GeoS® GNSS modules

NMEA Data Protocol

Version 4.0

R&D “GeoStar navigation” Ltd.
Moscow, 2018

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Revision History

#	Updates	Notes
Rev. 1.0 15/06/2018		
1	Initial release	

Scope

The document is the description of GeoS® NMEA 0183 Data Protocol v4.0 implemented in GeoS-5M, GeoS-5MR, GeoS-5MH, and GeoS-5 RTK GNSS modules. The modules support standard messages complying with two NMEA standard versions – v2.x and v4.10, as well as proprietary messages. Where applicable, the description is provided for both versions.

1 Abbreviations

1PPS:	One Pulse Per Second
2D:	two-dimensional
3D:	three-dimensional
AGC:	Auto Gain Control
DOP:	Dilution Of Precision
ID:	Identifier
PLL:	Phase Lock Loop
PRN:	Pseudo Random Number
PZ-90:	Parametry Zemli (Earth Parameters 1990), GLONASS geodetic datum
QZSS:	Quasi-Zenith Satellite System
RAIM:	Receiver Autonomous Integrity Monitoring
RF:	Radio Frequency
RLM:	Return Link Message
RSW:	Receiver Status Word
RTC:	Real Time Clock
RTCM:	Radio Technical Commission for Maritime Services
RTK:	Real Time Kinematic
SAR:	Search And Rescue
SBAS:	Space Based Augmentation System
SV:	Space Vehicle
UTC:	Universal Time Coordinated
WGS-84:	World Geodetic System 1984

2 Data Formats

$aaccc,c--c*hh<CR><LF>

1. "$": Start of Sentence.
2. "aaccc": Address Field.
   Alphanumeric characters identifying type of Talker, and Sentence Formatter. The first two characters identify the Talker ID which depend on satellite system being used: GP for GPS, GL for GLONASS, GA for GALILEO, GQ for QZSS, and GN for any mixed constellation.
   The last three are the Sentence Formatter mnemonic code identifying the data type and the string format. Address Field is GPSGG for any proprietary message.
3. ",": Field Delimiter.
   Starts each field except address and checksum fields. If it is followed by a null field, it is all that remains to indicate no data in a field.
4. "c--c": Data Sentence block.
   Follows address field and is a series of data fields containing all of the data to be transmitted. Data field sequence is fixed and identified by 3rd and subsequent characters of the address field (the "Sentence Formatter"). Data fields may be of variable length and are preceded by delimiters ",".
5. "*": Checksum Delimiter.
   Follows last data field of the sentence. It indicates that the following two alphanumeric characters show the HEX value of the Checksum.
6. "hh": Checksum Field.
   The absolute value calculated by exclusive-OR'ing the 8 data bits (no start bits or stop bits) of each character in the Sentence, between, but excluding "$" and "*". The hexadecimal value of the most significant and least significant 4 bits of the result are converted to two ASCII characters (0-9, A-F (upper case)) for transmission. The most significant character is transmitted first. Example: `$GPGSV,5,5,17,77,71,048,53*43`.
7. <CR><LF>: Terminates Sentence.

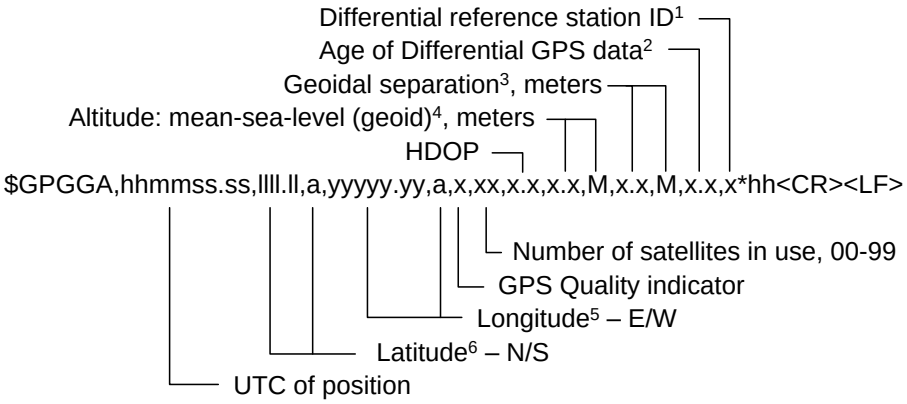
3 Output Messages

Table 1. The list of output messages

Mnemonics	Message	GeoS-5M	GeoS-5 RTK
	Standard		
GGA	Global Positioning System Fix Data	●	●
GLL	Geographic Position – Latitude/Longitude	●	
GNS	GNSS Fix Data	●	●
GSA	GNSS DOP and Active Satellites	●	●
GSV	GNSS Satellites in View	●	●
RMC	Recommended Minimum Specific GNSS Data	●	●
VTG	Course Over Ground and Ground Speed	●	
ZDA	Time and Date	●	
DTM	Datum Reference	●	
RLM	Return Link Message	●	
	Proprietary		
RQUERY	FW Version, Receiver Telemetry and Configuration	●	
NQUERY	Enabled NMEA Messages	●	

3.1 GGA: Global Positioning System Fix Data

Talker ID: only GP.



1) Differential reference station ID: 0000…4095. Null field in autonomous mode. Transmitted 0000 in differential mode using SBAS;
2) Time in seconds since last differential corrections have been received. Value range: 0…999.9. Null field in autonomous mode;
3) Geoidal separation: the difference between the WGS-84 earth ellipsoid surface and mean-sea-level. «-» = mean-sea-level surface below WGS-84 ellipsoid surface;
4) Altitude format:
   a. GeoS-5M: xxxxx.x
   b. GeoS-5 RTK: xxxxx.xxx
5) Longitude format:
   a. GeoS-5M: yyyyy.yyyy
   b. GeoS-5 RTK: yyyyy.yyyyyy
6) Latitude format:
   a. GeoS-5M: llll.llll
   b. GeoS-5 RTK: llll.llllll

Table 2. Description of the field GPS Quality indicator of GGA message

Value	Description	GeoS-5M	GeoS-5 RTK
0	fix not available or invalid	●	●
1	autonomous (standard accuracy) solution	●	●
2	code-differential (DGNSS, SBAS) solution(1)	●	●
4	fixed RTK		●
5	float RTK		●
6	extrapolated solution	●	●
7	coordinates hold mode(2)	●	●

Notes:

1. SBAS applicable to GeoS-5M only;
2. GeoS-5M: used in timing applications
   GeoS-5 RTK: used for Base station configuration.

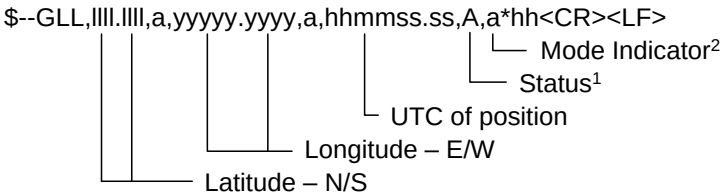
Examples:

After receiver power-up, no fix: `$GPGGA,000008.00,,,,,0,,,,,,,,,*40`
No solution, last valid coordinates transmitted: `$GPGGA,075512.00,5550.6127,N,03732.2526,E,0,00,9.9,00187.6,M,0017.2,M,,*64`
Autonomous solution: `$GPGGA,075241.00,5550.6135,N,03732.2515,E,1,22,0.5,00188.9,M,0014.4,M,,*67`
Code-differential solution with use of SBAS corrections: `$GPGGA,075140.00,5550.6135,N,03732.2515,E,2,22,0.5,00188.8,M,0014.4,M,001.0,0000*48`
Fixed RTK solution: `$GPGGA,153556.00,5550.602948,N,03732.239612,E,4,15,0.7,00192.245,M,0014.4,M,000.6,0100*46`

3.2 GLL: Geographic Position – Latitude/Longitude

Talker ID:

- v2.x: only GP;
- v4.10:
  - GN for any mixed mode;
  - GP for GPS only mode;
  - GL for GLONASS only mode;
  - GA for GALILEO only mode.



1) Status:
   a. A: data valid; being set for all values of Mode Indicator except N;
   b. V: data not valid; being set if Mode Indicator = N;
2) Mode Indicator: refer to Table 3.

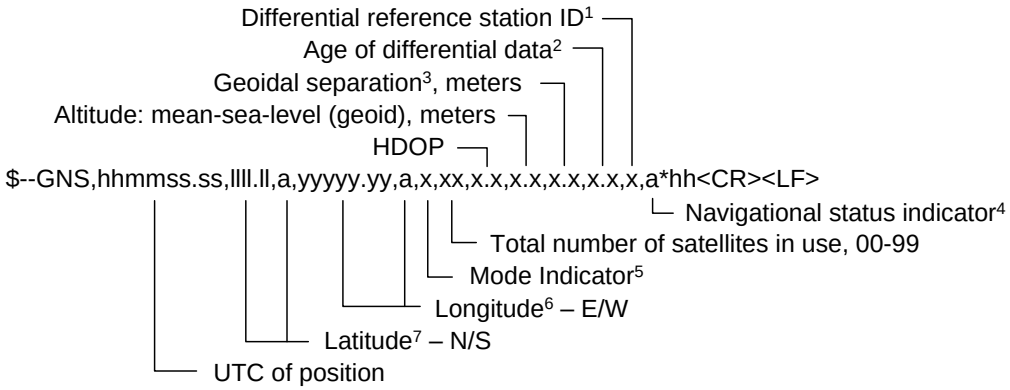
Table 3. Description of the field Mode Indicator of GLL message

Value	Description
A	autonomous (standard accuracy) mode
D	differential (DGNSS, SBAS) mode
E	extrapolation mode
M	coordinates hold mode
N	data not valid

Examples:

After receiver power-up, no fix, v4.10: `$GNGLL,,,,,000007.00,V,N*53`
No fix, last valid coordinates transmitted, v4.10: `$GNGLL,5550.6127,N,03732.2526,E,075712.00,V,N*68`
Autonomous solution, v4.10: `$GNGLL,5550.6111,N,03732.2534,E,081115.00,A,A*7C`
Code-differential solution, v4.10: `$GNGLL,5550.6111,N,03732.2534,E,081034.00,A,D*7B`

3.3 GNS: GNSS Fix Data



1) Differential reference station ID: 0000…4095. Null field in autonomous mode. Transmitted 0000 in differential mode using SBAS;
2) Time in seconds since last differential corrections have been received. Value range: 0…999.9. Null field in autonomous mode;
3) Geoidal separation: the difference between the WGS-84 earth ellipsoid surface and mean-sea-level. «-» = mean-sea-level surface below WGS-84 ellipsoid surface;
4) Navigational status indicator: V (equipment is not providing navigational status indication);
5) Mode Indicator: fixed length field; contains four characters, each character can take the values specified in Table 4. The first symbol relates to GPS, the second one – to GLONASS, the third one – to GALILEO, the fourth one – to QZSS. Examples of the Mode Indicator field in different conditions are provided in Table 5.

Table 4. Description of the field Mode Indicator of GNS message

Value	Description	GeoS-5M	GeoS-5 RTK
N	fix not available/invalid or GNSS is not used in solution	●	●
A	GNSS is used in autonomous solution	●	●
D	GNSS is used in differential solution (DGNSS, SBAS)(1)	●	●
R	fixed RTK		●
F	float RTK		●
E	extrapolated solution	●	●
M	coordinates hold mode(2)	●	●

Notes:

1. SBAS applicable to GeoS-5M only;

2. GeoS-5M: used in timing applications
   GeoS-5 RTK: used for Base station configuration.

6) Longitude format:
   a. GeoS-5M: yyyyy.yyyy
   b. GeoS-5 RTK: yyyyy.yyyyyy
7) Latitude format:
   a. GeoS-5M: llll.llll
   b. GeoS-5 RTK: llll.llllll

If the module is being set to operate on single GNSS, it outputs the only one GNS sentence with following Talker IDs: GP in GPS only mode, GL in GLONASS only mode, GA in GALILEO only mode.

If the module is being set to operate on multiple GNSS, it outputs one main GNS sentence and few additional sentences as described below:

- Talker ID for the main sentence is GN;
- The fields Differential reference station ID and Age of differential data in the main GNS sentence are null fields. The field Total number of satellites in use represents total number of satellites of all GNSS used in position fix;
- Each additional sentence relates to specific GNSS and uses following Talker ID: GP for GPS, GL for GLONASS, GA for GALILEO, GQ for QZSS;
- In additional sentences:
  - The fields Latitude, Longitude, Mode Indicator, HDOP, Altitude, Geoidal separation are null fields;
  - The field Total number of satellites in use represents total number of satellites of specific GNSS used in position fix;
  - The field Navigational status indicator is not produced;
  - The fields Differential reference station ID and Age of differential data represents data for specific GNSS.

Table 5. Examples of the field Mode Indicator of GNS message

Value	Description
NNNN	no fix, no one GNSS is used in position fix
AAAA	autonomous solution on mixed constellation GPS+GLONASS+GALILEO+QZSS
ADNN	autonomous solution on GPS, differential solution on GLONASS; GALILEO and QZSS are not used in position fix
DANN	autonomous solution on GLONASS, differential solution on GPS; GALILEO and QZSS are not used in position fix
DDNN	differential solution on GPS+GLONASS; GALILEO and QZSS are not used in position fix
RRNN	fixed RTK solution on GPS+GLONASS; GALILEO and QZSS are not used in position fix
MMMN	coordinates hold mode on GPS+GLONASS+GALILEO; QZSS is not used in position fix

Examples:

After receiver power-up, no fix, GPS only mode:

```
$GPGNS,000004.00,,,,,NNNN,,,,,,,V*1D
```

No fix, last valid coordinates transmitted, GPS only mode:

```
$GPGNS,075847.00,5550.6127,N,03732.2526,E,NNNN,00,9.9,00187.6,0017.2,,,V*38
```

Autonomous solution, GPS only mode:

```
$GPGNS,080700.00,5550.6111,N,03732.2534,E,ANNN,11,0.7,00182.1,0014.4,,,V*37
```

Code-differential solution, GPS only mode:

```
$GPGNS,080839.00,5550.6111,N,03732.2534,E,DNNN,10,0.8,00182.2,0014.4,001.0,
0000,V*15
```

Autonomous solution, GPS+GLONASS+GALILEO mode:

```
$GNGNS,080520.00,5550.6111,N,03732.2534,E,AAAN,25,0.5,00182.1,0014.4,,,V*2C
$GPGNS,080520.00,,,,,,11,,,,,,*40
$GLGNS,080520.00,,,,,,09,,,,,,*55
$GAGNS,080520.00,,,,,,05,,,,,,*54
```

Mixed solution, differential mode on GPS and GLONASS, autonomous mode on GALILEO:

```
$GNGNS,080606.00,5550.6111,N,03732.2534,E,DDAN,25,0.5,00182.1,0014.4,,,V*2B
$GPGNS,080606.00,,,,,,11,,,,001.0,0000,*68
$GLGNS,080606.00,,,,,,09,,,,001.0,0000,*7D
$GAGNS,080606.00,,,,,,05,,,,,,*53
```

Fixed RTK solution, GPS+GLONASS mode:

```
$GNGNS,153632.00,5550.602949,N,03732.239610,E,RR,15,0.7,00192.247,0014.4,,,
V*24
$GPGNS,153632.00,,,,,,09,,,,000.8,0100*4D
$GLGNS,153632.00,,,,,,06,,,,000.6,0100*50
```

3.4 GSA: GNSS DOP and Active Satellites

Talker ID:

- v2.x:
  - GP for GPS and SBAS;
  - GL for GLONASS;
  - GA for GALILEO;
  - GQ for QZSS;
- v4.10:
  - GN for any mixed mode;
  - GP for GPS only;
  - GL for GLONASS only;
  - GA GALILEO only.

v2.x:

```
$--GSA,a,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,x.x,x.x,x.x*hh<CR><LF>
```

- VDOP
- HDOP
- PDOP
- ID numbers[1] of satellites used in solution
- Mode: 1 = Fix not available, 2 = 2D, 3 = 3D
- Mode: M = Manual, forced to operate in 2D or 3D mode
  A = Automatic, allowed to automatically switch 2D/3D

1) SV ID:
   a. GPS: 1…32;
   b. SBAS: 33…64. The offset from SV ID to SBAS PRN is 87. SBAS PRN of 120 corresponds to SV ID of 33;
   c. GLONASS: 65…88. The offset from GLONASS SV system number and SV ID is 64. SV system number of 1 corresponds to SV ID of 65;
   d. GALILEO: 101…136;
   e. QZSS: 193…197.

v4.10:

- GNSS system ID[2]

```
$--GSA,a,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,x.x,x.x,x.x,h*hh<CR><LF>
```

- VDOP
- HDOP
- PDOP
- ID numbers[1] of satellites used in solution
- Mode: 1 = Fix not available, 2 = 2D, 3 = 3D
- Mode: M = Manual, forced to operate in 2D or 3D mode
  A = Automatic, allowed to automatically switch 2D/3D

1) SV ID:
   a. GPS: 1…32;
   b. SBAS: 33…64. The offset from SV ID to SBAS PRN is 87. SBAS PRN of 120 corresponds to SV ID of 33;
   c. GLONASS: 65…88. The offset from GLONASS SV system number and SV ID is 64. SV system number of 1 corresponds to SV ID of 65;
   d. GALILEO: 1…36;
   e. QZSS: 1…5. The offset from SV ID to QZSS PRN is 192. QZSS PRN of 193 corresponds to SV ID of 1;
2) GNSS System ID:
   a. GPS, SBAS: 1;
   b. GLONASS: 2;
   c. GALILEO: 3;
   d. QZSS: 15.

Examples:

No fix, GPS+GLONASS+GALILEO mode, v2.x:

```
$GPGSA,A,1,,,,,,,,,,,,,9.9,9.9,9.9*30
$GLGSA,A,1,,,,,,,,,,,,,9.9,9.9,9.9*2C
$GAGSA,A,1,,,,,,,,,,,,,9.9,9.9,9.9*21
```

No fix, GPS+GLONASS+GALILEO mode, v4.10:

```
$GNGSA,A,1,,,,,,,,,,,,,9.9,9.9,9.9,1*33
$GNGSA,A,1,,,,,,,,,,,,,9.9,9.9,9.9,2*30
$GNGSA,A,1,,,,,,,,,,,,,9.9,9.9,9.9,3*31
```

Fix available, GPS+GLONASS+GALILEO mode, v2.x:

```
$GPGSA,A,3,001,010,011,012,013,015,017,018,019,024,028,030,1.0,0.5,0.8*33
$GLGSA,A,3,068,069,070,077,078,079,081,087,088,,,,1.0,0.5,0.8*13
$GAGSA,A,3,104,119,130,,,,,,,,,,1.0,0.5,0.8*11
```

Fix available, GPS+GLONASS+GALILEO mode, v4.10:

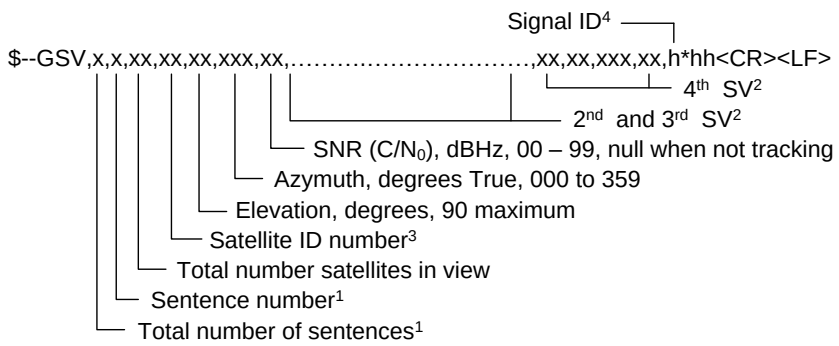
```
$GNGSA,A,3,01,10,11,12,13,15,17,18,19,24,28,30,1.0,0.5,0.8,1*30
$GNGSA,A,3,68,69,70,77,78,79,81,87,88,,,,1.0,0.5,0.8,2*3F
$GNGSA,A,3,04,19,30,,,,,,,,,,1.0,0.5,0.8,3*30
```

3.5 GSV: GNSS Satellites in View

Talker ID:

- v2.x: only GP;
- v4.10:
  - GP for GPS;
  - GL for GLONASS;
  - GA for GALILEO;
  - GQ for QZSS.

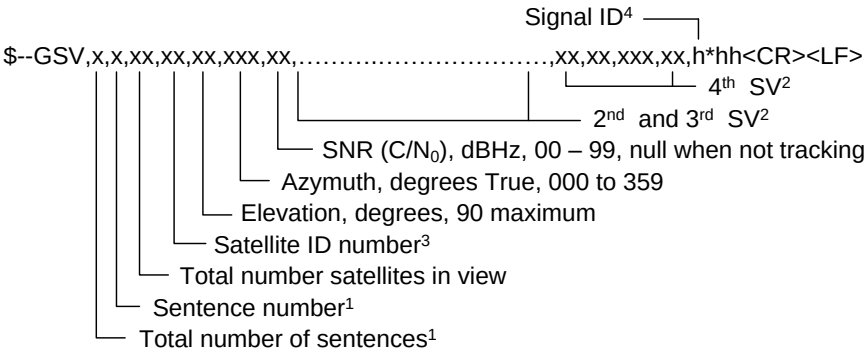
v2.x:



1) Satellite information may require the transmission of multiple sentences all containing identical field formats when sending a complete message. The first field specifies the total number of sentences, minimum value 1. The second field identifies the sentence number, minimum value 1;
2) A variable number of "Satellite ID-Elevation-Azimuth-SNR" sets are allowed up to a maximum of four sets per sentence. Null fields are not transmitted for unused sets when less than four sets are transmitted;
3) SV ID:
   a. GPS: 1…32;
   b. SBAS: 33…64. The offset from SV ID to SBAS PRN is 87. SBAS PRN of 120 corresponds to SV ID of 33;

c. GLONASS: 65…88. The offset from GLONASS SV system number and SV ID is 64. SV system number of 1 corresponds to SV ID of 65;
d. GALILEO: 101…136. The offset from GALILEO SV system number and SV ID is 100. SV system number of 1 corresponds to SV ID of 101;
e. QZSS: 193…197.

v4.10:



1) Satellite information may require the transmission of multiple sentences all containing identical field formats when sending a complete message. The first field specifies the total number of sentences, minimum value 1. The second field identifies the sentence number, minimum value 1;
2) A variable number of "Satellite ID-Elevation-Azimuth-SNR" sets are allowed up to a maximum of four sets per sentence. Null fields are not transmitted for unused sets when less than four sets are transmitted;
3) SV ID:
   a. GPS: 1…32;
   b. SBAS: 33…64. The offset from SV ID to SBAS PRN is 87. SBAS PRN of 120 corresponds to SV ID of 33;
   c. GLONASS: 65…88. The offset from GLONASS SV system number and SV ID is 64. SV system number of 1 corresponds to SV ID of 65;
   d. GALILEO: 1…36;
   e. QZSS: 1…5. The offset from SV ID to QZSS PRN is 192. QZSS PRN of 193 corresponds to SV ID of 1;
4) Signal ID:
   a. GPS, SBAS: 1 (L1 C/A);
   b. GLONASS: 1 (L1 C/A);
   c. GALILEO: 7 (E1B/C);
   d. QZSS: 1 (L1 C/A).

Examples:

Fix available, GPS+GLONASS+GALILEO mode, v2.x:

```
$GPGSV,08,01,32,002,33,059,47,004,-2,000,48,005,34,099,49,009,06,017,40*69
$GPGSV,08,02,32,012,17,143,45,021,18,218,43,023,05,344,41,025,55,167,53*75
$GPGSV,08,03,32,026,24,306,44,029,79,272,54,031,34,266,47,036,-2,000,44*69
$GPGSV,08,04,32,041,14,129,37,049,20,217,42,065,14,006,38,066,26,066,45*79
$GPGSV,08,05,32,067,07,115,23,073,51,298,49,074,11,337,41,080,42,206,43*75
$GPGSV,08,06,32,081,24,062,46,082,75,029,51,083,44,256,49,102,16,322,36*7D
$GPGSV,08,07,32,107,07,006,32,111,47,235,46,112,73,080,44,114,-2,000,51*64
$GPGSV,08,08,32,119,06,099,36,120,-2,000,28,124,42,191,45,125,55,274,44*6A
```

Fix available, GPS+GLONASS+GALILEO mode, v4.10:

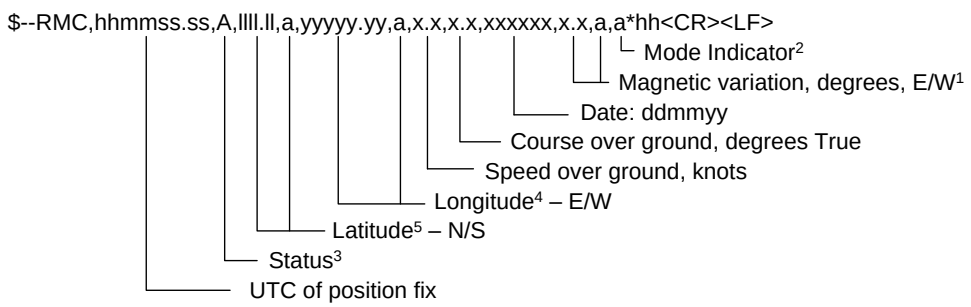
```
$GPGSV,4,1,16,02,43,143,51,03,08,014,39,06,45,081,49,12,87,266,55,1*68
$GPGSV,4,2,16,14,18,317,40,17,14,059,41,19,33,061,46,22,00,354,31,1*6F
$GPGSV,4,3,16,24,38,187,49,25,41,285,52,29,09,233,34,31,05,323,37,1*66
$GPGSV,4,4,16,32,19,288,41,36,-2,000,44,41,14,129,39,49,20,217,44,1*7C
$GLGSV,3,1,10,70,04,299,25,71,16,346,44,72,09,034,40,78,33,142,51,1*7E
$GLGSV,3,2,10,79,78,159,49,80,32,314,42,81,67,189,50,82,17,209,48,1*76
$GLGSV,3,3,10,87,07,036,41,88,53,047,46,1*76
$GAGSV,3,1,09,01,09,130,40,03,09,317,37,05,00,271,,08,06,005,,7*77
$GAGSV,3,2,09,12,38,189,44,24,60,290,48,25,12,304,33,26,24,047,39,7*7C
$GAGSV,3,3,09,31,58,143,,7*43
```

3.6 RMC: Recommended Minimum Specific GNSS Data

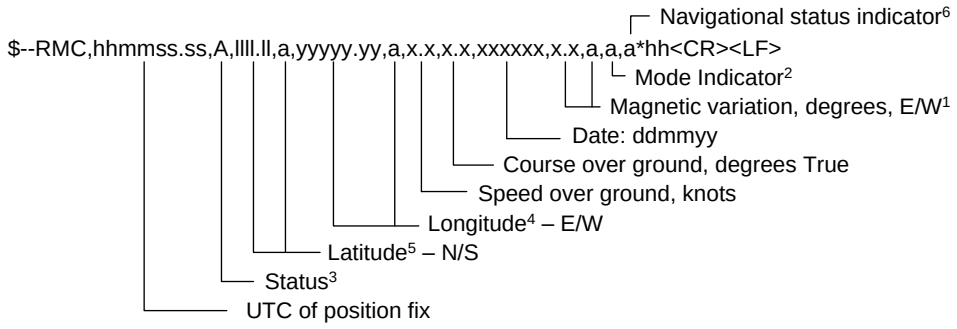
Talker ID:

- v2.x: only GP;
- v4.10:
  - GN for any mixed mode;
  - GP for GPS only mode;
  - GL for GLONASS only mode;
  - GA for GALILEO only mode.

v2.x:



v4.10:



1) Easterly variation subtracts from True course, westerly variation adds to True course;
2) Mode Indicator: refer to Table 6.

Table 6. Description of the field Mode Indicator of RMC message

Value	Description	GeoS-5M	GeoS-5 RTK
N	data not valid	●	●
A	autonomous (standard accuracy) mode	●	●
D	differential (DGNSS, SBAS) mode(1)	●	●
R	fixed RTK		●
F	float RTK		●
E	extrapolation mode	●	●
M	coordinates hold mode(2)	●	●

Notes:

1. SBAS applicable to GeoS-5M only;
2. GeoS-5M: used in timing applications
   GeoS-5 RTK: used for Base station configuration.

3) Status:
   c. A: data valid; being set for all values of Mode Indicator except N;
   a. V: data not valid; being set if Mode Indicator = N;
4) Longitude format:
   a. GeoS-5M: yyyyy.yyyy
   b. GeoS-5 RTK: yyyyy.yyyyyy
5) Latitude format:
   a. GeoS-5M: llll.llll
   b. GeoS-5 RTK: llll.llllll
6) Navigational status indicator: V (equipment is not providing navigational status indication).

Examples:

After receiver power-up, no fix, v2.x:

```
$GPRMC,142353.00,V,,,,,,,300518,,,N*70
```

After receiver power-up, no fix, v4.10: `$GNRMC,141821.00,V,,,,,,,300518,,,N,V*19`
No fix, las valid coordinates transmitted, v4.10: `$GNRMC,102348.00,V,5550.6083,N,03732.2489,E,000.00000,325.5,300518,,,N,V*07`
Autonomous solution, v2.x: `$GPRMC,141632.00,A,5550.6150,N,03732.2523,E,000.00000,243.5,300518,,,A*56`
Autonomous solution, v4.10: `$GNRMC,102014.00,A,5550.6082,N,03732.2488,E,000.00000,092.9,300518,,,A,V*16`
Ode-differential solution, v4.10: `$GNRMC,101925.00,A,5550.6081,N,03732.2485,E,000.00000,092.9,300518,,,D,V*15`
Fixed RTK solution, GPS+GLONASS mode, v2.x: `$GPRMC,153556.00,A,5550.602948,N,03732.239612,E,000.00000,000.0,310518,,,R*4E`
Fixed RTK solution, GPS+GLONASS mode, v4.10: `$GNRMC,153632.00,A,5550.602949,N,03732.239610,E,000.00000,000.0,310518,,,R,V*28`

3.7 VTG: Course Over Ground and Ground Speed

Talker ID:

- v2.x: only GP;
- v4.10:
  - GN for any mixed mode;
  - GP for GPS only mode;
  - GL for GLONASS only mode;
  - GA for GALILEO only mode.

```
$--VTG,x.x,T,x.x,M,x.x,N,x.x,K,a*hh<CR><LF>
```

- Mode Indicator[1]
- Speed over ground, km/hr
- Speed over ground, knots
- Course over ground, degrees Magnetic
- Course over ground, degrees True

1) Mode Indicator: refer to Table 3.

Examples:

Fix available, v2.x: `$GPVTG,224.5,T,,,0000.0,N,0000.0,K,A*41`
Fix available, v4.10: `$GNVTG,224.5,T,,,0000.0,N,0000.0,K,D*5A`

3.8 ZDA: Time and Date

Talker ID:

- v2.x: only GP;
- v4.10:
  - GN for any mixed mode;
  - GP for GPS only mode;
  - GL for GLONASS only mode;
  - GA for GALILEO only mode.

```
$--ZDA,hhmmss.ss,xx,xx,xxxx,xx,xx*hh<CR><LF>
```

- Local zone minutes[1], 00 to +59
- Local zone hours[1], 00 to ±13 hrs
- Year
- Month, 01 to 12
- Day, 01 to 31
- UTC (Year, Month, Day)
- UTC (hhmmss.ss)

1) Local time zone is the magnitude of hours plus the magnitude of minutes added, with the sign of local zone hours, to local time to obtain UTC.

Examples:

v2.x:

```
$GPZDA,072914.00,31,05,2018,+00,00*48
```

v4.10:

```
$GNZDA,072836.00,31,05,2018,+00,00*57
```

3.9 DTM: Datum Reference

Talker ID: only GP.

```
$GPDTM,ccc,,x.x,a,x.x,a,x.x,ccc*hh<CR><LF>
```

- Reference datum code[1]
- Altitude offset[2], meters
- Lon offset[2], minutes, E/W
- Lat offset[2], mimutes, N/S
- Local datum code[3]

1) Reference datum code: W84 = WGS-84;
2) Latitude and longitude offsets are positive values, the altitude offset may be negative. Position in the local datum is the sum of position in the reference datum and position offset;
3) Local datum code:
   W84: WGS-84;
   P90: PZ-90.11;
   999: user defined.

Example:

Reference datum WGS-84, local datum user-defined:

```
$GPDTM,999,,0.002,S,0.005,E,005.8,W84*1A
```

3.10 RLM: Return Link Message

Talker ID: only GP.

Maximum number of messages with different 15HEX IDs: 10 (per second).

```
$GPRLM,hhhhhhhhhhhhhhh,hhmmss.ss,h,h--h*hh<CR><LF>
                                  └─ Message body[3]
                                  └─ Message code[2]
                       └─ Time of reception (UTC)
       └─ Beacon ID[1]
```

1) 15HEX ID of COSPAS-SARSAT distress beacon;
2) The Message code 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;
3) Message body: 4 hexadecimal symbols (16 bits) for the short RLM; 24 hexadecimal symbols (96 bits) for the long RLM.

Example:

15HEX ID = 123456789ABCD12:

```
$GPRLM,123456789ABCD12,000128.00,3,333344445555666677778888*64
```

3.11 RQUERY: FW Version, Receiver Telemetry and Configuration

Talker ID: only GP.

The message is transmitted in following cases.

In ACTIVE state:

- As a response to `$GPSGG,RQUERY*70`;
- Once at power-up and when leaving SLEEP state;
- Periodically once per second if all standard NMEA messages are disabled.

In SLEEP state:

- Once at leaving ACTIVE state.

```
$GPSGG,RQUERY,GEOS-5,V.x.xxx,ddmmyy,xxxxxxxx,xxxxxxxx,xxxxxxxx*hh<CR><LF>
                                                        └─ Receiver Configuration Word #2[4], hex
                                                  └─ Receiver Configuration Word #1[3], hex
                                            └─ RSW[2], hex
                                      └─ FW date, ddmmyy
                                 └─ FW version
                       └─ Receiver name[1]
```

1) Receiver name: transmitted GEOS-5 for all types of modules of GeoS-5 family;
2) RSW: refer to Table 7.

Table 7. RSW description

Bit field	Parameter
31	Reserved
30	Saving data to Flash indicator: 0: saving not active 1: saving in progress
29	Reserved
28	Reserved
27	Calculated and reference position match indicator: 0: delta between calculated and reference coordinates exceeds the threshold and the receiver cannot transit to coordinates hold mode 1: delta between calculated and reference coordinates doesn't exceed the threshold Effective for coordinates hold mode only
26	Survey-in status indicator: 0: disabled or completed 1: in progress
25	Using RTCM corrections in solution indicator: 0: not used 1: used
24	Using RTCM corrections in solution indicator: 0: not used 1: used
23	ACTIVE/SLEEP indicator: 0: SLEEP 1: ACTIVE
22	Differential mode indicator: 0: autonomous mode 1: differential mode
21	DR mode indicator: 0: position fix calculated 1: position fix extrapolated
20	Static navigation indicator: 0: off (the receiver is in motion) 1: on (the receiver is static)
19	Position fix indicator: 0: position fix unavailable 1: position fix available
18	Indicator that at least one position fix has been available after receiver start: 0: unavailable 1: available
17	Reserved
16	2D/3D position fix indicator: 0: 3D 1: 2D
15	Reserved
14	Ionospheric model/UTC data decoded from GPS message availability indicator: 0: unavailable 1: available

Bit field	Parameter
13	Date decoded from navigation message availability indicator: 0: unavailable 1: available
12	Time decoded from navigation message availability indicator: 0: unavailable 1: available
11	QZSS almanac availability indicator: 0: unavailable 1: available
10	GALILEO almanac availability indicator: 0: unavailable 1: available
9	GLONASS almanac availability indicator: 0: unavailable 1: available
8	GPS almanac availability indicator: 0: unavailable 1: available
7:6	Antenna status: 0: not measured 1: overload 2: open 3: OK
5	GLONASS AGC: 0: failed 1: OK
4	GPS AGC: 0: failed 1: OK
3	Reserved
2	RF PLL status: 0: failed 1: OK
1	RTC test results: 0: failed 1: OK
0	Backup SRAM test results: 0: failed 1: OK

3) Receiver Configuration Word #1: refer to Table 8.

Table 8. Description of Receiver Configuration Word #1

Bit field	Parameter
31	Reserved
30	Antenna power: 0: off 1: on
29	Reserved

Bit field	Parameter
28	Operation mode: 0: autonomous or differential 1: coordinates hold
27	RAIM (T-RAIM): 0: off 1: on
26	Pseudorange measurements in message 0x10: 0: unsmoothed 1: smoothed
25	Power-save mode: 0: RELAXED FIX® 1: FIX-BY-REQUEST®
24	Power-save modes: 0: disabled 1: enabled
23:21	User dynamics profile: 0: auto select 1: pedestrian-car 2: marine 3: airborne 4: high-dynamic(1)
20	Reserved
19:18	Output data rate, Hz: 0: 10 1: 5 2: 2 3: 1
17:16	Reserved
15	Kalman filter: 0: off 1: on
14	2D for the first fix: 0: enabled 1: disabled
13	2D mode: 0: disabled 1: enabled
12	Pseudorange measurements used in solution: 0: unsmoothed 1: smoothed
11:9	1PPS synchronization time scale: 0: GPS 1: UTC 2: GLONASS 3: UTC(SU) 4…7: reserved
8	1PPS polarity: 0: positive 1: negative

Bit field	Parameter
7	1PPS output: 0: disabled 1: enabled
6	Signal search if GNSS is disabled: 0: disabled 1: enabled
5	Reserved
4	SBAS system: 0: disabled 1: enabled
3	QZSS system: 0: disabled 1: enabled
2	GALILEO system: 0: disabled 1: enabled
1	GPS system: 0: disabled 1: enabled
0	GLONASS system: 0: disabled 1: enabled

Notes:

1. For GeoS-5MH only.

4) Receiver Configuration Word #2: refer to Table 9.

Table 9. Description of Receiver Configuration Word #2

Bit field	Parameter
31:16	Receiver type: 0xF7FF: GeoS-5M 0xF7FE: GeoS-5MR 0xF7FD: GeoS-5MH
15:14	Coordinate system: 0: WGS-84 1: PZ-90.11 2: user-defined
13:9	Reserved
8	Differential mode: 0: disabled 1: enabled
7:5	Reserved
4	Using SBAS corrections if SV operates in test mode: 0: disabled 1: enabled
3	Using SVs in position fix if SBAS corrections are available: 0: only those SVs for which corrections are available 1: all available SVs

Bit field	Parameter
2	PRN SBAS: 0: user-defined 1: auto select
1:0	Reserved

Example:

GeoS-5 module, FW version 5.102, FW date 10.05.2018:

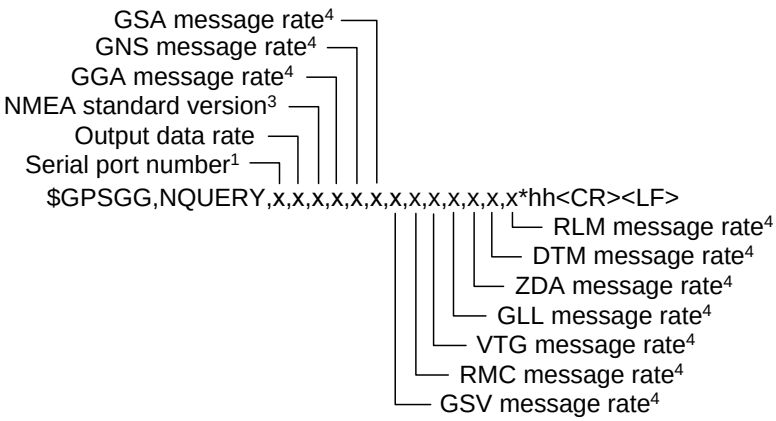
```
$GPSGG,RQUERY,GEOS-5,V.5.102,100518,00083037,802DC097,F7FF8064*5C
```

3.12 NQUERY: Enabled NMEA Messages

Talker ID: only GP.

The message is transmitted in following cases:

- As a response to `$GPSGG,NQUERY*6C`;
- Once at power-up;
- Periodically once per second if all standard NMEA messages are disabled.



1) Serial port number:
   0: Port #0;
   1: Port #1;
2) Output data rate, Hz:
   0: 10;
   1: 5;
   2: 2;
   3: 1;
3) NMEA standard version:
   2: v2.x;
   4: v4.10;
4) Message data rate:
   0: disabled;
   1: once a second;
   2: once a 2 seconds;
   3: once a 20 seconds;
   R: as per output data rate.

Example:

Port #1, output data rate 1Hz, NMEA v2.x, transmitted GGA, GSA, GSV, ZDA, DTM:

```
$GPSGG,NQUERY,1,3,2,R,0,R,1,0,0,0,1,1,0*71
```

4 Input Messages

Table 7. The list of input messages

Mnemonics	Message	GeoS-5M	GeoS-5 RTK
	Proprietary		
SWPROT	Switch to Binary Protocol	•	
SAVEFL	Save Almanacs to Flash	•	
CSTART	Cold Start	•	
WSTART	Warm Start	•	
HSTART	Hot Start	•	
RQUERY	Request FW Version, Receiver Telemetry and Configuration	•	
NQUERY	Request Enabled NMEA Messages	•	
BDR---	Set Serial Port Baud Rate	•	
STOP--	Set Serial Port Stop Bits	•	
GGA ON, GGAOFF	Enable/Disable GGA/GNS Message	•	
GLL ON, GLLOFF	Enable/Disable GLL Message	•	
GSA ON, GSAOFF	Enable/Disable GSA Message	•	
GSV ON, GSVOFF	Enable/Disable GSV Message	•	
RMC ON, RMCOFF	Enable/Disable RMC Message	•	
VTG ON, VTGOFF	Enable/Disable VTG Message	•	
ZDA ON, ZDAOFF	Enable/Disable ZDA Message	•	
DTM ON, DTMOFF	Enable/Disable DTM Message	•	
RLM ON, RLMOFF	Enable/Disable RLM Message	•	
NMEAV2, NMEAV4	Select NMEA Standard Version	•	
RATE--	Set Output Data Rate	•	
PSM ON, PSMOFF	Enter/Quit Power-save Mode/Wake-up	•	
ELEV--	Set Elevation Angle Mask	•	
DATP90, DATW84	Set PZ-90.11 Datum Set WGS-84 Datum	•	
NVSGPS, NVSGLN, NVSMIX	Set GPS only Mode Set GLONASS only Mode Set Mixed GLONASS+GPS ModeGLONASS+GPS+GALILEO	•	

4.1 SWPROT: Switch to Binary Protocol

Switches the port to binary protocol from NMEA protocol.

Format: `$GPSGG,SWPROT*75`.

4.2 SAVEFL: Save Almanacs to Flash

Initiates saving almanacs to the receiver's Flash memory.

Format: `$GPSGG,SAVEFL*63`.

4.3 CSTART: Cold Start

Initiates cold start of the receiver.

Format: `$GPSGG,CSTART*6B`.

4.4 WSTART: Warm Start

Initiates warm start of the receiver.

Format: `$GPSGG,WSTART*7F`.

4.5 HSTART: Hot Start

Initiates hot start of the receiver.

Format: `$GPSGG,HSTART*60`.

4.6 RQUERY: Request FW Version, Receiver Telemetry and Configuration

Requests FW version, hardware telemetry and configuration of the receiver.

Format: `$GPSGG,RQUERY*70`.

4.7 NQUERY: Request Enabled NMEA Messages

Requests enable/disable status and the rate of output NMEA messages.

Format: `$GPSGG,NQUERY*6C`.

4.8 BDR---: Set Serial Port Baud Rate

Sets the baud rate of the serial port.

Format: `$GPSGG,BDR---*`.

Table 8. Description of the messages $GPSGG,BDR---*

Message	Baud rate, bit/s
`$GPSGG,BDR004*08`	4800
`$GPSGG,BDR009*05`	9600
`$GPSGG,BDR019*04`	19200
`$GPSGG,BDR038*07`	38400
`$GPSGG,BDR057*0E`	57600
`$GPSGG,BDR115*09`	115200
`$GPSGG,BDR230*0D`	230400
`$GPSGG,BDR460*0E`	460800
`$GPSGG,BDR921*06`	921600

4.9 STOP--: Set Serial Port Stop Bits

Sets the number of stop bits of the serial port.

Format: $GPSGG,STOP--*.

Table 9. Description of the messages $GPSGG,STOP--*

Message	Stop bits
`$GPSGG,STOP01*71`	1
`$GPSGG,STOP02*72`	2

4.10 GGA ON, GGAOFF: Enable/Disable GGA/GNS Message

Enables/disables GGA/GNS message.

Format: `$GPSGG,GGA ON*08`, `$GPSGG,GGAOFF*66`.

Table 10. Description of the messages $GPSGG,GGA ON*08, $GPSGG,GGAOFF*66

Message	Description
`$GPSGG,GGA ON*08`	GGA/GNS enabled
`$GPSGG,GGAOFF*66`	GGA/GNS disabled

4.11 GLL ON, GLLOFF: Enable/Disable GLL Message

Enables/disables GLL message.

Format: `$GPSGG,GLL ON*OE`, `$GPSGG,GLLOFF*60`

Table 11. Description of the messages $GPSGG,GLL ON*OE, $GPSGG,GLLOFF*60

Message	Description
`$GPSGG,GLL ON*0E`	GLL enabled
`$GPSGG,GLLOFF*60`	GLL disabled

4.12 GSA ON, GSAOFF: Enable/Disable GSA Message

Enables/disables GSA message.

Format: `$GPSGG,GSA ON*1C`, `$GPSGG,GSAOFF*72`.

Table 12. Description of the messages $GPSGG,GSA ON*1C, $GPSGG,GSAOFF*72

Message	Description
`$GPSGG,GSA ON*1C`	GSA enabled
`$GPSGG,GSAOFF*72`	GSA disabled

4.13 GSV ON, GSVOFF: Enable/Disable GSV Message

Enables/disables GSV message.

Format: `$GPSGG,GSV ON*0B`, `$GPSGG,GSVOFF*65`.

Table 13. Description of the messages $GPSGG,GSV ON*0B, $GPSGG,GSVOFF*65

Message	Description
`$GPSGG,GSV ON*0B`	GSV enabled
`$GPSGG,GSVOFF*65`	GSV disabled

4.14 RMC ON, RMCOFF: Enable/Disable RMC Message

Enables/disables RMC message.

Format: `$GPSGG,RMC ON*15`, `$GPSGG,RMCOFF*7B`.

Table 14. Description of the messages $GPSGG,RMC ON*15, $GPSGG,RMCOFF*7B

Message	Description
`$GPSGG,RMC ON*15`	RMC enabled
`$GPSGG,RMCOFF*7B`	RMC disabled

4.15 VTG ON, VTGOFF: Enable/Disable VTG Message

Enables/disables VTG message.

Format: `$GPSGG,VTG ON*0C`, `$GPSGG,VTGOFF*62`.

Table 15. Description of the messages $GPSGG,VTG ON*0C, $GPSGG,VTGOFF*62

Message	Description
`$GPSGG,VTG ON*0C`	VTG enabled
`$GPSGG,VTGOFF*62`	VTG disabled

4.16 ZDA ON, ZDAOFF: Enable/Disable ZDA Message

Enables/disables ZDA message.

Format: `$GPSGG,ZDA ON*16`, `$GPSGG,ZDAOFF*78`.

Table 16. Description of the messages $GPSGG,ZDA ON*16, $GPSGG,ZDAOFF*78

Message	Description
`$GPSGG,ZDA ON*16`	ZDA enabled
`$GPSGG,ZDAOFF*78`	ZDA disabled

4.17 DTM ON, DTMOFF: Enable/Disable DTM Message

Enables/disables DTM message.

Format: `$GPSGG,DTM ON*14`, `$GPSGG,DTMOFF*7A`.

Table 17. Description of the messages $GPSGG,DTM ON*14, $GPSGG,DTMOFF*7A

Message	Description
`$GPSGG,DTM ON*14`	DTM enabled
`$GPSGG,DTMOFF*7A`	DTM disabled

4.18 RLM ON, RLMOFF: Enable/Disable RLM Message

Enables/disables RLM message.

Format: `$GPSGG,RLM ON*1A`, `$GPSGG,RLMOFF*74`.

Table 18. Description of the messages $GPSGG,RLM ON*1A, $GPSGG,RLMOFF*74

Message	Description
`$GPSGG,RLM ON*1A`	RLM enabled
`$GPSGG,RLMOFF*74`	RLM disabled

4.19 NMEAV2, NMEAV4: Select NMEA Standard Version

Selects NMEA standard version v2.x or v4.10.

Format: `$GPSGG,NMEAV2*0B`, `$GPSGG,NMEAV4*0D`.

Table 19. Description of the messages $GPSGG,NMEAV2*0B, $GPSGG,NMEAV4*0D

Message	Description
`$GPSGG,NMEAV2*0B`	v2.x version
`$GPSGG,NMEAV4*0D`	v4.10 version

4.20 RATE--: Set Output Data Rate

Sets the output data rate.

Format: `$GPSGG,RATE--*`.

Table 20. Description of the messages $GPSGG,RATE--*

Message	Output data rate, Hz
`$GPSGG,RATE01*6B`	1
`$GPSGG,RATE02*68`	2
`$GPSGG,RATE05*6F`	5
`$GPSGG,RATE10*6B`	10

4.21 PSM ON, PSMOFF: Enter/Quit Power-save Mode/Wake-up

Enters/quits power-save mode as well as wakes-up the receiver (for FIX-BY-REQUEST® mode).

Format: `$GPSGG,PSM ON*07`, `$GPSGG,PSMOFF*69`.

Table 21. Description of the messages $GPSGG,PSM ON*07, $GPSGG,PSMOFF*69

Message	Description	
	RELAXED FIX®	FIX-BY-REQUEST®
`$GPSGG,PSM ON*07`	ACTIVE: enter the mode SLEEP: has no effect	ACTIVE: enter the mode SLEEP: wake-up
`$GPSGG,PSMOFF*69`	ACTIVE: quit the mode SLEEP: quit the mode	ACTIVE: quit the mode SLEEP: quit the mode a

4.22 ELEV--: Set Elevation Angle Mask

Sets elevation angle mask (in degrees). The SVs with the elevation angle less than the specified mask are excluded from navigation solution.

Format: `GPSGG,ELEV--`.

Table 22. Description of the messages GPSGG,ELEV--

Message	Elevation mask, degree
`$GPSGG,ELEV05*77`	5
`$GPSGG,ELEV06*74`	6
`$GPSGG,ELEV07*75`	7

Message	Elevation mask, degree
$GPSGG,ELEV08*7A	8
$GPSGG,ELEV09*7B	9
$GPSGG,ELEV10*73	10
$GPSGG,ELEV11*72	11
$GPSGG,ELEV12*71	12
$GPSGG,ELEV13*70	13
$GPSGG,ELEV14*77	14
$GPSGG,ELEV15*76	15

4.23 DATP90: Set PZ-90.11 Datum; DATW84: Set WGS-84 Datum

Sets PZ-90.11 or WGS-84 datum.

Format: $GPSGG,DATP90*60, $GPSGG,DATW84*62.

Table 23. Description of the messages $GPSGG,DATP90*60, $GPSGG,DATW84*62

Message	Datum
$GPSGG,DATP90*60	PZ-90.11
$GPSGG,DATW84*62	WGS-84

4.24 NVSGPS: Set GPS only Mode; NVSGLN: Set GLONASS only Mode; NVSMIX: Set Mixed GLONASS+GPS+GALILEO Mode

Sets GNSS constellation used by the receiver: GPS only, GLONASS only, mixed GLONASS+GPS+GALILEO.

Format: $GPSGG,NVSGPS*67, $GPSGG,NVSGLN*66, $GPSGG,NVSMIX*7F.

Table 24. Description of the messages $GPSGG,NVSGPS*67, $GPSGG,NVSGLN*66, $GPSGG,NVSMIX*7F

Message	Operation mode
$GPSGG,NVSGPS*67	GPS only
$GPSGG,NVSGLN*66	GLONASS only
$GPSGG,NVSMIX*7F	GLONASS+GPS+GALILEO