Hardware Integration Guide

AirPrime Q2698

SIERRA WIRELESS

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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.

Safety and Hazards

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. Do not operate the Sierra Wireless modem in any aircraft, whether the aircraft is on the ground or in flight. In aircraft, the Sierra Wireless modem **MUST BE POWERED OFF**. When operating, the Sierra Wireless modem can transmit signals that could interfere with various onboard systems.

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.*

The driver or operator of any vehicle should not operate the Sierra Wireless modem while in control of a vehicle. Doing so will detract from the driver or operator's control and operation of that vehicle. In some states and provinces, operating such communications devices while in control of a vehicle is an offence.

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Consult our website for up-to-date product descriptions, documentation, application notes, firmware upgrades, troubleshooting tips, and press releases: www.sierrawireless.com

Document History

Version	Date	Updates
001	June 18, 2012	Creation

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1. Introduction

The Sierra Wireless AirPrime Q2698 soldered-down module forms the radio component for the products in which it is embedded.

Module-specific performance and physical characteristics are described in the corresponding product specification document.

Note: An understanding of network technology, and experience in integrating hardware components into electronic equipment is assumed.

1.1. Hardware Development Components

Sierra Wireless manufactures two hardware development components to facilitate the hardware integration process:

- AirPrime Delelopment kit for Q26 on which an Q2698 module is embedded. This board may be used as a stand-alone platform for basic hardware development.
- AirPrime Q26 Development Kit – Hardware development board on which an Q26 module is plugged.. The development kit provides access to all of the interfaces supported by the Q26 module.

For instructions on using theQ26 Development Kit, see document [1] Universal Development Kit User Guide for AirPrime Q26 Series.

2. Power Interface

2.1. Power Supply

The host device must provide power to the AirPrime soldered-down module over pins 1, 2, 3 and 4 (VCC_3V6) as detailed in the following table.

Table 1. Power Supply Requirements

Requirement Type	Value
Power Supply	3.8V (nominal)
Voltage Range (V_{MIN} – V_{MAX})	3.4V – 4.2V
Current (instantaneous (5ms))	3A
Current (continuous)	700mA

Note: The host must provide safe and continuous power to the module; the module does NOT have protection circuits to guard against electrical overstress.

2.2. Electrostatic Discharge (ESD)

The host device must provide adequate ESD protection on digital circuits and antenna ports as detailed in the following table.

Note: The level of protection required depends on the application.

Table 2. ESD Specifications

Category	Connection	Specification
Operational	RF ports	IEC-61000-4-2 — Level (Electrostatic Discharge Immunity Test)
Non-operational	Host connector interface	Unless otherwise specified: • JESD22-A114 +/- 2kV Human Body Model • JESD22-A115 +/- 200V Machine Model • JESD22-C101C +/- 500V Charged Device Model
Signals	USIM connector	ESD protection is highly recommended at the point where the USIM contacts are exposed, and for any other signals that would be subjected to ESD by the user.
	Other host signals	

2.3. Power States

The Q2698 module has five power states as detailed in the following table.

Table 3. Supported Q2698 Power States

State	Description	Host Powered	Module Powered	USB Interface Active	RF Enabled
Normal (Default state)	• Capable of placing / receiving calls or establishing data connections on network • USB interface is fully active • Current consumption in a call or data connection is affected by: ▪ Radio band in use ▪ Tx power ▪ Receive gain settings ▪ Data rate ▪ Number of active Tx time slots	✓	✓	✓	✓
Airplane Mode (RF off)	• 'Airplane' mode — Rx / Tx are disabled; USB interface is active • State entered automatically when critical voltage / temperature thresholds are exceeded. Host should consider powering off module to prevent damage to unit.	✓	✓	✓	×
Sleep (Idle Mode)	• Normal state of module between calls or data connections. • Module cycles between wake (polling the network) and sleep, at network provider-determined interval.	✓	✓	×	×
Off	• Host power is connected • Module is powered down (drawing minimal current from host power supply)	✓	×	×	×
Disconnected	• Host power is disconnected from module • All module-related voltages are at 0V	×	×	×	×

3. RF Integration

3.1. Supported RF Bands

Table 4. Supported Frequency Ranges

Band	Frequencies (MHz)	Q2698
GSM Bands		
GSM 850	Transmit: 824 – 849 Receive: 869 – 894	✓
EGSM 900	Transmit: 880 – 915 Receive: 925 – 960	✓
DCS 1800	Transmit: 1710 – 1785 Receive: 1805 – 1880	✓
PCS 1900	Transmit: 1850 – 1910 Receive: 1930 – 1990	✓
WCDMA Bands		
Band I WCDMA 2100	Transmit: 1920 – 1980 Receive: 2110 – 2170	✓
Band II WCDMA 1900	Transmit: 1850 – 1910 Receive: 1930 – 1990	✓
Band V WCDMA 850	Transmit: 824 – 849 Receive: 869 – 894	✓
Band VI WCDMA 800	Transmit: 830 – 840 Receive: 875 – 885	✓
Band VIII WCDMA 900	Transmit: 880 – 915 Receive: 925 – 960	✓
WCDMA Bands RX Diversity		
Band I WCDMA 2100	Transmit: 1920 – 1980 Receive: 2110 – 2170	✓
Band II WCDMA 1900	Transmit: 1850 – 1910 Receive: 1930 – 1990	✓
Band V WCDMA 850	Transmit: 824 – 849 Receive: 869 – 894	✓
Band VI WCDMA 800	Transmit: 830 – 840 Receive: 875 – 885	✓
Band VIII WCDMA 900	Transmit: 880 – 915 Receive: 925 – 960	✓
▪ **GPS**		
GPS	1575.42	✓

3.1.1. Ground Connection Guidelines

When connecting the module to system ground:

- Prevent noise leakage by establishing a very good ground connection to the module through the host connector.
- Minimize ground noise leakage into the RF.
  Depending on the host board design, noise could *potentially* be coupled to the module from the host board. This is mainly an issue for host designs that have signals traveling along the length of the module, or circuitry operating at both ends of the module interconnects.

3.1.2. Shielding Guidelines

The module is fully shielded to protect against EMI and to ensure compliance with FCC Part 15 - “Radio Frequency Devices” (or equivalent regulations in other jurisdictions).

Note: This shielding must NOT be removed.

3.2. Antenna Guidelines

3.2.1. Choosing the Correct Antenna and Cabling

Consider the following points for appropriate antenna selection:

- The antenna (and associated circuitry) should have a nominal impedance of 50Ω with a return loss of better than 10 dB across each frequency band of operation.
- The system gain value affects both radiated power *and* regulatory (FCC, IC, CE, etc.) test results.

3.2.2. Determining the Antenna’s Location

Consider the following points when deciding where to place the antenna:

- Antenna location may affect RF performance. Although the module is shielded to prevent interference in most applications, the placement of the antenna is still very important—if the host device is insufficiently shielded, high levels of broadband or spurious noise can degrade the module’s performance.
- Connecting cables between the module and the antenna must have 50Ω impedance. If the impedance of the module is mismatched, RF performance is reduced significantly.
- Antenna cables should be routed, if possible, away from noise sources (switching power supplies, LCD assemblies, etc.). If the cables are near the noise sources, the noise may be coupled into the RF cable and into the antenna.

3.3. RF Desense Sources

Common sources of interference that may affect the module's RF performance (RF desense) include

- Power supply noise
  - Can lead to noise in the RF signal
  - Module power supply ripple limit <= 100 mV_{p-p} 1 Hz–100 kHz
- Interference from other embedded wireless devices
  - Any harmonics, sub-harmonics, or cross-products of signals that fall in the module's Rx range may cause spurious response, resulting in decreased Rx performance.
  - Tx power and corresponding broadband noise may overload or increase the noise floor of the module's receiver, resulting in RF desense.
  - Severity of interference depends on proximity of other antennas to the module's antennas.
- Host electronic device-generated RF
  - Proximity of host electronics to the module's antenna can contribute to decreased Rx performance.
  - Some devices include microprocessor and memory, display panel and display drivers, and switching mode power supplies.

Note: *In practice, there are usually numerous interfering frequencies and harmonics. The net effect can be a series of desensitized receive channels.*

4. Audio Interface

The AirPrime Q2698 embedded module only supports digital audio interface (PCM) as summarized in the following tables. Refer to document [2] AirPrime Q2698Product Technical Specification and Customer Design Guidelines for detailed information about the digital audio interface.

Table 5. PCM Audio Interface Features

Feature	Details
Implementation	Primary PCM supported to interface with external codec
Power	1.8 V (use VREF_1V8 as logic reference)
Features	• IOM-2 compatible device on physical level • Master mode only with 16 slots by frame (user only on slot 0) • Bit rate single clock mode at 2.048 MHz • 16 bits data word MSB first only • Linear Law only (no compression law) • Long Frame Synchronization only • Push-pull configuration on PCM-OUT and PCM-IN

Table 6. Audio Pin Description

Pin #	Signal Name	Description	Notes
64	PCM_SYNC	PCM synchronization bit	8 kHz
65	PCM_DOUT	PCM output	
66	PCM_DIN	PCM input	
67	PCM_CLK	PCM clock	2.048 MHz for primary PCM mode

5. Regulatory Information

5.1. Important Notice

Because of 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 and its affiliates accept 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.

5.2. Safety and Hazards

Do not operate your AirPrime Q2698 modem:

- In areas where blasting is in progress
- Where explosive atmospheres may be present including refueling points, fuel depots, and chemical plants
- Near medical equipment, life support equipment, or any equipment which may be susceptible to any form of radio interference.

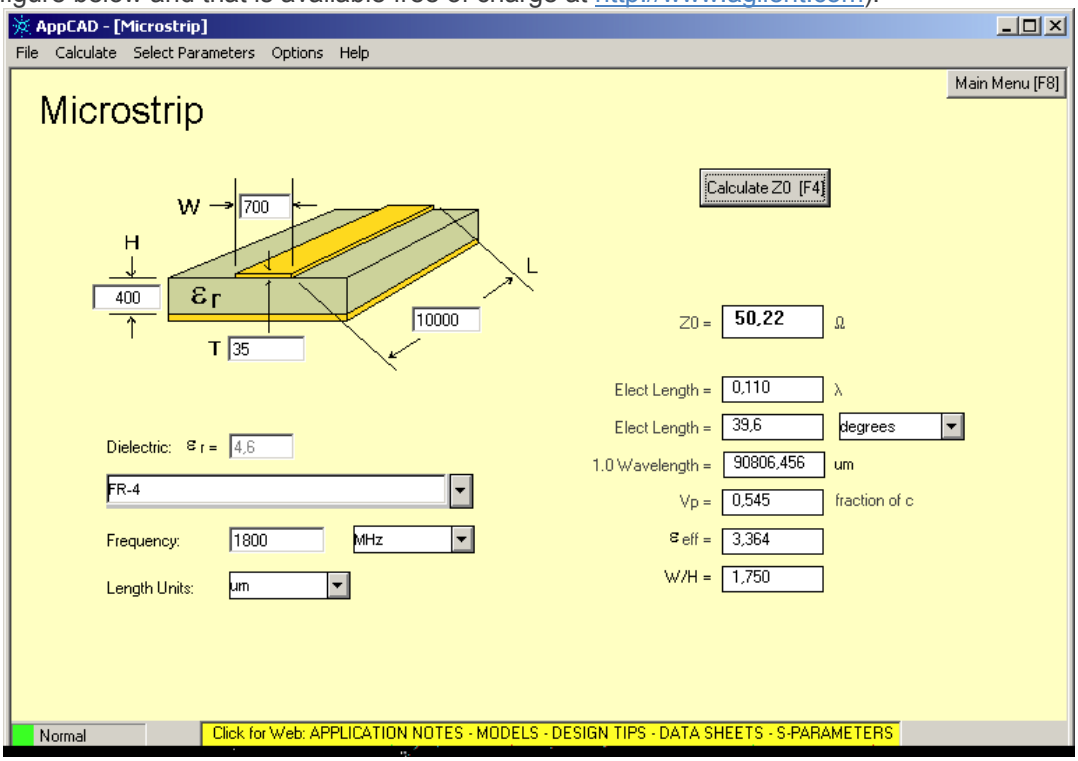
In such areas, the Q2698 modem **MUST BE POWERED OFF**. Otherwise, the Q2698 modem can transmit signals that could interfere with this equipment. In an aircraft, the Q2698 modem **MUST BE POWERED OFF**. Otherwise, the Q2698 modem can transmit signals that could interfere with various onboard systems and may be dangerous to the operation of the aircraft or disrupt the cellular network. Use of a cellular phone in an aircraft is illegal in some jurisdictions. Failure to observe this instruction may lead to suspension or denial of cellular telephone services to the offender, or legal action or both.

Some airlines may permit the use of cellular phones while the aircraft is on the ground and the door is open. The Q2698 modem may be used normally at this time.

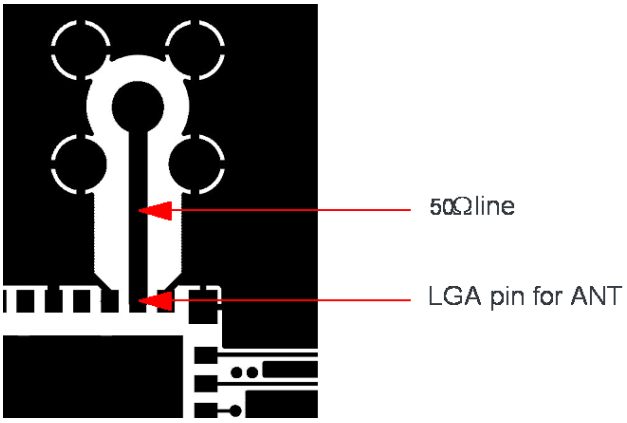
5.3. Important Compliance Information for North American Users

The Q2698 modem has been granted modular approval for mobile applications. Integrators may use the Q2698 modem in their final products without additional FCC/IC (Industry Canada) certification if they meet the following conditions. Otherwise, additional FCC/IC approvals must be obtained.

1. At least 20 cm separation distance between the antenna and the user's body must be maintained at all times.
2. To comply with FCC/IC regulations limiting both maximum RF output power and human exposure to RF radiation, the maximum antenna gain including cable loss in a mobile-only exposure condition must not exceed 7.5 dBi in the cellular band and 3.5 dBi in the PCS band for the Q2698.
3. The Q2698 modem and its antenna must not be co-located or operating in conjunction with any other transmitter or antenna within a host device.
4. The RF signal must be routed on the application board using tracks with a 50Ω characteristic impedance.
   Basically, the characteristic impedance depends on the dielectric, the track width and the ground plane spacing.
   In order to respect this constraint, Sierra Wireless recommends using MicroStrip or StripLine structure and computing the Tracks width with a simulation tool (like AppCad shown in the figure below and that is available free of charge at http://www.agilent.com).



   If a multi-layered PCB is used, the RF path on the board must not cross any signal (digital, analog or supply).
   If necessary, use StripLine structure and route the digital line(s) "outside" the RF structure as shown in the figure below.



Stripline and Coplanar design requires having a correct ground plane at both sides. Consequently, it is necessary to add some vias along the RF path.
It is recommended to use Stripline design if the RF path is fairly long (more than 3cm), since MicroStrip design is not shielded. Consequently, the RF signal (when transmitting) may interfere with neighbouring electronics (AF amplifier, etc.). In the same way, the neighbouring electronics (micro-controllers, etc.) may degrade the reception performances.
The GSM/GPRS connector is intended to be directly connected to a 50Ω antenna and no matching is needed.

5. A label must be affixed to the outside of the end product into which the Q2698 modem is incorporated, with a statement similar to the following for Q2698:

   This device contains FCC ID: N7NQ2698

   This equipment contains equipment certified under IC: 2417C-Q2698

6. A user manual with the end product must clearly indicate the operating requirements and conditions that must be observed to ensure compliance with current FCC/IC RF exposure guidelines.

The end product with an embedded Q2698 modem may also need to pass the FCC Part 15 unintentional emission testing requirements and be properly authorized per FCC Part 15.

Note: *If this module is intended for use in a portable device, you are responsible for separate approval to satisfy the SAR requirements of FCC Part 2.1093 and IC RSS-102.*

6. References

6.1. Reference Documents

[1] Universal Development Kit User Guide for AirPrime Q26 Series

Reference: User Guide for AirPrime Q26 Series Development Kit-Rev8.0

[2] AirPrime Q2698Product Technical Specification and Customer Design Guidelines

Reference: Product Technical Specification and Customer Design Guidelines for AirPrime Q2698-Rev2.0

6.2. List of Abbreviations

Acronym or Term	Definition
AGC	Automatic Gain Control
BER	Bit Error Rate - a measure of receive sensitivity
BLER	Block Error Rate
Call Box	Base Station Simulator - Agilent E8285A or 8960, Rohde & Schwarz CMU200
CDMA	Code Division Multiple Access
dB	Decibel = 10 x $\log_{10}$ (P1/P2) *P1 is calculated power; P2 is reference power* Decibel = 20 x $\log_{10}$ (V1/V2) *V1 is calculated voltage, V2 is reference voltage*
dBm	Decibels, relative to 1 mW - Decibel(mW) = 10 x $\log_{10}$ (Pwr (mW)/1mW)
DUT	Device Under Test
EDGE	Enhanced Data rates for GSM Evolution
EM	Embedded Module
ESD	ElectroStatic Discharge
FER	Frame Error Rate - a measure of receive sensitivity
GPRS	General Packet Radio Services
GPS	Global Positioning System
GSM	Global System for Mobile communications
Hz	Hertz = 1 cycle/second
inrush current	Peak current drawn when a device is connected or powered on
IS-2000	3G radio standards for voice and data (CDMA only)
IS-95	2G radio standards targeted for voice (cdmaONE)
LDO	Low Drop Out - refers to linear regulator
MHz	MegaHertz = 10E6 Hertz (Hertz = 1 cycle/second)
MIO	Module Input/Output
MPE	Maximum Permissible Exposure—the level of radiation to which a person may be exposed without hazardous effect or adverse biological changes
OTA	Over-The-Air or Radiated through the antenna
PCS	Personal Communication System - PCS spans the 1.9 GHz radio spectrum

Acronym or Term	Definition
RF	Radio Frequency
RMS	Root Mean Square
SA	Selective Availability
Sensitivity (Audio)	Measure of lowest power signal that the receiver can measure
Sensitivity (RF)	Measure of lowest power signal at the receiver input that can provide a prescribed BER/BLER/SNR value at the receiver output.
SIM	Subscriber Identity Module
Q2698	Sierra Wireless AirPrime soldered-down module used on GSM/UMTS networks
SNR	Signal to Noise Ratio
SOF	Start of Frame - a USB function
UART	Universal Asynchronous Receiver Transmitter
UMTS	Universal Mobile Telecommunications System
USB	Universal Serial Bus
USIM	Universal Subscriber Identity Module
VCC	Supply voltage
WCDMA	Wideband Code Division Multiple Access—In this document, the term “UMTS” is used instead of “WCDMA”.
XIM	In this document, XIM is used as part of the contact identifiers for the USIM interface (XIM_VCC, XIM_CLK, etc.).