Log & Command Reference for David30-D GNSS Receiver

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Revision History

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Foreword

This < Log & Command Reference > offers you information on commands, logs, default settings, and examples of Tersus David30-D GNSS receiver.

Audience

This < Log & Command Reference> is applied to the technicians who know GNSS Receiver to some extent but not to the general readers.

Contents

1. Overview of Command System

Tersus GNSS systems allow users to modify its configuration with command systems. Here are some general remarks on this command system:

- All commands are not case-sensitive.
- All loggings related command must specify the port related. If the port is not specified, the command is applied to current port.
- If the commands are executed successfully, the board returns OK. Otherwise, it returns an error message.

The Tersus commands for High precision GNSS receiver can be categorized into the following types.

Table 1- 1 Receivers command type

NO.	Type	Description
1	Log	Output the position/velocity, etc.
2	Mode	Set the working mode for receivers,like base/rover
		Check receiver’s current work mode
3	Config	Configure receiver’s function/interfaces
		Check receiver’s current configuration
4	Mask	Mask/unmask constellation or elevation. Set the satellite system, frequency, and elevation angle tracked by receivers.

Only printable ASCII characters are allowed, plus CR (carriage return) and LF (line feed). Each sentence starts with a “$” sign and ends with CR>LF>.

All commands are composed of command header and configuration parameters (if the parameter part can be empty, the command has only one command header). The header field contains the command name or message header.

2. Commands

2.1 ASSIGNALL

This command is used to override the automatic satellites/channel assignment and re-acquisition process. Generally, it is used to remove one or two systems from solution.

Table 2- 1 Assignall

Name		Value
Command		ASSIGNALL system state
Example		ASSIGNALL GLONASS idle ASSIGNALL GLONASS auto
Parameter description	System	GPS/GLONASS/BD2/GALILEO
	State	Idle: set the system channel to not track any satellites Auto: set the system channel active(default)

2.2 COM

This command is used to change the baud rate of the serial port to adapt its host device requirement.

Table 2- 2 COM

Name		Value
Command		COM [port] bps
Example		COM COM1 115200
Parameter description	Port	COM1/COM2/COM3
	Bps/baud	9600, 19200, 38400, 57600, 115200(default), 230400, 460800

2.3 FIX

This command is used to fix position to the input values.

FIX POSITION should only be used for base station receivers. A station coordinate command is used to manage whether fix the station coordinate. For RTK, the coordinates should be fixed as known value when it serves as the base station.If the position is unknown, please refer to MODE BASE command.

1) FIX POSITION

This command is to fix the coordinate of a base station.

Table 2-3 FIX POSITION

Name		Value
Command		Fix position Lat Long Height
Example		Fix position 31.24523012 121.58922341 40.35
Parameter description	Lat	Latitude in degree (-90.0~90.0)
	Long	Longitude in degree (-180.0~180.0)
	Height	Mean sea level in meter.

Note:

1.The base coordinates are expressed in DEGREE and METER, the coordinates with the right units are necessary.

2.The height parameter is mean sea level which is different from ellipsoid height.

2) LOG FIXA

This log is to inquire the fix status of a base station.

Input ‘log fixa’ in the text console window, the response is as blow:

POSITION X Y Z

in which, X Y Z are the fixed coordinates of a base entered by the user. When there is no antenna connected, the OEM board cannot be positioned. In this case it responses POSITION NONE.

3) FIX NONE

This command is for canceling fixed coordinate. When switching the role of the board from base station to rover station, removing the fixed coordinate is necessary. In this case, use this command to remove the fixed coordinate.

2.4 FRESET

This command is used to clear data which is stored in non-volatile memory. Such data includes the almanac, ephemeris, and any user specific configurations. Set the baud rate to 115200 bps when restoring factory default settings.

Table 2-4 FRESET

Name	Value
Command	FRESET
Example	FRESET
Description	Erase all stored data, including the ephemeris, almanac and any other configurations, and leads to restore the factory default settings, the factory set baud rate is 115200 bps.

2.5 LOG

This command is to request logs from the receiver.

If the log is synchronous, the trigger is ONTIME; if it is asynchronous, the trigger is ONCHANGED. The unit of period is second.

The [port] parameter is optional. If [port] is not specified, [port] is defaulted to the port that the command was received on.

Table 2-5 LOG

Name	Value
Command	LOG [port] message [trigger [period]]
Example 1	LOG COM1 BESTPOSB ONTIME 1 The above example shows BESTPOS logging to com port 1 at 1 second intervals.
Example 2	LOG COM2 VERSION ONCE

Table 2-6 ASCII format

ID	Field	ASCII Value	Description
1	LOG (ASCII) header	-	This field contains the command name or the message header depending on whether the command is abbreviated ASCII or ASCII respectively
2	port	COM1, COM2, COM3	Output port (default = THISPORT)
3	message	Any valid message name, with an optional A or B suffix	Message name of log to output
4	trigger	ONNEW	Output when the message is updated (not necessarily changed)
		ONCHANGED	Output immediately and thereafter when the message is changed
		ONTIME	Output on a time interval
		ONCE	Output only the current message (default). If no message is currently is present, the next message is output when available.
		ONMARK	Output when a pulse is detected on the mark 1 input
5	period	Valid values for the high rate logging are 0.05, 0.1, and 0.2. For logging slower than 1 Hz any integer value is accepted.	Log period (for ONTIME trigger) in seconds

2.6 NMEATALKER

This command is for NMEA talker configuration.

Table 2- 7 NMEATALKER

Name		Value	
Command		nmeatalker id	
Example		nmeatalker GP	
Parameter description	id	GP	All NMEA loggings will have a 'GP' talker solution, even when GLONASS/BDS satellites are used in solution. If there are GPS, GLONASS and BDS satellites in the solution, the talker ID will be GN. If there are only BDS satellites in the solution, the talker ID of this message is BD. If there are only GLONASS satellites in the solution, the talker ID of this message is GL.
		AUTO	default

2.7 RESET

This command is used to reset the receiver, which can also restart the receiver and clear the satellite ephemeris, position information, satellite almanac, ionosphere and UTC parameters and other data stored in the receiver.

Table 2- 8 RESET

Name		Value
Command		RESET [parameter]
Example		RESET EPHEM
Parameter description	——	Reset the receiver
	EPHEM	Reset the stored GPS ephemeris
	POSITION	Reset the stored position
	ALMANAC	Reset the stored almanac
	IONUTC	Reset the ionospheric and UTC information

2.8 RTKCOMMAND

This command is used to reset the RTK filter or clear any set RTK parameters. The RESET command causes the RTK algorithm to undergo a complete reset.

Table 2- 9 RTKCOMMAND

Name	Value	
Command	RTKCOMMAND [parameter]	
Example	RTKCOMMAND RESET RTKCOMMAND USER_DEFAULTS	
Parameter description	RESET	Reset RTK filter
	USER_DEFAULTS	Reset to defaults

2.9 RTKTIMEOUT

This command is used to set the maximum age of RTK data to use when operating as a rover station.

Table 2- 10 RTKTIMEOUT

Name		Value
Command		RTKTIMEOUT delay
Example		RTKTIMEOUT 60
Parameter description	delay	Maximum RTK data age (2 to 100). (unit second)

2.10 SAVECONFIG

This command is used to save current configurations to the non-volatile memory. The saved configurations are still valid even if the board is rebooted.

Table 2- 11 SAVECONFIG

Name	Value
Command	SAVECONFIG
Example	SAVECONFIG
Description	Save current configuration

2.11 UNDULATION

This command permits you to either enter a specific geoid undulation or use the built-in grid value of geoid undulations.When using UNDULATION and FIX continuously, you should first configure UNDULATION.

Table 2- 12 UNDULATION

Name		Value
Command		UNDULATION [parameter]
Example		UNDULATION AUTO UNDULATION 9.7
Parameter Description	auto	Use built-in geoid undulation grid table
	separation	Use user-specified undulation value, ranged from -1000 m to +1000 m

2.12 UNLOG

This command is used to stop specified output, which is cancelling particular output. The [port] parameter is optional. If [port] is not specified, it is defaulted to the port on which the command was received.

Table 2- 13 UNLOG

Name		Value
Command		Unlog port message
Example		Unlog COM1 GPGGA
Parameter description	port	COM1 / COM2 / COM3
	message	NMEA message / rtcm message / observation message

2.13 UNLOGALL

This command is used to stop all output from specified port.

Table 2- 14 UNLOGALL

Name		Value	
Command		unlogall [port] [held]	
Example		unlogall	
Parameter description	port	COM1 / COM2 / COM3	
	held	FALSE	Does not remove logs with the HOLD parameter (default).
		TRUE	Remove previously held logs, even those with the HOLD parameter.

2.14 Heading

This command is used for dual-antenna receivers. The heading result is the angle from True North to the baseline of the ANT1 to ANT2 in a clockwise direction. The heading function is enabled by default settings.Frequently used commands are as follows.

GPHDT 1

SAVECONFIG

3. MODE Command

MODE command can set the operating mode of the receiver. The receiver’s operating modes include base mode, rover mode, and heading mode. Re-entering a new command will make the receiver perform solution according to the latest input. For example, when the receiver is working in base mode, re-entering RTK rover mode will make it switch to rover mode and start RTK initialization.

The receiver supports all the operating modes above, but in actual use, the available functions are dependable on the authorization that the user bought.

The default setting is rover mode. The receivers can automatically identify the RTCM format, and users don't need to specify the type of RTCM.

Table 3- 1 Receiver work mode list

Name	Parameter	Description
MODE	BASE	Set the receiver to work in base station mode
	ROVER	Set the receiver to work in rover station mode
	HEADING	Set the receiver to work in heading mode

3.1 Check the Receiver Working Mode

The MODE command is used to check receiver working mode.

Table 3- 2 Receiver work mode checking

Command	Description
MODE	Check working mode like base/rover
Input	MODE
Output Example	#MODE,91,GPS,FINE,2253,114322000,0,0,18,170;mode base, HEADINGMODE FIXLENGTH*4B

3.2 Fixed Base Station with Precise Coordinates

This command is used to set coordinates of the base station to make the receiver work in base station mode. The receiver supports the coordinate input in geodetic Coordinates and Earth-Centered Earth-Fixed. After the coordinates are set, GPGGA message always displays the coordinates in the output positioning information.

Table 3- 3 Base station mode with fixed coordinates

Name	Value
Command	MODE BASE [ID] [param1 param2 param3]
Example 1	MODE BASE 40.45628476579 116.2859754968 58.0984
Example 2	MODE BASE -2160489.0276 4383620.1006 4084738.1110

Input the Latitude (deg), Longitude (deg), and Height above sea level in BLH Coordinates System.

Latitude, in degree, Range: -90≤param1≤90;

Longitude, in degree, Range: -180≤param2≤180;

Height above sea level, in meters, Range: -30000≤param3≤30000.

Set ECEF coordinates.

- The X-axis value in the ECEF coordinates system, in meters, Range: param1 < -90 or param1 > 90.
- The Y-axis value in the ECEF coordinates system, in meters, Range: param2 < -180 or param2 > 180.
- The Z-axis value in the ECEF coordinates system, in meters, Range: param3 < -30000 or param3 > 30000.

"[ID]" in the command is the base station ID. The value for ID is a positive integer between 0 and 4095.

3.3 Self-Optimizing Base Station Mode

This command sets the receiver to optimize the positioning results automatically until a specified time or after the accuracy of the horizontal and vertical coordinates reach the specified values. Then the receiver sets the optimized values as the coordinates of the base station.When the base station has been set in the self-optimizing mode, if user re-enters the fixed coordinates, the receiver will reset to the fixed base station mode and use the input coordinates as the position of the base station.

Table 3- 4 Base station mode with self-optimizing coordinates

Name	Description	
Command	MODE BASE [ID] TIME [T] [DISTANCE]	
Example	MODE BASE TIME 60 1.5 2.5 MODE BASE TIME 60 1.5 2.5 5 MODE BASE 1 TIME 60 2.5 3.5	
Parameters	ID	Integer between 0~4095 (can be omitted)
	T	Maximum time to calculate the average position, in seconds
	DISTANCE	Distance, in meters. The receiver starts in selfoptimizing base station mode and saves the optimized position in Flash. When the receiver restarts, it optimizes the position again. If the distance between the optimized coordinates and that saved in Flash is less than the value of "Distance", the receiver will set the coordinates saved in Flash as the base station coordinates. The range of "Distance" is: 0 ≤ Distance ≤ 10. If Distance = 0, the receiver will start in selfoptimizing base station mode and set the optimized result as the coordinates of the base station.

3.4 Base Station Mode without Parameters

The base station mode without parameters: MODE BASE, if the BASE command is not followed by any parameters, the receiver will start the default base station configuration. The default configuration means the receiver will average the currently 60 seconds positioning results and fix it, it must meet either of the following two factors.

a) Optimizing time lasts for 60 seconds;
b) The average horizontal error tolerance of position reaches the default value 1.5 m and the average vertical error tolerance of average position reaches the default value 2.5 m.

Command Format: MODE BASE

Table 3- 5 Base station mode with default parameters

Command	Mode	Parameter	Description
MODE	BASE	-	Option for default base station mode

3.5 Set Base Station ID

Set the base station ID, and use the positive integer in the range of 0≤ID<4096.

Command Format: MODE BASE [ID]
Abbreviated ASCII Syntax: MODE BASE 1

Table 3- 6 Base station ID parameter

Command	Mode	ID	Description
MODE	BASE	0≤ID<4096	Optional field for base station ID. Configure the receiver to work in the base station mode and set its ID number with a positive integer between 0 and 4096

3.6 Rover Station Mode Configuration

Rover Station receives the real-time differential correction data from the base station. Rover can adaptively recognize the RTCM data and perform RTK solution. There are three kinds of RTK mode: static mode, dynamic mode and automatic mode.

The default setting is dynamic mode. The receiver will automatically start RTK positioning when receiving correction data from any serial ports.

Command Format: MODE ROVER [parameter]

Abbreviated ASCII Syntax:

MODE ROVER

MODE ROVER STATIC

Table 3- 7 Rover station work mode parameters

Command	Mode	Parameter	Description
MODE	ROVER	-	RTK dynamic mode(default)
		STATIC	RTK static mode

4. CONFIG Command

CONFIG is the header of the commands that are used to set the serial ports, PPS, geoid undulation, DGNSS engine, and RTK engine of the receiver. It supports the following configuration:

1) Serial port settings, such as baud rate
2) PPS
3) Geoid undulation
4) DGPS engine
5) RTK engine
6) EVENT function
7) Heading

The characters that can be parsed include numbers, upper case and lower case letters, and specified characters including double quotation marks(“”), hyphen(-), colon(:), underscore(_), dollar sign($), comma(,), slash(/), and backslashes(\\). Other characters appeared in the command cannot be parsed.

Command Format: CONFIG [devices/function] [parameter]

Example:

CONFIG COM1 115200 8 n 1

CONFIG PPS ENABLE BDS POSITIVE 100000 1000 0 0

CONFIG UNDULATION 9.7

CONFIG RTK TIMEOUT 60

CONFIG DGPS TIMEOUT 100

Table 4- 1 Device function list

NO.	Name	Description
1	COM1	COM1 serial port: port settings related to COM1, such as baud rate, parity bit
2	COM2	COM2 serial port: port settings related to COM2, such as baud rate, parity bit
3	COM3	COM3 serial port: port settings related to COM3, such as baud rate, parity bit
4	PPS	PPS configuration: enable/disable PPS output, polarity, period and pulse width
5	EVENT	Reserved
6	UNDULATION	Geoid undulation configuration: input a specific undulation value or use built-in geoid grid
7	RTK	RTK configuration: RTK solution, maximum age of RTK data.
8	DGPS	DGPS configuration: maximum age of DGPS data

4.1 Query the Receiver's Configuration

The CONFIG command is used to check the receiver's current configuration.

Command Format: CONFIG

Output Example:

$CONFIG, COM1, CONFIG COM1 460800*65
$CONFIG, COM2, CONFIG COM2 115200*23
$CONFIG, COM3, CONFIG COM3 115200*23
$CONFIG, PPS, CONFIG PPS ENABLE GPS POSITIVE 500000 1000 0 0*6E

Table 4- 2 Receiver configuration checking command

Log	Description
CONFIG	Check the receiver's current function and configuration

Note: CONFIG can query the current status of the receiver's configuration (including default configurations)

4.2 Configure Serial Port

This command is used to configure data communication parameters for the physical serial port including baud rate, data bits, parity, stop bit properties of the serial port.

High-precision GNSS receivers support three serial ports, COM1, COM2, and COM3.

These three serial ports have same functions and work independently according to their respective configurations. The three ports can be configured mutually, for example, COM2 serial port properties can be configured through COM1, vice versa. Please remain COM1 for update when integrating GNSS boards or modules.

Command Format: CONFIG [serial number] [serial port property parameter]
Abbreviated ASCII Syntax:

CONFIG COM1 115200

CONFIG COM1 115200 8 n 1

Table 4- 3 Serial port parameters list

Command	Device	Field	Parameters Supported	Description
CONFIG	COM1 COM2 COM3	1	baud rate/bps	Option for COM port communication baud rate. **Table 4- 4 Baud Rate Supported** lists the supported baud rate
		2	data bits	Option for COM port data bits. To set this field, ensure that the preceding baud rate is set up. **Note:** seven or eight data bits are supported in data transmission. The current product only supports eight bits
		3	parity	Option for COM port parity. To set this field, ensure that the preceding baud rate is set up. **Note:** three settings are supported for parity check in data transmission: N, E, O. The current product only supports N.
		4	stop bits	Option for COM port stop bits. To set this field, ensure that the preceding baud rate is set up. **Note:** one or two stop bits are supported. The current product only supports one bit.

Table 4- 4 Baud rate supported

Serial port	Description
COM1	9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600
COM2	9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600
COM3	9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600

4.3 Configure PPS

This command sets the PPS pulse signal with a specific period and pulse width, meanwhile compensating for the delay of PPS.

Command Format: CONFIG PPS [parameter]
Abbreviated ASCII Syntax:

CONFIG PPS ENABLE GPS POSITIVE 500000 1000 0 0

Table 4- 5 PPS function list

Log Header	PPS Function	Parameter	Description
CONFIG	PPS	DISABLE	Disable PPS output (once disabling the function, all other parameters are ignored) Default = DISABLE
		ENABLE	Enable PPS output. only when the time is valid, the PPS pulse can output, if losing satellite signals, the receiver stops outputting PPS pulse.
		ENABLE2	Enable PPS output, keeping PPS pulse output after the first fix.

Table 4- 6 PPS configuration

Header	PPS Function	Enable Parameter	PPS Parameter	ASCII Value	Description
CONFIG	PPS	DISABLE	–	–	Disable PPS output (once disabling the function, all other parameters are ignored) Default=DISABLE
		ENABLE/ ENABLE2	Timeref	GPS /BDS	Option for reference time system, currently only supports the GPST and BDST
			polarity	POSITIVE	Option to generates a normally low, active high PPS pulse with the rising edge as the reference
				NEGATIVE	Option to generates a normally high, active low pulse with the falling edge as the reference
			Width	Pulse width	Option to specify the pulse width of the PPS signal, microseconds,smaller than the period

CONFIG	PPS		Period	The period of the pulse,	valid values: 50,100, 200, 250, 50, 1000, 2000, 3000, …, 20000 (milliseconds)
			RfDelay	Integer betwee n -32768 and 32767	Set RF delay, nanoseconds
			UserDelay	Integer betwee n -32768 and 32767	Set user delay, nanoseconds

4.4 Configure Undulation

This command permits you to either enter a specific geoid undulation or use the built-in grid value of geoid undulations.

Command Format: CONFIG UNDULATION [parameter]
Abbreviated ASCII Syntax: CONFIG UNDULATION 9.7

Table 4- 7 Undulation configuration

Log Header	Device	Parameter	Description
CONFIG	UNDULATION	Auto	Use built-in geoid undulation grid table
		separation	Use user-specified undulation value, ranged from -1000 m to +1000m

4.5 Configure DGPS Command

This command is used to set the receiver's maximum age of pseudorange differential data accepted from the base station. Pseudorange differential data received older than specified age is ignored, which can also be used to prohibit DGPS positioning calculations.

Command Format: CONFIG DGPS [parameter]
Abbreviated ASCII Syntax: CONFIG DGPS TIMEOUT 100

Table 4- 8 DGPS maximum age configuration

Log Header	DGPS	Parameter	Value	Description
CONFIG	DGPS	TIMEOUT	0	Disable the DGPS positioning
			1-1800	Option for maximum age of differential corrections data (default = 300), in units of seconds

4.6 Configure RTK

This command is used to reset RTK engine, configure the RTK working mode, and to clear RTK parameters.

Command Format: CONFIG RTK [parameter]
Abbreviated ASCII Syntax: CONFIG RTK TIMEOUT 60

Table 4- 9 RTK solution configuration

Log Header	RTK	Parameter	Description	
CONFIG	RTK	TIMEOUT	0	Disable RTK solution
			1-1800	Option for maximum age of RTK data (default = 100), seconds. Authorization without standalone real-time centimeter positioning can support to 600 seconds
		RESET	Reset RTK solution	
		USER_DEFAULTS	RTK dynamic mode, default state	
		DISABLE	Stop calculating RTK results, including FIX and Float	
		FLOAT	Only calculate RTK float solution	

4.7 Configure Heading

This command is used to set dual-antenna heading receiver. It sets the fixed baseline length, change of baseline length and low dynamic mode of heading. The dual-antenna receiver starts up with heading function enabled by default.

Syntax: CONFIG HEADING [parameter]
CONFIG HEADING LENGTH [parameter1(optional)][parameter2(optional)]
Example: CONFIG HEADING FIXLENGTH

Table 4-10 Heading configuration

Header	Item	Parameter	Description
CONFIG	HEADING	FIXLENGTH	The distance between the master antenna (ANT1) and the slave antenna (ANT2) is fixed. ANT1 and ANT2 move synchronously or in relatively static (default mode).
		VARIABLELENGTH	The relative position and distance between the master antenna (ANT1) and the slave antenna (ANT2) change dynamic in real time .
		STATIC	Both of the master antenna (ANT1) and the slave antenna (ANT2) are in static state.
		LOWDYNAMIC	Low dynamic, which can be used for low speed moving carriers such as pile drivers.
		TRACTOR	For agricultural machinery, operating mode.
		LENGTH	For dual-antenna application with fixed baseline.
		RELIABLITY	Heading reliability threshold: 1.low reliability, 2.normal reliability, 3.relatively high reliability(default), 4.high reliability

Table 4-11 Heading length configuration

Header	Item	Parameter1	Parameter2
CONFIG	HEADING LENGTH	Fixed length of the baseline, centimeters. If the length is 20cm, input 20.	Error tolerance, centimeters. If the error tolerance is 3cm, input 3.

Note:
If parameter 1 and parameter 2 are not configured, the system will automatically use default configuration.

4.8 Configure Heading offset and Pitch offset

This command is used to set the offset value in order to correct the heading angle and pitch angle output in HEADING and GPTHS messages.
Syntax: CONFIG HEADING OFFSET [Heading offset][Pitch offset]
Example: CONFIG HEADING OFFSET 90 45

Table 4-12 Heading offset and pitch offset configuration

Header	Item	Parameter	Description
CONFIG	HEADING OFFSET	Heading offset	Heading offset correction, degree, range: -180.0 ~ 180.0
		Pitch offset	Pitch offset correction, degree, range: -90.0 ~ 90.0

4.9 Configure EVENT

The log is used to configure EVENT and relative parameters. The function is disabled by default setting.

Command Format: CONFIG EVENT [parameter1][parameter2][parameter3]
Abbreviated ASCII Syntax: CONFIG EVENT ENABLE POSITIVE 10

Table 4- 13 EVENT command configuration

Header	EVENT	Parameter	Parameter	Description
CONFIG	EVENT	switch	Disable	Disable EVENT, the EVENT function is disabled by default setting.
			Enable	Enable EVENT
		polarity	POSITIVE	The rising edge as the reference
			NEGATIVE	The falling edge as the reference
		TGUARD	There is minimum time between two valid impulses, in millisecond, if less than TGUARD, the second Event is ignored. default: 4, minimum: 2, maximum: 3,599,999	

4.10 Configure SMOOTH

This command configures the SMOOTH function and related parameters of the RTK calculating results, heading results, and Doppler velocity in SPPNAV. The SMOOTH function is disabled by default.

Command Format: CONFIG SMOOTH [computing engine] [parameter]
Abbreviated ASCII Syntax: CONFIG SMOOTH RTKHEIGHT 10

Table 4- 14 SMOOTH configuration

Header	Item	Computing Engine	Parameter	Description
CONFIG	SMOOTH	RTKHEIGHT	Time length	Unit:s, range: 0~100
		HEADING	Time length	Unit:s, range: 0~100
		PSRVEL	enable	Enable smoothing of Doppler velocity in SPPNAV
			disable	Disable smoothing of Doppler velocity in SPPNAV

5. MASK Command

5.1 MASK - Set Satellite System

This command is used to forbid to receive the specific satellite systems, satellite frequencies, satellite cut-off angle. Take the satellite cut-off angle as an example, the receiver will not start capturing satellite signals unless it rises above the cut-off angle. Also, when the satellites go down below the cut-off angle, the receiver will stop following the signal where there is no any reconfiguration.

Command Format: MASK [satellite system] [frequency/cut-off angle]
Abbreviated ASCII Syntax:

MASK GPS	Disable receiver tracking GPS satellite system
MASK BDS	Disable receiver tracking BDS satellite system
MASK GLO	Disable receiver tracking GLO satellite system
MASK GAL	Disable receiver tracking GAL satellite system
MASK QZSS	Disable receiver tracking QZSS satellite system
MASK 10	Set cut-off angle of the receiver tracking satellite
MASK 10 GPS	Set cut-off angle of GPS satellite
MASK B1	Disable the receiver to track BDS B1 signal
MASK E5a	Disable the receiver to track Galileo E5a signal

Table 5- 1 Satellite systems and frequency

NO.	System	Frequency	Description
1	GPS	L1, L2, L5	Three frequencies of GPS system: L1, L2, L5. L1, L2, L5 of QZSS system are included.
2	BDS	B1I, B2I, B1C, B2a, B3I	Five frequencies of the BEIDOU-2 satellite system: B1I, B2I, B1C, B2a, B3I
3	GLO	R1, R2	Two frequencies of GLONASS satellites: R1, R2
4	GAL	E1, E5a, E5b	Three frequencies of Galileo system: E1, E5a, E5b

6. UNMASK Command

6.1 UNMASK - Set Satellite System

This command permits to receive the satellite systems, satellite frequencies, satellite cut-off angle that you have been forbidden.

Command Format: UNMASK [satellite system] [frequency]
Abbreviated ASCII Syntax:

UNMASK GPS	Enable receiver tracking GPS satellite system
UNMASK BDS	Enable receiver tracking BDS satellite system
UNMASK GLO	Enable receiver tracking GLO satellite system
UNMASK GAL	Enable receiver tracking GAL satellite system
UNMASK B1	Enable receiver tracking BDS B1 signal
UNMASK E5a	Enable receiver tracking Galileo E5a signal

7. Data Output

7.1 NEMA 0183 Message Output

High precision receivers support NMEA0183 message output. This chapter introduces NMEA0183 output.

Abbreviated ASCII Syntax:
GNGGA 0.1
GNGGA COM2 1

7.1.1 GNGGA - GNSS Multi-System Positioning Output

This command is used to set the current serial port or specify a serial port to output the multi-system positioning results, in which, the time of GNSS receiver and positioning data are included. The message begins with GNGGA. According to satellite systems, GPGGA/BDGGA/GLGGA/GAGGA may be involved in the positioning.

- Only when the GPS satellite system is involved in the positioning calculation, it is output in the form of GPGGA.
- Only when the BDS satellite system is involved in the positioning calculation, it is output in the form of BDGGA.
- Only when the GLONASS satellite system is involved in the positioning calculation, it is output in the form of GLGGA.
- Only when the Galileo satellite system is involved in the positioning calculation, it is output in the form of GAGGA.
- If there are two satellite systems or more to participate in the positioning calculation, the output is in the form of GNGGA.

Abbreviated ASCII Syntax:

GNGGA 1 Output 1Hz GNGGA message from current serial port

GNGGA COM2 1 Output 1Hz GNGGA message from COM2

Message Output:

$GNGGA,025754.00,4004.74102107,N,11614.19532779,E,1,18,0.7,63.3224,M,-9.7848,M,,* 58

Table 7- 1 GNGGA message structure

Field	Structure	Description	Symbol	Example
1	$GNGGA	Log header		$GNGGA
2	utc	UTC time status of position (hours/minutes/seconds/ decimal seconds)	hhmmss.ss	170659.00
3	lat	Latitude (DDmm.mm)	llll.ll	4001.1220
4	lat dir	Latitude direction (N = North, S = South)	a	N
5	lon	Longitude (DDDmm.mm)	yyyyy.yy	11600.3622
6	lon dir	Longitude direction (E = East, W = West)	a	E
7	GPS qual	GPS Quality indicator 0 = Fix is not available or invalid 1 = Single point 2 = Pseudorange differential/SBAS position 4 = RTK fixed ambiguity solution 5 = RTK floating ambiguity solution 6 = INS 7 = User fixed position	x	1
8	# sats	Number of satellites in use. May be different to the number in view	xx	10
9	hdop	Horizontal dilution of precision	x.x	1.0
10	alt	Antenna altitude above/below mean sea level	x.x	1098.44

11	a-units	Units of antenna altitude (M = meters)	M	M
12	undulation	Undulation, the relationship between the geoid and the WGS84 ellipsoid. The geoid is positive when it is above the ellipsoid, otherwise, it is negative	x.x	-15.174
13	u-units	Units of undulation (M = meter)	M	M
14	age	Age of correction data (in seconds)	xx	(empty when no differential data is present)
15	stn ID	Differential base station ID , 0000-4096	xxxx	(empty when no differential data is present)
16	*xx	Checksum	*hh	*3F
17	[CR][LF]	Sentence terminator		[CR][LF]

7.1.2 GPGGA - GNSS Fix Data Output by GPGGA

This command is used to log time, multi-system positioning fix data of the receiver. Output GNSS fix data using "$GPGGA" as the message header by force. The results of GPGGA is the same as GNGGA.

Abbreviated ASCII Syntax:

GPGGA 1 — Output 1Hz GPGGA message from current serial port

GPGGA COM2 1 — Output 1Hz GPGGA message from current serial port

Message Output:

$GPGGA,025754.00,4004.74102107,N,11614.19532779,E,1,18,0.7,63.3224,M,-9.7848,M,,*58

Table 7- 2 GPGGA message structure

Field	Structure	Field Description	Symbol	Example
1	$GPGGA	Log header		$GPGGA
2	utc	UTC time status of position (hours/minutes/seconds/ decimal seconds)	hhmmss.ss	170659.00
3	lat	Latitude (DDmm.mm)	llll.ll	4001.1220
4	lat dir	Latitude direction (N = North, S = South)	a	N

5	lon	Longitude (DDDmm.mm)	yyyyy.yy	11600.3622
6	lon dir	Longitude direction (E = East, W = West)	a	E
7	GPS qual	GPS Quality indicator 0 = Fix not available or invalid 1 =Single Point 2 = Pseudorange differential/SBAS position 4 = RTK fixed ambiguity solution 5 = RTK floating ambiguity solution 6 = INS 7 = User fixed position	x	1
8	# sats	Number of satellites in use. May be different to the number in view	xx	10
9	hdop	Horizontal dilution of precision	x.x	1.0
10	alt	Antenna altitude above/below msl	x.x	1098.44
11	a-units	Units of antenna altitude (M = meters)	M	M
12	undulation	Undulation - the relationship between the geoid and the WGS84 ellipsoid. The geoid is positive when it is above the ellipsoid, otherwise, it is negative.	x.x	-15.174
13	u-units	Units of undulation (M = meter)	M	M
14	age	Age of Differential GPS data (in seconds)	xx	(empty when no differential data is present)
15	stn ID	Differential base station ID, 0000-4096	xxxx	(empty when no differential data is present)

16	*xx	Checksum	*hh	*3F
17	[CR][LF]	Sentence terminator		[CR][LF]

7.1.3 GPGSA - GPS DOP and Active Satellites

This log contains GNSS receiver operating mode, satellites used for navigation and DOP values.

Abbreviated ASCII Syntax:

GPGSA 1 Output 1Hz GPGSA message from current serial port

GPGSA COM2 1 Output 1Hz GPGSA message from com2

Message Output:

$GNGSA,M,3,05,13,02,29,20,15,30,07,,,,,1.1,0.6,0.9*23
$GNGSA,M,3,81,66,82,88,67,,,,,,,,1.1,0.6,0.9*2D
$GNGSA,M,3,02,21,07,04,,,,,,,,,1.1,0.6,0.9*24
$GNGSA,M,3,13,06,08,09,03,14,01,02,04,05,,,1.1,0.6,0.9*2E

Table 7- 3 GPGSA message structure

Field	Structure	Field Description	Symbol	Example
1	$GPGSA	Log header		$GPGSA
2	mode MA	A = Automatic 2D/3D M = Manual, forced to operate in 2D or 3D	M	M
3	mode 123	Mode: 1 = Fix or unavailable; 2 = 2D; 3 = 3D	x	3
4 - 15	prn	PRN numbers of satellites used in solution (null for unused fields), total of 12 fields. (GPS: 1 to 32, GLONASS: 65 to 96, Galileo 1 to 38, BDS 1 to 63, SBAS 120 to141 and 183 to 187, QZSS 193 to 197)	xx,xx,.....	18,03,13, 25,16, 24,12, 20,,,,
16	pdop	Position dilution of precision	x.x	1.5
17	hdop	Horizontal dilution of precision	x.x	0.9
18	vdop	Vertical dilution of precision	x.x	1.2
19	*xx	Checksum	*hh	*3F
20	[CR][LF]	Sentence terminator		[CR][LF]

7.1.4 GPGST - Pseudorange Measurement Noise Statistics

Pseudorange measurement noise statistics included in this message are translated in the position domain in order to give statistical measures of the quality of the position solution. This log reflects the accuracy of the solution type used in GPGGA, except for the RMS field. The RMS field, since it specifically relates to pseudorange inputs, does not represent carrier-phase based positions. Instead it reflects the accuracy of the pseudorange position which is given in the PSRPOS log.

Abbreviated ASCII Syntax:

GPGST 1 Output 1Hz GPGST message from current serial port

GPGST COM2 1 Output 1Hz GPGST message from com2

LOG Message Output:

$GPGST,141451.00,1.18,0.00,0.00,0.0000,0.00,0.00,0.00*6B

Table 7-4 GPGST message structure

Field	Structure	Field Description	Symbol	Example
1	$GPGST	Log header		$GPGST
2	utc	UTC time status of position (hours/minutes/seconds/ decimal seconds)	hhmmss.ss	173653.00
3	rms	RMS value of the standard deviation of the range inputs to the navigation process	x.x	2.73
4	smjr std	Standard deviation of semi-major axis of error ellipse (m)	x.x	2.55
5	smnr std	Standard deviation of semi-minor axis of error ellipse (m)	x.x	1.88
6	orient	Orientation of semi-major axis of error ellipse (degrees from true north)	x.x	15.2525
7	lat std	Standard deviation of latitude error (m)	x.x	2.51
8	lon std	Standard deviation of longitude error (m)	x.x	1.94
9	alt std	Standard deviation of altitude error (m)	x.x	4.30
10	*xx	Checksum	*hh	*6E
11	[CR][LF]	Sentence terminator		[CR][LF]

7.1.5 GPGSV - Satellites in View

This log contains the number of SVs in view, PRN numbers, elevation, azimuth and SNR value. Each message contains up to four satellites. When required, additional satellite data sent in 2 or more messages (a maximum of 9). The total number of messages being transmitted and the current message being transmitted are indicated in the first two fields.

Abbreviated ASCII Syntax:

GPGSV 1 Output 1Hz GPGSV message from current serial port

GPGSV COM2 1 Output 1Hz GPGSV message from com2

Message Output:

```
$GPGSV,3,1,09,02,51,123,47,05,69,022,49,07,12,050,41,13,58,174,48*75
$GPGSV,3,2,09,15,32,210,45,20,44,281,45,29,49,272,49,30,19,081,40*74
$GPGSV,3,3,09,21,07,307,36*45
$GLGSV,2,1,08,74,05,021,37,66,69,333,49,82,34,325,46,75,07,070,42*61
$GLGSV,2,2,08,65,23,043,44,88,33,164,40,81,77,244,49,67,33,250,45*6E
$GAGSV,1,1,04,03,86,345,48,05,33,050,44,08,35,236,43,22,42,156,45*64

$BDGSV,3,1,10,01,36,146,42,02,34,225,38,03,43,188,40,04,25,124,38*6F
$BDGSV,3,2,10,05,17,249,36,06,74,234,45,08,56,155,44,13,79,211,47*67
$BDGSV,3,3,10,14,37,054,45,09,46,229,41*6F
```

Table 7- 5 GPGSV message structure

Field	Structure	Field Description	Symbol	Example
1	$GPGSV	Log header		$GPGSV
2	# msgs	Total number of messages (1-9)	x	3
3	msg #	Message number (1-9)	x	1
4	# sats	Total number of satellites in view. May be different from the number of satellites in use	xx	09
5	prn	Satellite PRN number BDS=1~37 GPS=1~32 GLONASS=65~96 Galileo=1~38 QZSS=193~197 SBAS=120~141, 183~187	xxx	03
6	elev	Elevation, in degrees, max: 90	xx	51
7	azimuth	Azimuth, degrees True, 000 to 359	xxx	140

8	SNR	SNR (C/No) 00-99 dB, null when not tracking	xx	42
… … …	… … …	Next satellite PRN number, elev, azimuth, SNR, ... Last satellite PRN number, elev, azimuth, SNR,		
variable	*xx	Checksum	*hh	*72
variable	[CR][LF]	Sentence terminator		[CR][LF]

7.1.6 GPHDT - GPS Heading Log

This log contains actual vessel heading in degrees True (from True North).

It is required for the receiver to work in heading mode to output information.

Abbreviated ASCII Syntax:

GPHDT 1 Output 1Hz GPHDT message from current serial port

GPHDT COM3 1 Output 1Hz GPHDT message from com3

Message Output: $ GPHDT,178.7236,T*15T

Table7-6 GPHDT Message Structure

Field	Structure	Field Description	Symbol	Example
1	$GPHDT	Log header		$GPHDT
2	heading	Heading in degrees	X.X	178.7236
3	TRUE	Degrees True	T	T
4	*XX	Checksum	*hh	*15
5	[CR][LF]	Sentence terminator		[CR][LF]

HEADING

Input: Log headinga

Output:

#HEADINGA,COM1,0,29.0,FINE,1740,367835.000,00000000,e,0;SOL_COMPUTED
,NARROW_INT,0.0014,286.2120,41.0552,0.0000,416.9299,654.8104,"0",20,17,17,17,0,

01,0,c3*ce3d9c8e

Table7-7 Heading Message Structure

Field	Structure	Description
1	HEADING header	Log header
2	sol stat	Solution status, see Table 3.5 Solution Status
3	pos type	Position type, see Table 3.6 Position or Velocity Type
4	length	Baseline length (0 to 3000 m).
5	heading	Heading in degrees (0 to 360.0 degrees)
6	pitch	Pitch (± 90 degrees)
7	Reserved	
8	hdg std dev	Heading standard deviation in degrees
9	ptch std dev	Pitch standard deviation in degrees
10	stn ID	Station ID string
11	#SVs	Number of satellites tracked
12	#solnSVs	Number of satellites in solution
13	#obs	Number of satellites above the elevation mask angle
14	#multi	Number of satellites above the mask angle with L2
15	Reserved	
16	ext sol stat	Extended solution status
17	Reserved	
18	sig mask	signals used mask (see Table 3.7 Signal-Used Mask)
19	xxxx	32-bit CRC (ASCII and Binary only)
20	[CR][LF]	Sentence terminator (ASCII only)

7.1.7 GNRMC - GNSS Specific Information

This log contains time, date, position, track made good and speed data provided by the GPS navigation receiver. RMC is the recommended minimum navigation data to be provided by a GNSS receiver.

GNRMC log outputs these messages without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status is set to WARNING since it may not be one hundred percent accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time status is set to VALID

Abbreviated ASCII Syntax:

GNRMC 1 Output 1Hz GNRMC message from current serial port

GNRMC COM2 1 Output 1Hz GNRMC message from com2

Message Output:

$GNRMC,055322.20,A,4004.73976661,N,11614.19695591,E,0.003,316.8,181017,6.7,W,A* 39

Table 7- 8 GNRMC message structure

Field	Structure	Field Description	Symbol	Example
1	$GNRMC	Log header		$GNRMC

2	utc	UTC of position	hhmmss.ss	144326.00
3	pos status	Position status: A = data valid, V = data invalid	A	A
4	lat	Latitude (DDmm.mm)	llll.ll	5107.0017737
5	lat dir	Latitude direction N = North, S = South	a	N
6	lon	Longitude (DDDmm.mm)	yyyyy.yy	11402.3291611
7	lon dir	Longitude direction E = East, W = West	a	W
8	speed Kn	Speed over ground, knots	x.x	0.080
9	track true	Track made good, degrees True	x.x	323.3
10	date	Date: dd/mm/yy	xxxxxx	210307
11	mag var	Magnetic variation, degrees [b]	x.x	0.0
12	var dir	Magnetic variation direction E/W [c]	a	E
13	mode ind	Positioning system mode indicator	a	A
14	*xx	Checksum	*hh	*72
15	[CR][LF]	Sentence terminator		[CR][LF]

7.1.8 GPRMC - GNSS Specific Information

The output information through this command is completely consistent with GNRMC, and the message is output with “$GPRMC” compulsively as the header, no matter in single system positioning or in multi-system positioning. This log contains time, date, position, track made good and speed data provided by the navigation receiver. RMC is the recommended minimum navigation data to be provided by a GNSS receiver.

Abbreviated ASCII Syntax:

GPRMC 1 Output 1Hz GPRMC message from current serial port

GPRMC COM2 1 Output 1Hz GPRMC message from com2

Message Output:

$GPRMC,094403.00,A,4004.73794422,N,11614.18999462,E,0.037,5.5,260815,6.5,W,A*35

Table 7-9 GPRMC message structure

ID	Structure	Field Description	Symbol	Example
1	$GPRMC	Log header		$GPRMC
2	utc	UTC of position	hhmmss.ss	144326.00

3	pos status	Position status: A = data valid, V = data invalid	A	A
4	lat	Latitude (DDmm.mm)	llll.ll	5107.0017737
5	lat dir	Latitude direction N = North, S = South	a	N
6	lon	Longitude (DDDmm.mm)	yyyyy.yy	11402.3291611
7	lon dir	Longitude direction E = East, W = West	a	W
8	speed Kn	Speed over ground, knots	x.x	0.080
9	track true	Track made good, degrees True	x.x	323.3
10	date	Date: dd/mm/yy	xxxxxx	210307
11	mag var	Magnetic variation, degrees [b]	x.x	0.0
12	var dir	Magnetic variation direction	a	E
		E/W [c]		
13	mode ind	Positioning system mode indicator	a	A
14	*xx	Checksum	*hh	*72
15	[CR][LF]	Sentence terminator		[CR][LF]

7.1.9 GPVTG - Track Made Good and Ground Speed

This log contains the track made good and speed relative to the ground. The GPVTG log outputs these messages without waiting for a valid almanac. Instead, it uses a UTC time, calculated with default parameters. In this case, the UTC time status (see the TIME log on page 822) is set to WARNING since it may not be one hundred percent accurate. When a valid almanac is available, the receiver uses the real parameters. Then the UTC time status is set to VALID.

Abbreviated ASCII Syntax

GPVTG 1 Output 1Hz GPVTG message from current serial port

GPVTG COM2 1 Output 1Hz GPRMC message from com2

Message Output:

$GNVTG,330.424,T,337.152,M,0.01159,N,0.02147,K,A*32

Table 7- 10 GPVTG message structure

ID	Structure	Field Description	Symbol	Example
1	$GPVTG	Log header		$GPVTG

2	Heading true	Track made good, degrees True	hhh	
3	TRUE NORTH	True track indicator	T	
4	Heading mag	Track made good, degrees Magnetic; Track mag = Track true + (MAGVAR correction)	hhh	
5	MAGNETIC NORTH	Magnetic track indicator	M	
6	speed Kn	Speed over ground, knots	Sss.s	
7	N	Nautical speed indicator (N = Knots)	N	
8	speed Km	Speed, kilometers/hour	Ssss.s	
9	K	Speed indicator (K = km/h)	K	
10	Mode ind	Positioning system mode indicator	a	
11	*xx	Check sum	*hh	*72
12	[CR][LF]	Sentence terminator		[CR][LF]

7.1.10 GPGLL - Geographic Position Information

This log contains latitude and longitude of present vessel position, time of position fix and status.

Abbreviated ASCII Syntax:

GPGLL 1 Output 1Hz GPGLL message from current serial port

GPGLL COM2 1 Output 1Hz GPGLL message from com2

Message Output:

$GPGLL,4250.5589,S,14718.5084,E,092204.999,A*2D

Table 7- 11 GPGLL message structure

ID	Structure	Field Description	Symbol	Example
1	$GPGLL	Log header		$GPGLL
2	lat	Latitude(DDmm.mm)	ddmm.mmmm	
3	lat dir	Latitude direction(N = North, S = South)	a	
4	lon	Longitude(DDDmm.mm)	dddmm.mmmm	
5	lon dir	Longitude direction(E = East, W = West)	a	
6	utc	UTC time	hhmmss.sss	

7	mode ind	Positioning system mode indicator, A=Data valid, V=Data invalid	a	
8	*xx	Check sum	*hh	*72
9	[CR][LF]	Sentence indicator		[CR][LF]

7.1.11 GPZDA - UTC Time and Date

The GPZDA log outputs the UTC date and time.

Abbreviated ASCII Syntax:

GPZDA 1 Output 1Hz GPZDA message from current serial port

GPZDA COM2 1 Output 1Hz GPZDA message from com2

Message Output:

$GNZDA,055435.00,13,11,2018,,*73

Table 7- 12 GPZDA message structure

ID	Structure	Field description	Symbol	Example
1	$GPZDA	Log header		$GPZDA
2	Utc	UTC time	hhmmss.ss	
3	Day	Day	xx	
4	Month	Month	xx	
5	Year	Year	xxxx	
6	Local zone description	Local zone description, 00 to +/- 13 hours	xx	
7	Local zone minutes description	Local zone minutes description. The same symbol as HOUR.	xx	
8	*xx	Check sum	*hh	*72
9	[CR][LF]	Sentence indicator		[CR][LF]

7.2 NMEA Log Output

7.2.1 GPNTR - Data Output

This message includes distance between base and rover, distance in east, north and vertical dimension respectively.

Abbreviated ASCII Syntax:

GPNTR 1 Output GPNTR information at 1 Hz from the current serial port

GPNTR COM2 1 Output GPNTR information at 1 Hz from com2

Message Output:

$GPNTR,090121.00,2,10737.152,+308.024,+10732.721,-15.751,0000*74

Table 7- 13 GPNTR message structure

ID	Structure	Field Description	Symbol	Example
1	$GPNTR	Log header		$GPNTR
2	utc	UTC time: yyyy/mm/dd/hh/mm/ss.ss	yyyy/mm/dd/ hh/mm/ss.ss	20170616093520.00
3	qual	GNSS quality indicator 0 = fix not available or invalid 1 = single point position 2 = DGPS or SBAS 4 = RTK fix 5 =RTK float 6 = INS 7 = manual input mode(Fixed Position)	x	1
4	Distance	Distance between base and rover, in meters.	xxxx.xxx	10737.152
5	N	Distance in North, +: North, -: South	xxxx.xxx	+308.024
6	E	Distance in East, +: East, -: West	xxxx.xxx	+10732.721
7	U	Distance in vertical direction +: Up, -: Down	xxxx.xxx	-15.751
8	stn ID	Base station ID，0000-4096	xxxx	It is 00 when there is no difference data
9	*xx	Check sum	*hh	*3F
10	[CR][LF]	Sentence terminator		[CR][LF]

7.3 Tersus Mode Data Output Command

Tersus mode data supports ASCII and BINARY format. Binary messages are meant strictly as a machine readable format. They are also ideal for applications where the amount of data being transmitted is large. Because of the inherent compactness of binary as opposed to ASCII data, the messages are much smaller. This allows a larger amount of data to be transmitted and received by the receiver's communication ports. Tersus data format is listed as follows:

Basic format:

Header 3 Sync bytes plus 24-bytes of header information. The header length is variables fields may be appended in the future. Always check the header length.

Data variable

CRC 4 bytes

Table 7- 14 Tersus ASCII and binary message structure

ID	Structure	Description
1	Header	All Tersus message formats have header messages. Three Sync bytes in Header messages, in the total of 24 bytes of header information. The header length is variable as fields may be appended in the future. Always check the header length
2	Data	Variable
3	CRC	Tersus message formats end in 32 bits CRC. Every ASCII or Binary log message contains CRC bits; CRC for ASCII format can be used for all data except the header with "#". "#"is not be used

Table 7- 15 Binary message structure header sync byte

Byte	Hex	Decimal
First	0xAA	170
Second	0x44	68
Third	0xB5	181

Table 7- 16 Binary message format header structure

ID	Field	Type	Description	Binary Bytes	Binary Offset
1	Sync	Uchar	Hexadecimal 0xAA.	1	0
2	Sync	Uchar	Hexadecimal 0x44.	1	1
3	Sync	Uchar	Hexadecimal 0xB5.	1	2
4	CPUIDle	Uchar	CPUIDle 0-100	1	3
5	Message ID	Ushort	Message ID	2	4
6	MessageLength	Ushort	Message Length	2	6
7	TimeRef	UChar	Reference time （GPST or BDST）	1	8
8	TimeStatus	Uchar	Time status	1	9
9	Wn	Ushort	Reference week number	2	10
10	Ms	ULONG	GPS seconds from the beginning of the reference week, accurate to the millisecond	4	12
11	Res	ULONG	Reserved	4	16
12	Version	uchar	Release version	1	20
13	Leap sec	Uchar		1	21
14	DelayMs	Ushort	Output delay time, ms	2	22

Table 7- 17 ASCII header structure

ID	Field	Type	Description
1	Sync	Char	Sync character. The ASCII message always starts with the “#” character
2	Message	Char	The ASCII name of the log or command of this manual
3	CPUIDle	Uchar	The minimum percentage of time that the processor is idle, calculated once per second
4	TimeRef	Uchar	Reference time of GPS or BDS
5	TimeStatus	Uchar	GPS time quality indicator: UNKNOWN = Time validity FINE = Time has fine precision
6	Wn	Ushort	GPS reference week number
7	Ms	ulong	GPS seconds from the beginning of the reference week, accurate to the millisecond
8	res	ulong	Reserved

9	version	uchar	8-bit hexadecimal number indicating the status of the hardware and software of the receiver
10	Leap sec	uchar	Leap seconds of GPST relative to UTC
11	Output Delay	Ushort	Output delay time, ms

7.3.1 VERSION Information

Version information contains product information, authorization, PN/SN number, hardware version and firmware version of the receiver. The authorization date format is year / month / day.

Message ID: 37

Abbreviated ASCII Syntax: VERSIONA

Abbreviated BINARY Syntax: VERSIONB

Message Output:

$VERSION,98,GPS,UNKNOWN,0,0,0,0,18,436,"UB982" , R3.00Build20655, B123G12R12E15a5bS1-HRBMDF0011N1-S50-P50-P,2117/11/01, 080101020000-GH1201173300357, 1712806238335,2017/11/01*14fe8d19

Table 7- 18 VERSION message structure

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	VERSION header	Log Header, see **Table 7-22 Binary Message Format Header Structure**		H	0
2	Type	Product Type 9 = David30-D A = CLAP-B B = CLAP-A	Enum	4	H+0
3	sw version	Firmware software version	Char[33]	33	H+4
4	model	Receiver model	Char[129]	129	H+37
5	Psn	Product PN number and serial number	Char[66]	66	H+166
9	efuse ID	Board ID	Char[33]	33	H+232
10	comp time	Firmware compile time YYYY/MM/DD	Char[43]	43	H+265
11..	Next Receiver or board message Binary Offset = H+4+308				
variable	Xxxx	32-bit CRC (ASCII and Binary only)	Hex		

variable	[CR][LF]	Sentence terminator (ASCII only)	-		

7.3.2 OBSVM Observation

OBSVM contains measurement information of the current receiver's tracking satellites.

Message ID: 12
Abbreviated ASCII Syntax: OBSVMA COM1 1
Abbreviated BINARY Syntax: OBSVMB COM1 1
Message Output:

$OBSVM,94,GPS,FINE,1971,280488800,0,0,18,1,0;85,0,2,21222412.195,-111524532.1941 96,4,54,-1782.123,4719,0,425.609,28101c24,0,2,21222405.863,-86902205.519989,8,81,-13
88.729,4411,0,422.200,21301c2b,0,5,20411034.146,-107260712.085988,4,50,-816.267,4947,0,425.609,28101c44,0,5,20411030.509,-83579760.046225,6,65,-636.174,4630,0,422.200,21301c4b,0,5,20411031.210,-83579765.043571,4,50,-636.081,4853,0,421.400,22301c4b,0,7,24548211.750,-129001723.217278,9,83,-492.474,4131,0,425.609,28101c64,0,7,24548208.940,-100520803.516577,25,262,-384.232,3368,0,387.800,21301c6b,0,7,24548209.781,-100520788.511940,14,130,-383.832,3597,0,422.000,22301c6b,0,13,20815721.791,-109387361.837300,4,51,2021.631,4776,0,425.609,28101c84,0,13,20815717.958,-85236892.035139,8,78,1575.494,4456,0,422.000,21301c8b,0,15,22379191.797,-117603449.600393,6,66,3353.041,4468,0,425.609,28101ca4,0,15,22379189.076,-91639036.925472,14,126,2612.773,4018,0,422.200,21301cab,0,15,22379189.827,-91639065.914678,8,79,2612.726,4206,0,421.200,22301cab,0,20,21388092.919,-112395192.169932,6,66,1979.461,4465,0,425.609,28101cc4,0,20,21388089.017,-87580651.598371,11,99,1542.516,4145,0,422.000,21301ccb,0,29,21187657.649,-111341896.264768,4,50,-222.121,4893,0,425.609,28101ce4,0,29,21187654.225,-86759903.085141,8,81,-173.232,4410,0,421.800,21301ceb,0,29,21187654.757,-86759901.075208,5,62,-173.102,4557,0,278.000,22301ceb,0,30,23713834.684,-124617041.851852,9,87,1030.285,4054,0,425.609,28101d04,0,30,23713834.462,-97104182.152488,20,202,803.465,3657,0,159.800,21301d0b,0,30,23713835.930,-93058184.972318,5,62,769.370,4556,0,425.609,21d01d00,0,30,23713835.374,-97104185.157783,9,85,802.748,4091,0,420.600,22301d0b,0,21,25536540.787,-134195417.985644,12,111,2945.978,3721,0,395.600,28101d64,0,21,25536539.796,-104567879.721552,44,377,2294.391,2987,0,13.800,21301d6b,0,47,24088022.124,-128402710.573309,11,99,-467.297,3816,0,145.000,28111c24,0,47,24088030.933,-99868824.817024,21,216,-363.421,3024,0,421.000,20b11c2b,3,39,19373536.406,-103380902.901757,4,50,-650.151,4929,0,421.000,28111c44,3,39,19373540.876,-80407388.032978,4,50,-505.675,4992,0,421.000,20b11c4b,4,55,21181385.664,-113067681.8162

58,4,55,3256.230,4692,0,423.000,28111c64,4,55,21181389.609,-87941532.413022,5,59,2532.627,4602,0,423.000,20b11c6b,7,48,23828924.976,-127334550.440490,7,74,2191.618,4302,0,423.000,28111c84,7,48,23828930.491,-99038014.262927,10,91,1704.585,3979,0,423.000,20b11c8b,8,38,22348894.598,-119467652.873635,7,70,-3389.813,4399,0,423.000,28

111ca4,8,38,22348898.130,-92919305.012375,11,97,-2636.373,3857,0,423.000,20b11cab,9,61,21534072.897,-115152363.389579,10,91,-3937.846,3980,0,47.000,28111cc4,9,61,21534074.725,-89562957.661143,16,152,-3062.768,3450,0,423.000,20b11ccb,11,54,19169428.543,-102579481.097235,4,50,-467.535,4919,0,421.000,28111ce4,11,54,19169427.813,-79784036.370922,4,50,-363.670,5027,0,423.000,20b11ceb,12,40,21320842.483,-114132125.893984,6,65,2510.345,4487,0,423.000,28111d04,12,40,21320841.181,-88769437.070578,5,58,1952.521,4626,0,423.000,20b11d0b,0,1,38058203.146,-198179055.329748,8,80,-17.748,4195,0,429.209,2c141c24,0,1,38058191.636,-153244568.938695,4,55,-13.751,4683,0,427.209,26341c2b,0,1,38058194.464,-161036675.262810,6,62,-14.456,4550,0,427.609,26a41c20,0,2,37980441.830,-197774134.361522,11,99,-11.797,3814,0,425.809,2c141c44,0,2,37980434.014,-152931471.984884,5,61,-9.076,4575,0,427.409,26341c4b,0,2,37980437.293,-160707659.255514,6,67,-9.558,4453,0,427.809,26a41c40,0,3,37520296.484,-195378031.357099,9,86,-26.363,4068,0,429.209,2c141c64,0,3,37520289.036,-151078660.605401,4,51,-20.336,4772,0,427.609,26341c6b,0,3,37520290.972,-158760630.041439,5,61,-21.367,4570,0,427.609,26a41c60,0,4,38936240.668,-202751230.928856,11,100,-23.196,3800,0,429.209,2c141c84,0,4,38936234.049,-156780081.759398,6,67,-17.886,4441,0,427.409,26341c8b,0,4,38936235.116,-164751955.098402,9,82,-18.862,4152,0,427.609,26a41c80,0,5,39849559.838,-207507123.809685,13,120,-9.338,3662,0,429.209,2c141ca4,0,5,39849553.652,-160457641.631816,7,74,-7.064,4319,0,426.009,26341cab,0,5,39849554.576,-168616505.129904,10,89,-7.527,4020,0,426.009,26a41ca0,0,6,36206998.273,-188539348.434993,6,62,211.339,4548,0,428.609,28141cc4,0,6,36206991.026,-145790550.817916,4,50,163.479,5156,0,423.600,22341ccb,0,6,36206991.028,-153203626.957558,4,50,171.762,5047,0,423.600,22a41cc0,0,8,36725569.798,-191239681.033605,7,71,-864.311,4379,0,428.609,28141ce4,0,8,36725561.871,-147878620.056780,4,50,-668.303,4938,0,423.600,22341ceb,0,8,36725561.526,-155397868.878389,4,50,-702.257,4859,0,423.600,22a41ce0,0,13,35554344.045,-185140805.845714,4,51,-314.216,4772,0,428.209,28141d04,0,13,35554343.509,-143162608.914397,4,50,-242.959,5039,0,423.600,22341d0b,0,13,35554342.382,-150442056.635603,4,50,-255.287,5057,0,423.600,22a41d00,0,14,23334957.821,-121511248.468354,6,63,-2184.181,4540,0,428.009,28141d24,0,14,23334951.618,-93960181.346592,4,50,-1688.921,5003,0,423.600,22341d2b,0,14,23334950.507,-98737810.615348,4,50,-1774.786,4952,0,423.600,22a41d20,0,9,37652644.421,-196067202.836501,9,81,645.307,4163,0,428.009,28141d44,0,9,37652639.893,-151611579.737359,4,50,499.054,4897,0,423.600,22341d4b,0,9,37652637.797,-159320632.687244,4,54,524.425,4706,0,423.600,22a41d40,0,3,23183584.743,-121830562.192879,4,50,-181.086,4862,0,425.809,28331c24,0,3,23183584.764,-90977365.113084,4,50,-135.177,5124,0,425.809,21931c2b,0,3,23183582.116,-93350679.010208,4,50,-138.716,5411,0,426.809,22331c20,0,5,25507209.112,-134041287.534354,7,69,-2264.297,4417,0,424.209,28331c44,0,5,25507210.183,-100095768.136885,6,62,-1690.830,4543,0,418.000,219

31c4b,0,5,25507207.050,-102706952.424800,4,52,-1734.882,4754,0,426.209,22331c40,0,8,23294166.581,-122411677.195573,8,75,2056.258,4299,0,424.609,28331c64,0,8,23294166.911,-91411315.900560,6,63,1535.476,4527,0,424.609,21931c6b,0,8,23294163.796,-

93795 949.141695,4,50,1575.635,4855,0,426.809,22331c60,0,18,28433603.739,-149419595.9458
07,16,147,-3788.807,3484,0,0.800,28331c84,0,18,28433614.471,-111579593.878126,11,94
,-2829.213,3916,0,418.000,21931c8b,0,18,28433608.918,-114490346.606701,10,92,-2903.
180,3941,0,424.809,22331c80,0,22,22981047.706,-120766218.441556,6,64,-2409.453,452
0,0,425.409,28331ca4,0,22,22981047.503,-90182562.199915,4,50,-1799.236,4797,0,425.4
09,21931cab,0,22,22981044.529,-92535141.158436,4,50,-1846.156,5030,0,426.809,22331
ca0*2E

Table 7- 19 OBSVM message structure

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	OBSVM header	Log header. See **Table 7- 22 Binary Message Format Header Structure** for the structure of binary message, and see **Table 7- 23 ASCII Header Structure** for the structure of ASCII message.		H	0
2	obs Number	Number of observations with information to follow	Ulong	4	H
3	System Freq	GLONASS Satellite frequency number (GLONASS + 7). GPS, BDS, Galileo are not supported.	UShort	2	H+4
4	PRN/ slot	Satellite PRN number of range measurement (starting from 1) BDS=1~63 GPS=1~32 GLONASS=38~61 Galileo=1~38 SBAS= 120~141,183~187 QZSS= 193~197)	UShort	2	H+6
5	psr	Pseudorange measurement (m)	Double	8	H+8
6	adr	Carrier phase, in cycles (accumulated Doppler range)	Double	8	H+16
7	psr std	Pseudorange measurement standard deviation*100	UShort	2	H+24
8	adr std	Estimated carrier phase standard deviation*10000	UShort	2	H+26
9	dopp	Instantaneous carrier Doppler frequency (Hz)	Float	4	H+28

10	C/No	Carrier to noise density ratio C/No = 10[log10(S/N0)] (dB-Hz). Carrier to noise density ratio*100	UShort	2	H+32
11	REV	Reserved	UShort	2	H+36
12	locktime	Number of seconds of continuous tracking (no cycle slipping) in seconds.	Float	4	H+38
13	ch-tr-status	Tracking status, refer to **Table 7- 26 Channel Tracking Status**		4	H+42
14…	Next OBS offset = H+4+ (#obs x 42) An epoch contains the observations of all frequency points and all satellites observed. Each frequency observation accounts for 42 bytes, and each frequency point loops from the third to the 14th.				
variable	xxxx	32-bit CRC	Hex	4	H+4+ (#obs x 42)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Table 7- 20 Channel tracking status

Nibble #	Bit #	Mask	Description	Range Value
N0	0	0x00000001	Reserved	
	1	0x00000002		
	2	0x00000004		
	3	0x00000008		
N1	4	0x00000010		
	5	0x00000020	SV channel number	0-n (0 = first, n = last) n depends on the receiver
	6	0x00000040		
	7	0x00000080		
N2	8	0x00000100		
	9	0x00000200		
	10	0x00000400	Carrier phase flag	0 = invalid, 1 = valid
	11	0x00000800	Reserved	
N3	12	0x00001000	Pseudorange flag	0 = invalid, 1 = valid
	13	0x00002000	Reserved	
	14	0x00004000		
	15	0x00008000		

N4	16	0x00010000	Satellite system	0 = GPS 1 = GLONASS 2 = SBAS 3 = GAL 4 = BDS 5 = QZSS 6-7 = Reserved
	17	0x00020000		
	18	0x00040000		
	19	0x00080000	Reserved	
N5	20	0x00100000	Reserved	
	21	0x00200000	Signal type	Dependent on satellite system above: GPS: 0 = L1 C/A 9 = L2P (Y), semicodeless 6 = L5 data 14 = L5 pilot 17 = L2C (L) GLONASS: 0 = L1 C/A 5 = L2 C/A BDS: 0 = B1I 4 = B1Q 8 = B1C 5 = B2Q 17 = B2I 12 = B2A 6 = B3Q 21 = B3I GAL: 1 = E1B 2 = E1C 12 = E5A pilot 17 = E5B pilot SBAS: 0 = L1 C/A 6 = L5 (I)
	22	0x00400000		
	23	0x00800000		
N6	24	0x01000000		
	25	0x02000000		
	26	0x04000000	Reserved	
	27	0x08000000	Reserved	
N7	28	0x10000000	Reserved	
	29	Reserved	Reserved	
	30	0x40000000	Reserved	
	31	0x80000000	Reserved	

7.3.3 OBSVH Observation

OBSVM contains measurement information of the current receiver's tracking satellites.

Message ID: 13
Abbreviated ASCII Syntax: OBSVHA COM1 1
Abbreviated BINARY Syntax: OBSVHB COM1 1
Message Output:

```
$OBSVH,93,GPS,FINE,1971,280559400,0,0,18,2,0;85,0,2,21246563.814,-111651450.3112
82,4,52,-1813.155,4757,0,496.209,28101c24,0,2,21246557.603,-87001102.717152,8,78,-14
12.040,4457,0,492.800,21301c2b,0,5,20422151.825,-107319135.401189,4,50,-838.619,501
0,0,496.209,28101c44,0,5,20422148.083,-83625284.703105,6,66,-653.217,4624,0,492.800,
21301c4b,0,5,20422148.735,-83625289.696302,4,50,-653.478,4848,0,492.000,22301c4b,0,
7,24555097.903,-129037910.067692,8,78,-532.447,4227,0,496.209,28101c64,0,7,2455509
5.330,-100549001.011807,24,253,-415.050,3409,0,458.400,21301c6b,0,7,24555095.526,-1
00548986.047458,14,130,-415.134,3595,0,492.600,22301c6b,0,13,20788837.832,-1092460
85.757039,4,50,1980.700,4848,0,496.209,28101c84,0,13,20788833.931,-85126806.818378
,8,75,1543.838,4489,0,492.600,21301c8b,0,15,22334307.904,-117367584.521957,6,64,332
8.780,4501,0,496.209,28101ca4,0,15,22334305.349,-91455246.122632,13,116,2594.435,4
066,0,492.800,21301cab,0,15,22334306.039,-91455275.123345,8,75,2593.830,4281,0,491.
800,22301cab,0,20,21361619.331,-112256072.151839,6,62,1961.747,4542,0,496.209,2810
1cc4,0,20,21361615.322,-87472246.432987,11,96,1528.788,4189,0,492.600,21301ccb,0,29
,21190975.160,-111359330.458807,4,50,-271.602,4930,0,496.209,28101ce4,0,29,2119097
1.856,-86773488.135554,8,78,-210.876,4447,0,492.400,21301ceb,0,29,21190972.483,-867
73486.150078,5,61,-211.724,4564,0,348.600,22301ceb,0,30,23700243.112,-124545618.43
7952,9,83,993.097,4129,0,496.209,28101d04,0,30,23700242.980,-97048527.546666,19,19
2,774.696,3703,0,230.400,21301d0b,0,30,23700244.562,-93004849.353541,5,62,741.552,4
554,0,496.209,21d01d00,0,30,23700243.893,-97048530.576957,9,83,773.849,4123,0,491.2

00,22301d0b,0,21,25496948.404,-133987359.827841,11,97,2948.176,3846,0,466.200,2810
1d64,0,21,25496945.670,-104405756.653349,44,388,2298.442,3076,0,17.400,21301d6b,0,
47,24094588.963,-128437714.785108,14,127,-524.247,3615,0,215.600,28111c24,0,47,240
94597.834,-99896050.327367,20,210,-407.528,3063,0,491.600,20b11c2b,3,39,19382371.3
66,-103428047.664277,4,50,-685.150,4903,0,491.600,28111c44,3,39,19382375.781,-80444
056.206854,4,50,-532.934,5015,0,491.600,20b11c4b,4,55,21138566.935,-112839112.0111
95,4,55,3218.809,4692,0,493.600,28111c64,4,55,21138570.781,-87763755.970497,5,58,25
03.524,4633,0,493.600,20b11c6b,7,48,23800230.876,-127181217.513352,7,74,2152.102,4
310,0,493.600,28111c84,7,48,23800236.238,-98918755.471575,10,87,1673.842,4047,0,49
3.600,20b11c8b,8,38,22393689.968,-119707109.737196,7,69,-3393.510,4406,0,493.600,28
111ca4,8,38,22393693.479,-93105549.181113,11,96,-2639.372,3871,0,493.600,20b11cab,
9,61,21586267.848,-115431471.706091,10,90,-3968.608,3996,0,117.600,28111cc4,9,61,21
586269.319,-89780041.805585,16,152,-3086.750,3452,0,493.600,20b11ccb,11,54,1917601
9.897,-102614752.527436,4,50,-531.554,4898,0,491.600,28111ce4,11,54,19176019.165,-7
9811469.703518,4,50,-413.449,5052,0,493.600,20b11ceb,12,40,21287928.841,-113955937
.368650,6,66,2480.915,4477,0,493.600,28111d04,12,40,21287927.629,-88632401.666176,
```

4,55,1929.630,4692,0,493.600,20b11d0b,0,1,38058449.391,-198180337.735370,8,80,-18.5
49,4182,0,499.809,2c141c24,0,1,38058437.844,-153245560.550125,4,54,-14.347,4708,0,4
97.809,26341c2b,0,1,38058440.711,-161037717.307865,6,63,-15.071,4529,0,498.209,26a4
1c20,0,2,37980610.307,-197775012.106405,12,100,-13.054,3793,0,496.409,2c141c44,0,2,3
7980602.521,-152932150.749658,5,60,-10.147,4599,0,498.009,26341c4b,0,2,37980605.79
8,-160708372.535672,6,68,-10.666,4435,0,498.409,26a41c40,0,3,37520658.963,-19537991
9.180620,9,87,-27.164,4056,0,499.809,2c141c64,0,3,37520651.428,-151080120.448378,4,
50,-21.044,4797,0,498.209,26341c6b,0,3,37520653.418,-158762164.117300,5,62,-22.121,4
554,0,498.209,26a41c60,0,4,38936560.986,-202752899.790897,12,102,-24.053,3784,0,499
.809,2c141c84,0,4,38936554.390,-156781372.255777,6,66,-18.622,4468,0,498.009,26341c
8b,0,4,38936555.554,-164753311.205573,9,83,-19.607,4129,0,498.209,26a41c80,0,5,3984
9693.104,-207507817.825727,13,124,-10.409,3638,0,499.809,2c141ca4,0,5,39849686.908,
-160458178.348569,7,73,-8.098,4339,0,496.609,26341cab,0,5,39849687.772,-168617069.1
12898,10,89,-8.487,4000,0,496.609,26a41ca0,0,6,36204179.624,-188524671.355730,6,62,
204.503,4543,0,499.209,28141cc4,0,6,36204172.334,-145779201.603625,4,50,158.106,517
5,0,494.200,22341ccb,0,6,36204172.436,-153191700.647308,4,50,166.136,5034,0,494.200,
22a41cc0,0,8,36737365.859,-191301107.254962,7,72,-875.775,4342,0,499.209,28141ce4,0
,8,36737358.039,-147926118.697148,4,50,-677.188,4950,0,494.200,22341ceb,0,8,3673735
7.765,-155447782.710365,4,50,-711.617,4836,0,494.200,22a41ce0,0,13,35558681.030,-18
5163389.740799,4,51,-325.438,4761,0,498.809,28141d04,0,13,35558680.456,-143180072.
212451,4,50,-251.630,5061,0,494.200,22341d0b,0,13,35558679.398,-150460407.906754,4,
50,-264.479,5044,0,494.200,22a41d00,0,14,23364625.316,-121665734.377409,6,67,-2192.
042,4457,0,498.609,28141d24,0,14,23364618.930,-94079639.637225,4,50,-1695.031,5000,
0,494.200,22341d2b,0,14,23364617.795,-98863343.053086,4,50,-1781.213,4939,0,494.200

,22a41d20,0,9,37643948.924,-196021923.587074,9,83,637.549,4135,0,498.609,28141d44,
0,9,37643944.361,-151576566.991013,4,50,492.925,4915,0,494.200,22341d4b,0,9,376439
42.290,-159283839.623689,4,55,517.999,4691,0,494.200,22a41d40,0,3,23186169.438,-121
844145.804248,4,50,-203.606,4833,0,496.409,28331c24,0,3,23186169.669,-90987508.756
380,4,50,-152.034,5100,0,496.409,21931c2b,0,3,23186166.942,-93361087.256507,4,50,-15
5.992,5404,0,497.409,22331c20,0,5,25537681.241,-134201421.471488,7,71,-2271.943,437
3,0,494.809,28331c44,0,5,25537682.609,-100215348.656667,6,65,-1696.623,4486,0,488.6
00,21931c4b,0,5,25537679.489,-102829652.441565,4,52,-1740.861,4742,0,496.809,22331
c40,0,8,23266657.315,-122267114.589514,8,76,2039.056,4276,0,495.209,28331c64,0,8,23
266657.382,-91303363.371759,6,65,1522.727,4498,0,495.209,21931c6b,0,8,23266654.529
,-93685180.464955,4,50,1562.410,4925,0,497.409,22331c60,0,18,28484323.274,-1496861
28.604221,34,289,-3762.348,3181,0,0.000,08331084,0,18,28484338.970,-111778646.4679
69,12,104,-2809.395,3766,0,488.600,21931c8b,0,18,28484335.109,-114694591.972402,10,
90,-2882.746,3983,0,495.409,22331c80,0,22,23013557.538,-120937058.902399,6,65,-2430
.128,4496,0,496.009,28331ca4,0,22,23013557.352,-90310137.827397,4,51,-1814.649,4769
,0,496.009,21931cab,0,22,23013554.227,-92666044.851554,4,50,-

1862.045,5008,0,497.40 9,22331ca0*41

Table 7- 21 OBSVH message structure

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	OBSVM header	Log header, see **Table 7- 22 Binary Message Format Header Structure**		H	0
2	obs Number	Number of observations with information to follow	Ulong	2	H
3	System Freq	GLONASS Satellite frequency number (GLONASS + 7). GPS, BDS, Galileo are not supported.	UShort	2	H+4
4	PRN/ slot	Satellite PRN number of range measurement (starting from 1) BDS=1~63 GPS=1~32 GLONASS=38~61 Galileo=1~38 SBAS= 120~141,183~187 QZSS= 193~197)	UShort	2	H+6
5	psr	Pseudorange measurement (m)	Double	8	H+8
6	adr	Carrier phase, in cycles (accumulated Doppler range)	Double	8	H+16
7	psr std	Pseudorange measurement standard deviation*100	UShort	2	H+24
8	adr std	Estimated carrier phase standard deviation*10000	UShort	2	H+26
9	dopp	Instantaneous carrier Doppler frequency (Hz)	Float	4	H+28
10	C/No	Carrier to noise density ratio C/No = 10[log10(S/N0)] (dB-Hz). Carrier to noise density ratio*100	UShort	2	H+32
11	REV	Reserved	UShort	2	H+36
12	locktime	Number of seconds of continuous tracking (no cycle slipping) in seconds.	Float	4	H+38
13	ch-tr-stat us	Tracking status, refer to **Table 7- 26 Channel Tracking Status**		4	H+42
14…	Next OBS offset = H+4+ (#obs x 42) An epoch contains the observations of all frequency points and all satellites observed. Each frequency observation accounts for 42 bytes, and each frequency point loops from the third to the 14th.				

variable	xxxx	32-bit CRC	Hex	4	H+4+ (#obs x 42)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

7.3.4 GPSION Ionosphere Parameters

This log provides GPS ionosphere model parameters.

Message ID: 8
Abbreviated ASCII Syntax: GPSIONA ONCHANGED
Abbreviated BINARY Syntax: GPSIONB ONCHANGED
Message Output:

$GPSION,89,GPS,FINE,1977,113605600,0,0,18,3,0;1.024454832077026e-08,-1.490116119384766e-08,-5.960464477539063e-08,1.192092895507813e-07,9.830400000000000e+04,-1.474560000000000e+05,-1.966080000000000e+05,8.519680000000000e+05,0*7E

Table 7- 22 GPSION message structure

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	GPSION	Log header, see **Table 7- 22 Binary Message Format Header Structure**		H	0
2	a0	Alpha parameter constant term	Double	8	H
3	a1	Alpha parameter 1st order term	Double	8	H+8
4	a2	Alpha parameter 2st order term	Double	8	H+16
5	a3	Alpha parameter 3st order term	Double	8	H+24
6	b0	Beta parameter constant term	Double	8	H+32
7	b1	Beta parameter 1st order term	Double	8	H+40
8	b2	Beta parameter 2st order term	Double	8	H+48
9	b3	Beta parameter 3st order term	Double	8	H+56
10	reserved	reserved	Ulong	4	H+64
11	xxxx	32-bit CRC	Hex	4	H+68
12	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

7.3.5 BDSION Ionosphere Parameters

This log provides BDS ionosphere model parameters.

Message ID: 4

Abbreviated ASCII Syntax: BDSIONA ONCHANGED
Abbreviated BINARY Syntax: BDSIONB ONCHANGED
Message Output:

$BDSION,89,GPS,FINE,1977,113605600,0,0,18,3,0;1.024454832077026e-08,-1.49011611 9384766e-08,-5.960464477539063e-08,1.192092895507813e-07,9.830400000000000e+04,
-1.474560000000000e+05,-1.966080000000000e+05,8.519680000000000e+05,0*7E

Table 7- 23 BDSION message structure

Field	Field Type	Description	Format	Binary Bytes	Binary Offset
1	BDSION	Log header, see **Table 7- 22 Binary Message Format Header Structure**		H	0
2	a0	Alpha parameter constant term	Double	8	H
3	a1	Alpha parameter 1st order term	Double	8	H+8
4	a2	Alpha parameter 2st order term	Double	8	H+16
5	a3	Alpha parameter 3st order term	Double	8	H+24
6	b0	Beta parameter constant term	Double	8	H+32
7	b1	Beta parameter 1st order term	Double	8	H+40
8	b2	Beta parameter 2st order term	Double	8	H+48
9	b3	Beta parameter 3st order term	Double	8	H+56
10	reserved	reserved	Ulong	4	H+64
11	xxxx	32-bit CRC	Hex	4	H+68
12	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

7.3.6 GALION Ionosphere Parameters

This log provides Galileo ionosphere model parameters.

Message ID: 9

Abbreviated ASCII Syntax: GALIONA ONCHANGED
Abbreviated BINARY Syntax: GALIONB ONCHANGED
Message Output:

$GALION,89,GPS,FINE,1977,120774600,0,0,18,3,0;4.375000000000000e+01,1.
328125000 000000e-01,2.319335937500000e-03,0,0,0,0,0*3B

Table 7- 24 GALION message structure

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	GALION	Log Header, see **Table 7- 22 Binary Message Format Header Structure**		H	0
2	a0	Alpha parameter 1st order	Double	8	H
3	a1	Alpha parameter 2nd order term	Double	8	H+8
4	a2	Alpha parameter 3rd order term	Double	8	H+16
5	SF1	Ionospheric disturbance flag for region 1	Double	8	H+24
6	SF2	Ionospheric disturbance flag for region 2	Double	8	H+32
7	SF3	Ionospheric disturbance flag for region 3	Double	8	H+40
8	SF4	Ionospheric disturbance flag for region 4	Double	8	H+48
9	SF5	Ionospheric disturbance flag for region 5	Double	8	H+56
10	RSV	Reserved	Ulong	4	H+64
11	xxxx	32-bit CRC	Hex	4	H+68
12	[CR][LF]	Sentence Terminator (ASCII only)	-	-	-

7.3.7 GPSUTC Coordinated Universal Time

This log contains time parameters transmitted by the GPS satellites. These parameters can be used to calculate the offset between GPST and UTC.

Message ID: 19
Abbreviated ASCII Syntax:GPSUTCA
Abbreviated BINARY Syntax:GPSUTCB
Message Output:

$GPSUTC,89,GPS,FINE,1977,114542800,0,0,18,3,0;1977,233472,-1.862645149230957e-0 9,-7.105427358e-15,1929,7,18,18,0,0*5F

Table 7- 25 GPSUTC message structure

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	GPSUTC	Log header, see **Table 7- 22 Binary Message Format Header Structure**		H	0
2	utc wn	UTC reference week number	Ulong	4	H
3	tot	Reference time of UTC parameters	Ulong	4	H+4
4	A0	GPST clock bias relative to UTC (seconds)	Double	8	H+8
5	A1	GPST clock rate relative to UTC (seconds/second)	Double	8	H+16
6	wn lsf	Future week number when a leap second newly added (GPS reference time)	Ulong	4	H+24
7	dn	Day number (the range is 1 to 7 where Sunday = 1 and Saturday = 7)	Ulong	4	H+28
8	deltat ls	Existing leap seconds of BDT relative to GPST before the next leap second arriving	Long	4	H+32
9	deltat lsf	Future total leap seconds of GPST relative to UTC when a leap second newly added	Long	4	H+36
10	deltat utc	Time offset of GPST relative to UTC	Ulong	4	H+40
11	reserved	Reserved	Ulong	4	H+44
12	xxxx	32-bit CRC	Hex	4	H+48
13	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

7.3.8 BDSUTC Coordinated Universal Time

This log contains time parameters transmitted by the BDS satellites. These parameters can be used to calculated the offset between BDST and UTC.

Message ID:2012
Abbreviated ASCII Syntax:BDSUTCA
Abbreviated BINARY Syntax:BDSUTCB
Message Output:

$BDSUTC,89,GPS,FINE,1977,114466600,0,0,18,3,0;0,0,5.587935447692871e-09,-9.76996 2617e-15,573,6,4,4,0,0*5A

Table 7- 26 BDSUTC message structure

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	BDSUTC	Log header, see **Table 7- 22 Binary Message Format Header Structure**		H	0
2	utc wn	UTC reference week number	Ulong	4	H
3	tot	Reference time of UTC parameters	Ulong	4	H+4
4	A0	BDT clock bias relative to UTC (seconds)	Double	8	H+8
5	A1	BDT clock rate relative to UTC (seconds/second)	Double	8	H+16
6	wn lsf	Future week number when a leap second newly added (BDST reference time)	Ulong	4	H+24
7	dn	Future day-of-week number when a leap second newly added (from 0 to 6, Sunday = 0, Saturday = 6)	Ulong	4	H+28
8	deltat ls	Existing leap seconds of BDT relative to UTC before the next leap second arriving	Long	4	H+32
9	deltat lsf	Future total leap seconds of BDT relative to UTC when a leap second newly added	Long	4	H+36
10	deltat utc	Time offset of BDT relative to UTC	Ulong	4	H+40
11	reserved	Reserved	Ulong	4	H+44
12	xxxx	32-bit CRC	Hex	4	H+48
13	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

7.3.9 GALUTC Coordinated Universal Time

This log contains time parameters transmitted by the Galileo satellites. These parameters can be used to calculated the offset between GALT and UTC.

Message ID: 20
Abbreviated ASCII Syntax:GALUTCA

Abbreviated BINARY Syntax:GALUTCB
Message Output:

$GALUTC,89,GPS,FINE,1977,117340200,0,0,18,3,0;1.862645149230957e-09,-8.881784197001252e-16,24,953,905,7,18,0,7.217749953269958e-09,-2.664535259100376e-15,86400,57*5C

Table 7- 27 GALUTC message structure

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	GALUTC	Log header, see **Table 7- 22 Binary Message Format Header Structure**		H	0
2	A0	Clock offset of Galileo relative to UTC time	Double	8	H+0
3	A1	Clock rate of Galileo relative to UTC time	Double	8	H+8
4	deltat ls	Existing leap seconds of GALT relative to GPST before the next leap second arriving	long	4	H+16
5	tot	Reference time of UTC parameters	Ulong	4	H+20
6	utc wn	UTC reference week number	Ulong	4	H+24
7	ulWNlsf	Future week number when a leap second newly added (BDST reference time)	Ulong	4	H+28
8	dn	Future day-of-week number when a leap second newly added (from 1 to 7, Sunday = 1, Saturday = 7)	Ulong	4	H+32
9	deltat lsf	Existing leap seconds of Galileo relative to UTC before the next leap second arriving	Long	4	H+36
10	dA0g	The constant term of the conversion parameter between Galileo time system and GPST system.	Long	8	H+40
11	dA1g	The first order term of the conversion parameter between Galileo time system and GPST system.	Ulong	8	H+48

12	ulT0g	Reference cycle seconds for conversion between Galileo time system and GPST system.	Ulong	4	H+44
13	ulWN0g	Reference cycle counting for conversion between Galileo time system and GPST system.	Ulong	4	H+48
14	xxxx	32-bit CRC	Hex	4	H+52
15	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

7.3.10 GLOEPHEM Decoded GLONASS Ephemeris

This log contains GLONASS ephemeris information. GLONASS ephemerides are referenced to the PZ90.02 geodetic datum. No adjustment between the GPS and GLONASS reference frames are made for positioning.

Message ID: 17

Abbreviated ASCII Syntax:GLOEPHEMA COM1 60
Abbreviated BINARY Syntax:GLOEPHEMB COM1 60
Message Output:

#GLOEPHEMA,41,GPS,FINE,2068,114877000,0,0,18,7;38,8,1,0,2068,1143180
00,10782,13 34,0,0,43,0,-
5.214640136718750e+06,1.326842138671875e+07,2.114945556640625e+07,-
1.141456604003906e+03,-2.661026954650879e+03,1.389506340026855e+03,0.00000186
2645149,-0.000000000000000e+00,-1.862645149230957e-06,-4.872400313615799e-05,8.
381903172e-09,0.000000000000000e+00,39210,2,1,0,12*b48d5f47

Table 7- 28 GLOEPHEM message structure

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	GLOEPHEM header	Log header, refer to **Table 7- 22 Binary Message Format Header Structure**		H	0
2	Sloto	Slot information offset – PRN identification (Slot + 37). This is also called SLOTO in Connect	Ushort	2	H
3	freqo	Frequency channel offset for satellite in the range 0 to 20	Ushort	2	H+2
4	sat type	Satellite type: 0 = GLO_SAT 1 = GLO_SAT_M (M type)	Uchar	1	H+4

5	Reserved			1	H+5
6	e week	Reference week of ephemeris (GPS reference time)	Ushort	2	H+6
7	e time	Reference time of ephemeris (GPS reference time) in ms	Ulong	4	H+8
8	t offset	Integer seconds between GPS and GLONASS time. A positive value implies GLONASS is ahead of GPS reference time.	Ulong	4	H+12
9	Nt	Calendar number of day within 4 year interval starting at Jan 1 of a leap year	Ushort	2	H+16
10	Reserved	Reserved		1	H+18
11	Reserved	Reserved		1	H+19
12	issue	15 minute interval number corresponding to ephemeris reference time	Ulong	4	H+20
13	health[a]	Ephemeris health where 0 = GOOD 1 = BAD	Ulong	4	H+24
14	pos x	X coordinate for satellite at reference time (PZ-90.02), in metres	Double	8	H+28
15	pos y	Y coordinate for satellite at reference time (PZ-90.02), in metres	Double	8	H+36
16	pos z	Z coordinate for satellite at reference time (PZ-90.02), in metres	Double	8	H+44
17	vel x	X coordinate for satellite velocity at reference time (PZ-90.02), in metres/s	Double	8	H+52
18	vel y	Y coordinate for satellite velocity at reference time (PZ-90.02), in metres/s	Double	8	H+60
19	vel z	Z coordinate for satellite velocity at reference time (PZ-90.02), in metres/s	Double	8	H+68
20	LS acc x	X coordinate for lunisolar acceleration at reference time (PZ-90.02), in metres/s/s	Double	8	H+76

21	LS acc y	Y coordinate for lunisolar acceleration at reference time (PZ-90.02), in metres/s/s	Double	8	H+84
22	LS acc z	Z coordinate for lunisolar acceleration at reference time (PZ-90.02), in metres/s/s	Double	8	H+92
23	tau_n	Correction to the nth satellite time t_n relative to GLONASS time t_c, in seconds	Double	8	H+100
24	delta_tau_n	Time difference between navigation RF signal transmitted in L2 sub-band and navigation RF signal transmitted in L1 sub-band by nth satellite, in seconds	Double	8	H+108
25	gamma	Frequency correction, in seconds/second	Double	8	H+116
26	Tk	Time of frame start (since start of GLONASS day), in seconds	Ulong	4	H+124
27	P	Technological parameter	Ulong	4	H+128
28	Ft	User range	Ulong	4	H+132
29	age	Age of data, in days	Ulong	4	H+136
30	Flags	Information flags, see **Table 7- 38 BDSEPHEM Message Structure**	Ulong	4	H+140
31	xxxx	32-bit CRC	Hex	4	H+144
32	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

a: The last four bits of this field are used to describe the health.

Bit 0-2: Bn
Bit 3: In

All other bits are reserved and set to 0.

Table 7- 29 GLONASS Ephemeris flags coding

Bit	Description	Value	Mark
0	P1 flag: time interval between two adjacent parameters fb values	Information flag, see **Table 7- 34 GLOEPHEM Message Structure:** P1 flag range values	00000001
1			00000002

2	P2 flag: Odd or Even flag of parameter fb	0=even,1=odd	00000004
3	P3 flag: satellite numbers of almanac information within current subframe	0=5,1=4	00000008
4	Reserved		
…			
31			

Table 7- 30 P1 flag range values

State	Description
00	0 minute
01	30 minutes
10	45 minutes
11	60 minutes

7.3.11 GPSEPHEMERIS Decoded GPS Ephemeris

This log contains GPS ephemeris information.

Message ID: 14

Abbreviated ASCII Syntax:GPSEPHEMERISA COM1 60

Abbreviated BINARY Syntax:GPSEPHEMERISB COM1 60

Message Output:

#GPSEPHEMERISA,41,GPS,FINE,2068,114877000,0,0,18,1;2,114840.0,0,34,34,2068,2068,115200.0,2.656136285e+07,4.642336229e-09,-1.632620599e+00,1.8996566301e-02,-1.7203454476e+00,-4.798173904e-06,5.951151252e-06,2.60312500e+02,-9.53125000e+01,3.036111593e-07,4.339963198e-07,9.5556896955e-01,-2.832260832e-10,1.606146407e+00,-8.13783897e-09,34,115200.0,-2.048909664e-08,-2.9118266e-04,-8.2991392e-12,0.0000000e+00,TRUE,1.458502611e-04,4.00000000e+00*588da46c

Table 7- 31 GPSEPHEM message structure

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	GPSEPHEM header	Log Header, refer to **Table 7- 22 Binary Message Format Header Structure**		H	0
2	PRN	Satellite PRN number (GPS:1 to 32)	Ulong	4	H
3	tow	Time stamp of subframe 0 (seconds)	Double	4	H+4
4	health	Health status - a 6-bit health code as defined in ICDGPS-200 a	Ulong	4	H+12
5	IODE1	Issue of ephemeris data 1	Ulong	4	H+16

6	IODE2	Issue of ephemeris data 2 = GPS 的 IODE1	Ulong	4	H+20
7	Week	GPS reference week number (GPS Week)	Ulong	4	H+24
8	Z Week	Z count week number. This is the week number from subframe 1 of the ephemeris. The ‘toe week’ (field #7) is derived from this to account for rollover	Ulong	4	H+28
9	Toe	Reference time for ephemeris, seconds	Double	8	H+32
10	A	Semi-major axis, metres	Double	8	H+40
11	ΔN	Mean motion difference, radians/second	Double	8	H+48
12	M0	Mean anomaly of reference time, radians	Double	8	H+56
13	Ecc	Eccentricity, dimensionless - quantity defined for a conic section where e= 0 is a circle, e = 1 is a parabola, 0<e<1 is an ellipse and e>1 is a hyperbola	Double	8	H+64
14	ω	Argument of perigee, radians - measurement along the orbital path from the ascending node to the point where the SV is closest to the Earth, in the direction of the SV's motion	Double	8	H+72
15	cuc	Argument of latitude (amplitude of cosine, radians)	Double	8	H+80
16	cus	Argument of latitude (amplitude of sine, radians)	Double	8	H+88
17	crc	Orbit radius (amplitude of cosine, metres)	Double	8	H+96
18	crs	Orbit radius (amplitude of sine, metres)	Double	8	H+104
19	cic	Inclination (amplitude of cosine, radians)	Double	8	H+112
20	cis	Inclination (amplitude of sine, radians)	Double	8	H+120
21	I0	Inclination angle at reference time, radians	Double	8	H+128

22	IDOT	Rate of inclination angle, radians/second	Double	8	H+136
23	Ω0	Right ascension, radians	Double	8	H+144
24	Ω dot	Rate of right ascension, radians/second	Double	8	H+152
25	iodc	Issue of data clock	Ulong	4	H+160
26	toc	SV clock correction term, seconds	Double	8	H+164
27	tgd	Estimated group delay difference, seconds	Double	8	H+172
28	af0	Clock aging parameter, seconds (s)	Double	8	H+180
29	af1	Clock aging parameter, (s/s)	Double	8	H+188
30	af2	Clock aging parameter, (s/s/s)		8	H+196
31	AS	Anti-spoofing on: 0 = FALSE 1 = TRUE	Enum	4	H+204
32	N	Corrected mean motion, radians/second, rad/s	Double	8	H+208
33	URA	User Range Accuracy variance, m2. The ICD a specifies that the URA index transmitted in the ephemerides can be converted to a nominal standard deviation value using an algorithm listed there. We publish the square of the nominal value (variance).	Double	8	H+216
34	xxxx	32-bit CRC	Hex	4	H+224
35	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

7.3.12 BDSEPHEM Decoded BDS Ephemeris

This log contains BDS ephemeris information.

Message ID: 15
Abbreviated ASCII Syntax:BDSEPHEMA COM1 60
Abbreviated BINARY Syntax:BDSEPHEMB COM1 60
Message Output:

#BDSEPHEMA,41,GPS,FINE,2068,114877000,0,0,18,4;1,114810.0,0,1,1,2068,2068,11160
0.0,4.216448683e+07,2.367955778e-09,1.101424762e+00,3.9647240192e-04,-2.07472808
77e+00,-7.542781532e-06,1.471303403e-05,-4.41109375e+02,-2.27625000e+02,-1.443549
991e-08,1.862645149e-08,8.4583233037e-02,-4.625192658e-10,-1.009548479e+00,-1.272
91016e-09,0,111600.0,1.420000000e-08,-1.040000000e-08,2.07696e-04,4.76259e-11,0.00
000e+00,TRUE,7.292270366e-05,4.00000000e+00*d5b5296b

Table 7- 32 BDSEPHEM message structure

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
1	BDSEPHEM header	Log header, refer to **Table 7- 22 Binary Message Format Header Structure**		H	0
2	PRN	Satellite PRN number: (BDS=1 to 63)	Ulong	4	H
3	Tow	Time stamp of subframe 1(refer to GPST), seconds	Double	8	H+4
4	Health	Health status - a 1-bit health code as defined in ICD-BDS	Ulong	4	H+12
5	AODE	Age of data, ephemeris	Ulong	4	H+16
6	AODE	Age of data, ephemeris (same as the fifth field)	Ulong	4	H+20
7	Week	GPS reference week number (GPS Week)	Ulong	4	H+24
8	Z Week	Z count week number. This is the week number from subframe 1 of the ephemeris. The 'toe week' (field #7) is derived from this to account for rollover (GPS reference time)	Ulong	4	H+28
9	Toe	Reference time of ephemeris parameters (GPS reference time), s	Double	8	H+32
10	A	Semi-major axis, meters	Double	8	H+40
11	ΔN	Mean motion difference, radians/second	Double	8	H+48
12	M0	Mean anomaly of reference time, radians	Double	8	H+56
13	Ecc	Eccentricity (sqrt(meters))	Double	8	H+64
14	ω	Argument of perigee, rad	Double	8	H+72
15	Cuc	Amplitude of cosine harmonic correction term to the argument of latitude (radians)	Double	8	H+80
16	Cus	Amplitude of sine harmonic correction term to the argument of latitude (radians)	Double	8	H+88
17	crc	Amplitude of cosine harmonic correction term to the orbit radius(meters)	Double	8	H+96

18	crs	Amplitude of sine harmonic correction term to the orbit radius(meters)	Double	8	H+104
19	cic	Amplitude of cosine harmonic correction term to the angle of inclination (radians)	Double	8	H+112
20	cis	Amplitude of sine harmonic correction term to the angle of inclination (radians)	Double	8	H+120
21	I0	Inclination angle at reference time(radians)	Double	8	H+128
22	IDOT	Rate of inclination angle (radians/second)	Double	8	H+136
23	Ω0	Longitude of ascending node of orbital of plane computed according to reference time (radians)	Double	8	H+144
24	Ω dot	Rate of right ascension (radians/second)	Double	8	H+152
25	AODC	Age of data, clock	Ulong	4	H+160
26	toc	Reference time of clock parameters(GPS reference time),s	Double	8	H+164
27	tgd1	Equipment group delay differential for the B1 signal (seconds)	Double	8	H+172
28	tgd2	Equipment group delay differential for the B2 signal (seconds)	Double	8	H+180
29	af0	Clock aging parameter, seconds (s)	Double	8	H+188
30	af1	Clock aging parameter, (s/s)	Double	8	H+196
31	af2	Clock aging parameter, (s/s/s)	Double	8	H+204
32	AS	Anti-spoofing on: 0 = FALSE 1 = TRUE	Enum	4	H+212
33	N	Corrected mean motion, radians/second, rad/s	Double	8	H+216
34	URA	User Range Accuracy variance, m2. The ICD a specifies that the URA index transmitted in the ephemerides can be converted to a nominal standard deviation value using an algorithm listed there. We publish the square of the nominal value (variance).	Double	8	H+224

35	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+232
36	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

7.3.13 GALEPHEM Decoded Galileo Ephemeris

This log contains Galileo ephemeris information.

Message ID: 16
Abbreviated ASCII Syntax:GALEPHEMA COM1 60
Abbreviated BINARY Syntax:GALEPHEMB COM1 60
Message Output:

#GALEPHEMA,41,GPS,FINE,2068,114877000,0,0,18,8;3,TRUE,TRUE,0,0,0,0,0,0,107,0,51,107400,5.44062128e+03,3.4376e-09,2.12179697e+00,3.354388755e-04,-2.733470916e-01

,9.4995e-07,7.4301e-06,1.731e+02,2.106e+01,-3.9116e-08,2.9802e-08,9.534512011e-01,5.2931e-10,-2.841927786e+00,-5.69452291e-09,107400,-2.037068480e-04,-4.206413e-12,0.0e+00,107400,-2.037078375e-04,-4.220624e-12,0.0e+00,9.313e-10,1.164e-09*e961a159

Table 7- 33 GALEPHEM message structure

Field	Structure	Field Description	Format	Binary Bytes	Binary Offset
1	GALEPHEMERIS header	Log header, refer to **Table 7-22 Binary Message Format Header Structure**		H	0
2	SatId	Satellite ID (Galileo=1 to 38)	Ulong	4	H
3	FNAVReceived	Indicates FNAV almanac data received	Bool	4	H+4
4	INAVReceived	Indicates INAV almanac data received	Bool	4	H+8
5	E1BHealth	E1B health status bits (only valid if INAVReceived is TRUE)	Uchar	1	H+12
6	E5aHealth	E5a health status bits (only valid if FNAVReceived is TRUE)	Uchar	1	H+13
7	E5bHealth	E5a health status bits (only valid if FNAVReceived is TRUE)	Uchar	1	H+14
8	E1BDVS	E1B data validity status (only valid if INAVReceived is TRUE)	Uchar	1	H+15

9	E5aDVS	E5a data validity status (only valid if FNAVReceived is TRUE)	Uchar	1	H+16
10	E5bDVS	E5b data validity status (only valid if INAVReceived is TRUE)	Uchar	1	H+17
11	SISA	Signal in space accuracy	Uchar	1	H+18
12	Reserved	Reserved	Uchar	1	H+19
13	IODNav	Issue of data ephemeris	Ulong	4	H+20
14	T0e	Ephemeris reference time (s)	Ulong	4	H+24
15	RootA	Square root of semi-major axis (m)	Double	8	H+28
16	DeltaN	Mean motion difference (radians/s)	Double	8	H+36
17	M0	Mean anomaly at ref time (radians)	Double	8	H+44
18	Ecc	Eccentricity (unitless)	Double	8	H+52
19	Omega	Argument of perigee (radians)	Double	8	H+60
20	Cuc	Amplitude of the cosine harmonic correction term to the argument of latitude (radians)	Double	8	H+68
21	Cus	Amplitude of the sine harmonic correction term to the argument of latitude (radians)	Double	8	H+76
22	Crc	Amplitude of the cosine harmonic correction term to the orbit radius (m)	Double	8	H+84
23	Crs	Amplitude of the sine harmonic correction term to the orbit radius (m)	Double	8	H+92
24	Cic	Amplitude of the cosine harmonic correction term to the angle of inclination (radians)	Double	8	H+100

25	Cis	Amplitude of the sine harmonic correction term to the angle of inclination (radians)	Double	8	H+108
26	I0	Inclination angle at ref time (radians)	Double	8	H+116
27	IDot	Rate of inclination angle (radians/s)	Double	8	H+124
28	Omega0	Longitude of ascending node of orbital plane at weekly epoch (radians)	Double	8	H+132
29	OmegaDot	Rate of right ascension (radians/s)	Double	8	H+140
30	FNAVT0c	Clock correction data reference time of week from the F/NAV message (s). Only valid if FNAVReceived is TRUE	Ulong	4	H+148
31	FNAVAf0	SV clock bias correction coefficient from the F/NAV message (s). Only valid if FNAVReceived is TRUE	Double	8	H+152
32	FNAVAf1	SV clock drift correction coefficient from the F/NAV message (s/s). Only valid if FNAVReceived is TRUE	Double	8	H+160
33	FNAVAf2	SV clock drift rate correction coefficient from the F/ NAV message (s/s^2). Only valid if FNAVReceived is TRUE	Double	8	H+168
34	INAVT0c	Clock correction data reference time of week from the I/NAV message (s). Only valid if INAVReceived is TRUE	Ulong	4	H+176
35	INAVAf0	SV clock bias correction coefficient from the I/NAV message (s). Only valid if INAVReceived is TRUE	Double	8	H+180

36	INAVAf1	SV clock drift correction coefficient from the I/NAV message (s/s). Only valid if INAVReceived is TRUE	Double	8	H+188
37	INAVAf2	SV clock drift rate correction coefficient from the I/ NAV message (s/s^2). Only valid if INAVReceived is TRUE	Double	8	H+196
38	E1E5aBGD	E1, E5a broadcast group delay	Double	8	H+204
39	E1E5bBGD	E1, E5b broadcast group delay. Only valid if INAVReceived is TRUE	Double	8	H+212
40	xxxx	32-bit CRC	Hex	4	H+220
41	[CR][LF]	Sentence terminator (ASCII only)	-		-

7.3.14 ANTENNA Detect

David30-D supports antenna working status query, the antenna state includes normal, open circuit, and short circuit. Hardware detection and software query output hardware functions, software output data protocol, and command format.

1. For active antenna of working normally, the board feeds the antenna, normal operating current forms a loop, the receiver queries its real-time status;

2. Antenna open circuit: when the receiver is not connected to the antenna, or the RF cable is damaged, disconnected or for other reasons, the receiver fails to receive satellite signals;

3. Antenna short circuit: due to antenna failure, short circuit of the receiver's RF cable connections, or other reasons, the receiver is short-circuit connected with the antenna, resulting in the receiver cannot work properly.

The electric current monitoring chip outputs 2 bit high low-level, which can make a real-time query for 2 bit IO to monitor the status of the antenna. If an abnormal power supply occurs to ANT1_PW and ANT2_PWR, the query result is invalid.

Command Format:ANTENNA [output rate ontime / once]
Message ID: 51

Abbreviated ASCII Syntax: ANTENNAA 1
Abbreviated BINARY Syntax: ANTENNAB 1

Table 7-34 Antenna message

Field	Field Type	Field Description	Format	Binary Bytes	Binary Offset
1	header	Log header, refer to **Table 7-22 Binary Message Format Header Structure**		H	0
2	status1	Antenna1 Status	ENUM	4	H
3	status2	Antenna 2 Status	ENUM	4	H+4
4	status3	Antenna 3 Status	ENUM	4	H+8
5	reserved	reserved	ENUM	4	H+12
6	xxxx	32-bit CRC	Hex	4	H+16
7	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Table 7-35 Antenna working status

Binary	Antenna state	Description	ANT*_NLOD,ANT*_FFLG
3	ON	Normal	1,1
1	OFF	Open circuit	0,1
2	SHORT	short circuit	1,0
0	RSV	other	0,0

7.3.15 AGRIC Information

This log contains position, velocity, SN, heading, base line, etc.

Message ID: 11276
Abbreviated ASCII Syntax:

AGRICA 1

AGRICA COM2 1
Abbreviated BINARY Syntax:

AGRICB 1

AGRICB COM2 1

Message Output:

#AGRICA,68,GPS,FINE,2063,454587000,0,0,18,38;GNSS,236,19,7,26,6,16,9,4,4,12,10,9,306.7191,10724.0176,-16.4796,0.0089,0.0070,0.0181,67.9651,29.3584,0.0000,0.003,0.003,0.001,-0.002,0.021,0.039,0.025,40.07896719907,116.23652055432,67.3108,-2160482.7849,4383625.2350,4084735.7632,0.0140,0.0125,0.0296,0.0107,0.0198,0.0128,40.07627310896,116.11079363322,65.3740,0.00000000000,0.00000000000,0.0000,454587000, 38.000,16.7 23207,-9.406086,0.000000,0.000000,8,0,0,0*e9402e02

Table 7- 36 AGRIC message structure

ID	Field	Type	Binary Bytes	Description	Note
1	AGRIC header		24	Log header	
2	GNSS	Char	4		
3	length	uchar	1	Command length	The digit length from GNSS to CRC is 236 bytes, Fixed value: 0XEC
4	Year	uchar	1	UTC time -year	For example: 2016: 16: 2116: 116
5	Month	uchar	1	UTC time -month	
6	Day	uchar	1	UTC time -day	
7	Hour	uchar	1	UTC time -hour	
8	Minute	uchar	1	UTC time -minute	
9	Second	uchar	1	UTC time-second	
10	RTK Status	uchar	1	Rover position status	0: Ineffective: 1: Single point: 2: Pseudo-range differential: 4: Fix solution: 5: Float solution:
11	Heading Status	uchar	1	Heading solution status of master and slave antennas	0: Ineffective: 4: Fix solution: 5: Float solution:
12	Num GPS Sta	uchar	1	number of GPS satellite involved in the calculation	
13	Num GLO Sta	uchar	1	number of BDS satellite involved in the calculation	
14	Num BDS Sta	uchar	1	number of GLONASS satellite involved in the calculation	

15	Baseline_N	float	4	From the base to rover baseline vector, Northing component	
16	Baseline_E	float	4	From the base to rover baseline vector, Easting component	
17	Baseline_U	float	4	From the base to rover baseline vector, zenith direction. component standard deviation	
18	Baseline_NStd	float	4	From the base to rover baseline vector, Northing component standard deviation	
19	Baseline_EStd	float	4	From the base to rover baseline vector, Easting component standard deviation	
20	Baseline_UStd	float	4	From the base to rover baseline vector, zenith direction. component standard deviation	
21	Heading	float	4	Heading	
22	Pitch	float	4	Pitch	
23	Roll	float	4	Roll	
24	Speed	float	4	Velocity	
25	Velocity of North	float	4	Northing velocity	
26	Velocity of East	float	4	Easting velocity	
27	Velocity of Up	float	4	velocity	
28	Xigema_Vx	float	4	Northing velocity standard deviation	
29	Xigema_Vy	float	4	Easting velocity standard deviation	
30	Xigema_Vz	float	4	velocity standard deviation	

31	lat	double	8	Rover station latitude (-90 to 90 degrees)	a '-' sign denotes south and a '+' sign denotes north
32	lon	double	8	Rover station longitude (-180 to 180 degrees)	a '-' sign denotes west and a '+' sign denotes east
33	Het	double	8	Rover station height	
34	ECEF_X	double	8	ECEF X value (m)	
35	ECEF_Y	double	8	ECEF Y value (m)	
36	ECEF_Z	double	8	ECEF Z value (m)	
37	Xigema_lat	float	4	Latitude standard deviation	
38	Xigema_lon	float	4	Longitude standard deviation	
39	Xigema_alt	float	4	Height standard deviation	
40	Xigema_ECEF_X	float	4	ECEF_X standard deviation	
41	Xigema_ECEF_Y	float	4	ECEF_Y standard deviation	
42	Xigema_ECEF_Z	float	4	ECEF_Z standard deviation	
43	BASE_lat	double	8	Base station latitude (-90 to 90 degrees)	
44	BASE_lon	double	8	Base station longitude(-180 to 180 degrees)	
45	BASE_alt	double	8	Base station height	
46	SEC_lat	double	8	Sub-antenna latitude (-90 to 90 degrees)	
47	SEC_lon	double	8	Sub-antenna longitude(-180 to 180 degrees)	
48	SEC_alt	double	8	Sub-antenna height	
49	GPS_WEEK_SECOND	int	4	Number of milliseconds into the GPS reference week	
50	Diffage	float	4	Differential age	

51	Speed_Heading	float	4	Direction of velocity	
52	Undulation	float	4	Height outlier	
53	Remain_float_3	float	4	Reserved	
54	Remain_float_4	float	4	Reserved	
55	Num GAL Sta	uchar	1	Galileo satellite number	
56	Remain_char_2	uchar	1	Reserved	
57	Remain_char_3	uchar	1	Reserved	
58	Remain_char_4	uchar	1	Reserved	
59	xxxx	HEX	4	32 bits CRC(only Binary and ASCII)	

Appendix 1 32-Bit CRC

The ASCII and Binary message formats all contain a 32-bit CRC for data verification. This allows the user to ensure the data received (or transmitted) is valid with a high level of certainty.

The C functions below may be implemented to generate the CRC of a block of data.

```
const ULONG aulCrcTable[256] =
{
    0x00000000UL, 0x77073096UL, 0xee0e612cUL, 0x990951baUL, 0x076dc419UL,
0x706af48fUL,
    0xe963a535UL, 0x9e6495a3UL, 0x0edb8832UL, 0x79dcb8a4UL,
0xe0d5e91eUL, 0x97d2d988UL,
    0x09b64c2bUL, 0x7eb17cbdUL, 0xe7b82d07UL, 0x90bf1d91UL,
0x1db71064UL, 0x6ab020f2UL,
    0xf3b97148UL, 0x84be41deUL, 0x1adad47dUL, 0x6ddde4ebUL,
0xf4d4b551UL, 0x83d385c7UL,
    0x136c9856UL, 0x646ba8c0UL, 0xfd62f97aUL, 0x8a65c9ecUL, 0x14015c4fUL,
0x63066cd9UL,
    0xfa0f3d63UL, 0x8d080df5UL, 0x3b6e20c8UL, 0x4c69105eUL, 0xd56041e4UL,
0xa2677172UL,
    0x3c03e4d1UL, 0x4b04d447UL, 0xd20d85fdUL, 0xa50ab56bUL,
0x35b5a8faUL, 0x42b2986cUL,
    0xdbbbc9d6UL, 0xacbcf940UL, 0x32d86ce3UL, 0x45df5c75UL,
0xdcd60dcfUL, 0xabd13d59UL,
    0x26d930acUL, 0x51de003aUL, 0xc8d75180UL, 0xbfd06116UL, 0x21b4f4b5UL,
0x56b3c423UL,
    0xcfba9599UL, 0xb8bda50fUL, 0x2802b89eUL, 0x5f058808UL,
0xc60cd9b2UL, 0xb10be924UL,
    0x2f6f7c87UL, 0x58684c11UL, 0xc1611dabUL, 0xb6662d3dUL, 0x76dc4190UL,
0x01db7106UL,
    0x98d220bcUL, 0xefd5102aUL, 0x71b18589UL, 0x06b6b51fUL,
0x9fbfe4a5UL, 0xe8b8d433UL,
    0x7807c9a2UL, 0x0f00f934UL, 0x9609a88eUL, 0xe10e9818UL, 0x7f6a0dbbUL,
0x086d3d2dUL,
    0x91646c97UL, 0xe6635c01UL, 0x6b6b51f4UL, 0x1c6c6162UL, 0x856530d8UL,
0xf262004eUL,
    0x6c0695edUL, 0x1b01a57bUL, 0x8208f4c1UL, 0xf50fc457UL, 0x65b0d9c6UL,

0x12b7e950UL,
```

```
        0x8bbeb8eaUL, 0xfcb9887cUL, 0x62dd1ddfUL, 0x15da2d49UL,
0x8cd37cf3UL, 0xfbd44c65UL,
        0x4db26158UL, 0x3ab551ceUL, 0xa3bc0074UL, 0xd4bb30e2UL,
0x4adfa541UL, 0x3dd895d7UL,
        0xa4d1c46dUL, 0xd3d6f4fbUL, 0x4369e96aUL, 0x346ed9fcUL,
0xad678846UL, 0xda60b8d0UL,
        0x44042d73UL, 0x33031de5UL, 0xaa0a4c5fUL, 0xdd0d7cc9UL, 0x5005713cUL,
0x270241aaUL,
        0xbe0b1010UL, 0xc90c2086UL, 0x5768b525UL, 0x206f85b3UL, 0xb966d409UL,
0xce61e49fUL,
        0x5edef90eUL, 0x29d9c998UL, 0xb0d09822UL, 0xc7d7a8b4UL,
0x59b33d17UL, 0x2eb40d81UL,
        0xb7bd5c3bUL, 0xc0ba6cadUL, 0xedb88320UL, 0x9abfb3b6UL,
0x03b6e20cUL, 0x74b1d29aUL,
        0xead54739UL, 0x9dd277afUL, 0x04db2615UL, 0x73dc1683UL, 0xe3630b12UL,
0x94643b84UL,
        0x0d6d6a3eUL, 0x7a6a5aa8UL, 0xe40ecf0bUL, 0x9309ff9dUL,
0x0a00ae27UL, 0x7d079eb1UL,
        0xf00f9344UL, 0x8708a3d2UL, 0x1e01f268UL, 0x6906c2feUL, 0xf762575dUL,
0x806567cbUL,
        0x196c3671UL, 0x6e6b06e7UL, 0xfed41b76UL, 0x89d32be0UL,
0x10da7a5aUL, 0x67dd4accUL,
        0xf9b9df6fUL, 0x8ebeeff9UL, 0x17b7be43UL, 0x60b08ed5UL,
0xd6d6a3e8UL, 0xa1d1937eUL,
        0x38d8c2c4UL, 0x4fdff252UL, 0xd1bb67f1UL, 0xa6bc5767UL,
0x3fb506ddUL, 0x48b2364bUL,
        0xd80d2bdaUL, 0xaf0a1b4cUL, 0x36034af6UL, 0x41047a60UL,
0xdf60efc3UL, 0xa867df55UL,
        0x316e8eefUL, 0x4669be79UL, 0xcb61b38cUL, 0xbc66831aUL,
0x256fd2a0UL, 0x5268e236UL,
        0xcc0c7795UL, 0xbb0b4703UL, 0x220216b9UL, 0x5505262fUL, 0xc5ba3bbeUL,
0xb2bd0b28UL,
        0x2bb45a92UL, 0x5cb36a04UL, 0xc2d7ffa7UL, 0xb5d0cf31UL,
0x2cd99e8bUL, 0x5bdeae1dUL,
        0x9b64c2b0UL, 0xec63f226UL, 0x756aa39cUL, 0x026d930aUL, 0x9c0906a9UL,
0xeb0e363fUL,
        0x72076785UL, 0x05005713UL, 0x95bf4a82UL, 0xe2b87a14UL, 0x7bb12baeUL,
0x0cb61b38UL,
        0x92d28e9bUL, 0xe5d5be0dUL, 0x7cdcefb7UL, 0x0bdbdf21UL, 0x86d3d2d4UL,

0xf1d4e242UL,
```

```
    0x68ddb3f8UL, 0x1fda836eUL, 0x81be16cdUL, 0xf6b9265bUL,
0x6fb077e1UL, 0x18b74777UL,
    0x88085ae6UL, 0xff0f6a70UL, 0x66063bcaUL, 0x11010b5cUL,
0x8f659effUL, 0xf862ae69UL,
    0x616bffd3UL, 0x166ccf45UL, 0xa00ae278UL, 0xd70dd2eeUL,
0x4e048354UL, 0x3903b3c2UL,
    0xa7672661UL, 0xd06016f7UL, 0x4969474dUL, 0x3e6e77dbUL, 0xaed16a4aUL,
0xd9d65adcUL,
    0x40df0b66UL, 0x37d83bf0UL, 0xa9bcae53UL, 0xdebb9ec5UL,
0x47b2cf7fUL, 0x30b5ffe9UL,
    0xbdbdf21cUL, 0xcabac28aUL, 0x53b39330UL, 0x24b4a3a6UL,
0xbad03605UL, 0xcdd70693UL,
    0x54de5729UL, 0x23d967bfUL, 0xb3667a2eUL, 0xc4614ab8UL, 0x5d681b02UL,
0x2a6f2b94UL,
    0xb40bbe37UL, 0xc30c8ea1UL, 0x5a05df1bUL, 0x2d02ef8dUL
};


// Calculate and return the CRC for usA
binary buffer ULONG
CalculateCRC32(UCHAR *szBuf, INT
iSize)
{
    int           iIndex;
    ULONG   ulCRC = 0;
    for (iIndex=0; iIndex<iSize; iIndex++)
    {
        ulCRC = aulCrcTable[(ulCRC ^ szBuf[iIndex]) & 0xff] ^ (ulCRC >> 8);
    }
    return ulCRC;
}
```

Appendix 2 RTCM V2 Differential Corrections

RTCM1 Pseudo - Differential GPS corrections
RTCM3 GPS base station coordinates
RTCM9 Grouping pseudo differential correction GPS corrections
RTCM1819 Uncorrected carrier phase and pseudo-distance observations (18, 19 are in the same log)

RTCM24 Antenna reference point information (decoding is supported only)
RTCM31 Pseudo - Differential GLONASS corrections
RTCM32 GLONAS base station coordinates
RTCM41 Multi-system pseudo-differential corrections (RTCM v2.4)
RTCM42 Grouping multi-system pseudo-differential corrections (RTCM v2.4)

Appendix 3 RTCM V3 Differential Corrections

RTCM committee recommends the GNSS (Global Navigation Satellite Systems) differential information standards version 3, the information in version 3.0 and 3.2 is partially supported. See http://www.rtcm.org/overview.php.
This log complies to RTCM normal format, including 1004, 1006, 1007, 1012, 1019, 1033, 1104, which are defined as RTCM1004, RTCM1006, RTCM1007, RTCM1012, RTCM1019, RTCM1033 and RTCM1104.

RTCM V3:
Group 1 - Observables

RTCM1001 GPS L1-only observables, basic
RTCM1002 GPS L1-only observables, extended
RTCM1003 GPS L1/L2 basic observables
RTCM1004 GPS L1/L2 basic observables, extended
RTCM1009 GLONASS L1-only observables, basic
RTCM1010 GLONASS L1-only observables, extended
RTCM1011 GLONASS L1/L2 basic observables, basic
RTCM1012 GLONASS L1/L2 basic observables, extended
RTCM1071 GPS MSM1 (Provide the code measurements)
RTCM1074 GPS MSM4 (Provide all the data from MSM3 (code and phase) and add the CNR measurements)
RTCM1075 GPS MSM5 (Provide all the data from MSM4 (code, phase and CNR) and add the doppler measurements)
RTCM1081 GLONASS MSM1 (Provide the code measurements)
RTCM1084 GLONASS MSM4 (Provide all the data from MSM3 (code and phase) and add the CNR measurements)
RTCM1085 GLONASS MSM5 (Provide all the data from MSM4 (code, phase and CNR) and add the doppler measurements)

RTCM1121 BDS MSM1（Provide the code measurements）

RTCM1124 BDS MSM4（Provide all the data from MSM3 (code and phase) and add the CNR measurements）

RTCM1125 BDS MSM5（Provide all the data from MSM4 (code, phase and CNR) and add the doppler measurements）

RTCM1104 BDS RTK observables (Domestic industry definition, cannot be mixed with other foreign products）

Group 2 –base station coordinates:

RTCM1005 RTK base station antenna reference point coordinates (ARP)
RTCM1006 RTK base station antenna reference point coordinates with antenna height

Group 3 –base station antenna description

RTCM1007 Antenna description and installation information (coding is supported only)

Group 4 –Auxiliary information:

RTCM63 BeiDou Ephemerides（test message）
RTCM1042 BeiDou Ephemerides（based on RTCM3.03）
RTCM1019 GPS Ephemerides
RTCM1020 GLONASS Ephemerides
RTCM1045 GALILEO F/NAV Ephemerides
RTCM1046 GALILEO I/NAV Ephemerides
RTCM1033 Receiver and antenna descriptors