RapidSE ZigBee Smart Energy Module

RapidSE™

RSE.ESP.MMB-PA.1.0, RSE.DVC.MMB-PA.1.0 Rev 1.2

The RapidSE Module is a drop-in ZigBee Smart Energy solution. Preloaded with MMB Research's RapidSE ZigBee Smart Energy application, it offers hardware vendors an easy way to integrate a fully-implemented ZigBee Smart Energy platform into their existing devices.

MMB Research offers a variety of hardware and software development tools to facilitate integration. For more information, please visit http://www.mmbresearch.com

Contents

1 | General Information

Note that some of the specifications refer to either EM250 or Module. Please note specifications cited as EM250 are taken from the EM250 datasheet (this should also be noted where referred to). Module means measurements taken with our production module.

2 | Module Pinout

Numbers in parentheses are the EM250 pin number.

Module Pad	Function	EM250 GPIO
1	GND	
2		GPIO10 (33)
3		GPIO9 (32)
4		GPIO6 (29)
5		GPIO7 (30)
6		GPIO5 (27)
7		GPIO4 (26)
8		GPIO12 (20)
9		GPIO11 (19)
10	VCC	
11	GND	
12		GPIO3 (25)
13		GPIO8 (31)
14		GPIO2 (24)
15		GPIO0 (21)
16		GPIO1 (22)
17		nReset (13)
18	VCC	
19	GND	
20	n.c.	
21	n.c.	
22	GND	
23		nReset (13)
24		SIF CLK (34)
25		SIF MISO (35)
26		SIF MOSI (36)
27		nSIF LOAD (37)
28		GPIO16 (40)
29		GPIO15 (41)
30		GPIO14 (42)
31		GPIO13 (43)
32	GND	

3 | **Electrical Specifications**

3.1 | Absolute Maximum Ratings

Parameter	Minimum	Maximum	Units
Supply Voltage (VCC)	-0.3	3.6	V
Voltage on any GPIO[0:16], SIF CLK, SIF MISO, SIF MOSI, nSIE LOAD, nReset	-0.3	VCC +0.3	V
Ambient Operating Temperature	-40	+75	°C
Storage Temperature	-40	+125	°C

3.2 | Recommended Operating Conditions

Parameter	Minimum	Typical	Maximum	Units
Supply Voltage (VCC)	2.7	3.3	3.6	V
Temperature Range	-40		+75	°C

3.3 | DC Electrical Characteristics

Parameter	Test Condition	Minimum	Typical	Maximum	Units
Operating current (VCC = 3.3v)	Average usage with radio in TX mode 27% of the time and RX mode 73% of the time		61.4		mA
Deep sleep current	At 25 °C, VCC = 3.3v, shutdown mode		10.5		µA
Idle current	At 25 °C, VCC = 3.3v, sleep mode		7.8		mA
RX current	At 25 °C, VCC = 3.3v		36		mA
TX current	At 25 °C, VCC = 3.3v, high power mode		130		mA

4 | RF Specifications

4.1 | Receive Specifications

Table 4.1 | Module Receive Characteristics

Parameter	Test Condition	Min	Typical	Max	Units
Receive sensitivity	Max gain		-97.56		dBm
Receive sensitivity (Boost)	Max gain		-99.53		dBm
Input 1dB Compression	CW		+26		dBm
Input IP3	Two -7 dBm CW tones spaced 1 MHz apart		+36		dBm

Table 4.2 | Receive Strength Signal Indicator (RSSI) Accuracy

Channel	Actual Level	Measured RSSI
18	-40	-40.0
18	-50	-50.0
18	-60	-60.0
18	-70	-70.0
18	-80	-79.0
18	-90	-89.2

Table 4.3 | EM250 Receive Characteristics

Table 4.3 lists the key parameters of the integrated IEEE 802.15.4 receiver on the EM250. This information is taken from the Ember EM250 Datasheet. Link to this document can be found in the References section.

Note: Receive Measurements were collected with Ember's EM250 Lattice Balun Reference Design (Version B1) at 2440MHz and using the EmberZNet software stack Version 3.0.1. The Typical number indicates one standard deviation above the mean, measured at room temperature (25C). The Min and Max numbers were measured over process corners at room temperature.

Parameter	Test Condition	Minimum	Typical	Maximum	Units
Frequency range		2400		2500	MHz
Sensitivity (Boost mode)	1% PER, 20 byte packet defined by IEEE 802.15.4		-100	-95	dBm
Sensitivity	1% PER, 20 byte packet defined by IEEE 802.15.4		-99	-94	dBm
High-side adjacent channel rejection	IEEE 802.15.4 signal at -82dBm		35		dB
Low-side adjacent channel rejection	IEEE 802.15.4 signal at -82dBm		35		dB
2nd high-side adjacent channel rejection	IEEE 802.15.4 signal at -82dBm		43		dB
2nd low-side adjacent channel rejection	IEEE 802.15.4 signal at -82dBm		43		dB
Channel rejection for all other channels	IEEE 802.15.4 signal at -82dBm		40		dB
802.11g rejection centered at +12MHz or -13MHz	IEEE 802.15.4 signal at -82dBm		35		dB
Maximum input signal level for correct operation (low gain)		0			dBm
Image suppression			30		dB
Co-channel rejection	IEEE 802.15.4 signal at -82dBm		-6		dBc

Table 4.3 | Continued

Parameter	Test Condition	Minimum	Typical	Maximum	Units
Relative frequency error (2x40 ppm required by IEEE 802.15.4)		-120		+120	ppm
Relative timing error (2x40 ppm required by IEEE 802.15.4)		-120		+120	ppm
Linear RSSI range		40			dB
RSSI Range		-90		-30	dB

4.2 | Transmit Specifications

Table 4.4 | Module Transmitter Parameters

Parameter	Test Condition	Min	Typical	Max	Units
Maximum output power (Boost mode)	At highest power setting		20.45		dBm
Output power (low power PA mode)	At lower power PA setting				???
Carrier frequency error		-40	-10	+40	ppm
PSD mask relative	3.5 MHz away	-20			dB
PSD mask absolute	3.5 MHz away	-30			dBm

4.3 | Synthesizer

Table 4.5 | EM250 Synthesizer Parameters

Table 4.5 lists the key parameters of the integrated synthesizer on the EM250. Taken from the EM250 datasheet.

Parameter	Test Condition	Min	Typical	Max	Units
Frequency range		2400		2500	MHz
Frequency resolution			11.7		kHz
Lock time	From off, with correct VCO DAC setting			100	us
Relock time	Channel change or Rx/Tx turnaround (IEEE 802.15.4 defines 192µs turnaround time)			100	us
Phase noise at 100kHz			-71		dBc/Hz
Phase noise at 1MHz			-91		dBc/Hz
Phase noise at 4MHz			-103		dBc/Hz
Phase noise at 10MHz			-111		dBc/Hz

5 | Functional Specifications

5.1 | Serial Ports

Refer to the EM250 data sheet for functionality and associated GPIO pin outs.

Note: The module pin out table in section 2 of this document provides a cross reference between the MMB PA module pins and the EM250 GPIO.

5.1.1 | SC1 (UART, SPI, I2C)

The SC1 module provides asynchronous (UART) or synchronous (SPI or I2C) serial communications.

The UART mode contains the following features:

- Baud rate (300bps up to 921kbps)
- Data bits (7 or 8)
- Parity bits (none, odd, or even)
- Stop bits (1 or 2)
- GPIO signals:
    - TXD
    - RXD
    - nRTS (optional)
    - nCTS (optional)

The SPI mode has the following features:

- Full duplex operation
- Programmable clock frequency (12MHz max.)
- Programmable clock polarity and clock phase
- Selectable data shift direction (either LSB or MSB first)
- Master mode only
- Fixed 8 bit word length
- The following signals can be made available on the GPIO pins:
    - MO (master out)
    - MI (master in)
    - MCLK (serial clock)

The SC1 I2C mode has the following features:

- Programmable clock frequency (400kHz max.)
- Supports both 7-bit and 10-bit addressing
- The SC1 I2C controller is only available in master mode.
- The I2C Master controller supports Standard (100kbps) and Fast (400kbps) I2C modes.
- Multiple master applications are not supported.
- The I2C signals are open-collector and external pull-up resistors are required.
- The following signals can be made available on the GPIO pins:
    - MSDA (serial data)
    - MSCL (serial clock)

5.1.2 | SC2 (SPI, I2C)

The SC2 module provides synchronous (SPI or I2C) serial communications.

The SC2 SPI mode has the following features:

- The SPI mode of the SC2 supports both master and slave modes.
- It has a fixed word length of 8 bits.
- Master and slave modes
- Full duplex operation
- Programmable master mode clock frequency (12MHz max.)
- Slave mode up to 5MHz bit rate
- Programmable clock polarity and clock phase
- Selectable data shift direction (either LSB or MSB first)
- Optional slave select input
- The following signals can be made available on the GPIO pins:
    - MOSI (master out/slave in)
    - MISO (master in/slave out)
    - MSCLK (serial clock)
    - nSSEL (slave select—only in slave mode)

The SC2 I2C mode has the following features:

- The SC2 I2C controller is only available in master mode.
- The I2C Master controller supports Standard (100kbps) and Fast (400kbps) I2C modes.
- Multiple master applications are not supported.
- The I2C signals are open-collector, and external pull-up resistors are required.
- Programmable clock frequency (400kHz max.)
- 7- and 10-bit addressing
- The following signals can be made available on the GPIO pins:
    - SDA (serial data)
    - SCL (serial clock)

5.2 | GPIO

The EM250 has 17 multi-purpose GPIO pins that can be configured in a variety of ways. All pins have the following programmable features:

- Selectable as input, output, or bi-directional.
- Output can be totem-pole, used as open drain or open source output for wired-OR applications.
- Can have internal pull-up or pull-down.

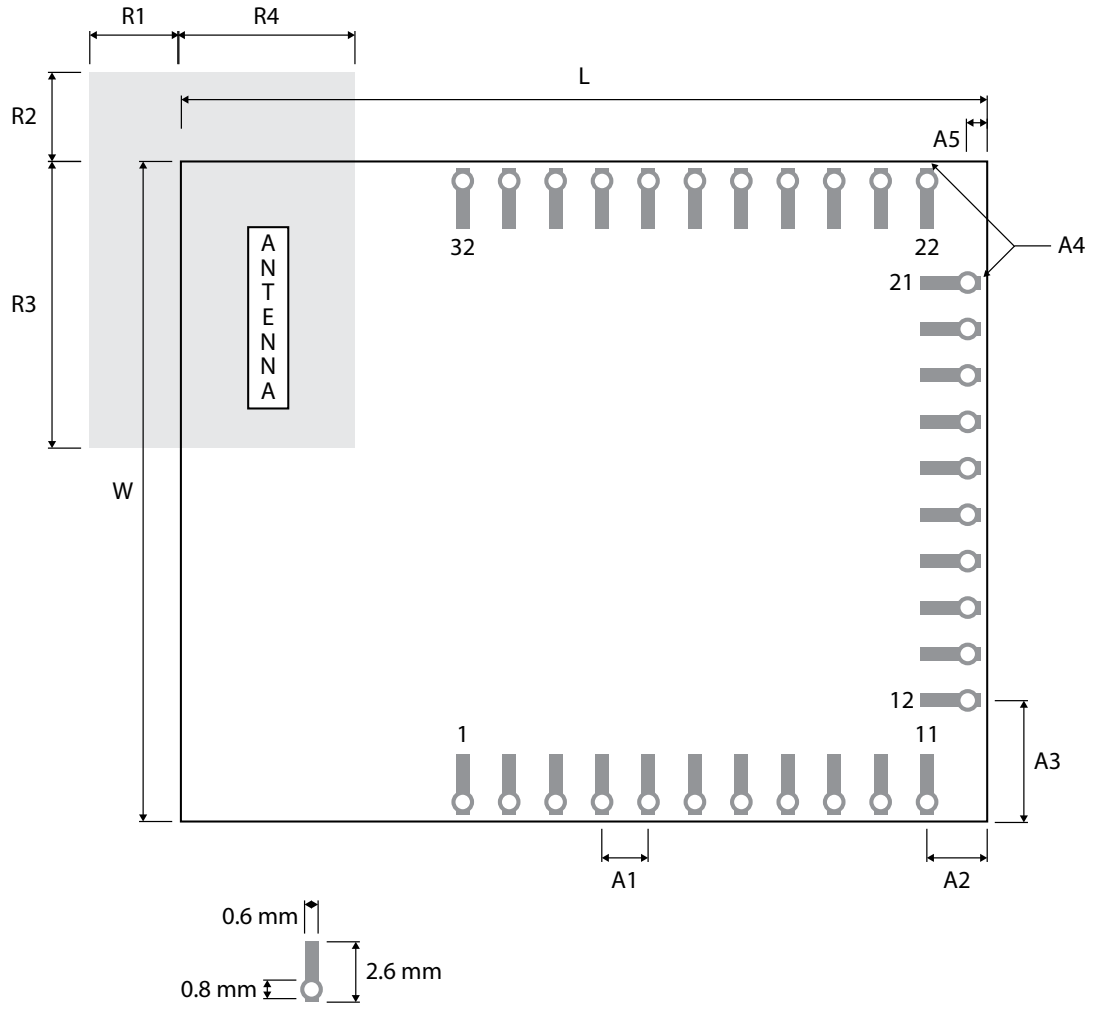
5.3 | Analog to Digital Converter (ADC)

The ADC is a first-order sigma-delta converter sampling at 1MHz with programmable resolution and conversion rate. the ADC Module supports both single-ended and differential inputs.

Parameter	Minimum	Typical	Maximum	Units
Conversion time	32		4096	µ S
VREF	1.19	1.2	1.21	V
VREF output current			1	mA
VREF load capacitance			10	nF
Minimum input voltage	0			V
Maximum input voltage			VCC	V
Single-ended signal range	0		VREF	V
Differential signal range	- VREF		+ VREF	V
Common mode range	0		VREF	V
Input referred ADC offset	-10		10	mV
Input impedance				
When taking a sample	1			M Ohm
When not taking a sample	10			M Ohm
INL	-0.5		0.5	LSB
DNL	-0.5		0.5	LSB

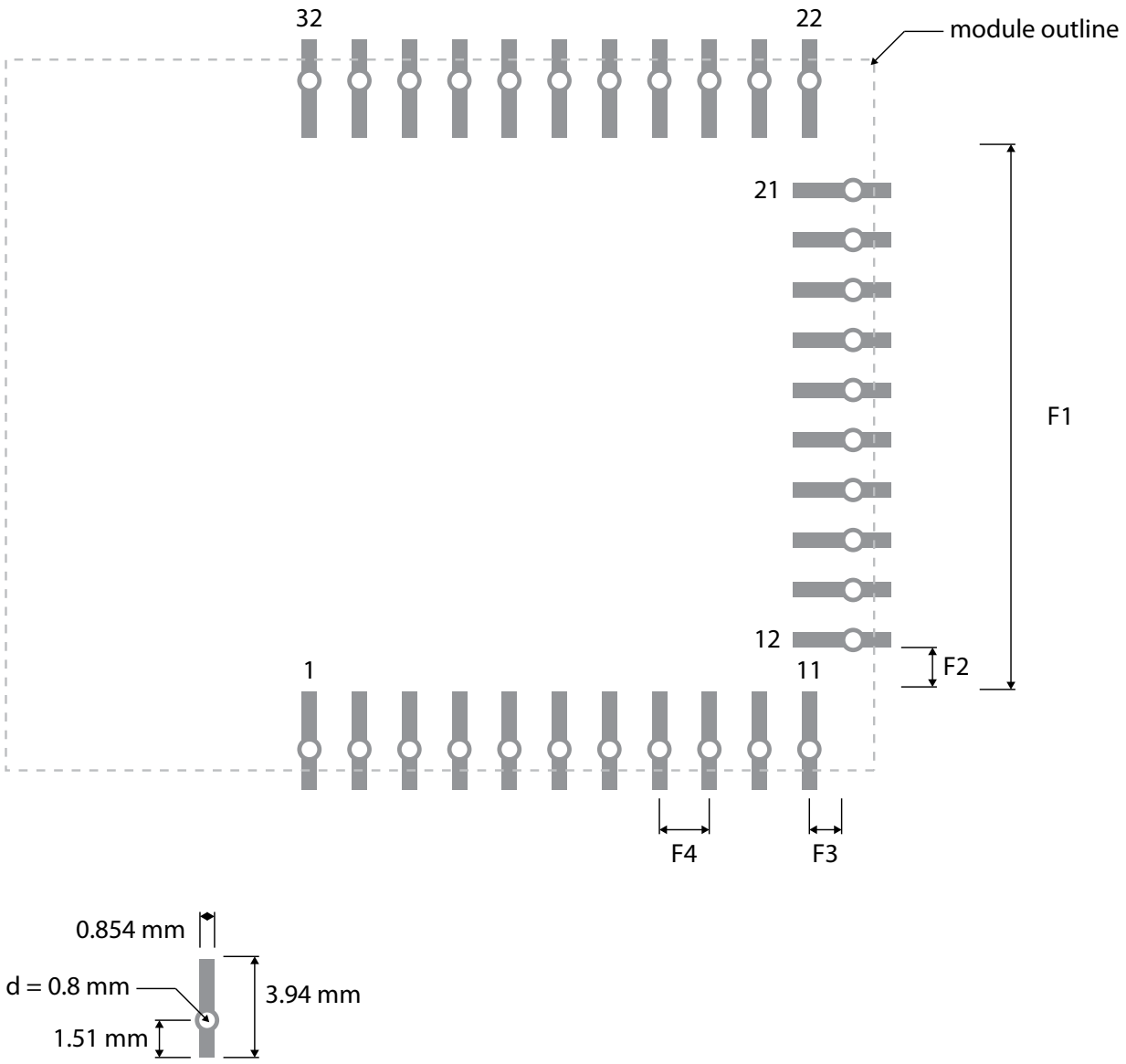
6 | **Mechanical Specifications**

6.1 | Physical Dimensions



Symbol	Description	Distance
L	Length of the module	34.73 mm
W	Width of the module	28.43 mm
H	Height of the module	TBD
A1	Pitch	2 mm
A2	Distance centre of pad to PCB edge	2.59 mm
A3	Distance center of pad to PCB edge	5.22 mm
A4	Distance pad edge to PCB edge	0.29 mm
A5	Distance center of via to PCB edge	0.84 mm
R1	Keep-out zone from corner of PCB	TBD
R2	Keep-out zone from corner of PCB	TBD
R3	Width of keep-out zone	TBD
R4	Length of keep-out zone	TBD

6.2 | Recommended Land Pattern (Surface Mount)



Symbol	Description	Distance
F1	Distance pad edge to pad edge	21.9 mm
F2	Distance pad edge to pad edge	1.523 mm
F3	Distance pad center to pad center	1.3 mm
F4	Pitch	2 mm

Note: It is advised that for surface mount applications, through holes / vias should not be designed into the carrier board.

6.3 | Connector Specifications

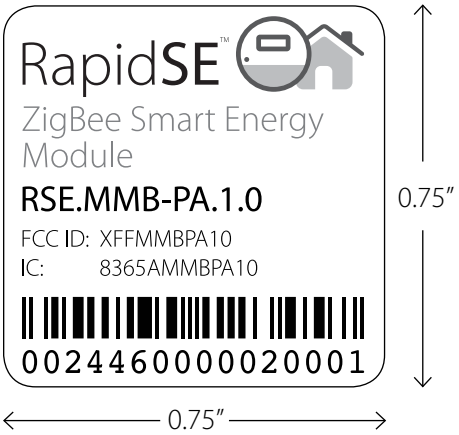
6.3.1 | Edge Mount (USNAP) Connector

10 pin 2mm pitch right angle female header

6.3.2 | SIP Header / Socket

11 + 11 + 10 (if no USNAP populated) pin 2mm pitch 0.8mm diameter through hole footprint

6.4 | Labelling



7 | **Regulatory Approvals**

7.1 | FCC

7.1.1 | FCC Notice

This device (ZGB.MMB-PA.1.0/ZGB.MMB-PA-LNA.1.0) 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.

To comply with FCC RF Exposure requirements, users of this device must ensure that the module be installed and/or configured to operate with a separation distance of 20cm or more from all persons.

7.1.2 | Modular Approval

This device (ZGB.MMB-PA.1.0/ZGB.MMB-PA-LNA.1.0) meets the requirements for modular transmitter approval as detailed in the FCC public notice DA 00-1407.

It should be noted that:

"While the applicant for a device into which an authorized module is installed is not required to obtain a new authorization for the module, this does not preclude the possibility that some other form of authorization or testing may be required for the device (e.g., a WLAN into which an authorized module is installed must still be authorized as a PC peripheral, subject to the appropriate equipment authorization)."
-- FCC Public Notice DA 00-1407

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

7.1.3 | Labeling Requirements

The user of this device is responsible for meeting the FCC labeling requirements. A clearly visible label on the exterior enclosure of an incorporating device must list the MMB Research Inc. FCC ID "XFFMMBPA10" and the FCC Notice above (section 7.1.1).

Devices intended for sale in the Canadian market should also include the Industry Canada (IC) ID "8365A-MMBPA10"