 to disable the automatic output.

Byte	Item	Type	Value	Description
0	Packet ID	U8	0x8E	
1	Subpacket ID	U8	0xAB	
2	Request Type	U8	0	Send 0x8F-AB immediately
			1	Send 0x8F-AB on-time next second
			2	Send 0x8F-AB and 0x8F-AC on-time next second

The Request Type item determines how the Acutime GG will reply to this command:

Type	Description
0	The most current primary timing values will be sent in packet 0x8F-AB immediately
1	The response is not sent immediately. Instead packet 0x8F-AB is sent after the next PPS output. This is the same time that the packet would be automatically sent if enabled
2	Same as type 1 except that both 0x8F-AB and 0x8F-AC are sent after the next PPS output

Command Packet 0x8E-AC: Request Supplemental Timing Packet

Use command packet 0x8E-AC to request the Supplemental Timing packet 0x8F-AC. By default, the Acutime GG automatically sends packet 0x8F-AC once per second so it is not necessary to request it. To receive 0x8F-AC information by request only, use packet 0x8E-A5 to disable the automatic output.

Byte	Item	Type	Value	Description
0	Packet ID	U8	0x8E	
1	Subpacket ID	U8	0xAC	
2	Request Type	U8	0	Send 0x8F-AC immediately
			1	Send 0x8F-AC on-time next secondS
			2	Send 0x8F-AB and 0x8F-AC on-time next second

The Request Type item determines how the Acutime GG will reply to this command:

Type	Description
0	The most current primary timing values will be sent in packet 0x8F-AC immediately

1	The response is not sent immediately. Instead packet 0x8F-AC is sent after the next PPS output. This is the same time that the packet would be automatically sent if enabled
2	Same as type 1 except that both 0x8F-AB and 0x8F-AC are sent after the next PPS output

Command Packet 0x8E-AD: Request or Configure Superpacket Output

If the 0x8E-AD byte sequence is sent with no data, the receiver generates an 0x8F-AD packet on port B. The time reported by the 0x8F-AD packet on port B is always the beginning of the current second.

Output of the 0x8F-AD Primary UTC timing packet on Port A is configured by sending a 3- byte message 0x8E-AD n, where n ranges from 0 to 3, as defined below. The receiver returns the 0x8F-A5 Superpacket Output Mask.

Byte	Item	Type	Value	Default	Meaning
0	Subcode	Byte	AD	Required	Superpacket ID
1	Flag	Byte	0	3	Disable packet output on port A
			1		Output packet on port A only at PPS
			2		Output packet on port A only at event input
			3		Output at both event input and PPS

***Note** – External event input is not supported in Acutime GG.*

Report Packet 0x8F-0B: Comprehensive Time

The output of the packet is synchronized with the PPS. Report packet 0x8F-0B provides easy identification of each timing pulse and contains all the information required for most timing and synchronization applications. Output of this packet can be disabled and configured using the 0x8E-A5 packet on Port B. If output of the 0x8F-AD packet is also enabled, the 0x8F-0B packet will always be output after the 0x8F-AD packet.

Byte	Item	Type	Units
0	Subpacket ID	BYTE	Subcode 0x0B
1-2	Event Count	INTEGER	Zero for PPS.
3-10	UTC/GPS TOW	DOUBLE	UTC/GPS time of week (seconds)
11	Date	BYTE	Date of PPS
12	Month	BYTE	Month of PPS
13-14	Year	INTEGER	Year of PPS
15	Receiver Mode	BYTE	Receiver operating dimensions 0: Horizontal (2D) 1: Full Position (3D)

Byte	Item	Type	Units
			2: Single Satellite (OD) 3: Automatic (2D/3D) 4: N/A 5: Clock hold (2D) 6: OD clock mode (default)
16-17	UTC Offset	INTEGER	UTC offset value (seconds)
18-25	Oscillator Bias	DOUBLE	Oscillator bias (meters)
26-33	Oscillator Drift Rate	DOUBLE	Oscillator drift (meters/second)
34-37	Oscillator Bias	SINGLE	Oscillator bias uncertainty (meters)
38-41	Oscillator Drift	SINGLE	Oscillator bias rate uncertainty (meters/second)
42-49	Latitude	DOUBLE	Latitude in radians
50-57	Longitude	DOUBLE	Longitude in radians
58-65	Altitude	DOUBLE	Altitude according to current datum, meters
66-73	Satellite ID	8 BYTES	Identification numbers of tracking and usable

Bytes 66 through 73 identify the tracking and usable satellites. A tracked satellite is distinguished from a usable satellite by a negative sign (−) appended to its PRN number.

In this Superpacket, time is referenced to UTC to correspond to the default PPS timebase. To configure the receiver to output time relative to GPS, the PPS must be characterized accordingly. Command packet 0x8E-4A enables the PPS to be re-defined at run-time and stores the new settings in flash memory.

***Note** – Leap seconds cannot be predicted in advance using only the 0x8F-0B packet. A leap second can be identified by observing that the date does not increment once 86400 seconds have elapsed in the current day. The date rollover is delayed for the duration of the leap second, and the day/month/year count reported does not increment to the next day until the beginning of the second following the leap event. Decoding of the 0x8F-AD packet provides complete leap status information.*

The UTC offset is incremented at the beginning of the first second following the leap second.

Report Packet 0x8F-20: Last Fix with Extra Information (binary fixed point)

This packet provides information about the time and origin of the previous position fix. This is the last-calculated fix; it could be quite old. The receiver sends this packet in response to Packet 0x8E-20; it also can replace automatic reporting of position and velocity packets. Automatic output of 0x8F-20 must also be enabled by setting bit 5 of byte 0 in command packet 0x0x35 and bit 0 of bytes 1-2 in command packet 0x8E-A5

Byte	Item	Type	Meaning
0	Subpacket ID	Byte	ID for this subpacket (always 0x20)
1	Key Byte	Byte	N/A
2-3	east velocity	Integer	Units 0.005 m/s or 0.020 m/s (see Byte 24). Overflow = 0 x 8000
4-5	north velocity	Integer	Units 0.005 m/s or 0.020 m/s (see Byte 24). Overflow = 0 x 8000
6-7	up velocity	Integer	Units 0.005 m/s or 0.020 m/s (see Byte 24). Overflow = 0 x 8000
8-11	Time of Week	Unsigned lon	GPS Time in milliseconds
12-15	Latitude	Long integer	Latitude, units = 2-31 semicircle, according to current datum. Range = -230 to 232
16-19	Longitude	Unsigned	Longitude east of meridian, units = 2-31 semicircle,
20-23	Altitude	Long integer	Altitude above ellipsoid, mm, according current datum.
24	Velocity scaling		When bit 0 is set to 1, velocities in bytes 2-7 have been scaled by 4
25	Reserved		0
26	Datum		Datum index + 1
27	Fix Type	Byte	Type of fix. This is a set of flags.
			0 (LSB) 0: Fix was available
			1: No fix available
			1 0: Fix is autonomous
			1: N/A
			2 0: 3D fix
			1: 2D fix
			3 0: 2D fix used last-circulated altitude
			1: 2D fix used entered altitude
			4 0: Unfiltered
			1: Position or altitude filter on
			5-7 Unused (always 0)
28	Num SVs	Byte	Number of satellites used for fix. Will be zero if no fix was available.
29			Number of leap seconds between UTC time and GPS time.
30-31	UTC Offset	Byte	GPS time of fix (weeks)

Report Packet 0x8F-26: Save Receiver Configuration to Non-volatile Storage Memory

This packet is sent in response to command packet 0x8E-26. The packet indicates whether the receiver configuration has been successfully saved to non-volatile memory.

Byte	Item	Type	Value	Description
0	Sub-code	U8	0x26	Packet sub-code
1-4	Status	U32	0	successfully stored receiver
			1	failed to store receiver configuration

Report Packet 0x8F-41: Stored Manufacturing Operating Parameters

This packet is sent in response to a command 0x8E-41.

Byte	Item	Type	Units
0	Subcode	U8	0x41
1-2	board serial number prefix	S16	
3-6	Board serial number	U32	
7	Year of build	U8	
8	Month of build	U8	
9	Day of build	U8	
10	Hour of build	U8	
11-14	Oscillator offset	Single	
15-16	Test code identification number	U16	

Report Packet 0x8F-42: Stored Production Parameters

This packet is sent in response to 0x8E-42.

Byte	Item	Type	Units
0	Subcode	U8	0x42
1	Production options prefix	U8	
2	Production number extension	U8	
3-4	Case serial number prefix	U16	
5-8	Case serial number	U32	
9-12	Production number	U32	
13-14	Reserved	U16	
15-16	Machine identification number	U16	
17-18	Reserved	U16	

Report Packet 0x8F-4A: Set PPS Characteristics

This is sent in response to a query by packet 0x8E-4A. See the corresponding command packet for information about the data format.

Byte	Item	Type	Units
0	Subcode	BYTE	0x42
1	PPS Driver Switch	BYTE	0: Off 1: On
2	Time Base	BYTE	0: GPS 1: UTC (default)
3	PPS Polarity	BYTE	0: Positive (default) 1: Negative
4-11	PPS Offset or Cable Delay	DOUBLE	seconds
12-15	Bias Uncertainty Threshold	SINGLE	meters

Report Packet 0x8F-4D: Automatic Packet Output Mask

This packet provides information on the automatic packets that may be output by the receiver. This packet is sent in response to 0x8E-4D query, or is set

Byte	Item	Type	Meaning
0	Subcode	BYTE	ID for this sub-packet is always 0x4D
1-4	Bit Mask	ULONG	Bits in the mask enable output packets

- A “0” in the bit position means that automatic output of the associated packets is disabled/
- A “1” in the bit positions means that the associated packets can be automatically output.

The meaning and packets output by each set bit is as follows:

Bit	Output packet	When output	Meaning
0 (LSB)	0x40	After Decode	Almanac data collected from satellite
1	0x58, 0x5B	After Decode	Ephemeris data collected from satellite
2	0x4F	After Decode	UTC data collected from satellite
3	0x58	After Decode	Ionospheric data collected from satellite
4	0x48	After Decode	GPS Message
5	0x49		Almanac health page collected from satellite
6			Reserved
7			Reserved

Bit	Output packet	When output	Meaning
8	0x41	New Fix	Partial & full fix complete and packet output timer has expired
9			Reserved
10			Reserved
11	0x6C	Constellation change	New satellite selection
12			Reserved
13-29			Reserved
30	4A, 8F-20, 42, 43, 54, 56, 83, 84	New fix update	Dynamic and timing information. Output must be enabled with I/O option
31[1]	0x5A	New Fix	Output must be selected with I/O options

[1]A 1 in the bit mask indicates that output for the associated packets is ON; a 0 indicates that the output is turned OFF

Report Packet 0x8F-4E: PPS Output

This report packet is output after the command packet 8E-4E has been executed. See the corresponding command packet for information about the data format.

Report Packet 0x8F-4F: PPS Width

This report packet is output after the command packet 0x8E-4F has been executed. See Report Packet 0x8F-4A: PPS Characteristics.

Report Packet 0x8F-A2: UTC/GPS Timing

This packet is sent in response to command packet 0x8E-A2. See the corresponding command packet for information about the data format.

Report Packet 0x8F-A5: Packet Broadcast Mask

This packet is sent in response to 0x8E-A5 command and describes which packets are currently automatically broadcast. A '0' in a bit field turns off broadcast, and a '1' in a bit field enables broadcast. See the corresponding command packet for information about the data format.

Report Packet 0x8F-A6: Self-Survey Command

This packet is sent in response to command packet 0x8E-A6. The packet indicates the result of the requested self-survey operation.

Byte	Item	Type	Value	Description
0	Sub-code	U8	0xA6	Packet sub-code

1	Self-survey command	U8	0	Restart self-survey
			1	Save position to Flash memory
			2	Delete position from Flash memory
2	Status	U8	0	Requested command successful
			1	Requested command failed

Report Packet 0x8F-A9: Self-Survey Parameters

Packet 0x8F-A9 is sent in response to command packet 0x8E-A9 and describes the current self-survey parameters. See the corresponding command packet for information about the data format.

Report Packet 0x8F-AB: Primary Timing Packet

This automatic report packet provides time information once per second if enabled with command packet 0x8E-A5. GPS week number, GPS time-of-week (TOW), UTC integer offset, time flags, date and time-of-day (TOD) information is provided. This packet can be requested with packet 0x8E-AB. This packet will begin transmission within 30 ms after the PPS pulse to which it refers.

Byte	Bit	Item	Type	Value	Description
0		Subcode	U8		0xAB
1-4		Time of week	U32		GPS seconds of week
5-6		Week number	U16		GPS week number (see above)
7-8		UTC Offset	S16		UTC Offset (seconds)
9	0	Timing flag	bit field	0	GPS time
				1	UTC time
	1			0	GPS PPS
				1	UTC PPS
	2			0	time is set
				1	time is not set
	3			0	have UTC info
				1	no UTC info
	4			0	Time base as indicated in Bit 0
				1	GLONASS time
	5			0	Time base as indicated in Bit 1

Byte	Bit	Item	Type	Value	Description
				1	GLONASS PPS
10		Seconds	U8	0-59	Seconds
11		Minutes	U8	0-59	Minutes
12		Hours	U8	0-23	Hours
13		Day of Month	U8	1-31	Day of month
14		Month	U8	1-12	Month of year
15-16		Year	U16		Four digits of year (e.g. 2013)

The data fields are as follows:

- Time of Week represents the number of seconds since Sunday at 00:00:00 GPS time for the current GPS week. Time of week is often abbreviated as TOW.
- Week Number represents the current GPS week number. GPS week number 0 started on 6 January 1980.
- UTC Offset represents the current integer leap second offset between GPS and UTC according to the relationship: Time (UTC) = Time (GPS) - UTC Offset. The UTC offset information is reported to receiver by the GPS system and can take up to 12.5 minutes to obtain. Before the receiver has received UTC information from the GPS system, it is only capable of representing time in the GPS time scale, and the UTC offset will be shown as 0.
- Timing Flags are bitwise encoded to provide information about the timing outputs. Unused bits should be ignored.
  - Bit 0: When 0, the date and time fields broadcast in packet 8F-AB are in the GPS time scale. When 1, these fields are in the UTC time scale and are adjusted for leap seconds. Use command packet 8E-A2 to select either GPS or UTC time scales.
  - Bit 1: When 0, the PPS output is aligned to GPS. When 1, the PPS output is aligned to UTC. Use command packet 8E-A2 to select either GPS or UTC PPS alignment.
  - Bit 2: When 0, time has been set from GPS. When 1, time has not yet been set from GPS.
  - Bit 3: When 0, UTC offset information has been received. When 1, UTC offset information is not yet known.
  - Bit 4: When 0, time is coming from GPS/UTC. When 1, the Acutime GG time is coming from GLONASS.
  - Bit 5: When 0, PPS output is aligned to GPS/UTC. When 1, the PPS output is aligned to GLONASS.
- Time of Day is sent in hours-minutes-seconds format and varies from 00:00:00 to 23:59:59, except when time is in UTC and a leap second insertion occur. In this case the

time will transition from 23:59:59 to 23:59:60 to 00:00:00. Date is sent in day-month-year format.

Report Packet 0x8F-AC: Supplemental Timing Packet

This broadcast packet provides supplemental timing information once per second. Information regarding position, unit status and health, and the operational state of the unit is provided. This packet cannot be requested. When enabled, this packet is transmitted once per second shortly after packet 8F-AB.

The position sent in packet 8F-AC depends on the Receiver Operating Mode and on self-survey activity. When a self-survey is in progress, the position sent is the running average of all of the position fixes collected so far. When the self-survey ends or whenever the receiver is using a time-only operating mode, then the position sent is the accurate position the receiver is using to perform time-only fixes. When the self- survey is disabled or otherwise inactive and the receiver is using a position fix operating mode, then the position sent is the position fix computed on the last second.

Byte	Item	Type	Value	Description
0	Subcode	U8	0xAC	
1	Receiver Mode	U8	1	Automatic (2D/3D)
			2	Single satellite time
			3	Horizontal (2D)
			4	Full position (3D)
			5	N/A
			6	Clock hold (2D)
			7	Over-determined Clock
2	Reserved	U8	0	Reserved
3	Self-Survey Progress	UINT 8	0-100	Percent completed
4-7	Reserved	UINT 32	0	Reserved
8-9	Reserved	U16	0	Reserved
10-11	Minor Alarms	U16	0	Not used
			1	Antenna open
			2	Antenna shorted
			3	Not tracking satellites
			4	Not used
			5	Survey-in progress
			6	No stored position
			7	Leap second pending
			8	In test mode

Byte	Item	Type	Value	Description
			9	Position is questionable
			10	EEPROM segment status
			11	Almanac not complete
			12	PPS not generated
12	GPS Decoding Status	U8	0	Doing fixes
			1	Don't have GPS time
			2	No Fix
			3	PDOP is too high
			8	No usable satellites
			9	Only 1 usable satellite
			0x0A	Only 2 usable satellites
			0x0B	Only 3 usable satellites
			0x0C	The chosen satellite is unusable
			0x10	T-RAIM rejected the fix
			0xBB	OD mode but not yet validated the satellite
13	Reserved	U8	0	Reserved
14	PPS indication	U8	0	PPS Good indication
			1	PPS Not Good indication
15	Reserved	U8		Reserved
16-19	Local clock bias	Single		ns
20-23	Local clock bias rate	Single		ppb
24-27	Reserved	U32		Reserved
28-31	Reserved	Single		Reserved
32-35	Temperature	Single		°C
36-43	Latitude	Double		radians
44-51	Longitude	Double		radians
52-59	Altitude	Double		meters
60-63	PPS Quantization Error	Single		PPS quantization error (ns)
64-67	Reserved	U8		Reserved

Data fields

- Receiver Mode: This field shows the fix mode that the GNSS receiver is currently configured for.

- Self-Survey Progress: When a self-survey procedure is in progress, this field shows the progress of the survey as a percentage of fixes collected so far. The self-survey will be complete when the self-survey progress reaches 100 percent.
- Minor Alarms: This field is bitwise encoded with several minor alarm indicators. A minor alarm indicates a condition that the user should be alerted to, but does not indicate an immediate (or necessarily any) impairment of functionality. For each bit, a value of 0 means that the condition is not indicated. Bits not described below should be ignored.
  - Bit 1: When 1, indicates that the antenna input connection is open. More precisely, this bit indicates that the antenna input is not drawing sufficient current.
  - Bit 2: When 1, indicates that the antenna input is shorted. More precisely, this bit indicates that the antenna input is drawing too much current.
  - Bit 3: When 1, indicates that no satellites are yet usable. In order for a satellite to be usable, it must be tracked long enough to obtain ephemeris and health data.
  - Bit 5: When 1, indicates that a self-survey procedure is in progress.
  - Bit 6: When 1, indicates that there is no accurate position stored in flash ROM.
  - Bit 7: When 1, indicates that the GNSS system has alerted the Acutime GG that a leap second transition is pending.
  - Bit 8: When 1, indicates that the Acutime GG is operating in one of its test modes.
  - Bit 9: When 1, indicates that the accuracy of the position used for time only fixes is questionable. This alarm may indicate that the unit has been moved since the unit completed the last self-survey. If this alarm persists, resurvey the position of the unit.
  - Bit 11: When 1, indicates that the Almanac is not current or complete.
  - Bit 12: When 1, indicates that the PPS was not generated this second. This could mean that there wasn't enough usable satellites to generate an accurate PPS output. It could also mean that the unit is generating an Even Second output (see Packet 8E-4E) and the unit did not output a PPS on the odd second.
- GPS Decoding Status: This field indicates the decoding status of the GPS receiver.
- Local Clock Bias: This field contains the bias of the local clock. Note that this data cannot be used to increase the accuracy of the PPS output.

- Local Clock Offset carries the offset of the local clock relative to UTC or GPS as reported by the GPS receiver in nanoseconds. Positive values indicate that the receiver's local clock is late relative to GPS or UTC. Also known as "bias".
- Oscillator Offset carries the frequency offset of the local clock relative to UTC or GPS as reported by the GPS receiver in ppb (parts-per-billion). Positive values indicate that the receiver's local clock is running slow relative to GPS or UTC. Also known as bias rate.
- Latitude: This field carries the latitude of the position being shown. The units are in radians and vary from -π/2 to +π/2. Negative values represent southern latitudes. Positive values represent northern latitudes.
- Longitude: This field carries the longitude of the position being shown. The units are in radians and vary from -π to +π. Negative values represent western longitudes. Positive values represent eastern longitudes.
- Altitude: This field carries the altitude of the position being shown. The units are in meters (WGS-84.)
- PPS Quantization Error: This field carries the PPS quantization error in units of seconds.
- PPS Output Status identifies the status of the PPS output.

Report Packet 0x8F-AD: Primary UTC Time

The output of the 0x8F-AD packet is synchronized with the PPS. This packet provides accurate time and date information for time stamping and time transfer. The leap flag provides complete UTC event information, allowing implementation of sophisticated distributed systems intended to operate synchronously with UTC time. This packet is always output first in a possible sequence of up to four synchronous packets. Output of this packet can be disabled and configured using the 0x8E-AD packet.

Byte	Item	Type	Units
0	Subpacket ID	Byte	Subcode 0xAD
1-2	Event Count	Integer	Zero for PPS.
3-10	Fractional Second	Double	Time elapsed in current second (seconds)
11	Hour	Byte	UTC Hour
12	Minute	Byte	UTC Minute
13	Second	Byte	Second (0-59; 60 = leap)
14	Day	Byte	Date (1-31)
15	Month	Byte	Month (1-12)

Byte	Item	Type	Units
16-17	Year	Integer	Year (4 digit)
18	Receiver Status	Byte	Tracking Status (see definition below)
19	UTC Flags	Byte	Leap Second Flags (see definition below)
20	Reserved	Byte	Contains 0xFF
21	Reserved	Byte	Contains 0xFF

Tracking Status flag

This flag allows precise monitoring of receiver tracking status and allows a host system to determine whether the time output by the receiver is valid. After self-survey has completed, the receiver only needs to track one satellite to maintain precise synchronization with UTC. The definitions are as follows:

Flag value	Status	Meaning
0	DOING_FIXES	Receiver is navigating.
1	GOOD_1SV	Receiver is timing using one satellite
2	APPX_1SV	Approximate time
3	NEED_TIME	Start-up
4	NEED_INITALIZATION	Start-up
5	PDOP_HIGH	Dilution of Precision too High
6	BAD_1SV	Satellite is unusable
7	0SVs	No satellites usable
8	1SV	Only 1 satellite usable
9	2SVs	Only 2 satellites usable
10	3SVs	Only 3 satellites usable
11	NO_INTEGRITY	Invalid solution
12	DCORR_GEN	Differential corrections
13	OVERDET_CLK	Over-determined fixes

Leap Second flag

Leap seconds are inserted into the UTC timescale to counter the effect of gradual slowing of the earth’s rotation due to friction. The 0x8F-AD packet provides extensive UTC leap second information to the user application. The definitions are as follows

Bit#	Name	Meaning if set to 1
0	UTC Flag	UTC Time is available

1-3	Reserved	N/A
4	Leap Scheduled	GPS Almanac’s leap second date is not in the past.
5	Leap Pending	24-hour warning. Cleared before leap second.
6	GPS Leap Warning	Set ± 6 hours before/after leap event.
7	Leap in Progress	Leap second is now being inserted.

- The Leap Scheduled bit is set by the receiver, when the leap second has been scheduled by the GPS control segment. The Control segment may schedule the leap second several weeks before the leap second takes place.
- The Leap Pending bit indicates that the leap second will be inserted at the end of the current day.
- The GPS Leap Warning bit is set while GPS is operating in the leap exception mode specified in ICD-200.
- The Leap in Progress bit is set to 1 at the beginning of the leap second, and cleared at the beginning of the second following the leap event. The date rollover is delayed by one second on the day the leap second is inserted. The date will not increment until the beginning of the first second following the leap second

Unused or miscellaneous packets

Report Packet 0x13: Unparsable Packet

This packet is sent in response to a received packet that was unparsable. A packet is unparsable if the packet ID is not recognized or if the length or content of the packet is not correct for the packet ID.

Report Packet 0x13: Data Format

Byte	Type	Item
0	UINT8	Packet ID of unparsable packet
1-N	UINT8	Packet data bytes of unparsable packet

Sample TSIP routine

The following sample routines use command packet 0x0x1F and report packet 0×45 to retrieve software version information from the Acutime GG through COM1.

Sending out TSIP command Packet 0x1F

In general, all TSIP packets use the structure TSIPPKT:Report Packet 0x13: Data Format

```
#define MAX_RPTBUF 256

typedef struct {
short
cnt;/* size of buf */
unsigned char
status,/* TSIP packet format and parse status */
code,/* TSIP id code */
buf[MAX_RPTBUF];/* command or report string */
} TSIPPKT;
```

Communication with the Acutime GG is accomplished through command routines and report routines. Each command routine use send_cmd() which supplies the DLE stuffing to the command string and sends the command to the serial port using the primitive function sendb().

All TSIP packet formats take the form <DLE><ID><Data String Bytes><DLE><ETX>, where <DLE> and <ETX> are reserved frame characters with values 0x10 and 0x03, respectively, and <ID> is the packet identifier. The following routines perform DLE stuffing on a command packet and send it to the Acutime GG.

```
#define DLE 0x10
#define ETX 0x03
#define PORT 1

/* Send a byte to Port 1 */
short sendb(unsigned char db)
{
/* put_char outputs a character to the serial port; it
```

```
* returns 0 for success and 1 for failure.
*/
return(put_char(PORT, db));
}
/* Format a command for sending to a TSIP receiver */
void send_cmd(TSIPPKT *cmd)
{
short i;
sendb(DLE);
sendb(cmd->code);
for (i = 0; i < cmd->cnt; i++) { if (cmd->buf[i] == DLE) sendb(DLE);
sendb(cmd->buf[i]);
}
sendb(DLE);
sendb(ETX);
}
```

To issue command packet 0x41 to request software version from the Acutime GG use the following routine.

```
/* Request software version */
void cmd_0x1F(void)
{
TSIPPKT cmd;
cmd.cnt = 0;
cmd.code = 0x1F;
send_cmd(&cmd);
}
```

Handling incoming TSIP packet 0x45

Report routines handle incoming receiver packets. They call the routine end_of_rptpkt() which accumulates from the serial buffer, unstuffs these bytes, and checks whether the end-of-packet sequence <DLE><EXT> has been received.

```
#define FALSE    0
#define TRUE     !FALSE
#define INCOMPLETE   0
#define HAVE_DLE         1
#define COMPLETE         2
#define MAXEND_RPTBUF 256

/* Read bytes until serial buffer is empty or a complete report has
*been received; end of report is signified by DLE ETX.
*/
short end_of_rptpkt(TSIPPKT *rpt)
{
short this_byte;
for (;;) {
this_byte = getb();
if (this_byte == -1) {
return(FALSE);
}
if (rpt->status == HAVE_DLE) {
switch (this_byte) {
case DLE: /* DLE-stuffed, so it's a data byte */
break;
case ETX: /* End of message. */ rpt->status = COMPLETE; return(TRUE);
default: /* If previous message has ended, this is new ID
code. */
reset_rptbuf(rpt); /* if not, this is an error. */
rpt->code = this_byte;
return(FALSE);
}
}
else if (this_byte == DLE) {
/* DLE byte without previous DLE stuffing…must be stuffing. */
rpt->status = HAVE_DLE;
```

```
continue;
}
/* normal byte; add to report */
rpt->status = INCOMPLETE;
rpt->buf[rpt->cnt] = this_byte;
rpt->cnt++;
if (rpt->cnt > MAX_RPTBUF) { reset_rptbuf (rpt); return(FALSE);
}
}
}
/* Prepare for receipt of new report */
void reset_rptbuf (TSIPPKT *rpt)
{
rpt->cnt = 0;
rpt->code = ETX;
rpt->status = INCOMPLETE;
}
```

APPENDIX

B

NMEA 0183 Protocol

In this chapter:

This appendix provides a brief overview of the NMEA 0183 protocol, and describes both the standard and optional messages offered by the Acutime GG.

Introduction

NMEA 0183 is a simple, yet comprehensive ASCII protocol which defines both the communication interface and the data format. The NMEA 0183 protocol was originally established to allow marine navigation equipment to share information. Since it is a well-established industry standard, NMEA 0183 has also gained popularity for use in applications other than marine electronics.

For those applications requiring output only from the GNSS receiver, NMEA 0183 is a popular choice since, in many cases, an NMEA 0183 software application code already exists. The Acutime GG is available with firmware that supports a subset of the NMEA 0183 messages: GGA, GLL, GSA, GSV, RMC, VTC, and ZDA. For a nominal fee, Trimble can offer custom firmware with a different selection of messages to meet your application requirements.

For a complete copy of the NMEA 0183 standard, contact:

NMEA National Office
Seven Riggs Avenue, Severna Park, MD 21146
Phone: +1-410-975-9425 or 800-808-6632 (NMEA)
Fax: +1-410-975-9450

NMEA 0183 communication interface

NMEA 0183 allows a single source (talker) to transmit serial data over a single twisted wire pair to one or more receivers (listeners). The table below lists the standard characteristics of the NMEA 0183 data transmissions.

Signal	NMEA Standard
Baud rate	4800
Data bits	8
Parity	None (Disabled)
Stop bits	1

NMEA 0183 message structure

The NMEA 0183 protocol covers a broad array of navigation data. This broad array of information is separated into discrete messages which convey a specific set of information. The entire protocol encompasses over 50 messages, but only a sub-set of these messages apply to a GPS receiver like the Acutime GG. The NMEA message structure is described below.

$IDMSG,D1,D2,D3,D4,.......,Dn*CS[CR][LF]

Where:

$	Signifies the start of a message
ID	The talker identification is a two letter mnemonic which describes the source of the navigation information. The GP identification signifies a GPS source while GL will signify a GLONASS source. In the event that the information in the sentence is agnostic the ID will be GP.
MSG	The message identification is a three letter mnemonic which describes the message content and the number and order of the data fields.
,	Commas serve as delimiters for the data fields.
Dn	Each message contains multiple data fields (Dn) which are delimited by commas.
*	The asterisk serves as a checksum delimiter.
CS	The checksum field contains two ASCII characters which indicate the hexadecimal value of the checksum.
[CR][LF]	The carriage return [CR] and line feed [LF] combination terminate the message.

NMEA 0183 messages vary in length, but each message is limited to 79 characters or less. This length limitation excludes the "$" and the [CR][LF]. The data field block, including delimiters, is limited to 74 characters or less.

Field definitions

Many of the NMEA date fields are of variable length, and the user should always use the comma delineators to parse the NMEA message date field. The following table specifies the definitions of all field types in the NMEA messages supported by Trimble:

Type	Symbol	Definition
Status	A	Single character field: A=Yes, data valid, warning flag clear V=No, data invalid, warning flag set
Special Format Fields		
Latitude	llll.lll	Fixed/variable length field: Degreesminutes.decimal-2 fixed digits of degrees, 2 fixed digits of minutes and a variable number of digits for decimal-fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length. The decimal point and associated decimal- fraction are optional if full resolution is not required.

Type	Symbol	Definition
Longitude	yyyyy.yyy	Fixed/Variable length field: Degreesminutes.decimal-3 fixed digits of degrees, 2 fixed digits of minutes and a variable number of digits for decimal-fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length. The decimal point and associated decimal- fraction are optional if full resolution is not required.
Time	hhmmss.ss	Fixed/Variable length field: hoursminutesseconds.decimal-2 fixed digits of minutes, 2 fixed digits of seconds and a variable number of digits for decimal-fraction of seconds. Leading zeros always included for hours, minutes, and seconds to maintain fixed length. The decimal point and associated decimal-fraction are optional if full resolution is not required.
Defined		Some fields are specified to contain pre-defined constants, most often alpha characters. Such a field is indicated in this standard by the presence of one or more valid characters. Excluded from the list of allowable characters are the following that are used to indicated field types within this standard: "A", "a", "c", "hh", "hhmmss.ss", "llll.ll", "x", "yyyyy.yy"
Numeric Value Fields		
Variable	x.x	Variable length integer or floating numeric field. Optional leading and trailing zeros. The decimal point and associated decimal-fraction are optional if full resolution is not required (example: 73.10=73.1=073.1=73).
Fixed HEX	hh	Fixed length HEX numbers only, MSB on the left
Information Fields		
Fixed Alpha	aa	Fixed length field of upper-case or lower-case alpha characters.
Fixed Number	xx	Fixed length field of numeric characters

Note –

- *Spaces are only be used in variable text fields.*
- *Units of measure fields are appropriate characters from the Symbol column unless a specified unit of measure is indicated.*

- *Fixed length field definitions show the actual number of characters. For example, a field defined to have a fixed length of 5 HEX characters is represented as hhhhh between delimiters in a sentence definition.*

NMEA 0183 message options

The Acutime GG can output any or all of the messages listed in the table below. In its default configuration (as shipped from the factory), the Acutime GG outputs only TSIP messages. Typically NMEA messages are output at a 1 second interval with the "GP" talker ID and checksums. These messages are output at all times during operation, with or without a fix. If a different set of messages has been selected (using Packet 0x7A), and this setting has been stored in flash memory (using Packet 0x8E-26), the default messages are permanently replaced until the receiver is returned to the factory default settings.

Note – The user can configure a custom mix of the messages listed in the table below. See Chapter 3, and TSIP command packets 0xBC, 0x7A, and 8E-26 in Appendix A for details on configuring NMEA output.

CAUTION – If too many messages are specified for output, you may need to increase the unit's baud rate.

Message	Description
GGA	GPS fix data
GLL	Geographic position Latitude/Longitude
GSA	GPS DOP and active satellites
GSV	GPS satellites in view
RMC	Recommended minimum specific GPS/Transit data
VTG	Track made good and ground speed
ZDA	Time and date

NMEA 0183 message formats

GGA-GPS Fix Data

The GGA message includes time, position and fix related data for the GNSS receiver.

$GPGGA,hhmmss.sss,llll.lll,a,nnnnn.nnnnnn,b,t,uu, v.v,w.w,M,x.x,M,y.y,M,,*hh <CR><LF>

Field	Description
1	UTC of Position
2, 3	Latitude, N (North) or S (South)
4, 5	Longitude, E (East) or W (West)
6	GPS Quality Indicator: 0 = No GPS, 1 = GPS,
7	Number of Satellites in Use
8	Horizontal Dilution of Precision (HDOP)
9, 10	Antenna Altitude in Meters, M = Meters
11, 12	Geoidal Separation in Meters, M=Meters. Geoidal separation is the difference
13	Age of Differential GPS Data. Time in seconds since the last Type 1 or 9 update
14	Differential Reference Station ID (0000 to 1023)
hh	checksum

GLL - Geographic Position - Latitude/Longitude

The GLL message contains the latitude and longitude of the present vessel position, the time of the position fix and the status.

$GPGLL,llll.lllll,a,yyyyy.yyyyyy,b,hhmmss.sss,c,d*hh <CR> <LF>

Field	Description
1	UTC of Position
2, 3	Latitude, N (North) or S (South)
4, 5	Longitude, E (East) or W (West)
6	Status, A=Valid, V=Invalid
hh	checksum

GSA - GPS DOP and Active Satellites

The GSA messages indicate the GNSS receiver's operating mode and lists the satellites used for navigation and the DOP values of the position solution.

$***id***GSA,a,v,ww,ww,ww,ww,ww,ww,ww,ww,ww,ww, , ,x.xx,y.yy,z.zz*hh<CR><LF>

Where 'id' is GP or GL, dependent on if the sentence contains GPS or GLONASS satellites.

Field	Description
1	Mode: M = Manual, A = Automatic. In manual mode, the receiver is forced to operate in
2	Current Mode: 1 = fix not available, 2 = 2D, 3 = 3D
3 - 14	PRN numbers of the satellites used in the position solution. When less than 12 satellites
15	Position dilution of precision (PDOP)
16	Horizontal dilution of precision (HDOP)
17	Vertical dilution of precision (VDOP)
hh	checksum

GSV - GPS Satellites in View

The GSV message identifies the GNSS satellites in view, including their PRN number, elevation, azimuth and SNR value. Each message contains data for four satellites. Second and third messages are sent when more than 4 satellites are in view. Fields #1 and #2 indicate the total number of messages being sent and the number of each message respectively.

$***id***GSV,t,u,vv,ww,ww,www,ww,xx,xx,xxx,xx,yy,yy, yyy,yy,zz,zz,zzz,zz*hh<CR><LF>

Where 'id' is GP or GL, dependent on if the sentence contains GPS or GLONASS satellites.

Field	Description
1	Total number of GSV messages
2	Message number: 1 to 3
3	Total number of satellites in view
4	Satellite PRN number
5	Satellite elevation in degrees (90° Maximum)
6	Satellite azimuth in degrees true (000 to 359)
7	Satellite SNR (C/No), null when not tracking
8, 9, 10, 11	PRN, elevation, azimuth and SNR for second satellite
12, 13, 14, 15	PRN, elevation, azimuth and SNR for third satellite
16, 17, 18, 19	PRN, elevation, azimuth and SNR for fourth satellite
hh	checksum

RMC - Recommended Minimum Specific GPS/Transit Data

The RMC message contains the time, date, position, course, and speed data provided by the GNSS navigation receiver. A checksum is mandatory for this message and the transmission interval may not exceed 2 seconds. All data fields must be provided unless the data is temporarily unavailable. Null fields may be used when data is temporarily unavailable.

$GPRMC,hhmmss.ss,a,llll.lllll,b,nnnnn.nnnnnn,c,x.xx,yyy,ddmmyy,,,d*hh<CR><LF>

Field	Description
1	UTC of Position Fix.
2	Status: A – Valid, V - Navigation receiver warning
3, 4	Latitude, N (North) or S (South).
5, 6	Longitude, E (East) or W (West).
7	Speed over the ground (SOG) in knots
8	Track made good in degrees true.
9	Date: dd/mm/yy
10, 11	Magnetic variation in degrees, E = East / W= West
hh	Checksum (Mandatory for RMC)

VTG - Track Made Good and Ground Speed

The VTG message conveys the actual track made good (COG) and the speed relative to the ground (SOG).

$GPVTG,xxx,T,,M,y.yyy,N,z.zzz,K,a*hh<CR><LF>

Field	Description
1,2	Track made good in degrees true.
3,4	Track made good in degrees magnetic.
5,6	Speed over the ground (SOG) in knots
7,8	Speed over the ground (SOG) in kilometer per hour
hh	Checksum

ZDA - Time & Date

The ZDA message contains UTC time, the day, the month, the year and the local time zone.

$GPZDA,hhmmss.sss,dd,mm,yyyy,,*hh<CR><LF>

Field	Description
1	UTC
2	Day (01 to 31)
3	Month (01 to 12)
4	Year
5	Unused
hh	Checksum

***Note** – Fields #5 and #6 are null fields in the Acutime GG output. A GNSS receiver cannot independently identify the local time zone offsets.*

CAUTION – If UTC offset is not available, time output will be in GPS time until the UTC offset value is collected from the GPS satellites. When the offset becomes available, the time will jump to UTC time.

Note – GPS time can be used as a timetag for the 1PPS. The ZDA message comes out 100–500 msec after the PPS.

AH - Almanac Health

Use this message to query or set almanac health data. Since the maximum number of bytes that can be contained in a single NMEA sentence is less than the total almanac health length, the almanac health must be sent in two parts that have to be sent or received together in the correct sequence. After receiving the query, the receiver sends out two messages.

Message 1

$PTNLaAH,1,hh,hhhhhhhh,hhhhhhhh,hhhhhhhh,hhhhhhhh,hh*hh<CR><LF>

Field	Description
a	Mode
	Q – Query
	S – Set
	R – Response
hh	Week number for health, variable length integer, 4 digits maximum
hhhhhhhh	Satellite 1 - 4 health, one byte for each satellite, HEX data conforming to GPS ICD 200.
hhhhhhhh	Satellite 5 - 8 health, one byte for each satellite, HEX data conforming to GPS ICD 200.
hhhhhhhh	Satellite 9 - 12 health, one byte for each satellite, HEX data conforming to GPS ICD 200.
hhhhhhhh	Satellite 13 - 16 health, one byte for each satellite, HEX data conforming to GPS ICD 200
hh	Checksum

Message 2

$PTNLaAH,2,hh,hhhhhhhh,hhhhhhhh,hhhhhhhh,hhhhhhhh,hh*hh<CR><LF>

Field	Description
a	Mode
	Q – Query
	S – Set

	R – Response
hh	Week number for health, variable length integer, 4 digits maximum
hhhhhhhh	Satellite 17 - 20 health, one byte for each satellite, HEX data conforming to GPS ICD 200.
hhhhhhhh	Satellite 21 - 24 health, one byte for each satellite, HEX data conforming to GPS ICD 200.
hhhhhhhh	Satellite 25 - 28 health, one byte for each satellite, HEX data conforming to GPS ICD 200.
hhhhhhhh	Satellite 29 - 32 health, one byte for each satellite, HEX data conforming to GPS ICD 200
hh	Checksum

AL - Almanac Page

Use this sentence to query or set almanac data for a specific satellite. The query format is:

$PTNLQAL,xx*hh<CR><LF>

Field	Description
xx	Satellite ID

The set or response format is as follows:

$PTNLaAL,xx,x.x,hh,hhhh,hh,hhhh,hhhh,hhhhhh,hhhhhh,hhhhh h,hhhhhh,hhh,hhh*
hh<CR><LF>

Field	Description
a	Mode
	S – Set
	R – Response
xx	Satellite ID, 01-32.
x.x	GPS week number, variable length integer, 4 digits maximum.
hh	SV health, HEX data conforming to GPS ICD 200
hhhh	Eccentricity, HEX data conforming to GPS ICD 200.
hh	t_oa, almanac reference time, HEX data conforming to GPS ICD 200.
hhhh	sigma_I,HEX data conforming to GPS ICD 200
hhhh	OMEGADOT, HEX data conforming to GPS ICD 200.
hhhhhh	root_a, HEX data conforming to GPS ICD 200.
hhhhhh	Omega, HEX data conforming to GPS ICD 200.
hhhhhh	Omega_0, HEX data conforming to GPS ICD 200.
hhhhhh	M_O, HEX data conforming to GPS ICD 200.
hhh	a_fO, HEX data conforming to GPS ICD 200.
hhh	a_fl, HEX data conforming to GPS ICD 200.

AS - Almanac Status

Use this sentence to query or set almanac status. The query format is:

$PTNLaAS,hh,xxxx,hh,hh,hh,hh,hh*hh<CR><LF>

Field	Description
a	Mode
	Q – Query
	S – Set
	R – Response
hh	Time of almanac
xxxx	Week of number of almanac
hh	Reserved
hh	Reserved
hh	Reserved
hh	Reserved
hh	Almanac Status
	0 – almanac incomplete
	1 – almanac complete and current

The corresponding response for the set is:

$PTNLRAS,a*hh<CR><LF>

where “a” is the action status: A = success; V= failure.

CR - Configure Receiver

Use this sentence to query or set NMEA receiver configuration information.

$PTNLaCR,x.x,x.x,x.x,x.x,x.x,a,a,a*hh<CR><LF>

Field	Description
a	Mode
	Q – Query
	S – Set
	R – Response

Field	Description
x.x	Signal level mask in dB-Hz (default = 0 dB-Hz). The signal level mask is used only when the receiver is operating in the Over Determined Clock mode
x.x	Elevation mask in degrees (default = 0 degrees). The elevation mask is used only when the receiver is operating in the Over Determined Clock mode.
x.x	Reserved
x.x	Reserved
x.x	Reserved
A	Receiver Mode
	0 – automatic
	4 – 3D mode
	7 – over-determined clock
a	Reserved
A	Reserved

EM - Enter Monitor Mode

This sentence is used to set the Acutime GG into Monitor mode. This is Set only, no query supported. The sentence format is:

$PTNLSEM*hh<CR><LF>

This sentence is used by the Firmware Uploading Program.

EP - Ephemeris

Use this sentence to query or set ephemeris data for a specific satellite. Since the maximum number of bytes that can be contained in a single NMEA sentence is less than the total ephemeris data length, the ephemeris data must be sent in three sentences. The three sentences have to be sent or received together in correct sequence. The query format is:

$PTNLQEP,xx*hh<CR><LF>

Field	Description
Q	Query
xx	Satellite ID

After receiving the query, the receiver should send out three messages.

Message 1

$PTNLaEP,1,xx,x.x,x.x,hh,hh,hh,hh,hhh,hh,hhhh,hh,hhhh,hh hhhh,x .x*hh<CR><LF>

Field	Description
a	Mode S – Set R – Response
1	Message number for EP, message 1 must be sent or received before message 2, and message 2 must be sent or received before message 3, and all three messages must be sent together with correct sequence
xx	Satellite id
x.x	T_ephem, This is a double precision floating point number.
x.x	Week number for health, variable length integer, 4 digits maximum.
hh	CodeL2, HEX data conforming to GPS ICD 200.
hh	L2Pdata, HEX data conforming to GPS ICD 200.
hh	Svacc_raw, HEX data conforming to GPS ICD 200.
hh	SV_health, HEX data conforming to GPS ICD 200.
hhh	IODC, HEX data conforming to GPS ICD 200.
hh	T_GD, HEX data conforming to GPS ICD 200.
hhhh	T_oc, HEX data conforming to GPS ICD 200.
hh	A_f2, HEX data conforming to GPS ICD 200.
hhhh	A_f1, HEX data conforming to GPS ICD 200.
hhhhhh	A_f0, HEX data conforming to GPS ICD 200

Message 2

$PTNLaEP,2,xx,hh,hh,hhhh,hhhh,hhhhhhhh,hhhh,hhhhhhhh,hhh h,hhhhhhhh,hhhh*
hh<CR><LF>

Field	Description
a	Mode S – Set R – Response
2	Sentence number for EP, sentence 1 must be sent or received before sentence 2, and sentence 2 must be sent or received before sentence 3, and all three sentences must be sent together
xx	Satellite id
hh	IODE, Hex data conforming to GPS ICD 200

Field	Description
hh	Fit_interval, Hex data conforming to GPS ICD 200
hhhh	C_rs, Hex data conforming to GPS ICD 200
hhhh	Delta_n, Hex data conforming to GPS ICD 200
hhhhhhhh	M_0, Hex data conforming to GPS ICD 200
hhhh	C_uc, Hex data conforming to GPS ICD 200
hhhhhhhh	E, Hex data conforming to GPS ICD 200
hhhh	C_us, Hex data conforming to GPS ICD 200

Message 3

$PTNLaEP,3,xx,hhhh,hhhhhhhh,hhhh,hhhhhhhh,hhhh,hhhhhhhh, hhhhhh,hhhh*hh< CR><LF>

Field	Description
a	Mode S – Set R – Response
3	Sentence number for EP, sentence 1 must be sent or received before sentence 2, and sentence 2 must be sent or received before sentence 3, and all three sentences must be sent together
xx	Satellite id
hh	C_ic, Hex data conforming to GPS ICD 200
hh	OMEGA_0, Hex data conforming to GPS ICD 200
hhhh	C_ri, Hex data conforming to GPS ICD 200
hhhh	I_O, Hex data conforming to GPS ICD 200
hhhhhhhh	C_rc, Hex data conforming to GPS ICD 200
hhhh	OMEGA, Hex data conforming to GPS ICD 200
hhhhhhhh	OMEGA_DOT, Hex data conforming to GPS ICD 200
hhhh	IDOT, Hex data conforming to GPS ICD 200

IO - Ionosphere

This sentence can be used to query or set ionosphere data.

$PTNLaIO,hh,hh,hh,hh,hh,hh,hh,hh*hh,<CR><LF>

Field	Description
a	Mode Q – Query

Field	Description
	S – Set
	R – Response
hh	Alpha_0, HEX data conforming to GPS ICD 200.
hh	Alpha_1, HEX data conforming to GPS ICD 200.
hh	Alpha_2, HEX data conforming to GPS ICD 200.
hh	Alpha_3, HEX data conforming to GPS ICD 200.
hh	Beta_0, HEX data conforming to GPS ICD 200.
hh	Beta_1, HEX data conforming to GPS ICD 200.
hh	Beta_2, HEX data conforming to GPS ICD 200.
hh	Beta_3, HEX data conforming to GPS ICD 200

KG - Set Initial Position

Use this sentence to set initial position or time info data or both for accelerating navigation startup:

- To set time only, send valid time fields and NULL position fields.
- To set position only, send valid position fields and NULL time fields. Query is not supported.

$PTNLaKG,x.x,x.x,llll.lllll,a,yyyyy.yyyyy,a,x.x*hh<CR><LF>

Note – When uploading a position, it should be within 100 Km of the actual position and time within 5 minutes of UTC.

Field	Description
a	Mode
	S – Set
	R – Response
x.x	GPS week number, maximum 4 digits
x.x	GPS time of week in milliseconds
llll.lllll	Latitude
a	N | S
yyyyy.yyyyy	Longitude
a	E | W
x.x	Altitude from the sea level in meters (maximum 5 digits)

NM - Automatic Message Output

This sentence may be issued by the user to configure automatic message output. The Query sentence format is:

$PTNLQNM*hh<CR><LF>

The Response to query sentence or Set sentence format is:
$PTNLaNM,hhhh,xx*hh<CR><LF>

Field	Description
a	Mode
	Q - Query
	S – Set
	R – Response
hhhh	Bit 0 -GGA Bit 1 -GLL Bit 2 -VTG Bit 3 -GSV Bit 4 -GSA Bit 5 -ZDA Bit 8 -RMC Bit 9 -TF Bit 10 -GST Bit 13 -BA
xx	Automatic Report Interval (1 – 99)

Examples

GGA Only	0001
GLL Only	0002
VTG Only	0004
GSV Only	0008
GSA Only	0010
ZDA Only	0020
RMC Only	0100
TF Only	0200
GST Only	0400
BA Only	2000
GGA and GLL	0003
GGA and TF	0201
RMC and TF	0300
GGA, GLL and TF	0203

PS - PPS Configuration

This sentence can query or set PPS configuration data.

$PTNLaPS,b,x...x,6,x...x*hh<CR><LF>

Field	Description
a	Mode
	Q – Query
	S – Set
	R – Response
b	PPS mode, default is 1
	0 – PPS_OFF (Always Off)
	1 – PPS_ON (Always On or Early PPS)
	2 – Reserved
	3 – Reserved
x...x	Reserved
c	Output pulse polarity, default is 1: 0 -output pulse is active low 1 -output pulse is active high
x...x	Antenna Cable Length Compensation. Default = 0, Units in nanoseconds. Can be positive or negative. Negative value will mean PPS comes out earlier, e.g. to compensate for cable delay
	Field value range is -100000000...100000000 (±100 milliseconds)

PT - Serial Port Configuration

This sentence may be issued by the user for configuring the current serial port. The Query sentence format is:

$PTNLQPT*hh<CR><LF>

The Response to query or Set sentence format is:

$PTNLRPT,xxxxxx,b,b,b,h,h*hh<CR><LF>

When the Set is issued, the first Response sentence is sent using the old parameters and the second response sentence is sent using the new parameters. If there is an error, an error response is sent. If there is no error, no additional response is sent.

Field	Description
a	Mode
	Q - Query
	S – Set
	R – Response

xxxxxx	Baud rate (4800, 9600, 19200, 38400, 57600, 115200). Default baud rate is 4800
b	# of data bits (7 or 8)
b	Parity (N - none, O - odd, E - even)
b	# of stop bits (1 or 2)
h	Input protocol, hex value (bit 0: reserved, bit1: TSIP, bit2: NMEA, bit 3: Reserved). Bits
h	Output protocol, hex value (bit 0: reserved, bit1: TSIP, bit2: NMEA, bit 3: reserved). It

RT - Reset

This sentence can be used to Set the reset type. No query is supported.

$PTNLaRT,b,c*hh<CR><LF>

Field	Description
a	Mode S – Set R – Response
b	Command C = Cold software reset, Erases RAM including the customer configuration in RAM and restarts F = Factory software reset. Erases the customer configuration, the almanac, ephemeris and last position in Flash Memory and in SRAM
c (decimal integer)	Flash operation 0 - Do not do any Flash operation 1 - reserved 2 - store user configuration to Flash Memory 3 - reserved 4 - reserved 5 - Erase user configuration from Flash Memory 6 - reserved

*Note – A successful command is followed by a $PTNLRRT,A*3F response. An incorrect command will be followed by a $PTNLRRT,V*28 response.*

*Note – To save user configuration to flash memory, send command $PTNLSRT,C,2*22.*

TF - Receiver Status and Position Fix

This sentence may be issued by the user to get receiver status and position fix. The Query sentence format is:

$PTNLQTF*hh<CR><LF>

The Response to query sentence format is:

$PTNLaTF,b,c,xxxxxx,xx,x,llll.lllll,d,yyyyy.yyyyy,e,xxxx x,x.x,x.x,x.x*hh<CR><LF>

Field	Description
a	Mode Q - Query R – Response
b	BBRAM status on startup (A = valid; V = invalid)
c	Almanac completion status (A = complete; V = incomplete)
xxxxxx	GPS time of week (in seconds)
xx	Number of satellites in use, 00 - 12, may be different from the number in view.
x	Position fix source (0 = no fix; 1 = Stationary Mode, 2 = 2D fix; 3 = 3D fix)
llll.lllll	Latitude of the current position fix d
yyyyy.yyyyy	Longitude of the current position fix
e	E | W
xxxxx	Antenna altitude re: mean-sea-level (MSL geoid, meters)
x.x	'East' component of ENU velocity (m/s)
x.x	'North' component of ENU velocity (m/s)
x.x	'Up' component of ENU velocity (m/s)

UT - UTC

Use this sentence to query or set UTC data.

$PTNLaUT,hhhhhhhh,hhhhhh,hh,hh,hhhh,hhhh,hh,hh*hh<CR><LF>

Field	Description
a	Mode Q - Query S – Set

	R – Response
hhhhhhhh	A_0, HEX data conforming to GPS ICD 200.
hhhhhh	A_1, HEX data conforming to GPS ICD 200.
hh	Delta_t_ls, HEX data conforming to GPS ICD 200.
hh	T_oa, HEX data conforming to GPS ICD 200.
hhhh	Wn_t, HEX data conforming to GPS ICD 200.
hhhh	Wn_LSF, HEX data conforming to GPS ICD 200.
hh	DN, HEX data conforming to GPS ICD 200.
hh	Delta_t_LSF, HEX data conforming to GPS ICD 200

VR - Version

This sentence may be issued by the user to get application version information. The Query sentence format is:

$PTNLQVR,a*hh<CR><LF>

where a is S = Application firmware, H=Hardware information

The Response to query sentence format is:

$PTNLRaVR,b,c..c,xx.xx.xx,xx,xx,xxxx*hh<CR><LF>

Application firmware

Field	Description
a	Mode
	Q - Query
	R – Response
b	Application firmware (A)
c..c	Receiver Name
xx	Major version
xx	Minor version
xx	Build version
xx	Month
xx	Day
xxxx	Year

Hardware version

Field	Description
a	Mode
	Q - Query
	R – Response
b	Hardware information indicator (H)
xxxx	Hardware ID
xxxxxxx	Serial number
xx	Build month
xx	Build day
xxxx	Build year
xx	Build hour

ZD – Extended Time and Date

This message reports extended time and date information - UTC, day, month, year, local time zone and UTC to GPS leap second.

Setting the data is not supported.

This message is output automatically if selected in the NMEA message output mask.

Query format:

$PTNLQZD*hh<CR><LF>

Response to query format:

$PTNLRZD, hhmmss.s,dd,mm,yyyy,zh,zm,ls,lsp*hh<CR><LF>

Field	Description
hhmmss.s	Hours, minutes, seconds, sub-seconds of position in UTC.
dd	Day (01 to 31)
mm	Month (01 to 12)
yyyy	Year
zh	Local Zone Hour, offset from UTC to obtain Local time
zm	Local Zone Minute
ls	Current leap second offset between GPS and UTC time
lsp	Pending leap second. If non-zero (+/- 1) then a leap second is scheduled to occur at

Exception behavior

When no position fix is available, some of the data fields in the NMEA messages will be blank. A blank field has no characters between the commas.

Interruption of GNSS signal

If the GNSS signal is interrupted temporarily, the NMEA will continue to be output according to the user-specified message list and output rate. Position and velocity fields will be blank until the next fix, but most other fields will be filled

NORTH AMERICA
Trimble Navigation Limited
Corporate Headquarters
935 Stewart Drive
Sunnyvale, CA 94085
+1-800-787-4225
+1-408-481-7741

EUROPE
Trimble Navigation Europe
Phone: +46-8-622-12-79

KOREA
Trimble Export Ltd, Korea
Phone: +82-2-555-5361

CHINA
Trimble Navigation Ltd,
China
Phone: +86-10-8857-
7575