CLARUS

ZigBee Module Unit Part (ZMP)

CRC2602

OEM/Integrator

Installation Instructions

Version 1.2 (Dec. 2011)

Contents

1. General specification

The ***CRC2602*** RF Transceiver Modem is a compact surfacemounted 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 16channels in the 2.45 GHz world-wide license-free ISM band.

The complete shielded module is only 14.5mm x 17.0mm x 2.5 mm.

256 kB flash memory, 21 digital and analog I/Os, an 8 channel 12 bit ADC, timers, UART and SPI interfaces make it possible to embed the complete application in this tiny modem. 32k, 64k, 128k flash memory options will be available.

1.1 Applications

- **2.4-GHz IEEE 802.15.4 Systems**
- **RF4CE Remote Control Systems**
- **ZigBee Systems**
- **Home/Building Automation**
- **Lighting Systems**
- **Industrial Control and Monitoring**
- **Low-Power Wireless Sensor Networks**
- **Consumer Electronics**
- **Health Care**

1.2 Features

- **2.4-GHz IEEE 802.15.4 Compliant RFTransceiver**
- **Excellent Receiver Sensitivity and Robustness to Interference**
- **Programmable Output Power Up to 4.5 dBm**
- **Suitable for Systems Targeting Compliance With Worldwide Radio-Frequency Regulations: ETSI EN 300 328 and EN 300 440 (Europe), FCC CFR47 Part 15 (US) and ARIB STD-T-66 (Japan)**
- **14.5 x 17.0 x 2.5 mm, compact shielded modem for SMD mounting**
- **High-Performance and Low-Power 8051 Microcontroller Core With Code Prefetch**
- **IR Generation Circuitry**
- **CSMA/CA Hardware Support**
- **Accurate Digital RSSI/LQI Support**
- **256 kB flash memory, 8 kB SRAM**
- **17 digital and analog I/Os, 8 channel 12 bit ADC**
- **High performance direct sequence spread spectrum (DSSS) RF transceiver**
- **16 channels in the 2.45 GHz ISM band**
- **Industrial operating temperature range –30 to 85°C**

- ▣ Two Powerful USARTs With Support for Several Serial Protocols
- ▣ Watchdog Timer
- ▣ Operating voltage 2.7 ~ 3.6V
- ▣ Compact size
  - Size 14.5±0.3mm x 17.0±0.3mm
  - Height 2.5±0.3mm
  - Weight 1.2±0.5grams
- ▣ RoHS compliant

1.3 Block diagram

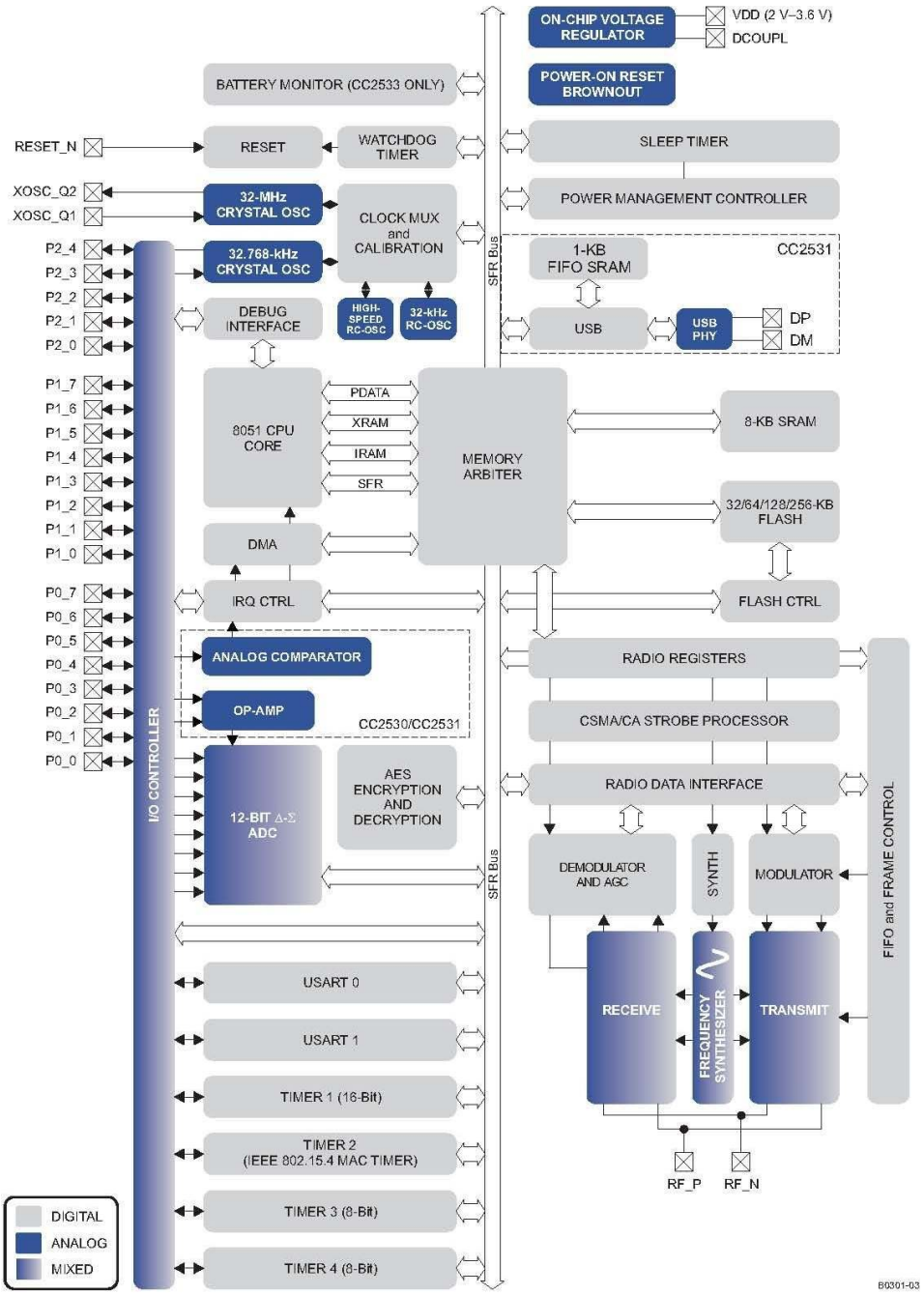


Figure 1-1. CC253x Block Diagram

Circuit description

The modem contains an IEEE 802.15.4 compliant SoC RF transceiver, external Reset, high speed oscillator and an RTC 32 kHz oscillator. The modem is intended for running the ZigBee network protocol.

The application software together with the ZigBee protocol software stack can be programmed in Flash memory through a proprietary serial debugging interface. The easiest way to do this is by using an evaluation board from TI and an IAR Embedded workbench.

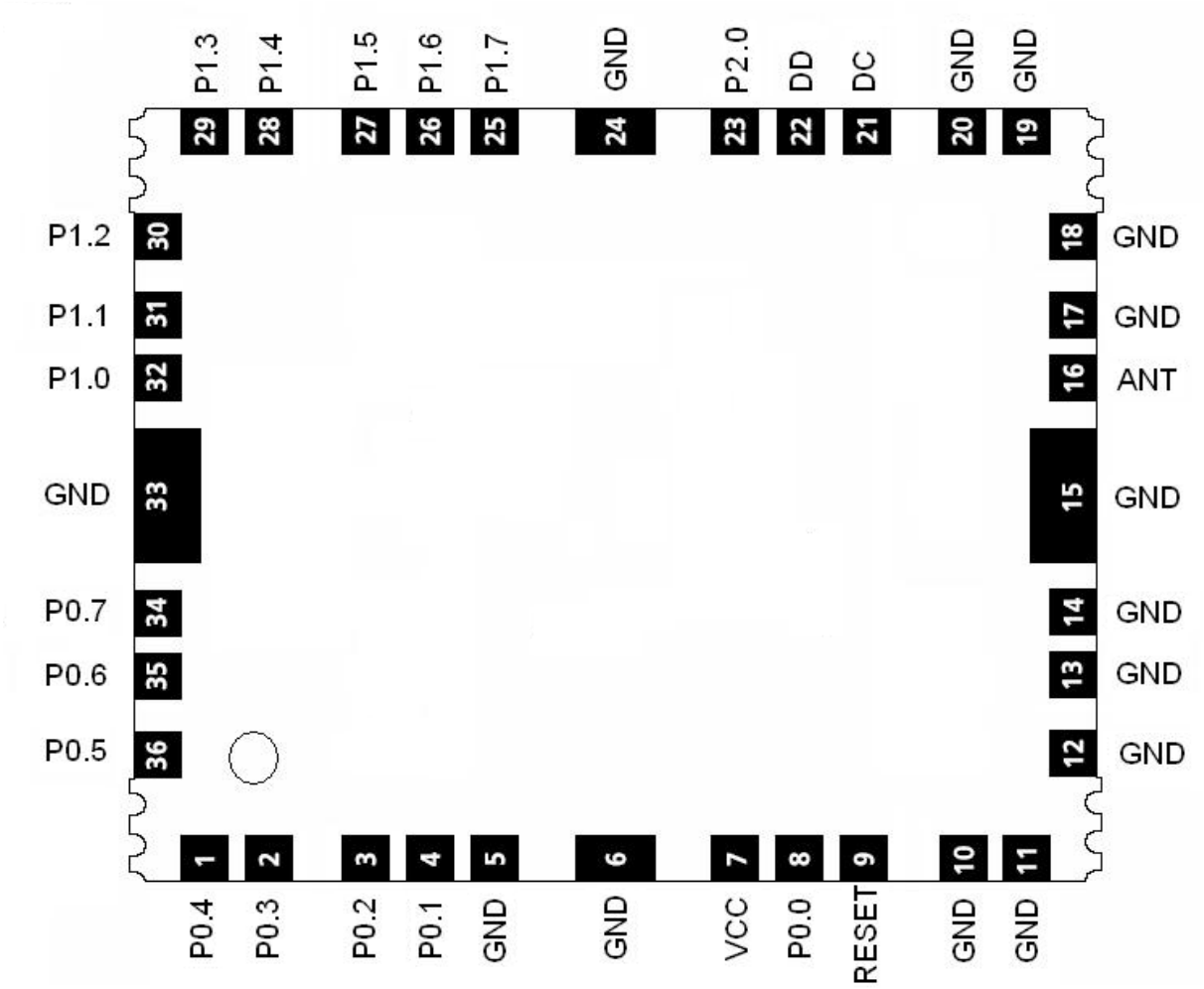
The module includes two USART that are configurable as either SPI or UART. Totally 21 I/O

pins are available to the user. 8 pins can be used for the internal 8-12 bit A/D converter. All of the pins have interrupt features.

The MCU provides several low power modes with can be utilized to reduce the current consumption in battery operated applications. An internal 32 kHz crystal oscillator can be used for real-time clock and timer applications.

For further details on the SoC transceiver (TI, CC2530), please consult the respective data sheet.

1.4 Pin assignment



Pin	Name	I/O	Description
1	P0.4	I/O	Digital I/O, P0.4
2	P0.3	I/O	Digital I/O, P0.3
3	P0.2	I/O	Digital I/O, P0.2
4	P0.1	I/O	Digital I/O, P0.1
5	GND	-	System ground
6	GND	-	System ground
7	VCC	-	Supply voltage input.(2.7 ~ 3.6V, typically 3.3V)
8	P0.0	I/O	Digital I/O, P0.0
9	RESET	-	Reset output with internal pullup
10	GND	-	System ground
11	GND	-	System ground
12	GND		System ground
13	GND	-	System ground
14	GND	-	System ground
15	GND	-	System ground
16	ANT	I/O	RF I/O connection to antenna, 50 Ohm
17	GND	-	System ground
18	GND	-	System ground

19	GND	-	System ground
20	GND	-	System ground
21	DC	I/O	Debug Clock, P2.2
22	DD	I/O	Debug Data, P2.1
23	P2.0	I/O	Digital I/O, P2.0
24	GND	-	System ground
25	P1.7	I/O	Digital I/O, P1.7
26	P1.6	I/O	Digital I/O, P1.6
27	P1.5	I/O	Digital I/O, P1.5
28	P1.4	I/O	Digital I/O, P1.4
29	P1.3	I/O	Digital I/O, P1.3
30	P1.2	I/O	Digital I/O, P1.2
31	P1.1	I/O	Digital I/O, P1.1, 20 mA sink/source capability
32	P1.0	I/O	Digital I/O, P1.0, 20 mA sink/source capability
33	GND	-	System ground
34	P0.7	I/O	Digital I/O, P0.7
35	P0.6	I/O	Digital I/O, P0.6
36	P0.5	I/O	Digital I/O, P0.5

1.5 I/O resources

Periphery /function	P0								P1								P2				
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**	**4**	**3**	**2**	**1**	**0**
ADC	A7	A6	A5	A4	A3	A2	A1	A0													T
Operational Amplifier						O	–	+													
Analog Comparator			+	–																	
USART 0 SPI			C	SS	MO	MI															
Alt. 2											MO	MI	C	SS							
USART 0 UART			RT	CT	TX	RX															
Alt. 2											TX	RX	RT	CT							
USART 1 SPI			MI	MO	C	SS															
Alt. 2											MI	MO	C	SS							
USART 1 UART			RX	TX	RT	CT															
Alt. 2									RX	TX	RT	CT									
TIMER 1		4	3	2	1	0															
Alt. 2	3	4												0	1	2					
TIMER 3												1	0								
Alt. 2									1	0											
TIMER 4															1	0					
Alt. 2																		1			0
32-kHz XOSC																	Q1	Q2			
DEBUG																			DC	DD	
OBSSEL											5	4	3	2	1	0					

2. ZigBee interface

2.1. The ZigBee protocol

The ZigBee Alliance is an association of companies working together to enable reliable, costeffective,
low-power, wirelessly networked, monitoring and control products based on an open global standard. The ZigBee Alliance is a rapidly growing, non-profit industry consortium of leading semiconductor manufacturers, technology providers, OEMs and end-users worldwide. Membership is open to all. The ZigBee Alliance, in collaboration with the IEEE, is defining the network, security, and application layers above the IEEE 802.15.4 PHY and MAC layers. This cooperation has resulted in an easy-to-use, standards-based wireless network platform optimized for wireless monitoring and control applications. For more information about the ZigBee Alliance and the ZigBee standard, please consult www.zigbee.org
The module is intended for using the ZigBee protocol. However, other proprietary network protocols can also be implemented using the module.
The ZigBee stack implementation from TI/Chipcon/Figure 8 Wireless is recommended as it provides seamless integration with the module. However, third party stack implementations can also be used provided they support the TI/Chipcon MAC firmware.

2.2. Debugging interface

The modem has a two-wire proprietary debug interface. This interface can also be used for incircuit programming of the device.
For debugging the device programmer sends command <DEBUGGING_INSTR> to the icrocontroller. The instructions succeeding the debugging commando are executed by the CPU without updating the program counter.
For in circuit programming the same debugging command is used, only the instruction preformed is flash programming with through the flash controller.
Supply and ground must also be connected during programming or debugging.

Pin	Description
21	P2.2, Debug Clock
22	P2.1, Debug Data

Pin 21 and 22 can be used as normal digital I/O pins when the module is not in debugging mode.

2.3. Power management

The ZigBee protocol allows End Devices to be powered down, while Routers must be powered all the time in order to handle packet routing. Battery operated devices should be End Devices in order to reduce the power consumption to a minimum.

The modem can be set in several sleep modes using the features of the MCU and turning off the RF transceiver. Sleep modes enable the application to shut down unused segments in the MCU, thereby saving power. The MCU provides various sleep modes allowing the user to tailor the power consumption to the application's requirements.

To enter any of the 3 sleep modes (power modes 1-3) available in the modem, the appropriate registers in CC2530 must be set. See datasheet for CC2530 for details.

The different power modes available are:

Power mode 1 – Digital regulator on; 16-MHz RCOSC and 32-MHz crystal oscillator off; 32.768-kHz XOSC, POR, BOD and sleep timer active; RAM and register retention.

Power mode 2 – Digital regulator off; 16-MHz RCOSC and 32-MHz crystal oscillator off; 1 2 µA 32.768-kHz XOSC, POR, and sleep timer active; RAM and register retention.

Power mode 3 – Digital regulator off; no clocks; POR active; RAM and register retention.

2.4. 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	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

For proprietary solutions (non-IEEE 802.15.4), the RF transceiver can be programmed in steps of 1 MHz.

The output power level can be configured from the firmware in the range about -22 to 4.5 dBm.

The RF transceiver uses direct sequence spread spectrum (DSSS) with 2 Mchip/s chip rate, giving a raw data rate of 250Kbit/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 modem 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 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.

2.5. Antenna and range considerations

This modem is a very compact solution containing all the critical RF parts within the modem. However, a somewhat better range can be achieved using an external antenna.
Range testing using the external antenna shows these typical distances:

- Compact size with a ceramic antenna working as a quarter-wave resonant antenna
- Good performance with ¼ wave monopole antenna on ground plane
- High performance with with 5/8 wave dipole antenna

Due to the dielectric ceramic material the antenna is shorter than a normal quarter wave antenna (in air), still providing high radiation efficiency (typical 1 dBi). The antenna is matched for use in the 2.45 GHz band. The radiating part of the antenna is the white ceramic component located outside the shield can. The radiation pattern from the antenna is similar to the donut-shaped radiation from a quarter wave antenna. That is, the maximum radiation is in the plane normal to the length axis of the antenna. For best possible omni-directional radiation the module should be oriented so that the antenna is vertical. To achieve the very best range the transmitting and receiving antenna should be oriented the same way, ensuring the same polarity at both devices. However, indoors reflections of the radio waves in metallic structures tend to spread the polarisation, so even if same orientation is not possible, communication will still take place, but the range is somewhat shorter, typically by 20%.
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.

On a two layer board made of FR4 the width of a microstrip transmission line should be 1.8 times the thickness of the board, assuming a dielectric constant of 4.8. The line should be run at the top of the board, and the bottom side should be a ground plane.

Example: For a 1.6 mm thick FR4 board, the width of the trace on the top side should be 1.8 x 1.6 mm = 2.88 mm.

The simplest antenna to use is the quarter wave whip antenna. A quarter wave whip antenna above a ground plane yields 37 Ohm impedance and a matching circuit for 50 Ohm are usually not required.

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 counterweight 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 a wavelength, the antenna should be matched to 50 ohms using a series inductor and a shunt capacitor.

2.6. Antenna Specifications

- Chip Antenna
- Gain: 3.5 dBi
- Model Number: ALA931C5
- Manufacture: AMOTECH

	Peak Gain (dBi)	Avg. Gain (dBi)	Total Avg. Gain (dBi)	Efficiency (%)
Azimuth	2.8	1.0	-0.22	95
Elevation 1	3.5	-0.7		
Elevation 2	1.7	-1.6		

3. Electrical specification

3.1 Absolute maximum ratings

Parameter	Min	Max	Units
Supply voltage, VCC	- 0.3	3.9	V
Voltage on any digital pin	- 0.3	VCC+0.3 V	V
RF output Power		4.5	dBm
Storage temperature	-40	125	℃
Operating temperature	- 40	125	℃

Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

3.2 Electrical Specifications

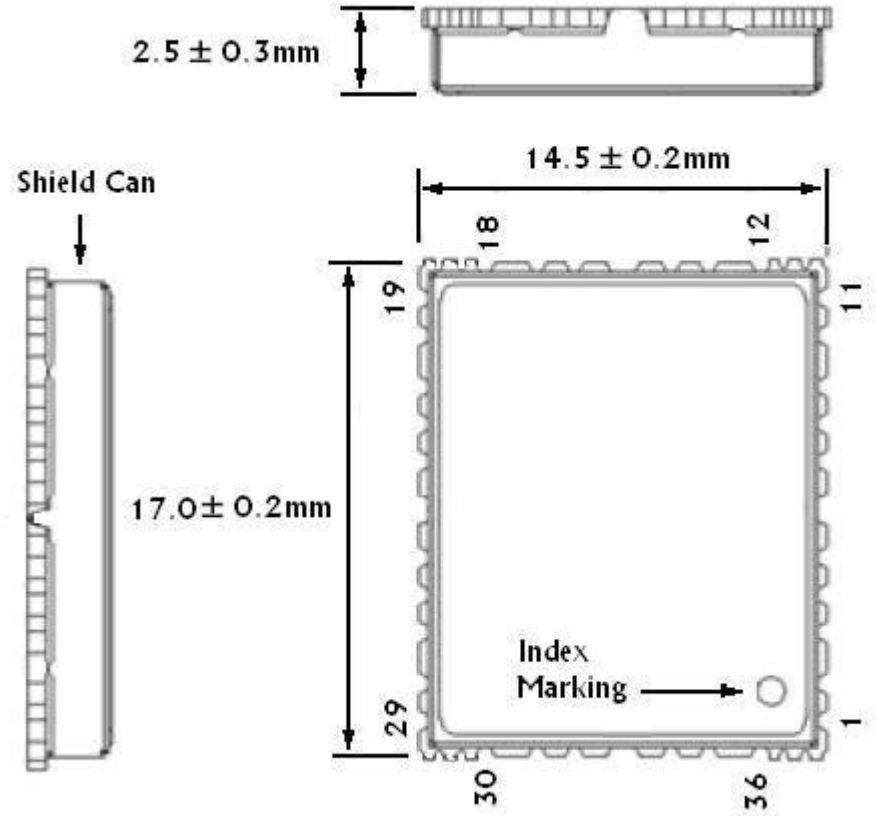
Parameter	Min	Typ	Max	Units	Notes
Operating frequency	2394		2507	MHz	Programmable in 1-MHz steps, 5 MHz between channels for compliance with [1]
Number of channels		16			For IEEE 802.15.4 compliance
Channel spacing		5		MHz	For IEEE 802.15.4 compliance
Input/output impedance		50		Ohm	
Data rate		250		kbit/s	
DSSS chip rate		2		Mc/s	
Frequency stability	-40		40	ppm	
Transmit power	-22	4.5		dBm	Programmable from firmware
Spurious emission, TX Max recommended output power setting 25 MHz–1000 MHz (outside restricted bands) 25 MHz–2400 MHz (within FCC restricted bands) 25 MHz–1000 MHz (within ETSI restricted bands) 1800–1900 MHz (ETSI restricted band) 5150–5300 MHz (ETSI restricted band) At 2 × f_c and 3 × f_c (FCC restricted band) At 2 × f_c and 3 × f_c (ETSI EN 300-440 and EN 300-328) 1 GHz–12.75 GHz (outside restricted bands) At 2483.5 MHz and above (FCC restricted band) f_c= 2480 MHz		 -60 -60 -60 -57 -55 -42 -31 -53 -42		dBm	Complies with EN 300 328, EN 300 440, FCC CRF47 Part 15 and ARIB STD-T66
Error Vector Magnitude		2		%	
Sensitivity		-97		dBm	PER = 1%, as specified by [1] [1] requires –85 dBm
Adjacent channel rejection +/- 5 MHz		49/49		dB	Wanted signal –82 dBm, adjacent modulated channel at 5 MHz, PER = 1 %, as specified by [1]. [1] requires 0 dB.
Alternate channel selectivity +/- 10 MHz		57/57		dB	Wanted signal –82 dBm, adjacent modulated channel at 10 MHz, PER = 1%, as specified by [1]. [1] requires 30 dB
Blocking / Interferer rejection / desensitization +/- 5 MHz +/- 10 MHz +/- 20 MHz +/- 50 MHz		 -33/-35 -33/-35 -32/-34 -31/-34		dBm	Wanted signal 3 dB above the sensitivity level, CW jammer, PER = 1%. Measured according to EN 300 440 class 2.

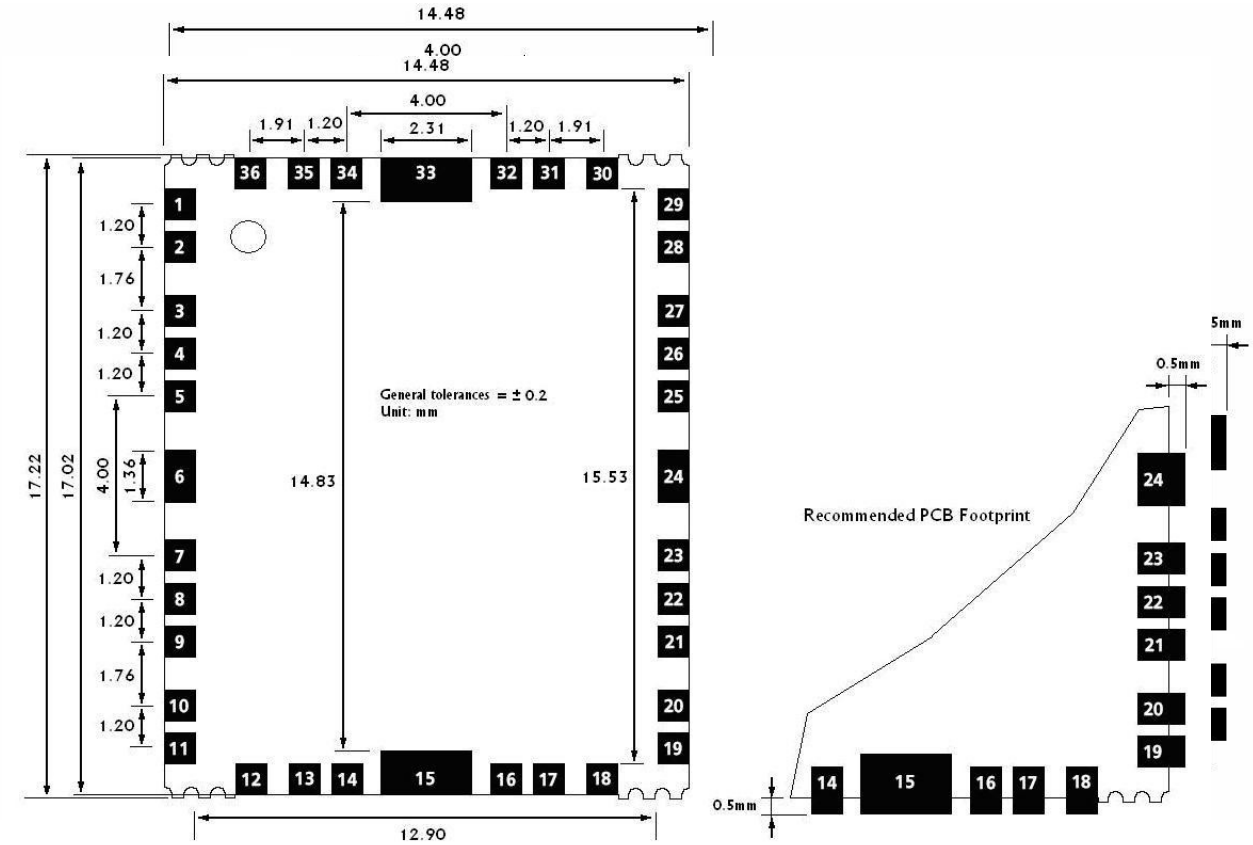
Parameter		Min	Typ	Max	Units	Notes
Saturation			10		dBm	
Spurious emission, RX 30 – 1000 MHz 1-12.75 GHz				 -80 -57	dBm	Conducted measurement with a 50-Ω single-ended load. Suitable for systems targeting compliance with EN 300 328, EN 300 440, FCC CFR47 Part 15 and ARIB STD-T-66.
Supply voltage		2.7	3.3	3.6	V	
Core current consumption			3.4		mA	Digital regulator on. 16-MHz RCOSC running. No radio, crystals, or peripherals active. Medium CPU activity: normal flash access(1), no RAM access
			6.5	8.9	mA	32-MHz XOSC running. No radio or peripherals active. Medium CPU activity: normal flash access(1), no RAM access
	32-MHz XOSC running, radio in RX mode		20.5		mA	–50-dBm input power, no peripherals active, CPU idle
			24.3	29.6	mA	-100-dBm input power (waiting for signal), no peripherals active, CPU idle
	32-MHz XOSC running, radio in TX mode		28.7		mA	1-dBm output power, no peripherals active, CPU idle
			33.5	39.6	mA	4.5-dBm output power, no peripherals active, CPU idle
	Power mode 1.		0.2	0.3	mA	Digital regulator on; 16-MHz RCOSC and 32-MHz crystal oscillator off; 32.768-kHz XOSC, POR, BOD and sleep timer active; RAM and register retention
	Power mode 2.		1	2	µA	Digital regulator off; 16-MHz RCOSC and 32-MHz crystal oscillator off; 32.768-kHz XOSC, POR, and sleep timer active; RAM and register retention
	Power mode 3.		0.4	1	µA	Digital regulator off; no clocks; POR active; RAM and register retention
Flash memory			32		kB	
RAM memory			8		kB	
MCU clock frequency			32		MHz	
MCU low frequency crystal			32.768		kHz	

3.3 Environmental specification

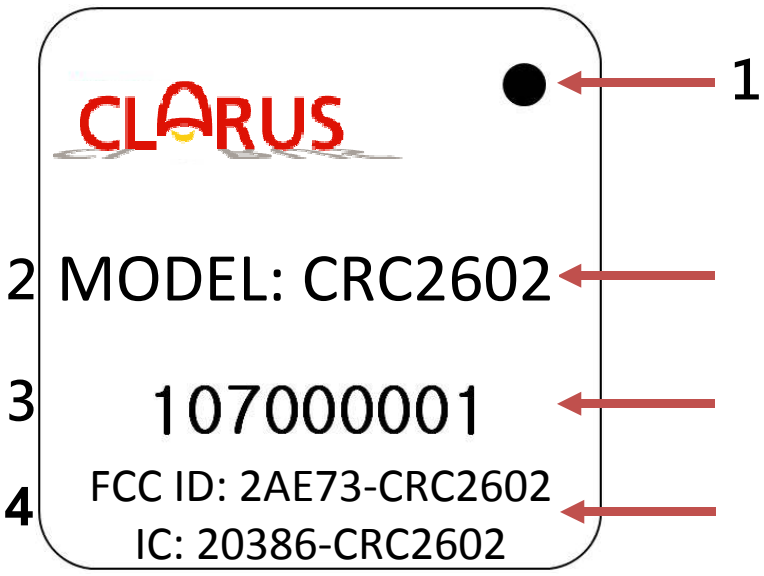
Test	Standard
Visual inspection	-
Thermal shock	KS C 0225 and IEC 68-2-14
Function at various temperature	KS C 0220/0221 and IEC 68-2-1/2
Damp heat	KS C 0225 and IEC 68-2-30
Vibration	KS C 0240 and IEC 68-2-6
Metallographic investigations	IPC-QE-650

4. Demensions (unit = mm)





5. Module label information (Option)



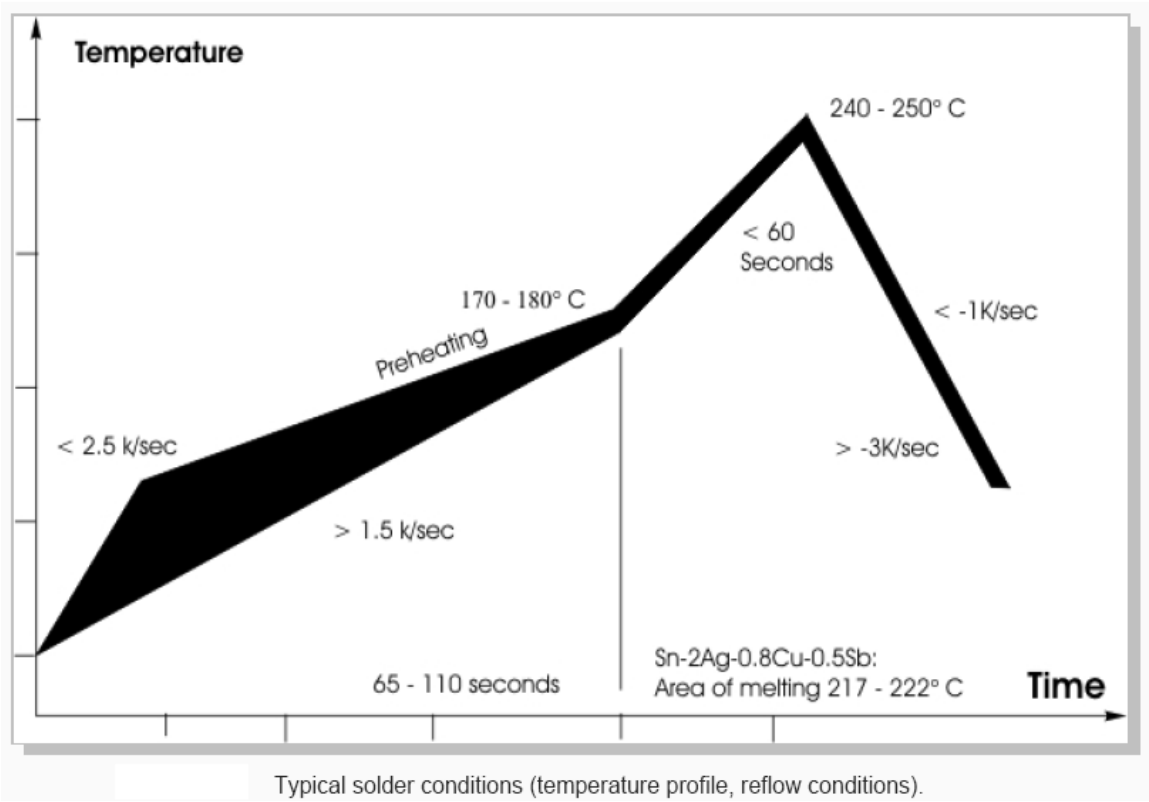
No.	Index
1	Pin number index
2	Manufacturer's model name
3	Manufactured year,serial number
4	FCC ID, IC Certification

6. Recommended soldering reflow profile

Consider for a long time in the soldering zone (with temperature higher than 180 °C) has to

be kept as short as possible to prevent component and substrate damages. Peak temperature

must not exceed 250 °C. (according to IPC/JEDEC J-STD-020C)

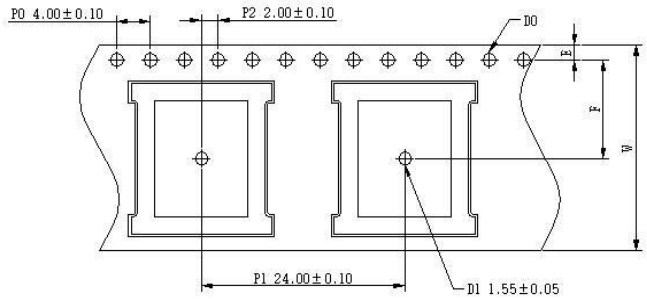


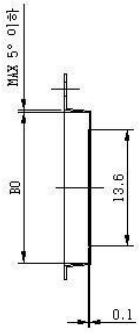
Typical solder conditions (temperature profile, reflow conditions).

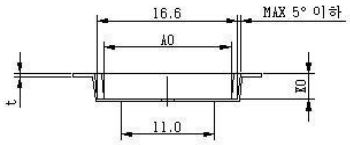
7. Mechanical specification

7.1 Carrier dimension

NO. C24B000

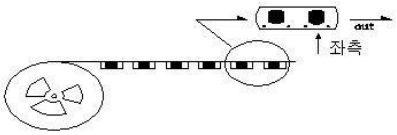






PACKING QUANTITY
1,000 PCS / REEL

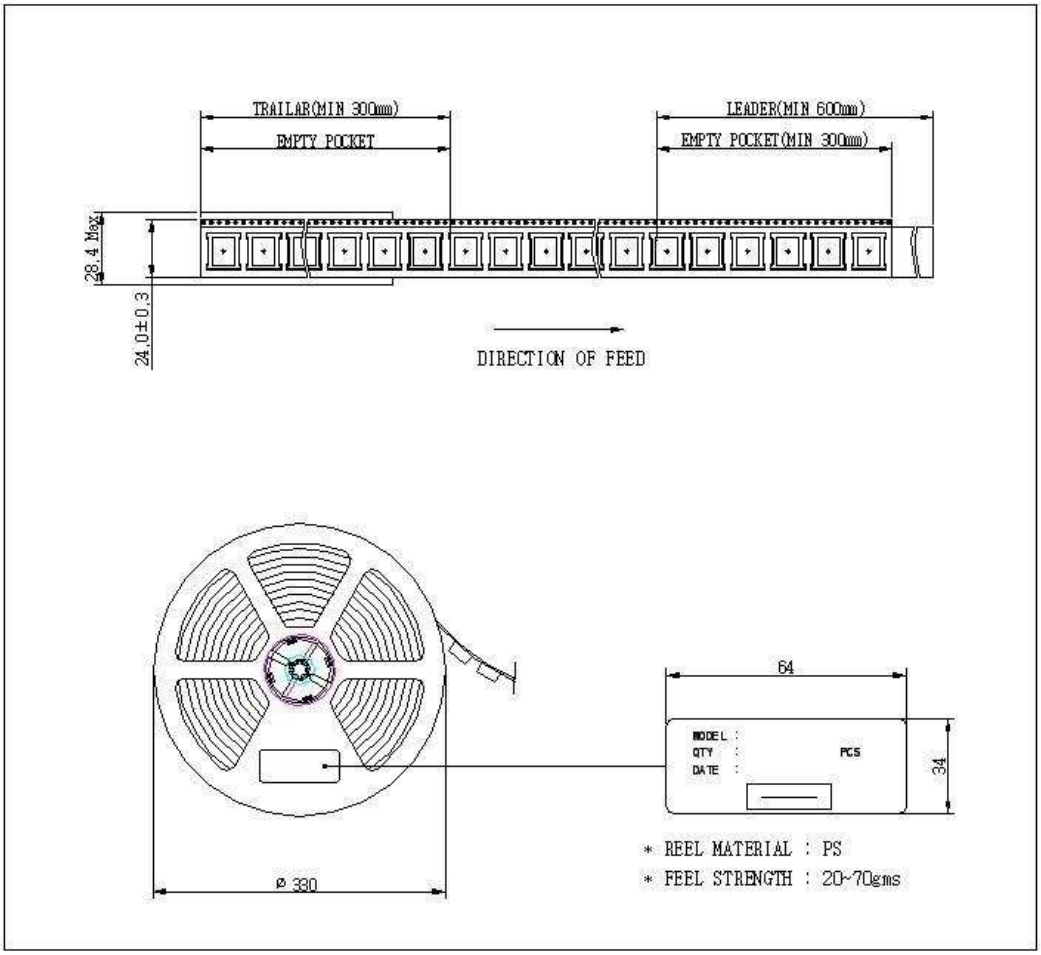
TAPING STYLE



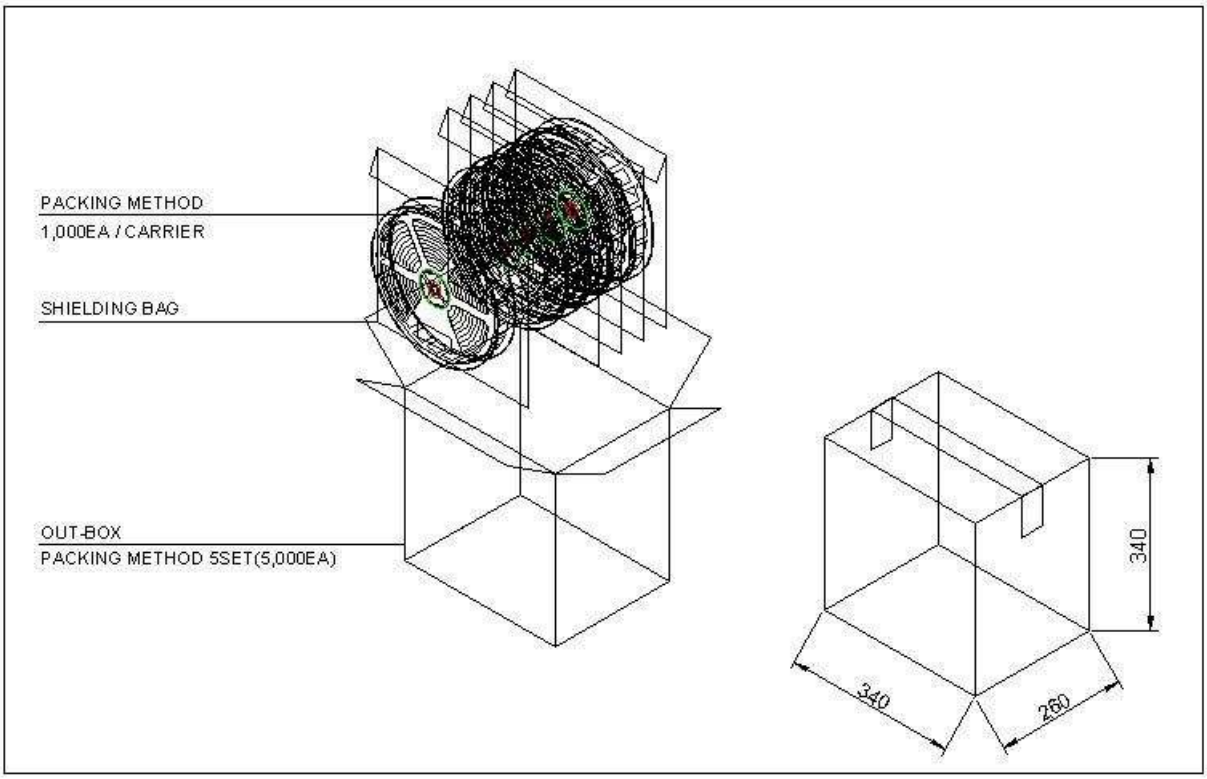
A0	15.00±0.10	E	1.75±0.10
B0	17.60±0.10	F	11.50±0.10
K0	2.70±0.10	t	0.30±0.05
D0	1.55±0.05	w	24.00±0.30

Scale	N/S	Unit	m/m	Customer & Title
Date	2007 . . .			
Designed by	Checked by	Approved by		

7.2 Taping package/reel dimension



7.3 Packing box dimension



FCC Statement

FCC Part 15.19

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.

FCC Part 15.21

Any changes or modifications (including the antennas) to this device that are not expressly approved by the manufacturer may void the user's authority to operate the equipment.

FCC RF Radiation Exposure Statement

This equipment complies with FCC RF Radiation exposure limits set forth for an uncontrolled environment. This device and its antenna must not be co-located or operating in conjunction with any other antenna or transmitter.

This equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body.

FCC Compliance Requirements with KDB996369

Information for OEM integrator

i. “Module is limited to OEM installation ONLY “

ii. “OEM integrators is responsible for ensuring that the end-user has no manual instructions to remove or install module”

iii. “FCC RF Exposure requirements: Module is limited to installation in mobile or fixed applications, according to Part 2.1091(b). Separate FCC approval is required for all other operating configurations, including portable configurations with respect to Part 2.1093 and different antenna configurations.”

iv. “If (1) the module’s FCC ID is not visible when installed in the host, or (2) if the host is marketed so that end users do not have straightforward commonly used methods for access to remove the module so that the FCC ID of the module is visible; then an additional permanent label referring to the enclosed module: “Contains Transmitter Module FCC ID: 2AE73-CRC2602” or “Contains FCC ID: 2AE73-CRC2602” must be used. The host OEM user manual must also contain clear instructions on how end users can find and/or access the module and the FCC ID.”

v. “A host product is required to comply with all applicable FCC equipment authorizations regulations, requirements and equipment functions not associated with the transmitter module portion. For example, compliance must be demonstrated to regulations for other transmitter components within the host product; to requirements for unintentional radiators (Part 15B), such as digital devices, computer peripherals, radio receivers, etc.; and to additional authorization requirements for the non-transmitter functions on the transmitter module (i.e., Verification, or Declaration of Conformity) (e.g., Bluetooth and WiFi transmitter modules may also contain digital logic functions) as appropriate.

vi. To ensure compliance with all non-transmitter functions the host manufacturer is responsible for ensuring compliance with the module(s) installed and is fully operational. For example, if a host was previously authorized as an unintentional radiator under the Declaration of Conformity procedure without a transmitter certified module and a module is added, the host manufacturer is responsible for ensuring that after the module is installed and operational the host continues to be compliant with the Part 15B unintentional radiator requirements. Since this may depend on the details of how the module is integrated with the host, the grantee (the party responsible for the module grant) shall provide guidance to the host manufacturer for compliance with the Part 15B requirements.”

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.

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.

RSS-Gen section 8.3
This radio transmitter (identify the device by certification number or model number if Category II) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Le présent émetteur radio (identifier le dispositif par son numéro de certification ou son numéro de modèle s'il fait partie du matériel de catégorie II) a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.