



TM Series
GNSS Receiver Module
Data Guide

Wireless made simple[®]



Warning: Some customers may want Linx radio frequency (“RF”) products to control machinery or devices remotely, including machinery or devices that can cause death, bodily injuries, and/or property damage if improperly or inadvertently triggered, particularly in industrial settings or other applications implicating life-safety concerns (“Life and Property Safety Situations”).

NO OEM LINX REMOTE CONTROL OR FUNCTION MODULE SHOULD EVER BE USED IN LIFE AND PROPERTY SAFETY SITUATIONS.

No OEM Linx Remote Control or Function Module should be modified for Life and Property Safety Situations. Such modification cannot provide sufficient safety and will void the product’s regulatory certification and warranty.

Customers may use our (non-Function) Modules, Antenna and Connectors as part of other systems in Life Safety Situations, but only with necessary and industry appropriate redundancies and in compliance with applicable safety standards, including without limitation, ANSI and NFPA standards. It is solely the responsibility of any Linx customer who uses one or more of these products to incorporate appropriate redundancies and safety standards for the Life and Property Safety Situation application.

Do not use this or any Linx product to trigger an action directly from the data line or RSSI lines without a protocol or encoder/decoder to validate the data. Without validation, any signal from another unrelated transmitter in the environment received by the module could inadvertently trigger the action.

All RF products are susceptible to RF interference that can prevent communication. RF products without frequency agility or hopping implemented are more subject to interference. This module does not have a frequency hopping protocol built in.

Do not use any Linx product over the limits in this data guide. Excessive voltage or extended operation at the maximum voltage could cause product failure. Exceeding the reflow temperature profile could cause product failure which is not immediately evident.

Do not make any physical or electrical modifications to any Linx product. This will void the warranty and regulatory and UL certifications and may cause product failure which is not immediately evident.

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Warning: This product incorporates numerous static-sensitive components. Always wear an ESD wrist strap and observe proper ESD handling procedures when working with this device. Failure to observe this precaution may result in module damage or failure.

Ordering Information

Ordering Information	
Part Number	Description
RXM-GNSS-TM-x	TM Series GNSS Receiver Module
MDEV-GNSS-TM	TM Series GNSS Receiver Master Development System
EVM-GNSS-TM	TM Series Evaluation Module

x = "T" for Tape and Reel, "B" for Bulk

Reels are 1,000 pieces

Quantities less than 1,000 pieces are supplied in bulk

Figure 2: Ordering Information

Absolute Maximum Ratings

Absolute Maximum Ratings				
Supply Voltage V_{CC}	+4.3			VDC
Input Battery Backup Voltage	+4.3			VDC
VCC_RF Output Current	50			mA
Operating Temperature	-40	to	+85	°C
Storage Temperature	-40	to	+85	°C

Exceeding any of the limits of this section may lead to permanent damage to the device. Furthermore, extended operation at these maximum ratings may reduce the life of this device.

Figure 3: Absolute Maximum Ratings

Electrical Specifications

TM Series GNSS Receiver Specifications						
Parameter	Symbol	Min.	Typ.	Max.	Units	Notes
Power Supply						
Operating Voltage	V_{CC}	3.0	3.3	4.3	VDC	
Supply Current	I_{CC}					
Peak				156	mA	1
Acquisition			28		mA	1
Tracking			20		mA	1
Standby			0.365		mA	1
Backup Battery Voltage	V_{BAT}	2.0		4.3	VDC	
Backup Battery Current	I_{BAT}		7		μA	2
VOUT Output Voltage	V_{OUT}	2.7	2.8	2.9	VDC	

Pin Assignments

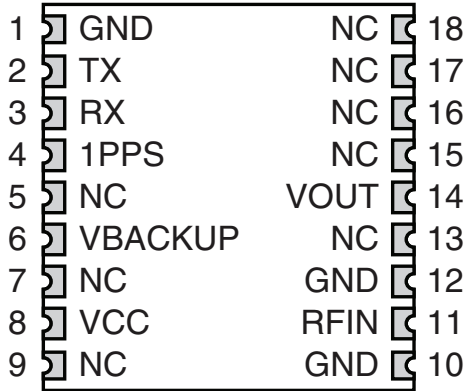


Figure 5: TM Series GNSS Receiver Pinout (Top View)

Pin Descriptions

Pin Descriptions			
Pin Number	Name	I/O	Description
1, 10, 12	GND	P	Ground
2	TX	O	Serial output (default NMEA)
3	RX	I	Serial input (default NMEA)
4	1PPS	O	1 Pulse Per Second (11nS accuracy)
5, 7, 9, 13, 15, 16, 17, 18	NC	–	No electrical connection
6	VBACKUP	P	Backup battery supply voltage. This line must be powered to enable the module.
8	VCC	P	Supply Voltage
11	RFIN	I	GNSS RF signal input
14	VOUT	O	Supply output for an active antenna

Figure 6: TM Series GNSS Receiver Pin Descriptions

Time To First Fix (TTFF)

TTFF is often broken down into three parts:

Cold: A cold start is when the receiver has no accurate knowledge of its position or time. This happens when the receiver's internal Real Time Clock (RTC) has not been running or it has no valid ephemeris or almanac data. In a cold start, the receiver takes up to 30 seconds to acquire its position.

Warm: A typical warm start is when the receiver has valid almanac and time data and has not significantly moved since its last valid position calculation. This happens when the receiver has been shut down for more than 2 hours, but still has its last position, time, and almanac saved in memory, and its RTC has been running. The receiver can predict the location of the current visible satellites and its location; however, it needs to wait for an ephemeris broadcast (every 30 seconds) before it can accurately calculate its position.

Hot: A hot start is when the receiver has valid ephemeris, time, and almanac data. In a hot start, the receiver takes 1 second to acquire its position. The time to calculate a fix in this state is sometimes referred to as Time to Subsequent Fix or TTTF.

Module Description

The TM Series GNSS Receiver module is based on the MediaTek MT3333 chipset, which consumes less power than competitive products while providing exceptional performance even in dense foliage and urban canyons. No external RF components are needed other than an antenna. The simple serial interface and industry standard NMEA protocol make integration of the TM Series into an end product extremely straightforward.

The module's high-performance RF architecture allows it to receive GNSS signals that are as low as -164dBm . The TM Series can track up to 33 satellites at the same time. Once locked onto the visible satellites, the receiver calculates the range to the satellites and determines its position and the precise time. It then outputs the data through a standard serial port using several standard NMEA protocol formats.

The GNSS core handles all of the necessary initialization, tracking, and calculations autonomously, so no programming is required. The RF section is optimized for low level signals, and requires no production tuning.

Antenna Considerations

The TM Series module is designed to utilize a wide variety of external antennas. The module has a regulated power output which simplifies the use of GNSS antenna styles which require external power. This allows the designer great flexibility, but care must be taken in antenna selection to ensure optimum performance. For example, a handheld device may be used in many varying orientations so an antenna element with a wide and uniform pattern may yield better overall performance than an antenna element with high gain and a correspondingly narrower beam. Conversely, an antenna mounted in a fixed and predictable manner may benefit from pattern and gain characteristics suited to that application. Evaluating multiple antenna solutions in real-world situations is a good way to rapidly assess which will best meet the needs of your application.

For GNSS, the antenna should have good right hand circular polarization characteristics (RHCP) to match the polarization of the GNSS signals. Ceramic patches are the most commonly used style of antenna, but there are many different shapes, sizes and styles of antennas available. Regardless of the construction, they will generally be either passive or active types. Passive antennas are simply an antenna tuned to the correct frequency. Active antennas add a Low Noise Amplifier (LNA) after the antenna and before the module to amplify the weak GPS satellite signals.

For active antennas, a 300-ohm ferrite bead can be used to connect the VOUT line to the RFIN line. This bead prevents the RF from getting into the power supply, but allows the DC voltage onto the RF trace to feed into the antenna. A series capacitor inside the module prevents this DC voltage from affecting the bias on the module's internal LNA.

Maintaining a 50-ohm path between the module and antenna is critical. Errors in layout can significantly impact the module's performance. Please review the layout guidelines section carefully to become more familiar with these considerations.

Slow Start Time

The most critical factors in start time are current ephemeris data, signal strength and sky view. The ephemeris data describes the path of each satellite as they orbit the earth. This is used to calculate the position of a satellite at a particular time. This data is only usable for a short period of time, so if it has been more than a few hours since the last fix or if the location has significantly changed (a few hundred miles), then the receiver may need to wait for a new ephemeris transmission before a position can be calculated. The GNSS satellites transmit the ephemeris data every 30 seconds. Transmissions with a low signal strength may not be received correctly or be corrupted by ambient noise. The view of the sky is important because the more satellites the receiver can see, the faster the fix and the more accurate the position will be when the fix is obtained.

If the receiver is in a very poor location, such as inside a building, urban canyon, or dense foliage, then the time to first fix can be slowed. In very poor locations with poor signal strength and a limited view of the sky with outdated ephemeris data, this could be on the order of several minutes. In the worst cases, the receiver may need to receive almanac data, which describes the health and course data for every satellite in the constellation. This data is transmitted every 15 minutes. If a lock is taking a long time, try to find a location with a better view of the sky and fewer obstructions. Once locked, it is easier for the receiver to maintain the position fix.

NMEA Output Messages

The following sections outline the data structures of the various NMEA messages that are supported by the module. By default, the NMEA commands are output at 9,600bps, 8 data bits, 1 start bit, 1 stop bit, and no parity.

Six messages are output at a 1Hz rate by default. The ZDA message is supported, but disabled by default. These messages are shown in Figure 8.

NMEA Output Messages	
Name	Description
GGA	Contains the essential fix data which provide location and accuracy
GLL	Contains just position and time
GSA	Contains data on the Dilution of Precision (DOP) and which satellites are used
GSV	Contains the satellite location relative to the receiver and its signal to noise ratio. Each message can describe 4 satellites so multiple messages may be output depending on the number of satellites being tracked.
RMC	Contains the minimum data of time, position, speed and course
VTG	Contains the course and speed over the ground
ZDA	Contains the date and time

Figure 8: NMEA Output Messages

Some of the message IDs can change based on which system is used for the position fix. Figure 9 shows the different message identifiers based on the system that is used.

NMEA Output Message Identifiers						
System	GGA	GLL	GSA	GSV	RMC	VTG
GPS	GPGGA	GPGLL	GPGSA	GPGSV	GPRMC	GPVTG
GPS & GLONASS	GPGGA	GNGLL	GNGSA	GPGSV GLGSV	GPRMC or GNRMC ¹	GPVTG

1. The RMC output is GPRMC before a 3D fix, then changes to GNRMC after a fix is locked.

Figure 9: NMEA Output Message Identifiers

Details of each message and examples are given in the following sections.

GLL – Geographic Position – Latitude / Longitude

Figure 12 contains the values for the following example:

`$GPGLL,2503.6319,N,12136.0099,E,053740.000,A,A*52`

Geographic Position – Latitude / Longitude Example			
Name	Example	Units	Description
Message ID	\$GPGLL		GLL protocol header (GNGLL or GPGLL)
Latitude	2503.6319		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12136.0099		dddmm.mmmm
E/W Indicator	E		E=east or W=west
UTC Time	053740.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Mode	A		A=autonomous, D=DGPS, N=Data not valid, R=Coarse Position, S=Simulator
Checksum	*52		
<CR> <LF>			End of message termination

Figure 12: Geographic Position – Latitude / Longitude Example

GSA – GNSS DOP and Active Satellites

Figure 13 contains the values for the following example:

`$GPGSA,A,3,24,07,17,11,28,08,20,04,,,,,2.0,1.1,1.7*35`

GNSS DOP and Active Satellites Example			
Name	Example	Units	Description
Message ID	\$GPGSA		GSA protocol header (GPGSA for GPS or GNGSA for GLONASS)
Mode 1	A		See Figure 14
Mode 2	3		1=No fix, 2=2D, 3=3D
ID of satellite used	24		Sv on Channel 1
ID of satellite used	07		Sv on Channel 2
...			...
ID of satellite used			Sv on Channel N
PDOP	2.0		Position Dilution of Precision
HDOP	1.1		Horizontal Dilution of Precision
VDOP	1.7		Vertical Dilution of Precision
Checksum	*35		
<CR> <LF>			End of message termination

Figure 13: GNSS DOP and Active Satellites Example

RMC – Recommended Minimum Specific GNSS Data

Figure 16 contains the values for the following example:

`$GPRMC,053740.000,A,2503.6319,N,12136.0099,E,2.69,79.65,100106,,,A*53`

Recommended Minimum Specific GNSS Data Example			
Name	Example	Units	Description
Message ID	\$GPRMC		RMC protocol header (GNRMC or GPRMC)
UTC Time	053740.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	2503.6319		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12136.0099		dddmm.mmmm
E/W Indicator	E		E=east or W=west
Speed over ground	2.69	knots	TRUE
Course over ground	79.65	degrees	
Date	100106		ddmmyy
Magnetic Variation		degrees	Not available, null field
Variation Sense			E=east or W=west (not shown)
Mode	A		A=autonomous, D=DGPS, E=DR, N=Data not valid, R=Coarse Position, S=Simulator
Checksum	*53		
<CR> <LF>			End of message termination

Figure 16: Recommended Minimum Specific GNSS Data Example

ZDA – Universal Time and Date

Figure 18 contains the values for the following example:

`$GPZDA,183746.000,22,08,2014,,*56`

Universal Time and Date Example			
Name	Example	Units	Description
Message ID	\$GPZDA		ZDA protocol header
UTC Time	183746.000		hhmmss.sss
Day	22		01 to 31
Month	08		01 to 12
Year	2014		1980 to 2079
Local Zone Hour			Offset from UTC; set to null
Local Zone Minutes			Offset from UTC; set to null
Checksum	*56		
<CR> <LF>			End of message termination

Figure 18: Universal Time and Date Example

Start-up Response

The module outputs a message when it starts up to indicate its state. The normal start-up message is shown below and the message formatting is shown in Figure 19.

`$PMTK010,001*2E<CR><LF>`

Start-up Response Example		
Name	Example	Description
Message ID	\$PMTK010	Message header
Message	MSG	System Message 0 = Unknown 1 = Start-up 2 = Notification for the host supporting EPO 3 = Transition to Normal operation is successful
Checksum	CKSUM	
End Sequence	<CR> <LF>	End of message termination

Figure 19: Start-up Response Example

Input Messages

The following outlines the serial commands input into the module for configuration. There are 3 types of input messages: commands, writes and reads. The module outputs a response for each input message.

The commands are used to change the operating state of the module. The writes are used to change the module's configuration and the reads are used to read out the current configuration. Messages are formatted as shown in Figure 21. All fields in each message are separated by a comma.

Serial Data Structure		
Name	Example	Description
Start Sequence	\$PMTK	
Message ID	<MID>	Message Identifier consisting of three numeric characters.
Payload	DATA	Message specific data.
Checksum	CKSUM	CKSUM is a two-hex character checksum as defined in the NMEA specification, NMEA-0183 Standard for Interfacing Marine Electronic Devices. Checksums are required on all input messages.
End Sequence	<CR> <LF>	Each message must be terminated using Carriage Return (CR) Line Feed (LF) (\r\n, 0x0D0A) to cause the receiver to process the input message. They are not printable ASCII characters, so are omitted from the examples.

Figure 21: Serial Data Structure

Figure 22 shows the input commands.

The module responds to commands with response messages. The acknowledge message is formatted as shown in Figure 24.

Acknowledge Message		
Name	Example	Description
Start Sequence	\$PMTK	
Message ID	001	Acknowledge Identifier
Command	CMD	The command that triggered the acknowledge
Flag	Flg	Flag indicating the outcome of the command 0 = Invalid Command 1 = Unsupported Command 2 = Valid command, but action failed 3 = Valid command and action succeeded
Checksum	CKSUM	CKSUM is a two-hex character checksum as defined in the NMEA specification, NMEA-0183 Standard for Interfacing Marine Electronic Devices. Checksums are required on all input messages.
End Sequence	<CR> <LF>	Each message must be terminated using Carriage Return (CR) Line Feed (LF) (\r\n, 0x0D0A) to cause the receiver to process the input message. They are not printable ASCII characters, so are omitted from the examples.

Figure 24: Acknowledge Message

101 – Hot Re-start

This command instructs the module to conduct a hot re-start using all of the data stored in memory. Periodic mode and static navigation settings are returned to default when this command is executed.

```
$PMTK101*32<CR><LF>
```

102 – Warm Re-start

This command instructs the module to conduct a warm re-start that does not use the saved ephemeris data. Periodic mode and static navigation settings are returned to default when this command is executed.

```
$PMTK102*31<CR><LF>
```

103 – Cold Re-start

This command instructs the module to conduct a cold re-start that does not use any of the data from memory. Periodic mode and static navigation settings are returned to default when this command is executed.

```
$PMTK103*30<CR><LF>
```

223 – Extended Receive Time

This command extends the amount of time that the receiver is on when in duty cycle mode. This allows the module to refresh its stored ephemeris data by staying awake until it received the data from the satellites.

Extended Receive Time Command and Response							
Command							
Start	Msg ID	SV	On Time	Extend Time	Extend Gap	Checksum	End
\$PMTK	223	,SV	,SNR	,EXT	,EXG	*Cksum	<CR><LF>
Response							
Start	Msg ID	CMD	Flag	Checksum	End		
\$PMTK	001	,223	,Flg	*Cksum	<CR><LF>		

Figure 26: Extended Receive Time Command and Response

Extended Receive Time Fields	
Field	Description
SV	The minimum number of satellites required to have valid ephemeris data. The extend time triggers when the number of satellites with valid ephemeris data falls below this number. The value is 1 to 4.
SNR	The minimum SNR of the satellites used for a position fix. The module will not wait for ephemeris data from any satellites whose SNR is below this value.
EXT	The extended time in ms to stay on to receive ephemeris data. This value can range from 40000 to 180000.
EXG	The minimum time in ms between a subsequent extended receive period. This value can range from 0 to 3600000.

Figure 27: Extended Receive Time Fields

The following example configures an extended on time to trigger if less than 1 satellite has valid ephemeris data. The satellite must have a signal to noise ratio higher than 30dB-Hz in order to be used. The module will stay on for 180,000ms and will have a gap time of 60,000ms.

```
$PMTK223,1,30,180000,60000*16<CR><LF>
```

251 – Serial Port Baud Rate

This command sets the serial port baud rate.

Serial Port Baud Rate Command and Response					
Command					
Start	Msg ID	Rate	Checksum	End	
\$PMTK	251	,Rate	*Cksum	<CR><LF>	
Response					
Start	Msg ID	CMD	Flag	Checksum	End
\$PMTK	001	,251	,Flg	*Cksum	<CR><LF>

Figure 30: Serial Port Baud Rate Command and Response

Rate = serial port baud rate

0 = default setting

4800

9600

14400

19200

38400

57600

115200

The following example sets the baud rate to 57,600bps.

```
$PMTK251,57600*2C<CR><LF>
```


256 – Set Timing Product

This command enables or disables the timing product. The timing product improves the accuracy of the 1PPS pulse relative to other modules.

Set Timing Product Command and Response					
Command					
Start	Msg ID	Enable	Checksum	End	
\$PMTK	256	,Enable	*Cksum	<CR><LF>	
Response					
Start	Msg ID	CMD	Flag	Checksum	End
\$PMTK	001	,256	,Fig	*Cksum	<CR><LF>

Figure 33: Set Timing Product Command and Response

This command needs to be sent again after hot, warm or cold starts or after waking from standby mode.

The following examples show the use of this command.

Enable Timing Product: `$PMTK256,1*2E<CR><LF>`

Disable Timing Product: `$PMTK256,0*2F<CR><LF>`

The set timing protocol configuration returns to the default values after a reset or restart.

285 – 1PPS Configuration

This command configures the 1PPS output.

1PPS Configuration Command and Response					
Command					
Start	Msg ID	Type	Pulse Width	Checksum	End
\$PMTK	285	,Type	,Width	*Cksum	<CR><LF>
Response					
Start	Msg ID	CMD	Flag	Checksum	End
\$PMTK	001	,285	,Flg	*Cksum	<CR><LF>

Figure 35: 1PPS Configuration Messages Command and Response

Figure 36 shows the Type values.

1PPS Configuration Type Values	
Value	Description
0	Disable
1	After the first fix
2	3D fix only (default)
3	2D/3D fix only
4	Always

Figure 36: 1PPS Configuration Type Values

The Width field is the width of the 1PPS pulse in milliseconds. The max width is 900ms at a 1Hz NMEA message rate. The default is 100ms.

These configurations are maintained during hot and warm starts, but are lost on cold starts and restore to factory defaults.

Set the 1PPS to activate after a 3D fix and have a 10ms pulse width.

```
$PMTK285,2,10*0E<CR><LF>
```

Set the 1PPS to activate after a 3D fix and have a 900ms pulse width.

```
$PMTK285,2,900*36<CR><LF>
```

875 – Enable PMTKLSC Message

This command enables or disables the Leap Second Change message.

Enable PMTKLSC Message Command and Response					
Command					
Start	Msg ID	CmdType	Enable	Checksum	End
\$PMTK	875	,CmdType	,Enable	*Cksum	<CR><LF>
Set Response					
Start	Msg ID	CMD	Flag	Checksum	End
\$PMTK	001	,875	,Flg	*Cksum	<CR><LF>
Query Response					
Start	Msg ID	CmdType	Enable	Checksum	End
\$PMTK	875	,2	,Enable	*Cksum	<CR><LF>

Figure 38: Sync 1PPS and NMEA Messages Command and Response

CmdType Values	
Value	Description
0	Query
1	Set
2	Result of the Query Operation

Figure 39: CmdType Values

Enable Values	
Value	Description
0	Message Disabled
1	Message Enabled

Figure 40: CmdType Values

The following examples show the use of this command.

Enable PMTKLSC: `$PMTK875,1,1*38<CR><LF>`

Disable PMTKLSC: `$PMTK875,1,0*39<CR><LF>`

Query PMTKLSC: `$PMTK875,0*24<CR><LF>`

Query Response: `$PMTK875,2,0*3A<CR><LF>` (Message disabled)

SBAS Enable

This enables and disables SBAS.

SBAS Enable Command and Response					
Write Message					
Start	Msg ID	Mode	Checksum	End	
\$PMTK	313	,Mode	*Cksum	<CR><LF>	
Acknowledge Response Message					
Start	Msg ID	CMD	Flag	Checksum	End
\$PMTK	001	,313	,Flg	*Cksum	<CR><LF>
Read Message					
Start	Msg ID	Checksum	End		
\$PMTK	413	*34	<CR><LF>		
Response Message					
Start	Msg ID	Mode	Checksum	End	
\$PMTK	513	,Mode	*Cksum	<CR><LF>	

Figure 42: SBAS Enable Command and Response

Mode = SBAS Mode

0 = disabled

1 = enabled

A satellite-based augmentation system (SBAS) sends additional information in the satellite transmissions to improve accuracy and reliability. Ground stations at accurately surveyed locations measure the satellite signals or other environmental factors that may impact the signal received by users. Correction information is then sent to the satellites and broadcast to the users. Disabling this feature also disables automatic DGPS.

The following example enables SBAS.

```
$PMTK313,1*2E<CR><LF>
```

The following example reads the current SBAS configuration and the module responds with SBAS is enabled.

```
$PMTK413*34<CR><LF>
```

```
$PMTK513,1*28<CR><LF>
```

Set Datum

This configures the current datum that is used.

Set Datum Command and Response					
Write Message					
Start	Msg ID	Datum	Checksum	End	
\$PMTK	330	,Datum	*Cksum	<CR><LF>	
Acknowledge Response Message					
Start	Msg ID	CMD	Flag	Checksum	End
\$PMTK	001	,330	,Flg	*Cksum	<CR><LF>
Read Message					
Start	Msg ID	Checksum	End		
\$PMTK	430	*35	<CR><LF>		
Response Message					
Start	Msg ID	Datum	Checksum	End	
\$PMTK	530	,Datum	*Cksum	<CR><LF>	

Figure 44: Set Datum Command and Response

Datum = the datum number to be used.

Reference datums are data sets that describe the shape of the Earth based on a reference point. There are many regional datums based on a convenient local reference point. Different datums use different reference points, so a map used with the receiver output must be based on the same datum. WGS84 is the default world referencing datum.

The module supports 223 different datums. These are listed in Appendix A.

The following example sets the datum to WGS84.

```
$PMTK330,0*2E<CR><LF>
```

The following example reads the current datum and the module replies with datum 0, which is WGS84.

```
$PMTK430*35<CR><LF>
```

```
$PMTK530,0*28<CR><LF>
```

Static Navigation Threshold

This configures the speed threshold to trigger static navigation. If the measured speed is below the threshold then the module holds the current position and sets the speed to zero.

Static Navigation Threshold Command and Response					
Write Message					
Start	Msg ID	Thold	Checksum	End	
\$PMTK	386	,Thold	*Cksum	<CR><LF>	
Acknowledge Response Message					
Start	Msg ID	CMD	Flag	Checksum	End
\$PMTK	001	,386	,Fig	*Cksum	<CR><LF>
Read Message					
Start	Msg ID	Checksum	End		
\$PMTK	447	*35	<CR><LF>		
Response Message					
Start	Msg ID	Thold	Checksum	End	
\$PMTK	527	,Thold	*Cksum	<CR><LF>	

Figure 46: Static Navigation Threshold Command and Response

Thold = speed threshold, from 0 to 2.0m/s. 0 = disabled.

The following example sets the threshold to 1.2m/s.

```
$PMTK386,1.2*3E<CR><LF>
```

The following example reads the static navigation threshold and the module responds with 1.2m/s

```
$PMTK447*35<CR><LF>
```

```
$PMTK527,1.20*03<CR><LF>
```

The static navigation threshold configuration returns to the default values after a reset or restart.

Typical Applications

Figure 48 shows the TM Series GNSS receiver in a typical application using a passive antenna.

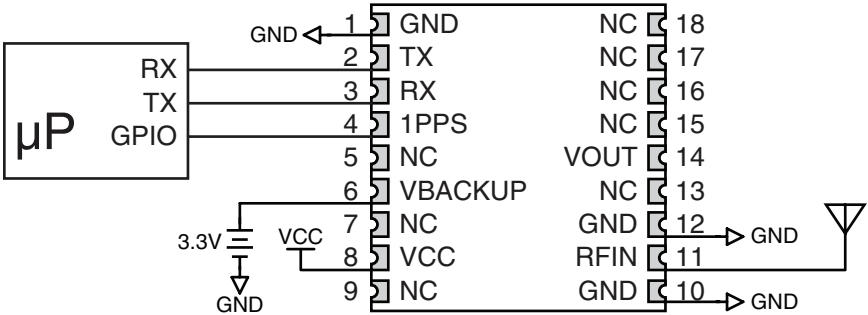


Figure 48: Circuit Using the TM Series Module with a Passive Antenna

A microcontroller UART is connected to the receiver's UART for passing data and commands. A 3.3V coin cell battery is connected to the VBACKUP line to provide power to the module's memory when main power is turned off.

Figure 49 shows the module using an active antenna.

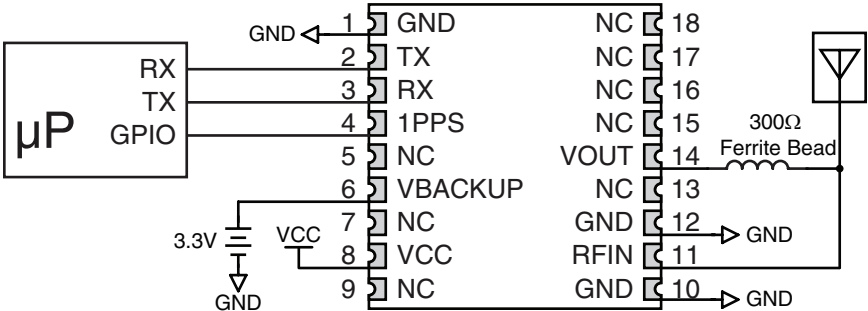


Figure 49: Circuit Using the TM Series Module with a an Active Antenna

A 300Ω ferrite bead is used to put power from VOUT onto the antenna line to power the active antenna.

Board Layout Guidelines

The module's design makes integration straightforward; however, it is still critical to exercise care in PCB layout. Failure to observe good layout techniques can result in a significant degradation of the module's performance. A primary layout goal is to maintain a characteristic 50-ohm impedance throughout the path from the antenna to the module. Grounding, filtering, decoupling, routing and PCB stack-up are also important considerations for any RF design. The following section provides some basic design guidelines which may be helpful.

During prototyping, the module should be soldered to a properly laid-out circuit board. The use of prototyping or "perf" boards will result in poor performance and is strongly discouraged.

The module should, as much as reasonably possible, be isolated from other components on your PCB, especially high-frequency circuitry such as crystal oscillators, switching power supplies, and high-speed bus lines.

When possible, separate RF and digital circuits into different PCB regions. Make sure internal wiring is routed away from the module and antenna, and is secured to prevent displacement.

Do not route PCB traces directly under the module. There should not be any copper or traces under the module on the same layer as the module, just bare PCB. The underside of the module has traces and vias that could short or couple to traces on the product's circuit board.

The Pad Layout section shows a typical PCB footprint for the module. A ground plane (as large and uninterrupted as possible) should be placed on a lower layer of your PC board opposite the module. This plane is essential for creating a low impedance return for ground and consistent stripline performance.

Use care in routing the RF trace between the module and the antenna or connector. Keep the trace as short as possible. Do not pass under the module or any other component. Do not route the antenna trace on multiple PCB layers as vias will add inductance. Vias are acceptable for tying together ground layers and component grounds and should be used in multiples.

Production Guidelines

The module is housed in a hybrid SMD package that supports hand and automated assembly techniques. Since the modules contain discrete components internally, the assembly procedures are critical to ensuring the reliable function of the modules. The following procedures should be reviewed with and practiced by all assembly personnel.

Hand Assembly

Pads located on the bottom of the module are the primary mounting surface (Figure 53). Since these pads are inaccessible during mounting, castellations that run up the side of the module have been provided to facilitate solder wicking to the module's underside. This allows for very

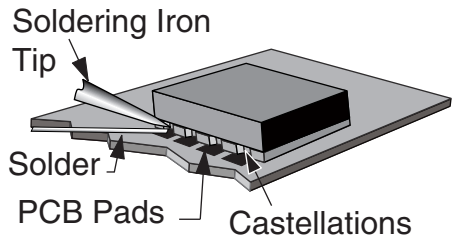


Figure 53: Soldering Technique

quick hand soldering for prototyping and small volume production. If the recommended pad guidelines have been followed, the pads will protrude slightly past the edge of the module. Use a fine soldering tip to heat the board pad and the castellation, then introduce solder to the pad at the module's edge. The solder will wick underneath the module, providing reliable attachment. Tack one module corner first and then work around the device, taking care not to exceed the times in Figure 54.

Warning: Pay attention to the absolute maximum solder times.

Absolute Maximum Solder Times

Hand Solder Temperature: +427°C for 10 seconds for lead-free alloys

Reflow Oven: +240°C max (see Figure 55)

Figure 54: Absolute Maximum Solder Times

Automated Assembly

For high-volume assembly, the modules are generally auto-placed. The modules have been designed to maintain compatibility with reflow processing techniques; however, due to their hybrid nature, certain aspects of the assembly process are far more critical than for other component types. Following are brief discussions of the three primary areas where caution must be observed.

Master Development System

The TM Series Master Development System provides all of the tools necessary to evaluate the TM Series GNSS receiver module. The system includes a fully assembled development board, an active antenna, development software and full documentation.

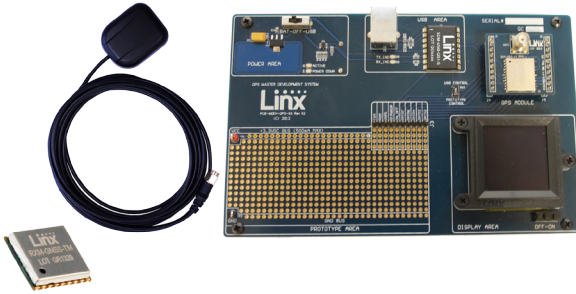


Figure 56: The TM Series Master Development System

The development board includes a power supply, a prototyping area for custom circuit development, and an OLED display that shows the GPS data without the need for a computer. A USB interface is also included for use with a PC running custom software or the included development software.



Figure 57: The Master Development System Software

The Master Development System software enables configuration of the receiver and displays the satellite data output by the receiver. The software can select from among all of the supported NMEA protocols for display of the data.

Full documentation for the board and software is included in the development system, making integration of the module straightforward.

TM Series GNSS Receiver Supported Datums

Number	Datum	Region
33	Astronomical Station 1952	Marcus Island
34	Australian Geodetic 1966	Australia, Tasmania
35	Australian Geodetic 1984	Australia, Tasmania
36	Ayabelle Lighthouse	Djibouti
37	Bellevue (IGN)	Efate and Erromango Islands
38	Bermuda 1957	Bermuda
39	Bissau	Guinea-Bissau
40	Bogota Observatory	Colombia
41	Bukit Rimpah	Indonesia (Bangka and Belitung Ids)
42	Camp Area Astro	Antarctica (McMurdi Camp Area)
43	Campo Inchauspe	Argentina
44	Canton Astro1966	Phoenix Island
45	Cape	South Africa
46	Cape Canaveral	Bahamas, Florida
47	Carthage	Tunisia
48	Chatham Island Astro1971	New Zealand (Chatham Island)
49	Chua Astro	Paraguay
50	Corrego Alegre	Brazil
51	Dabola	Guinea
52	Deception Island	Deception Island, Antarctica
53	Djakarta (Batavia)	Indonesia (Sumatra)
54	Dos 1968	New Georgia Islands (Gizo Island)
55	Easter Island 1967	Easter Island
56	Estonia Coordinate System1937	Estonia
57	European 1950	Cyprus
58	European 1950	Egypt
59	European 1950	England, Channel Islands, Scotland, Shetland Islands
60	European 1950	England, Ireland, Scotland, Shetland Islands
61	European 1950	Finland, Norway
62	European 1950	Greece
63	European 1950	Iran
64	European 1950	Italy (Sardinia)
65	European 1950	Italy (Sicily)
66	European 1950	Malta

TM Series GNSS Receiver Supported Datums

Number	Datum	Region
97	Kandawala	Sri Lanka
98	Kerguelen Island 1949	Kerguelen Island
99	Kertau 1948	West Malaysia and Singapore
100	Kusaie Astro 1951	Caroline Islands
101	Korean Geodetic System	South Korea
102	LC5 Astro 1961	Cayman Brac Island
103	Leigon	Ghana
104	Liberia 1964	Liberia
105	Luzon	Philippines (Excluding Mindanao)
106	Luzon	Philippines (Mindanao)
107	M'Poraloko	Gabon
108	Mahe 1971	Mahe Island
109	Massawa	Ethiopia (Eritrea)
110	Merchich	Morocco
111	Midway Astro 1961	Midway Islands
112	Minna	Cameroon
113	Minna	Nigeria
114	Montserrat Island Astro 1958	Montserrat (Leeward Island)
115	Nahrwan	Oman (Masirah Island)
116	Nahrwan	Saudi Arabia
117	Nahrwan	United Arab Emirates
118	Naparima BWI	Trinidad and Tobago
119	North American 1927	Alaska (Excluding Aleutian Ids)
120	North American 1927	Alaska (Aleutian Ids East of 180 degW)
121	North American 1927	Alaska (Aleutian Ids West of 180 degW)
122	North American 1927	Bahamas (Except San Salvador Islands)
123	North American 1927	Bahamas (San Salvador Islands)
124	North American 1927	Canada (Alberta, British Columbia)
125	North American 1927	Canada (Manitoba, Ontario)
126	North American 1927	Canada (New Brunswick, Newfoundland, Nova Scotia, Quebec)
127	North American 1927	Canada (Northwest Territories, Saskatchewan)
128	North American 1927	Canada (Yukon)
129	North American 1927	Canal Zone

TM Series GNSS Receiver Supported Datums

Number	Datum	Region
160	Pitcairn Astro 1967	Pitcairn Island
161	Point 58	Mean for Burkina Faso and Niger
162	Pointe Noire 1948	Congo
163	Porto Santo 1936	Porto Santo, Madeira Islands
164	Provisional South American 1956	Bolivia
165	Provisional South American 1956	Chile (Northern Near 19 deg S)
166	Provisional South American 1956	Chile (Southern Near 43 deg S)
167	Provisional South American 1956	Colombia
168	Provisional South American 1956	Ecuador
169	Provisional South American 1956	Guyana
170	Provisional South American 1956	Mean for Bolivia Chile, Colombia, Ecuador, Guyana, Peru, Venezuela
171	Provisional South American 1956	Peru
172	Provisional South American 1956	Venezuela
173	Provisional South Chilean 1963	Chile (Near 53 deg S) (Hito XVIII)
174	Puerto Rico	Puerto Rico, Virgin Islands
175	Pulkovo 1942	Russia
176	Qatar National	Qatar
177	Qornoq	Greenland (South)
178	Reunion	Mascarene Island
179	Rome 1940	Italy (Sardinia)
180	S-42 (Pulkovo 1942)	Hungary
181	S-42 (Pulkovo 1942)	Poland
182	S-42 (Pulkovo 1942)	Czechoslovakia
183	S-42 (Pulkovo 1942)	Lativa
184	S-42 (Pulkovo 1942)	Kazakhstan
185	S-42 (Pulkovo 1942)	Albania
186	S-42 (Pulkovo 1942)	Romania
187	S-JTSK	Czechoslovakia (Prior 1 Jan1993)
188	Santo (Dos) 1965	Espirito Santo Island
189	Sao Braz	Azores (Sao Miguel, Santa Maria Ids)
190	Sapper Hill 1943	East Falkland Island
191	Schwarzeck	Namibia
192	Selvagem Grande 1938	Salvage Islands
193	Sierra Leone 1960	Sierra Leone
194	South American 1969	Argentina
195	South American 1969	Bolivia

Notes



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