Teseo-VIC3D and Teseo-VIC3DA software instructions

Introduction

The Teseo-VIC3D and Teseo-VIC3DA modules are easy to use dead-reckoning global navigation satellite system (GNSS) stand-alone module, embedding Teseo III single die stand-alone positioning receiver IC working on multiple constellations (GPS/Galileo/Glonass/BeiDou/QZSS) and ST 3D IMU sensors to support Teseo dead reckoning automotive way (Teseo-DRAW) or Teseo dead reckoning unplugged mode (Teseo-DRUM).

Both modules are designed for top performance in a minimal space and it has been optimized for cost sensitive applications without quality compromise. They allow, at competitive costs, an easy integration and migration from existing designs of products.

Within their 16x12.2 mm compact size, they are offering superior accuracy, a reduced time to first fix (TTFF) and dead-reckoning capability. The devices are offered with a complete dead reckoning GNSS firmware which performs all GNSS operations including acquisition, tracking, sensors fusion and navigation and data output with no need of external memories.

Table 1. ST GNSS Teseo-VIC3x supported devices

Device Type	Firmware version	Device grade
Teseo-VIC3DA	Teseo-DRAW	Automotive grade
Teseo-VIC3D	Teseo-DRAW	Industrial grade

1 Document management

1.1 Acronyms and definitions

Table 2. Acronyms

Keyword	Definition
Accuracy	Deviation of a GPS-based calculated position from the true position
ADC	Analogue to Digital Converter
Almanac	Contains the information about all available satellites, their orbit data and time of their clocks.
ANF	Adaptive Notch Filter
Azim	Azimuth - Angular distance from a reference
Bank Swap	Exchanging two memory banks for storage of data
BAUD rate	Transmission Rate Measure for the effective transmission of data content. (may differ from Bits/sec).
BeiDou	China's regional navigation satellite system
Checksum	Calculated from the transmitted characters of a message by "ex-OR"ing the 8 bit character values excluding delimiters $ and *
CN0	Carrier to Noise Ratio - Identifies the quality of a received signal
Cold Start	Start Condition for a GPS system having no position nor time. Almanac and Ephemeris is not available, too.
BeiDou	China's global navigation satellite system (also known as Beidou-2, BD2)
Dead Reckoning	Sensor based process to determine the movement of a mobile unit, utilizing Gyro, Odometer and Wheel Pulses.
Delimiter (within NMEA 0183)	ASCII "$" to indicate Address Field ASCII "," to indicate Data Field ASCII "*" to indicate Checksum Field
DGPS	Differential GPS - GPS Augmentation System providing the accurate location of a Reference Station to reduce system errors.
EGNOS	European Geostationary Navigation Overlay System
Elev	Elevation - Angle between a high level or non-earth bound point and the horizontal plane of the viewer.
Ephemeris	Ephemeris Data is transmitted by each satellite and contains current and predicted satellite position.
FDA	Failure Detection Algorithm - Specific Algorithm to detect failures in position calculation
FDE	False Detection Exclusion
GALILEO	Europe's global navigation satellite system
GDOP	Geometric Dilution Of Position - Quality value representing all geometry based error factors in a system.
GNSS	Global Navigation Satellite System - Satellite based system to calculate the position of the Teseo on the earth surface.
GPS	Global Positioning System - United States Satellite Navigation System
GPS Library	STMicroelectronics C-Library containing all GPS relevant Functions
Gyro	Gyroscope - Sensor to determine rotational movements

Keyword	Definition
HDOP	Horizontal Dilution Of Precision - Quality value representing all 2D plane geometry based error factors in a system.
Hot Start	Start Condition for a GPS System having position, time, Almanac and Ephemeris already available. High time accuracy is required.
IMU	Inertial Measurement Unit
Lat	Lattitude - Angular difference of a given position to the Equator. Values include 0°-90° either North or South
Lat-Ref	Lattitude Reference - Reference if a Latitude value is North or South
Long	Longitude - Angular difference to a “reference” Longitude indicated as “000”. Values include 0°… 180° either West or East.
Long-Ref	Longitude Reference - Reference if a Longitude value is East or West of the “000” Meridian.
NMEA	National Marine Electronics Association - United States Standards Organisation For Marine Equipment
NMEA 0183	National Marine Electronics Association - Standard for Interfacing Marine Electronics Devices
NVM	Non Volatile Memory - Any type of memory that conserves data in the absence of regular supply voltage (includes battery buffered memories)
Proprietary Message	Messages within the scope of NMEA0183 which are not standardized. They start with $P and a 3 character identifier.
PRN	Pseudo Random Number - Satellite Specific 1023 Bit Number used for Spread Spectrum Modulation
RAIM	Teseo Autonomous Integrity Monitoring
RF	Radio Frequency - High Frequency for Reception with a RF-Teseo
RS232	IEEE Standard - Physical Layer Standard for Data Transmission
Sat-ID	Satellite Identifier - Satellite specific Number used to generate the corresponding PRN code
SBAS	Satellite Based Augmentation System - GPS enhancement system based on geostationary satellites.
SPS	Standard Positioning Service
Static Position Filtering	Algorithm to detect that the GPS Teseo doesn´t move and position output is kept stable.
UTC	Universal Time Coordinated
WAAS	Wide Area Augmentation System - American GPS Augmentation System delivering accurate Ionosphere Data
Warm Start	Start Condition for a GPS system having current Almanac, position and time availability. Ephemeris are not available. Time needs to be available with reasonable accuracy (some seconds).
2D Fix	Fix based on the use of 3 satellites
3D Fix	Fix based on the use of 4 satellites

2 Teseo-VIC3 binary introduction

The Teseo-Module embeds a pre-builded and configured Teseo dead-reckoning automotive way (Teseo-DRAW) software or Teseo dead-reckoning unplugged mode (Teseo-DRUM) running able to provide a complete PVT-dead-reckoning platform solution.

2.1 Binary configuration

The Teseo-Module binary image supports the firmware configuration facility. It allows changing some application parameters in order to address most of the specific customer's constraints and/or the final product functionality requirements.

The firmware configuration management supports the "factory setting", embedded in the binary code, and the "customized setting", stored in the Teseo-Module backup memory (NVM). The "factory setting" can be changed and saved at run-time using specific NMEA commands.

Teseo-Module binary image software is released with the ST defined default setting (factory setting).

2.1.1 Configuration concept

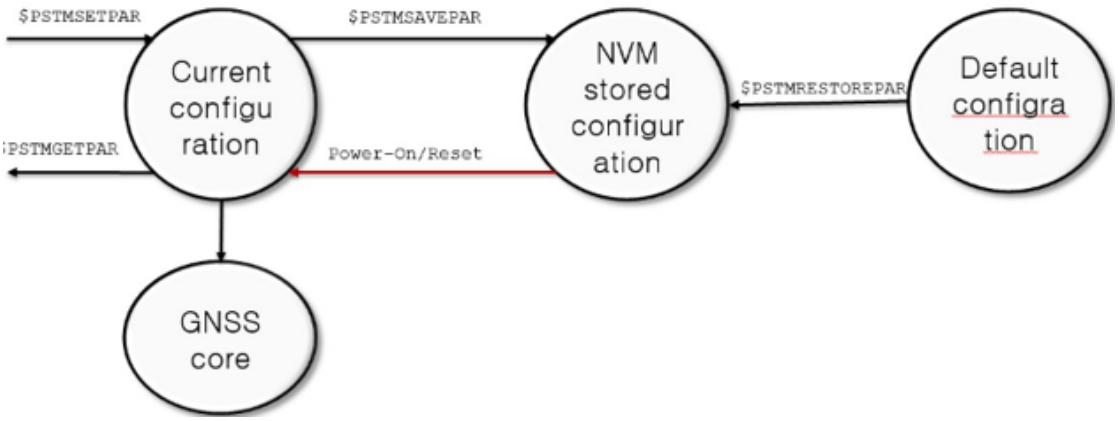
All configuration parameters are grouped in a data block. Each field is addressed by a unique ID. The IDs are made by three digits: the most significant one represents the parameter type and the others are used to identify different parameters of the same type.

Default setting of configuration data block is hard coded into the binary image file.

When the system is running, it could be possible to have up to three different configuration blocks as shown in the following figure.

- *Current configuration*: it is placed in RAM memory and it includes the current configuration of each parameter. At start-up, the current configuration block is loaded from NVM (if a stored data block is available) or it is loaded from the default one embedded in the code (factory settings).
- *Default configuration*: it is generally placed in the flash/rom memory. It includes the factory setting for each parameter. This configuration is used at system startup if there is no configuration data into the NVM memory.
- *NVM stored configuration*: it is available in the NVM backup. It includes all parameters modified and stored by the user. At system startup the SW configuration management checks if a valid configuration block is available in the NVM backup memory. In case the stored configuration is available, it will be used for system configuration. If not available the default setting will be used.

Figure 1. Binary configuration data block



Teseo-Module always uses only the current configuration.

Current configuration will be lost when there is:

- a power cycle

- an hardware reset
- a software reset

The current configuration can be made permanent (stored in a non-volatile memory) by saving it to the "*NVM stored configuration*".

On NMEA protocol the run-time configuration parameters can be read, changed and stored (in NVM) using the system configuration commands: $PSTMSETPAR, $PSTMGETPAR and $PSTMSAVEPAR. There is also a command to restore the factory setting parameters: $PSTMRESTOREPAR.

For example if the UART baud rate could be changed the following commands should be sent by the host:

```
1. $PSTMSETPAR,3102,0x9
2. $PSTMSAVEPAR
3. $PSTMSRR
```

Where:

1. `$PSTMSETPAR changes the UART's baud rate;`
2. `$PSTMSAVEPAR saves the whole configuration;`
3. `$PSTMSRR restarts the Teseo-VIC3 to guarantee that the change made are effectives;`

2.2 Binary version

The binary firmware version defines which set of messages the Teseo-Module is able to manage.

The command $PSTMGETSWVER returns the firmware and all software versions in string format.

While booting the Teseo-Module reports on the serial port the current configuration as showed in the following figure: Teseo-Module booting message from UART.

Figure 2. Teseo-Module booting message from UART

Each entry of Teseo-Module firmware subsystem version identifies a specific binary firmware subsystem version.

Table 3. **Teseo-Module firmware subsystem version**

Entry	Description
PSTMVER,GNSSLIB_8.4.14.21_ARM	GNSS Library Version
PSTMVER,OS20LIB_4.3.0_ARM	OS20 Version
PSTMVER,GPSAPP_2.8_ARM	GPS App Version
PSTMVER,BINIMG_4_x_12VERSIONE_SUFFIX_ARM	Binary Image Version
PSTMVER,SWCFG_81065329	Sw configuration Version
PSTMVER,STAGPSLIB_6.0.0_ARM	AGPS Library Version
PSTMVER,STA8090_622bc043	Chip Version
GPTXT,(C)2000-2018 ST Microelectronics	Log message
GPTXT, DEFAULT CONFIGURATION	Log message

The *Binary Image Version* covers all the firmware subsystem, therefore on every firmware subsystem update the binary image version updates as well.

2.3 Firmware update algorithm protocol

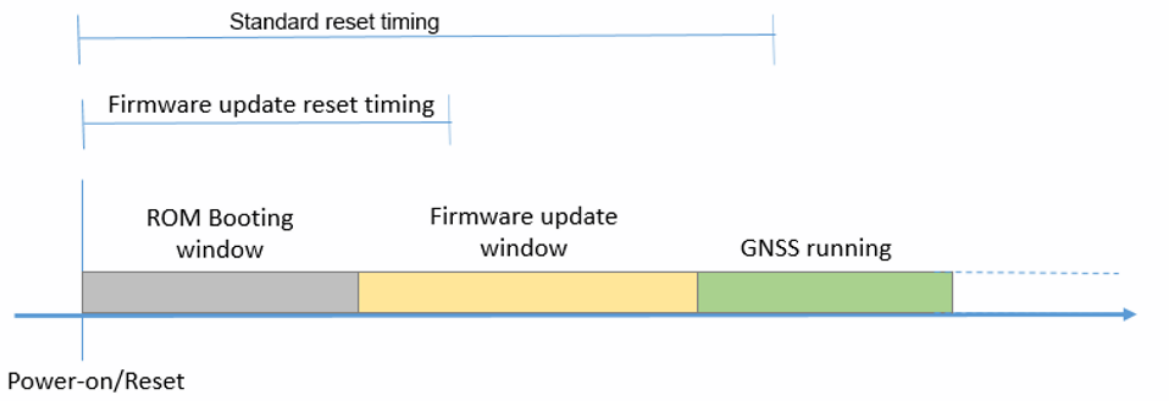
Teseo-Module supports the firmware upgrade on field.

2.3.1 Firmware update on reset

The firmware update procedure on reset can be triggered from the host only on a Power-On/Reset (POR); after a POR, Teseo-Module executes sequentially three actions as indicated in the following figure.

1. Teseo-Module initializes its-self (ROM booting windows)
2. Teseo-Module enters (firmware update windows) in polling mode on all the port interfaces to check if the host wants to trigger a firmware update procedure
3. If the timeout in step 2 fires the Teseo-Module will enter in the normal mode; while if in step 2 a request-firmware-update is detected, on an interface port, the Teseo-Module will enter in firmware update mode

Figure 3. **Teseo-Module operations from Power-on/reset**



Said that host has to manage two kind of reset depending on the elapse time the host has to wait from POR to operate with Teseo-Module:

- **Standard reset**: this is a normal reset required when the host wants Teseo-Module resetted and again up and running, in this case the host has to wait from PoR 500 ms before it can operate with Teseo-Module. No command has to be sent on the Teseo-Module's interface until the *Standard-reset-timing* elapses.

- **Firmware update reset**: this is the reset required when the host wants trigger a firmware update procedure, in this case host has to wait from PoR 100 ms (ROM booting windows) and during the firmware update windows it has to send the request firmware command

Both the host and Teseo-Module have to follow a well-defined protocol.

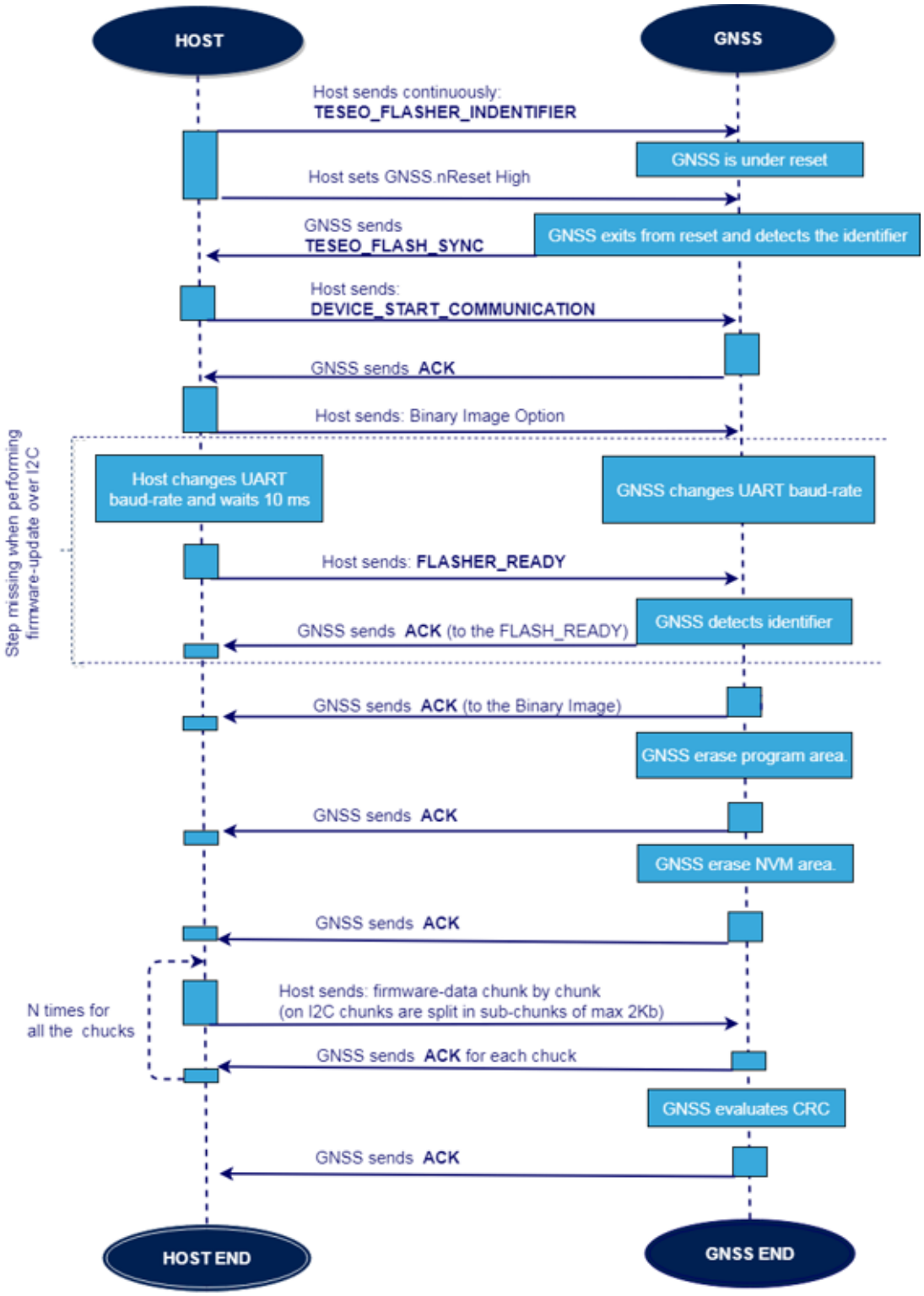
Caution: Take care that during the whole firmware upgrade procedure the voltage V_{CC} and V_{BAT} must remain applied and stable; a power outage, during the firmware upgrade procedure, could force the Teseo-Module in an unrecoverable state.

Firmware upgrade has a preliminary phase to synchronize the Host and the Teseo-Module.

Just after the synchronization with the device, the host must send the binary image options (the same as firmware update over NMEA).

The firmware upgrade procedure on reset is shown below.

Figure 4. **Teseo-Module firmware upgrade procedure on reset**



Firmware upgrade on reset procedure, on Teseo-Module, uses the constants shown in the following table:

Table 4. Firmware upgrade on reset constants

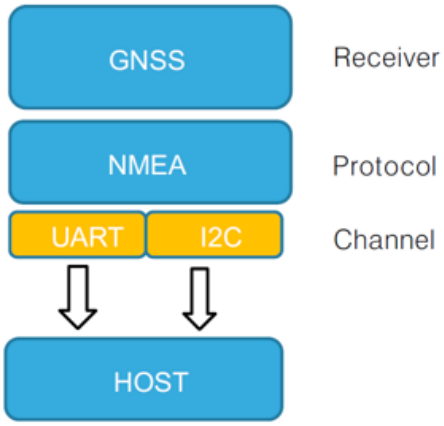
Constants	Value
TESEO_FLASHER_IDENTIFIER	0xBCD501F4
TESEO_FLASHER_SYNC	0x83984073
DEVICE_START_COMMUNICATION	0xA3
FLASHER_READY	0x4A
ACK	0xCC
NAK	0xDD
NVM_FLASH_OFFSET	0x00100000
NVM_FLASH_ERASE_SIZE	0x00100000

3 Communication channels

Teseo-Module has several independent communication channels.
Each channel can operate with a specific protocol (see protocol specification)
Users can select the channel based on their needs.
Teseo-Module receiver supports the following communication channels:

- UART channel;
- I2C channel

Figure 5. Teseo-Module protocol routing over the available ports



3.1 Communication over UART port

Teseo-Module receiver and Host are connected by serial port. Communication parameters are the following:

Table 5. Default UART configuration

Data bits	Parity	Stop bit	Baud-rate
8	None	1	115200

In both directions, communication is based on the frames described in next sections.
From Teseo-Module receiver to Host frames can be:

- *Unsolicited*: For instance, periodical frame reporting position
- *Data Responses*: Teseo-Module receiver returns data requested by host
- *ACK*: in case no data need to be returned to host (e.g. on a reset request), simple ACK is sent
- *NACK*: if request contains wrong parameters, NACK is returned to host.

From Host to Teseo-Module receiver frames can be:

- Read requests;
- Write reset, initialization requests

3.2 Communication over I2C port

I2C is a two-wire communication interface invented by Philips Semiconductor unlike all other interfaces, I2C is not able to communicate in full-duplex mode; it uses only two bidirectional open-drain lines, serial data line (SDA) and serial clock line (SCL), pulled up with resistors.

Teseo-Module always acts as slave and it cannot initiate data on the bus; Host has to periodically pull the receiver to check about data availability. Default I2C slave address is 0x3A.

The CDB that can be used to configure I2C specific parameters is CDB-ID 263 – NMEA over I2C configuration

3.2.1 I2C read access

When the host wants to read NMEA sentences from I2C, it must start a read operation over I2C, providing configured slave address.

After the acknowledge bit, a stream of bytes will be sent by Teseo-Module up to the stop/repeated start condition.

Figure 6. Read operation description

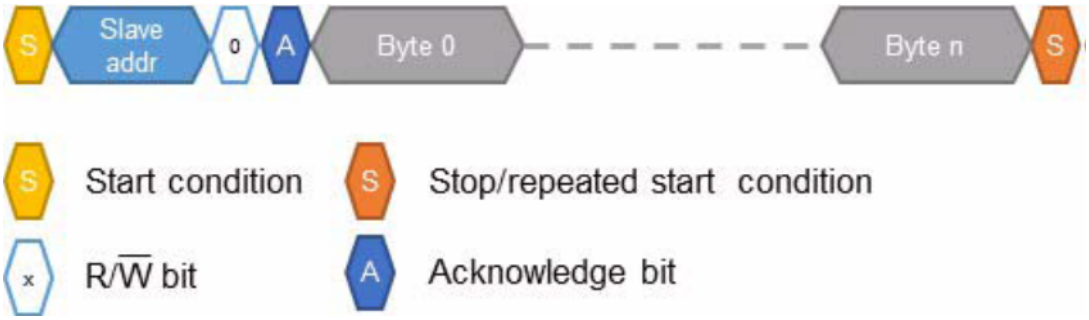
The format of the bytes is ASCII. When Teseo-Module does not have any character to send, a dummy 0xFF byte is sent.

The host can parse the data received as defined in the messages.

3.2.2 I2C write access

When the Host wants to send commands to Teseo-Module through I2C, it must start a write operation over I2C, providing configured slave address. After the acknowledge bit, Teseo-Module will receive any character coming from the host up to the stop/repeated start condition.

Figure 7. I2C write operation description



4 Format of the commands defined in NMEA

ST NMEA command specification **Error! Reference source not found.** and messages specification.

4.1 I2C communication channel

On I2C communication channel Teseo-Module allows 256 addressable registers.

Each register is 32bits wide and it can be addressed to support read or write operations.

On write operation:

- the first data byte is the register index while the following bytes are the register value;
- every write operation with less than 5 bytes is discarded;
- write operation with more than 5 bytes. All the extra bytes not required are discarded;

Figure 8. I2C register write operation

On read operation:

- the register index is the last one indexed in a write operation;
- Teseo-Module will send the 4 bytes register values;
- If the Host doesn't close the i2c-read-transaction after 4 bytes, extra bytes will be filled with 0x0 (zero) by the Teseo-Module;

Figure 9. I2C register read operation

Teseo-Module does not support auto-increment register index. This means, each register has to be addressed by the host to access.

Registers from 0x0 to 0xFE are currently reserved for future use, every read or write operation on these registers can provide unpredictable operation on Teseo-Module.

Teseo-Module has a special register, the register 0xFF reports, as it is, the NMEA stream where the host can perform read and write operations as a standard UART port.

On PowerOrReset the default register index value is 0xFF. In this way every Host can read the NMEA stream directly just raising a simple i2c-read-operation on Teseo-Module.

Table 6. I2C register map

Register id	Operation	Size	Description
0x00	-	32 bits	Reserved
…	-	-	-
0xFE			Reserved
0xFF	R/W	No-Limit	NMEA stream

5 Protocol specification

The receivers come with a highly flexible communication interface.

Teseo-Module supports the following protocols:

- NMEA Protocol based on NMEA 0183 Version 3.1;
- NMEA Protocol based on NMEA 0183 Version 4.10;
- RTCM protocol based on RTCM Version 2.3

5.1 NMEA protocol

NMEA messages sent by the Teseo-Module are based on NMEA 0183 Version 3.1 or based on NMEA 0183 Version 4.1.

NMEA (National Marine Electronics Association) is a non-profit association of manufacturers, distributors, dealers, educational institutions, and others interested in peripheral marine electronics occupations. The NMEA 0183 standard defines an electrical interface and data protocol for communications between marine instrumentation.

5.1.1 Communication interface

Communication between a Host processor and the Teseo-Module can be established in different ways, depending on the platform implementation.

For simplicity reasons this document will refer to the UART interface described in the examples.

5.1.2 Commands

A Command is a defined Data Packet which is sent from a Host processor to the Teseo-Module in order to control the system behavior. The regular structure of a command is:

`$command-ID,<parameters>*<checksum><cr><lf>`

Once the command is executed the device replies with messages according to what specified in this document, after the message the command is sent back to the Host as a final confirmation of the execution.

5.1.3 Messages

A message is a defined set of data sent from the Teseo-Module to an host processor using the same interface which is used to transfer commands to the system. Messages may not be enabled by default but can be switched on and off using a command at run-time. The basic structure of a message is:

`$message-ID,<parameters>*<checksum><cr><lf>`

5.2 RTCM protocol

RTCM (Radio Technical Commission for Maritime Services) is an international standards organization. RTCM protocol is an unidirectional protocol to supply, to Teseo-Module, real-time differential correction data.

Teseo-Module is compliant with RTCM 2.3 and it supports the following messages:

Table 7. RTCM message type supported

Message type	Description
1	Differential GPS Corrections
9	GPS Partial Correction Set
31	Differential GLONASS Corrections
34	GLONASS Partial Correction Set

On Teseo-Module RTCM does not need any configuration; when enabled the RTCM input stream is parsed and used in the DGPS algorithm.

The RTCM protocol can be enabled/disabled on CDB-ID 200.

6 Communication interface

Communication between a host processor and the Teseo-Module can be established in different ways.

For simplicity reasons this document will refer to “Stand-alone Processors” only and the interface described in the examples is a UART.

All information contained in this document is related to the “NMEA port” of the Teseo-Module may contain an additional “Debug port” but the data exchanged on the “Debug Port” is not within the scope of this document.

6.1 Commands

A Command is a defined Data Packet which is sent from a host processor to the Teseo-Module in order to control the system behaviour. The regular structure of a command is:

```
$command-ID,<parameters>*<checksum><cr><lf>
```

In order to receive the commands, the Teseo-Module is connected to the host via the NMEA port (make sure that the serial cable is the right one, sometimes it is necessary to use a cross-cable). The user interaction can be achieved through the use of a PC terminal emulator that is connected to the appropriate COM port with settings in Table 8. Default UART port configuration.

Table 8. Default UART port configuration

Baudrate	Parity bits	Stop Bit	Data bits
115200	0	1	8

The NMEA default value baud rate is automatically set at the system start-up.

It can be modified at system runtime using the appropriate command.

The simplest way to send a command to the device is to write the command string in a text file and send it using the “send file” capability of the terminal emulator. For this reason, it is required that the terminal emulator (or production test program) running on the PC is capable of sending text files down the RS232 link to the Teseo-Module.

Once the command is executed the device reply with messages according to what specify in this document, after the message the command is sent back to the host as final confirmation of the execution.

6.2 Messages

A message is a defined set of data sent from the Teseo-VIC3 to a host processor using the same interface which is used to transfer commands to the system. Messages may not be enabled by default but can be switched on and off using a command at run-time. The basic structure of a message is:

```
$message-ID,<parameters>*<checksum><cr><lf>
```

There are two basic sets of messages implemented.

6.2.1 Standard NMEA message

Standard NMEA Messages are defined in the “NMEA 0183” Standard, issued from the “National Marine Electronics Association”. The latest issue is Rev. 4.10 dated August 2012. NMEA0183 refers to it as Sentences (single line message) and Messages (multiple line messages).

By default, Standard NMEA Messages are compliant with the “NMEA 0183” Standard Rev. 3.1 dated January 2002. Anyway, it is possible to change their format to be compliant with Rev. 4.10, issued from the “National Marine Electronics Association” in the August 2012.To change NMEA format refer to 6.4 “Changing standard NMEA messages format” in this document.

To get an overview please refer to Standard NMEA messages specification in this document.

Standard NMEA messages start the “message-ID” with:

```
$<TalkerID>
```

Supported talker IDs are: “GP”, “GL”, “GA”, “BD”, “QZ” and “GN” for standard NMEA sentences.

Note: The set of supported talker IDs depends by supported constellations. It is strictly related to the hardware platform and software revision.

6.2.2 Proprietary messages

Teseo-Module can provide additional messages with more detailed data content. This is required to transmit Teseo-Module and System information content which is not defined in the NMEA standard output.

Proprietary messages from STMicroelectronics start with:

```
$PSTM...
```

To get an overview on the proprietary messages defined by STMicroelectronics please refer to ST NMEA messages specification chapter in this document.

7 Dead Reckoning

Teseo-Module embeds the Teseo-DRAW firmware.

Teseo Dead Reckoning solution (both Teseo-DRAW and Teseo-DRUM), also known as Teseo DR, is a technology combining inertial sensors together with GNSS, providing seamless fusion of satellite measurements, angular rate and acceleration data. It is designed to provide improved accuracy, availability and integrity of positioning data, in particular in environments where GNSS is absent or corrupted.

Teseo-DRAW is a FW which is fed by both inertial sensor (such like gyroscope and accelerometer) and vehicle sensors (such like speed signal and reverse indicator). Since DRAW requires electrical connection to vehicle speed signal, it is a solution, which is typically targeting OEM automotive customers. It provides a premium performance level, with cutting edge position accuracy even during extended periods of GNSS absence.

Teseo-DRUM is a FW which is fed by inertial sensor (such like gyroscope and accelerometer). Since DRUM do not require electrical connection to vehicle speed signal, it is a solution, which is typically targeting Industrial customers.

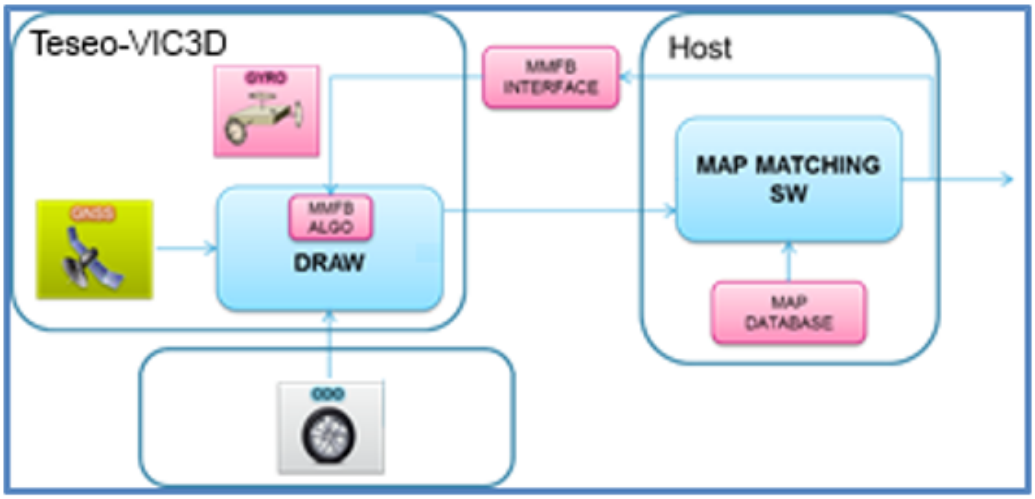
7.1 Map matching feedback

7.1.1 Overview

In applications where a map matching system is available (e.g. in an in dash navigation system) Teseo-Module can receive the map matched position to improve the quality of PV output. This feature is called Map Matching Feedback (MMFB). The mentioned feature and the way it should be used shall be described in detail in this section, along with examples of results.

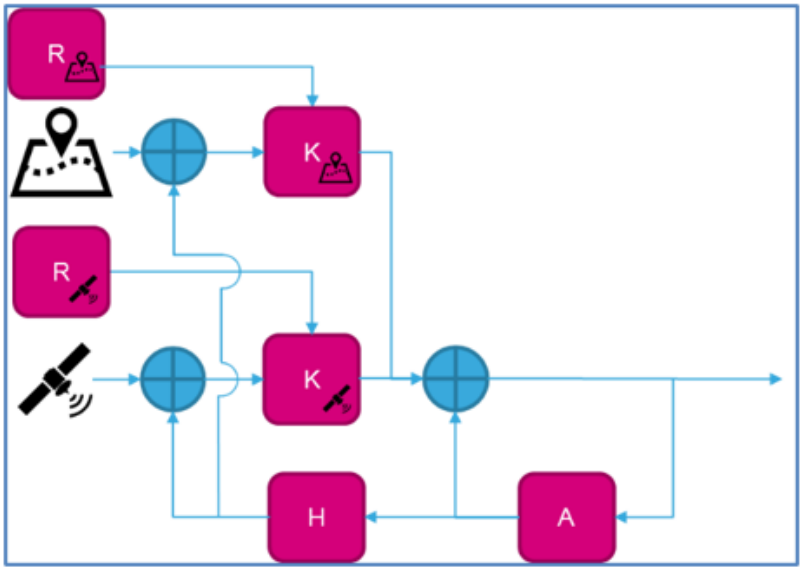
An overview of the components of a typical Teseo-Module based navigation system are reported in Figure 10. Navigation system feat. MMFB on Teseo-Module. Host processor is running the Map Matching SW – that is an IP matching the position provided by DR on a map database (which can be local or remote). MMFB Interface is the method used by Map Matching SW to send data to Teseo-Module. MMFB operation can be effective only in presence of such communication link.

Figure 10. Navigation system feat. MMFB on Teseo-Module



The core of feature is the algorithm, i.e. a sensor fusion engine that at each second of operation it compares the contribution of different sources of data, attempting to take the better of each one to guarantee continuous smart fusion of GNSS, sensors and map, for optimal accuracy and smoothness. A Weight (referred as R in figure) is used to modulate map contribution to output solution.

Figure 11. **MMFB fusion engine**

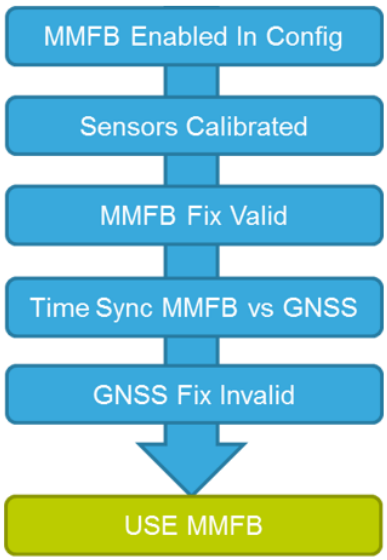


7.1.2 Acceptance conditions

In order to allow map data to enter the filter and influence Teseo DR output conditions need to be verified. Such conditions are reported in the following figure.

First of all, MMFB feature should be enabled in FW configuration CDB 667 (it is enabled by default). Sensors calibration phase needs to be completed. Moreover, MMFB dataset should be indicated as valid by the host; ST MMFB interface features a field allowing host to declare the validity status of sent data.

Figure 12. **Map data acceptance conditions**



There are indeed time constraints that must be met. In practice, after receiving a set of fix data from Teseo-Module, the time elapsed by host to process map data and send them back to Teseo-Module should not exceed 1 second.

MMFB approach is based on the statement that, in case GNSS fix is believed to be reliable (good signal conditions) its accuracy shall be in general better than map matching. For this reason, MMFB contribution is neglected in such benign reception scenario.

It is worth to underline that the fact that MMFB data is accepted and used into Kalman Filter does not necessarily mean that the user will see its influence in DR output. In fact, once accepted, the map will be subjected to the weighting logic previously mentioned. If the weight decided by the logic is very low (e.g. if the information coming from the map is inaccurate) its effect output shall be null or almost.

7.1.3 Interface

The interface is implemented by the $PSTMDRMMFB NMEA command aimed to allow an external module to input last mapped data point into Teseo-Module. Such $PSTMDRMMFB command must be sent via UART. If command format is accepted, MMFB data will be injected into Teseo DR algorithm and the command will be echoed on NMEA communication channel.

The typical MMFB command which shall be sent to Teseo-Module has the following aspect:

```
$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>
```

Example

```
$PSTMDRMMFB,085347.000,1,1,0,0,51.0314194,6.9349778,0.0,0.0,0.0,0.0,0.0,0.0,0.0*30
```

Parameters requested by $PSTMDRMMFB command are listed in detail in $PSTMDRMMFB command description. The command is composed by four categories of data:

- Time
- Map data validity flags
- Map data values
- Map data estimated errors

Each category is described more in deep in the following sub-sections, which also feature important suggestions about how to set the parameters.

Time stamp

It is expressed in UTC format; it defines the epoch of provided dataset. It is used to ensure the correct synchronization between MMFB algorithm and map matching engine; for this reason, it must exactly match the UTC time of a recent GxGGA message. The map-match information is assumed to be the position/heading estimate at the time of that GxGGA message. The latency in delivery should be less than 1 second.

Figure 13. Usage of MMFB interface with correct timing shows an example where the sending time is correct. It can be seen that Teseo DRAW is calculating its fix output at a given time, called $Fix_{UTC}(n-1)$. Once the host receives related fix data, it has to match them on the map database and transmit back to Teseo-Module that matched point, i.e. $MMFB_{UTC}(n-1)$. The time needed to fulfill these actions is called Δt_{mmfb}. In the meantime, DRAW process is continuing on Teseo-Module side, yielding the calculation of a new fix called $Fix_{UTC}(n)$, which is 1 second after $Fix_{UTC}(n-1)$. In order to MMFB to be correctly used by DRAW, $MMFB_{UTC}(n-1)$ should be sent to DRAW before $Fix_{UTC}(n)$; in other words Δt_{mmfb} should be less than one second.

Figure 14. Usage of MMFB interface with incorrect timing is instead representing a case in which the timing is not correct. In this case $MMFB_{UTC}(n-1)$ has been sent to DRAW after $Fix_{UTC}(n)$; i.e. Δt_{mmfb} is more than one second. In this condition map info shall be discarded by ST FW synchronization checks.

One important point to keep under attention is about selected fix rate. All the considerations above apply to the case in which DRAW is configured to provide 1 Hz fix rate. In case of fix rate > 1 Hz, only the GxGGA featuring hhmmss.000 UTC time needs to be fed back to DRAW. In this way the FW is allowed to treat this use case similarly way to 1 Hz.

Example

For a 5 Hz system, the fix at UTC 163024.000 should be considered by map matching engine to be sent to DR. Instead the fixes at UTCs 163024.200, 163024.400, 163024.600 and 163024.800 should not be sent. Fix at 163025.000 should be sent.

The following command is correct:

```
$PSTMDRMMFB,085347.000,1,1,0,0,51.0314194,6.9349778,0.0,0.0,0.0,0.0,0.0,0.0,0.0*30<cr><lf>
```

While the following command is not correct:

```
$PSTMDRMMFB,085347.200,1,1,0,0,51.0314194,6.9349778,0.0,0.0,0.0,0.0,0.0,0.0*30<cr><lf>
```

Figure 13. Usage of MMFB interface with correct timing

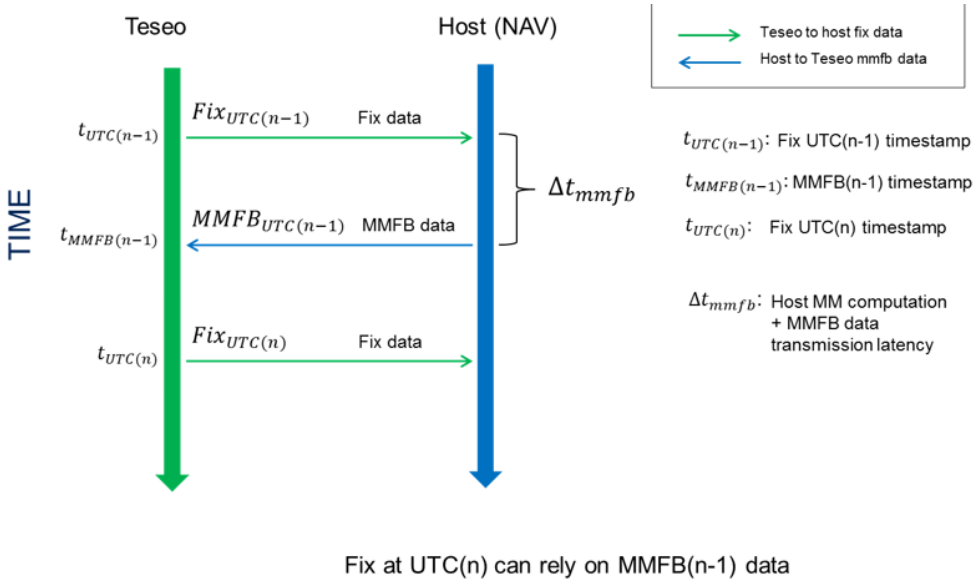
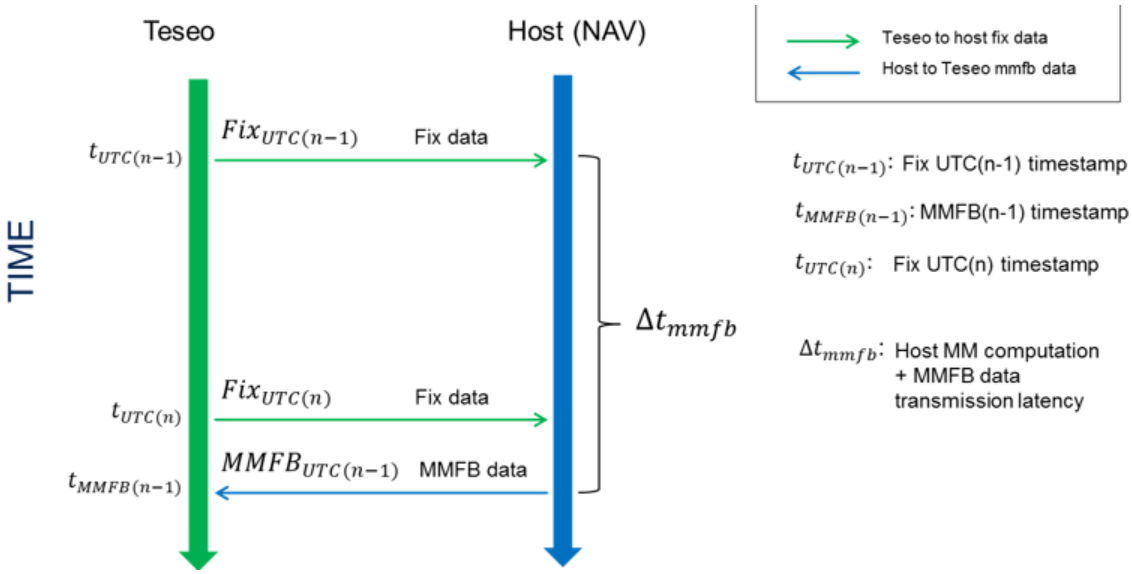


Figure 14. Usage of MMFB interface with incorrect timing



Data validity

Each validity flag asserts the respective data field validity. In case of validity flag set to '0' MMFB algorithm will ignore the data field. This feature allows the host processor to invalidate selectively a part of the MMFB information (or eventually the whole dataset). This should happen for example if matched data field is not available or believed wrong

E.g., a valid MMFB command to ensure that position data is accepted by Teseo DR is the following:

```
$PSTMDRMMFB,085347.000,1,1,0,0,51.0314194,6.9349778,0.0,0.0,0.0,0.0,0.0,0.0*30
```

While the following command should be used in case position data should be rejected:

```
$PSTMDRMMFB,085347.000,0,0,0,0,51.0314194,6.9349778,0.0,0.0,0.0,0.0,0.0,0.0*30
```

It is important to underline that only latitude and longitude validity flags should be manipulated by customer. Heading and height are reserved fields and must always be declared invalid, as showed in both examples. Height map feedback is currently not supported; heading feedback instead is not needed because it shall be automatically estimated from latitude and longitude.

Data values

Latitude and longitude must be expressed according to WGS84 reference ellipsoid datum. The whole concept assumes that map position is accurate. The filter is designed to be able to reject /mitigate the contribution of inaccurate map position, in order to avoid it to jeopardize filter stability and sensors' calibration. Nevertheless, for optimal fusion performance, ST recommends customer to ensure the data provided by the map matching engine are reliable, and in case they aren't to invalidate them through the validity flags.

Note: Height and heading fields, although reserved, are not supported currently in Teseo-DRAW and Teseo-DRUM. Related fields should be set to 0.

Estimated errors

Estimated error (aka accuracy) fields allow the host processor to inform Teseo-Module about reliability of the provided map matched data. Teseo-Module will base its output on this number. In this case navigation performance shall depend on estimated error choice.

Estimated error equals zero

Estimated error information is often not available at the map matching engine side; moreover, not all host owners need or want to set them as this implies to spend effort and time for testing in different scenarios to find the specific tuning for their specific case.

Consequently, setting it is not standard option for Teseo DR nor mandatory; by default, such error fields must be set to 0.0. In this way Teseo-Module shall ignore them, calculating autonomously its own weighting based on internal likelihood algorithms. Goal of such procedures is to maximize the employment of the map when it's good, and discard when it's bad (e.g. when the map point is matched on a wrong road).

Such default standard method has demonstrated to be optimal choice for applications featuring accurate and reliable map information, i.e. not interpolated. Nevertheless, it is still very important that, on host side, any known bad map point is flagged by '0' in validity fields.

Estimated error greater than zero

When non-zero value is specified, host shall take the control deciding how much MMFB data modify Teseo-Module output PV. One limitation is that this control shall happen only if the MMFB data has been accepted by Teseo-Module, i.e. it fulfills conditions described in Figure 3. Looking at it, it is important to underline that MMFB data is accepted only when GNSS is deemed as "not acceptable" by Teseo DR internal logics.

Inside a tunnel GNSS shall be not received; hence never declared acceptable; hence MMFB data shall be always used by Teseo-Module.

In open sky, GNSS is almost always declared acceptable; so MMFB data shall rarely be considered. So, in case a customer is testing in open sky and does not see influence of the map on Teseo-Module position, that's normal and expected, as in open sky GNSS is believed to be the most reliable absolute positioning source, better than map.

In urban canyon GNSS acceptance depends on actual signal quality, i.e. by multipath severity. In this case map data will be declared usable in areas where GNSS signal is most corrupted and not usable in areas where GNSS is better.

Since these fields are defined as "errors" they are expressing a concept of uncertainty of map data; so the lower is the value, the more map is trusted; the higher is value, the less map is trusted.

The maximum faith shall be obtained putting values in the range 0 < error < 5 m. Sending such value, the user should see Teseo-Module output to blindly follow map data in tunnel.

For values larger than 5 m, the larger is the value, the less is the faith Teseo-Module is putting in map data. It is not possible to describe in a table the precise effects of a given error value on output position, because, being the algorithm a Kalman Filter, the effect of the weight is strictly depending on current filter status. Nevertheless, very high values (e.g. 500 m) will result in Teseo-Module to completely ignore the map; but it is important to underline that if this is the intention of the user, the correct way to achieve this is to declare the data not valid, as described in section Data Validity.

Understanding and choosing intermediate values (5 m < error < 500 m) requires the skilled user to spend effort for testing, qualify and find the most suitable tuning depending on the working of his matching algorithm and the quality of its maps. For example, if the vehicle is near a junction, it could be useful to tell the system to reduce the trust in map, as the map system itself cannot be able to choose the correct road, while Teseo-Module gyroscope is.

The following table summarizes the above discussion.

Table 9. Effects of different MMFB estimated error settings on Teseo-Module output

Map error	Range	Effect on DRAW PV
Lat_err	0m	Map weight self-computed
	0 < lat_err <= 5m	Map trusted with maximum faith
	lat_err > 5m	The larger value, the less is the faith in map
Lon_err	0m	Map weight self-computed
	0 < lon_err <= 5m	Map trusted with maximum faith
	lon_err > 5m	The larger value, the less is the faith in map
Height err	Always ignored	No effect
Heading err	Always ignored	No effect

Example 1

Errors are left to zero. Standard suggested setting. Desired effect is that Teseo DR calculates his own weighting internally, in order to automatically decide how much trust map.

```
$PSTMDRMMFB,085347.000,1,1,0,0,51.0314194,6.9349778,0.0,0.0,0.0,0.0,0.0,0.0*30
```

Example 2

Errors are set at minimum value i.e. 5 m. Desired effect is that Teseo DR 100% trusts map (if usable), with its output totally matching with it.

```
$PSTMDRMMFB,085347.000,1,1,0,0,51.0314194,6.9349778,0.0,0.0,5.0,5.0,0.0,0.0*30
```

Example 3

Errors are set below the minimum value and > 0 m. The behavior shall be identical to Example 2.

```
$PSTMDRMMFB,085347.000,1,1,0,0,51.0314194,6.9349778,0.0,0.0,1.0,1.0,0.0,0.0*30
```

Example 4

Errors are set at maximum value. Desired effect is that Teseo DR ignores map data. Independently from error value, the validity flags should be set to 0.

```
$PSTMDRMMFB,085347.000,0,0,0,0,51.0314194,6.9349778,0.0,0.0,1000.0,1000.0,0.0,0.0*30
```

Example 5

Errors are set at intermediate value defined by user (in this case 70 m, but could be any > 5 m). Desired effect is that Teseo DR partially trusts map data. How much they will influence Teseo-Module output cannot be defined a priori, since it depends on internal KF status. It shall be task of integrator to spend effort to implement, test and qualify best values for its application depending on scenario and map variables.

```
$PSTMDRMMFB,085347.000,1,1,0,0,51.0314194,6.9349778,0.0,0.0,70.0,70.0,0.0,0.0*30
```

Estimated error command is supported only for latitude and longitude. Any error applied to heading or height fields shall be ignored, and ST recommendation is let those fields at zero, as per examples above. E.g.

```
$PSTMDRMMFB,085347.000,1,1,0,0,51.0314194,6.9349778,70.0,70.0,0.0,0.0*30
```

7.2 High dead-reckoning fix rate

While on Teseo-Module the GNSS Fix rate is 1 Hz with the Teseo DR firmware embedded in Teseo-Module it’s possible to achieve a Dead-reckoning fix rate up to 20 Hz.

GNSS data and sensors fusion are used to propagate and generate Dead-Reckoning Fix between two consecutive GNSS fixes.

Dead-reckoning fix rate can be configured using CDB-ID 600 – DRAW main setting.

8 Assisted GNSS

Teseo-Module needs accurate satellite position data from at least 4 satellites to produce a position fix (FIX).

Accurate satellite data -ephemeris data- is valid for 4 hrs only for GPS and 30 min only GLONASS.

After that time a Teseo-Module must download new ephemeris data.

Ephemeris download can take from dozens of seconds to several minutes, hours or can fail.

Assisted-GNSS is a mechanism to provide ephemeris assistance from external source; this reduces considerably the time to get a FIX especially in critical environments when the ephemeris download time could be very long.

Teseo-Module supports the following types of assisted GNSS:

- ST - AGNSS
- Real-time GNSS

8.1 ST - AGNSS

The ST-AGNSS library is able to provide predicted ephemerides to the Teseo-Module in a time frame less than the usual time (about 30 seconds) needed to download real ephemeris from the sky. This reduces considerably the time to get a FIX especially in critical environments when the ephemeris download time could be very long.

ST-AGNSS autonomous solution works using the past real ephemeris (downloaded from the sky and stored in its internal database) to extrapolate the parameter of future ephemeris (up to 5 days of prediction). For these reasons, the ST-AGNSS autonomous performances (in terms of position accuracy using predicted ephemeris) are strictly dependent on the real ephemeris database content. In normal usage of ST-AGNSS autonomous, the system automatically uploads the real ephemeris into its database as soon as new ephemerides are downloaded from the sky. This means that the global content of the real ephemeris input database is determined by the history of device running periods in the past.

Table 10. ST-AGNSS NMEA interface

Syntax	Description
$PSTMSTAGPSONOFF	Turns ON/OFF the STAGNSS engine
$PSTMSTAGPSINVALIDATE	Clears data stored in the STAGNSS internal database
$PSTMGETAGPSSTATUS	Returns the status of the STAGNSS internal processing
$PSTMSTAGPSSETCONSTMASK	Switches among the ST-AGNSS constellation
$PSTMAGPS	Message with the same syntax as standard NMEA GSA Message
$PSTMAGLO	Message with the same syntax as standard NMEA GSA Message
$PSTMPOLSTARTED	Message in response to $PSTMSTAGPSONOFF
$PSTMPOLSUSPENDED	Message in response to $PSTMSTAGPSONOFF
$PSTMPOLONOFFERROR	Message in response to $PSTMSTAGPSONOFF
$PSTMSTAGPSINVALIDATEOK	Message in response to $PSTMSTAGPSINVALIDATE
$PSTMSTAGPSINVALIDATEERROR	Message in response to $PSTMSTAGPSINVALIDATE
$PSTMAGPSSTATUS	Message in response to $PSTMGETAGPSSTATUS

8.2 Real-Time AGNSS

The Real-Time AGNSS is able to provide the approximate current time, the ephemerides, the almanacs and optionally the approximate position to the Teseo-Module in a time frame less than the usual time (about 30 seconds) needed to download real ephemeris from the sky. This reduces considerably the time to get fix especially in critical environments when the ephemeris download time could be very long.

Real-time AGNSS requires a network connection to download assistance data from the server. Assistance data include the current time (if not available, for instance, from RTC), the ephemerides, the almanacs and optionally the rough position.

All the assistance data can be injected into the device backup memory using a few NMEA commands.

Follow the Application note "AN5160: RxNetworks Assisted GNSS Server Interface Specification" to access the RxNetwork Service.

The first thing to do is to inject the current time into the device (if the device has no RTC, or if it is set to a wrong time). This can be done either using the $PSTMINITTIME command or, if also the approximate position is available, then both current time and position can be injected using the $PSTMINITGPS command.

Then the ephemerides can be injected into the device using the $PSTMEPHEM command for each satellite (between two consecutive commands there must be at least a 20 millisecond delay).

Then the almanacs can be injected into the device using the $PSTMALMANAC command for each satellite (between two consecutive commands there must be at least a 20 millisecond delay).

Now the device will be capable of achieving the fix very quickly, if enough satellites are in view.

8.2.1 Password generation - details

As mentioned in the previous section, in order to access the RxNetworks server, the user has to provide a set of parameters, which are used in generating the HTTP request. These parameters are used to generate a password string (up to 41 characters in length) that is required by the HTTP request string.

Teseo-Module provides the $PSTMSTAGPS8PASSGEN NMEA command that performs the password generation. The user must supply three parameters to this command that it will use to generate a unique password.

In order to generate the password the user must pass in the following parameters.

- *The vendor id string.*
- *The current time expressed as GPS seconds (i.e. the number of seconds since midnight 06-Jan-1980).*

The vendor id and device id strings are provided in Section Appendix B RxNetworks Teseo-Module credential. The current time will need to be calculated by the software creating the HTTP request string.

8.2.2 Real-Time assistance data uploading procedure

The real-time AGNSS performances depend on the availability of a network connection in order to download assistance data, which include:

1. the current time (if not available, from instance, from RTC),
2. the ephemerides,
3. the almanacs
4. the rough position (optional)

Once those data have been downloaded from the server, the first thing to do is to inject the current time into the device (if the device has no RTC, or if it is set to a wrong time). This can be done either using the $PSTMINITTIME command or, if also the approximate position is available, then both current time and position can be injected using the $PSTMINITGPS command.

Then the ephemerides can be injected into the device using the $PSTMEPHEM command for each satellite (between two consecutive commands there must be at least 20 millisecond delay).

Then the almanac can be injected into the device using the $PSTMALMANAC command for each satellite (between two consecutive commands there must be at least 20 millisecond delay).

Now the device will be capable of achieving the fix very quickly, if enough satellites are in view.

9 Geofencing

Geofence feature allows the Teseo-Module to raise an alarm when the resolved GNSS position is close a specific circle, entering or exiting from a circle

Teseo-Module supports at least 8 circular areas where 4 circular areas are configurable in the firmware.

Geofencing alarm can be notified over:

- NMEA message;
- GPIO;

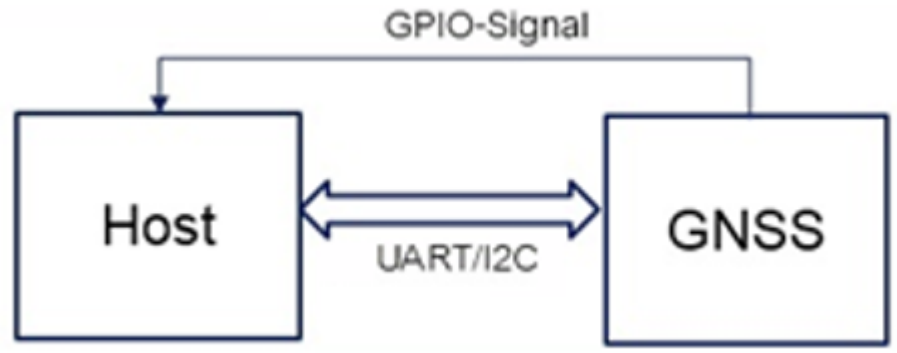
Teseo-Module supports the Geofencing features over NMEA.

In case of geofencing alarm over Teseo-Module pin, user can specifies which GPIO is used to notify geofencing alarm; the Teseo-Module pin will be triggered when geofencing alarm is raised

Geofencing can be configured and enabled in the firmware configurator (via CDB-ID 268 – Geofencing Configuration 0) or using the specific geofencing configuration command.

Geofencing system supports the following three scenarios.

Figure 15. Scenario 1 supported on Geofencing



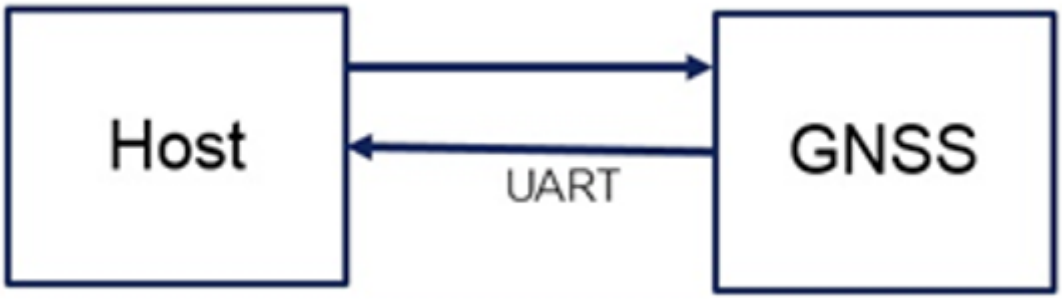
In case of Scenario 1, Teseo-Module is able to raise an interrupt to the host to notify it requires attention by the host.

Teseo-Module does not need raise any message autonomously.

On detection of GPIO-Geofence interrupt from the host:

- host has to send the $PSTMGEOFENCEREQ command;
- On $PSTMGEOFENCEREQ:
  1. Teseo-Module deasserts the GPIO-Geofence signal;
  2. Teseo-Module will reply with a $PSTMGEOFENCESTATUS message through the communication channel.

Figure 16. **Scenario 2 supported on Geofencing**

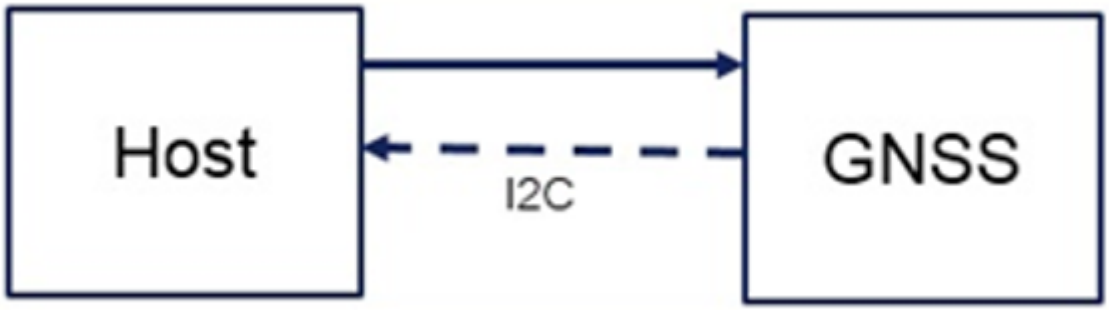


In case of Scenario 2, Teseo-Module can not raise an interrupt to the host but if $PSTMGEOFENCE message is enabled in the message-list the Teseo-Module can send the $PSTMGEOFENCE message autonomously to the host through the UART port, in this manner host doesn't need polling the Teseo-Module raising $PSTMGEOFENCEREQ commands.

When the host receives the $PSTMGEOFENCE message it's aware of geofence internal status.

The other datalog commands are raised by the host to manage, configure and query the log.

Figure 17. **Scenario 3 supported on Geofencing**



In case of Scenario 3, Teseo-Module can not raise interrupt to the host neither sends message autonomously. In this scenario, periodically, the host has to send the command $PSTMGEOFENCEREQ to the Teseo-Module with a bus-specific-write operation followed by a bus-specific-read operation where the host will read $PSTMGEOFENCESTATUS message posted by the Teseo-Module.

10 Odometer

Teseo-Module supports Odometer feature.

Odometer provides information on the travelled distance using only positioning information.

Odometer can not be configured in the firmware configurator datablock, this means it has to be configured and managed using specific odometer commands during the runtime.

Odometer subsystem has only 2 states:

- Odometer activated;
- Odometer resetted;

While activated the odometer reports the ground distance from the last reset.

Odometer can be configured and enabled in the firmware configurator (via CDB-ID 270 – odometer configuration).

Odometer travelled distance is resetted in case of:

- Power off/on
- Entering/Exiting from Reset and/or Standby

Odometer is also able to raise an alarm when a programmed distance is reached. Odometer alarm can be notified over:

- NMEA message;
- Teseo-Module pin;

Odometer system supports the following three scenarios.

Figure 18. Scenario 1 supported on Odometer

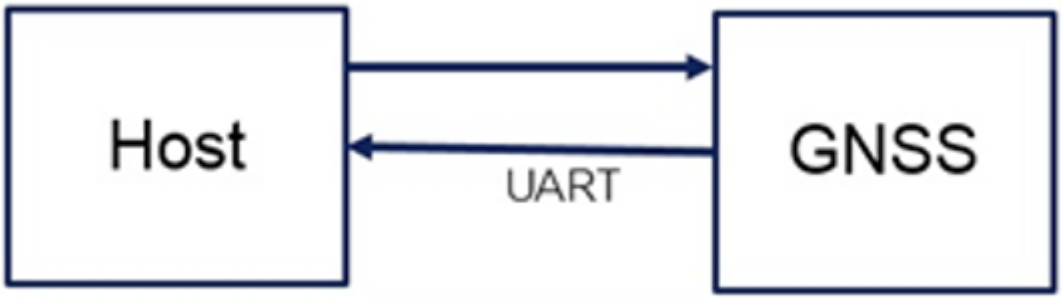
In case of Scenario 1, Teseo-Module is able to raise an interrupt to the host to notify it requires attention by the host.

Teseo-Module does not need raise any message autonomously.

On detection of GPIO-Odometer interrupts from the host:

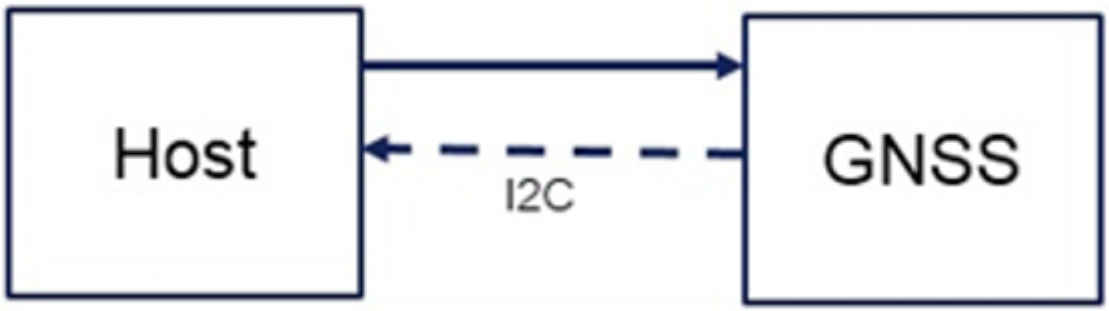
- host has to send the $PSTMODOREQ command;
- On $PSTMODOREQ：
  1. Teseo-Module deasserts the GPIO-Odometer signal;
  2. Teseo-Module will reply with a $PSTMODO message through the communication channel;

Figure 19. **Scenario 2 supported on Odometer**



In case of Scenario 2, Teseo-Module can not raise an interrupt to the host but if $PSTMODO message is enabled in the message-list the Teseo-Module can send the $PSTMODO message autonomously to the host through the UART port, in this manner host doesn't need polling the Teseo-Module raising $PSTMODOREQ commands.
When the host receives the $PSTMODO message it's aware of internal odometer status.

Figure 20. **Scenario 3 supported on Odometer**



11 Low power modes

The low power management library implements different modes including the functionalities below:

- Adaptive low power mode:
  - Change the constellation used by the system (dynamic constellation switch)
  - Update the number of GPS satellites used (active channel management)
- Cyclic low power mode:
  - Change the duty cycle of every channels.
- Active and standby periodic low power mode:
  - Report a fix at a given periodicity
  - Autonomous periodic ephemeris refresh
  - RTC calibration capability
  - Optional use of ST-AGNSS (Standby mode only)
  - Different hardware power state between fixes are possible
- Fix on demand low power mode (Standby mode only):
  - Report a fix on demand triggered by an hardware pin
  - Autonomous periodic ephemeris refresh
  - RTC calibration capability

Adaptive and cyclic modes can be mixed together. They are designed to save power while limiting the degradation of the sensitivity and accuracy. List of satellites and reception duration can be adjusted as long as the estimated error is above a threshold.

Adaptive and cyclic modes cannot be mixed with the periodic mode.

The periodic mode saves power when a fix is needed more than every 5 seconds and when accuracy degradation is acceptable. Two cases are depicted, corresponding to different hardware states between the fix activities. There is the active case and the standby case (maximum power saving). The usage of ST-AGNSS feature allows reducing the energy spent in the ephemeris refresh periods.

The choice between the different modes are driven by the required fix periodicity.

Table 11. Suggested power mode against the fix periodicity

Fix Periodicity	Appropriate mode
0.1s-1s	None
1s – 10s	Adaptive and Cyclic modes
5s-24H	Standby Periodic mode + optional ST-AGNSS
Asynchronous	Fix On Demand

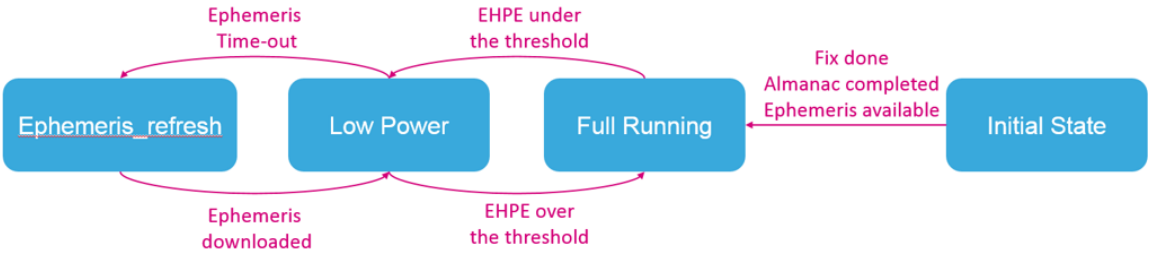
11.1 Adaptive and cyclic mode state diagram

The library, using the estimated horizontal position error (EHPE), implements a dynamic constellation switch, in this way the device is able to optimize the usage of multi-constellation satellites allowing the customer to select the proper compromise between accuracy performance and power consumption.

EHPE is a measure of the error in a GNSS position on the horizontal plane. This value can be monitored in the NMEA sentences $GPGST.

The following figure shows the algorithm’s state diagram:

Figure 21. **Adaptive and cyclic mode state diagram**



The adaptive and cyclic low power algorithm is scheduled every second.

Initial state is achieved only after the steady state is reached. The steady state in GNSS mode is a particular condition in which the software turns off the acquisition engine.

This condition is reached when all the following conditions are taken (true):

- the system is in position accurate condition (position fix available);
- ephemeris available (4 for GPS, 4 for GLONASS);
- almanac completely downloaded.

Generally, at first start up (full cold mode) this condition, in full sky is reached in 12.5 minutes.

Table 12. **Algorithm finite states machine descriptions**

State	Description	Next state
INITIAL_STATE		• FULL_CONST only when all the three condition are taken: • position fix available • almanac completely downloaded • ephemeris available (4 for GPS, 4 for GLONASS);
FULL_CONST	• All the GNSS constellation enabled in the firmware-configuration are active during the runtime	• LOW_POWER_STATE only if EHPE average is less than EHPE threshold (good sky condition)
LOW_POWER	Only one GNSS constellation is available (Dynamic constellation ON/OFF) and only the first N GPS/GLONASS satellites (with higher elevation) are used for the position calculation (Active channel management), duty cycle for every channels enabled. Turn-on the ephemeris-refresh timer	• FULL_CONST only if EHPE average is greater than EHPE threshold (bad sky condition) • EPHEMERIS_REFRESH only if the ephemeris-refresh timeout fires (30 minutes timeout)
EPHEMERIS_REFRESH	Turn on all constellation until the ephemeris are available	• LOW_POWER_STATE only when the ephemeris are downloaded

The Adaptive low power management can operate even in the case in which the constellation enabled is GPS only and GLONASS only. In this case, the low power state only consists in reducing the GPS/GLONASS used satellites.

Table 13. **Adaptive low power mode**

	LOW POWER MODE	Features
1	Dynamic Constellation ON/OFF	Constellation switch (GPS only enabled) based on estimated EHPE / Duty Cycle enable / ephemeris refresh / ability to reduce the tracked satellites (better elevation) / ability to disable the duty cycle based on estimated EHPE
2	Dynamic Constellation ON/OFF (standard mode)	Constellation switch (GPS only enabled) based on estimated EHPE / ephemeris refresh / ability to reduce the tracked satellites (better elevation)
3	Only Duty Cycle mode	Duty Cycle enable / ephemeris refresh / ability to disable the duty cycle based on estimated EHPE
4	Duty Cycle mode with reduced satellites (better elevation)	Duty Cycle enable / ephemeris refresh / ability to disable the duty cycle based on estimated EHPE / ability to reduce the tracked satellites

11.2 Periodic mode

The periodic mode has different settings to control the FIX reporting, and other settings to control the low power hardware state.

The periodic mode can have two different hardware states between FIX activities:

- Wait for interrupt state used in active periodic mode, where the system clock is set to the RING oscillator (a low power oscillator)
- Standby state used in standby periodic mode, where only Always ON domain is alive

Although the Wait For Interrupt hardware state ensure continuity of software execution and maintain data, the Standby hardware state is a reset and ARM core state and on-board memories except backup RAM are lost.

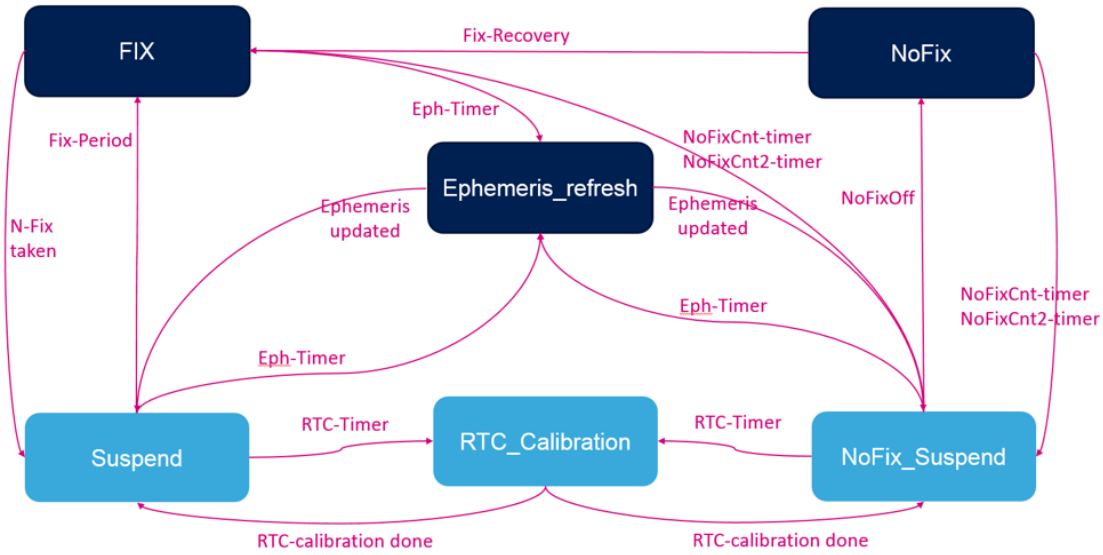
11.2.1 State machine

The periodic mode has basically two parts in its state machine – one to handle the fix (left) and one to handle the case of no fix (right). The transitions between both in case of fix loss or recovery is done according to the steady state condition. The steady state is the combination of the following information:

- The system is in position accurate condition (position fix available);
- Ephemeris available (5 each activated constellations);
- Almanac, ephemeris or health information collected for all satellites.

Generally, at first start up (full cold mode) this condition, in full sky is reached in 12.5 minutes for GPS constellation.

Figure 22. **Low power periodic mode state diagram**



The following table details the different states:

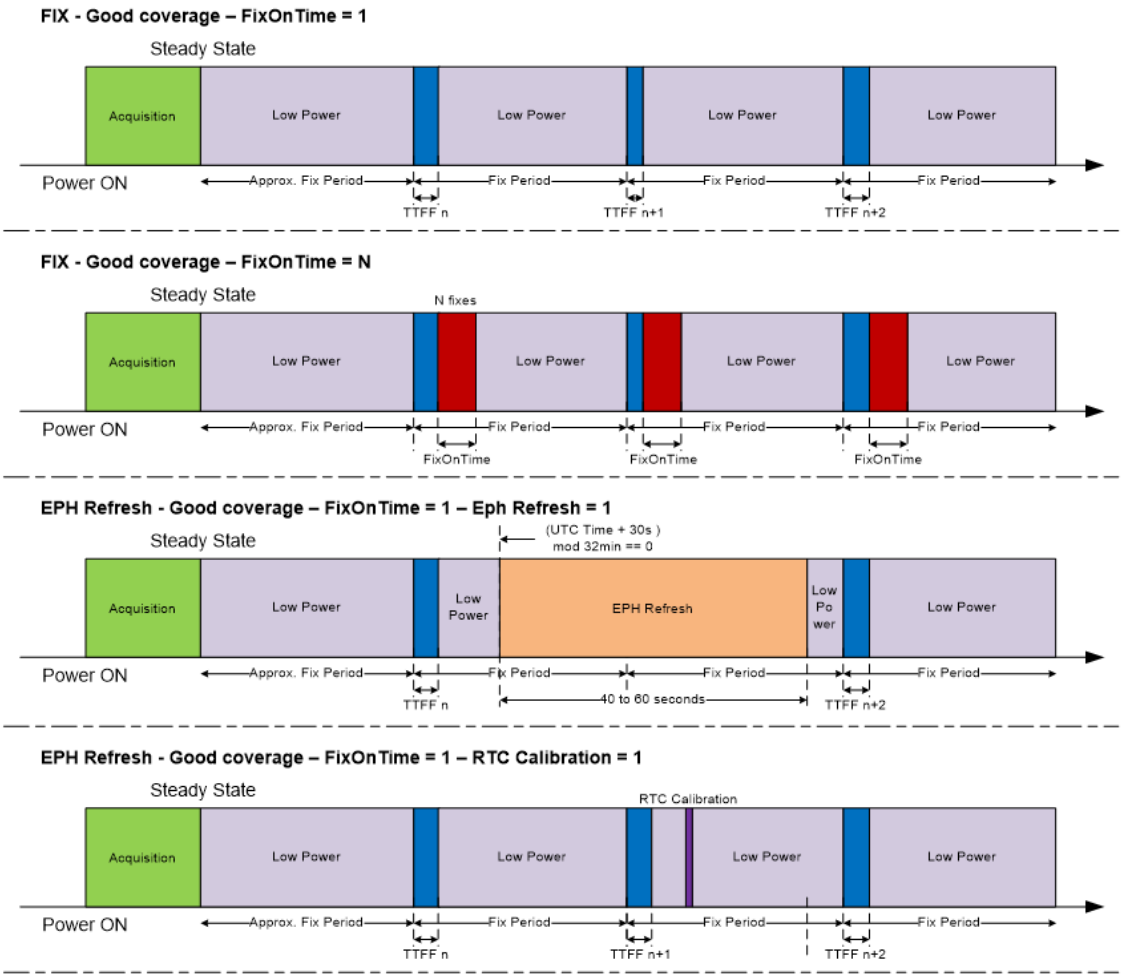
Table 14. Periodic mode finite state machine description

State	Description	Next state
SUSPEND	GNSS system sleeping. CPU in idle. System running at low frequency. Three timers running: • *FixPeriod* timer • *EphRefresh* timer • *RTC_clb* timer	FIX when FixPeriod timer fires
		EPH_REFRESH when EphRefresh timer fires (32 minutes timer)
		RTC_CALIB when RTC_clb timer fires (5 minutes timer)
FIX	GNSS system running to acquire a series of N fixes. CPU running Three timers running: • – ◦ *NoFixCnt* timer • *NoFixCnt2* timer • *EphRefresh* timer	SUSPEND when the N fixes are acquired
		NOFIX_SUS when the N fixes serie can not be completed and NoFixCnt timers fire (in HOT conditions)
		• NOFIX_SUS when the N fixes serie can not be completed and NoFixCnt2 timer fire • (in NOT-HOT conditions)
		• EPH_REFRESH when EphRefresh timer fires (32 minutes timer)
EPH_REFRESH	GNSS system running for 40/60s to download new ephemeris. CPU running Two timers running: • *NoFixCnt* timer • *NoFixCnt2* timer	• SUSPEND when ephemeris download completes
		• NOFIX_SUS when ephemeris download doesn't complete and NoFixCnt timers fire (in HOT conditions)
		• NOFIX_SUS when ephemeris download doesn't complete and NoFixCnt2 timer fire • (in NOT-HOT conditions)
NOFIX_SUS	GNSS system sleeping due to No satellites signal or no fix acquired CPU in idle. System running at low frequency. Three timers running: • *EphRefresh* timer • *NoFixCnt* timer • *NoFixCnt2* timer	EPH_REFRESH when EphRefresh timer fires (32 minutes timer)
		NOFIX when NoFixCnt timer fires (in HOT conditions)
		NOFIX when NoFixCnt2 timer fires (in NOT-HOT conditions)
NOFIX	GNSS system running but unable to acquire a fix. Two timers running: • *NoFixCnt* timer • *NoFixCnt2* timer	FIX if a fix is acquired
		NOFIX_SUS when fix is not acquired and NoFixCnt timer fires (in HOT conditions)
		NOFIX_SUS when fix is not acquired and NoFixCnt2 timer fires (in NOT-HOT conditions)
RTC Calibration	GNSS system sleeping. CPU running for rtc_calibration; calibration is performed at higher frequency settings	SUSPEND when calibration completes

HOT conditions: number of ephemeris and RTC are OK.
NOT-HOT conditions: start-up cases, obsolete ephemeris.

11.2.2 Good GNSS coverage sequences

Figure 23. **GNSS good coverage sequences**



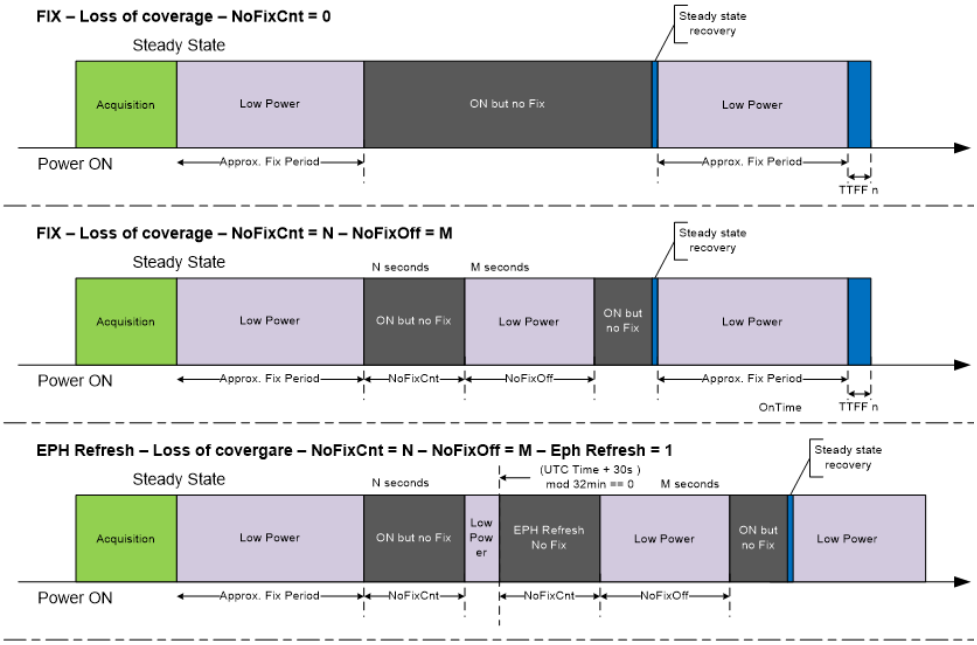
All sequences begin with an acquisition phase where all visible satellite ephemeris and almanacs are downloaded. The position of the first fix after the first low power period is approximate, but all next periods are regularly placed every “Fix Period”.

Sequence 3: example of an ephemeris download period among the fixes.

Sequence 4: example of the RTC calibration among the fixes.

11.2.3 Poor GNSS coverage sequences

Figure 24. **GNSS poor coverage sequences**



In all sequences, the acquisition phase is ok and all ephemeris and almanacs are downloaded. The steady state is entered, but a loss of coverage occurs during the Low Power period.

Sequence 1: *NoFixCnt* = 0 means we don't alternate fix activities and low power periods. On the GNSS activation, the loss of coverage is detected and the Teseo-Module will remain active until the recovery of the fix.

Sequence 2: As *NoFixCnt* is different from 0, the GNSS solution will remain active during N seconds and go back to low power state during M seconds. It will alternate this way until the fix is recovered.

Sequence 3: Despite the loss of coverage, the GNSS solution will try to decode the satellites when the ephemeris refresh activity is due. Instead of lasting 40 to 60s, the trial period will be only N seconds.

11.3 Shutdown

Safer shutdown procedure avoiding interrupted NVM driver operations can be implemented using the NMEA command $PSTMGPSSUSPEND.

When the Teseo-Module shutdown procedure is completed the Teseo-Module replies with a NMEA message $PSTMGPSSUSPENDED.

When the NMEA message $PSTMGPSSUSPENDED is received the Teseo-Module can be switched-OFF.

12 Low latency interface

Low Latency Inteface (LLI) implements a different mode of sending PVT data.

If LLI is disabled, when the new FIX is computed the GNSS-lib generates a FIX-Event and on that the NMEA process generates the message (i.e.: $xxGGA) with the PVT data and sends it to UART. This processing leads to delay jittering in the output messages.

If the LLI mode is enabled, the PVT data are interpolated by propagating the latest PTV values up to the UTC time-stamp of the NMEA message and then sent regularly without waiting for the fix event. Propagation is carried out using a faster algorithm therefore there is no jittering.

The propagation mode is always the same: hypothesis of uniform rectilinear motion starting from the last known point.

LLI can be enabled/disabled in the Application-CDB, moreover LLI rate can be configured in the CDB-ID 300 – Low Latency Interface rate

LLI is supported only on the message-list-2.

13 NMEA command specification

13.1 ST NMEA command specifications

13.1.1 $PSTMINITGPS

Initialize GNSS position and time using UTC format. This command must be issued after a cold reset or it fails. The date issued with parameters day, month and year must be later than January 2015, this threshold can be changed using the configuration options.

Synopsis:

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

Arguments:

Table 15. $PSTMINITGPS field description

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 (2015 - …)
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)

Results:

- The position and time will be initialized
- In case of no errors, the $PSTMINITGPSOK message is returned
- In case of errors, the error message $PSTMINITGPSERROR is returned

Example:

```
$PSTMINITGPS,4811.365,N,01164.123,E,0530,23,02,2015,09,44,12
```

13.1.2 $PSTMINITTIME

Initialize GPS time using UTC format. The date issued with parameters day, month and year must be later than January 2015, this threshold can be changed using the configuration options.

Synopsis:

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

Arguments:

Table 16. **$PSTMINITTIME field description**

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 (2015 - …)
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)

Results:

- The position and time will be initialized
- In case of no errors, the $PSTMINITTIMEOK message is returned
- In case of errors, the $PSTMINITTIMEERROR error message is returned

Example:

```
$PSTMINITTIME,23,02,2015,09,44,12
```

13.1.3 $PSTMINITFRQ

Initialize the centre frequency. This command can be used to set the local oscillator frequency offset.

Synopsis:

```
$PSTMINITFRQ,<offset>*<checksum><cr><lf>
```

Arguments:

Table 17. **$PSTMINITFRQ field description**

Parameter	Format	Description
offset	Decimal, 6 digits	Frequency offset in Hz

Results:

- The centre frequency will be initialized

Example:

```
$PSTMINITFRQ,-47000*<checksum><cr><lf>
```

13.1.4 $PSTMSETRANGE

Set the frequency range for satellite searching. The “min.” and “max.” values are used as offsets versus the centre frequency.

Synopsis:

```
$PSTMSETRANGE,<min>,<max>*<checksum><cr><lf>
```

Arguments:

Table 18. **$PSTMSETRANGE field description**

Parameter	Format	Description
min	Decimal, 6 digits	Lower limit range in Hz

Parameter	Format	Description
max	Decimal, 6 digits	Upper limit range in Hz

Results:

- In case of no errors, the $PSTMSETRANGEOK message is returned
- In case of errors, the $PSTMSETRANGEERROR error message is returned

Example:

```
$PSTMSETRANGE,-57000,-37000*<checksum><cr><lf>
```

13.1.5 $PSTMALMANAC

Load almanacs data. This command allows the user to load the almanacs data into NVM memory.

Synopsis:

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

Arguments:

Table 19. **$PSTMALMANAC field description**

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 without *<checksum><cr><lf> characters.

The N Bytes that are in the parameters are the dump of a structures that contain all the information of the almanac.

Data format are constellation dependant.

Table 20. **$PSTMALMANAC field description 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	Contains 1 if the satellite is unhealthy 0 if healthy.
1	available	Contains 1 if almanac is available 0 if not.

Table 21. **$PSTMALMANAC field description 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	Contains 1 if the satellite is unhealthy 0 if healthy.
1	available	Contains 1 if almanac is available 0 if not.
32	Tau_c	
11	NA	
5	N4	
16	Spare	

Table 22. $PSTMALMANAC field description 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	Contains 1 if the satellite is unhealthy 0 if healthy.
2	RESERVED	RESERVED for use by GNSS library
1	health	Contains 1 if the satellite is unhealthy, 0 if healthy
1	available	Contains 1 if almanac is available 0 if not.

Table 23. $PSTMALMANAC field description 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	

Bits	Structure member	Description
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	Contains 1 if almanac is available 0 if not.
8	last_received_toa	
6	spare6	

Results:

- The almanac will stored into backup memory
- In case of no errors the message $PSTMALMANACOK is returned
- In case of errors, the $PSTMALMANACERROR error message is returned

Example:

```
$PSTMALMANAC,12,32,0c1a06907c1a971160fd0800fa0da141ae9f0600d912e90075669700490f8000*75
```

13.1.6 $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 non-volatile backup memory, will be deleted.
- No message will be sent as reply.

Example:

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

13.1.7 $PSTMDUMPALMANAC

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

Synopsis:

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

Arguments:

None.

Results:

- Teseo-Module replies with the $PSTMALMANAC messages

Example:

```
$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
```

13.1.8 $PSTMEPHEM

This command allows the user to load the ephemeris data into NVM memory.

The commands need to be issued, between two consecutive commands there must be at least a 20 millisecond delay.

Synopsis:

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

Arguments:

Table 24. $PSTMEPHEM field description

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

The N Bytes that are in the parameters are the dump of structures that contain all the information of the ephemeris.

Results:

- The ephemeris will be stored into backup RAM
- In case of no errors, the $PSTMEPHEMOK message is returned
- In case of errors, the $PSTMEPHEMERROR error message is returned

Data format are constellation dependant.

Table 25. $PSTMEPHEM field description 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.

Bits	Structure member	Description
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	Contains 1 if ephemeris is available, 0 if not
1	health	Contains 1 if the satellite is unhealthy, 0 if healthy
1	RESERVED	Must be 0.
4	accuracy	Accuracy

Table 26. $PSTMEPHEM field description 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 (LBS).
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.
2	KP	Notification on forthcoming leap second correction of UTC

Bits	Structure member	Description
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	RESERVED	
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	Contains 1 if ephemeris is available, 0 if not.
1	health	Contains 1 if the satellite is unhealthy, 0 if healthy.
1	RESERVED	Must be 0.
4	RESERVED	

Table 27. **$PSTMEPHEM field description for Galileo constellation**

Bits	Structure member	Description
16	week	Week number of the Issue of Data
14	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	Contains 1 if ephemeris is available, 0 if not
1	health	Contains 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	

Bits	Structure member	Description
6	RESERVED	Must be 0
26	RESERVED	RESERVED for use by GNSS library – must be 1
1	RESERVED	Must be 0.

Table 28. $PSTMEPHEM field description 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

Bits	Structure member	Description
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	Contains 1 if ephemeris is available, 0 if not
1	health	Contains 1 if the satellite is unhealthy, 0 if healthy

Example:

```
$PSTMEPHEM,12,64,
0f06bc34bc3437373790f40045a7ff00fcf5d522480b4bf71b00fbff8931000096126f271f869101c3870ca107
afce79a763e13e360a1ce8e7003100380ff903*36
```

13.1.9 $PSTMCLREPHS

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

Synopsis:

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

Arguments:

None.

Results:

- All ephemeris, stored in the non-volatile backup memory will be deleted.
- No message will be sent as reply.

Example:

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

13.1.10 $PSTMDUMPEPHEMS

This command sends out all ephemeris stored in the backup memory.

Synopsis:

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

Arguments:

None.

Results:

- Teseo-Module replies with the $PSTMEPHEM messages

Example:

```
$PSTMDUMPEPHEMS
$PSTMEPHEM,1,64,
0f06bc34bc345f5f5f84f400dea4ff00f9f63c239f0a35f81400fbff
33420000ee632f27698ef001afa50da16cfcfa22e0b65a3e7a3cee27d700f7ffc616fe03
*57
$PSTMEPHEM,2,64
0f06bc34bc344f4f4f78110019a5ff00b004fa1d1e0e3f04c8ffcaff
1937000033515726556ba9048eae0da1b6c346bd8f985c93ade10c76db001d00f8c7c503
*58
$PSTMEPHEM,4,64,
0f06bb34bb344b4b4b98050038a4ff000005351e110eea041b00b8ff
d037000020b84e26b5138b0425580ca16b211030e68b1a949cac9615f30066ffea92f603
*06
$PSTMEPHEM,9,64,
0f06bc34bc341818189c0a0069aaff005f06eb249a09ca0477ff6c00
f72e00005131d827592b950a91010da1c7af88538e7ca1122fb9be3df4001300c4a0c203
*52
```

13.1.11 $PSTMSRR

Executes a system reset. The GNSS firmware is rebooted.

Synopsis:

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

Arguments:

None.

Results:

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

Example:

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

13.1.12 $PSTMGPSRESET

Reset the GNSS Teseo-Module engine.

Synopsis:

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

Arguments:

None.

Results:

- The Teseo-Module engine will be reset
- No message will be sent as reply.

Note: using this command the GNSS module won’t reboot.

Example:

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

13.1.13 $PSTMGPSSUSPEND

Suspend the GNSS Teseo-Module engine.

Synopsis:

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

Arguments:

None.

Results:

- the $PSTMGPSSUSPENDED message will be sent when Teseo-Module engine is suspended

Example:

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

13.1.14 $PSTMGPSRESTART

Restart the GNSS Teseo-Module engine.

Synopsis:

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

Arguments:

None.

Results:

- The GNSS Teseo-Module engine will be restarted
- No message will be sent as reply.

Example:

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

13.1.15 $PSTMCOLD

Perform a COLD start.

Synopsis:

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

Arguments:

Table 29. $PSTMCOLD field description

Parameter	Format	Description
Mask	Integer	Optional parameter to invalidate time, position, ephemeris and almanac : 0x1 – clear almanac 0x2 – clear ephemeris 0x4 – clear position 0x8 – clear time

Results:

- Coldstart initialization and system restart.
- If Mask parameter is used, only the selected GPS data is invalidated for this actual Coldstart. Multiple selects are supported (i.e. 0xD).
- If Mask parameter is not used, default is 0xE (clear ephemeris, time and position).

Example:

```
$PSTMCOLD,6
```

Note: The GNSS engine will be reset. It is not a system reboot.

13.1.16 $PSTMWARM

Perform a WARM start.

Synopsis:

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

Arguments:

None.

Results:

- Warm start initialization and system restart.

Example:

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

Note: The GNSS engine will be reset. It is not a system reboot.

13.1.17 $PSTMHOT

Perform an HOT start.

Synopsis:

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

Arguments:

None.

Results:

- The system restart.

Example:

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

Note: The GNSS engine will be reset. It is not a system reboot.

13.1.18 $PSTMNMEAONOFF

Toggle NMEA output. This command switches ON or OFF the output NMEA messages.

Synopsis:

```
$PSTMNMEAONOFF,<on_off>*<checksum><cr><lf>
```

Arguments:

Table 30. $PSTMNMEAONOFF field description

Parameter	Format	Description
on_off	Integer	0 = NMEA output is turned OFF 1 = NMEA output is turned ON

Results:

- NMEA output message is started or stopped according the ‘on_off’ field value.

Example:

```
$PSTMNMEAONOFF,0*<checksum><cr><lf>
```

13.1.19 $PSTMGNSSINV

Invalidate the GNSS Fix Status.

Synopsis:

```
$PSTMGNSSINV,<invalid>*<checksum><cr><lf>
```

Arguments:

Table 31. $PSTMGNSSINV field description

Parameter	Format	Description
invalid	Integer	Invalid flag allowing to change the GNSS Fix status 1: GNSS Fix status is set to NO_FIX 0: GNSS Fix Status unchanged

Results:

- `$PSTMGNSSINV,1` invalidates the GNSS Fix Status. A NO FIX status is so simulated.
- `$PSTMGNSSINV,0` allows to restore the real GNSS Fix status.

Example:

```
$PSTMGNSSINV,1*<checksum><cr><lf>
```

13.1.20 $PSTMTIMEINV

Invalidate the Real Time Clock (RTC).

Synopsis:

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

Arguments:

None.

Results:

- The RTC time will be invalidated.

Example:

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

13.1.21 $PSTMGETSWVER

Get the version string of the libraries embedded in the software application.

Synopsis:

```
$PSTMGETSWVER,<id>*<checksum><cr><lf>
```

Arguments:

Table 32. $PSTMGETSWVER field description

Parameter	Format	Description
id	Integer	Depending on the value of the <lib_id> parameter, the following version numbering is delivered by the command: 0 = GNSS Library Version 1 = OS20 Version

Parameter	Format	Description
		2 = SDK App Version 6 = Binary Image Version 7 = STA8089 HW version 11 = SW configuration ID 12 = Product ID 254 = configuration data block 255 = all versions strings (as reported at the NMEA startup).

Results:

- GNSS replies with $PSTMVER messages

13.1.22 $PSTMNVMSWAP

Execute a bank swap on the NVM memory.

Synopsis:

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

Arguments:

None.

Results:

- The non-volatile backup memory banks will be swapped

Example:

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

13.1.23 $PSTMSBASONOFF

Suspend / resume the SBAS software execution.

Synopsis:

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

Arguments:

None.

Results:

- If SBAS was running it will be suspended, if it was suspended it will start to run.

Example:

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

13.1.24 $PSTMSBASSERVICE

Change the SBAS service.

Synopsis:

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

Arguments:

Table 33. **$PSTMBASSERVICE field description**

Parameter	Format	Description
service	Integer	SBAS service 0 = WAAS 1 = EGNOS 2 = MSAS 3 = GAGAN 4 = SDCM 7 = OFF 15 = AUTO

Results:

- The SBAS engine will put in tracker all the satellites, which correspond to the specified service.
- With SBAS service OFF, no satellites are put in tracker. In that case, SBAS frames are to be provided to the SBAS engine through the $PSTMSBASM command
- With SBAS AUTO, the SBAS engines automatically selects the appropriate SBAS service based on the computed user position latitude and longitude.
- In case of no errors, the $PSTMSBASSERVICEOK message is returned
- In case of errors, the $PSTMSBASSERVICEERROR error message is returned

Example:

```
$PSTMSBASSERVICE,15*<checksum><cr><lf>
```

13.1.25 $PSTMSBASSAT

Change the SBAS satellite.

Synopsis:

```
$PSTMSBASSAT,<prn>*<checksum><cr><lf>
```

Arguments:

Table 34. **$PSTMSBASSAT field description**

Parameter	Format	Description
prn	Decimal, 3 digit	Satellite PRN (range: from 120 to 140)

Results:

- Kept for compatibility. Set SBAS service AUTO.
- The preferred NMEA command is $PSTMSBASSERVICE.

Example:

```
$PSTMSBASSAT,120*<checksum><cr><lf>
```

13.1.26 $PSTMSBASM

Send a SBAS frame to the SBAS engine.

Synopsis:

```
$PSTMSBASM,<prn><sbas_frame>*<checksum><cr><lf>
```

Arguments:

Table 35. **$PSTMSBASM field description**

Parameter	Format	Description
prn	Decimal, 3 digits	Satellite PRN (Range: from 120 to 140)
sbas_frame	Hexadecimal, 64 digits	SBAS frame (250 bits + 6 padding)

Results:

- Sends the SBAS frame to the SBAS engine.
- Note: The SBAS service has to be set to OFF before sending SBAS frames so that no SBAS satellites are put in tracking.
- In case of no errors, the $PSTMSBASMOK message is returned
- In case of errors, the $PSTMSBASMERROR error message is returned

Example:

```
$PSTMSBASM,123,536A481B40D8063829C12E08704B82DFFDFFEFFF7FFBFFDFFEF06E803
7EFB440*6D
```

13.1.27 $PSTMRFTESTON

Enable the RF test mode for production line tests.

Synopsis:

```
$PSTMRFTESTON,<sat_id>*<checksum><cr><lf>
```

Arguments:

Table 36. **$PSTMRFTESTON field description**

Parameter	Format	Description
sat_id	Decimal, 2 digits	Satellite number

Results:

- The GNSS engine will restart in the RF test modality. This RF test forces the GNSS acquiring process only on the provided satellite's id. It could be useful to reduce the RF testing time in the production line where generally a single channel simulator is present

Example:

```
$PSTMRFTESTON,24*<checksum><cr><lf>
```

13.1.28 $PSTMRFTESTOFF

Disable the RF test mode for production line tests.

Synopsis:

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

Arguments:

None.

Results:

- The RF test modality will be disabled and the GNSS engine will be restarted.

Note: the RF test mode can be disabled also resetting the Teseo-Module.

Example:

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

13.1.29 $PSTMGETALGO

Get False Detection and Exclusion (FDE) algorithm ON/OFF status.

Synopsis:

```
$PSTMGETALGO,<algo_type>*<checksum><cr><lf>
```

Arguments:

Table 37. $PSTMGETALGO field description

Parameter	Format	Description
algo_type	Decimal, 1 digit	1 = FDE algorithm on/off status is returned.

Results:

- In case of no errors, the $PSTMGETALGOOK message is returned
- In case of errors, the $PSTMGETALGOERROR error message is returned

Example:

```
$PSTMGETALGO,1*<checksum><cr><lf>
```

13.1.30 $PSTMSETALGO

Set false detection and exclusion (FDE) algorithm ON/OFF status.

Synopsis:

```
$PSTMSETALGO,<algo_type>,<algo_status>*<checksum><cr><lf>
```

Arguments:

Table 38. $PSTMSETALGO field description

Parameter	Format	Description
algo_type	Decimal, 1 digit	1 = FDE algorithm on/off status is returned.
algo_status	Decimal, 1 digit	0 = the algorithm is disabled. 1 = the algorithm is enabled.

Results:

- In case of no errors, the $PSTMSETALGOOK message is returned
- In case of errors, the $PSTMSETALGOERROR error message is returned

Example:

```
$PSTMSETALGO,1,0*<checksum><cr><lf>
```

13.1.31 $PSTMGETRTCTIME

Get the current RTC time.

Synopsis:

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

Arguments:

None.

Results:

- System will send $PSTMGETRTCTIME message

Example:

```
$PSTMGETRTCTIME
```

13.1.32 $PSTMDATUMSELECT

Set a local geodetic datum different from WGS84 (default).

Synopsis:

```
$PSTMDATUMSELECT,<datum_type>*<checksum><cr><lf>
```

Arguments:

Table 39. $PSTMDATUMSELECT field description

Parameter	Format	Description
datum_type	Integer	The following datum are selectable: 0 : WGS84 1: TOKYO MEAN 2: OSGB

Results:

- In case of no errors, the $PSTMDATUMSELECTOK message is returned
- In case of errors, the $PSTMDATUMSELECTERROR error message is returned

Example:

```
$PSTMSELETDATUM,1*<checksum><cr><lf>
```

13.1.33 $PSTMDATUMSETPARAM

Set parameters to local geodetic to WGS84 datum transformations.

Synopsis:

```
$PSTMDATUMSETPARAM,<d_x>,<d_y>,<d_z>,<d_a>,<d_f>*<checksum><cr><lf>
```

Arguments:

Table 40. $PSTMDATUMSETPARAM field description

Parameter	Format	Description
d_x d_y d_z	Decimal	shifts between centres of the local geodetic datum and WGS84 Ellipsoid
d_a	Decimal	differences between the semi-major axis of the local geodetic datum ellipsoid and the WGS 84 ellipsoid, respectively (WGS 84 minus Local)
d_f	Decimal	differences between flattening of the local geodetic datum ellipsoid and the WGS 84 ellipsoid, respectively (WGS 84 minus Local)

Results:

- In case of no errors, the $PSTMDATUMSETPARAMOK message is returned
- In case of errors, the $PSTMDATUMSETPARAMERROR error message is returned

Example:

```
$PSTMDATUMSETPARAM,-375,111,-431,-573.60, -0.000011960023
```

13.1.34 $PSTMENABLEPOSITIONHOLD

Enable/disable and set position for the Position Hold feature.

Synopsis:

```
$PSTMENABLEPOSITIONHOLD,<on_off>,<Lat>,<LatRef>,<Lon>,<LonRef>,
<Alt>*<checksum><cr><lf>
```

Arguments:

Table 41. $PSTMENABLEPOSITIONHOLD field description

Parameter	Format	Description
on_off	Decimal, 1 digit	Set the position hold enable/disable status: 0: disabled. 1: enabled.
Lat	DDMM.MMMMM	Latitude (Degree-Minute.Minute decimals)
LatRef	'N' or 'S'	Latitude direction (North or South)
Lon	DDDMM.MMMMM	Longitude (Degree-Minute.Minute decimals)
LonRef	'E' or 'W'	Longitude Direction (East or West)
Alt	dddddd.dddd	Altitude in meters (-1500 to 100000)

Results:

- In case of no errors, and position hold is enabled the $PSTMPOSITIONHOLDENABLED message is returned
- In case of no errors, and position hold is disabled the $PSTMPOSITIONHOLDDISABLED message is returned
- In case of error the $PSTMENABLEPOSITIONHOLDERROR error message is sent:

Example:

```
$PSTMENABLEPOSITIONHOLD,1,4811.365,N,01164.123,E,0530.0
```

Note: The altitude value must be reported without any geoid correction. It means that if the altitude value is retrieved by the $GPGGA message it must be added to the geoid correction before using it in the $PSTMENABLEPOSITIONHOLD command. This limitation may be removed in the future releases.

13.1.35 $PSTMSETCONSTMASK

Set the GNSS constellation mask. It allows switching the GNSS constellation at run-time.

Synopsis:

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

Arguments:

Table 42. $PSTMSETCONSTMASK field description

Parameter	Format	Description
constellation_mask	Decimal, 1 digit	It is a bit mask where each bit enable/disable a specific constellation independently by the others:

Parameter	Format	Description
		bit 0: GPS constellation enabling/disabling bit 1: GLONASS constellation enabling/disabling bit 2: QZSS constellation enabling/disabling bit 3: GALILELO constellation enabling/disabling bit 7: BEIDOU constellation enabling/disabling

Results:

- In case of no errors, the $PSTMSETCONSTMASKOK message is returned
- In case of errors, the $PSTMSETCONSTMASKERROR error message is returned

Examples:

Enabling GPS only:

```
$PSTMSETCONSTMASK,1*<checksum><cr><lf>
```

Enabling GLONASS only:

```
$PSTMSETCONSTMASK,2*<checksum><cr><lf>
```

Enabling GPS and GLONASS:

```
$PSTMSETCONSTMASK,3*<checksum><cr><lf>
```

13.1.36 $PSTMNOTCH

This command set the Adaptive Notch Filter (ANF) operation mode

Synopsis:

```
$PSTMNOTCH,<Sat_type>,<Mode>,<Frequency>,<kbw_gross>,<kbw_fine>,
<threshold>*<checksum><cr><lf>
```

Arguments:

Table 43. $PSTMNOTCH field description

Parameter	Format	Description
Sat_type	Decimal, 1 digits [Mandatory]	Sat type ANF path [0 -> GPS; 1->GLONASS]
Mode	Decimal, 1 digits [Mandatory]	ANF operation mode [0, disable, 1always on, 2 Auto (suggested)]
Frequency	Decimal, 8 digits [Optional]	IF Frequency, at which Notch search starts 0-8MHz range GPS / 0-16MHz Range Glonass path.
kbw_gross	Decimal, 1 digit [Optional]	Scan Speed [4,5,6 are supported values, the bigger the slower]. 5 is defauly
kbw_fine	Decimal, 1 digit [Optional]	Bandwidth Removed [4,5,6 are supported values, the smaller the bigger]. 6 is default
threshold	Decimal, 5 digits [Optional]	Detection threshold to lock the Notch at a given frequency [Default values *3010 (GPS)/3556(GLONASS)*]

The command can be issued in the following form:

Standard configuration (2 parameters only):

```
$PSTMNOTCH,<sat_type>,<mode>*<checksum><cr><lf>
```

Enhanced configuration (3 parameters):

```
$PSTMNOTCH,<sat_type>,<mode>,<frequency>*<checksum><cr><lf>
```

that accepts more the frequency parameter to start search for RFI.

Full configuration(6 parameters):

```
$PSTMNOTCH,Sat_type,Mode,Frequency,kbw_gross,kbw_fine,threshold*<checksum><cr><lf>
```

That allows completely tuning filter behaviour (speed / bandwidth / detection threshold).

Other configurations, with a different number of parameters and/or values out of specs are not supported and can result in not predictable behaviours.

Results:

- This command set the ANF operation mode.

Example:

Standard configuration

```
$PSTMNOTCH,0,0 [GPS path, ANF disabled]
$PSTMNOTCH,0,1 [GPS path, ANF set in always ON mode]
[For Int. usage only]
$PSTMNOTCH,0,2
[GPS path, auto insertion mode, Initial Scan Frequency is set @ 4f0][Default]
$PSTMNOTCH,1,0 [GLONASS path, ANF disabled]
$PSTMNOTCH,1,1 [GLONASS path, always ON mode]
[For Int.usage only]
$PSTMNOTCH,1,2
[GLONASS path, auto insertion mode, Initial Scan Frequency is set @ 8f0] [Default]
```

Extra supported usages

```
$PSTMNOTCH,0,2,frequency
[GPS path, auto insertion mode, Initial Frequency is frequency (Hz)]
$PSTMNOTCH,1,2,frequency
[GLONASS path, auto insertion mode, Initial Frequency is frequency (Hz)]
$PSTMNOTCH,0,2,frequency, kbw_gross, kbw_fine, threshold
[GPS path, auto insertion mode, Initial Scan Frequency (Hz), kbw_gross, kbw_fine, threshold
$PSTMNOTCH,1,2,frequency, kbw_gross, kbw_fine, threshold
[GLONASS path, auto insertion mode, Initial Frequency (Hz), kbw_gross, kbw_fine, threshold]
```

Usage note:

By default the

- **`$PSTMNOTCH,0,2`** command (notch enabled in Auto mode on GPS branch) corresponds to the explicit
  - *PSTMNOTCH,0,2,4092000,5,6, 3010*
- **`$PSTMNOTCH,1,2`** command (Notch enabled in Auto mode on Glonass Branch) corresponds to the explicit
  - *PSTMNOTCH,1,2,8184000,5,6, 3556*

13.1.37 $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:

Table 44. **$PSTMPPS field description**

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 digit	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		Parameters list according to the command type specification (see below).

Results:

- In case of errors, the $PSTMPPSERROR error message is returned

PPS Get PPS_IF_PULSE_DATA_CMD

Synopsis:

```
$PSTMPPS,1,7
```

PPS Get PPS_IF_TIMING_DATA_CMD

Synopsis:

```
$PSTMPPS,1,12
```

PPS Get PPS_IF_POSITION_HOLD_DATA_CMD

Synopsis:

```
$PSTMPPS,1,13
```

PPS Get PPS_IF_TRAIM_CMD

Synopsis:

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

PPS Get PPS_IF_TRAIM_USED_CMD

Synopsis:

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

PPS Get PPS_IF_TRAIM_RES_CMD

Synopsis:

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

PPS Get PPS_IF_TRAIM_REMOVED_CMD

Synopsis:

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

PPS Set PPS_IF_ON_OFF_CMD

Synopsis:

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

Arguments:

Table 45. $PSTMPPS field description on PPS_IF_ON_OFF_CMD

Parameter	Format	Description
on_off	Decimal, 1 digit	0 = PPS disabled. 1 = PPS enabled.

Results:

- According to the operation mode and to the command type, data is set into the PPS manager or it is retrieved from the PPS manager.

PPS Set PPS_IF_OUT_MODE_CMD

Synopsis:

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

Arguments:

Table 46. $PSTMPPS field description on PPS_IF_OUT_MODE_CMD

Parameter	Format	Description
out_mode	Decimal, 1 digit	0 = PPS always generated. 1 = PPS generated on even seconds. 2 = PPS generated on odd seconds.

Results:

- According to the operation mode and to the command type, data is set into the PPS manager or it is retrieved from the PPS manager.

PPS Set PPS_IF_REFERENCE_TIME_CMD

Synopsis:

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

Arguments:

Table 47. $PSTMPPS field description on PPS_IF_REFERENCE_TIME_CMD

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, it is 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.

Results:

- According to the operation mode and to the command type, data is set into the PPS manager or it is retrieved from the PPS manager.

PPS Set PPS_IF_PULSE_DELAY_CMD

Synopsis:

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

Arguments:

Table 48. $PSTMPPS field description on PPS_IF_PULSE_DELAY_CMD

Parameter	Format	Description
pulse_delay	Decimal	Pulse delay [ns]

Results:

- According to the operation mode and to the command type, data is set into the PPS manager or it is retrieved from the PPS manager.

PPS Set PPS_IF_CONSTELLATION_RF_DELAY_CMD

Synopsis:

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

Arguments:

Table 49. $PSTMPPS field description on PPS_IF_CONSTELLATION_RF_DELAY_CMD

Parameter	Format	Description
sat_type	Decimal	Satellite constellation type: 0 = GPS 1 = GLONASS 3 = Galileo 7 = BEIDOU
time_delay	Decimal	Time delay [ns]

Results:

- According to the operation mode and to the command type, data is set into the PPS manager or it is retrieved from the PPS manager.

PPS Set PPS_IF_PULSE_DURATION_CMD

Synopsis:

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

Arguments:

Table 50. $PSTMPPS field description on PPS_IF_PULSE_DURATION_CMD

Parameter	Format	Description
pulse_duration	Double	Pulse duration [s]

Results:

- According to the operation mode and to the command type, data is set into the PPS manager or it is retrieved from the PPS manager.

PPS Set PPS_IF_PULSE_POLARITY_CMD

Synopsis:

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

Arguments:

Table 51. $PSTMPPS field description on PPS_IF_PULSE_POLAROTY_CMD

Parameter	Format	Description
pulse_polarity	Decimal, 1 digit	0 = not inverted. 1 = inverted.

Results:

- According to the operation mode and to the command type, data is set into the PPS manager or it is retrieved from the PPS manager.

PPS Set PPS_IF_PULSE_DATA_CMD

Synopsis:

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

Arguments:

Table 52. $PSTMPPS field description on PPS_IF_PULSE_DATA_CMD

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.

Results:

- According to the operation mode and to the command type, data is set into the PPS manager or it is retrieved from the PPS manager.

PPS Set PPS_IF_FIX_CONDITION_CMD

Synopsis:

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

Arguments:

Table 53. $PSTMPPS field description on PPS_IF_FIX_CONDITION_CMD

Parameter	Format	Description
fix_condition	Decimal, 1 digit	1 = NOFIX. 2 = 2DFIX. 3 = 3DFIX.

Results:

- According to the operation mode and to the command type, data is set into the PPS manager or it is retrieved from the PPS manager.

PPS Set PPS_IF_SAT_TRHESHOLD_CMD

Synopsis:

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

Arguments:

Table 54. $PSTMPPS field description on PPS_IF_SAT_TRHESHOLD_CMD

Parameter	Format	Description
sat_th	Decimal	Minimum number of satellites for the PPS generation.

Results:

- According to the operation mode and to the command type, data is set into the PPS manager or it is retrieved from the PPS manager.

PPS Set PPS_IF_ELEVATION_MASK_CMD

Synopsis:

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

Arguments:

Table 55. $PSTMPPS field description on PPS_IF_ELEVATION_MASK_CMD

Parameter	Format	Description
elevation_mask	Decimal	Minimum satellite elevation for satellite usage in timing filtering.

Results:

- According to the operation mode and to the command type, data is set into the PPS manager or it is retrieved from the PPS manager.

PPS Set PPS_IF_CONSTELLATION_MASK_CMD

Synopsis:

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

Arguments:

Table 56. $PSTMPPS field description on PPS_IF_CONSTELLATION_MASK_CMD

Parameter	Format	Description
constellation_mask	Decimal (bit mask)	Satellite constellation selection for usage in timing filtering. bit0 = GPS bit1 = GLONASS NOTES:

Parameter	Format	Description
		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 the GPS satellites. When constellation mask is zero (default) only GPS sats are used to correct the GPS reference time and only GLONASS sats are used to correct the GLONASS reference time.

Results:

- According to the operation mode and to the command type, data is set into the PPS manager or it is retrieved from the PPS manager.

PPS Set PPS_IF_TIMING_DATA_CMD

Synopsis:

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

Arguments:

Table 57. $PSTMPPS field description on PPS_IF_TIMING_DATA_CMD

Parameter	Format	Description
fix_condition	Decimal, 1 digit	1 = NOFIX. 2 = 2DFIX. 3 = 3DFIX.
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

Results:

- According to the operation mode and to the command type, data is set into the PPS manager or it is retrieved from the PPS manager.

PPS Set PPS_IF_POSITION_HOLD_DATA_CMD

Synopsis:

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

Arguments:

Table 58. $PSTMPPS field description on PPS_IF_POSITION_HOLD_DATA_CMD

Parameter	Format	Description
on_off	Decimal, 1 digit	0 = Position Hold disabled. 1 = Position Hold enabled.
lat	DDmm.mmmmm	Position Hold position latitude.

Parameter	Format	Description
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.

Results:

- According to the operation mode and to the command type, data is set into the PPS manager or it is retrieved from the PPS manager.

PPS Set PPS_IF_AUTO_HOLD_SAMPLES_CMD

Synopsis:

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

Arguments:

Table 59. $PSTMPPS field description on PPS_IF_AUTO_HOLD_SAMPLES_CMD

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 every time the command is executed.

Results:

- According to the operation mode and to the command type, data is set into the PPS manager or it is retrieved from the PPS manager.

PPS Set PPS_IF_TRAIM_CMD

Synopsis:

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

Arguments:

Table 60. $PSTMPPS field description on PPS_IF_TRAIM_CMD

Parameter	Format	Description
on_off	Decimal, 1 digit	0 = TRAIM disabled. 1 = TRAIM enabled.
alarm	Double	TRAIM alarm [s] – scientific notation is allowed

Results:

- According to the operation mode and to the command type, data is set into the PPS manager or it is retrieved from the PPS manager.

13.1.38 $PSTMLOWPOWERONOFF

Allow setting the low power algorithm parameters at run-time.

Synopsis:

```
$PSTMLOWPOWERONOFF,<low power enable/disable>,<constellation mask>,
<EHPE threshold>,<Max tracked sats>,<Switch constellation features >,
<Duty Cycle enable/disable>,<Duty Cycle ms signal off>,<Periodic mode>,
<Fix period>,<Number of fix>,<Ephemeris refresh>,<RTC refresh>,
<No Fix timeout>,<No Fix timeout Off duration>*<checksum><cr><lf>
```

Synopsys to Disable low power mode:

```
$PSTMLOWPOWERONOFF,0,<constellation mask>*<checksum><cr><lf>
```

Synopsys to enable adaptive/cycling mode:

```
$PSTMLOWPOWERONOFF,1,<constellation mask>,<EHPE threshold>,
<Max tracked sats>,<Switch constellation features>,
<DutyCycle_enable/disable>,<Duty Cycle fix period>,
0,0,0,0,0,0,0*<checksum><cr><lf>
```

Synopsys to enable periodic mode:

```
$PSTMLOWPOWERONOFF,1,0,0,0,0,0,0,<Periodic mode>,<Fixperiod>,<Number of fix>,<Ephemeris
refresh>,<RTC refresh>,<No Fix timeout>,<No Fix timeout Off
duration>*<checksum><cr><lf>
```

Arguments:

Table 61. $PSTMLOWPOWERONOFF field description

Parameter	Format	Description
low power enable/ disable	Decimal, 1 digit	General Low Power features Enable/Disable 0: OFF, 1: ON
Adaptive mode settings		
Constellation mask	Decimal, 1 digit	It is a bit mask where each bit enable/disable 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
EHPE threshold	Decimal, 3 digits	EHPE average threshold [m]
Max tracked sats	Decimal, 2 digits	first N satellites (with higher elevation) used for the position calculation (Active channel management) in LOW POWER STATE
Switch constellation features	Decimal, 1 digit	Switch constellation features (enable it only for GNSS constellation case)
Cyclic mode settings		
Duty Cycle enable/ disable	Decimal, 1 digit	Duty Cycle features enable/disable
Duty Cycle ms signal off	Decimal, 3 digits	Estimated Horizontal Position Error Average
Periodic mode settings		
Periodic mode	Decimal, 1 digit	Setup Active or Standby periodic mode 0: OFF

Parameter	Format	Description
		3: Standby Periodic mode
FixPeriod	Decimal, 5 digits	Interval between two fixes [s]
FixOnTime	Decimal, 2 digits	Number of fixes reported for each interval
Ephemeris refresh	Decimal, 1 digit	Enable/Disable the refresh of ephemeris data 0: OFF, 1: ON
RTC calibration	Decimal, 1 digit	Enable/Disable the RTC calibration 0: OFF, 1: ON
NoFixCnt	Decimal, 2 digits	Time to declare fix loss [s] in HOT conditions
NoFixOff	Decimal, 2 digits	Period of off period after a fix loss [s]

Results:

- In case of no errors, the $PSTMLOWPOWERON message is returned
- In case of errors, the $PSTMLOWPOWERERROR error message is returned

13.1.39 $PSTMSTANDBYENABLE

When the periodic mode is configured with PSTMLOWPOWERONOFF, this command allows/disallows the Teseo-Module to go in Standby mode between the fixes.

Synopsis without argument:

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

Synopsis with argument

```
$PSTMSTANDBYENABLE,<on_off>*<checksum><cr><lf>
```

Arguments:

Table 62. $PSTMSTANDBYENABLE command field description

Parameter	Format	Description
Without parameter		Request the internal status
on_off	Decimal, 1 digits	Set the standby enable status 0: Active Periodic mode 1: Periodic mode, standby allowed

Results without parameter:

- The $PSTMSTANDBYENABLE message is sent back to report the internal status

Results with parameter:

- In case of no errors, the $PSTMSTANDBYENABLEOK message is returned
- In case of errors, the $PSTMSTANDBYENABLEERROR error message is returned

13.1.40 $PSTMFORCESTANDBY

Force the platform to go in standby mode.

Synopsis:

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

Arguments:

Table 63. **$PSTMFORCESTANDBY field description**

Parameter	Format	Description
duration	Decimal, 5 digits	Duration of the standby time in seconds: • zero means standby forever • 65535 is max value

Results:

- In case of no errors, the $PSTMFORCESTANDBYOK message is returned
- In case of errors, the $PSTMFORCESTANDBYERROR error message is returned

13.1.41 $PSTMNMEAREQUEST

Send a set of NMEA messages according to the input message list.

Synopsis:

```
$PSTMNMEAREQUEST,<msglist_l>,<msglist_h>*<checksum><cr><lf>
```

Arguments:

Table 64. **$PSTMNMEAREQUEST field description**

Parameter	Format	Description
msglist_l	Hexadecimal, 1 Digit	First 32 bits of 64 bits message list (low). Each bit is used to enable/disable a specific message. 0 = disabled 1 = enabled
msglist_h	Hexadecimal, 1 Digit	Second 32 bits of 64 bits message list (high). Each bit is used to enable/disable a specific message. 0 = disabled 1 = enabled

Results:

- A set of NMEA messages is sent according to the input message list.

Note: the order of NMEA messages in the message list is the same as for the periodic NMEA output messages.

13.1.42 $PSTMIONOPARAMS

Uploads a specific iono packet into the Teseo-Module NVM. The uploaded iono packet will be retained until a new iono packet for the same constellation is successfully uploaded or downloaded from the navigation message.

Synopsis: when sat_type = 0

```
$PSTMIONOPARAMS,<sat_type=0>,1,<A0>,<A1>,<A2>,<A3>,<B0>,<B1>,<B2>,<B3>*<checksum><cr><lf>
```

Synopsis: when sat_type = 1

```
$PSTMIONOPARAMS,<sat_type=1>,1,<ai0>,<ai1>,<ai2>,<Region1>,<Region2>,
<Region3>,<Region4>,<Region5>*<checksum><cr><lf>
```

Arguments:

Table 65. **$PSTMIONOPARAMS field description**

Parameter	Format	Description
sat_type	Decimal, 1 digits	1 is for GPS 3 is for Galileo 7 for BeiDou
A0,A1,A2,A3	Decimal, 3 digits	These parameters are used only if `sat_type=1 or 7` Iono parameters, raw integer values as from Navigation Messages.
B0,B1,B2,B3	Decimal, 3 digits	These parameters are used only if `sat_type=1 or 7` Iono parameters, raw integer values as from Navigation Messages.
ai0,ai1,ai2	Decimal, 3 digits	These parameters are used only if `sat_type=3` Iono parameters, raw integer values as from Navigation Messages.
Region1, Region2, Region3 ,Region4, Region5	Binary	These parameters are used only if `sat_type=3` Galileo iono regions

Results: None

13.1.43 $PSTMGALILEOGGTO

This command programs the Galileo broadcast GGTO.

Synopsis:

```
$PSTMGALILEOGGTO,<brd>,<WN0G>,<t0G>,<A0G>,<A1G>,<validity>*<checksum><cr><lf>
```

Arguments:

Table 66. **$PSTMGALILEOGGTO field description**

Parameter	Format	Description
brd	Decimal, 1 digits	1=broadcast GGTO
WN0G	Decimal, 3 digits	Value for WN0G
t0G	Decimal, 5 digits	Value for t0G
A0G	Decimal, 5 digits	Value for A0G
A1G	Decimal, 5 digits	Value for A1G
validity	binary	0=not valid, 1=valid

13.1.44 $PSTMGALILEODUMPGGTO

This command dumps the broadcast GGTO.

Synopsis:

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

Arguments:

None.

Results:

- If the command is executed the with $PSTMGALILEODUMPGGTO message is sent:

13.1.45 $PSTMSETTHTRK

Configures 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 value.

Synopsis:

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

Arguments:

Table 67. $PSTMCFGSETTHTRK field description

Parameter	Format	Description
cn0	Decimal	Tracking CN0 threshold as dB
el	Double	Tracking elevation mask angle as degree

Results:

- In case of no errors, the $PSTMSETTHTRKOK message is returned
- In case of errors, the $PSTMSETTHTRKERROR error message is returned

13.1.46 $PSTMSETTHPOS

Configures 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:

Table 68. $PSTMCFGSETTHPOS field description

Parameter	Format	Description
cn0	Decimal	Positioning CN0 threshold as dB
el	Double	Positioning elevation mask angle as degree

Results:

- In case of no errors, the $PSTMSETTHPOSOK message is returned
- In case of errors, the $PSTMSETTHPOSERROR error message is returned

13.1.47 $PSTMGETUCODE

This command reads the unique code from the secondary boot flash memory partition.

Synopsis:

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

Arguments:

None

Results:

- In case of no error the $PSTMGETUCODEOK message is sent
- In case of error the $PSTMGETUCODEERROR error message is sent

13.2 STM system configuration commands

The Teseo-Module Software utilizes a “Configuration Data Block” that holds the working parameters for the system. The parameters can be set, read or store (in NVM) using the system configuration commands: $PSTMSETPAR, $PSTMGETPAR and $PSTMSAVEPAR. There is also a command to restore the factory setting parameters: $PSTMRESTOREPAR.

At run-time it could be possible to have up to three different configuration blocks:

- Current configuration: it is placed in RAM memory and it includes the current configuration of each parameter. This configuration block can be modified with the $PSTMSETPAR command. The $PSTMSAVEPAR command stores the current configuration data block into the NVM memory. At startup the current configuration block is loaded from NVM (if a stored data block is available) or it is loaded from default one embedded in the code (factory settings).
- Default configuration: it is generally placed in the flash/rom memory. It includes the factory setting for each parameter. This configuration is used at system startup if there is no configuration data into the NVM memory.
- NVM stored configuration: it is available in the NVM backup memory as soon as the $PSTMSAVEPAR command is executed. It includes all parameters modified and stored by the user. At system startup the SW configuration managements checks if a valid configuration block is available in the NVM backup memory. In case the stored configuration is available, it will be used for system configuration. If not available the default setting will be used.

Note: Other “Configuration Data Block” parameters not documented in this manual must be considered as RESERVED and must not be modified. Modifying any other parameter intentionally or unintentionally may stop the system from working and/or degrade the system performance.

13.2.1 $PSTMSETPAR

This command sets the defined parameter (indicated by “ID”) to the value provided as “param_value” in the commands parameter.

Synopsis:

```
$PSTMSETPAR,<ConfigBlock><ID>,<param_value>[,<mode>]*<checksum><cr><lf>
```

Arguments:

Table 69. $PSTMSETPAR field description

Parameter	Format	Description
ConfigBlock	Decimal,1 digit	Indicates one of configuration blocks: 1 =Current Configuration, 2 = Default Configuration, 3 = NVM Stored configuration.
ID	Decimal, 3 digits	ID - Identifier
param_value	1 up to 80 bytes	Parameter to be set.
mode	Decimal, 1 digit	This parameter is optional. It allows to perform bit-to-bit “OR” or “AND” operations between the selected parameter in the configuration block and the param_value in input. It has the following meaning: 0: the parameter in the configuration block is overwritten by the param_value. This is the default action as in the case mode is omitted. 1: the parameter in the configuration block is the result of bit-to-bit “OR” between old value and the param_value.This is useful for bit mask setting. 2: the parameter in the configuration block is the result of bit-to-bit “AND” between old value and NOT(param_value). This is useful for bit mask resetting.

Results:

- In case of no errors, the $PSTMSETPAROK message is returned
- In case of errors, the $PSTMSETPARERROR error message is returned

Example:

Issuing the command:

```
$PSTMSETPAR,1121,10*<checksum><cr><lf>
```

You could have this answer:

```
$PSTMSETPAROK,1121*<checksum><cr><lf>
```

Note: The configuration block parameter is ignored by the "SET" command because only the current configuration, stored in the RAM memory, can be written. It is used only to keep same syntax as for the "GET" command. The configuration block stored in NVM will be overwritten by current configuration after the $PSTMSAVEPAR command.

There is no comma and no space between ConfigBlock and ID parameters.

The input param_value must be expressed in hexadecimal format without "0x" prefix for any integer value except DOP configuration. It must be decimal for any not integer value and DOP setting.

13.2.2 $PSTMGETPAR

This command reads the defined parameter (indicated by "ID") from the "Configuration Data Block" and returns it as a specific message.

Synopsis:

```
$PSTMGETPAR,<ConfigBlock><ID>*<checksum><cr><lf>
```

Arguments:

Table 70. $PSTMGETPAR field description

Parameter	Format	Description
ConfigBlock	Decima1, 1 digit	Indicates one of configuration blocks: 1 = Current Configuration, 2 = Default Configuration, 3 = NVM Stored configuration.
ID	Decimal, 3 digits	ID - Identifier

Results:

- In case of no errors, $PSTMSETPAR message is sent
- In case of errors, the $PSTMGETPARERROR error message is returned

Example:

Issuing the command:

```
$PSTMGETPAR,1403*<checksum><cr><lf>
```

You could have this answer:

```
$PSTMSET,1403,15,12,12,18*<checksum><cr><lf>
```

Note: There is no comma and no space between ConfigBlock and ID parameters.

In case of no errors the answer is deliberately $PSTMSET and not $PSTMGET.

If the parameter ID is "000" all the configuration block is printed out using one message for each parameter. The message syntax is the same as reported above.

13.2.3 $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).
- In case of no errors, the $PSTMSAVEPAROK message is returned
- In case of errors, the $PSTMSAVEPARERROR error message is returned

Note: the factory setting parameters can be restored using the $PSTMRESTOREPAR command.

Example:

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

13.2.4 $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 ad to get system working with default setting.
- In case of no errors, the $PSTMRESTOREPAROK message is returned
- In case of errors, the $PSTMRESTOREPARERROR error message is returned

Example:

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

13.2.5 $PSTMCFGPORT

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

Synopsis:

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

Arguments:

Table 71. $PSTMCFGPORT field description

Parameter	Format	Description
port_type	Decimal, 1 Digit	Select the port type: 0 = UART 1 = I2C

Parameter	Format	Description
protocol_type	Decimal, 1 Digit	Select the protocol type: 0 = NMEA 1 = Reserved 2 = Reserved 3 = RTCM
par_1 … par_N	Integer	Parameters list according to the command type Specification (see below).

Results:

- One or more parameters of swconfig are set according to the command parameters. In case of no errors, the following message is returned
- In case of no errors, the $PSTMCFGPORTOK message is returned
- In case of errors, the $PSTMCFGPORTERROR error message is returned

13.2.6 $PSTMCFGPORT on UART

Arguments:

Table 72. $PSTMCFGPORT field description when port_type is UART

Parameter	Format	Description
portnumb	From 0 to 255	UART ID (Linearly addressed)
baudrate	Integer	The port baud rate. Allowed values are: 300, 600, 1200, 2400, 4800, 9600, 14400, 19200, 38400, 57600, 115200, 230400, 460800, 921600

13.2.7 $PSTMCFGPORT on I2C

Arguments:

Table 73. $PSTMCFGPORT field description when port_type is I2C

Parameter	Format	Description
slaveaddr	Hexadecimal, 2Bytes	The I2C slave address
mode	Decimal, 1 digit	Reserved

13.2.8 $PSTMCFGMSGL

Configure the message list.

Synopsis:

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

Arguments:

Table 74. $PSTMCFGMSGL field description

Parameter	Format	Description
listid	Decimal, 1 digit	List selector: 0 = NMEA list on UART port 3 = NMEA on I2C port
rate	From 0 to 255	Message list rate scaler
listlow	Hexadecimal, 8 digits	Please refer to CDB 201 table in case of NMEA or 240 in case of STBin
listhigh	Hexadecimal, 8 digits	Please refer to CDB 228 table in case of NMEA or 241 in case of STBin

Results:

- One or more parameters of swconfig are set according to the command parameters. In case of no errors, the following message is returned
- In case of no errors, the $PSTMCFGMSGLOK message is returned
- In case of errors, the $PSTMCFGMSGLERROR error message is returned

13.2.9 $PSTMCFGGNSS

Configure the GNSS parameters algorithm.

Synopsis:

```
$PSTMCFGGNSS,<trkcn0>,<poscn0>,<trkmskang>,<posmskang>,
<NCOcntr>,<NCOmin>,<NCOmax>*<checksum><cr><lf>
```

Arguments:

Table 75. $PSTMCFGGNSS field description

Parameter	Format	Description
trkcn0	From 0 to 255	Minimum CN0 [dB] at which satellite can be tracked
poscn0	From 0 to 255	Minimum CN0 [dB] at which satellite can be tracked for positioning solution
trkmskang	From 0 to 255	Minimum elevation angle at which satellite can be tracked
posmskang	From 0 to 255	Minimum elevation angle at which satellite can be tracked for positioning solution
NCOcntr	From 0 to 255	NCO center value
NCOmin	From 0 to 255	NCO range minimum value
NCOmax	From 0 to 255	NCO range maximum value

Results:

- One or more parameters of swconfig are set according to the command parameters. In case of no errors, the following message is returned
- In case of no errors, the $PSTMCFGGNSSOK message is returned

- In case of errors, the $PSTMCFGGNSSERROR error message is returned

13.2.10 $PSTMCFGSBAS

Configure the SBAS algorithm.

Synopsis:

```
$PSTMCFGSBAS,<enengine>,<enreport>,<enautosearch>,<numofsats>,<sat_1prnid>,
<sat_1long>,<sat_1longsens>,<sat_1sbasserv>,<sat_1default>,…,>,<sat_Mprnid>,<sat_Mlong>,
<sat_Mlongsens>,<sat_Msbasserv>,<sat_Mdefault>,<par_1>,<par_2>,…,<par_N>*<checksum><cr><lf>
```

Arguments:

Table 76. $PSTMCFGSBAS field description

Parameter	Format	Description
enengine	Decimal, 1 digit	Enable SBAS engine switch: 0 = Disabled 1 = Enabled
enreport	Decimal, 1 digit	Enable satellite report in GSV message: 0 = Disabled 1 = Enabled
enautosearch	Decimal, 1 digit	Enable autosearch switch: 0 = Disabled 1 = Enabled
autosearchmask	Hexadecimal, 8 digits	Allow enabling/disabling the SBAS satellites to be searched by the auto search procedure
dectimeout	From 0 to 255	The time the autosearch waits to try to decode the current PRN Note: expressed in seconds. This value is ignored if `enautosearch` is 0
diftimeout	From 0 to 255	The time the autosearch waits before to change the prn when the current SBAS sat is not more decoded Note: expressed in seconds. This value is ignored if `enautosearch` is 0
nextsattimeout	From 0 to 255	The time the autosearch waits to try to acquire and tracking new SBAS satellite using the searching channel Note: expressed in seconds. This value is ignored if `enautosearch` is 0
nextsesstimeout	From 0 to 255	The time the autosearch waits before to start a new searching session using the searching channel Note: expressed in seconds. This value is ignored if `enautosearch` is 0
numofsats (N)	From 0 to 255	Number of SBAS satellites. Note that following configuration settings will be repeated “numofsat” times
satN_prnid	Integer	SBAS PRN configuration for satellite 1
satN_long	From 0 to 255	Longitude for satellite 1
satN_longsens	Decimal, 1 digit	Longitude sense for satellite 1

Parameter	Format	Description
		0 = EAST 1 = WEST
satN_sbasserv	Decimal, 1 digit	SBAS service for satellite 1 0 = WAAS 1 = EGNOS 2 = MSAS 3 = GAGAN
satN_default	Decimal, 1 digit	Select if satellite 1 is default or not 0 = Not default 1 = Default

Note: Last five parameters will be repeated N times, where N is the number of satellites user has chosen.

Results:

- One or more parameters of swconfig are set according to the command parameters. In case of no errors, the following message is returned
- In case of no errors, the $PSTMCFGSBASOK message is returned
- In case of errors, the $PSTMCFGSBASERROR error message is returned

Parameters when auto-search is enabled.

Table 77. $PSTMCFGSBAS field description when auto-search is enabled

Parameter	Format	Description
Satellite-Enable-mask	Integer	Enable/disable satellites to be searched by the autosearch procedure.
Autosearch-decoding-timeout	Integer	Set the timeout the autosearch waits to try to decode the current PRN
Autosearch-differentialtimeout	Integer	Set the timeout the autosearch waits before to change the PRN when the current SBAS satellite is no more decoded
Autosearch-searching-timeout-next-satellite	Integer	Set the timeout the auto-search waits to try to acquire and tracking new SBAS satellite using the searching channel
Autosearch-searching-timeout-next-session	Integer	Set the timeout the auto-search waits before to start a new searching session using the searching channel

13.2.11 $PSTMCFGPPSGEN

Configure the PPS with general settings.

Synopsis:

```
$PSTMCFGPPSGEN,<enpps>,<genmode>,<ppsclock>,<reftime>*<checksum><cr><lf>
```

Arguments:

Table 78. **$PSTMCFGPPSGEN field description**

Parameter	Format	Description
enpps	Decimal, 1 digit	Enable PPS engine switch 0 = Disabled 1 = Enabled
genmode	Decimal, 1 digit	Generation mode 0 = Every second 1 = Even seconds 2 = Odd seconds
ppsclock	Decimal, 1 digit	PPS clock 0 = 16 MHz 1 = 32 MHz 2 = 64 MHz
reftime	Decimal, 1 digit	Reference time 0 = UTC 1 = GPS time 2 = GLONASS time 3 = UTC (SU) 4 = GPS time from GLONASS time reference

Results:

- One or more parameters of swconfig are set according to the command parameters. In case of no errors, the following message is returned
- In case of no errors, the $PSTMCFGPPSGENOK message is returned
- In case of errors, the $PSTMCFGPPSGENERROR error message is returned

13.2.12 $PSTMCFGPPSSAT

Configure the PPS with satellite related configurations settings.

Synopsis:

```
$PSTMCFGPPSSAT,<enmix>,<fixcond>,<minsatnum>,<satelevmask>*<checksum><cr>
<lf>
```

Arguments:

Table 79. **$$PSTMCFGPPSSAT field description**

Parameter	Format	Description
enmix	Decimal, 1 digit	Enable Mixing 0 = Disabled 1 = GPS satellite enabled for GLONASS correction 2 = GLONASS satellite enabled for GPS correction
fixcond	Decimal, 1 digit	Fix condition 0 = No fix 1 = 2D fix 2 = 3D fix
minsatnum	From 0 to 255	Minimum number of satellites used for timing correction

Parameter	Format	Description
satelevmask	From 0 to 255	Satellite elevation mask for time correction. It is the minimum satellite elevation angle to use the satellite for time correction

Results:

- One or more parameters of swconfig are set according to the command parameters. In case of no errors, the following message is returned
- In case of no errors, the $PSTMCFGPPSSATOK message is returned
- In case of errors, the $PSTMCFGPPSSATERROR error message is returned

13.2.13 $PSTMCFGPPSPUL

Configure the PPS with pulse related settings.

Synopsis:

```
$PSTMCFGPPSPUL,<enpolinv>,<pulsedur>,<delcorr>*<checksum><cr><lf>
```

Arguments:

Table 80. $PSTMCFGPPSPUL field description

Parameter	Format	Description
enpolinv	Decimal, 1 digit	Enable polarity inversion switch 0 = Disabled 1 = Enabled
pulsedur	Double	Allow setting the pulse duration of the PPS signal
delcorr	Double	Allow setting a time correction to compensate any delay introduced on the Pulse Per Second (PPS) signal by cables and/or RF chain

Results:

- One or more parameters of swconfig are set according to the command parameters. In case of no errors, the following message is returned
- In case of no errors, the $PSTMCFGPPSPULOK message is returned
- In case of errors, the $PSTMCFGPPSPULERROR error message is returned

13.2.14 $PSTMCFGPOSHOLD

Configure the position hold.

Synopsis:

```
$PSTMCFGPOSHOLD,<poshold>,<poshlat>,<poshlon>,<poshhei>*<checksum><cr><lf>
```

Arguments:

Table 81. $PSTMCFGPOSHOLD field description

Parameter	Format	Description
poshold	Decimal, 1 digit	Enable position hold switch 0 = Disabled 1 = Enabled Next parameter will be ignored when poshold is Disabled.

Parameter	Format	Description
poshlat	Double	Set the position hold latitude
poshlon	Double	Set the position hold longitude
poshhei	Double	Set the position hold height

Results:

- One or more parameters of swconfig are set according to the command parameters. In case of no errors, the following message is returned
- In case of no errors, the $PSTMCFGPOSHOLDOK message is returned

13.2.15 $PSTMCFGTRAIM

Configure the PPS with general settings.

Synopsis:

```
$PSTMCFGTRAIM,<entraim>,<threshold>*<checksum><cr><lf>
```

Arguments:

Table 82. $PSTMCFGTRAIM field description

Parameter	Format	Description
entraim	Decimal, 1 digit	Enable TRAIM switch 0 = Disabled 1 = Enabled
threshold	Double	Time error threshold for the satellites exclusion in the TRAIM algorithm

Results:

- One or more parameters of swconfig are set according to the command parameters. In case of no errors, the following message is returned
- In case of no errors, the $PSTMCFGTRAIMOK message is returned

13.2.16 $PSTMCFGSATCOMP

Configure the PPS with general settings.

Synopsis:

```
$PSTMCFGSATCOMP,<numofcomp>,<pathid1>,<comp1>,<pathid2>,<comp2>*<checksum><cr><lf>
```

Arguments:

Table 83. $PSTMCFGSATCOMP field description

Parameter	Format	Description
numofcomp	Decimal	Number of RF path to compensate. Note that this affect next parameters. Next fields will be repeated “numofcomp” times
pathid	Decimal,1 Digit	Select the ID of the RF path to compensate 0 = GPS 1 = GLONASS
comp	Double	Time compensation value

Results:

- One or more parameters of swconfig are set according to the command parameters. In case of no errors, the following message is returned
- In case of no errors, the $PSTMCFGSATCOMPOK message is returned
- In case of errors, the $PSTMCFGSATCOMERROR error message is returned

13.2.17 $PSTMCFGLPA

Configure the low power algorithm.

Synopsis:

```
$PSTMCFGLPA,<en_lpa>,<feat>,<fix_period>,<fix_on_time>,<no_fix_cnt>,
<no_fix_cnt2>,<no_fix_off>,<adaptive_feat>,<adaptive_duty_cicle>,<ehpe_th>,<num_of_sat>,
<duty_off>,<const_type>*<checksum><cr><lf>
```

Arguments:

Table 84. $PSTMCFGLPA field description

Parameter	Format	Description
en_lpa	unsigned, 1 bytes	Enable Low Power Algorithm 0 = LPA Disabled 1 = LPA Enabled.
feat	unsigned, 1 bytes	Low Power Algorithm feature 0 = Periodic mode disabled 1 = Active Periodic mode 2 = RESERVED 3 = Standby Periodic mode
fix_period	From 0 to 86400	Fix period in seconds. 0 means the Fix will be given only on WAKEUP pin activation. Value 0 is only valid in Standby Periodic mode. Default is 10.
fix_on_time	unsigned, 2 bytes	Number of fix reported every Fix wakeup. Default is 1
no_fix_cnt	unsigned, 2 bytes	Number of no-fixes in hot conditions, before to signal a fix loss event. Default is 8
no_fix_cnt2	unsigned, 2 bytes	Number of no-fixes in non-hot conditions, before to signal a fix loss event. Default is 60
no_fix_off	unsigned, 2 bytes	Off duration time after a fix loss event. Default is 180
adaptive_feat	unsigned, 1 bytes	Enable disable adaptive multi-constellation algorithm. 0 = Adaptive Algorithm Disabled 1 = Adaptive Algorithm Enabled Default is 0
adaptive_duty_cicle	unsigned, 1 bytes	Enable disable trimming of correlation time for each cycle. 0 = Adaptive Duty Cycle Disabled

Parameter	Format	Description
		1 = Adaptive Duty Cycle Enabled Default is 0
ehpe_th	unsigned, 1 bytes	EHPE average threshold. Default is 15
num_of_sat	unsigned, 1 bytes 0 to 32	Number of satellite used in Adaptive mode (first N with higher elevation) Default is 9
duty_off	unsigned, 2 bytes 100 to 740	Duty cycle OFF period length in ms; Default is 700
const_type	unsigned, 1 bytes	RESERVED, set it as 0

Results:

- One or more parameters of swconfig are set according to the command parameters. In case of no errors, the following message is returned
- In case of no errors, the $PSTMCFGLPAOK message is returned
- In case of errors, the $PSTMCFGLPAERROR error message is returned

13.2.18 $PSTMCFGAGPS

Configure the assisted GNSS.

Synopsis:

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

Arguments:

Table 85. $PSTMCFGAGPS field description

Parameter	Format	Description
en_agps	Decimal	Enable/Disable AGNSS engine 0 = AGNSS Disables 1 = AGNSS Enabled

Results:

- One or more parameters of swconfig are set according to the command parameters. In case of no errors, the following message is returned
- In case of no errors, the $PSTMCFGAGPSOK message is returned

13.2.19 $PSTMCFGAJM

Configure the Anti-Jamming algorithm.

Synopsis:

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

Arguments:

Table 86. **$PSTMCFGAJM field description**

Parameter	Format	Description
gpsmode	Decimal, 1 digit	Notch filter on GPS path: 0 = Disabled 1 = Normal Mode 2 = Auto Mode
glonassmode	Decimal, 1 digit	Notch filter on GLONASS path: 0 = Disabled 1 = Normal Mode 2 = Auto Mode

Results:

- One or more parameters of swconfig are set according to the command parameters. In case of no errors, the following message is returned
- In case of no errors, the $PSTMCFGAJMOK message is returned
- In case of errors, the $PSTMCFGAJMERROR error message is returned

13.2.20 $PSTMCFGODO

Configure the odometer.

Synopsis:

```
$PSTMCFGODO,<en>,<enmsg>,<alarm>*<checksum><cr><lf>
```

Arguments:

Table 87. **$PSTMCFGODO field description**

Parameter	Format	Description
en	Decimal, 1 digit	Enable/Disable the odometer: 0 = Odometer disabled 1 = Odometer enabled
enmsg	Decimal, 1 digit	Enable/Disable odometer related periodic messages: 0 = Periodic message disabled 1 = Periodic message enabled
alarm	0 to 65535	Distance travelled between two NMEA messages

Results:

- One or more parameters of swconfig are set according to the command parameters. In case of no errors, the following message is returned
- In case of no errors, the $PSTMCFGODOOK message is returned
- In case of errors, the $PSTMCFGODOERROR error message is returned

13.2.21 $PSTMCFGGEOFENCE

Allows to configure Geofencing feature enabling circles and choosing tolerance.

Synopsis:

```
$PSTMCFGGEOFENCE,<en>,<tol>*<checksum><cr><lf>
```

Arguments:

Table 88. **$PSTMCFGGEOFENCE field description**

Parameter	Format	Description
en	Decimal, 1 digit	Enable/Disable the geo fencing: 0 = Geo fencing disabled 1 = Geo fencing enabled
tol	Decimal, 1 digit	Tolerance: 0 = none 1 = level 1 2 = level 2 3 = level 3

Results:

- One or more parameters of swconfig are set according to the command parameters. In case of no errors, the following message is returned
- In case of no errors, the $PSTMCFGGEOFENCEOK message is returned
- In case of errors, the $PSTMCFGGEOFENCEERROR error message is returned

13.2.22 $PSTMCFGGEOCIR

Allows to configure a circle of geofencing feature.

Synopsis:

```
$PSTMCFGGEOCIR,<circleid>,<en>,<lat>,<lon>,<rad>*<checksum><cr><lf>
```

Arguments:

Table 89. **$PSTMCFGGEOCIR field description**

Parameter	Format	Description
circleid	Decimal, 1 digit	The circle ID From 0 to 7
en	Boolean	Enable disable the circle 0 = Disable, 1 = Enable
lat	Double	N-th circle latitude
lon	Double	N-th circle longitude
rad	Double	N-th circle radius

Results:

- One or more parameters of swconfig are set according to the command parameters. In case of no errors, the following message is returned
- In case of no errors, the $PSTMCFGGEOCIROK message is returned
- In case of errors, the $PSTMCFGGEOCIRERROR error message is returned

13.2.23 $PSTMCFGCONST

Allow enable/disable all the GNSS constellations.

Synopsis:

```
$PSTMCFGCONST,<gps>,<glonass>,<galileo>,<qzss>,<beidou<*<checksumn><cr><lf>
```

Arguments:

Table 90. **$PSTMCFGCONST field description**

Parameter	Format	Description
Gps	Decimal, 1 digit	Allowed values: 1. Constellation disabled 2. Constellation satellites only tracked 3. Satellites constellation used in position evaluation
Gloanss	Decimal, 1 digit	Allowed values: 1. Constellation disabled 2. Constellation satellites only tracked 3. Satellites constellation used in position evaluation
Galileo	Decimal, 1 digit	Allowed values: 1. Constellation disabled 2. Constellation satellites only tracked 3. Satellites constellation used in position evaluation
Qzss	Decimal, 1 digit	Allowed values: 1. Constellation disabled 2. Constellation satellites only tracked 3. Satellites constellation used in position evaluation
Beidou	Decimal, 1 digit	Allowed values: 1. Constellation disabled 2. Constellation satellites only tracked 3. Satellites constellation used in position evaluation

Results:

- One or more parameters of swconfig are set according to the command parameters
- In case of no errors, the $PSTMCFGCONSTOK message is returned
- In case of errors, the $PSTMCFGCONSTERROR error message is returned

13.2.24 $PSTMCFGTHGNSS

Configures threshold related to GNSS algorithm.

Synopsis:

```
$PSTMCFGTHGNSS,<trkcn0>,<poscn0>,<trkmaskangle>,<posmaskangle>*<checksum><cr><lf>
```

Arguments:

Table 91. **$PSTMCFGTHGNSS field description**

Parameter	Format	Description
trkcn0	Unsigned	Minimum CN0 for tracking purposes
poscn0	Unsigned	Minimum CN0 for positioning purposes
trkmaskangle	Unsigned	Minimum angle for tracking purposes
posmaskangle	Unsigned	Minimum angle for positioning purposes

Results:

- If the command syntax is correct and parameter are correctly set the device return the following confirmation $PSTMCFGTHGNSSOK message:
- In case of errors, the $PSTMCFGTHGNSSERROR error message is returned

13.2.25 $PSTMCFGTDATA

Configures data and time related parameters.

Synopsis:

```
$PSTMCFGTDATA,<gpsminweek>,<gps_max_week>,<fix_rate>,<utcdelta>*<checksum><cr><lf>
```

Arguments:

Table 92. $PSTMCFGTDATA field description

Parameter	Format	Description
trkcn0	Unsigned	Minimum CN0 for tracking purposes
poscn0	Unsigned	Minimum CN0 for positioning purposes
trkmaskangle	Unsigned	Minimum angle for tracking purposes
posmaskangle	Unsigned	Minimum angle for positioning purposes

Results:

- If the command syntax is correct and parameter are correctly set the device return the $PSTMCFGTDATAOK confirmation message
- In case of errors, the $PSTMCFGTDATAERROR error message is returned

13.3 Datalogging NMEA commands

13.3.1 $PSTMLOGSTART

This command starts or restarts the current the data logging.

Synopsis:

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

Arguments:

None

Results:

- In case of no errors, the $PSTMLOGSTARTOK message is returned
- In case of errors, the $PSTMLOGSTARTERROR error message is returned

13.3.2 $PSTMLOGSTOP

This command stops the data logging.

Synopsis:

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

Arguments:

None

Results:

- In case of no errors, the $PSTMLOGSTOPOK message is returned
- In case of errors, the $PSTMLOGSTOPERROR error message is returned

13.3.3 $PSTMLOGERASE

This command erases the data log.

Synopsis:

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

Arguments:

None

Results:

- In case of no errors, the $PSTMLOGERASEOK message is returned
- In case of errors, the $PSTMLOGERASEERROR error message is returned

13.3.4 $PSTMLOGREQSTATUS

Raised from the host to get information about the datalog subsystem.

Synopsis:

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

Arguments:

None

Results:

- If logger has been created replies with the message $PSTMLOGSTATUS
- Otherwise, the $PSTMLOGSTATUSERROR error message is returned

13.4 Geofencing NMEA commands

13.4.1 $PSTMGEOFENCECFG

This command configure the geofence subsystem.

Each $PSTMGEOFENCECFG command can configure only one circle, if more circles are needed the Host has to raise more $PSTMGEOFENCECFG commands.

When more than a circle is configured to trigger a GPIO alarm, all the configurations have to specify the same GPIO with the same GPIO configuration.

Synopsis:

```
$PSTMGEOFENCECFG,<id>,<en>,<tol>,<lat>,<lon>,<rad>*<checksum><cr><lf>
```

Arguments:

Table 93. $PSTMGEOFENCECFG field description

Parameter	Format	Description
id	Decimal, 1 digit	Circle identifier
en	Decimal, 1 digit	Circle enabler: 0 = Circle not valid 1 = Circle enabled
tol	Decimal, 1 digit	Sigma tolerance 1 = 68% 2 = 95% 3 = 99%
lat	Double	Latitude as Decimal Degrees
lon	Double	Longitude as Decimal Degrees
rad	Double	Radius as meters

Results:

- In case of no errors, the $PSTMGEOFENCECFGOK message is returned
- In case of errors, the $PSTMGEOFENCECFGERROR error message is returned

13.4.2 $PSTMGEOFENCEREQ

This command force the Teseo-Module to send a $PSTMGEOFENCESTATUS message to know internal Geofence subsystem status.

Synopsis:

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

Arguments:

None

Results:

- In case of no errors, the Teseo-Module replies with the $PSTMGEOFENCESTATUS message
- In case of errors, the $PSTMGEOFENCEREQERROR error message is returned

13.5 Odometer NMEA commands

13.5.1 $PSTMODOSTART

This commands enables and resets the Odometer subsystem which begins evaluating the ground distance from the current resolved position.

Synopsis:

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

Arguments:

None.

Results:

- In case of no errors, the $PSTMODOSTARTOK message is returned
- In case of errors, the error message $PSTMODOSTARTERROR is returned

13.5.2 $PSTMODOSTOP

This command stops the Odometer subsystem.

Synopsis:

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

Arguments:

None

Results:

- In case of no errors, the $PSTMODOSTOPOK message is returned
- In case of errors, the $PSTMODOSTOPERROR error message is returned

13.5.3 $PSTMODORESET

This command resets the Odometer subsystem.

Synopsis:

```
$PSTMODORESET,<odo_mask>*<checksum><cr><lf>
```

Arguments:

Table 94. **$PSTMODORESET field description**

Parameter	Format	Description
odo_mask	Decimal	The odometers to be reset: 0 = none 1 = Odo-A 2 = Odo-B 3 = Odo-A and Odo-B 4 = Odo-Tot 5 = Odo-A and Odo-Tot 6 = Odo-B and Odo-Tot 7 = Odo-A, Odo-B and Odo-Tot

Results:

- In case of no errors, the $PSTMODORESETOK message is returned
- In case of errors, the $PSTMODORESETERROR error message is returned

13.5.4 $PSTMODOREQERROR

Message sent in response of command $PSTMODOREQ

Synopsis:

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

Arguments:

None

Results:

- Message sent in case of error.

13.6 Autonomous AGNSS NMEA commands

13.6.1 $PSTMSTAGPSONOFF

The command turns ON/OFF the ST-AGNSS engine; it affects both autonomous and server based solutions.

Synopsis:

```
$PSTMSTAGPSONOFF,<param>*<checksum><cr><lf>
```

Arguments:

Table 95. **$PSTMSTAGPSPONOFF field description**

Parameter	Format	Description
param	Decimal, 1 digits	ON/OFF status : 0: the ST-AGNSS engine is suspended. 1: the ST-AGNSS engine is started

Results:

According to the command parameter, the ST-AGNSS engine is started or suspended. One of the following messages is sent:

- $PSTMPOLSTARTED if the engine has been started ;
- $PSTMPOLSUSPENDED if the engine has been suspended;
- $PSTMPOLONOFFERROR in case of error

13.6.2 $PSTMSTAGPSINVALIDATE

The command clears data stored in the ST-AGNSS internal database. The input parameter allows selection of data to be cleared.

Synopsis:

```
$PSTMSTAGPSINVALIDATE,<param>*<checksum><cr><lf>
```

Arguments:

Table 96. $PSTMSTAGPSINVALIDATE field description

Parameter	Format	Description
param	Decimal, 1 digits	Selects which database should be erased: 1: Clear the real ephemeris database (only autonomous). 2: Clear the satellite seeds database (autonomous and server based) 4: Clear the satellite polys database (autonomous and server based) 7: Clear all databases

Results:

According to the command parameter, the internal ST-AGNSS databases will be erased.

The input parameter should be considered as a mask where the first three bits select the database to be cleared (e.g. using 3 as input parameter the real ephemeris and seed databases will be cleared).

At the end of operation ST-AGNSS subsystem sends the message end of a successful invalidation process the message:

- $PSTMSTAGPSINVALIDATEOK in case of successful;
- $PSTMSTAGPSINVALIDATEERROR in case of errors;

13.6.3 $PSTMGETAGPSSTATUS

The command returns the status of the ST-AGNSS internal processing.

Synopsis:

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

Arguments:

None

Results:

- The system sends back the ST-AGNSS status in the $PSTMAGPSSTATUS message.

13.6.4 $PSTMSTAGPSSETCONSTMASK

The command sets the ST-AGNSS constellation mask. It allows switching the ST-AGNSS constellation at run-time. All previous ST-AGNSS data will be erased

Synopsis:

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

Arguments:

Table 97. **$PSTMSTAGPSSETCONSTMASK field description**

Parameter	Format	Description
Constellation_mask	Decimal, 3 digits	It is a bit mask where each bit enable/disable a specific constellation independently by the others: bit 0: GPS constellation enabling/disabling bit 1: GLONASS constellation enabling/disabling bit 3: GALILEO constellation enabling/disabling bit 7: BEIDOU constellation enabling/disabling

Results:

According to the command parameter. one of the following messages is sent:

- $PSTMSTAGPSSETCONSTMASKOK in case of success;
- $PSTMSTAGPSSETCONSTMASKERROR in case of error;

Note: GALILEO and BEIDOU support is still experimental and should not be used in production environment.

13.7 Real Time AGNSS NMEA commands

13.7.1 $PSTMSTAGPS8PASSGEN

Request the generation of a password to access the Real-Time AGNSS server to the device.

Synopsis:

```
$PSTMSTAGPS8PASSGEN,<time>,<Vendor_ID>,<Dev_id>*<checksum><cr><lf>
```

Arguments:

Table 98. **$PSTMSTAGPS8PASSGEN field description**

Parameter	Description
<time>	GPS time in seconds.
<Vendor_ID>	Unique Vendor ID
<Dev_ID>	Unique Device ID

Results:

- Teseo-Module returns the password in the message $PSTMSTAGPS8PASSRTN

13.8 Dead Reckoning NMEA Commands

13.8.1 $PSTMDRMMFB

Input Map Match Data.

If Map Matching is used, host has to send this command each second. If for some reason MMFB data are believed to be unreliable, the command has to be sent anyway with its validity flags set to zero.

NMEA message list bitmask (64 bits): 0200 0000 0000 0000

Synopsis:

```
$PSTMDRMMFB,<time_stamp>,<lat_val>,<lon_val>,<height_val>,<heading_val>,<lat>,<lon>,<height>,<heading>,
```

Arguments:

Table 99. **$PSTMDRMMFB command field description**

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

Results:

- A MMFB data will be injected into Dead Reckoning process engine
- If successful (command format is accepted) the Teseo-Module responds with a message $PSTMDRMMFBKF

Example:

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

13.8.2 $PSTMDRCALCTLT

Start the tilt installation angles procedure. The procedure is effective only in case of no accelerometer is available.

Synopsis:

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

Arguments:

None

Results:

- if successful the message $PSTMDRCALCTLTOK is sent:
- in case of $PSTMDRCALCTLTERROR error the message is sent:

13.8.3 $PSTMDRNVMSAVE

Save the Dead Reckoning Status in NVM

When the DRAW Status is saved, $PSTMDRNVM_WRITE occurs.

Synopsis:

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

Arguments:

None

Results:

- if successful the $PSTMDRNVMSAVEOK message is sent
- in case of error the $PSTMDRNVMSAVEERROR error message is sent

14 Messages

This section contains both the standard NMEA messages and the proprietary messages delivered from Teseo-Module. Additionally, it contains messages which result from a specific command input.

14.1 Standard NMEA messages list

The type and number of messages outputted by receiver is completely configurable through dedicated CDBs.

The complete list of messages is defined by 64 bits, divided in two CDBs. First 32 bits [0-31] are defined as low section of the list; the following ones [32-63] are defined as high section of the list. For each bit, 0 means that correspondent message is disabled in NMEA out, 1 means that it is enabled. The complete matching between bit number and message is provided by the following tables.

For each port, three different message lists exist, and user can configure them acting on specific data blocks. Depending on required navigation rate one or more of them must be configured in order to indicate which messages are delivered in output and at which rate. Table below reports a summary of available, messages list, their purpose and related CDBs.

Table 100. UART- message-list

List-ID	Purpose	CDB Low [bits 0-31]	CDB High [bits 32-63]
0	Defines Messages to be sent at low rate (1 Hz)	201	228
1	Defines Messages to be sent at high rate (> 1 Hz)	210	229
2	Defines Messages to be sent at high rate and low latency (> 1 Hz)	211	230

Table 101. I2C- message-list

List-ID	Purpose	CDB Low [bits 0-31]	CDB High [bits 32-63]
0	Defines Messages to be sent at low rate (1 Hz)	231	232
1	Defines Messages to be sent at high rate (> 1 Hz)	233	234
2	Defines Messages to be sent at high rate and low latency (> 1 Hz)	235	236

14.2 ST NMEA messages list

Table 102. ST NMEA messages list

Syntax	Default	Description
$PSTMDIFF	OFF	ST: Differential Correction Data
$PSTMPRES	OFF	ST: Position Residuals
$PSTMVRES	OFF	ST: Velocity Residuals
$PSTMPA	OFF	ST: Position Algorithm
$PSTMRF	OFF	ST: Radio Frequency
$PSTMSAT	OFF	ST: Satellite Information
$PSTMSBAS	ON	ST: Augmentation System
PSTMSBASM	OFF	ST; Augmentation System Message
$PSTMTIM	OFF	ST: System Time
$PSTMTG	OFF	ST: Time and Number of used Satellites

Syntax	Default	Description
$PSTMTS	OFF	ST: Tracked Satellite Data
$PSTMKFCOV	OFF	ST: Standard Deviation and Covariance
$PSTMAGPS[1]	OFF	ST: STAGPS predicted ephemeris information
$PSTMNOTCHSTATUS	OFF	ST: Reports the Notch filter status.
$PSTMCPU	ON	ST: Reports the CPU usage and CPU speed setting.
$PSTMPOSNHOLD	OFF	ST: Reports the status and position of Position Hold.
$PSTMPPSDATA	OFF	ST: Reports the Pulse Per Second data.
$PSTMTRAIMSTATUS	OFF	ST: Reports the TRAIM status data.
$PSTMTRAIMUSED	OFF	ST: Reports the satellites used for timing correction.
$PSTMTRAIMRES	OFF	ST: Reports the residuals for used satellites.
$PSTMTRAIMREMOVED	OFF	ST: Reports the satellites removed by timing correction algorithm.
$PSTMLOWPOWERDATA	OFF	ST: Reports the status of low power algorithm
$PSTMGALILEOGGTO	OFF	ST: Reports the Galileo broadcast GGTO

14.3 Changing standard NMEA messages format

By default, Standard NMEA Messages are compliant with the “NMEA 0183” Standard Rev. 3.1 dated January 2002. To change format to Rev. 4.10, issued from the “National Marine Electronics Association” in the August 2012 some system configuration commands should be issued.

It is required to change the value of Configuration Data Block 122 from the default value to “4”.

```
$PSTMSETPAR,1122,4
$PSTMSAVEPAR
$PSTMSRR
```

It is possible to go back to default configuration restoring parameters or setting CDB 122 as 0xC

```
$PSTMSETPAR,1122,C
$PSTMSAVEPAR
$PSTMSRR
```

14.4 Preliminary notes about satellites’ PRN ranges

The satellite PRN is an ID used to identify satellites. In NMEA 0183 Rev 3.1, PRN was not described for new constellation. Starting from Rev 4.10 more constraint about this info have been added. Thus, PRN ranges depends on NMEA revision in use.

Table 103. Satellite PRNs for each NMEA version

	GPS	SBAS	GLONASS	BAIDEU	QZSS	GALILEO
NMEA 3.10	from 1 to 32	from 33 to 51	from 65 to 92	from 141 to 172	from 183 to 197	from 301 to 330
NMEA 4.10	from 1 to 32	from 33 to 64	from 65 to 99	from 1 to 32	from 1 to 32	from 1 to 36

14.5 Standard NMEA messages specification

14.5.1 $--GGA

Global Positioning System Fixed data

NMEA message list bitmask (64 bits): 0000 0000 0000 0002

Synopsis for NMEA 0183 Rev 3.1 (Default):

```
$GPGGA,<Timestamp>,<Lat>,<N/S>,<Long>,<E/W>,<GPSQual>,<Sats>,<HDOP>,
<Alt>,<AltVal>,<GeoSep>,<GeoVal>,<DGPSAge>,<DGPSRef>*<checksum><cr><lf>
```

Synopsis 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>
```

Arguments:

Table 104. $--GGA message field description

Parameter	Format	Description
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) Note that decimal fraction assumes non zero values when the fix rate is bigger than 1Hz. Note that 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 Note that for Rev 4.10 this field is empty in case of invalid value
Long	DDMM.MMMMM	Longitude 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
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

Parameter	Format	Description
Sats	Decimal, 2 digits	Satellites in use: example: 8
HDOP	Decimal, 3 digits	Horizontal Dilution of Precision, max: 99.0
Alt	Decimal, 6 digits	Height above mean sea level, max: 100000m
AltVal	“M”	Reference Unit for Altitude (“M” = meters)
GeoSep	Decimal, 4 digits	Geoidal Separation measure in “M” = meters
GeoVal	“M”	Reference Unit for GeoSep (“M” = meters)
DGPSAge	Empty	Not supported
DGPSRef	Empty	Not supported

Example:

```
$GPGGA,183417.000,04814.03970,N,01128.52205,E,0,00,99.0,495.53,M,47.6,M*53
```

14.5.2 $--GLL

Geographic Positioning Latitude / Longitude

NMEA message list bitmask (64 bits): 0000 0000 0010 0000

Synopsis for NMEA 0183 Rev 3.1 (Default):

```
$GPGLL,<Lat>,<N/S>,<Long>,<E/W>,<Timestamp>,<Status>,<mode indicator>*<checksum><cr><lf>
```

Synopsis for NMEA 0183 Rev 4.10:

```
$<TalkerID>GLL,<Lat>,<N/S>,<Long>,<E/W>,<Timestamp>,<Status>,<mode
indicator>*<checksum><cr><lf>
```

Arguments:

Table 105. $--GLL message field description

Parameter	Format	Description
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	Latitute 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 Note that for Rev 4.10 this field is empty in case of invalid value
Long	DDMM.MMMMM	Longitude as degrees: DD: Degree (Fixed two digits) MM: Minutes (Fixed two digits) .MMMMM: Decimal fraction of minutes (Variable)

Parameter	Format	Description
		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
Timestamp	hhmmss.sss	UTC Time of GGL Sample, example: 160836 “.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

Example:

```
$GPGLL,4055.04673,N,01416.54941,E,110505.000,A,A*54
```

14.5.3 $--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 3.1, it is possible to force the talker ID as GN also acting on CDB-ID 200. (See STA8089-90 Firmware Configuration document).

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. See parameter table for info about Talker ID available values.

NMEA message list bitmask (64 bits): 0000 0000 0000 0004

Synopsis for NMEA 0183 Rev 3.1 (Default):

```
$--GSA,<Mode>,<CurrentMode>,<SatPRN1>,...,<SatPRNN>,<PDOP>,<HDOP>,
<VDOP>*<checksum><cr><lf>
```

Synopsis for NMEA 0183 Rev 4.10:

```
$--GSA,<Mode>,<CurrentMode>,<SatPRN1>,...,<SatPRNN>,<PDOP>,<HDOP>,
<VDOP>,<SystemID>*<checksum><cr><lf>
```

Arguments:

Table 106. $--GSA message field description

Parameter	Format	Description
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.
CurrentMode	Decimal, 1 digit	Current Mode: 1 = Fix not available or invalid 2 = GPS, SPS Mode, fix valid 3 = Differential GPS, SPS Mode, fix valid

Parameter	Format	Description
SatPRN(1 to 12)	Decimal, 2 or 3 digits	Satellites list used for positioning. See Chapter 6.5 for more info about available values.
PDOP	Decimal, 3 digits	Position Dilution of Precision, max: 99.0
HDOP	Decimal, 3 digits	Horizontal Dilution of Precision, max: 99.0
VDOP	Decimal, 3 digits	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

Example for NMEA 0183 Rev 3.1 (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
```

14.5.4 $--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.

Prior to NMEA Revision 3.1 it is possible to force the “GN” talker ID acting on CDB-ID 200 Bit 19. In such case a single set of messages is sent.

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.

NMEA message list bitmask (64 bits): 0000 0000 0008 0000

Synopsis for NMEA 0183 Rev 3.1 (Default):

```
$--GSV,<GSVAmount>,<GSVNumber>,<TotSats>,<Sat1PRN>,<Sat1Elev>,
<Sat1Azim>,<Sat1CN0>,…,<Sat4PRN>,<Sat4Elev>,<Sat4Azim>,<Sat4CN0>*
<checksum><cr><lf>
```

Synopsis for NMEA 0183 Rev 4.10:

```
$--GSV,<GSVAmount>,<GSVNumber>,<TotSats>,<Sat1PRN>,<Sat1Elev>,
<Sat1Azim>,<Sat1CN0>,…,<Sat4PRN>,<Sat4Elev>,<Sat4Azim>,<Sat4CN0>,
<SignalID>*<checksum><cr><lf>
```

Arguments:

Table 107. $--GSV message field description

Parameter	Format	Description
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

Parameter	Format	Description
		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. 3
GSVNumber	Decimal, 1 digit	Continued GSV number of this message
TotSats	Decimal, 2 digits	Total Number of Satellites in view, max. 12
SatxPRN	Decimal, 2 digits	Satellites list used for positioning. See Chapter 6.5 for more info about available values.
SatxElev	Decimal, 2 digits	Elevation of satellite x in Degree, 0 … 90
SatxAzim	Decimal, 3 digits	Azimuth of satellite x in degree, ref. “North”, 000 … 359
SatxCN0	Decimal, 2 digits	Carrier to Noise Ratio for satellite x in dB, 00 … 99
SignalID	Decimal, 1 digits	An identifier to indicate the signal in use. Currently it is 1 for GPS, GLONASS, 2 for BEIDOU and QZSS 6 for GALILEO

Example for NMEA 0183 Rev 3.1 (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,3,1,09,30,68,039,49,05,61,266,50,28,52,137,47,07,38,052,48,01*5C
$GPGSV,3,2,09,13,37,301,45,09,17,105,43,15,07,297,40,08,06,056,41,01*56
$GPGSV,3,3,09,20,,,41,,,,,,,,,,,,01*5A
$GLGSV,2,1,06,68,86,031,43,78,78,013,46,79,51,226,43,69,33,325,38,01*43
$GLGSV,2,2,06,67,33,139,41,77,26,035,36,,,,,,,,01*46
$GAGSV,2,1,05,08,76,129,44,02,65,057,46,30,56,205,45,07,48,311,44,06*4F
$GAGSV,2,2,05,03,22,129,40,,,,,,,,,,,,06*7D
```

14.5.5 $--RMC

Recommended Minimum Specific GPS/Transit data. Time, date, position and speed data provided by the Teseo-Module. This sentence is transmitted at intervals not exceeding 2 seconds and is always accompanied by RMB when destination waypoint is active.

NMEA message list bitmask (64 bits): 0000 0000 0000 0040

Synopsis for NMEA 0183 Rev 3.1 (Default):

```
$GPRMC,<Timestamp>,<Status>,<Lat>,<N/S>,<Long>,<E/W>,<Speed>,
<Trackgood>,<Date>,<MagVar>,<MagVarDir>,<mode>*<checksum><cr><lf>
```

Synopsis 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>
```

Arguments:

Table 108. **$--RMC message field description**

Parameter	Format	Description
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) Note that decimal fraction assumes non zero values when the fix rate is bigger than 1Hz. Note that for Rev 4.10 this field is empty in case of invalid value
Status	“A” or “V”	Teseo warning: “A” = valid, “V” = Warning NOTE: “V” is reported in NO FIX conditions and “A” is reported in 2D and 3D fix conditions.
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 Note that for Rev 4.10 this field is empty in case of invalid value
Long	DDDMM.MMMMM	Longitude as degrees: DD: Degree (Fixed three 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
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
Speed	ddd.d	Speed over ground in knots
Trackgood	Decimal, 4 digits	Course made good, max. 999.9
Date	Decimal, 6 digits	Date of Fix : ddmmyy
MagVar	Decimal, 4 digits	Magnetic Variation, max.: 090.0
MagVarDir	“E” or “W”	Magnetic Variation Direction
Mode	“D”, “A”, “N” or “E”	Positioning system Mode Indicator: “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

Parameter	Format	Description
		“C” = Caution “U” = Unsafe “V” = Not valid

Example for NMEA 0183 Rev 3.1 (Default):

```
$GPRMC,183417.000,V,4814.040,N,01128.522,E,0.0,0.0,170907,0.0,W*6C
```

Example for NMEA 0183 Rev 4.10:

```
$GNRMC,,V,,,,,,,,,,N,V*37
```

or

```
$GNRMC,202340.000,A,4045.53297,N,01447.20361,E,0.2,0.0,291117,,,A,C*18
```

14.5.6 $--VTG

Course over ground and ground speed, this message provides the actual course and speed relative to ground.

NMEA message list bitmask (64 bits): 0000 0000 0000 0010

Synopsis for NMEA 0183 Rev 3.1 (Default):

```
$GPVTG,<TMGT>,T,<TMGM>,M,<SoGN>,N,<SoGK>,K,D*<checksum><cr><lf>
```

Synopsis for NMEA 0183 Rev 4.10:

```
$<TalkerID>VTG,<TMGT>,T,<TMGM>,M,<SoGN>,N,<SoGK>,K,D*<checksum><cr><lf>
```

Arguments:

Table 109. $--VTG message field description

Parameter	Format	Description
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		Indicates “terrestrial”
TMGM	ddd.d in degrees	Track in reference to “magnetic” earth poles
M		Indicates “magnetic”
SoGN	ddd.d in knots	Speed over Ground in knots
N		Indicates “knots”
SoGK	ddd.d in km/h	Speed over Ground in kilometers per hour
K		Indicates “kilometres”
D	char	Mode indicator: A = Autonoumus mode D = Differential mode E = Estimated mode

Example:

```
$GPVTG,73.2,T,,M,0.2,N,0.4,K,D*50
```

14.5.7 $--ZDA

UTC, day, month and year.

NMEA message list bitmask (64 bits): 0000 0000 0100 0000

Synopsis for NMEA 0183 Rev 3.1 (Default):

```
$GPZDA,<Timestamp>,<Day>,<Month>,<Year>,00,00*<checksum><cr><lf>
```

Synopsis for NMEA 0183 Rev 4.10:

```
$<TalkerID>ZDA,<Timestamp>,<Day>,<Month>,<Year>,,*<checksum><cr><lf>
```

Arguments:

Table 110. $--ZDA message field description

Parameter	Format	Description
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) Note that decimal fraction assumes non zero values when the fix rate is bigger than 1Hz. Note that for Rev 4.10 this field is empty in case of invalid value
Day	Decimal, 2 digits	Day of month (01 to 31)
Month	Decimal, 2 digits	Month (01 to 12)
Year	Decimal, 4 digits	Year (1994 - …)

Example for NMEA 0183 Rev 3.1 (Default):

```
$GPZDA,110505.00,25,01,2013,00,00*60
```

Example for NMEA 0183 Rev 4.10:

```
$GNZDA,204409.000,29,11,2017,,*4C
```

14.5.8 $--GST

Global Positioning System Pseudorange Noise Statistics.

NMEA message list bitmask (64 bits): 0000 0000 0000 0008

Synopsis for NMEA 0183 Rev 3.1 (Default):

```
$GPGST,<Timestamp>,<EHPE>,<Semi-major>,<Semi-minor>,<Angle>,<LatErr>,
<LonErr>,<Alt Err Dev>*<checksum><cr><lf>
```

Synopsis for NMEA 0183 Rev 4.10:

```
$<TalkerID>GST,<Timestamp>,<EHPE>,<Semi-major>,<Semi-minor>,
<Angle>,<LatErr>,<LonErr>,<Alt Err Dev>*<checksum><cr><lf>
```

Arguments:

Table 111. $--GST message field description

Parameter	Format	Description
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) Note that decimal fraction assumes non zero values when the fix rate is bigger than 1Hz. Note that for Rev 4.10 this field is empty in case of invalid value
EHPE	dd.d in m	Equivalent Horizontal Position Error
Semi-major	dd.d in m	Standard deviation (meters) of semi-major axis of error ellipse
Semi-minor	dd.d in m	Standard deviation (meters) of semi-minor axis of error ellipse
Angle	dd.d in degree	Orientation of semi-major axis of error ellipse (true north degrees)
LatErr	dd.d in m	Standard deviation (meters) of latitude error
LonErr	dd.d in m	Standard deviation (meters) of longitude error
AltErr	dd.d in m	Standard deviation (meters) of altitude error

Example for NMEA 0183 Rev 3.1 (Default):

```
$GPGST,101429.000,0.0,3.5,3.1,89.4,3.2,3.4,3.4*58
```

Example for NMEA 0183 Rev 4.10:

```
$GNGST,205512.000,16.5,5.6,4.5,0.8,5.0,5.0,6.7*41
```

or

```
$GAGST,,,,,,,,*46
```

14.5.9 $--GBS

GNSS Satellite Fault Detection

NMEA message list bitmask (64 bits): 0000 2000 0000 0000

Synopsis for NMEA 0183 Rev 3.1 (Default):

```
$GPGBS,<Timestamp>,<LatErr>,<LonErr>,<AltErr>,<SatPRN>,<Prob>,
<Res>,<StdDev>*<checksum><cr><lf>
```

Synopsis for NMEA 0183 Rev 4.10:

```
$<TalkerID>GBS,<Timestamp>,<LatErr>,<LonErr>,<AltErr>,<SatPRN>,<Prob>,
<Res>,<StdDev>,<SystemID>,<SignalID>*<checksum><cr><lf>
```

Arguments:

Table 112. $--GBS message field description

Parameter	Format	Description
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) Note that decimal fraction assumes non zero values when the fix rate is bigger than 1Hz. Note that for Rev 4.10 this field is empty in case of invalid value
LatErr	dd.d in m	Standard deviation (meters) of latitude error
LonErr	dd.d in m	Standard deviation (meters) of longitude error
AltErr	dd.d in m	Standard deviation (meters) of altitude error
SatPRN	Decimal, 2 digits	PRN Number of most likely failed satellite. This satellite is excluded by RAIM or FDE algorithm.
Prob	Empty	Probability of missed detection for most likely failed satellite Not supported
Res	dd.d in m	Range residual of most likely failed satellite
StdDev	Empty	Standard Deviation of bias estimate Not supported
SystemID	Hexadecimal, 1 digit	The system ID of this message: 1 = GPS 2 = GLONASS 3 = GALILEO 4 = BEIDOU 5 = QZSS
SignalID	Decimal, 1 digits	An identifier to indicate the signal in use. Currently it is 1 for GPS, GLONASS, 2 for BEIDOU and QZSS 6 for GALILEO

Example for NMEA 0183 Rev 3.1 (Default):

```
$GPGBS,033037.000,10.7,12.0,14.1,08,,-51.7,*7C
```

Example for NMEA 0183 Rev 4.10:

```
$GNGBS,211120.000,7.6,9.6,10.8,,,,,,*59
```

14.5.10 $--GNS

Fix data for single or combined satellite navigation system (GNSS).

NMEA message list bitmask (64 bits): 0000 0000 0000 0001

Synopsis for NMEA 0183 Rev 3.1 (Default):

```
$<TalkerID>GNS,<Timestamp>,<Lat>,<N/S>,<Long>,<E/W>,<Mode>,
<Sats>,<HDOP>,<AltVal>,<GEOVal>,<DGPSAge>,<DGPSRef>*<checksum><cr><lf>
```

Synopsis for NMEA 0183 Rev 4.10:

```
$<TalkerID>GNS,<Timestamp>,<Lat>,<N/S>,<Long>,<E/W>,<Mode>,
<Sats>,<HDOP>,<AltVal>,<GEOVal>,<DGPSAge>,<DGPSRef>*<checksum><cr><lf>
```

Arguments:

Table 113. $--GNS message field description

Parameter	Format	Description
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) Note that decimal fraction assumes non zero values when the fix rate is bigger than 1Hz. Note that 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 Note that for Rev 4.10 this field is empty in case of invalid value
Long	DDDMM.MMMMM	Longitude as degrees: DD: Degree (Fixed three 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
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
Mode Indicator	Char or String	In case of single constellation this is a character which can assume these values: N = NO Fix

Parameter	Format	Description
		A = Autonomous D = Differential GPS E = Estimated (dead reckoning mode) In multi-constellation mode this is a 5 letter string where each letter is the mode indicator of each constellation in this order: GPS, GLONASS, GALILEO, BEIDOU, QZSS
Sats	Decimal, 2 digits	Satellites in use: example: 8
HDOP	Decimal, 3 digits	Horizontal Dilution of Precision, max: 99.0
Alt	Decimal, 6 digits	Height above WGS84 Elipsoid, max: 100000m
GEOSep	Decimal, 4 digits	Geoidal separation, meter
DGNSSAge	Empty field	Not supported
DGNSSRef	Empty field	Not supported

Note: In case of single constellation setup the mode indicator consists in one character and the information about the constellation is given by talker id.

Example for NMEA 0183 Rev 3.1 (Default):

```
$GNGNS,091233.000,4055.04824,N,01416.55600,E,AAANN,19,0.7,0078.1,42.9,,*17
```

or

```
$GPGNS,083423.000,4055.04781,N,01416.55528,E,A,10,0.9,0092.0,42.9,,*06
```

Example for NMEA 0183 Rev 4.10:

```
$GPGNS,211803.000,4045.53340,N,01447.19988,E,A,04,2.2,0240.1,42.0,,*08
```

Or

```
$GAGNS,,,,,,N,00,99.0,0282.1,0.0,,*35
```

14.5.11 $--DTM

Local geodetic datum and datum offsets from a reference datum. This sentence is used to define the datum to which a position location, and geographic locations in subsequent sentences, is referenced. If enabled, this message is sent for every position fix as first NMEA message in the list.

NMEA message list bitmask (64 bits): 0000 0080 0000 0000

Synopsis for NMEA 0183 Rev 3.1 (Default):

```
$GPDTM,<Local_datum_code>,<local_datum_code_id>,<Lat_offset>,<N/S>,
<Long_offest>,<E/W>,<Alt_offset>,<Reference_datum_code>
*<checksum><cr><lf>
```

Synopsis for NMEA 0183 Rev 4.10:

```
$<TalkerID>DTM,<Local_datum_code>,<local_datum_code_id>,<Lat_offset>,
<N/S>,<Long_offest>,<E/W>,<Alt_offset>,<Reference_datum_code>
*<checksum><cr><lf>
```

Arguments:

Table 114. $--DTM message field description

Parameter	Format	Description
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

Parameter	Format	Description
		QZ: If system works in QZSS only mode GN: If system works in multi-constellation mode.
Local_datum_code	ccc	Local datum code (three characters): W84 = WGS84 P90 = PZ90 999 = User Defined Datum IHO = Datum reported in the International Hydrographic Organization Publication S-60 Appendices B and C. Note: all supported datum are listed in the Appendix A at the end of this document.
local_datum_code_id	ddd	In case the local datum code is W84 or 999 (User Defined) this field is left empty. In all other cases this field reports the local datum code ID (three numeric digits) as reported in Appendix A at the end of this document. The local datum code ID is the same number used to identify the datum code in the firmware configuration (CDB-ID)
Lat_offset	mmm.mmmmm	Latitude offset in minutes
N/S	“N” or “S”	Lat Direction: North or South
Long_offest	mmm.mmmmm	Longitude offset in minutes
E/W	“E” or “W”	Long Direction: East or West
Alt_offset	aaa.aaaaaa	Altitude offset in meters
Reference_datum_code	ccc	Reference datum code (three characters): W84 = WGS84

Example for NMEA 0183 Rev 3.1 (Default):

```
$GPDTM,W84,,000.00000,N,000.00000,E,0.000000,W84*5F
$GPDTM,P90,253,000.00005,S,000.00266,E,0.000000,W84*73
$GPDTM,999,,000.18907,N,000.05146,W,0.000000,W84*2E
$GPDTM,IHO,037,000.11581,N,000.01822,W,0.000000,W84*69
```

Example for NMEA 0183 Rev 4.10:

```
$GNDTM,W84,,2445.54843,N,887.20838,E,0.000000,W84*7E
```

14.5.12 $--RLM

Return Link Message data.

NMEA message list bitmask (64 bits): 8000 0000 0000 0000.

Synopsis for NMEA 0183 Rev 3.1 (Default):

```
$<TalkerID>RLM,<BeaconID>,<TimeOfReception>,<MessageCode>,<MessageBody>
*<checksum><cr><lf>
```

Synopsis for NMEA 0183 Rev 4.10:

```
$<TalkerID>RLM,<BeaconID>,<TimeOfReception>,<MessageCode>,<MessageBody>*
<checksum><cr><lf>
```

Arguments:

Table 115. **$--RLM message field description**

Parameter	Format	Description
TalkerID	String, 2 characters	The talker ID (Fixed two characters). GP: If the RLM has been received on a GPS satellite GL: If the RLM has been received on a GLO satellite GA: If the RLM has been received on a GAL satellite BD: If the RLM has been received on a BDS satellite QZ: If the RLM has been received on a QZS satellite **Note:** Currently only GALILEO supports RLM
BeaconID	Hexadecimal, 15 digits	Beacon intended to receive the message
TimeOfReception	hhmmss.ss	UTC Time of RLM (time of reception of the last 20 bit packet of the RLM): • hh: hours (Fixed two digits) • mm: minutes (Fixed two digits) • ss: seconds (Fixed two digits) • .ss: decimal fraction of seconds (Fixed two digits)
MessageCode	Hexadecimal, 1 digit	Type of RLM Message Service: • 0: Reserved • 1: Acknowledgment Service RLM • 2: Command Service RLM • 3: Message Service RLM • 4-E: Reserved • F: Test Service RLM
MessageBody	Hexadecimal, up to 24 digits	Variable field length encapsulating the data parameters into hexadecimal format. • GALILEO Short Message: 4 hexadecimal digits • GALILEO Long Message: 24 hexadecimal digits

Results:

None.

Example:

GALILEO Short RLM

```
$GARLM,A5A5A123213C3C3,220151.00,1,CAFE*0E
```

GALILEO Long RLM

```
$GARLM,00CAFE11DECAF00,221909.00,1,1F0F1ABCDE2F0F2123453F0F*0C
```

14.6 ST NMEA messages specification

In order to provide further data and information from the Teseo-Module, which are not provided by the standard NMEA messages, STMicroelectronics provides “proprietary messages”. Any proprietary message on the NMEA port starts with “$PSTM…” where “STM” indicate that it is a ST proprietary message ($PSTMxxx…)

There are two sorts of “proprietary messages” within a Teseo-Module. They are either send repeatedly with a defined or definable reporting rate or they are send only once as a reaction to a command.

14.6.1 $PSTMINITGPSOK

Message sent in response of command $PSTMINITGPS

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of successful operation.

14.6.2 $PSTMINITGPSERROR

Message sent in response of command $PSTMINITGPS

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of error.

14.6.3 $PSTMINITTIMEOK

Message sent in response of command $PSTMINITTIME

Synopsis:

```
$PSTMINITTIME OK*<checksum><cr><lf>
```

Arguments:

None.

Results:

- Message sent in case of successful operation.

14.6.4 $PSTMINITTIMEERROR

Message sent in response of command $PSTMINITTIME

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of error.

14.6.5 $PSTMSETRANGEOK

Message sent in response of command $PSTMSETRANGE

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of successful operation.

14.6.6 $PSTMSETRANGEERROR

Message sent in response of command $PSTMSETRANGE

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of error.

14.6.7 $PSTMSBASSERVICEOK

Message sent in response of command $PSTMSBASSERVICE

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of successful operation.

14.6.8 $PSTMSBASSERVICEERROR

Message sent in response of command $PSTMSBASSERVICE

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of error.

14.6.9 $PSTMSBASMOK

Message sent in response of command $PSTMSBASM

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of successful operation.

14.6.10 $PSTMSBASMERROR

Message sent in response of command $PSTMSBASM

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of error.

14.6.11 $PSTMGETALGOOK

Message sent in response of command $PSTMGETALGO

Synopsis:

```
$PSTMGETALGOOK,<algo_type>,<algo_status>*<checksum><cr><lf>
```

Arguments:

Table 116. $PSTMGETALGOOK field description

Parameter	Format	Description
algo_type	Decimal, 1 digit	1 = FDE algorithm on/off status is returned.
algo_status	Decimal, 1 digit	0 = the algorithm is disabled. 1 = the algorithm is enabled.

Results:

- Message sent in case of successful operation.

14.6.12 $PSTMGETALGOERROR

Message sent in response of command $PSTMGETALGO

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of error.

14.6.13 $PSTMSETALGOOK

Message sent in response of command $PSTMSETALGO

Synopsis:

```
$PSTMSETALGOOK,<algo_type>,<algo_status>*<checksum><cr><lf>
```

Arguments:

Table 117. $PSTMSETALGOOK field description

Parameter	Format	Description
algo_type	Decimal, 1 digit	1 = FDE algorithm on/off status is returned.
algo_status	Decimal, 1 digit	0 = the algorithm is disabled. 1 = the algorithm is enabled.

Results:

- Message sent in case of successful operation.

14.6.14 $PSTMSETALGOERROR

Message sent in response of command $PSTMSETALGO

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of error.

14.6.15 $PSTMGETRTCTIME

Message sent in response of command $PSTMGETRTCTIME

Synopsis:

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

Arguments:

Table 118. $PSTMGETRTCTIME message field description

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 - USER_TIME 3 - USER_RTC_TIME 4 - RTC_TIME 5 - RTC_TIME_ACCURATE 6 - APPROX_TIME 7 - POSITION_TIME 8 - EPHEMERIS_TIME

Results:

None

14.6.16 $PSTMDATUMSELECTOK

Message sent in response of command $PSTMDATUMSELECT

Synopsis:

```
$PSTMDATUMSELECTOK,<datum_type>*<checksum><cr><lf>
```

Arguments:

Table 119. $PSTMDATUMSELECTOK field description

Parameter	Format	Description
datum_type	Integer	0 : WGS84 1: TOKYO MEAN 2: OSGB

Results:

- Message sent in case of successful operation.

14.6.17 $PSTMDATUMSELECTERROR

Message sent in response of command $PSTMDATUMSELECT

Synopsis:

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

Arguments:

None

Result:

None

14.6.18 $PSTMDATUMSETPARAMOK

Message sent in response of command $PSTMDATUMSETPARAM

Synopsis:

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

Arguments:

None

Result:

- Message sent in case of successful operation.

14.6.19 $PSTMDATUMSETPARAMERROR

Message sent in response of command $PSTMDATUMSETPARAM

Synopsis:

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

Arguments:

None

Result:

None

14.6.20 $PSTMPOSITIONHOLDENABLED

Message sent in response of command $PSTMENABLEPOSITIONHOLD

Synopsis:

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

Arguments:

None

Results:

None

14.6.21 $PSTMPOSITIONHOLDDISABLED

Message sent in response of command $PSTMENABLEPOSITIONHOLD

Synopsis:

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

Arguments:

None

Results:

None

14.6.22 $PSTMENABLEPOSITIONHOLDERROR

Message sent in response of command $PSTMENABLEPOSITIONHOLD

Synopsis:

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

Arguments:

None

Results:

None

14.6.23 $PSTMSETCONSTMASKOK

Message sent in response of command $PSTMSETCONSTMASK

Synopsis:

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

Arguments:

Table 120. $PSTMSETCONSTMASKOK message field description

Parameter	Format	Description
constellation_mask	Decimal, 1 digit	It is a bit mask where each bit enable/disable 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: GALILELO constellation enabling/disabling bit 7: BEIDOU constellation enabling/disabling

Results:

- Message sent in case of successful operation.

14.6.24 $PSTMSETCONSTMASKERROR

Message sent in response of command $PSTMSETCONSTMASK

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of error.

14.6.25 $PSTMALMANAC

Almanac Data Dump.

This message is sent as a reply to a $PSTMDUMPALMANAC command.

Synopsis:

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

Arguments:

Table 121. $PSTMALMANAC message field description

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

The N Bytes that are in the message are the dump of a structures that contain all the information of the almanac. Data format are constellation dependant.

Table 122. $PSTMALMANAC message field description 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	Contains 1 if the satellite is unhealthy 0 if healthy.
1	available	Contains 1 if almanac is available 0 if not.

Table 123. $PSTMALMANAC field description 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.

Bits	Structure Member	Description
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	Contains 1 if the satellite is unhealthy 0 if healthy.
1	available	Contains 1 if almanac is available 0 if not.
32	Tau_c	
11	NA	
5	N4	
16	Spare	

Table 124. $ PSTMALMANAC field description 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	Contains 1 if the satellite is unhealthy 0 if healthy.
2	RESERVED	RESERVED for use by GNSS library
1	health	Contains 1 if the satellite is unhealthy, 0 if healthy
1	available	Contains 1 if almanac is available 0 if not.

14.6.26 $PSTMALMANACOK

Message sent in response of command $PSTMALMANAC

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of successful operation.

14.6.27 $PSTMALMANACERROR

Message sent in response of command $PSTMALMANAC

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of errors.

14.6.28 $PSTMEPHEM

Ephemeris Data Dump.

This message is sent as a reply to a $PSTMDUMPEPHEMS command.

Synopsis:

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

Arguments:

Table 125. $PSTMEPHEM message field description

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

The N Bytes that are in the message are the dump of a structures that contain all the information of the ephemeris.

Data format are constellation dependant.

Table 126. $PSTMEPHEM message field description 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

Bits	Structure Member	Description
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	Contains 1 if ephemeris is available, 0 if not
1	health	Contains 1 if the satellite is unhealthy, 0 if healthy
1	RESERVED	Must be 0.
4	accuracy	Accuracy

Table 127. $PSTMEPHEM message field description 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 (LBS).
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.

Bits	Structure Member	Description
1	P2	Flag of oddness ("1") or evenness ("0") of the value of tb
1	P4	Flag to show that ephemeris parameters are present.
2	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	RESERVED	
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	Contains 1 if ephemeris is available, 0 if not.
1	health	Contains 1 if the satellite is unhealthy, 0 if healthy.
1	RESERVED	Must be 0.
4	RESERVED	

Table 128. **$PSTMEPHEM message field description for Galileo constellation**

Bits	Structure Member	Description
16	week	Week number of the Issue of Data
14	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	Contains 1 if ephemeris is available, 0 if not
1	health	Contains 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 129. **$PSTMEPHEM message field description 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.

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

14.6.29 $PSTMEPHEMOK

Message sent in response of command $PSTMEPHEM.

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of successful operation.

14.6.30 $PSTMEPHEMERROR

Message sent in response of command $PSTMEPHEM.

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of errors.

14.6.31 $PSTMLOWPOWERON

Message sent in response of command $PSTMLOWPOWERONOFF

Synopsis:

```
$PSTMLOWPOWERON,<EHPE_threshold>,<Max_tracked_sats>,<Switch_constellation_features>,<Duty_Cycle_enable>
```

Arguments:

Table 130. $PSTMLOWPOWERON field description

Parameter	Format	Description
Adaptive mode settings		
EHPE threshold	Decimal, 3 digits	EHPE average threshold [m]
Max tracked sats	Decimal, 2 digits	first N satellites (with higher elevation) used for the position calculation (Active channel management) in LOW POWER STATE
Switch constellation features	Decimal, 1 digit	Switch constellation features
Cyclic mode settings		
Duty Cycle enable/disable	Decimal, 1 digit	Duty Cycle features enable/disable
Duty Cycle ms signal off	Decimal, 3 digits	Estimated Horizontal Position Error Average
Periodic mode settings		

Parameter	Format	Description
Periodic mode	Decimal, 1 digit	Setup Active or Standby periodic mode 0: OFF 3: Standby Periodic mode
FixPeriod	Decimal, 5 digits	Interval between two fixes [s]
FixOnTime	Decimal, 2 digits	Number of fixes reported for each interval
Ephemeris refresh	Decimal, 1 digit	Enable/Disable the refresh of ephemeris data 0: OFF, 1: ON
RTC calibration	Decimal, 1 digit	Enable/Disable the RTC calibration 0: OFF, 1: ON
NoFixCnt	Decimal, 2 digits	Time to declare fix loss [s] in HOT conditions
NoFixOff	Decimal, 2 digits	Period of off period after a fix loss [s]

Results:
Message sent in case of successful operation.

14.6.32 $PSTMLOWPOWERERROR

Message sent in response of command $PSTMLOWPOWERONOFF.
Synopsis:

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

Arguments:
None.
Results:

- Message sent in case of error.

14.6.33 $PSTMPPS

Message sent in response of command $PSTMPPS
Synopsis:

```
$PSTMPPS,1,<cmd_type>,<par_1>,…,<par_N>*<checksum><cr><lf>
```

Arguments:

Table 131. $PSTMPPS field description

Parameter	Format	Description
1	Decimal, 1 digit	1 = GET operation (to get data from PPS manager)
cmd_type	Decimal, 1 digit	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

Parameter	Format	Description
		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		Parameters list according to the command type specification (see below).

14.6.33.1 *PPS Get PPS_IF_PULSE_DATA_CMD*

Synopsis:

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

Arguments:

Table 132. $PSTMPPS field description on PPS_IF_PULSE_DATA_CMD

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, it is 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.

14.6.33.2 PPS Get PPS_IF_TIMING_DATA_CMD

Synopsis:

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

Arguments:

Table 133. $PSTMPPS field description on PPS_IF_TIMING_DATA_CMD

Parameter	Format	Description
fix_condition	Decimal, 1 digit	1 = NOFIX. 2 = 2DFIX. 3 = 3DFIX.
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 bit3 = BeiDou bit7 = Galileo
gps_rf_delay	Decimal	GPS path RF delay [ns]
glonass_rf_delay	Decimal	GLONASS path RF delay [ns]

14.6.33.3 PPS Get PPS_IF_POSITION_HOLD_DATA_CMD

Synopsis:

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

Arguments:

Table 134. $PSTMPPS field description on PPS_IF_POSITION_HOLD_DATA_CMD

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.

14.6.33.4 PPS_Get_PPS_IF_TRAIM_CMD

Synopsis:

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

Arguments:

Table 135. **$PSTMPPS field description on PPS_IF_TRAIM_CMD**

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 satellite used for timing correction.
removed_sats	Decimal	Number of satellites removed by the timing correction.

14.6.33.5 *PPS Get PPS_IF_TRAIM_RES_CMD*

Synopsis:

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

Arguments:

Table 136. **$PSTMPPS field description on PPS_IF_TRAIM_RES_CMD**

Parameter	Format	Description
traim_enabled	Decimal, 1 digit	TRAIM ON/OFF status 0 = OFF 1 = ON
used_sats	Decimal	Number of satellite 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.

14.6.33.6 *PPS Get PPS_IF_TRAIM_REMOVED_CMD*

Synopsis:

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

Arguments:

Table 137. **$PSTMPPS field description on PPS_IF_TRAIM_REMOVED_CMD**

Parameter	Format	Description
traim_enabled	Decimal, 1 digit	TRAIM ON/OFF status 0 = OFF 1 = ON
rem_sats	Decimal	Number of satellite removed by timing correction.
sat1..satN	Decimal	List of satellites IDs

14.6.34 $PSTMPPSERROR

Message sent in response of command $PSTMPPS

Synopsis:

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

Arguments:

None

Result:

- Message will be sent in case of error

14.6.35 $PSTMFORCESTANDBYOK

Message sent in response of command $PSTMFORCESTANDBY

Synopsis:

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

Arguments:

None

Results:

Message sent in case of successful operation.

14.6.36 $PSTMFORCESTANDBYERROR

Message sent in response of command $PSTMFORCESTANDBY

Synopsis:

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

Arguments:

None

Results:

Message is sent in case of error.

14.6.37 $PSTMGALILEODUMPGGTO

Message sent in response of command $PSTMGALILEODUMPGGTO

Synopsis:

```
$PSTMGALILEOGGTO,<brd>,<WN0G>,<t0G>,<A0G>,<A1G>,<validity>*
<checksum><cr><lf>
```

Arguments:

Table 138. $PSTMGALILEODUMPGGTO message field description

Parameter	Format	Description
brd	Decimal, 1 digits	1=broadcast GGTO
WN0G	Decimal, 3 digits	Value for WN0G
t0G	Decimal, 5 digits	Value for t0G
A0G	Decimal, 5 digits	Value for A0G
A1G	Decimal, 5 digits	Value for A1G
validity	binary	0=not valid, 1=valid

Results:

None

14.6.38 $PSTMSETTHTRKOK

Message sent in response of command $PSTMSETTHTRK

Synopsis:

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

Arguments:

None

Results:

Message sent in case of successful operation.

14.6.39 $PSTMSETTHTRKERROR

Message sent in response of command $PSTMSETTHTRK

Synopsis:

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

Arguments:

None

Results:

Message sent in case of error

14.6.40 $PSTMSETTHPOSOK

Message sent in response of command $PSTMSETTHPOS

Synopsis:

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

Arguments:

None

Results:

Message sent in case of successful operation.

14.6.41 $PSTMSETTHPOSERROR

Message sent in response of command $PSTMSETTHPOS

Synopsis:

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

Arguments:

None

Results:

- Message sent in in case of errors

14.6.42 $PSTMVER

Message sent in response of command $PSTMGETSWVER

Synopsis:

```
$PSTMVER,<Lib>_<Ver>_<Type>*<checksum><cr><lf>
```

Arguments:

Table 139. **$PSTMVER field specification**

Parameter	Format	Description
Lib	Text, fixed	Text String identifying the Library that the command is requiring the version: GNSSLIB if type = 0 OS20LIB if type = 1 GPSAPP if type = 2 BINIMG if type = 6 SWCFG if type = 11 PID if type = 12
Ver	x.x.x.x	GNSS Library Version: example 7.1.1.15
Type	ARM, GNU	Compiler Type: ARM or GNU

Example:

```
$PSTMGETSWVER,0*<checksum><cr><lf>
```

Note: if any id is passed as parameter to the command, its output act as in the id = 0 case

Note: when id is 255 consecutive messages are sent reporting the library version string on each line following the above message syntax.

Note: when id is 254 the entire configuration block is printed on several lines using the following syntax:

```
$PSTMSWCONFIG,<config_source>,<msg_n>,<msg_tot><data>*<checksum><cr><lf>
```

Arguments:

Table 140. **$PSTMSWCONFIG field specification**

Parameter	Format	Description
config_source	Decimal, 1 digit	Configuration block data source: 1 = Current Configuration (RAM) 2 = Default Configuration (ROM) 3 = Saved Configuration (FLASH)
msg_n	Decimal, 1 digit	Current message number
msg_tot	Decimal, 1 digit	Total number of messages
data	String	64 Bytes per line printing each byte in HEX format.

Note: The HW version has the following syntax:

```
$PSTMVER,STA80XX_<HW_SIGNATURE_STRING>*<checksum><cr><lf>
```

Table 141. **HW version field specification**

HW_SIGNATURE_STRING	STA8089 HW
0x622BC043	BD Mask

14.6.43 $PSTMRF

Provides “satellite signal data” for each tracked satellite. Single message contains the relevant fields for max 3 satellites. For all satellites the message is repeated with the data of the other satellites.

Synopsis:

```
$PSTMRF,<MessgAmount>,<MessgIndex>,<used_sats>,
 [<Sat1ID>,<Sat1PhN>,<Sat1Freq>,<Sat1CN0>],
 [<Sat2ID>,<Sat2PhN>,<Sat2Freq>,<Sat2CN0>],
 [<Sat3ID>,<Sat3PhN>,<Sat3Freq>,<Sat3CN0>],
 *<checksum><cr><lf>
```

Arguments:

Table 142. $PSTMRF message field description

Parameter	Format	Description
MessgAmount	Decimal, 1 digit	Number of consecutive $PSTMRF messages
MessgIndex	Decimal, 1 digit	Current number in the sequence of messages
used_sats	Decimal, 2 digits	Number of satellites used in the fix
SatxID	Decimal, 2 digits	Satellite x Number (PRN)
SatxPhN	Decimal, 5 digits	Satellite x Phase Noise
SatxFreq	Decimal, 6 digits	Satellite x Frequency
SatxCN0	Decimal, 2 digits	Satellite x Carrier to Noise Ratio (in dB)

Results:
None

14.6.44 $PSTMTESTRF

Specific message containing information on just one satellite for RF testing purposes.

Synopsis:

```
$PSTMTESTRF,<Sat-ID>,<Sat-Freq>,<Sat-PhN><Sat-CN0>*<checksum><cr><lf>
```

Arguments:

Table 143. $PSTMTESTRF message field description

Parameter	Format	Description
Sat-ID	Decimal, 2 digits	Satellite Number (PRN)
Sat-Freq	Decimal, 5 digits	Satellite Frequency
Sat-PhN	Decimal, 5 digits	Satellite Phase Noise
Sat-CN0	Decimal, 2 digits	Satellite Carrier to Noise Ratio (in dB)

Results:
None

14.6.45 $PSTMTG

Time and Satellites Information

Synopsis:

```
$PSTMTG,<Week>,<TOW>,<TotSat>,<CPUTime><Timevalid><NCO>
<kf_config_status><constellation_mask><time_best_sat_type><time_master_sat_type>
<time_master_week_n><time_master_tow><time_master_validity><time_aux_week_n><time_aux_tow>
<time_aux_validity>*
```

Arguments:

Table 144. $PSTMTG message field description

Parameter	Format	Description
Week	Decimal, 4 digits	Week Number
TOW	Decimal, 10 digits	Time of Week
Tot-Sat	Decimal, 2 digits	Total Number of satellites used for fix
CPU-Time	Decimal, 10 digits	CPU Time
Timevalid	Decimal, 2 digits	0 = no time 1 = time read from flash 2 = time set by user 3 = time set user RTC 4 = RTC time 5 = RTC time, accurate 6 = time approximate 7 = “not used” 8 = time accurate 9 = position time 10 = Ephemeris time
NCO	Decimal, 9 digits	NCO value
kf_config_status	Hexadecimal, 2 digits	Kalman Filter Configuration For each bit: · 0 means feature disabled · 1 means feature enabled
constellation_mask	Decimal, 3 digits max	It is a bit mask where each bit enable/disable 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: GALILELO constellation enabling/disabling bit 7: BAIDEU constellation enabling/disabling
time_best_sat_type	Decimal	selected best time satellite type
time_master_sat_type	Decimal	master time satellite type
time_aux_sat_type	Decimal	auxiliary time satellite type
time_master_week_n	Decimal	master time week number
time_master_tow	Floating	master time TOW
time_master_validity	Decimal	master week number time validity
time_aux_week_n	Decimal	auxiliary time
time_aux_tow	Floating	auxiliary time TOW
time_aux_validity	Decimal	auxiliary time validity

Table 145. kf_config_status bit configuration

Bit	Configuration
0	Walking mode ON
1	Stop Detection ON

Bit	Configuration
2	Frequency Ramp On (only Xtal mode)
3	Velocity estimator model: · 1 means MULTIPLE MODEL · 0 means SINGLE MODEL
4	Velocity estimator filter: · 1 means SLOW · 0 means FAST
5	FDE Status ON

Results:
None

14.6.46 $PSTMTS

This message is repeated for each satellite tracked and used for the calculation of a fix

Synopsis:

```
$PSTMTS,<dsp-dat>,<SatID>,<PsR>,<Freq>,<plf>,<CN0>,<ttim>,<Satdat>,
 <Satx>,<Saty>,<Satz>,<Velx>,<Vely>,<Velz>,<src>,<ac>,
 <difdat>,<drc>,<drrc><predavl>,<predage>,<predeph>,<predtd>
 *<checksum><cr><lf>
```

Arguments:

Table 146. $PSTMTS message field description

Parameter	Format	Description
dsp-dat	Decimal, 1 digit	DSP data available: 0 = satellite not tracked 1 = satellite tracked
Sat-ID	Decimal, 2 digits	Satellite Number (PRN)
PsR	Decimal, 10 digits	Pseudo range
Freq	Decimal, 8 digits	Satellite tracking frequency offset
Plf	Decimal, 1 digit	Preamble Lock Flag 0 = Navigation data stream preamble not locked 1 = Navigation data stream preamble locked
CN0	Decimal, 3 digits	Satellite Carrier to Noise Ratio (in dB)
Ttim	Decimal, 6 digits	Track Time of Satellite (in seconds)
Satdat	Decimal, 1 digit	Satellite Data available Flag 0 = Sat. Ephemeris not available or unhealthy Sat. 1 = Sat. Ephemeris available and healthy Satellite
Satx	Decimal, 10 digits	Satellite Position , X-Coordinate
Saty	Decimal, 10 digits	Satellite Position , Y-Coordinate
Satz	Decimal, 10 digits	Satellite Position , Z-Coordinate
Velx	Decimal, 8 digits	Satellite Velocity , X-Coordinate
Vely	Decimal, 8 digits	Satellite Velocity , Y-Coordinate
Velz	Decimal, 8 digits	Satellite Velocity , Z-Coordinate

Parameter	Format	Description
Src	Decimal, 6 Digits	Satellite Range Correction
Ac	Decimal, 3 Digits	Atmospheric Correction
Difdat	Decimal, 1 digit	Differential Data available Flag 0 = Differential Corrections not available 1 = Differential Corrections available
Drc	Decimal, 3 digits	Differential Range Correction (from DGPS Station)
Drrc	Decimal, 3 digits	Differential Range Rate Correction (from DGPS Stat.)
predavl	Decimal, 1 digit	Prediction available Flag 0 = Predicted Ephemeris not available 1 = Predicted Ephemeris available
predage	Decimal, 1 digit	Age of predicted Ephemeris (in hours)
predeph	Decimal, 1 digit	Number of satellites ussed for prediction (1 or 2)
predtd	Decimal, 1 digit	Time distance of Ephemeris calculated from 2 Sats. Only valid if <pred-eph> = 2

Note: <pred-xxx> fields are only included within the message if the AGPS software module has been included.

Results:

None

Example:

```
$PSTMTS,1,05,15748178.41,30992.22,1,44,306150,1,16278399.26,20504574.30,
4653136.69,38.03,703.04,-3046.01,141169.29,11.45,1,-12.75,0.00,
$PSTMTS,1,31,14242886.83,-28462.15,1,37,304775,1,20641723.13,
-8713847.54,14517949.66,1788.86,311.39,-2382.23,1804.01,7.09,1,
-5.74,0.00,
$PSTMTS,1,21,14885540.17,-25018.74,1,50,301653,1,25482227.75,
6629457.30,5528104.33,-699.61,220.74,2983.68,23248.85,8.12,1,
-2.84,0.00,
$PSTMTS,1,07,13337296.04,-27966.11,1,31,296621,1,15777659.46,
4155044.35,21301094.71,-1287.52,2301.27,509.20,-15394.31,5.65,1,
-3.83,0.00,
$PSTMTS,1,06,1216319.39,-28367.75,0,23,40492,1,14595868.85,
6511991.60,21397698.91,-1394.03,2294.91,251.81,70766.81,5.72,1,
-3.28,0.00,
$PSTMTS,1,24,13629659.89,-27176.62,1,40,298187,1,17698708.17,
12886703.95,15024752.78,-1901.12,-1.00,2298.33,11530.25,6.39,1,
-9.27,0.00,
$PSTMTS,1,30,14421546.48,-30401.97,1,44,298264,1,17539544.73,
16864817.03,10440026.12,394.97,1346.12,-2741.16,14708.79,7.87,1,
-9.96,0.00,
$PSTMTS,1,16,16177492.44,-24593.30,1,40,298572,1,6202032.13,
-17659074.51,18852818.90,1139.40,2098.88,1613.11,35896.88,12.03,1,
-4.54,0.00,
$PSTMTS,1,10,16728325.63,-26663.46,1,30,124750,1,-2057875.88,
21248945.17,15476302.66,-1018.51,-1731.48,2256.47,
-32564.02,15.33,1,-12.86,0.00,
$PSTMTS,1,12,17539958.05,-31018.23,1,35,10528,1,11788804.59,
23841922.01,245355.77,-236.27,137.48,-3173.58,-103404.01,20.66,1,
-19.21,0.00,
$PSTMTS,1,23,17770191.78,-27801.14,1,28,196026,1,-6131001.55,
-15740405.01,20363733.86,1549.10,-2097.11,-1173.09,89981.45,
27.98,0,0.00,0.00,
```

14.6.47 $PSTMPA

Position Algorithm

Synopsis:

```
$PSTMPA,<PosA>,<Dur>*<checksum><cr><lf>
```

Arguments:

Table 147. $PSTMPA message field description

Parameter	Format	Description
PosA	Char, 2	Position Algorithm Indicator Empty = none LS = LMS KF = Kalman Filter
Dur	Decimal, 3 digits	Time period in which the position has been stationary (count in seconds)

Results:

None

Example:

```
$PSTMPA,KF,433*<checksum><cr><lf>
$PSTMPA, ,00*<checksum><cr><lf>
```

14.6.48 $PSTMSAT

This message is repeated for each satellite tracked and used for the calculation of a fix. The information contained in this message is a subset of the $PSTMTS message.

Synopsis:

```
$PSTMSAT,<SatID>,<PsR>,<Freq>,<Satx>,<Saty>,<Satz>*<checksum><cr><lf>
```

Arguments:

Table 148. $PSTMSAT message field description

Parameter	Format	Description
SatID	Decimal, 2 digits	Satellite Number (PRN)
PsR	Decimal, 10 digits	Pseudo Range
Freq	Decimal, 8 digits	Tracking Frequency of Satellite
Satx	Decimal, 10 digits	Satellite Position, X-Coordinate
Saty	Decimal, 10 digits	Satellite Position, Y-Coordinate
Satz	Decimal, 10 digits	Satellite Position, Z-Coordinate

Results:

None

14.6.49 $PSTMPRES

Position Residual

Note: $PSTMPRES and $PSTMVRES are always enabled together.

Synopsis:

```
$PSTMPRES,<RMSpos>,<res1>,...,<resN>*<checksum><cr><lf>
```

N = number of tracked satellites

Arguments:

Table 149. $PSTMPRES message field description

Parameter	Format	Description
RMSpos	dd.d	position “rms” residual for the fix
resx	dd.d	Residual of tracked satellite x (Corresponds to x satellite in $GPGSA Message)

Results:

None

Example:

```
$PSTMPRES,8.1,-0.2,-0.2,-0.1,-0.3,-0.3,-0.4,,,,,,,*2D
 $PSTMPRES,0.0,,,,,,,,,,,,,*20
```

14.6.50 $PSTMVRES

Velocity Residual

Note: $PSTMPRES and $PSTMVRES are always enabled together.

Synopsis:

```
$PSTMPRES,<RMSvel>,<vres1>,...,<vresN>*<checksum><cr><lf>
```

N = number of tracked satellites

Arguments:

Table 150. $PSTMVRES message field description

Parameter	Format	Description
RMSvel	dd.d	velocity “rms” residual for the fix
vresx	dd.d	Residual of tracked satellite x (Corresponds to x satellite in $GPGSA Message)

Results:

None

Example:

```
$PSTMVRES,0.0,0.0,0.0,0.0,,,,,,,,,*26
```

14.6.51 $PSTMNOISE

This message contains the raw noise floor estimation for GPS and GLONASS

Synopsis:

```
$PSTMNOISE,<GPS_raw_NF>,<GLONASS_raw_NF>*<checksum><cr><lf>
```

Arguments:

Table 151. **$PSTMNOISE message field description**

Parameter	Format	Description
GPS_raw_NF	integer	Noise floor raw estimation for GPS.
GLONASS_raw_NF	integer	Noise floor raw estimation for GLONASS.

Results:
None

14.6.52 $PSTMCPU

This message contains the real time CPU usage and the CPU speed setting.

Synopsis:

```
$PSTMCPU,<CPU_Usage>,-1,<CPU_Speed>*<checksum><cr><lf>
```

Arguments:

Table 152. **$PSTMCPU message field description**

Parameter	Format	Description
CPU_Usage	ddd.dd	CPU usage %
CPU_Speed	Decimal, 1 digit	CPU clock frequency: 52, 104, 156, 208 MHz.

Results:
None

14.6.53 $PSTMPPSDATA

Reports the Pulse Per Second data

Synopsis:

```
$PSTMPPSDATA,<on_off>,<pps_valid>,<synch_valid>,<out_mode>,<ref_time>,
<ref_constellation>,<pulse_duration>,<pulse_delay>,<gps_delay>,<glo_delay>,<bei_delay>,
<gal_delay>,<inverted_polarity>,<fix_cond>,<sat_th>,<elev_mask>,<const_mask>,<ref_sec>,
<fix_status>,<used_sats>,<gps_utc_delta_s>,<gps_utc_delta_ns>,<glonass_utc_delta_ns>,
<galileo_utc_delta_ns>,<quantization_error>,<pps_clock_freq>,
<tcxo_clock_freq>*<checksum><cr><lf>
```

Arguments:

Table 153. **$PSTMPPSDATA message field description**

Parameter	Format	Description
on_off	Decimal, 1 digit	PPS signal ON/OFF status 0: OFF 1: ON
pps_valid	Decimal, 1 digit	Global PPS validity flag 0: PPS not valid 1: PPS valid
synch_valid	Decimal, 1 digit	PPS synchronization validity 0: Not Valid 1: Valid
out_mode	Decimal, 1 digit	0 = PPS_OUT_MODE_ALWAYS

Parameter	Format	Description
		1 = PPS_OUT_MODE_ON_EVEN_SECONDS 2 = PPS_OUT_MODE_ON_ODD_SECONDS
ref_time	Decimal, 1 digit	0 = UTC 1 = GPS_UTC (GPS Time) 2 = GLONASS_UTC (GLONASS Time) 3 = UTC_SU 4 = GPS_UTC_FROM_GLONASS NOTES: UTC(SU) is the Soviet Union UTC, it is 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.
ref_constellation	Decimal, 1 digit	0 = GPS 1 = GLONASS NOTE: the reference constellation reports which reference time has been used for the PPS generation.
pulse_duration	Double	Pulse duration [s]
pulse_delay	Decimal	Pulse delay [ns]
gps_delay	Decimal	GPS path RF delay [ns]
glo_delay	Decimal	GLONASS path RF delay [ns]
bei_delay	Decimal	BEIDOU path RF delay [ns] NOTE: this parameter is always zero if Beidou constellation is not supported by the hardware platform.
gal_delay	Decimal	GALILEO path RF delay [ns]
inverted_polarity	Decimal, 1 digit	Pulse polarity inversion: 0 = not inverted 1 = inverted
fix_cond	Decimal, 1 digit	Selected GNSS fix condition for PPS signal generation: 1 = NO_FIX 2 = 2D_FIX 3 = 3D_FIX
sat_th	Decimal	Selected minimum number of satellites for PPS signal generation.
elev_mask	Decimal	Selected minimum satellite elevation for time correction.
const_mask	Decimal	Selected constellations for time correction.
ref_sec	Decimal, 2 digits	Second at which the reported PPS data is applied. According to the reference time configuration it could be a UTC or a GPS or a GLONASS time second.
fix_status	Decimal, 1 digit	GNSS position fix status when the time has been corrected.
used_sats	Decimal	Used satellites for time correction.
gps_utc_delta_s	Decimal	UTC leap seconds [s]
gps_utc_delta_ns	Decimal	UTC – GPS delta time [ns]
glonass_utc_delta_ns	Decimal	UTC – GLONASS delta time [ns]
galileo_utc_delat_ns	Decimal	UTC – GALILEO delta time [ns]

Parameter	Format	Description
quantization_error	Double (scientific notation format)	Quantization error [s].
pps_clock_freq	Double, 2 fractional digits	PPS clock frequency [Hz]
tcxo_clock_freq	Double, 2 fractional digits	TCXO clock frequency [Hz]

Results:
None

14.6.54 $PSTMPOSHOLD

Reports the Position Hold status and position.

Synopsis:

```
$PSTMPOSHOLD,<on_off>,<Lat>,<N/S>,<Long>,<E/W>,<Alt>*<checksum><cr><lf>
```

Arguments:

Table 154. $PSTMPOSHOLD message field description

Parameter	Format	Description
On_off	Decimal, 1 digit	Position Hold enabling/disabling status 0: disabled 1: enabled
Lat	DDMM.MMMMM	Lat in degree: DD: Degree MM: Minutes .MMMMM: partsMinutes
N/S	“N” or “S”	Lat Direction: North or South
Long	DDMM.MMMMM	Long in degree: DD: Degree MM: Minutes .MMMMM: partsMinutes
E/W	“E” or “W”	Long Direction: East or West
Alt	Decimal, 8 digits	Height above WGS84 Elipsoid, max: 100000

Results:
None

14.6.55 $PSTMTRAIMSTATUS

Reports the TRAIM algorithm status.

Note: All TRAIM related messages are enabled/disabled all together by the same mask.

Synopsis:

```
$PSTMTRAIMSTATUS,<on_off>,<traim_solution>,<alarm>,<ave_error>
,<used_sats>,<removed_sats>,<ref_second>*<checksum><cr><lf>
```

Arguments:

Table 155. **$PSTMTRAIMSTATUS message field description**

Parameter	Format	Description
on_off	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
alarm	Decimal	Time error threshold [ns]
ave_error	Decimal	Average time error [ns]
used_sats	Decimal	Number of used satellites.
removed_sats	Decimal	Number of removed satellites.
ref_second	Decimal	Second at which the PPS signal is generated based on reported TRAIM status.

Results:
None

14.6.56 $PSTMTRAIMUSED

Reports the satellite used for timing correction.

Note: All TRAIM related messages are enabled/disabled all together by the same mask.

Synopsis:

```
$PSTMTRAIMUSED,<on_off>,<used_sats>,<sat1>,…,<satN>*<checksum><cr><lf>
```

Arguments:

Table 156. **$PSTMTRAIMUSED message field description**

Parameter	Format	Description
on_off	Decimal, 1 digit	TRAIM ON/OFF status 0: OFF 1: ON
used_sats	Decimal	Number of used satellites.
Sat1..satN	Decimal	Used satellites list.

14.6.57 $PSTMTRAIMRES

Reports the time error residuals for satellites used for timing correction.

Note: All TRAIM related messages are enabled/disabled all together by the same mask.

Synopsis:

```
$PSTMTRAIMRES,<on_off>,<used_sats>,<res1>,…,<resN>*<checksum><cr><lf>
```

Arguments:

Table 157. **$PSTMTRAIMRES message field description**

Parameter	Format	Description
on_off	Decimal, 1 digit	TRAIM ON/OFF status 0: OFF 1: ON
used_sats	Decimal	Number of used satellites.
res1..resN	Decimal	Time error residuals for satellites reported in the TRAIMUSED message. Each residual refer to the satellite in the same message position.

14.6.58 $PSTMTRAIMREMOVED

Reports the satellite removed by the timing correction algorithm.

Note: All TRAIM related messages are enabled/disabled all together by the same mask.

Synopsis:

```
$PSTMTRAIMUSED,<on_off>,<removed_sats>,<sat1>,…,<satN>*<checksum><cr><lf>
```

Arguments:

Table 158. **$PSTMTRAIMREMOVED message field description**

Parameter	Format	Description
on_off	Decimal, 1 digit	TRAIM ON/OFF status 0: OFF 1: ON
removed_sats	Decimal	Number of removed satellites.
Sat1..satN	Decimal	Removed satellites list.

14.6.59 $PSTMNAVM

Navigation Data Frame.

Synopsis:

```
$PSTMNAVM,<msg_id>,<prn>,<nav_frame>*<checksum><cr><lf>
```

Arguments:

Table 159. **$PSTMNAVM message field description**

Parameter	Format	Description
msg_id	Decimal, 1 digits	Message ID (GPS = 0, GLONASS = 1, GALILEO = 3, BEIDOU = 7)
prn	Decimal, 3 digits	Satellite PRN (Range: depending on the constellation)
nav_frame	Hexadecimal, up to 80 digits	Navigation data frame (length: depending on the constellation)

Details:

The navigation frame parameter depends on the constellation. The following table describe its meaning (see each constellation ICD document for details):

Table 160. Navigation frame data types

Constellation	Type	Length (bits)	Length (bytes)	Note
GPS	Sub-frame	300	40 (10 words)	For each 32 bit word 30 bits are used (the 2 msb are ignored)
GLONASS	1 or 2 strings	85 or 170 (85+85)	11 or 22 (11+11 bytes)	One string for each message for strings from 1 to 5. Two strings for each message for strings from 6 to 15. For the first byte of each string the 3 msb are ignored and the 4th is always zero. The payload is 84 bits long
GALILEO	payload	128	16 (4 words)	Each message contains the payload from I/NAV message (see Note for details)
BEIDOU	Sub-frame	300	40 (10 words)	For each 32 bit word 30 bits are used (the 2 msb are ignored)

Note: in the above table, "word" means a 32-bit little endian encoded word, while "msb" means most significant bit(s).
It means that, in a little endian architecture system, the navigation frame (converted to binary format) can be directly copied into a C 32 bit unsigned integer words array. In other words:

- For GPS, the navigation frame can be copied into a C language variable defined according to the following type definition:

```
typedef tU32 gps_subframe_t [10];
```

- For GLONASS, the navigation frame can be copied into a C language variable defined according to the following type definition:

```
typedef tU08 glo_subframe_t [22];
```

Note: for strings for #1 to #5 just the first 11 bytes will be used, while for strings from #6 to #15 all 22 bytes will be used by storing two consecutive strings (e.g. strings #7 and #6). In this latter case the first sting (e.g. string #n) will be stored in the second part of the array (i.e. from byte #12 to #22), and the second string (e.g. string #n+1) will be stored in the first part of the array (i.e. from byte #1 to #11).

- For GALILEO, the navigation frame can be copied in a C language variable defined according to the following type definition:

```
typedef tU32 gal_subframe_t [4];
```

- Note: the GALILEO navigation frame contains the message payload, encoded according to the following table:

Table 161. Galileo payload, 128[bit], 32-bit packing

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Data k 0-31 (112 bit)																															
1	Data k 32-63 (112 bit)																															
2	Data k 64-95 (112 bit)																															
3	Data k 96-111 (112 bit)																Data j (16 bit)														

- For BEIDOU, the navigation frame can be copied in a C language variable defined according to the following type definition:

```
typedef tU32 bds_subframe_t [10];
```

where *tU32* is a 32 bit unsigned integer type and *tU08* is a 8 bit unsigned integer type.

Example:

```
$PSTMNAVM,0,4,00AFC32268A9BD26337FF43AC40B60D1B8B80018C8EE0B0330BDA238AF
711D185E1000C088790781*23
```

14.6.60 $PSTMKFCOV

This message contains the Standard Deviations for position and velocity and their split into north, east and vertical components.

Synopsis:

```
$PSTMKFCOV,<PosStd>,<PosNcov>,<PosEcov>,<PosVcov>,
 <VelStd>,<VelNcov><VelEcov>,<VelVcov>*<checksum><cr><lf>
```

Arguments:

Table 162. $PSTMKFCOV message field description

Parameter	Format	Description
PosStd	ddd.d	Standard Deviation of Position in meters
PosNcov	ddd.d	Covariance (North/South) in m² (from Kalman Filter)
PosEcov	ddd.d	Covariance (East/West) in m² (from Kalman Filter)
PosVcov	ddd.d	Covariance (Vertical) in m² (from Kalman Filter)
VelStd	ddd.d	Standard Deviation of Velocity in meter/second
VelNcov	ddd.d	Covariance (North/South) in m²/s (from Kalman Filter)
VelEcov	ddd.d	Covariance (East/West) in m²/s (from Kalman Filter)
VelVcov	ddd.d	Covariance (Vertical) in m²/s (from Kalman Filter)

Example:

```
$PSTMKFCOV,8.7,50.9,25.4,150.7,0.4,0.1,0.0,0.2*49
```

14.6.61 $PSTMTIM

Time Validity.

Synopsis:

```
$PSTMTIM,<Tvalid>,<curr-CPU-Time>*<checksum><cr><lf>
```

Arguments:

Table 163. $PSTMTIM message field description

Parameter	Format	Description
Tvalid	ASCII	“RTC” = time read from RTC “VALID” = time downloaded from satellite or corrected using position “INVALID” = time is not valid
curr-CPU-Time	Decimal	Current CPU Time, i.e. the number of ticks since the system started to run

14.6.62 $PSTMDIFF

Time Validity.

Synopsis:

```
$PSTMDIFF,<ListSize>,<NCS>,
[<Sat1ID>,<Corr1Avl>,]
...
 [<SatNID>,<CorrNAvl>,]
 *<checksum><cr><lf>
```

N = number of tracked satellites

Arguments:

Table 164. $PSTMDIFF message field description

Parameter	Format	Description
ListSize	Decimal, 2 digits	Amount of visible satellites in this message (n)
NCS	Decimal, 2 digits	Number of corrected satellites
SatxID	Decimal, 2 digits	Satellite x ID (PRN)
CorrxAvl	Decimal	Correction available for Satellite x

14.6.63 $PSTMSBAS

SBAS Satellite Data.

Synopsis:

```
$PSTMSBAS,<Status>,<SatTrk>,<SatID>,<Elev>,<Azim>,
<Sig>*<checksum><cr><lf>
```

N = number of tracked satellites

Arguments:

Table 165. $PSTMSBAS message field description

Parameter	Format	Description
Status	Decimal, 1 digit	SBAS Status 0 = no SBAS used 1 = SBAS used
SatTrk	Decimal, 1 digit	SBAS Satellite tracked 0 = SBAS Satellite not tracked 1 = SBAS Satellite tracked, decoding is ongoing 2 = SBAS Satellite tracked and decoded. Differential Mode ON
SatID	Decimal, 3 digits	SBAS Satellite ID
Elev	Decimal, 2 digits	SBAS Satellite Elevation (in degrees)
Azim	Decimal, 3 digits	SBAS Satellite Azimuth (in degrees)
Sig	Decimal, 2 digits	SBAS Satellite Signal Strength CN0 (in dB)

Example:

```
$PSTMSBAS,1,0,124,65,090,00*09
```

14.6.64 $PSTMSBASM

SBAS Frame.

Synopsis:

```
$PSTMSBASM,<prn><sbas_frame>*<checksum><cr><lf>
```

Arguments:

Table 166. $PSTMSBASM message field description

Parameter	Format	Description
prn	Decimal, 3 digits	Satellite PRN (Range: from 120 to 140)
sbas_frame	Hexadecimal, 64 digits	SBAS frame (250 bits + 6 padding)

Example:

```
$PSTMSBASM,123,536A481B40D8063829C12E08704B82DFFDFFEFFF7FFBFFDFFEF06E803
7EFB440*6D
```

14.6.65 $PSTMNOTCHSTATUS

This message provide information on the Adaptive Notch Filter (ANF) status.

Synopsis:

```
$PSTMNOTCHSTATUS,<kfreq_now_Hz_gps>,<lock_en_gps>,<pwr_gps>,
<ovfs_gps>,<mode_gps>,<kfreq_now_Hz_gln>,<lock_en_gln>,<pwr_gln>, <ovfs_gln>,
<mode_gln>*<checksum><cr><lf>
```

Arguments:

Table 167. $PSTMNOTCHSTATUS message field description

Parameter	Format	Description
kfreq_now_Hz_gps	Decimal, 7 digits	`Notch frequency estimation actual value [Hz] (GPS path)`
lock_en_gps	Decimal, 1 digits	`Frequency lock flag (GPS path)`
pwr_gps	Decimal, 5 digits	Band Pass Filter internal power estimation (GPS path) [dimensionless quantity]
ovfs_gps	Decimal, 4 digits	Internal mask output as: 1000 * Notch_Removing_jammer (1/0,TRUE/FALSE) + overflow flags status (3 digits). E.g: “1000” means Block enabled, with no internal overflows detected
mode_gps	Decimal, 1 digits	ANF mode operation (GPS path) [0 → ANF disabled; 1 → Always ON(Internal Use only); 2 → Auto insertion mode (suggested);]
kfreq_now_Hz_gln	Decimal, 7 digits	Notch frequency estimation actual value [Hz] (GLONASS path)
lock_en_gln	Decimal, 1 digits	Frequency lock flag (GLONASS path)
pwr_gln	Decimal, 24 digits	Band Pass Filter internal power estimation (GLONASS path) [dimensionless quantity]
ovfs_gln	Decimal, 4 digits	Internal mask output as: 1000 * Notch_Removing_jammer (1/0,TRUE/FALSE) + overflow flags status (3 digits). E.g: “1000” means Block enabled, with no internal overflows detected
mode_gln	Decimal, 1 digits	ANF mode operation (GLONASS path) [0 → ANF disabled; 1 → Always ON (Internal Use only);

Parameter	Format	Description
		2 → Auto insertion mode(suggested);]

Results:

- This message provides the ANF status.
- When ANF is disabled all parameters are set to zero

Frequency / Power values are meaningful only when Notch is locked.

14.6.66 $PSTMLOWPOWERDATA

Reports the status of adaptive low power algorithm.

Synopsis:

```
$PSTMLOWPOWERDATA,<low power state>,<steady state>,<RESERVED>,
<RESERVED>,<ehpe>,<RESERVED>,<ehpe_average>,<RESERVED>, <RESERVED>,
< eph const mask>,<switch constellation>,<duty cycle enable>,<duty cycle ms off>,<duty cycle
state>*<checksum><cr><lf>
```

Arguments:

Table 168. $PSTMLOWPOWERDATA message field description

Parameter	Format	Description
low power state	Decimal, 1 digits	Low power state indicator: [0 → FULL CONST; 1 → LOW POWER STATE; 2 → EPH REFRESH]
steady state	Decimal, 1 digits	Steady state reached indicator
RESERVED		
RESERVED		
ehpe	dd.d [m]	Estimated Horizontal Position Error [m]
RESERVED		
ehpe_average	dd.d [m]	Estimated Horizontal Position Error Average [m]
RESERVED		
RESERVED		
eph const mask	Decimal, 2 digits	Bitfield of completed ephemeris download
switch constellation	Decimal, 1 digits	Switch constellation features indicator
duty cycle enable	Decimal, 1 digits	Duty cycle enable indicator
duty cycle ms off	Decimal, 3 digits	Duty cycle ms signal off
duty cycle state	Decimal, 1 digits	Duty cycle state indicator

Results:

This message provides the adaptive low power status. In the case of dynamic low power disabled, all parameters are set to zero.

14.6.67 $PSTMSTANDBYENABLE

Message sent in response of command $PSTMSTANDBYENABLE.

Synopsis:

```
$PSTMSTANDBYENABLE,<status>*<checksum><cr><lf>
```

Arguments:

Table 169. **$PSTMSTANDBYENABLE message field description**

Parameter	Format	Description
status	Decimal, 1 digits	Set the standby enable status 0: Active Periodic mode 1: Periodic mode, standby allowed

Result:

- Message sent in case of successful operation.

14.6.68 $PSTMSTANDBYENABLEOK

Message sent in response of command $PSTMSTANDBYENABLE.

Synopsis:

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

Arguments:

None

Result:

- Message sent in case of successful operation.

14.6.69 $PSTMSTANDBYENABLEERROR

Message sent in response of command $PSTMSTANDBYENABLE.

Synopsis:

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

Arguments:

None

Result:

- Message sent in case of error.

14.6.70 $PSTMPV

Provides position (Latitude, Longitude, Height), velocity (North, East, Vertical) and root square of covariance matrix values for position and velocity.

Synopsis:

```
$PSTMPV,<Timestamp>,<Lat>,<N/S>,<Long>,<E/W>,<Alt>,<AltVal>,<Vel_N>,<Vel_E>,<Vel_V>,
<P_cov_N>,<P_cov_NE>,<P_cov_NV>,<P_cov_E>,<P_cov_EV>,<P_cov_V>,<V_cov_N>,<V_cov_NE>,<V_cov_NV>,
<V_cov_E>,<V_cov_EV>,<V_cov_V>*<checksum><cr><lf>
```

Arguments:

Table 170. **$PSTMPV message field description**

Parameter	Format	Description
Timestamp	hhmmss.sss	UTC Time of GPS Sample, example: 160836.000 “.sss” is the fraction of seconds; it assumes non zero values when the fix rate is bigger than 1Hz.
Lat	DDMM.MMMMM	Lat in degree: DD: Degree MM: Minutes .MMMMM: partsMinutes

Parameter	Format	Description
N/S	“N” or “S”	Lat Direction: North or South
Long	DDMM.MMMMM	Long in degree: DD: Degree MM: Minutes .MMMMM: partsMinutes
E/W	“E” or “W”	Long Direction: East or West
Alt	Decimal, 6 digits	Height above mean sea level, max: 100000m
Alt-Val	“M”	Height measure in “M” = meters
Vel_N	ddd.d	Velocity North component [m/s]
Vel_E	ddd.d	Velocity East component [m/s]
Vel_V	ddd.d	Velocity Vertical component [m/s]
P_cov_N	ddd.d	Position North covariance [m]
P_cov_NE	ddd.d	Position North-East covariance [m]
P_cov_NV	ddd.d	Position North-Vertical covariance [m]
P_cov_E	ddd.d	Position East covariance [m]
P_cov_EV	ddd.d	Position East-Vertical covariance [m]
P_cov_V	ddd.d	Position Vertical covariance [m]
V_cov_N	ddd.d	Velocity North covariance [m/s]
V_cov_NE	ddd.d	Velocity North-East covariance [m/s]
V_cov_NV	ddd.d	Velocity North-Vertical covariance [m/s]
V_cov_E	ddd.d	Velocity East covariance [m/s]
V_cov_EV	ddd.d	Velocity East-Vertical covariance [m/s]
V_cov_V	ddd.d	Velocity Vertical covariance [m/s]

Example:

```
$PSTMPV,160635.000,4055.10928,N,01416.56027,E,026.96,M,0.2,0.0,0.1,22.6,
12.8,5.8,17.2,10.9,18.8,5.5,4.1,1.7,4.6,0.0,2.7*70
```

14.6.71 $PSTMPVRAW

Provides not filtered position (Latitude, Longitude, Height), not filtered velocity (North, East, Vertical) and LMS fix related info

Synopsis:

```
$PSTMPVRAW,<Timestamp>,<Lat>,<N/S>,<Long>,<E/W>,<GPSQual>,<Sats>,<HDOP>,<Alt>,
<AltVal>,<GeoSep>,<GeoVal>,<Vel_N>,<Vel_E>,<Vel_V>*<checksum><cr><lf>
```

Arguments:

Table 171. $PSTMPVRAW message field description

Parameter	Format	Description
Timestamp	hhmmss.sss	UTC Time of GPS Sample, example: 160836.000 “.sss” is the fraction of seconds; it assumes non zero values when the fix rate is bigger than 1Hz.
Lat	DDMM.MMMMM	Lat in degree:

Parameter	Format	Description
		DD: Degree MM: Minutes .MMMMM: partsMinutes
N/S	“N” or “S”	Lat Direction: North or South
Long	DDMM.MMMMM	Long in degree: DD: Degree MM: Minutes .MMMMM: partsMinutes
E/W	“E” or “W”	Long Direction: East or West
GPSQual	Decimal, 1digit	0 = invalid 1 = GPS 2 = DGPS
Sats	Decimal, 2 digits	Satellites in use: example: 8
HDOP	Decimal, 3 digits	Horizontal Dilution of Precision, max: 99.0
Alt	Decimal, 6 digits	Height above mean sea level, max: 100000m
AltVal	“M”	Reference Unit for Altitude (“M” = meters)
GeoSep	Decimal, 4 digits	Geoidal Separation measure in “M” = meters
GeoVal	“M”	Reference Unit for GeoSep (“M” = meters)
Vel_N	ddd.d	Velocity North component [m/s]
Vel_E	ddd.d	Velocity East component [m/s]
Vel_V	ddd.d	Velocity Vertical component [m/s]

Example:

```
 $PSTMPVRAW,144056.000,5131.12414,N,00005.31484,W,2,09,1.2,043.31,M,47.0,
M,-0.6,0.1,0.6*58
```

14.6.72 $PSTMPVQ

Provides position and velocity processing noise matrix values.

Synopsis:

```
$PSTMPVQ,<P_Q_N>,<P_Q_E>,<P_Q_V>,<Q_CLKO>,<Q_GLPD>,<V_Q_N>,<V_Q_E>,<V_Q_V>,<Q_CLKD>,
<RESERVED>*<checksum><cr><lf>
```

Arguments:

Table 172. $PSTMPVQ message field description

Parameter	Format	Description
P_Q_N	ddd.d	Position North processing noise [m]
P_Q_E	ddd.d	Position East processing noise [m]
P_Q_V	ddd.d	Position Vertical processing noise [m]
Q_CLKO	ddd.d	Clock offset processing noise [m]
Q_GLPD	ddd.d	Glonass path delay [m]
V_Q_N	ddd.d	Velocity North processing noise [m/s]
V_Q_E	ddd.d	Velocity East processing noise [m/s]

Parameter	Format	Description
V_Q_V	ddd.d	Velocity Vertical processing noise [m/s]
Q_CLKD	ddd.d	Clock drift processing noise [m/s]
RESERVED	-	RESERVED for future use

Example:

```
$PSTMPVQ,0.0,0.0,0.0,0.0,4.0,3.0,3.0,0.0,3.0,0.0*4A
```

14.6.73 $PSTMUTC

This message reports the UTC time, date and time offset parameters.

Synopsis:

```
$PSTMUTC,<utc_time>,<utc_date>,<utc_timestamp>,<utc_offset>,<utc_offset_validity>*<checksum><cr><lf>
```

Arguments:

Table 173. $PSTMUTC message field description

Parameter	Format	Description
utc_time	hhmmss.sss	UTC Time of Fix, example: 160836.000 ".sss" is the fraction of seconds; it assumes non zero values when the fix rate is bigger than 1Hz.
utc_date	ddmmyyyy	Date of Fix : ddmmyyyy
utc_timestamp	Decimal	UTC time expressed as number of seconds since January 6th 1980
utc_offset	Decimal, 2 digits	UTC to GPS time offset [s]
utc_offset_validity	Decimal, 1 digit	UTC to GPS time offset validity 0 = NOT Valid 1 = Read From NVM 2 = Valid (downloaded from sky)

Example:

```
$PSTMUTC,161344.000,19062012,1024157624,15,2*52
```

14.6.74 $PSTMERRORMSG

This message reports an error, its location as well as additional (and optional) parameters helpful to understand the error cause.

Synopsis:

```
$PSTMERRORMSG,<error_code>,<param1>,…,<param6>*<checksum><cr><lf>
```

Arguments:

Table 174. $PSTMERRORMSG message field description

Parameter	Format	Description
error_code	Hexadecimal, 8 digits	Indicates where does the error comes from.
Param1 up to param6	Hexadecimal, 8 digits	Optional parameters used to understand the error. There can be 0 additional parameter.

Example:

```
$PSTMERRORMSG,01900001,11111111,11111111,cccccccc,0000dddd,eeeeeeee*26
$PSTMERRORMSG,01920003*2E
```

14.6.75 $PSTMGNSSINTEGRITY

This message is sent from Teseo-Module to the host periodically it is enabled in the message list.

Synopsis:

```
$PSTMGNSSINTEGRITY,<type>,<pos_const_mask>,<pos_err_AtoB>,<pos_err_AtoC>,
<pos_err_BtoC>,<time_const_mask>,<time_err_AtoB>,<time_err_AtoC>,
<time_err_BtoC>*<checksum><cr><lf>
```

Arguments:

Table 175. $PSTMGNSSINTEGRITY message field description

Parameter	Format	Description
type	Decimal	Integrity message type (currently always 0)
pos_const_mask	Decimal	Position related constellation mask
pos_err_AtoB	Double	Position error of second active constellation in comparison to the first one as meters
pos_err_AtoC	Double	Position error of third active constellation in comparison to the first one as meters
pos_err_BtoC	Double	Position error of third active constellation in comparison to the second one as meters
time_const_mask	Decimal	Time related constellation mask
time_err_AtoB	Double	Time error of second active constellation in comparison to the first one as nanoseconds
time_err_AtoC	Double	Time error of third active constellation in comparison to the first one as nanoseconds
time_err_BtoC	Double	Time error of third active constellation in comparison to the second one as nanoseconds

14.6.76 $PSTMGPSSUSPENDED

Message sent in response of command $PSTMGPSSUSPEND

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of no error.

14.6.77 $PSTMGETUCODEOK

Message sent in response of command $PSTMGETUCODE

Synopsis:

```
$PSTMGETUCODEOK,<unique_code>*<checksum><cr><lf>
```

Arguments:

Table 176. $PSTMGETUCODEOK message field description

Parameter	Format	Description
unique_code	Char, 32 bytes	The Unique ID written in the secondary boots

Results:

- Message sent in case of successful operation.

14.6.78 $PSTMGETUCODEERROR

Message sent in response of command **Error! Reference source not found.**

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of errors.

14.7 ST system configuration messages

14.7.1 $PSTMSETPAROK

Message sent in response of command $PSTMSETPAR

Synopsis:

```
$PSTMSETPAROK ,<ConfigBlock><ID>*<checksum><cr><lf>
```

Arguments:

Table 177. $PSTMSETPAROK message field description

Parameter	Format	Description
ConfigBlock	Decima1,1 digit	Indicates one of configuration blocks: 1=Current Configuration, 2 = Default Configuration, 3 = NVM Stored configuration.
ID	Decimal, 3 digits	ID - Identifier

Results:

- Message sent in case of successful operation.

14.7.2 $PSTMSETPARERROR

Message sent in response of command $PSTMSETPAR

Synopsis:

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

Argument:

None

Results:

- Message sent in case of error.

14.7.3 $PSTMRESTOREPAROK

Message sent in response of command $PSTMRESTOREPAR

Synopsis:

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

Arguments:

None.

Results:

Message sent in case of successful operation.

14.7.4 $PSTMRESTOREPARERROR

Message sent in response of command $PSTMRESTOREPAR

Synopsis:

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

Arguments:

None.

Results:

Message sent in case of error.

14.7.5 $PSTMSAVEPAROK

Message sent in response of command $PSTMSAVEPAR

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of successful operation.

14.7.6 $PSTMSAVEPARERROR

Message sent in response of command $PSTMSAVEPAR

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of error.

14.7.7 $PSTMSETPAR

Message sent in response of command $PSTMGETPAR

Synopsis:

```
$PSTMSETPAR,<ConfigBlock><ID>,<value>*<checksum><cr><lf>
```

Arguments:

Table 178. $PSTMSETPAR message field description

Parameter	Format	Description
ConfigBlock	Decima1, 1 digit	Indicates one of configuration blocks: 1 = Current Configuration,

Parameter	Format	Description
		2 = Default Configuration, 3 = NVM Stored configuration.
ID	Decimal, 3 digits	ID - Identifier
value	Hexadecimal or Decimal	The value of returned parameter. According to the parameter type it could be expressed in hexadecimal format (in case parameter is integer) or decimal format (in case the parameter is floating).

14.7.8 $PSTMGETPARERROR

Message sent in response of command $PSTMGETPAR

Synopsis:

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

Arguments:

None.

Results:

In case of errors, the error message is returned.

14.7.9 $PSTMCFGPORTOK

Message sent in response of command $PSTMCFGPORT

Synopsis:

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

Arguments:

None.

Results:

Message sent in case of successful operation.

14.7.10 $PSTMCFGPORTERROR

Message sent in response of command $PSTMCFGPORT

Synopsis:

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

Arguments:

None.

Results:

Message sent in case of error.

14.7.11 $PSTMCFGMSGLOK

Message sent in response of command $PSTMCFGMSGL

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of successful operation.

14.7.12 $PSTMCFGMSGLERROR

Message sent in response of command $PSTMCFGMSGL

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of error.

14.7.13 $PSTMCFGGNSSOK

Message sent in response of command $PSTMCFGGNSS

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of successful operation.

14.7.14 $PSTMCFGGNSSERROR

Message sent in response of command $PSTMCFGGNSS

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of error.

14.7.15 $PSTMCFGSBASOK

Message sent in response of command $PSTMCFGSBAS

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of successful operation.

14.7.16 $PSTMCFGSBASERROR

Message sent in response of command $PSTMCFGSBAS

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of error.

14.7.17 $PSTMCFGPPSGENOK

Message sent in response of command $PSTMCFGPPSGEN

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of successful operation.

14.7.18 $PSTMCFGPPSGENERROR

Message sent in response of command $PSTMCFGPPSGEN

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of error.

14.7.19 $PSTMCFGPPSSATOK

Message sent in response of command $PSTMCFGPPSSAT

Synopsis:

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

Arguments:

None.

Results:

Message sent in case of successful operation.

14.7.20 $PSTMCFGPPSSATERROR

Message sent in response of command $$PSTMCFGPPSSAT

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of error.

14.7.21 $PSTMCFGPPSPULOK

Message sent in response of command $PSTMCFGPPSPUL

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of successful operation.

14.7.22 $PSTMCFGPPSPULERROR

Message sent in response of command $PSTMCFGPPSPUL

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of error.

14.7.23 $PSTMCFGPOSHOLDOK

Message sent in response of command $PSTMCFGPOSHOLD

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of successful operation.

14.7.24 $PSTMCFGPOSHOLDERROR

Message sent in response of command $PSTMCFGPOSHOLD

Synopsis:

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

Arguments:

None.

Results:

Message sent in case of error.

14.7.25 $PSTMCFGTRAIMOK

Message sent in response of command $PSTMCFGTRAIM

Synopsis:

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

Arguments:

None.

Results:

Message sent in case of successful operation.

14.7.26 $PSTMCFGTRAIMERROR

Message sent in response of command $PSTMCFGTRAIM

Synopsis:

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

Arguments:

None.

Results:

Message sent in case of error.

14.7.27 $PSTMCFGSATCOMPOK

Message sent in response of command $PSTMCFGSATCOMP

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of successful operation.

14.7.28 $PSTMCFGSATCOMERROR

Message sent in response of command $PSTMCFGSATCOMP

Synopsis:

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

Arguments:

None.

Results:

Message sent in case of error.

14.7.29 $PSTMCFGLPAOK

Message sent in response of command $PSTMCFGLPA

Synopsis:

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

Arguments:

Results:

- Message sent in case of successful operation.

14.7.30 $PSTMCFGLPAERROR

Message sent in response of command $PSTMCFGLPA

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of error.

14.7.31 $PSTMCFGAGPSOK

Message sent in response of command $PSTMCFGAGPS

Synopsis:

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

Arguments:
None.
Results:
Message sent in case of successful operation.

14.7.32 $PSTMCFGAGPSERROR

Message sent in response of command $PSTMCFGAGPS
Synopsis:

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

Arguments:
None.
Results:
- Message sent in case of error.

14.7.33 $PSTMCFGAJMOK

Message sent in response of command $PSTMCFGAJM
Synopsis:

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

Arguments:
None.
Results:
Message sent in case of successful operation.

14.7.34 $PSTMCFGAJMERROR

Message sent in response of command $PSTMCFGAJM
Synopsis:

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

Arguments:
None.
Results:
- Message sent in case of error.

14.7.35 $PSTMCFGODOOK

Message sent in response of command $PSTMCFGODO
Synopsis:

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

Arguments:
None.
Results:
Message sent in case of successful operation.

14.7.36 $PSTMCFGODOERROR

Message sent in response of command $PSTMCFGODO

Synopsis:

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

Arguments:
None.
Results:
- Message sent in case of error.

14.7.37 $PSTMCFGLOGOK

Message sent in response of command $PSTMCFGLOG
Synopsis:

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

Arguments:
None.
Results:
- Message sent in case of successful operation.

14.7.38 $PSTMCFGLOGERROR

Message sent in response of command $PSTMCFGLOG
Synopsis:

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

Arguments:
None.
Results:
Message sent in case of error.

14.7.39 $PSTMCFGGEOFENCEOK

Message sent in response of command $PSTMCFGGEOFENCE
Synopsis:

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

Arguments:
None.
Results:
- Message sent in case of successful operation.

14.7.40 $PSTMCFGGEOFENCEERROR

Message sent in response of command $PSTMCFGGEOFENCE
Synopsis:

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

Arguments:
None.
Results:
- Message sent in case of error.

14.7.41 $PSTMCFGGEOCIROK

Message sent in response of command $PSTMCFGGEOCIR

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of successful operation.

14.7.42 $PSTMCFGGEOCIRERROR

Message sent in response of command $PSTMCFGGEOCIR

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of error.

14.7.43 $PSTMCFGCONSTOK

Message sent in response of command $PSTMCFGCONST

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of successful operation.

14.7.44 $PSTMCFGCONSTERROR

Message sent in response of command $PSTMCFGCONST

Synopsis:

$PSTMCFGCONSTERROR*<checksum><cr><lf>

Arguments:

None.

Results:

- Message sent in case of error.

14.7.45 $PSTMCFGTHGNSSOK

Message sent in response of command $PSTMCFGTHGNSS

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of successful operation.

14.7.46 $PSTMCFGTHGNSSERROR

Message sent in response of command $PSTMCFGTHGNSS

Synopsis:

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

Arguments:

None.

Results:

Message sent in case of error.

14.7.47 $PSTMCFGTDATAOK

Message sent in response of command $PSTMCFGTDATA

Synopsis:

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

Arguments:

None.

Results:

Message sent in case of successful operation.

14.7.48 $PSTMCFGTDATAERROR

Message sent in response of command $PSTMCFGTDATA

Synopsis:

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

Arguments:

None.

Results:

Message sent in case of error.

14.8 Geofencing NMEA messages

14.8.1 $PSTMGEOFENCECFGOK

Message sent in response of command $PSTMGEOFENCECFG

Synopsis:

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

Arguments:

None

Results:

Message sent in case of successful operation.

14.8.2 $PSTMGEOFENCECFGERROR

Message sent in response of command $PSTMGEOFENCECFG

Synopsis:

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

Arguments:

None

Results:

Message sent in case of error.

14.8.3 $PSTMGEOFENCESTATUS

This message is sent from Teseo-Module to the host as response to $PSTMGEOFENCEREQ.

Geofence reports a bitmap against which circle is raising the alarm.

Synopsis:

```
$PSTMGEOFENCESTATUS,<timestamp>,<datestamp>,<status_1>,
<status_2>,…,<status_x>*<checksum><cr><lf>
```

Arguments:

Table 179. $PSTMGEOFENCESTATUS message field description

Parameter	Format	Description
timestamp	Decimal, 6 digits	Hour (2 digit) Minute (2 digit) Seconds (2 digit)
datestamp	Decimal, 8 digits	Year (4 digit); Month (2 digit); Day (2 digit)
status_x	Decimal, 1 digit	Geo fencing status for each circle where: 0 = Status unknown 1 = Current position is outside the circle 2 = Current position on circle boundary 3 = Current position is inside the circle

14.8.4 $PSTMGEOFENCEREQERROR

Message sent in response of command $PSTMGEOFENCEREQ

Synopsis:

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

Arguments:

None

Results:

Message sent in case of error.

14.8.5 $PSTMGEOFENCE

This message is sent asynchronously from Teseo-Module (if enabled in the message-list)

Geofence reports which circle changes its status.

Synopsis:

```
$PSTMGEOFENCE,<timestamp>,<datestamp>,<id>,<lat>,<lon>,<rad>,
<distance>,<sigma>,<status>*<checksum><cr><lf>
```

Arguments:

Table 180. **$PSTMGEOFENCE message field description**

Parameter	Format	Description
timestamp	Decimal, 6 digits	Hour (2 digit) Minute (2 digit) Seconds (2 digit)
datestamp	Decimal, 8 digits	Year (4 digit); Month (2 digit); Day (2 digit)
id	Decimal, 1 digit	Circle identifier
lat	Double	Latitude as Decimal Degrees
lon	Double	Longitude as Decimal Degrees
rad	Double	Radius as meters
distance	Double	Distance from centre of circle
sigma	Double	Sigma distance
status	Decimal, 1 digit	Geo fencing status for each circle where: 0 = Status unknown 1 = Current position is outside the circle 2 = Current position on circle boundary 3 = Current position is inside the circle

14.9 Odometer NMEA messages

14.9.1 $PSTMODOSTARTOK

Message sent in response of command $PSTMODOSTART

Synopsis:

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

Arguments:

None

Results:

Message sent in case of successful operation.

14.9.2 $PSTMODOSTARTERROR

Message sent in response of command $PSTMODOSTART

Synopsis:

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

Arguments:

None

Results:

Message sent in case of error.

14.9.3 $PSTMODOSTOPOK

Message sent in response of command $PSTMODOSTOP

Synopsis:

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

Arguments:

None

Results:

Message sent in case of successful operation.

14.9.4 $PSTMODOSTOPERROR

Message sent in response of command $PSTMODOSTOP

Synopsis:

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

Arguments:

None

Results:

- Message sent in case of error.

14.9.5 $PSTMODORESETOK

Message sent in response of command $PSTMODORESET

Synopsis:

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

Arguments:

None

Results:

Message sent in case of successful operation.

14.9.6 $PSTMODORESETERROR

Message sent in response of command $PSTMODORESET

Synopsis:

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

Arguments:

None

Results:

Message sent in case of error.

14.9.7 $PSTMODO

This message is sent from Teseo-Module to the host periodically if Odometer subsystem is enabled and related messages are in the message list.

Synopsis:

```
$PSTMODO,<timestamp>,<date-stamp>,<odo-A>,<odo-B>,<odo-pon>*<checksum><cr><lf>
```

Arguments:

Table 181. $PSTMODO message field description

Parameter	Format	Description
timestamp	Decimal, 6 digits	Hour (2 digit)

Parameter	Format	Description
		Minute (2 digit) Seconds (2 digit)
date-stamp	Decimal, 8 digits	Year (4 digit); Month (2 digit); Day (2 digit)
odo-A	Unsigned	Odometer A value
odo-B	Unsigned	Odometer B value
odo-pon	Unsigned	Odometer PON value

14.9.8 $PSTMODOREQERROR

Message sent in response of command $PSTMODOREQ

Synopsis:

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

Arguments:

None

Results:

- Message sent in case of error.

14.10 Autonomous AGNSS NMEA messages

14.10.1 $PSTMPOLSTARTED

Message sent in response to commands $PSTMSTAGPSONOFF

Synopsis:

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

Arguments:

None

Results:

- Message sent if the engine has been started

14.10.2 $PSTMPOLSUSPENDED

Message sent in response to commands $PSTMSTAGPSONOFF

Synopsis:

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

Arguments:

None

Results:

- Message sent if the engine has been suspended

14.10.3 $PSTMPOLONOFFERROR

Message sent in response to commands $PSTMSTAGPSONOFF

Synopsis:

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

Arguments:

None

Results:

- Message sent in case of error

14.10.4 $PSTMSTAGPSINVALIDATEOK

Message sent in response to commands $PSTMSTAGPSINVALIDATE

Synopsis:

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

Arguments:

None

Results:

Message sent in case of successful operation.

14.10.5 $PSTMSTAGPSINVALIDATEERROR

Message sent in response to commands $PSTMSTAGPSINVALIDATE

Synopsis:

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

Arguments:

None

Results:

- Message sent in case of error

14.10.6 $PSTMAGPSSTATUS

Message sent in response to commands $PSTMGETAGPSSTATUS

Synopsis:

```
$PSTMGETAGPSSTATUS,<status>*<checksum><cr><lf>
```

Arguments:

Table 182. $PSTMAGPSSSTATUS message field description

Parameter	Format	Description
status	Decimal, 1 digits	0 = the ST-AGNSS processing is completed. Any number different from zero on means that the ST-AGNSS processing is ongoing and so the ephemeris prediction data has been not completely generated.

Results:

- Message return the ST-AGNSS status

14.10.7 $PSTMSTAGPSSETCONSTMASKOK

Message sent in response to commands $PSTMSTAGPSSETCONSTMASK

Synopsis:

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

Arguments:

Table 183. **$PSTMSTAGPSSETCONSTMASKOK message field description**

Parameter	Format	Description
Constellation_mask	Decimal, 1 digits	It is a bit mask where each bit enable/disable a specific constellation independently by the others: bit 0: GPS constellation enabling/disabling bit 1: GLONASS constellation enabling/disabling bit 3: GALILEO constellation enabling/disabling bit 7: BEIDOU constellation enabling/disabling

Results:

- Message sent in case of successful operation

14.10.8 $PSTMSTAGPSSETCONSTMASKERROR

Message sent in response to commands $PSTMSTAGPSSETCONSTMASK

Synopsis:

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

Arguments:

None

Results:

- Message sent in case of error

14.10.9 $PSTMAGPS

This message has the same syntax as standard NMEA GSA message. Each parameter in the satellites PRN fields is an integer number that reports the satellite PRN and, in case a satellite is using a predicted ephemeris, it also reports the age of predicted ephemeris available for that satellite.

They are generated using the formula:

`satID + 32 * STAGPS_AGE_DAYS`

where `STAGPS_AGE_DAYS` is the number of days from current time back to the most recent ephemeris used for ST-AGNSS predictions. If a satellite has no predicted ephemeris (STAGPS_AGE_DAYS = 0) the satellite parameter, reported in the sentence, is exactly the satellite PRN.

Table 184. **$PSTMAGPS ephemeris aging description**

STAGPS_AGE_DAYS	Ephemeris aging description
1	Latest ephemeris has been downloaded from 0 up to 24 hours in the past
2	Latest ephemeris has been downloaded from 24 up to 48 hours in the past
3	Latest ephemeris has been downloaded from 48 up to 72 hours in the past
4	Latest ephemeris has been downloaded from 72 up to 96 hours in the past
5	Latest ephemeris has been downloaded from 96 up to 120 hours in the past

This message could be used to replace the standard GSA when ST-AGNSS is enabled. If ST-AGNSS is not enabled, it behaves in the same way as NMEA GSA message.

NMEA message list bitmask: 0x10000000 – This message is not enabled by default

Synopsis:

```
$PSTMAGPS,<Mode>,<CurrentMode>,[<SatPRN1>],...,[<SatPRNN>],<PDOP>,<HDOP>,
<VDOP>*<checksum><cr><lf>
```

Arguments:

Table 185. **$PSTMAGPS message field description**

Parameter	Format	Description
Mode	“M” or “A”	Operating Mode: M = Manual, A = Auto (2D/3D)
CurrentMode	Decimal, 1 digit	Current Mode: 1 = no FIX available 2 = 2D FIX 3 = 3D FIX
SatPRN1...N	Decimal, 2 digits	Satellites list used in position FIX (max N 12)
PDOP	Decimal, 3 digits	Position Dilution of Precision, from 0.0 to 99.0
HDOP	Decimal, 3 digits	Horizontal Dilution of Precision, from 0.0 to 99.0
VDOP	Decimal, 3 digits	Vertical Dilution of Precision, from 0.0 to 99.0

14.10.10 $PSTMAGLO

This message has the same syntax as standard NMEA GSA message. Each parameter in the satellites PRN fields is an integer number that reports the satellite PRN and, in case a satellite is using a predicted ephemeris, it also reports the age of predicted ephemeris available for that satellite. They are generated using the formula:

`satID + 32 * STAGPS_AGE_DAYS`

where `STAGPS_AGE_DAYS` is the number of days from current time back to the most recent ephemeris used for ST-AGNSS predictions. If a satellite has no predicted ephemeris (STAGPS_AGE_DAYS = 0) the satellite parameter, reported in the sentence, is exactly the satellite PRN.

Table 186. **$PSTMAGLO ephemeris aging description**

STAGPS_AGE_DAYS	Ephemeris aging description
1	Latest ephemeris has been downloaded from 0 up to 24 hours in the past
2	Latest ephemeris has been downloaded from 24 up to 48 hours in the past
3	Latest ephemeris has been downloaded from 48 up to 72 hours in the past
4	Latest ephemeris has been downloaded from 72 up to 96 hours in the past
5	Latest ephemeris has been downloaded from 96 up to 120 hours in the past

This message could be used to replace the standard GSA when ST-AGNSS is enabled. If ST-AGNSS is not enabled, it behaves in the same way as NMEA GSA message.

NMEA message list bitmask: 0x10000000 – This message is not enabled by default

Synopsis:

```
$PSTMAGLO,<Mode>,<CurrentMode>,[<SatPRN1>],...,[<SatPRNN>],<PDOP>,<HDOP>,
<VDOP>*<checksum><cr><lf>
```

Arguments:

Table 187. **$PSTMAGLO message field description**

Parameter	Format	Description
Mode	“M” or “A”	Operating Mode: M = Manual, A = Auto (2D/3D)
CurrentMode	Decimal, 1 digit	Current Mode: 1 = no FIX available 2 = 2D FIX 3 = 3D FIX

Parameter	Format	Description
SatPRN1...N	Decimal, 2 digits	Satellites list used in position FIX (max N 12)
PDOP	Decimal, 3 digits	Position Dilution of Precision, from 0.0 to 99.0
HDOP	Decimal, 3 digits	Horizontal Dilution of Precision, from 0.0 to 99.0
VDOP	Decimal, 3 digits	Vertical Dilution of Precision, from 0.0 to 99.0

14.11 Real Time AGNSS NMEA messages

14.11.1 $PSTMSTAGPS8PASSRTN

Message sent in response of command $PSTMSTAGPS8PASSGEN.

Synopsis:

```
$PSTMSTAGPS8PASSRTN,<DevID>,<Password>*<checksum><cr><lf>
```

Arguments:

Table 188. **$PSTMSTAGPS8PASSRTN message field description**

Parameter	Description
<DevID>	Unique Device ID
<Password>	41-character ASCII password.

Results:

None

14.12 Dead Reckobing NMEA Messages

14.12.1 $PSTMDRCALCTLTOK

Message sent in response of command $PSTMDRCALCTLT

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of successful operation.

14.12.2 $PSTMDRCALCTLTERROR

Message sent in response of command $PSTMDRCALCTLT

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of error.

14.12.3 $PSTMDRNVMSAVEOK

Message sent in response of command $PSTMDRNVMSAVE

Synopsis:

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

Arguments:

None.

Results:

Message sent in case of successful operation.

14.12.4 $PSTMDRNVMSAVEERROR

Message sent in response of command $PSTMDRNVMSAVE

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of error.

14.12.5 $PSTMIMUSELFTESTCMDOK

Message sent in response of command $PSTMIMUSELFTESTCMD

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of successful operation.

14.12.6 $PSTMIMUSELFTESTCMDKO

Message sent in response of command $PSTMIMUSELFTESTCMD

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of failing operation.

14.12.7 $PSTMIMUSELFTESTCMDERROR

Message sent in response of command $PSTMIMUSELFTESTCMD

Synopsis:

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

Arguments:

None.

Results:

- Message sent in case of command error or system not ready.

14.12.8 $PSTMDRSENMSG

This is a family of messages reporting sensor data. Depending on the specific ID, the message can contain information related to a specific sensor.

NMEA message list bitmask (64 bits): 1000 0000 0000 0000

Synopsis:

```
$PSTMDRSENMSG,<message_id>,<data…>*<checksum><cr><lf>
```

Arguments:

Table 189. $PSTMDRSENMSG message field description

Parameter	Format	Description
Message_id	Decimal, 2 digits	Specify the message id
data		Data dependent on message_id

Results:

- This message provides Dead Reckoning sensor data at the Dead Reckoning sampling rate.

$PSTMDRSENMSG,3

Odometer and reverse data (only on Teseo-ModuleDA)

Synopsis:

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

Arguments:

Table 190. $PSTMDRSENMSG message field description when ID = 3

Parameter	Format	Description
Message id	Decimal, 2 digits	data type
cpu timestamp	Decimal, 10 digits	microseconds
odometer	Decimal, 5 digits	Unsigned odometer count
reverse	Enum	• 0: forward • 1: reverse

$PSTMDRSENMSG,30

Accelerations from digital 3 axes accelerometer.

Synopsis:

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

Arguments:

Table 191. $PSTMDRSENMSG message field description when ID = 30

Parameter	Format	Description
cpu timestamp	Decimal, 10 digits	microseconds

Parameter	Format	Description
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

$PSTMDRSENMSG,31

Angular rates from digital 3 axes gyroscope.

Synopsis:

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

Arguments:

Table 192. $PSTMDRSENMSG message field description when ID = 31

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

$PSTMDRSENMSG,32

Air pressure from digital 3 barometer.

Synopsis:

```
$PSTMDRSENMSG,32,<cpu timestamp>,<raw_pressure>*<checksum><cr><lf>
```

Arguments:

Table 193. $PSTMDRSENMSG message field description when ID = 32

Parameter	Format	Description
cpu timestamp	Decimal, 10 digits	microseconds
raw_pressure	Decimal, 10 digits	Raw unsigned 32 bit. This is the pressure value (hPa) * 4096

14.12.9 $PSTMDRSTATE

Reports the current relevant values for Dead Reckoning navigation and calibration estimates.

NMEA message list bitmask (64 bits): 0400 0000 0000 0000

Synopsis:

```
$PSTMDRSTATE,<cpu timestamp>,<lat>,<lon>,<heading>,<speed>,
<gyro_offset>,<gyro_gain>,<odo_scale>,<gyro_ovst>,<acc_offset>,<height>*
<checksum><cr><lf>
```

Arguments:

Table 194. **$PSTMDRSTATE message field description**

Parameter	Format	Description
cpu timestamp	Decimal, 10 digits	microseconds
lat	Double, 5 significant digits	Decimal degrees
lon	Double, 5 significant digits	Decimal degrees
heading	Double, 5 digits	Degrees, -180 to +180
speed	Double, 5 digits	Meters/second
gyro_offset	Double, 4 significant digits	Volts
gyro_gain	Double, 4 significant digits	(Radians/s)/Volt
odo_scale	Double, 5 significant digits	Meters/pulse
gyro_ovst	Double, 6 significant digits	Volt/°C
acc_offset	Double, 6 significant digits	g
height	Double, 1 significant digits	Meters

Results:

This message is provided at 1 Hz.

14.12.10 $PSTMDRGPS

Reports GNSS fix and quality metrics.

NMEA message list bitmask (64 bits): 0100 0000 0000 0000

Synopsis:

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

Arguments:

Table 195. **$PSTMDRGPS message field description**

Parameter	Format	Description
lat	Double, 9 significant digits	Decimal degrees
lon	Double, 9 significant digits	Decimal degrees
vn	Double, 5 significant digits	Velocity's north vector component, in meters/second
ve	Double, 5 significant digits	Velocity's east vector component, in meters/second
pdop	Double, 5 significant digits	Position dilution of precision
hdop	Double, 5 significant digits	Horizontal dilution of precision
vdop	Double, 5 significant digits	Vertical dilution of precision
Rms_pos_residual	Double, 5 significant digits	Meters
Rms_vel_residual	Double, 5 significant digits	Meters
vv	Double, 5 significant digits	Velocity's vertical vector component, in meters/second
height	Double, 1 significant digits	Meters

Results:

This message is provided at 1 Hz.

14.12.11 $PSTMDRSTEP

Reports integrated values and averages for Dead Reckoning sensors' samples between two consecutive GNSS fixes, essentially for that last 1 second. This is useful for assessing the odometer count incremented as expected during that second, the sample count is as expected, the sample delta times added up to approximately 1 second, and the average gyro voltage is reasonable.

NMEA message list bitmask (64 bits): 0100 0000 0000 0000

Synopsis:

```
$PSTMDRSTEP,<sample_count>,<ave_gyro_volts>,<gyro_noise>,<tot_odo_step>,
<delta odo_count>,<delta cputime>,<delta cputime2>,
<valid_odo>*<checksum><cr><lf>
```

Arguments:

Table 196. $PSTMDRSTEP message field description

Parameter	Format	Description
Sample_count	Decimal, 2 digits	Should be 15, when sampling at 15Hz
Ave_gyro_volts	Double, 5 significant digits	Volts
Gyro noise	Double, 5 significant digits	Gyro voltage variation
Tot_odo_step	Decimal, 5 digits	Total odo count delta for that 1 second
Delta odo_count	Decimal, 5 digits	Total odo count delta for that 1 second
Delta cpu_time	Double, 3 significant digits	In seconds, of time between 1st and last Dead Reckoning sample taken between the last 2 GNSS fixes
Delta cpu_time	Double, 3 significant digits	In seconds, of time between 1st and last Dead Reckoning sample taken between the last 2 GNSS fixes
Valid_odo	Boolean	1 = valid odometer

Results:

This message is provided at 1 Hz.

14.12.12 $PSTMDRCONFID

Reports standard deviations for navigation and calibration parameters..

NMEA message list bitmask (64 bits): 4000 0000 0000 0000

Synopsis:

$PSTMDRCONFID

```
<lat_std_dev>,<lon_std_dev>,<heading_std_dev>,gyro_gain_std_dev>,
<gyro_offset_std_dev>,<odo_scale_std_dev>,<gyro_ovst_std_dev>,<acc_offset_std_dev>,
<height_std_dev>,<major_axis>,<minor_axis>,<angle>,<speed_std_dev>*
<checksum><cr><lf>
```

Arguments:

Table 197. $PSTMDRCONFID message field description

Parameter	Format	Description
Lat std dev	Double, 5 significant digits	Decimal degrees
Lon std dev	Double, 5 significant digits	Decimal degrees
Heading std dev	Double, 4 significant digits	Degrees, -180 to +180
Gyro_gain std dev	Double, 4 significant digits	(Radians/s)/millivolt

Parameter	Format	Description
Gyro_offset std dev	Double, 4 significant digits	millivolts
Odo_scale std dev	Double, 4 significant digits	millimeters/pulse
gyro_ovst std dev	Double, 6 significant digits	volt/°C
acc_offset_std_dev	Double, 6 significant digits	g
height_std_dev	Double, 4 significant digits	meters
Major_axis	Double, 3 significant digits	Standard deviation (meters) of semi-major axis of error ellipse
Semi-minor Dev	Double, 3 significant digits	Standard deviation (meters) of semi-minor axis of error ellipse
angle	Double, 3 significant digits	Speed standard deviation (m/s)
Speed_std_dev	Double, 3 significant digits	EMPTY?[NMP1]

Results:

This message is provided at 1 Hz.

14.12.13 $PSTMDRUPD

It reports the value by which the Teseo Dead Reckoning Kalman state variables changed during the update computation during the previous second.

NMEA message list bitmask (64 bits): 0200 0000 0000 0000

Synopsis:

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

Arguments:

Table 198. $PSTMDRUPD message field description

Parameter	Format	Description
lat	Double, 5 significant digits	Decimal degrees
lon	Double, 5 significant digits	Decimal degrees
heading	Double, 4 significant digits	Degrees, -180 to +180
gyro_gain	Double, 4 significant digits	(Radians/s)/millivolt
gyro_offset	Double, 4 significant digits	millivolts
odo_scale	Double, 4 significant digits	millimeters/pulse
gyro_ovst	Double, 6 significant digits	volt/°C
acc_offset	Double, 6 significant digits	g
height	Double, 1 significant digits	meters

Results:

This message is provided at 1 Hz.

14.12.14 $PSTMDRTUNNEL

Reports various Dead Reckoning metrics calculated during the last GNSS outage. Note, these may be approximate, due to the condition by which the algorithm determines tunnel start and stop not being absolute.

NMEA message list bitmask (64 bits): 0200 0000 0000 0000

Synopsis:

```
$PSTMDRTUNNEL
<exit>,<duration>,<length>,<heading_error>,<yaw_rate_error>,<calib_error>,
<pos_error_DR>,<pos_error_percent>,<noise_error>
*<checksum><cr><lf>
```

Arguments:

Table 199. $PSTMDRTUNNEL message field description

Parameter	Format	Description
exit	boolean	1 means the GNSS Kalman filter has deemed that second the point at which the tunnel was exited.
duration	Decimal, 5 digits	Seconds the GNSS Kalman considered it to have been traveling in a tunnel.
length	Double, 4 significant digits	Approximated tunnel length in meters
Heading_error	Double, 4 significant digits	Approximated heading error at tunnel exit in degrees
Yaw_rate_error	Double, 4 significant digits	Approximated yaw rate error at tunnel exit in degrees/second
Calib_error	Double, 4 significant digits	Approximated gyro gain error at tunnel exit in millivolts
Pos_error_DR	Double, 4 significant digits	Approximated position error at tunnel exit in meters
Pos_error_percent	Double, 4 significant digits	Approximated position error at tunnel exit as a percent of approximated tunnel length
Noise Error	Double, 4 significant digits	Calculated gyro noise error in degrees

Results:

This message is only provided when the corresponding event occurs.

14.12.15 $PSTMDRSTYPE

Reports Dead Reckoning sensor configuration (combination) type.

NMEA message list bitmask (64 bits): 0200 0000 0000 0000

Synopsis:

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

Arguments:

Table 200. $PSTMDRSTYPE message field description

Parameter	Format	Description
Sensor_type	Decimal, 1 digit	3: GYRO3, meaning yaw is calculated from a 3D MEMS gyro.

Results:

- This message is provided at 1 Hz.

14.12.16 $PSTMDRCAL

Reports the calibration status of the Dead Reckoning calibration parameters.

NMEA message list bitmask (64 bits): 0100 0000 0000 00000

Synopsis:

```
$PSTMDRCAL
<dr_is_calib>,<odo_is_calib>,<gyro_gain_is_calib>,<gyro_offset_is_calib>,
<imu_flag>,<gyro_integrity_flag>,<acc_integrity>,<dr_calib_status>
*<checksum><cr><lf>
```

Arguments:

Table 201. $PSTMDRCAL message field description

Parameter	Format	Description
Dr_is_calib	boolean	1: Dead Reckoning is fully calibrated
odo_is_calib	boolean	1: Odo scale is calibrated (on Teseo-Module)
Gyro_gain_is_calib	boolean	1: gyro gain is calibrated
Gyro_offset_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: Gyro z axis Bit 1: Gyro y axis Bit 2: Gyro x axis Bit 3: Acc z axis Bit 4 : Acc y axis Bit 5 : Acc x axis IMU installation status flags: 1: Self-detected 0: Not self-detected Bit fields: Bit 6: Roll installation angle Bit 7: Pitch installation angle[NMP1]
gyro_integrity_flag	boolean	• 1: gyro signal is healthy • 0: gyro signal is faulty
acc_integrity_flag	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 • C: Full calibration

Results:

This message is provided at 1 Hz.

14.12.17 $PSTMDRAHRS

Reports the attitude heading reference system data

NMEA message list bitmask (64 bits): 2000 0000 0000 0000

Synopsis:

```
$PSTMDRAHRS<inst_pitch>,<inst_roll>,<inst_yaw>,<slope>,<slope_acc>,
res>*<checksum><cr><lf>
```

Arguments:

Table 202. **$PSTMDRAHRS message field description**

Parameter	Format	Description
inst_pitch	double	Sensor frame vs vehicle frame 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]
slope	double	Estimated slope [deg]
slope_acc	double	Estimated slope accuracy [deg]. Set to 0 if not available
res	none	Reserved

Results:

This message is provided at 1 Hz.

14.12.18 $PSTMDREPE

Reports the Draw estimated position error.

NMEA message list bitmask (64 bits): 0200 0000 0000 0000

Synopsis:

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

Arguments:

Table 203. **$PSTMDREPE message field description**

Parameter	Format	Description
ehpe	double	Dead Reckoning estimated horizontal position error [m]
reserved	double	-1.00 Reserved for future use.

Results:

- This message is provided at 1Hz.

Example:

```
$PSTMDREPE,141.2,-1.00*72
```

14.12.19 $PSTMDRMMFBKF

MMFB acceptance and usage in Dead Reckoning. This message is only reported after the reception of a $PSTMDRMMFB command.

NMEA message list bitmask (64 bits): 0200 0000 0000 0000

Synopsis:

```
$PSTMDRMMFBKF,<cpu time>,<elapsed time>,<UTC Delta seconds>,<UTC Delta ms>,
<Pos Accepted>,<Pos Innovation lat>,<Pos Innovation lon>,<Pos Measurement Noise lat>,<Pos
Measurement Noise lon>,<Pos Update lat>,<Pos Update lon>,<Heading Accepted>,
<Heading Innovation>,<Heading Measurement Noise>,<Heading Update>*<checksum><cr><lf>
```

Arguments:

Table 204. **$PSTMDRMMFBKF message field description**

Parameter	Format	Description
Cpu time	Decimal, 10 digits	Unit: microseconds

Parameter	Format	Description
		Cpu time at which the $PSTMDRMMFB command is received.
Elapsed time	Decimal, 10 digit	Unit: microseconds Time difference between cpu time and the current GNSS fix cpu time (e.g. timestamp contained in last $PSTMTG message)
UTC Delta seconds	Decimal, 2 digits	Unit: seconds Difference between current GNSS UTC time and UTC time reported by host in $PSTMDRMMFB command.
UTC Delta ms	Decimal, 3 digits	Unit: microseconds If UTC Delta seconds is null, the difference between current GNSS UTC time and UTC time in $PSTMDRMMFB command is reported in UTC Delta ms.
Pos Accepted	Decimal, 1 digit	Flag indicating if the position reported in $PSTMDRMMFB command is accepted or not: • 1: Accepted • 0: Not accepted
Pos Innovation lat	Double, 2 fractional digits	Latitude in m. Difference between current Dead Reckoning position and MMFB position reported by host.
Pos Innovation lon	Double, 2 fractional digits	Longitude in m. Difference between current Dead Reckoning position and MMFB position reported by host.
Pos Measurement Noise lat	Double, 2 fractional digits	Latitude in m. Position Measurement noise used by Dead Reckoning (either auto-calculated or reported by host).
Pos Measurement Noise lat	Double, 2 fractional digits	Longitude in m. Position Measurement noise used by Dead Reckoning (either auto-calculated or reported by host).
Pos Update lat	Double, 2 fractional digits	Latitude in m. New position computed by Dead Reckoning with innovation and measurement noise.
Pos Update lon	Double, 2 fractional digits	Longitude in m. New position computed by Dead Reckoning with innovation and measurement noise.
Heading Accepted	Decimal, 1 digit	Flag indicating if the heading reported in $PSTMDRMMFB command is accepted or not: • 1: Accepted • 0: Not accepted
Heading Innovation	Double, 2 fractional digits	Heading in degrees. Difference between current Dead Reckoning heading and MMFB heading reported by host.
Heading Measurement Noise	Double, 2 fractional digits	Heading in degrees. Heading Measurement noise used by Dead Reckoning (either auto-calculated or reported by host).
Heading Update	Double, 2 fractional digits	Heading in degrees. New heading computed by Dead Reckoning with innovation and measurement noise.

Results:

This message is provided at 1Hz if MMFB feature is enabled and $PSTMDRMMFB command is received.

14.12.20 $PSTMDRSENCONFIG

Reports the 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:

Table 205. $PSTMDRSENCONFIG message field description

Parameter	Format	Description
IMU Type	String	IMU ACC: accelerometer internal configuration IMU GYRO: gyroscope internal configuration
Sensor name	String, max 10 char	"ASM330LHH",
Full Scale	Decimal, 3 digits	IMU ACC: Unit: g IMU GYRO: Unit: dps
Sensitivity	Decimal, 4 digits	IMU ACC: Unit: micro g/LSB IMU GYRO: Unit: micro dps/LSB
Output Data Rate	Decimal, 4 digits	Output Data Rate in Hz
Low Pass Filter Bandwidth	Double, 1 fractional digits	Low Pass Filter bandwidth in Hz
Temperature Compensation	Decimal, 1 digit	Present in case of IMU GYRO only • 0: Internal Temperature Compensation Disabled • 1: Internal Temperature Compensation Enabled.

Results:

- This message is provided at initialization.

15 Firmware configuration data block (CDB)

All configuration parameters are grouped in a data block. Each field is addressed by a unique ID. The IDs are made by three digits: the most significant one represent the parameter type and the others are used to identify different parameters of the same type.

15.1 CDB-ID 101 – NMEA port setting

Allow setting the NMEA port number.

System reboot needed to have new setting in use.

15.2 CDB-ID 102 – NMEA port baud rate setting

Allow setting the baud rate for the NMEA port number.

Table 206. CDB-ID 102 field description

Parameter value	Baudrate
0x0	300 baud
0x1	600 baud
0x2	1200 baud
0x3	2400 baud
0x4	4800 baud
0x5	9600 baud
0x 6	14400 baud
0x 7	19200 baud
0x 8	38400 baud
0x 9	57600 baud
0xA	115200 baud
0xB	230400 baud
0xC	460800 baud
0xD	921600 baud

System reboot needed to have new setting in use.

15.3 CDB-ID 104 – Mask angle setting

Allow setting the minimum elevation angle at which a satellite can be tracked. Satellite with elevation below the mask angle cannot be tracked.

System reboot needed to have new setting in use.

15.4 CDB-ID 105 – GNSS Tracking CN0 threshold

Allow setting the minimum CN0 [dB] at which a satellite can be tracked. Satellite with CN0 below the configured threshold cannot be tracked.

A Teseo-Module engine reset (suspend/restart) is needed to have this setting in place.

15.5 CDB-ID 120 – Cold start setting

Allow setting the data to be cleared during the COLD start command execution. This parameter is a bitmask where bit=1 indicates the data to be cleared.

Table 207. CDB-ID 120 field description

Bit	Bitmask	Description
0	0x1	Clear almanacs
1	0x2	Clear ephemeris
2	0x4	Clear position
3	0x8	Clear time

Any bitmask combination is allowed, the default one is 0xE.

This setting is in place as soon as the $PSTMSETPAR is performed.

15.6 CDB-ID 121 – Number of decimal digits for speed and course data in NMEA messages

Allow setting the number of decimal digits for the speed and course data in NMEA messages. It affects both RMC and VTG messages.

It is possible to set a different number of decimal digits.

Table 208. CDB-ID 121 field description

Bit	Values	Description
From B0 to B3	From 1 up to 5	Allow setting the number of decimal digits for speed value in RMC and VTG massages
From B4 to B7	From 1 up to 5	Allow setting the number of decimal digits for course value in RMC and VTG messages.

15.7 CDB-ID 122 – NMEA format configuration

Allow setting the change the format of NMEA. Note that this changing the default value of this parameter the Bit 6 of CDB-ID 200 – Application ON/OFF is bypassed.

The default value of this parameter is 0x0C.

In case of wrong configuration NMEA is configured as 3.01 like.

Table 209. CDB-ID 122 field description

Bit	Values	Description
From B0 to B3	Hexadecimal	Changes the NMEA format 0x01 = NMEA is 3.00 like 0x02 = NMEA is 3.01 like 0x04 = NMEA is 4.10 like 0x0C = Depends on Bit 6 of CDB-ID 200

15.8 CDB-ID 125 – Notch filter setting

Allow setting the notch filter usage on GPS RF path, GLONASS RF path or both GPS and GLONASS RF paths. The notch filter can be enabled and inserted in the RF path (normal mode – see b0, b1 below) or the notch filter can be enabled but inserted only if locked on a jammer (auto-insertion mode – see b2, b3 below).

Table 210. **CDB-ID 125 field description**

Bitmask	Description
b0..b3 = 0x00	Notch Filter is disabled on both GPS and GLONASS paths
b0	Enable/disable notch filter on GPS path (normal mode).
b1	Enable/disable notch filter on GLONASS path (normal mode).
b2	Enable/disable notch filter on GPS path in auto-insertion mode.
b3	Enable/disable notch filter on GLONASS path in auto-insertion mode.

15.9 CDB-ID 127 – Number of decimal digits in NMEA position messages

Allow setting the number of decimal digits for the NMEA position messages.
It is possible to set a different number of decimal digits for GGA and for both RMC and GLL messages.

Table 211. **CDB-ID 127 field description**

Bit	Values	Description
[3 : 0]	From 1 up to 5	Allow setting the number of decimal digits for the RMC and GLL massages
[7 : 4]	From 1 up to 5	Allow setting the number of decimal digits for the GGA massage.

15.10 CDB-ID 128 – Differential source type

Allow selecting the differential mode source type.

Table 212. **CDB-ID 128 field description**

Value	Description
0x0 - NONE	No differential source.
0x1 - SBAS	SBAS is the source for differential correction.
0x2 - RTCM	RTCM is the source for differential corrections.
0x3 - AUTO	RTCM (if available) or SBAS (if available) is the source for differential corrections.

15.11 CDB-ID 129 – GLONASS satellite ID type

Allow selecting between two different ways to report the GLONASS satellites ID in the GSV and GSA messages.

Table 213. **CDB-ID 129 field description**

Value	Description
0x0	GLONASS satellite ID based on the satellite frequency. If lowest frequency is marked with freq_ID = 1 and highest frequency is marked with freq_ID = 14, the satellite IDs are reported, starting from lowest frequency as 64+freq_ID. Satellites from 79 up to 92 are the antipodal of satellites from 65 up to 78 (they are received at the same frequency).
0x1	GLONASS satellite ID based on the satellite slot (reported in almanacs and ephemeris data). The satellite IDs are reported as 64+slot_number. The slot number is in the range from 1 up to 24.

15.12 CDB-ID 131 – NMEA talker ID

Allow setting the second character of the NMEA talker ID for the GGA, RMC, VTG, GLL NMEA sentences. The talked ID for GSV and GSA is managed in a different way (see CDB-ID 200, bits 19 and 20).

15.13 CDB-ID 132 – GNSS positioning CN0 threshold

Allow setting the minimum CN0 [dB] at which a satellite can be used in the position solution. Satellites with CN0 below the configured threshold are not used in the position evaluation.

A Teseo-Module engine reset (suspend/restart) is needed to have this setting in place.

15.14 CDB-ID 135 – SBAS default service

Allow setting the default service for the SBAS library.

System reboot needed to have new setting in use.

Note: for compatibility, a default SBAS PRN can also be set. In that case the SBAS AUTO service will be used.

15.15 CDB-ID 138 – RTCM port setting

Allow setting the RTCM port number.

Note: the RTCM feature is supported on all serial ports. It can be configured also to work on the same serial port already used for NMEA messages.

System reboot needed to have new setting in use.

15.16 CDB-ID 139 – RTCM port baud rate setting

Allow setting the baud rate for the RTCM port number.

Table 214. CDB-ID 139 field description

Parameter value	Baudrate
0x0	300 baud
0x1	600 baud
0x2	1200 baud
0x3	2400 baud
0x4	4800 baud
0x5	9600 baud
0x 6	14400 baud
0x 7	19200 baud
0x 8	38400 baud
0x 9	57600 baud
0xA	115200 baud
0xB	230400 baud
0xC	460800 baud
0xD	921600 baud

System reboot needed to have new setting in use.

15.17 CDB-ID 190 - CDB-ID 201 - CDB-ID 228 - NMEA message List 0 parameters

CDB-ID 201 and CDB-ID 228 allow enabling/disabling each NMEA message in the message list 0. CDB-ID 201 represents first 32 bits (low bits) of extended 64 bits NMEA message list. See CDB-ID 228 for second 32 bits (high bits) of 64 bits message list.

CDB-ID 190 allows setting the message list output rate for the message list 0. It is a scaling factor referred to the selected fix rate. The default value is 1 and means that messages are sent out on every fix. Setting the scaling factor to “N” means that the corresponding message list is sent out every “N” fixes.

Note: The message list 0 is the standard message list. Only the message list 0 should be used if the NMEA multiple rate features is not required.

For each bit:

- 0 means feature disabled
- 1 means feature enabled

Table 215. CDB-ID 201 - CDB-ID 228 fields description

	Bit(1)	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	$PSTMNOISE Message
	6	0x40	$GPRMC Message
	7	0x80	$PSTMRF Message
	8	0x100	$PSTMTG Message
	9	0x200	$PSTMTS Message
	10	0x400	$PSTMPA Message
	11	0x800	$PSTMSAT Message
	12	0x1000	$PSTMRES Message
	13	0x2000	$PSTMTIM Message
	14	0x4000	$PSTMWAAS Message
	15	0x8000	$PSTMDIFF Message
	16	0x10000	$PSTMCORR Message
	17	0x20000	$PSTMSBAS Message
	18	0x40000	$PSTMTESTRF Message
	19	0x80000	$GPGSV Message
	20	0x100000	$GPGLL Message
	21	0x200000	$PSTMPPSDATA Message
	22	0x400000	RESERVED
	23	0x800000	$PSTMCPU Message
	24	0x1000000	$GPZDA Message
	25	0x2000000	$PSTMTRAIMSTATUS Message
	26	0x4000000	$PSTMPOSHOLD Message
	27	0x8000000	$PSTMKFCOV Message

	Bit[1]	Bitmask (32 bits)	Function
Low 32 bits	28	0x10000000	$PSTMAGPS Message
	29	0x20000000	$PSTMLOWPOWERDATA Message
	30	0x40000000	$PSTMNOTCHSTATUS
	31	0x80000000	$PSTMTM Message
High 32 bits	32	0x1	$PSTMPV Message
	33	0x2	$PSTMPVQ Message
	34	0x4	$PSTMUTC Message
	35	0x8	$PSTMADCDATA Message
	36	0x10	$PSTMANTENNASTATUS Message
	37	0x20	RESERVED
	38	0x40	RESERVED
	39	0x80	$GPDTM Message
	40	0x100	$PSTMEPHEM Message
	41	0x200	$PSTMALMANAC Message
	42	0x400	$PSTMIONOPARAMS Message
	43	0x800	RESERVED
	44	0x1000	$PSTMBIASDATA Message
	45	0x2000	$GPGBS Message
	46	0x4000	$PSTMPVRAW Message
	47	0x8000	RESERVED
	48	0x10000	$PSTMFEDATA Message
	49	0x20000	RESERVED
	50	0x40000	$PSTMODO Message
	51	0x80000	$PSTMGEOFENCE Message
	52	0x100000	$PSTMLOGSTATUS Message
	53	0x200000	$PSTMGNSSINTEGRITY Message
	54	0x400000	RESERVED
	55	0x800000	DRAW messages: • $PSTMDRSTEP • $PSTMDRGPS • $PSTMDRCAL
	56	0x1000000	RESERVED
	57	0x2000000	DRAW messages: • $PSTMDRUPD • $PSTMDRTUNNEL • $PSTMDRTYPE • $PSTMDRMMFB • $PSTMDRMMFBKF
	58	0x4000000	DRAW messages: • $PSTMDROL • $PSTMDRSTATE
	59	0x8000000	RESERVED

	Bit[1]	Bitmask (32 bits)	Function
High 32 bits	60	0x10000000	DRAW messages: • $PSTMDRSENMSG
	61	0x20000000	DRAW messages: • $PSTMDRAHRS
	62	0x40000000	RESERVED
	63	0x80000000	$--RLM Return Link Message

1. *The Bit-value indicates the bit position, thus multiple choices are possible.*

Note: The message list 0 is the standard message list. Only the message list 0 should be used if the NMEA multiple rate features is not required.

15.18 CDB-ID 191 - CDB-ID 210 - CDB-ID 229 - NMEA message list 1 parameters

CDB-ID 210 and CDB 229 allow enabling/disabling each NMEA message in the message list 2. CDB-ID 210 represents first 32 bits (low bits) of extended 64 bits NMEA message list, CDB-ID 220 represents second 32 bits (high bits) of extended 64 bits NMEA message list.

CDB-ID 191 allows setting the message list 1 output rate. It is a scaling factor referred to the selected fix rate. The default value is 1 and means that messages are sent out on every fix. Setting the scaling factor to “N” means that the corresponding message list is sent out every “N” fixes.

Table 216. NMEA message list 1 CDB-IDs

CDB-ID	Description
191	Message list 1 - Output rate scaling factor
210	Message list 1 - Low bitmap mask
229	Message list 1 - High bitmap mask

15.19 CDB-ID 192 - CDB-ID 211 - CDB-ID 230 - NMEA message list 2 parameters

CDB-ID 211 and CDB 230 allow enabling/disabling each NMEA message in the message list 2. CDB-ID 211 represents first 32 bits (low bits) of extended 64 bits NMEA message list. See CDB-ID 230 for second 32 bits (high bits) of 64 bits message list. The message list configuration is done in the same way as for the message list 0.

If not used the message list must be set to “0”.

CDB-ID 230 allows setting the message list output rate for the message list 2. It is a scaling factor referred to the selected fix rate. The default value is 1 and means that messages are sent out on every fix. Setting the scaling factor to “N” means that the corresponding message list is sent out every “N” fixes.

Table 217. NMEA message list 2 CDB-IDs

CDB-ID	Description
192	Message list 2 - Output rate scaling factor
211	Message list 2 - Low bitmap mask
230	Message list 2 - High bitmap mask

Note: The message list 2 is RESERVED for those messages which need to be sent at high rate (e.g. 10 Hz) and/or require accurate message output timing (low jitter). If high rate messages or low jitter are not required, this message list should not be used.

15.20 CDB-ID 197 – PPS clock

Allow setting the PPS clock frequency. For accurate timing application 64MHz is mandatory.

Table 218. CDB-ID 197 field description

Values	Description
16	Sets PPS clock to 16MHz
32	Sets PPS clock to 32MHz
64	Sets PPS clock to 64MHz

15.21 CDB-ID 198 – GNSS mask angle positioning

Set the GNSS mask angle for positioning algorithm. Satellites with elevation below the mask angle are not used in the position solution.

15.22 CDB-ID 199 – Local geodetic datum selection

Set the local geodetic datum to be used when position data is reported over the NMEA messages. See Section Appendix A Local geodetic datum tables for the list of all supported datum. In the last column of tables is reported the number to be used for the CDB-ID configuration according to the selected datum.

15.23 CDB-ID 200 - CDB-ID 227 - application ON/OFF

All features are mapped in a 64 bits bitmap with one bit for each feature; CDB-ID 200 represents the first 32 bits (low 32 bits) and CDB-227 represents the second 32 bits (high 32bits).

For each bit:

- 0 means feature disabled;
- 1 means feature enabled

Table 219. CDB-ID 200 field description

Bit(1)	Bitmask	Function	Description
0	0x1	RESERVED	
1	0x2	RESERVED	
2	0x4	SBAS (WAAS / EGNOS) augmentation system	Enable/disable the SBAS engine. When enabled, the SBAS engine starts searching for SBAS satellites at system startup.
3	0x8	Enabling SBAS satellite reporting in the GSV messages	If enabled the SBAS satellite is reported in the GSV messages. The SBAS satellite ID, reported in the GSV messages, is in the range from 33 to 51 according to the NMEA specifications
4	0x10	ST-AGNSS enable	Enable/disable the ST-AGNSS functionality. During ST-AGNSS processing a high CPU load is required, for best performances it is suggested to increase the CPU frequency when the ST-AGNSS is enabled. The server based assisted GPS (P-GNSS) is included in the ST-AGNSS software. It is enabled/disabled if the ST-AGNSS functionality is enabled/disabled.
5	0x20	2.5ppm TCXO support enable	Enable/disable support for TCXO with 2.5ppm accuracy
6	0x40	NMEA v301 support enable	Enable/disable the NMEA v3.01 support. To support the NMEA v3.01 standard some new values have been reported in the –RMC, --VTG and –GLL NMEA messages. This feature is enabled by default. To ensure fully compatibility with previous releases, the old NMEA format can be restored disabling this feature
7	0x80	QZSS distributed acquisition mode enable	Enable/disable the distributed acquisition operative mode for the QZSS constellation. When distributed acquisition mode for QZSS is enabled, the acquisition stage usage is widespread along the time in order to mitigate the current consumption spikes required by the acquisition engine.

Bit[1]	Bitmask	Function	Description
9	0x200	Send “config text” in the “Header Message” at start up	Enable/disable sending the configured text on the NMEA port at startup.
10	0x400	Send standard ST NMEA Headers	Enable/disable sending the ST standard headers on the NMEA port at startup.
11	0x800	RTCM enable	Enable/disable the RTCM data processing.
12	0x1000	FDE Algorithm	Enable/disable the False Detection and Exclusion algorithm.
14	0x4000	Walking Mode Algorithm	Enable/disable the Walking Mode algorithm.
15	0x8000	Stop Detection Algorithm	Enable/disable the Stop Detection algorithm.
16	0x10000	GPS constellation enable	Enable/disable the GPS constellation. When this bit is enabled GPS satellites are enabled to be tracked and used for positioning. This bit setting affect also the talker ID of GSV and GSA NMEA messages. If only the GPS constellation is enabled the NMEA talker ID for GSV and GSA is “GP”. If GLONASS constellation is also enabled “GP” is used for GPS related GSV messages while “GN” is used for the GSA messages.
17	0x20000	GLONASS constellation enable	Enable/disable the GLONASS constellation. When this bit is enabled GLONASS satellites are enabled to be tracked. To be used for positioning also the Bit 21 should be enabled. This bit setting affect also the talker ID of GSV and GSA NMEA messages. If only the GLONASS constellation is enabled the NMEA talker ID for GSV and GSA is “GL”. If GPS constellation is also enabled “GL” is used for GLONASS related GSV messages while “GN” is used for the GSA messages
18	0x40000	QZSS constellation enable	Enable/disable the QZSS constellation. When this bit is enabled QZSS satellites are enabled to be tracked and used for positioning
19	0x80000	NMEA GNGSV enable	Enable/disable the “GN” talker ID for GSV messages reporting satellite for all constellations. When this bit is enabled, only the talker ID “GN” is used for GSV messages.
20	0x100000	NMEA GNGSA enable	Enable/disable the “GN” talker ID for GSA messages reporting satellite for all constellations. When this bit is enabled, only the talker ID “GN” is used for GSA messages.
21	0x200000	GLONAS usage for positioning enable	Enable/disable the usage of GLONASS satellite for the GNSS position fix. If this bit is disabled and GLONASS constellation is enabled, the GLONASS satellites are only tracked.
22	0x400000	GPS usage for positioning enable	Enable/disable the usage of GPS satellite for the GNSS position fix. If this bit is disabled and GPS constellation is enabled, the GPS satellites are only tracked
23	0x800000	QZSS usage for positioning enable	Enable/disable the usage of QZSS satellites for the GNSS position fix. If this bit is disabled and QZSS constellation is enabled, the QZSS satellites are only tracked.
24	0x1000000	PPS enabling	Enable/disable the PPS generation on the PPS pin.
25	0x2000000	PPS polarity inversion	Enable/disable the PPS signal polarity inversion. If polarity inversion is disabled (Bit25 = 0) the PPS signal has the rising edge on the PPS event. If polarity inversion is enabled (Bit25 = 1) the PPS signal has a falling edge on the PPS event.
26	0x4000000	Position Hold enable	Enable/disable the Position Hold functionality (timing applications).
27	0x8000000	TRAIM algorithm enable	Enable/disable the TRAIM algorithm (timing applications).
28	0x10000000	RESERVED	
29	0x20000000	High dynamics enable.	Enable/disable the high dynamics functionality. This feature increases the sample rate of the DSP measurements. It is required when high fix rate (> 5Hz) is selected
30	0x40000000	ST NMEA DSP raw messages enable	Enable/disable the DSP raw messages over the NMEA port. They are proprietary messages which reports info from DSP stage.
31	0x80000000	Low power algorithm enable	Enable/disable the low power management features

1. *The Bit-value indicates the bit position (starting from 0 as least significant bit), thus multiple choices are possible.*

Table 220. CDB-ID 227 field description

Bit[1]	Bitmask	Function	Description
0	0x1	NMEA commands eco enable	Enable/disable the command eco on the NMEA port
1	0x2	NMEA Time To First Fix enable	Enable/disable the Time To First Fix message on the NMEA port. If enabled, the TTFF message is sent only one time as soon as the GNSS position fix is achieved.
2	0x4	Few satellites position estimation enable	Enable/disable the position estimation algorithm when tracked satellites are less than 3.
3	0x8	Reserved	Reserved
4	0x10	Return Link Message enable	Enable/disable the Return Link Message on NMEA port
5	0x20	Reserved	Reserved
6	0x40	Galileo constellation enable	Enable/disable the Galileo constellation. When this bit is enabled Galileo satellites are enabled to be tracked and used for positioning
7	0x80	Galileo usage for positioning enable	Enable/disable the usage of Galileo satellite for the GNSS position fix. If this bit is disabled and Galileo constellation is enabled, the Galileo satellites are only tracked.
8	0x100	Beidou constellation enable	Enable/disable the Beidou constellation. When this bit is enabled Beidou satellites are enabled to be tracked and used for positioning.
9	0x200	Beidou usage for positioning enable	Enable/disable the usage of Beidou satellite for the GNSS position fix. If this bit is disabled and Beidou constellation is enabled, the Beidou satellites are only tracked.
10	0x400	RESERVED	
11	0x800	RTC usage disabling	Enable/disable the usage of RTC from the GNSS engine. It is recommended to have RTC usage disabled (Bit12 set to 1) is the RTC crystal is not mounted.
12	0x1000	Fast Satellite Drop feature enable	Enable/disable the Fast Satellite Drop feature. When fast satellite drop is enabled, the GNSS software reports NO FIX status immediately after the tunnel entrance; the position update is no more propagated for some seconds inside the tunnel.
13	0x2000	RESERVED	
14	0x4000	Excluded satellites reporting enable	Enable/disable the excluded satellites reporting in the GGA, GSA, GNS and PSTMTG nmea messages. If this bit is enabled, satellites excluded by positioning stage due to RAIM or FDE algorithms, are included in the number of used satellites (present in the GGA, GNS and PSTMG messages) and their satellites IDs are included in the list of used satellite (present in the GSA message). This bit is disabled by default.
15	0x8000	RESERVED	
16	0x10000	RESERVED	
17	0x20000	RESERVED	
18	0x40000	RESERVED	
19	0x80000	RESERVED	
20	0x100000	RESERVED	
21	0x200000	External RTC oscillator enable	Enable/disable the usage on an external oscillator for the RTC peripheral. When enabled the internal oscillator is not used and the RTC clock must be fed from the xtal_in pin
22	0x400000	RESERVED	
23	0x800000	RESERVED	
24	0x1000000	RESERVED	
25	0x2000000	RESERVED	
26	0x4000000	RTC calibration enable	Enable/disable the RTC calibration feature. When enabled the RTC counter is calibrated using the accurate GNSS internal time reference.
27	0x8000000	RESERVED	
28	0x10000000	RESERVED	

Bit(1)	Bitmask	Function	Description
29	0x20000000	RESERVED	
30	0x40000000	LLI interface Enable/Disable	Enable/disable Low Latency Interface
31	0x80000000	Min week handler switch	Automatically manage Min Wek number

1. *The Bit-value indicates the bit position (starting from 0 as least significant bit), thus multiple choices are possible.*

Note:
- *if the ST-AGNSS feature is not required (bit 4) and it is disabled, it is strongly suggested to clear all ST-AGNSS data from the NVM memory. This can be done via NMEA sending the "$PSTMSTAGPSINVALIDATE,7" command. If the NVM was empty (e.g. the ST-AGNSS has been never enabled or the NVM has been completely erased before) the invalidate command is not required.*
- *When GPS and GLONASS constellation are enabled, the GSV messages are sent in two separate sets: one with "GP" as talker ID and one with "GL".*
- *Only "GN" is supported as talker ID for QZSS GSV and GSA messages.*
- *In this case the GSV messages are sent in a single set reporting satellites for all enabled constellations.*

15.24 CDB-ID 202 – NCO range max value

Allow setting the upper limit for the NCO search range.

The NCO range and center frequency settings depend on the TCXO in use. There is the possibility to let the GNSS software to evaluate automatically the best range and center values for the selected TCXO. In such case all NCO configuration parameters (CDB-ID 202, 203 and 204) must be set to 0.

System reboot need to have new setting in use.

Note: configured value is used only if the NCO value is not yet stored in the GNSS backup memory.

15.25 CDB-ID 203 – NCO range min value

Allow setting the lower limit for the NCO search range.

The NCO range and center frequency settings depend on the TCXO in use. There is the possibility to let the GNSS software to evaluate automatically the best range and center values for the selected TCXO. In such case all NCO configuration parameters (CDB-ID 202, 203 and 204) must be set to 0.

System reboot needed to have new setting in use.

Note: configured value is used only if the NCO value is not yet stored in the GNSS backup memory.

15.26 CDB-ID 204 – NCO centre value

Allow setting the NCO centre frequency.

The NCO range and center frequency settings depend on the TCXO in use. There is the possibility to let the GNSS software to evaluate automatically the best range and center values for the selected TCXO. In such case all NCO configuration parameters (CDB-ID 202, 203 and 204) must be set to 0.

System reboot needed to have new setting in use.

Note: configured value is used only if the NCO value is not yet stored in the Teseo-Module backup memory.

15.27 CDB-ID 205 – position data time delay

Allow setting the time delay (ms) between the measurements (on the UTC second) and the GNSS position data delivery. This parameter should be never bigger than the time period of the configured fix rate.

If "0" is used, the time delay is set in accordance with the CPU speed:

- 50 ms if CPU is running @ 208 MHz
- 500 ms if CPU is running @ 52 MHz

System reboot need to have new setting in use.

15.28 CDB-ID 213 – PPS operating mode setting 1

Allow setting different operating modes for the PPS signal generation. Full operating mode setting is achieved using both 213 and 214 parameters. This parameter includes different fields as reported in the following table:

Table 221. CDB-ID 213 field description

Bits	Values	Description
[3 : 0]	0: on every second 1: on even seconds 2: on odd seconds	PPS generation mode
[7 : 4]	0: UTC 1: GPS_UTC (GPS Time) 2: GLONASS_UTC (GLONASS Time) 3: UTC_SU 4: GPS_UTC_FROM_GLONASS	Reference time on which the PPS signal is synchronized. NOTES: • UTC(SU) is the Soviet Union UTC, it is 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.
[11 : 8]	1: NO FIX 2: 2D FIX 3: 3D FIX	GNSS fix condition for PPS signal generation. NO FIX: PPS signal is present even in GNSS NO fix conditions. 2D FIX: the PPS is present if the GNSS is at least in 2D fix condition. 3D FIX: the PPS is present only if the GNSS is in 3D fix conditions.
[23 : 16]	0..24	Minimun number of satellites used for timing correction. PPS signal is generated if the number of satellites used for time correction is bigger than the minimun number. This parameter should be set to 0 if the threshold is not used.
[24 : 31]	0..90	Satellite elevation mask for time correction. It is the minimum satellite elevation angle to use the satellite for time correction. If this parameter is set to 0 there is no satellites filtered based on the elevation.

15.29 CDB-ID 214 – PPS operating mode setting 2

Allow setting different operating modes for the PPS signal generation. Full operating mode setting is achieved using both 213 and 214 parameters. This parameter includes different fields as reported in the following table:

Table 222. CDB-ID 214 field description

Bits	Values	Description
[7 : 0]	0: mixing constellation disabled 1: GPS sats are enabled for GLONASS time correction. 2: GLONASS sats are enabled for GPS time correction.	Enable/disable mixing constellations for time correction.

15.30 CDB-ID 215 – position hold auto survey samples

Sets the number of position samples to be captured before entering in the position hold mode. The auto survey procedure is disabled if the number of samples is set to 0.

15.31 CDB-ID 218 – SBAS satellite parameter

Allow to add or modify a SBAS satellite parameter into default list

Table 223. **CDB-ID 218 field description**

Bits	Values	Description
[7 : 0]	From 120 to 138	SBAS PRN
[15 : 8]	From 0 to 180	Satellite longitude in degree
[16]	0: EAST 1: WEST	Longitude sense
[18 : 17]	0: WAAS 1: EGNOS 2: MSAS 3:GAGAN	The SBAS service

15.32 CDB-ID 219 – SBAS satellite parameter

Allow to add or modify a SBAS satellite parameter into default list.

Table 224. **CDB-ID 219 field description**

Bits	Values	Description
[7 : 0]	From 120 to 138	SBAS PRN
[15 : 8]	From 0 to 180	Satellite longitude in degree
[16]	0: EAST 1: WEST	Longitude sense
[18 : 17]	0: WAAS 1: EGNOS 2: MSAS 3:GAGAN	The SBAS service

15.33 CDB-ID 220 – adaptive and cyclic operating mode setting 1

Allow setting different operating modes for the adaptive low power algorithm. This parameter includes different fields as reported in the following table:

Table 225. **CDB-ID 220 field description**

Bits	Values	Description
[0]	0/1	Enable/disable the Adaptive feature multi-constellation algorithm. 0: Disabled 1: Enabled
[1]	0/1	Enable/disable the Adaptive feature Duty Cycle: 0: Disabled 1: Enabled
[3 : 2]		RESERVED for further usage
Adaptive mode settings		
[11 : 4]	0….255	EHPE average threshold [m]
[19 : 12]	0…32	first N satellites (with higher elevation) used for the position calculation (Active channel management) in LOW POWER STATE

Bits	Values	Description
Cyclic mode settings		
[31 : 20]	100…740	Duty cycle signal off [ms]

15.34 CDB-ID 222 – LMS operating mode setting 1

Table 226. CDB-ID 222 field description

Bits	Values	Description
[0]	0/1	2D Fix enable/disable: • 0: disable • 1: enable
[1]	0/1	HDOP product in range error metric enable/disable: • 0: disable • 1: enable
[2]	0/1	GLONASS path delay lock enable/disable: • 0: disable • 1: enable
[15 : 8]	0..255	Position residual threshold [m]
[23: 16]	0..255	Position residual threshold after RAIM [m]

15.35 CDB-ID 223 – LMS operating mode setting 2

Table 227. CDB-ID 223 field description

Bits	Values	Description
[7 : 0]	0..255	Minimum number of satellites in GNSS mode
[15 : 8]	0..255	Minimum number of satellites in single constellation mode
[31: 16]	-32768..32767	Initial GLONASS path delay [dm]. (It is expressed in 2-complements on 16 bits)

15.36 CDB-ID 231 – CDB-ID 232 - NMEA on I2C port message list 0

Allow enabling/disabling each NMEA message in the message list 0 used for sending messages over the I2C port. CDB-ID 231 represents first 32 bits (low bits) of extended 64 bits NMEA message list. See CDB-ID 232 for second 32 bits (high bits) of 64 bits message list. The message list configuration is done in the same way as for the NMEA message list 0 (see CDB-ID 201 and CDB-ID 228 for details). See CDB-ID 201 also for supported message list table.

15.37 CDB-ID 233 – CDB-ID 234 - NMEA on I2C port message list 1

Allow enabling/disabling each NMEA message in the message list 1 used for sending messages over the I2C port. CDB-ID 233 represents first 32 bits (low bits) of extended 64 bits NMEA message list. See CDB-ID 234 for second 32 bits (high bits) of 64 bits message list. The message list configuration is done in the same way as for the NMEA message list 0 (see CDB-ID 201 and CDB-ID 228 for details). See CDB-ID 201 also for supported message list table.

15.38 CDB-ID 235 – CDB-ID 236 - NMEA on I2C port message list 2

Allow enabling/disabling each NMEA message in the message list 2 used for sending messages over the I2C port. CDB-ID 235 represents first 32 bits (low bits) of extended 64 bits NMEA message list. See CDB-ID 236 for second 32 bits (high bits) of 64 bits message list. The message list configuration is done in the same way as for the NMEA message list 0 (see CDB-ID 201 and CDB-ID 228 for details). See CDB-ID 201 also for supported message list table.

If not used the message list must be set to “0” (both CDB-ID 235 and CDB-ID 236 must be set to 0). It must be set to “0” also when the dual NMEA port feature is disabled (see CDB-ID 103 for details on enabling/disabling dual NMEA port).

15.39 CDB-ID 237 – default GPS MIN-MAX week number

Allow setting of minimum and maximum GPS week number.

Minimum week number is used for correct GPS week decoding. Teseo-Module software is able to decode correctly the GPS week number for a number of 1024 weeks (about 20 years) starting from minimum week number.

Maximum week number is used for GPS week validity check. It must be set at least 1024 weeks ahead to the minimum week number.

Table 228. CDB-ID 237 field description

Bits	Values	Description
[15 : 0]	0..65535	GPS minimum week number
[31 : 16]	0..65535	GPS maximum week number

Note:

- *The minimum week number should be moved ahead along years to guarantee at least 20 years of correct week decoding in the future*
- *as soon as the max week number is reached, the Teseo-Module software is no more able to validate the time and so it is no more able to achieve the GNSS position fix*

15.40 CDB-ID 238 – default UTC delta time

Allow setting the default value for the GPS time to UTC delta time seconds (leap seconds). This parameter is used by the Teseo-Module software only if the UTC backup data is not available in the backup memory (e.g. first start up after production or in case of backup memory content lost occurrence).

15.41 CDB-ID 257 – periodic operating mode setting 1

Configure the periodic low power mode. This CBD has to be combined with CBD-258.This parameter includes different fields as reported in the following table:

Table 229. CDB-ID 257 field description

Bits	Values	Description
[1 : 0]	0, 1, 2, 3	Periodic feature set Enable/Disable: 0: Periodic mode OFF 1: Active Periodic mode 2: Reserved 3: Standby Periodic mode
[2]	0/1	Ephemeris refresh required: 0: disabled 1: enabled

Bits	Values	Description
[3]	0/1	RTC calibration required: 0: disabled 1: enabled
[7 : 4]		RESERVED
[24 : 8]	0..86400	FixPeriod [s]. 0 means the Fix will be given only on WAKEUP pin activation. Value 0 is only valid in Standby Periodic mode.
[31 : 25]	1..127	FixOnTime - Number of fix to report every fix wakeup.

15.42 CDB-ID 258 – periodic operating mode setting 2

Configure the periodic low power mode. This CBD has to be combined with CBD-257.This parameter includes different fields as reported in the following table:

Table 230. CDB-ID 258 field description

Bits	Values	Description
[7 : 0]	0..255	NoFixCnt [s] - Time to declare fix loss in HOT conditions.
[19 : 8]	0..4095	NoFixOff [s] - Off duration time after a fix loss event.
[28 : 20]	0..300	NoFixCnt2 [s] – Time to declare fix loss in non-HOT conditions – startup case, obsolete ephemeris …

15.43 CDB-ID 260 – WLS algorithm configuration

Allow to configure the WLS algorithm implemented in the positioning stage.

Table 231. CDB-ID 260 field description

Bits	Values	Description
[0]	0..1	Enable/Disable the WLS algorithm usage in the positioning stage. 0: disabled 1: enabled
[7 : 1]	xxx	Not used
[15 : 8]	1..100	Parameter1 multiplied by 10. Parameter1 is a coefficient to change the measurements weighting in the position filter. Allowed values are from 0.1 to 10.0 (suggested value is 1.0) • means high acceptance of satellites measurements in the position filter 10.0 means low acceptance of satellites measurements in the position filter
[23 : 16]	10..100	Parameter2 multiplied by 10. Parameter2 is a coefficient to change the measurements acceptance threshold. Allowed values are from 1.0 to 10.0 (suggested value is 2.5) • means strong satellite exclusions by FDE (high false alarm rate) 10.0 means relaxed satellites exclusions by FDE.

15.44 CDB-ID 261 – dynamic modes configuration

Allow to configure supported dynamic modes for the satellites tracking engine. This configuration replaces the old high/low dynamic setting in the CDB-ID 200 bit mask 0x20000000.

Note: The old High/Low setting is still operative for backward compatibility reasons. To use CDB-ID 261 the CDB-ID 200 bit mask 0x20000000 must be set to 0.

Table 232. CDB-ID 261 field description

Bits	Values	Description
[3 : 0]	0, 1, 2, 3	Dynamic mode selection. 0: Low Dynamic 1: High Dynamic 2: RESERVED 3: Auto Dynamic

15.45 CDB-ID 263 – NMEA over I2C configuration

Allow configuring the NMEA over I2C.

Table 233. CDB-ID 263 field description

Bits	Values	Description	Default
[1: 0]	0..3	RESERVED	1
[5 :2]	-	RESERVED	0
[15 : 6]	0..0x3F	Slave address	0x3A
31 : 16]	0..2	RESERVED	0

15.46 CDB-ID 268 – geofencing configuration 0

Geofencing configuration field 0.

Table 234. CDB-ID 268 field description

Bits	Values	Description	Default
[0]	0..1	0 = Geofencing disabled on boot 1 = Geofencing enabled on boot	0
[2 : 1]	0..3	Geofencing tolerance	0x1
[3]	0 .. 1	0 = Autostart disabled 1 = Autostart enabled	0
[7 : 4]	-	RESERVED	0x1
[8]	0..1	0 = Circle 0 disabled 1 = Circle 0 enabled	0x1
[9]	0..1	0 = Circle 1 disabled 1 = Circle 1 enabled	0x1
[10]	0..1	0 = Circle 2 disabled 1 = Circle 2 enabled	0x1
[11]	0..1	0 = Circle 3 disabled 1 = Circle 3 enabled	0x1
[31 : 12]	-	RESERVED	0

15.47 CDB-ID 270 – odometer configuration

Odometer configuration field.

Table 235. CDB-ID 270 field description

Bits	Values	Description	Default
[0]	0..1	0: Odometer disabled on boot 1: Odometer enabled on boot	0
[1]	0..1	0: Odometer related NMEA messages disabled 1: Odometer related NMEA messages enabled	0
[15 : 2]	-	RESERVED	0
[31 : 16]	0..1	Distance in meter to trigger the alarm	0x03E8

15.48 CDB-ID 272 – GNSS integrity check configuration

Position and time integrity check enabling/disabling.

Table 236. CDB-ID 271 field description

Bits	Values	Description	Default
[0]	0..1	0: Position integrity check disabled 1: Position integrity check enabled	0
[1]	0..1	0: Time integrity check disabled 1: Time integrity check enabled	0

15.49 CDB-ID 300 – low latency Interface rate

Allow setting the Low Latency Interface rate. It is the time period between two consecutive NMEA message (only working on message-list-2).

System reboot needed to have new setting in use.

15.50 CDB-ID 301 – PPS pulse duration

Allow setting the pulse duration of the PPS signal. The pulse duration is intended to be the time distance between the PPS rising edge and the next falling edge if polarity inversion is disabled or the time distance between falling and rising edge if polarity inversion is enabled.

15.51 CDB-ID 302 – PPS delay correction

Allow setting a time correction to compensate any delay introduced on the pulse per second (PPS) signal by cables and/or RF chain.

15.52 CDB-ID 304 – position hold latitude

Allow setting the latitude [degrees] for the position hold mode.

Note: to be used the position hold functionality must be enabled, see CDB-ID 200 for details.

System reboot needed to have new setting in use.

15.53 CDB-ID 305 – position hold longitude

Allow setting the longitude [degrees] for the position hold mode

Note: to be used the position hold functionality must be enabled, see CDB-ID 200 for details.

System reboot needed to have new setting in use.

15.54 CDB-ID 306 – position hold altitude

Allow setting the altitude [m] for the position hold mode.

The altitude to be configured in this parameter must not be compensated with the geoid correction. If the altitude value is retrieved by the $GPGGA NMEA message, it must be added to the geoid correction (reported in the same $GPGGA message) before setting it in the CDB-ID 306 parameter.

System reboot needed to have new setting in use.

Note:

- *to be used the position hold functionality must be enabled, see CDB-ID 200 for details*

15.55 CDB-ID 307 – GPS RF delay correction

Allow setting the RF time delay for the GPS signal path. The RF compensation for GPS is independent by the PPS clock setting. The value calibrated for the ST reference design is 713E-9 s.

15.56 CDB-ID 308 – GLONASS RF delay correction

Allow setting the RF time delay for the GLONAS signal path. The RF compensation for GLONASS depends on the PPS clock setting (see CDB-ID). Here are the values calibrated for the ST reference design.

Table 237. CDB-ID 308 field description

PPS Clock Setting	GLONASS RF Correction
32 MHz	-
64 MHz	-

Note: If the PPS clock setting is changed in the configuration block, also the GLONASS RF delay correction must be changed accordingly. For accurate timing applications is strongly recommended to set PPS clock to 64 MHz.

15.57 CDB-ID 309 – TRAIM alarm threshold

Allow setting the time error threshold for satellites removal in the TRAIM algorithm. Satellites which have a time error bigger than the TRAIM threshold are not used for time correction. The TRAIM threshold is also used to rise the TRAIM alarm if the time correction error is bigger than it.

15.58 CDB-ID 310 – BeiDou RF delay correction

Allow setting the RF time delay for BeiDou signal path.

15.59 CDB-ID 311 – GALILEO RF delay correction

Allow setting the RF time delay for GALILEO signal path.

15.60 CDB-ID 314 – CDB-ID 315 – CDB-ID 316 – geofencing circle 0

Allows to set up the geofencing circle number 0 parameters.

Table 238. **Geofencing circle 0 field description**

CDB-ID	Type value	Description
314	Double precision floating number	Circle latitude
315	Double precision floating number	Circle longitude
316	Double precision floating number	Circle radius in meters

15.61 CDB-ID 317 – CDB-ID 318 - CDB-ID 319 - geofencing circle 1

Allows to set up the geofencing circle number 1 parameters.

Table 239. **Geofencing circle 1 field description**

CDB-ID	Type value	Description
317	Double precision floating number	Circle latitude
318	Double precision floating number	Circle longitude
319	Double precision floating number	Circle radius in meters

15.62 CDB-ID 320 – CDB-ID 321 – CDB-ID 322 – geofencing circle 2

Allows to set up the geofencing circle number 2 parameters.

Table 240. **Geofencing circle 2 field description**

CDB-ID	Type value	Description
320	Double precision floating number	Circle latitude
321	Double precision floating number	Circle longitude
322	Double precision floating number	Circle radius in meters

15.63 CDB-ID 323 – CDB-ID 324 – CDB-ID 325 – geofencing circle 3

Allows to set up the geofencing circle number 3 parameters.

Table 241. **Geofencing circle 3 field description**

CDB-ID	Type value	Description
323	Double precision floating number	Circle latitude
324	Double precision floating number	Circle longitude
325	Double precision floating number	Circle radius in meters

15.64 CDB-ID 400 – default 2D DOP

Allow setting the default value for the 2D DOP. This value is used at run-time, after the GNSS start-up phase, as a threshold for the 2D fix validation. DOP below this threshold will be considered valid for position fixing.

System reboot needed to have new setting in use.

15.65 CDB-ID 401 – default 3D DOP

Allow setting the default value for the 3D DOP. This value is used at run-time, after the GNSS start-up phase, as a threshold for the 3D fix validation. DOP below this threshold will be considered valid for position fixing.

System reboot needed to have new setting in use.

15.66 CDB-ID 402 – start-up 2D DOP

Allow setting the start-up value for the 2D DOP. This value is used during the GNSS start-up phase as a threshold for the 2D fix validation. DOP below this threshold will be considered valid for position fixing.

System reboot needed to have new setting in use.

15.67 CDB-ID 403 – start-up 3D DOP

Allow setting the start-up value for the 3D DOP. This value is used during the GNSS start-up phase as a threshold for the 3D fix validation. DOP below this threshold will be considered valid for position fixing.

System reboot need to have new setting in use.

15.68 CDB-ID 500 – Text message

Allow setting a text message which is sent (if enabled – see bit9 of CDB-ID 200 parameter) at start-up over the NMEA port. The user is free to use this text as product name or as specific configuration marker.

System reboot need to have new setting in use.

15.69 CDB-ID 600 – DRAW main setting

This data block contains configurations parameters which are the key for Dead-Reckoning workings, i.e. which sensors to enable and use for navigation solution, along with the output rate for both sensor and navigation data.

Table 242. CDB-ID 600 field description

Bits	Values	Description
[19 : 0]	0x116	Reserved (must be 0x116)
[30 : 20]	15 .. 0	Dead-Reckoning Fix Rate
[31]	0	Reserved (must be 0x0)

15.70 CDB-ID 653 – DRAW vehicle geometry

This data block contains settings specific parameters related to vehicle geometry, as the wheel size, distance and number of pulses per revolution, that are included in the mathematical model used by Teseo-DRAW.

Table 243. CDB-ID 653 field description

Bits	Description
[11 : 0]	nominal wheel circumference
[23 : 12]	represents nominal track distance, i.e. the distance between vehicle rear wheels
[31 : 24]	number of wheel pulses equalling a full wheel revolution

15.71 CDB-ID 667 – DRAW algorithm On/Off

15.72 CDB-ID 668 – DRAW installation angles

This parameter allows to define board installation angles, in order to optimize gyro performance on target vehicle installation. It is of interest only for systems including an onboard 3 axis digital gyroscope without 3 axis accelerometer.

Table 244. **CDB-ID 668 field description**

Bits	Description
[8 : 0]	Installation YAW
[17 : 9]	Installation ROLL
[26 : 18]	Installation Pitch
[31 : 27]	Reserved (must be 0x0)

Appendix A Local geodetic datum tables

Table 245. **Africa**

Region	Code	CDB-ID value
ADINDAN		
MeanSolution(Ethiopia-Sudan)	ADI-M	0
BurkinaFaso	ADI-E	1
Cameroon	ADI-F	2
Ethiopia	ADI-A	3
Mali	ADI-C	4
Senegal	ADI-D	5
Sudan	ADI-B	6
AFGOOYE		
Somalia	AFG	7
ARC_1950		
Mean_Solution	ARF-M	8
Botswana	ARF-A	9
Burundi	ARF-H	10
Lesotho	ARF-B	11
Malawi	ARF-C	12
Swaziland	ARF-D	13
Zaire	ARF-E	14
Zambia	ARF-F	15
Zimbabwe	ARF-G	16
ARC_1960		
Mean_Solution	ARS-M	17
Kenya	ARS-A	18
Tanzania	ARS-B	19
AYABELLE_LIGHTHOUSE		
Djibouti	PHA	20
BISSAU		
Guinea-Bissau	BID	21
CAPE		
South_Africa	CAP	22
CARTHAGE		
Tunisia	CGE	23
DABOLA		
Guinea	DAL	24
EUROPEAN_1950		
Egypt	EUR-F	73
Tunisia	EUR-T	83

Region	Code	CDB-ID value
LEIGON		
Ghana	LEH	25
LIBERIA_1964		
Liberia	LIB	26
MASSAWA		
Eritrea(Ethiopia)	MAS	27
MERCHICH		
Morocco	MER	28
MINNA		
Cameroon	MIN-A	29
Nigeria	MIN-B	30
M'PORALOKO		
Gabon	MPO	31
NORTH_SAHARA_1959		
Algeria	NSD	32
OLD_EGYPTIAN_1907		
Egypt	OEG	33
POINT_58		
Mean_Solution (BurkinaFaso-Niger)	PTB	34
POINTE_NOIRE_1948		
Congo	PTN	35
SCHWARZECK		
Namibia	SCK	36
SIERRA_LEONE_1960		
SierraLeone	SRL	37
VOIROL_1960		
Algeria	VOR	38

Table 246. **Asia**

Region	Code	CDB-ID value
AIN_EL_ABD_1970		
Bahrain_Island	AIN-A	39
Saudi_Arabia	AIN-B	40
DJAKARTA(BATAVIA)		
Sumatra(Indonesia)	BAT	41
EUROPEAN_1950		
Iran	EUR-H	77
HONG_KONG_1963		
Hong_Kong	HKD	42
HU-TZU-SHAN		
Taiwan	HTN	43
INDIAN		
Bangladesh	IND-B	44
India-Nepal	IND-I	45
INDIAN_1954		
Thailand	INF-A	46
INDIAN_1960		
Vietnam(near_16DegNorth)	ING-A	47
ConSonIsland(Vietnam)	ING-B	48
INDIAN_1975		
Thailand	INH-A	49
Thailand	INH-A1	50
INDONESIAN_1974		
Indonesia	IDN	51
KANDAWALA		
SriLanka	KAN	52
KERTAU_1948		
WestMalaysia-Singapore	KEA	53
KOREAN_1995		
SouthKorea	KGS	54
NAHRWAN		
MasirahIsland(Oman)	NAH-A	55
UnitedArabEmirates	NAH-B	56
SaudiArabia	NAH-C	57
OMAN		
Oman	FAH	58
QATAR_NATIONAL		
Qatar	QAT	59
SOUTH_ASIA		
Singapore	SOA	60

Region	Code	CDB-ID value
TIMBALAI_1948		
Brunei-East_Malaysia	TIL	61
TOKYO		
MeanSolution	TOY-M	62
Japan	TOY-A	63
Okinawa	TOY-C	64
South Korea	TOY-B	65
South Korea	TOY-B1	66

Table 247. Australia

Region	Code	CDB-ID value
AUSTRALIAN_1966		
Australia-Tasmania	AUA	67
AUSTRALIAN_1984		
Australia-Tasmania	AUG	68

Table 248. **Europe**

Region	Code	CDB-ID value
CO-ORDINATE SYSTEM 1937 OF ESTONIA		
Estonia	EST	69
EUROPEAN_1950		
MeanSolution	EUR-M	70
WesternEurope	EUR-A	71
Cyprus	EUR-E	72
Egypt	EUR-F	73
England,ChannelIslands,Scotland,ShetlandIslands	EUR-G	74
England,Ireland,Scotland,ShetlandIslands	EUR-K	75
Greece	EUR-B	76
Iran	EUR-H	77
ItalySardinia	EUR-I	78
ItalySicily	EUR-J	79
Malta	EUR-L	80
Norway,Finland	EUR-C	81
Portugal,Spain	EUR-D	82
Tunisia	EUR-T	83
EUROPEAN_1979		
MeanSolution	EUS	84
HJORSEY_1955		
Iceland	HJO	85
IRELAND_1965		
Ireland	IRL	86
ORDNANCE SURVEY OF GREAT BRITAIN 1936		
MeanSolution	OGB-M	87
England	OGB-A	88
England,IsleOfMan,Wales	OGB-B	89
Scotland,ShetlandIslands	OGB-C	90
Wales	OGB-D	91
ROME_1940		
Sardinia	MOD	92
S-42(PULKOVO_1942)		
Hungary	SPK-A	93
Poland	SPK-B	94
Czechoslovakia*	SPK-C	95
Latvia	SPK-D	96
Kazakhstan	SPK-E	97
Albania	SPK-F	98
Romania	SPK-G	99
S-JTSK		

Region	Code	CDB-ID value
Czechoslovakia	CCD	100

Table 249. **North america**

Region	Code	CDB-ID value
CAPE_CANAVERAL		
MeanSolution(Florida,Bahamas)	CAC	101
NORTH AMERICAN 1927		
MeanSolution	NAS-C	102
WesternUnitedStates	NAS-B	103
EasternUnitedStates	NAS-A	104
Alaska(ExcludingAleutianIslands)	NAS-D	105
AleutianIslands(East180°W)	NAS-V	106
AleutianIslands(West180°W)	NAS-W	107
Bahamas(Excluding San Salvador Island)	NAS-Q	108
SanSalvadorIsland	NAS-R	109
CanadaMeanSolution(Including Newfoundland)	NAS-E	110
Alberta,BritishColumbia	NAS-F	111
EasternCanada	NAS-G	112
Manitoba,Ontario	NAS-H	113
NorthwestTerritories,Saskatchewan	NAS-I	114
Yukon	NAS-J	115
CanalZone	NAS-O	116
Caribbean	NAS-P	117
CentralMerica	NAS-N	118
Cuba	NAS-T	119
Greenland	NAS-U	120
Mexico	NAS-L	121
NORTH AMERICAN 1983		
Alaska(ExcludingAleutianIslands)	NAR-A	122
AleutianIslands	NAR-E	123
Canada	NAR-B	124
CONUS	NAR-C	125
Hawaii	NAR-H	126
Mexico,CentralAmerica	NAR-D	127

Table 250. South america

Region	Code	CDB-ID value
BOGOTA OBSERVATORY		
Colombia	BOO	128
CAMPO NCHAUSPE 1969		
Argentina	CAI	129
CHUA ASTRO		
Paraguay	CHU	130
CORREGO ALEGRE		
Brazil	COA	131
PROVISIONAL SOUTH AMERICAN 1956		
MeanSolution	PRP-M	132
Bolivia	PRP-A	133
Northern Chile(near 19°S)	PRP-B	134
Southern Chile(near 43°S)	PRP-C	135
Colombia	PRP-D	136
Ecuador	PRP-E	137
Guyana	PRP-F	138
Peru	PRP-G	139
Venezuela	PRP-H	140
PROVISIONAL SOUTH CHILEAN		
Southern Chile (near 53°S)	HIT	141
SOUTH AMERICAN 1969		
MeanSolution	SAN-M	142
Argentina	SAN-A	143
Bolivia	SAN-B	144
Brazil	SAN-C	145
Chile	SAN-D	146
Colombia	SAN-E	147
Ecuador (Excluding Galapagos Islands)	SAN-F	148
Baltra,Galapagos Islands	SAN-J	149
Guyana	SAN-G	150
Paraguay	SAN-H	151
Peru	SAN-I	152
Trinidad and Tobago	SAN-K	153
Venezuela	SAN-L	154
SOUTH AMERICAN GEOCENTRIC REFERENCE SYSTEM(SIRGAS)		
South America	SIR	155
ZANDERIJ		
Suriname	ZAN	156

Table 251. **Atlantic ocean**

Region	Code	CDB-ID value
ANTIGUA ISLAND ASTRO 1943		
Antigua,Leeward Islands	AIA	157
ASCENSION ISLAND 1958		
Ascension Island	ASC	158
ASTRO DOS 71/4		
St.Helena Island	SHB	159
BERMUDA 1957		
Bermuda Islands	BER	160
CAPE CANAVERAL		
Mean Solution (Bahamas and Florida)	CAC	101
DECEPTION ISLAND		
Deception Islandand Antarctica	DID	161
FORT THOMAS 1955		
Nevis, St.Kitts and Leeward Islands	FOT	162
GRACIOSA BASE SW 1948		
Faial, Graciosa, Pico, SaoJorge and Terceira Islands (Azores)	GRA	163
HJORSEY 1955		
Iceland	HJO	85
ISTS 061 ASTRO 1968		
South Georgia Island	ISG	164
L.C. 5 ASTRO 1961		
Cayman Brac Island	LCF	165
MONTSERRAT ISLAND ASTRO 1958		
Montserrat and Leeward Islands	ASM	166
NAPARIMA,BWI		
Trinidad and Tobago	NAP	167
OBSERVATORIO METEOROLOGICO 1939		
Corvo and Flores Islands (Azores)	FLO	168
PICO DE LAS NIEVES		
Canary Islands	PLN	169
PORTO SANTO 1936		
Porto Santo and Madeira Islands	POS	170
PUERTO RICO		
Puerto Rico and Virgin Islands	PUR	171
QORNOQ		
South Greenland	QUO	172
SAO BRAZ		
Sao Miguel and Santa Maria Islands (Azores)	SAO	173
SAPPER HILL 1943		
East Falkland Island	SAP	174

Region	Code	CDB-ID value
SELVAGEM GRANDE 1938		
Salvage Islands	SGM	175
TRISTAN ASTRO 1968		
Tristan da Cunha	TDC	176

Table 252. Indian ocean

Region	Code	CDB-ID value
ANNA 1 ASTRO 1965		
Cocos Islands	ANO	177
GAN 1970		
Republic of Maldives	GAA	178
ISTS 073 ASTRO 1969		
Diego Garcia	IST	179
KERGUELEN ISLAND 1949		
Kerguelen Island	KEG	180
MAHE 1971		
Mahe Island	MIK	181
REUNION		
Mascarene Islands	REU	182

Table 253. **Pacific ocean**

Region	Code	CDB-ID value
AMERICAN SAMOA 1962		
American Samoa Islands	AMA	183
ASTRO BEACON “E” 1945		
Iwo Jima	ATF	184
ASTRO TERN ISLAND (FRIG) 1961		
Tern Island	TRN	185
ASTRONOMICAL STATION 1952		
Marcus Island	ASQ	186
BELLEVUE (IGN)		
Efate and Erromango Islands	IBE	187
CANTON ASTRO 1966		
Phoenix Islands	CAO	188
CHATHAM ISLAND ASTRO 1971		
Chatham Island (New Zealand)	CHI	189
DOS 1968		
Gizo Island (New Georgia Islands)	GIZ	190
EASTER ISLAND 1967		
Easter Island	EAS	191
GEODETIC DATUM 1949		
New Zealand	GEO	192
GUAM 1963		
Guam	GUA	193
GUX I ASTRO		
Guadalcanal Island	DOB	194
INDONESIAN 1974		
Indonesia	IDN	51
JOHNSTON ISLAND 1961		
Johnston Island	JOH	195
KUSAIE ASTRO 1951		
CarolineIslands, Fed.States of Micronesia	KUS	196
LUZON		
Philippines (Excluding Mindanao Island)	LUZ-A	197
Mindanao Island	LUZ-B	198
MIDWAY ASTRO 1961		
Midway Islands	MID_A	199
Midway Islands	MID_B	200
OLD_HAWAIIAN		
Mean Solution	OHA-M	201
Hawaii	OHA-A	202
Kauai	OHA-B	203

Region	Code	CDB-ID value
Maui	OHA-C	204
Oahu	OHA-D	205
OLD HAWAIIAN		
Mean Solution	OHI-M	206
Hawaii	OHI-A	207
Kauai	OHI-B	208
Maui	OHI-C	209
Oahu	OHI-D	210
PITCAIRN ASTRO 1967		
Pitcairn Island	PIT	211
SANTO (DOS) 1965		
Espirito Santo Island	SAE	212
VITI LEVU 1916		
VitiLevuIsland (Fiji Islands)	MVS	213
WAKE-ENIWETOK 1960		
Marshall Islands	ENW	214
WAKE ISLAND ASTRO 1952		
Wake Atoll	WAK	215

Table 254. **Non-satellite derived transformation parameter**

Region	Code	CDB-ID value
BUKIT RIMPAH		
Bangka and Belitung Islands (Indonesia)	BUR	216
CAMP AREA ASTRO		
Camp McMurdo Area, Antarctica	CAZ	217
EUROPEAN 1950		
Iraq, Israel, Jordan, Kuwait, Lebanon, Saudi Arabia, Syria	EUR-S	218
GUNUNG SEGARA		
Kalimantam (Indonesia)	GSE	219
HERAT NORTH		
Afghanistan	HEN	220
HERMANNSKOGEL		
Slovenia, Croatia, Bosnia and Herzegovina, Serbia	HER	221
INDIAN		
Pakistan	IND_P	222
PULKOVO 1942		
Russia	PUK	223
TANANARIVE OBSERVATORY 1925		
Madagascar	TAN	224
VOIROL 1874		
Tunisia, Algeria	VOI	225
YACARE		
Uruguay	YAC	226

Table 255. **Terrestrial reference systems**

GLONASS	Code	CDB-ID value
PZ90.2	PZ90_2	227
PZ90.11	PZ90_11	254

Appendix B RxNetworks Teseo-Module credential

The table below reports the Teseo-Module credential to access the RxNetworks AGNSS Web Server.
Credential access has to be used as described in the '*AN5160: RxNetworks Assisted GNSS Server Interface Specification*'

Table 256. Teseo-Module credential access on RxNetworks assisted GNSS server

String	Value
Server address : port	stm.api.location.io:80
<cld>	ZYDLLXxEH94dEeX2
<mld>	MYST

Table 257. **Document revision history**

Date	Revision	Changes
24-May-2021	1	Initial release.

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