13. MAXIMUM PERMISSIBLE EXPOSURE (MPE)

13.1. 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.

13.2. Special Accessories

Not available for this EUT intended for grant

13.3. Equipment Modifications

Not available for this EUT intended for grant.

13.4. 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

13.5. 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:

Operation in WCDMA II band (1852.4 – 1907.6 MHz)

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
WCDMA Band II	1852.4	9262	V	19.94	9.58	-6.86	**22.66**	33.01
			H	9.42	9.58	-6.86	12.14	33.01
	1880.0	9400	V	19.42	9.69	-6.91	22.2	33.01
			H	5.36	9.69	-6.91	8.14	33.01
	1907.6	9538	V	19.33	9.81	-6.96	22.18	33.01
			H	3.54	9.81	-6.96	6.39	33.01

Power Density = EIRP*Duty Cycle/(4πR^2)
Duty Cycle is 1 for WCDMA II band operation and R is 20cm.

EIRP	22.66	(dBm)
EIRP	184.502	(mW)
Duty cycle:	100	(%)
Maximum Pav :	184.501542	(mW)
Prediction distance:	20	(cm)
Prediction frequency:	1852.4	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	1.0000	(mW/cm2)
Power density at predication frequency at 20 (cm) distance	0.03672	(mW/cm2)

Measurement Result
The predicted power density level at 20 cm is 0.03672 mW/cm2.
This is below the uncontrolled exposure limit of 1 mW/cm2 at 1852.4MHz.

Operation in WCDMA IV band (1712.4 – 1752.6 MHz)

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
WCDMA Band IV	1712.4	1312	V	22.26	8.99	-6.58	**24.67**	30.00
			H	13.66	8.99	-6.59	16.06	30.00
	1732.6	1413	V	20.73	9.07	-6.62	23.18	30.00
			H	12.29	9.07	-6.62	14.74	30.00
	1752.6	1513	V	20.75	9.16	-6.67	23.24	30.00
			H	10.49	9.16	-6.67	12.98	30.00

Power Density = EIRP*Duty Cycle/(4πR^2)
Duty Cycle is 1 for WCDMA IV band operation and R is 20cm.

EIRP	24.67	(dBm)
EIRP	293.089	(mW)
Duty cycle:	100	(%)
Maximum Pav :	293.089325	(mW)
Prediction distance:	20	(cm)
Prediction frequency:	1712.4	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	1.0000	(mW/cm2)
Power density at predication frequency at 20 (cm) distance	0.05834	(mW/cm2)

Measurement Result

The predicted power density level at 20 cm is 0.05834 mW/cm2.

This is below the uncontrolled exposure limit of 1 mW/cm2 at 1712.4MHz.

Operation in WCDMA V band (826.4 – 846.6 MHz)

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
WCDMA Band V	826.4	4132	V	20.26	5.13	-4.19	**21.20**	38.45
			H	18.63	5.13	-4.19	19.57	38.45
	836.6	4183	V	19.35	5.1	-4.22	20.23	38.45
			H	17.76	5.1	-4.23	18.63	38.45
	846.6	4233	V	19.14	5.06	-4.26	19.94	38.45
			H	18.48	5.06	-4.26	19.28	38.45

Power Density = ERP*Duty Cycle/(4πR^2)
Duty Cycle is 1 for WCDMA V band operation and R is 20cm.

ERP	21.20	(dBm)
ERP	131.826	(mW)
Duty cycle:	100	(%)
Maximum Pav :	131.825674	(mW)
Prediction distance:	20	(cm)
Prediction frequency:	826.4	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	0.5509	(mW/cm2)
Power density at predication frequency at 20 (cm) distance	0.02624	(mW/cm2)

Measurement Result

The predicted power density level at 20 cm is 0.02624 mW/cm2.

This is below the uncontrolled exposure limit of 0.5509 mW/cm2 at 826.4MHz.

Operation in LTE 2 band (1855.0 – 1905.0 MHz)

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 2 BW: 1.4M QPSK RB: 1,0	1850.7	18607	V	17.78	9.57	-6.86	20.49	33.01
			H	9.96	9.57	-6.86	12.67	33.01
	1880.0	18900	V	20.01	9.69	-6.91	22.79	33.01
			H	11.02	9.69	-6.91	13.80	33.01
	1909.3	19193	V	17.13	9.82	-6.97	19.98	33.01
			H	9.08	9.82	-6.97	11.93	33.01

Power Density = EIRP*Duty Cycle/(4πR^2)
Duty Cycle is 1 for LTE 2 band operation and R is 20cm.

EIRP	22.79	(dBm)
EIRP	190.108	(mW)
Duty cycle:	100	(%)
Maximum Pav :	190.107828	(mW)
Prediction distance:	20	(cm)
Prediction frequency:	1880	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	1.0000	(mW/cm2)
Power density at predication frequency at 20 (cm) distance	0.03784	(mW/cm2)

Measurement Result
The predicted power density level at 20 cm is 0.03784 mW/cm2.
This is below the uncontrolled exposure limit of 1 mW/cm2 at 1880MHz.

Operation in LTE 4 band (1711.5 – 1753.5 MHz)

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 BW: 5M 16QAM RB: 1,0	1712.5	19975	V	17.36	8.98	-6.58	19.76	30.00
			H	11.43	8.98	-6.58	13.83	30.00
	1732.5	20175	V	16.39	9.07	-6.62	18.84	30.00
			H	12.87	9.07	-6.62	15.32	30.00
	1752.5	20375	V	19.18	9.15	-6.66	21.67	30.00
			H	10.34	9.15	-6.66	12.83	30.00

Power Density = EIRP*Duty Cycle/(4πR^2)
Duty Cycle is 1 for LTE 4 band operation and R is 20cm.

EIRP	21.67	(dBm)
EIRP	146.893	(mW)
Duty cycle:	100	(%)
Maximum Pav :	146.892628	(mW)
Prediction distance:	20	(cm)
Prediction frequency:	1752.5	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	1.0000	(mW/cm2)
Power density at predication frequency at 20 (cm) distance	0.02924	(mW/cm2)

Measurement Result

The predicted power density level at 20 cm is 0.02924 mW/cm2.
This is below the uncontrolled exposure limit of 1 mW/cm2 at 1752.5MHz.

Operation in LTE 5 band (825.5 – 847.5 MHz)

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 5 BW: 3M 16QAM RB: 1,0	825.5	20415	V	23.61	5.13	-4.19	24.55	38.45
			H	18.92	5.14	-4.18	19.88	38.45
	836.5	20525	V	21.83	5.10	-4.22	22.71	38.45
			H	18.14	5.10	-4.22	19.02	38.45
	847.5	20635	V	21.63	5.07	-4.26	22.44	38.45
			H	16.89	5.07	-4.26	17.70	38.45

Power Density = ERP*Duty Cycle/(4πR^2)
Duty Cycle is 1 for LTE 5 band operation and R is 20cm.

ERP	24.55	(dBm)
ERP	285.102	(mW)
Duty cycle:	100	(%)
Maximum Pav :	285.101827	(mW)
Prediction distance:	20	(cm)
Prediction frequency:	825.5	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	0.5503	(mW/cm2)
Power density at predication frequency at 20 (cm) distance	0.05675	(mW/cm2)

Measurement Result

The predicted power density level at 20 cm is 0.05675 mW/cm2.

This is below the uncontrolled exposure limit of 0.5503 mW/cm2 at 825.5MHz.

Operation in LTE 7 band (2507.5 – 2562.5 MHz)

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 7 BW: 5M 16QAM RB: 1,24	2502.5	20775	V	20.58	10.71	-7.83	23.46	33.01
			H	11.35	10.71	-7.84	14.22	33.01
	2535.0	21100	V	20.76	10.74	-7.87	23.63	33.01
			H	12.39	10.75	-7.87	15.27	33.01
	2567.5	21425	V	21.24	10.78	-7.91	24.11	33.01
			H	12.15	10.78	-7.91	15.02	33.01

Power Density = EIRP*Duty Cycle/(4πR^2)
Duty Cycle is 1 for LTE 7 band operation and R is 20cm.

EIRP	24.11	(dBm)
EIRP	257.632	(mW)
Duty cycle:	100	(%)
Maximum Pav :	257.632116	(mW)
Prediction distance:	20	(cm)
Prediction frequency:	2567.5	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	1.0000	(mW/cm2)
Power density at predication frequency at 20 (cm) distance	0.05128	(mW/cm2)

Measurement Result

The predicted power density level at 20 cm is 0.05128 mW/cm2.

This is below the uncontrolled exposure limit of 1 mW/cm2 at 2567.5MHz.

Operation in LTE 12 band (700.5 – 714.5 MHz)

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 12 BW: 1.4M QPSK RB: 1,5	699.7	23017	V	24.25	5.06	-3.82	25.49	24.77
			H	17.27	5.06	-3.82	18.51	24.77
	707.5	23095	V	22.66	5.08	-3.84	23.90	24.77
			H	16.20	5.08	-3.84	17.44	24.77
	715.3	23173	V	21.76	5.09	-3.87	22.98	24.77
			H	14.34	5.09	-3.87	15.56	24.77

Power Density = ERP*Duty Cycle/($4\pi R^2$)
Duty Cycle is 1 for LTE 12 band operation and R is 20cm.

ERP	25.49	(dBm)
ERP	353.997	(mW)
Duty cycle:	100	(%)
Maximum Pav :	353.997341	(mW)
Prediction distance:	20	(cm)
Prediction frequency:	699.7	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	0.4665	(mW/cm2)
Power density at predication frequency at 20 (cm) distance	0.07046	(mW/cm2)

Measurement Result

The predicted power density level at 20 cm is 0.07046 mW/cm2.

This is below the uncontrolled exposure limit of 0.4665 mW/cm2 at 699.7MHz.

Operation in LTE 13 band (779.5 – 784.5 MHz)

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 BW: 5M 16QAM RB: 1,0	779.5	23205	V	23.95	5.19	-4.04	25.10	34.77
			H	21.17	5.19	-4.04	22.32	34.77
	782.0	23230	V	24.58	5.20	-4.05	25.73	34.77
			H	22.02	5.20	-4.05	23.17	34.77
	784.5	23255	V	24.10	5.20	-4.06	25.24	34.77
			H	21.59	5.20	-4.06	22.73	34.77

Power Density = ERP*Duty Cycle/(4πR^2)
Duty Cycle is 1 for LTE 13 band operation and R is 20cm.

ERP	25.73	(dBm)
ERP	374.111	(mW)
Duty cycle:	100	(%)
Maximum Pav :	374.110588	(mW)
Prediction distance:	20	(cm)
Prediction frequency:	782	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	0.5213	(mW/cm2)
Power density at predication frequency at 20 (cm) distance	0.07446	(mW/cm2)

Measurement Result

The predicted power density level at 20 cm is 0.07446 mW/cm2.

This is below the uncontrolled exposure limit of 0.5213 mW/cm2 at 782MHz.

Operation in LTE 25 band (1850.7 – 1914.3 MHz)

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 25 BW: 1.4M QPSK RB: 1,5	1850.7	26047	V	21.78	9.58	-6.86	24.50	33.01
			H	13.50	9.57	-6.86	16.21	33.01
	1882.5	26365	V	21.28	9.71	-6.92	24.07	33.01
			H	9.18	9.71	-6.92	11.97	33.01
	1914.3	26683	V	19.71	9.84	-6.98	22.57	33.01
			H	9.13	9.84	-6.98	11.99	33.01

Power Density = ERP*Duty Cycle/(4πR^2)
Duty Cycle is 1 for LTE 25 band operation and R is 20cm.

EIRP	24.50	(dBm)
EIRP	281.838	(mW)
Duty cycle:	100	(%)
Maximum Pav :	281.838293	(mW)
Prediction distance:	20	(cm)
Prediction frequency:	1850.7	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	1.0000	(mW/cm2)
Power density at predication frequency at 20 (cm) distance	0.05610	(mW/cm2)

Measurement Result

The predicted power density level at 20 cm is 0.0561 mW/cm2.

This is below the uncontrolled exposure limit of 1 mW/cm2 at 1850.7MHz.

Operation in LTE 26 band (825.5 – 847.5 MHz)

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 26 BW: 3M 16QAM RB: 1,14	825.5	26805	V	24.39	5.13	-4.19	25.33	38.45
			H	22.92	5.13	-4.19	23.86	38.45
	836.5	26915	V	22.50	5.09	-4.23	23.36	38.45
			H	20.84	5.09	-4.23	21.70	38.45
	847.5	27025	V	21.18	5.06	-4.26	21.98	38.45
			H	19.40	5.06	-4.26	20.20	38.45

Power Density = ERP*Duty Cycle/($4\pi R^2$)
Duty Cycle is 1 for LTE 26 band operation and R is 20cm.

ERP	25.33	(dBm)
ERP	341.193	(mW)
Duty cycle:	100	(%)
Maximum Pav :	341.192912	(mW)
Prediction distance:	20	(cm)
Prediction frequency:	825.5	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	0.5503	(mW/cm2)
Power density at predication frequency at 20 (cm) distance	0.06791	(mW/cm2)

Measurement Result

The predicted power density level at 20 cm is 0.06791 mW/cm2.

This is below the uncontrolled exposure limit of 0.5503 mW/cm2 at 825.5MHz.

Operation in LTE 26 band (815.5 – 822.5 MHz) for Part 90S

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 26 BW: 1.4M QPSK RB: 1,5	814.7	26697	V	25.02	5.17	-4.15	26.04	50.00
			H	24.17	5.17	-4.14	25.20	50.00
	819.0	26740	V	23.72	5.15	-4.16	24.71	50.00
			H	22.81	5.16	-4.16	23.81	50.00
	823.3	26783	V	23.28	5.14	-4.17	24.25	50.00
			H	22.24	5.14	-4.18	23.20	50.00

Power Density = ERP*Duty Cycle/($4\pi R^2$)
Duty Cycle is 1 for LTE 26 band operation and R is 20cm.

ERP	26.04	(dBm)
ERP	401.791	(mW)
Duty cycle:	100	(%)
Maximum Pav :	401.790811	(mW)
Prediction distance:	20	(cm)
Prediction frequency:	814.7	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	0.5431	(mW/cm2)
Power density at predication frequency at 20 (cm) distance	0.07997	(mW/cm2)

Measurement Result

The predicted power density level at 20 cm is 0.07997 mW/cm2.

This is below the uncontrolled exposure limit of 0.5431 mW/cm2 at 814.7MHz.

Operation in LTE 30 band (2307.5 – 2312.5 MHz)

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 30 BW: 5M 16QAM RB: 1,0	2307.5	27685	V	23.69	10.51	-7.59	26.61	34.77
			H	13.00	10.51	-7.59	15.92	34.77
	2310.0	27710	V	24.42	10.51	-7.59	27.34	34.77
			H	13.62	10.51	-7.59	16.54	34.77
	2312.5	27735	V	23.20	10.51	-7.59	26.12	34.77
			H	13.19	10.51	-7.59	16.11	34.77

Power Density = ERP*Duty Cycle/(4πR^2)
Duty Cycle is 1 for LTE 30 band operation and R is 20cm.

EIRP	27.34	(dBm)
EIRP	542.001	(mW)
Duty cycle:	100	(%)
Maximum Pav :	542.00089	(mW)
Prediction distance:	20	(cm)
Prediction frequency:	2310	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	1.0000	(mW/cm2)
Power density at predication frequency at 20 (cm) distance	0.10788	(mW/cm2)

Measurement Result

The predicted power density level at 20 cm is 0.10788 mW/cm2.

This is below the uncontrolled exposure limit of 1 mW/cm2 at 2310MHz.

Operation in LTE 41 band (2506.0 – 2680.0 MHz)

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 41 BW: 5M QPSK RB: 1,24	2498.5	39675	V	24.47	10.70	-7.83	27.34	33.00
			H	15.34	10.70	-7.83	18.21	33.00
	2593.0	40620	V	24.89	10.81	-7.93	27.77	33.00
			H	12.21	10.82	-7.94	15.09	33.00
	2687.5	41565	V	22.95	10.93	-8.03	25.85	33.00
			H	12.23	10.93	-8.03	15.13	33.00

Power Density = EIRP*Duty Cycle/(4πR^2)
Duty Cycle is 1 for LTE 41 band operation and R is 20cm.

EIRP	27.77	(dBm)
EIRP	598.412	(mW)
Duty cycle:	100	(%)
Maximum Pav :	598.411595	(mW)
Prediction distance:	20	(cm)
Prediction frequency:	2593	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	1.0000	(mW/cm2)
Power density at predication frequency at 20 (cm) distance	0.11911	(mW/cm2)

Measurement Result
The predicted power density level at 20 cm is 0.11911 mW/cm2.
This is below the uncontrolled exposure limit of 1 mW/cm2 at 2593MHz.