

Maximum Permissible Exposure Report

1. Product Information

FCC ID:	2AJUZ- RHF2S008
Product name	Industrial LoRaWAN Gateway
Model Number	RHF2S008, RHF2S008P4G-915
Hardware version	RHF2S008_V4.0
Software version	0.0.7
Power supply	DC 48V (POE), 0.6A
Operation frequency	LTE Band 4: 1710 – 1755 MHz RoLa: 902.5 – 927.5 MHz
Modulation Type	LTE: QPSK, 16QAM RoLa: GFSK
LTE Version	R8
LTE Power Class	Class 3
Antenna Type	External antenna
Antenna Gain	5.00 dBi (Maximum) for LTE 2.00 dBi (Maximum) for RoLa
Exposure category	General population/uncontrolled environment
EUT Type	Production Unit
Device Type	Mobile Device

2. Evaluation Method

Systems operating under the provisions of FCC 47 CFR section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines. In accordance with 47 CFR FCC Part 2 Subpart J, section 2.1091 this device has been defined as mobile device whereby a distance of 0.2m normally can be maintained between the user and the device, and below RF Permissible Exposure limit shall comply with.

In accordance with KDB447498D01 for Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on the calculated/estimated, numerically modelled or measured field strengths or power density, is ≤ 1.0 . The MPE ratio of each antenna is determined at the minimum test separation distance required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to MPE limit, at the test frequency. Either the maximum peak or spatially averaged results from measurements or numerical simulations may be used to determine the MPE ratios. Spatial averaging does not apply when MPE is estimated using simple calculations based on far-field plane-wave equivalent conditions. The antenna installation and operating requirements for the host device must meet the minimum test separation distances required by all antennas, in both standalone and simultaneous transmission operations, to satisfy compliance.

3. Limit

3.1 Refer evaluation method

[ANSI C95.1-1999](#): IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

[FCC KDB publication 447498 D01 General 1 RF Exposure Guidance v06](#): Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

[FCC CFR 47 part1 1.1310](#): Radiofrequency radiation exposure limits.

[FCC CFR 47 part2 2.1091](#): Radiofrequency radiation exposure evaluation: mobile devices

3.2 Limit

Limits for Maximum Permissible Exposure (MPE)/Controlled Exposure

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density (mW/cm ²)	Averaging Time (minute)
Limits for Occupational/Controlled Exposure				
0.3 – 3.0	614	1.63	(100) *	6
3.0 – 30	1842/f	4.89/f	(900/f ²)*	6
30 – 300	61.4	0.163	1.0	6
300 – 1500	/	/	f/300	6
1500 – 100,000	/	/	5	6

Limits for Maximum Permissible Exposure (MPE)/Uncontrolled Exposure

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density (mW/cm ²)	Averaging Time (minute)
Limits for Occupational/Controlled Exposure				
0.3 – 3.0	614	1.63	(100) *	30
3.0 – 30	824/f	2.19/f	(180/f ²)*	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

*=Plane-wave equivalent power density

4. MPE Calculation Method

Predication of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S=PG/4\pi R^2$$

Where: S=power density

P=power input to antenna

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

5. Antenna Information

RHF2S008 can only use antennas certificated as follows provided by manufacturer;

Internal Identification	Antenna type and antenna number	Operate frequency band	Maximum antenna gain
Antenna 0	External Antenna (N type)	800.0-1000.0 MHz	2.00 dBi
Antenna 1	External Antenna (N type)	1700.0 – 1800.0 MHz	5.00 dBi

6. Conducted Power

LTE Band4

BW (MHz)	Frequency (MHz)	RB Configuration		Average Power [dBm]	
		Size	Offset	QPSK	16QAM
1.4	1710.7	1	0	23.32	22.50
		1	3	23.38	22.64
		1	5	23.30	22.52
		3	0	23.32	22.44
		3	2	23.34	22.43
		3	3	23.36	22.44
		6	0	22.39	21.36
	1732.5	1	0	23.47	22.78

		1	3	23.53	22.89
		1	5	23.47	22.75
		3	0	23.53	22.46
		3	2	23.49	22.45
		3	3	23.49	22.45
		6	0	22.50	21.47
	1754.3	1	0	23.63	22.90
		1	3	23.72	23.00
		1	5	23.65	22.88
		3	0	23.74	22.78
		3	2	23.71	22.75
		3	3	23.70	22.79
3	1711.5	6	0	22.75	21.86
		1	0	23.25	22.50
		1	7	23.35	22.62
		1	14	23.25	22.49
		8	0	22.40	21.45
		8	4	22.37	21.45
		8	7	22.39	21.41
	1732.5	15	0	22.34	21.31
		1	0	23.40	22.84
		1	7	23.52	22.96
		1	14	23.39	22.81
		8	0	22.72	21.78
		8	4	22.73	21.79
		8	7	22.74	21.78
	1753.5	15	0	22.71	21.68
		1	0	23.29	22.64
		1	7	23.40	22.76
		1	14	23.22	22.59
		8	0	22.38	21.37
		8	4	22.37	21.35
		8	7	22.36	21.33
5	1712.0	15	0	22.32	21.33
		1	0	23.52	22.89
		1	12	23.60	22.96
		1	24	23.55	22.88
		12	0	22.60	21.71
		12	6	22.60	21.73
		12	13	22.61	21.73
	1732.5	25	0	22.55	21.60
		1	0	23.74	22.84
		1	12	23.84	22.92
		1	24	23.68	22.74
		12	0	22.60	21.70
		12	6	22.57	21.67
		12	13	22.55	21.68
	1752.5	25	0	22.51	21.53
		1	0	23.69	22.72
		1	12	23.83	22.83
		1	24	23.70	22.71
		12	0	22.73	21.75
		12	6	22.74	21.77
		12	13	22.75	21.77
10	1715.0	25	0	22.69	21.72
		1	0	23.34	22.63
		1	24	23.44	22.69
		1	49	23.44	22.70
		25	0	22.44	21.45
		25	12	22.43	21.44
		25	25	22.44	21.46

	1732.5	50	0	22.43	21.43
		1	0	23.44	22.77
		1	24	23.56	22.78
		1	49	23.43	22.61
		25	0	22.53	21.55
		25	12	22.54	21.52
		25	25	22.48	21.46
		50	0	22.51	21.48
		1	0	23.62	22.97
		1	24	23.68	23.06
		1	49	23.68	23.05
		25	0	22.67	21.66
		25	12	22.68	21.70
		25	25	22.66	21.69
15	1717.5	50	0	22.67	21.73
		1	0	23.38	22.61
		1	37	23.49	22.76
		1	74	23.48	22.74
		37	0	22.49	21.46
		37	18	22.53	21.53
		37	38	22.54	21.54
	1732.5	75	0	22.53	21.51
		1	0	23.52	22.79
		1	37	23.61	22.86
		1	74	23.43	22.66
		37	0	22.61	21.59
		37	18	22.62	21.59
		37	38	22.58	21.52
	1747.5	75	0	22.62	21.58
		1	0	23.53	22.73
		1	37	23.74	23.08
		1	74	23.69	22.94
		37	0	22.69	21.66
		37	18	22.75	21.71
		37	38	22.77	21.75
20	1720.0	75	0	22.75	21.70
		1	0	23.51	22.68
		1	49	23.59	22.76
		1	99	23.57	22.73
		50	0	22.49	21.45
		50	25	22.49	21.50
		50	50	22.53	21.51
	1732.5	100	0	22.48	21.47
		1	0	23.69	22.86
		1	49	23.70	22.83
		1	99	23.64	22.73
		50	0	22.60	21.56
		50	25	22.53	21.52
		50	50	22.51	21.45
	1745.0	100	0	22.54	21.52
		1	0	23.54	22.81
		1	49	23.71	23.03
		1	99	23.77	23.05
		50	0	22.54	21.55
		50	25	22.65	21.67
		50	50	22.69	21.75
		100	0	22.60	21.59

RoLa

Test Mode	Channel	Frequency (MHz)	Measured Peak Output Power (dBm)
GFSK	00	902.5	24.655
	05	915.0	24.958
	10	927.5	24.219

7. Manufacturing Tolerance

Mode	Frequency Band	Peak Conducted Output Power (dBm)
		Antenna 0
RoLa	900 MHz	≤2500
Mode	Frequency Band	Burst Average Conducted Output Power (dBm)
		Antenna 1
LTE Band 4 – QPSK	1710 – 1755 MHz	≤24.50
LTE Band 4 – 16 QAM	1710 – 1755 MHz	≤23.50

8. Measurement Results

8.1 Standalone MPE

As declared by the Applicant, the EUT is a wireless device used in a fix application, at least 20 cm from any body part of the user or nearby persons; from the maximum EUT RF output power, the minimum separation distance, $r = 20\text{cm}$, as well as the gain of the used antenna refer to antenna information, the RF power density can be obtained.

Antenna 0

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
RoLa – GFSK	25.00	316.2278	2.0000	1.5849	100%	0.0998	0.6013

Antenna 1

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
LTE Band 4 – QPSK	24.50	281.8383	5.0000	3.1623	100%	0.1774	1.0000
LTE Band 4 – 16QAM	23.50	223.8721	5.0000	3.1623	100%	0.1409	1.0000

Remark:

1. Output power including turn-up tolerance;
2. Output power was adjust to duty cycle at 100% if measured duty cycle less than 98%;
3. MPE evaluate distance is 20cm from user manual provide by manufacturer;

8.2 Simultaneous Transmission MPE

RHF2S008 supports 1 antennas for RoLa and 1 antennas for LTE, and the 2 transmitter antennas can transmit simultaneous.

According to KDB447498 for Transmitters used in mobile exposure conditions for simultaneous transmission operations;

$\sum$ of MPE ratios ≤ 1.0

8.2.1 Summary simultaneous transmission results

Maximum Simultaneous transmission MPE Ratios for RoLa antenna and LTE antenna.

Maximum MPE ratio _{RoLa}	Maximum MPE ratio _{LTE}	Σ MPE ratios	Limit	Results
0.1659	0.1774	<0.4	1.0	PASS

9. Conclusion

The measurement results comply with the FCC Limit per 47 CFR 2.1091 for the uncontrolled RF Exposure of mobile device.

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