1. Radio Frequency Exposure

RESULT: **Pass**

Test standard : FCC Part 2: Section 2.1091
KDB 447498 D01 General RF Exposure Guidance v06
RSS-102 Issue 6, December 2023

1.1 Product Technical Information

The EUT is a WisBlock LPWAN Module which supports Lora and Bluetooth Low Energy technologies.

Previous Antenna information:

For LoRa:

Antenna #	Model	Antenna Gain	Antenna Type	Connector Type
1#	RAKARJ14	2.3 dBi	Dipole Antenna	RP-SMA connector
2#	RAKARJ16	2.3 dBi	Dipole Antenna	RP-SMA connector

Note:
1. When connecting to the module, all antennas listed above need to transfer to an IPEX connector.
2. Antennas 1# and 2# have the same type and similar in-band and out-of-band characteristics and only the color of enclosure different, they are considered as equivalent antennas. Thus, the antenna 1# was selected to be tested.

For BLE:

Antenna #	Model	Antenna Gain	Antenna Type	Connector Type
1#	R S2B1BH2A1B01000	3.12 dBi	PCB Layout Antenna	IPEX connector

Current Antenna information:

For LoRa:

Antenna #	Model	Antenna Gain	Antenna Type	Connector Type
1#	RAKARJ18	1.2 dBi	Dipole Antenna	RP-SMA connector
2#	RAKARG12	3 dBi	Dipole Fiberglass Antenna	RP-SMA connector
3#	RAK0009	2.5 dBi	PCB Layout Antenna	IPEX connector

For BLE:

Antenna #	Model	Antenna Gain	Antenna Type	Connector Type
1#	RAK0008	2 dBi	PCB Layout Antenna	IPEX connector

This report is for FCC CIIPC and ISED C4PC as changed transmit antennas and will be installed into HOST LoRa control and monitoring node (M/N: RF-V1-900-2LATCH-BATT, RF-V1-900-2LATCH-SOLAR, RF-V1-900-4LATCH-BATT, RF-V1-900-4LATCH-SOLAR), radiated spurious emissions for LoRa re-performed.

Configuration 1:

Data Rate	SF (Spreading factor)	Operating Frequency
0	LoRa Modulation: SF10 / Bandwidth 125 kHz	915.1 – 927.7 MHz
1	LoRa Modulation: SF9 / Bandwidth 125 kHz	
2	LoRa Modulation: SF8 / Bandwidth 125 kHz	
3	LoRa Modulation: SF7 / Bandwidth 125 kHz	
4	LoRa Modulation: SF8 / Bandwidth 500 kHz	915.8 – 927.0 MHz

Configuration 2:

Data Rate	SF (Spreading factor)	Operating Frequency
0	LoRa Modulation: SF12 / Bandwidth 500 kHz	902.5 – 927.1 MHz
1	LoRa Modulation: SF11 / Bandwidth 500 kHz	

2	LoRa Modulation: SF10 / Bandwidth 500 kHz	
3	LoRa Modulation: SF9 / Bandwidth 500 kHz	
4	LoRa Modulation: SF8 / Bandwidth 500 kHz	
6	LoRa Modulation: SF7 / Bandwidth 500 kH5	

HOST model list:

Model No.	Power Supply	Digital Inputs	Latching Outputs
RF-V1-900-2LATCH-BATT	31200mAh Battery	4 Digital Inputs: V1 IN V2 IN V3 IN V4 IN	2 Latching Outputs: V1 V2
RF-V1-900-2LATCH-SOLAR	13000mAh Battery and Solar Panel	4 Digital Inputs: V1 IN V2 IN V3 IN V4 IN	2 Latching Outputs: V1 V2
RF-V1-900-4LATCH-BATT	31200mAh Battery	4 Digital Inputs: V1 IN V2 IN V3 IN V4 IN	4 Latching Outputs: V1 V2 V3 V4
RF-V1-900-4LATCH-SOLAR	13000mAh Battery and Solar Panel	4 Digital Inputs: V1 IN V2 IN V3 IN V4 IN	4 Latching Outputs: V1 V2 V3 V4

For details refer to the User Manual, Technical Description and Circuit Diagram.

Technical Specification of EUT

General Information of EUT	**Value**
Kind of Equipment	WisDuo LPWAN+BLE Module
Type Designation	RAK11720
FCC ID	2AF6B-RAK11720
IC	25908-RAK11720
HVIN	RAK11720
FVIN	RUI_3.5.2+user_final.hex
HMN	RF-V1-900-2LATCH-BATT, RF-V1-900-2LATCH-SOLAR, RF-V1-900-4LATCH-BATT, RF-V1-900-4LATCH-SOLAR
Operating Voltage	DC 5V
Technical Specification of Lora DTS	
Operating Frequency	915.8 – 927.0 MHz 902.5 – 927.1 MHz
Type of Modulation	Lora
Data Rate	SF8 / DR4 for 903 – 914.2 MHz and 915.8 – 927.0 MHz SF7-SF12 / DR0 to DR5 for 902.5 – 927.1 MHz
Channel Number	8 channels for 915.8 – 927.0 MHz 43 channels for 902.5 – 927.1 MHz
Channel Separation	1.6 MHz
Occupied Bandwidth	500 kHz
Antenna Number:	1
Antenna Gain and Type:	Refer to section 3.1
Technical Specification of Lora FHSS	
Frequency Range	915.1 – 927.7 MHz
Type of Modulation	Lora
Data Rate	SF7 to SF10 / DR0 to DR3
Channel Number	64 channels (Upstream)
Channel Separation	200 KHz
Occupied Bandwidth	125 KHz

Antenna Number:	1
Antenna Gain and Type:	Refer to section 3.1
Technical Specification of BLE	
Frequency Range	2402 - 2480 MHz
Type of Modulation	GFSK
Data Rate	1Mbps
Channel Number	40 channels
Channel Separation	2 MHz
Antenna Number:	1
Antenna Gain and Type:	Refer to section 3.1

1.2 Product Classification

This device defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at 20 cm is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons.

1.3 Radio Frequency Exposure Limit

For FCC:

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm²)	Average Time (minutes)
(A) Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	*100	<6
3.0-30	1842/f	4.89/f	*(900/f²)	<6
30-300	61.4	0.163	1.0	<6
300-1,500	--	--	f/300	<6
1,500-100,000	--	--	1.0	<6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-3.0	614	1.63	*100	<30
3.0-30	824/f	2.19/f	*(180/f²)	<30
30-300	27.5	0.073	0.2	<30
300-1,500	--	--	f/1500	<30
1,500-100,000	--	--	1.0	<30

f = frequency in MHz. * = Plane-wave equivalent power density.

For IC:

Frequency range (MHz)	**Electric field (V_{RMS}/m)**	**Magnetic field (A_{RMS}/m)**	**Power density (W/m²)**	**Reference period (minutes)**
10-20	27.46	0.0728	2	6
20-48	$58.07 / f^{0.25}$	$0.1540 / f^{0.25}$	$8.944 / f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142\ f^{0.3417}$	$0.008335\ f^{0.3417}$	$0.02619\ f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158\ f^{0.5}$	$4.21 \times 10^{-4}\ f^{0.5}$	$6.67 \times 10^{-5}\ f$	$616000/f^{1.2}$

Note: f is frequency in MHz.

1.4 Radio Frequency Exposure Calculation Formula

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density (in appropriate units, e.g. mW/cm^2)
P = power input to the antenna (in appropriate units, e.g., mW)
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

or:

$$S = \frac{EIRP}{4\pi R^2}$$

where: EIRP = equivalent (or effective) isotropically radiated power

1.5 Calculation Result

1.5.1 Stand-alone transmission MPE

LoRa Configuration 1

Mode	Band	PG_conducted (dBm)	ANT Gain (dBi)	Power Density (mW/cm²)	FCC Limit (mW/cm²)
Lora	902-928MHz	21.31	3	0.054	0.601
BLE	2.4G	2.8	2	0.001	1.0

Mode	Band	PG_conducted (dBm)	ANT Gain (dBi)	Power Density (W/m²)	IC Limit (W/m²)
Lora	902-928MHz	21.31	3	0.537	2.74
BLE	2.4G	2.8	2	0.008	5.35

LoRa Configuration 2

Mode	Band	PG_conducted (dBm)	ANT Gain (dBi)	Power Density (mW/cm²)	FCC Limit (mW/cm²)
Lora	902-928MHz	21.36	3	0.054	0.601
BLE	2.4G	2.8	2	0.001	1.0

Mode	Band	PG_conducted (dBm)	ANT Gain (dBi)	Power Density (W/m²)	IC Limit (W/m²)
Lora	902-928MHz	21.36	3	0.543	2.74
BLE	2.4G	2.8	2	0.008	5.35

Note: R = 0.2m

1.5.2 Simultaneous transmission MPE

LoRa Configuration 1

FCC					
Operating Mode	**Lora Ratio**	**BLE Ratio**	**Sum Ratio**	**Limit**	**Result**
LoRa+BLE	**0.0900**	**0.0001**	**0.0901**	**1**	**Pass**
IC					
Operating Mode	**Lora Ratio**	**BLE Ratio**	**Sum Ratio**	**Limit**	**Result**
LoRa+BLE	**0.1960**	**0.0015**	**0.1975**	**1**	**Pass**

LoRa Configuration 2

FCC					
Operating Mode	**Lora Ratio**	**BLE Ratio**	**Sum Ratio**	**Limit**	**Result**
LoRa+BLE	**0.0900**	**0.0001**	**0.0901**	**1**	**Pass**
IC					
Operating Mode	**Lora Ratio**	**BLE Ratio**	**Sum Ratio**	**Limit**	**Result**
LoRa+BLE	**0.1982**	**0.0150**	**0.2132**	**1**	**Pass**

Note: R = 0.2m