CASIC multimode satellite navigation Receiver protocol Specification

V4.2.0.3

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Documentation	
Name _	CASIC multimode satellite navigation receiver protocol Specification
Summary	CASIC multimode satellite navigation receiver protocol Specification detailed description, Includes the common standard NMEA0183 protocol, as well as custom binary protocols.
Version number	V4.2.0.3
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1 NMEA Protocol

1.1 NMEA Protocol Features

The CASIC receiver is compatible with the international standard NMEA0183 protocol, supports NMEA0183 version 4.1 by default, is compatible with V2.3 and V3.X versions, and supports NMEA0183 V4.0 standard and standards before V2.3 by sending commands.

Data is transferred serially asynchronously. Bit 1 is the start bit, followed by the data bits. Data bits follow the least significant bit first rule.

Data transfer method

	start bit	D0	D1	D2	D3	D4	D5	D6	D7	s top bit	

Parameters used for data transfer

baud rate (bps)	Supported _ 4800, 9600, 19200, 38400, 57600, 115200
data bit	8 bits
s top bit	8 bits
check bit	empty

1.2 NMEA Protocol Framework

NMEA messages are sent by GNSS receivers that support the NMEA0183 protocol.

Data format Protocol Framework

NMEA Protocol Framework				
	Calculation range of checksum			
$	<address>	{,<data>}	*<Checksum>	<CR><LF>

start character	address segment	data segment	checksum segment	End Sequence
Every statement starts with '$'	Divided into two parts: sender identifier and statement type	It starts with ' ', and the length of the following value is variable and also has a fixed length	The result of XOR operation on the data between '$' and '*' (excluding these two characters), expressed as a hexadecimal value.	Each statement ends with <CR><LF>

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

Based on the NMEA protocol framework, this receiver protocol specification adds custom sentences to control the working mode of the receiver and query the product information of the receiver. The identifier for a custom statement is 'P'.

1.3 NMEA i dentifiers and field types

1.3.1 Transmitter Identifier

The NMEA sentences distinguish different GNSS modes by the transmitter identifier, which is defined as follows:

Transmitter	identifier
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
custom information	P

1.3.2 Satellite number identifier

satellite system	Satellite number identifier in NMEA	Satellite PRN number	Correspondence between satellite numbers and their PRNs
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

The CASIC receiver supports a variety of NMEA data protocol formats. The difference between different protocols is reflected in the system identifier. At the same time, the new version of the protocol adds some fields.

	NMEA4.0 and below	NMEA4.1
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] Logo	[1] Identification, adding additional fields to distinguish different systems
GSV	[2] Logo	[2] Logo

[1] Identification:[1] Identification: If only satellites such as BD, GPS, GLONASS, Galileo are used for position calculation,

The transmission identifiers are BD, GP, GL, GA, etc. If the satellite acquisition position calculation using multiple systems is used, the transmission identifier is GN.

[2] Identification: GP (GPS satellite), BD (BDS satellite), GL (GLONASS satellite)

As mentioned in Section 1.1, the CASIC receiver supports three versions of the NMEA0183 protocol standard. The differences between these three standards are listed below.

The main differences between NMEA2.2 and 2.3/4.0 are:

1) The item "Mode" in GLL, RMC and VTG statements is not output.
2) Use 1 for both dead reckoning and normal positioning in the Position Quality (FS) term in the GGA statement (for dead reckoning set to 6 in 2.3).

The NMEA 4.1 protocol adds some fields based on 4.0:

1) Add a systemId item to the GSA statement.
2) Add a signalId item to the GSV statement.
3) Add a navStatus item to the RMC statement.

For details, please refer to the introduction of NMEA sentences in Section 1.5.

1.3.4 Field Type

Field Type	symbol	definition
private format fields		
state	A	Single character fields: A=Yes, the data is valid, the alarm flag is cleared; V=No, the data is invalid, the alarm flag is set.
latitude	ddmm.mmmm	The fixed/variable length field dd represents degrees of fixed length 2, mm before the decimal point represents minutes of fixed length 2, and mmmm after the decimal point represents fractional minutes of variable length.
longitude	dddmm.mmmm	The fixed/variable length field ddd represents degrees with a fixed length of 3, mm before the decimal point represents minutes with a fixed length of 2, and mmmm after the decimal point represents a variable length fraction of minutes.
time	hhmmss.sss	The fixed-length field hh represents fixed-length 2 hours, mm represents fixed-length 2 minutes, ss before the decimal point represents fixed-length 2 seconds, and sss after the decimal represents fixed-length 3 fractional seconds.
determine field		Some fields are specified for predefined constants.
Numeric field		
variable number	xx	Variable-length or floating-point number fields
Fixed hex field	hh___	Fixed-length hexadecimal number with the most significant bit on the left
variable hex field	h--h	Variable-length hexadecimal number with MSB on the left

Information field		
Fixed letter field	aa___	Fixed-length uppercase or lowercase alpha character field
fixed number field	xx____	Fixed-length numeric character fields
variable text	c--c	variable-length valid character field

1.4 NMEA message overview

Page	message name	Class/ID	describe
NMEA standard messages			Standard message
	GGA	0x4E 0x00	receiver positioning data
	GLL	0x4E 0x01	Geographic location - latitude/longitude
	GSA	0X4E 0x02	Factor of Precision (DOP) vs. 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	Statistics of receiver pseudorange errors
	ZDA	0x4E 0x08	time and date
	ANT	0x4E 0x11	Antenna Status
	LPS	0x4E 0x12	Satellite system leap second correction information
	DHV	0x4E 0x13	receiver speed information
	UTC	0x4E 0x16	Receiver Status, Leap Second Correction Simplified Information
NMEA custom message			custom message
	CAS00	-	Save configuration information
	CAS01	-	Communication protocol and serial port configuration information
	CAS02	-	Set the location update rate

	CAS03	-	Enable or disable output information and its frequency
	CAS04	-	Set the initialization system and the number of channels
	CAS05	-	Set the sender identifier of the NMEA sentence
	CAS06	-	Query module software and hardware information
	CAS10	-	Boot mode and auxiliary information configuration
	CAS12	-	Standby Mode Control
	CAS20	-	Online Upgrade Instructions

1.5 NMEA standard messages

1.5.1 GGA

information	GGA		
describe	Receiver time, position and positioning related data		
type	output		
Format	$-GGA,UTCtime,lat,uLat,lon,uLon,FS,numSv,HDOP,msl,uMsl,sep,uSep,diffAge,diffSta*CS<CR><LF>		
Example	$GPGGA,235316.000,2959.9925,S,12000.0090,E,1,06,1.21,62.77,M,0.00,M,,*7B		
Parameter Description			
field	name	Format	Parameter Description
1	$--GGA	string	Message ID, GGA statement header, ' -- ' is the system identifier
2	UTCtime	hhmmss.sss	UTC time of the current positioning
3	lat	ddmm.mmmm	Latitude, the first 2 characters represent degrees, the following characters represent minutes

4	uLat	character	Latitude: N-North, S-South
5	lon	dddmm.mmmm	Longitude, the first 3 characters represent degrees, the following characters represent minutes
6	uLon	character	Longitude direction: E-east, W-west
7	FS	Numerical value	Indicates the current positioning quality (note [1]), this field should not be empty
8	numSv	Numerical value	The number of satellites used for positioning, 00~24
9	HDOP	Numerical value	Horizontal factor of precision (HDOP)
10	msl	Numerical value	Altitude, which is the height of the receiver antenna relative to the geoid
11	uMsl	character	Height unit, meters, fixed character M
12	sep	Numerical value	The distance between the reference ellipsoid and the geoid, "-" means the geoid is lower than the reference ellipsoid
13	uSep	character	Height unit, meters, fixed character M
14	diffAge	Numerical value	Differentially corrected data age, this field is empty when DGPS is not used
15	diffSta	Numerical value	ID of the differential reference station
16	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
17	<CR><LF>	character	carriage return and line feed

Remarks[1] Positioning Quality Mark	
Positioning quality marks	describe
0	Targeting unavailable or invalid
1	SPS positioning mode, positioning is valid
6	Estimation mode (dead reckoning) is only valid for NMEA2.3 and above

1.5.2 GLL

information	GLL		
describe	Information such as latitude, longitude, positioning time and positioning status.		
type	output		
Format	$--GLL,lat,uLat,lon,uLon,UTCtime,valid,mode*CS<CR><LF>		
Example	$GPGLL,2959.9925,S,12000.0090,E,235316.000,A,A*4E		
Parameter Description			
field	name	Format	Parameter Description
1	$--GLL	string	Message ID, GLL statement header, ' -- ' is the system identifier
2	lat	ddmm.mmmm	Latitude, the first 2 characters represent degrees, the following characters represent minutes
3	uLat	character	Latitude: N-North, S-South
4	lon	dddmm.mmmm	Longitude, the first 3 characters represent degrees, the following characters represent minutes
5	uLon	character	Longitude direction: E-east, W-west
6	UTCtime	hhmmss.sss	UTC time of the current positioning
7	valid	character	Data validity (Note [1])
8	mode	character	Positioning mode (Note [2]), only valid for NMEA2.3 and above
9	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
10	<CR><LF>	character	carriage return and line feed
Remarks [1] Data validity flag			
Positioning quality marks		describe	
A		Data is valid	
V		Invalid data	
Remark[2] Positioning mode flag			
Location mode flag		describe	
A		autonomous mode	

E	Estimation Mode (Dead Reckoning)
N	Invalid data
D	Differential mode
M	Not located, but there is an external input or a location where history is saved

1.5.3 GSA

information	GSA		
describe	Satellite number and DOP information for positioning. Regardless of whether there is positioning or whether there are available satellites, the GSA statement is output; when the receiver is in multi-system joint work, each system's available satellites correspond to a GSA statement, and each GSA statement contains PDOP, HDOP obtained from the combined satellite system and VDOP.		
type	output		
Format	$--GSA,smode,FS{,SVID},PDOP,HDOP,VDOP*CS<CR><LF>		
Example	$GPGSA,A,3,05,21,31,12,18,29,,,,,,2.56,1.21,2.25*01		
Parameter Description			
field	name	Format	Parameter Description
1	$--GSA	string	Message ID, GSA statement header, ' -- ' is the system identifier
2	smode	character	Mode switching mode indication (Note [1])
3	FS	number	Positioning status flag (Note [2])
4	{,SVID}	Numerical value	The number of satellites used for positioning, this field displays a total of 12 available satellite numbers, if there are more than 12 satellites, only the first 12 will be output.
5	PDOP	Numerical value	Position Factor of Precision (PDOP)
6	HDOP	Numerical value	Horizontal factor of precision (HDOP)
7	VDOP	Numerical value	Vertical Factor of Precision (VDOP)

8	systemId	Numerical value	The GNSS system ID number defined by NMEA (Note [3]) is only valid for NMEA4.1 and above
9	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
10	<CR><LF>	character	carriage return and line feed

Remark[1] Mode switch mode indication	
Mode switch mode indication	describe
M	Switch manually. Force 2D or 3D working mode
A	switch automatically. Receiver automatically switches 2D/3D working mode

Remark[2] Positioning status flag	
Positioning status	describe
1	Invalid targeting
2	2D positioning
3	3D positioning

Remark [3] GNSS system ID	
System ID	describe
1	GPS system
2	GLONASS system
4	BDS system

1.5.4 GSV

information	GSV
describe	The satellite number of the visible satellite and its elevation, azimuth, carrier-to-noise ratio and other information. The number of {satellite number, elevation, azimuth, carrier-to-noise ratio} parameter groups in each GSV sentence is variable, with a maximum of 4 groups and a minimum of 0 groups.
type	output
Format	$--GSV,numMsg,msgNo,numSv{,SVID,ele,az,cn0} *CS<CR><LF>
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

field	name	Format	Parameter Description
1	$--GSV	string	Message ID, GSV statement header, ' -- ' is the system identifier
2	numMsg	character	Total number of statements. Each GSV statement outputs up to 4 visible satellites, so when more than 4 satellites are visible to the system, multiple GSV statements will be required.
3	msgNo	number	current statement number
4	numSv	Numerical value	Total number of visible satellites
5	{,SVID,ele,az,cn0}	Numerical value	as followed: Satellite number; Elevation, the value range is 0~90, the unit is degree; Azimuth, the value range is 0~359, the unit is degree; Carrier-to-noise ratio, the value range is 0~99, the unit is dB-Hz, if the current satellite is not tracked, fill in the blank
6	signalId	Numerical value	The GNSS signal ID defined by NMEA (0 represents all signals) is only valid for NMEA4.1 and above

7	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
8	<CR><LF>	character	carriage return and line feed

1.5.5 RMC

information	RMC		
describe	Recommended minimum positioning information		
type	output		
Format	$--RMC,UTCtime,status,lat,uLat,lon,uLon,spd,cog,date,mv,mvE,mode*CS<CR><LF>		
Example	$GPRMC,235316.000,A,2959.9925,S,12000.0090,E,0.009,75.020,020711,,,A*45		
Parameter Description			
field	name	Format	Parameter Description
1	$--RMC	string	Message ID, RMC statement header, ' -- ' is the system identifier
2	UTCtime	hhmmss.sss	UTC time of the current positioning
3	status	string	Location valid flag. V= Receiver warning, invalid data A = data valid
4	lat	ddmm.mmmm	Latitude, the first 2 characters represent degrees, the following characters represent minutes
5	uLat	character	Latitude: N-North, S-South
6	lon	dddmm.mmmm	Longitude, the first 3 characters represent degrees, the following characters represent minutes
7	uLon	character	Longitude direction: E-east, W-west
8	spd	Numerical value	Ground speed in knots
9	cog	Numerical value	True heading over ground, in degrees
10	date	ddmmyy	Date (dd is day, mm is month, yy is year)
11	mv	Numerical value	Magnetic declination, in degrees. fixed empty

12	mvE	character	Magnetic Declination Direction: E-East, W-West. fixed empty
13	mode	character	Positioning mode flag (Note [1]) is only valid for *NMEA 2.3* and above
14	navStatus	character	Navigation status identifier (V means that the system does not output navigation status information) is only valid for NMEA4.1 and above
15	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
16	<CR><LF>	character	carriage return and line feed
Remark[1] Positioning mode flag			
Location mode flag		describe	
A		autonomous mode	
E		Estimation Mode (Dead Reckoning)	
N		Invalid data	
D		Differential mode	
M		Not located, but there is an external input or a location where history is saved	

1.5.6 VTG

information	VTG
describe	Ground speed and course information.
type	output
Format	$--VTG,cogt,T,cogm,M,sog,N,kph,K,mode*CS<CR><LF>
Example	$GPVTG,75.20,T,,M,0.009,N,0.017,K,A*02

Parameter Description

field	name	Format	Parameter Description
1	$--VTG	string	Message ID, VTG statement header, ' -- ' is the system identifier
2	cogt	Numerical value	True North heading over the ground, in degrees
3	T	character	True North indication, fixed at T
4	cogm	Numerical value	Heading to magnetic north, in degrees
5	M	character	Magnetic north indication, fixed as M
6	sog	Numerical value	Ground speed in knots
7	N	character	Speed unit knot, fixed as N
8	kph	Numerical value	Ground speed in kilometers per hour
9	K	character	Speed unit, kilometers per hour, fixed at K
10	mode	character	Positioning mode flag(Note1) Only valid for NMEA 2.3 and above
11	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
12	<CR><LF>	character	carriage return and line feed

Remark[1] Positioning mode flag

Location mode flag	
A	autonomous mode
E	Estimation Mode (Dead Reckoning)
N	Invalid data
D	Differential mode
M	Not located, but there is an external input or a location where history is saved

1.5.7 ZDA

information	ZDA
describe	Time and date information.
type	output
Format	$--ZDA,UTCtime,day,month,year,ltzh,ltzn*CS<CR><LF>
Example	$GPZDA,235316.000,02,07,2011,00,00*51

Parameter Description

field	name	Format	Parameter Description
1	$--ZDA	string	Message ID, ZDA statement header, ' -- ' is the system identifier
2	UTCtime	hhmmss.sss	UTC time when positioning
3	day	Numerical value	Day, fixed two digits, the value range is 01~31
4	month	Numerical value	Month, fixed two digits, the value range is 01~12
5	year	Numerical value	year, fixed four digits
6	ltzh	Numerical value	Hour in this time zone, not supported, fixed at 00
7	ltzn	Numerical value	Minutes in this time zone, not supported, fixed at 00
8	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
9	<CR><LF>	character	carriage return and line feed

1.5.8 TXT

product information

information	TXT
describe	product information
type	output, output once at boot
Format	$GPTXT,xx,yy,zz,info*hh<CR><LF>
Example	$GPTXT,01,01,02,MA=CASIC*27 Indicates the name of the manufacturer (CASIC) $GPTXT,01,01,02,IC=ATGB03+ATGR201*71 Indicates the model 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 the 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 code compile time (Jun 20, 2013, 13:02:49) $GPTXT,01,01,02,MO=GB*77 Indicates the working mode of the receiver this time (GB indicates the dual-mode mode of GPS+BDS) $GPTXT,01,01,02,CI=00000000*7A Indicates customer number (customer number is 00000000)

Parameter Description

field	name	Format	Parameter Description
1	$GPTXT	string	Message ID, TXT statement header
2	xx	Numerical value	The total number of sentences in the current message is 01~99. If a message is too long, it needs to be displayed in multiple pieces of information.
3	yy	Numerical value	Statement number 01~99

4	zz	Numerical value	text identifier. 00=error message; 01=warning message; 02 = notification information; 07=User information.
5	info		text message
6	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
7	<CR><LF>	character	carriage return and line feed

1.5.9 ANT

information	ANT		
describe	Antenna Status		
type	output		
Format	$GPTXT,xx,yy,zz,info*hh<CR><LF>		
Example	$GPTXT,01,01,01,ANTENNA OPEN*25 Indicates antenna status (open circuit) $GPTXT,01,01,01,ANTENNA OK*35 Indicates antenna status (good) $GPTXT,01,01,01,ANTENNA SHORT*63 Indicates antenna status (short circuit)		
Parameter Description			
field	name	Format	Parameter Description
1	$GPTXT	string	Message ID, TXT statement header
2	xx	Numerical value	The total number of sentences in the current message is 01~99. If a message is too long, it needs to be displayed in multiple pieces of information, which is fixed at 01.
3	yy	Numerical value	Statement number 01~99, fixed at 01.
4	zz	Numerical value	text identifier. Fixed to 01.

5	info		text message ANTENNA OPEN=Antenna open ANTENNA OK=Antenna is good ANTENNA SHORT=Antenna short circuit
6	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
7	<CR><LF>	character	carriage return and line feed

1.5.10 DHV

information	DHV		
describe	Details of receiver speed		
type	output		
Format	$--DHV,UTCtime,speed3D,spdX,spdY,spdZ,gdspd*CS<CR><LF>		
Example	$GNDHV,021150.000,0.03,0.006,-0.042,-0.026,0.06*65		
Parameter Description			
field	name	Format	Parameter Description
1	$--DHV	string	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 velocity, in m/s
4	spdX	Numerical value	Receiver ECEF-X-axis speed, in m/s
5	spdY	Numerical value	Receiver ECEF-Y-axis speed, in m/s
6	spdZ	Numerical value	Receiver ECEF-Z axis speed, unit is m/s
7	gdspd	Numerical value	The speed of the receiver in the horizontal ground direction, in m/s
8	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
9	<CR><LF>	character	carriage return and line feed

1.5.11 LPS (only 5T support)

information	LPS (only 5T support)
describe	Leap second information
type	output
Format	$GPTXT,xx,yy,zz,LS=system,valid,utcLS,utcLSF,utcTOW,utcWNT,utcDN,utcWNF,utcA0,utcA1,leapDt,dateLsf,lsfExp,wnExp,wnExpNum*hh<CR><LF>
Example	$GNZDA,235402.000,31,12,2016,00,00*4E The current UTC time is December 31, 2016, 23:54:02 $GPTXT,01,01,02,LS=0,3,17,18,61,138,7,137,0,0,358,311216,,,*64 The leap second information of GPS is valid and used for timing, the current leap second and the leap second after the jump are not equal, jumping from 17 seconds to 18 seconds, the leap second event occurs 358 seconds later (that is, December 31, 2016). 23:59:60). The current receiver GPS system has no satellites that give abnormal UTC parameter information alarm. There are currently no satellites giving abnormal GPS week number warnings. $GPTXT,01,01,02,LS=1,1,3,4,0,61,6,61,0,0,358,311216,,,*56 The leap second information of Beidou is not used for timing, the current leap second and the leap second after the jump are not equal, jumping from 3 seconds to 4 seconds, the leap second event occurred 358 seconds later (that is, December 31, 2016). 23:59:60). Note: The leap seconds of GPS and Beidou are different because their time start reference points are different. The current receiver Beidou system has no satellites that give abnormal UTC parameter information alarms. There are currently no satellites that have given abnormal Beidou week numbers.

Parameter Description

field	name	Format	Parameter Description
1	$GPTXT	string	Message ID, TXT statement header
2	xx	Numerical value	The total number of sentences in the current message is 01~99. If a message is too long, it needs to be displayed in multiple pieces of information, which is fixed at 01.
3	yy	Numerical value	Statement number 01~99, fixed at 01.
4	zz	Numerical value	text identifier. Fixed to 02.

5	LS=	string	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 valid flag. When multiple satellite systems are co-located, only one of them is used for timing (calibration of 1PPS and UTC time) 0=Invalid leap second information 1 = Leap second information is valid, but the system is not used for timing 2 = Leap second information is invalid, but the system is already used for timing 3 = Leap second information is valid and the system has been used for timing
8	utcLS	Numerical value	(Fields 8-15 are standard leap second 8 parameters, please refer to Beidou or GPS's ICD document) The current leap second, in seconds, a positive number indicates that the satellite time is ahead of UTC. Output if the leap second parameter is valid, otherwise empty.
9	utcLSF	Numerical value	Predicted leap second (after a leap second event), in seconds, positive table

			Indicates that the satellite time is ahead of the UTC time. Output if the leap second parameter is valid, otherwise empty.
10	utcTOW	Numerical value	The reference time of the UTC correction parameter, within the week, in 4096 seconds. Output if the leap second parameter is valid, otherwise empty.
11	utcWNT	Numerical value	The reference time for the UTC correction parameter, in weeks, in weeks, modulo 256. Output if the leap second parameter is valid, otherwise empty.
12	utcDN	Numerical value	The time the leap second occurred, the number of days in the week. For GPS system, the valid value range of this value is 1~7. For Beidou system, the valid value range of this value is 1~6. 1 is the end of Sunday, 2 is the end of Monday, and so on, and 7 is the end of Saturday. Output if the leap second parameter is valid, otherwise empty.
13	utcWNF	Numerical value	The time at which the leap second occurred, the number of weeks, in weeks, modulo 256. Output if the leap second parameter is valid, otherwise empty.
14	utcA0	Numerical value	The time error between UTC time and satellite time (scale factor 2^-30), in seconds. Output if the leap second parameter is valid, otherwise empty.
15	utcA1	Numerical value	The rate of change of time error between UTC time and satellite time (scale factor 2^-50), in seconds per second. Output if the leap second parameter is valid, otherwise empty.

16	leapDt	Numerical value	The time interval between the moment when the leap second event occurs and the current UTC time, a positive number indicates that the leap second event occurs in the future. Output when the leap second parameter is valid and there is a leap second change (utcLs≠utcLsf), otherwise it is empty.
17	dateLsf	ddmmyy	The date corresponding to the predicted leap second occurrence time, in day/month/year format. leap Output when the second parameter is valid and there is a leap second change (utcLs≠utcLsf), otherwise it is empty.
18	lsfExp	hexadecimal value	Alarm of abnormal leap second correction time of the current satellite system. The 32 satellites of the system are expressed as 8-digit hexadecimal values. From the lowest position to the highest position are No. 1 to No. 32 satellites. 0=There is no abnormality in the leap second correction information of this satellite. 1=The satellite's leap second correction information is abnormal. If the occurrence time of the leap second in the message is not the empirical time (June 30 or December 31), the receiver will give an abnormal message, but will adjust the leap second according to the changed time. Output if the leap second parameter is valid and there is an exception, otherwise it is empty.
19	wnExp	hexadecimal value	The current satellite system time week number is abnormal alarm (year jump alarm). The 32 satellites of the system are expressed as 8-digit hexadecimal values. From the lowest

			position to the highest position are No. 1 to No. 32 satellites. 0=No abnormality in the number of weeks of the satellite, no alarm 1=There is an abnormality in the number of weeks of the satellite, and it is output when the alarm ephemeris time is abnormal. Otherwise empty.
20	wnExpNum	Numerical value	The magnitude of the cycle number jump in the satellite message. If the week number jumps forward relative to the normal value, the value is negative; otherwise, it is positive. The unit is the number of weeks. Output when the ephemeris time is abnormal. Otherwise empty.
twenty one	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
			fruit
twenty two	<CR><LF>	character	carriage return and line feed

1.5.12 UTC (only 5T supported)

information	UTC (only 5T supported)		
describe	Receiver Status, Leap Second Correction Simplified Information		
type	output		
Format	$--UTC,UTCtime,lat,uLat,lon,uLon,FS,numSv,HDOP,hgt,uMsl,date,antSta,timeSrc,leapValid,dtLs,dtLsf,leapTime*CS<CR><LF>		
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	Format	Parameter Description
1	$--UTC	string	Message ID, UTC statement header
2	UTCtime	hhmmss	The currently positioned UTC time in the format of hours/minutes/seconds.

3	lat	ddmm.mmmm	Latitude, the first 2 characters represent degrees, the following characters represent minutes
4	uLat	character	Latitude: N-North, S-South
5	lon	dddmm.mmmm	Longitude, the first 3 characters represent degrees, the following characters represent minutes
6	uLon	character	Longitude direction: E-east, W-west
7	FS	Numerical value	Indicates the current positioning quality (note [1]), this field should not be empty
8	numSv	Numerical value	The number of satellites used for positioning, 00~24
9	HDOP	Numerical value	Horizontal factor of precision (HDOP)
10	hgt	Numerical value	high
11	uMsl	character	Height unit, meters, fixed character M
12	date	ddmmyy	The current targeting date in day/month/year format.
13	antSta	Numerical value	Antenna Status: 0=Antenna is open 2=Antenna is 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	The leap second correction value of the current time
17	utcLsf	Numerical value	If a predicted leap second occurs (utcLs≠utcLsf in the leap second correction information) , it indicates the predicted new leap second correction value. After a leap second event, this

			value is continuously output until a correction without a leap second forecast is received. If no leap second is predicted (dtls in the received leap second correction equal to dtlsf), the field is empty
18	leapTime	mmyy	If there is a predicted leap second occurrence (utcLs≠utcLsf in the leap second correction information) , this field indicates the predicted leap second occurrence time. After a leap second event, this value is continuously output until a correction without a leap second forecast is received. If no leap second is predicted (dtls and dtlsf are equal in the received leap second correction), this field is empty. The format is month/year.
19	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
20	<CR><LF>	character	carriage return and line feed

Remarks[1] Positioning Quality Mark

Positioning quality marks	describe
0	Targeting unavailable or invalid
1	Standard positioning mode, positioning is effective
6	Estimation mode

1.5.13 GST

information	GST
describe	Receiver Pseudo-Range Measurement Accuracy Details
type	output
Format	$--GST,UTCtime,RMS,stdDevMaj,stdfDevMin,orientation,stdLat,stdLon,stdAlt*CS<CR><LF>
Example	$BDGST,081409.000,0.5,,,,0.2,0.1,0.4*5E

Parameter Description			
field	name	Format	Parameter Description
1	$--GST	string	Message ID, DHV statement header, ' -- ' is the system identifier
2	UTCtime	hhmmss.sss	UTC time of the current moment
3	RMS	Numerical value	RMS value of receiver pseudorange error standard deviation during positioning, in meters
4	stdDevMaj	Numerical value	The standard deviation of the position along the semi-major axis of the receiver ellipse, not supported
5	stdfDevMin	Numerical value	The standard deviation of the position in the direction of the semi-minor axis of the receiver ellipse, not supported
6	orientation	Numerical value	The orientation of the receiver's ellipse semi-major axis, not supported
7	stdLat	Numerical value	Standard deviation of receiver latitude error, in meters
8	stdLon	Numerical value	Standard deviation of receiver longitude error, in meters
9	stdAlt	Numerical value	Standard deviation of receiver altitude error, in meters
10	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
11	<CR><LF>	character	carriage return and line feed

1.5.14 INS (only supported by 5S series)

information	INS (supported by 5S series only)		
describe	Inertial Navigation System (INS) Information		
type	output		
Format	$GPTXT,xx,yy,zz,INS_INF=sensorID,attMode,status,sesorOK,RAM, ramStart*hh<CR><LF>		
Example	$GPTXT,01,01,02,INS_INF=1,3,5,0,0,RAM,1*11 explain: k=1, the current sensor type of the module is 1; l=3, the module needs to only want the left side of the vehicle when installing the X-axis of the module package; m=5, the module currently outputs RXM _SENSOR statement, each statement contains 5 sets of MEMS sampling data; n =0, the combined navigation filter does not converge.		
Parameter Description			
field	name	Format	Parameter Description
1	$GPTXT	string	Message ID, TXT statement header
2	xx	Numerical value	The total number of sentences in the current message is 01~99. If a message is too long, it needs to be displayed in multiple pieces of information, which is fixed at 01.
3	yy	Numerical value	Statement number 01~99, fixed at 01.
4	zz	Numerical value	text identifier.
5	INS_INF	string	Fixed to INS_INF for INS information flags.
6	sensorID	Numerical value	Sensor type used by the current module: 1 or 2.
7	attMode	Numerical value	The mode configuration of the module relative to the relative installation attitude of the vehicle, the possible value range: 0, 1, 2, 3. 0: The module X axis points to 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 module relative pose.
8	fs	Numerical value	Used only for output of internal MEMS raw data RXM_SENSOR statement. Value range: 0 , 1 , 2 , 5 , 10 , 25 , 50 . If m=0 , it means that the RXM_SENSOR statement does not output; If m!=0 , it means that the RXM_SENSOR statement is output once per second , and one statement contains m groups of MEMS sensor sampling data.
9	status	Numerical value	It is used to display the convergence status of the combined navigation filter, n=2 means it has converged.
10	sesorOK	Numerical value	-
11	RAM	string	Fixed to RAM
	ramStart	Numerical value	1 : The dead reckoning function is turned on immediately when the backup power is turned on. 0 : The dead reckoning function is turned off immediately when the backup power is turned on.

			Off by default
6	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
7	<CR><LF>	character	carriage return and line feed

1.6 NMEA Custom Messages

1.6.1 CAS00

information	CAS00		
describe	Save the current configuration information to the FLASH, even if the receiver is completely powered off, the information in the FLASH will not be lost.		
type	enter		
Format	$PCAS00*CS<CR><LF>		
Example	$PCAS00*01		
Parameter Description			
field	name	Format	Parameter Description
1	$PCAS00	string	message ID, statement header
2	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
3	<CR><LF>	character	carriage return and line feed

1.6.2 CAS01

information	CAS01
describe	Set the serial communication baud rate.
type	enter
Format	$PCAS01,br*CS<CR><LF>
Example	$PCAS01,1*1D

Parameter Description

field	name	Format	Parameter Description
1	$PCAS01	string	message ID, statement header
2	br	number	Baud rate configuration. 0=4800bps 1=9600bps 2=19200bps 3=38400bps 4=57600bps 5=115200bps
3	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
4	<CR><LF>	character	carriage return and line feed

1.6.3 CAS02

information	CAS02		
describe	Set the location update rate.		
type	enter		
Format	$PCAS02,fixInt*CS<CR><LF>		
Example	$PCAS02,1000*2E		
Parameter Description			
field	name	Format	Parameter Description
1	$PCAS02	string	message ID, statement header
2	fixInt	Numerical value	Positioning update interval, in ms. 1000=update rate 1Hz , output 1 fix point per second 500=update rate 2Hz , output 2 fix points per second 250=update rate 4Hz , output 4 fix points per second 200=update rate 5Hz , output 5 positioning points per second 100=update rate 10Hz , output 10 positioning points per second
3	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
4	<CR><LF>	character	carriage return and line feed

1.6.4 CAS03

information	CAS03
describe	Sets the NMEA sentence to output or stop output.
type	enter
Format	$PCAS03,nGGA,nGLL,nGSA,nGSV,nRMC,nVTG,nZDA,nANT,nDHV,nLPS,res1,r es2,nUTC,nGST,res3,res4,res5,nTIM*CS<CR><LF>
Example	$PCAS03,1,1,1,1,1,1,1,1,0,0,,,1,1,,,,1*33

Parameter Description

field	name	Format	Parameter Description
1	$PCAS03	string	message ID, statement header
2	nGGA	Numerical value	GGA output frequency, the statement output frequency is based on the positioning update rate, n (0~9) means output once every n times of positioning, 0 means not outputting the statement, and if it is empty, the original configuration is maintained.
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	reserve
13	res2	Numerical value	reserve
14	nUTC	Numerical value	UTC output frequency, same as nGGA
15	nGST	Numerical value	GST output frequency, same as nGST
16	res3	Numerical value	reserve
17	res4	Numerical value	reserve
18	res5	Numerical value	reserve

19	nTIM	Numerical value	TIM (PCAS60) output frequency, same as nGGA
20	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
twenty one	<CR><LF>	character	carriage return and line feed

1.6.5 CAS04

information	CAS04		
describe	Configure the working system.		
type	enter		
Format	$PCAS04,mode*hh<CR><LF>		
Example	$PCAS04,3*1A Beidou and GPS dual mode $PCAS04,1*18 Single GPS working mode $PCAS04,2*1B Single Beidou working mode		
Parameter Description			
field	name	Format	Parameter Description
1	$PCAS04	string	message ID, statement header
2	mode	number	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 value	Checksum, XOR of all characters between $ and * (excluding $ and *)
4	<CR><LF>	character	carriage return and line feed

1.6.6 CAS05

information	CAS05		
describe	Set the NMEA protocol type selection. The multi-mode navigation receiver has many protocol types and many data protocol standards. This receiver product can support a variety of protocols (optional configuration) .		
type	enter		
Format	$PCAS05,ver*CS<CR><LF>		
Example	$PCAS05,1*19		
Parameter Description			
field	name	Format	Parameter Description
1	$PCAS05	string	message ID, statement header
2	mode	number	NMEA protocol type selection (Note [1])
3	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
4	<CR><LF>	character	carriage return and line feed
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 and above, compatible with NMEA4.0 protocol		
9	Compatible with single GPS NMEA0183 protocol, compatible with NMEA 2.2 version		

1.6.7 CAS06

information	CAS06		
describe	Query product information		
type	enter		
Format	$PCAS06,info*CS<CR><LF>		
Example	$PCAS06,0*1B		
Parameter Description			
field	name	Format	Parameter Description
1	$PCAS06	string	message ID, statement header
2	info	number	Query the information type of the product. Information content refer to 1.5.8. 0=Query firmware version number 1=Query the hardware model and serial number 2=Query the working mode of the multimode receiver 3=Query the customer number of the product 5=Query upgrade code information
3	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
4	<CR><LF>	character	carriage return and line feed

1.6.8 CAS10

information	CAS10
describe	Receiver restarts
type	enter
Format	$PCAS10,rs*CS<CR><LF>
Example	$PCAS10,0*1C warm start $PCAS10,1*1D warm start $PCAS10,2*1E Cold start $PCAS10,3*1F Factory Boot

Parameter Description

field	name	Format	Parameter Description
1	$PCAS10	string	message ID, statement header
2	rs	number	Boot mode configuration. 0=warm start. All data in backup storage is valid without initialization information. 1=warm start. Clear the ephemeris without using initialization information. 2=Cold start. No initialization information is used, and all data except the configuration is cleared from the backup storage. 3=Factory start. Clears all data in memory and resets the receiver to its factory default configuration.
3	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
4	<CR><LF>	character	carriage return and line feed

1.6.9 CAS12

information	CAS12		
describe	Receiver Standby Mode Control *5L* low power module supports this command		
type	enter		
Format	$PCAS12,stdbysec*CS<CR><LF>		
Example	$PCAS12,60*28 Receiver enters standby mode and automatically turns on after 60 seconds		
Parameter Description			
field	name	Format	Parameter Description
1	$PCAS12	string	message ID, statement header
2	stdbysec	Numerical value	Time for receiver to enter standby mode, maximum 65535 seconds
3	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
4	<CR><LF>	character	carriage return and line feed

1.6.10 CAS20

information	CAS20		
describe	Online Upgrade Instructions		
type	enter		
Format	$PCAS20*CS<CR><LF>		
Example	$PCAS20*03		
Parameter Description			
field	name	Format	Parameter Description
1	$PCAS20	string	message ID, statement header
2	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
3	<CR><LF>	character	carriage return and line feed

1.6.11 CAS15

information	CAS15
describe	Satellite system control command, you can configure whether to receive any satellite in the system *V5200* support this command
type	enter
Format	$PCAS15,X,YYYYYYYY*CS<CR><LF>
Example	$PCAS15,2,FFFFFFFF*37, enable Beidou satellites 1-32 $PCAS15,2,FFFFFFE0*42, Beidou satellites 6-32 are turned on, Beidou satellites 1-5 are turned off $PCAS15,4,FFFF*31, enable SBAS satellites 1-16, ie PRN=120-135 $PCAS15,5,1F*47, enable QZSS satellites 1-5, ie PRN=193, 194, 195, 199, 197

Parameter Description

field	name	Format	Parameter Description
1	$PCAS15	string	message ID, statement header
2	SYS_ID	1 number	2=Beidou 1-32 satellites 3 = Beidou 33-64 satellite 4= SBAS satellites(SBAS satellites1-19, corresponding to PRN 120-138) 5=QZSSsatellites(QZSS satellites1-5, corresponding to PRN 193,194, 195, 199, 197)
3	SV_MASK	1 to 8 hexadecimal values	Each hexadecimal character controls 4 satellites, the rightmost controls satellites 1-4. Hexadecimal characters are converted to 4bit binary, each 1bit corresponds to 1 satellite, 1=receive the satellite; 0=disable. For example: 3FFFFFE0, which means that satellites 31, 32, 1-5 are prohibited.
4	CS	hexadecimal value	Checksum, XOR of all characters between $ and * (excluding $ and *)
5	<CR><LF>	character	carriage return and line feed

1.6.12 CAS60

information	CAS60
describe	Receiver time information. *5T* - module *V5302* later versions support this command

type	output
Format	$PCAS60,UTCtime,ddmmyyyy,wn,tow,timevalid,leaps,leapsValid*CS
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			
field	name	Format	Parameter Description
1	$PCAS60	string	message id
2	UTCtime	hhmmss.sss	The UTC time of the current moment, if leapsValid is 0, the default leaps is used for calculation
3	ddmmyyyy	Numerical value	current day month year
4	wn	Numerical value	GPS system week number
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, leap seconds
8	leapsValid	Numerical value	Validity of leap seconds leaps, 1=valid, 0=invalid
9	CS	hexadecimal value	Checksum, XOR result of all characters between $ and (excluding $ and)
10		character	carriage return and line feed

2 CASIC protocol

2.1 CASIC Protocol Features

The CASIC receiver uses a self-defined standard interface protocol (CSIP, CASIC Standard Interface Protocol) to send data to the host, and the data is transmitted in an asynchronous serial manner.

2.2 CASIC Protocol Framework

CSIP packet structure

field 1	field 2	field 3	field 4	field 5	field 6
header	Payload length	message class	message number	Payload	check value
0xBA, 0xCE	unsigned short 2 bytes	1 byte	1 byte	<2k bytes	Unsigned int 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, indicating 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 of the data packet transmission, and its length (number of bytes) is variable and is an integer multiple of 4.

Field 6: Checksum (ckSum)

The checksum is the cumulative sum of all data from field 2 to field 5 (including field 2 and field 5) by word (1 word includes 4 bytes), occupying 4 bytes.

The calculation of the check value can follow the following algorithm:

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

In the formula, payload contains all the information of field 5. In the calculation process, the parts from field 2 to field 4 are first assembled (4 bytes form a word), and then the data of field 5 is accumulated in the order of a group of 4 bytes (the first received is in the lower order).

2.3 CASIC type and number

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

name	type	describe
NAV	0x01	Navigation results: position, speed, time
TIM	0x02	Timing messages: time pulse output, time stamp result
RXM	0x03	Measurement information output by the receiver (pseudorange, carrier phase, etc.)
ACK	0x05	ACK/NAK message: acknowledgment message to CFG message
CFG	0x06	Enter configuration messages: configure navigation mode, baud rate, etc.
MSG	0x08	Satellite message information output by receiver
MON	0x0A	Monitor messages: communication status, CPU load, stack utilization, etc.
AID	0x0B	Auxiliary messages: Ephemeris, almanac and other A-GPS data

2.4 CASIC Payload Definition Rules

2.4.1 Data encapsulation

In order to implement structured data encapsulation more easily, the data in the payload part is arranged in a specific way: the data in each type of message is closely arranged, the 2-byte value is placed at an offset address that is a multiple of 2, and the 4-byte value is placed Offset address in multiple of 4.

2.4.2 Message naming

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

2.4.3 Data Types

Unless otherwise defined, all multi-character values are in little-endian format. All floating-point values are transmitted according to the IEEE754 single- and double-precision standard.

abbreviation	type	number of bytes	Remark
U1	unsigned char	1	
I1	signed character	1	complement
U2	unsigned short	2	
I2	signed short integer	2	complement
U4	unsigned long	4	
I4	signed long integer	4	complement
R4	IEEE754 single precision	4	
R8	IEEE754 double precision	8	

2.5 CASIC message interaction

Mechanisms that define the input and output of receiver messages. When the receiver receives a CFG type message, it needs to reply an ACK-ACK or ACK-NACK message according to whether the configuration message is processed correctly. The sender shall not send a second CFG message until the receiver replies with a received CFG message. Other messages received by the receiver do not require a reply.

2.6 CASIC message overview

Page	message name	Class/ID	length	type	describe
Class NAV				NAV navigation results	
	NAV-STATUS	0x01 0x00	80	cycle	Receiver Navigation Status
	NAV-DOP	0x01 0x01	28	cycle	geometric precision factor
	NAV-SOL	0x01 0x02	72	cycle	Condensed PVT Navigation Information
	NAV-PV	0x01 0x03	80	cycle	position and velocity information
	NAV-TIMEUTC	0x01 0x10	twenty four	cycle	UTC time information
	NAV-CLOCK	0x01 0x11	64	cycle	Clock Resolution Information
	NAV-GPSINFO	0x01 0x20	8+12*N	cycle	GPS satellite information
	NAV-BDSINFO	0x01 0x21	8+12*N	cycle	BDS satellite information
	NAV-GLNINFO	0x01 0x22	8+12*N	cycle	GLONASS satellite information
Class TIM				TIM time message	
	TIM-TP	0x02 0x00	twenty four	cycle	timing pulse information
Class RXM				RXM receiver measurement information	
	RXM-MEASX	0x03 0x10	16+32*N	cycle	Pseudorange, carrier phase raw measurement information
	RXM-SVPOS	0x03 0x11	16+48*N	cycle	satellite location information
Class ACK				ACK/NACK message	
	ACK-NACK	0x05 0x00	4	reply message	Reply indicates that the message was not received correctly
	ACK-ACK	0x05 0x01	4	reply message	A reply indicates that the message was received correctly

Class CFG				CFG input configuration message	
	CFG-PRT	0x06 0x00	0/8	Query/Set	Query/configure the working mode of the UART
	CFG-MSG	0x06 0x01	0/4	Query/Set	Query/configuration information sending frequency
	CFG-RST	0x06 0x02	4	set up	Reboot receiver/clear saved data structures
	CFG-TP	0x06 0x03	0/16	Query/Set	Query/configure related parameters of receiver PPS
	CFG-RATE	0x06 0x04	0/4	Query/Set	Query/configure the navigation rate of the receiver
	CFG-CFG	0x06 0x05	4	set up	Clear, save and load configuration information
	CFG-TMODE	0x06 0x06	0/28	Query/Set	Query/configure the timing mode of the receiver PPS
	CFG-NAVX	0x06 0x07	0/44	Query/Set	Query/Professional Configuration Navigation Engine Parameters
	CFG-GROUP	0x06 0x08	0/56	Query/Set	Query/configure group delay parameters of GLONASS
Class MSG				MSG receiver satellite message information	
	MSG-BDSUTC	0x08 0x00	20	cycle	The receiver outputs the UTC information of the BDS system.
	MSG-BDSION	0x08 0x01	16	cycle	The receiver outputs the ionospheric information of the BDS system.
	MSG-BDSEPH	0x08 0x02	92	cycle	The receiver outputs the ephemeris information of the BDS system.
	MSG-GPSUTC	0x08 0x05	20	cycle	The receiver outputs GPS system UTC information.
	MSG-GPSION	0x08 0x06	16	cycle	The receiver outputs GPS system ionospheric information.
	MSG-GPSEPH	0x08 0x07	72	cycle	The receiver outputs GPS system ephemeris information.
	MSG-GLNEPH	0x08 0x08	68	cycle	The receiver outputs GLN system ephemeris information.
Class MON				MON monitor messages	
	MON-VER	0x0A 0x04	64	Respond to queries	output version information

	MON-HW	0x0A 0x09	56	cycle/query	Various configuration states of the hardware
Class AID				AID assistance message	
	AID-INI	0x0B 0x01	56	query/input	Auxiliary location, time, frequency, clock offset information
	AID-HUI	0x0B 0x03	60	enter	Auxiliary health information, UTC parameters, ionospheric parameters

2.7 NAV (0x01)

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

2.7.1 NAV-STATUS (0x01 0x00)

information	NAV-STATUS				
describe	Receiver Navigation Status				
type	cycle/query				
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	80	0x01 0x00	see table below	4 Bytes

payload content

character offset	type of data	scaling	name	unit	describe
0	U4	-	runTime	ms	Elapsed time to power-on/reset
4	U2	-	fixInterval	ms	Positioning time interval
6	U1	-	posValid	-	Positioning mark (remarks [1])
7	U1	-	velValid	-	Speed flag (Note [2])
8	U1*32	-	gpsMsgFlag	-	32 GPS satellite almanacs and ephemeris message validity flags (Note [3])
40	U1*24	-	glnMsgFlag	-	Almanac and Ephemeris Message Validity Marks for 24 GLONASS Satellites (Note [3])
64	U1*14	-	bdsMsgFlag	-	14 BDS satellite almanacs and ephemeris message validity flags (Note [3])
78	U1		gpsUtcionFlag	-	Message validity flag for GPS UTC and ionospheric

					information (Note [4])
79	U1	-	bdsUtcionFlag	-	Message validity flag for UTC and ionospheric information of BDS (Note [4])

Remark[1]: Positioning mark

Numerical value	describe
0	Invalid targeting
1	External input location
2	Roughly estimated location
3	keep the last location
4	dead reckoning
5	Quick mode positioning
6	2D positioning
7	3D positioning
8	GNSS+DR combined navigation

Remark[2]: Speed sign

Numerical value	describe
0	invalid speed
1	speed of external input
2	Roughly estimated speed
3	keep the last speed
4	Speed estimation
5	fast mode speed
6	2D speed
7	3D speed
8	Speed of combined GNSS+DR navigation

Remark [3]: The upper 4 bits of the message validity flag represent the message validity flag of the almanac, and the lower 4 bits represent the message validity flag of the ephemeris.

Numerical	describe

value	
0	missing
1	unhealthy
2	Expired
3	efficient

Note[4]: The upper 4 bits of the message validity flag represent the message validity flag of UTC parameters, and the lower 4 bits represent the message validity flag of ionospheric parameters

Numerical value	describe
0	missing
1	unhealthy
2	Expired
3	efficient

2.7.2 NAV-DOP (0x01 0x01)

information	NAV-DOP				
describe	Positioning Accuracy Factor				
type	cycle/query				
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	28	0x01 0x01	see table below	4 Bytes
payload content					

character offset	type of data	scaling	name	unit	describe
0	U4	-	runtime	ms	Elapsed time to power-on/reset
4	R4	-	pDop	-	Location DOP
8	R4	-	hDop	-	Horizontal DOP
12	R4	-	vDop	-	vertical DOP
16	R4	-	nDop	-	Northbound DOP
20	R4	-	eDop	-	Eastbound DOP
twenty four	R4	-	tDop	-	Time DOP

2.7.3 NAV-SOL (0x01 0x02)

information	NAV-SOL				
describe	PVT Navigation Information in ECEF Coordinate System				
type	cycle/query				
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	72	0x01 0x02	see table below	4 Bytes

payload content

character offset	type of data	scaling	name	unit	describe
0	U4	-	runTime	ms	Elapsed time to power-on/reset
4	U1	-	posValid	-	Positioning mark (remarks [1])
5	U1		velValid	-	Speed flag (Note [2])
6	U1	-	timeSrc	-	Time Source (Note [3])
7	U1	-	system	-	Multimode receive mode mask of the receiver (Note [4])
8	U1	-	numSV	-	The 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 participating in the solution
11	U1	-	numSVGLN	-	Number of GLONASS satellites involved in the solution
12	U2	-	res	-	reserve
14	U2	-	week	-	week number
16	R8	-	tow	s	during the week
twenty four	R8	-	ecefX	m	X coordinate in ECEF coordinate system
32	R8	-	ecefY	m	Y coordinate in ECEF coordinate system

40	R8	-	ecefZ	m	Z coordinate in ECEF coordinate system
48	R4	-	pAcc	M^2	The variance of the estimated accuracy error of the 3D position
52	R4	-	ecefVX	m/s	X velocity in ECEF coordinate system
56	R4	-	ecefVY	m/s	Y velocity in ECEF coordinate system
60	R4	-	ecefVZ	m/s	Z velocity in ECEF coordinate system
64	R4	-	sAcc	(m/s)^2	Variance of Estimated Accuracy Error for 3D Velocity
68	R4	-	pDop	-	Location DOP

Remark[1]: Positioning mark

Numerical value	describe
0	Invalid targeting
1	External input location
2	Roughly estimated location
3	keep the last location
4	dead reckoning
5	Quick mode positioning
6	2D positioning
7	3D positioning
8	GNSS+DR combined navigation

Remark[2]: Speed sign

Numerical value	describe
0	invalid speed
1	speed of external input
2	Roughly estimated speed
3	keep the last speed
4	Speed estimation
5	fast mode speed
6	2D speed
7	3D speed
8	Speed of combined GNSS+DR navigation

Remark[3]: Time source	
time source	describe
0	GPS timing, i.e. the time of week and the week number is the receiver's local time obtained from the GPS satellites
1	BDS
2	GLONASS
Note[4]: Multi-mode receiving mode	
bits	describe
B0	1=GPS satellites are used for positioning
B1	1=BDS satellites are used for positioning
B2	1=GLONASS satellites are used for positioning

2.7.4 NAV-PV (0x01 0x03)

information	NAV-PV				
describe	Position and Velocity Information in Geodetic Coordinate System				
type	cycle/query				
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	80	0x01 0x03	see table below	4 Bytes

payload content

character offset	type of data	scaling	name	unit	describe
0	U4	-	runTime	ms	Elapsed time to power-on/reset
4	U1	-	posValid	-	Positioning mark (refer to 2.7.3 Remarks [1])
5	U1		velValid	-	Speed flag (refer to 2.7.3 Remarks [2])
6	U1	-	system	-	Multimode receive mode mask for the receiver (Refer to 2.7.3 Remarks [4])
7	U1	-	numSV	-	The 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 participating in the solution
10	U1	-	numSVGLN	-	Number of GLONASS satellites involved in the solution
11	U1	-	res	-	reserve
12	R4	-	pDop	-	Location DOP
16	R8	-	lon	°	longitude
twenty four	R8	-	lat	°	latitude
32	R4	-	height	m	Geodetic height (with reference to ellipsoid)
36	R4	-	sepGeoid	m	Altitude anomalies (difference between the height of the earth

					and the altitude)
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	Northing velocity in ENU coordinate system
52	R4	-	velE	m/s	Easting Velocity in ENU Coordinate System
56	R4	-	velU	m/s	Celestial Velocity in ENU Coordinate System
60	R4	-	speed3D	m/s	3D speed
64	R4	-	speed2D	m/s	2D ground speed
68	R4	-	heading	°	course
72	R4	-	sAcc	(m/s)^2	Variance of accuracy error for ground velocity
76	R4	-	cAcc	°^2	Variance of accuracy error in heading (variance of heading)

2.7.5 NAV-TIMEUTC (0x01 0x10)

information	NAV-TIMEUTC				
describe	UTC time information				
type	cycle/query				
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	twenty four	0x01 0x10	see table below	4 Bytes
payload content					

character offset	type of data	scaling	name	unit	describe
0	U4	-	runTime	ms	Elapsed time to power-on/reset
4	R4	$1/c^2$	tAcc	s^2	time estimation accuracy

8	R4	-	msErr	ms	Residual error after rounding in milliseconds
12	U2	-	ms	ms	The millisecond part of UTC time, the value range is 0~999
14	U2	-	year	year	UTC year (1999~2099)
16	U1	-	month	month	UTC month (1~12)
17	U1	-	day	day	UTC day of the month (1~31)
18	U1	-	hour	hour	Hours of the day in UTC (0~23)
19	U1	-	min	min	UTC hour and minute (0~59)
20	U1	-	sec	s	UTC minutes and seconds (0~59)
twenty one	U1	-	valid	-	Time valid flag (Note [1])
twenty two	U1	-	timeSrc	-	Timing system logo (Note [2])
twenty three	U1	-	dateValid	-	Date valid flag (Note [3])

Remark[1]: Time valid flag	
Numerical value	describe
B0	Valid flag in UTC week, 0=invalid, 1=valid
B1	UTC week number valid flag, 0=invalid, 1=valid
B2	UTC leap second correction valid flag, 0=invalid, 1=valid

Remark[2]: Timing system logo	
Numerical value	describe
0	GPS timing
1	BDS timing
2	GLONASS timing

Remark[3]: Date valid sign	
Numerical value	describe
0	Invalid date
1	External input date
2	get date from satellite
3	Get reliable dates from multiple satellites

2.7.6 NAV-CLOCK (0x01 0x11)

information	NAV-CLOCK				
describe	Clock Resolution Information				
type	cycle/query				
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	64	0x01 0x11	see table below	4 Bytes

payload content

character offset	type of data	scaling	name	unit	describe
0	U4	-	runTime	ms	Elapsed time to 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)
Start of repeat 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	The fractional second part of the difference between satellite time and UTC time
28+16*N	U2	-	wn	-	week number
30+16*N	I1	-	leapS	-	UTC jump seconds, the integer second part of the difference between satellite time and UTC time
31+16*N	U1	-	valid	-	time validity sign
The repetition part ends, the maximum value of N is (SYSTEM_ALL-1), and the current version is 2					

2.7.7 NAV-GPSINFO (0x01 0x20)

information	NAV-GPSINFO				
describe	GPS satellite information				
type	cycle/query				
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	8+12*N	0x01 0x20	see table below	4 Bytes

payload content

character offset	type of data	scaling	name	unit	describe
0	U4	-	runTime	-	Elapsed time to power-on/reset
4	U1	-	numViewSv	-	The number of visible satellites, the valid range is 0~32
5	U1	-	numFixSv	-	Number of satellites used for positioning
6	U1		system	-	System Type (Note [1])
7	U1	-	res		reserve
Start of repeating part (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 (Note [2])
11+12*N	U1	-	quality	-	Quality Indication of Signal Measurements (Note [3])
12+12*N	U1	-	CN0	dB-Hz	Signal to noise ratio
13+12*N	I1	-	elev	°	Satellite elevation (-90~90)
14+12*N	I2	-	azim	°	Satellite Azimuth (0~360)
16+12*N	R4	-	prRes	m	Pseudorange residuals
end of repetition					

Remark[1]: System Type

Numerical value	describe
0	GPS

1	BDS
2	GLONASS
Remark[2]: Satellite Status	
bits	describe
B0	1 = Satellite participates in the calculation
B1-B3	reserve
B4	1=Invalid satellite prediction information
B5	reserve
B7:B6	00=Reserved 01 = Satellite forecast information based on almanac 10=Reserved 11=Satellite forecast information based on ephemeris
Remark[3]: Quality Indication of Signal Measurements	
quality	illustrate
BIT0	=1, indicating that the pseudorange measurement value prMes is valid
BIT1	=1, indicating that the carrier phase measurement value cpMes is valid
BIT2	=1, indicating that the half-cycle ambiguity is valid (inverted PI correction is valid)
BIT3	=1, indicating that the half-cycle ambiguity is subtracted from the carrier phase measurement
BIT4	reserve
BIT5	=1, indicating that the carrier frequency is valid
BIT6-BIT7	reserve

2.7.8 NAV-BDSINFO (0x01 0x21)

information	NAV-BDSINFO				
describe	BDS satellite information				
type	cycle/query				
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	8+12*N	0x01 0x21	see table below	4 Bytes

payload content

character offset	type of data	scaling	name	unit	describe
0	U4	-	runTime	-	Elapsed time to power-on/reset
4	U1	-	numViewSv	-	The number of visible satellites, the valid range is 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		reserve
Start of repeating part (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 Remarks [2])
11+12*N	U1	-	quality	-	Quality indication of signal measurement (refer to 2.7.7 Remarks [3])
12+12*N	U1	-	CN0	dB-Hz	Signal to noise ratio
13+12*N	I1	-	elev	°	Satellite elevation (-90~90)
14+12*N	I2	-	azim	°	Satellite Azimuth (0~360)
16+12*N	R4	-	prRes	m	Pseudorange residuals
end of repetition					

2.7.9 NAV-GLNINFO (0x01 0x22)

information	NAV-GLNINFO				
describe	GLONASS satellite information				
type	cycle/query				
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	8+12*N	0x01 0x22	see table below	4 Bytes

payload content

character offset	type of data	scaling	name	unit	describe
0	U4	-	runTime	-	Elapsed time to power-on/reset
4	U1	-	numViewSv	-	The number of visible satellites, the valid range is 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		reserve
Start of repeating part (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 Remarks [2])
11+12*N	U1	-	quality	-	Quality indication of signal measurement (refer to 2.7.7 Remarks [3])
12+12*N	U1	-	CN0	dB-Hz	Signal to noise ratio
13+12*N	I1	-	elev	°	Satellite elevation (-90~90)
14+12*N	I2	-	azim	°	Satellite Azimuth (0~360)
16+12*N	R4	-	prRes	m	Pseudorange residuals
end of repetition					

2.7.10 NAV-IMUATT (0x01 0x06)

information	NAV-IMUATT				
describe	Attitude of the IMU coordinate system relative to the local navigation coordinate system (NED)				
type	cycle/query				
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	32	0x01 0x06	see table below	4 Bytes

payload content

character offset	type of data	scaling	name	unit	describe
0	U4	-	tow	s	When the receiver GPS is within the week (Note [1])
4	U2	-	weekNum	week	Receiver GPS week number (Note [1])
6	U1		flag	-	Attitude available flag (Note [2])
7	U1	-	res	-	reserve
8	I4	1e-5	roll	deg	roll angle
12	I4	1e-5	pitch	deg	Pitch angle
16	I4	1e-5	heading	deg	Heading
20	U4	1e-5	rollAcc	deg	Roll angle accuracy
twenty four	U4	1e-5	pitchAcc	deg	Pitch angle accuracy
28	U4	1e-5	headingAcc	deg	Heading angle accuracy

Note[1]: When the receiver GPS is within the week

rcvTow/wn	Refer to the meaning of rcvTow/wn in RXM-MEASX.

Remark[2]: Attitude available flag

flag	0x01 - pose estimation is valid; 0xff pose estimation is invalid.

2.8 TIM (0x02)

2.8.1 TIM-TP (0x02 0x00)

message name	TIM-TP				
describe	timing pulse information				
type	cycle/query				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	twenty four	0x02 0x00	see table below	4 Bytes

payload content					
character offset	type of data	scaling	name	unit	describe
0	U4	-	runTime	ms	Elapsed time to power-on/reset
4	R4	-	qErr	s	Time quantization error corresponding to the next time pulse
8	R8	-	tow	s	The time of week corresponding to the next time pulse
16	U2	-	wn	-	The number of weeks corresponding to the next time pulse
18	U1	-	refTime	-	Reference time (Note [1])
19	U1	-	utcValid	-	Valid flags (remarks [2])
20	U4	-	res	-	reserve

Remark[1]: Timing pulse reference time	
value	describe
B3:B0	0: GPS time source 1: BDS time source 2: GLN time source
B7:B4	0: The time base is UTC

	1: The time reference is GNSS (refer to the value of B3:B0 for the specific system)
Remark[2]: UTC parameter valid flag	
value	describe
0	missing
1	reserve
2	Expired
3	efficient

2.9 RXM (0x03)

Measured value message.

2.9.1 RXM-MEASX (0x03 0x10)

information	RXM-MEASX				
describe	Pseudorange, carrier phase raw measurement information				
type	cycle/query				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	16+32*N	0x03 0x10	see table below	4 Bytes
Payload content:					

character offset	type of data	scaling	name	unit	describe
0	R8	-	rcvTow	s	When the receiver GPS is within the week (Note [1])
8	I2	-	wn	week	Receiver GPS week number
10	I1	-	leapS	s	UTC leap second value (note [2])
11	U1	-	numMeas	-	Number of measured values, valid range 0~32
12	U1	-	recStat	-	Receiver Status (Note [3])
13	U1	-	res1		reserve

14	U1	-	res2	-	reserve
15	U1	-	res3	-	reserve
Start of repeating part (N=numMeas, valid range 0~32)					
16+32*N	R8	-	prMes	m	Pseudorange measurement (unit: meters), for GLONASS inter-frequency deviation, the receiver compensates for it through the built-in correction table.
24+32*N	R8	-	cpMes	cycles	Carrier phase measurement (unit: cycle) (Note [4])
32+32*N	R4	-	doMes	Hz	Doppler measurement (unit: Hz), near 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	-	reserve
39+32*N	U1	-	freqid	-	Frequency number (offset 8), only valid for GLONASS. range of valid values [1,14], corresponding to frequency [-7,+6].
40+32*N	U2	-	locktime	ms	Carrier phase lock time, maximum 65535ms
42+32*N	U1	-	cn0	dB-Hz	carrier-to-noise ratio
43+32*N	U1	-	res5	-	reserve
44+32*N	U1	-	res6	-	reserve
45+32*N	U1	-	res7	-	reserve
46+32*N	U1	-	trkStat	-	Satellite tracking status (Note [5])
47+32*N	U1	-	res8	-	reserve

end of repetition	
Note[1]: When the receiver GPS is within the week	
rcvTow	The receiver time is aligned with the GPS time system as much as possible. The time can be converted to other time systems using the receiver time of week rcvTow, receiver week number week, leap second value leapS. For more information on the different time systems please refer to the RINEX3 documentation. When the receiver works in single GLONASS mode, The UTC time can be obtained by directly subtracting the leap second value leapS from the receiver time, regardless of whether the flag bit in recStat is valid.
Remark[2]: UTC leap second value	
leapS	The leap second value between GPS time and UTC time, which is the latest value known to the receiver. A flag bit in recStat indicates whether the value is valid.
Note[3]: Receiver status	
recStat	illustrate
BIT0	=1, indicating that leap second value leapS is valid (UTC correction parameter is valid).
BIT1	=1, indicating that a clock reset occurs, and the receiver time jumps by an integer number of milliseconds.
Remark[4]: Carrier phase measurement value	
cpMes	Initializes the initial integer ambiguity of the carrier phase with an approximation such that the carrier phase measurements are close to the pseudorange measurements. The clock reset mechanism acts on both pseudorange measurements and carrier phase measurements, in compliance with RINEX3.
Note[5]: Satellite tracking status	
trkStat	illustrate
BIT0	=1, indicating that the pseudorange measurement value prMes is valid
BIT1	=1, indicating that the carrier phase measurement value cpMes is valid
BIT2	=1, indicating that the half-cycle ambiguity is valid (inverted PI correction is valid)
BIT3	=1, indicating that the half-cycle ambiguity is subtracted from the carrier phase measurement

2.9.2 RXM-SVPOS (0x03 0x11)

information	RXM-SVPOS				
describe	satellite location information				
type	cycle/query				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	16+48*N	0x03 0x11	see table below	4 Bytes

Payload content:

character offset	type of data	scaling	name	unit	describe
0	R8	-	rcvTow	s	Receiver GPS week time (Note [1])
8	I2	-	wn	week	Receiver GPS week time (Note [1])
10	U1	-	numMeas	-	Number of measured values, valid range 0~32
11	U1	-	res1	-	reserve
12	I4	-	res2	-	reserve
Start of repeating part (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 offset
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), valid for GLONASS
58+48*N	U1	-	gnssid	-	System type, 0=GPS, 1=BDS,2=GLONASS
59+48*N	U1	-	res3	-	reserve
60+48*N	U4	-	res4	-	reserve
end of repetition					

Note[1]: When the receiver GPS is within the week	
rcvTow/wn	Refer to the meaning of rcvTow/wn in RXM-MEASX.

2.9.3 RXM-SENSOR (0x03 0x07)

information	RXM-SENSOR				
describe	sensor information				
type	cycle/query				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	16+16*N	0x03 0x11	see table below	4 Bytes

Payload content:

character offset	type of data	scaling	name	unit	describe
0	R8	-	rcvTow	s	Receiver GPS week time (Note [1])
8	I2	-	wn	week	Receiver GPS week number (Note[1])
10	I1	-	leapS	s	Leap second time in current GPS system
11	U1	-	numMeas	-	Number of measured values (Note [2])
12	U1	-	recStat	-	receiver status
13	U1	-	timeSrc	-	0-GPS time; 1-BDS time
14	U1	-	rcvrId	-	0
15	U1	-	res	-	reserve
Start of repeating part (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 measurements
22+16*N	I2	250/32768	gyroX	deg/s	Gyroscope X-axis measurement (Note[4])
24+16*N	I2	250/32768	gyroY	deg/s	Gyroscope Y-axis measurement

26+16*N	I2	250/32768	gyroZ	deg/s	Gyroscope Z-axis measurements
28+16*N	I2	1/326.8	temp	ₒC	Thermometer measurement
30+16*N	I2	-	res	-	reserve
end of repetition					
Note[1]: When the receiver GPS is within the week					
rcvTow/wn	Refer to the meaning of rcvTow/wn in RXM-MEASX.				
Remark[2]: Measured value data					
numMeas	Configured by the CFG-MSG statement, numMeas is related to the rate in the CFG-MSG. In the CFG-MSG statement rate=0, the RXM _SENSOR statement does not output; rate is equal to one of several discrete values of 1/2/5/10/25/50, and each statement contains numMeas =rate group of MEMS sampling data; otherwise , numMeas=50. If the RXM _SENSOR statement is output, it is output once per second.				
Remark[3]: Accelerometer					
acc	The accelerometer range is -2g~+2g.				
Note[4]: Gyroscope					
gyro	The range of the gyroscope 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)

information	ACK-NACK				
describe	Responding to incorrectly received information				
type	Reply				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	4	0x05 0x00	see table below	4 Bytes

payload content					
character offset	type of data	scaling	name	unit	describe
0	U1	-	clsID	-	Type of information not received correctly
1	U1	-	msgID	-	The number of the message was not received correctly
2	U2	-	res	-	reserve

2.10.2 ACK-ACK (0x05 0x01)

information	ACK-ACK				
describe	Respond to correctly received information				
type	Reply				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	4	0x05 0x01	see table below	4 Bytes
payload content					
character offset	type of data	scaling	name	unit	describe
0	U1	-	clsID	-	Types of information received correctly
1	U1	-	msgID	-	Number of correctly received messages
2	U2	-	res	-	reserve

2.11 CFG (0x06)

Configuration information, such as setting dynamic mode, baud rate, etc. 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)

information	CFG-PRT				
describe	Query the working mode of UART, including UART0, UART1 two statements, the last output of the current UART statement				
type	Inquire				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	0	0x06 0x00	0	4 Bytes
information	CFG-PRT				
describe	Set the working mode of the UART				
type	Set/respond to queries				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	8	0x06 0x00	see table below	4 Bytes

payload content

character offset	type of data	scaling	name	unit	describe
0	U1	-	portID	-	Port identifier number (0 and 1 for UART0 and UART1, 0xFF means the currently connected UART)
1	U1	-	protoMask	-	Protocol control mask, each port can support several protocols at the same time. Protocol is enabled when the corresponding bit is equal to 1

					(Note [1])
2	U2	-	mode	-	Bit mask of UART operating mode (Note[2])
4	U4	-	baudRate	bps	baud rate

Remark[1]: Protocol Control Mask

bits	describe
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 bit mask

bits	value	describe
[7:6]	00	5bits
	01	6bits
	10	7bits
	11	8bits
[11:9]	10x	no verification
	001	Odd parity
	000	even parity
	x1x	reserve
[13:12]	00	a stop bit
	01	1.5 stop bits
	10	two stop bits
	11	reserve

2.11.2 CFG-MSG (0x06 0x01)

information	CFG-MSG				
describe	Query all information sending frequency				
type	Inquire				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	0	0x06 0x01	0	4 Bytes
information	CFG-MSG				
describe	Set the frequency of sending messages				
type	set up				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	4	0x06 0x01	see table below	4 Bytes

payload content					
character offset	type of data	scaling	name	unit	describe
0	U1	-	clsID	-	type of information
1	U1	-	msgID	-	message number
2	U2	-	rate	-	Information sending frequency (Note [1])

Remarks[1]: Information sending frequency	
Numerical value	describe
0	not output
1	Every time you locate, output once
2	Position twice, output once
N	N times of positioning, output once; In particular, when clsID=0x03, msgID=0x07, rate indicates the number of samples per second of the sensor output in the configured RXM _SENSOR information.
0xFFFF	Immediately output once and only once, which is equivalent to query output

2.11.3 CFG-RST (0x06 0x02)

message name	CFG-RST				
describe	Reboot receiver/clear saved data structures				
type	set up				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	4	0x06 0x02	see table below	4 Bytes

payload content

character offset	type of data	scaling	name	unit	describe
0	U2	-	navBbrMask	-	Clear battery-backed RAM. If a bit of the mask is set to 1, then clear the data represented by this bit (Note [1])
2	U1	-	resetMode	-	Reset method (Note [2])
3	U1	-	startMode	-	Startup method (Note [3])

Remark[1]: Clear field

bit	describe
B0	Ephemeris
B1	almanac
B2	health information
B3	Ionospheric parameters
B4	receiver positioning information
B5	Clock drift (clock frequency offset)
B6	Crystal parameters
B7	UTC correction parameters
B8	RTC
B9	configuration information

Remark[2]: Reset method

Numerical value	describe
0	Immediate hardware reset (via WATCHDOG)

1	Controlled software reset
2	Controlled software reset (GPS only)
4	Hardware reset after shutdown (via WATCHDOG)
Remark[3]: Startup method	
Numerical value	describe
0	Hot Start
1	warm start
2	Cold start
3	Factory boot

2.11.4 CFG-TP (0x06 0x03)

information	CFG-TP				
describe	Query time pulse parameters				
type	Inquire				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	0	0x06 0x03	0	4 Bytes
information	CFG-TP				
describe	Read/set time pulse parameters				
type	read/set				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	16	0x06 0x03	see table below	4 Bytes

payload content					
character offset	type of data	scaling	name	unit	describe
0	U4	-	interval	us	Time interval between pulses (pulse period)
4	U4	-	width	us	Pulse Width
8	U1	-	enable	-	Enable flag (Note [1])
9	U1	-	polar	-	Pulse Polarity Configuration

					(Note [2)
10	U1	-	timeRef	-	Reference time (Note [3)
11	U1	-	timeSource	-	Time source (Note [4)
12	R4	-	userDelay	s	User time delay

Remark[1]: Pulse enable flag	
value	describe
0	off pulse
1	enable pulse
2	Pulses are enabled and output continuously. Automatically maintain pulse update rate when unable to locate normally
3	Output pulses during normal positioning, and do not output pulses when the receiver cannot be positioned normally
Remark[2]: Pulse Polarity Configuration	
0	rising edge
1	falling edge
Note[3]: Reference time	
0	UTC time
1	satellite time
Note[4]: Satellite time source	
Numerical value	describe
0	Mandatory single GPS timing
1	Mandatory single BDS timing
2	Mandatory single GLN timing
3	reserve
4	Main BDS, can automatically switch to other timing systems when BDS is unavailable
5	Main GPS, can automatically switch to other timing systems when GPS is not available
6	Main GLN, can automatically switch to other timing systems when GLN is unavailable
7	reserve
other	Automatic selection of timing system

2.11.5 CFG-RATE (0x06 0x04)

message name	CFG-RATE				
describe	Query positioning time interval				
type	Inquire				
Notes	The receiver supports different navigation rates (the default rate is one update per second). Navigation rate directly affects power consumption, the faster the rate, the greater the CPU and communication burden				
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	0	0x06 0x04	0	4 Bytes
message name	CFG-RATE				
describe	Set the positioning time interval				
type	set up				
Notes	The receiver supports different navigation rates (the default rate is one update per second). Navigation rate directly affects power consumption, the faster the rate, the greater the CPU and communication burden				
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	4	0x06 0x04	see table below	4 Bytes

payload content

character offset	type of data	scaling	name	unit	describe
0	U2	-	interval	ms	time interval between targeting
2	U2	-	res	-	reserve

2.11.6 CFG-CFG (0x06 0x05)

information	CFG - CFG				
describe	Clear, save and load configuration information				
type	Order				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	4	0x06 0x05	see table below	4 Bytes

payload content

character offset	type of data	scaling	name	unit	describe
0	U2	-	mask	-	Mask of configuration information (Note [1])
2	U1	-	mode	-	Operation mode for configuration information (Note [2])
3	U1	-	res	-	reserve

Remark[1]: Configuration information mask

bits	describe
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]: Operation Mode

Numerical value	describe
0	Clear permanent configuration
1	Save current configuration to permanent configuration
2	The permanent configuration is loaded into the current configuration

2.11.7 CFG-TMODE (0x06 0x06)

information	CFG-TMODE				
describe	Query timing mode				
type	Inquire				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	0	0x06 0x06	0	4 Bytes
information	CFG-TMODE				
describe	read/set timing mode				
type	read/set				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	40	0x06 0x06	see table below	4 Bytes

payload content

character offset	type of data	scaling	name	unit	describe
0	U4	-	mode	-	Timing Mode (Note [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 location
32	U4	-	svinMinDur	s	When the timing mode is 1, the minimum measurement time interval
36	R4		svinVarLimit	m^2	When the timing mode is 1, the positioning error limit

Note[1]: Timing mode	
Numerical value	describe
0	Autonomous positioning and timing
1	After autonomous positioning for a period of time to obtain the user's position with sufficient accuracy, it only uses all available satellites to calculate the user's clock parameters for timing. In this mode, when the user's location is fixed, single-star timing can be achieved
2	The user enters the current position, and only uses all available satellites to calculate the user's clock parameters for timing. In this mode, single-satellite timing can be achieved.

2.11.8 CFG-NAVX (0x06 0x07)

message name	CFG-NAVX				
describe	Query Navigation Engine Professional Configuration				
type	Inquire				
Notes	Query navigation related parameters				
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	0	0x06 0x07	0	4 Bytes
message name	CFG-NAVX				
describe	Navigation engine professional configuration				
type	set up				
Notes	Configure navigation related parameters				
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	44	0x06 0x07	see table below	4 Bytes

payload content					
character offset	type of data	scaling	name	unit	describe
0	U4	-	mask	-	Parameter mask, the parameter setting is applied only when the corresponding bit mask is set to 1 (Note [1])
4	U1	-	dyModel	-	Dynamic Mode (Note [2])
5	U1	-	fixMode	-	Positioning mode (Note [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	-	reserve
10	U1		iniFix3D		The initial positioning must be the 3D positioning flag (0/1)
11	I1	-	minElev	°	GNSS satellite minimum elevation angle for positioning
12	U1	-	drLimit	s	Maximum DR time without satellite signal
13	U1	-	navSystem	-	Navigation system enable flag (Note [4])
14	U2	-	wnRollOver	-	GPS week rollovers
16	R4	-	fixedAlt	m	Fixed height for 2D positioning
20	R4	-	fixedAltVar	m^2	Fixed height error in 2D positioning
twenty four	R4	-	pDop	-	Position DOP Max
28	R4	-	tDop	-	Time DOP Max
32	R4	-	pAcc	m^2	Position Accuracy Maximum
36	R4	-	tAcc	m^2	time precision maximum
40	R4	-	staticHoldTh	m/s	keep still threshold

Remark[1]: parameter mask	
bit	describe
B0	Apply dynamic mode settings
B1	Apply targeting mode settings
B2	Apply maximum/minimum number of navigation satellites setting
B3	Apply Minimum SNR setting
B4	reserve
B5	Apply initial positioning 3D settings
B6	Apply Minimum Elevation Setting
B7	Apply DR limit settings
B8	App Navigation System Enable
B9	Apply GPS week rollover settings
B10	Apply Altitude Assist
B11	Apply location DOP restrictions
B12	Apply Time DOP Limits
B13	Apply static hold settings
Remark[2]: Dynamic Mode	
model	describe
0	Portable Mode
1	still mode
2	walking mode
3	car mode
4	nautical mode
5	Airplane mode acceleration <1g
6	Airplane mode acceleration <2g
7	Airplane mode acceleration <4g
Remark[3]: Positioning mode	
model	describe
0	reserve
1	2D positioning
2	3D positioning
3	2D/3D positioning automatic switching
Note[4]: Navigation system enable	
bits	describe
B0	1=GPS
B1	1=BDS
B2	1=GLONASS

2.11.9 CFG-GROUP (0x06 0x08)

message name	CFG-GROUP				
describe	Query the group delay of GLONASS				
type	Inquire				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	0	0x06 0x08	0	4 Bytes
message name	CFG-GROUP				
describe	Configuring Group Delay for GLONASS				
type	set up				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	56	0x06 0x08	see table below	4 Bytes

payload content

character offset	type of data	scaling	name	unit	describe
0	R4[14]	-	groupDealy	m	GLONASS The group delay corresponding to each frequency is represented by distance (the group delay time is multiplied by the speed of light to obtain the distance)

2.11.10 CFG-INS (0x06 0x10)

message name	CFG-INS				
describe	Query INS installation mode				
type	Inquire				
Notes					
message	head	length (bytes)	identifier	Payload	checksum

structure	0xBA 0xCE	0	0x06 0x10	0	4 Bytes

message name	CFG-INS				
describe	Configure INS installation mode				
type	set up				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	4	0x06 0x10	see table below	4 Bytes
payload content					

character offset	type of data	scaling	name	unit	describe
0	U2	-	attMode	-	The mode configuration of the module relative to the relative installation attitude of the vehicle, the possible value range: 0, 1, 2, 3. 0: The module X axis points to 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 module relative pose. Default is 9.
2	U2		ramStart	-	1 : The dead reckoning function is turned on immediately after the backup power is powered on 0 : The dead reckoning function is turned off immediately after the backup power is powered on, and it is turned off by default.

2. 12 MSG (0x08)

Receiver navigation message, message class is 0x08.

2.12.1 MSG-BDSUTC (0x08 0x00)

information	MSG-BDSUTC
describe	BDS fixed-point UTC data (synchronization parameter with UTC time)
type	cycle

Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	20	0x08 0x00	see table below	4 Bytes

payload content

character offset	type of data	scaling	name	unit	describe
0	U4	-	res1	-	reserve
4	I4	2^{-30}	a0UTC	s	Clock offset of BDT relative to UTC
8	I4	2^{-50}	a1UTC	s/s	Clock speed of BDT relative to UTC
12	I1	-	dtls	s	Cumulative leap second corrections of the BDT relative to UTC before the new leap second takes effect
13	I1	-	dtlsf	s	The cumulative leap second correction of the BDT relative to UTC after the new leap second takes effect
14	U1	-	res2	-	reserve
15	U1	-	res3	-	reserve
16	U1	-	wnlsf	week	The week count for which the new leap second takes effect
17	U1	-	dn	day	Day of the week count for which the new leap second is in effect
18	U1	-	valid	-	Information available flag (Note [1])
19	U1	-	res4	-	reserve

Remark[1]: Information available flag

Numerical value	illustrate
0	invalid
1	unhealthy
2	Expired
3	efficient

2.12.2 MSG-BDSION (0x08 0x01)

information	MSG-BDSION				
describe	BDS8 parametric fixed-point ionospheric data				
type	cycle				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	16	0x08 0x01	see table below	4 Bytes

payload content

character offset	type of data	scaling	name	unit	describe
0	U4	-	res1	-	reserve
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 available flag (Note [1])
13	U1	-	res2	-	reserve
14	U2	-	res3	-	reserve

Remark[1]: Information available flag

Numerical value	illustrate

0	invalid
1	unhealthy
2	Expired
3	efficient

2.12.3 MSG-BDSEPH (0x08 0x02)

information	MSG-BDSEPH				
describe	BDS Ephemeris				
type	cycle				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	92	0x08 0x02	see table below	4 Bytes

payload content					
character offset	type of data	scaling	name	unit	describe
0	U4	-	res1	-	reserve
4	U4	2^{-19}	sqra	$m^{1/2}$	Square root of semi-major axis of satellite orbit
8	U4	2^{-33}	es	-	satellite orbit eccentricity
12	I4	2^{-31}	ω	π	argument of perigee
16	I4	2^{-31}	M_0	π	Perimeter angle of reference time
20	I4	2^{-31}	i_0	π	Orbital inclination at reference time
twenty four	I4	2^{-31}	Ω_0	π	Ascending node right ascension by reference time
28	I4	2^{-43}	$\dot{\Omega}$	$\frac{\pi}{s}$	Ascending node right ascension rate of change
32	I2	2^{-43}	Δn	$\frac{\pi}{s}$	The difference between the average speed of the satellite and the calculated value

34	I2	2^{-43}	IDOT	$\frac{\pi}{s}$	Orbital Inclination Rate of Change
36	I4	2^{-31}	cuc	rad	Cosine harmonic correction term amplitude of latitude argument
40	I4	2^{-31}	cus	rad	Sine harmonic correction term amplitude of latitude argument
44	I4	2^{-6}	crc	m	cosine harmonic correction term amplitude of orbit radius
48	I4	2^{-6}	crs	m	Sine harmonic correction term amplitude for orbit radius
52	I4	2^{-31}	cic	rad	Cosine harmonic correction term amplitude of orbit inclination
56	I4	2^{-31}	cis	rad	Sine harmonic correction term amplitude for orbit inclination
60	U4	2^{3}	toe	s	Ephemeris reference time
64	U2	-	wne	-	whole week number of reference time
66	U2	-	res2	-	reserve
68	U4	2^{3}	toc	s	Reference time of clock difference parameters in this period
72	I4	2^{-33}	af0	s	Satellite Ranging Code Phase Time Offset Coefficient
76	I4	2^{-50}	af1	s/s	Satellite Ranging Code Phase Time Offset Coefficient
80	I2	2^{-66}	af2	s/s^{2}	Satellite Ranging Code Phase Time Offset Coefficient
82	I2	0.1	tgd	ns	Onboard equipment delay difference
84	U1	-	iodc	-	clock data age
85	U1	-	iode	-	Ephemeris data age
86	U1	-	ura	-	User distance accuracy
87	U1	-	health	-	Satellite autonomous health label
88	U1	-	svid	-	satellite number
89	U1	-	valid	-	Information available flag

					(remarks [1])
90	U2	-	res3		reserve
Remark[1]: Information available flag					
Numerical value	illustrate				
0	invalid				
1	unhealthy				
2	Expired				
3	efficient				

2.12.4 MSG-GPSUTC (0x08 0x05)

information	MSG-GPSUTC				
describe	GPS fixed-point UTC data (synchronized with UTC time parameters)				
type	cycle				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	20	0x08 0x05	see table below	4 Bytes
payload content					

character offset	type of data	scaling	name	unit	describe
0	U4	-	res1	-	reserve
4	I4	2^{-30}	a0UTC	s	GPST clock offset from UTC
8	I4	2^{-50}	a1UTC	s/s	GPST clock speed relative to UTC
12	I1	-	dtls	s	Cumulative leap second corrections of the BDT relative to UTC before the new leap second takes effect
13	I1	-	dtlsf	s	The cumulative leap second correction of the BDT relative

					to UTC after the new leap second takes effect
14	U1	2^{12}	tot	s	Reference time for UTC data
15	U1	-	wnt	week	UTC reference week number
16	U1	-	wnlsf	week	The week count for which the new leap second takes effect
17	U1	-	dn	day	Day of the week count for which the new leap second is in effect
18	U1	-	valid	-	Information available flag (remarks [1])
19	U1	-	res2	-	reserve

Remark[1]: Information available flag	
Numerical value	illustrate
0	invalid
1	unhealthy
2	Expired
3	efficient

2.12.5 MSG-GPSION (0x08 0x06)

information	MSG-GPSION				
describe	GPS ionospheric data				
type	cycle				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	16	0x08 0x06	see table below	4 Bytes

payload content

character offset	type of data	scaling	name	unit	describe
0	U4	-	res1	-	reserve
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 available flag (remarks [1])
13	U1	-	res2	-	reserve
14	U2	-	res3	-	reserve

Remark[1]: Information available flag

Numerical value	illustrate
0	invalid
1	unhealthy
2	Expired
3	efficient

2.12.6 MSG-GPSEPH (0x08 0x07)

information	RXM-GPSEPH				
describe	GPS Ephemeris				
type	cycle				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	72	0x08 0x07	see table below	4 Bytes

payload content

character offset	type of data	scaling	name	unit	describe
0	U4	-	res1	-	reserve
4	U4	2^{-19}	sqra	$m^{1/2}$	Square root of semi-major axis of

					satellite orbit
8	U4	2^{-33}	es	-	satellite orbit eccentricity
12	I4	2^{-31}	ω	π	argument of perigee
16	I4	2^{-31}	M_0	π	Perimeter angle of reference time
20	I4	2^{-31}	i_0	π	Orbital inclination at reference time
twenty four	I4	2^{-31}	Ω_0	π	Ascending node right ascension by reference time
28	I4	2^{-43}	$\dot{\Omega}$	$\frac{\pi}{s}$	Ascending node right ascension rate of change
32	I2	2^{-43}	Δn	$\frac{\pi}{s}$	The difference between the average speed of the satellite and the calculated value
34	I2	2^{-43}	IDOT	$\frac{\pi}{s}$	Orbital Inclination Rate of Change
36	I2	2^{-29}	cuc	rad	Cosine harmonic correction term amplitude of latitude argument
38	I2	2^{-29}	cus	rad	Sine harmonic correction term amplitude of latitude argument
40	I2	2^{-5}	crc	m	cosine harmonic correction term amplitude of orbit radius
42	I2	2^{-5}	crs	m	Sine harmonic correction term amplitude for orbit radius
44	I2	2^{-29}	cic	rad	Cosine harmonic correction term amplitude of orbit inclination
46	I2	2^{-29}	cis	rad	Sine harmonic correction term amplitude for orbit inclination
48	U2	2^{4}	toe	s	Ephemeris reference time
50	U2	-	wne	-	whole week number of reference time
52	U4	2^{4}	toc	s	Reference time of clock difference parameters in this period
56	I4	2^{-31}	af0	s	Satellite Ranging Code Phase Time Offset Coefficient
60	I2	2^{-43}	af1	s/s	Satellite Ranging Code Phase Time Offset Coefficient
62	I1	2^{-55}	af2	s/s^2	Satellite Ranging Code Phase Time Offset Coefficient
63	I1	2^{-31}	tgd	s	Onboard equipment delay difference

64	U2	-	iodc	-	clock data age
66	U1	-	ura	-	User distance accuracy
67	U1	-	health	-	Satellite autonomous health label
68	U1	-	svid	-	satellite number
69	U1	-	valid	-	Information available flag (remarks [1])
70	U2	-	res2	-	reserve
Remark[1]: Information available flag					

Numerical value	illustrate
0	invalid
1	unhealthy
2	Expired
3	efficient

2.12.7 MSG-GLNEPH (0x08 0x08)

information	RXM-GLNEPH				
describe	GLONASS Ephemeris				
type	cycle				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	68	0x08 0x08	see table below	4 Bytes
payload content					

character offset	type of data	scaling	name	unit	describe
0	U4	-	res1	-	reserve
4	I4	2^{-30}	taon	s	Correction of 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 PZ-90 coordinate system
twenty four	I4	2^{-20}	dy	km/s	Satellite velocity in PZ-90 coordinate system
28	I4	2^{-20}	dz	km/s	Satellite velocity in PZ-90 coordinate system
32	I4	2^{-31}	taoc	s	GLONASS time relative to UTC time scale correction amount
36	I4	2^{-30}	taoGPS	day	Correction from GLONASS time to GPS time
40	I2	2^{-40}	gamman	-	Relative deviation of satellite predicted carrier frequency
42	U2	-	tk	-	The time of day in the current frame, a total of 12 bits
44	U2	-	nt	day	Current date since January of the previous leap year
46	I1	2^{-30}	ddx	km/s^2	Satellite acceleration in PZ-90 coordinate system
47	I1	2^{-30}	ddy	km/s^2	Satellite acceleration in PZ-90 coordinate system
48	I1	2^{-30}	ddz	km/s^2	Satellite acceleration in PZ-90 coordinate system
49	I1	2^{-30}	dtaon	s	The propagation time difference between the L2 signal and the L1 signal of the nth satellite
50	U1	-	bn	-	health sign
51	U1	900	tb	s	Intraday time of the current moment (in UTC+3)
52	U1	-	M	-	GLONASS satellite category
53	U1	-	P	-	Control part technical parameters
54	U1	-	ft	-	Prediction Accuracy of Satellite Pseudoranges
55	U1	-	en	day	satellite star age
56	U1	-	p1	-	Ephemeris information update time flag
57	U1	-	p2	-	tb parity bit

58	U1	-	p3	-	The almanac passed in the current frame contains the number of satellites
59	U1	-	p4	-	Ephemeris data update flag: 1 is updated
60	U1	-	ln	-	Satellite Health Mark (GLONASS-M satellites)
61	U1	-	n4	-	Time counting (starting in 1996, in four-year cycles)
62	U1	-	svid	-	satellite number
63	U1	-	nl	-	frequency number
64	U1	-	valid	-	Information available flag (remarks [1])
65	U1	-	res2	-	reserve
66	U2	-	res3	-	reserve

Remark[1]: Information available flag

Numerical value	illustrate
0	invalid
1	unhealthy
2	Expired
3	efficient

2.13 MON (0x0A)

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

2.13.1 MON-VER (0x0A 0x04)

information	MON-VER				
describe	Version Information				
type	Respond to queries				
Notes					
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	64	0x0A 0x04	see table below	4 Bytes
Payload content:					

character offset	type of data	scaling	name	unit	describe
0	CH[32]	-	swVersion	-	software version string
32	CH[32]	-	hwVersion	-	hardware version string

2.13.2 MON-HW (0x0A 0x09)

information	MON-HW				
describe	hardware status				
type	cycle/query				
Notes	Various configuration status of hardware, including antenna status, IO port status, noise level, AGC information, etc.				
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	56	0x0A 0x09	see table below	4 Bytes

Payload content:

character offset	type of data	scaling	name	unit	describe
0	U4	-	noisePerMs0	-	Noise power of DIF0 IF data
4	U4	-	noisePerMs1	-	Noise power of DIF1 IF data
8	U4	-	noisePerMs2	-	Noise power of DIF2 IF data
12	U2	-	agcData0	-	DIF0 The number of 1's for the amplitude bits of the IF data
14	U2	-	agcData1	-	DIF1 Number of 1's for the amplitude bits of the IF data
16	U2	-	agcData2	-	DIF2 Number of 1's for the amplitude bits of the IF data
18	U2	-	res	-	reserve
20	U1	-	antStatus	-	Antenna Status (Note [1])
21	U1	-	res	-	reserve
22	U1	-	res	-	reserve
23	U1	-	res	-	reserve
24	U4[8]	2^24	jamming	-	Center frequency of the interfering signal (normalized)

Remark[1]: Antenna Status

Numerical value	describe
0	initialization process
1	Unknown status
2	normal
3	short circuit
4	open circuit

2.14 AID (0x0B)

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

2.14.1 AID-INI (0x0B 0x01)

information	AID-INI				
describe	Auxiliary location, time, frequency, clock offset information				
type	query/input				
Notes	Configure navigation related parameters				
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	56	0x0B 0x01	see table below	4 Bytes

payload content					
character offset	type of data	scaling	name	unit	describe
0	R8	-	ecefXOrLat	m or 1°	X coordinate or latitude in ECEF coordinate system: if it is an ECEF coordinate system, the unit is m; if it is a latitude, the unit is degrees.
8	R8	-	ecefYOrLon	m or 1°	Y coordinate or longitude in the ECEF coordinate system: if it is an ECEF coordinate system, the unit is m; if it is a 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, which means that the frequency offset of the crystal oscillator is 1ppm;

					FreqBias=-150, indicates the frequency offset of the crystal oscillator -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 over time. Example: tAcc=9 , it 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 , it means that the time error is sqrt(fAcc)/300=30/300=0.1ppm
48	U4	-	res	-	reserve
52	U2	-	wn	-	GPS week number
54	U1	-	timeSource	-	time source
55	U1	-	flags	-	Flag mask (remarks[1])

Remark[1]: Flag mask

bits	describe
B0	1=Position is valid
B1	1=Time is valid
B2	1=Clock frequency drift data is valid
B3	reserve
B4	1=Clock frequency data is valid
B5	1=Location is in LLA format
B6	1=Invalid height
B7	reserve

2.14.2 AID-HUI (0x0B 0x03)

information	AID-HUI				
describe	Auxiliary health information, UTC parameters, ionospheric parameters				
type	enter				
Notes	Configure navigation related parameters				
message structure	head	length (bytes)	identifier	Payload	checksum
	0xBA 0xCE	60	0x0B 0x03	see table below	4 Bytes

payload content

character offset	type of data	scaling	name	unit	describe
4	U4	-	HeaGps	-	Health information of GPS satellites (Note [1])
8	U4	-	HeaBds	-	Health information of BDS satellites (Note [1])
12	U4	-	HeaGln	-	Health information of GLONASS satellites (Note [1])
16	I4	2^{-30}	utcGpsA0	s	UTC parameter A0, the clock offset of GPS time relative to UTC
20	I4	2^{-50}	utcGpsA1	s/s	UTC parameter A1, clock speed of GPS time relative to UTC
twenty four	I1	-	utcGpsLS	s	The jump second from GPS time relative to UTC before the new jump second
25	I1	-	utcGpsLSF	s	The new jump seconds after the GPS time with respect to UTC
26	U1	-	utcGpsTow	s	Reference time of week for the UTC parameter of GPS
27	U1	-	utcGpsWNT	week	The reference week number for the UTC parameter of the GPS
28	U1	-	utcGpsWNF	week	GPS week number for which the new jumping second takes effect

29	U1	-	utcGpSDN	day	Days of the week for which the GPS new jumping seconds are in effect
30	I2	-	Res	-	reserve
32	I4	2^{-30}	utcBdsA0	s	UTC parameter A0, the clock offset of BDS time relative to UTC
36	I4	2^{-50}	utcBdsA1	s/s	UTC parameter A1, the clock speed of BDS time relative to UTC
40	I1	-	utcBdsLS	s	The jump second relative to UTC in BDS time before the new jump second
41	I1	-	utcBdsLSF	s	The jump seconds relative to UTC in BDS time after the new jump seconds
42	U1	-	utcBdsTow	s	Reference time of week for the UTC parameter of the BDS
43	U1	-	utcBdsWNT	week	The reference week number for the UTC parameter of the BDS
44	U1	-	utcBdsWNF	week	The day of the week for which the BDS new jump second takes effect
45	U1	-	utcBdsDN	day	The number of days in the week for which the new BDS jump seconds are in effect
46	I2	-	Res	-	reserve
48	I1	2^{-30}	klobA0	s/π	Klobuchar model parameter alpha0
49	I1	2^{-27}	klobA1	s/π_1	Klobuchar model parameter alpha1
50	I1	2^{-24}	klobA2	s/π^2	Klobuchar model parameter alpha2
51	I1	2^{-24}	klobA3	s/π3	Klobuchar model parameter alpha3
52	I1	2^{11}	klobB0	s/ π	Klobuchar model parameter beta0
53	I1	2^{14}	klobB1	s/π_1	Klobuchar model parameter beta1
54	I1	2^{16}	klobB2	s/π^2	Klobuchar model parameter beta2
55	I1	2^{16}	klobB3	s/π^3	Klobuchar model parameter beta3
56	U4	-	flags	-	mask of valid flags (remarks[2])

Remark [1]: B0 represents the No. 1 satellite, and so on, the corresponding bit is equal to 0, which means the satellite is healthy.	
Remark[2]: Valid flag	
bits	describe
B0	health information is valid
B1	UTC parameters are valid
B2	Ionospheric parameters are valid