INTERFACE CONTROL DOCUMENT

Trimble OEM BD9xx
GNSS Receiver Family

Version 4.80
Revision A
May 2013

Trimble

Corporate Office

Trimble Navigation Limited
Integrated Technologies
510 DeGuigne Drive
Sunnyvale, CA 94085
USA
+1-408-481-8070 Phone
+1-408-481-8984 Fax
www.trimble.com/gnss-inertial
Email: GNSSOEMSupport@trimble.com

Release Notice

This is the May 2013 release (Revision A) of the Trimble OEM BD9xx GNSS Receiver Family Interface Control Document. It applies to version 4.80 of the receiver firmware.

For all of the relevant legal notices for the OEM BD9xx receiver family, refer to the Legal Notices at the front of the user guide for your receiver.

Contents

1

Introduction to the BD9xx interface protocol

This section provides the interface control specifications for communicating and configuring all Trimble BD-9xx and BX-9xx products using the Trimble proprietary interface control protocol.

The interface protocol is designed to be back and forward compatible with legacy and future generations of Trimble receiver modules.

The following topics describe the RS-232 serial specification, which can also be used with other communication protocols such as USB and Ethernet.

Note – *The position output by the receiver is the Antenna Phase Center position. You may want to reduce this position to a reference position elsewhere. If so, you should account for any tilt of the antenna in such a reduction. The settings for the Antenna Measurement Method and Antenna Height are not applied to the position outputs.*

Further information

To view the receiver module WebHelp, go to www.trimble.com/OEM_ReceiverHelp/Vx.xx/en/, where x.xx is the version number of the firmware installed on the receiver module.

For additional product information, including datasheets, brochures, and hardware and software integration documents, go to www.trimble.com/gnss-inertial.

If you cannot find the information you need in the product documentation, contact Trimble GNSS OEM Support at GNSSOEMSupport@trimble.com.

Technical support

If you have a problem and cannot find the information you need in the product documentation, send an email to GNSSOEMSupport@trimble.com.

Documentation, firmware, and software updates are available at: www.trimble.com/gnss-inertial/GNSS-Positioning-and-Heading-Systems.aspx.

2

RS-232 Serial Interface Specification

In this chapter:

This chapter describes the RS-232 Serial Interface Specification that enables a remote computing device to communicate with a BD9xx receiver over an RS-232 connection.

RS-232 serial interface specification

The RS-232 serial interface specification enables a remote computing device to communicate with a BD9xx receiver over an RS-232 connection, using data collector format packets. The RS-232 serial interface specification provides command packets for configuring the BD9xx receiver for operation, and report packets for retrieving position and status information from the receiver.

Data Collector Format packets are similar to the data collector format packets which evolved with the Trimble legacy receivers. The set of data collector format command and report packets implemented on the receiver are simplified with a more flexible method for scheduling the output of data. For a detailed explanation of the streamed data output format, refer to the “Output Messages” section of the *BD9xx GNSS Receivers WebHelp*.

The receiver can be configured using application files or single commands. Application files include fields for setting all receiver parameters and functions, and can be useful if multiple settings need to be changed or saved for a particular receiver application. The default application file for the receiver includes the factory default values. Multiple application files can be transferred to the receiver for selection with command packets. Application files for specific applications can be developed on one receiver and downloaded to a computer for transfer to other BD9xx receivers. For information about the structure of application files, see Response 64h, APPFILE (Application file record report), page 92.

Communications format

Supported data rates are: 2400, 4800, 9600, 19200, 38400, and 57600 baud and 115 kbaud. Any of these data rates can be used, however only 4800 baud or higher should be used. ***For example, a 20 Hz GGK string output requires the baud rate to be set to at least 19200.*** Only an 8-bit word format is supported, with Odd, Even, or No parity, and 1 stop bit. The default communications format for the receiver is 38400 baud, 8 data bits, no parity, and 1 stop bit.

Changes to the serial format parameter settings for all serial ports are stored in EEPROM (Electrically-Erasable Read-Only Memory) and remain in effect across power cycles until you change the parameter settings.

Testing the communications link

To determine whether the receiver can accept RS-232 commands, the protocol request ENQ (05h) is used. The response is either ACK (06h) or NAK (15h).

ENQ/ACK/NAK correspond to “Are you ready?”, “I am ready”, and “I am not ready”. This quick 1-byte test can be sent by the remote device before any other command to make sure that the RS-232 line is clear and operational. A NAK response can be expected due to an error, the requested command is not supported or else the command being sent has a syntax error.

Communications errors

The receiver normally responds to a RS-232 serial interface specification command packet within 500 milliseconds. If the receiver does not respond to the request or command, the external device can send numerous \0 characters (250) to cancel any partially received message before resending the previous message.

3

Data Collector Format Packets

In this chapter:

This chapter documents the Data Collector Format packets that are used to configure the receiver settings and outputs.

Data collector format packets

Command packets are sent from the remote device to the BD9xx receiver when requesting data, sending commands, or when managing application files. The BD9xx receiver acknowledges every command packet sent by the remote device. It does this by sending an associated report packet or by acknowledging the transaction with an ACK (06h) or NAK (15h) from the receiver.

Note – *The return of a NAK sometimes means that the receiver cannot fulfil the request. That is, the requested command is not supported.*

Data Collector Format command packets are sent from the remote device to the receiver to execute receiver commands or to request data reports.

Data Collector Format report packets are usually sent in response to a command packet. Report packets are generated immediately after the request is received. The receiver always responds to requests for reports, even in cases where a report cannot be transmitted for some reason or the transmission of a report is not necessary. In these cases, the receiver sends an ACK or NAK to acknowledge the request.

The receiver acknowledges all command packets. It does this by sending a corresponding report packet or by acknowledging the completion of an action.

Packets are processed by the receiver on a first-in, first-out (FIFO) basis. External devices can send multiple packets without waiting for a response from each packet. The external device is responsible for matching expected responses with the actual response sent by the receiver.

Each message begins with a 4-byte header, followed by the bytes of data in the packet, and the packet ends with a 2-byte trailer. Byte 3 is set to 0 (00h) when the packet contains no data. Most data is transmitted between the receiver and remote device in binary format.

Packet structure

Every command and report packet, regardless of its source and except for protocol sequences, has the same format as shown in the following table.

Byte #	Message	Description
Begin packet header		
0	STX (02h)	Start transmission
1	STATUS	Receiver status code
2	PACKET TYPE	Hexadecimal code assigned to the packet
3	LENGTH	Single byte # of data bytes, limits data to 255 bytes
Begin packet data		
4 to length	DATA BYTES	Data bytes
Begin packet trailer		
Length + 4	CHECKSUM	Sum bytes (status + type + length + data bytes) and modulo 256 the summation
Length + 5	ETX (03h)	End transmission

Receiver status byte

The status byte contains indicators regarding the receiver's operational status. When sending a packet to the receiver this byte should be left as 00h, since the receiver does not interpret the incoming status byte. When receiving a packet from the receiver the status byte may be decoded to determine the receiver's operational status. The following table lists the status byte codes.

Bit	Notes
Bit 0	Reserved
Bit 1	If set, low battery at the base station
Bit 2	Reserved
Bit 3	If set, receiver's kinematic state is currently set to 'Roving', otherwise 'static'
Bit 4–7	Reserved

Data collector format packet functions

The functions of data collector format command and report packets can be divided into the following categories:

- Information requests (command packets) and replies (report packets)
- Control functions (command packets) and RS-232 acknowledgments (ACK or NAK)
- Application file management

Requests for information, such as the Command Packet 4Ah (GETOPT), can be sent at any time. The expected reply (Report Packet 4Bh, RETOPT) is always sent. Some control functions may result in an RS-232 acknowledgment of NAK (15h) if one of the following conditions exists:

- The request is not supported (invalid) by the receiver (for example, a required option may not be installed on the receiver).
- The receiver cannot process the request.

4

Trimble Binary Format

In this chapter:

This chapter documents the Trimble binary format.

Reading binary values

The receiver stores numbers in Motorola format. The byte order of these numbers is the opposite of what personal computers expect (Intel format). To supply or interpret binary numbers (8-byte DOUBLES, 4-byte LONGS, and 2-byte INTEGERS), the byte order of these values must be reversed. A detailed description of the Motorola format used to store numbers in the receiver is provided in the following sections.

Integer data types

The INTEGER data types (CHAR, SHORT, and LONG) can be signed or unsigned. They are unsigned by default. All integer data types use two's complement representation. The table below lists the integer data types.

Type	# of bits	Range of values (Signed)	(Unsigned)
Type	# of bits	Range of values (Signed)	(Unsigned)
CHAR	8	–128 to 127	0 to 255
SHORT	16	–32768 to 32767	0 to 65535
LONG	32	–2147483648 to 2147483647	0 to 4294967295

Floating point data types

Floating-point data types are stored in the IEEE SINGLE and DOUBLE precision formats. Both formats have a sign bit field, an exponent field, and a fraction field. The fields represent floating-point numbers in the following manner:

Floating-Point Number = <sign> 1.<fraction field> x 2 (<exponent field> - bias)

- Sign bit field

  The sign bit field is the most significant bit of the floating-point number. The sign bit is 0 for positive numbers and 1 for negative numbers.

- Fraction field

  The fraction field contains the fractional part of a normalized number. Normalized numbers are greater than or equal to 1 and less than 2. Since all normalized numbers are of the form 1.XXXXXXXX, the 1 becomes implicit and is not stored in memory. The bits in the fraction field are the bits to the right of the binary point, and they represent negative powers of 2.

  For example:

  0.011 (binary) = $2^{-2} + 2^{-3} = 0.25 + 0.125 = 0.375$

- Exponent field

  The exponent field contains a biased exponent; that is, a constant bias is subtracted from the number in the exponent field to yield the actual exponent. (The bias makes negative exponents possible.)

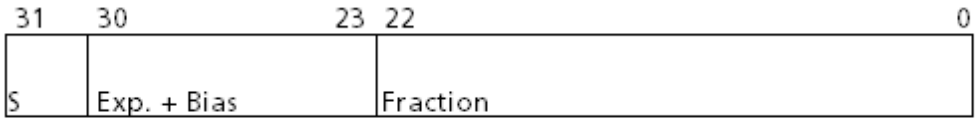
  If both the exponent field and the fraction field are zero, the floating-point number is zero.

- NaN

  A NaN (Not a Number) is a special value that is used when the result of an operation is undefined. For example, dividing a number by zero results in a NaN.

FLOAT data type

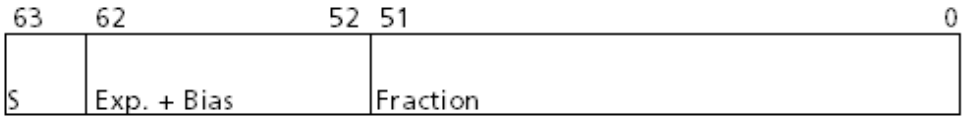
The FLOAT data type is stored in the IEEE single-precision format which is 32 bits long. The most significant bit is the sign bit, the next 8 most significant bits are the exponent field, and the remaining 23 bits are the fraction field. The bias of the exponent is 127. The range of single-precision format values is from 1.18×10^{-38} to 3.4×10^{38}. The floating-point number is precise to 6 decimal digits.




```
0  000  0000  0  000 0000 0000 0000 0000 0000 = 0.0
0  011  1111  1  000 0000 0000 0000 0000 0000 = 1.0
1  011  1111  1  011 0000 0000 0000 0000 0000 = -1.375
1  111  1111  1  111 1111 1111 1111 1111 1111 = NaN
```

DOUBLE

The DOUBLE data type is stored in the IEEE double-precision format which is 64 bits long. The most significant bit is the sign bit, the next 11 most significant bits are the exponent field, and the remaining 52 bits are the fractional field. The bias of the exponent is 1023. The range of single precision format values is from 2.23×10^{-308} to 1.8×10^{308}. The floating-point number is precise to 15 decimal digits.




```
0   000 0000 0000 0000 0000 ... 0000 0000 0000 = 0.0
0   011 1111 1111 0000 0000 ... 0000 0000 0000 = 1.0
1   011 1111 1110 0110 0000 ... 0000 0000 0000 = -0.6875
1   111 1111 1111 1111 1111 ... 1111 1111 1111 = NaN
```

5

Command and Report Packets

In this chapter:

This chapter documents the Command and Report packets.

Command packet and report packet summary

Category	Packets	See...
Receiver and antenna information packets	Command 06h, GETSERIAL	page 20
	Response 07h, RETSERIAL	page 21
	Command 4Ah, GETOPT	page 23
	Response 4Bh, RETOPT	page 24
Position, measurements, and satellite information packets	Command 54h GETSVDATA	page 28
	Response 55h, RETSVDATA (Satellite Information Reports)	page 31
	Command 56h, GETRAW (Position or real-time survey data request)	page 50
	Response 57h, RAWDATA (Position or real-time survey data report)	page 51
Application file packets	Command 64h, APPFILE (Application file record)	page 68
	Command 65h, GETAPPFILE (Application file request)	page 91
	Command 66h, GETAFDIR (Application file directory listing)	page 93
	Response 67h, RETAFDIR (Directory listing report)	page 94
	Command 68h, DELAPPFILE (Delete application file data)	page 96
	Command 6Dh, ACTAPPFILE (Activate application file)	page 97
Display screen and software interface packets	Command 81h, KEYSIM (Key simulator)	page 98
	Command 82h, SCRDUMP (Screen dump request)	page 100
	Response 82h, SCRDUMP (Screen dump)	page 101
Miscellaneous receiver control packets	Command/ResponseAEh, Ethernet configuration	page 102
	Command 6Fh, BREAKREQ	page 107
	Response 6Eh, BREAKRET (Break sequence return)	page 108
	Command 58h, RESETRCVR (Reset Receiver)	page 112

Receiver and antenna information packets

Receiver and antenna information packets sent and received by the receiver are described below.

Command 06h, GETSERIAL

Command Packet 06h requests receiver and antenna information. The receiver responds by sending the data in the Report Packet 07h.

All data in the packet flows from the data collector to the receiver.

Byte	Item	Type	Value	Meaning
0	STX	1 (Char)	02h	Start transmission
1	STATUS	1 (Char)	See Receiver status byte, page 12	Receiver status code
2	PACKET TYPE	1 (Char)	06h	Command Packet 06h
3	LENGTH	1 (Char)	00h	Data byte count
4	CHECKSUM	1 (Char)	See Packet structure, page 11	Checksum value
5	ETX	1 (Char)	03h	End transmission

Response 07h, RETSERIAL

Report Packet 07h is sent in response to the Command Packet 06h. The report returns the receiver and antenna serial number, antenna type, software processor versions, and the number of receiver channels.

All data in the packet flows from the receiver to the data collector.

Byte	Item	Type	Value	Meaning
0	STX	1 (Char)	02h	Start transmission.
1	STATUS	1 (Char)		Receiver status code. See Receiver status byte, page 12.
2	PACKET TYPE	1 (Char)	07h	
3	LENGTH	1 (Char)	??h	Bytes of data after this byte (excluding checksum and ETX).
4–11	RECEIVER SERIAL #	8 (Chars)	ASCII text	Receiver serial number. ***Note –*** *On newer receivers such as the BD920, this field gives the lowest (least significant) 8 characters of the serial number and so the LONG SERIAL NUMBER field should be used instead.*
12–19	RECEIVER TYPE	8 (Chars)	"BD9xx"	Space padding string with three spaces for the BD9xx.
20–24	NAV PROCESS VERSION	5 (Chars)	ASCII text	Version number for firmware.
25–29	SIG PROCESS VERSION	5 (Chars)		
30–34	BOOT ROM VERSION	5 (Chars)		
35–42	ANTENNA SERIAL #	8 (Chars)		
43–44	ANTENNA TYPE	2 (Chars)		“E” is unknown external; “KS” is Zephyr model; “GS” is Zephyr Geodetic.
45–46	# CHANNELS	2 (Chars)		Total number of GPS receive channels, including L1 and L2.
47–48	# CHANNELS L1	2 (Chars)		Number of channels only on L1.
49 - 58	LONG SERIAL NUMBER	10 (Chars)		This is the serial number that should be used instead of Receiver Serial.
59 - 89	LOCAL LONG ANT SERIAL	31 (Chars)		Not Applicable
90 - 120	BASE LONG ANT SERIAL	31 (Chars)		Not Applicable
121 - 151	BASE NGS ANT DESCRIPTOR	31 (Chars)		Not Applicable

Byte	Item	Type	Value	Meaning
152-153	# USABLE CHANNELS	2 (Bytes)		Maximum number of usable channels with current configuration.
154-155	# PHYSICAL CHANNELS	2 (Bytes)		Total number of hardware channels present.
156	# SIMULTANEOUS CHANNELS	1 (Byte)		Number of satellites that the receiver can track at one time.
157-161	Antenna INI version	5 (Chars)	ASCII text	Version number from the antenna.ini file that is currently loaded into the receiver.
162	CHECKSUM	1 (Char)	??h	Checksum value. See Packet structure, page 11.
163	ETX	1 (Char)	03h	End transmission.

Where,

Receiver Serial is an 8-character-maximum serial number. On newer receivers with longer serial numbers this field gives the lowest (least significant) 8 characters of the serial number, but the Long Serial Number field should be used instead.

Command 4Ah, GETOPT

This command requests a list of receiver options that are installed in the receiver. All data in DCOL packets should be stored in Big-Endian format.

All data in the packet flows from the data collector to the receiver.

The receiver responds by sending the data in the Response 4Bh, RETOPT, page 24.

Byte	Item	Type	Value	Meaning
0	STX	1 (Char)	02h	Start transmission
1	STATUS	1 (Char)	SeeReceiver status byte, page 12	Receiver status code
2	PACKET TYPE	1 (Char)	4Ah	Command Packet Type
3	LENGTH	1 (Char)	01h	Bytes of data after this byte (excluding CHECKSUM and ETX).
4	OPTIONS PAGE	1 (byte)	01h	Selects the required options information page
5	CHECKSUM	1 (Char)	SeePacket structure, page 11	Checksum value
6	ETX	1 (Char)	03h	End transmission

Response 4Bh, RETOPT

This packet response returns all the options installed in the receiver. These options can also be seen in the web interface (*Receiver Status* / *Receiver Options*).

All data in the packet flows from the receiver to the data collector.

Report Packet 4Bh is sent in response to the Command 4Ah, GETOPT, page 23.

Byte	Item	Type	Value	Meaning
0	STX	1 (Char)	02h	Start transmission.
1	STATUS	1 (Char)	00h	Receiver status code. See Receiver status byte, page 12.
2	PACKET TYPE	1 (Char)	4Bh	Command Packet Type.
3	LENGTH	1 (Char)	22h (34h or ??h)	Bytes of data after this byte (excluding checksum and ETX).
4	PAGE NUMBER	1 (byte)	5Bh	Elevation Mask / Page 91 = page 1 (page 0, 1, or 2)
			----- If page = 1 (page 0, 1, and 2 available) -----	
5	Number of Pages Supported	1 (byte)		
6–7	RESERVED	2 (short)		
8–9	RESERVED	2 (short)		
10–11	RESERVED	2 (short)		
12–15	OPTION BLOCK BITS 0–31 (LSB is bit 0)	4 (int)		OPTION BLOCK BITS 0–95 best processed as 3 unsigned long integers. For example, to determine if the GLONASS option is installed in receiver, check if bit #32 is enabled (1). GLONASS enable bit (data byte 16 counting from 1 page number) and least significant bit (0) of that byte. The currently defined bits are given below this table.
16–19	OPTION BLOCK BITS 32–63 (LSB is bit 32)	4 (int)		
20–23	OPTION BLOCK BITS 64–95 (LSB is bit 64)	4 (int)		
24–25	RESERVED	2 (short)		
26–28	RESERVED	3 (bytes)		
29–31	RESERVED	3 (bytes)		
32	RESERVED	1 (byte)		

Byte	Item	Type	Value	Meaning
33	RESERVED	1 (byte)		
34	RESERVED	1 (byte)		
35	RESERVED	1 (byte)		
36–37	RESERVED	2 (short)		
38	CHECKSUM	1 (Char)	??h	Checksum value. See Packet structure, page 11.
39	ETX	1 (Char)	03h	End transmission.

Where,

Option block bits are defined as follows: bit = 1 (enabled), bit = 0 (disabled)

bit 0: CMR inputs

bit 1: CMR outputs

bit 2: RTCM inputs

bit 3: RTCM outputs

bit 4: N/A

bit 5: N/A

bit 6: N/A

bit 7: Binary outputs (RT17)

bit 8: Moving base

bit 9: 10Hz measurements

bit 10: 20Hz measurements

bit 11: N/A

bit 12: N/A

bit 13: N/A

bit 14: Event markers

bit 15: N/A

bit 16: Force RTK float position

bit 17: N/A

bit 18: N/A

bit 19: Disable L2 outputs

bit 20: N/A

bit 21: L2CS support

bit 22–25: N/A

bit 26: Disable NMEA outputs

bit 27: Disable VRS

bit 28: RTCM DGPS only
bit 29: GPS L5 signal processing available
bit 30: Support OmniSTAR and XP/HP connection
bit 31: Disables the use of Everest multipath mitigation
bit 32: GLONASS enabled
bit 33: Enable Web UI support
bits 34–46: N/A
bit 37: Heading mode only
bit 40: Force float position with static CMR
bit 41: Only output scrambled CMR corrections
bit 42: N/A
bit 43: N/A
bit 44: Disable SBAS
bit 45: Disable FTP
bit 46: N/A
bit 47: Disable CMRx output
bit 48: Disable CMRx input
bit 49: N/A
bit 50: N/A
bit 51: N/A
bit 52: BeiDou enabled
bit 53: N/A
bit 54: N/A
bit 55: Galileo enabled
bit 56: N/A
bit 57: Enable scramble CMRx
bit 58: N/A
bit 59: N/A
bit 60: Enable scramble CMRx output
bit 62: Disable vector antenna
bit 63: N/A
bit 64: N/A
bit 65: N/A
bit 66: QZSS enabled

bit 67: N/A

bit 68: L1 RTK support enabled

bits 70–95:

Position, measurements, and satellite information packets

Position, measurements, and satellite information packets sent and received by the receiver are described below.

Command 54h, GETSVDATA

Command Packet 54h requests satellite information. The request may be for an array of flags showing the availability of satellite information such as an ephemeris or almanac. In addition, satellites may be enabled or disabled with this command packet.

Note – *The normal reply to Command Packet 54h is usually Report Packet 55h. However, a NAK is returned if the SV PRN is out of range (except for SV FLAGS), if the DATA SWITCH parameter is out of range, or if the requested data is not available for the designated SV.*

All data in the packet flows from the data collector to the receiver.

Byte	Item	Type	Value	Meaning
0	STX	1 (Char)	02h	Start transmission
1	STATUS	1 (Char)	00h	Receiver status code
2	PACKET TYPE	1 (Char)	54h	Command Packet Type
3	LENGTH	1 (Char)	03h, 04h	Data byte count
4	SUBTYPE	1 (byte)	See below	See below
----- DATA RECORDS 0—16 and 21–22-----				
Data from one of the records that are encoded in type 55h records, as indicated by byte #4 Subtype. Bytes 5 & 6 below; PRN & Flags, respectively; will be sent: 0: SV flags indicating Tracking, Ephemeris and Almanac, Enable/Disable state. (Deprecated. Use subtype 20.) 1: GPS Ephemeris 2: GPS Almanac 3: ION / UTC Data 4: Disable Satellite (Deprecated. Use subtype 20) 5: Enable Satellite (Deprecated. Use subtype 20) 7: Extended GPS Almanac (includes clock parameters) 8: GLONASS Almanac 9: GLONASS Ephemeris 11: Galileo Ephemeris 12: Galileo Almanac 14: QZSS Ephemeris				

Byte	Item	Type	Value	Meaning
16: QZSS Almanac 21: BeiDou Ephemeris 22: BeiDou Almanac				
5	SV PRN NUMBER	1 (byte)	See below	See below
6	FLAGS	1 (byte)	See below	See below
----- DATA RECORD 20----- Data from one of the records that are encoded in type 55h records, as indicated by byte #4 Subtype. Bytes 5, 6, & 7 below; PRN, SAT TYPE, & MODE, respectively; will be sent: 20: SV Enable/Disable/Ignore Health Controls				
5	SV PRN NUMBER	1 (byte)	See below	See below
6	SAT TYPE	1 (byte)	See below	See below
7	MODE	1 (byte)	See below	See below
	CHECKSUM	1 (Char)	See Packet structure, page 11	Checksum value
	ETX	1 (Char)	03h	End transmission

Where,

SV PRN Number: Satellite number for which ephemeris/almanac is required or to be enabled/ disabled. Ignored if SV flags or ION / UTC data is requested.

1–32 : GPS satellites

52–75: (GLONASS SV 1–24). FLAGS bit 1 must be set to 0 for subtypes 4 and 5.

Galileo SV Range: 1–36. FLAGS bit 1 must be set to 0 for subtypes 4 and 5.

QZSS SV Range: 193 - 198. FLAGS bit 1 must be set to 0 for subtypes 4 and 5.

BeiDou SV Range: 1–30. FLAGS bit 1 must be set to 0 for subtypes 4 and 5.

FLAGS: Bitmapped field having the following values:

Bit 0 set: Return GLONASS Flags appended to the GPS FLAGS replies (subtypes 0, 4, 5)

Bit 1 Set: Return Galileo and GLONASS Flags appended to the GPS FLAGS replies (subtypes 0, 4, 5). SV being controlled is Galileo, not GPS or GLONASS (subtypes 4, 5).

Bits 2 and 3 Specify the source of Galileo Ephemeris or QZSS Ephemeris:

For Galileo:

b3:b2 = 00 => E1B

b3:b2 = 01 => E5B

b3:b2 = 10 => E5A

For QZSS:

b3:b2 = 00 => L1CA

b3:b2 = 01 => L1C

b3:b2 = 10 => L2C

b3:b2 = 11 => L5

Bit4 Set: Return QZSS, Galileo and GLONASS flags appended to the GPS FLAGS replies (subtypes 0, 4, 5). SV being controlled is QZSS, not GPS, GLONASS or Galileo.

SAT TYPE: Subtype 20 only. Specifies the Satellite System for the PRN which is being configured.

0: GPS: 1–32

1: SBAS (WAAS, EGNOS, MSAS etc): 1–39 (PRN 120–158)

2: GLONASS: 1–24

3: Galileo: 1–36

4: QZSS: 1–5 (PRN 193-197)

7: BeiDou: 1–30

MODE: Subtype 20 only.

0: Return SV flags for SAT TYPE

1: Disable SV

2: Enable SV

3: Ignore Health SV

Only Mode = 0 is valid for SBAS.

The reply for this command will be a RETSVDATA packet, or a NAK if the request failed.

Enable/Disable satellite (subtype 20) always returns RETSVDATA (subtype 20) as if SV Flags were requested

Response 55h, RETSVDATA (Satellite information reports)

Report Packet 55h is sent in response to Command Packet 54h. The report includes either the ephemeris or almanac information for a specific satellite, or ION/UTC data, the Enabled/Disabled state and Heed/Ignore Health state of all satellites, or the condition of satellite status flags for one satellite or all satellites.

All data in the packet flows from the receiver to the data collector.

Byte	Item	Type	Value	Meaning
0	STX	1 (Char)	02h	Start Transmission
1	STATUS	1 (Char)	??h (see below)	Receiver Status Code
2	PACKET TYPE	1 (Char)	55h	Response Packet Type
3	LENGTH	1 (Char)	??h	Bytes of data after this byte (excluding checksum and ETX)
4	Subtype	1 byte	Refer subtype values below	Each subtype data field shown in the following tables will be output based on the 54h command sent, as shown above.
----- DATA RECORDS 0—22-----				
Data from one of the records that are encoded in type 55h records, as indicated by byte #4 Subtype. 0: SV flags indicating tracking, ephemeris, almanac, and enabled status (Deprecated. Use subtype 20.) 1: GPS Ephemeris 2: GPS Almanac 3: ION / UTC Data 4: Disable Satellite (Deprecated. Use subtype 20.) 5: Enable Satellite (Deprecated. Use subtype 20.) 7: Extended GPS Almanac (includes clock parameters) 8: GLONASS Almanac 9: GLONASS Ephemeris 11: Galileo Ephemeris 12: Galileo Almanac 14: QZSS Ephemeris 16: QZSS Almanac 20: SV Flags				

Byte	Item	Type	Value	Meaning
21: BeiDou Ephemeris 22: BeiDou Almanac				
Last subtype byte + 1	CHECKSUM	Char	??h	Checksum Value
Last subtype byte + 2	ETX	Char	03h	End Transmission

Only the satellite information, requested by Command Packet 54h, is sent in the report packet. As a result, several forms of the Report Packet 55h can be requested.

Returns a NAK if the GETSVDATA request meets one of the following criteria:

- SV PRN is out of range (except for SV flags)
- Data Switch is out of range
- Data is not available for the requested SV

SV Flags report

The SV FLAGS report is sent when Command Packet 54h is used to request the status of the SV Flags for one satellite or all satellites. The Command Packet 54h SUBTYPE byte (byte 4) is set to twenty (20) when requesting the report.

The following table shows the additional records provided in Report Packet 55h when SV flags data is included:

Subtype 20: SV Flags Report (?? bytes)				
Byte	**Item**	**Type**	**Value**	**Meaning**
6	SAT TYPE	1 byte	See below	See below
7	MODE	1 byte	See below	Mode from the 54h GETSVDATA request. See below.
8	Number of bytes (n) for each of the following fields.	1 byte	1–?	Number of bytes in each of the following flags.
	EPHEMERIS FLAGS	*n* bytes	? flag bits	Flags show availability of ephemeris, LSB = first PRN. Set to 1 when ephemeris is available.
	ALMANAC FLAGS	*n* bytes	? flag bits	Flags show availability of almanac, LSB = first PRN. Set to 1 when almanac is available.
	SV DISABLED FLAGS	*n* bytes	? flag bits	Flags show disabled SVs, LSB = first PRN. Set to 1 when satellite is disabled.
	SV UNHEALTHY FLAGS	*n* bytes	? flag bits	Flags show the health of satellites, LSB = first PRN. Set to one when satellite is unhealthy.
	SV "INGNORE HEALTH" FLAGS	*n* bytes	? flag bits	Flags show the health of satellites, LSB = first PRN. Set to 1 when satellite is set to ignore health.
---------- End of Subtype 0 ----------				

SAT TYPE: Subtype 20 only. Specifies the Satellite System for the PRN which is being configured.

0: GPS: 1–32

1: SBAS (WAAS, EGNOS, MSAS etc): 1–39 (PRN 120–158)

2: GLONASS: 1–24

3: Galileo: 1–36

4: QZSS: 1–5 (PRN 193-197)

7: BeiDou: 1–37

MODE: Subtype 20 only.

0: Return SV flags for SAT TYPE

1: Disable SV

2: Enable SV

3: Ignore Health SV

4: QZSS: 1-5 (PRN 193-197)

7: BeiDou: 1-37

Only Mode = 0 is valid for SBAS.

The Command Packet 54h subtype 0 message is depreciated, now subtype 20 should be used, for reference, the subtype 0 was structured as follows:

Subtype 0: SV Flags Report (48 bytes)				
Byte	**Item**	**Type**	**Value**	**Meaning**
6–9	EPHEMERIS FLAGS	4 (double word)	32 flag bits	For all satellites, the flags show availability of ephemeris data when set to one where bit #0 corresponds to PRN 1.
10–13	ALMANAC FLAGS	4 (double word)	32 flag bits	For all satellites, the flags show availability of almanac data when set to 1.
14–17	SV DISABLED FLAGS	4 (double word)	32 flag bits	Flags show Enabled or Disabled status of all satellites. Set to 1 when satellite is disabled.
18–21	SV UNHEALTHY FLAGS	4 (double word)	32 flag bits	Flags show the health of satellites. Set to 1 when satellite is unhealthy.
22–25	TRACKING L1 FLAGS	4 (double word)	32 flag bits	Flags show satellites tracked on L1 when set to one.
26–29	TRACKING L2 FLAGS	4 (double word)	32 flag bits	Flags show satellites tracked on L2 when set to one.
30–33	Y-CODE FLAGS	4 (double word)	32 flag bits	Flags show satellites with Anti-Spoofing turned on when set to one.
34–37	P-CODE ON L1 FLAGS	4 (double word)	32 flag bits	Flags show satellites which are tracking P-code on L1. Flags are not set for satellites not tracked on L1.
38–41	RESERVED	4 (double word)	32 flag bits	Reserved (set to 0).
42–45	RESERVED	4 (double word)	32 flag bits	Reserved (set to 0).
46–49	RESERVED	4 (double word)	32 flag bits	Reserved (set to 0).
50–53	RESERVED	4 (double word)	32 flag bits	Reserved (set to 0).
---------- End of Subtype 0 ----------				

GPS ephemeris report

The ephemeris report is sent when Command Packet 54h is used to request the ephemeris for one satellite or all satellites. The GETSVDATA SUBTYPE byte (byte 4) is set to one (1) to request the report. The first following table shows the additional records provided in Report Packet 55h when ephemeris data is included.

The ephemeris data follows the standard defined by GPS ICD-200 except for CUC, CUS, CIS, and CIC. These values must be multiplied by π to become the units specified in the GPS ICD-200 document. The ephemeris flags are described in the second following table.

Subtype 1: GPS ephemeris data (174 bytes)				
Byte	**Item**	**Type**	**Value**	**Meaning**
6–7	EPHEMERIS WEEK #	2 (short)	GPS ICD-200	Ephemeris Week Number.
8–9	IODC	2 (short)	GPS ICD-200	
10	RESERVED	1 (byte)	GPS ICD-200	
11	IODE	1 (byte)	GPS ICD-200	
12–15	TOW	4 (long)	GPS ICD-200	
16–19	TOC	4 (long)	GPS ICD-200	
20–23	TOE	4 (long)	GPS ICD-200	
24–31	TGD	8 (double)	GPS ICD-200	
32–39	AF2	8 (double)	GPS ICD-200	
40–47	AF1	8 (double)	GPS ICD-200	
48–55	AF0	8 (double)	GPS ICD-200	
56–63	CRS	8 (double)	GPS ICD-200	
64–71	DELTA N	8 (double)	GPS ICD-200	
72–79	M SUB 0	8 (double)	GPS ICD-200	
80–87	CUC	8 (double)		Multiply by π to obtain ICD units.
88–95	ECCENTRICITY	8 (double)	GPS ICD-200	
96–103	CUS	8 (double)		Multiply by π to obtain ICD units.
104–111	SQRT A	8 (double)	GPS ICD-200	
112–119	CIC	8 (double)		Multiply by π to obtain ICD units.
120–127	OMEGA SUB 0	8 (double)	GPS ICD-200	
128–135	CIS	8 (double)		Multiply by π to obtain ICD units.
136–143	I SUB 0	8 (double)	GPS ICD-200	
144–151	CRC	8 (double)	GPS ICD-200	
152–159	OMEGA	8 (double)	GPS ICD-200	
160–167	OMEGA DOT	8 (double)	GPS ICD-200	
168–175	I DOT	8 (double)	GPS ICD-200	
176–179	FLAGS	4 (double word)	GPS ICD-200	
		---------- End of Subtype 1 ----------		

Where FLAGS is encoded as a 32-bit value given by the following table:

Bit(s)	Description	Location
0	Data flag for L2 P-code	Sub 1, word 4, bit 1
1–2	Codes on L2 channel	Sub 1, word 3, bits 11–12
3	Anti-spoof flag: Y-code on: from ephemeris	Sub 1–5, HOW, bit 19
4–9	SV health: from ephemeris	Sub 1, word 3, bits 17–22
10	Fit interval flag	Sub 2, word 10, bit 17
11–14	URA: User Range Accuracy	Sub 1, word 3, bits 13–16
15	URA may be worse than indicated Block I: Momentum Dump flag	Sub 1–5, HOW, bit 18
16–18	SV Configuration: SV is Block I or Block II	Sub 4, page 25, word and bit depends on SV
19	Anti-spoof flag: Y-code on	Sub 4, page 25, word and bit depends on SV

Almanac report

The ALMANAC report is sent when Command Packet 54h is used to request the Almanac for one satellite or all satellites. The Command Packet 54h SUBTYPE byte (byte 4) is set to two (2) for GPS, seven (7) for Extended GPS, twelve (12) for Galileo, or sixteen (16) for QZSS when requesting the report. Data follows the format specified by GPS ICD-200.

The following table shows the additional records provided in Report Packet 55h when almanac data is included.

Subtype 2: GPS Almanac (67 bytes) OR Subtype 7: Extended GPS Almanac (83 bytes) OR Subtype 12: Galileo Almanac (85 bytes) OR Subtype 16: QZSS Almanac (84 bytes)				
Byte	**Item**	**Type**	**Value**	**Meaning**
6–9	ALM DECODE TIME	4 (unsigned long)	GPS ICD-200	Full GPS seconds from the start of GPS time.
10–11	AWN	2 (short)	GPS ICD-200	
12–15	TOA	4 (unsigned long)	GPS ICD-200	
16–23	SQRTA	8 (double)	GPS ICD-200	
24–31	ECCENT	8 (double)	GPS ICD-200	
32–39	ISUBO	8 (double)	GPS ICD-200	
40–47	OMEGADOT	8 (double)	GPS ICD-200	
48–55	OMEGSUBO	8 (double)	GPS ICD-200	
56–63	OMEGA	8 (double)	GPS ICD-200	
64–71	MSUBO	8 (double)	GPS ICD-200	
72	ALM HEALTH	1 (byte)	GPS ICD-200	
73–80**	ASUBF0	8 (double)		Field only available for subtype 7, 12, and 16.
81–88**	ASUBF1	8 (double)		Field only available for subtype 7, 12, and 16.
	ALM-SRC for Galileo and QZSS	1 (byte)		Field only available for subtype 12 and 16.
	IOD ALM for Galileo	1 (byte)		Field only available for subtype 12.
---------- End of Subtype 2, 7, 12, or 16 ----------				

BeiDou Almanac report

The ALMANAC report is sent when Command Packet 54h is used to request the Almanac for one satellite or all satellites. The Command Packet 54h SUBTYPE byte (byte 4) is set to twenty-two (22) when requesting the report. Data follows the format specified by GPS ICD-200.

The following table shows the additional records provided in Report Packet 55h when almanac data is included.

Subtype 22: BeiDou Almanac (90 bytes)				
Byte	**Item**	**Type**	**Value**	**Meaning**
6–9	ALM DECODE TIME	4 (unsigned long)		Full GPS seconds from the start of GPS time.
10–11	AWN	2 (short)		
12–15	TOA	4 (unsigned long)		
16–23	SQRTA	8 (double)		
24–31	ECCENT	8 (double)		
32–39	ISUBO	8 (double)		
40–47	OMEGADOT	8 (double)		
48–55	OMEGSUBO	8 (double)		
56–63	OMEGA	8 (double)		
64–71	MSUBO	8 (double)		
72–73	ALM HEALTH	2 (short)		Bit 9 (MSB): not set = satellite clock OK Bit 8: not set = B1 Signal OK Bits 7-3: reserved Bit 2: not set = Nav Message OK Bit 1 (LSB): reserved
74–81**	ASUBF0	8 (double)		
82–89**	ASUBF1	8 (double)		
90	ALM-SRC for BeiDou	1 (byte)		
---------- End of Subtype 22 ----------				

UTC/ION report

The UTC/ION report is sent when Command Packet 54h is used to request the UTC (Universal Time Coordinated) and Ionospheric data. The Command Packet 54h SUBTYPE byte (byte 4) is set to three (3) when requesting the report.

Data follows the standard defined within GPS ICD-200 except that some parameters are expanded. A NAK is returned if Command Packet 54h DATA SWITCH values is out of range.

The following table shows the additional records provided in Report Packet 55h when ION/UTC data is included.

Subtype 3: ION/UTC Report (121 bytes)				
Byte	**Item**	**Type**	**Value**	**Meaning**
		ION Parameters		
6–13	ALPHA 0	8 (double)	GPS ICD-200	
14–21	ALPHA 1	8 (double)	GPS ICD-200	
22–29	ALPHA 2	8 (double)	GPS ICD-200	
30–37	ALPHA 3	8 (double)	GPS ICD-200	
38–45	BETA 0	8 (double)	GPS ICD-200	
46–53	BETA 1	8 (double)	GPS ICD-200	
54–61	BETA 2	8 (double)	GPS ICD-200	
62–69	BETA 3	8 (double)	GPS ICD-200	
		UTC Parameters		
70–77	ASUB0	8 (double)	GPS ICD-200	
78–85	ASUB1	8 (double)	GPS ICD-200	
86–93	TSUB0T	8 (double)	GPS ICD-200	
94–101	DELTATLS	8 (double)	GPS ICD-200	
102–109	DELTATLSF	8 (double)	GPS ICD-200	
110–117	IONTIME	8 (double)	GPS ICD-200	
118	WNSUBT	1 (byte)	GPS ICD-200	
119	WNSUBLSF	1 (byte)	GPS ICD-200	
120	DN	1 (byte)	GPS ICD-200	
121–126	RESERVED	6 (byte)	GPS ICD-200	Reserved (set to 0).
		---------- End of Subtype 3 ----------		

GLONASS almanac report

The GLONASS ALMANAC report is sent when Command Packet 54h is used to request the Almanac for one GLONASS satellite or all GLONASS satellites. The Command Packet 54h SUBTYPE byte (byte 4) is set to eight (8) when requesting the report.

The following table shows the additional records provided in Report Packet 55h when GLONASS almanac data is included.

Subtype 8: GLONASS Almanac (68 bytes)				
Byte	**Item**	**Type**	**Value**	**Meaning**
6–7	DAY NUMBER	2 (word)		Day number within the current 4-year cycle.
8	FDMA NUMBER	1 (byte)	-7 to 13	(signed char) FDMA channel number
9–16	ECCENTRICITY	8 (double)		
17–24	ARG OF PERIGEE	8 (double)	radians	Argument of Perigee
25–32	ORBIT PERIOD	8 (double)	seconds	
33–40	ORBITAL PERIOD CORRECTION	8 (double)		
41–48	LONG FIRST ASCENDING NODE	8 (double)		Longitude of the first ascending node
49–56	TIME ASCENDING NODE	8 (double)		
57–64	INCLINATION	8 (double)	radians	Inclination is in
65–72	A0	8 (double)	seconds	Satellite clock offset from system time
73	HEALTH	1 (byte)		
---------- **End of Subtype 8** ----------				

GLONASS ephemeris report

The GLONASS ephemeris report is sent when Command Packet 54h is used to request the Ephemeris for one GLONASS satellite or all GLONASS satellites. The GETSVDATA SUBTYPE byte (byte 4) is set to nine (9) to request the report. The following table shows the additional records provided in Report Packet 55h when GLONASS ephemeris data is included.

The ephemeris data follows the standard defined by the GLONASS ICD.

Subtype 9: GLONASS Ephemeris Data (139 bytes)				
Byte	**Item**	**Type**	**Value**	**Meaning**
6–7	GPS WEEK EPH VALID REF TIME	2 (word)		GPS Week number of the ephemeris validity time.
8–11	GPS TIME EPH VALID REF TIME	4 (long)		GPS Time of Week (seconds) of the ephemeris validity time.
12–13	GPS WEEK EPH DECODE REF TIME	2 (word)		GPS Week number of the start time of the most recent GLONASS frame in which the current ephemeris has been decoded.
14–17	GPS TIME EPH DECODE REF TIME	4 (long)		GPS Time of Week (seconds) of the start time of the most recent GLONASS frame in which the current ephemeris has been decoded.
18–19	GLONASS DAY NUMBER	2 (word)		Days since the last leap year (rolls over every 4 years).
20	REF TIME OF EPHEMERIS	1 (byte)		Time of validity of the ephemeris in units of 900 seconds (tb in theGLONASS ICD).
21	LEAP SECONDS	1 (byte)		GPS System time to UTC integer seconds (from GPS).
22	FLAGS	1 (byte)		Bitmapped field of flags described in the GLONASS ICD: • Bit 0,1: P (if SV is GLONASS-M, 0 otherwise) • Bit 2,3: P1 (encode the time interval between the adjacent values of tb: (00, 01,10,11) map to (0,30,45,60) minutes respectively) • Bit 4: P2 • Bit 5: P3 • Bit 6: P4 (if SV is GLONASS-M, 0 otherwise) • Bit 7: Change bit

Subtype 9: GLONASS Ephemeris Data (139 bytes)				
Byte	**Item**	**Type**	**Value**	**Meaning**
23–26	FRAME START TIME	4 (long)		Time into the current date that this data was first decoded (tk in the GLONASS ICD).
27	AGE OF DATA	1 (byte)	days	
28	EPHEMERIS SOURCE	1 (byte)	0 or 1	0 (decoded from the C/A) or 1 (decoded from the P).
29	FDMA	1 (byte)	-7 to 13	(signed char) FDMA channel number
30	HEALTH	1 (byte)		
31	GENERATION	1 (byte)		Type of satellite: • 0: GLONASS • 1: GLONASS-M • 2–255: Reserved for future types
32	UDRE	1 (byte)		User range error, similar parameter to GPS. ***Note –*** *This is transmitted only by the GLONASS-M system.* The GLONASS ICD provides a LUT to convert to meters. Valid values are: • 0–15: Use the LUT • 255: Not a GLONASS-M
33–40	X	8 (double)	Meters	
41–48	X VELOCITY	8 (double)	Meters/sec	
49–56	X ACCELERATION	8 (double)	Meters/sec2	
57–64	Y	8 (double)	Meters	
65–72	Y VELOCITY	8 (double)	Meters/sec	
73–80	Y ACCELERATION	8 (double)	Meters/sec2	
81–88	Z	8 (double)	Meters	
89–96	Z VELOCITY	8 (double)	Meters/sec	
97–104	Z ACCELERATION	8 (double)	Meters/sec2	
105–112	A0 UTC	8 (double)		Seconds – Offset between GLONASS system time and UTC (SU).
113–120	A0	8 (double)		Seconds – Offset between GLONASS system time and the satellite clock (GLONASS ICD parameter τ n(tb)).
121–128	A1	8 (double)		Dimensionless – Rate of change of the satellite clock relative to GLONASS system time.
129–136	TAU GPS	8 (double)		GPS, GPS/GLONASS system time (sub 1-second) offset between GPS and GLONASS.

Subtype 9: GLONASS Ephemeris Data (139 bytes)				
Byte	**Item**	**Type**	**Value**	**Meaning**
				Note this is only available from GLONASS-M satellites, for legacy satellites this is 0. Also check “P” in the FLAGS byte.
137–144	DELTA TAU N	8 (double)		L1/L2 satellite delay.
---------- End of Subtype 9 ----------				

Galileo ephemeris report

The Galileo ephemeris report is sent when Command Packet 54h is used to request the Ephemeris for one Galileo satellite or all Galileo satellites. The GETSVDATA SUBTYPE byte (byte 4) is set to eleven (11) to request the report. The following table shows the additional records provided in Report Packet 55h when Galileo ephemeris data is included.

The ephemeris data follows the standard defined by the Galileo ICD.

Subtype 11: Galileo Ephemeris Data (187 bytes)				
Byte	**Item**	**Type**	**Value**	**Meaning**
6	DATA SOURCE	1 (byte)		Valid values are: 0: E1B 1: E5B 2: E5A
7–8	WEEK NUMBER	2 (bytes)		GST, but with 1024 added for normal Galileo satellites so that the GST start epoch matches GPS.
9–12	TOW	4 (bytes)		GST
13–14	IODnav	2 (bytes)		Ephemeris and clock correction issue of data.
15–18	TOE	4 (bytes)	Seconds	
19–26	CRS	8 (double)	Meters	
27–34	DELTA N	8 (double)	Semi-circles/sec	
35–42	MSUB0	8 (double)	Semi-circles	
43–50	CUC/PI	8 (double)	Semi-circles	The ICD value is in radians, so multiply by π to obtain radians.
51–58	ECCENTRICITY	8 (double)		Dimensionless.
59–66	CUS/PI	8 (double)	Semi-circles	The ICD value is in radians, so multiply by π to obtain radians.
67–74	SQRTA	8 (double)	Sqrt (meters)	
75–82	CIC/PI	8 (double)	Semi-circles	The ICD value is in radians, so multiply by π to obtain radians.
83–90	OMEGSUB0	8 (double)	Semi-circles	
91–98	CIS/PI	8 (double)	Semi-circles	The ICD value is in radians, so multiply by π to obtain radians.
99–106	ISUB0	8 (double)	Semi-circles	
107–114	CRC	8 (double)	Meters	
115–122	OMEGA	8 (double)	Semi-circles	
123–130	OMEGADOT	8 (double)	Semi-circles/sec	
131–138	IDOT	8 (double)	Semi-circles/sec	
149	SISA	1 (byte)		

Subtype 11: Galileo Ephemeris Data (187 bytes)				
Byte	**Item**	**Type**	**Value**	**Meaning**
140–141	HSDVS	2 (bytes)		Signal Health Flag.
142–145	TOC	4 (bytes)		E1, E5B for source E1B/E5B; E1, E5A for source E5A.
146–153	AF0	8 (double)	Seconds	
154–161	AF1	8 (double)	s/s	
162–169	AF2	8 (double)	s/s^2	
170–177	BGD1	8 (double)	Seconds	
178	MODEL 1	1 (byte)		Clock model for TOC/AF0–2/BGD1.
179–186	BGD2	8 (double)	Seconds	
187	MODEL 2	1 (byte)		Clock model for BGD2.
---------- **End of Subtype 11** ----------				

QZSS ephemeris report

The QZSS ephemeris report is sent when Command Packet 54h is used to request the Ephemeris for one QZSS satellite or all QZSS satellites. The GETSVDATA SUBTYPE byte (byte 4) is set to fourteen (14) to request the report. The first following table shows the additional records provided in Report Packet 55h when QZSS ephemeris data is included.

The ephemeris data follows the standard defined by the ICD200, except for CUC, CUS, CIS, and CIC. These values must be multiplied by p to become the units specified in the ICD document. The ephemeris flags are described in the second following table.

Subtype 14: QZSS Ephemeris Data (175 bytes)				
Byte	**Item**	**Type**	**Value**	**Meaning**
6	DATA SOURCE	1 (byte)		Valid values are: • 0: L1CA • 1: L1C • 2: L2C • 3: L5
8–9	WEEK NUMBER	2 (bytes)		GPS Week Number.
10–11	IODC	2 (bytes)		
12	Reserved	1 (byte)		
13	IODE	1 (byte)		
14–17	TOW	4 (bytes)		
18–21	TOC	4 (bytes)		
22–25	TOE	4 (bytes)		
26–33	TGD	8 (double)		
34–41	AF2	8 (double)		
42–49	AF1	8 (double)		
50–57	AF0	8 (double)		
58–65	CRS	8 (double)		
66–73	DELTA n	8 (double)		
74–81	M sub 0	8 (double)		
82–89	CUC/PI	8 (double)		Multiply by π to obtain ICD units.
90–97	ECCENTRICITY	8 (double)		
98–105	CUS/PI	8 (double)		Multiply by π to obtain ICD units.
106–113	SQRTA	8 (double)		
114–121	CIC/PI	8 (double)		Multiply by π to obtain ICD units.
122–129	OMEG sub 0	8 (double)		
130–137	CIS/PI	8 (double)		Multiply by π to obtain ICD units.

Subtype 14: QZSS Ephemeris Data (175 bytes)				
Byte	**Item**	**Type**	**Value**	**Meaning**
138–145	I sub 0	8 (double)		
146–153	CRC	8 (double)		
154–161	OMEGA	8 (double)		
162–169	OMEGADOT	8 (double)		
170–177	IDOT	8 (double)		
178–181	EPHEMERIS FLAGS	4 (long)		See below.
---------- End of Subtype 14 ----------				

Where FLAGS is encoded as a 32-bit value given by the following table:

Note – *Not all these flags are relevant for QZSS and so are transmitted as constant values by QZSS. To facilitate code sharing with GPS almanac code, these constants are propagated through the system and all the relevant flags below are in the same place as for GPS.*

Bit(s)	Description	Location
0	Data flag for L2 P-code (fixed at 1 for QZSS)	Sub 1, word 4, bit 1
1–2	Codes on L2 channel (fixed at 10b for QZSS)	Sub 1, word 3, bits 11–12
3	Anti-spoof flag: Y-code on: from ephemeris (fixed at 0 for QZSS)	Sub 1–5, HOW, bit 19
4–9	SV health: from ephemeris	Sub 1, word 3, bits 17–22
10	Fit interval flag	Sub 2, word 10, bit 17
11–14	URA: User Range Accuracy	Sub 1, word 3, bits 13–16
15	Block II: Alert flag: SV URA may be worse than indicated Block I: Momentum Dump flag	Sub 1–5, HOW, bit 18
16–18	SV Configuration: SV is Block I or Block II	Sub 4, page 25, word and bit depends on SV.
19	Anti-spoof flag: Y-code on	Sub 4, page 25, word and bit depends on SV.

BeiDou ephemeris report

The ephemeris report is sent when Command Packet 54h is used to request the ephemeris for one satellite or all satellites. The GETSVDATA SUBTYPE byte (byte 4) is set to twenty-one (21) to request the report. The first following table shows the additional records provided in Report Packet 55h when ephemeris data is included.

The ephemeris data follows the standard defined by GPS ICD-200 except for CUC, CUS, CIS, and CIC. These values must be multiplied by π to become the units specified in the GPS ICD-200 document.

Subtype 21: BeiDou ephemeris data (179 bytes)				
Byte	**Item**	**Type**	**Value**	**Meaning**
6–7	EPHEMERIS WEEK #	2 (short)		Ephemeris Week Number.
8–9	IODC	2 (short)		
10	RESERVED	1 (byte)		
11	IODE	1 (byte)		
12–15	TOW	4 (long)		
16–19	TOC	4 (long)		
20–23	TOE	4 (long)		
24–31	TGD	8 (double)		
32–39	AF2	8 (double)		
40–47	AF1	8 (double)		
48–55	AF0	8 (double)		
56–63	CRS	8 (double)		
64–71	DELTA N	8 (double)		
72–79	M SUB 0	8 (double)		
80–87	CUC	8 (double)		Multiply by π to obtain ICD units.
88–95	ECCENTRICITY	8 (double)		
96–103	CUS	8 (double)		Multiply by π to obtain ICD units.
104–111	SQRT A	8 (double)		
112–119	CIC	8 (double)		Multiply by π to obtain ICD units.
120–127	OMEGA SUB 0	8 (double)		
128–135	CIS	8 (double)		Multiply by π to obtain ICD units.
136–143	I SUB 0	8 (double)		
144–151	CRC	8 (double)		
152–159	OMEGA	8 (double)		
160–167	OMEGA DOT	8 (double)		
168–175	I DOT	8 (double)		
176–179	FLAGS	4 (double word)		
---------- End of Subtype 1 ----------				

Where FLAGS is encoded as a 32-bit value given by the following table:

Bit(s)	Description	Location
0	Data flag for L2 P-code	Sub 1, word 4, bit 1
1–2	Codes on L2 channel	Sub 1, word 3, bits 11–12
3	Anti-spoof flag: Y-code on: from ephemeris	Sub 1–5, HOW, bit 19
4–9	SV health: from ephemeris	Sub 1, word 3, bits 17–22
10	Fit interval flag	Sub 2, word 10, bit 17
11–14	URA: User Range Accuracy	Sub 1, word 3, bits 13–16
15	URA may be worse than indicated Block I: Momentum Dump flag	Sub 1–5, HOW, bit 18
16–18	SV Configuration: SV is Block I or Block II	Sub 4, page 25, word and bit depends on SV
19	Anti-spoof flag: Y-code on	Sub 4, page 25, word and bit depends on SV

Command 56h, GETRAW (Position or real-time survey data request)

Command Packet 56h requests raw satellite data in *.DAT Record 17 format or Concise format. The request may specify if Real-Time attribute information is required. The receiver responds by sending the data in Report Packet 57h. Alternatively, the packet can be used to request receiver position information in *.DAT record 11 format.

Note – *The reply to this command packet is usually a Report Packet 57h. A NAK is returned if the Real-Time Survey Data Option (RT17) is not installed on the receiver.*

The following table describes the packet structure. All data in the packet flows from the data collector to the receiver.

Byte	Item	Type	Value	Meaning
0	STX	1 (Char)	02h	Start transmission
1	STATUS	1 (Char)	??h	Receiver status code
2	PACKET TYPE	1 (Char)	56h	Command Packet Type
3	LENGTH	1 (Char)	03h	Bytes of data
4	TYPE RAW DATA	1 (Char)		**0 (00h):** Real-Time Survey Data Record (Record type 17) **1 (01h):** Position Record (Record type 11) (if ENHANCED FLAG is not set) else Enhanced Position Record Type 29 (if ENHANCED FLAG is set)
5	FLAGS	1 (Char)		**Bit 0 set to 0 (not set) :** Expanded *.DAT Record Type 17 format **Bit 0 set to 1 (set) :** Concise *.DAT Record Type 17 format **Bit 1 set to 0 (not set) :** Disabled – Enhanced record with real-time flags and IODE information **Bit 1 set to 1 (set) :** Enabled – Enhanced Record with real-time flags and IODE information **Bit 2 - 7 :** Reserved (set to 0)
6	ENHANCED FLAG	00h or 01h	Reserved	**00:** Output Subtype 0 and 1 Records **01:** Output Subtype 6 and 7 Enhanced Records
7	CHECKSUM	1 (Char)	??h See Packet structure, page 11	Checksum value
8	ETX	1 (Char)	03h	End transmission

Note – *Using the 56h command, the output is always at the port through which the command was sent. For example, if the command was sent through RS-232 serial then the output is through the same port and if the command is sent using USB then the 57h output is through the USB port.*

Response 57h, RAWDATA (Position or real-time survey data report)

Report Packet 57h is sent in response to Command 56h GETRAW or in response to a request for streamed Real-Time Survey Data via the 64h APPFILE command. This response may contain Expanded Format (".DAT" record 17 style) raw satellite measurements, "Concise Format" measurements, the current computed position or an Event Mark. An NAK is returned if the Real-Time Survey data option is not installed and the user requests this via the following options:

- Command Packet 56h
- Real-Time Survey Data steaming that can be enabled using the 64h Application File command

The raw satellite data responses following either the "Expanded" or the "Concise" format and are likely to span more than one RAWDATA reply. To overcome this, page information and an epoch counter are supplied as an extended framing. The first and subsequent RAWDATA record pages will be filled with a maximum of 248 bytes consisting of 4 bytes of page and flag information and 244 bytes of raw satellite data. The raw satellite data will be split where ever the 244 byte boundary falls, regardless of internal variable boundaries. Therefore the external device receiving the multiple pages must reconstruct the raw satellite record using the 244 byte pages before parsing the data.

All data in the packet flows from the receiver to the data collector.

Byte	Item	Type	Value	Meaning
0	STX	1 (Char)	02h	Start Transmission
1	STATUS	1 (Char)	??h	Receiver Status Code
2	PACKET TYPE	1 (Char)	57h	Response Packet Type
3	LENGTH	1 (Char)	??h	Bytes of data
				----- RESPONSE HEADER -----
4	Record Type	1 (byte)	00h, 01h, 02h, 06h, and 07h	Record Type indicates which raw data record type is being sent: • 0: Real-time GPS survey data (RT-17) • 1: Position Record (RT-11) • 2: Event Mark • 6: Real-time GNSS Survey Data (type 27) • 7: Enhanced Position Record (type 29)
5	Page Number	1 (byte)		Page Counter indicates how many pages there are for this epoch and what this page number is (for example, 10f 3, 2 of 3, 3 of 3).

Byte	Item	Type	Value	Meaning
				This byte is split into two sections of 4 bits allowing for 15 pages where: bits 0–3: Page total bits 4–7: Current page number So, for example, 0x23 would indicate the second page out of three.
6	Reply Number	1 (byte)	00h–FFh	Reply Number is a 0-255 rollover counter which is incremented with every reply but remains constant across pages within one reply. This value should be checked on 2nd and subsequent pages to ensure that pages of the same reply are recombined rather than those from different reply.
7	Record Interpretation Flags	1 (byte)		RECORD INTERPRETATION FLAGS indicates special attributes of the record that must be used in parsing values. Defined values are: • bit 0 set : Concise format • bit 1 set : Enhanced Record with real-time flags and IODE information • bits 2 - 7 : reserved
----- DATA RECORDS – Subtype 0, 1, 2, 6, or 7 ----- Data from one of the records that are encoded in type 57h records, as indicated by byte #4 RECORD TYPE. An individual record may extend over several RAWDATA packets. See: • Data record subtype 0: Real-time survey data (record type 17)—Expanded Format, page 53 • Data record subtype 0: Real-time survey data (record type 17)—Concise Format, page 56 • Data record subtype 1: Position (record type 11), page 58 • Data record subtype 2: Event mark (record type 19), page 60 • Data record subtype 6: Real-time GNSS Survey Data (record type 27)[1] • Data record subtype 7: Enhanced position (record type 29), page 61				
Last byte of data + 1	CHECKSUM	Char	??h See Packet structure, page 11.	Checksum Value
Last byte of data + 2	ETX	Char	03h	End Transmission

[1]The record type 27 message contains raw measurement information for all GNSS satellites, but the record type 17 messages contain raw measurement information for only GPS satellites. Because this information is considered proprietary by some parts of Trimble, users are requested to contact their dealer or sales person and sign a Non-Disclosure Agreement in order to obtain the documentation of this message format.

Data record subtype 0: Real-time survey data (record type 17)—Expanded Format

The following table shows the additional records provided in Report Packet 57h when Expanded Record format is enabled with Command Packet 56h.

See also Data record subtype 0: Real-time survey data (record type 17)—Concise Format, page 56.

Subtype 0: Real-time Survey Data (Record 17) – Expanded Format				
Byte	**Item**	**Type**	**Value**	**Notes**
		(Expanded Format) Header (17 bytes)		
8–15	RECEIVE TIME	8 (double)	msecs	Receive time within the current GPS week (common to code and phase data).
16–23	CLOCK OFFSET	8 (double)	msecs	Clock offset value. A value of 0.0 indicates that clock offset is not known.
24	# OF SVS IN RECORD	1 (byte)	blocks	Number of SV data blocks included in record.
Begin data for first satellite in constellation (block repeated for up to 12 SVs) *Begin Real-Time Survey Data (8 bytes)*				
	SV PRN	1 (byte)	01h–20h	Pseudorandom number of satellite (1–32).
	FLAGS1	1 (byte)		Indicates what data is loaded, is valid, etc. bit 0 set L2 data loaded and phase valid (see also b6) bit 1 set L1 cycle-slip (since last record 17 write) bit 2 set L2 cycle-slip (since last record 17 write) bit 3 L1 phase lock point (redundant, for diagnostics) bit 4 set L1 phase valid (lock-point valid) bit 5 set L2 pseudo range valid, reset = squared-L2 phase (for 4000SSE receivers bit 5 = bit 0) bit 6 set L1 data valid (non-zero but bytes always present) (see also bit 4), reset = only L2 data loaded (see FLAG STATUS field below) bit 7 set New position computed this receiver cycle
	FLAGS2	1 (byte)		bit 0 (L1 tracking Mode) 0: C/A Code 1 : P-code bit 1 (L2 tracking Mode) 0: C/A Code 1 : P-code bit 2 (L2 Tracking Encryption Code) 0 : Off 1 : On bit 3 (Filtered L1 pseudorange corrections)) 0 : Off 1 : On bits 4–7 reserved
	FLAG STATUS	1 (byte)		Indicates whether FLAGS2 is valid (not present for

Subtype 0: Real-time Survey Data (Record 17) – Expanded Format				
Byte	**Item**	**Type**	**Value**	**Notes**
(Expanded Format) Header (17 bytes)				
				concise format) bit 0 = 0 (Bit 6 of FLAGS1 and bit 0 - 7 of FLAGS2 are undefined bit 0 = 1 (Bit 6 of FLAGS1 and bit 0 - 7 of FLAGS2 are valid (always set for RAWDATA) bits 1–7 : reserved (set to 0)
	ELEVATION ANGLE	1 (signed integer)	Degrees	Satellite elevation angle (+/-)
	AZIMUTH	2 (signed integer)	Degrees	Satellite azimuth.
L1 Data: available if bit 6 of FLAGS1 set (40 bytes)				
	L1 SNR	8 (double)	dB	Measure of satellite signal strength.
	L1 FULL L1 C/A CODE P-RANGE	8 (double)	meters	Full L1 C/A code or P-code pseudorange (see bit 0 of FLAGS2).
	L1 CONTINUOUS PHASE	8 (double)	L1 cycles	L1 Continuous Phase. Range-Rate sign convention: When pseudorange is increasing, the phase is decreasing and the Doppler is negative.
	L1 DOPPLER	8 (double)	Hz	L1 Doppler.
	L1 RESERVED	8 (double)	0.0	
L2 Data: Available if bit 0 of FLAGS1 set (24 bytes)				
	L2 SNR	8 (double)	dB	Measure of satellite signal strength
	L2 CONTINUOUS PHASE	8 (double)	L2 cycles	L2 Continuous Phase is in L2 cycles if bit 5 of FLAGS1 = 1
	L2 P-CODE – L1 C/A CODE PSEUDORANGE	8 (double)	meters	L2 P-Code or L2 Encrypted Code (see bit 1 and bit 2 of FLAGS2) — L1 C/A-Code or P-code (see bit 0 of FLAGS2) pseudorange (valid only if bit 5 of FLAGS1 = 1)
Begin Enhanced Record if bit 1 of the Record Interpretation Flags byte is set to 1 (12 bytes)				
	IODE	1 (byte)	00h–FFh	Issue of Data Ephemeris
	L1 SLIP COUNTER	1 (byte)	00h–FFh	Roll-over counter is incremented for each occurrence of detected cycle-slips on L1 carrier phase
	L2 SLIP COUNTER	1 (byte)	00h–FFh	Roll-over counter is incremented for each occurrence of detected cycle-slips on the L2 carrier phase. The counter always increments when L2 changes from C/A code to Encrypted code and vice versa.

Subtype 0: Real-time Survey Data (Record 17) – Expanded Format				
Byte	**Item**	**Type**	**Value**	**Notes**
	(Expanded Format) Header (17 bytes)			
	RESERVED	1 (byte)	–	
	L2 DOPPLER	8 (double)	Hz	
	Repeat previous bytes for remaining satellites in constellation			
	---------- End of Subtype 0 ----------			

Data record subtype 0: Real-time survey data (record type 17)—Concise Format

The following table shows the additional records provided in Report Packet 57h when Concise Record format is enabled with Command Packet 56h.

See also Data record subtype 0: Real-time survey data (record type 17)—Expanded Format, page 53.

Subtype 0: Real-time Survey Data (Record 17) – Concise Format				
Byte	**Item**	**Type**	**Value**	**Notes**
		(Concise Format) Header (17 bytes)		
8–15	RECEIVE TIME	8 (double)	msecs	Receive time within the current GPS week (common to code and phase data).
16–23	CLOCK OFFSET	8 (double)	msecs	Clock offset value. A value of 0.0 indicates that clock offset is not known.
24	# OF SVS IN RECORD	1 (byte)	blocks	Number of SV data blocks included in record.
Begin data for first satellite in constellation (block repeated for up to 12 SVs) *Begin Real-Time Survey Data (6 bytes)*				
	SV PRN	1 (byte)	01h–20h	Pseudorandom number of satellite (1–32).
	FLAGS1	1 (byte)		Indicates what data is loaded, is valid, etc. bit 0 set L2 data loaded and phase valid (see also b6) bit 1 set L1 cycle-slip (since last record 17 write) bit 2 set L2 cycle-slip (since last record 17 write) bit 3 L1 phase lock point (redundant, for diagnostics) bit 4 set L1 phase valid (lock-point valid) bit 5 set L2 pseudo range valid, reset = squared-L2 phase (for 4000SSE receivers bit 5 = bit 0) bit 6 set L1 data valid (non-zero but bytes always present) (see also bit 4), reset = only L2 data loaded (see FLAG STATUS field below) bit 7 set New position computed this receiver cycle
	FLAGS2	1 (byte)		bit 0 (L1 tracking Mode) 0: C/A Code 1 : P-code bit 1 (L2 tracking Mode) 0: C/A Code 1 : P-code bit 2 (L2 Tracking Encryption Code) 0 : Off 1 : On bit 3 (Filtered L1 pseudorange corrections)) 0 : Off 1 : On bits 4–7 reserved
	ELEVATION ANGLE	2 (signed integer)	Degrees	Satellite elevation angle (+/-)

Subtype 0: Real-time Survey Data (Record 17) – Concise Format				
Byte	**Item**	**Type**	**Value**	**Notes**
		(Concise Format) Header (17 bytes)		
	AZIMUTH	2 (signed integer)	Degrees	Satellite azimuth.
		L1 Data: available if bit 6 of Flags 1 set (21 bytes)		
	L1 SNR	1 (byte)	dB*4	Measure of satellite signal strength.
	L1 FULL L1 C/A CODE P-RANGE	8 (double)	meters	Full L1 C/A code or P-code pseudorange (see bit 0 of FLAGS2).
	L1 CONTINUOUS PHASE	8 (double)	L1 cycles	L1 Continuous Phase. Range-Rate sign convention: When pseudorange is increasing, the phase is decreasing and the Doppler is negative.
	L1 DOPPLER	4 (float)	Hz	L1 Doppler.
		L2 Data: Available if bit 0 of FLAGS1 set (13 bytes)		
	L2 SNR	1 (byte)	dB*4	Measure of satellite signal strength
	L2 CONTINUOUS PHASE	8 (double)	L2 cycles	L2 Continuous Phase is in L2 cycles if bit 5 of FLAGS1 = 1
	L2 P-CODE – L1 C/A CODE PSEUDORANGE	4 (float)	meters	L2 P-Code or L2 Encrypted Code (see bit 1 and bit 2 of FLAGS2) — L1 C/A-Code or P-code (see bit 0 of FLAGS2) pseudorange (valid only if bit 5 of FLAGS1 = 1)
		Begin Enhanced Record if bit 1 of the Record Interpretation Flags byte is set to 1 (3 bytes)		
	IODE	1 (byte)	00h–FFh	Issue of Data Ephemeris
	L1 SLIP COUNTER	1 (byte)	00h–FFh	Roll-over counter is incremented for each occurrence of detected cycle-slips on L1 carrier phase
	L2 SLIP COUNTER	1 (byte)	00h–FFh	Roll-over counter is incremented for each occurrence of detected cycle-slips on the L2 carrier phase. The counter always increments when L2 changes from C/A code to Encrypted code and vice versa.
		Repeat previous bytes for remaining satellites in constellation		
		---------- End of Subtype 0 ----------		

Data record subtype 1: Position (record type 11)

The following table shows the additional records provided in Report Packet 57h when the Position Record is enabled with Command Packet 56h.

Position Record Length = 78 + N * 2, where *N* is the number of satellites

Position flags bit values are also shown below.

Subtype 1: Position Record (Record 11)				
Byte	**Item**	**Type**	**Value**	**Meaning**
8–15	LATITUDE	8 (double)	Units in semi-circles	Semi-circle angle = radians / Pi
16–23	LONGITUDE	8 (double)	Units in semi-circles	Semi-circle angle = radians / Pi
24–31	ALTITUDE	8 (double)	Meters	Altitude
32–39	CLOCK OFFSET	8 (double)	Meters	Clock offset
40–47	FREQUENCY OFFSET	8 (double)	Hz	Frequency offset from 1536*1.023 MHz
48–55	PDOP	8 (double)		PDOP (dimensionless)
56–63	LATITUDE RATE	8 (double)	Radians per second	Latitude rate
64–71	LONGITUDE RATE	8 (double)	Radians per second	Longitude rate
72–79	ALTITUDE RATE	8 (double)	Meters per second	Altitude rate
80–83	GPS MSEC OF WEEK	4 (unsigned long)	Msecs	Position time tag
84	POSITION FLAGS	1 (byte)	See Position flags bit values below.	Position status flags
85	# OF SVS	1 (byte)	00h–0Ch	Number of satellites used to compute position solution (0–12)
			Repeated for # of SVs	
	CHANNEL #	1 (byte)		Channel used to acquire satellite measurement. Zero is reported for RTK solutions.
			Repeated for # of SVs	
	PRN #	1 (byte)		PRN number of satellite
			---------- End of Subtype 1 ----------	

Position flags bit values

Bit	Notes
0–2	Position flag and position type definition 0: 0-D position fix (clock-only solution) (1+ SVs) (if # of SVs used is non-zero) 1: 1-D position fix (height only with fixed latitude/longitude) (2+ SVs) 2: 2-D position fix (fixed height and clock) (2+ SVs) 3: 2-D position fix (fixed height) (3+ SVs) 4: 3-D solution (4+ SVs) 5: 3D Solution (4+ SVs) Wide Area/Network RTK
3	RTK Solution: if set, position is fixed RTK, else float RTK 0: Floating integer ambiguity 1: Fixed integer ambiguity
4	DGPS Differential Corrections 0: No DGPS corrections are used in position computation 1: DGPS corrections are used to compute position
5	Reserved (set to zero)
6	RTK Solution: if set, position is from RTK (including Location RTK) 0: False 1: True
7	Position Derived While Static (RTK only) 0: False 1: True
Bit combinations: • Bit 4 and 6 are set if the solution type is SBAS • Bit 5 and 4 are set if the solution type is OmniSTAR HP/XP	

Data record subtype 2: Event mark (record type 19)

The following table shows the additional records provided in Report Packet 57h when the Event Mark record is enabled with Command Packet 56h.

Subtype 2: Event Mark (Record 19)				
Byte	**Item**	**Type**	**Value**	**Meaning**
8	Event Source	1 (byte)	00h–05h	0: External Event 1: Reserved 2: Reserved 3: Reserved 4: RS-232 Event 5: Reserved
9	Event Port	1 (byte)	00h–05h	0: Not Applicable 1: 1st Event Port or Serial Port 1 2: 2nd Event Port or Serial Port 2 3: Serial Port 3 4: Serial Port 4
10–11	Event Number	2 (short)		Event record tag number, incremented with each event
12–19	GPS time	8 (double)	Msec	GPS time of week
---------- End of Subtype 2 ----------				

Data record subtype 7: Enhanced position (record type 29)

The following table shows the additional records provided in Report Packet 57h when the Enhanced Position record is enabled with Command Packet 56h.

Subtype 7: Enhanced Position (Record 29)				
Byte	**Item**	**Type**	**Value**	**Meaning**
8	BLOCK LENGTH	1 (byte)		Indicates the length of the current data block, including the BLOCK LENGTH byte.
9–10	WEEK NUMBER	2 (short)		GPS week number of the observation.
11–14	RECEIVER TIME	4 (long)		Receiver time (seconds of the week) of the observation.
15	RECEIVER MOTION STATE	1 (byte)		Valid values are 0 (kinematic) or 1 (static).
16	NUMBER SVs TRACKED	1 (byte)		Number of SVs actually tracked.
17	NUMBER OF SVs USED IN SOLUTION	1 (byte)		Number of SVs actually used in calculating the solution.
18	RESERVED	1 (byte)		RESERVED
19	POSITION SYSTEM FLAGS	1 (byte)		See Position systems flags bit values, page 64.
20	POSITION SOLUTION MODE	1 (byte)		See Position solution mode bit values, page 64.
21	POSITION AUGMENTATION TYPE	1 (byte)		See Position augmentation type bit values, page 65.
22	POSITION PROCESSING TYPE	1 (byte)		See Position processing type bit values, page 65.
Position Block (53 bytes)				
23	BLOCK LENGTH	1 (byte)		Indicates the length of the current data block, including the BLOCK LENGTH byte.
24–29	LATITUDE	6 (integer)	Degrees	Range = +/-90 degrees. Increment = 240, approximately 9.1e–13 degrees.
30–35	LONGITUDE	6 (integer)	Degrees	Range = +/-180 degrees. Increment = 239, approximately 1.8e–12 degrees.
36–39	ALTITUDE	4 (long)	Meters	Range = +/-524,288 m. Increment = 212, approximately 0.24 mm.
40–43	VELOCITY N	4 (long)	Meters/sec	Range = +/-1024 m/s. Increment = 221, approximately 0.00048 mm/s.

Subtype 7: Enhanced Position (Record 29)				
Byte	**Item**	**Type**	**Value**	**Meaning**
44–47	VELOCITY E	4 (long)	Meters/sec	Range = +/-1024 m/s. Increment = 221, approximately 0.00048 mm/s.
48–51	VELOCITY U	4 (long)	Meters/sec	Range = +/-1024 m/s. Increment = 221, approximately 0.00048 mm/s.
52–55	RECEIVER CLOCK OFFSET	4 (long)	Milliseconds	Range = +/-32 msec. Increment = 226, approximately 1.5e–8 msec.
56–59	RECEIVER CLOCK DRIFT	4 (long)	Clock drift in PPM	Range = +/-16,384 ppm. Increment = 217, approximately 7.6e–6 ppm.
60–61	HDOP	2 (short)	Unitless	Range = 0–4096. Increment = 24, approximately 0.0625.
62–63	VDOP	2 (short)	Unitless	Range = 0–4096. Increment = 24, approximately 0.0625.
64–65	TDOP	2 (short)	Unitless	Range = 0–4096. Increment = 24, approximately 0.0625.
66–67	1SIGMA N	2 (short)	Meters	Range = 0–32 m. Increment = 211, approximately 4.9e–4 m.
68–69	1SIGMA E	2 (short)	Meters	Range = 0–32 m. Increment = 211, approximately 4.9e–4 m.
70–71	1SIGMA U	2 (short)	Meters	Range = 0–32 m. Increment = 211, approximately 4.9e–4 m.
72–73	RMS	2 (short)	Meters	Range = 0–4 m. Increment = 214, approximately 6.1e–5 m.
74–75	UNIT STD DEV	2 (short)	Square root of the unit variance	Range = 0–32. Increment = 211, approximately 4.9e–4.
RTK Solutions Block: available if POSITION AUGMENTATION TYPE is 3, 4, 5, or 6 (5 bytes).				
	BLOCK LENGTH	1 (byte)		Indicates the length of the current data block, including the BLOCK LENGTH byte.
	RTK MODE	1 (byte)	0 or 1	Valid values are 0 (synchronized) or 1 (low latency).
	AGE OF DATA	2 (short)	Seconds	Range is 0 to 1000 seconds, increment = 26.
	RESERVED	1 (byte)		
GLONASS Block: Available if bit 1 is set in POSITION SYSTEMS FLAGS (12 bytes).				
	BLOCK LENGTH	1 (byte)		Indicates the length of the current data block, including the BLOCK LENGTH byte.
	GPS GLONASS SYSTEM TIME OFFSET	4 (long)	Nanoseconds	Range = +/-32,768 nsec. Increment = 216.
	GPS GLONASS TIME DRIFT	4 (long)	Nanoseconds/sec	Range = +/-32,768 nsec. Increment = 216.

Subtype 7: Enhanced Position (Record 29)				
Byte	**Item**	**Type**	**Value**	**Meaning**
	GLONASS FLAGS	1 (byte)		Bit 0 set: GLONASS TDOP.
	GLONASS TDOP	2 (short)	If present, see GLONASS FLAGS bit 0	Increment = 24.
Inter-System Clock Offset Block: Available if bit 4 is set in POSITION SYSTEMS FLAGS (?? bytes).				
	BLOCK LENGTH	1 (byte)		Indicates the length of the current data block, including the BLOCK LENGTH byte.
	INTER-SYSTEM CLOCK OFFSET HEADER	1 (byte)		Bit 0-3: Satellite clock system to which time offsets are referenced. See Inter-System Clock Offset SV System bit values. Bit 4-6: Number of System Time Offsets stored (n = 0-7) Bit 7: One more header byte follows.
Repeated for the number of system time offsets stored.				
	INTER-SYSTEM CLOCK OFFSET INFO	1 (byte)		Bit 0-3: Satellite clock system. See Inter-System Clock Offset SV System bit values. Bit 4-6: Number of bytes (“M”) Bit 7: One more info byte follows.
	INTER-SYSTEM CLOCK OFFSET	"M" bytes		This is an M-byte signed integer in units of milliseconds/2^28. The lowest bit has a value of 0.0037 ns or 1.12 mm. Divide the integer by 2^28 to get milliseconds. The range based on the number of bytes is: 1 bytes: +/- 0.47 ns 2 bytes: +/- 122.07 ns 3 bytes: +/- 31250.00 ns (31 us) 4 bytes: +/- 8 ms 5 bytes: +/- 2.048 s 6 bytes: +/- 524.29 s 7 bytes: +/- 37.283 hours (LSB = 4.48mm if top 2 bits of 7th byte are used)
SV Block (SV ID, SV TYPE, and SV FLAGS are repeated for the number of SVs tracked. Trimble recommends using the BLOCK LENGTH to determine the number of SVs (4 bytes).				
	BLOCK LENGTH	1 (byte)		Indicates the length of the current data block, including the BLOCK LENGTH byte.
	SV ID	1 (byte)		
	SV TYPE	1 (byte)		SV TYPE is the GNSS system or satellite type.

Subtype 7: Enhanced Position (Record 29)				
Byte	**Item**	**Type**	**Value**	**Meaning**
				Defined values are 0: GPS 1: SBAS (WAAS, EGNOS, MSAS, etc.) 2: GLONASS 3: Galileo 4: QZSS 7: BeiDou
	SV FLAGS	1 (byte)		SV FLAGS is a bitmapped field with the following values: Bit 0: SV unhealthy Bit 1: SV used in position solution Bit 2:RAIM fault Bit 3–7: RESERVED
Repeat previous bytes for remaining satellites in constellation				
---------- **End of Subtype 7** ----------				

Position systems flags bit values

The following table shows the bit values for the Position System Flags byte in the Subtype 7: Enhanced position record.

Bit	Notes
0	GPS
1	GLONASS
2	RESERVED
3	RESERVED
4	System Time Offsets block present
5	RESERVED
6	Reserved
7	When set in this, or any subsequent flags byte, another flags byte follows.

Position solution mode bit values

The following table shows the bit values for the Position Solution Mode byte in the Subtype 7: Enhanced position record.

Bit	Notes
0	Old fix
1	Clock only
2	Overdetermined clock only
3	2D solution with fixed height and clock
4	2D solution with fixed height
5	3D solution

Position augmentation type bit values

The following table shows the bit values for the Position Augmentation Type byte in the Subtype 7: Enhanced position record.

Bit	Notes
0	None or Autonomous (Least Squares)
1	Conventional DGPS (Least Squares)
2	SBAS corrected DGPS (Least Squares)
3	RTK float
4	RTK fixed
5	Wide-area RTK float
6	Wide area RTK fixed
7	OmniSTAR
8	CDGPS (Least Squares)
9	Autonomous (Kalman Filter)
10	Conventional DGPS (Kalman Filter)
11	SBAS corrected DGPS (Kalman Filter)
12	CDGPS (Kalman Filter)
13	RESERVED
14	RESERVED
15	RTX
16	RESERVED
17	RESERVED

Position processing type bit values

The following table shows the bit values for the Position Processing Type byte in the Subtype 7: Enhanced position record.

Type	Value
If RTK	0: Min Error
	1: L1 only

Type	Value
	2: RESERVED
	3: RESERVED
	4: RESERVED
	5: RESERVED
If OmniSTAR	0: VBS (Least Squares)
	1: AM
	2: HP
	3: XP
	4: HP/XP
	5: HPG2
	6: G2
	7: VBS (Kalman Filter)
	8: MS 9: L1

Inter-system clock offset SV systems bit values

The following table shows the values for the INTER-SYSTEM CLOCK OFFSET SV SYSTEMS byte in the Subtype 7: Enhanced position record. Note that these values differ from the “Position Systems Flags”.

Bit	Notes
0	GPS
1	SBAS
2	GLONASS
3	Galileo
4	QZSS
5	BeiDou
6	RESERVED
7	RESERVED

Application file packets

To send application files to the receiver, upload the files via the web interface, or create the application files with a custom software program.

Application files contain a collection of individual records that fully prescribe the operation of the receiver. Application files are transferred using the standard Data Collector Format packet format.

Each application file can be tailored to meet the requirements of separate and unique applications. Up to 12 application files can be stored within the receiver for activation at a later date.

The two important application files in the receiver are:

Name	Function
DEFAULT	Permanently stored application file containing the receiver's factory default settings. This application file is used when the receiver is reset to the factory default settings.
CURRENT	Holds the current settings of the receiver.

Individual records within an existing application file can be updated using the software tools included with the receiver. For example, the OUTPUT MESSAGES record in an application file can be updated without affecting the parameter settings in other application file records.

Application files can be started immediately and/or the files can be stored for later use.

Once applications files are transferred into memory, command packets can be used to manage the files. Command packets are available for transferring, selecting, and deleting application files.

If any part of the application record data is invalid, then the receiver ignores the entire record. The receiver reads a record using the embedded length. Any extraneous data is ignored. This allows for backward compatibility when the record length is increased to add new functions.

If you are concerned about application files producing the same results on future receivers, make sure that the application records do not contain extraneous data.

Command Packet 64h is sent to create, replace, or report on an application file. The command packet requests the application file by System File Index.

For detailed information about application files and for guidelines about using application files to control remote devices, see Response 64h, APPFILE (Application file record report), page 92.

Packet paging

Since an application file contains a maximum of 248 bytes (all records are optional) of data and exceeds the byte limit for RS-232 Serial Interface Specification packets, Command Packet 64h is divided into several subpackets called pages. The PAGE INDEX byte (byte 5) identifies the packet page number and the MAXIMUM PAGE INDEX byte (byte 6) indicates the maximum number of pages in the report.

The first and subsequent pages are filled with a maximum of 248 bytes consisting of 3 bytes of page information and 245 bytes of application file data. The application file data is split wherever the 245 byte boundary falls. Therefore the remote device sending the Command Packet pages must construct the application file using the 248 byte pages before sending the file to the receiver.

To prevent data mismatches, each report packet is assigned a Transmission Block Identifier (byte 4) which gives the report pages a unique identity in the data stream. The software on the remote device can identify the pages associated with the report and reassemble the application file using bytes 4–6.

To save the Command Packet 64h in an application file format, the first two bytes of the file must indicate the length of the command packet in bytes. These bytes are in a little endian format as a UINT16. The bytes of the Command Packet 64h must then follow. All pages of the Command Packet 64h must be included in the file.

Command 64h, APPFILE (Application file record)

The following table shows the structure of the report packet containing the application file. All data in the packet flows from the data collector to the receiver.

Byte	Item	Type	Value	Notes
0	STX	1 (Char)	02h	Start transmission.
1	STATUS	1 (Char)	00h	Receiver status code.
2	PACKET TYPE	1 (Char)	64h	Command Packet 64h.
3	LENGTH	1 (Char)	00h	Data byte count.
4	TRANSMISSION NUMBER	1 (Char)	00h–FFh	A Transmission Number is a unique transmission serial number ranging from 0-255, typically incrementing by 1 each time an application file is sent.
5	PAGE INDEX	1 (Char)	00h–FFh	Index number (0–255) assigned to the current page.
6	MAXIMUM PAGE INDEX	1 (Char)	00h–FFh	Index number (0–255) assigned to the last page of the packet.
----- FILE CONTROL INFORMATION BLOCK -----				See File control information block, page 70.
----- APPLICATION FILE RECORDS -----				These are provided in the following order: • File storage record • General controls record • Serial port baud/format record • Reference (base) node record • GPS SV enable/disable record • GLONASS SV enable/disable record

Byte	Item	Type	Value	Notes
				• QZSS SV enable/disable record • Galileo SV enable/disable record • BeiDou SV enable/disable record • SBAS SV enable/disable record • Output message record • Antenna record • Device control record • Static/kinematic record • Multiplexed port control record
Length + 4	CHECKSUM	CHAR		Checksum value. See Packet structure, page 11.
Length + 5	ETX	CHAR	03h	End transmission.

After all pages of the 64h command are sent, the receivers ACK or NAK this command.

File control information block

The following table shows the data included in the file control information block of the Command packet 64h.

Note – *The file control information block must be sent in the first page of the report containing the application file. The second and consecutive pages must not include a file control information block.*

Byte	Item	Type	Value	Notes
7	APPLICATION FILE SPECIFICATION VERSION	1 (Char)	03h	Always 3 for this version of the specification.
8	DEVICE TYPE	1 (Char)	See Device type byte values, page 70.	Unique identifier for every receiver/device type that supports the application file interface.
9	START APPLICATION FILE FLAG	1 (Char)	See Start application file flag byte values, page 71.	Determines whether the application file is activated immediately after records are sent to receiver.
10	FACTORY SETTINGS FLAG	1 (Char)	See Factory settings byte values, page 71.	Determines whether the receiver is reset to factory default settings before activating the records in the application file.

The following tables provide byte values for the information in the file control information block.

Device type byte values

Byte value		Notes
Dec	**Hex**	
0	00h	All Devices
14	0Eh	BD950 receiver
41	29h	BD960 receiver
53	35h	BD970 receiver
60	3Ch	BD910 receiver
61	3Dh	BD920 receiver
66	42h	BD982 receiver
	All other values reserved	

Start application file flag byte values

Byte value		Notes
Dec	Hex	
0	00h	Do not apply the application file parameter settings to the active set of parameters when the transfer is complete.
1	01h	Apply application file records immediately.

Factory settings byte values

Byte value		Notes
Dec	Hex	
0	00h	Alter receiver parameters only as specified in the application file. Leave unspecified settings alone.
1	01h	Set all controls to factory settings prior to applying the application file.

Application file records

File storage record

The file storage record indicates the application file creation date and time, and provides identification information required to store the file in memory. When included in the application file, this record must be the first record in the file.

The following table shows the additional records provided when the file storage record is included with Command Packet 64h.

Byte	Item	Type	Value	Notes
0	RECORD TYPE	1 (Char)	00h	File Storage Record.
1	RECORD LENGTH	1 (Char)	0Dh	Number of bytes in record, excluding bytes 0 and 1.
2–9	APPLICATION FILE NAME	8 (Chars)	ASCII text *A...Z, a...z, _ (underscore)*	Eight-character name for the application file.
10	YEAR OF CREATION	1 (Char)	00h–FFh	Year when application file is created, ranging from 00–255 (1900 = 00).
11	MONTH OF CREATION	1 (Char)	01h–0Ch	Month when application file is created (01–12).
12	DAY OF CREATION	1 (Char)	00h–1Fh	Day of the month when application file is created (00–31).
13	HOUR OF	1	00h–17h	Hour of the day when application file is

Byte	Item	Type	Value	Notes
	CREATION	(Char)		created (00-23).
14	MINUTES OF CREATION	1 (Char)	00h–3Bh	Minutes of the hour when application file is created (00–59).

If multiple applications files or Command Packet 64h messages are sent with the same APPLICATION FILE NAME, these will overwrite any existing files with the same name (regardless of upper and/or lower case characters). The APPLICATION FILE NAME may contain upper and/or lower case characters, however Trimble recommends using only upper case characters.

General controls record

The general controls record sets general GPS operating parameters for the receiver, including the elevation mask, measurement rate, PDOP (Position Dilution of Precision) mask, and the positioning mode.

The following table shows the additional records provided when the general controls record is included with Command Packet 64h.

Byte	Item	Type	Value	Notes
0	RECORD TYPE	1 (Char)	01h	General controls record.
1	RECORD LENGTH	1 (Char)	08h	Number of bytes in record, excluding bytes 0 and 1.
2	ELEVATION MASK	1 (Char)	00h–5Ah	Elevation mask in degrees (0–90).
3	RESERVED	1 (Char)	00h	Reserved (set to zero).
4	PDOP MASK	1 (Char)	00h–FFh	Position Dilution of Precision mask (0–255).
5	RESERVED	1 (Char)	00h	Reserved (set to zero).
6	RESERVED	1 (Char)	00h	Reserved (set to zero).
7	RTK POSITIONING MODE	1 (Char)	See RTK positioning mode byte values, page 72.	Sets the RTK positioning mode.
8	POSITIONING SOLUTION SELECTION	1 (Char)	See Positioning solution selection values, page 73.	Controls use of DGPS and RTK solutions.
9	RESERVED	1 (Char)	00h	Reserved (set to zero).

The following tables provide byte values for the information in the general controls record.

RTK positioning mode byte values

Byte value		Notes
Dec	Hex	
0	00h	Synchronous positioning
1	01h	Low Latency positioning

Positioning solution selection values

Byte value		Notes
Dec	Hex	
0	00	Use best available solution.
1	01	Produce DGPS and Autonomous solutions.
2	02	Produce DGPS, RTK Float, and Autonomous solutions. On-the-fly RTK initialization is disabled, therefore no RTK Fix solutions are generated.
3	03	Produce RTK Fix, DGPS, and Autonomous solutions (no RTK Float solutions).

Serial port baud/format record

The serial port baud rate/format record sets communication parameters for the serial ports. Individual serial ports are identified within the records by the serial port index number.

The following table shows the additional records provided when the serial port baud rate/format record is included with Command Packet 64h.

Byte	Item	Type	Value	Notes
0	RECORD TYPE	1 (Char)	02h	Serial Port Baud Rate/Format Record.
1	RECORD LENGTH	1 (Char)	04h	Number of bytes in the record, excluding bytes 0 and 1.
2	SERIAL PORT INDEX	1 (Char)	00h–03h	The number of the serial port to configure.
3	BAUD RATE	1 (Char)	See Baud rate byte values, page 73.	Data transmission rate.
4	PARITY	1 (Char)	See Parity byte values, page 74.	Sets the parity of data transmitted through the port. The eight data bits and one stop bit are always used, regardless of the parity selection.
5	FLOW CONTROL	1 (Char)	See Flow control byte values, page 74.	Flow control.

The following tables provide byte values for the information in the serial port baud/format record.

Baud rate byte values

Byte value		Notes
Dec	Hex	
0	00h	9600 baud

Byte value		Notes
Dec	Hex	
1	01h	2400 baud
2	02h	4800 baud
3	03h	9600 baud
4	04h	19.2K baud
5	05h	38.4K baud (default)
6	06h	57.6K baud
7	07h	115.2K baud
8	08h	300 baud
9	09h	600 baud
10	0Ah	1200 baud
11	0Bh	230,000 baud
12	0Ch	460,000 baud

Parity byte values

Byte value		Notes
Dec	Hex	
0	00h	No Parity (10-bit format)
1	01h	Odd Parity (11-bit format)
2	02h	Even Parity (11-bit format)

Flow control byte values

Byte value		Notes
Dec	Hex	
0	00h	None
1	01h	CTS

Reference (base) node record

The reference node record is an optional record that provides LLA (Latitude, Longitude, Altitude) coordinates for reference station (base station) nodes.

The following table shows the additional records provided when the reference node record is included with Command Packet 64h.

Byte	Item	Type	Value	Notes
0	RECORD TYPE	1 (Char)	03h	Reference Node Record.
1	RECORD LENGTH	1 (Char)	25h	Data bytes in the record, excluding bytes

Byte	Item	Type	Value	Notes
				0 and 1.
2	FLAG	1 (Char)	00h	Reserved (set to zero).
3	NODE INDEX	1 (Char)	00h	Reserved (set to zero).
4–11	STATION NAME	8 (Char)	ASCII text	Eight-character reference node description.
12–19	REFERENCE LATITUDE	8 (Double)	Radians	Latitude of reference node, ± π/2.
20–27	REFERENCE LONGITUDE	8 (Double)	Radians	Longitude of reference node, ± π.
28–35	REFERENCE ALTITUDE	8 (Double)	Meters	Altitude of reference node, –9999.999 ≤ h ≤ +9999.999.
36–37	RTCM v2.x STATION ID	2 (Short)	0000h–03FFh	Reference Station ID for RTCM v2.x output.
38	CMR STATION	1 (Char)	00h–1Fh	Reference Station ID for CMR output.

The following bytes may also be included in this message, but are not required:

Byte	Item	Type	Value	Notes
39	FRAME CHAR	1 (Char)	40h	Indicates that bytes 39-88 contain data.
40	STATION NAME INDICATOR	1 (Char)	41h	Indicates that the Station ID (point ID) is present.
41–60	STATION NAME	20 (Char)	Up to 20 ASCII characters, space-padded as required	Transfer all 20 characters of the base point's ID to the rover station (CMR/RETBASE transfers only 4 of the characters in the STATION ID field).
61	STATION CODE INDICATOR	1 (Char)	42h	Indicates that the Feature Code field is present.
62–77	STATION CODE	16 (Char)	Up to 16 ASCII characters, space-padded as required	Transfer all 16 characters of the base point's feature code to the rover station.
78	FLAG	1 (Char)	20h	Reserved (set to 0x20).
79	FLAG	1 (Char)	20h	Reserved (set to 0x20).
80	FLAG	1 (Char)	20h	Reserved (set to 0x20).
81	FLAG	1 (Char)	20h	Reserved (set to 0x20).
82	FLAG	1 (Char)	20h	Reserved (set to 0x20).
83	FLAG	1 (Char)	20h	Reserved (set to 0x20).
84	FLAG	1 (Char)	20h	Reserved (set to 0x20).
85	FLAG	1 (Char)	20h	Reserved (set to 0x20).
86	FLAG	1 (Char)	20h	Reserved (set to 0x20).
87	FLAG	1 (Char)	20h	Reserved (set to 0x20).

Byte	Item	Type	Value	Notes
88	FRAME CHAR	1 (Char)	40h	Terminates string.
89–90	RTCM v3.x STATION ID	2 (Short)	0000h–0FFFh	Reference Station ID for RTCM v3.x output.

GPS SV enable/disable record

The GPS SV enable/disable record is used to enable or disable a selection of the 32 GPS satellites. By default, the receiver is configured to use all satellites that are in good health. This record is useful for enabling satellites that are not in good health. Once enabled, the health condition of the satellite(s) are ignored, and the GPS signal transmissions from the satellite(s) are considered when computing position solutions.

The following table shows the additional records provided when the GPS SV enable/disable record is included with Command Packet 64h.

Byte	Item	Type	Value	Notes
0	RECORD TYPE	1 (Char)	06h	SV Enable/Disable Record.
1	RECORD LENGTH	1 (Char)	20h	Number of bytes in record, excluding bytes 0 and 1.
2–33	SV ENABLE/DISABLE STATES	32 (Chars)	See GPS SV enable/disable states flag values, page 76.	Array of Enable/Disable flags for the 32 SVs. The first byte sets the required Enable/Disable status of SV1, the second sets the status of SV2, etc.

The following table provides byte values for the information in the SV enable/disable record.

GPS SV enable/disable states flag values

Byte value		Notes
Dec	Hex	
0	00h	Heed health (default)
1	01h	Disable the satellite
2	02h	Enable the satellite regardless of whether the satellite is in good or bad health

GLONASS SV enable/disable record

The GLONASS SV enable/disable record is used to enable or disable a selection of the 24 GLONASS satellites. By default, the receiver is configured to use all satellites that are in good health. This record is useful for enabling satellites that are not in good health. Once enabled, the health condition of the satellite(s) are ignored, and the GLONASS signal transmissions from the satellite(s) are considered when computing position solutions.

The following table shows the additional records provided when the GLONASS SV enable/disable record is included with Command Packet 64h.

Byte	Item	Type	Value	Notes
0	RECORD TYPE	1 (Char)	37h	GLONASS SV Enable/Disable Record.
1	RECORD LENGTH	1 (Char)	18h	Number of bytes in record, excluding bytes 0 and 1.
2–25	GLONASS SV ENABLE/DISABLE STATES	24 (Chars)	See GLONASS SV enable/disable states flag values, page 77.	Array of Enable/Disable flags for the 24 SVs. The first byte sets the required Enable/Disable status of SV1, the second sets the status of SV2, etc.

The following table provides byte values for the information in the GLONASS SV enable/disable record.

GLONASS SV enable/disable states flag values

Byte value		Notes
Dec	Hex	
0	00h	Heed health (default)
1	01h	Disable the satellite
2	02h	Enable the satellite regardless of whether the satellite is in good or bad health

QZSS SV enable/disable record

The QZSS SV enable/disable record is used to enable or disable a selection of the 5 QZSS satellites. By default, the receiver is configured to use all satellites that are in good health. This record is useful for enabling satellites that are not in good health. Once enabled, the health condition of the satellite (s) are ignored, and the QZSS signal transmissions from the satellite(s) are considered when computing position solutions.

The following table shows the additional records provided when the QZSS SV enable/disable record is included with Command Packet 64h.

Byte	Item	Type	Value	Notes
0	RECORD TYPE	1 (Char)	5Fh	QZSS SV Enable/Disable Record.
1	RECORD LENGTH	1 (Char)	05h	Number of bytes in record, excluding bytes 0 and 1.
2–6	QZSS SV ENABLE/DISABLE STATES	5 (Chars)	See QZSS SV enable/disable states flag values, page 78.	Array of Enable/Disable flags for the 5 SVs. The first byte sets the required Enable/Disable status of SV1, the second sets the status of SV2, etc.

The following table provides byte values for the information in the QZSS SV enable/disable record.

QZSS SV enable/disable states flag values

Byte value		Notes
Dec	Hex	
0	00h	Heed health (default)
1	01h	Disable the satellite
2	02h	Enable the satellite regardless of whether the satellite is in good or bad health

Galileo SV enable/disable record

The Galileo SV enable/disable record is used to enable or disable a selection of the 52 Galileo satellites. By default, the receiver is configured to use all satellites that are in good health. This record is useful for enabling satellites that are not in good health. Once enabled, the health condition of the satellite(s) are ignored, and the Galileo signal transmissions from the satellite(s) are considered when computing position solutions.

The following table shows the additional records provided when the Galileo SV enable/disable record is included with Command Packet 64h.

Byte	Item	Type	Value	Notes
0	RECORD TYPE	1 (Char)	4Fh	Galileo SV Enable/Disable Record.
1	RECORD LENGTH	1 (Char)	34h	Number of bytes in record, excluding bytes 0 and 1.
2–53	SV ENABLE/DISABLE STATES	52 (Chars)	See Galileo SV enable/disable states flag values, page 78.	Array of Enable/Disable flags for the 52 SVs. The first byte sets the required Enable/Disable status of SV1, the second sets the status of SV2, etc.

The following table provides byte values for the information in the Galileo SV enable/disable record.

Galileo SV enable/disable states flag values

Byte value		Notes
Dec	Hex	
0	00h	Heed health (default)
1	01h	Disable the satellite
2	02h	Enable the satellite regardless of whether the satellite is in good or bad health

BeiDou SV enable/disable record

The BeiDou SV enable/disable record is used to enable or disable a selection of the 30 BeiDou satellites. By default, the receiver is configured to use all satellites that are in good health. This record is useful for enabling satellites that are not in good health. Once enabled, the health condition of the satellite(s) are ignored, and the BeiDou signal transmissions from the satellite(s) are considered when computing position solutions.

The following table shows the additional records provided when the BeiDou SV enable/disable record is included with Command Packet 64h.

Byte	Item	Type	Value	Notes
0	RECORD TYPE	1 (Char)	50h	SV Enable/Disable Record.
1	RECORD LENGTH	1 (Char)	1Eh	Number of bytes in record, excluding bytes 0 and 1.
2–31	SV ENABLE/DISABLE STATES	30 (Chars)	See BeiDou SV enable/disable states flag values, page 79.	Array of Enable/Disable flags for the 30 SVs. The first byte sets the required Enable/Disable status of SV1, the second sets the status of SV2, etc.

The following table provides byte values for the information in the BeiDou SV enable/disable record.

BeiDou SV enable/disable states flag values

Byte value		Notes
Dec	Hex	
0	00h	Heed health (default)
1	01h	Disable the satellite
2	02h	Enable the satellite regardless of whether the satellite is in good or bad health

SBAS SV enable/disable record

The SBAS SV enable/disable record is used to enable or disable a selection of the SBAS satellites. By default, the receiver is configured to use all currently available satellites that are in good health. This record is useful for enabling satellites that are not in good health. Once enabled, the health condition of the satellite(s) are ignored, and the SBAS signal transmissions from the satellite(s) are considered when computing position solutions.

The following table shows the additional records provided when the SBAS SV enable/disable record is included with Command Packet 64h.

Byte	Item	Type	Value	Notes
0	RECORD TYPE	1	16h	SBAS SV Enable/Disable Record.

Byte	Item	Type	Value	Notes
		(Char)		
1	RECORD LENGTH	1 (Char)	18h	Number of bytes in record, excluding bytes 0 and 1.
2	SBAS MODE	1 (Char)	See SBAS mode values, page 80.	Enable/disable the use of SBAS for positioning.
3	OBSOLETE	1 (Char)	00h	Reserved
4	OBSOLETE	1 (Char)	00h	Reserved
5	OBSOLETE	1 (Char)	00h	Reserved
6	OBSOLETE	1 (Char)	00h	Reserved
7–25	SBAS SV ENABLE/DISABLE STATES	19 (Chars)	See SBAS SV mask values, page 80.	Array of Enable/Disable flags for the 19 SVs. The first byte sets the required Enable/Disable status of SV1, the second sets the status of SV2, etc.

The length of this message will be expanded in the future as SBAS SV PRN numbers are assigned to values higher than 138. See SBAS SVs available, page 81.

The following table provides byte values for the information in the SBAS SV enable/disable record.

SBAS mode values

Byte value		Notes
Dec	Hex	
0	00h	Off
1	01h	Reserved
2	02h	Track SBAS but do not use corrections
3	03h	Track and use SBAS corrections

SBAS SV mask values

Byte value		Notes
Dec	Hex	
0	00h	Disabled
1	01h	Enabled and heed health
2	02h	Use even if unhealthy
3	03h	Enable this SV if it can be used in the current location (Auto-Enable)

SBAS SVs available

Note – *This table gives the PRNs of the SBAS SVs available as of February 2013.*

PRN	Satellite
120	EGNOS – AOR-E
121	
122	
123	
124	EGNOS – ARTEMIS
125	
126	EGNOS – IND-W
127	GAGAN – GSAT 8
128	GAGAN
129	MSAS-1
130	
131	
132	
133	WAAS – INMARSAT 4-F3
134	
135	WAAS – GALAXY XV
136	EGNOS - SES-5
137	MSAS-2
138	WAAS – ANIK F1R
139	
140	SDCM - LUCH-5A
141	
142	
143	
144	
145	
146	
147	
148	
149	
150	
151	
152	
153	
154	

PRN	Satellite
155	
156	
157	
158	

Output message record

The output message record selects the outputs for a specified serial port, the frequency of message transmissions, the integer second offset from the scheduled output rate, and output-specific flags. Bytes 0 through 5 are included in all records, regardless of the output message type. The remaining bytes in the record are dependent on the output message type.

The following table shows the additional records provided when the output message record is included with Command Packet 64h.

Output message type	Byte	Item	Type	Value	Notes
All	0	RECORD TYPE	1 (Char)	07h	Output Message Record.
	1	RECORD LENGTH	1 (Char)	04h, 05h or 06h	Number of bytes in the record, excluding bytes 0 and 1. The number of bytes is dependent on the number of output specific flags.
	2	OUTPUT MESSAGE TYPE	1 (Char)	See Output message type byte values, page 83.	Type of message or packet.
	3	PORT INDEX	1 (Char)	See Port number values, page 84.	The port number for RS-232 Serial, USB or Ethernet ports is 0-based.
	4	FREQUENCY	1 (Char)	See Frequency byte values, page 85.	Frequency of message transmissions.
	5	OFFSET	1 (Char)	00h–FFh	Integer second offset (0–255 seconds) from scheduled output rate. (Only valid when frequency is < 1 Hz or >1 second.)
Type 10 (GSOF)	6	GSOF SUBMESSAGE TYPE	1 (Char)	See GSOF message record type, page 85.	GSOF message number.
	7	OFFSET	1 (Char)	0–255	Integer second offset from scheduled frequency.
Type 2	6	CMR	1 (Char)	See CMR message	CMR message types.

Output message type	Byte	Item	Type	Value	Notes
(RTK-CMR)		MESSAGE TYPE FLAGS		type byte values, page 86.	
Type 3 (RTCM)	6	RTCM FLAGS	1 (Char)	See RTCM flag bit values, page 87.	Bit settings for RTCM output flags.
Type 4 (RT17)	6	REAL-TIME 17 MESSAGE FLAGS	1 (Char)	See Real-time 17 message bit values , page 86.	RT17 (Real Time 17) flags.
	7	FLAG 2	1 (Char)	0: Disable	1: Enable Multi-System Support (RT27)

The following tables provide byte values for the information in the output message record.

Output message type byte values

Byte value	Notes
0xFF	Turn off all outputs on all ports. Frequency must also be 'Off' for this to work.
0	Turn off all outputs on the given port only. Frequency must be 'Off' for this to work
1	Not used.
2	CMR Output
3	RTCM Output
4	RT17 Output
5	Not used.
6	NMEA_GGA
7	NMEA_GGK
8	NMEA_ZDA
9	Reserved
10	GSOF
11	1PPS
12	NMEA_VTG
13	NMEA_GST
14	NMEA_PJK
15	NMEA_PJT
16	NMEA_VGK
17	NMEA_VHD
18	NMEA_GSV

Byte value	Notes
19	NMEA_TSN
20	NMEA_TSS
21	NMEA_PRC
22	NMEA_REF
23	NMEA_GGK_SYNC
24	J1939_VehPos
25	J1939_Time
26	J1939_VehSpd
27	J1939_ImpPos
28	J1939_ImpSpd
29	NMEA_AVR
30	Reserved
31	NMEA_HDT
32	NMEA_ROT
33	NMEA_ADV
34	NMEA_PIO
35	NMEA_BETA
36	Reserved
37	NMEA_VRSGGA
38	NMEA_GSA
39	Binex
40	NMEA_RMC
41	NMEA_BPQ
42	Reserved
43	Reserved
44	NMEA_GLL
45	NMEA_GRS
46	Reserved
47	NMEA_LDG

Port number values

1-based Port ID	0-based Port ID	Name	Notes
1	0	Serial port 1	
2	1	Serial port 2	
3	2	Serial port 3	
4	3	Serial port 4	On receivers with a 4th serial port

1-based Port ID	0-based Port ID	Name	Notes
5	4	Multiplexed port	On receivers with a multiplexed port (see Multiplexed port control record, page 90)
6	5	Pulse per second port	
16	15	USB virtual serial port	
18–20	17–19	Bluetooth virtual serial ports	
21–23	20–22	1st...3d IP sockets	On receivers with internal IP stacks
24–30	23–29	4th...10th IP sockets	On receivers with Ethernet connections

Frequency byte values

Byte value		Notes
Dec	Hex	
0	00h	Off
1	01h	10 Hz
2	02h	5 Hz
3	03h	1 Hz
4	04h	2 seconds
5	05h	5 seconds
6	06h	10 seconds
7	07h	30 seconds
8	08h	60 seconds
9	09h	5 minutes
10	0Ah	10 minutes
11	0Bh	2 Hz
12	0Ch	15 seconds
13	0Dh	20 Hz
15	0Fh	50 Hz
255	FFh	Once only, immediately
Certain message output types may not support >1 Hz output.		

GSOF message record type

Record Number	Description
1	POSITION TIME

Record Number	Description
2	LAT, LONG, HEIGHT
3	ECEF POSITION
4	LOCAL DATUM POSITION
5	LOCAL ZONE POSITION
6	ECEF DELTA
7	TANGENT PLANE DELTA
8	VELOCITY DATA
9	PDOP INFO
10	CLOCK INFO
11	POSITION VCV INFO
12	POSITION SIGMA INFO
13	SV BRIEF INFO
14	SV DETAILED INFO
15	RECEIVER SERIAL NUMBER
16	CURRENT TIME
26	POSITION TIME UTC
27	ALTITUDE INFO+[1]
41	BASE POSITION AND QUALITY INDICATOR
33	ALL SV BRIEF INFO
34	ALL SV DETAILED INFO
35	RECEIVED BASE INFO

CMR message type byte values

Byte value		Notes
Dec	Hex	
0	00h	Standard (CMR, CMR+).
1	01h	High speed CMR (5,10, or 20 Hz).
2	02h	Compatible with Trimble 4000 receivers.

Real-time 17 message bit values

Bit	Notes
7 (msb)	Reserved (set to zero)
6	Reserved (set to zero)
5	Reserved (set to zero)
4	Position Only – 0: Disabled 1: Enabled

[1] If flags are invalid, the record is not applied. (However, the application file may be accepted.)

Bit	Notes
3	Streamed Position – 0: Disabled 1: Enabled
2	Streamed Ephemeris – 0: Disabled 1: Enabled
1	RT (Real-Time) Enhancements – 0: Disabled 1: Enabled
0	(lsb) Compact Format – 0: Disabled 1: Enabled

RTCM flag bit values

Bit	Notes
0	Output RTK Packets (type 3, 18, 19)
1	Output DGPS Packets (type 3 ,1)
2	Output DGPS RTCM packets (Type 1)
3	Not set: Output RTCM v2.1 Set: Output RTCM v2.2
4	Not set: No Output Set: Output RTCM v2.3
5	Not set: No Output Set: Output RTCM v3.0 Setting bit 5 overrides bits 3 and 4. Bit 2 cannot be set when bit 5 is set because that is rejected as an error.

Antenna record

The antenna record identifies the antenna type and the true vertical height of the antenna above the ground mark.

The following table shows the additional records provided when the antenna record is included with Command Packet 64h.

Byte	Item	Type	Value	Notes
0	RECORD TYPE	1 (Char)	08h	Reference Node record.
1	RECORD LENGTH	1 (Char)	0Ch	Number of bytes in record, excluding bytes 0 and 1.
2–9	ANTENNA HEIGHT	8 (Double)	Meters	Vertical height of antenna, in meters.
10–11	ANTENNA TYPE	2 (Short)	See Antenna type byte values , page 88.	Defines the type of antenna connected to the receiver.
12	RESERVED	1 (Char)	00h	Reserved (set to zero).
13	RESERVED	1 (Char)	00h	Reserved (set to zero).

The following table provides byte values for the information in the antenna record.

Antenna type byte values

Byte value		Notes
Dec	Hex	
85	55h	Zephyr (KZ)
86	56h	Zephyr Geodetic™ (GZ)
184	B8h	Zephyr – Model 2 (KS)
185	B9h	Zephyr Geodetic 2 (GS)
266	01h 0Ah	AG25 (KT)
309	01h 35h	AV59 (FA)
349	01h 5Dh	AV33 (M0)
403	01h 93h	AV34 (M1)
404	01h 94h	AV37 (M2)
406	01h 96h	LV59 (M3)

For a complete and up-to-date list of antennas, go to www.trimble.com/trimbleconfiguration_ts.asp and install the Trimble Configuration Utility. Then open the Antenna.INI file (the default location is C:\Program Files\Common Files\Trimble\Config\antenna.ini) with an ASCII viewer to find antennas by name and their antenna type value.

Device control record

The device control record contains configuration parameters for controlling some external devices and the operation of some receiver options. The number of bytes contained in the record and the length of the record are determined by the device type entry.

The following table shows the additional records provided when the device type record is included with Command Packet 64h.

Device type	Byte	Item	Type	Value	Notes
All	0	RECORD TYPE	1 (Char)	09h	Device Control record.
	1	RECORD LENGTH	1 (Char)	02h or 0Dh	Number of bytes in record, excluding bytes 0 and 1.
	2	DEVICE TYPE	1 (Char)	See Device type byte values, page 89.	Type of device.
1 PPS Output only	3	1 PPS CONTROL	1 (Char)	See 1 PPS control byte values, page 89.	Enables or disables 1 PPS output; byte 2 is set to 2.

The following tables provide byte values for the information in the device control record.

Device type byte values

Byte value		Notes
Dec	Hex	
0	00h	Reserved
1	01h	Reserved
2	02h	1 PPS (Pulse per second) output
3	03h	Reserved
4	04h	Reserved
5	05h	Reserved
6	06h	Reserved
7	07h	Reserved

1 PPS control byte values

Byte value		Notes
Dec	Hex	
0	00h	1 PPS output is off
1	01h	1 PPS output is on

Static/kinematic record

The static/kinematic record identifies the antenna type and the true vertical height of the antenna above the ground mark.

The following table shows the additional records provided when the static/kinematic record is included with Command Packet 64h.

Byte	Item	Type	Value	Notes
0	RECORD TYPE	1 (Char)	0Ah	Static/Kinematic record.
1	RECORD LENGTH	1 (Char)	01h	Number of bytes in record, excluding bytes 0 and 1.
2	STATIC/KINEMATIC MODE	1 (Char)	See Static/kinematic byte values, page 90.	Configures receiver for static or kinematic operation.

The following table provides byte values for the information in the static/kinematic record.

Static/kinematic byte values

Byte value		Notes
Dec	Hex	
0	00h	Kinematic
1	01h	Static
2–255	02h–FFh	Reserved

Multiplexed port control record

The multiplexed port control record identifies which of the multiplexed ports is active.

The following table shows the additional records provided when the output message record is included with Command Packet 64h.

Byte	Item	Type	Value	Notes
0	RECORD TYPE	1 (Char)	53h	Multiplexed port control record.
1	RECORD LENGTH	1 (Char)	01h	Number of bytes in the record, excluding bytes 0 and 1.
2	SELECTED MUX PORT	1 (Char)	See Selected MUX port type byte values, page 90.	Type of message or packet.

The following table provides byte values for the information in the multiplexed port control record.

Selected MUX port type byte values

Byte value	Notes
0	None
1	CAN1
2	Serial (COM3 on the BD970 and BD982)
3	Event 2
4	PPS

Command 65h, GETAPPFILE (Application file request)

A specific application file can be downloaded from the receiver by sending the Command Packet 65h. If the request is valid, a copy of the application file is downloaded to the remote device in Report Packet 64h.

The receiver can store multiple application files (including a default application file, containing the factory default parameter settings) in the application file directory. Each application file is assigned a number to give the file a unique identity within the directory. The application file containing the factory default values is assigned a system file index code of zero (0).

The following table shows the packet structure. All data in the packet flows from the data collector to the receiver. For more information, see Command 64h, APPFILE (Application file record), page 68.

Byte	Item	Type	Value	Notes
0	STX	1 (Char)	02h	Start transmission
1	STATUS	1 (Char)	See Receiver status byte, page 12.	Receiver status indicator.
2	PACKET TYPE	1 (Char)	65h	Command Packet Type
3	LENGTH	1 (Char)	See Packet structure, page 11.	Data byte count.
4–5	SYSTEM FILE INDEX	2 (Short)	0–n	Unique number (ID code) assigned to each of the application files stored in the application file directory.
6	CHECKSUM	1 (Char)	See Packet structure, page 11.	Checksum value.
7	ETX	1 (Char)	03h	End transmission

Response 64h, APPFILE (Application file record report)

Report Packet 64h is sent to the remote device when Command Packet 65h is sent to request a specific application file. Command Packet 65h requests the application file by System File Index.

For more information about application files and guidelines for using application files to control remote devices, see Command 64h, APPFILE (Application file record), page 68.

The Application File Record Report format is identical to the format used for Command Packet 64h. For more information, see Packet paging, page 67.

Command 66h, GETAFDIR (Application file directory listing)

Command Packet 66h is used to request a directory listing of the application files stored in receiver memory. The receiver responds by sending the directory listing in Report Packet 67h.

The following table describes the packet structure.

Byte	Item	Type	Value	Notes
0	STX	1 (Char)	02h	Start transmission
1	STATUS	1 (Char)	See Table 3.2, page 13.	Receiver status code.
2	PACKET TYPE	1 (Char)	66h	Command Packet Type
3	LENGTH	1 (Char)	0h	Data byte count
4	CHECKSUM	1 (Char)	See Table 3.1, page 12.	Checksum value.
5	ETX	1 (Char)	03h	End transmission

Response 67h, RETAFDIR (Directory listing report)

Report Packet 67h sends a listing of the application files in the application file directory. The report is requested with Command Packet 66h.

Report Packet 67h can exceed the maximum data byte limit (248 bytes of data) for RS-232 Serial Interface Specification packets, depending on the number of application files stored in memory. Each application file directory entry occupies 17 bytes. The application file directory block (bytes 8–24) is repeated for every application file stored in directory. At least one application file exists (SYSTEM FILE INDEX number 0, the Default Application File). The receiver can store multiple user-defined application file records.

Report Packet 67h is divided into subpackets called pages when the data byte limit is exceeded. The PAGE INDEX and MAXIMUM PAGE INDEX bytes are used to account for the pages included in the report (0 of 2, 1 of 2, 2 of 2).

The TX BLOCK IDENTIFIER uses a roll-over counter to assign a transaction number to the report packet pages. The TX BLOCK IDENTIFIER INDEX number is useful for preventing data mismatches when stream synchronization is lost.

The following table describes the packet structure.

Note – *All date and time fields are relative to UTC.*

Byte	Item	Type	Value	Meaning
0	STX	1 (Char)	02h	Start transmission.
1	STATUS	1 (Char)	See Receiver status byte, page 12.	Receiver status code.
2	PACKET TYPE	1 (Char)	67h	Report Packet Type.
3	LENGTH	1 (Char)	See Packet structure, page 11.	Data byte count.
4	TX BLOCK IDENTIFIER	1 (Char)	00h–FFh	Unique number assigned to every application file transfer.
5	PAGE INDEX	1 (Char)	00h–FFh	Page index assigned to packet page.
6	MAXIMUM PAGE INDEX	1 (Char)	00h–FFh	Page index assigned to the last packet page.
7	# APP FILES	1 (Char)	00h–n	Number of application files in directory.
	First application file directory record. This block is repeated for each application file.			
8–9	SYSTEM FILE INDEX	2 (Char)	See System file index values, page 95.	Record number assigned to the file.
10–17	APP FILE NAME	8 (Chars)	ASCII text	Name of application file (8 ASCII characters).
18	CREATION YEAR	1 (Char)	00h–FFh	Year when file is created. Based on the years since 1900 (1900 = 00).
19	CREATION MONTH	1 (Char)	01h–0Ch	Month of the year when file is created (1–12).

Byte	Item	Type	Value	Meaning
20	CREATION DAY	1 (Char)	01h–1Fh	Day of the month when file is created (1–31).
21	CREATION HOUR	1 (Char)	00h–17h	Hour when file is created (0–23).
22	CREATION MINUTES	1 (Char)	00h–3Bh	Minutes of hour when file is created (0–59).
23–24	APP FILE SIZE	2 (Short)	bytes	Size of file.
Additional application file directory records.				
Length +4	CHECKSUM	(Char)	See Packet structure, page 11.	Checksum value.
Length +5	ETX	(Char)		End transmission.

System file index values

The following table provides values for the system file index byte.

Byte Value		Notes
Dec	Hex	
0	00h	Application file record number of the default application file which contains factory default values.
1	01h	Application file record number of the current application file which contains current setting values.
2–n	02h–nh	Application file record number for stored application files.

Command 68h, DELAPPFILE (Delete application file data)

Command Packet 68h deletes the data for a specified application file. The application file is selected by specifying the System File Index assigned to the file.

Byte	Item	Type	Value	Notes
0	STX	1 (Char)	02h	Start transmission.
1	STATUS	1 (Char)	See Receiver status byte, page 12.	Receiver status indicator.
2	PACKET TYPE	1 (Char)	68h	Command Packet Type.
3	LENGTH	1 (Char)	01h	Data byte count.
4–5	SYSTEM FILE INDEX	2 (Short)	0–n	Unique number assigned to each of the application files stored in the Application File directory.
6	CHECKSUM	1 (Char)	See Packet structure, page 11.	Checksum.
7	ETX	1 (Char)	03h	End transmission.

Command 6Dh, ACTAPPFILE (Activate application file)

Command Packet 6Dh is used to activate one of the application files stored in the Application File directory. The application file with the specified System File Index is activated.

Each application file is assigned a System File Index. The application file containing the factory default values is assigned a System File Index of zero (0), allowing this command to be used to reset the receiver to the factory default conditions.

The following table describes the packet structure.

Byte	Item	Type	Value	Notes
0	STX	1 (Char)	02h	Start transmission
1	STATUS	1 (Char)	See Receiver status byte, page 12.	Receiver status indicator.
2	PACKET TYPE	1 (Char)	6Dh	Command Packet Type
3	LENGTH	1 (Char)	01h	Data byte count
4–5	SYSTEM FILE INDEX	2 (Short)	0–n	Unique number assigned to each of the application files stored in the Application File directory
6	CHECKSUM	1 (Char)	See Packet structure, page 11.	Checksum.
7	ETX	1 (Char)	03h	End transmission

Display screen and software interface packets

Display screen and software interface packets sent and received by the receiver are described below.

Command 81h, KEYSIM (Key simulator)

Command Packet 81h simulates any front panel key press.

Byte	Item	Type	Value	Notes
0	STX	1 (Char)	02h	Start transmission
1	STATUS	1 (Char)	See Receiver status byte, page 12	Receiver status code.
2	PACKET TYPE	1 (Char)	81h	Command Packet Type
3	LENGTH	1 (Char)	01h	Data byte count
4	KEY ID	1 (Char)	See Key ID codes, page 98.	Key scan code ID.
5	CHECKSUM	1 (Char)	See Packet structure, page 11.	Checksum values.
6	ETX	1 (Char)	03h	End transmission

Key ID codes

The following table provides values for the key ID byte.

Scan code	Receiver key	ASCII character
7Fh	CLEAR	Del <del>
0Dh	ENTER	Enter <carriage return>
41h	Softkey Choice 1	<A>
42h	Softkey Choice 2	<B>
43h	Softkey Choice 3	<C>
44h	Softkey Choice 4	<D>
1Dh	<	—
1Ch	>	—
30h	0	<0>
31h	1	<1>
32h	2	<2>
33h	3	<3>
34h	4	<4>
35h	5	<5>
36h	6	<6>
37h	7	<7>
38h	8	<8>
39h	9	<9>
4Ch	STATUS	<L>
4Ah	SESSION	<J>

Scan code	Receiver key	ASCII character
4Bh	SAT INFO	<K>
4Fh	LOG DATA	<O>
4Dh	CONTROL	<M>
50h	ALPHA	<P>
4Eh	MODIFY	<N>
1Bh	POWER	—

Command 82h, SCRDUMP (Screen dump request)

Command Packet 82h has two forms—a command packet and report packet. Both packets are assigned the same hexadecimal code (82h).

Command Packet 82h requests an ASCII representation of a BD9xx simulated display screen. In response, Report Packet 82h sends the data used that is used to display the screen to the remote device in ASCII format.

The following table shows the packet structure.

Byte	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See Receiver status byte, page 12.	Receiver status code
2	PACKET TYPE	CHAR	82h	Command Packet 82h
3	LENGTH	CHAR	0h	Data bytes count
4	CHECKSUM	CHAR	See Packet structure, page 11.	Checksum value
5	ETX	CHAR	03h	End transmission

Response 82h, SCRDUMP (Screen dump)

Report Packet 82h is sent in response to Command Packet 82h. The receiver generates an ASCII representation (a dump) of a BD9xx display screen, and sends the dump to the remote device in Report Packet 82h.

The following table shows the packet structure.

Byte	Item	Type	Value	Notes
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See Receiver status byte, page 12.	Receiver status code.
2	PACKET TYPE	CHAR	82h	Report Packet Type
3	LENGTH	CHAR	A1h	Data byte count
4–163	ASCII DATA	CHARs		ASCII data
164	CURSOR POSITION	CHAR		Position of the cursor
165	CHECKSUM	CHAR	See Packet structure, page 11.	Checksum value.
166	ETX	CHAR	03h	End transmission

Miscellaneous receiver control packets

Miscellaneous receiver control packets are described below.

Command/response AEh, Ethernet configuration

The following table describes the structure of the report packet containing the application file. All data in the packet flows from the data collector to the receiver.

Byte	Item	Type	Value	Notes
0	STX	1 (Char)	02h	Start transmission.
1	STATUS	1 (Char)	See Receiver status byte, page 12.	Receiver status indicator.
2	PACKET TYPE	1 (Char)	AEh	Command/Response packet AEh
3	LENGTH	1 (Char)	See Packet structure, page 11.	Data byte count.
4	SUBTYPE	1 (Char)	00h, 01h, 02h, 0Ch, 0Dh, 0Eh, 0Fh, 10h	Subtypes can be: • 00h: Get DHCP and IP Address • 01h: Response DHCP and IP Address • 02h: Set DHCP and IP Address • 0Ch: Get IP Port Summary • 0Dh: Return IP Port Summary • 0Eh: Get Individual IP Port Configuration • 0Fh: Return Individual IP Port Configuration • 10h: Set Individual IP Port Configuration
	CHECKSUM	1 (Char)	See Packet structure, page 11.	Checksum value.
	ETX	1 (Char)	03h	End transmission.

Subtypes

The subtypes are:

- 00h: command sent from the data collector to the receiver this will cause the receiver to respond with the type 01h subtype message.
- 01h: response from the receiver giving the DHCP and IP Address status of the unit. For the response packets, see Subtype 1: Response DHCP and IP Address, page 103
- 02h: command sent from the data collector to the receiver setting the DHCP and IP Address status of the unit. For the structure of the command packet, see Subtype 2: Set DHCP and IP Address, page 103. It must include all fields even if DHCP is enabled (address fields can be set to 00h if DHCP is used).
- 0Ch: command sent from the data collector to the receiver this will cause the receiver to respond with the type 0Dh subtype message.
- 0Dh: response from the receiver giving the IP port summary of the unit. For the response packets, see Subtype 0Dh: Response IP Port Summary, page 104.
- 0Eh: command sent from the data collector to the receiver this will cause the receiver to respond with the type 0Fh subtype message. See Subtype 0Eh: Get Individual IP Port Configuration, page 104
- 0Fh: response from the receiver giving the IP port configuration for a specific port of the unit. For the response packets, see Subtype 0Fh: Response Individual IP Port Configuration, page 104.
- 10h: command sent from the data collector to the receiver setting the IP port configuration for a specific port of the unit. For the structure of the command packet, see Subtype 10h: Set Individual IP Port Configuration, page 105.

Subtype 1: Response DHCP and IP Address				
Byte	**Item**	**Type**	**Value**	**Meaning**
5	DHCP ACTIVE	1 (Char)	00h–01h	Set if DHCP is active, otherwise Static IP addresses are used.
6–9	IP ADDRESS	4 (Chars)	00h–FFh	Each byte gives one of the integers (0-255) in the dot-decimal notation of the IP v4 IP address assigned.
10–13	NETMASK	4 (Chars)	00h–FFh	
14–17	BROADCAST ADDRESS	4 (Chars)	00h–FFh	
18–21	GATEWAY	4 (Chars)	00h–FFh	
22–25	DNS SERVER ADDRESS	4 (Chars)	00h–FFh	
---------- End of Subtype 1 ----------				

Subtype 2: Set DHCP and IP Address				
Byte	**Item**	**Type**	**Value**	**Meaning**
5	DHCP ACTIVE	1 (Char)	00h–01h	Set if DHCP is active, otherwise Static IP addresses are used.

Subtype 2: Set DHCP and IP Address				
Byte	**Item**	**Type**	**Value**	**Meaning**
6–9	IP ADDRESS	4 (Chars)	00h–FFh	Each byte gives one of the integers (0-255) in the dot-decimal notation of the IP v4 IP address assigned when in a static IP mode (if DHCP is active this is determined from the DHCP server and can be left as four 00h characters).
10–13	NETMASK	4 (Chars)	00h–FFh	
14–17	BROADCAST ADDRESS	4 (Chars)	00h–FFh	
18–21	GATEWAY	4 (Chars)	00h–FFh	
22–25	DNS SERVER ADDRESS	4 (Chars)	00h–FFh	
---------- End of Subtype 2 ----------				

After the 02h subtype message is sent, the receivers will ACK or NAK this command.

Subtype 0Dh: Response IP Port Summary				
Byte	**Item**	**Type**	**Value**	**Meaning**
5	FIRST VIRTUAL PORT	1 (Char)	00h–FFh	The lowest numbered virtual receiver port allocated to the Ethernet interface (zero-based, see Port number values, page 84).
6	LAST VIRTUAL PORT	1 (Char)	00h–FFh	The highest numbered virtual receiver port allocated to the Ethernet interface ((zero-based, see Port number values, page 84).
7	NUMBER OF ACTIVE VIRTUAL PORTS	1 (Char)	00h–FFh	The number of active virtual ports. This specifies the number of byest to follow.
??	ACTIVE VIRTUAL PORTS	1 (Char)	00h–FFh	List of virtual port numbers set up as active IP ports. Each byte gives the virtual port ID for a single virtual port.
---------- End of Subtype 0Dh ----------				

Subtype 0Eh: Get Individual IP Port Configuration				
Byte	**Item**	**Type**	**Value**	**Meaning**
5	VIRTUAL PORT	1 (Char)	00h–FFh	The numbered virtual receiver port whose configuration will be returned (zero-based, see Port number values, page 84).
---------- End of Subtype 0Eh ----------				

Subtype 0Fh: Response Individual IP Port Configuration				
Byte	**Item**	**Type**	**Value**	**Meaning**
5	VIRTUAL PORT	1 (Char)	00h–FFh	The numbered virtual receiver port whose configuration has been returned (zero-based, see Port number values, page 84).

Subtype 0Fh: Response Individual IP Port Configuration				
Byte	**Item**	**Type**	**Value**	**Meaning**
6	ACTIVE	1 (Char)	00h–01h	Set if the virtual port is active.
7–8	IP PORT	2 (Chars)	0000h–FFFFh	The IP port number for this virtual port.
9	MODE	1 (Char)	00h–FFh	0 (TCP) or 1 (UDP)
10	UDP TIMEOUT	1 (Char)	00h–FFh	UDP Timeout in seconds
11	OUTPUT ONLY	1 (Char)	00h–FFh	If set, the port will operate in an output-only mode and allow multiple connections.
12	RESERVED	1 (Char)	00h	Reserved (set to zero).
13	INITIATE CONNECTION	1 (Char)	00h–01h	The port will operate in a client mode if set (in client mode, "OUTPUT ONLY" must be disabled).
14–15	REMOTE IP PORT	2 (Chars)	0000h–FFFFh	The IP port to connect to if initiating a connection in client mode.
16–22	RESERVED	7 (Chars)	00h	Reserved (set to zero).
23	REMOTE IP ADDR LENGTH	1 (Char	00h–FFh	Number of bytes to follow in the REMOTE IP ADDRESS.
24–??	REMOTE IP ADDRESS	?? Chars	00h–FFh	The IP address to connect to if initiating a connection in client mode. Each byte is converted to its ASCII character value.
---------- End of Subtype 0Fh ----------				

Subtype 10h: Set Individual IP Port Configuration				
Byte	**Item**	**Type**	**Value**	**Meaning**
5	VIRTUAL PORT	1 (Char)	00h–FFh	The numbered virtual receiver port whose configuration has been returned (zero-based, see Port number values, page 84).
6	ACTIVE	1 (Char)	00h–01h	Set if the virtual port is active.
7–8	IP PORT	2 (Chars)	0000h–FFFFh	The IP port number for this virtual port.
9	MODE	1 (Char)	00h–FFh	0 (TCP) or 1 (UDP)
10	UDP TIMEOUT	1 (Char)	00h–FFh	UDP Timeout in seconds
11	OUTPUT ONLY	1 (Char)	00h–FFh	If set, the port will operate in an output-only mode and allow multiple connections.
12	RESERVED	1 (Char)	00h	Reserved (set to zero).
13	INITIATE CONNECTION	1 (Char)	00h–01h	The port will operate in a client mode if set (in client mode, "OUTPUT ONLY" must be disabled).
14–15	REMOTE IP PORT	2 (Chars)	0000h–FFFFh	The IP port to connect to if initiating a connection in client mode.

Subtype 10h: Set Individual IP Port Configuration				
Byte	**Item**	**Type**	**Value**	**Meaning**
16–22	RESERVED	7 (Chars)	00h	Reserved (set to zero).
23	REMOTE IP ADDR LENGTH	1 (Char	00h–FFh	Number of bytes to follow in the REMOTE IP ADDRESS.
24–??	REMOTE IP ADDRESS	?? Chars	00h–FFh	The IP address to connect to if initiating a connection in client mode. Each byte is converted from its ASCII character value.
---------- End of Subtype 10h ----------				

After the 10h subtype message is sent, the receivers will ACK or NAK this command.

Command 6Fh, BREAKREQ

Command Packet 6Fh requests the receivers current serial port communication parameters, receiver version numbers and dates, and communication protocol settings. The receiver responds by sending the data in the Report Packet 6Eh.

All data in the packet flows from the data collector to the receiver.

Byte	Item	Type	Value	Notes
0	STX	1 (Char)	02h	Start transmission.
1	STATUS	1 (Char)	See Receiver status byte, page 12.	Receiver status indicator.
2	PACKET TYPE	1 (Char)	6Fh	Command packet 6Fh.
3	LENGTH	1 (Char)	00h	Data byte count.
4	CHECKSUM	1 (Char)	See Packet structure, page 11.	Checksum value.
5	ETX	1 (Char)	03h	End transmission.

Response 6Eh, BREAKRET (Break sequence return)

Response Packet 6Eh is sent in response to the Command Packet 6Fh. Response Packet 6Eh returns the receivers current serial port communication parameters, receiver version numbers and dates, and communication protocol settings when the remote device sends a 250 millisecond (minimum duration) break sequence.

Sending a break sequence

To initiate a break sequence return, the following events need to occur:

1. The remote device sends a break sequence with a minimum duration of 250 milliseconds to the receiver. For example, pressing Ctrl + Break from an office computer is equivalent to sending a break sequence.
2. The receiver detects the break signal and responds by setting the communication parameters for the serial port to 9600 baud, 8 data bits, no parity, and 1 stop bit.
3. The receiver outputs an Identity Message through the serial port to the remote device.

The following table describes the structure of Report Packet 6Eh.

Byte	Item	Type	Value	Notes
0	STX	1 (Char)		Start transmission.
1	STATUS	1 (Char)	See Receiver status byte, page 12.	Receiver status indicator.
2	PACKET TYPE	1 (Char)	6Eh	Report Packet Type.
3	LENGTH	1 (Char)	See Packet structure, page 11.	Data byte count.
	PRODUCT	(Chars)	Comma-delimited ASCII string	Comma-delimited ASCII string indicating the receiver product family name. For more information, see Product, page 110.
	PORT SETTING	(Chars)	Comma-delimited ASCII string	Comma-delimited ASCII string indicating the serial port settings and the break sequence acknowledgment code. For more information, see Port, page 110.
	PORT STATUS	(Chars)	“FIX” / “ADJ”	FIX: Port settings cannot be changed. ADJ: Port settings can be changed.
	VERSION	(Chars)	Comma-delimited ASCII string	Comma-delimited ASCII string indicating the software version number and version release date. For more information, see Version, page 110.

Byte	Item	Type	Value	Notes
	COMM PROTOCOL	(Chars)	Comma-delimited ASCII string	Comma-delimited ASCII string indicating the communication protocols supported on serial port. For more information, see Comm, page 111.
	SERIAL NUMBER	(Chars)	Comma-delimited ASCII string	Comma-delimited ASCII string indicating the receiver serial number.
	NAME (optional)	(Chars)	Comma-delimited ASCII string	Comma-delimited ASCII string indicating the receiver name and serial number.
	IP ADDRESS	(Chars)	Comma-delimited ASCII string	Comma-delimited ASCII string indicating the IP address of the receiver. If no IP address is assigned or set, 0.0.0.0 is returned.
	WLANIP (optional)	(Chars)	Comma-delimited ASCII string	Comma-delimited ASCII string indicating the receiver Wireless LAN IP address. If no IP address is assigned or set, 0.0.0.0 is returned.
	CORE VER	(Chars)	Comma-delimited ASCII string	Comma-delimited ASCII string indicating the receiver firmware version number.
	CHECKSUM	1 (Char)	See Packet structure, page 11.	Checksum value.
	ETX	1 (Char)	03h	End transmission.

Identity message format

The following example shows the structure of an Identity Message:

<STX><0><0x6E><93>

PRODUCT,BD9xx;

PORT,1,38400,38400,8,1,N,F;

VERSION,4.70,12/20/12,,;

COMM,DCOL,NMEA;

SERIAL,1028014797;

NAME,BD920-W3G, 1028014797: Trimble BD920-W3G;

ETHIP,10.1.94.242;

WLANIP,192.168.142.1;

CORE_VER,4.70;

<CHECKSUM><ETX>

Note – *The previous example shows the strings on separate lines for clarity, but the actual message is one continuous string of characters.*

Detailed information about the four parameter strings is described in the following sections.

Product

For the receiver, the PRODUCT string is always set to BD9xx. The string always begins with the word PRODUCT, followed by a comma, followed by the word BD9xx, and terminated with a semicolon as in the following example:

PRODUCT,BD9xx;

Port

The PORT parameter is a comma-delimited string of ASCII characters describing the current input baud rate, output baud rate, data bits, stop bits, parity, and the break sequence status acknowledgment. The syntax of the comma delimited string is shown below:

PORT,input baud rate,output baud rate,data bits,stop bits, parity,boolean acknowledgement;

The string always begins with the word PORT, and the end of the string is always terminated with a semicolon character. Commas are used to delimit the other fields within the string.

The input and output protocols can be 2400, 4800, 9600, 19200, 38400, 57600, or 115k baud. The number of data bits is always set to 8, and the number of stop bits is always set to 1. The parity can be O (Odd), E (Even), or N (None). The string always identifies the current communication parameters defined for the port.

The final field in the string contains the boolean (T or F) code used to acknowledge the break sequence. A value of T (True) indicates that the communication parameters for the port are going to be set to 9600,8,N,1 for at least 5 seconds. A value of F (False) indicates that the receiver outputs the identity strings at 9600,8,N,1 and returns to the current port settings.

A sample string is shown below:

PORT,38400,38400,8,1,N,F;

Version

The VERSION parameter is a comma-delimited string of ASCII characters with the BD9xx firmware and hardware version numbers and release dates. The end of the string is terminated with a semicolon. The syntax of the comma-delimited ASCII string is shown below:

VERSION,software version number,version date,hardware version,version date;

The string always begins with the word VERSION, followed by the software version number and date and two commas (,). The slash character (/) is used to separate the month, day, and year in date fields. The string is always terminated with a semicolon character. The following example shows a sample string:

VERSION,0.81,5/20/11,,;

Comm

The COMM parameter is a comma-delimited string of communication protocols supported on the connected serial port. The string has the following syntax:

COMM,first protocol,...last protocol;

The string always begins with the word COMM and a comma, followed by the comma-delimited list of protocols. The string is terminated with a semicolon character. The following table identifies the ASCII codes assigned to the various protocols supported by the receiver:

Protocol	Notes
DCOL	Data Collector Format
NMEA	Outputs a subset of NMEA-0183 messages
RTCM	Radio Technical Commission for Maritime Services protocol specification RTCM SC-104

For example, the comma-delimited ASCII string for the connected serial port which supports DCOL and RTCM is shown below:

COMM,DCOL,RTCM;

Serial

The SERIAL parameter indicates the serial number of the unit.

Name

This is an optional parameter. If present, the NAME parameter indicates the model name of the unit and serial number.

ETHIP

The ETHIP parameter indicates the Ethernet IP address of the unit.

WLANIP

This is an optional parameter. If present, the WLANIP parameter indicates the Wi-Fi (or other Wireless LAN) IP address of the unit.

CORE_VER

The CORE_VER parameter indicates the version number of the firmware. For released firmware this will be the same as the VERSION parameter.

Command 58h, RESETRCVR (Reset Receiver)

Command Packet 58h can be used to reset the receiver to a known state and may cause some or all of the receiver parameters and/or memory to be cleared. It can be used to clear all satellite data (ephemeris, almanac, last position, and so on) and reboots the receiver.

Use this command to emulate the *Clear All Satellite Data* option in the web interface (*Receiver Configuration* / *Reset* / *Clear All Satellite Data*).

The following table describes the packet structure.

Byte	Item	Type	Value	Meaning
0	STX	1 (Char)	02h	Start transmission
1	STATUS	1 (Char)	??h. See Receiver status byte, page 12.	Receiver status code
2	PACKET TYPE	1 (Char)	58h	Command Packet Type
3	LENGTH	1 (Char)	07h	Bytes of data
4	RESET FLAG1	1 (Byte)	FFh	This byte is always FFh for BD series receivers.
5	RESET FLAG2	1 (Byte)	See Reset values, page 112.	Reset flag
6–10	“Reset” String	5 (String)	52h 45h 53h 45h 54h	“RESET” is the literal string which must be sent. It is intended to prevent accidental erasure of receiver memory should there be a bad communications line.
11	CHECKSUM	1 (Char)	??h See Packet structure, page 11.	Checksum value
12	ETX	1 (Char)	03h	End transmission

Reset values

The following table provides values for the Reset Flag 2 byte.

Byte Value		Notes
Dec	Hex	
0	00h	Reboots the receiver (simulates a shutdown from a power failure).
1	01h	Clears the file system, including all application files, resets the unit to the default configuration, and reboots the receiver. All

Byte Value		Notes
Dec	Hex	
		Ethernet network settings are preserved.
2	02h	Clears RAM, including all satellite data, and reboots the receiver. All Ethernet network settings are preserved.
3	03h	Clears the file system, RAM, Ethernet network settings, resets the unit to the default configuration, and reboots the receiver.