REYAX
TECHNOLOGY CORPORATION, LTD

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RYS352x

PAIR Command Guide

Contents

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1 Introduction

RYS3520 GNSS modules support GPS, GLONASS, Galileo, BDS and QZSS constellations. Concurrent tracking of multi-frequency bands provides fast and accurate acquisition and makes these modules ideal solutions for positioning and navigation in various vertical markets.

This document describes the software commands that are used to control and modify the module configuration. The software commands are NMEA proprietary commands defined by REYAX. To report GNSS information, the modules support outputting messages in NMEA 0183 protocol format and RTCM protocol format.

Table 1: Applicable Variants and Supported Frequency Bands

Module	Variant	Frequency Band
RYS352x	RYS3520	GPS L1 C/A + GLONASS L1 + Galileo E1 + BDS B1I + QZSS L1 C/A
	,,,	

Table 2: Supported Protocols

Protocol	Type
RYS352x	Output, ASCII, standard
	Input/output, ASCII, proprietary
RTCM 10403.3	Output, binary, proprietary

2 NMEA Protocol

2.1. Structure of NMEA Protocol Messages

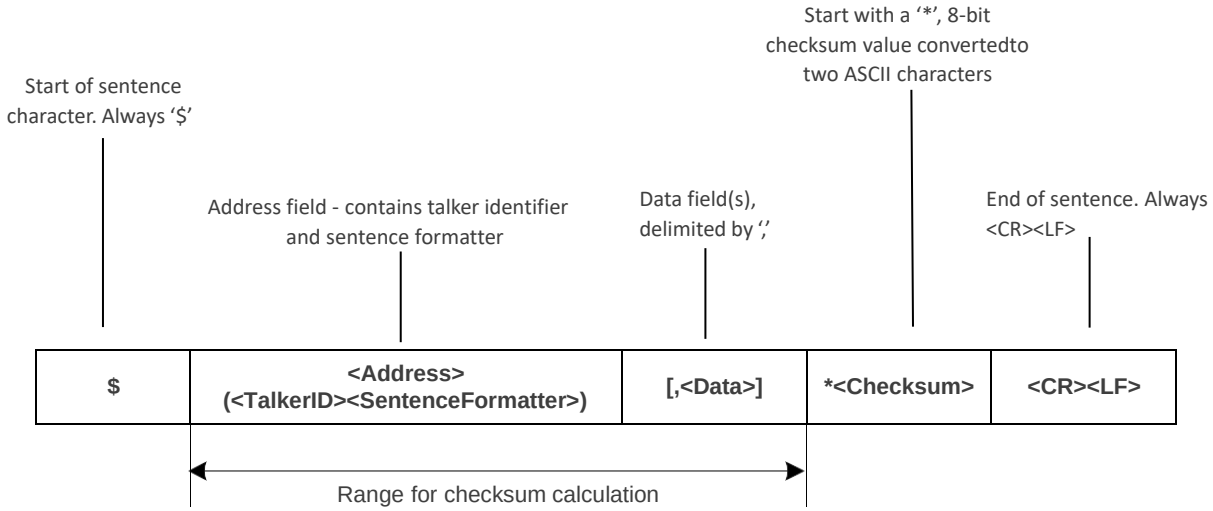

Figure 1: Structure of NMEA Protocol Messages

Table 3: Structure of NMEA Protocol Messages

Field	Description
$	Start of the sentence (Hex 0x24).
<Address>	**In Standard Messages:** In NMEA standard messages, this field consists of a two-character talker identifier (TalkerID) and a three-character sentence formatter (SentenceFormatter). The talker identifier identifies the data type of talker. For more information on the TalkerID, see *Table 4: NMEA Talker ID*. The sentence formatter identifies the data type and the string format of the successive fields. **In Proprietary Messages:** In NMEA proprietary messages, this field consists of the proprietary character P followed by a three-character Manufacturer's Mnemonic Code, used to identify the TALKER issuing a proprietary sentence, and any additional characters as required
<Data>	Data fields, delimited by data field delimiter ','. Variable length (depends on the NMEA message type).
<Checksum>	Checksum field follows the checksum delimiter character *. Checksum is the 8-bit exclusive OR of all characters in the sentence, including the ',' field delimiter, between but not including the '$' and the '*' delimiters.
<CR><LF>	End of the sentence (Hex 0x0D 0x0A).

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Table 4: NMEA Talker ID

GNSS Constellation Configuration	TalkerID (NMEA V4.10)
GPS	GP
GLONASS	GL
Galileo	GA
BDS	GB
QZSS	GP
Combination of Multiple Satellite Systems	GN

Sample Code for NMEA Checksum:

```
// pData is the data array whose checksum needs to be calculated:

unsigned char Ql_Check_XOR(const unsigned char *pData, unsigned int Length)
{
	unsigned char result = 0;
	unsigned int i = 0;

	if((NULL == pData) || (Length < 1))
	{
		return 0;
	}
	for(i = 0; i < Length; i++)
	{
		result ^= *(pData + i);
	}

	return result;
}
```

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2.2. Standard Messages

This chapter explains the NMEA 0183 V4.10 standard messages supported by the modules.

2.2.1. RMC

Message	RMC
Description	Recommended Minimum Specific GNSS Data. Time, date, position, course, and speed data provided by a GNSS receiver
Type	Output

Message Structure:

```
$<TalkerID>RMC,<UTC>,<Status>,<Lat>,<N/S>,<Lon>,<E/W>,<SOG>,<COG>,<Date>,<MagVar>,
<MagVarDir>,<ModeInd>,<NavStatus>*<Checksum><CR><LF>
```

Example:

```
$GNRMC,040143.000,A,3149.334166,N,11706.941670,E,0.01,0.00,010522,,,D,V*0E
```

Parameter:

Field	Format	Unit	Example	Description
$	Character	-	$	Each NMEA message starts with **$**.
<TalkerID>	String, 2 characters		GN	Talker identifier. See *Table 4: NMEA Talker ID*
RMC	String, 3 characters		RMC	Recommended Minimum Specific GNSS Data.
<UTC>	hhmmss.sss		040143.000	GNSS Data. Position fix UTC. hh: Hours (00–23) mm: Minutes (00–59) ss: Seconds (00–59) sss: Decimal fraction of seconds
<Status>	Character		A	Positioning system status. A = Data valid V = Navigation receiver warning
<Lat>	ddmm.mmmmmm		3149.334166	Latitude. dd. Degrees (00–90) mm. Minutes (00–59) mmmmmm: Decimal fraction of minutes Note that this field is empty in case of an invalid value.

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Field	Format	Unit	Example	Description
<N/S>	Character		N	North-south direction. N = North S = South Note that this field is empty in case of an invalid value.
<Lon>	dddmm.mmmmmm		11706.941670	Longitude. ddd: Degrees (000–180) mm: Minutes (00–59) mmmmmm: Decimal fraction of minutes. Note that this field is empty in case of an invalid value.
<E/W>	Character		E	East-west direction. E = East W = West Note that this field is empty in case of an invalid value.
<SOG>	Numeric	Knot	0.01	Speed over ground. Variable length. Note that this field is empty in case of an invalid value.
<COG>	Numeric	Degree	0.00	Course over ground. Variable length. Maximum value: 359.99. Note that this field is empty in case of an invalid value.
<Date>	ddmmyy		010522	Date. dd: Day of month mm: Month yy: Year
<MagVar>				Magnetic variation. Not supported.
<MagVarDir>				Direction of magnetic variation. Not supported.

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Field	Format	Unit	Example	Description
<ModeInd>	Character		D	Mode indicator. A = Autonomous mode. Satellite system used in non-differential mode for position fixing. D = Differential mode. Satellite system used in differential mode for position fixing. Corrections from ground stations or Satellite Based Augmentation System (SBAS). E = Estimated (dead reckoning) mode F = Float RTK. Satellite system used in RTK mode with floating integers. M = Manual input mode N = No fix. Satellite system not used for position fixing, or fix not valid. R = Real Time Kinematic (RTK). Satellite system used in RTK mode with fixed integers
<NavStatus>	Character		V	Navigational status indication. Note that this parameter is only available in messages in line with NMEA0183 V4.10 and later versions.
<Checksum>	Hexadecimal		*0E	Checksum.
<CR><LF>	Character			Carriage return and line feed.

2.2.2.GGA

Message	GGA
Description	Global Positioning System Fix Data. Time, position, and fix-related data for a GNSS receiver
Type	Output

Message Structure:

```
$<TalkerID>GGA,<UTC>,<Lat>,<N/S>,<Lon>,<E/W>,<Quality>,<NumSatUsed>,<HDOP>,<Alt>,M,<Sep>,M,<DiffAge>,<DiffStation>*<Checksum><CR><LF>
```

Example:

```
$GNRMC,040143.000,A,3149.334166,N,11706.941670,E,0.01,0.00,010522,,,D,V*0E
```

Parameter:

Field	Format	Unit	Example	Description
$	Character	-	$	Each NMEA message starts with **$**.
<TalkerID>	String, 2 characters		GN	Talker identifier. See *Table 4: NMEA Talker ID*

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Field	Format	Unit	Example	Description
GGA	String, 3 characters		GGA	Global Positioning System Fix Data.
<UTC>	hhmmss.sss		040143.000	GNSS Data. Position fix UTC. hh: Hours (00–23) mm: Minutes (00–59) ss: Seconds (00–59) sss: Decimal fraction of seconds
<Lat>	ddmm.mmmmmm		3149.334166	Latitude. dd. Degrees (00–90) mm. Minutes (00–59) mmmmmm: Decimal fraction of minutes Note that this field is empty in case of an invalid value.
<N/S>	Character		N	North-south direction. N = North S = South Note that this field is empty in case of an invalid value.
<Lon>	dddmm.mmmmmm		11706.941670	Longitude. ddd: Degrees (000–180) mm: Minutes (00–59) mmmmmm: Decimal fraction of minutes. Note that this field is empty in case of an invalid value.
<E/W>	Character		E	East-west direction. E = East W = West Note that this field is empty in case of an invalid value.
<Quality>	Numeric, 1 digit		2	GPS quality indicator. 0 = Fix not available or invalid 1 = GPS SPS Mode, fix valid 2 = Differential GPS, SPS Mode, or Satellite Based Augmentation. System (SBAS), fix valid 3 = GPS PPS Mode, fix valid 4 = Real Time Kinematic (RTK) System used in RTK mode with fixed integers 5 = Float RTK. Satellite system used in RTK mode, floating integers 6 = Estimated (dead reckoning) mode
<NumSat Used> [1)]	Numeric, 2 digits		36	Number of satellites in use.
<HDOP>	Numeric		0.48	Horizontal dilution of precision. Note that this field is empty in case of an invalid value.

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Field	Format	Unit	Example	Description
<Alt>	Numeric	Meter	61.496	Altitude above mean-sea-level (geoid). Note that this field is empty in case of an invalid value.
M	Character		M	Unit of <Alt>. “M” = Meter.
<DiffAge>				Differential GPS data age. Not supported.
<Diffstation>				Differential reference station ID. Not supported.
<Checksum>	Hexadecimal		*58	Checksum.
<CR><LF>	Character			Carriage return and line feed.

Note:

1. **The NMEA 0183 specification indicates that GGA messages are GPS specific. However, when the receiver is configured for multi-constellations, the content of GGA messages will be generated from the multi-constellation solution.**

2.2.3.GSV

Message	GSV
Description	GNSS Satellites in View. The GSV sentence provides the number of satellites in view (SV), satellite ID numbers, elevation, azimuth, and SNR value, and it contains maximum four satellites per transmission. Therefore, it may take several sentences to get complete information. The total number of sentences being transmitted and the sentence number are indicated in the first two data fields.
Type	Output

Message Structure:

```
$<TalkerID>GSV,<TotalNumSen>,<SenNum>,<TotalNumSat>{,<SatID>,<SatElev>,<SatAz>,<SatCN0>},<SignalID>*<Checksum><CR><LF>
```

Example:

```
$GPGSV,3,1,12,195,72,076,42,01,69,158,45,194,66,111,29,21,61,060,44,1*6D
$GPGSV,3,2,12,07,61,233,42,30,52,284,44,199,51,162,37,08,39,045,42,1*59
$GPGSV,3,3,12,14,29,312,29,196,20,148,36,17,18,258,36,27,07,061,36,1*53
$GLGSV,2,1,05,79,80,068,47,82,62,248,44,81,56,014,38,78,31,137,24,1*7F
$GLGSV,2,2,05,88,07,034,29,1*46
$GAGSV,2,1,06,26,80,095,42,01,69,353,13,21,49,106,26,33,42,207,41,7*72
$GAGSV,2,2,06,13,28,040,34,31,19,313,34,7*72
$GBGSV,4,1,16,46,81,194,38,07,68,349,31,40,61,016,40,30,60,259,43,1*71
$GBGSV,4,2,16,10,59,321,,03,51,192,36,36,41,314,38,02,37,229,32,1*71
$GBGSV,4,3,16,09,31,219,26,08,27,175,31,37,25,146,29,06,23,202,29,1*78
$GBGSV,4,4,16,16,20,199,31,13,17,186,26,39,12,192,29,28,09,048,30,1*7C
```

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Parameter:

Field	Format	Unit	Example	Description
$	Character	-	$	Each NMEA message starts with **$**.
<TalkerID>	String, 2 characters		GP	Talker identifier. See *Table 4: NMEA Talker ID*
GSV	String, 3 characters		GSV	GNSS Satellites in view
<TotalNumSen>	Numeric		3	Total number of sentences. Range: 1–9.
<SetNum>	Numeric		1	Sentence number. Range: 1–<TotalNumSen>.
<TotalNumSat>	Numeric		12	Total number of satellites in view.
Start of repeat block. Repeat times: 1–4.				
<SatID>	Numeric		195	Satellite ID. See *Table 8: GNSS Satellites (NEMA) Numbering.*
<SatElev>	Numeric	Degree	72	Satellite elevation. Range: 00–90.
<SatAz>	Numeric	Degree	076	Satellite azimuth, with true north as the reference plane. Range: 000–359.
<SatCN0>	Numeric	dB-Hz	42	Satellite C/N0. Range 00–99. Null when not tracking.
<SignalID>	Numeric		1	GNSS signal ID. See *Table 8: GNSS Satellites (NEMA) Numbering.* Note that this parameter is only available in messages in line with NMEA 0183 V4.10 and later versions.
<Checksum>	Hexadecimal		*58	Checksum.
<CR><LF>	Character			Carriage return and line feed.

Note:

1. **GN cannot be used for GSV sentences. If satellites of multiple constellations are in view, use separate GSV sentences with the corresponding talker ID for each constellation.**

2.2.4.GSA

Message	GSA
Description	GNSS DOP and Active Satellites. GNSS receiver operating mode, satellites used in the navigation solution reported by the GGA sentence, and DOP values.
Type	Output

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Message Structure:

$<TalkerID>GSA,<Mode>,<FixMode>{,<SatID>},<PDOP>,<HDOP>,<VDOP><SystemID>*<Checksum>

Example:

$GNGSA,A,3,195,01,194,21,07,30,199,08,14,17,27,,0.71,0.48,0.52,1*34
$GNGSA,A,3,79,82,81,78,88,,,,,,,,0.71,0.48,0.52,2*0D
$GNGSA,A,3,26,21,33,13,31,,,,,,,,0.71,0.48,0.52,3*09
$GNGSA,A,3,46,07,40,30,03,36,02,09,08,37,06,16,0.71,0.48,0.52,4*0B
$GNGSA,A,3,13,39,28,,,,,,,,,,0.71,0.48,0.52,4*0B

Parameter:

Field	Format	Unit	Example	Description
$	Character	-	$	Each NMEA message starts with **$**.
<TalkerID>	String, 2 characters		GN	Talker identifier. See *Table 4: NMEA Talker ID*
GSA	String, 3 characters		GSA	GNSS DOP and Active Satellites.
<Mode>	Character		A	Selection of 2D or 3D fix. M = Manual, forced to operate in 2D or 3D Mode A= Automatic, allowed to automatically switch to 2D/3D
<FixMode>	Numeric	-	3	Fix mode. 1 = Fix not available 2 = 2D 3 = 3D
Start of repeat block. Repeat times: 12.				
<SatID>	Numeric		195	ID numbers of satellites used in solution. See *Table 8: GNSS Satellites (NEMA) Numbering.* Note that this field is empty in case of an invalid value.
End of repeat block.				
<PDOP>	Numeric		0.71	Position dilution of precision. Maximum value: 99.00. Note that this field is empty in case of an invalid value.
<HDOP>	Numeric		0.48	Horizontal dilution of precision. Maximum value: 99.00. Note that this field is empty in case of an invalid value.
<VDOP>	Numeric		0.52	Vertical dilution of precision. Maximum value: 99.00. Note that this field is empty in case of an invalid value

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Field	Format	Unit	Example	Description
<HDOP>	Numeric		0.48	Horizontal dilution of precision. Maximum value: 99.00. Note that this field is empty in case of an invalid value.
<VDOP>	Numeric		0.52	Vertical dilution of precision. Maximum value: 99.00. Note that this field is empty in case of an invalid value
<System ID>	Numeric		1	GNSS system ID. See *Table 8: GNSS Satellites (NEMA) Numbering*
<Checksum>	Hexadecimal		*34	Checksum
<CR><LF>	Character			Carriage return and line feed.

Note:

1. **If less than 12 satellites are used for navigation, the remaining <SatID> fields are left empty. If more than 12 satellites are used for navigation, only the IDs of the first 12 are output**

2.2.5.VTG

Message	VTG
Description	Course Over Ground & Ground Speed. The actual course and speed relative to the ground.
Type	Output

Message Structure:

```
$<TalkerID>VTG,<COGT>,T,<COGM>,M,<SOGN>,N,<SOGK>,K,<ModeInd>*<Checksum><CR><LF>
```

Example:

```
$GNVTG,0.00,T,,M,0.01,N,0.02,K,D*25
```

Parameter:

Field	Format	Unit	Example	Description
$	Character	-	$	Each NMEA message starts with **$**.
<TalkerID>	String, 2 characters		GN	Talker identifier. See *Table 4: NMEA Talker ID*
VTG	String, 3 characters		GSA	Course Over Ground & Ground Speed.
<COGT>	Numeric	Degrees	0.00	Course over ground, in true north course direction. Note that this field is empty in case of an invalid value.

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Field	Format	Unit	Example	Description
T	Character		T	Fixed field: true.
<COGM>	Numeric	Degrees	M	Course over ground (magnetic). Not supported.
M	Character			Fixed field: magnetic.
<SOGN>	Numeric	Knots	0.01	Speed over ground in knots. Note that this field is empty in case of an invalid value.
N	Character		N	Fixed field: knot.
<SOGK>	Numeric	km/h	0.02	Speed over ground in kilometers per hour. Note that this field is empty in case of an invalid value0
K	Character		K	Fixed field: kilometers per hour.
<ModeInd>	Character		D	Mode indicator. A = Autonomous mode D = Differential mode E = Estimated (dead reckoning) mode F = Float RTK. Satellite system used in real time kinematic mode with floating integers M = Manual input mode N = No fix. Satellite system not used for position fixing, or fix not valid R = Real Time Kinematic. Satellite system used in RTK mode with fixed integers
<Checksum>	Hexadecimal		*25	Checksum
<CR><LF>	Character			Carriage return and line feed.

2.2.6.GLL

Message	GLL
Description	Geographic Position – Latitude/Longitude. Latitude and longitude of the GNSS receiver position, the time of position fix and status
Type	Output

Message Structure:

```
$<TalkerID>GLL,<Lat>,<N/S>,<Lon>,<E/W>,<UTC>,<Status>,<ModeInd>*<Checksum><CR><LF>
```

Example:

```
$GNGLL,3149.334166,N,11706.941670,E,040143.000,A,D*46
```

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Parameter:

Field	Format	Unit	Example	Description
$	Character	-	$	Each NMEA message starts with **$**.
<TalkerID>	String, 2 characters		GN	Talker identifier. See *Table 4: NMEA Talker ID*
GLL	String, 3 characters		GLL	Geographic Position – Latitude/Longitude.
<Lat>	ddmm.mmmmmm	-	3149.334166	Latitude. dd: Degrees (00–90) mm: Minutes (00–59) mmmmmm: Decimal fraction of minutes Note that this field is empty in case of an invalid value.
<N/S>	Character		N	North-south direction. N = North S = South Note that this field is empty in case of an invalid value.
<Lon>	dddmm.mmmmmm		11706.941670	Latitude. dd: Degrees (000–180) mm: Minutes (00–59) mmmmmm: Decimal fraction of minutes Note that this field is empty in case of an invalid value.
<E/W>	Character		E	East-west direction. E = East W = West Note that this field is empty in case of an invalid value
<UTC>	hhmmss.sss		040143.000	Position UTC. hh: Hours (00–23) mm: Minutes (00–59) ss: Seconds (00–59) sss: Decimal fraction of seconds
<Status>	Character		A	Positioning system status. A = Data valid V = Invalid data

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Field	Format	Unit	Example	Description
<ModeInd>	Character		GN	Mode indicator. A = Autonomous mode D = Differential mode E = Estimated (dead reckoning) mode F = Float RTK. Satellite system used in real time kinematic mode with floating integers M = Manual input mode N = No fix. Satellite system not used for position fixing, or fix not valid R = Real Time Kinematic. Satellite system used in RTK mode with fixed integers.
<Checksum>	Hexadecimal		*46	Checksum
<CR><LF>	Character			Carriage return and line feed.

2.2.7.ZDA

Message	ZDA
Description	Time and date. UTC, day, month, year and local time zone.
Type	Output

Message Structure:

$<TalkerID>ZDA,<UTC>,<Day>,<Month>,<Year>,<LocalHour>,<LocalMin>*<Checksum><CR><LF>

Example:

$GNZDA,055054.000,19,09,2022,,*4A

Parameter:

Field	Format	Unit	Example	Description
$	Character	-	$	Each NMEA message starts with **$**.
<TalkerID>	String, 2 characters		GN	Talker identifier. See *Table 4: NMEA Talker ID*
ZDA	String, 3 characters		ZDA	Time&Date. UTC, day, month, year and local time zone.

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Field	Format	Unit	Example	Description
<UTC>	hhmmss.sss		055054.000	Position fix UTC. hh: Hours (00–23) mm: Minutes (00–59) ss: Seconds (00–59) sss: Decimal fraction of seconds
<DAY>	Numeric		19	Day of month. Range: 01–31.
<Month>	Numeric		09	Month. Range: 01–12.
<Year>	Numeric		2022	Year.
<LocalHour>	Numeric			Local zone hours, 00 to ±13 hours. Not supported.
<LocalMin>	Numeric			Local zone minutes, 00 to +59 minutes. Not supported.
<Checksum>	Hexadecimal		*4A	Checksum
<CR><LF>	Character			Carriage return and line feed.

2.2.8.GNS

Message	GNS
Description	GNSS fix data. Fix data for single or combined satellite navigation systems (GNSS).
Type	Output

Message Structure:

$<TalkerID>GNS,<UTC>,<Lat>,<N/S>,<Lon>,<E/W>,<ModeInd>,<NumSatUsed>,<HDOP>,<Alt>,M,<Sep>,M,<DiffAge>,<DiffStation>,<NavStatus>*<Checksum><CR><LF>

Example:

$GNGNS,053106.000,3149.334190,N,11706.948654,E,DANN,16,0.63,51.287,M,-0.335,M,,,V*05

Parameter:

Field	Format	Unit	Example	Description
$	Character	-	$	Each NMEA message starts with **$**.
<TalkerID>	String, 2 characters			Talker identifier. See *Table 4: NMEA Talker ID*
GNS	String, 3 characters		GNS	GNSS Fix Data.

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Field	Format	Unit	Example	Description
<UTC>	hhmmss.sss		053106.000	North-south direction. N = North S = South Note that this field is empty in case of an invalid value.
<LAT>	ddmm.mmmmmm		3149.334190	Longitude. ddd: Degrees (00–90) mm: Minutes (00–59) mmmmmm: Decimal fraction of minutes Note that this field is empty in case of an invalid value.
<N/S>	Character		N	East-west direction. E = East W = West Note that this field is empty in case of an invalid value.
<Lon>	dddmm.mmmmmm		11706.948654	Longitude. ddd: Degrees (000–180) mm: Minutes (00–59) mmmmmm: Decimal fraction of minutes Note that this field is empty in case of an invalid value.
<E/W>	Character		E	East-west direction. E = East W = West Note that this field is empty in case of an invalid value.
< ModeInd>[1)]	Character		DANN	Mode indicator. A = Autonomous mode. Satellite system used in non-differential mode for position fixing D = Differential mode. Satellite system used in differential mode for position fixing. Corrections from ground stations or Satellite Based Augmentation System (SBAS) E = Estimated (dead reckoning) mode F = Float RTK. Satellite system used in RTK mode with floating integers M = Manual input mode N = No fix. Satellite system not used for position fixing, or fix not valid R = Real Time Kinematic (RTK). Satellite system used in RTK mode with fixed integers.

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Field	Format	Unit	Example	Description
<NumSatUsed>	Numeric		16	Total number of satellites in use. Range: 0–99.
<HDOP>	Numeric		0.63	Horizontal dilution of precision. Maximum value: 99.00. Note that this field is empty in case of an invalid value.
<Alt>	Numeric	Meter	51.287	Antenna altitude above the meansea-level (geoid). Note that this field is empty in case of an invalid value.
M	Character		M	Unit of <Alt>. “M” = Meter.
<Sep>	Numeric	Meter	-0.335	Geoid separation (the difference between the earth ellipsoid surface and the mean-sea-level (geoid) surface defined by the reference datum used in the position solution). Note that this field is empty in case of an invalid value.
M	Character		M	Unit of <Sep>. “M” = Meter.
<DiffAge>				Differential GPS data age. Not supported.
<DiffStation>				Differential reference station ID. Not supported.
<NavStatus>	Character		V	Navigational status indicator. Always “V” (Navigational status not valid).
<Checksum>	Hexadecimal		*05	Checksum
<CR><LF>	Character			Carriage return and line feed.

Note:

1. **1) <ModeInd> is a variable length field. The first character indicates the use of GPS satellites, the second character indicates the use of GLONASS satellites, and the third character indicates the use of Galileo satellites. The fourth character indicates the use of BDS satellites, the fifth character indicates the use of QZSS satellites, and the sixth character indicates the use of NavIC (IRNSS) satellites.**

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2.2.9.GST

Message	GST
Description	GNSS Psuedorange Error Statistics. This sentence supports Receiver Autonomous Integrity Monitoring (RAIM). Pseudorange measurement error statistics can be translated in the position domain in order to give statistical measures of the quality of the position solution
Type	Output

Message Structure:

```
$<TalkerID>GST,<UTC>,<RMS_D>,<MajorD>,<MinorD>,<Orient>,<LatD>,<LonD>,<AltD>*<Checksum><CR><LF>
```

Example:

```
$GNGST,123624.000,6.3,2.5,2.4,88.4,2.4,2.5,9.2*43
```

Parameter:

Field	Format	Unit	Example	Description
$	Character	-	$	Each NMEA message starts with **$**.
<TalkerID>	String, 2 characters		GN	Talker identifier. See *Table 4: NMEA Talker ID*
GST	String, 3 characters		GST	GNSS Psuedorange Error Statistics
<UTC>	hhmmss.sss		123624.000	UTC time of the GGA or GNS fix associated with this sentence.
< RMS_D>	Numeric	Meter	6.3	RMS value of the standard deviation of the range inputs to the navigation process.
<MajorD>	Numeric	Meter	2.5	Standard deviation of semi-major axis of error ellipse.
<MinorD>	Numeric	Meter	2.4	Standard deviation of semi-minor axis of error ellipse.
<Orient>	Numeric	Degrees	88.4	Orientation of semi-major axis of error ellipse.
< LatD>	Numeric	Meter	2.4	Standard deviation of latitude error.
<LonD>	Numeric	Meter	2.5	Standard deviation of longitude error.
<AltD>	Numeric	Meter	5.9	Standard deviation of altitude error.
<Checksum>	Hexadecimal		*43	Checksum.
<CR><LF>	Character			Carriage return and line feed.

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2.2.10. GRS

Message	GRS
Description	GNSS range residuals. This sentence supports Receiver Autonomous Integrity Monitoring (RAIM). Range residuals can be computed in two ways for this process. The basic measurement integration cycle of most navigation filters generates a set of residuals and uses these to update the position state of the receiver.
Type	Output

Message Structure:

```
$<TalkerID>GRS,<UTC>,<Mode>{,<Resi>},<SystemID>,<SignalID>*<Checksum><CR><LF>
```

Example:

```
$GNGRS,125524.000,1,-0.4,-0.7,0.5,-4.6,0.2,1.1,-2.2,-0.6,-1.1,9.2,-2.1,3.1,1,1*42
$GNGRS,125524.000,1,-11.4,,,,,,,,,,,1,1*52
$GNGRS,125524.000,1,19.4,-5.0,11.4,6.3,-118,3.3,-7.5,,,,,,2,1*79
$GNGRS,125524.000,1,-5.6,4.6,21.1,,,,,,,,,3,7*51
```

Parameter:

Field	Format	Unit	Example	Description
$	Character	-	$	Each NMEA message starts with **$**.
<TalkerID>	String, 2 characters		GN	Talker identifier. See *Table 4: NMEA Talker ID*
GRS	String, 3 characters		GRS	GNSS Range Residuals
<UTC>	hhmmss.sss		125524.000	Position fix UTC. hh: Hours (00–23) mm: Minutes (00–59) ss: Seconds (00–59) sss: Decimal fraction of seconds
<Mode>	Numeric		1	Residual calculation mode. 0 = Residuals were used to calculate the position given in the matching GGA or GNS sentence 1 = Residuals were recomputed after the GGA or GNS position was computed
Start of repeat block. Repeat times: 12.				
< Resi>	Numeric	Meter	-0.4	Range residuals for SVs used in navigation. Range: -999 to 999. Note that this field is empty in case of an invalid value.
End of repeat block.				

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Field	Format	Unit	Example	Description
<SystemID>	Numeric		1	GNSS system ID. See *Table 8: GNSS Satellites (NEMA) Numbering.* Note that this parameter is only available in messages in line with NMEA 0183 V4.10 or later versions.
<SignalID>	Numeric		1	GNSS system ID. See *Table 8: GNSS Satellites (NEMA) Numbering.* Note that this parameter is only available in messages in line with NMEA 0183 V4.10 or later versions.
<Checksum>	Hexadecimal		*42	Checksum.
<CR><LF>	Character			Carriage return and line feed.

2.2.11. RLM

Message	RLM
Description	Return Link Message. The receiver will detect the Galileo Search and Rescue (SAR) Return Link Message when the RLM function is enabled
Type	Output

Message Structure:

```
$<TalkerID>RLM,<BeaconID>,<UTC>,<Meg_Code>,<Para>*<Checksum><CR><LF>
```

Example:

```
$GARLM,9A22BE29630F010,125713.000,F,5402*3B
```

Parameter:

Field	Format	Unit	Example	Description
$	Character	-	$	Each NMEA message starts with **$**.
<TalkerID>	String, 2 characters		GN	Talker identifier. See *Table 4: NMEA Talker ID*
RLM	String, 3 characters		RLM	Return Link Message
<BeaconID>	Hexadecimal		9A22BE296 30F010	Beacon of RLM. Beacon ID 15 hex characters (60 bits).
<UTC>	hhmmss.sss		055054.000	Position fix UTC. hh: Hours (00–23) mm: Minutes (00–59) ss: Seconds (00–59) sss: Decimal fraction of seconds

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Field	Format	Unit	Example	Description
< Meg_Code>	Hexadecimal		F	Message code, a hex character (4 bits). Identifies the Type of RLM Message Service. 0 = Reserved for future RLM services. 1 = Acknowledgement Service RLM 2 = Command Service RLM 3 = Message Service RLM 4 – E = Reserved for future RLM services F = Test Service RLM (currently used only by the Galieo Program)
<Para>	Numeric		5402	The data parameters provided by RLS. Short message contains 4 hex characters (16 bits) and long message contains 24 hex characters (96 bits).
<Checksum>	Hexadecimal		*3B	Checksum.
<CR><LF>	Character			Carriage return and line feed.

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2.3. PAIR Messages

This chapter explains PAIR messages (proprietary NMEA messages defined by the chipset supplier) supported by the modules.

2.3.1. Packet Type: 001 PAIR_ACK

Message	$PAIR001
Description	Acknowledges a PAIR command. An acknowledgement packet $PAIR001 is returned to inform the sender that the receiver has received the packet.
Type	Output

Message Structure:

```
$PAIR001,<CommandID>,<Result>*<Checksum><CR><LF>
```

Example:

```
$PAIR001,004,0*3F
```

Parameter:

Field	Format	Unit	Description
<CommandID>	Numeric	-	Type of command/packet to be acknowledged.
<Result>	Numeric		0 = Command has been successfully sent 1 = Command is being processed. Please wait for the result. 2 = Command sending failed. 3 = is not supported. 4 = Command parameter error. Out of range/Some parameters were lost/Checksum error. 5 = MNL service is busy. You can try again soon.

2.3.2. Packet Type: 002 PAIR_GNSS_SUBSYS_POWER_ON

Message	$PAIR002
Description	Acknowledges a PAIR command. An acknowledgement packet $PAIR001 is returned to inform the sender that the receiver has received the packet.
Type	Command

Message Structure:

```
$PAIR002*<Checksum><CR><LF>
```

Example:

```
$PAIR002*38
$PAIR001,002,1*38
$PAIR001,002,0*39
```

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Parameter:

None

Result:

Returns **$PAIR001** message.

2.3.3. Packet Type: 003 PAIR_GNSS_SUBSYS_POWER_OFF

Message	$PAIR003
Description	Power off GNSS system. Include DSP/RF/Clock and other GNSS modules. CM4 also can receive commands (Include the AT command / the race Command / the part of PAIR command which is not dependent on DSP.) after sending this command.
Type	Command

Message Structure:

```
$PAIR003*<Checksum><CR><LF>
```

Example:

```
$PAIR003*39
$PAIR001,003,1*39
$PAIR001,003,0*38
```

Parameter:

None

Result:

Returns **$PAIR001** message.

Note:

1. **The location service is not available after this command is executed.**
2. **The system can still receive configuration PAIR commands. The application is running if necessary.**
3. **CM4 will go to sleep if the application is not working at this time. The system can be awoken by the GNSS_DATA_IN_EINT pin after going to sleep.**

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2.3.4.Packet Type: 004 PAIR_GNSS_SUBSYS_HOT_START

Message	$PAIR004
Description	Performs a hot start (uses all available data in the NVRAM). Normally a hot start means that the GNSS module has been powered down for less than 2 hours (RTC must be alive) with its ephemeris still valid. Therefore, there is no need to download an ephemeris again upon a hot start, thus making this startup method the fastest
Type	Command

Message Structure:

```
$PAIR004*<Checksum><CR><LF>
```

Example:

```
$PAIR004*3E
$PAIR001,004,1*3E
$PAIR001,004,0*3F
```

Parameter:

None

Result:

Returns **$PAIR001** message.

2.3.5.Packet Type: 005 PAIR_GNSS_SUBSYS_WARM_START

Message	$PAIR005
Description	Performs a warm start. A warm start means that the GNSS module remembers only rough time, position,and almanacs data, and thus needs to download an ephemeris before it can fix a position.
Type	Command

Message Structure:

```
$PAIR005*<Checksum><CR><LF>
```

Example:

```
$PAIR005*3F
$PAIR001,005,1*3F
$PAIR001,005,0*3E
```

Parameter:

None

Result:

Returns **$PAIR001** message.

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2.3.6.Packet Type: 006 PAIR_GNSS_SUBSYS_COLD_START

Message	$PAIR006
Description	Performs a cold start, which means that there is no location information stored in the receiver, including time, position, and almanacs and ephemeris data.
Type	Command

Message Structure:

```
$PAIR006*<Checksum><CR><LF>
```

Example:

```
$PAIR006*3C
$PAIR001,006,1*3C
$PAIR001,006,0*3D
```

Parameter:

None

Result:

Returns **$PAIR001** message.

2.3.7.Packet Type: 007 PAIR_GNSS_SUBSYS_FULL_COLD_START

Message	$PAIR007
Description	Performs a cold start and clears system and user configurations at the start, i.e., resets the module to its factory settings. Upon a full cold start, the module loses all data on the previous position. Therefore, it needs to search over the full frequency spectrum for all visible satellites before fixing a position.
Type	Command

Message Structure:

```
$PAIR007*<Checksum><CR><LF>
```

Example:

```
$PAIR007*3D
$PAIR001,007,1*3D
$PAIR001,007,0*3C
```

Parameter:

None

Result:

Returns **$PAIR001** message.

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2.3.8.Packet Type: 010 PAIR_REQUEST_AIDING

Message	$PAIR010
Description	Notifies the expiration of GNSS aiding data stored in the module. This message is automatically output when the module powers on
Type	Output

Message Structure:

$PAIR010,<Type>,<GNSS_System>,<WN>,<TOW>*<Checksum><CR><LF>

Example:

$PAIR010,0,0,2044,369413*33

Parameter:

Field	Format	Unit	Description
<Type>	Numeric		Type of data to be updated. 0 = EPO data 1 = Time 2 = Location
<GNSS_System>	Numeric		Type of required GNSS data. 0 = GPS data 1 = GLONASS data 2 = Galileo data 3 = BDS data 4 = QZSS data
<WN>	Numeric	Week	Week number (including roll-over)
<TOW>	Numeric	Second	Time of week

Note:

1. The GNSS system outputs this message automatically. Do not send $PAIR010 manually.

2.3.9.Packet Type: 050 PAIR_COMMON_SET_FIX_RATE

Message	$PAIR050
Description	Set Position Fix Interval. If set less than 1000 ms, ASCII NMEA will automatically increase the update interval in order to decrease IO throughput. It will return false if the operating voltage setting is not correct. (Any fix interval change between 1Hz <-> multihz causes GNSS to power on/off)
Type	Set

Message Structure:

$PAIR050,<Time>*<Checksum><CR><LF>

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Example:

```
$PAIR050,1000*12
$PAIR001,050,0*3E
```

Parameter:

Field	Format	Unit	Description
<Time>	Numeric	Millisecond	Position fix interval. Range: 100–1000. Default value: 1000.

Result:

Returns **$PAIR001** message.

2.3.10. Packet Type: 051 PAIR_COMMON_GET_FIX_RATE

Message	$PAIR051
Description	Gets the position fix interval.
Type	Get

Message Structure:

```
$PAIR051*<Checksum><CR><LF>
```

Example:

```
$PAIR051*3E
$PAIR001,051,0*3F
$PAIR051,1000*13
```

Parameter:

None

Result:

Returns **$PAIR001** message and the query result.

Query result message format:

```
$PAIR051,<Time>*<Checksum><CR><LF>
```

Parameter included in the result:

Field	Format	Unit	Description
<Time>	Numeric	Millisecond	Position fix interval. Range: 100–1000. Default value: 1000.

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2.3.11. Packet Type: 058 PAIR_COMMON_SET_MIN_SNR

Message	$PAIR058
Description	Sets the minimum SNR of satellites in use. If the minimum SNR threshold is set, the module will not use the satellites with SNR below the threshold.
Type	Set

Message Structure:

$PAIR058,<MIN_SNR>*<Checksum><CR><LF>

Example:

$PAIR058,15*1F
$PAIR001,058,0*36

Parameter:

Field	Format	Unit	Description
< MIN_SNR>	Numeric	dB	Minimum SNR threshold of satellites in use. Range: 9–37. Default value: 9.

Result:

Returns **$PAIR001** message and the query result.

2.3.12. Packet Type: 062 PAIR_COMMON_SET_NMEA_OUTPUT_RATE

Message	$PAIR062
Description	Sets the output rate of standard NMEA sentences of each type.
Type	Set

Message Structure:

$PAIR062,<Type>,<OutputRate>*<Checksum><CR><LF>

Example:

$PAIR062,0,3*3D
$PAIR001,062,0*3F

Parameter:

Field	Format	Unit	Description
<Type>	Numeric		Type of standard NMEA sentence. -1 = Reset the output rates of all types of sentences to default values. 0 = NMEA_SEN_GGA 1 = NMEA_SEN_GLL

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			2 = NMEA_SEN_GSA 3 = NMEA_SEN_GSV 4 = NMEA_SEN_RMC 5 = NMEA_SEN_VTG 6 = NMEA_SEN_ZDA 7 = NMEA_SEN_GRS 8 = NMEA_SEN_GST 9 = NMEA_SEN_GNS
<OutputRate>	Numeric		Message outputting rate setting. 0 = Disabled or not supported N = Output a message once every N position fix(es) Range of N: 0–20. Default value: 1.

Result:

Returns **$PAIR001** message and the query result.

2.3.13. Packet Type: 059 PAIR_COMMON_GET_MIN_SNR

Message	$PAIR059
Description	Gets the minimum SNR of satellites in use.
Type	Get

Message Structure:

```
$PAIR059*<Checksum><CR><LF>
```

Example:

```
$PAIR059*36
$PAIR001,059,0*37
$PAIR059,9*23
```

Parameter:

None

Result:

Returns **$PAIR001** message and the query result.

Query result message format:

```
$PAIR059,<MIN_SNR>*<Checksum><CR><LF>
```

Parameter included in the result:

Field	Format	Unit	Description
< MIN_SNR>	Numeric	dB	Minimum SNR of satellites in use. Range: 9–37. Default value: 9.

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2.3.14. Packet Type: 063
PAIR_COMMON_GET_NMEA_OUTPUT_RATE

Message	$PAIR063
Description	Gets the output rate of standard NMEA sentences of each type.
Type	Get

Message Structure:

```
$PAIR063,<Type>*<Checksum><CR><LF>
```

Example:

```
$PAIR063,0*23
$PAIR001,063,0*3E
$PAIR063,0,3*3C
```

Parameter:

Field	Format	Unit	Description
< MIN_SNR>	Numeric	dB	Type of standard NMEA sentence. -1 = Return the output rates of all types of standard NMEA sentences. 0 = NMEA_SEN_GGA 1 = NMEA_SEN_GLL 2 = NMEA_SEN_GSA 3 = NMEA_SEN_GSV 4 = NMEA_SEN_RMC 5 = NMEA_SEN_VTG 6 = NMEA_SEN_ZDA 7 = NMEA_SEN_GRS 8 = NMEA_SEN_GST 9 = NMEA_SEN_GNS

Result:

Returns **$PAIR001** message and the query result.

Query result message format:

```
$PAIR063,<Type>,<OutputRate>*<Checksum><CR><LF>
```

Parameter included in the result:

Field	Format	Unit	Description
<Type>	Numeric		Type of standard NMEA sentence. 0 = NMEA_SEN_GGA 1 = NMEA_SEN_GLL 2 = NMEA_SEN_GSA 3 = NMEA_SEN_GSV 4 = NMEA_SEN_RMC

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			5 = NMEA_SEN_VTG 6 = NMEA_SEN_ZDA 7 = NMEA_SEN_GRS 8 = NMEA_SEN_GST 9 = NMEA_SEN_GNS
<Output Rate>	Numeric		Message outputting rate setting. 0 = Disabled or not supported N = Output message once per every N position fix(es) Range: 1–20. Default value: 1.

2.3.15. Packet Type: 066 PAIR_COMMON_SET_GNSS_SEARCH_MODE

Message	$PAIR066
Description	Sets the GNSS search mode. The setting is valid when the NVRAM data are valid. The module reboots when it receives this command.
Type	Set

Message Structure:

```
$PAIR066,<GPS_Enabled>,<GLONASS_Enabled>,<Galileo_Enabled>,<BDS_Enabled>,<QZSS_Enabled>,<Reserved>*<Checksum><CR><LF>
```

Example:

```
//Search for GPS + GLONASS + Galileo + BDS satellites:
$PAIR066,1,1,1,1,0,0*3A
$PAIR001,066,0*3B
```

Parameter:

Field	Format	Unit	Description
<GPS_Enabled>	Numeric		0 = Disable (DO NOT search for GPS satellites) 1 = Search for GPS satellites
<GLONASS_Enabled>	Numeric		0 = Disable (DO NOT search for GLONASS satellites) 1 = Search for GLONASS satellites
<Galileo_Enabled>	Numeric		0 = Disable (DO NOT search for Galileo satellites) 1 = Search for Galileo satellites
<BDS_Enabled>	Numeric		0 = Disable (DO NOT search for BDS satellites) 1 = Search for BDS satellites

Field	Format	Unit	Description
<QZSS_Enabled>	Numeric		0 = Disable (DO NOT search for QZSS satellites) 1 = Search for QZSS satellites
<Reserved>	Numeric		Always "0"

Result:

Returns **$PAIR001** message and the query result.

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Note:
1. QZSS is always enabled by default.
2. GNSS search modes supported by RYS3520:

- **GPS only**
- **GPS + QZSS**
- **GPS + GLONASS**
- **GPS + GLONASS+ QZSS**
- **GPS + Galileo**
- **GPS + Galileo + QZSS**
- **GPS + BDS**
- **GPS + BDS+ QZSS**
- **GPS + GLONASS + Galileo + BDS**
- **GPS + GLONASS + Galileo + BDS+ QZSS**

2.3.16. Packet Type: 067 PAIR_COMMON_GET_GNSS_SEARCH_MODE

Message	$PAIR067
Description	Gets the GNSS search mode.
Type	Get

Message Structure:

```
$PAIR067*<Checksum><CR><LF>
```

Example:

```
$PAIR067*3B
$PAIR001,067,0*3A
$PAIR067,1,1,1,1,1,0*3A
```

Parameter:

None

Result:

Returns **$PAIR001** message and the query result.

Query result message format:

```
$PAIR067<GPS_Enabled>,<GLONASS_Enabled>,<Galileo_Enabled>,<BDS_Enabled>,<QZSS_Enabled>,<Reserved>*,<Checksum><CR><LF>
```

Parameter included in the result:

Field	Format	Unit	Description
<GPS_Enabled>	Numeric		0 = Disable (DO NOT search for GPS satellites) 1 = Search for GPS satellites
<GLONASS_Enabled>	Numeric		0 = Disable (DO NOT search for GLONASS satellites) 1 = Search for GLONASS satellites
<Galileo_Enabled>	Numeric		0 = Disable (DO NOT search for Galileo satellites)

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			1 = Search for Galileo satellites
<BDS_Enabled>	Numeric		0 = Disable (DO NOT search for BDS satellites) 1 = Search for BDS satellites
<QZSS_Enabled>	Numeric		0 = Disable (DO NOT search for QZSS satellites) 1 or other non-zero values = Search for QZSS satellites
<Reserved>	Numeric		Always "0"

2.3.17. Packet Type: 070
PAIR_COMMON_SET_STATIC_THRESHOLD

Message	$PAIR070
Description	Sets the static navigation speed threshold. If the actual speed is below the threshold, the output position remains unchanged and the output speed is 0. If the threshold value is set to 0, this function is disabled
Type	Set

Message Structure:

```
$PAIR070,<SpeedThreshold>*<Checksum><CR><LF>
```

Example:

```
$PAIR070,4*25
$PAIR001,070,0*3C
```

Parameter:

Field	Format	Unit	Description
<SpeedThreshold>	Numeric	dm/s	Static navigation speed threshold. Range: 0–20. Default value: 0.

Result:

Returns **$PAIR001** message and the query result.

2.3.18. Packet Type: 071
PAIR_COMMON_GET_STATIC_THRESHOLD

Message	$PAIR071
Description	Gets the static navigation speed threshold.
Type	Get

Message Structure:

```
$PAIR071*<Checksum><CR><LF>
```

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Example:

```
$PAIR071*3C
$PAIR001,071,0*3D
$PAIR071,0.4*3A
```

Parameter:

None

Result:

Returns **$PAIR001** message and the query result.

Query result message format:

```
$PAIR071,<SpeedThreshold>*<Checksum><CR><LF>
```

Parameter included in the result:

Field	Format	Unit	Description
<SpeedThreshold>	Numeric	m/s	Static navigation speed threshold. Range: 0–20. Default value: 0.

2.3.19. Packet Type: 072 PAIR_COMMON_SET_ELEV_MASK

Message	$PAIR072
Description	Sets satellite elevation mask.
Type	Set

Message Structure:

```
$PAIR072,<Degree>*<Checksum><CR><LF>
```

Example:

```
$PAIR072,5*26
$PAIR001,072,0*3E
```

Parameter:

Field	Format	Unit	Description
< Degree>	Numeric	Degree	Satellite elevation mask. Range: -90 to 90. Default value: 5.

Result:

Returns **$PAIR001** message and the query result.

Note:

1. **Satellites below the elevation mask cannot be used**

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for positioning.

2.3.20. Packet Type: 073 PAIR_COMMON_GET_ELEV_MASK

Message	$PAIR073
Description	Gets satellite elevation mask.
Type	Get

Message Structure:

```
$PAIR073*<Checksum><CR><LF>
```

Example:

```
$PAIR073*3E
$PAIR001,073,0*3F
$PAIR073,5*27
```

Parameter:

None

Result:

Returns **$PAIR001** message and the query result.

Query result message format:

```
$PAIR073,<Degree>*<Checksum><CR><LF>
```

Parameter included in the result:

Field	Format	Unit	Description
< Degree>	Numeric	Degree	Satellite elevation mask. Range: -90 to 90.

2.3.21. Packet Type: 074 PAIR_COMMON_SET_AIC_ENABLE

Message	$PAIR074
Description	Enables/disables the active interference cancellation (AIC) function
Type	Set

Message Structure:

```
$PAIR074,<Enabled>*<Checksum><CR><LF>
```

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Example:

```
$PAIR074,1*24
$PAIR001,074,0*38
```

Parameter:

Field	Format	Unit	Description
< Enabled>	Numeric		Enable/disable AIC function. 0 = Disable 1 = Enable

Result:

Returns **$PAIR001** message and the query result.

2.3.22. Packet Type: 075 PAIR_COMMON_GET_AIC_STATUS

Message	$PAIR075
Description	Queries the status of active interference cancellation (AIC) function.
Type	Get

Message Structure:

```
$ PAIR075*<Checksum><CR><LF>
```

Example:

```
$PAIR075*38
$PAIR001,075,0*39
$PAIR075,1*25
```

Parameter:

None

Result:

Returns **$PAIR001** message and the query result.

Query result message format:

```
$PAIR075,<Status>*<Checksum><CR><LF>
```

Parameter included in the result:

Field	Format	Unit	Description
<Status>	Numeric		Status of active AIC function. 0 = Disabled 1 = Enabled

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2.3.23. Packet Type: 080
PAIR_COMMON_SET_NAVIGATION_MODE

Message	$PAIR080
Description	Sets navigation mode The command fails in the following situations: if ULP is enabled, it fails to set Non Fitness mode. if the current RF LNA gain is "High gain", only Normal mode and Drone mode can be configured. all detailed failure information will be displayed in system log.
Type	Set

Message Structure:

```
$PAIR080,<NavMode>*<Checksum><CR><LF>
```

Example:

```
1 Send:
2       $PAIR080,1*2F\r\n ==> Enter fitness mode.
3 Response:
4       $PAIR001,080,0*33\r\n ==> Success
```

Parameter:

Field	Format	Unit	Description
< NavMode>	Numeric		Navigation mode. 0 = Normal mode. For general purposes. 1 = Fitness mode: Used for running and walking purposes, making low-speed movement (< 5 m/s) more impactful on position calculation. 2 = Reserved. 3 = Balloon mode: For high-altitude balloon purpose that the vertical movement will have more effect on the position calculation. 4 = Stationary mode: For stationary applications where a zero dynamic assumed. 5 = Drone mode: Used for drone applications with equivalent dynamic range and vertical acceleration at different flight phases. (For example, hovering, cruising). 6 = Reserved. 7 = Swimming mode: Used for swimming purposes to smooth the trajectory and improve the accuracy of distance calculation.

Result:

Returns **PAIR_ACK for send result.**

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[Note]
Each mode has its altitude limitation.
Please choose the appropriate mode based on the following table.
If your test scenario exceeds the limitation, the position calculation will be incorrect.

Mode	Altitude Limitation
Normal mode	10000 m
Fitness mode	10000 m
Balloon mode	80000 m
Stationary mode	10000 m
Drone mode	10000 m
Swimming mode	10000 m

2.3.24. Packet Type: 081 PAIR_COMMON_GET_NAVIGATION_MODE

Message	$PAIR081
Description	Queries navigation mode.
Type	Get

Message Structure:

```
$PAIR081*<Checksum><CR><LF>
```

Example:

```
$PAIR074,1*24
$PAIR001,074,0*38
```

Parameter:

None

Result:

Returns **$PAIR001** message and the query result.

Query result message format:

```
$PAIR081,<NavMode>*<Checksum><CR><LF>
```

Parameter included in the result:

Field	Format	Unit	Description

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< NavMode>	Numeric		Navigation mode. 0 = Normal mode. For general purposes. 1 = Fitness mode: Used for running and walking purposes, making low-speed movement (< 5 m/s) more impactful on position calculation. 2 = Reserved. 3 = Reserved. 4 = Reserved. 5 = Drone mode: Used for drone applications with equivalent dynamic range and vertical acceleration at different flight phases. (For example, hovering, cruising) 6 = Reserved. 7 = Swimming mode: Used for swimming purpose to smooth the trajectory and improve the accuracy of distance calculation.

2.3.25. Packet Type: 086 PAIR_COMMON_SET_DEBUGLOG_OUTPUT

Message	$PAIR086
Description	Enables/disables debug log output in binary format.
Type	Set

Message Structure:

```
$PAIR086,<Status>*<Checksum><CR><LF>
```

Example:

```
$PAIR086,1*29
$PAIR001,086,0*35
```

Parameter:

Field	Format	Unit	Description
< Status>	Numeric		Debug log output setting. 0 = Disable 1 = Enable with full debug log output 2 = Enable with lite debug log output

Result:

Returns **$PAIR001** message and the query result.

2.3.26. Packet Type: 087 PAIR_COMMON_GET_DEBUGLOG_OUTPUT

Message	$PAIR087

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Description	Queries the debug log output setting.
Type	Get

Message Structure:

```
$PAIR087*<Checksum><CR><LF>
```

Example:

```
$PAIR087*35
$PAIR001,087,0*34
$PAIR087,0*29
```

Parameter:

None

Result:

Returns **$PAIR001** message and the query result.

Query result message format:

```
$PAIR087,<Status>*<Checksum><CR><LF>
```

Parameter included in the result:

Field	Format	Unit	Description
< Status>	Numeric		Debug log output setting. 0 = Disabled 1 = Enabled

2.3.27. Packet Type: 154 PAIR_COMMON_SET_RLM_OUTPUT_ENABLE

Message	$PAIR154
Description	Enables/disables outputting of RLM message.
Type	Set

Message Structure:

```
$PAIR154,<Enable>*<Checksum><CR><LF>
```

Example:

```
$PAIR154,1*27
$PAIR001,154,0*3B
```

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Parameter:

Field	Format	Unit	Description
< Enable>	Numeric		Enable/disable outputting RLM message: 0 = Disable 1 = Enable

Result:
Returns $PAIR001 message and enable/disable RLM message outputting periodically (1 Hz).

2.3.28. Packet Type: 155 PAIR_COMMON_GET_RLM_OUTPUT_STATUS

Message	$PAIR155
Description	Queries RLM message output setting
Type	Get

Message Structure:

```
$PAIR155*<Checksum><CR><LF>
```

Example:

```
$PAIR155*3B
$PAIR001,155,0*3A
$PAIR155,1*26
```

Parameter:

None

Result:

Returns **$PAIR001** message and the query result.

Query result message format:

```
$PAIR155,<Enable>*<Checksum><CR><LF>
```

Parameter included in the result:

Field	Format	Unit	Description
< Enable>	Numeric		RLM message output setting. 0 = Disabled 1 = Enabled

2.3.29. Packet Type: 158 PAIR_COMMON_SET_B1C_ENABLE

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Message	$PAIR158
Description	Enable/Disable tracking of BDS B1C band.
Type	Set

Message Structure:

$PAIR158,<Enable>*<Checksum><CR><LF>

Example:

$PAIR158,1*2B
$PAIR001,158,0*37

Parameter:

Field	Format	Unit	Description
< Enable>	Numeric		Enable/disable tracking of BDS B1C band: 0 = Disable 1 = Enable

Result:
Returns **$PAIR001** message

2.3.30. Packet Type: 382 PAIR_TEST_LOCK_SYSTEM_SLEEP

Message	$PAIR382
Description	Enables/disables the locking of Sleep mode. The CPU core will not enter Sleep mode automatically after the command is sent.
Type	Set

Message Structure:

$PAIR382,<Enabled>*<Checksum><CR><LF>

Example:

$PAIR382,1*2E
$PAIR001,382,0*32

Parameter:

Field	Format	Unit	Description
< Enable>	Numeric		Enable/disable tracking of BDS B1C band: 0 = Disable 1 = Enable

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Result:
Returns **$PAIR001** message

2.3.31. Packet Type: 400 PAIR_DGPS_SET_MODE

Message	$PAIR400
Description	Sets the DGPS correction data source.
Type	Set

Message Structure:

```
$PAIR400,<Mode>*<Checksum><CR><LF>
```

Example:

```
$PAIR400,2*20
$PAIR001,400,0*3F
```

Parameter:

Field	Format	Unit	Description
< Mode>	Numeric		DGPS data source. 0 = No DGPS data source 1 = RTCM 2 = SBAS (Including WAAS/EGNOS/GAGAN/MSAS))

Result:
Returns a **$PAIR001** message.

Note:

1. **If there is no jamming, $PAIRSPF,1*52 will be reported to indicate good status (status 1).**
2. **In case of continuous jamming, the jamming status will change from 1 to 2 and finally to 3**
   1) When no position fix has been completed: module status is 1 right after jamming detection is enabled, and then changes to 2 when jamming is detected. During this process, the module keeps attempting to get a fix; if the anti-jamming repair fails, the jamming status changes to 3.
   2) After a successful position fix: jamming status is 1 right after jamming detection is enabled, and changes to 2 and 3 consecutively when jamming is detected.

2.3.32. Packet Type: 401 PAIR_DGPS_GET_MODE

Message	$PAIR401
Description	Queries the DGPS correction data source.
Type	Get

Message Structure:

```
$PAIR401*<Checksum><CR><LF>
```

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Example:

```
$PAIR401*3F
$PAIR001,401,0*3E
$PAIR401,2*21
```

Parameter:

None

Result:
Returns **$PAIR001** message and the query result.

Query result message format:

```
$PAIR401,<Mode>*<Checksum><CR><LF>
```

Parameter included in the result:

Field	Format	Unit	Description
< Mode>	Numeric		DGPS data source. 0 = No DGPS data source 1 = RTCM 2 = SBAS (Including WAAS/EGNOS/GAGAN/MSAS)

2.3.33. Packet Type: 410 PAIR_SBAS_ENABLE

Message	$PAIR410
Description	Enables/disables SBAS satellite searching. SBAS supports wide-area or regional augmentation through geostationary satellite broadcast messages. The geostationary satellites broadcast GNSS integrity and correction data with the assistance of multiple ground stations that are located at accurately surveyed points.
Type	Set

Message Structure:

```
$PAIR410,<Enabled>*<Checksum><CR><LF>
```

Example:

```
$PAIR410,1*22
$PAIR001,410,0*3E
```

Parameter:

Field	Format	Unit	Description
< Enabled>	Numeric		Enable or disable the search of SBAS satellites. 0 = Disable 1 = Enable

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Result:
Returns **$PAIR001** message.

2.3.34. Packet Type: 411 PAIR_SBAS_GET_STATUS

Message	$PAIR411
Description	Queries the status of SBAS satellite search.
Type	Get

Message Structure:

```
$PAIR411*<Checksum><CR><LF>
```

Example:

```
$PAIR411*3E
$PAIR001,411,0*3F
$PAIR411,1*23
```

Parameter:

None

Result:
Returns **$PAIR001** message and the query result.

Query result message format:

```
$PAIR411,<Enabled>*<Checksum><CR><LF>
```

Parameter included in the result:

Field	Format	Unit	Description
< Enabled>	Numeric		tatus of SBAS satellite search. 0 = Disabled 1 = Enabled

Note:
1. When the navigation mode is Fitness or Swimming mode (see $PAIR080), SBAS is not supported.

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2.3.35. Packet Type: 432 PAIR_RTCM_SET_OUTPUT_MODE

Message	$PAIR432
Description	Sets RTCM output mode.
Type	Set

Message Structure:

$PAIR432,<Mode>*<Checksum><CR><LF>

Example:

$PAIR432,1*22
$PAIR001,432,0*3E

Parameter:

Field	Format	Unit	Description
<Mode>	Numeric		RTCM output mode setting. -1 = Disable outputting RTCM 0 = Enable outputting RTCM3 with message type MSM4 1 = Enable outputting RTCM3 with message type MSM7

Result:
Returns **$PAIR001** message.

2.3.36. Packet Type: 433 PAIR_RTCM_GET_OUTPUT_MODE

Message	$PAIR433
Description	Queries RTCM output mode.
Type	Get

Message Structure:

$PAIR433*<Checksum><CR><LF>

Example:

$PAIR433*3E
$PAIR001,433,0*3F
$PAIR433,-1*0E

Parameter:
None

Result:

Returns $**PAIR001** message and the query result.

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Query result message format:

```
$PAIR433,<Mode>*<Checksum><CR><LF>
```

Parameter included in the result:

Field	Format	Unit	Description
< Mode>	Numeric		RTCM output mode setting. -1 = Disable outputting RTCM 0 = Enable outputting RTCM 10403.3 with message type MSM4 1 = Enable outputting RTCM 10403.3 with message type MSM7

2.3.37. Packet Type: 434 PAIR_RTCM_SET_OUTPUT_ANT_PNT

Message	$PAIR434
Description	Enables/disables outputting stationary antenna reference in RTCM format.
Type	Set

Message Structure:

```
$PAIR434,<ENABLE>*<Checksum><CR><LF>
```

Example:

```
$PQTM434,1*36
$PAIR001,432,0*3E
```

Parameter:

Field	Format	Unit	Description
<Enable>	Numeric		Stationary antenna reference point (Message type 1005). 0 = Disable 1 = Enable

Result:
Returns **$PAIR001** message.

2.3.38. Packet Type: 435 PAIR_RTCM_GET_OUTPUT_ANT_PNT

Message	$PAIR435
Description	Queries the setting of stationary antenna reference point.
Type	Get

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Message Structure:

```
$PAIR435*<Checksum><CR><LF>
```

Example:

```
$PAIR435*38
$PAIR001,435,0*39
$PAIR435,0*24
```

Parameter:
None

Result:
Returns **$PAIR001** message and the query result.

Query result message format:

```
$PAIR435,<Enabled>*<Checksum><CR><LF>
```

Parameter included in the result:

Field	Format	Unit	Description
< Enable>	Numeric		Stationary antenna reference point (Message type 1005). 0 = Disable 1 = Enable

2.3.39. Packet Type: 436 PAIR_RTCM_SET_OUTPUT_EPHEMERIS

Message	$PAIR436
Description	Enables/disables outputting satellite ephemeris information in RTCM format.
Type	Set

Message Structure:

```
$PAIR436,<ENABLE>*<Checksum><CR><LF>
```

Example:

```
$PQTM436,1*34
$PAIR001,436,0*3A
```

Parameter:

Field	Format	Unit	Description
<Enable>	Numeric		Enable/disable outputting satellite ephemeris. 0 = Disable 1 = Enable

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Result:
Returns $PAIR001 message

2.3.40. Packet Type: 437 PAIR_RTCM_GET_OUTPUT_EPHEMERIS

Message	$PAIR437
Description	Queries the setting of satellite ephemeris.
Type	Get

Message Structure:

```
$PAIR437*<Checksum><CR><LF>
```

Example:

```
$PAIR437*3A
$PAIR001,437,0*3B
$PAIR437,1*27
```

Parameter:
None

Result:
Returns **$PAIR001** message and the query result.

Query result message format:

```
$PAIR437,<ENABLE>*<Checksum><CR><LF>
```

Parameter included in the result:

Field	Format	Unit	Description
< Enable>	Numeric		Enable/disable getting satellite ephemeris 0 = Disable 1 = Enable

2.3.41. Packet Type: 490 PAIR_EASY_ENABLE

Message	$PAIR490
Description	Enables/disables EASY function.
Type	Set

Message Structure:

```
$PAIR490,<Enabled>*<Checksum><CR><LF>
```

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Example:

```
$PAIR490,1*2A
$PAIR001,490,0*36
```

Parameter:

Field	Format	Unit	Description
<Enabled>	Numeric		EASY function setting. 0 = Disable 1 = Enable

Result:
Returns **$PAIR001** message

2.3.42. Packet Type: 491 PAIR_EASY_GET_STATUS

Message	$PAIR491
Description	Queries the status of EASY function.
Type	Get

Message Structure:

```
$PAIR491*<Checksum><CR><LF>
```

Example:

```
$ //If <Enabled> is set to enable:
$PAIR491*36
$PAIR001,491,0*37
$PAIR491,1,0*37

//If <Enabled> is set to disable:
$PAIR491*36
$PAIR001,491,0*37
$PAIR491,0*2A
```

Parameter:
None

Result:
Returns **$PAIR001** message and the query result.

Query result message format:

```
$PAIR491,<Enabled>,<Status>*<Checksum><CR><LF>
```

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Parameter included in the result:

Field	Format	Unit	Description
<Enabled>	Numeric		EASY function setting. 0 = Disable 1 = Enable
<Status>	Numeric		EASY data extension status. 0 = Not finished 1 = 1-day extension finished 2 = 2-day extension finished 3 = 3-day extension finished If <Enabled> is set to 0, <Status> will not be displayed in the result.

2.3.43. Packet Type: 511
PAIR_NVRAM_SAVE_NAVIGATION_DATA

Message	$PAIR511
Description	Saves current navigation data from RTC RAM to flash.
Type	Command

Message Structure:

```
$PAIR511*<Checksum><CR><LF>
```

Example:

```
$PAIR511*3F
$PAIR001,511,1*3F
$PAIR001,511,0*3E:
```

Parameter:
None

Result:
Returns **$PAIR001** message

Query result message format:

```
$PAIR491,<Enabled>,<Status>*<Checksum><CR><LF>
```

***Note:**

1. **If RTC cannot be powered after module power supply is cut off, this command must be sent every time the parameters are modified.**
2. **In case of fix rates greater than 1 Hz, power off the GNSS system with $PAIR382,1*2E and $PAIR003*39 before sending this command. After sending $PAIR511*3F, send $PAIR002*38 to re power the module. This limitation does not apply to fix rates below 1 Hz**

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2.3.44. Packet Type: 513 PAIR_NVRAM_SAVE_SETTING

Message	$PAIR513
Description	Saves the current configurations from RTC RAM to flash.
Type	Command

Message Structure:

```
$PAIR513*<Checksum><CR><LF>
```

Example:

```
$PAIR513*3D
$PAIR001,513,0*3C
```

Parameter:
None

Result:
Returns **$PAIR001** message

***Note:**

1. **I If RTC cannot be powered by the hardware after the module power supply is cut off, this command must be sent every time the parameters are modified.**
2. **In multi-Hz, power off the GNSS system with $PAIR382,1*2E and $PAIR003*39 before sending this command. After sending $PAIR513*3D, send $PAIR002*38 again to power on the module. This limitation does not apply to frequencies below 1 Hz.**

2.3.45. Packet Type: 650 PAIR_LOW_POWER_ENTRY_RTC_MODE

Message	$PAIR650
Description	Powers off the GNSS system, except the clock. This command sets the CPU to Backup mode, in which it cannot receive any commands. For details about Backup mode, see documents [1], [2] and [3] hardware designs.
Type	Set

Message Structure:

```
$PAIR650,<Second>*<Checksum><CR><LF>
```

Example:

```
$PAIR650,1*24
$PAIR001,650,4*3C
```

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Parameter:

Field	Format	Unit	Description
<Second>	Numeric		Duration of Backup mode. Range: 0. Enter Backup mode without any timer 10–62208000 (2 years).

Result:

- If successful, the module will be set to Backup mode and be prevented from receiving any commands
- If failed, the $PAIR001 message will be returned

2.3.46. Packet Type: 680 PAIR_GLP_ENABLE

Message	$PAIR680
Description	Enables/disables GPS Low Power (GLP) mode, which utilizes the adjustment of the duty cycle concept to ensure good performance and low power consumption in different environments.
Type	Set

Message Structure:

```
$PAIR680,<Enabled>*<Checksum><CR><LF>
```

Example:

```
$PAIR680,1*29
$PAIR001,680,0*35
```

Parameter:

Field	Format	Unit	Description
<Enabled>	Numeric		Enable/disable GLP mode. 0 = Disable 1 = Enable

Result:

Returns **$PAIR001** message.

***Note:**

1. **Requirements for entering GLP mode**
   1) Fix rate is 1 Hz.
   2) Satellite constellation configuration is GPS only.
   3) Navigation mode is fitness mode.
2. **When the GLP mode is enabled, some of the features will be disabled automatically, such as SBAS ALP, FLP, and the periodic power saving mode.**

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2.3.47. Packet Type: 681 PAIR_GLP_GET_STATUS

Message	$PAIR681
Description	Queries GPS Low Power (GLP) mode setting.
Type	Get

Message Structure:

```
$PAIR681*<Checksum><CR><LF>
```

Example:

```
$PAIR681*35
$PAIR001,681,0*34
$PAIR681,1*28
```

Parameter:
None

Result:
Returns **$PAIR001** message and the query result.

Query result message format:

```
$PAIR681,<Enabled>*<Checksum><CR><LF>
```

Parameter included in the result:

Field	Format	Unit	Description
<Enabled>	Numeric		EASY function setting. 0 = Disable 1 = Enable

2.3.48. Packet Type: 690 PAIR_PERIODIC_SET_MODE

Message	$PAIR690
Description	Sets Periodic Power Saving mode configurations. There are two stages in periodic power saving mode (Run stage and Sleep stage), and they will change periodically according to the setting. In Run stage, the GNSS module measures and calculates the position. In Sleep stage, the GNSS module enters power saving modes.
Type	Set

Message Structure:

```
$PAIR690,<Mode>,<FirstRun>,<FirstSleep>,<SecondRun>,<SecondSleep>*<Checksum><CR><LF>
```

Example:

```
$PAIR690,1,21,39,48,72*28
$PAIR001,690,0*34
```

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Parameter:

Field	Format	Unit	Description
<Mode>	Numeric		State of Periodic Power Saving mode. 0 = Disabled 1 = Smart periodic mode enabled 2 = Strict periodic mode enabled
<FirstRun>	Numeric	Second	Run time. Range: 3–518400.
<FirstSleep>	Numeric	Second	Sleep time. Range: 3–518400.
<SecondRun>	Numeric	Second	Second run time. Range: 0 or 3–518400.
<SecondSleep>	Numeric	Second	Second sleep time. Range: 0 or 3–518400.

Result:
Returns a **$PAIR001** message.

***Note:**

1. **<FirstRun>: Interval in seconds after exiting Sleep mode and getting a new position fix.**
2. **<FirstSleep>: Duration of Sleep mode after getting a fix (or attempting to get a fix).**
3. **<SecondRun>: GNSS module will use "second run time" instead of "first run time" setting when there is no signal. The second run time can be "0" only when the second sleep time is "0".**
4. **<SecondSleep>: GNSS module will use "second sleep time" instead of "first sleep time" setting when there is no signal. The second sleep time can be "0" only when the second run time is "0".**

2.3.49. Packet Type: 691 PAIR_PERIODIC_GET_MODE

Message	$PAIR691
Description	Queries Periodic Power Saving Mode configurations.
Type	Get

Message Structure:

```
$PAIR691*<Checksum><CR><LF>
```

Example:

```
$PAIR691*34
$PAIR001,691,1*34
$PAIR001,691,0*35
$PAIR691,0,3,12,18,72*14
```

Parameter:
None

Result:
Returns **$PAIR001** message and the query result.

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Query result message format:

$PAIR691,<Mode>,<FirstRun>,<FirstSleep>,<SecondRun>,<SecondSleep>*<Checksum><CR><LF>

Parameter included in the result:

Field	Format	Unit	Description
<Mode>	Numeric		State of Periodic Power Saving mode. 0 = Disabled 1 = Smart periodic mode enabled 2 = Strict periodic mode enabled
<FirstRun>	Numeric	Second	Run time. Range: 3–518400.
<FirstSleep>	Numeric	Second	Sleep time. Range: 3–518400.
<SecondRun>	Numeric	Second	Second run time. Range: 0 or 3–518400.
<SecondSleep>	Numeric	Second	Second sleep time. Range: 0 or 3–518400.

2.3.50. Packet Type: 730 PAIR_FLP_ENABLE

Message	$PAIR730
Description	The fitness low power mode is a concept to ensure good performance and low power consumption in different environments. This command is to activate fitness low power mode. For more detailed information, please refer to the Power Saving Mode chapter of fitness low power mode section in the Airoha_IoT_SDK_for_GNSS_Developers_Guide under the doc folder in IoT_SDK_for_Location package. This command is only supported under FITNESS navigation mode.
Type	Set

Message Structure:

$PAIR730,<Enabled>*<Checksum><CR><LF>

Example:

$PAIR730,1*23
$PAIR001,730,0*3F

Parameter:

Field	Format	Unit	Description
<Enabled>	Numeric		Enable/disable FLP mode setting. 0 = Disable 1 = Enable

Result:
Returns a **$PAIR001** message.

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***Note:**
This configuration will not keep in the flash or RTC RAM. Please send this command every time after the GNSS subsystem or main power reboots.
This command will get a failed response if GNSS-SubSys does not power on. You can get the GNSS-SubSys status by PAIR_GNSS_SUBSYS_GET_STATUS.

2.3.51. Packet Type: 731 PAIR_FLP_GET_STATUS

Message	$PAIR731
Description	Queries FLP mode setting.
Type	Get

Message Structure:

```
$PAIR731*<Checksum><CR><LF>
```

Example:

```
$PAIR731*3F
$PAIR001,731,0*3E
$PAIR731,1*22
```

Parameter:
None

Result:
Returns **$PAIR001** message and the query result.

Query result message format:

```
$PAIR731,<Enabled>*<Checksum><CR><LF>
```

Parameter included in the result:

Field	Format	Unit	Description
<Enabled>	Numeric		Enable/disable FLP mode setting. 0 = Disable 1 = Enable

2.3.52. Packet Type: 732 PAIR_FLP_ENABLE

Message	$PAIR732
Description	Enables/disables adaptive low power (ALP) mode, which ensures good performance and low power consumption in different environments.
Type	Set

Message Structure:

```
$PAIR732,<Enabled>*<Checksum><CR><LF>
```

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Example:

```
$PAIR732,1*21
$PAIR001,732,0*3D
```

Parameter:

Field	Format	Unit	Description
<Enabled>	Numeric		Enable/disable ALP mode setting. 0 = Disable 1 = Enable

Result:
Returns a **$PAIR001** message.

***Note:**
This configuration will not keep in the flash or RTC RAM. Please send this command every time after the GNSS subsystem or main power reboots.
This command will get a failed response if GNSS-SubSys does not power on. You can get the GNSS-SubSys status by PAIR_GNSS_SUBSYS_GET_STATUS.

2.3.53. Packet Type: 733 PAIR_ALP_GET_STATUS

Message	$PAIR733
Description	Queries adaptive low-power (ALP) mode configuration setting.
Type	Get

Message Structure:

```
$PAIR733*<Checksum><CR><LF>
```

Example:

```
$PAIR733*3D
$PAIR001,733,0*3C
$PAIR733,1*20
```

Parameter:
None

Result:
Returns **$PAIR001** message and the query result.

Query result message format:

```
$PAIR733,<Enabled>*<Checksum><CR><LF>
```

Parameter included in the result:

Field	Format	Unit	Description

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<Enabled>	Numeric		Enable/disable ALP mode setting. 0 = Disable 1 = Enable

2.3.54. Packet Type: 752 PAIR_PPS_SET_CONFIG_CMD

Message	$PAIR752
Description	Sets PPS configurations.
Type	Set

Message Structure:

```
$PAIR752,<PPSType>,<PPSPulseWidth>*<Checksum><CR><LF>
```

Example:

```
$PAIR752,2,100*39
$PAIR001,752,0*3B
```

Parameter:

Field	Format	Unit	Description
<PPSType>	Numeric		PPS pulse type. 0 = Disable 1 = After the first fix 2 = 3D fix only 3 = 2D/3D fix only 4 = Always
<PPSPulseWidth>	Numeric	Millisecond	PPS pulse width. Range: 1-999. Default value: 100.

Result:
Returns a **$PAIR001** message.

2.3.55. Packet Type: 900 PAIR_LOCUS_ENABLE

Message	$PAIR900
Description	Enables/disables LOCUS to save fix data
Type	Set

Message Structure:

```
$PAIR900,<Enable>*<Checksum><CR><LF>
```

Example:

```
$PAIR900,1*2E
$PAIR001,900,0*32
```

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Parameter:

Field	Format	Unit	Description
<Enable>	Numeric		Enable/disable saving fix data by LOCUS. 0 = Disable 1 = Enable

Result:
Returns a **$PAIR001** message.

2.3.56. Packet Type: 901 PAIR_LOCUS_GET_STATUS

Message	$PAIR901
Description	Queries whether LOCUS saves data.
Type	Get

Message Structure:

```
$PAIR901*<Checksum><CR><LF>
```

Example:

```
$PAIR901*32
$PAIR001,901,0*33
$PAIR901,0*2E
```

Parameter:
None

Result:
Returns **$PAIR001** message and the query result.

Query result message format:

```
$PAIR901,<Enabled>*<Checksum><CR><LF>
```

Parameter included in the result:

Field	Format	Unit	Description
<Enabled>	Numeric		LOCUS setting: 0 = Disable 1 = Enable

2.3.57. Packet Type: 902 PAIR_LOCUS_SET_MODE

Message	$PAIR902

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Description	Sets LOCUS saving mode.
Type	Set

Message Structure:

```
$PAIR902,<Mode>,<Check_3D_Fix>*<Checksum><CR><LF>
```

Example:

```
//Set mode as out of time & out of speed mode. It is necessary to check 3D fix:
$PAIR902,6,1*36
$PAIR001,902,0*30
```

Parameter:

Field	Format	Unit	Description
<Mode>	Hexadecimal		Save Mode: Bit 0 = 1. Normal. Record each fix data. Bit 1 = 1. Time-triggered save mode. Record once after the time threshold is met. For details, see *Chapter 2.3.64 Packet Type: 904 PAIR_LOCUS_SET_THRESHOLD.* Bit 2 = 1. Speed-triggered save mode. Record once after the speed threshold is met. For the value of N, see *Chapter 2.3.64 Packet Type: 904 PAIR_LOCUS_SET_THRESHOLD.* Bit 3= 1. Distance-triggered save mode. Record once after the distance threshold is met. For details, see *Chapter 2.3.64 Packet Type: 904 PAIR_LOCUS_SET_THRESHOLD.* Bit 4 = 1. Before entering sleep mode. Record before entering sleep. Bit 5 = 1. User control. Record after user send $PAIR907*34. For details, see *Chapter 2.3.67 Packet Type: 907 PAIR_LOCUS_LOG_NOW.* Note that when the value of each bit is 0, it means that the corresponding data is not recorded.
<Check_3D_Fix>	Numeric	Millisecond	Whether it is necessary to check 3D fix or not. 0 = Do not check 1 = It is necessary to check. If you set this type as 1, system will save the position with 3D fixed

Result:

Returns **$PAIR001** message.

***Note:**

1. **LOCUS saving must be disabled before sending this command**

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2.3.58. Packet Type: 903 PAIR_LOCUS_GET_MODE

Message	$PAIR903
Description	Queries LOCUS saving mode.
Type	Get

Message Structure:

```
$PAIR903*<Checksum><CR><LF>
```

Example:

```
$PAIR903*30
$PAIR001,903,0*31
$PAIR903,6,1*37
```

Parameter:
None

Result:
Returns **$PAIR001** message and the query result.

Query result message format:

```
$PAIR903,<Mode>,<Check_3D_Fix>*<Checksum><CR><LF>
```

Parameter included in the result:

Field	Format	Unit	Description
<Mode>	Hexadecimal		Save Mode: Bit 0 = 1. Normal. Record each fix data. Bit 1 = 1. Time-triggered save mode. Record once after the time threshold is met. For details, see *Chapter 2.3.64 Packet Type: 904 PAIR_LOCUS_SET_THRESHOLD.* Bit 2 = 1. Speed-triggered save mode. Record once after the speed threshold is met. For the value of N, see *Chapter 2.3.64 Packet Type: 904 PAIR_LOCUS_SET_THRESHOLD.* Bit 3= 1. Distance-triggered save mode. Record once after the distance threshold is met. For details, see *Chapter 2.3.64 Packet Type: 904 PAIR_LOCUS_SET_THRESHOLD.* Bit 4 = 1. Before entering sleep mode. Record before entering sleep. Bit 5 = 1. User control. Record after user send $PAIR907*34. For details, see *Chapter 2.3.67 Packet Type: 907 PAIR_LOCUS_LOG_NOW.* Note that when the value of each bit is 0, it means that the corresponding data is not recorded.

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<Check_3D_Fix>	Numeric	Millisecond	Whether it is necessary to check 3D fix or not. 0 = Do not check 1 = It is necessary to check. If you set this type as 1, system will save the position with 3D fixed

Result:
Returns a **$PAIR001** message.

2.3.59. Packet Type: 904 PAIR_LOCUS_SET_THRESHOLD

Message	$PAIR904
Description	Sets LOCUS mode threshold.
Type	Set

Message Structure:

```
$PAIR904,<Mode>,<Threshold>*<Checksum><CR><LF>
```

Example:

```
$PAIR904,1,5*33
$PAIR001,904,0*36
```

Parameter:

Field	Format	Unit	Description
<Mode>	Numeric		Saving Mode: 0 = Time-triggered save mode 1 = Speed-triggered save mode. 2 = Distance-triggered save mode
<Check_3D_Fix>	Numeric	Meter second m/s	When <mode> = 0, it indicates time threshold. Range: 1-43200. Unit: second. When <mode> = 1, it indicates speed threshold. Range: 1-100. Unit: m/s. When <mode> = 2, it indicates distance threshold. Range: 1-50000. Unit: meter.

Result:
Returns **$PAIR001** message.

***Note:**

1. **Make sure that LOCUS saving is disabled before executing $PAIR902.**
2. **Make sure to set the save mode as time-triggered save mode, speed-triggered save mode, or distance-triggered save mode before executing $PAIR904 to set mode threshold.**

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2.3.60. Packet Type: 905 PAIR_LOCUS_GET_THRESHOLD

Message	$PAIR905
Description	Queries LOCUS mode threshold.
Type	Get

Message Structure:

```
$PAIR905*<Checksum><CR><LF>
```

Example:

```
$PAIR905,0*2A
$PAIR001,905,0*37
$PAIR905,15*1E
```

Parameter:

Field	Format	Unit	Description
<Mode>	Numeric		Saving Mode: 0 = Time-triggered save mode 1 = Speed-triggered save mode. 2 = Distance-triggered save mode

Result:

Returns **$PAIR001** message and the query result.

Query result message format:

```
$PAIR905,<Threshold>*<Checksum><CR><LF>
```

Parameter included in the result:

Field	Format	Unit	Description
<Threshold>	Numeric	Meter second m/s	When <mode> = 0, it indicates time threshold. Range:1-43200. Unit: second. When <mode> = 1, it indicates speed threshold. Range:1-100. Unit: m/s. When <mode> = 2, it indicates distance threshold. Range: 1-50000. Unit: meter

2.3.61. Packet Type: 906 PAIR_LOCUS_CLEAR

Message	$PAIR906
Description	Clears LOCUS Data.
Type	Command

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Message Structure:

$PAIR906,<Type>*<Checksum><CR><LF>

Example:

$PAIR906,0*29
$PAIR001,906,0*34

Parameter:

Field	Format	Unit	Description
<Type>	Numeric		Clean type. 0 = Clear record data and restore to default setting 1 = Clear record data only 2 = Clear user setting and restore to default setting

Result:
Returns **$PAIR001** message.

2.3.62. Packet Type: 907 PAIR_LOCUS_LOG_NOW

Message	$PAIR907
Description	Saves current fix data in flash.
Type	Command

Message Structure:

$PAIR907*<Checksum><CR><LF>

Example:

$PAIR907*34
$PAIR001,907,0*35

Parameter:
None

Result:
Returns **$PAIR001** message

***Note:**

1. **Make sure to set the value of user control (bit 5) as 1 in <mode> field of $PAIR902 before executing this command.**
2. **Saved fix data: UTC time, fix status, longitude, latitude, altitude, ground speed, heading degree, horizontal dilution of precision, number of satellites used.**

2.3.63. Packet Type: 908 PAIR_LOCUS_GET_DATA

Message	$PAIR908

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Description	Queries LOCUS data. There are two output formats to choose from standard NMEA format and PAIR format.
Type	Command

Message Structure:

```
$PAIR908,<Type>*<Checksum><CR><LF>
```

Example:

```
//If <Type> = 0, LOCUS example:
$PAIR908,0*27
LOCUS output:
$PAIR908,0*27
$PAIR908,1,5699,23*24
$LOGGA,033632.000,3148.8100,N,11707.0463,E,1,4,2.45,3.0,M,,M,,*53
$LORMC,033632.000,A,3148.8100,N,11707.0463,E,0.00,0.00,160122,,,A,V*07
…
$LOGGA,033645.000,3148.8108,N,11707.0451,E,1,8,1.14,13.0,M,,M,,*60
$LORMC,033645.000,A,3148.8108,N,11707.0451,E,0.00,0.00,160122,,,A,V*0E
$LOGGA,033649.000,3148.8133,N,11707.0461,E,1,9,1.00,15.0,M,,M,,*65
$LORMC,033649.000,A,3148.8133,N,11707.0461,E,0.00,0.00,160122,,,A,V*09
$PAIR908,3*24
$PAIR001,908,0*3A

//If <Type> = 1, LOCUS example:
$PAIR908,0*27
LOCUS output:
$PAIR908,0*27
$PAIR908,1,5699,23*24
$PAIR908,2,61E392B9,01,12F65A6D,45CEB007,0021,0000,0000,005F,09*77
$PAIR908,2,61E392BA,01,12F65A67,45CEAFDD,0021,0000,0000,005D,0A*74
…
$PAIR908,2,61E3AC35,02,12FBDCD1,45E9D8ED,0006,0000,8960,003C,1D*0F
$PAIR908,2,61E3AC44,02,12FBDCD1,45E9D8ED,0006,0000,8960,0038,1D*72
$PAIR908,2,61E3AC4E,02,12FBE812,45E9D677,0007,0007,8BBC,0036,1E*75
$PAIR908,3*24
$PAIR001,908,0*3A
```

Parameter:

Field	Format	Unit	Description
<Type>	Numeric		Response type: 0 = Response in NMEA format 1 = Response in PAIR format

Result:
Returns **$PAIR001** message.

Query result message format:

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1. Start reading LOCUS data

```
$PAIR908,0*<Checksum><CR><LF>
```

2. Read LOCUS data:

```
$PAIR908,1,<Record_Num>,<Record_Size>*<Checksum><CR><LF>
```

Parameters included in the result:

Field	Format	Unit	Description
<Record_Num>	Numeric		Total number of recorded LOCUS data.
<Record_Size>	Numeric		Size of each LOCUS data recorded.

3. Output LOCUS data according to response type of field:

- If = 0, the message outputtings are LOGGA + LORMC. Please refer to GGA for LOGGA format and RMC for LORMC format.
- If = 1, output message format is as follows:

```
$PAIR908,2,<UTC>,<Fix_Type>,<Lat>,<Lon>,<Height>,<Speed>,<Heading>,<HDOP>,<SatNo>*<Checksum><CR><LF>
```

Parameters included in the result:

Field	Format	Unit	Description
<Fix_Type>	Hexadecimal		Fix quality, refer to Quality Indicator in GGA. 1 byte in LOCUS data.
<Lat>	Hexadecimal	Degree	User latitude in WGS84. 4 bytes in LOCUS data.
<Lon>	Hexadecimal	Degree	User longitude in WGS84. 4 bytes in LOCUS data.
<Height>	Hexadecimal	Meter	User altitude above mean sea level. 2 bytes in LOCUS data.
<Speed>	Hexadecimal	m/s	User ground speed (2-D). 2 bytes in LOCUS data.
<Heading>	Hexadecimal	Degree	User heading of motion. 2 bytes in LOCUS data.
<HDOP>	Hexadecimal		Horizontal (2-D) dilution of precision. 2 bytes in LOCUS data.
<SatNo>	Hexadecimal		Number of satellites used in navigation solution. 2 bytes in LOCUS data.

4. LOCUS data read ends.

```
$PAIR908,0*<Checksum><CR><LF>
```

***Note:**

1. **Make sure to execute $PAIR900,1*2E before executing $PAIR908.**

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2.3.64. Packet Type: 909 PAIR_LOCUS_GET_RECORD_NUM

Message	$PAIR909
Description	Queries total number of recorded LOCUS data.
Type	Command

Message Structure:

```
$PAIR909*<Checksum><CR><LF>
```

Example:

```
$PAIR909*3A
$PAIR001,909,0*3B
$PAIR909,5699*15
```

Parameter:
None

Result:
Returns **$PAIR001** message and the query result.

Query result message format:

```
$PAIR909,<Record_Num>*<Checksum><CR><LF>
```

Parameter included in the result:

Field	Format	Unit	Description
< Record_Num>	Numeric		Total number of recorded LOCUS data.

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3 RTCM Protocol

The modules support RTCM protocol which is in accordance with RTCM Standard 10403.3 Differential GNSS (Global Navigation Satellite Systems) Services – Version 3. This protocol is used to transfer GNSS raw measurement data and is available from https://www.rtcm.org/

Table 5: Applicable Variants and Supported Frequency Bands

Message Type	Mode	Message Name
1005	Output	Stationary RTK Reference Station ARP.
1019	Output	GPS Ephemerides.
1020	Output	GLONASS Ephemerides.
1042	Output	BDS Satellite Ephemeris Data.
1044	Output	QZSS Ephemerides.
1046	Output	Galileo I/NAV Satellite Ephemeris Data.
1074	Output	GPS MSM4.
1077	Output	GPS MSM7.
1084	Output	GLONASS MSM4.
1087	Output	GLONASS MSM7.
1094	Output	Galileo MSM4.
1097	Output	Galileo MSM7.
1114	Output	QZSS MSM4.
1117	Output	QZSS MSM7.
1124	Output	BDS MSM4.
1127	Output	BDS MSM7.

***Note:**

1. **$PAIR432 can enable/disable MSM4/MSM7 (1074, 1077, 1084, 1087, 1094, 1097,1114, 1117, 1124, 1127) messages if the corresponding constellation is enabled.**
2. **$PAIR434 can enable/disable Stationary RTK Reference Station ARP (1005) message.**
3. **$PAIR436 can enable/disable ephemeris (1019, 1020, 1042, 1044, 1046) messages if the corresponding constellation is enabled.**

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4 Appendix A – References

Table 6: Terms and Abbreviations

Abbreviation	Description
2D	2 Dimension
3D	3 Dimension
ACK	Acknowledgement
ALP	Adaptive Low Power
AIC	Active Interference Cancellation
BDS	BDS Navigation Satellite System
C/N0	Carrier-to-Noise-Density Ratio
COG	Course over Ground
COGM	Course over Ground (in Magnetic North Course Direction)
COGT	Course over Ground (in True North Course Direction)
DGPS	Differential Global Positioning System
DOP	Dilution of Precision
EASY	Embedded Assist System
EGNOS	European Geostationary Navigation Overlay Service
EPO	Extended Prediction Orbit
FLP	Fitness Low Power
GAGAN	GPS Aided GEO Augmented Navigation
GGA	Global Positioning System Fix Data
GLL	Geographic Position – Latitude/Longitude
GLONASS	Global Navigation Satellite System (Russia)
GLP	GPS Low Power
GNS	GNSS Fix Data
GNSS	Global Navigation Satellite System

Abbreviation	Description
GPS	Global Positioning System
GRS	GNSS Range Residuals
GSA	GNSS DOP and Active Satellites
GST	GNSS Psuedorange Error Statistics
GSV	GNSS Satellites in View

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HDOP	Horizontal Dilution of Precision
HW	Hardware
ID	Identifier
MNL	MTK Navigation Lib
MSAS	Multi-functional Satellite Augmentation System
NMEA	NMEA (National Marine Electronics Association) 0183 Interface Standard
NVDM	Non-volatile Data Memory
NVRAM	Non-Volatile Random Access Memory
PAIR	Proprietary Protocol of MTK
PDOP	Position Dilution of Precision
PPS	Pulse Per Second
QZSS	Quasi-Zenith Satellite System
RAIM	Receiver Autonomous Integrity Monitoring
RMC	Recommended Minimum Specific GNSS Data
RMS	Root Mean Square
RLM	Return Link Message
RLS	Return Link Service
RTC	Real-time Clock
RTCM	Radio Technical Commission for Maritime Services
RTK	Real Time Kinematic
SBAS	Satellite-Based Augmentation System
SNR	Signal-to-noise Ratio
SOG	Speed over Ground
SPS	Standard Positioning Service
SV	Satellites in View
UART	Universal Asynchronous Receiver/Transmitter
ULP	Ultra-Low Power

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Abbreviation	Description
UTC	Coordinated Universal Time
VDOP	Vertical Dilution of Precision
VTG	Course Over Ground and Ground Speed
WAAS	Wide Area Augmentation System
ZDA	Time and Date

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5 Appendix B - GNSS Satellites (NEMA) Numbering

Table 7: Terms and Abbreviations

GNSS Type	System ID	Satellite ID	Signal ID
GPS	1	1–32	1 = L1 C/A
GLONASS	2	65–88	1 = L1
Galileo	3	1–36	7 = E1
BDS	4	1-63	1 = B1I 3 = B1C
QZSS	5	193–199	
SBAS		33-51	

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6 Appendix C – Special characters

Table 8: Special Characters

Special Character	Definition
<...>	Parameter name. Angle brackets do not appear in the message.
[...]	Optional field of a message. Square brackets do not appear in the message.
{…}	Repeated field of a message. Curly brackets do not appear in the message.
Underline	Default setting of a parameter.

REYAX
TECHNOLOGY CORPORATION, LTD

E-mail : sales@reyax.com
Website : https://reyax.com

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