



Excellence in Compliance Testing

Certification Exhibit

FCC ID: U9O-SM240

IC: 7084A-SM240

FCC Rule Part: 15.247

IC Radio Standards Specification: RSS-210

ACS Project Number: 12-2121

Manufacturer: Synapse Wireless, Inc.

Model: SM240

User Manual

DATA SHEET

RF Engine[®] 200 Series

Model Number: SM240

Part Numbers: SM240PP1

Document Revision v1.0



Wireless Technology to Control and
Monitor Anything from Anywhere™

© 2012 Synapse, All Rights Reserved
All Synapse products are patented or patent pending
Specifications are subject to change without notice – confirm that data is current
Synapse, the Synapse logo, SNAP, and Portal are all registered trademarks of
Synapse Wireless, Inc.
500 Discovery Drive
Huntsville, Alabama 35806
877-982-7888
Doc # 430154-01A

This Page Intentionally Blank

Table of Contents

1.0 SM240 OEM Module Overview	4
1.1 Specifications	5
1.2 Electrical Characteristics	6
1.3 Mechanical Drawings.....	7
1.4 Board Mounting Configurations.....	8
2.0 Agency Certifications	8
2.1 United States (FCC)	8
2.1.1 OEM Labeling Requirements	9
2.1.2 FCC Notices	9
2.1.3 FCC Approved Antennas.....	10
2.2 Canada (IC).....	11
2.2.1 OEM Labeling Requirements.....	11

1.0 RF Engine 200 Series OEM Modules Overview

The RF Engine 200 Series (Model Number SM240) is an IEEE 802.15.4, low power, highly-reliable solution to embedded wireless control and monitoring network needs that require high data rates. The SM240 embeds Synapse's SNAP OS, the industry's first Internet-enabled, wireless mesh network operating system into the Atmel ATmega128RFA1 single-chip AVR® microcontroller with an integrated transceiver that delivers up to 2Mbps/sec. These low-cost modules can have a range of up to three miles and power consumption as low as 1.6 μ A to enable a new generation of battery-driven systems.

SNAP's on-board Python interpreter provides for rapid application development and over-the-air programming, while Atmel's low-power RF single-chip design saves board space and lowers the overall Bill of Materials and power consumption. The SM240 is approved as an FCC Part 15 unlicensed modular transmitter. The modules provide up to 16 channels of operation in the ISM 2.4GHz frequency band. The SM240 module contains both a power amplifier for transmission and a low noise amplifier in the receive path for extended range.

This Data Sheet details Part Numbers SM240:



- 20 GPIO and up to 7 A/D inputs
- 128k flash, 58.5k free for over-the-air uploaded user apps
- Two UART ports for control or transparent data which surmounts noisy environments
- Low power modes: 1.6 μ A with internal timer running
- Spread spectrum (DSSS) technology
- Socket-able or solder-able
- Up to 2 Mbps Data Rate
- 2.4 GHz RF Frequency
- Spread Spectrum (DSSS) technology
- Receive Amplifier (7 dBm) standard
- Transmit amplifier (15 dBm) for best-in-class range
- SM240: F-Antenna (2.5 miles LoS at 250Kbps)

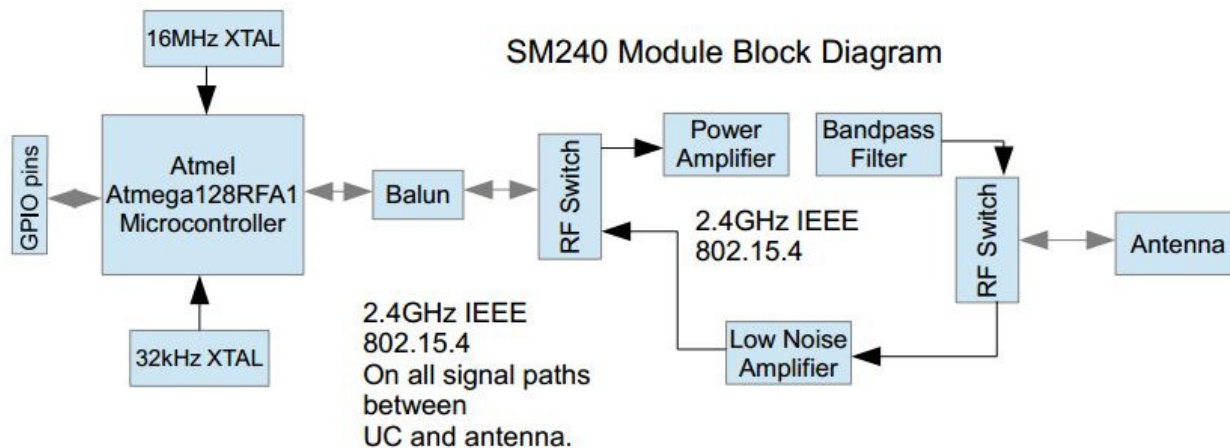


Figure 1.0 Block diagram showing the major subsystems comprising the SM240

1.1 Specifications

Table 1.0. SM240 Specifications

Performance	Outdoor LOS Range	Up to 2.5 miles at 250Kbps
	Transmit Power Output	18.4 dBm
	RF Data Rate	250Kbps, 500Kbps, 1Mbps, 2Mbps
	Receiver Sensitivity	-107 dBm (1% PER)
Power Requirements	Supply Voltage	2.7 - 3.6 V
	Transmit Current (Typ@3.3V)	80mA
	Idle/Receive Current (Typ@3.3V)	20mA
	Power-down Current (Typ@3.3V)	1.6uA
General	Frequency	ISM 2.4 GHz
	Spreading Method	Direct Sequence (DSSS)
	Modulation	O-QPSK
	Dimensions	1.404" x 0.592"
	Operating Temperature	- 40 to 85 deg C.
	Antenna Option	F- antenna
Networking	Topology	SNAP
	Error Handling	Retries and acknowledgement
	Number of Channels	16
Available I/O	UARTS with HW Flow Control	2 Ports - 8 total I/O
	GPIO	20 total; 7 can be analog-in with 10bit ADC
Agency Approvals	FCC Part 15.247	FCC ID: U9O-SM240
	Industry Canada (IC)	IC: 7084A-SM240

1.2 Electrical Characteristics

Table 1.2. SM240 DC Characteristics						
Symbol	Parameter	Condition	Min	Typ ¹	Max	Units
V_{CC}^2	Supply Voltage		2.7	3.3	3.6	V
T_{OP}	Operating Temp		-40		85	°C
V_{IH}	Input Hi Voltage	All Digital Inputs	$V_{CC} - 0.4$			V
V_{IL}	Input Low Voltage	All Digital Inputs			0.4	V
V_{OL}	Output Low Voltage	All drive strengths (2,4,6,8 mA)			0.4	V
V_{OH}	Output High Voltage	All drive strengths (2,4,6,8 mA)	$V_{CC} - 0.4$			V
$I_{L_{IN}}$	In Leakage Current	$V_{IN}=V_{CC}$ or V_{SS} , all Pins			TBD	uA
$TX-I_{CC}$	Transmit Current	$V_{CC} = 3.3V$		80		mA
$RX-I_{CC}$	Receive Current			20		mA
$SHDN-I_{CC}$	Sleep Current	$V_{CC} = 3.3V$		1.6		uA

¹ All typical specifications are measured at 25 °C.

² Absolute maximum stress rated voltage for VCC is -0.3 to 3.6. It is recommended that a bulk decoupling capacitor (47 uF tantalum rated at 6.3volts) be located close to the VCC pin 21 of the SM240 connector on host board.

Table 1.3. ADC Electrical Characteristics (Operating)						
Symbol	Parameter	Condition	Min	Typical	Max	Unit
V_{REFH}^3	Voltage Reference, High	Programmable	1.5	1.6	1.8	V
V_{INDC}	Analog input voltage	Single Ended	0		1.8	V
		Differential ⁴	0		3.3	

³ V_{REFH} is programmable to three fixed values; 1.5V, 1.6V, and 1.8V. The default is 1.6V.

⁴ Each differential analog input may be as high as 3.3V but the differential voltage is still limited.

Table 1.4. ADC Timing/Performance Characteristics						
Symbol	Parameter	Condition	Min	Typical	Max	Unit
R_{AS}	Source impedance at input ⁵				3k	kΩ
RES	Conversion Resolution	Single Ended CLKADC ≤ 4MHz		10		Bits
		Single Ended CLKADC > 8MHz		8		
DNL	Differential non-linearity	$V_{REFH} = 1.6V$ CLKADC=4MHz	-0.5			LSB
INL	Integral non-linearity	$V_{REFH} = 1.6V$ CLKADC=4MHz		0.8		LSB
E_{ZS}	Zero-scale error			1.5		LSB
E_G	Gain error			1		LSB

⁵ Any analog source with a source impedance greater the 3kΩ will increase the sampling time.

1.3 Mechanical Drawings

Figure 1.1 shows the PCB layout of the F antenna, and the keep out area for the F-antenna.

Recommended Antenna:

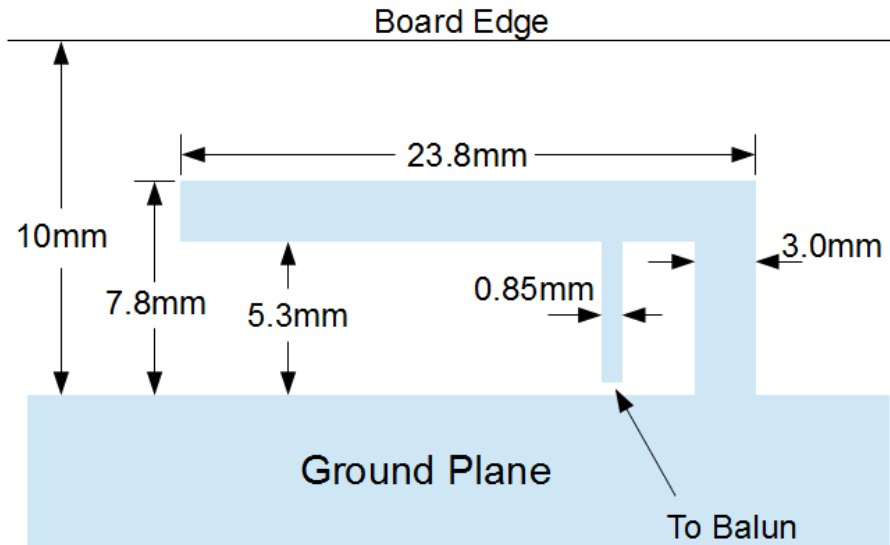


Figure 1.1

The antenna pattern should be present on the top and bottom layer of the PCB. The antenna patterns should be connected by sufficient vias to maintain an impedance of 50 ohms. There should be no plane or trace on the inner layers between the antenna patterns. In the antenna area, there should be no parts in the area between the edge of the ground plane and the edge of the PCB on either side of the PCB.

A sample layer stack up which will yield the correct impedance is shown in Table 1.5. The antenna is connected directly to the module by a 50 ohm trace (18.5mil width using stack shown in Table 1.5), and connected by vias to the antenna on the opposite side at the point in Figure 1.1 labeled “To Balun”. Example Gerber files are available.

In order to verify the completed design, connect a whip antenna with a known gain, such as a Pulse P/N W1027, to a spectrum analyzer. Verify that the circuit radiates only at the intended frequencies, and that spurious frequencies are below regulatory agency limits. Regulatory certification will require testing at a licensed facility. Production line testing should also include verification, with a spectrum analyzer, that the unit is transmitting only in the intended frequency band.

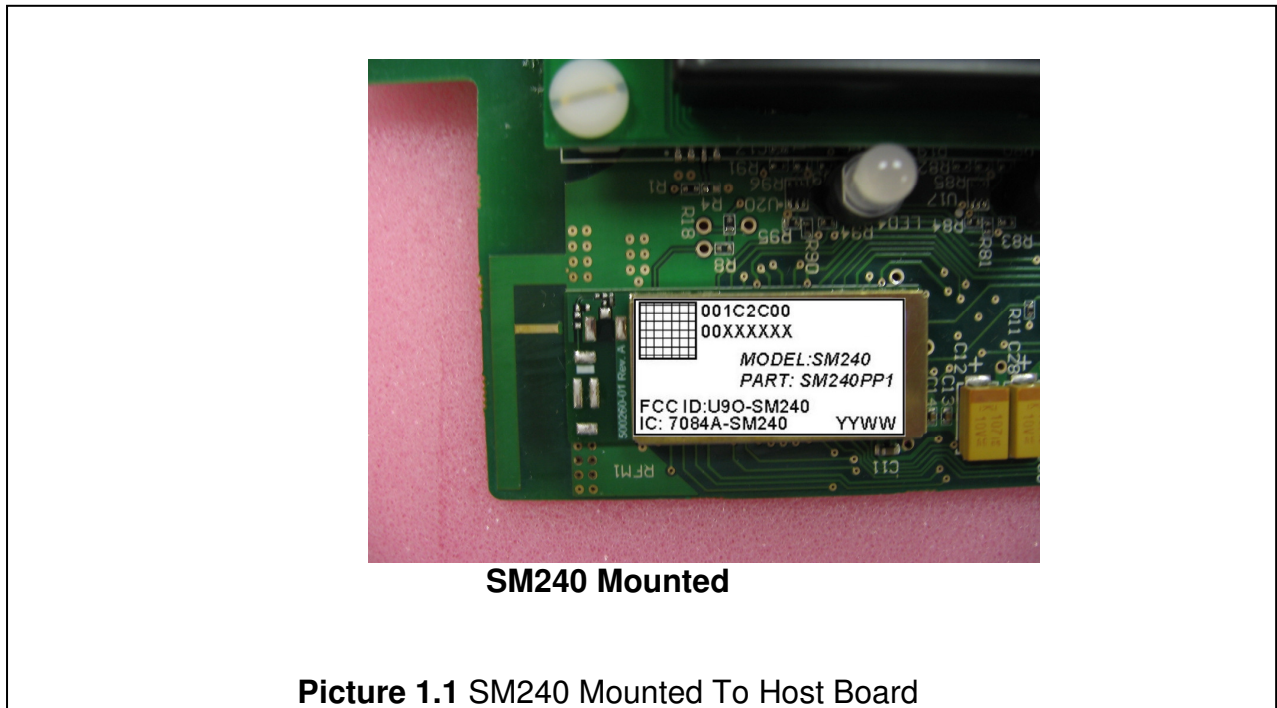
Table 1.5 – Sample PCB Layer Stackup

Layer Name	Gerber Document	Copper Thickness	Dielectric Height	Dielectric Material	Dielectric Constant	Dielectric Type
Top Solder Mask	(.GTS)		0.8mil	Solder Resist	3.50	
Top Layer	(.GTL)	1.4mil	11.9mil	FR-4	4.50	Core
Ground Plane	(.GPI)	1.4mil	28mil	FR-4	4.50	PrePreg
Power Plane	(.GP2)	1.4mil	11.9mil	FR-4	4.50	Core
Bottom Layer	(.GBL)	1.4mil				
Bottom Solder Mask	(.GBS)		0.8mil	Solder Resist	3.50	

1.4 Board Mounting Considerations

The SM240 module is designed to mount directly onto the host board. Picture 1.1 shows an SM240 module plugged in to a host board.

Picture 1.1 shows the SM240 with PCB F antenna mounted to the host board.



2.0 Agency Certifications

2.1 United States (FCC)

The Model SM240 modules comply with Part 15 of the FCC rules and regulations. Compliance with the labeling requirements, FCC notices and antenna usage guidelines is 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 SM240 Modules. Figure 2.1 below shows the contents that must be included in this label.
2. SM240 Modules may only be used with the antenna that has been tested and approved for use with the module. Please refer to the antenna table provided in this section.

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.

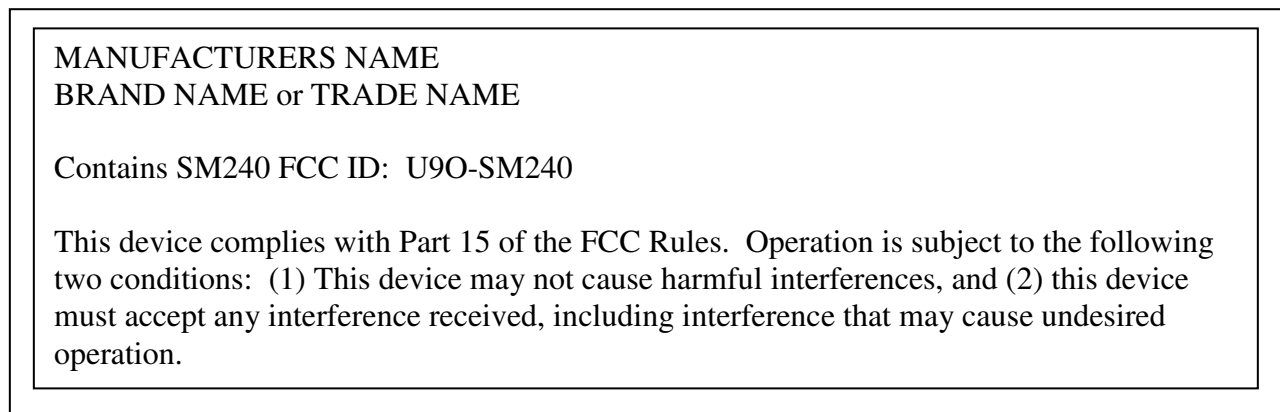


Figure 2.1 FCC Label

2.1.2 FCC Notices

WARNING: The SM240 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.

WARNING: 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.

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 SM240 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 SM240 modules are FCC-approved for fixed base station and mobile applications. The FCC requirement for mobile applications states that the antenna must be mounted at least 20 cm (8 in) from nearby persons.

Notice: To reduce potential radio interference to other users, the antenna type and its gain should be chosen so that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication. The SM240 module has been designed to operate with the antennas listed below in Table 2.1. The required antenna impedance is 50 ohms.

Table 2.1. Approved FCC Antennas				
Part Number	Type	Gain	Application	Min. Separation
N/A	Inverted F PCB etch	0.0 dBi	Fixed/Mobile	20 cm.

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.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

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.

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

This radio transmitter Model: SM240, IC: 7084A-SM240 has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Le présent émetteur radio Model: SM240, IC: 7084A-SM240 a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

Table 2.2. Approved IC Antennas				
Part Number	Type	Gain	Application	Min. Separation
N/A	Inverted F PCB etch	0.0 dBi	Fixed/Mobile	20 cm.

2.2.1 OEM Labeling Requirements

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.

<p>MANUFACTURERS NAME BRAND NAME or TRADE NAME MODEL: Contains IC: 7084A-SM240</p>

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.

<p>MANUFACTURERS NAME BRAND NAME or TRADE NAME</p> <p>Contains FCC ID: U9O-SM240 Contains IC: 7084A-SM240</p> <p>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.</p>

Figure 2.3 Combined FCC and IC Label