HIGH PRECISION

COMMANDS AND LOGS

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NebulasII
High Precision Products

Revision History

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R3	Add 'RAWIMUX IMU' in chapter 8.5 Appendix 4: add the corresponding message ID for eventall and eventmark Chapter 5.1 MASK: update the supported GNSS frequencies Chapter 7.3.4 GPSION Ionosphere Parameters and 7.3.5 BDSION Ionosphere Parameters: update data structure adding usSVID, usWeek, ulSec 1. NEW commands: 4.28 L1 Positioning Status Configuration 4.1 NMEA Version Configuration 2. Remove PPP description in Chapter3 MODE Command 3. New commad: NMEA0183 version cfg 4. Add RTCM message: rtcm1122 / rtcm1123 / rtcm1126 / rtcm1127	2020-06-17
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Foreword

This document offers you information on commands, logs, default settings, and examples of Unicore high precision receivers.

For the generic version of this manual, please refer to different part of the manual according to your purchased product configuration, concerning CORS, RTK and Heading.

Audience

This <User Manual> is applied to the technicists who know GNSS Receiver to some extent but not to the general readers.

Contents

Tables

1. Frequently Used Commands

Unicore high precision receivers support abbreviated ASCII format. Abbreviated ASCII format with no CRC bits is easy for users' input.

All commands compose with command header and configuration parameters. Header field contains the command name or the message header.

Frequently used commands are listed below:

Table 1- 1 Unicore Commands Sorted by Function

Command Name	Description
freset	Restore the factory default settings. **Note:** the factory set baud rate is 115200 bps.
version	Query version information for all components.
config	Query status of the serial port
mask GPS	Disable GPS system satellites, BDS/GPS/GLO/GAL system are all supported to disable
unmask BDS	Enable GPS system satellites, BDS/GPS/GLO/GAL system are all supported to enable
config com1 115200	Configure com1 port operating at 115200 baud rate. The usable COM ports are COM1, COM2, COM3. The baud rate could be 9600, 19200, 38400, 57600, 115200, 230400,460800 bps
unlog	Disable all outputs of the port in use
saveconfig	Save the settings
Base/Rover Station Settings	
mode base time 60 1.5 2.5	Within the 60- seconds of the receiver automatic positioning of the receiver, or when the standard deviation of horizontal positioning is no more than 1.5 m and that of vertical positioning is no more than 2.5 m, set the average value of averaging the horizontal and vertical positioning results as and fixing them to the base station coordinates. The base station coordinates are automatically set in this mode. Restarting the receiver triggers a new calculation and reposition
mode base lat lon height	Set datum coordinates manually: latitude, longitude, height. Datum coordinates are fixed, when restarting the receiver. For example, lat=40.07898324818, lon=116.23660197714, height=60.4265

Command Name	Description
	Note: Longitude and latitude can be obtained by **GGA** command. The Southern Hemisphere is corresponding a negative latitude value; The Western Hemisphere is corresponding a negative longitude value
mode base	Set the default base station mode
mode movingbase	Set the moving base station mode
mode rover	Set the default rover station mode (this command transfers the receiver from base station mode rover mode)
rtcm1033 comx 10 **rtcm1006 comx 10** **rtcm1074 comx 1** **rtcm1124 comx 1** **rtcm1084 comx 1** **rtcm1094 comx 1**	Set base station to transmit RTCM messages to rover receivers via CMOX, ICMOX, and NCMOX. The serial port CMOX can be assigned as COM1, COM2, COM3. Refer to **Table 4- 1 Device Function List** for details on ICMOX and NCMOX
NMEA0183 Messages Associated	
gpgga comx 1	Set GGA message output rate at 1Hz. Users can choose the message type and update rate. 1, 0.5, 0.2, 0.1 are corresponding to the frequency 1Hz,2Hz,5Hz,10Hz respectively. The optional message types are: GGA, RMC, VTG, ZDA, NTR
gphdt comx 1	Output the heading message HDT of the present instant. Vessel Heading message types include HDT and TRA

1.1 Base Station Configuration

For RTK base station (fixed base station), the antenna is placed at known coordinates with no changes during the whole use.

Meanwhile, the precise coordinates of the known measurement station and the received satellite information will be sent to rover (yet to be positioned) by RTCM protocol directly or after processing.

The rover receives the base station information including coordinates and the satellite observations, performing the RTK solution to achieve centimeter or millimeter level accuracy.

When the precise coordinates are known, configure the following commands to the receiver.

Table 1- 2 Fixed Base Station Configuration

Number	Command	Description
1	mode base 40.078983248 116.236601977 60.42	Set the known base station coordinates: latitude, longitude, ellipsoid height
2	rtcm1006 com2 10	Base station antenna coordinates (antenna height included)
3	rtcm1033 com2 10	Receiver and antenna description
4	rtcm1074 com2 1	GPS system correction data
5	rtcm1124 com2 1	BDS system correction data
6	rtcm1084 com2 1	GLO system correction data
7	rtcm1094 com2 1	Galileo system correction data
8	saveconfig	Save configuration

If base station coordinates are unknown, we recommend you to get the average coordinates from a period time of positioning in specific conditions. The following instructions required to enter and save at the base station:

Table 1- 3 Self-Optimizing Base Station Configuration

Number	Command	Description
1	mode base time 60 1.5 2.5	Within 60-second automatic positioning of the receiver, or when the standard deviation of horizontal positioning is no more than 1.5 m and that of vertical positioning is no more than 2.5 m, set the average value of horizontal and vertical positioning results as the base station coordinates. Restarting the receiver triggers a new calculation and reposition of the datum coordinates
2	rtcm1006 com2 10	Base station antenna coordinates (antenna height included)
3	rtcm1033 com2 10	Description of receiver and antenna
4	rtcm1074 com2 1	GPS system correction data
5	rtcm1124 com2 1	BDS system correction data
6	rtcm1084 com2 1	Glonass system correction data
7	rtcm1094 com2 1	Galileo system correction data
8	saveconfig	Save configuration

1.2 Rover Station Configuration

The RTK Rover Station receives correction data from a base station. Meanwhile, the rover can adaptively recognize the RTCM format and performs an RTK solution. Frequently used commands for RTK rover station is:

MODE ROVER
GPGGA 1
SAVECONFIG

1.3 Moving Base Configuration

The moving base station is different from a fixed base station. The fixed base station is fixed with known precise coordinates, while the moving base station is at moving status, the correction data will be sent to the rover (with an undetermined point) by RTCM protocol. For the rover side, it will receive the satellite signals first, simultaneously, it also receives the RTCM data from the moving base station. Then, it calculates the relative position of the rover. Frequently used commands to configure the moving base station are as follows:

Table 1- 4 Moving Base Station Configuration

Number	Command	Description
1	mode movingbase	Set base station in moving base mode
2	rtcm1006 com2 1	Base station antenna coordinates (include antenna height)
3	rtcm1033 com2 1	Description of receiver and antenna
4	rtcm1074 com2 1	GPS system correction data
5	rtcm1124 com2 1	BDS system correction data
6	rtcm1084 com2 1	Glonass system correction data
7	rtcm1094 com2 1	Galileo system correction data
8	saveconfig	Save configuration

1.4 Heading

This command is used for dual-antenna receivers (UB482, UM482, UM442). 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. See fig 3-1 for the schematic.
Frequently used commands are as follows:

GPHDT 1
SAVECONFIG

1.5 Heading2

The heading2 result is the angle from True North to the baseline of the base to rover in a clockwise direction. Dual-antenna heading receiver (UB482, UM482, UM442) supports heading2. The heading2 for the dual-antenna receiver is the angle from True North to the baseline of the Base to ANT1 in a clockwise direction. Please refer to **Figure 3-1 Heading Schematic for the detailed schematic.**

Frequently used commands are as follows:

MODE HEADING2
GPHDT2 ONCHANGED
SAVECONFIG

1.6 Inertial Navigation

UB482, UM4B0, and UM482 have built-in inertial navigation devices. Please refer to the corresponding manual to set the installation angle.

Refer to **Figure 1-1 Vehicle Coordinates (XYZ)** for the boards' inertial coordinate system, in which, the X, Y, Z axis are mutually perpendicular, and follow the right-hand rule.

The vehicle coordinate system is defined as follows: The Y axis is along the vehicle's travel forward direction, the X axis squares with the Y axis and points to the right. Ensure the boards' inertial coordinate system matches with the vehicle's coordinate system.

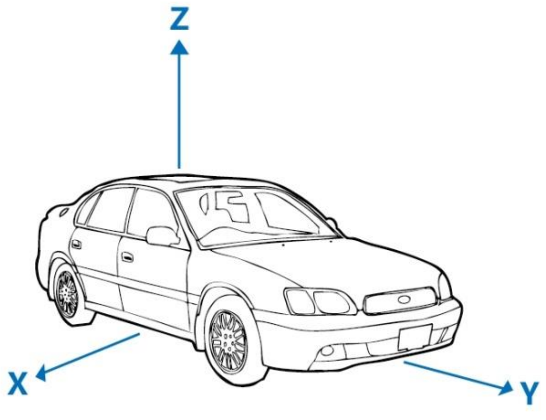

Figure 1-1 Vehicle Coordinates (XYZ)

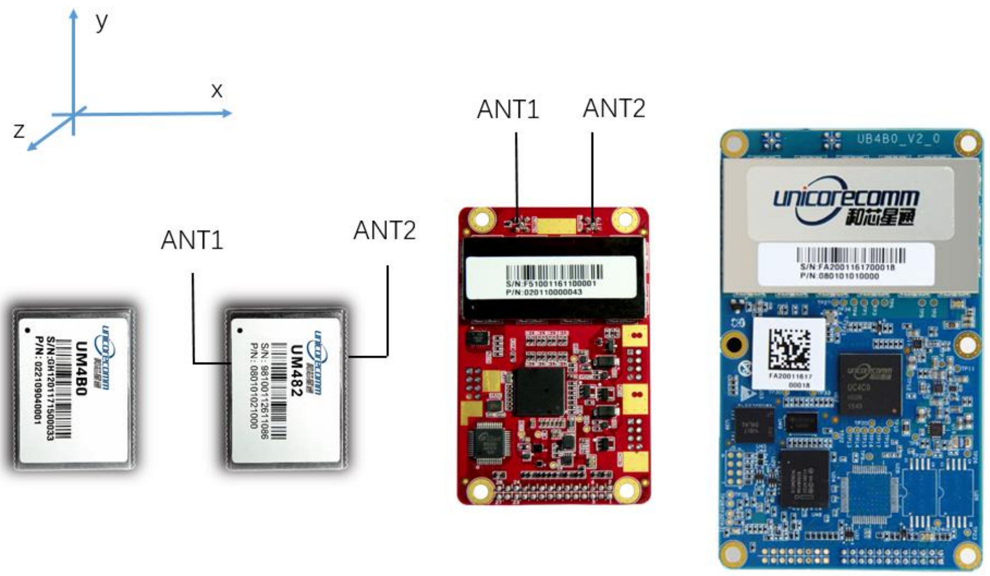

Figure 1-2 Module/Boards Inertial Coordinate System

2. Unicore Command Types Introduction

The Unicore commands for High precision GNSS boards and modules can be categorized into the following types.

Table 2- 1 Receivers Command Type

No.	Type	Description	Receiver Type
1	MODE	Set the working mode for receivers, like base/rover	UM4B0, UM482, UB482, UB4B0, UB4B0M
		Check receiver's current work mode	UM4B0, UM482, UB482, UB4B0, UB4B0M
2	CONFIG	Configure receiver's function/interfaces	UM4B0, UM482, UB482, UB4B0, UB4B0M
		Check receiver's current configuration	UM4B0, UM482, UB482, UB4B0, UB4B0M
3	Mask	Mask/unmask constellation or elevation. Set the satellite system, frequency, and elevation angle tracked by receivers.	UM4B0, UM482, UB482, UB4B0, UB4B0M
4	Log	Output the position/heading/velocity, etc.	UM4B0, UM482, UB482, UB4B0, UB4B0M
5	Timing	Dedicated for the timing application configuration	UM4B0, UT4B0
6	MISC	Reset/Freset/Saveconfig	UM4B0, UM482, UB482, UB4B0, UB4B0M
7	Compatible	Compatible with UB380, UB280, UB351.	UM4B0, UM482, UB482, UB4B0, UB4B0M

3. MODE Command

MODE command is used to set the working mode of the receiver. The receiver's working modes include base mode, rover mode, moving base mode, heading mode, TDIF mode, ARTK mode, and high precision timing mode.
The above working modes are mutually exclusive. In other words, the receiver can only work under one mode. Re-enter a new command to the receiver, the receiver will be reset according to the latest input working mode (mode).
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.

Command Format:
MODE [mode][parameters]

Abbreviated ASCII Syntax:
MODE BASE 40.45628476579 116.2859754968 58.0984
MODE ROVER
MODE MOVINGBASE

Table 3- 1 Receiver Work Mode List

No.	Mode	Description
1	BASE	Set the fixed base station mode
2	ROVER	Set the rover station mode
3	MOVINGBASE	Set the moving base station mode
4	HEADING2	Set the heading mode
5	TIMING	Set the timing mode

3.1 Check the Receiver Working Mode

The MODE command is used to check receiver working mode.

Command Format:
MODE

Abbreviated ASCII Syntax:
MODE

Output Example:

#MODE,98,GPS,FINE,2063,94651000,0,0,18,19;mode rover,HEADINGMODE FIXLENGTH*2C

Table 3- 2 Receiver Work Mode Checking

Command	Description	Receiver Type
MODE	Check working mode like base/rover	UM4B0, UM482, UB482, UB4B0, UB4B0M

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 base station are coordinates are set, the output positioning information (GPGGA) will always keep the fixed coordinates.
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.

Command Format:
MODE BASE [ID] [param1 param2 param3]

Abbreviated ASCII Syntax:
MODE BASE 40.45628476579 116.2859754968 58.0984
MODE BASE -2160489.0276 4383620.1006 4084738.1110

Table 3- 3 Base Station Mode with Fixed Coordinates

Command	Mode	ID	Parameter	Description
MODE	BASE	Base Station ID 0~4095 (can be omitted)[1]	param1	Input coordinates parameters: Latitude coordinate in degrees (BLH Coordinate System) -90 ≤ param1 ≤ 90
				The X-axis coordinate in the ECEF coordinate system param1 < -90 or param1 > 90

[1] Restricted to RTCM3.2

Command	Mode	ID	Parameter	Description
			Param2	Input coordinates parameters: Longitude coordinate in degree (BLH Coordinate System) -180 ≤ param2 ≤ 180
				The Y-axis coordinate in the ECEF coordinate system Param2 < -180 or param2 > 180
			Param3	Input coordinates parameters: Height in meters -30000 ≤ param3 ≤ 30000
				The Z-axis coordinate in meters (ECEF coordinate system) Param3 < -30000 or Param3 > 30000

3.3 Self-Optimizing Base Station Mode

Set the receiver to optimize the positioning results automatically to the specified accuracy and the receiver will fix the optimized result as the base station coordinates. The position optimization will last for a specific number of hours, or until the optimized position error is within the specific threshold. Which means, when the optimization time is up, or the optimized coordinates accuracy of the horizontal and vertical reach the setting values, the self-optimizing base mode is automatically invoked.

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.

For the command "MODE BASE [ID] TIME [T STD1 STD2] [DISTANCE]", the DISTANCE means the length of self-optimizing fixed positions between the current coordinates and the saved ones during the last positioning. If the user configures base station under this mode, the optimized base station coordinates are saved in the FLASH. When restarting the receiver, it will start with self-optimizing mode and get fixed, meanwhile comparing with the fixed coordinates from FLASH before the restart and calculating the distance between them. If the distance is less than your threshold value, it will use the coordinates saved in FLASH. If not, it will be optimized again. DISTANCE value: 0≤DISTANCE≤10, in meters. If the DISTANCE value is 0, it means the receiver will start with self-optimized mode and fix the currently calculated results.

Command Format:

MODE BASE [ID] TIME [T STD1 STD2] [DISTANCE]

Abbreviated ASCII Syntax:

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

Table 3- 4 Base Station Mode with Self-Optimizing Coordinates

Command	Mode	ID	Name	Parameters	Description
MODE	BASE	Integer 0~4095 (can be omitted)	Time	T	Maximum time for average position, in units of seconds
				STD1	Horizontal error tolerance of average position (default =1.5 m)
				STD2	Vertical error tolerance of average position (default = 2.5 m)
				DISTANCE	Distance, in meters. The receiver starts in the mode of base station self-optimization. If the distance between the optimized coordinates and the ones stored in the FLASH is less than the value of DISTANCE, the receiver sets the coordinates stored in the FLASH as the base station coordinates. DISTANCE value: $0 \le DISTANCE \le 10$, in meters. If the DISTANCE value is 0, the receiver will start with the mode of base station self-optimization and take the optimized results as the coordinates of

Command	Mode	ID	Name	Parameters	Description
					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

Abbreviated ASCII Syntax:
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

3.7 Moving Base Mode Configuration

This command is used to set moving base working mode for receivers. The moving base station is different from the fixed base station. Fixed base station is fixed with the known precise coordinates, while the moving base station is at moving status, the correction data is sent to the rover side by RTCM format. While receiving the satellite observations, the rover station receiver also receives the correction data from moving base and calculates the relative position or heading. Also, the coordinates of the rover station are relative to the moving base.

Command Format:
MODE MOVINGBASE

Abbreviated ASCII Syntax:
MODE MOVINGBASE

Table 3- 8 Moving Base Station Work Mode Parameters

Command	Mode	Parameter	Parameters Description
MODE	MOVINGBASE		Enable moving base station mode

3.8 Heading Configuration Command

This command is used to set the heading mode for the receiver (UB482, UM482, UM442). The heading result is the angle from True North to the baseline of the ANT1 to

ANT2 in a clockwise direction. For UM482 and UB482, the heading function is enabled by default setting. Refer to **Figure 3-1 Heading Schematic for the detailed schematic**.

3.9 Heading2 Configuration Command

The heading2 result is the angle from True North to the baseline of the base to rover in a clockwise direction.

The heading2 is supported in the dual-antenna receivers (UB482, UM482), and it is the angle from True North to the baseline of the Base to ANT1 in a clockwise direction. See **Figure 3-1 Heading Schematic** for more details.

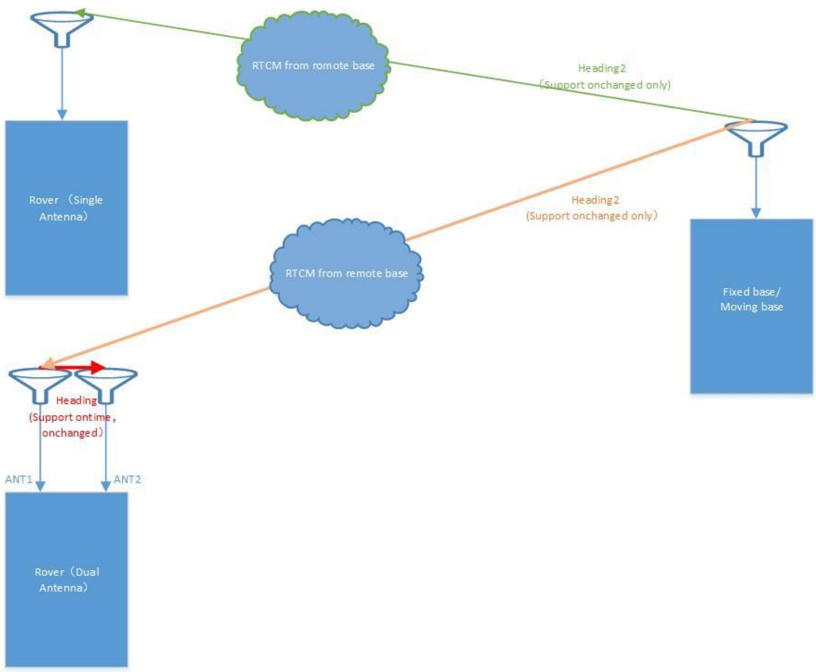

Figure 3- 1 Heading Schematic

Command Format:

MODE HEADING2 [parameter]

Abbreviated ASCII Syntax:

MODE HEADING2

MODE HEADING2 FIXLENGTH

MODE HEADING2 VARIABLELENGTH

MODE HEADING2 STATIC

MODE HEADING2 LOWDYNAMIC

Table 3- 9 Heading2 Mode Parameters

Command	Mode	Parameter	Description
MODE	HEADING2		Enable Heading2 mode. Between two antennas (static or dynamic) of moving base station and heading receiver, the relative positions or distance keeps relative stationary
		FIXLENGTH	Enable Heading2 mode. Between two antennas (static or dynamic) of moving base station and heading receiver, the relative positions or distance keeps stationary
		STATIC	Enable Heading2 mode. Both two antennas of moving base station and heading receiver are in static status
		VARIABLELENGTH	Enable Heading2 mode. Between two antennas of moving base station and heading receiver, the relative positions or distance dynamic changes
		LOWDYNAMIC	Low dynamic application
		TRACTOR	For agricultural machinery, working mode

4. CONFIG Command

CONFIG command is used to configure the header of serial ports, antenna feed, Inertial devices, PPS, geoid undulation, DGNSS engine, and RTK engine of the receiver.

1) Baud rate of the receiver's serial ports
2) antenna feed
3) Inertial devices
4) PPS
5) geoid undulation
6) DGPS engine
7) RTK engine

8) TDIF engine
9) Heading engine
10) Heading2 engine
11) SBAS function
12) EVENT function
13) Ntrip function
14) Network function

Command Format:

CONFIG [devices/function] [parameter]

Abbreviated ASCII Syntax:

CONFIG COM1 115200 8 n 1
CONFIG ANTENNA POWERON
CONFIG PPS ENABLE BDS POSITIVE 100000 1000 0 0
CONFIG UNDULATION 9.7
CONFIG RTK TIMEOUT 60
CONFIG DGPS TIMEOUT 100
CONFIG ETH1 DHCP
CONFIG ETH1 192.168.0.100 192.168.0.1 255.255.255.0 192.168.0.1
CONFIG ICOM1 TCP 30001
CONFIG ICOM1 TCP 10.0.100.1 80001
CONFIG NCOM1 10.0.100.2 9000 UB4B0_RTCM32 SERV_PASSWORD
CONFIG NCOM20 10.0.100.2 9001 UB4B0_RTCM32 UNAME CLI_PASSWORD

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	INS	INS configuration: enable/disable INS, and configure INS installation angle, INS time, INS alignment velocity threshold, distance between IMU and lever arm of master antenna, distance between IMU and lever arm of slave antenna, offsets of INS output position, initial heading angle and STD of INS, and initial attitude angle and STD of INS.
5	ANTENNA	Antenna feed switch configuration
6	PPS	PPS configuration: enable/disable PPS output, polarity, period and pulse width

NO.	Name	Description
7	EVENT	Reserved
8	UNDULATION	Geoid undulation configuration: input a specific undulation value or use built-in geoid grid
9	RTK	RTK configuration: RTK solution, maximum age of RTK data.
10	DGPS	DGPS configuration: maximum age of DGPS data
11	TDIF	TDIF configuration: enable/disable TDIF function
12	ETH1	Configure IPv4
13	ICOM1	Configure ICOM1 port
14	ICOM2	Configure ICOM2 port
15	ICOM3	Configure ICOM3 port
16	NCOM1	Configure Ntrip Server NCOM1
17	NCOM2	Configure Ntrip Server NCOM2
18	NCOM3	Configure Ntrip Server NCOM3
19	NCOM20	Configure Ntrip Client NCOM20

4.1 Check the Receiver Configuration

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

Command Format:
CONFIG

Abbreviated ASCII Syntax:
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
$CONFIG, INS, CONFIG INS DISABLE*70
$CONFIG, INS, CONFIG INS ANGLE 0,0,0*75
$CONFIG, INS, CONFIG INS ALIGNMENTVEL 5.0*2F
$CONFIG, INS, CONFIG INS TIMEOUT 200*6D

Table 4- 2 Receiver Configuration Checking Command

Log	Description	Receiver Type
CONFIG	Check the receiver's current function and configuration	UM4B0, UM482, UB482, UB4B0, UB4B0M

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 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 INS Devices to Be Enabled

The receiver integrates with onboard MEMS chips and the INS function is disabled by default setting. So, the receiver is working under GNSS mode only.

The inertial navigation device functions when the INS enabled command is sent to the receiver and the receiver responses correctly. If a single antenna is connected, the receiver will work under the GNSS+INS mode when the attitude angle of the receiver is initialized, or the velocity of the vehicle reaches the initialization speed threshold. If dual antennas are connected, the receiver will work under the GNSS+INS mode when the attitude angle of the receiver is initialized, or the lever arm values of the master antenna and the slave antenna are input and the receiver completes heading concurrently. After the inertial navigation device is enabled, the receiver is required to be rigid coupling with the vehicle. UB4B0 supports neither this command nor onboard inertial navigation devices.

Command Format:
CONFIG INS [parameter]

Abbreviated ASCII Syntax:
CONFIG INS ENABLE

Table 4- 5 INS Configuration

Log Header	Device	Parameter	Description
CONFIG	INS	Enable	Enable INS: CONFIG INS ENABLE
		Disable	Disable INS: CONFIG INS DISABLE

4.4 Configure INS Device Installation Angel

This command is used to set the installation angle of the board and it should be relative to the vehicle's XYZ direction. The receiver is labeled with the XYZ axis of the inertial navigation device. It is required that the XYZ axis of the receiver must be consistent with the vehicle. If the coordinate system of INS is not corresponding to the vehicle's, a rotation angle of INS is required to input.
Command Format:
CONFIG INS ANGLE [parameter]

Abbreviated ASCII Syntax:

CONFIG INS ANGLE 0 9000 18000

Table 4- 6 INS Installing Angle Configuration

Log Header	Device	Angle	Number	Parameter	Description
CONFIG	INS	ANGLE	1	ANGLEX	Rotation angle from vehicle X-axis to INS module X-axis (right-handed coordinate system), in units of 0.01 degrees, range: 0-36000.
			2	ANGLEY	Rotation angle from vehicle Y-axis to INS module Y-axis (right-handed coordinate system), in units of 0.01 degrees, range: 0-36000.
			3	ANGELZ	Rotation angle from vehicle Z-axis to INS module Z-axis (right-handed coordinate system), in units of 0.01 degrees, range: 0-36000.

The vehicle coordinate is XYZ, and the board coordinate is xyz. AngleX, angleY, and angleZ are defined as below:

1. Coincide the initial state of XYZ coordinate with xyz coordinate's
2. Rotate γ angle of the board along the z axis
3. Rotate α angle of the board along the new x axis
4. Rotate β angle of the board along the new y axis
5. The board is now in the same state as the actual installation, with that, angleX=α, angleY=β, angleZ=γ

The rotation angles and symbols above follow the right-hand rule.

4.5 Configure INS Timeout

This command is used to set the output duration of INS system when losing GNSS signals, in seconds.

Command Format:
CONFIG INS TIMEOUT [parameter]

Abbreviated ASCII Syntax:
CONFIG INS TIMEOUT 60

Table 4- 7 INS Maximum Prediction Time Configuration

Log Header	Device	Field	ASCII Value	Description
CONFIG	INS	TIMEOUT	1-1000	The maximum time allowing INS to position after losing GNSS satellite signals (For UM, UB series receivers default = 200, CLAP receivers default = 300), seconds
			> 1000	Non-recommended value

4.6 Configure INS Alignment Velocity Threshold

This command allows you to set the initialization calibration of the INS device when the vehicle reaches the specified velocity. If the velocity hasn't reached the threshold, the INS cannot be triggered. When the receiver is connected with to dual antennas that can complete heading, the command is invalid, which means the initialization calibration is finished and the CNSS+INS mode is enabled.

Command Format:
CONFIG INS ALIGNMENTVEL [parameter]

Abbreviated ASCII Syntax:
CONFIG INS alignmentvel 5.0

Table 4- 8 INS Velocity Threshold Configuration

Log Header	Device	Field	ASCII Value	Parameters Description
CONFIG	INS	alignmentvel	velocity	Option for the velocity threshold of INS calibration speed, meters/second

4.7 Configure Lever Arm between IMU & Master Antenna

This command is used to input the offset between IMU and the phase center of GNSS master antenna, that is, the lever arm distance from INS to the master antenna. The measurement of the lever arm parameters should be as accurate as possible, especially in the RTK mode, and the error should be within 1 mm. Any error in the lever arm parameters will be transferred into the error of the INS position directly. X, Y and Z represent the vectors from the IMU to the phase center of the master antenna. Fields a, b, and c are used to input any possible errors in the measurement. For example, if the offset 'X' is measured in centimeters, enter 0.01 in the 'a' field.
The IMU should be positioned as close to the GNSS master antenna as possible in the horizontal direction to improve the accuracy.

Command Format:
CONFIG IMUTOANT OFFSET x y z [a] [b] [c]

Abbreviated ASCII Syntax:
CONFIG IMUTOANT OFFSET 0.54 0.32 1.20 0.03 0.03 0.05

Table 4- 9 Configuration of Lever Arm Parameters from IMU to Master Antenna

Log Header	Parameters	Description
CONFIG IMUTOANT OFFSET	X	X-axis offset, unit: meter, range: -100~100.
	Y	Y-axis offset, unit: meter, range: -100~100.
	Z	Z-axis offset, unit: meter, range: -100~100.
	a	Error of the X-axis offset, unit: meter, range: 0.01~10. 0.01 m defaults to the minimum value for 10% of the X-axis offset
	b	Error of the Y-axis offset, unit: meter, range: 0.01~10. 0.01 m defaults to the minimum value for 10% of the Y-axis offset
	c	Error of the Z-axis offset, unit: meter, range: 0.01~10. 0.01 m defaults to the minimum value for 10% of the Z-axis offset

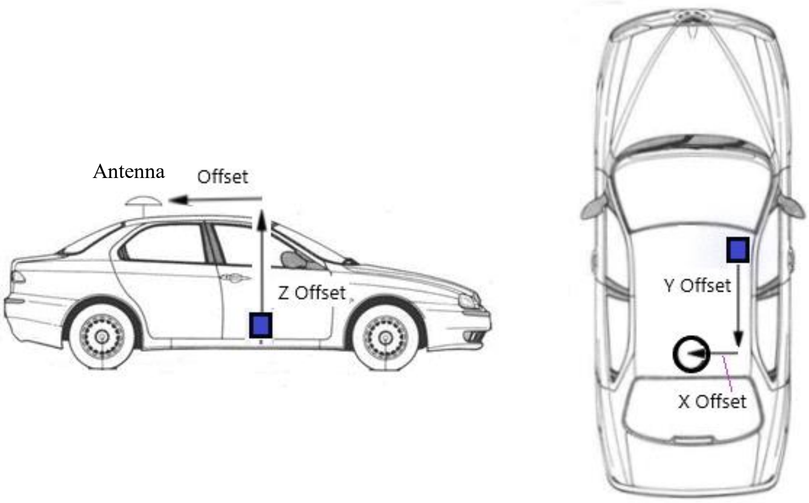

Figure 4- 1 Offset from IMU to Antenna Phase Center

When proceeding the installation per **Figure 4- 1 Offset from IMU to Antenna Phase Center**, the offset is –X, -Y, -Z.

4.8 Configure Lever Arm between IMU & Slave Antenna

This command is used to input the offset between IMU and the phase center of GNSS slave antenna, that is, the lever arm parameters from INS to the slave antenna. The measurement of the lever arm parameters should be as accurate as possible, especially in the RTK mode; the error should be within 1 mm. Any error in the lever arm parameters will be transferred into the error of the INS position directly. X, Y and Z represent the vectors from IMU to the phase center of the slave antenna. Fields a, b, and c are used to input any possible errors in the measurement. For example, if the offset 'X' is measured in centimeters, enter 0.01 in the 'a' field.

The IMU should be positioned as close to the GNSS master antenna as possible in the horizontal direction to improve the accuracy.

In general, the master GNSS antenna is installed behind the forward axis (Y-axis) of IMU, and the slave GNSS antenna is installed in front of the forward axis (Y-axis) of IMU. When inputting the lever arm parameters of both the master GNSS antenna and the slave GNSS antenna, the receiver will calculate the angular deviation between the Y-axis of IMU and the baseline of the dual antenna. The command format is similar to that of command CONFIG IMUTOANT OFFSET.

Command Format:

CONFIG IMUTOANT2 OFFSET x y z [a] [b] [c]

Abbreviated ASCII Syntax:

CONFIG IMUTOANT2 OFFSET 0.24 0.32 1.20 0.03 0.03 0.05

Table 4- 10 Configuration of Lever Arm Parameters from IMU to Slave Antenna

Log Header	Parameters	Description
CONFIG IMUTOANT2 OFFSET	X	X-axis offset, unit: meter, range: -100~100
	Y	Y-axis offset, unit: meter, range: -100~100
	Z	Z-axis offset, unit: meter, range: -100~100
	a	Error of the X-axis offset, unit: meter, range: 0.01~10. 0.01 m defaults to the minimum value for 10% of the X-axis offset
	b	Error of the Y-axis offset, unit: meter, range: 0.01~10. 0.01 m defaults to the minimum value for 10% of the Y-axis offset
	c	Error of the Z-axis offset, unit: meter, range: 0.01~10. 0.01 m defaults to the minimum value for 10% of the Z-axis offset

4.9 Configure Position Offsets of INS

The command CONFIG INS OFFSET is used to set the position offsets of IMU when INS position and velocity are output. This command deviates the values output by INSPVA relative to the IMU coordinate axis, in meters.

Message ID: 676

Command Format:
CONFIG INSSOL OFFSET xoffset yoffset zoffset

Abbreviated ASCII Syntax:
CONFIG INSSOL OFFSET 0.15 0.15 0.25

Table 4- 11 INS Position Offsets Configuration

Log Header	Parameters	Description
CONFIG INSSOL OFFSET	X offset	X-axis offset, unit: meter, range: -100~100
	Y offset	Y-axis offset, unit: meter, range: -100~100
	Z offset	Z-axis offset, unit: meter, range: -100~100

4.10 Configure Initial Azimuth and STD of INS

The command CONFIG INS AZIMUTH is used for the initial azimuth and STD configuration. This command can take the azimuth obtained through other approaches as the initial alignment azimuth to input through this command. The azimuth is the weakest component of a coarse alignment and is also the easiest to know from an external source. To obtain good system performance, the azimuth value must be accurate when inputting it. Sending the command CONFIG INS AZIMUTH resets the composite filter, which may take at least 30 seconds to realign, and then it still takes some time and vehicle maneuverability to converge the combined filter before which, the system performance is poor.

Command Format:
CONFIG INS AZIMUTH azimuth azSTD

Abbreviated ASCII Syntax:
CONFIG INS AZIMUTH 90 5

In this example, the initial azimuth is set to 90 degrees, which means the Y axis of CLAP points east, within a standard deviation of five degrees.

Table 4- 12 Initial Azimuth and STD of INS Configuration

Log Header	Parameters	Description
CONFIG INS AZIMUTH	azimuth	Initial azimuth of INS, unit: degree, range: 0~360. (north by east is positive）
	azSTD	Standard deviation of azimuth, unit: degree，range: 0.0002778 ~45. (0.0002778 degrees are about one arcsecond)

4.11 Configure Initial Attitude and STD of INS

The command CONFIG INS AZIMUTH is used for the initial attitude and STD configuration. The pitch, roll and azimuth obtained via other approaches can be used as the initial alignment attitude input through this command, and the coarse alignment is not proceeded when completing alignment process with this command.
The considerations and special conditions for this command are listed below.

1. The alignment must be instantly entered. This command enables the system to start faster and enter the navigation mode. However, the input value must be accurate, otherwise the system performance will be affected.
2. If the attitude for input is not explicit, increase the attitude value of STD.
3. Sending the command CONFIG INS ATTITUDE resets the composite filter, and the command takes effect immediately. But it still takes some time and vehicle maneuverability to converge the combined filter, before which, the system performance is poor.

Command Format:
CONFIG INS ATTITUDE pitch roll azimuth pitchSTD rollSTD azSTD

Abbreviated ASCII Syntax:
CONFIG INS ATTITUDE 0 0 90 5 5 5

In this example, the initial pitch and roll are set to 0 degree, the initial azimuth is set to 90 degrees, within a standard deviation of five degrees. This means that CLAP is basically mounted horizontally with the Y axis pointing east, which is within a standard deviation of five degrees.

Table 4- 13 Initial Attitude and STD of INS Configuration

Log Header	Parameters	Description
CONFIG INS ATTITUDE	pitch	The initial pitch of INS, unit: degree, range: -90~90. (along the X-axis, the right-hand spiral is positive）
	roll	The initial roll of INS, unit: degree, range: -90~90. (along the Y-axis, the right-hand spiral is positive）
	azimuth	The initial azimuth of INS, unit: degree, range: 0~360. (north by east is positive)
	pitchSTD	Standard deviation of the pitch, unit: degree, range: 0.0002778 ~45
	rollSTD	Standard deviation of the roll, unit: degree, range: 0.0002778 ~45
	azSTD	Standard deviation of the azimuth, unit: degree, range: 0.0002778 ~45. (0.0002778 degrees is about one arcsecond)

4.12 Configure Antenna

This command is used to configure the power switch of the antenna. The receiver is connected to an active antenna and the receiver will feed the antenna through the RF cable. Currently, only UB4B0 board can support this command, for other products, the receiver will feed the antenna through the RF cable by default. The default setting is ANTENNA POWERON with 5V power supply.

Command Format:
CONFIG ANTENNA [parameter]

Abbreviated ASCII Syntax:
CONFIG ANTENNA POWERON
CONFIG ANTENNA POWEROFF

Table 4- 14 Antenna Parameter

<table>
<tr><th>Log Header</th><th>Antenna</th><th>Parameter</th><th>Description</th></tr>
<tr><td rowspan="2">CONFIG</td><td rowspan="2">ANTENNA</td><td>POWERON</td><td>Switch on the antenna feed</td></tr>
<tr><td>POWEROFF</td><td>Switch off the antenna feed</td></tr>
</table>

4.13 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- 15 PPS Function List

<table>
<tr><th>Log Header</th><th>PPS Function</th><th>Parameter</th><th>Description</th></tr>
<tr><td rowspan="3">CONFIG</td><td rowspan="3">PPS</td><td>DISABLE</td><td>Disable PPS output (once disabling the function, all other parameters are ignored)
Default = DISABLE</td></tr>
<tr><td>ENABLE</td><td>Enable PPS output. only when the time is valid, the PPS pulse can output; if losing satellite signals, the receiver stops outputting PPS pulse</td></tr>
<tr><td>ENABLE2</td><td>Enable PPS output, keeping PPS pulse output after the first fix</td></tr>
</table>

Table 4- 16 PPS Configuration

<table>
<tr><th>Log Header</th><th>PPS Function</th><th>Enable Parameter</th><th>PPS Parameter</th><th>ASCII Value</th><th>Description</th></tr>
<tr><td rowspan="3">CONFIG</td><td rowspan="3">PPS</td><td>DISABLE</td><td></td><td></td><td>Disable PPS output (once disabling the function, all other parameters are ignored)
Default=DISABLE</td></tr>
<tr><td rowspan="2">ENABLE</td><td>Timeref</td><td>GPST
/BDST</td><td>Option for reference time system, currently only supports the GPS and BDS</td></tr>
<tr><td>polarity</td><td>POSITIVE</td><td>Option to generates a normally low, active high</td></tr>
</table>

Log Header	PPS Function	Enable Parameter	PPS Parameter	ASCII Value	Description
					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	Any value between 0 and the period	Option to specify the pulse width of the PPS signal, microseconds
			Period	The period of the pulse,	valid values: 50,100, 200, 250, 50, 1000, 2000, 3000, …, 20000 (milliseconds)
			RfDelay	Integer between -32768 and 32767	Set RF delay, nanoseconds
			UserDelay	Integer between -32768 and 32767	Set user delay, nanoseconds
		ENABLE2	Timeref	GPST /BDST	Option for reference time system, currently only supports the GPS and BDS
			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	Any value between 0 and the period	Option to specify the pulse width of the PPS signal, microseconds
			Period	The period of the	valid values: 50,100, 200, 250, 50,

Log Header	PPS Function	Enable Parameter	PPS Parameter	ASCII Value	Description
				pulse,	1000, 2000, 3000, …, 20000 (milliseconds)
			RfDelay	Integer between -32768 and 32767	Set RF delay, nanoseconds
			UserDelay	Integer between -32768 and 32767	Set user delay, nanoseconds

4.14 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- 17 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 +1000 m

NOTE:

The input format of undulation value is float. Even if the input value is an integer, one decimal place is required, such as 900.0.

4.15 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- 18 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

4.16 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- 19 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	

4.17 Configure Standalone Mode

This command is used to set up the standalone mode for the receiver.

Command Format:

CONFIG STANDALONE [Function Parameter] [Param1] [Param2] [Param3]

Abbreviated ASCII Syntax:

CONFIG STANDALONE ENABLE 3

CONFIG STANDALONE DISABLE

Table 4- 20 STANDALONE Parameters

Log Header	STANDALONE	Function Parameter	Param1	Param2	Param3	Description
CONFIG	STANDLONE	ENABLE	param1 is the input coordinate parameter. -90 ≤ param1 ≤ 90 is the latitude in geodetic Coordinates, in degrees. param1 < -90 or param1 > 90	param2 is the input coordinate parameter. -180 ≤ param2 ≤ 180 is the longitude in geodetic Coordinates, in degrees. Param2 < -180 or param2 > 180 is the Y-axis coordinate under	Param3 is the input coordinate parameter. -30000 ≤ param3 ≤ 30000 is the altitude in meters. Param3 < -30000 or Param3 > 30000 is the Z-axis coordinate under ECEF, in meters	

Log Header	STANDALONE	Function Parameter	Param1	Param2	Param3	Description
			is the X-axis coordinate under ECEF, in meters	ECEF, in meters		
		ENABLE	Time parameter, which is used to configure the waiting time for automatically entering stanalone mode. 3≤param1≤ 100, in seconds			
		DISABLE				Disable STANDALONE.

4.18 Configure TDIF

The command is used to configure TDIF.

Command Format:
CONFIG TDIF [parameter]

Abbreviated ASCII Syntax:
CONFIG TDIF Enable

Table 4- 21 TDIF Command Configuration

Log Header	TDIF	Parameter	Description
CONFIG	TDIF	Enable	Enable TDIF
		Disable	Disable TDIF

4.19 Configure Heading

This command supports the receiver of UB482, UM482, UM442, and it sets the fixed baseline length, change of baseline length and low dynamic mode of heading. The receiver with single board (module) and dual antenna starts up with heading function enabled by default. For details, see Figure 3-1 Heading Schematic for details.

Command Format:
CONFIG HEADING [parameter]

Abbreviated ASCII Syntax:
CONFIG HEADING FIXLENGTH
CONFIG HEADING VARIABLELENGTH
CONFIG HEADING STATIC
CONFIG HEADING LOWDYNAMIC

Table 4- 22 Heading Engine Configuration

Log Header	Heading Engine	Parameter	Description
CONFIG	HEADING	FIXLENGTH	The distance between the master antenna (ANT1) and the slave antenna (ANT2) is fixed. ANT1 and ANT2 move or stall synchronously (default mode).
		STATIC	Both the master antenna (ANT1) and the slave

Log Header	Heading Engine	Parameter	Description
			antenna (ANT2) are in static state
		VARIABLELENGTH	The real-time dynamic changes of the relative positions and distance between the master antenna (ANT1) and the slave antenna of the receiver.
		LOWDYNAMIC	Low dynamic, enabled for Low speed motion carrier like pile driver.
		TRACTOR	For agricultural machinery , working mode.

4.20 Configure Heading Offset

This command is used to to set the correcting value for the heading and pitch. The heading and pitch in HEADING and GPHDT data output by the receiver is corrected through the correcting value.

Command Format:
CONFIG HEADING OFFSET [Headingoffset Pitchoffset]

Abbreviated ASCII Syntax:
CONFIG HEADING OFFSET 90 45

UB482，UM482，UM442 are supported.

Table 4- 23 Correcting Value Configuration for Heading and Pitch

Log Header	Heading	Parameter	Description
CONFIG	HEADING OFFSET	Headingoffset	Correcting value for heading, unit: deg, range: -180.0 ~180.0
		Pitchoffset	Correcting value for pitch, unit: deg, range: -90.0 ~ 90.0

4.21 Configure Network IP Address

The network device ETH1 is the network interface of the receiver. CONFIG is the header of the network configuration command, followed by the network device and network device properties, which are used for setting the IPv4 address. High precision GNSS receiver supports one network device: ETH1.

Command Format:
CONFIG ETH1 [parameter]

Abbreviated ASCII Syntax:
CONFIG ETH1 DHCP
CONFIG ETH1 192.168.0.100 192.168.0.1 255.255.255.0 192.168.0.1

Table 4- 24 Ethernet Parameter Configuration

Log Header	Name	Parameter	Description
CONFIG	ETH1	DCHP	Obtain configuration using DHCP mode
		IPv4 list	IP GateWay NetMask DNS_Server. Use ASCII “SPACE “as segmented symbol. Local IP, IP gateway, IP Netmask, DNS servers

4.22 Network Serial Port Configuration

The network serial port is an interface of receiver to input and output data. CONFIG is the header of the serial port configuration command, followed by the network serial port device and network serial port properties, which are used for setting the port number of network serial ports or IP and port number of the server, etc.
High precision GNSS receiver supports three network serial ports: icom1, icom2, and icom3. The three serial ports of the receiver have the same function, but the data input and output of each network serial port is configured to work independently.

Command Format:
CONFIG [COM number] [parameter]

Abbreviated ASCII Syntax:
CONFIG ICOM1 TCP 30001
CONFIG ICOM1 TCP 192.168.0.2 80001

Table 4- 25 Devices Parameter Configuration

Command	Port	Parameter	Description
CONFIG	ICOM1 ICOM2 ICOM3	Disable	Disable the server connection function of the TCP/IP client
	ICOM1 ICOM2 ICOM3	Protocol	TCP/UDP. (TCP protocol by default)
		IP	Set up the IPv4 address for the server end of network ports; the network port is

Command	Port	Parameter	Description
			in SERVER mode by default.
		port[2]	Set up port number. Use the local port number (local) for SERVER mode; otherwise, use a sever port number

4.23 Configure Ntripserver

Ntrip server is the specific device for receiver uploading data to Ntrip caster, now only supporting Ntrip protocol V1. High precise GNSS receivers support three Ntripservers (NCOM1, NCOM2, NCOM3)

Command Format:
CONFIG [Ntrip Server number] [parameter]

Abbreviated ASCII Syntax:
CONFIG NCOM1 10.0.100.2 9000 UB4B0_RTCM32 SERV_PASSWORD

Table 4- 26 Devices Parameter List

Command	Port	Parameter	Description
CONFIG	NCOM1 NCOM2 NCOM3	Disable	Disable Ntripserver
	NCOM1 NCOM2 NCOM3	Caster IP	Ntrip caster TCP IPv4
		port	Ntrip caster TCP port number
		mountport	Ntrip caster mount point number
		password	Ntrip caster password for uploading data

4.24 Configure Ntripclient

Ntripclient is the specific device for receiver downloading data from Ntrip caster, now only supporting Ntrip protocol V1.
High precision GNSS receivers only support one Ntrip Client: NCOM20.

Command Format:
CONFIG [Ntrip Client device number] [parameter]

[2] The port number 40000 cannot be configured as it is allocated to the internal system programming.
It is recommended to use 30001/30002/30003, and try to avoid using ports above 32768

Abbreviated ASCII Syntax:

CONFIG NCOM20 10.0.100.2 9000 UB4B0_RTCM32 UNAME CLI_PASSWORD

Table 4- 27 Devices Parameter List

Command	Port	Parameter	Description
CONFIG	NCOM20	Disable	Disabled Ntripclient
	NCOM20	Caster IP	Ntrip caster IPv4 address or domain name
		port	Ntrip caster TCP port number
		mountport	Ntrip caster mount point
		uname	Ntrip caster user name which downloads data
		cli_password	Ntrip caster download data password

4.25 SBAS Configuration

The command is used to enable or disable SBAS function.

Command Format:

CONFIG SBAS [parameter 1] [parameter 2]

Abbreviated ASCII Syntax:

CONFIG SBAS Enable

CONFIG SBAS ENABLE WAAS

Supported Board:

UM4B0, UB4B0M, UM440

Table 4- 28 SBAS Configuration

Header	SBAS	Parameter 1	Parameter 2	Description
CONFIG	SBAS	Enable	-*	Enable SBAS
		Disable	-*	Disable SBAS
		Enable	WAAS	Enable only WAAS
		Disable	WAAS	Disable only WAAS
		Enable	GAGAN	Enable only GAGAN
		Disable	GAGAN	Disable only GAGAN
		Enable	MSAS	Enable only MSAS
		Disable	MSAS	Disable only MSAS
		Enable	EGNOS	Enable only EGNOS

Header	SBAS	Parameter 1	Parameter 2	Description
		Disable	EGNOS	Disable only EGNOS
		Enable	SDCM	Enable only SDCM
		Disable	SDCM	Disable only SDCM

*: It's not recommended to enable/disable all SBAS systems, better to enable/disable a specific SBAS system.

4.26 Configure EVENT

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

Command Format:
CONFIG EVENT [parameter]

Abbreviated ASCII Syntax:
CONFIG EVENT ENABLE POSITIVE 10

Table 4- 29 EVENT Command Configuration

Log 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	default: 4 minimum: 2 maximum: 3,599,999 There is minimum time between two valid impulses, in millisecond, if less than TGuard, the second Event is ignored	

4.27 Configure SMOOTH

This command configures the SMOOTH function and related parameters of the RTK calculating results， the Heading calculating results and PSRVEL. The SMOOTH function is disabled by default.

Command Format:
CONFIG SMOOTH [Parameter1] [Parameter2]

Abbreviated ASCII Syntax:
CONFIG SMOOTH RTKHEIGHT 10
CONFIG SMOOTH HEADING 10
CONFIG SMOOTH PSRVEL enable

Table 4- 30 SMOOTH Configuration

<table>
<tr><th>Log Header</th><th>SMOOTH</th><th>Parameter1</th><th>Parameter2</th><th>Description</th></tr>
<tr><td rowspan="4">CONFIG</td><td rowspan="4">SMOOTH</td><td>RTKHEIGHT</td><td>time</td><td>Unit: s
Range: 0~100</td></tr>
<tr><td>HEADING</td><td>time</td><td>Unit: s
Range: 0~100</td></tr>
<tr><td rowspan="2">PSRVEL*</td><td>enable</td><td>Smooth PSRVEL is enabled</td></tr>
<tr><td>disable</td><td>Smooth PSRVEL is disabled</td></tr>
</table>

CONFIG SMOOTH PSRVEL enable/disable is only supported by the firmware of V21759 and above

4.28 Single-frequency Positioning Status Configuration

This command enables or disables the criterion of single-frequency positioning status. By default, the algorithm forcibly switch to L1 floating solution from fixed solution if the baseline length exceeds 5km. After the command is enabled, the criterion is removed and the user can still use fixed solution in the condition of qualified accuracy in some application scenes.

Command Format:
CONFIG L1RTKINT [Parameter]

Abbreviated ASCII Syntax:
CONFIG L1RTKINT Enable

Table 4- 31 L1RTKINT Configuration

Header	L1RTKINT	Parameter	Description
CONFIG	L1RTKINT	Enable	Enable L1RTKINT
		Disable	Disable L1RTKINT

4.29 NMEA Version Configuration

This command configures the protocol version of the output NMEA messages, support the version of V31 and V41. By default, NMEA protocol version is V31.

Command Format:
CONFIG NMEAVERSION [Parameter]

Abbreviated ASCII Syntax:
CONFIG NMEAVERSION V31

Table 4- 32 NMEAVERSION Configuration

Header	NMEA VERSION	Parameter	Description
CONFIG	NMEAVERSION	V31	Set NMEA version to V31
		V41	Set NMEA version to V41

4.30 NMEA0138 Version Configuration

This document supplements the definition of NMEA-0183 data format definition. Because NMEA-0183 released Version 2.3, 3.1, 4.0, 4.10 and other versions. The changes of the version are continuously improved and upgraded with the improvement of the satellite system. The message output of different versions of NMEA-0183 is configured by the CONFIG command. Currently, Version 3.1 and 4.10 are temporarily supported.

Command Format:
CONFIG NMEA0183 [Parameter]

Abbreviated ASCII Syntax:
CONFIG NMEA0183 V31
CONFIG NMEA0183 V41

Table 4- 33 NMEA0183VERSION Configuration

Header	NMEA0183 Version	Parameter	Description
CONFIG	NMEA0183	V31	Set the NMEA0183 message format currently output by the receiver to the NMEA-0183 version 3.1. The default output format protocol is NMEA-0183 version 3.1
		V41	Set the NMEA0183 message format currently output by the receiver to the NMEA-0183 version 4.10.

4.31 RTCMB1CB2a Version Configuration

This command is used to configure whether to incorporate the B1C&B2a signal of the BDS system satellite into the RTCM protocol. The configuration is disabled by default. Only applicable to UB4B0 model.

Command Format:
CONFIG RTCMB1CB2a [parameter]

Abbreviated ASCII Syntax:
CONFIG RTCMB1CB2a Enable

Table 4- 34 RTCMB1CB2a Configuration

Header	RTCMB1CB2a Mode	Parameter	Description
CONFIG	RTCMB1CB2a	Enable	Incorporate the B1C&B2a signal of the BDS system satellite into the RTCM protocol
		Disable	Stop incorporating the B1C&B2a signal of the BDS system satellite into the RTCM protocol

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, L2C, L2P, L5	Supported frequencies of GPS system: L1, L2, L2C, L2P, L5
2	BDS	B1, B2, B3, BD3B1C, BD3B2A	Supported frequencies of the BEIDOU-2 satellite system: B1I, B2I, B3I; Supported frequencies of the BEIDOU-23satellite system: B1I, B3I; Supported frequencies of the BEIDOU-23satellite system: BD3B1C, BD3B2A
3	GLO	R1, R2	Supported frequencies of GLONASS satellites: R1, R2
4	GAL	E1, E5a, E5b	Supported frequencies of Galileo system: E1, E5a, E5b
5	QZSS	Q1、Q2、Q5	Supported frequencies of QZSS system: Q1, Q2, Q5

5.2 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

6. Timing Command

Timing function is only suitable for UT4B0, UT910 receivers.

This command is used to set timing mode for the high precision receiver. There are three kinds of GNSS receiver timing modes according to different application requirements: self-optimizing timing, timing with fixed coordinate, and the self-optimizing timing mode is for default. The details are shown as below:

Table 6- 1 Timing Mode Type

Command	Mode	Parameter	Description
MODE TIMING			Generates PPS with real time positioning
	FIX	Lat Lon Hei	Generate PPS with fixed receiver coordinates
	Surveyin	Time param1 param2	Generate PPS with self-optimizing coordinates

6.1 Real-time Positioning Timing

Real-time positioning timing, refers that once the receiver capturing the satellite signals and doing positioning/timing solution, meanwhile, it will output the correct PPS pulse signal.

Command Format:

MODE TIMING

Abbreviated ASCII Syntax:

MODE TIMING

Table 6- 2 Command Parameter

Mode	Name	Parameter	Description
MODE	TIMING		Generates PPS with real time positioning

6.2 Timing with Fixed Coordinate

Timing with fixed coordinate means that the receiver antenna is correctly and stably installed in a known proper position. With precise coordinates, the receiver performs high-precision solution, and outputs the PPS pulse signal.

Command Format:
MODE TIMING FIX [Latitude Longitude Height]

Abbreviated ASCII Syntax:
MODE TIMING FIX 40.245757 116.24323987 56.862

Table 6- 3 Command Parameter

Mode	Name	Parameter	Description
MODE TIMING	FIX	Latitude	Latitude coordinate, in degrees. Set fixed coordinates of base receiver Range: ±90°
		Longitude	Longitude coordinate, in degrees. Set fixed coordinates of base receiver Range: ±180°
		Height	Height, in meters. Set fixed coordinates of base receiver Range: ±30000

6.3 Self-optimized Timing

Self-optimized timing refers that the receiver makes an autonomous positioning optimization based on the input time, horizontal accuracy and elevation accuracy set by users.

Only when the time length, horizontal accuracy, elevation accuracy satisfies the optimization requirements simultaneously, the coordinate becomes a normal optimized coordinate. If one of these three factors are not satisfied, the optimization fails. The final coordinates of the optimization are set to fixed coordinates. The high precision time information is calculated based on the coordinates, and the correct PPS second pulse signal is output.

Command Format:
MODE TIMING Surveyin [Time param1 param2]

Abbreviated ASCII Syntax:
MODE TIMING Surveyin 60 1.5 2.5

Table 6- 4 Timing Mode Type

Mode	Name	Parameter	Description
MODE TIMING	Surveyin	Time	Self-optimized time, in seconds
		param1	Self-optimized horizontal accuracy, in meters
		param2	Self-optimized vertical accuracy, in meters

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
BDSGGA COM1 0.5

Naming rules:
1> If using “GN” as header, it is the joint system positioning or related output by default when there is no special instruction.
2> If using the first 3 letters of satellite systems as header, the output is calculated independently through each system by default when there is no special instruction.
BDS represents Beidou navigation system;
GPS represents the United States Global Positioning System;
GLO represents GLONASS;
GAL represents EU Galileo system;

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,00,0000*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	x	1

Field	Structure	Description	Symbol	Example
		2 = Pseudorange differential/SBAS position 4 = RTK fixed ambiguity solution 5 = RTK floating ambiguity solution 6 = INS 7 = User fixed position		
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,00,0000*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	x.x	-15.174

Field	Structure	Field Description	Symbol	Example
		ellipsoid, otherwise, it is negative.		
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: 1~32 GLONASS: 65~96	xx,xx,.....	18,03,13, 25,16, 24,12, 20,,,,

Field	Structure	Field Description	Symbol	Example
		Galileo: 1~36 BDS: 1~63 QZSS: 193~197 SBAS: 33-54		
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.

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	x.x	15.2525

Field	Structure	Field Description	Symbol	Example
		north)		
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 multiple messages. 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
GLGSV 1	Output 1Hz GLGSV message from current serial port
GLGSV COM2 1	Output 1Hz GLGSV message from com2
GAGSV 1	Output 1Hz GAGSV message from current serial port
GAGSV COM2 1	Output 1Hz GAGSV message from com2
BDGSV 1	Output 1Hz BDGSV message from current serial port
BDGSV COM2 1	Output 1Hz BDGSV message from com2
GQGSV 1	Output 1Hz GQGSV message from current serial port
GQGSV COM2 1	Output 1Hz GQGSV message from com2

Message Output:

```
$GPGSV,3,1,09,02,57,309,42,04,18,049,35,05,34,225,40,06,63,038,44*73
$GPGSV,3,2,09,09,35,085,40,12,35,280,40,17,34,136,39,19,54,132,41*7F
$GPGSV,3,3,09,25,18,309,35*42
$GLGSV,2,1,06,82,60,060,42,66,21,031,34,73,13,293,33,81,20,106,34*6F
$GLGSV,2,2,06,67,66,079,42,68,41,180,40*6C
$GAGSV,2,1,08,30,15,307,31,04,36,062,38,05,14,184,33,09,48,138,40*6A
$GAGSV,2,2,08,11,45,082,37,02,23,255,33,36,65,335,41,25,07,207,29*66
$BDGSV,5,1,19,08,67,357,38,12,54,109,39,13,56,301,39,01,34,140,34*6A
$BDGSV,5,2,19,11,64,325,41,14,21,205,32,07,17,189,28,10,31,213,31*6E
```

$BDGSV,5,3,19,16,11,170,29,03,45,189,35,06,14,165,29,04,26,123,32*63
$BDGSV,5,4,19,21,66,082,43,22,20,043,36,34,81,070,43,38,70,340,42*6C
$BDGSV,5,5,19,39,10,175,29,40,27,199,33,42,45,194,39*52
$GQGSV,1,1,02,193,59,124,40,195,59,135,41*7D

Table 7- 5 GPGSV Message Structure

Field	Structure	Field Description	Symbol	Example
1	$GPGSV	Log header		$GPGSV
2	# msgs	Total number of messages	x	3
3	msg #	Message number	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 GPS: 1~32 GLONASS: 65~96 Galileo: 1~36 BDS: 1~63 QZSS: 193~197 SBAS: 33~54	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 COM2 1 Output 1Hz GPHDT message from com2

Message Output:

$ GPHDT,178.7236,T*15

Table 7- 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]

7.1.7 GPHDT2 - GPS Heading Log

The log contains the heading information of the baseline vector relative to true north. The baseline vector is in degrees and consisted of a base station and a rover station, and in the direction from the base station to the rover station. It is required for receiver to work in heading2 mode to output information.

Abbreviated ASCII Syntax:

GPHDT2 1 Output 1Hz GPHDT2 message from current serial port

GPHDT2 COM2 1 Output 1Hz GPHDT2 message from com2

Message Output:

$ GPHDT2,178.7236,T*15

Table 7- 7 GPHDT2 Message Structure

Field	Structure	Field Description	Symbol	Example
1	$GPHDT2	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]

7.1.8 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 = single point positioning D = Differential positioning E = dead reckoning M = user input N = invalid data	a	A
14	*xx	Checksum	*hh	*72

Field	Structure	Field Description	Symbol	Example
15	[CR][LF]	Sentence terminator		[CR][LF]

7.1.9 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 E/W [c]	a	E
13	mode ind	Positioning system mode indicator A = single point positioning D = Differential positioning E = dead reckoning	a	A

ID	Structure	Field Description	Symbol	Example
		M = user input N = invalid data		
14	*xx	Checksum	*hh	*72
15	[CR][LF]	Sentence terminator		[CR][LF]

7.1.10 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]

7.1.11 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	$--GLL	Log header		
2	lat	Latitude	llll.ll	
3	lat dir	Latitude direction (N = North, S = South)	a	
4	lon	Longitude	yyyyy.yy	
5	lon dir	Longitude direction (E = East, W = West)	a	
6	Utc	UTC time	hhmmss.ss	
7	status	Status: V = invalid data A = adaptive D = differential	A	
8	mode ind	Positioning system mode indicator: N = not positioning A = adaptive positioning D = differential positioning E = inertial navigation mode M = manual input S = simulator	a	
9	*xx	Check sum	*hh	
10	[CR][LF]	Sentence indicator		[CR][LF]

7.1.12 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]

7.1.13 GPTRA - Heading, Pitch & Roll Information

The GPTRA message includes heading, pitch and roll angles of the baseline vector between two antennas, as which are used with dual GNSS RF input receiver for attitude determination.

Abbreviated ASCII Syntax:

GPTRA 1 Output 1Hz GPTRA message from current serial port
GPTRA COM2 1 Output 1Hz GPTRA message from com2

Message Output:

$GNTRA,074453.00,206.59,36.19,0.00,4,32,0.00,0000*61

Table 7- 13 GPTRA Message Structure

ID	Structure	Field description	Symbol	Example
1	$GPTRA	Log header		$GPTRA
2	utc	UTC time	hhmmss.ss	

ID	Structure	Field description	Symbol	Example
3	heading	0~360 degree	hhh.hh	
4	pitch	-90~90 degree	ppp.pp	
5	roll	-90~90 degree	rrr.rr	
6	Sol status	solution indicator: 0 = fix not available or invalid 1 = single point positioning 2 = differential GPS 4 = RTK fix 5 = RTK float	q	
	Sat num	Satellite number	n	
7	Age	Age of correction data	dd.dd	
	Station ID	Differential base station ID	xxxx	
8	*xx	Check sum	*hh	*72
9	[CR][LF]	Sentence terminator		[CR][LF]

7.2 NMEA Log Output

7.2.1 GPSGGA - GPS Fix Data Output

This is used to log time, GPS system positioning fix data of the receiver. It only represents the navigation results of GPS system. The message begins with “$GPSGGA”.

Abbreviated ASCII Syntax:

GPSGGA 1 Output 1Hz GPSGGA message from current serial port

GPSGGA COM2 1 Output 1Hz GPSGGA message from com2

Message Output:

$GPSGGA,025754.00,4004.74102107,N,11614.19532779,E,1,18,0.7,63.3224,M,-9.7848,M,00,0000*58

Table 7- 14 GPSGGA Message Structure

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

Field	Structure	Field Description	Symbol	Example
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	Quality indicator 0 = Fix not available or invalid 1 = Single point 2 = Pseudorange differential 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 = meters)	M	M
14	age	Age of correction data (in seconds)	xx	This value is set to 00 when no correction data is available
15	stn ID	Differential base station ID , 0000-4096	xxxx	This value is set to 00 when no correction data is available
16	*xx	Checksum	*hh	*3F
17	[CR][LF]	Sentence terminator		[CR][LF]

7.2.2 BDSGGA - BDS Fix Data Output

This message is used to log time, BDS system navigation results of the receiver. The message begins with “$BDSGGA”.

Abbreviated ASCII Syntax:

BDSGGA 1 Output 1Hz BDSGGA message from current serial port

BDSGGA COM2 1 Output 1Hz BDSGGA message from com2

Message Output:

$BDSGGA,025754.00,4004.74102107,N,11614.19532779,E,1,18,0.7,63.3224,M,-9.7848,M,00,0000*58

Table 7- 15 BDSGGA Message Structure

Field	Structure	Field Description	Symbol	Example
1	$BDSGGA	Log header		$BDSGGA
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	Quality indicator 0 = Fix not available or invalid 1 = Single point 2 = Pseudorange differential 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	x.x	-15.174

Field	Structure	Field Description	Symbol	Example
		between the geoid and the WGS84 ellipsoid. The geoid is positive when it is above the ellipsoid, otherwise, it is negative.		
13	u-units	Units of undulation (M = meters)	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]

7.2.3 GLOGGA - GLONASS Fix Data Output

This message is used to log time, GLONASS system navigation results of the receiver. The message begins with “$GLOGGA”.

Abbreviated ASCII Syntax:

GLOGGA 1 Output 1Hz GLOGGA message from current serial port
GLOGGA COM2 1 Output 1Hz GLOGGA message from com2

Message Output:

$GLOGGA,025754.00,4004.74102107,N,11614.19532779,E,1,18,0.7,63.3224,M,-9.7848,M,00,0000*58

Table 7- 16 GLOGGA Message Structure

Field	Structure	Field Description	Symbol	Example
1	$GLOGGA	Log header		$GLOGGA
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 =	a	N

Field	Structure	Field Description	Symbol	Example
		North, S = South)		
5	lon	Longitude (DDDmm.mm)	yyyyy.yy	11600.3622
6	lon dir	Longitude direction (E = East, W = West)	a	E
7	GPS qual	Quality indicator 0 = Fix not available or invalid 1 = Single point 2 = Pseudorange differential 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 = meters)	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 , 0000-1023	xxxx	(empty when no differential data is present)
16	*xx	Checksum	*hh	*3F
17	[CR][LF]	Sentence terminator		[CR][LF]

7.2.4 GALGGA - Galileo Fix Data Output

This message is used to log time, Galileo system navigation results of the receiver. The message begins with “$GALGGA”

Abbreviated ASCII Syntax:

GALGGA 1 Output 1Hz GALGGA message from current serial port

GALGGA COM2 1 Output 1Hz GALGGA message from com2

Message Output:

$ GALGGA,025754.00,4004.74102107,N,11614.19532779,E,1,18,0.7,63.3224,M,-9.7848,M,00,0000*58

Table 7- 17 GALGGA Message Structure

ID	Field	Description	Symbol	Example
1	$ GALGGA	Log header		$ GALGGA
2	utc	Log header	hhmmss.ss	170659.00
3	lat	UTC time of the current position (hours/minutes/seconds/ decimal seconds)	llll.ll	4001.1220
4	lat dir	Latitude (DDmm.mm)	a	N
5	lon	Latitude direction (N = North, S = South)	yyyyy.yy	11600.3622
6	lon dir	Longitude (DDDmm.mm)	a	E
7	GPS qual	Longitude direction (E = East, W = West)	x	1
8	# sats	Quality indicators of positioning results: 0 = Positioning not available or invalid 1 = Single point 2 = Pseudorange differential or SBAS 4 = RTK fixed solution 5 = RTK floating solution 6 = INS 7 = User fixed position	xx	10
9	hdop	Horizontal dilution of precision	x.x	1.0
10	alt	Antenna height, above/below the mean sea level	x.x	1098.44
11	a-units	Units of antenna height(M =	M	M

ID	Field	Description	Symbol	Example
		meter)		
12	undulation	Undulation: the vertical separation 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 correction data, seconds	xx	This value is set to 00 when no correction data is available
15	stn ID	Differential base station ID, between 0000 and 1023	xxxx	This value is set to 00 when no correction data is available
16	*xx	Checksum	*hh	*3F
17	[CR][LF]	Sentence terminator		[CR][LF]

7.2.5 KSXT - Log Output

The message contains time, positioning and heading of GNSS receiver.

Abbreviated ASCII Syntax:

KSXT 1 Output 1Hz KSXT message from current serial port

KSXT COM2 1 Output 1Hz KSXT information from com2

Message Output:

$KSXT,20171124082056.50,116.23661278,40.07899413,67.39731939,0.00,0.00,317.85,0.009,,3,0,0,33,0.000,0.000,0.000,-0.002,0.002,0.001,,,*00000007

Table 7- 18 KSXT Message Structure

Field	Structure	Field Description	Symbol	Example
1	$KSXT	Log header	$KSXT	$KSXT
2	utc	UTC time of the current position, yyyy/mm/dd/hh/mm/ss.ss	yyyymmddhhmmss.ss	20170616093520.00
3	lon	Longitude in degrees, retain the 8 significant digits after the decimal point	DDD.DDDDDDDD	

Field	Structure	Field Description	Symbol	Example
4	lat	Latitude in degrees, retain the 8 significant digits after the decimal point	DD.DDDDDDDD	
5	Height	Height above mean sea level in meters, retain the 4 significant digits after the decimal point		
6	Heading	Heading in degrees (0 to 360.0 degrees)	a	E
7	pitch	Pitch (±90 degrees)		
8	track true	Actual direction of motion over ground (track over ground) with respect to True North, in degrees		
9	Vel	Horizontal velocity		
10	Roll	Roll		
11	POS qual	GNSS position quality symbol 0 = Fix not available or invalid 1 = Single point 2 = RTK floating ambiguity solution 3 = RTK fixed ambiguity solution	x	1
12	HEADING qual	GNSS heading quality symbol 0 = Heading not available or invalid 1 = Single point heading 2 = RTK floating ambiguity solution 3 = RTK fixed ambiguity solution		
13	#solnSVs	The number of satellites in used for the slave antenna		
14	#solnSVs	The number of satellites in used for the master antenna		
15	East	The Coordinate of east, in local Cartesian coordinate system. Unit: meters.		
16	north	The Coordinate of north, in local Cartesian coordinate system. Unit: meters.		
17	up	The Coordinate of up, in local Cartesian coordinate system. Unit: meters.		
18	EastVel	East velocity, Unit: Km/h.		
19	northVel	North velocity, Unit: Km/h.		
20	upVel	Up velocity, Unit: Km/h.		

Field	Structure	Field Description	Symbol	Example
21	Reserved			
22	Reserved			
23	CRC	XOR checkout, hexadecimal string, checked from the frame header	*FFFFFFFF	*FFFFFFFF

7.2.6 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- 19 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	20170616093520.0 0
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

ID	Structure	Field Description	Symbol	Example
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 Unicore Mode Data Output Command

Unicore 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. Unicore 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- 20 Unicore ASCII and Binary Message Structure

ID	Structure	Description
1	Header	All Unicore 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	Unicore 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- 21 Binary Message Structure Header Sync Byte

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

Table 7- 22 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- 23 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:
#VERSIONA,97,GPS,FINE,2133,201180000,0,0,18,28;"UM482","R3.00Build21773","B123G12R12E15bS1-HRBMDF0011N1-S20-P20-A3P","022109020003-GG2101172500040","1713881081967","2020/Nov/11"*f438b824

Table 7- 24 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 0 = UNKNOWN 1 = UB4B0 2 = UM4B0 3 = UM480 4 = UM440 5 = UM482 6 = UM442 7 = UB482 8 = UT4B0 9 = UB4B0M A = CLAP-B B = CLAP-A	Enum	4	H+0
3	sw version	Firmware software	Char[33]	33	H+4

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
		version			
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				
varia ble	Xxxx	32-bit CRC (ASCII and Binary only)	Hex		
varia ble	[CR][LF]	Sentence terminator (ASCII only)	-		

7.3.2 OBSVM Observation

OBSVM contains measurement information of the current receiver's tracking satellites. For dual-antenna receivers, the "OBSVM" are corresponding to the master antenna.

Message ID: 12

Abbreviated ASCII Syntax:
OBSVMA COM1 1

Abbreviated BINARY Syntax:
OBSVMB COM1 1

Message Output:
#OBSVMA,48,GPS,FINE,2176,376437000,0,0,18,5;86,0,31,25094466.625,-
131872310.967911,83,112,3513.634,3673,0,26.020,00181c23,0,10,20980557.047,-
110253572.519762,18,50,1981.439,4941,0,31.024,00181c43,0,10,20980554.178,-
85911862.047132,22,54,1543.939,4711,0,31.024,05381c43,0,12,22029872.952,-
115767765.482592,34,67,1883.656,4453,0,31.024,00181c63,0,12,22029868.308,-
90208628.781395,58,81,1467.697,4177,0,31.024,05381c63,0,15,23792358.009,-
125029682.814258,68,92,-2446.413,3959,0,31.024,00181c83,0,15,23792354.940,-
97425725.019692,104,110,-1906.181,3700,0,31.024,05381c83,0,18,23202702.207,-
121931022.330490,72,96,-3229.562,3865,0,31.024,00181ca3,0,18,23202701.122,-
95011179.824908,78,90,-2516.518,3998,0,31.024,05381ca3,0,23,20148383.676,-
105880469.002868,16,50,-448.313,4808,0,31.024,00181cc3,0,23,20148378.948,-

82504243.668608,27,64,-349.321,4645,0,31.024,01301cc3,0,24,21394685.217,-
112429828.306895,38,71,-2677.200,4370,0,31.024,00181ce3,0,24,21394681.986,-
87607646.271692,54,75,-2085.984,4281,0,31.024,05381ce3,0,25,22411188.735,-
117771595.461592,74,88,3139.500,4024,0,31.024,00181d03,0,25,22411189.086,-
91770076.313225,50,72,2446.407,4353,0,31.024,05381d03,0,32,22926905.202,-
120481701.067108,40,69,1896.748,4406,0,31.024,00181d23,0,32,22926903.201,-
93881835.276167,57,78,1478.152,4229,0,31.024,05381d23,0,33,38493628.565,-
202285383.419511,29,65,767.572,4495,0,25.020,00181dc3,0,33,38493624.213,-
157624956.759198,49,62,598.130,4544,0,29.024,05381dc3,0,34,37323453.046,-
196136070.181648,31,66,-213.049,4474,0,31.024,00181de3,0,34,37323450.614,-
152833289.341194,29,57,-166.081,4657,0,31.024,05381de3,0,35,37647969.370,-
197841411.719951,67,95,-377.195,3893,0,26.020,00181e03,0,35,37647978.597,-
154162184.069574,220,112,-293.665,3673,0,24.020,05381e03,0,51,19348801.313,-
103140000.387243,17,50,-67.782,5465,0,25.020,00191c23,0,51,19348800.310,-
80219996.224171,17,50,-52.700,5091,0,25.020,00b91c23,5,50,22328801.459,-
119234560.672624,97,105,-3681.941,3748,0,27.020,00191c83,5,50,22328799.227,-
92737981.279994,78,94,-2863.785,3906,0,27.020,00b91c83,7,52,20975801.563,-
112088327.498764,22,50,3630.499,5040,0,27.020,00191cc3,7,52,20975799.101,-
87179793.561945,18,50,2823.686,4895,0,27.020,00b91cc3,8,42,22654632.850,-
121101998.363542,23,50,2889.510,4828,0,25.020,00191ce3,8,42,22654629.760,-
94190430.023353,41,61,2247.360,4572,0,25.020,00b91ce3,9,57,23274905.419,-
124461378.784900,117,122,-1076.432,3578,0,25.020,00191d03,9,57,23274904.356,-
96803290.098333,87,87,-837.358,4046,0,25.020,00b91d03,12,40,21220718.846,-
113596162.600458,20,50,-1470.823,5117,0,27.020,00191d23,12,40,21220711.450,-
88352544.609654,19,50,-1143.945,4834,0,27.020,00b91d23,13,41,20088963.340,-
107575487.658608,20,50,1181.340,5352,0,27.020,00191d43,13,41,20088955.679,-
83669792.020388,19,50,918.798,5210,0,27.020,00b91d43,0,1,37358101.381,-
194533437.403780,60,65,-27.983,4498,0,35.024,041c1c23,0,1,37358088.622,-
150425542.241822,19,50,-21.662,4803,0,35.024,063c1c23,0,2,37947521.526,-
197602701.614075,87,90,-28.196,3993,0,35.024,041c1c43,0,2,37947506.311,-
152798884.093895,24,54,-21.673,4707,0,35.024,063c1c43,0,3,36978412.979,-
192556299.114388,60,63,-64.221,4523,0,35.024,041c1c63,0,3,36978397.767,-
148896684.715341,19,50,-49.596,4793,0,35.024,063c1c63,0,6,36514478.779,-
190140472.783688,50,61,-119.698,4563,0,35.024,001c1c83,0,6,36514462.616,-
147028610.402460,18,50,-92.495,4794,0,35.024,023c1c83,0,7,40380325.695,-
210270952.328157,114,99,1358.110,3800,0,35.024,001c1ca3,0,7,40380320.512,-
162594817.632844,61,89,1050.065,4005,0,35.024,023c1ca3,0,9,37537180.111,-
195465949.285952,63,66,-106.248,4478,0,35.024,001c1cc3,0,9,37537167.338,-
151146618.489496,17,50,-82.168,4844,0,35.024,023c1cc3,0,10,41014334.128,-
213572409.169824,366,126,1050.907,3537,0,29.024,001c1ce3,0,10,41014336.584,-
165147719.964711,259,110,812.550,3693,0,35.024,023c1ce3,0,13,36478456.110,-
189952891.062278,51,56,-1236.123,4672,0,35.024,001c1d03,0,13,36478447.613,-
146883592.569947,26,52,-955.814,4753,0,35.024,023c1d03,0,16,36850029.327,-

191887774.551037,41,54,-166.296,4707,0,35.024,001c1d23,0,16,36850019.111,-
148379756.829854,19,51,-128.570,4761,0,35.024,023c1d23,0,4,38159579.919,-
198706948.121188,98,85,-37.913,4095,0,35.024,041c1d43,0,4,38159564.165,-
153652751.838185,30,60,-29.334,4590,0,35.024,063c1d43,0,8,37241877.284,-
193928227.200195,67,75,-1550.914,4287,0,35.024,001c1d63,0,8,37241861.684,-
149957546.558292,23,50,-1199.185,4806,0,35.024,023c1d63,0,20,22109359.000,-
115129234.145386,46,50,-205.355,5152,0,29.024,001c1d83,0,32,25249932.279,-
131483025.667735,111,80,-2274.378,4181,0,29.024,001c1da3,0,36,25420825.309,-
132372911.103423,110,95,3171.356,3890,0,29.024,001c1dc3,0,37,23128796.850,-
120437714.410181,37,50,-1833.747,4865,0,29.024,001c1de3,0,38,37529112.745,-
195423939.773820,85,68,-1648.529,4438,0,29.024,001c1e03,0,39,36392428.897,-
189504927.522371,46,50,-148.543,4922,0,29.024,001c1e23,0,40,40612164.721,-
211478197.031904,164,98,1670.693,3823,0,29.024,001c1e43,0,46,21860741.451,-
113834615.838112,38,50,1376.667,5009,0,29.024,001c1e63,0,19,22805316.640,-
118753268.666385,45,50,2048.063,4851,0,29.024,001c1ea3,0,3,26339641.166,-
138415752.760307,45,80,-1400.407,4189,0,35.024,005b1c23,0,3,26339641.049,-
106058819.071914,33,64,-1073.144,4510,0,36.024,02331c23,0,7,25758301.273,-
135360796.005020,46,77,1478.502,4248,0,37.648,005b1c43,0,7,25758302.779,-
103718008.167509,17,50,1132.822,4802,0,36.024,02331c43,0,8,22079996.078,-
116031163.636706,20,53,68.052,4727,0,37.648,005b1c63,0,8,22079993.646,-
88906984.463334,14,50,51.993,5094,0,36.024,02331c63,0,13,26005124.309,-
136657853.814197,60,88,-2244.856,4032,0,35.024,005b1c83,0,13,26005125.080,-
104711862.101732,32,68,-1720.227,4425,0,34.024,02331c83,0,26,26441779.401,-
138952489.301369,68,89,-110.477,4015,0,29.024,005b1ca3,0,26,26441780.909,-
106470095.970844,39,78,-84.672,4236,0,29.004,02331ca3,0,25,27299609.698,-
143460410.878067,80,108,-1939.414,3714,0,35.024,005b1cc3,0,25,27299609.692,-
109924214.267082,38,69,-1486.193,4414,0,36.024,02331cc3,0,15,27837842.312,-
146288839.888649,283,134,-2728.291,3454,0,21.020,005b1ce3,0,15,27837860.527,-
112091523.594749,167,104,-2090.740,3758,0,20.020,02331ce3,0,30,24415990.475,-
128306902.039283,43,75,2591.904,4291,0,37.648,005b1d03,0,30,24415990.120,-
98313073.396728,20,55,1985.904,4696,0,36.024,02331d03,0,2,24361865.689,-
128022467.400861,26,57,363.067,4650,0,37.648,005b1d23,0,2,24361864.072,-
98095131.103969,14,50,278.092,4910,0,36.024,02331d23*5cddaf94

Table 7- 25 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		H	0

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
		structure of ASCII message.			
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=1~36 SBAS= 120~ 141 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+34
12	locktime	Number of seconds of continuous tracking (no cycle slipping) in seconds.	Float	4	H+36
13	ch-tr-status	Tracking status, refer to **Table 7- 26 Channel Tracking Status**.		4	H+40
14…	Next OBS offset = H+4+ (#obs x 40) An epoch contains the observations of all frequency points and all satellites observed. Each frequency observation accounts for 40 bytes, and each frequency point loops from the third to the 14th.				

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
variable	xxxx	32-bit CRC	Hex	4	H+4+ (#obs x 40)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Table 7- 26 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	Depend on the supported satellite system:
	22	0x00400000		

Nibble #	Bit #	Mask	Description	Range Value
	23	0x00800000		
N6	24	0x01000000		
	25	0x02000000		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 QZSS: 0 = L1 C/A 6 = L5 data 14 = L5 pilot 17 = L2C (L) 27 = L2C (L) BDS: 0 = B1I 4 = B1Q 8 = B1C(Pilot) 23 = B1C(Data) 5 = B2Q 17 = B2I 12 = B2a(Pilot) 28 = B2a(Data) 6 = B3Q 21 = B3I 13= B2b(I) GAL: 1 = E1B 2 = E1C 12 = E5A pilot 17 = E5B pilot SBAS: 0 = L1 C/A 6 = L5 (I)
	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 (UB482, UM482) tracking satellites. For dual-antenna receivers, the "OBSVH" are corresponding to the slave antenna.

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,-111651450.311282,4,52,-1813.155,4757,0,496.209,28101c24,0,2,21246557.603,-87001102.717152,8,78,-1412.040,4457,0,492.800,21301c2b,0,5,20422151.825,-107319135.401189,4,50,-838.619,5010,0,496.209,28101c44,0,5,20422148.083,-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,-532.447,4227,0,496.209,28101c64,0,7,24555095.330,-100549001.011807,24,253,-415.050,3409,0,458.400,21301c6b,0,7,24555095.526,-100548986.047458,14,130,-415.134,3595,0,492.600,22301c6b,0,13,20788837.832,-109246085.757039,4,50,1980.700,4848,0,496.209,28101c84,0,13,20788833.931,-85126806.818378,8,75,1543.838,4489,0,492.600,21301c8b,0,15,22334307.904,-117367584.521957,6,64,3328.780,4501,0,496.209,28101ca4,0,15,22334305.349,-91455246.122632,13,116,2594.435,4066,0,492.800,21301cab,0,15,22334306.039,-91455275.123345,8,75,2593.830,4281,0,491.800,22301cab,0,20,21361619.331,-112256072.151839,6,62,1961.747,4542,0,496.209,28101cc4,0,20,21361615.322,-87472246.432987,11,96,1528.788,4189,0,492.600,21301ccb,0,29,21190975.160,-111359330.458807,4,50,-271.602,4930,0,496.209,28101ce4,0,29,21190971.856,-86773488.135554,8,78,-210.876,4447,0,492.400,21301ceb,0,29,21190972.483,-86773486.150078,5,61,-211.724,4564,0,348.600,22301ceb,0,30,23700243.112,-124545618.437952,9,83,993.097,4129,0,496.209,28101d04,0,30,23700242.980,-97048527.546666,19,192,774.696,3703,0,230.400,21301d0b,0,30,23700244.562,-93004849.353541,5,62,741.552,4554,0,496.209,21d01d00,0,30,23700243.893,-97048530.576957,9,83,773.849,4123,0,491.200,22301d0b,0,21,25496948.404,-133987359.827841,11,97,2948.176,3846,0,466.200,28101d64,0,21,25496945.670,-104405756.653349,44,388,2298.442,3076,0,17.400,21301d6b,0,47,24094588.963,-128437714.785108,14,127,-524.247,3615,0,215.600,28111c24,0,47,24094597.834,-99896050.327367,20,210,-407.528,3063,0,491.600,20b11c2b,3,39,19382371.366,-103428047.664277,4,50,-685.150,4903,0,491.600,28111c44,3,39,19382375.781,-80444056.206854,4,50,-532.934,5015,0,491.600,20b11c4b,4,55,21138566.935,-112839112.011195,4,55,3218.809,4692,0,493.600,28111c64,4,55,21138570.781,-87763755.970497,5,58,2503.524,4633,0,493.600,20b11c6b,7,48,23800230.876,-127181217.513352,7,74,2152.102,4310,0,493.600,28111c84,7,48,23800236.238,-98918755.471575,10,87,1673.842,4047,0,493.600,20b11c8b,8,38,22393689.968,-119707109.737196,7,69,-3393.510,4406,0,493.600,28111ca4,8,38,22393693.479,-93105549.181113,11,96,-2639.372,3871,0,493.600,20b11cab,9,61,21586267.848,-115431471.706091,10,90,-3968.608,3996,0,117.600,28111cc4,9,61,21586269.319,-89780041.805585,16,152,-3086.750,3452,0,493.600,20b11ccb,11,54,19176019.897,-102614752.527436,4,50,-531.554,4898,0,491.600,28111ce4,11,54,19176019.165,-79811469.703518,4,50,-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,-18.549,4182,0,499.809,2c141c24,0,1,38058437.844,-
153245560.550125,4,54,-14.347,4708,0,497.809,26341c2b,0,1,38058440.711,-
161037717.307865,6,63,-15.071,4529,0,498.209,26a41c20,0,2,37980610.307,-
197775012.106405,12,100,-13.054,3793,0,496.409,2c141c44,0,2,37980602.521,-
152932150.749658,5,60,-10.147,4599,0,498.009,26341c4b,0,2,37980605.798,-
160708372.535672,6,68,-10.666,4435,0,498.409,26a41c40,0,3,37520658.963,-
195379919.180620,9,87,-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,-22.121,4554,0,498.209,26a41c60,0,4,38936560.986,-
202752899.790897,12,102,-24.053,3784,0,499.809,2c141c84,0,4,38936554.390,-
156781372.255777,6,66,-18.622,4468,0,498.009,26341c8b,0,4,38936555.554,-
164753311.205573,9,83,-19.607,4129,0,498.209,26a41c80,0,5,39849693.104,-
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,-
168617069.112898,10,89,-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,-
145779201.603625,4,50,158.106,5175,0,494.200,22341ccb,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,0,8,36737357.765,-
155447782.710365,4,50,-711.617,4836,0,494.200,22a41ce0,0,13,35558681.030,-
185163389.740799,4,51,-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,0,9,37643942.290,-
159283839.623689,4,55,517.999,4691,0,494.200,22a41d40,0,3,23186169.438,-
121844145.804248,4,50,-203.606,4833,0,496.409,28331c24,0,3,23186169.669,-
90987508.756380,4,50,-152.034,5100,0,496.409,21931c2b,0,3,23186166.942,-
93361087.256507,4,50,-155.992,5404,0,497.409,22331c20,0,5,25537681.241,-
134201421.471488,7,71,-2271.943,4373,0,494.809,28331c44,0,5,25537682.609,-
100215348.656667,6,65,-1696.623,4486,0,488.600,21931c4b,0,5,25537679.489,-
102829652.441565,4,52,-1740.861,4742,0,496.809,22331c40,0,8,23266657.315,-
122267114.589514,8,76,2039.056,4276,0,495.209,28331c64,0,8,23266657.382,-
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,-
149686128.604221,34,289,-3762.348,3181,0,0.000,08331084,0,18,28484338.970,-
111778646.467969,12,104,-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,-1862.045,5008,0,497.409,22331ca0*41

Table 7- 27 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=1~36 SBAS= 120~ 141 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+34
12	locktime	Number of seconds of continuous tracking (no cycle slipping) in seconds.	Float	4	H+36
13	ch-tr-status	Tracking status, refer to Table 7- 26 Channel Tracking Status.		4	H+40
14…	Next OBS offset = H+4+ (#obs x 40) An epoch contains the observations of all frequency points and all satellites observed. Each frequency observation accounts for 40 bytes, and each frequency point loops from the third to the 14th.				

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
variable	xxxx	32-bit CRC	Hex	4	H+4+ (#obs x 40)
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,96,GPS,FINE,2094,280302000,0,0,18,1;9.313225746154785e-09,0.000000000000000e+00,-5.960464477539062e-08,0.000000000000000e+00,9.011200000000000e+04,0.000000000000000e+00,-1.966080000000000e+05,0.000000000000000e+00,1,2094,257035000,0*a65e9813

Table 7- 28 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	Double	8	H+48

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
		term			
9	b3	Beta parameter 3st order term	Double	8	H+56
10	usSVID	Satellite ID for calculating ionosphere parameters	Ushort	2	H+64
11	usWeek	GPS week corresponding to the time when the ionosphere parameters are solved	Ushort	2	H+66
12	ulSec	GPS second corresponding to the time when removing ionosphere parameters, millisecond	ULong	4	H+68
13	reserved	reserved	Ulong	4	H+72
14	xxxx	32-bit CRC	Hex	4	H+76
15	[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,96,GPS,FINE,2094,280316000,0,0,18,1;7.450580596923828e-09,1.639127731323242e-07,-1.728534698486328e-06,3.874301910400391e-06,1.269760000000000e+05,-4.259840000000000e+05,1.245184000000000e+06,5.242880000000000e+05,16,2094,277189000,0*a3be051b

Table 7- 29 BDSION Message Structure

Field	Field Type	Description	Format	Binary Bytes	Binary Offset
1	BDSION	Log header, see Table 7- 22		H	0

Field	Field Type	Description	Format	Binary Bytes	Binary Offset
		Binary Message Format Header Structure.			
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	usSVID	Satellite ID for calculating ionosphere parameters	Ushort	2	H+64
11	usWeek	GPS week corresponding to the time when the ionosphere parameters are solved	Ushort	2	H+66
12	ulSec	GPS second corresponding to the time when removing ionosphere parameters, millisecond	ULong	4	H+68
13	reserved	reserved	Ulong	4	H+72
14	xxxx	32-bit CRC	Hex	4	H+76
15	[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+01,1.328125000000000e-01,2.319335937500000e-03,0,0,0,0,0*3B

Table 7- 30 BDSION 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 calculated 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-09,-7.105427358e-15,1929,7,18,18,0,0*5F

Table 7- 31 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,-9.769962617e-15,573,6,4,4,0,0*5A

Table 7- 32 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

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
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- 33 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

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
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+56
13	ulWN0g	Reference cycle counting for conversion between Galileo time system and GPST system.	Ulong	4	H+60
14	xxxx	32-bit CRC	Hex	4	H+64
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;38,8,1,0,2068,114318000,1078 2,1334,0,0,43,0,-5.214640136718750e+06,1.326842138671875e+07,2.114945556640625e+07,-1.141456604003906e+03,-2.661026954650879e+03,1.389506340026855e+03,0.000001862645149,-0.000000000000000e+00,-1.862645149230957e-06,-4.872400313615799e-05,8.381903172e-09,0.000000000000000e+00,39210,2,1,0,12*b48d5f47

Table 7- 34 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	Ulong	4	H+24

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
		0 = GOOD 1 = BAD			
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

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
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- 35 GlONASS Ephemeris Flags Coding

<table>
<tr><th>Bit</th><th>Description</th><th>Value</th><th>Mark</th></tr>
<tr><td>0</td><td rowspan="2">P1 flag: time interval between two adjacent parameters fb values</td><td rowspan="2">Information flag, see Table 7-34 GALEPHEM Message Structure: P1 flag range values</td><td>00000001</td></tr>
<tr><td>1</td><td>00000002</td></tr>
<tr><td>2</td><td>P2 flag: Odd or Even flag of parameter fb</td><td>0=even,1=odd</td><td>00000004</td></tr>
<tr><td>3</td><td>P3 flag: satellite numbers of almanac information within current subframe</td><td>0=5,1=4</td><td>00000008</td></tr>
<tr><td>4</td><td rowspan="3">Reserved</td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>…</td></tr>
<tr><td>31</td></tr>
</table>

Table 7- 36 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- 37 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	8	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 = IODE1 of GPS	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,	Double	8	H+32

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
		seconds			
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,	Double	8	H+172

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
		seconds			
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;1,114810.0,0,1,1,2068,2068,111600.0,4.216448683e+07,2.367955778e-09,1.101424762e+00,3.9647240192e-04,-2.0747280877e+00,-7.542781532e-06,1.471303403e-05,-4.41109375e+02,-2.27625000e+02,-1.443549991e-08,1.862645149e-08,8.4583233037e-02,-4.625192658e-10,-1.009548479e+00,-1.27291016e-09,0,111600.0,1.420000000e-08,-1.040000000e-08,2.07696e-04,4.76259e-11,0.00000e+00,TRUE,7.292270366e-05,4.00000000e+00*d5b5296b

Table 7- 38 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

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
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	Double	8	H+224

Field	Field Type	Data Description	Format	Binary Bytes	Binary Offset
		a nominal standard deviation value using an algorithm listed there. We publish the square of the nominal value (variance).			
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- 39 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

Field	Structure	Field Description	Format	Binary Bytes	Binary Offset
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

Field	Structure	Field Description	Format	Binary Bytes	Binary Offset
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	Ulong	4	H+176

Field	Structure	Field Description	Format	Binary Bytes	Binary Offset
		valid if INAVReceived is TRUE			
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

UM4B0 and UM482 support 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- 40 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- 41 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,-2160482.7849,4383625.2350,4084735.7632,0.0140,0.0125,0.0296,0.0107,0.0198,0.0128,40.07627310896,116.11079363322,65.3740,0.00000000000,0.00000000000,0.0000,454587000,38.000,16.723207,-9.406086,0.000000,0.000000,8,0,0,0*e9402e02

Table 7- 42 AGRIC Message Structure

ID	Field	Type	Binary Bytes	Description	Note
1	header		24	Log header	
2	GNSS	Char	4		
3	length	uchar	1	Command length	The digit length from GNSS to CRC is 232 bytes, Fixed value: 0XE8
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	GPS satellite number	
13	Num GLO Sta	uchar	1	BDS satellite number	

ID	Field	Type	Binary Bytes	Description	Note
14	Num BDS Sta	uchar	1	GLONASS satellite number	
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	

ID	Field	Type	Binary Bytes	Description	Note
				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	doubl	8	Sub-antenna latitude	

ID	Field	Type	Binary Bytes	Description	Note
		e		(-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)	

8. Other Command

8.1 Unlog - Remove a Log from Logging Control

This command is used to remove a specific log request from the system. The [port] parameter is optional. If [port] is not specified, it is defaulted to the port on which the command was received.

Command Format:

UNLOG [port] [message]

Abbreviated ASCII Syntax:

UNLOG	Stop outputting all messages from the current serial port
UNLOG GPGGA	Stop outputting GPGGA message from current serial port
UNLOG COM1	Stop outputting all messages from com1
UNLOG COM2 GPGGA	Stop outputting GPGGA message from com2

Table 8- 1 Unlog Parameters

Log Header	Port	Message
UNLOG	COM1 COM2 COM3	Name of the message to be stopped

8.2 Freset - Clear Selected Data from NVM and Reset

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.

Command Format:
FRESET

Abbreviated ASCII Syntax:
FRESET

Table 8- 2 FRESET Log Parameters

Log Header	Log Parameter	Description
FRESET		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.

8.3 Reset Configuration

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

Command Format:
RESET [parameter]

Abbreviated ASCII Syntax:
RESET
RESET EPHEM
RESET POSITION

Table 8- 3 RESET Log Parameters

Header	Parameter	Description
RESET		Reset the receiver

Header	Parameter	Description
	EPHEM	Reset the stored GPS ephemeris
	POSITION	Reset the stored position
	ALMANAC	Reset the stored almanac
	IONUTC	Reset the ionospheric and UTC information

8.4 Saveconfig - Save Current Configuration in NVM

This command saves the present configuration in Non-Volatile Memory (NVM). The configuration includes the current log settings, FIX settings, port configurations and so on.

Command Format:
SAVECONFIG

Abbreviated ASCII Syntax:
SAVECONFIG

Table 8- 4 SAVECONFIG Log Parameters

Header	Parameter	Description
SAVECONFIG		Save current configuration in NVM

8.5 RAWIMUX - IMU Extended Original Data

This log contains the IMU status indicator and measurements of the accelerometer and gyroscope relative to the IMU housing coordinate system. The log is an extended version of the RAWIMU log intended for use with post-processing.

Message ID: 1461

Command Format:
log rawimuxb onnew

Abbreviated ASCII Syntax:
#RAWIMUXA,COM1,0,81.5,FINESTEERING,1691,410338.819,004c0020,3fd1,43495;00,5,1691,410338.818721000,00170705,-113836,-464281, 43146813,89,11346, 181*01cd06bf

Table 8- 5 RAWIMUX Data Structure

ID	Field Type	Description	Format	Binary Bytes	Binary Offset
1	RAWIMUX header	Log header. Refer to **Table 8- 6 Binary Header Structure**	-	H	0
2	IMU error	simplified IMU error flag 01-IMU error 00-IMU normal If an IMU error was detected, check the IMU Status field for details. The data field output is hexadecimal	Uchar	1	H
3	IMU Type	IMU Type identifier. Refer to **Table 8- 8 IMU Type**	Uchar	1	H+1
4	Week	GNSS Week	Ushort	2	H+2
5	Seconds Into Week	Seconds from week start	Double	8	H+4
6	IMU Status	The status of the IMU. This field is given in a fixed length (n) array of bytes in binary but in ASCII or Abbreviated ASCII is converted into 2 character hexadecimal pairs. For the raw IMU status, see **Table 8- 9 ADI164XX IMU Status** and **Table 8- 10 BMI055 IMU Status**	Hex Ulong	4	H+12
7	Z Accel Output*	Change in velocity count along Z-axis.	Long	4	H+16
8	- (Y Accel Output) *	- (Change in velocity count along y axis) A negative value implies the output is along the positive y-axis marked on the IMU. A positive value implies the change is in the direction opposite to that of the y-axis marked on the IMU.	Long	4	H+20
9	X Accel Output*	Change in velocity count along x axis.	Long	4	H+24
10	Z Gyro Output*	Change in angle count around z axis. Right-handed.	Long	4	H+28
11	- (Y Gyro Output) *	- (Change in angle count around y axis). Right-handed	Long	4	H+32

ID	Field Type	Description	Format	Binary Bytes	Binary Offset
		A negative value implies the output is along the positive y-axis marked on the IMU. A positive value implies the change is in the direction opposite to that of the y-axis marked on the IMU.			
12	X Gyro Output*	Change in angle count around x axis. Right-handed	Long	4	H+36
13	xxxx	32-bit CRC	Hex	4	H+40
14	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

*: The change in velocity (acceleration) and angle (rotation rate) scale factors for each IMU type can be found in **Table 8- 7 Raw IMU Scale Factors**. Multiply the appropriate scale factor by the count value for the velocity (field 5-7) and angle (field 8-10) increments. To obtain acceleration in m/s/s or rotation rate in rad/s, multiply the velocity/rotation increments by the output rate of the IMU.

Table 8- 6 Binary Header Structure

ID	Field Name	Field Type	Description	Binary Bytes	Binary Offset	Ignored on Input
1	Sync	Char	Hexadecimal 0xAA	1	0	N
2	Sync	Char	Hexadecimal 0x44	1	1	N
3	Sync	Char	Hexadecimal 0x12	1	2	N
4	Header Length	Uchar	Length of the header 0x1C	1	3	N
5	Message ID	Ushort	This is the Message ID number of the log	2	4	N
6	Message Type	Char	00 = Binary 01 = ASCII 10 = Abbreviated ASCII	1	6	N
7	Reserved	Uchar	Reserved	1	7	N
8	Message Length	Ushort	The length in bytes of the body of the message, not including the header nor the	2	8	N

ID	Field Name	Field Type	Description	Binary Bytes	Binary Offset	Ignored on Input
			CRC			
9	Reserved	Ushort	Reserved	2	10	N
10	Idle Time	Uchar	Time the processor is idle, calculated once per second. This value is a percentage, ranging from 0 to 100. 0% indicates the processor is fully occupied. Other values indicate the availability of the processor to take on tasks.	1	12	Y
11	Time Status	Enum	The quality of the GPS reference time 20 = UNKNOWN; 160 = FINE.	1	13	N
12	Week	Ushort	GPS reference week number	2	14	N
13	ms	Ulong	Milliseconds from the beginning of the GPS reference week	4	16	N
14	Reserved	Ulong		4	20	Y
15	BDS time offset to GPS Second	Ushort	Time offset between BDS and GPS. The field stores the time offset between BDS Second and GPS Second within a week, and it is used to calculate the coordinates of BDS.	2	24	Y

ID	Field Name	Field Type	Description	Binary Bytes	Binary Offset	Ignored on Input
			BDS Second = GPS Seconds – offset			
16	Reserved	Ushort		2	26	Y

Table 8- 7 Raw IMU Scale Factors

IMU	Gyroscope Scale Factor	Acceleration Scale Factor
ADIS16470	$2160/2^{31}$ deg/LSB	$400/2^{31}$ m/s/LSB
BMI055	$250/(2^{15}-1)$ deg/s/LSB	$2g/(2^{15}-1)$ /LSB, g= 9.80 m/s^2

Table 8- 8 IMU Type

ID	Field	Description
0	UNKNOWN	Unknown IMU type (default)
64	BMI055	
74	ADIS16470	Analog Devices ADIS16470

Table 8- 9 ADI164XX IMU Status

Nibble	Bit	Mask	Description	Range Value
N0	0	0x00000001	Alarm Status Flag	
	1	0x00000002	Reserved	
	2	0x00000004		
	3	0x00000008	SPI Communication Error	0 = Passed, 1 = Failed
N1	4	0x00000010	Sensor Over-Range	0 = Passed, 1 = One of more sensors over-ranged
	5	0x00000020	Initial Self Test Failure	0 = Passed, 1= Failed
	6	0x00000040	Flash Memory Failure	0 = Passed, 1 = Failed
	7	0x00000080	Processing Overrun	0 = Passed, 1 = Failed
N2	8	0x00000100	Self Test Failure – X-axis gyro	0 = Passed, 1 = Failed
	9	0x00000200	Self Test Failure – Y-axis gyro	0 = Passed, 1 = Failed
	10	0x00000400	Self Test Failure – Z-axis gyro	0 = Passed, 1 = Failed
	11	0x00000800	Self Test Failure – X-axis accelerometer	0 = Passed, 1 = Failed
N3	12	0x00001000	Self Test Failure – Y-axis	0 = Passed, 1 = Failed

Nibble	Bit	Mask	Description	Range Value
			accelerometer	
	13	0x00002000	Self Test Failure – Z-axis	0 = Passed, 1 = Failed
	14	0x00004000	Reserved	
	15	0x00008000		
N4	16	0x00010000	IMU temperature reading as follows: Signed 2-byte value (SHORT) 0°C = 0x0000 ADIS16470：1 LSB = 0.1 ºC	
	17	0x00020000		
	18	0x00040000		
	19	0x00080000		
N5	20	0x00100000		
	21	0x00200000		
	22	0x00400000		
	23	0x00800000		
N6	24	0x01000000		
	25	0x02000000		
	26	0x04000000		
	27	0x08000000		
N7	28	0x10000000		
	29	0x20000000		
	30	0x40000000		
	31	0x80000000		

Table 8- 10 BMI055 IMU Status

Nibble	Bit	Mask	Description	Range Value
N0	0	0x00000001	Alarm Status Flag	
	1	0x00000002	Reserved	
	2	0x00000004		
	3	0x00000008	SPI Communication Error	0 = Passed, 1 = Failed
N1	4	0x00000010	Sensor Over-Range	0 = Passed, 1 = One of more sensors over-ranged
	5	0x00000020	Initial Self Test Failure	0 = Passed, 1= Failed
	6	0x00000040	Flash Memory Failure	0 = Passed, 1 = Failed
	7	0x00000080	Processing Overrun	0 = Passed, 1 = Failed
N2	8	0x00000100	Self Test Failure – X-axis gyro	0 = Passed, 1 = Failed
	9	0x00000200	Self Test Failure – Y-axis gyro	0 = Passed, 1 = Failed
	10	0x00000400	Self Test Failure – Z-axis gyro	0 = Passed, 1 = Failed
	11	0x00000800	Self Test Failure – X-axis accelerometer	0 = Passed, 1 = Failed
N3	12	0x00001000	Self Test Failure – Y-axis	0 = Passed, 1 = Failed

Nibble	Bit	Mask	Description	Range Value
			accelerometer	
	13	0x00002000	Self Test Failure – Z-axis	0 = Passed, 1 = Failed
	14	0x00004000	Reserved	
	15	0x00008000		
N4	16	0x00010000	Reserved	
	17	0x00020000		
	18	0x00040000		
	19	0x00080000		
N5	20	0x00100000		
	21	0x00200000		
	22	0x00400000		
	23	0x00800000		
N6	24	0x01000000		
	25	0x02000000		
	26	0x04000000		
	27	0x08000000		
N7	28	0x10000000		
	29	0x20000000		
	30	0x40000000		
	31	0x80000000		

Appendix 1 Checksum

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;
}
```

2. XOR Checkout

Unicore comamnds not only output the message starting with '#', but also output the message sentence starting with '$' at certain specific moments. In such messages, the two characters after the '*' in the message are the checksum, the calculation method of checksum is the exclusive OR of all characters from '$' to '*' (excluding '*'), expressed in hexadecimal. Such as:

During message request and receiver configuration, the receiver returns a command message after receiving the request to confirm whether the message is accepted.

Example: $command,unlog,response: OK*21

When the receiver finishes starting up, it outputs a piece of device information on the corresponding serial port.

Example: $devicename,COM1*67

It should be noted that Unicore's XOR verification method is different from the NMEA0183 protocol. For the NMEA0183 verification method, please refer to the NMEA0183 standard protocol.

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）

RTCM1122

BDS MSM2（Provide Compact BeiDou PhaseRanges）

RTCM1123

BDS MSM3（Provide Compact BeiDou Pseudoranges and PhaseRanges）

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）

RTCM1126

BDS MSM6（Provide Full BeiDou Pseudoranges and PhaseRanges plus CNR (high resolution)）

RTCM1127

BDS MSM7（Provide Full BeiDou Pseudoranges, PhaseRanges, PhaseRangeRate and CNR (high resolution)）

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）

RTCM1019

GPS Ephemerides

RTCM1020

GLONASS Ephemerides

RTCM1033

Receiver and antenna descriptors

RTCM1105

Internal heading application, heading end transmits heading information to rover end (Unicorecomm-defined)

Appendix 4 EVENT Output

1 EVENTMARK - EVENT Position Information

This log outputs the accurate time and relative time the moment EVENT happens, supporting ASCII/ABBASCII/BINARY format, and once/onchanged output. The EVENTMARK log must be used in conjunction with output GGA.

Message ID: 309

Command Format:
LOG EVENTMARK [parameter]

Abbreviated ASCII Syntax:
LOG EVENTMARK
LOG EVENTMARKB ONCHANGED
LOG EVENTMARKA ONCHANGED

Table 0- 1 EVENTMARK Data Structure

ID	Type	Description	Format	Binary Bytes	Binary Offset
1	eventMark header	Log header		H	0
2	eventID	Event Index（Event 1 or Event 2）	UCHAR	1	H
3	status	event status（TBD）	UCHAR	1	H+1
4	reserved0	reserved	UCHAR	1	H+2
5	reserved1	reserved	UCHAR	1	H+3
6	week	week	UINT	4	H+4
7	second	second	UINT	4	H+8
8	subSecond	nanosecond	UINT	4	H+12
9	reserved2			4	H+16

ID	Type	Description	Format	Binary Bytes	Binary Offset
10	offset_second	Per the offset between current GGA output frequency and the absolute time of EVENT time and the closest GGA output	UINT	4	H+20
11	offset_SubSecond	Per the offset between current GGA output frequency and the absolute time of EVENT time and the closest GGA output (nanosecond)	UINT	4	H+24
12	xxxx	32-bit CRC (ASCII and binary only)	Hex	4	H+28
13	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

2 EVENTALL - EVENT Position and Time Information

This log outputs the time, position, velocity and solution status when the EVENT happens. The EVENTALL log must be used in conjunction with output GGA.

Message ID: 308

Command Format:
LOG EVENTALL [Parameter]

Abbreviated ASCII Syntax:
LOG EVENTALL
LOG EVENTALLB ONCHANGED
LOG EVENTALLA ONCHANGED

Table 0- 2 EVENTALL Data Structure

ID	Type	Description	Format	Binary Bytes	Binary Offset
1	event header	Log header		H	0
2	eventID	Event Index (Event 1 or Event 2) -- only Event 1 is supported for now	UCHAR	1	H
3	status	event status（TBD）	UCHAR	1	H+1
4	reserved0	reserved	UCHAR	1	H+2
5	reserved1	reserved	UCHAR	1	H+3
6	week	week	UINT	4	H+4
7	second	second	UINT	4	H+8
8	subSecond	nanosecond	UINT	4	H+12
9	reserved2			4	H+16
10	offset_second	Per the offset between current GGA output frequency and the absolute time of EVENT time and the closest GGA output	UINT	4	H+20
11	offset_subSecond	Per the offset between current GGA output frequency and the absolute time of EVENT time and the closest GGA output (nanosecond)	UINT	4	H+24
12	sol status	Solution status, refer to **Table 9- 49 Solution Status**	Enum	4	H+28
13	pos type	Position type, refer to **Table 9- 48 Position or Velocity Type**	Enum	4	H+32
14	lat	latitude, deg	Double	8	H+36
15	lon	longitude, deg	Double	8	H+44
16	hgt	Height above mean sea level (m)	Double	8	H+52
17	undulation	Undulation - the relationship between the geoid and the WGS84 ellipsoid(m)	Float	4	H+60
18	datum id#	Datum ID number , only WGS84 is supported for now	Enum	4	H+64

ID	Type	Description	Format	Binary Bytes	Binary Offset
19	lat σ	Latitude standard deviation (m)	Float	4	H+68
20	lon σ	Longitude standard deviation (m)	Float	4	H+72
21	hgt σ	Height standard deviation (m)	Float	4	H+76
22	stn id	Base station ID	Char[4]	4	H+80
23	diff_age	Differential age in seconds	Float	4	H+84
24	sol_age	Solution age in seconds	Float	4	H+88
25	#SVs	Number of satellites tracked	Uchar	1	H+92
26	#solnSVs	Number of satellites vehicles used in solution	Uchar	1	H+93
27	reserved		Uchar	1	H+94
28	reserved		Uchar	1	H+95
29	EastVel	Velocity along east: Velocity along east under the geographic coordinate system, keep three behind the decimal, unit: Km/h (null if there is no values)	Float	4	H+96
30	northVel	Velocity along north: Velocity along north under the geographic coordinate system, keep three behind the decimal, unit: Km/h (null if there is no values)	Float	4	H+100
31	upVel	vertical velocity: vertical velocity under the geographic coordinate system, keep three behind the decimal, unit: Km/h (null if there is no values)	Float	4	H+104
32	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+108
33	[CR][LF]	Sentence terminator (ASCII only)			

Table 0- 3 Position or Velocity Type

Binary	ASCII	Description
0	NONE	No solution
1	FIXEDPOS	Position has been fixed by the **FIX position** command or by position averaging.
2	FIXEDHEIGHT	Not supported for now
8	DOPPLER_VELOCITY	Velocity computed using instantaneous Doppler
16	SINGLE	Single point position
17	PSRDIFF	Pseudorange differential solution
18	SBAS	SBAS position
32	L1_FLOAT	Floating L1 ambiguity solution
33	IONOFREE_FLOAT	Floating ionosphere ambiguity solution
34	NARROW_FLOAT	Floating narrow-lane ambiguity solution
48	L1_INT	Integer L1 ambiguity solution
49	WIDE_INT	Integer wide-lane ambiguity solution
50	NARROW_INT	Integer narrow-lane ambiguity solution
52	INS	INS solution
53	INS_PSRSP	INS position solution
54	INS_PSRDIFF	INS pseudorange single point solution – no DGPS corrections
55	INS_RTKFLOA	INS pseudorange differential solution
56	INS_RTKFIXED	INS RTK floating point ambiguities solution

Table 0- 4 Solution Status

Solution Status		Description
0	SOL_COMPUTED	Solution computed
1	INSUFFICIENT_OBS	Insufficient observations
2	NO_CONVERGENCE	No convergence
4	COV_TRACE	Covariance trace exceeds maximum (trace > 1000 m)

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