# AirPrime XM1100

## Product Technical Specification


41111067
Rev 7.0

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Due to the nature of wireless communications, transmission and reception of data can never be guaranteed. Data may be delayed, corrupted (i.e., have errors) or be totally lost. Although significant delays or losses of data are rare when wireless devices such as the Sierra Wireless modem are used in a normal manner with a well-constructed network, the Sierra Wireless modem should not be used in situations where failure to transmit or receive data could result in damage of any kind to the user or any other party, including but not limited to personal injury, death, or loss of property. Sierra Wireless accepts no responsibility for damages of any kind resulting from delays or errors in data transmitted or received using the Sierra Wireless modem, or for failure of the Sierra Wireless modem to transmit or receive such data.

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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:<br>• Pin Assignment on page 13<br>• Figure 5-3 on page 27 |
| 3.1 | May 07, 2018 | Fixed typo in Drying on page 29 |
| 4.0 | May 28, 2018 | Updated Reference Design on page 24 |
| 5.0 | October 03, 2018 | Updated:<br>• Specifications on page 12<br>• Table 3-4 on page 20 |

| Revision number | Release date | Changes |
|---|---|---|
| 6.0 | February 12, 2019 | Updated Figure 2-2 on page 12 |
| | | Deleted:<br>• section 5 Packing and Handling<br>• section 6 Reflow Soldering Temperature Profile |
| 7.0 | July 17, 2019 | Changed Update Rate in:<br>• Product Highlights and Features on page 8<br>• Table 2-4 on page 15 |

# Contents

# List of Figures

# List of Tables

# 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, EASYTM, 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 (±20ns 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

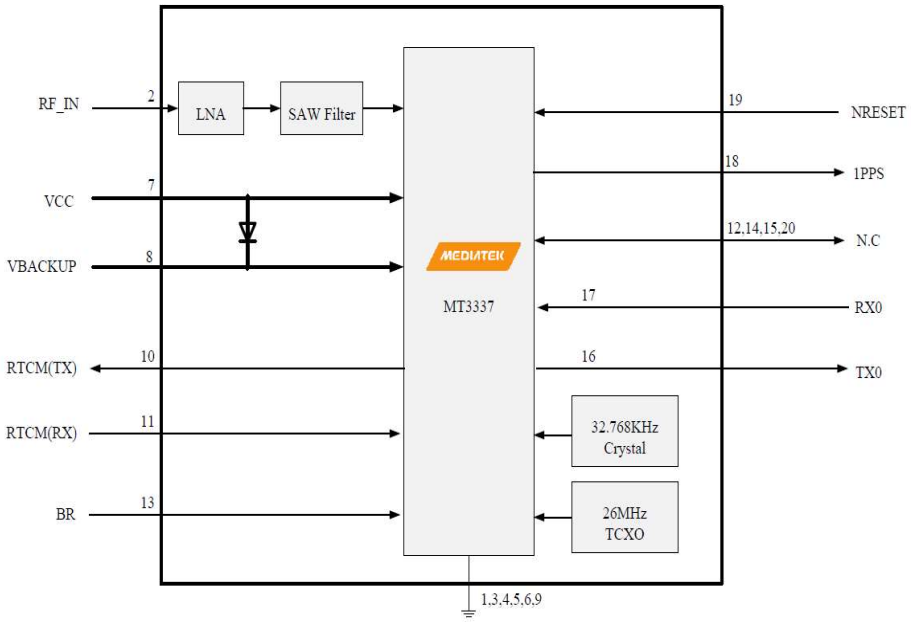


*Figure 1-2: System Block Diagram*

# 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 ±20ns 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™.

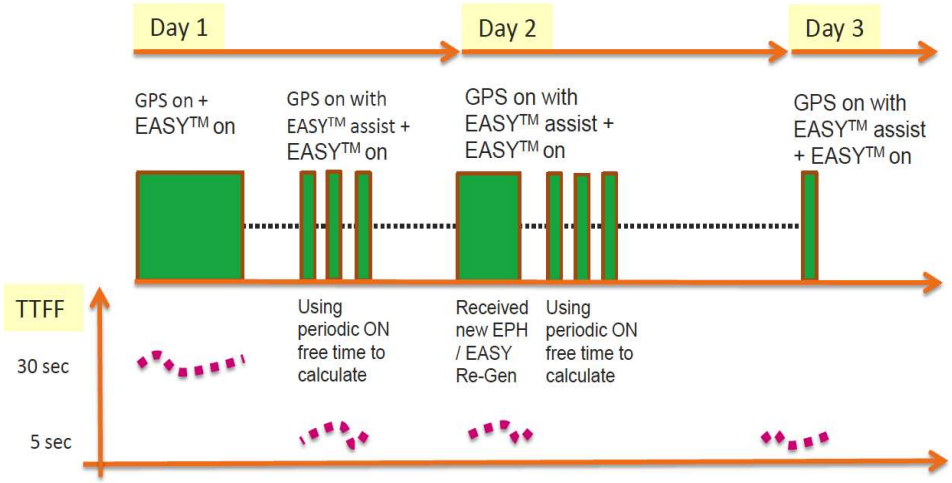


*Figure 1-3: Operation of EASY™*

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.

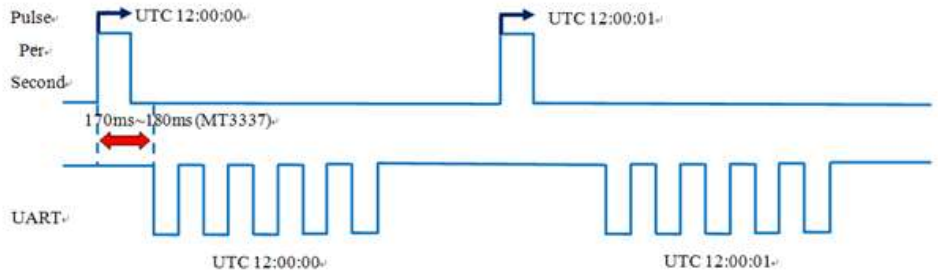


*Figure 1-4: PPS sync NMEA*

# 2: Specifications

## Mechanical Dimensions

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

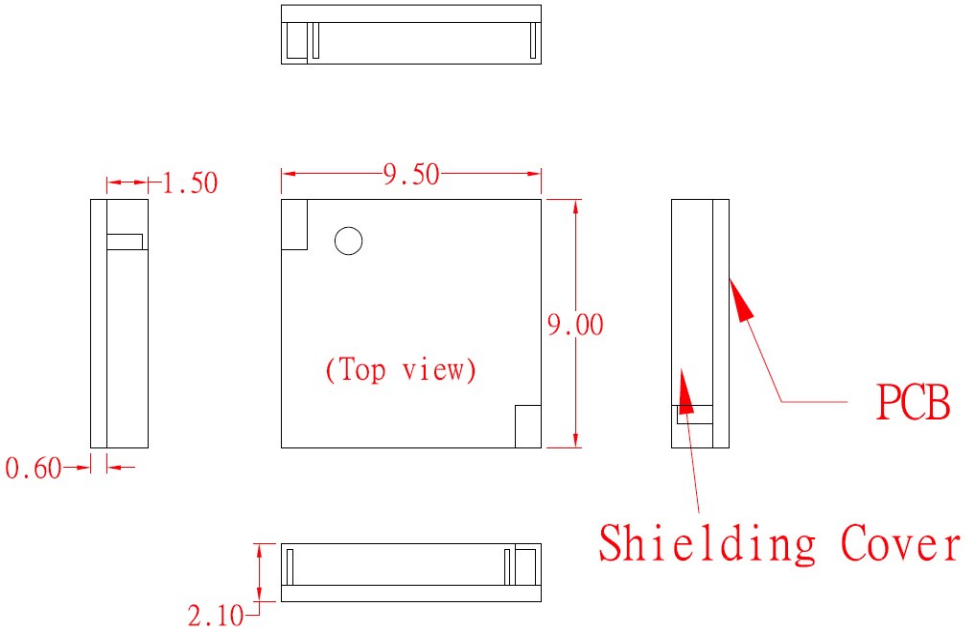


*Figure 2-1: Mechanical Dimensions*

## PCB Copper Pad Definition

(Unit: mm, Tolerance: ±0.1mm)

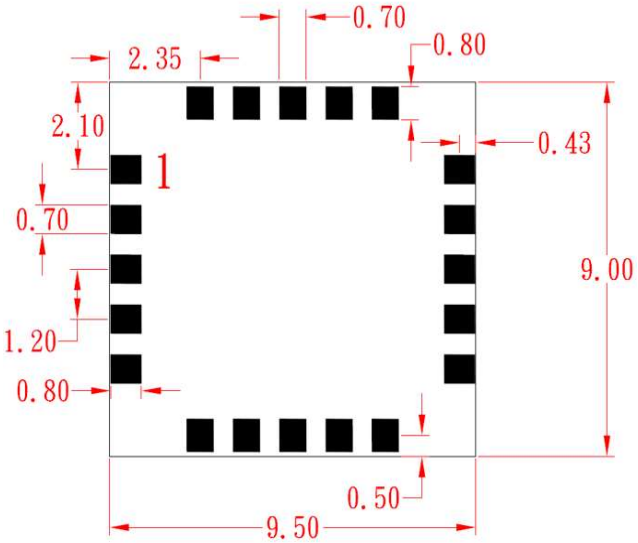


*Figure 2-2: PCB Copper Pad*

# Pin Configuration

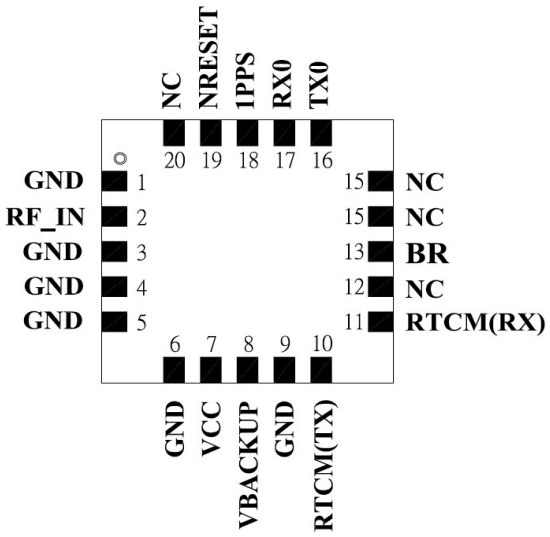


*Figure 2-3: Pin Configuration*

# Pin Assignment

**Table 2-1: Pin Assignment**

| Pin | Name | I/O | Description and Note | Active Low / High | IO Voltage Domain | Reset State[a] | 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[a] | 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 10KΩ resistor).

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

| Baud Rate | BR (Pin13) |
|---|---|
| **9600** | No Connect (default) |
| **115200** | 10KΩ |

- **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<br>Reacquisition: -163dBm, Hot start<br>Tracking: -165dBm |
| **SV Number** | #1~32 |
| **TTFF<br>(GPS, No. of SVs>4, C/N>40dB, PDop<1.5)** | Hot start: 1 second typical<br>Warm start: 24 seconds typical<br>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 | |
|---|---|
| **Timing Accuracy (1PPS Output)** | ±20ns RMS within 100ms in one pulse |
| **Altitude** | 10,000m maximum (Normal mode: Car/ Pedestrian/ Aviation)<br>80,000m maximum (Balloon mode) |
| **Velocity** | Maximum 515m/s (1000 knots) |
| **Acceleration** | Maximum 4G |
| **Update Rate** | 1Hz (default), maximum 10Hz |
| **Baud Rate** | 9600 bps (default), 115200 bps |
| **Power Supply** | VCC: 3V to 4.3V; VBACKUP: 2.0V to 4.3V |
| **Current Consumption @ 3.3V,1Hz Update Rate** | Acquisition: 19mA/ 20mA / 21mA (min / typical / max)<br>Tracking: 18mA / 19mA / 24mA (min / typical / max) |
| **Power Saving (Periodic)** | Standby mode: 420uA(TYP) |
| **NRESET Current @ 3.3V** | 8mA (TYP) |
| **Backup Power Consumption @ 3.3V** | 7μA (TYP) |
| **Working Temperature** | -40 °C to +85 °C |
| **Dimension** | 9.0x9.5 x 2.1 mm, SMD |
| **Weight** | 0.4g |

# Absolute Maximum Ratings

The maximum power supply voltage is 4.3 VDC.

**Table 2-5: Maximum Ranges**

| | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Power Supply Voltage** | VCC | 3.0 | 3.3 | 4.3 | V |
| **Backup Battery Voltage** | 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 |
|---|---|
| **GGA** | Time, position and fix type data. |
| **GSA** | GPS receiver operating mode, active satellites used in the position solution and DOP values. |
| **GSV** | The number of GPS satellites in view, satellite ID numbers, elevation, azimuth, and SNR values. |
| **RMC** | Time, date, position, course and speed data.<br>The recommended minimum navigation information. |
| **VTG** | 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,1
7.8,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**[a] | 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,4,1,15,29,36,029,42,21,46,314,43,26,44,020,43,15,21,321,39*7D

$GPGSV,4,2,15,18,26,314,40,09,57,170,44,06,20,229,37,10,26,084,37*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) [a] |
| **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<br>V: data not valid |
| **Latitude** | 2307.1256 | | ddmm.mmmm |
| **N/S Indicator** | N | | N: North<br>S: South |
| **Longitude** | 12016.4438 | | dddmm.mmmm |
| **E/W Indicator** | E | | E: East<br>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<br>D: Differential mode<br>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<br>(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<br>D: Differential mode<br>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.*

# 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):

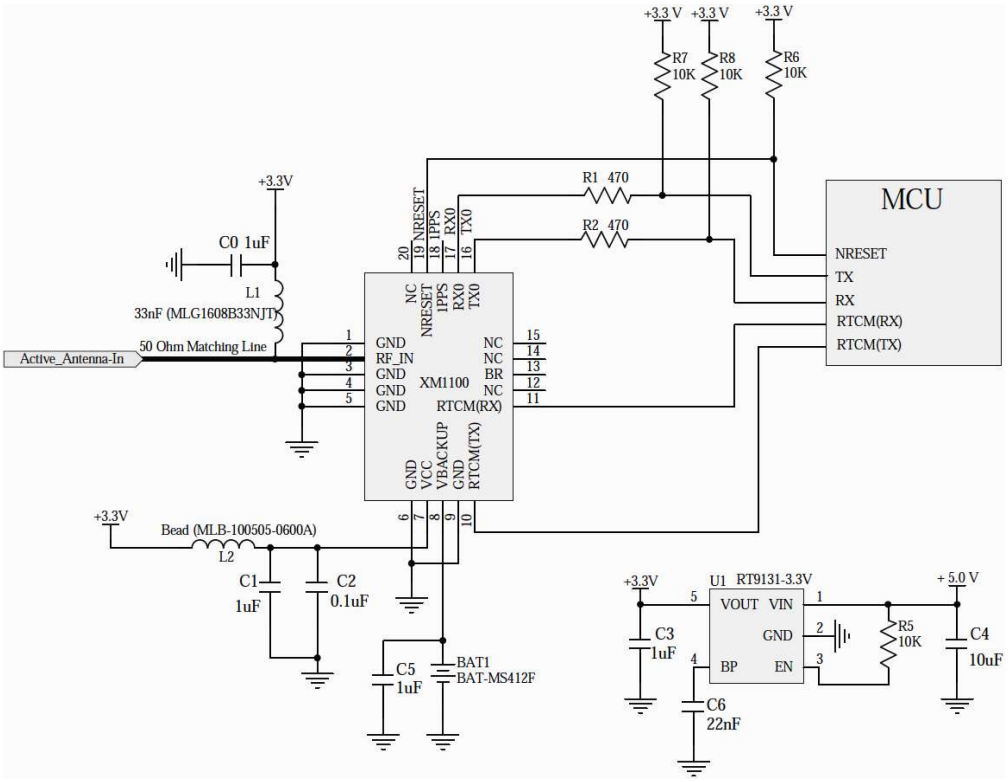


*Figure 4-1: Active Antenna Application*

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):

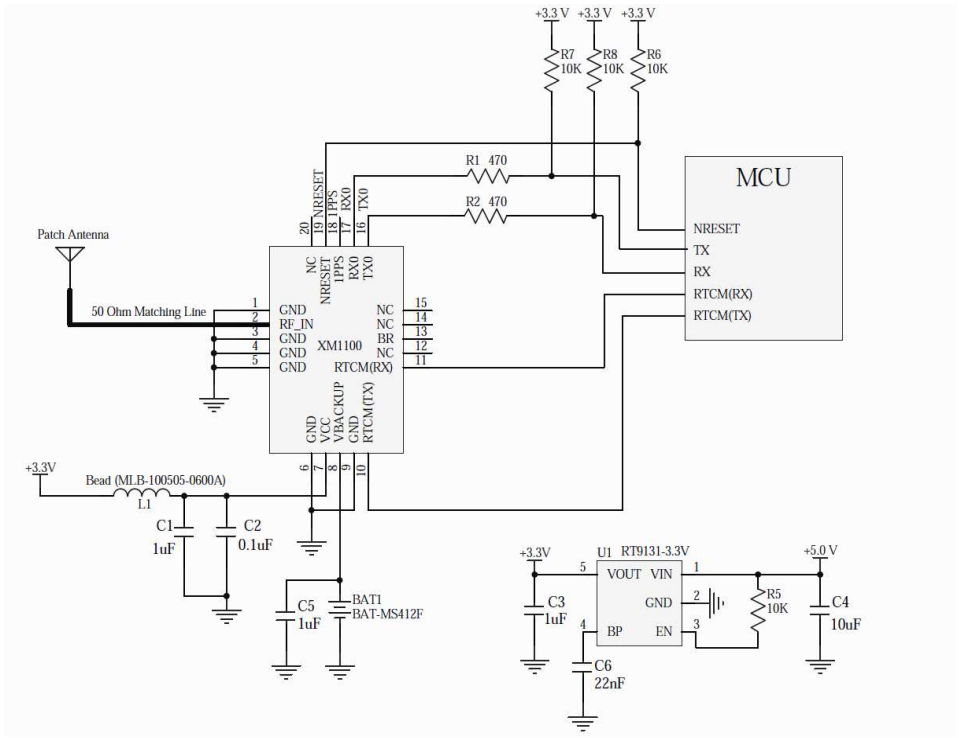


*Figure 4-2: Patch Antenna Application*

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.