DATA SHEET

SNAP Engine RF200 Series

Model Number: RF200

Part Numbers: RF200P81 and RF200PU1

©2008-2014 Synapse, All Rights Reserved. All Synapse products are patent pending. Synapse, the Synapse logo, SNAP, and Portal are all registered trademarks of Synapse Wireless, Inc.

Doc# 430162-01A

6723 Odyssey Drive // Huntsville, AL 35806 // (877) 982-7888 // Synapse-Wireless.com

SNAP Engine RF200 Modules Overview

The SNAP Engine Model RF200 series includes the RF200P81 and RF220PU1 part numbers. They are IEEE 802.15.4, low-power, highly reliable solutions to embedded wireless control and monitoring network needs that require high data rates. The Model RF200 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 2Mbits/sec. These low-cost modules can have current consumption as low as 0.37 µA 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 Model RF200 modules are approved as an FCC Part 15 unlicensed modular transmitters, as well as having CE Certification and IC Certification. The modules provide up to 16 channels of operation in the ISM 2.4GHz frequency band.

Data Sheet covers Part Numbers RF200P81 and RF200PU1:

- 20 GPIO with 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
- Low power modes:
  - 0.37 µA with external interrupt
  - 1.37 µA with internal timer running
- Spread Spectrum (DSSS) technology
- Up to 2 Mbps radio data rate
- 2.4 GHz RF Frequency
- AES 128-bit encryption
- Integrated chip antenna or U.FL connecter
- 4K internal EEPROM
- 8 PWM outputs





The RF200 is also available with a U.FL connector. Contact Synapse for details.

Specifications

Table 1.1: RF200 Specifications at 25° C

Performance	Outdoor LOS Range	Up to 1500/2500 feet at 250Kbps
	Transmit Power Output	3 dBm
	RF Data Rate	250Kbps, 500Kbps, 1Mbps, 2Mbps
	Receiver Sensitivity	-100 dBm (1% PER, 250Kbps)
Power Requirements	Supply Voltage	1.8 - 3.6 V
	Transmit Current (Typ@3.3V)	22.5 mA
	Idle/Receive Current (Typ@3.3V)	20.5 mA
	Power-down Current (Typ@3.3V)	0.37 µA
General	Frequency	ISM 2.4 GHz
	Spreading Method	Direct Sequence (DSSS)
	Modulation	O-QPSK
	Dimensions	33.86mm x 33.86mm
	Operating Temperature	- 40 to 85 deg C.
	Antenna Options	Integrated Chip Antenna / External Antenna
Networking	Topology	SNAP
	Error Handling	Retries and acknowledgement
	Number of Channels	16
Available I/O	UARTS with HW Flow Control	2 Ports
	GPIO	20 total; 7 can be analog-in with 10bit ADC
Agency Approvals	FCC Part 15.247	FCC ID: U9O-RF200
	Industry Canada (IC)	IC: 7084A-RF200
	CE Certified	Yes

RF Module Pin Compatibility

Table 1.2: RF200P81/PU1 Pin Assignments

RF200 Pin	Name	Description
1	GND	Power Supply
2	GPIO0/OC0A/OC1C/PCINT7/PB7/ IO7	GPIO_0, PWM, or Interrupt
3	GPIO1/OC1B/PCINT6/PB6/IO6	GPIO_1, PWM, or Interrupt

RF200 Pin	Name	Description
4	GPIO2/OC1A/PCINT5/PB5IO5	GPIO_2, PWM, or Interrupt
5	GPIO3/RXD0/PCINT8/PE0/IO16	GPIO_3, Interrupt, or UART0 Data Input
6	GPIO4/TXD0/PE1/IO17	GPIO_4, UART0 Data Output
7	GPIO5/OC3B/INT4/PE4/IO20	GPIO_5, PWM, Interrupt, or UART0 CTS Output
8	GPIO6/OC3C/INT5/PE5/IO21	GPIO_6, PWM, Interrupt, or UART0 RTS Input
9	GPIO7/RXD1/INT2/PD2/IO10	GPIO_7, Interrupt, or UART1 Data Input
10	GPIO8/TXD1/INT3/PD3/IO11	GPIO_8, Interrupt, or UART1 Data Output
11	GPIO9/ICP1/PD4/IO12	GPIO_9, or UART1 CTS Output
12	GPIO10/ICP3/INT7/CLK0/PE7/IO23	GPIO_10, Interrupt, Clock Output, or UART1 RTS Input
13	GPIO11/ADC0/PF0/IO24	GPIO_11, or Analog In
14	GPIO12/ADC1/P81/IO25	GPIO_12, SPI MOSI, or Analog In
15	GPIO13/ADC2/DIG2/PF2/IO26	GPIO_13, SPI SCLK, Antenna Diversity, or Analog In
16	GPIO14/XCK0/AIN0/PE2/IO18	GPIO_14, SPI MISO, USART CLK, Analog Comparator, or Analog In
17	GPIO15/ADC4/TCK/PF4/IO28	GPIO_15, JTAG TCK, or Analog In
18	GPIO16/ADC5/TMS/PF5/IO29	GPIO_16, JTAG TMS, or Analog In
19	GPIO17/ADC6/TDO/PF6/IO30	GPIO_17, JTAG TDO, I^2C SDA, or Analog In
20	GPIO18/ADC7/TDI/PF7/IO31	GPIO_18, JTAG TDI, I^2C SCL, or Analog In
21	VCC	Power Supply
22	GPIO19/OC3A/AIN1/PE3/IO19	GPIO_19, PWM, Analog Comparator
23	RESET	Module Reset, Active Low
24	GND	Power Supply

Electrical Characteristics

Table 1.3: RF200 DC Characteristics at 25° C

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{CC}[1]	Supply Voltage		1.8	3.3	3.6	V
T_{OP}	Operating Temp		-40		85	°C
T_{STOR}	Storage Temp		-40		125	°C

1 Absolute maximum stress rated voltage for VCC is -0.3 to 3.6. It is recommended that bulk capacitance be located as close as possible to the VCC pin on the host board. Ideally, use a single 47µF capacitor at 10V directly at the VCC pin.

Symbol	Parameter	Condition	Min	Typ	Max	Units
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
IL_{IN}	In Leakage Current	V_{IN} =V_{CC} or V_{SS} , all Pins		<10nA	1	µA
TX-I_{CC}	Transmit Current - Transceiver only	V_{CC} = 3.3V P_{TX} =3dBm		14.5		mA
	Transmit Current - Transceiver and CPU			22.5		mA
RX-I_{CC}	Receive Current - Transceiver only	V_{CC} = 3.3V		12.5[2]		mA
	Receive Current - Transceiver and CPU			20.5[2]		mA
SHDN- I_{CC}	Sleep Current	V_{CC} = 3.3V		0.37		µA

Table 1.4: 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	

Table 1.5: 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
DNL	Differential non-linearity	V_{REFH} = 1.6V CLKADC=4MHz	-0.5			LSB

2 2.4 GHz transceiver current only. Does not include current required to run CPU.
3 VREFH 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 single-ended voltage is still limited to the voltage reference.
5 Any analog source with a source impedance greater than 3kΩ will increase the sampling time.

Symbol	Parameter	Condition	Min	Typical	Max	Unit
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

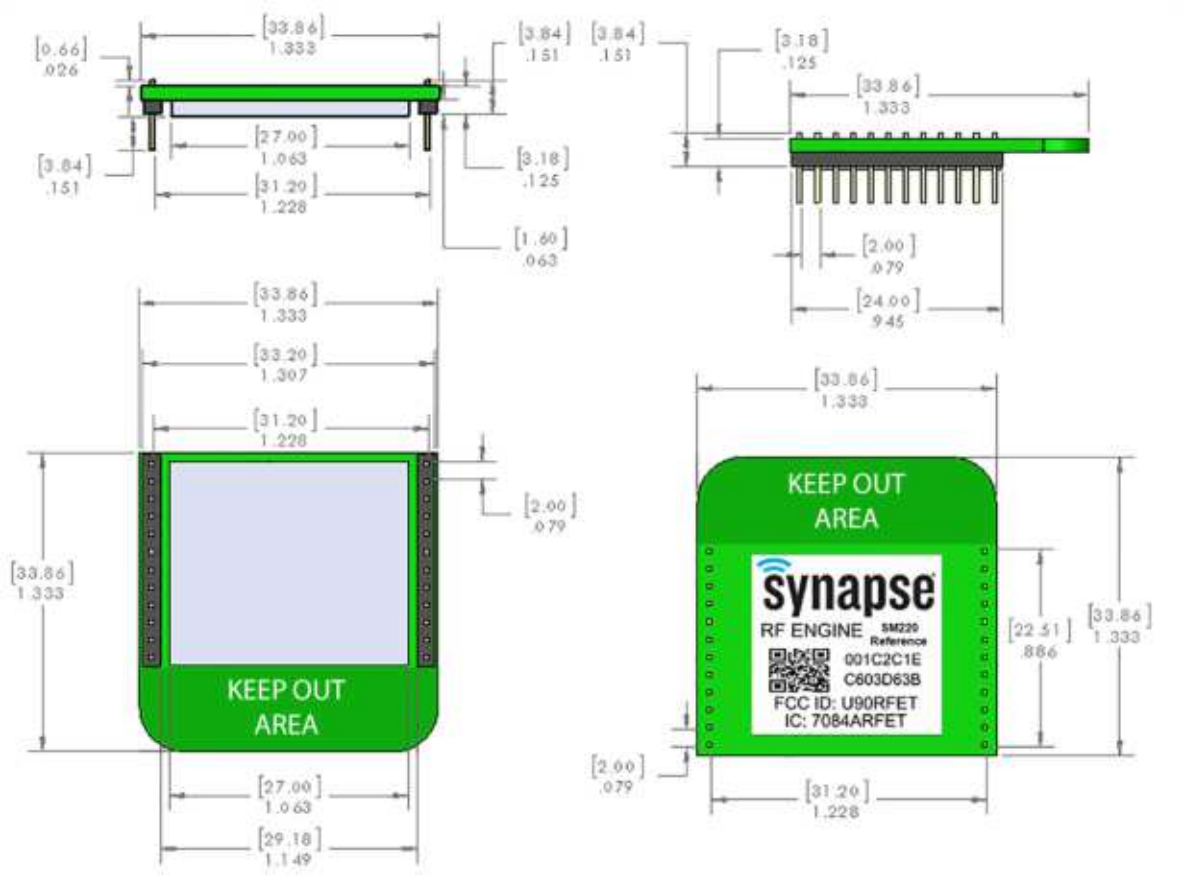
Table 1.6: Reset, Brown-out and Internal Voltage Characteristics

Symbol	Parameter	Condition	Min	Typical	Max	Unit
$V_{POT\ (rising)}$	Power-on Reset Threshold Voltage (rising)	Power supply fully discharged		1.6		V
$V_{POT\ (falling)}$	Power-on Reset Threshold Voltage (falling)		0.05	0.3		V
t_{POT}	Power-on Reset recovery time	Time of EVDD/DEVDD < V_{POT}	1.0			ms
V_{PSR}	Power-on slope rate		1.8		3300	V/ms
V_{RST}	RSTN Pin Threshold Voltage		0.1V DD		0.9 V_{DD}	V
t_{RST}	Minimum pulse width on RSTN Pin			200	300	ns
V_{HYS}	Brown-out Detector Hysteresis			7.5	50	mV
t_{BOD}	Min Pulse Width on Brown-out Reset			100		ns

Mechanical Drawings

The drawings in **Figure 1.1** show the modules with the option of the integrated chip antenna or U.FL Connector.

NOTE: The area under the module's antenna (marked NO COPPER or KEEP OUT AREA) should have no components, no traces, and no copper on any layer of the printed circuit board.



NOTE: Metric measurements are between brackets, with standard measurements below.

Figure 1.1: RF200P81/PU1 Mechanical Drawing

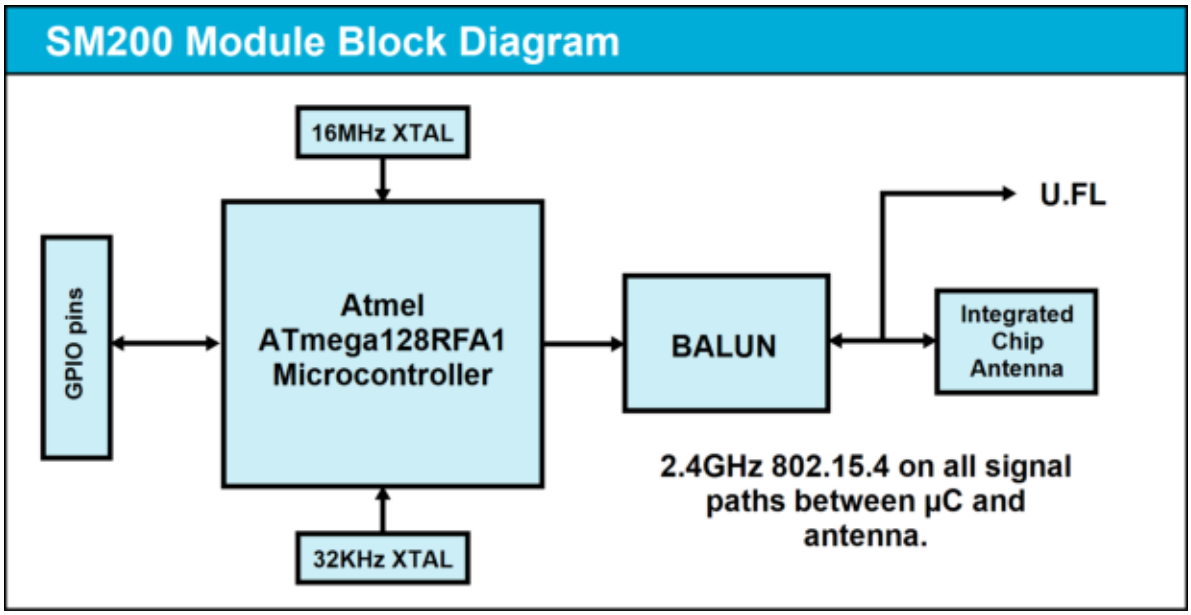


Figure 1.2: Block diagram showing the major subsystems comprising Model RF200

Agency Certifications

United States (FCC)

The Model RF200 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 RF200 Modules. **Figure 1.3** below shows the contents that must be included on this label.
2. RF200 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.

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 1.3** below.

MANUFACTURERSNAME
BRANDNAME or TRADENAME

Contains RF200 FCC ID: U90-RF200

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 1.3: FCC Label

FCC Notices

WARNING!: The RF200 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 Sections 15.107 and 15.109) before declaring compliance of their final product to Part 15 of the FCC Rules.

NOTICE: The RF200 modules have been certified for remote and base radio applications. If the module will be used used for portable applications as defined by the FCC, 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.

FCC Approved Antennas

The RF200 modules are FCC-approved for fixed base station and mobile applications.

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 (EIRP) is not more than that permitted for successful communication. This module has been designed to operate with the antennas listed in **Table 1.7** and **Table 1.8**. The required antenna impedance is 50 ohms..

Table 1.7: RF200P81 Approved FCC Antennas

Part Number	Type	Gain	Application	Min. Separation
Murata LDA312G4413H-280	Chip	-2.3 dBi	Fixed/Mobile	20 cm.

Table 1.8: RF220PU1 Approved FCC Antennas

Part Number	Type	Gain	Application	Min. Separation
Pulse W1027	Dipole (quarter-wave RPSMA)	3.2 dBi	Fixed/Mobile	20 cm.

For more information on approved antennas, please consult the manufacturer's website.

WARNING!: RF Exposure: 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.

NOTE: Antenna and transmitters may be co-located or operated in conjunction with this device only if the transmitters do not simultaneously transmit. Otherwise, additional regulatory requirements will apply.

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 (EIRP) 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: RF200, IC: 7084A-RF200 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 : RF200, IC : 7084A-RF200 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 1.9: Approved IC Antennas

Part Number	Type	Gain	Application	Min. Separation
Murata LDA312G4413H-280	Chip	-2.3 dBi	Fixed/Mobile	20 cm.

Table 1.10: RF220PU1 Approved IC Antennas

Part Number	Type	Gain	Application	Min. Separation
Pulse W1027	Dipole (quarter-wave RPSMA)	3.2 dBi	Fixed/Mobile	20 cm.

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 1.4** below.

MANUFACTURERSNAME
BRANDNAME or TRADENAME
MODEL:

Contains RF200 IC: 7084A-RF200

Figure 1.4: 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 1.5** below.

MANUFACTURERSNAME
BRANDNAME or TRADENAME

Contains RF200 FCC ID: U90-RF200
Contains RF200 IC: 7084A-RF200

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 1.5: Combined FCC and IC Label