GPS Active Antenna Supply

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APN Content Level	BASIC		INTERMEDIATE	✓	ADVANCED		Confidentiality	Public	✓	Private	

Hardware Compatibility	Product Line	AirPrime	Series	Q2698	XM0110
				SL80XX	
				MC73XX, MC77XX, MC87XX	

Software Compatibility	Series	All

1 Version

Application Notes may be updated over their lifetime. To ensure you are designing with the correct version, please check the application notes page in www.sierrawireless.com for latest versions.

2 Introduction

This Application Note (APN) is provided to Sierra Wireless distributors and clients to aid more rapid development of embedded applications using the Sierra Wireless portfolio of cellular solutions. To request a new application note, please contact your regional Sierra Wireless Product Marketing Manager.

3 Overview

GPS receivers of Sierra Wireless AirPrime modules can be connected to a passive antenna (which should be physically located very close to the unit) or a remote active antenna containing an LNA, which will both improve SNR and compensate for any cable/insertion losses.

Figure 1. GPS Receiver Example

Passive antennas can be connected directly to the GPS receiver input, however active antennas need a DC power supply which is generally received through the RF coaxial cable.

Some AirPrime products can provide this power supply, allowing a direct antenna connection to the module GPS antenna port. For AirPrimes products without this feature, external circuitry is needed to power the active antenna.

This application note describes the use of the integrated GPS active antenna powering function when available, and how to design an external powering circuit where required.

4 Glossary

Initials	Definition
DC	Direct Current
ESD	Electrostatic Discharge
GPS	Global Positioning System
LDO	Low Drop Out voltage regulator
LNA	Low Noise Amplifier
PCB	Printed Circuit Board
RF	Radio Frequency (1575.42MHz with the GPS signal)
SNR	Signal to Noise Ratio

5 Modules with Integrated Active Antenna Supply

AirPrime modules that support a DC supply out of the dedicated GPS antenna port are:

- MC77XX
- MC73XX

This consist of a 3.3V, 100mA max DC bias which can be activated/deactivated using the AT commands described below.

The GPS antenna can be directly connected as in Figure 2.

For active antennas requiring a different power supply voltage, the external antenna supply solution described in *Section 6, Modules without Integrated Antenna Supply* must be used.

Useful AT commands for this application include:

AT!CUSTOM="GPSSEL",0: Use dedicated GPS antenna port with antenna bias enable (default).

AT!CUSTOM="GPSSEL",1: Use shared GPS/RX div antenna port for GPS, no antenna bias available.

AT!CUSTOM="GPSSEL",2: Use dedicated GPS antenna port with bias disable.

AT!RESET: After issuing any of the above AT commands, a Reset is required for the new values to take effect.

The DC voltage can be measured on the GPS connector after it is enabled, the GPS receiver is powered, and a GPS session is started.

A complete AT sequence to do this is as follows:

AT!ENTERCND="A710"

AT!CUSTOM="GPSENABLE",1

AT!CUSTOM="GPSSEL",0

AT!RESET (then wait for the module to be ready again)

AT!ENTERCND="A710"

AT!GPSTRACK=1,255,1000,30,1

Note: The Receive Diversity antenna can also be used for GPS reception, however no DC supply output is available on this port. It is not recommended to use it in this manner, as this antenna path is mandatory to Mimo management with LTE.

Figure 2. GPS Antenna and AirPrime MC Series Module

6 Modules without Integrated Antenna Supply

Modules that support GPS but do not supply a DC bias voltage are as follow:

- Q2698
- SL80XX
- MC87XX
- XM0110, used in conjunction with Q268X, SL6087, and WMPXXX.

6.1 Methodology

Typically, active antennas are designed to be powered through their output coaxial cable where some kind of “T” connection is needed to connect a DC supply. However, a simple T connector cannot be used because the GPS RF signal must be isolated from the DC power supply. Instead, a “Bias Tee” is used: the DC supply is fed through an inductor having a high impedance at the GPS frequency to provide isolation with the antenna signal.

Commercially available connectorized “Bias Tee” designed to work at GPS frequency will perform this function.

Figure 3 shows a typical connection:

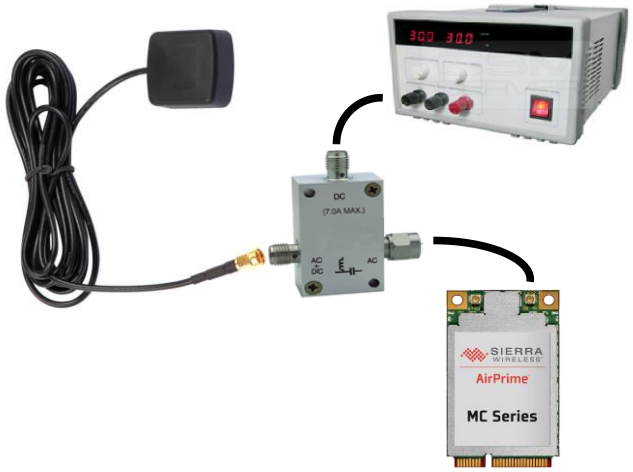

Figure 3. Typical Bias Tee Connection Example

A similar function can be designed at much lower cost and implemented on the product PCB, enabling a direct connectorized connection to the antenna as shown in Figure 4:

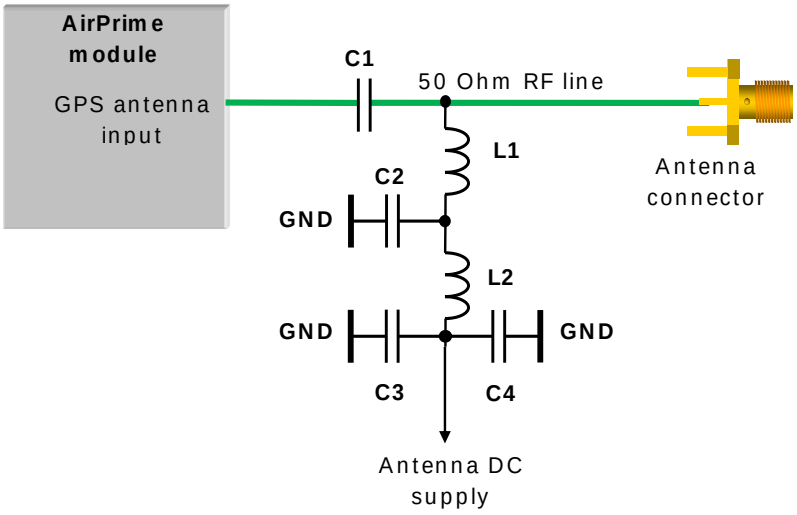

Figure 4. Alternate Direct, Connectorized Connection Example

6.2 Components, Function, and Selection

- C1: 33pF, 0402 or 0603 size: Used for DC isolation of the GPS module antenna input.

  The previously mentioned modules which do not supply a bias voltage have an internal serial capacitor and do not require this component.

  This capacitor is recommended for modules that provide antenna supply however use the Figure 4 circuitry to power an antenna requiring a different supply voltage.
- L1: 47nH to 100nH, 0402 or 0603 size: This inductor needs to be “high impedance” at GPS frequency (1575.42MHz), i.e minimum 500Ω.
- C2, C3: 33pF: These capacitors need to be “short circuit” at GPS frequency.
- C4: 1nF: Wideband decoupling capacitor.
- L2: 47nH to 100nH as L1: A resistor can be used instead, 0 to 100Ω, this gives additional wideband RF decoupling and provides a DC power supply short-circuit protection.

Where minimum component count is required only L1 and C2 are mandatory. The RF isolation will be lower and it must be checked if GPS sensibility is as expected.

Antenna DC supply: any DC power source already available in the product or a dedicated LDO.

Where there is user accessibility to the connector, it is recommended to add an ESD protection close to this connector.

6.3 PCB Routing Constraints

- RF lines design rules:
  - Must be 50 Ohm characteristic impedance.
  - Right angle bends must be avoided, round bends or 45° corners are recommended.
  - Line structure can be microstrip, stripline, or coplanar waveguide.

  Free simulation software (Appcad from Agilent, TxLine from AWR…) can be used to tune the line width according to the PCB stackup and to check losses as a function of frequency.
- The L1 pad must be on the RF line (no T connection) and C2 close to L1 with a short direct ground connection.
- The C1 pads must be on the RF line.
- L1 and L2 must be close together and C3/C4 close to L2 with a short direct ground connection.

The photograph in Figure 5 below shows the Sierra Wireless implementation on the AirPrime XM0110 daughter board.

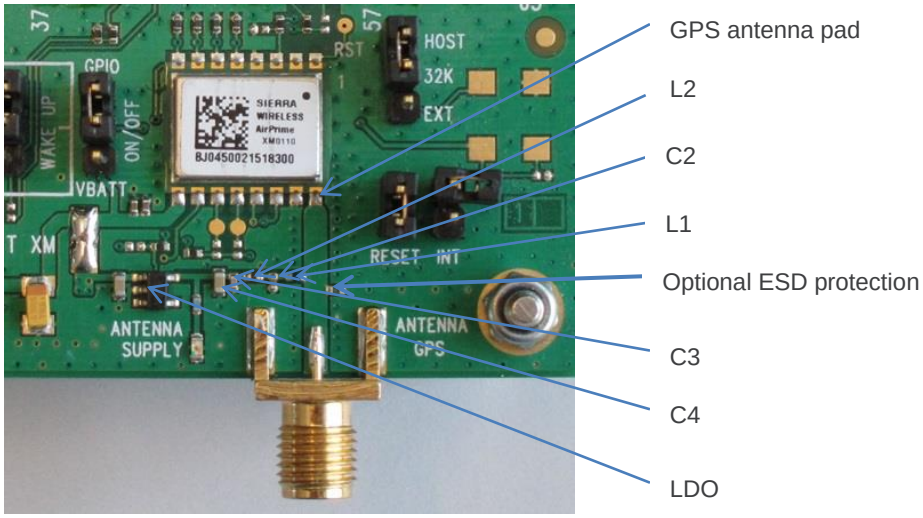

Figure 5. AirPrime XM0110 Daughter Board Implementation

7 Useful Links

- AGILENT (Appcad download): http://www.hp.woodshot.com/
- AWR (TxLine download): http://web.awrcorp.com/Usa/Products/Optional-Products/TX-Line/
- Wikipedia: http://en.wikipedia.org/wiki/Bias_tee
- Sierra Wireless forum: https://forum.sierrawireless.com/

8 Support

For direct clients: contact your Sierra Wireless FAE

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9 Document History

Revision	Date	History
1.0	May 29, 2014	Creation.

10 Legal Notice