Hardware Integration Guide

AirPrime MC7350

SIERRA WIRELESS

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Important Notice

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

Safety and Hazards

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

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

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

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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
1.0	October 30, 2013	Creation
1.1	November 19, 2013	Updated section 5.3 Important Compliance Information for North American Users

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1. Introduction

The Sierra Wireless MC7350 PCI Express Mini Card is a compact, lightweight, wireless LTE- and CDMA-based modem.

It provides LTE and CDMA connectivity for networking, and M2M applications over several radio frequency bands and supports 2G / 3G roaming.

1.1. 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 [2] AirPrime MC Series Development Kit Quick Start Guide.

2. Power Interface

2.1. Power Supply

The host device must provide power to the MC7350 mini card over pins 2, 24, 39, 41 and 52 (VCC) as detailed in the following table.

Table 1. Power Supply Requirements

Signal Name	Pin	Specification	Minimum	Typical	Maximum	Unit
VCC	2, 24, 39, 41, 52	Voltage range	3.0	3.3	3.6	V
		Ripple voltage	-	-	100	mVpp
GND	4, 9, 15, 18, 21, 26, 27, 29, 34, 35, 37, 40, 43, 50	-	-	0	-	V

Note: The host must provide safe and continuous power at all times; the module does not have an independent power supply, or protection circuits to guard against electrical issues.

2.2. Electrostatic Discharge (ESD)

The OEM is responsible for ensuring that the Mini Card host interface pins are not exposed to ESD during handling or normal operation.

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

Table 2. ESD Specifications

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

2.3. Power States

The MC7350 mini card has four power states as detailed in the following table.

Table 3. Supported MC7350 Power States

State	Details	Host is Powered	Module is Powered	USB Interface Active	RF Enabled
Normal (Default state)	• Module is active • Default state when VCC is first applied in the absence of W_DISABLE_N control • Module is capable of placing / receiving calls, or establishing data connections on the wireless network • Current consumption is affected by several factors, including: ▪ Radio band being used ▪ Transmit power ▪ Receive gain settings ▪ Data rate ▪ Number of active Tx time slots	✓	✓	✓	✓
Low power (‘Airplane mode’)	• Module is active • Module enters this state: ▪ Under host interface control: ▪ Host issues **AT+CFUN=0**, or ▪ Host asserts W_DISABLE_N, after **AT!PCOFFEN=0** has been issued. ▪ Automatically, when critical temperature or voltage trigger limits have been reached	✓	✓	✓	×
Sleep	• Normal state of module between calls or data connections • Module cycles between wake (polling the network) and sleep, at network provider-determined interval.	✓	✓	×	×
Disconnected	Host power source is disconnected from the module and all voltages associated with the module are at 0 V.	×	×	×	×

3. RF Integration

3.1. Supported RF Bands

Table 4. Supported RF Bands

Band/Connectivity	Data Rates	Notes
CDMA BC0 (Cellular 800 MHz)	CDMA IS-2000 Up to 153 kbps, simultaneous forward and reverse channel CDMA IS-856 (1xEV-DO Release A) • Up to 3.1 Mbps forward channel • Up to 1.8 Mbps reverse channel Circuit-switched data bearers up to 14.4 kbps	3G diversity support
CDMA BC1 (PCS 1900 MHz)		
CDMA BC10 (Secondary 800 MHz)		
LTE Band 4 (AWS 1700/2100 MHz)	HSPA+ rates • Downlink: Up to 42 Mbps (category 24) • Uplink: Up to 5.76 Mbps (category 7) Circuit-switched data bearers up to 64 kbps	MIMO support
LTE Band 13 (700 MHz)		
LTE Band 25 (1900 MHz G Block)	Category 3 Downlink: • 100 Mbps (20 MHz bandwidth) • 50 Mbps (10 MHz bandwidth) Uplink: • 50 Mbps (20 MHz bandwidth) • 25 Mbps (10 MHz bandwidth)	MIMO support
GPS	1575.42 MHz	
GLONASS	1602 MHz	

3.2. Ground Connection

When connecting the mini card to system ground:

- Prevent noise leakage by establishing a very good ground connection to the mini card through the host connector.
- Connect to system ground using the two mounting holes at the top of the module. (Refer to document [1] AirPrime MC7350 and MC7350-L Product Technical Specification and Customer Design Guidelines for more information.)
- Minimize ground noise leakage into the RF. Depending on the host board design, noise could potentially be coupled to the mini card from the host board. This is mainly an issue for host designs that have signals traveling along the length of the mini card, or when circuitry operating at both ends of the mini card interconnects.

3.3. Shielding Guidelines

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

Note: The module shields must NOT be removed.

3.4. Antenna Guidelines

When selecting the antenna and cable, it is critical to RF performance to match antenna gain and cable loss.

3.4.1. Choosing the Correct Antenna and Cabling

Consider the following points for appropriate antenna selection:

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

3.4.2. Designing Custom Antennas

Note that in designing custom antennas, a skilled RF engineer should do the development to ensure that the RF performance is maintained.

3.4.3. Determining the Antenna’s Location

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

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

3.4.4. Disabling the Diversity Antenna

- For LTE bands, use the AT command **`!RXDEN=0`** to disable receive diversity or **`!RXDEN=1`** to enable receive diversity.
- For CDMA bands, use the AT command **`!DIVERSITY`** to enable or disable receive diversity.

Note: A diversity antenna is used to improve connection quality and reliability through redundancy. Because two antennas may experience difference interference effects (signal distortion, delay, etc.), when one antenna receives a degraded signal, the other may not be similarly affected.

3.5. RF Desense Sources

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

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

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

4. Audio Interface

The MC7350 supports a PCM/I^2S digital audio interface using a dedicated serial link for digital audio data; all other signals, such as subcoding and control, are transmitted separately. The audio interface can be switched from PCM to I^2S and vice versa via AT commands.

Table 5. Audio Pin Description

Signal Name	Pin	Description
PCM_CLK/I2S_CLK	45	PCM Clock/I^2S Clock
PCM_DOUT/I2S_DOUT	47	PCM Data Out/I^2S Data Out
PCM_DIN/I2S_DIN	49	PCM Data In/I^2S Data In
PCM_SYNC/I2S_WS	51	PCM SYNC/I^2S WS

5. Regulatory Information

This module is designed to meet, and upon commercial release, will meet the requirements of the following regulatory bodies and regulations, where applicable:

- Federal Communications Commission (FCC) of the United States
- The Certification and Engineering Bureau of Industry Canada (IC)
- The National Communications Commission (NCC) of Taiwan, Republic of China

Upon commercial release, the following industry approvals will have been obtained, where applicable:

- CDG2

Additional certifications may be obtained upon customer request; contact your Sierra Wireless account representative for details.

Additional testing and certification may be required for the end product with an embedded MC7350 modem and are the responsibility of the OEM. Sierra Wireless offers professional services-based assistance to OEMs with the testing and certification process, if required.

5.1. Important Notice

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

5.2. Safety and Hazards

Do not operate your MC7350 modem:

- In areas where blasting is in progress
- Where explosive atmospheres may be present including refuelling points, fuel depots, and chemical plants
- Near medical equipment, life support equipment, or any equipment which may be susceptible to any form of radio interference. In such areas, the MC7350 modem **MUST BE POWERED OFF**. Otherwise, the MC7350 modem can transmit signals that could interfere with this equipment.

In an aircraft, the MC7350 modem **MUST BE POWERED OFF**. Otherwise, the MC7350 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 MC7350 modem may be used normally at this time.

5.3. Important Compliance Information for North American Users

Note: Details are preliminary and subject to change.

The MC7350 modem has been granted modular approval for mobile applications. Integrators may use the MC7350 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:
   - 6.5 dBi in Cellular band (note that CDMA BC10 is not permitted in Canada)
   - 3 dBi in PCS band
   - 6.0 dBi in LTE Band 4
   - 9.0 dBi in LTE Band 13
   - 3.0 dBi in LTE Band 25
3. The MC7350 modem may transmit simultaneously with other collocated radio transmitters within a host device, provided the following conditions are met:
   - Each collocated radio transmitter has been certified by FCC / IC for mobile application.
   - At least 20 cm separation distance between the antennas of the collocated transmitters and the user's body must be maintained at all times.
   - The output power and antenna gain must not exceed the limits and configurations stipulated in the following table.

Device	Technology	Band	Frequency (MHz)	Maximum Conducted Power (dBm)	Maximum Antenna Gain (dBi)
MC7350	LTE	4	1710–1755	24	6
		13	777–787	24	6
		25	1850–1915	24	3
	CDMA	BC0	824–849	25	3
		BC1	1850–1910	25	3
		BC10	817–824	25	3
Collocated transmitters*	WLAN		2400–2500	29	5.0
			5150–5850	29	5.0
	WiMAX		2300–2400	29	5.0
			2500–2700	29	5.0
			3300–3800	29	5.0
	BT		2400–2500	15	5.0

* Valid collocated transmitter combinations: WLAN+BT; WiMAX+BT. (WLAN+WiMAX+BT is not permitted.)

4. A label must be affixed to the outside of the end product into which the MC7350 modem is incorporated, with a statement similar to the following:

   This device contains FCC ID: N7NMC7350

   Contains transmitter module IC: 2417C-MC7350

   where 2417C-MC7350 is the module's certification number.

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

The end product with an embedded MC7350 modem may also need to pass the FCC Part 15 unintentional emission testing requirements and be properly authorized per FCC Part 15.

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

6. References

6.1. Reference Documents

[1] AirPrime MC7350 and MC7350-L Product Technical Specification and Customer Design Guidelines

Reference: 4114103

[2] AirPrime MC Series Development Kit Quick Start Guide

Reference: 2130705

6.2. List of Abbreviations

Abbreviation	Definition
AC	Alternative Current
ADC	Analog to Digital Converter
A/D	Analog to Digital conversion
AF	Audio-Frequency
AT	Attention (prefix for modem commands)
AUX	Auxiliary
CAN	Controller Area Network
CB	Cell Broadcast
CEP	Circular Error Probable
CLK	Clock
CMOS	Complementary Metal Oxide Semiconductor
CS	Coding Scheme
CTS	Clear To Send
DAC	Digital to Analogue Converter
dB	Decibel
DC	Direct Current
DCD	Data Carrier Detect
DCE	Data Communication Equipment
DCS	Digital Cellular System
DR	Dynamic Range
DSR	Data Set Ready
DTE	Data Terminal Equipment
DTR	Data Terminal Ready
EDGE	Enhance Data rates for GSM Evolution
EFR	Enhanced Full Rate
E-GSM	Extended GSM
EGPRS	Enhance GPRS
EMC	Electromagnetic Compatibility

Abbreviation	Definition
EMI	Electromagnetic Interference
EMS	Enhanced Message Service
EN	Enable
ESD	Electrostatic Discharges
FIFO	First In First Out
FR	Full Rate
FTA	Full Type Approval
GND	Ground
GPI	General Purpose Input
GPC	General Purpose Connector
GPIO	General Purpose Input Output
GPO	General Purpose Output
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile communications
HR	Half Rate
I/O	Input / Output
LED	Light Emitting Diode
LGA	Land Grid Array
LNA	Low Noise Amplifier
MAX	Maximum
MIC	Microphone
MIN	Minimum
MMS	MultiMedia Message Service
MO	Mobile Originated
MT	Mobile Terminated
na	Not Applicable
NC	Not Connected
NF	Noise Factor
NMEA	National Marine Electronics Association
NOM	Nominal
NTC	Negative Temperature Coefficient
PA	Power Amplifier
Pa	Pascal (for speaker sound pressure measurements)
PBCCH	Packet Broadcast Control Channel
PC	Personal Computer
PCB	Printed Circuit Board
PDA	Personal Digital Assistant
PFM	Power Frequency Modulation
PSM	Phase Shift Modulation
PWM	Pulse Width Modulation
RAM	Random Access Memory
RF	Radio Frequency

Abbreviation	Definition
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
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

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