A Trimble Standard Interface Protocol

The Trimble Standard Interface Protocol (TSIP) provides the system designer with over 75 commands that may be used to configure a GPS receiver for optimum performance in a variety of applications. TSIP enables the system designer to customize the configuration of a GPS module to meet the requirements of a specific application.

This appendix provides the information needed to make judicious use of the powerful features TSIP has to offer, to greatly enhance overall system performance and to reduce the total development time. The reference tables beginning on Page A-2 will help you determine which packets apply to your application. For those applications requiring customizing, see Page A-3. For a detailed description of the key setup parameters see Page A-13. Application guidelines are provided for each TSIP Command Packet, beginning on Page A-17.

A.1 Interface Scope

The Trimble Standard Interface Protocol is used in Trimble 6-channel and 8-channel receiver designs. The protocol was originally created for the Trimble Advanced Navigation Sensor (TANS) and is colloquially known as the TANS protocol even though the protocol applies to many other devices.

The ACE II GPS module has two independently configurable serial I/O communication ports. Port 1 is a bi-directional control and data port utilizing a Trimble Standard Interface Protocol (TSIP) or Trimble ASCII Interface Protocol (TAIP). Port 2 is a bi-directional port used to receive differential GPS (DGPS) corrections in the industry standard RTCMSC-104 format and for output of industry standard ASCII NMEA sentences. Port 1 can also be configured to TAIP I/O using TSIP commands. The dual data I/O port characteristics and other options are user programmable and stored in non-volatile memory.

The TSIP protocol is based on the transmission of packets of information between the user equipment and the unit. Each packet includes an identification code that identifies the meaning and format of the data that follows. Each packet begins and ends with control characters.

This document describes in detail the format of the transmitted data, the packet identification codes, and all available information over the output channel to allow the user to choose the data required for his particular application. As will be discussed, the receiver transmits some of the information (position and velocity solutions, etc.) automatically when it is available, while other information is transmitted only on request. Additional packets may be defined for particular products and these will be covered in the specifications for those products as necessary.

The TSIPCHAT utility, part of the GPS Tool Kit, is designed to exercise many of the TSIP packets. The GPSSK Utility, part of the GPS Took Kit, is designed to exercise many of the TSIP messages

A.2 Automatic Output Packets

The ACE II GPS receiver module is configured to automatically output the following packets. For minimal system implementations, these output packets provide all of the information required for operation including time, position, velocity, and receiver and satellite status and health. Position and velocity are reported using one or more of the packets listed below, depending on the selected I/O options. While there are other packets automatically output, the following packets provide the information most commonly used. No input packets are required.

Table A-1. Automatic Output Packets

Output Packet ID	Description	Reporting Interval
0x40	Almanac	When decoded
0x41	GPS time	With position fix every 150 seconds No position fix every 15 seconds
0x42, 0x83, 0x4A, 0x84, 0x43, 0x56, 0x8F-17, 0x8F-18, 0x8F-20	position (choose packet with I/O options)	1 second
0x43, 0x56, 0x8F-20	velocity (choose packet with I/O options)	1 second
0x46	health of receiver	30 seconds (Note 1.)
0x4B	machinecode/status (includes antenna fault detect)	30 seconds (Note 1.)
0x5B	Ephemeris status	When decoded
0x6D	all-in-view satellite selection	30 second (Note 1.)
0x82	DGPS position fix mode (only in DGPS mode)	30 second (Note 1.)
0x5A, 0x6F	Pseudorange	1 second

Note 1. – See page A-18 for a detailed description of the key receiver setup parameters.

A.3 Customizing Receiver Operations

For information on customizing receiver operations, see page 3-7, *Configuring the ACE II GPS Receiver Protocols*.

A.4 Automatic Position and Velocity Reports

The receiver automatically outputs position and velocity reports at set intervals. Automatic report packets are controlled by Packet 35. Setting the control bits as indicated in the table below allows you to control which position and velocity packets are output.

Table A-2. Automatic Position and Velocity Reports Control Setting Bits

Packet ID	Description	Byte 0				Byte 1	
		Bit 0	**Bit 1**	**Bit 4**	**Bit 5**	**Bit 0**	**Bit 1**
0x42	single precision XYZ position	1		0			
0x83	double-precision XYZ position	1		1			
0x4A	single-precision LLA position		1	0			
0x84	double-precision LLA position		1	1			
0x43	velocity fix (XYZ, ECEF)					1	
0x56	velocity fix (ENU)						1
0x8F-17	single precision UTM			0	1		
0x8F-18	double precision UTM			1	1		
0x8F-20	LLA & ENU				1		

A.5 Initialization Packets to Speed Start-up

If you are not supplying the receiver with battery power when main power is off, you can still "warm-start" the receiver by sending the following commands after the receiver has completed its internal initialization and has sent Packet 82 (see Table A-5).

Table A-3. Receiver Initialization Commands

Input		Description
Byte	**Subcode**	
0x2B		initial position
0x2E		initial time
0x38	02	almanac (for each SV)
0x38	03	almanac health
0x38	04	ionosphere page
0x38	05	UTC correction

A.6 Packets Output at Power-Up

The following table lists the messages output by the receiver at power-up. After completing its self-diagnostics, the receiver automatically outputs a series of packets which indicate the initial operating condition of the receiver. Messages are output in the following order. After Packet 82 is output, the sequence is complete and the receiver is ready to accept commands.

Table A-4. Output Packets at Power-up

Output ID	Description	Notes
0x46	Receiver health	--
0x4B	Machine code/status	--
0x4A	Position output	As chosen, see Table A-2
0x56	Velocity fix	As chosen, seeTable A-2
0x41	GPS time	This Packet is only output if GPS time is available.
0x82	DGPS position fix mode	--

A.7 Differential GPS Packets

For differential GPS applications you may need to implement the following TSIP control commands.

Table A-5. Differential GPS Packet TSIP Control Commands (DGPS)

Input ID	Description	Output ID
0x60	differential GPS corrections (types 1 and 9)	--
0x61	differential GPS corrections (type 2)	--
0x65	differential correction data request	0x85
0xBB	differential Auto or Manual operating mode.	0xBB
0xBB	Maximum age that differential corrections will be used	0xBB
0xBC	port configuration	0xBC

A.8 Timing Packets

If you are using the ACE II GPS as a timing system, you may need to implement the following TSIP control commands.

Table A-6. Timing Packet TSIP Control Commands

Input ID	Description	Output ID
0x21	get the current GPS time	0x41
0x38-05	request UTC parameters	0x58-05

A.9 Satellite Data Packets

The following packets contain a variety of GPS satellite data.

Table A-7. Satellite Date Packet Data I/O Descriptions

Input ID	Description	Output ID
0x27	request signal levels	0x47
0x28	request GPS system message	0x48
0x38	request/load satellite system data	0x58
0x39	set/request satellite disable or ignore health	0x59
0x3A/auto	request last raw measurement	0x5A
0x3C	request tracking status	0x5C
auto	synchronized measurement packet	0x6F

A.10 Background Packets

The receiver automatically outputs a set of packets that the user may want to monitor for changes in receiver operations. These messages are output at the rates indicated in the table below.

Table A-8. Background Packet Output Messages

Output ID	Description	Notes
0x40	almanac	As new almanacs are decoded. See 0x58 message for more information.
0x41	GPS time	If the receiver's GPS clock is set and the receiver is not outputting positions, time is output approximately every 15 seconds. After tracking occurs this packet ever 150 seconds
0x46, 0x4B	receiver health messages	Receiver health messages are output every 30 seconds.
0x5B	ephemeris status	As new ephemerides are decoded. See 0x58 message for more information.
0x6D	mode packets	Mode packets are output every 30 seconds.

A.11 Backwards Incompatibility of ACE II GPS Packets with Previous Versions of CM3 and SVeeSix

Several new TSIP command packets have been made available with the release of the ACE II GPS receiver module, and some existing packets have been modified or are no longer supported. Table A-10 identifies the backwards compatibility of auto-output packets. Table A-11 identifies the backwards compatibility of the TSIP command packets. Unless otherwise noted, the commands and their corresponding output packets are still supported in the firmware.

Table A-9. Supported Auto-Output Packet Command Backward Incompatibility

Old Packet	New Packet
0x44	0x6D
0x5E	
0x8F-01, 0x8F-02	0x8F-20

Table A-10. TSIP Command Backward Incompatibility

Old Packet		New Packet		Notes
Input	Output	Input	Output	
0x20	0x40	0x38-02	0x58-02	
0x22		0xBB	0xBB	
0x29	0x49	0x38-03	0x58-03	
0x2A	none	0x2A	0x4A (9 byte)	
0x2C	0x4C	0xBB	0xBB	
0x2F	0x4F	0x38-05	0x58-05	
0x34	0x44, 0x6D			0x34 not supported
0x36				0x36 not supported
0x3B	0x5B	0x38-06	0x58-06	
0x3D	0x3D	0xBC	0xBC	
0x3E	0x5E			0x3E not supported
0x62 (set mode)	0x82	0xBB	0xBB	use 0x62 for query of current mode
0x75	0x76	0xBB	0xBB	0x75 not properly supported
0x77	0x78	0xBB	0xBB	
0x79	0x79			0x79 not supported
0x8E-01, 0x8E-02	0x8F-01, 0x8F-02	0x8E-20	0x8F-20	0x8E-01 and 0x8E-02 not supported
0x8E-03	0x8F-03	0xBB	0xBB	
0x8E-14	0x8F-14	0x8E-15	0x8F-15	

A.12 Recommended TSIP Packets

Table A-11. Recommended TSIP Packet Data

Function	Description	Input	Output
Protocol and port setup	set/query port configuration	0xBC	0xBC
	set/query NMEA configuration	0x7A	0x7B
	set/query I/O options (autoreport and format options)	0x35	0x55
	packet output control	0x6E	0x6E
	Set TAIP protocol	0x8E-40	0x8F-40
Receiver settings	query software version	0x1F	0x45
	set/query datum values	0x8E-15	0x8F-15
	query receiver ID & error status	0x26	0x4B, 0x46
	set/query satellite flags	0x39	0x59
	set/query receiver configuration	0xBB	0xBB
	set altitude for 2D mode	0x2A	0x4A
	disable PV/altitude filters	0x70	0x70
Initialization	full reset (clear battery backup and/or non-volatile settings)	0x1E	--
	soft reset	0x25	--
	set GPS time	0x2E	0x4E
	set exact LLA	0x32	--
	set approx. XYZ	0x23	--
	set approx. LLA	0x2B	--
	set exact XYZ	0x31	--
Navigation	GPS time	0x21	0x41
	position & velocity (superpacket)	0x8E-20 or 0x37 or auto	0x8F-20
	double-precision LLA	0x37/auto	0x84
	double-precision XYZ	0x37/auto	0x83
	ENU velocity	0x37/auto	0x56
	XYZ velocity	0x37/auto	0x43

Table A-11. Recommended TSIP Packet Data (Continued)

Satellite and tracking information	query receiver state (health)	0x26	0x46, 0x4B
	query current satellite selection	0x24	0x6D
	query signal levels	0x27	0x47
	query satellite information (azimuth, elevation, etc.)	0x3C	0x5C
	synchronized measurement packet	auto	0x6F
	set/query positioning mode (2D v. 3D)	0xBB	0xBB
DGPS	query DGPS corrections	0x65	0x85
	query DGPS operating mode & status	0x62	0x82
	load DGPS Type 1 correction	0x60	--
	load DGPS Type 2 correction	0x61	--
GPS system	query/load GPS system data	0x38	0x58
	GPS system message	0x28	0x48

A.13 Command Packets Sent to the Receiver

The table below summarizes the command packets sent to the receiver. The table includes the input Packet ID, a short description of each packet, and the associated response packet. In some cases, the response packets depend on user-selected options. These selections are covered in the packet descriptions in Section A-18.

Table A-12. Standard TSIP Command Packets

Input ID	CM3	ACE	Packet Description	Output ID
0x1D	X	X	Clear Oscillator Offset	--
0x1E	X	X	Clear Battery Backup	(Note 1)
0x1F	X	X	Software Version	0x45
0x20	X	X	Almanac	0x40
0x21	X	X	Current Time	0x41
0x22	X	X	Mode Select (3D, 2D, Auto)	0x44 or 0x 6D (Note 2)
0x23	X	X	Initial Position (XYZ ECEF)	--
0x24	X	X	Request receiver position fix mod	0x6D
0x25	X	X	Soft reset / Self test	(Note 1)
0x26	X	X	Receiver Health	0x46, 0x4B
0x27	X	X	Signal Levels	0x47 (Note 2)
0x28	X	X	GPS System Message	0x48
0x29	X	X	Almanac health page	0x49
0x2A	X	X	Altitude for 2D mode	--
0x2B	X	X	Initial Position (Lat, Long, Alt)	--
0x2C	X	X	Operating parameters	0x4C
0x2D	X	X	Show Oscillator Offset	0x4D
0x2E	X	X	Set GPS time	0x4E
0x2F	X	X	UTC parameters	0x4F
0x31	X	X	Accurate Initial position (XYZ ECEF)	--
0x32	X	X	Accurate Initial position	--
0x34	X		Satellite # for 1-sat mode	--
0x35	X	X	I/O options	0x55
0x36	X		Velocity aiding of acquisition	--
0x37	X	X	Status and values of last position and velocity	0x57 (Note 1)
0x38	X	X	Load satellite system data	0x58
0x39	X	X	Satellite disabled	0x59 (Note 3)

Table A-12. Standard TSIP Command Packets

Input ID	CM3	ACE	Packet Description	Output ID
0x3A	X	X	Last raw measurement	0x5A (Note 3)
0x3B	X	X	Satellite ephemeris status	0x5B
0x3C	X	X	Tracking Status	0x5C (Note 2)
0x3D	X	X	Main port configuration	0x3D
0x3E	X		Additional fix parameters	0x5E
0x60	X	X	Type 1 differential GPS position fix mode	--
0x61	X	X	Set differential correction	--
0x62	X	X	Set / Request differential GPS position fix mode	0x82
0x65	X	X	Differential correction status	0x85 (Note 2)
0x6E		X	Synchronized measurement parameters	0x6E
0x70		X	Filter configuration	0x70
0x71	X	X	Position filter parameters	0x72
0x73	X	X	Height filter control	0x74
0x75	X		Best 4 / High 6 (Over-determined) control	0x76
0x77	X	X	Maximum rate of DGPS corrections	0x78
0x7A		X	Set / Request NMEA output configuration	0x7B
0xBB		X	Set receiver configuration	0xBB
0xBC		X	Set port configuration	0xBC

Note 1. – Output is determined by packet 35 settings.

Note 2. – No response sent if data is not available.

Note 3. – Not all packet 0x39 operations have a response.

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Table A-13. TSIP Super Command Packets

Input ID	CM3	ACE	Packet Description	Output ID
0x8E 03	X	X	auxiliary port configuration	0x8F-03
0x8E 14	X	X	datum	0x8F-14
0x8E 15	X	X	datum	0x8F-15
0x8E 19	X	X	UTM Enabled / Disabled	0x8F-19
0x8E 20	X	X	last fix with extra information (fixed point)	0x8F-20
0x8E 26		X	SEEPROM write status	0x8F-26
0x8E 40		X	TAIP configuration	0x8F-40

A.14 Report Packets Sent by the GPS Receiver to the User

The table below summarizes the packets output by the receiver. 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. These selections are covered in the packet descriptions beginning on page A-23.

Table A-14. Standard TSIP Report Packets

Output ID	Packet Description	Input ID
0x41	GPS time	0x21, auto
0x42	single-precision XYZ position	0x37, auto, power-up
0x43	velocity fix (XYZ ECEF)	0x37, auto
0x45	software version information	0x1F, power-up
0x46	health of Receiver	0x26, auto, power-up
0x47	signal level for all satellites	0x27
0x48	GPS system message	0x28
0x4A	single-precision LLA position	0x37, auto
0x4B	machine code/status	0x26, auto, power-up
0x4D	oscillator offset	0x2D
0x4E	response to set GPS time	0x2E
0x55	I/O options	0x35
0x56	velocity fix (ENU)	0x37, auto
0x57	information about last computed fix	0x37
0x58	GPS system data/acknowledge	0x38
0x59	sat enable/disable & health heed	0x39
0x5A	raw measurement data	0x3A
0x5C	satellite tracking status	0x3C

Table A-14. Standard TSIP Report Packets

0x6D	all-in-view satellite selection	0x24, auto
0x6F	synchronized measurement output	0x6E
0x72	PV filter parameters	0x71
0x74	Altitude filter parameters	0x73
0x78	Max DGPS correction age	0x77
0x7B	NMEA message schedule	0x7A
0x82	differential position fix mode	0x62, auto
0x83	double-precision XYZ	auto, 0x37
0x84	double-precision LLA	auto, 0x37
0x85	differential correction status	0x65
0x8F-20	last fix with extra information (fixed point)	auto, 0x37, 0x8E-20
0x8F-17	UTM single precision	auto, 0x37
0x8F-18	UTM double precision	auto, 0x37
0x8F-26	SEEPROM write status	8E-26
0x8F-40	TAIP configuration	8E-40

A.15 Key Setup Parameters

A.15.1 Packet BB

Selecting the correct operating parameters has significant impact on receiver performance. Packet 0xBB (set receiver configuration) controls the key setup parameters.

The default operating parameters allow the receiver to perform well in almost any environment. The user can optimize the receiver to a particular application if the vehicle dynamics and expected level of obscuration are understood. If the receiver is then taken out of this environment, the specifically tuned receiver may not operate as well as a receiver with the default options.

The Table A-16 lists suggested parameter selections as a function of obscuration and whether accuracy or fix density is important. In this table, N/A indicates that the operating parameter is not applicable, DC (don't care) indicates that the user may choose the operating parameter.

Table A-15. Setup Parameters

Packet	Parameter	Accuracy	Fixes	Factory Default
0xBB	Fix mode	Man 3D	AUTO	AUTO
0xBB	Dynamics code	Land	Land	Land
0xBB	Elevation mask	10°	5°	5°
0xBB	Signal mask	6.0	4.0	2.0
0xBB	DOP mask	6.0	12.0	12.0
0xBB	DOP switch	N/A	8.0	5.0
0xBB	DGPS mode	manual on	manual off	auto
0xBB	DGPS correction age	10 Seconds	N/A	30 Seconds

The default values in Table A-17 allow the receiver to operate well under the most varied and demanding conditions. A user may choose to change the default parameters if the receiver is only required to perform in a specific or limited environment. The user should be warned that when the receiver is exposed to operating conditions which are different from the conditions described by the user setup, then the performance may be degraded.

Initially, the user must consider the environment in which the receiver is expected to operate. There is a trade-off between how frequently a position fix is output versus the absolute accuracy of the fix. The user must decide which takes priority and then make the appropriate selections. This becomes increasingly important when frequent satellite blockages are expected, as in downtown "urban canyon" environments and heavily foliated areas.

Following is a description of the key fields in Packet 0xBB.

Set Fix Mode

Packet 0xBB is used to choose the appropriate position fix mode for your application: 2-D, 3-D or AUTO. The default mode is AUTO 2-D/3-D, where the receiver first attempts to obtain a 3-D solution with a PDOP below both the DOP mask and DOP switch. If this is not possible, then the receiver attempts to obtain a 2-D solution with a DOP less than the DOP mask. This mode supplies fairly continuous position fixes even when there is frequent obscuration. This mode is preferable for most land or air applications, where altitude changes are occurring and there is occasional obscuration.

The highest accuracy fix mode is 3-D manual, where altitude is always calculated along with the latitude, longitude, and time. However, this requires four satellites with a PDOP below the DOP mask set in Packet BB in order to obtain a position. Normally, this will provide the most accurate solution. Thus, if only 3-D solutions are desired, then the user should request 3-D manual mode. Depending on how the PDOP mask is set, this may be restrictive when the receiver is subjected to frequent obscuration, or when the geometry is poor due to an incomplete constellation.

Alternatively, if the user only wants a 2-D solution, then 2-D manual should be requested. In this case, the receiver uses either the last altitude obtained in a 3-D fix, or the altitude supplied by the user. However, any error in the assumed altitude will affect the accuracy of the latitude and longitude solution.

High accuracy users should avoid the 2-D mode and should expect fixes with accuracies which are at best as accurate as the supplied altitude. If a marine user enters sea-level as the altitude, then small errors in the horizontal solution will occur when the sea state is rough or there are high tidal variations. However, these errors may be smaller than the altitude errors induced by SA, so 2-D may be preferable for a marine user who does not want to observe “unusual” altitudes.

Dynamics Code

The feature default is LAND mode, where the receiver assumes a moderate dynamic environment. In this case, the satellite search and re-acquisition routines are optimized for vehicle type environments. In SEA mode, the search and re-acquisition routines assume a low acceleration environment and reverts to user entered altitude in 2-D auto. In AIR mode, the search and re-acquisition routines are optimized for high acceleration conditions.

Elevation Mask

This is the minimum elevation angle for satellites to be used in a solution output by the receiver. Satellites which are near the horizon are typically more difficult to track due to signal attenuation, and are also generally less accurate due to higher variability in the ionospheric and tropospheric corruption of the signal. When there are no obstructions, the receiver can generally track a satellite down to near the horizon. However, when this mask is set too low, the receiver may experience frequent constellation switching due to low elevation satellites being obscured.

Frequent constellation switching is undesirable because position jumps may be experienced when SA is present and DGPS is not available to remove these effects. The benefit of a low elevation mask is that more satellites are available for use in a solution and a better PDOP may be yielded. The current mask is set to five degrees and provides a reasonable trade-off of the benefits and drawbacks. High accuracy users may prefer a mask angle around ten degrees, where the ionosphere and troposphere begin to be more predictable

Signal Level Mask

This mask defines the minimum signal strength for a satellite used in a solution. There is some internal hysteresis on this threshold which allows brief excursions below the threshold if lock is maintained and the signal was previously above the mask. The factory default mask has been set to 2.0. High accuracy users may use a slightly higher mask of 6.0-8.0, since weaker measurements may be slightly noisier and are often caused by reflected signals which provide erroneous ranges.

One should also resist the temptation to set the elevation and SNR masks too low. The satellite geometry is sometimes improved considerably by selecting low elevation satellites. They are, however, subject to significant signal degradation by the greater ionospheric and tropospheric attenuation that occurs. They are also subject to more obscuration by the passing scenery when the receiver is in a moving vehicle. The code phase data from those satellites is therefore more difficult to decode and therefore has more noise.

Note – A level of hysteresis in the signal level mask is allowed in the core operating software. The hysteresis allows the receiver to continue using satellite signals which fall slightly below the mask and prevents the receiver from incorporating a new signal until the signal level slightly exceeds the mask. This feature minimizes constellation changes caused by temporary fluctuations in signal levels.

DOP Mask and Switch

The DOP mask is the maximum DOP limit for any 2-D or 3-D position solution will be made. The DOP switch is the level at which the receiver stops attempting a 3-D solution, and tries for a 2-D solution when in automatic 2-D/3-D mode. The switch level has no effect in either manual mode. Raising the DOP mask will generally increase the fix density during obscuration, but the fixes with the higher DOP will be less accurate (especially with SA present). Lowering the mask will improve the average accuracy at the risk of lowering the fix density.

Set DGPS Mode

Packet 0xBB is used to set the differential GPS operating mode. The factory default mode is DGPS Auto. In this mode, the receiver computes differentially corrected positions whenever valid corrections are available. Otherwise, the receiver computes non-differentially corrected positions.

In manual DGPS mode, the receiver computes solutions only if corrections are available for the selected satellites. This is the most accurate mode but it is also the most selective, since the fix density is dependent on the availability of corrections. The applicability of corrections is determined by the maximum age which can be set using Packet 0xBB.

The AUTO mode avoids the fix density problem but opens the possibility of going in and out of DGPS mode, potentially resulting in position and velocity jumps. If accuracy is critical, use MANUAL DGPS mode. If fix density is critical, AUTO DGPS is the recommended mode.

In differential OFF mode, the receiver will not use corrections even if they are valid.

A.16 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. Notice that 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. This may involve switching the order of the bytes as they are normally stored in Intel based machines. Specifically:

- UINT8 = Byte: An 8 bit unsigned integer.
- UINT16 = Word : A 16 bit unsigned integer.
- INT16 = Integer: A 16 bit integer.
- INT32 = Long: A 32 bit integer.
- UINT32 = ULong: A 32 bit unsigned integer.
- Single — Float, or 4 byte REAL has a precision of 24 significant bits, roughly 6.5 digits.
- Double — 8 byte REAL has a precision of 52 significant bits. It is a little better than 15 digits.

A.17 Packet Descriptions

A.17.1 Report Packet 0x13 - Packet Received

If a packet is received and it cannot be parsed, the packet is returned through the output port with a 0x13 inserted between the leading DLE and the input TSIP identification code. Two common causes of command failure are improper DLE stuffing and serial link noise.

A.17.2 Command Packet 0x1D - Clear Oscillator Offset

This packet commands the GPS receiver to set or clear the oscillator offset in battery backed memory. This is normally used for servicing the unit.

To clear the oscillator offset, one data byte is sent: The ASCII letter "C" = 0x43.

To set the oscillator offset, four data bytes are sent: The oscillator offset is expressed in Hertz as a single, real value.

A.17.3 Command Packet 0x1E - Clear Battery Backup, then Reset

This packet commands the GPS receiver to clear all battery back-up data and to perform a software reset. This packet contains one data byte, and will output packet 0x4B.

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Table A-16. Command Packet 0x1E Format

Byte	Item	Type	Value	Definition
0	Reset mode	UINT8	0x4B	Cold start: Erase BBRAM and restart
			0x46	Factory reset: Erase BBRAM and SEEPROM and restart

Caution – All almanac, ephemeris, current position, mode, and communication port setup information is lost when executing the reset full factory configuration command. In normal use this packet should not be sent.

Caution – It is very helpful to keep a fresh copy of the current almanac, which is stored in the file GPSALM.DAT collected by the TSIPCHAT command “!”. This allows near-instantaneous recuperation by the receiver in case of power loss or clearing of battery-backed memory by using the TSIPCHAT command “@” to load it back into the receiver memory.

A.17.4 Command Packet 0x1F - Request Software Versions

This packet requests information about the version of software running in the Navigation and Signal Processors. This packet contains no data. The GPS receiver returns Packet 0x45.

A.17.5 Command Packet 0x20 - Request Almanac

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

A.17.6 Command Packet 0x21 - Request Current Time

This packet requests current GPS time. This packet contains no data. The GPS receiver returns Packet 0x41.

A.17.7 Command Packet 0x22 - Position Fix Mode Select

This packet commands the GPS receiver to operate in a specific position fix mode. This packet contains one data byte indicating the mode, as follows.

Table A-17. Command Packet 0x22 Position Fix Mode Select

Byte	Type	Value	Definition
0	UINT8	0	Auto (3-D / 2-D)
		3	Horizontal only (2-D)
		4	3-D only

In auto 3D/2D, the receiver tries for a 3D fix that meets the PDOP switch criteria set in the TSIP operating parameters packet. If the 3D DOP switch is exceeded, then the 2D HDOP is compared to the DOP mask. If this HDOP satisfies the DOP mask, then a 2-D fix is allowed. Otherwise, no fixing is allowed until tracking conditions change favorably.

Likewise, in Horizontal 2D only mode, the receiver is asked to perform 2D solutions only (using fixed or reference altitude) with a HDOP less than the DOP mask. If this criteria is not satisfied, then no fixing is allowed for the current tracking conditions.

In 3-D mode the receiver tries to obtain a 3D fix. However if the PDOP is greater than the DOP mask, fixing will not occur.

A.17.8 Command Packet 0x23 - Initial Position (XYZ Cartesian ECEF)

This packet provides the GPS receiver with an approximate initial position in XYZ coordinates. This packet is useful if the user has moved more than about 1,000 miles after the previous fix. (Note that the GPS 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 below.

To initialize with latitude-longitude-altitude, use Command Packet 0x2B.

Table A-18. Command Packet 0x23 Data Format

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

A.17.9 Command Packet 0x24 - Request GPS Receiver Position Fix Mode

This packet requests current position fix mode of the GPS receiver. This packet contains no data. The GPS receiver returns Packet 0x6D.

A.17.10 Command Packet 0x25 - Initiate Soft Reset & Self Test

This packet commands the GPS receiver to perform a software reset. This is equivalent to cycling the power. The GPS receiver performs a self-test as part of the reset operation. This packet contains no data. Following completion of the reset, the receiver will output the start-up messages (see Table A-5). The GPS receiver sends Packet 0x45 only on power-up and reset (or on request); thus if Packet 0x45 appears unrequested, then either the GPS receiver power was cycled or the GPS receiver was reset.

A.17.11 Command Packet 0x26 - Request Health

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

A.17.12 Command Packet 0x27 - Request Signal Levels

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

A.17.13 Command Packet 0x28 - Request GPS Systems Message

This packet requests the most recent GPS system ASCII message sent with the navigation data by each satellite. This packet contains no data. The GPS receiver returns Packet 0x48 only if a GPS message has been received.

A.17.14 Command Packet 0x29 - Request Almanac Health Page

This packet requests the GPS receiver to send the health page from the almanac. This packet contains no data. The GPS receiver returns packet 49 hex.

A.17.15 Command Packet 0x2A - Altitude for 2-D Mode

Reference Altitude is the altitude used for manual 2-D positions if the altitude flag is set. Altitude is in units of HAE WGS-84 or MSL depending on the selected I/O options for the position. See section A.17.23. The Altitude Flag determines whether or not the Reference Altitude will be used. If set, it will be used. If cleared, altitude hold (last 3-D altitude) is used.

Note – With no data bytes, this packet requests the current values of these altitude parameters. In this case, the GPS receiver returns Packet 4A.

This packet sets or requests the altitude parameters used for the Manual 2-D mode: Reference Altitude and Altitude Flag. Packet 0x4A (type 2) is returned.

Table A-19 Packet 0x2A Set Reference Altitude Description

Byte	Item	Type	Definition
0-3	Altitude	Single	Reference altitude for 2-D

Table A-20. Packet 0x2A Clear Reference Altitude Only Description

Byte	Item	Type	Value	Definition
0	Altitude Flag	UINT8	0 x FF	Clear Altitude flag

Note – With no data bytes, this packet requests the current values of these altitude parameters. In this case, the GPS receiver returns Packet 4A.

A.17.16 Command Packet 0x2B - Initial Position (Latitude, Longitude, Altitude)

This packet provides the GPS 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 after the previous fix. (Note that the GPS 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 Table A-23:

Table A-21. Command Packet 0x2B Data Format

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

Note – To initialize with ECEF position, use Command Packet 0x23.

A.17.17 Command Packet 0x2C - Set/Request Operating Parameters

Note – This Command Packet has been replaced by Command Packet 0xBB. Although the ACE II GPS retains compatibility with this command, it is recommended that you use the 0xBB Command Packet.

This packet sets the operating parameters of the GPS receiver or requests the current values. The data format is shown below. The GPS receiver returns packet 0x4C. See Section A.15 for a complete description of the key setup parameters.

The dynamics code indicates the expected vehicle dynamics and is used to set the search bandwidths.

The elevation angle mask determines the lowest angle at which the GPS receiver will attempt to track a satellite and use it in a position solution.

The signal level mask sets the required signal level for a satellite to be used for position fixes.

The DOP mask sets the maximum DOP with which position fixes are calculated. The DOP switch selects the PDOP at which a receiver in automatic 2-D/3-D mode will switch from 3-D to 2-D position solutions. If 4 or more satellites are available and the resulting PDOP is not greater than the DOP switch value, then 3-D fixes are calculated. Otherwise, 2-D fixes are calculated. The DOP switch is effective only in the automatic 2-D/3-D mode.

Table A-22. Command Packet 0x2C Data Format

Byte	Item	Type	Units	Default	Definition
0	Dynamics code	UINT8	---	1 - Land	(0) current value left unchanged (1) land/<120 knots (2) sea/<50 knots (3) air/<800 knots
1-4	Elevation angle mask	Single	radians	5°	
5-8	Signal level mask	Single	---	4	Minimum signal strength
9-12	PDOP mask	Single	---	12	Maximum PDOP setting
13-16	PDOP switch (3-D or 2-D)	Single	---	5	2D / 3D switch

A negative value in a “single” field leaves that current setting unchanged. This information is held in battery-backed memory.

To query current values, send the 0x2C command with the data field values of 0, for byte 1 and -1.0 for all other values

A.17.18 Command Packet 0x2D - Request Oscillator Offset

This packet requests the calculated offset of the GPS receiver master oscillator. This packet contains no data. The GPS receiver returns Packet 0x4D. This packet is used mainly for service. The permissible oscillator offset varies with the particular GPS receiver unit.

A.17.19 Command Packet 0x2E - Set GPS Time

This packet provides the approximate GPS time of week and the week number to the GPS receiver. The GPS receiver returns Packet 0x4E. The data format is shown below. The GPS week number reference is Week # 0 starting January 6, 1980. The seconds count begins at the midnight which begins 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 GPS satellite.

Note – See A.18.30, Report Packet 41 for information on the Extended GPS week number.

Table A-23. Command Packet 0x2E Data Formats

Byte	Item	Type	Units
0-3	GPS time of week	Single	Seconds
4-5	Extended GPS week number	INT16	Weeks

A.17.20 Command Packet 0x2F - Request UTC Parameters

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

A.17.21 Command Packet 0x31 - Accurate Initial Position (XYZ Cartesian ECEF)

This packet is identical in content to Packet 0x23. This packet provides an initial position to the GPS receiver in XYZ coordinates. However, the GPS 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. For acquisition aiding, the position provided by the user to the GPS receiver in this packet should be accurate to a few kilometers. For high-accuracy time transfer, position should be accurate to a few meters.

Table A-24 Command Packet 0x31 Data Format

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

A.17.22 Command Packet 0x32 - Accurate Initial Position (Latitude, Longitude, Altitude)

This packet is identical in content to Packet 0x2B. This packet provides the GPS receiver with an accurate initial position in latitude, longitude, and altitude coordinates. However, the GPS 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. For acquisition aiding, the position provided by the user to the GPS receiver in this packet should be accurate to a few kilometers. For high-accuracy time transfer, position should be accurate to a few meters.

Table A-25 Command Packet 0x32 Data Format

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

A.17.23 Command Packet 0x35 - Set/Request I/O Options

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

To request the option states without changing them, the user sends the packet with no data bytes included. 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 option states are held in battery-backed memory and can be set into non-volatile RAM (EEPROM) with the 0x8E-26 command. The GPS receiver returns Packet 0x55. See A.3 for information on saving the settings to non-volatile memory.

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 (mean sea level), and UTC (coordinated universal time).

Table A-26. Command Packets 0x35 and 0x55 Data Descriptions

Byte	Bit	Item	Type	Value	Definition	**Associated Packet**
Position						
0	0 (LSB)	XYZ ECEF	Bit	0 1	XYZ ECEF output off XYZ ECEF output on	0x42 or 0x83
	1	LLA Output	Bit	0 1	LLA output off LLA output on	0x4A or 0x84
	2	LLA ALT Output	Bit	0 1	HAE (WGS-84 datum) MSL geoid	0x4A / 0x84 0x8F-17 0x8F-18
	3	ALT input	Bit	0 1	HAE (WGS-84 datum) MSL geoid.	0x2A
	4	Precision-of-position output	Bit	0 1	Send single-precision packet. Send double-precision packet.	0x42/0x4A/ 8F-17 0x83/84/ 8F-18
	5	Super Packet Output	Bit	0 1	Output no Super Packets. Output all enabled Super Packets.	0x8F-17, 0x8F-18 0x8F-20 Note 1. –
	6-7	reserved				
Velocity						
1	0	XYZ ECEF	Bit	0 1	XYZ ECEF output off XYZ ECEF output on	0x43
	1	ENU output	Bit	0 1	ENU output off ENU output on	0x56
	2-7	reserved				
Timing						
2	0	Time Type	Bit	0 1	GPS time UTC	0x42, 0x43, 0x4A, 0x83, 0x84, 0x56, 0x8F-17, 0x8F-18
	1-7	reserved				

Table A-26. Command Packets 0x35 and 0x55 Data Descriptions (Continued)

Byte	Bit	Item	Type	Value	Definition	Associated Packet
Auxiliary / Pseudo Range Measurements						
3	0	Raw measuring	Bit	0 1	Raw measurements off Raw measurements on	0x5A
	1	Raw / Filtered	Bit	0 1	Raw PR's in 5A Filtered PR's in 5A	0x5A Note 2. –
	2	reserved				
	3	Output dB Hz instead of AMU	Bit	0 1	Output dB Hz Output AMU's	0x5A, 0x5C, 0x47, 0x6F
	4-7	reserved				

Note 1. – See the associated superpacket output, described in Section A.19. Packet 8E must be used to specify which superpacket is to be output.

Note 2. – Automatic output of 0x5A messages is supported in the ACE II GPS for backwards compatibility with older TSIP applications.

A.17.24 Command Packet 0x37 - Request Status and Values of Last Position and Velocity

This packet requests information regarding the last position fix and is only used when the receiver is not automatically outputting positions. The GPS receiver returns Report Packet 0x57 followed by the position/velocity packets specified in Command Packet 0x35.

A.17.25 Command Packet 0x38 - Request/Load Satellite System Data

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

Table A-27. Command Packet 0x38 Data Formats

Byte	Item	Type	Value	Definition
0	Operation	UINT8	1 2	Request data from ACE II GPS; Load data into ACE II GPS
1	Type of data	UINT8	2 3 4 5 6	Almanac Health page, T_oa, WN_oa Ionosphere UTC Ephemeris; request only
2	Sat PRN#	UINT8	0 1 - 32	Data that is not satellite - ID specific Satellite PRN number
3	Length (n)	UINT8		Number of bytes of data to be loaded
4 to n+3	Data	UINT8		Satellite data

Caution – Proper structure of satellite data is critical to ACE II GPS operation. Requesting data is not hazardous; Loading data improperly is hazardous. Use this packet only with extreme caution. The data should not be modified in any way. It should only be retrieved and stored for later download.

Note – Ephemeris cannot be loaded into the receiver.

A.17.26 Command Packet 0x39 - Set/Request Satellite Disable or Ignore Health

Normally the GPS receiver selects only healthy satellites (based on transmitted values in the ephemeris and almanac) which satisfy all mask values used 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 GPS receiver returns Packet 0x59 for operation modes 3 and 6 only.

It should be noted that when viewing the satellite disables 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”.

Table A-28. Command Packet 0x39 Data Formats

Byte	Item	Type	Value	Definition
0	Operation	UINT8	1 2 3 4 5 6	Enable SV (default) Disable SV selection List enable - or - disable status of all 32 satellites Heed SV health on satellite(default) Ignore SV health on satellite List heed - or - ignore health on all 32 satellites
1	Satellite #	UINT8	0 1 - 32	All 32 satellites Any one satellite PRN number

This information is not held in battery-backed memory. At power-on and after a reset the default values are set for all satellites.

Caution – Improperly ignoring health can cause the GPS receiver software to lock up, as an unhealthy satellite may contain defective data. Use extreme caution in ignoring satellite health.

A.17.27 Command Packet 0x3A - Request Last Raw Measurement

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

Table A-29 Command Packet 0x3A Data Format

Byte	Item	Type	Value	Definition
0	Satellite #	UINT8	0 1-32	All satellites in the current tracking set. Desired satellite.

A.17.28 Command Packet 0x3B - Request Current Status Of Satellite Ephemeris Data

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

Table A-30 Command Packet 0x3B Data Format

Byte	Item	Type	Value	Definition
0	Satellite #	UINT8	0 1-32	All satellites Desired satellite.

A.17.29 Command Packet 0x3C - Request Current Satellite Tracking Status

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

Table A-31. Command Packet 0x3C Data Format

Byte	Item	Type	Value	Definition
0	Satellite #	UINT8	0 1 - 32	All satellites in the current tracking set Desired satellite

A.17.30 Command / Report Packet 0x3D - Primary Port Configuration

Note – This Command Packet has been replaced by Command Packet 0xBC. Although the ACE II GPS retains compatibility with this command, it is recommended that you use the 0xBC Command Packet.

This packet requests and optionally sets the primary port (port 1) configuration. This configuration includes the baud rate, number of bits, parity, and number of stop bits and also the language mode. When this packet is used only to request the configuration the packet contains no data bytes. When this packet is used to set the configuration, the packet contains the 5 data bytes shown below.

A 0x3D input packet, with or without data, is responded to with a 0x3D output packet. The language mode is defined as follows: For transmission, the language mode specifies whether TSIP packets or NMEA are output on primary port. For reception, the language mode specifies whether packets or RTCM data are received on the primary port. See Note 1.

The baud rate for the transmitter and the receiver can be set independently, but for TSIP, the number of bits, parity, and the stop bits are common between them. The default mode is packets for both transmission and reception at 9,600 baud with 8 data bits, odd parity, and one stop bit. For TAIP and NMEA, the default factory setting is 4800 baud, 8 data bits, no parity, 1 stop bit.

When the language mode for reception is set to RTCM (SC-104), raw RTCM (SC-104) data is accepted on the primary port for differential GPS corrections. These corrections are used only if the mode is set to Differential Auto or Manual DGPS (Differential On) with packet 0x62.

Note – RTCM input for the secondary port is the default mode at power-on to allow for direct connection to a radio modem. The default speed is 4800,8,none,1.

Table A-32. Command/Report Packet 0x3D Data Format

Byte	Bit	Item	Type	Value	Definition
0		Output Baud Rate	UINT8	4 5 6 8 9 11 28 12	300 baud 600 baud 1200 baud 2400 baud 4800 baud 9600 baud 19200 baud 38400 baud
1		Input Baud Rate	UINT8	As Above	As Above
2	0-1	Data bits code		2 3	7 data bits 8 data bits
2	2-4	Parity code		0 1 4	even parity odd parity no parity
3		Stop bits code	UINT8	7 15	1 stop bit 2 stop bits
4		Language mode for Transmission	UINT8	0 1 5	TSIP Off NMEA See Note 2.
5		Language mode for Reception	UINT8	0 1	TSIP RTCM SC-104 Note 3.

This information is held in battery-backed memory. After loss of battery-backed memory, the receiver will reset to the default values.

Note 1. – The default NMEA output is GGA and VTG at 1 second intervals.

Note 2. – Before the main port language for reception can be set to RTCM SC-104, the auxiliary port language for reception must be set to packets (using command 0xBC). Only one port may be set to receive RTCM at a time, not both.

A.17.31 Report Packet 0x40 - Almanac Data Page

Table A-33. Report Packet 0x40 Data Format

Byte	Item	Type	Units
0	satellite	UNIT8	(identification number)
1	T_zc	single	seconds
5	week number	INT16	weeks
7	eccentricity	single	(dimensionless)
11	T_oa	single	seconds
15	i_o	single	radians
19	OMEGA_dot	single	radians/second
23	square root A	single	$(\text{meters})^{1/2}$
27	OMEGA o	single	radians
31	omega	single	radians
35	M_o	single	radians

The symbols are defined in ICD-200.

T_zc is normally positive. 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.

A.17.32 Report Packet 0x41 - GPS Time

This packet provides the current GPS time of week and the week number. The GPS receiver sends this packet in response to Packet 0x21 and during an update cycle. Update cycles occur approximately every 5 seconds. The data format is shown below.

Table A-34. Report Packet 0x41 Data Formats

Byte	Item	Type	Units
0-3	GPS time of week	Single	seconds
4-5	Extended GPS week number	INT16	weeks
6-9	GPS UTC offset	Single	seconds

Note – UTC time lags behind GPS time by an integer number of seconds;
UTC = (GPS time) - (GPS UTC offset).

Caution – GPS week number runs from 0 to 1023 and then cycles back to week #0. Week # 0 began January 6, 1980. There will be another week #0 beginning August 22, 1999. The extended GPS week number however, does not cycle back to 0. For example, August 22, 1999 starts week number 1024.

The seconds count begins with "0" each Sunday morning at midnight GPS time. A negative indicated time-of-week indicates that time is not yet known; in that case, the packet is sent only on request. The following table shows the relationship between the information in Packet 0x41, and the Packet 0x46 status code.

Table A-35. Packets 0x41 and 0x46 Status Code Relationships

Approximate Time Accuracy	Time Source	Sign (TOW)	Packet 46 Status Code
none	no time at all	-	0x01
unknown	approximate time from real-time clock or Packet 2E	+	0x01
20-50 msec + clock drift	time from satellite	+	0x02 - 0x0C
full accuracy	time from GPS solution	+	0x00

Note – Before using the GPS time from Packet 0x41, verify that the Packet 0x46 status code is 00 ("Doing position fixes"). This will ensure the most accurate GPS time.

A.17.33 Report Packet 0x42 - Single-Precision Position Fix, XYZ ECEF

This packet provides current GPS 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 GPS receiver sends this packet each time a fix is computed. The data format is shown below.

Table A-36. Report Packet 0x42 Data Formats

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 GPS time or UTC as selected by the I/O "timing" option. Packet 83 provides a double-precision version of this information.

A.17.34 Report Packet 0x43 - Velocity Fix, XYZ ECEF

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

Table A-37. Report Packet 0x43 Data Formats

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

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

A.17.35 Report Packet 0x45 - Software Version Information

This packet provides information about the version of software in the Navigation and Signal Processors. The GPS receiver sends this packet after power-on and in response to Packet 0x1F.

Table A-38. Report Packet 0x45 Data Formats

Byte	Item	Type
0	Major version number	UINT8
1	Minor version number	UINT8
2	Month	UINT8
3	Day	UINT8
4	Year number minus 1900	UINT8
5	Major revision number	UINT8
6	Minor revision number	UINT8
7	Month	UINT8
8	Day	UINT8
9	Year number minus 1900	UINT8

The first 5 bytes refer to the Navigation Processor and the second 5 bytes refer to the Signal Processor.

A.17.36 Report Packet 0x46 - Health of Receiver

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 and, during an update cycle. Packet 0x4B is always sent along with this packet.

Table A-39. Report Packet 0x46 Data Formats

Byte	Bit	Item	Type	Value	Definition
0		Status code	UINT8	0x00	Doing position fixes
				0x01	Don't have GPS time yet
				0x02	Need initialization
				0x03	PDOP is too high
				0x08	No usable satellites
				0x09	Only 1 usable satellite
				0x0A	Only 2 usable satellites
				0x0B	Only 3 usable satellites
				0x0C	The chosen satellite is unusable
1	0	Battery backup	Bit	0	OK
				1	BBRAM not available at start-up
1	4	Antenna feedline fault		0	OK
				1	short or open detected

The status codes in Byte 1 of Packet 0x46 are encoded into individual bits within the byte. The battery backup bit, once set, will remain set until the receiver is reset.

A.17.37 Report Packet 0x47 - Signal Levels for all Satellites

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.

Table A-40. Report Packet 0x47 Data Formats

Byte	Item	Type
0	Count	UINT8
1	Satellite number 1	UINT8
2- 5	Signal level 1	Single
6	Satellite number 2	UINT8
7-10	Signal level 2	Single
(etc.)	(etc.)	(etc.)

Up to 8 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. If it is negative then that satellite is not currently in lock. The absolute value of signal level field is the last known signal level of that satellite.

Note – The signal level provided in this packet is a linear measurement of the signal strength after correlation or de-spreading. Units, either AMU or dBHz, are controlled by Packet 0x35.

A.17.38 Report Packet 0x48 - GPS System Message

This packet provides the most recent 22-byte ASCII message broadcast in the GPS satellite navigation message. The receiver sends this packet in response to Packet 0x28.

The message effectively is a bulletin board from the Air Force to GPS users. The format is free-form ASCII and is often encrypted. The message may be blank.

A.17.39 Report Packet 0x49 - Almanac Health Page

This packet provides health information on 32 satellites. Packet data consists of 32 bytes each containing the 6-bit health from Almanac page 25. The receiver sends this packet in response to packet 29 hex and when this data is received from a satellite. A value of 0 indicates the satellite is healthy. If all values are 0, this indicates that the health page is not yet available.

Table A-41. Report Packet 0x49 Almanac Health Page Data Formats

Byte	Item	Type
0	health of satellite #1	UINT8
1	health of satellite #2	UINT8
---	---	---
---	---	---
---	---	---
32	health of satellite #32	UNIT8

A.17.40 Report Packet 0x4A - 20 Byte Format

This packet provides current GPS 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. Command Packet 35 controls position output (XYZ or LLA) and (single or Double) output precision. The data format is shown below:

Table A-42. Report Packet 0x4A Data Formats

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 (HAE or MSL)
2-15	Clock Bias	Single	meters
6-19	Time-of-Fix	Single	seconds (GPS or UTC)

The LLA conversion is done according to the datum selected using Packet 0x8E-15. The default is WGS-84. Altitude is referred to the datum ellipsoid or the MSL Geoid, depending on which I/O “LLA altitude” option is selected. The time-of-fix is in GPS time or UTC, depending on which I/O “timing” option is selected.

This packet also is sent at start-up with a negative time-of-fix to report the current known position. Packet 0x84 provides a double-precision version of this information

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 PI). The value of the constant PI as specified in ICD-GPS-200 is 3.1415926535898.

A.17.41 Report Packet 0x4A - 9 Byte Format

Report Packet 0x4A is also sent in response to the setting or requesting of the Reference Altitude Parameters using Command Packet 0x2A. These parameters can be used in the Manual 2-D mode.

Reference Altitude

The altitude used for manual 2-D positions if the altitude flag is set. Altitude is in units of HAE WGS-84 or MSL depending on the selected I/O options set for positioning with Command Packet 35.

Altitude Flag

A flag that determines whether or not the Reference Altitude will be used. If set, it will be used. If cleared, altitude hold (last 3-D altitude) will be used. The data format is shown in the following table.

Table A-43. Reference Altitude

Byte	Item	Type	Units
0-3	Reference Altitude	Single	Meters
4-7	Reserved	Single	
8	Altitude flag	UINT8	

A.17.42 Report Packet 0x4B - Machine/Code ID and Additional Status

The receiver transmits this packet in response to packets 0x25 and 0x26 and following a change in state. In conjunction with Packet 0x46, “health of receiver,” this packet identifies the receiver and may present status messages. 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.

Table A-44. Report Packet 0x4B Data Formats

Byte	Item	Type/	Definition
0	Machine ID	UINT8	Receiver dependent
1	Status 1	UINT8	See Table A-46
2	Status 2	UINT8	Bit 0 = Super packets supported

The status codes are encoded into individual bits within the bytes. The bit positions and their meanings are shown in Table A-46.

Table A-45. Report Packet 0x4B Bit Positions and Descriptions

Status 1 Bit Positions	Meaning if bit value = 1
0 (LSB)	Not used
1	Real-time Clock is not available at power-up.
2	Not used
3	The almanac stored in the receiver is not complete and current.
4-7	Not used

A.17.43 Report Packet 0x4C - Report Operating Parameters

Note – This Command Packet has been replaced by Command Packet 0xBB. Although the ACE II GPS retains compatibility with this command, it is recommended that you use the 0xBB Command Packet.

This packet provides several operating parameter values of the receiver. The receiver sends this packet in response to packet 2C hex. The dynamics code indicates the expected vehicle dynamics and is used to assist the initial solution. The elevation angle mask determines the lowest angle at which the SVeeSix series receiver tries to track a satellite. The signal level mask sets the required signal level for a satellite to be used for position fixes.

The PDOP mask sets the maximum PDOP with which position fixes are calculated. The PDOP switch sets the threshold for automatic 3D/2D mode. If four or more satellites are available and the resulting PDOP is not greater than the PDOP mask value, then 3-dimensional fixes are calculated.

Table A-46. Report Packet 0x4C Data Formats

Byte	Item	Type	Default	Value
0	Dynamics code	UINT8	6-channel (1) land (2) sea (3) air	 <120 knots <50 knots <800 knots
1-4	Elevation angle mask	single/ radians	5^{o} = .08 radians	
5-8	Signal level mask	single	2.0	
9-12	DOP mask	single	12.0	
13-16	PDOP switch (3D or 2D)	single	5.0	

This information is held in battery-backed memory.

A.17.44 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. The receiver sends this packet in response to Packet 0x2D. The permissible offset varies with the receiver unit.

A.17.45 Report Packet 0x4E - Response to Set GPS Time

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

Table A-47. Report Packet 0x4E Data Formats

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 0x 2E.

A.17.46 Report Packet 0x4F - UTC parameters

This packet is sent in response to Command Packet 2F 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, obtain the correct UTC offset from the 0x41 or 8F-20 message.

Table A-48. Report Packet 0x4F Data Formats

Byte	Item	Type
0-7	A0	double
8-11	A1	single
12-13	ΔT_{LS}	INT16
14-17	T_{OT}	single
18-19	WN_T	INT16
20-21	WN_{LSF}	INT16
22-23	DN	INT16
24-25	ΔT_{LSF}	INT16

A.17.47 Report Packet 0x55 - I/O Options

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), and UTC (coordinated universal time).

Table A-49. Command Packets 0x55 and 0x35 Data Descriptions

Byte	Bit	Item	Type	Value	Definition
Position					
0	0	XYZ ECEF	Bit	0 1	XYZ ECEF output off XYZ ECEF output on
0	1	LLA Output	Bit	0 1	LLA output off LLA output on
0	2	LLA ALT Output	Bit	0 1	HAE (WGS-84 datum) MSL geoid
0	3	ALT input	Bit	0 1	HAE (WGS-84 datum). MSL geoid.
0	4	Precision-of-position output	Bit	0 1	Send single-precision packet. Send double-precision packet.
0	5	Super Packet Output	Bit	0 1	Output no Super Packets. Output all enabled Super Packets.
0	6-7	reserved			
Velocity					
1	0	XYZ ECEF	Bit	0 1	XYZ ECEF output off XYZ ECEF output on
1	1	ENU output	Bit	0 1	ENU output off ENU output on
1	2-7	reserved			
Timing					
2	0	Time Type	Bit	0 1	GPS time UTC
2	1-7	reserved			
Auxiliary / Range Measurements					
3	0	Raw measuring	Bit	0 1	Raw measurements off Raw measurements on
3	1	Raw / Filtered	Bit	0 1	Raw PR’s in 5A Filtered PR’s in 5A
3	2	reserved			
3	3	Output dB Hz instead of AMU	Bit	0 1	Output dB Hz Output AMU’s
3	4-7	reserved			

Note 1. – See the associated superpacket output, described later in this appendix. Packet 8E must be used to specify which superpacket is to be output.

Note 2. – Automatic output of 0x5A messages is supported in the ACE II GPS for backwards compatibility with older TSIP applications.

A.17.48 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.

Table A-50. Report Packet 0x56 Data Formats

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 (GPS or UTC)

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

A.17.49 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.

Table A-51. Report Packet 0x57 Data Formats

Byte	Item	Type	Units	Byte 0 Value/Velocity
0	Source of information	UINT8	--	00 temporary no fix 01 good current fix
1	Mfg. diagnostic	UINT8	--	
2-5	Time of last fix	Single	seconds, GPS time	
6-7	Week of last fix	INT16	weeks, GPS time	

A.17.50 Report Packet 0x58 - Satellite System Data/Acknowledge from Receiver

This packet provides GPS data (almanac, ephemeris, etc.). The receiver sends this packet in response to Packet 0x38 (acknowledges the loading of data).

The data format is shown below.

Table A-52. Report Packet 0x58 Data Formats

Byte	Item	Type	Value	Definition
0	Operation	UINT8	1 2	Request data from receiver; Load data into receiver
1	Type of data	UINT8	2 3 4 5 6	Almanac Health page, T_oa, WN_oa Ionosphere UTC Ephemeris; request only
2	Sat PRN#	UINT8	0 1 - 32	Data that is not satellite - ID specific satellite PRN number
3	Length (n)	UINT8		Number of bytes of data to be loaded
4 to n+3	Data			

Note – If data is not available, byte 3 is set to 0 and “no” data is sent.

The binary almanac, health page, and UTC data streams are similar to Report Packets 0x40, 0x49, and 0x4F respectively, but these reports are preferred. To get ionosphere or ephemeris, this report must be used.

Table A-53. Report Packet 0x58 Almanac Data

Byte	Item	Type	Definition / ICD-GPS-200
4	t_oa_raw	UINT8	Sec 20.3.3.5.1.2
5	SV_HEALTH	UINT8	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_zc	Single	Sec 20.3.3.5.1.2. see Note 2.
66-67	weeknum	INT16	Sec 20.3.3.5.1.2
68-69	wn_oa	INT16	Sec 20.3.3.5.1.2

Note 1. – All angles are in radians.

Note 2. – If data is not available, t_zc is set to -1.0.

Table A-54. Report Packet 0x58 Almanac Health Data

Byte	Item	Type	Definition/ ICD-GPS-200
4	week # for health	UINT8	Sec 20.3.3.5.1.3
5-36	SV_health	UINT8	Sec 20.3.3.5.1.3
37	t_oa for health	UINT8	Sec 20.3.3.5.1.3
38	current t_oa	UINT8	units = seconds/2048
39-40	current week #	INT16	

Table A-55 Report Packet 0x58 Ionosphere Data

Byte	Item	Type	Definition / IDC-GPS-200
4-11	---	---	not used
12-15	alpha_0	Single	Sec 20.3.3.5.1.9
16-19	alpha_1	Single	Sec 20.3.3.5.1.9
20-23	alpha_2	Single	Sec 20.3.3.5.1.9
24-27	alpha_3	Single	Sec 20.3.3.5.1.9
28-31	beta_0	Single	Sec 20.3.3.5.1.9
32-35	beta_1	Single	Sec 20.3.3.5.1.9
36-39	beta_2	Single	Sec 20.3.3.5.1.9
40-43	beta_3	Single	Sec 20.3.3.5.1.9

Table A-56 Report Packet 0x58 UTC Data

Byte	Item	Type	Definition / IDC-GPS-200
4-16	---	---	not used
17-24	A_0	Double	Sec 20.3.3.5.1.8
25-28	A_1	Single	Sec 20.3.3.5.1.8
29-30	delta_t_LS	Integer	Sec 20.3.3.5.1.8
31-34	t_ot	Single	Sec 20.3.3.5.1.8
35-36	WN t	Integer	Sec 20.3.3.5.1.8
37-38	WN_LSF	Integer	Sec 20.3.3.5.1.8
39-40	DN	Integer	Sec 20.3.3.5.1.8
41-42	delta_t_LSF	Integer	Sec 20.3.3.5.1.8

Table A-57 Ephemeris

Byte	Item	Type	Definition / IDC -GPS-200
4	sv_number	UINT8	SV PRN number
5-8	t_ephem	Single	time of collection
9-10	weeknum	INT16	Sec 20.3.3.3, Table 20-I
11	codeL2	UINT8	Sec 20.3.3.3, Table 20-I
12	L2Pdata	UINT8	Sec 20.3.3.3, Table 20-I
13	SVacc_raw	UINT8	Sec 20.3.3.3, Table 20-I
14	SV_health	UINT8	Sec 20.3.3.3, Table 20-I
15-16	IODC	INT16	Sec 20.3.3.3, Table 20-I
17-20	T_GD	Single	Sec 20.3.3.3, Table 20-I
21-24	t_oc	Single	Sec 20.3.3.3, Table 20-I
25-28	a_f2	Single	Sec 20.3.3.3, Table 20-I
29-32	a_f1	Single	Sec 20.3.3.3, Table 20-I
33-36	a_f0	Single	Sec 20.3.3.3, Table 20-I

Table A-57 Ephemeris

Byte	Item	Type	Definition / IDC -GPS-200
37-40	SVacc	Single	Sec 20.3.3.3, Table 20-I
41	IODE	UINT8	Sec 20.3.3.4
42	fit_interval	UINT8	Sec 20.3.3.4
43-46	C_rs	Single	Sec 20.3.3.4
47-50	delta_n	Single	Sec 20.3.3.4
51-58	M_0	Double	Sec 20.3.3.4
59-62	C_uc	Single	Sec 20.3.3.4, radians
63-70	e	Double	Sec 20.3.3.4
71-74	C_us	Single	Sec 20.3.3.4, radians
75-82	sqrt_A	Double	Sec 20.3.3.4
83-86	t_oe	Single	Sec 20.3.3.4
87-90	C_ic	Single	Sec 20.3.3.4, radians
91-98	OMEGA_0	Double	Sec 20.3.3.4
99-102	C_is	Single	Sec 20.3.3.4, radians
103-110	i_0	Double	Sec 20.3.3.4
111-114	C_rc	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	$= (\text{sqrt\_A})^2$
139-146	n	Double	derived from delta_n
147-154	r1me2	Double	$= \text{sqrt}(1.0\text{-}e^2)$
155-162	OMEGA_n	Double	derived from OMEGA_0, OMEGADOT
163-170	ODOT_n	Double	derived from OMEGADOT

Note – All angles are in radians.

A.17.51 Report Packet 0x59 - Status of Satellite Disable or Ignore Health

Normally the GPS receiver selects only healthy satellites (based on transmitted values in the ephemeris and almanac) which 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 GPS receiver returns Packet 0x59 for operation modes 3 and 6 only. The data format is shown below.

Table A-58. Report Packet 0x59 Data Formats

Byte	Item	Type	Value	Definition
0	Operation	UINT8	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 to 32	Status	32 Bytes (1 byte per satellite)	0	Enable satellite selection or heed satellite's health. Default value.
			1	Disable satellite selection or ignore satellite's health

This information is not held in battery-backed memory. At power-on and after a reset, the default values are reset for all satellites.

A.17.52 Report Packet 0x5A - Raw Measurement Data

This packet provides raw GPS measurement data. If the I/O "auxiliary" option has been selected, the receiver sends this data automatically as measurements are taken. The data format is shown below.

Note – A new Report Packet, 0x6F, has full pseudo-ranges and integrated Doppler.

Table A-59. Report Packet 0x5A Data Formats

Byte	Item	Type	Units
0	Satellite PRN Number	UINT8s	-----
1	reserved		
5	Signal Level	Single	AMU or dBHz
9	Code phase	Single	1/16th chip
13	Doppler	Single	Hertz
17	Time of Measurement	Double	sec

Application Note – Packet 0x5A provides the raw satellite signal measurement information used in computing a fix.

Satellite PRN (Byte 0) is a unique identification number or each of the 32 GPS satellites.

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.

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.

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 user and satellite.

The receiver codephase is expressed in 1/16th of a C/A code chip, this corresponds to:

1/16 x C/A code chip	≈	977.517ns/16	≈	61.0948 ns
	≈	61.0948 x speed of light, m/s		
	≈	18.3158 meter		

The integer millisecond portion of the pseudo-range must then be derived by utilizing the approximate user and satellite positions. Rough user 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 x speed of light	=	1 ms x speed of light, m/s
	≈	300km (approx.)
	≈	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.

Note – The receiver occasionally adjusts its clock to maintain time accuracy within 1 msec. At this time, all pseudorange values for all satellites are adjusted upward or downward by one millisecond. Report packet 0x6F shows this clearly. Report packet 0x5A, check packet 0x83 or 0x84 for clock bias.

A.17.53 Report Packet 0x5B - Satellite Ephemeris Status

This packet is sent in response to packet 3B and when a new ephemeris (based on IODE) is received. In contains information on the status of the ephemeris in the receiver for a given satellite. The structure of packet 5B is as follows:

Table A-60. Report Packet 0x5B Data Formats

Byte	Item	Type	Units
0	SV PRN Number	UNIT8	
1-4	Time of Collection	single	seconds
5	Health	UNIT8	
6	IODE	UINT8	
7-10	toe	single	seconds
11	Fit Interval Flag	UINT8	
12-15	SV Accuracy (URA)	single	meters

A.17.54 Report Packet 0x5C - Satellite Tracking Status

This packet provides tracking status data for a specified satellite. Some of the information is very implementation-dependent and is provided mainly for diagnostic purposes. The receiver sends this packet in response to Packet 0x3C. The data format is shown in Table A-61.

Table A-61. Report Packet 0x5C Data Formats

Byte	Bit	Item	Type	Value	Definition
0		Satellite PRN number	UINT8	number 1 - 32	
1	0-2	reserved	Bits	reserved	
1	3-5	Channel	Bits	0-7	
1	6-7	reserved	Bits	reserved	
2		Acquisition flag	UINT8	0 1 2	Never acquired Acquired Re-opened search
3		Ephemeris flag	UINT8	0 1	Flag not set Good ephemeris for this satellite (<4 hours old, good health)
4-7		Signal level	Single	Same as in Packet 0x47	
8-11		GPS time of last measurement	Single	<0 >0	No measurements have been taken. Center of the last measurement taken from this satellite.
12-15		Elevation	Singles	radians	Approximate elevation of this satellite above the horizon. Updated about every 15 sec.s. Used for searching and computing measurement correction factors.
16-19		Azimuth	Single	radians	Approximate azimuth from true north to this satellite. Updated typically about every 3 to 5 minutes. Used for computing measurement correction factors.
20-23		reserved	UINT8	0	

A.17.55 Command Packet 0x60 -Type 1 Differential GPS Corrections

This packet provides the ACE II GPS with differential corrections from RTCM SC-104 record types 1 and 9, in the TSIP format. There is no response to this packet. If bit 6 is set, the corrections are as in RTCM Type 9 records. The format for this packet is shown in Table A-62:

Table A-62. Report Packet 0x60 Data Formats

Byte	Bit	Item	Type	Range	Units
0 - 1		Modified z-count	UINT16	0-5999	.6 SEC
2		Station health	UINT8	--	
3	0 - 5	Number of SVs in packet	Bits	0-31	0 - 5
3	6	Type 9 flag	Bit	0 1	type 1 type 9
3	7	Version 2 flag	Bit	1	must be set

The next 5 bytes are repeated as a group for each satellite. The SV PRN and scale factor contains the SV PRN in the lower 5 bits, and the scale factor in the upper 3 bits. Range corrections are scaled by 0.02 meters times 2 raised to the scale factor power. Range-rate corrections are scaled by 0.002 meters per second times 2 raised to the scale factor power. The format is shown in Table A-63.

Table A-63. Report Packet 0x60 Data Formats for Health and Power

Byte	Bit	Item	Type	Value	Definition
4+ (N*5)	0-4	SV PRN		0-31	"0" Is SV 32
4+ (N*5)	5-7	Scale factor		0 4 7	Low Scale factor (.02m,.002 m/s) High Scale factor (.32m, .032 m/s) Correction not usable
5+ (N*5)		Range correction	UINT16		RTCM-104
7+ (N*5)		Range-rate correction	UINT8		RTCM-104
8+ (N*5)		IODE	UINT8		

A.17.56 Command Packet 0x61 - Set Differential GPS Corrections

This TSIP packet provides the delta differential corrections from RTCM-104 record type 2. There is no response to this packet. Scale factors are version 1 unless the version 2 flag is set. The format for this packet is shown in Table A-64.

Table A-64. Command Packet 0x61 Data Formats

Byte	Bit	Item	Type	Value	Definition
0 - 1		Modified Z-count	UINT16	0-5999	.6 SEC
2	0-6	Number of SVs		0-31	
2	7	Version 2 flag	Bit	1	must be set
The next 3 bytes are repeated as a group for each satellite:					
3+(N*2)	0-4	SV PRN		0-31	"0" Is SV 32
3+(N*2)	5-7	Scale factor		0 4 7	Low Scale factor (.02m, .002 m/s) High Scale factor (.32m, .032 m/s) Correction not usable
4+(N*2)		Range correction	UINT16		RTCM-104

The units and scale factors are as defined by Packet 0x60. Delta range correction rates are not entered.

A.17.57 Command Packet 0x62 - Request/Set Differential Position Fix Mode

Note – This Command Packet has been replaced by Command Packet 0xBB. Although the ACE II GPS retains compatibility with this command, it is recommended that you use the 0xBB Command Packet to set the differential fix mode.

This packet requests the differential position fix mode of the GPS receiver. A single data byte is sent.

To request Report Packet 0x82, the data byte is set to 0xFF.

A.17.58 Command Packet 0x65 - Request Differential Correction Status

This packet requests the status of differential corrections for a specific satellite or for all satellites for which data is available. This packet contains only one byte specifying the PRN number of the desired satellite or zero to request all available. The response is a Packet 0x85 for each satellite if data is available. If the receiver has no valid data for any satellite, no reply will be sent.

A.17.59 Report Packet 0x6D - All-In-View Satellite Selection

This packet provides a list of satellites used for position fixes by the GPS 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). This packet has variable length equal to 16+nsvs where “nsvs” is the number of satellites used in the solution.

The GPS receiver sends this packet in response to Packet 0x24 when the receiver is doing an overdetermined fix. The data format is shown in Table A-65.

Table A-65. Report Packet 0x6D Data Formats

Byte	Bit	Item	Type	Value	Definition
0	0-2	Dimension	UINT8	3 4	2D 3D
0	3			0 1	Auto Manual
0	4-7			-	nsvs
1-4		PDOP	Single		PDOP
5-8		HDOP	Single		HDOP
9-12		VDOP	Single		VDOP
13-16		TDOP	Single		TDOP
(16+nsvs)		SV PRN	UINT8		

A.17.60 Command Packet 0x6E - Set or Request Synchronized Measurement Parameters

Packet 6E sets or requests the Synchronized Measurement parameters. The synchronized measurement reports are sent by the GPS receiver in Packet 0x6F.

Enable / Disable Synchronized Measurements

Controls whether synchronized measurements will be output at the output interval.

Note – Synchronized measurement outputs will only be available after the GPS receiver has made a position fix once the receiver is turned on or reset by Command Packet 0x25. This ensures that information within the synchronized measurement packet will be valid.

Output Level

The period of the synchronized measurement outputs is synchronized to the GPS time of week. For example, outputs occur when the GPS time of week equals (INT*N), where INT is the selected output interval and N is an integer.

Two forms of this packet are shown in Table A-66 and Table A-67. The response for both forms of this packet is Packet 0x6E, Synchronized Measurement Parameters.

Table A-66. Set Synchronized Measurement Parameters

Byte #	Item	Type	Value	Definition
0	Subcode	UINT8	1	DSM format
1	Enable Output	UINT8	0 1	Disable outputs Enable output
2	Output interval	UINT8	1-255	Output interval in seconds, synchronized to the GPS time of week

Table A-67. Request Synchronized Measurement Parameters

Byte #	Item	Type	Value	Definition
0	Subcode	UINT8	1	Synchronized measurement parameters

A.17.61 Report Packet 0x6E — Synchronized Measurements

Report Packet 0x6E reports the setting of synchronized measurement parameters. The values are shown in Table A-68. See Command Packet 0x6E for more information.

Table A-68. Set Synchronized Measurement Parameters

Byte #	Item	Type	Value	Definition
0	Subcode	UINT8	1	DSM Unfiltered pseudorange
			3	DSM filtered pseudorange
1	Enable Output	UINT8	0 1	Disable outputs Enable output
2	Output Interval	UINT8	1-255	Output interval in seconds, synchronized to the GPS time of week

A.17.62 Report Packet 0x6F, Subcode 1

Table A-69. Synchronized Measurements Report

Byte #	Item	Type	Value	Definition
0	Subcode	UINT8	1	DSM format
		Begin Preamble		
1	Preamble	UINT8	2	Begin preamble
2–3	Length	INT16		Number of bytes: preamble to postamble inclusive
4–11	Receive Time	Double	*msecs*	Time of GPS week
12–19	Clock Offset	Double	*msecs*	Receiver clock offset
20	# of SVs	UINT8		Number of satellites
		Begin Packet Data (bytes = number of SVs times 27 bytes per SV)		
21,48,...	SV PRN	UINT8	1–32	Pseudorandom number of satellite
22, 49,...	FLAGS1	UINT8	Table 0-2	Flag values show synchronized measurement status of satellite
23, 50,...	FLAGS2	UINT8	0	Reserved (set to zero)
24, 51,...	Elevation Angle	UINT8	*degrees*	Satellite elevation angle
25–26, 52–53,...	Azimuth	INT16	*degrees*	Satellite azimuth
27, 54,...	SNR	UINT8	*AMUs/4*	Number of AMUs times four
28–35, 55–62,...	Pseudorange	Double	*meters*	Full L1 C/A Pseudorange, filtered
36–43, 63–70,...	Carrier Phase	Double	*cycles*	L1 band Continuous Phase (truncated to integer value)
44–47, 71–74,...	Doppler	Single	*hertz*	L1 band Doppler
		End of the packet data		
21+27n 22+27n	Checksum	INT16	—	Sum of bytes before checksum starting with preamble
23+27n	Postamble	UINT8	3	

Note – The sign convention provides for a carrier-phase decrease when the pseudorange increases and the Doppler is negative.

Table A-70. FLAGS1 Bit Assignments

Bit	Item	Type	Value	Definition
0 (LSB)	Reserved (set to zero)	Bit		
1	L1 Carrier-phase Cycle Slip	Bit	0	No
			1	Yes
2	Reserved (set to zero)	Bit	0	Reserved
3	Reserved (set to zero)	Bit	0	Reserved
4	Valid L1 Carrier-phase: l	Bit	0	No
			1	Yes
5	Reserved (set to zero)	Bit	0	Reserved (set to zero)
6	Reserved (set to zero)	Bit	0	Reserved (set to zero)
7 (MSB)	New position calculated	Bit	0	No
			1	Yes

A.17.63 Command Packet 0x70 - Filter Control

Trimble OEM receivers have a number of filters. Command 0x70 provides control for these filters. It returns Report 0x70. There are three filters associated with 0x70:

- Position-Velocity (PV) Filter
- Static Filter
- Altitude Filter

The Position-Velocity (PV) Filter is the main filter and is used to “soften” the effect of constellation switches on position fixes. The filter has no effect on velocity output and there is no lag due to vehicle dynamics. There may be a small increase in accuracy however.

A feature of the PV filter is the “Static Filter” which engages when the receiver is moving very slowly. This feature improves accuracy in the urban environment. The static filter should be turned off for the following applications:

- Slow-moving environments such as walking or drifting with the current
- When rooftop testing of receivers for moving applications

The altitude filter is a simple averaging filter with a time constant of a few seconds. It should be left on in marine and land applications.

To query for the current settings, use Command Packet 0x70 with no databytes. To input new settings, Command Packet 0x70 is sent with four data bytes, as shown in Table A-71 Also see A.3 for information on saving the settings to non-volatile memory.

Table A-71 Command Packet 70 Data Formats

Byte	Item	Type	Value	Definition
0	Position Velocity Filter	UINT8	0 1	Off On
1	Static Filter	UINT8	0 1	Off On
2	Altitude Filter	UINT8	0 1	Off On
3	Reserved	UINT8	reserved	

A.17.64 Report Packet 0x70

This report is sent as a response to Command Packet 0x70 as either a query or a set. It contains four bytes, as shown in Table A-71.

A.17.65 Command Packet 0x71 - Set/Request/Disable Position Filter

Note – To simply turning filters on and off, use Command Packet 0x70.

This command sets position filter parameters, enables/disables the filter, and requests the position filter parameters. The receiver returns Report Packet 0x72. To request filter parameters, this command is sent with no data bytes.

This packet controls two filters: a dynamic filter used when the unit is in motion, and a static filter. To turn both filters off, set byte 0 to 0. The filters can also be turned off individually. To turn off the static filter only, set byte 25 to 255. To turn off the dynamic filter only, set the single value of byte 1 - 4 to 1.0. In both cases, leave byte 0 set to 1. To set the parameters or enable/disable the filter, the data string contains 26 bytes. The message format is shown below.

Table A-72 Command Packet 0x71 Data Formats

Byte	Type	Value
0	UINT8	0=disable 1=enable
1-4	Single	0.0625
5	UNIT8	1
6	UNIT8	1
7	UNIT8	0
8	UNIT8	6
9-12	Single	0.1
13-16	Single	100.0
17-20	Single	1.21
21-24	Single	1,000,000.0
25	UNIT8	2

Note – When the filter is being disabled, the parameters are reset as well. Consequently, when the filter is enabled, care should be taken to reset all parameters to their desired values. Documentation on the effect of the individual position filter parameters on position is currently not available.

A.17.66 Report Packet 0x72 - Position Filter Parameters

Byte	Type	Value
0-1	UINT8	0=disable 1=enable
2-5	Single	0.0625
6-7	INT16	1
8-9	INT16	1
10-11	INT16	0
12-13	INT16	6
14-17	Single	0.1
18-21	Single	100.0
22-25	Single	1.21
26-29	Single	1,000,000.0
30-31	INT16	2

A.17.67 Command Packet 0x73 - Set/Request/Disable Altitude Filter

Note – To simply turning filters on and off, use Command Packet 0x70.

This command sets or requests the averaging count of the altitude filter. The receiver returns Report Packet 0x74.

To request altitude filter parameters, the command is sent with no data bytes.

To set the altitude filter parameters or disable the filter, the data string format is listed below:

Table A-73. Command Packet 0x73 Report

Byte	Item	Type	Value	Definition
0 - 3	Altitude Filter Constant	Single	0	Resets value to default
			1	Disables filter
			>1	Sets value to input

The old altitude average is always discarded and the averaging process is re-started with this command.

The default value depends on the dynamics code set in packet 0x2C.

A.17.68 Report Packet 0x74 - Altitude Filter Parameters

This packet is in response to Command Packet 73 and provides the parameter used in the altitude filter. The data string has one single byte, equal to the number of fixes averaged in the altitude filter. If the values is -1, the altitude filter is currently disabled.

Table A-74 Report 0x74 Field Descriptions

Byte	Item	Type	Value	Definition
0 - 3	Altitude Filter Constant	Single	-1	Altitude filter off
			>1	Sets value to input

A.17.69 Command Packet 0x75

Not available in ACE II GPS.

A.17.70 Report Packet 0x76

Not available in the ACE II GPS.

A.17.71 Command Packet 0x77 - Set/Request Maximum Age of Differential Corrections

Note – This Command Packet has been replaced by Command Packet 0xBB. Although the ACE II GPS retains compatibility with this command, it is recommended that you use the 0xBB Command Packet.

This command sets the maximum age at which differential corrections will still be used by the receiver. The default is 30 seconds. For best accuracy, 20 seconds is preferred if it is supported by the differential link. The receiver returns packet 78.

A differential reference station will output corrections at a specified rate, normally between 1 per second and 1 per 30 seconds. The corrections contain a time tag so when they arrive at the receiver (via radio link or some other means) their age can be determined. This command allows the maximum usable age to be set. Older corrections tend to be less accurate therefore a trade-off will need to be made based on available bandwidth and correction age as well temporary signal blockages. For high accuracy implementations this number can be set as well as 2 times the reference station output frequency. This age limit applies to corrections received in RTCM format (all types), TSIP packets 0x60 and 0x61 as well as TAIP DC and DD messages. To request the current setting, the packet is sent with no data bytes. To set the maximum age, 2 data bytes are sent containing an integer.

Table A-75. Command Packet 0x77 Report

Byte	Item	Type	Value	Definition
0-1	Max Age of Differential Corrections	INT16	2-90	Maximum Age (seconds)

A.17.72 Report Packet 0x78 - Maximum Age of Differential Corrections

This packet contains a 2 byte integer representing the maximum age in seconds which the receiver will consider differential corrections to still be valid. The default is 60 seconds and can be changes with packet 0x77. See Table A-70.

A.17.73 Command Packet 0x7A

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. Use the values shown in Table A-76 to determine the NMEA interval and message mask. While fixes are being generated, the output order is: ZDA, GGA, GLL, VTG, GSA, GSV, RMC. Some firmware versions output GGA at 1 second intervals until fixes begin.

Table A-76 Command Packet 0x7A and Report Packet 0x7B Data Formats

Byte	Bit	Item	Type	Value	Definition
0		Subcode	UINT8	0	
1		Interval	UINT8	1-255	Fix interval in seconds
2		Reserved	UINT8	0	
3		Reserved	UINT8	0	
4	0	RMC	Bit	0 1	Off On
4	1-7	Reserved	Bit	0	
5	0	GGA	Bit	0 1	Off On
5	1	GLL	Bit	0 1	Off On
5	2	VTG	Bit	0 1	Off On
5	3	GSV	Bit	0 1	Off On
5	4	GSA	Bit	0 1	Off On
5	5	ZDA	Bit	0 1	Off On
5	6-7	Reserved	Bit	0	

A.17.74 Report Packet 0x7B

This packet provides the NMEA settings and interval. See Table A-76 for the data format.

A.17.75 Report Packet 0x82 - Differential Position Fix Mode

This packet provides the differential position fix mode of the receiver. This packet contains only one data byte to specify the mode. The packet is sent in response to Packet 0x62 and whenever a satellite selection is made and the mode is Auto GPS / DGPS (modes 2 and 3). The receiver switches automatically between modes 2 and 3 based on the availability of differential corrections for a constellation which meets all other masks. If such a constellation is not available, then the receiver stays in its current automatic mode (2 or 3), and does not do position solutions.

Valid modes are:

Mode 0 Manual GPS (Differential off) — The receiver does position solutions without differential corrections, even if the differential corrections are available.

Mode 1 Manual DGPS (Differential on) — The receiver only does position solutions if valid differential correction data are available.

Mode 2 Auto DGPS (Differential currently off) — The receiver is not receiving differential correction data for all satellites in constellation which meets all other masks, and is doing non-differential position solutions.

Mode 3 Auto DGPS (Differential currently on) — The receiver is receiving differential correction data for all satellites in a constellation which meets all other masks, and is doing differential position solutions.

A.17.76 Report Packet 0x83 - Double-Precision XYZ Position Fix and Bias Information

This packet provides current GPS 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 in Table A-77.

Table A-77. Report Packet 0x83 Data Formats

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

The time-of-fix is in GPS time or UTC, as selected by the I/O “timing” option.

Packet 42 provides a single-precision version of this information.

A.17.77 Report Packet 0x84 - Double-Precision LLA Position Fix and Bias Information

This packet provides current GPS position fix in LLA coordinates. If the I/O “position” option is set to “LLA” and the double position option is selected, the receiver sends this packet each time a fix is computed. The data format is shown in Table A-80.

Table A-78. Report Packet 0x84 Data Formats

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
32-35	time-of-fix	Single	seconds

The time-of-fix is in GPS time or UTC, 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 ICD-GPS-200 is 3.1415926535898.

A.17.78 Report Packet 0x85 - Differential Corrections Status

This packet provides the status of differential corrections for a specific satellite. It is sent in response to Packet 0x65. The format of this packet is shown in Table A-79.

Table A-79. Report Packet 0x85 Data Formats

Byte	Item	Type	Units	Values
0	Satellite PRN number	UINT8		
1	reserved	UINT8		0xFF
2	reserved	UINT8		0xFF
3	Satellite health (UDRE)	UINT8		
4	IODE 1	UINT8		
5	IODE 2	UINT8		
6	Z-count as Time-of-Week	Single	seconds	
10	Range correction	Single	meters	
14	Range-rate correction	Single	m/sec	
18	Delta range correction	Single	meters	

A.17.79 Packets 0x8E and 0x8F - Superpacket

Refer to Section A.19 for information on Packets 0x8E and 0x8F.

A.17.80 Command Packet 0xBB - Navigation Configuration

In query mode, Packet 0xBB is sent with a single data byte and returns Report Packet 0xBB.

Note – This Command Packet replaces packets 0x2C, 0x62, 0x75, and 0x77.

Table A-80. Command Packet 0xBB Query Mode Data Format

Byte #	Item	Type	Value	Definition	Default
0	Subcode	UINT8	0x00	Query mode	

TSIP Packet 0xBB is used to set GPS Processing options. The table below lists the individual fields within the 0xBB Packet. See Section A.3 for information on saving the settings to non-volatile memory.

Table A-81. Command and Report Packet 0xBB Field Descriptions

Byte #	Item	Type	Value	Definition	Default
0	Subcode	UINT8	0x00	Query mode	0x03
1	Operating Dimension	UINT8	0* 3 4	Automatic (2D/3D) Horizontal (2D) Full Position (3D)	Automatic
2	DGPS Mode	UINT8	0 1 2 or 3	DGPS off DGPS only DGPS auto	DGPS auto
3	Dynamics Code	UINT8	1 2 3 4	Land Sea Air Stationary	Land
4	reserved				
5-8	Elevation Mask	Single	0.0 - 1.57	Lowest satellite elevation for fixes	0.0873 (5)
9-12	AMU Mask	Single	0-25	Minimum signal level for fixes	2.0
13-16	DOP Mask	Single	0.2-100	Maximum DOP for fixes	12.0
17-20	DOP Switch	Single	0.2-100	Selects 2D/3D mode	5.0

Table A-81. Command and Report Packet 0xBB Field Descriptions

Byte #	Item	Type	Value	Definition	Default
21	DGPS Age Limit	UINT8	2-90	Maximum time to use a DGPS correction (seconds)	30
22-39	reserved				

A.17.81 Command Packet 0xBC - Protocol Configuration

TSIP Packet 0xBC is used to query the port characteristics. In query mode, Packet 0xBC is sent with a single data byte and returns Report Packet 0xBC. (See A.3 for information on saving the settings to non-volatile memory.)

Note – This Command Packet replaces packets 0x3D and 0x8E-03.

TSIP Packet 0xBC is used to set the communication parameters on Port 1 and Port 2. The table below lists the individual fields within the Packet 0xBC and provides query field descriptions.

Table A-82 Command Packet 0xBC Port Characteristics

Byte	Bit	Item	Type	Value	Definition
0		Port to Set	UINT8	0 1 0xFF	Port 1 Port 2 Current port
1		Input Baud Rate	UINT8	2 3 4 5 6 7 8 9	300 baud 600 baud 1200 baud 2400 baud 4800 baud 9600 baud 19200 baud 38400 baud
2		Output Baud Rate	UINT8	As above	As above
3		# Data Bits	UINT8	2 3	7 bits 8 bits
4		Parity	UINT8	0 1 2	None Odd Even
5		# Stop Bits	UINT8	0 1	1 bit 2 bits
6		Flow Control	UINT8	0	0 = none
7	0	TAIP input	Bit	0/1	off/on
	1	TSIP input	Bit	0/1	off/on

Byte	Bit	Item	Type	Value	Definition
	2	reserved	Bit	0/1	off/on
	3	RTCM input	Bit	0/1	off/on
	4-7	reserved	Bit	0/1	off/on
8	0	TAIP output	Bit	0/1	off/on
	1	TSIP output	Bit	0/1	off/on
	2	NMEA output	Bit	0/1	off/on
	3-7	reserved	UINT8	0	None
9		reserved	UINT8	0	None

Note 1. – To set port 1 configuration, use port 2; to set port 2 configuration, use port 1.

Note 2. – The BC command settings are retained in battery-backed RAM.

Caution – TSIP input or output must have 8 databits (byte 3).

Caution – At least one port must be either TSIP input or TAIP input at all times.

A.18 TSIP Superpackets

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

A.18.1 Command Packet 0x8E-03 - Set / Request Auxiliary Configuration

Note – This Command Packet has been replaced by Command Packet 0xBC. Although the ACE II GPS retains compatibility with this command, it is recommended that you use the 0xBC Command Packet.

This packet requests and optionally sets the AUX Port configuration. This configuration includes the baud rate, number of bits, parity, and number of stop bits and also the language mode. When this packet is used only to request the configuration the packet contains no data bytes. When this packet is used to set the configuration, the packet contains the 6 data bytes shown below.

A 0x8E-03 input packet, with or without data, is responded to with a 0x8F-03 output packet. The language mode is defined as follows. For reception, the language mode specifies whether packets or RTCM data are received on the AUX Port.

The default mode is RTCM for reception at 4800 baud with 8 data bits, no parity, and 1 stop bit. For NMEA transmission, the default mode is 4800 baud, 8 data bits, no parity and 1 stop bit. RTCM corrections are used only if the mode is set to Differential Auto or Manual DGPS (Differential On) with packet 0x62.

Table A-83. Command Packet 0x8E-03 Data Formats

Byte	Bit	Item	Type	Value	Definition
0		Subcode	UINT8	0x03	
1		Output Baud Rate	UINT8	4 5 6 8 9 11 28 12	300 baud 600 baud 1200 baud 2400 baud 4800 baud 9600 baud 19200 baud 38400 baud
2		Input Baud Rate	UINT8	As Above	As Above
3	0-1	Data bits code		2 3	7 data bits 8 data bits
3	2-4	Parity code		0 1 4	even parity odd parity no parity
4		Stop bits code	UINT8	7 15	1 stop bit 2 stop bits
5		Language mode for Transmission	UINT8	0 1 5	TSIP Off NMEA See Note 2.
6		Language mode for Reception	UINT8	0 1	TSIP RTCM SC-104 Note 3.

Note 1. – The default NMEA output is GGA and VTG at 1 second intervals.

Note 2. – Before the main port language for reception can be set to RTCM SC-104, the auxiliary port language for reception must be set to TSIP (using command 0x8E-03). Only one port may be set to receive RTCM at a time, not both.

This information is held in battery-backed memory. After loss of battery-backed memory, the default values are set.

A.18.2 Report Packet 0x8F-03 - Request Auxiliary Port Configuration

See Table A-85 for a description of this packet.

A.18.3 Command Packet 0x8E-15 - Set/Request Datum

This packet allows the user to change the default datum from WGS-84 to one of 180 selected datums or a user-entered custom datum. The datum is a set of 5 parameters which describe an ellipsoid to convert the GPS receiver's internal coordinate system of XYZ ECEF into Latitude, Longitude and Altitude (LLA). This will affect all calculations of LLA in packets 0x4A and 0x84.

The user may wish to change the datum to match coordinates with some other system (usually a map). Most maps are marked with the datum used and in the US the most popular datum for maps is NAD-27. The user may also wish to use a datum which is more optimized for the local shape of the earth in that area. However, these optimized datum are truly “local” and will provide very different results when used outside of the area for which they were intended. WGS-84 is an excellent general ellipsoid valid around the world. See A.3 for information on saving the settings to non-volatile memory.

To request the current datum setting, one data byte is sent. Report Packet 0x8F-15 is returned.

Table A-84. Command Packet 0x8E-15 Field Descriptions

Byte	Type	Value
0	Superpacket ID	0 x 15

To change to one of the internally held datums, the packet must contain exactly 2 bytes representing the integer value of the index of the datum desired:

Table A-85. Command Packet 0x8E-15 Datum Index Field Descriptions

Byte	Type	Value
0	Superpacket ID	0 x 15
1-2	INT16	Datum index

Note 1. – To request the current datum, send Packet 8E-15 with no data bytes.

Note 2. – v7.80 does not support custom datums.

Note – Eccentricity Squared is related to flattening by the following equation:

$e^2=2\rho-\rho^2$

A.18.4 Report Packet 0x8F-15 - Current Datum Values

This packet contains 43 data bytes with the values for the datum currently in use and is sent in response to Packet 0x8E 15. Both the datum index and the 5 double precision values for that index will be returned.

Table A-86. Report Packet 0x8F-15 Data Formats

Byte	Type	Value
0	UINT8	Id for this sub-packet (always x15)
1-2	INT16	Datum Index
3-10	Double	DX
11-18	Double	DY
19-26	Double	DZ
27-34	Double	A-axis
35-42	Double	Eccentricity Squared

Note – A complete list of datums is provided at the end of this appendix. Eccentricity Squared is related to flattening by the following equation:

$e^2=2\rho-\rho^2$

A.18.5 Report Packet 0x8F-17 - UTM Single Precision Output

This packet reports position in UTM (Universal Transverse Mercator) format. The UTM coordinate system is typically used for U.S. and international topographical maps.

The UTM coordinate system lays out a world-wide grid consisting of the following:

- 60 North/South zones in 6° increments extending eastward from the International Date Line
- 10 East/West zones divided in 8° increments extending above and below the Equator.

Coordinates within these boundaries cover all surface locations from 80° South to 84° North and encircle the earth. Locations are indicated by offset from the equator and in the zones east of the International Date Line. These offsets are known as Northing and Easting and are expressed in meters. UTM is not usable in polar regions.

Table A-87. Report Packet 0x8F-17 Data Formats

Byte	Item	Type	Value
0	Subcode		0x17
1	Gridzone Designation	Char	
2-3	Gridzone	INT16	
4-7	Northing	Single	Meters
8-11	Easting	Single	Meters
12-15	Altitude	Single	Meters
16-19	Clock Bias	Single	Meters
20-23	Time of Fix	Single	Seconds

A.18.6 Report Packet 0x8F-18 - UTM Double Precision Output

This packet reports position in UTM (Universal Transverse Mercator) format. The UTM coordinate system is typically used for U.S. and international topographical maps.

The UTM coordinate system lays out a world-wide grid consisting of the following:

- 60 North/South zones in 6° increments extending eastward from the International Date Line
- 10 East/West zones divided in 8° increments extending above and below the Equator.

Coordinates within these boundaries cover all surface locations from 80° South to 84° North and encircle the earth. Locations are indicated by offset from the equator and in the zones east of the International Date Line. These offsets are known as Northing and Easting and are expressed in meters. UTM is not usable in polar regions.

Table A-88. Report Packet 0x8F-18 Field Descriptions

Byte	Description	Type	Value
0	Subcode		0x18
1	Gridzone Designation	Char	
2-3	Gridzone	INT16	
4-11	Northing	Double	Meters
12-19	Easting	Double	Meters
20-27	Altitude	Double	Meters
28-35	Clock Bias	Double	Meters
36-39	Time of Fix	Single	Seconds

A.18.7 Command Packet 0x8E-19 - Enable / Disable UTM Output

This packet allows the user to enable or disable the position report, in UTM format. The UTM (Universal Transverse Mercator) coordinate system is typically used for U.S. and international topographical maps. It is a world -wide grid consisting of 60: 6(N/S zones extending eastward from the international Date Line, and 10:8 (E/W bands above and below the equator). This covers the surface location from 80 south to 84 north. Locations are indicated by offset of the equator and in the zones east of the International Date Line. These offsets are known as northing and easting and are express in meters. UTM is not usable in polar regions.

This packet allows the user to enable or disable the position report in UTM (Universal Transverse Mercator) format. If bit 4, byte 0 of Command Packet 0x35 is set to double precision, the 0x8F-18 packets will be enabled. If the bit set to single precision, the 0x8F-17 packets will be enabled.

Table A-89. Command Packet 0x8E-19 Field Description

Byte	Description	Type	Value
0	Subcode		0/19
1	UTM Status	Char	'E' = Enable, 'D' = Disable

A.18.8 Report Packet 0x8F-19 UTM Status

This packet reports whether the 0x8F-17 and 0x8F-18 packets are enabled.

Table A-90. Command Packet 0x8F-19 Field Descriptions

Byte	Item	Type	Value
0	Subcode		0x19
1	UTM Status	Char	E = Enable D = Disable

A.18.9 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, an 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 as shown in Table A-91. 0x37 can also be used for requesting 0x8F-20 if the 0x8F-20 is scheduled for auto output.

Table A-91. Command Packet 0x8E-20 Field Descriptions

Byte	Item	Type	Definition
0	Sub-packet id	UINT8	Id for this sub-packet (always 0x20)
1	Mark for Auto-report (See packet 35 byte 0 bit 5)	UINT8	0 = do not auto-report 1 = mark for auto-report

Note – Auto-report requires that superpacket output is enabled. Refer to Command Packet 35.

A.18.10 Report Packet 0x8F-20 - Last Fix with Extra Information (binary fixed point)

This packet provides complete information about the current position velocity fix in a compact, fixed-length 56-byte packet. The fields are fixed-point with precision matched to the receiver accuracy. It can be used for automatic position/velocity reports. The latest fix can also be requested by 0x8E-20 or 0x37 commands.The data format is shown in Table A-95:

Table A-92. Report Packet 0x8F-20 Data Formats

Byte	Bit	Item	Type	Value	Definition
0		Sub-packet id	UINT8		Id for this sub-packet (always 0x20)
1		KeyByte	UINT8		Reserved for Trimble DGPS Post-processing.
2-3		east velocity	INT16		0.005 m/s or 0.020 m/s See Note 1.
4-5		north velocity	INT16		0.005 m/s or 0.020 m/s See Note 1.
6-7		up velocity	INT16		0.005 m/s or 0.020 m/s See Note 1.
8-11		Time Of Week	UINT32		GPS Time in milliseconds
12-15		Latitude	INT32	-2^{30} to 2^{30}	WGS-84 latitude, 2^{-31} semicircle (-90° - 90°)
16-19		Longitude	UINT32	0 to 2^{32}	WGS-84 latitude, 2^{-31} semicircle (0° - 360°)
20-23		Altitude	UINT32		Altitude above WGS-84 ellipsoid, mm.
24	0	Velocity Scaling		0 1	0.005 m/s^2 0.020 m/s^2
	1-7	reserved			
25		reserved			
26		Datum			Datum index + 1 0=unknown
27	0	Fix Available	Bit	0 1	Yes No
	1	DGPS Corrected	Bit	0 1	No Yes
	2	Fix Dimension	Bit	0 1	3D 2D
	3	Alt Hold	Bit	0 1	Last 3D Altitude User-entered altitude
	4	Filtered	Bit	0 1	Unfiltered Filtered
	5-7	reserved			

Table A-92. Report Packet 0x8F-20 Data Formats (Continued)

Byte	Bit	Item	Type	Value	Definition
28		NumSVs	UINT8		Number of satellites used for fix. Will be zero if no fix was available.
29		UTC Offset	UINT8		Number of leap seconds between UTC time and GPS time.
30-31		Week	INT16		GPS time of fix, weeks.
32	0-5	PRN 1	UINT8	1-32	PRN of first satellite
	6-7	reserved			
33		IODE 1	UINT8		IODE of first satellite
34	0-5	PRN 2	UINT8	1-32	PRN of second satellite
	6-7	reserved			
35		IODE 2	UINT8		IODE of second satellite
36	0-5	PRN 3	UINT8	1-32	PRN of third satellite
	6-7	reserved			
37		IODE 3	UINT8		IODE of third satellite
38	0-5	PRN 4	UINT8	1-32	PRN of fourth satellite
	6-7	reserved			
39		IODE 4	UINT8		IODE of fourth satellite
40	0-5	PRN 5	UINT8	1-32	PRN of fifth satellite
	6-7	reserved			
41		IODE 5	UINT8		IODE of fifth satellite
42	0-5	PRN 6	UINT8	1-32	PRN of sixth satellite
	6-7	reserved			
43		IODE 6	UINT8		IODE of sixth satellite
44	0-5	PRN 7	UINT8	1-32	PRN of seventh satellite
	6-7	reserved			
45		IODE 7	UINT8		IODE of seventh satellite
46	0-5	PRN 8	UINT8	1-32	PRN of eighth satellite
	6-7	reserved			
47		IODE 8	UINT8		IODE of eighth satellite
48-55		Ionospheric Parameters			

Note 1. – Velocity scale controlled by byte 24, bit 1. Overflow = 0x8000.

Note 2. – See Section A-20, ***Datums*** for datum index tables.

A.18.11 Command Packet 0x8E-26 - SEEPROM Storage

The 0x8E-26 command is issued with no data to cause the current settings to be saved to non-volatile memory. See A.3 for information on saving the settings to non-volatile memory. The 0x8F-26 report is generated after the values have been saved.

Table A-93. Command Packet 0x8E-26 Definitions

Byte #	Item	Type	Value	Definition
0	Subcode	UINT8	0x26	Save Settings

A.18.12 Report Packet 0x8F-26 - SEEPROM Storage Status

This report will be issued after an 0x8E-26 command.

Table A-94. Report Packet 0x8F-26 Field Descriptions

Byte/	Item	Type	Value	Definition
0	Subcode	UINT8	0x26	Save Settings
1-4	reserved			

A.18.13 Command Packet 0x8E-40 - TAIP Configuration

The 0x8E-40 command can be issued with no data to request the current mask and internal settings. The 0x8F-40 report is sent in response to this command.

Table A-95. TAIP Configuration Request

Byte	Item	Type	Value	Definition
0	Subcode	UINT8	40	Request TAIP Configuration

The 0x8E-40 command can be issued with 5 data bytes to set the TAIP configuration.

Table A-96. TAIP Configuration Command Report Data Formats

Byte	Bit	Item	Type	Value	Definition		Default
0		Subcode	UINT8	0x40	Set TAIP config		0x40
1					TAIP sentence flags		0x0E
	0	ID Flag	Bit	0 1	off on		0=off
	1	CS Flag	Bit	0 1	off on		1=on
	2	EC Flag	Bit	0 1	off on		1=on
	3	FR Flag	Bit	0 1	off on		1=on
	4	CR Flag	Bit	0 1	off on		0=off
	5-7	reserved					
2		TAIP Auto Output Heartbeat Sentence	UINT8	0 2 6 8 11 14 15 16	AL CP ID LN PV ST TM VR		11 PV
3-4		Toh Offset	INT16	0-3599	Top of hour offset		0
5-6		HB rate	UINT16	0-3599	Auto output interval (sec)		5
7-10		Veh ID	String	"See TAIP ID"	Vehicle ID		"0000"

A.18.14 Report Packet 0x8F-40 - TAIP Configuration

The 8F:40 will be issued as a response to any valid 8E:40 command. See Table A-96 for report format and definitions.

A.19 Datums

Reference: DMA TR 8350.2 Second Edition, 1 Sept. 1991. DMA Technical Report, Department of Defense World Geodetic System 1984, Definition and Relationships with Local Geodetic Systems.

Continent:

Table 1: International Datums

Trimble Datum	**Local Geodetic Datum**	
Index	Name	Code
0	**WGS-84**	
6	**WGS-72**	
7	**NAD-83**	
8	**NAD-02**	
9	**Mexican**	
10	**Hawaii**	
11	**Astronomic**	
12	**U.S. Navy**	

Table 2: Africa

Trimble Datum	**Local Geodetic Datum**	
Index	Name	Code
15	**Adindan** Mean Solution (Ethiopia and Sudan)	ADI-M
16	**Adindan** Ethiopia	ADI-A
17	**Adindan** Mali	ADI-C
18	**Adindan** Senegal	ADI-D
19	**Adindan** Sudan	ADI-B
20	**Afgooye** Somalia	AFG
23	**ARC 1950** Mean Solution	ARF-M
24	**ARC 1950** Botswana	ARF-A
25	**ARC 1950** Lesotho	ARF-B
26	**ARC 1950** Malawi	ARF-C
27	**ARC 1950** Swaziland	ARF-D
28	**ARC 1950** Zaire	ARF-E
29	**ARC 1950** Zambia	ARF-F
30	**ARC 1950** Zimbabwe	ARF-G
31	**ARC 1960** Mean Solution	ARS
32	**ARC 1960** Kenya	ARS

Trimble Datum	Local Geodetic Datum	
33	**ARC 1960** Tanzania	ARS
45	**Cape** South Africa	CAP
47	**Carthage** Tunisia	CGE
82	**Liberia 1964** Liberia	LIB
87	**Massawa** Eritrea (Ethiopia)	MAS
88	**Merchich** Morocco	MER
90	**Minna** Nigeria	MIN-B
94	**Schwarzeck** Namibia	SCK
118	**Old Egyptian 1907** Egypt	OEG

Table 3: Asia

Trimble Datum	Local Geodetic Datum	
1	**Tokyo**	
21	**Ain El Abd 1970** Bahrain Island	AIN-A
51	**Djakarta (Batavia)** Sumatra (Indonesia)	BAT
71	**Hong Kong 1963** Hong Kong	HKD
72	**Indian 1975** Thailand	INH -A
73	**Indian** India and Nepal	IND-I
77	**Kandawala** Sri Lanka	KAN
79	**Kertau 1948** West Malaysia and Singapore	KEA
91	**Nahrwan** Masirah Island (Oman)	NAH-A
92	**Nahrwan** United Arab Emirates	NAH-B
93	**Nahrwan** Saudi Arabia	NAH-C
124	**Oman** Oman	FAH
143	**Quatar National** Qatar	QAT
161	**South Asia** Singapore	SOA
164	**Timbalai 1948** Brunei and East Malaysia (Sarawak and Sabah)	TIL
165	**Tokyo** Mean Solution (Japan, Okinawa and South Korea)	TOY-M
166	**Tokyo** South Korea	TOY-B
167	**Tokyo** Okinawa	TOY-C
176	**Hu-Tzu-Shan** Taiwan	HTN
179	**Tokyo GIS Coordinates**	TOY-B

Table 4: Australia

Trimble Datum	Local Geodetic Datum	
5	**Australian Geodetic 1966** Australia and Tasmania	AUA
14	**Australian Geodetic 1984** Australia and Tasmania	AUG
39	**Australian Geodetic 1966** Australia and Tasmania	AUA

Table 5: Europe

Trimble Datum	Local Geodetic Datum	
4	**European 1950** Mean Solution	EUR-M
13	**European 1950** Mean Solution	EUR-M
54	**European 1950** Mean Solution	EUR-M
55	**European 1950** Cyprus	EUR-E
56	**European 1950** Egypt	EUR-F
57	**European 1950** England, Ireland, Scotland, Shetland Islands	EUR-G
58	**European 1950** England, Ireland, Scotland, Shetland Islands	EUR-K
59	**European 1950** Greece	EUR-B
60	**European 1950** Iran	EUR-H
61	**European 1950** Sardinia	EUR-I
62	**European 1950** Sicily	EUR-J
63	**European 1950** Norway and Finland	EUR-C
64	**European 1950** Portugal and Spain	EUR-D
65	**European 1979** Mean Solution	EUS
74	**Ireland 1965** Ireland	IRL
125	**Ordnance Survey of Great Britain** Mean Solution	OGB-M
126	**Ordnance Survey of Great Britain** England	OGB-M
127	**Ordnance Survey of Great Britain** Isle of Man	OGB-M
128	**Ordnance Survey of Great Britain** Scotland and Shetland Islands	OGB-M
129	**Ordnance Survey of Great Britain** Wales	OGB-M
145	**Rome 1940** Sardinia	MOD

Table 6: North America

Trimble Datum	Local Geodetic Datum	
0	**WGS-84**	
2	**North American 1927** Mean Solution (CONUS)	NAS-C

Table 6: North America

Trimble Datum	Local Geodetic Datum	
3	**Alaska Canada**	
46	**Cape Canaveral** Mean Solution (Florida and Bahamas)	CAC
96	**NAD 27** Western United States	NAS-B
97	**NAD 27** Eastern United States	NAS-A
98	**NAD 27** Alaska	NAS-D
99	**NAD 27** Bahamas	NAS-Q
100	**NAD 27** San Salvador	NAS-R
101	**NAD 27** Canada	NAS-E
102	**NAD 27** Alberta BC	NAS-F
103	**NAD 27** East Canada	NAS-G
104	**NAD 27** Manitoba Ontario	NAS-H
105	**NAD 27** Northwest Territories Saskatchewan	NAS-I
106	**NAD 27** Yukon	NAS-J
107	**NAD 27** Canal Zone	NAS-O
108	**NAD 27** Caribbean	NAS-P
109	**NAD 27** Central America	NAS-N
110	**NAD 27** Cuba	NAS-T
111	**NAD 27** Greenland	NAS-U
112	**NAD 27** Mexico	NAS-V
113	**NAD 83** Alaska	NAR-A
114	**NAD 83** Canada	NAR-B
115	**NAD 83** CONUS	NAR-C
116	**NAD 83** Mexico and Central America	NAR-D

Table 7: South America

Trimble Datum	Local Geodetic Datum	
42	**Bogota Observatory** Columbia	BOO
43	**Compo Inchauspe 1969** Argentina	CAI
49	**Chua Astro** Paraguay	CHU
50	**Corrego Alegre** Brazil	COA
132	**Provisional South Chilean 1963** Southern Chile (near 53ºS)	HIT
133	**Provisional South American 1956** Mean Solution (Bolivia, Chile, Columbia, Ecuador, Guyana, Peru, Venezuela)	PRP-M
134	**Provisional South American 1956** Bolivia, Chile	PRP-A
135	**Provisional South American 1956** Northern Chile (near 19ºS)	PRP-B

Table 7: South America

Trimble Datum	Local Geodetic Datum	
136	**Provisional South American 1956** Southern Chile (near 43ºS)	PRP-C
137	**Provisional South American 1956** Columbia	PRP-D
138	**Provisional South American 1956** Ecuador	PRP-E
139	**Provisional South American 1956** Guyana	PRP-F
140	**Provisional South American 1956** Peru	PRP-G
141	**Provisional South American 1956** Venezuela	PRP-H
149	**South American 1969** Mean Solution (Argentina, Bolivia, Brazil, Chile, Columbia, Ecuador, Guyana, Paraguay, Peru, Trinidad Tobago, Venezuela)	SAN-M
150	**South American 1969** Argentina	SAN-A
151	**South American 1969** Bolivia	SAN-B
152	**South American 1969** Brazil	SAN-C
153	**South American 1969** Chile	SAN-D
154	**South American 1969** Columbia,	SAN-E
155	**South American 1969** Ecuador (Excluding Galapagos Islands)	SAN-F
156	**South American 1969** Guyana	SAN-G
157	**South American 1969** Paraguay	SAN-H
158	**South American 1969** Peru	SAN-I
159	**South American 1969** Trinidad and Tobago	SAN-K
160	**South American 1969** Venezuela	SAN-L
171	**Zanderij** Surinam	ZAN

Table 8: Atlantic Ocean

Trimble Datum	Local Geodetic Datum	
34	**Ascension Island 1958** Ascension Island	ASC
37	**Astro Dos 71 /4** St. Helena Island	SHB
41	**Bermuda 1957** Bermuda Islands	BER
70	**Hjorsey 1955** Iceland	HJO
81	**L.C.5 Astro 1961** Cayman Brac Island	LCF
86	**Selvagem Grande 1938** Salvage Islands	SGM
95	**Naparima, BWI** Trinidad and Tobago	NAP
117	**Observatorio Meteorologico 1939** Corvo and Flores Islands (Azores)	FLO
130	**Pico De Las Nieves** Canary Islands	PLN
142	**Puerto Rico** Puerto Rico and Virgin Islands	PUR
144	**Qornoq** South Greenland	QUO

Table 8: Atlantic Ocean

Trimble Datum	Local Geodetic Datum	
146	**Santa Braz** Sao Miguel, Santa Maria Islands (Azores)	SAO
148	**Sapper Hill 1943** East Falkland Islands	SAP
162	**Porto Santo 1936** Porto Santo and Madera Islands	POS
163	**Graciosa Base Southwest 1948** Faial, Graciosa, Pico, San Jorg, and Terceira Islands (Azores)	GRA
168	**Tristan Astro 1968** Tristan Da Cunha	TDC

Table 9: Indian Ocean

Trimble Datum	Local Geodetic Datum	
22	**Anna 1 Astro 1965** Cocos Islands	ANO
66	**Gan 1970** Republic of Maldives	GAA
75	**ISTS 073 Astro 1969** Diego Garcia	IST
78	**Kerguelen Island 1949** Kerguelen Island	KEG
80	**Reunion** Mascarene Island	REU
85	**Mahe 1971** Mahe Island	MIK

Table 10: Pacific Ocean

Trimble Datum	Local Geodetic Datum	
35	**Astro Beacon E 1945** Iwo Jima	ATF
36	**Astro Tern Island (FRIG) 1961** Tern Island	TRN
38	**Astronomical Station 1952** Marcus Island	TRN
40	**Bellevue (IGN)** Efate Erromango Island	IBE
44	**Canton Astro1966** Phoenix Island	CAO
48	**Chatham Island Astro 1971** Chatham Island (New Zealand)	CHI
52	**Dos 1968** Gizo Island (New Georgia Islands)	GIZ
53	**Easter Island 1967** Easter Island	EAS
67	**Geodetic Datum 1948** New Zealand	GEO
68	**Guam 1963** Guam	GUA
69	**Gux 1 Astro** Guadalcanal Islands	DOB
76	**Johnstone Island 1961** Johnstone Island	JOH
83	**Luzon** Philippines	LUZ-A
84	**Luzon** Mindanao Island	LUZ-B
89	**Midway Astro 1961** Midway Islands	MID
119	**Old Hawaiian** Mean Solution	OHA-M

Table 10: Pacific Ocean

Trimble Datum	Local Geodetic Datum	
120	**Old Hawaiian** Hawaii	OHA-A
121	**Old Hawaiian** Kauai	OHA-B
122	**Old Hawaiian** Maui	OHA-C
123	**Old Hawaiian** Oahu	OHA-D
131	**Pitcairn Astro 1967**Pitcairn Island	PIT
147	**Santo (DOS) 1952** Espirito Santo Island	SAE
169	**Viti Levu 1916** Viti Levu Island (Fiji Islands)	MVS
170	**Wake Eniwetok 1960** Marshall Islands	ENW

Table 11: Non-Satellite Derived Datums

Trimble Datum	Local Geodetic Datum	
172	**Bukit Rimpah** Bangka and Belitung Islands (Indonesia)	BUR
173	**Camp Area Astro** Camp McMurdo Area, Antarctica	CAZ
174	**Gunung Segara** Kalimantan (Indonesia)	GSE
175	**Herat North** Afghanistan	HEN