



# AirPrime XM1100

## Product Technical Specification



**SIERRA**  
WIRELESS®

41111067  
Rev 7.0

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*Note: Some airlines may permit the use of cellular phones while the aircraft is on the ground and the door is open. Sierra Wireless modems may be used at this time.*

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## Revision History

Revision number	Release date	Changes
1	June 23, 2017	Initial revision in SWI template
2	January 29, 2018	Updates throughout
3.0	April 27, 2018	Updated: <ul style="list-style-type: none"> <li>• <a href="#">Pin Assignment</a> on page 13</li> <li>• Figure 5-3 on page 27</li> </ul>
3.1	May 07, 2018	Fixed typo in Drying on page 29
4.0	May 28, 2018	Updated <a href="#">Reference Design</a> on page 24
5.0	October 03, 2018	Updated: <ul style="list-style-type: none"> <li>• <a href="#">Specifications</a> on page 12</li> <li>• <a href="#">Table 3-4</a> on page 20</li> </ul>

Revision number	Release date	Changes
6.0	February 12, 2019	Updated <a href="#">Figure 2-2</a> on page 12
		Deleted: <ul style="list-style-type: none"><li>• section 5 Packing and Handling</li><li>• section 6 Reflow Soldering Temperature Profile</li></ul>
7.0	July 17, 2019	Changed Update Rate in: <ul style="list-style-type: none"><li>• <a href="#">Product Highlights and Features</a> on page 8</li><li>• <a href="#">Table 2-4</a> on page 15</li></ul>

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# >> 1: Function Description

## Overview

The XM1100 is a GNSS receiver that is capable of tracking GPS, SBAS and QZSS satellite systems. The module provides an external antenna interface that supports both active and passive GNSS antennas.

XM1100 is one of the smallest GPS modules on the market with an ultra-compact size of 9.0 x 9.5 x 2.1 mm in a QFN Package. The module supports UART for communication as well as a dedicated RTCM input.

The module comes integrated with SMPS (switched-mode power supply) which allows for the lowest power consumption while offering optimum performance.

The XM1100 is based on the latest MT3337(E) chipset and supports all standard GNSS features including QZSS, Anti-Jamming, EASY™, PPS sync NMEA and AGPS.

## Target Applications

- Handheld Devices
- M2M applications
- Asset management
- Surveillance systems
- Wearable products



Figure 1-1: XM1100

## Product Highlights and Features

- 22 tracking/ 66 acquisition-channel GPS receiver
- Supports QZSS
- Sensitivity: -165dBm
- Update Rate: 1Hz (default), up to 10Hz
- 12 multi-tone active interference canceller
- High accuracy 1-PPS timing ( $\pm 20$ ns RMS) and the pulse width is 100ms
- AGPS Support for Fast TTFF (Host Aiding EPO™)
- EASY™: Self-Generated Orbit Prediction for instant positioning fix
- PPS sync NMEA



- Consumption current(@3.3V):
- Acquisition: 19mA / 20mA / 21mA (min / typical / max)
- Tracking: 18mA / 19mA / 24mA (min / typical / max)
- RoHS compliant

## System Block Diagram

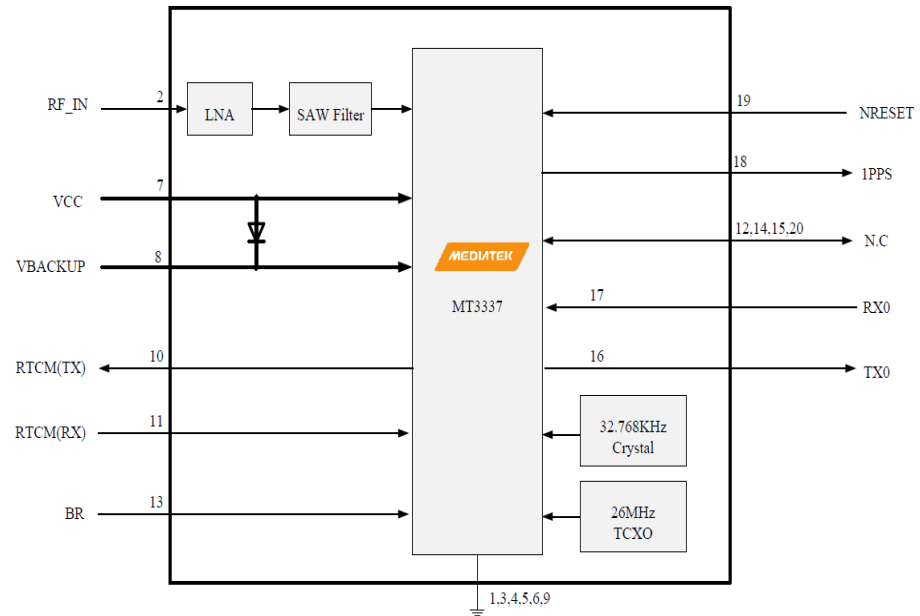


Figure 1-2: System Block Diagram

## Multi-tone Active Interference Canceller

Many GNSS systems today also integrate various other RF systems such as Wi-Fi, Cellular and Bluetooth. These other radios can often generate RF harmonics which can influence GPS reception and performance.

The embedded Multi-tone Active Interference Canceller (MTAIC) also known as Anti-Jamming, can reject such unwanted RF harmonics from nearby on-board active components. Anti-Jamming can improve the capacity of GPS reception, eliminating the need for additional hardware engineering to compensate for these interferences. This built-in feature can cancel up to 12 independent channels of continuous interference waves.

## 1PPS

The XM1100 generates a-pulse-per-second signal (1 PPS). It is an electrical signal which precisely indicates the start of a second with the accuracy of  $\pm 20\text{ns}$  RMS (Root Mean Square). The PPS signal is provided through a designated output pin for many external applications.

## AGPS for Faster TTFF (HOST)

The AGPS (HOST EPO) provides predicted EPO (Extended Prediction Orbit) data to speed up TTFF (Time To First Fix). This feature is useful when satellite signal is weak. AGPS data can be downloaded from an FTP server via the Internet or through a wireless network.

The GPS engine of the module will use EPO data to assist with position calculation when navigation information from satellites is insufficient. For more details on EPO, please refer to our AGPS application note.

## EASY™

EASY™ (Embedded Assist System) is for quick positioning/TTFF when information received from the satellites is insufficient (e.g. in a weak signal). When EASY™ is enabled, the GPS engine will automatically calculate and then predict single ephemeris up to three days. The predicted information will be saved into the memory and the GPS engine will then use the saved information for later positioning. Backup power (VBACKUP) is required for EASY™.

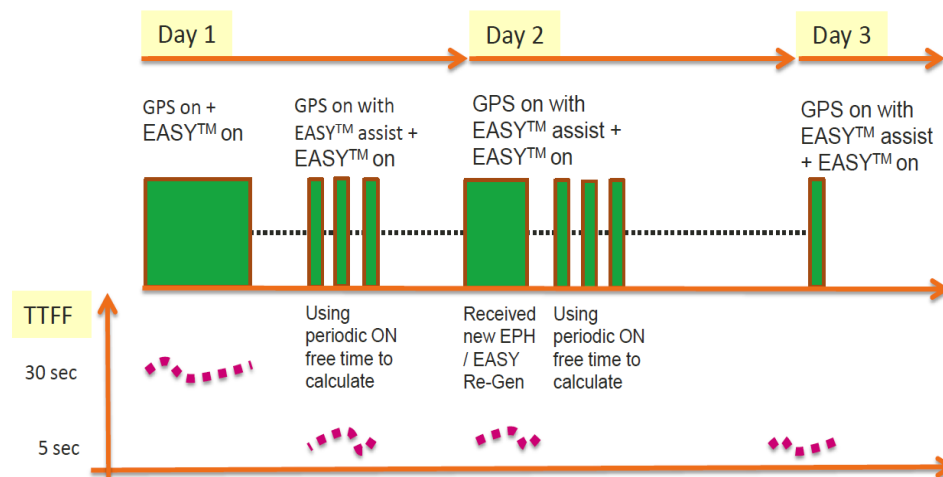


Figure 1-3: Operation of EASY™

Figure 1-3 shows that when the module obtains information from GPS satellites, the GPS engine will start to pre-calculate and predict orbits automatically for the next three days.

## PPS sync NMEA

Pulse-Per-Second (PPS) VS. NMEA can be used in the time service. The latency range of the beginning of UART Tx is between 170ms~180 ms at the MT3337(E) platform and behind the rising edge of PPS.

The PPS sync NMEA only supports 1Hz NMEA output and baud rate at 115200~14400 bps. For baud rates at 9600 bps and 4800 bps, only the RMC NMEA sentence is supported. If the NMEA sentence outputs are supported even at the low baud rate, per-second transmission may exceed the threshold of one second.

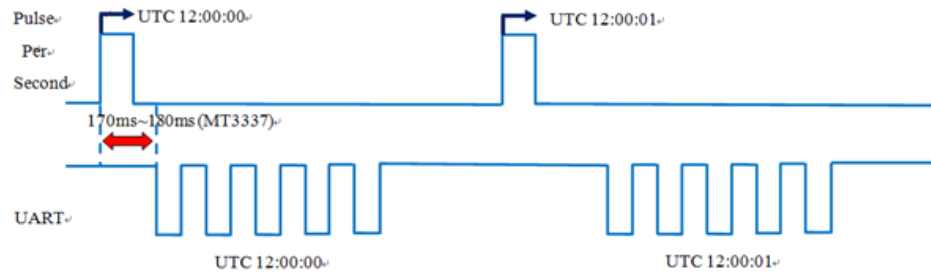


Figure 1-4: PPS sync NMEA

## >> 2: Specifications

### Mechanical Dimensions

Dimension: (Unit: mm, Maximum height: 2.3 mm)

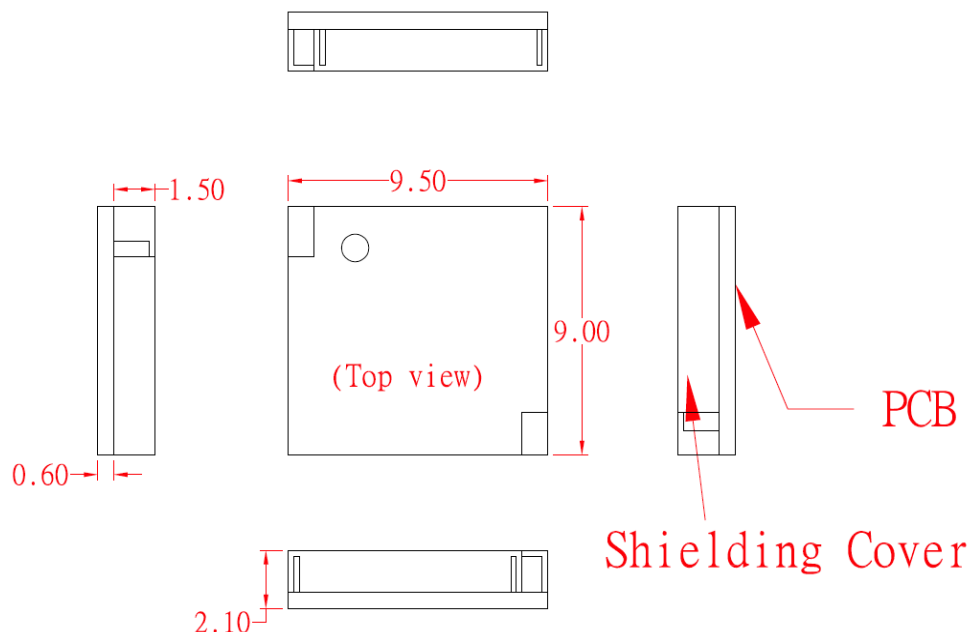


Figure 2-1: Mechanical Dimensions

### PCB Copper Pad Definition

(Unit: mm, Tolerance:  $\pm 0.1$  mm)

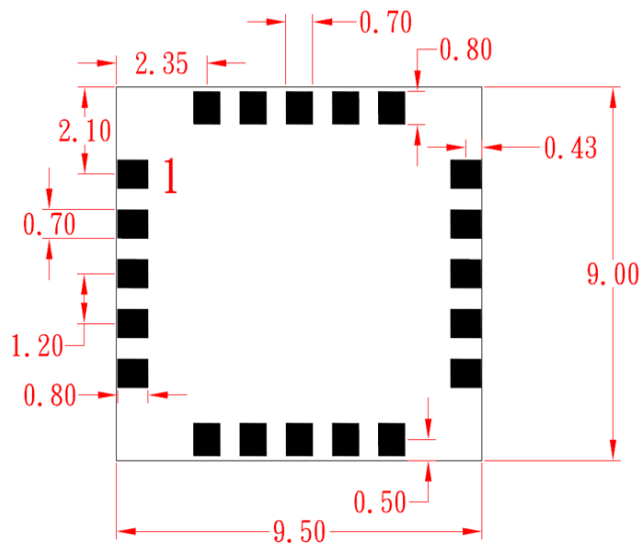


Figure 2-2: PCB Copper Pad

## Pin Configuration

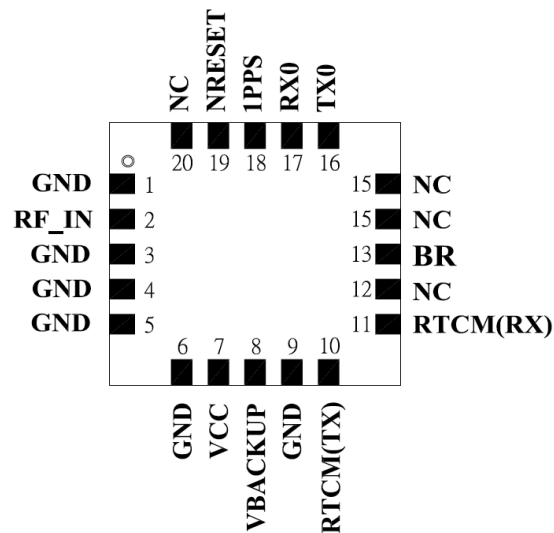


Figure 2-3: Pin Configuration

## Pin Assignment

Table 2-1: Pin Assignment

Pin	Name	I/O	Description and Note	Active Low / High	IO Voltage Domain	Reset State <sup>a</sup>	Recommendation for Unused Pad
1	GND	P	Ground		0V		Mandatory connection
2	RF_IN	I	GPS RF signal input				Mandatory connection
3	GND	P	Ground		0V		Mandatory connection
4	GND	P	Ground		0V		Mandatory connection
5	GND	P	Ground		0V		Mandatory connection
6	GND	P	Ground		0V		Mandatory connection
7	VCC	PI	Main DC power input		3.3V		Mandatory connection
8	VBACKUP	PI	Backup power input for RTC and navigation data keep		3.0V		Connection to C=1μF
9	GND	P	Ground		0V		Mandatory connection
10	RTCM (TX)	O	Serial Data Input (TTL) for RTCM data ACK (Acknowledge Character)		2.8V	O, PU	Left open
11	RTCM (RX)	I	Serial Data Input (TTL) for RTCM data streaming		2.8V	I, PU	Left open
12	NC	--	None Connect				Left open

**Table 2-1: Pin Assignment (Continued)**

Pin	Name	I/O	Description and Note	Active Low / High	IO Voltage Domain	Reset State <sup>a</sup>	Recommendation for Unused Pad
13	BR	I	Baud rate selection needs to match BR		2.8V	I, PU	Left open
14	NC	--	No Connect				Left open
15	NC	--	No Connect				Left open
16	TX0	O	Serial Data Output for NMEA output (TTL)		2.8V	O, PU	Mandatory connection
17	RX0	I	Serial Data Input for Firmware update (TTL)		2.8V	I, PU	Mandatory connection
18	1PPS	O	1PPS Time Mark Output		2.8V	O, PU	Left open
19	NRESET	I	Reset Input	L	2.8V	I, PU	Left open
20	NC	--	None Connect				Left open

a. I = Input, O = Output, PU = Pull up, PD = Pull Down, H = High, T = High Impedance

## Description of I/O Pins

- **Pin1:** GND (Ground)
- **Pin2:** RF\_IN
  - The GPS RF signal input which can be connected to an active or passive antenna.
- **Pin3:** GND (Ground)
- **Pin4:** GND (Ground)
- **Pin5:** GND (Ground)
- **Pin6:** GND (Ground)
- **Pin7:** VCC
  - Main DC power supply (3.0V to 4.3V; typical: 3.3V). The ripple must be controlled under 50mVpp.
- **Pin8:** VBACKUP
  - This connects to the backup power of the GPS module. A power source (such as a battery) connected to this pin will help the GPS chipset in keeping its internal RTC running when the main power source is turned off. The voltage ranges from 2.0V~4.3V (typical: 3.0V).
  - This pin is also available when VCC is connected to a power supply.
  - VBACKUP functions with a shottky diode and limited-current resistor.
  - If VBACKUP power is not reserved, the GPS module will perform a lengthy cold start each time it is powered on, as previous satellite information is not retained and needs to be re-transmitted.
  - If not used, keeps this pin floating.
- **Pin9:** GND (Ground)
- **Pin10:** RTCM (TX). Acknowledges RTCM message when connected. If not used, keep this pin floating.

- **Pin11:** RTCM (RX). Acknowledges RTCM function when connected. If not used, keep this pin floating.
- **Pin12:** NC (None Connect)
- **Pin13:** BR (Baud Rate selection is configurable through BR with a combination of a grounded 10K $\Omega$  resistor).

**Table 2-2: Pin13 Baud Rates**

Baud Rate	BR (Pin13)
9600	No Connect (default)
115200	10K $\Omega$

- **Pin14:** NC (No Connect)
- **Pin15:** NC (No Connect)
- **Pin16:** TX0 (UART 0 transmitter; outputs GPS information for application)
- **Pin17:** RX0 (UART 0 receiver; to receive commands from host)
- **Pin18:** 1PPS.
  - This pin provides one pulse-per-second signal output. If not used, keeps this pin floating.
- **Pin19:** NRESET
  - Active on Low; it causes the module to reset. If not used, keep floating.

**Table 2-3: Pin19 NRESET Levels**

Symbol	Min (V)	Typ (V)	Max (V)
Low	0	0	1.5
High	2	2.8	3.3

- **Pin20:** NC (No Connect)

## Specifications

**Table 2-4: Specification Data**

Description	
GPS Solution	MTK MT3337(E)
Frequency	GPS L1, 1575.42MHz
Sensitivity	Acquisition: -148dBm, cold start Reacquisition: -163dBm, Hot start Tracking: -165dBm
SV Number	#1~32
TTFF (GPS, No. of SVs>4, C/N>40dB, PDop<1.5)	Hot start: 1 second typical Warm start: 24 seconds typical Cold start: 28 seconds typical, 60 seconds Max
Position Accuracy	3m (50% CEP)
Velocity Accuracy	0.1m/s

**Table 2-4: Specification Data (Continued)**

Description	
<b>Timing Accuracy (1PPS Output)</b>	±20ns RMS within 100ms in one pulse
<b>Altitude</b>	10,000m maximum (Normal mode: Car/ Pedestrian/ Aviation) 80,000m maximum (Balloon mode)
<b>Velocity</b>	Maximum 515m/s (1000 knots)
<b>Acceleration</b>	Maximum 4G
<b>Update Rate</b>	1Hz (default), maximum 10Hz
<b>Baud Rate</b>	9600 bps (default), 115200 bps
<b>Power Supply</b>	VCC: 3V to 4.3V; VBACKUP: 2.0V to 4.3V
<b>Current Consumption @ 3.3V, 1Hz Update Rate</b>	Acquisition: 19mA / 20mA / 21mA (min / typical / max) Tracking: 18mA / 19mA / 24mA (min / typical / max)
<b>Power Saving (Periodic)</b>	Standby mode: 420uA(TYP)
<b>NRESET Current @ 3.3V</b>	8mA (TYP)
<b>Backup Power Consumption @ 3.3V</b>	7µA (TYP)
<b>Working Temperature</b>	-40 °C to +85 °C
<b>Dimension</b>	9.0x9.5 x 2.1 mm, SMD
<b>Weight</b>	0.4g

## Absolute Maximum Ratings

The maximum power supply voltage is 4.3 VDC.

**Table 2-5: Maximum Ranges**

	Symbol	Min	Typ	Max	Unit
<b>Power Supply Voltage</b>	VCC	3.0	3.3	4.3	V
<b>Backup Battery Voltage</b>	VBACKUP	2.0	3.0	4.3	V



## Operating Conditions

**Table 2-6: Operating Conditions**

	Condition	Min	Typ	Max	Unit
Operation Supply Ripple Voltage	-	-	-	50	mVpp
RX0 TTL H Level	-	2.0	-	3.3	V
RX0 TTL L Level	-	0	-	0.8	V
TX0 TTL H Level	-	2.4	-	3.3	V
TX0 TTL L Level	-	0	-	0.4	V

## >> 3: Protocols

### NMEA Output Sentences

Table 3-1 lists all NMEA output sentences specifically developed and defined by MTK for MTK's products.

**Table 3-1: Position Fix Indicator**

Option	Description
<b>GGA</b>	Time, position and fix type data.
<b>GSA</b>	GPS receiver operating mode, active satellites used in the position solution and DOP values.
<b>GSV</b>	The number of GPS satellites in view, satellite ID numbers, elevation, azimuth, and SNR values.
<b>RMC</b>	Time, date, position, course and speed data. The recommended minimum navigation information.
<b>VTG</b>	Course and speed information relative to the ground.

## GGA—Time, Position and Related Data of Navigation Fix

Table 3-2 explains the sentence below:

```
$GPGGA,064951.000,2307.1256,N,12016.4438,E,1,8,0.95,39.9,M,17.8,M,*65
```

**Table 3-2: GGA Data Format**

Name	Example	Units	Description
Message ID	\$GPGGA		GGA protocol header
UTC Time	064951.000		hhmmss.sss
Latitude	2307.1256		ddmm.mmmm
N/S Indicator	N		N North or S South
Longitude	12016.4438		dddmm.mmmm
E/W Indicator	E		E East or W West
Position Fix Indicator	1		See Table 3-3
Satellites Used	8		
HDOP	0.95		Horizontal Dilution of Precision
MSL Altitude	39.9	meter	Antenna Altitude above/below mean-sea-level
Units	M	meter	Units of antenna altitude
Geoidal Separation	17.8	meter	
Units	M	meter	Units of geoids separation
Age of Diff. Corr.			Null fields when DGPS is not used
Checksum	*65		
<CR> <LF>			End of message termination

**Table 3-3: Position Fix Indicator**

Value	Description
0	Fix not available
1	GPS Fix
2	Differential GPS Fix

## GSA—GPS DOP and Active Satellites

Table 3-4 explains the example NMEA sentence below:

```
$GPGSA,A,3,29,21,26,15,18,09,06,10,,,,,2.32,0.95,2.11*00
```

**Table 3-4: GSA Data Format**

Name	Example	Units	Description
Message ID	\$GPGSA		GSA protocol header
Mode 1	A		See Table 3-5
Mode 2	3		See Table 3-6
Satellite Used <sup>a</sup>	29		SV on Channel 1
Satellite Used	21		SV on Channel 2
....	....	....	....
Satellite Used			SV on Channel 12
PDOP	2.32		Position Dilution of Precision
HDOP	0.95		Horizontal Dilution of Precision
VDOP	2.11		Vertical Dilution of Precision
Checksum	*00		
<CR> <LF>			End of message termination

a. GPS SV No. #01~#32

**Table 3-5: Mode 1**

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

**Table 3-6: Mode 2**

Value	Description
1	Fix not available
2	2D (<4 SVs used)
3	3D (>=4 SVs used)

## GSV— Satellites in View

Table 3-7 explains the example NMEA sentence below:

```
$GPGSV,4,1,15,29,36,029,42,21,46,314,43,26,44,020,43,15,21,3
21,39*7D
```

```
$GPGSV,4,2,15,18,26,314,40,09,57,170,44,06,20,229,37,10,26,0
84,37*77
```

```
$GPGSV,4,3,15,07,,,26*73
```

**Table 3-7: GSV Data Format**

Name	Example	Units	Description
Message ID	\$GPGSV		GSV protocol header
Number of Messages	4		(Depending on the number of satellites tracked, multiple messages of GSV data may be required) <sup>a</sup>
Message Number	1		
Satellites in View	15		
Satellite ID	29		Channel 1 (Range 1 to 32)
Elevation	36	degrees	Channel 1 (Maximum 90)
Azimuth	029	degrees	Channel 1 (True, Range 0 to 359)
SNR (C/No)	42	dB-Hz	Range 0 to 99, (null when not tracking)
....	....	....	....
Satellite ID	15		Channel 4 (Range 1 to 32)
Elevation	21	degrees	Channel 4 (Maximum 90)
Azimuth	321	degrees	Channel 4 (True, Range 0 to 359)
SNR (C/No)	39	dB-Hz	Range 0 to 99, (null when not tracking)
Checksum	*7D		
<CR> <LF>			End of message termination

a. One GSV sentence can only receive up to 4 SVs

## RMC—Recommended Minimum Navigation Information

Table 3-8 explains the example sentence below:

```
$GPRMC,064951.000,A,2307.1256,N,12016.4438,E,0.03,165.48,260
406,3.05,W,A*2C
```

**Table 3-8: RMC Data Format**

Name	Example	Units	Description
Message ID	\$GPRMC		RMC protocol header
UTC Time	064951.000		hhmmss.sss
Status	A		A: data valid V: data not valid
Latitude	2307.1256		ddmm.mmmm
N/S Indicator	N		N: North S: South
Longitude	12016.4438		dddmm.mmmm
E/W Indicator	E		E: East W: West
Speed over Ground	0.03	knots	
Course over Ground	165.48	degrees	TRUE
Date	260406		ddmmyy
Magnetic Variation			
Mode	A		A: Autonomous mode D: Differential mode E: Estimated mode
Checksum	*2C		
<CR> <LF>			End of message termination

## VTG—Course and Speed information Relating to the Ground

Table 3-9 explains the example sentence below:

\$GPVTG,165.48,T,,M,0.03,N,0.06,K,A\*37

**Table 3-9: VTG Data Format**

Name	Example	Units	Description
Message ID	\$GPVTG		VTG protocol header
Course	165.48	degrees	Measured heading
Reference	T		TRUE
Course		degrees	Measured heading
Reference	M		Magnetic Variation (By Customization)
Speed	0.03	Knots/hr	Measured horizontal speed
Units	N		Knots
Speed	0.06	km/hr	Measured horizontal speed
Units	K		Kilometers per hour
Mode	A		A: Autonomous mode D: Differential mode E: Estimated mode
Checksum	*37		
<CR> <LF>			End of message termination

## MTK NMEA Command Protocols

**Packet Type:** 103 PMTK\_CMD\_COLD\_START

**Packet Meaning:** Cold Start --- Discarding the data of Time, Position, Almanacs and Ephemeris at re-start.

**Example:** \$PMTK103\*30<CR><LF>

---

*Note: Please refer to the XM-XA Software User Guide document for more details.*

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## >> 4: Reference Design

This section introduces reference schematic designs for best performance. For additional design guidelines please refer to the Hardware Design Guide document for the specific model.

### Reference Schematic Design for Using an Active Antenna

Connect the external antenna to RF\_IN (Pin2):

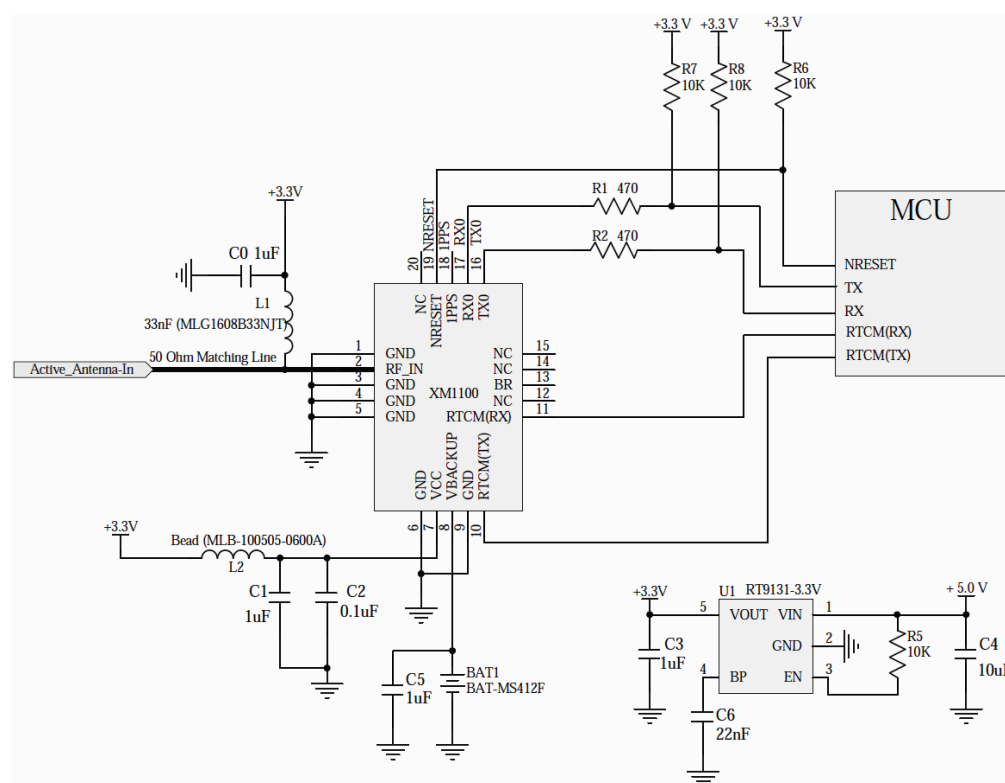


Figure 4-1: Active Antenna Application

Notes:

1. Choke coil L1 is used in electrical circuits to pass direct current and attenuate alternating current.
2. Ferrite bead L2 is added for power noise reduction. Use one with equivalent impedance (600Ω at 100MHz; IDC 200mA).
3. Place C0, C1, C2 and C5 bypass-capacitors as close as possible to the module.
4. Damping resistors R1 and R2 can be modified based on system application for EMI.



# Reference Schematic Design for Using a Patch (Passive) Antenna

Connect the external antenna to RF\_IN (Pin2):

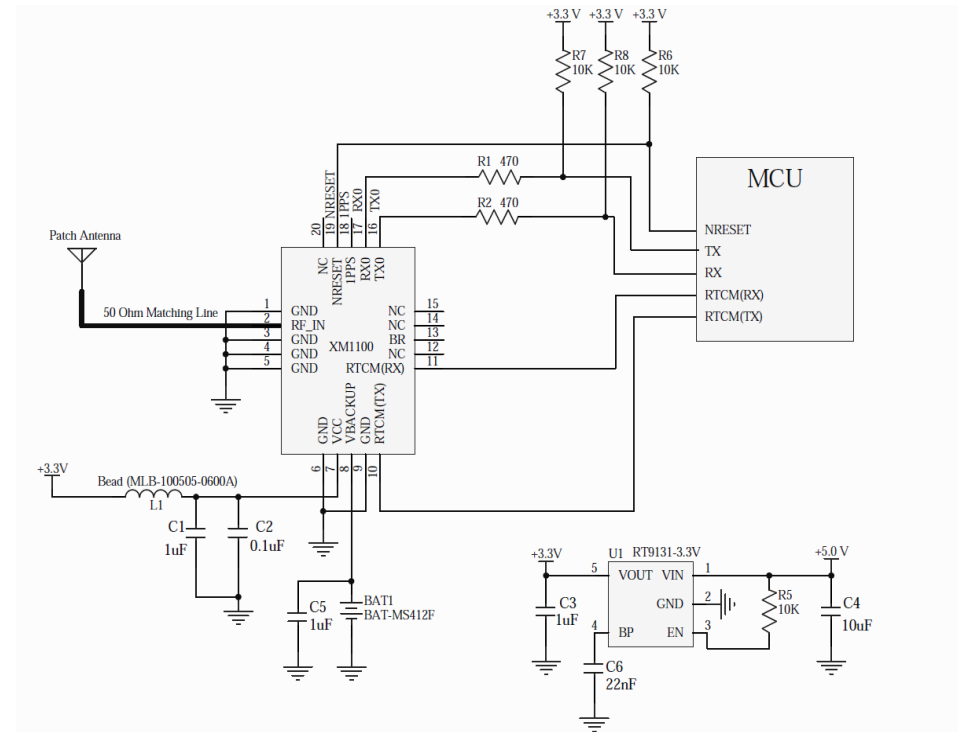


Figure 4-2: Patch Antenna Application

## Notes:

1. Ferrite bead L1 is added for power noise reduction. Use one with equivalent impedance (600Ω at 100MHz; IDC 200mA).
2. Place C1, C2 and C5 bypass-capacitors as close as possible to the module.
3. Damping resistors R1 and R2 can be modified based on system application for EMI.