L26-DR GNSS

Protocol Specification

GNSS Module Series

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About the Document

History

Revision	Date	Author	Description
1.0	2019-07-16	Jenn XIANG	Initial

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1 Introduction

L26-DR is a multi-constellation GNSS module supporting Dead Reckoning (DR) function. The module supports GPS, GLONASS, BeiDou, Galileo and QZSS constellations and features accurate acquisition. It can be used in the positioning, navigation and other industries.

This document describes the software aspects of L26-DR. L26-DR supports output of NMEA 0183 standard messages and ST proprietary protocol messages to report GNSS information. Also it supports module control and configuration through ST proprietary commands (PSTM commands).

2 Commands

2.1. List of ST NMEA Proprietary Commands

The table below summarizes all commands supported by ST proprietary protocol (PSTM commands).

Table 1: Summary of PSTM Commands

Syntax	Description
$PSTMINITGPS	Initialize GNSS receiver’s position and time
$PSTMINITTIME	Initialize GNSS receiver’s time
$PSTMCLREPHS	Clear all ephemeris
$PSTMDUMPEPHEMS	Dump ephemeris data
$PSTMCLRALMS	Clear all almanacs
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$PSTMSETCONSTMASK	Set GNSS constellation mask
$PSTMPPS	Command interface for Pulse Per Second management

$PSTMFORCESTANDBY	Force the platform to enter into standby mode
$PSTMCFGPORT	Char port configuration
$PSTMCFGMSGL	Message list configuration
$PSTMCFGAGPS	Assisted GNSS configuration
$ PSTMCFGAJM	Anti-jamming configuration
$PSTMSETTHTRK	Track threshold setting
$PSTMSETTHPOS	Position threshold setting
$PSTMSAVEPAR	Save current configuration data block into the backup memory
$PSTMRESTOREPAR	Restore the factory setting parameters
$PSTMDRMMFB	Input map match data
$PSTMIMUSELFTESTCMD	Execute the self-test command in IMU

2.2. Structure of ST NMEA Proprietary Commands

Table 2: Structure of ST NMEA Proprietary Commands

Filed		Length (Bytes)	Description
$		1	Each NMEA message starts with ‘$’
Talker ID		1	‘P’ for proprietary message
NMEA	Data type	3	Always ‘STM’ to indicate ST proprietary command
Data Filed	Packet type	Valid characters	Packet type
	Packet data	Variable, depend on the packet type	Data fields, delimited by comma ‘,’
*		1	End character of data field
Checksum		2	A hexadecimal number calculated by exclusive OR of all characters between ‘$’ and ‘*’
<cr><lf>		2	Each NMEA message ends with ‘cr’ and ‘lf’

2.3. GNSS Commands

2.3.1. $PSTMINITGPS

Initialize GNSS receiver's position and time using UTC format. This command must be issued after a cold reset or the command fails. The date issued with parameters Day, Month and Year must be later than January 2018.

Synopsis:

```
$PSTMINITGPS,<Lat>,<LatRef>,<Lon>,<LonRef>,<Alt>,<Day>,<Month>,<Year>,<Hour>,<Minute>,<Second>*<checksum><cr><lf>
```

Parameter	Format	Description
Lat	DDMM.MMM	Latitude (Degree-Minute.Minute decimals)
LatRef	'N' or 'S'	Latitude direction (North or South)
Lon	DDDMM.MMM	Longitude (Degree-Minute.Minute decimals)
LonRef	'E' or 'W'	Longitude Direction (East or West)
Alt	dddd - Decimal,4 digits	Altitude in meters (-1500 to 100000)
Day	dd - Decimal, 2 digits	Day of month (01 to 31)
Month	mm - Decimal, 2 digits	Month (01 to 12)
Year	YYYY - Decimal, 4 digits	Year (2018 - …)
Hour	HH - Decimal, 2 digits	Hour (00 to 23)
Minute	MM - Decimal, 2 digits	Minute (00 to 59)
Second	SS - Decimal, 2 digits	Second (00 to 59)
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the "$" and "*" characters

Results:

- In case of no errors, the GNSS receiver's position and time will be initialized:

```
$PSTMINITGPSOK*<checksum><cr><lf>
```

- In case of errors, the error message is returned:

```
$PSTMINITGPSERROR*<checksum><cr><lf>
```

Example:

```
$PSTMINITGPS,4811.365,N,01164.123,E,0530,23,02,2018,09,44,12
```

NOTES

1. The error between input time and real time should be less than 3 seconds. And the error between input position and real position should be less than 30 kilometers.
2. The string "*<checksum>" is optional when users input commands.

2.3.2. $PSTMINITTIME

Initialize GNSS receiver's time using UTC format. The date issued with parameters Day, Month and Year must be later than January 2018.

Synopsis:

```
$PSTMINITTIME,<Day>,<Month>,<Year>,<Hour>,<Minute>,<Second>*<checksum><cr><lf>
```

Arguments:

Parameter	Format	Description
Day	dd - Decimal, 2 digits	Day of month (01 to 31)
Month	mm - Decimal, 2 digits	Month (01 to 12)
Year	YYYY - Decimal, 4 digits	Year (2018 - …)
Hour	HH - Decimal, 2 digits	Hour (00 to 23)
Minute	MM - Decimal, 2 digits	Minute (00 to 59)
Second	SS - Decimal, 2 digits	Second (00 to 59)
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the "$" and "*" characters

Results:

- The time will be initialized
- In case of no errors, the following message is returned:

```
$PSTMINITTIMEOK*<checksum><cr><lf>
```

- In case of errors, the error message is returned:

```
$PSTMINITTIMEERROR*<checksum><cr><lf>
```

Example:

```
$PSTMINITTIME,23,02,2018,09,44,12
```

NOTE

The error between input time and real time should be less than 3 seconds.

2.3.3. $PSTMCLREPHS

Clear all ephemeris. This command erases all the ephemeris stored in the NVM backup memory.

Synopsis:

```
$PSTMCLREPHS*<checksum><cr><lf>
```

Arguments:

None.

Results:

- All ephemeris, stored in the NVM backup memory (SRAM or Flash), will be deleted.
- No message will be sent as reply.

Example:

```
$PSTMCLREPHS
```

2.3.4. $PSTMDUMPEPHEMS

Send out all ephemeris stored in the backup memory.

Synopsis:

```
$PSTMDUMPEPHEMS*<checksum><cr><lf>
```

Arguments:

None.

Result:

```
$PSTMEPHEM,<sat_id>,<N>,<byte1>…<byteN>*<checksum><cr><lf>
```

The parameters included in the result above are listed:

Parameter	Format	Description
sat_id	Decimal, 2 digits	Satellite number
N	Decimal, 1 Digit	Number of the ephemeris data bytes
byte1	Hexadecimal, 2 digits	First byte of the ephemeris data
byteN	Hexadecimal, 2 digits	Last byte of the ephemeris data
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

The data from byte1 to byteN are the dump of structures that contain all the information of the ephemeris.

Ephemeris data format varies according to different constellations. Please see tables below for details.

Table 3: Ephemeris Data Format for GPS Constellation

Bits	Structure Member	Description
16	week	Week number of the Issue of Data
16	toe	Time of week for ephemeris epoch
16	toc	Time of week for clock epoch
8	iode1	Issue of data 1
8	iode2	Issue of data 2
10	iodc	Issue of data clock
14	i_dot	Rate of inclination angle
8	reserved	
24	omega_dot	Rate of right ascension
8	reserved	Must be 0
16	crs	Amplitude of the sine harmonic correction to the orbit radius
16	crc	Amplitude of the cosine harmonic correction to the orbit radius
16	cus	Amplitude of the sine harmonic correction to the argument of latitude
16	cuc	Amplitude of the cosine harmonic correction to the argument of latitude
16	cis	Amplitude of the sine harmonic correction to the angle of inclination
16	cic	Amplitude of the cosine harmonic correction to the angle of inclination
16	motion_difference	Mean motion difference from computed value
16	reserved	Must be 0
32	inclination	Inclination angle at reference time
32	e	Eccentricity
32	root_A	Square root of major axis

32	mean_anomaly	Mean anomaly at reference time
32	omega_zero	Longitude of ascending node of orbit plane at weekly epoch
32	perigee	Argument of perigee
8	time_group_delay	Estimated group delay differential
8	af2	Second order clock correction
16	af1	First order clock correction
22	af0	Constant clock correction
1	reserved	Reserved for use by GNSS library – must be 1
1	reserved	Reserved for use by GNSS library – must be 1
1	reserved	Reserved for use by GNSS library – must be 1
1	available	Contain 1 if ephemeris is available, 0 if not
1	health	Contain 1 if the satellite is unhealthy, 0 if healthy
1	reserved	Must be 0
4	accuracy	Accuracy

Table 4: Ephemeris Data Format for GLONASS Constellation

Bits	Structure Member	Description
16	week	Week number of the Issue of Data
16	toe	Time of week for ephemeris epoch
4	toe_lsb	Time of week for ephemeris epoch (LSB)
11	NA	Calendar day number within the four-year period since the beginning of last leap year (almanac)
7	tb	Time of ephemeris index
2	M	Type of satellite 00=GLONASS, 01=GLONASS-M
2	P1	Time interval between two adjacent tb parameters
1	P3	Number of satellites for which almanac is transmitted within this frame

		0=4, 1=5
1	P2	Flag of oddness ("1") or evenness ("0") of the value of tb
1	P4	Flag to show that ephemeris parameters are present
1	KP	Notification on forthcoming leap second correction of UTC
1	Reserved	
27	xn	Satellite PZ-90 x coordinate at epoch tb
5	xn_dot_dot	Satellite PZ-90 x velocity at epoch tb
24	xn_dot	Satellite PZ-90 x acceleration component at epoch tb
5	n	Slot number (1…24)
3	Bn	Healthy flags
27	yn	Satellite PZ-90 y coordinate at epoch tb
5	yn_dot_dot	Satellite PZ-90 y acceleration component at epoch tb
24	yn_dot	Satellite PZ-90 y velocity at epoch tb
8	age_h	Age of predicted ephemeris (hours)
27	zn	Satellite PZ-90 z coordinate at epoch tb
5	zn_dot_dot	Satellite PZ-90 z acceleration component at epoch tb
24	zn_dot	Satellite PZ-90 z velocity at epoch tb
8	reserved	Must be 0
11	gamma_n	Satellite clock frequency drift at epoch tb
5	E_n	Age of the ephemeris information
4	freq_id	Frequency ID
12	reversed	
22	tau_n	Satellite clock correction at epoch tb
10	reserved	Must be 0
32	tau_c	GLONASS to UTC (SU) time correction

22	tau_GPS	GLONASS to GPS system time correction
10	reserved	
11	NT	Calendar day number of ephemeris within the four-year period since the beginning of last leap year
5	N4	Four-year interval number starting from 1996
12	tk	Satellite time referenced to the beginning of the frame
4	FT	Predicted satellite user range accuracy at time tb
32	reserved	
5	m_available	Must be 0x1F
1	nvm_reliable	Must be 1
26	spare	
25	reserved	
1	available	Contain 1 if ephemeris is available, 0 if not
1	health	Contain 1 if the satellite is unhealthy, 0 if healthy
1	reserved	Must be 0
4	reserved	

Table 5: Ephemeris Data Format for Galileo Constellation

Bits	Structure Member	Description
16	week	Week number of the Issue of Data
16	toe	Time of week for ephemeris epoch
2	reserved	
16	toc	Time of week for clock epoch
10	iod_nav	Issue of data
8	SISA	Signal In Space Accuracy
10	reserved	Must be 0

10	BGD_E1_E5a	E1-E5a Broadcast Group Delay
10	BGD_E1_E5b	E1-E5b Broadcast Group Delay
2	E1BHS	E1-B Signal Health Status
32	inclination	Inclination angle at reference time
32	eccentricity	Eccentricity
32	root_a	Square root of major axis
32	mean_anomaly	Mean anomaly at reference time
32	omega_zero	Longitude of ascending node of orbit plane at weekly epoch
32	perigee	Argument of perigee
14	i_dot	Rate of inclination angle
1	available	Contain 1 if ephemeris is available, 0 if not
1	health	Contain 1 if the satellite is unhealthy, 0 if healthy
16	motion_difference	Mean motion difference from computed value
16	crs	Amplitude of the sine harmonic correction to the orbit radius
16	crc	Amplitude of the cosine harmonic correction to the orbit radius
16	cus	Amplitude of the sine harmonic correction to the argument of latitude
16	cuc	Amplitude of the cosine harmonic correction to the argument of latitude
16	cis	Amplitude of the sine harmonic correction to the angle of inclination
16	cic	Amplitude of the cosine harmonic correction to the angle of inclination
24	omega_dot	Rate of right ascension
6	SVID	Satellite Identification
1	E1BDVS	E1-B Data Validity Status
1	reserved	Must be 0
8	reserved	Must be 0
16	reserved	Must be 0

6	af2	Second order clock correction
21	af1	First order clock correction
5	word_available	Must be 0x1F
31	af0	Constant clock correction
1	reserved	
6	reserved	Must be 0
26	reserved	Reserved for use by GNSS library – must be 1
1	reserved	Must be 0

Table 6: Ephemeris Data Format for BeiDou Constellation

Bits	Structure Member	Description
32	inclination	Inclination angle at reference time
32	eccentricity	Eccentricity
32	root_a	Square root of major axis
32	mean_anomaly	Mean anomaly at reference time
32	omega_zero	Longitude of ascending node of orbit plane at weekly epoch
32	perigee	Argument of perigee
17	toe	Time of week for ephemeris epoch
10	time_group_delay	Estimated group delay differential
5	aode	Issue of data, ephemeris
24	omega_dot	Rate of right ascension
8	A0	Ionospheric Delay Model Parameter α0
24	af0	Constant clock correction
8	A1	Ionospheric Delay Model Parameter α1
20	sow	Seconds of week
11	af2	Second order clock correction

1	is_geo	1 for Geostationary satellites, otherwise 0
22	af1	First order clock correction
10	subframe_avail	Must be 0x3FF
16	motion_difference	Mean motion difference from computed value
8	A2	Ionospheric Delay Model Parameter α2
8	A3	Ionospheric Delay Model Parameter α3
18	crs	Amplitude of the sine harmonic correction to the orbit radius
8	B2	Ionospheric Delay Model Parameter β2
4	urai	User range accuracy index
2	reserved	Must be 0
18	crc	Amplitude of the cosine harmonic correction to the orbit radius
8	B3	Ionospheric Delay Model Parameter β3
5	aodc	Issue of data, clock
1	spare	
18	cus	Amplitude of the sine harmonic correction to the argument of latitude
14	i_dot	Rate of inclination angle
18	cuc	Amplitude of the cosine harmonic correction to the argument of latitude
8	B0	Ionospheric Delay Model Parameter β0
6	spare	
18	cis	Amplitude of the sine harmonic correction to the angle of inclination
8	B1	Ionospheric Delay Model Parameter β1
6	reserved	Must be 0
18	cic	Amplitude of the cosine harmonic correction to the angle of inclination
1	nvm_reliable	Must be 1
11	reserved	Must be 0

2	spare	
17	toc	Time of week for clock epoch
13	week	Week number of the Issue of Data
1	available	Contain 1 if ephemeris is available, 0 if not
1	health	Contain 1 if the satellite is unhealthy, 0 if healthy

Examples:

```
$PSTMDUMPEPHEMS
$PSTMEPHEM,1,64,0f06bc34bc345f5f5f84f400dea4ff00f9f63c239f0a35f81400fbff33420000ee632f27698ef001afa50da16cfcfa22e0b65a3e7a3cee27d700f7ffc616fe03*57
$PSTMEPHEM,2,64,0f06bc34bc344f4f4f78110019a5ff00b004fa1d1e0e3f04c8ffcaff1937000033515726556ba9048eae0da1b6c346bd8f985c93ade10c76db001d00f8c7c503*58
$PSTMEPHEM,4,64,0f06bb34bb344b4b4b98050038a4ff000005351e110eea041b00b8ffd037000020b84e26b5138b0425580ca16b211030e68b1a949cac9615f30066ffea92f603*06
$PSTMEPHEM,9,64,0f06bc34bc341818189c0a0069aaff005f06eb249a09ca0477ff6c00f72e00005131d827592b950a91010da1c7af88538e7ca1122fb9be3df4001300c4a0c203*52
```

2.3.5. $PSTMCLRALMS

This command erases all the almanacs stored in the NVM backup memory.

Synopsis:

```
$PSTMCLRALMS*<checksum><cr><lf>
```

Arguments:

None.

Results:

- All almanacs, stored in the NVM backup memory, will be deleted.
- No message will be sent as reply.

Example:

```
$PSTMCLRALMS
```

2.3.6. $PSTMDUMPALMANAC

Dump almanac data. This command sends out all almanacs stored in the backup memory.

Synopsis:

```
$PSTMDUMPALMANAC*<checksum><cr><lf>
```

Arguments:

None.

Result:

```
$PSTMALMANAC,<sat_id>,<N>,<byte1>…<byteN>*<checksum><cr><lf>
```

The parameters included in the result above are listed:

Parameter	Format	Description
sat_id	Decimal, 2 digits	Satellite number
N	Decimal, 1 Digit	Number of the almanac data bytes
byte1	Hexadecimal, 2 digits	First byte of the almanac data
byteN	Hexadecimal, 2 digits	Last byte of the almanac data
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

The data from byte1 to byteN are the dump of structures that contain all the information of the almanac. Almanac data format varies according to different constellations. Please see tables below for details.

Table 7: Almanac Data Format for GPS Constellation

Bits	Structure Member	Description
8	satid	The satellite number
16	week	The week number for the epoch
8	toa	Reference time almanac
16	e	Eccentricity
16	delta_i	Rate of inclination angle
16	omega_dot	Rate of right ascension
24	root_A	Square root of semi-major axis
24	omega_zero	Longitude of ascending node of orbit plane at weekly epoch
24	perigee	Argument of perigee

24	mean_anomaly	Mean anomaly at reference time
11	af0	Constant clock correction
11	af1	First order clock correction
1	health	Contain 1 if the satellite is unhealthy 0 if healthy
1	available	Contain 1 if almanac is available 0 if not

Table 8: Almanac Data Format for GLONASS Constellation

Bits	Structure Member	Description
8	satid	The satellite number
16	week	The week number for the epoch
8	toa	Reference time almanac
5	n_A	Slot number (1…24)
5	H_n_A	Carrier frequency channel number
2	M_n_A	Type of satellite 00=GLONASS, 01=GLONASS-M
10	tau_n_A	Satellite clock correction
15	epsilon_n_A	Eccentricity
21	t_lambda_n_A	Time of the first ascending node passage
21	lambda_n_A	Longitude of ascending node of orbit plane at almanac epoch
18	delta_i_n_A	Inclination angle correction to nominal value
7	delta_T_n_dot_A	Draconian period rate of change
22	delta_T_n_A	Draconian period correction
16	omega_n_A	Argument of perigee
1	health	Contain 1 if the satellite is unhealthy, 0 if healthy
1	available	Contain 1 if almanac is available, 0 if not
32	Tau_c	

11	NA
5	N4
16	Spare

Table 9: Almanac Data Format for Galileo Constellation

Bits	Structure Member	Description
16	satid	The satellite number
6	svid	Space Vehicle Identificator
16	week	The week number for the epoch
20	toa	Reference time almanac
13	delta_a	Delta of semi-major axis
11	e	Eccentricity
16	perigee	Argument of perigee
11	delta_i	Rate of inclination angle
16	omega_zero	Longitude of ascending node of orbit plane at weekly epoch
11	omega_dot	Rate of right ascension
16	mean_anomaly	Mean anomaly at reference time
16	af0	Constant clock correction
13	af1	First order clock correction
2	E5b_HS	E5 signal health status
2	E1B_HS	E1-B signal health status
4	ioda_1	Issue of data Almanac 1
4	ioda_2	Issue of data Almanac 2
1	health	Contain 1 if the satellite is unhealthy 0, if healthy
2	reserved	Reserved for use by GNSS library
1	health	Contain 1 if the satellite is unhealthy, 0 if healthy

1	available	Contain 1 if almanac is available 0 if not

Table 10: Almanac Data Format for BeiDou Constellation

Bits	Structure Member	Description
8	prn	PRN number of the corresponding almanac data
16	week	Almanac reference week number
8	toa	Almanac reference time
17	eccentricity	Eccentricity
11	af0	Satellite clock time bias correction coefficient
1	is_geo	Satellite orbit type
1	WNa_valid	
2	spare0	
17	omega_dot	Rate of right ascension
11	af1	Satellite clock time drift correction coefficient
4	spare1	
24	root_a	Square root of semi-major axis
8	spare2	
24	omega_zero	Longitude of ascending node of orbital plane at weekly epoch
8	spare3	
24	perigee	Argument of perigee
8	spare4	
24	mean_anomaly	Mean anomaly at reference time
8	spare5	
16	delta_i	Correction of inclination angle at reference time
1	health	Satellite health information
1	available	Contain 1 if almanac is available 0 if not

8	last_received_toa
6	spare6

Examples:

```
$PSTMDUMPALMANAC
$PSTMALMANAC,1,32,011a06903f1f9f0d58fd0800d90ca1418713060099ee260034024200b4ffff00*1a
$PSTMALMANAC,2,32,021a0690944b78fe37fd0800770da141ef0c5b0060487700989bd800d8088000*1a
$PSTMALMANAC,3,32,031a06904f68a2f540fd0800f60ca141922a2c003cae27009496cf00020a8000*15
$PSTMALMANAC,4,32,041a0690a94aeffd36fd0800390ca141afc95b00de7a1700dfc74e004ddebf00*13
$PSTMALMANAC,5,32,051a0690940eee0b5efd0800900ca141582b8600d3000b0060641200e40f8000*14
```

2.3.7. $PSTMCOLD

Perform a cold start.

Synopsis:

```
$PSTMCOLD*<checksum><cr><lf>
```

Arguments:

None.

Results:

- Cold start initialization and GNSS engine restart [1].

Example:

```
$PSTMCOLD
```

NOTE

[1] It is not a system reboot.

2.3.8. $PSTMWARM

Perform a warm start.

Synopsis:

```
$PSTMWARM*<checksum><cr><lf>
```

Arguments:

None.

Result:

- Warm start initialization and GNSS engine restart [1].

Example:

```
$PSTMWARM
```

NOTE

[1] It is not a system reboot.

2.3.9. $PSTMHOT

Perform a hot start.

Synopsis:

```
$PSTMHOT*<checksum><cr><lf>
```

Arguments:

None.

Result:

- GNSS engine restart [1].

Example:

```
$PSTMHOT
```

NOTE

[1] It is not a system reboot.

2.3.10. $PSTMSRR

Execute a system reset. The GNSS firmware is rebooted.

Synopsis:

```
$PSTMSRR*<checksum><cr><lf>
```

Arguments:

None.

Results:

- The GNSS firmware will be rebooted.
- No message will be sent as reply.

Example:

```
$PSTMSRR
```

2.3.11. $PSTMSBASONOFF

Suspend/resume the SBAS software execution.

Synopsis:

```
$PSTMSBASONOFF*<checksum><cr><lf>
```

Arguments:

None.

Result:

- If SBAS is running it will be suspended, and if it has been suspended it will start to run.

Example:

```
$PSTMSBASONOFF
```

2.3.12. $PSTMSBASSERVICE

Change the SBAS service.

Synopsis:

```
$PSTMSBASSERVICE,<service>*<checksum><cr><lf>
```

Arguments:

Parameter	Format	Description
service	Integer	SBAS service 0 = WAAS 1 = EGNOS 2 = MSAS 3 = GAGAN 4 = SDCM 7 = OFF

		15 = AUTO
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Results:

- The SBAS engine will put in tracker all the satellites which correspond to the specified service.
- When SBAS service is set to be OFF, no satellites are put in tracker.
- When SBAS is set to be AUTO, the SBAS engine automatically selects the appropriate SBAS service based on the computed user position latitude and longitude.
- In case of no errors, the following message is returned:

```
$PSTMSBASSERVICEOK*<checksum><cr><lf>
```

- In case of errors, the error message is returned:

```
$PSTMSBASSERVICEERROR*<checksum><cr><lf>
```

Example:

```
$PSTMSBASSERVICE,15
```

2.3.13. $PSTMGETRTCTIME

Get the current RTC time.

Synopsis:

```
$PSTMGETRTCTIME*<checksum><cr><lf>
```

Arguments:

None.

Result:

- System will send RTC data and status.

```
$PSTMRTCTIME,<time>,<date>,<rtc_status>,<time_validity>*<checksum><cr><lf>
```

The parameters included in the result above are listed:

Parameter	Format	Description
time	hhmmss.mms	Current time read on RTC
date	ddmmyy	Current date read on RTC
rtc_status	Decimal, 1 digit	Status: 0 - RTC_STATUS_INVALID 1 - RTC_STATUS_STORED 2 - RTC_STATUS_APPROXIMATE
time_validity	Decimal, 1 digit	Validity: 0 - NO_TIME

		1 - FLASH_TIME 2 - TOW_TIME 3 - USER_TIME 4 - USER_RTC_TIME 5 - RTC_TIME 6 - RTC_TIME_ACCURATE 7 - APPROX_TIME 8 - ACCURATE_TIME 9 - POSITION_TIME 10 - EPHEMERIS_TIME
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Example:

```
$PSTMGETRTCTIME
```

2.3.14. $PSTMSETCONSTMASK

Set the GNSS constellation mask. It allows GNSS constellation switching at run-time. In case of reset, constellation mask is restored to default value.

Synopsis:

```
$PSTMSETCONSTMASK,<constellation_mask>*<checksum><cr><lf>
```

Arguments:

Parameter	Format	Description
constellation_mask	Decimal	It is a bit mask where each bit enables/disables a specific constellation independently by the others: bit 0: GPS constellation enabling/disabling bit 1: GLONASS constellation enabling/disabling bit 2: QZSS constellation enabling/disabling bit 3: Galileo constellation enabling/disabling bit 7: BeiDou constellation enabling/disabling
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Results:

- In case of no errors, the following message is returned:

```
$PSTMSETCONSTMASKOK,<constellation_mask>*<checksum><cr><lf>
```

- In case of errors, the error message is returned:

```
$PSTMSETCONSTMASKERROR*<checksum><cr><lf>
```

Examples:

Enabling GPS only:

```
$PSTMSETCONSTMASK,1
```

Enabling GLONASS only:

```
$PSTMSETCONSTMASK,2
```

Enabling GPS and GLONASS:

```
$PSTMSETCONSTMASK,3
```

2.3.15. $PSTMPPS

Allow interfacing all parameters for Pulse Per Second management. This is a parametric command.

Synopsis:

```
$PSTMPPS,<cmd_mode>,<cmd_type>,<par_1>,…,<par_N>*<checksum><cr><lf>
```

Arguments:

Parameter	Format	Description
cmd_mode	Decimal, 1 digit	Select the command operation mode: 1 = GET operation (to get data from PPS manager) 2 = SET operation (to set data into PPS manager)
cmd_type	Decimal	1 = PPS_IF_ON_OFF_CMD 2 = PPS_IF_OUT_MODE_CMD 3 = PPS_IF_REFERENCE_CONSTELLATION_CMD 4 = PPS_IF_PULSE_DELAY_CMD 5 = PPS_IF_PULSE_DURATION_CMD 6 = PPS_IF_PULSE_POLARITY_CMD 7 = PPS_IF_PULSE_DATA_CMD 8 = PPS_IF_FIX_CONDITION_CMD 9 = PPS_IF_SAT_TRHESHOLD_CMD 10 = PPS_IF_ELEVATION_MASK_CMD 11 = PPS_IF_COSTELLATION_MASK_CMD 12 = PPS_IF_TIMING_DATA_CMD 13 = PPS_IF_POSITION_HOLD_DATA_CMD 14 = PPS_IF_AUTO_HOLD_SAMPLES_CMD 15 = PPS_IF_TRAIM_CMD 16 = PPS_IF_TRAIM_USED_CMD 17 = PPS_IF_TRAIM_RES_CMD 18 = PPS_IF_TRAIM_REMOVED_CMD 19 = PPS_IF_REFERENCE_TIME_CMD 20 = PPS_IF_CONSTELLATION_RF_DELAY_CMD
par_1 … par_N		Parameter list is determined by the command type. Please check the tables below for details.

checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Result:
According to the operation mode and the command type of $PSTMPPS, data is set into the PPS manager or it is retrieved from the PPS manager.

2.3.15.1. Getting PPS Data (cmd_mode = 1)

- **PPS_IF_PULSE_DATA_CMD**

```
$PSTMPPS,1,7*<checksum><cr><lf>
```

Reply:

```
$PSTMPPS,1,7,<out_mode>,<reference_time>,<pulse_delay>,<pulse_duration>,<pulse_polarity>*<checksum><cr><lf>
```

The parameters included in the reply above are listed:

Parameter	Format	Description
out_mode	Decimal, 1 digit	0 = PPS always generated 1 = PPS generated on even seconds 2 = PPS generated on odd seconds
reference_time	Decimal, 1 digit	0 = UTC 1 = GPS_UTC 2 = GLONASS_UTC 3 = UTC_SU 4 = GPS_UTC_FROM_GLONASS 5 = BEIDOU_UTC 6 = UTC_NTSC 7 = GST 8 = UTC_GST 9 = GPS_FROM_GST Notes: UTC(SU) is the Soviet Union UTC derived from GLONASS time applying the UTC delta time downloaded from GLONASS satellites. GPS_UTC_FROM_GLONASS is the GPS time derived from GLONASS time applying the GPS delta time downloaded from GLONASS satellites. If the software is configured to work in GLONASS only mode, UTC(SU) is identical to UTC and GPS_UTC_FROM_GLONASS is identical to GPS_UTC.

pulse_delay	Decimal	Pulse delay [ns]
pulse_duration	Double	Pulse duration [s]
pulse_polarity	Decimal, 1 digit	0 = not inverted 1 = inverted
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

- **PPS_IF_TIMING_DATA_CMD**

$PSTMPPS,1,12*<checksum><cr><lf>

Reply:

$PSTMPPS,1,12,<fix_condition>,<sat_th>,<elevation_mask>,<constellation_mask>,<gps_rf_delay>,<glonass_rf_delay>*<checksum><cr><lf>

The parameters included in the reply above are listed:

Parameter	Format	Description
fix_condition	Decimal, 1 digit	1 = No Fix 2 = 2D Fix 3 = 3D Fix
sat_th	Decimal	Minimum number of satellites for the PPS generation.
elevation_mask	Decimal	Minimum satellite elevation for satellite usage in timing filtering.
constellation_mask	Decimal (bit mask)	Satellite constellation selection for usage in timing filtering. bit0 = GPS bit1 = GLONASS bit7 = BeiDou
gps_rf_delay	Decimal	GPS path RF delay [ns]
glonass_rf_delay	Decimal	GLONASS path RF delay [ns]
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

- **PPS_IF_POSITION_HOLD_DATA_CMD**

$PSTMPPS,1,13*<checksum><cr><lf>

Reply:

$PSTMPPS,1,13,<on_off>,<lat>,<lat_dir>,<lon>,<lon_dir>,<h_msl>*<checksum><cr><lf>

The parameters included in the reply above are listed:

Parameter	Format	Description
on_off	Decimal, 1 digit	0 = Position Hold disabled 1 = Position Hold enabled
lat	DDMM.MMMMM	Position Hold position latitude
lat_dir	"N" or "S"	North or South direction
lon	DDDMM.MMMMM	Position Hold position longitude
lon_dir	"E" or "W"	East or West direction
h_msl	Double	Position Hold mean sea level altitude
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

- **PPS_IF_TRAIM_CMD**

```
$PSTMPPS,1,15*<checksum><cr><lf>
```

Reply:

```
$PSTMPPS,1,15,<traim_enabled>,<traim_solution>,<ave_error> ,<used_sats>,<removed_sats>*<checksum><cr><lf>
```

The parameters included in the reply above are listed:

Parameter	Format	Description
traim_enabled	Decimal, 1 digit	TRAIM ON/OFF status 0 = OFF 1 = ON
traim_solution	Decimal, 1 digit	TRAIM Algorithm status: 0 = UNDER Alarm 1 = OVER Alarm 2 = Unknown
ave_error	Decimal	Average time error [ns]
used_sats	Decimal	Number of satellites used for timing correction
removed_sats	Decimal	Number of satellites removed by the timing correction
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

- **PPS_IF_TRAIM_USED_CMD**

```
$PSTMPPS,1,16*<checksum><cr><lf>
```

Reply:

```
$PSTMPPS,1,16,<traim_enabled>,<used_sats>,<sat1>,...,<satN>*<checksum><cr><lf>
```

The parameters included in the reply above are listed:

Parameter	Format	Description
traim_enabled	Decimal, 1 digit	TRAIM ON/OFF status 0 = OFF 1 = ON
used_sats	Decimal	Number of satellites used for timing correction
sat1...satN	Decimal	List of satellite IDs
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

- **PPS_IF_TRAIM_RES_CMD**

```
$PSTMPPS,1,17*<checksum><cr><lf>
```

Reply:

```
$PSTMPPS,1,17,<traim_enabled>,<used_sats>,<res1>,..,<resN>*<checksum><cr><lf>
```

The parameters included in the reply above are listed:

Parameter	Format	Description
traim_enabled	Decimal, 1 digit	TRAIM ON/OFF status 0 = OFF 1 = ON
used_sats	Decimal	Number of satellites used for timing correction
res1..resN	Decimal	List of satellites residuals [ns] Each residual corresponds to the satellite in the used sat list at the same message position
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

- **PPS_IF_TRAIM_REMOVED_CMD**

```
$PSTMPPS,1,18*<checksum><cr><lf>
```

Reply:

```
$PSTMPPS,1,18,<traim_enabled>,<rem_sats>,<sat1>,...,<satN>*<checksum><cr><lf>
```

The parameters included in the reply above are listed:

Parameter	Format	Description
traim_enabled	Decimal, 1 digit	TRAIM ON/OFF status 0 = OFF 1 = ON
rem_sats	Decimal	Number of satellites removed by timing correction
sat1...satN	Decimal	List of satellite IDs
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

2.3.15.2. Setting PPS Data (cmd_mode = 2)

- **PPS_IF_ON_OFF_CMD**

```
$PSTMPPS,2,1,<on_off>*<checksum><cr><lf>
```

Parameter	Format	Description
on_off	Decimal, 1 digit	0 = PPS disabled 1 = PPS enabled
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

- **PPS_IF_OUT_MODE_CMD**

```
$PSTMPPS,2,2,<out_mode>*<checksum><cr><lf>
```

Parameter	Format	Description
out_mode	Decimal, 1 digit	0 = PPS always generated 1 = PPS generated on even seconds 2 = PPS generated on odd seconds
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

- **PPS_IF_REFERENCE_TIME_CMD**

```
$PSTMPPS,2,19,<reference_time>*<checksum><cr><lf>
```

Parameter	Format	Description
reference_time	Decimal, 1 digit	0 = UTC 1 = GPS_UTC 2 = GLONASS_UTC 3 = UTC_SU

		4 = GPS_UTC_FROM_GLONASS 5 = BEIDOU_UTC 6 = UTC_NTSC 7 = GST 8 = UTC_GST 9 = GPS_FROM_GST Notes: UTC(SU) is the Soviet Union UTC derived from GLONASS time applying the UTC delta time downloaded from GLONASS satellites. GPS_UTC_FROM_GLONASS is the GPS time derived from GLONASS time applying the GPS delta time downloaded from GLONASS satellites. If the software is configured to work in GLONASS only mode, UTC(SU) is identical to UTC and GPS_UTC_FROM_GLONASS is identical to GPS_UTC.
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

- **PPS_IF_PULSE_DELAY_CMD**

$PSTMPPS,2,4,<pulse_delay>*<checksum><cr><lf>

Parameter	Format	Description
pulse_delay	Decimal	Pulse delay [ns]
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

- **PPS_IF_CONSTELLATION_RF_DELAY_CMD**

$PSTMPPS,2,20,<sat_type><time_delay>*<checksum><cr><lf>

Parameter	Format	Description
sat_type	Decimal	Satellite constellation type: 0 = GPS 1 = GLONASS 3 = Galileo 7 = BeiDou
time_delay	Decimal	Time delay [ns]
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

- **PPS_IF_PULSE_DURATION_CMD**

$PSTMPPS,2,5,<pulse_duration>*<checksum><cr><lf>

Parameter	Format	Description
pulse_duration	Double	Pulse duration [s]
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

- **PPS_IF_PULSE_POLARITY_CMD**

$PSTMPPS,2,6,<pulse_polarity>*<checksum><cr><lf>

Parameter	Format	Description
pulse_polarity	Decimal, 1 digit	0 = not inverted 1 = inverted
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

- **PPS_IF_PULSE_DATA_CMD**

$PSTMPPS,2,7,<out_mode>,<reference_time>,<pulse_delay>,<pulse_duration>,<pulse_polarity>*<checksum><cr><lf>

Parameter	Format	Description
out_mode	Decimal, 1 digit	0 = PPS always generated 1 = PPS generated on even seconds 2 = PPS generated on odd seconds
reference_time	Decimal, 1 digit	0 = UTC 1 = GPS_UTC 2 = GLONASS_UTC 3 = UTC_SU 4 = GPS_UTC_FROM_GLONASS
pulse_delay	Decimal	Pulse delay [ns]
pulse_duration	Double	Pulse duration [s]
pulse_polarity	Decimal, 1 digit	0 = not inverted 1 = inverted
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

- **PPS_IF_FIX_CONDITION_CMD**

$PSTMPPS,2,8,<fix_condition>*<checksum><cr><lf>

Parameter	Format	Description
fix_condition	Decimal, 1 digit	1 = NO FIX 2 = 2D FIX 3 = 3D FIX
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

- **PPS_IF_SAT_TRHESHOLD_CMD**

```
$PSTMPPS,2,9,<sat_th>*<checksum><cr><lf>
```

Parameter	Format	Description
sat_th	Decimal	Minimum number of satellites for the PPS generation
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

- **PPS_IF_ELEVATION_MASK_CMD**

```
$PSTMPPS,2,10,<elevation_mask>*<checksum><cr><lf>
```

Parameter	Format	Description
elevation_mask	Decimal	Minimum satellite elevation for satellite usage in timing filtering
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

- **PPS_IF_CONSTELLATION_MASK_CMD**

```
$PSTMPPS,2,11,<constellation_mask>*<checksum><cr><lf>
```

Parameter	Format	Description
constellation_mask	Decimal (bit mask)	Satellite constellation selection for usage in timing filtering bit0 = GPS bit1 = GLONASS bit7 = BeiDou Notes: This parameter enables the usage of mixed constellations satellites in the timing filtering. If bit0 is enabled, GPS satellites are used to correct the GLONASS reference time together with GLONASS satellites. If bit1 is enabled, GLONASS satellites are used to correct the GPS reference time together with

		GPS satellites. When constellation mask is zero (default), only GPS satellites are used to correct the GPS reference time and only GLONASS satellites are used to correct the GLONASS reference time. Same description is also valid for GPS and BeiDou constellations through enabling/disabling bit0 and bit7.
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

- **PPS_IF_TIMING_DATA_CMD**

$PSTMPPS,2,12,<fix_condition>,<sat_th>,<elevation_mask>,<constellation_mask>*<checksum><cr><lf>

Parameter	Format	Description
fix_condition	Decimal, 1 digit	1 = NO FIX 2 = 2D FIX 3 = 3D FIX
sat_th	Decimal	Minimum number of satellites for the PPS generation
elevation_mask	Decimal	Minimum satellite elevation for satellite usage in timing filtering
constellation_mask	Decimal (bit mask)	Satellite constellation selection for usage in timing filtering bit0 = GPS bit1 = GLONASS
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

- **PPS_IF_POSITION_HOLD_DATA_CMD**

$PSTMPPS,2,13,<on_off>,<lat>,<lat_dir>,<lon>,<lon_dir>,<h_msl>*<checksum><cr><lf>

Parameter	Format	Description
on_off	Decimal, 1 digit	0 = Position Hold disabled 1 = Position Hold enabled
lat	DDMM.MMMMM	Position Hold position latitude
lat_dir	"N" or "S"	North or South direction
lon	DDDMM.MMMMM	Position Hold position longitude
lon_dir	"E" or "W"	East or West direction
h_msl	Double	Position Hold mean see level altitude

checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

- **PPS_IF_AUTO_HOLD_SAMPLES_CMD**

$PSTMPPS,2,14,<auto_ph_samples>*<checksum><cr><lf>

Parameter	Format	Description
auto_ph_samples	Decimal, 1 digit	Number of position samples for the auto position algorithm. If the number of samples is set to “0”, the auto position hold feature is disabled. The position average evaluation is restarted when the command is executed every time.
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

- **PPS_IF_TRAIM_CMD**

$PSTMPPS,2,15,<on_off>,<alarm>*<checksum><cr><lf>

Parameter	Format	Description
on_off	Decimal, 1 digit	0 = TRAIM disabled 1 = TRAIM enabled
alarm	Double	TRAIM alarm [s] – scientific notation is allowed
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

2.3.16. $PSTMFORCESTANDBY

Force the module to enter into standby mode.

Synopsis:

$PSTMFORCESTANDBY,<duration>*<checksum><cr><lf>

Arguments:

Parameter	Format	Description
duration	Decimal, 5 digits	Duration of the standby time in seconds
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Results:

- In case of no errors, the following message is returned:

```
$PSTMFORCESTANDBYOK*<checksum><cr><lf>
```

- In case of errors, the error message is returned:

```
$PSTMFORCESTANDBYERROR*<checksum><cr><lf>
```

2.3.17. $PSTMCFGPORT

Configure a general-purpose port for NMEA, STBIN, DEBUG or RTCM purpose.

Synopsis:

```
$PSTMCFGPORT,<port_type>,<protocol_type>,<par_1>,<par_2>,…,<par_N>*<checksum><cr><lf>
```

Arguments:

Parameter	Format	Description
port_type	Decimal, 1 Digit	Select the port type: 0 = UART
protocol_type	Decimal, 1 Digit	Select the protocol type: 0 = NMEA
par_1 … par_N	Integer	Parameters list is determined by the command type. Please check the tables below for details.
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Results:

- In case of no errors, the following message is returned:

```
$PSTMCFGPORTOK*<checksum><cr><lf>
```

- In case of errors, this error message is returned:

```
$PSTMCFGPORTERROR*<checksum><cr><lf>
```

Table 11: Parameter List (when port_type is UART)

Parameter	Format	Description
portnumb	Integer	fixed at 1
baudrate	Integer	The port baud rate. Allowed values are: 115200bps, 230400bps, 460800bps, 921600bps
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

2.3.18. $PSTMCFGMSGL

Configure the message list.

Synopsis:

$PSTMCFGMSGL,<listid>,<rate>,<listlow>,<listhigh>*<checksum><cr><lf>

Arguments:

Parameter	Format	Description
listid	Decimal, 1 digit	List selector: 0 = NMEA list 0
rate	From 0 to 255	Message list rate scaler
listlow	Hexadecimal, 8 digits	Check the table below for details
listhigh	Hexadecimal, 8 digits	Check the table below for details
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Table 12: NMEA Message List

Bit	Bitmask (32 bits)	Function
Low 32 bits		
0	0x1	$GPGNS message
1	0x2	$GPGGA message
2	0x4	$GPGSA message
3	0x8	$GPGST message
4	0x10	$GPVTG message
5	0x20	Reserved
6	0x40	$GPRMC message
7	0x80	Reserved
8	0x100	Reserved
9	0x200	Reserved
10	0x400	Reserved

11	0x800	Reserved
12	0x1000	Reserved
13	0x2000	Reserved
14	0x4000	Reserved
15	0x8000	Reserved
16	0x10000	Reserved
17	0x20000	Reserved
18	0x40000	Reserved
19	0x80000	$GPGSV message
20	0x100000	$GPGLL message
21	0x200000	Reserved
22	0x400000	Reserved
23	0x800000	Reserved
24	0x1000000	$GPZDA message
25	0x2000000	Reserved
26	0x4000000	Reserved
27	0x8000000	Reserved
28	0x10000000	$PSTMAGPS message
29	0x20000000	Reserved
30	0x40000000	Reserved
31	0x80000000	Reserved
High 32 bits		
32	0x1	Reserved
33	0x2	Reserved
34	0x4	Reserved
35	0x8	Reserved

36	0x10	$PSTMANTENNASTATUS message
37	0x20	Reserved
38	0x40	Reserved
39	0x80	$GPDTM message
40	0x100	Reserved
41	0x200	Reserved
42	0x400	Reserved
43	0x800	Reserved
44	0x1000	Reserved
45	0x2000	$GPGBS message
46	0x4000	Reserved
47	0x8000	Reserved
48	0x10000	Reserved
49	0x20000	Reserved
50	0x40000	Reserved
51	0x80000	Reserved
52	0x100000	Reserved
53	0x200000	Reserved
54	0x400000	Reserved
55	0x800000	$PSTMDRSTEP message $PSTMDRGPS message $PSTMDRCAL message
56	0x1000000	Reserved
57	0x2000000	$PSTMDRDEBUG message $PSTMDRUPD message $PSTMDRSTYPE message $PSTMDRMMFB message
58	0x4000000	$PSTMDRSTATE message
59	0x8000000	Reserved

60	0x10000000	$PSTMDRSENMSG message
61	0x20000000	$PSTMDRAHRS message
62	0x40000000	$PSTMDRCONFID message
63	0x80000000	$GARLM message

Results:

- In case of no errors, the following message is returned:

```
$PSTMCFGMSGLOK*<checksum><cr><lf>
```

- In case of errors, this error message is returned:

```
$PSTMCFGMSGLERROR*<checksum><cr><lf>
```

2.3.19. $PSTMCFGAGPS

Configure the Assisted GPS.

Synopsis:

```
$PSTMCFGAGPS,<en_agps>*<checksum><cr><lf>
```

Arguments:

Parameter	Format	Description
en_agps	Decimal	Enable/Disable AGPS engine 0 = AGPS Disabled 1 = AGPS Enabled
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Results:

- In case of no errors, the following message is returned:

```
$PSTMCFGAGPSOK*<checksum><cr><lf>
```

- In case of errors, this error message is returned:

```
$PSTMCFGAGPSERROR*<checksum><cr><lf>
```

2.3.20. $PSTMCFGAJM

Configure the anti-jamming algorithm.

Synopsis:

```
$PSTMCFGAJM,<gpsmode>,<glonassmode>*<checksum><cr><lf>
```

Arguments:

Parameter	Format	Description
gpsmode	Decimal, 1 digit	Notch filter on GPS path: 0 = Disable 1 = Normal Mode 2 = Auto Mode
glonassmode	Decimal, 1 digit	Notch filter on GLONASS path: 0 = Disable 1 = Normal Mode 2 = Auto Mode
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Results:

- In case of no errors, the following message is returned:

```
$PSTMCFGAJMOK*<checksum><cr><lf>
```

- In case of errors, this error message is returned:

```
$PSTMCFGAJMERROR*<checksum><cr><lf>
```

2.3.21. $PSTMSETTHTRK

Configure the CN0 and Angle Elevation Mask thresholds for tracking. This command changes these parameters at run-time and no reset is required. In case of reset, tracking CN0 and Angle Elevation Mask are restored to default values.

Synopsis:

```
$PSTMSETTHTRK,<cn0>,<el>*<checksum><cr><lf>
```

Arguments:

Parameter	Format	Description
cn0	Decimal	CN0 threshold in dB for tracking
el	Double	Elevation mask angle in degree for tracking
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Results:

- If the command syntax is correct and the tracking CN0 and Elevation Mask are correctly changed, this message is returned:

```
$PSTMSETTHTRKOK*<checksum><cr><lf>
```

- In case of errors, this error message is returned:

```
$PSTMSETTHTRKERROR*<checksum><cr><lf>
```

2.3.22. $PSTMSETTHPOS

Configure the CN0 and Angle Elevation Mask thresholds for positioning. This command changes these parameters at run-time and no reset is required. In case of reset, positioning CN0 and Angle Elevation Mask are restored to default value.

Synopsis:

```
$PSTMSETTHPOS,<cn0>,<el>*<checksum><cr><lf>
```

Arguments:

Parameter	Format	Description
cn0	Decimal	CN0 threshold in dB for positioning
el	Double	Elevation mask angle in degree for positioning
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Results:

- If the command syntax is correct and the positioning CN0 and Elevation Mask are correctly changed, this message is returned:

```
$PSTMSETTHTRKOK*<checksum><cr><lf>
```

- In case of errors, this error message is returned:

```
$PSTMSETTHTRKERROR*<checksum><cr><lf>
```

2.4. System Commands

The GNSS software utilizes a “Configuration Data Block” that holds the working parameters for the system.

2.4.1. $PSTMSAVEPAR

Save current configuration data block into the backup memory.

Synopsis:

```
$PSTMSAVEPAR*<checksum><cr><lf>
```

Arguments:

None.

Results:

- The current configuration data block, including changed parameters, will be stored into the backup memory (NVM).
- If there are no error, the following message is returned:

```
$PSTMSAVEPAROK*<checksum><cr><lf>
```

- In case of errors, the error message is returned:

```
$PSTMSAVEPARERROR*<checksum><cr><lf>
```

Example:

```
$PSTMSAVEPAR
```

2.4.2. $PSTMRESTOREPAR

Restore the factory setting parameters. The configuration data block stored in NVM, if present, will be invalidated. Any changed parameter will be lost.

Synopsis:

```
$PSTMRESTOREPAR*<checksum><cr><lf>
```

Arguments:

None.

Results:

- The factory setting parameters will be restored and the configuration block in the backup memory will be lost. A system reboot is needed to complete the factory reset restoring and to get system working with default setting.
- If there are no error, the following message is returned:

```
$PSTMRESTOREPAROK*<checksum><cr><lf>
```

- In case of errors, the error message is returned:

```
$PSTMRESTOREPARERROR*<checksum><cr><lf>
```

Example:

```
$PSTMRESTOREPAR
```

2.5. DR Commands

2.5.1. $PSTMDRMMFB

Input map match data.

Synopsis:

$PSTMDRMMFB,<time_stamp>,<lat_val>,<lon_val>,<height_val>,<heading_val>,<lat>,<lon>,<height>,<heading>,<lat_err>,<lon_err>,<height_err>,<heading_err>*<checksum><cr><lf>

Arguments:

Parameter	Format	Description
time_stamp	hhmmss.sss	UTC Time of map matched position. hh: hours mm: minutes ss: seconds .sss: fraction of seconds
lat_val	Decimal, 1 digit	Latitude validity flag: 1 = Valid 0 = Not valid
lon_val	Decimal, 1 digit	Longitude validity flag: 1 = Valid 0 = Not valid
height_val	Decimal, 1 digit	Height validity flag: 1 = Valid 0 = Not valid
heading_val	Decimal, 1 digit	Heading validity flag: 1 = Valid 0 = Not valid
lat	Double, 7 fractional digits	Latitude in signed decimal degrees
lon	Double, 7 fractional digits	Longitude in signed decimal degrees
height	Double, 1 fractional digit	Height in m
heading	Double, 1 fractional digit	Heading in signed decimal degrees [0,360]
lat_err	Double, 1 fractional digit	Latitude error (accuracy) in m
lon_err	Double, 1 fractional digit	Longitude error (accuracy) in m
height_err	Double, 1 fractional digit	Height error (accuracy) in m
heading_err	Double, 1 fractional digit	Heading error (accuracy) in signed decimal degrees
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Results:

- An MMFB data will be injected into DR process engine
- If successful (command format is accepted) the command will be echoed on NMEA communication channel

Example:

```
$PSTMDRMMFB,160836.000,1,1,1,1,45.4567890,9.4567890,180.5,90.0,10.1,10.2,4.7,0.3*3E
```

2.5.2. $PSTMIMUSELFTESTCMD

Execute the self-test command in IMU. It allows testing the mechanical and electrical parts of the gyroscope. When the self-test function is activated, an actuation force is applied, emulating a defined Coriolis force. The output data is internally analyzed.

Synopsis:

```
$PSTMIMUSELFTESTCMD,<IMU Cat>*<checksum><cr><lf>
```

Arguments:

Parameter	Format	Description
IMU Cat	Decimal, 1 digit	0 Gyroscope 1 Reserved
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Results:

- If the self-test command is passed, the following message is sent:

```
$PSTMIMUSELFTESTCMDOK*<checksum><cr><lf>
```

- If the self-test command fails, the following message is sent:

```
$PSTMIMUSELFTESTCMDKO*<checksum><cr><lf>
```

- In case of command error or system not ready, the following message is sent:

```
$PSTMIMUSELFTESTCMDERROR*<checksum><cr><lf>
```

3 Messages

3.1. Standard NMEA Messages

This chapter introduces the Standard NMEA Messages supported by L26-DR module.

3.1.1. List of Standard NMEA Messages

Table 13: List of Standard NMEA Messages

Syntax	Default	Description
$--RMC	ON	NMEA: Recommended Minimum Specific GNSS Data
$--VTG	ON	NMEA: Track made good and ground speed
$--GGA	ON	NMEA: Global Position System Fix Data
$--GSA	ON	NMEA: GPS DOP and Active Satellites
$--GSV	ON	NMEA: GPS Satellites in View
$--GLL	ON	NMEA: Geographic Position Latitude / Longitude

3.1.2. Standard NMEA Messages Specification

These messages are defined within the "NMEA 0183" Specification. The structure of NMEA message is shown as below:

Table 14: Structure of NMEA Message

Filed	Length (Bytes)	Description
$	1	Each NMEA message starts with ‘$’
Talker ID	1~2	GP: If system works in GPS only mode GL: If system works in GLONASS only mode

		GA: If system works in Galileo only mode BD: If system works in BeiDou only mode QZ: If system works in QZSS only mode GN: If system works in multi-constellation mode
NMEA Message ID	3	NMEA message ID
Data Field	Variable, depend on the NMEA message type	Data fields, delimited by comma ‘,’
*	1	End character of data field
Checksum	2	A hexadecimal number calculated by exclusive OR of all characters between ‘$’ and ‘*’
<cr><lf>	2	Each NMEA message ends with ‘cr’ and ‘lf’

NOTE

The default output message of L26-DR module includes the following six sentences: RMC, VTG, GGA, GSA, GSV and GLL.

3.1.2.1. $--RMC

Recommended Minimum position Data (inlcuding position, velocity and time).

Format for NMEA 0183 Rev 3.01 (Default):
$GPRMC,<Timestamp>,<Status>,<Lat>,<N/S>,<Long>,<E/W>,<Speed>,<Trackgood>,<Date>,<MagVar>,<MagVarDir>,<mode>*<checksum><cr><lf>
Format for NMEA 0183 Rev 4.10:
$<TalkerID>RMC,<Timestamp>,<Status>,<Lat>,<N/S>,<Long>,<E/W>,<Speed>,<Trackgood>,<Date>,<MagVar>,<MagVarDir>,<mode>,<Nav_status>*<checksum><cr><lf>
Example for NMEA 0183 Rev 3.01 (Default):
$GPRMC,091241.000,A,3150.79761,N,11711.92397,E,0.0,351.6,130619,,,A*64
Example for NMEA 0183 Rev 4.10:
$GNRMC,202340.000,A,4045.53297,N,01447.20361,E,0.2,0.0,291117,,,A,C*18

Field	Format	Description
$	Char	Each NMEA message starts with ‘$’
TalkerID	String, 2 characters	The talker ID (Fixed two characters). GP: If system works in GPS only mode GL: If system works in GLONASS only mode GA: If system works in Galileo only mode BD: If system works in BeiDou only mode

		QZ: If system works in QZSS only mode GN: If system works in multi-constellation mode
Timestamp	hhmmss.sss	UTC Time of GNSS Sample: hh: hours (Fixed two digits) mm: minutes (Fixed two digits) ss: seconds (Fixed two digits) .sss: decimal fraction of seconds (Variable length) Note that decimal fraction assumes non zero values when the fix rate is bigger than 1Hz. Please note that for Rev 4.10, this field is empty in case of invalid value.
Status	"A" or "V"	'V' = Invalid 'A' = Valid
Lat	DDMM.MMMMM	Latitude as degrees: DD: Degree (Fixed two digits) MM: Minutes (Fixed two digits) .MMMMM: Decimal fraction of minutes (Variable) Please note that for Rev 4.10, this field is empty in case of invalid value.
N/S	"N" or "S"	Latitude direction: 'N' = North 'S' = South Please note that for Rev 4.10, this field is empty in case of invalid value.
Long	DDDMM.MMMMM	Longitude as degrees: DDD: Degree (Fixed three digits) MM: Minutes (Fixed two digits) .MMMMM: Decimal fraction of minutes (Variable) Please note that for Rev 4.10, this field is empty in case of invalid value.
E/W	"E" or "W"	Longitude direction: 'E' = East 'W' = West Please note that for Rev 4.10, this field is empty in case of invalid value.
Speed	x.x, variable length field	Speed over ground in knots
Trackgood	x.x, variable length field	Course made good, max. 999.9
Date	Decimal, 6 digits	Date in format 'ddmmyy'
MagVar	Decimal, 4 digits	Magnetic variation in degree. This field is empty.
MagVarDir	"E" or "W"	Magnetic variation "E" or "W" indicator. This field is empty.

Mode	"D", "A", "N" or "E"	Positioning system modeindicator: "D" = Differential mode "A" = Autonomous mode "N" = Data not valid "E" = Estimated (dead reckoning) mode
Nav_status	"S", "C", "U" or "V"	Navigational status indicator: "S" = Safe "C" = Caution "U" = Unsafe "V" = Not valid
*		End character of data field
Checksum		Hexadecimal checksum
<cr><lf>		Each NMEA message ends with ‘cr’ and ‘lf’

3.1.2.2. $--VTG

Course Over Ground and Ground Speed. This message provides the actual course and speed relative to ground.

Format for NMEA 0183 Rev 3.01 (Default):
$GPVTG,<TMGT>,T,<TMGM>,M,<SoGN>,N,<SoGK>,K,D*<checksum><cr><lf>
Format for NMEA 0183 Rev 4.10:
$<TalkerID>VTG,<TMGT>,T,<TMGM>,M,<SoGN>,N,<SoGK>,K,D*<checksum><cr><lf>
Example:
$GPVTG,73.2,T,,M,0.2,N,0.4,K,D*50

Field	Format	Description
$	Char	Each NMEA message starts with ‘$’
TalkerID	String, 2 characters	The talker ID (fixed two characters). GP: If system works in GPS only mode GL: If system works in GLONASS only mode GA: If system works in Galileo only mode BD: If system works in BeiDou only mode QZ: If system works in QZSS only mode GN: If system works in multi-constellation mode.
TMGT	ddd.d in degrees	Track in reference to "true" earth poles
T		Indicate "terrestrial"
TMGM	ddd.d in degrees	Track in reference to "magnetic" earth poles

M		Indicate "magnetic"
SoGN	ddd.d in knots	Speed over Ground in knots
N		Indicate "knots"
SoGK	ddd.d in km/h	Speed over Ground in kilometers per hour
K		Indicate "kilometres"
D	Char	Mode indicator: A = Autonomous mode D = Differential mode E = Estimated mode
*		End character of data field
Checksum		Hexadecimal checksum
<cr><lf>		Each NMEA message ends with ‘cr’ and ‘lf’

3.1.2.3. $--GGA

Global Positioning System Fix Data.

Format for NMEA 0183 Rev 3.01 (Default):
$GPGGA,<Timestamp>,<Lat>,<N/S>,<Long>,<E/W>,<GPSQual>,<Sats>,<HDOP>,<Alt>,<AltVal>,<GeoSep>,<GeoVal>,<DGPSAge>,<DGPSRef>*<checksum><cr><lf>
Format for NMEA 0183 Rev 4.10:
$<TalkerID>GGA,<Timestamp>,<Lat>,<N/S>,<Long>,<E/W>,<GPSQual>,<Sats>,<HDOP>,<Alt>,<AltVal>,<GeoSep>,<GeoVal>,<DGPSAge>,<DGPSRef>*<checksum><cr><lf>
Example:
$GPGGA,183417.000,04814.03970,N,01128.52205,E,0,00,99.0,495.53,M,47.6,M,,*53

Field	Format	Description
$	Char	Each NMEA message starts with ‘$’
TalkerID	String, 2 characters	The talker ID (Fixed two characters). GP: If system works in GPS only mode GL: If system works in GLONASS only mode GA: If system works in Galileo only mode BD: If system works in BeiDou only mode QZ: If system works in QZSS only mode GN: If system works in multi-constellation mode.
Timestamp	hhmmss.sss	UTC Time of GPS Sample:

		hh: hours (Fixed two digits) mm: minutes (Fixed two digits) ss: seconds (Fixed two digits) .sss: decimal fraction of seconds (Variable length) Please note that: Decimal fraction assumes non zero values when the fix rate is bigger than 1Hz. For Rev 4.10, this field is empty in case of invalid value.
Lat	DDMM.MMMMM	Latitude as degrees: DD: Degree (Fixed two digits) MM: Minutes (Fixed two digits) .MMMMM: Decimal fraction of minutes (Variable) Note that for Rev 4.10 this field is empty in case of invalid value
N/S	"N" or "S"	Latitude direction: North or South Please note that for Rev 4.10, this field is empty in case of invalid value.
Long	DDDMM.MMMMM	Longitude as degrees: DDD: Degree (Fixed three digits) MM: Minutes (Fixed two digits) .MMMMM: Decimal fraction of minutes (Variable) Please note that for Rev 4.10, this field is empty in case of invalid value.
E/W	"E" or "W"	Longitude direction: East or West Note that for Rev 4.10 this field is empty in case of invalid value
GPSQual	Decimal, 1digit	0 = Fix not available or invalid 1 = GPS, SPS Mode, fix valid 2 = Differential GPS, SPS Mode, fix valid 6 = Estimated (dead reckoning) mode
Sats	Decimal, 2 digits	Satellites in use: example: 08
HDOP	x.x, variable length field	Horizontal Dilution of Precision, max: 99.0
Alt	x.x, variable length field	Height above mean sea level, max: 100000.0 m
AltVal	“M”	Reference Unit for Altitude ("M" = meters)
GeoSep	x.x, variable length field	Geoidal Separation measure in "M" = meters

DGPSAge	Empty	Not supported
DGPSRef	Empty	Not supported
*		End character of data field
Checksum		Hexadecimal checksum
<cr><lf>		Each NMEA message ends with ‘cr’ and ‘lf’

3.1.2.4. $--GSA

GNSS DOP and Active Satellites. Satellites from different constellations are sent on separate messages. In case of multi-constellation mode, the talker ID is always GN. If NMEA is set as Rev 3.01, it is possible to force the talker ID as GN.

When NMEA is set as Rev 4.10, the talker ID could not be forced and is managed internally to be compliant with the standard. Please check the following parameter table for information about Talker ID available values.

Format for NMEA 0183 Rev 3.01 (Default):
$--GSA,<Mode>,<CurrentMode>,<SatPRN1>,...,<SatPRNN>,<PDOP>,<HDOP>,<VDOP>*<checksum><cr><lf>
Format for NMEA 0183 Rev 4.10:
$<TalkerID>GSA,<Mode>,<CurrentMode>,<SatPRN1>,...,<SatPRNN>,<PDOP>,<HDOP>,<VDOP>,<SystemID>*<checksum><cr><lf>
Example for NMEA 0183 Rev 3.01 (Default):
$GPGSA,A,3,05,21,07,24,30,16,12,,,,,,2.4,1.9,1.5*38
Example for NMEA 0183 Rev 4.10:
$GNGSA,A,3,23,03,22,09,01,19,17,06,31,11,,,1.1,0.6,0.9,1*3E
$GNGSA,A,3,67,66,81,65,88,75,82,74,,,,, 1.1,0.6,0.9,2*3D
$GNGSA,A,3,03,05,22,08,30,16,12,,,,,, 1.1,0.6,0.9,3*32

Field	Format	Description
$	Char	Each NMEA message starts with ‘$’
TalkerID	String, 2 characters	The talker ID (Fixed two characters). GP: If system works in GPS only mode GL: If system works in GLONASS only mode GA: If system works in Galileo only mode BD: If system works in BeiDou only mode QZ: If system works in QZSS only mode GN: If system works in multi-constellation mode

Mode	1 character	M = Manual, forced to operate in 2D or 3D mode A = Automatic, allowed to automatically switch 2D/3D
CurrentMode	Decimal, 1 digit	1 = Fix not available 2 = 2D 3 = 3D
SatPRN(1 to 12)	Decimal, 2 or 3 digits	Satellites list used for positioning
PDOP	x.x, variable length field	Position dilution of precision, max. 99.0
HDOP	x.x, variable length field	Horizontal dilution of precision, max. 99.0
VDOP	x.x, variable length field	Vertical dilution of precision, max. 99.0
SystemID	Hexadecimal, 1 digit	The system ID of this message: 1 = GPS 2 = GLONASS 3 = Galileo 4 = BeiDou 5 = QZSS
*		End character of data field
Checksum		Hexadecimal checksum
<cr><lf>		Each NMEA message ends with ‘cr’ and ‘lf’

3.1.2.5. $--GSV

GNSS Satellites in View. Usually GSV messages are organised per constellation and each message carries information about up to 4 satellites in view. Thus, in certain cases, to describe all the satellites in view from a constellation more than a message is needed. This set of message is printed once per each constellation with talker ID related to described constellation.

With NMEA Rev 4.10 the “GN” talker ID is forbidden in order to be compliant with the standard. Thus the module will print a set of messages for each constellation.

Format for NMEA 0183 Rev 3.01 (Default):
$--GSV,<GSVAmount>,<GSVNumber>,<TotSats>,<Sat1PRN>,<Sat1Elev>,<Sat1Azim>,<Sat1CN0>,…,<Sat4PRN>,<Sat4Elev>,<Sat4Azim>,<Sat4CN0>*<checksum><cr><lf>
Format for NMEA 0183 Rev 4.10:
$--GSV,<GSVAmount>,<GSVNumber>,<TotSats>,<Sat1PRN>,<Sat1Elev>,<Sat1Azim>,<Sat1CN0>,…,<Sat4PRN>,<Sat4Elev>,<Sat4Azim>,<Sat4CN0>,<SignalID>*<checksum><cr><lf>
Example for NMEA 0183 Rev 3.01 (Default):

$GPGSV,3,1,12,02,04,037,,05,27,125,44,06,78,051,23,07,83,021,30*7C
$GPGSV,3,2,12,10,16,067,30,12,11,119,36,16,24,301,41,21,44,175,50*73
$GPGSV,3,3,12,23,06,326,28,24,61,118,40,30,45,122,43,31,52,253,37*7C
Example for NMEA 0183 Rev 4.10:
$GPGSV,3,1,11,02,67,018,44,05,65,296,27,06,39,086,46,13,29,181,32,1*62
$GPGSV,3,2,11,19,23,152,18,29,19,321,24,12,19,244,,09,17,042,36,1*63
$GPGSV,3,3,11,25,13,281,24,17,06,151,25,30,06,107,32,,,,,1*5C
$GLGSV,2,1,06,85,72,023,47,70,72,002,42,71,48,227,,84,35,125,21,1*73
$GLGSV,2,2,06,86,22,330,22,69,16,031,38,,,,,,,,1*71

Field	Format	Description
$	Char	Each NMEA message starts with ‘$’
TalkerID	String, 2 characters	The talker ID (Fixed two characters). GP: If system works in GPS only mode GL: If system works in GLONASS only mode GA: If system works in Galileo only mode BD: If system works in BeiDou only mode QZ: If system works in QZSS only mode GN: If system works in multi-constellation mode.
GSVAmount	Decimal, 1 digit	Total amount of GSV messages, max. 8
GSVNumber	Decimal, 1 digit	Continued GSV number of this message
TotSats	Decimal, 2 digits	Total number of satellites in view, max. 32
SatxPRN	Decimal, 2 digits	Satellites list used for positioning.
SatxElev	Decimal, 2 digits	Elevation of satellite in Degree, 0 - 90
SatxAzim	Decimal, 3 digits	Azimuth of satellite in degree, ref. "North", 000 … 359
SatxCN0	Decimal, 2 digits	Carrier to noise ratio for satellite x in dB, 00 … 99
SignalID	Decimal, 1 digit	An identifier to indicate the signal in use. Currently it is 1 for GPS, GLONASS, 2 for BeiDou and QZSS, 6 for Galileo
*		End character of data field
Checksum		Hexadecimal checksum
<cr><lf>		Each NMEA message ends with ‘cr’ and ‘lf’

3.1.2.6. $--GLL

Geographic Positioning Latitude/Longitude.

Format for NMEA 0183 Rev 3.01 (Default):
$GPGLL,<Lat>,<N/S>,<Long>,<E/W>,<Timestamp>,<Status>,<mode indicator>*<checksum><cr><lf>
Format for NMEA 0183 Rev 4.10:
$<TalkerID>GLL,<Lat>,<N/S>,<Long>,<E/W>,<Timestamp>,<Status>,<mode indicator>*<checksum><cr><lf>
Example:
$GPGLL,4055.04673,N,01416.54941,E,110505.000,A,A*54

Field	Format	Description
$	Char	Each NMEA message starts with '$'
TalkerID	String, 2 characters	The talker ID (Fixed two characters). GP: If system works in GPS only mode GL: If system works in GLONASS only mode GA: If system works in Galileo only mode BD: If system works in BeiDou only mode QZ: If system works in QZSS only mode GN: If system works in multi-constellation mode
Lat	DDMM.MMMMM	Latitude as degrees: DD: Degree (Fixed two digits) MM: Minutes (Fixed two digits) .MMMMM: Decimal fraction of minutes (Variable) Please note that for Rev 4.10, this field is empty in case of invalid value.
N / S	"N" or "S"	Latitude direction: North or South Please note that for Rev 4.10, this field is empty in case of invalid value.
Long	DDDMM.MMMMM	Longitude as degrees: DDD: Degree (Fixed three digits) MM: Minutes (Fixed two digits) .MMMMM: Decimal fraction of minutes (Variable) Please note that for Rev 4.10, this field is empty in case of invalid value.
E / W	"E" or "W"	Longitude direction: East or West Please note that for Rev 4.10, this field is empty in case of invalid value.
Timestamp	hhmmss.sss	UTC Time of GGL Sample ".sss" is the fraction of seconds; it assumes non zero values when the fix rate is bigger than 1Hz.

Status	"A" or "V"	Validity of Data: "A" = valid, "V" = invalid
Mode indicator	"D", "A", "N" or "E"	Positioning system Mode Indicator: "D" = Differential mode "A" = Autonomous mode "N" = Data not valid "E" = Estimated (dead reckoning) mode
*		End character of data field
Checksum		Hexadecimal checksum
<cr><lf>		Each NMEA message ends with 'cr' and 'lf'

3.2. ST Proprietary Protocol Messages

This chapter introduces the ST Proprietary Protocol Messages supported by L26-DR module.

3.2.1. List of ST Proprietary Protocol Messages

Table 15: List of ST Proprietary Protocol Messages

Syntax	Description	Comment
$PSTMANTENNASTATUS	Report the status of the antenna	
$PSTMDRSENMSG	Report DR sensor message data	Messages for DR Function
$PSTMDRCONFID	Report the error estimations (standard deviation) for navigation and calibration estimates	
$PSTMDRGPS	Report relevant GNSS information at 1 Hz	
$PSTMDRSTYPE	Report DR sensor configuration (combination) type	
$PSTMDRSTEP	Report integrated values for sensors' samples for the last 1 second epoch	
$PSTMDRUPD	Report the value by which the DR Kalman state variables changed during the update computation in the previous second	
$PSTMDRSTATE	Report a summary of current navigation and calibration estimates	

$PSTMDRCAL	Report the calibration status of the DR calibration parameters
$PSTMDRAHRS	Report data about device installation angles (separating sensor frame from navigation frame) and calculated vehicle pitch angle
$PSTMDREPE	Report the DR estimated position error
$PSTMDRDEBUG	Report DR debug information
$PSTMDRSENCONFIG	Report data about sensors internal configuration

3.2.2. ST NEMA Messages Specification

3.2.2.1. $PSTMANTENNASTATUS

This message reports the status of the antenna (working normally, open or short). It also reports information on antenna detection operating mode as well as the information which antenna (external or internal) is being used. It is printed asynchronously when the antenna status changes.

Synopsis:

$PSTMANTENNASTATUS,<ant_status>,<op_mode>,<rf_path>,<pwr_switch>*<checksum><cr><lf>

Arguments:

Parameter	Format	Description
ant_status	Decimal, 1 digit	Antenna status: 0 = Antenna NORMAL 1 = Antenna OPEN 2 = Antenna SHORT
op_mode	Decimal, 1 digit	Operating mode: 0 = Auto - the antenna is managed automatically by the software logic 1 = Manual - the antenna ON-OFF or RF switching is controlled by commands
rf_path	Decimal, 1 digit	Current RF path: 0 = External antenna 1 = Internal antenna
pwr_switch	Decimal, 1 digit	Current Antenna power status: 0 = Antenna power is on 1 = Antenna power is off

checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

NOTE

This message is not supported in the standard NMEA message list. It is automatically enabled when the antenna sensing feature is enabled.

3.2.2.2. $PSTMDRSENMSG

This message reports DR sensor message data, which is specific to the message ID for each specific DR sensor configuration.

Synopsis: for Message ID = 1

$PSTMDRSENMSG,1,<cpu timestamp>,<odometer>*<checksum><cr><lf>

Arguments:

Parameter	Format	Description
cpu timestamp	Decimal, 10 digits	Microseconds
odometer	Decimal, 5 digits	Unsigned odometer count
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Synopsis: for Message ID = 2

$PSTMDRSENMSG,2,<cpu timestamp>,<reverse>*<checksum><cr><lf>

Arguments:

Parameter	Format	Description
cpu timestamp	Decimal, 10 digits	Microseconds
reverse	Enum	0 = Forward 1 = Reverse
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Synopsis: for Message ID = 3

$PSTMDRSENMSG,3,<cpu timestamp>,<odometer>,<reverse>*<checksum><cr><lf>

Arguments:

Parameter	Format	Description
cpu timestamp	Decimal, 10 digits	Microseconds
odometer	Decimal, 5 digits	Unsigned odometer count
reverse	Enum	0 = Forward 1 = Reverse
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Synopsis: for Message ID = 14

$PSTMDRSENMSG,14,<cpu timestamp>,<vehicle speed>*<checksum><cr><lf>

Arguments:

Parameter	Format	Description
cpu timestamp	Decimal, 10 digits	Microseconds
vehicle speed	Decimal, 5 digits	1 Kph resolution
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Synopsis: for Message ID = 24

$PSTMDRSENMSG,24,<cpu timestamp>,<temperature>,<validity>*<checksum><cr><lf>

Arguments:

Parameter	Format	Description
cpu timestamp	Decimal, 10 digits	Microseconds
temperature	Decimal	Gyro sensor temperature
validity	Boolean	0 = Temperature is not valid 1 = Temperature is valid
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Synopsis: for Message ID = 30

$PSTMDRSENMSG,30,<cpu timestamp>,<raw_x>,<raw_y>,<raw_z>*<checksum><cr><lf>

Arguments:

Parameter	Format	Description
cpu timestamp	Decimal, 10 digits	Microseconds
raw_x	Decimal, 5 digits	Raw signed 16 bit X-axis acceleration
raw_y	Decimal, 5 digits	Raw signed 16 bit Y-axis acceleration
raw_z	Decimal, 5 digits	Raw signed 16 bit Z-axis acceleration
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Synopsis: for Message ID = 31

$PSTMDRSENMSG,31,<cpu timestamp>,<raw_x>,<raw_y>,<raw_z> *<checksum><cr><lf>

Arguments:

Parameter	Format	Description
cpu timestamp	Decimal, 10 digits	Microseconds
raw_x	Decimal, 5 digits	Raw signed 16 bit X-axis angular rate
raw_y	Decimal, 5 digits	Raw signed 16 bit Y-axis angular rate
raw_z	Decimal, 5 digits	Raw signed 16 bit Z-axis angular rate
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Result:

This message provides DR sensor data at the DR sampling rate which is typically 15Hz.

3.2.2.3. $PSTMDRCONFID

This message reports the error estimations (standard deviation) for navigation and calibration estimates.

Synopsis:

$PSTMDRCONFID,<lat_std_dev>,<lon_std_dev>,<heading_std_dev>,<reserved>,<gyro_bias_std_dev>,<odo_scale_std_dev>,<reserved>,<acc_offset_std_dev>,<height_std_dev>,<major_semi_axis>,<minor_semi_axis>,<ellipse_angle>,<speed_std_dev>*<checksum><cr><lf>

Arguments:

Parameter	Format	Description
lat_std_dev	Double, 5 significant digits	Latitude standard deviation [meters]
lon_std_dev	Double, 5 significant digits	Longitude standard deviation[meters]
heading_std_dev	Double, 4 significant digits	Heading direction standard deviation [degrees]
reserved	-	-
gyro_bias_std_dev	Double, 4 significant digits	Gyro bias standard deviation [millivolts]
odo_scale_std_dev	Double, 4 fractional digits	Odometer scale standard deviation [millimeters/pulse]
reserved	-	-
acc_offset_std_dev	Double, 6 significant digits	Accelerometer offset standard deviation [g]
height_std_dev	Double, 4 significant digits	Height standard deviation [meters]
major_semi_axis	Double, 3 significant digits	Major semi axis of 1 sigma error ellipse [meters]
minor_semi_axis	Double, 3 significant digits	Minor semi axis of 1 sigma error ellipse [meters]
ellipse_angle	Double, 3 significant digits	Angle vs North of 1 sigma error ellipse [meters] [deg]
speed_std_dev	Double, 3 significant digits	Speed standard deviation [m/s]
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Result:
This message is provided at 1Hz.

3.2.2.4. $PSTMDRGPS

This message reports relevant GNSS information at 1 Hz. This includes position, velocity and attitude data, as well as quality metrics related to GNSS measurements and constellation used.

Synopsis:

```
$PSTMDRGPS,<lat>,<lon>,<vn>,<ve>,<pdop>,<hdop>,<vdop>,<rms_pos_residual>,<rms_vel_residual>,<vv>,<height>*<checksum><cr><lf>
```

Arguments:

Parameter	Format	Description
lat	Double, 9 significant digits	GNSS latitude [Decimal degrees]
lon	Double, 9 significant digits	GNSS longitude [Decimal degrees]
vn	Double, 5 significant digits	GNSS velocity north component [m/s]
ve	Double, 5 significant digits	GNSS velocity east component [m/s]
pdop	Double, 5 significant digits	3D position dilution of precision of used GNSS constellation [adimensional]
hdop	Double, 5 significant digits	Horizontal position dilution of precision of used GNSS constellation [adimensional]
vdop	Double, 5 significant digits	Vertical position dilution of precision of used GNSS constellation [adimensional]
rms_pos_residual	Double, 5 significant digits	RMS error on GNSS pseudo range measurements [m]
rms_vel_residual	Double, 5 significant digits	RMS error on GNSS frequency measurements [m/s]
vv	Double, 5 significant digits	GNSS velocity up component [m/s]
height	Double, 1 significant digit	GNSS altitude [m]
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Result:
This message is provided at 1Hz.

3.2.2.5. $PSTMDRSTYPE

This message reports DR sensor configuration (combination) type.

Synopsis:

```
$PSTMDRSTYPE,<sensor_type>*<checksum><cr><lf>
```

Arguments:

Parameter	Format	Description
sensor_type	Decimal, 1 digit	2 = GYRO2, meaning yaw is calculated from a single axis gyro. 3 = GYRO3, meaning yaw is calculated from a 3D MEMS gyro or CAN bus provided gyro data.

		4 = DWP_GYRO, meaning yaw is calculated from DWP values. 5 = CAN_GYRO, meaning yaw is calculated from CAN bus provided gyro data.
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Result:
This message is provided at 1Hz.

3.2.2.6. $PSTMDRSTEP

This message reports integrated values for sensors’ samples for the last 1 second epoch.

Synopsis:
$PSTMDRSTEP,<sample_count>,<ave_gyro>,<gyro_noise>,<odo_pulses>,<reserved>,<delta cputime>, <reserved>, <valid_odo>*<checksum><cr><lf>

Arguments:

Parameter	Format	Description
sample_count	Decimal, 2 digits	Number of IMU samples integrated. Should be 15 for DRAW default, or equal to IMU sampling rate
ave_gyro	Double, 5 significant digits	Average signal of gyro z axis [Volts]
gyro_noise	Double, 5 significant digits	Noise on gyro signal over 1 Hz bandwidth [Volts]
odo_pulses	Decimal, 5 digits	Number of odo pulses received
reserved	-	-
delta cputime	Double, 3 significant digits	Time between 1st and last IMU sample [s]
reserved	-	-
valid_odo	Boolean	1 = valid odometer
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Result:
This message is provided at 1Hz.

3.2.2.7. $PSTMDRUPD

This message reports the value by which the DR Kalman state variables changed during the update computation in the previous second.

Synopsis:

$PSTMDRUPD,<lat>,<lon>,<heading>,<gyro_offset>,<gyro_gain>,<odo_scale>,<gyro_ovst>,<acc_offset>,<height>*<checksum><cr><lf>

Arguments:

Parameter	Format	Description
lat	Double, 5 significant digits	Latitude: decimal degrees
lon	Double, 5 significant digits	Longitude: decimal degrees
heading	Double, 4 significant digits	Heading direction: degrees, -180 to +180
gyro_offset	Double, 4 significant digits	Gyro offset: millivolts
gyro_gain	Double, 4 significant digits	Gyro gain: (radians/s)/millivolt
odo_scale	Double, 4 significant digits	Odometer scale: millimeters/pulse
gyro_ovst	Double, 6 significant digits	Volt/°C
acc_offset	Double, 6 significant digits	Accelerometer offset: g
height	Double, 1 significant digit	Height: meters
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Result:

This message is provided at 1Hz.

3.2.2.8. $PSTMDRSTATE

This message reports a summary of current navigation and calibration estimates.

Synopsis:

$PSTMDRSTATE,<cpu timestamp>,<lat>,<lon>,<heading>,<speed>,<gyro_bias>,<gyro_sensitivity>,<odometer_scale>,<reserved>,<acc_bias>,<height>*<checksum><cr><lf>

Arguments:

Parameter	Format	Description
cpu timestamp	Decimal, 10 digits	CPU timestamp: microseconds
lat	Double, 5 significant digits	Latitude: decimal degrees
lon	Double, 5 significant digits	Longitude: decimal degrees
heading	Double, 5 digits	Heading direction: degrees, -180 to +180
speed	Double, 5 digits	Speed: meters/second
gyro_bias	Double, 4 significant digits	Gyro bias: volts
gyro_sensitivity	Double, 4 significant digits	Gyro sensitivity: (radians/s)/Volt
odometer_scale	Double, 5 significant digits	Odometer scale: meters/pulse
reserved	-	-
acc_bias	Double, 6 significant digits	g
height	Double, 1 significant digit	Height: meters
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Result:
This message is provided at 1Hz.

3.2.2.9. $PSTMDRCAL

This message reports the calibration status of the DR calibration parameters.

Synopsis:

$PSTMDRCAL,<dr_is_calib>,<odo_is_calib>,<gyro_sensitivity_is_calib>,<gyro_bias_is_calib>,<imu_flag>,<gyro_integrity_flag>,<acc_integrity>,<dr_calib_status>*<checksum><cr><lf>

Arguments:

Parameter	Format	Description
dr_is_calib	boolean	1 = DR is fully calibrated
odo_is_calib	boolean	1 = Odo scale is calibrated

gyro_sensitivity_is_calib	boolean	1 = gyro gain is calibrated
gyro_bias_is_calib	boolean	1 = gyro offset is calibrated
imu_flag	Hexadecimal, 2 digits	IMU calibration status flags: 1: Calibrated 0: Not calibrated Bit fields: Bit 0: Reserved Bit 1: Reserved Bit 2: Reserved Bit 3: Reserved Bit 4: Reserved Bit 5: Reserved IMU installation status flags: 1: Self-detected 0: Not self-detected Bit fields: Bit 6: Roll installation angle Bit 7: Pitch installation angle
gyro_integrity_flag	boolean	1: gyro signal is healthy 0: gyro signal is faulty
acc_integrity	boolean	1: acc signal is healthy 0: acc signal is faulty
dr_calib_status	“N”, “L” or “F”	N: calibration Not available L: Light calibration F: Full calibration
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Result:
This message is provided at 1Hz.

3.2.2.10. $PSTMDRAHRS

This message reports data about device installation angles (separating sensor frame from navigation frame) and calculated vehicle pitch angle.

Synopsis:

```
$PSTMDRAHRS,<inst_pitch>,<inst_roll>,<inst_yaw>,<vehicle_pitc>,<vehicle_pitch_acc>,<reserved>*<checksum><cr><lf>
```

Arguments:

Parameter	Format	Description
inst_pitch	double	Installation pitch angle [deg]
inst_roll	double	Sensor frame vs vehicle frame roll angle [deg]
inst_yaw	double	Sensor frame vs vehicle frame yaw angle [deg]
vehicle_pitc	double	Estimated vehicle pitch in navigation frame [deg]
vehicle_pitch_acc	double	Estimated vehicle pitch accuracy [deg]. 0 means information not available.
reserved	none	Reserved
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Result:
This message is provided at 1Hz.

3.2.2.11. $PSTMDREPE

This message reports the DR estimated position error.

Synopsis:

```
$PSTMDREPE,<ehpe>,<reserved>*<checksum><cr><lf>
```

Arguments:

Parameter	Format	Description
ehpe	double	DR estimated horizontal position error [m]
reserved	double	-1.00 Reserved for future use.
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Result:
This message is provided at 1Hz.

3.2.2.12. $PSTMDRDEBUG

This message reports DR debug information, such as the following 6 error values which contain the

differences between the GNSS Kalman and DR Kalman calculated values for key parameters.

Synopsis:

$PSTMDRDEBUG,<lat_error>,<lon_error>,<heading_error>,<speed_error>,<height_error>,<vv_error>*<checksum><cr><lf>

Arguments:

Parameter	Format	Description
lat_error	Double, 1 significant digit	Latitude error: meters
lon_error	Double, 1 significant digit	Longitude error: meters
heading_error	Double, 1 significant digit	Heading direction error: degrees
speed_error	Double, 1 significant digit	Speed error: meters/second
height_error	Double, 1 significant digit	Height error: meters
vv_error	Double, 1 significant digit	Meters/second
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the “$” and “*” characters

Result:

This message is provided at 1Hz.

3.2.2.13. $PSTMDRSENCONFIG

This message reports data about sensors‘ internal configuration.

Synopsis:

$PSTMDRSENCONFIG,<IMU Type>,<sensor name>,<Full Scale>,<Sensitivity>,<Output Data Rate>,<Low Pass Filter Bandwidth>,<Temperature Compensation>*<checksum><cr><lf>

Arguments:

Parameter	Format	Description
IMU Type	String	Type of sensor reported: IMU ACC - Accelerometer IMU GYRO - Gyroscope
sensor name	String, max 10 char	Sensor part name: ”LSM6DSR"
Full Scale	Decimal, 3 digits	Maximum sensible value Unit is [g] for accelerometer or [dps] for gyro

Sensitivity	Decimal, 4 digits	Nominal sensitivity value Unit is [g/LSB] for accelerometer or [dps/LSB] for gyro
Output Data Rate	Decimal, 4 digits	Digital data output rate [Hz]
Low Pass Filter Bandwidth	Double, 1 fractional digit	Bandwidth of sensor's analog low pass filter [Hz]
Temperature Compensation	Decimal, 1 digit	Only available in IMU GYRO message. Status of sensors embedded temperature compensation block. 0: Disabled 1: Enabled
checksum	Hexadecimal, 2 digits	Checksum of the message bytes between but not including the "$" and "*" characters

Result:

This message is provided at initialization.

4 Default Configurations

Table 16: Default Configurations

Item	Default
NMEA Port Baud Rate	115200bps
Datum	WGS84
Rate of Position Fixing	1Hz
DGPS Mode	On
NMEA Output Messages	RMC, VTG, GGA, GSA, GSV and GLL

5 Appendix A References

Table 17: Related Documents

SN	Document Name	Remark
[1]	Quectel_L26-DR_Hardware_Design	L26-DR Hardware Design
[2]	Quectel_L26-DR_Reference_Design	L26-DR Reference Design

Table 18: Terms and Abbreviations

Abbreviation	Description
AHRS	Attitude and Heading Reference System
DGPS	Differential Global Positioning System
DR	Dead Reckoning
GGA	NMEA: Global Positioning System Fix Data
GLL	NMEA: Geographic Position – Latitude/Longitude
GLONASS	Global Navigation Satellite System (The Russian GNSS)
GNSS	Global Navigation Satellite System
GPS	Global Navigation Satellite System
GSA	NMEA: GPS DOP and Active Satellites
GSV	NMEA: GPS Satellites in View
HDOP	Horizontal Dilution of Precision
IMU	Inertial Measurement Unit
LSB	Least Significant Bit

MMFB	Map Match Feedback
NMEA	National Marine Electronics Association
NVM	Non-Volatile Memory
PDOP	Position Dilution of Precision
PPS	Pulse Per Second
RMC	NMEA: Recommended Minimum Position Data
RMS	Root Mean Square
SBAS	Satellite-Based Augmentation System
STBIN	the ST Binary Protocol
ST	STMicroelectronics
TRAIM	Time-Receiver Autonomous Integrity Monitoring
UTC	Universal Time Coordinated
VDOP	Vertical Dilution of Precision
VTG	NMEA: Track Made Good and Ground Speed
WGS84	World Geodetic System 1984