

## Maximum Permissible Exposure (MPE)

### Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended to comply with § 2.1091 Radiofrequency radiation exposure evaluation: mobile devices of the FCC CFR 47 Rules, CFR 1.1310 (b) Radio frequency Radiation Exposure Requirement.

### Special Accessories

Not available for this EUT intended for grant

### Equipment Modifications

Not available for this EUT intended for grant.

### Limitation

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm <sup>2</sup> )	Averaging Time (minute)
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 <sup>2</sup> )	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	F/1500	30
1500-15000	/	/	1.0	30

F = frequency in MHz

\* = Plane-wave equipment power density

## Exposure (MPE) Evaluation

The evaluation and calculation as deduces below presents only worst-case that produces highest value of the result:

Operation Configuration of the Worst-Case picked up to evaluate:

### LTE Band 4 / 13

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## Operation in LTE Band 4 (1710 to 1755 MHz)

BAND 4 / BW: 20M / QPSK / RB: 1,0

EUT			Measurement					
Operation Band	Fundamental Frequency	CH	Antenna Pol.	S.G. Output	Antenna Gain	Cable Loss	EIRP	Limit
	MHz		V/H	dBm	dBi	dB	dBm	dBm
LTE BAND 4	1720	20050	V	12.25	9.17	-2.49	18.93	30
			H	16.43	9.17	-2.49	23.11	30
	1732.5	20175	V	13.59	9.21	-2.5	20.3	30
			H	16.52	9.21	-2.5	<b>23.23</b>	30
	1745	20300	V	10.96	9.25	-2.51	17.7	30
			H	14.55	9.25	-2.51	21.29	30

**Power Density = EIRP\*Duty Cycle/(4πR<sup>2</sup>)**

**Duty Cycle is 1 for LTE band operation and R is 20cm.**

EIRP	<b>23.23</b>	(dBm)
EIRP	210.378	(mW)
Duty cycle:	<b>100</b>	(%)
Maximum Pav :	210.377844	(mW)
Prediction distance:	20	(cm)
Prediction frequency:	<b>1732.5</b>	(MHz)
MPE limit for uncontrolled exposure at prediction	1.0000	(mW/cm <sup>2</sup> )
Power density at predication frequency at 20 (cm)	0.04187	(mW/cm <sup>2</sup> )

### Measurement Result

The predicted power density level at 20 cm is 0.04187 mW/cm<sup>2</sup>.

This is below the uncontrolled exposure limit of 1 mW/cm<sup>2</sup> at 1732.5MHz.

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## Operation in LTE Band 13 (777 to 787 MHz)

BAND 13 / BW: 10M / 16QAM / RB: 1,0

EUT			Measurement					
Operation Band	Fundamental Frequency	CH	Antenna Pol.	S.G. Output	Antenna Gain	Cable Loss	ERP	Limit
	MHz		V/H	dBm	dBd	dB	dBm	dBm
LTE BAND 13	782.0	23230	V	24.31	0.03	-1.63	<b>22.71</b>	44.77
			H	20.19	0.03	-1.63	18.59	44.77

$$\text{Power Density} = \text{EIRP} \times \text{Duty Cycle} / (4\pi R^2)$$

Duty Cycle is 1 for LTE band operation and R is 20cm.

ERP	<b>22.71</b>	(dBm)
ERP	186.638	(mW)
Duty cycle:	<b>100</b>	(%)
Maximum Pav :	186.637969	(mW)
Prediction distance:	20	(cm)
Prediction frequency:	<b>782</b>	(MHz)
MPE limit for uncontrolled exposure at prediction	0.5213	(mW/cm <sup>2</sup> )
Power density at predication frequency at 20 (cm)	0.03715	(mW/cm <sup>2</sup> )

### Measurement Result

The predicted power density level at 20 cm is 0.03715 mW/cm<sup>2</sup>.

This is below the uncontrolled exposure limit of 0.5213 mW/cm<sup>2</sup> at 782MHz.

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## Collocated MPE Analysis

The modem may transmit simultaneously with other collocated radio transmitters within a host device, provided the following conditions are met:

- Each collocated radio transmitter has been certified by FCC for mobile application (that will be met since SQNS module will have its own FCC ID and host device will have its own FCC ID)
- At least 20 cm separation distance between the antennas of the collocated transmitters and the user's body must be maintained at all times (host installation should taking care of that)

The output power and antenna gain in a collocated configuration must not exceed the limits and configurations stipulated in the following table 1. The power density calculations for the individual transmitters per wireless technology at an exposure minimum separation distance of 20cm.

### Exclusion of test condition:

*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 calculated or measured field strengths or power density, is  $\leq 1.0$ .*

$$MPE\ ratio1 + MPE\ ratio2 + MPE\ ratio3 \leq 1.0$$

The spreadsheet as FCC deduces, and releases is employed to conduct the measurement:

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**Table 1: Collocated MPE Calculation (Worst Case Table)**

Technology	Frequency (MHz)	Max. Conducted Power (dBm)	Max. Gain (dBi)	Duty Cycle	FCC Power Density @20cm (mW/cm <sup>2</sup> )	FCC MPE Limit (mW/cm <sup>2</sup> )
WLAN 2.4G	2412	15.53	0.4	48.34	0.004	1.000
LTE Band 4	1732.5	24.15	0.8	100	0.062	1.000
LTE Band 13	782	23.40	-1.2	100	0.033	0.521

**Scenario 1:**

WLAN 2.4G + LTE B4 + LTE B13

WLAN (mW/cm <sup>2</sup> )	WLAN / MPE limit	(WLAN) / MPE limit	LTE B4 (mW/cm <sup>2</sup> )	LTE B4 / MPE limit	LTE B4 / MPE limit	LTE B13 (mW/cm <sup>2</sup> )	LTE B13 / MPE limit	LTE B13 / MPE limit	WLAN+ LTE B4+ LTE B13	FCC Limit (mW/cm <sup>2</sup> )
0.004	1.00	0.004	0.062	1.00	0.062	0.033	0.521	0.063	0.129	1.000

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