Product Technical Specification & Customer Design Guidelines

AirPrime MC8090 and MC8092

SIERRA WIRELESS®

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7.0
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Important Notice

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

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

Document History

Version	Date	Updates
001	September 28, 2011	Creation
	October 13, 2011	Updated product naming convention
	October 25, 2011	Updated GPIO and PCM pin numbers. Updated RF performance and power consumption values.
		Updated Figure 4 Dimensioned View
2.0	December 29, 2011	Updated the product information in section 1 Introduction
3.0	April 03, 2012	Updated: • Table 47 Averaged Standby DC Power Consumption (Preliminary/Estimated Values) • Table 48 Averaged Call Mode Data DC Power Consumption
4.0	June 27, 2012	Updated Figure 4 Dimensioned View
5.0	September 24, 2012	Added support for Band 6 (UMTS800)
		Updated: • Table 67 Standards Conformity for the MC8090/MC8092 Mini Card • Table 3 Power and Ground Specifications
		Removed sections 5.2.3 and 5.3.3; moved 5.3.3.1 one level up (currently section 5.3.3).
6.0	September 17, 2014	Updated: • Voltage range (Vmin = 3.0V, Vnom = 3.3V) • 1.7 Environmental Issues
	February 11, 2015	Removed TBDs in the following tables: • Table 12 Reset State Definition • Table 49 Miscellaneous DC Power Consumption (Preliminary Values) • Table 54 Supported Specifications
7.0	August 13, 2015	Added section 3.6 SED (Smart Error Detection)

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1. Introduction

The AirPrime MC8090 and MC8092 with Audio Mini Card are compact, lightweight, wireless UMTS-based modems. Their wireless UMTS-based modem provides data connectivity on HSDPA and HSUPA, WCDMA, EDGE, and GPRS networks; and also supports GPS connection (as listed in Table 1 Supported Bands/Connectivity).

The MC8090/MC8092 uses existing SL solder-down modules mounted on the MC_SL adapter board. All software applicable to the AirPrime SL8090/SL8092 embedded modules are also applicable to the MC8090/MC8092 mini card. For more information, refer to section 14.2.1 Sierra Wireless Documentation.

Both MC8090 and MC8092 come with either PCM or UART functionality.

Table 1. Supported Bands/Connectivity

Band/Connectivity	MC8090	MC8092
GSM850 EGSM900 DCS1800 PCS1900	✓	✓
Band 1 (UMTS2100)	✓	✓
Band 2 (UMTS1900)	✓	
Band 5 (UMTS850)	✓	
Band 6 (UMTS800)	✓	
Band 8 (UMTS900)		✓
RX diversity Band 1 (UMTS2100)		✓
RX diversity Band 2 (UMTS1900)	✓	
RX diversity Band 5 (UMTS850)	✓	
RX diversity Band 6 (UMTS800)	✓	
RX diversity Band 8 (UMTS900)		✓
GPS (1575.42MHz)	✓	✓

1.1. General Features

The following table lists several AirPrime MC8090/MC8092 mini card features.

Table 2. MC8090/MC8092 Mini Card Features

Feature	Description
Physical	• Small form factor—conforms to F1 as specified in PCI Express • Mini Card Electromechanical Specification Revision 1. • Three U.FL RF connector jacks
Electrical	• Single supply voltage (VCC) — 3.0V–4.3V • Complete body shielding — No additional shielding required

Feature	Description

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

Application interface	• NDIS NIC interface support (Windows XP, Windows Vista, Windows 7, Windows CE[a], Linux) • Multiple non-multiplexed USB channel support • Dial-up networking • USB selective suspend to maximize power savings • AT command interface —(non-voice) 27.007 standard, plus proprietary extended AT commands • CnS — Sierra Wireless' proprietary Control and Status host interface protocol • Software Development Kits (SDK) including APIs (Application Program Interfaces) and drivers (core, device) for Windows, Windows CE, and Linux
Phone book	Supports Release 99 phone book features
Packet mode	• Dual-mode UMTS (WCDMA) / HSDPA and HSUPA / EDGE / GPRS operation • GPRS class B, multislot class 10 operation — Supports CS1–CS4 coding schemes • EDGE multislot class 12 operation — Supports MCS1–MCS9 coding schemes • UMTS (WCDMA) R99 data rates—384 kbps downlink, 384 kbps uplink • HSDPA Category 10 data rate — 14.4 Mbps (peak rate) • HSUPA Category 6 data rate — 5.76 Mbps • Circuit-switched data bearers — 64 kbps (maximum) uplink and downlink

Feature	Description
Connectivity / GSM	• Multiple (up to 16) cellular packet data profiles • Traditional modem COM port support for DUN, CSD, and AT commands (concurrent with NDIS) • Suspend / Resume • Sleep mode for minimum idle power draw • SIM application tool kit with proactive SIM commands • Enhanced Operator Name String (EONS) • Profile list. Typical carrier profiles are available in a drop-down list in Watcher; the user can select a profile rather than enter all the parameters. • Automatic GPRS attach at power-up • GPRS detach • Combined GPRS / IMSI detach; MS-initiated and network-initiated detach • Mobile-originated PDP context activation / deactivation • Support QoS profile ▪ Release 99 QoS negotiation—Background, Interactive, and Streaming ▪ Release 97—Precedence Class, Reliability Class, Delay Class, Peak Throughput, Mean Throughput • Static and Dynamic IP address. The network may assign a fixed IP address or dynamically assign one using DHCP (Dynamic Host Configuration Protocol). • PAP and CHAP support • PDP context type (IPv4). IP Packet Data Protocol context • RFC1144 TCP/IP header compression • Interaction with existing GSM services (MO/MT SMS voice calls) while: ▪ GPRS is attached, or ▪ In a GPRS data session (class B GPRS suspend / resume procedures) • Support for EAP-SIM authentication and PC / SC. EAP-SIM is available through: ▪ The API ▪ AT commands ▪ The PC / SC interface
Voice (Digital Audio)[b]	Supports: • All GSM vocoders, Enhanced Full Rate (EFR), Full Rate (FR), Half Rate (HR), and WCDMA Adaptive Multirate (AMR) encoders • MO and MT calling • Echo cancellation and noise reduction • Emergency calls (112, 110, 911, etc.) • Incoming call notification • TTY/TDD compatibility
Supplementary Services[b]	• Call Barring • Call Forwarding • Call Hold • Caller ID • Call Waiting • Multi-party service • USSD

Feature	Description
GPS	Provides: • Standalone GPS functionality • gpsOneXTRA™ • A-GPS features • NMEA support *Note: GPS specifications are preliminary targets that are subject to change without notice. Actual GPS functionality is dependent on the firmware version, and on module configuration.*
Network selection	• Network selection procedures described in 3G 22.011, R5 (June 2005), 3G 23.122 (June 2005), and 3G 43.022, R4 • RRC connection reject message to redirect from a 3G system to a 2G system, according to 25.331, R5 (June 2004) • A CPHS Customer Service Profile-like feature [PLMN Mode bit] on a USIM / SIM that hides network selection related menus • Initial HPLMN scan at two minutes after power on • An HPLMN rescan irrespective of the serving MCC • Selective disabling of any 2G or 3G frequency band • Equivalent PLMN • Network selection generally within 30 seconds of power up • Enhanced network selection (ENS)
RF	• Quad-band GSM / GPRS / EDGE (850 MHz, 900 MHz, 1800 MHz, 1900 MHz) • Dual-band UMTS WCDMA FDD ▪ MC8092: 900 MHz, 2100 MHz • Quad-band UMTS WCDMA FDD ▪ MC8090: 800 MHz, 850 MHz, 1900 MHz, 2100MHz • GPS (1575.42 MHz)
Environmental	Operating temperature ranges: • Class A: -30°C to +70°C • Class B: -40°C to +85°C
Interfaces	• 1.8 V digital section • 3 V / 1.8 V SIM interface • Serial (UART1) • Digital Audio (PCM) • USIM • USB 2.0 Slave
Operating system	Full GSM or GSM / GPRS / EGPRS operating system stack

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

b Voice (Digital Audio)/Supplementary services on PCM variants of the MC8090/MC8092.

1.2. Support Feature

The MC8090/MC8092 offers the following support feature:

- Enabling software (drivers, SDK, etc.): Windows, Windows CE, Linux

1.3. Support Tools

The MC8090/MC8092 is compatible with the following support tools from Sierra Wireless and authorized third parties:

- Sierra Wireless Watcher connection manager (available for Windows and Mac operating systems)
- QXDM from Qualcomm

1.4. Accessories

The MC Series Development Kit includes:

- Mini Card Interface Kit
- Documentation suite
- USB cable
- Serial cable
- Power supply
- GSM antenna

1.5. Hardware Development Components

Sierra Wireless manufactures the MC Series Development Kit, a hardware development component that is used to facilitate the hardware integration process. This development kit is the hardware development board on which an MC mini card is plugged. The development kit provides access to all of the interfaces supported by the MC mini card.

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

1.6. Ordering Information

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

1.7. Environmental Issues

1.7.1. RoHS Directive Compliant

The AirPrime MC8090/MC8092 mini card is compliant with RoHS Directive 2011/65/EU 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 2012/19/EU for Waste Electrical and Electronic Equipment (WEEE). As such, this product must not be disposed of 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 MC8090/MC8092 mini card is described in Figure 1 Functional Architecture.

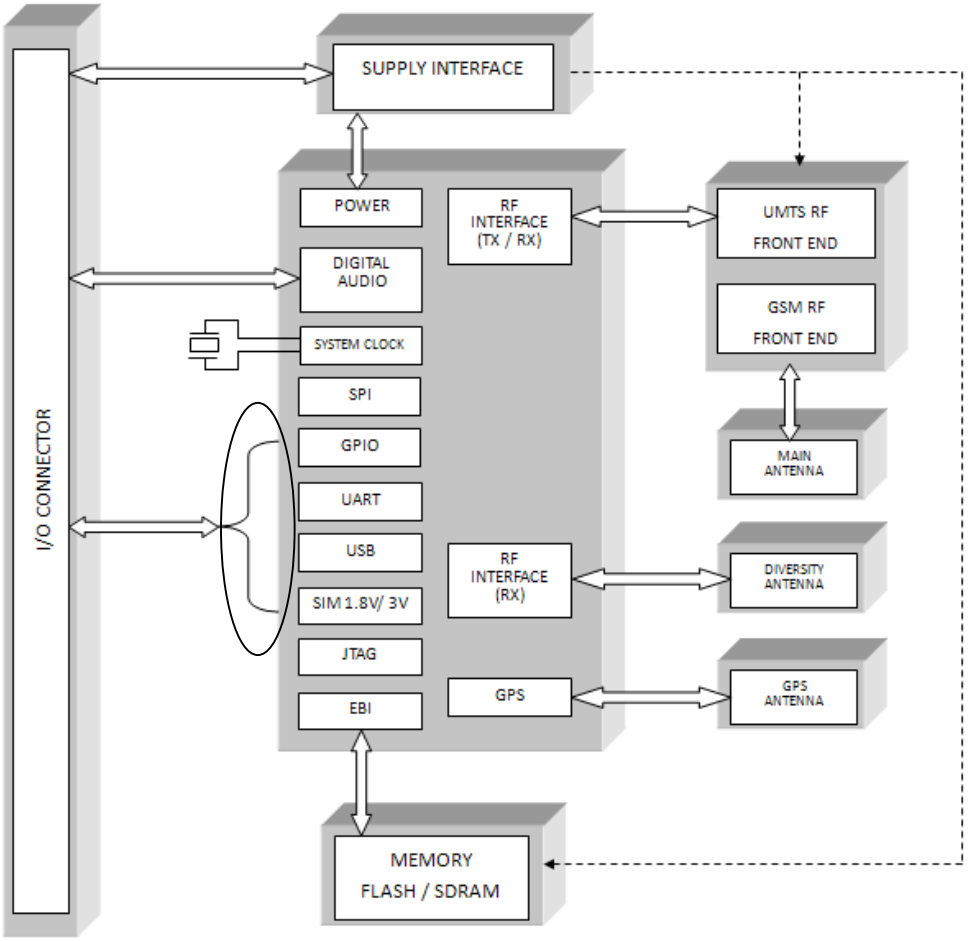


Figure 1. Functional Architecture

2.1.1. Chipsets

MC8090/MC8092 mini cards are based on Qualcomm solution MDM6200.

2.2. Extended AT Commands

Several proprietary AT commands are available for AirPrime mini cards to use in hardware integration design and testing (these commands are NOT intended for use by end users). For lists of all available commands and descriptions of their functionality, refer to documents [4] AirCard/AirPrime UMTS Supported AT Command Reference and [5] AirPrime MC/SL Series (UMTS/LTE) Extended AT Command Reference.

3. Technical Specifications

3.1. Power Supply

Power is provided to the MC8090/MC8092 through power and ground pins as detailed in the following table.

Table 3. Power and Ground Specifications

Pin #	Signal Name	Type	Specification	Parameter	Min.	Typ.	Max.	Unit
2, 24, 39, 41, 52	VCC_3V6*	V	Voltage range	VCC	3.00	3.30	4.30	V
			Ripple voltage (U_{ripp})				100**	mVpp
4, 9, 15, 18, 21, 26, 27, 29, 34, 35, 37, 40, 43, 50	GND	V			-	0	-	V

* Host-provided input voltage should provide 3 A instantaneous (lasting 5 ms). Refer to Table 48 Averaged Call Mode Data DC Power Consumption.

** For frequencies less than 2MHz.

The host device must provide power to the MC8090/MC8092 mini card over pins 2, 24, 39, 41 and 52 (VCC_3V6) as detailed in the following table.

Table 4. Power Supply Requirements

Requirement Type	Value
Power supply	3.3 V (nominal)
Voltage range (Vmin–Vmax)	3.0–4.3 V
Current (instantaneous (5 ms))	3 A
Current (continuous)	Refer to Table 48 Averaged Call Mode Data DC Power Consumption.
Power input capacitor(s)	• Add capacitance to host power rail (100 µF) to keep module operational with Vin in range. • Additional capacitance may be required if the host cannot meet the module's current requirements. • Conditioning capacitor (1µF, 0.1µF, 10 nF and 1 nF) recommended close to the power input for decoupling.

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

3.1.1. Burst Emission Current Requirements

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

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

Table 5. Radio Burst Rates – Connected Mode

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

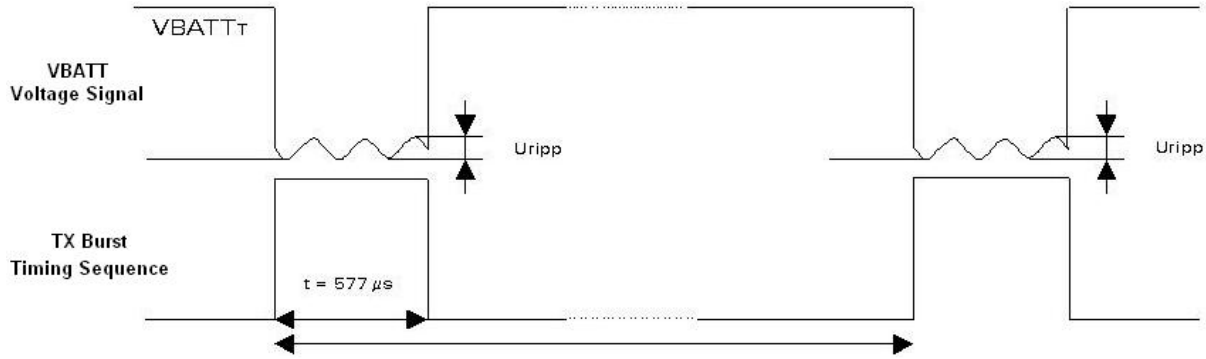


Figure 2. Power Supply During Burst Emission

3.1.2. Power Input (VCC_3V6)

An external power supply uses the VCC_3V6 pins to:

- Supply the AirPrime MC8090/MC8092 mini card.
- Directly supply the RF components with 3.3 V.
  - It is essential to keep the voltage ripple to a minimum at this connection in order to avoid any phase error or spectrum modulation degradation.
  - An inadequate power supply can significantly affect RF performance (TX power, modulation spectrum, EMC performance, spurious emission, frequency error, etc.).

When the AirPrime MC8090/MC8092 is supplied with a battery, the total impedance (battery + protections + PCB) should be such that the supply will be >= 3.0 V during GSM burst mode operation (drawing a maximum peak current of 2.2 A for 577 µs (one slot) or 1154 µs (two slots) TX.

3.1.3. Start-up Current

During the first second following Power ON, a current peak occurs. This current peak ($t_{Startup}$) occurs during the first 5ms (typical). The following table indicates the expected peak current range.

Table 6. Start-up Current Peak Range

Current Peak at Ambient Temperature (25°C)	VCC_3V6$_{min}$ (3.0V)	VCC_3V6$_{typ}$ (3.3V)	VCC_3V6$_{max}$ (4.3V)
$t_{Startup}$	~183mA	~177 mA	~162 mA

3.2. Decoupling of Power Supply Signals

Although the AirPrime MC8090/MC8092 has embedded decoupling capacitors on the power supply lines, additional decoupling may be required:

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

3.3. Mechanical Specifications

This section describes mechanical specifications for the AirPrime MC8090/MC8092.

Table 7. Mechanical Specifications

Specification	Details
Form factor	The MC8090/MC8092 are PCI-Express Mini Cards, comprised of an AirPrime SL809x embedded module mounted on the MC_SL adapter board.
Dimensions (nominal)	Length: 50.85 mm Width: 29.85 mm Thickness: 4.30 mm (typical, including label thickness) Weight: approximately 11 g

3.3.1. Mechanical Illustrations

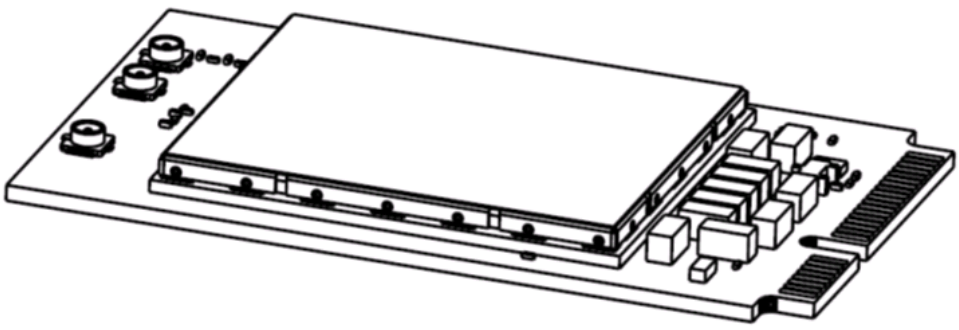


Figure 3. AirPrime MC8090/MC8092 Mini Card

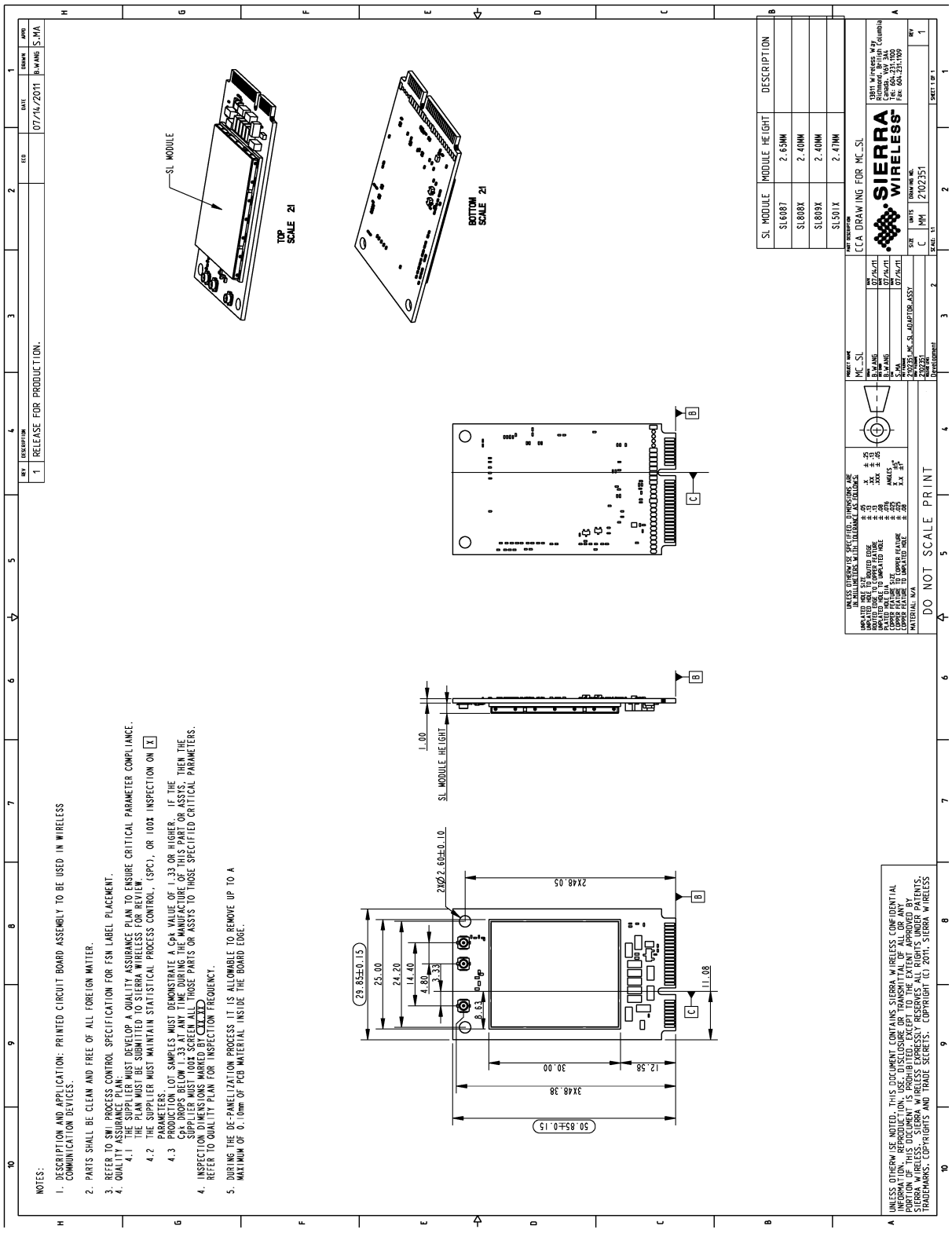


Figure 4. Dimensioned View

3.4. Labeling

Figure 5. Unit Label

The MC8090/MC8092 label is non-removable and contains:

- Sierra Wireless AirPrime logo
- Product Name (MC8090 or MC8092)
- Carrier Name
- CPN: Optional Customer Number*
- QUALCOMM® 3G
- Serial number and barcode
- CE Marking (if applicable)
- IMEI number and barcode
- FCC ID number
- IC number
- Made in China

*Note: * The MC8090/MC8092 support OEM partner specific label requirements.*

3.5. Thermal Considerations

When transmitting, the AirPrime MC8090/MC8092 can generate significant amounts of heat (due to the internal Power Amplifier) that must be dissipated in the host device for safety and performance reasons.

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

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

You can enhance heat dissipation by:

- Maximizing airflow over / around the module
- Locating the module away from other components that generate heat

You can use **!PCTEMP** or **!GSTATUS** to return the module's current temperature. Refer to document [4] AirCard/AirPrime UMTS Supported AT Command Reference for details.

3.6. SED (Smart Error Detection)

The AirPrime MC8090/MC8092 use a form of SED to track premature module resets. In such cases, the module automatically forces a pause in boot-and-hold mode at power-on to accept an expected firmware download to resolve the problem.

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

3.7. Firmware Upgrade

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

4. Interfaces

4.1. System Design

This chapter describes the AirPrime MC8090/MC8092 mini card connector interface configuration and supported interfaces, which are listed in the table below.

Table 8. Available Interfaces and Signals

Name	Driven by AT Commands
General Purpose Input/Output	✓
Main Serial Link (UART1) or Digital Audio Interface (PCM)	✓
USIM Interface	✓
USB 2.0 Interface	✓
RF Interface	

The MC8090/MC8092 has two main interface areas, the host I/O perimeter I/O ports (pins) and the RF ports. The following figure shows the main interface areas of the MC8090/MC8092; for a more detailed architecture diagram, refer to Figure 1 Functional Architecture.

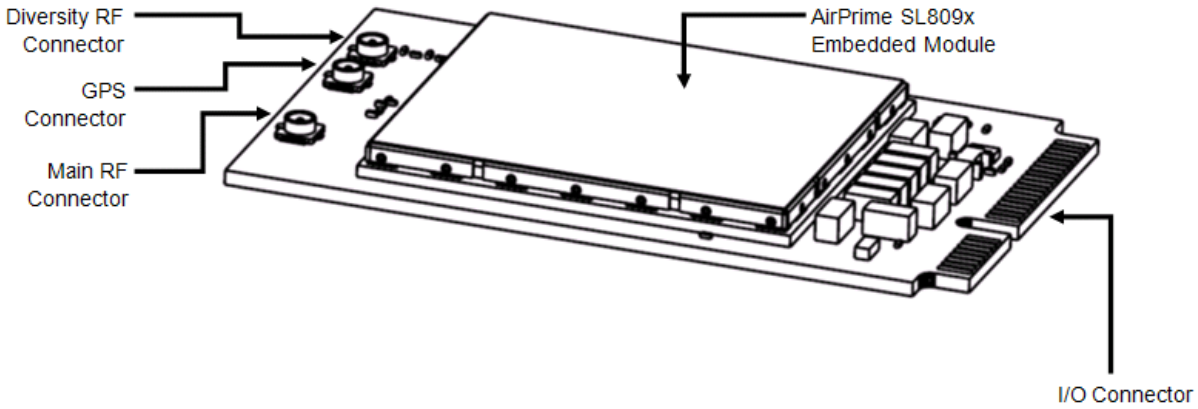


Figure 6. AirPrime MC8090/MC8092 Interface Areas

4.1.1. Pin Description

The following table describes the pin assignments.

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

Table 9. AirPrime MC8090/MC8092 Pin Assignments

Pin #	Signal Name	Description	Active State	Input/Output of MC8090/MC8092	Voltage (V)			Type
					Minimum	Typical	Maximum	
1	NC	Not connected						
2	VCC_3V6	3.3 V supply	Power	Input	3.00	3.30	4.30	Power
3	NC	Not connected						
4	GND	Ground	GND	GND	-	-	-	
5	NC	Not connected						
6	GPIO_0	General purpose I/O	High / Low	Input High	1.23	1.80	2.00	Digital
				Input Low	-0.30		0.59	
				Output High	1.25	1.80	1.90	
				Output Low	0		0.45	
7	NC	Not connected						
8	EXT_VREG_USIM	USIM VCC supply	Power	Output (1.8 V)	1.70	1.80	1.90	Power
				Output (3.0 V)	2.95	3.00	3.05	
9	GND	Ground	GND	GND	-	-	-	

Pin #	Signal Name	Description	Active State	Input/Output of MC8090/MC8092	Voltage (V)			Type
					Minimum	Typical	Maximum	
10	EXT_USIM_DATA	USIM I/O pin	Low	Input High (1.8 V)	1.26	1.80	2.10	Digital
				Input Low (1.8 V)	0		0.40	
				Output High (1.8 V)	1.26	1.80	2.10	
				Output Low (1.8 V)	0		0.40	
				Input High (3.0 V)	2.10	3.00	3.30	
				Input Low (3.0 V)	0		0.60	
				Output High (3.0 V)	2.10	3.00	3.30	
				Output Low (3.0 V)	0		0.60	
11	VREF_1V8	1.8 V LDO	High (when module is on)	Output	1.70	1.80	1.90	Power
12	EXT_USIM_CLK	USIM clock	High	Output High (1.8V)	1.26	1.80	2.10	Digital
				Output Low (1.8V)	0		0.40	
				Output High (3.0V)	2.10	3.00	3.30	
				Output Low (3.0V)	0		0.60	
13	NC	Not connected						
14	EXT_USIM_RESET	USIM reset	Low	Output High (1.8V)	1.44	1.80	2.10	Digital
				Output Low (1.8V)	0		0.40	
				Output High (3.0V)	2.40	3.00	3.30	
				Output Low (3.0V)	0		0.60	
15	GND	Ground	GND	GND	-	-	-	
16	NC	Not connected						
17	NC	Not connected						
18	GND	Ground	GND	GND	-	-	-	
19	NC	Not connected						
20	W_DISABLE_N	Wireless disable	High / Low	Input High	1.23	1.80	2.00	Digital
				Input Low	-0.30		0.59	
21	GND	Ground	GND	GND	-	-	-	

Pin #	Signal Name	Description	Active State	Input/Output of MC8090/MC8092	Voltage (V)			Type
					Minimum	Typical	Maximum	
22	NC	Not connected						
23	NC	Not connected						
24	VCC_3V6	3.3 V supply	Power	Input	3.00	3.30	4.30	Power
25	NC	Not connected						
26	GND	Ground	GND	GND	-	-	-	
27	GND	Ground	GND	GND	-	-	-	
28	NC	Not connected						
29	GND	Ground	GND	GND	-	-	-	
30	NC	Not connected						
31	NC	Not connected						
32	WAKE_N*	Wake Host Interface	Low	Output High	1.25	1.80	1.90	Digital
				Output Low	0		0.45	
33	SYSTEM_RESET_N	Reset	High / Low	Input High	1.23	1.80	2.00	Digital
				Input Low	-0.30		0.59	
34	GND	Ground	GND	GND	-	-	-	
35	GND	Ground	GND	GND	-	-	-	
36	USB_D-	USB data negative (Low / Full speed)		Input High	2.00	3.30	3.60	Differential
				Input Low	0		0.80	
				Output High	2.80	3.30	3.60	
				Output Low			0.30	
		USB data negative (High speed)		Input High	0.30		0.44	
				Input Low	0		0.01	
				Output High	0.36	0.38	0.44	
				Output Low	0		0.01	
37	GND	Ground	GND	GND	-	-	-	

Pin #	Signal Name	Description	Active State	Input/Output of MC8090/MC8092	Voltage (V)			Type
					Minimum	Typical	Maximum	
38	USB_D+	USB data positive (Low / Full speed)		Input High	2.00	3.30	3.60	Differential
				Input Low	0		0.80	
				Output High	2.80	3.30	3.60	
				Output Low			0.30	
		USB data positive (High speed)		Input High	0.30		0.44	
				Input Low	0		0.01	
				Output High	0.36	0.38	0.44	
				Output Low	0		0.01	
39	VCC_3V6	3.3 V supply	Power	Input	3.00	3.30	4.30	Power
40	GND	Ground	GND	GND				
41	VCC_3V6	3.3 V supply	Power	Input	3.00	3.30	4.30	Power
42	LED_FLASH	LED driver	Open Drain Output	Output Low	0		Open Drain	Digital
43	GND	Ground	GND	GND				
44	GPIO_1*	General purpose I/O	High / Low	Input High	1.23	1.80	2.00	Digital
				Input Low	-0.30		0.59	
				Output High	1.25	1.80	1.90	
				Output Low	0		0.45	
45	UART1_CTS_N/ PCM_CLK**	UART Clear To Send/ PCM Clock	High / Low	Output High	1.25	1.80	1.90	Digital
				Output Low	0		0.45	
46	GPIO_3*	General purpose I/O	High / Low	Input High	1.23	1.80	2.00	Digital
				Input Low	-0.30		0.59	
				Output High	1.25	1.80	1.90	
				Output Low	0		0.45	
47	UART1_RTS_N/ PCM_DIN**	UART Request To Send/ PCM Data In	High / Low	Input High	1.23	1.80	2.00	Digital
				Input Low	-0.30		0.59	

Pin #	Signal Name	Description	Active State	Input/Output of MC8090/MC8092	Voltage (V)			Type
					Minimum	Typical	Maximum	
48	GPIO_2*	General purpose I/O	High / Low	Input High	1.23	1.80	2.00	Digital
				Input Low	-0.30		0.59	
				Output High	1.25	1.80	1.90	
				Output Low	0		0.45	
49	UART1_RXD/ PCM_DOUT**	UART Receive Data/ PCM Data Out	High / Low	Output High	1.25	1.80	1.90	Digital
				Output Low	0		0.45	
50	GND	Ground	GND	GND				
51	UART1_TXD/ PCM_SYNC**	UART Transmit Data/PCM Sync Out	High / Low	Input High	1.23	1.80	2.00	Digital
				Input Low	-0.30		0.59	
52	VCC_3V6	3.3 V supply	Power	Input	3.00	3.30	4.30	Power

* This pin may be reconfigured for use in a full UART implementation. Refer to section 4.4.3 Full UART Implementation for more information.

** The MC8090/MC8092 can either have PCM or UART; the function of this pin varies depending on whether the mini card is an MC8090/MC8092 with PCM or with UART.

4.2. Digital I/O Electrical Information

The AirPrime MC8090/MC8092 uses 1.8V CMOS for digital I/O. Refer to section 4.2.1 Electrical Characteristics for electrical characteristics.

4.2.1. Electrical Characteristics

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

Table 10. Electrical Characteristics of a 1.8V Type (1V8) Digital I/O

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

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

4.2.2. Pin Types

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

Table 11. Pin Type Codes

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

4.2.3. Signal Reset States

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

Table 12. Reset State Definition

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

4.3. General Purpose Input/Output

The AirPrime MC8090/MC8092 mini card includes four general purpose I/O (GPIO) pins. The following table describes the purpose and features of this interface.

Table 13. GPIO Interface Features

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

Three of the four available GPIO pins (GPIO_1, GPIO_2 and GPIO_3) may also be used to configure a full UART. Refer to section 4.4.3 Full UART Implementation for more information about configuring these pins as additional UART signals.

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

4.3.1. Pin Description

The following table describes the GPIO interface pins.

Table 14. GPIO Pin Description

Pin #	Signal Name	I/O Type	Reset State	Description
46	GPIO_3*	1V8		Configurable general purpose I/O
48	GPIO_2*	1V8		

Pin #	Signal Name	I/O Type	Reset State	Description
44	GPIO_1*	1V8		Configurable general purpose I/O
6	GPIO_0	1V8		

* This pin may be reconfigured for use in a full UART implementation. Refer to section 4.4.3 Full UART Implementation for more information.

Refer to Table 9 AirPrime MC8090/MC8092 Pin Assignments for other pin-specific details.

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

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

4.4. Main Serial Link (UART1)

UART variants of the MC8090/MC8092 include a serial link (UART1) for host–module communication. The following table describes the purpose and features of this interface.

Refer to section 4.4.4 Level Shifter Implementation for an implementation example of the UART1 interface.

Note: MC8090/MC8092 with UART mini cards may be provisioned with the ability to use the UART interface to communicate with peripheral devices. Contact Sierra Wireless for further information.

Table 15. UART1 Interface Features

Feature	Details
Purpose	• Serial host–module communication • Dependent on provisioning, communication with peripheral devices. Contact Sierra Wireless for further information.
Implementation	• Four-wire serial interface based on TIA-232 (RS232 protocol) • An RS-232 level shifter device may be required, as described in section 4.4.4 Level Shifter Implementation. • Optional full UART configuration as described in section 4.4.3 Full UART Implementation.
Data rates supported	High speed (up to 4 Mbps)
Optional functionality	Dependent on provisioning, module may be able to communicate with peripheral devices. Contact Sierra Wireless to discuss possible firmware support.

Note: This interface is NOT AVAILABLE in the MC8090/MC8092 with PCM variants.

4.4.1. Available Services

Dependent on device configuration, the AirPrime MC8090/MC8092 with UART support the following data services (logical protocols) for the transfer of data and control information over the UART1 interface:

- AT – Command processor/data service
- DM (Diagnostic Message service)
- NMEA (GPS) service

- PDP services
- HIP
- CnS

4.4.2. Pin Description

The following table describes the UART1 interface pins.

Table 16. 4-wire UART1 Pin Description

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

* According to PC view.

Refer to Table 9 AirPrime MC8090/MC8092 Pin Assignments for other pin-specific details.

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

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

Table 17. Additional Signals for an 8-wire UART

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

Refer to section 4.4.3 Full UART Implementation for available configuration settings to implement a full UART interface (DCD, DTR and DSR signals multiplexed over GPIO).

4.4.3. Full UART Implementation

UART variants of the MC8090/MC8092 mini card have the ability to support full UART by configuring GPIO pins and the WAKE_N pin as additional UART pins. Refer to the following table for more information.

Table 18. Configuration for Supporting a Full UART

Additional UART Signal			GPIO Pins Used for an Extended UART Configuration		
Signal Name	**Function**	**Value**	**Pin #**	**Signal Name**	**Function**
DCD	Data Carrier Detect	1V8 output	44	GPIO_1	General Purpose I/O
DTR	Data Terminal Ready	1V8 input	48	GPIO_2	General Purpose I/O
DSR	Data Set Ready	1V8 output	46	GPIO_3	General Purpose I/O
RI	Ring Indicator	1V8 output	32	WAKE_N	Wake Host Interface

4.4.4. Level Shifter Implementation

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

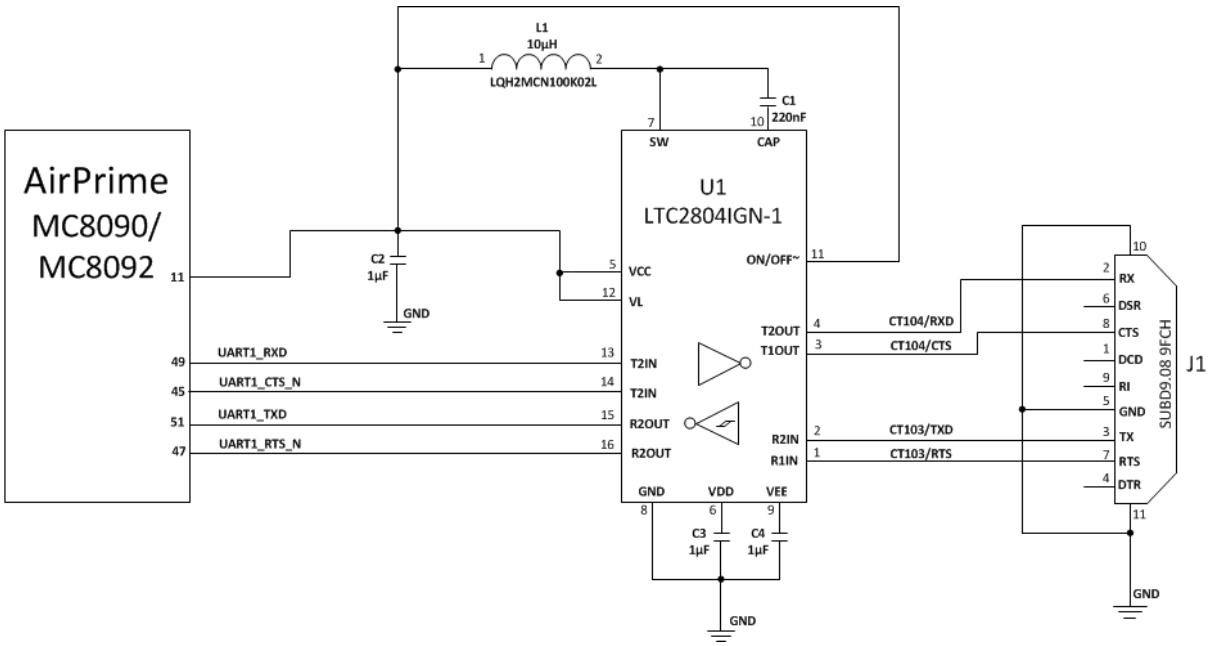


Figure 7. UART RS-232 Level Shifter Implementation

Note: The U1 chip also protects the AirPrime MC8090/MC8092 mini card against ESD at 15kV (air discharge).

4.4.5. Configure the UART Interface

Use **AT+WHCNF** to:

- Enable/disable the UART interface
- Default to 4-wire UART
- Configure the device for 8-wire UART (using GPIO pins as additional UART signals).
- Enable/disable the specific signals. For example, you can enable DTR only for use with 4-wire UART to control low power operation.

For more information about **AT+WHCNF**, refer to document [5] AirPrime MC/SL Series (UMTS/LTE) Extended AT Command Reference.

4.4.5.1. Low Power Operation

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

- 8-wire UART with DTR enabled—UART is halted when DTR is deasserted, and resumed when DTR is asserted. Refer to section 4.4.5 Configure the UART Interface for details on enabling the DTR signal.
- 4-wire UART with Sleep flag enabled:
  - The UART remains on for 15 seconds after the device boots. If there is no activity on the UART during this period, the UART is stopped.
  - The UART will resume when there is activity on the receive line (UART1_RXD). Note that the first character may be missed due to latency. This can be mitigated by sending a spare character (for example, AAT).
  - After no activity for approximately 4 seconds, the UART will be stopped again.
- 4-wire UART with Sleep flag disabled—UART never sleeps.

4.4.6. Lock the UART Interface

On systems that do not have USB support:

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

Refer to document [5] AirPrime MC/SL Series (UMTS/LTE) Extended AT Command Reference for more information about **HWCFGLOCK**.

4.5. USIM Interface

The AirPrime MC8090/MC8092 mini card includes a 4-wire USIM interface that allows a SIM to be directly connected. The following table describes the purpose and features of this interface.

Table 19. USIM Interface Features

Feature	Details
Purpose	Communicate with USIM socket on host device

Feature	Details
Implementation	• Four-wire interface • Voltage levels comply with 3GPP standards
Power	• 1.8 V (3G) or 3.0 V (2G) operation. Compliant with GSM 11.11 recommendations concerning SIM functions. • Host must keep current draw 10mA

4.5.1. Pin Description

The following table describes the USIM interface pins.

Table 20. USIM Pin Description

Pin #	Signal Name	I/O Type	Description	Notes
8	EXT_VREG_USIM		USIM power supply	• 1.8 V (3G) or 3 V (2G). • Maximum allowed current draw = 10 mA.
14	EXT_USIM_RESET		USIM reset signal	
10	EXT_USIM_DATA		USIM data	• Requires a 15–25 kΩ pull-up resistor to EXT_VREG_USIM. • Filtering cap in pF range may be needed.
12	EXT_USIM_CLK		USIM clock	• Typically 4 MHz at EXT_VREG_USIM level. • Host should minimize rise time (< 50 ns) by adjusting trace capacitance and filtering needs as required.

Refer to Table 9 AirPrime MC8090/MC8092 Pin Assignments for other pin-specific details.

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

4.5.2. Application

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

4.5.2.1. USIM Socket Pin Description

The following table describes the required USIM socket pins.

Table 21. SIM Socket Pin Description

Pin #	Signal Name	Description
1	VCC	EXT_ VREG_USIM
2	RST	EXT_USIM_RESET

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

4.6. USB 2.0 Interface

The AirPrime MC8090/MC8092 mini card features a USB 2.0 interface for data transfer, modem control, and diagnostic information.

Table 22. USB 2.0 Interface Features

Feature	Details
Standards compliance	• Universal Serial Bus Specification, Rev 2.0 • CDC 1.1 - ACM compliant
Performance	• Optimized for high speed (480 Mbps) Throughput rates may vary significantly based on packet size, host interface, and firmware revision. • Support for Full speed (12 Mbps) Throughput performance is on an “as-is” basis and must be characterized by the OEM.
Power supply	• VCC supply • 3.3 V type compatible
Additional features	Firmware download over USB

4.6.1. Pin Description

The following table describes the USB interface pins.

Table 23. USB Pin Description

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

Refer to Table 9 AirPrime MC8090/MC8092 Pin Assignments for other pin-specific details.

4.6.2. Electrical Characteristics

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

Table 24. USB Interface Electrical Characteristics

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

4.6.3. USB Configurations

The AirPrime MC8090/MC8092 mini card supports the USB configurations in the following table. The basic service configuration is PRI-dependent, and some services can be excluded, if required.

Table 25. Supported USB Configurations

Configuration	Interfaces	Services
Composite, Direct IP	OBEX, ACM, ECM	CnS, DM, NMEA, AT, DIP data
Composite, MUX-capable	OBEX, ACM	CnS, DM, NMEA, AT, PPP data
Composite	OBEX, ACM	CnS, DM, NMEA, AT, PPP data
Non-composite, MUX-capable	OBEX, ACM	CnS, DM, NMEA, AT, PPP data

4.6.4. Application

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

4.6.5. USB Host Drivers

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

4.6.5.1. Host Driver Requirements

The host driver must support:

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

The host driver may optionally support:

- Low power mode – USB suspend, resume, and remote wakeup as described in document [9] Universal Serial Bus Specification, Rev 2.0

- ECM – Ethernet Control Model for Direct IP
- MUX – Sierra Wireless' implementation of the 3GPP 27.010 MUX standard over CDC-ACM

4.7. RF Interface

The AirPrime MC8090/MC8092 mini card's RF (radio frequency) interface uses three antenna ports for Tx/Rx, Rx and GPS. The following table describes the purpose and features of this interface.

Table 26. RF Interface Features

Feature	Details
Purpose	• Primary antenna — Tx / Rx • Diversity antenna — Rx • GPS antenna — GPS functionality
Impedance	Nominal: 50Ω DC: High Impedance

4.7.1. RF Connections

The MC8090/MC8092 includes three RF connectors for use with a host-supplied antenna. (It does not have integrated antennas.) One connector is used for the main TX/RX path, the second connector is used for diversity, and the third connector is used for GPS.

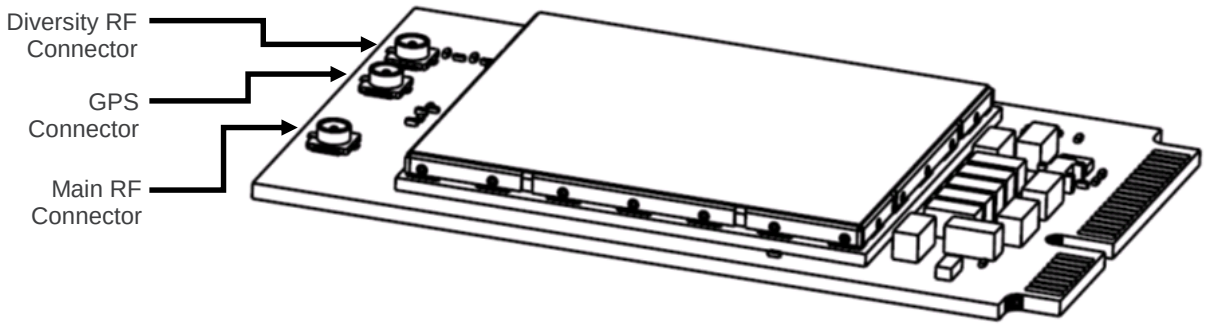


Figure 8. AirPrime MC8090/MC8092 RF Connections

The RF connectors (Hirose part number U.FL # CL331-0471-0-10 or equivalent) are 3 mm x 3 mm low profile connectors that support coaxial cable connections to the module. The path is assumed to be 50Ω. These connectors are installed on the top side of the module.

Note: If the antenna connection is shorted or open, the modem will not sustain permanent damage.

4.7.2. RF Performance

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

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

Table 27. Band Support, Conducted Tx Power and Conducted Rx Sensitivity

Band	Frequencies (MHz)	MC8090	MC8092	Conducted Tx Power		Conducted Rx Sensitivity (dBm)			
				Average (dBm)	Notes				
GSM Bands						**Coding**	**Mode**	**Typical**	**Worst Case**
GSM 850	Tx: 824 - 849 Rx: 869 - 894	✓	✓	+33 ± 2	GMSK, connectorized (Class 4)	CS1-3[a]	GMSK	-106	-102
				+27 ± 3	8PSK, connectorized (Class E2)	CS4[b]	GMSK	-103	-99
EGSM 900	Tx: 880 - 915 Rx: 925 - 960	✓	✓	+33 ± 2	GMSK, connectorized (Class 4)	MCS1-3[c]	GMSK	-106	-102
				+27 ± 3	8PSK, connectorized (Class E2)	MCS4[c]	GMSK	-103.5	-99.5
DCS 1800	Tx: 1710 - 1785 Rx: 1805 - 1880	✓	✓	+30 ± 2	GMSK, connectorized (Class 1)	MCS5[c]	8PSK	-100	-96
				+26 ± 3	8PSK, connectorized (Class E2)	MCS6[c]	8PSK	-98	-94
PCS 1900	Tx: 1850 - 1910 Rx: 1930 - 1990	✓	✓	+30 ± 2	GMSK, connectorized (Class 1)	MCS7[c]	8PSK	-95	-91
				+26 ± 3	8PSK, connectorized (Class E2)	MCS8[c]	8PSK	-92.5	-88.5
						MCS9[c]	8PSK	-90	-86

Band	Frequencies (MHz)	MC8090	MC8092	Conducted Tx Power		Conducted Rx Sensitivity (dBm)		
				Average (dBm)	Notes			
WCDMA Bands						**Call Details**	**Typical**	**Worst Case**
Band I WCDMA 2100	Tx: 1920–1980 Rx: 2110–2170	✓	✓	+24 +1/-3	• Connectorized (Class 3) • Nominal conditions	RMC DL 12.2 kbps; 0.1% BER	-107.5	-106.7
Band II WCDMA 1900	Tx: 1850–1910 Rx: 1930–1990	✓					-107	-104.7
Band V WCDMA 850	Tx: 824–849 Rx: 869–894	✓					-108	-104.7
Band VI WCDMA 800	Tx: 830–840 Rx: 875–885	✓					-108	-104.7
Band VIII WCDMA 900	Tx: 880–915 Rx: 925–960		✓				-108	-103.7
WCDMA Bands RX Diversity						**Call Details**	**Typical**	**Worst Case**
Band I WCDMA 2100	Tx: 1920 – 1980 Rx: 2110 – 2170		✓			RMC DL 12.2 kbps; 0.1% BER	-107.5	-106.7
Band II WCDMA 1900	Tx: 1850 – 1910 Rx: 1930 – 1990	✓					-107	-104.7
Band V WCDMA 850	Tx: 824 – 849 Rx: 869 – 894	✓					-108	-104.7
Band VI WCDMA 800	Tx: 830–840 Rx: 875–885	✓					-108	-104.7
Band VIII WCDMA 900	Tx: 880 – 915 Rx: 925 – 960		✓				-108	-103.7
GPS								
GPS	1575.42	✓	✓					

a 2% Bit Error Rate (BER) circuit switched.

b 10% Block Error Rate (BLER).

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

4.7.3. GPS Specifications

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

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

4.7.3.1. Standalone GPS

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

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

4.7.3.2. gpsOneXTRA™

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

4.7.3.3. A-GPS Features

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

4.7.3.4. Enhanced Navigation 2.0 Feature

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

4.7.3.5. NMEA

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

4.7.3.6. Software

GPS monitor application is built into Watcher.

4.7.4. Antenna Specifications

The antenna must meet the requirements specified in Table 28 Main RF Antenna Specification.

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

Table 28. Main RF Antenna Specification

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

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

4.7.4.1. Application

The following are suggested guidelines for the three antenna ports:

- The antenna should be isolated as much as possible from analog and digital circuitry (including interface signals).
- On applications with an embedded antenna, poor shielding could dramatically affect the receiving sensitivity. Moreover, the power radiated by the antenna could affect the application (TDMA noise, for instance).
- As a general recommendation, all components or chips operated at high frequencies (microprocessors, memories, DC/DC converter) or other active RF parts should not be placed too close to the AirPrime MC8090/MC8092 mini card. 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.
- The antenna should be protected from ESD using an 8 kV-rated suppressor to avoid damage during antenna assembly, etc. Capacitance should be < 0.2 pF.

- RF trace and cable connecting the pin to the antenna should be of low loss (<0.3 dB)
- Antenna connected on the main RF connector should offer 1.6:1 or better VSWR in order to maintain Tx power within +/- 2dB from the nominal power and the VSWR could be 2.3:1 or better for the Rx band frequencies.
- Antenna connected on the diversity RF connector should offer 3:1 or better VSWR in order to maintain radiated sensitivity.
- Antenna connected on the GPS connector should offer 3:1 or better VSWR in order to maintain radiated sensitivity.
- Antenna location may affect RF performance. Although the module is shielded to prevent interference in most applications, the placement of the antenna is still very important – if the host device is insufficiently shielded, high levels of broadband or spurious noise can degrade the module's performance.
- Antenna cables should be routed, if possible, away from noise sources (switching power supplies, LCD assemblies, etc.). If the cables are near the noise sources, the noise may be coupled into the RF cable and into the antenna.

4.7.5. Radiated Emissions

The device alone meets all regulatory emissions limits when tested into a cabled (conducted) 50Ω system. With antenna designs with up to 2.5:1 VSWR or worse, the radiated emissions could exceed limits. These emissions must be tested with the final antenna to ensure they pass. Examples of these limits would be FCC Part 22 and Part 24, test case 12.2.1 for GSM (3GPP TS 51.010), and test case 4.2.2 for WCDMA (ETSI EN 301 511).

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

4.7.6. Radiated Sensitivity Measurement

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

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

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

4.8. Digital Audio Interface (PCM)

PCM variants of the AirPrime MC8090/MC8092 support a digital audio interface and allow dynamic run-time selection of the appropriate interface.

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 following table describes the purpose and features of this interface.

Table 29. PCM Audio Interface Features

Feature	Details
Implementation	Primary PCM supported to interface with external codec
Power	1.8 V (use VREF_1V8 as logic reference)

Feature	Details
Features	• IOM-2 compatible device on physical level • Master mode only with 6 slots by frame (user only on slot 0) • Bit rate single clock mode at 2.048 MHz • 16 bits data word MSB first only • Linear Law only (no compression law) • Long Frame Synchronization only • Push-pull configuration on PCM-OUT and PCM-IN

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

Note: This interface is NOT AVAILABLE in the MC8090/MC8092 with UART variants.

4.8.1. Pin Description

The following table describes the digital audio (PCM) interface pins.

Table 30. Audio Pin Description

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

Refer to Table 9 AirPrime MC8090/MC8092 Pin Assignments for other pin-specific details.

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

4.8.2. PCM Waveforms

The following figures describe the PCM Frame and Sampling waveforms.

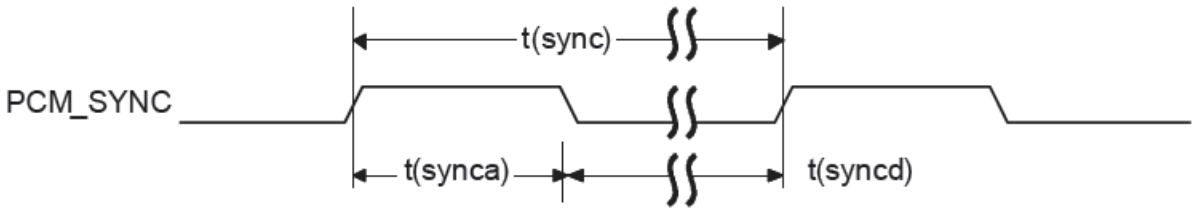


Figure 9. PCM_Sync Timing

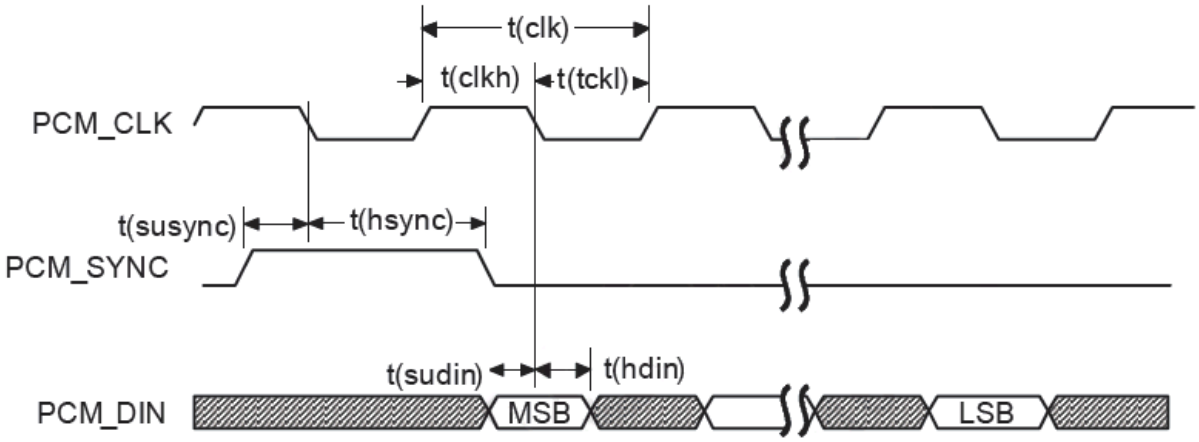


Figure 10. PCM_CODEC to MC8090/MC8092 with PCM Timing

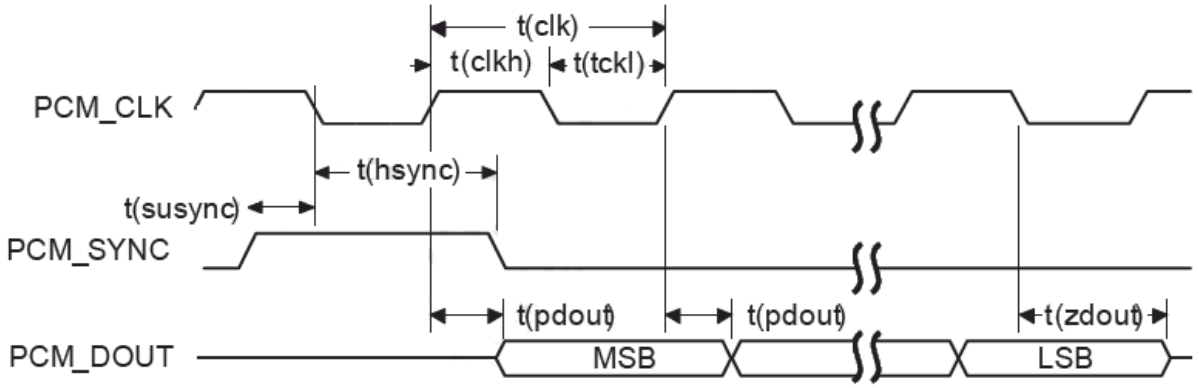


Figure 11. MC8090/MC8092 with PCM to PCM_CODEC Timing

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

Table 31. Digital Audio Interface Timing Parameters

Signal	Description	Minimum	Typical	Maximum	Unit
Tsync_low + Tsync_high	PCM-SYNC period		125		µs
Tsync_low	PCM-SYNC low time		124.5		µs
Tsync_high	PCM-SYNC high time	400	500		ns

Signal	Description	Minimum	Typical	Maximum	Unit
TSYNC_CLK	PCM-SYNC to PCM-CLK time	60			ns
TCLK-cycle	PCM-CLK period		488		ns
TIN-setup	PCM-IN setup time	50			ns
TIN-hold	PCM-IN hold time	10			ns
TOUT-delay	PCM-OUT delay time			350	ns

4.9. Short Message Service (SMS)

The MC8090/MC8092 mini card complies with the following SMS features:

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

4.10. UMTS Radio Access Bearers Supported

The MC8090/MC8092 supports the majority of the radio access bearers specified in 3GPP TS 34.108. Contact Sierra Wireless for a detailed list.

5. Signals and Indicators

This chapter describes signals for control and handshaking of the AirPrime MC8090/MC8092 mini card from the host and describes how the system implements Smart Error Detection using those signals.

The MC8090/MC8092 will automatically switch ON when power supply is present.

Table 32. Available Signals

Name	Driven by AT Commands
Reset Signal (SYSTEM_RESET_N)	
Wake Host Signal (WAKE_N)	✓
Wireless Disable Signal (W_DISABLE_N)	✓
Flash LED (LED_FLASH)	✓

5.1. Reset Signal (SYSTEM_RESET_N)

The SYSTEM_RESET_N signal is an input that is used to force the AirPrime MC8090/MC8092 mini card to reset.

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

Table 33. Reset Signal Features

Feature	Details
Purpose	Used by host to reset the module
Implementation	• Digital input. 1.8 V logic (active low) • The MC8090/MC8092 has been provided with a 10 kΩ internal pull-up resistor (to module-provided 1.8 V reference (pin 11 — VREF_1V8)).

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

5.1.1. Pin Description

The following table describes the SYSTEM_RESET_N signal pins.

Table 34. Reset Signal Pin Description

Pin #	Signal Name	I/O	I/O Type	Description
33	SYSTEM_RESET_N	I	1V8	MC8090/MC8092 reset

Refer to Table 9 AirPrime MC8090/MC8092 Pin Assignments for other pin-specific details.

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

5.1.2. Electrical Characteristics

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

Table 35. Reset Signal Electrical Characteristics

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

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

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

5.1.3. Application

5.1.3.1. Reset Sequence

To reset the MC8090/MC8092 mini card (force the baseband circuit to reset), the host drives the signal low for 10 – 30 ms.

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

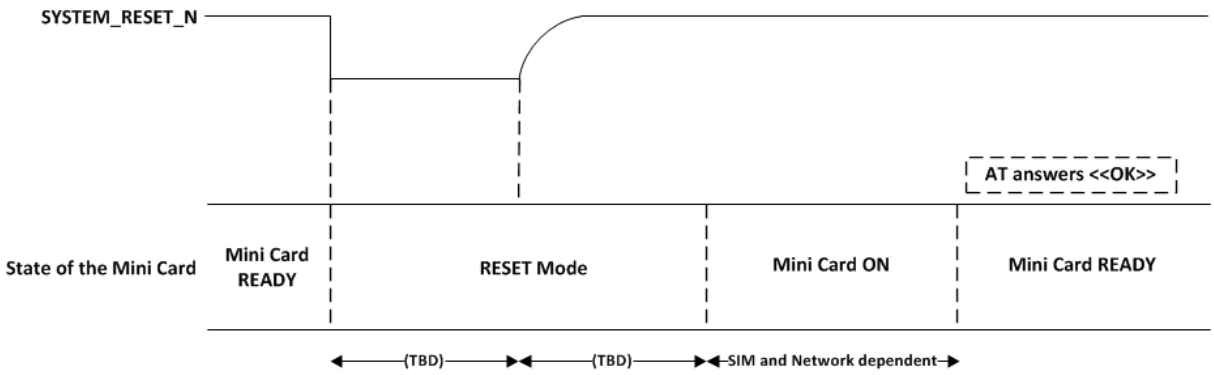


Figure 12. Reset Sequence Waveform

5.1.3.2. General Notes

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

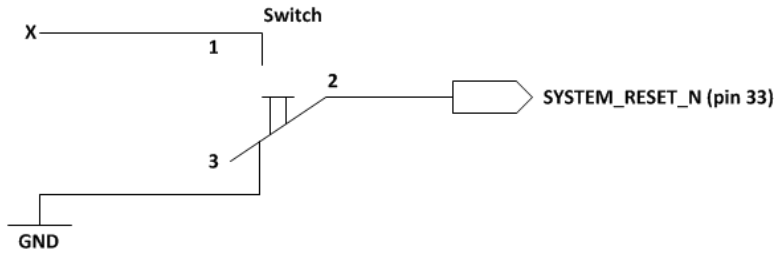


Figure 13. Example of SYSTEM_RESET_N Pin Connection with Switch Configuration

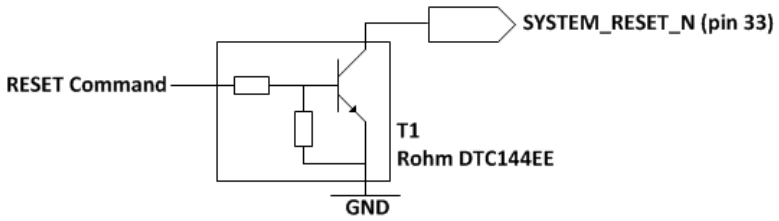


Figure 14. Example of SYSTEM_RESET_N Pin Connection with Transistor Configuration

Table 36. Reset Settings

Reset Command	SYSTEM_RESET_N (Pin 33)	Operating Mode
1	0	Reset activated
0	1	Reset inactive

5.2. Wake Host Signal (WAKE_N)

This signal is used by the AirPrime MC8090/MC8092 mini card to wake the host when a predetermined condition is satisfied (such as when a call is received).

Table 37. Wake Host Signal Features

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

5.2.1. Pin Description

The following table describes the wake signal pin.

Table 38. Wake Signal Pin Description

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

* This pin may be reconfigured for use in a full UART implementation. Refer to section 4.4.3 Full UART Implementation for more information.

Refer to Table 9 AirPrime MC8090/MC8092 Pin Assignments for other pin-specific details.

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

5.2.2. Electrical Characteristics

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

Table 39. Wake Signal Electrical Characteristics

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

5.3. Wireless Disable Signal (W_DISABLE_N)

This signal is used by the host to disable (or enable) the AirPrime MC8090/MC8092 mini card's RF connection.

Table 40. Wireless Disable Signal Features

Feature	Details
Purpose	Wireless disable • Used by host to disable or enable low power mode ('airplane mode').
Implementation	• Low = Put module in airplane mode • Digital input • Active low, 1.8V logic • The MC8090/MC8092 has been provided with a 10 kΩ internal pull-up resistor (to module-provided 1.8 V reference (pin 11 — VREF_1V8)).

5.3.1. Pin Description

The following table describes the wireless disable signal pin.

Table 41. Wireless Disable Signal Pin Description

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

Refer to Table 9 AirPrime MC8090/MC8092 Pin Assignments for other pin-specific details.

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

5.3.2. Electrical Characteristics

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

Table 42. Wireless Disable Signal Electrical Characteristics

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

5.3.3. Signal Timing

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

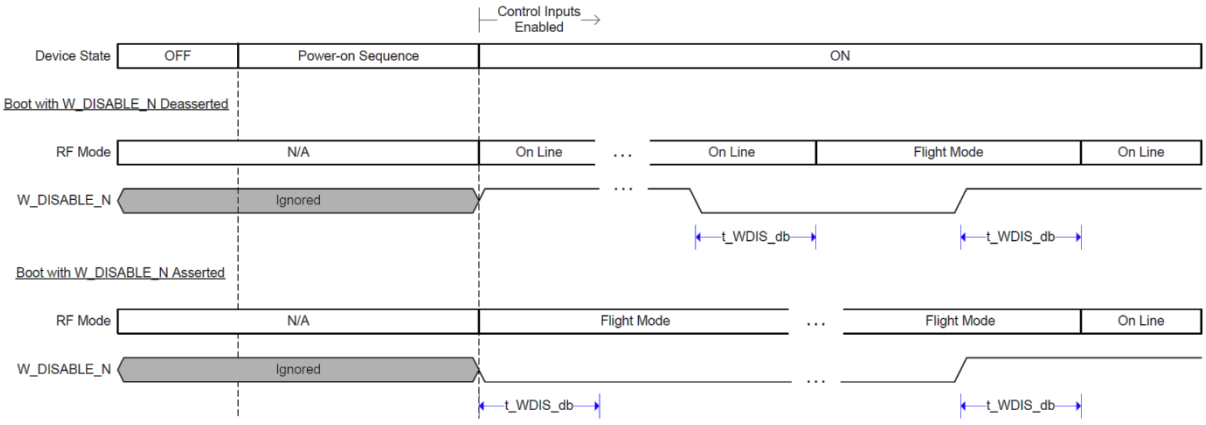


Figure 15. W_DISABLE_N Signal Timing

Table 43. W_DISABLE_N Signal Timing Parameters

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

5.4. Flash LED (LED_FLASH)

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

Table 44. LED Signal Features

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

5.4.1. Pin Description

The following table describes the LED signal pin.

Table 45. LED_FLASH Pin Description

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

Refer to Table 9 AirPrime MC8090/MC8092 Pin Assignments for other pin-specific details.

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

5.4.2. Electrical Characteristics

The following table describes the LED_FLASH signal's electrical characteristics. Refer to Table 9 AirPrime MC8090/MC8092 Pin Assignments for basic characteristics (type, voltage).

Table 46. LED_FLASH Signal Electrical Characteristics

Parameter	Condition	Minimum	Typical	Maximum	Unit
Tri-state					
V_{OL}		0.00		0.45	V

6. Power Consumption

The power consumption numbers listed in this section are for the AirPrime MC8090/MC8092 mini card connected to the host PC via USB. The module has its own power source. The minimum, typical and maximum values were measured at room temperature only. For a description of input voltage requirements, see section 3.1 Power Supply.

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

Table 47. Averaged Standby DC Power Consumption (Preliminary/Estimated Values)

Signal	Description	Bands	Typ.	Peak	Units	Notes/Configuration
VCC	**Standby current consumption with Sleep mode activated (assumes USB bus is fully suspended during measurements)**					
	HSDPA / WCDMA	UMTS bands	2.3	731	mA	DRX cycle = 8 (2.56 s)
	GSM / GPRS / EDGE	GSM bands	3.2	664	mA	MFRM = 5 (1.175 s)
	Standby current consumption with Sleep mode deactivated (assumes USB bus is fully suspended during measurements)					
	HSDPA / WCDMA	UMTS bands	23.9	726	mA	• DRX cycle = 8 (2.56 s) • Module power up and idle (Assumes Sleep mode is never entered)
	GSM / GPRS / EDGE	GSM bands	47.8	654	mA	• MFRM = 5 (1.175 s) • Module power up and idle (Assumes Sleep mode is never entered)
	Low Power Mode (LPM) / Offline Mode					
	RF disabled, but module is operational		13.5	23.1	mA	• State is entered when Watcher shuts down / turns off the radio. • LPM is the lowest possible (‘rock bottom’) state in Sleep mode.

Table 48. Averaged Call Mode Data DC Power Consumption

Mode	Current (at 3.3V)		Tx (output) Power	Conditions
WCDMA Data Current Consumption (includes USB bus current)				
WCDMA	Average	681.8 mA	23 dBm	384kbps*
		224.5 mA	0 dBm	
	Peak	788.6 mA		Averaged over 100µs
HSDPA	Average	708.542 mA	23 dBm	All speeds
		234.3 mA	0 dBm	
	Peak	842.031 mA		Averaged over 100µs
HSUPA	Average	698.4 mA	23 dBm	All speeds
		225.7 mA	0 dBm	
	Peak	838.386 mA		Averaged over 100µs

Mode	Current (at 3.3V)		Tx (output) Power	Conditions
GSM / EDGE Data Current Consumption				
GSM/GPRS	Average	267.7 mA (1TX) 437.3 mA (2TX)	+33 dBm	• 50Ω • Max PCL for each band
	Peak	2.18 A		• Averaged over 100µs • Worst case on 850 / 900 band
	Average	97.5 mA (1TX) 120.2 mA (2TX)	+10 dBm	50Ω
	Peak	243.2 mA		• Averaged over 100µs • Worst case on 850 / 900 band
EDGE (850 MHz)	Average	190.6 mA (1TX) 284.9 mA (2TX) 377.6 mA (3TX) 464.9 mA (4TX)	+26 dBm	• 50Ω • Class 12
	Peak	2.182 A	+33 dBm	• Averaged over 100µs • Worst case on 850 / 900 band

* Highest current is in Band I

Table 49. Miscellaneous DC Power Consumption (Preliminary Values)

Signal	Description	Band	Typ.	Max.	Units	Notes/Configuration
VCC	Module OFF leakage current	All bands	0.135	1.6	mA	Room temperature
	USB transmit current	All bands	10*	100	mA	Full speed USB connection, CL = 50 pF on D+ and D- signals

* Typical value for MC8790 mini card used as estimate.

Table 50. Supported GPRS/EDGE Power Classes

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

* E2 power class applies to 8PSK modulation.

6.1. Power States

The MC8090/MC8092 mini card has five power states as detailed in the following table.

Table 51. Supported MC8090/MC8092 Power States

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

6.1.1. Power State Transitions

The module monitors supply voltage and operating temperature and notifies the host when critical threshold limits are exceeded. See Table 52 Power State Transitions (including voltage/temperature trigger levels) for details.

Power state transitions may occur automatically when critical supply voltage or module temperature trigger levels are encountered. See Figure 16 Automatic ("Triggered") Power State Transitions for details.

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

Table 52. Power State Transitions (including voltage/temperature trigger levels)

Transition	Voltage		Temperature		Notes
	Trigger	V	Trigger	°C	
Normal to Low Power	VOLT_HI_CRIT	4.4	TEMP_LO_CRIT	-45	• RF suspended • CNS_RADIO_POWER notification issued*
	VOLT_LO_CRIT	3.0	TEMP_HI_CRIT	110	
Low Power to Normal	VOLT_HI_NORM	4.3	TEMP_NORM_LO	-40	• RF suspended • CNS_RADIO_POWER notification issued*
Low Power to Normal or Remain in Normal (remove warnings)	VOLT_LO_NORM	3.6	TEMP_HI_NORM	85	
Normal (issue warning)	VOLT_LO_WARN	3.3	TEMP_HI_WARN	95	

* Notification issued only if previously enabled. Refer to document [6] AirPrime UMTS MC Series CnS Reference for details.

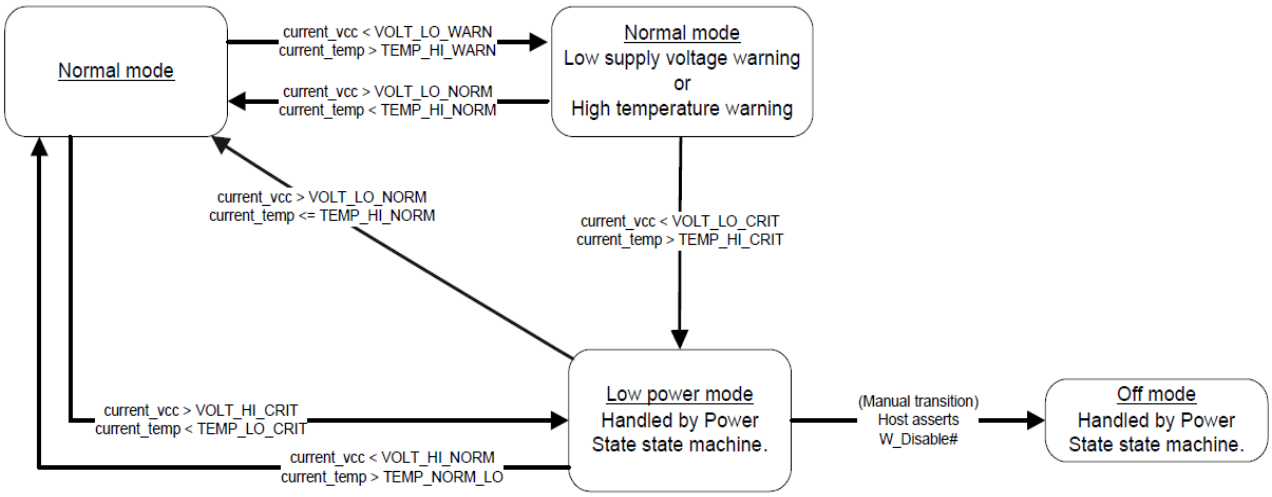


Figure 16. Automatic ("Triggered") Power State Transitions

7. Network Technology Specifications

7.1. UMTS WCDMA FDD Specifications

The MC8090/MC8092 supports the common WCDMA FDD specifications listed in the following table.

Table 53. Supported WCDMA FDD Specifications

Specification	Supported Feature
Physical Layer Specification	DL Channels: BCH, PCH, FACH, DCH, AICH, CPICH
	UL Channels: RACH, DCH
	Measurement for PCCPCH RSCP RSCP/SIR
	BTFD
	CCTrCH As defined by examples in 25.944
	Multifinger support
	Cell reselection
	Soft handover
	Power control
	PICH / DRX
	Measurement for SFN / CFN timing, SFN / SFN timing
	Cell selection
RLC Specifications	TM / UM / AM
	Max AM entities (4) • 3 for signalling • 1 for user data
	Only timer based polling for AM
	No timer based SDU discard for TM / UM / AM
	Poll PU polling for AM
	Poll prohibit
	Polling options: Last ReTX PU Poll, Poll Window, Poll SDU
	Status report transfer: Timer Status, Status Prohibit, Missing PU indicator
	Reset procedure: Indication to RRC
	Suspend / Resume
	Timer based SDU discard (UM / AM / TM)
	Status report transfer: Piggybacked Status PDUs, EPC based transfer
	SUFIs: Sending BITMAP and RLIST
	Start / stop for all three modes

Specification	Supported Feature
RRC Specifications	Cell selection
	RRC connection establishment
	RRC connection release
	System information processing
	Idle mode paging
	Dedicated mode paging
	Initial direct transfer
	Uplink direct transfer
	Downlink direct transfer
	Signalling connection release
	Signalling connection release request
	Radio bearer establishment
	Radio bearer release
	Cell update
	UE capability enquiry
	Transmission of UE capability
	Cell reselection
	Measurement control
	Measurement reporting
	Soft HO/Active Set update
	DRX mode
	NV support for RRC channel scan
	Radio bearer reconfiguration
	Transport channel reconfiguration
	Physical channel reconfiguration
	UTRAN mobility information
	Integrity protection
	Security mode control
	Encryption: UEA1
	Integrity algorithm: U1A11

7.2. Supported Specifications

The MC8090/MC8092 supports the specifications listed in Table 54 Supported Specifications, as well as Enhanced Network Selection (ENS), and Enhanced Operator Name String (EONS).

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

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

Table 54. Supported Specifications

Item	Comments
8PSK modulation	Octagonal Phase Shift Keying Coding schemes MCS1-4 are GMSK and MCS5-9 are 8PSK.
GPRS header compression	Data packet header compression supported
3GPP compliance	Protocol stack supports the requirements of: • GPRS/EDGE: 3GPP Release 99 and GERAN Feature Package #1 • WCDMA: Release 6
GPRS operation mode class B	Class B terminals support either circuit-switched or packet-switched traffic (with simultaneous network attachment) but do not support both kinds of traffic simultaneously.
Link Adaptation (LA)	Together with IR (next table entry), LA adapts the EGPRS transmission to meet changing radio link conditions.
EGPRS Incremental Redundancy (IR)	IR adjusts the physical layer code rate to actual channel conditions by incrementally transmitting redundant information until decoding is successful. Automatic Repeat Request (ARQ) protocol takes care of requesting and retransmitting incorrectly received blocks. ARQ enables both dynamic RLC window management (to avoid window stalling) and dynamic RLC polling frequency (to minimize retransmission delay and save radio bandwidth).
GPRS multislot class 10	Multislot class 10 and 12 allow for dynamic allocation of time slots.
EGPRS multislot class 12	
NC0	NC0 is the normal mode of control for a GPRS mobile in which the MS (Mobile Station) performs autonomous cell reselection.
DPC	Downlink Power Control Allows the network to adjust the downlink power of any dedicated channels on the BTS based on measurement reports sent by the mobile. This allows the network to reduce interference between multiple mobiles while still maintaining adequate signal quality for the individual mobiles.
One-phase packet access for GPRS	In establishing a TBF (Temporary Block Flow) connection, the MS (Mobile Station) requests either one-phase or two-phase packet access. In one-phase access, the network responds to a packet channel request by sending a packet uplink assignment message and reserving resources for uplink transfer of a number of radio blocks. In two-phase access, a packet resource request is sent on receipt of the packet uplink assignment.
One-phase packet access for EGPRS	
Two-phase packet access for GPRS	
Two-phase packet access for EGPRS	
RLC-acknowledged operation mode	The RLC-acknowledged and LLC-acknowledged modes are used to ensure the integrity of received data where QoS requires it. RLC (Radio Link Control) acknowledgment is typically the default (depending on the network and user profile). LLC-acknowledgment is optional and ensures that all LLC (Logical Link Control) frames are received without error. Since LLC-acknowledged mode requires acknowledgement of all LLC frames, the mode has an impact on throughput.
RLC-unacknowledged operation mode	
LLC-acknowledged transmission mode	
LLC-unacknowledged transmission mode	
GSM network operation mode I and II	The Network Operating Mode specifies the coordination of paging for circuit-switched and packet-switched services. Mode I - The mobile can receive circuit-switched pages while in a packet-switched call. Mode II - The mobile cannot receive a circuit-switched page while in a packet-switched call, as it would force the mobile to constantly monitor its CCCH channel.

Item	Comments
PBCCH / PCCCHI	Packet Broadcast Control Channel PBCCH is a packet data signalling channel that can supplement the BCCH GSM control channel, allowing decoupling of voice and packet control channels to set up data calls. PBCCH broadcasts GPRS / EGPRS specific cell re-selection parameters for serving and neighbour cells used in cell selection / re-selection for packet services.
GPRS test modes (ETSI test mode A and B)	The European Telecommunications Standards Institute (ETSI) defines standards and requirements for testing of GSM mobile equipment. In test mode A, the mobile requests an uplink TBF and transmits random data on a designated number of timeslots. This causes a device to transmit data without using upper layer protocols. Once the transmission has started, the downlink TBF halts. The device remains in this mode until the testing equipment terminates it. In test mode B, the mobile is prompted to receive data on a number of specified downlink timeslots and re-transmit the same data back on the corresponding uplink timeslots. Test mode B allows tests to be performed on both the transmitter and receiver within a single session.
NACC (R4 GERAN Feature Set 1)	Network Assisted Cell Change Enables the network to provide additional information about neighbour cells to the mobile while in a packet data session, which decreases the experienced service delays caused by cell re-selection.
MAIO	Mobile Allocation Index Offset MAIO and Hopping Sequence Number (HSN) are used in conjunction with Frequency Hopping to determine the hopping sequence used in each frame. The MAIO supports as many values as there are frequencies in the hopping list, and these are used to indicate the offset within the hopping list that identifies the frequency used.
Packet enhanced measurement report (PEMR)	Packet Enhanced Measurement Report (PEMR) is one of the RLC / MAC (Radio Link Control and Medium Access Control) control messages that include a carrier identifier. This message is a requirement of supporting multicarrier TBF.
Delayed TBF Release	Delayed Temporary Block Flow Release (also called Extended Uplink TBF) Delayed TBF Release reduces latency between uplink data transfers and reduced signalling on the network by maintaining a connection for brief periods when the network is temporarily inactive and the mobile station has no radio link control information to send. For this feature to work properly, the mobile station must support delayed TBF release.
Extended Dynamic Allocation	Radio blocks can be transmitted on up to four different PDCHs. Permits full class 12 operation.
Single Antenna Interference Cancellation (SAIC)	SAIC mitigates code-channel interference from neighbouring cells resulting in fewer dropped calls, and faster download rates for e-mail and websites.
Circuit-switched data bearers	These circuit-switched data bearers are supported on 2G networks: • Asynchronous 9,600 bps • Asynchronous 14,400 bps
Security	
Encryption support	GPRS / EGPRS support GEA1, GEA2, and GEA3 data ciphering. GSM CSD and SMS use A5/1 and A5/3 encryption.
PAP for RADIUS authentication - GPRS / EGPRS	PAP (Password Authentication Protocol) is a method of authenticating usernames and passwords against a database on a RADIUS (Remote Authentication Dial-In User Service) server. In a standard login, the service provider prompts for a username and password. In PAP authentication, the username and password are entered in the client's dialling software and sent as one data package, rather than the server sending a login prompt and waiting for a response.

Item	Comments
CHAP for RADIUS authentication - GPRS / EGPRS	CHAP (Challenge Handshake Authentication Protocol) is a more secure method for connecting to a system than PAP. After a link is established, the server sends a challenge message to the client. The client responds with a value calculated using a one-way hash function. The server compares its own calculation of the expected hash value to the client's response. If the values match, the authentication is acknowledged; otherwise the connection is terminated.
Support for encryption algorithm UEA1 (Kasumi)	UEA1 (UMTS Encryption Algorithm) generates the keystream as a function of a cipher key that is re-synchronized to every MAC / RLC frame. UEA is based on the Kasumi algorithm.
Support for integrity algorithm UIA1 (Kasumi)	UIA1 (UMTS Integrity Algorithm) is the algorithm used to compute the IK (Integrity Key) used in message authentication. UIA is based on the Kasumi algorithm.
UMTS	
WCDMA-to-GPRS reselection in CELL_FACH	CELL_FACH is an RRC (Radio Resource Control) service state in which cell reselection is performed. This feature prevents dropping of RRC connections.
Inter-frequency reselection in Cell_FACH	
Radio link failure	Radio link failure is a procedure that indicates an ‘out-of-synch’ state on one or more radio links. Node B of the RNC (Radio Network Controller) reports this event before attempting resynchronization. The radio link restoration procedure indicates restoration of the ‘synchronized’ state.
SIB scheduling	SIB (System Information Block) scheduling controls the broadcasting of information to user equipment in a cell. The user equipment retrieves the schedule, and is then able to change to sleep mode, receiving only those blocks that it needs.
SIB modification	
Re-establishment procedure	Following a radio link failure, the RNC maintains the RRC connection, waiting for re-establishment.
VT + PS call (subject to network availability)	Simultaneous VT (Video Terminal) and PS (Packet Switched) calls are supported.
Packet Cell Change Order from GSM→UTRAN	Call transfer between GSM-based and UTRAN-based cells is supported.
Background PLMN search	Improved algorithm for Higher Priority PLMN (HPPLMN) search while camped on a 3G cell.
Configurable Release 5 or Release 99 support	
Circuit-switched data bearers	
Data bearers	These circuit-switched data bearers are supported on 3G networks: • Synchronous transparent mode = 64000 bps • Synchronous transparent mode = 56000 bps • Asynchronous V110 UDI = 14400 bps • Asynchronous V110 UDI = 28800 bps • Asynchronous V110 UDI = 38400 bps • Asynchronous V120 = 14400 bps • Asynchronous V120 = 28800 bps • Asynchronous V120 = 56000 bps

Item	Comments
HSDPA	
Data rates	The following data rates are supported: • Category 10 (14.4 Mbps)
HSDPA logical channels	These HSDPA logical channels are supported: • HS-SCCH • HS-DPCCH • HS-PDSCH—Up to ten HS-PDSCH channels are supported.
HSDPA transport channels	HS-DSCH is supported at these rates: • 120 kbps • 240 kbps • 360 kbps
Incremental redundancy	IR adjusts the physical layer code rate to actual channel conditions by incrementally transmitting redundant information until decoding is successful. Automatic Repeat Request (ARQ) protocol takes care of requesting and retransmitting incorrectly received blocks. ARQ enables both dynamic RLC window management (to avoid window stalling) and dynamic RLC polling frequency (to minimize retransmission delay and save radio bandwidth).
Chase combining retransmission scheme	The Chase combining retransmission scheme is the simplest HARQ (Hybrid Automatic Request) link adaptation technique. HARQ techniques are used to enhance system performance.
HSDPA Compressed Mode	Allows the user equipment to interrupt transmission and reception during a call for brief periods in order to measure the signal strength of neighbouring cells that use different frequencies.
(MC8090) Concurrent voice and HSDPA data	Maximum value of 900 mA
HSDPA Indicator	Allows user interface to display an indicator when HSDPA data transfer is in progress.
Receiver equalizer support	
Miscellaneous	
Fast link adaptation	The data rate is adapted to radio conditions.
Vary the effective code rate	The effective code rate is varied based on code space resources.
HARQ, MAC-HS disassembly	MAC-HS (High Speed MAC) is the base station MAC (Medium Access Control) protocol. MAC-HS enables fast radio resource allocation.
MAC-HS reordering queue distribution and processing support	
Cell change	These cell change methods are supported: • Synchronous and non-synchronous • Intra-Node B (softer repointing) • Inter-Node B (soft repointing)
Up-switching and down-switching of PS RAB between HS-PDSCH and DPCH	RAB (Radio Access Bearer) and channel mappings between the HS-PDSCH (High Speed Physical Downlink Shared Channel) and DPCH (Dedicated Physical Channel) are reallocated according to volume thresholds and inactivity timers.
Ciphering on the HS channel	Ciphering on high-speed channels protects radio-transmitted data against unauthorized third parties.
Support to not resume the HS channel if inter-RAT handover fails, but save the RB mapping information	RB (Radio Bearer) mapping information is preserved if a high-speed channel is dropped due to the failure of an inter-RAT (Radio Access Technology) transfer.

Item	Comments
Support to not resume the HS channel if a radio link failure occurs, but save the RB mapping information	RB (Radio Bearer) mapping information is preserved if a high-speed channel is dropped due to a radio link failure.
WINS address support primary and secondary	Primary and secondary IP addresses can be assigned for WINS (Windows Internet Name Service) name servers.
(MC8090/MC8092 with PCM) Voice support	Digital audio (PCM) is supported.
Unstructured supplementary services data (USSD)	USSD provides support for transmitting information over the GSM network signalling channels. It provides fast session-based communication between the user and an application, enabling use of text messaging, prepaid roaming, chat, etc.
Supplementary services	Support for supplementary voice services such as Call Hold, Call Forward, Call Waiting, Multi-party Calls, Caller ID, Fixed Number Dialling, Service Dialling Numbers, etc.
Cell reselection / handover	Supports InterRat and InterFrequency cell-reselection and handover between supported frequency bands.
Security - IMEI Security	
SIM lock	The device can be 'MEP locked' to a particular PLMN.
SIM security	Both CHV1 and CHV2 are supported (unlock and unblock).

7.3. UMTS (WCDMA)/GSM Specifications

The following table details the MC8090/MC8092 mini card support for common UMTS (WCDMA) and GSM specifications.

Table 55. UMTS (WCDMA)/GSM Specifications

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

Item	GSM	UMTS
Inter-RAT change procedure	✓	✓
CS follow-on procedure	✓	✓
Access class barring	✓	✓
Resumption procedure for Class B operation in GPRS	✓	✓
Handling of domain change CS to CS/PS and other combinations	✓	✓
MM information	✓	✓
Network mode of operation I, II	✓	✓
GPRS mobility management		
GPRS attach	✓	✓
GPRS detach	✓	✓
Routing area update	✓	✓
GPRS authentication	✓	✓
GPRS identification	✓	✓
GMM status	✓	✓
Periodic routing area update	✓	✓
Ciphering	✓	✓
Access class barring	✓	✓
GMM status	✓	✓
Combined GPRS attach	✓	✓
Combined GPRS detach	✓	✓
Combined routing location / area update	✓	✓
PS SMS	✓	✓
Network initiated combined GPRS detach	✓	✓
Network mode of operation change	✓	✓
RAB management		
QoS-based activation, network offers lower / higher QoS	✓	✓
Primary PDP context activation	✓	✓
PDP context deactivation	✓	✓
Data services		
AT commands	✓	✓
MS PS data calls	✓	✓
Single PDP context	✓	✓
PDP type PPP		
PDP type IP	✓	✓
9.6 / 14.4 CS transparent data	✓	N/A
9.6 / 14.4 CS nontransparent data	✓	N/A
Fax	✓	✓
MT Sync CS data calls	✓	✓
MO Sync CS data calls	✓	✓
V.80	N/A	✓
V.42bis		N/A
Multiple PDP context profiles (up to 16)	✓	✓

Item	GSM	UMTS
SMS specifications		
CS domain MT SMS point-to-point	✓	✓
CS domain MO SMS point-to-point	✓	✓
SMMA	✓	✓
Dedicated mode	✓	✓
Message classes 0, 1, 2, 3, none	✓	✓
SMS / SMSP / SMSS access from SIM / USIM	✓	✓
Reply path	✓	✓
Validity period	✓	✓
PS domain MT SMS point-to-point	✓	✓
PS domain MO SMS point-to-point	✓	✓
SMS status reports	✓	✓
SMS commands	✓	✓

8. Reliability Compliance and Recommended Standards

8.1. Reliability Compliance

The AirPrime MC8090/MC8092 mini card connected on a development kit board application is compliant with the following requirements.

Table 56. Standards Conformity for the AirPrime MC8090/MC8092 Mini Card

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

8.2. Applicable Standards

The table hereafter gives the basic list of standards applicable to the MC8090/MC8092 mini card.

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

Table 57. 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.

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

8.3. Environmental Specifications

The MC8090/MC8092 mini card 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 58. 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 MC8090/MC8092 mini card.

Table 59. ISO Failure Mode Severity Classification

Class	Description
Class A	The MC8090/MC8092 mini card remains fully functional during and after environmental exposure; and shall meet the minimum requirements of 3GPP or appropriate wireless standards.
Class B	The MC8090/MC8092 mini card 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 Test

The following tests the MC8090/MC8092’s product performance.

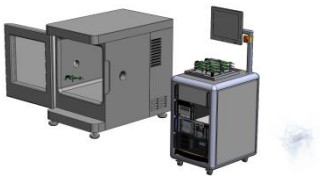
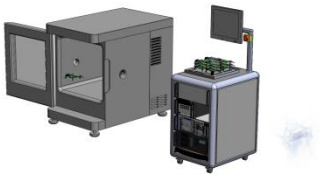
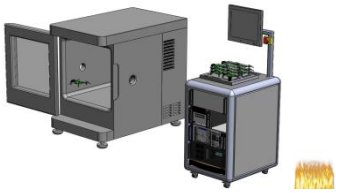
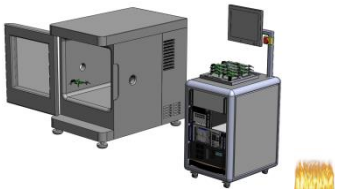
Table 60. Life Stress Test

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

8.4.2. Environmental Resistance Stress Tests

The following tests the MC8090/MC8092's resistance to extreme temperature.

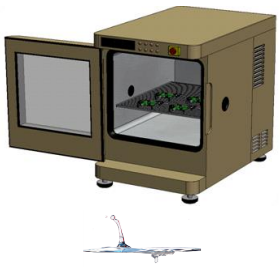
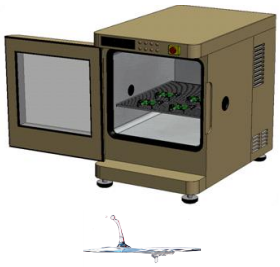
Table 61. Environmental Resistance Stress Tests

Designation	Condition
Cold Test Active **COTA** 	Standard: IEC 680068-2-1, Test Ad
	Special conditions: • Temperature: -30°C • Rate of temperature change: dT/dt >= ± 3°C/min • Recovery time: 3 hours
	Operating conditions: Powered
	Duration: 72 hours
Cold Test Active **COTP** 	Standard: IEC 680068-2-1, Test Ab
	Special conditions: • Temperature: -40°C • Rate of temperature change: dT/dt >= ± 3°C/min • Recovery time: 3 hours
	Operating conditions: Un-powered
	Duration: 72 hours
Resistance to Heat Test **RH** 	Standard: IEC 680068-2-2, Test Bb
	Special conditions: • Temperature: +85°C • Rate of temperature change: dT/dt >= ± 3°C/min • Recovery time: 3 hours
	Operating conditions: The DUT is switched ON for 1 min and then OFF for 1 min
	Duration: 50 days
Dry Heat Test **DHT** 	Standard: IEC 680068-2-2, Test Bb
	Special conditions: • Temperature: +85°C • Rate of temperature change: dT/dt >= ± 3°C/min • Recovery time: 3 hours
	Operating conditions: Un-powered
	Duration: 72 hours

8.4.3. Corrosive Resistance Stress Tests

The following tests the MC8090/MC8092's resistance to corrosive atmosphere.

Table 62. Corrosive Resistance Stress Tests

Designation	Condition
Humidity Test **HT** 	Standard: IEC 60068-2-3
	Special conditions: • Temperature: +65°C • RH: 95% • Rate of temperature change: dT/dt >= ± 3°C/min • Recovery time: 3 hours
	Operating conditions: The DUT is switched ON for 15 minutes and then OFF for 15 minutes
	Duration: 10 days
Moist Heat Cyclic Test **MHCT** 	Standard: IEC 60068-2-30, Test Db
	Special conditions: • Upper temperature: +40 ± 2°C • Lower temperature: +25 ± 2°C • RH: ▪ Upper temperature: 93% ▪ Lower temperature: 95% • Number of cycles: 21 (1 cycle/24 hours) • Rate of temperature change: dT/dt >= ± 3°C/min • Recovery time: 3 hours
	Operating conditions: Un-powered
	Duration: 21 days

8.4.4. Thermal Resistance Cycle Stress Tests

The following tests the MC8090/MC8092's resistance to extreme temperature cycling.

Table 63. Thermal Resistance Cycle Stress Tests

Designation	Condition
Thermal Shock Test **TSKT** 	Standard: IEC 60068-2-14, Test Na
	Special conditions: • Upper temperature: +90°C • Lower temperature: -40°C • Rate of temperature change: 30s • Number of cycles: 300 (MC8090/MC8092 with PCM), 50 (MC8090/MC8092 with UART) • Duration of exposure: 20 minutes • Recovery time: 3 hours
	Operating conditions: Un-powered
	Duration: 8 days

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

8.4.5. Mechanical Resistance Stress Tests

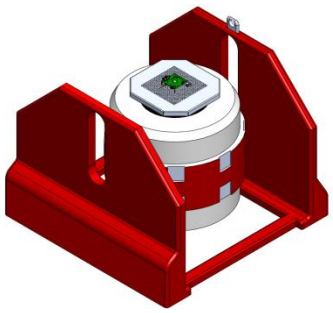
The following tests the MC8090/MC8092's resistance to vibrations and mechanical shocks.

Table 64. Mechanical Resistance Stress Tests

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

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

	Operating conditions: Un-powered
	Duration: 72 hours

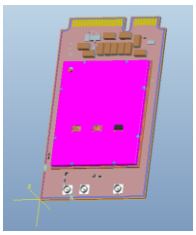
Designation	Condition
Random Vibration Test **RVT** 	Standard: IEC 60068-2-64
	Special conditions: • Density spectrum: 0.96m^2/s3 • Frequency range: ▪ 0.1 g2/Hz at 10Hz ▪ 0.01 g2/Hz at 250Hz ▪ 0.0005 g2/Hz at 1000Hz ▪ 0.0005 g2/Hz at 2000Hz • Slope: -3dB/octave • Acceleration: 0.9gRMS • Number of axis: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

8.4.6. Handling Resistance Stress Tests

The following tests the MC8090/MC8092's resistance to handling malfunctions and damage.

Table 65. Handling Resistance Stress Tests

Designation	Condition
ESD Test 	Standard: IEC 1000-4-2
	Special conditions: • Contact and Air discharges: 10 positive and 10 negative applied • Contact Voltage: ±2kV, ±4kV, ±6kV • Air Voltage : ±2kV, ±4kV, ±8kV
	Operating conditions: Powered
	Duration: 24 hours

Designation	Condition
Free Fall Test **FFT 1** 	Standard : IEC 60068-2-32, Test Ed
	Special conditions: • Drop: 2 samples for each direction • Equivalent drop height: 1m • Number of directions: 6 (±X, ±Y, ±Z) • Number of drops/face: 2
	Operating conditions: Un-powered
	Duration: 24 hours
Free Fall Test **FFT 2** 	Standard : Standard Sierra Wireless Methodology
	Special conditions: • Drop: 2 samples for each direction • Equivalent drop height: 1.5m • Number of directions: 6 (±X, ±Y, ±Z) • Number of drops/face: 2 • DUT in end-user host device
	Operating conditions: Un-powered
	Duration: 24 hours

9. Design Guidelines

9.1. SIM Interface Routing Constraint

The length of the tracks between the AirPrime MC8090/MC8092 mini card and the SIM socket should be as short as possible. The maximum recommended length is 10cm.

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

The capacitor (100 nF) on the SIM_VCC signal must be placed as close as possible to the DALC208SC6 component on the PCB (see section 4.5 USIM Interface).

9.2. EMC and ESD Recommendations

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

When designing, special attention should be paid to:

- Possible spurious emissions radiated by the application to the RF receiver in the receiver band
- ESD protection is mandatory on all signals which are externally accessible

  Typically, ESD protection is mandatory for the:

  - SIM (if accessible from outside)
  - Serial link
  - USB
  - Antenna Port

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

  Manufacturer: INNOCHIPS TECHNOLOGY CO.

  Part Number: ULCE0505A015FR
- Length of the SIM interface lines (preferably <10 cm)
- EMC protection on audio input/output (filters against 900 MHz emissions)
- Biasing of the microphone inputs
- Ground plane: Sierra Wireless recommends a common ground plane for analog/digital/RF grounds
- A metallic case or plastic casing with conductive paint are recommended, except area around the antenna

Note: The AirPrime MC8090/MC8092 mini card does not include any protection against over voltage.

The host device must provide adequate ESD protection on digital circuits and antenna ports as detailed in Table 66 ESD Specifications.

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

Table 66. ESD Specifications

Connection	Specification
Operational	The RF port (antenna launch and RF connector) complies with the following standard: • IEC 61000-4-2 Electrostatic Discharge Immunity: ▪ Test: Level3 ▪ Contact Discharge: ±6 kV ▪ Air Discharge: ±8 kV
Non-operational	The host connector Interface complies with the following standards only: • ±1 kV Human Body Model (JESD22-A114-B) • ±125 V Charged Device Model (JESD22-C101)

9.3. Mechanical Integration

Note: Attention should be paid to antenna cable integration (bending, length, position, etc).

9.4. Operating System Upgrade

The AirPrime MC8090/MC8092 mini card's Operating System is stored in flash memory and can be easily upgraded.

Tip: *In order to follow regular changes in the GPRS standard and to offer a state-of-the-art operating system, Sierra Wireless recommends that the application designed around a mini card (or mini card based product) should allow easy operating system upgrades on the mini card via the recommended firmware download protocol (see document [7] AirCard/AirPrime USB Driver Developer's Guide). Therefore, the application shall either allow a direct access to the mini card serial interface through an external connector or implement any mechanism allowing the mini card operating system to be downloaded.*

10. Embedded Testability

10.1. Testing Assistance Provided by Sierra Wireless

Extended AT commands have been implemented to assist with performing FTA GCF tests and portions of CE Mark tests requiring radio module access. These are documented in documents [4] AirCard/AirPrime UMTS Supported AT Command Reference and [5] AirPrime MC/SL Series (UMTS/LTE) Extended AT Command Reference.

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

10.2. Integration Requirements

When integrating the MC8090/MC8092 mini card, the following items must be addressed:

- Mounting — Effect on temperature, shock, and vibration performance
- Power supply — Impact on battery drain and possible RF interference
- Antenna location and type — Impact on RF performance
- Regulatory approvals — As discussed in section 11 Certification Compliance and Recommended Standards
- Service provisioning — Manufacturing process

Sierra Wireless provides guidelines for successful MC8090/MC8092 mini card integration with the document suite and offers integration support services as necessary.

10.3. IOT/Operator

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

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

10.4. Module Testing Recommendations

When testing your integration design:

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

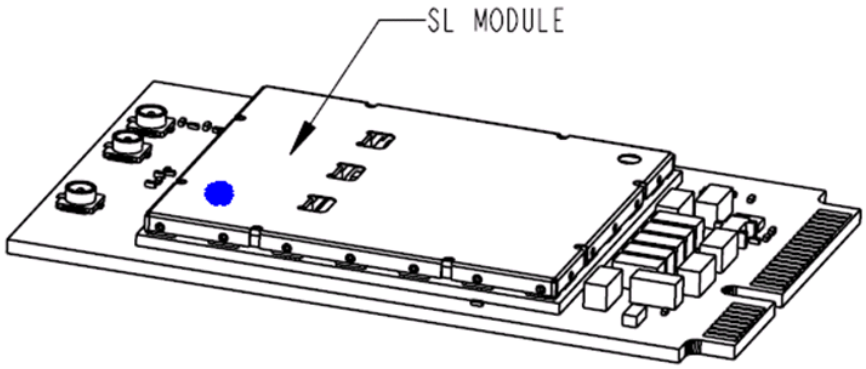


Figure 17. Recommended Thermocouple Location

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

10.5. Serial Link Access

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

- Testability operations
- Firmware download

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

10.6. RF Output Accessibility

During the integration phase of the AirPrime MC8090/MC8092 mini card, it can be helpful to connect the AirPrime MC8090/MC8092 mini card to a WCDMA/HSDPA/HSUPA/GSM/GPRS simulator in order to check critical RF TX parameters and power behaviour.

Although the AirPrime MC8090/MC8092 mini card 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. Certification Compliance and Recommended Standards

11.1. UMTS Compliance Acceptance and Certification

The MC8090/MC8092 is designed to be compliant with the 3GPP Release 5 UMTS Specification for Mobile Terminated Equipment. Final regulatory and operator certification requires regulatory agency testing and approval with the fully integrated UMTS UE host device incorporating the MC8090/MC8092 mini card.

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

Note: Tests that require features not supported by the MC8090/MC8092 (as defined by this document) are not supported.

11.2. Certification Compliance

Tests that require features not supported by the MC8090/MC8092 (as defined by this document) are not supported.

Table 67. Standards Conformity for the MC8090/MC8092 Mini Card

Domain	Applicable Standard	MC8090	MC8092
Safety standard (art 3.1.a)	IEC 60950:2005 EN60950-1: 2006 +A11:2009	✓	✓
Health standard (EMF Exposure Evaluation)	EN 62311 (ed. 2008)	✓	✓
Efficient use of the radio frequency spectrum (art 3.2)	EN 301 440-1 V1.5.1 EN 301 440-2 V1.3.1 EN 301 511 V9.0.2 EN 301 908-1 V4.2.1 EN 301 908-2 V4.2.1	✓	✓
EMC (art 3.1.b)	EN 301 489-1 V1.8.1 EN 301 489-3 V1.4.1 EN 301 489-7 V1.3.1 EN 301 489-24 V1.4.1	✓	✓
FCC	FCC Part 22, 24	✓	
IC	RSS-132 Issue 2 RSS-133 Issue 5	✓	
EU	GCF-CC compliance CE Mark regulatory certification of compliance	CE	CE
A-Tick certification		✓	
North / Latin America operators / carriers	PTCRB approval per NAPRD requirement AT&T	✓	

11.3. Applicable Standards

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

11.3.1. Important Notice

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

11.3.2. Safety and Hazards

Do not operate your AirPrime MC8090/MC8092 mini card modem:

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

In such areas, the MC8090/MC8092 modem **MUST BE POWERED OFF**. Otherwise, the MC8090/MC8092 modem can transmit signals that could interfere with this equipment. In an aircraft, the MC8090/MC8092 modem **MUST BE POWERED OFF**. Otherwise, the MC8090/MC8092 modem can transmit signals that could interfere with various onboard systems and may be dangerous to the operation of the aircraft or disrupt the cellular network. Use of a cellular phone in an aircraft is illegal in some jurisdictions. Failure to observe this instruction may lead to suspension or denial of cellular telephone services to the offender, or legal action or both.

Some airlines may permit the use of cellular phones while the aircraft is on the ground and the door is open. The MC8090/MC8092 modem may be used normally at this time.

11.3.3. Important Compliance Information for North American Users

The MC8090/MC8092 modem has been granted modular approval for mobile applications. Integrators may use the MC8090/MC8092 modem in their final products without additional FCC/IC (Industry Canada) certification if they meet the following conditions. Otherwise, additional FCC/IC approvals must be obtained.

1. At least 20 cm separation distance between the antenna and the user's body must be maintained at all times.
2. To comply with FCC/IC regulations limiting both maximum RF output power and human exposure to RF radiation, the maximum antenna gain including cable loss in a mobile-only exposure condition must not exceed 6.2 dBi in the cellular band and 3.8 dBi in the PCS band for the MC8090.
3. The MC8090/MC8092 modem and its antenna must not be co-located or operating in conjunction with any other transmitter or antenna within a host device.
4. Refer to section 4.7 RF Interface for RF signal conditions.
5. A label must be affixed to the outside of the end product into which the MC8090 modem is incorporated, with a statement similar to the following:

   This device contains FCC ID: N7NSL8090

   This equipment contains equipment certified under IC: 2417C-SL8090
6. A user manual with the end product must clearly indicate the operating requirements and conditions that must be observed to ensure compliance with current FCC/IC RF exposure guidelines.

The end product with an embedded MC8090/MC8092 modem may also need to pass the FCC Part 15 unintentional emission testing requirements and be properly authorized per FCC Part 15.

Note: *If this mini card 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.*

11.3.4. EU Regulatory Conformity

Sierra Wireless hereby declares that the MC8090/MC8092 modem conforms with all essential requirements of Directive 1999/5/EC.

CE

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

Sierra Wireless (UK) Limited
Suite 5, The Hub
Fowler Avenue
Farnborough Business Park
Farnborough, United Kingdom GU14 7JP

12. Customization

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

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

Table 68. Customizable Features

Name	Description	Default
MEP network locked	Mobile Equipment Personalization network locked to only allow use with specific preconfigured PLMNs (SIMs). MMI supports the entry of an unlock code subject to permanent locking feature below.	Off
MEP service provider locked		
Permanent MEP locked	Can block deactivation of MEP locked feature	Off
Roaming indicator disable*	Watcher never shows the onscreen roaming indicator.	Indicator enabled
SIM PUK prompt enable	If enabled, Watcher shows the message "SIM blocked please enter PIN code".	Disabled, Watcher displays "Contact Service Provider" when SIM PIN is blocked
Scan for profile	The modem scans through all its programmed profiles to find successful GPRS connection.	Not scanning. Only the selected profile is used for connection.
Display of IMSI	Display of International Mobile Subscriber Identity via AT+CIMI command	Display enabled
UART baudrate	Default UART speed	115200 bps
UART enabled	Defines whether UART port is enabled by default or not	UART enabled

* Only available if supported in the user interface.

13. Signal Reference Schematics

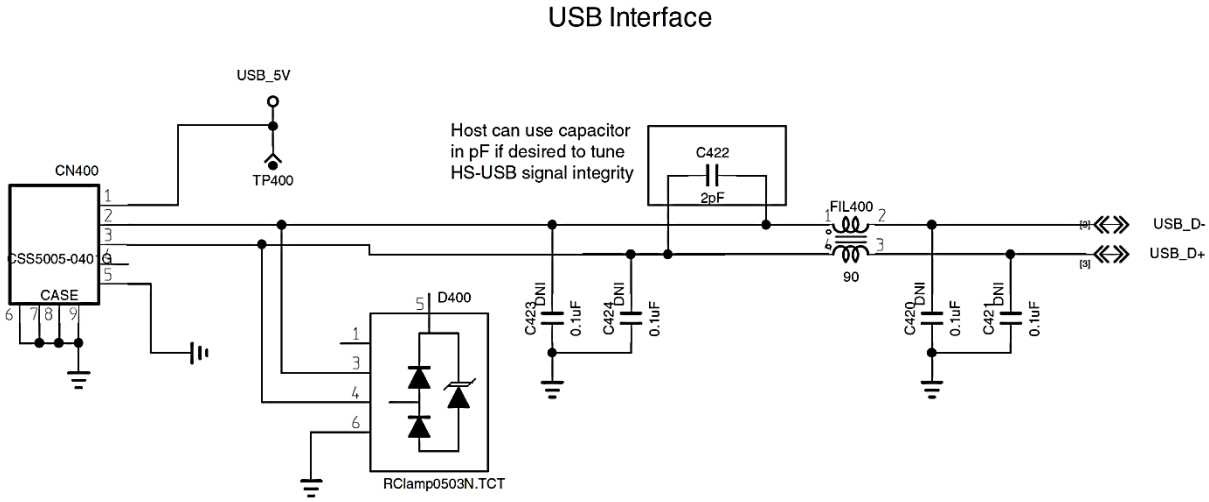


Figure 18. USB Interface

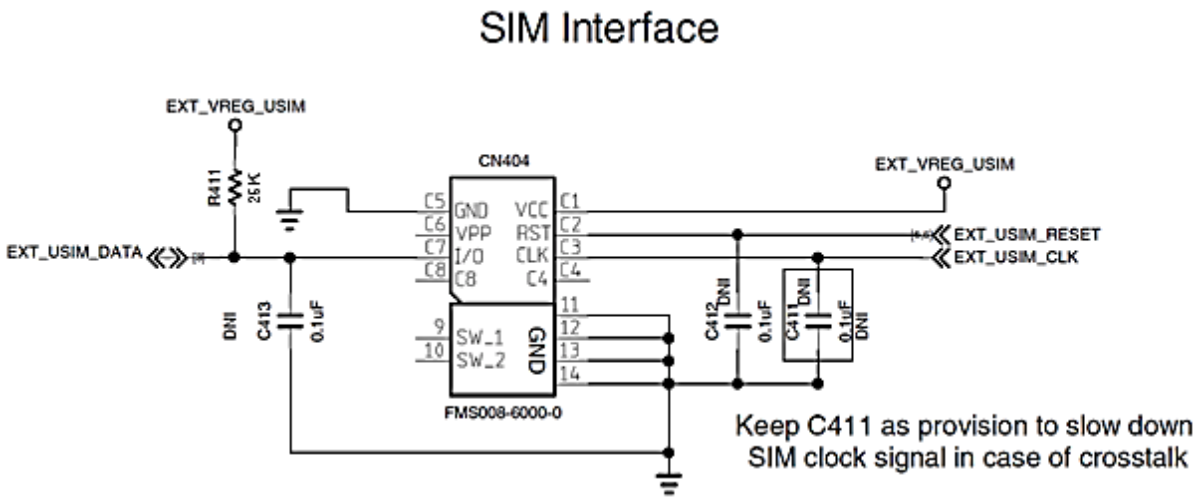


Figure 19. SIM Interface

14. References

14.1. Web Site Support

For additional documents describing mini card design, usage, and integration issues, visit http://source.sierrawireless.com/.

14.2. Reference Documents

14.2.1. Sierra Wireless Documentation

The following Sierra Wireless documents are provided in the Sierra Wireless documentation package, or are available from the Source.

[1] AirPrime MC Series Development Kit Quick Start Guide

Reference: 2130705

[2] AirPrime SL Series Customer Process Guideline

Reference: WM_DEV_LG_PTS_001

[3] AirPrime MC879x to AirPrime MC8090/MC8092 Migration Guide

Reference: 4110933

[4] AirCard/AirPrime UMTS Supported AT Command Reference

Reference: 2130617

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

Reference: 2130616

[6] AirPrime UMTS MC Series CnS Reference

Reference: 2130602

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

Reference: 2130634

[8] Sierra Wireless Reliability Specification

Reference: 4110485

14.2.2. Industry/ Other Documentation

[9] Universal Serial Bus Specification, Rev 2.0

[10] 3GPP TS 34.108

14.3. List of Abbreviations

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

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

Abbreviation	Definition
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 MC8090/MC8092 mini card, please read the following information carefully.

15.1. RF Safety

15.1.1. General

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

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

15.1.2. Exposure to RF Energy

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

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

15.1.3. Efficient Terminal Operation

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

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

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

15.1.4. Antenna Care and Replacement

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

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

15.2. General Safety

15.2.1. Driving

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

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

15.2.2. Electronic Devices

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

15.2.3. Vehicle Electronic Equipment

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

15.2.4. Medical Electronic Equipment

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

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

15.2.5. Aircraft

Turn your terminal OFF before boarding any aircraft.

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

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

15.2.6. Children

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

15.2.7. Blasting Areas

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

15.2.8. Potentially Explosive Atmospheres

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

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

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

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

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