RGPSM002

GPS Receiver Module

Ultra Low Power Position-Velocity-Time Platform

GENERAL DESCRIPTION

The ultra low power RGPSM002 GPS Receiver is a fully autonomous module that provides position, speed and time information derived from the Global Positioning System. The module shows high position and speed accuracy performances as well as high sensitivity and tracking capabilities in urban canyon conditions. They can easily be interfaced with any application controller through a simple serial interface. The solutions come in a small form factor package that facilitates integration into portable equipment. The RGPSM002 delivers major advancements in GPS performances, accuracy, integration, computing power and flexibility. It is designed to simplify the embedded system integration process.

The RGPSM002 is based on the mixed hardware/software architecture supported by the Semtech XE1610 GPS chipset.

APPLICATIONS

- Automotive
- Fleet management/asset tracking
- Palmtop, Laptop, PDA
- Location Based Services enabled devices
- Handheld receivers

KEY FEATURES

- High sensitivity: to -143 dBm tracking, superior urban canyon performances
- Position accuracy: < 5m CEP (50%) without SA (horizontal)
- Warm Start is under 32 seconds (50%)
- Hot Start is under 12 seconds (50%)
- Ultra low power: 19 mA @ 3V full power, 3 additional low power modes
- Embedded ARM7TDMI
- Small form factor and low cost solution
- Ready-to-plug solution, fully autonomous PVT solution. Easily integrated into existing systems
- On-board RAM for GPS navigation data, on-board Flash memory back-up
- PPS output
- Bidirectional NMEA interface
- Real Time Clock with separate back-up power supply

REFERENCE

RGPSM002 – 16M Flash version

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1 FIRSTGPS ARCHITECTURE HIGHLIGHTS

1.1 INDUSTRY LEADING GPS PERFORMANCE

- Builds on high performance FirstGPS core
- Satellite signal tracking engine to perform GPS acquisition and tracking functions without CPU intervention
- High sensitivity: to -143 dBm tracking, superior urban canyon performances
- Position accuracy: < 5m CEP (50%) without SA (horizontal)
- Warm Start is under 32 seconds (50%)
- Hot Start is under 12 seconds (50%)
- Timing output accuracy: +/- 100 ns

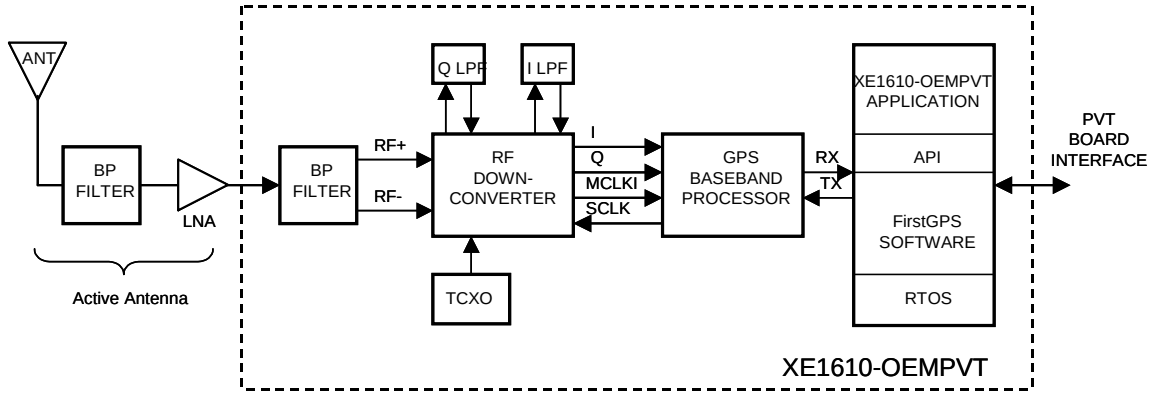
1.2 LOW POWER

- Ultra low power integrated circuit design, optimized RF and DSP architectures, 19 mA @ 3V tracking/doing fixes
- Further power saving thanks to 3 different power down modes
  - Power Save – RF section and GPS engine turned Off
  - Stand-by – RF section, GPS engine, and MCU clock turned Off, main power supply On, RTC running
  - Power down - RF section, GPS engine, and MCU clock turned Off, main power supply Off, RTC running on the back-up supply

1.3 RGPSM002 GPS RECEIVER HIGHLIGHTS

- Embedded AT91 MCU, ARM7TDMI-based
- Small form factor
- Low cost
- Ready-to-plug solution, fully autonomous PVT solution. Easily integrated into existing systems
- High signal acquisition & tracking performances
- On-board RAM for GPS navigation data. On-board Flash memory is used to back-up data such as the Almanac
- PPS output
- On-board RTC can be supplied by a separate back-up power supply if the main supply is turned off.
- Application software can be customized for high volume applications (Flash memory)

2 FUNCTIONAL BLOCK DIAGRAM



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3 PIN DESCRIPTION

PIN	NAME		DESCRIPTION
1	GND		Power and Signal Ground
2	ON/OFF	I	ON / Off command line
3	VCC		3.0 to 3.6 Volts DC Input Power Supply
4	USPED	I	UART Speed
5	RXA	I	Serial Receive Data, Port A, GPS NMEA Data
6	VRTCBK		Back-up supply for the RTC
7	TXA	O	Serial Transmit Data, Port A, GPS NMEA Data
8	PPS	O	One Pulse Per Second timing output
9	GND		Power and Signal Ground
10	RESETN	I	Manual Reset, Active low
11	ALMRDY	O	Almanac full and up to date, output
12	STY1	O	Search/Track mode indicator output
13			N.C.
14	DELPOSN	I	Delete Initial Position
15			N.C.
16	STANDBYN	I	Stand-by (Active Low)

Table 1 – Pin description

4 TECHNICAL CHARACTERISTICS

4.1 SPECIFICATIONS

Description	Min.	Typ.	Max.
Receiver		L1, C/A code	
Correlators/Channels		32/8	
Update Rate	1/minute	1/second	1/second
Satellite Reacquisition Time		1 second	
Hot Start		12 seconds (50%)	
Warm Start		32 seconds (50%)	
Cold Start		120 seconds (50%)	
Tracking Sensitivity		-173 dBW	
Power Consumption (VCC) @ 3.3V • Active mode, searching & tracking • Power save mode • Stand-by mode • Power down mode		 19 mA 2.2 mA 400 uA 2 uA	
Voltage Supply VCC	3V	3.3V	3.65V
Back Up Voltage Supply VRTCBK	1.9V		3.65V
Output Protocol		NMEA 0183, v3.0	
Position Accuracy • Horizontal, SA off • DGPS corrected		 5 meters CEP (50%) 1 meter	
Timing output accuracy PPS output (rising edge)	- 100 nanosec.		100 nanosec.

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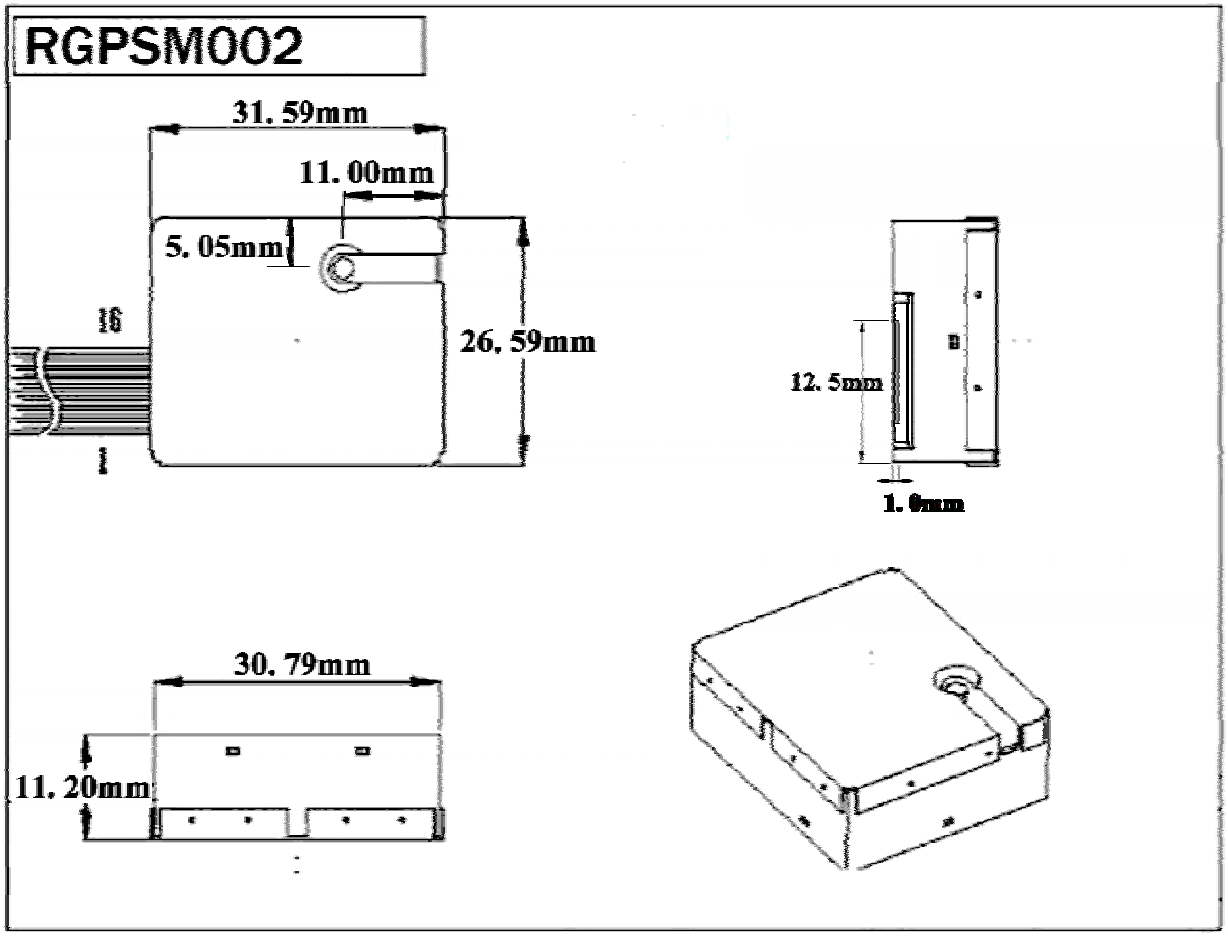
Description		Min.	Typ.	Max.
Input voltage – data interface	Low			0.8V
	High	2.0V		
Output voltage, VCC = 3V, I = 2mA	Low			0.4V
	High	2.6V		

Table 2 – Electrical specifications

4.2 PHYSICAL CHARACTERISTICS

The RGPSM002 is 26.59 x 31.59 x 11.2 mm module.



4.3 MECHANICAL INTERFACE

4.3.1 RF Interface Connector

Subminiature HFL. Works with 3.0V active antenna

4.3.2 Data Interface Connector

16 contact board-to-board flat cable connector.
Ref: Fujikura DDK FF6-16A-R15 or equivalent

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5 INTERFACE DEFINITION, PRINCIPLES OF OPERATION

5.1 DATA INTERFACE

VCC – This is the main power supply
GND – This is the power and signal ground
VRTCBK – This is the back-up supply for the on-board hardware Real Time Clock
All I/Os on the Data Interface are related to VCC and GND levels.

ON/OFF - The ON/OFF input pin controls whether the GPS engine is turned ON or OFF. If this pin is "high" whenever a reset condition occurs or if it is turned "high" when in operation, then the GPS engine is turned on. If this pin is "low" whenever a reset condition occurs then the GPS engine is not started. If this pin is turned "low" when in operation then the GPS engine is turned off. When ON/OFF is "low", the on/off state can be superseded with the PXEMaRT manufacturer specific NMEA sentence on RXA, as defined hereafter. This input pin has a pull-up resistor.

RXA – Serial Receive data. This input pin has a pull-up resistor.
TXA – Serial Transmit data
USPED – Hardware Baudrate selection
The Serial NMEA data port (lines RXA and TXA) is an asynchronous serial port (UART). Upon reset, if the USPED input pin is "low" the setting for this port is defined by the set A of UART parameters #19 to #22 in the Default Parameters Table *, or if USPED is "high" the setting is defined by the set B #23 to #26. This setting can be modified with the PXEMaPT manufacturer specific NMEA sentence defined hereafter. This input pin has a pull-up resistor. There is no flow control on the UART.
(*) see the Default Settings section below

PPS - The PPS output pin is a Pulse Per Second highly accurate timing signal generated by the on-board GPS baseband processor. The PPS signal is available only when the receiver does position fixes. Otherwise its output level is "low". After a reset condition, the setting for this port is defined in the Default Parameters Table *, parameter #1. This setting can be modified with the PXEMaPS manufacturer specific NMEA sentence defined hereafter.
(*) see the Default Settings section below

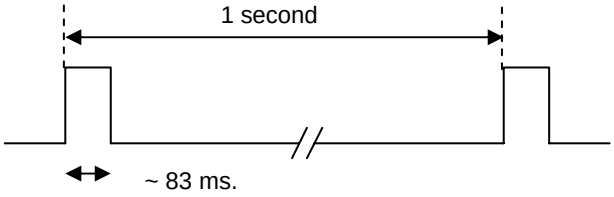

Figure 1 – PPS timing diagram

The rising edge of the PPS signal is synchronous with the GPS time.

RESETN – Manual Reset input pin. The receiver has 2 reset conditions: first, on power-on, thanks to an on-board Power On Reset circuitry; and an external reset when the RESETN pin is "low". This input pin has a pull-up resistor.

ALMRDY – When in Active mode, this output indicates the on-board Almanac status. Upon start up and whenever the Almanac data are tested invalid or not up-to-date the output level is "low. If tested valid and up-to-date the output level is "high".

STANDBYN – This input sets the receiver in Stand-by mode when its level is "low". Otherwise the receiver is either in Active or Power Save modes. See below, under Operating modes for details. This input pin has a pull-up resistor.
DELPOSN – Delete Initial Position pin. When set "low" for less than 1.5 seconds, this allows deleting of the initial position in the RAM portion of the MCU and triggering re-computation of the tracking set. The position will not be deleted if GPS fixes are already being generated. This function is useful when the initial position is known to be incorrect, for example when the receiver is powered down, put on a plane, flown 20,000 km, and then warm-started. See timing information in the figure below. This input pin has a pull-up resistor.

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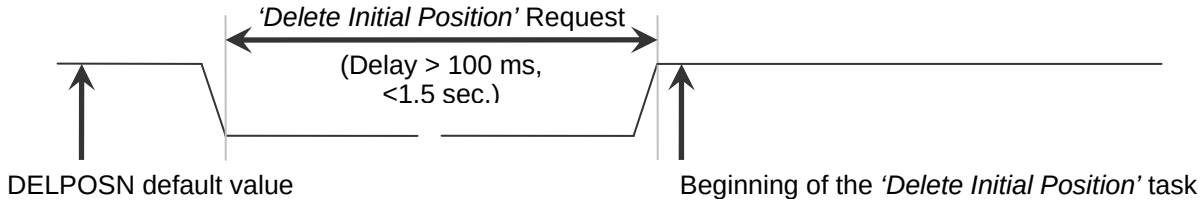

Figure 2 – DELPOSN timing diagram

Important Note: after the DELPOSN is activated, the receiver should make a position fix before it saves GPS data in its back-up Flash memory

If the DELPOSN is set "low" for more than 3 seconds, the BBFLASH content is erased and the receiver restarts in Cold Start condition.

5.2 OPERATING MODES

The receiver has 4 main operating modes, as summarized in the table below

Mode	Description	VCC pin	ON/Off pin	STANDBYN pin	Current consumption
Active Mode	Receiver is running, doing acquisition, tracking, position fixes	Powered	High	High	20 mA
Power Save Mode	GPS receiver functions are turned OFF, MCU in idle mode, MCU clock is running, RTC is running	Powered	Low (or thru NMEA command)	High	3 mA
Stand-by Mode	GPS receiver functions are turned OFF, MCU clock is stopped, RTC is running	Powered	Low (or thru NMEA command)	Low	<500 uA
Power Down Mode	GPS receiver functions are turned OFF, MCU clock is stopped, RTC is running on the Back-up supply	No power	*Low*	*Low*	2 uA

Table 3 – Operating modes

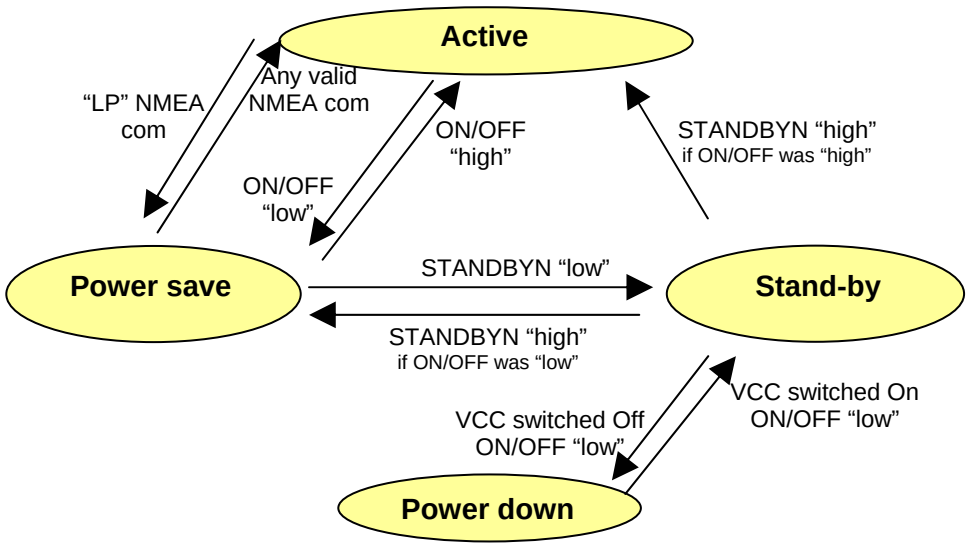

Figure 3 - Switching between operating modes

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Notes on TTFF / start-up condition:

- When switching from Power Save or Stand-by to Active mode, the start up condition will be
  - Hot start if Almanac is valid, Ephemeris is valid (less than 4 hours old), approximate position is known and RTC is valid
  - Warm start if Almanac is valid, Ephemeris is not valid, approximate position is known and RTC is valid
  - Cold start otherwise
- When switching from Power Down to Stand-by then to Active mode, the start up condition will be
  - Hot start if Almanac is valid, Ephemeris is valid (less than 4 hours old), approximate position is known and RTC is valid
  - Warm start if the Almanac and approximate position saved in Flash are valid, and RTC is valid
  - Cold start otherwise

5.2.1 Operating the GPS receiver in a basic "stand-alone" configuration

The simplest and easiest way to operate the RGPSM002 is the stand-alone configuration described below. In this case, the GPS receiver is simply controlled by its main power supply. It only sends NMEA strings through its TXA line. The data interface should be connected as follows:

Pin	Name	Connection
1	GND	To Ground
2	ON/OFF	To VCC or N.C.
3	VCC	To the main power supply, turned on to operate the receiver, off to stop it
4	USPED	To VCC or N.C.
5	RXA	To VCC or N.C
6	VRTCBK	To the back-up supply for the RTC
7	TXA	To the host interface, microcontroller, or other device that read the NMEA strings
8	PPS	N.C.
9	GND	To Ground
10	RESETN	To VCC or N.C.
11	ALMRDY	N.C.
12	STY1	N.C.
14	DELPOSN	To VCC or N.C.
16	STANDBYN	To VCC or N.C.

Table 4 – Basic data interface to operate the receiver in "stand-alone" configuration

Turning the main supply VCC on and off will switch the module into Active or Power-Down modes (see Figure 3 above). When turned on, after the internal power-up sequence, the RGPSM002 will send the NMEA sentences through its TXA pin. In this configuration, the serial port settings, the type of NMEA sentences, and the output rate are those defined in Flash in the Default Parameters Table (see Section 6 below). No other initialization is required.

5.2.2 Operating the GPS receiver in a basic "serial, bidirectional" configuration

This is a slightly more elaborate way to operate the RGPSM002. Compared to Paragraph 5.2.1, the module can receive command/data ASCII character strings from its RXA serial line. In this case the RXA line should be connected to a host, microcontroller, or any other device that can send NMEA strings through a UART

Pin	Name	Connection
5	RXA	To the host, microcontroller, or other device that send the NMEA strings Other pins similar to Table 4 above

Table 5 - Basic data interface to operate the receiver in "serial, bidirectional" configuration

Turning the main supply VCC on and off will switch the module into Active or Power-Down modes (see Figure 3 above). When turned on, after the internal power-up sequence, the RGPSM002 will send the NMEA sentences through its TXA pin. In this configuration, the serial port settings, the type of NMEA sentences, and the output rate are those defined in Flash in the Default Parameters Table (see Section 6 below). These parameters can then be temporarily modified by

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sending the appropriate proprietary NMEA commands defined in Section 5.4 below. Note these temporary settings will be lost the next time the main supply VCC is turned off.

5.3 NMEA STANDARD MESSAGE SET SPECIFICATION

The RGPSM002 supports NMEA-0183. Brief descriptions of the output messages are provided below.

5.3.1 NMEA Standard Sentences

Semtech receivers use the standard output messages listed in Table 6:

NMEA	Message Description
GGA	Global positioning system fixed data
GLL	Geographic position – latitude/longitude
GSA	GNSS DOP and active satellites
GSV	GNSS satellites in view
RMC	Recommended minimum specific GNSS data
VTG	Course over ground and ground speed
ZDA	Time & Date

Table 6. NMEA-0183 Messages

After a reset condition occurs, as defined above, the default setting for NMEA sentences is GGA, GSA, GSV and RMC, with update every second. This default setting can be modified in the Default Parameters Table (parameters #3 to #9) in Flash, and can also be overridden with the PXEMaNM manufacturer specific sentence defined hereafter.

Note on Latitude and Longitude format in NMEA sentences

The standard, variable-length, NMEA format for Latitude is ddmm.mmmm, where “dd” are 2 digit characters for the degrees, “mm” are 2 digit characters for the minutes, and the “.mmmm” are n digits for the decimal value of the minutes. So 6 degree 9.789 minutes is represented by the string “0609.789”, “0609.7890”, or “0609.78900”. Similarly, the standard, variable-length, NMEA format for Longitude is dddmm.mmmm, where “ddd” are 3 digit characters for the degrees, “mm” are 2 digit characters for the minutes, and the “.mmmm” are n digits for the decimal value of the minutes. So 45 degrees 6.129 minutes is represented by the string “04506.129”, “04506.1290”, or “04506.12900”

5.3.2 GGA —Global Positioning System Fixed Data

Description: This message reports the global positioning system fixed data, as shown in Table 7.

Name	Example	Units	Description
Message ID	$GPGGA		GGA protocol header
UTC Position	161229.487		hhmmss.sss
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N = north or S = south
Longitude	12158.3416		dddmm.mmmm
E/W Indicator	W		E = east or W = west
Position Fix Indicator	1		See Table 8
Satellites Used	07		Range 0 to 12
HDOP	1.0		Horizontal Dilution of Precision
MSL Altitude[1]	9.0	Meters	
Units	M	Meters	
Geoid Separation[1]		Meters	
Units	M	Meters	
Age of Diff. Corr.		Second	Null fields when DGPS is not used
Diff. Ref. Station ID	0000		
Checksum	*18		
<CR><LF>			End of message termination

[1]does not support geoid corrections. Values are WGS-84 ellipsoid heights.

Table 7. GGA Data Format

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Value	Description
0	Fix not available or invalid
1	GPS SPS Mode, fix valid
2	Differential GPS, SPS Mode, fix valid
3	GPS PPS Mode, fix valid

Table 8. Position Fix Indicator

Example: The values reported in this example are interpreted as shown in Table 7:
`$GPGGA,161229.487,3723.2475,N,12158.3416,W,1,07,1.0,9.0,M, ,M, ,0000*18`

5.3.3 GLL—Geographic Position - Latitude/Longitude

Description: This message reports latitude and longitude geographic positioning data, as described in Table 9.

Name	Example	Description
Message ID	$GPGLL	GLL protocol header
Latitude	3723.2475	dd mm.mmmm
N/S Indicator	N	N = north or S = south
Longitude	12158.3416	ddd mm.mmmm
E/W Indicator	W	E = east or W = west
UTC Position	161229.487	hh mm ss.sss
Status	A	A = data valid or V = data not valid
Mode Indicator	A	A = autonomous, D = differential, E = estimated, M = manual input, S=simulator mode, N = not valid
Checksum	*2C	
<CR><LF>		End of message termination

Table 9. GLL Data Format

Example: The values reported in this example are interpreted as shown in Table 9:
`$GPGLL,3723.2475,N,12158.3416,W,161229.487,A,A*2C`

5.3.4 GSA—GNSS DOP and Active Satellites

Description: This message reports the satellites used in the navigation solution reported by the GGA message. GSA is described in Table 10.

Name	Example	Description
Message ID	$GPGSA	GSA protocol header
Mode 1	A	See Table 11
Mode 2	3	See Table 12
Satellite Used [1]	07	SV on Channel 1
Satellite Used [1]	02	SV on Channel 2
…		…
Satellite Used [1]		SV on Channel N
PDOP	1.8	Position Dilution of Precision
HDOP	1.0	Horizontal Dilution of Precision
VDOP	1.5	Vertical Dilution of Precision
Checksum	*33	
<CR><LF>		End of message termination

[1] Satellite used in solution.

Table 10. GSA Data Format

Value	Description
M	Manual – forced to operate in 2D or 3D mode
A	Automatic – allowed to automatically switch 2D/3D

Table 11. Mode 1

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Value	Description
1	Fix not available
2	2D
3	3D

Table 12. Mode 2

Example: The values reported in this example are interpreted as shown in Table 10:

```
$GPGSA,A,3,07,02,26,27,09,04,15, , , , , ,1.8,1.0,1.5*33
```

5.3.5 GSV—GNSS Satellites in View

Description: This message reports the satellites in view, their ID numbers, elevation, azimuth, and SNR values (up to four satellites per message). GSV is described in Table 13.

Name	Example	Units	Description
Message ID	$GPGSV		GSV protocol header
Number of Messages[1]	2		Range 1 to 3
Message Number [1]	1		Range 1 to 3
Satellites in View	07		
Satellite ID	07		Channel 1 (Range 1 to 32)
Elevation	79	degrees	Channel 1 (Maximum 90)
Azimuth	048	degrees	Channel 1 (True, Range 0 to 359)
SNR (C/No)	42	dBHz	Range 0 to 99, null when not tracking
…			…
Satellite ID	27		Channel 4 (Range 1 to 32)
Elevation	27	degrees	Channel 4 (Maximum 90)
Azimuth	138	degrees	Channel 4 (True, Range 0 to 359)
SNR (C/No)	42	dBHz	Range 0 to 99, null when not tracking
Checksum	*71		
<CR><LF>			End of message termination

[1] Depending on the number of satellites tracked multiple messages of GSV data may be required.

Table 13. GGA Data Format

Example: The values reported in this example are interpreted as shown in Table 13. Two messages are required to complete the data transmission.

```
$GPGSV,2,1,07,07,79,048,42,02,51,062,43,26,36,256,42,27,27,138,42*71
$GPGSV,2,2,07,09,23,313,42,04,19,159,41,15,12,041,42*41
```

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5.3.6 RMC—Recommended Minimum Specific GNSS Data

Description: This message reports the time, date, position, course, and speed from the receiver's navigation solution. RMC is described in Table 14.

Name	Example	Units	Description
Message ID	$GPRMC		RMC protocol header
UTC Position	161229.487		Hh mm ss.sss
Status	A		A = data valid or V = data not valid
Latitude	3723.2475		Dd mm.mmmm
N/S Indicator	N		N = north or S = south
Longitude	12158.3416		Ddd mm.mmmm
E/W Indicator	W		E = east or W = west
Speed Over Ground	0.13	knots	
Course Over Ground	309.62	degrees	True
Date	120598		Dd mm yy
Magnetic Variation[1]	02.6	degrees	
E/W Indicator	W		E = east or W = west
Mode Indicator	A		A = autonomous, D = differential, E = estimated, M = manual input, S=simulator mode, N = not valid
Checksum	*10		
<CR><LF>			End of message termination

[1] All "course over ground" data are geodetic WGS84 directions.

Table 14. RMC Data Format

Example: The values reported in this example are interpreted as shown in Table 14:
`$GPRMC,161229.487,A,3723.2475,N,12158.3416,W,0.13,309.62,120598, 02.6,W,A*10`

5.3.7 VTG—Course Over Ground and Ground Speed

Description: This message reports current ground course and speed data. Course is reported relative to true north only. The VTG message is defined in Table 15.

Name	Example	Units	Description
Message ID	$GPVTG		VTG protocol header
Course	309.62	degrees	Measured heading
Reference	T		True
Course	139.6	degrees	Measured heading
Reference	M		Magnetic [1]
Speed	0.13	knots	Measured horizontal speed
Units	N		Knots
Speed	0.2	km/hr	Measured horizontal speed
Units	K		Kilometer per hour
Mode Indicator	A		A = autonomous, D = differential, E = estimated, M = manual input, S=simulator mode, N = not valid
Checksum	*6E		
<CR><LF>			End of message termination

[1] All "course over ground" data are geodetic WGS84.

Table 15. VTG Data Format

Example: The values reported in this example are interpreted as shown in Table 15:
`$GPVTG,137.7,T,139.6,M,007.4,N,013.7,K,A*47`

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5.3.8 ZDA—Time & Date

Description: This message reports current time and date. The ZDA message is defined in Table 16.

Name	Example	Units	Description
Message ID	$GPZDA		ZDA protocol header
Hour, Min, Sec, Sub Sec	114523.62		hhmmss.ss
Day	12		day in UTC, 01 to 31
Month	04		month in UTC, 01 to 12
Year	2001		year in UTC
Local Zone Hours	10		local zone hours, +/- 13 hours
Local Zone Minutes	34		local zone minutes, 0 to +59
<CR><LF>			End of message termination

Table 16 ZDA Data Format

Example: The values reported in this example are interpreted as shown in Table 15:
`$GPZDA,114523.62,12,04,2001,10,34*6E`

5.3.9 GPQ—NMEA Sentence Query

Description: Query of a specific NMEA sentence. Any GGA, GLL, GSA, GSV, RMC, VTG, or ZDA sentence can be queried manually by sending this query sentence to the receiver. The requested sentence will be sent only once. The GPQ message is defined in Table 17.

Name	Example	Units	Description
Message ID	$GPGPQ		GPQ protocol header
NMEA id	RMC		Identifier of the requested NMEA sentence: GGA, GLL, GSA, GSV, RMC, VTG, or ZDA
<CR><LF>			End of message termination

Table 17 – GPQ Data format

Example: $`GPGPQ,RMC*21`
`$GPRMC,161229.487,A,3723.2475,N,12158.3416,W,0.13,309.62,120598, 02.6,W,A*10`

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5.4 NMEA SPECIFIC SENTENCES

The NMEA 0183 Standard dictates that proprietary NMEA sentences have the following structure:

$Paaaxxxxxxxxxxxxx*hh

where *aaa* – mnemonic code, XEM in our case; *xxxxxxxxx*…– data; *hh* – sentence checksum

Two types of input sentences are defined: *query* and *se*t. *Query* sentences request certain information from the receiver. *Set* sentences allow configuring of the receiver with certain configuration parameters or forcing the receiver to perform a specific action. For each type of input sentence, a corresponding output *response* sentence is defined.
For a *query* sentence, the *response* sentence contains requested data. For a *set* sentence, the *response* sentence contains the status of the action requested in the *set* sentence. Taking these aspects into account, the following is the general structure of the specific NMEA sentence:

$PXEMmaa,x1,x2,x3,x4,….,xN*hh

where *m* – sentence type: 'Q' for 'query', 'S' for 'set', 'R' for 'response'; *aa* – proprietary sentence identifier (see below); *x1…xN* – data parameters (only for *set* and *query response* sentences); *hh* – sentence checksum
NOTE: Each of the data parameters must be preceded with a comma, except for the *aa* sentence identifier, and the checksum which is preceded with a checksum delimiter character '*'.

- QUERY sentence: to send a *query* sentence, no data fields are transmitted. The following format is used:
  $PXEMQaa*hh

- RESPONSE sentence to QUERY: for a *query* sentence, a *response* sentence with all fields is transmitted. The following format is used:
  $PXEMRaa,x1,x2,x3,x4,….,xN*hh

- SET sentence: to send a *set* sentence, x1…xN must contain valid values. The following format is used:
  $PXEMSaa,x1,x2,x3,x4,….,xN*hh

- RESPONSE sentence to SET: for a *set* sentence, a status *response* sentence is transmitted. The following format is used:
  $PXEMRaa,s*hh
  where *s* is the status of the requested action: 'A' if the action was successful; 'V' otherwise.

The following proprietary NMEA sentence identifiers are implemented:

5.4.1 DI – Diagnostic Message

This sentence outputs a diagnostic string. It is used to report various error conditions. This is a response-only sentence.

$PXEMRDI,ccccccc*hh where ccccccc is a diagnostic string up to 50 characters

5.4.2 TF—Quick Test

Description: This sentence contains information which helps a monitoring station figure out the status of the receiver. This sentence can be automatically output at a given rate by setting Bit #9 of the NMEA sentence mask (see NM-Sentence Mask and Automatic Output Rate section below). This is a query-only sentence.

$PXEMaTF,a,a,xxxxxx,xx,x,llll.llllll,a,yyyyy.yyyyy,a,xxxxx*hh

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Name	Example	Units	Description
Message ID	$PXEMaTF		TF protocol header, (a: Q = query; R = response)
BBFStatus	A		a: BBFlash status on startup (A = valid; V = invalid)
AlmStatus	A		a: Almanac completion status (A = complete; V = incomplete)
GPSTime	12367	seconds	xxxxxx: GPS time of week
SatInView	06		xx: Number of satellites in use
FixSource	3		x: Position fix source (0=no fix; 2=2D fix; 3=3D fix)
Lat	34.1453	deg	llll.lllll: Latitude of the current position fix
N/S	N		a: N (North), S (South)
Lon		deg	yyyyy.yyyyy: Longitude of the current position fix
E/W	E		a: E (East), W (West)
Alt	283	meter	xxxxx: Antenna altitude ref mean-sea-level (MSL geoid)
<CR><LF>			End of message termination

Table 18 TF Data Format

Example:
```
$PXEMQTF*6E
$PXEMRTF,A,A,112345,05,2,45.45677,N,6.26789,E,387*6E
```

NM – Sentence Mask and Automatic Output Rate

This sentence configures the application to automatically output standard NMEA sentences at a specified time interval.
$PXEMaNM,xxxx,xx*hh

Name	Example	Units	Description
Message ID	$PXEMaNM		Proprietary NM protocol header, a-mode (Q = query; S = set; R = response)
Mask	0008		xxxx Output sentence mask, hex value (see Notes below)
Rate	01	sec	xx Automatic output sentence rate (00 to 99)
<CR><LF>			End of message termination

Table 19 NM Data Format

Notes: xxxx is a hexadecimal value representing a 2-byte bit-mask where a specific bit sets or clears automatic output of a particular NMEA sentence according to the table below. The mask is derived by combining all bits which represent the NMEA sentences which will be automatically output. For example, to automatically output GGA, GSA, ZDA, and RMC, the bits 0, 4, 5, and 8 are set to 1 in a 2-byte mask, resulting in a hex value 0x131 (0x1+0x10+0x20+0x100). This value is sent as an ASCII string '0131' in the *xxxx* field of the NM sentence.

NMEA Sentence	xxxx Bit#	Field value
GGA	0	0001
GLL	1	0002
VTG	2	0004
GSV	3	0008
GSA	4	0010
ZDA	5	0020
RMC	8	0100
TF	9	0200

Table 20 Possible MASK field values for the NM command

Example: `$PXEMSNM,0008,01*6E (set)`
`$PXEMRNM,a*6E (response to set: a – action status: A = success; V = failure)`
Example: `$PXEMQNM*6E (query)`
`$PXEMRNM,0119,01*6E (response to query)`

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PS – Pulse-Per-Second Configuration

This sentence sets the pulse-per-second (PPS) output on or off. This is a set-only sentence.

$PXEMaPS,x*hh

Name	Example	Units	Description
Message ID	$PXEMaPS		Proprietary PS protocol header, a-mode (S = set; R = response0
On/Off	1		PPS output switch (1 = ON; 0 = OFF)
<CR><LF>			End of message termination

Table 21 PS Data Format

Example:
```
$PXEMSPS,1*6E   (set)
$PXEMRPS,a*6E   (response to set: a – action status: A = success; V = failure)
```

PT – Port Configuration

This sentence configures the application serial port communication parameters.
$PXEMaPT,xxxxxx,x,a,x*hh

Name	Example	Units	Description
Message ID	$PXEMaPT		Proprietary PT protocol header, a-mode (S = set; R = response)
Baudrate	009600		xxxxxx Baud rate (057600, 038400, 019200, 009600, 004800, 002400)
Data length	8		x # of data bits (7 or 8)
Parity	N		Parity (N = None; O = Odd; E = Even)
Stop bit	1		# of stop bits (1 or 2)
<CR><LF>			End of message termination

Table 22 PT Data Format

Example:
```
$PXEMSPT,009600,8,N,1*6E   (set)
$PXEMRPT,a*6E   (response to set: a – action status: A = success; V = failure)
```

5.4.6 RT – Reset the Receiver / Start-Stop FirstGPS

This sentence forces the receiver to perform a software reset. It also allows starting up and shutting down of the FirstGPS library without performing a full software reset. This is a set-only sentence.
$PXEMaRT,a*hh

Name	Example	Units	Description
Message ID	$PXEMaRT		Proprietary RT protocol header, a-mode (S = set; R = response)
Command	S		C = cold software reset W = warm software reset H = hot software reset S = start the FirstGPS library X = shut down the FirstGPS library B = save GPS data into the BBFLASH (ignored if there is no position fix)
<CR><LF>			End of message termination

Table 23 RT Data Format

Example:
```
$PXEMSRT,W*6E   (set)
$PXEMRRT,a*6E   (response to set: a – action status: A = success; V = failure)
```

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5.4.7 VR – Version Information

This sentence obtains software versions for the measurement platform (MPM) firmware, FirstGPS API, FirstGPS Library, native RTOS, and native processor (CPU). This is a query-only sentence.
Note: A complete VR sentence returns only the version of a particular product component one at a time (either MPM firmware, API, library, RTOS or CPU). The sentence must include the component type for which to obtain the version for any given query.

$PXEMaVR,a,cccccc,xx,xx,xx,xx,xx,xxxx*hh

Name	Example	Units	Description
Message ID	$PXEMaVR		Proprietary RT protocol header, a-mode (Q = query; R = response)
Component type	A		M = measurement platform (MPM) firmware A = FirstGPS API N = FirstGPS Library R = native RTOS U = native processor (CPU) V = Software build
Name	abcdef		variable length field; may be up to 17 characters long
Maj version	04		Major version number (00 to 99)
Min version	02		Minor version number (00 to 99)
Beta version	03		Beta version number (00 to 99)
Month	10		Month of the release (01 to 12)
Day	27		Day of the release (01 to 31)
Year	2002		Year of the release
<CR><LF>			End of message termination

Table 24 VR Data Format

Example:
```
$PXEMQVR,R*6E   (query)
$PXEMRVR,R,nucleus,04,03,03,10,27,2000*6E   (response to query)
```

5.4.8 GS – Geodetic System Configuration

This sentence sets the geodetic system use to compute the geographic positioning data.

$PXEMaGS,ee,xxxx.xxxxxx,yyyy.yyyyyy,zzzz.zzzzzz*hh

Name	Example	Units	Description
Message ID	$PXEMaGS		Proprietary GS protocol header, a-mode (S = set; R = response)
Ellipsoid	12		ee Ellipsoid Model (see table below)
Delta X	-0.148	m	xxxx.xxxxxx, shift parameter on x axis
Delta Y	0.096	m	yyyy.yyyyyy, shift parameter on y axis
Delta Z	0.122	m	zzzz.zzzzzz, shift parameter on z axis
<CR><LF>			End of message termination

Table 25 GS Data Format

Index	Ellipsoid Name	Semi-Major Axis	Flattening
00	Airy 1830	6377563.396	299.3249646
01	Australian National & South American 1969	6378160	298.25
02	Bessel 1841 Ethiopia	6377397.155	299.1528128
03	Bessel 1841 Namibia	6377483.865	299.1528128
04	Clarke 1866	6378206.4	294.9786982
05	Clarke 1880	6378249.145	293.465
06	Everest Brunei and E. Malaysia	6377298.556	300.8017

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07	Everest India 1830	6377276.345	300.8017
08	Everest India 1956	6377301.243	300.8017
09	Everest Pakistan	6377309.613	300.8017
10	Everest W. Malaysia and Singapore 1948	6377304.063	300.8017
11	Geodetic Reference System 1980	6378137	298.257222101
12	Helmert 1906	6378200	298.3
13	Hough 1960	6378270	297
14	Indonesian 1974	6378160	298.247
15	International 1924 & Hayford	6378388	297
16	Krassovsky 1940	6378245	298.3
17	Modified Airy	6377340.189	299.3249646
18	Modified Fischer 1960	6378155	298.3
19	WGS 1972	6378135	298.26
20	WGS 1984	6378137	298.257223563

Table 26 Ellipsoid models

Example:
```
$PXEMSGS,12,-0.148,0.096,0.122*44   (set)
$PXEMRGS,a,12,-0.148,0.096,0.122*08 (response to set: a – action status: A = success; V
= failure)
```
see also Exhibit A for further examples

LP – Power Save Mode

This sentence sets the receiver in Power Save mode. To go back to the Active mode, users should send any valid NMEA sentence to the receiver. Do not toggle the ON/OFF pin to go to the Active Mode if a NMEA LP command is used to switch to the Power Save mode

$PXEMaLP*****hh

Name	Example	Units	Description
Message ID	$PXEMaLP		Proprietary LP protocol header, a-mode (S = set; R = response)
<CR><LF>			End of message termination

Table 27 LP Data format

Example:
```
$PXEMSLP*4F (set)
$PXEMRLP,a*23     (response to set: a – action status: A = success; V = failure)
```

5.4.10 TR – Transparent Mode

With this type of sentence, an API function call is passed thru the NMEA interface. This can be a query, set, and response type of sentence.

$PXEMaTR,c..c,x..xx, .., x..x*hh

Example:
```
$PXEMQTR,SQCS*6E
$PXEMRTR,SQCS,NAV_OK,GPS Time of Week,Channel status for satellite 1, … Channel
status for satellite n*4F     (response to the channel status query)
```

The most useful TR types of proprietary NMEA sentences are listed below. See Exhibit B for detailed information on all the API function calls

Set the RTC time

The purpose of GPS time is to allow use of the almanac data and position to determine which satellites are in view and to allow rough ranging to the satellites. XE1610-PVT products load GPS time every start-up. If the local RTC, from which

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this GPS time is loaded, is not valid it is possible to provide the GPS time from another source. The accuracy of this external source should be better than 30 minutes.

The time/date information in the GPS system is coded using a standard GPS time format that is a week number and the time of the week. The week number of the GPS time is the number of weeks from Sunday, January 6 1980. However, due to the GPS data message format, the week number is a modulo-1024 number (10-bit number). The last rollover occurred on August 22, 1999. The next rollover will happen on April 7, 2019. The GPS time of the week is the number of milliseconds since the beginning of the current GPS week, the GPS week starting on Sundays at 0 hour, 0 minute, 0 millisecond.

When the GPS engine is running the TR sentence to use is:

$PXEMSTR,SSIT,WeekNb,TimeOfWeek,Accu*_hh_

where:
- WeekNb is the week number (see above)
- TimeOfWeek is the time of the week information, in milliseconds (see above)
- Accu (integer value) reflects the accuracy of the time information provided to the system. Use 1 only if the time of the week and the week number are valid (accuracy better than 30 minutes), otherwise -1

Important notes:
- if the Accu parameter is set to 1, the hardware RTC will be updated when receiving this command
- if the Accu parameter is set to -1, the hardware RTC will NOT be updated when receiving the sentence
- if the Accu parameter is set to another negative value, the hardware RTC will be updated when receiving the sentence

Also, it is strongly advised to avoid setting the Accu parameter to 1 if one is not sure about the accuracy, as this may lead to improper behavior.

Set the initial position

The purpose of the rough initial position is to allow use of the almanac data and GPS time to determine which satellites are in view. This is achieved by sending a proprietary TR command which format is:

$PXEMSTR,SSIP,L.LLL,O.OOO,Alt,Accu*hh

where:
- L.LLL is the latitude expressed in radian
- O.OOO is the longitude expressed in radian
- Alt is the altitude expressed in meter. Note that if you are not sure about the altitude, a default value of 200 gives acceptable results in most cases.
- Accu reflects the accuracy of the initial position. Use -1

For example, to set the position to New Delhi in India (coordinates being lat: 0.499, lon: 1.347), the full sentence should be:

`$PXEMSTR,SSIP,0.499,1.347,200,-1*hh`

The initial position can only be set when the GPS engine is running and before the system does position fix. Note that an initial position error of 1,000 km will result in an almanac based satellite search set which has rotated out of view by approximately 10%. Beyond this, the specified performance will degrade. Initial position errors greater than 3,000 km will result in a constellation which is almost out of view. So, the recommendation is to set the initial position only if its accuracy is better than 1,200 km.

Important Note: after the receiver gets this command the content of the GPS data RAM will be saved in the back-up Flash upon the first position fix.

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Delete the initial position

This NMEA sentence has the same effect as the hardware input DELPOSN. It allows deleting the initial position in the RAM portion of the MCU and triggering re-computation of the tracking set. The position will not be deleted if GPS fixes are already being generated. This function is useful when the initial position is known to be incorrect, for example when the receiver is powered down, put on a plane, flown 20,000 km, and then warm-started. The command is:

$PXEMSTR,SSDI*74

Important Note: after the PXEMSTR,SSDI command is sent, the receiver should make a position fix before it saves GPS data in its back-up Flash memory

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5.5 GPS DATA BACK-UP

The almanac data is the information transmitted by each satellite on the orbits and state (health) of the entire constellation. The ephemeris is a list of accurate positions or locations of celestial objects as a function of time. So, the availability of almanac and ephemeris data, in addition to time and approximate position, allows the GPS receiver to rapidly acquire satellites as soon as it is turned on. There are 3 possible start conditions when the receiver is turned on: a) the Cold Start, that is the start-up sequence of the receiver when no initialization data is available; b) the Warm Start, that is the start-up sequence of the receiver when the last position, the time and the almanac information are available; and c) the Hot Start, that is the start-up sequence of the receiver when the ephemeris, the last position, the time and the almanac information are available.

In the RGPSM002, the GPS data structure, including almanac, ephemeris and last position fix, is copied into a specific sector of the on-board Flash memory, that's the back-up Flash sector, or BBFlash. The data are stored the first time the almanac is complete and up-to-date, then every M minutes, where M is defined in Default Parameters Table *, parameter #37. Alternatively, the Flash can be programmed with valid information during the manufacturing process. This is to avoid downloading it from satellites, which takes approx. 12.5 minutes. Then, as long as the main power supply remains turned ON, the GPS data structure is kept in RAM. However, data in RAM are not maintained if the main supply is switched OFF (or in case of a power failure). In this case, upon power up, these data are uploaded from the Flash back-up memory into the GPS data RAM. Provided these data are valid – 2 months for the Almanac, 2 hours for ephemeris – the TTFF will be shorter than Cold Start TTFF, since the receiver will be in Warm or Hot start condition.
(*) see the Default Settings section below

With the Flash technology embedded technology, it takes approx. 0.5 seconds to erase and update the Flash sectors where the GPS data structure is stored.

5.6 REAL TIME CLOCK

The receiver board has a hardware Real Time Clock chip that operates independently from the MCU and the GPS function. When the GPS receiver is active and as soon as the GPS time becomes available the RTC is synchronized with GPS time. Then, as long as GPS time is available, the RTC is synchronized every 60 seconds.

If the main power supply VCC is turned OFF and provided the VRTCBK supply is available, the RTC operates and keep RTC information up to date. By doing so, when both the main VCC supply and the GPS receiver are turned ON again the time information will be available.

5.7 SPLIT SEARCH MODE

This feature is useful when the initial position is incorrect, for example when the receiver is powered down, put on a plane, flown 10,000 km, and then warm-started. If the user does not activate the DELPOSN I/O or does not sent the proprietary PXEMSTR,SSDI NMEA command, the receiver will start to search for the satellites it believes are above it (warm start condition). However, after approximately 5 minutes, it will free up some of its channels to search for other satellites in the constellation. When it finds one it will free up more channels and recover from a Warm start with an inaccurate initial position.

5.8 HARDWARE RESET AND SYSTEM WATCHDOG

The receiver has an embedded microcontroller voltage supply supervisor. This device will automatically generate a hardware reset if the voltage supply goes under the specified value. In this case, the receiver will restart from a known and stable state in case of a power shortage on the main supply while in operation.

In addition, the receiver firmware includes a system watchdog reset procedure. Should a system exception occurs, the receiver will execute a software reset to restart operation in a safe mode. In this case the receiver will not have position fixes for 15 seconds on average.

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6 DEFAULT SETTINGS

A number of system settings are stored in a particular area of the embedded Flash. That's the Default Parameters Table, whose content is listed hereafter. Some of these settings can be modified by sending a proprietary NMEA sentence to the receiver, as defined above.

#	Default parameter	Data Type	Default value	Range values
1	PPS Output Enabled	Char	Y	Y / N
2	NMEA refresh rate	Integer	1 second	1 to 99 seconds
3	NMEA GGA output displ'd	Char	Y	Y / N
4	NMEA GLL output displ'd	Char	N	Y / N
5	NMEA VTG output displ'd	Char	N	Y / N
6	NMEA GSV output displ'd	Char	Y	Y / N
7	NMEA GSA output displ'd	Char	Y	Y / N
8	NMEA ZDA output displ'd	Char	N	Y / N
9	NMEA RMC output displ'd	Char	Y	Y / N
10	NMEA TF output displ'd	Char	N	Y / N
11	NMEA GGA display order	Integer	2	1 .. 8
12	NMEA GLL display order	Integer	5	1 .. 8
13	NMEA VTG display order	Integer	6	1 .. 8
14	NMEA GSV display order	Integer	4	1 .. 8
15	NMEA GSA display order	Integer	1	1 .. 8
16	NMEA ZDA display order	Integer	7	1 .. 8
17	NMEA RMC display order	Integer	3	1 .. 8
18	NMEA TF display order	Integer	8	1 .. 8
19	Serial Port A Baudrate	Integer	4800	2400 / 4800 / 9600 / 19200 / 38400 / 57600
20	Serial Port A Data bits	Integer	8	7 .. 8
21	Serial Port A Stop bits	Integer	1	1 .. 2
22	Serial Port A Parity bits	Character	N	N / O / E
23	Serial Port B Baudrate	Integer	9600	2400 / 4800 / 9600 / 19200 / 38400 / 57600
24	Serial Port B Data bits	Integer	8	7 .. 8
25	Serial Port B Stop bits	Integer	1	1 .. 2
26	Serial Port B Parity bits	Character	N	N / O / E
27	Dynamic Code	Integer	5	1 – Land 2 – Sea 3 – Air 4 – Stationary 5 - Automobile
28	Max Oscillator Offset	Real	7.9e-6	Depends on the Oscillator
29	Elevation Mask (radian)	Real	0.087	0 to Pi/2 radian
30	Signal Level Mask (AMU)	Real	1.3	1 to 20
31	DOP Mask	Real	12	0.2 to 40
32	PDOP Switch	Real	8	0.2 to 40
33	Geodetic System Ellipsoid	Integer	20	0 to 20
34	Geodetic System Delta X	Real	0	-9999.99999 to +9999.99999
35	Geodetic System Delta Y	Real	0	-9999.99999 to +9999.99999
36	Geodetic System Delta Z	Real	0	-9999.99999 to +9999.99999
37	BBFlash Update rate (minutes)	32 bits Integer	10 - v 2.2 – 16 MB Flash option	1 to (2**32)-1

Table 28 – Default parameters

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6.1 GPS ENGINE CONFIGURATION

In addition, there are some settings for the embedded FirstGPS navigation software that cannot be modified by the users

6.1.1 Receiver configuration

DGPS Mode	DGPS Off	

6.1.2 Filter configuration

Kalman Filter

6.1.3 Offset configuration

Offset	0 ppm	
Window	-1 ppm	

6.1.4 Application settings

Number of channels	8	
Week epoch	1024	the offset number of 1024 week periods since 6 January 1980. Setting to 1024 includes all dates between August 22, 1999 and March 2019.

7 APPLICATION INFORMATION

7.1 ACTIVE ANTENNA

For proper operation, the RGPSM002 receiver should be operated with an active GPS antenna that has the following characteristics:

Power supply voltage	2.7 - 3.6 V
Frequency range	1,575.42+/-1.023MHz
LNA Gain	26 dB typ. at 3.0 V
LNA NF	1.3 dB typ. at 3.0 V
Antenna and LNA total Gain	25 dBi Max at 3.0 V

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EXHIBIT A

The following table illustrates datums for some cities around the world.

Country	City	NNEA Syntax	WGS-84 Datum	Local Datum
Wales	Cardiff	$PXEMSGS,00,375,-111,431*78	51° 23' N 3° 20' W 100.0 m	51° 22' 58.454" N 3° 19' 55.396" W 51.497 m
Australia	Sydney	$PXEMSGS,01,-134,-48,149*40	33° 52' S 151° 12' E 100.0 m	33° 52' 5.738" S 151° 11' 55.851" E 81.918 m
Japan	Tokyo	$PXEMSGS,02,-148,507,685*5C	35° 41' N 139° 46' E 100.0 m	35° 40' 48.239" N 139° 46' 11.591" E 59.959 m
Namibia	Windhoek	$PXEMSGS,03,616,-97,251*60	22° 34' S 17° 5' E 100.0 m	22° 33' 58.644" S 17° 5' 3.088" E 77.040 m
Cuba	Havana	$PXEMSGS,04,-3,142,183*50	23° 08' N 82° 21' W 100.0 m	23° 7' 58.302" N 82° 21' 0.559" W 125.109 m
Senegal	Dakar	$PXEMSGS,05,-128,-18,224*44	14° 42' N 17° 29' W 100.0 m	14° 41' 57.554" N 17° 28' 58.140" W 66.314 m
Brunei	Bandar S. B.	$PXEMSGS,06,-679,669,-48*4C	4° 56' N 114° 50' E 100.0 m	4° 56' 3.033" N 114° 49' 49.116" E 52.227 m
Thailand	Bangkok	$PXEMSGS,07,210,814,289*7D	13° 44' N 100° 30' E 100.0 m	13° 43' 54.002" N 100° 30' 11.811" E 141.421 m
India	Calcutta	$PXEMSGS,08,295,736,257*73	22° 32' N 88° 20' E 100.0 m	22° 31' 57.337" N 88° 20' 9.571" E 122.930 m
Pakistan	Karachi	$PXEMSGS,09,283,682,231*7B	24° 48' N 66° 59' E 100.0 m	24° 47' 58.714" N 66° 58' 59.779" E 128.006 m
Singapore	Singapore	$PXEMSGS,10,-11,851,5*62	1° 18' N 103° 50' E 100.0 m	1° 18' 0.179" N 103° 50' 6.237" E 103.999 m
Russia	*Moscow*	*$PXEMSGS,11,1.08,0.27,0.9*6C*	*55° 46' N* *37° 40' E* *100.0 m*	*55° 46' 0.010" N* *37° 39' 59.865" E* *99.446 m*
Egypt	Cairo	$PXEMSGS,12,-130,110,-13*44	29° 52' N 31° 20' E 100.0 m	29° 51' 59.415" N 31° 19' 53.980" E 89.458 m
Marshall Island	Majuro	$PXEMSGS,13,102,52,-38*57	41° 32' N 12° 18' E 100.0 m	41° 32' 6.227" N 12° 17' 58.745" E -50.775 m
Indonesia	Djakarta	$PXEMSGS,14,-24,-15,5*75	6° 11' S 106° 50' E 100.0 m	6° 11' 0.141" S 106° 49' 59.111" E 84.912 m
France	Paris	$PXEMSGS,15,-87,-96,-120*5D	48° 49' N 2° 29' E 100.0 m	48° 49' 3.271" N 2° 29' 4.516" E 50.964 m

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Country	City	NNEA Syntax	WGS-84 Datum	Local Datum
Somalia	Mogadiscio	$PXEMSGS,16,-43,-163,45*72	2° 2' N 49° 19' E 100.0 m	2° 1’ 58.354” N 49° 19’ 2.383” E 141.943 m
Ireland	Dublin	$PXEMSGS,17,506,-122,611*58	53° 22' N 6° 21' W 100.0 m	53° 21’ 59.163” N 6° 20’ 56.468” W 47.599 m
Singapore	Singapore	$PXEMSGS,18,7,-10,26*51	1° 18' N 103° 50' E 100.0 m	1° 18’ 0.833” N 103° 50’ 0.142” E 93.969 m
Ireland	*Dublin*	*$PXEMSGS,19,0,0,4.5*60*	*53° 22' N* *6° 21' W* *100.0 m*	*53° 21’ 59.906” N* *6° 21’ 0.554” W* *96.856 m*
Ireland	Dublin	$PXEMSGS,20,0,0,0*75	53° 22' N 6° 21' W 100.0 m	53° 22' N 6° 21' W 100.0 m

Table 29 - Datums

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EXHIBIT B

The list and description of parameters for the $PXEMaTR proprietary NMEA sentence is a restricted document. It is passed to customers on request and upon approval by Semtech.

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