ARCH ROCK

RMB-2000 Series

Embedded Processor/IEEE 802.15.4 Modules

Features

- TI MSP430 Microcontroller
- TI CC2420 2.4 GHz IEEE 802.15.4 Transceiver
- 250kbps data rate
- 3.0V operation
- Selectable Channels
- AES-128 CBC-MAC Security
- Transmission Power Control
- 17 General-purpose Digital I/O
- 6 Analog Inputs, 2 Analog Outputs
- 3 LED outputs
- 2 USART/UART Ports (Asynchronous, SPI and I2C capable)
- FCC Part 15 Authorization suitable for residential and industrial use (when used with approved antennas)
- Multiple antenna connection options
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Applications

- Wireless Sensor Networking
- Embedded IEEE 802.15.4 connectivity
- OEM devices

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Overview

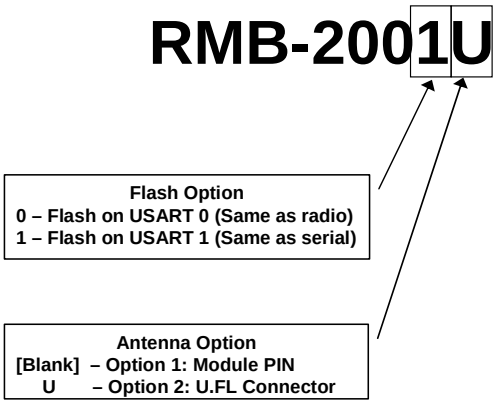
The RMB-2000 series modules provide a complete system-on-module solution which includes a TI MSP430 Microcontroller, a TI CC2420 2.4 GHz, IEEE 802.15.4 radio and an Atmel AT45DB flash storage chip. It runs the Arch Rock Software distribution which includes the industry's first IP/6LowPAN network stack over IEEE 802.15.4.

The RMB-2000 series are intended for embedded and OEM applications requiring out-of-the-box low power computing and wireless IP connectivity. To simplify application, the RMB-2000 series are FCC pre-certified to operate in the 2.4 GHz range when used with the antennas described in this manual. The RMB-2000 series has options for attaching the antenna via a pad on the module or a U.FL connector.

Specifications

Parameter	Min	Typ	Max	Units	Condition
Supply Voltage	2.7	3.0	3.3	V	
Operating Temperature	-40		+85	℃	
Humidity	0&		100%		Non-condensing
Storage Temperature	-50		150	℃	
Frequency Range	2.405		2.480	GHz	Channels 11 - 26
Output Power			0	dBm	-7 dBm @ 2.480 GHz
Receiver Sensitivity	-94	-90		dBm	
Data Rate		250		kbps	

Part Numbering



System Description

This section describes the RMB-2000 functional components and pinout.

Block Diagram

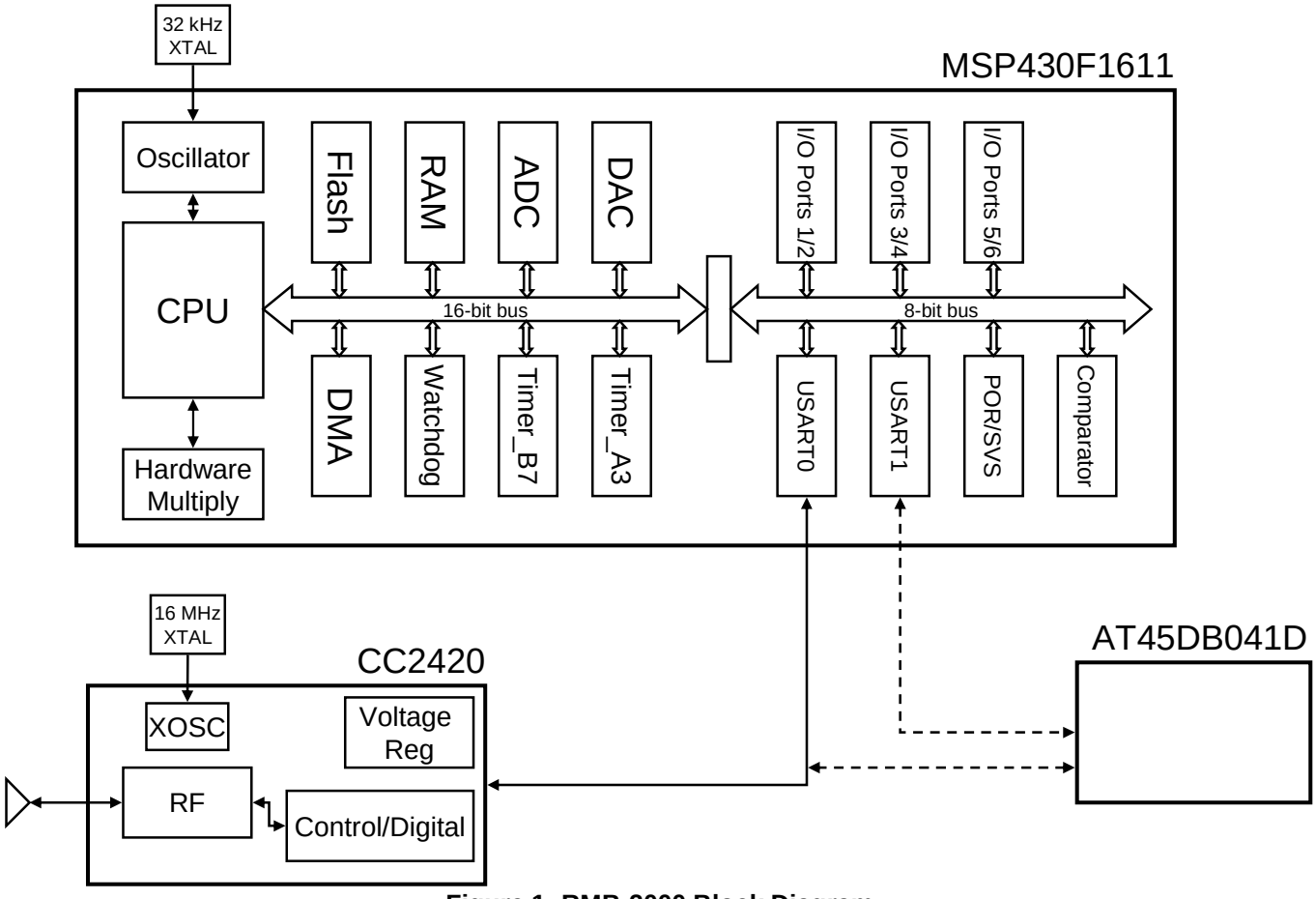


Figure 1: RMB-2000 Block Diagram

Microcontroller

The RMB-2000 Series incorporate a low power Texas Instruments MSP430F1611 Microcontroller with 10kB of RAM and 48kB of FLASH. The microcontroller runs the Arch Rock Software distribution that provides higher level networking and management functions as well as an environment for user applications.

The module provides access to many of the functions and peripherals of the microcontroller including general-purpose digital I/Os (GPIOS), ADC ports, USART/UART, and an I2C bus. Users should refer to the Texas Instruments MSP430x1xx Family User's guide and the MSP430F1611 datasheet available at http://www.ti.com for more information on these ports.

Included on the module is a 32.768 kHz crystal that provides a clock source during sleep modes and to calibrate the MPS430's internal digitally controlled oscillator. The module also provides a separate power input and ground plane for the analog inputs to the MSP430F1611 for noise isolation purposes.

Radio

The RMB-2000 series employ the Texas Instruments CC2420 IEEE 802.15.4 radio transceiver. The module provides all the necessary components and RF impedance matching circuitry for the transceiver. An antenna with 50-Ohm impedance may be attached to the RFOUT pad (RMB-2000 & RMB-2001) or the U.FL connector (RMB-2000U & RMB-2001U).

Control of the radio is provided through the Arch Rock networking stack. Applications may select the appropriate channel and power for their application up to a maximum of 0dBm (-7 dBm on channel 26). Note that the radio transceiver is attached to the module microcontroller via the USART0 peripheral. Applications desiring to use this same peripheral must multiplex this operation with radio communication.

To simplify deployment, the RMB-2000 series has obtained FCC Part 15 authorization when used with certain pre-approved antennas. When used with these antenna configurations and installed per this manual, no additional FCC certification of the module is necessary. See the section titled 'Antenna Considerations' for more information.

Flash Storage

The RMB-2000 includes an Atmel AT45DB041D 4-megabit flash chip to supplement the internal flash storage of the microcontroller. To provide application flexibility, the flash isattached to the microcontroller via one of the two serial interfaces: USART0 (RMB-2000 & RMB-2000U) or USART1 (RMB-2001 & RMB-2001U). Programmatic access to the flash is provided via the Arch Rock Software distribution API.

The module also provides a means to externally write-protect the flash chip. Assering the FLASH_WP# pin low asserts the hardware write protect function of the AT458DB041D. Users should refer to the Atmel AT45DB041D Datasheet for specifics on the write protect feature.

Pin Assignment

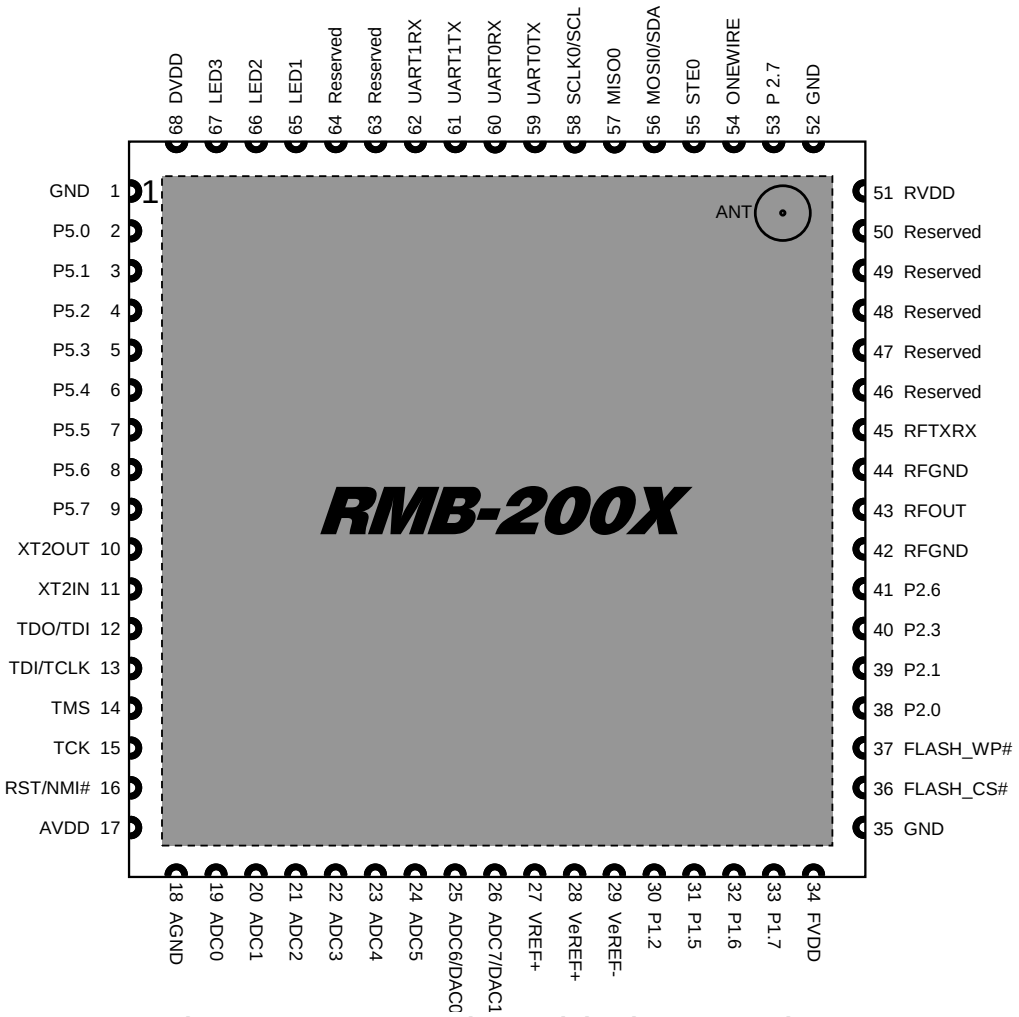


Figure 2: RMB-2000 Series Module Pinout, Top View

Pad	Pad Name	Type	Pin Description
1,35,52	GND	Power (digital)	Ground Connections for digital components
2	P5.0	Input/Ouput	General-purpose Digital I/O[1]
3	P5.1	Input/Ouput	General-purpose Digital I/O[1]
4	P5.2	Input/Ouput	General-purpose Digital I/O[1]
5	P5.3	Input/Ouput	General-purpose Digital I/O[1]
6	P5.4	Input/Ouput	General-purpose Digital I/O[1]
7	P5.5	Input/Ouput	General-purpose Digital I/O[1]
8	P5.6	Input/Ouput	General-purpose Digital I/O[1]
9	P5.7	Input/Ouput	General-purpose Digital I/O[1]
10	XT2OUT	Output	Crystal Oscillator XT2 output terminal
11	XT2IN	Input	Crystal Oscillator XT2 input terminal
12	TDO/TDI	Input/Ouput	Test Data Output or Programming Data Input
13	TDI/TCLK	Input	Test Data Input or Test Clock Input
14	TMS	Input	Test Mode Select
15	TCK	Input	Test Clock
16	RST/NMI#	Input	Reset/Non-Maskable Interrupt Input
17	AVDD	Power (analog)	Analog Power Supply (for noise isolation)
18	AGND	Power (analgo)	Analog Ground (for noise isolation)
19	ADC0	Input	Analog Input[1]
20	ADC1	Input	Analog Input[1]
21	ADC2	Input	Analog Input[1]

22	ADC3	Input	Analog Input[1]
23	ADC4	Input	Analog Input[1]
24	ADC5	Input	Analog Input[1]
25	ADC6/DAC0	Input/Output	Analog I/O[1]
26	ADC7/DAC1	Input/Output	Analog I/O[1]
27	VREF+	Output	ADC Reference Voltage Output
28	VeREF+	Input	External Voltage Reference Input Positive Terminal
29	VeREF-	Input	External Voltage Reference Input Negative Terminal
30	P1.2	Input/Output	General-purpose Digital I/O[1]
31	P1.5	Input/Output	General-purpose Digital I/O[1]
32	P1.6	Input/Output	General-purpose Digital I/O[1]
33	P1.7	Input/Output	General-purpose Digital I/O[1]
34	FVDD	Power (digital)	Power supply for Flash Chip
36	FLASH_CS#	Input	Flash Chip Select
37	FLASH_WP#	Input	Flash Write Protect
38	P2.0	Input/Output	General-purpose Digital I/O[1]
39	P2.1	Input/Output	General-purpose Digital I/O[1]
40	P2.3	Input/Output	General-purpose Digital I/O[1]
41	P2.6	Input/Output	General-purpose Digital I/O[1]
42,44	RFGND	RF	RF Ground Pads
43	RFOUT	RF	RF Output (RMB-2000 and RMB-2001 units)
45	RFTXRX	Output	RF TX/RX mode switch. 1.8 V when transmitting
46 – 50	Reserved	-	Reserved (no connect)
51	RVDD	Power (digital)	Power supply for radio subsystem
53	P2.7	Input/Output	General-purpose Digital I/O[1]
54	ONEWIRE	Input/Output	Onewire digital interface
55	STE0	Input/Output	USART0-SPI Mode Slave Transmit Enable[1]
56	MOSI0/SDA	Input/Output	USART0-SPI Mode Master Out Slave In, I2C Data[1]
57	MISO0	Input/Output	USART0-SPI Mode Master In Slave Out[1]
58	SCLK0/SCL	Input/Output	USART0-SPI Mode Master Clock , I2C Clock [1]
59	UART0TX	Input/Output	USART0-UART0 Transmit Data[1]
60	UART0RX	Input/Output	USART0-UART0 Receive Data[1]
61	UART1TX	Input/Output	USART1-UART1 Transmit Data[1]
62	UART1RX	Input/Output	USART1-UART1 Receive Data[1]
63,64	Reserved	-	Reserved (no connect)
65	LED1	Input/Output	LED 1 Output
66	LED2	Input/Output	LED 2 Output
67	LED3	Input/Output	LED 3 Output
68	DVDD	Power (digital)	Power supply for digital core.
ANT	Antenna	RF	U.FL antenna connector (RMB-2000U and RMB-2001U units)

[1]Refer to the TI MSP430x1xx Family User's guide for additional information on these pins.

Antenna Considerations

The RMB-2000 has achieved FCC Part 15 and IC ICES-003, RSS-Gen & RSS210 approval for the following antennas:

- 3.3 dBi PCB PIFA (see below)
- 3dBi omni-directional antenna
- 9dBi omni-directional antenna

When used with one of these antennas and installed per this manual, no additional FCC/IC authorization to use the RMB-2000 series modules is necessary. Note that verification of the end digital system may still be required per applicable regulations.

PCB Antenna

The Planar Inverted 'F' Antenna (PIFA) is an economical embedded antenna described in Texas Instruments' Chipcon Design Note DN0007 (http://focus.ti.com/lit/an/swru120a/swru120a.pdf). Users are referred to this document when incorporating this antenna into their designs. For convenience, the design dimensions of this antenna are reproduced in Figure 3. The PIFA is normally used with the RMB-2000/RMB-2001 and attaches to the module via a 50-Ohm trace to the RFOUT pad with the ground plane counterpoise attached to the RFGND pads. Care must be taken not to place any additional copper near or underneath the antenna structure as this may adversely affect it's performance.

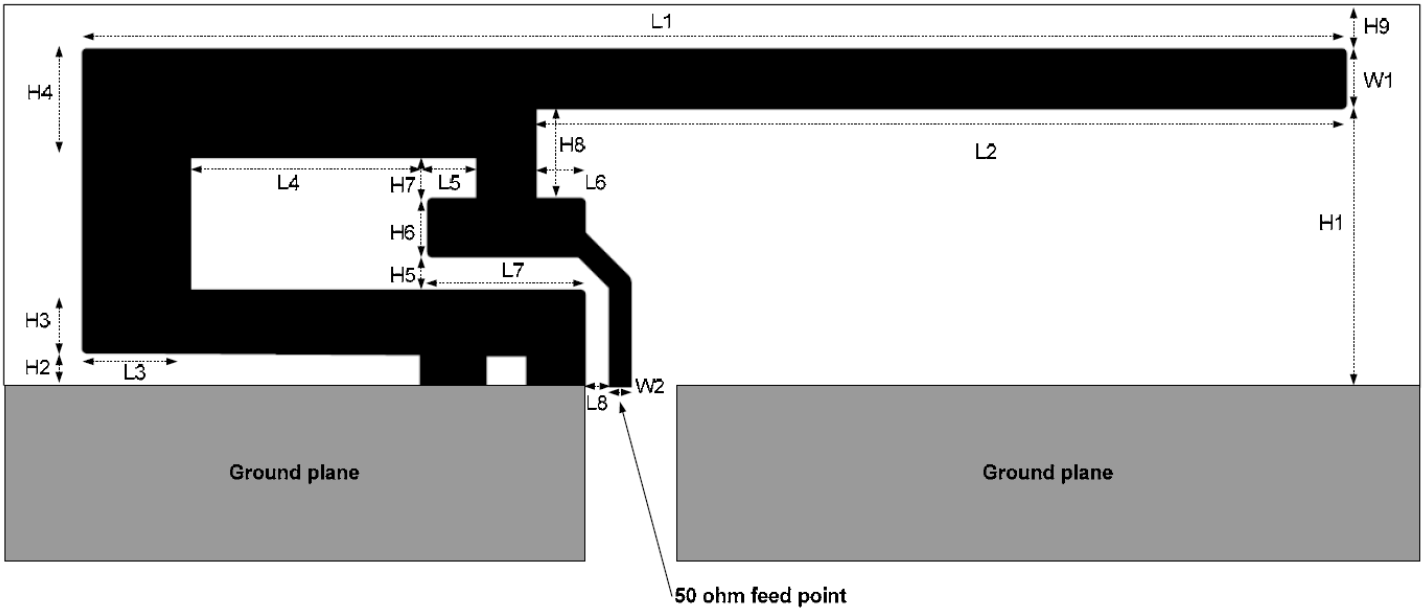


Figure 3: PIFA Antenna Layout

H1	5.70 mm (224.41 mil)	W2	0.46 mm (18.11 mil)
H2	0.74 mm (29.13 mil)	L1	25.58 mm (1007.09 mil)
H3	1.29 mm (50.79 mil)	L2	16.40 mm (645.67 mil)
H4	2.21 mm (87.01 mil)	L3	2.18 mm (85.83 mil)
H5	0.66 mm (25.98 mil)	L4	4.80 mm (188.98 mil)
H6	1.21 mm (47.64 mil)	L5	1.00 mm (39.37 mil)
H7	0.80 mm (31.50 mil)	L6	1.00 mm (39.37 mil)
H8	1.80 mm (70.87 mil)	L7	3.20 mm (125.98 mil)
H9	0.61 mm (24.02 mil)	L8	0.45 mm (17.72 mil)
W1	1.21 mm (47.64 mil)		

Installation and Layout Considerations

Caution! ESD Sensitive components. Use precaution when handling components to prevent damage

A host board that uses independent power and ground planes is highly recommended.

Ground pins should be connected to ground the ground plane as close as possible to the module using individual vias. Decoupling capacitors should also be placed as close as possible to the supply pins and connected to ground via separate vias. If the ADC/DAC pins of the MSP430 are used, the AVDD and AGND pins should be filtered to prevent any digital noise from contaminating the signals When placing the module, caution must be used to avoid potential interference to the RF outputs of the device. There should be no copper traces or vias beneath the modules location.

Unused pins must be terminated as shown in the table below. Unless listed, the pin may be left open.

Pin	Connection
AVDD	VCC
AGND	GND
VeREF+	GND
VeREF-	GND
XT2IN	GND
RST/NMI#	VCC
FVDD	VCC
RVDD	VCC
DVDD	VCC

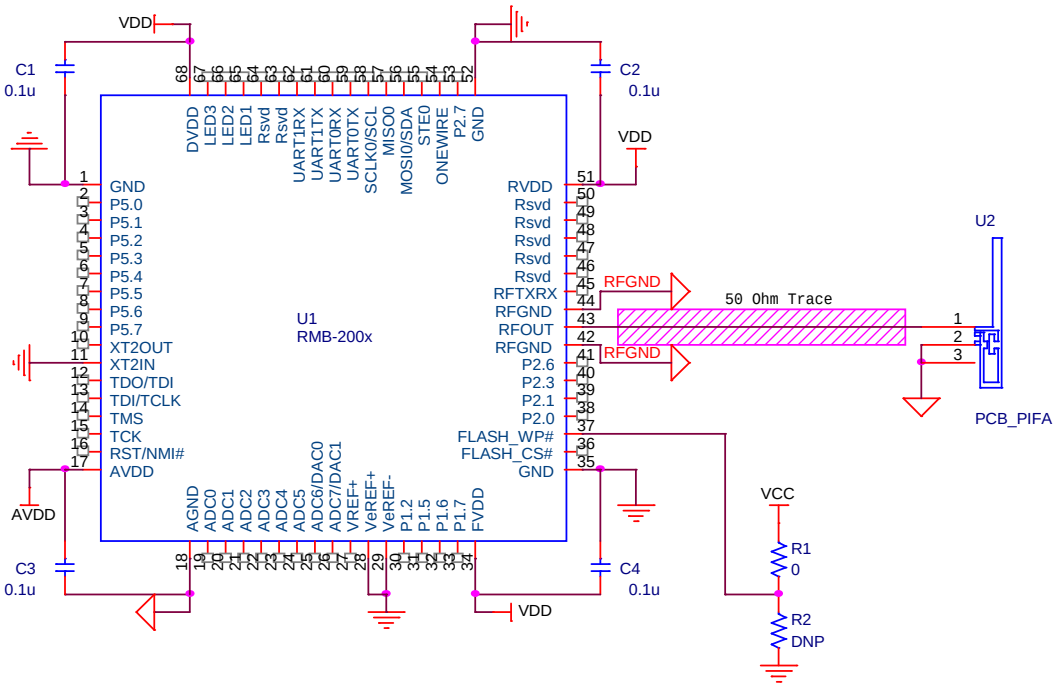


Figure 4: Example minimal configuration schematic using PIFA PCB antenna

Recommended layout for package

The RMB-2000 modules uses an LCC-68 style compatible footprint. The modules are constructed out of FR4 using RoHS compliant processes.

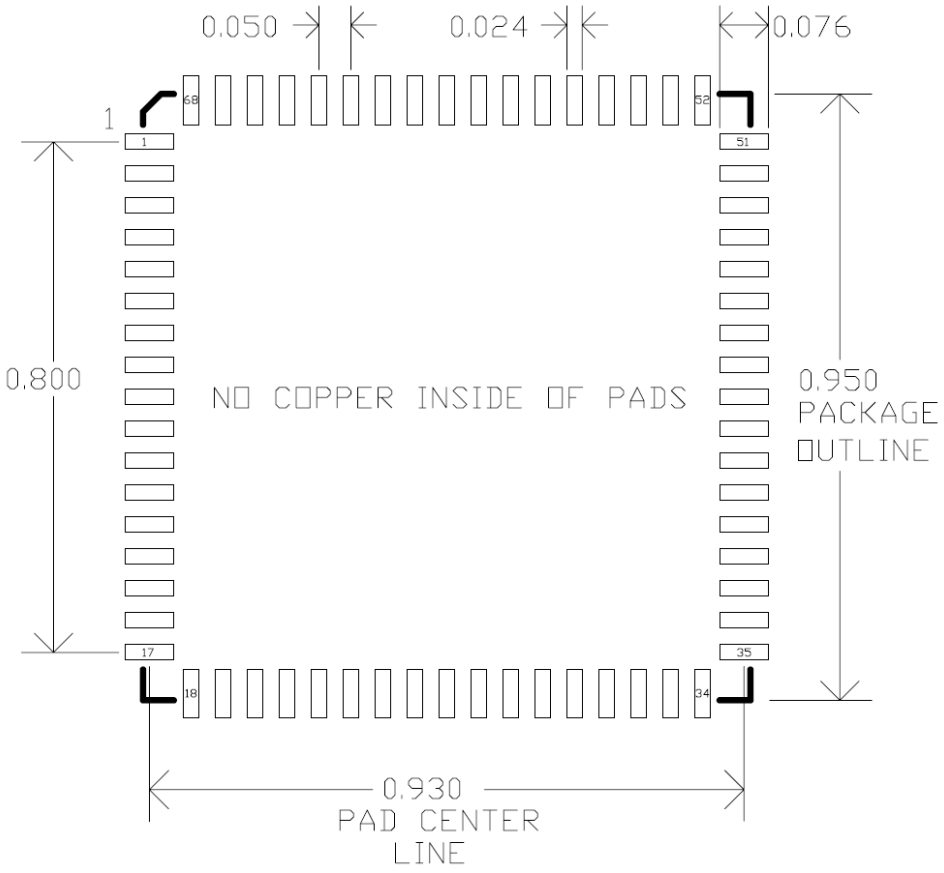


Figure 5: Suggested PCB Footprint

Soldering Information

Recommended soldering profile is according to IPC/JEDEC J-STD-020B.

Safety and Regulatory Notices

FCC Statement

This device has been tested and found to comply with part 15 of the FCC Rules.. Operation is subject to the following two conditions: (1) These devices may not cause harmful interference, and (2) these devices must accept any interference received, including interference that may cause undesired operation.

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.

Unauthorized changes or modifications to the equipment could void the user's authority to operate the equipment.

FCC RF Radiation Exposure Statement

To comply with the FCC and ANSI C95.1 RF Exposure limits, the antenna(s) for this device must comply with the following:

- The antenna must operate with a separation distance of at least 20 cm from all persons using this equipment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter

End-users must be provided with specific operations for satisfying RF exposure compliance.

OEM Requirement

The Original Equipment Manufacturer must ensure that FCC labeling requirements are met. This includes a clearly visible label on the outside of the final product that displays the contents shown in the figure below.

> Contains FCC ID: U3SRMB200XR1
> The enclosed 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.

OEMs must test final product to comply with unintentional radiators (FCC section 15.107 & 15.109) before declaring compliance of their final product to Part 15 of the FCC Rules

IC Statement

This Class B digital apparatus complies with Canadian ICES-003 and RSS210.

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.

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 permitted for successful communication.

OEM Requirement

The Original Equipment Manufacturer must ensure that IC labeling requirements are met. This includes a clearly visible label on the outside of the final product that displays the contents shown in the figure below.

IC: 7598A-RMB200XR1 This Class B digital apparatus complies with Canadian ICES-003 and RSS210.

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Document History

Revision	Date	Notes
1	April 1, 2008	First Release

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