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CASIC Multimode Satellite Navigation Receiver Protocol Specification

V4.2.0.3

2020-01-06

documentation		
document name	CASIC Multimode Satellite Navigation Receiver Protocol Specification	
document summary	Describes in detail the CASIC Multimode Satellite Navigation Receiver Protocol Specification, including the generic standard NMEA0183 protocol. protocols, and customized binary protocols.	
version number	V4.2.0.3	
dates	2020.01.06	
version update		
V3.7.0.1	2017.07.21	Modify the RXM-MEASX message to comply with the RINEX302 standard.
V3.8.0.1	2017.12.06	Expansion of the Leap Second Profile (LPS) portion of the NMEA protocol; addition of the NMEA-DHV and the corresponding protocols for NMEA-UTC statements.
V3.9.0.0	2017.12.20	Add support and content for NMEA-GST statements.
V4.0.0.0	2017.12.26	Additions to NMEA-LPS message content. Content of some statements updated.
V4.1.0.0	2018.3.26	Corrects the significance of some of the binary protocol content; corrects some of the names.
V4.2.0.0	2018.11.14	Add the NMEA-INS statement and the corresponding protocol for the NAV=IMUATT message.
V4.2.0.1	2018.11.22	Corrected clerical error.
V4.2.0.2	2019.05.14	Modify the NMEA-INS statement, CFG-INS.
V4.2.0.3	2020.01.06	Add the PCAS60 statement and modify the PCAS03 statement.

1 NMEA Protocol

1.1 NMEA Protocol Features

CASIC receivers are compatible with the international standard NMEA0183 protocol and support NMEA0183 version 4.1 by default, and are compatible with versions V2.3 and V3.X. They support the NMEA0183 V4.0 standard, as well as standards prior to V2.3, by sending commands.

Data is transmitted in serial asynchronous mode. Bit 1 is the start bit, followed by the data bits. The data bits follow the rule of least significant bit first.

data transmission method

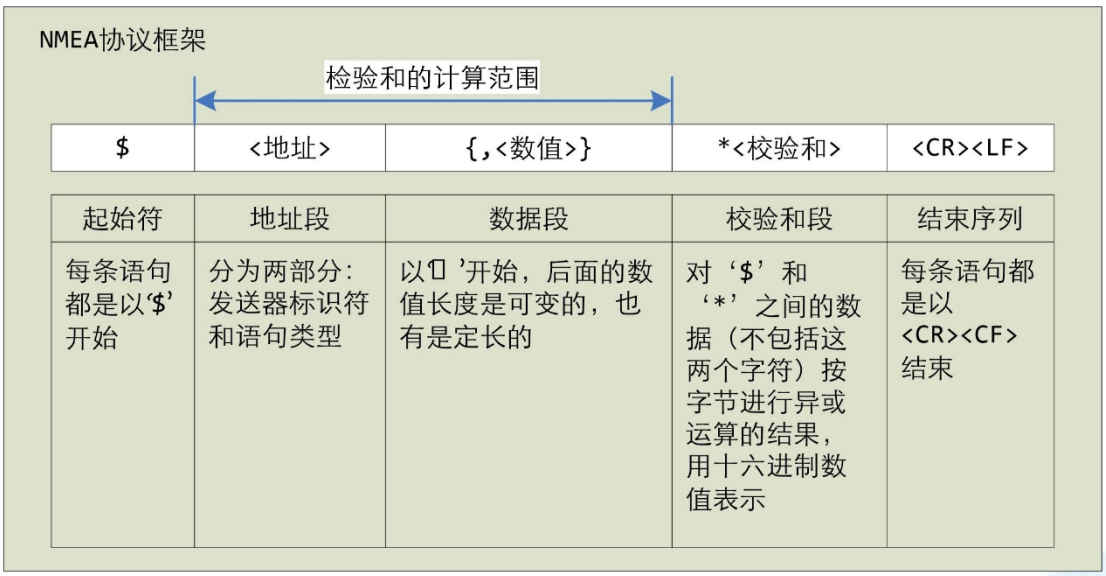
	starting position	D0	D1	D2	D3	D4	D5	D6	D7	stop bit	

Parameters used for data transfer

Baud rate (bps)	Support 4800,9600,19200,38400,57600,115200
data bit	8-bit
stop bit	1 position
check digit	not have

1.2 NMEA Protocol Framework

NMEA messages are sent by GNSS receivers and support the NMEA0183 protocol. Data Format Protocol Framework



Detailed NMEA protocol standards reference http://www.nmea.org/

This receiver protocol specification adds customized statements to the NMEA protocol framework for controlling the receiver's operating mode and for querying the receiver's product information. The identifier of the custom statement is 'P'.

1.3 NMEA Identifiers and Field Types

1.3.1 sender identifier

The NMEA statement distinguishes between the different GNSS modes by means of a transmitter identifier, which is defined as follows:

transmitters	identifiers
Beidou Navigation Satellite System (BDS)	BD
Global Positioning System (GPS, SBAS, QZSS)	GP
Global Navigation Satellite System (GLONASS)	GL
Global Navigation Satellite System (GNSS)	GN
Customized information	P

1.3.2 Satellite number identifier

Satellite systems	Satellite number identifier in NMEA	Satellite PRN No.	Correspondence between satellite number and its PRN
GPS	1~32	1~32	0+PRN
SBAS	33~51	120~138	87+PRN
GLONASS	65~88	1~24	64+PRN
BDS	1~37	1~37	0+PRN
QZSS	33~37	193~197	PRN-160

1.3.3 system identifier

CASIC receivers support a variety of NMEA data protocol formats, the difference between the different protocols is reflected in the system identifier, while newer versions of the protocols have additional fields.

	NMEA 4.0 and below	NMEA 4.1
GGA	[1] Identification	[1] Identification
ZDA	[1] Identification	[1] Identification
GLL	[1] Identification	[1] Identification
RMC	[1] Identification	[1] Identification
VTG	[1] Identification	[1] Identification
GSA	[2] Identification	[1] Identification, adding additional fields to distinguish between different systems
GSV	[2] Identification	[2] Identification

[1] Identifier: If only BD, GPS, GLONASS, Galileo, etc. satellites are used for position solving, the transmission identifier is BD, GP, GL, GA, etc. If satellites from multiple systems are used for position solving, the transmission identifier is GN.

[2] Markers: GP (GPS satellites) BD (BDS satellites) GL (GLONASS satellites)

As mentioned in section 1.1, CASIC receivers support three versions of the NMEA0183 protocol standard. The differences between the three standards are listed below.

The main differences between NMEA 2.2 and 2.3/4.0 are:

1) The Mode item in the GLL, RMC, and VTG statements is not output.

2) In the Positioning Quality (FS) item of the GGA statement, 1 is used for both trajectory projection and normal positioning (trajectory projection is set to 6 in 2.3).

The NMEA 4.1 protocol adds a number of fields to the 4.0 protocol: 1) A systemId is added to the GSA statement. 2) A signalId is added to the GSV statement. 3) A signalId is added to the GSV statement. (2) A signalId is added to the GSV statement.

3) Add a navStatus entry to the RMC statement.

For details, please refer to the NMEA Statement Introduction section in the subsequent Section 1.5.

1.3.4 Field type

Field type	notation	define
Specialized format fields		
state of affairs	A	Single character field: A=Yes, the data is valid and the alarm flag is cleared; V=No, data invalid, alarm flag set.
longitude	ddmm.mmmm	Fixed/variable length fields dd denotes a fixed length of 2 degrees, mm before the decimal point denotes a fixed length of 2 minutes, and mmmm after the decimal point denotes a fixed length of 2 minutes. Fractional cents of variable length.
longitudes	dddmm.mmmm	Fixed/variable length fields ddd denotes a degree of fixed length 3. mm before the decimal point indicates a fixed length of 2 minutes, the decimal point followed by mmmm denotes a decimal fraction of variable length.
timing	hhmmss.sss	Fixed Length Fields hh denotes a fixed length of 2 hours, mm denotes a fixed length of 2 minutes, and ss before the decimal point denotes a fixed length of 2 hours. seconds, sss after the decimal point indicates a fixed length of 3 decimal seconds.
Identify the field		Some fields are specified for use with predefined constants.
numeric field		
variable digital	x.x	Variable-length or floating-point number field
Fixed hexadecimal field	hh___	Hexadecimal number of fixed length, with the most significant bit on the left side
Variable hexadecimal field	h--h	Hexadecimal number of variable length, with the most significant bit on the left side
message field		

Fixed letter field	aa___	Upper or lower case character field of fixed length
Fixed numeric field	xx___	Numeric character field of fixed length
variable text	c - c	Valid character fields of variable length

1.4 NMEA Message Overview

leaf	message name	Class/ID	descriptive
NMEA Standard Messages			**standard message**
	GGA	0x4E 0x00	Receiver positioning data
	GLL	0x4E 0x01	Geographic location – latitude/longitude
	GSA	0X4E 0x02	Precision Factor (DOP) and Effective Satellites
	GSV	0x4E 0x03	visible satellite
	RMC	0x4E 0x04	Recommended minimum dedicated navigation data
	VTG	0x4E 0x05	Ground speed and heading
	GST	0x4E 0x07	Statistical information on receiver pseudorange errors
	ZDA	0x4E 0x08	Time and date
	ANT	0x4E 0x11	antenna state
	LPS	0x4E 0x12	Leap second correction information for satellite systems
	DHV	0x4E 0x13	Receiver speed information
	UTC	0x4E 0x16	Receiver Status, Leap Second Correction Simplified Information
NMEA Customized Messages			**Customized Messages**
	CAS00	-	Saving configuration information
	CAS01	-	Communication protocol and serial port configuration information
	CAS02	-	Setting the positioning update rate
	CAS03	-	Enable or disable the output message and its frequency
	CAS04	-	Setting the initialization system and number of channels
	CAS05	-	Setting the sender identifier for NMEA statements
	CAS06	-	Query module hardware and software information
	CAS10	-	Startup mode and auxiliary information configuration
	CAS12	-	Standby mode control
	CAS20	-	Online upgrade instructions

1.5 NMEA Standard Messages

1.5.1 GGA

text	GGA		
descriptive	Receiver time, location and positioning related data		
typology	exports		
specification	$--GGA,UTCtime,lat,uLat,lon,uLon,FS,numSv,HDOP,msl,uMsl,sep,uSep,diffAge,diffSta*CS<CR><LF>		
typical example	$GPGGA,235316.000,2959.9925,S,12000.0090,E,1,06,1.21,62.77,M,0.00,M,,*7B		
Parameter Description			
(numeric, data) field	name (of a thing)	specification	Parameter description
1	$--GGA	string (computer science)	Message ID, GGA statement header, '--' is the system identifier
2	UTCtime	hhmmss.sss	The UTC time of the current location
3	lat	ddmm.mmmm	Latitude and longitude, the first 2 characters represent degrees and the following characters represent minutes.
4	uLat	character	Latitudinal direction: N-North, S-South
5	lon	dddmm.mmmm	Longitude, the first 3 characters represent degrees and the following characters represent minutes.
6	uLon	character	Direction of longitude: E-East, W-West
7	FS	numerical value	Indicates the current positioning quality (Remark [1]) this field should not be empty
8	numSv	numerical value	Number of satellites used for positioning, 00-24
9	HDOP	numerical value	Horizontal accuracy factor (HDOP)
10	msl	numerical value	Elevation, i.e., the height of the receiver antenna relative to the level of the earth
11	uMsl	character	Height unit, meters, fixed character M
12	sep	numerical value	The distance between the reference ellipsoid and the geoid"-" denoting geoid Level below reference ellipsoid
13	uSep	character	Height unit, meters, fixed character M
14	diffAge	numerical value	Differential corrected data age, field is empty when not using DGPS
15	diffSta	numerical value	ID of the differential reference station
16	CS	Hexadecimal values	Checksum, all characters between $ and * (excluding $ and *) are different or knotted. resolute
17	<CR><LF>	character	carriage return and line feed (computing)
Remarks [1] Positioning quality markers			

Positioning quality markers	descriptive
0	Positioning unavailable or invalid
1	SPS Positioning Mode, Positioning Effective
6	Estimation Mode (Position Projection) is only a[illegible]NMEA3.x[illegible]e

1.5.2 GLL

text	GLL		
descriptive	Latitude, longitude, positioning time and positioning status information.		
typology	exports		
specification	$--GLL,lat,uLat,lon,uLon, UTCtime,valid,mode*CS<CR><LF>		
typical example	$GPGLL,2959.9925,S,12000.0090,E,235316.000,A,A*4E		
Parameter Description			
(numeric, data) field	name (of a thing)	specification	Parameter Description
1	$--GLL	string (computer science)	Message ID, GLL statement header, '--' is system identification
2	lat	ddmm.mmmm	Latitude and longitude, the first 2 characters represent degrees and the following characters represent minutes.
3	uLat	character	Latitudinal direction: N-North, S-South
4	lon	dddmm.mmmm	Longitude, the first 3 characters represent degrees and the following characters represent minutes.
5	uLon	character	Direction of longitude: E-East, W-West
6	UTCtime	hhmmss.sss	The UTC time of the current location
7	valid	character	Data validity (Remark [1])
8	mode	character	Positioning Mode (Remark [2]), v[illegible]nly for NMEA2[illegible]
9	CS	Hexadecimal values	Checksum, all characters between $ and * (excluding $ and *) are different or knotted. resolute
10	<CR><LF>	character	carriage return and line feed (computing)
Remark [1] Data validity flag			
Positioning quality markers		descriptive	
A		Data validity	
V		Invalid data	
Remarks [2] Positioning mode flags			
Positioning mode flag		descriptive	
A		autonomous model	
E		Estimation models (sea level projections)	
N		Invalid data	
D		differential mode	
M		Not located, but external input or history saved location exists	

1.5.3 GSA

text	GSA		
descriptive	Satellite number and DOP information for positioning. The GSA statement is output regardless of whether or not a position is located or a satellite is available; when the receiver is operating in a multi-system configuration, the available satellites for each system correspond to a single GSA statement, and the GSA statement is output regardless of whether or not a position is located or a satellite is available. Each GSA statement contains the PDOP, HDOP, and VDOP obtained from the combined satellite system.		
typology	exports		
specification	$--GSA,smode,FS{,SVID},PDOP,HDOP,VDOP*CS<CR><LF>		
typical example	$GPGSA,A,3,05,21,31,12,18,29,,,,,,,2.56,1.21,2.25*01		
Parameter description			
field	name (of a thing)	specification	Parameter description
1	$--GSA	string (computer science)	Message ID, GSA statement header, '--' is the system identifier
2	smode	character	Mode switching method indication (Remark [1])
3	FS	numeric	Positioning status flag (Remark [2])
4	{,SVID}	numerical value	Satellite number used for positioning, this field shows a total of 12 available satellites numbering, only the first 12 are output when there are more than 12, and not when there are fewer than 12. Fill in the gaps in sufficient areas
5	PDOP	numerical value	Positional accuracy factor (PDOP)
6	HDOP	numerical value	Horizontal accuracy factor (HDOP)
7	VDOP	numerical value	Vertical accuracy factor (VDOP)
8	systemId	numerical value	GNSS system ID number as defined by NMEA (Remark [3]) Valid only for NMEA 4.1 and above
9	CS	Hexadecimal values	Checksum, all characters between $ and * (excluding $ and *) are different or knotted. resolute
10	<CR><LF>	character	carriage return and line feed (computing)
Remarks [1] Mode switching method indication			
Mode switching mode indication		descriptive	
M		Manual switching. Force to 2D or 3D working mode	
A		Automatic switching. Receiver automatically switches between 2D/3D operating modes	
Remarks [2] Positioning status flag			
localization state		descriptive	

1	Invalid positioning
2	2D Positioning
3	3D positioning
Remarks [3] GNSS System ID	
System ID	descriptive
1	GPS system
2	GLONASS system
4	BDS system

1.5.4 GSV

text	GSV
descriptive	The satellite number of the visible satellite and its elevation angle, azimuth angle, carrier-to-noise ratio and other information. The {satellite number in each GSV statement No., Elevation Angle, Azimuth Angle, Carrier-to-Noise Ratio} The number of parameter groups is variable, with a maximum of 4 groups and a minimum of 0 groups.
typology	exports
specification	$--GSV,numMsg,msgNo,numSv{,SVID,ele,az,cn0} *CS<CR><LF>
typical example	$GPGSV,3,1,10,25,68,053,47,21,59,306,49,29,56,161,49,31,36,265,49*79 $GPGSV,3,2,10,12,29,048,49,05,22,123,49,18,13,000,49,01,00,000,49*72 $GPGSV,3,3,10,14,00,000,03,16,00,000,27*7C

Parameter Description			
(numeric, data) field	name (of a thing)	specification	Parameter Description
1	$--GSV	string (computer science)	Message ID, GSV statement header, '--' is the system identifier
2	numMsg	character	Total number of statements. Each GSV statement outputs information on up to 4 visible satellites, so when the system has more than 4 visible satellites, more than one GSV statement will be required. A GSV statement.
3	msgNo	numeric	Current statement number
4	numSv	numerical value	Total number of visible satellites
5	{,SVID,ele. az,cn0}	numerical value	In order. Satellite number. Elevation angle, ranging from 0 to 90 in degrees. Azimuth angle, ranging from 0 to 359 in degrees. Carrier-to-noise ratio, value range is 0~99 in dB-Hz, if no We're tracking the current satellite.
6	signalId	numerical value	GNSS signal ID as defined by NMEA (0 for all signals) Only for NMEA 4.1 and above
7	CS	Hexadecimal values	Checksum, all characters between $ and * (excluding $ and *) are different or knotted. resolute
8	<CR><LF>	character	carriage return and line feed (computing)

1.5.5 RMC

text	RMC
descriptive	Recommended Minimum Positioning Information
typology	exports
specification	$--RMC,UTCtime,status,lat,uLat,lon,uLon,spd,cog,date,mv,mvE,mode*CS<CR><LF>
typical example	$GPRMC,235316.000,A,2959.9925,S,12000.0090,E,0.009,75.020,020711,,,A*45

Parameter description			
field	name (of a thing)	specification	Parameter description
1	$--RMC	string (computer science)	Message ID, RMC statement header, '--' is the system identifier
2	UTCtime	hhmmss.sss	The UTC time of the current location
3	status	string (computer science)	Location valid sign. V=Receiver warning, invalid data A = Data valid
4	lat	ddmm.mmmm	Latitude and longitude, the first 2 characters represent degrees and the following characters represent minutes.
5	uLat	character	Latitudinal direction: N-North, S-South
6	lon	dddmm.mmmm	Longitude, the first 3 characters represent degrees and the following characters represent minutes.
7	uLon	character	Direction of longitude: E-East, W-West
8	spd	numerical value	Ground speed in knots
9	cog	numerical value	True heading to earth in degrees
10	date	ddmmyy	Date (dd is day, mm is month, yy is year)
11	mv	numerical value	Magnetic declination in degrees. Fixed to null
12	mvE	character	Direction of magnetic declination: E-East, W-West. Fixed to null
13	mode	character	Positioning mode flag (Remark [1]) Valid only for NMEA 2.3 and above
14	navStatus	character	Navigation status identifier (V indicates that the system does not output navigation status information) Valid only for NMEA 4.1 and above
15	CS	Hexadecimal values	Checksum, all characters between $ and * (excluding $ and *) are different or knotted. resolute
16	<CR><LF>	character	carriage return and line feed (computing)

Remark [1] Positioning mode flags	
Positioning mode flag	descriptive
A	autonomous model
E	Estimation models (sea level projections)

N	Invalid data
D	differential mode
M	Not located, but external input or history saved location exists

1.5.6 VTG

text	VTG
descriptive	Ground speed and ground heading information.
typology	exports
specification	$--VTG,cogt,T,cogm,M,sog,N,kph,K,mode*CS<CR><LF>
typical example	$GPVTG,75.20,T,,M,0.009,N,0.017,K,A*02

Parameter Description			
field	name (of a thing)	specification	Parameter description
1	$--VTG	string (computer science)	Message ID, VTG statement header, '--' is system identification
2	cogt	numerical value	True north heading to earth in degrees.
3	T	character	True North indication, fixed to T
4	cogm	numerical value	Magnetic northward heading to the earth in degrees
5	M	character	Magnetic north indication, fixed to M
6	sog	numerical value	Ground speed in knots
7	N	character	Velocity unit knots, fixed to N
8	kph	numerical value	Velocity to earth in kilometers per hour
9	K	character	The unit of speed, kilometers per hour, is fixed to K
10	mode	character	Positioning mode flag (Remark [1]) Vdonly for *NMEA 2.3* andabove
11	CS	Hexadecimal values	Checksum, all characters between $ and * (excluding $ and *) are different or knotted. resolute
12	<CR><LF>	character	carriage return and line feed (computing)

Remark [1] Positioning mode flag	
Positioning mode flag	descriptive
A	autonomous model
E	Estimation models (sea level projections)
N	Invalid data
D	differential mode
M	Not located, but external input or history saved location exists

1.5.7 ZDA

text	ZDA		
descriptive	Time and date information.		
typology	exports		
specification	$--ZDA,UTCtime,day,month,year,ltzh,ltzn*CS<CR><LF>		
typical example	$GPZDA,235316.000,02,07,2011,00,00*51		
Parameter description			
field	name (of a thing)	specification	Parameter description
1	$--ZDA	string (computer science)	Message ID, ZDA statement header, '--' is the system identifier
2	UTCtime	hhmmss.sss	UTC time at the time of positioning
3	day	numerical value	Day, fixed two digits, value range 01~31
4	month	numerical value	Month, fixed two digits, value range 01~12
5	year	numerical value	Year, fixed four-digit
6	ltzh	numerical value	Hour in this time zone, not supported, fixed to 00
7	ltzn	numerical value	Minutes in this time zone, not supported, fixed to 00
8	CS	Hexadecimal values	Checksum, all characters between $ and * (excluding $ and *) are different or knotted. resolute
9	<CR><LF>	character	carriage return and line feed (computing)

1.5.8 TXT

Product Information

text	TXT
descriptive	Product Information
typology	Output, once at power on
specification	$GPTXT,xx,yy,zz,info*hh<CR><LF>
typical example	$GPTXT,01,01,02,MA=CASIC*27 Indicates manufacturer's name (CASIC) $GPTXT,01,01,02,IC=ATGB03+ATGR201*71 Indicates the model number of the chip or chipset (baseband chip model ATGB03, RF chip model ATGR201) $GPTXT,01,01,02,SW=URANUS2,V2.2.1.0*1D Indicates software name and version number (software name URANUS2, version number V2.2.1.0) $GPTXT,01,01,02,TB=2013-06-20,13:02:49*43 Indicates when the code was compiled (June 20, 2013, 13:02:49) $GPTXT,01,01,02,MO=GB*77 Indicates the operating mode in which the receiver is activated this time (GB indicates the dual-mode mode of GPS+BDS) $GPTXT,01,01,02,CI=00000000*7A Indicates the customer number (customer number 00000000)

Parameter description

field	name (of a thing)	specification	Parameter description
1	$GPTXT	string (computer science)	Message ID, TXT Statement Header
2	xx	numerical value	Total number of statements in the current message 01 to 99. If a message is too long, the Needs to be divided into multiple message displays
3	yy	numerical value	Statement Number 01~99
4	zz	numerical value	Text Identifier. 00 = error message; 01 = Warning message; 02 = Notification message; 07 = User information.
5	info		text message
6	CS	Hexadecimal values	Checksum, all characters between $ and * (excluding $ and *) are different or knotted. resolute
7	<CR><LF>	character	carriage return and line feed (computing)

1.5.9 ANT

text	ANT
descriptive	antenna state
typology	exports
specification	$GPTXT,xx,yy,zz,info*hh<CR><LF>
typical example	$GPTXT,01,01,01,01,ANTENNA OPEN*25 Indicates antenna status (open) $GPTXT,01,01,01,01,ANTENNA OK*35 Indicates antenna status (good) $GPTXT,01,01,01,01,ANTENNA SHORT*63 Indicates antenna status (short circuit)

Parameter description

field	name (of a thing)	specification	Parameter description
1	$GPTXT	string (computer science)	Message ID, TXT Statement Header
2	xx	numerical value	Total number of statements for the current message 01~99, if a message is too long, the Need to be divided into multiple messages to display, fixed to 01.
3	yy	numerical value	Statement number 01~99, fixed to 01.
4	zz	numerical value	Text identifier. Fixed to 01.
5	info		text message ANTENNA OPEN = antenna open ANTENNA OK = antenna good ANTENNA SHORT=Antenna short circuit
6	CS	Hexadecimal values	Checksum, all characters between $ and * (excluding $ and *) are different or knotted. resolute
7	<CR><LF>	character	carriage return and line feed (computing)

1.5.10 DHV

text	DHV		
descriptive	Detailed information on receiver speed		
typology	exports		
specification	$--DHV,UTCtime,speed3D,spdX,spdY,spdZ,gdspd*CS<CR><LF>		
typical example	$GNDHV,021150.000,0.03,0.006,-0.042,-0.026,0.06*65		
Parameter description			
field	name (of a thing)	specification	Parameter description
1	$--DHV	string (computer science)	Message ID, DHV statement header, '--' is the system identifier
2	UTCtime	hhmmss.sss	UTC time of the current moment
3	speed3D	numerical value	Receiver three-dimensional speed in m/s
4	spdX	numerical value	Receiver ECEF-X-axis velocity in m/s
5	spdY	numerical value	Receiver ECEF-Y-axis velocity in m/s
6	spdZ	numerical value	Receiver ECEF - Z-directional speed in m/s
7	gdspd	numerical value	Receiver horizontal ground speed in m/s
8	CS	Hexadecimal values	Checksum, all characters between $ and * (excluding $ and *) are different or knotted. resolute
9	<CR><LF>	character	carriage return and line feed (computing)

1.5.11 LPS (5T support only)

text	LPS (5T support only)
descriptive	Leap second information
typology	exports
specification	$GPTXT,xx,yy,zz,LS=system,valid,utcLS,utcLSF,utcTOW,utcWNT,utcDN,utcWNF,utcA0,utcA1,leapDt,dateLsf,lsfExp,wnExp,wnExpNum*hh<CR><LF>
typical example	$GNZDA,235402.000,31,12,2016,00,00*4E The current UTC time is 23:54:02 on December 31, 2016 $GPTXT,01,01,02,LS=0,3,17,18,61,138,7,137,0,0,358,311216,,,*64 The leap second information of the GPS is valid and used for timing, the current leap second is not equal to the leap second after the jump from 17 to 18 seconds, and the leap second event occurred 358 seconds later (i.e., on December 31, 2016 at 23:59:60) There are no satellites in the current receiver GPS system that give UTC parameter information anomaly alarms. There are no satellites with GPS week anomaly alarms. $GPTXT,01,01,02,LS=1,1,3,4,0,61,6,61,0,0,0,358,311216,,,*56 Beidou's leap second information is valid and not used for timing, the current leap second is not equal to the leap second after the jump from 3 to 4 seconds. seconds, the leap second event occurs 358 seconds later (i.e., on December 31, 2016 at 23:59:60) Note: Leap seconds are different for GPS and BeiDou because they have different time start reference points. The current receiver Beidou There are no satellites that give anomaly alarms for UTC parameter information. Currently there are no satellites giving anomalous alarms for BeiDou week number.

Parameter Description

(numeric, data) field	name (of a thing)	specification	Parameter Description
1	$GPTXT	string (computer science)	Message ID, TXT Statement Header
2	xx	numerical value	Total number of statements in the current message 01 to 99. If a message is too long, the Need to be divided into multiple messages to display, fixed to 01.
3	yy	numerical value	Statement number 01~99, fixed to 01.
4	zz	numerical value	Text identifier. Fixed to 02.
5	LS=	string (computer science)	Leap second message identifier, fixed character.
6	system	character	The system corresponding to the leap second information. 0=GPS 1 = BDS (Beidou)

7	valid	character	Leap second information validity flag. When multiple satellite systems are combined for positioning, only one of them is used for timing (calibration of 1PPS and UTC time) 0 = Leap second information not valid 1 = Leap second information is valid, but the system is not used for timekeeping 2 = Leap second information is not valid, but the system has been used for timekeeping 3 = Leap second information is valid and the system has been used for timekeeping
8	utcLS	numerical value	(Fields 8-15 are standard leap second 8 parameters, see BeiDou or GPS ICD documentation for format) Current leap second in seconds, positive numbers indicate satellite time overrun UTC Time. Output when the leap second parameter is valid, otherwise null.
9	utcLSF	numerical value	Forecasted leap seconds (after a leap second event) seconds, positive meter

			Indicates satellite time ahead of UTC time. Output when the leap second parameter is valid. Otherwise empty.
10	utcTOW	numerical value	The reference time for the UTC correction parameter, intra-week time in 4096 seconds. Output when the leap second parameter is valid, otherwise null.
11	utcWNT	numerical value	UTC Reference time for the correction parameter, in weeks, modulo 256. Output when the leap second parameter is valid, otherwise null.
12	utcDN	numerical value	The number of days in the week at the moment the leap second occurs. For GPS system, the valid range of this value is 1~7. For BeiDou system, the valid range of this value is 1~6. 1 is the end of Sunday, 2 is the end of Monday, and so on, 7 is the end of Saturday. Output when the leap second parameter is valid, otherwise null.
13	utcWNF	numerical value	The moment when the leap second occurs, the number of weeks in weeks, modulo 256. leap second reference Output when the number is valid, otherwise null.
14	utcA0	numerical value	Time error between UTC time and satellite time (scale factor 2^-30). The unit is seconds. Output when the leap second parameter is valid, otherwise null.
15	utcA1	numerical value	Rate of change of time error between UTC time and satellite time (scale factor 2^-50) in seconds/second. Output when the leap second parameter is valid, otherwise as empty.
16	leapDt	numerical value	The time interval between the moment of the leap second event and the current UTC time, a positive number indicates that the leap second event will occur in the future. A positive number indicates that a leap second event is in the future. Output when there is a leap second change (utcLs ≠ utcLsf), otherwise null.
17	dateLsf	ddmmyy	The date corresponding to the predicted time of the leap second occurrence, in dd/mm/yyyy format. Output when the leap second parameter is valid and there is a leap second change (utcLs ≠ utcLsf). Otherwise empty.

18	lsfExp	Hexadecimal values	Leap second correction time anomaly alarm for the current satellite system. Alerts on leap second correction time anomalies for the current satellite system in an 8-bit The hexadecimal values represent the situation related to the 32 satellites of the system. From The lowest to highest positions are for satellites 1 through 32 in that order. 0 = No anomaly in the leap second correction information for this satellite. 1 = Leap second correction information anomaly for this satellite. If the time of the leap second occurrence in the message is not the empirical time (June 30 or December 31) the receiver will give an exception message, but will follow the changed time for leap second adjustment. Leap second parameter is valid and there is an exception Outputs when it is used, otherwise it is null.
19	wnExp	Hexadecimal values	Current Satellite System Time Week Abnormal Alarm (Jump Year Alarm) Taking 8 The hexadecimal value of the 32 satellites of the system is expressed in hexadecimal digits. Status. Satellites 1 through 32 are listed in order from lowest to highest. 0 = no anomaly in the satellite week, no alarms 1=There is an anomaly in the number of weeks of this satellite, give an alarm Output when an exception exists for the ephemeris time. Otherwise null.
20	wnExpNum	numerical value	The magnitude of the jump in the number of weeks in a satellite message. The value is negative if the number of weeks jumps forward relative to the normal value, and positive if the opposite is true. The unit is the number of weeks. Ephemeris Output if there is an exception between. Otherwise, null.
21	CS	Hexadecimal values	Checksum, all characters between $ and * (excluding $ and *) are different or knotted.

			resolute
22	<CR><LF>	character	carriage return and line feed (computing)

1.5.12 UTC (5T support only)

text	UTC (5T support only)
descriptive	Receiver Status, Leap Second Correction Simplified Information
typology	exports
specification	$--UTC,UTCtime,lat,uLat,lon,uLon,FS,numSv,HDOP,hgt,uMsl,date,antSta,timeSrc,leapValid,dtLs,dtLsf,leapTime*CS<CR><LF>
typical example	$GNUTC,235402.000,3200.00001,N,11900.00005,e,1,20,0.6,10.5,m,311216,0,0,1,17,18,1216*3C

Parameter description			
field	name (of a thing)	specification	Parameter description
1	$--UTC	string (computer science)	Message ID, UTC Statement Header
2	UTCtime	hhmmss	The UTC time of the current location in hour/minute/second format.
3	lat	ddmm.mmmm	Latitude and longitude, the first 2 characters represent degrees and the following characters represent minutes.
4	uLat	character	Latitudinal direction: N-North, S-South
5	lon	dddmm.mmmm	Longitude, the first 3 characters represent degrees and the following characters represent minutes.
6	uLon	character	Direction of longitude: E-East, W-West
7	FS	numerical value	Indicates the current positioning quality (Remark [1]) this field should not be empty
8	numSv	numerical value	Number of satellites used for positioning, 00-24
9	HDOP	numerical value	Horizontal accuracy factor (HDOP)
10	hgt	numerical value	high degree
11	uMsl	character	Height unit, meters, fixed character M
12	date	ddmmyy	The current positioning date in dd/mm/yyyy format.
13	antSta	numerical value	Antenna status: 0 = antenna open 2 = antenna normal 3 = antenna short circuit
14	timeSrc	numerical value	Current timing source system: 0 = GPS system 1 = BDS system
15	leapValid	numerical value	Leap second correction value validity flag: 0 = no valid leap second

			value 1 = leap second value is valid
16	utcLs	numerical value	Leap second correction value at the current moment
17	utcLsf	numerical value	If there is a forecasted leap second occurrence (utcLs≠ utcLsf in the Leap Second Correction message), this indicates the forecasted new leap second correction value. This value continues to be output after a leap second event until a correction message is received with no leap second forecast. If no forecasted leap second occurs (in the received leap second correction message dtls

			(equivalent to dtlsf), the field is empty
18	leapTime	mmyy	If there is a forecasted leap second occurrence (utcLs≠ utcLsf in the Leap Second Correction message), this field indicates the forecasted time of the leap second occurrence. This value continues to be output after a leap second event has occurred until a correction message is received with no leap second forecast. If no leap second is forecasted (dtls in the received leap second correction message is the same as the dtlsf equivalent) the field is empty. The format is month/year.
19	CS	Hexadecimal values	Checksum, all characters between $ and * (excluding $ and *) are different or knotted. resolute
20	<CR><LF>	character	carriage return and line feed (computing)
Remarks [1] Positioning quality markers			
Positioning quality markers		descriptive	
0		Positioning unavailable or invalid	
1		Standardized positioning model for effective positioning	
6		Estimation model	

1.5.13 GST

text	GST
descriptive	Detailed information on the measurement accuracy of receiver pseudorange
typology	exports
specification	$--GST,UTCtime,RMS,stdDevMaj,stdfDevMin,orientation,stdLat,stdLon,stdAlt*CS<CR><LF>
typical example	$BDGST,081409.000,0.5,,,,0.2,0.1,0.4*5E

Parameter description

field	name (of a thing)	specification	Parameter description
1	$--GST	string (computer science)	Message ID, DHV statement header, '--' is the system identifier
2	UTCtime	hhmmss.sss	The UTC time of the current moment
3	RMS	numerical value	RMS value of the standard deviation of the receiver pseudorange error during positioning, in meters
4	stdDevMaj	numerical value	Standard deviation of the position in the direction of the half-length axis of the receiver ellipse, unsupported
5	stdfDevMin	numerical value	Standard deviation of the position in the direction of the short axis of the receiver ellipse half, not supported
6	orientation	numerical value	Orientation in the direction of the half-length axis of the receiver ellipse, unsupported
7	stdLat	numerical value	Standard deviation of receiver latitude-direction error in meters
8	stdLon	numerical value	Standard deviation of the receiver's longitude-direction error, in meters
9	stdAlt	numerical value	Standard deviation of receiver altitude-direction error in meters
10	CS	Hexadecimal values	Checksum, the result of all characters between $ and * (excluding $ and *).
11	<CR><LF>	character	carriage return and line feed (computing)

1.5.14 INS (supported by 5S series only)

text	INS (supported by 5S series only)
descriptive	Inertial Navigation System (INS) Information
typology	exports
specification	$GPTXT,xx,yy,zz,INS_INF=sensorID,attMode,status,sesorOK,RAM.ramStart*hh<CR><LF>
typical example	$GPTXT,01,01,02,INS_INF=1,3,5,0,0,RAM,1*11 Explanation: k=1, current module sensor type 1; l=3, Module Packaging X-axis mounting requires that only the left side of the vehicle be thought of; m=5, the module currently outputs RXM_SENSOR statements with 5 sets of MEMS sampling data per statement; n=0,the combined navigation filter did not converge.

Parameter description

field	name (of a thing)	specification	Parameter description
1	$GPTXT	string (computer science)	Message ID, TXT Statement Header
2	xx	numerical value	Total number of statements in the current message 01 to 99. If a message is too long, the Need to be divided into multiple messages to display, fixed to 01.
3	yy	numerical value	Statement number 01~99, fixed to 01.
4	zz	numerical value	Text Identifier.
5	INS_INF	string (computer science)	Fixed to INS_INF for INS info flags.
6	sensorID	numerical value	Current sensor type used in the module: 1 or 2.
7	attMode	numerical value	Mode configuration of the module with respect to the relative mounting attitude of the vehicle, possible range of values: 0, 1, 2, 3. 0: The module's X-axis is pointing toward the front of the vehicle. 1: The module X-axis points to the right of the vehicle. 2: The module's X-axis points to the rear of the vehicle. 3: The module X-axis points to the left of the vehicle. 9: Adaptive estimation of module relative attitude.

8	fs	numerical value	Used for the number of samples within the RXM_SENSOR statement that is only used to output the internal MEMS raw data. Value range: 0, 1, 2, 5, 10, 25, 50. If m=0, the RXM_SENSOR statement is not output; If m!=0, the RXM_SENSOR statement is output once per second. One statement contains m sets of MEMS sensor sample data.
9	status	numerical value	Used to display the convergence status of the combined navigation filter, n=2 means converged.
10	sesorOK	numerical value	-
11	RAM	string (computer science)	Fixed to RAM
	ramStart	numerical value	1: There is a backup power supply to power on immediately the navigation position projection function is turned on 0: With backup power supply power-up immediately heading projection function off

			Close by default
6	CS	Hexadecimal values	Checksum, all characters between $ and * (excluding $ and *) are different or knotted. resolute
7	<CR><LF>	character	carriage return and line feed (computing)

1.6 NMEA Customized Messages

1.6.1 CAS00

text	CAS00		
descriptive	Save the current configuration information into FLASH, even if the receiver is completely powered off, the information in FLASH is not lost.		
typology	importation		
specification	$PCAS00*CS<CR><LF>		
typical example	$PCAS00*01		
Parameter description			
field	name (of a thing)	specification	Parameter Description
1	$PCAS00	string (computer science)	Message ID, Statement Header
2	CS	Hexadecimal values	Checksum, all characters between $ and * (excluding $ and *) are different or knotted. resolute
3	<CR><LF>	character	carriage return and line feed (computing)

1.6.2 CAS01

text	CAS01
descriptive	Sets the serial port communication baud rate.
typology	importation
specification	$PCAS01,br*CS<CR><LF>
typical example	$PCAS01,1*1D

Parameter Description			
(numeric, data) field	name (of a thing)	specification	Parameter Description
1	$PCAS01	string (computer science)	Message ID, Statement Header
2	br	numeric	Baud rate configuration. 0=4800bps 1=9600bps 2=19200bps 3=38400bps 4=57600bps 5=115200bps
3	CS	Hexadecimal values	Checksum, all characters between $ and * (excluding $ and *) are different or knotted. resolute
4	<CR><LF>	character	carriage return and line feed (computing)

1.6.3 CAS02

text	CAS02		
descriptive	Set the positioning update rate.		
typology	importation		
specification	$PCAS02,fixInt*CS<CR><LF>		
typical example	$PCAS02,1000*2E		
Parameter Description			
field	name (of a thing)	specification	Parameter description
1	$PCAS02	string (computer science)	Message ID, Statement Header
2	fixInt	numerical value	Position update interval in ms. 1000 = update rate of 1 Hz, 1 positioning point output per second 500 = 2 Hz update rate, 2 position points per second output 250 = 4 Hz update rate, 4 position points per second output 200 = update rate of 5 Hz, 5 position points per second output 100 = 10 Hz update rate, 10 position points per second output
3	CS	Hexadecimal values	Checksum, the result of all characters between $ and * (excluding $ and *).
4	<CR><LF>	character	carriage return and line feed (computing)

1.6.4 CAS03

text	CAS03
descriptive	Sets the NMEA statement that requests output or stops output.
typology	importation
specification	$PCAS03,nGGA,nGLL,nGSA,nGSV,nRMC,nVTG,nZDA,nANT,nDHV,nLPS,res1,res2,nUTC,nGST,res3,res4,res5,nTIM*CS<CR><LF>
typical example	$PCAS03,1,1,1,1,1,1,1,1,0,0,,,1,1,,,,1*33

Parameter description			
field	name (of a thing)	specification	Parameter description
1	$PCAS03	string (computer science)	Message ID, Statement Header
2	nGGA	numerical value	GGA output frequency, the statement output frequency is based on the localization update rate, n (0~9) means every n times localization output, 0 means no output This statement, empty keeps the original configuration.
3	nGLL	numerical value	GLL output frequency, same as nGGA
4	nGSA	numerical value	GSA output frequency, same as nGGA
5	nGSV	numerical value	GSV output frequency, same as nGGA
6	nRMC	numerical value	RMC output frequency, same as nGGA
7	nVTG	numerical value	VTG output frequency, same as nGGA
8	nZDA	numerical value	ZDA output frequency, same as nGGA
9	nANT	numerical value	ANT output frequency, same as nGGA
10	nDHV	numerical value	DHV output frequency, same as nGGA
11	nLPS	numerical value	LPS output frequency, same as nGGA
12	res1	numerical value	reservations
13	res2	numerical value	reservations
14	nUTC	numerical value	UTC output frequency, same as nGGA
15	nGST	numerical	GST output frequency, same as nGST

		value	
16	res3	numerical value	reservations
17	res4	numerical value	reservations
18	res5	numerical value	reservations
19	nTIM	numerical value	TIM (PCAS60) output frequency, same as nGGA
20	CS	Hexadecimal values	Checksum, the result of all characters between $ and * (excluding $ and *).
21	<CR><LF>	character	carriage return and line feed (computing)

1.6.5 CAS04

text	CAS04		
descriptive	Configure the work system.		
typology	importation		
specification	$PCAS04,mode*hh<CR><LF>		
typical example	$PCAS04,3*1A Beidou and GPS Dual Mode $PCAS04,1*18 Single GPS Operating Mode $PCAS04,2*1B Single BeiDou operating mode		
Parameter description			
field	name (of a thing)	specification	Parameter description
1	$PCAS04	string (computer science)	Message ID, Statement Header
2	mode	numeric	Working System Configuration. For featured product models, some of the following configurations are supported. 1=GPS 2=BDS 3=GPS+BDS 4=GLONASS 5=GPS+GLONASS 6=BDS+GLONASS 7=GPS+BDS+GLONASS
3	CS	Hexadecimal values	Checksum, all characters between $ and * (excluding $ and *) are different or knotted. resolute
4	<CR><LF>	character	carriage return and line feed (computing)

1.6.6 CAS05

text	CAS05		
descriptive	Set the NMEA protocol type selection. Multimode navigation receivers have a wide range of protocol types, and data protocol standards are also More, this receiver product can support a variety of protocols		
typology	importation		
specification	$PCAS05,ver*CS<CR><LF>		
typical example	$PCAS05,1*19		
Parameter Description			
(numeric, data) field	name (of a thing)	specification	Parameter Description
1	$PCAS05	string (computer science)	Message ID, Statement Header
2	mode	numeric	NMEA Protocol Type Selection (Remark [1])
3	CS	Hexadecimal values	Checksum, all characters between $ and * (excluding $ and *) are different or knotted. resolute
4	<CR><LF>	character	carriage return and line feed (computing)
Remark [1] NMEA protocol type selection			
2	Compatible with NMEA 4.1 and above		
5	Compatible with BDS/GPS dual mode protocol of China Transportation Information Center, compatible with NMEA 2.3 or above, compatible with NMEA4.0 Protocol		
9	Single GPS NMEA0183 protocol compatible, NMEA version 2.2 compatible		

1.6.7 CAS06

text	CAS06		
descriptive	Search for product information		
typology	importation		
specification	$PCAS06,info*CS<CR><LF>		
typical example	$PCAS06,0*1B		
Parameter description			
field	name (of a thing)	specification	Parameter description
1	$PCAS06	string (computer science)	Message ID, Statement Header
2	info	numeric	Queries the type of information about the product. Refer to 1.5.8 for information content. 0=Query firmware version number 1=Query hardware model and serial number 2=Query the operating mode of a multimode receiver 3=Query the customer number of the product 5=Query upgrade code information
3	CS	Hexadecimal values	Checksum, all characters between $ and * (excluding $ and *) are different or knotted. resolute
4	<CR><LF>	character	carriage return and line feed (computing)

1.6.8 CAS10

text	CAS10
descriptive	receiver reboot
typology	importation
specification	$PCAS10,rs*CS<CR><LF>
typical example	$PCAS10,0*1C Hot start $PCAS10,1*1D Warm Start $PCAS10,2*1E Cold Start $PCAS10,3*1F Factory Startup

Parameter description			
field	name (of a thing)	specification	Parameter description
1	$PCAS10	string (computer science)	Message ID, Statement Header
2	rs	numeric	Startup Mode Configuration. 0 = hot start. No initialization information is used and all data in the backup store is valid. 1 = warm start. No initialization information is used to clear the ephemeris. 2 = Cold start. No initialization information is used and all data in the backup store except the configuration is cleared. 3 = Factory startup. Clears all data from memory and resets the receiver to the factory default configuration.
3	CS	Hexadecimal values	Checksum, all characters between $ and * (excluding $ and *) are different or knotted. resolute
4	<CR><LF>	character	carriage return and line feed (computing)

1.6.9 CAS12

text	CAS12		
descriptive	Receiver Standby Mode Control 5L [illegible]		
typology	importation		
specification	$PCAS12,stdbysec*CS<CR><LF>		
typical example	$PCAS12,60*28 Receiver enters standby mode for 60 seconds and turns on automatically.		
Parameter Description			
(numeric, data) field	name (of a thing)	specification	Parameter Description
1	$PCAS12	string (computer science)	Message ID, Statement Header
2	stdbysec	numerical value	Time for receiver to enter standby mode, max. 65535 sec.
3	CS	Hexadecimal values	Checksum, all characters between $ and * (excluding $ and *) are different or knotted. resolute
4	<CR><LF>	character	carriage return and line feed (computing)

1.6.10 CAS20

text	CAS20		
descriptive	Online upgrade instructions		
typology	importation		
specification	$PCAS20*CS<CR><LF>		
typical example	$PCAS20*03		
Parameter description			
field	name (of a thing)	specification	Parameter description
1	$PCAS20	string (computer science)	Message ID, Statement Header
2	CS	Hexadecimal values	Checksum, all characters between $ and * (excluding $ and *) are different or knotted. resolute
3	<CR><LF>	character	carriage return and line feed (computing)

1.6.11 CAS15

text	CAS15		
descriptive	Satellite system control commands to configure whether or not to receive any of the satellites in the system Tom adopted the version of 5200		
typology	importation		
specification	$PCAS15,X,YYYYYYYY*CS<CR><LF>		
typical example	$PCAS15,2,FFFFFFFF*37, turn on Beidou satellites 1-32. $PCAS15,2,FFFFFFE0*42, turn on Beidou satellites 6-32, Beidou satellites 1-5 are turned off. $PCAS15,4,FFFF*31 to turn on satellites 1-16 of SBAS, i.e. PRN=120-135 $PCAS15,5,1F*47, turn on QZSS satellites 1-5, i.e. PRN=193, 194, 195, 199, 197		
Parameter description			
field	name (of a thing)	specification	Parameter description
1	$PCAS15	string (computer science)	Message ID, Statement Header
2	SYS_ID	1 number	2 = Beidou 1-32 satellites 3 = Beidou 33-64 satellites 4=SBAS satellites (SBAS satellites 1-19, corresponding to PRN 120-138) (No.) 5=QZSS satellites (QZSS satellites 1-5, corresponding to PRN 193. No. 194, 195, 199, 197)
3	SV_MASK	1 to 8 hexadecimal values	Each hex character controls 4 satellites, with the rightmost controlling satellites 1-4. Converts hexadecimal characters to 4bit binary, each 1bit corresponds to 1 satellite, 1=receive the satellite; 0=disable. Example: 3FFFFFE0 to disable satellites 31,32,1-5.
4	CS	Hexadecimal values	Checksum, all characters between $ and * (excluding $ and *) are different or knotted. resolute
5	<CR><LF>	character	carriage return and line feed (computing)

1.6.12 CAS60

text	CAS60

descriptive	Receiver time information. 5Hz Module V5302 Sleep execution command

typology	exports		
specification	$PCAS60,UTCtime,ddmmyyyyy,wn,tow,timevalid,leaps,leapsValid*CS		
typical example	$PCAS60,091242.000,23122019,2085,119580,1,18,1*33 $PCAS60,091222.000,23122019,,,0,,0*33 $PCAS60,092011.000,23122019,2085,120029,1,,0*33		
Parameter description			
(numeric, data) field	name (of a thing)	specification	Parameter Description
1	$PCAS60	string (computer science)	Message ID
2	UTCtime	hhmmss.sss	UTC time at the current moment, if leapsValid is 0, then the default leaps are calculated
3	ddmmyyyy y y	numerical value	Current day, month and year
4	wn	numerical value	GPS system weeks
5	tow	numerical value	GPS system seconds of the week
6	timeValid	numerical value	Time validity (2/3/4/5 fields), 1 = valid, 0 = invalid
7	leaps	numerical value	Difference between GPS time and UTC time, number of leap seconds
8	leapsValid	numerical value	Leap seconds leaps Validity, 1=valid, 0=invalid
9	CS	Hexadecimal values	Checksum, all characters between $ and (not including) *
10		character	carriage return and line feed (computing)

2 CASIC protocol

2.1 CASIC protocol features

The CASIC receiver sends data to the host using a customized standard interface protocol (CSIP, CASIC Standard Interface Protocol), which is transmitted in asynchronous serial mode.

2.2 CASIC protocol framework

CSIP packet structure

Field 1	Field 2	Field 3	Field 4	Field 5	Field 6
message header	Payload length	message class	Message number	payload	calibration value
0xBA,0xCE	Unsigned integer 2 bytes	1 byte	1 byte	<4 bytes	unsigned integer 4 bytes

Field 1: Message Header (0xBA, 0xCE)

Four hexadecimal characters are used as the message start delimiter character (message header), occupying two bytes. **Field 2: Payload length (len)**

The message length (two bytes) indicates the number of bytes occupied by the payload (field 5), **excluding the** message header, message type, message number, length, and checksum fields.

Field 3: Message Class (class)

Occupies one byte and indicates the basic subset to which the current message belongs.

Field 4: Message number (id)

The message class is followed by a one-byte message number. **Field 5: Payload**

The payload is the specific content transmitted in the packet, which is variable in length (number of bytes) and is an integer multiple of four. **Field 6: Checksum Value (**ckSum**)**

The checksum is a word-by-word (1 word including 4) of all data from field 2 to field 5, including field 2 and field 5.

(bytes) cumulative sum,

occupying 4 bytes. The calculation of the checksum value can follow the following algorithm:

```
ckSum = (id << 24) + (class << 16) + len;
for (i = 0; i < (len / 4); i++)
{
    ckSum = ckSum + payload [i];
```

}

where **payload** contains all the information for field 5. In the calculation process, the portion of field 2 to field 4 is first

The data in field 5 is assembled (4 bytes to form a word), and then the data in field 5 is accumulated in the order of 4 bytes (the first received is in the lower bit).

2.3 CASIC type and number

Each class of interaction message for a CASIC receiver is a collection of related messages.

name (of a person or thing)	typology	descriptive
NAV	0x01	Navigation results: position, speed, time
TIM	0x02	Timing messages: time pulse output, time stamp results
RXM	0x03	Measurement information (pseudo-distance, carrier phase, etc.) output by the receiver
ACK	0x05	ACK/NAK message: answer message to CFG message
CFG	0x06	Enter configuration messages: configure navigation mode, baud rate, etc.
MSG	0x08	Satellite message information output by the receiver
MON	0x0A	Monitor messages: communication status, CPU load, stack utilization, etc.
AID	0x0B	Auxiliary messages: ephemeris, almanacs and other A-GPS data

2.4 CASIC payload definition rules

2.4.1 data encapsulation

To make it easier to implement structured data encapsulation, the data in the payload section is arranged in a specific way: the data in each class of message is closely spaced, with 2-byte values placed at offset addresses that are multiples of 2 and 4-byte values placed at offset addresses that are multiples of 4.

2.4.2 Message naming

The name of the message consists of a structure such as "message type + message name". For example, the name of the configuration message for configuring PPS is: CFG-PPS.

2.4.3 data type

Unless otherwise defined, all multiple character values follow the small end format. All floating-point values are transmitted according to the IEEE754 single- and double-precision standards.

abridge	typology	byte count	note
U1	unsigned character	1	
I1	signed character	1	binary code with 0 and 1 interchanged
U2	Unsigned short integer	2	
I2	Signed short integer	2	binary code with 0 and 1 interchanged
U4	unsigned long integer	4	

I4	signed long integer	4	binary code with 0 and 1 interchanged
R4	IEEE754 Single Precision	4	
R8	IEEE754 Double Precision	8	

2.5 CASIC Message Interaction

Mechanism for defining the input and output of receiver messages. When a receiver receives a message of type CFG, it is required to reply with an ACK-ACK or ACK-NACK message, depending on whether the configuration message was processed correctly. The sender shall not send a second CFG message until the receiver replies to a received CFG message. Other messages received by the receiver need not be replied to.

2.6 CASIC Message Overview

leaf	message name	Class/ID	lengths	typology	descriptive
Class NAV				**NAV Navigation Results**	
	NAV-STATUS	0x01 0x00	80	cyclicality	Receiver navigation status
	NAV-DOP	0x01 0x01	28	cyclicality	Geometric accuracy factor
	NAV-SOL	0x01 0x02	72	cyclicality	Streamlined PVT navigation information
	NAV-PV	0x01 0x03	80	cyclicality	Position and speed information
	NAV-TIMEUTC	0x01 0x10	24	cyclicality	UTC time information
	NAV-CLOCK	0x01 0x11	64	cyclicality	Clock solving information
	NAV-GPSINFO	0x01 0x20	8+12*N	cyclicality	GPS satellite information
	NAV-BDSINFO	0x01 0x21	8+12*N	cyclicality	BDS Satellite Information
	NAV-GLNINFO	0x01 0x22	8+12*N	cyclicality	GLONASS satellite information
Class TIM				**TIM Time Messages**	
	TIM-TP	0x02 0x00	24	cyclicality	Timing pulse information
Class RXM				**RXM Receiver Measured Value Information**	
	RXM-MEASX	0x03 0x10	16+32*N	cyclicality	Pseudorange, carrier phase raw measurement information
	RXM-SVPOS	0x03 0x11	16+48*N	cyclicality	GPS (satellite location information)
Class ACK				**ACK/NACK messages**	
	ACK-NACK	0x05 0x00	4	response message	The reply indicates that the message was not received correctly
	ACK-ACK	0x05 0x01	4	response message	The reply indicates that the message was received correctly
Class CFG				**CFG Input Configuration Message**	
	CFG-PRT	0x06 0x00	0/8	Query/Set up	Query/configure the UART's operating mode
	CFG-MSG	0x06 0x01	0/4	Query/Set up	Query/configuration message sending frequency
	CFG-RST	0x06 0x02	4	set up	Reboot the receiver/clear the saved data structure
	CFG-TP	0x06 0x03	0/16	Query/Set up	Querying/Configuring Receiver PPS Parameters
	CFG-RATE	0x06 0x04	0/4	Query/Set up	Query/configure the receiver's navigation rate
	CFG-CFG	0x06 0x05	4	set up	Clearing, saving and loading configuration information
	CFG-TMODE	0x06 0x06	0/28	Query/Set up	Query/configure the timing mode of the receiver PPS
	CFG-NAVX	0x06 0x07	0/44	Query/Set up	Query/specialized configuration of navigation engine parameters
	CFG-GROUP	0x06 0x08	0/56	Query/Set up	Query/Configure Group Delay Parameters for GLONASS
Class MSG				**MSG Receiver Satellite Message Information**	
	MSG-BDSUTC	0x08 0x00	20	cyclicality	The receiver outputs the BDS system UTC message.

	MSG-BDSION	0x08 0x01	16	cyclicality	The receiver outputs BDS system ionospheric information.
	MSG-BDSEPH	0x08 0x02	92	cyclicality	The receiver outputs BDS system ephemeris information.
	MSG-GPSUTC	0x08 0x05	20	cyclicality	The receiver outputs GPS system UTC information.
	MSG-GPSION	0x08 0x06	16	cyclicality	The receiver outputs GPS system ionospheric information.
	MSG-GPSEPH	0x08 0x07	72	cyclicality	The receiver outputs GPS system ephemeris information.
	MSG-GLNEPH	0x08 0x08	68	cyclicality	The receiver outputs GLN system ephemeris information.
Class MON				**MON Monitor Messages**	
	MON-VER	0x0A 0x04	64	Responding to inquiries	Exporting version information

	MON-HW	0x0A 0x09	56	Periodicity /Inquiry	Various configuration states of the hardware
Class AID				**AID Auxiliary Message**	
	AID-INI	0x0B 0x01	56	Query/Input	Auxiliary position, time, frequency, clock frequency offset information
	AID-HUI	0x0B 0x03	60	importation	Ancillary health information, UTC parameters, ionospheric parameters

2.7 NAV (0x01)

Navigation results: position, velocity, time, accuracy, heading, geometric accuracy factor and number of satellites, etc. NAV messages are subdivided into several types, each containing different information.

2.7.1 NAV-STATUS (0x01 0x00)

text	NAV-STATUS				
descriptive	Receiver navigation status				
typology	Periodicity/Inquiry				
message structure	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	80	0x01 0x00	table below	4 Bytes

Payload content					
character misalignment	digital typology	proportions resizing	name (of a person or thing)	mono classifier for honorific people	descriptive
0	U4	-	runTime	ms	Runtime from power-on/reset
4	U2	-	fixInterval	ms	Positioning interval
6	U1	-	posValid	-	Positioning markers (Remark [1])
7	U1	-	velValid	-	Speed sign (Remark [2])
8	U1*32	-	gpsMsgFlag	-	Message validity of the almanacs and ephemerides of 32 GPS satellites Logo (Remark [3])
40	U1*24	-	glnMsgFlag	-	Messages from the almanacs and ephemerides of 24 GLONASS satellites Markers of validity (Remark [3])
64	U1*14	-	bdsMsgFlag	-	Message validity of almanacs and ephemerides of 14 BDS satellites Logo (Remark [3])
78	U1		gpsUtcionFlag	-	Message validity criteria for GPS UTC and ionospheric information (Remark [4])
79	U1	-	bdsUtcionFlag	-	Message validity markers for UTC and ionospheric information for BDS (Remark [4])

Remark [1]: Positioning markers	
numerical value	descriptive

0	Invalid positioning
1	External Input Position
2	Roughly estimated location
3	Maintaining the last positioning position
4	projected flight levels
5	Quick Mode Positioning
6	2D Positioning
7	3D positioning
8	GNSS+DR combined navigation
Remark [2]: Speed signs	
numerical value	descriptive
0	Speed nullification

1	Speed of external input
2	Roughly estimated speed
3	Maintain the same speed as last time.
4	Speed projection
5	Speed in fast mode
6	2D Speed
7	3D Speed
8	Speed of combined GNSS+DR navigation
Remark [3]: Message validity marking The high 4 bits indicate the message validity flag for the almanac and the low 4 bits indicate the message validity flag for the ephemeris.	
numerical value	descriptive
0	deficiencies
1	unhealthy
2	expire (as in expiration date)
3	validity
Remark [4]: Message validity marking The high 4 bits indicate the message validity flag for the UTC parameters and the low 4 bits indicate the message validity flag for the ionospheric parameters.	
numerical value	descriptive
0	deficiencies
1	unhealthy
2	expire (as in expiration date)
3	validity

2.7.2 NAV-DOP (0x01 0x01)

text	NAV-DOP				
descriptive	Positioning accuracy factor				
typology	Periodicity/Inquiry				
message structure	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	28	0x01 0x01	table below	4 Bytes

Payload content					
character displacement	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U4	-	runtime	ms	Runtime from power-on/reset
4	R4	-	pDop	-	Location DOP
8	R4	-	hDop	-	Level DOP
12	R4	-	vDop	-	Vertical DOP
16	R4	-	nDop	-	Northbound DOP
20	R4	-	eDop	-	Eastbound DOP
24	R4	-	tDop	-	Time DOP

2.7.3 NAV-SOL (0x01 0x02)

text	NAV-SOL				
descriptive	PVT Navigation Information in ECEF Coordinate System				
typology	Periodicity/Inquiry				
message structure	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	72	0x01 0x02	table below	4 Bytes

Payload content					
character displacement	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U4	-	runTime	ms	Runtime from power-on/reset
4	U1	-	posValid	-	Positioning markers (Remark [1])
5	U1		velValid	-	Speed sign (Remark [2])
6	U1	-	timeSrc	-	Time source (Remark [3])
7	U1	-	system	-	Multimode receive mode mask for receivers (Remark [4])
8	U1	-	numSV	-	Total number of satellites involved in the solution
9	U1	-	numSVGPS	-	Number of GPS satellites involved in the solution
10	U1	-	numSVBDS	-	Number of BDS satellites involved in solving
11	U1	-	numSVGLN	-	Number of GLONASS satellites involved in the solution
12	U2	-	res	-	reservations
14	U2	-	week	-	weeks
16	R8	-	tow	s	weekly
24	R8	-	ecefX	m	X-coordinate in the ECEF coordinate system
32	R8	-	ecefY	m	Y-coordinate in the ECEF coordinate system
40	R8	-	ecefZ	m	Z-coordinate in the ECEF coordinate system
48	R4	-	pAcc	M^2	Variance of estimation accuracy error for 3D position
52	R4	-	ecefVX	m/s	X velocity in the ECEF coordinate system
56	R4	-	ecefVY	m/s	Y velocity in the ECEF coordinate system
60	R4	-	ecefVZ	m/s	Z velocity in the ECEF coordinate system
64	R4	-	sAcc	(m/s)^2	Variance of the estimation accuracy error for 3D velocity
68	R4	-	pDop	-	Location DOP

Remark [1]: Positioning markers	
numerical	descriptive

value	
0	Invalid positioning
1	External Input Position
2	Roughly estimated location
3	Maintaining the last positioning position
4	projected flight levels
5	Quick Mode Positioning
6	2D Positioning
7	3D positioning
8	GNSS+DR combined navigation
Remark [2]: Speed signs	
numerical value	descriptive

0	Speed nullification
1	Speed of external input
2	Roughly estimated speed
3	Maintain the same speed as last time.
4	Speed projection
5	Speed in fast mode
6	2D Speed
7	3D Speed
8	Speed of combined GNSS+DR navigation
Remark [3]: Time source	
time source	descriptive
0	GPS timing, i.e., the time of the week and the number of days of the week are obtained from GPS satellites in the local time of the receiver.
1	BDS
2	GLONASS
Remark [4]: Multimode reception mode	
bit (binary digit) (loanword)	descriptive
B0	1 = GPS satellites for positioning
B1	1 = BDS satellite for positioning
B2	1 = GLONASS satellites for positioning

2.7.4 NAV-PV (0x01 0x03)

text	NAV-PV				
descriptive	Position and velocity information in the geodetic coordinate system				
typology	Periodicity/Inquiry				
message structure	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	80	0x01 0x03	table below	4 Bytes

Payload content					
character misalignment	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U4	-	runTime	ms	Runtime from power-on/reset
4	U1	-	posValid	-	Positioning sign (refer to 2.7.3 Remark [1])
5	U1		velValid	-	Speed sign (refer to 2.7.3 Remark [2])
6	U1	-	system	-	Multimode receive mode mask for receivers (refer to 2.7.3 Remark [4])
7	U1	-	numSV	-	Total number of satellites involved in the solution
8	U1	-	numSVGPS	-	Number of GPS satellites involved in the solution
9	U1	-	numSVBDS	-	Number of BDS satellites involved in solving
10	U1	-	numSVGLN	-	Number of GLONASS satellites involved in the solution
11	U1	-	res	-	reservations
12	R4	-	pDop	-	Location DOP
16	R8	-	lon	°	longitudes
24	R8	-	lat	°	longitude
32	R4	-	height	m	Geodesic height (ellipsoid as reference)
36	R4	-	sepGeoid	m	Height anomaly (difference between geodetic height and elevation)
40	R4	-	hAcc	m^2	Variance of horizontal position accuracy error
44	R4	-	vAcc	m^2	Variance of vertical position accuracy error
48	R4	-	velN	m/s	Northward velocity in the ENU coordinate system
52	R4	-	velE	m/s	Eastward velocity in the ENU coordinate system
56	R4	-	velU	m/s	Celestial velocity in the ENU coordinate system
60	R4	-	speed3D	m/s	3D Speed

64	R4	-	speed2D	m/s	2D ground speed
68	R4	-	heading	°	direction (a ship or plane is heading in)
72	R4	-	sAcc	(m/s)^2	The variance of the accuracy error for the ground speed
76	R4	-	cAcc	°^2	Variance of the accuracy error of heading

2.7.5 NAV-TIMEUTC (0x01 0x10)

text	NAV-TIMEUTC				
descriptive	UTC time information				
typology	Periodicity/Inquiry				
message structure	remnant	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	24	0x01 0x10	table below	4 Bytes

Payload content					
character misalignment	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U4	-	runTime	ms	Runtime from power-on/reset
4	R4	$1/c^2$	tAcc	s^2	Time estimation accuracy
8	R4	-	msErr	ms	Residual error after millisecond rounding
12	U2	-	ms	ms	Milliseconds part of UTC time, value range 0~999
14	U2	-	year	year	UTC years (1999-2099)
16	U1	-	month	month	UTC Month (1~12)
17	U1	-	day	day	UTC Days of the month (1~31)
18	U1	-	hour	hour	UTC Hour of day (0~23)
19	U1	-	min	min	UTC minutes in hours (0-59)
20	U1	-	sec	s	UTC Intra-minute seconds (0~59)
21	U1	-	valid	-	Time-validated markers (Remark [1])
22	U1	-	timeSrc	-	Timing system logo (Remark [2])
23	U1	-	dateValid	-	Date validity symbol (Remark [3])

Remark [1]: Time validity flag	
numerical value	descriptive
B0	UTC Valid flag during the week, 0=invalid, 1=valid
B1	UTC Weekly Valid Flag, 0=invalid, 1=valid
B2	UTC Leap second correction valid flag, 0=invalid, 1=valid

Remark [2]: Timing system flags	
numerical value	descriptive
0	GPS timing
1	BDS Timing
2	GLONASS Timing

Remark [3]: Date validity markers	
numerical value	descriptive
0	Invalid date
1	External input date

2	Date from satellite
3	Reliable dates from multiple satellites

2.7.6 NAV-CLOCK (0x01 0x11)

text	NAV-CLOCK				
descriptive	Clock solving information				
typology	Periodicity/Inquiry				
message structure	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	64	0x01 0x11	table below	4 Bytes

Payload content					
character displacement	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U4	-	runTime	ms	Runtime from power-on/reset
4	R4	1/c	freqBias	-	Clock drift (clock frequency deviation)
8	R4	1/c^2	tAcc	s^2	Time precision (variance)
12	R4	1/c^2	fAcc	-	Frequency accuracy (variance)
Beginning of repeating section (N=0 for GPS, 1 for BDS, 2 for GLONASS)					
16+16*N	R8	-	tow	ms	Time of week
24+16*N	R4	-	dtUtc	s	Fractional seconds part of the difference between satellite time and UTC time
28+16*N	U2	-	wn	-	weeks
30+16*N	I1	-	leapS	-	UTC jump seconds, the whole of the difference between satellite time and UTC time. seconds
31+16*N	U1	-	valid	-	Time validity flag
Repeat section ends, N is maximized to (SYSTEM_ALL-1), and is currently valued at 2.					

2.7.7 NAV-GPSINFO (0x01 0x20)

text	NAV-GPSINFO				
descriptive	GPS satellite information				
typology	Periodicity/Inquiry				
message structure	remnant	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	8+12*N	0x01 0x20	table below	4 Bytes

Payload content					
character misalignment	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U4	-	runTime	-	Runtime from power-on/reset
4	U1	-	numViewSv	-	Number of visible satellites, effective range 0-32
5	U1	-	numFixSv	-	Number of satellites used for positioning
6	U1		system	-	Type of system (Remark [1])
7	U1	-	res		reservations
Repeat section start (N=numViewSv, valid range 0~32)					
8+12*N	U1	-	chn	-	channel number
9+12*N	U1	-	svid	-	Satellite number
10+12*N	U1	-	flags	-	Satellite status mask (Remark [2])
11+12*N	U1	-	quality	-	Indication of the quality of the signal measurement (Remark [3])
12+12*N	U1	-	CN0	dB-Hz	signal-to-noise ratio
13+12*N	I1	-	elev	°	Satellite elevation angle (-90~90)
14+12*N	I2	-	azim	°	Satellite azimuth (0~360)
16+12*N	R4	-	prRes	m	pseudorange residual
End of repetition					

Remarks [1]: System type	
numerical value	descriptive
0	GPS
1	BDS
2	GLONASS

Remark [2]: Satellite status	
bit (binary digit) (loanword)	descriptive
B0	1 = Satellite participation in solving calculations
B1-B3	reservations
B4	1 = Invalid satellite prediction information
B5	reservations

B7:B6	00 = Reserved 01=Satellite prediction information based on almanacs 10 = Reserved 11 = Satellite prediction information based on ephemeris
Remark [3]: Indication of the quality of the signal measurement	
quality	clarification
BIT0	= 1 for pseudo-distance measurements prMes valid
BIT1	= 1 for carrier phase measurements cpMes valid

BIT2	= 1, indicating that half-perimeter ambiguity is valid (inverse PI correction is valid)
BIT3	= 1, indicating that the half-period ambiguity is subtracted from the carrier phase measurement
BIT4	reservations
BIT5	= 1, indicates that the carrier frequency is valid
BIT6-BIT7	reservations

2.7.8 NAV-BDSINFO (0x01 0x21)

text	NAV-BDSINFO				
descriptive	BDS Satellite Information				
typology	Periodicity/Inquiry				
message structure	remnant	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	8+12*N	0x01 0x21	table below	4 Bytes

Payload content					
character misalignment	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U4	-	runTime	-	Runtime from power-on/reset
4	U1	-	numViewSv	-	Number of visible satellites, effective range 0-32
5	U1	-	numFixSv	-	Number of satellites used for positioning
6	U1	-	system	-	System type (refer to 2.7.7 Remarks [1])
7	U1	-	res		reservations
Repeat section start (N=numViewSv, valid range 0~32)					
8+12*N	U1	-	chn	-	channel number
9+12*N	U1	-	svid	-	Satellite number
10+12*N	U1	-	flags	-	Satellite status mask (refer to 2.7.7 Remark [2])
11+12*N	U1	-	quality	-	Indication of the quality of the signal measurement (refer to note 2.7.7) (Note [3])
12+12*N	U1	-	CN0	dB-Hz	signal-to-noise ratio
13+12*N	I1	-	elev	°	Satellite elevation angle (-90~90)
14+12*N	I2	-	azim	°	Satellite azimuth (0~360)
16+12*N	R4	-	prRes	m	pseudorange residual
End of repetition					

2.7.9 NAV-GLNINFO (0x01 0x22)

text	NAV-GLNINFO				
descriptive	GLONASS satellite information				
typology	Periodicity/Inquiry				
message structure	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	8+12*N	0x01 0x22	table below	4 Bytes

Payload content					
character displacement	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U4	-	runTime	-	Runtime from power-on/reset
4	U1	-	numViewSv	-	Number of visible satellites, effective range 0-32
5	U1	-	numFixSv	-	Number of satellites used for positioning
6	U1	-	system	-	System type (refer to 2.7.7 Remarks [1])
7	U1	-	res		reservations
Repeat section start (N=numViewSv, valid range 0~32)					
8+12*N	U1	-	chn	-	channel number
9+12*N	U1	-	svid	-	Satellite number
10+12*N	U1	-	flags	-	Satellite status mask (refer to 2.7.7 Remark [2])
11+12*N	U1	-	quality	-	Indication of the quality of the signal measurement (refer to note 2.7.7) (Note [3])
12+12*N	U1	-	CN0	dB-Hz	signal-to-noise ratio
13+12*N	I1	-	elev	°	Satellite elevation angle (-90~90)
14+12*N	I2	-	azim	°	Satellite azimuth (0~360)
16+12*N	R4	-	prRes	m	pseudorange residual
End of repetition					

2.7.10 NAV-IMUATT (0x01 0x06)

text	NAV-IMUATT					
descriptive	Attitude of the IMU coordinate system relative to the local navigation coordinate system (NED)					
typology	Periodicity/Inquiry					
message structure	remnant		Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE		32	0x01 0x06	table below	4 Bytes
Payload content						
character displacement	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive	
0	U4	-	tow	s	Receiver GPS time of week (Remark [1])	
4	U2	-	weekNum	weekly	Receiver GPS weeks (Remark [1])	
6	U1		flag	-	Posture available sign (Remark [2])	
7	U1	-	res	-	reservations	
8	I4	1e-5	roll	deg	roll angle	
12	I4	1e-5	pitch	deg	tilt	
16	I4	1e-5	heading	deg	heading angle	
20	U4	1e-5	rollAcc	deg	Tumble Angle Accuracy	
24	U4	1e-5	pitchAcc	deg	Pitch angle accuracy	
28	U4	1e-5	headingAcc	deg	Heading Angle Accuracy	
Remark [1]: Receiver GPS time of week						
rcvTow/wn	Refer to RXM-MEASX for rcvTow/wn meaning.					
Remarks [2]: Posture availability flag						
flag	0x01-Attitude estimate is valid; 0xff Attitude estimate is invalid.					

2.8 TIM (0x02)

2.8.1 TIM-TP (0x02 0x00)

message name	TIM-TP				
descriptive	Timing pulse information				
typology	Periodicity/Inquiry				
marginal notes					
messages framework	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	24	0x02 0x00	table below	4 Bytes

Payload content					
character misalignment	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U4	-	runTime	ms	Runtime from power-on/reset
4	R4	-	qErr	s	Time quantization error corresponding to the next time pulse
8	R8	-	tow	s	The intra-periodic time corresponding to the next time pulse
16	U2	-	wn	-	Number of weeks corresponding to the next time pulse
18	U1	-	refTime	-	Reference time (Remark [1])
19	U1	-	utcValid	-	Valid symbols (Remark [2])
20	U4	-	res	-	reservations

Remark [1]: Reference time of the timing pulse	
retrieve a value	descriptive
B3:B0	0: GPS time source 1: BDS Time Source 2: GLN Time Source
B7:B4	0: Time base is UTC 1: Time base is GNSS (refer to B3:B0 for system-specific values).

Remark [2]: UTC parameter validity flag	
retrieve a value	descriptive
0	deficiencies
1	reservations
2	expire (as in expiration date)
3	validity

2.9 RXM (0x03)

Measured value message.

2.9.1 RXM-MEASX (0x03 0x10)

text	RXM-MEASX				
descriptive	Pseudorange, carrier phase raw measurement information				
typology	Periodicity/Inquiry				
marginal notes					
message structure	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	16+32*N	0x03 0x10	table below	4 Bytes

Payload content:					
character displacement	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	R8	-	rcvTow	s	Receiver GPS time of week (Remark [1])
8	I2	-	wn	week	Receiver GPS Weeks
10	I1	-	leapS	s	UTC Leap second value (Remark [2])
11	U1	-	numMeas	-	Number of measured values, valid range 0~32
12	U1	-	recStat	-	Receiver status (Remark [3])
13	U1	-	res1		reservations
14	U1	-	res2	-	reservations
15	U1	-	res3	-	reservations
Beginning of repeating section (N=numMeas, valid range 0~32)					
16+32*N	R8	-	prMes	m	Pseudorange measurements in meters, for GLONASS inter-frequency deviation, receiver Compensated for by a built-in correction table.
24+32*N	R8	-	cpMes	cycles	Carrier phase measurements (in weeks) (Remark [4])
32+32*N	R4	-	doMes	Hz	Doppler measurements (in Hz) close to the of the satellite Doppler is positive.
36+32*N	U1	-	gnssid	-	System type. 0=GPS,1=BDS. 2=GLONASS

37+32*N	U1	-	svid	-	Satellite number
38+32*N	U1	-	res4	-	reservations
39+32*N	U1	-	freqid	-	Frequency number (offset 8), valid for GLONASS only. Valid value range [1,14], corresponding to frequencies [-7,+6].
40+32*N	U2	-	locktime	ms	Carrier phase lock time, max. 65535ms
42+32*N	U1	-	cn0	dB-Hz	Carrier-to-noise ratio
43+32*N	U1	-	res5	-	reservations
44+32*N	U1	-	res6	-	reservations
45+32*N	U1	-	res7	-	reservations

46+32*N	U1	-	trkStat	-	Satellite tracking status (Remark [5])
47+32*N	U1	-	res8	-	reservations
End of repetition					
Remark [1]: Receiver GPS time of week					
rcvTow	The receiver time is aligned as closely as possible to the GPS time system. Time can be converted to other time systems using the receiver intra-week time rcvTow, the receiver week number week, and the leap second value leapS. Refer to the RINEX3 documentation for more information on the different time systems. When the receiver is operating in single GLONASS mode, the UTC time can be obtained by subtracting the leapS value from the receiver time without taking into account recStat The validity of the flag bits in the				
Remark [2]: UTC leap second value					
leapS	The value of the leap second between GPS time and UTC time, which is the latest value known to the receiver. recStat The flag bit in the indicates whether the value is valid or not.				
Remark [3]: Receiver status					
recStat	clarification				
BIT0	= 1, indicates that the leap second value leapS is valid (UTC correction parameter is valid)				
BIT1	= 1, indicates that a clock rest has occurred and the receiver time has jumped by an integer millisecond.				
Remark [4]: Measured value of carrier phase					
cpMes	An approximation is used to initialize the initial perimeter ambiguity of the carrier phase so that the carrier phase measurement is close to the pseudorange measurement. The clock reset mechanism acts on both the pseudorange measurement and the carrier phase measurement. Wave phase measurements in accordance with RINEX3.				
Remark [5]: Satellite tracking status					
trkStat	clarification				
BIT0	= 1 for pseudo-distance measurements prMes valid				
BIT1	= 1 for carrier phase measurements cpMes valid				
BIT2	= 1, indicating that half-perimeter ambiguity is valid (inverse PI correction is valid)				
BIT3	= 1, indicating that the half-period ambiguity is subtracted from the carrier phase measurement				

2.9.2 RXM-SVPOS (0x03 0x11)

text	RXM- SVPOS				
descriptive	GPS (satellite location information)				
typology	Periodicity/Inquiry				
marginal notes					
message structure	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	16+48*N	0x03 0x11	table below	4 Bytes

Payload content:					
character misalignment	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	R8	-	rcvTow	s	Receiver GPS time-of-week (Remark [1])
8	I2	-	wn	week	Receiver GPS weeks (Remark [1])
10	U1	-	numMeas	-	Number of measured values, valid range 0~32
11	U1	-	res1	-	reservations
12	I4	-	res2	-	reservations
Beginning of repeating section (N=numMeas, valid range 0~32)					
16+48*N	R8	-	x	m	satellite coordinates
24+48*N	R8	-	y	m	satellite coordinates
32+48*N	R8	-	z	m	satellite coordinates
40+48*N	R4	-	svdt	m	satellite clock difference
44+48*N	R4	-	svdf	m/s	Satellite frequency deviation
48+48*N	R4	-	tropDelay	m	tropospheric delay
52+48*N	R4	-	ionoDelay	m	Ionospheric delay
56+48*N	U1	-	svid	-	Satellite number
57+48*N	U1	-	glnFreqid	-	Frequency number (offset 8), for GLONASS validity
58+48*N	U1	-	gnssid	-	System type, 0=GPS, 1=BDS. 2=GLONASS
59+48*N	U1	-	res3	-	reservations
60+48*N	U4	-	res4	-	reservations
End of repetition					
Remark [1]: Receiver GPS time of week					
rcvTow/wn	Refer to RXM-MEASX for rcvTow/wn meaning.				

2.9.3 RXM-SENSOR (0x03 0x07)

text	RXM- SENSOR				
descriptive	Sensor Information				
typology	Periodicity/Inquiry				
marginal notes					
message structure	remnant	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	16+16*N	0x03 0x11	table below	4 Bytes

Payload content:					
character misalignment	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	R8	-	rcvTow	s	Receiver GPS time-of-week (Remark [1])
8	I2	-	wn	week	Receiver GPS weeks (Remark [1])
10	I1	-	leapS	s	Leap second time in current GPS system time
11	U1	-	numMeas	-	Number of measured values (Remark [2])
12	U1	-	recStat	-	receiver state
13	U1	-	timeSrc	-	0-GPS time; 1-BDS time
14	U1	-	rcvrId	-	0
15	U1	-	res	-	reservations
Beginning of repeating section (N=numMeas, valid range: 1/2/5/10/25/50 several discrete values)					
16+16*N	I2	1g/16384	accX	m/s/s	Accelerometer X-axis measurement (note [3])
18+16*N	I2	1g/16384	accY	m/s/s	Accelerometer Y-axis measurement
20+16*N	I2	1g/16384	accZ	m/s/s	Accelerometer Z-axis measurement
22+16*N	I2	250/32768	gyroX	deg/s	Gyro X-axis measurements (note [4])
24+16*N	I2	250/32768	gyroY	deg/s	Gyro Y-axis measurement
26+16*N	I2	250/32768	gyroZ	deg/s	Gyro Z-axis measurement
28+16*N	I2	1/326.8	temp	oC	Thermometer measurements
30+16*N	I2	-	res	-	reservations
End of repetition					
Remark [1]: Receiver GPS time of week					
rcvTow/wn	Refer to RXM-MEASX for rcvTow/wn meaning.				

Remark [2]: Measured value data	
numMeas	Configured by the CFG-MSG statement, numMeas is related to rate in the CFG-MSG. rate=0 in the CFG-MSG statement, no output from the RXM_SENSOR statement; rate equals one of several discrete values of 1/2/5/10/25/50, and there are numMeas = rate groups of MEMS sampled data in each statement; No. Then, numMeas = 50. the RXM_SENSOR statement, if output, is output once per second.
Remark [3]: Accelerometer	
acc	Accelerometer range is -2g~+2g.
Remark [4]: Gyroscope	
gyro	Gyroscope range is -250deg/s~+250deg/s.

2.10 ACK (0x05)

ACK and NACK are used to reply to received CFG messages.

2.10.1 ACK-NACK (0x05 0x00)

text	ACK-NACK				
descriptive	Responding to messages not received correctly				
typology	responsive				
marginal notes					
message structure	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	4	0x05 0x00	table below	4 Bytes

Payload content					
character misalignment	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U1	-	clsID	-	Types of information not received correctly
1	U1	-	msgID	-	Number of messages not received correctly
2	U2	-	res	-	reservations

2.10.2 ACK-ACK (0x05 0x01)

text	ACK-ACK				
descriptive	Responding to correctly received information				
typology	responsive				
marginal notes					
message structur	remnant	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	4	0x05 0x01	table below	4 Bytes

e					
Payload content					
character displacement	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U1	-	clsID	-	Types of information received correctly
1	U1	-	msgID	-	Number of correctly received messages
2	U2	-	res	-	reservations

2.11 CFG (0x06)

Configuration information, such as setting dynamic mode, baud rate and so on. When the effective length is 0, it means querying the configuration information, and the system will output the data with the same identifier.

2.11.1 CFG-PRT (0x06 0x00)

messages	CFG-PRT				
descriptive	Queries the operating mode of the UART, including UART0 and UART1 statements, and the final output of the current UART statement.				
typology	consult (a document etc)				
marginal notes					
messages framework	remnant	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	0	0x06 0x00	0	4 Bytes

messages	CFG-PRT				
descriptive	Setting the operating mode of the UART				
typology	Setting up/responding to queries				
marginal notes					
messages framework	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	8	0x06 0x00	table below	4 Bytes

Payload content					
character displacement	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U1	-	portID	-	Port identifier number (0 and 1 for UART0 and UART1.) (0xFF indicates the currently connected UART)
1	U1	-	protoMask	-	Protocol Control Mask, each port can support several protocols at the same time. Protocol. The corresponding bit equals 1 to enable the protocol (Remark [1])

2	U2	-	mode	-	Bitmask for UART operating mode (Remark [2])
4	U4	-	baudRate	bps	baud

Remark [1]: Protocol Control Mask	
bit (binary digit) (loanword)	descriptive
B0	1 = binary protocol input
B1	1 = text protocol input
B4	1 = binary protocol output
B5	1 = text protocol output

Remark [2]: UART operating mode bitmask		
bit (binary digit) (loanword)	retrieve a value	descriptive
[7:6]	00	5bits
	01	6bits
	10	7bits
	11	8bits
[11:9]	10x	uncalibrated
	001	odd-calibration

	000	even-calibrated
	x1x	reservations
[13:12]	00	A stop bit.
	01	1.5 stop bits
	10	Two stop bits
	11	reservations

2.11.2 CFG-MSG (0x06 0x01)

text	CFG-MSG				
descriptive	Query all message sending frequencies				
typology	consult (a document etc)				
marginal notes					
messages framework	remnant	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	0	0x06 0x01	0	4 Bytes

text	CFG-MSG				
descriptive	Setting the frequency of message sending				
typology	set up				
marginal notes					
messages framework	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	4	0x06 0x01	table below	4 Bytes

Payload content

character displacement	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U1	-	clsID	-	Type of information
1	U1	-	msgID	-	Message number
2	U2	-	rate	-	Frequency of messages (Remark [1])

Remark [1]: Frequency of message delivery

numerical value	descriptive
0	non-output
1	Output once per positioning
2	Two positioning, one output
N	N positioning, output once; In particular, when clsID=0x03,msgID=0x07, rate indicates the configured RXM_SENSOR information The number of samples per second in the sensor output.
0xFFFF	Immediate output once and only once, equivalent to query output

2.11.3 CFG-RST (0x06 0x02)

message name	CFG-RST				
descriptive	Reboot the receiver/clear the saved data structure				
typology	set up				
marginal notes					
messages framework	remnant	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	4	0x06 0x02	table below	4 Bytes

Payload content					
character misalignment	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U2	-	navBbrMask	-	Clear the battery-powered RAM. if a bit of the mask is set to 1, then the data indicated on this bit is cleared (Remark [1])
2	U1	-	resetMode	-	Reset mode (Remark [2])
3	U1	-	startMode	-	Activation method (Remark [3])

Remark [1]: Clear the fields.	
classifier for honorific people	descriptive
B0	astronomic calendar
B1	almanac
B2	Health Information
B3	ionospheric parameters
B4	Receiver positioning information
B5	Clock drift (clock frequency skew)
B6	Crystal Parameters
B7	UTC correction parameter
B8	RTC
B9	configuration information

Remark [2]: Reset method	
numerical value	descriptive
0	Immediate hardware reset (via WATCHDOG)
1	Controlled Software Reset
2	Controlled software reset (GPS only)
4	Hardware reset after power off (via WATCHDOG)

Remark [3]: Start-up method	
numerical	descriptive

value	
0	hot start
1	warm start
2	cold start
3	factory start

2.11.4 CFG-TP (0x06 0x03)

text	CFG-TP				
descriptive	Query time pulse parameters				
typology	consult (a document etc)				
marginal notes					
message structure	remnant	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	0	0x06 0x03	0	4 Bytes

text	CFG-TP				
descriptive	Read/set time pulse parameters				
typology	Read/Set				
marginal notes					
message structure	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	16	0x06 0x03	table below	4 Bytes

Payload content					
character displacement	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U4	-	interval	us	Time interval between pulses (pulse period)
4	U4	-	width	us	pulse width
8	U1	-	enable	-	Enable flag (Remark [1])
9	U1	-	polar	-	Pulse polarity configuration (Remark [2])
10	U1	-	timeRef	-	Reference time (Remark [3])
11	U1	-	timeSource	-	Time source (Remark [4])
12	R4	-	userDelay	s	user time delay

Remark [1]: Pulse enable flag	
retrieve a value	descriptive
0	Shutdown Pulse
1	Enable Pulse

2	Pulse enable and continuous output. Automatically maintains pulse update rate when normal positioning is not possible
3	Outputs pulses during normal positioning, does not output pulses when the receiver cannot be positioned properly
Remark [2]: Pulse polarity configuration	
0	rising edge
1	falling edge
Remark [3]: Reference time	
0	UTC time
1	satellite time
Remark [4]: Satellite time source	
numerical value	descriptive
0	Forced Single GPS Timing
1	Forced single BDS timing
2	Forced Single GLN Timing
3	reservations

4	Primary BDS, automatically switches to other timing systems when BDS is not available
5	Primary GPS, automatically switches to other timing systems when GPS is unavailable
6	Primary GLN, automatically switches to other timing systems when GLN is not available
7	reservations
other than	Automatic Selective Timing System

2.11.5 CFG-RATE (0x06 0x04)

message name	CFG-RATE				
descriptive	Query Locate Interval				
typology	consult (a document etc)				
marginal notes	The receiver supports different navigation rates (the default rate is one update per second) The navigation rate directly affects the power consumption of the The faster the rate, the greater the burden on the CPU and communication				
messages framework	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	0	0x06 0x04	0	4 Bytes

message name	CFG-RATE				
descriptive	Setting the positioning interval				
typology	set up				
marginal notes	The receiver supports different navigation rates (the default rate is one update per second) The navigation rate directly affects the power consumption of the The faster the rate, the greater the burden on the CPU and communication				
messages framework	remnant	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	4	0x06 0x04	table below	4 Bytes

Payload content					
character displacement	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U2	-	interval	ms	Time interval between localizations
2	U2	-	res	-	reservations

2.11.6 CFG-CFG (0x06 0x05)

text	CFG- CFG					
descriptive	Clearing, saving and loading configuration information					
typology	command					
marginal notes						
messages framework	beginning or end		Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE		4	0x06 0x05	table below	4 Bytes
Payload content						
character misalignment	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive	
0	U2	-	mask	-	Mask for configuration information (Remark [1])	
2	U1	-	mode	-	Mode of operation for configuration information (Remark [2])	
3	U1	-	res	-	reservations	

Remark [1]: Configuration information mask	
bit (binary digit) (loanword)	descriptive
B0	IO Port Configuration Information (CFG-PRT)
B1	Message Configuration (CFG-MSG)
B2	INF message configuration (CFG-INF)
B3	Navigation configuration (CFG-RATE,CFG-TMODE)
B4	Time pulse configuration (CFG-TP)
B5	Group Delay (CFG-GROUP)

Remark [2]: Mode of operation	
numerical value	descriptive
0	Clear permanent configuration
1	Save current configuration to permanent configuration
2	Permanent configuration loaded into current configuration

2.11.7 CFG-TMODE (0x06 0x06)

text	CFG-TMODE				
descriptive	Query Timing Mode				
typology	consult (a document etc)				
marginal notes					
message structure	remnant	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	0	0x06 0x06	0	4 Bytes

text	CFG-TMODE				
descriptive	Read/Set Timing Mode				
typology	Read/Set				
marginal notes					
message structure	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	40	0x06 0x06	table below	4 Bytes

Payload content

character misalignment	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U4	-	mode	-	Timing model (Remark [1])
4	R8	-	fixedPosX	m	X-coordinate in ECEF coordinate system
12	R8	-	fixedPosY	m	Y-coordinate in ECEF coordinate system
20	R8	-	fixedPosZ	m	Z-coordinate in ECEF coordinate system
28	R4	-	fixedPosVar	m^2	3D variance of position
32	U4	-	svinMinDur	s	Minimum measurement interval when timing mode is 1
36	R4		svinVarLimit	m^2	Positioning error limit when timing mode is 1

Remark [1]: Timing mode	
numerical value	descriptive
0	Autonomous positioning and simultaneous timing
1	After obtaining the user's position with sufficient accuracy for a certain period of time, autonomous localization only utilizes all available satellites to calculate the user's position using The user clock parameters are used for timing. In this mode when the user position is fixed, single star timing can be realized.
2	The user enters the current position and only all available satellites are used to calculate the user clock parameters for timing in this mode Single-star timing is possible under

2.11.8 CFG-NAVX (0x06 0x07)

message name	CFG-NAVX				
descriptive	Query Navigation Engine Professional Configuration				
typology	consult (a document etc)				
marginal notes	Query navigation-related parameters				
messages framework	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	0	0x06 0x07	0	4 Bytes

message name	CFG-NAVX				
descriptive	Navigation Engine Professional Configuration				
typology	set up				
marginal notes	Configure navigation-related parameters				
messages framework	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	44	0x06 0x07	table below	4 Bytes

Payload content

character misalignment	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U4	-	mask	-	Parameter mask, only the corresponding bit mask is set to 1, parameter Setup before application (Remark [1])
4	U1	-	dyModel	-	Dynamic model (Remark [2])
5	U1	-	fixMode	-	Positioning mode (Remark [3])
6	U1	-	minSVs	-	Minimum number of satellites for positioning
7	U1	-	maxSVs	-	Maximum number of satellites used for positioning
8	U1	-	minCNO	dB-Hz	Minimum satellite signal carrier-to-noise ratio for positioning
9	U1	-	res1	-	reservations
10	U1		iniFix3D		Initialized positioning must be 3D positioning flag (0/1)
11	I1	-	minElev	°	Minimum elevation angle of GNSS satellites used for positioning
12	U1	-	drLimit	s	Maximum DR time without satellite signal
13	U1	-	navSystem	-	Navigation system enable flag (Remark

					[4])
14	U2	-	wnRollOver	-	GPS Number of weekly flips
16	R4	-	fixedAlt	m	2D Fixed height for positioning
20	R4	-	fixedAltVar	m^2	Fixed height error during 2D positioning
24	R4	-	pDop	-	Position DOP Max.
28	R4	-	tDop	-	Time DOP Max.
32	R4	-	pAcc	m^2	Positional accuracy max.
36	R4	-	tAcc	m^2	Time Accuracy Maximum
40	R4	-	staticHoldTh	m/s	Holding the stationary threshold
Remarks [1]: Parameter masks					
classifier for honorific people	descriptive				
B0	Apply dynamic mode settings				
B1	Application Location Mode Settings				
B2	Apply maximum/minimum number of navigation satellites setting				
B3	Apply minimum signal-to-noise ratio setting				

B4	reservations
B5	Applying Initial Positioning 3D Settings
B6	Apply minimum elevation setting
B7	Applying DR limit settings
B8	Application Navigation System Enablement
B9	Applying GPS Weekly Flip Settings
B10	Application height assistance
B11	Application Location DOP Restrictions
B12	Application Time DOP Limit
B13	Apply static hold settings
Remark [2]: Dynamic models	
paradigm	descriptive
0	Portable mode
1	stationary mode
2	walking mode
3	vehicle mode
4	sailing mode
5	Flight mode acceleration <1g
6	Flight mode acceleration <2g
7	Flight mode acceleration <4g
Remark [3]: Positioning mode	
paradigm	descriptive
0	reservations
1	2D Positioning
2	3D positioning
3	Automatic switching between 2D/3D positioning
Remark [4]: Navigation system enabled	
bit (binary digit) (loanword)	descriptive
B0	1=GPS
B1	1=BDS
B2	1=GLONASS

2.11.9 CFG-GROUP (0x06 0x08)

message name	CFG-GROUP				
descriptive	Query the group delay of GLONASS				
typology	consult (a document etc)				
marginal notes					
messages framework	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	0	0x06 0x08	0	4 Bytes

message name	CFG-GROUP				
descriptive	Configuring Group Delay for GLONASS				
typology	set up				
marginal notes					
messages framework	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	56	0x06 0x08	table below	4 Bytes

Payload content

character misalignment	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	R4[14]	-	groupDealy	m	The group delay corresponding to each GLONASS frequency is characterized by the distance (the group delay time multiplied by the speed of light is obtained as to distance)

2.11.10 CFG-INS (0x06 0x10)

message name	CFG-INS				
descriptive	Query INS Installation Mode				
typology	consult (a document etc)				
marginal notes					
messages framework	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	0	0x06 0x10	0	4 Bytes

message name	CFG-INS				
descriptive	Configuring the INS Installation Mode				
typology	set up				
marginal notes					
messages framework	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	4	0x06 0x10	table below	4 Bytes

Payload content

character misalignment	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U2	-	attMode	-	Mode configuration of the module's relative mounting attitude with respect to the vehicle, range of possible values: 0, 1, 2, 3. 0: The module's X-axis is pointing towards the front of the vehicle. 1: The module X-axis points to the right of the vehicle. 2: The module X-axis points to the rear of the vehicle. 3: The module X-axis points to the left of the vehicle. 9: Adaptive estimation of module relative attitude. The default is 9.

2	U2		ramStart	-	1: Backup power supply power up immediately heading projection function on 0: Backup power supply power up immediately heading projection function off Close by default

2.12 MSG (0x08)

Receiver navigation message with message class 0x08.

2.12.1 MSG-BDSUTC (0x08 0x00)

text	MSG-BDSUTC					
descriptive	BDS fixed-point UTC data (parameters synchronized with UTC time)					
typology	cyclicality					
marginal notes						
message structure	beginning or end		Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE		20	0x08 0x00	table below	4 Bytes
Payload content						
character displacement	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive	
0	U4	-	res1	-	reservations	
4	I4	2-30	a0UTC	s	Clock Difference of BDT with respect to UTC	
8	I4	2-50	a1UTC	s/s	BDT clock speed relative to UTC	
12	I1	-	dtls	s	Before the new leap second takes effect, the cumulative leap second of the BDT with respect to UTC is changed to a new leap second of the BDT. positive number	
13	I1	-	dtlsf	s	With the new leap second in effect, the cumulative leap second of the BDT with respect to UTC is changed to positive number	
14	U1	-	res2	-	reservations	
15	U1	-	res3	-	reservations	
16	U1	-	wnlsf	week	Weekly count of new leap seconds in effect	
17	U1	-	dn	day	Count of days in the week in which the new leap second takes effect	
18	U1	-	valid	-	Information availability flag (Remark [1])	
19	U1	-	res4	-	reservations	
Remark [1]: Information availability flag						
numerical value	clarification					
0	null					

1	unhealthy
2	expire (as in expiration date)
3	validity

2.12.2 MSG-BDSION (0x08 0x01)

text	MSG-BDSION				
descriptive	BDS8 parametric fixed-point ionospheric data				
typology	cyclicality				
marginal notes					
message structure	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	16	0x08 0x01	table below	4 Bytes

Payload content					
character misalignment	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U4	-	res1	-	reservations
4	I1	2-30	alpha0	s	ionospheric parameters
5	I1	2-27	alpha1	$\frac{s}{\pi}$	ionospheric parameters
6	I1	2-24	alpha2	$\frac{s}{\pi^2}$	ionospheric parameters
7	I1	2-24	alpha3	$\frac{s}{\pi^3}$	ionospheric parameters
8	I1	211	beta0	s	ionospheric parameters
9	I1	214	beta1	$\frac{s}{\pi}$	ionospheric parameters
10	I1	216	beta2	$\frac{s}{\pi^2}$	ionospheric parameters
11	I1	216	beta3	$\frac{s}{\pi^3}$	ionospheric parameters
12	U1	-	valid	-	Information availability flag (Remark [1])
13	U1	-	res2	-	reservations
14	U2	-	res3	-	reservations

Remark [1]: Information availability flag	
numerical value	clarification
0	null
1	unhealthy
2	expire (as in expiration date)
3	validity

2.12.3 MSG-BDSEPH (0x08 0x02)

text	MSG-BDSEPH				
descriptive	BDS Ephemeris				
typology	cyclicality				
marginal notes					
message structure	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	92	0x08 0x02	table below	4 Bytes

Payload content					
character displacement	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U4	-	res1	-	reservations
4	U4	2-19	sqra	m1/2	Square root of the half-length axis of the satellite orbit
8	U4	2-33	es	-	Satellite orbital eccentricity
12	I4	2-31	ω	π	perigee angle
16	I4	2-31	M_0	π	Angle of Approximation of Reference Time
20	I4	2-31	i_0	π	Orbital inclination at reference time
24	I4	2-31	Ω_0	π	Ascending node ruddy longitude at reference time
28	I4	2-43	$\dot{\Omega}$	$\frac{\pi}{s}$	Rate of change of ruddy longitude of ascending nodes
32	I2	2-43	Δn	$\frac{\pi}{s}$	Difference between the average satellite motion rate and the calculated value
34	I2	2-43	IDOT	$\frac{\pi}{s}$	Rate of change of orbital inclination
36	I4	2-31	cuc	rad	Amplitude of the cosine modulation correction term for latitude amplitude angles
40	I4	2-31	cus	rad	Amplitude of the sinusoidal tuning and correction terms for latitude amplitude angles
44	I4	2-6	crc	m	Amplitude of the cosine tuning and correction terms of the orbital radius
48	I4	2-6	crs	m	Amplitude of the sinusoidal tuning and correction terms of the orbital radius
52	I4	2-31	cic	rad	Amplitude of cosine tuning and correction terms for orbital inclinations
56	I4	2-31	cis	rad	Amplitude of the sinusoidal tuning and

					correction terms for the inclination of the orbit
60	U4	2^{3}	toe	s	Ephemeris Reference Moments
64	U2	-	wne	-	Number of full weeks of reference time
66	U2	-	res2	-	reservations
68	U4	2^{3}	toc	s	Reference time for clock difference parameter for this time period
72	I4	2^{-33}	af0	s	Satellite ranging code phase time offset factor
76	I4	2^{-50}	af1	s/s	Satellite ranging code phase time offset factor
80	I2	2^{-66}	af2	s/s^2	Satellite ranging code phase time offset factor
82	I2	0.1	tgd	ns	On-planet equipment delay difference
84	U1	-	iodc	-	Clock data ageing
85	U1	-	iode	-	Ephemeris data age
86	U1	-	ura	-	User distance accuracy
87	U1	-	health	-	Satellite Autonomous Health Marker
88	U1	-	svid	-	Satellite number
89	U1	-	valid	-	Information availability flag (Remark [1])

90	U2	-	res3	-	reservations
Remark [1]: Information availability flag					
numerical value	clarification				
0	null				
1	unhealthy				
2	expire (as in expiration date)				
3	validity				

2.12.4 MSG-GPSUTC (0x08 0x05)

text	MSG-GPSUTC				
descriptive	GPS fixed-point UTC data (parameters synchronized with UTC time)				
typology	cyclicality				
marginal notes					
message structure	remnant	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	20	0x08 0x05	table below	4 Bytes

Payload content					
character misalignment	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U4	-	res1	-	reservations
4	I4	2-30	a0UTC	s	GPST Clock Difference Relative to UTC
8	I4	2-50	a1UTC	s/s	GPST clock speed relative to UTC
12	I1	-	dtls	s	Before the new leap second takes effect, the BDT is accumulated relative to UTC. intercalary second correction
13	I1	-	dtlsf	s	After the new leap second comes into effect, the BDT accumulates with respect to UTC, and the BDT accumulates with respect to UTC. intercalary second correction
14	U1	212	tot	s	Reference time for UTC data
15	U1	-	wnt	week	UTC Reference week
16	U1	-	wnlsf	week	Weekly count of new leap seconds in effect
17	U1	-	dn	day	Count of days in the week in which the new leap second takes effect
18	U1	-	valid	-	Information availability flag (Remark [1])
19	U1	-	res2	-	reservations

Remark [1]: Information availability flag	
numerical value	clarification
0	null
1	unhealthy
2	expire (as in expiration date)
3	efficiently

2.12.5 MSG-GPSION (0x08 0x06)

text	MSG-GPSION				
descriptive	GPS ionospheric data				
typology	cyclicality				
marginal notes					
message structure	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	16	0x08 0x06	table below	4 Bytes

Payload content

character displacement	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U4	-	res1	-	reservations
4	I1	2^{-30}	alpha0	s	ionospheric parameters
5	I1	2^{-27}	alpha1	$\frac{s}{\pi}$	ionospheric parameters
6	I1	2^{-24}	alpha2	$\frac{s}{\pi^2}$	ionospheric parameters
7	I1	2^{-24}	alpha3	$\frac{s}{\pi^3}$	ionospheric parameters
8	I1	2^{11}	beta0	s	ionospheric parameters
9	I1	2^{14}	beta1	$\frac{s}{\pi}$	ionospheric parameters
10	I1	2^{16}	beta2	$\frac{s}{\pi^2}$	ionospheric parameters
11	I1	2^{16}	beta3	$\frac{s}{\pi^3}$	ionospheric parameters
12	U1	-	valid	-	Information availability flag (Remark [1])
13	U1	-	res2	-	reservations
14	U2	-	res3	-	reservations

Remark [1]: Information availability flag

numerical value	clarification
0	null
1	unhealthy
2	expire (as in expiration date)
3	validity

2.12.6 MSG-GPSEPH (0x08 0x07)

text	RXM-GPSEPH				
descriptive	GPS ephemeris				
typology	cyclicality				
marginal notes					
message structure	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	72	0x08 0x07	table below	4 Bytes

Payload content					
character misalignment	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U4	-	res1	-	reservations
4	U4	2-19	sqra	m1/2	Square root of the half-length axis of the satellite orbit
8	U4	2-33	es	-	Satellite orbital eccentricity
12	I4	2-31	ω	π	perigee angle
16	I4	2-31	M_0	π	Angle of Approximation of Reference Time
20	I4	2-31	i_0	π	Orbital inclination at reference time
24	I4	2-31	Ω_0	π	Ascending node ruddy longitude at reference time
28	I4	2-43	$\dot{\Omega}$	$\frac{\pi}{s}$	Rate of change of ruddy longitude of ascending nodes
32	I2	2-43	Δn	$\frac{\pi}{s}$	Difference between the average satellite motion rate and the calculated value
34	I2	2-43	IDOT	$\frac{\pi}{s}$	Rate of change of orbital inclination
36	I2	2-29	cuc	rad	Amplitude of the cosine modulation correction term for latitude amplitude angles
38	I2	2-29	cus	rad	Amplitude of the sinusoidal tuning and correction terms for latitude amplitude angles
40	I2	2-5	crc	m	Amplitude of the cosine tuning and correction terms of the orbital radius
42	I2	2-5	crs	m	Amplitude of the sinusoidal tuning and correction terms of the orbital radius
44	I2	2-29	cic	rad	Amplitude of cosine tuning and correction terms for orbital inclinations

46	I2	2^{-29}	cis	rad	Amplitude of the sinusoidal tuning and correction terms for the inclination of the orbit
48	U2	2^{4}	toe	s	Ephemeris Reference Time
50	U2	-	wne	-	Number of full weeks of reference time
52	U4	2^{4}	toc	s	Reference time for clock difference parameter for this time period
56	I4	2^{-31}	af0	s	Satellite ranging code phase time offset factor
60	I2	2^{-43}	af1	s/s	Satellite ranging code phase time offset factor
62	I1	2^{-55}	af2	s/s^2	Satellite ranging code phase time offset factor
63	I1	2^{-31}	tgd	s	On-planet equipment delay difference
64	U2	-	iodc	-	Clock data ageing
66	U1	-	ura	-	User distance accuracy
67	U1	-	health	-	Satellite Autonomous Health Marker
68	U1	-	svid	-	Satellite number
69	U1	-	valid	-	Information availability flag (Remark [1])
70	U2	-	res2	-	reservations
Remark [1]: Information availability flag					

numerical value	clarification
0	null
1	unhealthy
2	expire (as in expiration date)
3	validity

2.12.7 MSG-GLNEPH (0x08 0x08)

text	RXM-GLNEPH					
descriptive	GLONASS Ephemeris					
typology	cyclicality					
marginal notes						
message structure	beginning or end	Length (bytes)		identifiers	payload	checksum
	0xBA 0xCE	68		0x08 0x08	table below	4 Bytes
Payload content						
character displacement	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive	
0	U4	-	res1	-	reservations	
4	I4	2-30	taon	s	Corrections for the nth satellite relative to GLONASS time	
8	I4	2-11	x	km	Satellite position coordinates in PZ-90 coordinate system	
12	I4	2-11	y	km	Satellite position coordinates in PZ-90 coordinate system	
16	I4	2-11	z	km	Satellite position coordinates in PZ-90 coordinate system	
20	I4	2-20	dx	km/s	Satellite velocity in the PZ-90 coordinate system	
24	I4	2-20	dy	km/s	Satellite velocity in the PZ-90 coordinate system	
28	I4	2-20	dz	km/s	Satellite velocity in the PZ-90 coordinate system	
32	I4	2-31	taoc	s	GLONASS time relative to UTC time scale corrections	
36	I4	2-30	taoGPS	day	Correction from GLONASS time to GPS time	
40	I2	2-40	gamman	-	Relative deviation of satellite-predicted carrier frequencies	
42	U2	-	tk	-	Intraday time of the current frame, total 12bit	

44	U2	-	nt	day	Current date from January of the previous leap year
46	I1	2-30	ddx	km/s2	Satellite acceleration in the PZ-90 coordinate system
47	I1	2-30	ddy	km/s2	Satellite acceleration in the PZ-90 coordinate system
48	I1	2-30	ddz	km/s2	Satellite acceleration in the PZ-90 coordinate system
49	I1	2-30	dtaon	s	Difference in propagation time between L2 and L1 signals for the nth satellite
50	U1	-	bn	-	health symbol
51	U1	900	tb	s	Intraday time a t the current moment (UTC+3)
52	U1	-	M	-	GLONASS satellite category
53	U1	-	P	-	Control part of the technical parameters
54	U1	-	ft	-	Predictive accuracy of satellite pseudorange
55	U1	-	en	day	Satellite ephemeris age
56	U1	-	p1	-	Ephemeris information update time flag bit
57	U1	-	p2	-	tb parity flag bit

58	U1	-	p3	-	Number of satellites included in the almanac for the current frame pass
59	U1	-	p4	-	Ephemeris data update flag: 1 for updated
60	U1	-	ln	-	Satellite health markers (GLONASS-M satellites)
61	U1	-	n4	-	Time count (four-year cycle starting in 1996)
62	U1	-	svid	-	Satellite number
63	U1	-	nl	-	frequency number
64	U1	-	valid	-	Information availability flag (Remark [1])
65	U1	-	res2	-	reservations
66	U2	-	res3	-	reservations

Remark [1]: Information availability flag

numerical value	clarification
0	null
1	unhealthy
2	expire (as in expiration date)
3	validity

2.13 MON (0x0A)

Monitoring information, such as configuration status, task status, etc.

2.13.1 mon-ver (0x0a 0x04)

text	MON-VER				
descriptive	version information				
typology	Responding to inquiries				
marginal notes					
message structure	remnant	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	64	0x0A 0x04	table below	4 Bytes

Payload content:

character misalignment	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	CH[32]	-	swVersion	-	Software version string
32	CH[32]	-	hwVersion	-	Hardware version string

2.13.2 MON-HW (0x0A 0x09)

text	MON-HW				
descriptive	hardware state				
typology	Periodicity/Inquiry				
marginal notes	Various configuration statuses of the hardware, including antenna status, IO port status, noise level, AGC information, etc.				
message structure	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	56	0x0A 0x09	table below	4 Bytes

Payload content:

character misalignment	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	U4	-	noisePerMs0	-	DIF0 Noise power of IF data
4	U4	-	noisePerMs1	-	DIF1 Noise power of IF data
8	U4	-	noisePerMs2	-	DIF2 Noise power of IF data
12	U2	-	agcData0	-	DIF0 Number of 1's in the amplitude bit of IF data
14	U2	-	agcData1	-	DIF1 Number of 1's in the amplitude bits of IF data
16	U2	-	agcData2	-	DIF2 Number of 1's in amplitude bits of IF data
18	U2	-	res	-	reservations
20	U1	-	antStatus	-	Antenna status (Remark [1])
21	U1	-	res	-	reservations
22	U1	-	res	-	reservations
23	U1	-	res	-	reservations
24	U4[8]	2^24	jamming	-	Center frequency of the interfering signal (normalized)

Remark [1]: Antenna status

numerical value	descriptive
0	initialization process
1	unknown state
2	normalcy
3	shorts
4	open up a path

2.14 AID (0x0B)

Auxiliary information such as initial receiver position, time, etc.

2.14.1 AID-INI (0x0B 0x01)

text	AID-INI				
descriptive	Auxiliary position, time, frequency, clock frequency offset information				
typology	Query/Input				
marginal notes	Configure navigation-related parameters				
messages framework	remnant	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	56	0x0B 0x01	table below	4 Bytes

Payload content					
character misalignment	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
0	R8	-	ecefXOrLat	m or 1°	X-coordinate or latitude in ECEF coordinate system: in m if ECEF coordinate system; In case of latitude, the units are degrees.
8	R8	-	ecefYOrLon	m or 1°	Y-coordinate or longitude in ECEF coordinate system: in m if ECEF coordinate system; If it is longitude, the unit is degrees.
16	R8	-	ecefZOrAlt	m	Y-coordinate or height in ECEF coordinate system
24	R8	-	tow	s	GPS time of week
32	R4	300	freqBias	ppm	Clock frequency drift. Example: FreqBias=300, indicates 1ppm oscillator frequency drift; FreqBias=-150, indicates the frequency bias of the crystal. -0.5ppm;
36	R4	-	pAcc	m^2	Variance of estimation error for 3D position
40	R4	C^2	tAcc	s^2	The variance of the estimation error of time. Example: tAcc=9, which means that the time error is sqrt(tAcc)/C=3/3e8=10ns
44	R4	300^2	fAcc	ppm^2	The variance of the clock frequency drift error. Example: fAcc=900, indicating that the

					time error is sqrt(fAcc)/300=30/300=0.1ppm
48	U4	-	res	-	reservations
52	U2	-	wn	-	Week number for GPS
54	U1	-	timeSource	-	time source
55	U1	-	flags	-	Flag mask (Remark [1])

Remark [1]: Flag Mask	
bit (binary digit) (loanword)	descriptive
B0	1 = Position valid
B1	1 = time valid
B2	1 = clock frequency drift data valid

B3	reservations
B4	1 = clock frequency data valid
B5	1=Position is in LLA format
B6	1 = highly ineffective
B7	reservations

2.14.2 AID-HUI (0x0B 0x03)

text	AID-HUI				
descriptive	Ancillary health information, UTC parameters, ionospheric parameters				
typology	importation				
marginal notes	Configure navigation-related parameters				
messages framework	beginning or end	Length (bytes)	identifiers	payload	checksum
	0xBA 0xCE	60	0x0B 0x03	table below	4 Bytes

Payload content					
character misalignment	digital typology	proportions resizing	name (of a person or thing)	unit (of measure)	descriptive
4	U4	-	HeaGps	-	GPS satellite health information (Remark [1])
8	U4	-	HeaBds	-	Health information on BDS satellites (Remark [1])
12	U4	-	HeaGln	-	Health information on GLONASS satellites (Remark [1])
16	I4	2-30	utcGpsA0	s	UTC parameter A0, clock difference in GPS time relative to UTC
20	I4	2-50	utcGpsA1	s/s	UTC parameter A1, clock speed in GPS time relative to UTC
24	I1	-	utcGpsLS	s	New pre-jump second GPS time jump relative to UTC
25	I1	-	utcGpsLSF	s	New jump seconds after GPS time relative to UTC
26	U1	-	utcGpsTow	s	The reference time of day for the UTC parameter of GPS
27	U1	-	utcGpsWNT	week	The reference week number of the UTC parameter for GPS
28	U1	-	utcGpsWNF	week	GPS New Day of Week with Jumping Seconds in Effect
29	U1	-	utcGpsDN	day	GPS Number of days in the week when the new jump seconds are in effect
30	I2	-	Res	-	reservations
32	I4	2-30	utcBdsA0	s	UTC Parameter A0, Clock Difference at BDS with respect to UTC
36	I4	2-50	utcBdsA1	s/s	UTC parameter A1, clock speed in BDS time relative to UTC
40	I1	-	utcBdsLS	s	Jump seconds in BDS time relative to UTC before the new jump seconds
41	I1	-	utcBdsLSF	s	BDS time jump in relation to UTC after new jump seconds
42	U1	-	utcBdsTow	s	Reference time of day for the UTC parameter of BDS
43	U1	-	utcBdsWNT	week	The reference week number for the UTC parameter of the BDS.

44	U1	-	utcBdsWNF	week	BDS New week number for jump seconds to take effect
45	U1	-	utcBdsDN	day	BDS Number of days in the week when the new jump seconds are in effect
46	I2	-	Res	-	reservations
48	I1	2^{-30}	klobA0	s/π	Klobuchar model parameters alpha0
49	I1	2^{-27}	klobA1	s/π^1	Klobuchar model parameters alpha1
50	I1	2^{-24}	klobA2	s/π^2	Klobuchar model parameters alpha2
51	I1	2^{-24}	klobA3	s/π^3	Klobuchar model parameters alpha3
52	I1	2^{11}	klobB0	s/π	Klobuchar model parameters beta0
53	I1	2^{14}	klobB1	s/π^1	Klobuchar model parameters beta1
54	I1	2^{16}	klobB2	s/π^2	Klobuchar model parameters beta2
55	I1	2^{16}	klobB3	s/π^3	Klobuchar model parameters beta3
56	U4	-	flags	-	Valid flag mask (Remark [2])
Remark [1]: B0 means satellite No. 1, and so on, the corresponding bit is equal to 0, which means the satellite is healthy.					
Remark [2]: Valid symbols					
bit (binary digit) (loanword)	descriptive				

B0	Health information is valid
B1	UTC parameter is valid
B2	Ionospheric parameters are valid