ZigBee- Ready SoC RF Transceiver Modules

CT- EM2506 Series Specification

Table of Content

ZigBee- Ready SoC RF Transceiver Modules

1. General Description

The CT-EM2506 SoC RF Transceiver Modules is a compact surface mounted module specially designed for Ember's ZigBee™ protocol stack for wireless networks, EmberZNet, based on IEEE 802.15.4 standard in the 2.4GHz world-wide ISM band. It provides 16 channels and compliant PHY and MAC layers. The complete module is only 25.4 x 32.4 x 4.1mm. They both integrate a 2.4GHz, IEEE 802.15.4-compliant transceiver with a 16-bit XAP2b microprocessor and a FEM. They consist of integrated Flash and RAM memory and peripherals. A number of peripherals such as GPIO, UART, SPI, I2C, ADC, and general purpose timers are integrated to support user-defined applications.

2. Applications

Home automation & building control

Home appliances & alarms

Monitoring of remote systems

Lighting controls

Sensor data capturing

3. Features

- Integrated PCB trace antenna
- IEEE 802.15.4 compliant PHY and MAC layer
- 12MHz XAP2b 16-bit microcontroller core
- 128kB Flash and 5kB RAM, emulation EEPROM
- 17 GPIO , 4 channel 12 bit ADC
- UART, SPI, I^2C and debug interfaces
- External 32.768 kHz real time clock or internal RC oscillator for timer
- 16 channels in the 2.4 GHz ISM band
- On-chip regulator for 2.7-3.6V operation, three sleep low power modes
- -15dBm------20dBm output power, SW controlled

4. 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, nSIF_LOAD, OSC32A, OSC32B, nRESET		- 0.3	VDD_PADS+ 0.3	V
Storage temperature		- 40	+ 140	°C

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

5. Recommended Operating Conditions

Parameter	Test Conditions	Min.	Typ.	Max.	Unit
Regulator input voltage (VDD_PADS)		2.7		3.6	
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

6. Electrical Specifications

T = 25℃, VCC = 3.0V, fo = 2450Mhz, if nothing else stated.

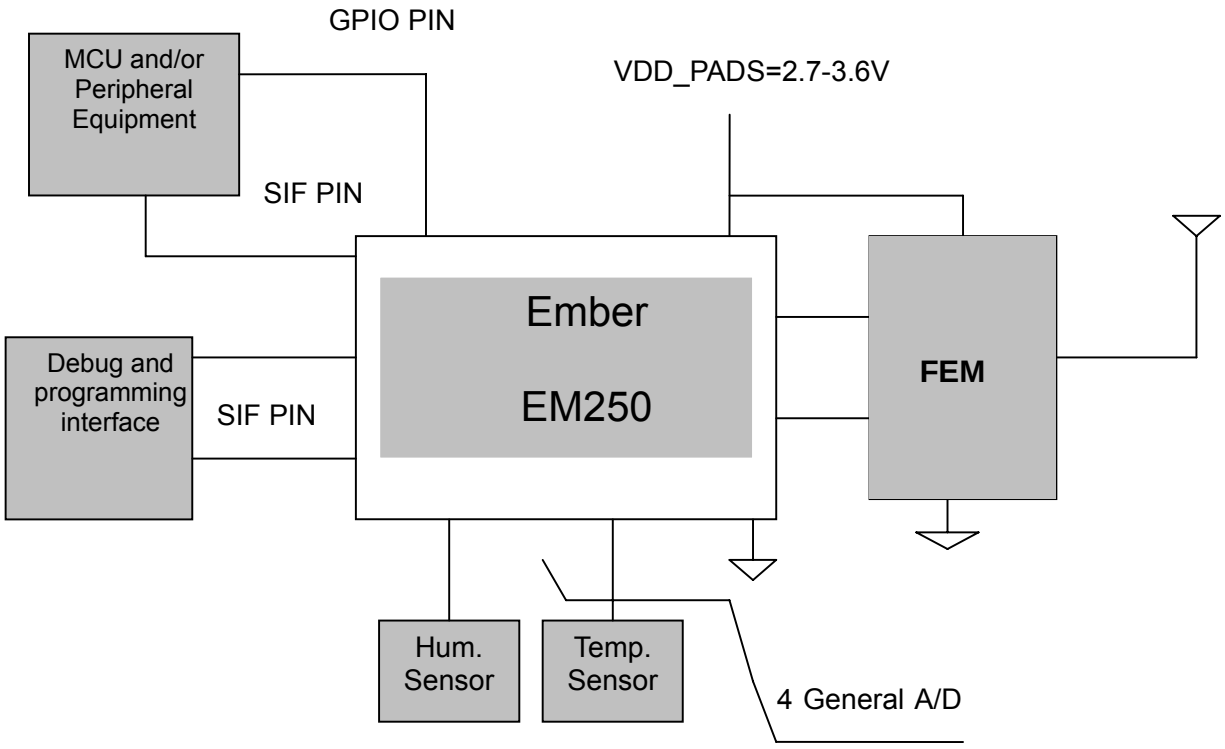
Parameter	Min.	Typ.	Max	Unit	Condition / Note
Operating frequency	2400		2483.5	MHz	Programmable in 5 MHz steps for IEEE 802.15.4 compliance
Number of channels		16			For IEEE 802.15.4 compliance
Channel spacing		5		MHz	For IEEE 802.15.4 compliance
Input/output impedance		50		Ohm	
Data rate		250		kbit/s	
DSSS chip rate		2		Mc/s	
Frequency stability			+/-40	ppm	
Transmit power	-15		20	dBm	Programmable from software

Parameter	Min.	Typ.	Max	Unit	Condition / Note
Sensitivity		-98		dBm	PER = 1% Boost Mode
Adjacent channel rejection +/-5 MHz		35/35		dB	IEEE 802.15.4 signal at - 82dBm
Adjacent channel rejection +/-10 MHz		40/40		dB	IEEE 802.15.4 signal at - 82dBm
Co-channel rejection		-6		dB	IEEE 802.15.4 signal at - 82dBm
Supply voltage	2.7		3.6	V	
Current consumption RX mode		36		mA	Max RX sensitivity (normal mode)
		38		mA	Max RX sensitivity (boost mode)
Current consumption TX Mode		190		mA	20dBm output
Quiescent current		5.0		μA	
Flash memory		128		KB	
RAM memory		5		KB	
Simulated EEPROM memory		8		KB	
MCU clock frequency		12		MHz	
RC OSCILATOR frequency		10		KHZ	
MCU low frequency crystal		32.768		kHz	

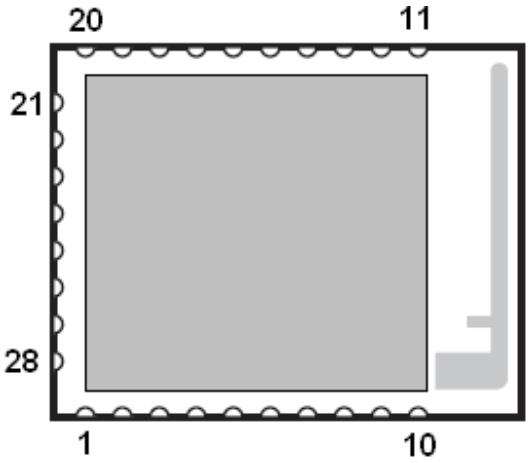
7. Introduction

The CT-EM2506 series of modules are specially designed for ZigBee application. They provide a fast jump start design for system integrators or electronic designers wishing to use ZigBee wireless technologies. The module contains qualified RF hardware and enough processor power to run the EmberZNet stack or other ZigBee network stack (depending on version), making it a powerful platform for building wireless networking products. ZigBee Coordinators (ZC), ZigBee Routers (ZR), and ZigBee End Devices (ZED) are all supported and are programmed onto the module together with a custom application. Minimal RF design experience is needed to use CT-EM2506 modules.

8. Typical application block



9. Pin Assignment



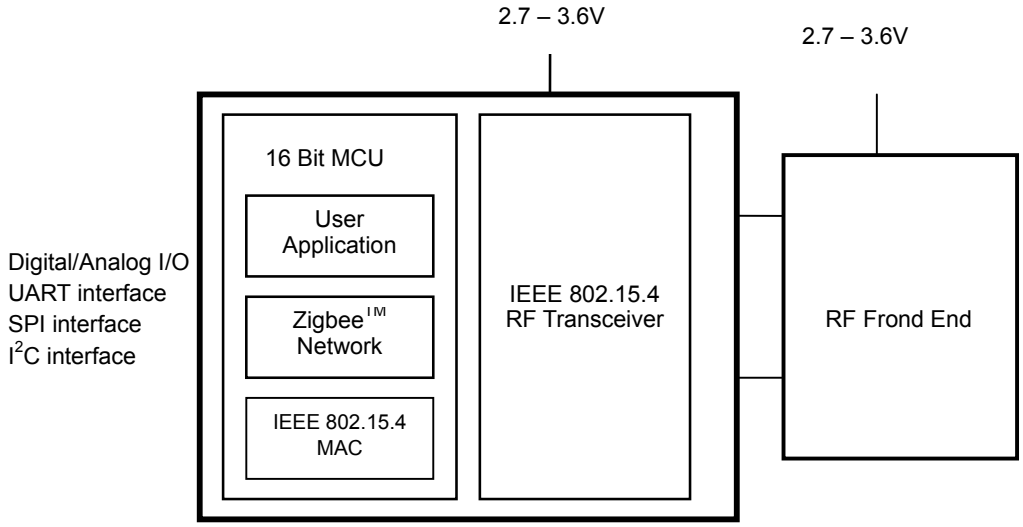
TOP VIEW

10. Pin Description

Pin#	Signal	Direction	Description
1	CLK	DI	SIF Interface clock
2	MISO	DO	SIF Interface master in/slave out
3	MOSI	DI	SIF Interface master out/slave in
4	LOADB	DI/DO	SIF Interface load strobe
5	GPIO16	DI/DO	General Purpose Digital I/O, Output B of Timer 1, Capture Input B of Timer 2, or Source D Interrupt
6	GPIO15	DI/DO	General Purpose Digital I/O, Output A of Timer 1, Capture Input A of Timer 2, or Source C Interrupt
7	GPIO14	DI/DO	General Purpose Digital I/O, Output B of Timer 2, Capture Input B of Timer 1, or Source B Interrupt
8	GPIO13	DI/DO	General Purpose Digital I/O, Output A of Timer 2, or Capture Input A of Timer 1
9	GROUND	GND	Ground

10	GROUND	GND	Ground
11	GROUND	GND	Ground
12	GROUND	GND	Ground
13	IDLE_EN	I	Enable the FEM in deep sleep mode , Active high, in other state, set it in low level
14	V_{BRD}	PI	Power Supply Input
15	RSTB	DI	Reset, active low
16	GPIO11	DI/DO	General Purpose Digital I/O, SC1 UART CTS, SC1 SPI master clock, or Capture Input A of Timer 2
17	GPIO12	DI/DO	General Purpose Digital I/O, SC1 UART RTS, or Capture Input B of Timer 2
18	GPIO0	DI/DO	General Purpose Digital I/O, SC2 SPI MOSI, or Capture Input A of Timer 1
19	GPIO1	DI/DO	General Purpose Digital I/O, SC2 SPI MISO, SC2 I_2C SDA, or Capture Input A of Timer 2
20	GPIO2	DI/DO	General Purpose Digital I/O, SC2 SPI master clock, SC2 I_2C SCL, or Capture Input B of Timer 2
21	GPIO3	DI/DO	General Purpose Digital I/O, SC2 SPI slave select, or Capture Input B of Timer 1
22	GPIO4	DI/DO/AI	General Purpose Digital I/O, ADC Input 0, or PTI frame signal
23	GPIO5	DI/DO/AI	General Purpose Digital I/O, ADC Input 1, or PTI data signal
24	GPIO6	DI/DO/AI	General Purpose Digital I/O, ADC Input 2, Timer 2 Clock Input, or Timer 1 Enable
25	GPIO7	DI/DO/AI	General Purpose Digital I/O, ADC Input 3, Timer 2 Clock Input, External regulator open collector output
26	GPIO8	DI/DO/AO	General Purpose Digital I/O, ADC Reference Output, Timer 1 Clock Input, Timer 2 Enable, or Source A Interrupt
27	GPIO9	DI/DO	General Purpose Digital I/O, SC1 TXD, SC1 MO, SC1 I_2C Data, or Capture Input A of Timer 1
28	GPIO10	DI/DO	General Purpose Digital I/O, SC1 RXD, SC1 MI, SC1 I_2C Clock, or Capture Input B of Timer 1

11. Block Diagram



12. Circuit Description

The module contains an IEEE 802.15.4 compliant SoC RF transceiver, internal memory, high speed oscillator, RC oscillator, an FEM . The module is intended to run the EmberZNet ZigBee software or other ZigBee network implementation, depending on the specific version.

The application software together with the ZigBee protocol software stack can be programmed in Flash memory through the SIF module, using an evaluation board from Ember InSight Desktop.

To support user-defined applications, a number of peripherals such as GPIO, UART, SPI, I2C, ADC, and general-purpose timers 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 5μA , allowing products to achieve long battery life.

For further details on the SoC transceiver (Ember EM250), please consult the data sheet at http://www.ember.com

13. 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-EM2506. 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.

14. Power Management

The CT-EM2506 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 up 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.

15. RF Frequency, Output Power Levels and Data Rates

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

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

The output power level of EM250 can be configured in the range -32 to 3dBm and the gain of FEM is 17dB, So the module output can controlled in range -15 to 20dBm. The RF transceiver uses direct sequence spread spectrum (DSSS) with a raw data rate of 250 kbit/s. The modulation format is Offset – Quadrature Phase Shift Keying (O-QPSK). It is robust even under noisy environments when sharing the same frequency band with other applications.

Note: The output power of EM250 should be configured lower than -19dBm for the channel 2480MHz to comply FCC.

The use of RF frequencies and maximum allowed RF power should according to different national regulations. The CT-EM2506 is complying with the applicable regulations for the world wide 2.4GHz ISM band.

[Subject to final approval: Specifically it complies with the European Union R&TTE directive meeting EN 300 328 and EN300 440 class 2. It also meets the FCC CFR47 Part15 regulations for use in the US and the ARIB T-66 for use in Japan.]

16. Antenna Design Considerations

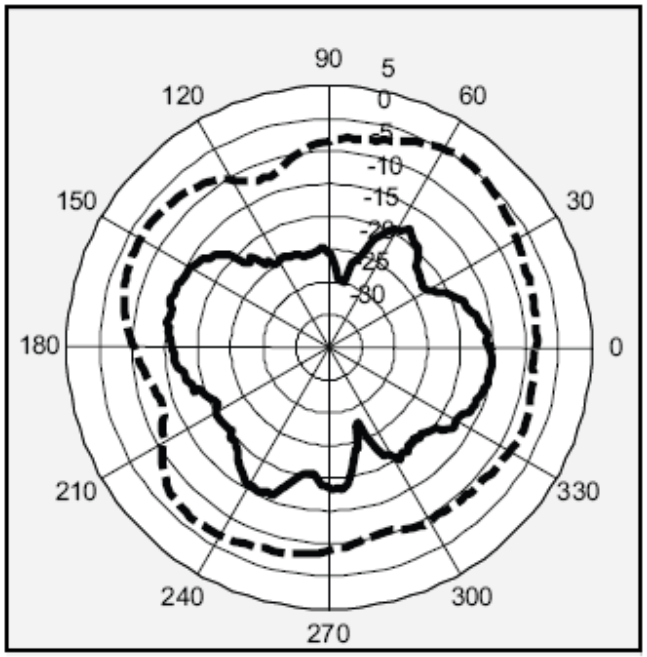
The CT-EM2506 module includes an integrated PCB trace antenna. An optional MMCX connector can be specified, enabling connection to a 50-ohm external antenna of the user's choice..

The PCB antenna employs an F-Antenna topology that is compact and supports an omni-directional radiation pattern. To maximize antenna efficiency, an adequate ground plane must be provided on the host PCB. If positioned correctly, the ground plane on the host board under the module can contribute significantly to antenna performance.

The position of the module on the host board and overall design of the product enclosure contribute to antenna performance. Poor design effects radiation patterns and can result in reflection, diffraction, and/or scattering of the transmitted signal.

Here are some design guidelines to help ensure antenna performance:

- Never place the ground plane or route copper traces directly underneath the antenna portion of the module.
- Never place the antenna close to metallic objects.
- In the overall design, ensure that wiring and other components are not placed near the antenna.
- Do not place the antenna in a metallic or metallized plastic enclosure.
- Keep plastic enclosures 1cm or more from the antenna in any direction.



Test at 2440MHZ

____ Vertical Polarization Gain (dBi)

Avg : -14.8

- - - Horizontal Polarization Gain (dBi)

Avg : -3.4

17. Product Approvals

17.1 FCC Approvals

The CT-EM2506 has been designed to meet all national regulations for World-wide use. Using the integrated antenna it conforms to FCC CFR 47 Part 15 (USA).

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.

The device CT-EM2506 carries FCC authorization and is marked with the FCC ID Number. Whilst any device into which this authorized module is installed will not normally be required to obtain FCC authorization, this does not preclude the possibility that some other form of authorization or testing may be required for the finished device.
When the CT-EM2506 module is integrated inside another device/product, then the outside surface of that device/product must display a label referring to the enclosed module. This exterior label can use wording such as **"Contains Transmitter Module FCC ID:** DI2CT-EM2506**"** or **"Contains FCC ID:** DI2CT-EM2506**"**, although any similar wording that expresses the same meaning may be used.

To meet the Section 15.209 emission requirements in the restricted frequency bands of Section 15.205, the transceiver transmitter power for the CT-EM2506 module needs to be reduced from the typical maximum setting on the upper channels(2480MHz).Maximum output power of Ember is -19dBm(Configured the output power of EM250 lower than -19dBm and enable the boost mode at the same time).

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

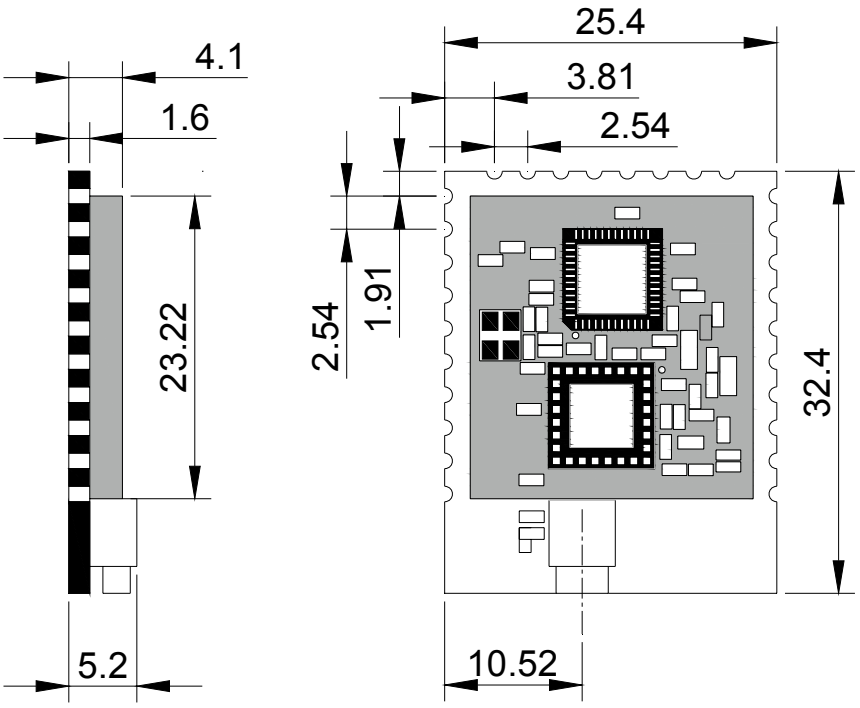
17.2 CE Certificate

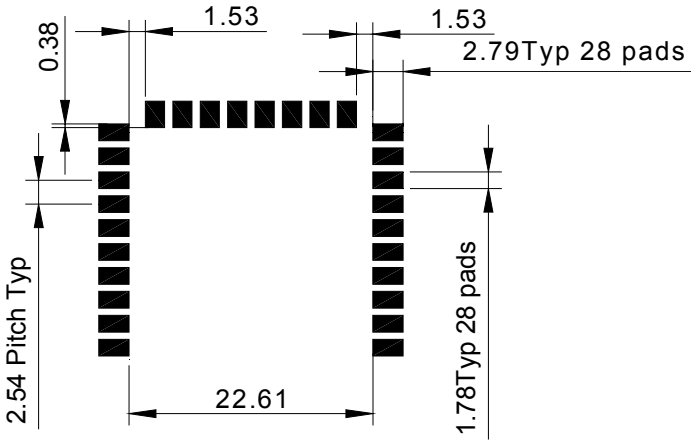
With the integrated antenna the CT-EM2506 has been tested and conforms to the following standards:

- Radio: ETSI EN300 328 V1.6.
- EMC: ETSI EN301 489-17 V1.2.1
- EMC: ETSI EN301 489-1 V1.6.1
- Safety: IEC/EN60950-1

If the CT-EM2506 module is incorporated into an OEM product, the OEM product manufacturer must ensure compliance of the final product to the European EMC, and low voltage/safety standards. A Declaration of Conformity must be issued for each of these standards and kept on file as described in the R&TTE Directive. The final product must not exceed the specified power ratings, as specified in this specification. If any of these specifications are exceeded in the final product then a submission must be made to a notified body for compliance testing to all of the required standard

18 Mechanical Dimension





Unit in mm

19 Ordering Information

Ordering Part Number	Description
CT-EM2506	ZigBee-ready RF module, 128 KB Flash, PCB trace antenna, 20dBm output. FCC/CE certificate

20 Document Revision History

Document Revision	change
1.0	Draft
1.1	Add MSL
1.2	Modify output power of 2480MHz