Zigbee®/Thread®/Bluetooth® Smart Mini Module

ZB3212F6R4SP2-1, ZB3212F6R4SP2-1C

Silicon Labs Mighty Gecko-Based Module

Embedded Multi-Protocol IOT Module

DESCRIPTION

The ZB3212F6R4SP2 ZigBee, Thread, Bluetooth Smart Mini Modules feature the Silicon Labs EFR32MG12 single chip transceiver. These devices are footprint-compatible with CEL's existing line of ZigBee-, Thread-, and Bluetooth-based modules, allowing for fast and simple performance upgrades via drop-in compatible hardware.

The ZB3212F6R4SP2 Mini Modules are fully certified standalone solutions for designers looking to take advantage of the robustness of the Silicon Labs EmberZNet PRO™ stack while having the flexibility to interface to Bluetooth Smart-enabled devices previously deployed in the field. These modules eliminate design risk and significantly reduce time-to-market for a multitude of IoT applications.

These EFR32-based devices are compatible with Silicon Labs' Simplicity Studio development environment which includes an eclipse-based IDE, documentation, debug, energy management tools, and flashing tools. Simplicity Studio supports a multitude of sample applications for many common uses of the ERF32, accelerating the development proof-of-concept designs and demos.

KEY FEATURES

- Multi-Protocol Support in a Single Device:
  ZigBee 3.0, Thread, Bluetooth Smart 5.0
- Enhanced Memory
  1MB Flash
  256kB SRAM
- Up to 24 Analog/Digital GPIOs, including SPI, USART, I2C, 12b ADC, iDAC, Comparators and Timers
- Radiated Output power up to 20dBm
- Two Antenna Configurations
  - Integrated PCB Trace Antenna
  - External Antenna Connections via 50Ω RF Castellation Port for development
- Mini Footprint: 0.940" x 0.655" (23.9 x 16.6mm)
- Footprint-compatible with CEL's Bluetooth, ZigBee, and Thread Module Family, Allowing for Fast and Simple Performance Upgrades
- ZB3212F6R4SP2-1 Variant FCC, IC, Certified* for Usage Throughout North America and Canada

APPLICATIONS

- Connected Home & Appliances
- Building Control & Automation
- Lighting
- Security
- Wireless Sensor Networks
- Wireless Audio & Video
- Remote Health and Wellness Monitoring
- General IoT Wireless Networking

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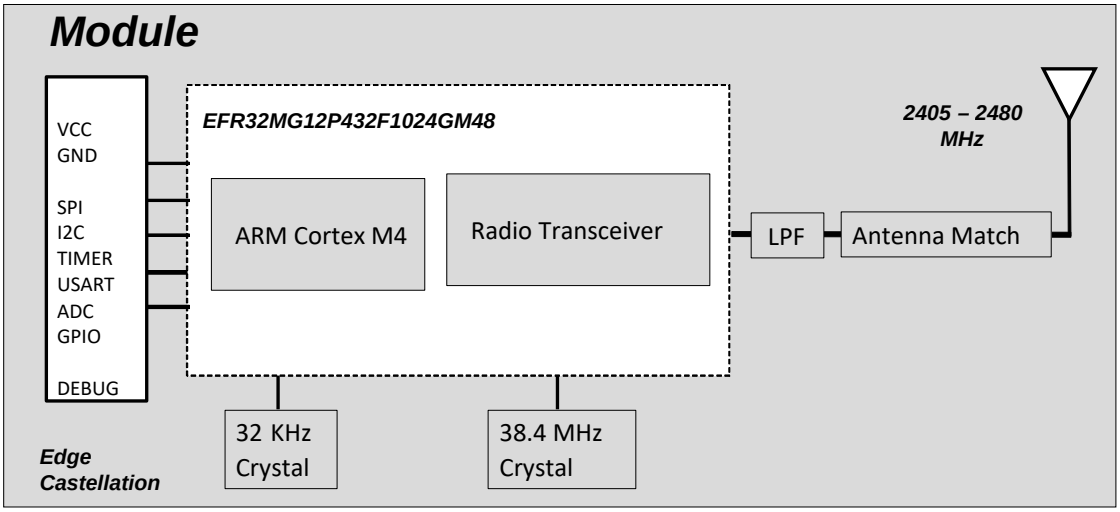
BLOCK DIAGRAM



ORDERING INFORMATION

Order Number	Description	Min/Multiple
ZB3212F6R4SP2-1-R	Zigbee/Thread/BT Smart Module, EFR32MG12P432F1024GM48-C0 single chip transceiver + MCU (1MB flash, 256kB RAM), Trace Antenna	600
ZB3212F6R4SP2-1C-R	Zigbee/Thread/BT Smart Module, EFR32MG12P432F1024GM48-C0 single chip transceiver + MCU (1MB flash, 256kB RAM), Castellation Pin for External Antenna. *NOT FCC OR IC CERTIFIED. END USER MUST CERTIFY BEFORE PLACING ON THE MARKET.*	600

ABSOLUTE MAXIMUM RATINGS

Description	Min	Max	Unit
Power Supply Voltage	0	3.8	V
Voltage on any 5V Tolerant IO Line	-0.3	Min of 5.25 and IOVDD+2	V
Voltage on any non-5V Tolerant IO Line	-0.3	IOVDD+0.3	V
RF Input Power	-	10	dBm
Storage Temperature	-50	150	°C
Reflow Soldering Temperature	-	260	°C

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Typ	Max	Unit
Power Supply Voltage		2.4	3.3	3.8	V
Frequency		2405		2480	MHz
Ambient Temperature Range		-40		85	°C

DC CHARACTERISTICS

(@ 3.3VDC and 25°C unless otherwise specified)

Item	Condition	Min	Nom	Max	Unit
Tx Mode: 2.4 GHz 19.5 dBm[1]	Continuously Modulated Carrier		120		mA
Tx Mode: 2.4 GHz 10 dBm[1]	Continuously Modulated Carrier		55		mA
Tx Mode: 2.4 GHz 0 dBm[1]	Continuously Modulated Carrier		18		mA
RX Current	802.15.4 / Bluetooth Smart		12		mA
Idle Current	802.15.4 / Bluetooth Smart		4		mA
Sleep Modes	EM1: All peripherals disabled		80		µA/MHz
	EM2: RAM retention and RTCC running from LFXO		2.9		µA
	EM3: RAM retention & Cryotimer running from ULFR-CO		2.6		µA
	EM4: No RAM retention		0.43		µA

1. When transmitting packets in a typical application, the transmit current will be reduced by the duty cycle of the transmission. The current stated above I

RF CHARACTERISTICS

(@ 3.3VDC and 25°C unless otherwise specified)

TRANSMITTER

Item	Condition	Nom	Unit
RF Frequency Range	Zigbee Channels (11-26)	2405 - 2480	MHz
	BLE Channels (0-39)	2402 – 2480	MHz
Maximum Radiated TX Power	3.8 V supply	20	dBm
Minimum TX Power	Power Setting -20 or less	-25	dBm
Frequency Error		< 10	KHz

The RF performance reported above assumes a default supply voltage of 3.3V unless otherwise noted.

RECEIVER

Item	Condition	Nom	Unit
RF Frequency Range	Zigbee Channels (11-26)	2405 - 2480	MHz
	BLE Channels (0-39)	2402 – 2480	MHz
Sensitivity 1% PER 802.15.4	250kbps	-101	dBm
Sensitivity 0.1 % BER	1Mbps 2GFSK signal	-95	dBm
Sensitivity 0.1 % BER	2Mbps 2GFSK signal	-91	dBm
Saturation (Maximum Input Level)		10	dBm

- *Sensitivity for the 802.15.4 was measured and based on 1000 Packets using a Zigbee Waveform*
- *Sensitivity for 1Mbps was measured with Bluetooth Tester based on 1000 packets, PBRS 9 data, with a length of 37 bytes, and dirty transmitter OFF. The sensitivity for 2Mbps Is referenced from the datasheet for the IC. BLE 30.8% PER corresponds to a 0.1% BER.*

ANTENNA

The CEL Mini Modules include an integrated Printed Circuit Board (PCB) trace antenna certified for FCC & IC requirements. An optional configuration which uses a castellation pin on the module allows the user to connect to an external antenna however this implementation would require certification by the end user and may not use the CEL FCC ID number on the label. The PCB antenna employs a topology that is compact and highly efficient. To maximize range, an adequate ground plane must be provided on the host PCB. Correctly positioned, the ground plane on the host PCB will contribute significantly to the antenna performance.

For optimum antenna performance, the CEL Mini Module should be mounted with the PCB trace antenna overhanging the edge of the host board and ideally in the upper left corner of the host board so that free space is left of the module as opposed to additional pcb and components. To further improve performance, a ground plane may be placed on the host board under the module, up to the antenna but not extending under the antenna (a minimum of 1.5" x 1.5" is recommended). The installation of an uninterrupted ground plane on a layer directly beneath the module will also allow traces to be routed under the layer. Refer to the application note *Mini Modules Hardware Design Guidelines* for more details. CEL can assist with your PCB layout.

The following are some design guidelines to help ensure optimal antenna performance:

- The antenna portion of the Mini Module should hang over the host board so that there is not any additional PCB under the antenna
- Never place the antenna close to metallic objects
- In the final assembly, ensure that wiring and other components are not placed near the antenna
- Do not place the antenna in a metallic or metalized plastic enclosure
- Keep plastic enclosures a minimum of 1cm away from the antenna in any direction

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

38.4MHz Crystal Trim Value

The CEL module comes with the crystal trim values programmed into the CTUNE token from the factory. This token value is used with the 802.15.4 manufacturing library image loaded onto the module which allows the radio to be exercised.

The BLE stack does not use this token value and must be included in the user's application firmware. This can be configured using the HAL Configuration utility included with Simplicity Studio. The recommended value for the CEL module is 0x0140 or 320d. Including this value minimizes the frequency error of the module.

Programming

Programming the Module can be accomplished by using the Silicon Labs WSTK along with the Silicon Labs STK/Adapter Board (BRD8010A) and interfacing to the SWDIO, SWCLK pins of the module through the ISA header. Either Simplicity Studio or Simplicity Commander Utility can be used as the interface with the WSTK KIT DEBUG MODE set to "OUT".

Firmware Compliance

The ZB3212P6R4SP2-1 module required the firmware to limit the transmit power on channel 26 to comply with agency certification requirements. These restrictions have been implemented in the application image contained within the device when it leaves the factory.

The firmware restrictions which have been implemented are contained in the table below:

		Valid TX Power Setting	
Certification	RF Channel	Zigbee	BLE
FCC/IC	11-25	20	20
	26	7	12

I/O PIN ASSIGNMENTS

Refer to the EFR32MG12 Reference Manual & datasheet for pin functionality details.

Module Pin Number	Pin Name	Notes
1, 2, 12, 31, 33	GND	
3	PA0	
4	RESETN	Module Reset
5	PA1	
6	PA2	
7	PA3	
8	PA5/US0_SCLK/CTS	5V Tolerant Pin
9	PB11/US0_CS/RTS	
10	PB12/US1_TX	
11	PB13/Wake/US1_RX/I2C0_SDA	
13	VREGVDD/IOVDD	Input power to the module.
14	PC6/I2C0_SCL/US1_CLK	5V Tolerant Pin
15	PC7/US1_CS	5V Tolerant Pin
16	PC8	5V Tolerant Pin
17	PC9	5V Tolerant Pin
18	PC10/	5V Tolerant Pin
19	PC11/I2C0_SDA/US0_TX	UART _TX for CEL Mini Module Compatibility 5V Tolerant Pin
20	PF4/I2C0_SCL/US0_RX	UART _RX for CEL Mini Module Compatibility 5V Tolerant Pin
21	PF0/JTCK/SWCLK	Serial Programming Clock line/5V Tolerant Pin
22	PF2/JTDO/SWO	5V Tolerant Pin
23	PF3/JTDI	5V Tolerant Pin
24	PF1/JTMS/SWDIO	Serial Programming Data IO/5V Tolerant Pin
25	PF5	5V Tolerant Pin
26	PF6/APBY/APAX	5V Tolerant Pin
27	PF7	5V Tolerant Pin
28	PD13/APCY/APDX	
29	PD14/APDY/APCX	
30	PD15/APCY/APDX	
32	RF OUT	Castellation Pin for External Antenna

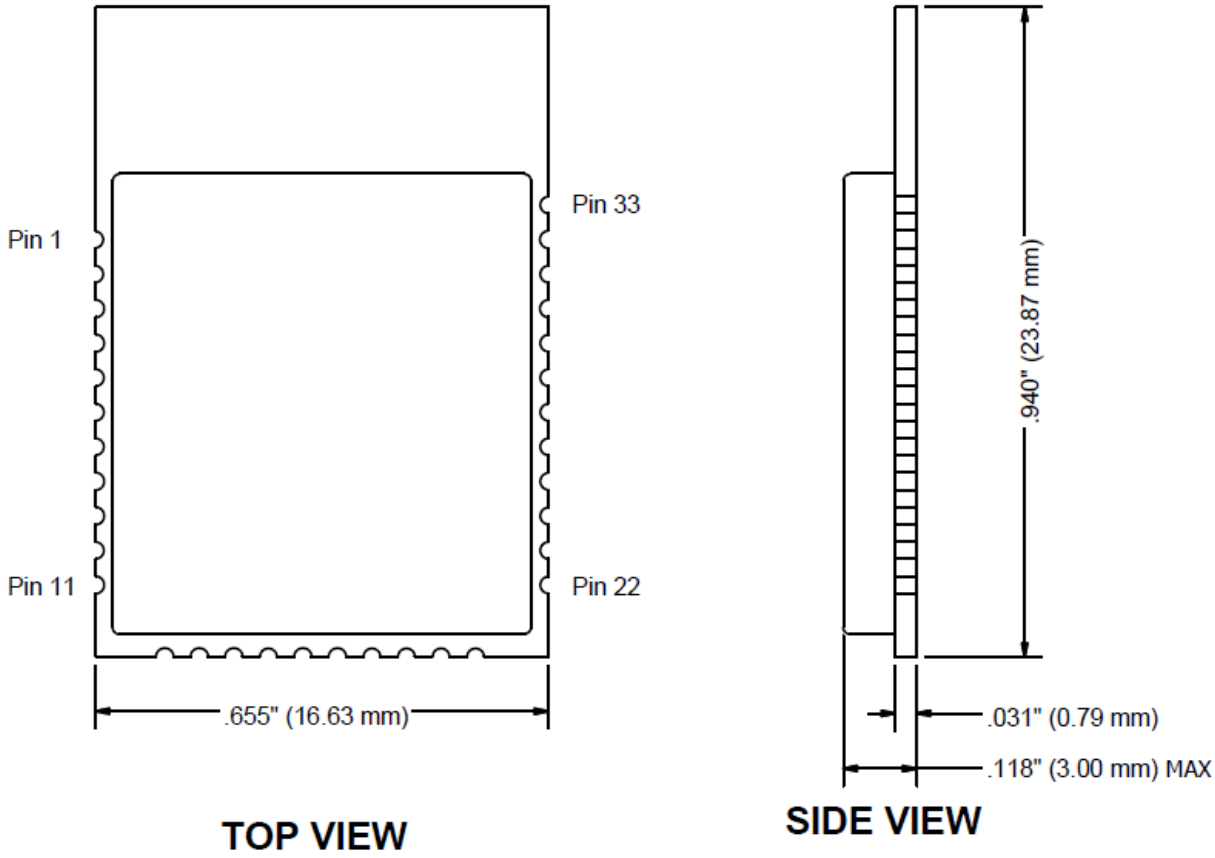
Note: To maintain footprint compatibility with other CEL Mini Modules, EFR32MG12 pins PA4, PD10, PD11, and PD12 were not brought out to castellation pins and are not available.

CEL MINI MODULE COMPATIBILITY

The geometry of the land pattern and location of the RF castellations is identical to CEL's ZICM35x family of ZigBee/Thread and B1010 Bluetooth Smart Mini Modules. The digital and analog mapping to develop a drop-in compatible solution is described below:

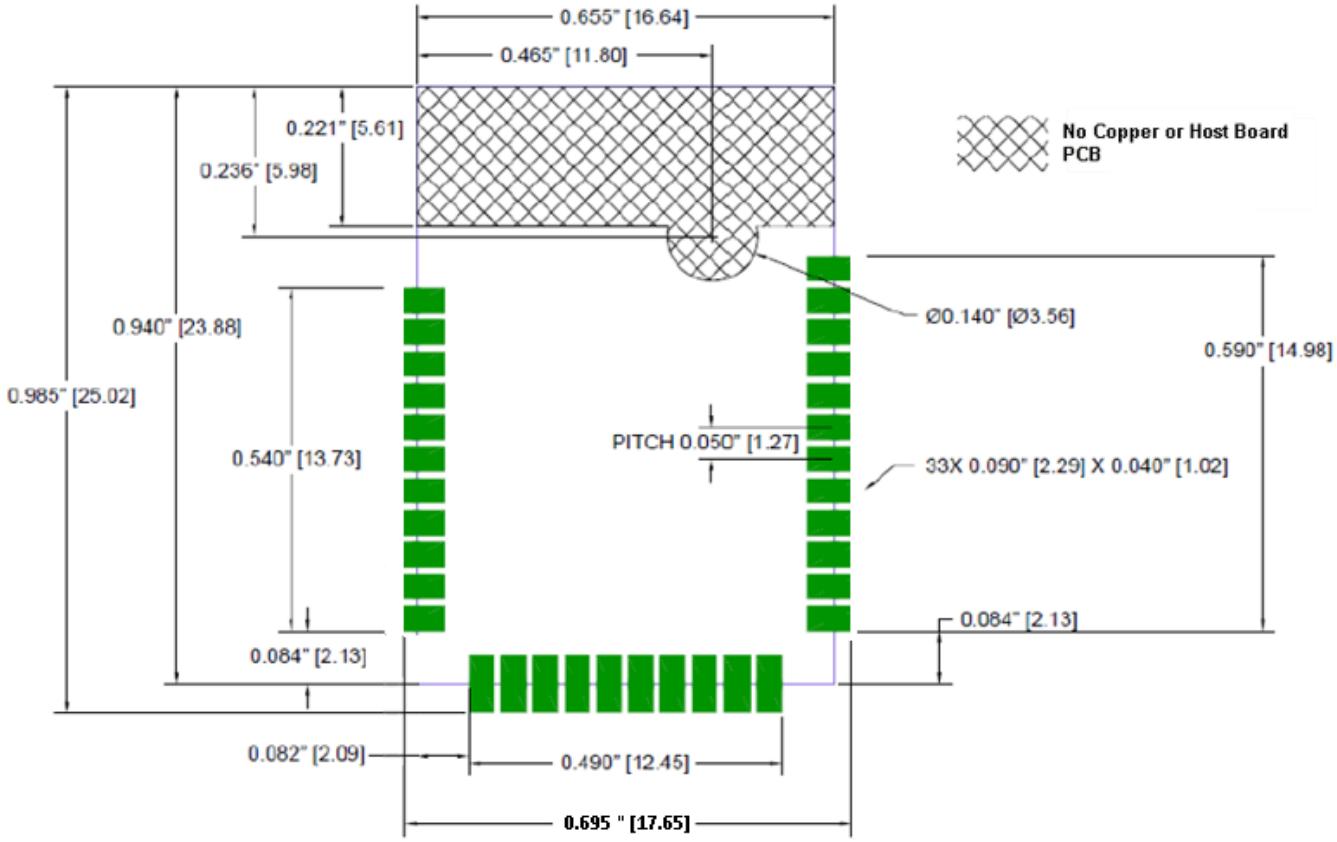
Module Pin #	Function	ZICM35x	B1010	ZB3212F6R4SP2
4	**Reset**	RESET	N/C	RESET
7	**Wake**	PA7	WAKE	PA3
8, 9, 19, 20	**Serial Controller 1**	UART/SPI/I2C	Two wire UART/I2C	USART/I2C
10, 11, 14, 15	**Serial Controller 2**	SPI/I2C	I2C	SPI/I2C
16, 17, 21, 22, 23, 24, 27	**Debug & Programming**	Debug & Programming	Debug & Programming	Debug & Programming
28, 30	**ADC**	PB7, PB5	AIO[1], AIO[2]	PD13, PD15
29	**Timer**	PB6	PIO[11]	PD14

MODULE DIMENSIONS



Note: *All dimensions are ± .005 in (0.12 mm) unless otherwise specified*

MODULE LAND FOOTPRINT



Note: *Refer to the Antenna section in this document for layout recommendations which will yield optimal antenna performance.*

The Land Footprint pads have been reduced so that the amount which extends beyond the module has been reduced from 40 mils to 20 mils. This change can be used on all CEL mini modules and has been found to Improve solderability of the module to the host board

PROCESSING

Recommended Reflow Profile

Parameter Values	
Ramp Up Rate (from $T_{soakmax}$ to T_{peak})	3º/sec max
Minimum Soak Temperature	150ºC
Maximum Soak Temperature	200ºC
Soak Time	60-120 sec
$T_{Liquidus}$	217ºC
Time above $T_{Liquidus}$	60-150 sec
T_{peak}	250ºC
Time within 5º of T_{peak}	20-30 sec
Time from 25º to T_{peak}	8 min max
Ramp Down Rate	6ºC/sec max

Pb-Free Solder Paste

Use of “No Clean” soldering paste is strongly recommended, as it does not require cleaning after the soldering process.

> **Note:** *The quality of solder joints on the castellations ("half vias") where they contact the host board should meet the appropriate IPC Specification. See the Castellated Terminations Section in the latest IPC-A-610 Acceptability of Electronic Assemblies document.*

Cleaning

In general, cleaning the populated module is strongly discouraged. Residuals under the module cannot be easily removed with any cleaning process.

- Cleaning with water can lead to capillary effects where water is absorbed into the gap between the host board and the module. The combination of soldering flux residuals and encapsulated water could lead to short circuits between neighboring pads. Water could also damage any stickers or labels.
- Cleaning with alcohol or a similar organic solvent will likely flood soldering flux residuals into the two housings, which is not accessible for post-washing inspection. The solvent could also damage any stickers or labels.
- Ultrasonic cleaning could damage the module permanently.

The best approach is to consider using a “No Clean” solder paste and eliminate the post-soldering cleaning step.

Optical Inspection

After soldering the module to the host board, consider optical inspection to check the following:

- Proper alignment and centering of the module over the pads
- Proper solder joints on all pads
- Excessive solder or contacts to neighboring pads or vias

Repeating Reflow Soldering

Only a single reflow soldering process is encouraged for host boards.

Wave Soldering

If a wave soldering process is required on the host boards due to the presence of leaded components, only a single wave soldering process is encouraged.

Hand Soldering

Hand soldering is possible. When using a soldering iron, follow IPC recommendations (reference document *IPC-7711*).

Rework

The CEL module can be unsoldered from the host board. Use of a hot air rework tool should be programmable and the solder joint and module should not exceed the maximum peak reflow temperature of 250ºC.

Caution

If temperature ramps exceed the reflow temperature profile, module and component damage may occur due to thermal shock. Avoid overheating.

Warning

Never attempt a rework on the module itself (i.e., replacing individual components); such actions will terminate warranty coverage.

Additional Grounding

Attempts to improve the module or the system grounding by soldering braids, wires or cables onto the module RF shield cover is done at the customer's own risk. The ground pins at the module perimeter should be sufficient for optimum immunity to external RF interference.

AGENCY CERTIFICATIONS

The ZB3212F6R4SP2-1(C) as been assigned the following identification numbers:

- FCC ID: W7Z-WD907102
- IC ID: 8254A-WD907102

In addition this device was certified as a composite BLE and Zigbee device meaning the module can be used with either protocol and reference the same ID's listed above.

FCC Compliance Statement Part 15.19, Section 7.15 of RSS-GEN

This device complies with Part 15 of the FCC Rules and with Industry Canada licence-exempt RSS Standards. 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.

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.

Warning (Part 15.21)

Changes or modifications not expressly approved by CEL could void the user's authority to operate the equipment.

20cm Separation Distance

To comply with FCC/IC RF exposure limits for general population/uncontrolled exposure, the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20cm from all persons and must not be operated in conjunction with any other antenna or transmitter.

OEM Responsibility to the FCC and IC Rules and Regulations

The CEL Mini Module has been certified per FCC Part 15 Rules and to Industry Canada license exempt RSS Standards for integration into products without further testing or certification. To fulfill the FCC and IC certification requirements, the OEM of the CEL Module must ensure that the information provided on the CEL label is placed on the outside of the final product. The CEL Mini Module is labeled with its own FCC ID number and IC ID number. If the FCC ID and the IC ID are 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. The exterior label can use wording such as the following

"Contains Transmitter Module FCC ID: W7Z-WB4343S"
"Contains Transmitter Module IC: 8254A-WB4343S"

The OEM of the CEL Mini Module may only use the approved antennas (PCB Trace Antenna) that have been certified with this module. The OEM of the CEL Mini Module must test their final product configuration to comply with Unintentional Radiator Limits before declaring FCC Compliance per Part 15 of the FCC Rules.

IC Certification — Industry Canada Statement

The term "IC" before the certification/registration number only signifies that the Industry Canada technical specifications were met.

Certification IC — Déclaration d'Industrie Canada

Le terme "IC" devant le numéro de certification/d'enregistrement signifie seulement que les spécifications techniques Industrie Canada ont été respectées.

Section 14 of RSS-210

The installer of this radio equipment must ensure that the antenna is located or pointed such that it does not emit RF field in excess of Health Canada limits for the general population. Consult Safety Code 6, obtainable from Health Canada's website: http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/radio_guide-lignes_direct-eng.php

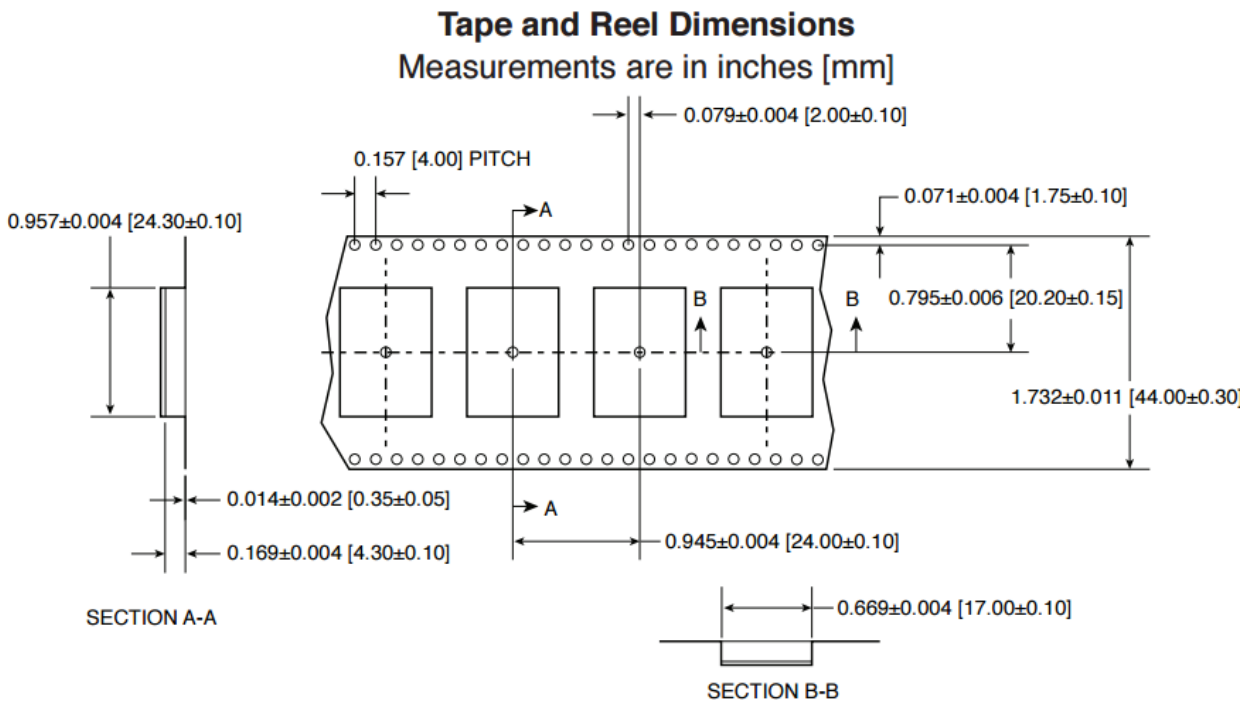
L'article 14 du CNR-210

Le programme d'installation de cet équipement radio doit s'assurer que l'antenne est située ou orientée de telle sorte qu'il ne pas émettre de champ RF au-delà des limites de Santé Canada pour la population générale. Consulter le Code de sécurité 6, disponible sur le site Web de Santé Canada: http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/radio_guide-lignes_direct-eng.php

SHIPMENT, HANDLING AND STORAGE

Shipment

The CEL modules are delivered in reels of 600 units. The reel diameter is 12.992 inches (330mm).



Handling

The CEL modules are designed and packaged to be processed in an automated assembly line.

Warning

The CEL modules contain highly sensitive electronic circuitry. Handling without proper ESD protection may destroy or damage the module permanently.

Warning

The CEL modules are moisture-sensitive devices. Appropriate handling instructions and precautions are summarized in J-STD-033. Read carefully to prevent permanent damage due to moisture intake.

Moisture Sensitivity Level (MSL)

MSL 3, per J-STD-033

Storage

Storage/shelf life in sealed bags is 12 months at <40°C and <90% relative humidity.

QUALITY

CEL modules offer the highest quality at competitive prices. Our modules are manufactured in compliance with the IPC-A-610 specification, Class II. Our modules go through JESD22 qualification processes which includes high temperature operating life tests, mechanical shock, temperature cycling, humidity and reflow testing.

CEL builds the quality into our products, giving our customers confidence when integrating our products into their systems.

REVISION HISTORY

Previous Versions	Changes to Current Version	Page(s)
0020-00-07-00-000 (Preliminary) September 2017	Initial Preliminary Data Sheet	N/A
0020-00-07-00-000 (Preliminary) November 2017	Reorganized content, Updated Sensitivity Table, added note regarding Crystal Trim Values, added comment about programming	5-6
0020-00-07-00-000 (Preliminary) March 2018	Updated the CTUNE default value, updated certification information	6, 12
0020-00-07-00-000 Issue B, July 2019	Removed Preliminary, corrected Description on Ordering Information, updated as CEL	All, 3

DISCLAIMER

FOR MORE INFORMATION

For more information about CEL products and solutions, visit our website at
http://www.cel.com/inquiry.do?command=inquiryForm&id=6.

TECHNICAL ASSISTANCE

For Technical Assistance, visit WirelessModules@cel.com.