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Wio-E5-LE

LoRa Wireless Module - Powered by STM32WLE5

Datasheet

V1.1

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Content

1 Introduction

Wio-E5-LE, a highly cost-efficient, ultra-compact, and impressively low power LoRaWAN® module. As the newest addition to the Wio-E5 series, the Wio-E5-LE exemplifies power efficiency with an unprecedentedly low power consumption profile, marking a significant improvement over Wio-E5. The energy-saving design of this module makes it an ideal candidate for a wide range of applications that require minimized power usage.

The module uses ST system-level package chip STM32WLE5JC, embedded high-performance LoRa® chip SX126X and ultra-low power Consumption of MCU. The target application of this module is wireless sensor networks and other Internet of Things devices, especially battery-powered low power consumption and long- distance occasions.

This product overview encapsulates the hardware details, performance specifications, and application information pertaining to the Wio-E5-LE module. For an exhaustive description of the module's performance and functionality, please refer to the product specification. For any queries regarding the latest firmware updates, product revisions, or errata, please reach out to Seeed Studio.

The Wio-E5-LE LoRaWAN® module is optimally designed to serve applications that demand long-range communication and ultra-low-power performance. This includes, but is not limited to, wireless meter reading, sensor networks, and other low-power wide -area IoT scenarios.

1.1 Specification

Item	Parameter
Low power consumption	Supply voltage as low as 2.1uA sleep current (WOR mode)
Small size	12mm X 12mm * 2.5mm 28 pins SMT
High performance	TXOP=14dBm@868/915MHz
	-136.5dBm sensitivity for SF12 with 125KHz BW
	158dB link budget, suitable for long distance
	Embedded LoRaWAN® protocol, AT command, support global LoRaWAN® frequency plan

Frequency plan	EU868 US915 AU915 AS923 KR920 IN865
Interface	3*USART 1*I2C 1*ADC 1*SWD

2 Description

The Wio-E5-LE, embedded with the high-performance STM32WLE5JC, is perfectly suited for designing various IoT nodes. It leverages the multi-modal capabilities of the high-performance SX126X chip and supports (G) FSK mode and LoRa®. In the LoRa® mode, bandwidths of 62.5kHz, 125kHz, 250kHz, and 500kHz can be utilized.

Drawing on the robust features and diverse peripherals of the STM32WLE5JC, the Wio-E5-LE module offers UART, I2C, SPI, ADC, and GPIOs, allowing users to select as per their application needs. To upgrade the built-in AT command firmware, a two-wire interface (UART) can be used to program based on the boot mode. Moreover, customers can develop software using the module's internal MCU for program erasure and programming via SWD.

Currently, the Wio-E5 series includes two sub-models: Wio-E5-LE (Single-core STM32WLE5JC integrated with SX126X IP), supporting 14dBm @ HF band (868/915 MHz); Wio-E5 (Single-core STM32WLE5JC integrated with SX126X IP), which supports 22dBm @ HF band (868/915 MHz).

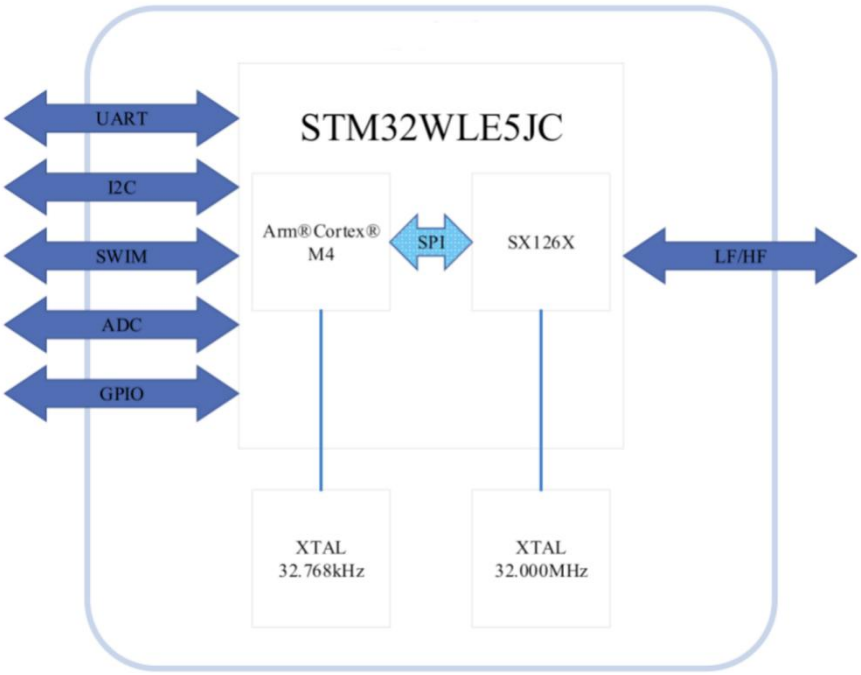


Figure 1 Wio-E5-LE Schematic diagram

2.1 Pin definition

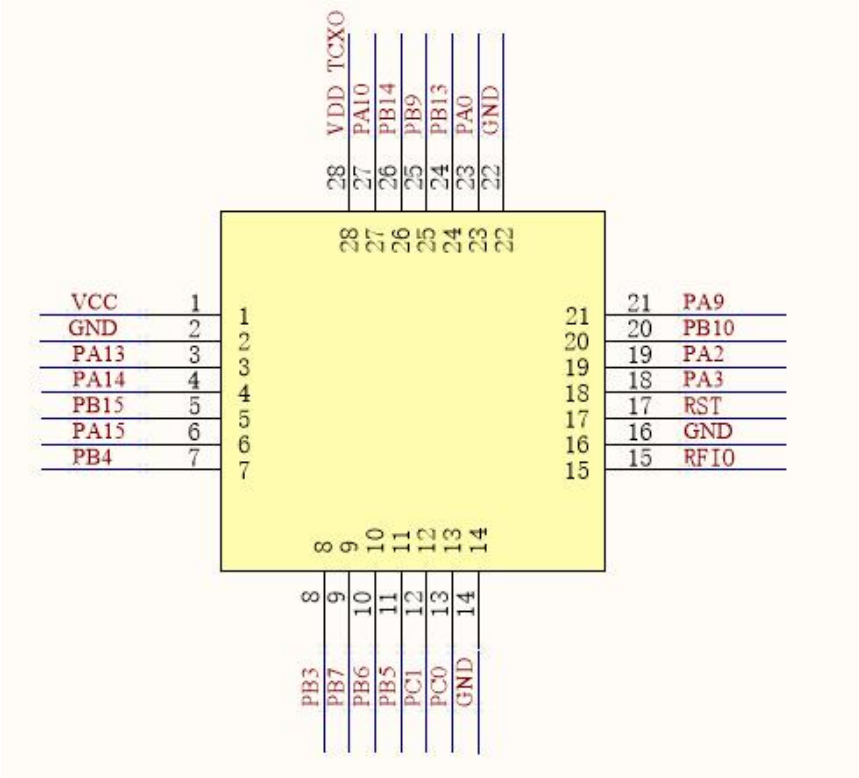


Figure 2 Wio-E5-LE Pin Definition

Table 1 Wio-E5-LE pin out

Number	Name	Type	Description
1	VCC	-	Supply voltage for the module
2	GND	-	Ground
3	PA13	I	SWDIO of SWIM for program download
4	PA14	I/O	SWCLK of SWIM for program download
5	PB15	I/O	SCL of I2C2 from MCU
6	PA15	I/O	SDA of I2C2 from MCU
7	PB4	I/O	MCU GPIO
8	PB3	I/O	MCU GPIO
9	PB7	I/O	UART1_RX from MCU
10	PB6	I/O	UART1_TX from MCU
11	PB5	I/O	MCU GPIO
12	PC1	I/O	MCU GPIO ； LPUART1_TX from MCU
13	PC0	I/O	MCU GPIO ； LPUART1_RX from MCU
14	GND	-	Ground
15	RFIO	I/O	RF input/output
16	GND	-	Ground
17	RST	I/O	Reset trigger input for MCU
18	PA3	I/O	MCU GPIO； USART2_RX from MCU
19	PA2	I/O	MCU GPIO； USART2_TX from MCU
20	PB10	I/O	MCU GPIO
21	PA9	I/O	MCU GPIO
22	GND	-	Ground
23	PA0	I/O	MCU GPIO
24	PB13	I/O	SPI2_SCK from MCU; Boot pin(Active low)
25	PB9	I/O	SPI2_NSS from MCU
26	PB14	I/O	SPI2_MISO from MCU
27	PA10	I/O	SPI2_MOSI from MCU
28	PB0	I/O	Unavailable； Suspended treatment

3 Electrical characteristics

3.1 Extreme Operation conditions

Reaching or exceeding the maximum ratings listed in the table below can cause equipment damage.

Table 2 Absolute Maximum Ratings

Item	Description	min	max	unit
VCC	Power Supply voltage	-0.3	+3.9	V
Temperature	Ambient temperature	-40	+85	℃
P	RF input power	-	+10	dBm

Note: Stresses exceeding the absolute ratings may cause permanent damage. Functional operation is not guaranteed under these conditions. Extended exposure to absolute ratings may adversely affect reliability.

3.2 Normal Operation conditions

Table 3 Recommended Operating Conditions

Item	Description	min	max	unit
VCC	Supply voltage	+1.8	+3.6	V
Top	Ambient temperature	-40	+85	℃
Pop	RF input power	-	+10	dBm

Table 4 Wio-E5-LE 868MHz Currents of varying power levels

Tx Power(dBm)	1	2	3	4	5	6	7
Current(mA)	12.41	13.11	13.84	14.48	15.33	16.29	17.16
Output Power(dBm)	1.161	2.159	3.069	3.863	4.895	6.025	7.014

Tx Power(dBm)	8	9	10	11	12	13	14
Current(mA)	18	19.21	20.36	21.65	22.93	24.5	26.22
Output Power(dBm)	7.88	8.954	9.878	10.814	11.642	12.545	13.461

Table 5 Wio-E5-LE 915MHz Currents of varying power levels

Tx Power(dBm)	1	2	3	4	5	6	7
Current(mA)	11.96	12.55	13.18	13.73	14.42	15.19	15.92
Output Power(dBm)	0.025	1.057	2.005	2.835	3.888	5.036	6.029

Tx Power(dBm)	8	9	10	11	12	13	14
Current(mA)	16.59	17.58	18.51	19.62	20.71	22.04	23.58
Output Power(dBm)	6.914	8.005	8.938	9.909	10.773	11.718	12.694

3.3 Module specifications

Table 6 Wio-E5-LE features

ITEMs	Parameter	Specifications	Unit
Structure	Size	12(W) X 12(L) X 2.5(H)	mm
	Package	28 pins, SMT	
Electrical Characteristics	power supply	3.3V type	V
	Sleep current	2.1uA (WDT on);	uA
	Operation current (Transmitter+MCU)	26mA @14dBm in 868MHz type	mA
		26mA @14dBm in 915MHz type	
	Operation current (Receiver+MCU)	6.7mA @BW125kHz, 868MHz type	mA
		6.7mA @BW125kHz, 915MHz type	
	Output power	14dBm max @868MHz	dBm
		14dBm max @915MHz	
	Sensitivity	@SF12, BW125kHz	dBm
		Fr(MHz) / min / type / max	
		868 / - / -135 / -137	
		915 / - / -135 / -137	
	Harmonics	<-36dBm below 1GHz	dBm
		<-40dBm above 1GHz	dBm
Interface	RFIO	RF port	
	UART	3 group of UART, include 6 pins	
	I2C	1 group of I2C, include 2 pins	
	ADC	1 ADC Input, include 1pins,12-bit 1Msps	
	NRST	Manual reset pin input	
	SPI	1 group of SPI, include 4 pins	

4 Typical RF performance test

4.1 Wio-E5-LE Performance Testing

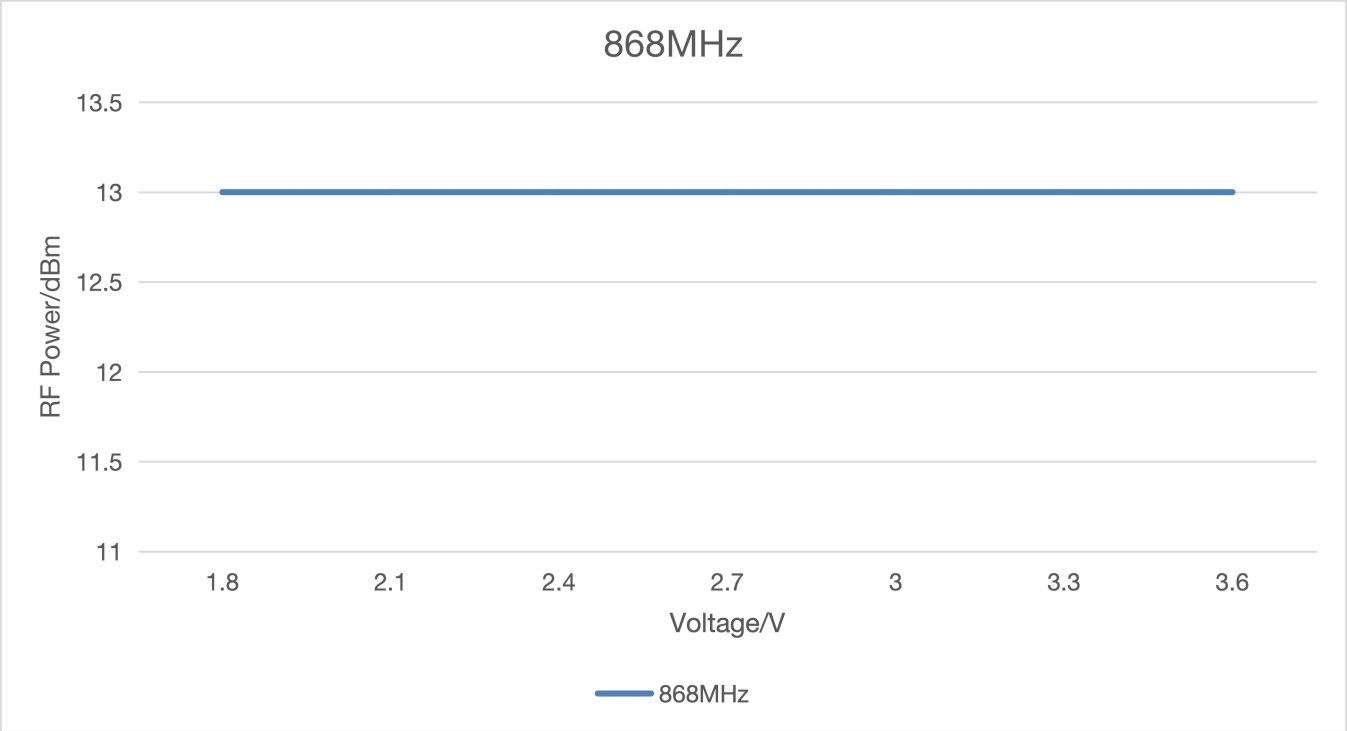


Figure 3 RF Power vs Voltage（868MHz）

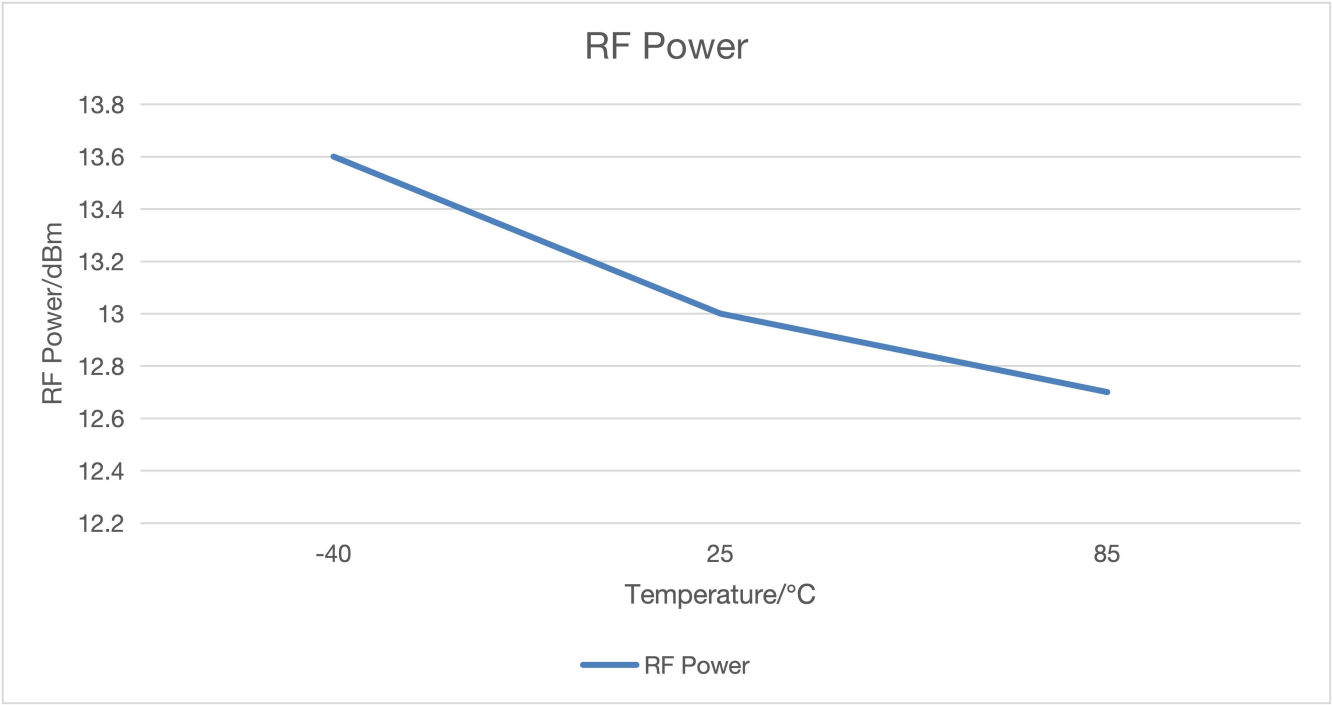


Figure 4 RF Power VS Temperature（868MHz）

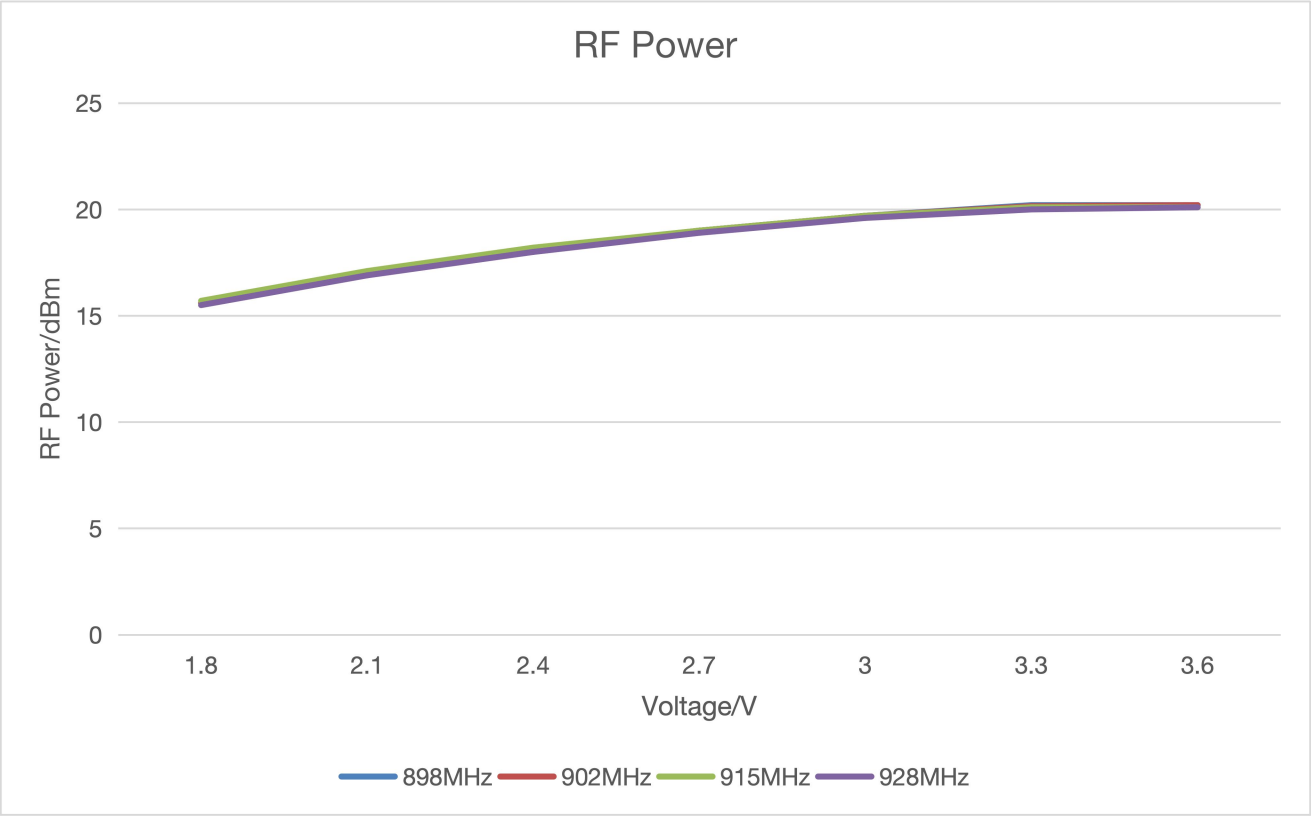


Figure 5 RF Power vs Voltage（898-928MHz）

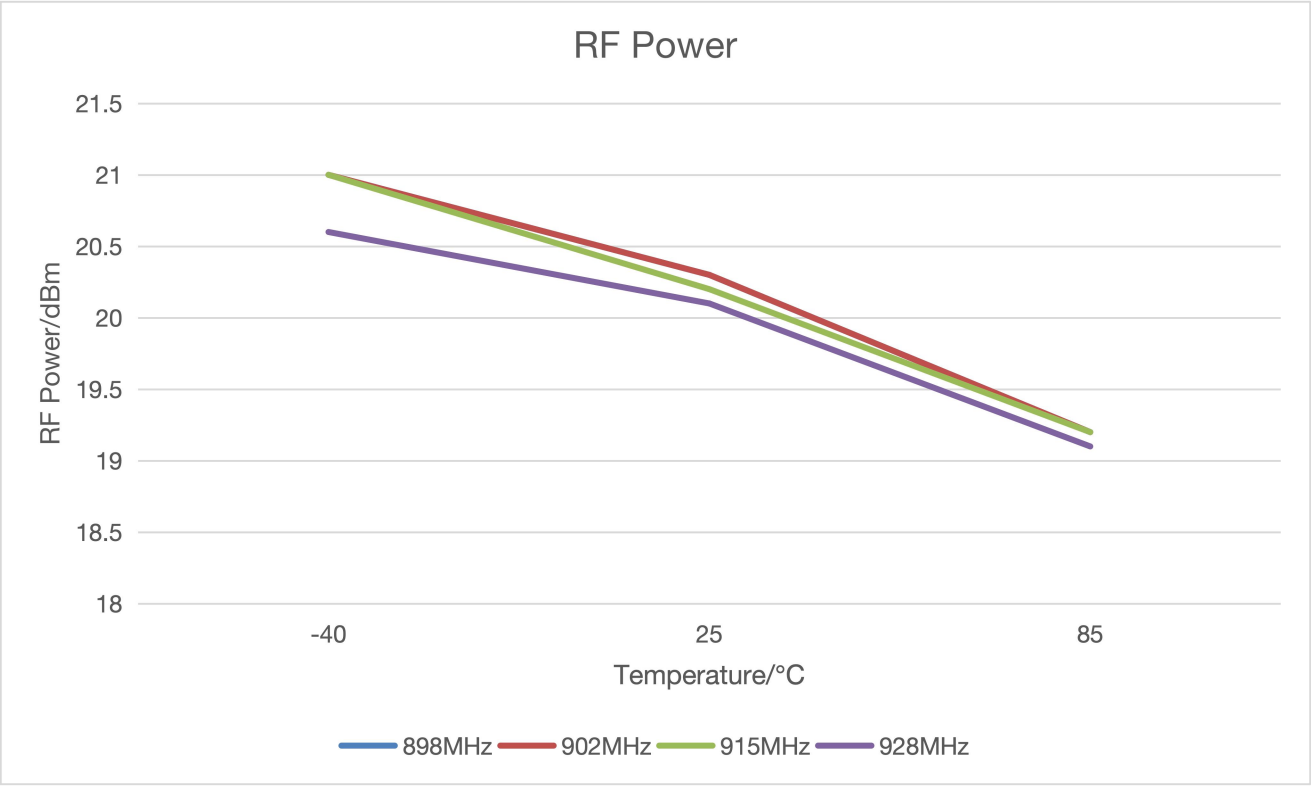


Figure 6 RF Power VS Temperature（898-928MHz）

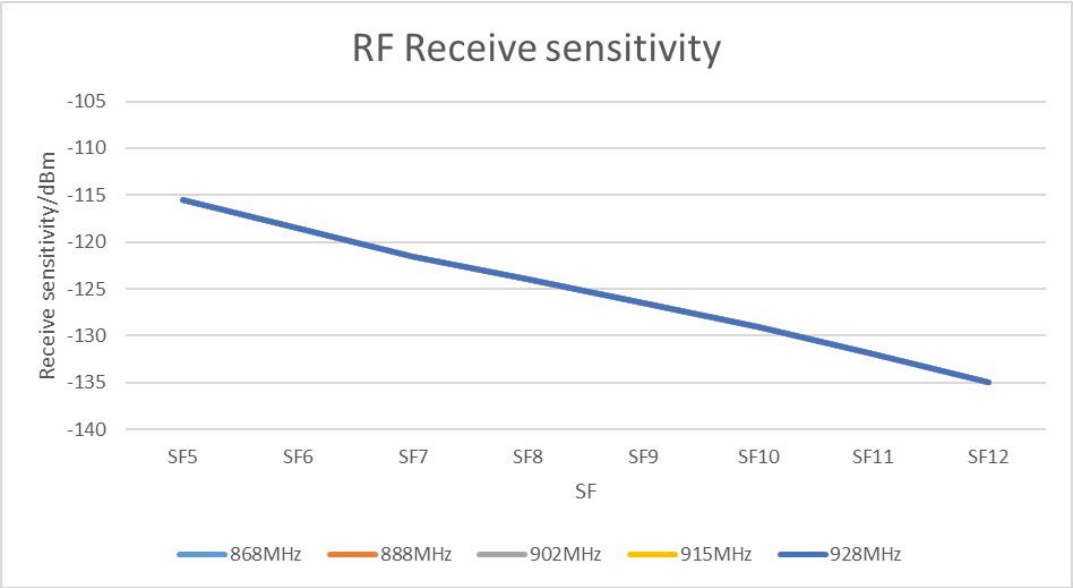


Figure 7 RF Receiver Sensitivity vs Spreading factor（868~928MHz）

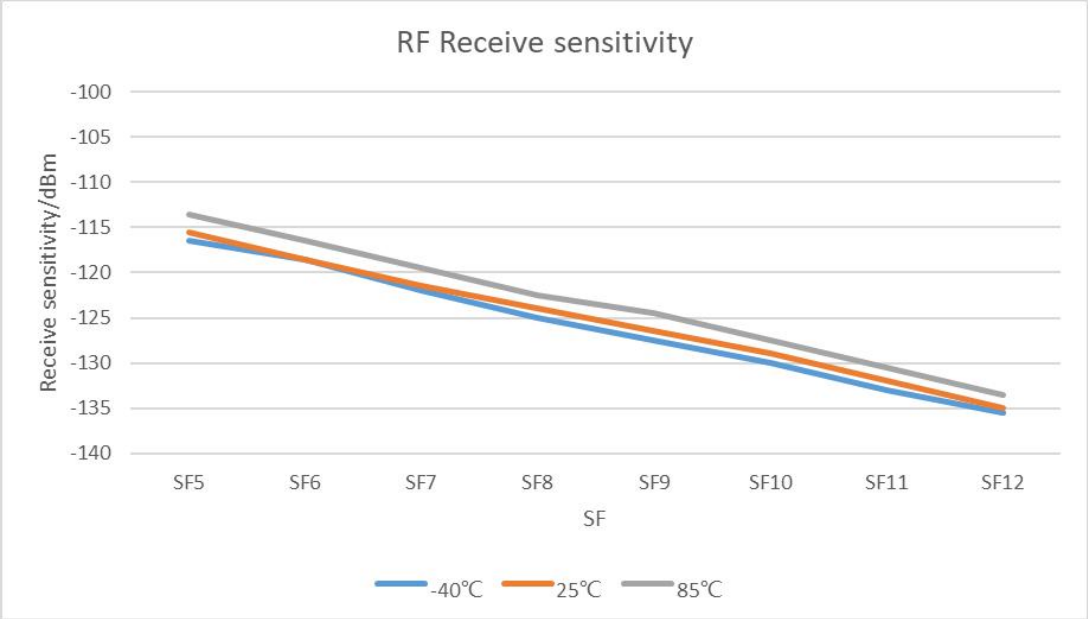


Figure 8 RF Receiver Sensitivity VS Temperature（868MHz）

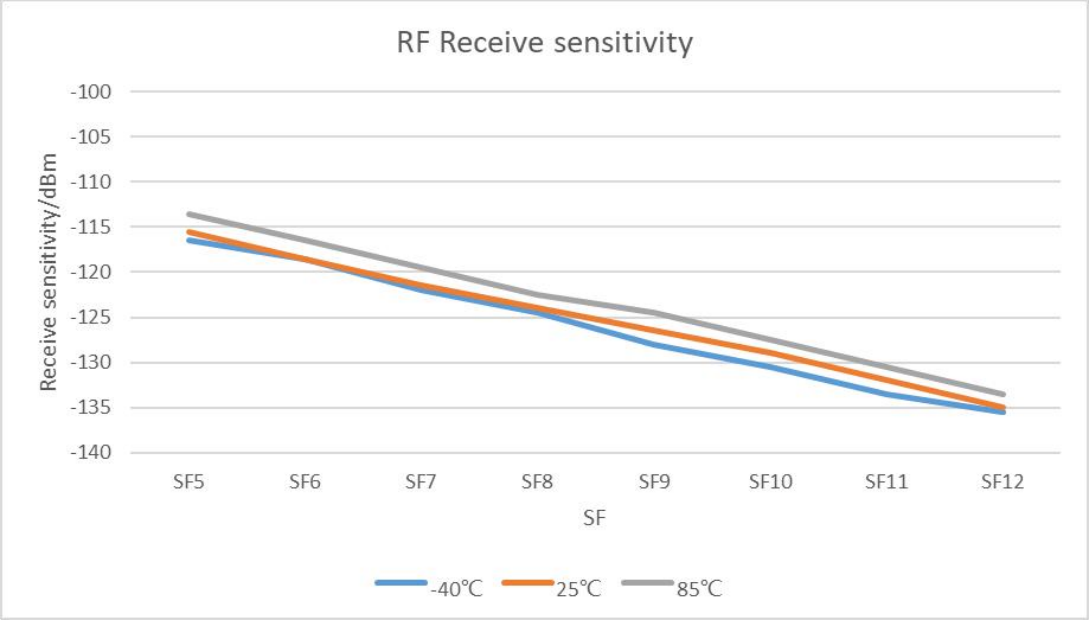


Figure 9 RF Receiver Sensitivity VS Temperature (915MHz)

5 Application information

5.1 Package information

Unless specified dimension tolerance, the Dimension below will be with tolerance ±0.1mm, all the dimension unit is mm.

Wio-E5-LE has a 28-pin SMD package:

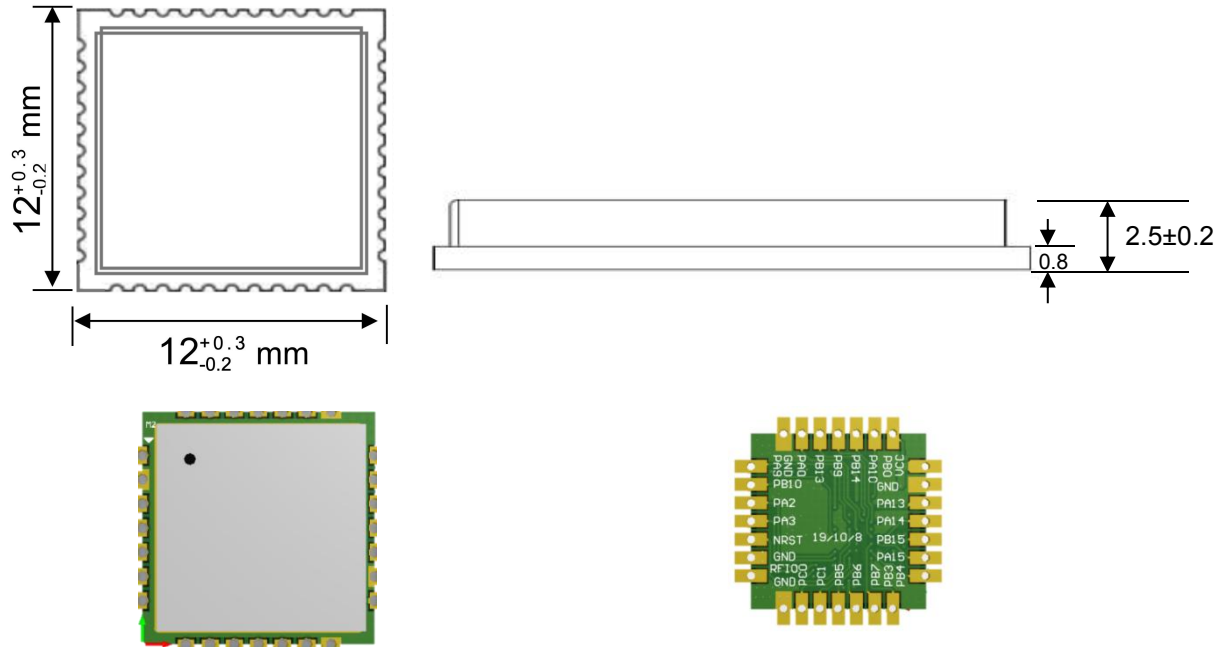


Figure 10 Wio-E5-LE Module appearance

The following figure shows the recommended Layout package dimensions.

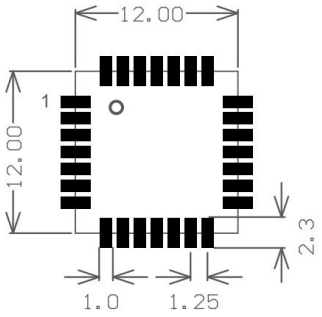


Figure 11 PCB footprint

5.2 External interface of the module

In addition to several necessary GPIO ports and a set of SPI ports used for internal RF transceiver control, other GPIOs of the MCU have been derived, including UART (for AT commands), I2C, ADC, etc. For customers who want to develop software or expand peripherals on the MCU of the module, these rich GPIO interfaces can satisfy most application requirements.

5.3 Reference design based on Wio-E5-LE module

Wio-E5-LE embeds the global LoRaWAN® protocol and AT instruction set. This will make the design of LoRaWAN® nodes based on this module very easy. The following is a typical reference design that uses Wio-E5-LE to quickly start a LoRaWAN® application. Just connect UART and NRST to the host MCU and send AT commands.

In addition,Pin24 grounding of the module will force the module to enter Boot upgrade mode.

Note: The 28-pin PB0 must be left floating and not allowed to be pulled up or grounded.

For the RF antenna part, there are no specific values available. Furthermore, you will need to conduct tests based on parameters such as circuit board thickness or other relevant factors to determine the resistance value of the required resistor to be used.

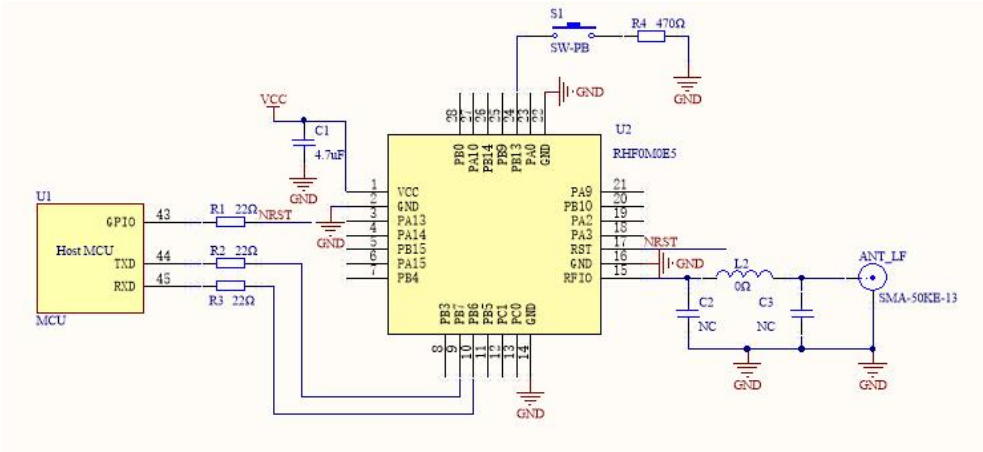


Figure 12 Reference design based on Wio-E5-LE

6 LoRaWAN® application information

6.1 LoRaWAN® application

The topology of the LoRaWAN® network is a star network, and the gateway acts as a relay between nodes and network servers. The gateway is connected to the network server through a standard IP link, and the node device uses LoRa® or FSK to communicate with one or more gateways. Communication is bidirectional, although it is mainly upstream communication from the node to the network server.

The communication between the node and the gateway uses different frequencies and rates. The choice of rate is a compromise between power consumption and distance, and different rates do not interfere with each other. According to different spreading factors and bandwidths, the rate of LoRa® can be from 300bps to 50Kbps. In order to maximize battery life and network capacity, the network server manages the node's rate and output power through rate adaptation (ADR).

The node device may transmit on a random channel at any time and at any rate, as long as the following conditions are met:

1) The channel currently used by the node is pseudo-random. This makes the system more resistant to interference

2) The maximum transmission time (dwell time of the channel) and duty cycle of the node depends on the frequency band used and local regulations

Wio-E5-LE module integrates ST ultra-low power IC STM32WLE5JC. The current is only 2.1uA in sleep mode, this module is very suitable for various applications of LoRaWAN®.

6.2 Design LoRaWAN® wireless sensor based on Wio-E5-LE

Wio-E5-LE is an AT instruction set that encapsulates the global LoRaWAN® standard protocol. The customer only needs a very simple MCU as the main control, and can control the Wio-E5-LE through the serial port, thereby easily implementing the LoRaWAN® protocol. This helps customers quickly bring sensor products to the LoRaWAN® market.

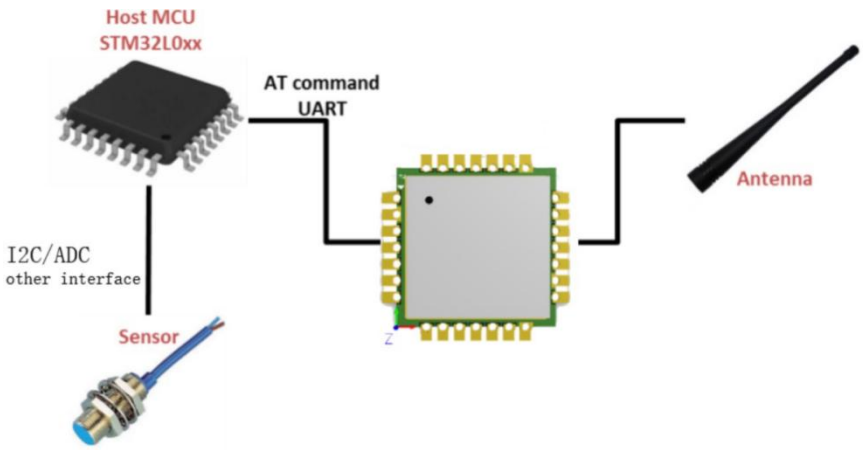


Figure 13 Design of LoRaWAN® wireless sensor based on Wio-E5-LE module

6.3 Dev kit for getting started

To facilitate your development, we have designed Grove Wio-E5, Wio-E5 mini Dev Board, Wio-E5 Dev Kit that you can choose according to your needs to speed up your project development.

Grove Wio-E5

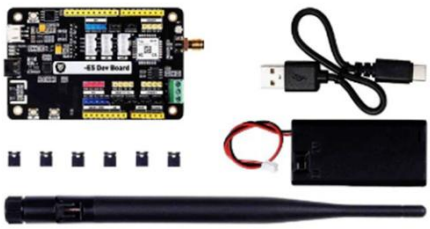
SKU 113020091

Grove Wio-E5 Module With Standard Grove Interface and Antenna

Wio-E5 mini Dev Board

SKU 113990939

Low cost, rapid testing and prototyping board for LoRa developers



Wio-E5 Dev Kit

SKU 113990934

Provides full Wio-E5's GPIOs and interfaces, including RS-485, Grove, male/female headers, and the like. Perfectfor your long-range IoT projects!

We also provide a few Wiki to get you started with these Kits.

Wio-E5 Wireless Module
Wio-E5 mini
Wio-E5 Development Kit
Grove-Wio-E5

7 Ordering information

Technical Support:sensecap@seeed.cc
Sales:iot@seeed.cc

Table 7 Ordering Information

SKU	Name	
114993120	Wio-E5-LE Wireless Module (Bulk)	
114993121	Wio-E5-LE Wireless Module (Tape Reel)	
317990687	Wio-E5 Wireless Module (Bulk)	
317990829	Wio-E5 Wireless Module (Tape Reel)	
113990939	Wio-E5 mini Dev Board	
113990934	Wio-E5 Dev Kit	

Note: Should you prioritize transmission distance and be less concerned about power consumption, the Wio-E5 would be an ideal choice. Conversely, if minimizing power consumption is your primary objective and your operational range is relatively short, the Wio-E5-LE would be a more fitting selection.

8 ODM & OEM Services

With decades of ODM & OEM experience, our engineers and product experts are proficient in delivering customization service for popular open-source hardware platforms – NVIDIA® Jetson™, Raspberry Pi ®, Beagleboard ®,and more. Use the Wio-E5 series module to create industrial-grade sensors or development boards for rapid AIoT implementation.

Feature product using Wio-E5

Such as our SenseCAP S210x series products

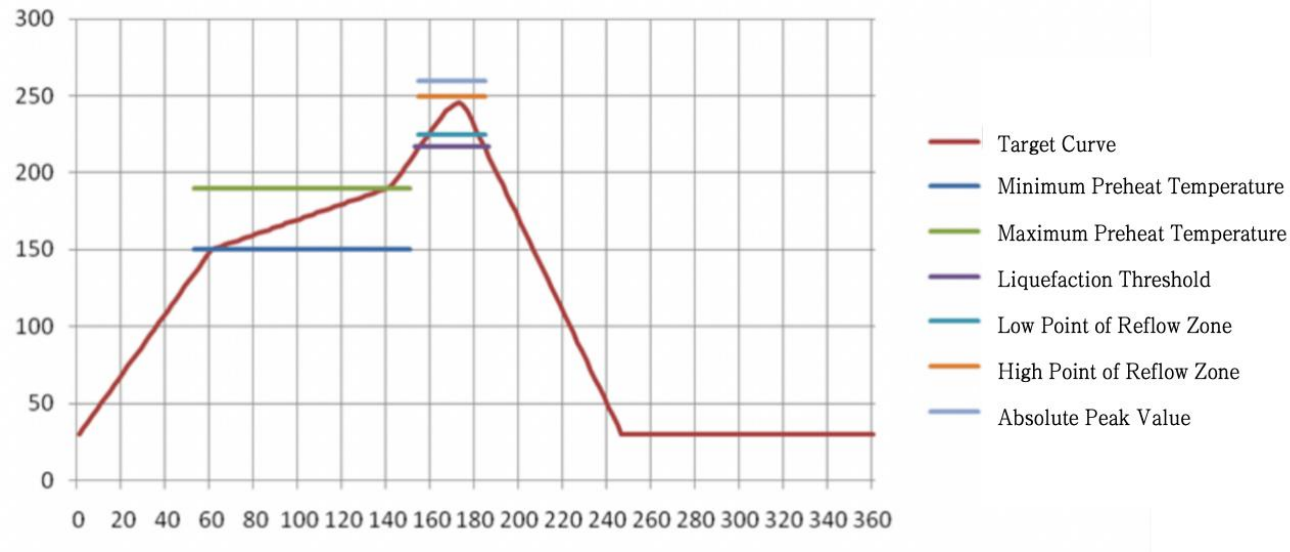
Fusion customize products

We're dedicated to supporting you and streamlining your idea-to-product journey. We are ready to bring your product concept to the market with Seeed Studio's industrial capabilities from design, manufacturing, testing, certification, global distribution, and marketplace. To design with the Wio-E5-LE module, please contact iot@seeed.cc.

9 Reflow Soldering Parameters

The Wio-E5 Seriels module is designed for convenient application in production, including soldering onto a PCB using reflow soldering techniques. A critical factor is that users need to select the appropriate solder paste and ensure it meets the temperature requirements during reflow.

Note: The module temperature must not exceed 260°C during reflow soldering. The duration in the reflow zone should not exceed 30 seconds.



Technical Specifications	Value	Unit
Ramp Rate	1 ~ 3	°C/Sec
Cooling Rate	2 ~ 4	°C/Sec
Preheat Ramp Rate	0.5 ~ 1	°C/Sec
Preheat Duration MIN	70	Sec
Preheat Duration MAX	120	Sec
Preheat Temperature MIN	150	°C
Preheat Temperature MAX	190	°C
Maximum time above solder paste liquefaction temperature	70	Sec
Minimum time above solder paste liquefaction temperature	50	Sec
Reflow zone dwell time	30	Sec
Peak temperature dwell time maximum	5	Sec
Recommended Liquidus Threshold	218	°C
Reflow Zone Minimum Temperature	240	°C
Reflow Zone Maximum Temperature	250	°C
Absolute Peak Temperature	260	°C

10 Version

V1.0 2023-07-27 First release

V1.1 2024-07-19 Add Reflow Soldering Parameters

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: Z4T-LORA-E5" . 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 limited to installation in mobile or fixed applications. Separate approval is required for all other operating configurations, including portable configuration with respect to Part 2.1093 and different antenna configurations.

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

This equipment complies with FCC RF radiation exposure limits set forth for an uncontrolled environment.

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.

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 radio frequency 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
- This device and its antenna(s) must not be co-located or operating in conjunction with any other antenna or transmitter.

NOTE: The manufacturer is not responsible for any radio or TV interference caused by unauthorized modifications to this equipment. Such modifications could void the user's authority to operate the equipment.

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