Product Technical Specification & Customer Design Guidelines

AirPrime SL6087

SIERRA WIRELESS

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8.0
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Document History

Version	Date	Updates
001	May 18, 2010	Creation
002	August 31, 2010	Updated section 12 Certification Compliance and Recommended Standards.
		Removed battery charging information throughout the document, renamed AUX-ADC to ADC2 and BAT-TEMP to ADC1 throughout the document.
		Updated Table 3 Input Power Supply Voltage, Figure 3 Power Supply Ripple Graph and section 3.1.2 Start-Up Current.
		Updated section 5.4.3.1 Super Capacitor.
		Deleted section 13.2.6 Application Notes (these application notes no longer exist).
		Added a note in sections 6 Power Consumption and 7.2.1 Embedded Module Configuration regarding entering Sleep Mode.
		Updated UART1 voltage tolerance.
		Added section 4.13 JTAG Interface.
		Updated Table 7 LGA Pads Description and Figure 7 AirPrime SL6087 Embedded Module Pin Configuration (top view, through component).
		Deleted section 10.3 Debug Access.
		Updated section 5.10 Reserved, added Figure 53 Reserved_41 Pulled Up to VCC_2V8 Through an NC Resistor.
		Added section 5.9.3 ADC Measurements Using AT Command.
		Deleted the last sentence “After a reset (hardware or software), if the ON/~OFF signal is OFF (low level), the AirPrime SL6087 Embedded Module switches OFF.” in section 5.1.3 Power-ON.
		Added a note in Table 12 GPIO Pin Description, specifying which GPIO is associated with AT+WTBI.
		Updated Figure 1 Functional Architecture.
003	August 09, 2011	Added additional external interrupt pins in the following tables: • Table 7 LGA Pads Description • Table 12 GPIO Pin Description • Table 18 UART1 Pin Description • Table 19 UART2 Pin Description • Table 47 External Interrupt Pin Description • Table 48 Electrical Characteristics of the External Input/Interrupt
		Updated Table 58 Power Consumption Without the Open AT Application Framework; Typical Values
		Updated sections 15.2.7 and 15.2.8 for ATEX compliance.
004	October 12, 2011	Added section 13 ATEX Specifications; moved section 3.4 to section 13.3 Conformance with ATEX 94/9/CE Directive.
4.1	January 31, 2012	Updated the document’s reference number.
5.0	March 28, 2012	Updated: • Table 1 SL6087 Embedded Module Features • Figure 5 SL6087 Embedded Module Mechanical Drawing • Table 7 LGA Pads Description

Version	Date	Updates
6.0	August 10, 2012	Updated the Reset State for pin 46 (CT104-RXD2) and pin 47 (~CT106-CTS2) in the following tables: • Table 7 LGA Pads Description • Table 12 GPIO Pin Description • Table 19 UART2 Pin Description • Table 47 External Interrupt Pin Description
7.0	October 26, 2012	Updated: • Reference documents in section 14.2 Reference Documents • Product name (from Sierra Wireless Software Suite to Open AT Application Framework) • Figure 15 Example of an RS-232 Level Shifter Implementation for UART1 • Resolution of figures throughout the document
8.0	February 04, 2013	Added ADC3 restriction in section 4.12 Temperature Sensor Interface

Contents

List of Figures

List of Tables

1. Introduction

The AirPrime SL6087 Intelligent Embedded Module is a self-contained E-GSM/DCS/GSM850/PCS-GPRS/EGPRS 900/1800/850/1900 quad-band embedded module. It supports the Open AT Application Framework, the world's most comprehensive cellular development environment which allows embedded standard ANSI C applications to be natively executed directly on the embedded module. For more information about the Open AT Application Framework, refer to the documents listed in section 14.1 Web Site Support.

Note that this document only covers the AirPrime SL6087 Embedded Module and does not cover the programmable capabilities available through Open AT Application Framework.

1.1. Physical Dimensions

- Length: 30.0mm
- Width: 25.0mm
- Thickness: 2.65mm (excluding label thickness)
- Weight: 3.8g

1.2. General Features

The following table lists the AirPrime SL6087 Embedded Module features.

Table 1. SL6087 Embedded Module Features

Feature	Description
Shielding	The AirPrime SL6087 Embedded Module has complete body shielding.
Embedded Module Control	• Full set of AT commands for GSM/GPRS/EGPRS including GSM 07.07 and 07.05 AT command sets • Status indication for GSM
GSM/DCS Output Power	• Class 4 (2 W) for GSM 850 and E-GSM • Class 1 (1 W) for DCS and PCS
GPRS	• GPRS multislot class 10 • Multislot class 2 supported • PBCCH support • Coding schemes: CS1 to CS4
EGPRS	• EGPRS multislot class 10 • Multislot class 2 supported • PBCCH support • Coding schemes MCS1 to MCS9
Voice	• GSM Voice Features with Emergency calls 118 XXX • Full Rate (FR)/ Enhanced Full Rate (EFR) / Half Rate (HR) / Adaptive Multi Rate (AMR) • Echo cancellation and noise reduction • Full duplex Hands free

Feature	Description
SMS	• SMS MT, MO • SMS CB • SMS storage into SIM card
GSM Supplementary Services	• Call Forwarding, Call Barring • Multiparty • Call Waiting, Call Hold • USSD
Data/Fax	• Data circuit asynchronous, transparent, and non-transparent up to 14400 bits/s • Fax Group 3 compatible
SIM Interface	• 1.8V/3V SIM interface • 5V SIM interfaces are available with external adaptation • SIM Tool Kit Release 99
Real Time Clock	Real Time Clock (RTC) with calendar and alarm

1.3. GSM/GPRS/EGPRS Features

- 2-Watt EGSM – GPRS 900/850 radio section running under 3.6 volts
- 1-Watt GSM – GPRS1800/1900 radio section running under 3.6 volts
- 0.5-Watt EGPRS 900/850 radio section running under 3.6 volts
- 0.4-Watt EGPRS 1800/1900 radio section running under 3.6 volts
- Hardware GSM/GPRS class 10 and EGPRS class 10 capable

1.4. Interfaces

- Digital section running under 2.8V and 1.8V
- 3V/1V8 SIM interface
- Complete Interfacing:
  - Power supply
  - Serial link
  - Analog audio
  - PCM digital audio
  - SIM card
  - USB 2.0 slave
  - Serial LCD (not available with AT commands)

1.5. Operating System

- Real Time Clock (RTC) with calendar
- Echo cancellation + noise reduction (quadri codec)
- Full GSM or GSM/GPRS/EGPRS Operating System stack

1.6. Connection Interfaces

The SL6087 Embedded Module has a 74-solderable pad LGA form factor that includes:

- One RF connection pad (antenna connection)
- Baseband signals connection

1.7. Environment and Mechanics

1.7.1. RoHS Directive Compliant

The AirPrime SL6087 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 SL6087 Embedded Module is described in the figure below.

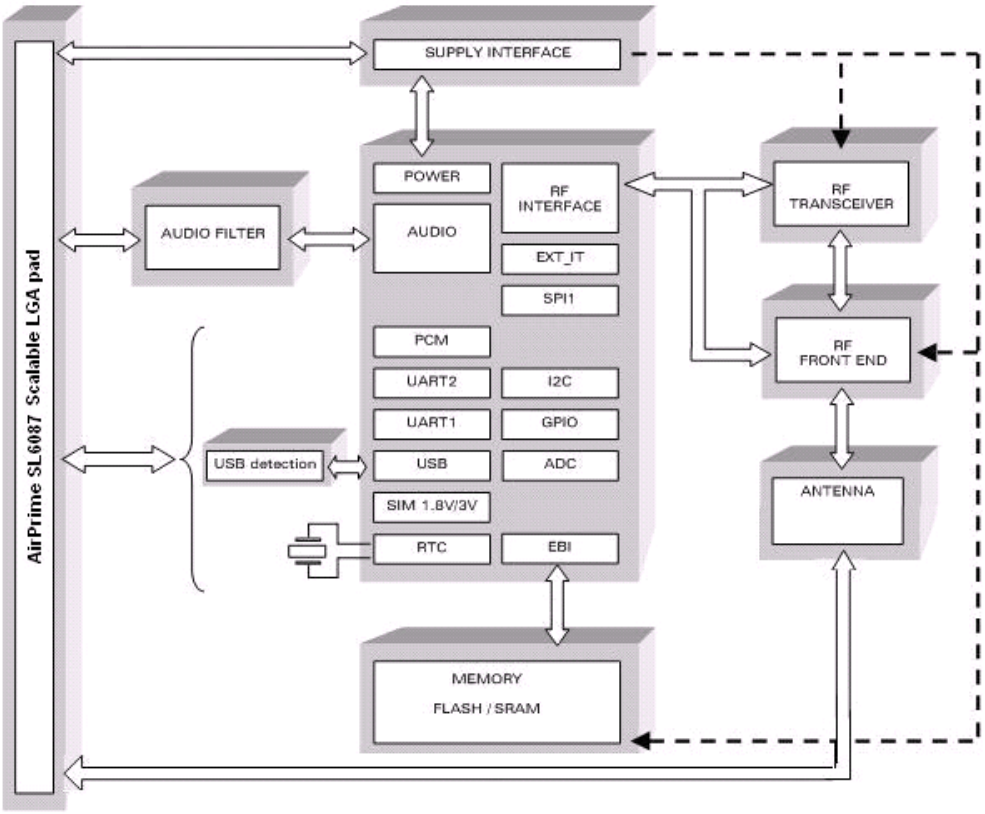


Figure 1. Functional Architecture

2.1.1. RF Functionalities

The Radio Frequency (RF) functionalities of the AirPrime SL6087 Embedded Module complies with the Phase II EGSM 900/DCS 1800 and GSM 850/PCS 1900 recommendations. The frequency range for the transmit band and receive band are given in the table below.

Table 2. List of RF Frequency Ranges

RF Bandwidth	Transmit Band (Tx)	Receive Band (Rx)
GSM 850	824 to 849 MHz	869 to 894 MHz
E-GSM 900	880 to 915 MHz	925 to 960 MHz
DCS 1800	1710 to 1785 MHz	1805 to 1880 MHz
PCS 1900	1850 to 1910 MHz	1930 to 1990 MHz

The Radio Frequency (RF) component is based on a specific quad-band chip that includes the following:

- Quad-band LNAs (Low Noise Amplifier)
- Direct Conversion Receiver
- Offset PLL/PL (Phase Locked Loop and Polar Loop) transmitter
- Frequency synthesizer
- Digitally controlled crystal oscillator (DCXO)
- Tx/Rx FEM (Front-End module) for quad-band GSM/GPRS/EGPRS

2.1.2. Baseband Functionalities

The digital part of the AirPrime SL6087 Embedded Module is composed of a **PCF5213 PHILIPS** chip. This chipset uses a 0.18µm mixed technology CMOS, which allows massive integration as well as low current consumption.

2.2. Operating System

The AirPrime SL6087 Embedded Module is Open AT Application Framework compliant. With the Open AT Application Framework and the AirPrime SL6087 Embedded Module, customers can embed their own applications with the AirPrime SL6087 and turn the AirPrime SL6087 embedded module into a solution for their specific market need.

The operating system allows for the AirPrime SL6087 Embedded Module to be controlled by AT commands. However, some interfaces in the AirPrime SL6087 Embedded Module may still not be available even with AT command control as these interfaces are dependent on the peripheral devices connected to the AirPrime SL6087 Embedded Module.

3. Technical Specifications

3.1. Power Supply

The power supply is one of the key issues in the design of a GSM terminal. Due to the burst emission in GSM/GPRS, the power supply must be able to deliver high current peaks in a short time. During these peaks, the ripple (U_{ripp}) on the supply voltage must not exceed a certain limit (refer to Table 3 Input Power Supply Voltage).

Listed below are the corresponding radio burst rates in connected mode:

- GSM/GPRS class 2 terminals emit 577µs radio bursts every 4.615ms (see Figure 2 Power Supply During Burst Emission)
- GPRS class 10 terminals emit 1154µs radio bursts every 4.615ms

In connected mode, the RF Power Amplifier current (2.0A peak in GSM /GPRS mode) flows with a ratio of:

- 1/8 of the time (around 577µs every 4.615ms for GSM /GPRS cl 2 – 2RX/1TX)

  and

- 2/8 of the time (around 1154µs every 4.615ms for GSM /GPRS cl 10 – 3RX/2TX)

  with the rising time at around 10µs.

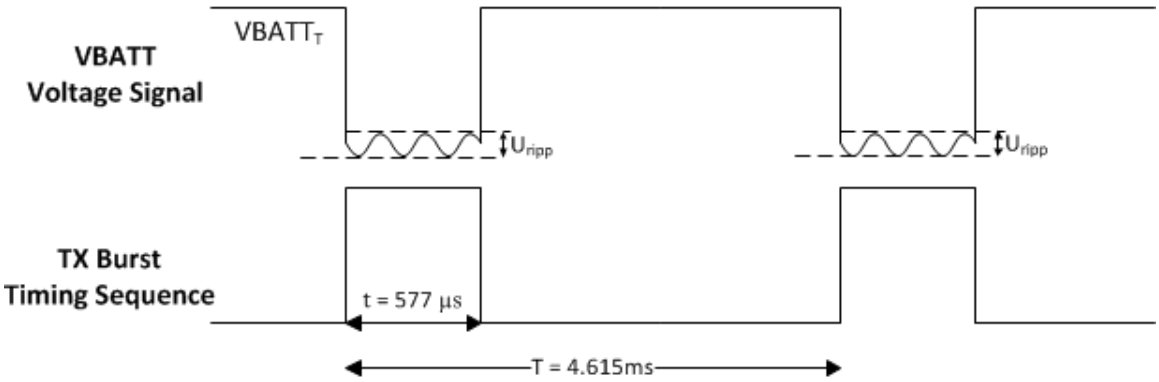


Figure 2. Power Supply During Burst Emission

Only VBATT (external power supply source) input is necessary to supply the AirPrime SL6087 Embedded Module. VBATT also provides for the following functions:

- Directly supplies the RF components with 3.6V. (Note that it is essential to keep a minimum voltage ripple at this connection in order to avoid any phase error or spectrum modulation degradation. On the other hand, insufficient power supply could dramatically affect some RF performances such as TX power, modulation spectrum, EMC performance, spurious emission and frequency error.)
- Internally used to provide through several regulators, the power supplies VCC_2V8 and VCC_1V8, which are needed for the baseband signals.

The AirPrime SL6087 Embedded Module shielding case is the grounding. The ground must be connected on the motherboard through a complete layer on the PCB.

The following table describes the electrical characteristics of the input power supply voltage that will guarantee nominal functioning of the AirPrime SL6087 Embedded Module.

Table 3. Input Power Supply Voltage

	V_{MIN}	V_{NOM}	V_{MAX}	Ripple Max (U_{ripp})	I_{peak} Max
VBATT	3.2V[1,2]	3.6V	4.8V	390mVpp (freq < 10kHz) 80mVpp (10kHz < freq < 200kHz) 10mVpp (freq > 200kHz)	2.0A

1: This value must be guaranteed during the burst (with 2.0A Peak in GSM, GPRS or EGPRS mode)

2: Maximum operating Voltage Standing Wave Ratio (VSWR) 2:1.

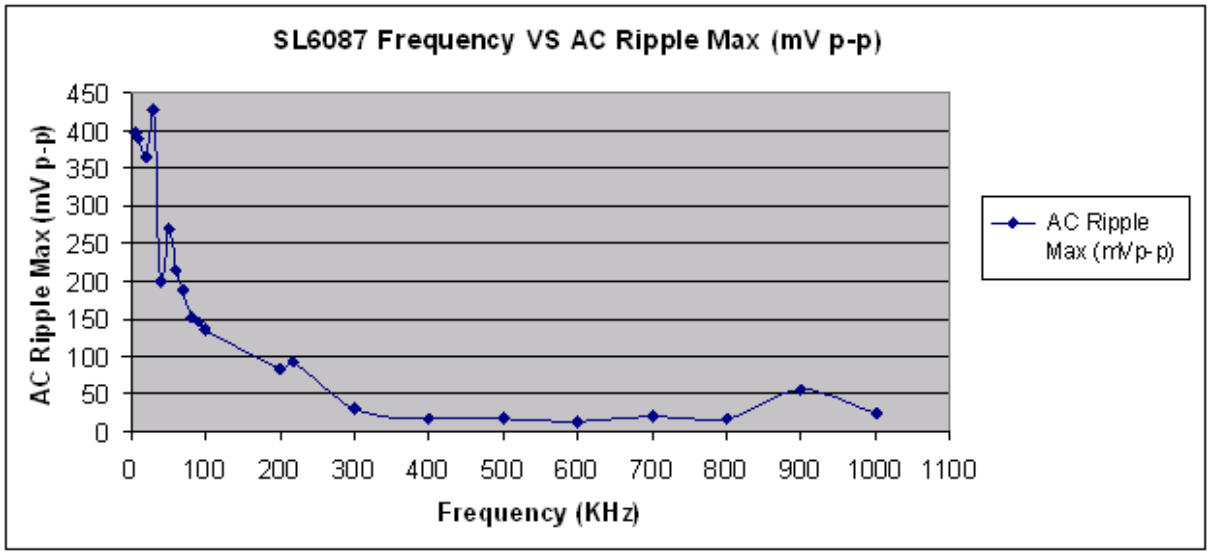


Figure 3. Power Supply Ripple Graph

When the AirPrime SL6087 Embedded Module is supplied with a battery, the total impedance (battery + protections + PCB) should be less than 150 mΩ.

Caution: *When the AirPrime SL6087 embedded module is in Alarm mode or Off mode, no voltage has to be applied on any pin of the 74-pin connector except on VBATT (pins 42 and 44), BAT-RTC (pin 3) for RTC operation or ON/~OFF (pin 43) to power-ON the AirPrime SL6087 embedded module.*

3.1.1. Power Supply Pin-Out

Table 4. Power Supply Pin-Out

Signal	Pin Number
VBATT	42, 44
GND	21, 23, 25, 28, 30, 52 and the LGA ground pad

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, refer to section 9.6.1.1 Ground Plane and Shielding Connection.

3.1.2. Start-Up Current

During the initial second following Power ON, a peak of current appears. This peak of current is called "$t_{Startup}$ current" and has a duration of about 165ms (typical).

Figure 4: Start-up Current Waveform shows the current waveform and identifies the peak considered as the start-up current.

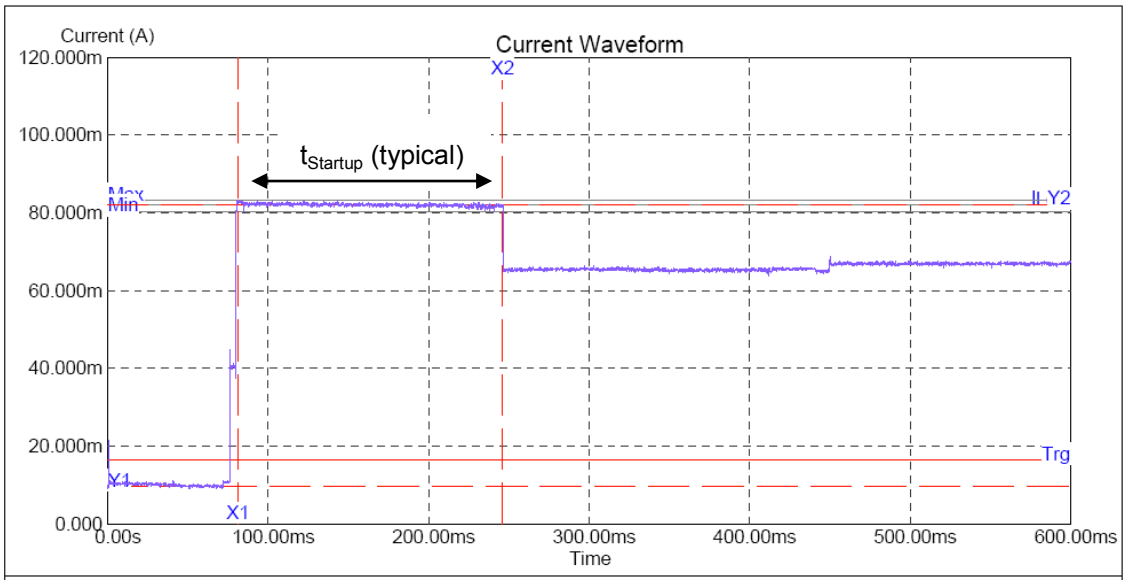


Figure 4. Start-up Current Waveform

In this condition, we can consider the following results:

Table 5. Current Start-Up; Typical Values

Current Peak at Ambient Temperature (25°C)	VBATTmin (3.2V)	VBATTtyp (3.6V)	VBATTmax (4.8V)
$t_{Startup}$	90mA	82mA	65mA

3.1.3. Decoupling of Power Supply Signals

Decoupling capacitors on VBATT lines are embedded in the AirPrime SL6087 Embedded Module, so it should not be necessary to add decoupling capacitors close to the embedded module.

However, in case of EMI/RFI problems, the VBATT signal may require some EMI/RFI decoupling – parallel 33pF capacitors close to the embedded module or a serial ferrite bead (or both to get better results). Low frequency decoupling capacitors (22µF to 100µF) can be used to reduce TDMA noise (217Hz).

Caution: *When ferrite beads are used, the recommendation given for the power supply connection must be carefully followed (high current capacity and low impedance).*

3.2. Mechanical Specifications

The AirPrime SL6087 Embedded Module has a nearly-complete self-contained shield. The mechanical specifications are shown in the figures below, including the area needed for the AirPrime SL6087 Embedded Module to fit in an application.

Also take note that when transmitting, the AirPrime SL6087 Embedded Module produces heat (due to the internal Power Amplifier). This heat will generate a temperature increase and may warm the application board on which the AirPrime SL6087 Embedded Module is soldered. This is especially true for GPRS Class 10 use in low band. The AirPrime SL6087 Embedded Module's built-in

temperature sensor can be used to monitor the temperature inside the module. For more information, refer to section 4.12 Temperature Sensor Interface.

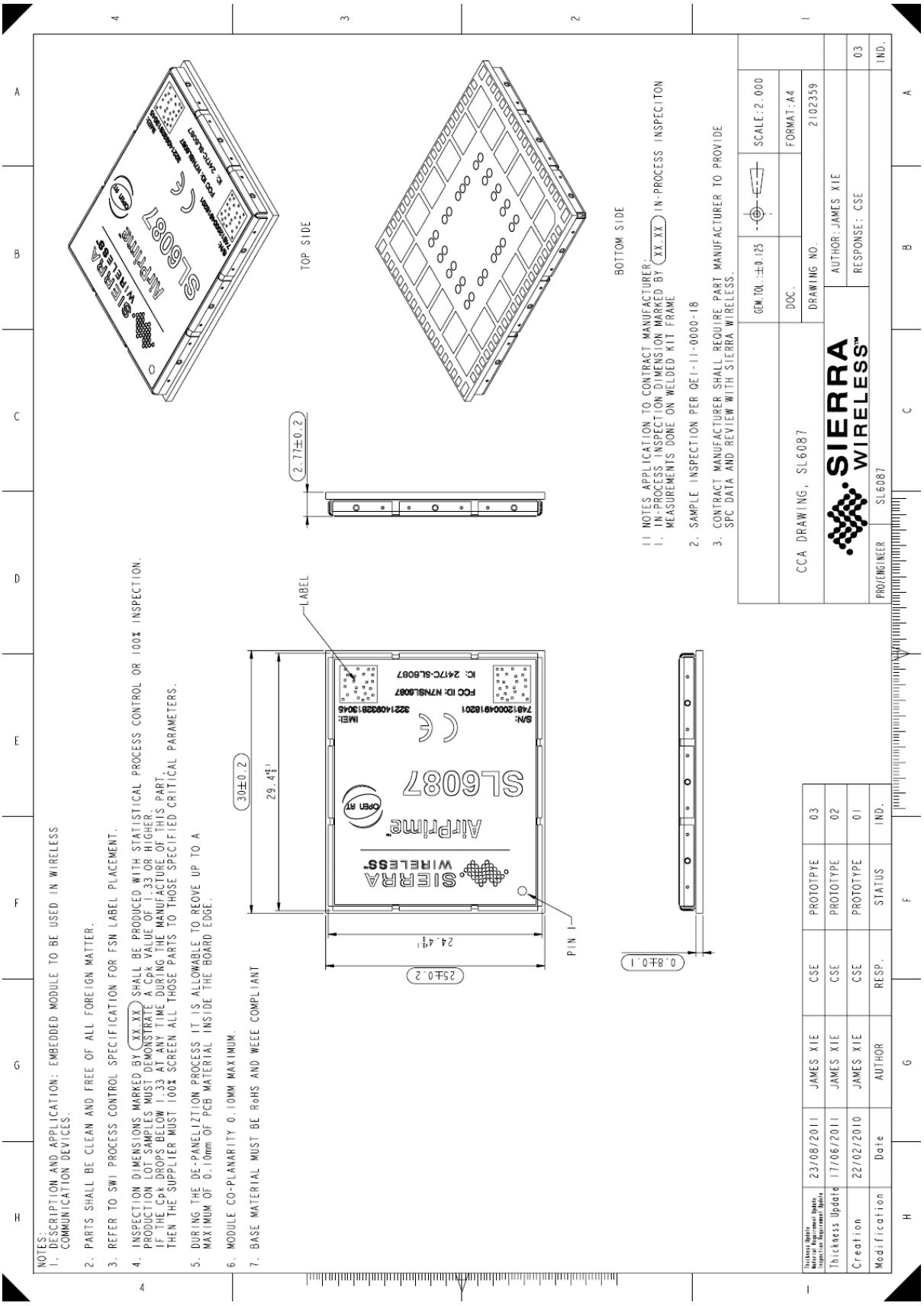


Figure 5. SL6087 Embedded Module Mechanical Drawing

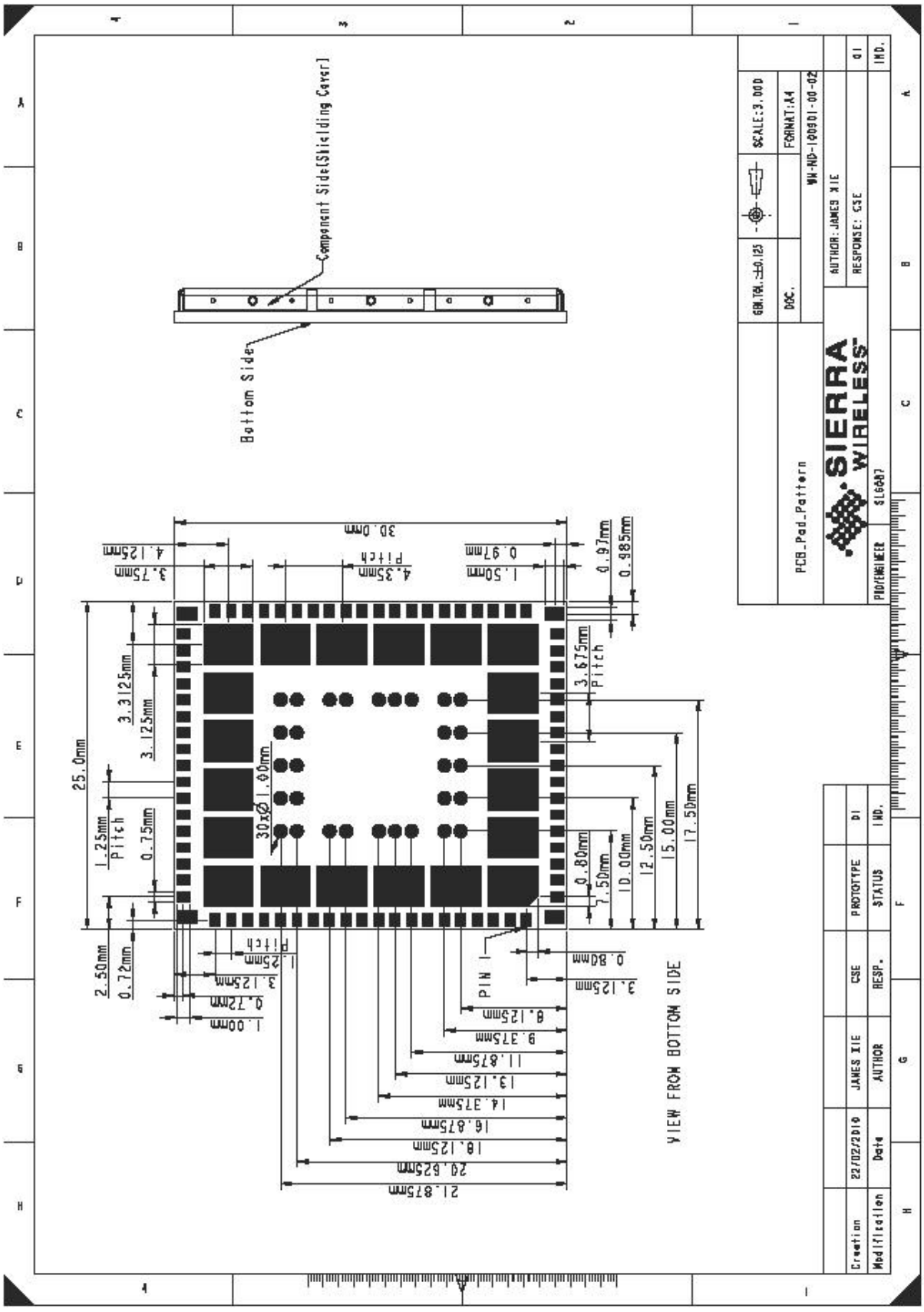


Figure 6. LGA Pin Dimension and Location

3.3. Firmware Upgrade

The firmware upgrade process consists of downloading GSM/GPRS/EGPRS software into the corresponding internal flash memories of the AirPrime SL6087 Embedded Module.

Downloading is done through the GSM Main Serial link port (UART1) connected to a PC using the XMODEM protocol.

A specific AT command, **AT+WDWL**, is used to start the download. For more information, refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5.

Access to the following UART1 main serial link signals are required to carry out downloading:

- CT103-TXD1
- CT104-RXD1
- ~CT106-CTS1
- ~CT105-RTS1
- GND

Consequently, it is very important to plan and define easy access to these signals during the hardware design of the application board. For more information about these signals, refer section 4.5 Main Serial Link (UART1).

4. Interfaces

Caution: *Some of the Embedded Module interface signals are multiplexed in order to limit the number of pins but this architecture includes some restrictions.*

4.1. LGA Pads

A 74-solderable pad LGA design is provided to interface the AirPrime SL6087 Embedded Module with a board containing a serial LCD module; a SIM connector or a battery connection.

The following table lists the interfaces and signals available on the LGA pad and specifies whether these interfaces and signals are driven by AT Command, Open AT® or both.

Table 6. Available Interfaces and Signals

Name	Driven by AT commands	Driven by Open AT®
Serial Interface		✓
Main Serial Link	✓	✓
Auxiliary Serial Link	✓	✓
SIM Interface	✓	✓
General Purpose IO	✓	✓
Analog to Digital Converter	✓	✓
Analog Audio Interface	✓	✓
PWM / Buzzer Output	✓	✓
External Interruption	✓	✓
BAT-RTC (Backup Battery)		
LED0 signal	✓	✓
Digital Audio Interface (PCM)		✓
USB 2.0 Interface	✓	✓

4.1.1. Pin Configuration

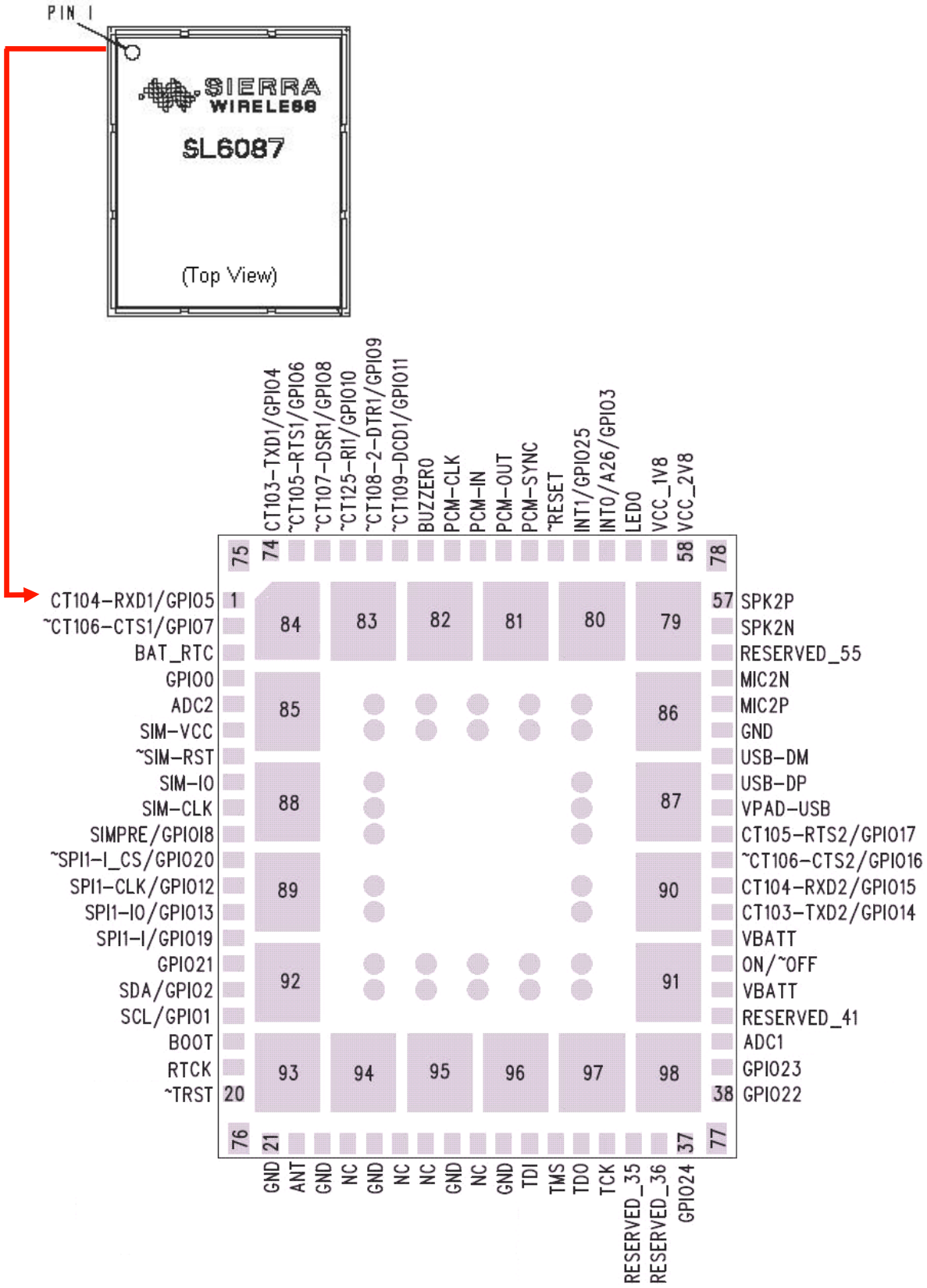


Figure 7. AirPrime SL6087 Embedded Module Pin Configuration (top view, through component)

4.1.2. Pin Description

Refer to the following table for the LGA pads description.

Table 7. LGA Pads Description

Pin #	Signal Name		I/O Type	Voltage	I/O*	Reset State	Description	Dealing with Unused Pins
	Nominal	Mux						
1	CT104-RXD1	GPIO5 / INT2		VCC_2V8	O	1	Main RS232 Receive	(RXD1) Add a test point for firmware update
2	~CT106-CTS1	GPIO7		VCC_2V8	O	Z	Main RS232 Clear To Send	(CTS1) Add a test point for firmware update
3	BAT-RTC			BAT-RTC	I/O		RTC Battery connection	NC
4	GPIO0	32kHz		VCC_2V8	I/O	32 kHz		NC
5	ADC2			Analog	I		Analog to Digital Input	Pull to GND
6	SIM-VCC			1V8 or 3V	O		SIM Power Supply	
7	~SIM-RST			1V8 or 3V	O	0	SIM reset Output	
8	SIM-IO			1V8 or 3V	I/O	Pull-up (about 10kΩ)	SIM Data	
9	SIM-CLK			1V8 or 3V	O	0	SIM Clock	
10	SIMPRES	GPIO18		VCC_1V8	I	Z	SIM Detection	NC
11	~SPI1-I_CS	GPIO20		VCC_2V8	I/O	Z	SPI1 Chip Select	NC
12	SPI1-CLK	GPIO12		VCC_2V8	O	Z	SPI1 Clock	NC
13	SPI1-IO	GPIO13		VCC_2V8	I/O	Z	SPI1 Data Input / Output	NC
14	SPI1-I	GPIO19		VCC_2V8	I	Z	SPI1 Data Input	NC
15	GPIO21			VCC_2V8	I/O	Undefined		NC
16	SDA	GPIO2		Open Drain	I/O	Z	I²C Data	NC
17	SCL	GPIO1		Open Drain	O	Z	I²C Clock	NC

Pin #	Signal Name		I/O Type	Voltage	I/O*	Reset State	Description	Dealing with Unused Pins
	Nominal	Mux						
18	BOOT			VCC_1V8	I		Not Used	Add a test point / a jumper/ a switch to VCC_1V8 (Pin 5) in case Download Specific mode is used (See product specification for details)
19	RTCK			VCC_1V8	O		JTAG return test clock from the ARM JTAG for external debug HW	Add an open connector or a test point. Refer to section 4.13 JTAG Interface for more information on JTAG.
20	~TRST			VCC_1V8	I		JTAG asynchronous reset	Add an open connector or a test point. Refer to section 4.13 JTAG Interface for more information on JTAG.
21	GND							
22	ANT							
23	GND							
24	NC							
25	GND							
26	NC							
27	NC							
28	GND							
29	NC							
30	GND							
31	TDI			VCC_1V8	I		JTAG input data	Add an open connector or a test point. Refer to section 4.13 JTAG Interface for more information on JTAG.
32	TMS			VCC_1V8	I		JTAG test mode select	Add an open connector or a test point. Refer to section 4.13 JTAG Interface for more information on JTAG.

Pin #	Signal Name		I/O Type	Voltage	I/O*	Reset State	Description	Dealing with Unused Pins
	Nominal	Mux						
33	TDO			VCC_1V8	O		JTAG output data	Add an open connector or a test point. Refer to section 4.13 JTAG Interface for more information on JTAG.
34	TCK			VCC_1V8	I		JTAG scan clock	Add an open connector or a test point. Refer to section 4.13 JTAG Interface for more information on JTAG.
35	Reserved_35							
36	Reserved_36							
37	GPIO24			VCC_2V8	I/O	Z		NC
38	GPIO22	**		VCC_2V8	I/O	Z		NC
39	GPIO23	**		VCC_2V8	I/O	Z		NC
40	ADC1			Analog	I		Analog temperature	Pull to GND
41	Reserved_41							
42	ADC0/VBATT			VBATT	I		Power Supply	
43	ON/~OFF			VBATT	I		ON / ~OFF Control	
44	ADC0/VBATT			VBATT	I		Power Supply	
45	CT103-TXD2	GPIO14		VCC_1V8	I	Z	Auxiliary RS232 Transmit	(TXD2) Pull-up to VCC_1V8 with 100kΩ and add a test point for debugging
46	CT104-RXD2	GPIO15 / INT4		VCC_1V8	O	0	Auxiliary RS232 Receive	Add a test point for debugging
47	~CT106-CTS2	GPIO16		VCC_1V8	O	0	Auxiliary RS232 Clear To Send	(CTS2) Add a test point for debugging
48	~CT105-RTS2	GPIO17		VCC_1V8	I	Z	Auxiliary RS232 Request To Send	(RTS2) Pull-up to VCC_1V8 with 100kΩ and add a test point for debugging
49	VPAD-USB			VPAD-USB	I		USB Power supply input	NC

Pin #	Signal Name		I/O Type	Voltage	I/O*	Reset State	Description	Dealing with Unused Pins
	Nominal	Mux						
50	USB-DP			VPAD-USB	I/O		USB Data	NC
51	USB-DM			VPAD-USB	I/O		USB Data	NC
52	GND							
53	MICP			Analog	I		Microphone Input Positive	NC
54	MICN			Analog	I		Microphone Input Negative	NC
55	Reserved_55						Do not connect	NC
56	SPKN			Analog	O		Speaker Output Negative	NC
57	SPKP			Analog	O		Speaker Output Positive	NC
58	VCC_2V8			VCC_2V8	O		2.8V Supply Output	NC
59	VCC_1V8			VCC_1V8	O		1.8V Supply Output	NC
60	LED0			Open Drain	O	1 and Undefined	LED0 Output	NC
61	INT0	GPIO3		VCC_1V8	I	Z	Interruption 0 Input	If INT0 is not used, it should be configured as GPIO
62	INT1	GPIO25		VCC_2V8	I	Z	Interruption 1 Input	If INT1 is not used, it should be configured as GPIO
63	~RESET			VCC_1V8	I/O		RESET Input	NC or add a test point
64	PCM-SYNC			VCC_1V8	O	Pull-down	PCM Frame Synchro	NC
65	PCM-OUT			VCC_1V8	O	Pull-up	PCM Data Output	NC
66	PCM-IN			VCC_1V8	I	Pull-up	PCM Data Input	NC
67	PCM-CLK			VCC_1V8	O	Pull-down	PCM Clock	NC
68	BUZZER0			Open Drain	O	Z	Buzzer Output	NC
69	~CT109-DCD1	GPIO11		VCC_2V8	O	Undefined	Main RS232 Data Carrier Detect	NC
70	~CT108-2-DTR1	GPIO9 / INT3		VCC_2V8	I	Z	Main RS232 Data Terminal Ready	(DTR1) Pull-up to VCC_2V8 with 100kΩ
71	~CT125-RI	GPIO10		VCC_2V8	O	Undefined	Main RS232 Ring Indicator	NC
72	~CT107-DSR1	GPIO8		VCC_2V8	O	Z	Main RS232 Data Set Ready	NC

Pin #	Signal Name		I/O Type	Voltage	I/O*	Reset State	Description	Dealing with Unused Pins
	Nominal	Mux						
73	~CT105-RTS1	GPIO6		VCC_2V8	I	Z	Main RS232 Request To Send	(RTS1) Pull-up to VCC_2V8 with 100kΩ and add a test point for firmware update
74	CT103-TXD1	GPIO4		VCC_2V8	I	Z	Main RS232 Transmit	(TXD1) Pull-up to VCC_2V8 with 100kΩ and add a test point for firmware update
75–98	GND							

* The I/O direction information is only for the nominal signal. When the signal is configured in GPIO, it can always be an Input or an Output.

** For more information about multiplexing these signals, refer to section 4.3 General Purpose Input/Output.

Refer to section 4.2 Electrical Information for Digital I/O for open drain, 2V8 and 1V8 voltage characteristics and reset state definitions.

4.2. Electrical Information for Digital I/O

There are three types of digital I/Os on the SL6087 Embedded Module:

- 2.8 volt CMOS
- 1.8 volt CMOS
- Open drain

Refer to the tables below for the electrical characteristics of these three digital I/Os.

Table 8. Electrical Characteristic of a 2.8 Volt Type (2V8) Digital I/O

Parameter		I/O Type	Minimum	Typical	Maximum	Condition
Internal 2.8V power supply		VCC_2V8	2.74V	2.8V	2.86V	
Input / Output Pin	V_{IL}	CMOS	-0.5V*		0.84V	
	V_{IH}	CMOS	1.96V		3.2V*	
	V_{OL}	CMOS			0.4V	I_{OL} = - 4 mA
	V_{OH}	CMOS	2.4V			I_{OH} = 4 mA
	I_{OH}				4mA	
	I_{OL}				- 4mA	

* Absolute maximum ratings

All 2.8V I/O pins do not accept input signal voltages above the maximum voltage specified above; except for the UART1 interface, which is 3.3V tolerant.

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

Parameter		I/O Type	Minimum	Typical	Maximum	Condition
Internal 1.8V power supply		VCC_1V8	1.76V	1.8V	1.94V	
Input / Output Pin	V_{IL}	CMOS	-0.5V*		0.54V	
	V_{IH}	CMOS	1.33V		2.2V*	
	V_{OL}	CMOS			0.4V	I_{OL} = - 4 mA
	V_{OH}	CMOS	1.4V			I_{OH} = 4 mA
	I_{OH}				4mA	
	I_{OL}				- 4mA	

* Absolute maximum ratings

Table 10. Open Drain Output Type

Signal Name	Parameter	I/O Type	Minimum	Typical	Maximum	Condition
LED0	V_{OL}	Open Drain			0.4V	
	I_{OL}	Open Drain			8mA	
BUZZER0	V_{OL}	Open Drain			0.4V	
	I_{OL}	Open Drain			100mA	

Signal Name	Parameter	I/O Type	Minimum	Typical	Maximum	Condition
SDA/GPIO2 and SCL/GPIO1	V_{TOL}	Open Drain			3.3V	Tolerated voltage
	V_{IH}	Open Drain	2V			
	V_{IL}	Open Drain			0.8V	
	V_{OL}	Open Drain			0.4V	
	I_{OL}	Open Drain			3mA	

The reset states of the I/Os are given in each interface description chapter. Definitions of these states are given in the table below.

Table 11. Reset State Definition

Parameter	Definition
0	Set to GND
1	Set to supply 1V8 or 2V8 depending on I/O type
Pull-down	Internal pull-down with ~60kΩ resistor
Pull-up	Internal pull-up with ~60kΩ resistor to supply 1V8 or 2V8 depending on I/O type
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 SL6087 Embedded Module provides up to 26 General Purpose I/O. They are used to control any external device such as an LCD.

4.3.1. Pin Description

Refer to the following table for the pin description of the general purpose input/output interface.

Table 12. GPIO Pin Description

Signal	Pin Number	I/O	I/O Type	Reset State	Multiplexed With
GPIO0	4	I/O	2V8	Undefined	32kHz**
GPIO1	17	I/O	Open drain	Z	SCL
GPIO2	16	I/O	Open drain	Z	SDA
GPIO3***	61	I/O	1V8	Z	INT0
GPIO4	74	I/O	2V8	Z	CT103/TXD1
GPIO5	1	I/O	2V8	1	CT104/RXD1 / INT2
GPIO6	73	I/O	2V8	Z	~CT105/RTS1
GPIO7	2	I/O	2V8	Z	~CT106/CTS1
GPIO8	72	I/O	2V8	Z	~CT107/DSR1
GPIO9	70	I/O	2V8	Z	~CT108-2/DTR1 / INT3

Signal	Pin Number	I/O	I/O Type	Reset State	Multiplexed With
GPIO10	71	I/O	2V8	Undefined	~CT125/RI1
GPIO11	69	I/O	2V8	Undefined	~CT109/DCD1
GPIO12	12	I/O	2V8	Z	SPI1-CLK
GPIO13	13	I/O	2V8	Z	SPI1-IO
GPIO14	45	I/O	1V8	Z	CT103/TXD2
GPIO15	46	I/O	1V8	0	CT104/RXD2 / INT4
GPIO16	47	I/O	1V8	0	~CT106/CTS2
GPIO17	48	I/O	1V8	Z	~CT105/RTS2
GPIO18	10	I/O	1V8	Z	SIMPRES
GPIO19	14	I/O	2V8	Z	SPI1-I
GPIO20	11	I/O	2V8	Z	~SPI1-CS
GPIO21	15	I/O	2V8	Undefined	Not mux
GPIO22	38	I/O	2V8	Z	Not mux*
GPIO23	39	I/O	2V8	Z	Not mux*
GPIO24	37	I/O	2V8	Z	Not mux
GPIO25	62	I/O	2V8	Z	INT1

* If a Bluetooth module is used with the SL6087 Embedded Module, this GPIO must be reserved.

** With the Open AT Application Framework. For more details, refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5.

*** GPIO3 is the associated GPIO used with **AT+WTBI** to monitor TDM bursts. For more information about this AT command, refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5.

Refer to section 4.2 Electrical Information for Digital I/O for open drain, 2V8 and 1V8 voltage characteristics and reset state definitions.

4.4. Serial Interface

The AirPrime SL6087 Embedded Module may be connected to an LCD module driver through either the SPI bus (3 or 4-wire interface) or through the I^2C bus (2-wire interface).

4.4.1. SPI Bus

The SPI bus interfaces include:

- A CLK signal (SPI1-CLK)
- An I/O signal (SPI1-IO)
- An I signal (SPI1-I)
- A CS (Chip Select) signal complying with the standard SPI bus (any GPIO ~SPI1-CS)
- An optional Load signal (only the SPI1-LOAD signal)

4.4.1.1. Characteristics

The following lists the features available on the SPI bus.

- Master mode operation
- The CS signal must be any GPIO
- The LOAD signal (optional) is used for word handling mode (only the SPI1-LOAD signal)
- SPI speed is from 102Kbit/s to 13Mbit/s in master mode operation
- 3 or 4-wire interface (5-wire interface is possible with the optional SPI1-LOAD signal)
- SPI-mode configuration: 0 to 3 (for more details, refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5)
- 1 to 16 bits data length

4.4.1.2. SPI Configuration

Table 13. SPI Bus Configuration

Operation	Maximum Speed	SPI-Mode	Duplex	3-wire Type	4-wire Type	5-wire Type
Master	13 Mb/s	0,1,2,3	Half	SPI1-CLK; SPI1-IO; GPIOx as CS	SPI1-CLK; SPI1-IO; SPI1-I; GPIOx as CS	SPI1-CLK; SPI1-IO; SPI1-I; GPIOx as CS; SPI1-LOAD (not muxed in GPIO)

Refer to section 4.4.1.5 Application for more information on the signals used and their corresponding configurations.

4.4.1.3. SPI Waveforms

The figure below shows the waveforms for SPI transfers with a 4-wire configuration in master mode 0.

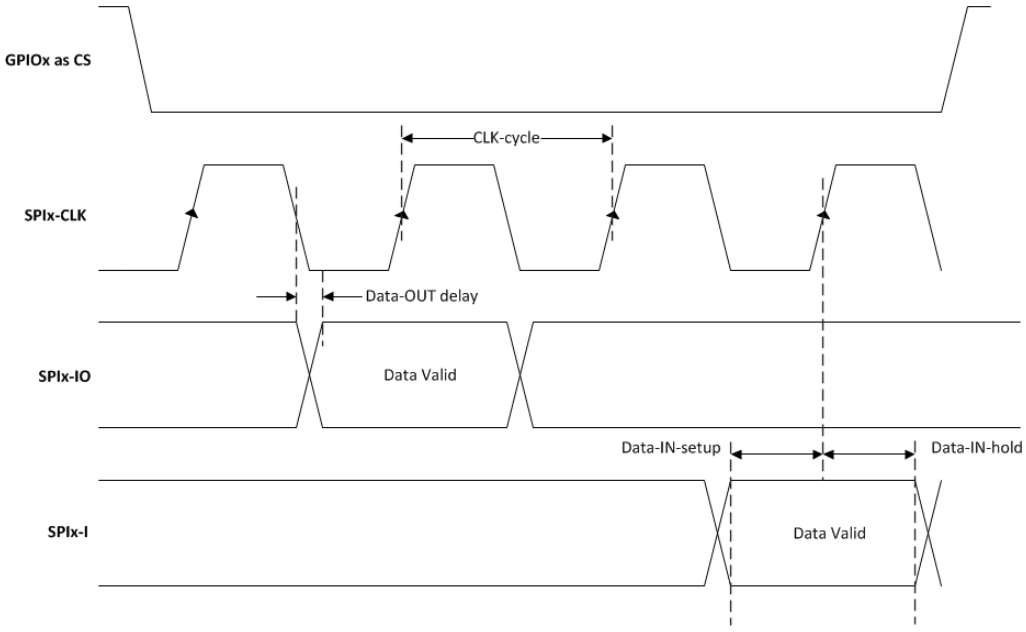


Figure 8. SPI Timing Diagram (Mode 0, Master, 4 wires)

Table 14. SPI Bus AC Characteristics

Signal	Description	Minimum	Typical	Maximum	Unit
CLK-cycle	SPI clock frequency	0.102		13	MHz
Data-OUT delay	Data out ready delay time			10	ns
Data-IN-setup	Data in setup time	2			ns
Data-OUT-hold	Data out hold time	2			ns

The following figure shows the waveform for SPI transfer with the LOAD signal configuration in master mode 0 (chip select is not represented).

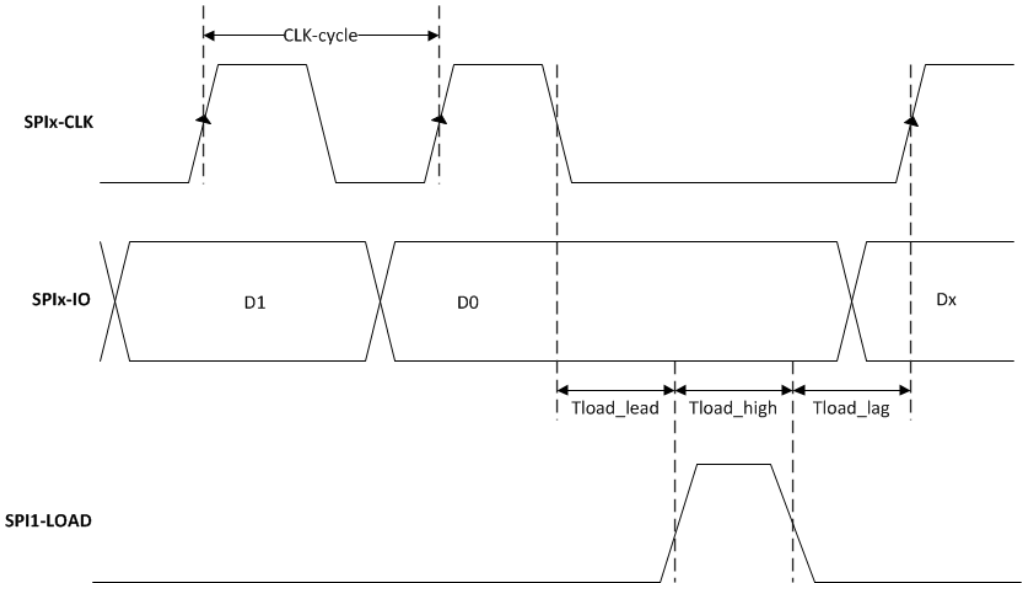


Figure 9. SPI Timing Diagram with LOAD Signal (Mode 0, Master, 4 wires)

4.4.1.4. SPI Pin Description

Refer to the following table for the SPI pin description.

Table 15. SPI Pin Description

Pin Number	Signal	I/O	I/O Type	Reset State	Description	Multiplexed With
11	SPI1-LOAD	O	2V8	Z	SPI load	GPIO20
12	SPI1-CLK	O	2V8	Z	SPI Serial Clock	GPIO12
14	SPI1-I	I	2V8	Z	SPI Serial input	GPIO19
13	SPI1-IO	I/O	2V8	Z	SPI Serial input/output	GPIO13

Refer to section 4.2 Electrical Information for Digital I/O for open drain, 2V8 and 1V8 voltage characteristics and reset state definitions.

4.4.1.5. Application

4.4.1.5.1. 3-wire Application

For the 3-wire configuration, only the SPI1-I/O is used as both input and output.

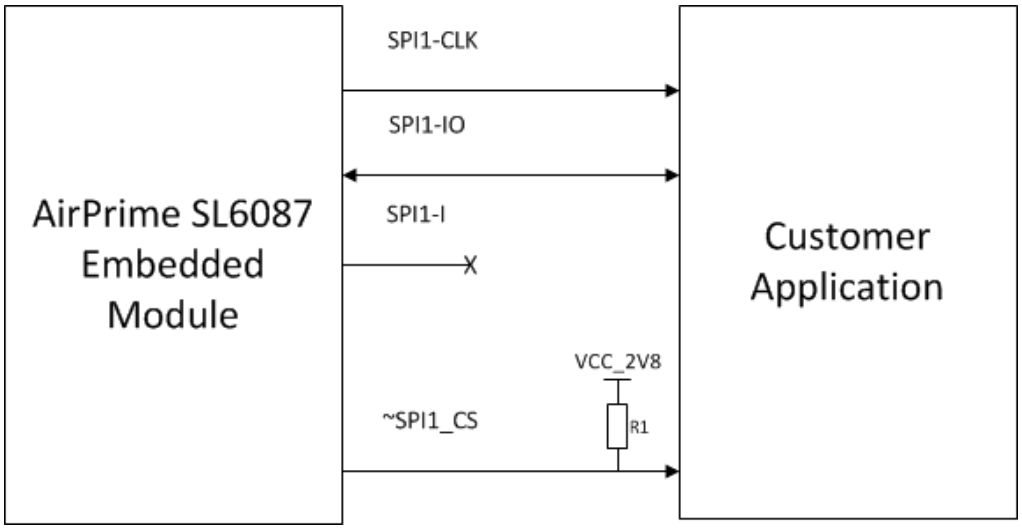


Figure 10. Example of a 3-wire SPI Bus Application

The SPI1-I line is not used in a 3-wire configuration. Instead, this can be left open or used as a GPIO for other application functionality.

One pull-up resistor, R1, is needed to set the SPI1-CS level during the reset state. Except for R1, no other external component is needed is the electrical specifications of the customer application comply with the AirPrime SL6087 Embedded Module interface electrical specifications.

Note that the value of R1 depends on the peripheral plugged to the SPI1 interface.

4.4.1.5.2. 4-wire Application

For the 4-wire configuration, the input and output data lines are dissociated. SPI1-I/O is used as output only and SPI1-I is used as input only.

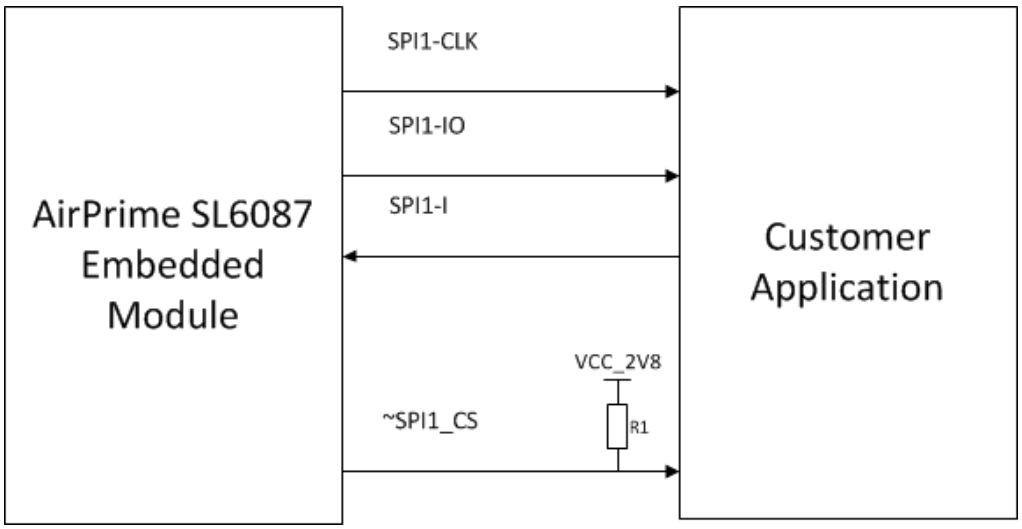


Figure 11. Example of a 4-wire SPI Bus Application

One pull-up resistor, R1, is needed to set the SPI1-CS level during the reset state. Except for R1, no other external component is needed if the electrical specifications of the customer application comply with the AirPrime SL6087 Embedded Module SPI1 interface electrical specifications.

4.4.1.5.3. 5-wire Application

For the 5-wire configuration, SPI1-I/O is used as output only and SPI1-I is used as input only. The dedicated SPI1-LOAD signal is also used. This is an additional signal in more than a Chip Select (any other GPIOx).

4.4.2. I²C Bus

The I²C Bus interface includes a CLK signal (SCL) and a data signal (SDA) complying with a 100kbit/s-standard interface (standard mode: s-mode).

The I²C bus is always in master mode operation.

The maximum speed transfer is 400Kbit/s (fast mode: f-mode).

For more information on the I²C bus, see document [9] “I2C Bus Specification”, Version 2.0, Philips Semiconductor 1998.

4.4.2.1. I²C Waveforms

The figure below shows the I²C bus waveform in master mode configuration.

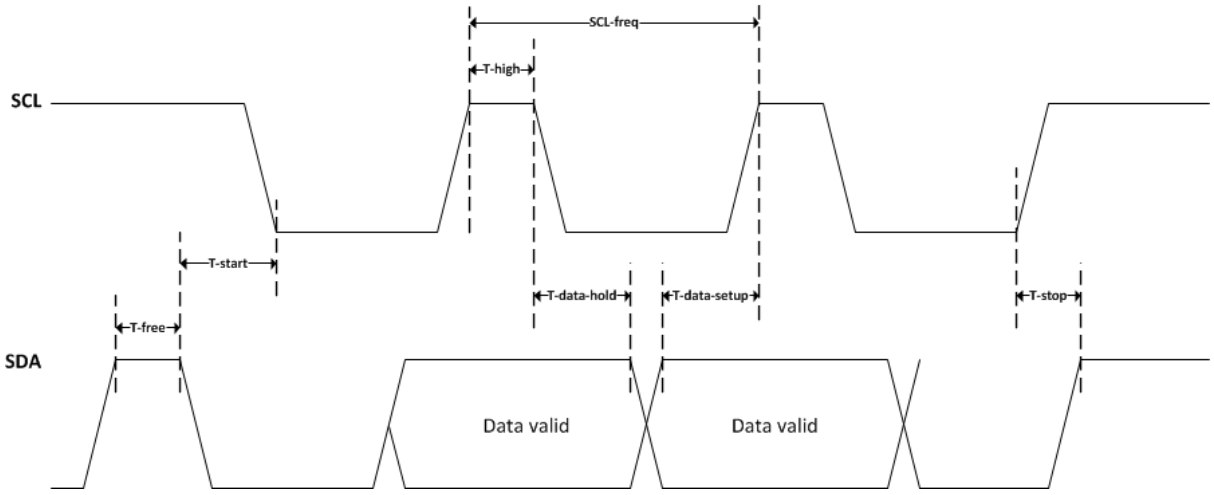


Figure 12. I²C Timing Diagram (master)

Table 16. I²C AC Characteristics

Signal	Description	Minimum	Typical	Maximum	Unit
SCL-freq	I²C clock frequency	100		400	kHz
T-start	Hold time START condition	0.6			µs
T-stop	Setup time STOP condition	0.6			µs
T-free	Bus free time, STOP to START	1.3			µs
T-high	High period for clock	0.6			µs
T-data-hold	Data hold time	0		0.9	µs

Signal	Description	Minimum	Typical	Maximum	Unit
T-data-setup	Data setup time	100			ns

4.4.2.2. I²C Pin Description

Refer to the following table for the I²C pin description.

Table 17. I²C Pin Description

Pin Number	Signal	I/O	I/O Type	Reset State	Description	Multiplexed With
17	SCL	O	Open drain	Z	Serial Clock	GPIO1
16	SDA	I/O	Open drain	Z	Serial Data	GPIO2

Refer to section 4.2 Electrical Information for Digital I/O for open drain, 2V8 and 1V8 voltage characteristics and reset state definitions.

4.4.2.3. Application

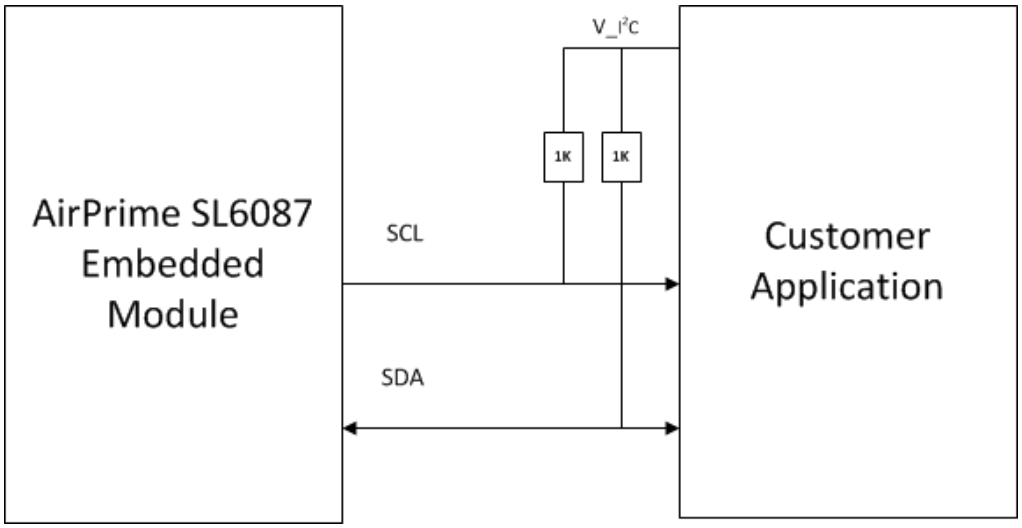


Figure 13. Example1 of an I²C Bus Application

The two lines, SCL and SDA, both need to be pulled-up to the VI²C voltage. Although the VI²C voltage is dependent on the customer application component connected to the I²C bus, it must comply with the AirPrime SL6087 Embedded Module electrical specifications.

The VCC_2V8 (pin 58) of the AirPrime SL6087 Embedded Module can be used to connect the pull-up resistors if the I²C bus voltage is 2.8V.

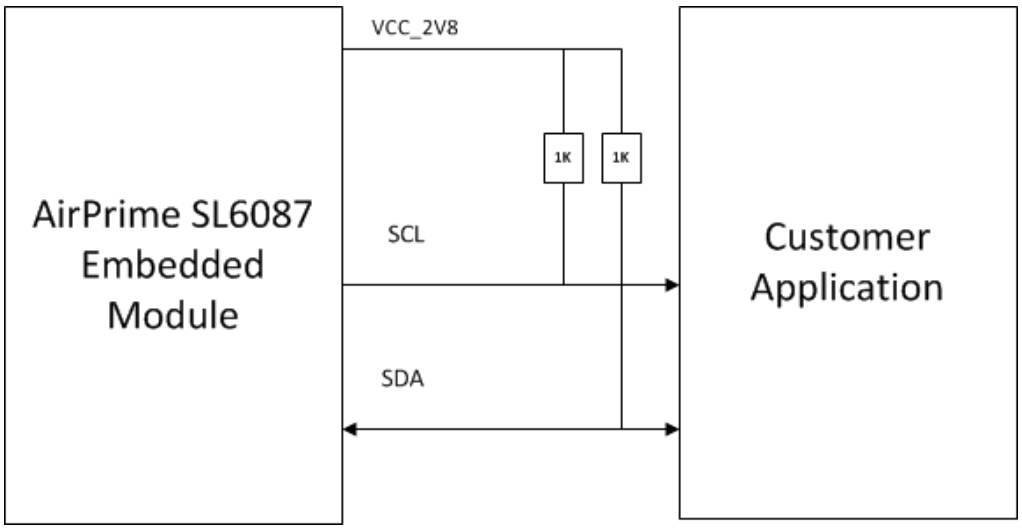


Figure 14. Example2 of an I²C Bus Application

The I²C bus complies with both standard mode (baud rate = 100Kbit/s) and fast mode (baud rate = 400Kbit/s). The value of the pull up resistors varies depending on the mode used. When using Fast mode, it is recommended to use 1KΩ resistors to ensure compliance with the I²C specifications. When using Standard mode, a higher resistance value can be used to save power consumption.

4.5. Main Serial Link (UART1)

The main serial link (UART1) is used for communication between the AirPrime SL6087 Embedded Module and a PC or host processor. It consists of a flexible 8-wire serial interface that complies with V24 protocol signalling, but not with the V28 (electrical interface) due to its 2.8V interface.

To get a V24/V28 (i.e. RS-232) interface, an RS-232 level shifter device is required as described in section 4.5.2 Level Shifter Implementation.

The signals used by UART1 are as follows:

- TX data (CT103/TXD1)
- RX data (CT104/RXD1)
- Request To Send (~CT105/RTS1)
- Clear To Send (~CT106/CTS1)
- Data Terminal Ready (~CT108-2/DTR1)
- Data Set Ready (~CT107/DSR1)
- Data Carrier Detect (~CT109/DCD1)
- Ring Indicator (CT125/RI1)

4.5.1. Pin Description

Refer to the following table for the pin description of the UART1 interface.

Table 18. UART1 Pin Description

Pin Number(s)	Signal*	I/O	I/O Type	Reset State	Description	Multiplexed With
71	~CT125/RI1	O	2V8	Undefined	Ring Indicator	GPIO10
69	~CT109/DCD1	O	2V8	Undefined	Data Carrier Detect	GPIO11

Pin Number(s)	Signal*	I/O	I/O Type	Reset State	Description	Multiplexed With
74	CT103/TXD1	I	2V8	Z	Transmit serial data	GPIO4
73	~CT105/RTS1	I	2V8	Z	Request To Send	GPIO6
1	CT104/RXD1	O	2V8	1	Receive serial data	GPIO5 / INT2
72	~CT107/DSR1	O	2V8	Z	Data Set Ready	GPIO8
2	~CT106/CTS1	O	2V8	Z	Clear To Send	GPIO7
70	~CT108-2/DTR1	I	2V8	Z	Data Terminal Ready	GPIO9 / INT3
21, 23, 25, 28, 30 and 52	Ground		GND		Ground	

* According to PC view

Refer to section 4.2 Electrical Information for Digital I/O for open drain, 2V8 and 1V8 voltage characteristics and reset state definitions.

With the Open AT Application Framework, when the UART1 service is used, the set of multiplexed signals becomes unavailable for any other purpose. In the same way, if one or more GPIOs (from the table above) are allocated elsewhere, the UART1 service becomes unavailable.

The maximum baud rate of UART1 is **921**kbit/s with the Open AT Application Framework 2.33.

The rise and fall times of the reception signals (mainly CT103/TXD1) must be less than 300ns.

The UART1 interface is 2.8V type, but it is 3.3V tolerant.

Tip: *The AirPrime SL6087 Embedded Module is designed to operate using all the serial interface signals and it is recommended to use ~CT105/RTS1 and ~CT106/CTS1 for hardware flow control in order to avoid data corruption or loss during transmissions.*

4.5.2. Level Shifter Implementation

The level shifter must be a 2.8V with V28 electrical signal compliance.

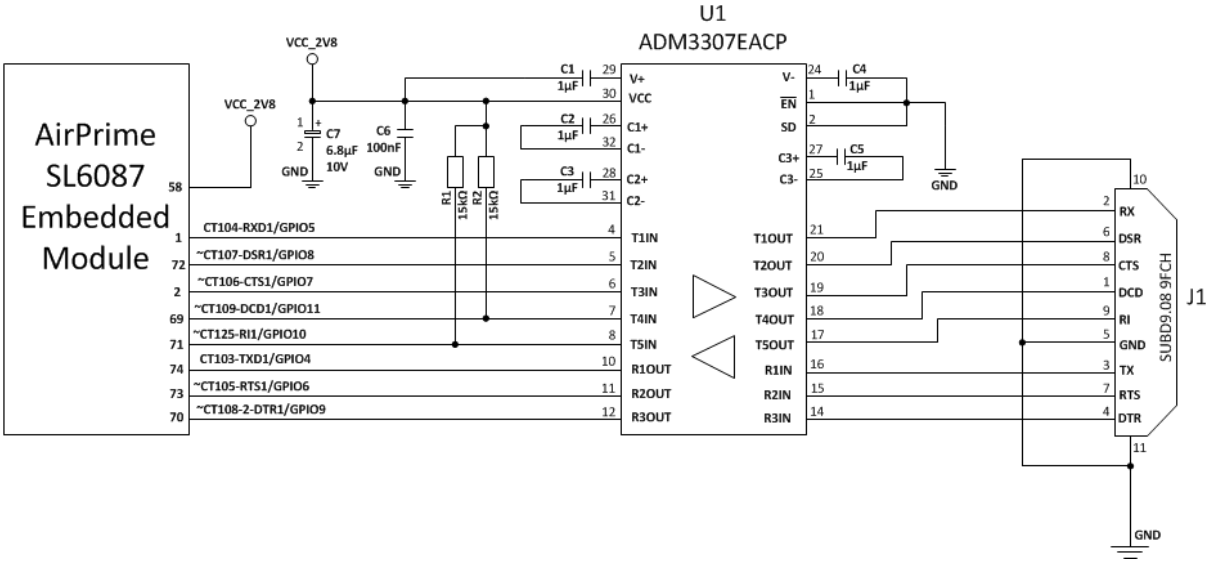


Figure 15. Example of an RS-232 Level Shifter Implementation for UART1

Note: The U1 chip also protects the AirPrime SL6087 Embedded Module against ESD at 15KV (air discharge).

4.5.2.1. Recommended Components

- R1, R2 :15KΩ
- C1, C2, C3, C4, C5 :1uF
- C6 :100nF
- C7 :6.8uF TANTAL 10V CP32136 AVX
- U1 :ADM3307AECP ANALOG DEVICES
- J1 :SUB-D9 female

R1 and R2 are only necessary during the Reset state to force the ~CT125-RI1 and ~CT109-DCD1 signals to HIGH level.

The **ADM3307AECP** chip is able to speed up to 921Kb/s. If other level shifters are used, ensure that their speeds are compliant with the UART1 speed.

The **ADM3307AECP** can be powered by VCC_2V8 (pin 58) of the AirPrime SL6087 Embedded Module or by an external regulator at 2.8 V.

If the UART1 interface is connected directly to a host processor, it is not necessary to use level shifters. The interface can be connected as defined in the following sub-section.

4.5.3. V24/CMOS Possible Designs

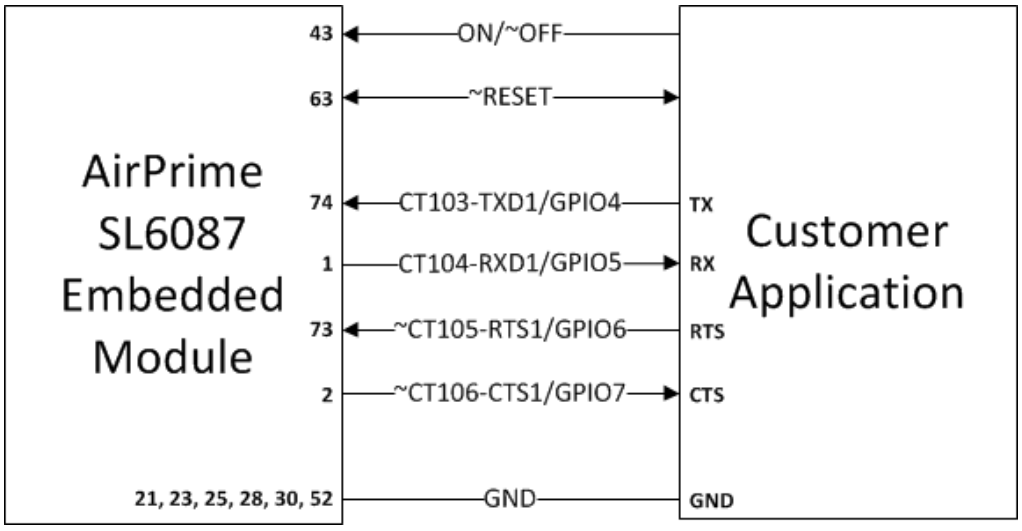


Figure 16. Example of V24/CMOS Serial Link Implementation for UART1

Note that the design presented above is a basic one and that a more flexible design to access the serial link with all modem signals is presented below.

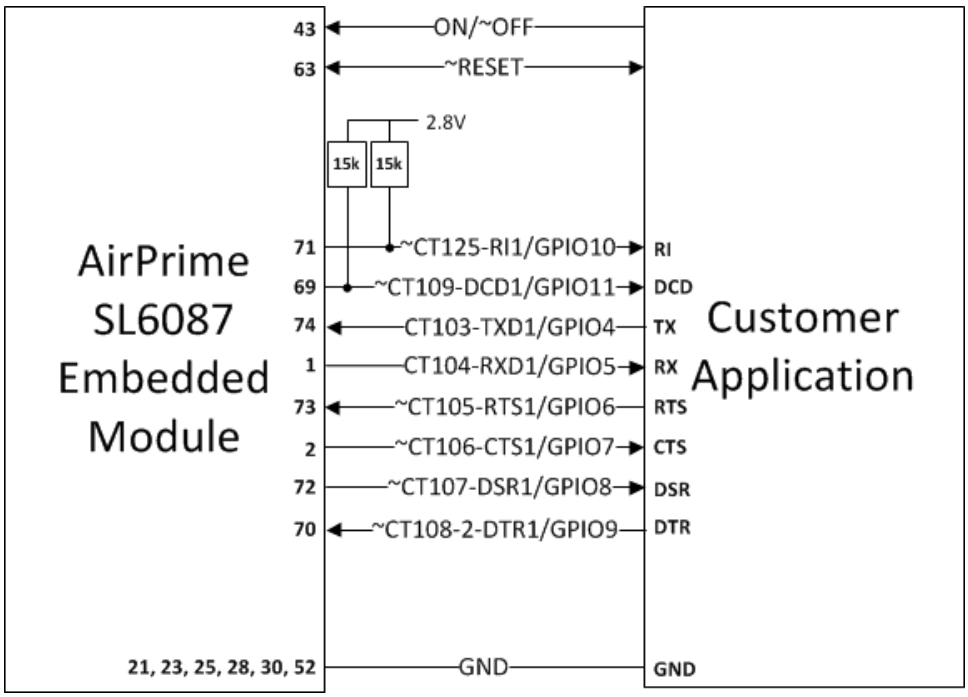


Figure 17. Example of a Full Modem V24/CMOS Serial Link Implementation for UART1

It is recommended to add a 15kΩ pull-up resistor on the ~CT125-RI1 and ~CT109-DCD1 signals to set them to HIGH level during the reset state.

Caution: *In case the Power Down mode (Wavecom 32K mode) is to be activated using the Open AT Application Framework, the DTR pin must be wired to a GPIO. Refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5 for more information regarding using the Open AT Application Framework to activate Wavecom 32K mode.*

4.5.4. 5-wire Serial Interface

The signals used in this interface are as follows:

- CT103/TXD1
- CT104/RXD1
- ~CT105/RTS1
- ~CT106/CTS1
- ~CT108-2/DTR1

The signal ~CT108-2/DTR1 must be managed following the V24 protocol signaling if slow (or fast) idle mode is to be used.

The other signals and their multiplexed GPIOs are not available.

Refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5 for more information.

4.5.5. 4-wire Serial Interface

The signals used in this interface are as follows:

- CT103/TXD1
- CT104/RXD1
- ~CT105/RTS1
- ~CT106/CTS1

The signal ~CT108-2/DTR1 must be configured from low level.

The other signals and their multiplexed GPIOs are not available.

Refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5 for more information.

4.5.6. 2-wire Serial Interface

Caution: *Although this case is possible for a connected external chip, it is not recommended (and forbidden for AT command or modem use).*

The flow control mechanism has to be managed from the customer side. The signals used in this interface are as follows:

- CT103/TXD1
- CT104/RXD1

Signals ~CT108-2/DTR1 and ~CT105/RTS1 must be configured from low level.

Signals ~CT105/RTS1 and ~CT106/CTS1 are not used; default hardware flow control on UART1 should be de-activated using AT command **AT+IFC=0,0**. Refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5.

The other signals and their multiplexed GPIOs are not available.

Refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5 for more information.

4.6. Auxiliary Serial Link (UART2)

The auxiliary serial link (UART2) is used for communications between the AirPrime SL6087 Embedded Module and external devices. It consists of a flexible 4-wire serial interface that complies with V24 protocol signaling, but not with the V28 (electrical interface) due to its 1.8V interface.

To get a V24/V28 (i.e. RS-232) interface, an RS-232 level shifter device is required as described in section 4.6.2 Level Shifter Implementation.

The signals used by UART1 are as follows:

- TX data (CT103/TXD2)
- RX data (CT104/RXD2)
- Request To Send (~CT105/RTS2)
- Clear To Send (~CT106/CTS2)

4.6.1. Pin Description

Refer to the following table for the pin description of the UART2 interface.

Table 19. UART2 Pin Description

Pin Number	Signal*	I/O	I/O Type	Reset State	Description	Multiplexed With
46	CT104/RXD2	O	1V8	0	Receive serial data	GPIO15 / INT4
45	CT103/TXD2	I	1V8	Z	Transmit serial data	GPIO14
47	~CT106/CTS2	O	1V8	0	Clear To Send	GPIO16
48	~CT105/RTS2	I	1V8	Z	Request To Send	GPIO17

* According to PC view

Refer to section 4.2 Electrical Information for Digital I/O for open drain, 2V8 and 1V8 voltage characteristics and reset state definitions.

The maximum baud rate of UART2 is **921**kbit/s with the Open AT Application Framework 2.33.

Tip: *The AirPrime SL6087 Embedded Module is designed to operate using all the serial interface signals and it is recommended to use ~CT105/RTS2 and ~CT106/CTS2 for hardware flow control in order to avoid data corruption during transmissions.*

4.6.2. Level Shifter Implementation

The voltage level shifter must be a 1.8V with V28 electrical signal compliance.

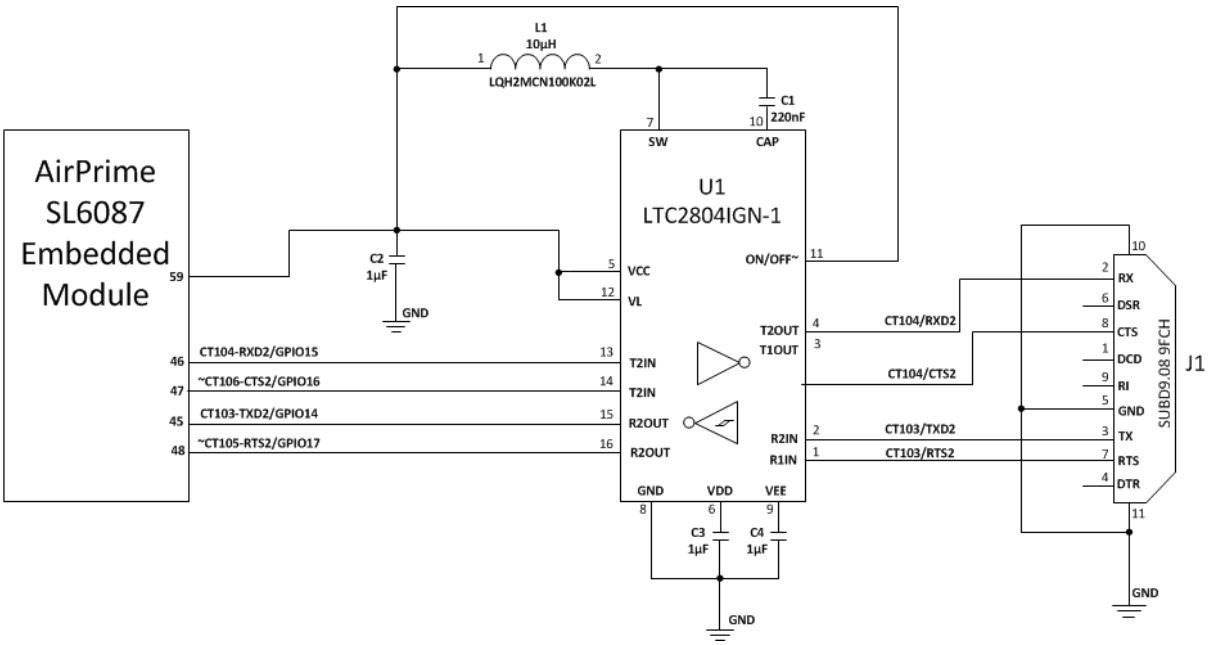


Figure 18. Example of RS-232 Level Shifter Implementation for UART2

4.6.2.1. Recommended Components

- Capacitors
  - C1 :220nF
  - C2, C3, C4 :1µF
- Inductor
  - L1 :10µH
- RS-232 Transceiver
  - U1 :LINEAR TECHNOLOGY LTC® 2804IGN
  - J1 :SUB-D9 female

The LTC2804 can be powered by VCC_1V8 (pin 59) of the AirPrime SL6087 Embedded Module or by an external regulator at 1.8 V.

The UART2 interface can be connected directly to others components if the voltage interface is 1.8V.

4.6.3. 4-wire Serial Interface

The signals used in this interface are as follows:

- CT103/TXD2
- CT104/RXD2
- ~CT105/RTS2
- ~CT106/CTS2

The other signals and their multiplexed GPIOs are not available.

Refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5 for more information.

4.6.4. 2-wire Serial Interface

Caution: *Although this case is possible for a connected external chip, it is not recommended (and forbidden for AT command or modem use).*

The flow control mechanism has to be managed from the customer side. The signals used in this interface are as follows:

- CT103/TXD2
- CT104/RXD2

Signals ~CT105/RTS2 and ~CT106/CTS2 are not used; default hardware flow control on UART2 should be de-activated using AT command **AT+IFC=0,0**. Refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5.

The signal ~CT105/RTS2 must be configured from low level.

The other signals and their multiplexed GPIOs are not available.

Refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5 for more information.

4.7. SIM Interface

The Subscriber Identification Module (SIM) may be directly connected to the AirPrime SL6087 Embedded Module via this dedicated interface. This interface controls either a 3V or a 1V8 SIM and it is fully compliant with GSM 11.11 recommendations concerning SIM functions.

The five signals used by this interface are as follows:

- SIM-VCC: SIM power supply
- ~SIM-RST: reset
- SIM-CLK: clock
- SIM-IO: I/O port
- SIMPRES: SIM card detect

4.7.1. Pin Description

Refer to the following table for the pin description of the SIM interface.

Table 20. SIM Pin Description

Pin Number	Signal	I/O	I/O Type	Reset State	Description	Multiplexed With
6	SIM-VCC	O	2V9 / 1V8		SIM Power Supply	Not mux
8	SIM-IO	I/O	2V9 / 1V8	Pull-up*	SIM Data	Not mux
10	SIMPRES	I	1V8	Z	SIM Card Detect	GPIO18
7	~SIM-RST	O	2V9 / 1V8	0	SIM Reset	Not mux
9	SIM-CLK	O	2V9 / 1V8	0	SIM Clock	Not mux

* SIM-IO pull-up is about 10kΩ.

Refer to section 4.2 Electrical Information for Digital I/O for open drain, 2V8 and 1V8 voltage characteristics and reset state definitions.

4.7.2. Electrical Characteristics

Refer to the following table for the electrical characteristics of the SIM interface.

Table 21. Electrical Characteristics of the SIM Interface

Parameter	Conditions	Minimum	Typical	Maximum	Unit
SIM-IO $\mathbf{V_{IH}}$	I_{IH} = ± 20µA	0.7xSIMVCC			V
SIM-IO $\mathbf{V_{IL}}$	I_{IL} = 1mA			0.4	V
~SIM-RST, SIM-CLK $\mathbf{V_{OH}}$	Source current = 20µA	0.9xSIMVCC			V
SIM-IO $\mathbf{V_{OH}}$	Source current = 20µA	0.8xSIMVCC			
~SIM-RST, SIM-IO, SIM-CLK $\mathbf{V_{OL}}$	Sink current = -200µA			0.4	V

Parameter	Conditions	Minimum	Typical	Maximum	Unit
SIM-VCC Output Voltage	SIMVCC = 2.9V IVCC= 1mA	2.84	2.9	2.96	V
	SIMVCC = 1.8V IVCC= 1mA	1.74	1.8	1.86	V
SIM-VCC current	VBATT = 3.6V			10	mA
SIM-CLK Rise/Fall Time	Loaded with 30pF		20		ns
~SIM-RST, Rise/Fall Time	Loaded with 30pF		20		ns
SIM-IO Rise/Fall Time	Loaded with 30pF		0.7	1	µs
SIM-CLK Frequency	Loaded with 30pF			3.25	MHz

Note: When SIMPRES is used, a low to high transition means that a SIM card is inserted and a high to low transition means that the SIM card is removed.

4.7.3. Application

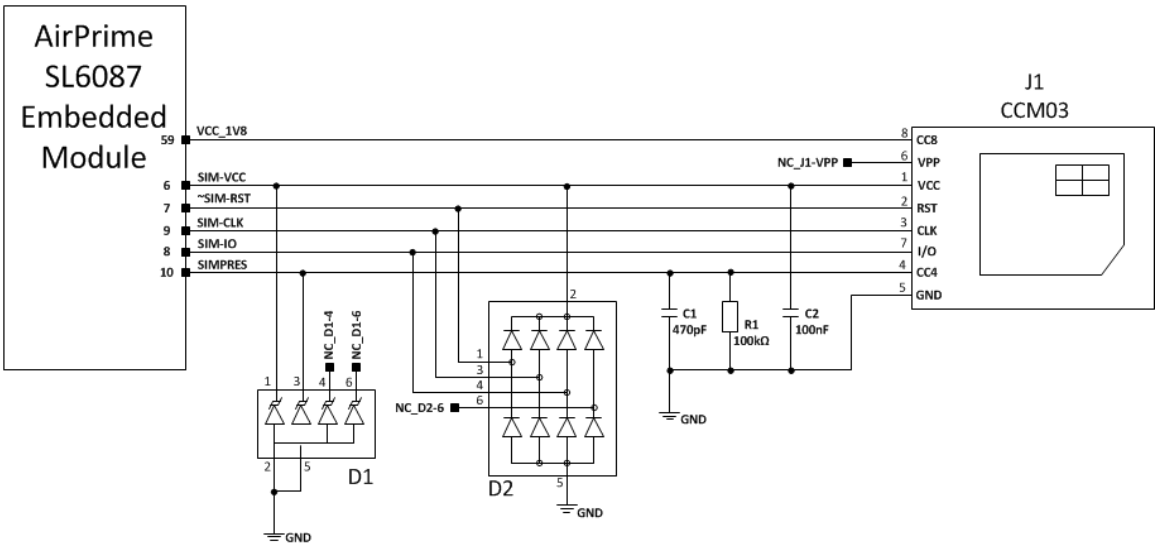


Figure 19. Example of a Typical SIM Socket Implementation

It is recommended to add Transient Voltage Suppressor diodes (TVS) on the signal(s) connected to the SIM socket in order to prevent any ElectroStatic Discharge.

TVS diodes with low capacitance (less than 10pF) have to be connected on SIM-CLK and SIM-IO signals to avoid any disturbance of the rising and falling edge. These types of diodes are mandatory for the Full Type Approval and should be placed as close to the SIM socket as possible.

4.7.3.1. SIM Socket Pin Description

The following table lists the SIM socket pin description.

Table 22. SIM Socket Pin Description

Pin Number	Signal	Description
1	VCC	SIM-VCC
2	RST	~SIM-RST
3	CLK	SIM-CLK
4	CC4	SIMPRES with 100 kΩ pull down resistor
5	GND	GROUND
6	VPP	Not connected
7	I/O	SIM-IO
8	CC8	VCC_1V8 of the AirPrime SL6087 Embedded Module (pin 59)

4.7.3.2. Recommended Components

- R1 :100KΩ
- C1 :470pF
- C2 :100nF

Note: Note that this capacitor, C2, on the SIM-VCC line must not exceed 330nF.

- D1 :ESDA6V1SC6 from ST
- D2 :DALC208SC6 from SGS-THOMSON/ST Microelectronics
- J1 :ITT CANNON CCM03 series (Refer to section 11.1 SIM Card Reader.)

4.8. USB 2.0 Interface

A 4-wire USB slave interface is available on the AirPrime SL6087 Embedded Module that complies with USB 2.0 protocol signaling, but not with the electrical interface due to the 5V interface of VPAD-USB.

The signals used by the USB interface are as follows:

- VPAD-USB
- USB-DP
- USB-DM
- GND

The USB 2.0 interface also features the following:

- 12Mbit/s full-speed transfer rate
- 3.3V type compatible
- USB Soft connect feature
- Download feature is not supported by USB
- CDC 1.1 – ACM compliant

Note: A 5V to 3.3V typical voltage regulator is needed between the external interface power in line (+5V) and the AirPrime SL6087 Embedded Module line (VPAD-USB).

4.8.1. Pin Description

Refer to the following table for the pin description of the USB interface.

Table 23. USB Pin Description

Pin Number	Signal	I/O	I/O Type	Description
49	VPAD-USB	I	VPAD_USB	USB Power Supply
50	USB-DP	I/O	VPAD_USB	Differential data interface positive
51	USB-DM	I/O	VPAD_USB	Differential data interface negative

4.8.2. Electrical Characteristics

Refer to the following table for the electrical characteristics of the USB interface.

Table 24. Electrical Characteristics of the USB Interface

Parameter	Minimum	Typical	Maximum	Unit
VPAD-USB, USB-DP, USB-DM	3	3.3	3.6	V
VPAD_USB Input current consumption		8		mA

4.8.3. Application

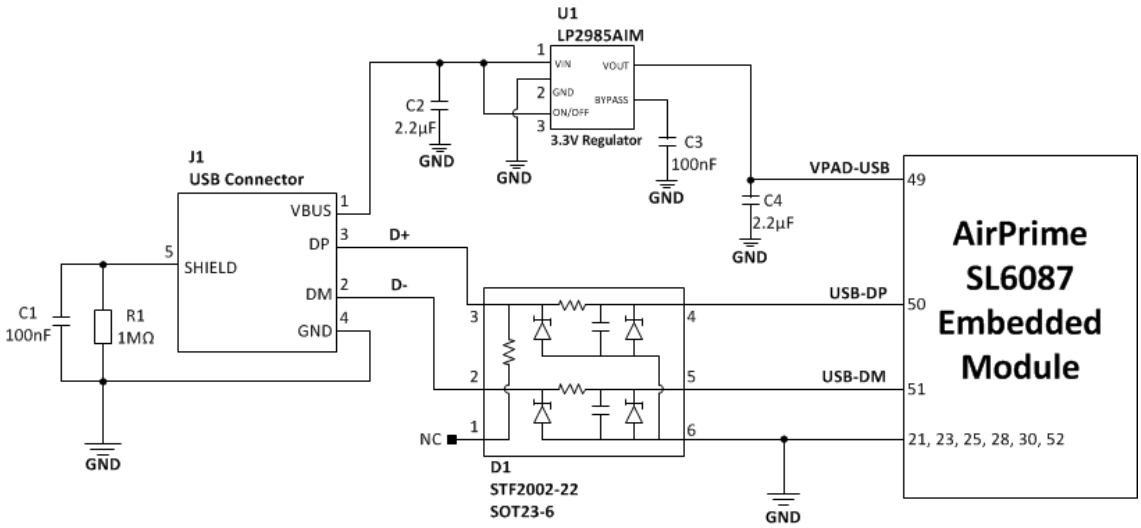


Figure 20. Example of a USB Implementation

The regulator used is a 3.3V regulator and it is supplied through J1 when the USB wire is plugged.

D1 is an EMI/RFI filter with ESD protection. The internal pull-up resistor of D1 which is used to detect the interface's full speed is not connected because it is embedded into the Embedded Module.

Note that both R1 and C1 have to be close to J1.

4.8.3.1. Recommended Components

- R1 :1MΩ
- C1, C3 :100nF
- C2, C4 :2.2µF
- D1 :STF2002-22 from SEMTECH
- U1 :LP2985AIM 3.3V from NATIONAL SEMICONDUCTOR

4.9. RF Interface

The RF (radio frequency) interface of the AirPrime SL6087 Embedded Module allows the transmission of RF signals. This interface has a 50Ω nominal impedance and a 0Ω DC impedance.

4.9.1. RF Connections

The RF input/output of the AirPrime SL6087 Embedded Module is through one of the LGA pins (pin 22, ANT), with grounded LGA pins at both sides. This LGA pin must be connected to a 50Ω RF line in order to protect the antenna line from noise coming from baseband signals. Refer to Figure 59 Routing Examples for more information.

The 50Ω RF line is surrounded by **two ground planes** in order to protect the antenna line from noise. The length of the line shouldn't be too long (no more than a few centimeters) because of RF insertion loss. The **width of the line must be calculated** in order to ensure a 50Ω characteristic impedance.

For this same reason, the embedded RF line should likewise be kept about 1cm away from any (noisy) baseband signal in order to ensure a good RX sensitivity level.

The other end of the 50Ω RF line can be connected to an RF connector or to a soldering pad in order to connect an antenna. It is also possible to use an antenna chip or to design a PCB antenna directly on the application board.

The ANT pin of the AirPrime SL6087 Embedded Module is ESD protected for both ±4KV contact and ±8KV air discharge.

4.9.2. RF Performance

The RF performance is compliant with ETSI GSM 05.05 recommendations.

The main receiver parameters are:

- GSM850 Reference Sensitivity = -109 dBm typical (Static & TUHigh)
- E-GSM900 Reference Sensitivity = -109 dBm typical (Static & TUHigh)
- DCS1800 Reference Sensitivity = -108 dBm typical (Static & TUHigh)
- PCS1900 Reference Sensitivity = -108 dBm typical (Static & TUHigh)
- Selectivity @ 200 kHz: > +9 dBc
- Selectivity @ 400 kHz: > +41 dBc
- Linear dynamic range: 63 dB
- Co-channel rejection: >= 9 dBc

The main transmitter parameters are:

- Maximum output power (EGSM & GSM850): 33 dBm +/- 2 dB at ambient temperature
- Maximum output power (GSM1800 & PCS1900): 30 dBm +/- 2 dB at ambient temperature
- Minimum output power (EGSM & GSM850): 5 dBm +/- 5 dB at ambient temperature
- Minimum output power (GSM1800 & PCS1900): 0 dBm +/- 5 dB at ambient temperature

4.9.3. Antenna Specifications

The antenna must meet the requirements specified in the table below.

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 following characteristics.

Table 25. Antenna Specifications

Characteristic		E-GSM 900	DCS 1800	GSM 850	PCS 1900
TX Frequency		880 to 915 MHz	1710 to 1785 MHz	824 to 849 MHz	1850 to 1910 MHz
RX Frequency		925 to 960 MHz	1805 to 1880 MHz	869 to 894 MHz	1930 to 1990 MHz
Impedance		50Ω			
VSWR	**RX max**	1.5:1			
	TX max	1.5:1			
Typical Radiated Gain		0dBi in one direction at least			

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

4.9.3.1. Application

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 SL6087 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.

4.10. Analog Audio Interface

The AirPrime SL6087 Embedded Module supports one microphone input and one speaker output. It also includes an echo cancellation and a noise reduction feature which allows for an improved quality of hands-free functionality.

In some cases, ESD protection must be added on the audio interface lines.

4.10.1. Pin Description

The following table lists the pin description of the analog audio interface.

Table 26. Analog Audio Pin Description

Pin Number	Signal	I/O	I/O Type	Description
53	MICP	I	Analog	Microphone positive input
54	MICN	I	Analog	Microphone negative input
57	SPKP	O	Analog	Speaker positive output
56	SPKN	O	Analog	Speaker negative output

4.10.2. Microphone Features

The microphone can be connected in either differential or single-ended mode. However, it is strongly recommended to use a differential connection in order to reject common mode noise and TDMA noise. When using a single-ended connection, be sure to have a very good ground plane, very good filtering, as well as shielding in order to avoid any disturbance on the audio path. Also note that using a single-ended connection decreases the audio input signal by 6dB as compared to using a differential connection.

The gain of both MIC inputs are internally adjusted and can be tuned using AT commands. For more information on AT commands, refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5.

4.10.2.1. MIC Microphone Input

By default, the MIC input is differential, but can be configured in single-ended mode.

The MIC input already includes biasing for an electret microphone and the electret microphone may be directly connected to this input.

AC coupling is already embedded in the AirPrime SL6087 Embedded Module.

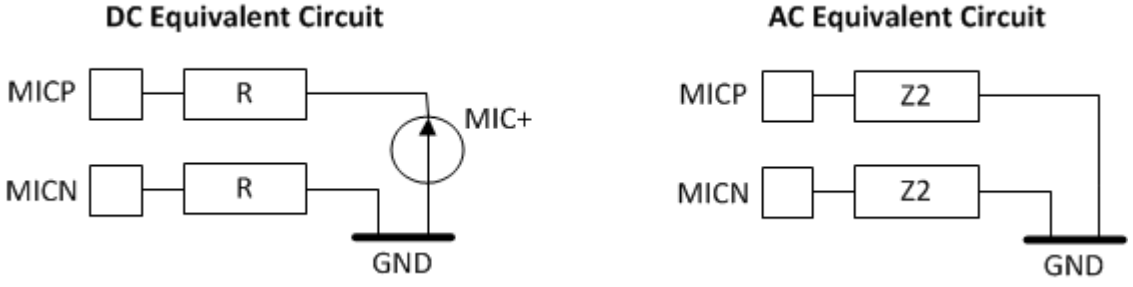


Figure 21. MIC Equivalent Circuits

Refer to the following table for the electrical characteristics of MIC.

Table 27. Electrical Characteristics of MIC

Parameter		Minimum	Typical	Maximum	Unit
Parameters Internal biasing DC Characteristics	MIC+	2	2.1	2.2	V
	Output current		0.5	1.5	mA
	R2	1650	1900	2150	Ω
AC Characteristics 200 Hz<F<4 kHz	Z2 MICP (MICN=Open)	1.1	1.3	1.6	kΩ
	Z2 MICN (MICP=Open)				
	Z2 MICP (MICN=GND)	0.9	1.1	1.4	
	Z2 MICN (MICP=GND)				
	Impedance between MICP and MICN	1.3	1.6	2	
Working voltage (MICP-MICN)	AT+VGT*=3500(1)		13.8	18.6***	mVrms
	AT+VGT*=2000(1)		77.5	104***	
	AT+VGT*=700(1)		346	466***	
Maximum rating voltage (MICP or MICN)	Positive			+7.35**	V
	Negative	-0.9			

* The input voltage depends of the input micro gain set by AT command. Refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5.

** Because MICP is internally biased, it is necessary to use a coupling capacitor to connect an audio signal provided by an active generator. Only a passive microphone can be directly connected to the MICP and MICN inputs.

*** This value is obtained with digital gain = 0, for frequency = 1 kHz

(1) This value is given in dB, but it's possible to toggle it to index value. Refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5.

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

4.10.2.1.1. MIC Differential Connection Example

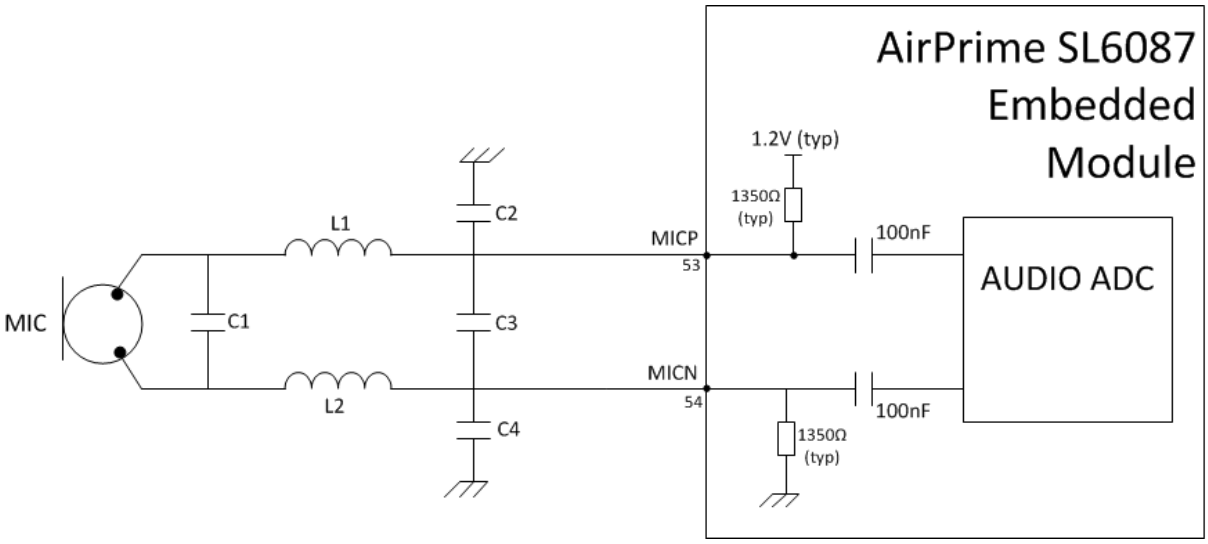


Figure 22. Example of a MIC Differential Connection with LC Filter

Audio quality can be very good without a filter (L1, L2, C2, C3 and C4), depending on the design. But if there is EMI perturbation, this filter can reduce TDMA noise. Note though that this filter is not mandatory. If the filter is not to be used, the capacitors must be removed and the coil replaced by 0Ω resistors as shown in the following diagram.

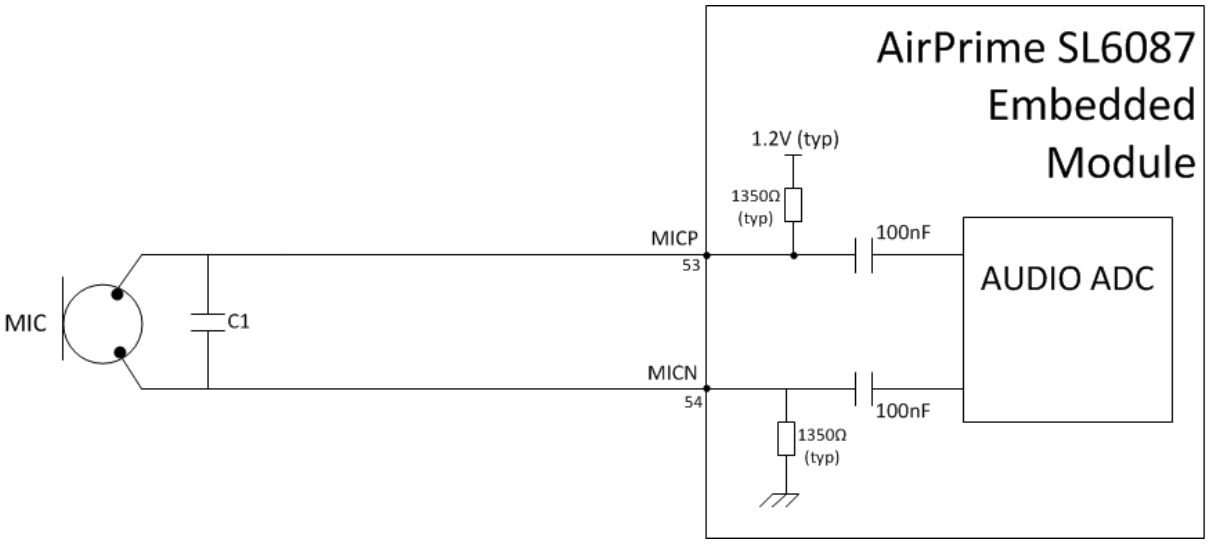


Figure 23. Example of a MIC Differential Connection without an LC Filter

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

The following table lists the recommended components to use in creating the LC filter.

Table 28. Recommended Components for a MIC Differential Connection

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

4.10.2.1.2. MIC Single-Ended Connection Example

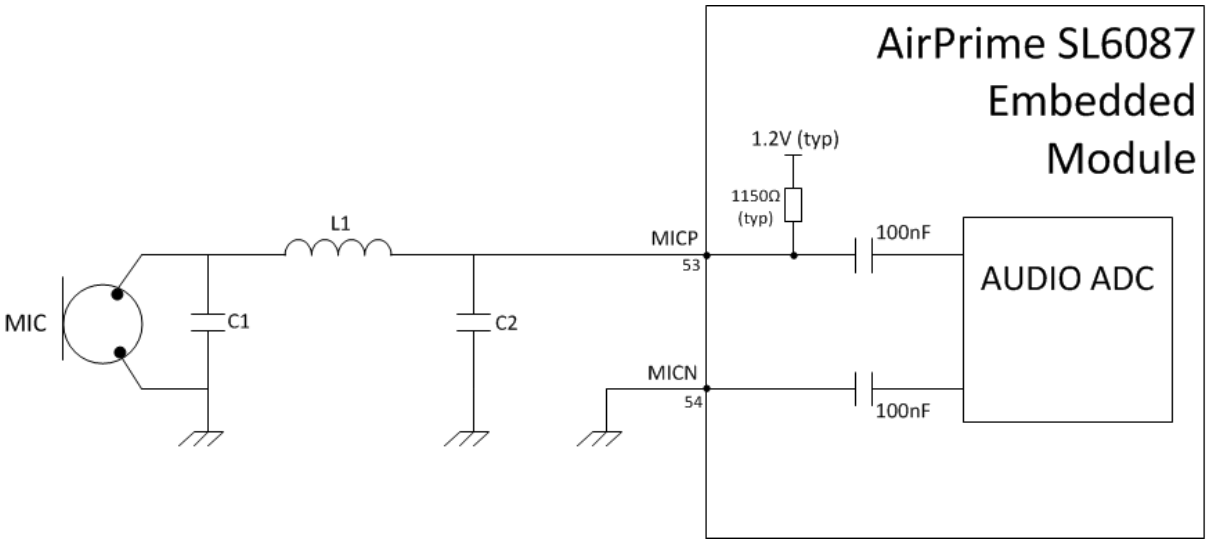


Figure 24. Example of a MIC Single-Ended Connection with LC Filter

The single-ended design is not recommended for improving TDMA noise rejection as it is usually difficult to eliminate TDMA noise from a single-ended design.

The internal input resistor value becomes 1150Ω due to the connection of MICN to the ground.

It is recommended to use an LC filter (L1 and C2) to eliminate TDMA noise. Note though that this filter is not mandatory. If the filter is not to be used, the capacitor C2 must be removed and the coil replaced by 0Ω resistors as shown in the following diagram.

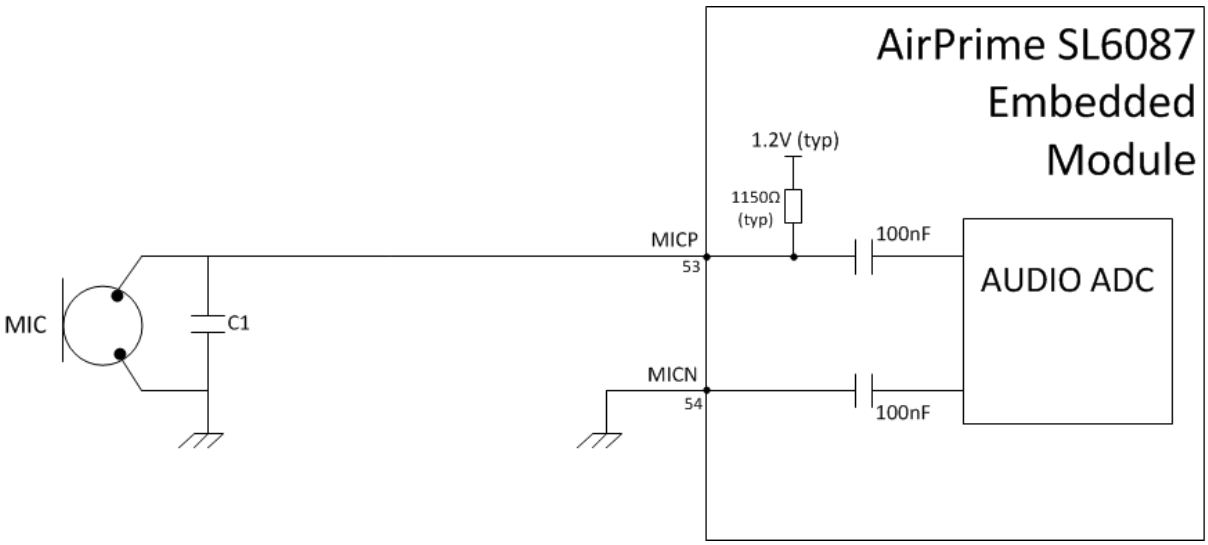


Figure 25. Example of a MIC Single-Ended Connection without an LC Filter

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

The following table lists the recommended components to use in creating the LC filter.

Table 29. Recommended Components for a MIC Single-Ended Connection

Component	Value	Notes
C1	12pF to 33pF	Must be tuned depending on the design.

Component	Value	Notes
C2		Must be tuned depending on the design.
L1		Must be tuned depending on the design.

4.10.3. Speaker Features

A speaker channel, SPK, is available on the AirPrime SL6087 Embedded Module; and it may be configured in either differential or single-ended mode.

However, as with the microphone connection, it is strongly recommended to use a differential connection in order to reject common mode noise and TDMA noise. Furthermore, using a single-ended connection entails losing power (the power is divided by 4 in a single-ended connection) as compared to using a differential connection.

Note that when using a single-ended connection, a very good ground plane, very good filtering, as well as shielding is needed in order to avoid any disturbance on the audio path.

The gain of each speaker output channel is internally adjusted and can be tuned using AT commands. For more information on AT commands, refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5.

No discreet components like resistors or capacitors are needed when using this interface.

The following table lists the typical values of both speaker outputs.

Table 30. Speaker Information

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

4.10.3.1. Speakers Output Power

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

Caution: *It is mandatory not to exceed the maximal speaker output power and the speaker load must be in accordance with the gain selection (gain is controlled by AT command). Exceeding beyond the specified maximal output power may damage the AirPrime SL6087 Embedded Module.*

4.10.3.2. SPK Speaker Output

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

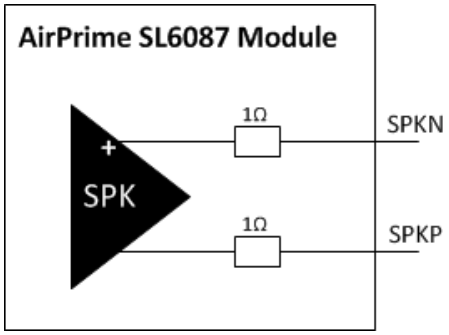


Figure 26. SPK Equivalent Circuit

Refer to the following table for the electrical characteristics of SPK.

Table 31. Electrical Characteristics of SPK

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

* The output voltage depends of the output speaker gain set by AT command. This value is given in dB, but it's possible to toggle it to index value. Refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5.

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

4.10.3.3. Differential Connection Example

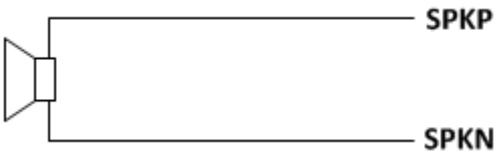


Figure 27. Example of an SPK Differential Connection

The impedance of the speaker amplifier output in differential mode is **R ≤ 1Ω +/-10%**.

Note that the connection between the speaker and the AirPrime SL6087 Embedded Module pins must be designed to keep the serial impedance lower than 3Ω when it is connected in differential mode.

4.10.3.4. Single-Ended Connection Example

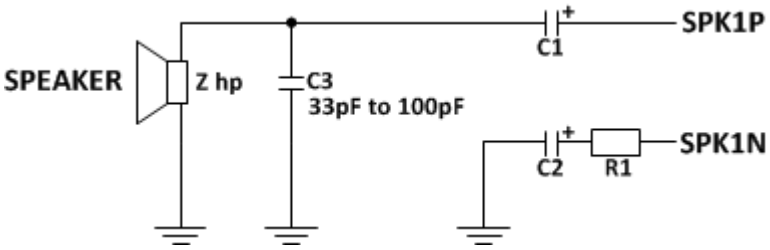


Figure 28. Example of an SPK Single-Ended Connection

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

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

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

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

Also note that the connection between the speaker and the AirPrime SL6087 Embedded Module pins must be designed to keep the serial impedance lower than 1.5Ω when it is connected in single-ended mode.

4.10.3.5. Recommended Characteristics

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

4.11. Digital Audio Interface (PCM)

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

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

The signals used by the Digital Audio Interface are as follows:

- **PCM-SYNC (output)**: The frame synchronization signal delivers an 8kHz frequency pulse that synchronizes the frame data in and the frame data out.
- **PCM-CLK (output)**: The frame bit clock signal controls data transfer with the audio peripheral.
- **PCM-OUT (output)**: The frame “data out” relies on the selected configuration mode.
- **PCM-IN (input)**: The frame “data in” relies on the selected configuration mode.

The Digital Audio Interface also features the following:

- 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 768kHz only
- 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

Note that the digital audio interface configuration cannot differ from those specified above.

4.11.1. PCM Waveforms

The following figures describe the PCM Frame and Sampling waveforms.

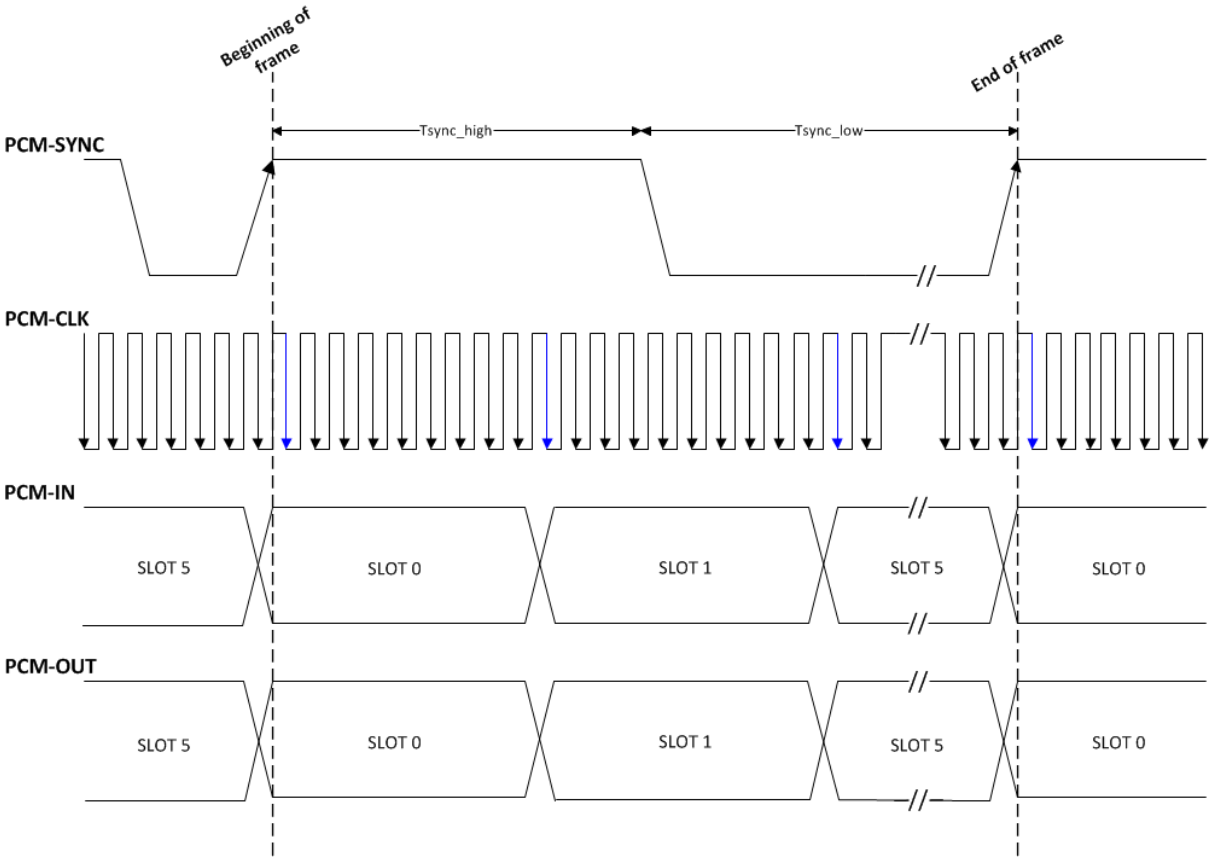


Figure 29. PCM Frame Waveform

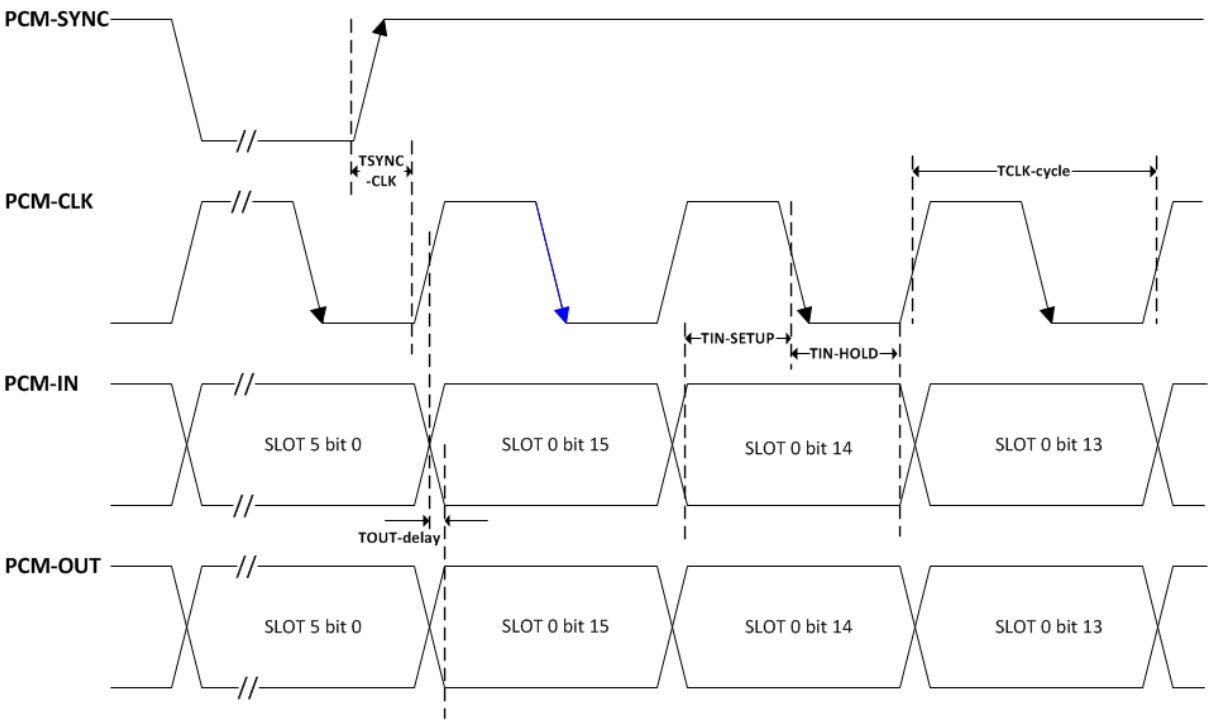


Figure 30. PCM Sampling Waveform

Refer to the following table for the AC characteristics of the digital audio interface.

Table 32. AC Characteristics of the Digital Audio Interface

Signal	Description	Minimum	Typical	Maximum	Unit
Tsync_low + Tsync_high	PCM-SYNC period		125		µs
Tsync_low	PCM-SYNC low time		93		µs
Tsync_high	PCM-SYNC high time		32		µs
TSYNC-CLK	PCM-SYNC to PCM-CLK time		-154		ns
TCLK-cycle	PCM-CLK period		1302		ns
TIN-setup	PCM-IN setup time	50			ns
TIN-hold	PCM-IN hold time	50			ns
TOUT-delay	PCM-OUT delay time			20	ns

4.11.2. Pin Description

Refer to the following table for the pin description of the digital audio (PCM) interface.

Table 33. PCM Interface Pin Description

Pin Number	Signal	I/O	I/O Type*	Reset State	Description
64	PCM-SYNC	O	1V8	Pull-down	Frame synchronization 8kHz
66	PCM-IN*	I	1V8	Pull-up	Data input
67	PCM-CLK	O	1V8	Pull-down	Data clock
65	PCM-OUT	O	1V8	Pull-up	Data output

* When using analog audio interface, the PCM_In signal should be in HZ.

Refer to section 4.2 Electrical Information for Digital I/O for open drain, 2V8 and 1V8 voltage characteristics and reset state definitions.

4.12. Temperature Sensor Interface

A temperature sensor is implanted in the AirPrime SL6087 embedded module which is used to detect the temperature in the embedded module. The software can be used to report the temperature via **ADC3**. For more details about **ADC3**, refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5.

Note: ADC3 is not available during network initialization.

The following waveform describes the characteristic of this function.

The average step of the AirPrime SL6087 is 13mV/°C and the formula for computing the temperature sensor output is as follows:

VTemp (V) = -0.013 x Temperature (°C) + 1.182

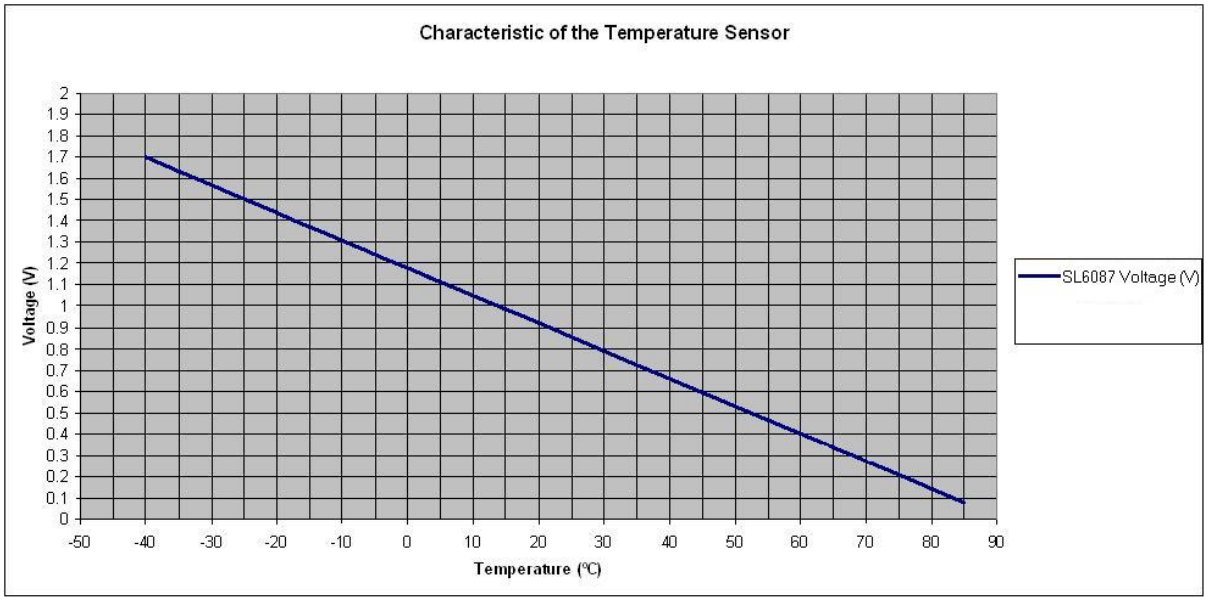


Figure 31. Temperature Sensor Characteristics

4.13. JTAG Interface

The JTAG interface is an in-circuit debugging solution capable of tracking down issues which may occur in routines but cannot be reproduced with the Remote Task Environment.

Sierra Wireless recommends planning access to the JTAG pins on the customer PCB for hardware debugging and product troubleshooting. This access from the customer product can be provided through test points or connectors. Refer to section 4.13.2.2 Recommended Connector Type for more information.

The JTAG interface could then be used to test the hardware without software running on the system. A 6-wire JTAG interface is available powered by 1.8V.

The JTAG interface signals are:

- TDI
- TMS
- TCK
- RTCK
- TDO
- ~TRST

Caution: *An NC pull-down resistor on the TCK pin must be reserved on the customer PCB. Refer to section 4.13.2 Application for more information.*

The following lists the features available on the JTAG interface:

- In-circuit debugging
- Step-over and step-in debugging operations
- Setting breakpoints and watchpoints
- Run, break and continue debugging operations
- Memory retrieval and modification capabilities

Caution: *Extra attention must be made to the PCB design to prevent coupling between JTAG signals and other digital, power supply and RF signals.*

4.13.1. Pin Description

Table 34. JTAG Pin Description

Pin Number	Signal	I/O	I/O Type	Description	Multiplexed With
31	TDI	I	1V8	JTAG input data	Not mux
32	TMS	I	1V8	JTAG test mode select	Not mux
34	TCK	I	1V8	JTAG scan clock	Not mux
19	RTCK	O	1V8	JTAG return test clock from the ARM JTAG for external debug HW	Not mux
33	TDO	O	1V8	JTAG output data	Not mux
20	~TRST	I	1V8	JTAG asynchronous reset	Not mux
18	BOOT	I	1V8	Must be connected to high level* to select the ARM946 JTAG module	Not mux
59	VCC_1V8	O	1V8	Digital Supply	Not mux
30**	GND	-	-	GROUND	Not mux

* Refer to section 5.3 BOOT Signal.

** For other GND pin numbers, refer to Table 7 LGA Pads Description.

Refer to section 4.2 Electrical Information for Digital I/O for open drain, 2V8 and 1V8 voltage characteristics and reset state definitions.

4.13.2. Application

A schematic for the JTAG connection must be reserved on the customer PCB as shown in the figure below. This circuitry is reserved for JTAG debugging using the AirPrime SL Development Kit. The connector, J1, used here is matched with the AirPrime SL Development Kit. Customers only need to reserve the footprint on the customer PCB, which can then be manually soldered when JTAG is needed.

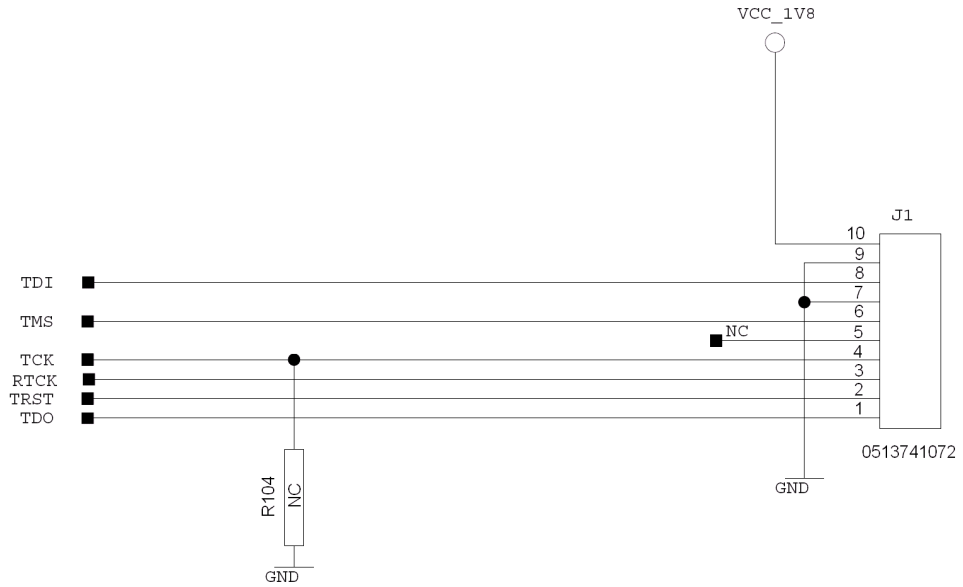


Figure 32. JTAG Circuitry Reserved on Customer PCB

Caution: *An NC pull-down resistor on the TCK pin must be reserved on the customer PCB.*

For customers who don't have the AirPrime SL Development Kit for JTAG debugging, they can use the same schematic as the AirPrime SL Development Kit on an external board as shown in the figure below. Note that an FPC cable is needed for the connection between the connector, J1, on the customer PCB and the connector, J2, on the external board.

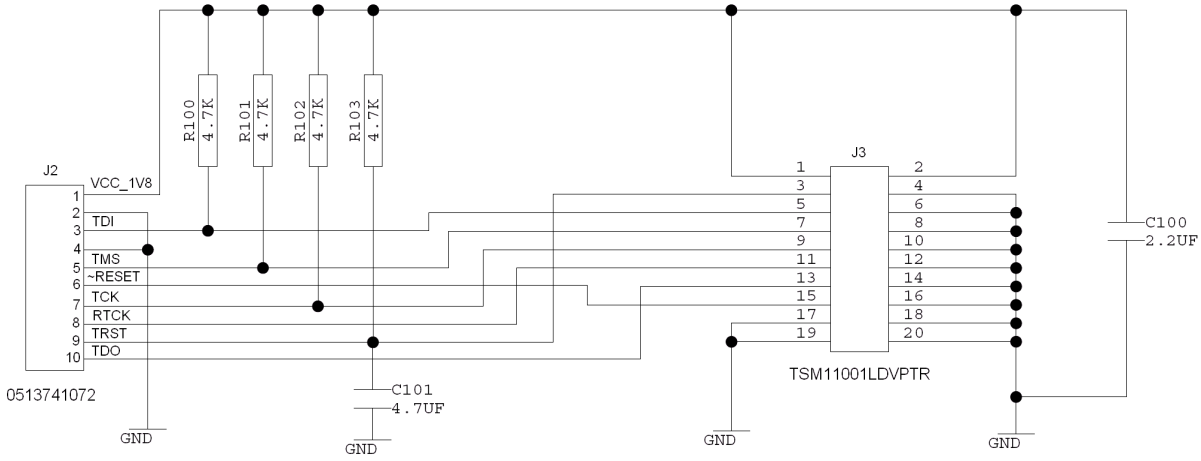


Figure 33. JTAG Implementation Example

Caution: *An NC pull-down resistor on the TCK pin must be reserved on the customer PCB.*

Typically, if the BOOT signal is not connected to HIGH level, the JTAG debugging interface cannot run.

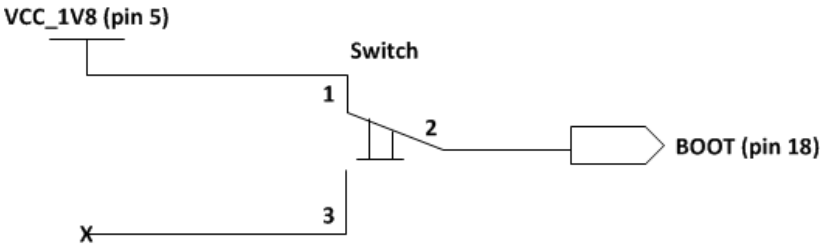
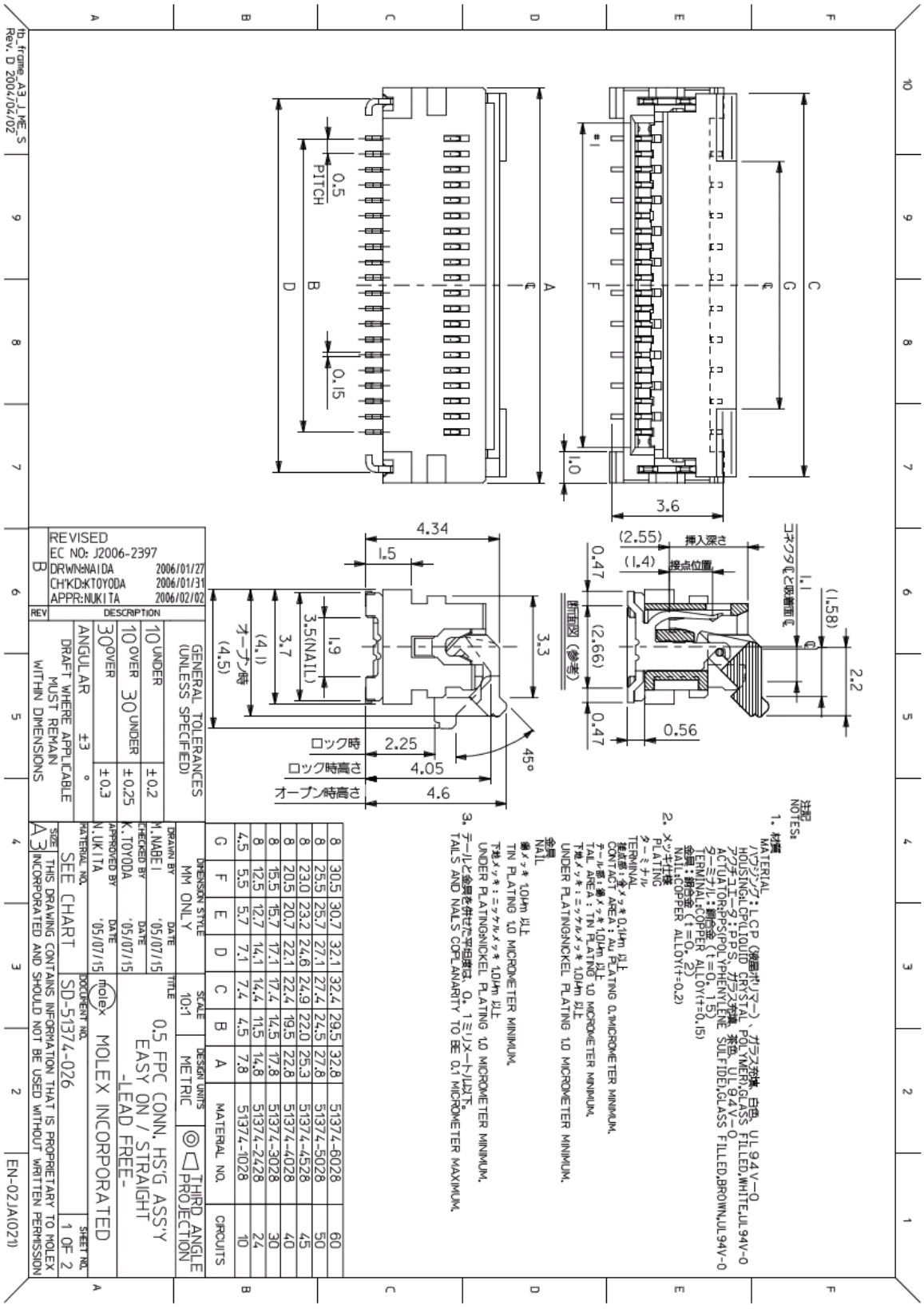


Figure 34. BOOT Signal Configuration Example

4.13.2.1. Recommended Components

- R100, R101, R102, R103 : 4.7kΩ
- R104 : NC
- C101 : 4.7µF
- C100 : 2.2 µF
- J1, J2 : 0513741072 (Molex)
- J3 : TSM11001LDVPTR (SAMTEC)

4.13.2.2. Recommended Connector Type



CIRCUITS	MATERIAL NO.	A	B	C	D	E	F	G
8	51374-8028	32.8	29.5	32.4	32.1	30.7	30.5	8
10	51374-1028	7.8	4.5	7.4	7.1	5.7	5.5	4.5
24	51374-2428	14.8	11.5	14.4	14.1	12.7	12.5	8
30	51374-3028	17.8	14.5	17.4	17.1	15.7	15.5	8
40	51374-4028	22.8	19.5	22.4	22.1	20.7	20.5	8
45	51374-4528	25.3	22.0	24.9	24.6	23.2	23.0	8
50	51374-5028	27.8	24.5	27.4	27.1	25.7	25.5	8
60	51374-6028	32.8	29.5	32.4	32.1	30.7	30.5	8

Figure 35. Recommended Connector Type

Note: Datasheet link: http://www.molex.com/pdm_docs/sd/513741072_sd.pdf

5. Signals and Indicators

5.1. ON/~OFF Signal

This input is used to switch the AirPrime SL6087 Embedded Module ON or OFF.

A HIGH level signal must be provided on the ON/~OFF pin to switch the AirPrime SL6087 Embedded Module ON. The voltage of this signal has to be maintained higher than 0.8 x VBATT during a minimum of 1500ms. This signal can be left at HIGH level until switched off.

To switch the AirPrime SL6087 Embedded Module OFF, the ON/~OFF signal must be reset and an **AT+CPOF** command must be sent to the embedded module.

5.1.1. Pin Description

Refer to the following table for the pin description of the ON/~OFF signal.

Table 35. ON/~OFF Signal Pin Description

Pin Number	Signal	I/O	I/O Type	Description
43	ON/~OFF	I	CMOS	Embedded Module Power-ON

Refer to section 4.2 Electrical Information for Digital I/O for open drain, 2V8 and 1V8 voltage characteristics and reset state definitions.

5.1.2. Electrical Characteristics

Refer to the following table for the electrical characteristics of the ON/~OFF signal.

Table 36. Electrical Characteristics of the ON/~OFF Signal

Parameter	I/O Type	Minimum	Maximum	Unit
V_{IL}	CMOS		VBATT x 0.2	V
V_{IH}	CMOS	VBATT x 0.8	VBATT	V

Caution: *All external signals must be inactive when the AirPrime SL6087 Embedded Module is OFF to avoid any damage when starting and to allow the embedded module to start and stop correctly.*

5.1.3. Power-ON

Once the AirPrime SL6087 Embedded Module is supplied through VBATT, the application must set the ON/OFF signal to high to start the AirPrime SL6087 Embedded Module power-ON sequence. The ON/OFF signal must be held high during a minimum delay of $\mathbf{T_{on/off\text{-}hold}}$ (minimum hold delay on the ON/~OFF signal) to power-ON. After this delay, an internal mechanism maintains the AirPrime SL6087 Embedded Module in power-ON condition.

During the power-ON sequence, an internal reset is automatically performed by the AirPrime SL6087 Embedded Module for 40ms (typical). During this phase, any external reset should be avoided.

Once initialization is completed (timing is SIM and network dependent), the AT interface answers the application with "OK". For further details, refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5.

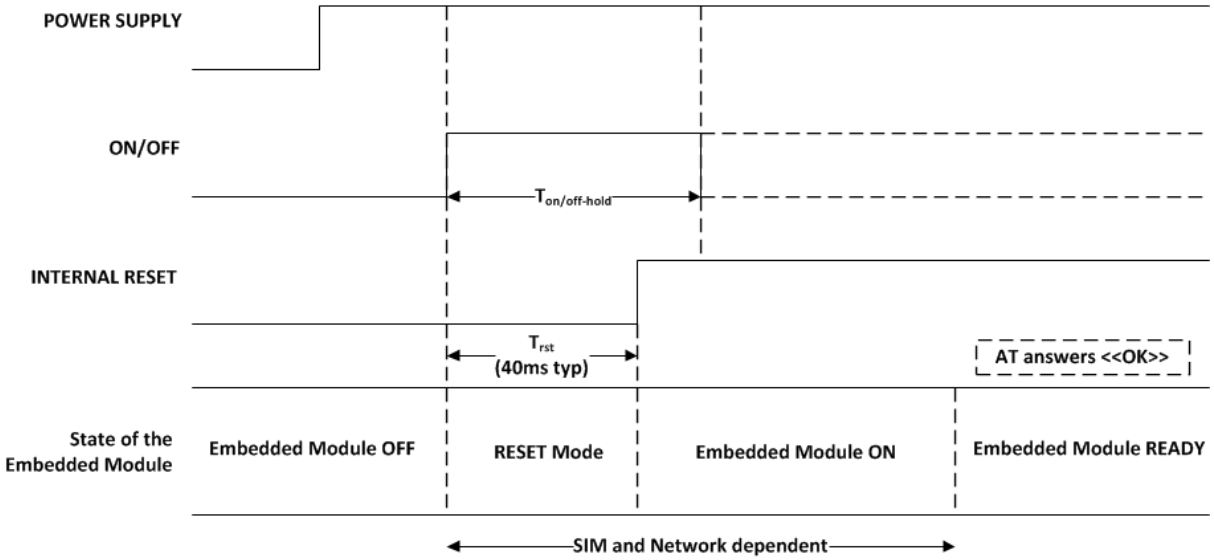


Figure 36. Power-ON Sequence (no PIN code activated)

The duration of the firmware power-ON sequence depends on the need to perform a recovery sequence if power has been lost during a flash memory modification.

Listed below are the other factors that have a minor influence on the power-ON sequence:

- The number of parameters stored in EEPROM by the AT commands received so far
- The ageing of the hardware components, especially the flash memory
- The temperature conditions

The *recommended* way to release the ON/~OFF signal is to use either an AT command or WIND indicators: the application has to detect the end of the power-up initialization and release the ON/~OFF signal afterwards.

To release the ON/~OFF signal, either of the following methods may be used:

- Using AT Command
  - An AT command is sent to the application. Once the initialization is complete, the AT interface will answer with «OK».

Note: If the application manages hardware flow control, the AT command can be sent during the initialization phase.

- Using WIND Indicators
  - If configured to do so, an unsolicited “+WIND: 3” message is returned after initialization. Note that the generation of this message is either enabled or disabled using AT command.

For more information on these commands, refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5.

Proceeding thus, by software detection, will always prevent the application from releasing the ON/~OFF signal too early.

If WIND indicators are disabled or AT commands are unavailable or not used, it is still possible to release the ON/~OFF signal after a delay that is long enough ($\mathbf{T_{on/off-hold}}$) to ensure that the firmware has already completed its power-up initialization.

The table below gives the minimum values of $T_{on/off-hold}$:

Table 37. $T_{on/off-hold}$ Minimum Values

Firmware	$T_{on/off-hold}$
	Safe Evaluations of the Firmware Power-Up Time
Firmware 7.43 (Open AT Application Framework 2.33)	8s

The value in the table above take the worst cases into account: power-loss recovery operations, slow flash memory operations in high temperature conditions, and so on. But they are safe because they are large enough to ensure that ON/~OFF is not released too early.

The typical power-up initialization time figures for best case conditions (no power-loss recovery, fast and new flash memory, etc.) is approximately 3.5 seconds in every firmware version. Note that releasing the ON/~OFF signal after this delay does not guarantee that the application will actually start-up (for example, the power plug has been pulled off during a flash memory operation, like a phone book entry update or an AT&W command).

The ON/~OFF signal can be left at a HIGH level until switched OFF. But this is not recommended as it will prevent the **AT+CPOF** command from performing a clean power-OFF.

When using a battery as power source, it is not recommended to let the ON/OFF signal high.

If the battery voltage is too low and the ON/~OFF signal is at LOW level, an internal mechanism switches the AirPrime SL6087 Embedded Module OFF. This automatic process prevents the battery from being over discharged and optimizes its life span.

During the power-ON sequence, an internal reset is automatically performed by the AirPrime SL6087 Embedded Module for 40 ms (typical). Any external reset should be avoided during this phase.

5.1.4. Power-OFF

Caution: *All external signals must be inactive when the AirPrime SL6087 Embedded Module is OFF to avoid any damage when starting.*

To properly power-OFF the AirPrime SL6087 Embedded Module, the application must reset the ON/OFF signal and then send the **AT+CPOF** command to unregister the module from the network and switch the embedded module OFF.

Once the response "OK" is returned by the embedded module, the external power supply can be switched OFF.

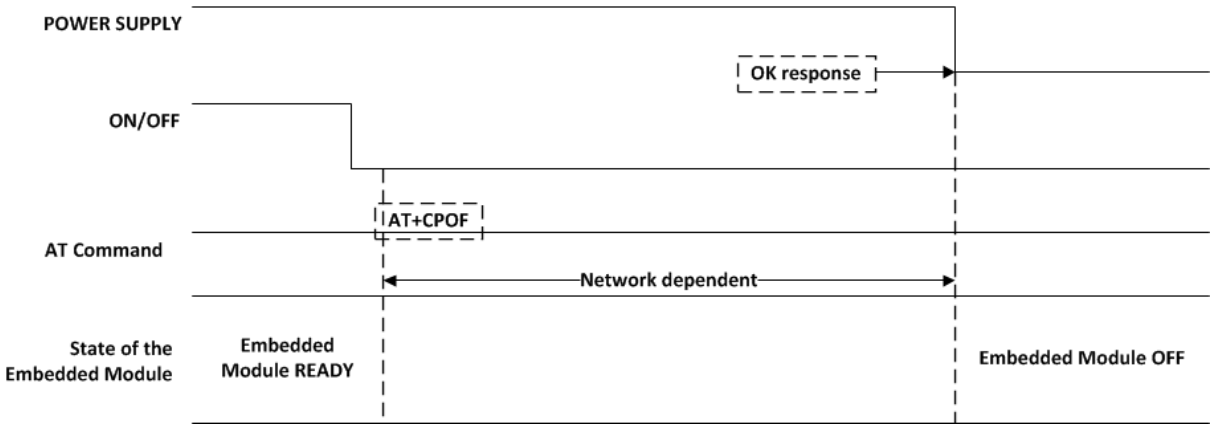


Figure 37. Power-OFF Sequence

If the ON/~OFF pin is maintained at high level (ON), then the AirPrime SL6087 Embedded Module cannot be switched OFF.

5.1.5. Application

The ON/~OFF input (pin 43) is used to switch ON (ON/~OFF=1) or OFF (ON/~OFF=0) the AirPrime SL6087 Embedded Module.

A high level signal has to be provided on the ON/~OFF pin to switch the AirPrime SL6087 Embedded Module ON.

The level of the voltage of this signal has to be maintained at 0.8 x VBATT for a minimum of 2000ms.

This signal can be left at HIGH level until switched OFF.

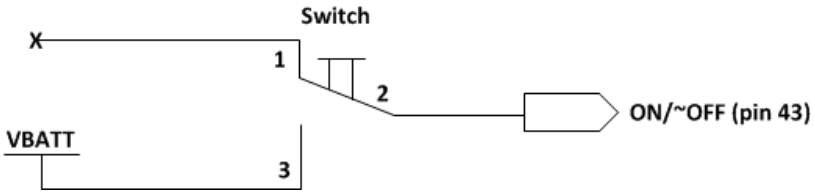


Figure 38. Example of ON/~OFF Pin Connection

5.2. Reset Signal (~RESET)

This signal is used to force a reset procedure by providing the AirPrime SL6087 Embedded Module with a LOW level for at least 200µs. This signal must be considered as an emergency reset only. A reset procedure is already driven by the internal hardware during the power-up sequence.

This signal may also be used to provide a reset to an external device (at power-ON only). If no external reset is necessary, this input may be left open. If used (emergency reset), it must be driven either by an open collector or an open drain.

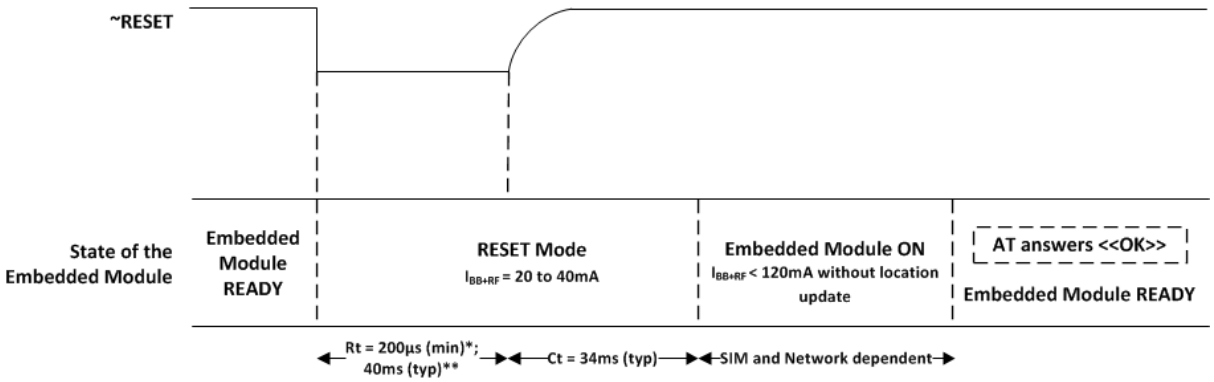
The AirPrime SL6087 Embedded Module remains in reset mode as long as the ~RESET signal is held LOW.

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

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

5.2.1. Reset Sequence

To activate the "emergency" reset sequence, the ~RESET signal must be set to LOW for a minimum of 200µs. As soon as the reset is completed, the AT interface returns "OK" to the application.



* This reset time is the minimum time to be carried out on the ~RESET signal when the power supply is already stabilized.
** This reset time is internally carried out by the embedded module power supply supervisor only when the embedded module power supplies are powered ON.

Figure 39. Reset Sequence Waveform

At power-up, the ~RESET time (Rt) is carried out after switching the AirPrime SL6087 Embedded Module ON. It is generated by the internal voltage supervisor.

The ~RESET time is provided by the internal RC component. To keep the same time, it is not recommended to connect another R or C component (resistor or capacitor) on the ~RESET signal. Only a switch or an open drain gate is recommended.

Ct is the cancellation time required for the AirPrime SL6087 Embedded Module initialization. Ct is automatically carried out after hardware reset.

5.2.2. Pin Description

Refer to the following table for the pin description of the reset signal.

Table 38. Reset Signal Pin Description

Pin Number	Signal	I/O	I/O Type	Description
63	~RESET	I/O Open Drain	1V8	Embedded Module Reset

Refer to section 4.2 Electrical Information for Digital I/O for open drain, 2V8 and 1V8 voltage characteristics and reset state definitions.

5.2.3. Electrical Characteristics

Refer to the following table for the electrical characteristics of the reset signal.

Table 39. Electrical Characteristics of the Reset Signal

Parameter	Minimum	Typical	Maximum	Unit
Input Impedance (R)*		100		kΩ
Input Impedance (C)		10n		F
~RESET time (Rt)[1]	200			µs
~RESET time (Rt)[2] at power up only	20	40	100	ms
Cancellation time (Ct)		34		ms

Parameter	Minimum	Typical	Maximum	Unit
V_H**	0.57			V
V_{IL}	0		0.57	V
V_{IH}	1.33			V

* Internal pull-up

** VH: Hysterisis Voltage

1 This reset time is the minimum to be carried out on the ~RESET signal when the power supply is already stabilized.

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

5.2.4. Application

The ~RESET input (pin 63) is used to force a reset procedure by providing a LOW level for at least 200µs.

This signal has to be considered as an emergency reset only: a reset procedure is automatically driven by an internal hardware during the power-ON sequence.

This signal can also be used to provide a reset to an external device (it then behaves as an output).

If no external reset is necessary this input can be left open.

If used (emergency reset), it has to be driven by an open collector or an open drain output (due to the internal pull-up resistor embedded into the AirPrime SL6087 Embedded Module) as shown in the diagram below.

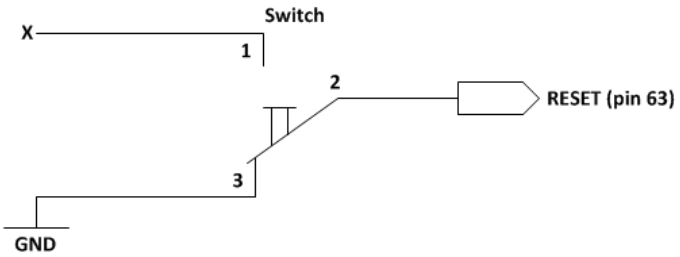


Figure 40. Example of ~Reset Pin Connection with Switch Configuration

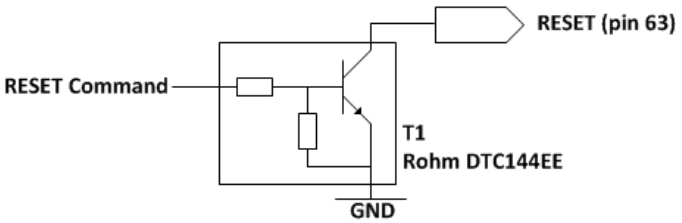


Figure 41. Example of ~Reset Pin Connection with Transistor Configuration

An open collector or open drain transistor can be used. If an open collector is chosen, T1 can be a ROHM DTC144EE.

Table 40. Reset Settings

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

5.3. BOOT Signal

A specific BOOT control pin is available to download to the AirPrime SL6087 Embedded Module (only if the standard XMODEM download, controlled with AT command, is not possible).

A specific PC software program, provided by Sierra Wireless, is needed to perform this specific download.

The BOOT pin must be connected to VCC_1V8 for this specific download.

Table 41. BOOT Settings

BOOT	Operating Mode	Comment
Leave open	Normal use	No download
Leave open	Download XMODEM	AT command for Download **AT+WDWL***
1	Download specific	Need Sierra Wireless PC software

* Refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5 for more information about this AT command.

5.3.1. Pin Description

Refer to the following table for the pin description of the Boot signal.

Table 42. Boot Signal Pin Description

Pin Number	Signal	I/O	I/O Type	Description
18	BOOT	I	1V8	Download mode selection

Refer to section 4.2 Electrical Information for Digital I/O for open drain, 2V8 and 1V8 voltage characteristics and reset state definitions.

For more information about using AT commands to manipulate this signal, refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5.

Note that this BOOT pin must be left open for normal use or XMODEM download.

However, in order to render the development and maintenance phases easier, it is highly recommended to set a test point, either a jumper or a switch on the VCC_1V8 (pin 59) power supply.

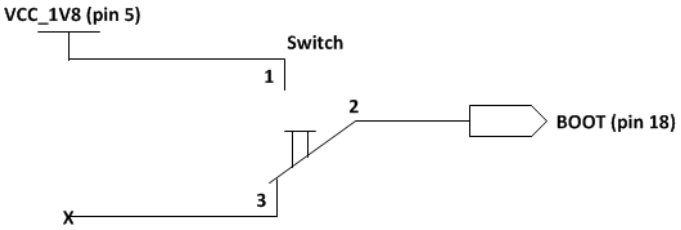


Figure 42. Example of BOOT Pin Implementation

5.4. BAT-RTC (Backup Battery)

The AirPrime SL6087 Embedded Module provides an input/output to connect a Real Time Clock power supply.

This pin is used as a back-up power supply for the internal Real Time Clock. The RTC is supported by the AirPrime SL6087 Embedded Module when VBATT is available, but a backup power supply is needed to save date and time when VBATT is switched off (VBATT = 0V).

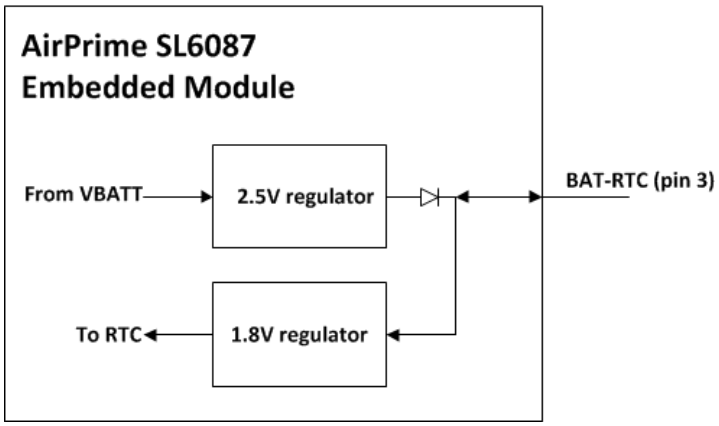


Figure 43. Real Time Clock Power Supply

If RTC is not used, this pin can be left open. If VBATT is available, the back-up battery can be charged by the internal 2.5V power supply regulator.

The back-up power supply can be provided by any of the following:

- A super capacitor
- A non-rechargeable battery
- A rechargeable battery

5.4.1. Pin Description

Refer to the following table for the pin description of the BAT-RTC interface.

Table 43. BAT-RTC Pin Description

Pin Number	Signal	I/O	I/O Type	Description
3	BAT-RTC	I/O	Supply	RTC Back-up supply

5.4.2. Electrical Characteristics

Refer to the following table for the electrical characteristics of the BAT-RTC interface.

Table 44. Electrical Characteristics of the BAT-RTC Interface

Parameter	Minimum	Typical	Maximum	Unit
Input voltage	1.85		3.0	V
Input current consumption*	3.0	3.3	3.6	µA
Output voltage	2.40	2.45	2.50	V
Output current			2	mA

* Provided by an RTC back-up battery when the AirPrime SL6087 Embedded Module power supply is off (VBATT = 0V).

5.4.3. Application

5.4.3.1. Super Capacitor

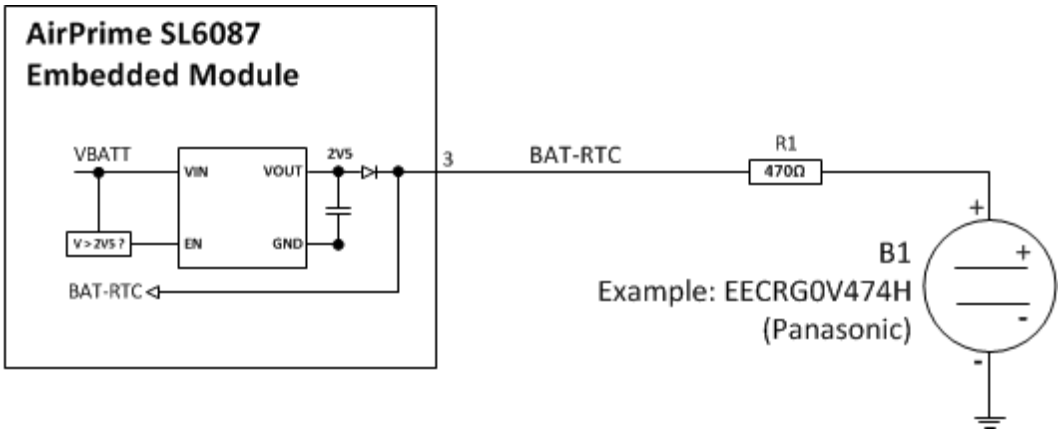


Figure 44. RTC Supplied by a Gold Capacitor

The estimated range with a 0.47Farad gold capacitor is 25 hours for 3µA.

Note: The gold capacitor maximum voltage is 2.5V.

5.4.3.2. Non-Rechargeable Battery

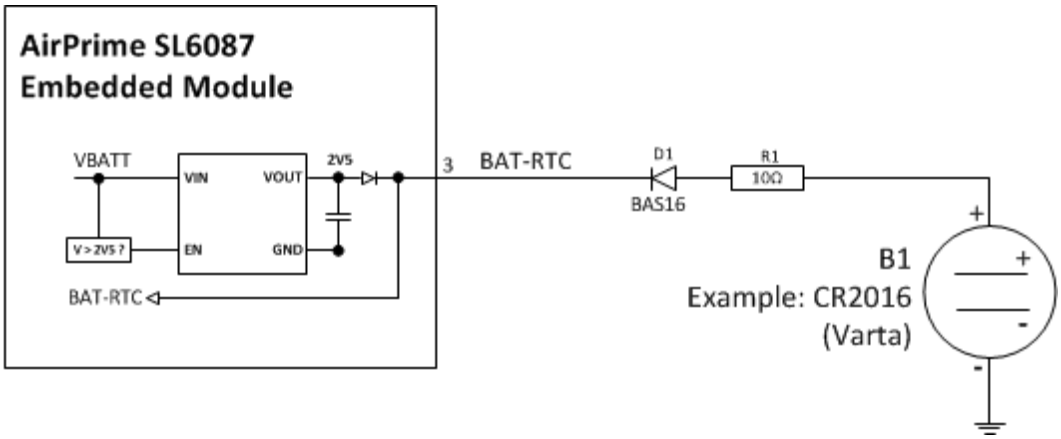


Figure 45. RTC Supplied by a Non-Rechargeable Battery

Diode D1 is mandatory to prevent the non-rechargeable battery from becoming damaged.

The estimated range with an 85mAh battery is 800H (minimum).

5.4.3.3. Rechargeable Battery

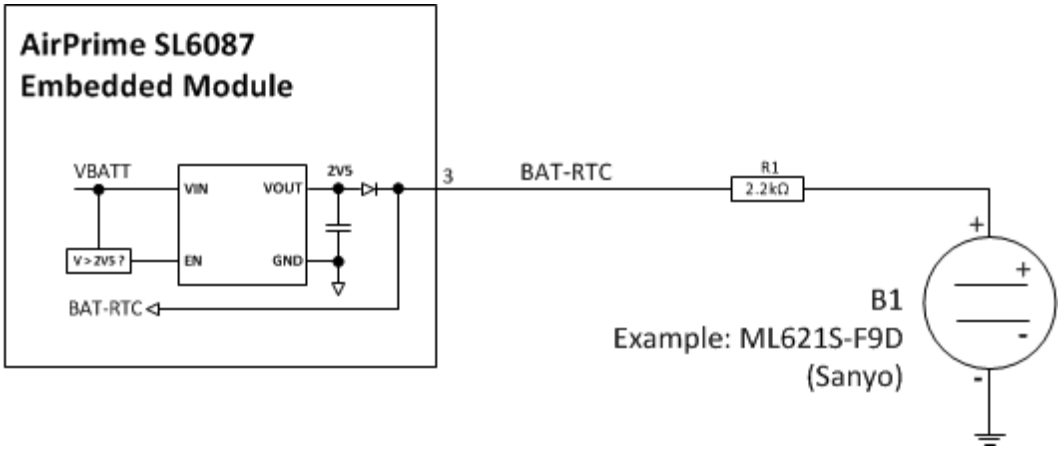


Figure 46. RTC Supplied by a Rechargeable Battery

The estimated range with a 2mAh rechargeable battery is approximately 15H.

Caution: *Ensure that the cell voltage is lower than 2.75V before battery cell assembly to avoid damaging the AirPrime SL6087 Embedded Module.*

5.5. Buzzer Output

This digital output is controlled by a pulse-width modulation controller and is an open drain output. This signal may only be used in the implementation of a buzzer. The buzzer can be directly connected to this output signal and VBATT. The maximum current is 100mA (PEAK).

5.5.1. Pin Description

Refer to the following table for the pin description of the buzzer output.

Table 45. PWM/Buzzer Output Pin Description

Pin Number	Signal	I/O	I/O Type	Reset State	Multiplexed With
68	BUZZER0	O	Open drain	Z	Buzzer output

Refer to section 4.2 Electrical Information for Digital I/O for open drain, 2V8 and 1V8 voltage characteristics and reset state definitions.

5.5.2. Electrical Characteristics

Refer to the following table for the electrical characteristics of the buzzer output.

Table 46. Electrical Characteristics of the Buzzer Output

Parameter	Condition	Minimum	Maximum	Unit
$V_{OL\ on}$	Iol = 100mA		0.4	V
I_{PEAK}	VBATT = VBATTmax		100	mA

Parameter	Condition	Minimum	Maximum	Unit
Frequency		1	50000	Hz

5.5.3. Application

The maximum peak current for this interface is 100mA and the maximum average current is 40mA. A transient voltage suppressor (TVS) diode, D1, must be added to the circuit as shown in the figure below.

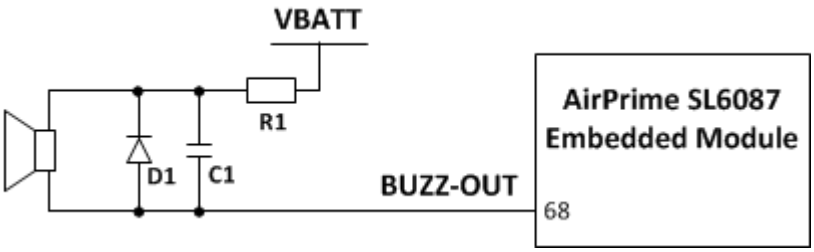


Figure 47. Example of a Buzzer Implementation

Take note of the following when implementing a buzzer:

- R1 must be chosen in order to limit the current at I_{PEAK} max
- C1 = 0 to 100nF (depending on the buzzer type)
- D1 = BAS16 (example)

The BUZZ-OUT output can also be used to drive an LED as shown in the following figure:

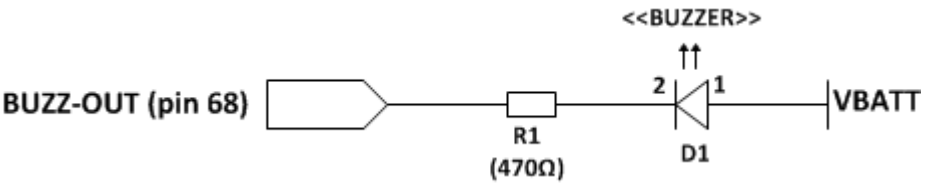


Figure 48. Example of an LED Driven by the Buzzer Output

The value of R1 should correspond with the characteristics of the LED (D1).

5.5.4. Recommended Characteristics

- Type :electro-magnetic
- Impedance :7Ω to 30Ω
- Sensitivity :90dB SPL minimum @ 10cm
- Current :60mA to 90mA

5.6. External Interrupt

The AirPrime SL6087 Embedded Module provides five external interrupt inputs with different voltages. These interrupt inputs can be activated on the:

- High to low level transition
- Low to high level transition
- Low to high and high to low level transitions

When used, the interrupt inputs must not be left open; and when they are not used, they must be configured as GPIOs.

5.6.1. Pin Description

Refer to the following table for the pin description of the external input/interrupt.

Table 47. External Interrupt Pin Description

Signal	Pin Number	I/O	I/O Type	Reset State	Description	Multiplexed With
INT0	61	I	1V8	Z	External Interrupt	GPIO3
INT1	62	I	2V8	Z	External Interrupt	GPIO25
INT2	1	I	2V8	1	External Interrupt	CT104-RXD1/GPIO5
INT3	70	I	2V8	Z	External Interrupt	~CT108-2-DTR1/GPIO9
INT4	46	I	1V8	0	External Interrupt	CT104-RXD2/GPIO15

Refer to section 4.2 Electrical Information for Digital I/O for open drain, 2V8 and 1V8 voltage characteristics and reset state definitions.

5.6.2. Electrical Characteristics

Refer to the following table for the electrical characteristics of the external input/interrupt.

Table 48. Electrical Characteristics of the External Input/Interrupt

Parameter		Minimum	Maximum	Unit
INT0	V_{IL}		0.54	V
	V_{IH}	1.33		V
INT1	V_{IL}		0.84	V
	V_{IH}	1.96		V
INT2	V_{IL}		0.84	V
	V_{IH}	1.96		V
INT3	V_{IL}		0.84	V
	V_{IH}	1.96		V
INT4	V_{IL}		0.54	V
	V_{IH}	1.33		V

5.6.3. Application

INT0, INT1, INT3 and INT4 are high impedance input types so it is important to set the interrupt input signals with pull-up or pull-down resistors if they are driven by an open drain, an open collector or by a switch. If the interrupt signals are driven by a push-pull transistor, then no pull-up or pull-down resistors are necessary.

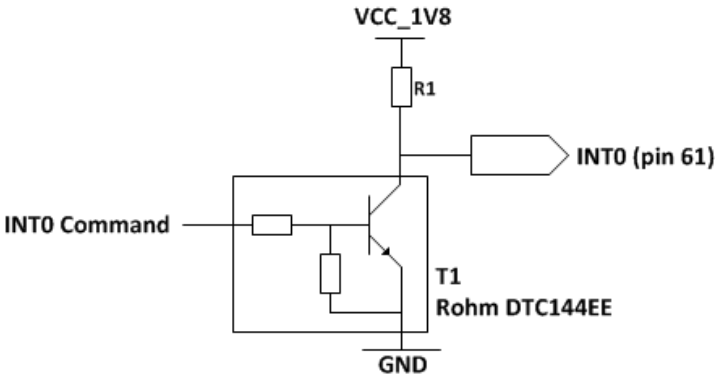


Figure 49. Example of INT0 Driven by an Open Collector

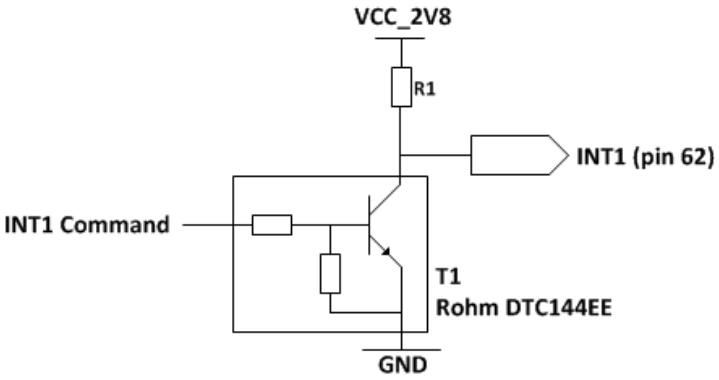


Figure 50. Example of INT1 Driven by an Open Collector

where:

- The value of R1 can be 47kΩ
- T1 can be a ROHM DTC144EE open collector transistor

5.7. VCC_2V8 and VCC_1V8 Output

These digital power supply outputs are mainly used to:

- Pull-up signals such as I/Os
- Supply the digital transistors driving LEDs
- Supply the SIMPRES signal
- Act as a voltage reference for the ADC interface ADC2 (VCC_2V8 only)

Each digital output has a maximum current of 15mA.

Both **VCC_2V8** and **VCC_1V8** are only available when the AirPrime SL6087 Embedded Module is ON.

5.7.1. Pin Description

Refer to the following table for the pin description of the VCC_2V8 and VCC_1V8 output.

Table 49. VCC_2V8 and VCC_1V8 Pin Description

Pin Number	Signal	I/O	I/O Type	Description
59	VCC_1V8	O	Supply	1.8V digital supply
58	VCC_2V8	O	Supply	2.8V digital supply

Refer to section 4.2 Electrical Information for Digital I/O for open drain, 2V8 and 1V8 voltage characteristics and reset state definitions.

5.7.2. Electrical Characteristics

Refer to the following table for the electrical characteristics of the VCC_2V8 and VCC_1V8 output signals.

Table 50. Electrical Characteristics of the VCC_2V8 and VCC_1V8 Signals

Parameter		Minimum	Typical	Maximum	Unit
VCC_2V8	Output voltage	2.74	2.8	2.86	V
	Output Current			15	mA
VCC_1V8	Output voltage	1.76	1.8	1.94	V
	Output Current			15	mA

5.8. FLASH-LED (LED0)

The FLASH-LED is the GSM activity status indicator signal of the AirPrime SL6087 Embedded Module and it can be used to drive an LED. This signal is an open drain output. An LED and a resistor can be directly connected between this output and VBATT.

When the AirPrime SL6087 Embedded Module is ON, this output is used to indicate the network status.

Table 51. FLASH-LED Status

SL6087 State	VBATT Status	FLASH-LED Status	SL6087 Embedded Module Status
OFF	VBATT< 2.8V or VBATT > 3.2V	OFF	OFF

SL6087 State	VBATT Status	FLASH-LED Status	SL6087 Embedded Module Status
ON	VBATT > 3.2V	Permanent	ON; not registered on the network
		Slow flash LED ON for 200 ms, OFF for 2 s	ON; registered on the network
		Quick flash LED ON for 200 ms, OFF for 600 ms	ON; registered on the network, communication in progress
		Very quick flash LED ON for 100ms, OFF for 200ms	ON; software downloaded is either corrupted or non-compatible ("BAD SOFTWARE")

5.8.1. Pin Description

Refer to the following table for the pin description of the FLASH-LED.

Table 52. FLASH-LED Pin Description

Pin Number	Signal	I/O	I/O Type*	Reset State	Description
60	LED0	O	Open Drain Output	1 and Undefined	LED driving

Refer to section 4.2 Electrical Information for Digital I/O for open drain, 2V8 and 1V8 voltage characteristics and reset state definitions.

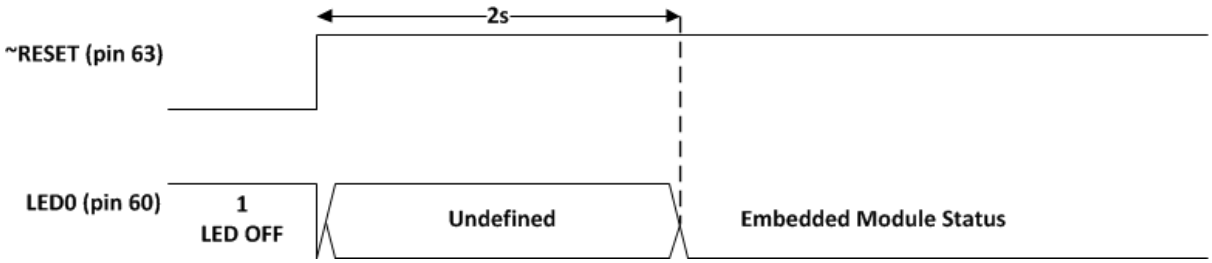


Figure 51. LED0 State During RESET and Initialization Time

LED0 state is HIGH during the RESET time and undefined during the software initialization time. During software initialization time, for a maximum of 2 seconds after RESET cancellation, the LED0 signal is toggling and does not provide the AirPrime SL6087 Embedded Module status. After the 2s period, the LED0 provides the true status of the AirPrime SL6087 Embedded Module.

5.8.2. Electrical Characteristics

Refer to the following table for the electrical characteristics of the FLASH-LED signal.

Table 53. Electrical Characteristics of the FLASH-LED Signal

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

5.8.3. Application

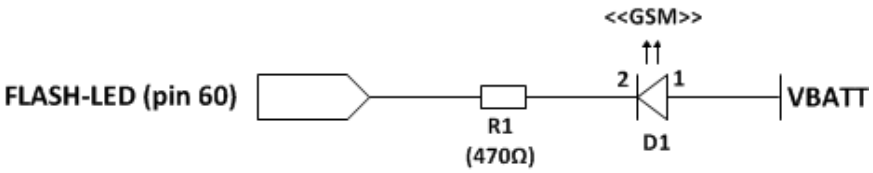


Figure 52. Example of FLASH-LED Implementation

R1 can be harmonized depending on the characteristics of the LED (D1).

5.9. Analog to Digital Converter

Two Analog to Digital Converter inputs, ADC1 and ADC2, are provided by the AirPrime SL6087 Embedded Module. These converters are 10-bit resolution ADCs ranging from 0V to 2V.

Typically, the ADC1 input is used to monitor external temperature. This is very useful for monitoring the application temperature and can be used as an indicator to safely power OFF the application in case of overheating (for Li-Ion batteries).

The ADC2 input can be used for customer specific applications.

5.9.1. Pin Description

Refer to the following table for the pin description of the ADC.

Table 54. ADC Pin Description

Pin Number	Signal	I/O	I/O Type	Description
40	ADC1	I	Analog	A/D converter
5	ADC2	I	Analog	A/D converter

5.9.2. Electrical Characteristics

Refer to the following table for the electrical characteristics of the ADC.

Table 55. Electrical Characteristics of the ADC

Parameter		Minimum	Typical	Maximum	Unit
Maximum output code			1635		LSBs
Sampling rate				138[1]	sps
Input signal range		0		2	V
INL (Integral non linearity)			15		mV
DNL (Differential non linearity)			2.5		mV
Input impedance	ADC1		1M*		Ω
	ADC2		1M		Ω

* Internal pull-up to 2.8V

1 Sampling rate only for ADC2 and the application.

5.9.3. ADC Measurements Using AT Command

The AT command **AT+ADC** may be used to retrieve measures of the various ADCs available on the embedded module. The following table enumerates the ADC IDs linked to the AT command and the corresponding signal or interface that they measure.

Table 56. ADC ID Mapping

ADCIdx	Signal or Interface Being Measured
ADC0	Battery voltage
ADC1	External temperature sensor interface (e.g. when connecting to NTC)
ADC2	External ADC interface
ADC3	Internal temperature sensor interface (refer to section 4.12 Temperature Sensor Interface)

For more information about the **ADC** AT command, refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5.

5.10. Reserved

There are four reserved pins on the AirPrime SL6087 Embedded Module, which are used for debug purpose or production. It is highly recommended to add a test point on each reserved pin for debug trace.

Table 57. Reserved Pin Description

Pin Number	Signal	I/O Type	Description
35	Reserved_35	-	Reserved for production
36	Reserved_36	-	Reserved for production
41	Reserved_41	-	Reserved for power management
55	Reserved_55	2.8V	Reserved for production

Caution: *An NC pull-up resistor from Reserved_41 to VCC_2V8 must be reserved on the customer PCB.*

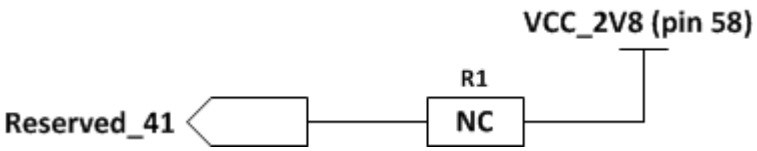


Figure 53. Reserved_41 Pulled Up to VCC_2V8 Through an NC Resistor

6. Power Consumption

The power consumption values of the AirPrime SL6087 Embedded Module vary depending on the operating mode, RF band and software used (with or without the Open AT Application Framework). The following power consumption values were obtained by performing measurements on AirPrime SL6087 Embedded Module samples at a temperature of 25°C with the assumption of a 50Ω RF output.

Three VBATT values were used to measure the power consumption of the AirPrime SL6087 Embedded Module:

- VBATT = 3.2V
- VBATT = 3.6V
- VBATT = 4.8V

The average current and the maximum current peaks were also measured for all three VBATT values.

For a more detailed description of the operating modes, refer to the appendix of document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5.

For more information on the consumption measurement procedure, refer to section 7 Consumption Measurement Procedure.

6.1. Power Consumption without the Open AT Application Framework

The following measurement results are relevant when:

- there is an application
- the application is disabled
- no processing is required by an application

Note: Power consumption performance is software related. The values listed below were based on Firmware 7.45.

$_{TX}$ means that the current peak is the RF transmission burst (Tx burst).

$_{RX}$ means that the current peak is the RF reception burst (Rx burst).

Table 58. Power Consumption Without the Open AT Application Framework; Typical Values

Operating Mode	Parameter	$I_{Average}$			I_{Peak}	Unit
		VBATT=3.2V	VBATT=3.6V	VBATT=4.8V		
ALARM Mode		17.00	17.50	18.00	----	µA
SLEEP Mode		0.39	0.39	0.41	1.53	mA
ACTIVE Mode		22.50	21.17	18.46	62.08	mA
SLEEP mode with telecom stack in Idle Mode *	Paging 9/Rx burst occurrence ~2s	2.20	1.99	1.80	259.54	mA
	Paging 2/Rx burst occurrence ~0,5s	5.69	5.33	4.69	271.08	mA
ACTIVE mode with telecom stack in Idle Mode	Paging 9/Rx burst occurrence ~2s	22.63	20.56	19.02	145.39	mA
	Paging 2/Rx burst occurrence ~0,5s	24.29	22.14	19.30	145.84	mA

Operating Mode	Parameter	$I_{Average}$			I_{Peak}	Unit
		VBATT=3.2V	VBATT=3.6V	VBATT=4.8V		
Peak current in GSM/GPRS Mode	850/900 MHz - PCL5/gam.3 (TX power 33dBm)	1596.52	1519.03	1497.96	1596.52	mA
	1800/1900 MHz - PCL0/gam.3 (TX power 30dBm)	1162.45	1132.00	1126.04	1162.45	mA
GSM Connected Mode (Voice)	850/900 MHz - PCL5 (TX power 33dBm)	250.1	239.2	228.4	1701.5	mA
	850/900 MHz - PCL19 (TX power 5dBm)	102.0	97.6	89.1	323.2	mA
	1800/1900 MHz - PCL0 (TX power 30dBm)	214.7	207.3	198.2	1377.5	mA
	1800/1900 MHz - PCL15 (TX power 0dBm)	99.0	94.6	86.1	299.7	mA
GPRS Transfer Mode class 10 (3Rx/2Tx)	850/900 MHz - gam.3 (TX power 30dBm)	425.5	408.5	396.5	1731.7	mA
EGPRS Transfer Mode class 10 (3Rx/2Tx)	850/900 MHz - gam.6 (TX power 24dBm)	372.0	368.5	368.5	1925.2	mA
	1800/1900 MHz - gam.5 (TX power 23dBm)	332.8	327.5	323.6	1725.5	mA

* Sleep Idle Mode consumption is dependent on the SIM card used. Some SIM cards respond faster than others; the longer the response time, the higher the consumption.

Note: The USB port must be deactivated to enter Sleep Mode.

6.2. Power Consumption with the Open AT Application Framework

The following consumption results were measured during the Dhrystone application run.

Note: Power consumption performance is software related. The values listed in the tables below were based on Firmware 7.43.A1.

$_{TX}$ means that the current peak is the RF transmission burst (Tx burst).

$_{RX}$ means that the current peak is the RF reception burst (Rx burst).

Table 59. Power Consumption With the Application CPU @ 26MHz; Typical Values

Operating Mode	Parameter	$I_{Average}$			I_{Peak}	Unit
		VBATT=3.2V	VBATT=3.6V	VBATT=4.8V		
ALARM Mode		N/A	N/A	N/A	N/A	µA

Operating Mode	Parameter	$I_{Average}$			I_{Peak}	Unit
		VBATT=3.2V	VBATT=3.6V	VBATT=4.8V		
SLEEP Mode		N/A	N/A	N/A	N/A	mA
ACTIVE Mode		48.1	43.9	35.7	67.8	mA
SLEEP mode with telecom stack in Idle Mode *	Paging 9/Rx burst occurrence ~2s	N/A	N/A	N/A	N/A	mA
	Paging 2/Rx burst occurrence ~0,5s	N/A	N/A	N/A	N/A	mA
ACTIVE mode with telecom stack in Idle Mode	Paging 9/Rx burst occurrence ~2s	46.9	42.8	34.8	147	mA
	Paging 2/Rx burst occurrence ~0,5s	47.8	43.7	35.7	149	mA
Peak current in GSM/GPRS Mode	850/900 MHz - PCL5/gam.3 (TX power 33dBm)	1668	1595	1524	1668	mA
	1800/1900 MHz - PCL0/gam.3 (TX power 30dBm)	1275	1237	1221	1275	mA
GSM Connected Mode (Voice)	850/900 MHz - PCL5 (TX power 33dBm)	260	245	232	1651	mA
	850/900 MHz - PCL19 (TX power 5dBm)	104	99	90	309	mA
	1800/1900 MHz - PCL0 (TX power 30dBm)	216	208	198	1275	mA
	1800/1900 MHz - PCL15 (TX power 0dBm)	101	96	87	280	mA
GPRS Transfer Mode class 10 (3Rx/2Tx)	850/900 MHz - gam.3 (TX power 30dBm)	446	424	403	1668	mA
EGPRS Transfer Mode class 10 (3Rx/2Tx)	850/900 MHz - gam.6 (TX power 24dBm)	325	329	337	1384	mA
	1800/1900 MHz - gam.5 (TX power 23dBm)	290	289	293	1346	mA

* Sleep Idle Mode consumption is dependent on the SIM card used. Some SIM cards respond faster than others; the longer the response time, the higher the consumption.

Note: The USB port must be deactivated to enter Sleep Mode.

Table 60. Power Consumption With the Application CPU @ 104MHz; Typical Values

Operating Mode	Parameter	$I_{Average}$			I_{Peak}	Unit
		VBATT=3.2V	VBATT=3.6V	VBATT=4.8V		
ALARM Mode		N/A	N/A	N/A	N/A	µA
SLEEP Mode		N/A	N/A	N/A	N/A	mA
ACTIVE Mode		87.6	78.8	61.8	110.9	mA

Operating Mode	Parameter	$I_{Average}$			I_{Peak}	Unit
		VBATT=3.2V	VBATT=3.6V	VBATT=4.8V		
SLEEP mode with telecom stack in Idle Mode *	Paging 9/Rx burst occurrence ~2s	N/A	N/A	N/A	N/A	mA
	Paging 2/Rx burst occurrence ~0,5s	N/A	N/A	N/A	N/A	mA
ACTIVE mode with telecom stack in Idle Mode	Paging 9/Rx burst occurrence ~2s	86.2	77.6	60.8	183	mA
	Paging 2/Rx burst occurrence ~0,5s	87.0	78.3	61.6	183	mA
Peak current in GSM/GPRS Mode	850/900 MHz - PCL5/gam.3 (TX power 33dBm)	1740	1623	1565	1740	mA
	1800/1900 MHz - PCL0/gam.3 (TX power 30dBm)	1329	1282	1252	1329	mA
GSM Connected Mode (Voice)	850/900 MHz - PCL5 (TX power 33dBm)	301	280	257	1724	mA
	850/900 MHz - PCL19 (TX power 5dBm)	142	133	115	354	mA
	1800/1900 MHz - PCL0 (TX power 30dBm)	253	241	222	1329	mA
	1800/1900 MHz - PCL15 (TX power 0dBm)	138	129	111	322	mA
GPRS Transfer Mode class 10 (3Rx/2Tx)	850/900 MHz - gam.3 (TX power 30dBm)	488	455	428	1740	mA
EGPRS Transfer Mode class 10 (3Rx/2Tx)	850/900 MHz - gam.6 (TX power 24dBm)	365	363	361	1416	mA
	1800/1900 MHz - gam.5 (TX power 23dBm)	322	316	317	1387	mA

* Sleep Idle Mode consumption is dependent on the SIM card used. Some SIM cards respond faster than others; the longer the response time, the higher the consumption.

Note: The USB port must be deactivated to enter Sleep Mode.

7. Consumption Measurement Procedure

This chapter describes the consumption measurement procedure used to obtain the AirPrime SL6087 Embedded Module consumption specification.

7.1. Hardware Configuration

Consumption results are highly dependent on the hardware configuration used during measurement and this section describes the hardware configuration settings that must be used to obtain optimum consumption measurements.

The following hardware configuration includes both the measurement equipment used and the Airprime SL6087 Embedded Module on the AirPrime SL Series Development Kit board v1.

7.1.1. Equipments Used

Four devices were used to perform consumption measurement:

- Network Analyzer
- Current Measuring Power Supply
- Standalone Power Supply
- Computer, to control the AirPrime SL6087 Embedded Module and to save measurement data

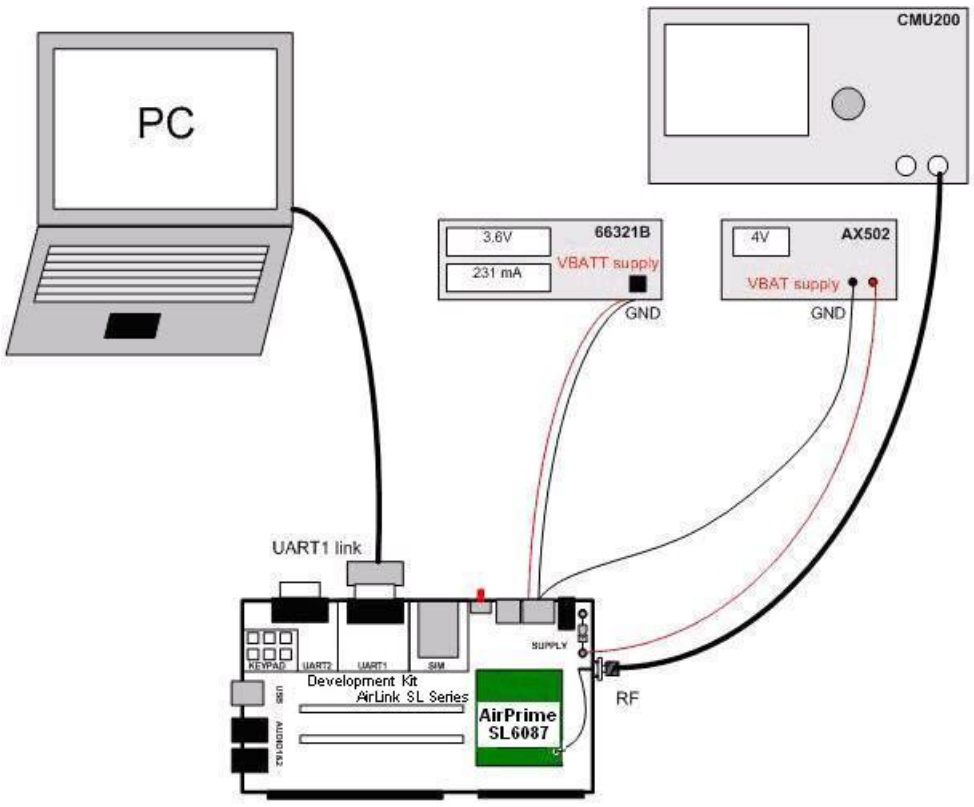


Figure 54. Typical Hardware Configuration

The **network analyzer** is a **CMU 200** from **Rhode & Schwartz**. This analyzer offers all GSM/GPRS/EGPRS network configurations required and allows a wide range of network configurations to be set.

The **AX502** standalone power supply is used to supply all development kit board components except the AirPrime SL6087 Embedded Module. The goal is to separate the development kit board consumption from the embedded module consumption which is measured by the other power supply, the **66321B** “current measuring power supply”.

The “current measuring power supply” is also connected and controlled by the computer (GPIB control not shown in the previous figure).

A SIM must be inserted in the AirPrime SL Series Development Kit during all consumption measurements.

The following table lists the recommended equipments to use for the consumption measurement.

Table 61. Recommended Equipments

Device	Manufacturer	Reference	Notes
Network analyzer	Rhode & Schwartz	CMU 200	Quad Band GSM/DCS/GPRS/EGPRS
Current measuring power supply	Agilent	66321B	Used for VBATT
Standalone power supply	Metrix	AX502	Used for VBAT

7.1.2. AirPrime SL Series Development Kit Board v1

The AirPrime SL Series Development Kit Board v1 is used as a basis for the AirPrime SL6087 Embedded Module measurements using several settings. For more information about these settings, refer to document [4] AirPrime SL Series Development Kit User Guide.

The AirPrime SL Series Development Kit board is powered by the standalone power supply VBAT; while the AirPrime SL6087 Embedded Module is powered by the current measuring power supply, VBATT. Because of this, the link between VBATT and VBAT (J605) must be opened (by removing the solder at the top of the board in the SUPPLY area).

- VBATT is powered by the current measuring power supply **66321B**
- VBAT is powered by the standalone power supply **AX502**

Also take note of the following additional configuration/settings:

- The R600 and R601 resistors (around the ADC1 connector) must be removed.
- The UART2 link is not used; therefore, J201, J202, J203 and J204 must be opened (by removing the solder).
- The USB link is not used; therefore, J301, J302, J303, J304 and J305 must be opened (by removing the solder).
- The standalone power supply, VBAT, may be set to 4V.

The goal of the settings listed above is to eliminate all bias current from VBATT and to supply the entire board (except the SL6087 Embedded Module) using only VBAT.

Note: When measuring the current consumption in alarm mode, it is necessary to remove D100, D103 and R103 from the AirPrime SL Series Development Kit in order to have accurate results.

7.1.3. SIM Cards

Consumption measurement may be performed with either 3-Volt or 1.8-Volt SIM cards. However, all specified consumption values are for a 3-Volt SIM card.

Note: The SIM card's voltage is supplied by the embedded module's power supply. Consumption measurement results may vary depending on the SIM card used.

7.2. Software Configuration

The software configuration for the equipment(s) used and the AirPrime SL6087 Embedded Module settings are presented in the following sub-sections.

7.2.1. Embedded Module Configuration

The software configuration for the AirPrime SL6087 Embedded Module is done by selecting the operating mode to use in performing the measurement.

A description of the operating modes and the procedures used to change the operating mode are given in the appendix of document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5.

The available operating modes in the AirPrime SL6087 Embedded Module are as follows:

- Alarm Mode
- Active Idle Mode
- Sleep Idle Mode
- Active Mode
- Sleep Mode
- Connected Mode
- Transfer Mode class 8 (4Rx/1Tx)
- Transfer Mode class 10 (3Rx/2Tx)

Note: The USB port must be deactivated to enter Sleep Mode.

7.2.2. Equipment Configuration

The network analyzer is set according to the AirPrime SL6087 Embedded Module's operating mode.

Paging during Idle modes, TX burst power, RF band and GSM/DCS/GPRS/EGPRS may be selected on the network analyzer.

Refer to the following table for the network analyzer configuration according to operating mode.

Table 62. Operating Mode Configuration

Operating Mode	Network Analyzer Configuration
ALARM Mode	N/A
SLEEP Mode	N/A
ACTIVE Mode	N/A
SLEEP mode with telecom stack in Idle Mode	Paging 9/Rx burst occurrence ~2s
	Paging 2/Rx burst occurrence ~0,5s

Operating Mode	Network Analyzer Configuration
ACTIVE mode with telecom stack in Idle Mode	Paging 9/Rx burst occurrence ~2s
	Paging 2/Rx burst occurrence ~0,5s
Peak current in GSM/GPRS Mode	850/900 MHz - PCL5/gam.3 (TX power 33dBm)
	1800/1900 MHz - PCL0/gam.3 (TX power 30dBm)
GSM Connected Mode (Voice)	850/900 MHz - PCL5 (TX power 33dBm)
	850/900 MHz - PCL19 (TX power 5dBm)
	1800/1900 MHz - PCL0 (TX power 30dBm)
	1800/1900 MHz - PCL15 (TX power 0dBm)
GPRS Transfer Mode class 10 (3Rx/2Tx)	850/900 MHz - gam.3 (TX power 30dBm)
EGPRS Transfer Mode class 10 (3Rx/2Tx)	850/900 MHz - gam.6 (TX power 24dBm)
	1800/1900 MHz - gam.5 (TX power 23dBm)

The standalone power supply, VBAT, may be set from 3.2V to 4.8V.

The current measuring power supply, VBATT, may be set from 3.2V to 4.8V according to the AirPrime SL6087 Embedded Module VBATT specifications.

8. Reliability Compliance and Recommended Standards

8.1. Reliability Compliance

The AirPrime SL6087 Embedded Module connected on a development kit board application is compliant with the following requirements.

Table 63. Standards Conformity for the AirPrime SL6087 Embedded Module

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

8.2. Applicable Standards Listing

The table hereafter gives the basic list of standards applicable to the AirPrime SL6087 Embedded Module.

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

Table 64. 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.
IEC60068238	2.0	Environmental testing - part 2-38: Test Z/AD: composite temperature/humidity cyclic test.

Document	Current Version	Title
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 I: 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).

8.3. Environmental Specifications

The AirPrime SL6087 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 65. 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

8.3.1. 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 AirPrime SL6087 Embedded Module.

Table 66. ISO Failure Mode Severity Classification

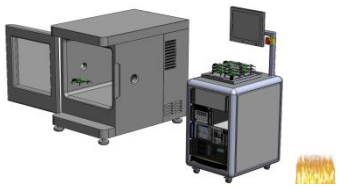
Class	Definition
CLASS A	The AirPrime SL6087 Embedded Module remains fully functional during and after environmental exposure; and shall meet the minimum requirements of 3GPP or appropriate wireless standards.
CLASS B	The AirPrime SL6087 Embedded Module remains fully functional during and after environmental 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.

8.4. Reliability Prediction Model

8.4.1. Life Stress Tests

The following tests the AirPrime SL6087 Embedded Module's product performance.

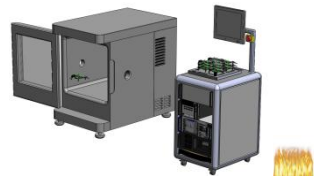
Table 67. Life Stress Tests

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
Durability Test DT 	Standard: IEC 60068-2-2, Test Bb
	Special conditions: • Temperature: +85°C • Rate of temperature change: ± 3°C/min • Recovery time: 3 hours
	Operating conditions: Powered and Un-powered
	Duration: 156 days

8.4.2. Environmental Resistance Stress Tests

The following tests the AirPrime SL6087 Embedded Module's resistance to extreme temperature.

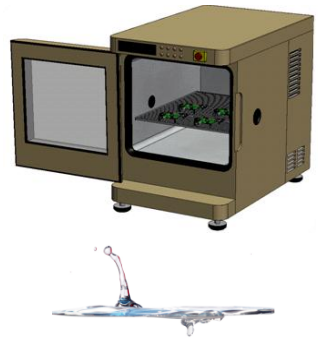
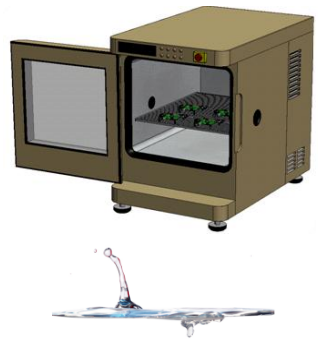
Table 68. Environmental Resistance Stress Tests

Designation	Condition
Cold Test COT 	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 minute and then OFF for 1 minute
	Duration: 60 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: 60 days

8.4.3. Corrosive Resistance Stress Tests

The following tests the AirPrime SL6087 Embedded Module's resistance to corrosive atmosphere.

Table 69. 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 5 minutes and then OFF for 15 minutes
	Duration: 10 days
Moist Heat Cyclic Test MHCT 	Standard: IEC 60068-2-30, Test Db
	Special conditions: • Upper temperature: +55 ± 2°C • Lower temperature: +25°C ± 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

8.4.4. Thermal Resistance Cycle Stress Tests

The following tests the AirPrime SL6087 Embedded Module's resistance to extreme temperature cycling.

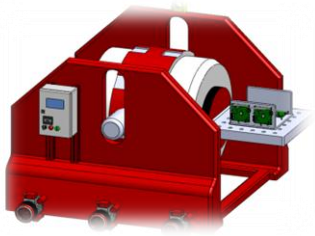
Table 70. Thermal Resistance Cycle Stress Tests

Designation	Condition
Thermal Shock Test TSKT 	Standard: IEC 60068-2-14
	Special conditions: • Upper temperature: +85°C • Lower temperature: -40°C • Rate of temperature change: 30s • Number of cycles: 200 • Duration of exposure: 30 minutes • Recovery time: 3 hours
	Operating conditions: Un-powered
	Duration: 72 hours
Temperature Change TCH 	Standard: IEC 60068-2-14, Test Nb
	Special conditions: • Upper temperature: +85°C • Lower temperature: -40°C • Rate of temperature change: dT/dt >= ± 3°C/min • Number of cycles: 400 • Duration of exposure: 30 minutes • Recovery time: 3 hours
	Operating conditions: Un-powered

8.4.5. Mechanical Resistance Stress Tests

The following tests the AirPrime SL6087 Embedded Module's resistance to vibrations and mechanical shocks.

Table 71. Mechanical Resistance Stress Tests

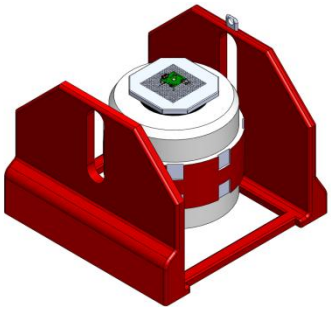
Designation	Condition
Sinusoidal Vibration Test SVT1 	Standard: IEC 60068-2-6, Test Fc

	Special conditions:
	• Frequency range: 10Hz to 1000Hz
	  ▪ Displacement: ±5mm (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 oct/min.
	• Test duration: 20 cycles
	• Sweep directions: X, Y and Z

	Operating conditions: Un-powered
	Duration: 72 hours
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

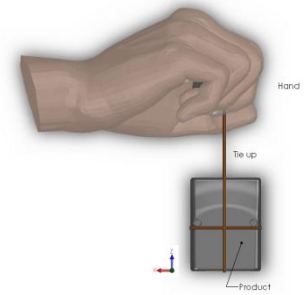
	Operating conditions: Un-powered
	Duration: 16 hours

Designation	Condition
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: 200G ▪ Duration: 3ms ▪ Number of shocks: 3 per direction ▪ Number of directions: 6 (±X, ±Y, ±Z) • Shock Test 3: ▪ 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

8.4.6. Handling Resistance Stress Tests

The following tests the AirPrime SL6087 Embedded Module's resistance to handling malfunctions and damage.

Table 72. Handling Resistance Stress Tests

Designation	Condition
ESD Test 	Standard: IEC 1000-4-2
	Special conditions: • Contact discharges: 10 positive and 10 negative applied • Voltage: ±2kV, ±4kV, ±6kV
	Operating conditions: Powered
	Duration: 24 hours
Free Fall Test FFT 	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

9. Design Guidelines

This section provides general design guidelines for the AirPrime SL6087 Embedded Module.

9.1. 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 SL6087 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 SL6087 Embedded Module on the application board.*

9.2. 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 VBATT line must support peak currents with an acceptable voltage drop which guarantees a minimal VBATT value of 3.2V (lower limit of VBATT)

9.3. 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, refer to section 9.6.4 RF Circuit.

9.4. 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 SL6087 Embedded Module. A 4-layer through-hole type PCB structure can be used.

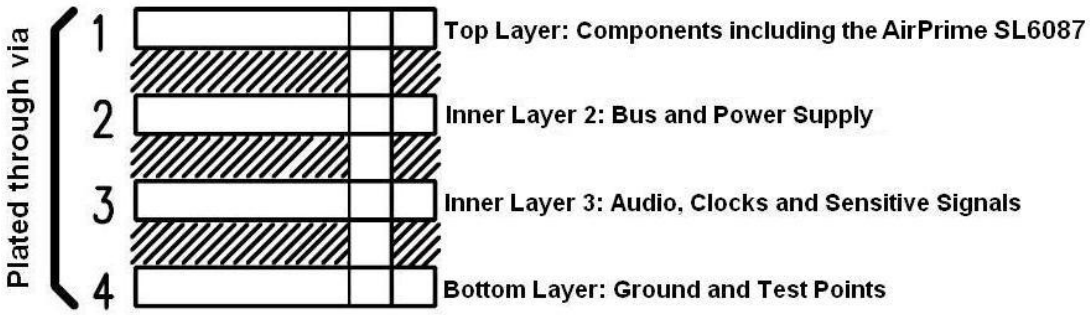


Figure 55. PCB Structure Example for the Application Board

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.*

9.5. Recommended PCB Landing Pattern

Refer to document [6] AirPrime SL Series Customer Process Guideline.

9.6. Routing Constraints

9.6.1. 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 SL6087 Embedded Module supply).

Pins 42 and 44 of the AirPrime SL6087 Embedded Module should be gathered in the same piece of copper, as shown in the figure below.

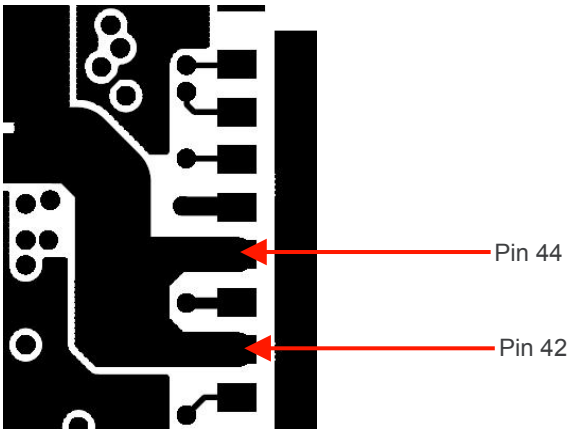


Figure 56. Power Supply Routing Example

Filtering capacitors near the AirPrime SL6087 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 SL6087 Embedded Module. The ground track or the ground plane on the application board must support current peaks as well as with the VBATT track.

If the ground track between the AirPrime SL6087 Embedded Module and the power supply is a copper plane, it must not be parceled out.

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

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

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

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.

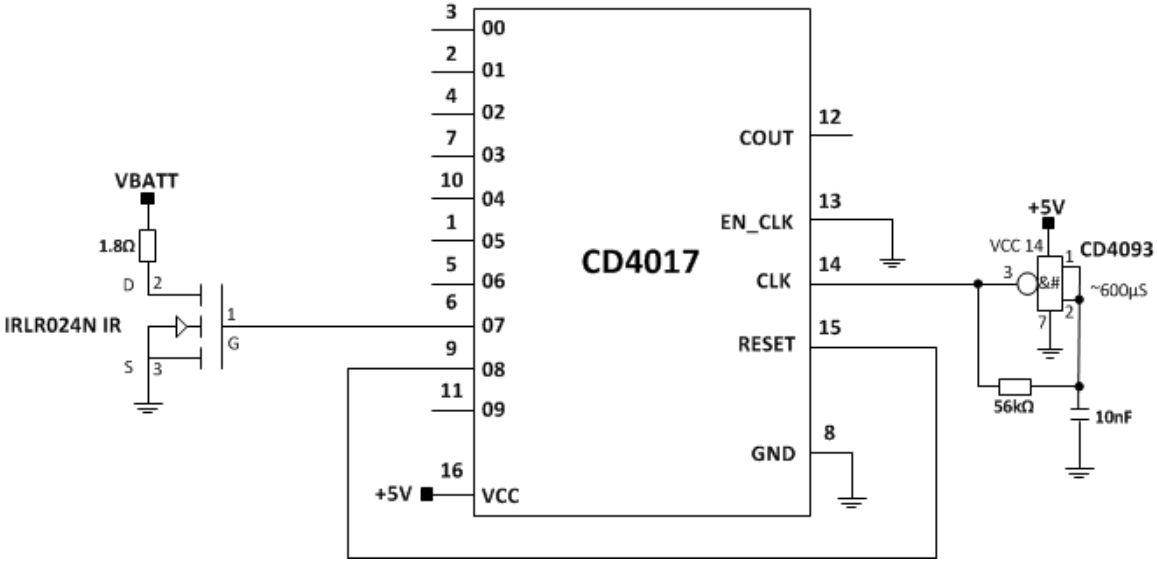


Figure 57. Burst Simulation Circuit

9.6.1.1. Ground Plane and Shielding Connection

The AirPrime SL6087 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 SL6087 Embedded Module. The bottom side shielding of the AirPrime SL6087 Embedded Module is achieved by soldering the ground plane of the application board and the AirPrime SL6087 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 SL6087 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, refer to section 9.5 Recommended PCB Landing Pattern.

9.6.2. SIM Interface

The length of the tracks between the AirPrime SL6087 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 (100nF) on the SIM_VCC signal must be placed as close as possible to the DALC208SC6 component on the PCB (refer to section 4.7 SIM Interface).

9.6.3. Audio Circuit

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

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

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

9.6.4. 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).

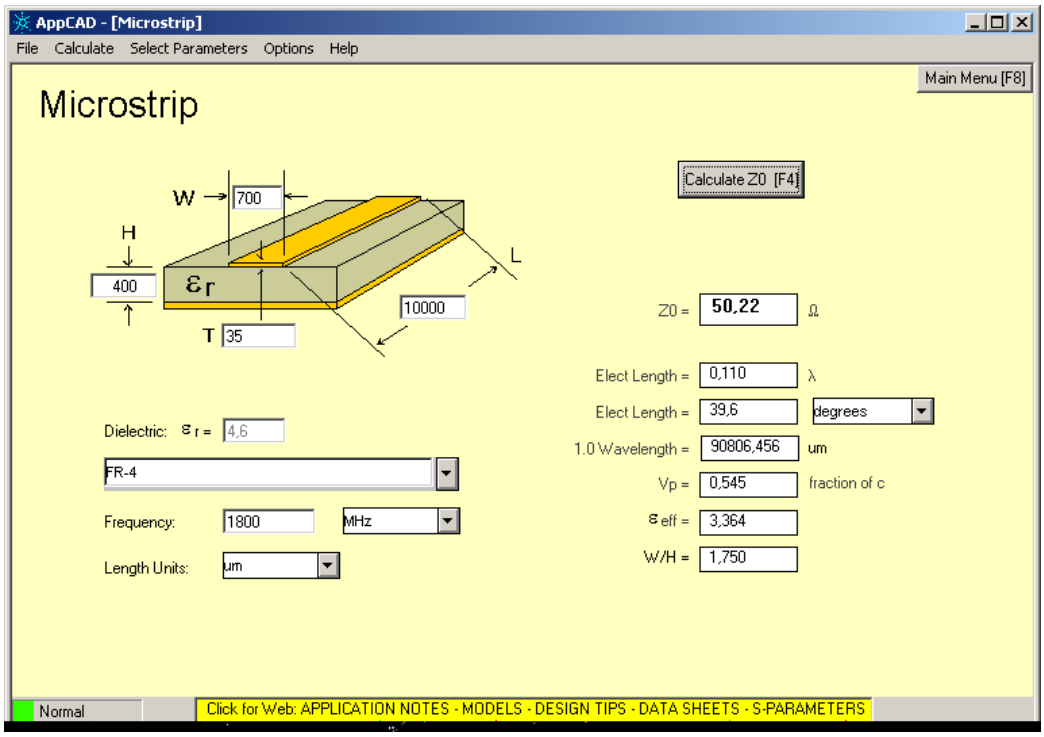


Figure 58. AppCad Screenshot for MicroStrip Design

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.

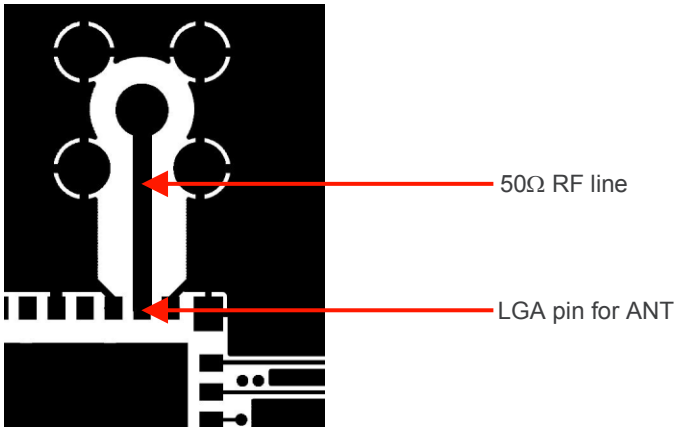


Figure 59. Routing Examples

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

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

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

9.7. EMC and ESD Recommendations

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

When designing, special attention should be paid to:

- Possible spurious emissions radiated by the application to the RF receiver in the receiver band
- ESD protection is mandatory on all signals which are externally accessible
  - Typically, ESD protection is mandatory for the:
    - SIM (if accessible from outside)
    - Serial link
- Length of the SIM interface lines (preferably <10cm)
- EMC protection on audio input/output (filters against 900MHz 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 SL6087 Embedded Module does not include any protection against over voltage.

9.8. Mechanical Integration

Attention should be paid to:

- Antenna cable integration (bending, length, position, etc)
- Leads of the AirPrime SL6087 Embedded Module to be soldered to the ground plane

9.9. Operating System Upgrade

The AirPrime SL6087 Embedded Module Operating System is stored in flash memory and can be easily upgraded.

Important: *In order to follow regular changes in the GPRS standard and to offer a state-of-the-art operating system, Sierra Wireless recommends that the application designed around an embedded module (or embedded module based product) should allow easy operating system upgrades on the embedded module via the standard XMODEM protocol. Therefore, the application shall either allow a direct access to the embedded module serial link through an external connector or implement any mechanism allowing the embedded module operating system to be downloaded via XMODEM.*

The operating system file can be downloaded to the embedded module using the XMODEM protocol. The **AT+WDWL** command allows the downloading process to be launched. For more details, refer to document [2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5.

The serial signals required to proceed with XMODEM downloading are:

- RXD
- TXD
- RTS
- CTS
- GND

The Operating System file can also be downloaded to the embedded module using the DOTA (download over the air) feature. This feature is available with the Open AT Application Framework interface. For more details, refer to the list of documents in section 14.1 Web Site Support.

10. Embedded Testability

10.1. Serial Link Access

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

- Testability operations
- Firmware download (for more information on firmware upgrade, refer to section 3.3 Firmware Upgrade)

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

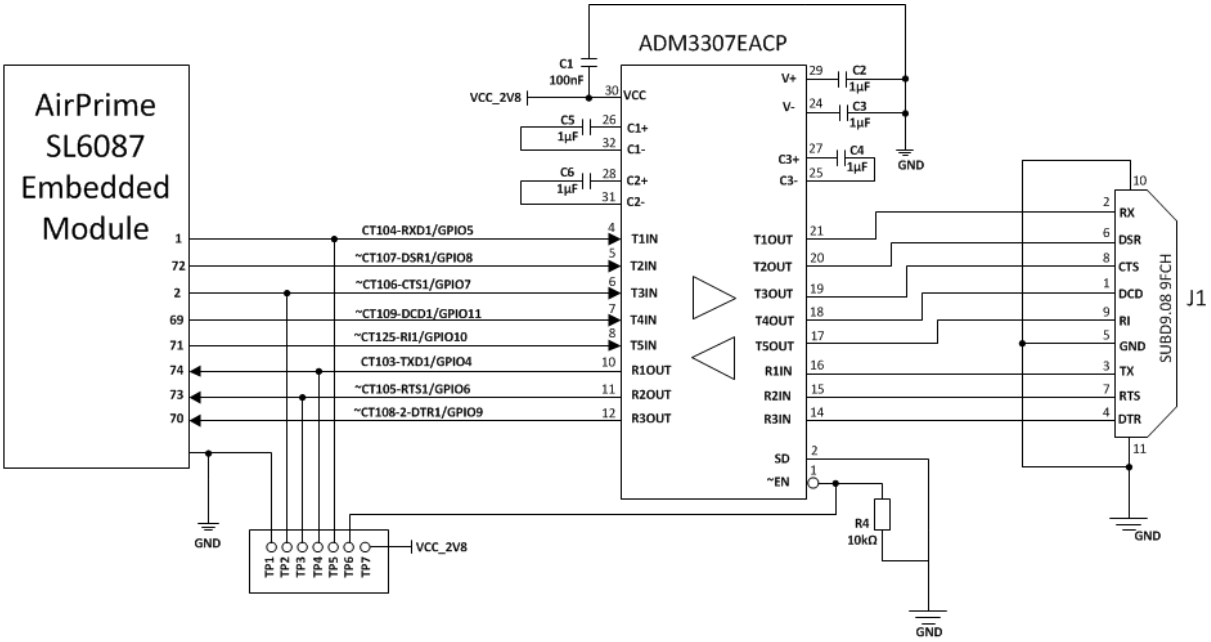


Figure 60. Main Serial Link (UART1) Debug Access

When it is necessary to download firmware into the AirPrime SL6087 Embedded Module without going through the RS232 interface, access to the embedded module is forced via the debug connector. In such cases, input signals coming from this connector masks the input signals coming from the **ADM3307** device.

VCC_2V8 and GND are available on the debug connector to allow the powering of an external RS232 transceiver in order to communicate with a PC via a COM (COM1 or COM2) port, for example.

It is also possible to trace the signals on the serial link through the debug connector.

Note:	*R4 is used to have the possibility to disable the R1OUT, R2OUT and R3OUT of the ADM3307 by the enable signal (~EN) when the debug connector is used. For debug connector use, TP6 must be connected to VCC_2V8. For normal use, TP6 must be left open.*

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

Caution:	*If communications on UART1 above the baud rate of 720kbps is needed, an external power supply source (3.0V typical) should be used.*

10.2. RF Output Accessibility

During the integration phase of the AirPrime SL6087 Embedded Module, it can be helpful to connect the AirPrime SL6087 Embedded Module to a GSM/GPRS simulator in order to check critical RF TX parameters and power behaviour.

Although the AirPrime SL6087 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.

11. Connector and Peripheral Device References

This section contains a list of recommended manufacturers or suppliers for the peripheral devices to be used with the AirPrime SL6087 Embedded Module.

11.1. SIM Card Reader

- ITT CANNON CCM03 series (see http://www.ittcannon.com)
- AMPHENOL C707 series (see http://www.amphenol.com)
- JAE (see http://www.jae.com)

Drawer type:

- MOLEX (see http://www.molex.com)
  - Connector: MOLEX 99228-0002
  - Holder: MOLEX 91236-0002

11.2. Microphone

The microphone selected must comply with GSM recommendations in terms of frequency response.

Possible suppliers:

- HOSIDEN (see http://www.hosiden.co.jp/)
- PANASONIC (see http://www.panasonic/com/industrial/components/)
- PEIKER

11.3. Speaker

The speaker selected must comply with GSM recommendations in terms of frequency response.

Possible suppliers:

- SANYO (see http://www.sanyo.com/industrial/components/)
- HOSIDEN (see http://www.hosiden.co.jp/)
- PRIMO (see http://www.primo.com.sg/)
- PHILIPS (see http://www.semiconductors.philips.com/)

11.4. GSM Antenna

GSM antennas and support for antenna adaptation can be obtained from manufacturers such as:

- ALLGON (see http://www.allgon.com)
- IRSCHMANN (see http://www.hirschmann.com/)
- MOTECO (see http://www.moteco.com)
- GALTRONICS (see http://www.galtronics.com)

The following table lists the contact details for other GSM antenna providers.

Table 73. Contact Information of GSM Antenna Providers

Provider	Reference	Address	Contact
Mat Equipment	MA112VX00	Z.I. La Boitardière Chemin du Roy 37400 Amboise FRANCE	Laurent.LeClainche@matequipement.com Tel: +33 2 47 30 69 70 Fax: +33 2 47 57 35 06
ProComm	MU 901/1801/UMTS-MMS + 2M FME	Europarc 121, Chemin des Bassins F-94035 CRETEIL CEDEX	Tel: +33 1 49 80 32 00 Fax: +33 1 49 80 12 54 procom@procom.fr

11.5. Buzzer

One possible Buzzer supplier is:

- SAMBU (see http://www.sambuco.co.kr)

12. Certification Compliance and Recommended Standards

12.1. Certification Compliance

The AirPrime SL6087 Embedded Module connected on a development kit board application is compliant with the following requirements.

Table 74. Standards Conformity for the SL6087 Embedded Module

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

12.2. Applicable Standards Listing

The table hereafter gives the basic list of standards applicable for the AirPrime SL6087 Embedded Module (2G (R99/Rel. 4)).

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

Table 75. Applicable Standards and Requirements for the SL6087 Embedded Module

Document	Current Version	Title
GCF-CC	3.38.0	GSM Certification Forum - Certification Criteria
NAPRD.03	5.3	Overview of PCS Type certification review board (PTCRB) Mobile Equipment Type Certification and IMEI control
TS 51.010-1	9.1.0	3rd Generation Partnership Project; Technical Specification Group GSM/EDGE Radio Access Network; Digital cellular telecommunications system (Phase 2+); Mobile Station (MS) conformance specification; Part 1: Conformance specification
TS 51.010-2	9.1.0	3rd Generation Partnership Project; Technical Specification Group GSM/EDGE Radio Access Network; Mobile Station (MS) conformance specification; Part 2: Protocol Implementation Conformance Statement (PICS) proforma specification
TS 51.010-4	4.14.1	3rd Generation Partnership Project; Technical Specification Group GSM/EDGE Radio Access Network; Digital cellular telecommunications system (Phase 2+); Mobile Station (MS) conformance specification; Part 4: SIM Application Toolkit Conformance specification

Document	Current Version	Title
EN 301 511	9.0.2	Global System for Mobile Communications (GSM); Harmonised standard for mobile stations in the GSM 900 and DCS 1800 bands covering essential requirements under article 3.2 of the R&TTE directive (1999/5/EC)
ETSI 102.230	3.9.0	Smart cards; UICC-Terminal interface; Physical, electrical and logical test specification(Release 99)

The AirPrime SL6087 Intelligent Embedded Module has been granted modular approval for mobile applications. Integrators may use this device in their final products without additional FCC/IC (Industry Canada) certification if the following conditions are met. 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 8.0dBi in the cellular band and 3.6dBi in the PCS band.
3. The AirPrime SL6087 Intelligent Embedded Module and its antenna must not be co-located or operating in conjunction with any other transmitter within a host device.
4. A label must be affixed to the outside of the end product into which the AirPrime SL6087 Intelligent Embedded Module is incorporated, with a statement similar to the following:

   This device contains FCC ID: N7NSL6087

   This equipment contains device certified under IC: 2417C–SL6087

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

The end product with an AirPrime SL6087 Intelligent Embedded Module may also need to pass the FCC Part 15 unintentional emission testing requirements and be properly authorized per FCC Part 15.

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

Please note that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

13. ATEX Specifications

ATEX stands for “ATmosphere EXplosive” (Explosive Atmosphere). The ATEX directive defines which equipments/systems and functioning conditions are allowed in an environment with an explosive atmosphere (gas, chemical fluids, etc.).

13.1. SL6087 ATEX Characteristics

13.1.1. SL6087 ATEX Parameters

The SL6087 embedded module has been attributed with the ATEX parameters listed in the figure below. These parameters describe the characteristics to be taken into account by the customer in any application that use the SL6087 for an ATEX certified global system.

L C I E

1 **ATTESTATION D'EXAMEN CE DE TYPE**

2 **Composant** destiné à être utilisé en atmosphères explosibles **(Directive 94/9/CE)**

3 Numéro de l'attestation d'examen CE de type
LCIE 11 ATEX 3069 U

4 Composant :
Module radio
Type : SL6087

5 Demandeur : SIERRA WIRELESS
Adresse : 3 Esplanade du Foncet
92442 ISSY les MOULINEAUX

6 Fabricant : SIERRA WIRELESS
Adresse : 3 Esplanade du Foncet
92442 ISSY les MOULINEAUX

7 Ce composant et ses variantes éventuelles acceptées sont décrits dans l'annexe de la présente attestation et dans les documents descriptifs cités en référence.

8 Le LCIE, organisme notifié sous la référence 0081 conformément à l'article 9 de la directive 94/9/CE du Parlement européen et du Conseil du 23 mars 1994, certifie que ce composant est conforme aux exigences essentielles de sécurité et de santé pour la conception et la construction de composants destinés à être utilisés en atmosphères explosibles, données dans l'annexe II de la directive.

Les résultats des vérifications et essais figurent dans le rapport confidentiel N°106246/610659.

9 Le respect des exigences essentielles de sécurité et de santé est assuré par la conformité à :
- EN 60079-0 (2006)
- EN 60079-11 (2007)

10 Le signe U placé à la suite du numéro de l'attestation, indique que cette attestation ne doit pas être confondue avec celle destinée à un appareil ou un système de protection. Cette attestation partielle peut être utilisée comme base pour l'attestation d'un appareil ou d'un système de protection.

11 Cette attestation d'examen CE de type concerne uniquement la conception et la construction du composant spécifié, conformément à l'annexe III de la directive 94/9/CE.
Des exigences supplémentaires de la directive sont applicables pour la fabrication et la fourniture du composant. Ces dernières ne sont pas couvertes par la présente attestation.

12 Le marquage du composant doit comporter les informations détaillées au point 15.

1 **EC TYPE EXAMINATION CERTIFICATE**

2 **Component** Intended for use in Potentially explosive atmospheres **(Directive 94/9/EC)**

3 EC type examination certificate number
LCIE 11 ATEX 3069 U

4 Component :
Radio module
Type : SL6087

5 Applicant : SIERRA WIRELESS
Address : 3 Esplanade du Foncet
92442 ISSY les MOULINEAUX

6 Manufacturer : SIERRA WIRELESS
Address : 3 Esplanade du Foncet
92442 ISSY les MOULINEAUX

7 This component and any acceptable variation thereto is specified in the schedule to this certificate and the documents therein refered to.

8 LCIE, notified body number 0081 in accordance with article 9 of the directive 94/9/EC of the European Parliament and the Council of 23 March 1994, certifies that this component has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of component intended for use in potentially explosive atmospheres, given in Annex II to the directive.

The examination and test results are recorded in confidential report N°106246/610659.

9 Compliance with the Essential Health and Safety Requirements has been assured by compliance with :
- EN 60079-0 (2006)
- EN 60079-11 (2007)

10 The sign U placed after the certificate number indicates that this certificate shall not be mistaken with a certificate intended for an equipment or protective system. This partial certification may be used as a basis for certification of an equipment or protective system.

11 This EC Type examination certificate relates only to the design, and construction of this specified component in accordance with annex III of the directive 94/9/EC.
Further requirements of the directive apply to the manufacturing process and supply of this component. These are not covered by this certificate.

12 The marking of the component shall include informations as detailed at 15.

Le responsable de certification ATEX
ATEX certification manager

Fontenay Aux Roses

08 AOUT 2011

Michel BRENON

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Page 1 sur 2
02-Annexe III_CE_cp – rev1.DOC

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au capital de 15 745 984 €
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Figure 61. ATEX Certificate LCIE 11 ATEX 3069 U, page 1 of 2

13 **ANNEXE**

14 **ATTESTATION D'EXAMEN CE DE TYPE**

LCIE 11 ATEX 3069 U

15 **DESCRIPTION DU COMPOSANT**

Module radio
Type : SL6087

L'équipement est un module de transmission radio destiné à être soudé sur un circuit imprimé.

Paramètres spécifiques du ou des modes de protection concerné(s) :
Ci ≤ 97 µF, Li ≤ 13 µH
Groupe IIB : Ui ≤ 5V; Ii ≤ 2,5A
Groupe IIA : Ui ≤ 5V; Ii ≤ 4,3A

Le marquage doit être :
SIERRA WIRELESS
Adresse :
Type : SL6087
N° de fabrication : ...
Année de fabrication : ...
Ex II 1G
Ex ia IIB Ci ≤ 97 µF Li ≤ 13 µH Ui ≤ 5V Ii ≤ 2,5A (1)
Ex ia IIA Ci ≤ 97 µF Li ≤ 13 µH Ui ≤ 5V Ii ≤ 4,3A (1)
LCIE 11 ATEX 3069 U
(1) l'un des codes en fonction du groupe de gaz choisi

L'appareil doit également comporter le marquage normalement prévu par les normes de construction qui le concerne.

16 **DOCUMENTS DESCRIPTIFS**
Dossier technique n°WM_DEV_SL6087_CTI_001 daté du 10/05/11.
Ce document comprend 1 rubrique (38 pages).

17 **CONDITIONS SPECIALES POUR UNE UTILISATION SÛRE**
Le module doit être monté dans une enveloppe conforme aux exigences de la norme EN 60079-0 et ayant au minimum un degré de protection IP20.
Le module ne peut être raccordé qu'à un équipement certifié de sécurité intrinsèque et cette association doit être compatible vis-à-vis de la sécurité intrinsèque (voir les paramètres de sécurité intrinsèque au paragraphe 15).
Température ambiante d'utilisation : -40°C à +85°C.

18 **EXIGENCES ESSENTIELLES DE SECURITE ET DE SANTE**
Couvertes par les normes listées au point 9.

19 **VERIFICATIONS ET ESSAIS INDIVIDUELS**
Néant.

20 **CONDITIONS DE CERTIFICATION**

Les détenteurs d'attestations d'examen CE de type doivent également satisfaire les exigences de contrôle de production telles que définies à l'article 8 de la directive 94/9/CE.

13 **SCHEDULE**

14 **EC TYPE EXAMINATION CERTIFICATE**

LCIE 11 ATEX 3069 U

15 **DESCRIPTION OF COMPONENT**

Radio module
Type : SL6087

The equipment is a module of radio transmission intended to be welded on a printed board.

Specific parameters of the concerned protection mode :

Ci ≤ 97 µF, Li ≤ 13 µH
Groupe IIB : Ui ≤ 5V; Ii ≤ 2,5A
Groupe IIA : Ui ≤ 5V; Ii ≤ 4,3A

The marking shall be :
SIERRA WIRELESS
Address :
Type : SL6087
Serial number : ...
Year of construction : ...
Ex II 1G
Ex ia IIB Ci ≤ 97 µF Li ≤ 13 µH Ui ≤ 5V Ii ≤ 2,5A (1)
Ex ia IIA Ci ≤ 97 µF Li ≤ 13 µH Ui ≤ 5V Ii ≤ 4,3A (1)
LCIE 11 ATEX 3069 U
(1) one of the codes following the group of selected gas

The equipment shall also bear the usual marking required by the manufacturing standards applying to such equipment.

16 **DESCRIPTIVE DOCUMENTS**
Certification file n° WM_DEV_SL6087_CTI_001 dated 10/05/11.
This file includes 1 item (38 pages).

17 **SPECIAL CONDITIONS FOR SAFE USE**
The module shall be fitted inside an enclosure fulfilling the requirements of the standard EN 60079-0 with a minimum degree of protection IP20.
The module can be only connected to a certified intrinsically safe equipment and this combination must be compatible as regard the intrinsic safety rules (see electrical parameters clause 15).
Operating ambient temperature : -40°C to +85°C.

18 **ESSENTIAL HEALTH AND SAFETY REQUIREMENTS**
Covered by standards listed at 9.

19 **ROUTINE VERIFICATIONS AND TESTS**
None.

20 **CONDITIONS OF CERTIFICATION**

Holders of EC type examination certificates are also required to comply with the production control requirements defined in article 8 of directive 94/9/EC.

Figure 62. ATEX Certificate LCIE 11 ATEX 3069 U, page 2 of 2

13.1.2. Identifying the SL6087 from other SL Variants

13.1.2.1. ATEX Logo in the SL6087 Label

The ATEX logo (shown below), is displayed in the ATEX certified SL6087 embedded module's label.

Figure 63. ATEX Logo

Figure 64. AirPrime SL6087 Label with the ATEX Logo

13.1.2.2. SKU Reference Number

ATEX certified SL6087 embedded modules have a specific SKU reference number, **1101422**, which allows Sierra Wireless to track customer deliveries (refer to the SL Series product catalogue for more information).

13.2. ATEX Directive and Related Norms

The objective of the ATEX Directive is to ensure free movement for products to which it applies in the EU territory.

Based on Article 95, the EC Treaty (see reference below) provides harmonized requirements and procedures to establish compliance.

This Directive appliance is mandatory since July 2003 for the equipment to be used in potential explosive atmospheres.

- European Directive 94/9/EC
- EN60079-0 (2004)
- EN60079-11 (2007)
- EN13980 (2002)

13.3. Conformance with ATEX 94/9/CE Directive

To evaluate the conformity of a product using the AirPrime SL6087 with ATEX 94/9/CE directive, the integrator must take into account the following data from the AirPrime SL6087:

- Sum of all capacitors: 98µF
- Sum of all inductors: 12.1µH
- Biggest single capacitor: 26.4µF
- Biggest single inductor: 12µH

14. References

14.1. Web Site Support

Check the Sierra Wireless Developer Zone at http://developer.sierrawireless.com for the latest documentation available.

Content	Web Site
General information about the AirPrime SL Series of Intelligent Embedded Modules	http://www.sierrawireless.com/en/productsandservices/AirPrime/Embedded_Modules/SL_Series.aspx
Specific support about the AirPrime SL6087 Embedded Module	http://www.sierrawireless.com/productsandservices/AirPrime/Embedded_Modules/SL_Series/SL_6087.aspx
Carrier/Operator approvals	http://www.sierrawireless.com/en/sitecore/content/Sierra%20Wireless/Support/Downloads/AirPrime/SL_Series/AirPrime_SL6087.aspx
Open AT Application Framework Introduction	http://www.sierrawireless.com/productsandservices/AirPrime/Sierra_Wireless_Software_Suite/Open_AT_Operating_System.aspx
Developer support for software and hardware	http://forum.sierrawireless.com/

14.2. Reference Documents

For more details, several reference documents can be consulted. The Sierra Wireless documents referenced herein are provided in the Sierra Wireless documentation package; however, the general reference documents which are not Sierra Wireless owned are not provided in the documentation package.

14.2.1. Software and Firmware Documentation

[1] ADL User Guide for Open AT Framework OS 6.37

Reference: 4111704

[2] Open AT Framework AT Commands Interface Guide for Firmware 7.45.5

Reference: 4111703

[3] Firmware 7.45.5 Customer Release Note

Reference: 4111867

14.2.2. Hardware Documentation

[4] AirPrime SL Series Development Kit User Guide

Reference: WA_DEV_SL6087_UGD_003

[5] AirPrime SL Series Mechanical Socket Development Kit Quick Start Gudie

Reference: 4112314

[6] AirPrime SL Series Customer Process Guideline
Reference: WM_DEV_LG_PTS_001

[7] AirPrime Q26 Series to AirPrime SL6087 Migration Guide
Reference: WA_DEV_SL6087_UGD_001

[8] AirPrime SL Series Migration Guide
Reference: 4112055

14.2.3. Other Related Documentation

[9] "I^2C Bus Specification", Version 2.0, Philips Semiconductor 1998

[10] ISO 7816-3 Standard

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

Abbreviation	Definition
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
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

Abbreviation	Definition
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
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 SL6087 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.

Note: *This is not applicable for final products that are ATEX compliant. For final products that are ATEX compliant, the condition of use depends on specific ATEX requirements instead.*

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.

Note: *This is not applicable for final products that are ATEX compliant. For final products that are ATEX compliant, the condition of use depends on specific ATEX requirements instead.*

SIERRA
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