

Maximum Permissible Exposure (MPE)

Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended to comply with Section Part 22, subpart H and Part 24, subpart E and Part 27 subpart C & subpart L of the FCC CFR 47 Rules. And RSS-102 issue 4 For 47 CFR 1.1310 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 ²)	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 ²)	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

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Averaging Time (minutes)
0.003-1	280	2.19	-	6
1-10	280/f	2.19/f	-	6
10-30	28	2.19/f	-	6
30-300	28	0.073	2*	6
300-1500	$1.585 f^{0.5}$	$0.0042 f^{0.5}$	f/150	6
1500-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158 f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$

Note: f is frequency in MHz.

* Power density limit is applicable at frequencies greater than 100 MHz.

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Maximum Permissible Exposure (MPE) Evaluation

In this application we seek approval to the 1KU1. Based on the FCC OET Bulletin 65 Supplement C and 47 CFR §2.1091, we have concluded that the 1KU1 module will comply with the FCC rules on RF exposure for mobile devices in cellular band and PCS band. The following analysis will demonstrate such compliance. The analysis will be done in two US bands.

Operation in cellular band (824.7 – 848.31 MHz)

The ERP of 1KU1 in cellular band is 22.95dBm max at CDMA2000 EVDO Cellular mode. The resulted power density at a distance of 20 cm can be deducted as follows:

EUT				Measurement					
Operation Band	Pol.	Fundamental Frequency	CH	Antenna Pol.	S.G. Output	Antenna Gain	Cable Loss	ERP	Limit
		MHz		V/H	dBm	dBi	dB	dBm	dBm
CDMA 2000 EVDO Cellular	E2	824.70	1013	V	22.92	3.96	-4.22	22.66	38.45
				H	22.98	3.97	-4.22	22.73	38.45
		836.52	384	V	22.81	4.00	-4.24	22.57	38.45
				H	22.55	4.00	-4.24	22.31	38.45
		848.31	777	V	23.25	4.03	-4.33	22.95	38.45
				H	21.47	4.03	-4.33	21.17	38.45

$$\text{ERP} = 22.95\text{dBm} = 197.242\text{mW}$$

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

$$= 197.242 \times 1 / (4 \times \pi \times 20^2) = 0.039 \text{ mW/cm}^2$$

where Duty Cycle is 1 for CDMA operation and R is 20 cm.

The MPE limit for General Population/Uncontrolled Exposure is shown in the FCC OET Bulletin 65 Supplement C and can be calculated as follows:

$$\text{MPE limit} = 824/1500 = 0.55 \text{ mW/cm}^2$$

As we can see the resulted power density is below the MPE limit, therefore 1KU1 in cellular band is compliant with the FCC rules on RF exposure.

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Operation in PCS band (1851.25 – 1908.75 MHz)

The EIRP of 1KU1 in PCS band is 29.83dBm max at CDMA2000 EVDO PCS mode. The resulted power density at a distance of 20 cm can be deducted as follows:

EUT				Measurement					
Operation Band	Pol.	Fundamental Frequency	CH	Antenna Pol.	S.G. Output	Antenna Gain	Cable Loss	EIRP	Limit
		MHz		V/H	dBm	dBi	dB	dBm	dBm
CDMA 2000 EVDO PCS	E2	1851.25	25	V	31.14	4.17	-5.49	29.83	33.00
				H	26.22	4.51	-5.49	25.24	33.00
		1880.00	600	V	29.08	4.13	-5.56	27.65	33.00
				H	26.78	4.44	-5.56	25.66	33.00
		1908.75	1175	V	29.02	4.10	-5.56	27.56	33.00
				H	25.87	4.37	-5.56	24.68	33.00

$$\text{EIRP} = 29.83 \text{ dBm} = 961.612 \text{ mW}$$

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

$$= 961.612 \times 1 / (4 \times \pi \times 20^2) = 0.191 \text{ mW/cm}^2$$

where Duty Cycle is 1 for CDMA2000 operation and R is 20 cm.

The MPE limit for General Population/Uncontrolled Exposure is shown in the FCC OET Bulletin 65 Supplement C and can be calculated as follows:

$$\text{MPE limit} = 1.0 \text{ mW/cm}^2$$

As we can see the resulted power density is below the MPE limit, therefore 1KU1 in PCS band is compliant with the FCC rules on RF exposure.

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Operation in LTE band (779.5 – 784.56 MHz)

The ERP of 1KU1 in **LTE band 13 5MHz /QPSK /RB 1** is 23.17dBm max at LTE mode. The resulted power density at a distance of 20 cm can be deducted as follows:

EUT Mode	Frequency (MHz)	CH	EUT Pol.	Antenna Pol.	SPA Reading (dBuV)	S.G. Output (dBm)	Antenna Gain (dBd)	Cable Loss (dB)	ERP (dBm)	Limit (dBm)
5MHz BW LTE-Band 13 (QPSK RB 1 Offset 0)	779.50	23205	E2	V	119.98	33.14	-7.87	3.53	21.74	44.70
				H	117.78	27.08	-7.87	5.84	13.37	44.70
	782.00	23230	E2	V	121.39	34.57	-7.87	3.53	23.17	44.70
				H	118.75	28.58	-7.87	3.53	17.18	44.70
	784.50	23255	E2	V	119.90	33.11	-7.87	3.54	21.70	44.70
				H	117.66	28.02	-7.87	3.54	16.61	44.70

$$\text{ERP} = 23.17\text{dBm} = 207.491\text{mW}$$

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

$$= 207.491 \times 1 / (4 \times \pi \times 20^2) = 0.041 \text{ mW/cm}^2$$

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

The MPE limit for General Population/Uncontrolled Exposure is shown in the FCC OET Bulletin 65 Supplement C and can be calculated as follows:

$$\text{MPE limit} = 779.5/1500 = 0.52 \text{ mW/cm}^2$$

As we can see the resulted power density is below the MPE limit, therefore 1KU1 in LTE band is compliant with the FCC rules on RF exposure.

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Operation in LTE band (779.5 – 784.56 MHz)

The ERP of 1KU1 in **LTE band 13 5MHz /16QAM/RB 1** is 24.31dBm max at LTE mode. The resulted power density at a distance of 20 cm can be deducted as follows:

EUT Mode	Frequency (MHz)	CH	EUT Pol.	Antenna Pol.	SPA Reading (dBuV)	S.G. Output (dBm)	Antenna Gain (dBd)	Cable Loss (dB)	ERP (dBm)	Limit (dBm)
5MHz BW LTE-Band 13 (16QAM RB 1 Offset 0)	779.50	23205	E2	V	120.79	33.95	-7.87	3.53	22.55	44.70
				H	118.45	27.75	-7.87	5.84	14.04	44.70
	782.00	23230	E2	V	122.53	35.71	-7.87	3.53	24.31	44.70
				H	118.77	28.60	-7.87	3.53	17.20	44.70
	784.50	23255	E2	V	120.76	33.97	-7.87	3.54	22.56	44.70
				H	118.14	28.50	-7.87	3.54	17.09	44.70

$$\text{ERP} = 24.31\text{dBm} = 269.774\text{mW}$$

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

$$= 269.774 \times 1 / (4 \times \pi \times 20^2) = 0.054 \text{ mW/cm}^2$$

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

The MPE limit for General Population/Uncontrolled Exposure is shown in the FCC OET Bulletin 65 Supplement C and can be calculated as follows:

$$\text{MPE limit} = 779.5/1500 = 0.52 \text{ mW/cm}^2$$

As we can see the resulted power density is below the MPE limit, therefore 1KU1 in LTE band is compliant with the FCC rules on RF exposure.

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Operation in LTE band (782 MHz)

The ERP of 1KU1 in **LTE band 13 10MHz /QPSK/RB 1** is 23.59dBm max at LTE mode. The resulted power density at a distance of 20 cm can be deducted as follows:

EUT Mode	Frequency (MHz)	CH	EUT Pol.	Antenna Pol.	SPA Reading (dBuV)	S.G. Output (dBm)	Antenna Gain (dBd)	Cable Loss (dB)	ERP (dBm)	Limit (dBm)
10MHz BW LTE-Band 13 (QPSK RB 1 Offset 0)	782.00	23230	E2	V	121.81	34.99	-7.87	3.53	23.59	44.70
				H	117.45	27.28	-7.87	3.53	15.88	44.70

$$\text{ERP} = 23.59\text{dBm} = 228.560\text{mW}$$

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

$$= 228.560 \cdot 1 / (4 \cdot \pi \cdot 20^2) = 0.045 \text{ mW/cm}^2$$

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

The MPE limit for General Population/Uncontrolled Exposure is shown in the FCC OET Bulletin 65 Supplement C and can be calculated as follows:

$$\text{MPE limit} = 782/1500 = 0.52 \text{ mW/cm}^2$$

As we can see the resulted power density is below the MPE limit, therefore 1KU1 in LTE band is compliant with the FCC rules on RF exposure.

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Operation in LTE band (782 MHz)

The ERP of 1KU1 in **LTE band 13 10MHz /16QAM /RB 1** is 24.03dBm max at LTE mode. The resulted power density at a distance of 20 cm can be deducted as follows:

EUT Mode	Frequency (MHz)	CH	EUT Pol.	Antenna Pol.	SPA Reading (dBuV)	S.G. Output (dBm)	Antenna Gain (dBd)	Cable Loss (dB)	ERP (dBm)	Limit (dBm)
10MHz BW LTE-Band 13 (16QAM RB 1 Offset 0)	782.00	23230	E2	V	122.25	35.43	-7.87	3.53	24.03	44.70
				H	117.70	27.53	-7.87	3.53	16.13	44.70

$$\text{ERP} = 24.03\text{dBm} = 252.930\text{mW}$$

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

$$= 252.930 \times 1 / (4 \times \pi \times 20^2) = 0.050 \text{ mW/cm}^2$$

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

The MPE limit for General Population/Uncontrolled Exposure is shown in the FCC OET Bulletin 65 Supplement C and can be calculated as follows:

$$\text{MPE limit} = 782/1500 = 0.52 \text{ mW/cm}^2$$

As we can see the resulted power density is below the MPE limit, therefore 1KU1 in LTE band is compliant with the FCC rules on RF exposure.

- End of Report -

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