STANDARD POSITIONING

PROTOCOL SPECIFICATION

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UFirebird II Series

GNSS Multi-Constellation Dual-Frequency Positioning Products

Revision History

Version	Revision History	Date
R1.0	• First release	Oct. 2022
R1.1	• Optimized the structure of the document • Applicable to UFirebird II series chips and modules • Added section 1.4 Start Information • Added section 2.3 Second NMEA Output • Added sections 3.2.2 PRODUCTINFO, 3.3.4 CFGDOP, 3.3.5 CFGMSM, 3.3.14 CFGWMODE, 3.3.16 CFGRTK, 3.3.17 CFGMSK, 3.3.18 CFGKILOWEEK, 3.3.19 CFGLEAPSEC, 3.3.20 CFGDYN, 3.3.21 CFGFWCHECK, 3.3.22 CFGLOGLIST, 3.3.26 CFGIMUMEAS, 3.4.4 NAVATT, 3.4.5 INSPVA, 3.4.7 INSTALL, 3.4.8 IMUVEH, 3.4.9 ODODATA and 3.6.3 OSNMA • Added Chapter 5 Extended RTCM messages • Updated sections 3.3.1 CFGPRT, 3.3.2 CFGMSG, 3.3.6 CFGNAV, 3.3.7 CFGSYS, 3.3.15 CFGTP, 3.3.25 CFGINS and 3.4.3 IMURAW	Jan. 2024
R1.2	• Added Table 5-3; updated Table 5-1 and Table 5-2; • Removed the checksum of OSNMA; • Added definitions of bit 28 and bit 29 in CFGSYS; • Added sections: 3.3.27 CFGNMEAMODE, 3.3.28 CFGGLARM, 3.3.29 CFGILARM, 3.5.3 ANTSTAT, 3.5.4 Ephemeris Lacking, 3.5.5 Data Incomplete, 3.6.4 QZQSM, 3.6.5 ENVINFO, 5.2.2.6 Leap Second Message, 5.2.2.8 Jamming and Spoofing Detection, 5.2.2.9 SBAS Message, 5.2.1.7 DR Protection Level Information, 5.2.2.5 Protection level Information, 5.2.2.10 Hardware status, 5.2.2.11 PPS Status; • Product model UM620N changed to UM620A, UM621N changed to UM621A; • Updated the “quality" field in Receiver Information (Sub ID 0xFF); • Updated the format of the PTV parameter in PRODUCTINFO; • Updated the “quality” field in NAVATT;	Dec. 2024

	• Updated the decimal places of longitude, latitude and ellipsoidal height in INSPVA; • Updated the description of the “flag” field in CFGTP.	
R1.3	• Added the message version in section 5.2.2 and 5.2.1.7. • Corrected typo (“bytes” to “bits”) in Table 5-17 GAL TGD/ISC Info. • 5.2.2.11 PPS Status (Sub ID 0x0E4): (1) modified the description of week, TowMs, TowSubMS. (2) removed “0xFE: UTC” in the TimeRef field. • Updated the notes in 3.3.7 CFGSYS. • Added the Antenna Status in 3.3.2 CFGMSG. • Added 5.2.2.6 Antenna Status (Sub ID 0x0EB). • Removed UM620 and UM621. For more information, see the *UM62X_Protocol Specification*. • B2b and B3I are supported (removed the “reserved” description) in 3.3.7 CFGSYS. • Updated a note related to UM670A UART2 in 3.3.1 CFGPRT. • Updated the output examples in 2.2.4 GSV. • Added B3I and B2I in Table 1-3 Signal Identifiers. • Added the “RTK fix” and “RTK float” modes in 2.2.6 VTG. • Modified the decimal places of the "time" field in 3.4.1 GYOACC and 3.4.5 INSPVA to 2 digits. • Modified the applicable products in 5.2.2.9 SBAS Information (Sub ID 0x0E8) and 5.2.2.10 Hardware Status (Sub ID 0x0E6).	Jun. 2025
R1.4	• Added 5.2.2.12 Satellite Information (Sub ID 0x0E1). • Added 5.2.2.13 AidInfo (Sub ID 0x0E0). • Added a note about OSNMA in 1.3 Data Types. • Added 3.2.3 PDTINFOC. • Updated bit5 and bit6 of the clrMask field in 3.2.4 RESET.	Jul. 2025

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Should you purchase our product and encounter any inconsistency, please contact us or our local authorized distributor for the most up-to-date version of this manual along with any addenda or corrigenda.

Target Readers

This manual applies to technicians who have certain knowledge in GNSS modules.

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List of Tables

1 General Introduction

1.1 Range of Application

This manual is applicable to UC6580, UM670A, UM680A and UM681A. See the specific message for its scope.

Product	Include
UC6580	UC6580I: Industrial-grade multi-constellation dual-frequency GNSS navigation and positioning chip UC6580A: Automotive grade multi-constellation dual-frequency navigation and positioning chip
UM670A	Automotive grade multi-constellation navigation and positioning module
UM680A	Automotive grade multi-constellation dual-frequency high precision RTK positioning module
UM681A	Automotive grade multi-constellation dual-frequency high precision RTK integrated positioning module

The receiver is delivered to you with default settings, and you can configure it according to section 3.3 to meet your needs.

1.2 GNSS/Satellite/Signal Identifiers

1.2.1 GNSS Identifiers

Table 1-1 GNSS Identifiers

Constellation	NMEA	Unicore	RTCM
GPS	1	1	Refer to Chapter 6 [1] RTCM Standard
BDS	4	4	
GAL	3	3	
GLO	2	2	
QZSS	5	5	
NavIC	6	6	

1.2.2 Satellite Identifiers

Table 1-2 Satellite Identifiers

Constellation	NMEA	Unicore	RTCM
GPS	01 to 32	01 to 32	Refer to Chapter 6 [1] RTCM Standard
SBAS (WAAS etc.)	33 to 64	33 to 64	
BDS	01 to 64	01 to 64	
SBAS (BDS SBAS etc.)	65 to 79	65 to 79	
GLO	65 to 92	65 to 92	
SBAS (SDCM etc.)	33 to 64	33 to 64	
GAL	01 to 36	01 to 36	
SBAS (EGNOS etc.)	37 to 64	37 to 64	
QZSS	01 to 10	01 to 10	
SBAS (MSAS etc.)	33 to 64	33 to 64	
NavIC	01 to 15	01 to 15	
SBAS (GAGAN etc.)	33 to 64	33 to 64	

1.2.3 Signal Identifiers

Table 1-3 Signal Identifiers

Frequency	NMEA	Unicore	RTCM
GPS L1C/A	1	1	Refer to Chapter 6 [1] RTCM Standard
GPS L2C-M	5	5	
GPS L5-Q	8	8	
GAL E5a	1	1	
GAL E5b	2	2	
GAL E1BC	7	7	
BDS B1I	1	1	
BDS B1C	3	3	
BDS B2a	5	5	
BDS B2b	6	6	
BDS B3I	8	8	
BDS B2I	B	B	
GLO G1	1	1	
GLO G2	3	3	
NavIC L5 SPS	1	1	
QZSS L1	1	1	
QZSS L2C-M	5	5	
QZSS L5-Q	8	8	

1.3 Data Types

In the protocol, input and output commands are collectively called messages. Each message is a string composed of ASCII characters.

Table 1-4 Message Type

Message Type	Description
Input	The message that inputs to the receiver
Output	The message that is output by the receiver
Input/Output	The message that can input to the receiver and also can be output by the receiver

In this protocol, the data in the message contains the following types:

String (STR)

The string consists of up to 32 ASCII characters except '\r' and '\n', such as GPSL1.

Unsigned Integers (UINT)

Unsigned integers range from 0 to 4294967295, and are defined in both decimal and hexadecimal. A decimal unsigned integer consists of ASCII characters 0 to 9 with a maximum of 10 characters, such as 123, 4291075193. A hexadecimal unsigned integer starts with the ASCII character h or H[1], followed by a string of 0 to 9 and a to f (or A to F), with a maximum of 8 characters (excluding the starting h or H), such as hE10, hE41BA7C0.

Signed Integers (INT)

Signed integers are composed of the ASCII characters 0 to 9 and a negative sign, in the range of -2147483648 to 2147483647, such as 123217754, -245278. It has 10 characters (excluding the negative sign) at most.

Double-precision Floating-point Data (DOUBLE)

Double-precision floating-point data consists of ASCII characters 0 to 9, a negative sign and decimal points, ranging from -2^1023 to 2^1023, such as 3.1415926, -9024.12367225. It has 20 characters at most.

Unsigned Long Integers (UINT64)

The integer has 16 characters (excluding the starting h or H) at most if it is in hexadecimal.

Table 1-5 Data Types

Symbol	Type	Length (bit)	Range
U4	Unsigned bitfield value of 4 bits width	4	[0,2^4-1]
U8	unsigned char	8	[0,2^8-1]
S8	signed char	8	[-2^7,2^7-1]
U16	unsigned short	16	[0,2^16-1)
S16	signed short	16	[-2^15,2^15-1]
U32	unsigned long	32	[0,2^32-1]
S32	signed long	32	[-2^31,2^31-1]
U64	unsigned long long	64	[0,2^64-1]
S64	signed long long	64	[-2^63,2^63-1]
int17	17 bit 2's complement integer	17	[-2^16,2^16-1]

[1] The OSNMA x1, x2, x3, …, x30 parameters do not start with h or H.

1.4 Start Information

At each power-on, the receiver outputs the start information, including product name, output port, part number, serial number, hardware version, firmware version and copyright information

Taking UM681A-12 for example:

UM681A-12 G1B1L1E1 COM1	Product name & output port
PN 2310414000034	Part number
SN PI10A2235000909	Serial number
HWVer 1.0	Hardware version
FWVer R6.0.3.0Build7926-220	Firmware version
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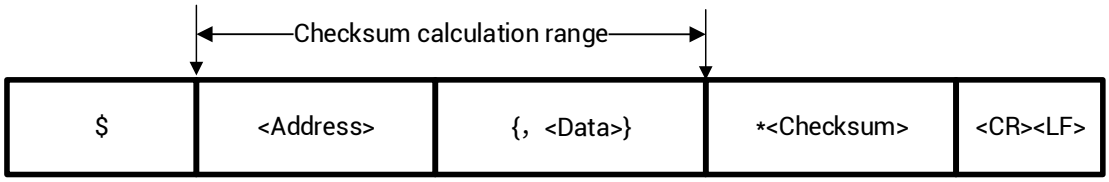
2 NMEA Messages

This chapter describes the NMEA V4.11 messages supported by the receivers, including GGA, GBS, GLL, GSA, GSV, RMC, VTG, ZDA and GST. Refer to the document [2] in Chapter 6 for more information.

Applicable to: UC6580, UM670A, UM680A, UM681A.

2.1 NMEA Messages Structure

The following figure shows the structure of a NMEA message.



Start Character	Address Field	Data Field	Checksum Field	End Sequence
Always “$”	Divided into two sections: The first two characters identify the TalkerID (eg: GP, GB etc.) and the latter three characters identify the message type	Separated by “,” and the data can be null	Two hexadecimal characters obtained by calculating an XOR of all characters between but not including ‘$’ to ‘*’ in this message	Each message ends with <CR><LF>

2.2 Standard NMEA Messages

2.2.1 GGA

Table 2-1 GGA Description

Syntax	$--GGA,time,Lat,N,Lon,E,FS,NoSV,HDOP,msl,M,Altref,M,DiffAge,DiffStation*cs\r\n	
Example	$GPGGA,060845.00,4004.74005,N,11614.19613,E,1,10,0.85,53.5,M,,M,,*7B	
Description	GNSS positioning data	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
--	STR	Positioning system flag GP - GPS standalone positioning GB - BDS standalone positioning GA - Galileo standalone positioning GL - GLONASS standalone positioning GI - NavIC standalone positioning GN - Dual or multiple constellations joint positioning
time	STR	UTC time; in the format of hhmmss.ss: hh - Hour mm - Minute ss.ss - Second
Lat	STR	Latitude; in the format of ddmm.mmmmm or ddmm.mmmmmmm: dd - Degree mm.mmmmm - Minute (applicable to UC6580, UM670A) mm.mmmmmmm - Minute (applicable to UM680A, UM681A)
N	STR	North or south latitude indicator N - North latitude S - South latitude
Lon	STR	Longitude; in the format of dddmm.mmmmm or dddmm.mmmmmmm: ddd - Degree mm.mmmmm - Minute (applicable to UC6580, UM670A) mm.mmmmmmm - Minute (applicable to UM680A, UM681A)
E	STR	East longitude or west longitude indicator: E - East longitude W - West longitude
FS	UINT	Positioning status indicator: 0 - Invalid

		1 - Single point positioning 2 - Differential positioning 4 - RTK fixed solution 5 - RTK float solution 6 - INS positioning
NoSV	UINT	Number of satellites participating in positioning
HDOP	DOUBLE	Horizontal dilution of precision; output 2 decimal places; value range is 0.00 to 99.99 and the value is 99.99 when not positioning
msl	DOUBLE	Ellipsoidal height or geoid height; output 1 or 3 decimal places: 1 decimal place for UC6580 and UM670A 3 decimal places for UM680A and UM681A
M	STR	Unit of ellipsoidal height or geoid height; specified to constant M
Altref	DOUBLE	Geoidal separation; only valid when the geoidal separation function is enabled; output 1 or 3 decimal places: 1 decimal place for UC6580 and UM670A 3 decimal places for UM680A and UM681A
M	STR	Unit of Geoidal separation; specified to constant M
DiffAge	DOUBLE	Differential correction latency; unit: s; output 1 decimal place; null for non-differential positioning
DiffStation	UINT	Differential reference station ID; null for non-differential positioning
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

2.2.2 GLL

Table 2-2 GLL Description

Syntax	$--GLL,Lat,N,Lon,E,time,Valid,Mode*cs\r\n	
Example	$GPGLL,4004.74005,N,11614.19613,E,060845.00,A,A*6F	
Description	Geographic position - Longitude/Latitude	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
--	STR	Positioning system flag GP - GPS standalone positioning GB - BDS standalone positioning GA - Galileo standalone positioning GL - GLONASS standalone positioning GI - NavIC standalone positioning GN - Dual or multiple constellations joint positioning
Lat	STR	Latitude; in the format of ddmm.mmmmm or ddmm.mmmmmmm: dd - Degree mm.mmmmm - Minute (applicable to UC6580, UM670A) mm.mmmmmmm - Minute (applicable to UM680A, UM681A)
N	STR	North or south latitude indicator: N - North latitude S - South latitude
Lon	STR	Longitude; in the format of dddmm.mmmmm or dddmm.mmmmmmm: ddd - Degree mm.mmmmm - Minute (applicable to UC6580, UM670A) mm.mmmmmmm - Minute (applicable to UM680A, UM681A)
E	STR	East longitude or west longitude indicator: E - East longitude W - West longitude
time	STR	UTC time; in the format of hhmmss.ss: hh - Hour mm - Minute ss.ss - Second
Valid	STR	Position valid indicator: V - Invalid A - Valid
Mode	STR	Positioning system mode indicator: N - Not positioning

		A - Single Point positioning D - Differential positioning E - INS positioning
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

2.2.3 GSA

Table 2-3 GSA Description

Syntax	$--GSA,Smode,FS,sv1,sv2,sv3,sv4,sv5,sv6,sv7,sv8,sv9,sv10,sv11,sv12,PDOP,HDOP,VDOP,systemID*cs\r\n	
Example	$GPGSA,A,3,02,03,06,09,12,17,19,23,28,25,,,1.34,0.85,1.04,1*1E	
Description	GNSS dilution of precision and active satellites	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
--	STR	Positioning system flag GP - GPS standalone positioning GB - BDS standalone positioning GA - Galileo standalone positioning GL - GLONASS standalone positioning GI - NavIC standalone positioning GN - Dual or multiple constellations joint positioning
Smode	STR	Positioning mode specified states: M - Manually specify 2D or 3D positioning A - Automatically switch to 2D or 3D positioning
FS	UINT	Positioning mode: 1 - Not positioning 2 - 2D positioning 3 - 3D positioning
sv1 to sv12	UINT	ID of satellites participating in positioning; when there are less than 12 satellites participating in positioning, the insufficient area is filled in empty; when there are more than 12 satellites, it only outputs the first 12 satellites; see Table 1-2 for satellite IDs
PDOP	DOUBLE	Position dilution of precision; range: 0.00 to 99.99; the value is 99.99 when not positioning
HDOP	DOUBLE	Horizontal dilution of precision; range: 0.00 to 99.99; the value is 99.99 when not positioning
VDOP	DOUBLE	Vertical dilution of precision; range: 0.00 to 99.99; the value is 99.99 when not positioning

systemID	UINT	GNSS system ID; see Table 1-1
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

2.2.4 GSV

Table 2-4 GSV Description

Syntax	$--GSV,NoMsg,MsgNo,NoSv,sv1,elv1,az1,cno1,sv2,elv2,az2,cno2,sv3,elv3,az3,cno3,sv4,elv4,az4,cno4,signalID*cs\r\n	
Example	$GBGSV,3,1,12,29,71,095,50,30,18,118,40,07,61,185,43,08,62,247,43,1*74 $GBGSV,3,2,12,10,68,215,44,13,49,241,43,19,49,184,46,20,63,080,50,1*72 $GBGSV,3,3,12,32,14,039,41,35,41,309,46,38,76,264,49,40,57,157,46,1*75	
Description	GNSS satellites in view; each GSV message contains information for only 4 satellites. When the number of satellites exceeds 4, the receiver sends multiple GSV messages continuously	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
--	STR	Positioning system flag: GP - GPS/WAAS satellite information GB - BDS/BDS SBAS satellite information GA - GAL/EGNOS satellite information GL - GLO/SDCM satellite information GI - NavIC/GAGAN satellite information GQ - QZSS/MASAS satellite information
NoMsg	UINT	Total number of GSV messages on the current system at the current frequency; the minimum value is 1 and the maximum value is 9
MsgNo	UINT	GSV message ID; the minimum value is 1 and the maximum value is 9
NoSv	UINT	Total number of visible satellites on the current system at the current frequency
sv1 to sv4	UINT	Satellite IDs of the first to fourth satellite; see Table 1-2.
elv1 to elv4	UINT	Elevation of the first to fourth satellite; unit: deg; range: 0 to 90; fixed output of 2 digits; add leading zeros if less than 2 digits

az1 to az4	UINT	Azimuth of the first to fourth satellite; unit: deg; range: 0 to 359; fixed output of 3 digits; add leading zeros if less than 3 digits
cno1 to cno4	UINT	CNR of the first to fourth satellite; unit: dB-Hz; range: 0 to 99; fixed output of 2 digits; add leading zeros if less than 2 digits; fill null for untracked satellites
signalID	UINT	Signal ID defined by NMEA protocol; see Table 1-3.
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

2.2.5 RMC

Table 2-5 RMC Description

Syntax	$--RMC,time,status,Lat,N,Lon,E,spd,cog,date,mv,mvE,mode,navStates*cs\r\n	
Example	$GPRMC,060845.00,A,4004.74005,N,11614.19613,E,0.000,,180817,,,A,V*0B	
Description	The recommended minimum data	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
--	STR	Positioning system flag GP - GPS standalone positioning GB - BDS standalone positioning GA - Galileo standalone positioning GL - GLONASS standalone positioning GI - NavIC standalone positioning GN - Dual or multiple constellations joint positioning
time	STR	UTC time; in the format of hhmmss.ss: hh - Hours mm - Minute ss.ss - Second
status	STR	Position valid indicator: V - Invalid A - Valid
Lat	STR	Latitude; in the format of ddmm.mmmmm or ddmm.mmmmmmm: dd - Degree mm.mmmmm - Minute (applicable to UC6580, UM670A) mm.mmmmmmm - Minute (applicable to UM680A, UM681A)

N	STR	North or south latitude indicator: N - North latitude S - South latitude
Lon	STR	Longitude; in the format of dddmm.mmmmm or dddmm.mmmmmmm: ddd - Degree mm.mmmmm - Minute (applicable to UC6580, UM670A) mm.mmmmmmm - Minute (applicable to UM680A, UM681A)
E	STR	East longitude or west longitude indicator: E - East longitude W - West longitude
spd	DOUBLE	Speed over ground; unit: knot; output 3 decimal places
cog	DOUBLE	Course over ground; unit: deg; output 2 decimal places; calculated clockwise from north
date	STR	UTC date; in the format of ddmmyy: dd - Day mm - Month yy - Year
mv	DOUBLE	Magnetic variation; specified to null
mvE	STR	Magnetic variation direction; specified to null
mode	STR	Positioning mode: N - Not positioning A - Single point positioning D - Differential positioning E - INS positioning F - RTK floating solution R - RTK fixed solution
navStates	STR	Navigation states flag; output 'V': V - Device does not provide navigation state information
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

2.2.6 VTG

Table 2-6 VTG Description

Syntax	$--VTG,cogt,T,cogm,M,sog,N,kph,K,mode*cs\r\n	
Example	$GPVTG,,T,,M,0.000,N,0.000,K,A*23	
Description	Course over ground and ground speed	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
--	STR	Positioning system flag GP - GPS standalone positioning GB - BDS standalone positioning GA - Galileo standalone positioning GL - GLONASS standalone positioning GI - NavIC standalone positioning GN - Dual or multiple constellations joint positioning
cogt	DOUBLE	Course over ground with reference to true north; unit: deg; range: 0.00 to 359.99
T	STR	Course flag; specified to constant T
cogm	DOUBLE	Course over ground with reference to magnetic north; unit: deg; range: 0.00 to 359.99
M	STR	Course flag; specified to constant M
sog	DOUBLE	Speed over ground; unit: knot; output 3 decimal places
N	STR	Unit of speed; specified to constant N
kph	DOUBLE	Speed over ground; unit: km/h; output 3 decimal places
K	STR	Unit of speed; specified to constant K
mode	STR	Positioning mode: N – Not positioning A – Point positioning D – Differential positioning E – Inertial positioning F – RTK float R – RTK fix
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

2.2.7 ZDA

Table 2-7 ZDA Description

Syntax	$--ZDA,time,day,mon,year,ltzh,ltzn*cs\r\n	
Example	$GPZDA,060845.00,18,08,2017,00,00*6C	
Description	Time and date	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
--	STR	Positioning system flag GP - GPS standalone positioning GB - BDS standalone positioning GA - Galileo standalone positioning GL - GLONASS standalone positioning GI - NavIC standalone positioning GN - Dual or multiple constellations joint positioning
time	STR	UTC time; in the format of hhmmss.ss: hh - Hours mm - Minute ss.ss - Second
day	UINT	UTC day with two digits; range: 01 to 31
mon	UINT	UTC month with two digits; range: 01 to 12
year	UINT	UTC year with four digits
ltzh	UINT	Local zone hours; output 00
ltzn	UINT	Local zone minutes; output 00
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

2.2.8 GST

Table 2-8 GST Description

Syntax	$--GST,time,rngRMS,stdMajor,stdMinor,hdg,stdLat,stdLon,stdAlt*cs\r\n	
Example	$GNGST,062516.40,0.6,0.1,0.1,113.2,0.5,0.6,1.0*4E	
Description	GNSS pseudorange error statistics	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
--	STR	Positioning system flag GP - GPS standalone positioning GB - BDS standalone positioning GA - Galileo standalone positioning GL - GLONASS standalone positioning GI - NavIC standalone positioning GN - Dual or multiple constellations joint positioning
time	STR	UTC time; in the format of hhmmss.ss: hh - Hour mm - Minute ss.ss - Second
rngRMS	DOUBLE	Standard deviation of pseudorange error; unit: m; with a maximum of 99.9; output 1 decimal place
stdMajor	DOUBLE	Standard deviation of semi-major axis of the error ellipse; unit: m; output 1 decimal place
stdMinor	DOUBLE	Standard deviation of semi-minor axis of the error ellipse; unit: m; output 1 decimal place
hdg	DOUBLE	Orientation of semi-major axis of the error ellipse; unit: deg; clockwise from north; output 1 decimal place
stdLat	DOUBLE	Standard deviation of latitude error; unit: m; output 1 decimal place
stdLon	DOUBLE	Standard deviation of longitude error; unit: m; output 1 decimal place
stdAlt	DOUBLE	Standard deviation of altitude error; unit: m; output 1 decimal place
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

2.2.9 GBS

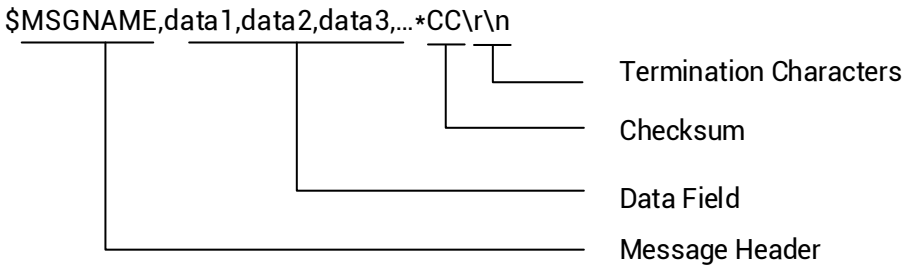
Table 2-9 GBS Description

Syntax	$-GBS,time,errLat,errLon,Lon,errAlt,Svid,Prob,Bias,Std,systemID,signalID*cs\r\n	
Example	$GPGBS,121314.00,0.5,0.6,0.9,03,,100.4,5.0,1,1*4C	
Description	RAIM error information	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
--	STR	Positioning system flag GP - GPS standalone positioning GB - BDS standalone positioning GA - Galileo standalone positioning GL - GLONASS standalone positioning GI - NavIC standalone positioning GN - Dual or multiple constellations joint positioning
time	STR	UTC time; in the format of hhmmss.ss: hh - Hour mm - Minute ss.ss - Second
errLat	DOUBLE	Latitude error; unit: m; output 1 decimal place
errLon	DOUBLE	Longitude error; unit: m; output 1 decimal place
errAlt	DOUBLE	Altitude error; unit: m; output 1 decimal place
Svid	UINT	Number of satellites that most likely have problems; output 2 digits
Prob	DOUBLE	Probability of missed detection for the satellites that most likely have problems; specified to constant null
Bias	DOUBLE	Estimation error of the satellites that most likely have problems; specified to constant null
Std	DOUBLE	Standard deviation of the estimation error; specified to constant null
systemID	UINT	GNSS system ID; see Table 1-1
signalID	UINT	Signal ID defined by NMEA protocol; see Table 1-3
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

3 Unicore Messages

3.1 Messages

The basic format of the Unicore message is:



All messages include the following parts:

- Message header. It starts with '$' (0x24).
- Data field. It follows a delimiter "," (0x2C) and consists of a number of parameters or data. The adjacent data are also separated by the delimiter ",".
- Checksum. It is separated from the previous data by '*' (0x2A).
- Termination characters. The input message ends with '\r' (0x0D) or '\n' (0x0A) or any combination of the two. The output message ends with '\r\n'.

The termination characters are omitted in Unicore Messages, as shown in each table of message introduction.

Message header and parameters, as well as letters in the checksum are case-sensitive, and the command echoes according to your inputs.

The total length of each message cannot exceed 128 bytes.

Some parameters of the commands can be omitted (marked as optional in the command description), which means that those parameters can be empty and there is no character between the two delimiters ',,' or ',*'. If there is no special instruction, the parameter is ignored and the option it controls remains unchanged.

Most of the message headers can be used for both input commands and output messages. As the input, it sets parameters or queries the current configuration; as the output, it outputs the receiver information or configuration.

Checksum

The two characters after '*'(0x2A) in the message are the checksum, which is the XOR of all characters (excluding '$' and '*') from '$' to '*'in hexadecimal.

The checksum in the input command is optional. If the input message contains '*' followed by two characters, the checksum is examined. If it is wrong, the command is not executed, and the receiver outputs the $FAIL message, in which a checksum error appears. If the message does not contain a checksum, the command is executed directly.

The output message (except for OSNMA) always contains a checksum.

3.2 General Messages

3.2.1 PDTINFO: Product Information Inquiry

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-1 Read Product Information

Syntax	$PDTINFO
Example	$PDTINFO
Description	Read product information. The receiver outputs PDTINFO message after receiving this command.
Input/Output	Input
No parameters	

Table 3-2 Output Product Information

Syntax	$PDTINFO,pdtName,config,hwVer,fwVer,PN,SN*cs	
Example	$PDTINFO,UM681A-12,G1B1L1E1,V1.0,R6.0.3.0Build7926-220,2310414000034,PI10A2235000909*22	
Description	The receiver outputs product information.	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
pdtName	STR	Product model
config	STR	Flag of satellite system: Gx - GPS Bx - BDS Lx - GLONASS Ex - Galileo Nx - NavIC Note: This flag does not change with configuration changes.
hwVer	STR	Hardware version
fwVer	STR	Firmware version
PN	STR	Part number (null for a chip)
SN	STR	Serial number (chip ID for a chip)
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

3.2.2 PRODUCTINFO: Complete Product Information Inquiry

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-3 Read Complete Product Information (PRODUCTINFO)

Syntax	$PRODUCTINFO
Example	$PRODUCTINFO
Description	Read complete product information. The receiver outputs PRODUCTINFO message after receiving this command.
Input/Output	Input
No parameters	

Table 3-4 Output Complete Product Information (PRODUCTINFO)

Syntax	$PRODUCTINFO,pdtName,config,hwVer,fwVer,PN,SN,PTV,RSV,RSV,RSV,RSV*cs	
Example	$PRODUCTINFO,UM681A-12,G1B1L1E1,V1.0,R6.0.3.0Build7926-220,2310414000034,PI10A2235000909,R1.2,,,,*7A	
Description	The receiver outputs complete product information.	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
pdtName	STR	Product model
config	STR	Flag of satellite system: Gx - GPS Bx - BDS Lx - GLONASS Ex - Galileo Nx - NavIC Note: This flag does not change with configuration changes.
hwVer	STR	Hardware version
fwVer	STR	Firmware version
PN	STR	Part number (null for chips)
SN	STR	Serial number (chip ID for chips)
PTV	STR	Protocol version
RSV		Reserved
RSV		Reserved
RSV		Reserved
RSV		Reserved
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

3.2.3 PDTINFOC: Complete Product Information Inquiry

Applicable to: UM680A-13, UM670A-03

Table 3-5 Read Complete Product Information (PDTINFO)

Syntax	$PDTINFOC
Example	$PDTINFOC
Description	Read complete product information. The receiver outputs PDTINFOC message after receiving this command.
Input/Output	Input
No parameters	

Table 3-6 Output Complete Product Information (PDTINFO)

Syntax	$PDTINFOC,pdtName,config,hwVer,fwVer,PN,SN,PTV,CUV,RSV,RSV,RSV*cs	
Example	$PDTINFOC,UM670-03,G1B1L1E1,V1.2,R6.0.0.0Build2810,2310414000033,000101114303845,P1.1.19,V1.2.1,,,*61	
Description	The receiver outputs complete product information.	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
pdtName	STR	Product model
config	STR	Flag of satellite system: Gx - GPS Bx - BDS Lx - GLONASS Ex - Galileo Nx - NavIC Note: This flag does not change with configuration changes.
hwVer	STR	Hardware version
fwVer	STR	Firmware version
PN	STR	Part number (null for chips)
SN	STR	Serial number (chip ID for chips)
PTV	STR	Protocol version
CUV	STR	Customer-related version
RSV		Reserved
RSV		Reserved

RSV		Reserved
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

3.2.4 RESET: Receiver Reset

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-7 Receiver Reset

Syntax	$RESET,type,clrMask	
Example	$RESET,0,h01 (warm start)	
Description	Receiver reset	
Input/Output	Input	
Parameter Definition		
Parameter	Format	Description
type	UINT	Reset type: 0 - Software reset 1 - Chip-level reset (watchdog reset) 2 - Board-level reset (not supported currently) 3 - Receiver stops working
clrMask	UINT	Set the corresponding bit to 1 to clear the saved information during the reset: bit0 - Clear ephemeris bit1 - Reserve0 bit2 - Clear receiver position and time bit3 - Clear initial navigation parameter (applicable to integrated products) bit4 - Clear ionosphere correction parameter and UTC parameter bit5 – Clear time bit6 – Clear position bit7 - Clear almanac Three common start methods: H00 - Hot start H01 - Warm start H85/HFF - Cold start

Use H85 or HFF (recommended) to have a cold start, and an incorrect parameter can cause the receiver to start in a wrong state.
When a leap second occurs, it may take the receiver 25 minutes to sync with the UTC time after a cold start reset.

3.2.5 OK: Message Response Mechanism

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-8 Correct Execution of a Command

Syntax	$OK*cs	
Example	$OK*04	
Description	A response that the receiver executed the command correctly. This message only outputs at the port receiving the command.	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

3.2.6 FAIL: Message Response Mechanism

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-9 Incorrect Execution of a Command

Syntax	$FAIL,errorCode*cs	
Example	$FAIL,0*1E	
Description	A response that the parameters or the checksum in the input command is incorrect. No response to the illegal command. This message only outputs at the port receiving the command.	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
errorCode	UINT	Error code: 0 - Incorrect parameters 1 - Incorrect checksum
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

3.3 Configuration Messages

3.3.1 CFGPRT: Configure the Output Port

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-10 Read Port Configuration

Syntax	$CFGPRT,portID	
Example	$CFGPRT,1	
Description	Read the receiver port configuration. The receiver outputs CFGPRT message after receiving this command.	
Input/Output	Input	
Parameter Definition		
Parameter	Format	Description
portID	UINT	Port number: 0, 1, 2, 4

Table 3-11 Set/Output Port Configuration

Syntax	$CFGPRT,portID,addr,baud,inPro,outPro	
Example	$CFGPRT,1,0,115200,1,3	
Description	Set or output the port configuration.	
Input/Output	Input/output	
Parameter Definition		
Parameter	Format	Description
portID	UINT	Port number: 0 - I²C* 1 - UART1 2 - UART2* 4 - SPI* If empty, configure the current port.
addr	UINT	UART - fixed at 0 or null I²C - slave address[2]; fixed at 0x46 when inquiring and must be null when configuring, otherwise it would return FAIL.

* I²C and SPI interfaces are only supported by the specific firmware; if your firmware does not support I²C and SPI, this message will return $FAIL,0*1E when you set or make an inquiry. UART2 is supported by UM670A hardware V1.3 and later versions.

[2] The default slave address is 0x46 which cannot be changed via commands.

baud	UINT	For UART, the baud rate could be set as: 9600/14400/19200/38400/57600/115200/230400/460800/921600 For I^2C, the parameter is null while inquiring and must be null while configuring, otherwise it would return FAIL.
inPro	UINT	Port input protocol; set the corresponding bit to 1 to enable it: bit0 - UNICORE bit7 - RTCM3.3 (compatible with RTCM3.2) bit10 – MAPFB and ODODATA input protocol (applicable to UM681A)
outPro	UINT	Port output protocol; set the corresponding bit to 1 to enable it: bit0 - UNICORE bit1 - NMEA bit2 - RTCM3.3 (compatible with RTCM3.2) bit5 - Notice messages bit7 - Extended RTCM 4074_DR messages (applicable to UM681A) bit8 - Extended RTCM 4074_PVT messages (applicable to UC6580, UM670A, UM680A)

If you need to output a message at a higher rate, such as 10 Hz, increase the baud rate. Otherwise, incomplete satellite information may appear.

Do not disable the UNICORE input, otherwise it can cause an abnormal command receiving and returns FAIL.

3.3.2 CFGMSG: Configure Message Output Frequency

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-12 Read Message Output Configuration

Syntax	$CFGMSG,msgClass,msgID	
Example	$CFGMSG,0,1	
Description	Read the message output configuration. The receiver outputs CFGMSG message after receiving this command.	
Input/Output	Input	
Parameter Definition		
Parameter	Format	Description
msgClass	UINT	Message class; see Table 3-14 Message Class and ID
msgID	UINT	Message ID; see Table 3-14 Message Class and ID

Table 3-13 Set/Output Message Output Frequency

Syntax	$CFGMSG,msgClass,msgID,Rate/Switch

Example	$CFGMSG,0,1,1	
Description	Set or output the message output frequency.	
Input/Output	Input/output	
Parameter Definition		
Parameter	Format	Description
msgClass	UINT	Message class; see Table 3-14 Message Class and ID
msgID	UINT	Message ID; see Table 3-14 Message Class and ID;
Rate/Switch	UINT	Rate: The ratio of reference output frequency to the configured output frequency; range: 0 to 100; 0 means disable the output. Take a NMEA message as an example: The NMEA message reference output frequency is equal to the positioning frequency (1000/NavRate), and the Rate defines that the receiver selects a message to output after performing N times positioning solutions. Eg. When the positioning frequency is configured to be 10 Hz by CFGNAV, if you need an output frequency at 10 Hz, then you configure the rate to 1, and similarly configure the rate to 2 if 5 Hz output frequency is needed. In summary, in NMEA messages Rate = 1000/NavRate/Output frequency Note: The reference output frequency cannot be less than the actual output frequency, and 1000/NavRate can be divisible by Rate or Rate can be divisible by 1000/NavRate. Switch: 0 - Disable the corresponding message 1 - Enable the corresponding message

Table 3-14 Message Class and ID

Standard NMEA Messages	Class	ID	Rate
GGA	0: Configure the four ports or query the current port 100: NMEA messages at I²C port 200: NMEA messages at UART1 port 300: NMEA messages at UART2 port 400: NMEA messages at SPI port	0	1000/NavRate/Output frequency
GLL		1	
GSA		2	
GSV		3	
RMC		4	
VTG		5	
ZDA		6	
GST		7	
GBS		8	
RTCM Messages[3]	Class	ID	Rate
RTCM MSM	2: Configure the four ports or query the current port 102: Observation messages at I²C port 202: Observation messages at UART1 port 302: Observation messages at UART2 port 402: Observation messages at SPI port	3	1000/MeasRate/Output frequency
RTCM EPH		4	
RTCM STM (1005)		5	
System Parameters (1013)		14	
Sensor Fusion Message[4]	Class	ID	Rate
GYOACC	4: Configure the four ports or query the current port 104: Sensor fusion messages at I²C port 204: Sensor fusion messages at UART1 port 304: Sensor fusion messages at UART2 port 404: Sensor fusion messages at SPI port	0	1000/DRNavRate/Output frequency
SNRSTAT		1	
NAVATT		2	
IMURAW		3	1000/IMUMeasRate/Output frequency
INSPVA		4	1000/DRNavRate/Output frequency
IMUVEH		5	1000/IMUMeasRate/Output frequency
Misc Message	Class	ID	Switch

[3] Supported by UM670A (some of the sub-models), UM680A and UM681A.

[4] Supported by UM681A.

CWOUT[5]	5: Configure the four ports or query the current port 105: Misc messages at I²C port 205: Misc messages at UART1 port 305: Misc messages at UART2 port 405: Misc messages at SPI port	0	0 - disable; 1 - enable
OSNMA[6]		1	0 - disable; 1 - enable
QZQSM[5]		2	0 - disable; 1 - enable
ENVINFO		3	1000/NavRate/Output frequency
Notice Message	Class	ID	Rate
General Notice Messages	6: Configure the four ports or query the current port 106: Notice messages at I²C port 206: Notice messages at UART1 port 306: Notice messages at UART2 port 406: Notice messages at SPI port	0	1000/NavRate/Output frequency
Notice Message Package		1	
Command Echo		2	0 - disable; 1 - enable
Antenna Status		3	1000/NavRate/Output frequency
Ephemeris Lacking		4	0 - disable; 1 - enable
Data Incomplete		5	0 - disable; 1 - enable
Extended RTCM Messages[4]	Class	ID	Rate
GYOACC	8: Configure the four ports or query the current port 108: Observation messages at I²C port 208: Observation messages at UART1 port 308: Observation messages at UART2 port 408: Observation messages at SPI port	0	1000/DRNavRate/Output frequency
SNRSTAT		1	
NAVATT		2	
IMURAW		3	1000/IMUMeasRate/Output frequency
INSPVA		4	1000/DRNavRate/Output frequency
IMUVEH		5	1000/IMUMeasRate/Output frequency
DR Protection level Information		6	0 - disable; 1 - enable; rate = 1000/NavRate

[5] Output at constant 1 Hz.

[6] Output at constant 0.5 Hz only when there is no error code in GALILEO messages

Extended RTCM Messages	Class	ID	Rate
Receiver Information	9: Configure the four ports or query the current port 109: Observation messages at I²C port 209: Observation messages at UART1 port 309: Observation messages at UART2 port 409: Observation messages at SPI port	1	1000/MeasRate/Output frequency
Signal Information		2	
TGD/ISC Information		3	0 - disable; 1 - enable; output once every 30 seconds
Ionosphere Information		4	
Antenna Status		6	1000/MeasRate/Output frequency
Leap Second Message		7	1000/MeasRate/Output frequency
Jamming and Spoofing Detection		8	
SBAS Information		9	0 - disable; 1 - enable
Protection level Information		11	0 - disable; 1 - enable; rate = 1000/NavRate
Hardware Status		15	0 - disable; 1 - enable; output at 1 Hz
PPS Status		16	
Satellite Information		19	1000/MeasRate/Output frequency
AidInfo		20	

The COM2 of UM680A and UM681A only supports the output and frequency configuration of four types of messages: NMEA messages, Notice messages, Misc messages, and extended RTCM messages (PVT). Other messages cannot be output through COM2.

See section 3.3.6 CFGNAV for the information of NavRate, MeasRate and DRNavRate, and section 3.3.24 CFGIMUMEAS for that of IMUMeasRate.

3.3.3 CFGNMEA: Read NMEA Configuration

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-15 Read NMEA Configuration

Syntax	$CFGNMEA
Example	$CFGNMEA
Description	Read the current NMEA configuration. The receiver outputs the NMEA version H52 (NMEA 4.11) after receiving this command. The output is $CFGNMEA,H52*26.
Input/Output	Input
No parameters	

3.3.4 CFGDOP: Configure Doppler Sign

Applicable to: UM670A[7], UM680A, UM681A

Table 3-16 Read Doppler Sign Configuration

Syntax	$CFGDOP
Example	$CFGDOP
Description	Read the current Doppler sign configuration. The receiver outputs the CFGDOP message after receiving this command.
Input/Output	Input
No parameters	

Table 3-17 Set/Output Doppler Sign Configuration

Syntax	$CFGDOP,DopplerSignal,Reserved	
Example	$CFGDOP,0,0	
Description	Set/Output the configuration of Doppler sign in the observations.	
Input/Output	Input/Output	
Parameter Definition		
Parameter	Format	Description
DopplerSignal	UINT	Doppler sign configuration: 0 - Output raw Doppler information 1 - Output the Doppler information after taking the opposite number
Reserved	UINT	Reserved

[7] Only some of the sub-models of UM670A support the output of raw data.

3.3.5 CFGMSM: Configure the Observation Type

Applicable to: UM670A, UM680A, UM681A

Table 3-18 Read Observations Type Configuration

Syntax	$CFGMSM
Example	$CFGMSM
Description	Read the current observations type configuration. The receiver outputs the CFGMSM message after receiving this command.
Input/Output	Input

Table 3-19 Set/Output Observations Type

Syntax	$CFGMSM,MsmType,Reserved	
Example	$CFGMSM,7,0	
Description	Set/Output the configuration of observations type	
Input/Output	Input/Output	
Parameter Definition		
Parameter	Format	Description
MsmType	UINT	Output the observations type: 4 - Pseudoranges and PhaseRanges plus CNR 5 - Pseudoranges PhaseRanges PhaseRangeRate and CNR 7 - Pseudoranges PhaseRanges PhaseRangeRate and CNR (high resolution)
Reserved	UINT	Reserved

3.3.6 CFGNAV: Configure Positioning Frequency

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-20 Read Positioning Frequency Configuration

Syntax	$CFGNAV
Example	$CFGNAV
Description	Read the positioning frequency configuration. The receiver outputs CFGNAV message after receiving this command.
Input/Output	Input
No parameters	

Table 3-21 Set/Output Positioning Frequency Configuration

Syntax	$CFGNAV,MeasRate,NavRate,DRNavRate	
Example	$CFGNAV,1000,1000,100	
Description	Set or output positioning frequency configuration	
Input/Output	Input/output	
Parameter Definition		
Parameter	Format	Description
MeasRate	UINT	Observation interval; unit: ms; 1000 - corresponding to 1 Hz observation frequency 200 - corresponding to 5 Hz observation frequency 100 - corresponding to 10 Hz observation frequency
NavRate	UINT	GNSS positioning interval; unit: ms; 1000 - corresponding to 1 Hz GNSS positioning frequency 200 - corresponding to 5 Hz GNSS positioning frequency 100 - corresponding to 10 Hz GNSS positioning frequency
DRNavRate	UINT	INS positioning interval; unit: ms; 100 - corresponding to 10 Hz INS positioning frequency 50 - corresponding to 20 Hz INS positioning frequency 20 - corresponding to 50 Hz INS positioning frequency Except for the integrated products, the parameter is invalid for other modules which return 0 when making an inquiry.

measRate and navRate should be the same, otherwise, the message would return FAIL.

When the GNSS positioning frequency is 10 Hz, CFGINS cannot be configured to 2 - Vehicle-mounted mode to enable the second NMEA output.

After the configuration of NavRate is finished, GSV and the RTCM Ephemeris will be reset to output at 1 Hz, and the Ionosphere Information and TGD/ISC Information in extended RTCM messages will output once every 30 s.

After the configuration of DRNavRate is finished, SNRSTAT will output at 1 Hz.

3.3.7 CFGSYS: Configure Satellite System

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-22 Read Satellite System Configuration

Syntax	$CFGSYS
Example	$CFGSYS
Description	Read the current satellite system configuration. The receiver outputs the CFGSYS message after receiving the command.
Input/Output	Input
No parameter	

Table 3-23 Set/Output Satellite System Configuration

Syntax	$CFGSYS,sysMask	
Example	$CFGSYS,h55155	
Description	Set or output satellite system and frequency configuration. The receiver resets automatically after receiving the command, and the enabled frequencies take effect after the reset.	
Input/Output	Input/output	
Parameter Definition		
Parameter	Format	Description
sysMask	UINT	Enabled frequency; set the corresponding bit to 1 to enable it: bit0 - GPS L1CA bit1 - GPS L2* bit2 - GPS L5 bit3 - GPS L1C (reserved) bit4 - BDS B1I bit5 - BDS B2b bit6 - BDS B2a bit7 - BDS B1C bit8 - GLONASS L1 bit9 - GLONASS L2 (reserved) bit10:11 - Reserved bit12 - GALILEO E1 bit13 - GALILEO E5b (reserved) bit14 - GALILEO E5a bit15 - Reserved bit16 - QZSS L1CA bit17 - QZSS L2 (reserved) bit18 - QZSS L5 bit19 - reserved

* Supported by the specific firmaware.

		bit20 - SBAS bit21 to bit23 - reserved bit24 - NavIC L5 SPS (reserved) bit25 to bit31 - reserved bit28 - BDS B2I (reserved) bit29 - BDS B3I

The reserved bit is specified to constant 0.

QZSS can function effectively only when GPS is enabled.

SBAS can function effectively only when GPS or BDS is enabled.

When configuring L5 of multiple constellations, each constellation must be enabled or disabled at the same time.

3.3.8 CFGGEOID: Configure Height

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-24 Read Height Configuration

Syntax	$CFGGEOID
Example	$CFGGEOID
Description	Read the current height configuration. The receiver outputs the CFGGEOID message after receiving the command.
Input/Output	Input
No parameter	

Table 3-25 Set/Output Height Configuration

Syntax	$CFGGEOID,Model	
Example	$CFGGEOID,1	
Description	Set or output the height configuration.	
Input/Output	Input/output	
Parameter Definition		
Parameter	Format	Description
Model	UINT	0 - Outputs the ellipsoidal height 1 - Outputs the geoid height

3.3.9 CFGSAVE: Save the Configuration

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-26 Save the Configuration

Syntax	$CFGSAVE
Example	$CFGSAVE
Description	Save the current configuration, which is stored in the memory.
Input/Output	Input
No parameter	

Do NOT power off the product within one second after entering the **$CFGSAVE** command. A power off during this process may cause damage to the receiver's configuration, and the configuration will be restored to factory settings. After configuring the parameters, if you do not type in the CFGSAVE, the configurations will not be effective after the reset.

This command is only applicable to the flash-version products.

3.3.10 CFGCLR: Clear the Configuration

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-27 Clear the Configuration

Syntax	$CFGCLR
Example	$CFGCLR
Description	Clear current receiver's configuration.
Input/Output	Input
No parameter	

The configuration changed by this command takes effect after resetting the receiver.

3.3.11 AIDTIME: Configure Assisted Time

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-28 Input Assisted Time Information

Syntax	$AIDTIME,year,month,day,hour,minute,second,millisecond	
Example	$AIDTIME,2018,4,9,17,41,36,200	
Description	Input the assisted time, UTC time	
Input/Output	Input	
Parameter Definition		
Parameter	Format	Description
year	UINT	Year
month	UINT	Month
day	UINT	Day
hour	UINT	Hour
minute	UINT	Minute
second	UINT	Second
millisecond	UINT	Millisecond

3.3.12 AIDPOS: Configure Assisted Position

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-29 Input Assisted Position

Syntax	$AIDPOS,Latitude,N,Longitude,E,altitude	
Example	$AIDPOS,4002.229934,N,11618.096855,E,37.254	
Description	Input the assisted position	
Input/Output	Input	
Parameter Definition		
Parameter	Format	Description
Latitude	DOUBLE	Latitude; in the format of ddmm.mmmmmm: dd - Degree mm.mmmmmm - Minute Range: 0 to 90
N	STR	North or south latitude indicator: N - North latitude S - South latitude
Longitude	DOUBLE	Longitude; in the format of dddmm.mmmmmm: ddd - Degree mm.mmmmmm - Minute Range: 0 to 180
E	STR	East or west longitude indicator: E - East longitude W - West longitude

altitude	DOUBLE	Ellipsoidal height; unit: m

3.3.13 AIDINFO: Configure Assisted Information

Applicable to: UM6580, UM670A, UM680A, UM681A

Table 3-30 Read Assisted Information Configuration

Syntax	$AIDINFO
Example	$AIDINFO
Description	Read the assisted information configuration. The receiver outputs AIDINFO message after receiving this command.
Input/Output	Input
No parameter	

Table 3-31 Output Assisted Information

Syntax	$AIDINFO,GPSRS,GPSUS,BDSRS,BDSUS,GALRS,GALUS,GLORS,GLOUS,IRNRS,IRNUS,AType*cs	
Example	$AIDINFO,H003FFFFFF7,H000000FA00,H0000003F7F,H0000001A3F,H0000000000,H0000000000,H0000000000,H0000000000,,,H0000000F*52	
Description	Output the status and type of the assisted information	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
GPSRS	UINT64	Receiving status of the GPS ephemeris; set the corresponding bit to 1 as long as the received data pass the verification; fill Null when the GPS is not enabled
GPSUS	UINT64	Set the corresponding bit to 1 when GPS ephemeris is effective and can be used in positioning; fill Null when the GPS is not enabled
BDSRS	UINT64	Receiving status of the BDS ephemeris; set the corresponding bit to 1 as long as the received data pass the verification; fill Null when the BDS is not enabled.
BDSUS	UINT64	Set the corresponding bit to 1 when BDS ephemeris is effective and can be used in positioning; fill Null when the BDS is not enabled.
GALRS	UINT64	Receiving status of the GAL ephemeris; set the corresponding bit to 1 as long as the received data pass the verification; fill Null when the GAL system is not enabled.
GALUS	UINT64	Set the corresponding bit to 1 when GAL ephemeris is effective and can be used in positioning; fill Null when the GAL system is not enabled.

GLORS	UINT64	Receiving status of the GLO ephemeris; set the corresponding bit to 1 as long as the received data pass the verification; fill Null when the GLO system is not enabled
GLOUS	UINT64	Set the corresponding bit to 1 when GLO ephemeris is effective and can be used in positioning; fill Null when the GLO system is not enabled.
IRNRS	UINT64	Receiving status of the NavIC ephemeris; Set the corresponding bit to 1 as long as the received data pass the verification; fill Null when the NavIC system is not enabled.
IRNUS	UINT64	Set the corresponding bit to 1 when NavIC ephemeris is effective and can be used in positioning; fill Null when the NavIC system is not enabled.
Atype	UINT	Assistance type: Bit 0:4 - Corresponding to the assisted GPS/BDS/GAL/GLO/NavIC ephemeris respectively Bit 5 - Assisted position valid Bit 6 - Using the assisted position Bit 7:8 - Reserved Bit 9 - Assisted time valid Bit 10 - Using the assisted time Bit 11:16 - Reserved
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

3.3.14 CFGTP: Configure PPS

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-32 Read PPS Configuration

Syntax	$CFGTP
Example	$CFGTP
Description	Read the time pulse configuration. The receiver outputs CFGTP message after receiving this command.
Input/Output	Input
Parameter Definition	
No parameter	

Table 3-33 Set/Output PPS Configuration

Syntax	$CFGTP,interval,length,flag,antDelay,rfDelay,usrDelay	
Example	$CFGTP,1000000,500000,1,0,800,0	
Description	Set or output time pulse configuration.	
Input/Output	Input/output	
Parameter Definition		
Parameter	Format	Description
interval	UINT	Time pulse frequency; unit: μs; supports: 1000000, 500000, 200000, 100000
length	UINT	Time pulse width; unit: μs; recommended: 25%*interval ≤ length ≤ 75%*interval (High-level when the rising edge is aligned to top of second; low-level when the falling edge is aligned to top of second)
flag	UINT	Time pulse configuration: Bit 0 0 - Disable time pulse output 1 - Enable time pulse output Bit 1 0 - Rising edge at top of second 1 - Falling edge at top of second Bit 2 0 - Output after the positioning is stable 1 - Output after the receiver is turned on
antDelay	INT	Antenna delay; unit: ns; range: -32768 to 32767
rfDelay	INT	RF delay; unit: ns; range: -32768 to 32767
usrDelay	INT	User-set delay; unit: ns; range: -32768 to 32767; modifying the delay may result in a loss of precision when time pulse is adapting to the value

3.3.15 CFGRTK: Configure RTK Mode

Applicable to: UM680A, UM681A

Table 3-34 Read RTK Mode Configuration

Syntax	$CFGRTK
Example	$CFGRTK
Description	Read RTK mode configuration. The receiver outputs CFGRTK message after receiving this command.
Input/Output	Input
No parameters	

Table 3-35 Set/Output RTK Mode Configuration

Syntax	$CFGRTK,TIMEOUT,RELIABILITY,ENABLE	
Example	$CFGRTK,1,1,1	
Description	Set or output RTK mode configuration	
Input/Output	Input/Output	
Parameter Definition		
Parameter	Format	Description
TIMEOUT	UINT	Maximum age of corrections; unit: s; range: 1 to 1800
RELIABILITY	UINT	RTK engine reliability threshold: 1 - Low reliability 2 - Normal reliability 3 - Relatively high reliability (default) 4 - High reliability (may cause low fix)
ENABLE	UINT	0 - Disable RTK solution, including float solution and fixed solution 1 - Enable RTK solution, including float solution and fixed solution (default)

3.3.16 CFGMSK: Configure Satellite Cutoff Angle

Applicable to: UM680A, UM681A

The message is to configure the cutoff angle when RTK algorithm participates the positioning.

Table 3-36 Read Satellite Cutoff Angle

Syntax	$CFGMSK
Example	$CFGMSK
Description	Read the current satellite cutoff angle
Input/Output	Input
No parameters	

Table 3-37 Set/Output Satellite Cutoff Angle

Syntax	$CFGMSK,ANGLE	
Example	$CFGMSK,10	
Description	Set/Output satellite cutoff angle	
Input/Output	Input/Output	
Parameter Definition		
Parameter	Format	Description
ANGLE	INT	Satellite cutoff angle; unit: deg; range: -90 to 90

3.3.17 CFGKILOWEEK: Configure GPS Epoch

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-38 Read GPS Week Number When Epoch Begins

Syntax	$CFGKILOWEEK
Example	$CFGKILOWEEK
Description	Read the GPS week number when the epoch begins.
Input/Output	Input
No parameters	

Table 3-39 Set/Output GPS Week Number When Epoch Begins

Syntax	$CFGKILOWEEK,GpsStartWeekNum	
Example	$CFGKILOWEEK,2243	
Description	Read/Output the GPS week number when the epoch begins	
Input/Output	Input/Output	
Parameter Definition		
Parameter	Format	Description
GpsStartWeekNum	UINT	The week number at the beginning of the epoch

3.3.18 CFGLEAPSEC: Configure Leap Second

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-40 Read Leap Second Configuration

Syntax	$CFGLEAPSEC
Example	$CFGLEAPSEC
Description	Read the leap second configuration
Input/Output	Input
No parameters	

Table 3-41 Set/Output Leap Second

Syntax	$CFGLEAPSEC,DefaultMode,NavBitsEnable,GpsLeapSec,BdsLeapSec,GalLeapSec,NavICLeapSec	
Example	$CFGLEAPSEC,0,1,18,4,18,18	
Description	Set/Output leap second configuration; you can only set the leap seconds of GPS, BDS, GAL and NavIC systems when the parameter DefaultMode = 1.	
Input/Output	Input/Output	
Parameter Definition		
Parameter	Format	Description
DefaultMode	UINT	0 - default leap second in firmware 1 - leap second mode configured by user 2 - automatic calculation mode
NavBitsEnable	UINT	0 - Do not use the leap second parsing from the message 1 - Use the leap second parsing from the message
GpsLeapSec	UINT	GPS leap second set by user
BdsLeapSec	UINT	BDS leap second set by user
GalLeapSec	UINT	GAL leap second set by user
IrnLeapSec	UINT	NavIC leap second set by user

3.3.19 CFGDYN: Configure Lock Point

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-42 Read Lock Point Configuration

Syntax	$CFGDYN
Example	$CFGDYN
Description	Read Lock Point Configuration
Input/Output	Input
No parameters	

Table 3-43 Set/Output Lock Point Configuration

Syntax	$CFGDYN,mask,DynModel,StaticHoldThresh	
Example	$CFGDYN,1,0,0	
Description	Set/Output the lock point configuration	
Input/Output	Input/Output	
Parameter Definition		
Parameter	Format	Description
mask	UINT	Set the corresponding bit to 1 to enable: bit0 - dynModel; bit1 - staticHoldThresh
dynModel	UINT	Lock Point Mode: 0 - Portable 1 - Static
StaticHoldThresh	UINT	Speed threshold in static hold mode; unit: cm/s; range: 0 to 51500; if this value is 0, it means the static hold mode is disabled.

3.3.20 CFGFWCHECK: Configure Firmware Check

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-44 Configure Random Number

Syntax	$CFGFWCHECK,CRCIN	
Example	$CFGFWCHECK,HAE1206	
Description	Configure the random number for the firmware check.	
Input/Output	Input	
Parameter Definition		
Parameter	Format	Description
CRCIN	UINT	Random number typed in by user; a hexadecimal input beginning with H, with a length of 0 to 32 bytes, that is 64 hexadecimal characters at most.

Table 3-45 Output Integrity Check Value

Syntax	$CFGFWCHECK,CRCOUT*cs	
Example	$CFGFWCHECK,H3E9E7680*72	
Description	Output the check code.	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
CRCOUT	UINT	The result after the CRC check
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

3.3.21 CFGLOGLIST: Configure LOGLIST Information

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-46 Read LOGLIST Information

Syntax	$CFGLOGLIST,portID	
Example	$CFGLOGLIST,1	
Description	Read LOGLIST information. The receiver outputs the LOGLIST message of the corresponding port after receiving the command.	
Input/Output	Input	
Parameter Definition		
Parameter	Format	Description
portID	UINT	Port ID: 0, 1, 2, 4

Table 3-47 Output LOGLIST Information

Syntax	$LOGLIST,NoMsg,MsgNo,NoSv,msgClass1,msgID1,rate1,msgClass2,msgID2,rate2,msgClass3,msgID3,rate3,msgClass4,msgID14,rate4,msgClass5,msgID5,rate5,msgClass6,msgID6,rate6,msgClass7,msgID7,rate7,msgClass8,msgID8,rate8*cs	
Example	$LOGLIST,2,1,11,200,0,1,200,2,1,200,3,5,200,4,1,207,0,1,207,2,1,207,3,5,207,4,1*69 $LOGLIST,2,2,11,204,0,1,204,1,10,206,0,1*42	
Description	The receiver outputs the LOGLIST message.	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
LOGLIST	STR	Header
NoMsg	UINT	Total number of LOGLIST message; minimum value: 1
MsgNo	UINT	The LOGLIST message number; minimum value: 1
NoSv	UINT	Total number of msg configuration information that LOGLIST outputs
msgClassX	UINT	Message class; output maximum 8 classes; see section 3.3.2 CFGMSG
msgIDX	UINT	Message ID; see section 3.3.2 CFGMSG
rateX	UINT	Message output rate; see section 3.3.2 CFGMSG
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

3.3.22 CFGODOFWD: Configure Direction Signal

Applicable to: UM681A

Table 3-48 Read Direction Signal Configuration

Syntax	$CFGODOFWD
Example	$CFGODOFWD
Description	Read the configuration of odometer's direction signal
Input/Output	Input
No parameter	

Table 3-49 Set/Output Direction Signal Configuration

Syntax	$CFGODOFWD,FWD	
Example	$CFGODOFWD,1	
Description	Set or output the odometer's direction signal in the integrated navigation module.	
Input/Output	Input/Output	
Parameter Definition		
Parameter	Format	Description
FWD	UINT (optional)	Mode configuration: 0 - Low level forward; high level backward 1 - High level forward; low level backward

3.3.23 CFGINS: Configure Integrated Navigation

Applicable to: UM681A

Table 3-50 Read Integrated Navigation Configuration

Syntax	$CFGINS
Example	$CFGINS
Description	Read the integrated navigation configuration. The receiver outputs the CFGINS message after receiving the command.
Input/Output	Input
No parameter	

Table 3-51 Set/Output Integrated Navigation Configuration

Syntax	$CFGINS,mode,ImusrcType,OdosrcType,MapsrcType	
Example	$CFGINS,1,1,1,1	
Description	Set or output the integrated navigation mode and IMU input.	
Input/Output	Input/Output	
Parameter Definition		
Parameter	Format	Description
mode	UINT (Optional)	Mode configuration: 0 - Disable the integrated navigation function. The NMEA messages only output the GNSS positioning results. 1 - Vehicle-mounted mode (single-engine) 2 - Vehicle-mounted mode (dual-engine[8]) 5 - Two-wheeled mode (only supported by the firmware for two-wheeled vehicles; can be queried) 9 - Reserved
ImusrcType	UINT (Optional)	0 - Disable IMU input 1 - Built-in IMU chip input
OdosrcType	UINT (Optional)	0 - Disable the odometer's signal input 1 - Input from the built-in odometer pulse counter 2 - Odometer signal input via an external port[9]
MapsrcType	UINT (Optional)	0 - Disable Map input 1 - Use the external port to input the map-matching information

[8] UM681A does not support dual-engine configuration.

[9] Supported by the specific firmware.

3.3.24 CFGIMUMEAS: Configure IMU Measurement Interval

Applicable to: UM681A

Table 3-52 Read IMU measurement Interval Configuration

Syntax	$CFGIMUMEAS
Example	$CFGIMUMEAS
Description	Read the IMU measurement interval configuration. The receiver outputs the CFGIMUMEAS message after receiving the command.
Input/Output	Input
No parameter	

Table 3-53 Set/Output IMU measurement Interval Configuration

Syntax	$CFGIMUMEAS,IMUMeasRate	
Example	$CFGIMUMEAS,10	
Description	Configure IMURAW measurement output rate	
Input/Output	Input/Output	
Parameter Definition		
Parameter	Format	Description
IMUMeasRate	UINT	IMU measurement output rate; unit: ms: 20 - Corresponding to 50 Hz IMURAW reference output rate 10 - Corresponding to 100 Hz IMURAW reference output rate[10]

3.3.25 CFGROTAT: Configure Installation Angle

Applicable to: UM681A

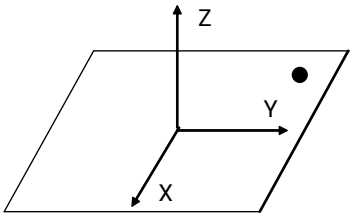
Table 3-54 Read Configuration of Installation Angle

Syntax	$CFGROTAT
Example	$CFGROTAT
Description	Read the current installation angle of the positioning module. The receiver outputs the CFGROTAT message after receiving the command.
Input/Output	Input
No parameter	

[10] UM681A does not support 100 Hz currently.

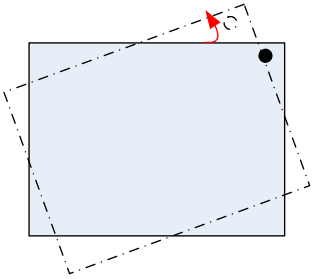
Table 3-55 Set/Output Configuration of Installation Angle

Syntax	$CFGROTAT,angleX,angleY,angleZ,mode	
Example	$CFGROTAT,0,0,0,2	
Description	Set or output the configuration of the module's installation angle relative to the vehicle body coordinate.	
Input/Output	Input/Output	
Parameter Definition		
Parameter	Format	Description
angleX	UINT (Optional)	Rotation angle of the module X axis relative to the body coordinate X axis (right-hand screw rule); unit: 0.01 deg; range: 0 to 36000
angleY	UINT (Optional)	Rotation angle of the module Y axis relative to the body coordinate Y axis (right-hand screw rule); unit: 0.01 deg; range: 0 to 36000
angleZ	UINT (Optional)	Rotation angle of the module Z axis relative to the body coordinate Z axis (right-hand screw rule); unit: 0.01 deg; range: 0 to 36000
mode	UINT (Optional)	Configuration mode of installation angle: 0 - General installation mode; the accuracy of input installation angle is rough (within 10 degrees) 2 - Auto installation mode; no need to input the installation angle but need to complete a calibration

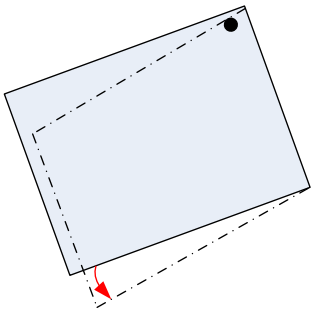


Module Coordinate

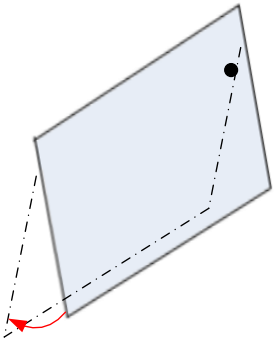
Align the module coordinate with the body coordinate



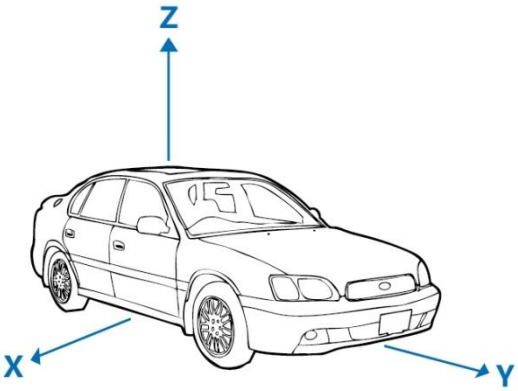
Rotate the module γ deg around the Z axis (right-hand screw rule)



Rotate the module α deg around the X axis (right-hand screw rule)



Rotate the module β deg around the Y axis (right-hand screw rule)



Vehicle Body Coordinate

3.3.26 CFGCOG: Configure Heading Angle

Applicable to: UM681A

Table 3-56 Read Configuration of Heading Angle

Syntax	$CFGCOG
Example	$CFGCOG
Description	Read the output configuration of heading angle
Input/Output	Input
No parameter	

Table 3-57 Set/Output Configuration of Heading Angle

Syntax	$CFGCOG,mode	
Example	$CFGCOG,0	
Description	Set or output heading angle configuration	
Input/Output	Input/Output	
Parameter Definition		
Parameter	Format	Description
mode	UINT	0 - Heading angle is aligned with the front of the vehicle 1 - Heading angle is aligned with the driving direction

3.3.27 CFGNMEAMODE: Configure NMEA Output Mode

Applicable to: UM681A

Table 3-58 Read NMEA Output Mode Configuration

Syntax	$CFGNMEAMODE
Example	$CFGNMEAMODE
Description	Read the NMEA output mode configuration of the GNSS+INS integrated navigation product.
Input/Output	Input
No parameters	

Table 3-59 Set/Output NMEA Output Mode

Syntax	$CFGNMEAMODE,mode	
Example	$CFGNMEAMODE,0	
Description	Set or output the NMEA mode configuration of the GNSS+INS integrated navigation product.	
Input/Output	Input/Output	
Parameter Definition		
Parameter	Format	Description

mode	UINT	0 – Output raw observation data first (NMEA message output with a delay of approximately 50 ms). 1 –Output positioning data first (NMEA message output with a delay of approximately 10 ms).

3.3.28 CFGGLARM: Configure the GNSS Lever Arm

Applicable to: UM681A

Table 3-60 Read GNSS Lever Arm Configuration

Syntax	$CFGGLARM
Example	$CFGGLARM
Description	Read the lever arm configuration used in GNSS navigation.
Input/Output	Input
No parameters	

Table 3-61 Set/Output GNSS Lever Arm Configuration

Syntax	$CFGGLARM,flag,AntIstX,AntIstY,AntIstZ,ImuIstX,ImuIstY,ImuIstZ	
Example	$CFGGLARM,1,12,19,33,123,-18,90	
Description	Set or output the lever arm configuration used in GNSS navigation.	
Input/Output	Input/Output	
Parameter Definition		
Parameter	Format	Description
flag	UINT (optional)	Validity flag of GNSS lever arm configuration 0 - invalid 1 - valid
AntIstX	INT	The X-axis coordinate of the antenna in the vehicle coordinate system; positive: right; unit: 0.01 m; range: ± 2000
AntIstY	INT	The Y-axis coordinate of the antenna in the vehicle coordinate system; positive: forward; unit: 0.01 m; range: ± 2000
AntIstZ	INT	The Z-axis coordinate of the antenna in the vehicle coordinate system; positive: up;

		unit: 0.01 m; range: ± 2000
ImuIstX	INT	The X-axis coordinate of the IMU in the vehicle coordinate system; positive: right; unit: 0.01 m; range: ± 2000
ImuIstY	INT	The Y-axis coordinate of the IMU in the vehicle coordinate system; positive: forward; unit: 0.01 m; range: ± 2000
ImuIstZ	INT	The Z-axis coordinate of the IMU in the vehicle coordinate system; positive: up; unit: 0.01 m; range: ± 2000

3.3.29 CFGILARM: Configure the DR Lever Arm

Applicable to: UM681A

Table 3-62 Read DR Lever Arm Configuration

Syntax	$CFGILARM
Example	$CFGILARM
Description	Read the lever arm configuration used in DR navigation.
Input/Output	Input
No parameters	

Table 3-63 Set/Output DR Lever Arm Configuration

Syntax	$CFGILARM,flag,OdoIstX,OdoIstY,OdoIstZ,ImuIstX,ImuIstY,ImuIstZ	
Example	$CFGILARM,1,12,19,33,123,-18,90	
Description	Set or output the lever arm configuration used in DR navigation.	
Input/Output	Input/Output	
Parameter Definition		
Parameter	Format	Description
flag	UINT (optional)	Validity flag of DR lever arm configuration 0 - invalid 1 - valid

OdoIstX	INT	The X-axis coordinate of the odometer in the vehicle coordinate system; positive: right; unit: 0.01 m; range: ± 2000
OdoIstY	INT	The Y-axis coordinate of the odometer in the vehicle coordinate system; positive: forward; unit: 0.01 m; range: ± 2000
OdoIstZ	INT	The Z-axis coordinate of the odometer in the vehicle coordinate system; positive: up; unit: 0.01 m; range: ± 2000
ImuIstX	INT	The X-axis coordinate of the IMU in the vehicle coordinate system; positive: right; unit: 0.01 m; range: ± 2000
ImuIstY	INT	The Y-axis coordinate of the IMU in the vehicle coordinate system; positive: forward; unit: 0.01 m; range: ± 2000
ImuIstZ	INT	The Z-axis coordinate of the IMU in the vehicle coordinate system; positive: up; unit: 0.01 m; range: ± 2000

The figure below is a schematic diagram of the lever arm configurations, and the vehicle coordinate system is defined as follows:

- The center of the rear axle of the vehicle is the origin of the coordinate system;
- The longitudinal direction of the vehicle is the Y axis, which points forward;
- The lateral direction of the vehicle is the X axis, which points right;
- The vertical direction of the vehicle is the Z axis, which points up.

The lever arm configurations contain the coordinates of the antenna, IMU and Odometer.

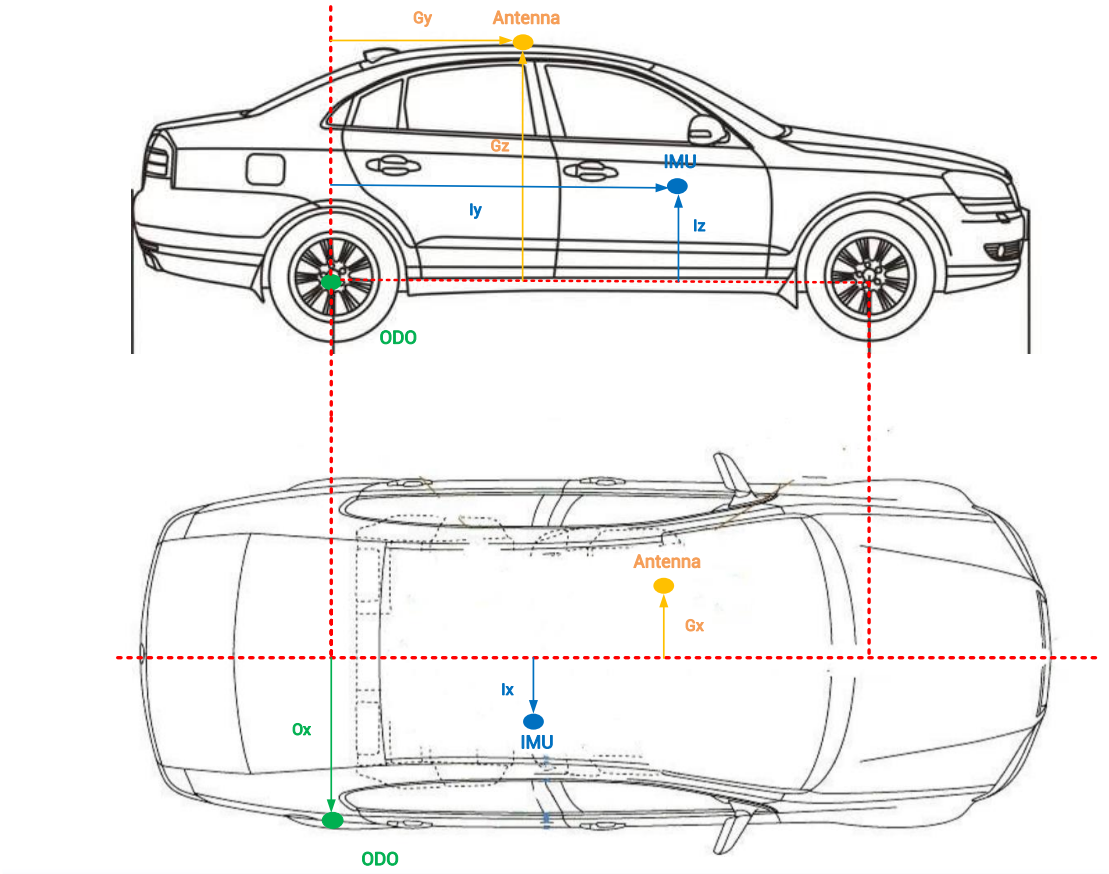


Figure 3-1 Lever Arm Configurations

3.4 Sensor Fusion Message

3.4.1 GYOACC

Applicable to: UM681A

Table 3-64 Output MEMS Sensor Data

Syntax	$GYOACC,date,time,gyroX,gyroY,gyroZ,gyroPeriod,accX,accY,accZ,accPeriod,temp,speed,pulsePeriod,fwd*cs	
Example	$GYOACC,260325,065538.80,0.003469,-0.012649,-0.131719,100,-0.977248,2.201379,9.454832,100,18,77,100,0*1C	
Description	Output the sensor data of MEMS and odometer etc.	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
date	STR	UTC date; in the format of ddmmyy: dd - Day mm - Month yy - Year Fill null if no exact year, month and day are parsed.

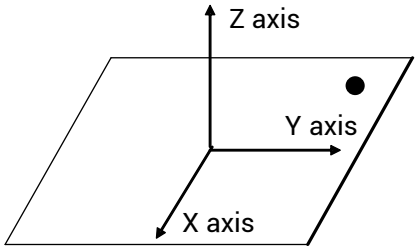
time	STR	UTC time; in the format of hhmmss.ss: hh - Hour mm - Minute ss.ss - Second Fill null if no exact hour, minute and second are parsed.
gyroX	DOUBLE	X-axis angular velocity of the built-in gyroscope; unit: rad/s
gyroY	DOUBLE	Y-axis angular velocity of the built-in gyroscope; unit: rad/s
gyroZ	DOUBLE	Z-axis angular velocity of the built-in gyroscope; unit: rad/s
gyroPeriod	UINT	Output interval of the built-in gyroscope data; unit: ms
accX	DOUBLE	X-axis acceleration of the built-in accelerometer; unit: m/s^2
accY	DOUBLE	Y-axis acceleration of the built-in accelerometer; unit: m/s^2
accZ	DOUBLE	Z-axis acceleration of the built-in accelerometer; unit: m/s^2
accPeriod	UINT	Output interval of the built-in accelerometer data; unit: ms
temp	INT	Temperature; unit: °C; no meaning if not connecting a temperature sensor
speed	INT	Vehicle speed pulse; no meaning if not accessing the pulse signal.
pulsePeriod	UINT	Output interval of pulses; unit: ms; no meaning if not accessing the pulse signal.
fwd	UINT	Vehicle direction signal: 0: Forward 1: Backward No meaning if not accessing the signal.
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

Note:

- To output GYOACC message at 10 Hz, you need to set the baud rate of the serial port 1 or 2* to 230400 bps.
- GYOACC message is based on the module coordinate defined as follows (see the figure below):
  - Positive direction of X axis: ID point right-hand direction, horizontal.
  - Positive direction of Y axis: ID point forward direction, horizontal.

* Not supported by UM681A

- Positive direction of Z axis: Vertical to the module plane, upward.



Module Coordinate

3.4.2 SNRSTAT

Applicable to: UM681A

Table 3-65 Output Initialization Status

Syntax	$SNRSTAT,insstatus,odostatus,InstallState,mapstat*cs	
Example	$SNRSTAT,3,0,0,2*5C	
Description	Output initialization status	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
insstatus	INT	INS initialization state: -1 - IMU device failure 0 - Disable 1 - Initialization started 2 - Known installation angle 3 - Initialization completed
odostatus	INT	Odometer initialization status: -1 - Odometer device failure 0 - Disable 1 - Initialization of scale factor 2 - Initialization of scale factor completed 3 - Scale factor calibration completed
InstallState	INT	-1 - IMU device failure, unable to estimate the installation angle 0 - Calibration in progress 1 - The quality of current satellite information is insufficient and better satellite conditions are needed 2 - The current vehicle mobility conditions are insufficient, and acceleration is required 3 - The current carrier speed is too low, and it is

		required to increase the speed
mapstat	INT	-2 - Abnormal map data is detected -1 - No port is configured to receive MAP information 0 - The port fails to receive MAP information or the MAP information transmission times out 1 - The MAP information is received but not applied to the integrated navigation 2 - The MAP information is received and applied to the integrated navigation
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

3.4.3 NAVATT

Applicable to: UM681A

Table 3-66 Output Attitude and Heading Information

Syntax	$NAVATT,time,quality, roll_v,pitch_v,yaw_v,roll_acc,pitch_acc,yaw_acc*cs	
Example	$NAVATT,091649.00,0,-3562,-43265,0,0,0,0*31	
Description	Output the vehicle's attitude and heading information	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
time	STR	UTC time in the format of hhmmss.sss: hh - Hour mm - Minute ss.sss - Second
quality	UINT	Current quality: 0 - Invalid 2 - Valid
roll_v	INT	Roll; unit: 1e-5 deg; range: -180*1e5 to 180*1e5
pitch_v	INT	Pitch; unit: 1e-5 deg; range: -90*1e5 to 90*1e5
yaw_v	INT	Yaw; unit: 1e-5 deg; range: 0 to 360*1e5
roll_acc	INT	Roll accuracy; unit: 1e-5 deg,
pitch_acc	INT	Pitch accuracy; unit: 1e-5 deg,
yaw_acc	INT	Yaw accuracy; unit: 1e-5 deg,
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

3.4.4 IMURAW

Applicable to: UM681A

Table 3-67 Output MEMS Sensor Raw Data in Module Coordinate System

Syntax	$IMURAW,date,time,gyroX,gyroY,gyroZ,accX,accY,accZ,speed*cs	
Example	$IMURAW,111223,064122.661,-0.017642,0.016745,0.015113,0.347367,-0.004711,10.241478,2*29	
Description	Output the raw data of the MEMS sensor	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
date	STR	UTC date; in the format of ddmmyy: dd - Day mm - Month yy - Year Fill null if no exact year, month and day are parsed.
time	STR	UTC time; in the format of hhmmss.sss: hh - Hour mm - Minute ss.sss - Second Fill null if no exact hour, minute and second are parsed.
gyroX	DOUBLE	X-axis angular velocity of the built-in gyroscope; unit: rad/s
gyroY	DOUBLE	Y-axis angular velocity of the built-in gyroscope; unit: rad/s
gyroZ	DOUBLE	Z-axis angular velocity of the built-in gyroscope; unit: rad/s
accX	DOUBLE	X-axis acceleration of the built-in accelerometer; unit: m/s^2
accY	DOUBLE	Y-axis acceleration of the built-in accelerometer; unit: m/s^2
accZ	DOUBLE	Z-axis acceleration of the built-in accelerometer; unit: m/s^2
speed	INT	Vehicle speed pulses; >0 means forward and <0 means backward; the field is invalid if there is no vehicle pulse signal.
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

3.4.5 INSPVA

Applicable to: UM681A

Table 3-68 Output the DR Position, Velocity and Attitude

Syntax	$INSPVA,date,time,Lon,Lat,Hae,Vel_E, Vel_N,Vel_U, roll_v,pitch_v,yaw_v *cs	
Example	$INSPVA,020822,111025.10,40.08652241,116.21819501,34.011,0.000,0.001,-0.002,-0.801,0.416,291.386*30	
Description	Output the dead reckoning position, velocity and attitude.	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
date	STR	UTC date; in the format of ddmmyy dd - day mm - month yy - year If the calculation of date fails, this field is null.
time	STR	UTC time; in the format hhmmss.ss hh - hour mm - minute ss.ss - second If the calculation of date fails, this field is null.
Lon	DOUBLE	Longitude; unit: deg; positive means east and negative means west; output 8 decimal places
Lat	DOUBLE	Latitude; unit: deg; positive means north and negative means south; output 8 decimal places
Hae	DOUBLE	Ellipsoidal height; unit: m; output 3 decimal places
Vel_E	DOUBLE	East velocity in ENU coordinate system; unit: m/s; output 3 decimal places
Vel_N	DOUBLE	North velocity in ENU coordinate system; unit: m/s; output 3 decimal places
Vel_U	DOUBLE	Up velocity in ENU coordinate system; unit: m/s; output 3 decimal places
roll_v	DOUBLE	Roll; unit: deg; output 3 decimal places
pitch_v	DOUBLE	Pitch; unit: deg; output 3 decimal places
yaw_v	DOUBLE	Yaw; unit: deg; output 3 decimal places
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

3.4.6 IMUVEH

Applicable to: UM681A

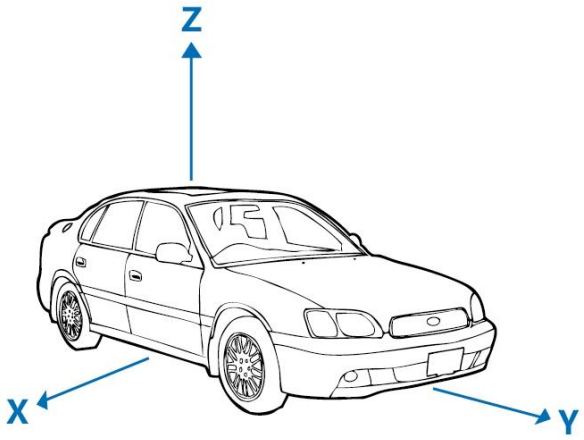
Table 3-69 Output Compensated MEMS Data in the Vehicle Body Coordinate System

Syntax	$IMUVEH,date,time,gyroX,gyroY,gyroZ,accX,accY,accZ,speed*cs	
Example	$IMUVEH,260124,072202.910,0.013316,-0.011917,-0.022969,-0.418275,-0.106812,9.719531,0*09	
Description	Output the compensated built-in sensor data in vehicle body coordinate system.	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
date	STR	UTC date; in the format of ddmmyy: dd - Day mm - Month yy - Year Fill null if no exact year, month and day are parsed
time	STR	UTC time; in the format of hhmmss.sss: hh - Hour mm - Minute ss.sss - Second Fill null if no exact hour, minute and second are parsed
gyroX	DOUBLE	X-axis angular velocity of the built-in gyroscope in body coordinate system; unit: rad/s; fill null before the finish of MEMS calibration
gyroY	DOUBLE	Y-axis angular velocity of the built-in gyroscope in body coordinate system; unit: rad/s; fill null before the finish of MEMS calibration
gyroZ	DOUBLE	Z-axis angular velocity of the built-in gyroscope in body coordinate system; unit: rad/s; fill null before the finish of MEMS calibration
accX	DOUBLE	X-axis acceleration of the built-in accelerometer in body coordinate system; unit: m/s^2; fill null before the finish of MEMS calibration
accY	DOUBLE	Y-axis acceleration of the built-in accelerometer in body coordinate system; unit: m/s^2; fill null before the finish of MEMS calibration
accZ	DOUBLE	Z-axis acceleration of the built-in accelerometer in body coordinate system; unit: m/s^2; fill null before the finish of MEMS calibration
speed	INT	Vehicle speed pulses; >0 means forward and <0 means backward; the field is null if there is no vehicle pulse signal.

cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

Note:

- IMUVEH message is based on the body coordinate defined as follows:
  - Positive direction of X axis: Driver's right-hand direction, horizontal.
  - Positive direction of Y axis: Vehicle forward direction, horizontal.
  - Positive direction of Z axis: Vertical to the body plane, upward.



Vehicle Body Coordinate

3.4.7 INSTALL

Applicable to: UM681A

Table 3-70 Read Installation Angle Information

Syntax	$INSTALL
Example	$INSTALL
Description	Read the calculated installation angle of the module. The receiver outputs $INSTALL message after receiving this command.
Input/Output	Input
No parameter	

Table 3-71 Output Installation Angle Information

Syntax	$INSTALL,angleX,angleY,angleZ,valid*cs	
Example	$INSTALL,100,100,100,1*41	
Description	Output the calculated installation angle of the module.	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
angleX	UINT	Rotation angle of the module X axis relative to the body coordinate X axis (right-hand screw rule); unit: 1e-2 deg; range: 0 to 36000
angleY	UINT	Rotation angle of the module Y axis relative to the body coordinate Y axis (right-hand screw rule); unit: 1e-2 deg; range: 0 to 36000
angleZ	UINT	Rotation angle of the module Z axis relative to the body coordinate Z axis (right-hand screw rule); unit: 1e-2 deg; range: 0 to 36000
Valid	UINT	0 - Invalid output of calculated installation angle 1 - Valid output of calculated installation angle
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

3.4.8 MAPFB

Applicable to: UM681A

Table 3-72 Input Map Feedback

Syntax	$MAPFB,hhmmss.sss,TotalRoadCount,RoadIdx,RoadType, Probability,LatDiff,LonDiff,UpDiff,RoadWidth,RoadAzi	
Example	$MAPFB, 082324.000,3,1,1,520,15,-4,0,4,4945 $MAPFB, 082324.000,3,2,1,320,25,8,0,3,4745 $MAPFB, 082324.000,3,3,1,160,-17,-4,0,8,4645	
Description	Input map feedback	
Input/Output	Input	
Parameter Definition		
Parameter	Format	Description
hhmmss.sss	STR	UTC timestamp
TotalRoadCount	INT	Total number of the matched road
RoadIdx	INT	Road number; each message only outputs one road-matching information
RoadType	INT	Road type: 0 - Invalid 1 - Normal 2 - Tunnel 3 - Roundabout 4 - Viaduct 5 - Bridge
Probability	INT	Matching probability; unit: 1e-3
LatDiff	INT	Latitude offset; unit: 1e-6 deg
LonDiff	INT	Longitude offset; unit: 1e-6 deg
UpDiff	INT	Height offset; unit: m
RoadWidth	INT	Road width; unit: m
RoadAzi	INT	Road angle; unit: 1e-2 deg

The command needs to be sent to the module within 700 ms after the current integer seconds, for example, the current is 1 second, and the matching protocol needs to be sent to the module within 1.7 seconds.

3.4.9 ODODATA

Applicable to: UM681A

Table 3-73 Input Odometer Information

Syntax	$ODODATA,time,speed,forward,RSV,RSV,RSV	
Example	$ODODATA,091649.00,10000,1,,,	
Description	Input odometer information	
Input/Output	Input	
Parameter Definition		
Parameter	Format	Description
time	STR	UTC time; in the format of hhmmss.ss hh - Hour mm - Minute ss.ss - Second
speed	UINT	Driving speed; unit: 1e-3 m/s
forward	UINT	Driving direction: 0 - Forward 1 - Backward
RSV		Reserved
RSV		Reserved
RSV		Reserved

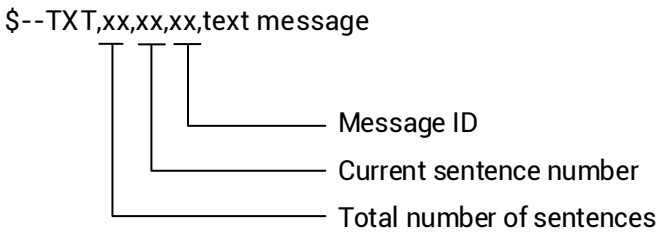
This message supports 10 Hz only.

3.5 Notice Message

3.5.1 General Notice Message and Notice Message Package

Applicable to: UC6580, UM670A, UM680A, UM681A

General Notice Message and Notice Message Package are used by Unicore for research and development. See the following for the syntax of the output message.



3.5.2 Command Echo

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-74 Command Echo

Syntax	$--TXT,01,01,00,command*cs	
Example	$GNTXT,01,01,00,PDTINFO*1F	
Description	Output the command that input by the user currently	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
--	STR	Positioning system flag GP - GPS standalone positioning GB - BDS standalone positioning GA - Galileo standalone positioning GL - GLONASS standalone positioning GI - NavIC standalone positioning GN - Dual or multiple constellations joint positioning
01	INT	Total number of sentences
01	INT	Current sentence number
00	INT	Message ID
Command	STR	Unicore command currently input by users
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

3.5.3 ANTSTAT: Antenna Status

Applicable to: UM670A, UM680A, UM681A

The antenna status detection is supported by specific hardware.

Table 3-75 Output Antenna Status Information

Syntax	$ANTSTAT,status1,status2	
Example	$ANTSTAT,0,0	
Description	Output the antenna status and the antenna type	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
status1, status2	INT	Antenna status: $ANTSTAT,0,0 - Normal, active antenna $ANTSTAT,0,1 - Short circuit $ANTSTAT,1,0 - Open circuit or passive antenna $ANTSTAT,1,1 - Hardware anomaly

3.5.4 Ephemeris Lacking

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-76 Ephemeris Lacking

Syntax	$--TXT,01,01,03,EphLackLevel*cs	
Example	$GNTXT,01,01,03,2*60	
Description	Output this message when the ephemeris is insufficient.	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
--	STR	Positioning system flag GP - GPS standalone positioning GB - BDS standalone positioning GA - Galileo standalone positioning GL - GLONASS standalone positioning GI - IRNSS standalone positioning GN - Dual or multiple constellations joint positioning
Total number of sentences	INT	Total number of sentences, specified to 01
Sentence number	INT	Current sentence number, specified to 01

Text indentifier	INT	Message ID, specified to 03
EphLackLevel	INT	0 - ephemeris sufficient 1 - ephemeris insufficient 2 - ephemeris severely insufficient
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

3.5.5 Data Incomplete

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-77 Data Incomplete

Syntax	$--TXT,01,01,04,The output data is INCOMPLETE. MAX Bytes Per Epoch:1732*cs	
Example	$GNTXT,01,01,04,The output data is INCOMPLETE. MAX Bytes Per Epoch:1732*1F	
Description	This message indicates that the output data is incomplete because of insufficient bandwidth of the output port.	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
--	STR	Positioning system flag GP - GPS standalone positioning GB - BDS standalone positioning GA - Galileo standalone positioning GL - GLONASS standalone positioning GI - IRNSS standalone positioning GN - Dual or multiple constellations joint positioning
Total number of sentences	INT	Total number of sentences, specified to 01
Sentence number	INT	Current sentence number, specified to 01
Text identifier	INT	Message ID, specified to 04
Text message	STR	Text message: The output data is INCOMPLETE. MAX Bytes Per Epoch:1732
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

3.6 Misc Message

3.6.1 CWOUT

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-78 Output Interference Detection Information

Syntax	$CWOUT,CWFlagOut,CWToneFreqOut_GPL1,CWRatioOut-GPL1,CWToneFreqOut_GL,CWRatioOut-GL,CWToneFreqOut_BDB1,CWRatioOut-BDB1,CWToneFreqOut_L5,CWRatioOut-L5*cs	
Example	$CWOUT,1,1575620,-100,1602100,-80,1561088,-90,1176470,-79*7E	
Description	Output interference detection information	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
CWFlagOut	UINT	Interference flag: 0 - No interference 1 - Having interference
CWToneFreqOut_GPL1	UINT	GPS L1 interference signal frequency; unit: KHz
CWRatioOut-GPL1	INT	GPS L1 interference strength; unit: dBm; range: -150 to 0
CWToneFreqOut_GL	UINT	GLONASS L1 interference signal frequency; unit: KHz
CWRatioOut-GL	INT	GLONASS L1 interference strength; unit: dBm; range: -150 to 0
CWToneFreqOut_BDB1	UINT	BDS B1 interference signal frequency; unit: KHz
CWRatioOut-BDB1	INT	BDS B1 interference strength; unit: dBm; range: -150 to 0
CWToneFreqOut_L5	UINT	L5 interference signal frequency; unit: KHz
CWRatioOut-L5	INT	L5 interference strength; unit: dBm; range: -150 to 0
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

3.6.2 LSF

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-79 Query Leap Seconds Forecast Information

Syntax	$LSF,system	
Example	$LSF,1	
Description	Query leap seconds forecast information of the specified satellite, and the receiver outputs LSF message after receiving the command	
Input/Output	Input	
Parameter Definition		
Parameter	Format	Description
system	UINT	Query the system corresponding to the leap seconds forecast information 0 - GPS 1 - BDS 2 - GLO 3 - GAL 4 - NavIC

Table 3-80 Output Leap Seconds Forecast Information

Syntax	$LSF,system,flag,utcTLS,utcTLSF,utcTOT,utcWN,utcDN,utcWNLSF,utcA0,utcA1*cs	
Example	$LSF,0,1,15,16,462836,82,6,86,7811626,14*5C	
Description	Output leap seconds forecast information	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
System	UINT	Output the system corresponding to the leap seconds forecast information 0 - GPS 1 - BDS 2 - GLO 3 - GAL 4 - NavIC
Flag	UINT	Validity flag of leap seconds forecast information 0 - Invalid 1 - Valid
utcTLS	UINT	Time difference between UTC and the system before a leap second event occurs; unit: s; GLO system does not have this parameter

utcTLSF	UINT	Time difference between UTC and the system after a leap second event occurs; unit: s; GLO system does not have this parameter
utcTOT	UINT	UTC reference seconds of week; unit: s (Fill 0 for BDS); GLO system: the parameter corresponds to GLO UTC A0
utcWN	UINT	UTC reference week number; unit: week (Fill 0 for BDS); GLO system: the parameter corresponds to GLO UTC A1
utcDN	UINT	Days of week when the leap second event occurs; unit: day; GLO system: the parameter corresponds to GLO UTC DN
utcWNLSF	UINT	UTC week number when the leap second event occurs; unit: week; GLO system: the parameter corresponds to GLO UTC KP
utcA0	INT	Constant coefficient A0 of UTC polynomial (scale factor 2^-30); unit: s; GLO system: the parameter corresponds to GLO UTC tc
utcA1	INT	First-order coefficient A1 of UTC polynomial (scale factor 2^-50); unit: s/s; GLO system: the parameter corresponds to GLO UTC tg
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

Note

- GPS Week is the time system adopted in the GPS system. Time Zero is defined as: 00:00 on January 6,1980 and every 1024 weeks (7168 days) is a cycle. The first roll-over happened at 00:00:00 on August 22,1999. That is, from this moment on, the week number starts again from zero. In GPST, 1 to 7 corresponds to Sunday to Saturday.
- The BDS time starts at 00:00:00 UTC on 1 January 2006, and uses week and day of week to count. 0 to 6 corresponds to Sunday to Saturday.
- utcWNLSF: The decimal number converted from the binary lower eight bits of the week when a leap second occurs.

  For example: A leap second occurred in the week 900 (binary: 1110000100), then the utcWNLSF broadcasts 132 (binary: 10000100).
- Calculating the GPS week when a leap second occurs:

  1. Convert the RMC date into GPS week;
  2. Convert the GPS week into binary, set the lower eight bits to zero, and then convert to decimal.
  3. Add utcWNLSF to the number got from step 2.

- Calculating the BDS week when a leap second occurs:
  1. Convert the RMC date into BDS week;
  2. Convert the BDS week into binary, set the lower eight bits to zero, and then convert to decimal.
  3. Add utcWNLSF to the number got from step 2.
- utcDN: Day of week when a leap second occurs. GPS: 1 to 7 corresponding to Sunday to Saturday; BDS: 0 to 6 corresponding to Sunday to Saturday
- Leap seconds occur at 23:59:59

3.6.3 OSNMA[11]

Applicable to: UC6580, UM670A, UM680A, UM681A

Table 3-81 Output Galileo I/NAV Message

Syntax	$PNAVMSG,svid,wordtype,x1, x2, x3, …, x30	
Example	$PNAVMSG,1,0,BE,DA,49,72,CB,C3,80,EA,AA,AA,4D,41,0A,3F,40	
Description	Output Galileo I/NAV message	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
svid	UINT	Satellite ID
wordtype	UINT	Galileo I/NAV message word type; range: 1 to 32
x1, x2, x3, …, x30	INT	Odd and even part of I/NAV message; a hexadecimal number with 2 digits

[11] Output at constant 0.5 Hz only when there is no error code in GALILEO messages.

3.6.4 QZQSM

Applicable to: UC6580

QZSS provides the service of Disaster and Crisis report (DC report) using L1 SAIF. When the disasters such as earthquake and tsunamis happen, QZSS will broadcast the warning message. See the following table for the format and refer to Chapter 6 [3] for more information.

Table 3-82 Output Disaster and Crisis Report

Field	Value	Characters
Message Header	$QZQSM	6
Field delimiter	,	1
Satellite ID	56,57,61 (PRN184,185,189) 55 (PRN183)[12] 58 (PRN186)[13]	2
Field delimiter	,	1
DC Report Message		63
Field delimiter	,	1
Checksum		2

Example:
$QZQSM,58,53ADF5729180050C30A18754322A864A547DAA8FC952F08000000011671
7F6C*05

3.6.5 ENVINFO

Applicable to: UM680

Table 3-83 Output Environmental Information

Syntax	$ENVINFO,weeknum,ms of week,Sat Vis,Sat Slo,Slo type,Base sat Num,Pub sat Num,Env Score,Reserved*cs	
Example	$ENVINFOA,2338,309894200,89,100,50,33,26,96,0*07	
Description	Output environmental information such as the ratio of visible satellites and the score of the environment.	
Input/Output	Output	
Parameter Definition		
Parameter	Format	Description
weeknum	UINT	GPS week
ms of week	UINT	GPS milliseconds of week
Sat Vis	UINT	Ratio of visible satellites, an integer in the unit of %.

[12] 55 takes effect before the service of QZS1R (PRN186).

[13] 58 does not take effect until the service of QZS1R (PRN186).

Sat Slo	UINT	Ratio of satellites used in solution, an integer in the unit of %.
Slo type	UINT	Solution type: 0: no RTK solution 32: Single-frequency float 34: Dual-frequency float 48: Single-frequency fix 49: Wide-lane fix 50: Dual-frequency fix
Base sat Num	UINT	Number of satellites observed by the base station
Pub sat Num	UINT	Number of satellites in the common view of the base station and rover station
Env Score	UINT	Score of the environment, 0~100, integer
Reserved	UINT	Reserved, specified to 0
cs	U8	Checksum; two hexadecimal characters obtained by calculating an XOR of all characters between but not including '$' to '*' in this message

4 RTCM Messages

UM670A[14], UM680A and UM681A all support the raw data observations output of RTCM MSM, RTCM EPH and RTCM STM.

Refer to Chapter 6 [1] for the information of RTCM format.

The supported messages include:

Messages	Type
Station Coordinates	1005
System Parameters	1013
GPS MSMs	107x, x depends on CFGMSM
BDS MSMs	112x, x depends on CFGMSM
GALILEO MSMs	109x, x depends on CFGMSM
GLONASS MSMs	108x, x depends on CFGMSM
QZSS MSMs	111x, x depends on CFGMSM
SBAS MSMs	110x, x depends on CFGMSM
GPS Ephemeris Data	1019
QZSS Ephemeris Data	1044
BDS Ephemeris Data	1042
GALILEO Ephemeris Data	1046
GLONASS Ephemeris Data	1020
Unicore proprietary messages	4074

[14] Only some of the sub-models of UM670A support the output of raw data.

5 Extended RTCM Messages

The messages obey RTCM3.3 standards, and Unicore defines the filed **Variable Length Data Message**. The data transmission uses Big Endian method.

5.1 Data Structure

See the following tables for the format of the extended RTCM messages defined by Unicore.

Table 5-1 Description of Binary Format

ID	Structure	Description
1	Header	See Table 5-2
2	Data	Data field, the length is variable according to different messages. Please see Table 5-3 for the message type and sub message type.
3	CRC	CRC24Q check (Header + Data)

Table 5-2 Description of Header

Field	Bits	Unit	Range	Description
Preamble	8	—	—	Constant 11010011
Reserved	6	—	—	Reserved; set to 000000
Data Field Length	10	—	—	Data Field length in bytes

Table 5-3 Message Type and Sub Message Type

Field	Bits	Unit	Range	Description
Message Type	12	—	—	UINT; Unicore message type = 4074
Sub Message Type	12	—	—	UINT 0x00B: GYOACC; 0x00C: SNRSTAT 0x00D: NAVATT 0x00E: IMURAW 0x00F: INSPVA 0x010: IMUVEH 0x014: DR Protection level information 0x0FF: Receiver information 0x0FE: Signal information 0x0FD: TGD/ISC information

Field	Bits	Unit	Range	Description
				0x0FB: Ionosphere information 0x0F9: Protection level information 0x0EB: Antenna Status 0x0EA: Leap Second Message 0x0E9: Jamming and Spoofing Detection 0x0E8: SBAS Information 0x0E6: Hardware Status 0x0E4: PPS Status 0x0E1: Satellite Information 0x0E0: AidInfo

The messages use CRC24Q check, and the following is an example in C programming language.

```
U32 Crc24Q_U8(U8 *src, int len)
{
int i;
U32 crc = 0;
for (i = 0; i < len; i++)
crc = (crc << 8) ^ CRC24Q_Table[src[i] ^ (U8)(crc >> 16)];
return crc & 0xFFFFFF;
}
```

5.2 Message Definition

5.2.1 Sensor Fusion Message

5.2.1.1 GYOACC (Sub ID 0x00B)

Applicable to: UM681A

Table 5-4 Output MEMS and Odometer Data

ID	Field	Type	Description	Bytes	Byte Offset
1	Year	U16	Year: (UTC) 0xFFFF means invalid	2	0
2	Month	U8	Month: 1 to 12 (UTC) 0xFF means invalid	1	2
3	Day	U8	Day: 1 to 31 (UTC) 0xFF means invalid	1	3
4	Hour	U8	Hour: 0 to 23 (UTC) 0xFF means invalid	1	4
5	Min	U8	Minute: 0 to 59 (UTC) 0xFF means invalid	1	5
6	mSec	U16	Millisecond 0xFFFF means invalid	2	6
7	gyroX	S32	X-axis angular velocity of the built-in gyroscope; unit: 2^-16 rad/s	4	8
8	gyroY	S32	Y-axis angular velocity of the built-in gyroscope; unit: 2^-16 rad/s	4	12
9	gyroZ	S32	Z-axis angular velocity of the built-in gyroscope; unit: 2^-16 rad/s	4	16
10	gyroPeriod	U8	Output interval of the built-in gyroscope data; unit: ms	1	20
11	accX	S32	X-axis acceleration of the built-in accelerometer; unit: 2^-16 m/s^2	4	21

ID	Field	Type	Description	Bytes	Byte Offset
12	accY	S32	Y-axis acceleration of the built-in accelerometer; unit: 2^-16 m/s^2	4	25
13	accZ	S32	Z-axis acceleration of the built-in accelerometer; unit: 2^-16 m/s^2	4	29
14	accPeriod	U8	Output interval of the built-in accelerometer data; unit: ms	1	33
15	temp	S8	Temperature; unit: °C; 0x80 means invalid	1	34
16	speed	U16	Vehicle speed pulse; output 0xFFFF if not accessing the odometer signal, meaning invalid	2	35
17	pulsePeriod	U8	Output interval of pulses; unit: ms; output 0xFF if not accessing the odometer signal, meaning invalid	1	37
18	fwd	U8	Vehicle direction signal: 0 - Forward 1 - Backward; output 0xFF if not accessing the odometer signal, meaning invalid	1	38
Total				39	39

5.2.1.2 SNRSTAT (Sub ID 0x00C)

Applicable to: UM681A

Table 5-5 Output Initialization Status

ID	Field	Type	Description	Bytes	Byte Offset
1	insstatus	S8	INS initialization state: -1 - IMU device failure 0 - Disable 1 - Initialization started 2 - Known installation angle 3 - Initialization completed	1	0
2	odostatus	S8	Odometer initialization status: -1 - Odometer device failure 0 - Disable 1 - Initialization of scale factor 2 - Initialization of scale factor completed 3 - Scale factor calibration completed	1	1
3	InstallState	S8	-1 - IMU device failure, unable to estimate the installation angle 0 - Calibration in progress 1 - The quality of current satellite information is insufficient and better satellite conditions are needed 2 - The current vehicle mobility conditions are insufficient, and acceleration is required 3 - The current vehicle speed is too low, and it is required to increase the speed	1	2
4	mapstat	S8	-2 - Abnormal map data is detected -1 - No port is configured to receive MAP information	1	3

ID	Field	Type	Description	Bytes	Byte Offset
			0 - The port fails to receive MAP information or the MAP information transmission times out 1 - The MAP information is received but not applied to the integrated navigation 2 - The MAP information is received and applied to the integrated navigation		
Total				4	4

5.2.1.3 NAVATT (Sub ID 0x00D)

Applicable to: UM681A

Table 5-6 Output Vehicle's Attitude and Heading Information

ID	Field	Description	Type	Bytes	Bytes Offset
1	Hour	U8	Hour 0 to 23 (UTC); 0xFF means invalid	1	0
2	Min	U8	Minute 0 to 59 (UTC); 0xFF means invalid	1	1
3	mSec	U16	Millisecond; 0xFFFF means invalid	2	2
4	quality	U8	Current quality: 0 - Invalid 2 - Valid	1	4
5	roll_v	S32	Roll; unit: 1e-5 deg; 0x80000000 means invalid	4	5
6	pitch_v	S32	Pitch; unit: 1e-5 deg; 0x80000000 means invalid	4	9
7	yaw_v	S32	Yaw; unit: 1e-5 deg; 0x80000000 means invalid	4	13
8	roll_acc	U32	Roll accuracy; unit: 1e-5 deg; 0xFFFFFFFF means invalid	4	17
9	pitch_acc	U32	Pitch accuracy; unit: 1e-5 deg; 0xFFFFFFFF means invalid	4	21
10	yaw_acc	U32	Yaw accuracy; unit: 1e-5 deg; 0xFFFFFFFF means invalid	4	25
Total				29	29

5.2.1.4 IMURAW (Sub ID 0x00E)

Applicable to: UM681A

Table 5-7 Output Raw MEMS Data

ID	Field	Type	Description	Bytes	Byte Offset
1	Year	U16	Year: (UTC); 0xFFFF means invalid	2	0
2	Month	U8	Month: 1 to 12 (UTC); 0xFF means invalid	1	2
3	Day	U8	Day: 1 to 31 (UTC); 0xFF means invalid	1	3
4	Hour	U8	Hour: 0 to 23 (UTC); 0xFF means invalid	1	4
5	Min	U8	Minute: 0 to 59 (UTC); 0xFF means invalid	1	5
6	mSec	U16	Millisecond; 0xFFFF means invalid	2	6
7	gyroX	S32	X-axis angular velocity of the built-in gyroscope; unit: 2^-16 rad/s	4	8
8	gyroY	S32	Y-axis angular velocity of the built-in gyroscope; unit: 2^-16 rad/s	4	12
9	gyroZ	S32	Z-axis angular velocity of the built-in gyroscope; unit: 2^-16 rad/s	4	16
10	accX	S32	X-axis acceleration of the built-in accelerometer; unit: 2^-16 m/s^2	4	20
11	accY	S32	Y-axis acceleration of the built-in accelerometer; unit: 2^-16 m/s^2	4	24
12	accZ	S32	Z-axis acceleration of the built-in accelerometer; unit: 2^-16 m/s^2	4	28
13	Speed	S16	Vehicle speed pulses; >0 means forward and <0 means backward The field is invalid if there is no vehicle pulse signal.	2	32
Total				34	34

5.2.1.5 INSPVA (Sub ID 0x00F)

Applicable to: UM681A

Table 5-8 Output the DR Position, Velocity and Attitude

ID	Field	Description	Type	Bytes	Bytes Offset
1	Year	U16	Year: (UTC); 0xFFFF means invalid	2	0
2	Month	U8	Month: 1 to 12 (UTC); 0xFF means invalid	1	2
3	Day	U8	Day: 1 to 31 (UTC); 0xFF means invalid	1	3
4	Hour	U8	Hour: 0 to 23 (UTC); 0xFF means invalid	1	4
5	Min	U8	Minute: 0 to 59 (UTC); 0xFF means invalid	1	5
6	mSec	U16	Millisecond; 0xFFFF means invalid	2	6
7	Lon	S64	Longitude; unit: 2^-32 deg; positive means east, and negative means west; 0x8000000000000000 means invalid	8	8
8	Lat	S64	Latitude; unit: 2^-32 deg; positive means north, and negative means south; 0x8000000000000000 means invalid	8	16
9	Hae	S32	Ellipsoidal height; unit: mm; 0x80000000 means invalid	4	24
10	Vel_E	S32	East velocity in ENU coordinate system; unit: mm/s; 0x80000000 means invalid	4	28
11	Vel_N	S32	North velocity in ENU coordinate system; unit: mm/s; 0x80000000 means invalid	4	32
12	Vel_U	S32	Up velocity in ENU coordinate system; unit: mm/s; 0x80000000 means invalid	4	36
13	roll_v	S32	Roll; unit: 1e-5 deg; 0x80000000	4	40

ID	Field	Description	Type	Bytes	Bytes Offset
			means invalid		
14	pitch_v	S32	Pitch; unit: 1e-5 deg; 0x80000000 means invalid	4	44
15	yaw_v	S32	Yaw; unit: 1e-5 deg; 0x80000000 means invalid	4	48
Total				52	52

5.2.1.6 IMUVEH (Sub ID 0x010)

Applicable to: UM681A

Table 5-9 Output Compensated MEMS data in the Vehicle Body Coordinate System

ID	Field	Description	Type	Bytes	Bytes Offset
1	Year	U16	Year: (UTC); 0xFFFF means invalid	2	0
2	Month	U8	Month: 1 to 12 (UTC); 0xFF means invalid	1	2
3	Day	U8	Day: 1 to 31 (UTC); 0xFF means invalid	1	3
4	Hour	U8	Hour: 0 to 23 (UTC); 0xFF means invalid	1	4
5	Min	U8	Minute: 0 to 59 (UTC); 0xFF means invalid	1	5
6	mSec	U16	Millisecond; 0xFFFF means invalid	2	6
7	gyroX	S32	X-axis angular velocity of the built-in gyroscope in body coordinate system; unit: 2^-16 rad/s; before the calibration of the initial device, it is invalid and outputs 0x80000000	4	8
8	gyroY	S32	Y-axis angular velocity of the built-in gyroscope in body coordinate system; unit: 2^-16 rad/s; before the calibration of the initial device, it is invalid and outputs 0x80000000	4	12
9	gyroZ	S32	Z-axis angular velocity of the built-in gyroscope in body coordinate system; unit: 2^-16	4	16

ID	Field	Description	Type	Bytes	Bytes Offset
			rad/s; before the calibration of the initial device, it is invalid and outputs 0x80000000		
10	accX	S32	X-axis acceleration of the built-in accelerometer in body coordinate system; unit: 2^-16 m/s^2; before the calibration of the initial device, it is invalid and outputs 0x80000000	4	20
11	accY	S32	Y-axis acceleration of the built-in accelerometer in body coordinate system; unit: 2^-16 m/s^2; before the calibration of the initial device, it is invalid and outputs 0x80000000	4	24
12	accZ	S32	Z-axis acceleration of the built-in accelerometer in body coordinate system; unit: 2^-16 m/s^2; before the calibration of the initial device, it is invalid and outputs 0x80000000	4	28
13	Speed	S16	Vehicle speed pulses; >0 means forward and <0 means reverse; the field is invalid and outputs 0x8000 if there is no input of vehicle pulse signal	2	32
Total				34	34

5.2.1.7 DR Protection level Information (Sub ID 0x014)

Applicable to: UM681A

This message provides the protection level (PL) information and the target misleading information risk (TMIR) for DR navigation. When the value of the protection level is less than the actual error, misleading information happens. Denote TMIR as X [%MI/epoch], which means that the occurrence possibility of the misleading information every epoch is X%, and X = tmirCoeff*(10^TmirExt). Therefore, this message outputs the positioning confidence and positioning error estimation.

Table 5-10 DR Protection Level Information Structure

ID	Field	Type	Description	Bytes	Bytes Offset
1	msgVersion	U8	Message version: 0x01	1	0
2	tmirCoeff	U8	Coefficient integer number of base 10 scientific notation[15] (TMIR=X [%MI/epoch])	1	1
3	TmirExt	U8	Exponent integer number of base 10 scientific notation[15] (TMIR=X [%MI/epoch])	1	2
4	plPosValid	U8	Validity of the PL position 0 – Invalid (PL position cannot be used) 1 – Valid	1	3
5	plPosFrame	U8	Reference frame of the PL position 0 – Invalid (frame conversion cannot be calculated) 1 – North-East-Down	1	4
6	plVelValid	U8	Validity of the PL velocity 0 – Invalid (PL velocity cannot be used) 1 – Valid	1	5
7	plVelFrame	U8	Reference frame of the PL velocity 0 – Invalid (frame conversion cannot be calculated) 1 – North-East-Down	1	6
8	Reserved	U8	Reserved	1	7
9	Reserved	U8[4]	Reserved	4	8
10	Week	U16	GPS week, 0xFFFF means invalid	2	12
11	GNSS Epoch Tim	U32	GPS seconds of week, unit: ms, 0xFFFFFFFF means invalid	4	14
12	plPos1	U32	PL position along the first axis; unit: mm; output 0xFFFFFFFF when plPosValid is invalid	4	18
13	plPos2	U32	PL position along the second axis; unit: mm; output 0xFFFFFFFF when plPosValid is invalid	4	22
14	plPos3	U32	PL position along the third axis;	4	26

15 X=tmirCoeff*(10^TmirExt). For example, if tmirCoeff=5, TmirExt=0, then X=5*10^0=5.

ID	Field	Type	Description	Bytes	Bytes Offset
			unit: mm; output 0xFFFFFFFF when plPosValid is invalid		
15	plVel1	U32	PL velocity along the first axis; unit: mm/s; output 0xFFFFFFFF when plVelValid is invalid	4	30
16	plVel2	U32	PL velocity along the second axis; unit: mm/s; output 0xFFFFFFFF when plVelValid is invalid	4	34
17	plVel3	U32	PL velocity along the third axis; unit: mm/s; output 0xFFFFFFFF when plVelValid is invalid	4	38
18	Reserved	U16	Reserved	2	42
19	Reserved	U16	Reserved	2	44
20	Reserved	U32	Reserved	4	46
21	Reserved	U32	Reserved	4	50
Total				54	54

5.2.2 PVT messages

5.2.2.1 Receiver Information (Sub ID 0x0FF)

Applicable to: UC6580, UM670A, UM680A, UM681A

The message **Receiver Information** contains parameters related to receiver status, including position, speed, positioning quality, DOP value and clock information etc. The data transmission uses Big Endian method. See the following table for more details.

Table 5-11 Receiver Information Structure

ID	Field	Type	Description	Bytes	Bytes Offset
1	Version	U8	Message version: 0x01	1	0
2	Week	U16	GPS week, starting from Jan. 6th 1980; 0xFFFF means invalid	2	1
3	Tow	U32	GPS time of week; unit: ms; 0xFFFFFFFF means invalid	4	3
4	SatNum	U8	Number of satellites used in positioning; 0xFF means invalid	1	7
5	Lon	S64	Longitude; unit: 2^-32 deg; positive - East; negative - West;	8	8

ID	Field	Type	Description	Bytes	Bytes Offset
			0x8000000000000000 means invalid		
6	Lat	S64	Latitude; unit: 2^-32 deg; positive - North; negative - South; 0x8000000000000000 means invalid	8	16
7	Hae	S32	Ellipsoidal height; unit: mm; 0x80000000 means invalid	4	24
8	Hmsl	S32	Altitude; unit: mm; 0x80000000 means invalid	4	28
9	X	S64	ECEF X coordinate; unit: mm; 0x8000000000000000 means invalid	8	32
10	Y	S64	ECEF Y coordinate; unit: mm; 0x8000000000000000 means invalid	8	40
11	Z	S64	ECEF Z coordinate; unit: mm; 0x8000000000000000 means invalid	8	48
12	Quality	U8	Positioning quality: 0 - Invalid 1 - Single point positioning 2 - DGPS 4 - RTK fixed solution 5 - RTK floating solution 6 - INS positioning	1	56
13	Vel_E	S32	East velocity in ENU coordinate; unit: mm/s; 0x80000000 means invalid.	4	57
14	Vel_N	S32	North velocity in ENU coordinate; unit: mm/s; 0x80000000 means invalid	4	61
15	Vel_U	S32	Up velocity in ENU coordinate; unit: mm/s; 0x80000000 means invalid	4	65
16	Speed	S32	Speed over ground; unit: mm/s; 0x80000000 means invalid	4	69
17	Heading	U16	Heading; unit: 1e-2 deg; range: 0 to 35999; 0xFFFF means invalid	2	73
18	HDOP	U16	Horizontal dilution of precision; unit: 1e-2; range: 0 to 9999;	2	75

ID	Field	Type	Description	Bytes	Bytes Offset
			0xFFFF means invalid		
19	VDOP	U16	Vertical dilution of precision; unit: 1e-2; range: 0 to 9999; 0xFFFF means invalid	2	77
20	PDOP	U16	Position dilution of precision; unit: 1e-2; range: 0 to 9999; 0xFFFF means invalid	2	79
21	GDOP	U16	Geometric dilution of precision; unit: 1e-2; range: 0 to 9999; 0xFFFF means invalid	2	81
22	TDOP	U16	Time dilution of precision; unit: 1e-2; range: 0 to 9999; 0xFFFF means invalid	2	83
23	EACC	U32	East mean square error; unit: mm; 0xFFFFFFFF means invalid	4	85
24	NACC	U32	North mean square error; unit: mm; 0xFFFFFFFF means invalid	4	89
25	UACC	U32	Up mean square error; unit: mm; 0xFFFFFFFF means invalid	4	93
26	TACC	U32	Time mean square error; unit: ns; 0xFFFFFFFF means invalid	4	97
27	XACC	U32	Mean square error of X coordinate; unit: mm; 0xFFFFFFFF means invalid	4	101
28	YACC	U32	Mean square error of Y coordinate; unit: mm; 0xFFFFFFFF means invalid	4	105
29	ZAcc	U32	Mean square error of Z coordinate; unit: mm; 0xFFFFFFFF means invalid	4	109
30	VelEAcc	U32	Mean square error of east velocity; unit: mm/s; 0xFFFFFFFF means invalid	4	113
31	VelNAcc	U32	Mean square error of north velocity; unit: mm/s; 0xFFFFFFFF means invalid	4	117
32	VelUAcc	U32	Mean square error of up velocity; unit: mm/s; 0xFFFFFFFF means invalid	4	121
33	ClkErr	S32	Receiver clock error; unit: ns; 0x80000000 means invalid	4	125
34	ClkDrift	S32	Equivalent speed of clock drift;	4	129

ID	Field	Type	Description	Bytes	Bytes Offset
			unit: 1e-1 Hz; 0x80000000 means invalid		
35	Year	U16	Year: (UTC); 0xFFFF means invalid	2	133
36	Month	U8	Month: 1 to 12 (UTC); 0xFF means invalid	1	135
37	Day	U8	Day: 1 to 31 (UTC); 0xFF means invalid	1	136
38	Hour	U8	Hour: 0 to 23 (UTC); 0xFF means invalid	1	137
39	Min	U8	Minute: 0 to 59 (UTC); 0xFF means invalid	1	138
40	mSec	U16	Millisecond; 0xFFFF means invalid	2	139
41	StationID	U16	Reference station ID; 0xFFFF means invalid	2	141
42	DiffAge	U8	Differential age; unit: s; 0xFF means invalid	1	143
43	CACC	U16	Mean square error of course error; unit: 1e-2 deg; 0xFFFF means invalid	2	144
44	Reserved	U16*7	Reserved	14	146
Total	-			160	160

5.2.2.2 Signal Information (Sub ID 0x0FE)

Applicable to: UC6580, UM670A, UM680A, UM681A

The message **Signal Information** contains parameters related to satellite status, including PRN, CN0, elevation, azimuth and pseudo-range residual etc. If there is no GNSS signal, the message outputs the header and the field SatNum = 0. The data transmission uses Big Endian method. See the following tables for the details of the message structure.

Table 5-12 Signal Information Structure

ID	Field	Type	Description	Bytes	Byte Offset
1	Version	U8	Message version: 0x01	1	0
2	Week	U16	GPS week, starting from Jan. 6th 1980; 0xFFFF means invalid	2	1
3	Tow	U32	GPS time of week; unit: ms; 0xFFFFFFFF means invalid	4	3
4	SatNum	U32	Repeat time of satellite status	4	7
5	SatInfo	—	See Table 5-13 for details	SatNum* (8 + 6*N_f)	11
Total	-			11+SatNum * (8 + 6*N_f)	11+ SatNum * (8+6*N_f)

Table 5-13 shows the encoding structure of satellite information.

Table 5-13 Satellite Information Encoding Structure

ID	Field	Type	Description	Bytes	Byte Offset
1	Prn	U8	Satellite ID: GPS 01 to 32 QZSS 01 to 10 GLO 65 to 99 BDS 01 to 64 GAL 01 to 36 SBAS 33 to 51	1	0
2	System	U8	1 - GPS 2 - GLO 3 - GAL 4 - BDS 5 - QZSS 6 - SBAS	1	1
3	El	U16	Satellite elevation; unit: 1e-1 deg; range: 0 to 900; 0xFFFF means invalid	2	2
4	Az	U16	Satellite azimuth; unit: 1e-1 deg; range: 0 to 3600; 0xFFFF means invalid	2	4
5	InUse	U8	0 - not used in positioning 1 - used in positioning	1	6
6	Freq Num (N_f)	U8	The frequency number of the satellite	1	7
Field 7 to 10 repeat N_f times (see Field 6)					
7	Freq ID	U8	GPS 2 - GPS L1C/A 16 - GPS L2C(L) 23 - GPS L5Q GLO 2 - G1C/A BDS 2 - B1I 14 - B2I 23 - B2a_pilot 31 - B1C_pilot GAL 2 - E1C no data 15 - E5bQ 23 - E5aQ	1	2 + 6*N_f

ID	Field	Type	Description	Bytes	Byte Offset
			QZSS 2 - QZSS L1C/A 16 - QZSS L2C(L) 23 - QZSS L5Q SBAS 2 - SBAS L1C/A 23 - SBAS L5Q		
8	CN0	U8	Unit: dB.Hz	1	3 + 6*N_f
9	PrResi	U16	Positioning pseudo-range residual of each satellite; unit: 1e-1 m; 0xFFFF means invalid	2	4 + 6*N_f
10	DpResi	U16	Velocity measurement Doppler residual of each satellite; unit: 1e-1 Hz; 0xFFFF means invalid	2	6 + 6*N_f
Total	-			8 + 6*N_f	8 + 6*N_f

5.2.2.3 TGD/ISC Information (Sub ID 0x0FD)

Applicable to: UC6580, UM670A

This message outputs the parsed TGD/ISC information of each satellite. The data transmission uses Big Endian method.

Table 5-14 TGD/ISC Information Structure

ID	Field	Type	Description	Bits	Bit Offset
1	System	U8	1 - GPS 2 - GLO 3 - GAL 4 - BDS 5 - QZSS	8	0
2	SatNum	U8	Output the TGD satellite numbers	8	8
3	TGDInfo	—	See Table 5-15 to Table 5-17	SatNum * 89	16
Total	-			16 + SatNum * 89	16 + SatNum * 89

Table 5-15 to Table 5-17 are the TGD/ISC information encoding structure for GPS/QZSS, BDS and GAL systems.

Table 5-15 GPS/QZSS TGD/ISC Info

ID	Field	Type	Description	Bytes	Byte Offset
1	Svid	U8	GPS satellite number: 01 to 32 QZSS satellite number: 01 to 10	8	0
2	toe	Int17	Time of ephemeris; LSB: 2^4; unit: s	17	8
3	TGDL1	S16	L1 group delay; LSB: 2^-31; unit: s; 0x8000 means invalid	16	25
4	ISCL1C	S16	L1 group delay; LSB: 2^-35; unit: s; 0x8000 means invalid	16	41
5	TGDL5	S16	L5 group delay; LSB: 2^-35; unit: s; 0x8000 means invalid	16	57
6	ISCL5Q	S16	L5 group delay; LSB: 2^-35; unit: s; 0x8000 means invalid	16	73
Total				89	89

Table 5-16 BDS TGD/ISC Info

ID	Field	Type	Description	Bytes	Byte Offset
1	Svid	U8	BDS satellite number: 01 to 64	8	0
2	toe	Int17	Time of ephemeris; LSB: 2^3; unit: s	17	8
3	TGDB1I	S16	B1I group delay; LSB:1e-1; unit: ns; 0x8000 means invalid	16	25
4	ISCB1I	S16	Specified to constant 0x8000	16	41
5	TGDB2A	S16	B2A group delay; LSB:2^-34; unit: s; 0x8000 means invalid;	16	57
6	ISCB2A	S16	B2A (data) delay; LSB:2^-34; unit: s; 0x8000 means invalid	16	73
Total				89	89

Table 5-17 GAL TGD/ISC Info

ID	Field	Type	Description	Bits	Bit Offset
1	Svid	U8	GAL satellite number: 01 to 36	8	0
2	toe	Int17	Time of ephemeris; LSB:6e1; unit: s	17	8
3	TGDE1	S16	E1 group delay; LSB:2^-32; unit: s; 0x8000 means invalid	16	25
4	ISCE1	S16	Specified to constant 0x8000	16	41
5	TGDE5A	S16	E5A group delay; LSB:2^-32; unit: s; 0x8000 means invalid;	16	57
6	ISCE5A	S16	Specified to constant 0x8000	16	73
Total				89	89

5.2.2.4 Ionosphere Information (Sub ID 0x0FB)

Applicable to: UC6580, UM670A, UM680A, UM681A

This message outputs the ionosphere parameters broadcasted by GPS and BDS. See Table 5-18 for the details. The data transmission uses Big Endian method.

Table 5-18 Ionosphere Information Structure

ID	Field	Type	Description	Bytes	Byte Offset
1	System	U8	0 - GPS 1 - BDS	1	0
2	a0	S8	Alpha parameter constant term; LSB: 2^-30	1	1
3	a1	S8	Alpha parameter 1st order term; LSB: 2^-27	1	2
4	a2	S8	Alpha parameter 2nd order term; LSB: 2^-24	1	3
5	a3	S8	Alpha parameter 3rd order term; LSB: 2^-24	1	4
6	b0	S8	Beta parameter constant term; LSB: 2^11	1	5
7	b1	S8	Beta parameter 1st order term; LSB: 2^14	1	6
8	b2	S8	Beta parameter 2nd order term; LSB: 2^16	1	7
9	b3	S8	Beta parameter 3rd order term; LSB: 2^16	1	8
Total	-			9	9

5.2.2.5 Protection Level Information (Sub ID 0x0F9)

Applicable to: UC6580, UM670A

This message provides the protection level (PL) information and the target misleading information risk (TMIR) for GNSS navigation. When the value of the protection level is less than the actual error, misleading information happens. Denote TMIR as X [%MI/epoch], which means that the occurrence possibility of the misleading information every epoch is X%, and X = tmirCoeff*(10^TmirExt). Therefore, this message outputs the positioning confidence and positioning error estimation.

Table 5-19 GNSS Protection Level Information Structure

ID	Field	Type	Description	Bytes	Bytes Offset
1	msgVersion	U8	Message version: 0x01	1	0
2	tmirCoeff	U8	Coefficient integer number of base 10 scientific notation[16] (TMIR=X [%MI/epoch])	1	1
3	TmirExt	U8	Exponent integer number of base 10 scientific notation[16] (TMIR=X [%MI/epoch])	1	2
4	plPosValid	U8	Validity of the PL position 0 – Invalid (PL position cannot be used) 1 – Valid	1	3
5	plPosFrame	U8	Reference frame of the PL position 0 – Invalid (frame conversion cannot be calculated) 1 – North-East-Down	1	4
6	plVelValid	U8	Validity of the PL velocity 0 – Invalid (PL velocity cannot be used) 1 – Valid	1	5
7	plVelFrame	U8	Reference frame of the PL velocity 0 – Invalid (frame conversion cannot be calculated) 1 – North-East-Down	1	6
8	Reserved	U8	Reserved	1	7
9	Reserved	U8*4	Reserved	4	8

16 X=tmirCoeff*(10^TmirExt). For example, if tmirCoeff=5, TmirExt=0, then X=5*10^0=5.

ID	Field	Type	Description	Bytes	Bytes Offset
10	Week	U16	GPS week, 0xFFFF means invalid	2	12
11	GNSS Epoch Tim	U32	GPS seconds of week, unit: ms, 0xFFFFFFFF means invalid	4	14
12	plPos1	U32	PL position along the first axis; unit: mm; output 0xFFFFFFFF when plPosValid is invalid	4	18
13	plPos2	U32	PL position along the second axis; unit: mm; output 0xFFFFFFFF when plPosValid is invalid	4	22
14	plPos3	U32	PL position along the third axis; unit: mm; output 0xFFFFFFFF when plPosValid is invalid	4	26
15	plVel1	U32	PL velocity along the first axis; unit: mm/s; output 0xFFFFFFFF when plVelValid is invalid	4	30
16	plVel2	U32	PL velocity along the second axis; unit: mm/s; output 0xFFFFFFFF when plVelValid is invalid	4	34
17	plVel3	U32	PL velocity along the third axis; unit: mm/s; output 0xFFFFFFFF when plVelValid is invalid	4	38
18	Reserved	U16	Reserved	2	42
19	Reserved	U16	Reserved	2	44
20	Reserved	U32	Reserved	4	46
21	Reserved	U32	Reserved	4	50
Total				54	54

5.2.2.6 Antenna Status (Sub ID 0x0EB)

Applicable to: UM680A and UM681A hardware V1.3, UM670A hardware V1.3

Table 5-20 Antenna Status Message Structure

ID	Field	Type	Description	Bytes	Byte Offset
1	Status	U8	Antenna status: 0 – Normal, active antenna 1 – Short circuit 2 – Open circuit, or passive antenna 3 – Hardware error	1	0

ID	Field	Type	Description	Bytes	Byte Offset
Total				1	1

5.2.2.7 Leap Second Message (Sub ID 0x0EA)

Applicable to: UC6580, UM670A

Leap second message outputs leap second and leap second prediction information. See the following table for more details.

Table 5-21 Leap Second Message Structure

ID	Field	Type	Description	Bytes	Byte Offset
1	Version	U8	Message version: 0x01	1	0
2	Week	U16	GPS week, starting from Jan. 6, 1980, 0xFFFF means invalid	2	1
3	Tow	U32	GPS time of week, unit: ms, 0xFFFFFFFF means invalid	4	3
4	srcOfCurrLs	U8	Source of the current leap second: 0 = default (data stored in firmware, maybe out of date) 1 = time difference between GPST and GLONASS time 2 = GPS 3 = SBAS 4 = BeiDou 5 = Galileo 6 = assistance data 7 = configuration 8 = NavIC 255 = unknown	1	7
5	currLs	S8	Current number of leap second since the start of GPST (Jan. 6, 1980), which reflects how much GPST is ahead of UTC time. The leap second of Galileo is as same as that of GPS. The leap second of BeiDou is 14 seconds less than that of GPS. GLONASS follows UTC time, so it has no leap second. 0x80 means invalid.	1	8
6	srcOfLsChange	U8	Source of the future leap second: 0 = no source	1	9

ID	Field	Type	Description	Bytes	Byte Offset
			2 = GPS 3 = SBAS 4 = BeiDou 5 = Galileo 6 = GLONASS 7 = NavIC		
7	lsChange	S8	Change of the leap second in the future: +1 = positive leap second -1 = negative leap second 0 = no leap second event in the future or no information available If this value is 0, it indicates that the number of leap second has not changed and the event should be ignored.	1	10
8	timeToLsEvent	S32	Time to the next leap second event, in seconds. If there is no leap second event in the future, it refers to the number of seconds since the last leap second moment. >0 leap second in the future, =0 leap second at present, <0 leap second in the past. 0x80000000 means invalid.	4	11
9	dateOfLsGpsWN	U16	GPS week number (WN) when the next leap second occurs. If there is no leap second in the future, it refers to the GPS WN when the last leap second occurred. 0xFFFF means invalid.	2	15
10	dateOfLsGpsDn	U8	GPS day number (DN) of the week when the next leap second occurs. If there is no leap second in the future, it refers to the GPS DN when the last leap second occurred. DN of GPS and Galileo: from 1 = Sunday to 7 = Saturday. DN of BeiDou: from 0 = Sunday to 6	1	17

ID	Field	Type	Description	Bytes	Byte Offset
			= Saturday 0xFF means invalid		
Total				18	18

5.2.2.8 Jamming and Spoofing Detection (SUB ID 0x0E9)

Applicable to: UC6580, UM670A

This message outputs jamming and spoofing information periodically. The message structure is shown in the following table.

Table 5-22 Jamming and Spoofing Detection Message Structure

ID	Field	Type	Description	Bytes	Byte Offset
1	Version	U8	Message version: 0x01	1	0
2	Week	U16	GPS week, starting from Jan. 6, 1980, 0xFFFF means invalid	2	1
3	Tow	U32	GPS time of week, unit: ms, 0xFFFFFFFF means invalid	4	3
4	jamDetEnabled	U8	Enable or disable jamming detection 0: disable 1: enable	1	7
5	jammingState	S8	Jamming state 0: unknown 1: no jamming 2: warning (jamming detected but the positioning quality is good) 3: severe (jamming detected without positioning solution)	1	8
6	spfDetEnabled	U8	Enable or disable spoofing detection 0: disable 1: enable	1	9
7	spoofingState	S8	Spoofing state 0: unknown 1: no spoofing 2: spoofing detected Note: The spoofing state only reflects the state in the	1	10

ID	Field	Type	Description	Bytes	Byte Offset
			current navigation epoch. For example, if the value is 1, it does not mean that there is no spoofing signal, but only that the spoofing detector is not triggered in the current epoch.		
8	Reserved	U32	Reserved	4	11
Total				15	15

5.2.2.9 SBAS Information (Sub ID 0x0E8)

Applicable to: UM670A

This message outputs SBAS information.

Table 5-23 SBAS Message Structure

ID	Field	Type	Description	Bytes	Byte Offset
1	Version	U8	Message version: 0x01	1	0
2	gnssId	U8	GNSS system ID	1	1
3	svId	U8	Satellite ID	1	2
4	sigId	U8	Signal ID	1	3
5	Reserved	U8	Reserved, output 0	1	4
6	chn	U8	Tracking channel	1	5
7	DataNum	U8	Data number of SBAS messages (in the unit of U32 for each message), specified to 8	1	6
8	Data[DataNum]	U32	SBAS messages	DataNum*4	7
9	Reserved	U32	Reserved	16	7+ DataNum*4
Total				DataNum*4+23	DataNum*4 +23

5.2.2.10 Hardware Status (Sub ID 0x0E6)

Applicable to: UC6580, UM670A, UM680A, UM681A

Hardware Status is supported by specific firmware.

Table 5-24 Hardware Status Message Structure

ID	Field	Type	Description	Bits	Bit Offset
1	msgVersion	U8	Message version: 0x02	8	0
2	Week	U16	GPS week, starting from Jan. 6, 1980, 0xFFFF means invalid	16	8
3	Tow	U32	GPS time of week, unit: ms, 0xFFFFFFFF means invalid	32	24
4	Antenna Fault	U8	0x0: All OK (default) 0x3: Jamming detected **Recovered 0x0 after fault solved**	8	56
5	AGCCnt	U8	Number of repetitions of the 6th and 7th fields	8	64
Repeat the 6th and 7th fields in sequence AGCCnt times (field 5).					
6	AGC Band ID	U8	0: L1 (1575.42MHZ) 1: L5 (1176.45MHz) 2: L2 (1227.60MHz)	8	72
7	AGC Band Value	U8	AGC band value, X*0.6dB	8	80
8	NoiseCnt	U8	Number of repetitions of the 9th and 10th fields	8	72+16* AGCCnt
Repeat the 9th and 10th fields in sequence NoiseCnt times (field 8).					
9	Noise SignalID	U8	0: L1 (1575.42MHz) 1: B1 (1561.098) 2: R1 (1602MHz) 3: L5 (1176.45MHz) 4: GPS L2C (1227.60MHz) 5: B2B/E5B (1207.14MHz) 6: GLO R2 (1246MHz)	8	80+16* AGCCnt
10	NoiseValue	U16	Noise floor	16	88+16* AGCCnt
11	RTC Fault	U4	0x0: All OK (default) 0x1: RTC not synchronized 0x2: RTC not working **Recovered 0x0 after fault solved**	4	80+16* AGCCnt +24* NoiseCnt

ID	Field	Type	Description	Bits	Bit Offset
12	1PPS Fault	U4	0x0: PPS synchronized in 60 seconds 0x1: PPS synchronized in 300 seconds but exceeds 60 seconds 0x2: PPS synchronization exceeds 300 seconds 0x3: PPS not synchronized 0x4: PPS not output **Recovered 0x0 after fault solved**	4	84+16* AGCCnt +24* NoiseCnt
13	Flash Fault	U4	0x0: Code loaded from Flash 0x4: Code loaded externally	4	88+16* AGCCnt +24* NoiseCnt t
14	IMU Fault	U4	0x0: IMU not working 0x1: IMU working (BMI088)	4	92+16* AGCCnt +24* NoiseCnt
Total				96+16* AGCCnt +24* NoiseCnt	96+16* AGCCnt +24* NoiseCnt

5.2.2.11 PPS Status (Sub ID 0x0E4)

Applicable to: UM670A, UM680A, UM681A

PPS Status is supported by specific firmware.

This message outputs PPS status information, including the pulse period, width, polarity and delay. It only supports 1 Hz output.

Table 5-25 PPS Status Message Structure

ID	Field	Type	Description	Bytes	Byte Offset
1	PPS Status	U8	0: disable 1: enable	1	0
2	Mode	U8	0: Output after the positioning is stable 1: Output after the receiver is turned on	1	1
3	Sync	U8	0x0: PPS synchronized in 60 seconds 0x1: PPS synchronization exceeds 60 seconds 0x2: PPS not synchronized	1	2

ID	Field	Type	Description	Bytes	Byte Offset
			0x3: PPS not output		
4	Period	U32	Time pulse output period, unit: us	4	3
5	Width	U32	Time pulse width, unit: us	4	7
6	Polarity	U8	0: Rising edge at top of second 1: Falling edge at top of second	1	11
7	Delay	S32	RF delay + antenna delay + user-set delay, unit: ns	4	12
8	TimeRef	U8	1: GPS 2: GLO 3: GAL 4: BDS 0xFF: Unknown	1	16
9	Week	U16	Week for the next PPS pulse edge, in accordance with the reference system. 0xFFFF means invalid. When the reference system is GLONASS, this field is the GLONASS day.	2	17
10	TowMs	U32	Milliseconds of week for the next PPS pulse edge, in accordance with the reference system. 0xFFFFFFFF means invalid. When the reference system is GLONASS, this field is the milliseconds of GLONASS day.	4	19
11	TowSubMS	U32	Sub-milliseconds of week for the next PPS pulse edge, in accordance with the reference system. 0xFFFFFFFF means invalid.	4	23
12	TimeErr	S32	Time error, unit: ns. 0x80000000 means invalid	4	27
Total	-			31	31

5.2.2.12 Satellite Information (Sub ID 0x0E1)

Applicable to: UM670A-03 hardware V1.3

The Satellite Information message mainly outputs the status of visible or tracked satellites, including PRN, elevation angle, azimuth angle, ephemeris source, health

status, etc.

Table 5-26 Satellite Information Message Structure

ID	Field	Type	Description	Bytes	Byte Offset
1	Version	U8	Message version: 0x01	1	0
2	Week	U16	GPS week, starting from Jan. 6, 1980, 0xFFFF means invalid	2	1
3	Tow	U32	GPS time of week, unit: ms, 0xFFFFFFFF means invalid	4	3
4	SatNum	U8	Number of satellites	1	7
5	Reserved	U16	Reserved	2	8
6	SatInfo	—	Status of each satellite, see Table 5-27. Output repeatedly based on the number of satellites (SatNum).	SatNum * 10	10
Total	-			10 + SatNum * 10	10 + SatNum * 10

Table 5-27 Satellite Status

ID	Field	Type	Description	Bytes	Byte Offset
1	Prn	U8	Satellite ID: GPS: 01~32 QZSS: 01~10 GLO: 65~99 BDS: 01~64 GAL: 01~36 SBAS: 33-51	1	0
2	System	U8	1: GPS 2: GLO 3: GAL 4: BDS 5: QZSS 6: SBAS	1	1
3	El	U16	Satellite elevation; 0~900; unit: 0.1 degrees; 0xFFFF means invalid	2	2
4	Az	U16	Satellite azimuth; 0~3600; unit: 0.1 degrees; 0xFFFF means invalid	2	4

ID	Field	Type	Description	Bytes	Byte Offset
5	flags	U16	Bit 0, whether used in positioning solution or not. 0: not used in positioning 1: used in positioning	2	6
			Bits 1~2, satellite health status. 0: unknown 1: healthy 2: unhealthy		
			Bits 3~4, ephemeris status. 0: No available ephemeris 1: Invalid ephemeris 2: Valid ephemeris		
			Bits 5~6, ephemeris source. 0: No available ephemeris 1: Ephemeris from real-time message parsing 2: Ephemeris from Flash/RTM 3: Ephemeris from injected assisted ephemeris		
6	Reserved	U16	Reserved	2	8
Total	-			10	10

5.2.2.13 AidInfo (Sub ID 0x0E0)

Applicable to: UM670A-03 hardware V1.3

The AidInfo message mainly outputs the assisted time and position of AGNSS, the validity of the values, and the estimated accuracy deviations.

Once the receiver autonomously acquires time and position, it will not use the assisted information and will not update the content of this message.

Table 5-28 AidInfo Message Structure

ID	Field	Type	Description	Bytes	Byte Offset
1	Version	U8	Message version: 0x01	1	0
2	Week	U16	GPS week, starting from Jan. 6, 1980, 0xFFFF means invalid	2	1
3	Tow	U32	GPS time of week, unit: ms, 0xFFFFFFFF means invalid	4	3
4	TimeFlag	U8	Bit 0: No time available Bit 1: Time from RTC	1	7

ID	Field	Type	Description	Bytes	Byte Offset
			Bit 2: Time from AGNSS Bit 3: Time from system broadcast		
5	aidWeek	U16	GPS week converted from the assisted UTC, starting from Jan. 6, 1980, 0xFFFF means invalid	2	8
6	aidTow	U32	GPS time of week converted from the assisted UTC, unit: ms, 0xFFFFFFFF means invalid	4	10
7	DeltaTime	U16	Time difference between the assisted time and the current time, unit: ms, range: 0 ~ 60,000. 0xFFFF means invalid. If the DeltaTime exceeds 60,000 ms, it outputs 60,000.	2	14
8	PosFlag	U8	Bit 0: No assisted position Bit 1: Assisted position valid	1	16
9	aidLon	S64	Assisted longitude, unit: 2^-32 degrees, 0x8000000000000000 means invalid	8	17
10	aidLat	S64	Assisted latitude, unit: 2^-32 degrees, 0x8000000000000000 means invalid	8	25
11	aidHae	S32	Assisted ellipsoidal height, unit: mm, 0x80000000 means invalid	4	33
Total				37	37

5.3 Decoding Example

5.3.1 TOW (U32)

Hex-ASCII	07 92 04 08
U32 value	0x7920408 (127009800)
Tow	127009800 ms

5.3.2 Lon (S64)

Hex-ASCII	00 00 00 74 3D EC E6 E1
S64 value	0x000000743DECE6E1(499255142113)
Lon	(499255142113/(2^32))° = 116.24189608567°

5.3.3 Vel_E (S32)

Hex-ASCII	00 00 00 1B
S32 value	0x0000001B (27)
Vel_E	27 mm/s

5.3.4 Year (U16)

Hex-ASCII	07 E7
S32 value	0x07E7 (2023)
Year	2023

6 Reference

[1] RTCM STANDARD 10403.3, DIFFERENTIAL GNSS (GLOBAL NAVIGATION SATELLITE SYSTEMS) SERVICES: VERSION 3

[2] NMEA 0183 Standard for Interfacing Marine Electronic Devices, Version 4.11

[3] Quasi-Zenith Satellite System Interface Specification DC Report Service (IS-QZSS-DCR-012)

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