DATA SHEET

SM700 RF Engines®

Model Number: SM700

Part Number: SM700PC1

Document Revision v1.0

Wireless Technology to Control and Monitor Anything from Anywhere™

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Be sure to read the ERRATA which follow this page.

Errata

Be sure you are using SNAP 2.4.21, which is the official release for the MC1322X chip and the Model SM700 module. All of the following errata can be found in the SNAP Reference Manual; be sure to read the sections on the MC1322x chip and the SM700 module.

1) Wakeup pins

Four pins, GPIO_26 through GPIO_29, can be configured to wake the module from sleep. Note that these pins automatically become inputs when entering sleep. Four other pins, GPIO_22 through GPIO_25 automatically become outputs when entering sleep (this behavior is not under software control).

2) Network IDs

The MC13224 hardware does not function properly with all network IDs. An MC13224 node set to a network ID that fits the pattern 0xn2nn or 0xnAnn will not be able to receive radio transmissions, though it can still send them. This is an issue with the underlying Freescale radio.

For example:
Network ID 0xFADE does not work. Network ID 0xFBDE does work.

3) Built-in functions – setPinPullup()

The setPinPullup() function does not apply a pull-up to GPIO_30 through GPIO_41. No internal pull-ups are available on these pins.

4) Built-in functions – sleep()

There are four sleep() modes on the MC13224 module. Even-numbered sleep modes do not require that an external 32 kHz crystal be connected and are less accurate with their timing. (The internal clock can be regulated on a node-by-node basis, if necessary, using NV Parameter 65.) Odd-numbered sleep modes provide very accurate timing but require the presence of the external crystal.

Sleep Mode	Details
0, 1	• Fast recovery • GPIO states are maintained during sleep† • Highest current usage
2, 3	• Fast recovery • GPIO states are NOT maintained (though they are reset on waking)

† *Pins GPIO_22, GPIO_23, GPIO_24, and GPIO_25 will always shift to being outputs while the node is sleeping in all sleep modes. Pins GPIO_26, GPIO_27, GPIO_28, and GPIO_29 will always shift to being inputs while the node is sleeping in all sleep modes.*

1.0 SM 700 RF Engines Overview

Synapse raises the bar on integrated performance with its SM700 RF Engine® based on the Freescale™ MC13224V transceiver platform. This wireless network module uses an ARM7 32-bit processor with large on-chip memory and integrated 12-bit ADCs.

And like all RF Engines from Synapse, the Model SM700 comes with SNAP® already loaded and ready to perform right out of the box. SNAP is Synapse's award-winning, mesh network operating system that provides wireless connectivity for Internet-to-machine and machine-to-machine communications.

With 96K RAM of memory, large applications can bring intelligence to the very edge of the network for local operations. These applications can be uploaded over-the-air… even mesh hopping across the network to reach its destination. And because of the large memory in the SM700, the core SNAP operating system can also be upgraded over-the-air and leaves your network in place and intact.

Very little board space is needed for this RF Engine (25mm x 36mm). Even the antenna is integrated to further reduce system size and cost. What comes in a small package however is big on capabilities. The SM700 can achieve a range of over 1.5 miles and deliver an output of up to +20dBm. For applications requiring battery power, the Model SM700 can perform at power consumption levels as low as 12 µA.

This Data Sheet details the SM700PC1 module, which includes:

- Powerful 32-bit TDMI ARM7 microprocessor
- 2.4 GHz RF Frequency (2400 - 2483.5 MHz)
- Up to 100mW output power
- 16 RF Channels
- Small footprint: 1" x 1.4" (25.4mm x 36.5mm)
- Operating temperature: -40°C to +85°C
- Over 1.5 miles range
- AES 128-bit encryption
- FCC, CE and IC certified
- Accurate 12-bit ADC for precision sensors
- Large on-board memory resources
- -96 dBm Rx sensitivity
- +20dBm Tx output power
- 2.0 to 3.6 Volts Vcc
- Low power consumption:
  - Transmit mode……193mA
  - Receive mode…….30mA
  - Sleep mode……12/53µA
- Integrated F-antenna
- Small surface-mount IC footprint

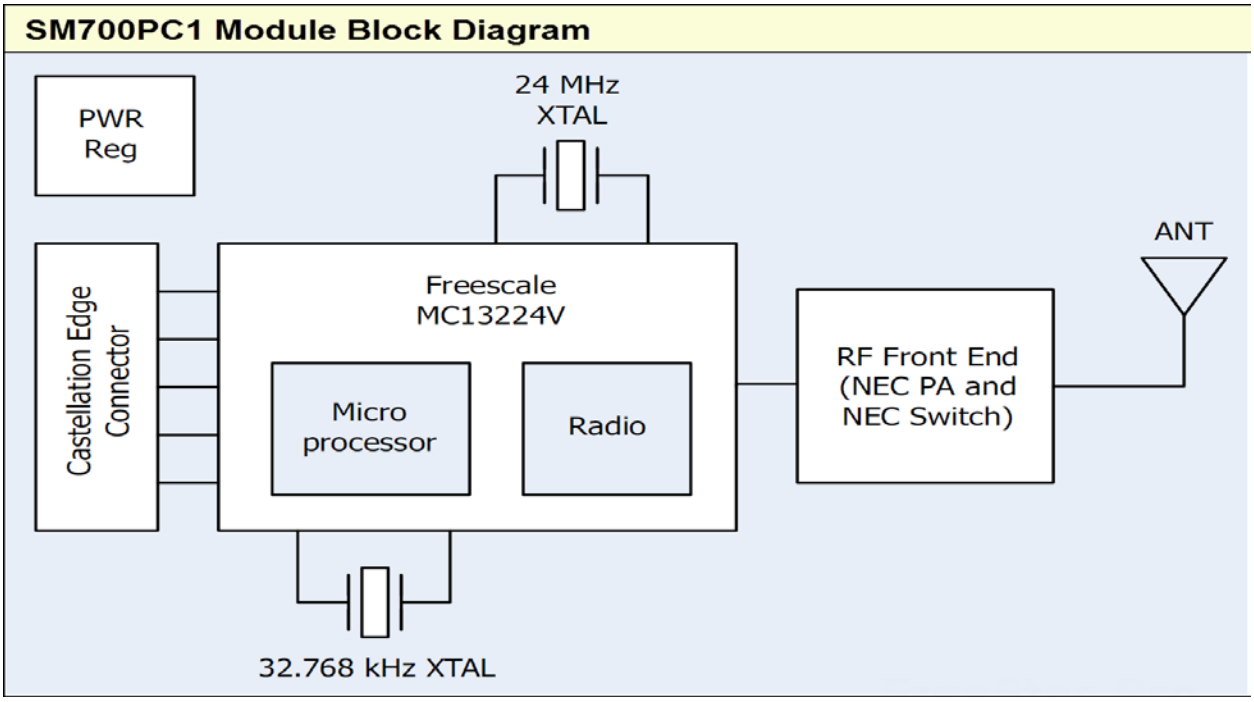

Figure 1.0 Block diagram showing the major subsystems comprising the SM700PC1

1.1 Specifications

Table 1.0. SM700PC1 Specifications		
Performance	Outdoor LOS Range	1.5 miles
	Transmit Power Output	20 dBm
	RF Data Rate	250Kbps
	Receiver Sensitivity	-94 dBm (1% PER)
Power Requirements	Supply Voltage	2.0 - 3.6 V
	Transmit Current (Typ@3.3V)	193mA
	Idle/Receive Current (Typ@3.3V)	30mA
	Sleep Current (Typ@3.3V)	12uA / 53uA
General	Frequency	ISM 2.4GHz
	Spreading Method	FHSS
	Modulation	GFSK
	Dimensions	1" x 1.4" (25.4mm x 36.5mm)
	Operating Temperature	- 40 to 85 deg C.
	Antenna Options	Integrated F-antenna
Networking	Topology	SNAP
	Error Handling	Retries and acknowledgement
	Number of Channels	16
Available I/O	UARTS with HW Flow Control	2
	GPIO	46 total; 12bit ADC
Agency Approvals	FCC Part 15.247	FCC ID: U9O-SM700
	Industry Canada (IC)	IC: 7084A-SM700
	European Union (EU) Directive	CE

1.2 Module Pin Definitions

Table 1.1. SM700PC1 Module Pin Assignments

Pin#	Name	Type	Description
1	GND	GND	GND
2	GND	GND	GND
3	GND	GND	GND
4	ADC2_VREFL	Analog Input or Digital I/O	GPIO39 Alternate function: Low reference voltage for ADC2
5	ADC1_VREFL	Analog Input or Digital I/O	GPIO41 Alternate function: Low reference voltage for ADC1
6	ADC1_VREFH	Analog Input or Digital I/O	GPIO40 Alternate function: High reference voltage for ADC1
7	ADC2_VREFH	Analog Input or Digital I/O	GPIO38 Alternate function: Low reference voltage for ADC2
8	ADC0	Analog Input or Digital I/O	GPIO30 Alternate function: ADC analog input Channel 0
9	ADC1	Analog Input or Digital I/O	GPIO31 Alternate function: ADC analog input Channel 1
10	ADC2	Analog Input or Digital I/O	GPIO32 Alternate function: ADC analog input Channel 2
11	ADC3	Analog Input or Digital I/O	GPIO33 Alternate function: ADC analog input Channel 3
12	VCC	Power Input	High side supply voltage to buck regulator switching MOSFET & IO buffers
13	ADC4	Analog Input or Digital I/O	GPIO34 Alternate function: ADC analog input Channel 4
14	ADC5	Analog Input or Digital I/O	GPIO35 Alternate function: ADC analog input Channel 5
15	ADC6	Analog Input or Digital I/O	GPIO36 Alternate function: ADC analog input Channel 6
16	ADC7_RTCK	Analog Input or Digital I/O	GPIO37 Alternate function: ADC analog input Channel 7 / Return Clock
17	TDO	Digital I/O	GPIO49 Alternate function: JTAG Test Data Output
18	TDI	Digital I/O	GPIO48 Alternate function: JTAG Test Data Input
19	TCK	Digital I/O	GPIO47 Alternate function: JTAG Test Clock Input
20	TMS	Digital I/O	GPIO46 Alternate function: JTAG Test Mode Select Input
21	UART2_RTS	Digital I/O	GPIO21 Alternate function: UART2 Request to Send input
22	GND	GND	GND
23	UART2_CTS	Digital I/O	GPIO20 Alternate function: UART2 Clear to Send output
24	UART2_RX	Digital I/O	GPIO19 Alternate function: UART2 RX data input
25	UART2_TX	Digital I/O	GPIO18 Alternate function: GPIO18UART2 TX data output
26	UART1_RTS	Digital I/O	GPIO17 Alternate function: UART1 Request to Send input
27	UART1_CTS	Digital I/O	GPIO16 Alternate function: UART1 Clear to Send output
28	I2C_SDA	Digital I/O	GPIO13 Alternate function: I2C Bus data
29	I2C_SCL	Digital I/O	GPIO12 Alternate function: I2C Bus clock
30	TMR3	Digital I/O	GPIO11 Alternate function: Timer 3 IO signal
31	VCC	Power Input	High side supply voltage to buck regulator switching MOSFET & IO buffers
32	TMR2	Digital I/O	GPIO10 Alternate function: Timer 2 IO signal
33	TMR1	Digital I/O	GPIO9 Alternate function: Timer 1 IO signal
34	TMR0	Digital I/O	GPIO8 Alternate function: Timer 0 IO signal
35	SPI_SCK	Digital I/O	GPIO7 Alternate function: SPI Port clock
36	UART1_TX	Digital I/O	GPIO14 Alternate function: UART1 TX data output
37	UART1_RX	Digital I/O	GPIO15 Alternate function: UART1 RX data input
38	GND	GND	GND
39	SPI_MOSI	Digital I/O	GPIO6 Alternate function: SPI Port MOSI
40	SPI_MISO	Digital I/O	GPIO5 Alternate function: SPI Port MISO

Pin#	Name	Type	Description
41	SPI_SS	Digital I/O	GPIO4 Alternate function: SPI Port SS
42	SSI_BITCK	Digital I/O	GPIO3 Alternate function: SSI Bit Clock
43	SSI_FSYN	Digital I/O	GPIO2 Alternate function: SSI Frame Sync
44	SSI_RX	Digital I/O	GPIO1 Alternate function: SSI RX data input
45	SSI_TX	Digital I/O	SSI TX data output / GPIO0
46	KBI_7	Digital I/O	GPIO29 Alternate function: Keyboard Interface Bit 7
47	COIL_BK	Power Switch Output	Buck Converter coil drive output
48	KBI_6	Digital I/O	GPIO28 Alternate function: Keyboard Interface Bit 6
49	RESETB	Digital Input	System reset input
50	LREG_BK_FB	Power Input	Voltage input to onboard regulators, buck regulator feedback voltage
51	GND	GND	GND
52	KBI_5	Digital I/O	GPIO27 Alternate function: Keyboard Interface Bit 5
53	KBI_4	Digital I/O	GPIO26 Alternate function: Keyboard Interface Bit 4
54	KBI_3	Digital I/O	GPIO25 Alternate function: Keyboard Interface Bit 3
55	KBI_2	Digital I/O	GPIO24 Alternate function: Keyboard Interface Bit 2
56	KBI_1	Digital I/O	GPIO23 Alternate function: Keyboard Interface Bit 1
57	KBI_0_HST _WK	Digital I/O	GPIO22 Alternate function: Keyboard Interface Bit 0 / Host Walk-up output
58	GND	GND	GND
59	GND	GND	GND
60	GND	GND	GND

1.3 Electrical Characteristics

Table 1.2. Absolute Maximum Ratings

Description	Min	Max	Unit
Power Supply Voltage	-0.3	3.6	VDC
Voltage on Any Digital Pin	-0.3	VCC + 0.2	VDC
RF Input Power		10	dBm
Storage Temperature Range	-45	125	ºC
Reflow Soldering Temperature		260	ºC

Note: *Exceeding the maximum ratings may cause permanent damage to the module.*

Table 1.3. Recommended Operating Conditions

Description	Min	Typ	Max	Unit
Power Supply Voltage (VCC)	2.1		3.6	VDC
Ambient Temperature Range	-40	25	85	ºC
Crystal Reference Oscillator		24		MHz

Table 1.4. DC Characteristics *(@ 25 ºC, VCC = 3.3V unless otherwise noted)*

Description	Min	Max	Unit
Transmit Mode Current (at +20 dBm Output Power)	193		mA
Receive Mode Current	30		mA
Sleep Mode Current	12	53	uA

1.4 Mechanical Drawings

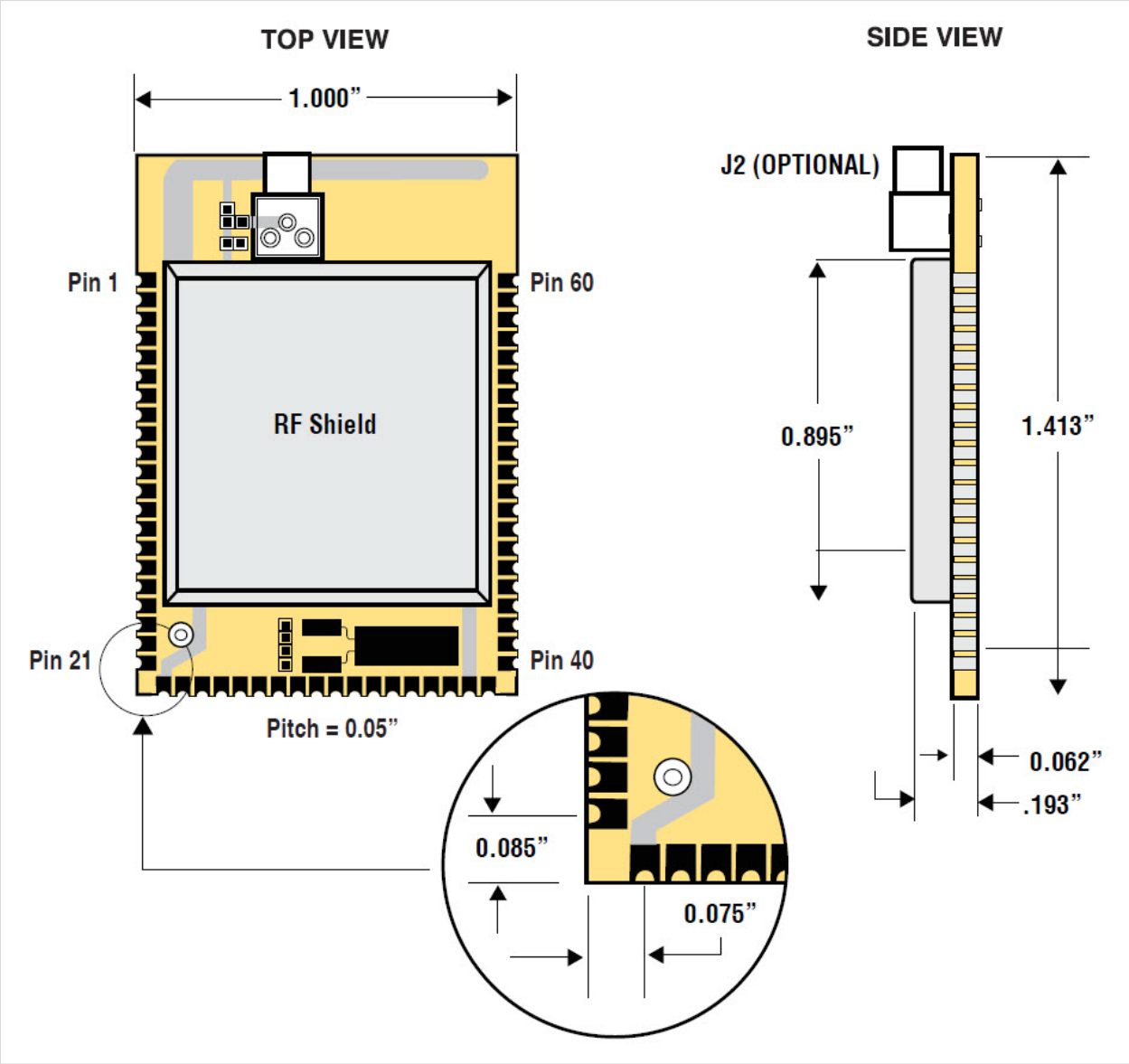

Figure 1.1 Mechanical drawings of the SM700PC1 Module

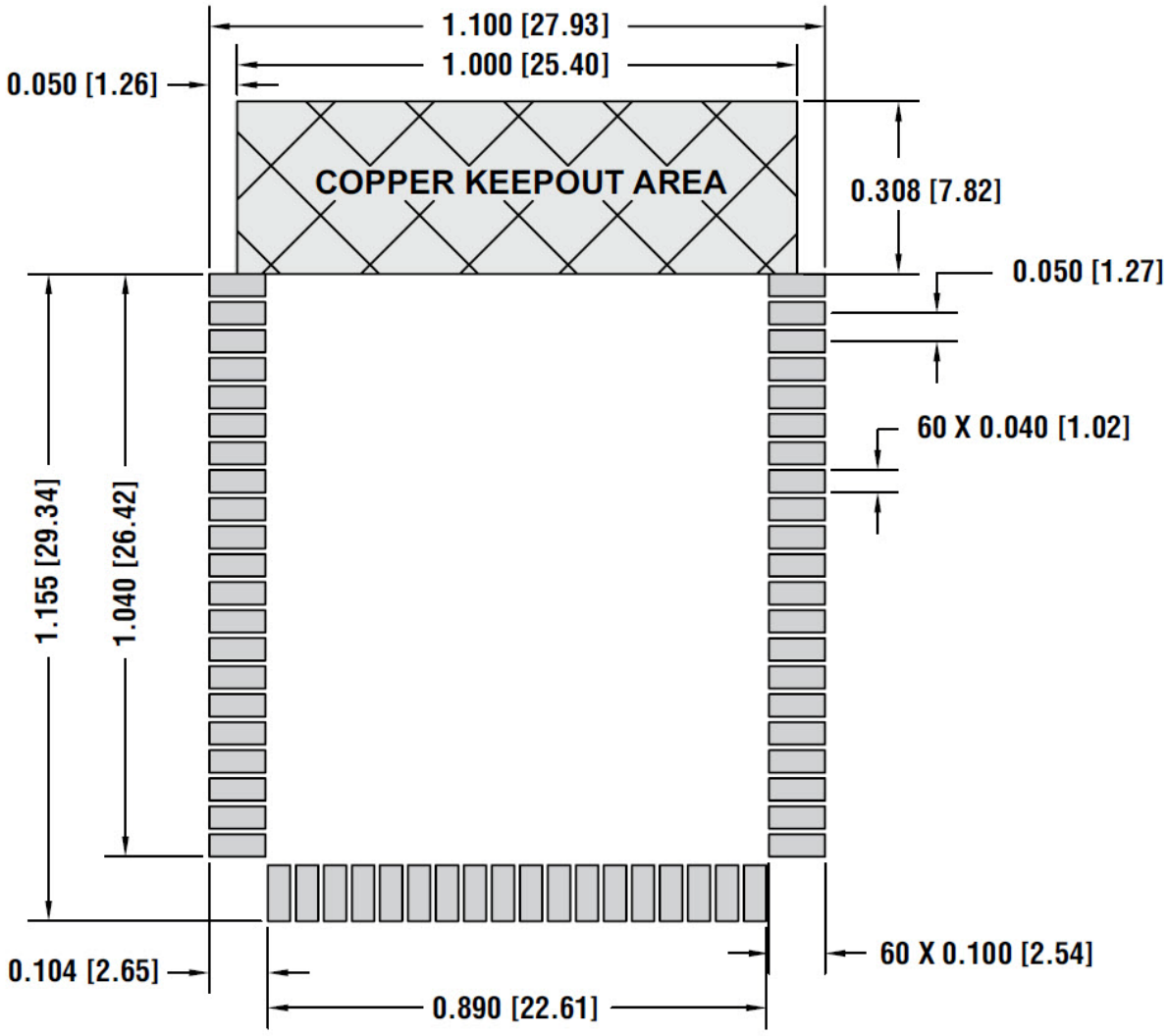

Figure 1.2 Module Land Footprint for the SM700PC1 Module

1.5 Board Mounting Considerations

1.5.1 Processing

Table 1.5 Recommended Reflow Profile	
Parameter	**Value**
Ramp up rate (from Tsoakmax to Tpeak)	3º/sec max
Minimum Soak Temperature	150ºC
Maximum Soak Temperature	200ºC
Soak Time	60-120 sec
TLiquidus	217ºC
Time above TL	60-150 sec
Tpeak	250ºC
Time within 5º of Tpeak	20-30 sec
Time from 25º to Tpeak	8 min max
Ramp down rate	6ºC/sec max

Achieve the brightest possible solder fillets with a good shape and low contact angle.

1.5.2 Pb-Free Soldering Paste

Use of “No Clean” soldering paste is strongly recommended, as it does not require cleaning after the soldering process.

Notice: The quality of solder joints on the castellations (‘half vias’) where they contact the host board should meet the appropriate IPC Specification. See IPC-A-610: Acceptability of Electronic Assemblies, section 8.2.4 Castellated Terminations.

1.5.3 Cleaning

In general, cleaning the populated modules is strongly discouraged. Residuals under the module cannot be easily removed with any cleaning process.

- Cleaning with water can lead to capillary effects where water is absorbed into the gap between the host board and the module. The combination of soldering flux residuals and encapsulated water could lead to short circuits between neighboring pads. Water could also damage any stickers or labels.

- Cleaning with alcohol or a similar organic solvent will likely flood soldering flux residuals into the two housings, which is not accessible for post-washing inspection. The solvent could also damage any stickers or labels.

- Ultrasonic cleaning could damage the module permanently.

The best approach is to consider using a “no clean” soldering paste and eliminate the post-soldering cleaning step.

1.5.4 Optical Inspection

After soldering the Module to the host board, consider optical inspection to check the following:

- Proper alignment and centering of the module over the pads.
- Proper solder joints on all pads.
- Excessive solder or contacts to neighboring pads, or vias.

1.5.5 Repeating Reflow Soldering

Only a single reflow soldering process is encouraged for host boards.

1.5.6 Wave Soldering

If a wave soldering process is required on the host boards due to the presence of leaded components, only a single wave soldering process is encouraged.

1.5.7 Hand Soldering

Hand soldering is possible. Use a soldering iron temperature setting equivalent to 350°C, follow IPC recommendations/ reference document IPC-7711.

1.5.8 Rework

The Model SM700 Module can be unsoldered from the host board. Use of a hot air rework tool and hot plate for pre-heating from underneath is recommended. Avoid overheating.

Warning: Never attempt a rework on the module itself (e.g. replacing individual components). Such actions will terminate warranty coverage.

1.5.9 Additional Grounding

Attempts to improve module or system grounding by soldering braids, wires, or cables onto the module RF shield cover is done at the customers own risk. The numerous ground pins at the module perimeter should be sufficient for optimum immunity to external RF interference.

2.0 Agency Certifications

2.1 United States (FCC)

The Model SM700 modules comply with Part 15 of the FCC rules and regulations. Compliance with the labeling requirements, FCC notices and antenna usage guidelines are required. In order to comply with FCC Certification requirements, the Original Equipment Manufacturer (OEM) must fulfill the following requirements.

1. The system integrator must place an exterior label on the outside of the final product housing the SM700 Modules. Figure 2.1 below shows the contents that must be included in this label.
2. SM700 Modules may only be used with the antenna that has been tested and approved for use with the module.

2.1.1 OEM Labeling Requirements

NOTICE: The OEM must make sure that FCC labeling requirements are met. This includes a clearly visible exterior label on the outside of the final product housing that displays the contents shown in Figure 2.1 below.

MANUFACTURERS NAME
BRAND NAME or TRADE NAME

Contains SM700 FCC ID: U9O-SM700

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interferences, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Figure 2.1 FCC Label

2.1.2 FCC Notices

WARNING: The SM700 modules have been tested by the FCC for use with other products without further certification (as per FCC Section 2.1091). Changes or modifications to this device not expressly approved by Synapse Wireless Inc. could void the user's authority to operate the equipment.

NOTICE: OEM's must certify final end product to comply with unintentional radiators (FCC Section 15.107 and 15.109) before declaring compliance of their final product to Part 15 of the FCC Rules.

NOTICE: The SM700 modules have been certified for remote and base radio applications. If the module will be used for portable applications, the device must undergo SAR testing.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

2.1.3 FCC Approved Antennas

The SM700 modules are FCC-approved for fixed base station and mobile applications.

RF Exposure WARNING: This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

NOTICE: The preceding statement must be included as a CAUTION statement in OEM product manuals in order to alert users of FCC RF Exposure compliance.

2.2 Canada (IC)

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

2.2.1 OEM Labeling Requirements

The “CE” mark must be placed on the OEM product in a visible location. The CE mark will consist of the Initials “CE” with the following form:

If the CE marking is reduced or enlarged, the proportions given in the following drawing must be adhered too.

The CE mark must be a minimum of 5mm in height.

The CE marking must be affixed visibly, legibly and indelibly.

Since the 2400-2483.5 MHz band is not harmonized by a few countries throughout Europe, the Restriction sign must be placed to the right of the CE marking as shown in the drawing.

Labeling requirements for Industry Canada are similar to those of the FCC. A clearly visible label on the outside of the final product housing must display the contents shown in Figure 2.2 below.

MANUFACTURERS NAME
BRAND NAME or TRADE NAME
MODEL:
Contains RF Engine IC: 7084A-SM700

Figure 2.2 IC Label

NOTE: The OEM can choose to implement a single label combined for both FCC and IC labeling requirements. If a combined single label is chosen, there must be a clearly visible label on the outside of the final product housing displaying the contents shown in Figure 2.3 below.

MANUFACTURERS NAME
BRAND NAME or TRADE NAME

Contains RF Engine FCC ID: U9O-SM700
Contains RF Engine IC: 7084A-SM700

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interferences, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Figure 2.3 Combined FCC and IC Label

NOTE: The OEM can choose to implement a single label combined for FCC, CE and IC labeling requirements. If a combined single label is chosen, there must be a clearly visible label on the outside of the final product housing displaying the contents shown in Figure 2.4 below.

MANUFACTURERS NAME
BRAND NAME or TRADE NAME

Contains RF Engine FCC ID: U9O-SM700
Contains RF Engine IC: 7084A-SM700
CE

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interferences, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Figure 2.4 Combined FCC, CE and IC Label