

RAK11160 WisDuo LPWAN +Wi-Fi/Bluetooth Module Datasheet

Overview

Description

RAK11160 is a stamp-hole module that integrates Bluetooth, Wi-Fi and LORA technologies. It is designed based on ESP8684H2 (ESP core) and STM32WLE5CCU6 (ST core). The ESP core and the ST core can communicate with each other via the UART interface, while the ST core has the capability to control the CHIP_EN pin of the ESP core through GPIO, with the aim of reducing the sleep current of the entire module.

The default firmware for the ST Core is based on RUI3, while the default firmware for the ESP Core is based on the official Espressif AT command firmware. Therefore, a typical application scenario would involve a customer utilizing an additional MCU to control the wireless data transmission and reception (LoRa, Bluetooth, Wi-Fi) on the RAK11160 through AT commands. The additional MCU can communicate with the low-power UART of the ST core, and by using AT commands, it can instruct the ST core to bypass AT commands to the ESP Core.

Customers also have the option to develop their own firmware by consulting the documentation provided by RUI, STMicroelectronics, or Espressif. In this scenario, either of the two MCUs can serve as the master MCU, with the other acting as the slave MCU. The master MCU can control the slave MCU through the UART interface.

Features

Lora

- **LoRaWAN 1.0.3** specification compliant
- LoRaWAN Activation by OTAA/ABP
- LoRa Point-to-Point (P2P) communication
- Transmitter output power, programmable up to +22 dBm
- -137 dBm for LoRa (BW = 125 kHz, SF = 12)
- TCXO crystal
- LoRa Point-to-Point (P2P) communication

Wi-Fi

- complies with IEEE 802.11b/g/n
- Supports 20 MHz bandwidth in 2.4 GHz band
- 1T1R mode with data rate up to 72.2 Mbps
- Wi-Fi Multimedia
- TX/RX A-MPDU, TX/RX A-MSDU
- Immediate Block ACK
- Fragmentation and defragmentation
- Transmit opportunity (TXOP)
- Automatic Beacon monitoring
- Three virtual Wi-Fi interfaces

- Simultaneous support for Infrastructure BSS in Station mode, SoftAP mode, Station + SoftAP mode, and promiscuous mode
- Antenna diversity

Bluetooth

- Bluetooth LE: Bluetooth 5.0 certified
- High power mode (20 dBm)
- Speed: 125 Kbps, 500 Kbps, 1 Mbps, 2 Mbps
- Advertising extensions
- Channel selection algorithm
- Internal co-existence mechanism between Wi-Fi and Bluetooth to share the same antenna

CPU and Memory

ST Core

- ARM Cortex-M4 32-bit
- 256 kbytes flash memory with ECC
- 64 kbytes RAM

ESP Core

- 32-bit RISC-V single-core processor, up to 120 MHz
- 576 KB ROM
- 272 KB SRAM (16 KB for cache)
- 2 MB In-package flash

Peripheral Interfaces

ST Core

- 20 GPIOs
- LPUART,I2C,SPI,ADC.SWD

ESP Core

- 12 GPIOs (support IO MUX Functions)
- LPUART,I2C,SPI,ADC

Specifications

This section covers the hardware and software specifications of the RAK11160. Also, it includes the block diagram and an updated firmware [link](#) for the RAK11160 WisDuo Module.

Overview

Block Diagram

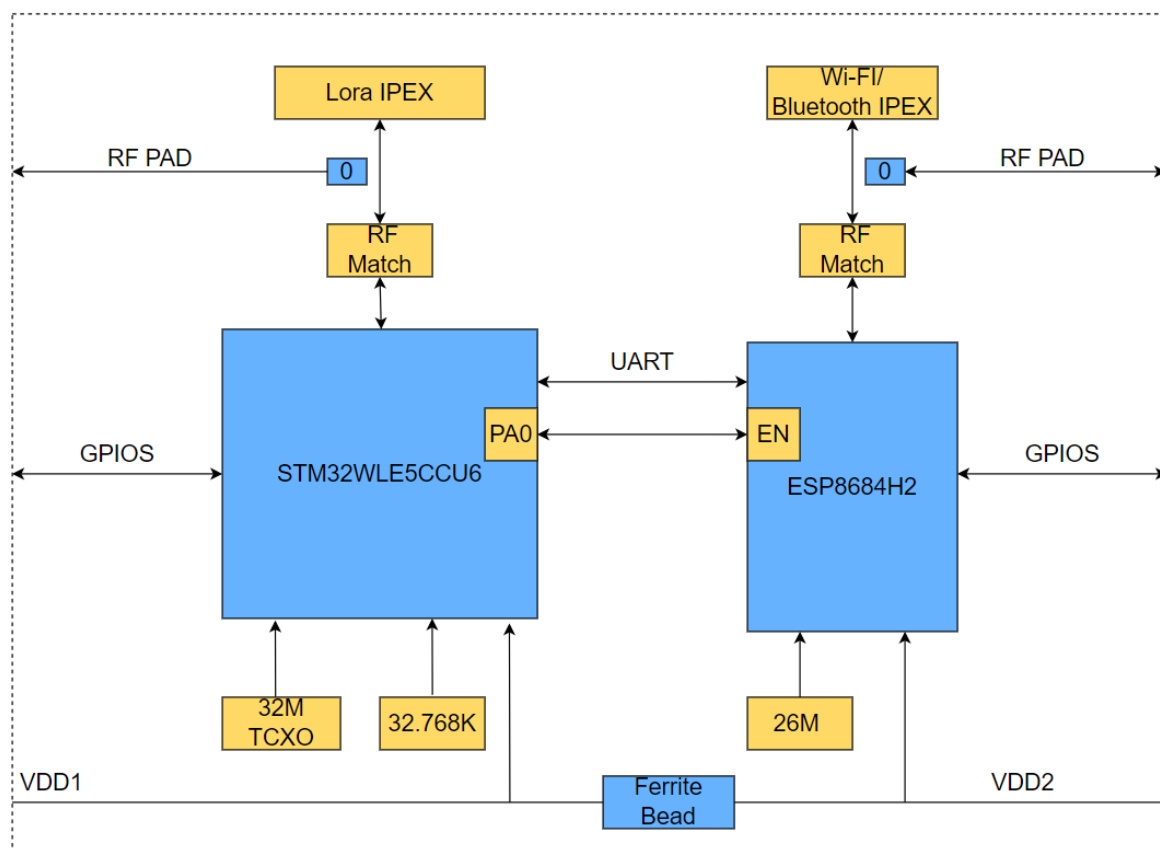


Figure 1: RAK11160 System Block Diagram

Hardware

Pin Definition

Pin No.	Name	Type	Description
1	VDD1	POWER	VDD1 - Voltage Supply
2	GND	POWER	Ground connections
3	ST_PA8	I/O	GPIO ,PA8 of ST core
4	ST_PA9	I/O	GPIO ,PA9 of ST core
5	ST_RST		Reset (NRST) pin of ST core
6	ST_BOOT0		Boot 0 pin of ST core - high active
7	ST_PB2	I/O	GPIO,PB2 of ST core
8	ST_PB12	I/O	GPIO,PB12 of ST core 10 kΩ internally pulled-up for high freq variant or pulled-down for low freq variant
9	ST_PA10	I/O	GPIO,PA10 of ST core

Pin No.	Name	Type	Description
10	ST_PA11/I2C_SDA	I/O	GPIO,PA11 and I2C_SDA of ST core
11	ST_PA12/I2C_SCL	I/O	GPIO,PA12 and I2C_SCL of ST core
12	ST_PA13/SWDIO	I/O	GPIO,PA13 and SWDIO of ST core
13	ST_PA14/SWCLK	I/O	GPIO,PA14 and SWCLK of ST core
14	ST_PA15	I/O	GPIO ,PA15 of ST core
15	GND	POWER	Ground connections
16	RF_Wi-Fi		Wi-Fi RF Port (only available on RAK11160 No-IPEX connector variant)
17	GND	POWER	Ground connections
18	VDD2	POWER	VDD2 - Voltage Supply
19	ESP_GPIO0	I/O	GPIO,GPIO0 of ESP core
20	ESP_GPIO1	I/O	GPIO,GPIO1 of ESP core
21	ESP_GPIO2	I/O	GPIO,GPIO2 of ESP core
22	ESP_GPIO3	I/O	GPIO,GPIO3 of ESP core
23	GND	POWER	Ground connections
24	ESP_GPIO5	I/O	GPIO,GPIO5 of ESP core
25	ESP_GPIO4	I/O	GPIO,GPIO4 of ESP core
26	ESP_GPIO8	I/O	GPIO,GPIO8 of ESP core
27	ESP_GPIO9	I/O	GPIO,GPIO9 of ESP core
28	ESP_GPIO10	I/O	GPIO,GPIO10 of ESP core
29	ESP_GPIO18	I/O	GPIO,GPIO18 of ESP core
30	ESP_GPIO19/U0RXD	I/O	GPIO,GPIO19 and U0RXD of ESP core (ESP Core FW Update)
31	ESP_GPIO20/U0TXD	I/O	GPIO,GPIO20 and U0TXD of ESP core (ESP Core FW Update)
32	ST_PB3	I/O	GPIO,PB3 of ST core
33	ST_PB4	I/O	GPIO,PB4 of ST core
34	ST_PB5	I/O	GPIO,PB5 of ST core
35	ST_PA1	I/O	GPIO,PA1 of ST core
36	GND	POWER	Ground connections

Pin No.	Name	Type	Description
37	GND	POWER	Ground connections
38	RF_Lora		Lora RF Port (only available on RAK11160 No-IPEX connector variant)
39	GND	POWER	Ground connections
40	ST_PA2/UART2_TX	I/O	GPIO,PA2 of ST core Reserved - UART2/LPUART1 Interface (AT Commands and FW Update)
41	ST_PA3/UART2_RX	I/O	GPIO,PA3 of ST core Reserved - UART2/LPUART1 Interface (AT Commands and FW Update)
42	ST_PA4/SPI_NSS	I/O	GPIO,PA4 and SPI NSS of ST core
43	ST_PA5/SPI_SCK	I/O	GPIO,PA5 and SPI SCK of ST core
44	ST_PA6/SPI_MISO	I/O	GPIO,PA6 and SPI MISO of ST core
45	ST_PA7/SPI_MOSI	I/O	GPIO,PA7 and SPI MOSI of ST core

RF Characteristics

LORA

Operating Frequencies

Module	Region	Frequency
RAK11160	Europe	EU868
	North America	US915
	Australia	AU915
	Korea	KR920
	Asia	AS923-1/2/3/4
	India	IN865
	Russia	RU864

TX Power

Transmitter output power, programmable up to +22 dBm.

RX Sensitivity

- -124 dBm for LoRa (BW = 125 kHz, SF = 7)
- -121 dBm for LoRa (BW = 250 kHz, SF = 7)
- -137 dBm for LoRa (BW = 125 kHz, SF = 12)
- -134 dBm for LoRa (BW = 250 kHz, SF = 12)

Wi-Fi

Operating Frequencies

2412 ~ 2484 MHz

TX Power

Rate	Type (dBm)
802.11b, 1 Mbps	21.5
802.11b, 11 Mbps	21.5
802.11g, 6 Mbps	21.5
802.11g, 54 Mbps	19.5
802.11n, HT20, MCS0	21.0
802.11n, HT20, MCS7	19.0

RX Sensitivity

Rate	Type (dBm)
802.11b, 1 Mbps	-99.0
802.11b, 11 Mbps	-90.0
802.11g, 6 Mbps	-94.0
802.11g, 54 Mbps	-77.0
802.11n, HT20, MCS0	-92.5
802.11n, HT20, MCS7	-74.0

Bluetooth

Operating Frequencies

2402 ~ 2480 MHz

Electrical Characteristics

Operating Voltage

Feature	Minimum	Typical	Maximum	Unit
VCC	3.0	3.3	3.6	Volts (V)

RF Current Consumption in Active Mode

The current consumption measurements are taken with a 3.3 V supply at 25 °C of ambient temperature .

Work Mode	Condition	Peak current	Unit
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Work Mode	Condition	Peak current	Unit
Wi-Fi TX	802.11b, 1 Mbps, @22 dBm	370	mA
	802.11g, 54 Mbps, @20 dBm	320	mA
	802.11n, HT20, MCS7, @19 dBm	300	mA
Wi-Fi RX	802.11b/g/n, HT20	65	mA
Bluetooth TX	Bluetooth LE @ 20.0 dBm	320	mA
	Bluetooth LE @ 9.0 dBm	190	mA
	Bluetooth LE @ -15.0 dBm	150	mA
Bluetooth RX	Bluetooth LE	62	mA
Lora TX	+22 dBm@ 868 to 915Mhz	120	mA
	+20 dBm@ 868 to 915Mhz	107.5	mA
	+17 dBm@ 868 to 915Mhz	98	mA
	+14 dBm@ 868 to 915Mhz	92	mA
Lora RX	LoRa 125 kHz	5.46	mA

Sleep Current

The current consumption measurements are taken with a 3.3 V supply at 25 °C of ambient temperature

Feature	Condition	Maximum	Unit
Current Consumption	Supply current in Stop 1 mode RTC disabled	2.8	uA

Mechanical Characteristics

Module Dimensions

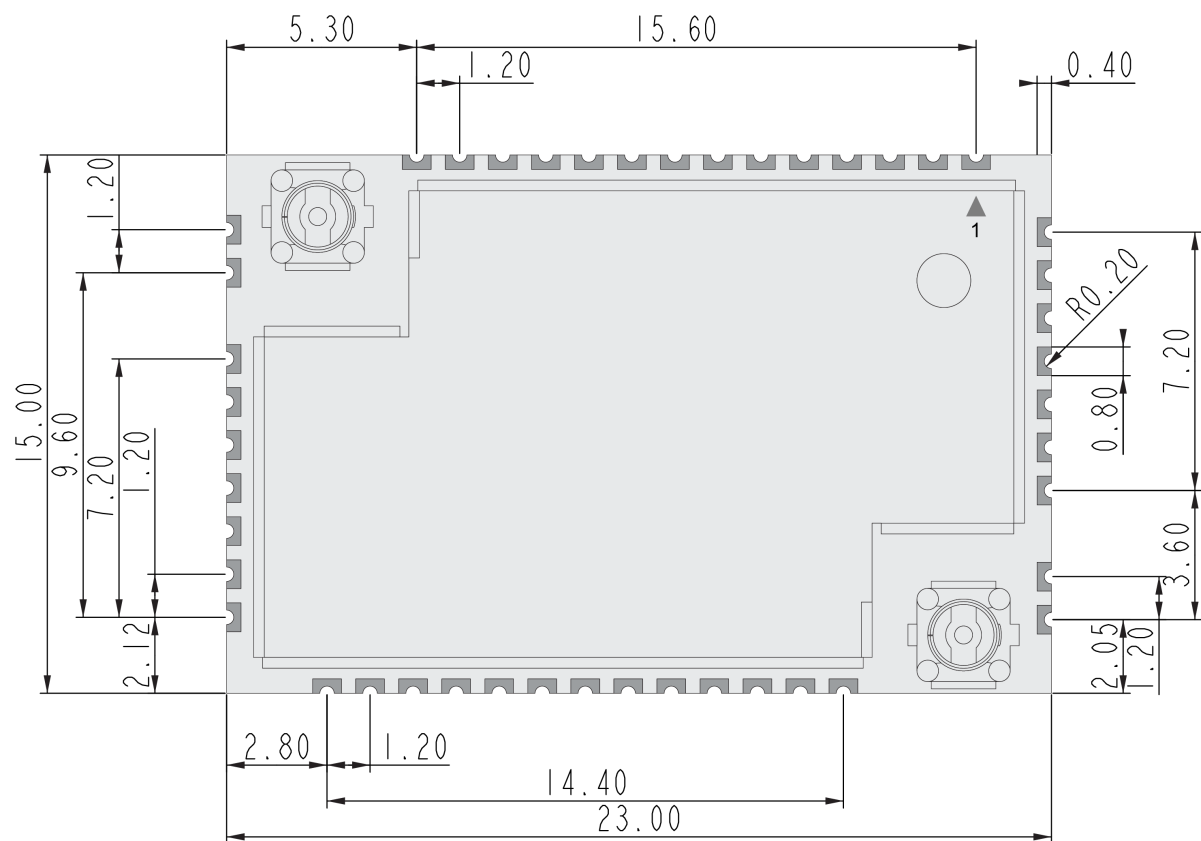


Figure 3: RAK11160 Physical Dimension

Layout Recommendation

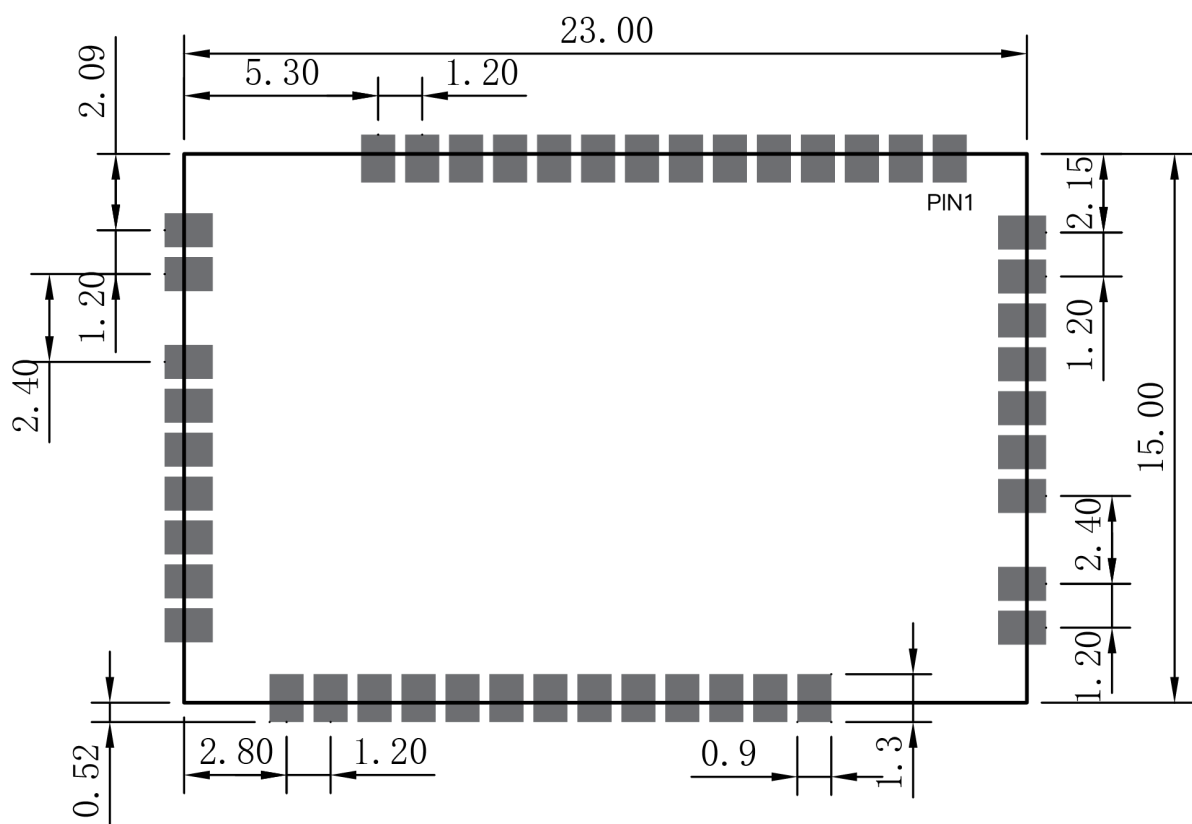


Figure 4: RAK11160 Layout

Environmental Characteristics

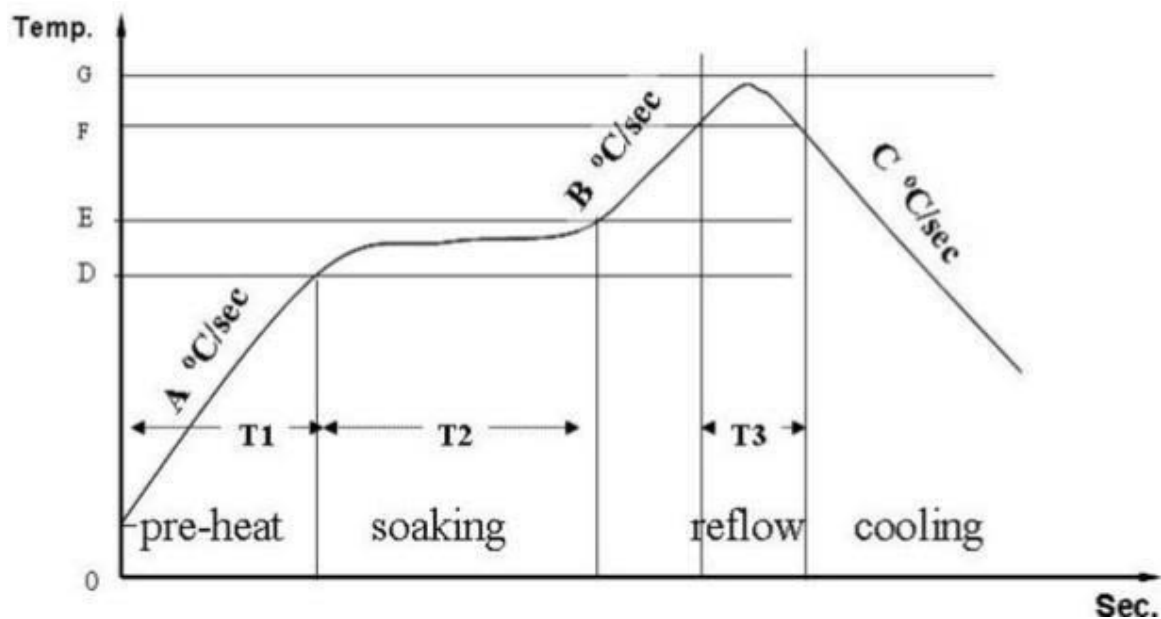
Operating Temperature

Feature	Minimum	Typical	Maximum	Unit
Operating Temperature	-40	-	85	°C

Storage Temperature

Feature	Minimum	Typical	Maximum	Unit
Storage Temperature	-40	-	85	°C

Recommended Reflow Profile



Standard conditions for reflow soldering:

- Pre-heating Ramp (A) (Initial temperature: 150 °C): **1~2.5 °C/sec**
- Soaking Time (T2) (150~180 °C): **60~100 sec**
- Peak Temperature (G): **230~250 °C**
- Reflow Time (T3) (>220 °C): **30~60 sec**
- Ramp-up Rate (B): **0~2.5 °C/sec**
- Ramp-down Rate (C): **1~3 °C/sec**

FCC Warnings

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) this device may not cause harmful interference, and

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

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

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

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Federal Communication Commission (FCC) Radiation Exposure Statement When using the product, maintain a distance of 20cm from the body to ensure compliance with RF exposure requirements.

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

ORIGINAL EQUIPMENT MANUFACTURER (OEM) NOTES

The OEM must certify the final end product to comply with unintentional radiators (FCC Sections 15.107 and 15.109) before declaring compliance of the final product to Part 15 of the FCC rules and regulations. Integration into devices that are directly or indirectly connected to AC lines must add with Class II Permissive Change.

The OEM must comply with the FCC labeling requirements. If the module's label is not visible when installed, then an additional permanent label must be applied on the outside of the finished product which states: "Contains transmitter module FCC ID: 2AF6B-11160. Additionally, the following statement should be included on the label and in the final product's user manual: "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 interferences, and

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

The module is allowed to be installed in mobile and portable applications. A module or modules can only be used without additional authorizations if they have been tested and granted under the same intended end-use operational conditions, including simultaneous transmission operations. When they have not been tested and granted in this manner, additional testing and/or FCC application filing may be required. The most straightforward approach to address additional testing conditions is to have the grantee responsible for the certification of at least one of the modules submit a permissive change application. When having a module grantee file a permissive change is not practical or feasible, the following guidance provides some additional options for host manufacturers. Integrations using modules where additional testing and/or FCC application filing(s) may be required are: (A) a module used in devices requiring additional RF exposure compliance information (e.g., MPE evaluation or SAR testing); (B) limited and/or split modules not meeting all of the module requirements; and (C) simultaneous transmissions for independent collocated transmitters not previously granted together.

This Module is full modular approval, it is limited to OEM installation ONLY. Integration into devices that are directly or indirectly connected to AC lines must add with Class II Permissive Change. (OEM) Integrator has to assure compliance of the entire end product include the integrated Module. Additional measurements (15B) and/or equipment authorizations(e.g. Verification) may need to be addressed depending on co-location or simultaneous transmission issues if applicable.(OEM) Integrator is reminded to assure that these installation instructions will not be made available to the end user.

ISED Warnings

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions:

- (1) this device may not cause interference, and
- (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Cet appareil est conforme avec Industrie Canada RSS exemptes de licence standard(s). Son fonctionnement est soumis aux deux conditions suivantes:

- (1) cet appareil ne peut pas provoquer d'interférences, et
- (2) cet appareil doit accepter toute interférence, y compris celles pouvant causer un mauvais fonctionnement de l'appareil.

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada. Radiation Exposure Statement:

This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

Déclaration d'exposition aux radiations:Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps.