



## SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch

SZEMC-TRF-01 Rev. A/1

Report No.: SZCR250400147204

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# RF EXPOSURE EVALUATION REPORT

**Application No.:** SZCR2504001472AT  
**Applicant:** Shenzhen RAKwireless Technology Co.,Ltd.  
**Address of Applicant:** Room 506, Building B, New Compark, Pingshan First Road, Taoyuan Street, Nanshan District, Shenzhen, China

**Equipment Under Test (EUT):**

**EUT Name:** WisLink LPWAN Concentrator  
**Model No.:** RAK5146  
**Trade Mark:** RAK  
**FCC ID:** 2AF6B-RAK5146  
**Standard(s) :** FCC Rules 47 CFR §2.1091  
KDB 447498 D04 interim General RF Exposure Guidance v01  
**Date of Receipt:** 2025-04-14  
**Date of Evaluation:** 2025-05-07 to 2025-05-07  
**Date of Issue:** 2025-06-02

<b>Evaluation Result:</b>	<b>Pass*</b>
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\* In the configuration evaluated, the EUT complied with the standards specified above.

Keny Xu  
EMC Laboratory Manager



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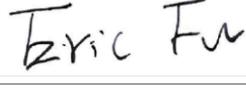
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**Revision Record**

Version	Chapter	Date	Modifier	Remark
01		2025-06-02		Original

**Authorized for issue by:**

	 Benson Wang		
	<b>Benson Wang/Project Engineer</b>		
	 Eric Fu		
	<b>Eric Fu/Reviewer</b>		

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### 3 General Information

#### 3.1 General Description of E.U.T.

Product Type:	<input type="checkbox"/> Portable device
	<input checked="" type="checkbox"/> Mobile device
	<input type="checkbox"/> Fixed device

#### 3.2 Details of E.U.T.

Power supply:	Charging adapter information Model: RP025-4800500YG Input: 100-240VAC, 50/60Hz 0.7A Max Output: 48.0Vdc, 0.5A, 24.0W
Cable(s):	AC cable of adapter:155cm unshielded
Lora module:	
Technical Specification of Lora DTS	
Operating Frequency:	923.3 - 927.5MHz
Type of Modulation:	LoRa
Data Rate:	SF7 - SF12 / DR8 – DR13,
Channel Number:	8Channels
Channel Separation:	600KHz
Occupied Bandwidth:	500KHz
Technical Specification of Lora Hybrid	
Operating Frequency:	903.9 - 905.3MHz
Type of Modulation:	LoRa
Data Rate:	SF7 - SF10 / DR0 –DR3,
Channel Number:	8 Channels (DSS & DTS)
Channel Separation:	200KHz
Occupied Bandwidth:	125KHz
Antenna Gain:	Fiberglass Antenna 1: RAKARG14: 5.8dBi; Fiberglass Antenna 2: RAKARG15: 8dBi; Fiberglass Antenna 3: RAKARG19: 5.1dBi;
(2.4G Wi-Fi module) FCC ID:	2ABCB-RPICM4
(LTE module) FCC ID:	XMR201807EG95NA
Remark:	
The host is configured as follows:	
Host 1: Model No.: RAK7393C: lora US915 16ch/8ch* with GPS (RAK5146) + 2.4G Wi-Fi (CM4) +LTE (EG95-NA) power by POE or DC source 9-36V	
Host 2: Model No.: RAK7393: lora US915 16ch/8ch* with GPS (RAK5146) + 2.4G Wi-Fi (CM4)	



power by POE or DC source 9-36V

\*16ch: 2pcs Lora module in the host.; 8ch: 1pcs Lora module in the host.

Remark: The information in this section is provided by the applicant or manufacturer, SGS is not liable to the accuracy, suitability, reliability or/and integrity of the information.

### 3.3 Separation Distance

Minimum test separation distance: 30cm

Remark: This minimum test separation distance is determined by the smallest distance from the antenna and radiating structures or outer surface of the device, according to the host form factor, exposure conditions and platform requirements, to any part of the body or extremity of a user or bystander.



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### 3.4 Test Location

All tests were performed at:

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No tests were sub-contracted.

### 3.5 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

- **A2LA (Certificate No. 3816.01)**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory is accredited by the American Association for Laboratory Accreditation(A2LA). Certificate No. 3816.01.

- **VCCI (Member No. 1937)**

The 3m Fully-anechoic chamber for above 1GHz, 10m Semi-anechoic chamber for below 1GHz, Shielded Room for Mains Port Conducted Interference Measurement and Telecommunication Port Conducted Interference Measurement of SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen EMC laboratory have been registered in accordance with the Regulations for Voluntary Control Measures with Registration No.: G-20026, R-14188, C-12383 and T-11153 respectively.

- **FCC –Designation Number: CN1336**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory has been recognized as an accredited testing laboratory.

Designation Number: CN1336. Test Firm Registration Number: 787754.

- **Innovation, Science and Economic Development Canada**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory has been recognized by ISED as an accredited testing laboratory.

CAB identifier: CN0006.

IC#: 4620C.

### 3.6 Deviation from Standards

None

### 3.7 Abnormalities from Standard Conditions

None



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## 4 FCC Radiofrequency radiation exposure limits

Test exemptions apply for devices used in general population/uncontrolled exposure environments, according to the SAR-based, or MPE-based exemption thresholds.

### 4.1 Blanket 1 mW Blanket Exemption

The 1 mW Blanket Exemption of §1.1307(b)(3)(i)(A) applies for single fixed, mobile, and portable RF sources with available maximum time-averaged power of no more than 1 mW, regardless of separation distance.

The 1-mW blanket exemption applies at separation distances less than 0.5 cm, including where there is no separation. This exemption shall not be used in conjunction with other exemption criteria other than those for multiple RF sources in paragraph §1.1307(b)(3)(ii)(A).

The 1-mW exemption is independent of service type and covers the full range of 100 kHz to 100 GHz, but it shall not be used in conjunction with other exemption criteria or in devices with higher-power transmitters operating in the same time-averaging period. Exposure from such higher-power transmitters would invalidate the underlying assumption that exposure from the lower-power transmitter is the only contributor to SAR in the relevant volume of tissue.

### 4.2 MPE-based Exemption

General frequency and separation-distance dependent MPE-based effective radiated power (ERP) thresholds are in Table B.1 [Table 1 of §1.1307(b)(1)(i)(C)] to support an exemption from further evaluation from 300 kHz through 100 GHz.

**Table B.1—Thresholds For Single RF Sources Subject to Routine Environmental Evaluation**

RF Source Frequency		Minimum Distance			Threshold ERP
$f_L$ MHz	$f_H$ MHz	$\lambda_L / 2\pi$	$\lambda_H / 2\pi$	W	
0.3	—	1.34	159 m	—	35.6 m
1.34	—	30	35.6 m	—	1.6 m
30	—	300	1.6 m	—	159 mm
300	—	1,500	159 mm	—	3.83 R <sup>2</sup>
1,500	—	100,000	31.8 mm	—	0.0128 R <sup>2</sup> f
Subscripts L and H are low and high; $\lambda$ is wavelength.					
From §1.1307(b)(3)(i)(C), modified by adding Minimum Distance columns.					

The table applies to any RF source (i.e. single fixed, mobile, and portable transmitters) and specifies power and distance criteria for each of the five frequency ranges used for the MPE limits. These criteria apply at separation distances from any part of the radiating structure of at least  $\lambda/2\pi$ . The thresholds are



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based on the general population MPE limits with a single perfect reflection, outside of the reactive near-field, and in the main beam of the radiator.

For mobile devices that are not exempt per Table B.1 [Table 1 of §1.1307(b)(1)(i)(C)] at distances from 20 cm to 40 cm and in 0.3 GHz to 6 GHz, evaluation of compliance with the exposure limits in §1.1310 is necessary if the ERP of the device is greater than  $ERP_{20\text{cm}}$  in Formula (B.1) [repeated from §2.1091(c)(1); also in §1.1307(b)(1)(i)(B)].

$$P_{\text{th}} \text{ (mW)} = ERP_{20\text{cm}} \text{ (mW)} = \begin{cases} 2040f & 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz} \\ 3060 & 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz} \end{cases} \quad (\text{B.1})$$

If the ERP is not easily obtained, then the available maximum time-averaged power may be used (i.e., without consideration of ERP only if the physical dimensions of the radiating structure(s) do not exceed the electrical length of  $\lambda/4$  or if the antenna gain is less than that of a half-wave dipole).

SAR-based exemptions are constant at separation distances between 20 cm and 40 cm to avoid discontinuities in the threshold when transitioning between SAR-based and MPE-based exemption criteria at 40 cm, considering the importance of reflections.

Limit calculation			
Frequency range	Frequency(MHz)	R( $\lambda/2\pi$ )(m)	Threshold ERP(W)
300~1500MHz	<b>915</b>	0.0522	0.032
1500~100000MHz	<b>2480</b>	0.0193	0.007

### 4.3 SAR-based Exemption

SAR-based thresholds are derived based on frequency, power, and separation distance of the RF source. The formula defines the thresholds in general for either available maximum time-averaged power or maximum time-averaged ERP, whichever is greater.

If the ERP of a device is not easily determined, such as for a portable device with a small form factor, the applicant may use the available maximum time-averaged power exclusively if the device antenna or radiating structure does not exceed an electrical length of  $\lambda/4$ .

As for devices with antennas of length greater than  $\lambda/4$  where the gain is not well defined, but always less than that of a half-wave dipole (length  $\lambda/2$ ), the available maximum time-averaged power generated by the device may be used in place of the maximum time-averaged ERP, where that value is not known.



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The separation distance is the smallest distance from any part of the antenna or radiating structure for all persons, during operation at the applicable ERP. In the case of mobile or portable devices, the separation distance is from the outer housing of the device where it is closest to the antenna.

The SAR-based exemption formula of §1.1307(b)(3)(i)(B), repeated here as Formula (B.2), applies for single fixed, mobile, and portable RF sources with available maximum time-averaged power or effective radiated power (ERP), whichever is greater, of less than or equal to the threshold  $P_{th}$  (mW).

This method shall only be used at separation distances from 0.5 cm to 40 cm and at frequencies from 0.3 GHz to 6 GHz (inclusive).  $P_{th}$  is given by Formula (B.2).

$$P_{th} \text{ (mW)} = \begin{cases} ERP_{20 \text{ cm}}(d/20 \text{ cm})^x & d \leq 20 \text{ cm} \\ ERP_{20 \text{ cm}} & 20 \text{ cm} < d \leq 40 \text{ cm} \end{cases} \quad (\text{B.2})$$

where

$$x = -\log_{10} \left( \frac{60}{ERP_{20 \text{ cm}} \sqrt{f}} \right)$$

and  $f$  is in GHz,  $d$  is the separation distance (cm), and  $ERP_{20\text{cm}}$  is per Formula (B.1).

Example values shown in Table B.2 are for illustration only.

**Table B.2—Example Power Thresholds (mW)**

Frequency (MHz)	Distance(mm)									
	5	10	15	20	25	30	35	40	45	50
300	39	65	88	110	129	148	166	184	201	217
450	22	44	67	89	112	135	158	180	203	226
835	9	25	44	66	90	116	145	175	207	240
1900	3	12	26	44	66	92	122	157	195	236
2450	3	10	22	38	59	83	111	143	179	219
3600	2	8	18	32	49	71	96	125	158	195
5800	1	6	14	25	40	58	80	106	136	169

Limit calculation				
Frequency range(GHz)	Frequency(GHz)	X	Distance(cm)	Pth (mW)
0.3~1.5	0.915	1.474	0.5	8.133
1.5~6	2.48	1.905	0.5	2.717

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2. According to FCC Part1.1310: The criteria listed in the following table shall be used to evaluate the environment impact of human exposure to radio frequency (RF) radiation as specified in part1.1307(b)

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm <sup>2</sup> )	Averaging time (minutes)
<b>(A) Limits for Occupational/Controlled Exposures</b>				
0.3–3.0 .....	614	1.63	*(100)	6
3.0–30 .....	1842/f	4.89/f	*(900/f <sup>2</sup> )	6
30–300 .....	61.4	0.163	1.0	6
300–1500 .....	.....	.....	f/300	6
1500–100,000 .....	.....	.....	5	6
<b>(B) Limits for General Population/Uncontrolled Exposure</b>				
0.3–1.34 .....	614	1.63	*(100)	30
1.34–30 .....	824/f	2.19/f	*(180/f <sup>2</sup> )	30
30–300 .....	27.5	0.073	0.2	30
300–1500 .....	.....	.....	f/1500	30
1500–100,000 .....	.....	.....	1.0	30

F= Frequency in MHz

## Friis Formula

Friis transmission formula:  $P_d = (P_{out} \cdot G) / (4 \cdot \pi \cdot R^2)$

Where

Pd = power density in mW/cm<sup>2</sup>

Pout = output power to antenna in mW

**G** = gain of antenna in linear scale

$$\pi = 3.1416$$

R = distance between observation point and center of the radiator in cm

Pd is the limit of MPE, 1 mW/cm<sup>2</sup>. If we know the maximum gain of the antenna and the total power input to the antenna, through the calculation, we will know the distance *r* where the MPE limit is reached.



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**5. Measurement and Calculation****Maximum transmit power**

Test Mode	Max Conducted power (dBm)	Antenna Gain (dBi)	Power Density (mW/cm <sup>2</sup> )	Limit (mW/cm <sup>2</sup> )	Ratio	Verdict
2.4G Wi-Fi	15.4	3.5	0.007	1	0.0070	Pass
Lora	24.69	5.8	0.099	0.6	0.1650	Pass
WCDMA Band II	21.52	4	0.031	1	0.0310	Pass
WCDMA Band IV	21.83	4	0.034	1	0.0340	Pass
WCDMA Band V	21.46	4	0.031	0.55	0.0564	Pass
LTE B2	21.83	4	0.034	1	0.0340	Pass
LTE B4	21.34	4	0.030	1	0.0300	Pass
LTE B5	20.06	4	0.023	0.55	0.0418	Pass
LTE B12	18.05	4	0.014	0.47	0.0298	Pass
LTE B13	20.76	4	0.026	0.52	0.0500	Pass

Simultaneous transmission

Host 1: Model No.: RAK7393C: lora US915 16ch/8ch with GPS (RAK5146) + 2.4G Wi-Fi (CM4) +LTE (EG95-NA)

Test Mode	2.4G Wi-Fi	Lora	Lora	WCDMA Band V	Total Ratio	Limit	Verdict
Ratio	0.0070	0.1650	0.1650	0.0564	0.3934	1.0	Pass

Host 2: Model No.: RAK7393: lora US915 16ch/8ch with GPS (RAK5146) + 2.4G Wi-Fi (CM4)

Test Mode	2.4G Wi-Fi	Lora	Lora	Total Ratio	Limit	Verdict
Ratio	0.0070	0.1650	0.1650	0.337	1.0	Pass

So, the device is to qualify for SAR test exemption, the exemption report is in lieu of the SAR report.

Note:

2.4G Wi-Fi &amp; Lora Power Density data are form MPE report of following FCC ID:

WCDMA &amp; LTE Max conducted power are form RF report of following FCC ID:

(2.4G Wi-Fi module) FCC ID:	2ABCB-RPICM4
(LTE module) FCC ID:	XMR201807EG95NA
(Lora module) FCC ID:	2AF6B-RAK5146



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## 5 EUT Constructional Details (EUT Photos)

Refer to Appendix - External and Internal photos for SZCR2504001472AT

-End of the Report-

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