

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, automated 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

<b>1   General Information</b>	<b>2</b>
<b>2   Module Pinout</b>	<b>2</b>
<b>3   Electrical Specifications</b>	<b>3</b>
3.1   Absolute Maximum Ratings	3
3.2   Recommended Operating Conditions	3
3.3   DC Electrical Characteristics	3
<b>4   RF Specifications</b>	<b>4</b>
4.1   Receive Specifications	4
4.2   Transmit Specifications	5
4.3   Synthesizer	5
<b>5   Functional Specifications</b>	<b>6</b>
5.1   Serial Ports	6
5.2   GPIO	7
5.3   Analog to Digital Converter (ADC)	8
<b>6   Mechanical Specifications</b>	<b>9</b>
6.1   Physical Dimensions	9
6.2   Recommended Land Pattern (Surface Mount)	10
6.3   Connector Specifications	11
6.4   Labelling	11
<b>7   Soldering Temperature Time Profile for reflow soldering (Lead-free solder)</b>	<b>11</b>
<b>8   Regulatory Approvals</b>	<b>12</b>
8.1   FCC	12

## 1 | General Information

Note that some of the specifications refer to either EM357 or Module. Please note specifications cited as EM357 are taken from the EM357 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 EM357 pin number.

Module Pad	Function	EM357 GPIO (Pin Number)
1	GND	
2	Module UART RX	PB2 (31)
3	Module UART TX	PB1 (30)
4		PB4 (20)
5		PB3 (19)
6		PA5 (27)
7		PA4 (26)
8		PC1 (38)
9		PB0 (36)
10	VCC	
11	GND	
12	Host Controlled Handshake Line	PB4 (20)
13	Module Controlled Handshake Line	PA6 (29)
14	SPI Slave CLK	PB3 (19)
15	SPI Slave In	PB2 (31)
16	SPI Slave Out	PB1 (30)
17		nReset (12)
18	VCC	
19	GND	
20	n.c.	
21	n.c.	
22	GND	
23		nReset (12)
24		JTCK (32)
25		JTDO, PC2 (33)
26		JTDI, PC3 (34)
27		JTMS, PC4 (35)
28		JRST, PC0 (40)
29		PB7 (41)
30	n.c.	
31	n.c.	
32	GND	

## 3 | Electrical Specifications

### 3.1 | Absolute Maximum Ratings

Parameter	Minimum	Maximum	Units
Supply Voltage (VCC)	0	3.6	V
Voltage on any GPIO ([PA[0:7], PB[0:7], PC[0:7]), JTCK, nReset	-0.3	VCC + 0.3	V
Voltage on any GPIO pin (PA4, PA5, PB5, PB6, PB7, PC1) when used as an input to the general purpose ADC with the low voltage range selected	-0.3	2.0	V
Ambient Operating Temperature	-40	+85	°C

### 3.2 | Recommended Operating Conditions

Parameter	Minimum	Typical	Maximum	Units
Supply Voltage (VCC)	2.7	3.3	3.6	V
Temperature Range	-40		+85	°C

### 3.3 | DC Electrical Characteristics

Parameter	Test Condition	Minimum	Typical	Maximum	Units
Deep sleep current	At 25 °C, VCC = 3.3v, shutdown mode		0.65		μA
Idle current	At 25 °C, VCC = 3.3v, sleep mode		8.5		mA
RX current	At 25 °C, VCC = 3.3v		28		mA
TX current	At 25 °C, VCC = 3.3v, boost mode		TBD		mA
TX current	At 25 °C, VCC = 3.3v, normal mode		TBD		mA
Low Schmitt switching threshold	Schmitt input threshold going from high to low	0.42 x VCC		0.5 x VCC	V
High Schmitt switching threshold	Schmitt input threshold going from low to high	0.62 x VCC		0.8 x VCC	V
Input current for logic 0				-0.5	μA
Input current for logic 1				0.5	μA
Input pull-up resistor value		24	29	34	kΩ
Input pull-down resistor value		24	29	34	kΩ
Output voltage for logic 0		0		0.18 x VCC	V
Output voltage for logic 1		0.82 x VCC		VCC	V
Output source current (standard current pad)				4	mA
Output sink current (standard current pad)				4	mA



## EM357 Receive Characteristics

This table lists the key parameters of the integrated IEEE 802.15.4-2003 receiver on the EM357. This information is taken from the Ember EM357 Datasheet. Link to this document can be found in the References section.

**Note:** Receive measurements were collected with Ember's EM35x Ceramic Balun Reference Design (Version A0) at 2440MHz. 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 802.15.4-2003		-102	-96	dBm
Sensitivity	1% PER, 20 byte packet defined by IEEE 802.15.4-2003		-100	-94	dBm
High-side adjacent channel rejection	IEEE 802.15.4-2003 signal at – 82 dBm		35		dB
Low-side adjacent channel rejection	IEEE 802.15.4-2003 signal at – 82 dBm		35		dB
2nd high-side adjacent channel rejection	IEEE 802.15.4-2003 signal at – 82 dBm		46		dB
2nd low-side adjacent channel rejection	IEEE 802.15.4-2003 signal at – 82 dBm		46		dB
High-side adjacent channel rejection	Filtered IEEE 802.15.4-2003 signal at – 82 dBm		39		dB
Low-side adjacent channel rejection	Filtered IEEE 802.15.4-2003 signal at – 82 dBm		47		dB
2nd high-side adjacent channel rejection	Filtered IEEE 802.15.4-2003 signal at – 82 dBm		49		dB
2nd low-side adjacent channel rejection	Filtered IEEE 802.15.4-2003 signal at – 82 dBm		49		dB
High-side adjacent channel rejection	CW signal at – 82 dBm		44		dB
Low-side adjacent channel rejection	CW signal at – 82 dBm		47		dB
2nd high-side adjacent channel rejection	CW signal at – 82 dBm		59		dB
2nd low-side adjacent channel rejection	CW signal at – 82 dBm		59		dB
Channel rejection for all other channels	IEEE 802.15.4-2003 signal at – 82 dBm		40		dB
802.11g rejection centered at + 12MHz or - 13MHz	IEEE 802.15.4-2003 signal at – 82 dBm		36		dB
Maximum input signal level for correct operation		0			dBm
Co-channel rejection	IEEE 802.15.4-2003 signal at – 82 dBm		-6		dBc
Relative frequency error (2x40 ppm required by IEEE 802.15.4-2003)		-120		+120	ppm
Relative timing error (2x40 ppm required by IEEE 802.15.4-2003)		-120		+120	ppm

## EM357 Receive Characteristics | Continued

Parameter	Test Condition	Minimum	Typical	Maximum	Units
Linear RSSI range	As defined by IEEE 802.15.4-2003	40			dB
RSSI Range		-90		-40	dB

## 4.2 | Transmit Specifications

### Module Transmitter Parameters

Parameter	Test Condition	Min	Typical	Max	Units
Maximum output power (boost mode)	At highest power setting		TBD		dBm
Carrier frequency error		-40		+40	ppm
PSD mask relative	3.5 MHz away	-20			dB
PSD mask absolute	3.5 MHz away	-30			dBm

## 4.3 | Synthesizer

### EM357 Synthesizer Parameters

This table lists the key parameters of the integrated synthesizer on the EM357. Taken from the EM357 datasheet.

Parameter	Test Condition	Min	Typical	Max	Units
Frequency range		2400		2500	MHz
Frequency resolution			11.7		kHz
Lock time	From off			100	$\mu$ s
Relock time	Channel change or Rx/Tx turnaround (IEEE 802.15.4-2003 defines 192 $\mu$ s turnaround time)			100	$\mu$ s
Phase noise at 100kHz offset			-75		dBc/Hz
Phase noise at 1MHz offset			-100		dBc/Hz
Phase noise at 4MHz offset			-108		dBc/Hz
Phase noise at 10MHz offset			-114		dBc/Hz

## 5 | Functional Specifications

### 5.1 | Serial Ports

Refer to the EM357 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 EM357 GPIO.

#### 5.1.1 | SC1 and SC2 Serial Controllers (UART, SPI, TWI)

The SC1 module provides UART, SPI (master or slave), or TWI (master) serial communications.

The SC2 module provides SPI (master or slave), or TWI (master) serial communications.

#### Serial Controller Features

The SPI master controller 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)
- Receive and transmit FIFOs
- Receive and transmit DMA channels
- The following signals can be made available on the GPIO pins:
  - MOSI (serial data out)
  - MISO (serial data in)
  - MCLK (serial clock out)

The SPI slave controller has the following features:

- Full duplex operation
- Up to 5Mbps data transfer rate
- Programmable clock polarity and clock phase
- Selectable data shift direction (either LSB or MSB first)
- Slave select input
- The following signals can be made available on the GPIO pins:
  - MOSI (serial data in)
  - MISO (serial data out)
  - SCLK (serial clock in)
  - nSSEL (slave select)

The TWI master controller has the following features:

- Uses only two bidirectional GPIO pins
- Programmable clock frequency (up to 400kHz)
- Supports 7-bit and 10-bit addressing
- Compatible with Philips I2C-bus slave devices
- The following signals can be made available on the GPIO pins:
  - SDA (bidirectional serial data)
  - SCL (bidirectional serial clock)

## Serial Controller Features | Continued

The SC1 UART supports the following features:

- Baud rate (300bps up to 921.6 kbps)
- Data bits (7 or 8)
- Parity bits (none, odd, or even)
- Stop bits (1 or 2)
- False start bit and noise filtering
- Receive and transmit FIFOs
- Optional CTS/RTS flow control
- Receiver and transmit DMA channels
- GPIO signals:
  - TXD (serial data out)
  - RXD (serial data in)
  - nRTS (optional)
  - nCTS (optional)

## 5.2 | GPIO

The EM357 has 24 multi-purpose GPIO pins that may be individually configured as:

- General purpose output
- General purpose open-drain output
- Alternate output controlled by a peripheral device
- Alternate open-drain output controlled by a peripheral device
- Analog
- General purpose input
- General purpose input with pull-up or pull-down resistor

## 5.3 | Analog to Digital Converter (ADC)

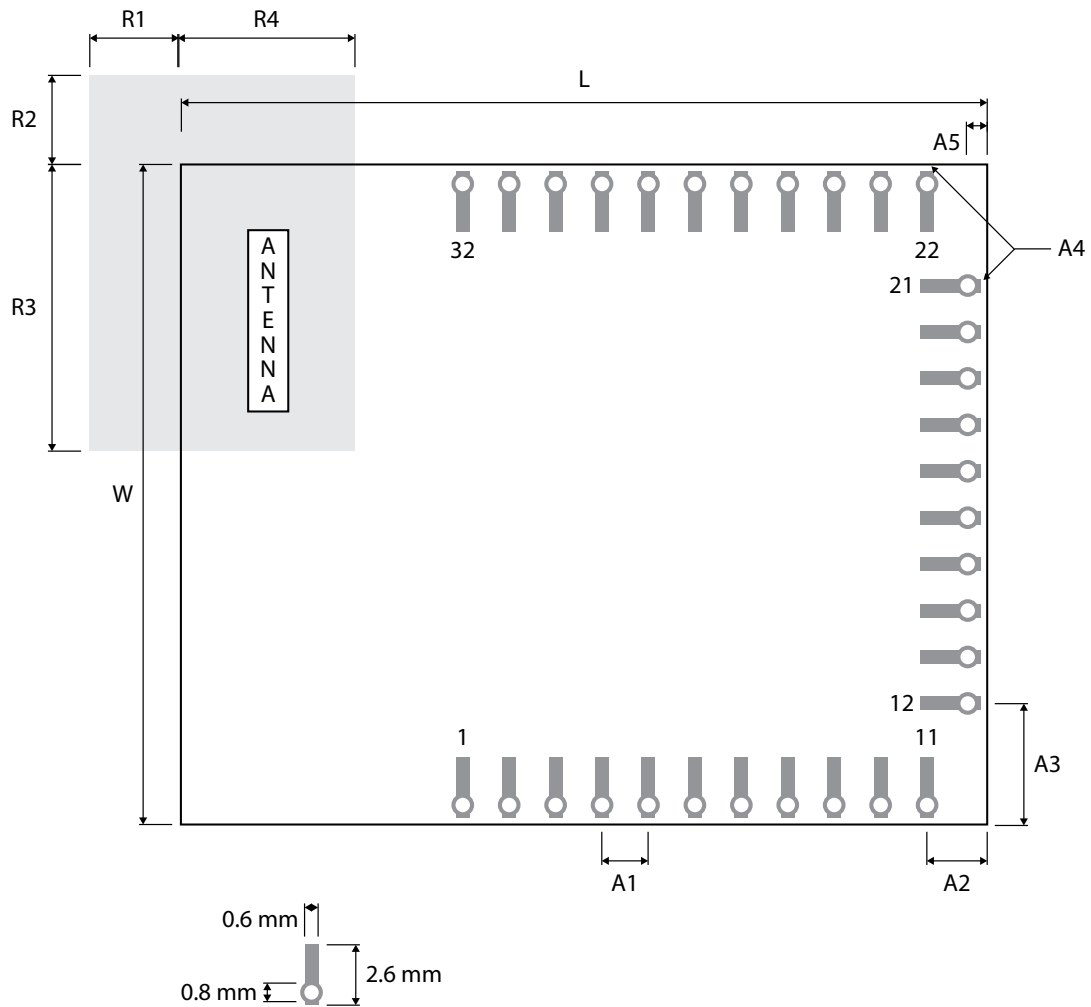
The ADC is a first-order sigma-delta converter with the following features:

- Resolution of up to 14 bits
- Sample times as fast as 5.33  $\mu$ s (188 kHz)
- Differential and single-ended conversions from six external and four internal sources
- Two voltage ranges (differential): -VREF to +VREF, and -VDD\_PADS to +VDD\_PADS
- Choice of internal or external VREF
- internal VREF may be output to PB0 or external VREF may be derived from PB0
- Digital offset and gain correction
- Dedicated DMA channel with one-shot and continuous operating modes

Parameter	Minimum	Typical	Maximum	Units
Conversion time	32		4096	$\mu$ s
VREF	1.17	1.2	1.23	V
VREF output current			1	mA
VREF load capacitance			10	nF
Minimum input voltage (input buffer disabled)	0			V
Minimum input voltage (input buffer enabled)	0.1			V
Maximum input voltage (input buffer disabled)			VREF	V
Maximum input voltage (input buffer enabled)			VCC - 0.1	V
Single-ended signal range (input buffer disabled)	0		VREF	V
Single-ended signal range (input buffer enabled)	0.1		VCC - 0.1	V
Differential signal range (input buffer disabled)	-VREF		+VREF	V
Differential signal range (input buffer enabled)	-VCC + 0.1		+VCC - 0.1	V
Common mode range (input buffer disabled)	0		VREF	V
Common mode range (input buffer enabled)		VCC/2		V
Input referred ADC offset	-10		10	mV
<b>Input impedance</b>				
1 MHz sample clock	1			M Ohm
6 MHz sample clock	0.5			M Ohm
Not Sampling	10			M Ohm

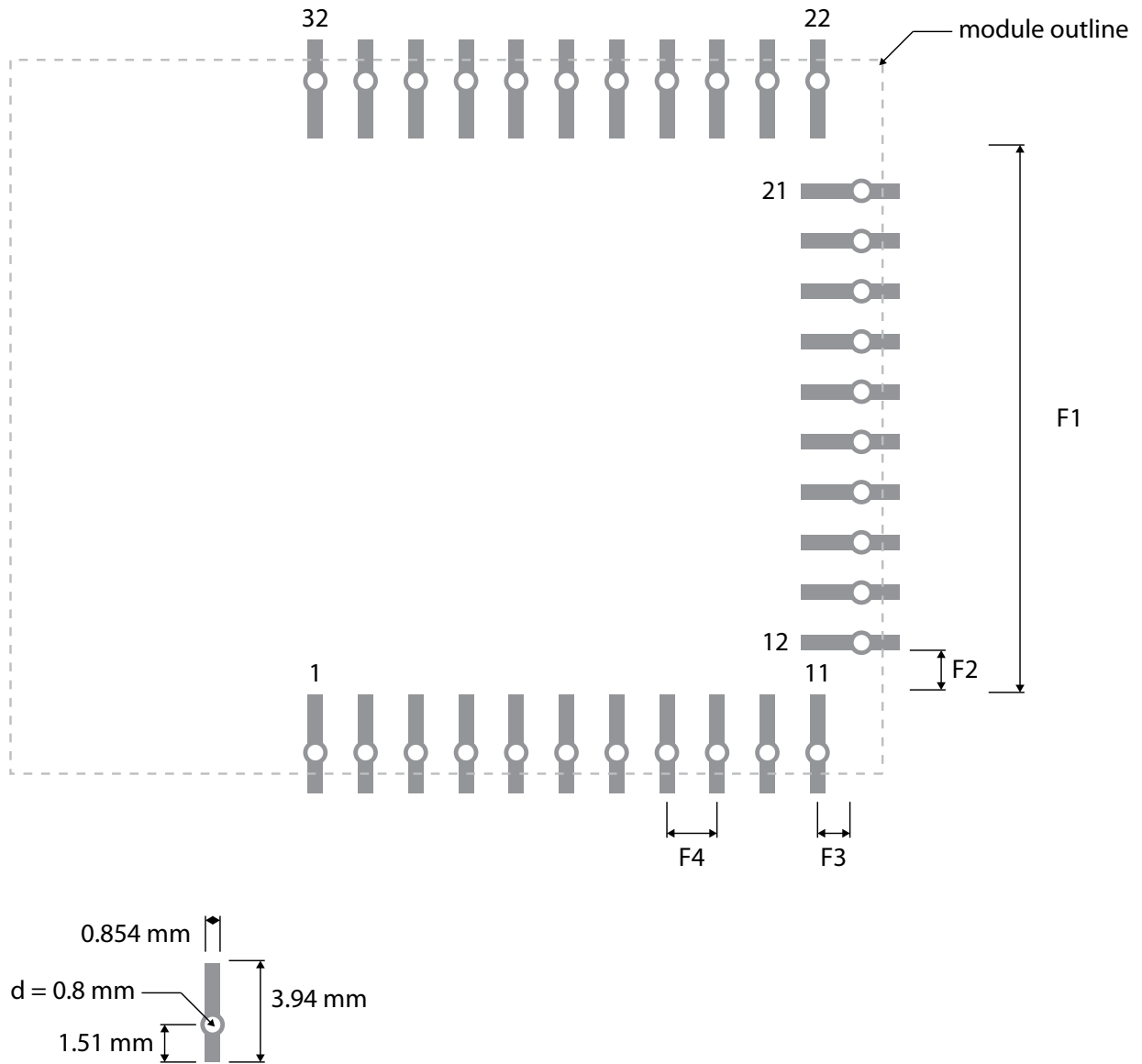
## 6 | Mechanical Specifications

### 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	4.45 mm
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	5 mm (minimum)
R2	Keep-out zone from corner of PCB	5 mm (minimum)
R3	Width of keep-out zone	15 mm
R4	Length of keep-out zone	5.5 mm

## 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

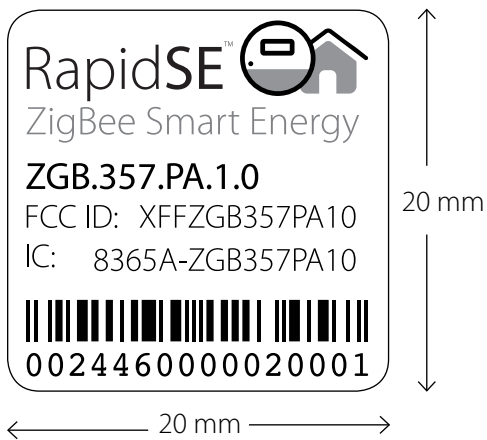
### 6.3.1 | Edge Mount (USNAP) Connector

10 pin 2mm pitch right angle female header

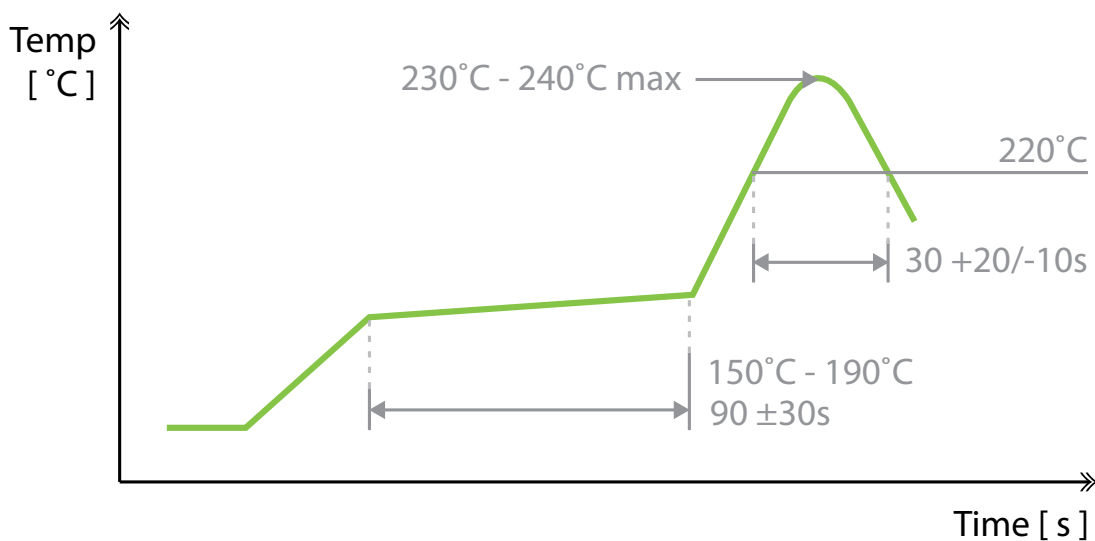
### 6.3.2 | SIP Header / Socket

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

## 6.4 | Labelling



## 7 | Soldering Temperature Time Profile for reflow soldering (Lead-free solder)



Maximum reflow cycles: 2

Opposite-side reflow is prohibited due to the module weight. You must not place the module on the bottom / underside of your PCB and re-flow.

## 8 | Regulatory Approvals

### 8.1 | FCC

#### 8.1.1 | FCC Notice

This device (ZGB.357.PA.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.

#### 8.1.2 | Modular Approval

This device (ZGB.357.PA.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.

#### 8.1.3 | 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 “XFFZGB357PA10” 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-ZGB357PA10”



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