a module solution provider

ZB7

SimpleLink™ Multistandard Wireless MCU Module

TI CC26X0 series BLE & 802.15.4 Solution
With optional 4Mbits Serial SPI Flash Memory

Datasheet

Draft 0.2

Prepared By	Reviewed By	Approved By

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1. OVERVIEW

The certified ZB7 module from JORJIN is a wireless MCU module targeting Bluetooth Smart, ZigBee®, 6LoWPAN, and ZigBee® RF4CE remote control applications. This module is based on TI CC26X0 wireless MCU QFN-32 package chip.

The module is a cost-effective, ultralow power, 2.4-GHz RF devices. Very low active RF and MCU current and low-power mode current consumption provide excellent battery lifetime and allow for operation on small coin cell batteries and in energy-harvesting applications.

The ZB7 module offers six footprint-compatible, function variants by embedded software.

Test Grade Code	BLE	802.15.4 - Zigbee (6LoWPAN)	802.15.4 (RF4CE)	Addition 4Mbs SPI Flash
500-00	V	V	V	
500-04	V	V	V	V
410-00	V			
410-04	V			V
320-00		V		
320-04		V		V

1.1. General Features

- TI CC26X0, 24MHz & 32.768KHz crystals, DC2DC, 4M bits SPI serial flash memory (optional), and chip antenna on a single module.
- Built-in TI CC26X0 5x5mm RHB VQFN32 (15 GPIOs)
- LGA 25pins package.
- Dimension 16.9mm(L) x 11mm(W) x 2.45mm(H)
- Powerful ARM® Cortex®-M3 Microcontroller
- Ultra-Low Power Sensor Controller
- Efficient Code Size Architecture, Placing Drivers, Bluetooth® Low Energy Controller, IEEE 802.15.4 MAC, and Bootloader in ROM
- No external component required.
- Low Power and Wide Supply Voltage Range: 1.8 to 3.8V
    - Internal DC-DC converter built-in

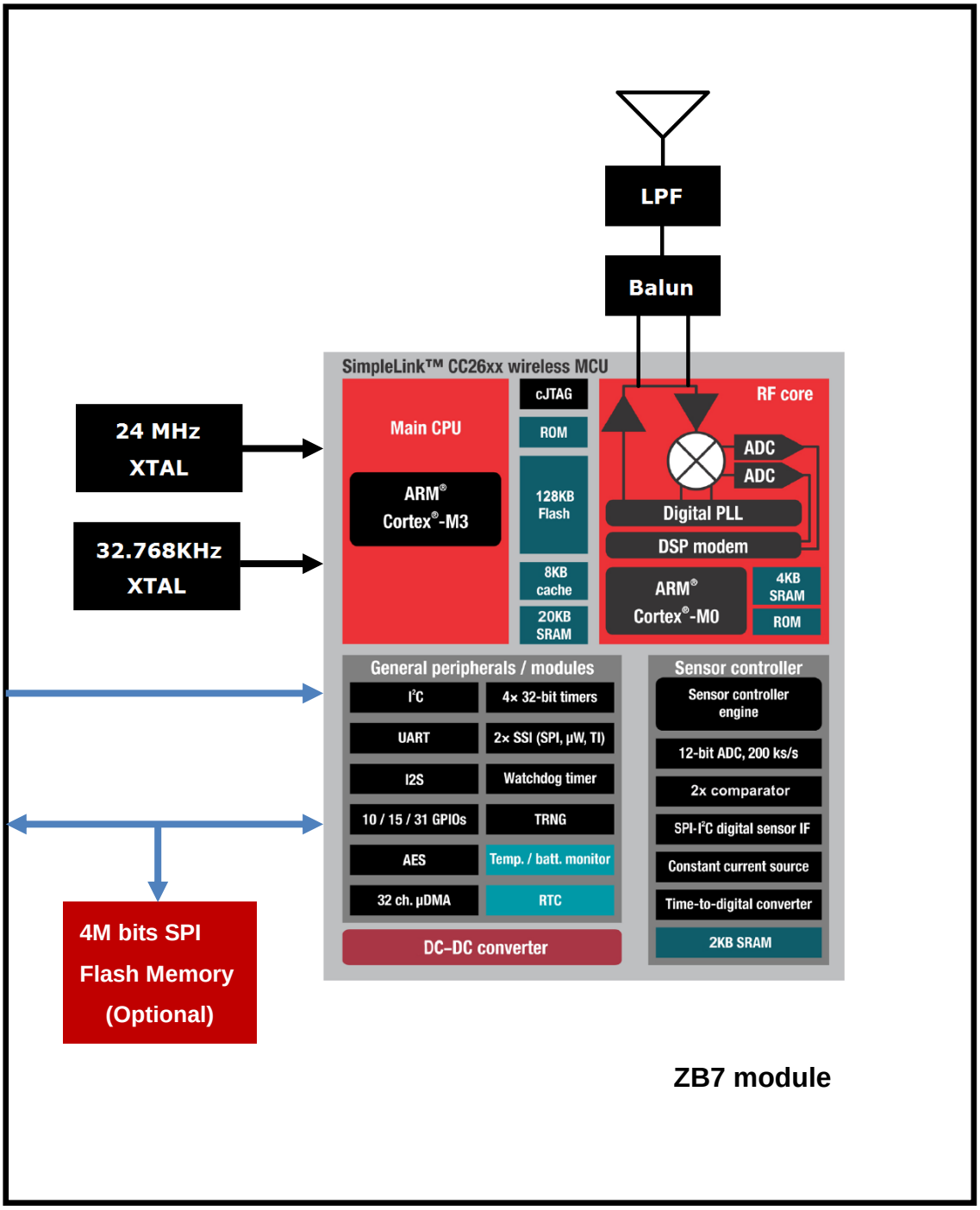
- 2.4-GHz RF Transceiver Compatible With Bluetooth Low Energy (BLE) 4.2 Specification and IEEE 802.15.4 PHY and MAC
  - Excellent Receiver Sensitivity (–96 dBm for BLE and –99 dBm for 802.15.4), Selectivity, and Blocking Performance
  - Programmable Output Power up to +5 dBm
  - Integrated Antenna
- Tools and Development Environment from TI
  - Full-Feature and Low-Cost Development Kits
  - Packet Sniffer PC Software
  - Sensor Controller Studio
  - SmartRF™ Studio
  - SmartRF Flash Programmer 2
  - IAR Embedded Workbench® for ARM
  - Code Composer Studio™

1.2. Applications

- Consumer Electronics
- Mobile Phone Accessories
- Sports and Fitness Equipment
- HID Applications
- Home and Building Automation
- Lighting Control
- Alarm and Security
- Electronic Shelf Labeling
- Proximity Tags
- Medical
- Remote Controls
- Wireless Sensor Networks

2. FUNCTIONAL FEATURES

2.1. Module Block Diagram



2.2. Block Functional Feature

Microcontroller

- Powerful ARM® Cortex®-M3
- EEMBC CoreMark® score: 142
- Up to 48-MHz Clock Speed
- 128KB of In-System Programmable Flash
- 8-KB SRAM for Cache
- 20-KB Ultra-Low Leakage SRAM
- 2-Pin cJTAG and JTAG Debugging
- Supports Over-The-Air Upgrade (OTA)

Ultra-Low Power Sensor Controller

- Can run autonomous from the rest of the system
- 16-Bit Architecture
- 2-KB Ultra-Low Leakage SRAM for Code and Data

Peripherals

- All Digital Peripheral Pins can be routed to any GPIO.
- 15 GPIOs
- 4 General-Purpose Timer Modules (8 × 16-Bit or 4 × 32-Bit Timer, PWM Each)
- 12-Bit ADC, 200-ksamples/s, 8-Channel Analog MUX
- Continuous Time Comparator
- Ultra-Low Power Analog Comparator
- Programmable Current Source
- UART
- 2x SSI (SPI, MICROWIRE, TI)
- I2C
- I2S
- Real-Time Clock (RTC)

- AES-128 Security Module
- True Random Number Generator (TRNG)
- Support for 8 Capacitive Sensing Buttons
- Integrated Temperature Sensor

RF Section

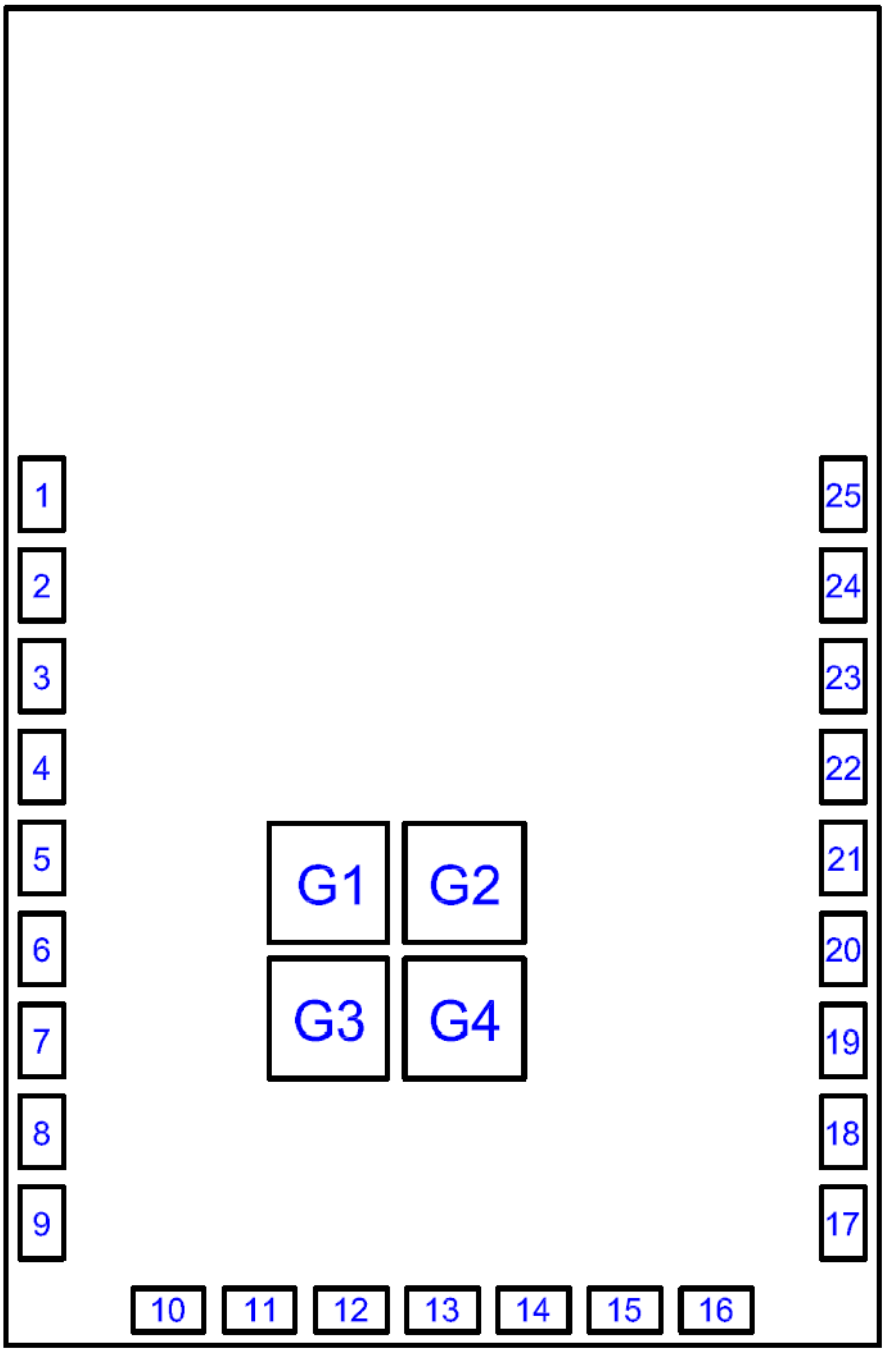
- 2.4 GHz RF Transceiver Compatible With *Bluetooth* Low Energy (BLE) 4.1 specification and IEEE 802.15.4 PHY and MAC
- Excellent Receiver Sensitivity (–96 dBm for BLE and –99 dBm for 802.15.4), Selectivity, and Blocking Performance
- Link budget of 101 dB/104 dB (BLE/802.15.4)
- Programmable Output Power up to +5 dBm
- Integrated Antenna
- Suitable for Systems Targeting Compliance With Worldwide Radio Frequency Regulations
  - ETSI EN 300 328 (Europe)
  - EN 300 440 Class 2 (Europe)
  - FCC CFR47 Part 15 (US)
  - ARIB STD-T66 (Japan)

4M bits SPI serial Flash (optional)

- AT25DF041B SPI serial Flash from Adesto technologies.
- 128-byte, One-Time Programmable (OTP) Security Register
  - 64 bytes factory programmed with a unique identifier
  - 64 bytes user programmable
- Flexible Programming
  - Byte/Page Program (1 to 256 Bytes)
  - Sequential Program Mode Capability

3. MODULE OUTLINE

3.1. Signal Layout (Top View)



3.2. Pin Description

Table 3-1. Pin Description

Pin No.	Pin Name	Type	Description
1	GND	GND	GND
2	NC	NC	No connection. For internal test only.
3	GND	GND	GND
4	DIO_0	Digital I/O	GPIO, Sensor Controller
5	DIO_1	Digital I/O	GPIO, Sensor Controller
6	DIO_2	Digital I/O	GPIO, Sensor Controller, High drive capability
7	DIO_3	Digital I/O	GPIO, Sensor Controller, High drive capability
8	DIO_4	Digital I/O	GPIO, Sensor Controller, High drive capability
9	JTAG_TMSC	Digital I/O	JTAG_TMSC, High drive capability
10	JTAG_TCKC	Digital I/O	JTAG_TCKC
11	DIO_5	Digital I/O	GPIO, High drive capability, JTAG_TDO
12	DIO_6	Digital I/O	GPIO, High drive capability, JTAG_TDI
13	RESET_N	Digital Input	Reset, active-low. No internal pullup. Built-in 0.1uF capacitor to GND.
14	DIO_7	Digital/Analog I/O	GPIO, Sensor Controller, Analog
15	DIO_8	Digital/Analog I/O	GPIO, Sensor Controller, Analog
16	DIO_9	Digital/Analog I/O	GPIO, Sensor Controller, Analog. In -04 module, DIO_9 pin is connected to CS# pin of internal serial SPI Flash.
17	DIO_10	Digital/Analog I/O	GPIO, Sensor Controller, Analog. In -04 module, DIO_10 pin is connected to SCLK pin of internal serial SPI Flash.
18	DIO_11	Digital/Analog I/O	GPIO, Sensor Controller, Analog. In -04 module, DIO_11 pin is connected to SI pin of internal serial SPI Flash.
19	DIO_12	Digital/Analog I/O	GPIO, Sensor Controller, Analog. In -04 module, DIO_12 pin is connected to SO pin of internal Serial SPI Flash.
20	DIO_13	Digital/Analog I/O	GPIO, Sensor Controller, Analog

21	DIO_14	Digital/Analog I/O	GPIO, Sensor Controller, Analog
22	VDDS (1)	Power	1.8 V to 3.8 V main chip and DC/DC supply
23	VDDS2 (1)	Power	1.8 V to 3.8 V GPIO supply
24	NC	NC	No connection.
25	GND	GND	Ground
G1~G4	GND	GND	Ground

(1) The power range is 1.8V to 3.6V for -04 module.

4. MODULE SPECIFICATIONS

4.1. Absolute Maximum Ratings(1)(2)

over operating free-air temperature range (unless otherwise noted)

Parameter	Conditions	MIN	MAX	Unit
Supply voltage, VDDS(3)		-0.3	4.1	V
Voltage on any digital pin(4)		-0.3	VDDS+0.3 Max 4.1	V
Voltage on ADC input (V_{in})	Voltage scaling enabled	-0.3	VDDS	V
	Internal reference, voltage scaling disabled	-0.3	1.49	V
	VDDS as reference, voltage scaling disabled	-0.3	VDDS/2.9	V
Input RF level			+5	dBm
Storage temperature range		-40	+85	°C

(1) All voltage values are with respect to VDDS, unless otherwise noted.

(2) 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) VDDS2 must be at the same potential as VDDS.

(4) Including analog capable DIO.

4.2. ESD Ratings

Parameter			Value	Unit
Electrostatic discharge performance (V_{ESD})	Human Body Model (HBM), per ANSI/ESDA/JEDEC JS001(1)	All pins	±2500	V
	Charged Device Model (CDM), per JESD22-C101(2)	RF pins	±750	V
		Non-RF pins	±750	V

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

4.3. Recommended Operating Conditions

Parameter	Conditions	MIN	MAX	Unit
Ambient temperature range		-40	85	°C
Operating supply voltage (VDDS) For -00 module	For operation in battery-powered and 3.3 V systems	1.8	3.8	V
Operating supply voltage (VDDS) For -04 module	For operation in battery-powered and 3.3 V systems	1.8	3.6	V

4.4. Electrical Characteristics

Tc = 25°C, VDDS = 3.0 V with internal DC-DC converter, unless otherwise noted.

	Parameter	Test Conditions	Min	Typ	Max	Units
I_{core}	Core current consumption	Reset. RESET_N pin asserted or VDDS below Power-on-Reset threshold		100		nA
		Shutdown. No clocks running, no retention		150		nA
		Standby. With RTC, CPU, RAM and (partial) register retention. RCOSC_LF		1		µA
		Standby. With RTC, CPU, RAM and (partial) register retention. XOSC_LF		1.2		µA
		Standby. With Cache, RTC, CPU, RAM and (partial) register retention. RCOSC_LF		2.5		µA
		Standby. With Cache, RTC, CPU, RAM and (partial) register retention. XOSC_LF		2.7		µA
		Idle. Supply Systems and RAM powered.		550		µA
		Active. Core running CoreMark		1.45mA + 31uA/MHz		
		Radio RX		6.1		mA
		Radio TX, 5 dBm output power		9.1		mA
I_{peri}	Peripheral Current Consumption (Adds to core current I_{core} for each peripheral unit activated)(1)					
	Peripheral power domain	Delta current with domain enabled		20		µA
	Serial power domain	Delta current with domain enabled		13		µA
	RF Core	Delta current with power domain enabled, clock enabled, RF Core Idle		237		µA
	µDMA	Delta current with clock enabled, module idle		130		µA
	Timers	Delta current with clock enabled, module idle		113		µA
	I2C	Delta current with clock enabled, module idle		12		µA
	I2S	Delta current with clock enabled, module idle		36		µA
	SSI	Delta current with clock enabled, module idle		93		µA
	UART	Delta current with clock enabled, module idle		164		µA

(1) I_{peri} is not supported in standby or shutdown modes.

4.5. General Characteristics

Tc = 25°C, VDDS = 3.0 V, unless otherwise noted.

Parameter	Test Conditions	Min	Typ	Max	Units
FLASH MEMORY					
Supported flash erase cycles before failure		100			K Cycles
Flash page/sector erase current	Average delta current		12.6		mA
Flash page/sector erase time(1)			8		ms
Flash page/sector size			4		KB
Flash write current	Average delta current, 4 bytes at a time		8.15		mA
Flash write time(1)	4 bytes at a time		8		µs

(1) This number is dependent on Flash aging and will increase over time and erase cycles

4.6. 1-Mbps GFSK (Bluetooth Low Energy) – RX

RF performance is specified in a single ended 50 ohm reference plane at the antenna feeding point with Tc = 25°C, VDDS = 3.0 V, f_{RF} = 2440 MHz, unless otherwise noted.

Parameter	Test Conditions	Min	Typ	Max	Units
Receiver sensitivity	BER = 10^{-3}		-96		dBm
Receiver saturation	BER = 10^{-3}		4		dBm
Frequency error tolerance	Difference between center frequency of the received RF signal and local oscillator frequency.	-350		350	kHz
Data rate error tolerance	Difference between incoming data rate and the internally generated data rate	-750		750	ppm
Co-channel rejection(1)	Wanted signal at –67 dBm, modulated interferer in channel, BER = 10^{-3}		-6		dB
Selectivity, ±1 MHz(1)	Wanted signal at –67 dBm, modulated interferer at ±1 MHz, BER = 10^{-3}		7 / 3(2)		dB
Selectivity, ±2 MHz(1)	Wanted signal at –67 dBm, modulated interferer at ±2 MHz, BER = 10^{-3}		34/25(2)		dB
Selectivity, ±3 MHz(1)	Wanted signal at –67 dBm, modulated interferer at ±3 MHz, BER = 10^{-3}		38/26(2)		dB
Selectivity, ±4 MHz(1)	Wanted signal at –67 dBm, modulated interferer at ±4 MHz, BER = 10^{-3}		42/29(2)		dB

Selectivity, ±5 MHz or more(1)	Wanted signal at –67 dBm, modulated interferer at ≥ ±5 MHz, BER = 10^{-3}		32		dB
Selectivity, Image frequency(1)	Wanted signal at –67 dBm, modulated interferer at image frequency, BER = 10^{-3}		25		dB
Selectivity, Image frequency ±1 MHz (1)	Wanted signal at –67 dBm, modulated interferer at ±1 MHz from image frequency, BER = 10^{-3}		3/26(2)		dB
Out-of-band blocking(3)	30 MHz to 2000 MHz		-20		dBm
Out-of-band blocking	2003 MHz to 2399 MHz		-5		dBm
Out-of-band blocking	2484 MHz to 2997 MHz		-8		dBm
Out-of-band blocking	3000 MHz to 12.75 GHz		-8		dBm
Intermodulation	Wanted signal at 2402 MHz, –64 dBm. Two interferers at 2405 and 2408 MHz respectively, at the given power level		-34		dBm
Spurious emissions, 30 to 1000 MHz	Conducted measurement in a 50-Ω single-ended load. Suitable for systems targeting compliance with EN 300 328, EN 300 440 class 2, FCC CFR47, Part 15 and ARIB STD-T-66		-71		dBm
Spurious emissions, 1 to 12.75 GHz	Conducted measurement in a 50-Ω single-ended load. Suitable for systems targeting compliance with EN 300 328, EN 300 440 class 2, FCC CFR47, Part 15 and ARIB STD-T-66		-62		dBm
RSSI dynamic range			70		dB
RSSI accuracy			±4		dB

(1) Numbers given as I/C dB

(2) X / Y, where X is +N MHz and Y is –N MHz

(3) Excluding one exception at F_{wanted} / 2, per Bluetooth Specification

4.7. 1-Mbps GFSK (Bluetooth Low Energy) – TX

RF performance is specified in a single ended 50 ohm reference plane at the antenna feeding point with Tc = 25°C, VDDS = 3.0 V, f_{RF} = 2440 MHz, unless otherwise noted.

Parameter	Test Conditions	Min	Typ	Max	Units
Output power, highest setting	Delivered to a single-ended 50-Ω load		5		dBm
Output power, lowest setting	Delivered to a single-ended 50-Ω load		-21		dBm

Spurious emission conducted measurement(1)	f < 1 GHz, outside restricted bands		-43		dBm
	f < 1 GHz, restricted bands ETSI		-65		dBm
	f < 1 GHz, restricted bands FCC		-76		dBm
	f > 1 GHz, including harmonics		-46		dBm

(1) Suitable for systems targeting compliance with worldwide radio-frequency regulations ETSI EN 300 328 and EN 300 440 Class 2 (Europe), FCC CFR47 Part 15 (US), and ARIB STD-T66 (Japan).

4.8. IEEE 802.15.4 (Offset Q-PSK DSSS, 250 kbps) – RX

RF performance is specified in a single ended 50 ohm reference plane at the antenna feeding point with Tc = 25°C, VDDS = 3.0 V, fRF = 2440 MHz, unless otherwise noted.

Parameter	Test Conditions	Min	Typ	Max	Units
Receiver sensitivity	PER = 1%		-99		dBm
Receiver saturation	PER = 1%		+4		dBm
Adjacent channel rejection	Wanted signal at –82 dBm, modulated interferer at ±5 MHz, PER=1%		39		dB
Alternate channel rejection	Wanted signal at –82 dBm, modulated interferer at ±10 MHz, PER=1%		52		dB
Channel rejection, ±15 MHz or more	Wanted signal at –82 dBm, undesired signal is IEEE 802.15.4 modulated channel, stepped through all channels 2405 to 2480 MHz, PER = 1%		57		dB
Blocking and desensitization, 5MHz from upper band edge	Wanted signal at –97 dBm (3 dB above the sensitivity level), CW jammer, PER = 1%		64		dB
Blocking and desensitization, 10MHz from upper band edge	Wanted signal at –97 dBm (3 dB above the sensitivity level), CW jammer, PER = 1%		64		dB
Blocking and desensitization, 20MHz from upper band edge	Wanted signal at –97 dBm (3 dB above the sensitivity level), CW jammer, PER = 1%		65		dB
Blocking and desensitization, 50MHz from upper band edge	Wanted signal at –97 dBm (3 dB above the sensitivity level), CW jammer, PER = 1%		68		dB
Blocking and desensitization, -5MHz from lower band edge	Wanted signal at –97 dBm (3 dB above the sensitivity level), CW jammer, PER = 1%		63		dB
Blocking and desensitization, -10MHz from lower band edge	Wanted signal at –97 dBm (3 dB above the sensitivity level), CW jammer, PER = 1%		63		dB
Blocking and desensitization, -20MHz from lower band edge	Wanted signal at –97 dBm (3 dB above the sensitivity level), CW jammer, PER = 1%		65		dB

Blocking and desensitization, -50MHz from lower band edge	Wanted signal at –97 dBm (3 dB above the sensitivity level), CW jammer, PER = 1%		67		dB
Spurious emissions, 30 MHz to 1000 MHz	Conducted measurement in a 50 Ω single-ended load. Suitable for systems targeting compliance with EN 300 328, EN 300 440 class 2, FCC CFR47, Part 15 and ARIB STD-T-66		-71		dBm
Spurious emissions, 1 GHz to 12.75 GHz	Conducted measurement in a 50 Ω single-ended load. Suitable for systems targeting compliance with EN 300 328, EN 300 440 class 2, FCC CFR47, Part 15 and ARIB STD-T-66		-62		dBm
Frequency error tolerance	Difference between center frequency of the received RF signal and local oscillator frequency		>200		ppm
Symbol rate error tolerance	Difference between incoming symbol rate and the internally generated symbol rate		>1000		ppm
RSSI dynamic range			100		dB
RSSI accuracy			±4		dB

4.9. IEEE 802.15.4 (Offset Q-PSK DSSS, 250 kbps) – TX

RF performance is specified in a single ended 50 ohm reference plane at the antenna feeding point with Tc = 25°C, VDDS = 3.0 V, fRF = 2440 MHz, unless otherwise noted.

Parameter	Test Conditions	Min	Typ	Max	Units
Output power, highest setting	Delivered to a single-ended 50-Ω load		5		dBm
Output power, lowest setting	Delivered to a single-ended 50-Ω load		-21		dBm
Error vector magnitude	At maximum output power		2		%
Spurious emission conducted measurement	f < 1 GHz, outside restricted bands		-43		dBm
	f < 1 GHz, restricted bands ETSI		-65		dBm
	f < 1 GHz, restricted bands FCC		-76		dBm
	f > 1 GHz, including harmonics		-46		dBm
	Suitable for systems targeting compliance with worldwide radio-frequency regulations ETSI EN 300 328 and EN 300 440 Class 2 (Europe), FCC CFR47 Part 15 (US), and ARIB STD-T66 (Japan)				

4.10. Internal 24-MHz Crystal Oscillator (XOSC_HF)(1)

Tc = 25°C, VDDS = 3.0 V, unless otherwise noted.

Parameter	Test Conditions	Min	Typ	Max	Units
Crystal frequency			24		MHz
Crystal frequency tolerance(2)		-40		+40	ppm
Start-up time(3)			150		µs

(1) Probing or otherwise stopping the XTAL while the DC-DC converter is enabled may cause permanent damage to the device.

(2) Includes initial tolerance of the crystal, drift over temperature, aging and frequency pulling due to incorrect load capacitance. As per Bluetooth and IEEE 802.15.4 specification

(3) Kick-started based on a temperature and aging compensated RCOSC_HF using precharge injection

4.11. 32.768-kHz Crystal Oscillator (XOSC_LF)

Tc = 25°C, VDDS = 3.0 V, unless otherwise noted.

Parameter	Test Conditions	Min	Typ	Max	Units
Crystal frequency			32.768		KHz
Crystal frequency tolerance, Bluetooth low energy applications(1)		-500		500	ppm

(1) Includes initial tolerance of the crystal, drift over temperature, ageing and frequency pulling due to incorrect load capacitance. As per Bluetooth and IEEE 802.15.4 specification.

4.12. 48-MHz RC Oscillator (RCOSC_HF)

Tc = 25°C, VDDS = 3.0 V, unless otherwise noted.

Parameter	Test Conditions	Min	Typ	Max	Units
Frequency			48		MHz
Uncalibrated frequency accuracy			±1		%
Calibrated frequency accuracy(1)			±0.25		%
Start-up time			5		µs

(1) Accuracy relatively to the calibration source (XOSC_HF).

4.13. 32-kHz RC Oscillator (RCOSC_LF)

Tc = 25°C, VDDS = 3.0 V, unless otherwise noted.

Parameter	Test Conditions	Min	Typ	Max	Units
Calibrated frequency			32.8		KHz
Temperature coefficient			50		ppm/°C

4.14. ADC Characteristics(1)

Tc = 25°C, VDDS = 3.0 V and voltage scaling enabled, unless otherwise noted.

Parameter	Test Conditions	Min	Typ	Max	Units
Input voltage range		0		V_{DDS}	V
Resolution			12		Bits
Sample rate				200	ksps
Offset	Internal 4.3-V equivalent reference(2)		2		LSB
Gain error	Internal 4.3-V equivalent reference(2)		2.4		LSB
DNL(3) Differential nonlinearity			>-1		LSB
INL Integral nonlinearity			±3		LSB
ENOB Effective number of bits	Internal 4.3-V equivalent reference(2), 200 ksps, 9.6-kHz input tone		9.8		Bits
	VDDS as reference, 200 ksps, 9.6-kHz input tone		10		Bits
	Internal 1.44-V reference, voltage scaling disabled, 32 samples average, 200 ksps, 300-Hz input tone		11.1		Bits
THD - Total harmonic distortion	Internal 4.3-V equivalent reference(2), 200 ksps, 9.6-kHz input tone		-65		dB
	VDDS as reference, 200 ksps, 9.6-kHz input tone		-69		dB
	Internal 1.44-V reference, voltage scaling disabled, 32 samples average, 200 ksps, 300-Hz input tone		-71		dB
SINAD / SNDR - Signal-to-noise and distortion ratio	Internal 4.3-V equivalent reference(2), 200 ksps, 9.6-kHz input tone		60		dB
	VDDS as reference, 200 ksps, 9.6-kHz		63		dB

	input tone				
	Internal 1.44-V reference, voltage scaling disabled, 32 samples average, 200 ksps, 300-Hz input tone		69		dB
SFDR – Spurious-free dynamic range	Internal 4.3-V equivalent reference(2), 200 ksps, 9.6-kHz input tone		67		dB
	VDDS as reference, 200 ksps, 9.6-kHz input tone		72		dB
	Internal 1.44-V reference, voltage scaling disabled, 32 samples average, 200 ksps, 300-Hz input tone		73		dB
Conversion time	Serial conversion, time-to-output, 24-MHz clock		50		Clock cycles
Current consumption	Internal 4.3-V equivalent reference(2)		0.66		mA
Current consumption	VDDS as reference		0.75		mA
Reference voltage	Equivalent fixed internal reference (input voltage scaling enabled)		4.3 (2)(4)		V
Reference voltage	Fixed internal reference (input voltage scaling disabled)		1.44 ±1%		V
Reference voltage	VDDS as reference (Also known as RELATIVE) (input voltage scaling enabled)		VDDS		V
Reference voltage	VDDS as reference (Also known as RELATIVE) (input voltage scaling disabled)		VDDS/ 2.82(4)		V
Input Impedance	200 ksps, voltage scaling enabled. Capacitive input, Input impedance depends on sampling frequency and sampling time		>1		MΩ

(1) Using IEEE Std 1241™-2010 for terminology and test methods.

(2) Input signal scaled down internally before conversion, as if voltage range was 0 to 4.3 V.

(3) No missing codes. Positive DNL typically varies from +0.3 to +3.5, depending on device

(4) Applied voltage must be within absolute maximum ratings (Section 4.1) at all times.

4.15. Temperature Sensor

Tc = 25°C, VDDS = 3.0 V, unless otherwise noted.

Parameter	Test Conditions	Min	Typ	Max	Units
Resolution			4		°C
Range		-40		+85	°C
Accuracy			±5		°C
Supply voltage coefficient(1)			3.2		°C/V

(1) Automatically compensated when using supplied driver libraries.

4.16. Battery Monitor

Tc = 25°C, VDDS = 3.0 V, unless otherwise noted.

Parameter	Test Conditions	Min	Typ	Max	Units
Resolution			50		mV
Range		1.8		3.8	V
Accuracy			13		mV

4.17. Continuous Time Comparator

Tc = 25°C, VDDS = 3.0 V, unless otherwise noted.

Parameter	Test Conditions	Min	Typ	Max	Units
Input voltage range		0		V_{DDS}	V
External reference voltage		0		V_{DDS}	V
Internal reference voltage	DCOUPL as reference		1.27		V
Offset			3		mV
Hysteresis			<2		mV
Decision time	Step from –10 mV to +10 mV		0.72		µs
Current consumption when enabled(1)			8.6		µA

(1) Additionally the bias module needs to be enabled when running in standby mode.

4.18. Low-Power Clocked Comparator

Tc = 25°C, VDDS = 3.0 V, unless otherwise noted.

Parameter	Test Conditions	Min	Typ	Max	Units
Input voltage range		0		V_{DDS}	V
Clock frequency			32		kHz
Internal reference voltage, VDDS / 2			1.49-1.51		V
Internal reference voltage, VDDS / 3			1.01-1.03		V
Internal reference voltage, VDDS / 4			0.78-0.79		V
Internal reference voltage, DCOUPL / 1			1.25-1.28		V
Internal reference voltage, DCOUPL / 2			0.63-0.65		V
Internal reference voltage, DCOUPL / 3			0.42-0.44		V
Internal reference voltage, DCOUPL / 4			0.33-0.34		V
Offset			<2		mV
Hysteresis			<5		mV
Decision time	Step from –50 mV to +50 mV		<1		clock cycle
Current consumption when enabled			362		nA

4.19. Programmable Current Source

Tc = 25°C, VDDS = 3.0 V, unless otherwise noted.

Parameter	Test Conditions	Min	Typ	Max	Units
Current source programmable output range			0.25-20		µA
Resolution			0.25		µA
Current consumption(1)	Including current source at maximum programmable output		23		µA

(1) Additionally, the bias module must be enabled when running in standby mode.

4.20. DC Characteristics

Parameter	Test Conditions	Min	Typ	Max	Units
TA = 25°C, VDDS = 1.8 V					
GPIO VOH at 8-mA load	IOCURR = 2, high drive GPIOs only	1.32	1.54		V
GPIO VOL at 8-mA load	IOCURR = 2, high drive GPIOs only		0.26	0.32	V
GPIO VOH at 4-mA load	IOCURR = 1	1.32	1.58		V
GPIO VOL at 4-mA load	IOCURR = 1		0.21	0.32	V
GPIO pullup current	Input mode, pullup enabled, Vpad=0V		71.7		µA
GPIO pulldown current	Input mode, pulldown enabled, Vpad=VDDS		21.1		µA
GPIO high/low input transition, no hysteresis	IH = 0, transition between reading 0 and reading 1		0.88		V
GPIO low-to-high input transition, with hysteresis	IH = 1, transition voltage for input read as 0→1		1.07		V
GPIO high-to-low input transition, with hysteresis	IH = 1, transition voltage for input read as 1→0		0.74		V
GPIO input hysteresis	IH = 1, difference between 0→1 and 1→0 points		0.33		V
TA = 25°C, VDDS = 3.0 V					
GPIO VOH at 8-mA load	IOCURR = 2, high drive GPIOs only		2.68		V
GPIO VOL at 8-mA load	IOCURR = 2, high drive GPIOs only		0.33		V
GPIO VOH at 4-mA load	IOCURR = 1		2.72		V
GPIO VOL at 4-mA load	IOCURR = 1		0.28		V
TA = 25°C, VDDS = 3.8 V					
GPIO pullup current	Input mode, pullup enabled, Vpad = 0 V		277		µA
GPIO pulldown current	Input mode, pulldown enabled, Vpad = VDDS		113		µA
GPIO high/low input transition, no hysteresis	IH = 0, transition between reading 0 and reading 1		1.67		V
GPIO low-to-high input transition, with hysteresis	IH = 1, transition voltage for input read as 0→1		1.94		V
GPIO high-to-low input transition, with hysteresis	IH = 1, transition voltage for input read as 1→0		1.54		V
GPIO input hysteresis	IH = 1, difference between 0→1 and 1→0 points		0.4		V
TA = 25°C					
VIH	Lowest GPIO input voltage reliably interpreted as a ”High”			0.8	VDDS (1)

VIL	Highest GPIO input voltage reliably interpreted as a ”Low”	0.2			VDDS (1)

(1) Each GPIO is referenced to a specific VDDS pin. See the CC2650 technical reference manual listed in Section 8.2 for more details.

4.21. Timing Requirements

			Min	Typ	Max	Units
Rising supply-voltage slew rate			0		100	mV/µs
Falling supply-voltage slew rate			0		20	mV/µs
Positive temperature gradient in standby[1]	No limitation for negative temperature gradient, or outside standby mode				5	°C/s
CONTROL INPUT AC CHARACTERISTICS[2]						
RESET_N low duration			1			µs
SYNCHRONOUS SERIAL INTERFACE (SSI) [3]						
S1 (SLAVE) [4]	T_{clk_per}	SSIClk period	12		65024	system clock
S2 [4]	t_{clk_high}	SSIClk high time		0.5		T_{clk_per}
S3[4]	t_{clk_low}	SSIClk low time		0.5		T_{clk_per}

(1) Applications using RCOSC_LF as sleep timer must also consider the drift in frequency caused by a change in temperature.

(2) T_A = –40°C to 85°C, VDDS = 1.8 V to 3.8 V, unless otherwise noted.

(3) T_c = 25°C, V_{DDS} = 3.0 V, unless otherwise noted. Device operating as SLAVE. For SSI MASTER operation, see Section 4.22.

(4) Refer to SSI timing diagrams Figure 4-1, Figure 4-2, and Figure 4-3.

4.22. Switching Characteristics

Tc = 25°C, VDDS = 3.0 V, unless otherwise noted.

Parameter	Test Conditions	Min	Typ	Max	Units
WAKEUP AND TIMING					
Idle → Active			14		µs
Standby → Active			151		µs
Shutdown → Active			1015		µs
SYNCHRONOUS SERIAL INTERFACE (SSI) [1]					
S1 (TX only)[2] t_{clk_per} (SSIClk period)	One-way communication to SLAVE	4		65024	system

S1(TX and RX)[2] t_{clk_per} (SSIClk period)	Normal duplex operation	8		65024	clocks
S2 [2] t_{clk_high} (SSIClk high time)			0.5		t_{clk_per}
S3 [2] tclk_low(SSIClk low time)			0.5		t_{clk_per}

(1) Device operating as MASTER. For SSI SLAVE operation, see Section 4.21.

(2) (4) Refer to SSI timing diagrams Figure 4-1, Figure 4-2, and Figure 4-3.

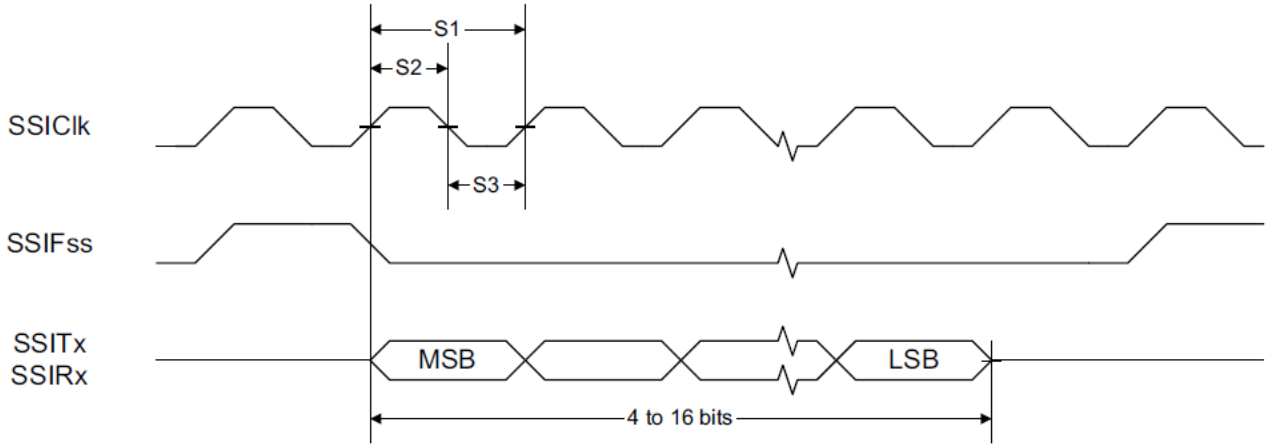


Figure 4-1. SSI Timing for TI Frame Format (FRF = 01), Single Transfer Timing Measurement

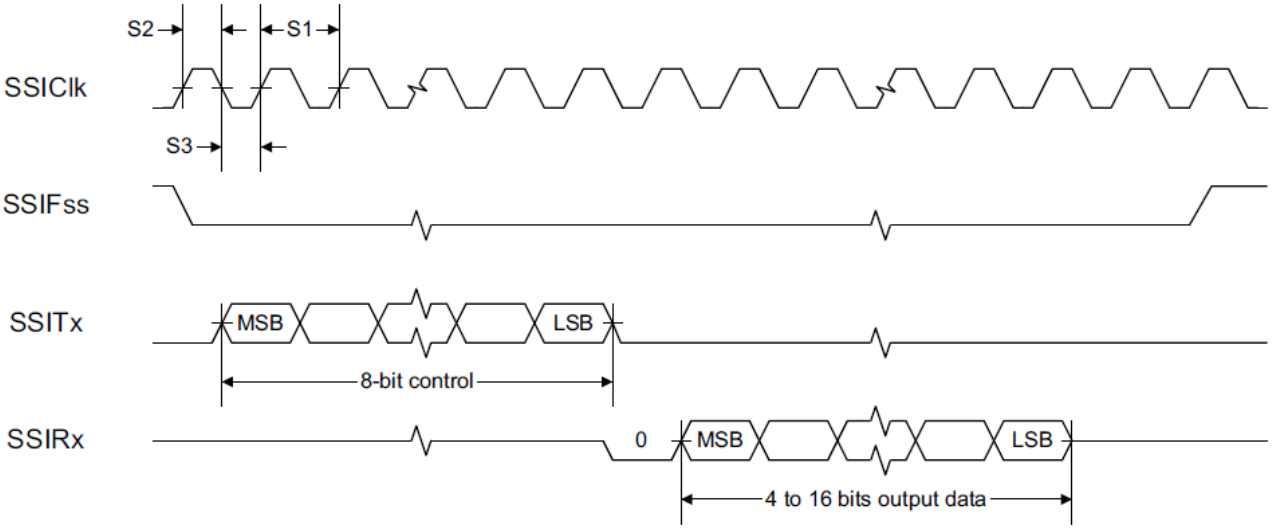


Figure 4-2. SSI Timing for MICROWIRE Frame Format (FRF = 10), Single Transfer

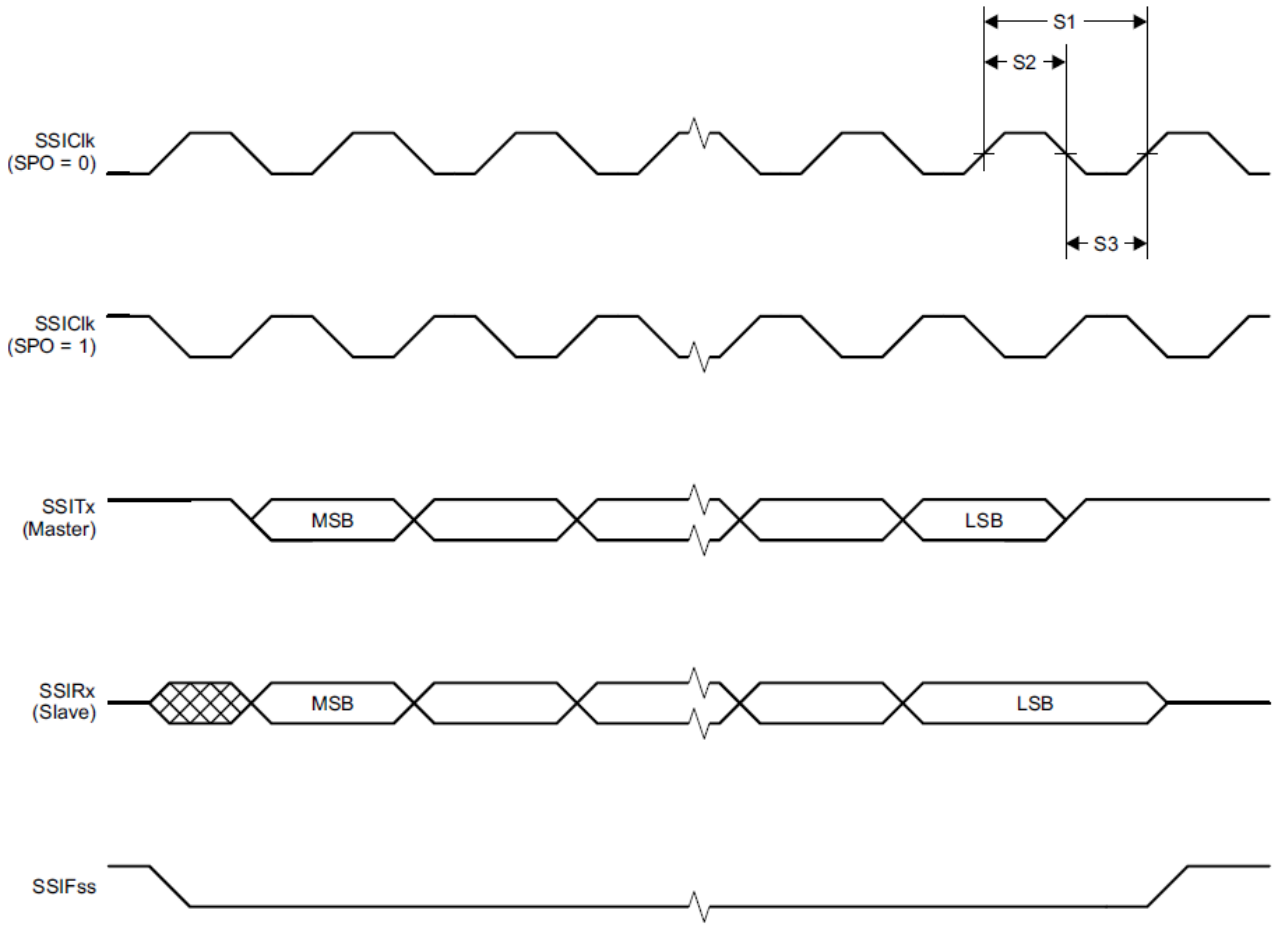


Figure 4-3. SSI Timing for SPI Frame Format (FRF = 00), With SPH = 1

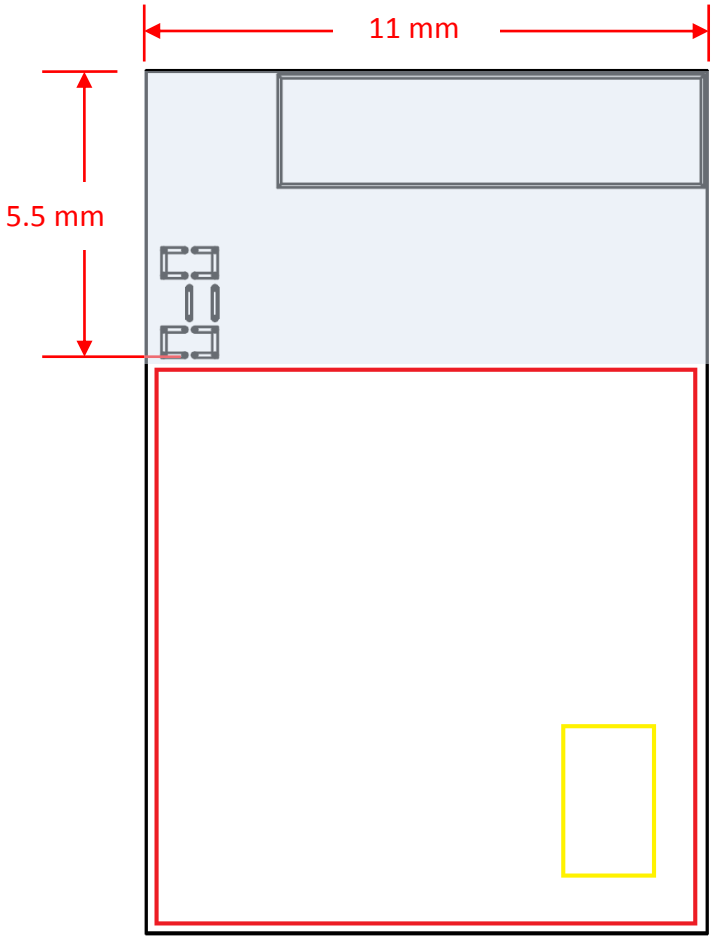
5. DESIGN RECOMMENDATIONS

5.1. Module Layout Recommendations

Follow these module layout recommendations:

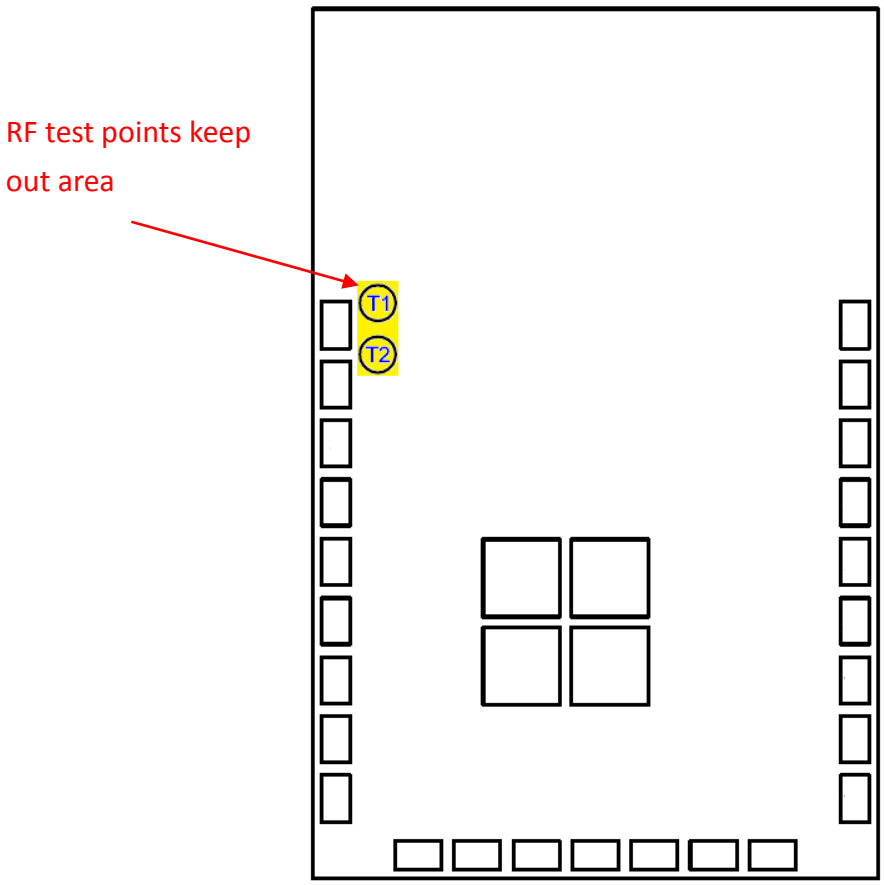
- Antenna

  For a module with on board chip antenna, to eliminate the influence from other components or ground, recommended that the module is placed in the corner of main PCB, and define a clearance area around the antenna, where no grounding or signal trace are contained. The clearance area applies to all layers of the main PCB. The recommended dimensions of the main PCB keep out area are shown in bellow.



- RF test point

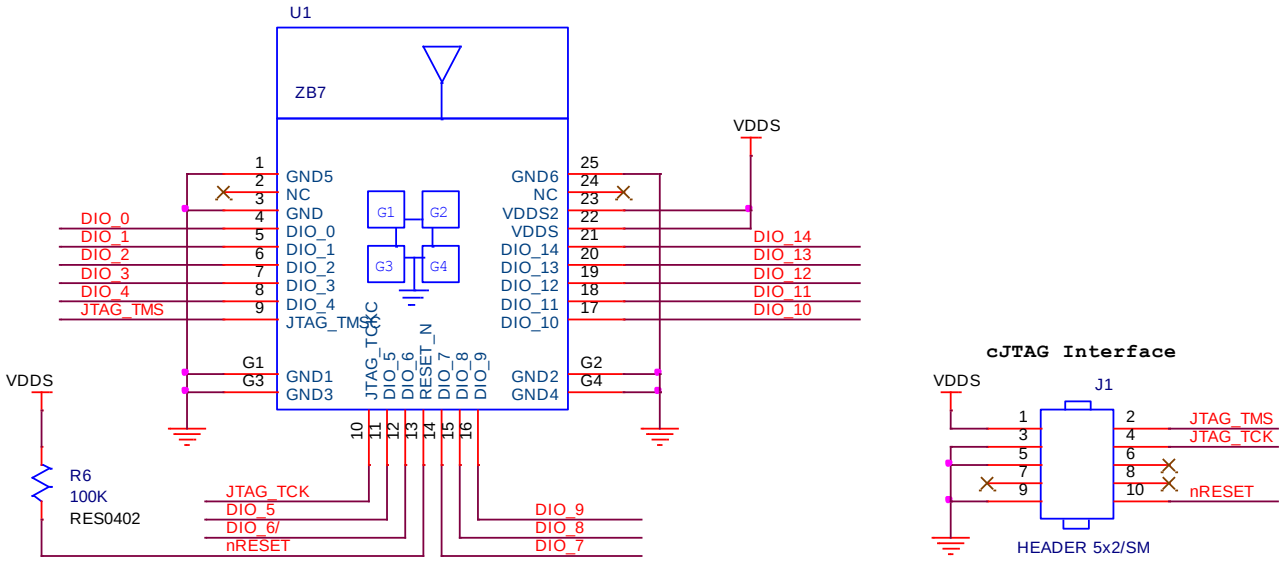
  There are RF test points in the bottom side of this module. It is only for module production used. Do not connect any signal to these test points (leave no connection). Please reserve a keep out area. Do not route any signal or place via in this keep out area.



- Device and Documentation Support

  For a complete device and tool documents for the CC2650 platform, visit the Texas Instruments website at http://www.ti.com.

5.2. Reference Schematic

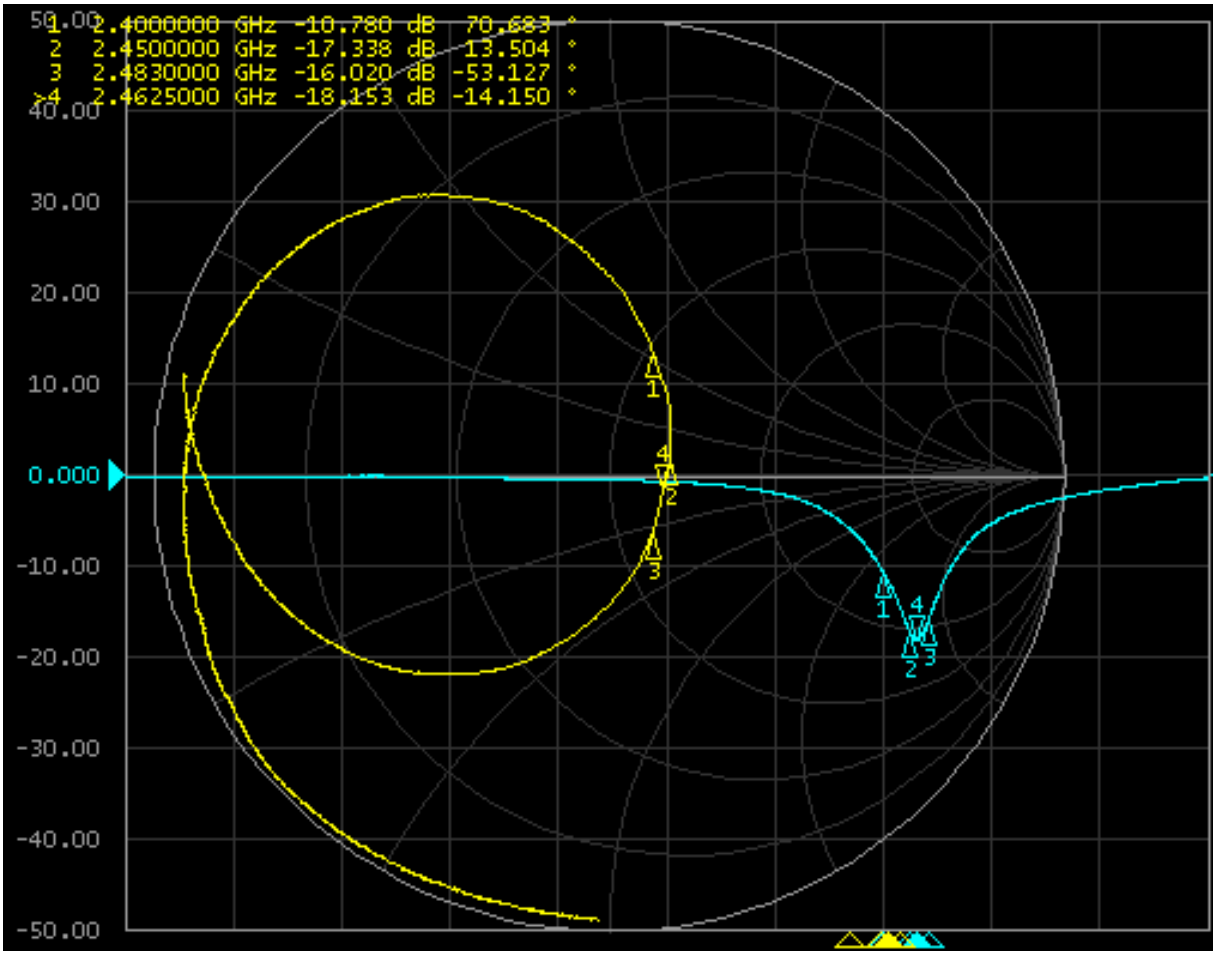


*** All Digital Peripheral Pins can be routed to any GPIO.**

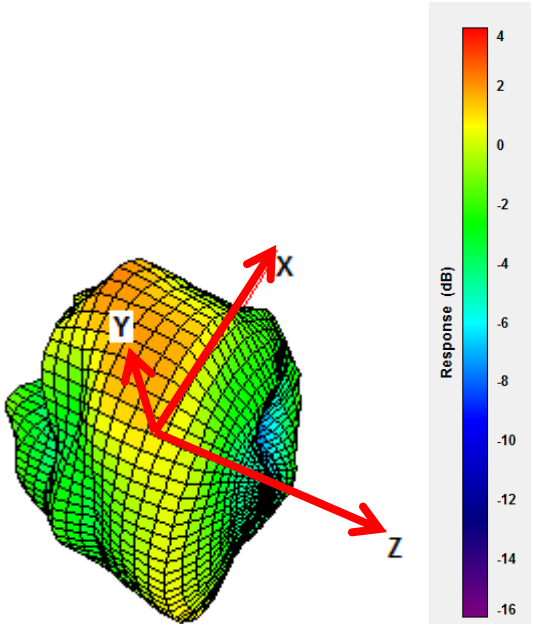
6. CHIP ANTENNA PERFORMACE SUMMARY

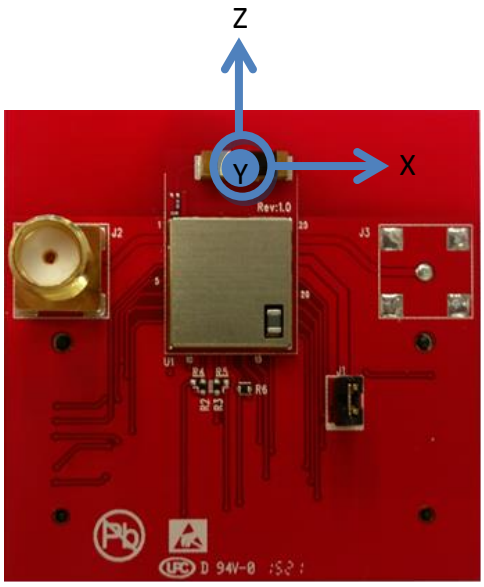
Measured on the Jorjin ZB7500E00 EM board with TA = 25°C

6.1. S-Parameter Test



6.2. DUT 3D Pattern



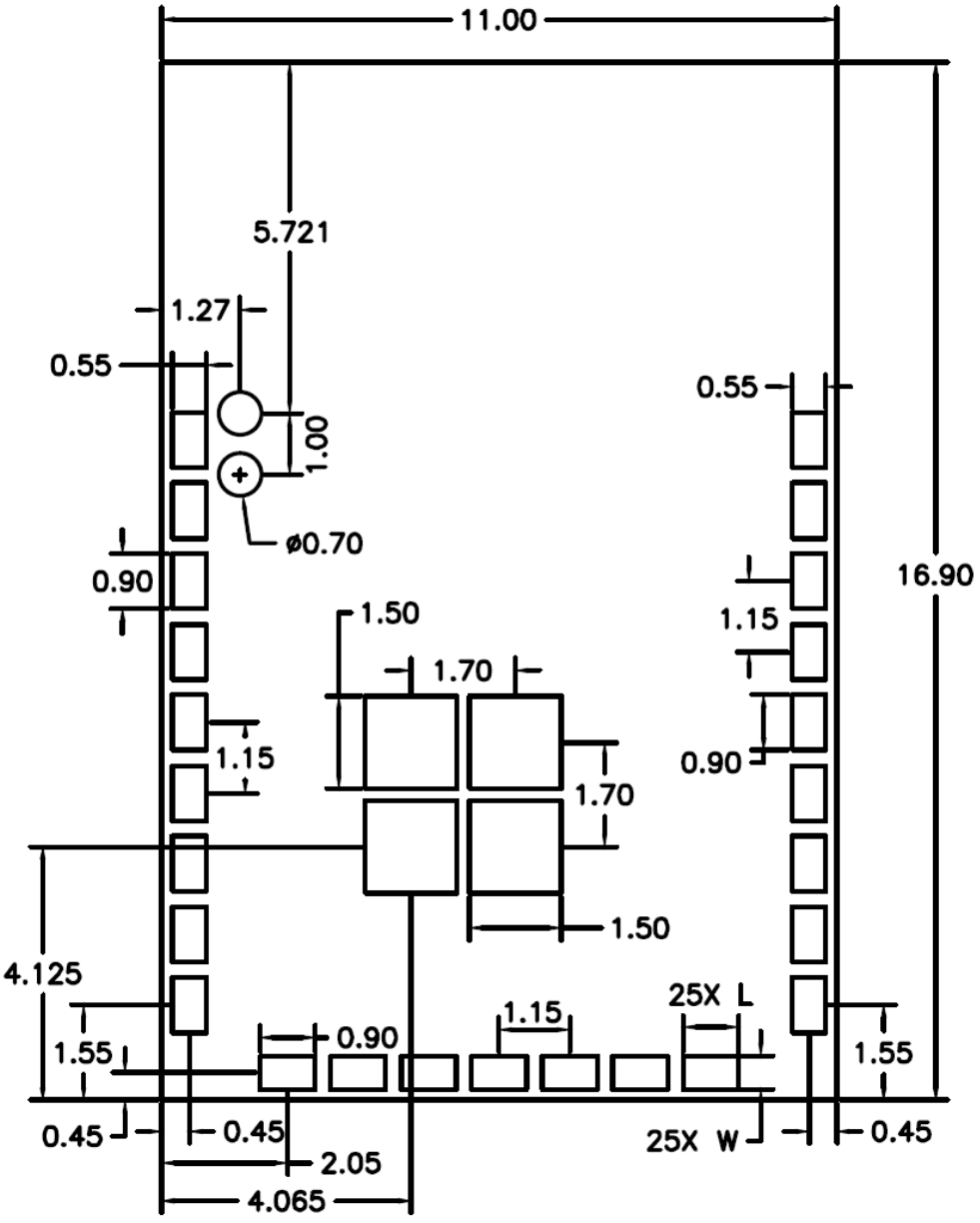


6.3. Total Efficiency

Parameter	2400MHz	2450MHz	2483MHz
S11	-10.780 dB	-17.338 dB	-16.020 dB
Efficiency%	53.97 %	56.87 %	53.64 %
Peak Gain	1.080 dBi	1.256 dBi	1.034 dBi

7. PACKAGE INFORMATION

7.1. Module Mechanical Outline



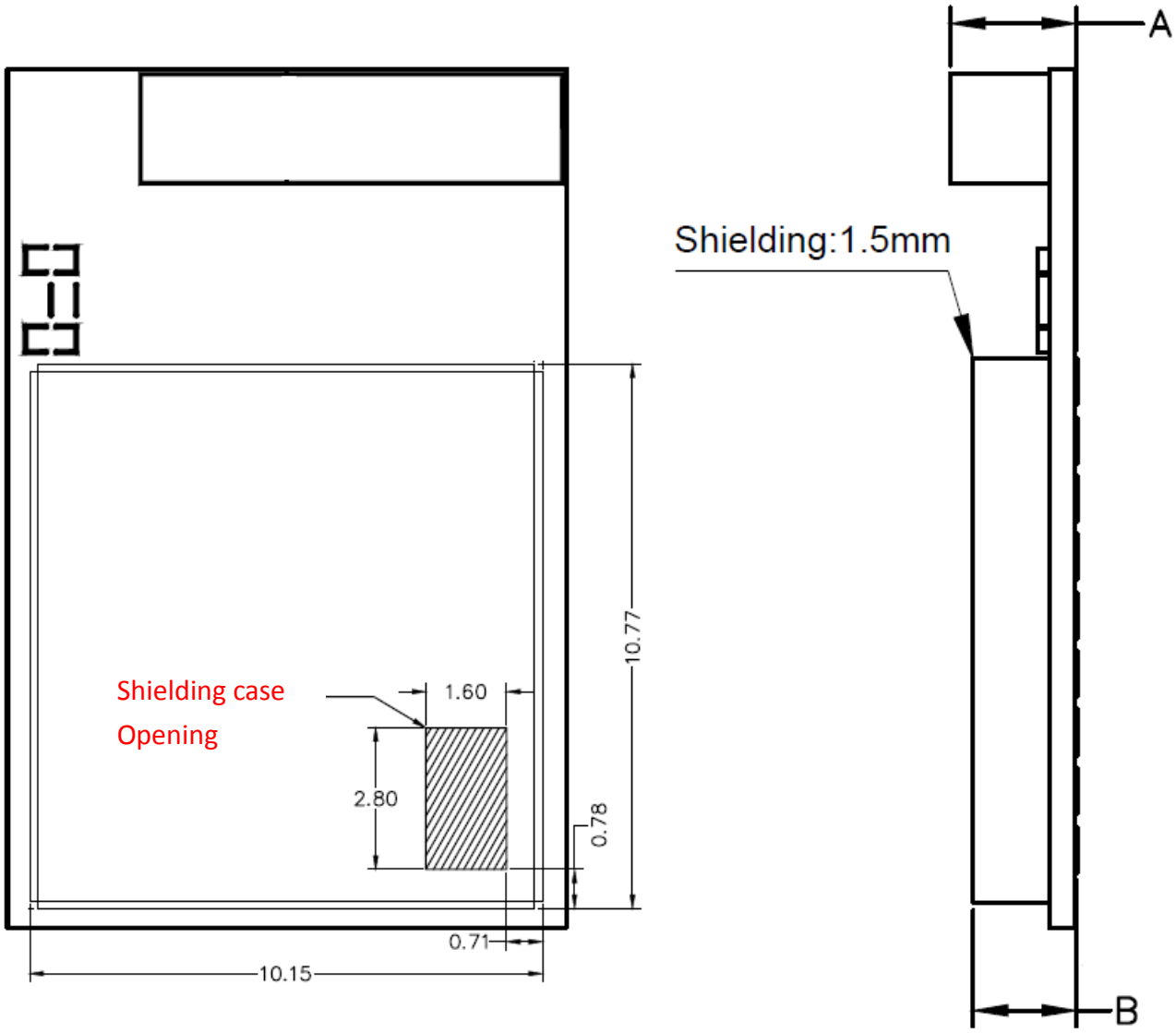
Top View

Note:

1> Pad tolerance as ±30um

2> Unit: mm

Top and Side View



Note:

A: Typical: 2.45mm, Maximum: 2.69mm

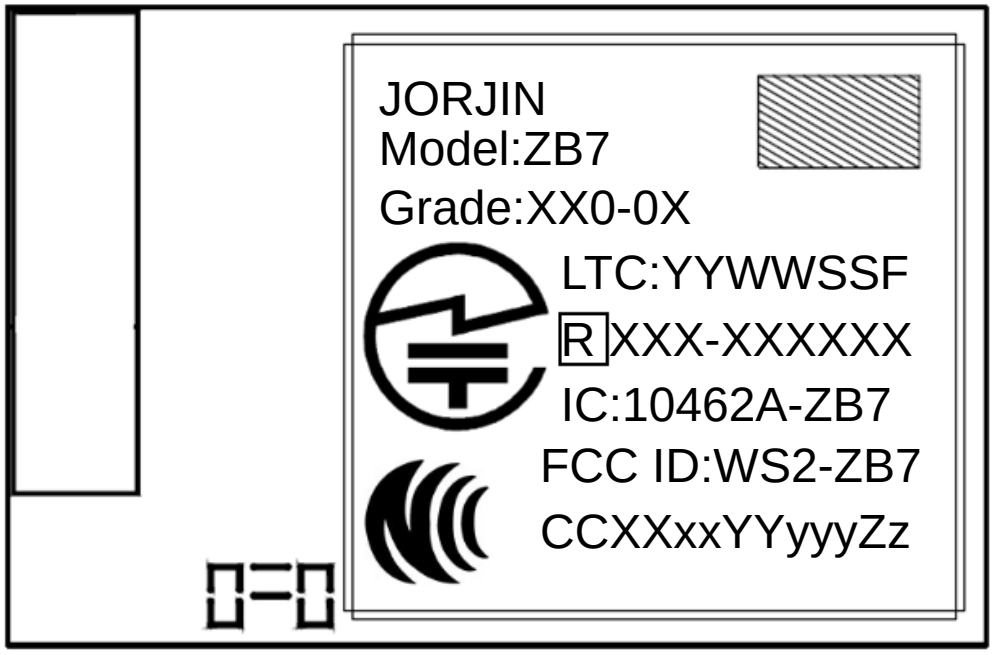
B: Typical: 2.00mm, Maximum: 2.20mm

Unit: mm

7.2. Ordering Information

Order Number	Package	Test Grade
ZB7500-00	LGA-25	500-00
ZB7500-04	LGA-25	500-04
ZB7410-00	LGA-25	410-00
ZB7410-04	LGA-25	410-04
ZB7320-00	LGA-25	320-00
ZB7320-04	LGA-25	320-04

7.3. Package Marking



Marking	Description
JORJIN	Brand name
ZB7	Model name
XX0-0X	Test grade (for more information, see Section 7.4, Test Grades)

YYWWSSF	Lot Trace Code: YYWWSSF YY= Digit of the year, ex: 2016=16 WW= Week (01~52) SS= Serial number from 01~98 match to MFG's lot number, or 99 to repair control code F= Reverse for internal use
	TELEC compliance mark, and ID
10462A-ZB7	Canada IC ID
WS2-ZB7	FCC ID
	NCC compliance mark, and ID

7.4. Test Grades

The ZB7 module offers six footprint-compatible, function variants by embedded software.

Test Grade	BLE	802.15.4	Addition 4Mbs SPI Flash
500-00	Tested	Tested	
500-04	Tested	Tested	Installed
410-00	Tested		
410-04	Tested		Installed
320-00		Tested	
320-04		Tested	Installed

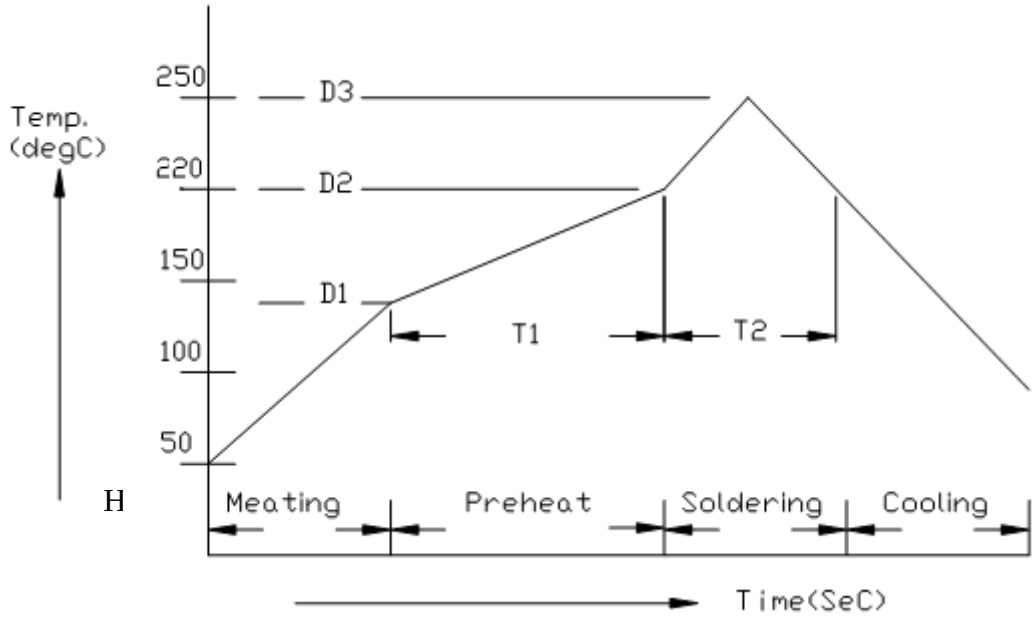
8. SMT AND BAKING RECOMMENDATION

8.1. Baking Recommendation

- Baking condition：
  - Follow MSL Level 4 to do baking process.
  - After bag is opened, devices that will be subjected to reflow solder or other high temperature process must be
    a) Mounted within 72 hours of factory conditions <30°C/60% RH, or
    b) Stored at <10% RH.
  - Devices require bake, before mounting, if Humidity Indicator Card reads >10%
  - If baking is required, Devices may be baked for 8 hrs. at 125 °C.

8.2. SMT Recommendation

- Recommended Reflow profile：



No.	Item	Temperature (°C)	Time (sec)
1	Pre-heat	D1: 140 ~ D2: 200	T1: 80 ~ 120
2	Soldering	D2: = 220	T2: 60 +/- 10
3	Peak-Temp.	D3: 250 °C max	

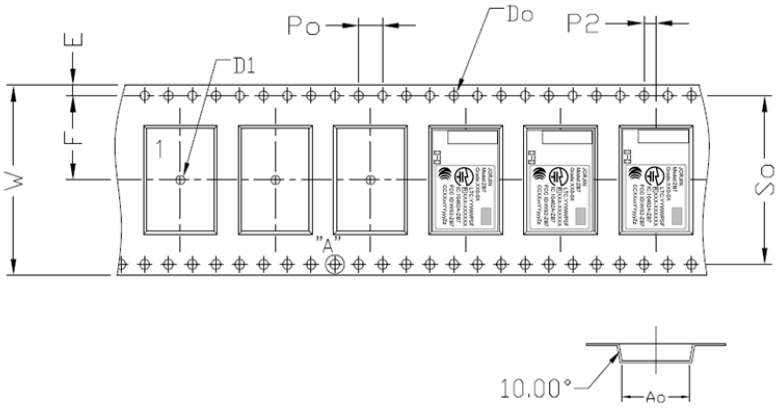
Note: (1) Reflow soldering is recommended two times maximum.

(2) Add Nitrogen while Reflow process： SMT solder ability will be better.

- **Stencil thickness**： 0.1~ 0.13 mm (Recommended)
- **Soldering paste (without Pb)**： Recommended SENJU N705-GRN3360-K2-V can get better soldering effects.

9. TAPE REEL INFROMATION

9.1. Cover / Carrier Tape Dimension



SMT Direction

ITEM	DIM	ALTERNATE
W	32.00 +0.30 −0.30	
E	1.75 +0.10 −0.10	
F	14.20 +0.10 −0.10	
So	28.40 +0.10 −0.10	
P	16.00 +0.10 −0.10	
Po	4.00 +0.10 −0.10	
P2	2.00 +0.10 −0.10	
Do	ø1.50 +0.10 −0.00	
T	0.35 +0.05 −0.05	
Ao	11.40 +0.10 −0.10	
Bo	17.40 +0.10 −0.10	
Ko	2.90 +0.10 −0.10	

Packing Qty	Dry Bag	Inner Box	Outer Box
1200 EA / Reel	1 Reel (1200 EA)	1 Dry Bag (1200 EA)	4 Inner Box (4800 EA)

Inner Box Size : 352mm x 352mm x 56mm

Outer Box Size : 354mm x 362mm x 250mm

10. REGULATORY INFORMATION

This section outlines the regulatory information for the following countries:

- United States
- Canada
- Europe
- Japan
- Taiwan

10.1. United States

Federal Communications Commission Statement

15.21. You are cautioned that changes or modifications not expressly approved by the part 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 of the device.

FCC RF Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure limits. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

End Product Labeling:

This module is designed to comply with the FCC statement, FCC ID: WS2-ZB7. The host system using this module must display a visible label indicating the following text:

"Contains FCC ID: WS2-ZB7"

Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this

module.
The end user manual shall include all required regulatory information/warning as shown in this manual.

10.2. Canada

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.

IC RF Radiation Exposure Statement:
To comply with IC RF exposure requirements, this device and its antenna must not be co-located or operating in conjunction with any other antenna or transmitter.

Pour se conformer aux exigences de conformité RF canadienne l'exposition, cet appareil et son antenne ne doivent pas étre co-localisés ou fonctionnant en conjonction avec une autre antenne ou transmetteur.

End Product Labeling:
This module is designed to comply with the IC statement, IC: 10462A-ZB7. The host system using this module must display a visible label indicating the following text:
"Contains IC: 10462A-ZB7"

Manual Information to the End User
The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this

module.
The end user manual shall include all required regulatory information/warning as shown in this manual.

10.3. Europe

This module is an R&TTE Directive assessed radio module that is CE marked and has been manufactured and tested with the intention of being integrated into a final product.

This module is conformity with the following standards

- EN300328 v1.9.1 (Bluetooth Low Energy)
- EN300328 v1.9.1 (802.15.4)
- IEC/EN62479:Ver 2010 (MPE) (replacing EN50371)
- EN301489-1 v1.9.2:2011
- EN301489-3 v1.6.1:2013
- EN301489-17 v2.2.1:2012 (EMC)
- EN55022:2010+AC:2011
- EN55024:2011
- EN60950-1: A2/2013

Labeling and User Information Requirements
As a result of the conformity assessment procedure described in Annex III of the Directive 1999/5/EC, the end-customer equipment should be labeled as follows:

CE

10.4. Japan

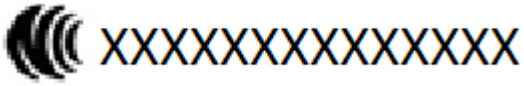
The ZB7 is certified as a module with type certification number XXX-XXXXXX. End products that integrate this module do not need additional MIC Japan certification for the end product.

End product can display the certification label of the embedded module.

10.5. Taiwan

The ZB7 is certified as a module with type certification number XXXXXXXXXXXXX. End products that integrate this module do not need additional NCC Taiwan certification for the end product.

End product can display the certification label of the embedded module.



The user's manual should contain following warning (for RF device) in traditional Chinese:

注意
本產品符合低功率電波輻射性電機管理辦法：

第十二條
經形式認證合格之低功率射頻電機，非經許可，公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計之特性及功能。

第十四條
低功率射頻電機之使用不得影響飛航安全及干擾合法通信；經發現有干擾現象時，應立即停用，並改善至無干擾時方的繼續使用。
前項合法通信，指依電信規定作業之無線電信。低功率射頻電機須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾。

系統廠商應於平台上標示「本產品內含射頻模組: CCXXxxYYyyyZzW」字樣

11. HISTORY CHANGE

Revision	Date	Description
Revision A Design		
D 0.1	2015/06/22	Initial Released
Revision B Design		
D 0.1	2016/01/21	1. Upgrade the design to Revision B 2. Module size extended to 16.9mm x 11mm 3. Change antenna
D 0.2	2016/08/02	1. Update part number 2. Modify sensitivity characteristics 3. Add reference schematic 4. Add antenna characteristics 5. Add marking information 6. Add Tape Reel information 7. Add Regulatory Information