ZigBee- Ready SoC RF Transceiver Modules
CTL2607

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1. General Description

The CTL2607 RF Transceiver Modules is compact surface mounted modules specially designed for Ember ZigBee™ protocol stack for wireless networks, EmberZNet, based on IEEE 802.15.4 standard in the 2.4GHz world-wide ISM band. The complete module is only 32.4 x 25.4 x 4.1mm .They both integrate a 2.4GHz, IEEE 802.15.4-compliant transceiver with a 16-bit network processor (XAP2b core) to run EmberZNet. They contain embedded Flash and integrated RAM for program and data storage. It utilizes the non-intrusive SIF module for powerful software debugging and programming of the network processor.

The CTL2607 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 need to use CTL2607 modules.

2. Applications

Home automation & building control

Home appliances & alarms

Monitoring of remote systems

Lighting controls

Sensor data capturing

3. Features

- Complete ZigBee-ready module with or without integrated chip antenna
- Integrated IEEE 802.15.4 PHY and MAC layer
- 12MHz XAP2b 16-bit network processor core
- Integrated FEM(Front-End Module)
- Non-intrusive debug interface (SIF)
- SPI interface for communication and controlled by the Host using the EmberZNet Serial Protocol (EZSP)
- 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
- -19+/-1dBm ------ 18+/-1dBm output power, SW controlled

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4. Absolute Maximum Ratings

Parameter	Test Conditions	Min.	Max.	Unit
Regulator voltage (VDD_PADS)		- 0.3	3.6	V
Voltage on nSSEL INT, MOSI, MISO, SCLK, nSSEL, PTI_EN, PTI_DATA, nHOST_INT, SIF_CLK, SIF_MISO, SIF_MOSI, nSIF_LOAD, SDBG, LINK_ACTIVITY, nWAKE, 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	
Temperature range		- 40		+ 85	°C

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6. Electrical Specifications

T=25℃, VCC = 3.0V, Fo =2450MHZ, if nothing else stated.

Parameter	Min	Typ.	Max	Unit	Condition / Note
Operating frequency	2.405		2.480	GHz	Programmable in 5MHz 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	
Frequency stability			+/-40	ppm	
Transmit power	-19+/-1		18+/-1	dBm	Programmable from firmware
Sensitivity		-98		dBm	PER = 1% PER, 20byte packet defined by IEEE 802.15.4 Boost mode
Adjacent channel rejection +/-5 MHz		35/35		dB	IEEE 802.15.4 compliance at -82 dBm
Adjacent channel rejection +/-10 MHz		40/40		dB	IEEE 802.15.4 compliance at -82 dBm
Co-channel rejection		-6		dB	
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	
Deep sleep current		5		µA	
Flash Memory		1		Kbit	

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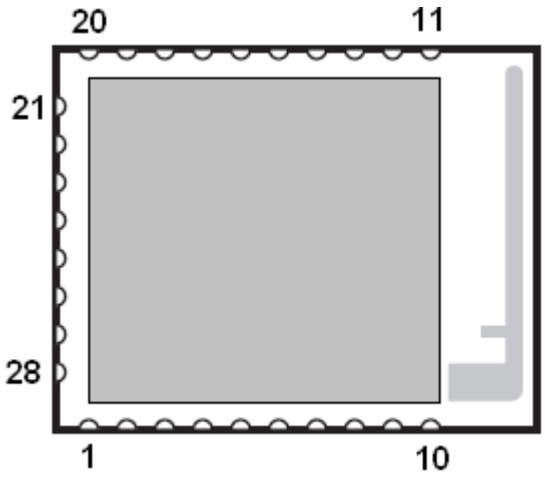
7. Pin Assignment



TOP VIEW

8. Pin Description

Pin#	Signal	Direction	Description
1	SIF_CLK	I	Programming and debug interface, clock(internal pull down)
2	SIF_MISO	O	Programming and debug interface, master In/Slave Out
3	SIF_MOSI	I	Programming and Debug Interface, Master Out / Slave In (external pull-down re-quired to guarantee state in Deep Sleep Mode)
4	nSIF_LOAD	I/O	Programming and Debug Interface, load strobe (open collector pull up)
5	SDBG	O	Spare Debug Signal
6	LINK_ACTIVITY	O	Link and Activity signal
7	GROUND	GND	Ground
8	GROUND	GND	Ground
9	GROUND	GND	Ground
10	GROUND	GND	Ground
11	GROUND	GND	Ground
12	GROUND	GND	Ground
13	RX IDLE_EN	I	Enable the FEM in deep sleep mode , Active high. low level for RX enable

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Pin#	Signal	Direction	Description
14	GROUND	GND	Ground
15	VBRD	Power	Power Supply Input
16	nRESET	I	Active low chip reset(internal pull-up)
17	MOSI	I	SPI Data, Master Out / Slave In (from Host to EM260)
	N.C.	I	When using the UART interface, this signal is left not connected.
18	MISO	O	SPI Data, Master In/Slave Out (from EM260 to host)
	N.C.	I	When using the UART interface, this signal is left not connected.
19	SCLK	I	SPI Clock
	N.C.	I	When using the UART interface, this signal is left not connected.
20	NC	NC	NC
21	nRTS	O	UART Request To Send(enables host transmission) When using the UART interface, this signal should be left unconnected if not used
	N.C.	I	When using the SPI interface, this signal is left not connected.
22	nSSEL_INT	I	SPI Slave Select interrupt(from Host to EM260)
	nCTS	I	UART Clear To Send(enables EM260 transmission) When using the UART interface, this signal should be left unconnected if not used.
	nSSEL	I	SPI Slave Select (from Host to EM260)
	N.C	I	When using the UART interface, this signal is left not connected .
23	PTI_EN	O	Frame signal of Packet Trace Interface(PTI)
24	PTI_DATA	O	Data signal of Packet Trace Interface(PTI)
25	TXD	O	UART Transmitted Date(from EM260 to Host)
	N.C.	I	When using the SPI interface, this signal is left not connected.
26	nHOST_INT	O	SPI Host Interrupt Signal (from EM260 to Host)
	RXD	I	UART Received Data(from Host to EM260)
27	nWAKE	I	SPI Wake Interrupt Signal (from Host to EM260)
	N.C.	I	When using the UART interface, this signal is left not connected.
28	GROUND	GND	Ground

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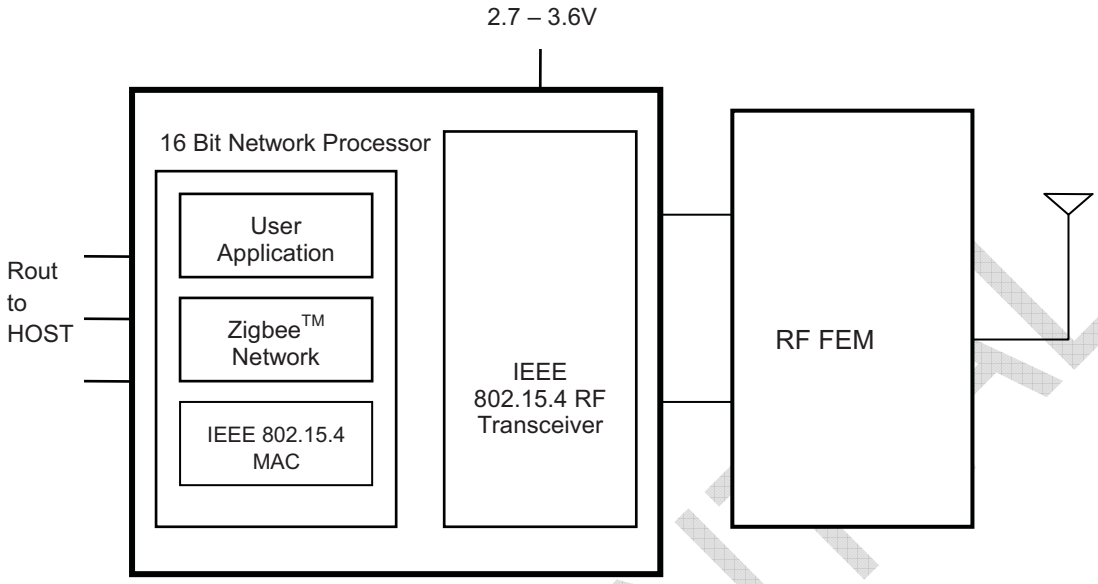
9. Block Diagram



Block Diagram

10. Circuit Description

The module contains an IEEE 802.15.4 compliant RF transceiver, high speed oscillator, RC oscillator and RF FEM . The module is intended to running the Ember 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 SIF module, using an evaluation board from Ember InSight Desktop.

To support user-defined applications, the module exposes the Ember Serial API over the SPI, which allows application development to occur on a Host microcontroller of choice. In addition to the four SPI signals, two additional signals, nHOST_INT and nWAKE, provide an easy-to-use handshake mechanism between the Host and the module. 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 transceiver (Ember EM260), please consult data sheet at http://www.ember.com

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11. 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 CTL2607. 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
- Firmware download
- 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, deep sleep or power down modes. An edge on nSIF_LOAD wakes the chip to allow SIF cycles.

12. Power Management

The module supports four different power modes: active, idle, deep sleep, and power down.

Active mode is the normal, operating state of the module.

While in idle mode, code execution halts until any interrupt occurs. All modules including the radio continue to operate normally. The EmberZNet stack automatically invokes idle as appropriate.

Deep sleep mode and power down mode both power off most of the functions, including the radio, and leave only the critical chip functions powered. The internal regulator is disabled. All output signals are maintained in a frozen state. Upon waking from deep sleep or power down mode, the internal regulator is re_enabled. Deep sleep and power down result in the same sleep current consumption. The two sleep modes differ as follows: the module can wake on both an internal timer and an external signal from deep sleep mode; power down mode can only wake on an external signal.

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13. RF Frequency Detail

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

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 4.5 dBm and the gain of FEM is 17dB, So the module output can controlled in range -20 to 19dBm . 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). It is robust even under noisy environments when sharing the same frequency band with other applications.

Note: the output power of em260 should be configured lower than -19dBm for 2480M channel to Comply FCC

The use of RF frequencies and maximum allowed RF power should according to different national regulations. The]CTL2607 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.]

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14. Antenna Design Considerations

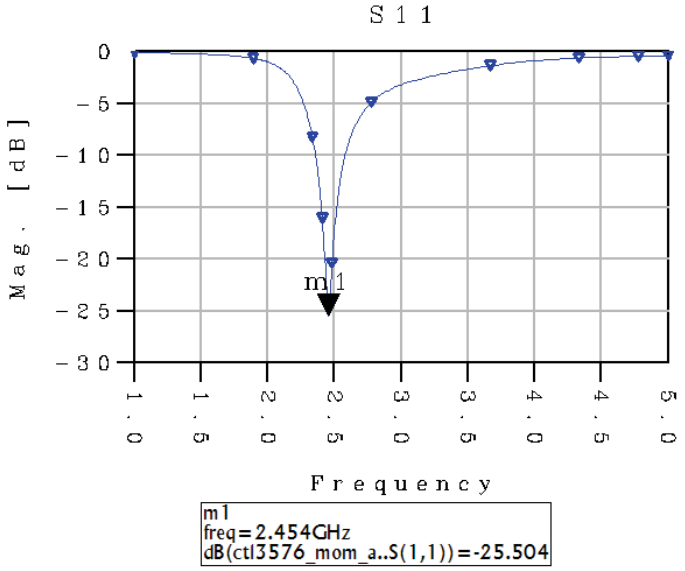
The CTL2607 module includes an integrated PCB trace antenna. An optional MMCX connector can be specified, enabling connection to a 50-ohm external antenna of the user's choice..

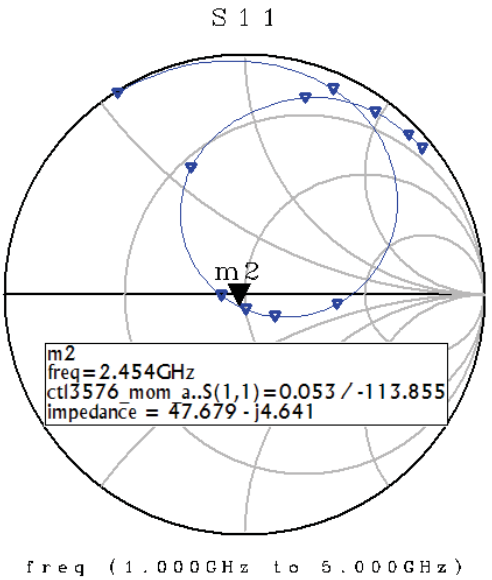
The PCB antenna employs an F-Antenna topology that is compact and supports an omni-directional radiation pattern. To maximize antenna efficiency, an adequate ground plane must be provided on the host PCB. If positioned correctly, the ground plane on the host board under the module can contribute significantly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





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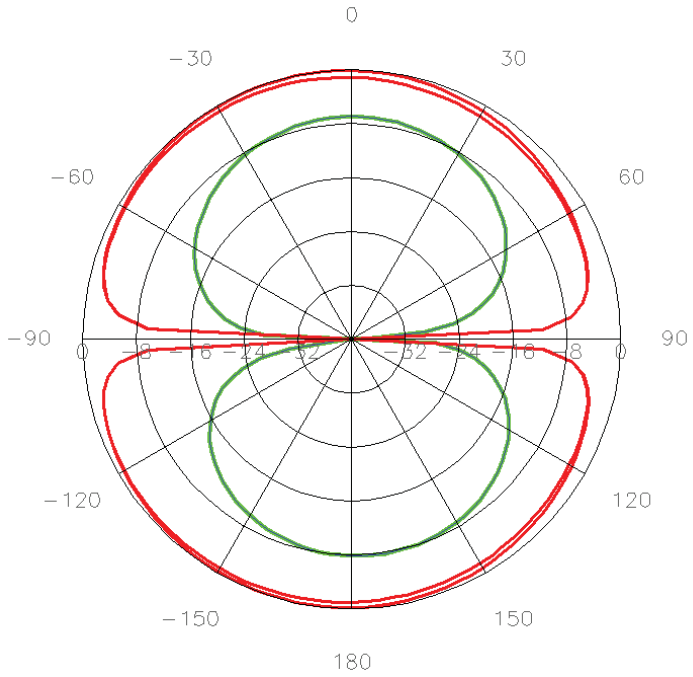

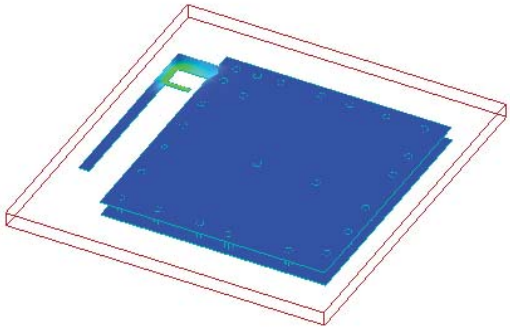

Power radiated (watts)	0.001557872194	
Effective angle (degrees)	391.18	
Directivity (dB)	2.649522578	
Gain (dB)	0.4496856333	
Maximum Intensity (Watts/Steradian)	0.0002281782367	
Angle of U Max (theta, phi)	24.00	159
E(theta) Max (mag, phase)	0.07370709819	-155.2586588
E(phi) Max (mag,phase)	0.4080326029	-96.72083834
E(x) Max (mag,phase)	0.1868931588	66.60636793
E(y) Max (mag,phase)	0.3689112705	86.47758731
E(z) Max (mag,phase)	0.02997937769	24.7413412

15. 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.

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

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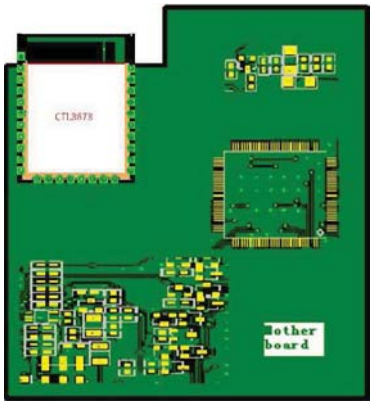

A recommended placement of the module on a main PCB

16. Product Approvals

16.1FCC Approvals

The CTL2607 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 CTL2607 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 CTL2607 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:**DICTCTL2607**"** or **"Contains FCC ID:** DICTL2607**"**, 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 CTL2607 module needs to be reduced from the typical maximum setting on the upper channels (2480 MHz). Maximum values are 0dBm (Configured the output power of em260 lower than -15dBm).

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.

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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.

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16.2CE Certificate

With the integrated antenna the CTL2607 has been tested and conforms to the following standards:

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

If the CTL2607 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 standards

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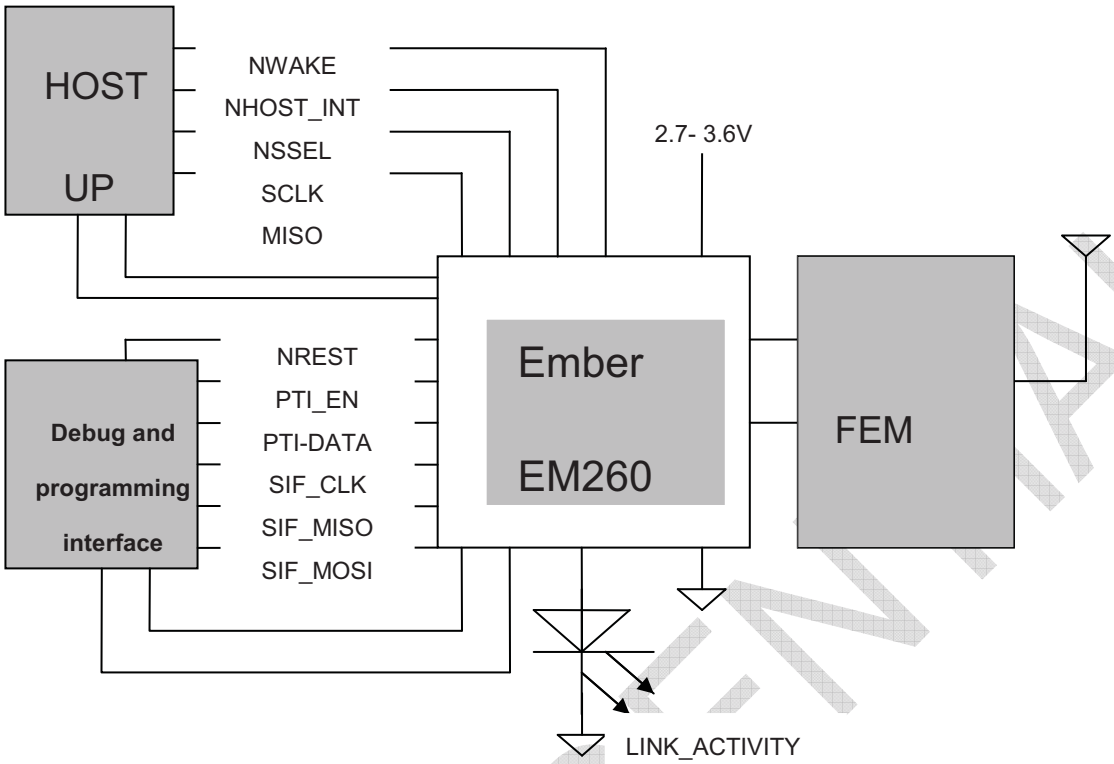
17. Typical application block



Example of application circuit

18. Mechanical Dimensions

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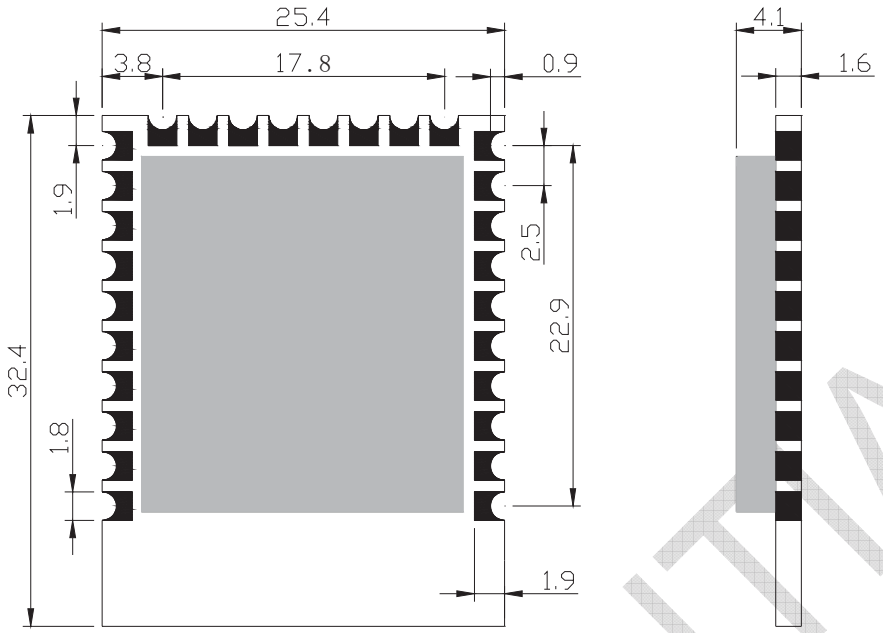
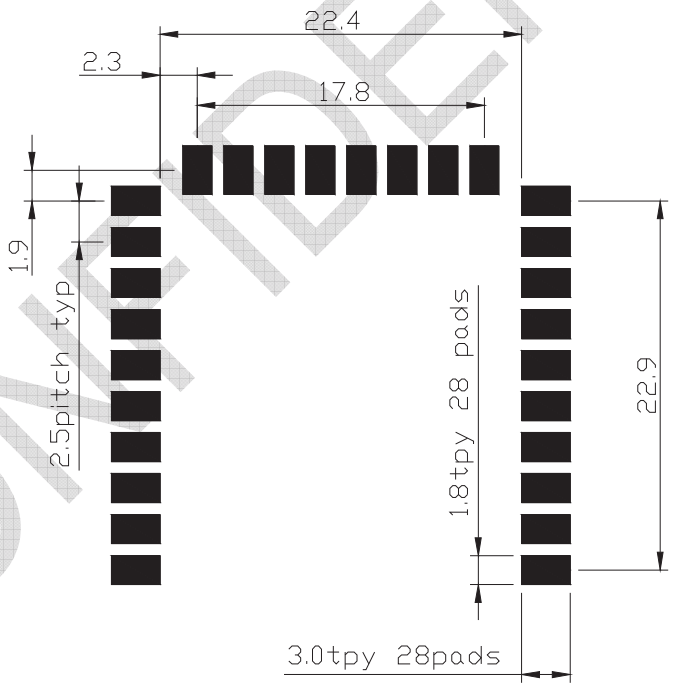


Unit in mm（Top View）



Recommended PCB layout(unit in mm)

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19. Ordering Information

Ordering Part Number	Description
CTL2607	ZigBee-ready RF module, 1kB Flash, PCB trace antenna, 20dBm Version FCC/CE certificate

20. Moisture Sensitivity Level (MSL)

MSL 3, per J-STD-033

21. Document Revision History

Document Revision	change
1.0	**Draft**
1.1	Add MSL

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About Computime

Founded in 1974, **Computime** is a global technology, brand and manufacturing company providing innovative automation and control solutions to customers in commercial, industrial and consumer markets.
The Company provides technologies and products that save energy and make people's lives more productive and comfortable.

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FCC Statement

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.

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

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. 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.

FCC Radiation Exposure Statement

The modular can be installed or integrated in mobile or fix devices only. This modular cannot be installed in any portable device, for example, USB dongle like transmitters is forbidden.

This modular complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. This modular must be installed and operated with a minimum distance of 20 cm between the radiator and user body.

If the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: “Contains Transmitter Module FCC ID: 2AAUQ-CTL2607 Or Contains FCC ID: 2AAUQ-CTL2607 ”

when the module is installed inside another device, the user manual of this device must contain below warning statements;

1. 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.

(2) This device must accept any interference received, including interference that may cause undesired operation.

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

The devices must be installed and used in strict accordance with the manufacturer's instructions as described in the user documentation that comes with the product

IC STATEMENT

This device complies with Industry Canada’s licence-exempt RSSs. 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.

Cet appareil est conforme aux CNR exemptes de licence d'Industrie Canada . Son fonctionnement est soumis aux deux conditions suivantes :

(1) Ce dispositif ne peut causer d'interférences ; et

(2) Ce dispositif doit accepter toute interférence , y compris les interférences qui peuvent causer un mauvais fonctionnement de l'appareil.

IC Radiation Exposure Statement

The modular can be installed or integrated in mobile or fix devices only. This modular cannot be installed in any portable device, for example, USB dongle like transmitters is forbidden.

This modular complies with IC RF radiation exposure limits set forth for an uncontrolled environment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. This modular must be installed and operated with a minimum distance of 20 cm between the radiator and user body. Cette modulaire doit être installé et utilisé à une distance minimum de 20 cm entre le radiateur et le corps de l'utilisateur.

If the IC number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following:

“Contains IC:1700D-CTL2607 ”

when the module is installed inside another device, the user manual of this device must contain below warning statements;

1. This device complies with Industry Canada’s licence-exempt RSSs. 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.

2. Cet appareil est conforme aux CNR exemptes de licence d'Industrie Canada . Son fonctionnement est soumis aux deux conditions suivantes :

(1) Ce dispositif ne peut causer d'interférences ; et

(2) Ce dispositif doit accepter toute interférence , y compris les interférences qui peuvent causer un mauvais fonctionnement de l'appareil.

The devices must be installed and used in strict accordance with the manufacturer's instructions as described in the user documentation that comes with the product