Product Technical Specification & Customer Design Guidelines

AirPrime SL9090

SIERRA WIRELESS

4111766
2.0
October 16, 2012

Important Notice

Due to the nature of wireless communications, transmission and reception of data can never be guaranteed. Data may be delayed, corrupted (i.e., have errors) or be totally lost. Although significant delays or losses of data are rare when wireless devices such as the Sierra Wireless modem are used in a normal manner with a well-constructed network, the Sierra Wireless modem should not be used in situations where failure to transmit or receive data could result in damage of any kind to the user or any other party, including but not limited to personal injury, death, or loss of property. Sierra Wireless accepts no responsibility for damages of any kind resulting from delays or errors in data transmitted or received using the Sierra Wireless modem, or for failure of the Sierra Wireless modem to transmit or receive such data.

Safety and Hazards

Do not operate the Sierra Wireless modem in areas where cellular modems are not advised without proper device certifications. These areas include environments where cellular radio can interfere such as explosive atmospheres, medical equipment, or any other equipment which may be susceptible to any form of radio interference. The Sierra Wireless modem can transmit signals that could interfere with this equipment. Do not operate the Sierra Wireless modem in any aircraft, whether the aircraft is on the ground or in flight. In aircraft, the Sierra Wireless modem **MUST BE POWERED OFF**. When operating, the Sierra Wireless modem can transmit signals that could interfere with various onboard systems.

Note:	*Some airlines may permit the use of cellular phones while the aircraft is on the ground and the door is open. Sierra Wireless modems may be used at this time.*

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

Limitations of Liability

This manual is provided "as is". Sierra Wireless makes no warranties of any kind, either expressed or implied, including any implied warranties of merchantability, fitness for a particular purpose, or noninfringement. The recipient of the manual shall endorse all risks arising from its use.

The information in this manual is subject to change without notice and does not represent a commitment on the part of Sierra Wireless. SIERRA WIRELESS AND ITS AFFILIATES SPECIFICALLY DISCLAIM LIABILITY FOR ANY AND ALL DIRECT, INDIRECT, SPECIAL, GENERAL, INCIDENTAL, CONSEQUENTIAL, PUNITIVE OR EXEMPLARY DAMAGES INCLUDING, BUT NOT LIMITED TO, LOSS OF PROFITS OR REVENUE OR ANTICIPATED PROFITS OR REVENUE ARISING OUT OF THE USE OR INABILITY TO USE ANY SIERRA WIRELESS PRODUCT, EVEN IF SIERRA WIRELESS AND/OR ITS AFFILIATES HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES OR THEY ARE FORESEEABLE OR FOR CLAIMS BY ANY THIRD PARTY.

Notwithstanding the foregoing, in no event shall Sierra Wireless and/or its affiliates aggregate liability arising under or in connection with the Sierra Wireless product, regardless of the number of events, occurrences, or claims giving rise to liability, be in excess of the price paid by the purchaser for the Sierra Wireless product.

Customer understands that Sierra Wireless is not providing cellular or GPS (including A-GPS) services. These services are provided by a third party and should be purchased directly by the Customer.

SPECIFIC DISCLAIMERS OF LIABILITY: CUSTOMER RECOGNIZES AND ACKNOWLEDGES SIERRA WIRELESS IS NOT RESPONSIBLE FOR AND SHALL NOT BE HELD LIABLE FOR ANY DEFECT OR DEFICIENCY OF ANY KIND OF CELLULAR OR GPS (INCLUDING A-GPS) SERVICES.

Patents

This product may contain technology developed by or for Sierra Wireless Inc.

This product includes technology licensed from QUALCOMM®.

This product is manufactured or sold by Sierra Wireless Inc. or its affiliates under one or more patents licensed from InterDigital Group.

Copyright

Trademarks

AirCard® is a registered trademark of Sierra Wireless. Sierra Wireless™, AirPrime™, AirLink™, AirVantage™, Watcher™ and the Sierra Wireless logo are trademarks of Sierra Wireless.

, ®, inSIM®, WAVECOM®, WISMO®, Wireless Microprocessor®, Wireless CPU®, Open AT® are filed or registered trademarks of Sierra Wireless S.A. in France and/or in other countries.

Windows® and Windows Vista® are registered trademarks of Microsoft Corporation.

Macintosh and Mac OS are registered trademarks of Apple Inc., registered in the U.S. and other countries.

QUALCOMM® is a registered trademark of QUALCOMM Incorporated. Used under license.

Other trademarks are the property of the respective owners.

Contact Information

Sales Desk:	Phone:	1-604-232-1488
	Hours:	8:00 AM to 5:00 PM Pacific Time
	E-mail:	sales@sierrawireless.com
Post:	Sierra Wireless 13811 Wireless Way Richmond, BC Canada V6V 3A4	
Technical Support:	support@sierrawireless.com	
RMA Support:	repairs@sierrawireless.com	
Fax:	1-604-231-1109	
Web:	www.sierrawireless.com	

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

Document History

Version	Date	Updates
1.0	December 12, 2011	Creation
	April 23, 2012	Updated minimum voltage from 3.3V to 3.4V
		Removed SPI information and replaced feature with I^2C
		Changed PCM information with I^2S
		Updated pin configurations in section 4 Interfaces
		Deleted section 7 Network Technology Specifications
	June 06, 2012	Updated legal boilerplates
	September 19, 2012	Added Band 6 support
		Updated: • Section 4.8.5 Antenna Specifications • Section 4.9 Digital Audio • Section 5.7 TX Burst and PA Indication • Section 6 Power Consumption • Changed instances of CnS to QMI • Reference documents
	September 24, 2012	Updated: • Figure 5 Unit Label • Figure 6 SL9090 Pinouts (top view, through component) • Table 45 POWER_ON_N Signal Timing Parameters
	October 03, 2012	Added section 2.2 QMI Commands
		Updated: • Section 4.8.4 GPS Specifications • Table 83 Standards Conformity for the SL9090 Embedded Module
		Deleted DIP from section 4.7.3 USB Configurations
1.1	October 15, 2012	Updated section 10 Certification Compliance and Recommended Standards
2.0	October 16, 2012	Updated section 1 Introduction

Contents

List of Figures

List of Tables

1. Introduction

The AirPrime SL9090 Embedded Module is a 74-pin soldered-down 25mmx30mm LGA module. It provides multimode HSPA+ and EV-DO wireless connectivity; and supports data connectivity on UMTS HSPA+, GSM/GPRS/EDGE networks and on CDMA EV-DO Rev A, CDMA 1X RTT networks as enumerated below:

- GSM850
- EGSM900
- DCS1800
- PCS1900
- Band 1 (UMTS2100)
- Band 2 (UMTS1900)
- Band 5 (UMTS850)
- Band 6 (UMTS800)
- RX diversity Band 2 (UMTS1900)
- RX diversity Band 5 (UMTS850)
- BC0 (CDMA 800)
- BC1 (CDMA 1900)

The AirPrime SL9090 embedded module also provides GPS (1575.42) and voice (serial digital audio) functionality.

1.1. General Features

The following table lists several AirPrime SL9090 Embedded Module features.

Table 1. Embedded Module Features

Feature	Description
Physical	• Small form factor (74-pin solderable pad LGA) — 25mm x 30mm x 2.40mm (nominal) • Complete body shielding • RF connection pads — RF primary, diversity and GPS interfaces • Baseband signals connection
Electrical	• Single supply voltage (VCC) — 3.4V–4.3V • Complete body shielding — No additional shielding required

Feature	Description

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

CDMA SMS	• Mobile Terminated SMS • Mobile Originated SMS • Point-to-Point Messaging • Broadcast Messaging • Acknowledge Messaging • Analog Mode SMS • Wireless Paging Teleservice • Wireless Messaging Teleservice • Voice Mail Notification • Wireless Application Teleservice • Service Category Programming Teleservice
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 • QMI – Qualcomm MSM Interface Protocol support • Software Development Kits (SDK) including APIs (Application Program Interfaces) and drivers (core, device) for Windows, Windows CE, and Linux
Phone book	Supports Release 99 phone book features
Packet mode	• Multi-mode UMTS (WCDMA) / HSDPA and HSUPA / EDGE / GPRS / CDMA EVDO Rev A 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 10 data rate — 14.4 Mbps (peak rate) • HSUPA Category 6 data rate — 5.76 Mbps • Circuit-switched data bearers — 64 kbps (maximum) uplink and downlink • CDMA EVDO Rev A data rates — 3.1 Mbps downlink, 1.8 Mbps uplink • IS-2000 data rates up to 153 kbps[b], simultaneous forward and reverse channel

Feature	Description
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 • 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 • Support IPv6, 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
Application Interface / CDMA	• NDIS supported for Windows Vista, Windows XP, and Windows 2000 platforms • USB supporting multiple logical channels over the USB MUX protocol • USB selective suspend supported for maximum power savings • Wakeup Enable – the module can be set to wake the host device upon ring, restoration of radio coverage, and/or receipt of SMS • One UART port and one USB port • AT command interface • Support RUIM feature for 1st release • QMI – Qualcomm MSM Interface Protocol support • Available Software Development Kit (SDK including an Application Program Interface (API) for Windows-based applications
Voice (Digital Audio)	Supports: • All GSM vocoders, Enhanced Full Rate (EFR), Full Rate (FR), Half Rate (HR), and WCDMA Adaptive Multirate (AMR) encoders • Enhanced Variable Rate Voice Service (8 kbps) MO and MT calling • Echo cancellation and noise reduction • Emergency calls (112, 110, 911, etc.) • Incoming call notification • TTY/TDD compatibility

Feature	Description
CDMA Data Service	• Quick Net Connect • Pre-arrangement for incoming Async data or fax • In-Band DCE Control (TIA/EIA-617) • Facsimile Digital Interfaces (TIA/EIA/IS-134) • Asynchronous facsimile DCE Control Standard (TIA/EIA-592) • Simple IP
Supplementary Services	• Call Barring • Call Forwarding • Call Hold • Caller ID • Call Waiting • Multi-party service • USSD
GPS	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) • Quad-band UMTS WCDMA FDD (800 MHz, 850MHz, 1900 MHz, 2100 MHz) • Dual-band CDMA EVDO Rev A (800MHz, 1900 MHz) • GPS (1575.42 MHz)
Environmental	Operating temperature ranges: • Class A: -30°C to +70°C • Class B: -40°C to +85°C

Feature	Description
Interfaces	• 1.8 V digital section • 3 V / 1.8 V SIM interface • Serial (UART1) • Audio — Digital (PCM or I^2S) • USIM • USB 2.0 slave
Operating system	Full GSM or GSM / GPRS / EGPRS / CDMA operating system stack

a Contact Sierra Wireless for platform-specific Windows CE support details.

b Data rate supported depends on network implementation.

1.2. Support Feature

The SL9090 offers enabling software (drivers, SDK, etc.) for Windows, Windows CE, Linux, Android.

1.3. Support Tools

The SL9090 is compatible with the following support tools from Sierra Wireless and authorized third parties:

- Sierra Wireless Watcher connection manager (available for Windows operating systems)
- Directed Test tool
- Update tool
- Sierra Wireless Product Support Tool (PST)
- CDMA Air Interface Tool (CAIT) from QUALCOMM
- QXDM from QUALCOMM
- Universal Diagnostic Monitor (UDM) from Spirent Communications
- Universal Product Support Tool (UPST) from Spirent Communications

1.4. Accessories

The SL Series Development Kit includes:

- Embedded Module Interface Kit
- Documentation suite
- USB cable
- Serial cable
- Power supply
- Antenna
- Handset

For more information, refer to the SL Series Mechanical Socket Development Kit page on the Sierra Wireless Developer Zone.

1.5. Hardware Development Components

Sierra Wireless manufactures the AirPrime SL Series Mechanical Socket Development Kit, which is a hardware development board on which an SL embedded module can be plugged to facilitate the hardware integration process. The development kit provides access to all of the interfaces supported by the SL Series embedded module.

For instructions on using the SL Development Kit, see document [1] AirPrime SL Series Mechanical Socket Development Kit Quick Start Guide.

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 SL9090 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 SL9090 Embedded Module is described in Figure 1 Functional Architecture.

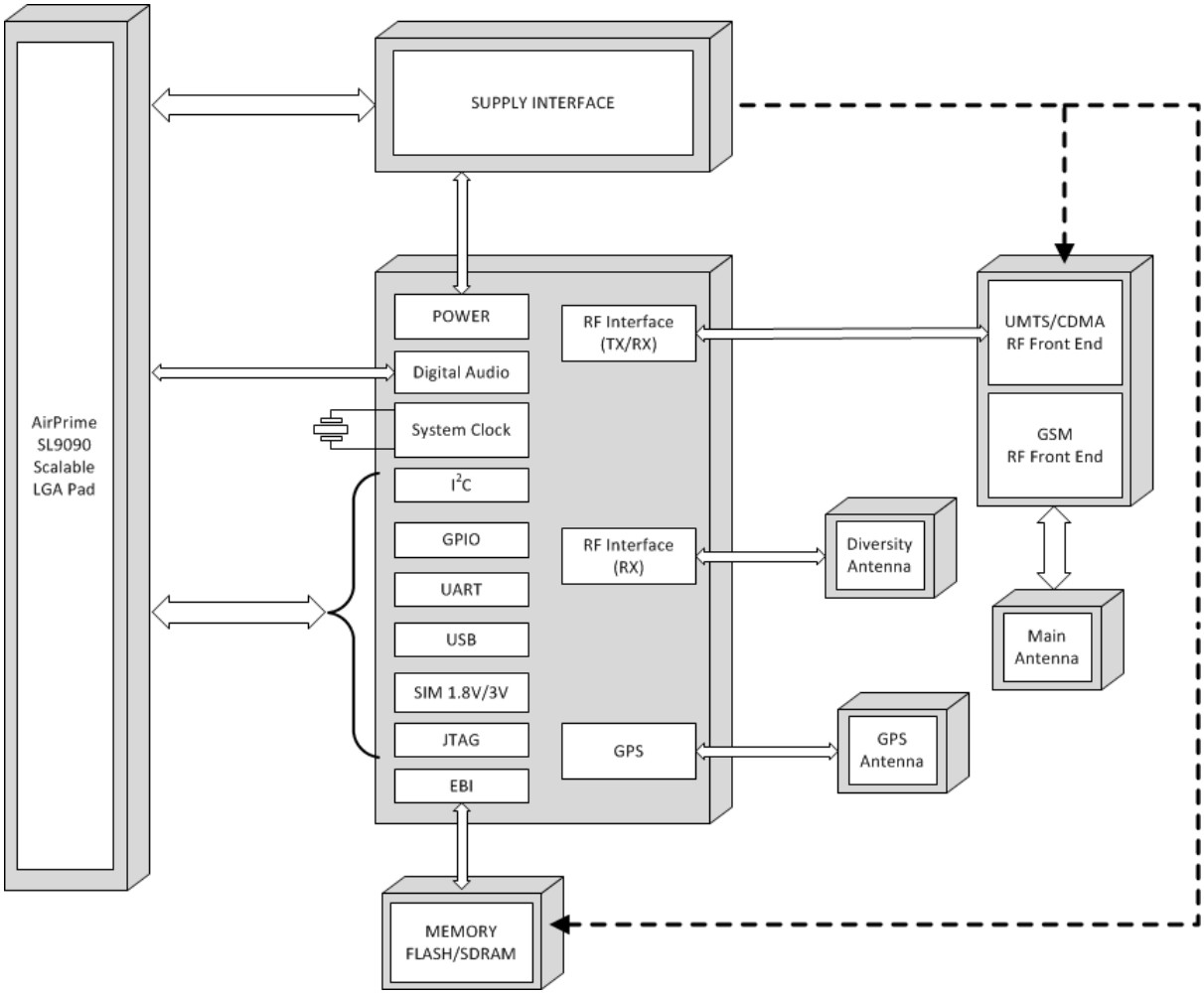


Figure 1. Functional Architecture

2.1.1. Chipsets

SL9090 modems are based on Qualcomm solution MDM6600.

2.2. QMI Commands

QMI commands are available for the AirPrime SL9090 embedded module for use in hardware integration design and testing. Note though that these commands are NOT intended for use by end users. For the list of available QMI commands and descriptions of their functionality, refer to document [4] AirPrime SL9090 QMI Command Reference.

2.3. Extended AT Commands

Several proprietary AT commands are available for the AirPrime SL9090 embedded module 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 documents [5] AirCard/AirPrime UMTS Supported AT Command Reference and [6] AirPrime MC/SL Series (UMTS/LTE) Extended AT Command Reference.

3. Technical Specifications

3.1. Power Supply

Power is provided to the SL9090 through power and ground pins as detailed in the following table.

Table 2. Power and Ground Specifications

Pin #	Signal Name	Type	Specification	Parameter	Min.	Typ.	Max.	Unit
42, 44	VCC_3V6*	V	Voltage range	VCC	3.40	3.60	4.30	V
19, 20, 21, 23, 28, 30, 35, 37, 38, 39, 52	GND	V			-	0	-	V

* Host-provided input voltage should provide 3 A instantaneous (lasting 5 ms). Refer to Table 66 Averaged Standby DC Power Consumption for CDMA (Preliminary Values).

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

Table 3. Power Supply Requirements

Requirement Type	Value
Power supply	3.6 V (nominal)
Voltage range (Vmin–Vmax)	3.4–4.3 V
Current (instantaneous (5 ms))	3 A
Current (continuous)	Refer to Table 66 Averaged Standby DC Power Consumption for CDMA (Preliminary Values).
Power input capacitor(s)	• Add capacitance to host power rail (100 µF) to keep module operational with Vin in range. • Additional capacitance may be required if the host cannot meet the module's current requirements. • Conditioning capacitor (1µF, 0.1µF, 10 nF and 1 nF) recommended close to the power input for decoupling.

* 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 Emission Current Requirements

The power supply must be able to deliver high current peaks in a short time due to the burst emission nature of GSM.

The following table describes radio burst rates in connected mode (as shown in Figure 2 Power Supply During Burst Emission).

Table 4. Radio Burst Rates – Connected Mode

GSM/GPRS Multislot Class	RF Power Amplifier Current	Burst Duration	Period	Rising Time
Class 2 (2 Rx / 1 Tx)	3.0 A peak	577 µs	4.615 ms	10 µs
Class 10 (3 Rx / 2 Tx)		1154 µs	4.615 ms	

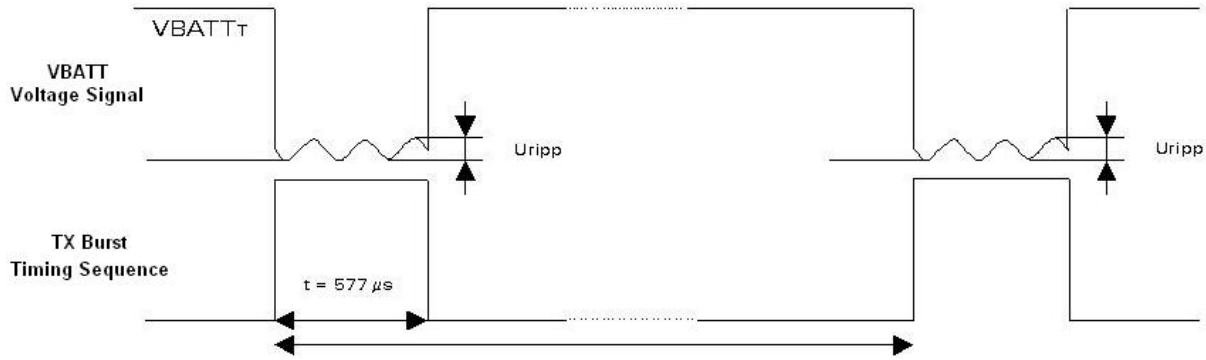


Figure 2. Power Supply During Burst Emission

3.1.2. Power Input (VCC_3V6)

An external power supply uses the VCC_3V6 pins to:

- Supply the AirPrime SL9090 Embedded Module.
- Directly supply the RF components with 3.6 V.
  - It is essential to keep the voltage ripple to a minimum at this connection in order to avoid any phase error or spectrum modulation degradation.
  - An inadequate power supply can significantly affect RF performance (TX power, modulation spectrum, EMC performance, spurious emission, frequency error, etc.).

When the AirPrime SL9090 Embedded Module is supplied with a battery, the total impedance (battery + protections + PCB) should be such that the supply will be >= 3.4 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 ($t_{Startup}$) occurs during the first 5ms (typical). The following table indicates the expected peak current range.

Table 5. Start-up Current Peak Range

Current Peak at Ambient Temperature (25°C)	VCC_3V6_{min} (3.4V)	VCC_3V6_{typ} (3.6V)	VCC_3V6_{max} (4.3V)
$t_{Startup}$	~183mA	~177 mA	~162 mA

3.2. Ground Connection

The AirPrime SL9090 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 section 8.7.1.1 Ground Plane and Shielding Connection.

3.3. Decoupling of Power Supply Signals

Although the AirPrime SL9090 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 SL9090 Embedded Module.

Table 6. Mechanical Specifications

Specification	Details
Form factor	The SL9090 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 (typical, including label thickness) Weight: approximately 3.8 g

3.4.1. Mechanical Illustrations

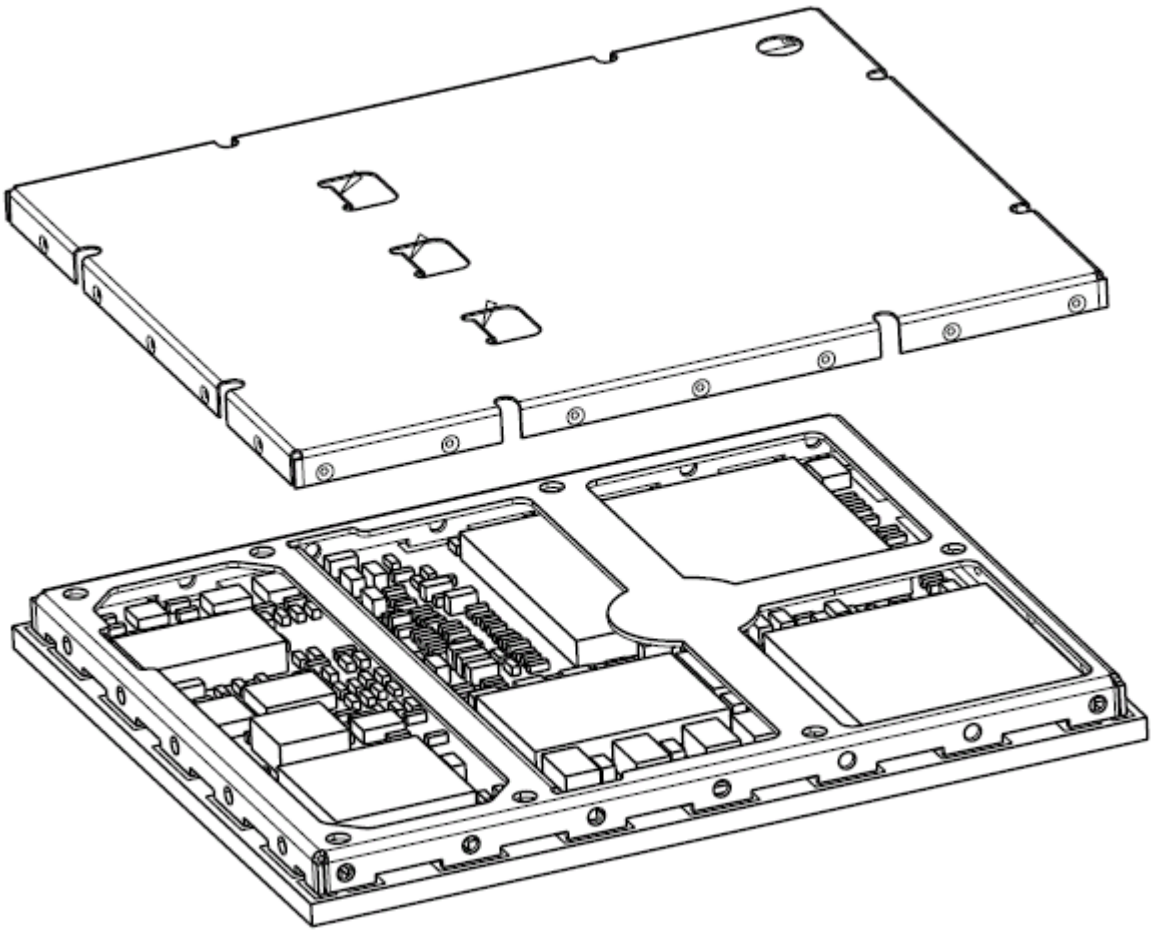


Figure 3. Exploded View

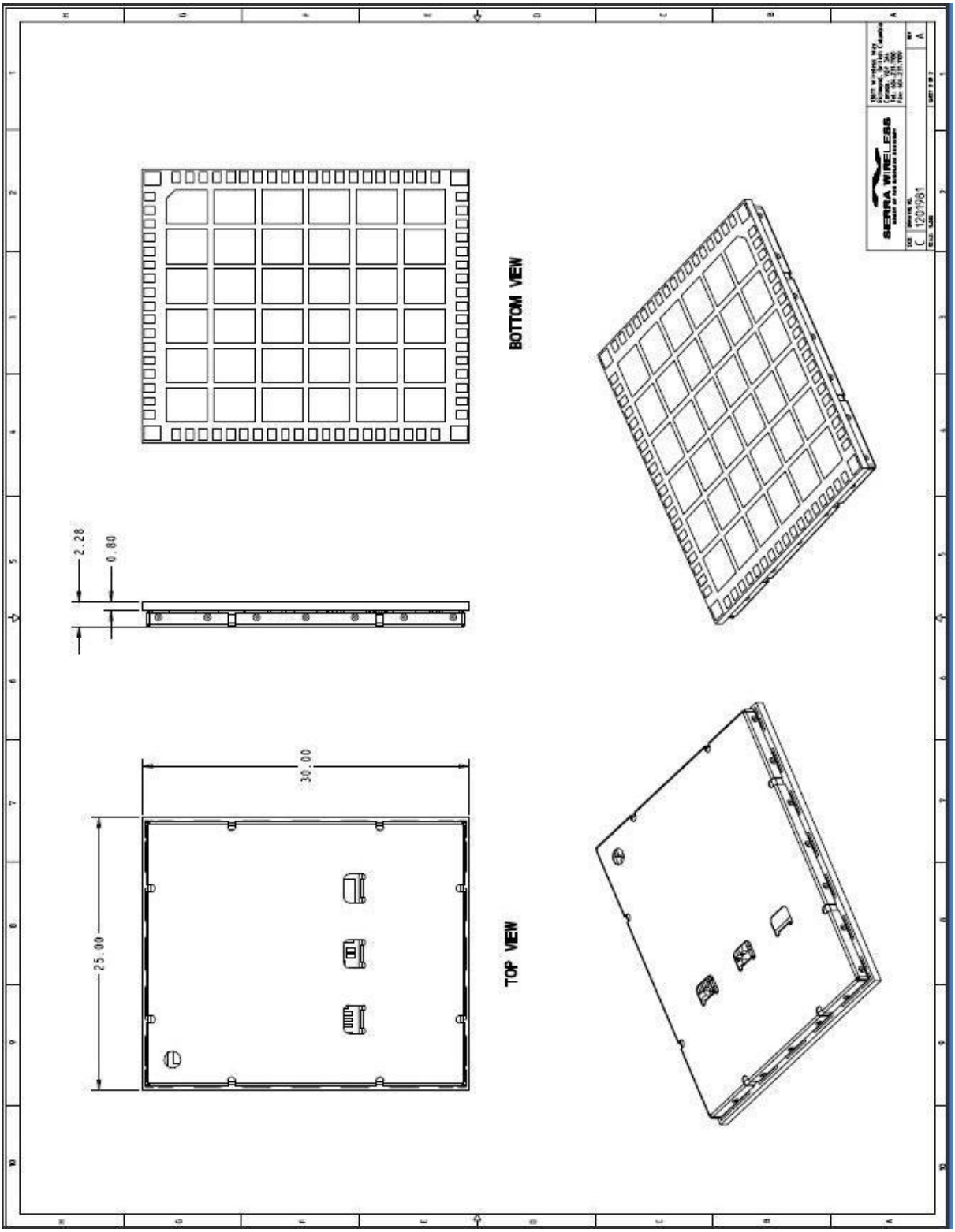


Figure 4. Dimensioned View

3.5. Labeling

Figure 5. Unit Label

The SL9090 label is non-removable and contains:

- Sierra Wireless AirPrime logo
- Product Name (SL9090)
- CPN: Optional Customer Number*
- QUALCOMM® 3G
- MEID number and barcode
- Serial number and barcode
- CE Marking (if applicable)
- IMEI number and barcode
- FCC ID number
- IC number
- Made in China

*Note: * The SL9090 supports OEM partner specific label requirements.*

3.6. Thermal Considerations

When transmitting, the AirPrime SL9090 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 components that generate heat

You can use **!PCTEMP** or **!GSTATUS** to return the module's current temperature. Refer to document [5] AirCard/AirPrime UMTS Supported AT Command Reference for details.

3.7. SED (Smart Error Detection)

The AirPrime SL9090 Embedded Module modules use a form of SED to track premature module 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 (up to 30 seconds) for a firmware download to resolve the power-cycle problem.

3.8. Firmware Upgrade

Firmware upgrades are downloaded to the embedded module 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 SL9090 Embedded Module's LGA pad configuration (see section 4.1.1 Pin Configuration) and supported interfaces, which are listed in the table below.

Table 7. Available Interfaces and Signals

Name	Driven by AT Commands
General Purpose Input/Output	✓
Inter-Integrated Circuit (I2C)	✓
Main Serial Link (UART1)	✓
USIM Interface	✓
USB 2.0 Interface	✓
RF Interface	
Digital Audio	✓
Buzzer Output (BUZZER_EN)	✓
JTAG Interface	

The SL9090 has two main interface areas, the host I/O perimeter I/O ports (pins) and the RF ports. Refer to Figure 1 Functional Architecture for more information.

4.1.1. Pin Configuration

Figure 6 SL9090 Pinouts illustrates the pin configuration of the SL9090 module. Table 8 AirPrime SL9090 LGA Pad Pin Assignments provides details for each of the module's pins.

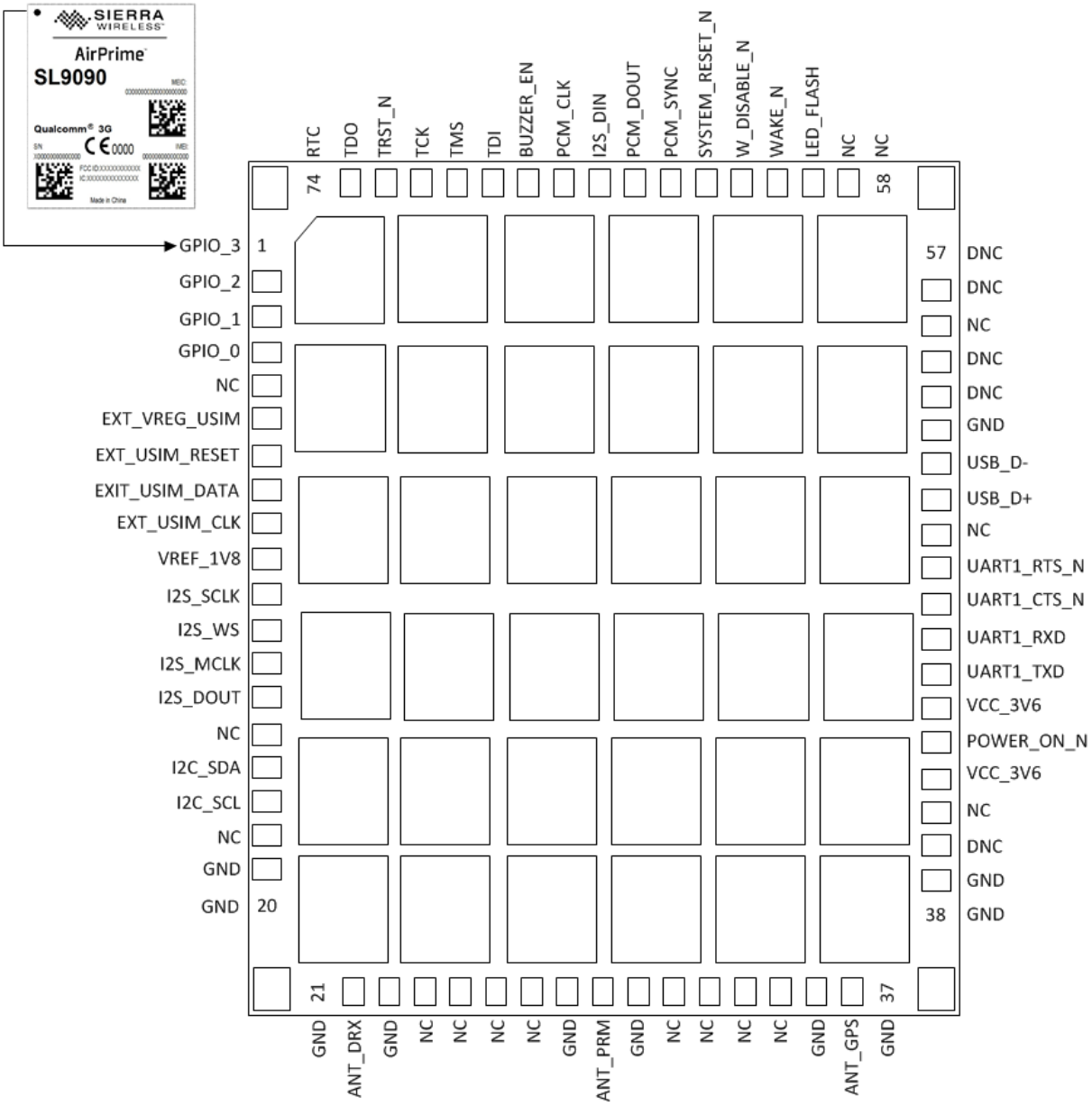


Figure 6. SL9090 Pinouts (top view, through component)

4.1.2. Pin Description

The following table describes the LGA pad pin assignments.

Refer to section 4.2 Digital I/O Electrical Information for 1V8 voltage characteristics and reset state definitions.

Table 8. AirPrime SL9090 LGA Pad Pin Assignments

Pin #	Signal Name	Description	Active State	Input/Output of SL9090	Voltage (V)			Type
					Minimum	Typical	Maximum	
1	GPIO_3*	General purpose I/O	High / Low	Input High	1.23	1.80	2.00	Digital
				Input Low	-0.30		0.59	
				Output High	1.25	1.80	1.90	
				Output Low	0		0.45	
2	GPIO_2*	General purpose I/O	High / Low	Input High	1.23	1.80	2.00	Digital
				Input Low	-0.30		0.59	
				Output High	1.25	1.80	1.90	
				Output Low	0		0.45	
3	GPIO_1*	General purpose I/O	High / Low	Input High	1.23	1.80	2.00	Digital
				Input Low	-0.30		0.59	
				Output High	1.25	1.80	1.90	
				Output Low	0		0.45	
4	GPIO_0	General purpose I/O	High / Low	Input High	1.23	1.80	2.00	Digital
				Input Low	-0.30		0.59	
				Output High	1.25	1.80	1.90	
				Output Low	0		0.45	
5	NC	Not connected						
6	EXT_VREG_USIM	USIM VCC supply	Power	Output (1.8 V)	1.70	1.80	1.90	Power
				Output (3.0_V)	2.95	3.00	3.05	

Pin #	Signal Name	Description	Active State	Input/Output of SL9090	Voltage (V)			Type
					Minimum	Typical	Maximum	
7	EXT_USIM_RESET	USIM reset	Low	Output High (1.8V)	1.44	1.80	2.10	Digital
				Output Low (1.8V)	0		0.40	
				Output High (3.0V)	2.40	3.00	3.30	
				Output Low (3.0V)	0		0.60	
8	EXT_USIM_DATA	USIM I/O pin	Low	Input High (1.8 V)	1.26	1.80	2.10	Digital
				Input Low (1.8 V)	0		0.40	
				Output High (1.8 V)	1.26	1.80	2.10	
				Output Low (1.8 V)	0		0.40	
				Input High (3.0 V)	2.10	3.00	3.30	
				Input Low (3.0 V)	0		0.60	
				Output High (3.0 V)	2.10	3.00	3.30	
				Output Low (3.0 V)	0		0.60	
9	EXT_USIM_CLK	USIM clock	High	Output High (1.8V)	1.26	1.80	2.10	Digital
				Output Low (1.8V)	0		0.40	
				Output High (3.0V)	2.10	3.00	3.30	
				Output Low (3.0V)	0		0.60	
10	VREF_1V8	1.8 V LDO	High (when module is on)	Output	1.70	1.80	1.90	Power
11	I2S_SCLK*	I^2S Clock		Output High	1.25	1.80	1.90	Digital
				Output Low	0		0.45	
12	I2S_WS*	I^2S Word Select		Output High	1.25	1.80	1.90	Digital
				Output Low	0		0.45	
13	I2S_MCLK*	I^2S Master Clock		Output High	1.25	1.80	1.90	Digital
				Output Low	0		0.45	
14	I2S_DOUT*	I^2S Data Output		Output High	1.25	1.80	1.90	Digital
				Output Low	0		0.45	

Pin #	Signal Name	Description	Active State	Input/Output of SL9090	Voltage (V)			Type
					Minimum	Typical	Maximum	
15	NC	Not connected						
16	I2C_SDA	I^2C Serial Data		Output High	1.25	1.80	1.90	Digital
				Output Low	0		0.45	
17	I2C_SCL	I^2C Serial Clock		Output High	1.25	1.80	1.90	Digital
				Output Low	0		0.45	
18	NC	Not connected						
19	GND	Ground	GND	GND	-	-	-	
20	GND	Ground	GND	GND	-	-	-	
21	GND	Ground	GND	GND	-	-	-	
22	ANT_DRX	Diversity antenna		Input	Refer to section 4.8 RF Interface			RF
23	GND	Ground	GND	GND	-	-	-	
24	NC	Not connected						
25	NC	Not connected						
26	NC	Not connected						
27	NC	Not connected						
28	GND	Ground	GND	GND	-	-	-	
29	ANT_PRM	Main (primary) antenna		Input/Output	Refer to section 4.8 RF Interface			RF
30	GND	Ground	GND	GND	-	-	-	
31	NC	Not connected						
32	NC	Not connected						
33	NC	Not connected						
34	NC	Not connected						
35	GND	Ground	GND	GND	-	-	-	
36	ANT_GPS	GPS antenna		Input	Refer to section 4.8 RF Interface			RF
37	GND	Ground	GND	GND	-	-	-	
38	GND	Ground	GND	GND	-	-	-	

Pin #	Signal Name	Description	Active State	Input/Output of SL9090	Voltage (V)			Type
					Minimum	Typical	Maximum	
39	GND	Ground	GND	GND	-	-	-	
40	NC	Not connected						
41	DNC	Do not 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		Open Drain	Digital
44	VCC_3V6	3.6 V supply	Power	Input	3.30	3.60	4.30	Power
45	UART1_TXD	UART Transmit Data	High / Low	Input High	1.23	1.80	2.00	Digital
				Input Low	-0.30		0.59	
46	UART1_RXD	UART Receive Data	High / Low	Output High	1.25	1.80	1.90	Digital
				Output Low	0		0.45	
47	UART1_CTS_N	UART Clear To Send	High / Low	Output High	1.25	1.80	1.90	Digital
				Output Low	0		0.45	
48	UART1_RTS_N	UART Request To Send	High / Low	Input High	1.23	1.80	2.00	Digital
				Input Low	-0.30		0.59	
49	NC	Not connected						
50	USB_D+	USB data positive (Low / Full speed)		Input High	2.00	3.30	3.60	Differential
				Input Low	0		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		0.01	
				Output High	0.36	0.38	0.44	
				Output Low	0		0.01	

Pin #	Signal Name	Description	Active State	Input/Output of SL9090	Voltage (V)			Type
					Minimum	Typical	Maximum	
51	USB_D-	USB data negative (Low / Full speed)		Input High	2.00	3.30	3.60	Differential
				Input Low	0		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		0.01	
				Output High	0.36	0.38	0.44	
				Output Low	0		0.01	
52	GND	Ground	GND	GND	-	-	-	
53	DNC	Do not connect						
54	DNC	Do not connect						
55	NC	Not connected						
56	DNC	Do not connect						
57	DNC	Do not connect						
58	NC	Not connected						
59	NC	Not connected						
60	LED_FLASH	LED driver	High	Output High	1.25	1.80	1.90	Digital
				Output Low	0		0.45	
61	WAKE_N*	Wake Host Interface	Low	Output High	1.25	1.80	1.90	Digital
				Output Low	0		0.45	
62	W_DISABLE_N	Wireless disable	High / Low	Input High	1.23	1.80	2.00	Digital
				Input Low	-0.30		0.59	
63	SYSTEM_RESET_N	Reset	High / Low	Input High	1.23	1.80	2.00	Digital
				Input Low	-0.30		0.59	
64	PCM_SYNC*	PCM Sync Out	High / Low	Output High	1.25	1.80	1.90	Digital
				Output Low	0		0.45	

Pin #	Signal Name	Description	Active State	Input/Output of SL9090	Voltage (V)			Type
					Minimum	Typical	Maximum	
65	PCM_DOUT*	PCM Data Out	High / Low	Output High	1.25	1.80	1.90	Digital
				Output Low	0		0.45	
66	I2S_DIN*	I^2S Data In	High / Low	Input High	1.23	1.80	2.00	Digital
				Input Low	-0.30		0.59	
67	PCM_CLK*	PCM Clock	High / Low	Output High	1.25	1.80	1.90	Digital
				Output Low	0		0.45	
68	BUZZER_EN		High / Low	Output High	1.25	1.80	1.90	Digital
				Output Low	0		0.45	
69	TDI	Test Data Input	High / Low	Input High	1.23	1.80	2.00	Digital
				Input Low	-0.30		0.59	
70	TMS	Test Mode Select	High / Low	Input High	1.23	1.80	2.00	Digital
				Input Low	-0.30		0.59	
71	TCK	Test Clock	High / Low	Input High	1.23	1.80	2.00	Digital
				Input Low	-0.30		0.59	
72	TRST_N	Test Reset	Low	Input High	1.23	1.80	2.00	Digital
				Input Low	-0.30		0.59	
73	TDO	Test Data Output	High / Low	Output High	1.25	1.80	1.90	Digital
				Output Low	0		0.45	
74	RTC	Return TCK	High / Low	Output High	1.25	1.80	1.90	Digital
				Output Low	0		0.45	

* This pin may be reconfigured for use in a full UART implementation. Refer to section 4.5.3 Full UART Implementation for more information.

4.2. Digital I/O Electrical Information

The AirPrime SL9090 uses 1.8V CMOS for digital I/O. Refer to section 4.2.1 Electrical Characteristics for electrical characteristics.

4.2.1. Electrical Characteristics

The following tables describe the electrical characteristics of 1.8V CMOS pins.

Table 9. Electrical Characteristics of a 1.8V Type (1V8) Digital I/O

Parameter*		I/O Type	Minimum	Typical	Maximum	Condition
Input/Output Pin	V_{IL}	CMOS	-0.30 V		0.59 V	
	V_{IH}	CMOS	1.23 V		2.00 V	
	V_{OL}	CMOS			0.45 V	I_{OL} = -2 mA
	V_{OH}	CMOS	1.25 V		1.90 V	I_{OH} = 2 mA
	I_{OH}				2 mA	
	I_{OL}		-2 mA			

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

4.2.2. Pin Types

Several tables in this chapter include pin types as part of their descriptions. The following table describes these pin types.

Table 10. Pin Type Codes

Parameter	Definition
A	Analog pin
I	Input
NP	No Pull
O	Digital Output
PU	Pull Up
PD	Pull Down
V	Power or Ground pin

4.2.3. Signal Reset States

Each interface described in this chapter includes a pin description table, which identifies each signal’s reset state. The following table describes these reset states.

Table 11. Reset State Definition

Parameter	Definition
0	Set to GND

Parameter	Definition
1	Set to supply 1V8
Pull-down	Internal pull-down with ~60 kΩ resistor (TBD)
Pull-up	Internal pull-up with ~60 kΩ resistor to supply 1V8 (TBD)
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. General Purpose Input/Output

The AirPrime SL9090 Embedded Module includes four general purpose I/O (GPIO) pins. The following table describes the purpose and features of this interface.

Table 12. GPIO Interface Features

Feature	Details
Purpose	OEM-configurable general purpose I/O (control, signaling, monitoring, etc.)
Implementation	Defaults to digital output
Power	• 1.8V (use VREF_1V8 as logic reference) • Output drive current up to 2 mA.

Three of the four available GPIO pins (GPIO_1, GPIO_2 and GPIO_3) may also be used to configure a full UART. Refer to section 4.5.3 Full UART Implementation for more information about configuring these pins as additional UART signals.

Note: These pins can only be used as either GPIO or additional UART pins.

GPIO_0 may be used as a TX_Burst indicator. Refer to section 5.7 TX Burst and PA Indication for more information about TX_Burst.

4.3.1. Pin Description

The following table describes the GPIO interface pins.

Table 13. GPIO Pin Description

Pin #	Signal Name	I/O Type	Reset State	Description
1	GPIO_3*	1V8		Configurable general purpose I/O
2	GPIO_2*	1V8		
3	GPIO_1*	1V8		
4	GPIO_0**	1V8		

* This pin may be reconfigured for use in a full UART implementation. Refer to section 4.5.3 Full UART Implementation for more information.

** This pin may be reconfigured for use as a TX_Burst indicator. Refer to section 5.7 TX Burst and PA Indication for more information.

Refer to Table 8 AirPrime SL9090 LGA Pad Pin Assignments for other pin-specific details.

Refer to section 4.2 Digital I/O Electrical Information for 1V8 voltage characteristics and reset 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.*

4.4. Inter-Integrated Circuit (I^2C)

The AirPrime SL9090 supports Inter-Integrated Circuit (I^2C). The following tables describe the supported standards and pin configuration of this interface.

Some of the I^2C pins may also be used to configure a full UART. Refer to section 4.5.3 Full UART Implementation for more information about configuring these pins as additional UART signals.

Note: *These pins can only be used as either I^2C pins or additional UART pins.*

4.4.1. Supported I^2C Standards

Table 14. Supported I^2C Standards and Exceptions

Applicable Standard	Feature Exception	MDM6x00 Variations
I^2C Specification, version 2.1, January 2000 (Phillips Semiconductor document number 9398 393 40011)	Clock stretching is not available	None

4.4.2. Pin Description

The following table describes the I^2C pins.

Table 15. I^2C Pin Description

Pin #	Signal Name	I/O Type	Reset State	Direction with respect to Host	Description
16	I2C_SDA	1V8	Z	Output	I^2C Serial Data
17	I2C_SCL	1V8	Z	Output	I^2C Serial Clock

Refer to Table 8 AirPrime SL9090 LGA Pad Pin Assignments for other pin-specific details.

Refer to section 4.2 Digital I/O Electrical Information for 1V8 voltage characteristics, pin types and reset state definitions.

4.5. Main Serial Link (UART1)

The AirPrime SL9090 Embedded Module includes a serial link (UART1) for host–module communication. The following table describes the purpose and features of this interface.

Refer to section 4.5.4 Level Shifter Implementation for an implementation example of the UART1 interface.

Note: *SL9090 may be provisioned with the ability to use the UART interface to communicate with peripheral devices. Contact Sierra Wireless for further information.*

Table 16. 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, as described in section 4.5.4 Level Shifter Implementation. • Optional full UART configuration as described in section 4.5.3 Full UART Implementation.
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. Available Services

Dependent on device configuration, the AirPrime SL9090 Embedded Module supports the following data services (logical protocols) for the transfer of data and control information over the UART1 interface:

- AT – Command processor/data service
- DM (Diagnostic Message service)
- NMEA (GPS) service
- PDP services
- HIP
- QMI

4.5.2. Pin Description

The following table describes the UART1 interface pins.

Table 17. 4-wire UART1 Pin Description

Pin #	Signal Name	I/O Type	Reset State	Description	Direction*	Notes
45	UART1_TXD	1V8		High speed UART - Transmit data	Input	• Digital pin input, internal Pull Down • UART1 serial data transmit line (module input)
46	UART1_RXD	1V8		High speed UART - Receive data	Output	UART1 serial data receive line (module output)
47	UART1_CTS_N	1V8		High speed UART - Clear to send	Output	Clear to Send
48	UART1_RTS_N	1V8		High speed UART - Request to send	Input	Request to Send

* According to PC view.

Refer to Table 8 AirPrime SL9090 LGA Pad Pin Assignments for other pin-specific details.

Refer to section 4.2 Digital I/O Electrical Information for 1V8 voltage characteristics, pin types and reset state definitions.

To implement an 8-wire UART1 interface, the following additional signals are needed.

Table 18. Additional Signals for an 8-wire UART

Signal Name	I/O Type	Reset State	Description	Direction with respect to Host	Notes
DTR	1V8		Data Carrier Detect	Output	
DCD	1V8		Data Terminal Ready	Input	
DSR	1V8		Data Set Ready	Input	
RI	1V8		Ring Indicator	Input	

Refer to section 4.5.3 Full UART Implementation for available configuration settings to implement a full UART interface (DCD, DTR and DSR signals multiplexed over GPIO, Digital Audio or I^2C lines).

4.5.3. Full UART Implementation

There are several configuration options that allow the SL9090 to support full UART. Configuration A is set by default.

Table 19. Configurations for Supporting a Full UART

Additional UART Signal			Configuration A			Configuration B			Configuration C		
Signal Name	**Function**	**Value**	**Pin #**	**Signal Name**	**Function**	**Pin #**	**Signal Name**	**Function**	**Pin #**	**Signal Name**	**Function**
DCD	Data Carrier Detect	1V8 output	3	GPIO_1	General Purpose I/O	66	I2S_DIN	I^2S Data In	11	I2S_SCLK	I^2S Clock
DTR	Data Terminal Ready	1V8 input	2	GPIO_2	General Purpose I/O	65	PCM_DOUT	PCM Data Out	12	I2S_WS	I^2S Word Select
DSR	Data Set Ready	1V8 output	1	GPIO_3	General Purpose I/O	67	PCM_CLK	PCM Clock	13	I2S_MCLK	I^2S Master Clock
RI	Ring Indicator	1V8 output	61	WAKE_N	Wake Host Interface	64	PCM_SYNC	PCM Sync Out	14	I2S_DOUT	I^2S Data Output

4.5.4. Level Shifter Implementation

The level shifter must be 1.8V with V24 protocol signal compliance.

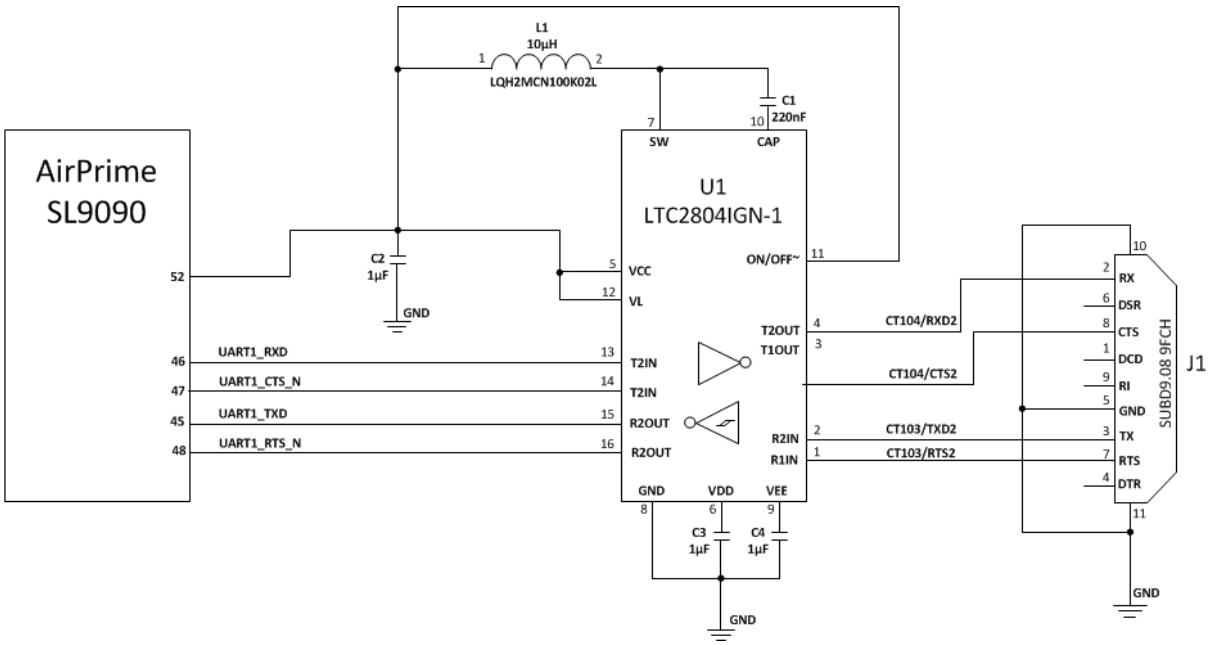


Figure 7. UART RS-232 Level Shifter Implementation

Note: The U1 chip also protects the AirPrime SL9090 Embedded Module against ESD at 15kV (air discharge).

4.5.5. Configure the UART Interface

Use **AT+WHCNF** to:

- Enable/disable the UART interface
- Default to 4-wire UART
- Configure the device for 8-wire UART by selecting an I/O signal group (GPIO/Digital Audio/I^2C) to use for DCD, DTR, and DSR.
- Enable/disable the specific signals. For example, you can enable DTR only for use with 4-wire UART to control low power operation.

For more information about **AT+WHCNF**, refer to document [6] AirPrime MC/SL Series (UMTS/LTE) Extended AT Command Reference.

4.5.5.1. Low Power Operation

The modem uses **AT+WHCNF** to configure low power operation in the following ways:

- 8-wire UART with DTR enabled—UART is halted when DTR is deasserted, and resumed when DTR is asserted. Refer to section 4.5.5 Configure the UART Interface for details on enabling the DTR signal.
- 4-wire UART with sleep flag enabled:
  - The UART remains on for 15 seconds after the device boots. If there is no activity on the UART during this period, the UART is stopped.

  - The UART will resume when there is activity on the receive line (UART1_RXD). Note that the first character may be missed due to latency. This can be mitigated by sending a spare character (for example, AAT).
  - After no activity for approximately 4 seconds, the UART will be stopped again.
- 4-wire UART with sleep flag disabled—UART never sleeps.

4.5.6. Lock the UART Interface

On systems that do not have USB support:

- The "**HWCFGLOCK**" customization may be used to prevent **!MAPUART** from being changed. This prevents the UART interface from being inadvertently disabled.
- The UART interface should only be used for AT and PDP services.

Refer to document [6] AirPrime MC/SL Series (UMTS/LTE) Extended AT Command Reference for more information about **HWCFGLOCK**.

4.6. USIM Interface

The AirPrime SL9090 Embedded Module includes a 4-wire USIM interface that allows a SIM to be directly connected. The following table describes the purpose and features of this interface.

Table 20. USIM Interface Features

Feature	Details
Purpose	Communicate with USIM socket on host device
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. Pin Description

The following table describes the USIM interface pins.

Table 21. USIM Pin Description

Pin #	Signal Name	I/O Type	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 a 15–25 kΩ pull-up resistor to EXT_VREG_USIM. • Filtering cap in pF range may be needed.

Pin #	Signal Name	I/O Type	Description	Notes
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.

Refer to Table 8 AirPrime SL9090 LGA Pad Pin Assignments for other pin-specific details.

Refer to section 4.2 Digital I/O Electrical Information for 1V8 voltage characteristics, pin types and reset state definitions.

4.6.2. Application

Refer to section 13 Signal Reference Schematics for an implementation of the USIM interface.

4.6.2.1. USIM Socket Pin Description

The following table describes the required USIM socket pins.

Table 22. SIM Socket Pin Description

Pin #	Signal Name	Description
1	VCC	EXT_ VREG_USIM
2	RST	EXT_USIM_RESET
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 SL9090 Embedded Module features a USB 2.0 interface for data transfer, modem control, and diagnostic information.

Table 23. USB 2.0 Interface Features

Feature	Details
Standards compliance	• Universal Serial Bus Specification, Rev 2.0 • CDC 1.1 - ACM compliant

Feature	Details
Performance	• Optimized for high speed (480 Mbps) Throughput rates may vary significantly based on packet size, host interface, and firmware revision. • Support for Full speed (12 Mbps) Throughput performance is on an “as-is” basis and must be characterized by the OEM.
Power supply	• VCC supply • 3.4 V type compatible
Additional features	Firmware download over USB

4.7.1. Pin Description

The following table describes the USB interface pins.

Table 24. USB Pin Description

Pin #	Signal Name	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 (90Ω impedance) between the module and destination.
51	USB_D-	HS-USB data -	

Refer to Table 8 AirPrime SL9090 LGA Pad Pin Assignments for other pin-specific details.

4.7.2. Electrical Characteristics

The following table describes the USB interface’s electrical characteristics.

Table 25. USB Interface Electrical Characteristics

Parameter	Minimum	Typical	Maximum	Unit
USB_D+ USB_D- (Low/Full speed)	2.00	3.30	3.60	V
USB_D+ USB_D- (High speed)	0.30	0.38	0.44	V

4.7.3. USB Configurations

The AirPrime SL9090 Embedded Module supports the USB configurations in the following table. The basic service configuration is PRI-dependent, and some services can be excluded, if required.

Table 26. Supported USB Configurations

Configuration	Interfaces	Services
Composite	OBEX, ACM, ECM	QMI, DM, NMEA, AT
Composite, MUX-capable	OBEX, ACM	QMI, DM, NMEA, AT, PPP data
Composite	OBEX, ACM	QMI, DM, NMEA, AT, PPP data
Non-composite, MUX-capable	OBEX, ACM	QMI, DM, NMEA, AT, PPP data

4.7.4. Application

Refer to section 13 Signal Reference Schematics for an implementation of the USB interface.

4.7.5. USB Host Drivers

If you will not be using Sierra Wireless drivers, refer to document [7] AirCard/AirPrime USB Driver Developer's Guide for details on developing your own USB drivers.

4.7.5.1. Host Driver Requirements

The host driver must support:

- USB host in order to interface with the module
- CDC-ADM and OBEX interface types

The host driver may optionally support:

- Low power mode – USB suspend, resume, and remote wakeup as described in document [9] Universal Serial Bus Specification, Rev 2.0
- ECM – Ethernet Control Model for Direct IP
- MUX – Sierra Wireless' implementation of the 3GPP 27.010 MUX standard over CDC-ACM

4.8. RF Interface

The AirPrime SL9090 Embedded Module's RF (radio frequency) interface uses three antenna ports for Tx/Rx, Rx and GPS. The following table describes the purpose and features of this interface.

Table 27. RF Interface Features

Feature	Details
Purpose	• Primary antenna — Tx / Rx • Diversity antenna — Rx • GPS antenna — GPS functionality

Feature	Details
Impedance	Nominal: 50Ω DC: High Impedance

4.8.1. RF Connections

To protect the antenna lines from baseband signal noise, each antenna port must be connected to a 50Ω RF line:

- RF line is surrounded by two ground planes.
- Line length must be short (no more than a few centimeters) because of RF insertion loss.
- Line width must be calculated to ensure 50Ω characteristic impedance.
- Embedded RF line should be kept ≥ 1 cm from noisy baseband signals to ensure a good Rx sensitivity level.
- Under the LGA pad of any antenna pin, keep at least 0.5mm ground clearance to avoid parasitic capacitance.
- To connect an antenna, either:
  - Connect the other end of the RF line to an RF connector or soldering pad.
  - Use an antenna chip, or design a PCB antenna directly on the application board.

For more information, see Figure 26 Routing Example.

4.8.2. Pin Description

The following table describes the RF interface pins.

Table 28. RF Pin Description

Pin #	Signal Name	Description	Notes
Rx Antenna			
21	Ground		
22	ANT_DRX	Diversity antenna	Refer to the note below the table for information on ESD protection.
23	Ground		
Tx/Rx Antenna			
28	Ground		
29	ANT_PRM	Main (primary) antenna	Refer to the note below the table for information on ESD protection.
30	Ground		
GPS Antenna			
35	Ground		
36	ANT_GPS	GPS antenna	Refer to the note below the table for information on ESD protection.
37	Ground		

Note: *In order to have ESD protection against ±4 kV contact and ±8 kV air discharge, it is required to add ESD protection. One of the suggested ESD diodes is listed below :*

Manufacturer: ***INNOCHIPS TECHNOLOGY CO.***
Part Number: ***ULCE0505A015FR***

4.8.3. RF Performance

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

The following table describes supported GSM, WCDMA, and GPS bands, conducted Tx power, and conducted Rx sensitivity.

Table 29. Band Support, Conducted Tx Power and Conducted Rx Sensitivity

Band	Frequencies (MHz)	Conducted Tx Power		Conducted Rx Sensitivity (dBm)			
		Average (dBm)	Notes				
GSM Bands				**Coding**	**Mode**	**Typical**	**Worst Case**
GSM 850	Tx: 824 - 849 Rx: 869 - 894	+33 ± 2	GMSK, connectorized (Class 4)	CS1-3[a] CS4[b] 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)				

Band	Frequencies (MHz)	Conducted Tx Power		Conducted Rx Sensitivity (dBm)		
		Average (dBm)	Notes			
WCDMA Bands				**Call Details**	**Typical**	**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 VI WCDMA 800	Tx: 830–840 Rx: 875–885				-108	-104.7
WCDMA Bands RX Diversity				**Call Details**	**Typical**	**Worst Case**
Band II WCDMA 1900	Tx: 1850 – 1910 Rx: 1930 – 1990			RMC DL 12.2 kbps; 0.1% BER	-108	-106.7
					-107	-104.7
Band V WCDMA 850	Tx: 824 – 849 Rx: 869 – 894				-108	-104.7
GPS						
GPS	1575.42					

a 2% Bit Error Rate (BER) circuit switched

b 10% Block Error Rate (BLER)

c WCDMA channel spacing is 5 MHz, but this can be adjusted to optimize performance in a particular deployment scenario.

The following table describes supported CDMA conducted Rx sensitivity.

Table 30. CDMA Band Support, Conducted Rx Sensitivity

Parameter	Min	Typ	Max	Unit	Notes
Maximum output power	+23.0	+24.0	+25.0	dBm	+25.0 dBm is the maximum output power for IS-95, IS-2000, 1xEV-DO Revision 0, and 1xEV-DO Revision A.
RX sensitivity (US Cell)	-	-107	-	dBm	IS-2000 SO2
RX sensitivity (US PCS)	-	-107	-	dBm	IS-2000 SO2
RX sensitivity (US Cell)	-	-110	-	dBm	1xEV-DO Revision 0, DRC4

4.8.4. GPS Specifications

Note: These specifications are preliminary targets that are subject to change without notice. Actual GPS functionality depends on the firmware version and module configuration.

The module provides the GPS features listed in the following sub-sections.

4.8.4.1. Standalone GPS

- Leading standalone/autonomous GPS performance
- -145 dBm cold start sensitivity
- -153 dBm hot start sensitivity
- -155 dBm tracking sensitivity
- < 45 second average cold start TTFF (Time To First Fix) in open air
- < 3 second average super hot TTFF in open sky
- < 10 m accuracy in open sky

Note: For optimum performance, the modem should be registered on the GSM/UMTS/CDMA network, but does not need to be on an active data or voice call.

4.8.4.2. gpsOneXTRA™

- Enables enhanced standalone GPS operation by downloading < 40 kB file from a server on the Internet
- Performance closer to UE-based operation than traditional standalone GPS operation
- Best if downloaded once every 1–2 days, but valid for up to 7 days with some accuracy degradation

4.8.4.3. A-GPS Features

- Leading A-GPS performance
  - Exceeds 3GPP RAN 4 AGPS performance specification
- -153 dBm cold start sensitivity
- -155 dBm tracking sensitivity
- < 5 second average cold start TTFF in open sky (UE-based)
- < 3 second average super hot TTFF in open sky
- < 2 m accuracy in open sky 1 Hz tracking with CEP-50
- UMTS Control Plane (CP) – UE-assisted and UE-based
- GSM Control Plane (CP) – UE-assisted and UE-based
- CDMA Control Plane (CP) – UE-assisted and UE-based
- OMA SUPL 1.0 User Plane (UP) – UE-assisted and UE-based

4.8.4.4. Enhanced Navigation 2.0 Feature

- Provides leading performance in car and walking navigation modes as well as accuracy while stationary
- Airline/Game/Offline mode
- GPS capability is available while phone is offline

4.8.4.5. NMEA

Supported sentences: GGA, GSA, GSV, RMC, VTG.

4.8.4.6. Software

GPS monitor application is built into Watcher.

4.8.5. Antenna Specifications

The main antenna must meet the requirements specified in Table 31 Main Antenna (ANT_PRM) Specification.

The GPS antenna must be an active antenna with integrated LNA to meet the specifications listed in Table 32 GPS Antenna (ANT_GPS) Recommendations. Note that additional power supply is needed based on the active antenna specifications since the AirPrime SL9090 has no internal bias voltage.

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 31. Main Antenna (ANT_PRM) Specification

Parameter	Minimum	Typical	Maximum	Unit	Description
Cable loss	-	-	0.5	dB	Maximum loss to antenna
Impedance	-	50	-	Ω	Antenna load impedance
VSWR	-	-	1.6:1		Maximum allowed VSWR of antenna
Radiated gain		0		dBi	In one direction at least

Note: Sierra Wireless recommends a maximum VSWR of 1.6:1 for both TX and RX bands.

Table 32. GPS Antenna (ANT_GPS) Recommendations

Parameter		Value
Frequency (MHz)	GPS L1	1575.42±1 MHz (minimum)
RF Impedance		50Ω
VSWR max	RX	1.5:1
LNA Bias Voltage		4.4 —4.9V
LNA Noise Figure		2.0 dB Max
LNA Current Consumption		50 mA Max
Antenna System Gain (Antenna + LNA - Cable)		20—24 dB

Parameter	Value
Polarization	Right Hand Circular Polarization

Note: Additional pre-external GNSS filter is needed to avoid running into external GPS LNA saturation.

4.8.5.1. Application

The following are suggested guidelines for the three 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 SL9090 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.
- For the RF line design, refer to section 8.7.3 RF Circuit.
- The antenna should be protected from ESD using an 8 kV-rated suppressor to avoid damage during antenna assembly, etc. Capacitance should be < 0.2 pF. For more details, refer to section 4.8.1 RF Connections.
- 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 1.6:1 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_DRX port should offer 3:1 or better VSWR in order to maintain radiated sensitivity.
- 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.

4.8.6. Radiated Emissions

The device alone meets all regulatory emissions limits when tested into a cabled (conducted) 50Ω system. With antenna designs with up to 2.5:1 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.

4.8.7. 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. Digital Audio

The AirPrime SL9090 Embedded Module only supports digital audio interfaces and allows dynamic run-time selection of the appropriate interface.

The Digital Audio Interface (either PCM or I^2S) interface allows connectivity with standard audio peripherals. It can be used, for example, to connect an external audio codec.

Note: Although the SL9090 has hardware provisions for PCM support, the current firmware release does not support switching to PCM from I^2S.

Table 33. Digital Audio Interface

Feature	Details
Implementation	Primary digital audio supported to interface with external codec
Power	1.8 V (use VREF_1V8 as logic reference)
Applicable Standards (for I^2S)	Phillips I^2S Bus Specifications, revised June 5, 1996.
Features (for PCM)	• 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 2.048 MHz • 16 bits data word MSB first only • Linear Law only (no compression law) • Long Frame Synchronization only • Push-pull configuration on PCM-OUT and PCM-IN

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

Some of the digital audio pins may also be used to configure a full UART. Refer to section 4.5.3 Full UART Implementation for more information about configuring these pins as additional UART signals.

Note: These pins can only be used as either digital audio pins (PCM or I^2S) or additional UART pins.

4.9.1. Pin Description

The following table describes the serial digital audio interface pins.

Table 34. PCM Pin Description

Pin #	Signal Name	Type	Description	Notes
64	PCM_SYNC	PD	PCM synchronization bit	Delivers 8 kHz frequency pulse that synchronizes frame data in / out.
65	PCM_DOUT*	O	PCM output	Frame ‘data out’ relies on selected configuration mode.
66	PCM_DIN*	PD	PCM input	Frame ‘data in’ relies on selected configuration mode.
67	PCM_CLK*	O	PCM clock	2 MHz for primary PCM mode. Controls data transfer with the audio peripheral.

* This pin may be reconfigured for use in a full UART implementation. Refer to section 4.5.3 Full UART Implementation for more information.

Table 35. I^2S Pin Description

Pin #	Signal Name	I/O Type	Reset State	Direction wrt Host	Description
11	I2S_SCLK *	1V8	Z	Output	I^2S Clock
12	I2S_WS *	1V8	Z	Output	I^2S Word Select
13	I2S_MCLK*	1V8	Z	Output	I^2S Master Clock
14	I2S_DOUT*	1V8	Z	Output	I^2S Data Output
66	I2S_DIN*	1V8	Z	Input	I^2S Data Input

* This pin may be reconfigured for use in a full UART implementation. Refer to section 4.5.3 Full UART Implementation for more information.

Refer to Table 8 AirPrime SL9090 LGA Pad Pin Assignments for other pin-specific details.

Refer to section 4.2 Digital I/O Electrical Information for 1V8 voltage characteristics, pin types and reset state definitions.

4.9.2. PCM Waveforms

The following figures describe the PCM Frame and Sampling waveforms.

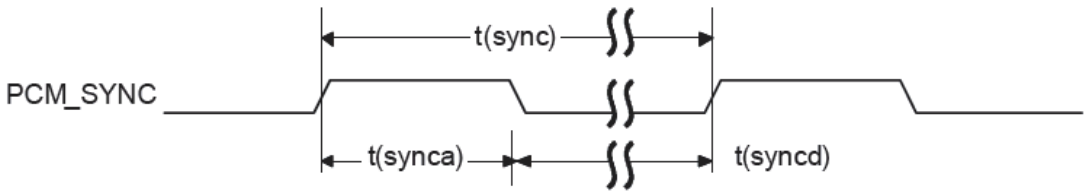


Figure 8. PCM_Sync Timing

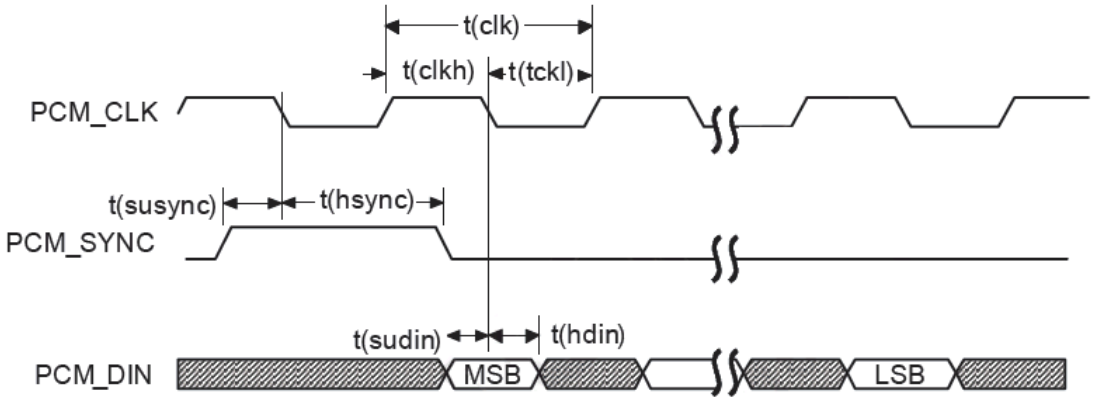


Figure 9. PCM_CODEC to SL9090 Timing

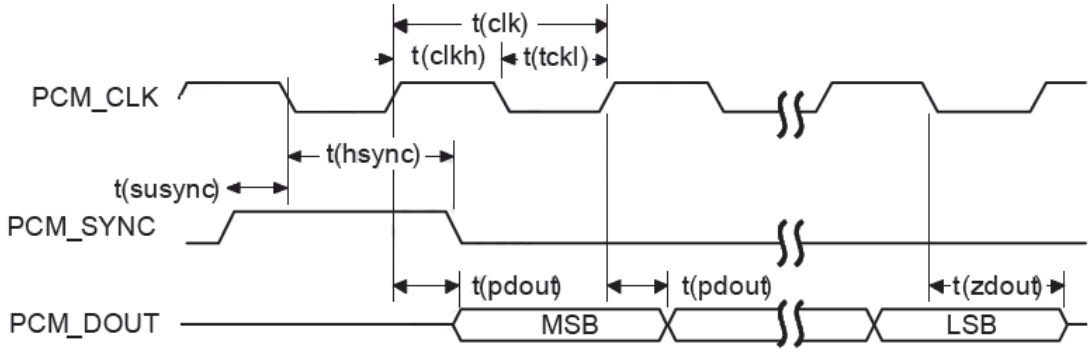


Figure 10. SL9090 to PCM_CODEC Timing

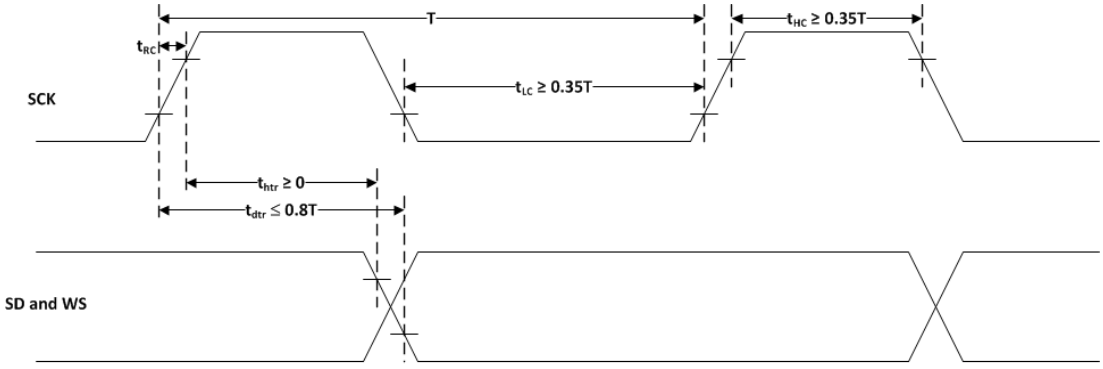
The following table describes the timing parameters of the digital audio interface.

Table 36. Digital Audio Interface Timing Parameters

Signal	Description	Minimum	Typical	Maximum	Unit
Tsync_low + Tsync_high	PCM-SYNC period		125		µs
Tsync_low	PCM-SYNC low time		124.5		µs
Tsync_high	PCM-SYNC high time	400	500		ns
TSYNC_CLK	PCM-SYNC to PCM-CLK time	60			ns
TCLK-cycle	PCM-CLK period		488		ns
TIN-setup	PCM-IN setup time	50			ns
TIN-hold	PCM-IN hold time	10			ns
TOUT-delay	PCM-OUT delay time			350	ns

4.9.3. I²S Waveforms

The following figure describes the I²S transmitter timing waveform.



T = clock period
T_r = minimum allowed clock period for transfer
$T > T_r$

Note: t_{RC} is only relevant for transmitters in slave mode

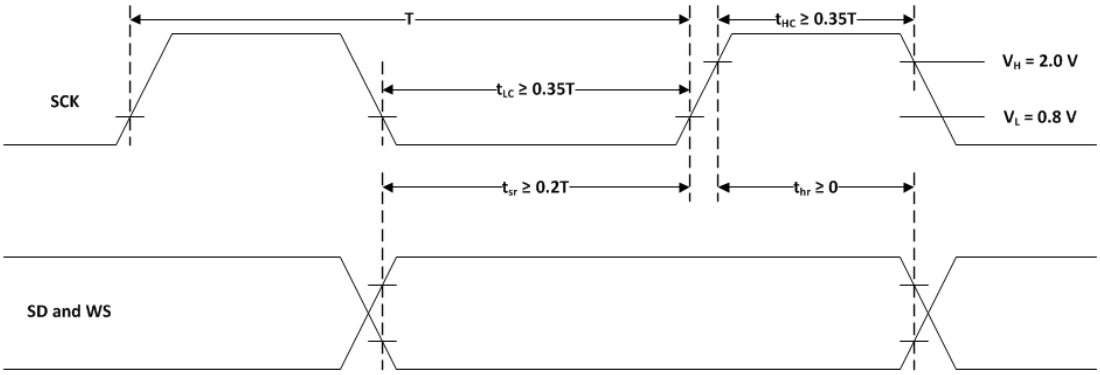
Figure 11. I²S Transmitter Timing Waveform

The following table describes the timing parameters of the master transmitter.

Table 37. Master Transmitter with Data Rate of 1.536 MHz (±10%)

Signal	I²S Requirement	Minimum	Typical	Maximum	Unit
Clock period T	Ttr = 586	586	651	716	ns
Clock high t_{HC}	Min > 0.35T	250			ns
Clock low t_{LC}	Min > 0.35T	250			ns
Delay t_{dtr}	Max < 0.8T			60	ns
Hold time t_{htr}	Min > 0	60			ns

The following figures describe the I²S receiver timing waveform.



T = clock period
T_r = minimum allowed clock period for transfer
$T > T_r$

Figure 12. Receiver Timing Diagram

The following table describes the timing parameters of the slave receiver.

Table 38. Slave Receiver with Data Rate of 1.536 MHz (±10%)

Signal	I^2S Requirement	Minimum	Typical	Maximum	Unit
Clock period T	Ttr = 586	586	651	716	ns
Clock high t_{HC}	Min < 0.35T	200			ns
Clock low t_{LC}	Min < 0.35T	200			ns
Delay t_{dtr}	Max < 0.2T	80			ns
Hold time t_{htr}	Min < 0	0			ns

4.9.4. Application

To use I^2S, the following I^2S pins have to be shorted with PCM pins before connecting to the codec:

- I2S_SCLK (pin 11) to PCM_CLK (pin 67)
- I2S_WS (pin 12) to PCM_SYNC (pin 64)

I2S_MCLK (pin 13) can be left floating if not used.

4.10. Buzzer Output (BUZZER_EN)

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

Table 39. Buzzer Signal Features

Feature	Details
Purpose	Enable off-board buzzer
Implementation	• Binary I/O used by host as a buzzer enable line • Can also be reconfigured as a PWM. For more details, refer to document [5] AirCard/AirPrime UMTS Supported AT Command Reference • Controlled by pulse-width modulation controller • Buzzer connects directly to this output signal and VCC_3V6 • Maximum current — 100 mA (peak)

4.10.1. Pin Description

The following table describes the wireless disable signal pin.

Table 40. Buzzer Output Pin Description

Pin #	Signal Name	I/O	I/O Type	Reset State
68	BUZZER_EN	O	Digital	Z

Refer to Table 8 AirPrime SL9090 LGA Pad Pin Assignments for other pin-specific details.

Refer to section 4.2 Digital I/O Electrical Information for 1V8 voltage characteristics, pin types and reset state definitions.

4.10.2. Electrical Characteristics

The following table describes the buzzer signal's electrical characteristics.

Table 41. Buzzer Signal Electrical Characteristics

Parameter	Minimum	Typical	Maximum	Unit
Output High	1.25	1.80	1.90	V
Output Low	0		0.45	V

4.11. JTAG Interface

The AirPrime SL9090 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 section 12.1 JTAG Connector for recommended suppliers.)

If platform issues arise, contact Sierra Wireless for assistance.

4.12. Short Message Service (SMS)

The SL9090 module complies with the following SMS features:

- Mobile-terminated SMS
- Mobile-originated SMS
- Point-to-Point messaging

4.13. UMTS Radio Access Bearers Supported

The SL9090 supports the majority of the radio access bearers specified in 3GPP TS 34.108. Contact Sierra Wireless for a detailed list.

5. Signals and Indicators

This chapter describes signals for control and handshaking of the AirPrime SL9090 Embedded Module from the host and describes how the system implements Smart Error Detection using those signals.

Table 42. Available Signals

Name	Driven by AT Commands
Power ON/OFF Signal (POWER_ON_N)	
Reset Signal (SYSTEM_RESET_N)	
Wake Host Signal (WAKE_N)	✓
Wireless Disable Signal (W_DISABLE_N)	✓
Flash LED (LED_FLASH)	✓
Power Rail (VREF_1V8)	
TX Burst and PA Indication	✓
Reserved	

5.1. Power ON/OFF Signal (POWER_ON_N)

This signal is used to switch the AirPrime SL9090 Embedded Module ON or OFF.

Table 43. Power Signal Features

Feature	Details
Purpose	Power on /off
Implementation	• Digital input with internal pull up • 1.8V logic • Active low • Signal driven only by open-drain output from the host.

5.1.1. Pin Description

The following table describes the POWER_ON_N signal pins.

Table 44. POWER_ON_N Signal Pin Description

Pin #	Signal Name	I/O	I/O Type	Description
43	POWER_ON_N	I	CMOS	Embedded module power-on

Refer to Table 8 AirPrime SL9090 LGA Pad Pin Assignments for other pin-specific details.

Refer to section 4.2 Digital I/O Electrical Information for 1V8 voltage characteristics, pin types and reset state definitions.

5.1.2. Electrical Characteristics

Caution: *All external signals must be inactive when the AirPrime SL9090 Embedded Module is OFF to avoid any damage when starting and to allow the embedded module to start and stop correctly.*

Refer to Table 8 AirPrime SL9090 LGA Pad Pin Assignments for basic characteristics (type, voltage).

5.1.3. Application Notes

This signal has to be kept at LOW level until switched OFF.

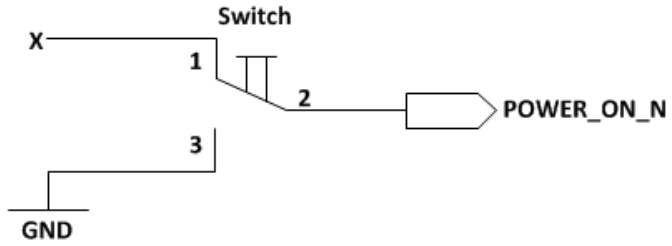


Figure 13. Example of POWER_ON_N Pin Connection

5.1.3.1. Signal Timing

The following figure and table describes the timing sequence for powering the device on and off.

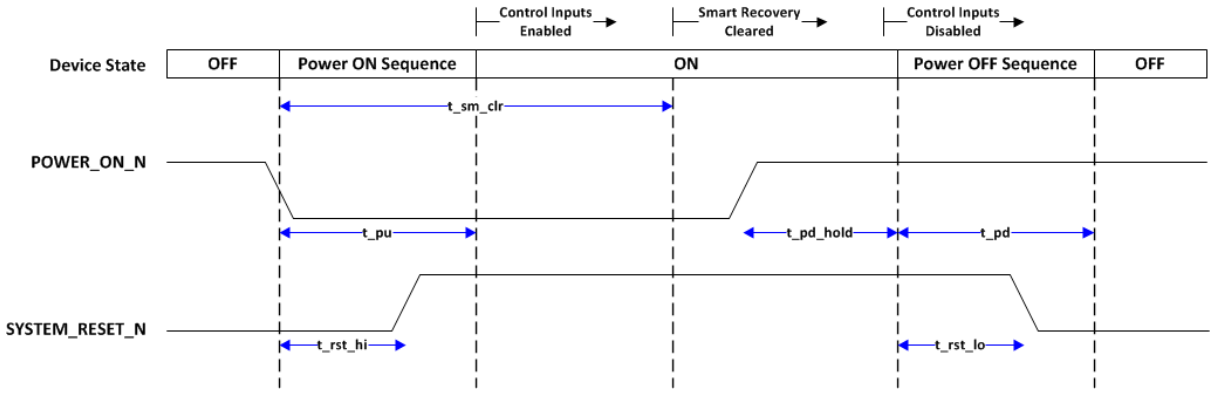


Figure 14. Power-OFF Sequence

Table 45. POWER_ON_N Signal Timing Parameters

Parameter	Description	Period		
		Minimum	Typical	Maximum
t_pu	Power up—Time required to boot device and reach device ready state.	5s	-	7s
t_pd_hold	Power down hold—Time required to acknowledge POWER_ON_N deassertion.	500ms	-	-
t_pd	Power down—Time required to power device off after POWER_ON_N is acknowledged	700ms	10s	-

Parameter	Description	Period		
		Minimum	Typical	Maximum
t_sm_clr	Smart recovery cleared—Time between booting device and reaching smart recovery mechanism disabled state.	-	20s	-
t_rst_hi	Reset high—Time between POWER_ON_N assertion and SYSTEM_RESET_N deassertion.	-	400ms	-
t_rst_lo	Reset low—Time between initiating power-off sequence and SYSTEM_RESET_N assertion.	-	1s	-

5.2. Reset Signal (SYSTEM_RESET_N)

The SYSTEM_RESET_N signal is an input that is used to force the AirPrime SL9090 Embedded Module to reset.

Note: An operating system reset is preferred to a hardware reset.

Table 46. Reset Signal Features

Feature	Details
Purpose	Used by host to reset the module
Implementation	• Digital input. 1.8 V logic (active low) • Signal is driven only by an open-drain output from the host. • Host must provide a 100 kΩ external pull-up resistor (to module-provided 1.8 V reference (pin 10 — VREF_1V8)). *Note: This pin is also required for JTAG programming.*

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

5.2.1. Pin Description

The following table describes the SYSTEM_RESET_N signal pins.

Table 47. Reset Signal Pin Description

Pin #	Signal Name	I/O	I/O Type	Description
63	SYSTEM_RESET_N	I	1V8	Embedded module reset

Refer to Table 8 AirPrime SL9090 LGA Pad Pin Assignments for other pin-specific details.

Refer to section 4.2 Digital I/O Electrical Information for 1V8 voltage characteristics, pin types and reset state definitions.

5.2.2. Electrical Characteristics

The following table describes the reset signal's electrical characteristics.

Table 48. Reset Signal Electrical Characteristics

Parameter	Minimum	Typical	Maximum	Unit
SYSTEM_RESET_N time (Rt)[a]	30			ms
SYSTEM_RESET_N time (Rt)[b] at power up only	10	20	30	ms
V_{IL}			0.59	V
V_{IH}	1.23			V

a This reset time is the minimum to be carried out on the SYSTEM_RESET_N signal when the power supply is already stabilized.

b This reset time is internally carried out by the embedded module power supply supervisor only when the embedded module power supplies are powered ON.

5.2.3. Application

5.2.3.1. Reset Sequence

To reset the embedded module (force the baseband circuit to reset), the host drives the 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.

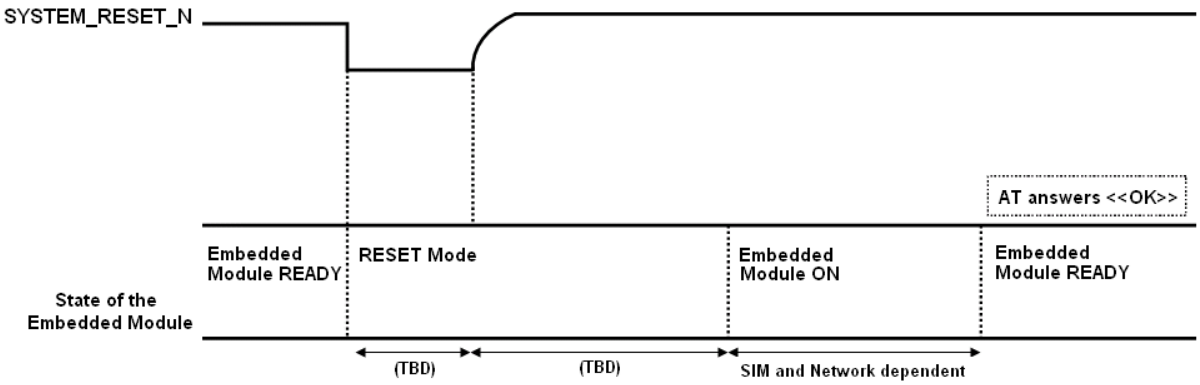


Figure 15. Reset Sequence Waveform

5.2.3.2. General Notes

- This reset line should not be driven unless the host needs to enforce a baseband reset by asserting a logic low.
- A switch, an open collector or open drain transistor can be used. If an open collector is chosen, T1 can be a ROHM DTC144EE.
- If no external reset is necessary this input can be left open.

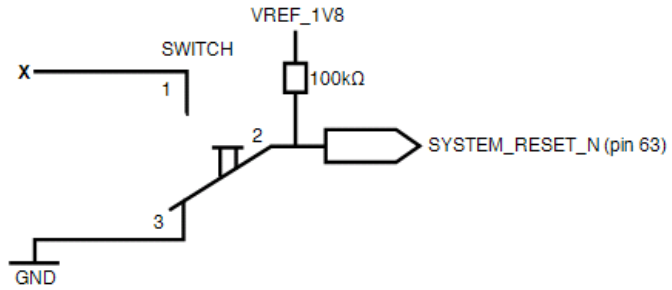


Figure 16. Example of SYSTEM_RESET_N Pin Connection with Switch Configuration

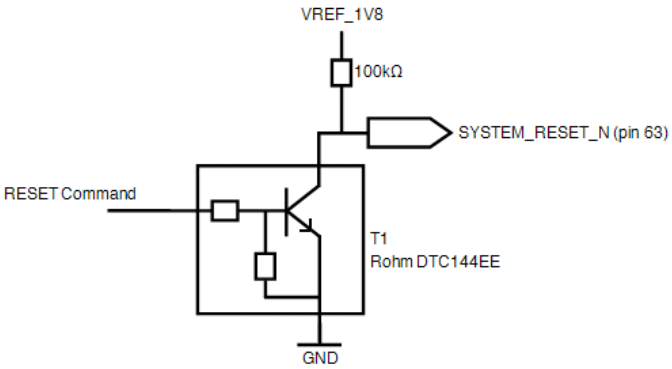


Figure 17. Example of SYSTEM_RESET_N Pin Connection with Transistor Configuration

Table 49. Reset Settings

Reset Command	SYSTEM_RESET_N (Pin 63)	Operating Mode
1	0	Reset activated
0	1	Reset inactive

5.3. Wake Host Signal (WAKE_N)

This signal is used by the AirPrime SL9090 Embedded Module to wake the host when a predetermined condition is satisfied (such as when a call is received).

Table 50. Wake Host 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, 1.8V logic • During the powered-off state, this pin may not be in a high impedance state. The host side must implement appropriate measures to accommodate this.

5.3.1. Pin Description

The following table describes the wake signal pin.

Table 51. Wake Signal Pin Description

Pin #	Signal Name	I/O	I/O Type	Description
61	WAKE_N*	O	Digital	Wake Host interface

* This pin may be reconfigured for use in a full UART implementation. Refer to section 4.5.3 Full UART Implementation for more information.

Refer to Table 8 AirPrime SL9090 LGA Pad Pin Assignments for other pin-specific details.

Refer to section 4.2 Digital I/O Electrical Information for 1V8 voltage characteristics, pin types and reset state definitions.

5.3.2. Electrical Characteristics

The following table describes the wake signal's electrical characteristics.

Table 52. Wake Signal Electrical Characteristics

Parameter	Minimum	Typical	Maximum	Unit
Output High	1.25	1.80	1.90	V
Output Low	0		0.45	V

5.4. Wireless Disable Signal (W_DISABLE_N)

This signal is used by the host to disable (or enable) the AirPrime SL9090 Embedded Module's RF connection.

Table 53. 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, 1.8V logic • Host to provide a pull-up resistor of 50-100 kΩ

5.4.1. Pin Description

The following table describes the wireless disable signal pin.

Table 54. Wireless Disable Signal Pin Description

Pin #	Signal Name	I/O	I/O Type	Description
62	W_DISABLE_N	I	Digital	Wireless disable

Refer to Table 8 AirPrime SL9090 LGA Pad Pin Assignments for other pin-specific details.

Refer to section 4.2 Digital I/O Electrical Information for 1V8 voltage characteristics, pin types and reset state definitions.

5.4.2. Electrical Characteristics

The following table describes the wireless disable signal's electrical characteristics.

Table 55. Wireless Disable Signal Electrical Characteristics

Parameter	Minimum	Typical	Maximum	Unit
Input High	1.23	1.80	2.00	V
Input Low	-0.30		0.59	V

5.4.3. Signal Timing

The following figure and table describe the timing sequence for entering/exiting low power mode ('airplane mode').

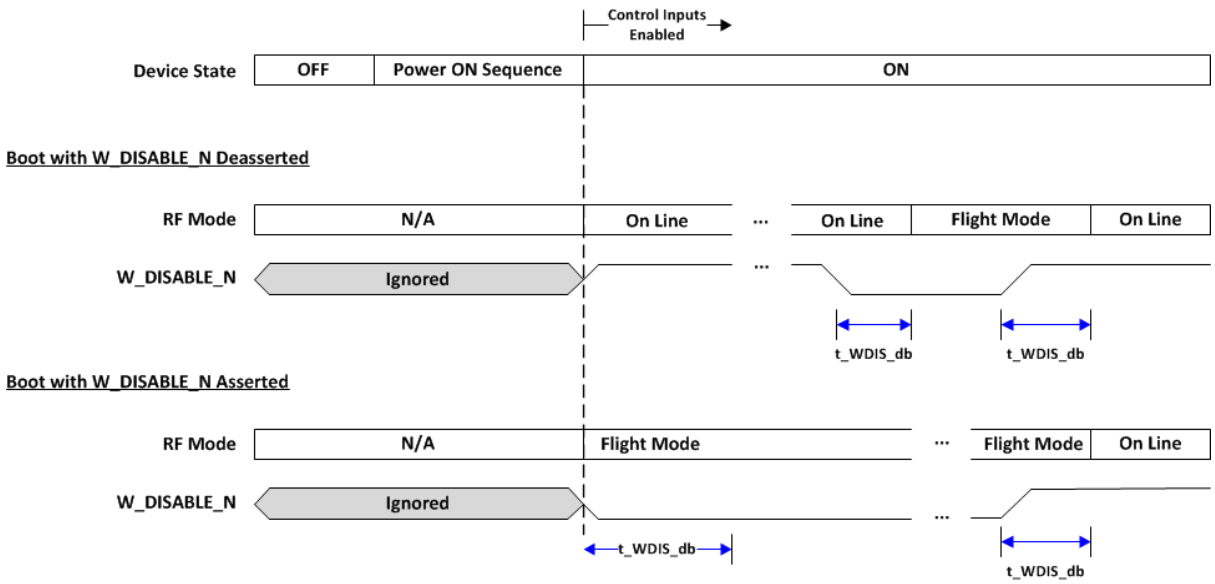


Figure 18. W_DISABLE_N Signal Timing

Table 56. W_DISABLE_N Signal Timing Parameters

Parameter	Description	Period		
		Min	Typ	Max
t_WDIS_db	W_DISABLE_N Debounce – Time between changing W_DISABLE_N logic level and RF mode changing.	1s	-	7s

5.5. Flash LED (LED_FLASH)

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

Table 57. 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

5.5.1. Pin Description

The following table describes the LED signal pin.

Table 58. LED_FLASH Pin Description

Pin #	Signal Name	I/O	I/O Type	Reset State	Description
60	LED_FLASH	O	Digital	1 and Undefined	LED driving

Refer to Table 8 AirPrime SL9090 LGA Pad Pin Assignments for other pin-specific details.

Refer to section 4.2 Digital I/O Electrical Information for 1V8 voltage characteristics, pin types and reset state definitions.

5.5.2. Electrical Characteristics

The following table describes the LED_FLASH signal's electrical characteristics. Refer to Table 8 AirPrime SL9090 LGA Pad Pin Assignments for basic characteristics (type, voltage).

Table 59. LED_FLASH Signal Electrical Characteristics

Parameter	Condition	Minimum	Typical	Maximum	Unit
V_{OL}		0		0.45	V
V_{OH}		1.25	1.80	1.90	V

Parameter	Condition	Minimum	Typical	Maximum	Unit
I_{OUT}				8	mA

5.6. Power Rail (VREF_1V8)

The AirPrime SL9090 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 61 1.8V Connector Pins.

5.6.1. Pin Description

The following table describes the VREF_1V8 output pin.

Table 60. VREF_1V8 Pin Description

Pin #	Signal Name	I/O	I/O Type	Description
10	VREF_1V8	O	Supply	1.8 V digital supply

Refer to Table 8 AirPrime SL9090 LGA Pad Pin Assignments for other pin-specific details.

Refer to section 4.2 Digital I/O Electrical Information for 1V8 voltage characteristics, pin types and reset state definitions.

Table 61. 1.8V 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
4	GPIO_0	General Purpose I / O
6	EXT_VREG_USIM*	USIM VCC supply
7	EXT_USIM_RESET*	USIM reset
8	EXT_USIM_DATA*	USIM I/O pin
9	EXT_USIM_CLK*	USIM clock
11	I2S_SCLK	I^2S Clock
12	I2S_WS	I^2S Word Select
13	I2S_MCLK	I^2S Master Clock
14	I2S_DOUT	I^2S Data Output
16	I2C_SDA	I^2C Serial Data
17	I2C_SCL	I^2C Serial Clock
45	UART1_TXD	UART Transmit Data
46	UART1_RXD	UART Receive Data
47	UART1_CTS_N	UART Clear To Send
48	UART1_RTS_N	UART Request To Send
60	LED_FLASH	LED driver
61	WAKE_N	Wake Host Interface
62	W_DISABLE_N	Wireless disable

Pin #	Signal Name	Description
63	SYSTEM_RESET_N	Reset
64	PCM_SYNC	PCM sync
65	PCM_DOUT	PCM data output
66	I2S_DIN	I^2S Data In
67	PCM_CLK	PCM clock

* USIM Interface may be configured as 1.8V or 3V.

5.6.2. Electrical Characteristics

The following table describes the power rail signal's electrical characteristics.

Table 62. VREF_1V8 Signal Electrical Characteristics

Parameter		Minimum	Typical	Maximum	Unit
VREF_1V8	Output voltage	1.70	1.80	1.90	V
	Output current			1 (TBD)	mA

5.6.3. VREF_1V8 – 1.8V Logic Reference

Note: VREF_1V8 is only available when the AirPrime SL9090 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 100Ω resistor should be put in series.
- Depending on the host PCB trace length for this signal, PCB provision for decoupling capacitors may be required.

5.7. TX Burst and PA Indication

The TX_Burst signal and PA indicator is a 1.8V indication signal for TX burst (for GSM only) or PA (for GSM, WCDMA, 1x, 1XDO) available in the AirPrime SL9090 embedded module. This signal is available via GPIO_0 (pin 4) and enabled via a specific AT command, **AT+WTBI**.

Note that only one indicator can be used at a time. The user can set which feature (TX Burst or PA indicator) to use using **AT+WTBI**:

```
AT+WTBI=<TX_IND_MODE>,<LEVEL>
```

Where:

TX_IND_MODE:

0 – Disable the Tx indication feature

1 – Enable the Tx Burst indication feature (for GSM only)

2 – Enable the PA indication feature (for GSM, WCDMA, 1X, 1XDO)

LEVEL: (this is only effective when TX_IND_MODE is 2)

0 – When PA is on, the output will be low level; when PA is off, the output is high level.

1 – When PA is on, the output will be high level; when PA is off, the output is low level.

Refer to document [6] AirPrime MC/SL Series (UMTS/LTE) Extended AT Command Reference for more information regarding **AT+WBTI**.

Table 63. TX_Burst Status

AirPrime SL9090 State	TX_Burst Status
During TX burst	High
No TX	Low

During TX burst, there will be higher current drain from the VCC_3V6 power supply which causes a voltage drop. This voltage drop from VCC_3V6 is a good indication of a high current drain situation during TX burst.

The TX burst frequency is about 216Hz.

The output logic high duration, $T_{duration}$, depends on the number of TX slots and is computed as follows:

$T_{duration} = T_{advance} + (0.577ms \times number\ of\ TX\ slots) + T_{delay}$.

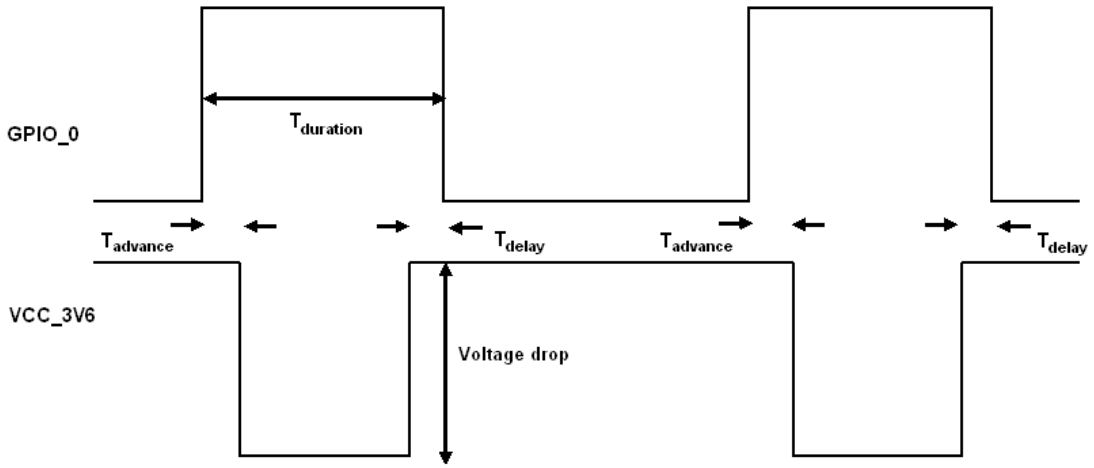


Figure 19. GPIO_0 State During TX Burst

Table 64. TX Burst Indication Signal Electrical Characteristics

Parameter	Minimum	Typ.	Maximum	Unit
V_{OH}	1.25	1.80	1.90	V
V_{OL}	0		0.45	V
$T_{advance}$	155	165	175	µs
T_{delay}	6	16	26	µs

5.7.1. Application

The TX burst indication signal available via GPIO_0, can be used to drive an LED through a transistor. It will then be a good visual indicator for any TX activity.

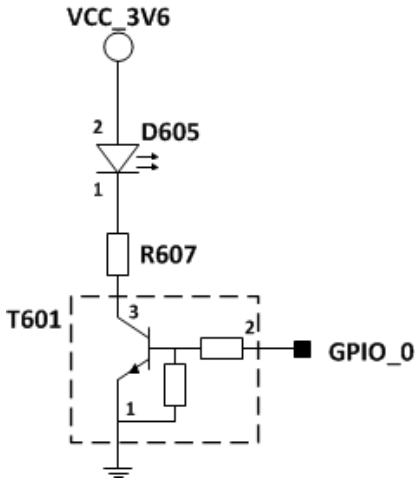


Figure 20. Example of TX Burst Implementation

The value of R607 can be harmonized depending on the LED (D605) characteristics.

5.8. Reserved

The AirPrime SL9090 Embedded Module includes pins that may not be used in your host design. These pins should be handled in the following ways:

- Pins marked 'DNC' — Leave these pins untouched. (See Table 8 AirPrime SL9090 LGA Pad Pin Assignments for pin assignments / names.)
- Unused inputs / outputs on specific interfaces (USB, USIM, etc.) — Leave as no-connects.

6. Power Consumption

The power consumption numbers listed in this section are for the AirPrime SL9090 Embedded Module connected to the host PC via USB. The module has its own power source. The minimum, typical and maximum values were measured at room temperature only. For a description of input voltage requirements, see section 3.1 Power Supply.

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

Table 65. Averaged Standby DC Power Consumption for UMTS (Preliminary Values)

Signal	Description	Bands	Typ.	Peak	Units	Notes/Configuration
VCC	**Standby current consumption with Sleep mode activated (assumes USB bus is fully suspended during measurements)**					
	HSDPA / WCDMA	UMTS bands	2.3	123	mA	DRX cycle = 8 (2.56 s)
	GSM / GPRS / EDGE	GSM bands	3.4	112	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	29	135	mA	• DRX cycle = 8 (2.56 s) • Module power up and idle (Assumes sleep mode is never entered)
	GSM / GPRS / EDGE	GSM bands	30	181	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		4.1	38	mA	• State is entered when Watcher shuts down / turns off the radio. • LPM is the lowest possible (‘rock bottom’) state in Sleep mode.

Table 66. Averaged Standby DC Power Consumption for CDMA (Preliminary Values)

Description	Band	Typ	Max	Unit	Notes
IS-95 Standby current	PCS or Cellular	4.7	-	mA	SCI=2, PCH = full rate, Registration rate = 30 min, Sector power -70 dBm. Neighbor list on.
IS-2000 Standby current	PCS or Cellular	1.7	-	mA	SCI=2, PCH = full rate, Registration rate = 30 min, Sector power -70 dBm. Neighbor list on. QPCH on.
Hybrid Mode Standby current	PCS or Cellular	TBD	-	mA	SCI=2, PCH = full rate, Registration rate = 30 min, Sector power -70 dBm. Neighbor list on. QPCH on. Modem idling on both IS-2000 and 1xEV-DO networks.

Description	Band	Typ	Max	Unit	Notes
IS-2000 Talk current, Reverse Pilot Channel Gating Disabled	PCS	TBD	-	mA	SO9, RC5 (Fwd) / RC4 (Rvs), CDG Urban Profile
		211 (TBD)	-	mA	SO9, RC5 (Fwd) / RC4 (Rvs), CDG Suburban Profile
	Cellular	185 (TBD)	-	mA	SO9, RC5 (Fwd) / RC4 (Rvs), CDG Urban Profile
		201 (TBD)	-	mA	SO9, RC5 (Fwd) / RC4 (Rvs), CDG Suburban Profile
IS-2000 Talk current, Reverse Pilot Channel Gating enabled	PCS	226 (TBD)	-	mA	SO9, RC5 (Fwd) / RC4 (Rvs), CDG Urban Profile
		248 (TBD)	-	mA	SO9, RC5 (Fwd) / RC4 (Rvs), CDG Suburban Profile
	Cellular	204 (TBD)	-	mA	SO9, RC5 (Fwd) / RC4 (Rvs), CDG Urban Profile
		224 (TBD)	-	mA	SO9, RC5 (Fwd) / RC4 (Rvs), CDG Suburban Profile
IS-2000 1X Data current	PCS	286	-	mA	SO32, RC3 (Fwd) / RC3 (Rvs), 153.6 kbps (Fwd) / 76.8 kbps (Rvs), CDG Urban Profile, USB active
		331	-	mA	SO32, RC3 (Fwd) / RC3 (Rvs), 153.6 kbps (Fwd) / 76.8 kbps (Rvs), CDG Suburban Profile, USB active
	Cellular	255	-	mA	SO32, RC3 (Fwd) / RC3 (Rvs), 153.6 kbps (Fwd) / 76.8 kbps (Rvs), CDG Urban Profile, USB active
		300	-	mA	SO32, RC3 (Fwd) / RC3 (Rvs), 153.6 kbps (Fwd) / 76.8 kbps (Rvs), CDG Suburban Profile, USB active
IS-856 1xEV-DO Revision 0 Data current	PCS	364	-	mA	CDG Urban Profile, USB active
		430	-	mA	CDG Suburban Profile, USB active
	Cellular	308	-	mA	CDG Urban Profile, USB active
		367	-	mA	CDG Suburban Profile, USB active
IS-856A 1xEV-DO Revision A Data current	PCS	388	-	mA	CDG Urban Profile, USB active
		458	-	mA	CDG Suburban Profile, USB active
	Cellular	321	-	mA	CDG Urban Profile, USB active
		387	-	mA	CDG Suburban Profile, USB active

Table 67. Averaged Call Mode Data DC Power Consumption

Mode	Current (at 3.6V)		Tx (output) Power	Conditions
WCDMA Data Current Consumption (includes USB bus current)				
WCDMA	Average	546 mA	23 dBm	384kbps*
		224.5 mA	0 dBm	
	Peak	628 mA		Averaged over 100µs
HSDPA	Average	560 mA	23 dBm	All speeds
		234.3 mA	0 dBm	
	Peak	650 mA		Averaged over 100µs
HSUPA	Average	450 mA	23 dBm	All speeds
		225.7 mA	0 dBm	
	Peak	470mA		Averaged over 100µs
GSM / EDGE Data Current Consumption				
GSM/GPRS	Average	240 mA (1TX) 435 mA (2TX)	+33 dBm	50Ω Max PCL for each band
	Peak	2.82 A		Averaged over 100µs Worst case on 850 / 900 band
	Average	97.5 mA (1TX) 120.2 mA (2TX)	+10 dBm	50Ω
	Peak	243.2 mA		Averaged over 100µs Worst case on 850 / 900 band
EDGE (850 MHz)	Average	170 mA (1TX) 245 mA (2TX)	+26 dBm	50Ω Class 12
	Peak	1.5 A	+33 dBm	Averaged over 100µs Worst case on 850 / 900 band

* Highest current is in Band I

Table 68. Miscellaneous DC Power Consumption (Preliminary Values)

Signal	Description	Band	Typ.	Max.	Units	Notes/Configuration
VCC	Module OFF leakage current	All bands	135	(TBD)	µA	Room temperature
	USB transmit current	All bands	10	(TBD)	mA	Full speed USB connection, CL = 50 pF on D+ and D- signals

Table 69. 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*; 27 dBm, 0.5 W
EDGE Power Class for 800 / 1900 MHz	Class E2*; 26 dBm, 0.4 W

* E2 power class applies to 8PSK modulation.

6.1. Power States

The SL9090 module has five power states as detailed in the following table.

Table 70. Supported SL9090 Power States

State	Description	Host Powered	Module Powered	USB Interface Active	RF Enabled
Normal (Default state)	• Capable of placing / receiving calls or establishing data connections on network • USB interface is fully active • Current consumption in a call or data connection is affected by: ▪ Radio band in use ▪ Tx power ▪ Receive gain settings ▪ Data rate ▪ Number of active Tx time slots • Module defaults to Normal state when VCC is first applied in the absence of POWER_ON_N control.	✓	✓	✓	✓
Airplane Mode (RF off)	• 'Airplane' mode — Rx / Tx are disabled; USB interface is active • State entered automatically when critical voltage / temperature thresholds are exceeded. Host should consider powering off module to prevent damage to unit.	✓	✓	✓	
Sleep (Idle Mode)	• Normal state of module between calls or data connections. • Module cycles between wake (polling the network) and sleep, at network provider-determined interval.	✓	✓		
Off	• Host power is connected • Module is powered down (drawing minimal current from host power supply)	✓			
Disconnected	• Host power is disconnected from module • All module-related voltages are at 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 71 Power State Transitions (including voltage/temperature trigger levels) for details.

Power state transitions may occur automatically when critical supply voltage or module temperature trigger levels are encountered. See Figure 21 Automatic ("Triggered") Power State Transitions for details.

Under host control, using available AT or QMI commands in response to user choices (for example, opting to switch to airplane mode) or operating conditions.

Table 71. Power State Transitions (including voltage/temperature trigger levels)

Transition	Voltage		Temperature		Notes
	Trigger	V	Trigger	°C	
Normal to Low Power	VOLT_HI_CRIT	4.4	TEMP_LO_CRIT	-45	• RF suspended • QMI_RADIO_POWER notification issued*
	VOLT_LO_CRIT	3.0	TEMP_HI_CRIT	110	
Low Power to Normal	VOLT_HI_NORM	4.3	TEMP_NORM_LO	-40	• RF suspended • QMI_RADIO_POWER notification issued*
Low Power to Normal or Remain in Normal (remove warnings)	VOLT_LO_NORM	3.6	TEMP_HI_NORM	85	
Normal (issue warning)	VOLT_LO_WARN	3.4	TEMP_HI_WARN	95	

* Notification issued only if previously enabled.

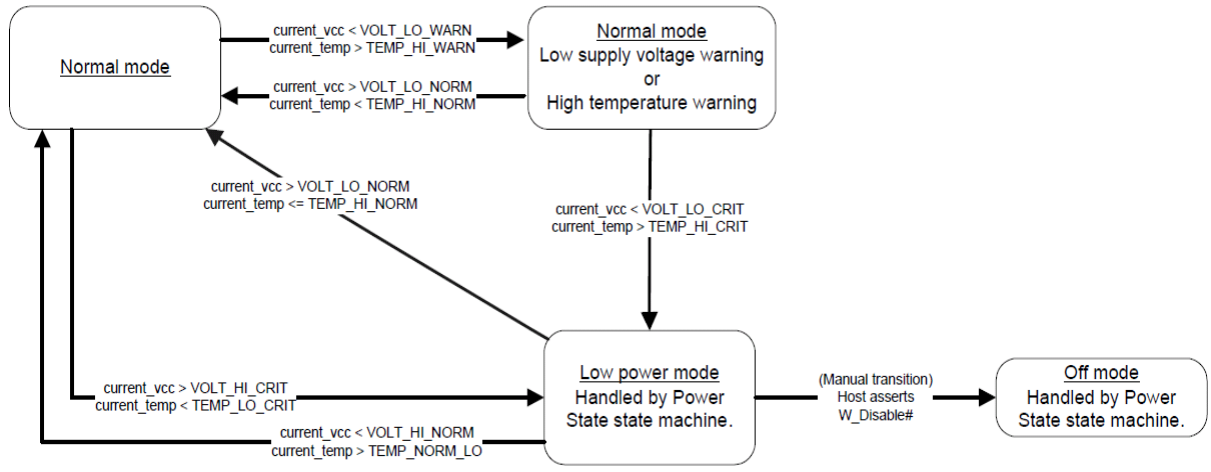


Figure 21. Automatic ("Triggered") Power State Transitions

7. Reliability Compliance and Recommended Standards

7.1. Reliability Compliance

The AirPrime SL9090 embedded module connected on a development kit board application is compliant with the following requirements.

Table 72. Standards Conformity for the AirPrime SL9090 Embedded Module

Abbreviation	Definition
IEC	International Electro technical Commission
ISO	International Organization for Standardization

7.2. Applicable Standards

The table hereafter gives the basic list of standards applicable to the SL9090 Embedded Module.

Note: References to any features can be found from these standards.

Table 73. Applicable Standards and Requirements

Document	Current Version	Title
IEC6006826	7.0	Environmental testing - Part 2.6: Test FC: Sinusoidal Vibration.
IEC60068234	73	Basic environmental testing procedures part 2: Test FD: random vibration wide band - general requirements Cancelled and replaced by **IEC60068-2-64**. For reference only.
IEC60068264	2.0	Environmental testing - part 2-64: Test FH: vibration, broadband random and guidance.
IEC60068232	2.0	Basic environmental testing procedures - part 2: Test ED: (procedure 1) (withdrawn & replaced by IEC60068-2-31).
IEC60068231	2.0	Environmental testing part 2-31: Test EC: rough handling shocks, primarily for equipment-type specimens.
IEC60068229	2.0	Basic environmental testing procedures - part 2: Test EB and guidance: bump Withdrawn and replaced by **IEC60068-2-27**. For reference only.
IEC60068227	4.0	Environmental testing - part 2-27: Test EA and guidance: shock.
IEC60068214	6.0	Environmental testing - part 2-14: Test N: change of temperature.
IEC6006822	5.0	Environmental testing - part 2-2: Test B: dry heat.
IEC6006821	6.0	Environmental testing - part 2-1: Test A: cold.
IEC60068230	3.0	Environmental testing - part 2-30: Test DB: damp heat, cyclic (12 h + 12 h cycle).
IEC6006823	69 w/A1	Basic environmental testing procedures part 2: Test CA: damp heat, steady State Withdrawn and replaced by **IEC60068-2-78**. For reference only.
IEC60068278	1.0	Environmental testing part 2-78: Test CAB: damp heat, steady state.

Document	Current Version	Title
IEC60068238	2.0	Environmental testing - part 2-38: Test Z/AD: composite temperature/humidity cyclic test.
IEC60068240	1.0 w/A1	Basic environmental testing procedures - part 2: Test Z/AM combined cold/low air pressure tests.
ISO167501	2ND	Road vehicles - environmental conditions and testing for electrical and electronic equipment - part 1: general.
ISO167502	2ND	Road vehicles - environmental conditions and testing for electrical and electronic equipment - part 2: electrical loads.
ISO167503	2ND	Road vehicles - environmental conditions and testing for electrical and electronic equipment - part 3: mechanical loads.
ISO167504	2ND	Road vehicles - environmental conditions and testing for electrical and electronic equipment - part 4: climatic loads.
IEC60529	2.1 w/COR2	Degrees of protection provided by enclosures (IP code).
IEC60068217	4.0	Basic environmental testing procedures - part 2: Test Q: sealing.
IEC60068218	2.0	Environmental testing - part 2-18: Tests - R and guidance: water.
IEC60068270	1.0	Environmental testing - part 2: tests - test XB: abrasion of markings and letterings caused by rubbing of fingers and hands.
IEC60068268	1.0	Environmental testing - part 2: tests - test l: dust and sand.
IEC60068211	3.0	Basic environmental testing procedures, part 2: test KA: salt mist.
IEC60068260	2.0	Environmental testing - part 2: Test KE: flowing mixed gas corrosion test.
IEC60068252	2.0 w/COR	Environmental testing - part 2: Test KB: salt mist, cyclic (sodium chloride solution).

7.3. Environmental Specifications

The SL9090 Embedded Module is compliant with the operating classes listed in the table below. The ideal temperature range of the environment for each operating class is also specified.

Table 74. Operating Class Temperature Range

Conditions	Temperature Range
Operating/Class A	-30°C to +70°C
Operating/Class B	-40°C to +85°C
Storage	-40°C to +85°C

7.3.1. Function Status Classification

The classes reported below comply with the Annex “ISO Failure Mode Severity Classification”, ISO Standard 7637, and Section 1.

Note: The word “function” as used here concerns only the function performed by the SL9090 Embedded Module.

Table 75. ISO Failure Mode Severity Classification

Class	Description
Class A	The SL9090 Embedded Module remains fully functional during and after environmental exposure; and shall meet the minimum requirements of 3GPP or appropriate wireless standards.
Class B	The SL9090 Embedded Module remains fully functional during and after environmental exposure; and shall exhibit the ability to establish a voice, SMS or DATA call at all times even when one or more environmental constraint exceeds the specified tolerance. Unless otherwise stated, full performance should return to normal after the excessive constraint(s) have been removed.

7.4. Reliability Prediction Model

7.4.1. Life Stress Test

The following tests the SL9090's product performance.

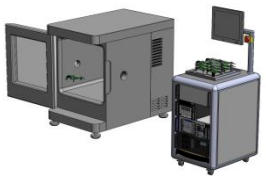
Table 76. Life Stress Test

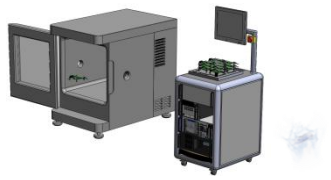
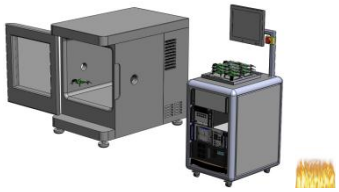
Designation	Condition
Performance Test PT3T° & PT 	Standard: N/A
	Special conditions: • Temperature: ▪ Class A: -30°C to +70°C ▪ Class B: -40°C to +85°C ▪ Rate of temperature change: ± 3°C/min • Recovery time: 3 hours
	Operating conditions: Powered
	Duration: 14 days

7.4.2. Environmental Resistance Stress Tests

The following tests the SL9090's resistance to extreme temperature.

Table 77. Environmental Resistance Stress Tests

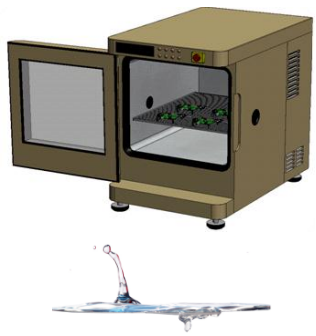
Designation	Condition
Cold Test Active COTA 	Standard: IEC 680068-2-1, Test Ad
	Special conditions: • Temperature: -30°C • Rate of temperature change: dT/dt >= ± 3°C/min • Recovery time: 3 hours
	Operating conditions: Powered
	Duration: 72 hours

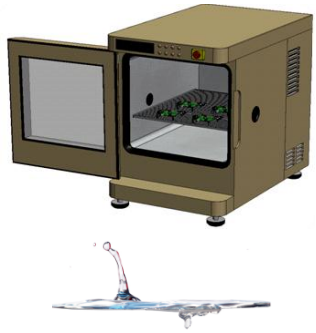
Designation	Condition
Cold Test Active **COTP** 	Standard: IEC 680068-2-1, Test Ab
	Special conditions: • Temperature: -40°C • Rate of temperature change: dT/dt >= ± 3°C/min • Recovery time: 3 hours
	Operating conditions: Un-powered
	Duration: 72 hours
Resistance to Heat Test **RH** 	Standard: IEC 680068-2-2, Test Bb
	Special conditions: • Temperature: +85°C • Rate of temperature change: dT/dt >= ± 3°C/min • Recovery time: 3 hours
	Operating conditions: The DUT is switched ON for 1 min and then OFF for 1 min
	Duration: 50 days
Dry Heat Test **DHT** 	Standard: IEC 680068-2-2, Test Bb
	Special conditions: • Temperature: +85°C • Rate of temperature change: dT/dt >= ± 3°C/min • Recovery time: 3 hours
	Operating conditions: Un-powered
	Duration: 72 hours

7.4.3. Corrosive Resistance Stress Tests

The following tests the SL9090's resistance to corrosive atmosphere.

Table 78. Corrosive Resistance Stress Tests

Designation	Condition
Humidity Test **HT** 	Standard: IEC 60068-2-3
	Special conditions: • Temperature: +65°C • RH: 95% • Rate of temperature change: dT/dt >= ± 3°C/min • Recovery time: 3 hours
	Operating conditions: The DUT is switched ON for 15 minutes and then OFF for 15 minutes
	Duration: 10 days

Designation	Condition
Component Solder Wettability **CSW** 	Standard: JESD22 – B102, Method 1
	Special conditions: • Test method: Dip and Look Test with Steam preconditioning • Test Time: 8 h+/-15min. dip for 5 +0/-0.5 seconds
	Operating conditions: Un-powered
	Duration: 5 days
Moist Heat Cyclic Test **MHCT** 	Standard: IEC 60068-2-30, Test Db
	Special conditions: • Upper temperature: +40 ± 2°C • Lower temperature: +25 ± 2°C • RH: ▪ Upper temperature: 93% ▪ Lower temperature: 95% • Number of cycles: 21 (1 cycle/24 hours) • Rate of temperature change: dT/dt >= ± 3°C/min • Recovery time: 3 hours
	Operating conditions: Un-powered
	Duration: 21 days

7.4.4. Thermal Resistance Cycle Stress Tests

The following tests the SL9090's resistance to extreme temperature cycling.

Table 79. Thermal Resistance Cycle Stress Tests

Designation	Condition
Thermal Shock Test **TSKT** 	Standard: IEC 60068-2-14, Test Na
	Special conditions: • Upper temperature: +90°C • Lower temperature: -40°C • Rate of temperature change: 30s • Number of cycles: 300 (Industrial grade), 50 (Commercial grade) • Duration of exposure: 20 minutes • Recovery time: 3 hours
	Operating conditions: Un-powered
	Duration: 8 days

Designation	Condition
Temperature Change TCH 	Standard: IEC 60068-2-14, Test Nb
	Special conditions: • Upper temperature: +90°C • Lower temperature: -40°C • Rate of temperature change: dT/dt >= ± 3°C/min • Number of cycles: 400 • Duration of exposure: 10 minutes • Recovery time: 3 hours
	Operating conditions: Un-powered
	Duration: 30 days

7.4.5. Mechanical Resistance Stress Tests

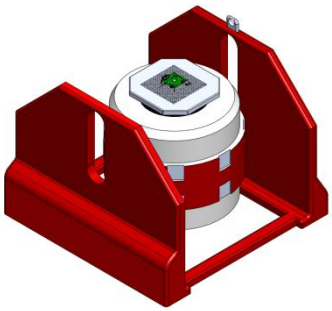
The following tests the SL9090's resistance to vibrations and mechanical shocks.

Table 80. Mechanical Resistance Stress Tests

Designation	Condition
Sinusoidal Vibration Test SVT 	Standard: IEC 60068-2-6, Test Fc

	Special conditions:
	• Frequency range: 16Hz to 1000Hz
	  ▪ Displacement: 0.35mm (peak)
	• Frequency range: 16Hz to 62Hz
	  ▪ Acceleration: 5G
	• Frequency range: 62Hz to 200Hz
	  ▪ Acceleration: 3G
	• Frequency range: 200Hz to 1000Hz
	  ▪ Acceleration: 1G
	• Sweep rate: 1 octave/min
	• Test duration: 20 sweeps/axis (2.3h)
	• Sweep directions: X, Y and Z

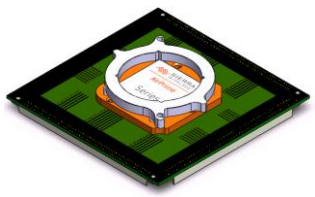
	Operating conditions: Un-powered
	Duration: 72 hours

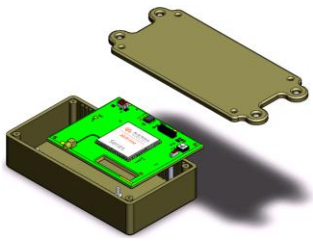
Designation	Condition
Random Vibration Test **RVT** 	Standard: IEC 60068-2-64
	Special conditions: • Density spectrum: 0.96m^2/s3 • Frequency range: ▪ 0.1 g2/Hz at 10Hz ▪ 0.01 g2/Hz at 250Hz ▪ 0.0005 g2/Hz at 1000Hz ▪ 0.0005 g2/Hz at 2000Hz • Slope: -3dB/octave • Acceleration: 0.9gRMS • Number of axis: 3
	Operating conditions: Un-powered
	Duration: 24 hours
Mechanical Shock Test **MST** 	Standard: IEC 60068-2-27, Test Ea
	Special conditions: • Shock Test 1: ▪ Wave form: Half sine ▪ Peak acceleration: 30G ▪ Duration: 11ms ▪ Number of shocks: 8 per direction ▪ Number of directions: 6 (±X, ±Y, ±Z) • Shock Test 2: ▪ Wave form: Half sine ▪ Peak acceleration: 100G ▪ Duration: 6ms ▪ Number of shocks: 3 per direction ▪ Number of directions: 6 (±X, ±Y, ±Z)
	Operating conditions: Un-powered
	Duration: 72 hours

7.4.6. Handling Resistance Stress Tests

The following tests the SL9090's resistance to handling malfunctions and damage.

Table 81. Handling Resistance Stress Tests

Designation	Condition
ESDC Test 	Standard: JESD22-A114, JESD22-A115, JEDEC JESD 22 – C101C
	Special conditions: • HBM (Human Body Model) : 2KV (Class 2) • MM (Machine Model) : 200V (Class B) • CDM (Charged Device Model) : 500V (Class III)
	Operating conditions: Powered
	Duration: 24 hours

Designation	Condition
ESD Test 	Standard: IEC 1000-4-2
	Special conditions: • Contact and Air discharges: 10 positive and 10 negative applied • Contact Voltage: ±2kV, ±4kV, ±6kV • Air Voltage : ±2kV, ±4kV, ±8kV
	Operating conditions: Powered
	Duration: 24 hours
Free Fall Test **FFT 1** 	Standard : IEC 60068-2-32, Test Ed
	Special conditions: • Drop: 2 samples for each direction • Equivalent drop height: 1m • Number of directions: 6 (±X, ±Y, ±Z) • Number of drops/face: 2
	Operating conditions: Un-powered
	Duration: 24 hours
Free Fall Test **FFT 2** 	Standard : Standard Sierra Wireless Methodology
	Special conditions: • Drop: 2 samples for each direction • Equivalent drop height: 1.5m • Number of directions: 6 (±X, ±Y, ±Z) • Number of drops/face: 2 • DUT in end-user host device
	Operating conditions: Un-powered
	Duration: 24 hours

8. Design Guidelines

This section provides general design guidelines for the AirPrime SL9090 Embedded Module.

Note:	*This is a non-exhaustive list of suggested design guidelines. The developer is responsible for deciding whether to implement these guidelines.*

For industrial assembly guidelines, refer to document [2] AirPrime SL Series Customer Process Guideline.

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 SL9090 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 SL9090 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 3.4 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 section 8.7.3 RF Circuit.

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 SL9090 Embedded Module. A 4-layer through-hole type PCB structure can be used.

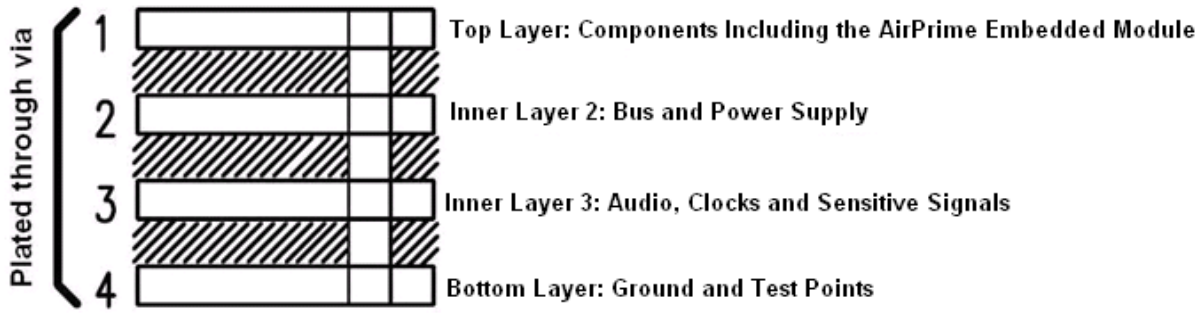


Figure 22. PCB Structure Example for the Application Board

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 document [2] AirPrime SL Series Customer Process Guideline.

8.7. Routing Constraints

8.7.1. Power Supply

Since the maximum peak current can reach 2A, 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 SL9090 Embedded Module supply).

Pins 42 and 44 of the AirPrime SL9090 Embedded Module should be gathered in the same piece of copper, as shown in the figure below.

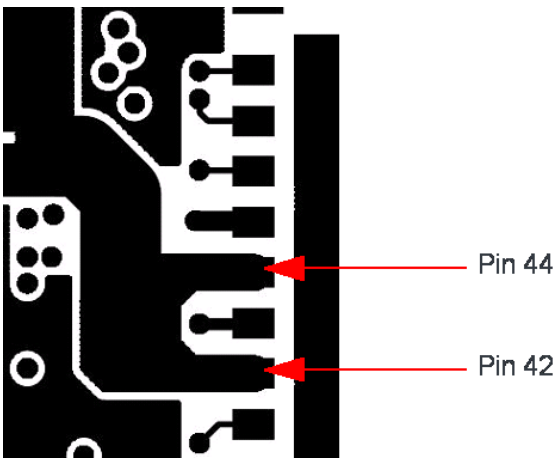


Figure 23. Power Supply Routing Example

Filtering capacitors near the AirPrime SL9090 Embedded Module power supply are also recommended (22µF to 100µF).

Attention should be paid to the ground track or the ground plane on the application board for the power supply which supplies the AirPrime SL9090 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 SL9090 Embedded Module and the power supply is a copper plane, it must not be parcelled 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.

In order to test the supply tracks, a burst simulation circuit is given below. This circuit simulates burst emissions, equivalent to bursts generated when transmitting at full power.

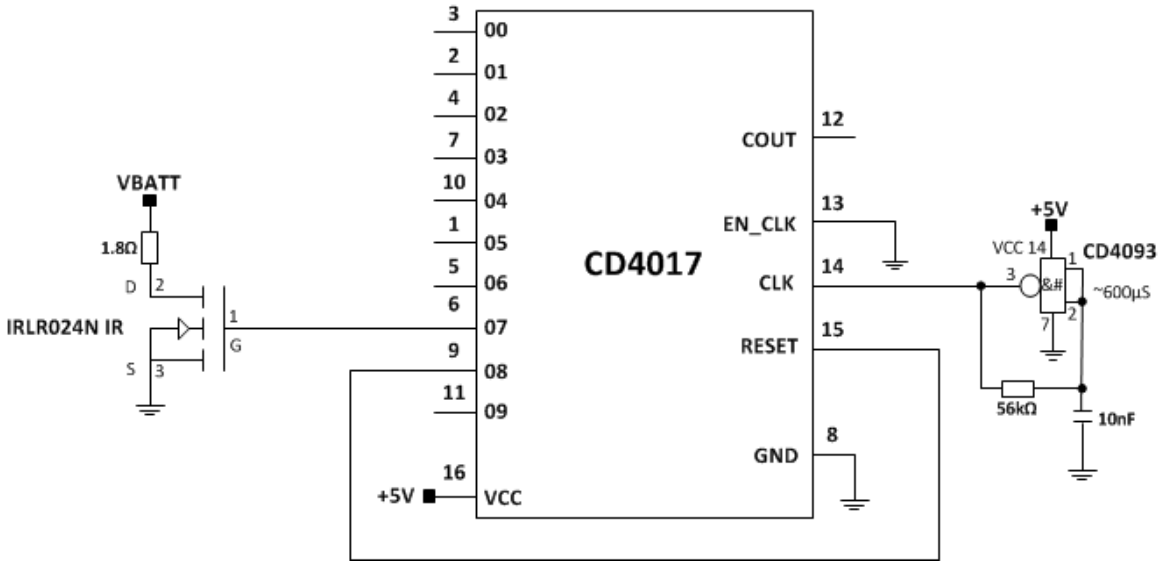


Figure 24. Burst Simulation Circuit

8.7.1.1. Ground Plane and Shielding Connection

The AirPrime SL9090 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 SL9090 Embedded Module. The bottom side shielding of the AirPrime SL9090 Embedded Module is achieved by soldering the ground plane of the application board and the AirPrime SL9090 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 SL9090 Embedded Module, a complete ground plane layer on the application board must be available, with no trade-offs. 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 section 8.6 Recommended PCB Landing Pattern.

8.7.2. SIM Interface

The length of the tracks between the AirPrime SL9090 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 SIM_VCC signal must be placed as close as possible to the DALC208SC6 component on the PCB (see section 4.5.5 Configure the UART Interface).

8.7.3. RF Circuit

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

Basically, the characteristic impedance depends on the dielectric, the track width and the ground plane spacing.

In order to respect this constraint, Sierra Wireless recommends using MicroStrip or StripLine structure and computing the Tracks width with a simulation tool (like AppCad shown in the figure below and that is available free of charge at http://www.agilent.com).

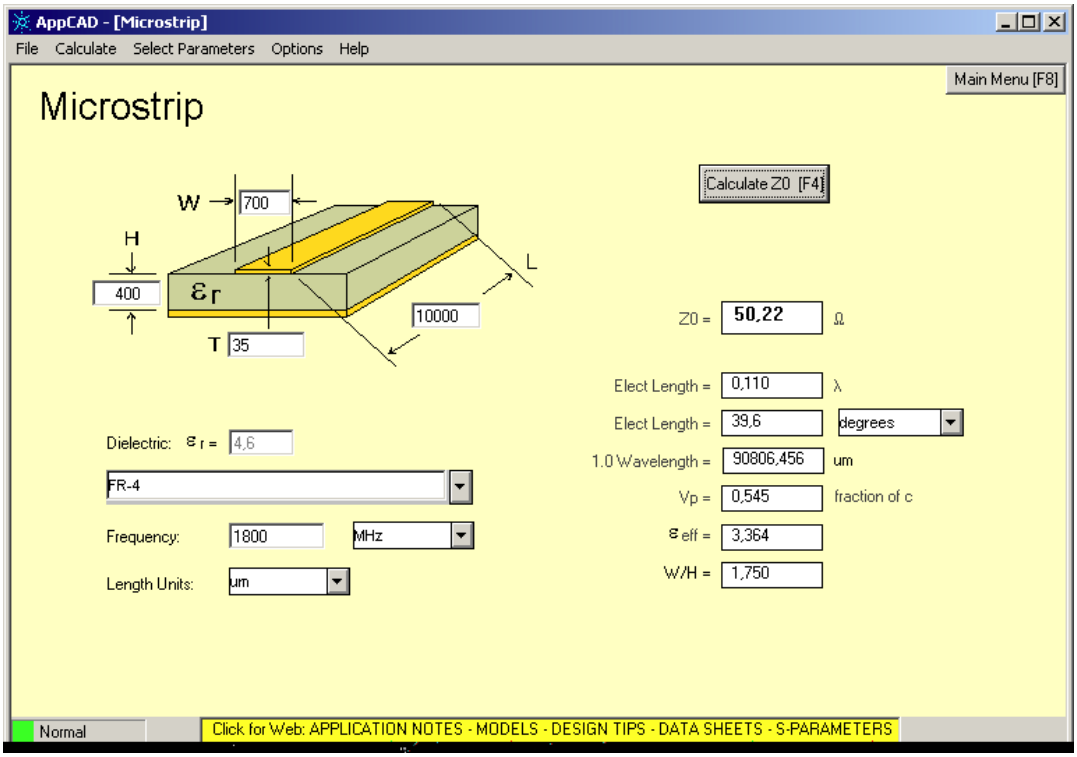


Figure 25. AppCad Screenshot for MicroStrip Design

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.

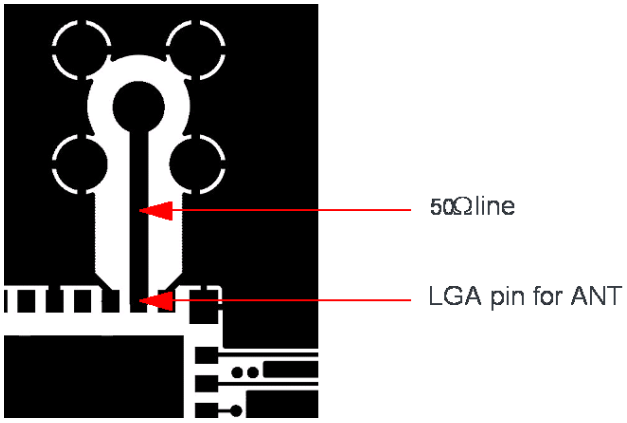


Figure 26. Routing Example

Stripline and Coplanar design requires having a correct ground plane at both sides. Consequently, it is necessary to add some vias along the RF path.

It is recommended to use Stripline design if the RF path is fairly long (more than 3cm), since MicroStrip design is not shielded. Consequently, the RF signal (when transmitting) may interfere with neighbouring electronics (AF amplifier, etc.). In the same way, the neighbouring electronics (micro-controllers, etc.) may degrade the reception performances.

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

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
  - USB
  - Antenna Port

  The selection of the ESD diode on the Antenna Port should prevent any degradation in the RF performance. One of the suggested ESD diodes is listed below:

  Manufacturer: INNOCHIPS TECHNOLOGY CO.

  Part Number: ULCE0505A015FR
- 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 SL9090 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 82 ESD Specifications.

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

Table 82. ESD Specifications

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

8.9. Mechanical Integration

Attention should be paid to:

- Antenna cable integration (bending, length, position, etc)
- Leads of the AirPrime SL9090 Embedded Module to be soldered to the ground plane

8.10. Operating System Upgrade

The AirPrime SL9090 Embedded Module Operating System is stored in flash memory and can be easily upgraded.

Tip: *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 document [7] AirCard/AirPrime USB Driver Developer's Guide). Therefore, the application shall either allow a direct access to the embedded module serial interface 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 documents [5] AirCard/AirPrime UMTS Supported AT Command Reference and [6] AirPrime MC/SL Series (UMTS/LTE) Extended AT Command Reference.

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

9.2. Integration Requirements

When integrating the SL9090 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 section 10 Certification Compliance and Recommended Standards
- Service provisioning — Manufacturing process

Sierra Wireless provides guidelines for successful SL9090 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).

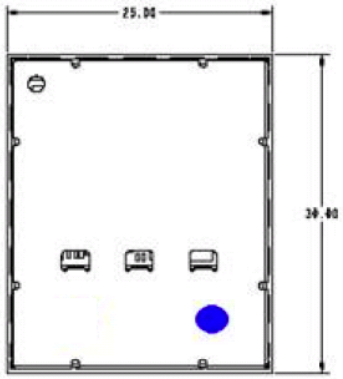


Figure 27. Recommended Thermocouple Location

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 damaging the module's components.

9.5. Serial Link Access

Direct access to the UART1 serial link is very useful for:

- Testability operations
- Firmware download (for more information on firmware upgrade, see section 3.7 SED (Smart Error Detection)

To allow that access, refer to Figure 7 UART RS-232 Level Shifter Implementation.

9.6. RF Output Accessibility

During the integration phase of the AirPrime SL9090 Embedded Module, it can be helpful to connect the AirPrime SL9090 Embedded Module to a WCDMA/HSDPA/HSUPA/GSM/GPRS simulator in order to check critical RF TX parameters and power behaviour.

Although the AirPrime SL9090 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 SL9090 is designed to be compliant with the 3GPP Release 6 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 SL9090 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 SL9090 (as defined by this document) are not supported.

10.2. CDMA Compliance Certification

10.2.1. CDG2

Testing with other infrastructure providers will be conducted as necessary to achieve Network Operator approvals for host platforms. Sierra Wireless will provide the CDG 2 modem test reports to Integrators, which can be provided to Network Operators as part of their CDG 3/approval requirements. Some Network Operators may require regression testing of your finished unit at one or more infrastructure vendor(s).

10.2.2. CDG3

The Integrator is responsible for testing the finished system. The test process will be determined with the chosen Network Operator(s) and depends on the Integrator's business relationship with them as well as the product's application and sales channel strategy. Sierra Wireless offers assistance to Integrators with the CDG-3 testing process, if required.

10.3. Certification Compliance

Tests that require features not supported by the SL9090 (as defined by this document) are not supported.

Table 83. Standards Conformity for the SL9090 Embedded Module

Domain	Applicable Standard
Safety standard	EN 60950-1 (ed.2006)
FCC	FCC Part 22, 24
IC	RSS-132 Issue 2 RSS-133 Issue 5

Domain	Applicable Standard
EMC	EN 301 489-1 (v1.8.1) EN 301 489-7 (v1.3.1) EN 301 489-24 (v1.5.1)
EU	CE Mark regulatory certification of compliance Interoperability Testing (IOT) CE / GCF-CC
A-Tick certification	TBC
CDG2/IOT	Alcatel Lucent Ericsson Motorola
North / Latin America operators / carriers	PTCRB approval per NAPRD requirement AT&T Verizon Sprint

10.4. Applicable Standards

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

10.4.1. 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.

10.4.2. Safety and Hazards

Do not operate your AirPrime SL9090 Embedded Module modem:

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

In such areas, the SL9090 modem **MUST BE POWERED OFF**. Otherwise, the SL9090 modem can transmit signals that could interfere with this equipment. In an aircraft, the SL9090 modem **MUST BE POWERED OFF**. Otherwise, the SL9090 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 SL9090 modem may be used normally at this time.

10.4.3. Important Compliance Information for North American Users

The SL9090 modem has been granted modular approval for mobile applications. Integrators may use the SL9090 modem in their final products without additional FCC/IC (Industry Canada) certification if they meet the following conditions. Otherwise, additional FCC/IC approvals must be obtained.

1. At least 20 cm separation distance between the antenna and the user's body must be maintained at all times.
2. To comply with FCC/IC regulations limiting both maximum RF output power and human exposure to RF radiation, the maximum antenna gain including cable loss in a mobile-only exposure condition must not exceed 7.5 dBi in the cellular band and 3.5 dBi in the PCS band.
3. The SL9090 modem and its antenna must not be co-located or operating in conjunction with any other transmitter or antenna within a host device.
4. Refer to section 8.7.3 RF Circuit for RF signal conditions.
5. A label must be affixed to the outside of the end product into which the SL9090 modem is incorporated, with a statement similar to the following:

   This device contains FCC ID: N7NSL9090

   This equipment contains equipment certified under IC: 2417C-SL9090
6. A user manual with the end product must clearly indicate the operating requirements and conditions that must be observed to ensure compliance with current FCC/IC RF exposure guidelines.

The end product with an embedded SL9090 modem may also need to pass the FCC Part 15 unintentional emission testing requirements and be properly authorized per FCC Part 15.

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

10.4.4. EU Regulatory Conformity

Sierra Wireless hereby declares that the SL9090 modem conforms with all essential requirements of Directive 1999/5/EC.

CE

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
Suite 5, The Hub
Fowler Avenue
Farnborough Business Park
Farnborough, United Kingdom GU14 7JP

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 84. Customizable Features

Name	Description	Default
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
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
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.
UART baudrate	Default UART speed	115200 bps
UART enabled	Defines whether UART port is enabled by default or not	UART enabled

* Only applicable for UMTS.

12. Connector and Peripheral Device References

12.1. JTAG Connector

Sierra Wireless suggests that a MOLEX ZIF connector (MFG#: 0513741072) 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).

13. Signal Reference Schematics

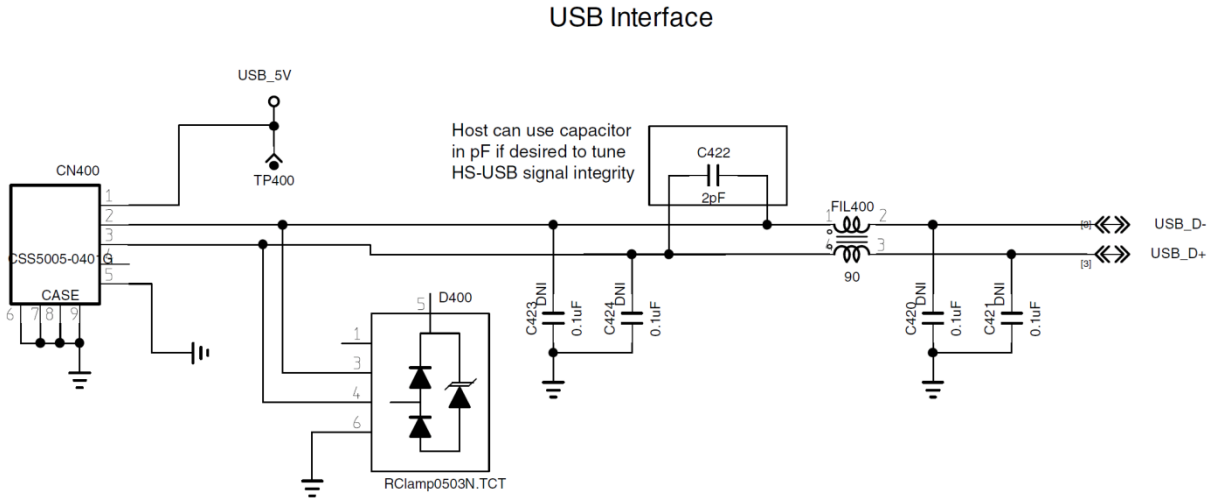


Figure 28. USB Interface

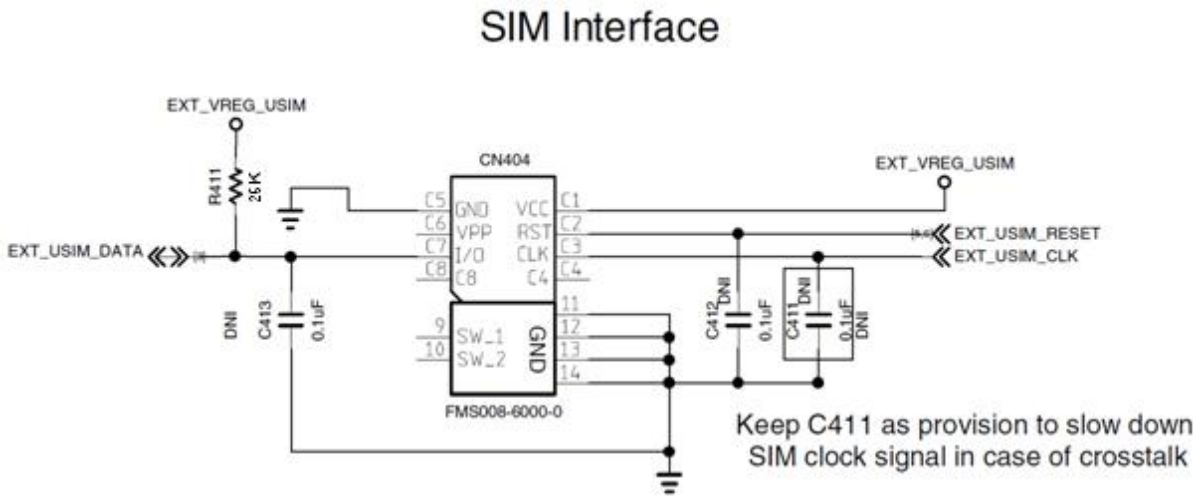


Figure 29. SIM Interface

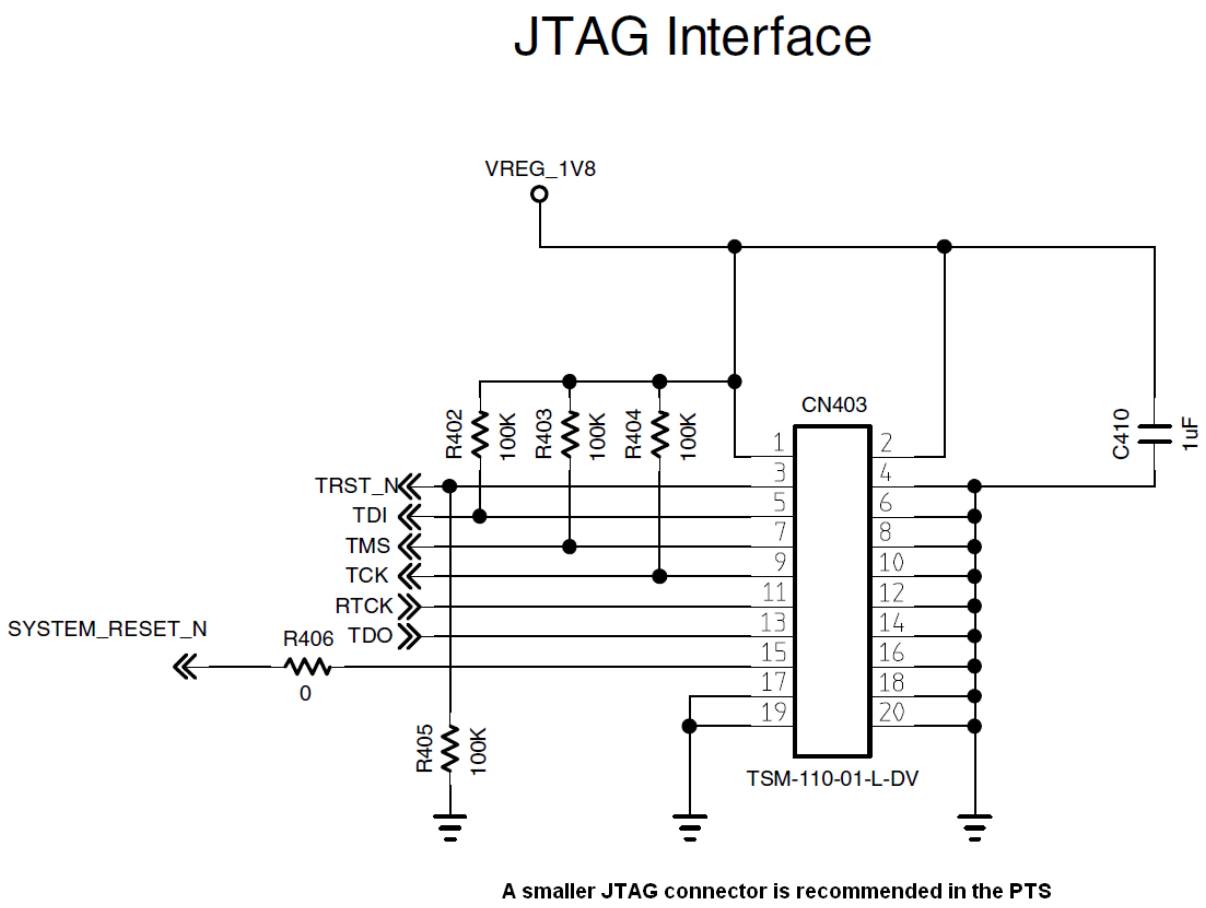


Figure 30. JTAG Interface

14. References

14.1. Web Site Support

For additional documents describing embedded module design, usage, and integration issues, visit the Sierra Wireless Developer Zone at http://developer.sierrawireless.com/.

14.2. Reference Documents

14.2.1. Sierra Wireless Documentation

The following Sierra Wireless documents are provided in the Sierra Wireless documentation package, or are available from http://developer.sierrawireless.com/.

[1] AirPrime SL Series Mechanical Socket Development Kit Quick Start Guide

Reference: 4112314

[2] AirPrime SL Series Customer Process Guideline

Reference: WM_DEV_LG_PTS_001

[3] AirPrime SL Series Migration Guide

Reference: 4112055

[4] AirPrime SL9090 QMI Command Reference

Reference: TBD

[5] AirCard/AirPrime UMTS Supported AT Command Reference

Reference: 2130617

[6] AirPrime MC/SL Series (UMTS/LTE) Extended AT Command Reference

Reference: 2130616

[7] AirCard/AirPrime USB Driver Developer's Guide

Reference: 2130634

[8] Sierra Wireless Reliability Specification

Reference: 4110485

14.2.2. Industry/ Other Documentation

[9] Universal Serial Bus Specification, Rev 2.0

[10] 3GPP TS 34.108

14.3. List of Abbreviations

Abbreviation	Definition
AC	Alternative Current
ADC	Analog to Digital Converter
A/D	Analog to Digital conversion
AF	Audio-Frequency
AT	Attention (prefix for modem commands)
AUX	Auxiliary
CAN	Controller Area Network
CB	Cell Broadcast
CEP	Circular Error Probable
CLK	Clock
CMOS	Complementary Metal Oxide Semiconductor
CS	Coding Scheme
CTS	Clear To Send
DAC	Digital to Analogue Converter
dB	Decibel
DC	Direct Current
DCD	Data Carrier Detect
DCE	Data Communication Equipment
DCS	Digital Cellular System
DR	Dynamic Range
DSR	Data Set Ready
DTE	Data Terminal Equipment
DTR	Data Terminal Ready
EDGE	Enhance Data rates for GSM Evolution
EFR	Enhanced Full Rate
E-GSM	Extended GSM
EGPRS	Enhance GPRS
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EMS	Enhanced Message Service
EN	Enable
ESD	Electrostatic Discharges
FIFO	First In First Out
FR	Full Rate
FTA	Full Type Approval
GND	Ground
GPI	General Purpose Input
GPC	General Purpose Connector
GPIO	General Purpose Input Output
GPO	General Purpose Output
GPRS	General Packet Radio Service

Abbreviation	Definition
GPS	Global Positioning System
GSM	Global System for Mobile communications
HR	Half Rate
I/O	Input / Output
LED	Light Emitting Diode
LGA	Land Grid Array
LNA	Low Noise Amplifier
MAX	Maximum
MIC	Microphone
MIN	Minimum
MMS	MultiMedia Message Service
MO	Mobile Originated
MT	Mobile Terminated
na	Not Applicable
NC	Not Connected
NF	Noise Factor
NMEA	National Marine Electronics Association
NOM	Nominal
NTC	Negative Temperature Coefficient
PA	Power Amplifier
Pa	Pascal (for speaker sound pressure measurements)
PBCCH	Packet Broadcast Control Channel
PC	Personal Computer
PCB	Printed Circuit Board
PDA	Personal Digital Assistant
PFM	Power Frequency Modulation
PSM	Phase Shift Modulation
PWM	Pulse Width Modulation
RAM	Random Access Memory
RF	Radio Frequency
RFI	Radio Frequency Interference
RHCP	Right Hand Circular Polarization
RI	Ring Indicator
RST	Reset
RTC	Real Time Clock
RTCM	Radio Technical Commission for Maritime services
RTS	Request To Send
RX	Receive
SCL	Serial Clock
SDA	Serial Data
SIM	Subscriber Identification Module
SMS	Short Message Service
SPI	Serial Peripheral Interface

Abbreviation	Definition
SPL	Sound Pressure Level
SPK	Speaker
SRAM	Static RAM
TBC	To Be Confirmed
TDMA	Time Division Multiple Access
TP	Test Point
TVS	Transient Voltage Suppressor
TX	Transmit
TYP	Typical
UART	Universal Asynchronous Receiver-Transmitter
USB	Universal Serial Bus
USSD	Unstructured Supplementary Services Data
VSWR	Voltage Standing Wave Ratio

15. Safety Recommendations (For Information Only)

For the efficient and safe operation of your GSM application based on the AirPrime SL9090 Embedded Module, please read the following information carefully.

15.1. RF Safety

15.1.1. 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.

15.1.2. 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.

15.1.3. 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.

15.1.4. 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.

15.2. General Safety

15.2.1. 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.

15.2.2. 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.

15.2.3. Vehicle Electronic Equipment

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

15.2.4. 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.

15.2.5. 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.

15.2.6. 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.

15.2.7. 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.

15.2.8. 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.

SIERRA
WIRELESS