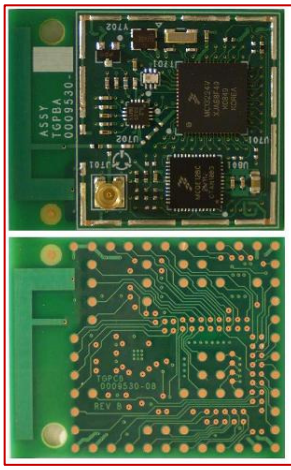
2.4GHz ZigBee Module - Smart Energy 2.0 Compliant

DESCRIPTION

The ZIM module provides a high performance and cost effective RF transceiver solution for 2.4 GHz IEEE 802.15.4, ZigBee, and Zigbee PRO wireless networks with Smart-Energy 2.0 requirements.

The ZIM module combines the Freescale™ MC13224V transceiver platform with a QE128 microprocessor and includes an on-board 100mW Power Amplifier. Ideal for remote sensing, AMR/AMI, home and building automation, industrial control, and security applications, ZIM-B combines extensive processing capability with high output power and low power consumption.

The processing power of the MC13224V enables the ZIM-B to provide a level of integration unprecedented in a ZigBee module. The 32-bit ARM7TDMI processor and expansive on-chip memory enable designers to eliminate the peripheral host processors often required by 8- and 16-bit transceiver solutions. This high level of integration reduces component count, lower power consumption and overall system costs.



ZIM

- Transmit Power: 100 mW
- Receive Sensitivity: -95 dBm
- Freescale MC13224V platform
- 256 kB Serial Flash Memory
- 96 kB SRAM
- 80 kB ROM
- 32-bit ARM7TDMI-based MCU
- 46 GPIO Pins

FEATURES

- Smart-Energy 2.0 “ready”
- Powerful 32-bit ARM7TDMI based microprocessor
- Extensive on-board memory resources
- Up to 100mW output power (+20dBm)
- Miniature footprint: 1.2” x 1.5” (30.5 mm x 38.1 mm)
- Integrated PCB trace antenna
- Optional external antenna
- 16 RF channels
- Over 4000 feet of range (Outdoor LOS)
- AES 128-bit encryption
- Low power consumption
- FCC and IC certifications pending
- RoHS compliant
- Security
- SW Development Kits for Home Automation, Smart Energy and other application profiles
- “Connector-less” host-board interface

APPLICATIONS

- Automated Meter Reading
- Industrial Controls
- Food processing controls
- Traffic Management
- Sensor Networks
- Asset Management
- Barcode reader
- Patient Monitoring
- Glucose monitor
- In meter applications
- Thermostats
- In-home display units
- Home & Building Automation

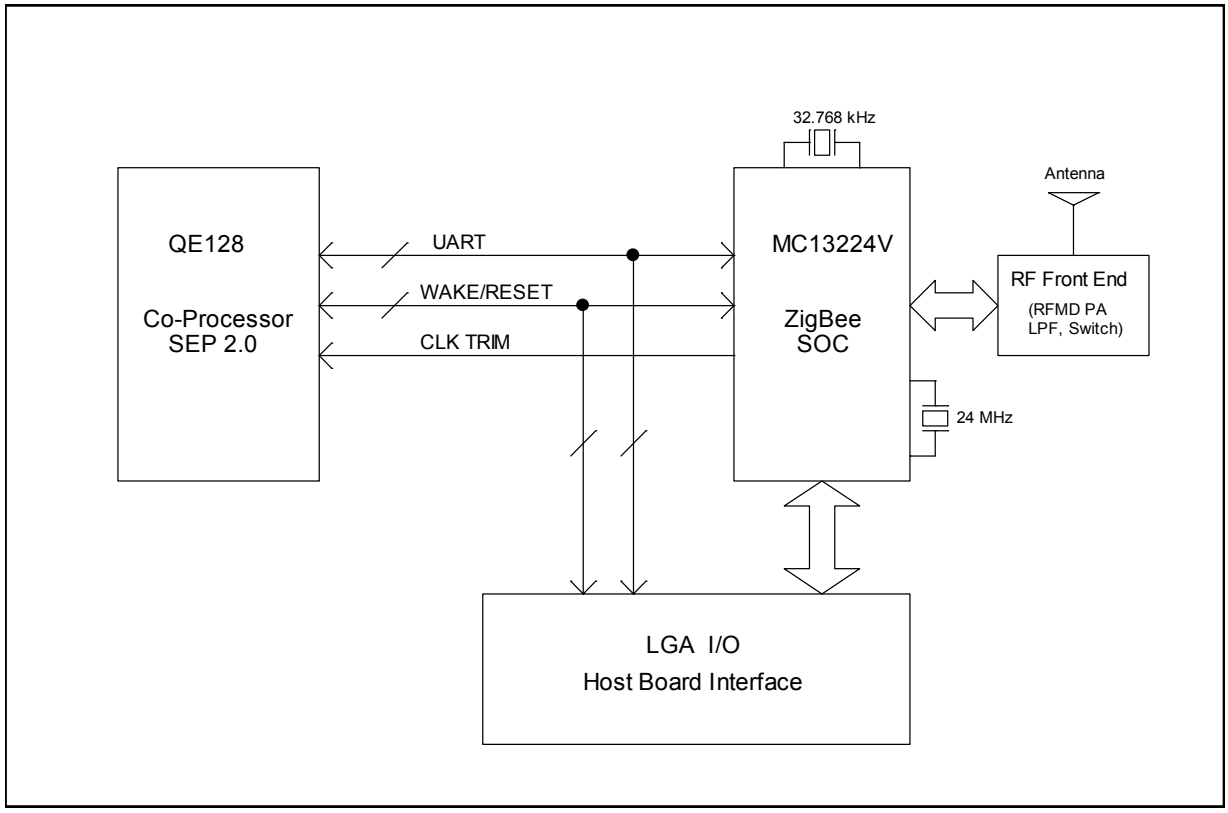
ORDERING INFORMATION

Part Number : ZIM-B/C-WWW-XX-YYYY-ZZ

- Host Interface : B = Land Grid Array, C = Castellation
- WWW : 001 = MC13224V, 002 = MC13224V + QE128, 003 = MC13224V + QE96, 004 = MC13224V + QE64
- With power amp installed, XX = ER. With no power amp, XX = 00.
- With MMCX connector installed, YYYY=EXTA. With inverted-F antenna, YYYY=INTA.
- ZZ = Optional Designators TBD (e.g. Home Automation part? SE1.0? SE2.x?)

Example : 100 mW Output power, Land Grid Array, PCB Trace Antenna, with QE128 (Smart-Energy 2.0) = ZIM-B-002-ER-INTA

ZIM BLOCK DIAGRAM



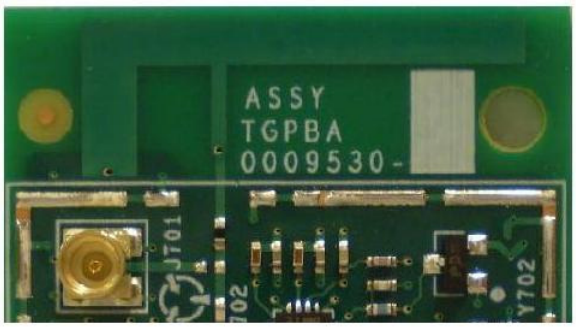
MICROPROCESSOR

The primary component of the ZIM module is Freescale's third generation ZigBee platform. It incorporates a complete, low power, 2.4GHz radio frequency transceiver, 32-bit ARM7TDMI-based microprocessor, hardware acceleration for both IEEE 802.15.4 MAC and AES security plus a full suite of processor peripherals.

The MC13224V architecture offers superior processing power for ZigBee applications. The core operates up to 26 MHz. An 80 kByte ROM is utilized for the low level IEEE 802.15.4 MAC and Physical layer commands. This off loads the Flash memory, leaving more space for the end user application. The MC13224V supports 128 kBytes of Flash memory. The program code is mirrored in 96 kBytes of RAM for faster execution by the processor core. A full set of peripherals and Direct Memory Access (DMA) capability for transceiver packet data are also included.

In addition, the MC13224V provides extensive power savings options. options, including low current sleep modes allowing for maximum operating life when battery-powered.

ANTENNA



ZIM modules include 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. See Ordering Information on page 1.

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. Correctly positioned, the ground plane on the host board under the module will 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 affects 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.

MODES OF OPERATION

ZIM power management is controlled through the Freescale MC13224V's Clock and Reset Module (CRM). The CRM is a dedicated module to handle clock, reset, and power management functions including control of the power regulators. All these functions have direct impact on attaining the lowest power.

The ZIM module supports three modes of operation: Active, Doze and Hibernation. The latter two modes are the low-power sleep modes.

Active Mode

In this mode all functions / features are operating normally.

Doze Mode

Doze mode provides significant reduction in power consumption while still maintaining a high degree of sleep timing accuracy. In Doze mode, the reference oscillator of the processor continues to operate normally.

Hibernation Mode

Hibernation mode provides the greatest reduction in power consumption however the sleep timing accuracy is not as precise as in Doze mode.

The CRM manages the recovery from the low-power modes, similar to power-up from reset, providing regulator and clock management.

The module can be awoken from the low-power modes in 3 ways, wake-up can occur:

- On external interrupts through any of the 4 Keyboard Interface inputs
- From internal interrupts
- On the Real Time (wake-up) timer interrupt

For more detail information on modes of operation refer to Freescale's MC13224V datasheet available at Freescale's website (www.freescale.com)

HOST-BOARD

A host-board for evaluation purposes is available for configuring and testing the ZIM module. This host board has a USB interface for connection to a PC whereby SMAC commands can be sent via HyperTerminal.

INTERFACE

The ZIM module has all major pins routed to the host-board interface, this includes, but is not limited, to the pins for JTAG, serial communication, A/D, etc.

HOST PROTOCOL INTERFACE COMMANDS

Jabil provides the Host Serial and RF Protocols document which details the protocols and commands between the Host processor (i.e. an external microprocessor, a PC, etc.) and the ZIM module. An example of the commands, but not limited to, included in the host protocol interface are as follows:

- Query Version (MAC version, SMAC version, etc)
- Set RF Channel
- Set RF Power
- Transmit Packet Error Test

For more detail refer to Jabil ZIM Test SMAC Application User's Guide ZIM_Test_SMAC_AUG

ABSOLUTE MAXIMUM RATINGS

Description	Min	Max	Unit
Power Supply Voltage	-0.3	3.6	VDC
Voltage on Any Digital Pin	-0.3	VCC + 0.2	VDC
RF Input Power		10	dBm
Storage Temperature Range	-45	125	°C
Reflow Soldering Temperature		260	°C

Note: Exceeding the maximum ratings may cause permanent damage to the module.

RECOMMENDED OPERATING CONDITIONS

Description	Min	Typ	Max	Unit
Power Supply Voltage (VCC)		3.3 *		VDC
Ambient Temperature Range	-40	25	85	°C
Crystal Reference Oscillator		24		MHz

DC CHARACTERISTICS *(@ 25°C, VCC = 3.3V unless otherwise noted)*

Description	Typ	Max	Unit
Transmit Mode Current (at +20 dBm Output Power)	193		mA
Receive Mode Current	30		mA
Hibernate or Doze Mode Current	5		µA

* To meet FCC compliance, the end-user must provide a regulated 3.3 VDC ± 1% voltage source to Vcc.

RF CHARACTERISTICS *(@ 25°C, VCC = 3.3V unless otherwise noted)*

Parameter	Min	Typ	Max	Unit
General Charcteristics				
RF Frequency Range	2400		2483.5	MHz
RF Data Rate		250		kbps
Transmitter				
Nominal Output Power		20		dBm
Programmable Output Power Range		18		dB
Error Vector Magnitude		8	35	%
Receiver				
Receiver Sensitivity (1% PER)	-92	-95		dBm
Saturation (Maximum Input Level) (1% PER)	0			dBm
802.15.4 Adjacent Channel Rejection (±5 MHz)	35	40		dB
802.15.4 Alternate Channel Rejection *(±10 MHz)*		50		dB

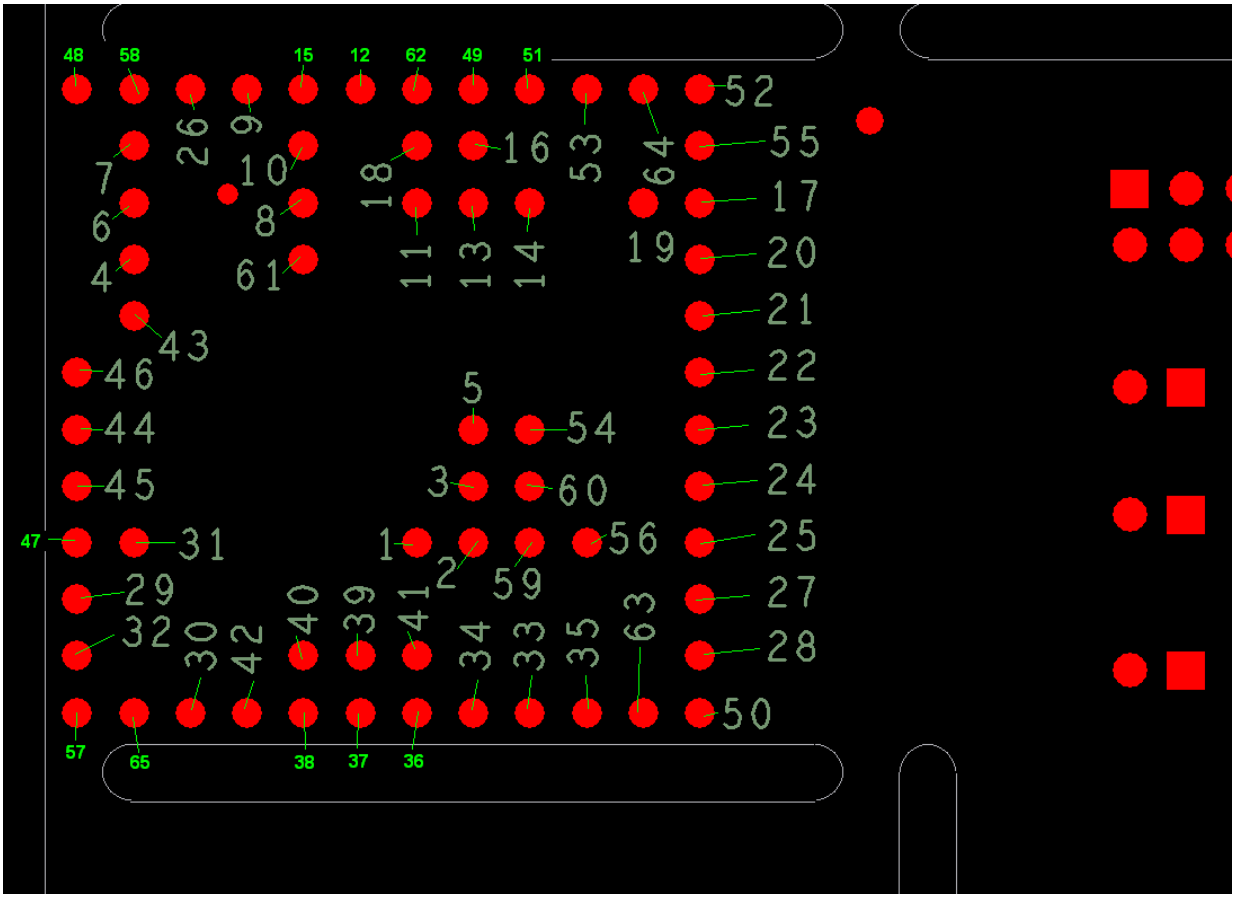
ZIM I/O PIN ASSIGNMENTS

Pin	Name	MC13224 Pin		Description
		Number	Name	
1	ZIM_ADC0	1	ADC0	ADC analog input Channel 0/GPIO30
2	ZIM_ADC1	2	ADC1	ADC analog input Channel 0/GPIO31
3	ZIM_ADC2	3	ADC2	ADC analog input Channel 0/GPIO32
4	ZIM_ADC3	4	ADC3	ADC analog input Channel 0/GPIO33
5	ZIM_ADC4	5	ADC4	ADC analog input Channel 0/GPIO34
6	ZIM_ADC5	6	ADC5	ADC analog input Channel 0/GPIO35
7	ZIM_ADC6	7	ADC6	ADC analog input Channel 0/GPIO36
8	ZIM_ADC7	8	ADC7_RTCK	ADC analog input Channel 0/ReTurn ClocK/GPIO37
9	ZIM_TDO	9	TDO/GPIO49	JTAG debug port serial data output
10	ZIM_TDI	10	TDI/GPIO48	JTAG debug port serial data input
11	ZIM_TCK	11	TCK/GPIO47	JTAG debug port clock input
12	ZIM_TMS	12	TMS/GPIO46	JTAG debug port test mode select input
13	ZIM_UART2_RTS	13	UART2_RTS	UART2 RTS control input/GPIO21
14	ZIM_UART2_CTS	14	UART2_CTS	UART2 CTS control output/GPIO20
15	ZIM_UART2_RX	15	UART2_RX	UART2 RX receive data input/GPIO19
16	ZIM_UART2_TX	16	UART2_TX	UART2 TX transmit data output/GPIO18
17	ZIM_UART1_RTS	17	UART1_RTS	UART1 RTS control input/GPIO17
18	ZIM_UART1_CTS	18	UART1_CTS	UART1 CTS control output/GPIO16
19	ZIM_UART1_RX	19	UART1_RX	UART1 RX receive data input/GPIO15
20	ZIM_UART1_TX	20	UART1_TX	UART1 TX transmit data output/GPIO14
21	ZIM_I2C_SDA	21	I2C_SDA	I2C bus signal SDA/GPIO13
22	ZIM_I2C_SCL	22	I2C_SCL	I2C bus signal SCL/GPIO12
23	ZIM_TMR3	23	TMR3	Counter output or input clock/GPIO11
24	ZIM_TMR2	24	TMR2	Counter output or input clock/GPIO10
25	ZIM_TMR1	25	TMR1	Counter output or input clock/GPIO9
26	ZIM_TMR0	26	TMR0	Counter output or input clock/GPIO8
27	ZIM_SPI_SCK	27	SPI_SCK	SPI port Clock/GPIO7
28	ZIM_SPI_MO	28	SPI_MOSI	SPI port master out/GPIO6
29	ZIM_SPI_MI	29	SPI_MISO	SPI port master in/GPIO5

30	ZIM_SPI_SS	30	SPI_SS	SPI port slave select/GPIO4
31	ZIM_SSI_BITCK	31	SSI_BITCK	SSI TX/RX clock/GPIO3
32	ZIM_SSI_FSYN	32	SSI_FSYN	SSI frame sync for data/GPIO2
33	ZIM_SSI_RX	33	SSI_RX	SSI RX data input/GPIO1
34	ZIM_SSI_TX	34	SSI_TX	SSI TX data output/GPIO0
35	ZIM_KBI7	35	KBI_7	Keyboard interface bit 7/GPIO29
36	ZIM_KBI6	36	KBI_6	Keyboard interface bit 6/GPIO28
37	ZIM_KBI5	37	KBI_5	Keyboard interface bit 5/GPIO27
38	ZIM_KBI4	38	KBI_4	Keyboard interface bit 4/GPIO26
39	ZIM_KBI3	39	KBI_3	Keyboard interface bit 3/GPIO25
40	ZIM_KBI2	40	KBI_2	Keyboard interface bit 2/GPIO24
41	ZIM_KBI1	41	KBI_1	Keyboard interface bit 1/GPIO23
42	ZIM_KBI0_HSTWK	42	KBI_0_HST_WK	Keyboard interface bit 0/Host Wake Up output/GPIO22
43	ZIM_RESET	51	RESETB	Active low, asynchronous reset
44	ZIM_ADC2_REFL	61	ADC2_REFL	Low ref voltage for ADC2/GPIO39
45	ZIM_ADC1_REFL	62	ADC1_REFL	Low ref voltage for ADC1/GPIO41
46	ZIM_ADC1_REFH	63	ADC1_REFH	High ref voltage for ADC1/GPIO40
47	ZIM_ADC2_REFH	64	ADC2_REFH	High ref voltage for ADC2/GPIO38
48	ZIM_GND	48	VSS	Connect to Ground
49	ZIM_GPIO52	102	MDO01	GPIO52
50	ZIM_GND	50	VSS	Connect to Ground
51	ZIM_GPIO54	111	MDO03	GPIO54
52	ZIM_GND	52	VSS	Connect to Ground
53	ZIM_GPIO56	120	MDO05	GPIO56
54	ZIM_GPIO57	130	MDO06	GPIO57
55	ZIM_GPIO58	129	MDO07	GPIO58
56	ZIM_GPIO59	114	MSEO0_B	GPIO59
57	ZIM_GND	57	VSS	Connect to Ground
58	ZIM_GND	58	VSS	Connect to Ground
59	ZIM_GPIO62	123	EVTO_B	GPIO62
60	ZIM_GPIO63	132	EVTI_B	GPIO63
61	ZIM_WAKE_QE	131	MCKO	GPIO50

62	QE_BDM_BKGD	NA	NA	NA
63	ZIM_VCC	44	BK_FB	Power Input to module
64	ZIM_VCC	45	VBATT	Power Input to module
65	ZIM_VCC	NA	NA	Power Input to module
66	ZIM_VCC	NA	NA	Power Input to module
67- 86	ZIM_GND	75-79, 84-88, 93-97, 104-106, 115	VSS	Connect to ground

ZIM I/O PIN LOCATIONS



SPECIAL RESTRICTIONS / LIMITATIONS

In order to meet certification requirements, RF power, packet length, and DC supply voltage shall adhere to the following restrictions.

RF Power

The ZIM module is limited to +20dBm (power register setting = 0x0C) for channels 13 – 23. In order to comply with emissions requirements, however, the ZIM module must operate at reduced power settings for channels 11-12 and 24-26. The firmware provided with the modules limits users to power level of +10dBm (power register setting = 0x09) for channels 11, 12, 24, & 25 and a power level of +6dBm (power register setting = 0x07) for channel 26.

Packet Length

The firmware also limits the maximum data payload to 106 bytes for any transmitted packet.

DC Supply

To ensure FCC compliance, the end-user must provide a regulated 3.3 VDC $\pm$ 1% voltage source to Vcc.

AGENCY CERTIFICATIONS

FCC Compliance Statement (Part 15.19) Section 7.15 of RSS-GEN

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.

Warning (Part 15.21)

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

This device may only be used with approved antennas that are shipped with the unit and installed per installation instructions. The use of any other antennas will invalidate the unit's FCC Part 15 certification.

This device has been designed to operate with the on-board inverted-F antenna. The use of an external antenna will require authorization. Contact the responsible party for details.

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 permitted for successful communication. Operating the device with the supplied antenna will ensure that this requirement is met.

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.

20 cm 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 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

OEM Responsibility to the FCC Rules and Regulations

The ZIM Module has been certified per FCC Part 15 rules for integration into products without further testing or certification. To fulfill the FCC certification requirements, the OEM using the ZIM Module must ensure that the information provided on the ZIM Label is placed on the outside of the final product. The ZIM Module is labeled with its own FCC ID Number and Industry Canada Certification Number. If these approval numbers 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. This exterior label can use wording such as the following: "Contains Transmitter Module FCC ID: K4U-ZIM-B IC: 2146A-ZIM-B or "Contains FCC ID: K4U-ZIM-B IC: 2146A-ZIM-B.

The OEM using the ZIM Module must only use the approved antenna, (PCB Trace Antenna) that has been certified with this module. The OEM using the ZIM 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.

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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/99ehd-dhm237/index-eng.php

REFERENCES & REVISION HISTORY

Reference Documents

Jabil ZIM Test SMAC Application User's Guide ZIM_Test_SMAC_AUG

FreeScale MC13224V Datasheet

Freescale Semiconductor MC1322x Reference Manual MC1322xRM

Freescale Semiconductor BeeKit™ Quick Start Guide BKWCTKQUG

Freescale Semiconductor BeeKit™ User Guide BKWCTKUG

Freescale Semiconductor Software Driver Reference Manual 22XDRVRRM

Freescale Semiconductor MC1322x Simple Media Access Controller (SMAC) Reference Manual 22xSMACRM

Freescale Semiconductor Simple Media Access Controller (SMAC) User's Guide SMACRM

IAR J-Link and IAR J-Trace user Guide J-Link_J-TraceARM-1

ARM® IAR Embedded Workbench® IDE User Guide UARM-13

Revision History

Previous Versions

Changes to Current Version