The Device is a carrier grade gateway designed for IoT applications. The device is intended to be installed in controlled area like tower or roof top building with restricted access to general public. The installation and maintenance must be performed by professional trained RF technician.

Kona Mega gateway is evaluated for RF radiation exposure according to the provisions of FCC §2.1091, MPE guidelines identified in FCC §1.1310 and FCC KDB 447498:2015.

Limits for General Population/Uncontrolled Exposure: 47 CFR 1.1310 Table 1 (B)

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (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
300-1,500			f/1500	30
1,500-100,000			1.0	30
Where *f* is in MHz			*Plane-wave equivalent power density	

Using the highest transmitted power at a distance of 20 cm in the equation below:

$$S = EIRP / (4 \pi R^2)$$

Where: S, power density in 'mW/cm^2'
EIRP, Effective Isotropic Radiated Power in 'mW'
R, distance to the center of the radiation of the antenna in 'cm'

The power density calculations for the EM7455 at an exposure minimum separation distance of 0.2m are shown in the table below for each mode of operation. The worst case value is highlighted below.

LTE Module Pre- Certified[1].									
Operating Band	Tx Freq. Range (MHz)		Max. Time-Avg Cond. Power (dBm)	Max Antenna Gain (dBi)	Max. Time-Avg EIRP (dBm)	Max. Time-Avg EIRP (mW)	[Pd] Power density (mW/cm^2) @ 20cm	[Limit] FCC MPE Limit (mW/cm^2)	Ratio Pd/limit
WCDMA Band II LTE Band 2	1850	1910	24	6	30	1000	0.199	1	0.199
WCDMA Band IV LTE Band 4	1710	1755	24	6	30	1000	0.199	1	0.199
WCDMA Band V LTE Band 5	824	849	24	6	30	1000	0.199	0.549	0.362
LTE Band 7	2500	2570	23	9	32	1584.9	0.315	1	0.315
LTE Band 12	699	716	24	6	30	1000	0.199	0.466	0.427
LTE Band 13	777	787	24	6	30	1000	0.199	0.518	0.384
LTE Band 25	1850	1915	24	6	30	1000	0.199	1	0.199
LTE Band 26	814	849	24	6	30	1000	0.199	0.543	0.366
LTE Band 30	2305	2315	23	1	24	251.19	0.05	1	0.05
LTE Band 41	2496	2690	23	9	32	1584.9	0.315	1	0.315

[1] MPE Evaluation for EM7455 Radio Module, issue date July 08, 2015.

LoRa and BLE RF conducted power measurement and antenna gain as per ETC test reports t29e22a261-DTS_FCC and t29e22a261-DSS_FCC section 2.3.5 are reported below. The maximum duty cycle of the radio in real operation as stated in the Operation Description exhibit to be 20%. The worst-case value is in bold below

TX	Frequency (MHz)	Max Avg Conducted RF Output 100% Duty Cycle (dBm)	Cable Loss BTW ANT Port & ANT (dB)	Max. antenna gain (dBi)	EIRP 100% Duty Cycle (mW)	EIRP 20% Duty Cycle (mW	[Pd] 20 % Power density (mW/cm^2) @20cm	[Limit] FCC MPE Limit (mW/cm^2)	Ratio Pd / limit
LoRa 500 KHz DTS	923.3	28.37	0.5	8	3863.7	772.74	0.154	0.6155	0.250
	925.1	28.13	0.5	8	3655.9	731.18	0.146	0.617	0.237
	927.5	28.39	0.5	8	3881.5	776.3	0.155	0.618	0.251
LoRa 125 KHz DSS	915.2	22.26	0.5	8	946.24	189.248	0.0377	0.610	0.062
	921.4	22.25	0.5	8	944.07	188.14	0.0374	0.6143	0.061
	927.8	22.07	0.5	8	905.73	181.146	0.0360	0.6185	0.058
Using a worst case scenario after tuning procedure									
Tx Power		28.5	0.5	8	3981.1	796.22	0.158	0.6155	0.257

Conclusion

When EM7455 module co-transmits with LoRa radio transmitter (distances ≥ 20cm), per KDB 447498 D01, 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 modeled or measured field strengths or power density, is ≤ 1.0.
The formula to calculate the MPE is:

$$\Sigma MPE\ Ratio = \text{Max (EM7455 MPE ratio)} + \text{Max (LoRa MPE ratio)} < 1$$

$$\Sigma MPE\ Ratio = 0.427 + 0.260 < 1$$

$$\Sigma MPE\ Ratio = 0.43 + 0.260 < 1$$

$$\Sigma MPE\ Ratio = 0.69 < 1$$

The RF exposure from the radios is less than the limit specified as shown below and meets the exemption criteria.

Rounded up **0.7** **<** **1**

Worse Case with 100% Duty Cycle For LoRa Radio:

The worst-case scenario for **LoRa Radio at 923 MHz** is

S = 0.615 mW/cm^2, for General Population/Uncontrolled Exposure

S = 3.615 mW/cm^2, for Occupational/Controlled Exposure

The worst-case scenario for **LTE pre-certifies Module (EM7455) LTE Band 12 at 699 MHz** is

S = 0.466 mW/cm2, for General Population/Uncontrolled Exposure

S = 2.33 mW/cm2, for Occupational/Controlled Exposure

The Avg EIRP calculations for the EM7355 are shown in the table below for each mode of operation. The worst case value is highlighted below.

Operating Band	Tx Freq. Range (MHz)		Max. Time-Avg Cond. Power (dBm)	Max Antenna Gain (dBi)	Max. Time-Avg EIRP (dBm)	Max. Time-Avg EIRP (mW)
WCDMA Band II LTE Band 2	1850	1910	24	6	30	1000
WCDMA Band IV LTE Band 4	1710	1755	24	6	30	1000
WCDMA Band V LTE Band 5	824	849	24	6	30	1000
LTE Band 7	2500	2570	23	9	32	1584.9
LTE Band 12	699	716	24	6	30	1000
LTE Band 13	777	787	24	6	30	1000
LTE Band 25	1850	1915	24	6	30	1000
LTE Band 26	814	849	24	6	30	1000
LTE Band 30	2305	2315	23	1	24	251.19
LTE Band 41	2496	2690	23	9	32	1584.9

LoRa and BLE RF conducted power measurement and antenna gain as per ETC test reports t29e22a261-DTS_FCC and t29e22a261-DSS_FCC section 2.3.5 are reported below. The worst-case value is highlighted below

TX	Frequency (MHz)	Max Avg Conducted RF Output 100% Duty Cycle (dBm)	Cable Loss BTW ANT Port & ANT (dB)	Max. antenna gain (dBi)	EIRP 100% Duty Cycle (mW)
LoRa 500 KHz DTS	923.3	28.37	0.5	8	3863.7
	925.1	28.13	0.5	8	3655.9
	927.5	28.39	0.5	8	3881.5
LoRa 125 KHz DSS	915.2	22.26	0.5	8	946.24
	921.4	22.25	0.5	8	944.07
	927.8	22.07	0.5	8	905.73
Tx Power (After tuning)		28.5	0.5	8	3981.1

Conclusion

Total Worse Case EIRP from Two Radios = Worse LTE EIRP (mW) + Worse LoRA EIRP (mW)

= 1585 mW + 3981 mW

EIRP = 5566 mW

To determine the minimum safe distance, the sum of all transmitted power is used

S = EIRP / (4πR2)

Where: S, power density in 'mW/cm2'

EIRP, Effective Isotropic Radiated Power in 'mW'

R, distance to the center of the radiation of the antenna in 'cm'

And then re-arrange to determine the minimum safe distance for **General Population/Uncontrolled Exposure.**

R = √ [EIRP / (4πS)]

R = √ [5566 / (4π x 0.466)]

R = 30.8300132 cm

R = rounded up to 31.0 cm distance Uncontrolled Exposure

Power Density using calculated distance

S = EIRP / (4πR2)

S = 5566 / [4π (31)2]

S = 0.461 < **0.466 mW/cm2**

To determine the minimum safe distance for Occupational/Controlled Exposure.

R = √ [EIRP / (4πS)]

R = √ [5566 / (4π x 2.33)]

R = 13.78760105 cm

R = rounded up to 14.0 cm

Power Density using calculated distance

S = EIRP / (4πR2)

S = 5566 / [4π (14)2]

S = 2.26 < **2.33 mW/cm2**

R = 31 cm, for **uncontrolled exposure** (rounded up to the first decimal)

R = 14 cm, for **controlled exposure** (rounded up to the first decimal)

The device is intended to be installed in a fix controlled area location like tower or roof top building with restricted access to general public. The installation and maintenance must be performed by professional trained RF technician. The device has 3 antenna ports, which must be used with approved antenna respecting the requirement specified in the technical documentation. The manufacturer manual specified a minimum safe distance of 80 cm.