AirPrime XA1210

Product Technical Specification

41112821
Rev 2.1

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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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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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Revision History

Revision number	Release date	Changes
1.0	November 14, 2018	Creation
1.1	November 21, 2018	Fixed links and typos
2.0	February 19, 2019	Updated: • Figure 2-2 on page 12 • Links in Table 3-9 on page 22 • Figure 7-2 on page 43 • Figure 7-4 on page 44
2.1	March 08, 2019	Added GST in: • Table 3-2 on page 19 • Table 3-3 on page 19 • Table 3-4 on page 19 • GST—Position Error Statistics on page 29

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1: Function Description

Overview

The XA1210 is a POT (Patch On Top) GNSS module that is capable of tracking GPS and GLONASS satellites simultaneously. It comes with an integrated GPS+GLONASS patch antenna that is optimized for performance in compact devices.

The XA1210 is ultra-compact and comes in a 12.5 x 12.5 x 7.9 mm 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 consumption of power while offering optimum GNSS sensitivity and performance.

The XA1210 is based on latest HD8021 chipset and supports all standard GNSS features including QZSS, SBAS, Anti-Jamming and AGPS.

Target Applications

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

Figure 1-1: XA1210

Product Highlights and Features

- 24 tracking/48 acquisition-channel GPS and GLONASS receiver
- Supports QZSS and SBAS (WAAS, EGNOS, MSAS, GAGAN)
- Sensitivity: -161dBm
- Update Rate: 1Hz (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 (typical)
    - Tracking: 35mA (typical)
- RoHS compliant

System Block Diagram

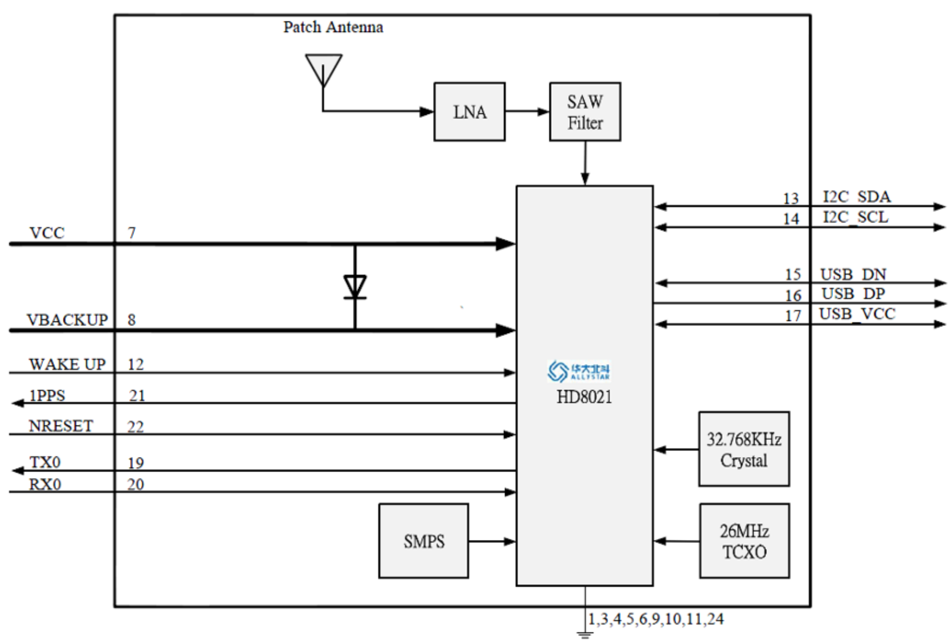


Figure 1-2: System Block Diagram

I2C

The I2C interface is a serial input & 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.

- Supports USB 2.0 full speed
- Full Speed: 12Mbps

1PPS

The XA1210 generates a-pulse-per-second signal (1 PPS) after 3D fixed. It is an electrical signal which precisely indicates the start of a second with 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) to speed up TTFF (Time To First Fix). This feature is useful when satellite signal is weak. AGNSS ephemeris can be downloaded from an FTP server via the internet.

PVT Logger Function

PVT logger function is enabled in the XA1210 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 XA1210 module has 32 KB for this function which use the smart overlapping mechanism to keep the latest logger data (4KB).

2: Specifications

Mechanical Dimensions

Dimension: (Unit: mm, Maximum height: 7.9 mm)

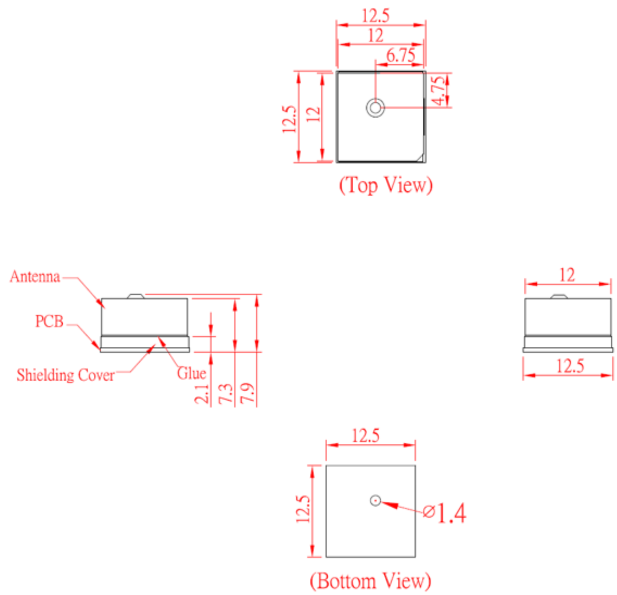


Figure 2-1: Mechanical Dimensions

PCB Copper Pad Definition

(Unit: mm, Tolerance: ±0.1mm)

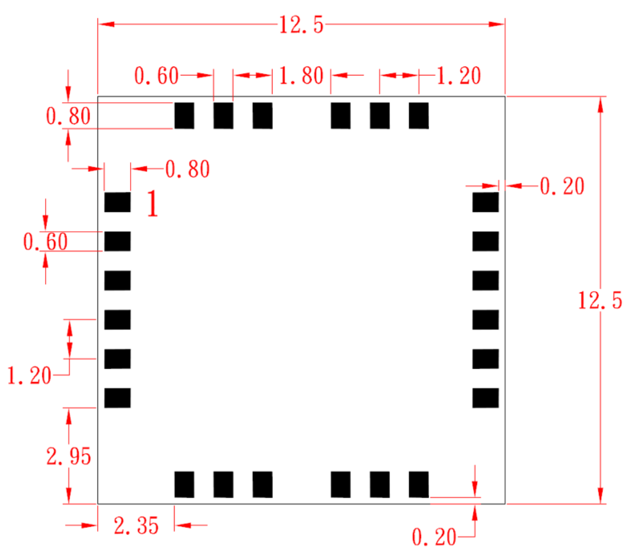


Figure 2-2: PCB Copper Pad

Pin Configuration

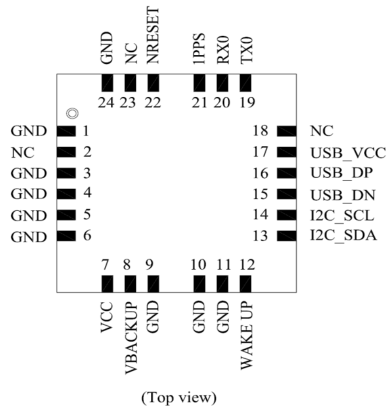


Figure 2-3: Pin Configuration.

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	NC	-	Not connected				Left open
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	GND	P	Ground		0V		Mandatory connection
11	GND	P	Ground		0V		Mandatory connection
12	WAKE UP	PI	Wake up from power saving	H			Left open
13	I2C_SDA	I/O	I2C Serial data (in slave mode)		3.3V	O, PU	Left open[b]
14	I2C_SCL	I	I2C Serial clock (in slave mode)		3.3V	I, PU	Left open[b]
15	USB_DN	I/O	USB differential data bus minus		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
16	USB_DP	I/O	USB differential data bus plus		3.3V		Left open[b]
17	USB_VCC	PI	USB supply voltage input		3.3V		Left open[b]
18	NC	-	Not connected				Left open
19	TX0	O	Serial data output for NMEA output (TTL)		3.3V	O, PU	Left open[b]
20	RX0	I	Serial data input for Firmware update (TTL)		3.3V	I, PU	Left open[b]
21	1PPS	O	1PPS time mark output		3.3V	O, PU	Left open
22	NRESET	I	Reset Input	L	3.3V	I, PU	Left open
23	NC	-	Not connected				Left open
24	GND	P	Ground		0V		Mandatory connection

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**: NC (Not connected)
- **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 GNSS module. A power source (such as a battery) connected to this pin will help the GNSS chipset 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 GNSS 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, keep this pin floating.
- **Pin9**: GND (Ground)
- **Pin10**: GND (Ground)
- **Pin11**: GND (Ground)
- **Pin12**: WAKE UP
  - Active on High will wake up the module from backup (power-saving) mode.

Table 2-2: WAKE UP

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

Table 2-3: Power-Saving Mode and BootROM Mode

Mode	Function
Normal (default)	When the module is existed firmware code, system will enter Normal mode.
Power-saving	When the module enters power-saving mode, it can be woken up by this pin. (WAKEUP pin is active on High.)
BootROM	Enter BootROM mode to upgrade firmware. Follow the steps below before powering up the module: 1. WAKEUP pin must be connected to “GND”. 2. Power up the module’s main power. 3. WAKEUP pin can be completely removed from “GND”. 4. Use “SWGNSSTool” to upgrade firmware.

- **Pin13**: I2C_SDA
  - This pin can be used to transmit and receive data and communicate with the host.
  - If not used, keep this pin floating.
- **Pin14**: I2C_SCL
  - This pin can be used to transmit and receive clock information and communicate with the host.
  - If not used, keep this pin floating.
- **Pin15**: USB_DN
  - Dedicated Full Speed v2.0 (DN pin of the USB connector)
- **Pin16**: USB_DP
  - Dedicated Full Speed v2.0 (DP pin of the USB connector)
- **Pin17**: USB_VCC
  - USB supply voltage (3.0V to 3.6V; typical: 3.3V)
- **Pin18**: NC (Not connected)
- **Pin19**: TX0 (UART 0 transmitter; outputs GNSS information for application)
- **Pin20**: RX0 (UART 0 receiver; to receive commands from host)
- **Pin21**: 1PPS
  - This pin provides one pulse-per-second signal output.
  - If not used, keep this pin floating.

- **Pin22**: NRESET
  - Active on Low for the module to reset.
  - If not used, keep this pin floating.

Table 2-4: NRESET

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

- **Pin23**: NC (Not connected)
- **Pin24**: GND (Ground)

Specifications

Table 2-5: Specification Data

Description	
GNSS Solution	Allystar HD8021
Frequency	GPS/QZSS L1, 1575.42MHz GLONASS L1, 1598.0625~1605.375MHz
Sensitivity	Acquisition: -147dBm Tracking: -161dBm
SV Number GPS BEIDOU	GPS #1~32 GLONASS #65~96 (see Chapter 3 for details)
Protocol	NMEA 0183 V3.01 (Default), NMEA 0183 V4.0, NMEA 0183 V 4.1
TTFF (Num of SVs≥6, C/N>40dB)	Hot start: 2 seconds 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]

Table 2-5: Specification Data (Continued)

Description	
Power Supply	VCC: 3.0V to 3.6V VBACKUP: 1.6V to 3.6V USB: 3.0V to 3.6V
Current Consumption @ 3.3V,1Hz Update Rate	GPS and GLONASS Acquisition: 40mA (typical) Full Power Tracking: 35mA (typical)
Backup Power Consumption @ 3.3V	10µA (typical)
Power Saving	Sleep mode: 7mA (typical) Deep sleep mode: 300µA (typical) Main power down mode: 15µA (typical)
NRESET Current @ 3.3V	75µA (typical)
Working Temperature	-40°C to +85°C
Dimension	12.5 x 12.5 x 7.9 mm, SMD
Weight	4.8g

Absolute Maximum Ratings

The maximum power supply voltage is 3.6V.

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	2.0	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	2.0	3.3	V
USB_L level Input	-	0	1	V
USB_H level output	USB_VCC=3.3V	2.3	3.3	V
USB_L 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 GPS 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

The following tables list NMEA output sentences used in GPS and GLONASS 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 and GLONASS)	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 and GLONASS)	GNGGA	GPGSA GLGSA[a]	GPGSV GLGSV[a]	GNRMC	GNZDA	GNGST

a. In Talker ID, GP is a short term of GPS, GL is GLONASS 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 and GLONASS)	GNGGA	GNGSA	GPGSV GLGSV[a]	GNRMC	GNZDA	GNGST

a. In Talker ID, GP is a short term of GPS, GL is GLONASS 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 and GLONASS satellites:

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

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
Satellites Used	17		
HDOP	0.81		Horizontal Dilution of Precision
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) and, GPS and GLONASS

The following tables 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 and GLONASS satellites:

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

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
```

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 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
```

Table 3-7: GGA Data Format for NMEA v.301

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
Satellite Used	19		SV on Channel 2
....	....	....	....
Satellite Used			SV on Channel 12
PDOP	1.21		Position Dilution of Precision

Table 3-7: GGA Data Format for NMEA v.301 (Continued)

Name	Example	Units	Description
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: GGA 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: GGA 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

Table 3-9: GGA Data Format for NMEA v4.10 (Continued)

Name	Example	Units	Description
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	QZSS	SBAS
3.01	01-32	65-96	193-199	40-54
4.00	01-32	65-96	193-199	40-54
4.10	01-32	01-24	193-199	127-141

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

System	ID
GPS	1
GLONASS	2

GSV—Satellites in View, Including GPS (GPGSV), GLONASS (GLGSV) and, GPS and GLONASS (GNGSV)

The following tables explain 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 and GLONASS satellites:

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

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
```

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
```

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)

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

Name	Example	Units	Description
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
Elevation	74	degrees	Channel 1 (Maximum 90)
Azimuth	27	degrees	Channel 1 (True, Range 0 to 359)
SNR (C/No)	42	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	QZSS	SBAS
3.01	01-32	65-96	193-199	40-54
4.00	01-32	65-96	193-199	40-54
4.10	01-32	01-24	193-199	127-141

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

System	ID
GPS	1
GLONASS	2

RMC—Recommended Minimum Navigation Information

The following tables explain the NMEA (version 3.01/4.00/4.10) sentences below.

NMEA version 3.01 and 4.00

GPS satellite:

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

GPS and GLONASS satellites:

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

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 and GLONASS satellites:

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

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 V: data not valid
Latitude	4006.20852		ddmm.mmmm
N/S Indicator	N		N: North S: South
Longitude	11628.14483		dddmm.mmmm
E/W Indicator	E		E: East 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 W: West

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

Name	Example	Units	Description
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 V: data not valid
Latitude	4006.20885		ddmm.mmmm
N/S Indicator	N		N: North S: South
Longitude	11628.14498		dddmm.mmmm
E/W Indicator	E		E: East 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 W: West
Mode	D		A: Autonomous mode D: Differential mode E: Estimated mode
Navigation Status	S		S: Safe C: Caution U: Unsafe V: Invalid
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 and GLONASS satellites:

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

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		01-12
Year	2018		
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 and GLONASS 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	055116.00		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	

Table 3-22: GST Data Format (Continued)

Name	Example	Units	Description
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

Example:

Cold start command: `$PHD,06,40,U,BB,1*3A<CR><LF>`

Response: None

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

4: Reference Design

The XA1210 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

The following sub-sections introduces the reference schematic design for best performance.

Reference Schematic Design for Using UART0 + I2C

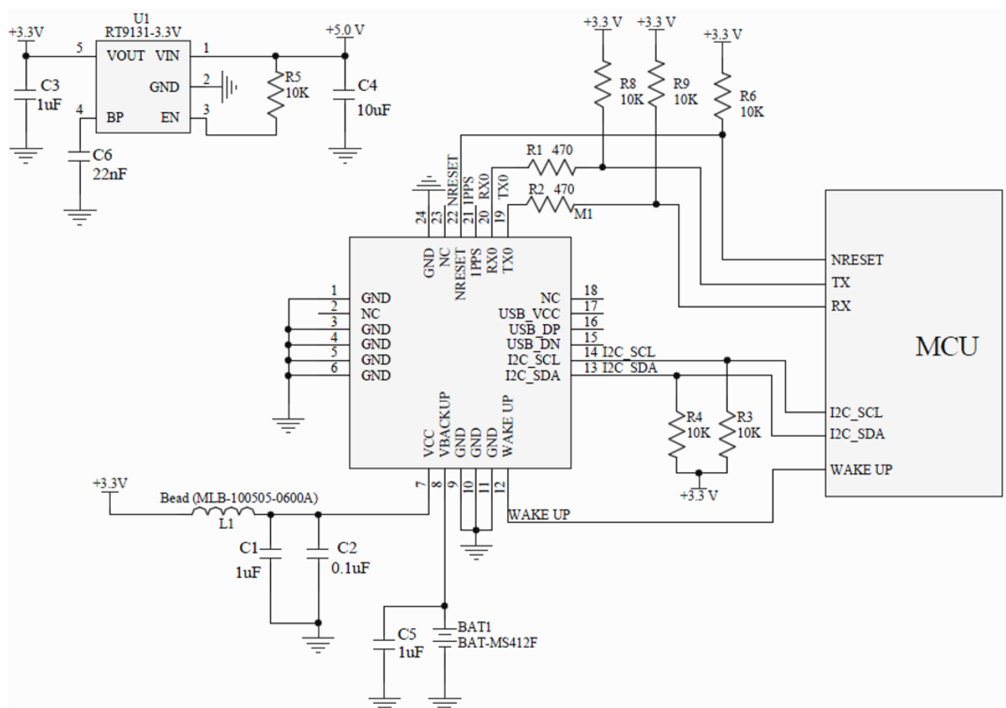


Figure 4-1: UART + I2C

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

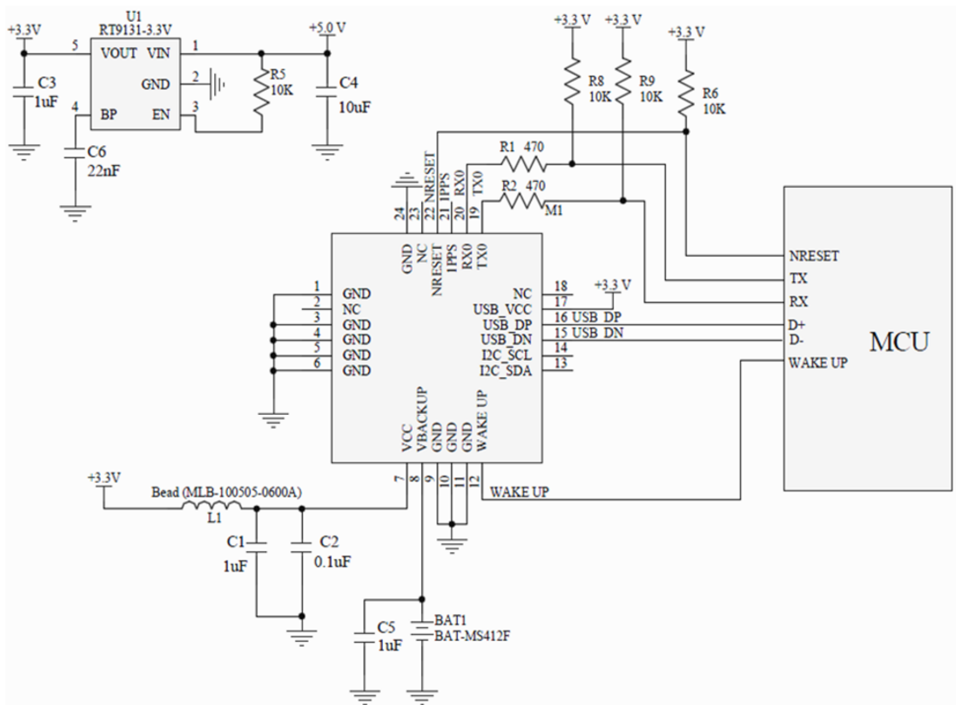


Figure 4-2: UART + USB

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.

5: General Rules for Circuit Design

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

Power Supply

A low ripple voltage and stable power supply is required for the module 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 to a switched DC/DC power supply.
3. Using enough decoupling capacitors with VCC input for stable voltage.

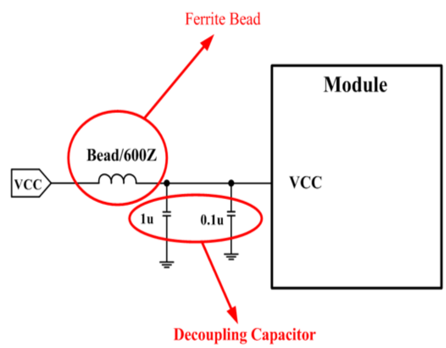


Figure 5-1: Power Design

VBACKUP Backup Battery

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

It is 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 45.

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.

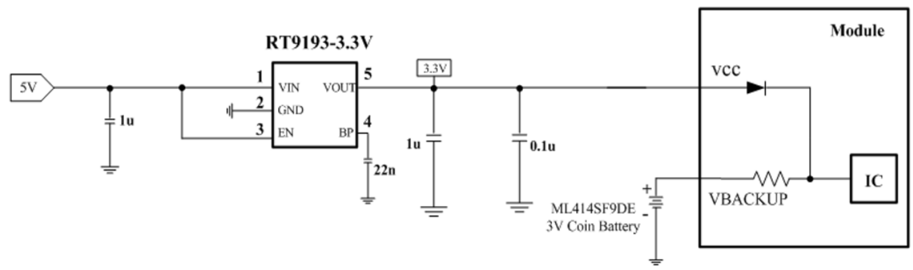


Figure 5-2: Rechargeable Coin Battery with VBACKUP

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 47.
5. If USB logic-level is needed please refer to the UART to USB Interface on page 48 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 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:

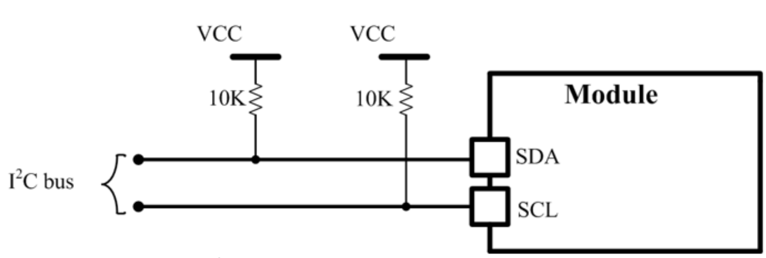


Figure 5-3: Addition of Pull-up Resistor

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. (A AZ1605-01L TVS diode from Amazing can be used.)

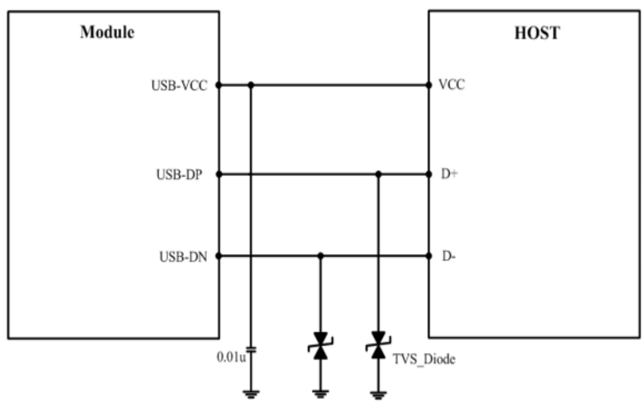


Figure 5-4: Addition of Capacitance and TVS Diode

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

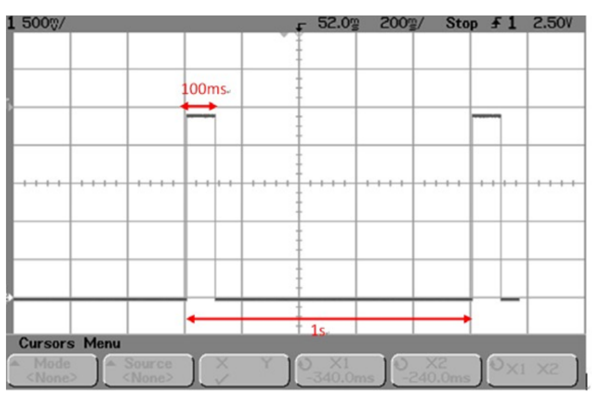


Figure 5-5: 1PPS Signal and its Pulse Width with 100ms Duration

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

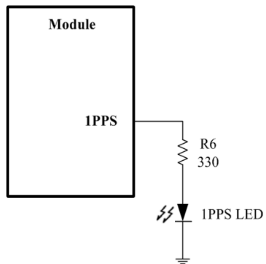


Figure 5-6: 1PPS Signal Design for IO

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 5-7 and Figure 5-8 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.

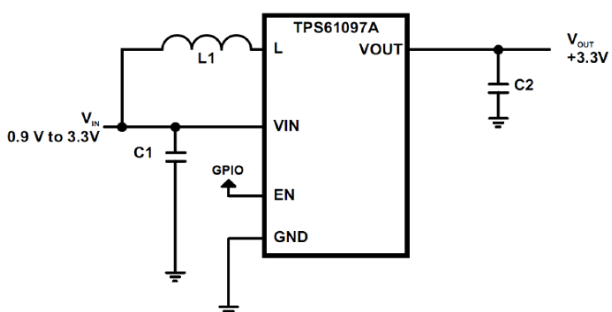


Figure 5-7: TI Boost IC Application Schematic

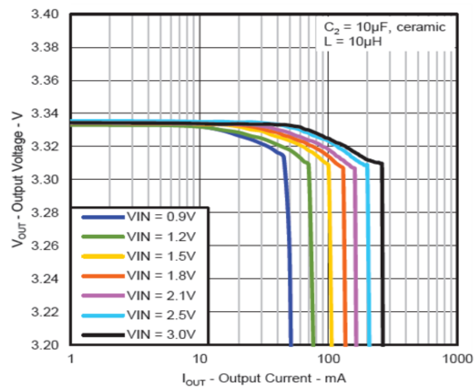


Figure 5-8: Output Voltage vs. Output Current

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 5-9 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.

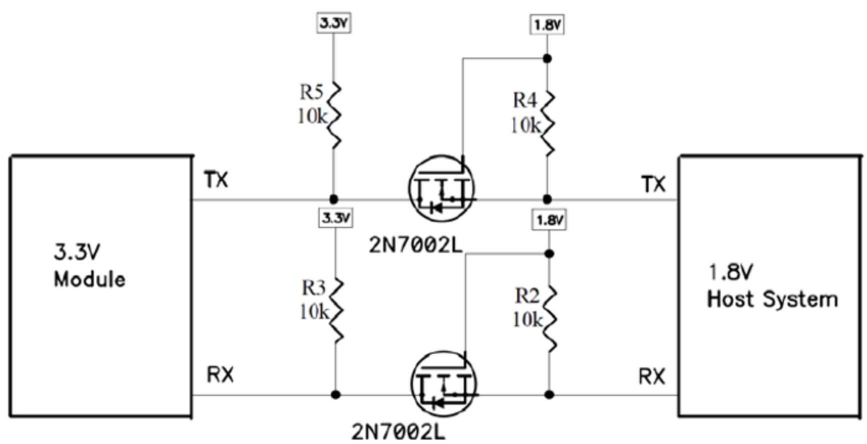


Figure 5-9: Signal Level Shift Circuit

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 1572.42MHz±2MHz
- GLONASS 1598.0625~1605.375MHz

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 5-10 below.

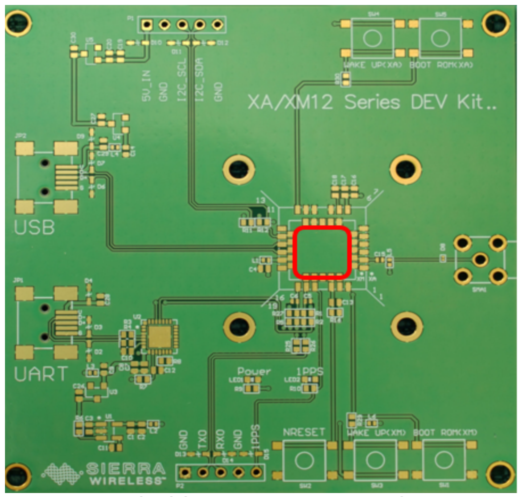


Figure 5-10: GNSS Module with a clean GND Plane

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

It is good practice to place the module far away from any high-profile components especially those enclosed in metal cases such as the e-cap, coin battery, and pin header. Placing the module close to these components can affect the antenna field pattern, and pattern distortion can occur. At worst, this will decrease the GNSS signal up to ~10dB.

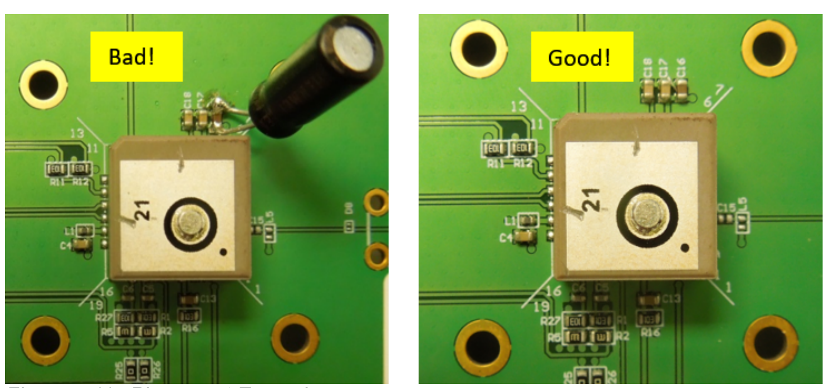


Figure 5-11: Placement Examples

Generally:
- Place the decoupling capacitors for the VCC close to the module.
- Place the damping resistors for TX/RX close to the 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 5-12: Examples of Turns in Trace Routing

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

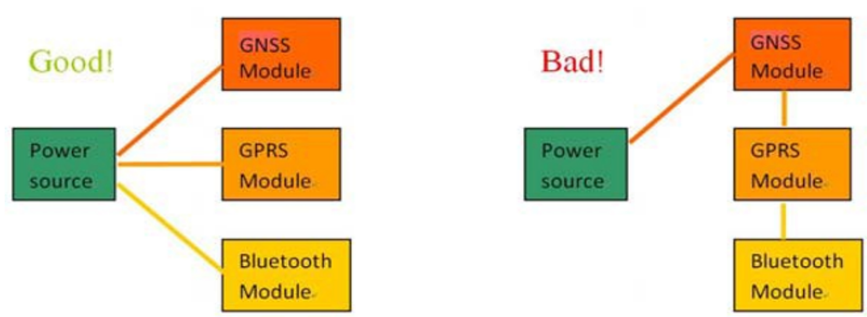


Figure 5-13: Examples of Independent Trace

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 GPRS.

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.

Ground Plane

A large Ground plane directly underneath the module can enhance the magnetic field line of the antenna for better GNSS signal reception. This will typically improve reception by up to ~2dB. It is strongly recommended that the ground plane underneath the module be as large as possible.

The recommended thickness for the ground layer is 0.5 to 1 OZ (0.0175 to 0.035 mm). It is best to place the ground plane on the top layer of the PCB, directly underneath the GNSS module as shown in Figure 5-14.

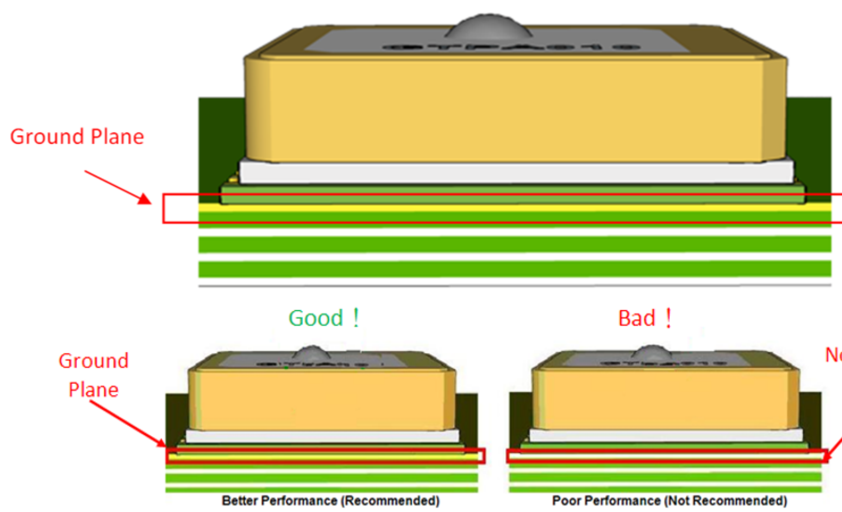


Figure 5-14: Ground Plane Example

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 VBACKUP 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.

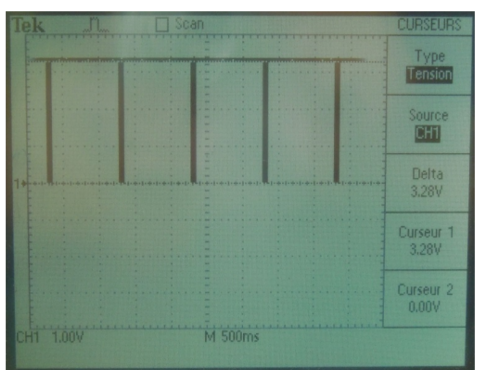


Figure 6-1: TX0

7: Co-Design Layout Guide

Co-Design Between XA1110 and XA1210

The following provides the necessary guidelines to successfully design XA1210 applications which are compatible with XA1110 modules.

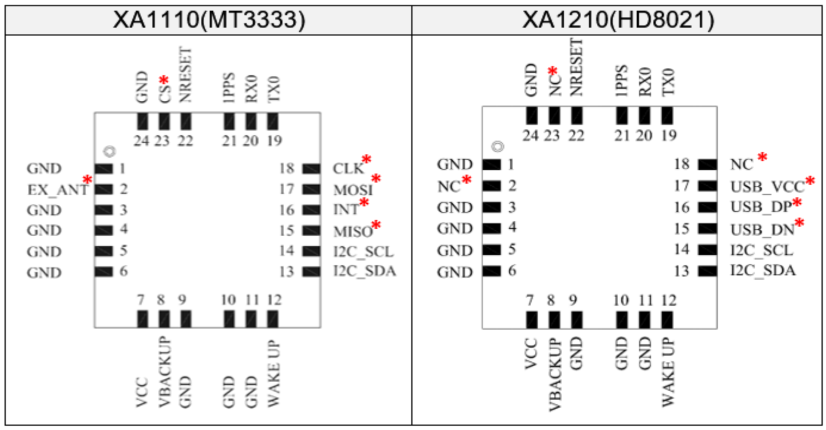


Figure 7-1: XA1110 and XA1210 Module Pin Configuration

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

The following table enumerates pin assignments that are different between the XA1110 and XA1210.

Table 7-1: Pin Assignment Differences

XA1110 (MT3333)				XA1210 (HD8021)			
Pin	**Name**	**I/O**	**Description**	**Pin**	**Name**	**I/O**	**Description**
2	EX_ANT	I/PO	External active antenna RF input	2	NC		Not connected
15	MISO	O	SPI serial data output (in salve mode)	15	USB_DN	I/O	USB differential data bus minus
16	INT	O	Interrupt pin for SPI or I2C	16	USB_DP	I/O	USB differential data bus plus
17	MOSI	I	SPI serial data input (in slave mode)	17	USB_VCC	PI	USB supply voltage input
18	CLK	I	SPI serial clock	18	NC		Not connected
23	CS	I	SPI serial chip select	23	NC		Not connected

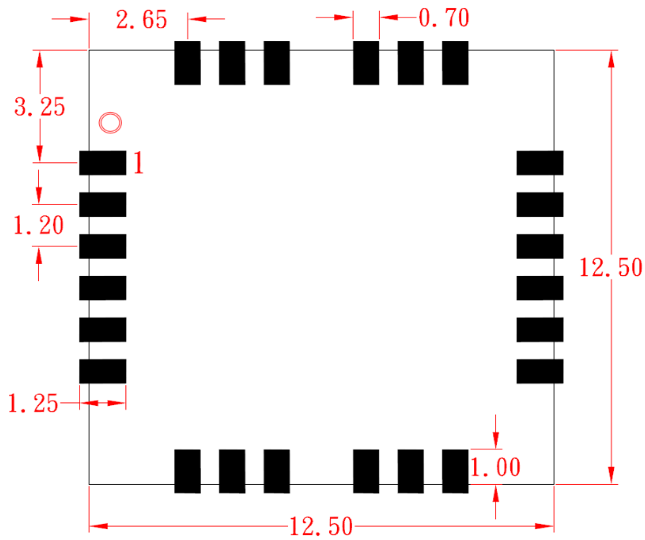


Figure 7-2: Recommended PCB Layout for XA1110 and XA1210 Migration

Co-Design Between XM1210 and XA1210

The following provides the necessary guidelines to successfully design XA1210 applications which are compatible with XM1210 modules.

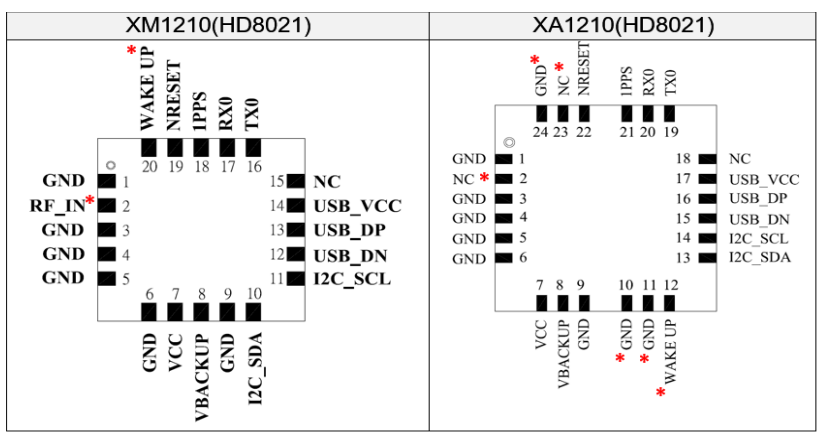


Figure 7-3: XM1210 and XA1210 Module Pin Configuration

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

The following table enumerates pin assignments that are different between the XM1210 and XA1210.

Table 7-2: Pin Assignment Differences

XM1210 (HD8021)				XA1210 (HD8021)			
Pin	**Name**	**I/O**	**Description**	**Pin**	**Name**	**I/O**	**Description**
2	RF_IN	I	GNSS RF signal input	2	NC		Not connected
10	I2C_SDA	I/O	I2C serial data (in slave mode)	10	GND	P	Ground
11	I2C_SCL	I	I2C serial clock (in slave mode)	11	GND	P	Ground
12	USB_DN	I/O	USB differential data bus minus	12	WAKE UP	I	Wake up from power saving
20	WAKE UP	I	Wake up from power saving	20	RX0	I	Serial data input for firmware update (TTL)
-	-	-	-	23	NC		Not connected
-	-	-	-	24	GND	P	Ground

Note: The XM1210 only has 20 pins while the XA1210 has 24 pins.

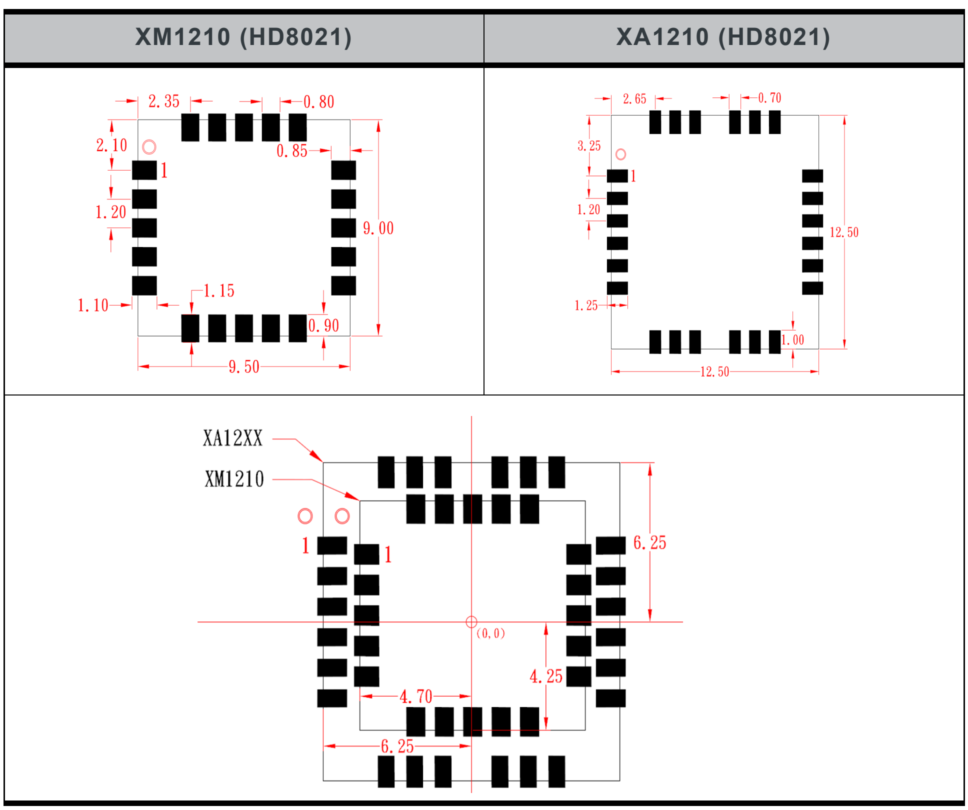


Figure 7-4: Recommended PCB Layout for XA1110 and XA1210 Migration

8: Super Capacitor Design

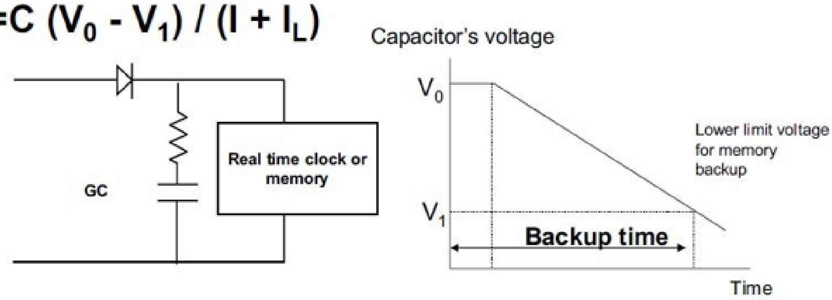
About Super Capacitors

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:

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



Example:

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

$T = 0.2\ (\ 2.5 - 1.8\ )\ /\ (10\ e\text{-}6 + 0.2\times10^{-6})$
$= 0.14/10.2\times10^{-6}$
$= 13{,}725$ 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 H-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

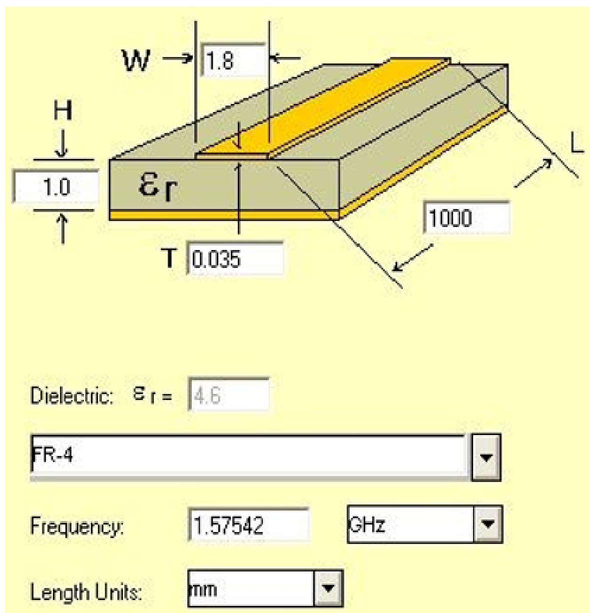


Figure 9-1: Dimensions

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

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.

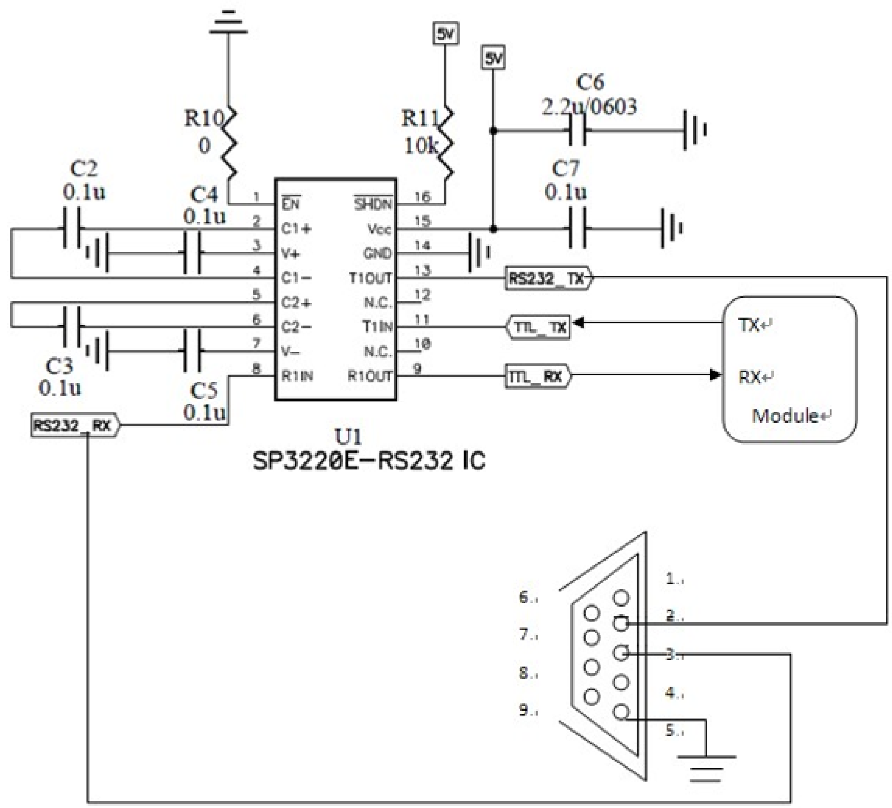


Figure 10-1: RS232 Signal Conversion Example

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.

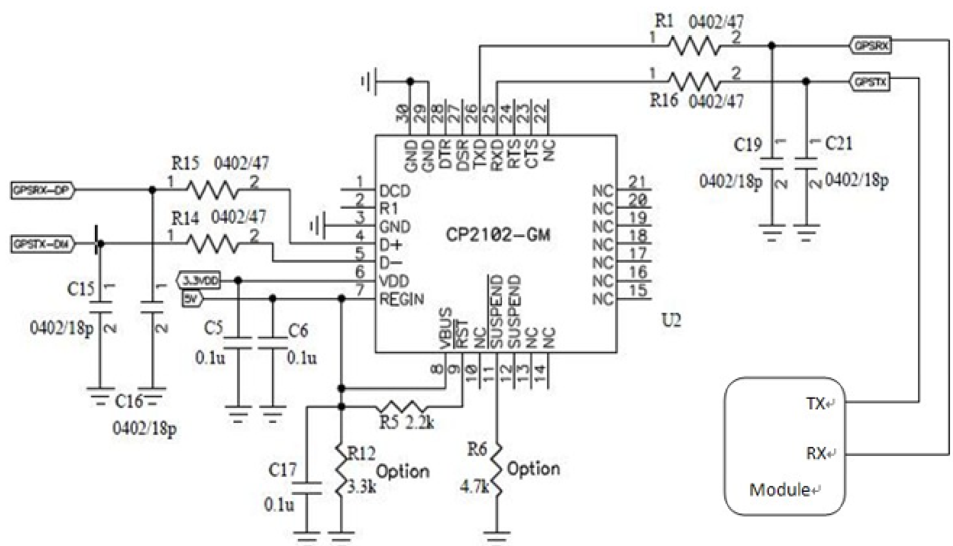


Figure 11-1: UART to USB

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.