AirPrime XM1210

Product Technical Specification

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Important Notice

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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Do not operate the Sierra Wireless modem in areas where blasting is in progress, where explosive atmospheres may be present, near medical equipment, near life support equipment, or any equipment which may be susceptible to any form of radio interference. In such areas, the Sierra Wireless modem **MUST BE POWERED OFF**. The Sierra Wireless modem can transmit signals that could interfere with this equipment.

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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
1.0	October 30, 2018	Creation
1.1	November 05, 2018	Fixed typos throughout the document
1.2	November 14, 2018	Updated: • Figure 10-1 on page 50 • Figure 11-1 on page 51
2.0	February 13, 2019	Updated: • Figure 2-2 on page 11 • Co-Design Layout Guide on page 46
2.1	February 18, 2019	Updated reference link in Table 3-5 on page 18
2.2	March 11, 2019	Added GST in: • Table 3-2 on page 17 • Table 3-3 on page 17 • Table 3-4 on page 18 • GST—Position Error Statistics on page 29 Updated Figure 1-2 on page 9

Revision number	Release date	Changes
2.3	March 18, 2019	Updated Table 3-1 on page 17
3.0	August 3, 2020	Updated Frequency under Table 2-5 Added Galileo information in Protocols Other minor edits

>> Contents

1: Function Description

Overview

This document provides the necessary guidelines for a successful system design using XM1210 modules.

The XM1210 is a multi-GNSS receiver that is capable of tracking GPS+Galileo+GLONASS or GPS+Galileo+BeiDou systems simultaneously. The module provides an external antenna interface that supports both active and passive GNSS antennas.

The XM1210 is one of the smallest multi-GNSS modules on the market with an ultra-compact size of 9.0 x 9.5 x 2.1 mm in a QFN Package. It supports multiple interfaces such as USB and I2C that can be used instead of UART.

The module is integrated with SMPS (switched-mode power supply) which allows for the lowest possible power consumption while offering optimum GNSS sensitivity and performance.

The XM1210 is based on the latest HD8021 chipset and supports all standard GNSS features including QZSS, SBAS, Anti-Jamming and AGNSS (Assisted-GNSS).

Target Applications

- Hand-held devices
- M2M applications
- Asset management
- Surveillance systems
- Wearable products

Figure 1-1: XM1210

Product Highlights and Features

- 24 tracking / 48 acquisition-channel GPS+Galileo+GLONASS or GPS+Galileo+BeiDou receiver
- Supports QZSS and SBAS (WAAS, EGNOS, MSAS, GAGAN)
- Sensitivity: -161 dBm
- Update Rate: 1 Hz (default)
- High accuracy 1-PPS timing (25ns RMS) and the pulse width is 100ms
- AGNSS Support for Fast TTFF
- PVT Logger Function
- Support interface types: I2C/ USB/ UART
- Consumption current (@ 3.3V):
  For GPS and GLONASS constellations
  - Acquisition: 40mA (typ)
  - Tracking: 35mA (typ)
- RoHS

Precautions

Please read carefully before you start:

If you use the GNSS receiver inside buildings, tunnels, or beside any huge objects, the GNSS signals might be cut-off or weakened. Please do not assume the receiver has malfunctioned.

The XM1210 modules is an electrostatic sensitive device, please DO NOT touch the XM1210 module directly. Follow ESD safety rules when handling. When using the XM1210 module for the first time, it is strongly recommended that you test the XM1210 Module outdoors with open sky for at least 10 to 15 minutes to ensure that full ephemeris data is received.

System Block Diagram
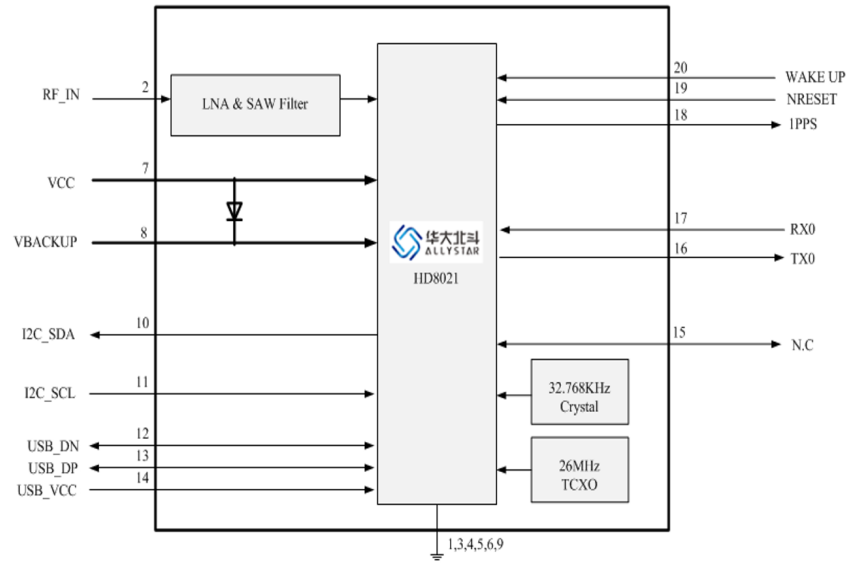
Figure 1-2: System Block Diagram

I2C

The I2C interface is a serial input and output port, operating as a slave device.
*   Slave receiving
*   Slave address: 0x55
*   Speed grades: Standard-mode 100kbit/s, Fast-mode 400kbit/s

USB

A USB version 2.0 FS compatible interface can be used for communication as an alternative to the UART. It supports USB 2.0 full speed at 12Mbps.

1PPS

The XM1210 generates a-pulse-per-second signal (1 PPS) after 3D fixed. It is an electrical signal which precisely indicates the start of a second within an accuracy of 25ns. The PPS signal is provided through a designated output pin for external applications.

AGNSS for Faster TTFF (PED in Flash)

The AGNSS provides pre-download PED (Proprietary Ephemeris Data) data to speed up TTFF (Time To First Fix). This feature is useful when a satellite signal is weak; it allows the module to still get position information quickly. AGNSS ephemeris can be downloaded from an FTP server via the Internet.

PVT Logger Function

PVT logger function is enabled in the XM1210 module and can become a logger-capable (built-in internal flash) device, and record GNSS data such as UTC, latitude, longitude, valid or checksum which makes it convenient for users for record logger and debugging use.

The internal flash of the XM1210 has 32 KB for this function, and uses the smart overlapping mechanism to keep the latest logger data (4KB).

≫ 2: Specifications

Mechanical Dimensions

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

Figure 2-1: Mechanical Dimensions
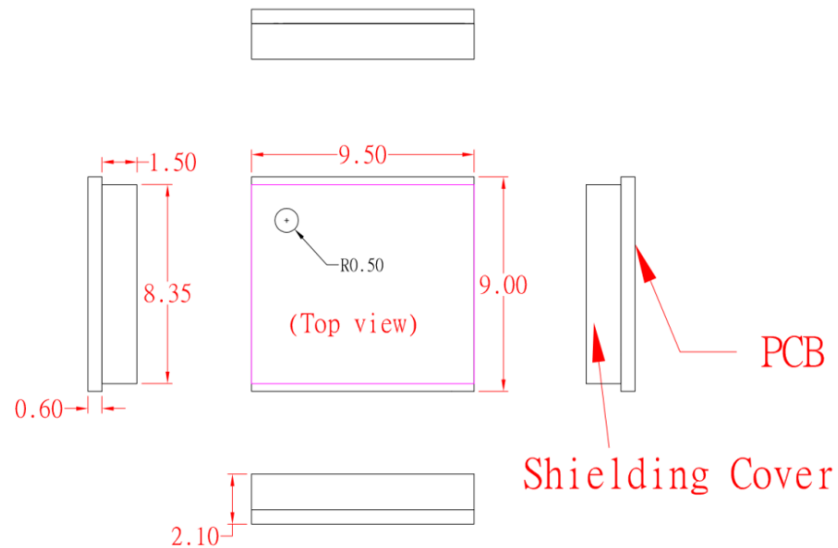
PCB Copper Pad Definition

(Unit: mm, Tolerance: ±0.1mm)

Figure 2-2: PCB Copper Pad
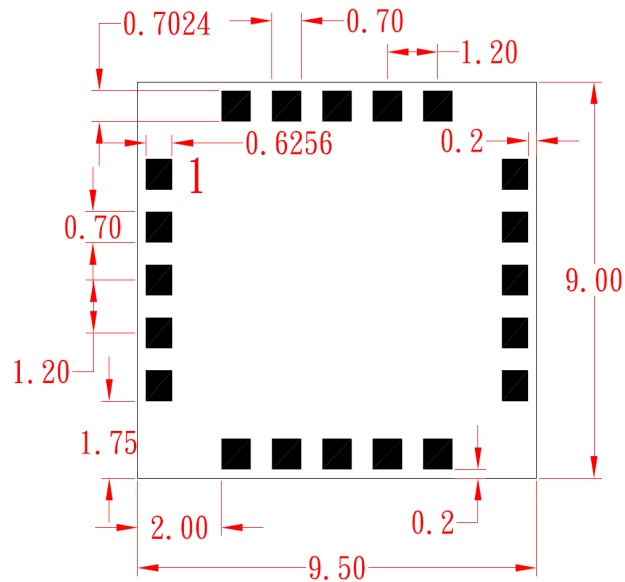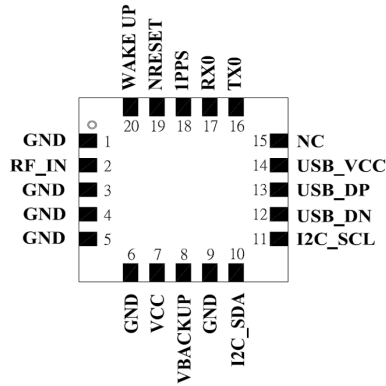
Pin Configuration

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	GNSS 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		3.3V		Connection to C=1µF
9	GND	P	Ground		0V		Mandatory connection
10	I2C_SDA	I/O	I2C serial data (in slave mode)		3.3V	O, PU	Left open[b]
11	I2C_SCL	I	I2C serial clock (in slave mode)		3.3V	I, PU	Left open[b]
12	USB_DN	I/O	USB differential data bus minus		3.3V		Left open[b]
13	USB_DP	I/O	USB differential data bus plus		3.3V		Left open[b]

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
14	USB_VCC	PI	USB supply voltage input		3.3V		Left open[b]
15	NC	-	Not connected				Left open
16	TX0	O	Serial data output for NMEA output (TTL)		3.3V	O, PU	Left open[b]
17	RX0	I	Serial data input for firmware update (TTL)		3.3V	I, PU	Left open[b]
18	1PPS	O	1PPS time mark output		3.3V	O, PU	Left open
19	NRESET	I	Reset input	L	3.3V	I, PU	Left open
20	WAKE UP	I	Wake up from power saving	H			Left open

a. I = Input, O = Output, PU = Pull up, PD = Pull Down, H = High, T = High Impedance
b. Based on Firmware version, the user can decide if the UART / I2C / USB pin is a mandatory connection.

Description of I/O Pins

- **Pin1**: GND (Ground)
- **Pin2**: RF_IN
  - · The GNSS RF signal input which can be connected to a passive antenna or an active antenna.
    For details on how to select an active antenna, refer to External Antenna Specification on page 39.
- **Pin3**: GND (Ground)
- **Pin4**: GND (Ground)
- **Pin5**: GND (Ground)
- **Pin6**: GND (Ground)
- **Pin7**: VCC
  - · Main DC power supply (3.0V to 3.6V; typical: 3.3V)
- **Pin8**: VBACKUP
  - · This connects to the backup power of the XM1210. A power source (such as a battery) connected to this pin will help the module in keeping its internal RTC running and save ephemeris data in the module which can speed up TTFF when the main power source is turned off.
  - · The voltage ranges from 1.6V to 3.6V (typical: 3.3V).
  - · 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 module will perform a lengthy cold start each time it is powered on, as previous ephemeris data is not retained and needs to be re-acquired.
  - · If not used, keep this pin floating.
- **Pin9**: GND (Ground)
- **Pin10**: I2C_SDA
  - · Can be used to transmit and receive data and communicate with the host.
  - · If not used, keep this pin floating.

- **Pin11**: I2C_SCL
  - ・ Can be used to transmit and receive clock and communicate with the host.
  - ・ If not used, keep this pin floating.
- **Pin12**: USB_DN
  - ・ Dedicated Full Speed v2.0 (DN pin of the USB connector)
- **Pin13**: USB_DP
  - ・ Dedicated Full Speed v2.0 (DP pin of the USB connector)
- **Pin14**: USB_VCC
  - ・ USB supply voltage (3.0V to 3.6V; typical: 3.3V)
- **Pin15**: NC (Not Connected)
- **Pin16**: TX0 (UART 0 transmitter; outputs GNSS information for application)
- **Pin17**: RX0 (UART 0 receiver; to receive commands from system)
- **Pin18**: 1PPS
  - ・ This pin provides one pulse-per-second signal output.
  - ・ If not used, keep this pin floating.
- **Pin19**: NRESET
  - ・ Active on Low for the module to reset.
  - ・ If not used, keep this pin floating.

Table 2-2: NRESET

Symbol	Min (V)	Typ (V)	Max (V)
Low	0	-	0.89
High (default)	2.2	-	3.3

- **Pin20**: WAKE UP
  - ・ Active on High will wake the module up from power saving mode.

Table 2-3: WAKE UP

Symbol	Min (V)	Typ (V)	Max (V)
Low (default)	0	-	0.89
High	2.2	-	3.3

Table 2-4: WAKE UP Pin Modes

Mode	Function
Normal (default)	The module automatically enters normal mode by default.
Power Saving	The module can be woken up by this pin when it is in power saving mode (set WAKE UP pin active on high)

Table 2-4: WAKE UP Pin Modes (Continued)

Mode	Function
BootROM	Enter BootROM mode to upgrade firmware using these steps: 1. The WAKE UP pin must be initially connected to ground. 2. Power up the module's main power. 3. The WAKE UP pin can be removed from ground. 4. Use "SWGNSSTool" to upgrade the firmware.

Specifications

Table 2-5: Specification Data

Description	
GNSS Chipset	Allystar HD8021
Frequency	GPS / QZSS / SBAS L1, 2.046 MHz BW NB (centered on 1575.42 MHz) GLONASS L1, ~8.3 MHz BW (1597–1606 MHz), 14 channels (-7 to +6) Galileo E1, 4.092 MHz BW (centered on 1575.42 MHz) BEIDOU B1, 4.092 MHz BW (1559.05 –1563.14 MHz)
Sensitivity	Acquisition: -147dBm Tracking: -161dBm
SV Numbers	GPS #1~32 GLONASS #65~96 BEIDOU #201~237 (see Protocols on page 17 for details) GALILEO #301-330
Protocol	NMEA 0183 V3.01 (Default), NMEA 0183 V4.0, NMEA 0183 V4.1
TTFF **(Num of SVs ≥ 6, C/N > 40dB)**	Hot start: 2 second typical Warm start: 30 seconds typical Cold start: 35 seconds typical, 60 seconds maximum
Position Accuracy	Without aid: 2.5m (50% CEP) DGPS (SBAS(WAAS,EGNOS,MSAS, GAGAN)):2.0m (50% CEP)
Velocity Accuracy	Without aid: 0.1m/s DGPS(SBAS(WAAS,EGNOS,MSAS, GAGAN)):0.05m/s
Timing Accuracy (1PPS Output)	25ns RMS within 100ms in one pulse
Altitude	18,000m maximum
Velocity	Maximum 515m/s
Update Rate	1Hz (default)
Acceleration	Maximum 4G
Baud Rate	115200 bps (default)
DGPS	SBAS (default) [WAAS, EGNOS, MSAS, GAGAN]
Power Supply	VCC: 3.0V to 3.6V VBACKUP: 1.6V to 3.6V USB: 3.0V to 3.6V

Table 2-5: Specification Data (Continued)

Description	
Current Consumption @ 3.3V,1Hz Update Rate	GPS and GLONASS Acquisition: 40mA (TYP) Tracking: 35mA (TYP)
Backup Power Consumption@ 3.3V	10µA (TYP)
Power Saving	Sleep mode: 7mA (TYP) Deep sleep mode: 300µA (TYP) Main power down mode: 15µA (TYP)
NRESET Current @ 3.3V	75µA (TYP)
Working Temperature	-40 °C to +85 °C
Dimension	9.0 x 9.5 x 2.1 mm, SMD
Weight	0.4g

Absolute Maximum Ranges

Table 2-6: Maximum Ranges

	Symbol	Min	Max	Unit
Power Supply Voltage	VCC	3.0	3.6	V
Backup Battery Voltage	VBACKUP	1.6	3.6	V
USB Supply Voltage	USB_VCC	3.0	3.6	V

Operating Conditions

Table 2-7: Operating Conditions

Parameter	Condition	Min	Max	Unit
RX0 TTL H Level	VCC = 3.3V	2	3.3	V
RX0 TTL L Level	-	0	1	V
TX0 TTL H Level	VCC = 3.3V	2.6	3.3	V
TX0 TTL L Level	-	0	0.5	V
USB_H Level Input	USB_VCC = 3.3V	2	3.3	V
USB_L Level Input	-	0	1	V
USB_H Level Output	USB_VCC = 3.3V	2.3	3.3	V
USB_H Level Output	-	0	0.5	V

3: Protocols

NMEA Output Sentences

Table 3-1 lists all NMEA output sentences specifically developed and defined by Allystar.

Table 3-1: Position Fix Indicator

Option	Description
GGA	Time, position and fix type data.
GSA	GNSS receiver operating mode, active satellites used in the position solution and DOP values.
GSV	The number of GNSS satellites in view, satellite ID numbers, elevation, azimuth, and SNR values.
RMC	Time, date, position, course and speed data. The recommended minimum navigation information.
ZDA	Time and date
GST	Position error statistics

The following tables list NMEA output sentences used in GPS, GLONASS and BeiDou systems.

Table 3-2: NMEA v3.01 Output Sentence for GPS and GNSS

System	GGA	GSA	GSV	RMC	ZDA	GST
GPS	GPGGA	GPGSA	GPGSV	GPRMC	GPZDA	GPGST
GNSS (GPS+Galileo+ GLONASS) (GPS+Galileo+BeiDou)	GNGGA	GNGSA	GNGSV	GNRMC	GNZDA	GNGST

Table 3-3: NMEA v4.00 Output Sentence for GPS and GNSS

System	GGA	GSA	GSV	RMC	ZDA	GST
GPS	GPGGA	GPGSA	GPGSV	GPRMC	GPZDA	GPGST
GNSS (GPS+Galileo+ GLONASS)	GNGGA	GPGSA GLGSA[a] GAGSA[a]	GPGSV GLGSV[a] GAGSV[a]	GNRMC	GNZDA	GNGST
GNSS (GPS+Galileo+ BeiDou)	GNGGA	GAGSA[a] GPGSA BDGSA[a]	GPGSV BDGSV[a] GAGSV[a]	GNRMC	GNZDA	GNGST

a. In Talker ID, GP is a short term of GPS, GL is GLONASS, BD is BeiDou, GA is Galileo, and GN is GNSS.

Table 3-4: NMEA v4.10 Output Sentence for GPS and GNSS

System	GGA	GSA	GSV	RMC	ZDA	GST
GPS	GPGGA	GPGSA	GPGSV	GPRMC	GPZDA	GPGST
GNSS (GPS+Galileo+ GLONASS)	GNGGA	GNGSA	GPGSV GLGSV[a] GAGSV[a]	GNRMC	GNZDA	GNGST
GNSS (GPS+Galileo+ BeiDou)	GNGGA	GNGSA	GPGSV BDGSV[a] GAGSV[a]	GNRMC	GNZDA	GNGST

a. In Talker ID, GP is a short term of GPS, GL is GLONASS, BD is BeiDou, GA is Galileo, and GN is GNSS.

GGA—Time, Position and Related Data of Navigation Fix

Table 3-5 explains the NMEA (version 3.01 / 4.00 / 4.10) sentences below:

(GPS satellite)

`$GPGGA,082929.000,2305.76749,N,12017.02532,E,1,10,1.06,17.5, M,17.2,M,,*59`

(GPS+Galileo and GLONASS satellites)

`$GNGGA,022827.000,2305.76627,N,12017.02387,E,2,17,0.81,9.7, M,17.2,M,,*74`

(GPS+Galileo and BeiDou satellites)

`$GNGGA,055818.000,2305.76768,N,12017.02310,E,2,19,0.84,11.1, M,17.2,M,,*48`

Table 3-5: GGA Data Format

Name	Example	Units	Description
Message ID	$GNGGA		GGA protocol header
UTC Time	022827.000		hhmmss.sss
Latitude	2305.76627		ddmm.mmmm
N/S Indicator	N		N North or S South
Longitude	12017.02387		dddmm.mmmm
E/W Indicator	E		E East or W West
Position Fix Indicator	2		See Table 3-6 on page 19
Satellites Used	17		
HDOP	0.81		Horizontal Dilution of Precision

Table 3-5: GGA Data Format (Continued)

Name	Example	Units	Description
MSL Altitude	9.7	meters	Antenna Altitude above/below mean-sea-level
Units	M	meters	Units of antenna altitude
Geoidal Separation	17.2	meters	
Units	M	meters	Units of geoids separation
Age of Diff. Corr.		second	Null fields when DGPS is not used
Checksum	*74		
<CR> <LF>			End of message termination

Table 3-6: Position Fix Indicator

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

GSA — GNSS DOP and Active Satellites, Including GPS (GPGSA), GLONASS (GLGSA), BeiDou (BDGSA), Galileo (GAGSA), GPS+Galileo and GLONASS or GPS+Galileo and BeiDou (GNGSA)

Table 3-7, Table 3-8 and Table 3-9 explain the NMEA (version 3.01 / 4.00 / 4.10) sentences below:

NMEA version 3.01

(GPS satellite)

`$GPGSA,A,3,193,199,15,24,194,13,05,29,195,02,,,1.93,1.06,1.61*0F`

(GPS+Galileo and GLONASS satellites)

`$GNGSA,A,3,82,19,194,12,29,30,15,07,,,,,1.21,0.71,0.98*2F`

(GPS+Galileo and BeiDou satellites)

`$GNGSA,A,3,206,193,13,02,213,199,203,217,201,05,209,195,1.37,0.84,1.08*27`

NMEA version 4.00

(GPS satellite)

```
$GPGSA,A,3,30,12,07,,,,,,,,,,1.21,0.72,0.97,1*11
```

(GLONASS satellite)

```
$GLGSA,A,3,83,69,68,82,,,,,,,,,1.21,0.72,0.97,2*09
```

(BeiDou satellite)

```
$BDGSA,A,3,06,13,03,17,01,09,,,,,,,1.20,0.78,0.90,4*07
```

(Galileo satellite)

```
$GAGSA,A,3,16,21,22,09,15,20,23,,,,,,1.11,0.69,0.87,3*07
```

NMEA version 4.10

(GPS satellite)

```
$GPGSA,A,3,193,199,15,24,194,13,05,29,195,02,,,1.89,1.06,
1.56,1*1D
```

(GPS+Galileo and GLONASS satellites)

```
$GNGSA,A,3,193,195,17,19,199,06,128,09,28,23,05,194,1.32,
0.81,1.03,1*35
```

```
$GNGSA,A,3,01,02,24,08,13,,,,,,,,1.32,0.81,1.03,2*06
```

(GPS+Galileo and BeiDou satellites)

```
$GNGSA,A,3,13,193,02,199,05,195,128,15,06,194,30,19,1.18,
0.76,0.90,1*3D
```

```
$GNGSA,A,3,06,13,03,17,01,09,,,,,,,1.18,0.76,0.90,4*0D
```

Table 3-7: GSA Data Format for NMEA v3.01

Name	Example	Units	Description
Message ID	$GNGSA		GSA protocol header
Mode 1	A		See Table 3-10
Mode 2	3		See Table 3-11
Satellite Used	82		SV on Channel 1. See Table 3-12
Satellite Used	28		SV on Channel 2. See Table 3-12
….	….	….	....
Satellite Used			SV on Channel 12
PDOP	1.21		Position Dilution of Precision
HDOP	0.71		Horizontal Dilution of Precision
VDOP	0.98		Vertical Dilution of Precision
Checksum	*2F		
<CR> <LF>			End of message termination

Table 3-8: GSA Data Format for NMEA v4.00

Name	Example	Units	Description
Message ID	$GPGSA		GSA protocol header
Mode 1	A		See Table 3-10
Mode 2	3		See Table 3-11
Satellite Used	30		SV on Channel 1. See Table 3-12
Satellite Used	12		SV on Channel 2. See Table 3-12
….	….	….	....
Satellite Used			SV on Channel 12
PDOP	1.21		Position Dilution of Precision
HDOP	0.72		Horizontal Dilution of Precision
VDOP	0.97		Vertical Dilution of Precision
System ID	1		See Table 3-13
Checksum	*11		
<CR> <LF>			End of message termination

Table 3-9: GSA Data Format for NMEA v4.10

Name	Example	Units	Description
Message ID	$GPGSA		GSA protocol header
Mode 1	A		See Table 3-10
Mode 2	3		See Table 3-11
Satellite Used	193		SV on Channel 1. See Table 3-12
Satellite Used	199		SV on Channel 2. See Table 3-12
….	….	….	....
Satellite Used			SV on Channel 12
PDOP	1.89		Position Dilution of Precision
HDOP	1.06		Horizontal Dilution of Precision
VDOP	1.56		Vertical Dilution of Precision
System ID	1		See Table 3-13
Checksum	*1D		
<CR> <LF>			End of message termination

Table 3-10: 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 3-11: Mode 2

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

Table 3-12: Satellite ID

Version	GPS	GLONASS	BeiDou	Galileo	QZSS	SBAS
3.01	01-32	65-96	201-237	301-330	193-199	40-54
4.00	01-32	65-96	01-36	01-30	193-199	40-54
4.10	01-32	01-24	01-36	01-30	193-199	127-141

Table 3-13: System ID (for NMEA v4.10 only)

System	ID
GPS	1
GLONASS	2
Galileo	3
BeiDou	4

GSV— Satellites in View, Including GPS (GPGSV), GLONASS (GLGSV), BeiDou (BDGSV), Galileo (GAGSV), GPS+Galileo and GLONASS or GPS+Galileo and BeiDou (GNGSV)

Table 3-14 explains the NMEA (version 3.01 / 4.00 / 4.10) sentences below:

NMEA version 3.01

(GPS Satellite)

```
$GPGSV,4,1,16,193,67,34,43,199,62,163,30,15,60,339,42,24,56,
170,32*4C
```

(GPS+Galileo and GLONASS satellites)

```
$GNGSV,6,3,24,6,48,343,32,41,40,243,36,88,37,358,42,66,36,
186,34*5B
```

(GPS+Galileo and BeiDou satellites)

```
$GNGSV,6,1,24,206,77,254,19,193,69,22,41,13,68,186,44,2,67,
54,38*52
```

NMEA version 4.00

(GPS Satellite)

```
$GPGSV,5,1,18,193,74,27,42,199,61,163,34,195,56,163,41,5,53,
293,28*44
```

(GLONASS Satellite)

```
$GLGSV,2,1,06,83,62,17,35,68,62,358,41,69,51,241,34,82,44,
119,31*54
```

(BeiDou Satellite)

```
$BDGSV,2,1,08,6,77,256,19,13,63,343,33,3,60,205,34,17,60,
204,35*6A
```

(Galileo Satellite)

```
$GAGSV,2,1,07,16,65,20,41,21,64,212,41,22,58,40,41,9,37,106,
40*58
```

NMEA version 4.10

(GPS Satellite)

```
$GPGSV,4,1,14,6,67,28,47,2,53,299,45,17,39,135,45,12,35,283,
43,1*5C
```

(GLONASS Satellite)

```
$GLGSV,2,1,07,1,64,188,27,8,60,41,33,23,44,12,34,22,30,88,
41,2*40
```

(BeiDou Satellite)

`$BDGSV,2,1,08,6,77,258,14,13,63,343,32,3,60,205,33,17,60,204,33,4*71`

(Galileo Satellite)

`$GAGSV,2,1,07,16,65,21,40,21,64,213,40,22,58,39,41,9,37,107,40,3*48`

Table 3-14: GNGSV Data Format for NMEA v3.01

Name	Example	Units	Description
Message ID	$GNGSV		GSV protocol header
Number of Messages	6		(Depending on the number of satellites tracked, multiple messages of GSV data may be required)
Message Number	3		
Satellites in View	24		
Satellite ID	6		Channel 1. See Table 3-17
Elevation	48	degrees	Channel 1 (Maximum 90)
Azimuth	343	degrees	Channel 1 (True, Range 0 to 359)
SNR (C/No)	32	dB-Hz	Range 0 to 99, (null when not tracking)
....	....	....	....
Satellite ID	66		Channel 4. See Table 3-17
Elevation	36	degrees	Channel 4 (Maximum 90)
Azimuth	186	degrees	Channel 4 (True, Range 0 to 359)
SNR (C/No)	34	dB-Hz	Range 0 to 99, (null when not tracking)
Checksum	*5B		
<CR> <LF>			End of message termination

Table 3-15: GPGSV Data Format for NMEA v4.00

Name	Example	Units	Description
Message ID	$GPGSV		GSV protocol header
Number of Messages	5		(Depending on the number of satellites tracked, multiple messages of GSV data may be required)
Message Number	1		
Satellites in View	18		
Satellite ID	193		Channel 1. See Table 3-17

Table 3-15: GPGSV Data Format for NMEA v4.00 (Continued)

Name	Example	Units	Description
Elevation	74	degrees	Channel 1 (Maximum 90)
Azimuth	27	degrees	Channel 1 (True, Range 0 to 359)
SNR (C/No)	32	dB-Hz	Range 0 to 99, (null when not tracking)
….	….	….	....
Satellite ID	5		Channel 4. See Table 3-17
Elevation	53	degrees	Channel 4 (Maximum 90)
Azimuth	293	degrees	Channel 4 (True, Range 0 to 359)
SNR (C/No)	28	dB-Hz	Range 0 to 99, (null when not tracking)
Checksum	*44		
<CR> <LF>			End of message termination

Table 3-16: GPGSV Data Format for NMEA v4.10

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)
Message Number	1		
Satellites in View	14		
Satellite ID	6		Channel 1. See Table 3-17
Elevation	67	degrees	Channel 1 (Maximum 90)
Azimuth	28	degrees	Channel 1 (True, Range 0 to 359)
SNR (C/No)	47	dB-Hz	Range 0 to 99, (null when not tracking)
….	….	….	....
Satellite ID	12		Channel 4. See Table 3-17
Elevation	35	degrees	Channel 4 (Maximum 90)
Azimuth	283	degrees	Channel 4 (True, Range 0 to 359)
SNR (C/No)	43	dB-Hz	Range 0 to 99, (null when not tracking)
Signal ID	1		See Table 3-18
Checksum	*5C		
<CR> <LF>			End of message termination

Table 3-17: Satellite ID

Version	GPS	GLONASS	BeiDou	Galileo	QZSS	SBAS
3.01	01-32	65-96	201-237	301-330	193-199	40-54
4.00	01-32	65-96	01-36	01-30	193-199	40-54
4.10	01-32	01-24	01-36	01-30	193-199	127-141

Table 3-18: Signal ID (for NMEA v4.10 only)

System	ID
GPS	1
GLONASS	2
Galileo	3
BeiDou	4

RMC—Recommended Minimum Navigation Information

Table 3-19 explains the NMEA (version 3.01 / 4.00 / 4.10) sentences below:

NMEA version 3.01 / 4.00

(GPS satellite)

```
$GPRMC,082929.000,A,2305.76749,N,12017.02532,E,0.008,310.72,
270918,,,A*50
```

(GPS+Galileo and GLONASS satellites)

```
$GNRMC,115332.000,A,4006.20852,N,11628.14483,E,0.000,298.12,
130918,,,D*48
```

(GPS+Galileo and BeiDou satellites)

```
$GNRMC,055841.000,A,2305.76786,N,12017.02377,E,0.008,87.90,
260918,,,D*7A
```

NMEA version 4.10

(GPS satellite)

```
$GPRMC,083148.000,A,2305.76780,N,12017.02465,E,0.003,310.72,
270918,,,A,S*2C
```

(GPS+Galileo and GLONASS satellites)

```
$GNRMC,115522.000,A,4006.20885,N,11628.14498,E,0.000,298.12,
130918,,,D,S*30
```

(GPS+Galileo and BeiDou satellites)

```
$GNRMC,060037.000,A,2305.76737,N,12017.02383,E,0.011,87.90,2
60918,,,D,S*03
```

Table 3-19: RMC Data Format for NMEA v3.01 and v4.00

Name	Example	Units	Description
Message ID	$GNRMC		RMC protocol header
UTC Time	115332.000		hhmmss.sss
Status	A		A: data valid or V: data not valid
Latitude	4006.20852		ddmm.mmmm
N/S Indicator	N		N North or S South
Longitude	11628.14483		dddmm.mmmm
E/W Indicator	E		E East or W West
Speed over Ground	0.000	Knots/hr	
Course over Ground	298.12	degrees	TRUE
Date	130918		ddmmyy
Magnetic Variation		degrees	
E/W Indicator	E		E East or W West
Mode	D		A: Autonomous mode D: Differential mode E: Estimated mode
Checksum	*48		
<CR> <LF>			End of message termination

Table 3-20: RMC Data Format for NMEA v4.10

Name	Example	Units	Description
Message ID	$GNRMC		RMC protocol header
UTC Time	115522.000		hhmmss.sss
Status	A		A: data valid or V: data not valid
Latitude	4006.20885		ddmm.mmmm
N/S Indicator	N		N North or S South
Longitude	11628.14498		dddmm.mmmm

Table 3-20: RMC Data Format for NMEA v4.10 (Continued)

Name	Example	Units	Description
E/W Indicator	E		E East or W West
Speed over Ground	0.000	Knots/hr	
Course over Ground	298.12	degrees	TRUE
Date	130918		ddmmyy
Magnetic Variation		degrees	
E/W Indicator			E East or W West
Mode	D		A: Autonomous mode D: Differential mode E: Estimated mode
Navigation Status	S		S: Safe C: Caution U: Unsafe V: Invalid (NMEA v4.10 and above only)
Checksum	*30		
<CR> <LF>			End of message termination

ZDA—Time and Date

Table 3-21 explains the NMEA (version 3.01 / 4.00 / 4.10) sentences below:

(GPS satellite)

`$GPZDA,082929.000,27,09,2018,08,00*51`

(GPS+Galileo and GLONASS satellites)

`$GNZDA,022826.000,27,09,2018,08,00*4B`

(GPS+Galileo and BeiDou satellites)

`$GNZDA,060037.000,26,09,2018,00,00*4C`

Table 3-21: ZDA Data Format

Name	Example	Units	Description
Message ID	$GNZDA		ZDA protocol header
UTC Time	022826.000		hhmmss.sss
Day	27		01 to 31
Month	09		01 to 12
Year	2018		

Table 3-21: ZDA Data Format

Name	Example	Units	Description
Local zone hours	08		
Local zone minutes	00		
Checksum	*4B		
<CR> <LF>			End of message termination

GST—Position Error Statistics

Table 3-22 explains the NMEA (version 3.01 / 4.00 / 4.10) sentences below:

(GPS satellite)

`$GPGST,054634.000,11,,,,3.5,4.6,12*4E`

(GPS+Galileo and GLONASS satellites)

`$GNGST,055116.000,4.1,,,,1.9,2.3,4.4*5D`

(GPS+Galileo and BeiDou satellites)

`$GNGST,055116.000,4.1,,,,1.9,2.3,4.4*5D`

Table 3-22: GST Data Format

Name	Example	Units	Description
Message ID	$GNGST		GST protocol header
UTC Time	055116.000		hhmmss.sss
Total RMS standard deviation of range inputs to the navigation solution	4.1	meters	
Standard deviation of semi-major axis of error ellipse		meters	
Standard deviation of semi-minor axis of error ellipse		meters	
Orientation of semi-major axis of error ellipse		degrees	
Standard deviation of latitude error	1.9	meters	
Standard deviation of longitude error	2.3	meters	
Standard deviation of altitude error	4.4	meters	
Checksum	*4E		
<CR> <LF>			End of message termination

NMEA Command Protocols

Command Meaning: Execute GNSS startup process.

Data Field: $PHD,06,40,U,BB,Mode*Checksum

Response Field: None

Mode:
- 0 = Reset
- 1 = Cold Start
- 2 = Warm Start
- 3 = Hot Start

Table 3-23: NMEA Command Protocol Example

Command	Response
Cold Start $PHD,06,40,U,BB,1*3A<CR><LF>	None

Note: Please refer to AirPrime XM1210 and XA12xx Software User Guide for more details.

>> 4: Reference Design

This section introduces the reference schematic design for best performance.

Reference Schematic Design for Using UART0 + I2C / UART0 + USB

The XM1210 provides several interfaces to process GNSS NMEA data (by specified firmware):

1. UART0 + I2C — both interfaces can support NMEA output. Refer to Figure 4-1.
2. UART0 + USB — both interfaces can support NMEA output. Refer to Figure 4-2.

Reference Schematic Design for Using UART0 + I2C

Figure 4-1: Reference Schematic for Using UART0 + I2C

Notes:

1. Ferrite bead, L1, is added for power noise reduction. Use one with an equivalent impedance (600Ω at 100MHz; IDC 200mA).

2. Place bypass capacitors, C1, C2 and C5, as close to the module as possible.

3. Damping resistors, R1 and R2, can be modified based on system application for EMI.

4. Pull high resistors, R3 and R4, can be modified based on system application for I2C.

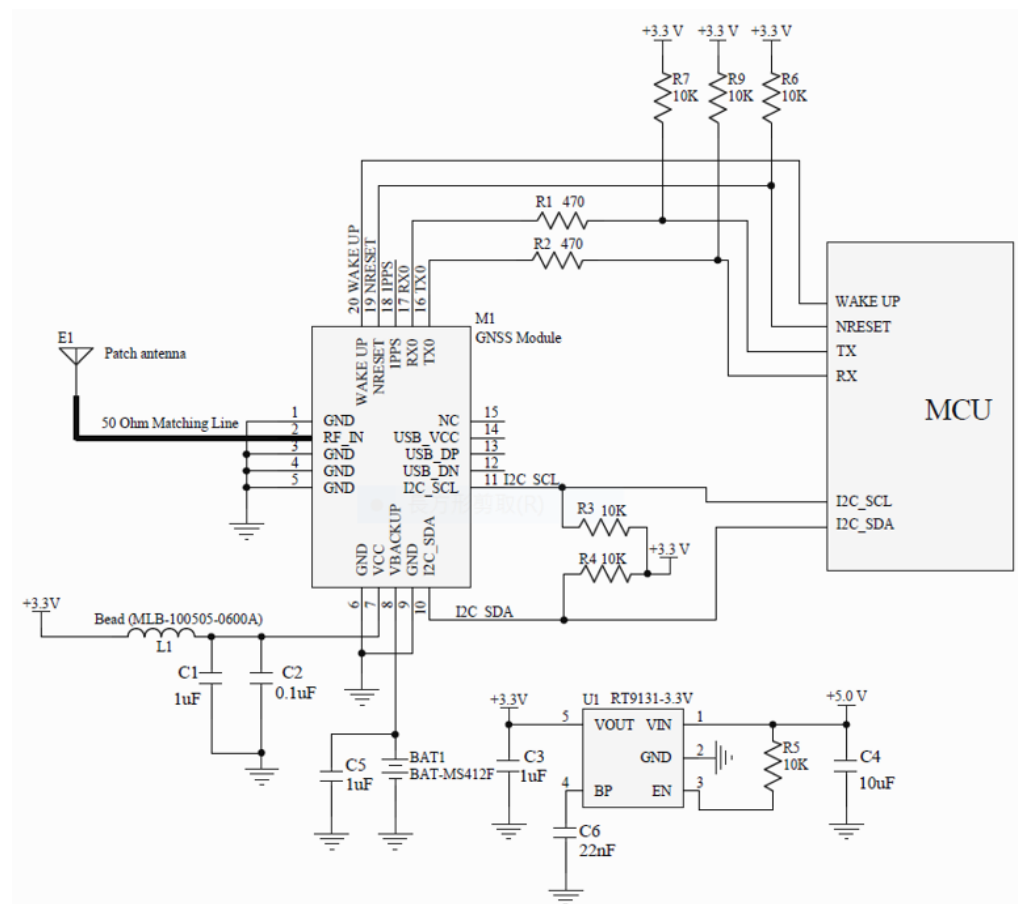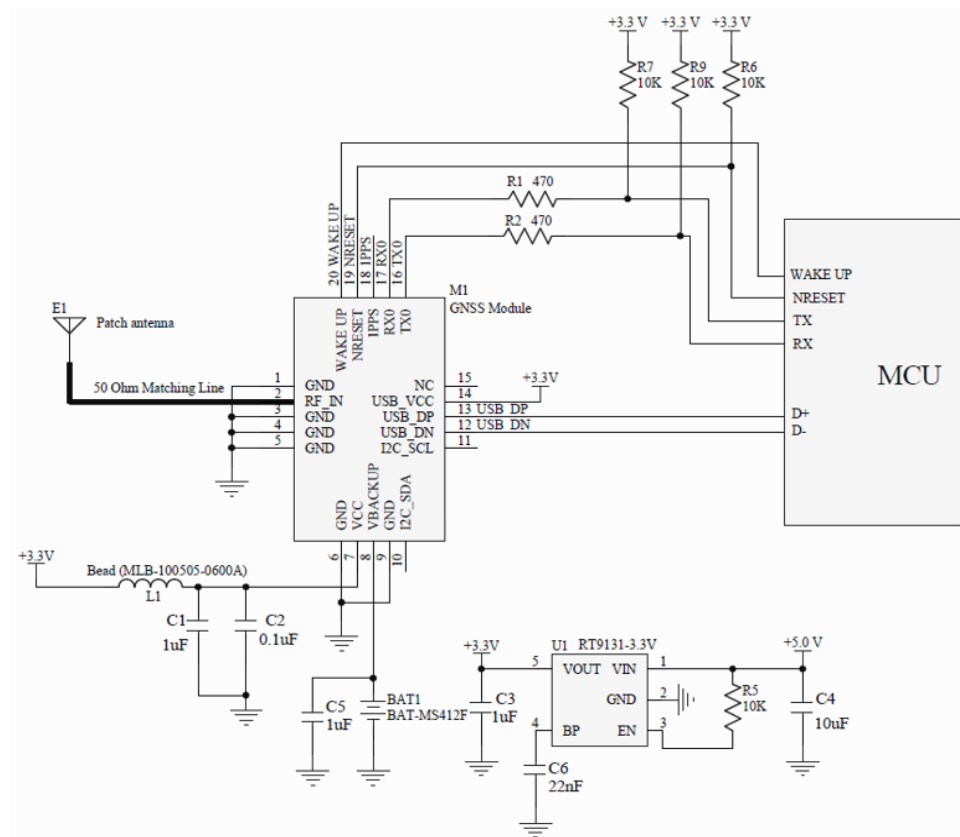# Reference Schematic Design for Using UART0 + USB

Figure 4-2: Reference Schematic for Using UART0 + USB

Notes:

1. Ferrite bead, L1, is added for power noise reduction. Use one with an equivalent impedance (600Ω at 100MHz; IDC 200mA).

2. Place bypass capacitors, C1, C2 and C5, as close to the module as possible.

3. Damping resistors, R1 and R2, can be modified based on system application for EMI.

Reference Schematic Design for Using a Patch (Passive) Antenna

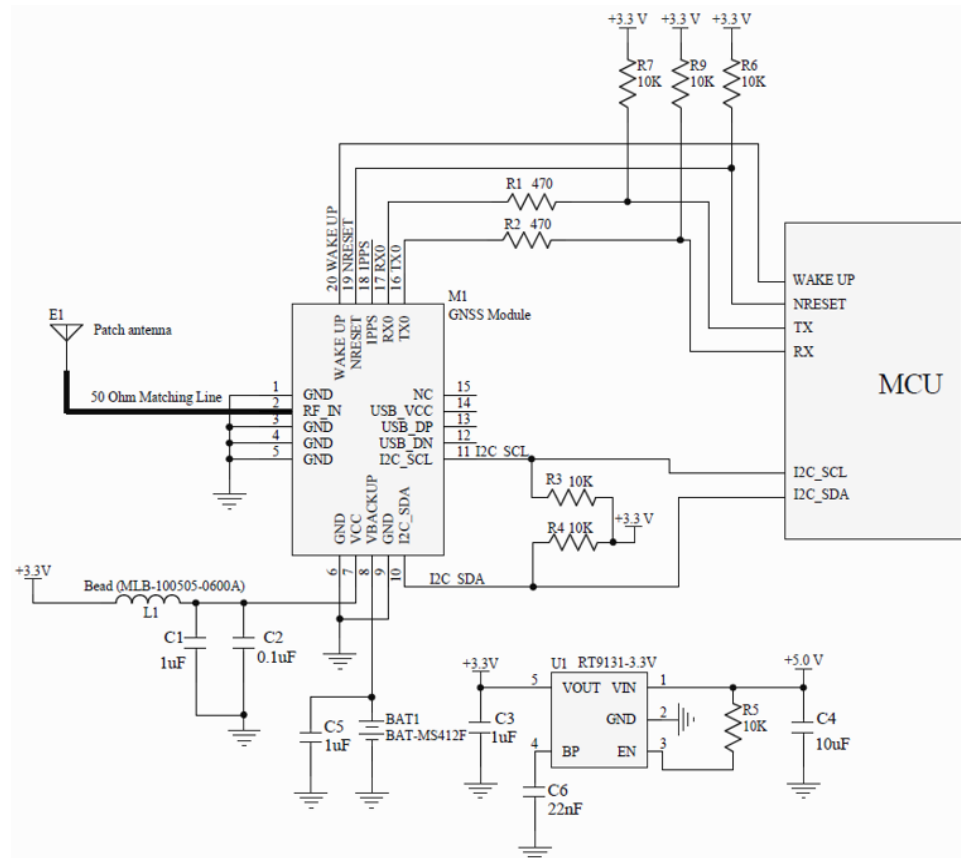Connect the passive antenna directly to RF_IN (Pin 2).

Figure 4-3: Patch Antenna

Notes:

1. Ferrite bead, L1, is added for power noise reduction. Use one with an equivalent impedance (600Ω at 100MHz; IDC 200mA).

2. Place bypass capacitors, C1, C2 and C5, as close to the module as possible.

3. Damping resistors, R1 and R2, can be modified based on system application for EMI.

4. Pull high resistors, R3 and R4, can be modified based on system application for I2C.

5. If you need more support and information on antenna implementation, please contact Sierra Wireless Sales.

Reference Schematic Design for Using an Active Antenna

Please connect the external antenna to RF_IN (Pin2)
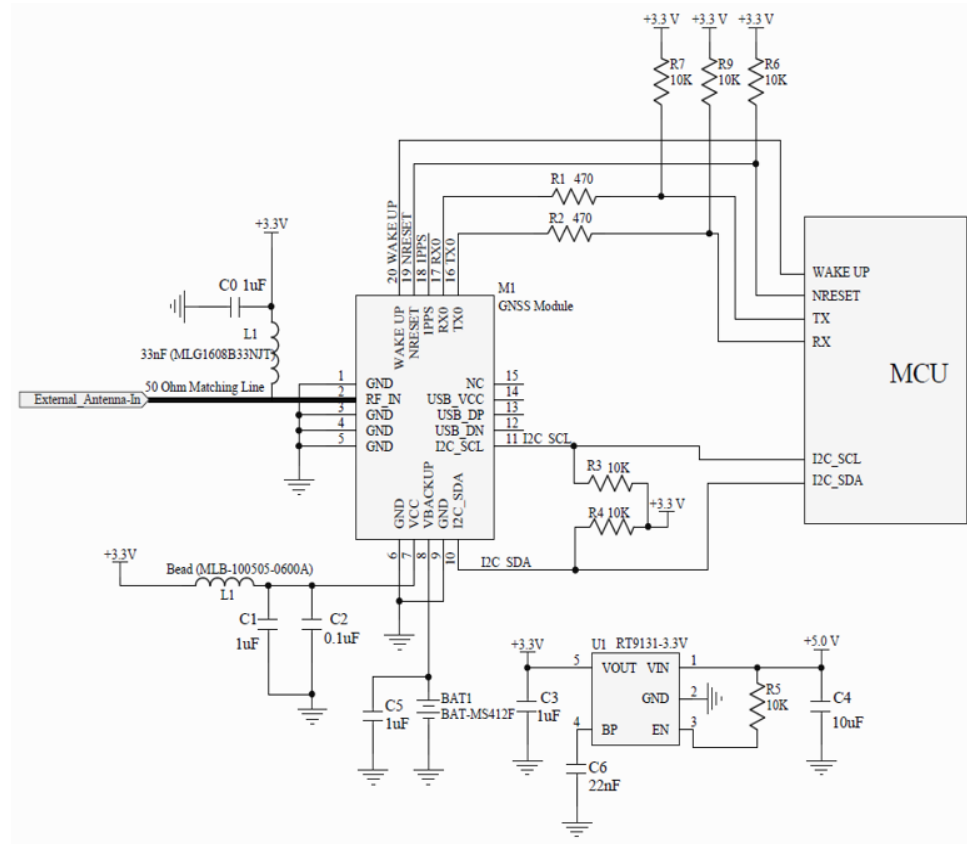

Figure 4-4: Active Antenna Application

Notes:

1. Ferrite bead, L1, is added for power noise reduction. Use one with an equivalent impedance (600Ω at 100MHz; IDC 200mA).

2. Place bypass capacitors, C1, C2 and C5, as close to the module as possible.

3. Damping resistors, R1 and R2, can be modified based on system application for EMI.

>> 5: General Rules for Circuit Design

This section provides rules to obtain the best performance when using the GNSS module.

Circuit Design

Power Supply

A low ripple voltage and stable power supply is required for the GNSS modules to perform optimally. An unstable power source will significantly impact GNSS RF reception performance. To achieve high-quality performance, additional considerations to stabilize power supply include:

1. Adding a ferrite bead, power choke, or low pass filter for power noise reduction.
2. Adding a linear regulator (LDO) is preferred rather than a switched DC/DC power supplier in the ripple.
3. Using enough decoupling capacitors with VCC input for stable voltage.
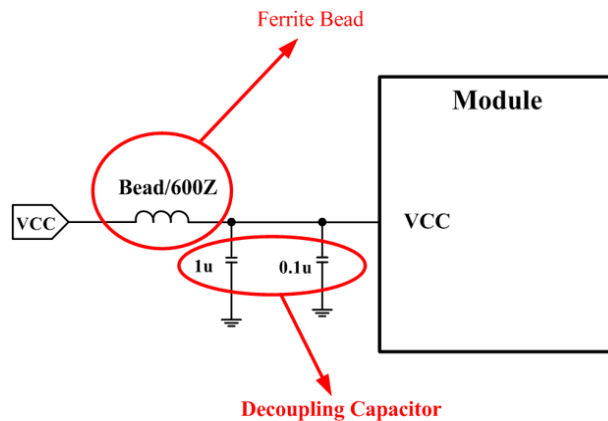

Figure 5-1: Power Design

VBACKUP Backup Battery

The GNSS module has a built-in charging circuit which charges the rechargeable coin battery.

It's recommended that the power supply of the module be provided with a backup power source (e.g. Li-Ion rechargeable coin battery, super capacitor). See Figure 5-2 for a reference design.

For information on the super capacitor reference design, please refer to Super Capacitor Design on page 48.

Backup power is needed to maintain RTC operation and retain ephemeris data in flash memory which speeds up 3D fixed and reduces TTFF time, and acquire PVT (Position, Velocity, Time) information.

If the VBACKUP pin isn't connected to any coin battery, the GNSS module will execute cold start procedure whenever the system is restarted.
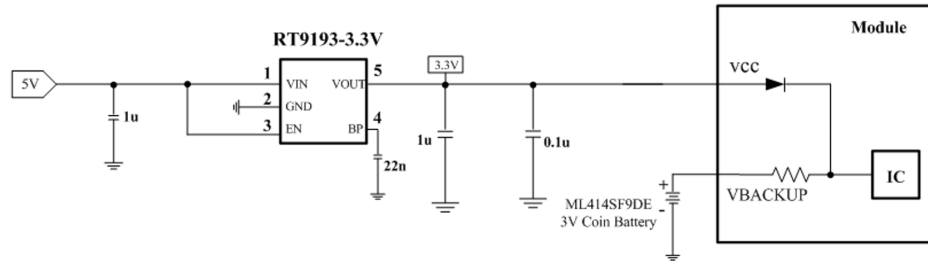

Figure 5-2: Rechargeable Coin Battery with VBACKUP

UART0 / I2C / USB Serial Interface

UART 0 (RX/TX)

1. UART is the TTL level interface that carries the baud rate ranging from 9600 bps to 115200 bps.

2. Placing a damping resistor on the RX and TX of the GNSS module could limit the interference from the host MCU or high-speed digital logics. Fine tuning the damping resistor is required to efficiently suppress interference. The damping resistor is a wire-wound component and may function as a choke coil.

3. Don't connect diode(s) to RX/TX as it will decrease the signal driving capability which might adversely affect the RX/TX signal level. In some cases, no data output will occur.

4. If RS232 logic-level is needed, a level shifter should be used. For more information please refer to UART to RS232 Interface on page 50.

5. If USB logic-level is needed please refer to the UART to USB Interface on page 51 design guidelines.

I2C (SCL/SDA)

1. The I2C interface is usually connected to external devices. ALLYSTAR HD8021only supports slave mode (default slave address is 0x55). The bit rate is up to 400 kbit/s for fast mode (default normal mode is 100 kbit/s). In addition, the GNSS module supports manual or automatic indicator for data transfer in slave mode.

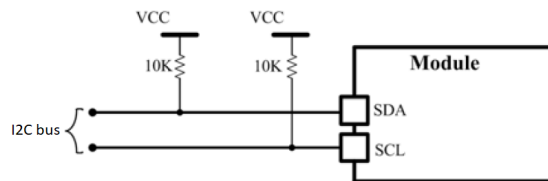2. Pull-up resistors must be added for the I2C bus as shown below:

Figure 5-3: Addition of Pull-up Resistor

USB (DP/DN)

1. USB supports version 2.0 full speed specifications as a peripheral interface which can also be used for communications as an alternative to UART.

2. The USB_DP and USB_DM pair must be traced by 90Ω (TYP) differential impedance.

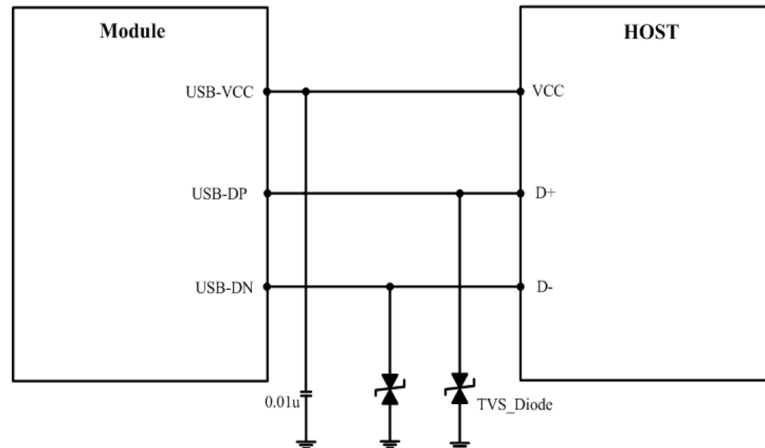3. Capacitance and TVS diode should be placed as close to USB bus as possible, as shown below:

Figure 5-4: Addition of Capacitance and TVS Diode

Antenna Compliance Design

The GNSS antenna is the receiving part of the device that acquires weak GNSS signals from the sky. A common solution is to use a ceramic patch antenna because of its small form factor and low cost. There are two types of antennas: passive and active.

A *passive* antenna is a standalone component without a signal amplifier such as an LNA. Patch antennas and chip antennas are the most commonly used passive antennas with GNSS modules. When using an external passive antenna, ensure that it is correctly fine-tuned for the specific module to ensure best possible signal strength.

An *active* antenna is a standalone external antenna that comes with an integrated LNA. These antennas provide higher gain and better performance than that of a passive antenna. An example of an active antenna includes Patch Antenna with RF Cable and Integrated LNA. When using an active antenna, an LNA antenna gain of 20dB–30dB (noise figure not more than 2dB) is recommended. Make sure that the internal LNA gain of the antenna will not leas to an overload condition for the GNSS module. For more details, refer to External Antenna Specification on page 39.

Make sure the ground plane is sufficient for the antenna to ensure best performance.

Designing an External Passive Patch Antenna with a GNSS Module

1. In general, a 50Ω patch antenna will work well with the GNSS module. The antenna can be connected to the *Antenna IN* pin with a 50Ω impedance trace.

2. Please keep the patch antenna far away from noise sources such as the switch power supply, high-speed digital logic signal and radar wave guide.

3. The 50Ω trace should be kept as short as possible to reduce the chance of picking up noise from the air and PCB. A simple direct-line trace is recommended.

4. If needed, a matching circuit can be placed between the patch antenna and the GNSS module. The matching circuit design could vary depending on the patch antenna.

5. For a 50Ω matching, please refer to 50Ω Antenna Matching on page 49 and the following figure:

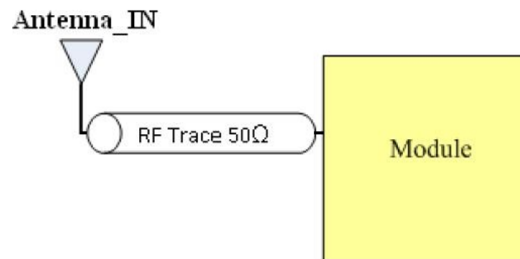*Figure 5-5: PCB Trace Design for Antenna Impedance Matching*

Selecting an Active Antenna Reference Design for the GNSS Module

An external active antenna requires DC power to work properly. A typical method is to feed DC into the RF trace. The external antenna then extracts the DC from the RF trace. Thus, the RF trace transports both the RF signal and DC power.

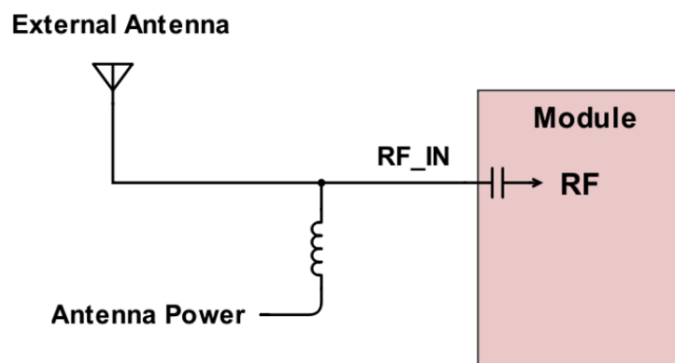An RF choke coil couples the DC power to the RF trace to perform this method.

Figure 5-6: External Choke Coil Method

The power supply needs to be externally provided and should be directly connected to the external antenna via a choke coil. (Reference choke coil: LQG15HS33NJ02D from Murata.)

External Antenna Specification

Refer to the various specifications listed in the tables below when selecting an external antenna.

Table 5-1: GPS/GLONASS External Antenna

Characteristic	Specification
Polarization	Right-hand circular polarized
Frequency Received	1.575GHz–1.615GHz
Power Supply	3.3V
DC Current	5mA<IDC<11mA at 3.3V
Total Gain	27±3dB
Output VSWR	2.0
Impedance	50Ω
Noise Figure	2dB

Table 5-2: BeiDou/GPS External Antenna

Characteristic	Specification
Polarization	Right-hand circular polarized
Frequency Received	1.516GHz–1.575GHz
Power Supply	3.3V
DC Current	3mA<IDC<30mA at 3.3V
Total Gain	27±1dB
Output VSWR	2.0
Impedance	50Ω
Noise Figure	1.5dB

Table 5-3: Tri-Frequency External Antenna

Characteristic	Specification
Polarization	Right-hand circular polarized (R.H.C.P)
Frequency Received	1558MHz–1615MHz

Table 5-3: Tri-Frequency External Antenna (Continued)

Characteristic	Specification
Center Frequency	1582±5MHz
Power Supply	3.3V
DC Current	10±3mA (at 3.3±0.1V)
BeiDou Gain (1561.098MHz)	25±3dB (at 3.3±0.1V)
GPS Gain (1575.42MHz)	27±3dB (at 3.3±0.1V)
GLONASS Gain (1602MHz)	27±3dB (at 3.3±0.1V)
Output VSWR	2.0 (typ)
Impedance	50Ω
Noise Figure	2dB

1PPS

1PPS signal is an output pulse signal used for timing applications. Its electrical characteristics are:
- Voltage level: 3.3V(Typ)
- Period: 1s
- Accuracy (jitter): 25ns
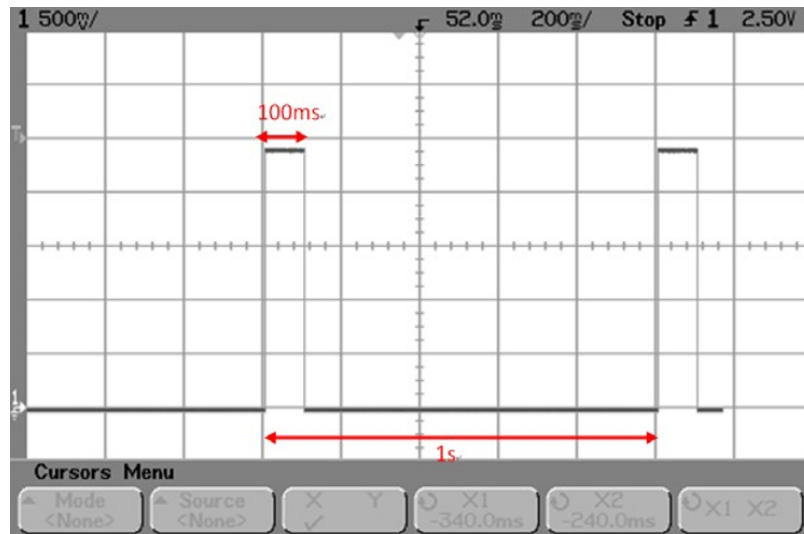- 100ms pulse width duration
- 1PPS Delay Compensation

Figure 5-7: 1PPS Signal and its Pulse Width with 100ms Duration

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Note: For information regarding 1PPS delay compensation command, refer to AirPrime XM1210 and XA12xx Software User Guide.

LED Indicator for 1PPS Signal

An LED indicator with a 330Ω resistor in series can be connected to indicate the 1PPS signal.
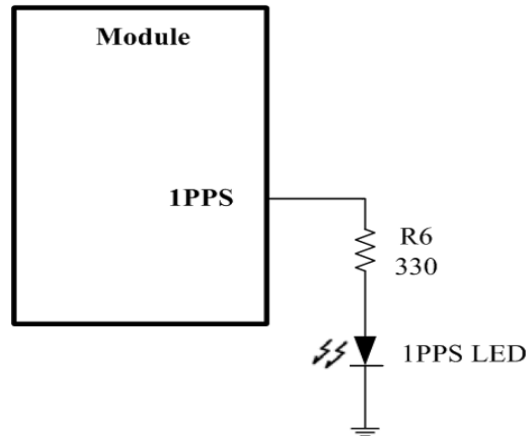

Figure 5-8: 1PPS Signal Design for IO

1.8V Boost to 3.3V Application

There are two considerations to use a 3.3V GNSS module in a 1.8V system: power supply translation and signal level shift.

For power supply translation, you can use a boost circuit which can boost 1.8V to 3.3V (refer to Figure 5-9 and Figure 5-10 below).

TPS61097A-33 is TI's boost IC which can support boost functionality. In the example application below, C1 and C2 need to use 10µF and L1 is 10µH. It can support approximately 100mA of output. For information about the capacitor and inductor's placement, refer to the application note on the TI web site: http://www.ti.com/lit/ds/symlink/tps61097a-33.pdf.
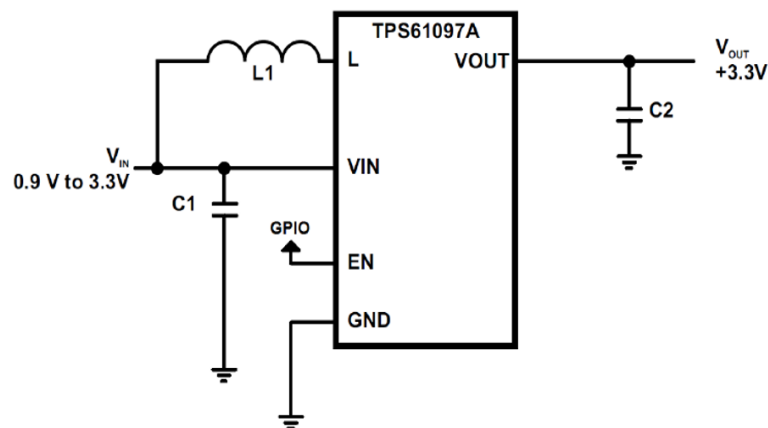
Figure 5-9: TI Boost IC Application Schematic
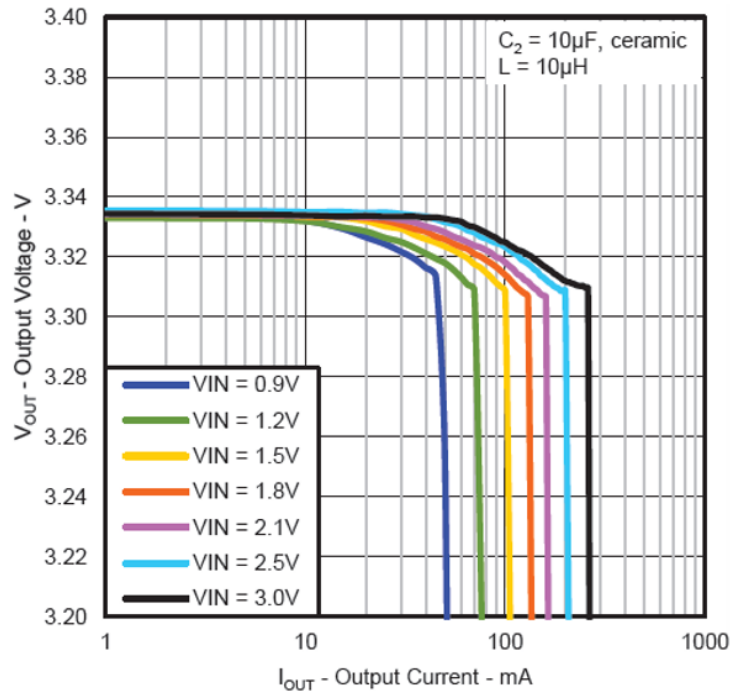
Figure 5-10: Output Voltage vs. Output Current

For signal level shift, when your host system is 1.8V and the GNSS module is 3.3V, the host system can control the GNSS module by using a signal level shift circuit (refer to Figure 5-11 below). R2 to R5's values are default values; these can be adjusted in the actual design to achieve control. The 2N7002L can select a low RDS(On) to reduce power consumption through a voltage drop.

Figure 5-11: Signal Level Shift Circuit

Layout Guidelines

Please follow the layout guidelines during the design process.

Layout Underneath the GNSS Module

In general, GNSS modules have high receiving sensitivity at around -161dBm. During hardware integration, try to avoid noise or harmonics in the following bands to prevent unnecessary reception degradation:
- GPS / QZSS / SBAS L1, 2.046 MHz BW NB (centered on 1575.42 MHz)
- GLONASS L1, ~8.3 MHz BW (1597–1606 MHz), 14 channels (-7 to +6)
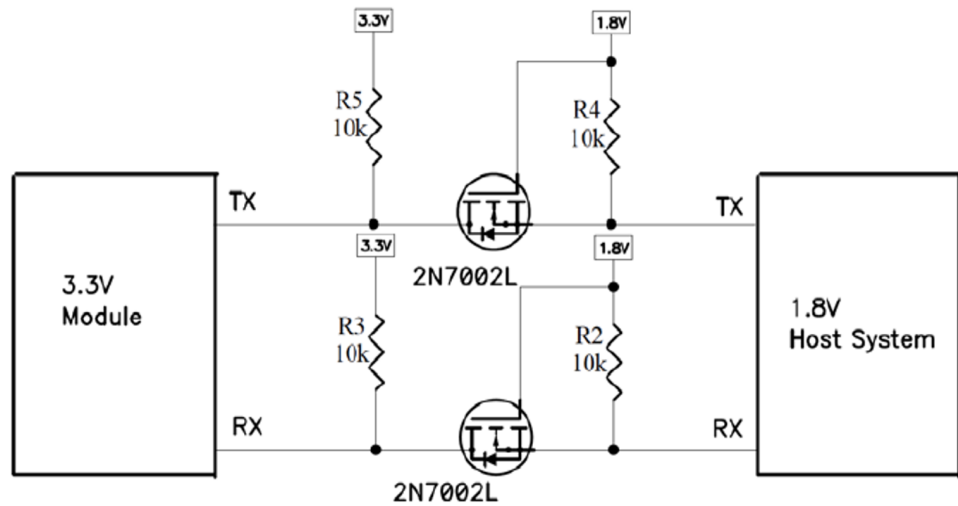- Galileo E1, 4.092 MHz BW (centered on 1575.42 MHz)
- BEIDOU B1, 4.092 MHz BW (1559.05 –1563.14 MHz)

Modern GNSS positioning products include many components such as an LCD screen, MCU, high-speed digital signal (access memory card), and an RF system (i.e. cellular module, BT, Wi-Fi, DVB-T). Keep these components away from the GNSS module to avoid noise interference, otherwise it may result in poor GNSS RF reception.

Don't leave any trace or mark underneath the GNSS module as indicated by the circled area in figure Figure 5-12 below.

Figure 5-12: GNSS Module with a clean GND Plane

Don't place any trace such as I2C (SCL/SDA), USB (DP/DN), UART (TX/RX) underneath the GNSS module, otherwise it will cause a sensitivity decrease.

Placement

- Place the decoupling capacitors for the VCC close to the GNSS module.
- Place the damping resistors for TX/RX close to the GNSS module.

Do not place the GNSS module:
- in proximity to high-speed digital processing circuitry
- in proximity to high-current switching power circuitry
- in proximity to clock sources circuitry

Trace

1. USB differential signals should be traced closely and be of equal length for better noise immunity and minimum radiation.
2. Apply a 50Ω RF trace impedance for correct impedance matching.
3. Any right angle turn in trace routing should be done with two 135 degree turns or an arc turn.

Figure 5-13: Examples of Turns in Trace Routing

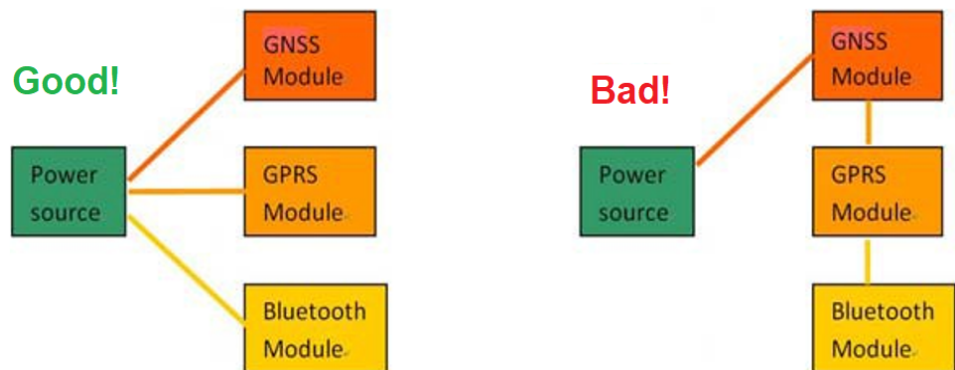It is better to have an independent trace of the power source for all components.

Figure 5-14: Examples of Independent Trace

Ground Segmentation

In general, the separation of ground between the GNSS module and the rest of the system is recommended to avoid interference. If this is not possible, it is best to follow these rules: segmentation of ground between digital and analog system, high current and low current system, and different radiation systems such as GPS and GSM/WCDMA/LTE.

One way to segment the ground is to place digital and noise components at one corner of the board, while placing analog and quiet components at the opposite corner of the board. Make sure there is no crossing of microstrip or current between the two component sets with ground; each set is to be contacted to one point only.

Another method is to place the two different sets at different layers of the board, while the ground of each layer is contacted at one point only which is ideally located at the border of the board.

⟫ 6: Troubleshooting

How to Check the Working Status of the GNSS Module

The first thing to check for is the NMEA sentence output through TX using various application tools. For example: you may use the Windows tool HyperTerminal, or you may use another GNSS application program.

Secondly, if there is no NMEA output at the TX pin, this indicates that the module is currently not working. Please double check your schematic design. The following is a list of possible items to check:

Item 1: VCC

The voltage should be kept between 3V to 3.6V (typical: 3.3V).

Item 2: VBACKUP

The voltage should be kept between 1.6V and 3.6V (typical: 3.3V). If a backup battery is not installed for the VBACKUP pin, the pin could still be measured as the voltage comes from the built-in battery recharging circuit. It is recommended that power be provided to the VBACUP pin as it is used to keep the RTC time running and to preserve stored navigation data.

Item 3: TX0

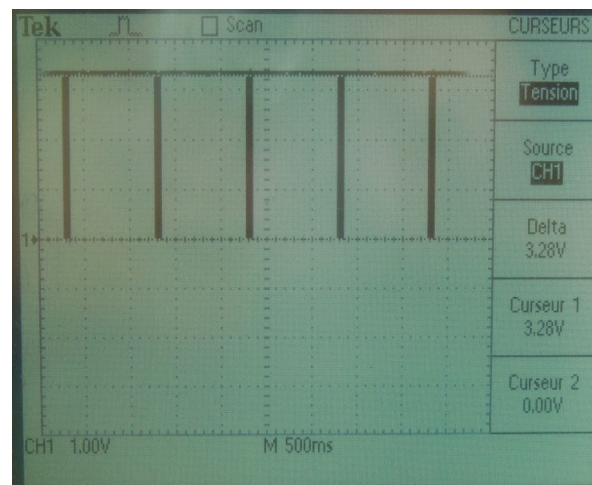The TX0 pin of the module outputs GNSS NMEA information.

Figure 6-1: TX0

7: Co-Design Layout Guide

Type 1: Co-Design Between XM1110 and XM1210

The following provides the necessary guidelines to successfully design XM1210 applications which are compatible with XM1110 modules.
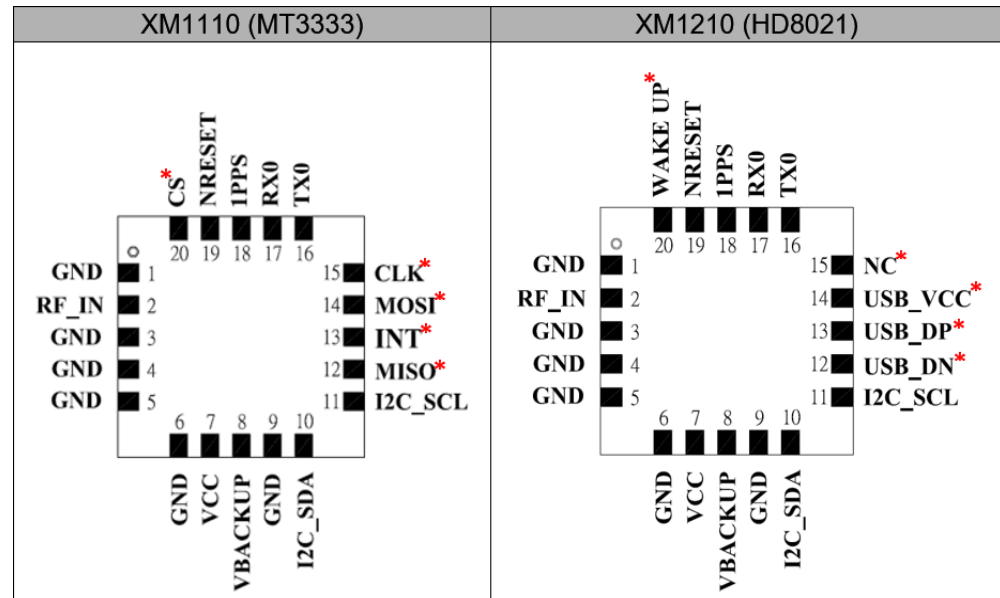

Figure 7-1: Module Pin Configuration

Note: A red asterisk (*) indicates a different pin assignment.

The following table enumerates pin assignments that are different between the XM1210 and XM1110.

Table 7-1: Pin Assignment Differences

XM1110 (MT3333)				XM1210 (HD8021)			
Pin	Name	I/O	Description	Pin	Name	I/O	Description
12	MISO	O	SPI serial data output (in slave mode)	12	USB_DN	I/O	USB differential data bus minus
13	INT	O	Interrupt pin for SPI or I2C	13	USB_DP	I/O	USB differential data bus plus

Table 7-1: Pin Assignment Differences (Continued)

XM1110 (MT3333)				XM1210 (HD8021)			
14	MOSI	I	SPI serial data input (in slave mode)	14	USB_VCC	PI	USB supply voltage input
15	CLK	I	SPI serial clock	15	NC	-	Not connected
20	CS	I	SPI serial chip select	20	WAKE UP	PI	Wake up from power saving

Refer to section 3.2.2 of the AirPrime XM Series Customer Process Guidelines for PCB layout recommendations for migrating between XM1110 and XM1210.
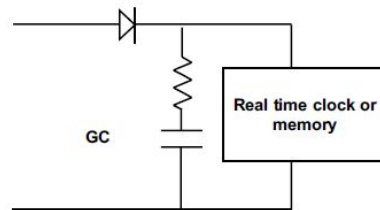
8: Super Capacitor Design

About Super Capacitors

Super capacitors have a lifetime similar to that of aluminum electrolytic capacitors. The service life of a super capacitor is greatly dependent on the operating temperature, humidity, applied voltage, current, and backup time. Therefore, the service life is determined based on the backup time set by the customer.
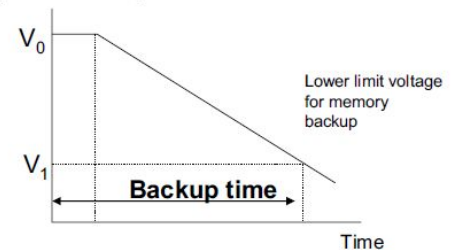
How to Calculate the Backup Time

The example below shows how to calculate the backup time:

$$T = C(V_0 - V_1) / (I + I_L)$$

Capacitor's voltage

V_0

Lower limit voltage for memory backup

V_1

Backup time

Time

Real time clock or memory

GC

Example:

$V_0 = 2.5V$, $V_1 = 1.8V$, $I = 10uA$, $C = 0.2F$

$T = 0.2 (2.5 - 1.8) / (10\ e\text{-}6 + 0.2 \times 10^{-6})$
   $= 0.14 / 10.2 \times 10^{-6}$
   $= 13,725$ seconds
   $= 3.8$ hours

T: Backup time (second)
C: Capacitance of Gold Capacitor (F)
V_0: Applied voltage(V)
V_1: Lower limit voltage for memory backup(V)
I: Current during backup(A)
I_L: Leakage current(A)   about 0.2uA

Figure 8-1: Calculating Backup Time

9: 50Ω Antenna Matching

We used the AppCAD tool to simulate 50Ω impedance for the RF PCB layout.

Table 9-1: Antenna Matching

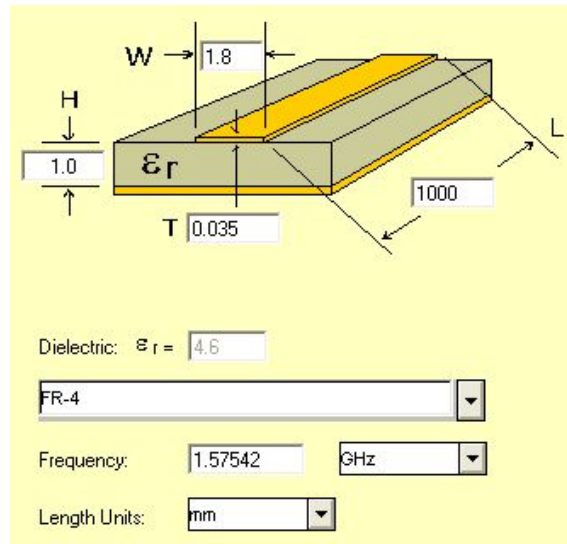| RF Line Width (W)	PCB FR4 Thickness	Dielectric Parameters	Copper Thickness per ounce
1.8mm	1mm	4.6	0.035mm

Figure 9-1: Dimensions

Notice:

For multi-layer layouts, you can place a ground layer in the second layer to minimize the trace width in a specific PCB (such as FR4) and impedance.

For impedance calculation, there is free software available to calculate the trace width or impedance. Once such software package is:

http://www.awrcorp.com/products/additional-products/tx-line-transmission-line-calculator

10: UART to RS232 Interface

Typically, an RS232 or USB interface is required to connect the PC to the Sierra Wireless GNSS module for communication. Most Sierra Wireless modules use a set of communication ports in TTL-logic. A bridge IC may be needed for RS232 signal conversion.

The supported baud-rates are 9600, 19200, 38400, 57600, and 115200 bps.

Please refer to the reference circuit in Figure 10-1 below for RS232 signal conversion. An SP3220E IC is used here as an example.
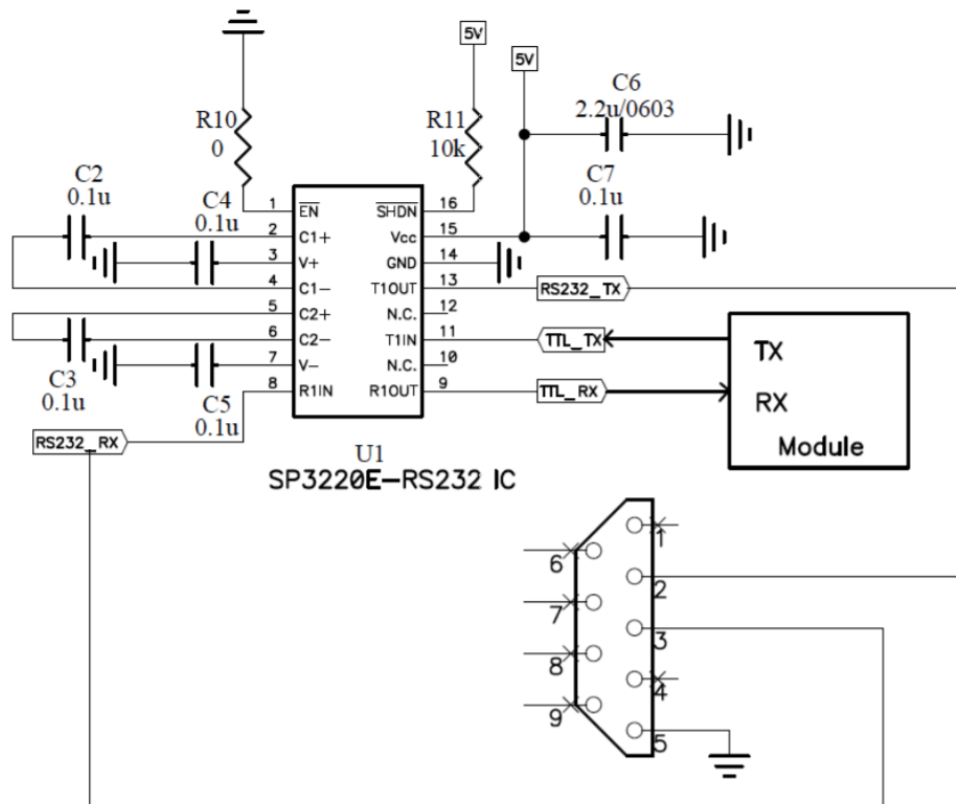

Figure 10-1: RS232 Signal Conversion Example

11: UART to USB Interface

If the Sierra Wireless module you have purchased does not come with a USB interface, it is possible to connect the module to an external USB IC. To further enhance the transferring speed, use one that is capable of USB version 2.0. Once the driver for the chosen USB Bridge IC is successfully installed in Windows or another operating system, the USB Bridge IC will automatically be recognized as a COM port.

Note: a proper driver must be installed for the USB to be recognized by the operating system.

Please refer to the reference circuits in Figure 11-1 below for the conversion. A CP2102 IC is used here as an example.
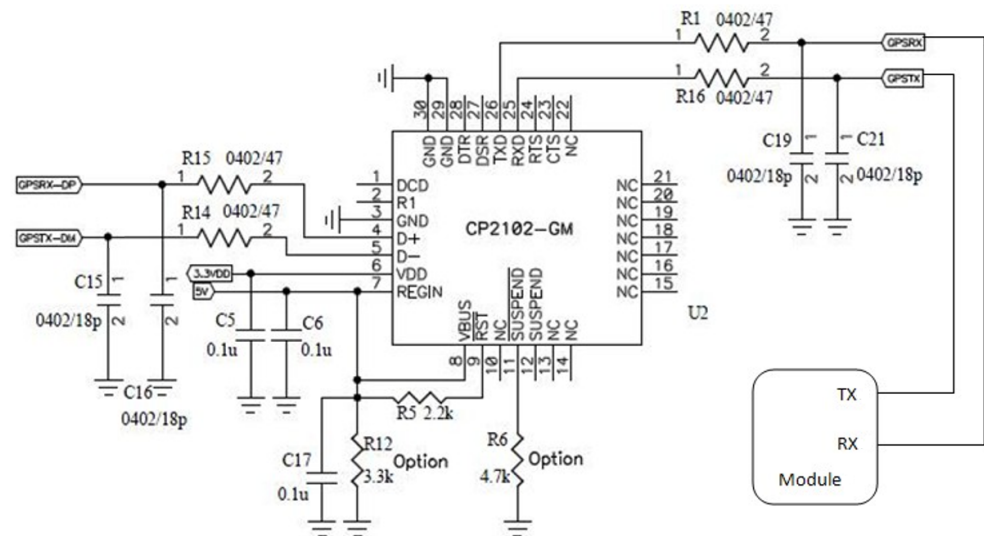

Figure 11-1: UART to USB

Pin 29 and Pin 30 are the bottom ground pads which are not documented in the IC datasheet. You may ignore these two pins in the drawing.