1 Test Sample Description:

Product Name:	KONA Macro Ex Gateway
Category:	Fix Use
Functional Description:	The device is a carrier grade gateways designed for IoT applications. It designed to be used in hazardous environments for industrial use. The device have 1 LoRa antenna port and 1 LTE antenna port, which must be used with approved antennas with a maximum gain of 6 dBi, respecting the requirement specified in the technical documentation. RF exposure calculation is done using the highest gain of the LoRa radio antenna.
Power supply:	48 VDC

LoRa: Radio

Frequency Range:	923.3 – 927.5 MHz
Mode of operation:	DTS
Antenna Description:	Isotropic Gain: 6.0 dBi

LTE: Pre-Certified Module

FCC ID:	N7NEM7455
Equipment Class:	PCS Licensed Transmitter
Modular Type:	Single Modular
Manufacture:	Sierra Wireless, ULC

Prepared for: Tektelic Communication Inc.

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2 RF Exposure Limits:

KONA Macro Ex Gateway 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.

TABLE 1 TO §1.1310(E)(1)—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)
(i) 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
300-1,500			f/300	<6
1.500-100,000			5	<6
(ii) Limits for General Population/Uncontrolled Exposure				
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 = frequency in MHz. * = Plane-wave equivalent power density.

Using the lowest transmitter frequency of all possible on-board radio (module radio EM7455) for worst case calculation: 699 MHz (EM7455 module, LTE band 12) is used.

S = f/1500 mW/cm2, for General Population/Uncontrolled Exposure

S = 699/1500 mW/cm2, for General Population/Uncontrolled Exposure

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

S = f/300 mW/cm2, for Occupational/Controlled Exposure

S = 699/300 mW/cm2, for Occupational/Controlled Exposure

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

3 Pre-certified LTE Module EIRP:

As per Sierra Wireless, ULC Pre-certified Module MPE Evaluation for EM7455 Radio Module Report dated July 8, 2015. The average EIRP calculations are shown in the table below for each mode of operation. The worst case value is highlighted below.

Operating Mode	TX Frequency Range (MHz)	Max. Conducted average output power (dBm)	Antenna Gain (dBi)	Max. average EIRP(dBm)	Average EIRP (mW)
WCDMA Band II LTE Band 2	1850 – 1910	24.0	6	30.0	1000.0
WCDMA Band IV LTE Band 4	1710 – 1755	24.0	6	30.0	1000.0
WCDMA Band V LTE Band 5	824 – 849	24.0	6	30.0	1000.0
LTE Band 7	**2500 – 2570**	**23.0**	**9**	**32.0**	**1584.9**
LTE Band 12	699 – 716	24.0	6	30.0	1000.0
LTE Band 13	777 – 787	24.0	6	30.0	1000.0
LTE Band 25	1850 – 1915	24.0	6	30.0	1000.0
LTE Band 26	814 – 849	24.0	6	30.0	1000.0
LTE Band 30	2305 – 2315	23.0	1	24.0	251.2
LTE Band 41	**2496 – 2690**	**23.0**	**9**	**32.0**	**1584.9**

4 LoRa Radio EIRP:

EIRP calculated using highest gain antenna associated with LoRa Radio for KONA Macro Ex Gateway variant. The table below shows the EIRP value for LoRa radios both 1 channel and in 2 channels transmission mode. The worst case value is highlighted below.

Technology	Frequency (MHz)	Measured Power (Conducted) (dBm)	Cable Loss (dB)	Highest Antenna Gain (dBi)	Measured EIRP (dBm)	Measured EIRP (mW)
LoRa (1 Carrier)	923.3	27.11	0.5	6	32.61	1824.0
	925.1	28.41	0.5	6	33.91	2460.4
	927.5	27.49	0.5	6	32.99	1991.0
LoRa (2 Carrier)	923.3 + 923.9	28.35	0.5	6	33.85	2426.6
	924.5 + 925.1	**29.29**	**0.5**	**6**	**34.79**	**3013.0**
	926.7 + 927.5	28.33	0.5	6	33.83	2415.5

3 Calculation and Equations:

When both radios transmitting simultaneously:

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

= 1584.9 mW + 3013 mW

EIRP = 4597.9 mW

EIRP = 4598.0 mW (rounded up)

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 = √ [4598 / (4π x 0.466)]

R = 28.02119118 cm

R = rounded up to <u>29 cm distance Uncontrolled Exposure</u>

Power Density using calculated distance

S = EIRP / (4πR2)

S = 4598 / [4π (29)2]

S = 0.435073976

S = 0.4351 < **0.466 mW/cm2**

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

R = √ [EIRP / (4πS)]

R = √ [4598 / (4π x 2.33)]

R = 12.53145766 cm

R = rounded up to **<u>13.0 cm distance Occupational/Controlled Exposure</u>**

Power Density using calculated distance

S = EIRP / (4πR2)

S = 4598 / [4π (13)2]

S = 2.165072273

S = 2.2 < **2.33 mW/cm2**

5 Conclusion:

<u>R = 29 cm, for uncontrolled exposure (rounded up to the first decimal)</u>

<u>R = 13 cm, for Occupational/Controlled Exposure (rounded up to the first decimal)</u>

The KONA Macro Ex Gateway variant is intended to be installed in hazardous controlled area environment with restricted access to general public. The installation and maintenance must be performed by professional trained RF technician.