ZigBee- Ready SoC RF Transceiver Modules

General Description

The CT-EM2500 SoC RF Transceiver Modules is compact surface mounted modules specially designed for the ZigBee™ protocol stack for wireless star and mesh networks based on IEEE 802.15.4 compliant PHY and MAC layers providing 16 channels in the 2.4-2.4835GHz world-wide license-free ISM band. The complete module is only 20.6 x 25.65 x 3 mm and 20.6 x 19.53 x 3 mm

Optionally available with integrated antenna or external antenna. It integrates a 2.4GHz, IEEE 802.15.4-compliant transceiver with a 16-bit XAP2b microprocessor. It contains integrated Flash and RAM memory and peripherals of use to designers of ZigBee-based applications, A number of peripherals such as GPIO, UART, SPI, I2C, ADC, and general purpose timers are integrated to support user-defined applications,

Applications

Home automation& building control	Home appliances& fire/CO2 alarms	Monitoring of remote systems	Security systems & lighting controls	Sensor data capture in embedded networks





Features

- Complete ZigBee-ready module with
- integrated antenna
- IEEE 802.15.4 compliant PHY
- 128kB Flash and 5kB RAM, emulation EEPROM
- 17 GPIO , 4 channel 12 bit ADC
- UART, SPI ,I2C and debug interfaces
- real time clock or internal RC oscillator for timer
- High performance direct sequence spread spectrum (DSSS) RF transceiver
- 16 channels in the 2.45 GHz ISM band
- on-chip regulator for operation , two sleep low power modes
- Conforms with EN 300 328 (Europe), FCC CFR 47 part 15 (US),ARIB STD-T66 (Japan)

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Absolute Maximum Ratings

Parameter	Test Conditions	Min.	Max.	Unit
Regulator voltage (VDD_PADS)		– 0.3	3.6	V
Voltage on any GPIO[16:0], SIF_CLK, SIF_MISO, SIF_MOSI, SIF_LOADB, OSC32A, OSC32B, RSTB, VREG_OUT		– 0.3	VDD_PADS + 0.3	V
Storage temperature		– 40	+ 140	°C

Under no circumstances the absolute maximum ratings given above should be violated. Stress exceeding one or more of the limiting values may cause permanent damage to the device.

Recommended Operating Conditions

Parameter	Test Conditions	Min.	Typ.	Max.	Unit
Regulator input voltage (VDD_PADS)		2.1		3.6	V
Core input voltage (VDD_24MHZ, VDD_VCO, VDD_RF, VDD_IF, VDD_PADSA, VDD_FLASH, VDD_PRE, VDD_SYNTH, VDD_CORE)		1.7	1.8	1.9	V
Temperature range		– 40		+ 85	°C

Electrical Specifications

T=25 C, VCC = 3.0V if nothing else stated.

Parameter	Min.	Typ.	Max	Unit	Condition / Note
Operating frequency	2405		2480	MHz	Programmable in 11.7Khz steps, 5 MHz steps for IEEE 802.15.4 compliance
Number of channels		16			For IEEE 802.15.4 compliance
Channel spacing		5		MHz	For IEEE 802.15.4 compliance
Input/output impedance		50		Ohm	
Data rate		250		kbit/s	
DSSS chip rate		2		Mc/s	
Frequency stability			+/-40	ppm	
Transmit power	-32		0	dBm	Programmable from firmware
Harmonics 2nd harmonic 3rd harmonic		 -55 -57			
Spurious emission, TX 30 – 1000 MHz 1-12.75 GHz 1.8-1.9 GHz 5.15-5.3 GHz			 -58 -48 -58 -56	dBm	Complies with EN 300 328, FCC CRF47 Part 15 and ARIB STD-T66
Sensitivity		-93		dBm	PER = 1%

Adjacent channel rejection +/-5 MHz		35/35		dB	At -82 dBm, PER = 1%. 0 dB for IEEE 802.15.4 compliance
Alternate channel selectivity +/-10 MHz		54/53		dB	At -82 dBm, PER = 1%. 30 dB for IEEE 802.15.4 compliance
Blocking / Interferer rejection / desensitization +/-5 MHz +/-10 MHz +/-20 MHz +/-50 MHz		-29 -25 -19 -17		dBm	Wanted signal 3 dB above sensitivity level, CW interferer, PER = 1%. Minimum numbers corresponds to class 2 receiver requirements in EN 300 440.
Max. Input signal for correct operation			0	dBm	
Max. Input signal for correct operation			0	dBm	
Spurious emission, RX 30 -1000 MHz			-57	dBm	Complies with EN 300 328, EN 300 440, FCC CRF47 Part 15
1-12.75 GHz			-47		and ARIB STD-T66
Supply voltage	2.1		3.6	V	
Current consumption, RX		35.5		mA	Set it in receive boost mode
Current consumption, TX		35.5		mA	At max. TX power (+ 0 dBm boost)
Quiescent current, Mode1		1.0		µA	including internal RC oscillator
Quiescent current, Mode2		1.5		µA	including 32.768k oscillator
Flash memory		128		KB	
RAM memory		5		kB	
Simulated EEPROM memory		8		kB	
RC OSCILATOR FREQUENCY		10		KHZ	

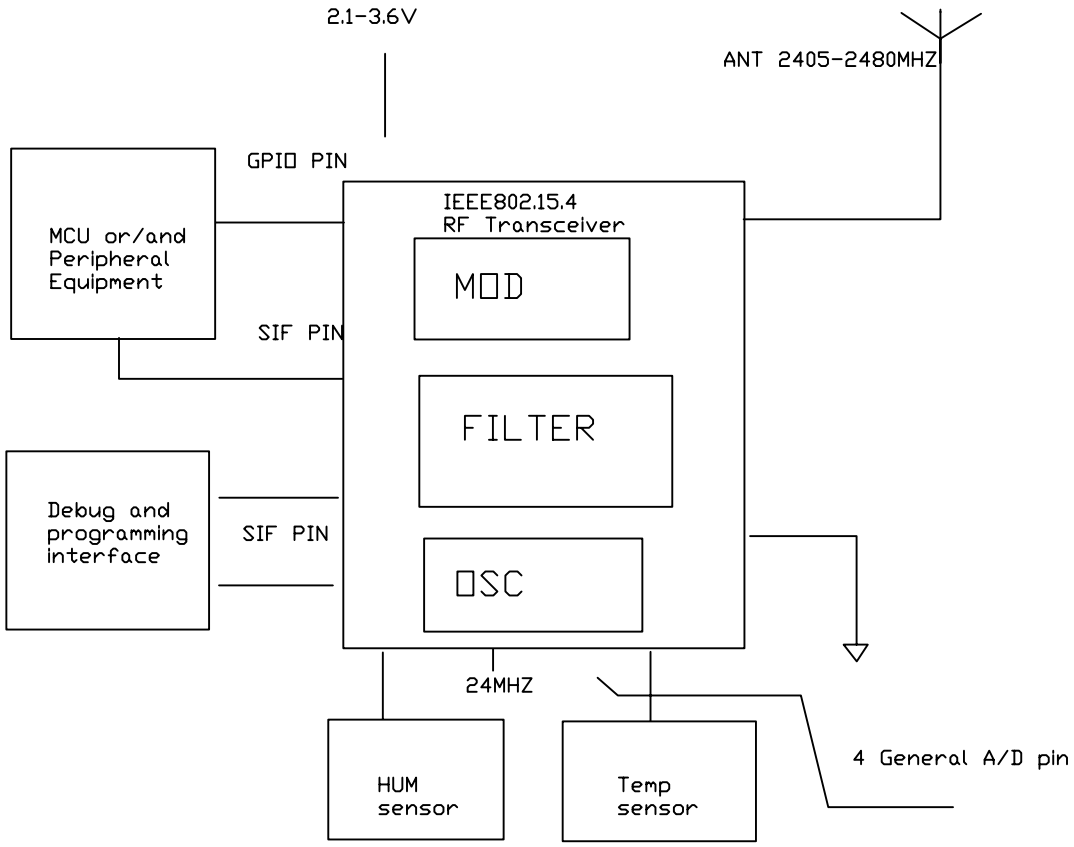
EM2531/01 ZigBee-ReadyRF Transceiver Module

QUICK Product introduction

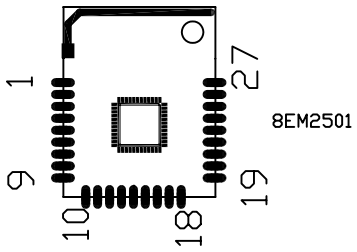
The CT-EM2500 series of modules are specially designed to meet the IEEE802.15.4 Standard used by zigbee and a variety of proprietary network protocals. Using the module together with the Emberznet stack or any other zigbee network implementation makes it a powerful platform to bulid any zigbee profile and application .the module contains qualified RF hardware and enough processor power to run the complete zigbee mesh network protocol for a full function device including the application.

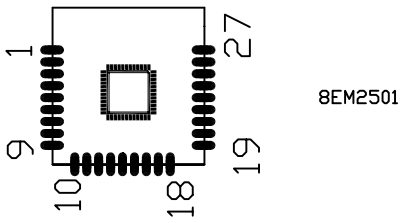
using a pre -qualified module is the fastest way to make a zigbee product and shortest time to market. because it contains all the RF hW and MCU resource you need in a 100%RF tested and pre-qualified module shorten the qualification and approval process. NO RF design or expertise is requrired to add powerful wirelss net working to the product .AS an option you
can even get the module with integrated antenna .in the simplest case like a home light remote control you only neeed an external battery and a pushbutton.

Typical application block



PIN ASSIGNMENT





PIN#	Signal	Direction	Description
1	nRESET	I	Active low chip reset (internal pull-up)
2	□SCB	I/□	24mhz crystal oscillator or left open when using external clolck input on □SCA
3	□SCA	I/□	24mhz crystal oscillator or external clock input
4	VBRD	Power	pads supply (2.1-3.6v)
5	GPI□11	I/□	digital I/□ Enable GPI□11 with GPI□_CFG(7:4)
6	GPI□12	I/□	digital I/□ Enable GPI□12 with GPI□_CFG(7:4)
7	GPI□0	I/□	digital I/□ Enable GPI□0 with GPI□_CFG(7:4)
8	GPI□1	I/□	digital I/□ Enable GPI□1 with GPI□_CFG(7:4)
9	GPI□2	I/□	digital I/□ Enable GPI□2 with GPI□_CFG(7:4)
10	GPI□3	I/□	digital I/□ Enable GPI□3 with GPI□_CFG(7:4)
11	GPI□4	I/□	digital I/□ Enable GPI□4 with GPI□_CFG(12) and GPI□_CFG(8)
12	GPI□5	I/□	digital I/□ Enable GPI□5 with GPI□_CFG(12) and GPI□_CFG(9)
13	GPI□6	I/□	digital I/□ Enable GPI□6with GPI□_CFG(10)
14	GPI□7	I/□	digital I/□ Enable GPI□7 with GPI□_CFG(13) and GPI□_CFG(11)
15	GPI□8	I/□	digital I/□ Enable GPI□8 with GPI□_CFG(14)
16	TXD	□	UART transmit data of serial controller SC1 Enable SC1-4A or SC1-2 with GPI□_CFG(7:4) ,select UART with SC1_M□DE
17	RXD	I	UART receive data of serial controller SC1 Enable SC1-4A or SC1-2 with GPI□_CFG(7:4) ,select UART with SC1_M□DE
18	SIF_CLK	I	serial interface ,clock(internal pull-down)
19	SIF_MIS□	□	serial interface,master in/salve out
20	SIF_M□SI	I	serial interface ,mater out/slave in
21	SIF_L□ADB	I/□	serial interface ,load strobe (open-collector with internal pull-up)
22	GND	Ground	grond supply pad in the bottom center of the package forms Pin49
23	GPI□16	I/□	Digital I/□ Enable GPI□16 with GPI□_CFG(3)
24	GPI□15	I/□	Digital I/□ Enable GPI□15with GPI□_CFG(2)
25	GPI□14	I/□	Digital I/□ Enable GPI□14 with GPI□_CFG(1)
26	GPI□13	I/□	Digital I/□ Enable GPI□13 with GPI□_CFG(0)
27	GND	Ground	Ground supply

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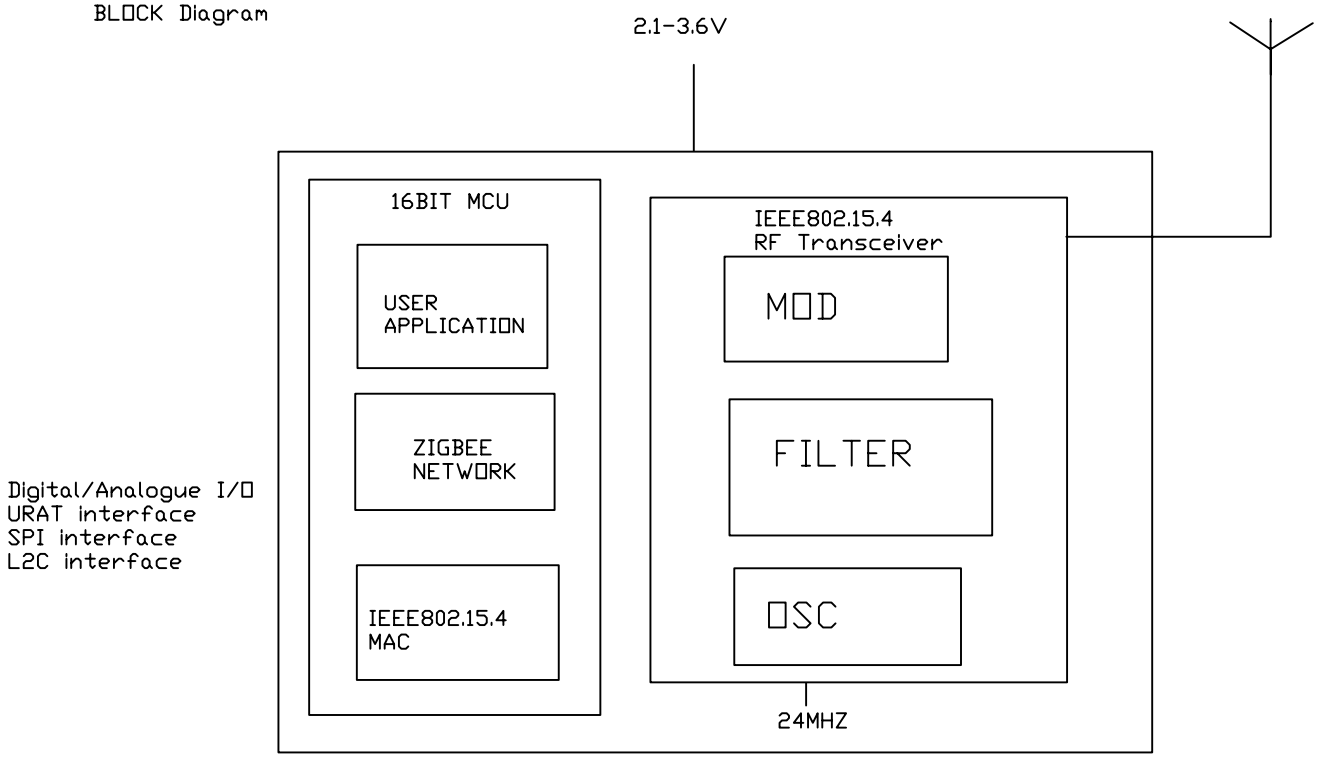
BLOCK Diagram



circuit description
the module contains an IEEE 802.15.4 compliant SoC RF transceiver ,internal memory high speed oscillator ,RC oscillator and an external 32kHZ oscillator,the module is intended for running the zigbee network protocal.

the application software together with the zigbee protocal software stack can be programmed in flash memory through SIF Module .the easiest way to do this is by using an evaluation board from Ember Embedded workbench

TO support user-defined applications. a number of peripherals such as GOIO,UART SPI ,12C,ADC, and general-prupse times are integrated ,also,an integrated voltage regulator ,power-on-reset circuitry,sleep timer ,and low-power sleep modes are available ,the deep sleep mode draws less than 1uA,allowing products to achieve long battery life

SIF Module Programming and Debug Interface

SIF is a synchronous serial interface developed by Cambridge Consultants Ltd. It is the primary programming and debug interface of the CT-EM2500. The SIF module allows external devices to read and write memory-mapped registers in real-time without changing the functionality or timing of the XAP2b core.

The SIF interface provides the following:

- IC production test (especially analog)
- PCB production test
- XAP2b code development
- Product control and characterization

The pins are:

- SIF_LOADB
- SIF_CLK
- SIF_MOSI
- SIF_MISO

The maximum serial shift speed for the SIF interface is 48MHz. SIF interface accesses can be initiated even when the chip is in idle and deep sleep modes. An edge on SIF_LOADB wakes the chip to allow SIF cycles.

Power Management

The CT-EM2500 supports three different power modes: processor ACTIVE, processor IDLE, and DEEP SLEEP.

The IDLE power mode stops code execution of the XAP2b until any interrupt occurs or an external SIF wakeup command is seen. All peripherals including the radio continue to operate normally.

The DEEP SLEEP power mode powers off most of the module but leaves the critical chip functions, such as the GPIO pads and RAM powered by the High Voltage Supply (VDD_PADS). The module can be woken by configuring the sleep timer to generate an interrupt after a period of time, using an external interrupt, or with the SIF interface. Activity on a serial interface may also be configured to wake the module, though actual reception of data is not re-enabled until the module has finished waking up. Depending on the speed of the serial data, it is possible to finish waking up in the middle of a byte. Care must be taken to reset the serial interface between bytes and discard any garbage data before the rest. Another condition for wakeup is general activity on GPIO pins.

RF Frequency, Output Power Levels and Data Rates

The following table shows the RF channels as defined by the IEEE 802.15.4 standard.

RF channel	Frequency
11	2405 MHz
12	2410 MHz
13	2415 MHz
14	2420 MHz
15	2425 MHz
16	2430 MHz
17	2435 MHz
18	2440 MHz
19	2445 MHz
20	2450 MHz
21	2455 MHz
22	2460 MHz
23	2465 MHz
24	2470 MHz
25	2475 MHz
26	2480 MHz

For proprietary solutions (non-IEEE 802.15.4), the RF transceiver can be programmed in resolution of 11.7 KHZ.

The output power level can be configured from the firmware in the range -32 to 5 dBm. The RF transceiver uses direct sequence spread spectrum (DSSS) with 2 Mchip/s chip rate, giving a raw data rate of 250 kbit/s. The modulation format is Offset – Quadrature Phase Shift Keying (O-QPSK). The DSSS makes the communication link robust in noisy environments when sharing the same frequency band with other applications.

The use of RF frequencies and maximum allowed RF power is limited by national regulations. The CT-EM2500 is complying with the applicable regulations for the world wide 2.45 GHz ISM band.

Specifically it complies with the European Union R&TTE directive meeting EN 300 328 . It also meets the FCC CFR47 Part15 regulations for use
in the US and the ARIB T-66 for use in Japan.

Antenna and Range Considerations

As an option the module can be delivered with an integrated antenna.

The integrated antenna is a compact ceramic antenna working as a quarter-wave resonant antenna. Due to the dielectric ceramic material the antenna is shorter than a normal quarter wave antenna (in air), still providing high radiation efficiency
The antenna is matched for use in the 2.45 GHz band.

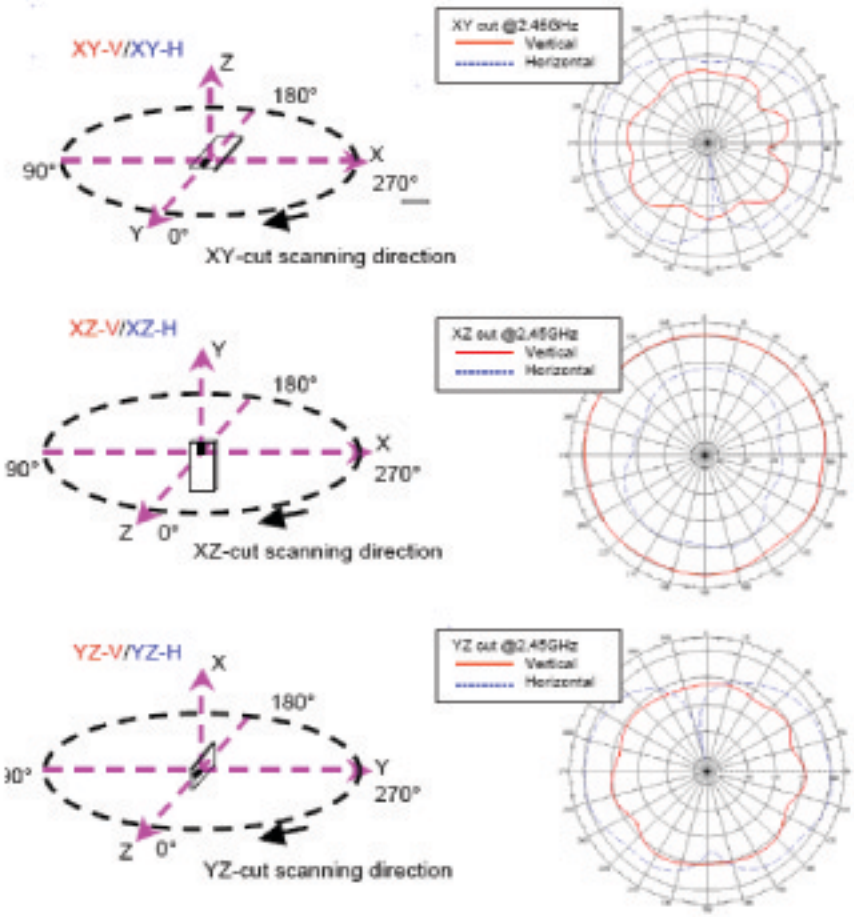


Figure 2 : Integrated printed Antenna radiation pattern at different orientations

The antenna should be kept away (> 10mm) from metallic or other conductive and dielectric materials, and should never be used inside a metallic enclosure.

Compared to lower frequencies, operation at 2.45 GHz is more limited to LOS. Reflections from walls and other objects may give multi-path fading resulting in dead-zones. The ZigBee mesh network topology is used to overcome this fading as it allows for alternative routing paths. The mesh network is therefore highly recommended for increased reliability and extended coverage throughout buildings.

In applications where the module must be placed in a metallic enclosure, an external antenna must be used. The RF available at a module pin must be fed to external antenna. The RF input/output is matched to 50 Ohm. If the antenna or antenna connector is placed away from the module at the motherboard, the track between the RF pin and the connector should be a 50 Ohm transmission line

A PCB antenna can be made as a copper track where the ground plane is removed on the back

side. The rest of the PCB board should have a ground plane as large as possible, preferably as large (in one dimension) as the antenna itself, to make it act as a a reflector mirror to the antenna. A quarter wavelength Antenna on a PCB must be shorter than the wire antenna due to the influence of the dielectric material of the PCB. The length reduction depends on the PCB thickness and material, as well as how close to the edge of the board the antenna is placed. Typical reduction is to 75-90 % but must be found empirically.

The length of a quarter-wave antenna is given in the table below.

Frequency [MHz]	Length of whip antenna [cm]	Length of PCB track [cm]
2450	2.9	2.25 – 2.7

If, for space reasons, the track is made even shorter than the resonating quarter of wavelength, the antenna should be matched to 50 ohms using a series inductor and a shunt capacitor.

PCB Layout Recommendations

For recommended layout pads for the module, please reference **Mechanical Dimensions**
The area underneath the module should be covered with solder resist in order to prevent short circuiting the test pads on the back side of the module. A solid ground plane is preferred. Unconnected pins should be soldered to the pads, and the pads should be left floating. For the module version with integrated antenna, the RF pad can be soldered, but the pad should not be connected further. The two ground pads (pin 10 should be grounded for all variants.)

When using the onboard chip antenna, careful attention is required to the layout of the PCB where the module is mounted. In Figure 3 a mother PCB is shown with a recommended placement of the module.

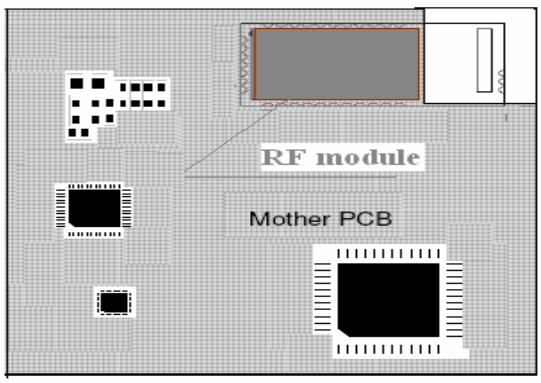
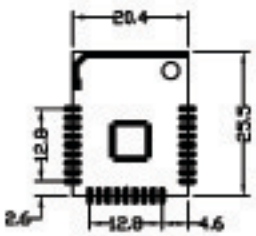


Figure 3 A recommended placement of the module on a mother PCB (Shaded area is ground-plane on mother PCB)

Mechanical Dimensions



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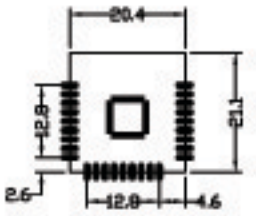

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Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment

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.