RM2420 Modular Approval Request Letter

Introduction:

The RM2420 module offers a complete microcontroller/transceiver solution, containing all hardware features necessary for development of a low-data-rate, low-power wireless application. The primary components include a 2.4GHz, IEEE 802.15.4 compliant Zigbee-ready transceiver (RM2420), a 8-bit microcontroller (ATmega128L or ATmega64L), a 40-pin interface connector, a reverse-polar SMA antenna connector, three low profile crystals (32.768KHz, 16MHz) and power management circuitry.

To seek FCC authorization as a modular transmitter, the EUT meets the requirements for modular approval as detailed in FCC public notice DA00-1407. Compliance to each of the requirements is described bellow.

Requirement 1.

The modular transmitter must have its own RF shielding. This is intended to ensure that the module does not have to rely upon the shielding provided by the device into which it is installed in order for all modular transmitter emissions to comply with Part 15 limits. It is also intended to prevent coupling between the RF circuitry of the module and any wires or circuits in the device into which the module is installed. Such coupling may result in non-compliant operation.

The RM2420 has its own RF shielding, which is connected to analog ground. Refer the Appendix 1 for a picture.

Requirement 2.

The modular transmitter must have buffered modulation/data inputs (if such inputs are provided) to ensure that the module will comply with Part 15 requirements under conditions of excessive data rates or over-modulation.

RM2420 has only digital I/Os for data input or output. All these I/O are all buffered. Refer the Appendix 2 for schematics.

Requirement 3.

The modular transmitter must have its own power supply regulation. This is intended to ensure that the module will comply with Part 15 requirements regardless of the design of the power supplying circuitry in the device into which the module is installed.

The RFIC EM2420 includes a low-drop out voltage regulator to provide a constant 1.8V power supply to RM2420 from a 2.1V to 3.6V input. Please refer to the EM2420 datasheet. Appendix 3

Requirement 4.

The modular transmitter must comply with the antenna requirements of Section 15.203 and 15.204(c). The antenna must either be permanently attached or employ a "unique" antenna coupler (at all connections between the module and the antenna, including the cable). Any antenna used with the module must be approved with the module, either at the time of initial authorization or through a Class II permissive change. The "professional installation" provision of Section 15.203 may not be applied to modules.

RM2420 is using reverse-polar SMA antenna connector on the board and specify LINX TECHNOLOGIES ANT-2.4-CW-RCS-SMA as the antenna. See Appendix 1.

Requirement 5.

The modular transmitter must be tested in a stand-alone configuration, i.e., the module must not be inside another device during testing. This is intended to demonstrate that the module is capable of complying with Part 15 emission limits regardless of the device into which it is eventually installed. Unless the transmitter module will be battery powered, it must comply with the AC line conducted requirements found in Section 15.207. AC or DC power lines and data input/output lines connected to the module must not contain ferrites, unless they will be marketed with the module (see Section 15.27(a)). The length of these lines shall be length typical of actual use or, if that length is unknown, at least 10 centimeters to insure that there is no coupling between the case of the module and supporting equipment. Any accessories, peripherals, or support equipment connected to the module during testing shall be unmodified or commercially available (see Section 15.31(i)).

The EUT was tested in a stand alone configuration. See appendix 4 for test report and set up configuration.

Requirement 6.

The modular transmitter must be labeled with its own FCC ID number, and, if the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: "Contains Transmitter Module FCC ID: XYZMODEL1" or "Contains FCC ID: XYZMODEL1." Any similar wording that expresses the same meaning may be used. The Grantee may either provide such a label, an example of which must be included in the application for equipment authorization, or, must provide adequate instructions along with the module which explain this requirement. In the latter case, a copy of these instructions must be included in the application for equipment authorization.

See appendix 5 for label drawing and its location. An instruction is given to customer on how to apply the exterior label.

Requirement 7.

The modular transmitter must comply with any specific rule or operating requirements applicable to the transmitter and the manufacturer must provide adequate instructions along with the module to explain any such requirements. A copy of these instructions must be included in the application for equipment authorization. For example, there are very strict operational and timing requirements that must be met before a transmitter is authorized for operation under Section 15.231. For instance, data transmission is prohibited, except for operation under Section 15.231(e), in which case there are separate field strength level and timing requirements. Compliance with these requirements must be assured.

EUT comply to all applicable FCC rules. See test report (Appendix 4) and EUT application datasheet for these compliance.

Requirement 8.

The modular transmitter must comply with any applicable RF exposure requirements. For example, FCC Rules in Sections 2.1091, 2.1093 and specific Sections of Part 15, including 15.319(i), 15.407(f), 15.253(f) and 15.255(g), require that Unlicensed PCS, UNII and millimeter wave devices perform routine environmental evaluation for RF Exposure to demonstrate compliance. In addition, spread spectrum transmitters operating under Section 15.247 are required to address RF Exposure compliance in accordance with Section 15.247(b)(4). Modular transmitters approved under other Sections of Part 15, when necessary, may also need to address certain RF Exposure concerns, typically by providing specific installation and operating instructions for users, installers and other interested parties to ensure compliance.

EUT complies with all applicable FCC rules. See test report (Appendix 4) and EUT application datasheet for these compliance.

Appendix 1

FCC ID:SU3RM2420
P/N 031-2205-000
RAE
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 interference, and 2) This
device must accept any interference received, including
interference that may cause undesired operation

Appendix 2

Schematics

Ember Confidential

REVISION HISTORY		
REVISION	ECO NUMBER	DATE
A 0	PRODUCT RELEASE	1/21/04
B0	ECO 63	4/2/04

EM2420 RADIO COMMUNICATION MODULE

Sheet	Details
1	Cover Sheet, Revision History
2	INTERFACE, POWER
3	AVR
4	RADIO EM2420
5	NOTES

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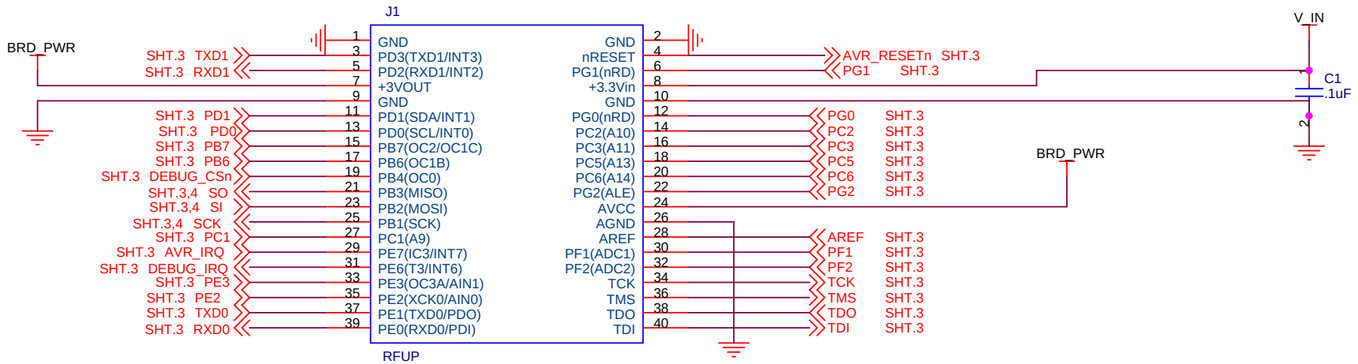
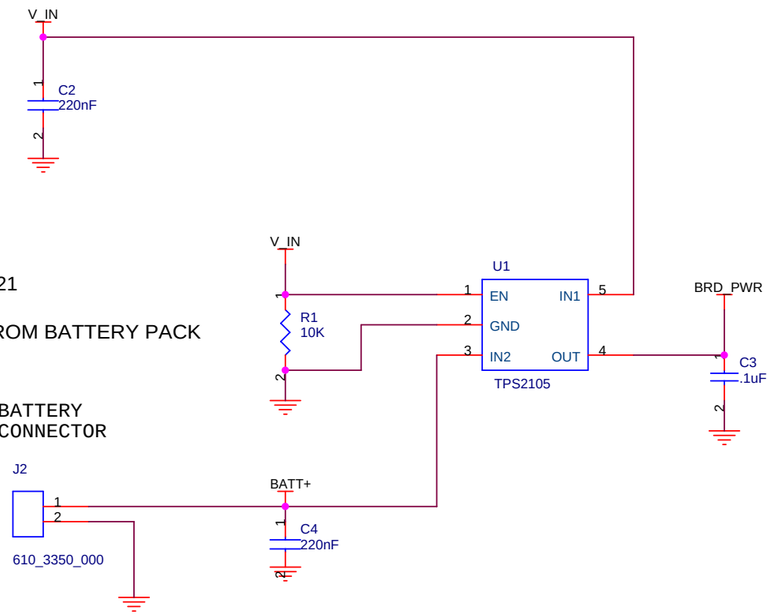
Title	RFuP Board - Cover Page	
Size	Document Number SCH0301	Rev B0
Date: Wednesday, November 10, 2004	Sheet 1 of 5	





X4 1

X5 1

PCB
710-0301-000

FID1 1 FIDUCIAL

FID2 1 FIDUCIAL

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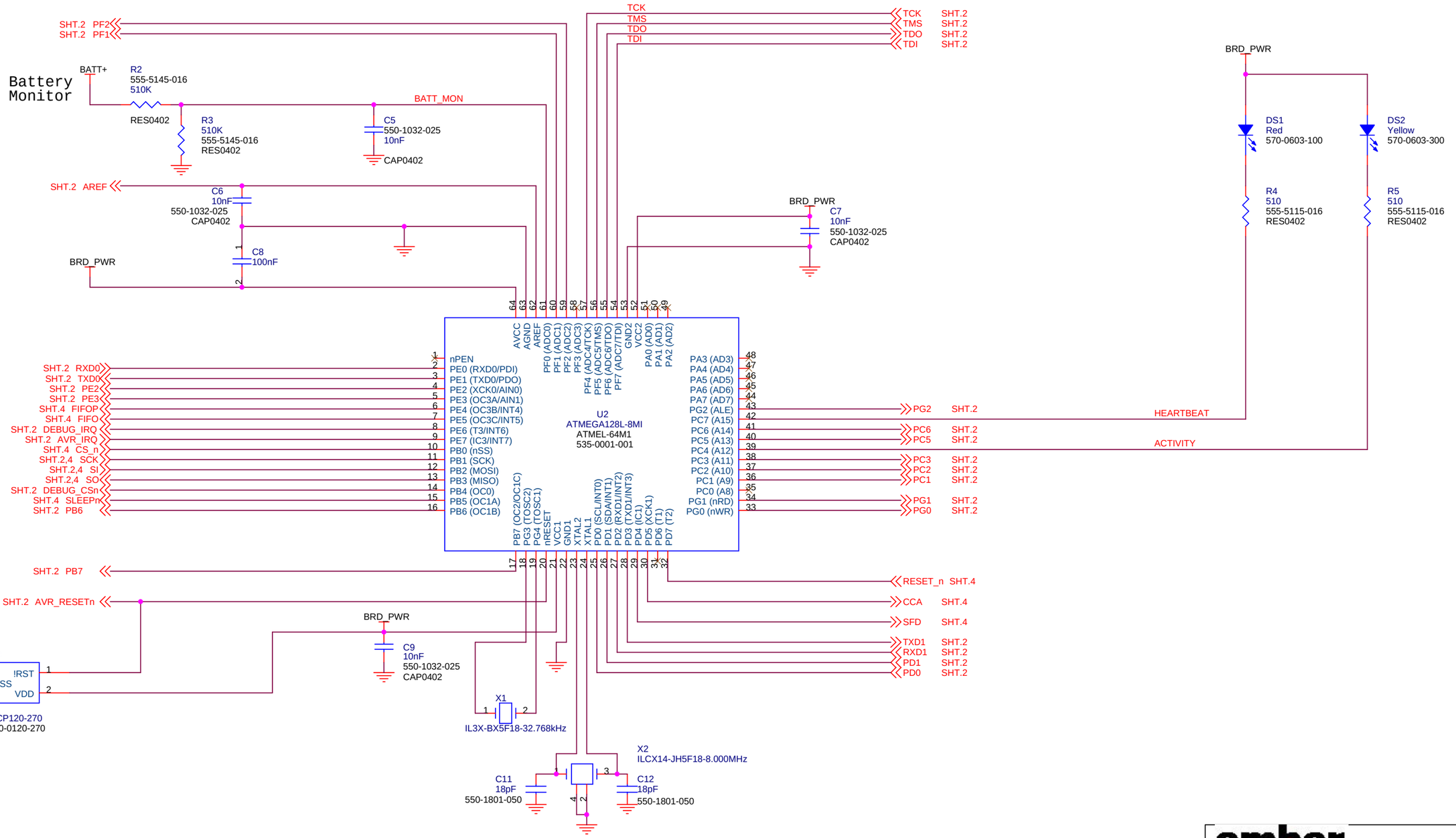
Title: RFuP Board - Interface, Power Distribution

Size | Document Number: SCH0301 | Rev: B0

Date: Wednesday, November 10, 2004 | Sheet 2 of 5



C14, C15 WILL REQUIRE TUNING DURING PROTO BUILD

ember

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Title	RFuP Board - AVR	
Size	Document Number SCH0301	Rev B0
Date: Wednesday, November 10, 2004	Sheet 3 of 5	

4 LAYER .062" FR-4
REFERENCE GROUND PLANE TO LAYER 4
OPEN LAYERS 2 AND 3

MATCHING INTO 50 SYSTEM
REFERENCED @ J4

U4
EM2420
540-2420-000

R6 100k
SLEEPn SHT.3

AV1p8
R7 0 Ohm 556-0000-000
C13 10uF 554-106A-6V3

BRD_PWR
C16 552-1063-6v3
R8 43K 555-4331-016

X3 ILCX17-JH5F18-16.000
C14 27pF 550-2701-050
C15 27pF 550-2701-050

C17 550-1043-6V3
C18 68pF 550-6801-050 CAP0402
C19 68pF 550-6801-050 CAP0402
C20 68pF 550-6801-050 CAP0402

J3 CONREVSMA003.62
RF_OUT
C24 5p6F 550-5P61-050
C23 0p5F 550-0P51-050
L1 8.2nH
L2 6n8H
L3 6.8nH
C25 5p6F 550-5P61-050
C26 0p5F 550-0P51-050

48	47	46	45	44	43	42	41	40	39	38	37												
AVDD_CHP	ATEST1	ATEST2	R_BIAS	AVDD_IF1	VREG_IN	VREG_OUT	VREG_EN	NC	XOSC16_Q1	XOSC16_Q2	AVDD_XOSC16												
1 VCO_GUARD																							
2 AVDD_VCO																							
3 AVDD_PRE																							
4 AVDD_RF1																							
5 GND																							
6 RF_P																							
7 TXRX_SWITCH																							
8 RF_N																							
9 GND																							
10 AVDD_SW																							
11 NC																							
12 NC																							
49 AGND																							

Appendix 3

FCC Approved RM2420 RF Communication Module Data Sheet

RAE Systems has partnered with Ember to manufacture and promote module-level products. RAE Systems manufactures the EM2420 RF Communications Module as the **RM2420** RF Communications Module.

The RM2420 module offers a complete microcontroller/transceiver solution Containing all hardware features necessary for development of a low-data-rate, low-power wireless application. The primary components include a 2.4GHz, IEEE 802.15.4 compliant Zigbee-ready transceiver (RM2420), an 8-bit microcontroller (ATmega128L or ATmega64L), a 40-pin interface connector, a reverse-polar SAM antenna connector, three low profile crystals (32.768KHz, 16MHz) and power management circuitry.

The RM2420 Module is available to companies who have purchased the Ember EM2420 Developer's Kit and it complies with part 15 of the FCC rules.

Specifications

Frequency Band	16 channels of operation in the 2.4GHz world wide ISM band. 5MHz channel spacing.
High Performance	RX sensitivity of better than -90 dBm at 1% packet error rate for a 20 byte payload.
Efficient	Built-in CRC and AES-128 encryption. Buffered full packet transmit and receive. High performance SPI data and control interface operates up to 10MHz.
Power	+3.3V $\pm$ .3V from carrier board, 3.0V to 3.6V from battery

	pack
Microcontroller	ATmega128L (U2) or Atmega64L (U2).
Radio	RM2420 (U5) Rx sensitivity; -94dBm (1% PER, 20-byte packet) Type Tx power: 0dBm max
Interfaces	40-pin surface-mount RM2420 RCM header (J1) 2-pin surface-mount right-angle battery connector (J2)
Flexible	Designed for a broad spectrum of applications including IEEE 802.15.4 and Zigbee compliant devices.
Range	Line of sight range of 75 meters. Available option of a +10dBm output amplifier for longer range transmission.
RF	250kbps OQPSK Direct Sequence Spread Spectrum radio in accordance with the IEEE 802.15.4 specification. 0dBm output power.
Dimensions	1 x 1.75 inches
Antenna Interface	50-Ohm reverse polar SMA
Operating Temperature Range	-40ºC to +85ºC
External Power Pin	Used to power external sensors (J1.7) 20mA max
Indicators	Two LEDs, one red, one yellow (DS1, DS2)

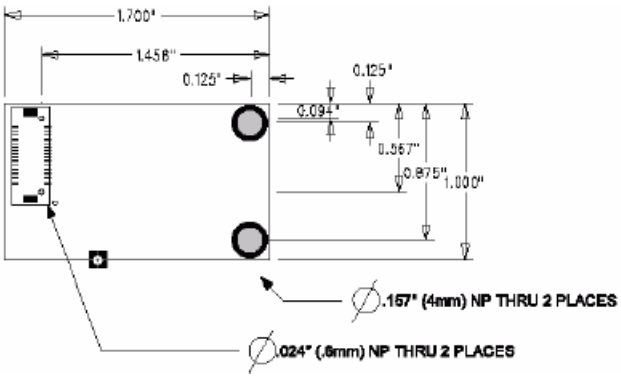
Specifications (continued)

Operating Voltage	1.8 V (1.6 V to 2.0 V) Internal Regulator Disabled 3.3 V (2.0V to 3.6 V) Internal Regulator Enabled
Current Consumption	0.5 µA Sleep 20.7 mA TX @ 0 dBm 19.7 mA RX / Idle
Frequency Range	2405 to 2480 MHz
Output Power	-32 to +0 dBm
Data Rate	250 kbps
FCC ID	SU3RM2420 - Complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: 1) This device may not cause harmful interference, and 2) This device

must accept any interference received, including interference that may cause undesired operation

*On going projects to enhance our products means that these specifications are subject to changes

Interface Decal Dimensions



Components

Microcontroller (U2)

The 8-bit flash-based ATmega 128L/ATmega64L microcontroller contains software for the configuration and control of the RM2420, AMC and network functions, and the user-defined application software. The microcontroller utilizes a 32.768KHz crystal for MAC timing and power management, as well as external crystal operating at 8Hz. A variety of peripherals are routed to headers on the Developer Kit carrier board for application development. For detail information on the microcontroller, see www.atmel.com.

When configuring the Ember Studio Debug Reader, enter the following baud rate into the Debug Preference Window: 100,000. This rate is set by the microcontroller operating frequency.

Radio (U5)

The radio is an RM2420, a true single-chip 2.4GHz IEEE 802.15.4 – compliant and Zigbee-ready radio frequency transceiver designed for low-power and low-voltage wireless applications. It includes a digital direct sequence spread-spectrum (DSSS) baseband modem with an effective data rate of 250kbps.

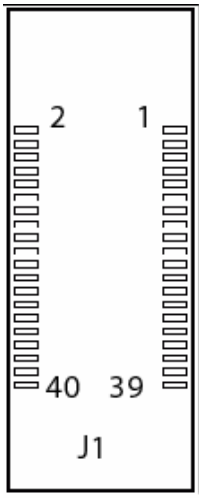
Channel Frequencies

These channels are equivalent to IEEE 802.15.4 channels 11 to 26.

RM2420 Channel Frequencies (GHz)

Channel	Frequency	Channel	Frequency	Channel	Frequency
0	2.405	6	2.435	12	2.465
1	2.410	7	2.440	13	2.470
2	2.415	8	2.445	14	2.475
3	2.420	9	2.450	15	2.480
4	2.425	10	2.455	—	—
5	2.430	11	2.460	—	—

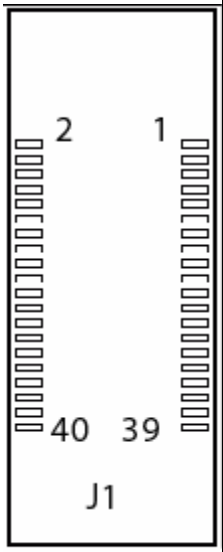
Pin Layout



Viewed from bottom

Pin	ATmega 128/64 Pin Name	Description
1	GND	Digital GND
2	GND	Digital GND
3	PD3 (TXD1/INT3)	EmberNet stack defaults to Alternate Function TX UART (TXD1)
4	nRESET	External reset, active low
5	PD2 (RXD1/INT2)	EmberNet stack defaults to Alternate Function RX UART (Rxd1)
6	PG1 (nRD)	General purpose I/O
7	+3.3V out	External power pin used to run custom external sensors and/or devices; 20mA max
8	+3.3V in	Input power from carrier boards
9	GND	Digital GND
10	GND	Digital GND
11	PD1 (SDA/INT1)	General purpose I/O; EmberNet defaults signal as an output connected to EM2 (button 1) on carrier board (with J11 installed)
12	PG0 (nWR)	General purpose I/O
13	PD0 (SDl/INT0)	General purpose I/O; EmberNet defaults signal as an output connected to EM1 (button 0) on carrier board (with J10 installed)
14	PC2	Dedicated connection to red LED (D55 on carrier board) for debugging purposes
15	PB7 (OC2/OC1C)	General purpose I/O
16	PC3	Dedicated connection to yellow LED (DS4 on carrier board) for debugging purposes
17	PB6	General purpose I/O

18	PC5	Dedicated connection to orange LED (DS2 on carrier board) for debugging purposes
19	NC	Dedicated for use with carrier board emulator/debug module



Viewed from bottom

Pin	ATmega 128/64 Pin Name	Description
20	PC6	Dedicated connection to green LED (DS3 on carrier board) for debugging purposes
21	PB3	Master In/Slave Out SPI (used to configure the EM2420)
22	PG2	General purpose I/O
23	PB2 (MOSI)	Master Out/Slave In SPI (used to configure the RM2420)
24	AVCC	Analog voltage reference pin
25	PB1 (SCK)	SPI clock (used to configure the RM2420)
26	AGND	Analog ground pin (same as digital GND)
27	PC1	Dedicated signal for Temperature Enable (active high) for temperature sensor on carrier board
28	AREF	ADC voltage reference pin
29	NC	——
30	PF1 (ADC1)	EmberNet stack uses alternate function ACD1 to monitor external battery pack voltage
31	NC	——
32	PF2 (ADC2)	EmberNet stack uses alternate function ACD2 for temperature calibration
33	PE3 (OC3A/AIN1)	General purpose I/O
34	PF4 (ADC4/TCK)	General purpose I/O; if JTAG is enabled, the EmberNet stack uses alternate function TCK for JTAG
35	PE2 (XCK0/AIN0)	General Purpose I/O
36	PF5 (ADC5/TMS)	General purpose I/O; if JTAG is enabled, the EmberNet stack uses alternate function TMS for JTAG
37	PE1 (TXD0/PDO)	EmberNet stack defaults to alternate function TX UART (TXD0)

38	PF6 (ADC6/TDO)	General purpose I/O; if JTAG is enabled, the EmberNet stack uses alternate function TDO for JTAG
39	PE0 (RXD0/PDI)	EmberNet stack defaults to alternate function RX UART (RXD0)
40	PF7 (ADC7/TDI)	General purpose I/O; if JTAG is enabled, the EmberNet stack uses alternate function TDI for JTAG

Warning (Part 15.21)

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

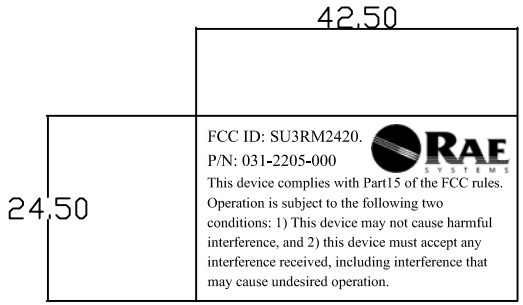
This device must be operated as supplied by RAE Systems. Any changes or modifications made the device RM2420 can be jeopardize, but there is one exception. The radio's antenna can be replaced as long as the specification of the antenna matches the original (ant-2.4-cw-rcs-sma by Linx technologies).

Appendix 4

Test Report

Appendix 5

Label Drawing


42.50
24.50
FCC ID: SU3RM2420.
P/N: 031-2205-000
RAE SYSTEMS
This device complies with Part15 of the FCC rules. Operation is subject to the following two conditions: 1) This device may not cause harmful interference, and 2) this device must accept any interference received, including interference that may cause undesired operation.

Model number: RPF2000

This device contains
FCC ID: SU3RM2420.

This device complies with Part15 of the FCC rules.
Operation is subject to the following two conditions: 1) This device may not cause harmful interference, and 2) this device must accept any interference received, including interference that may cause undesired operation.