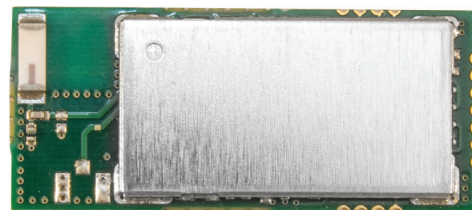


The MMB Networks EM357 ZigBee Module is a drop-in ZigBee Smart Energy and Home Automation solution. Preloaded with MMB Networks' RapidSE ZigBee Smart Energy application or RapidHA Home Automation application, it offers hardware vendors an easy way to integrate a fully-implemented, automated ZigBee Smart Energy or ZigBee Home Automation platform into their existing devices.

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



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## 1 | General Information

Note that some of the specifications refer to either “EM357” or “Module”. Specifications cited as “EM357” are taken from the EM357 datasheet (this should also be noted where referred to). “Module” measurements were taken with the production Z357PA20/Z357PA21 module.

## 2 | Memory

RAM (kB)	On-Chip Flash (kB)	Serial Flash (kB)
12	192	512

## 3 | Module Pinout

Module Pad	Function	EM357 GPIO (EM357 Pin Number)
1	VCC (3.3 VDC)	
2	nCTS/SPI Slave CLK	PB3 (19)
3	nRTS/SPI Select (Host Controlled Handshake Line)	PB4 (20)
4	nReset, active low	(12)
5	PTI_EN	PA4 (26)*
6	PTI_DATA	PA5 (27)*
7	JTDO	PC2 (33)
8	JTCK	(32)
9	JTDI	PC3 (34)
10	JTMS	PC4 (35)
11	JRST	PCO (40)
12	RXD, SPI Slave In	PB2 (31)
13	Module Controlled Handshake Line	PA6 (29)
14	TXD, SPI Slave Out	PB1 (30)
15	GND	

\*Indicates ADC capable pin

## 3.1 | Debug and Programming Interface

In order to access the EM357 for programming and debug purposes, it is recommended that the designer incorporate the 10-pin Ember InSight Port connector. This will enable use of the Ember InSight Adapter (ISA3). Contact Silicon Labs for details regarding the InSight Port connector and ISA3. The InSight Port can be used to load the Ember Node Test application for the purpose of RF testing, but it cannot be used to load MMB's firmware on the device - see Section 3.2 for further details.

The following table shows a pin mapping between the 10-pin Ember InSight Port connector and the module. The graphic to the right displays the layout of the InSight Port connector. The footprint should match the following connector: Samtec FTSH-105-01-L-DV-K

Ember InSight Port Pin	Module Pad
1	1 (VCC)
2	7 (PC2 / JTDO / SWO)
3	11 (PC0 / JRST)
4	9 (PC3 / JTDI)
5	15 (GND)
6	8 (JTCK/SWCLK)
7	10 (PC4 / JTMS / SWDIO)
8	4 (nReset)
9	5 (PA4/PTI_EN)
10	6 (PA5/PTI_DATA)

VBRD	1	2	PC2 (JTDO/SWO)
PC0 (nJRST)	3	4	PC3 (JTDI)
GND	5	6	JTCK/SWCLK
PC4 (JTMS/SWDIO)	7	8	nRESET
PA4 (PTI_EN)	9	10	PA5 (PTI_DATA)

## 3.2 | Upgrading RapidConnect Firmware

The RapidConnect firmware will only run on hardware that includes special security tokens, which are loaded by MMB at the time of manufacturing.

For security reasons, MMB enables read protection on all hardware. Due to the read protection, it is not possible to use the Insight Port to upload new firmware without erasing all manufacturing tokens on the device. Instead, please use MMB's RapidSE or RapidHA Desktop software or implement the appropriate frames from the RapidSE or RapidHA Serial Protocol to complete serial firmware upgrades from a Host microcontroller.

## 4 | Electrical Specifications

### 4.1 | 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	V
Ambient Operating Temperature	-40	85	°C

## 4.2 | Recommended Operating Conditions

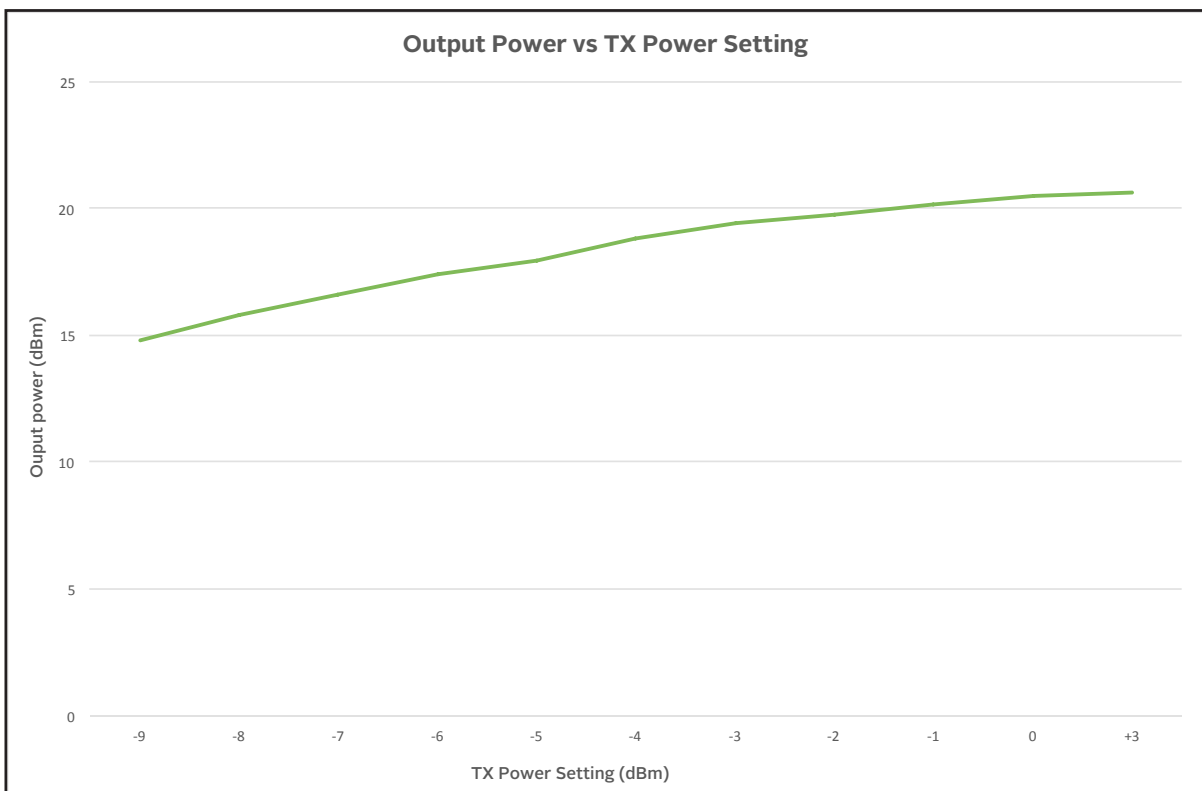
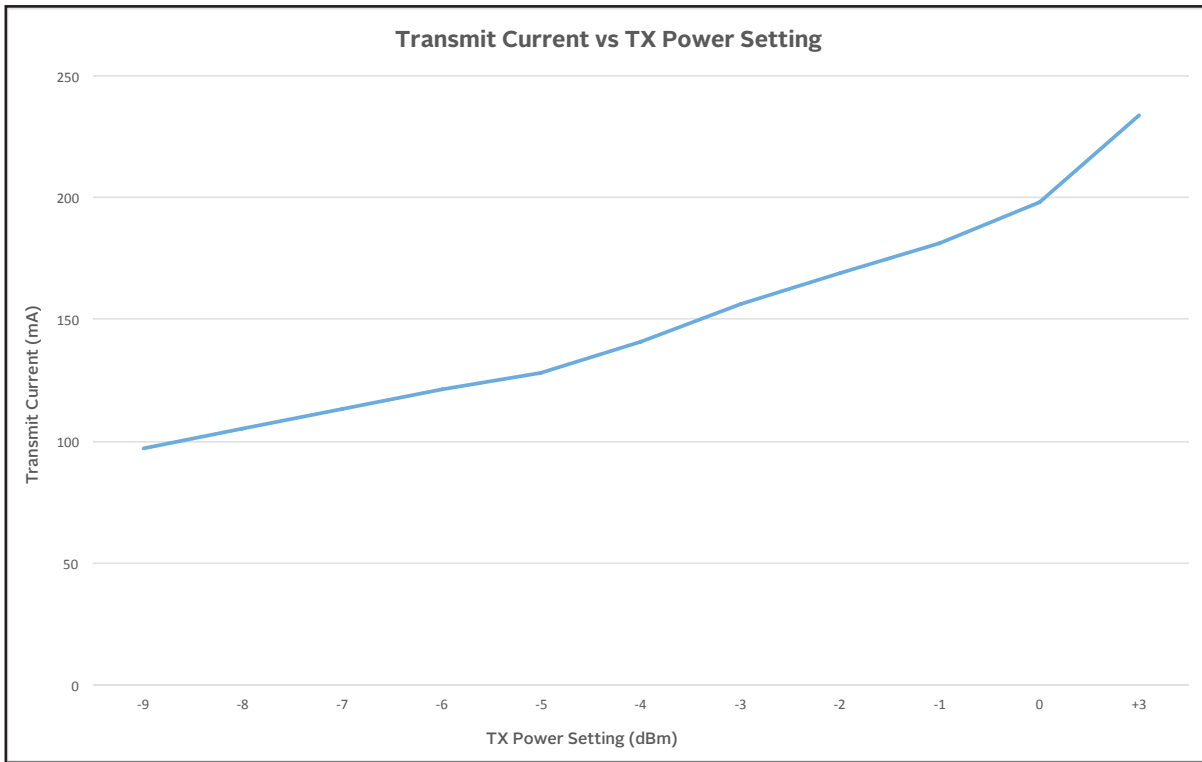
Parameter	Minimum	Typical	Maximum	Units
Supply Voltage (VCC)	2.2	3.3	3.6	V
Temperature Range	-40		85	°C

## 4.3 | DC Electrical Characteristics

Parameter	Test Condition	Minimum	Typical	Maximum	Units
Deep sleep current (Z357PA20)	At 25 °C, VCC = 3.3v, shutdown mode		0.65		μA
Deep sleep current (Z357PA21)	At 25 °C, VCC = 3.3v, shutdown mode		N/A		μA
Idle current	At 25 °C, VCC = 3.3v, sleep mode		13		mA
RX current	At 25 °C, VCC = 3.3v		32		mA
TX current	At 25 °C, VCC = 3.3v, normal mode, 20 dBm		175	235	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
Output source current, high current pad: PA6, PA7, PB6, PB7, PC0				8	mA
Output sink current, high current pad: PA6, PA7, PB6, PB7, PC0				8	mA
Total output current (for I/O Pads)				40	mA

## 4.4 | TX Power Setting

The RF Output Power of the module can be adjusted via the EM357's TX Power setting. The Transmit Current is directly related to the TX Power setting. The charts below show the relationship between the Transmit Current or Output Power vs the TX power setting.



## 5 | RF Specifications

### 5.1 | Receive Specifications

**Note:** The Typical number indicates one standard deviation above the mean, measured at room temperature (25°C). The Min and Max numbers were measured over process corners at room temperature.

Parameter	Test Condition	Min	Typical	Max	Units
Frequency range		2405		2480	MHz
Sensitivity	1% PER, 20 byte packet defined by IEEE 802.15.4-2003	-107	-106	-100	dBm
Saturation (maximum input level for correct operation)		-3	2		dBm
High-side adjacent channel rejection	IEEE 802.15.4-2003 signal at -82dBm		41		dBm
Low-side adjacent channel rejection	IEEE 802.15.4-2003 signal at -82dBm		40		dBm
2nd high-side adjacent channel rejection	IEEE 802.15.4-2003 signal at -82dBm		54		dBm
2nd low-side adjacent channel rejection	IEEE 802.15.4-2003 signal at -82dBm		52		dBm
Relative frequency error (2x40ppm required by IEEE 802.15.4-2003)		-120		120	ppm
Relative timing error (2x40ppm required by IEEE 802.15.4-2003)		-120		120	ppm
Linear RSSI range		35			dB

### 5.2 | Transmit Specifications

Parameter	Test Condition	Min	Typical	Max	Units
Output Power at highest power setting		20	21	21.5	dBm
Error vector magnitude as per IEEE 802.15.4			5	15	%
Carrier frequency error		-40		40	ppm
PSD Mask relative	3.5 MHz distance from carrier	-20			dB
PSD Mask absolute	3.5 MHz distance from carrier	-30			dBm

## 6 | Functional Specifications

### 6.1 | Serial Ports

Refer to the EM357 data sheet for functionality and associated GPIO pin outs.

Note: The module pinout table in section 3 of this document provides a cross-reference between the MMB module pins and the EM357 GPIO.

#### 6.1.1 | SC1 Serial Controller (UART)

The SC1 module provides UART serial communications.

##### Serial Controller Features

The SC1 UART supports the following features:

- Baud rate (300 bps up to 921.6 kbps) (*\*Note: these values are provided to show the hardware capability. RapidSE and RapidHA do not provide the ability to modify the baud rate from the default value of 115.2 kbps. However, MMB can adjust it as necessary through a Non-Recurring Engineering engagement*)
- 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)

Both EM35x serial controllers SC1 and SC2 include a Two Wire serial Interface (TWI) master controller with the following features: (*\*Note: Current MMB modules are not configured to support TWI/I2C. Please contact MMB for further information*)

- Uses only two bidirectional GPIO pins
- Programmable clock frequency (up to 400 kHz)
- Supports both 7-bit and 10-bit addressing
- Compatible with Philips' I2C-bus slave devices

### 6.2 | GPIO

The EM357 has 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

### 6.3 | Analog to Digital Converter (ADC)

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

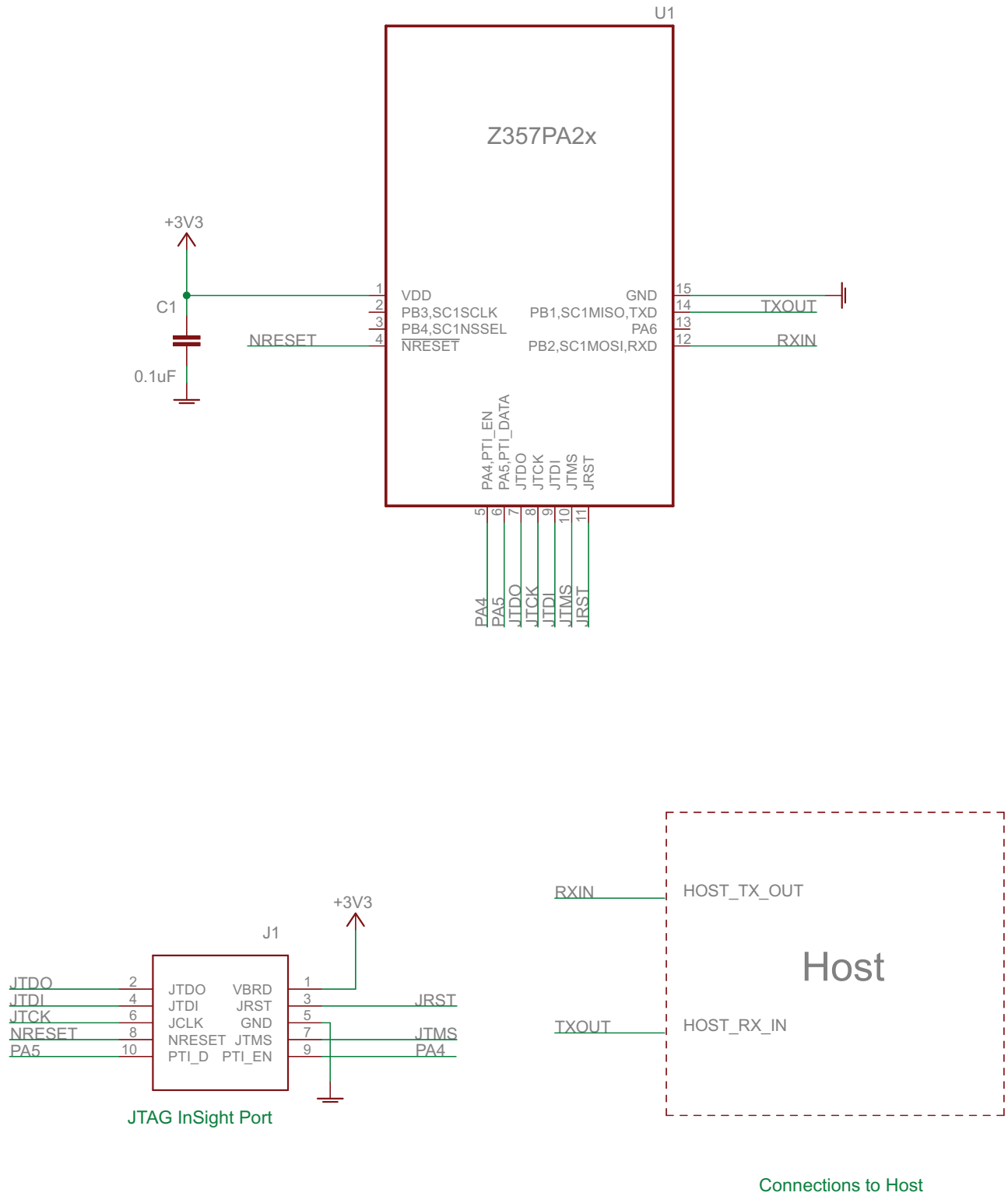
- Resolution of up to 14 bits
- Sample times as fast as 5.33  $\mu$ s (188 kHz)

- Differential and single-ended conversions from six external and four internal sources
- One voltage range (differential): -VREF to +VREF
- 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	Min	Typical	Max	Units
Conversion time	32		4096	μs
VREF	1.17	1.2	1.23	V
VREF output current			1	mA
VREF load capacitance			10	nF
External VREF voltage range	1.1	1.2	1.3	V
External VREF input impedance	1			M Ohm
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
Input impedance (1 MHz sample clock)	1			M Ohm
Input impedance (6 MHz sample clock)	0.5			M Ohm
Input impedance (Not Sampling)	10			M Ohm



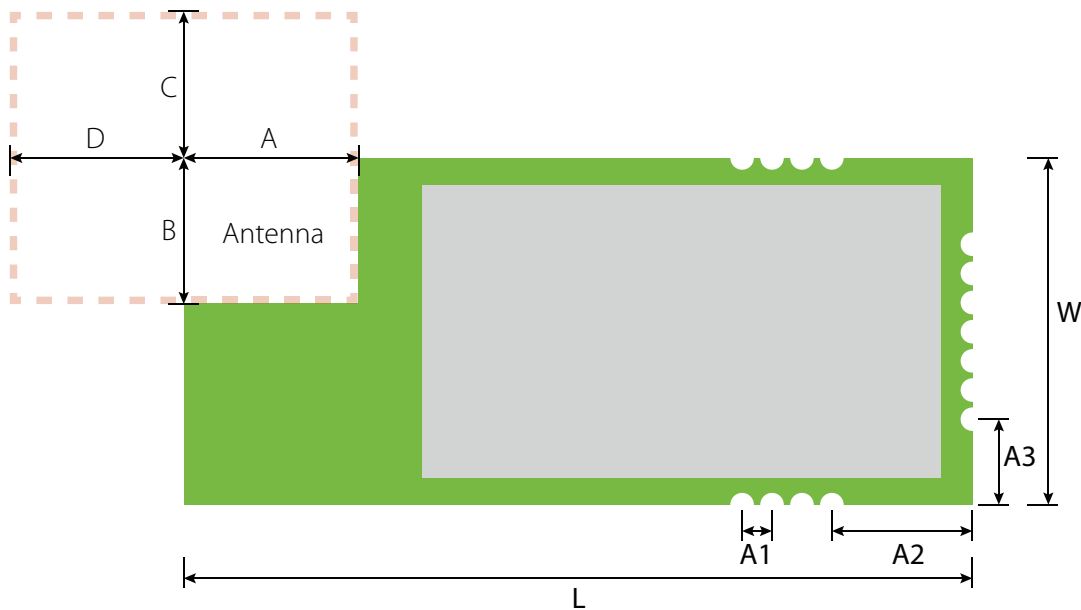
## 7 | Typical Application Circuit



## 8 | Mechanical Specifications

### 8.1 | Physical Dimensions

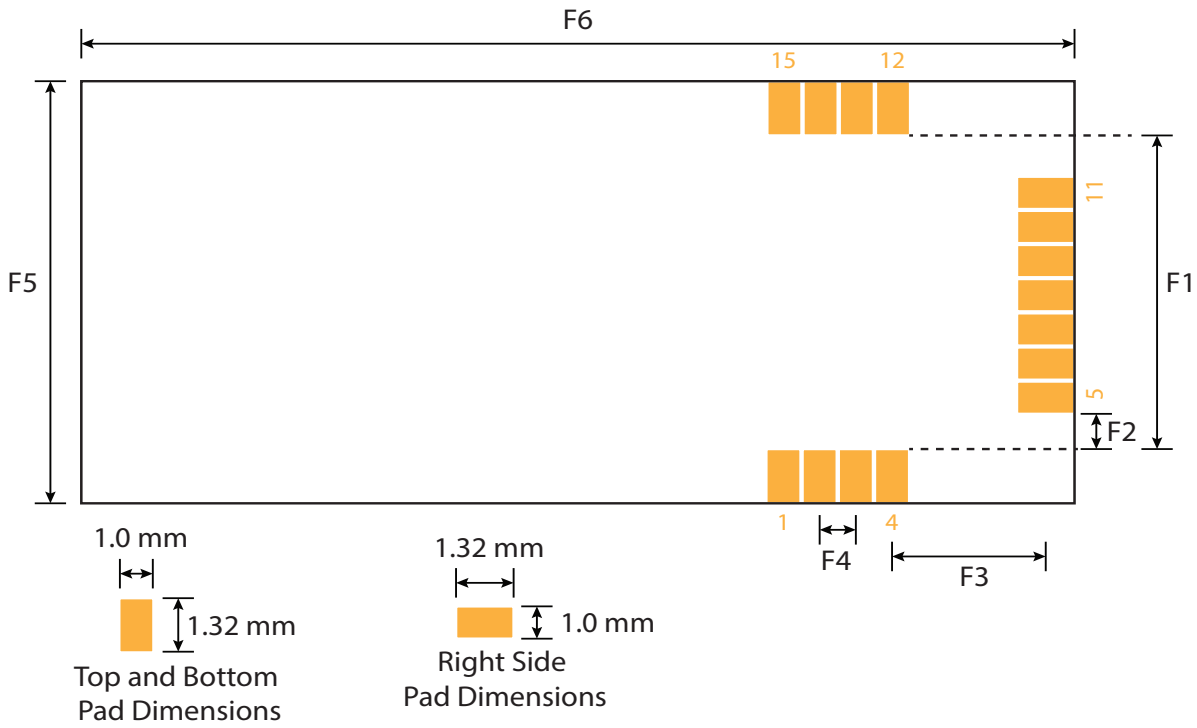
Please note the antenna keep-out zone in the graphic below. No metal components should be located above or below this region (in the z-axis).



Symbol	Description	Distance
L	Length of the module	34.2 mm
W	Width of the module	15 mm
H	Height of the module	2.88 mm
A1	Pitch	1.27 mm
A2	Distance centre of pad to PCB edge	6 mm
A3	Distance center of pad to PCB edge	3.7 mm
A	Length of keep-out zone	7.55 mm
B	Width of keep-out zone	6.2 mm
C	Keep-out zone from corner of PCB	5 mm (minimum)
D	Keep-out zone from corner of PCB	5 mm (minimum)

### 8.2 | Recommended Land Pattern (Surface Mount)

The diagram below shows the recommended dimensions and arrangement of the pads for the module. The daughtercard upon which the module will be mounted should not include any traces or vias directly under the module, because they may come in contact with the module's traces and cause unexpected behavior. If it is absolutely necessary to include traces and/or vias under the module due to space constraints, then a customer can elect to do so at their own risk. MMB can provide a Hardware Designer Package to show the module's footprint and drill locations, which must not line up with the daughtercard's drill locations.

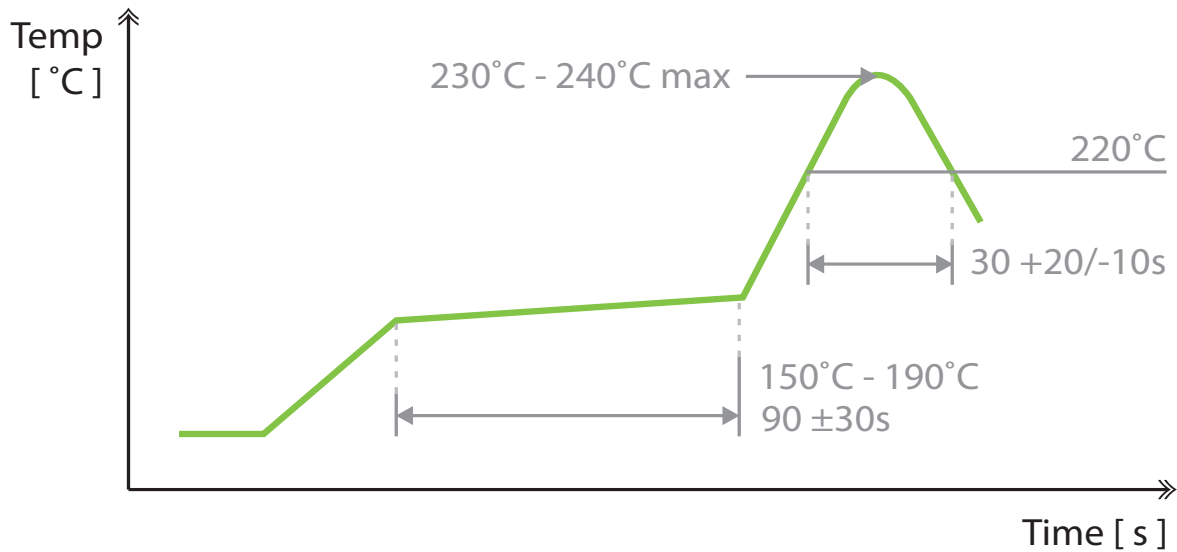


Symbol	Description	Distance
F1	Distance pad edge to pad edge	12.95 mm
F2	Distance pad edge to pad edge	2.17 mm
F3	Distance pad center to pad center	5.72 mm
F4	Pitch	1.27 mm
F5	Module silkscreen outline	15.7 mm
F6	Module silkscreen outline	35.0 mm

### 8.3 | Labelling



## 9 | 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.

## 10 | Regulatory Approvals

### 10.1 | Approved Antennas

The Module has been certified with one onboard chip antenna (Johanson 2450AT42A100E) and the following external whip antennas:

- Mag Layers EDA-1713-2G4C1-A2
- Pulse W5001, W5010, W5011
- Delock 88395
- Taoglas GW.40.2153
- Linx ANT-2.4-CW-HW
- Walsin RFDPA870900SBLB8G1

See the individual jurisdictions in the following sections for the output power settings that were used for certification.

### 10.2 | Federal Communications Commission (FCC - US)

#### 10.2.1 | RF Output Power Settings

For the Z357PA20 and Z357PA21 modules using the onboard chip antenna, the approved power level settings are -2 dBm for channels 11-25 and -20 dBm for channel 26.

For the Z357PA20 and Z357PA21 modules using one of the approved external antennas, the approved power level settings are -11 dBm for channels 11-25 and -26 dBm for channel 26.

#### 10.2.2 | FCC Notice

This device (Z357PA20, Z357PA21) 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.

Usage of Channel 26 at full power will result in non-compliance to FCC standards. MMB recommends avoiding use of channel 26 and if necessary only use with a reduced power setting. For further details please contact MMB.

### 10.2.3 | Modular Approval

This device (Z357PA20, Z357PA21) 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.

### 10.2.4 | 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 “XFFZ357PA20” and the FCC Notice above (section 10.2.2).

The exterior label should use the wording “Contains” or “Contains Transmitter Module”. For example:

**Contains FCC ID: XFFZ357PA20**

or

**Contains Transmitter Module FCC ID: XFFZ357PA20**

Any similar wording that expresses the same meaning may be used.

## 10.3 | Industry Canada (IC)

### 10.3.1 | RF Output Power Settings

For the Z357PA20 and Z357PA21 modules using the onboard chip antenna, the approved power level settings are -2 dBm for channels 11-25 and -20 dBm for channel 26.

For the Z357PA20 and Z357PA21 modules using one of the approved external antennas, the approved power level settings are -11 dBm for channels 11-25 and -26 dBm for channel 26.

### 10.3.2 | IC Notice

This device complies with Industry Canada licence-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.

### 10.3.3 | Labeling Requirements

The host device shall be properly labelled to identify the modules within the host device. The Industry Canada certification label of a module shall be clearly visible at all times when installed in the host device, otherwise the host device must be labelled to display the Industry Canada certification number of the module, preceded by the words “Contains transmitter module”, or the word “Contains”, or similar wording expressing the same meaning, as follows:

**Contains transmitter module IC: 8365A-Z357PA20**

### 10.4 | EU

This device is compliant with the following EU standards: ETSI EN 300 328 (v1.9.1), ETSI EN 301 489 1 (v1.9.2) and ETSI EN 301 489 17 (v2.2.1), provided that the transmit power level is set to -2 dBm (if on-board antenna is used) or -6 dBm (if approved external antenna is used).

### 10.5 | AUS/NZ (C-Tick)

The Z357PA20 and Z357PA21 modules have been certified to be used in Australia and New Zealand.

### 10.6 | Co-Location

If the end product will include additional radio transmitters, additional certification testing may be necessary. The extent of this “co-location” testing will vary depending on the jurisdiction.

### 10.7 | RoHS Compliance

MMB declares, based on the declaration of its suppliers, that this product meets the requirements of RoHS Directive 2011/65/EU (RoHS2).

## 11 | Ordering Information

SKU	Deep Sleep Optimization	Antenna Option	Status*	Recommended Alternative
Z357PA21-SMT	No	Chip	EOL	Z357PA40-SMT
Z357PA21-UFL	No	U.FL	EOL	Z357PA40-UFL
Z357PA20-SMT	Yes	Chip	NRND	Z357PA40-SMT
Z357PA20-UFL	Yes	U.FL	NRND	Z357PA40-UFL

\*EOL = End of Life, NRND = Not Recommended for New Designs



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