



November 11, 2024

TUV SUD America CB
10 Centennial Drive FL2
Peabody, MA 01960

Attention: Director of Certification

RE: Analysis of RF Exposure for Mobile and Portable Device per KDB 447498 D01 General RF Exposure Guidance v06 and RSS-102 Issue 5 March 2015, A1 February 2021.

Max System Gain calculations for Downlink were made to ensure compliance to the signal booster power limits and requirements as specified in Sections 20.21(e)(9)(i)(D)

FCC ID: LDL-000036
IC Number: 7322A-000036

1. Support Documents

721003029A Watkins FCC Part 15.247 LoRa (Issue by TÜV SÜD America on November 11, 2024)

RSHD200218007-00A (Original module MPE exhibit FCC ID:2AC7Z-ESP32WROOM32E)

2. FCC Limits

Limits for General Population/Uncontrolled Exposure (Title 47 Subpart J §2.1091 and KDB 447498 D01 referring to limits under §1.1310)

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Electric Field Strength (H) (A/m)	Power Density (S) (mW/cm ²)	Averaging Time (minutes)
0.3 - 1.34	614	1.63	*(100)	30
1.34 - 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



3. ISED Limits:

Limits for Devices Used by the General Public (Uncontrolled Environment (RSS-102 Issue 6 December 2023))

Frequency Range (MHz)	Electric Field Strength (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Reference Period (minutes)
0.003 - 10 ²¹	83	90	-	Instantaneous
0.1 - 10	-	0.73/f	-	6**
1.1 - 10	87/f ^{0.5}	-	-	6**
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	0.158f ^{0.5}	4.21 x 10 ⁻⁴ f ^{0.5}	6.67 x 10 ⁻⁵ f	616000/f ^{1.2}

f is frequency in MHz

*Based on nerve stimulation (NS)

** Based on specific absorption rate (SAR)

4. MPE Calculation Summary using a 20cm separation distance:

Worst case at 20 cm Separation Distance				
Mode	Output Power (dBm)	Power Density at 20 cm (mW/cm ²)	ISED Limit (mW/cm ²)	FCC Limit (mW/cm ²)
LoRa (903 MHz)	20.02	0.03139	0.2741	1
802.11 b (2412 MHz)	26.0	0.1734	0.5366	1

5. Worst Case Simultaneous Transmission MPE:

Only ISED limits presented being the more stringent between the two limits.

Worst case at 20 cm Separation Distance			
Transmitter type	MPE (mw/cm ²)	ISED Limit (mW/cm ²)	ISED MPE ratio (MPE/Limit)
LoRa (903 MHz)	0.03139	0.2741	0.11452
802.11 b (2412 MHz)	0.1734	0.5366	0.32314
Sum of the ratios (should be <1.0)			0.43766



6. MPE Calculation using a 20cm separation distance:

Using Power Density formula:

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

where: S = power density

P = power input to the antenna

G = power gain of the antenna in the direction of interest relative to isotropic

R = distance to the center of radiation of the antenna

LoRa at 20 cm Separation Distance:

Maximum peak output power at antenna input terminal:	20.02	(dBm)
Maximum peak output power at antenna input terminal:	100.46	(mW)
Maximum System Gain	1.96	(dBi)
Maximum System Gain	1.570	(numeric)
Prediction distance:	20	(cm)
Source Based Time Average Duty Cycle:	100	(%)
Prediction frequency:	903	(MHz)
ISED MPE limit for uncontrolled exposure at prediction frequency:	0.5366	(mW/cm ²)
Power density at prediction frequency:	0.03139	(mW/cm ²)
ISED Margin of Compliance:	-12.33	(dB)

Sincerely,

A handwritten signature in black ink, appearing to read 'Omar Castillo', positioned above a horizontal line.

Omar Castillo

Name

Authorized Signatory

Title: Senior EMC/Wireless Engineer