Two DeLorme Drive
Yarmouth, ME 04096
(Phone) 800-293-2389
(Fax) 207-846-7054
www.delorme.com

DELORME

GPS2058-10

GPS Receiver Module Specification

December 2009

General Description

The DeLorme GPS2058 module combines the STMicroelectronics high sensitivity STA2058 (Teseo) GPS baseband chip with the STA5620 Low Power GPS RF front end to form a complete high performance GPS receiver module. The GPS2058 is an ideal solution for consumer, Handheld, PND (Portable Navigation), in-vehicle Navigation and Telematics systems. The GPS2058 is offered with a complete GPS firmware which performs all basic GPS operations including tracking, acquisition, navigation, timing, and data output with no need of external memories.

Features

- Compact 16mm x 16mm footprint minimizes board space
- Very high sensitivity and fast time to fix for very accurate position fixes in all environments
- Fully Integrated RF Section for direct Interface to Active or Passive Antenna Systems
- GPS Firmware embedded in FLASH eliminates programming
- Standard NMEA0183 output message structure for easy interfacing or optional binary protocol
- All messages at 1Hz rate
- SBAS (WAAS and EGNOS) supported
- Evaluation kit and Reference Design Available
- Low Power with standby mode for battery powered applications
- PPS Output Synchronized to UTC for Time Synchronization Applications
- Superior Multi-path Error rejection algorithm for optimum performance in urban canyons
- TRAIM algorithm assures high integrity timing
- RoHS Compliant

Performance Specifications

Reacquisition time:	0.1 seconds average
Position Accuracy:	0.63 meters, CEP 50% (24hr static) 1.31 meters, 95% (24hr static)
Acquisition Time:	
• Hot Start:	2.5 seconds
• Warm Start:	34 seconds
• Cold Start:	39 seconds
Reacquisition Time:	<1 second
Altitude	<+/5 m vertical (50%)
Velocity	0.1 m/s

Time (PPS):	+/-62ns synchronized to UTC time
Acquisition Sensitivity:	-146dBm (warm)
Tracking Sensitivity:	-159dBm
Velocity:	<515 m/s (~1,000 knots) Max
Acceleration:	4g Max
Altitude:	<18,000 m (~60,000 ft)
Jerk:	20 m/s^3

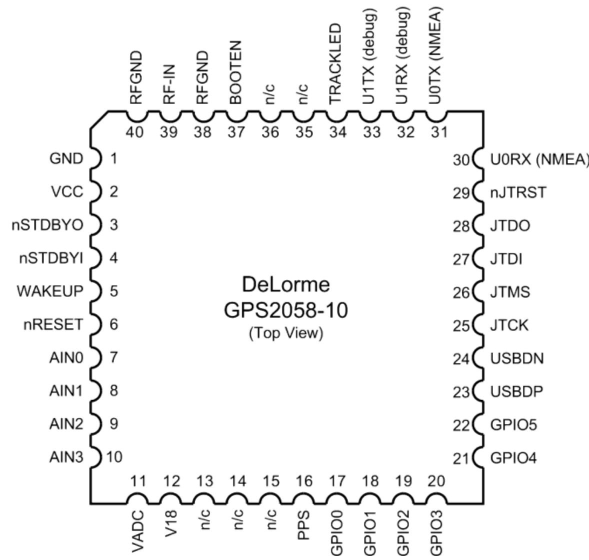
Functional Description

The DeLorme GPS2058-10 module simplifies embedded applications of GPS-based information systems. The important components of a basic GPS receiver subsystem are LNA, SAW Filter, RF front end, power conditioning, and the GPS baseband receiver itself. All these subsystems have been built into the DeLorme GPS module to eliminate the cost and time needed for the user to develop them independently. In simple terms, the user must connect an active or passive antenna, provide a power source, and connect the module to a host system via a NMEA UART to produce GPS positional data and enable a complete GPS receiver system. Designed for PCB mounted application, the module has a tiny 16x16mm footprint for use in small form-factor end applications such as portable systems.

For fast startup times, the Teseo baseband features an onboard dedicated 16KB of FLASH memory for storing the satellite almanac and ephemeris data, and this data is saved and restored automatically as a background process. This eliminates the need for additional external memory, backup battery, and eliminates any programming to save and recover this data.

The Pulse-Per-Second (PPS) output provides an accurate timestamp, synchronized to Universal Coordinated Time (UTC).

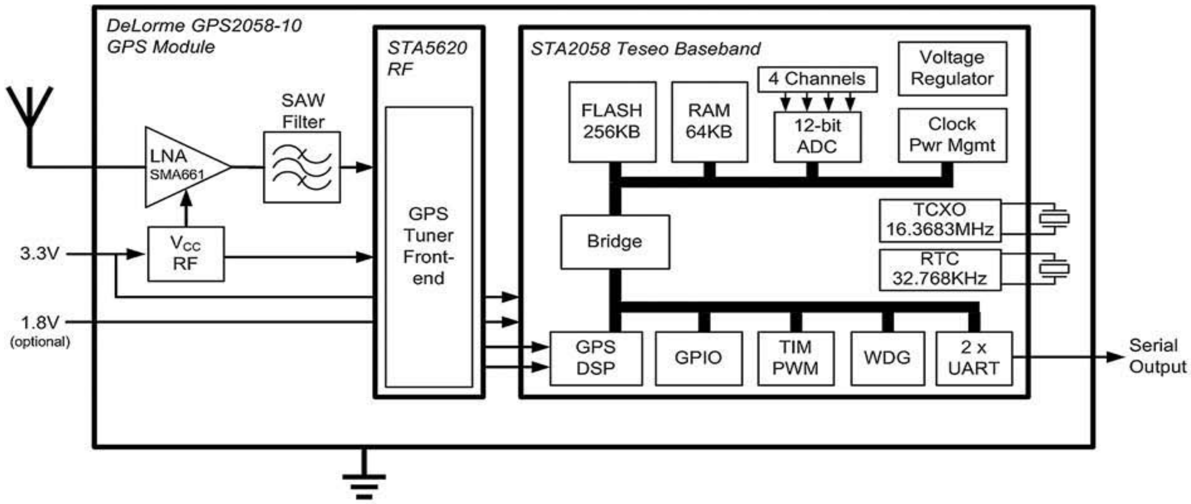
Module Pinout



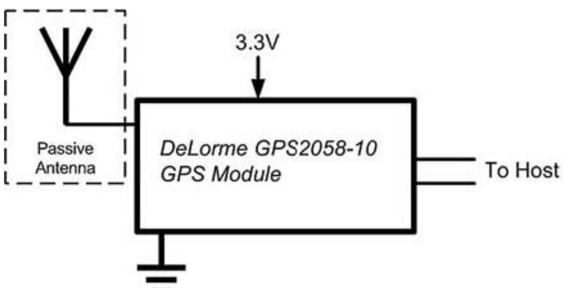
Pin Descriptions

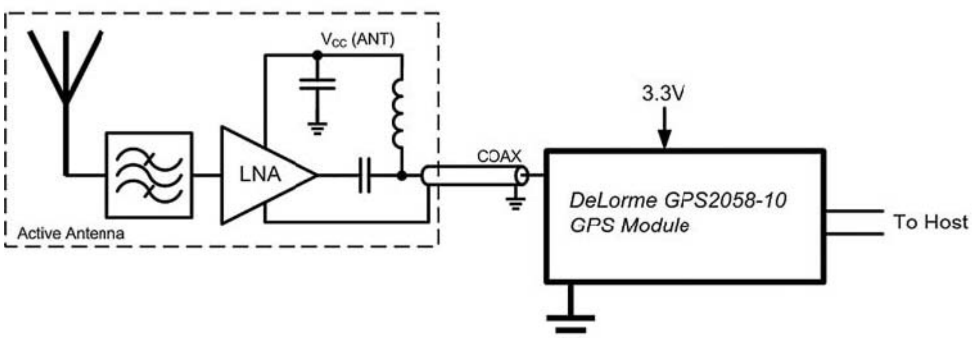
Pin	Name	Function	Description	Alternate Function
1	Ground	Power	Digital Ground	N/A
2	VCC	Power	Digital 3.3v +/- 5% supply	N/A
3	nSTDBYO	Output	Low indicates Module is in standby mode	N/A
4	nSTDBYI	Input	Low input forces Module into standby mode	N/A
5	WAKEUP	Input	Wakeup from standby mode	N/A
6	nRESET	Input	Module reset active Low	N/A
7	n/c	I/O	N/A	Analog Input 0 (Future)
8	n/c	I/O	N/A	Analog Input 1(Future)
9	n/c	I/O	N/A	Analog input 2 (Future)
10	n/c	I/O	N/A	Analog Input 3 (Future)
11	VADC	Power	External ADC Power (tie to VCC if ADC's are not used)	N/A
12	V18	Power	Optional 1.8V core supply to reduce power (refer to Page 8)	N/A
13	n/c	I/O	N/A	N/A
14	n/c	I/O	N/A	N/A
15	n/c	I/O	N/A	N/A
16	PPS	I/O	Pulse Per Second Output	N/A
17	GPIO0	I/O	GPIO0	SPI0 MISO (Future)
18	GPIO1	I/O	GPIO1	SPI0 MOSI (Future)
19	GPIO2	I/O	GPIO2	SPI CK (Future)
20	GPIO3	I/O	GPIO3	SPI SS (Future)
21	GPIO4	I/O	GPIO4	N/A
22	GPIO5	I/O	GPIO5	N/A
23	USBDP	I/O	N/A	USB Data+ (Future)
24	USBDN	I/O	N/A	USB Data- (Future)
25	JTCK	Input	JTAG Clock (Factory Test Only)	N/A
26	JTMS	Input	JTAG Mode Select (Factory Test Only)	N/A
27	JTDI	Input	JTAG Data Input (to module) (Factory Test Only)	N/A
28	JTDO	Output	JTAG Data Output (from module) (Factory Test Only)	N/A
29	nJTRST	Input	JTAG Reset (active low) (Factory Test Only)	N/A
30	U0RX	I/O	NMEA UART0 Receive Data Input (to module)	N/A
31	U0TX	I/O	NMEA UART0 Transmit Data Output (from module)	BOOT0
32	U1RX	I/O	DEBUG UART1 Receive Data Input (to module)	BOOTRX
33	U1TX	I/O	DEBUG UART1 Transmit Data Output (from module)	BOOTTX
34	TRACKLED	I/O	3D Fix Indicator	N/A
35	n/c	I/O	N/A	N/A
36	DEFAULT_CONFIG	I/O	High forces load of DEFAULT SWConfig (refer to page 12)	N/A
37	BOOTEN	Input	Enable sampling of BOOT[0:1] pins on exit from external reset	N/A
38	RFGND	Ground	RF Ground, connect only to RF	N/A
39	RF-IN	Input	GPS signal in from antenna	N/A
40	RFGND	Ground	RF Ground, connect only to RF	N/A

GPS2058 Block Diagram



Typical Applications





Absolute Maximum Ratings

Symbol	Parameter	Value		Unit
		Min	Max	
VDD	Voltage on VDD with respect to ground (VSS)	-0.3	+4.0	V
V18	Voltage on optional 1.8V core supply input	-0.3	+2.0	V
VADC	Voltage on VADC pin with respect to ground (VSS)	-0.3	+3.6	V
VIN	Voltage on any pin with respect to ground (VSS)	-0.3	+4.0	V
IOV	Input Current on any pin during overload condition	-10	+10	mA
ITDV	Absolute sum of all input currents during overload conditions		|200|	mA
TST	Storage Temperature	-55	+130	°C
ESD	ESD Susceptibility (Human Body Model)	2000		V

NOTE: Stresses exceeding above listed recommended "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Recommended Operating Conditions

Symbol	Parameter	Value		Unit
		Min	Max	
VDD	Digital Supply Voltage for I/O Circuitry	3.0	3.6	V
VADC	Analog Supply Voltage for the A/D Converter	VDD	VDD	V
V18	Voltage on optional 1.8V core supply input	1.7	1.9	V
TA	Ambient Temperature under bais	-40	+85	°C
TJ	Junction Temperature under bias	-40	+105	°C

DC Electrical Characteristics

Symbol	Parameter	Conditions	Value			Unit
			Min	Typ	Max	
VIH	Input High Level CMOS	With or w/o Hysteresis	0.7*VDD			V
VIL	Input Low Level CMOS	With or w/o Hysteresis			0.3*VDD	V
VHYS	Input Hysteresis CMOS Schmitt Trigger		0.4	0.8	1.2	V
	Input Hysteresis Schmitt Trigger	WAKEUP pin only	0.3	0.5		V
VOH	Output High Level High Current Pins (GPIO)	IOH = 8mA	VDD-0.8			V
	Output High Level Standard Current Pins	IOH = 4mA	VDD-0.8			V
VOL	Output Low Level High Current Pins (GPIO)	IOL = 8mA			0.4	V
	Output Low Level Standard Current Pins	IOL = 4mA			0.4	V
RWPU	Weak Pull-up Resistor	Measured at 0.5 VDD		100		KΩ
RWPD	Weak Pull-down Resistor	Measured at 0.5 VDD		100		KΩ

AC Electrical Characteristics

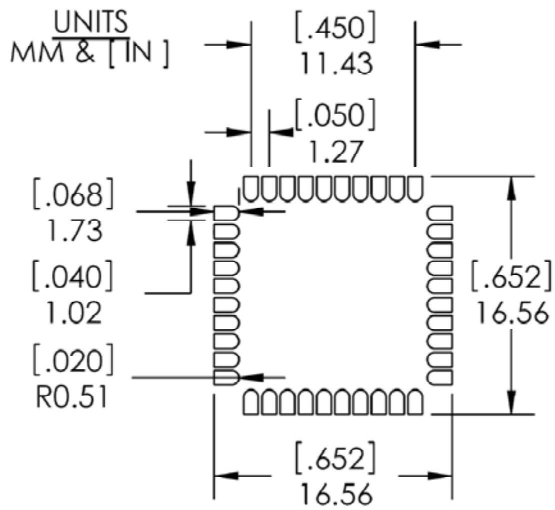
Symbol	Parameter	Conditions	Value			Unit
			Min	Typ	Max	
IDDRUN	RUN mode current	VDD=3.3V		64		mA
IDDRUN18	Run mode current using both 3.3V and 1.8V supplies (internal regulator powered off)	3.3V supply current		31		mA
		1.8V supply current		33		mA
IDDSB1	STANDBY mode current	LP Vreg & 32kHz OSC on		90		uA
IDDRESET0	RESET mode current	Active but held in Reset		8		mA

Environmental Specifications

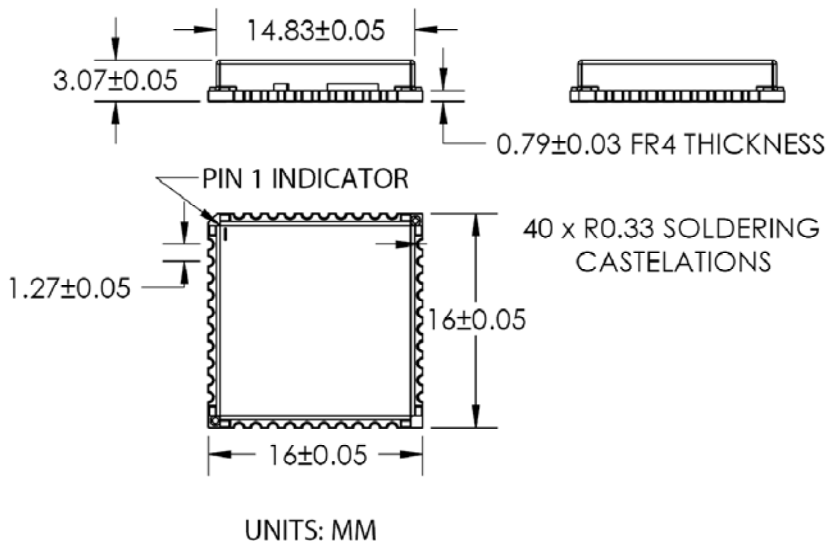
Operating Temperature -40 °C to +85 °C
Storage Temperature -55 °C to +130 °C
Relative Humidity 5% to 95%, non-condensing

Mechanical Specifications

GPS2058 Recommended PC Board Layout



GPS2058 Package Outline

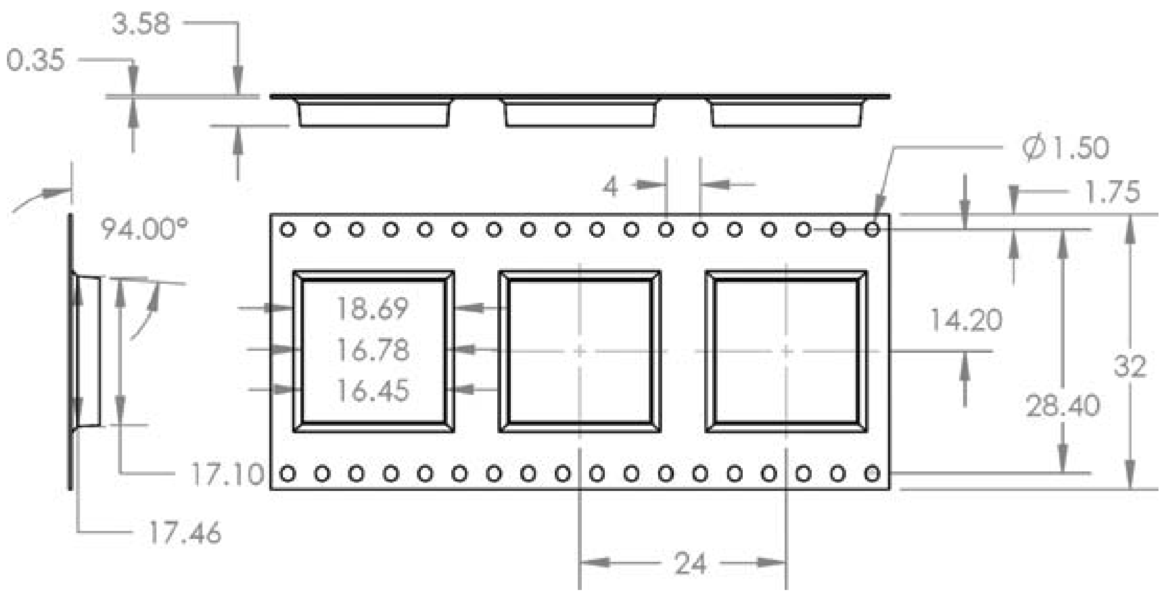


Ordering Information

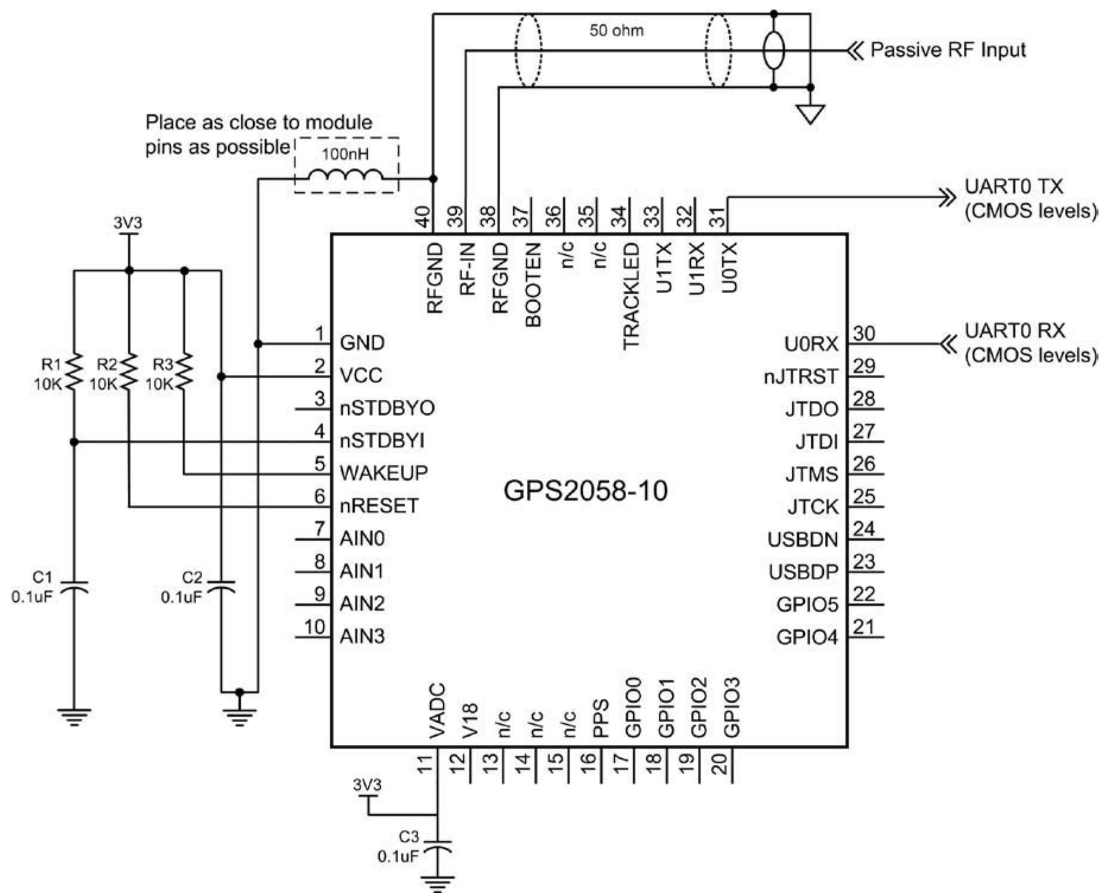
GPS2058-10 Ordering Code: GM-205810-000
Tape And Reel minimum order quantity: 500 units

Evaluation Kit Ordering Code: GM-2058EV-101

Tape Dimensions



Minimum Connectivity



The following describes the minimum GPS2058 GPS receiver module connectivity necessary to obtain a position fix with passive antenna and host connection.

The Antenna connects to the module on the RF-input pin. It is very important that this connection maintains a 50 ohm impedance with minimal discontinuities to maximize the energy transfer from the antenna to the module RF input. Both RF ground pins (38 and 40) must be isolated from digital ground through a 100nH inductor to eliminate high frequency loop currents and preventing self jamming from digital noise injected into the RF section or RF noise from being introduced to the digital section. Refer to our application note titled 'GPS Module Antenna and RF Design Guidelines' for additional discussion and layout recommendations.

Power is supplied to the module by connecting a 3.3V digital supply to pin 2. Use 0.1uF decoupling cap as close to the module pin as possible. Pin 1 is digital ground, connect to ground plane as close to module as possible. For reducing the supply current when an additional 1.8V supply is available, refer to the section titled "Power Supply Options" in this document.

To ensure that module powers up in the correct state, nRESET (pin 6) must be tied to 3.3V thru a 10Kohm resistor to prevent accidental receiver reset. The WAKEUP input (pin 5) must be tied to 3.3V thru a 10Kohm resistor and the nSTDBYI input (pin 4) must also be tied to 3.3V thru a 10K ohm resistor to hold the receiver out of standby mode. A 0.1uF cap to ground is also tied to the nSTDBYI input to delay the ramp up to 3.3V, which brings the pin biasing up in the right sequence.

The UART0 NMEA connection is a CMOS level TTL signal level. Pin 31 is the transmit output pin for sending the NMEA data FROM the module TO the host, and pin 30 is the receive input for sending commands FROM the host TO the Module.

The VADC input (pin 11) should also be tied to the 3.3V supply to properly bias the device. A decoupling capacitor of 0.1uF is used as close to the pin as possible.

All other pins may remain unconnected.

Power Supply Options

The GPS2058 module can be powered by two different methods. The preferred method will depend on the supply voltages available on the PCB and the power consumption goals of the system.

A single external 3.3V supply can be used to power the entire module. When only the external 3.3V supply is used the voltage is down converted inside the module to supply the core 1.8V.

There is power loss associated with the internal regulator. If external 3.3V and 1.8V sources are both available to power the module the internal regulator can be shut off to eliminate its power loss. The external 3.3V supply is still needed to power the I/O and some other components in the module requiring 3.3V (i.e.; LNA).

When using the dual 3.3V and 1.8V supply rails approximately half of current comes from the 1.8V rail while about half will come from the 3.3V supply.

There is a NMEA command to turn off the internal regulator, $PDME,12,2. When the GPS2058 is initially powered on (and not in STANDBY mode) the $PDME,12,2 command can be issued to power off the internal regulator and reduce the total power consumption. When a hardware reset occurs the 1.8V regulator is powered on and the $PDME,12,2 command must be reissued to bypass the 1.8V regulator.

Note that the GPS2058 will still function properly using two supplies with the internal regulator still ON, providing the V18 never exceeds 2.0V (abs max).

When an external 1.8V supply is not used the V18 supply pin should be left floating.

In order to fully enter STANDBY mode you should disable the internal 1.8V regulator when using an external 1.8V supply. Coming out of STANDBY mode will require you to re-issue the command to disable the internal regulator if an external 1.8V supply is used.

Standby Mode

In Standby mode, the CPU core is switched off to reduce power consumption. The Real Time Clock and Wake-Up logic remains independently powered by an internal low-power voltage regulator for fast start-ups coming out of Standby mode.

The Standby mode power-down sequence may be initiated by either a software command, or by hardware control using the nSTDBYI and WAKEUP inputs. DO NOT tie the nSTDBYI and WAKEUP pins together if you are using STANDBY mode.

Coming out of Standby mode requires the nSTDBYI and WAKEUP inputs to be in the proper state even if Standby mode was initiated via software (see below).

The WAKEUP input must be low to initiate Standby mode. If WAKEUP is high then Standby mode cannot be initiated by any event, software or hardware.

A Reset event (nRESET pin goes low) has priority over nSTDBYI. Therefore, reset activation will force an exit from the Standby mode. If nRESET is activated while nSTDBYI is logic high, the device exits from Standby mode. If a Reset pulse is given while nSTDBYI is kept at constant low level, the device will enter Standby mode again after nRESET rising edge.

If the nSTDBYI pin is low when the device wakes up, the module will re-enter Standby mode.

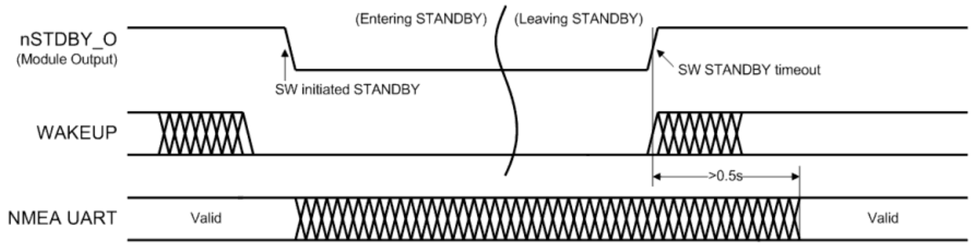
When the GPS2058 comes out of standby (or even during a power-up) the time to fix depends on a number of variables. The receiver requires a valid time or known position, valid almanac, valid ephemeris, and strong enough signals from 4 or more satellites.

- Cold Start: No RTC or time, no known position, no ephemeris, no almanac
- Warm Start: No RTC, but current time is known, no ephemeris, but last position is known, almanac valid
- Hot Start: RTC valid and current time is known, ephemeris valid and last position is known, almanac valid

Ephemeris data is valid for several hours. The Almanac data is valid for 6 months. Both Almanac and Ephemeris data are stored in onboard FLASH automatically as a background process, so power cycles should result in Hot Starts. If the receiver is powered off for a few minutes to an hour then hot starts can still be achieved. Once the ephemeris becomes invalid the receiver has to download the ephemeris again, which takes 30 seconds and results in warm or cold start times. Note that as the constellation orbits the earth the satellites in view are constantly changing, and new satellites entering the sky view will need valid ephemeris downloaded in order to be used in the position solution.

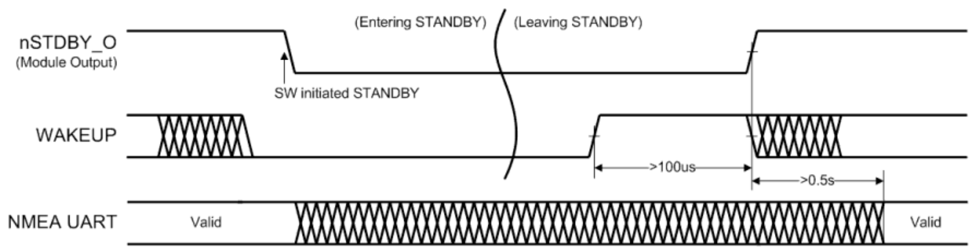
Software Standby

The following figure shows the sequence of events when entering Standby mode via software by sending a $PDME,13,1,#seconds command to the GPS2058. When this command is executed the module will enter Standby mode if the WAKEUP input is low. After the #milliseconds has timed out the module wakes itself up and the CPU restarts. If the #seconds is zero the module remains in standby mode indefinitely or until an external wake-up is initiated via the WAKEUP input or a reset event occurs.

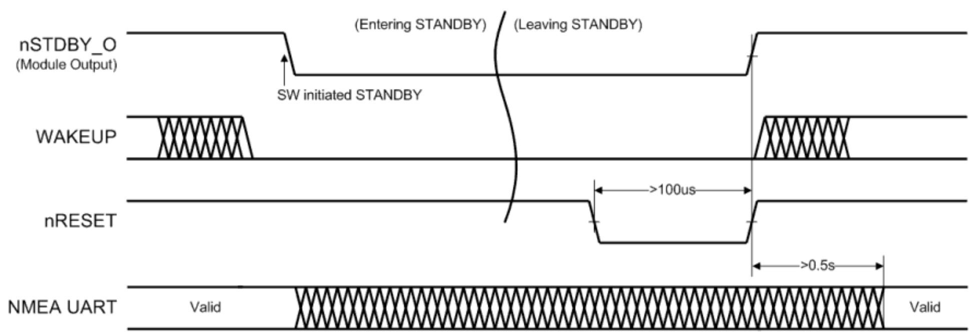


SW-Entered STANDBY Mode with timeout exit

Applying a positive pulse of 100us (minimum) on the WAKEUP pin switches the main internal voltage regulator back on and applies power to the core. The CPU core is kept in reset mode until the internal voltage is correctly regulated, then the CPU restarts itself.



SW-Entered STANDBY Mode with WAKEUP Exit



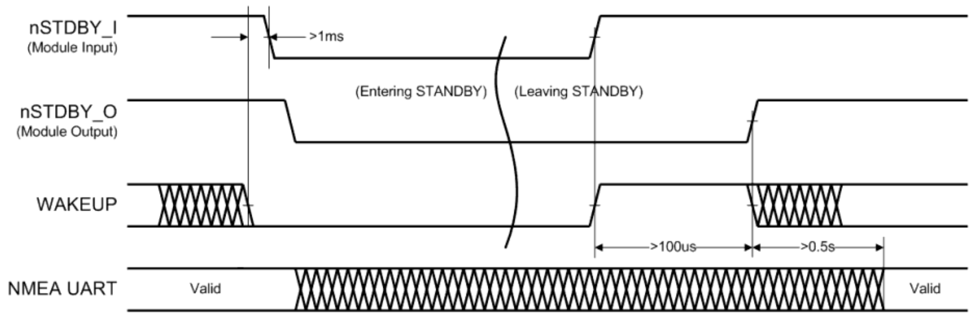
SW-Entered STANDBY Mode with nRESET Exit

The nSTDBYO output is useful as an indication of the module status – when this output is low the module is in Standby mode.

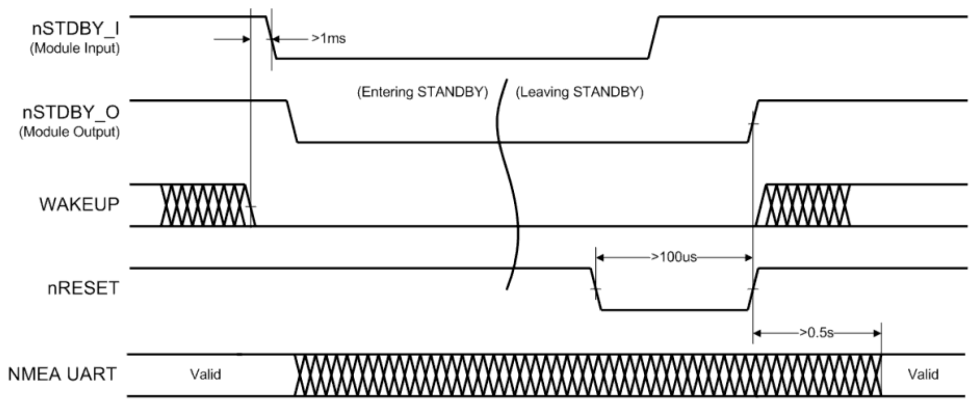
Hardware Standby

To enter Standby mode via hardware requires bringing the nSTDBYI pin to a logic low state while the WAKEUP input is low. If the WAKEUP pin is at a high logic level the GPS2058 will not enter Standby mode.

To exit standby mode via hardware both the WAKEUP and nSTDBYI pin must be high. The WAKEUP rising edge switches the Main Voltage Regulator back on, while nSTDBYI pin rising edge releases the internal Reset to the CPU core.



HW-Entered STANDBY Mode with WAKEUP Exit



HW-Entered STANDBY Mode with nRESET Exit

DEBUG UART Interface

The Debug interface is primarily for factory testing, and under normal conditions the user will not need to use this port. However, for initial prototype debug and system testing it is good practice to bring this port out to a connector. If there are any problems getting an initial fix with the system DeLorme can use data from the debug port in order to determine what the root of the problem is. Once the system has been proven to function properly and moves into mass production then the debug connector can be eliminated to save cost. The user can also redirect the debug messages to the NMEA port using the command $PDME,10 on page 19.

Firmware Updates

The GPS2058 module was designed with multiple methods of firmware access, but the simplest and safest means of updating firmware utilizes a built-in bootloader and the primary NMEA UART interface.

When the module comes out of reset, it reads characters from the NMEA UART, specifically looking for 0xAA. If it finds that character, it will assume that a firmware update is being requested and will send a "call host" message to initiate a handshake. Subsequent receipts of 0xAA will cause the module to continue this sequence, issuing additional messages back to the host until four 0xAA's and associated responses have been received and transmitted, thus indicating a good connection. (If the sequence of four 0xAA's was not seen or times out, the module firmware will branch to the GPS application). Once the handshake is established, the actual update starts. The module accepts a stream of data transfers from the host until a final message and close are issued. The actual time taken to update the entire module flash memory is about 30 seconds. For more details, release notes, and firmware files please go to our GPS2058 website pages and select the 'Firmware' tab.

Navigation Mode GPS Timing

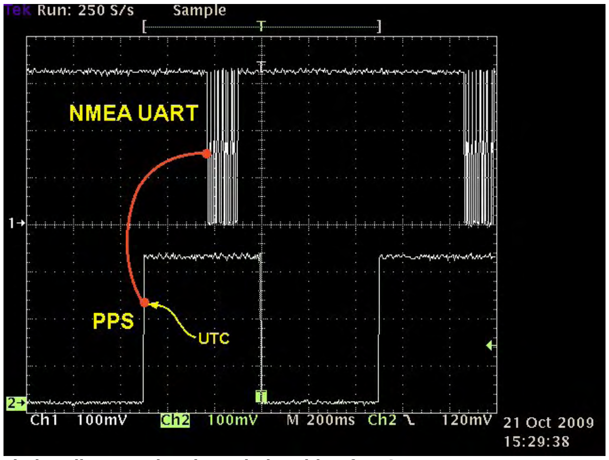
When the GPS2058 is in Navigation Mode GPS time is established via communication with one satellite and confirmed with a second satellite before the time is reported via a NMEA message and the PPS pulse becomes active.

For the most accurate PPS pulse edge placement a 3-D fix is necessary in order to subtract out the path delays and to resolve the time to within the specified +/-62ns of UTC. The PPS signal is re-clocked to the onboard 16.368MHz TCXO, hence the +/-62ns granularity in the PPS signal accuracy.

If the 3-D fix is lost the time is still reported and the PPS is active as long as one satellite is visible. With only one satellite in view the path delays cannot be computed, so the PPS time accuracy will drift with the TCXO at a rate of 2.5ppm.

No PPS pulse indicates the time is not valid. No 3-D fix with PPS pulse means the time is valid but not the most accurate.

The PPS rising edge is the time stamp to UTC. Following the rising PPS edge is the start of the NMEA message that indicates the value of the time. In other words, the rising PPS edge marks the time and the following NMEA message gives the time value.



Timing diagram showing relationship of PPS to NMEA UART output

In the diagram above, UTC time is marked by the rising edge of the PPS and the first edge of the NMEA message following the PPS contains the value of the marked time. This example only has the $GPRMC message enabled. $GPRMC is normally the first message to appear in the NMEA messages, providing $GPRMC is an active message.

Position Hold Mode GPS Timing

Starting with Firmware version 2.0 and higher a stationary timing mode is supported. In this mode the time will be reported with only one satellite in view. To establish the initial time an accurate position must be supplied to the GPS receiver in order to initially compute the time. The user can also establish the initial position by performing a host-based self-survey. In Navigation mode once a 3-D fix is obtained the host can average the position over a time period to establish the location of the antenna. Once the position has stabilized the host can submit this position in the $PDME,21 command in order to enable position hold mode.

Note that when the module is placed in position hold mode the mask angle is changed from its current setting to 5.0 in order to eliminate questionable or intermittent signals from satellites close to the horizon. This location is also where the atmospheric conditions contribute to less predictable timing errors, so by eliminating satellites at these low angles the reported timing can be more accurate.

TRAIM Algorithm

With Firmware version 2.0 and higher a TRAIM (Timing Receiver Autonomous Integrity Monitor) algorithm is supported that can be enabled and configured by the user. The TRAIM algorithm automatically detects and rejects faulty satellites from the solution. The user can enable or disable this algorithm using the $PDME,22 command. The user can also define the time error allowed, beyond which the satellite will be rejected from the solution.

Saving Startup Configuration Settings

With the release of Firmware v2.0 and forward the user now has the ability to save the GPS2058 startup configuration settings. These settings are loaded on each GPS startup initiated by a reset or power-on condition. Once the GPS has started, the user can configure the runtime settings using the NMEA commands across the UART interface. These runtime settings will remain valid until the next power-on or reset, when the startup configuration settings will be reloaded.

In order to change the startup configuration the user may use the NMEA commands $PDME,16 through $PDME,20. These startup configuration changes will not take effect immediately during the current run-time; rather the changed and saved startup configuration will be loaded at the next power-on cycle or reset.

There are three memory locations available for working with GPS2058 startup configuration settings:

- DEFAULT (Hard coded in firmware, these are effectively Factory Settings)
- ACTIVE (in RAM, this is the live set, a user 'scratch pad')
- BACKUP (in NVM, for user default settings)

At initial startup the GPS2058 device loads the DEFAULT configuration settings as the ACTIVE set in RAM.

The user can change the ACTIVE settings in RAM using the $PDME,16 command (refer to the Table of Configuration Parameter IDs and Values). Using the $PDME,16 command to set parameters will only change the ACTIVE set. If the GPS2058 is power-cycled or reset, the ACTIVE set in RAM will be discarded and the DEFAULT set will again be loaded as the ACTIVE set in RAM on startup.

The user can also query the parameter set values using the $PDME,17 command by specifying the parameter and the parameter set of interest – either DEFAULT, ACTIVE, or BACKUP.

The user can commit the changes made to the ACTIVE set by copying them into the BACKUP in NVM for later recall. The user has to copy the ACTIVE set to BACKUP by issuing the $PDME,18 command. If ACTIVE parameters are changed and not saved they are lost at the next power-cycle or reset.

At any time the GPS2058 can be restored to the factory parameter settings. The $PDME,19 command will erase the BACKUP set in NVM and the GPS2058 will be restarted. Upon restart, the DEFAULT set will be loaded into the ACTIVE locations in RAM. In addition a hardware restore can be initiated by using Pin 36 to force a reload of DEFAULT parameters on startup. When the module first boots it will check the state of this pin, after which it is ignored. If the pin is tied high, it will clear the BACKUP set in NVM and load the DEFAULT parameters. If tied Low or left floating, it will not have any effect.

The user can also specify which parameter set is loaded at GPS2058 startup using the $PDME,20 command. The choices are either the DEFAULT set or the BACKUP NVM set, providing a BACKUP set has been saved in NVM.

Note that any changes to the parameters must be saved to the BACKUP set in order to be used at the next startup. The DEFAULT parameter set cannot be changed.

For live run-time changes to the parameters the NMEA Software Commands must be used (refer to page 17).

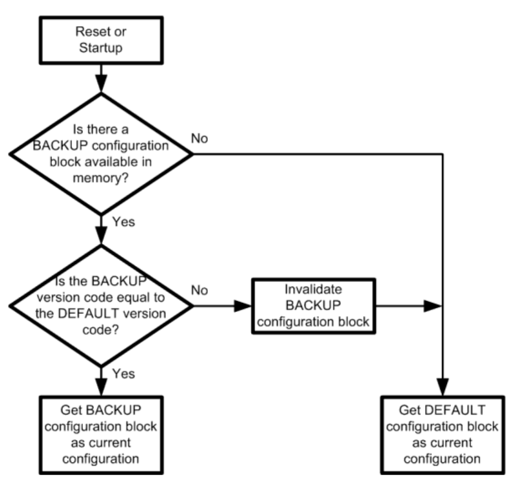


Table of Configuration Parameter IDs and Values

Param ID	Parameter Name	Size (Bytes)	Allowed Values	Description
100	nmea_port_baudrate	1	0 = 4800 [default] 1 = 9600 2 = 19200 3 = 38400 4 = 57600 5 = 115200	Set the NMEA port baudrate
101	gps_nmea_mode	1	0 = NMEA OFF 1 = NMEA ON [default]	Set the NMEA mode
102	gps_debug_mode	1	0 = Debug OFF [default] 1 = Debug ON	Set the debug mode
103	gps_mask_angle	1	0..45	Set the GPS mask angle
104	config_status	1	0 = DEFAULT CONFIG 1 = SAVED_CONFIG 2 = MODIFIED_CONFIG	Read Only Parameter
105	default_config_ver	1	0..255	Default Configuration version. Read Only
106	sbas_prn	1	120..138	SBAS PRN
107	reserved			reserved
108	gpio_config	1	0x1 = GPIO0 0x2 = GPIO1 0x4 = GPIO2 0x8 = GPIO3 0x10 = GPIO4 0x20 = GPIO5	1 = Input 0 = Output
109	gpio_values	1	0x1 = GPIO0 0x2 = GPIO1 0x4 = GPIO2 0x8 = GPIO3 0x10 = GPIO4 0x20 = GPIO5	1 = Hi 0 = Lo
200	app_on_off	4	0x1 = WAAS_ON_OFF 0x2 = BYPASS_INTERNAL_1V8_REG 0x4 = USER_TEXT_AS_HEADER	Set application features ON/OFF WAAS: 0 = Off, 1 = On Bypass Internal 1.8V: 0 – Internal 1.8V On, 1 = Off User Text as Header: 0 = No, 1 = Yes
201	nmea_port_msglist	4	0x0..0xFFFFFFFF	Set the NMEA message list: 0x01 = GGA 0x02 = GGA5 (default) 0x04 = GSA (default) 0x08 = GSV (default) 0x10 = VTG 0x20 = GLL 0x40 = RMC (default) 0x80 = RF message 0x100 = TRAIM 0x200 = POSHOLD 0x40000 = RF Test
300	reserved			reserved
400	reserved			reserved
401	reserved			reserved
402	startup_2D_DOPs	4	PDOP, VDOP, HDOP	Set the startup 2D DOP values
403	startup_3D_DOPs	4	PDOP, VDOP, HDOP	Set the startup 3D DOP values
500	USER_TEXT_MESSAGE	80	User Text	Set a user message optionally sent at startup (to mark configuration or to show a logo)

Format:	Input	Output
Section 1:	hex (1 byte)	hex (1 byte)
Section 2:	hex (4 bytes)	hex (4 bytes)
Section 4:	dec (1 byte), dec (1 byte), dec (1 byte)	dec (1 byte), dec (1 byte), dec (1 byte)
Section 5:	char (80 chars max)	char (80 chars max)

NMEA Output Messages

When the GPS receiver is running a set of standard GPS messages is presented on the NMEA port. These output strings are compatible with the NMEA 0183 standard and provide all the information needed by a navigation system. At system run-time the current message list can be modified using the $PDME,11 (see the NMEA software commands section). A description of the available NMEA 0183 navigation messages is reported in the next pages.

To use the DeLorme Binary Protocol, refer to page 23 of this document.

$GPGGA
GPS fix data, message available at startup in the default message list. It can be enabled/disabled with the $PDME,11 command. GGA5 (default) provides latitude/longitude out to 5 decimal places. GGA provides latitude/longitude out to 2 decimal places.
Message rate: 1 Hz
Message: **$GPGGA**,<**PosUTC**>,<**Lat**>,<**LatRef**>,<**Lon**>,<**LonRef**>,<**Qual**>,<**NbSat**>,<**HDOP**>,<**AltMsl**>,M,<**GeoidSep**>,M,<**null**>,<**null**>***checksum<cr><lf>**

Field	Description	Format
PosUTC	Universal time coordinated	Hhmmss.sss
Lat	Latitude	Ddmm.mmmmm
LatRef	Latitude direction	'N' or 'S'
Lon	Longitude	Dddmm.mmmmm
LonRef	Longitude Direction	'E' or 'W'
Qual	Quality indicator 0 – no fix 1 – GPS fix 2 – Differential GPS fix	X
NbSat	Number of satellites in use	Xx
HDOP	Horizontal dilution of precision	x.x
AltMsl	Antenna altitude above/below main sea level	x.x
M	Meters	'M'
GeoidSep	Geoidal separation	x.x
M	Meters	'M'
Null	–	
Null	–	

$GPGSA
DOP and active satellite list, available at startup in the default message list. It can be enabled/disabled with the $PDME,11 command. For compatibility with the NMEA standard, the $GPGSA message will provide a maximum 12 used satellites even though the 16 channels are tracked. The 12 strongest signals are reported and 4 are ignored to reduce power consumption.
Message rate: 1 Hz
Message: **$GPGSA**,<**Opmode**>,<**FixMode**>,<**Sat**>,<**Sat**>,<**Sat**>,<**Sat**>,<**Sat**>,<**Sat**>,<**Sat**>,<**Sat**>,<**Sat**>,<**Sat**>,<**Sat**>,<**Sat**>,<**PDOP**>,<**HDOP**>,<**VDOP**>***checksum<cr><lf>**

Field	Description	Format
Opmode	Operating mode (A for automatic switch 2D/3D)	'A'
Fixmode	Fis mode 1 – no fix 2 – 2D fix 3 – 3D fix	X
Sat	ID of the satellite	Xx / null
PDOP	Position dilution of precision (PDOP) in meters	x.x
HDOP	Horizontal dilution of precision (HDOP) in meters	x.x
VDOP	Vertical dilution of precision (VDOP) in meters	x.x

$GPGSV

Satellites in view, available as soon as the first satellite is acquired. It can be enabled/disabled with the $PDME,11 command. Note that this message is repeated MaxMsg times to report the status of all satellites in view (up to 12 satellites). For compatibility with the NMEA standard, the $GPGSV message will provide a maximum of 12 satellites even though 16 channels are tracked. The 12 strongest signals are reported and 4 are ignored to reduce power.

Message rate: 1 Hz

Message:

$GPGSV,<**MaxMsg**>,<**NumMsg**>,<**NumSats**>,<**SatPrn**>,<**Elev**>,<**Az**>,<**SNR**>,<**SatPrn**>,<**Elev**>,<**Az**>,<**SNR**>,<**SatPrn**>,<**Elev**>,<**Az**>,<**SNR**>, <**SatPrn**>,<**Elev**>,<**Az**>,<**SNR**>***checksum**<**cr**><**lf**>

Field	Description	Format
MaxMsg	Total number of messages	X
NumMsg	Message number	X
NumSats	Total number of satellites in view	Xx
SatPrn	Satellite PRN number	Xx
Elev	Elevation in degrees (90 maximum)	Xx
Az	Azimuth in true degrees (000 to 359)	Xxx
SNR	SNR (C/No) 00 to 99dB, null when tracking	Xx

$GPVTG

Track made good and ground speed. It can be enabled/disabled with the $PDME,11 command.

Message rate: 1 Hz

Message: **$GPVTG**,<**TrueCourse**>,T, <**MagneticCourse**>,M,<**SpeedKnots**>,N,<**SpeedKmh**>,K***checksum**<**cr**><**lf**>

Field	Description	Format
Course (True)	Measured reading (True)	
T	True	
Course (Magnetic)	Measured heading (magnetic)	
M	Magnetic	
Speed Knots	Measured horizontal speed (knots)	
N	Knots	
SpeedKmh	Measured horizontal speed (km/h)	
K	Kilometers per hour	

$GPRMC

Recommended minimum specific data. Available at startup in the basic message list. It can be enabled/disabled with the $PDME,11 command.

Message rate: 1 Hz

Message: **$GPRMC**,<**PosUTC**>,<**PosStat**>,<**Lat**>,<**LatRef**>,<**Lon**>,<**LonRef**>,<**Spd**>,<**Hdg**>,<**Date**>,<**MagVar**>,<**MagRef**> ***checksum**<**cr**><**lf**>

Field	Description	Format
PosUTC	Universal time coordinated	Hhmmss.sss
PosStat	Position status (A=valid or V=invalid)	'A' or 'V'
Lat	Latitude	Ddmm.mmm
LatRef	Latitude direction	'N' or 'S'
Lon	Longitude	Dddmm.mmm
LonRef	Longitude Direction	'E' or 'W'
Spd	Speed over ground (knots)	x.x
Hdg	Heading track make good (degree true)	x.x
Date	Date	Ddmmyy
MagVar	Magnetic variation (degree)	x.x
MagRef	Magnetic variation	‘E’ or ‘W’

$GPGLL

Geographic Position - Latitude/Longitude. It can be enabled/disabled with the $PDME,11 command.

Message rate: 1 Hz

Message: **$GPGLL**,<**Lat**>,<**LatRef**>,<**Lon**>,<**LonRef**>,<**PosUTC**>,<**Status**>***checksum**<cr><lf>

Field	Description	Format
Lat	Latitude	Ddmm.mmm
LatRef	Latitude direction	'N' or 'S'
Lon	Longitude	Ddmm.mmm
LonRef	Longitude Direction	'E' or 'W'
PosUTC	Universal time coordinated	Hhmmss.sss
Status	Status A – Data valid, V – Data invalid	'A' or 'V'

$PDMETRAIM

Timing Receiver Autonomous Integrity Monitoring status message. This message can be enabled/disabled with the $PDME,11 command. Note that the data in this message will not be valid unless the TRAIM algorithm is enabled using the $PDME,22 command.

Message rate: 1 Hz

Message: **$PDMETRAIM**,<**Solution**>,<**Valid**>,<**Time_Error**>,<**Removed_SVIDs**>,[<**bad_sat_id**>] repeated 12 times,***<checksum><cr><lf>**

Parameter	Description	Format
Solution	0 = UNDER_ALARM, 1 = OVER_ALARM 2 = UNKNOWN	X
Valid	0 = NOT_VALID, 1 = VALID	X
Time_Error	Time Error in sec	Floating, 9 digits
Removed_SVIDs	Number of removed SVID (bad satellites)	X
bad_sat_id	sat_id of the bad satellites; 0 if none present	XX

$PDMEPOSHOLD

Position Hold message status message. This message can be enabled/disabled with the $PDME,11 command. Note that the data in this message will not be valid unless Position Hold is enabled with the $PDME,21 command.

Message Rate: 1Hz

Message: **$PSTMPOSHOLD**,<**OnOff**>,<**Latitude**>,<**LatRef**>,<**Longitude**>,<**LonRef**>,<**Height**>***<checksum><cr><lf>**

Parameter	Description	Format
OnOff	0='OFF', 1='ON' to describe POSITION HOLD mode status	X
Latitude	latitude	Ddmm.mmm
LatRef	latitude direction	'N' or 'S'
Longitude	longitude	Dddmm.mmm
LonRef	longitude direction	'E' or 'W'
Height	altitude in meters (-1500 to 18000)	Decimal

NMEA Software Commands

Summary of Commands

Command: ***Cold Start***
Format: $PDME,0<cr><lf>
Variables: None
Return: If monitoring NMEA, the module will issue power-on start-up message (Delorme F/W and H/W versions are displayed), satellite vehicle NMEA message should indicate only 1 satellite (i.e., $GPGSV,1,1…) and the active satellite message will indicate no fix ($GPGSA,A,1…).
Operation: Suspends GPS operations, clears ephemeris and almanac, invalidates user position and RTC, then issues restart/reset
Application: Diagnostic purposes – used to reproduce TTFF for an initial acquisition.

Command: ***Warm Start***
Format: $PDME,1<cr><lf>
Variables: None
Return: If monitoring NMEA, the module will issue power-on start-up message (Delorme F/W and H/W versions are displayed), satellite vehicle NMEA message will maintain existing information but the active satellite message will indicate no fix ($GPGSA,A,1…).
Operation: Suspends GPS operations, clears ephemeris then issues restart/reset
Application: Diagnostic purposes – used to reproduce TTFF for a device that had a previous fix and is downloading new ephemeris info.

Command: ***Hot Start***
Format: $PDME,2<cr><lf>
Variables: None
Return: If monitoring NMEA, the module will issue power-on start-up message (Delorme F/W and H/W versions are displayed), satellite vehicle NMEA message will maintain existing information but the active satellite message will indicate no fix ($GPGSA,A,1…).
Operation: Suspends GPS operations, then issues restart/reset
Application: Diagnostic purposes – used to reproduce TTFF for a device that had a previous fix and is downloading new ephemeris info.

Command: *Get Version Information*
Format: $PDME,4,n<cr><lf>
Variables: n = 1, 2, 3 or 4
Return:
If n=1, return is "$PDME,4,1, GPS2058_FW_1.0.0";
if n=2, return is "$PDME,4,2, GPS2058_HW_1.0.1";
if n=3, return is "$PDME,4,3, GPS_LIBRARY_VERSION GPSLIB_5.4.1.5 GNU – Jun 11 2007 10:05:32";
if n=4, return is "$PDME,4,4, WAAS_VERSION SBASLIB_01.08.03 – Jun 11 2007 10:05:42".
Operation: n=1 returns DeLorme firmware revision, n=2 returns DeLorme hardware revision, n=3 returns GPS library revision, n=4 returns SBAS/WAAS library revision
Application: Informational; n=1 and n=2 are valuable for revision checking by systems integrators

Command: *Get Dilution of Precision Threshold Values*
Format: $PDME,5<cr><lf>
Variables: None
Return: "$PDME,5,<pdop3>,<hdop3>,<vdop3>,<pdop2>,<hdop2>,<vdop2>"
Operation: Returns the threshold values used for determining a fix; by default these are very large values. 3-D thresholds are sent first, followed by 2D.
Application: Informational; used in conjunction with the Set DOP to restrict or loosen initial position calculation thresholds

Command: *Set Dilution of Precision Threshold Values*
Format: $PDME,6,n,f1,f2,f3<cr><lf>
Variables: n=3 for 3D DOP thresholds, n=2 for 2D DOP thresholds, f1=positional DOP, f2=horizontal DOP, f3=vertical DOP
Return: "$PDME,6,OK" if the command is accepted
Operation: Sets the thresholds used for initial positional accuracy calculations in either 3D or 2D fix types.
Application: Used for restricting or loosening initial position calculations. Threshold DOPs may range from 1 (ideal) to 50 (poor), but tend to be set to large values, e.g., 30. Operational DOPs, which are different than the threshold DOPs, typically range from 1-2 (ideal to excellent)

Command: *Get Satellite Masking Angle*
Format: $PDME,7<cr><lf>
Variables: None
Return: "$PDME,7,<maskang>"
Operation: Returns the angle below which satellites are ignored; returned value is in whole degrees for the current GPS Library.
Application: Informational; used with Set Mask Angle to establish and effective satellite horizon to eliminate multipath (reflected) signals

Command: *Set Satellite Masking Angle*
Format: $PDME,8,f<cr><lf>
Variables: f=0 to 45 degrees
Return: "$PDME,8,OK" if the command is accepted
Operation: Sets the angle below which satellites are ignored; decimal values may be entered but the GPS Library only accepts whole numbers as of now.
Application: Valuable tool for eliminating multipath signals typically found in environments with a limited sky view and a lot of reflected satellite signals, such as urban canyons.

Command: *Initialize GPS Position and Time*

Format: $PDME,9,n1,n2,n3,n4,n5,n6,n7,n8,n9<cr><lf>

Variables: n1=Latitude in (whole) degrees
n2=Longitude in (whole) degrees
n3=Altitude in (whole) meters
n4=Year (four digits)
n5=Month (1-12)
n6=Day(1-31)
n7=Hour(0-23)
n8=Min(0-59)
n9=Sec(0-59)

Return: "$PDME,9,OK" if the command is accepted

Operation: Sets the values used for the initial position calculations

Application: Valuable for a unit that has been moved while off; a faster TTFF can be achieved by preloading the position and time information; must be issued immediately after a reset or startup to be most effective.

Command: *NMEA Port Messaging Controls*

Format: $PDME,10,n<cr><lf>

Variables: n = 0, 1, 2, 3, 4 or 5

Return: "$PDME,10,OK" if command is accepted.

Operation: n=0,1 turns NMEA messages Off or On, respectively;
n=2,3 turns ECH messages Off or On, respectively, but if the NMEA messages are off, the n=2,3 has no effect.
n=4,5 turns Debug messages Off or On, respectively. When on, Debug info is directed to the NMEA port and regular NMEA messages are disabled; Debug information remains on the Debug port. Disabling the Debug message returns the NMEA port to normal messaging.

Application: Valuable for customizing the content selection on NMEA port.

Command: *NMEA Messaging Configuration*

Format: $PDME,11,n1,h,n2<cr><lf>

Variables: *All variables are independent of each other.*
n1= Baud Rate, acceptable values
4800 (default), 9600, 19200, 38400, 57600, 115200
h = Hex value to enable the corresponding NMEA message
0x01 = GGA
0x02 = GGA5* (default)
0x04 = GSA (default)
0x08 = GSV (default)
0x10 = VTG
0x20 = GLL
0x40 = RMC (default)
0x80 = RF
0x100 = TRAIM**
0x200 = POSHOLD***
0x40000 = RF Test, diagnostic
n2 = 0 (broadcast on UTC second, default)

Return: "$PDME,11,OK" if the command is accepted

Operation: Configures the communications parameters for the NMEA port (only).

Application: Used for customizing the NMEA messages and changing communications rates. (All serial communications uses <Baud Rate>,8,N,1.) Care should be taken when using lower rates so as to avoid overloading the stream. For example, the GSV messaging will broadcast three lines of ASCII when a full contingent of satellites is available, so additional messages may require a higher baud rate. The default message selection is given by 0x40+0x08+0x04+0x02 = 0x4E, so an equivalent default statement is "$PDME,11,4800,0x4E,0".

**Note: GGA5 is equivalent to GGA except that there are 5 decimal places of precision in the location values.*

***Note: $PDME,11 enables the TRAIM messaging, but not the TRAIM Algorithm. Use $PDME,22 to enable/disable the TRAIM algorithm*

****Note: $PDME,11 enables POSHOLD messaging, but not the algorithm. Use $PDME,21 to enable/disable the POSHOLD algorithm*

Command: *System Control Set A, Bypass Internal 1.8V Regulator*
Format: $PDME,12,n<cr><lf>
Variables: n = 2
Return: "$PDME,12,OK" if the command is accepted
Operation: Assumes an external 1.8V source is connected to pin 12 of the module. This command bypasses the internal regulator in favor of the external connection. The bypass is cleared through a hardware reset.
Application: The primary purpose is to save on power. The internal regulator takes 3.3V as its source and the core of the device operates at 1.8V, reducing overall power efficiency.

Command: *System Control Set A, Invalidate RTC*
Format: $PDME,12,n<cr><lf>
Variables: n = 3
Return: "$PDME,12,OK" if the command is accepted
Operation: This can be used to invalidate the RTC information obtained from the first satellite.
Application: Diagnostic command; this is a key component in a Cold Start but rarely used alone. It is most effective in the early stages of establishing a fix because once communications from multiple satellites has been established the module will assume its RTC is valid.

Command: *System Control Set A, Install SBAS Satellite List*
Format: $PDME,12,n<cr><lf>
Variables: n = 4
Return: "$PDME,12,OK" if the command is accepted
Operation: This is an internal command that moves the SBAS list into the WAAS/SBAS operational code.
Application: This is usually handled automatically but may be of value if WAAS communications is problematic.

Command: *System Control Set A, Return Estimated Position Error*
Format: $PDME,12,n<cr><lf>
Variables: n = 5
Return: "$PDME,12,<horizontal error>,<vertical error>"
Operation: Returns a running statistical estimate of horizontal and vertical positional errors in meters.
Application: Useful for general evaluation of accuracy, particularly if a more elaborate data collection tool is not available to collect and analyze the data in more detail.

Command: *System Control Set A, GPS Leap Seconds*
Format: $PDME,12,n<cr><lf>
Variables: n = 6
Return: "$PDME,12,<leap second value>"
Operation: Returns the number of leap seconds added to UTC relative to maintain consistency with mean solar time (and GPS timing).
Application: Valuable information for UTC synchronized GPS systems.

Command: *System Control Set B, Software Standby Mode*
Format: $PDME,13,n1,n2<cr><lf>
Variables: n1 = 1, n2 = any integer
Return: "$PDME,13,OK" if the command is accepted
Operation: This is used to put the module into standby mode; if n2=0, the module enters standby mode indefinitely and requires an external wakeup (pin 5 high) or reset (pin 6 low) to remove the standby; any other value of n2 is equivalent to the number of seconds the module remains in standby
Application: This is valuable for power savings. The module drops to less than 100uA during standby, so it may be self timed off the RTC crystal or left in standby indefinitely until woken up by hardware.

Command: *System Control Set B, WAAS Control*
Format: $PDME,13,n1,n2<cr><lf>
Variables: n1 = 2, n2 = 0 or 1
Return: "$PDME,13,OK" if the command is accepted
Operation: If n2 = 0, WAAS can be disabled; if n2 = 1 (default), WAAS is (re)enabled;
Application: In most cases, leaving WAAS enabled provides the better fix. If WAAS is disabled, the vacated processing channel can be used to capture information from another GPS satellite.

Command: *System Control Set B, Set SBAS Satellite PRN Code*
Format: $PDME,13,n1,n2<cr><lf>
Variables: n1 = 3, n2 = valid SBAS PRN codes
Return: "$PDME,13,OK" if the command is accepted
Operation: This is used to select a specific WAAS satellite by PRN code. As of this writing, valid WAAS PRNs are 122, 134, 135 and 138 (East Coast). Valid EGNOS satellites are 120, 124 and 126. Valid MSAS satellites are 129 and 137.
Application: This can be used to improve the fix time for WAAS (by eliminating the need for hunting) or to improve a fix if the module is located on the boundary where two SBAS satellites are available and one is obscured.

Command: *System Control Set B, Set RF Test Satellite PRN Code*
Format: $PDME,13,n1,n2<cr><lf>
Variables: n1 = 3, n2 = 0 – 11 (GPS correlator channel number)
Return: "$PDME,13,OK" if the command is accepted
Operation: This is used to select a specific satellite for the RF Test (NMEA) Message (see section on "NMEA Messaging Configuration")
Application: This is a diagnostic which will return the PRN, center frequency, phase error and CN0 (gain) of the satellite in that GPS correlator channel.

Command: *Turn Debug messages ON/OFF*
Format: $PDME,13,n1,n2<cr><lf>
Variables: n1 = 5, n2 = 0 to turn Debug port OFF, 1 to turn Debug port ON (default)
Return: "$PDME,13,OK" if the command is accepted
Operation: This is used to enable/disable the messages on the Debug port.
Application: If the debug port is not connected of if the messages are not needed then the port can be turned OFF to save power.

Command: *GPIO Read*
Format: $PDME,14,n<cr><lf>
Variables: n = 0 to 5
Return: "$PDME,14,n,<0 or 1>" if the command is accepted
Operation: This is used to sample a GPIO input of the module, checking for a high ("1") or low ("0") value. A high is detected when the input is at 0.7Vcc or more, a low at 0.3Vcc or less. The "n" value corresponds to GPIO pins 0 – 5, which correspond to package pins 17 – 22. The GPIO pin accessed remains an input unless changed to output by a GPIO Write (see below).

Command: *GPIO Write*
Format: $PDME,15,n1,n2<cr><lf>
Variables: n1 = 0 to 5, n2 = 0 or 1
Return: "$PDME,15,OK" if the command is accepted
Operation: This is used to drive a GPIO output from the module as a high ("1") or low ("0") value. A high will be at least Vcc-0.8, a low no more than 0.4V. Voh & Vol are measured with 2mA currents. The "n" value corresponds to GPIO pins 0 – 5, which correspond to package pins 17 – 22. The GPIO pin accessed remains an output unless changed to input by a GPIO Read (see above) or a device reset. Reset changes all GPIOs back to inputs.

Command: *SW Config - Set a Parameter*
Format: $PDME,16,<param_id><value><cr><lf>
Variables: param_id, value
Return: "$PDME,16,OK" if the command is accepted
Operation: This command is used to set a single parameter in the ACTIVE control set.

Command: *SW Config - Get a Parameter*
Format: $PDME,17,<param_set>,<param_id><cr><lf>
Variables: param_set = 1 (ACTIVE), 2 (DEFAULT), 3 (BACKUP), param_id
Return: "$PDME,17,<location>,<param_id><value>" if the command is accepted.
Operation: This command allows the user to read a single parameter value from either the ACTIVE set in RAM, the DEFAULT set in Flash, or from the BACKUP set in NVM. Note that you cannot access BACKUP NVM parameters until a parameter set has been saved in NVM. Refer to the Table of Configuration ID's and Values for details.

Command: ***SW Config - Save ACTIVE Parameter set***
Format: $PDME,18<cr><lf>
Variables: none
Return: "$PDME,18,OK" if the command is accepted
Operation: This command copies the ACTIVE parameter set in RAM to the BACKUP set in NVM for later recall.

Command: ***SW Config – Reload Default Parameter Set***
Format: $PDME,19<cr><lf>
Variables: none
Return: none
Operation: Erases the BACKUP parameter set in NVM and restarts the GPS. Upon restart, the DEFAULT set will be loaded as the ACTIVE set in RAM.

Command: ***SW Config - Select Parameter Set Used On Startup***
Format: $PDME,20,n1<cr><lf>
Variables: 0 = use DEFAULT set, anything else uses BACKUP parameter set from NVM, provided a parameter set has been saved to the NVM backup location.
Return: "$PDME,20,OK" if the command is accepted
Operation: This command lets the user determine whether the DEFAULT parameter set is used at startup, or whether the BACKUP (user default) parameter set from NVM is used, providing a NVM parameter set available.

Command: ***Enable/Disable Position Hold (Timing) Mode***
Format: $PDME,21,n1,<lat>,<latref>,<lon>,<lonref>,<alt><cr><lf>
Variables: n1=0 (Disable) or 1 (Enable), <lat> - DDMM.MMM, <latref> - 'N' or 'S', <lon> - DDDMM.MMM, <lonref> - 'E' or 'W', <alt> - dddd (altitude in meters 0000 to 9999)
Return: "$PDME,21,OK" if the command is accepted
Operation: This command places the device in position hold mode in order to obtain timing data with only one satellite in view. To determine the time the position must be known and provided to the GPS module. $PDME,21,0<cr><lf> is all that is necessary to disable position hold mode. To enable position hold mode the variables <lat>, <latref>, <lon>, <lonref>, <alt> must be included in the command.

Command: ***Enable/Disable TRAIM algorithm***
Format: $PDME,22,n1,<traim_alarm><cr><lf>
Variables: n1 = 0 (disable) or 1 (enable), <traim_alarm> in seconds (0.000000025 = 25 ns)
Return: "$PDME,22,OK" if the command is accepted
Operation: This command turns on the TRAIM algorithm. When disabling TRAIM the command $PDME,22,0<cr><lf> is all that is necessary. When enabling the TRAIM algorithm the <traim_alarm> must also be included in the command. In order to see the TRAIM status message use $PDME,11 to enable/disable the TRAIM message

Command: ***Switch to Binary Protocol Mode***
Format: $PDME,23<cr><lf>
Variables: none
Return: none (switches to binary mode).
Operation: Executing this command places the UART in binary interface mode. If you switch to binary mode using $PDME,23 the module will store that binary interface setting in NVM. The module will continue to operate in binary mode after reset or power-on. To return to NMEA ASCII messages you must use the NMEA_SWITCH message (class 1, ID 7).

DeLorme Binary Interface

With the release of Firmware V2.0 and forward a binary interface is now supported. This interface supports higher message throughput when compared with ASCII format messages and the resulting binary payload data can be directly used in calculations without an ASCII conversion.

Once the device is placed in binary interface mode, that protocol setting is stored in NVM. With each successive power on or reset the device will remain in binary mode. To go back to NMEA mode use the **NMEA_SWITCH** binary message.

The binary message format is as follows:

Start Sequence	**Class**	**Message ID**	**Payload Length**	**Payload**
0xD0, 0xD2	1 Byte	1 Byte	4 Bytes	Depending on length

- Every Message starts with a 2 Byte header: 0xD0 0xD2
- A 1 Byte Class Field follows. The Class defines the basic subset of the message
- A 1 Byte ID Field defines the message that is to follow
- A 4 Byte Length Field follows. Length is defined as being the length of the payload, only. It does not include Start Sequence, Class, Message ID, or Payload Length. The number format of the length field is an unsigned 32-Bit integer in Little Endian format.
- The Payload is a variable length field in Little Endian format.

There is also an ACK/NACK response message for each class:

Message	**ACK**			
Description	**Acknowledge message receipt**			
Comment				
Message Structure	*Header*	*Class, ID*	*Length (Bytes)*	*Payload*
	0xD0, 0xD2	0x09, 0x01	4	*see below*
Name	*Bytes*	*Scaling*	*Unit*	*Description*
Reserved	U2	-	-	Unused
Class response to	U1	-	-	The Class this ACK message is responding to
ID response to	U1	-	-	The ID this ACK message is responding to

Message	**NACK**			
Description	**Not Acknowledge message receipt**			
Comment				
Message Structure	*Header*	*Class, ID*	*Length (Bytes)*	*Payload*
	0xD0, 0xD2	0x09, 0x02	4	*see below*
Name	*Bytes*	*Scaling*	*Unit*	*Description*
Reserved	U2	-	-	Unused
Class response to	U1	-	-	The Class this NACK message is responding to
ID response to	U1	-	-	The ID this NACK message is responding to

The following several pages detail the binary configuration and navigation messages

Configuration Messages

Message	**INIT_GPSECEF**			
Description	**Initialize GPS position in ECEF and time**			
Comment	The position and time will be initialized. Command has effect only at startup condition.			
Message Structure	*Header*	*Class, ID*	*Length (Bytes)*	*Payload*
	0xD0, 0xD2	0x01, 0x01	18	*see below*
Name	*Bytes*	*Scaling*	*Unit*	*Description*
ecefX	S4	-	cm	ECEF X coordinate
ecefY	S4	-	cm	ECEF Y coordinate
ecefZ	S4	-	cm	ECEF Z coordinate
iTOW	U4	-	s	GPS Time of Week
week	U2	-	-	GPS Week Number

Message	**INIT_GPSLLH**			
Description	**Initialize GPS geodetic position and time**			
Comment	The position and time will be initialized. Command has effect only at startup condition.			
Message Structure	*Header*	*Class, ID*	*Length (Bytes)*	*Payload*
	0xD0, 0xD2	0x01, 0x02	18	*see below*
Name	*Bytes*	*Scaling*	*Unit*	*Description*
lon	S4	1e-7	deg	Latitude
lat	S4	1e-7	deg	Longitude
height	S4	-	mm	Height above sea level
iTOW	U4	-	s	GPS Time of Week
week	U2	-	-	GPS Week Number

Message	**INIT_GPSTIME**			
Description	**Initialize GPS time in easy notation**			
Comment	Time will be initialized. Command has effect only at startup condition.			
Message Structure	*Header*	*Class, ID*	*Length (Bytes)*	*Payload*
	0xD0, 0xD2	0x01, 0x03	6	*see below*
Name	*Bytes*	*Scaling*	*Unit*	*Description*
day	U1	-	-	Day of month (range 01 – 31)
month	U1	-	-	Month (range 01 – 12)
year	U1	-	-	Year. Offset respect year 1996
hour	U1	-	-	Hour (range 00 – 23)
minute	U1	-	-	Minute (range 00 – 59)
seconds	U1	-	-	Seconds (range 00 – 59)

Message	**MSG_ ENABLE**			
Description	**Start / stop messaging output**			
Comment	-			
Message Structure	*Header*	*Class, ID*	*Length (Bytes)*	*Payload*
	0xD0, 0xD2	0x01, 0x05	1	*no payload*
Name	*Bytes*	*Scaling*	*Unit*	*Description*
enable	U1	-	-	If 0 messaging output will be stopped. If 1 messaging output will be started.

Message	MSG_CONFIG			
Description	**Configure messaging output: baud rate and message list.**			
Comment	The selected configuration will be set-up. **NOTE**: to use the command just to change the port baud rate it is possible to write "0" in the message list field in order to leave previous configuration unchanged.			
Message Structure	*Header*	*Class, ID*	*Length (Bytes)*	*Payload*
	0xD0, 0xD2	0x01, 0x06	8	*see below*

Name	Bytes	Scaling	Unit	Description
baud_rate	U4	-	-	Desired baud rate
msg_list	U4	-	-	Configurable bitmask for desired message list. See description below. The bitmask field must be set to a non-zero value. If the user wishes to start/stop binary messages, MSG_ENABLE (ID: 0x01, 0x05) should be used.

MSG_CONFIG: Message list

Bit	Description
0	NAV_POS
1	NAV_STATUS
2	NAV_DOP
3	NAV_VEL
4	NAV_TIME
5	NAV_SOLUTION

Message	NMEA_SWITCH			
Description	**Switch to NMEA (ASCII) output**			
Comment	-			
Message Structure	*Header*	*Class, ID*	*Length (Bytes)*	*Payload*
	0xD0, 0xD2	0x01, 0x07	1	*no payload*

Name	Bytes	Scaling	Unit	Description
U1	-	-	-	0x01

Navigation Messages

Message	NAV_POS			
Description	**Position solution**			
Comment	-			
Message Structure	*Header*	*Class, ID*	*Length (Bytes)*	*Payload*
	0xD0, 0xD2	0x07, 0x01	16	*see below*

Name	Bytes	Scaling	Unit	Description
iTOW	U4	-	s	GPS Time of Week
ecefX	S4	-	cm	ECEF X coordinate
ecefY	S4	-	cm	ECEF Y coordinate
ecefZ	S4	-	cm	ECEF Z coordinate

Message	NAV_STATUS			
Description	**Receiver navigation status**			
Comment	-			
Message Structure	*Header*	*Class, ID*	*Length (Bytes)*	*Payload*
	0xD0, 0xD2	0x07, 0x02	8	*see below*

Name	Bytes	Scaling	Unit	Description
iTOW	U4	-	s	GPS Time of Week
gpsFix	U2	-	-	GPS fix type. Possible values are: 0 -no fix 1 -2D-fix 2 -3D-fix
diffSoln	U2	-	-	If 0 dgps is not used. If 1 dgps is used.

Message	NAV_DOP			
Description	**Dilution of precision**			
Comment	-			
Message Structure	Header	Class, ID	Length (Bytes)	Payload
	0xD0, 0xD2	0x07, 0x03	12	see below
Name	Bytes	Scaling	Unit	Description
iTOW	U4	-	s	GPS Time of Week
reserved	U2	-	-	Padding field
pDOP	U2	0.01	-	Position DOP
vDOP	U2	0.01	-	Vertical DOP
hDOP	U2	0.01	-	Horizontal DOP

Message	NAV_VEL			
Description	**Velocity solution**			
Comment	-			
Message Structure	Header	Class, ID	Length (Bytes)	Payload
	0xD0, 0xD2	0x07, 0x04	16	see below
Name	Bytes	Scaling	Unit	Description
iTOW	U4	-	s	GPS Time of Week
ecefVX	S4	-	cm/sec	ECEF X velocity
ecefVY	S4	-	cm/sec	ECEF Y velocity
ecefVZ	S4	-	cm/sec	ECEF Z velocity

Message	NAV_TIME			
Description	**GPS Time solution**			
Comment	-			
Message Structure	Header	Class, ID	Length (Bytes)	Payload
	0xD0, 0xD2	0x07, 0x05	8	see below
Name	Bytes	Scaling	Unit	Description
iTOW	U4	-	s	GPS Time of Week
week	U2	-	-	GPS week number
leapS	S1	-	s	Leap Seconds (GPS-UTC)
validity	U1	-	-	Time validity status, see table below.

Time validity

Bit	Description
0	No time
1	Flash time
2	User time
3	User RTC time
4	RTC time
5	RTC time accurate
6	Approximate time
8	Accurate time
9	Position time
10	Ephemeris time

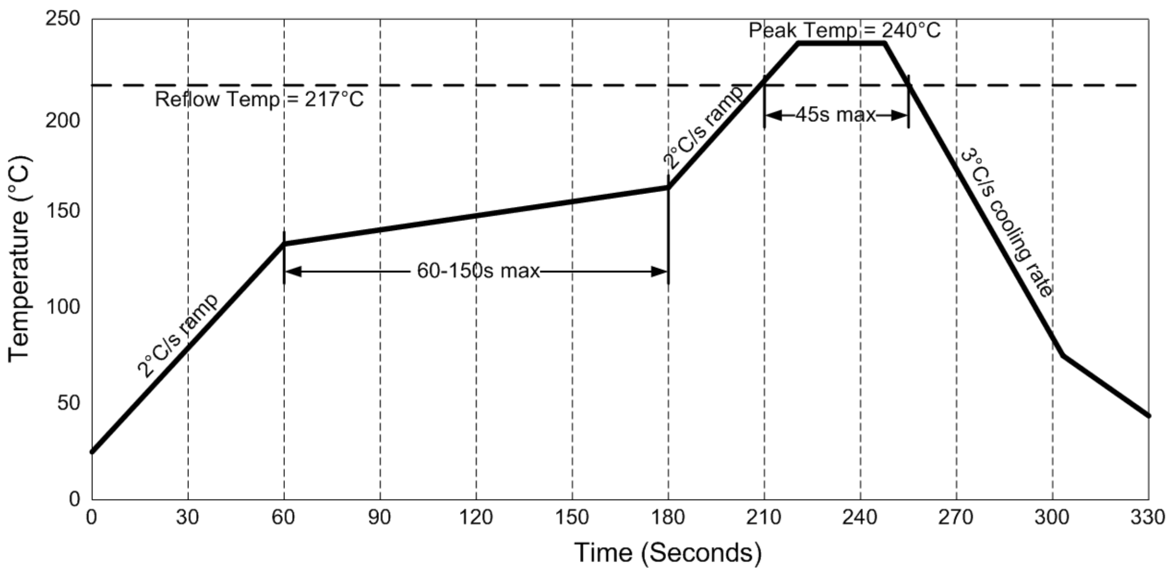
Message	**NAV_SOLUTION**			
Description	**Navigation solution information**			
Comment	-			
Message Structure	*Header*	*Class, ID*	*Length (Bytes)*	*Payload*
	0xD0, 0xD2	0x07, 0x06	36	*see below*

Name	*Bytes*	*Scaling*	*Unit*	*Description*
iTOW	U4	-	s	GPS Time of Week
week	U2	-	-	GPS week number
gpsFix	U1	-	-	GPS fix type. Possible values are: 0 -no fix 1 -2D-fix 2 -3D-fix
diffSoln	U1	-	-	If 0 dgps is not used. If 1 dgps is used.
ecefX	S4	-	cm	ECEF X coordinate
ecefY	S4	-	cm	ECEF Y coordinate
ecefZ	S4	-	cm	ECEF Z coordinate
ecefVX	S4	-	cm/sec	ECEF X velocity
ecefVY	S4	-	cm/sec	ECEF Y velocity
ecefVZ	S4	-	cm/sec	ECEF Z velocity
pDOP	U2	0.01	-	Position DOP
numSV	U2	-	-	Number of SVs used in navigation solution.

Recommended Reflow Profile

The following graph shows a suggested reflow profile for an automated surface mount assembly processes. This reflow profile follows the recommendations for the lead-free solder used in the module assembly. The reflow process follows 4 complete stages:

Pre-heat: Ramp to 130°C at a rate of 2°C/second
Soak: Ramp from 130 to 165°C over 60-150 seconds
Reflow: Ramp from 165°C to 217°C at a rate of 2°C/second. The peak reflow temperature should be 230-240°C, total time above 217°C should be less than 45 seconds. Do not exceed 250°C peak temperature.
Cool-down: A cooling rate of 3°C/second is recommended



WARNING: Ideally the module will only be subjected to a single reflow process with the module on the top side surface of the printed circuit board. Additional reflows may cause bridging between pads, or potential damage to the module.

WARNING: If the PCB is a two-sided board the secondary reflow should be performed with the module on the top side of the board to avoid damage to the module. If a secondary reflow is performed with the module on the bottom side of the printed circuit board the weight of the shield can or entire module may exceed the adhesive properties of the solder menisci and the shield can or the entire module may fall off the board.