Product Technical Specification & Customer Design Guidelines

AirPrime SL808X

SIERRA WIRELESS™

2400058
Rev 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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Consult our website for up-to-date product descriptions, documentation, application notes, firmware upgrades, troubleshooting tips, and press releases:

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Contents

Introduction 15
General features 15
Support features 19
Support tools 19
Accessories 20
Hardware development components 20
Ordering information 20
Environmental issues 20
RoHS directive compliant 20
Disposing of the product 21

Functional Specifications 23
Functional architecture 23
Chipsets 23
Extended AT commands 23

Technical Specifications 25
Power supply 25
Burst transmission current requirements 26
Power input (VCC_3V6) 26
Start-up current 26
Ground connection 27
Decoupling of power supply signals 27
Mechanical specifications 27
Mechanical illustrations 28
Labeling 29
Embedded SIM (eSIM) 29
Thermal considerations 30
SED (Smart Error Detection) 30

Firmware upgrade 30

Interfaces 31

System design 31
Pin configuration 33
Pin description 34
Digital I/O electrical information 39
Electrical characteristics 39
Signal reset states 40
Reference schematic 40
General purpose input/output 40
Pin descriptions 41
Main serial link (UART1) 41
UART1 pin descriptions 42
Interface implementation 42
SIM interface 42
SIM pin descriptions 43
Application notes 43
USB 2.0 interface. 44
USB pin descriptions 45
Electrical characteristics 45
Application notes 45
Host-developed USB drivers 45
USB Suspend mode 46
USB Resume mode 46
RF interface 47
RF connections 47
RF pin descriptions 48
RF performance 48
Antenna specifications 50
Radiated emissions 51
Radiated sensitivity measurement 51
Audio interfaces 51

Analog audio interface 52
Pin descriptions 52
Microphone features 52
Speaker features 57
Supported voice features 60
Short Message Service (SMS) 61
UMTS radio access bearers supported 61
Digital audio interface (PCM) 62
PCM pin descriptions 62
PCM waveforms 63
JTAG interface 64

Signals and Indicators 65
Overview 65
Power on/off signal (POWER_ON_N) 66
Pin descriptions 66
Electrical characteristics 66
Application notes 66
Reset Signal (SYSTEM_RESET_N) 68
Pin descriptions 68
Electrical characteristics 68
Application notes 69
Wake signal (WAKE_N) 70
Pin descriptions 70
Electrical characteristics 70
Disable signal (W_DISABLE_N) 71
Pin descriptions 71
Electrical characteristics 71
Application notes 71
Buzzer output (BUZZER_EN) 72
Pin descriptions 72
Electrical characteristics 72

Flash LED (LED_FLASH) 73
Pin descriptions 73
Electrical characteristics 73
Power rail (VREF_1V8) 74
Pin descriptions 74
Electrical characteristics 75
Application notes 75
Reserved 75

Power Consumption 77
Power states 79
Power state transitions 80

Network technology specifications 83
UMTS WCDMA FDD specifications. 83
Supported specifications 85
UMTS (WCDMA) / GSM specifications 91

Design Guidelines 95
General rules and constraints 95
PCB layout recommendations 95
Power supply 95
Antenna 96
PCB specifications for the application board 96
Recommended PCB landing pattern 96
Routing constraints 97
Power supply 97
SIM interface 98
Audio circuit 98
RF circuit 98
EMC and ESD recommendations 100
Mechanical integration. 101

Operating system upgrade 101

Embedded Testability 103

Testing assistance provided by Sierra Wireless. 103

Integration requirements 103

IOT/Operator 103

Module testing recommendations 104

Serial link access 104

RF output accessibility 105

Certification Compliance and Recommended Standards 107

UMTS compliance acceptance and certification 107

Certification compliance 107

Applicable standards listing 108

Important notice 108

Safety and hazards 108

Important compliance information for North American users 109

EU regulatory conformity 110

Customization 111

Safety Recommendations 113

RF safety 113

General 113

Exposure to RF energy 113

Efficient terminal operation 113

Antenna care and replacement 114

General safety 114
Driving 114
Electronic devices 114
Vehicle electronic equipment 114
Medical electronic equipment 114
Aircraft 115
Children 115
Blasting areas 115
Potentially explosive atmospheres 115

Connector and Peripheral Device References 117
JTAG connector. 117

References 119
Web site support 119
Reference documents 119
Sierra Wireless documents 119
Industry/other documents 119
Abbreviations/acronyms 120

List of Figures

Functional architecture 23
Exploded view 28
Dimensioned view 28
Unit label 29
SL808x System block (TBD) 32
SL808X device pinouts 33
MIC equivalent circuits 53
Example—MIC differential connection with LC filter (TBD) 54
Example—MIC differential connection without an LC filter (TBD) 55
Example—MIC single-ended connection with LC filter (TBD) 56
Example - MIC single-ended connection without an LC filter (TBD) 56
SPK equivalent circuit 58
Example - SPK differential connection 59
Example - SPK single-ended connection 59
PCM frame waveform 63
PCM sampling waveform 63
Automatic (‘triggered’) power state transitions 81
PCB structure example for the application board 96
Power supply routing example 97
AppCad screenshot for MicroStrip design 99
Routing examples 99
Recommended thermocouple location 104
Main serial link (UART1) debug access 105

List of Tables

Supported bands/ connectivity . . . 15
Modem features . . . 15
Power and ground specifications . . . 25
Power supply requirements . . . 25
Radio burst rates—Connected mode . . . 26
Start-up current peak range . . . 26
Mechanical specifications . . . 27
Available interfaces and signals . . . 31
SL808X LGA pad pin assignments . . . 34
Electrical characteristics—1.8 V type (1V8) digital I/O . . . 39
Reset state definition . . . 40
GPIO interface features . . . 40
GPIO pin descriptions . . . 41
UART1 interface features . . . 41
Serial port UART1 interface . . . 42
USIM interface features . . . 42
USIM interface signals . . . 43
SIM socket pin descriptions . . . 43
USB interface features . . . 44
USB interface pins . . . 45
USB interface electrical characteristics . . . 45
USB interface features . . . 47
RF interface pins . . . 48
Band support, Conducted Tx Power, and Conducted Rx Sensitivity . . . 49
Main antenna (ANT_PRI) specification . . . 50
Audio interface features . . . 52
Analog audio interface connections . . . 52
MIC input electrical characteristics . . . 53
Microphone interface parameters . . . 54
Recommended components for a MIC differential connection . . . 55
Recommended components for a MIC single-ended connection . . . 57
Speaker information . . . 57
SPK electrical characteristics . . . 58
Speaker interface parameters . . . 59
Supported voice features . . . 60
Supported supplementary services . . . 60
SMS features . . . 61
PCM audio interface features . . . 62
Audio pins . . . 62
Digital audio interface AC characteristics . . . 63
Available signals . . . 65
Power signal features . . . 66
ON/~OFF signal pin description . . . 66
Reset signal features . . . 68
Reset signal pin description . . . 68

Reset signal electrical characteristics 68
Reset settings 69
Wake signal features 70
Wake signal pin description 70
Wireless Disable signal features 71
Wireless disable signal pin description 71
Buzzer signal features 72
Buzzer output pin description 72
LED signal features 73
LED_FLASH pin description 73
LED_FLASH signal electrical characteristics 73
VREF_1V8 pin descriptions 74
1.8 V connector pins 74
VREF_1V8 signal electrical characteristics 75
Averaged standby DC power consumption 77
Averaged call mode data DC power consumption 77
Miscellaneous DC power consumption 79
Supported SL808X power states 79
Supported GPRS / EDGE power classes 79
Power state transitions (including voltage/temperature trigger levels) 80
Supported WCDMA FDD specifications 83
Supported GSM / GPRS specifications 85
UMTS (WCDMA)/GSM specifications 91
ESD specifications 100
Standards conformity for the SL808X embedded module 107
Customizable features 111
List of abbreviations/acronyms 120

1. Introduction

The AirPrime SL808X Embedded Module[1] is a 74-pin soldered-down module. Its wireless UMTS-based modem provides (as listed in Table 1-1) data connectivity on HSDPA, WCDMA, EDGE, and GPRS networks, and, for specific devices, GPS and voice functionality.

Table 1-1: Supported bands / connectivity

	SL8080	SL8081	SL8082	SL8083	SL8084	SL8085
GSM850 EGSM900 DCS1800 PCS1900	✔	✔	✔	✔	✔	✔
Band 1 (UMTS2100)			✔	✔	✔	✔
Band 2 (UMTS1900)	✔	✔				
Band 5 (UMTS850)	✔	✔			✔	✔
Band 8 (UMTS900)			✔	✔		
GPS (1575.42)	✔		✔		✔	
Voice	✔		✔		✔	

1.1 General features

Table 1-2 lists several AirPrime SL808X Embedded Module features.

Table 1-2: Modem features

Feature	Description
Physical	• Small form factor (74-pin solderable pad LGA)—25mm x 30mm x 2.35mm (nominal) • Complete body shielding • Embedded SIM available (SIM integrated at component level) • RF connection pads—Tx/Rx (all modems) and GPS (Voice/GPS modems only) • Baseband signals connection
Electrical	• Single supply voltage (VCC)—3.3V–4.3V • Complete body shielding—No additional shielding required

1. SL808X—SL8080/SL8081/SL8082/SL8083/SL8084/SL8085.

Table 1-2: Modem features (Continued)

SMS	• Send and receive (mobile originate and mobile terminate)
	  ◦ Mobile-originated / terminated over CS and PS channels
	  ◦ Mobile-originated SMS over PS falls back to CS if PS service is not available, or there is a PS network failure.
	• New message notification
	• Message sorting
	• Multiple recipients
	• Return voice call
	• Save contact details
	• Mobile-originated SMS e-mail
	• Mobile-originated / terminated SMS concatenation
	• Mobile-originated SMS e-mail concatenation
	• Receipt notification

Application interface	• NDIS NIC interface support (Windows XP, Windows Vista, Windows 7, Windows CE[a], Linux) • Multiple non-multiplexed USB channel support • Dial-up networking • USB selective suspend to maximize power savings • AT command interface—(non-voice) 27.007 standard, plus proprietary extended AT commands • CnS—Sierra Wireless' proprietary Control and Status host interface protocol • Software Development Kits (SDK) including APIs (Application Program Interfaces) and drivers (core, device) for Windows, Windows CE, and Linux • Optional eSIM support
Phone book	Supports Release 99 phone book features

Packet mode	• Dual-mode UMTS (WCDMA) / HSDPA / EDGE / GPRS operation
	• GPRS class B, multislot class 10 operation—Supports CS1–CS4 coding schemes
	• EDGE multislot class 12 operation—Supports MCS1–MCS9 coding schemes
	• UMTS (WCDMA) R99 data rates—384 kbps downlink, 384 kbps uplink
	• HSDPA
	  ◦ Category 5/6 data rate—3.6 Mbps (peak rate)
	  ◦ Category 12 data rate—1.8 Mbps
	• Circuit-switched data bearers—64 kbps (maximum) uplink and downlink

Table 1-2: Modem features (Continued)

Connectivity / GSM	• Multiple (up to 16) cellular packet data profiles
	• Traditional modem COM port support for DUN, CSD, and AT commands (concurrent with NDIS)
	• Suspend / Resume
	• Sleep mode for minimum idle power draw
	• SIM application tool kit with proactive SIM commands
	• Enhanced Operator Name String (EONS)
	• Profile list. Typical carrier profiles are available in a drop-down list in Watcher; the user can select a profile rather than enter all the parameters.
	• Automatic GPRS attach at power-up
	• GPRS detach
	• GPRS detach only
	• Combined GPRS / IMSI detach; MS-initiated and network-initiated detach
	• Mobile-originated PDP context activation / deactivation
	• Support QoS profile
	  ◦ Release 99 QoS negotiation—Background, Interactive, and Streaming
	  ◦ Release 97—Precedence Class, Reliability Class, Delay Class, Peak Throughput, Mean Throughput
	• Static and Dynamic IP address. The network may assign a fixed IP address or dynamically assign one using DHCP (Dynamic Host Configuration Protocol).
	• PAP and CHAP support
	• PDP context type (IPv4). IP Packet Data Protocol context
	• RFC1144 TCP/IP header compression
	• Interaction with existing GSM services (MO/MT SMS voice calls) while:
	  ◦ GPRS is attached, or
	  ◦ In a GPRS data session (class B GPRS suspend / resume procedures)
	• Support for EAP-SIM authentication and PC / SC. EAP-SIM is available through:
	  ◦ The API
	  ◦ AT commands
	  ◦ The PC / SC interface

Voice[b]	Supports: • All GSM vocoders, Enhanced Full Rate (EFR), Full Rate (FR), Half Rate (HR), and WCDMA Adaptive Multirate (AMR) encoders • MO and MT calling • Echo cancellation and noise reduction • Emergency calls (112, 110, 911, etc.) • Incoming call notification • TTY/TDD compatibility through microphone/speaker connections using the audio interface

Table 1-2: Modem features (Continued)

Supplementary services[b]	• Call Barring • Call Forwarding • Call Hold • Caller ID • Call Waiting • Multi-party service • USSD
GPS[c]	Provides: • Standalone GPS functionality • gpsOneXTRA™ • A-GPS features • NMEA support *Note: GPS specifications are preliminary targets that are subject to change without notice. Actual GPS functionality is dependent on the firmware version, and on module configuration.*
Network selection	• Network selection procedures described in 3G 22.011, R5 (June 2005), 3G 23.122 (June 2005), and 3G 43.022, R4 • RRC connection reject message to redirect from a 3G system to a 2G system, according to 25.331, R5 (June 2004) • A CPHS Customer Service Profile-like feature [PLMN Mode bit] on a USIM / SIM that hides network selection related menus • Initial HPLMN scan at two minutes after power on • An HPLMN rescan irrespective of the serving MCC • Selective disabling of any 2G or 3G frequency band • Equivalent PLMN • Network selection generally within 30 seconds of power up • Enhanced network selection (ENS)

RF	• Quad-band GSM/GPRS/EDGE (850 MHz, 900 MHz, 1800 MHz, 1900 MHz)
	• Dual-band UMTS WCDMA FDD
	  - SL8080/SL8081: 850 MHz, 1900 MHz
	  - SL8082/SL8083: 900 MHz, 2100 MHz
	  - SL8084/SL8085: 850 MHz, 2100 MHz
	• GPS (1575.42 MHz) (SL8080/82/84 only)

Environmental	Operating temperature ranges • Normal use (3GPP compliant): -20°C to +65°C • Industry extended temperature range (non-3GPP compliant): TBD

Table 1-2: Modem features (Continued)

Interfaces	• 1.8 V digital section • 3 V/1.8 V SIM interface • Serial (UART1) • Audio—Analog and digital (PCM) • SIM/Embedded SIM • USB 2.0 slave • LCD
Operating system	• Full GSM or GSM/GPRS/EGPRS operating system stack

a. Contact Sierra Wireless for platform-specific Windows CE support details.
b. Voice/Supplementary services on SL8080/SL8082/SL8084
c. GPS on SL8080/SL8082/SL8084

1.2 Support features

The SL808X offers the following support features:

- Standard 1-year warranty
- Extended warranties available (additional one or two years)
- Enabling software (drivers, SDK, etc.): Windows, Windows CE, Linux

1.3 Support tools

The SL808X is compatible with the following support tools from Sierra Wireless and authorized third parties:

- Sierra Wireless Watcher connection manager (available for Windows and Mac operating systems)
- CDMA Air Interface Tool (CAIT) from Qualcomm
- QXDM from Qualcomm

1.4 Accessories

The Universal SL Dev Kit includes:

- Embedded Modem Interface Kit
- Documentation suite
- Initial allotment of support hours
- USB cable
- Serial cable
- Power supply
- Quad-band antenna
- Handset

1.5 Hardware development components

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

- AirPrime SL Socket-Up Board—Adapter board into which an SL module is embedded. This board may be used as a stand-alone platform for basic hardware development. See Reference schematic on page 40 for details.
- AirPrime SL Development Kit—Hardware development platform that integrates with the socket-up board. The development kit provides access to all of the interfaces supported by the SL module.

For instructions on using the SL Development Kit, see [1] SL Dev Kit Quick Start Guide (TBD).

1.6 Ordering information

To order, contact the Sierra Wireless Sales Desk at +1 (604) 232-1488 between 8 AM and 5 PM Pacific Time.

1.7 Environmental issues

1.7.1 RoHS directive compliant

The AirPrime SL808X Embedded Module is compliant with RoHS Directive 2002/95/EC which sets limits for the use of certain restricted hazardous substances. This directive states that "from 1st July 2006, new electrical and electronic equipment put on the market does not contain lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE)".

1.7.2 Disposing of the product

This electronic product is subject to the EU Directive 2002/96/EC for Waste Electrical and Electronic Equipment (WEEE). As such, this product must not be disposed off at a municipal waste collection point. Please refer to local regulations for directions on how to dispose of this product in an environmental friendly manner.

2: Functional Specifications

2.1 Functional architecture

The global architecture of the AirPrime SL808X Embedded Module is described in Figure 2-1.

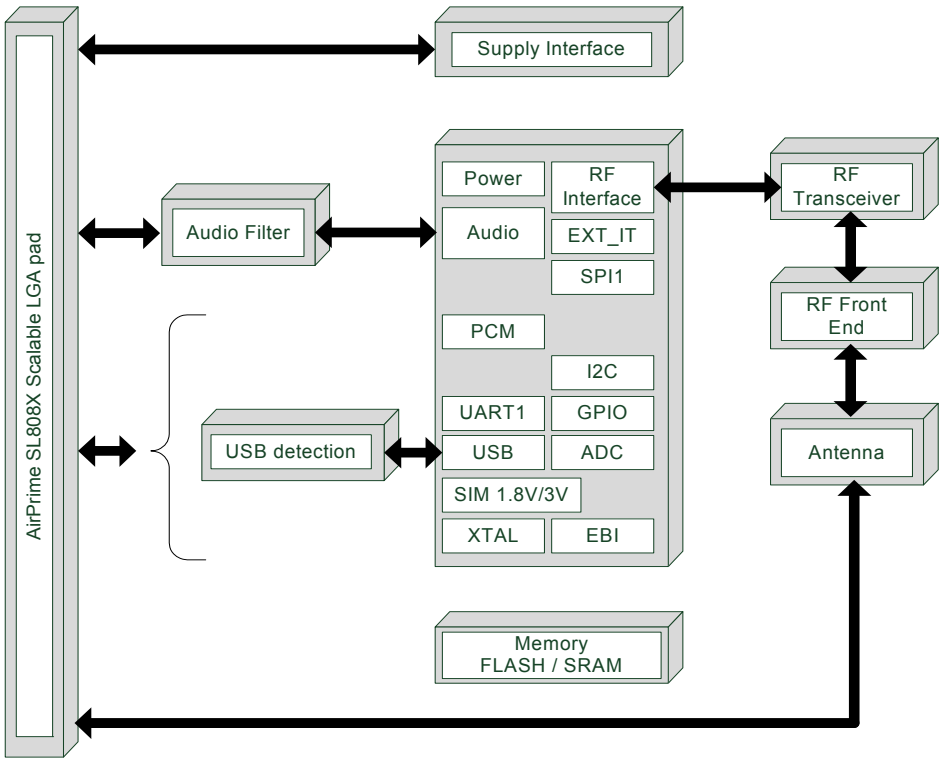

Figure 2-1: Functional architecture

2.1.1 Chipsets

SL808X modems are based on Qualcomm single chip solutions (integrated baseband processor, RF transceiver, and power management IC):

- Voice modems: SL8080/82/84—QSC6270
- Data modems: SL8081/83/85—MDM6270

2.2 Extended AT commands

Several proprietary AT commands are available for AirPrime embedded modules to use in hardware integration design and testing (these commands are *NOT* intended for use by end users). For lists

of all available commands and descriptions of their functionality, refer to [3] AirPrime MC8xxx Embedded Modules Extended AT Command Reference and [2] AirCard/AirPrime UMTS Devices Supported AT Command Reference.

3: Technical Specifications

3.1 Power supply

Power is provided to the SL808X through power and ground pins as detailed in Table 3-1.

Table 3-1: Power and ground specifications

Signal / Pin Name	Pins	Type	Specification	Parameter	Min	Typ	Max	Units
VCC_3V6[a]	42, 44	V	Voltage range	VCC	3.30	3.60	4.30	Va
			Ripple voltage (U_{ripp})				100	mV_{pp}
VREF_1V8	10	V	Maximum supply current = 1 mA		1.62	1.80	1.98	V
GND	19, 20, 21, 23, 28, 39, 35, 37, 38, 39, 52	V			-	0	-	V

a. Host-provided input voltage should provide 3 A instantaneous (lasting 5 ms) and 1.5 A continuous current, while staying within specified min/max range.

The host device must provide power to the AirPrime soldered-down module over pins 42 and 44 (VCC_3V6) as detailed in Table 3-2.

Table 3-2: Power supply requirements

Requirement type	Value
Power supply	3.6 V (nominal)
Voltage range (V_{min}–V_{max})	3.3–4.3 V
Current (instantaneous (≤5 ms))	3 A
Current (continuous)	700 mA[a] (maximum)
Power input capacitor(s)	• Add capacitance to host power rail (≥ 100 µF) to keep module operational with V_{in} in range. • Additional capacitance may be required if the host cannot meet the module's current requirements. • Conditioning capacitor (1 µF, 0.1 µF, 10 nF and 1 nF) recommended close to the power input for decoupling.

a. Maximum current is for HSDPA mode; other modes will have lower continuous current. Average value depends on usage model, antenna design, PCB layout, etc.

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

3.1.1 Burst transmission current requirements

The power supply must be able to deliver high current peaks in a short time due to the burst transmission nature of GSM. During these peaks, the ripple (U_{ripp}) on the supply voltage must not exceed the level noted in Table 3-1 on page 25.

Table 3-3 describes radio burst rates in connected mode. For detailed power consumption figures, see Table 6-2 on page 77.

Table 3-3: Radio burst rates—Connected mode

GSM/GPRS Multislot class[a]	RF Power Amplifier current	Burst duration	Period	Rising time
Class 10	2.0 A peak	577 µs	4.615 ms	10 µs
Class 12		1154 µs	4.615 ms	

a. (TBD) Table contents to be updated to classes supported by SL808X.

3.1.2 Power input (VCC_3V6)

An external power supply uses the VCC_3V6 pins to:

- Supply the AirPrime SL808X Embedded Module.
- Directly supply the RF components with 3.6 V.
  - It is essential to keep a minimum voltage ripple at this connection in order to avoid any phase error or spectrum modulation degradation.
  - Insufficient power supply can significantly affect RF performance (TX power, modulation spectrum, EMC performance, spurious emission, frequency error, etc.).
- Provide reference voltage VREF_1V8 (through several internal regulators) for the baseband signals. The host should draw less than 1 mA on this rail.

When the AirPrime SL808X Embedded Module is supplied with a battery, the total impedance (battery + protections + PCB) should be such that the supply will be >= 3.3 V during GSM burst mode operation (drawing a maximum peak current of 2.2 A for 577 µs (one slot) or 1154 µs (two slots) TX.

3.1.3 Start-up current

During the first second following Power ON, a current peak occurs. This current peak ($t_{Startup}$) has a duration of about 165 ms (typical).

Table 3-4 indicates the expected peak current range.

Table 3-4: Start-up current peak range

Current peak at ambient temperature (25°C)	VCC_3V6_{min} (3.3 V)	VCC_3V6_{typ} (3.6 V)	VCC_3V6_{max} (4.3 V)
$t_{Startup}$	150 mA	140 mA	115 mA

3.2 Ground connection

The AirPrime SL808X Embedded Module shielding case is the grounding. The ground must be connected on the motherboard through a complete layer on the PCB.

The ground connection is made by soldering the LGA ground pins and rectangular ground pad to the ground plane of the application board. For more information about ground connection, see Ground plane and shielding connection on page 97.

3.3 Decoupling of power supply signals

Although the AirPrime SL808X Embedded Module has embedded decoupling capacitors on the VCC_3V6 lines, additional decoupling may be required:

- EMI/RFI issues—Parallel 33 pF capacitors close to the embedded module.
- TDMA noise (217 Hz)—Low frequency decoupling capacitors (22–100 µF) can be used to reduce noise.

3.4 Mechanical specifications

This section describes mechanical specifications for the AirPrime SL808X Embedded Module. For additional mechanical and environmental specifications, refer to [5] Sierra Wireless Reliability Specification.

Table 3-5: Mechanical specifications

Specification	Details
Form factor	The SL808X is a 74-pin LGA soldered-down module with a two-piece shielded case.
Dimensions (nominal)	Length: 30 mm Width: 25 mm Thickness: 2.40 mm (nominal)/2.55 mm (maximum) Weight: approximately 3.5 g

3.4.1 Mechanical illustrations

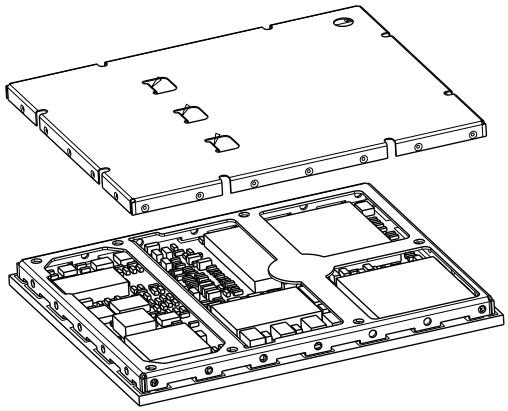

Figure 3-1: Exploded view

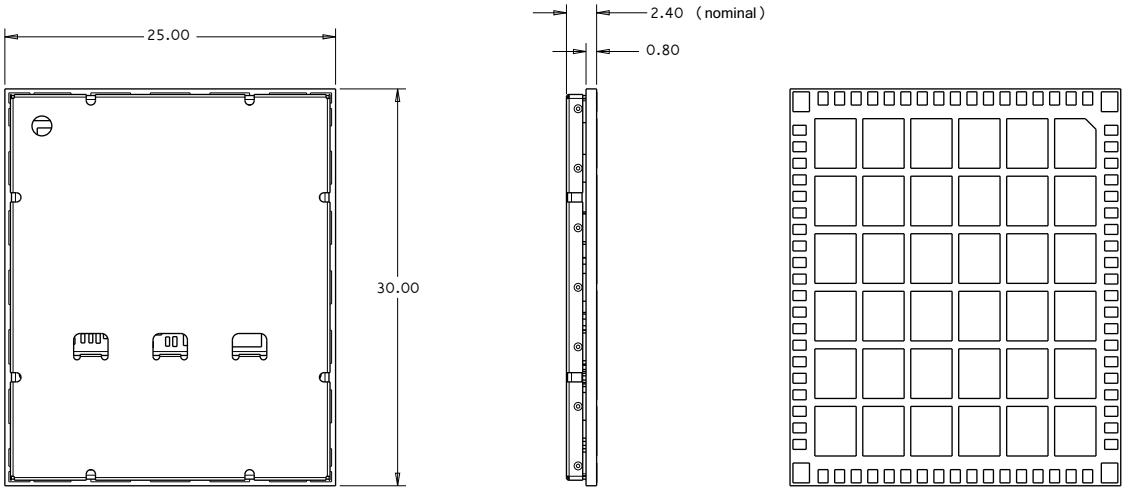

Figure 3-2: Dimensioned view

3.5 Labeling

Figure 3-3: Unit label

The SL808X label is non-removable and contains:

- Sierra Wireless logo and product name. (Figure 3-3 uses ‘X’ to represent the actual product name. For example, SL8080, SL8081, SL8082, etc.)
- Factory Serial Number (FSN) and IMEI number are shown in alphanumeric and Data Matrix (ECC200) 2D barcode formats
- SKU number (when required)
- Manufacturing date code (incorporated into FSN)
- Licensed vendor logo when required
- Device-specific regulatory certification marks (for example, FCC/IC, CE, A-Tick)

Note: The SL808X supports OEM partner specific label requirements.

3.6 Embedded SIM (eSIM)

The AirPrime SL808X Embedded Module is available with an embedded SIM solution that eliminates design issues related to working with a consumer-style SIM card, including:

- Improved environmental performance—The embedded SIM operates in extreme temperatures, and has higher vibration and humidity tolerances.
- Minimized size—The embedded SIM eliminates the requirements of a SIM card holder and plastic SIM, and the module is the same size with or without the embedded SIM.
- Service provider choice—You can provision the SIM with your preferred service provider or carrier, or take advantage of Sierra Wireless’ existing carrier partnerships.
- Subscription portability and security—An integrated switch allows developers to provide the flexibility of switching between the embedded SIM and an external SIM as required.

- Simplified logistics—The embedded SIM does not need to be tracked, stored, or activated (as would a physical SIM card).

3.7 Thermal considerations

When transmitting, the AirPrime SL808X Embedded Module can generate significant amounts of heat (due to the internal Power Amplifier) that must be dissipated in the host device for safety and performance reasons.

The amount of thermal dissipation required depends on the following factors:

- Supply voltage—Maximum power dissipation for these modules can be up to 2.0 W at voltage supply limits.
- Usage—Typical power dissipation values depend on the location within the host, amount of data transferred, etc.

You can enhance heat dissipation by:

- Maximizing airflow over/around the module
- Locating the module away from other hot components

You can use !PCTEMP or !GSTATUS to return the module's current temperature. See [2] AirCard/AirPrime UMTS Devices Supported AT Command Reference for details.

3.8 SED (Smart Error Detection)

The AirPrime SL808X Embedded Module modules use a form of SED to track premature modem resets. In such cases, the module automatically forces a pause in boot-and-hold mode at power-on to accept an expected firmware download to resolve the problem.

1. Module tracks consecutive resets within 30 seconds of power-on.
2. After a third consecutive reset, the module waits in boot-and-hold mode for a firmware download to resolve the power-cycle problem.

3.9 Firmware upgrade

Firmware upgrades are downloaded to the modem over the USB or UART interfaces. Contact your Sierra Wireless account representative for assistance.

4: Interfaces

4.1 System design

This chapter describes the AirPrime SL808X Embedded Module's LGA pad configuration (see Pin configuration on page 33) and supported interfaces (Table 4-1).

Table 4-1: Available interfaces and signals

Name	Driven by AT commands
General purpose input/output on page 40	✔
Main serial link (UART1) on page 41	✔
SIM interface on page 42	✔
USB 2.0 interface on page 44	✔
RF interface on page 47	
Analog audio interface on page 52	✔
Digital audio interface (PCM) on page 62	
JTAG interface on page 64	

The SL808X has two main interface areas—the host I/O perimeter I/O ports (pins) and the RF ports. Figure 4-1 portrays the AirPrime SL808X Embedded Module's system block with these interface areas identified.

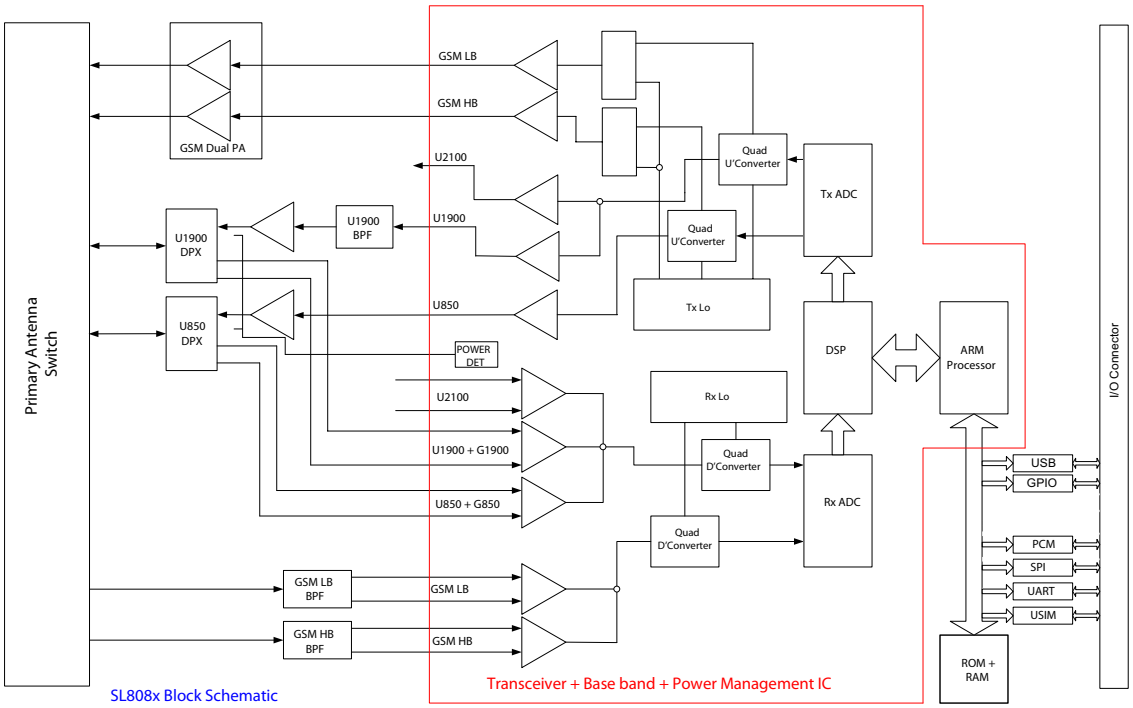

Figure 4-1: SL808x System block (TBD)

4.1.1 Pin configuration

Figure 4-2 illustrates the pin configuration of SL808X modules. Table 4-2 on page 34 provides details for each of the module's pins.

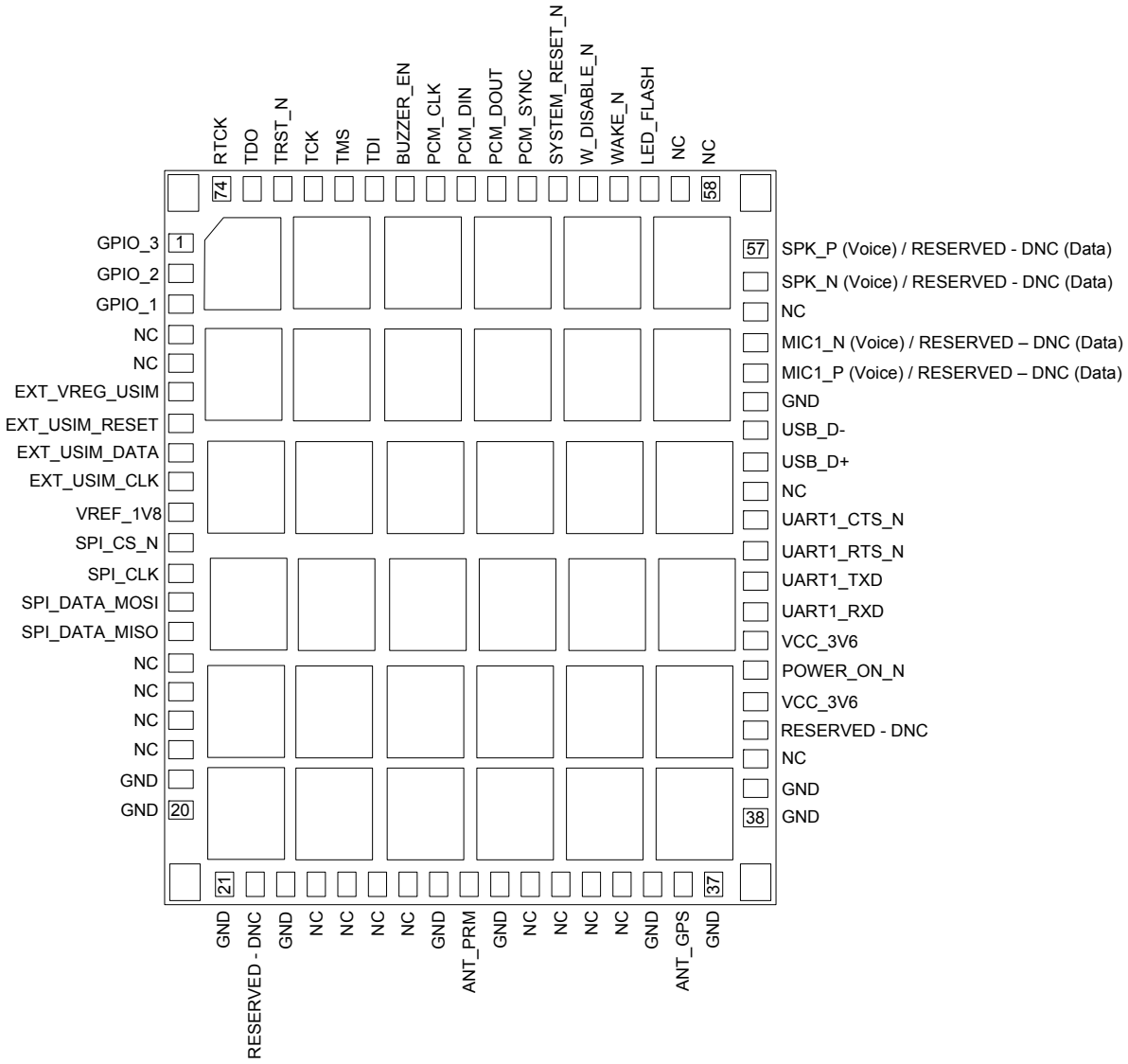

Figure 4-2: SL808X device pinouts

4.1.2 Pin description

Table 4-2 describes the LGA pad pin assignments.

See Digital I/O electrical information on page 39 for 1V8 voltage characteristics and reset state definitions.

Table 4-2: SL808X LGA pad pin assignments [a]

Pin	Signal name	Description	Active state	Input / Output (Direction to module)	Voltage (V)			
					Min[b]	Typ[b]	Max[b]	Type
1	GPIO_3	General purpose I/O	High/Low	Input High	1.17	-	2.1	Digital
				Input Low	-0.3	-	0.63	
				Output High	1.35	-	1.8	
				Output Low	0	-	0.45	
2	GPIO_2	General purpose I/O	High/Low	Input High	1.17	-	2.1	Digital
				Input Low	-0.3	-	0.63	
				Output High	1.35	-	1.8	
				Output Low	0	-	0.45	
3	GPIO_1	General purpose I/O	High/Low	Input High	1.17	-	2.1	Digital
				Input Low	-0.3	-	0.63	
				Output High	1.35	-	1.8	
				Output Low	0	-	0.45	
4	NC	No connect						
5	NC	No connect						
6	EXT_VREG_USIM	USIM VCC supply	Power	Output (1.8 V)	1.60	1.80	1.90	Power
				Output (3.0_V)	2.70	3.00	3.30	
7	EXT_USIM_RESET	USIM reset	Low	Output High (1.8V)	1.44	1.80	2.10	Digital
				Output Low (1.8V)	0.00		0.40	
				Output High (3.0V)	2.40	3.00	3.30	
				Output Low (3.0V)	0.00		0.60	

Table 4-2: SL808X LGA pad pin assignments (Continued)[a]

Pin	Signal name	Description	Active state	Input / Output (Direction to module)	Voltage (V)			
					Min[b]	Typ[b]	Max[b]	Type
8	EXT_USIM_DATA	USIM I/O pin		Input High (1.8 V)	1.26		2.10	Digital
				Input Low (1.8 V)	0.00		0.40	
				Output High (1.8 V)	1.26	1.80	2.10	
				Output Low (1.8 V)	0.00		0.40	
				Input High (3.0 V)	2.10		3.30	
				Input Low (3.0 V)	0.00		0.60	
				Output High (3.0 V)	2.10	3.00	3.30	
				Output Low (3.0 V)	0.00		0.60	
9	EXT_USIM_CLK	USIM clock		Output High (1.8V)	1.26	1.80	2.10	Digital
				Output Low (1.8V)	0.00		0.40	
				Output High (3.0V)	2.10	3.00	3.30	
				Output Low (3.0V)	0.00		0.60	
10	VREF_1V8	1.8 V LDO	High (when module is on)	Output	1.62	1.8	1.98	Power
11	SPI_CS_N	SPI chip select	Low	Output High	1.35	-	1.8	Digital
				Output Low	0	-	0.45	
12	SPI_CLK	SPI clock		Output High	1.35	-	1.8	Digital
				Output Low	0	-	0.45	
13	SPI_DATA_MOSI	SPI Master Output / Slave Input data pin		Output High	1.35	-	1.8	Digital
				Output Low	0	-	0.45	
14	SPI_DATA_MISO	SPI Master Input / Slave Output data pin		Input High	1.17	-	2.1	Digital
				Input Low	-0.3	-	0.63	
15	NC	No connect						
16	NC	No connect						
17	NC	No connect						
18	NC	No connect						

Table 4-2: SL808X LGA pad pin assignments (Continued)[a]

Pin	Signal name	Description	Active state	Input / Output (Direction to module)	Voltage (V)			
					Min[b]	Typ[b]	Max[b]	Type
19	GND	Ground	GND	GND	-	-	-	
20	GND	Ground	GND	GND	-	-	-	
21	GND	Ground	GND	GND	-	-	-	
22	RESERVED - DNC	No connect						
23	GND	Ground	GND	GND	-	-	-	
24	NC	No connect						
25	NC	No connect						
26	NC	No connect						
27	NC	No connect						
28	GND	Ground	GND	GND	-	-	-	
29	ANT_PRM	Main (primary) antenna		Input/Output	Refer to RF specifications			RF
30	GND	Ground	GND	GND	-	-	-	
31	NC	No connect						
32	NC	No connect						
33	NC	No connect						
34	NC	No connect						
35	GND	Ground	GND	GND	-	-	-	
36	ANT_GPS	GPS antenna		Input	Refer to RF specifications			RF
37	GND	Ground	GND	GND	-	-	-	
38	GND	Ground	GND	GND	-	-	-	
39	GND	Ground	GND	GND	-	-	-	
40	NC	No connect						
41	RESERVED - DNC	No connect						
42	VCC_3V6	3.6 V supply	Power	Input	3.30	3.60	4.30	Power
43	POWER_ON_N	Power on		Input	0		2.6	Digital
44	VCC_3V6	3.6 V supply	Power	Input	3.30	3.60	4.30	Power
45	UART1_RXD	UART Receive Data	High/Low	Input High	1.17	-	2.1	Digital
				Input Low	-0.3	-	0.63	
46	UART1_TXD	UART Transmit Data	High/Low	Output High	1.35	-	1.8	Digital
				Output Low	0	-	0.45	

Table 4-2: SL808X LGA pad pin assignments (Continued)[a]

Pin	Signal name	Description	Active state	Input / Output (Direction to module)	Voltage (V)			
					Min[b]	Typ[b]	Max[b]	Type
47	UART1_RTS_N	UART Request To Send	High/Low	Output High	1.35	-	1.8	Digital
				Output Low	0	-	0.45	
48	UART1_CTS_N	UART Clear To Send	High/Low	Input High	1.17	-	2.1	Digital
				Input Low	-0.3	-	0.63	
49	NC	No connect						
50	USB_D+	USB data positive (Low/Full speed)		Input High	2.00	3.30	3.60	Differential
				Input Low	0.00		0.80	
				Output High	2.80	3.30	3.60	
				Output Low			0.30	
		USB data positive (High speed)		Input High	0.30		0.44	
				Input Low	0.00		0.01	
				Output High	0.36	0.38	0.44	
				Output Low	0.00		0.01	
51	USB_D-	USB data negative (Low/Full speed)		Input High	2.00	3.30	3.60	Differential
				Input Low	0.00		0.80	
				Output High	2.80	3.30	3.60	
				Output Low			0.30	
		USB data negative (High speed)		Input High	0.30		0.44	
				Input Low	0.00		0.01	
				Output High	0.36	0.38	0.44	
				Output Low	0.00		0.01	
52	GND	Ground	GND	GND	-	-	-	
53	(SL8081/83/85) RESERVED - DNC	Do not connect						
	(SL8080/82/84) MIC1_P	Microphone positive in series with 0.1µF DC blocking capacitor (Differential input across MIC1_P/MIC1_N)		Input		200 (mV_{pp})	2.6 (V_{pp})	Analog
54	(SL8081/83/85) RESERVED - DNC	Do not connect						
	(SL8080/82/84) MIC1_N	Microphone negative in series with 0.1µF DC blocking capacitor (Differential input across MIC1_P/MIC1_N)		Input		200 (mV_{pp})	2.6 (V_{pp})	Analog

Table 4-2: SL808X LGA pad pin assignments (Continued)[a]

Pin	Signal name	Description	Active state	Input / Output (Direction to module)	Voltage (V)			
					Min[b]	Typ[b]	Max[b]	Type
55	NC	No connect						
56	(SL8081/83/85) RESERVED - DNC	No connect						
	(SL8080/82/84) SPK_N	Speaker negative (Differential output across SPK_P/SPK_N)		Output		80 (mV_{pp})	4.24 (V_{pp})	Analog
57	(SL8081/83/85) RESERVED - DNC	No connect						
	(SL8080/82/84) SPK_P	Speaker positive (Differential output across SPK_P/SPK_N)		Output		80 (mV_{pp})	4.24 (V_{pp})	Analog
58	NC	No connect						
59	NC	No connect						
60	LED_FLASH	LED driver	High	Output High	1.35	-	1.8	Digital
				Output Low	0	-	0.45	
61	WAKE_N	Wake Host Interface	Low	Output High	1.35	-	1.8	Digital
				Output Low	0	-	0.45	
62	W_DISABLE_N	Wireless disable	High/Low	Input High	1.17	-	2.1	Digital
				Input Low	-0.3	-	0.63	
63	SYSTEM_RESET_N	Reset	High/Low	Input High	1.17	-	2.1	Digital
				Input Low	-0.3	-	0.63	
64	PCM_SYNC	PCM Sync Out	High/Low	Output High	1.35		1.8	Digital
				Output Low	0		0.45	
65	PCM_DOUT	PCM Data Out	High/Low	Output High	1.35		1.8	Digital
				Output Low	0		0.45	
66	PCM_DIN	PCM Data In	High/Low	Input High	1.17	-	2.1	Digital
				Input Low	-0.3	-	0.63	
67	PCM_CLK	PCM Clock	High/Low	Output High	1.35		1.8	Digital
				Output Low	0		0.45	
68	BUZZER_EN		High/Low	Output High	1.35	-	1.8	Digital
				Output Low	0	-	0.45	
69	TDI	Test Data Input	High/Low	Input High	1.17	-	2.1	Digital
				Input Low	-0.3	-	0.63	

Table 4-2: SL808X LGA pad pin assignments (Continued)[a]

Pin	Signal name	Description	Active state	Input / Output (Direction to module)	Voltage (V)			
					Min[b]	Typ[b]	Max[b]	Type
70	TMS	Test Mode Select	High/Low	Input High	1.17	-	2.1	Digital
				Input Low	-0.3	-	0.63	
71	TCK	Test Clock	High/Low	Input High	1.17	-	2.1	Digital
				Input Low	-0.3	-	0.63	
72	TRST_N	Test Reset	Low	Input High	1.17	-	2.1	Digital
				Input Low	-0.3	-	0.63	
73	TDO	Test Data Output	High/Low	Output High	1.35	-	1.8	Digital
				Output Low	0	-	0.45	
74	RTCK	Return TCK	High/Low	Output High	1.35	-	1.8	Digital
				Output Low	0	-	0.45	

a. During the powered-off state, digital signal pins may not be in a high impedance state.
b. All values are preliminary.

4.2 Digital I/O electrical information

The AirPrime SL808X Embedded Module uses 1.8 V CMOS for digital I/O. For electrical characteristics, see Table 4-3 on page 39.

4.2.1 Electrical characteristics

Table 4-3 describes the electrical characteristics of 1.8 V CMOS pins.

Table 4-3: Electrical characteristics—1.8 V type (1V8) digital I/O

Parameter[a]		I/O type	Minimum	Typical	Maximum	Condition
Input/Output pin	V_{IL}	CMOS	-0.3 V		0.63 V	
	V_{IH}	CMOS	1.17 V		2.1 V	
	V_{OL}	CMOS			0.45 V	I_{OL} = -4 mA
	V_{OH}	CMOS	1.35 V		1.8 V	I_{OH} = 4 mA
	I_{OH}				4 mA	
	I_{OL}				-4 mA	

a. ‘IL’—Input Low; ‘IH’—Input High; ‘OL’—Output Low; ‘OH’—Output High

4.2.2 Signal reset states

Each interface described in this chapter includes a pin descriptions table, which identifies each signal's reset state. Table 4-4 describes these reset states.

Table 4-4: Reset state definition

Parameter	Definition
0	Set to GND
1	Set to supply 1V8
Pull-down	Internal pull-down with ~60 kΩ resistor
Pull-up	Internal pull-up with ~60 kΩ resistor to supply 1V8
Z	High impedance
Undefined	**Caution:** *Undefined must not be used in an application if a special state is required at reset. These pins may be toggling a signal(s) during reset.*

4.3 Reference schematic

Reference schematics are forthcoming.

4.4 General purpose input/output

The AirPrime SL808X Embedded Module includes three general purpose I/O (GPIO) pins. Table 4-5 describes the purpose and features of this interface.

Table 4-5: GPIO interface features

Feature	Details
Purpose	• OEM-configurable general purpose I/O (control, signaling, monitoring, etc.)
Implementation	• Defaults to digital output
Power	• 1.8 V (use VREF_1V8 as logic reference) • Output drive current up to 8 mA.

4.4.1 Pin descriptions

Table 4-6 describes the GPIO interface pins.

See Digital I/O electrical information on page 39 for 1V8 voltage characteristics and reset state definitions.

Table 4-6: GPIO pin descriptions

Pin	Signal	I/O type	Reset state[a]	Description
1	GPIO_3	1V8	• Using EMConnect: Set by user • Not using EMConnect: Input, pull-down	Configurable general purpose I/O
2	GPIO_2	1V8		
3	GPIO_1	1V8		

a. See Table 4-4 on page 40 for state definitions.

Caution: *Sierra Wireless reserves the right to dedicate any of these pins for specific purposes in the future. Use at your own risk.*

4.5 Main serial link (UART1)

The AirPrime SL808X Embedded Module includes a serial link (UART1) for host–module communication. Table 4-7 describes the purpose and features of this interface.

Note: The SL808X may be provisioned with the ability to use the UART1 interface to communicate with peripheral devices. Contact Sierra Wireless for further information.

Table 4-7: UART1 interface features

Feature	Details
Purpose	• Serial host–module communication • Dependent on provisioning, communication with peripheral devices. Contact Sierra Wireless for further information.
Implementation	• Four-wire serial interface based on TIA-232 (RS232 protocol) • An RS-232 level shifter device may be required.
Data rates supported	• High speed (up to 4 Mbps)
Optional functionality	• Dependent on provisioning, module may be able to communicate with peripheral devices. Contact Sierra Wireless to discuss possible firmware support.

4.5.1 UART1 pin descriptions

Table 4-8 describes the UART1 interface pins.

See Digital I/O electrical information on page 39 for 1V8 voltage characteristics and reset state definitions.

Table 4-8: Serial port UART1 interface

Pin	Signal	I/O type	Reset state[a]	Description	Direction wrt host	Notes
45	UART1_RXD	1V8		High speed UART - Transmit data	Input	• Digital pin input, internal Pull Down • UART1 serial data transmit line (modem output)
46	UART1_TXD	1V8		High speed UART - Receive data	Output	• UART1 serial data receive line (modem input)
47	UART1_RTS_N	1V8		High speed UART - Clear to send	Output	
48	UART1_CTS_N	1V8		High speed UART - Request to send	Input	

a. See Table 4-4 on page 40 for state definitions.

4.5.2 Interface implementation

See Reference schematic on page 40 for an implementation of the UART1 interface.

4.6 SIM interface

The AirPrime SL808X Embedded Module includes a 4-wire USIM interface that allows a SIM to be directly connected. Table 4-9 describes the purpose and features of this interface.

Table 4-9: USIM interface features

Feature	Details
Purpose	• Communicate with USIM socket on host device • Supports regular and embedded SIMs
Implementation	• Four-wire interface • Voltage levels comply with 3GPP standards
Power	• 1.8 V (3G) or 3.0 V (2G) operation. Compliant with GSM 11.11 recommendations concerning SIM functions. • Host must keep current draw ≤10mA

4.6.1 SIM pin descriptions

Table 4-10 describes the SIM interface pins.

See Digital I/O electrical information on page 39 for 1V8 voltage characteristics and reset state definitions.

Table 4-10: USIM interface signals

Pin	Name	I/O Type	Reset state[a]	Description	Notes
6	EXT_VREG_USIM			USIM power supply	• 1.8 V (3G) or 3 V (2G). • Maximum allowed current draw = 10 mA.
7	EXT_USIM_RESET			USIM reset signal	
8	EXT_USIM_DATA			USIM data	• Requires 15–25 kΩ pull-up resistor to EXT_VREG_USIM. • Shunt capacitor in pF range may be needed (PCB provision for capacitor is recommended)
9	EXT_USIM_CLK			USIM clock	• Typically 4 MHz at EXT_VREG_USIM level. • Host should minimize rise time (< 50 ns) by adjusting trace capacitance and filtering needs as required

a. See Table 4-4 on page 40 for state definitions.

Note: To reduce crosstalk from clock to SIM data line, it is recommended to have 18pF on the EXT_USIM_CLK for the eSIM-installed model of SL, and 36pF for modules without eSIMs.

4.6.2 Application notes

See Reference schematic on page 40 for an implementation of the SIM interface.

4.6.2.1 SIM socket pin description

Table 4-11 describes the required SIM socket pins.

Table 4-11: SIM socket pin descriptions

Pin	Signal	Description
1	VCC	EXT_VREG_USIM
2	RST	EXT_USIM_RESET

Table 4-11: SIM socket pin descriptions (Continued)

Pin	Signal	Description
3	CLK	EXT_USIM_CLK
4	-	-
5	GND	GROUND
6	-	-
7	I/O	EXT_USIM_DATA
8	-	-

4.7 USB 2.0 interface

The AirPrime SL808X Embedded Module features a 3-wire USB slave interface that complies with USB 2.0 protocol signaling. Table 4-12 describes the purpose and features of this interface.

Table 4-12: USB interface features

Feature	Details
Purpose	Host–module communication via AT commands, CnS objects, etc.
Standard	• USB 2.0 compliant • CDC 1.1 - ACM compliant
Data rates supported	• Optimized for high speed (480 Mbps) • Full speed (12 Mbps)—Throughput performance is on an “as-is” basis and must be characterized by the OEM. *Note: Throughput rates may vary significantly based on packet size, host interface, and firmware revision.*
Enumeration	• Windows (using host Windows drivers)—COM ports • Linux (with Sierra Wireless driver)—/dev/ttyUSB*n* devices
Power supply	• VCC supply • 3.3 V type compatible
Additional features	• Firmware download over USB

4.7.1 USB pin descriptions

Table 4-13 describes the UART1 interface pins.

See Digital I/O electrical information on page 39 for 1V8 voltage characteristics and reset state definitions.

Table 4-13: USB interface pins

Pin	Signal	I/O type	Reset state[a]	Description	Notes
50	USB_D+			HS-USB data +	• Protected against ±500V Human Body Model ESD. • ESD suppressor with shunt capacitance <1 pF is recommended. • Host must ensure D+ and D- traces are well matched and of differential impedance of 90 Ω. All high-speed differential routing techniques should be applied. • Allocate room to accommodate a common-mode choke filter (90 Ω impedance) between the module and destination
51	USB_D-			HS-USB data -	

a. See Table 4-4 on page 40 for state definitions.

4.7.2 Electrical characteristics

Table 4-14 describes the USB interface's electrical characteristics.

Table 4-14: USB interface electrical characteristics

Parameter	Minimum	Typical	Maximum	Unit
USB_D+ USB_D-	3	3.3	3.6	V

4.7.3 Application notes

See Reference schematic on page 40 for an implementation of the USB interface.

4.7.4 Host-developed USB drivers

Note: If you are using Sierra Wireless drivers, you can skip this section—it is intended for developers who are creating their own USB drivers.

Detailed USB driver specifications for Sierra Wireless AirPrime modules are included in the AirCard/AirPrime USB Driver Developer's Guide, available from your Sierra Wireless account representative.

4.7.4.1 Supported architectures

The AirPrime SL808X Embedded Module supports the following architectures over the USB interface on Windows, Windows CE, and Linux systems:

- Sierra Wireless Direct IP—Composite USB
- Non-MUX—Composite USB
- MUX (3GPP 27.010)—Composite USB (The MUX architecture is also available over the UART interface.)
- Non-MUX—Non-composite USB

For design requirements, see [6] AirCard/AirPrime USB Driver Developer's Guide.

The basic service configuration is PRI-dependent and may include the NDIS, AT, and CnS services. The advanced service configuration (available for Windows and Windows CE) is disabled by default, and may include the DM and PDP services.

4.7.4.2 USB driver requirements

The host USB driver must meet each of these requirements:

- Must act as a USB host device to interface with the module.
- Must support remote wakeup, resume, and suspend operations as described in Universal Serial Bus Specification, Rev 2.0, and USB Suspend mode on page 46 and USB Resume mode on page 46.
- Must support serial port emulation. The module implements both 27.010 multiplexing and USB-CDC.
- Should NOT send any SOF tokens (start-of-frames) to the module when there is no valid data to send. These tokens keep the module awake and cause unnecessary power consumption.

4.7.5 USB Suspend mode

When the module enters suspend mode, it shuts down the USB clock to save power.

While in the suspend state:

- Module provides signalling on the USB interface (USB_D+/USB_D-) to indicate its current state to the host device.
- VCC_3V6 must be maintained.

4.7.6 USB Resume mode

USB activity may be resumed by either the USB host or by the module:

- Host-initiated:
  - **a.** USB transceiver detects the change in bus activity and triggers the USB_RESUME interrupt to the module's processor.
  - **b.** Module enables its USB clock and responds to the host.

- Modem-initiated (Remote Wakeup):
  a. Module enables its USB clock.
  b. Module enables the USB transceiver.
  c. Module sends the resume signal for at least 20 ms.

4.8 RF interface

The AirPrime SL808X Embedded Module's RF (radio frequency) interface uses two antenna ports for Tx/Rx and GPS. Table 4-15 describes the purpose and features of this interface.

Table 4-15: USB interface features

Feature	Details
Purpose	• Primary antenna—Rx/Tx • GPS antenna—GPS functionality
Standard	• USB 2.0 compliant • CDC 1.1 - ACM compliant
Data rates supported	• Optimized for high speed (480 Mbps) • Full speed (12 Mbps)—Throughput performance is on an "as-is" basis and must be characterized by the OEM. *Note: Throughput rates may vary significantly based on packet size, host interface, and firmware revision.*
Enumeration	• Windows (using host Windows drivers)—COM ports • Linux (with Sierra Wireless driver)—/dev/ttyUSB*n* devices
Additional features	• Firmware download over USB
Power supply	• VCC supply • 3.3 V type compatible
Impedance	• Nominal: 50 Ω • DC: 0 Ω

4.8.1 RF connections

To protect the antenna lines from baseband signal noise:

- Connection from each antenna port (RF) to the antenna should use a coax cable or a good microstrip/strip line.
- RF trace should be 50 Ω to avoid mismatch and load pull effects.
- RF connection must be isolated from other high voltage and noisy signals to ensure a good Rx sensitivity level.
- RF traces on the host PCB could be lossy, so should be kept as short as possible.

For more information, see Figure 8-4, Routing examples, on page 99.

4.8.2 RF pin descriptions

Table 4-16 describes the RF interface pins.

Table 4-16: RF interface pins

Pin	Signal	I/O type	Reset state[a]	Description	Notes
RX/Tx antenna					
28	Ground				
29	ANT_PRM			Main (primary) antenna	ESD protected—See [5] Sierra Wireless Reliability Specification for details.
30	Ground				
GPS antenna					
35	Ground				
36	ANT_GPS			GPS antenna	
37	Ground				

a. See Table 4-4 on page 40 for state definitions.

4.8.3 RF performance

The module's radio transceiver meets the requirements of 3GPP Release 5.

Table 4-17 on page 49 describes supported GSM, WCDMA, and GPS bands, conducted Tx power, and conducted Rx sensitivity.

Table 4-17: Band support, Conducted Tx Power, and Conducted Rx Sensitivity[a]

Band	Frequencies (MHz)	SL8080 SL8081	SL8082 SL8083	SL8084 SL8085	Conducted Tx Power		Conducted Rx Sensitivity (dBm)			
					Avg (dBm)	Notes				
GSM bands							**Coding**	**Mode**	**Typ**	**Worst Case**
GSM 850	Tx: 824–849 Rx: 869–894	✔	✔	✔	+33 ± 2	GMSK, connectorized (Class 4)	CS1-3[b] CS4[c] MCS1-3[c] MCS4[c] MCS5[c] MCS6[c] MCS7[c] MCS8[c] MCS9[c]	GMSK GMSK GMSK GMSK 8PSK 8PSK 8PSK 8PSK 8PSK	-106 -103 -106 -103.5 -100 -98 -95 -92.5 -90	-102 -99 -102 -99.5 -96 -94 -91 -88.5 -86
					+27 ± 3	8PSK, connectorized (Class E2)				
EGSM 900	Tx: 880–915 Rx: 925–960	✔	✔	✔	+33 ± 2	GMSK, connectorized (Class 4)				
					+27 ± 3	8PSK, connectorized (Class E2)				
DCS 1800	Tx: 1710–1785 Rx: 1805–1880	✔	✔	✔	+30 ± 2	GMSK, connectorized (Class 1)				
					+26 ± 3	8PSK, connectorized (Class E2)				
PCS 1900	Tx: 1850–1910 Rx: 1930–1990	✔	✔	✔	+30 ± 2	GMSK, connectorized (Class 1)				
					+26 ± 3	8PSK, connectorized (Class E2)				
WCDMA bands[d]							**Call details**		**Typ**	**Worst Case**
Band I WCDMA 2100	Tx: 1920–1980 Rx: 2110–2170		✔	✔	+24 +1/-3	• Connectorized (Class 3) • Nominal conditions	RMC DL 12.2 kbps; 0.1% BER		-108	-106.7
Band II WCDMA 1900	Tx: 1850–1910 Rx: 1930–1990	✔							-107	-104.7
Band V WCDMA 850	Tx: 824–849 Rx: 869–894	✔		✔					-108	-104.7
Band VIII WCDMA 900	Tx: 880–915 Rx: 925–960		✔						-108	-103.7
GPS										
GPS	1575.42	✔ (SL8080/82/84)								

a. Preliminary values
b. 2% Bit Error Rate (BER) circuit switched
c. 10% Block Error Rate (BLER)
d. WCDMA channel spacing is 5 MHz, but this can be adjusted to optimize performance in a particular deployment scenario.

4.8.4 Antenna specifications

The antenna must meet the requirements specified Table 4-18.

The optimum operating frequency depends on the application. A dual-band, tri-band or quad-band antenna should operate in these frequency bands and have the described characteristics.

Table 4-18: Main antenna (ANT_PRI) specification

Parameter		Min[a]	Typ[a]	Max[a]	Units	Notes
Connection loss		-	-	0.5	dB	Maximum loss to antenna
VSWR		-	-	2.3:1		Maximum allowed VSWR of antenna
Radiated gain	Low bands		0	5[b]	dBi	
	High bands			3[c]		

a. Preliminary values
b. When Tx power from modem is ≤ +33 dBm (2W)
c. When Tx power from modem is ≤ +30 dBm (1W)

Note: Sierra Wireless recommends a maximum VSWR of 1.5:1 for both TX and RX bands. Even so, all aspects of this specification will be fulfilled even with a maximum VSWR of 2:1.

4.8.4.1 Application notes

The following are suggested guidelines for the two antenna ports:

- The antenna should be isolated as much as possible from analog and digital circuitry (including interface signals).
- On applications with an embedded antenna, poor shielding could dramatically affect the receiving sensitivity. Moreover, the power radiated by the antenna could affect the application (TDMA noise, for instance).
- As a general recommendation, all components or chips operated at high frequencies (microprocessors, memories, DC/DC converter) or other active RF parts should not be placed too close to the AirPrime SL808X Embedded Module. In the event that this happens, the correct power supply layout and shielding should be designed and validated.
- Components near RF connections or unshielded feed lines must be prohibited.
- RF lines must be kept as short as possible to minimize loss.
- Primary path common for Tx and Rx should be routed on the host PCB using a 240 micron wide trace with (to withstand high power up to 2W RF) 50 Ω as impedance up to the antenna connector or launch point. Note: If the impedance of the module is mismatched, RF performance is reduced significantly.
- Should be protected for ESD using a 8 kV-rated suppressor to avoid damage during antenna assembly, etc. Capacitance should be < 0.2 pF.

- RF trace and cable connecting the pin to the antenna should be of low loss (<0.3 dB)
- Antenna connected on the ANT_PRM port should offer 2:1 or better VSWR in order to maintain Tx power within +/- 2dB from the nominal power and the VSWR could be 2.3:1 or better for the Rx band frequencies.
- Antenna connected on the ANT_GPS port should offer 3:1 or better VSWR in order to maintain radiated sensitivity.
- 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.
- 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.

4.8.5 Radiated emissions

The device alone meets all regulatory emissions limits when tested into a cabled (conducted) 50 Ω system. With antenna designs with up to 2.3:1 VSWR or worse, the radiated emissions could exceed limits. These emissions must be tested with the final antenna to ensure they pass. Examples of these limits would be FCC Part 22 and Part 24, test case 12.2.1 for GSM (3GPP TS 51.010), and test case 4.2.2 for WCDMA (ETSI EN 301 511).

The system gain value affects both radiated power *and* regulatory (FCC, IC, CE, etc.) test results.

4.8.6 Radiated sensitivity measurement

A wireless device contains many sources of noise that contribute to a reduction in Rx performance.

To determine the extent of any desensitization of receiver performance due to self-generated noise in the host device, over-the-air (OTA) or radiated testing is required. This testing can be performed by Sierra Wireless or you can use your own OTA test chamber for in-house testing.

Most carriers require a certain level of receiver performance to ensure proper functioning of the device on their networks. Although AirPrime soldered-down modules have been designed to meet these carrier requirements, they are still susceptible to various performance inhibitors.

4.9 Audio interfaces

The AirPrime SL808X Embedded Module supports two audio interfaces (analog and PCM digital) and allows dynamic run-time selection of the appropriate interface:

- Analog audio interface on page 52
- Digital audio interface (PCM) on page 62

4.10 Analog audio interface

The AirPrime SL808X Embedded Module analog audio interface supports one microphone input and one speaker output.

Table 4-15 describes the purpose and features of this interface.

Table 4-19: Audio interface features

Feature	Details
Implementation	• Supports analog audio processing • Does not provide on-board filtering (except for 0.1 µFblocking capacitors on microphone lines) • Host must provide bias and signal filters • Host should terminate unused audio lines with pull-down resistors • ESD protection may be required on audio interface lines
Features	• Echo cancellation and noise reduction • TTY/TDD compatibility through the microphone/speaker connections (Note: TTY/TDD is not supported by the PCM interface.)

4.10.1 Pin descriptions

Table 4-20 describes the analog audio interface pins.

Table 4-20: Analog audio interface connections

Pin	Name	I/O type	Description	Type	Notes
53	MIC1_P		Line Audio input	A	Differential audio input, line level. In series with 0.1µF DC blocking capacitor.
54	MIC1_N		Line Audio input	A	Differential audio input, line level. In series with 0.1µF DC blocking capacitor.
56	SPK_N		Main speaker	A	Differential audio output, line level
57	SPK_P		Main speaker	A	Differential audio output, line level

4.10.2 Microphone features

The microphone can be connected in either differential or single-ended mode:

- Differential mode—Default method (recommended). Rejects common mode noise and TDMA noise.
- Single-ended mode—Requires good ground plane, filtering and shielding to avoid audio path disturbances. Note that the audio input signal is decreased by 6 dB compared to differential mode.

The gain of both MIC inputs are internally adjusted and can be tuned using AT commands. For more information on AT commands, refer to [3] AirPrime MC8xxx Embedded Modules Extended AT Command Reference.

4.10.2.1 MIC microphone input

The microphone input has the following features:

- Default mode—Differential. Can also be configured in single-ended mode.
- Includes biasing for electret microphone, which can be directly connected to the input.
- AirPrime SL808X Embedded Module has embedded AC coupling.
- For electrical characteristics, see Table 4-21.

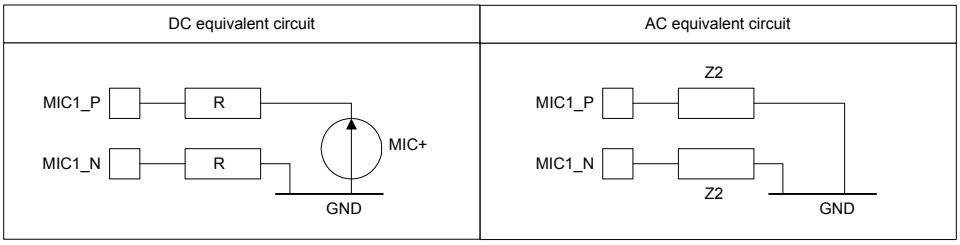

Figure 4-3: MIC equivalent circuits

Table 4-21: MIC input electrical characteristics

Parameter		Minimum	Typical	Maximum	Unit
Parameters	MIC1_P	2	2.1	2.2	V
Internal biasing	Output current		0.5	1.5	mA
DC characteristics	R2	1650	1900	2150	Ω
AC characteristics 200 Hz<F<4 kHz	Z2 MIC1_P (MIC1_N = Open)	1.1	1.3	1.6	kΩ
	Z2 MIC1_N (MIC1_P = Open)				
	Z2 MIC1_P (MIC1_N=GND)	0.9	1.1	1.4	
	Z2 MIC1_N (MIC1_P=GND)				
	Impedance between MIC1_P and MIC1_N	1.3	1.6	2	
Working voltage (MIC1_P-MIC1_N)	AT+VGT[a]=3500[b]		13.8	18.6[c]	mVrms
	AT+VGT[a]=2000[b]		77.5	104[c]	
	AT+VGT[a]=700[b]		346	466[c]	
Maximum rating voltage (MIC1_P or MIC1_N)	Positive			+7.35[d]	V
	Negative	-0.9			

a. Input voltage depends on the input micro gain set by AT command. Refer to [3] AirPrime MC8xxx Embedded Modules Extended AT Command Reference
b. Value in dB. To toggle it to index value, refer to [3] AirPrime MC8xxx Embedded Modules Extended AT Command Reference.
c. Value is obtained with digital gain=0, for frequency=1 kHz.
d. Because MIC1_P is internally biased, a coupling capacitor must be used to connect an audio signal provided by an active generator. Only a passive microphone can be directly connected to the MIC1_P and MIC1_N inputs.

Table 4-22: Microphone interface parameters

Parameter / Description		Test	Min[a]	Typ[a]	Max[a]	Units
	Input DC common mode voltage		1.13	1.25	1.38	V
Z_{In1}	Input impedance between MIC1_P and MIC1_N	Fully differential, A/D path	16	20	24	kΩ
THD_V	Total harmonic distortion +Noise (voice)	All inputs: • AV_{DD} = 2.5 V • 13-bit mode • analog input at 229 mV_{pp} • 498 Hz sine wave			3.5	%

a. Preliminary values

Caution: *The voltage input value for MIC cannot exceed the maximum working voltage; otherwise, clipping will appear.*

MIC differential connection example

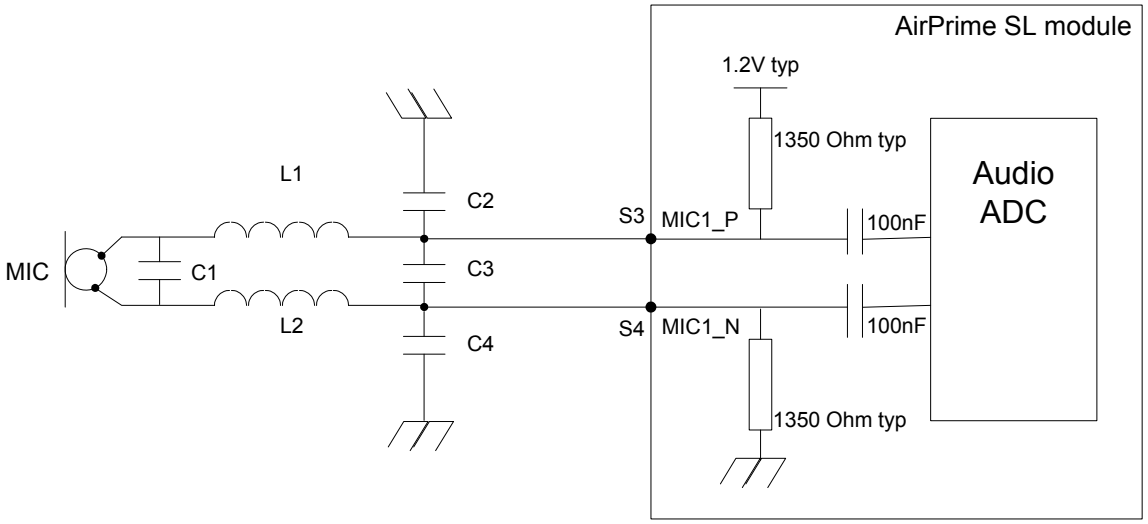

Figure 4-4: Example—MIC differential connection with LC filter (TBD)

LC filter (L1, L2, C2, C3, C4) considerations:

- Filter is not mandatory. Audio quality may be good enough without it, depending on the design.
- Filter may be used to reduce TDMA noise (from EMI perturbation).

- If no filter is used, capacitors must be removed and the coil replaced by 0Ω resistors as shown in Figure 4-5 on page 55.

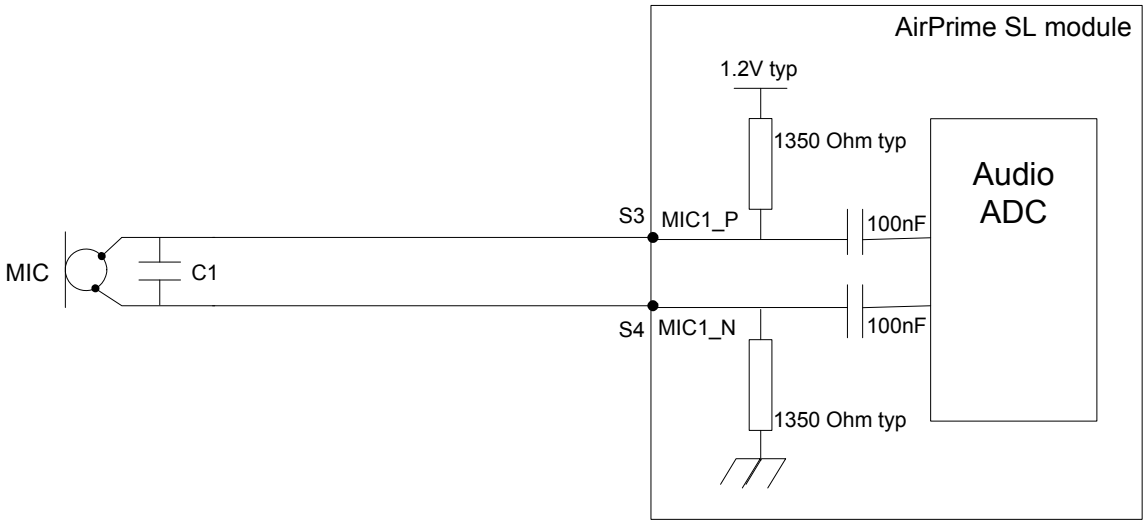

Figure 4-5: Example—MIC differential connection without an LC filter (TBD)

Capacitor C1 is highly recommended to eliminate TDMA noise and it must be connected close to the microphone.

Table 4-23 lists the recommended components to use in creating the LC filter.

Table 4-23: Recommended components for a MIC differential connection

Component	Value	Notes
C1	12–33 pF	Must be tuned depending on the design.
C2, C3, C4	47 pF	Must be tuned depending on the design.
L1, L2	100 nH	Must be tuned depending on the design.

MIC single-ended connection example

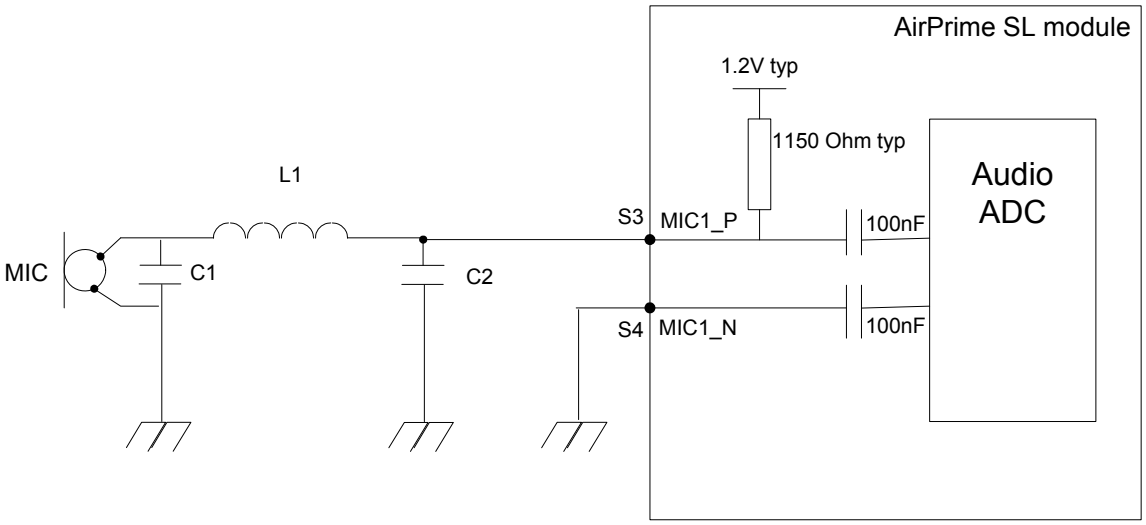

Figure 4-6: Example—MIC single-ended connection with LC filter (TBD)

Single-ended connection considerations:

- Not recommended for improving TDMA noise rejection as it is usually difficult to eliminate TDMA noise from a single-ended design.
- Internal input resistor value becomes 1150 Ω due to the connection of MIC1_N to the ground.
- LC filter (L1 and C2) is recommended (but not mandatory) to eliminate TDMA noise. If the filter is not to be used, the capacitor C2 must be removed and the coil replaced by 0 Ω resistors as shown in Figure 4-7 on page 56.

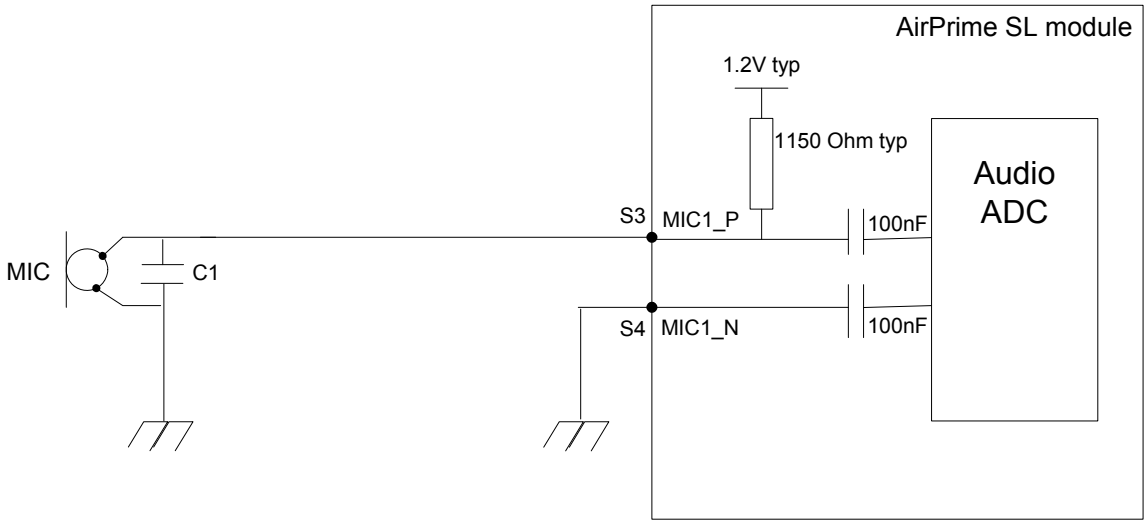

Figure 4-7: Example - MIC single-ended connection without an LC filter (TBD)

Capacitor C1 is highly recommended to eliminate TDMA noise and it must be connected close to the microphone.

Table 4-24 lists the recommended components to use in creating the LC filter.

Table 4-24: Recommended components for a MIC single-ended connection

Component	Value	Notes
C1	12–33 pF	Must be tuned depending on the design.
C2		Must be tuned depending on the design.
L1		Must be tuned depending on the design.

4.10.3 Speaker features

The speaker can be connected in either differential or single-ended mode:

- Differential mode—Default method (recommended). Rejects common mode noise and TDMA noise.
- Single-ended mode—Requires good ground plane, filtering, and shielding to avoid audio path disturbances. Experiences power loss (power is divided by 4 in a single-ended connection) compared to differential connection.

The gain of each speaker output channel is internally adjusted and can be tuned using AT commands. For more information on AT commands, see [3] AirPrime MC8xxx Embedded Modules Extended AT Command Reference.

Discreet components (for example, resistors and capacitors) are not needed for this interface.

Table 4-25 lists the typical values of both speaker outputs.

Table 4-25: Speaker information

Parameter	Typical	Unit	Connection
Z (SPK_P, SPK_N)	4	Ω	Single-ended mode
Z (SPK_P, SPK_N)	8	Ω	Differential mode

4.10.3.1 Speakers output power

Because SPK can provide more power, it can be connected in differential mode. The maximal specifications given below are available with the maximum power output configuration values set by AT command, and the typical values are recommended.

Caution: *It is mandatory not to exceed the maximal speaker output power and the speaker load must be in accordance with the gain selection (gain is controlled by AT command). Exceeding beyond the specified maximal output power may damage the AirPrime SL808X Embedded Module.*

4.10.3.2 SPK speaker output

SPK can have either a single-ended or a differential connection.

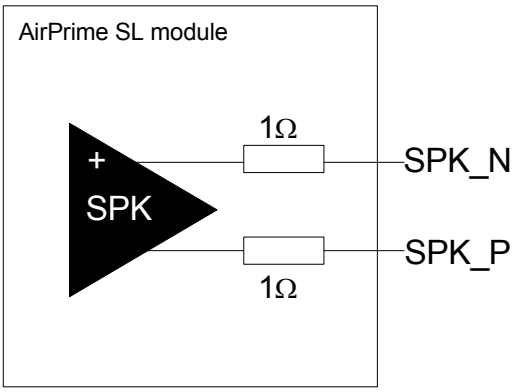

Figure 4-8: SPK equivalent circuit

Table 4-26 describes the speaker's electrical characteristics.

Table 4-26: SPK electrical characteristics

Parameter		Minimum	Typical	Maximum	Unit
Biasing voltage	SPK_P and SPK_N		1.30		V
Output swing voltage	RL=8 Ω: AT+VGR=-1000[a]; single ended	-	-	2	Vpp
	RL=8 Ω: AT+VGR=-1000[a]; differential	-	-	4	Vpp
	RL=32 Ω: AT+VGR=-1000[a]; single ended	-	-	2.5	Vpp
	RL=32 Ω: AT+VGR=-1000[a]; differential	-	-	5	Vpp
RL	Load resistance	6	8	-	Ω
IOUT	Output current; peak value; RL=8 Ω	-	-	180	mA
POUT	RL=8 Ω; AT+VGR=-1000[a]	-	-	250	mW
RPD	Output pull-down resistance at power-down	28	40	52	kΩ
VPD	Output DC voltage at power-down	-	-	100	mV

a. Output voltage depends on the output speaker gain set by AT command. This value is given in dB, but it's possible to toggle it to index value. Refer to [3] AirPrime MC8xxx Embedded Modules Extended AT Command Reference.

Table 4-27: Speaker interface parameters

Parameter / Description		Test	Min[a]	Typ[a]	Max[a]	Units
	Output DC offset voltage between MIC1_P and MIC1_N, SPK_P and SPK_N	Fully differential	-20		20	mV
	Output common mode voltage, SPK_P and SPK_N	Measured at each output pin with respect to AVSS: V_{DD} = 2.5 V to 2.7 V	1.13	1.25	1.38	V
Z_{OUT1}	Differential output impedance	At 1.02 kHz, for outputs SPK_P and SPK_N			1	Ω

a. Preliminary values

If a single-ended connection is used, only one of either SPK outputs have to be chosen. The result is a maximal output power divided by 4.

4.10.3.3 Differential connection example

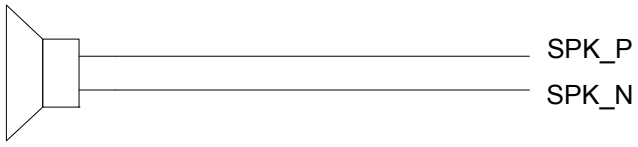

Figure 4-9: Example - SPK differential connection

The impedance of the speaker amplifier output in differential mode is R≤1 Ω ±10%.

Note that the connection between the speaker and the AirPrime SL808X Embedded Module pins must be designed to keep the serial impedance lower than 3 Ω when it is connected in differential mode.

4.10.3.4 Single-ended connection example

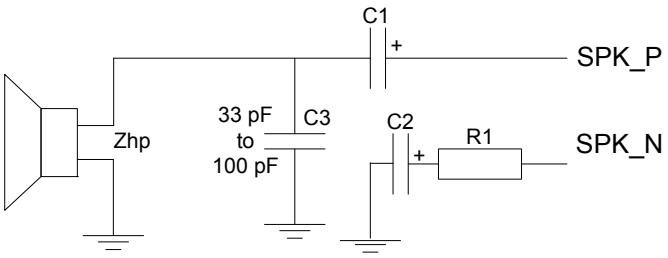

Figure 4-10: Example - SPK single-ended connection

Take note of the following when connecting the speaker in single-ended mode:

- 6.8µF < C1 < 47 µF (depending on the characteristics of the speaker and the output power)
- C1 = C2
- R1 = Zhp

Again, note that using a single-ended connection includes losing power (-6dB) as compared to a differential connection.

In the case of a 32 Ω speaker, a cheaper and smaller solution can be implemented where R1 = 82 Ω and C2 = 6.8µF (ceramic).

Also note that the connection between the speaker and the AirPrime SL808X Embedded Module pins must be designed to keep the serial impedance lower than 1.5 Ω when it is connected in single-ended mode.

4.10.3.5 Recommended characteristics

- Type: 10 mW, electro-magnetic
- Impedance: 8 Ω for hands-free
- Sensitivity: 110dB SPL minimum (0dB = 20 µPa)
- Frequency response must be compatible with GSM specifications

4.10.4 Supported voice features

The AirPrime SL808X Embedded Module modem supports the voice-related features listed in Table 4-28, and Table 4-29 details its support for supplementary services.

Table 4-28: Supported voice features

Item	Comments
USSD (Unstructured Supplementary Services Data)	This is a GSM-specific capability that supports transmitting information over GSM network signalling channels.
Voice encryption	Both A5/1 and A5/2 voice encryption are supported.
SIM Application Tool Kit with proactive SIM commands (compliant to R96)	3GPP TS 11.14 SIM Application Toolkit commands are stored on the SIM. These commands enable the SIM card to proactively drive the GSM host device and support interactions between the network and the end user.
User-configurable audio prompts	Several audio features, such as ‘Incoming Call’ and ‘New SMS message’, can be configured in Watcher.
Multi-party calling	Up to 5 remote parties are supported on a single call, plus an additional party on hold (on a separate call).

Table 4-29: Supported supplementary services

Service	Supported by		
	Watcher / CnS	GSM service code	AT command
Calling Line Identification Presentation (Caller ID)	Yes	Yes	Yes
Calling LIne Identification Restriction (hides your ID on outgoing calls)	Yes	Yes	Yes

Table 4-29: Supported supplementary services (Continued)

Service	Supported by		
	Watcher / CnS	GSM service code	AT command
Call Waiting	Yes	Yes	Yes
Call Hold	Yes	N/A (TBD)	Yes
Multi-party service	Yes	N/A (TBD)	Yes
Call Forwarding			
Unconditional	Yes	Yes	Yes
on Mobile Subscriber Busy	Yes	Yes	Yes
on No Reply	Yes	Yes	Yes
on Mobile Subscriber Not Reachable	Yes	Yes	Yes
Call Barring			
All outgoing calls	Yes	Yes	Yes
Outgoing international calls	Yes	Yes	Yes
Outgoing international calls (except those directed to the home PLMN country)	Yes	Yes	Yes
All incoming calls	Yes	Yes	Yes
Incoming calls when roaming outside the home PLMN country	Yes	Yes	Yes

4.10.5 Short Message Service (SMS)

Table 4-30 summarizes the SL808X module's compliance with specific SMS features:

Table 4-30: SMS features

Feature	Supported
Mobile-terminated SMS	✔
Mobile-originated SMS	✔
Point-to-Point messaging	✔
Cell Broadcast messaging	✘

4.10.6 UMTS radio access bearers supported

The SL808X modem supports the majority of the radio access bearers specified in 3GPP TS 34.108. If you require a detailed list, contact Sierra Wireless.

4.11 Digital audio interface (PCM)

The Digital Audio Interface (PCM) interface allows connectivity with standard audio peripherals. It can be used, for example, to connect an external audio codec. Table 4-31 describes the purpose and features of this interface.

Table 4-31: 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 6 slots by frame (user only on slot 0) • Bit rate single clock mode at 768 kHz only • 16 bits data word MSB first only • Linear Law only (no compression law) • Long Frame Synchronization only • Push-pull configuration on PCM_DOUT and PCM_DIN

The programmability of this interface allows addressing a large range of audio peripherals.

4.11.1 PCM pin descriptions

Table 4-32 describes the digital audio (PCM) interface pins.

See Digital I/O electrical information on page 39 for 1V8 voltage characteristics and reset state definitions.

Note: Note that the digital audio interface configuration cannot differ from this specification.

Table 4-32: Audio pins

Pin	Name	I/O type	Reset state[a]	Description	Notes
64	PCM_SYNC			PCM synchronization bit	• Delivers 8 kHz frequency pulse that synchronizes frame data in/out.
65	PCM_DOUT			PCM output	• Frame ‘data out’ relies on selected configuration mode.
66	PCM_DIN			PCM input	• Frame ‘data in’ relies on selected configuration mode.
67	PCM_CLK			PCM clock	• 2 MHz for primary PCM mode. Controls data transfer with the audio peripheral.

a. See Table 4-4 on page 40 for state definitions.

4.11.2 PCM waveforms

The following figures describe the PCM Frame and Sampling waveforms.

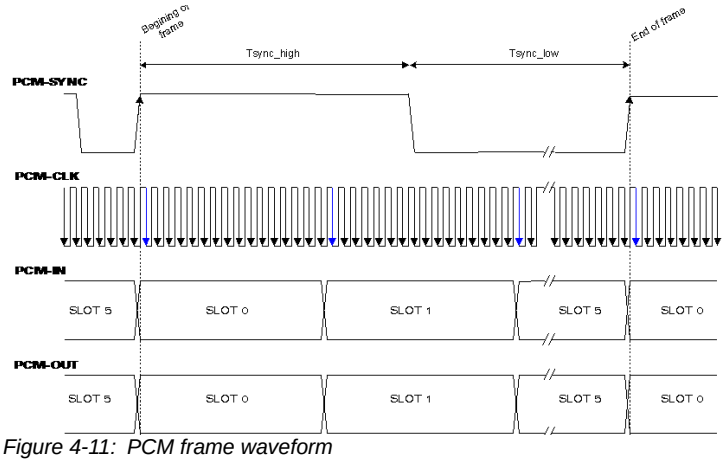

Figure 4-11: PCM frame waveform

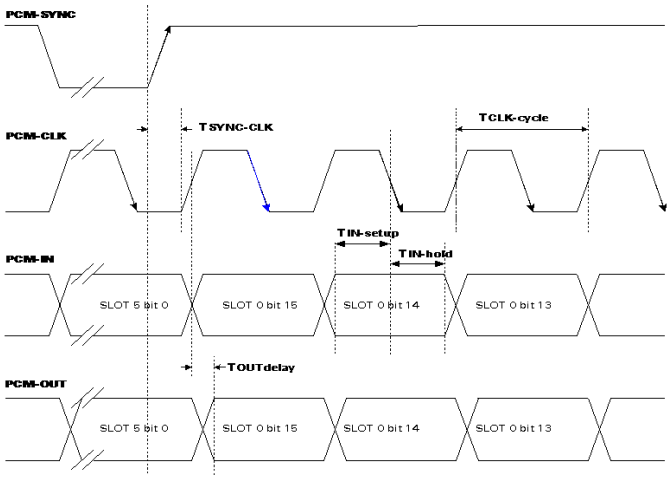

Figure 4-12: PCM sampling waveform

Table 4-33 describes the AC characteristics of the digital audio interface.

Table 4-33: Digital audio interface AC characteristics

Signal	Description	Minimum	Typical	Maximum	Unit
Tsync_low + Tsync_high	PCM_SYNC period		125		us
Tsync_low	PCM_SYNC low time		93		us
Tsync_high	PCM_SYNC high time		32		us

Table 4-33: Digital audio interface AC characteristics (Continued)

Signal	Description	Minimum	Typical	Maximum	Unit
TSYNC_CLK	PCM_SYNC to PCM_CLK time		-154		ns
TCLK-cycle	PCM_CLK period		1302		ns
TIN-setup	PCM_DIN setup time	50			ns
TIN-hold	PCM_DIN hold time	50			ns
TOUT-delay	PCM_DOUT delay time			20	ns

4.12 JTAG interface

The AirPrime SL808X Embedded Module includes a six-wire JTAG interface.

A six-wire JTAG ZIF connector may be installed to allow Sierra Wireless to use the interface for debugging/testing. (See JTAG connector on page 117 for recommended suppliers.)

If platform issues arise, contact Sierra Wireless for assistance.

5: Signals and Indicators

5.1 Overview

This chapter describes signals for control and handshaking of the AirPrime SL808X Embedded Module from the host (Table 5-1), and describes how the system implements Smart Error Detection using those signals.

Table 5-1: Available signals

Name	Driven by AT commands
Power on/off signal (POWER_ON_N) on page 66	
Reset Signal (SYSTEM_RESET_N) on page 68	
Wake signal (WAKE_N) on page 70	?
Disable signal (W_DISABLE_N) on page 71	?
Buzzer output (BUZZER_EN) on page 72	✔
Flash LED (LED_FLASH) on page 73	✔
Power rail (VREF_1V8) on page 74	?
Reserved on page 75	?

5.2 Power on/off signal (POWER_ON_N)

This signal is used to switch the AirPrime SL808X Embedded Module ON or OFF.

Table 5-2: Power signal features

Feature	Details
Purpose	Power on/off • Simulates a power button.
Implementation	• Low = On • Digital input • Line should be driven only by an open-drain output from the host • Level is internally pulled up to 2.6 V

5.2.1 Pin descriptions

Table 5-3 describes the POWER_ON_N signal pins.

See Digital I/O electrical information on page 39 for 1V8 voltage characteristics and reset state definitions.

Table 5-3: ON/~OFF signal pin description

Pin	Signal	I/O	I/O type	Description
43	POWER_ON_N	I	CMOS	Embedded module power-on

5.2.2 Electrical characteristics

Caution: *All external signals must be inactive when the AirPrime SL808X Embedded Module is OFF to avoid any damage when starting and to allow the embedded module to start and stop correctly.*

Refer to Table 4-2 on page 34 for basic characteristics (type, voltage).

5.2.3 Application notes

Caution: *This section is under review and subject to change.*

5.2.3.1 Procedure: Power on/off

To power on the modem, the host must:

1. Apply input voltage within valid range to power-supply pins. (See Table 3-1 on page 25 for Vcc range.)

2. Wait at least 50 ms, then assert POWER_ON_N (active low) for at least 400 ms to turn on the module.
3. Release the POWER_ON_N signal (module has internal pull-up to 2.6 V). Module is now in the ‘on’ (normal) power state.

To power off the modem, the host must:

1. Drive the signal low for at least 500 ms in order to initiate the power-down sequence, and then release it. (The modem continually monitors POWER_ON_N.)
   The module should now be in the ‘off’ power state.

5.3 Reset Signal (SYSTEM_RESET_N)

This signal is used to force the AirPrime SL808X Embedded Module to reset.

Note that an operating system reset is preferred to a hardware reset.

Table 5-4: Reset signal features

Feature	Details
Purpose	Reset modem • Used by host to reset the modem.
Implementation	• Digital input. 1.8 V logic • Signal is driven only by an open-drain output from the host. • Host must provide a 50-100 kΩ external pull-up resistor to 1.8 V. *Note: This pin is also required for JTAG programming.*

Caution: *This signal should only be used for EMERGENCY resets.*

5.3.1 Pin descriptions

Table 5-5 describes the SYSTEM_RESET_N signal pin.

See Digital I/O electrical information on page 39 for1V8 voltage characteristics and reset state definitions.

Table 5-5: Reset signal pin description

Pin	Signal	I/O	I/O type	Description
63	SYSTEM_RESET_N	I	1V8	Embedded module reset

5.3.2 Electrical characteristics

Table 5-6 describes the reset signal's electrical characteristics.

Refer to Table 4-2 on page 34 for basic characteristics (type, voltage).

Table 5-6: Reset signal electrical characteristics

Parameter	Minimum	Typical	Maximum	Unit
Input impedance (R)[a]		100		kΩ
Input impedance (C)		10n		F
SYSTEM_RESET_N time (Rt)[b]	200			us

Table 5-6: Reset signal electrical characteristics

Parameter	Minimum	Typical	Maximum	Unit
SYSTEM_RESET_N time (Rt)[c] at power up only	20	40	100	ms
Cancellation time (Ct)		34		ms
V_H[d]	0.57			V
V_{IL}	0		0.57	V
V_{IH}	1.33			V

a. Internal pull-up
b. This reset time is the minimum to be carried out on the SYSTEM_RESET_N signal when the power supply is already stabilized.
c. This reset time is internally carried out by the embedded module power supply supervisor only when the embedded module power supplies are powered ON.
d. VH: Hysterisis voltage

5.3.3 Application notes

Caution: *This section is under review and subject to change.*

5.3.3.1 Reset sequence

To reset the modem (force the baseband circuit to reset):

1. Host drives signal low for 10–30 ms.

Note: Driving the signal low for a longer period will not damage the module, but will delay the reset process—the baseband circuit needs the line to be high at the end of the reset stage.

5.3.3.2 General notes

- This reset line should not be driven unless the host needs to enforce a baseband reset by asserting a logic low.
- An open collector or open drain transistor can be used. If an open collector is chosen, T1 can be a ROHM DTC144EE.

Table 5-7: Reset settings

Reset command	SYSTEM_RESET_N (Pin 63)	Operating mode
1	0	Reset activated
0	1	Reset inactive

5.4 Wake signal (WAKE_N)

This signal is used by the AirPrime SL808X Embedded Module to wake the host when a predetermined condition is satisfied (such as when a call is received).

Table 5-8: Wake signal features

Feature	Details
Purpose	Wake Host interface • Wake host when a predetermined condition is satisfied (for example, when a call is received).
Implementation	• Low = On • Active low, 1.8 V logic. • During the powered-off state, this pin may not be in a high impedance state. The host side must implement appropriate measures to accomodate this.

5.4.1 Pin descriptions

Table 5-9 describes the wake signal pin.

See Digital I/O electrical information on page 39 for 1V8 voltage characteristics and reset state definitions.

Table 5-9: Wake signal pin description

Pin	Signal	I/O	I/O type	Description
61	WAKE_N			Wake Host interface

5.4.2 Electrical characteristics

Refer to Table 4-2 on page 34 for basic characteristics (type, voltage).

5.5 Disable signal (W_DISABLE_N)

This signal is used by the host to disable (or enable) the AirPrime SL808X Embedded Module's RF connection.

Table 5-10: Wireless Disable signal features

Feature	Details
Purpose	Wireless disable • Used by host to disable or enable low power mode ('airplane mode').
Implementation	• Low = Put module in airplane mode • Digital input. Active low, 1.8 V logic. • Host to provide a pull-up resistor of 50-100 kΩ.

5.5.1 Pin descriptions

Table 5-11 describes the wireless disable signal pin.

See Digital I/O electrical information on page 39 for 1V8 voltage characteristics and reset state definitions.

Table 5-11: Wireless disable signal pin description

Pin	Signal	I/O	I/O type	Description
62	W_DISABLE_N	I	Digital	Wireless disable

5.5.2 Electrical characteristics

Refer to Table 4-2 on page 34 for basic characteristics (type, voltage).

5.5.3 Application notes

Caution: *This section is under review and subject to change.*

5.5.3.1 Procedure: Disable/enable radio

To disable the RF connection:

1. Host asserts W_DISABLE_N.

To enable the RF connection (when in RF-disabled mode):

1. Host de-asserts W_DISABLE_N.

5.6 Buzzer output (BUZZER_EN)

This signal is used in the implementation of a buzzer circuit.

Table 5-12: Buzzer signal features

Feature	Details
Purpose	Enable off-board buzzer
Implementation	• Binary I/O used by host as a buzzer enable line

5.6.1 Pin descriptions

Table 5-13 describes the wireless disable signal pin.

See Digital I/O electrical information on page 39 for 1V8 voltage characteristics and reset state definitions.

Table 5-13: Buzzer output pin description

Pin	Signal	I/O	I/O type	Reset state
68	BUZZER_EN	O	Digital output	Z

5.6.2 Electrical characteristics

Refer to Table 4-2 on page 34 for basic characteristics (type, voltage).

5.7 Flash LED (LED_FLASH)

This digital output may be used to drive a general purpose LED.

Table 5-14: LED signal features

Feature	Details
Purpose	Flash LED output • Used by host to control LED status by controlling LED diode bias.
Implementation	• Digital output. 1.8 V logic • Source/sink maximum—8 mA • LED behavior can be configured by adjusting software settings. • LED pattern can be used to indicate network connection status. • Blink rate up to 10 Hz supported

5.7.1 Pin descriptions

Table 5-15 describes the LED signal pin.

See Digital I/O electrical information on page 39 for 1V8 voltage characteristics and reset state definitions.

Table 5-15: LED_FLASH pin description

Pin	Signal	I/O	I/O type	Reset state	Description
60	LED_FLASH	O	Digital output	1 and Undefined	LED driving

5.7.2 Electrical characteristics

Table 5-16 describes the LED_FLASH signal's electrical characteristics.

Refer to Table 4-2 on page 34 for basic characteristics (type, voltage).

Table 5-16: LED_FLASH signal electrical characteristics

Parameter	Condition	Minimum	Typical	Maximum	Unit
V_{OL}				0.4	V
V_{OH}					V
I_{OUT}				8	mA

5.8 Power rail (VREF_1V8)

The AirPrime SL808X Embedded Module includes a rail that the host uses to provide a 1.8 V logic reference (maximum limit) for the pins listed in Table 5-18 on page 74.

5.8.1 Pin descriptions

Table 5-17 describes the VREF_1V8 output pin.

See Digital I/O electrical information on page 39 for 1V8 voltage characteristics and reset state definitions.

Table 5-17: VREF_1V8 pin descriptions

Pin	Signal	I/O	I/O type	Description
10	VREF_1V8	O	Supply	1.8 V digital supply

Table 5-18: 1.8 V connector pins

Pin	Signal name	Description
1	GPIO_3	General Purpose I/O
2	GPIO_2	General Purpose I/O
3	GPIO_1	General Purpose I/O
6	EXT_VREG_USIM[a]	USIM VCC supply
7	EXT_USIM_RESET[a]	USIM reset
8	EXT_USIM_DATA[a]	USIM I/O pin
9	EXT_USIM_CLK[a]	USIM clock
11	SPI_CS_N	SPI chip select
12	SPI_CLK	SPI clock
13	SPI_DATA_MOSI	SPI data (Master Output / Slave Input)
14	SPI_DATA_MISO	SPI data (Master Input / Slave Output)
45	UART1_RXD	UART Receive Data
46	UART1_TXD	UART Transmit Data
47	UART1_RTS_N	UART Request To Send
48	UART1_CTS_N	UART Clear To Send
64	PCM_SYNC	PCM sync
65	PCM_DOUT	PCM data output
66	PCM_DIN	PCM data input
67	PCM_CLK	PCM clock
63	SYSTEM_RESET_N	Reset

Table 5-18: 1.8 V connector pins (Continued)

Pin	Signal name	Description
62	W_DISABLE_N	Wireless disable
63	WAKE_N	Wake Host Interface
60	LED_FLASH	LED driver

a. USIM interface may be configured as 1.8 V or 3.0V.

Each digital output has a maximum current of 15mA.

5.8.2 Electrical characteristics

Table 5-19 describes the power rail signal's electrical characteristics.

Table 5-19: VREF_1V8 signal electrical characteristics

Parameter		Minimum	Typical	Maximum	Unit
VREF_1V8	Output voltage	1.76	1.8	1.94	V
	Output current			1	mA

5.8.3 Application notes

Caution: *This section is under review and subject to change.*

5.8.3.1 VREF_1V8—1.8 V logic reference

Note: VREF_1V8 is only available when the AirPrime SL808X Embedded Module is ON.

The following are good design practices to consider:

- Total current draw must be < 1 mA.
- If used as a reference only (host provides its own pull-up voltage rail), a 100 Ω resistor should be put in series.
- Depending on the host PCB trace length for this signal, PCB provision for decoupling capacitors may be required.

5.9 Reserved

The AirPrime SL808X Embedded Module includes pins that may not be used in your host design. These pins should be handled in the following ways:

- Pins marked 'Reserved - DNC'—Leave these pins untouched. (See Table 4-2 on page 34 for pin assignments/names.)
- Unused inputs/outputs on specific interfaces (USB, USIM, etc.)—Leave as no-connects.

6: Power Consumption

Note: All specifications in these tables are preliminary, based on chipset published expectations.

The power consumption numbers listed in this section are for the AirPrime SL808X Embedded Module module connected to the host PC via USB. The module does not have its own power source and depends on the host device for power. Typical values are measured at room temperature, and minimum and maximum values are measured over the entire operating temperature range. For a description of input voltage requirements, see Power supply on page 41.

Table 6-1: Averaged standby DC power consumption[a]

Signal	Description	Bands	Typ	Max	Units	Notes / Configuration
VCC	**Standby current consumption with Sleep mode activated** (assumes USB bus is fully suspended during measurements)					
	HSDPA / WCDMA	UMTS bands	2	TBD	mA	• DRX cycle = 8 (2.56 s)
	GSM / GPRS / EDGE	GSM bands	2.7	TBD	mA	• MFRM = 5 (1.175 s)
	Standby current consumption with Sleep mode deactivated (assumes USB bus is fully suspended during measurements)					
	HSDPA / WCDMA	UMTS bands	55	TBD	mA	• DRX cycle = 8 (2.56 s) • Module power up and idle (Assumes sleep mode is never entered)
	GSM / GPRS / EDGE	GSM bands	55	TBD	mA	• MFRM = 5 (1.175 s) • Module power up and idle (Assumes sleep mode is never entered)
	Low Power Mode (LPM) / Offline Mode					
	RF disabled, but module is operational		1	TBD	mA	• State is entered when Watcher shuts down / turns off the radio. • LPM is the lowest possible ('rock bottom') state in Sleep mode.

a. All measurements are preliminary/estimated values

Table 6-2: Averaged call mode data DC power consumption

Mode	Current (at 3.6 V)		Tx (output) power	Conditions
WCDMA data current consumption (includes USB bus current)				
WCDMA	Average	700 mA	23 dBm	• 384kbps[a]
		200 mA	0 dBm	
	Peak	800 mA		• Averaged over 100µs

Table 6-2: Averaged call mode data DC power consumption (Continued)

Mode	Current (at 3.6 V)		Tx (output) power	Conditions
HSDPA (1.8 Mbps/3.6 Mbps)	Average	775 mA	23 dBm	• All speeds[b]
		275 mA	0 dBm	
	Peak	900 mA		• Averaged over 100µs
GSM/EDGE data current consumption (with four time slots; assumes USB bus current)				
GSM/GPRS	Average	240 mA (1 slot) 400 mA (2 slots) 560 mA (3 slots) 650 mA (4 slots)	+32 dBm	• 50 Ω • Max PCL for each band[c]
	Peak	1.7 A		• Averaged over 100µs • Worst case on 850/900 band
	Average	330 mA (1 slot) 550 mA (2 slots) 770 mA (3 slots) 900 mA (4 slots)		• 2.3:1 VSWR • Max PCL for each band[c]
	Peak	2.2 A		• Averaged over 100µs • Worst case on 850/900 band
	Average	125 mA (1 slot) 150 mA (2 slots) 175 mA (3 slots) 200 mA (4 slots)	+10 dBm	• 50 Ω
	Peak	330 mA		• Averaged over 100µs • Worst case on 850/900 band
	Average	175 mA (1 slots) 210 mA (2 slots) 245 mA (3 slots) 275 mA (4 slots)		• 2.3:1 VSWR
	Peak	450 mA		• Averaged over 100µs • Worst case on 850/900 band
EDGE (850 MHz)	Average	200 mA (1 slot) 275 mA (2 slots) 360 mA (3 slots) 400 mA (4 slots)	+26 dBm	• 50 Ω • Class 12[c]
	Peak	920 mA		• Averaged over 100µs • Worst case on 850/900 band
	Average	275 mA (1 slots) 380 mA (2 slots) 500 mA (3 slots) 550 mA (4 slots)		• 2.3:1 VSWR • Class 12[c]
	Peak	1300 mA		• Averaged over 100µs • Worst case on 850/900 band

a. Highest current is on Band II (PCS1900)
b. Approximate current difference between speeds = 30 mA
c. Highest current is on 850/900 band Class 10 (Class 12 implements power backoff). Current on 1800/900 bands is typically 100—200 mA less.

Table 6-3: Miscellaneous DC power consumption[a]

Signal	Description	Band	Typ	Max	Units	Notes/Configuration
VCC	Module OFF leakage current	All bands	35	TBD	µA	• Full operating temperature range
	USB transmit current	All bands	10[b]	TBD	mA	• Full speed USB connection, C_L = 50 pF on D+ and D- signals

a. All measurements are preliminary values
b. Typical value for MC8790 modem used as estimate

Table 6-4: Supported GPRS / EDGE power classes

Feature	Notes
EGSM 900/GSM 850 Power Class 4	2 W 33 dBm
GSM 1800/1900 Power Class 1	1 W 30 dBm
EDGE Power Class for 850/900 MHz	Class E2[a]; 27 dBm, 0.5 W
EDGE Power Class for 800/1900 MHz	Class E2[a]; 26 dBm, 0.4 W

a. E2 power class applies to 8PSK modulation.

6.1 Power states

The SL808X module has five power states as detailed in Table 6-5.

Table 6-5: Supported SL808X power states

State	Description	Host powered	Modem 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
	• Module defaults to Normal state when VCC is first applied in the absence of POWER_ON_N control. [TBD]
		✔	✔	✔	✔

Low power	• '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	• Normal state of module between calls or data connections. • Module cycles between wake (polling the network) and sleep, at network provider-determined interval.	✔	✔	✘	✘

Table 6-5: Supported SL808X power states (Continued)

State	Description	Host powered	Modem powered	USB interface active	RF enabled
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 0 V.	✘	✘	✘	✘

6.1.1 Power state transitions

The module monitors supply voltage and operating temperature and notifies the host when critical threshold limits are exceeded. (See Table 6-6 for details.)

Power state transitions may occur:

- Automatically, when critical supply voltage or module temperature trigger levels are encountered. See Figure 6-1 for details.
- Under host control, using available AT or CnS commands in response to user choices (for example, opting to switch to airplane mode) or operating conditions.

Table 6-6: Power state transitions (including voltage/temperature trigger levels)

Transition	Voltage [TBD]		Temperature [TBD]		Notes
	Trigger	V	Trigger	°C	
Normal to Low Power	**VOLT_HI_CRIT**	4.3	**TEMP_LO_CRIT**	-25	• RF suspended • CNS_RADIO_POWER notification issued[a]
	VOLT_LO_CRIT	3.3	**TEMP_HI_CRIT**	108	
Low Power to Normal	**VOLT_HI_NORM**	3.9	**TEMP_NORM_LO**	-15	• RF resumed • CNS_RADIO_POWER notification issued[a]
Low Power to Normal *or* Remain in Normal (remove warnings)	**VOLT_LO_NORM**	3.4	**TEMP_HI_NORM**	85	
Normal (issue warning)	**VOLT_LO_WARN**	3.35	**TEMP_HI_WARN**	95	•
Power off/on (host-initiated)	-	-	-	-	• Power off recommended when supply voltage or module operating temperature is critically low or high. • See Procedure: Power on/off on page 66.

a. Notification issued only if previously enabled. See [4] AirPrime UMTS MiniCard CnS Reference for details.

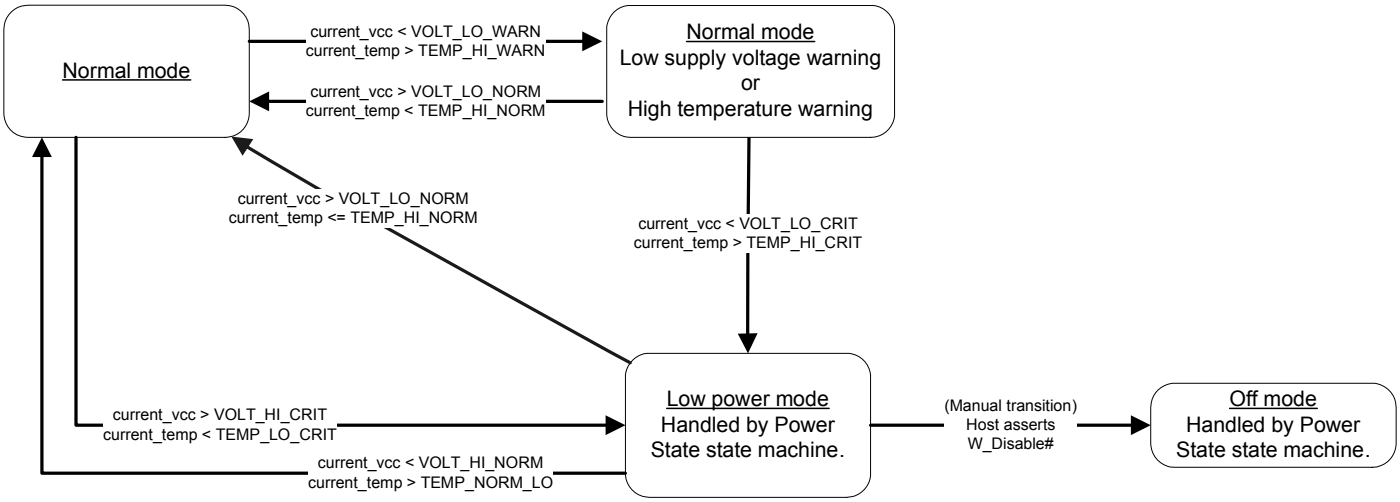

Figure 6-1: Automatic ('triggered') power state transitions

7: Network technology specifications

7.1 UMTS WCDMA FDD specifications

The SL808X supports the common WCDMA FDD specifications listed in Table 7-1.

Table 7-1: Supported WCDMA FDD specifications

Item
Physical layer specifications
DL Channels: BCH, PCH, FACH, DCH, AICH, CPICH
UL Channels: RACH, DCH
Measurement for PCCPCH RSCP RSCP/SIR
BTFD
CCTrCH As defined by examples in 25.944
Multifinger support
Cell reselection
Soft handover
Power control
PICH / DRX
Measurement for SFN / CFN timing, SFN / SFN timing
Cell selection
RLC specifications
TM / UM / AM
Max AM entities (4) • 3 for signalling • 1 for user data
Only timer based polling for AM
No timer based SDU discard for TM / UM / AM
Poll PU polling for AM
Poll prohibit

Table 7-1: Supported WCDMA FDD specifications

Item
Polling options: Last ReTX PU Poll, Poll Window, Poll SDU
Status report transfer: Timer Status, Status Prohibit, Missing PU indicator
Reset procedure: Indication to RRC
Suspend / Resume
Timer based SDU discard (UM / AM / TM)
Status report transfer: Piggybacked Status PDUs, EPC based transfer
SUFIs: Sending BITMAP and RLIST
Start / stop for all three modes
RRC Specifications
Cell selection
RRC connection establishment
RRC connection release
System information processing
Idle mode paging
Dedicated mode paging
Initial direct transfer
Uplink direct transfer
Downlink direct transfer
Signalling connection release
Signalling connection release request
Radio bearer establishment
Radio bearer release
Cell update
UE capability enquiry
Transmission of UE capability
Cell reselection
Measurement control
Measurement reporting
Soft HO/Active Set update
DRX mode
NV support for RRC channel scan

Table 7-1: Supported WCDMA FDD specifications

Item
Radio bearer reconfiguration
Transport channel reconfiguration
Physical channel reconfiguration
UTRAN mobility information
Integrity protection
Security mode control
Encryption: UEA1
Integrity algorithm: U1A11

7.2 Supported specifications

The SL808X supports the specifications listed in Table 7-2 on page 85, as well as Enhanced Network Selection (ENS), and Enhanced Operator Name String (EONS).

EONS allows the operator to define the operator name displayed for any registered network based on the MCC, MNC, and LAI on which the MS is currently registered. Strings that can be displayed when a MS is registered on a network are:

- Enhanced Operator Name String (EONS) from SIM
- Operator Name String (ONS) from SIM
- Service Provider Name (SPN) from SIM
- Network Identity and Time Zone (NITZ) as broadcast by network
- String from internal lookup table in UE

Table 7-2: Supported GSM / GPRS specifications

Item	Comments
8PSK modulation	Octagonal Phase Shift Keying Coding schemes MCS1-4 are GMSK and MCS5-9 are 8PSK.
GPRS header compression	Data packet header compression supported
3GPP compliance	Protocol stack supports the requirements of: • GPRS/EDGE: 3GPP Release 99 and GERAN Feature Package #1 • WCDMA: Release 5
GPRS operation mode class B	Class B terminals support either circuit-switched or packet-switched traffic (with simultaneous network attachment) but do not support both kinds of traffic simultaneously.

Table 7-2: Supported GSM / GPRS specifications (Continued)

Item	Comments
Link Adaptation (LA)	Together with IR (next table entry), LA adapts the EGPRS transmission to meet changing radio link conditions.
EGPRS Incremental Redundancy (IR)	IR adjusts the physical layer code rate to actual channel conditions by incrementally transmitting redundant information until decoding is successful. Automatic Repeat Request (ARQ) protocol takes care of requesting and retransmitting incorrectly received blocks. ARQ enables both dynamic RLC window management (to avoid window stalling) and dynamic RLC polling frequency (to minimize retransmission delay and save radio bandwidth).
GPRS multislot class 10	Multislot class 10 and 12 allow for dynamic allocation of time slots. See Table A-4 on page 77.
EGPRS multislot class 12	
NC0	NC0 is the normal mode of control for a GPRS mobile in which the MS (Mobile Station) performs autonomous cell reselection.
DPC	Downlink Power Control Allows the network to adjust the downlink power of any dedicated channels on the BTS based on measurement reports sent by the mobile. This allows the network to reduce interference between multiple mobiles while still maintaining adequate signal quality for the individual mobiles.
One-phase packet access for GPRS	In establishing a TBF (Temporary Block Flow) connection, the MS (Mobile Station) requests either one-phase or two-phase packet access. In one-phase access, the network responds to a packet channel request by sending a packet uplink assignment message and reserving resources for uplink transfer of a number of radio blocks. In two-phase access, a packet resource request is sent on receipt of the packet uplink assignment.
One-phase packet access for EGPRS	
Two-phase packet access for GPRS	
Two-phase packet access for EGPRS	
RLC-acknowledged operation mode	The RLC-acknowledged and LLC-acknowledged modes are used to ensure the integrity of received data where QoS requires it. RLC (Radio Link Control) acknowledgment is typically the default (depending on the network and user profile). LLC-acknowledgment is optional and ensures that all LLC (Logical Link Control) frames are received without error. Since LLC-acknowledged mode requires acknowledgement of all LLC frames, the mode has an impact on throughput.
RLC-unacknowledged operation mode	
LLC-acknowledged transmission mode	
LLC-unacknowledged transmission mode	
GSM network operation mode I and II	The Network Operating Mode specifies the coordination of paging for circuit-switched and packet-switched services. Mode I - The mobile can receive circuit-switched pages while in a packet-switched call. Mode II - The mobile cannot receive a circuit-switched page while in a packet-switched call, as it would force the mobile to constantly monitor its CCCH channel.

Table 7-2: Supported GSM / GPRS specifications (Continued)

Item	Comments
(SL8080/82/84) PBCCH / PCCCHI	Packet Broadcast Control Channel PBCCH is a packet data signaling channel that can supplement the BCCH GSM control channel, allowing decoupling of voice and packet control channels to set up data calls. PBCCH broadcasts GPRS / EGPRS specific cell re-selection parameters for serving and neighbor cells used in cell selection / re-selection for packet services.
GPRS test modes (ETSI test mode A and B)	The European Telecommunications Standards Institute (ETSI) defines standards and requirements for testing of GSM mobile equipment. In test mode A, the mobile requests an uplink TBF and transmits random data on a designated number of timeslots. This causes a device to transmit data without using upper layer protocols. Once the transmission has started, the downlink TBF halts. The device remains in this mode until the testing equipment terminates it. In test mode B, the mobile is prompted to receive data on a number of specified downlink timeslots and re-transmit the same data back on the corresponding uplink timeslots. Test mode B allows tests to be performed on both the transmitter and receiver within a single session.
NACC (R4 GERAN Feature Set 1)	Network Assisted Cell Change Enables the network to provide additional information about neighbor cells to the mobile while in a packet data session, which decreases the experienced service delays caused by cell re-selection.
MAIO	Mobile Allocation Index Offset MAIO and Hopping Sequence Number (HSN) are used in conjunction with Frequency Hopping to determine the hopping sequence used in each frame. The MAIO supports as many values as there are frequencies in the hopping list, and these are used to indicate the offset within the hopping list that identifies the frequency used.
Packet enhanced measurement report (PEMR)	Packet Enhanced Measurement Report (PEMR) is one of the RLC / MAC (Radio Link Control and Medium Access Control) control messages that include a carrier identifier. This message is a requirement of supporting multicarrier TBF.
Delayed TBF Release	Delayed Temporary Block Flow Release (also called Extended Uplink TBF) Delayed TBF Release reduces latency between uplink data transfers and reduced signaling on the network by maintaining a connection for brief periods when the network is temporarily inactive and the mobile station has no radio link control information to send. For this feature to work properly, the mobile station must support delayed TBF release.
Extended Dynamic Allocation	Radio blocks can be transmitted on up to four different PDCHs. Permits full class 12 operation.
Single Antenna Interference Cancellation (SAIC)	SAIC mitigates code-channel interference from neighboring cells resulting in fewer dropped calls, and faster download rates for e-mail and websites.

Table 7-2: Supported GSM / GPRS specifications (Continued)

Item	Comments
Circuit-switched data bearers	These circuit-switched data bearers are supported on 2G networks: • Asynchronous 9,600 bps • Asynchronous 14,400 bps
Security	
Encryption support	GPRS / EGPRS support GEA1, GEA2, and GEA3 data ciphering. GSM CSD and SMS use A5/1 and A5/3 encryption.
PAP for RADIUS authentication - GPRS / EGPRS	PAP (Password Authentication Protocol) is a method of authenticating usernames and passwords against a database on a RADIUS (Remote Authentication Dial-In User Service) server. In a standard login, the service provider prompts for a username and password. In PAP authentication, the username and password are entered in the client's dialing software and sent as one data package, rather than the server sending a login prompt and waiting for a response.
CHAP for RADIUS authentication - GPRS / EGPRS	CHAP (Challenge Handshake Authentication Protocol) is a more secure method for connecting to a system than PAP. After a link is established, the server sends a challenge message to the client. The client responds with a value calculated using a one-way hash function. The server compares its own calculation of the expected hash value to the client's response. If the values match, the authentication is acknowledged; otherwise the connection is terminated.
Support for encryption algorithm UEA1 (Kasumi)	UEA1 (UMTS Encryption Algorithm) generates the keystream as a function of a cipher key that is re-synchronized to every MAC / RLC frame. UEA is based on the Kasumi algorithm.
Support for integrity algorithm UIA1 (Kasumi)	UIA1 (UMTS Integrity Algorithm) is the algorithm used to compute the IK (Integrity Key) used in message authentication. UIA is based on the Kasumi algorithm.
UMTS	
WCDMA-to-GPRS reselection in CELL_FACH	CELL_FACH is an RRC (Radio Resource Control) service state in which cell reselection is performed. This feature prevents dropping of RRC connections.
Inter-frequency reselection in Cell_FACH	
Radio link failure	Radio link failure is a procedure that indicates an ‘out-of-synch’ state on one or more radio links. Node B of the RNC (Radio Network Controller) reports this event before attempting resynchronization. The radio link restoration procedure indicates restoration of the ‘synchronized’ state.
SIB scheduling	SIB (System Information Block) scheduling controls the broadcasting of information to user equipment in a cell. The user equipment retrieves the schedule, and is then able to change to sleep mode, receiving only those blocks that it needs.
SIB modification	
Re-establishment procedure	Following a radio link failure, the RNC maintains the RRC connection, waiting for re-establishment.

Table 7-2: Supported GSM / GPRS specifications (Continued)

Item	Comments
VT + PS call (subject to network availability)	Simultaneous VT (Video Terminal) and PS (Packet Switched) calls are supported.
Packet Cell Change Order from GSM→UTRAN	Call transfer between GSM-based and UTRAN-based cells is supported.
Background PLMN search	Improved algorithm for Higher Priority PLMN (HPPLMN) search while camped on a 3G cell.
Configurable Release 5 or Release 99 support	
Circuit-switched data bearers	
Data bearers	These circuit-switched data bearers are supported on 3G networks: • Synchronous transparent mode = 64000 bps • Synchronous transparent mode = 56000 bps • Asynchronous V110 UDI = 14400 bps • Asynchronous V110 UDI = 28800 bps • Asynchronous V110 UDI = 38400 bps • Asynchronous V120 = 14400 bps • Asynchronous V120 = 28800 bps • Asynchronous V120 = 56000 bps
HSDPA	
Data rates	The following data rates are supported: • Category 12 (1.8 Mbps) • Category 5/6 (3.6 Mbps)
HSDPA logical channels	These HSDPA logical channels are supported: • HS-SCCH • HS-DPCCH • HS-PDSCH—Up to ten HS-PDSCH channels are supported.
HSDPA transport channels	HS-DSCH is supported at these rates: • 120 kbps • 240 kbps • 360 kbps
Incremental redundancy	IR adjusts the physical layer code rate to actual channel conditions by incrementally transmitting redundant information until decoding is successful. Automatic Repeat Request (ARQ) protocol takes care of requesting and retransmitting incorrectly received blocks. ARQ enables both dynamic RLC window management (to avoid window stalling) and dynamic RLC polling frequency (to minimize retransmission delay and save radio bandwidth).

Table 7-2: Supported GSM / GPRS specifications (Continued)

Item	Comments
Chase combining retransmission scheme	The Chase combining retransmission scheme is the simplest HARQ (Hybrid Automatic Request) link adaptation technique. HARQ techniques are used to enhance system performance.
HSDPA Compressed Mode	Allows the user equipment to interrupt transmission and reception during a call for brief periods in order to measure the signal strength of neighboring cells that use different frequencies.
(SL8080/82/84) Concurrent voice and HSDPA data	
HSDPA Indicator	Allows user interface to display an indicator when HSDPA data transfer is in progress.
Receiver equalizer support	
Miscellaneous	
Fast link adaptation	The data rate is adapted to radio conditions.
Vary the effective code rate	The effective code rate is varied based on code space resources.
HARQ, MAC-HS disassembly	MAC-HS (High Speed MAC) is the base station MAC (Medium Access Control) protocol. MAC-HS enables fast radio resource allocation.
MAC-HS reordering queue distribution and processing support	
Cell change	These cell change methods are supported: • Synchronous and non-synchronous • Intra-Node B (softer repointing) • Inter-Node B (soft repointing)
Up-switching and down-switching of PS RAB between HS-PDSCH and DPCH	RAB (Radio Access Bearer) and channel mappings between the HS-PDSCH (High Speed Physical Downlink Shared Channel) and DPCH (Dedicated Physical Channel) are reallocated according to volume thresholds and inactivity timers.
Ciphering on the HS channel	Ciphering on high-speed channels protects radio-transmitted data against unauthorized third parties.
Support to not resume the HS channel if inter-RAT handover fails, but save the RB mapping information	RB (Radio Bearer) mapping information is preserved if a high-speed channel is dropped due to the failure of an inter-RAT (Radio Access Technology) transfer.
Support to not resume the HS channel if a radio link failure occurs, but save the RB mapping information	RB (Radio Bearer) mapping information is preserved if a high-speed channel is dropped due to a radio link failure.
WINS address support primary and secondary	Primary and secondary IP addresses can be assigned for WINS (Windows Internet Name Service) name servers.
(SL8080/82/84) Voice support	

Table 7-2: Supported GSM / GPRS specifications (Continued)

Item	Comments
Unstructured supplementary services data (USSD)	USSD provides support for transmitting information over the GSM network signalling channels. It provides fast session-based communication between the user and an application, enabling use of text messaging, prepaid roaming, chat, etc.
(SL8080/82/84) Supplementary services	Support for supplementary voice services such as Call Hold, Call Forward, Call Waiting, Multi-party Calls, Caller ID, Fixed Number Dialing, Service Dialing Numbers, etc.
Cell reselection/handover	Supports InterRat and InterFrequency cell-reselection and handover between supported frequency bands.
Security - IMEI Security	
SIM lock	The device can be 'MEP locked' to a particular PLMN.
SIM security	Both CHV1 and CHV2 are supported (unlock and unblock).

7.3 UMTS (WCDMA) / GSM specifications

Table 7-3 details the SL808X modem's support for common UMTS (WCDMA) and GSM specifications.

Table 7-3: UMTS (WCDMA)/GSM specifications[a]

Item	GSM	UMTS
Mobility management		
Automatic PLMN selection / reselection	✔	✔
Location updating procedure	✔	✔
IMSI attach procedure	✔	✔
IMSI detach procedure	✔	✔
Periodic location update	✔	✔
Authentication procedure	✔	✔
CM connection establishment from MS or network	✔	✔
CM connection release	✔	✔
Encryption key management	✔	✔
TMSI reallocation	✔	✔
Paging response	✔	✔
Abort procedure	✔	✔
Identification	✔	✔
CN system information	✔	✔
Call re-establishment	✔	✔

Table 7-3: UMTS (WCDMA)/GSM specifications[a] (Continued)

Item	GSM	UMTS
MM connection establishment emergency calls	✔	✔
Inter-RAT change procedure	✔	✔
CS follow-on procedure	✔	✔
Access class barring	✔	✔
Resumption procedure for Class B operation in GPRS	✔	✔
Handling of domain change CS to CS/PS and other combinations	✔	✔
MM information	✔	✔
Network mode of operation I, II	✔	✔
GPRS mobility management		
GPRS attach	✔	✔
GPRS detach	✔	✔
Routing area update	✔	✔
GPRS authentication	✔	✔
GPRS identification	✔	✔
GMM status	✔	✔
Periodic routing area update	✔	✔
Ciphering	✔	✔
Access class barring	✔	✔
GMM status	✔	✔
Combined GPRS attach	✔	✔
Combined GPRS detach	✔	✔
Combined routing location / area update	✔	✔
PS SMS	✔	✔
Network initiated combined GPRS detach	✔	✔
Network mode of operation change	✔	✔
RAB management		
QoS-based activation, network offers lower / higher QoS	✔	✔
Primary PDP context activation	✔	✔
PDP context deactivation	✔	✔
Data services		
AT commands	✔	✔

Table 7-3: UMTS (WCDMA)/GSM specifications[a] (Continued)

Item	GSM	UMTS
MS PS data calls	✔	✔
Single PDP context	✔	✔
PDP type PPP	✘	✘
PDP type IP	✔	✔
9.6 / 14.4 CS transparent data	✔	N/A
9.6 / 14.4 CS nontransparent data	✔	N/A
Fax	TBD	TBD
MT Sync CS data calls	✔	✔
MO Sync CS data calls	✔	✔
V.80	N/A	✔
V.42bis	✘	N/A
Multiple PDP context profiles (up to 16)	✔	✔
SMS specifications		
CS domain MT SMS point-to-point	✔	✔
CS domain MO SMS point-to-point	✔	✔
SMMA	✔	✔
Dedicated mode	✔	✔
Message classes 0, 1, 2, 3, none	✔	✔
SMS / SMSP / SMSS access from SIM / USIM	✔	✔
Reply path	✔	✔
Validity period	✔	✔
PS domain MT SMS point-to-point	✔	✔
PS domain MO SMS point-to-point	✔	✔
SMS status reports	✔	✔
SMS commands	✔	✔

a. ✔—Supported; ✘—Not supported; N/A—Not applicable

8: Design Guidelines

This chapter provides general design guidelines for the AirPrime SL808X Embedded Module.

Caution: *This chapter is under development—all recommendations must be considered as 'TBD'.*

For industrial assembly guidelines, refer to [7] Customer Process Guidelines—AirPrime SL Series, available from your Sierra Wireless account representative.

8.1 General rules and constraints

Clock and other high frequency digital signals (e.g. serial buses) should be routed as far as possible from the AirPrime SL808X Embedded Module analog signals.

If the application design makes it possible, all analog signals should be separated from digital signals by a ground line on the PCB.

Tip: *It is recommended to avoid routing any signals under the AirPrime SL808X Embedded Module on the application board.*

8.2 PCB layout recommendations

Ground slugs should be reflowed on to the host PCB with <25% voiding to allow effective heat dissipation.

8.3 Power supply

The power supply is one of the key issues in the design of a GSM terminal.

A weak power supply design could, in particular, affect:

- EMC performance
- The emission spectrum
- The phase error and frequency error

When designing the power supply, careful attention should be paid to the following:

- The quality of the power supply—low ripple, PFM or PSM systems should be avoided; linear regulation or PWM converters are preferred for low noise.

- The capacity to deliver high current peaks in a short time (pulsed radio emission).
- The VCC_3V6 line must support peak currents with an acceptable voltage drop which guarantees a minimal VCC_3V6 value of 3.3 V (lower limit of VCC_3V6)

8.4 Antenna

Another key issue in the design of a GSM terminal is the mechanical and electrical antenna adaptation. Sierra Wireless strongly recommends working with an antenna manufacturer either to develop an antenna adapted to the application or to adapt an existing solution to the application.

For more information on routing constraints for the RF circuit, see RF circuit on page 98.

8.5 PCB specifications for the application board

In order to save costs for simple applications, a cheap PCB structure can be used for the application board of the AirPrime SL808X Embedded Module. A 4-layer through-hole type PCB structure can be used.

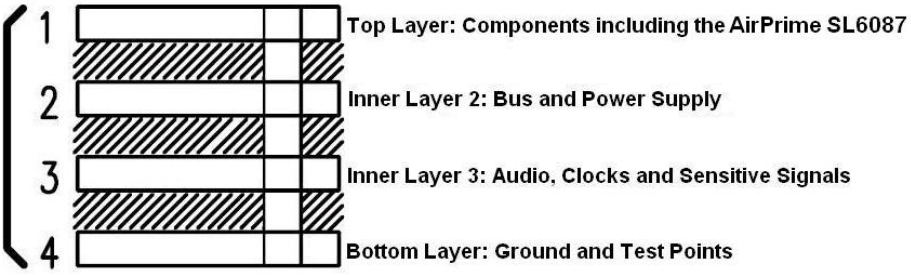

Figure 8-1: PCB structure example for the application board

Note: Due to the limited layers of 4-layer PCBs, sensitive signals like audio, SIM and clocks cannot be protected by 2 adjacent ground layers. As a result, care must be taken during PCB layout for these sensitive signals by avoiding coupling to noisy baseband through adjacent layers.

8.6 Recommended PCB landing pattern

Refer to [7] Customer Process Guidelines—AirPrime SL Series.

8.7 Routing constraints

8.7.1 Power supply

Since the maximum peak current can reach 2 A, Sierra Wireless strongly recommends having a large width for the layout of the power supply signal (to avoid voltage loss between the external power supply and the AirPrime SL808X Embedded Module supply).

Pins 42 and 44 of the AirPrime SL808X Embedded Module should be gathered in the same piece of copper, as shown in the figure below.

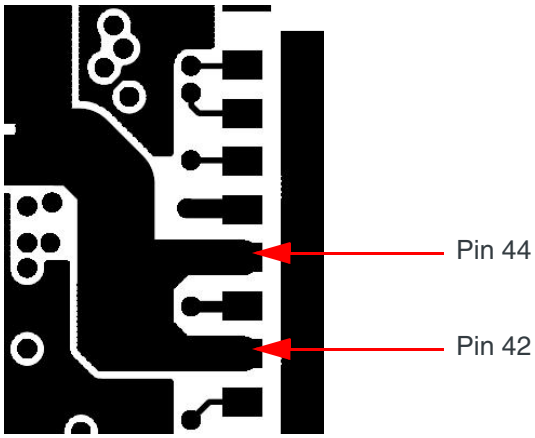

Figure 8-2: Power supply routing example

Filtering capacitors near the AirPrime SL808X Embedded Module power supply are also recommended (22 µF to 100 µF).

Attention should be paid to the ground track or the ground plane on the application board for the power supply which supplies the AirPrime SL808X Embedded Module. The ground track or the ground plane on the application board must support current peaks as well as with the VCC_3V6 track.

If the ground track between the AirPrime SL808X Embedded Module and the power supply is a copper plane, it must not be parceled out.

The routing must be done in such a way that the total line impedance could be 10mΩ @ 217Hz. This impedance must include the bias impedances.

The same care should be taken when routing the ground supply.

If these design rules are not followed, phase error (peak) and power loss could occur.

8.7.1.1 Ground plane and shielding connection

The AirPrime SL808X Embedded Module has LGA ground pads linked to the ground. The ground has to be connected to the application board through a complete layer on the PCB.

A ground plane must be available on the application board to provide efficient connection to the bottom ground of the AirPrime SL808X Embedded Module. The bottom side shielding of the AirPrime SL808X Embedded Module is achieved by soldering the ground plane of the application board and the AirPrime SL808X Embedded Module.

The best shielding performance is achieved when the application ground plane is a complete layer of the application PCB. To ensure good shielding of the AirPrime SL808X Embedded Module, a complete ground plane layer on the application board must be available, with no tradeoffs. Connections between other ground planes should be done with bias.

Without this ground plane, external spurious TX or RX blockings could appear.

For more information, see Recommended PCB landing pattern on page 96.

8.7.2 SIM interface

The length of the tracks between the AirPrime SL808X Embedded Module and the SIM socket should be as short as possible. Maximum recommended length is 10cm.

ESD protection is mandatory on the SIM lines if access from outside of the SIM socket is possible.

The capacitor (100 nF) on the EXT_VREG_USIM signal must be placed as close as possible to the DALC208SC6 component on the PCB (see SIM interface on page 42).

8.7.3 Audio circuit

To get better acoustic performances, the basic recommendations are as follows:

- The speaker lines (SPK) must be routed in parallel without any wires in between
- The microphone lines (MIC) must be routed in parallel without any wires in between

All the filtering components (RLC) must be placed as close as possible to the associated MIC and SPK pins.

8.7.4 RF circuit

The RF signal must be routed on the application board using tracks with a 50 Ω 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).

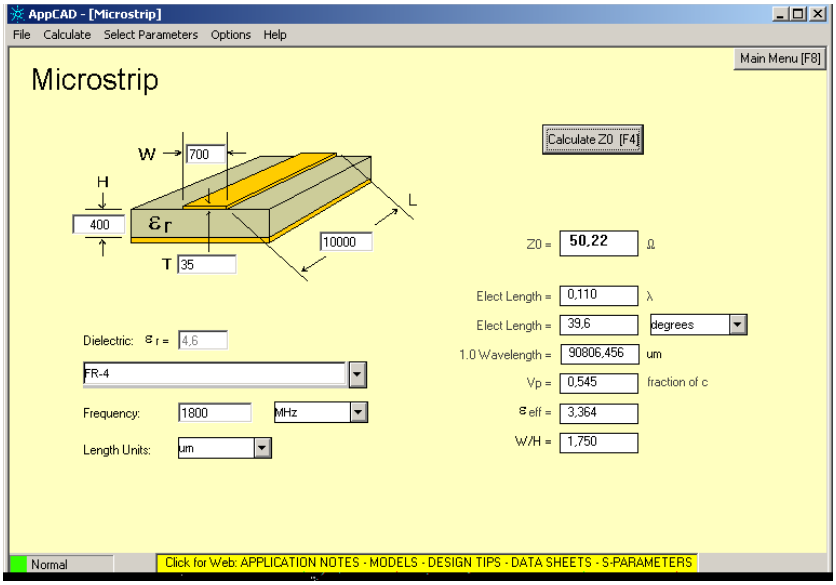

Figure 8-3: AppCad screenshot for MicroStrip design

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.

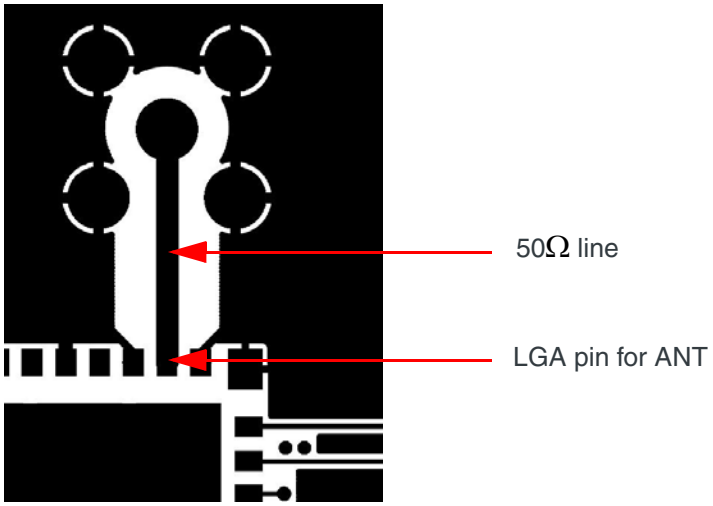

Figure 8-4: Routing examples

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 neighboring electronics (AF amplifier, etc.). In the same way, the neighboring electronics (micro-controllers, etc.) may degrade the reception performances.

The GSM/GPRS connector is intended to be directly connected to a 50 Ω antenna and no matching is needed.

8.8 EMC and ESD recommendations

EMC tests have to be performed on the application as soon as possible to detect any potential problems.

When designing, special attention should be paid to:

- Possible spurious emissions radiated by the application to the RF receiver in the receiver band
- ESD protection is mandatory on all signals which are externally accessible
  - Typically, ESD protection is mandatory for the:
    - SIM (if accessible from outside)
    - Serial link
- Length of the SIM interface lines (preferably <10 cm)
- EMC protection on audio input/output (filters against 900 MHz emissions)
- Biasing of the microphone inputs
- Ground plane: Sierra Wireless recommends a common ground plane for analog/digital/RF grounds
- A metallic case or plastic casing with conductive paint are recommended, except area around the antenna

Note: The AirPrime SL808X Embedded Module does not include any protection against over voltage.

The host device must provide adequate ESD protection on digital circuits and antenna ports as detailed in Table 8-1.

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

Table 8-1: 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-B +/- 2kV Human Body Model • JESD22-C101 +/- 300V 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	

8.9 Mechanical integration

Attention should be paid to:

- Antenna cable integration (bending, length, position, etc)
- Leads of the AirPrime SL808X Embedded Module to be soldered to the ground plane

8.10 Operating system upgrade

The AirPrime SL808X Embedded Module Operating System is stored in flash memory and can be easily upgraded.

Important: In order to follow regular changes in the GPRS standard and to offer a state-of-the-art operating system, Sierra Wireless recommends that the application designed around an embedded module (or embedded module based product) should allow easy operating system upgrades on the embedded module via the recommended firmware download protocol (see [6] AirCard/AirPrime USB Driver Developer's Guide). Therefore, the application shall either allow a direct access to the embedded module serial link through an external connector or implement any mechanism allowing the embedded module operating system to be downloaded.

9: Embedded Testability

9.1 Testing assistance provided by Sierra Wireless

Extended AT commands have been implemented to assist with performing FTA GCF tests and portions of CE Mark tests requiring radio module access. These are documented in the AirCard/AirPrime UMTS devices Supported AT Command Reference and AirPrime MC8xxx Embedded Modules Extended AT Command Reference.

Sierra Wireless offers optional professional services based assistance to OEMs with regulatory approvals.

9.2 Integration requirements

When integrating the SL808X module, the following items must be addressed:

- Mounting—Effect on temperature, shock, and vibration performance
- Power supply—Impact on battery drain and possible RF interference
- Antenna location and type—Impact on RF performance
- Regulatory approvals—As discussed in Certification compliance on page 107.
- Service provisioning—Manufacturing process

Sierra Wireless provides guidelines for successful SL808X module integration with the document suite and offers integration support services as necessary.

9.3 IOT/Operator

Interoperability and Operator/Carrier testing of the finished system is the responsibility of the OEM. The test process will be determined with the chosen network operator(s) and will be dependent upon your business relationship with them, as well as the product's application and sales channel strategy.

Sierra Wireless offers assistance to OEMs with the testing process, if required.

9.4 Module testing recommendations

When testing your integration design:

- Test to your worst case operating environment conditions (temperature and voltage)
- Test using worst case operation (transmitter on 100% duty cycle, maximum power)
- Monitor temperature at the location shown below—this should be the hottest spot on the device (the WCDMA PA).

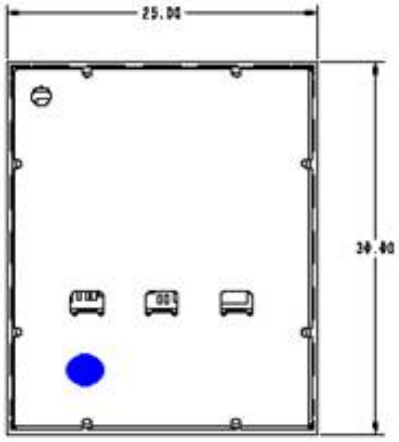

Figure 9-1: Recommended thermocouple location

Note: Make sure that your system design provides sufficient cooling for the module. The RF shield temperature should be kept below 90°C when integrated to prevent damage to the module's components.

9.5 Serial link access

Direct access to the UART1 serial link is useful for:

- Testability operations
- Firmware download (for more information on firmware upgrade, see Firmware upgrade on page 30)

To allow that access, the following serial link access design is recommended:

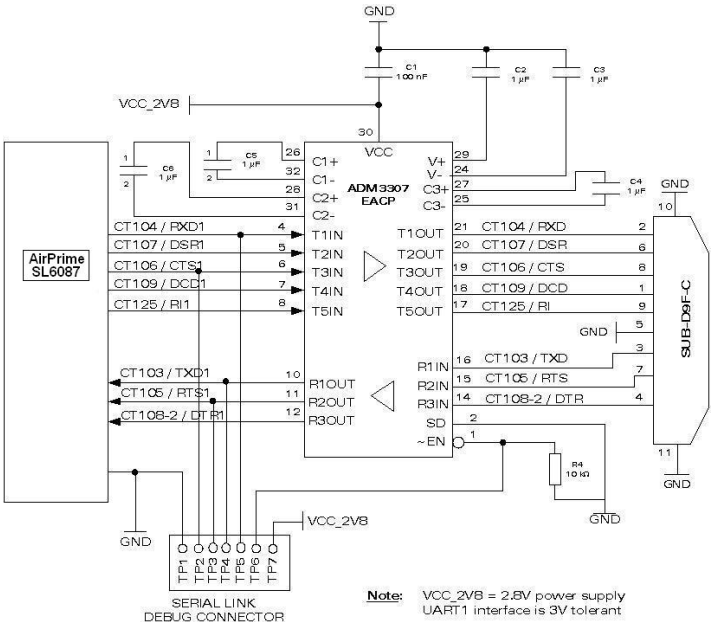

Figure 9-2: Main serial link (UART1) debug access

When it is necessary to download firmware into the AirPrime SL808X Embedded Module without going through the RS232 interface, access to the embedded module is forced via the debug connector.

An economical solution consists of making the debug connection using 7 test points (TP) and placing these points on the edge of the application board.

9.6 RF output accessibility

During the integration phase of the AirPrime SL808X Embedded Module, it can be helpful to connect the AirPrime SL808X Embedded Module to a GSM/GPRS simulator in order to check critical RF TX parameters and power behavior.

Although the AirPrime SL808X Embedded Module has been certified, some parameters may have degraded due to some basic precautions not having been followed (poor power supply, for example). This will not affect the functionality of the product, but the product will not comply with GSM specifications.

The following TX parameters can be checked using a GSM/GSM simulator:

- Phase & Frequency Error
- Output Power and GSM Burst Time
- Output Spectrum (Modulation and Switching)

Listed below are available typical GSM/GPRS simulators:

- CMU200 from Rhode & Schwarz
- 8960 from Agilent

Because of the high prices associated with GSM/GPRS simulators and the necessary GSM know-how to perform simulations, customers can check their applications in the Sierra Wireless laboratories. Contact the Sierra Wireless support team for more information.

10: Certification Compliance and Recommended Standards

10.1 UMTS compliance acceptance and certification

The SL808X is designed to be compliant with the 3GPP Release 5 UMTS Specification for Mobile Terminated Equipment. Final regulatory and operator certification requires regulatory agency testing and approval with the fully integrated UMTS UE host device incorporating the SL808X module.

The OEM host device and, in particular, the OEM antenna design and implementation will affect the final product functionality, RF performance, and certification test results.

Note: Tests that require features not supported by the SL808X (as defined by this document) are not supported.

10.2 Certification compliance

The AirPrime SL808X Embedded Module connected on a development kit board application is compliant with the requirements in Table 10-1.

Table 10-1: Standards conformity for the SL808X embedded module

Domain	Applicable standard	SL8080	SL8081	SL8082	SL8083	SL8084	SL8085
Safety standard	EN 60950-1 (ed.2006)						
Health standard (EMF Exposure Evaluation)	EN 62311 (ed. 2008)						
Efficient use of the radio frequency spectrum	EN 301 511 (V 9.0.2)						
EMC	EN 301 489-1 (v1.8.1) EN 301 489-7 (v1.3.1)						
FCC	FCC Part 22, 24	✔	✔				
IC	RSS-132 Issue 2 RSS-133 Issue 5						

Table 10-1: Standards conformity for the SL808X embedded module

Domain	Applicable standard	SL8080	SL8081	SL8082	SL8083	SL8084	SL8085
EU	FTA GCF regulatory certification CE Mark regulatory certification of compliance Interoperability Testing (IOT)			✔	✔		
A-Tick certification						✔	✔
North/Latin America operators/carriers	PTCRB approval per NAPRD requirement AT&T	✔	✔				

10.3 Applicable standards listing

For queries concerning specific industry standards and certifications not described in this chapter, contact your Sierra Wireless account representative.

10.3.1 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.

10.3.2 Safety and hazards

Do not operate your AirPrime SL808X Embedded Module modem:

- In areas where blasting is in progress
- Where explosive atmospheres may be present including refuelling 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 SL808X modem **MUST BE POWERED OFF**. Otherwise, the SL808X modem can transmit signals that could interfere with this equipment.

In an aircraft, the SL808X modem **MUST BE POWERED OFF**. Otherwise, the SL808X 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 SL808X modem may be used normally at this time.

10.3.3 Important compliance information for North American users

The AirPrime SL808X Embedded Module has been granted modular approval for mobile applications. Integrators may use this device 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 5 dBi in the cellular band and 3 dBi in the PCS band.
3. The AirPrime SL808X Embedded Module and its antenna must not be co-located or operating in conjunction with any other transmitter or antenna within a host device.
4. A label must be affixed to the outside of the end product into which the AirPrime SL808X Embedded Module is incorporated, with a statement similar to the following:
   - For SL8080:
     This device contains FCC ID: N7NSL8080
     This equipment contains equipment certified under IC: 2417C-SL8080
   - For SL8081:
     This device contains FCC ID: N7NSL8081
     This equipment contains equipment certified under IC: 2417C-SL8081
5. 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 AirPrime SL808X Embedded Module 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.

10.3.4 EU regulatory conformity

Sierra Wireless hereby declares that the SL8082 and SL8083 modems conform with all essential requirements of Directive 1999/5/EC.

SL8082/SL8083:

The Declaration of Conformity made under Directive 1999/5/EC is available for viewing at the following location in the EU community:

Sierra Wireless (UK), Limited
Lakeside House
1 Furzeground Way, Stockley Park East
Uxbridge, Middlesex
UB11 1BD
England

11: Customization

Subject to commercial terms, Sierra Wireless can supply custom-configured modems to facilitate a carrier's network and performance requirements. Sierra Wireless also offers a standard configuration for each country.

Custom configurations are entered into a selector spreadsheet that Sierra supplies. A unique part number is assigned to each custom configuration to facilitate customer ordering.

Table 11-1: Customizable features

Name	Description	Default
(SL8080/82/84) Voice functionality	When enabled, supports voice calls and displays the Watcher 'voice' tab.	Enabled
MEP network locked	Mobile Equipment Personalization network locked to only allow use with specific preconfigured PLMNs (SIMs). MMI supports the entry of an unlock code subject to permanent locking feature below.	Off
MEP service provider locked		
Permanent MEP locked	Can block deactivation of MEP locked feature	Off
Roaming indicator disable[a]	Watcher never shows the onscreen roaming indicator.	Indicator enabled
Service indicator disable[a]	Watcher never shows the onscreen indicator. (For example, "HSDPA", "GPRS", "3G")	Indicator enabled
Data counter disable[a]	Watcher never shows Rx and Tx data counters.	Rx and Tx data counters enabled
Disable advanced profile menu (QoS)[a]	If disabled Watcher never shows advanced profile's QoS menus and user cannot change the minimum and requested QoS parameters.	Advance profile menu disabled
SIM PUK prompt enable	If enabled, Watcher shows the message "SIM blocked please enter PIN code".	Disabled, Watcher displays "Contact Service Provider" when SIM PIN is blocked
GPRS attach on start-up[a]	If disabled, modem attaches when GPRS connection is required.	The modem GPRS attaches at start-up.
Disable Auto Connect	If disabled, the Auto Connect feature is blocked and cannot be enabled by the user. If blocked, the "Auto Connect" button on the profile edit menu is greyed out and cannot be selected.	The auto-connect feature menu item is enabled with the default state set to manual (not auto-connect).
Scan for profile	The modem scans through all its programmed profiles to find successful GPRS connection.	Not scanning. Only the selected profile is used for connection.

a. Features only available if supported in the user interface

12: Safety Recommendations

(For Information Only)

For the efficient and safe operation of your GSM application based on the AirPrime SL808X Embedded Module, please read the following information carefully.

12.1 RF safety

12.1.1 General

Your GSM terminal is based on the GSM standard for cellular technology. The GSM standard is spread all over the world. It covers Europe, Asia and some parts of America and Africa. This is the most used telecommunication standard.

Your GSM terminal is actually a low power radio transmitter and receiver. It sends out as well as receives radio frequency energy. When you use your GSM application, the cellular system which handles your calls controls both the radio frequency and the power level of your cellular modem.

12.1.2 Exposure to RF energy

There has been some public concern about possible health effects of using GSM terminals. Although research on health effects from RF energy has focused on the current RF technology for many years, scientists have begun research regarding newer radio technologies, such as GSM. After existing research had been reviewed, and after compliance to all applicable safety standards had been tested, it has been concluded that the product was fitted for use.

If you are concerned about exposure to RF energy, there are things you can do to minimize exposure. Obviously, limiting the duration of your calls will reduce your exposure to RF energy. In addition, you can reduce RF exposure by operating your cellular terminal efficiently by following the guidelines below.

12.1.3 Efficient terminal operation

For your GSM terminal to operate at the lowest power level, consistent with satisfactory call quality:

If your terminal has an extendable antenna, extend it fully. Some models allow you to place a call with the antenna retracted. However your GSM terminal operates more efficiently with the antenna when it is fully extended.

Do not hold the antenna when the terminal is "IN USE". Holding the antenna affects call quality and may cause the modem to operate at a higher power level than needed.

12.1.4 Antenna care and replacement

Do not use the GSM terminal with a damaged antenna. If a damaged antenna comes into contact with the skin, a minor burn may result. Replace a damaged antenna immediately. You may repair antenna to yourself by following the instructions provided to you. If so, use only a manufacturer-approved antenna. Otherwise, have your antenna repaired by a qualified technician.

Buy or replace the antenna only from the approved suppliers list. Using unauthorized antennas, modifications or attachments could damage the terminal and may contravene local RF emission regulations or invalidate type approval.

12.2 General safety

12.2.1 Driving

Check the laws and the regulations regarding the use of cellular devices in the area where you have to drive as you always have to comply with them. When using your GSM terminal while driving, please:

- give full attention to driving,
- pull off the road and park before making or answering a call if driving conditions so require.

12.2.2 Electronic devices

Most electronic equipment, for example in hospitals and motor vehicles is shielded from RF energy. However, RF energy may affect some improperly shielded electronic equipment.

12.2.3 Vehicle electronic equipment

Check with your vehicle manufacturer representative to determine if any on-board electronic equipment is adequately shielded from RF energy.

12.2.4 Medical electronic equipment

Consult the manufacturer of any personal medical devices (such as pacemakers, hearing aids, etc...) to determine if they are adequately shielded from external RF energy.

Turn your terminal OFF in health care facilities when any regulations posted in the area instruct you to do so. Hospitals or health care facilities may be using RF monitoring equipment.

12.2.5 Aircraft

Turn your terminal OFF before boarding any aircraft.

- Use it on the ground only with crew permission.
- Do not use it in the air.

To prevent possible interference with aircraft systems, Federal Aviation Administration (FAA) regulations require you should have prior permission from a crew member to use your terminal while the aircraft is on the ground. To prevent interference with cellular systems, local RF regulations prohibit using your modem while airborne.

12.2.6 Children

Do not allow children to play with your GSM terminal. It is not a toy. Children could hurt themselves or others (by poking themselves or others in the eye with the antenna, for example). Children could damage the modem, or make calls that increase your modem bills.

12.2.7 Blasting areas

To avoid interfering with blasting operations, turn your unit OFF when you are in a "blasting area" or in areas posted: "turn off two-way radio". Construction crew often uses remote control RF devices to set off explosives.

12.2.8 Potentially explosive atmospheres

Turn your terminal OFF when in any area with a potentially explosive atmosphere. Though it is rare, but your modem or its accessories could generate sparks. Sparks in such areas could cause an explosion or fire resulting in bodily injuries or even death.

Areas with a potentially explosive atmosphere are often, but not always, clearly marked. They include fuelling areas such as petrol stations; below decks on boats; fuel or chemical transfer or storage facilities; and areas where the air contains chemicals or particles, such as grain, dust, or metal powders.

Do not transport or store flammable gas, liquid, or explosives, in the compartment of your vehicle which contains your terminal or accessories.

Before using your terminal in a vehicle powered by liquefied petroleum gas (such as propane or butane) ensure that the vehicle complies with the relevant fire and safety regulations of the country in which the vehicle is used.

13: Connector and Peripheral Device References

13.1 JTAG connector

- Sierra Wireless suggests that a MOLEX ZIF connector be applied to your design to enable debugging/testing of devices by Sierra Wireless in the event of platform issues (see http://www.molex.com).

14: References

14.1 Web site support

For additional documents describing embedded module design, usage, and integration issues, visit www.sierrawireless.com.

14.2 Reference documents

14.2.1 Sierra Wireless documents

The following Sierra Wireless documents are provided in your documentation package, or are available from www.sierrawireless.com:

[1] SL Dev Kit Quick Start Guide (TBD)

[2] AirCard/AirPrime UMTS Devices Supported AT Command Reference
Document 2130617

[3] AirPrime MC8xxx Embedded Modules Extended AT Command Reference
Document 2130616

[4] AirPrime UMTS MiniCard CnS Reference
Document 2130602

[5] Sierra Wireless Reliability Specification
Document 4110485

[6] AirCard/AirPrime USB Driver Developer's Guide
Document 2130634

[7] Customer Process Guidelines—AirPrime SL Series
Document WM_DEV_LG_PTS_001

14.2.2 Industry/other documents

The following non-Sierra Wireless references are not included in your documentation package:

[8] Universal Serial Bus Specification, Rev 2.0

[9] 3GPP TS 34.108

14.3 Abbreviations/acronyms

Table 14-1: List of abbreviations/acronyms

Abbreviation	Definition
3GPP	3rd Generation Partnership Project
A-GPS	Assisted GPS
API	Application Programming Interface
AT	ATtention (prefix for modem commands)
CHAP	Challenge Handshake Authentication Protocol
CnS	Contol and Status (Sierra Wireless' proprietary host interface protocol)
CPHS	Common PCN Handset Specification
CS	Circuit-switched
CSD	Circuit-switched Data
DHCP	Dynamic Host Configuration Protocol
DUN	Dial-Up Networking
EAP-SIM	Extensible Authentication Protocol Method for GSM Subscriber Identity
EDGE	Enhanced Data rates for GSM Evolution
EFR	Enhanced Full Rate
EONS	Enhanced Operator Name String
eSIM	embedded SIM
FR	Full Rate
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile Communications
HPLMN	Home PLMN
HR	Half Rate
HSDPA	High Speed Downlink Packet Access
IMSI	International Mobile Subscriber Identity
LGA	Land Grid Array
MO	Modem Originated
MT	Modem Terminated
NDIS	Network Driver Interface Specification
NIC	Network Interface Card

Table 14-1: List of abbreviations/acronyms

Abbreviation	Definition
NMEA	National Marine Electronics Association
PAP	Password Authentication Protocol
PC/SC	PC / Smart Card
PDP	Packet Data Protocol
PLMN	Public Land Mobile Network
PS	Packet-switched
QoS	Quality of Service
RF	Radio Frequency
RTC	Real Time Clock
Rx	Receive
SDK	Software Development Kit
SIM	Subscriber Identity Module
SMS	Short Message Service
TDD	Telecommunications Device for the Deaf
TTY	Teletypewriter
Tx	Transmit
UMTS	Universal Mobile Telecommunications System
USB	Universal Serial Bus
USIM	Universal Subscriber Identity Module (UMTS)
USSD	Unstructured Supplementary Services Data
VCC	Collector Common Voltage
WCDMA	Wideband Code Division Multiple Access


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