



14. 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 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 VTC6110-ATT4. Based on the FCC OET Bulletin 65 Supplement C and 47 CFR §2.1091, we have concluded that the MC55i 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 – 849 MHz)

The ERP of VTC6110-ATT4 in cellular band is 22.16dBm max at GSM/GPRS 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.	S.G. Output (dBm)	Antenna Gain (dBi)	Cable Loss (dB)	ERP (dBm)	Limit (dBm)
GPRS 850	824.20	1013	H	V	20.13	3.96	-4.22	19.87	38.45
				H	22.42	3.96	-4.22	22.16	38.45
	836.60	384	H	V	19.18	4.00	-4.24	18.94	38.45
				H	21.99	4.00	-4.24	21.75	38.45
	848.80	777	H	V	20.03	4.03	-4.33	19.73	38.45
				H	20.37	4.03	-4.33	20.07	38.45

$$\text{ERP} = 22.16 \text{ dBm} = 164.43 \text{ mW}$$

$$\begin{aligned} \text{Power Density} &= \text{ERP} \times \text{Duty Cycle} / (4 \times R^2) \\ &= 164.43 \times 0.25 / (4 \times 20^2) = 0.0082 \text{ mW/cm}^2 \end{aligned}$$

where Duty Cycle is 0.25 for GPRS operation (class 10) 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 VTC6110-ATT4 in cellular band is compliant with the FCC rules on RF exposure.

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Operation in PCS band (1850 – 1910 MHz)

The EIRP of VTC6110-ATT4 in PCS band is 26.69 dBm. max. The resulted EIRP can be expressed as follows:

EUT Mode	Frequency (MHz)	CH	EUT Pol.	Antenna Pol.	S.G. Output (dBm)	Antenna Gain (dBi)	Cable Loss (dB)	EIRP (dBm)	Limit (dBm)
GPRS 1900	1850.20	512	H	V	28.01	4.17	-5.49	26.69	33.00
				H	21.24	4.51	-5.49	20.26	33.00
	1880.00	661	H	V	25.79	4.13	-5.56	24.36	33.00
				H	19.93	4.44	-5.56	18.80	33.00
	1909.80	810	H	V	26.41	4.10	-5.56	24.95	33.00
				H	18.25	4.36	-5.56	17.06	33.00

$$\text{EIRP} = 26.69 \text{ dBm} = 466.65 \text{ mW}$$

$$\begin{aligned} \text{Power Density} &= \text{EIRP} \times \text{Duty Cycle} / (4 \times R^2) \\ &= 466.65 \times 0.25 / (4 \times 20^2) = 0.0232 \text{ mW/cm}^2 \end{aligned}$$

where Duty Cycle is 0.25 for GPRS operation (class 10) 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 VTC6110-ATT4 in PCS band is compliant with the FCC rules on RF exposure.

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The EIRP of VTC6110-ATT4 in cellular band is 23.34dBm max at HSDPA Band 2mode. The resulted power density at a distance of 20 cm can be deducted as follows:

EUT Mode	Frequency (MHz)	CH	EUT Pol.	Antenna Pol.	S.G. Output (dBm)	Antenna Gain (dBd)	Cable Loss (dB)	EIRP (dBm)	Limit (dBm)
HSDPA II	1852.40	9262	E2	V	24.65	4.17	-5.49	23.34	33.00
				H	17.81	4.51	-5.49	16.83	33.00
	1880.00	9400	E2	V	23.83	4.14	-5.56	22.41	33.00
				H	17.60	4.44	-5.56	16.47	33.00
	1907.60	9538	E2	V	23.90	4.10	-5.62	22.38	33.00
				H	14.95	4.37	-5.62	13.70	33.00

$$\text{EIRP} = 23.34\text{dBm} = 215.77 \text{ mW}$$

$$\begin{aligned} \text{Power Density} &= \text{EIRP} * \text{Duty Cycle} / (4 * R^2) \\ &= 215.77 * 1 / (4 * 20^2) = 0.0429 \text{ mW/cm}^2 \end{aligned}$$

Where Duty Cycle is 1 for HSDPA Band 2 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 VTC6110-ATT4 in cellular band is compliant with the FCC rules on RF exposure.

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Operation in cellular band (826.40– 846.60 MHz)

The ERP of VTC6110-ATT4 in cellular band is 16.04dBm max at HSDPA Band 5 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.	S.G. Output (dBm)	Antenna Gain (dBd)	Cable Loss (dB)	ERP (dBm)	Limit (dBm)
HSDPA V	826.40	4132	E2	V	14.16	3.97	-4.22	13.91	38.45
				H	16.30	3.97	-4.22	16.04	38.45
	836.60	4183	E2	V	12.88	4.00	-4.24	12.64	38.45
				H	15.94	4.00	-4.24	15.70	38.45
	846.60	4233	E2	V	14.10	4.02	-4.24	13.89	38.45
				H	13.89	4.02	-4.24	13.67	38.45

$$\text{ERP} = 16.04\text{dBm} = 40.17 \text{ mW}$$

$$\begin{aligned} \text{Power Density} &= \text{EIRP} \times \text{Duty Cycle} / (4 \pi R^2) \\ &= 40.17 \times 1 / (4 \pi \times 20^2) = 0.00799 \text{ mW/cm}^2 \end{aligned}$$

where Duty Cycle is 1 for HSDPA Band 5 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:

$$\text{MPE limit} = 826.40 / 1500 = 0.55093 \text{ mW/cm}^2$$

As we can see the resulted power density is below the MPE limit, therefore VTC6110-ATT4 in cellular band is compliant with the FCC rules on RF exposure.

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Operation in LTE band (1712.5 – 1752.5 MHz)

The EIRP of VTC6110-ATT4 in **LTE band 4 5MHz /QPSK/RB 1** is 20.69dBm 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.	S.G. Output (dBm)	Antenna Gain (dBd)	Cable Loss (dB)	EIRP (dBm)	Limit (dBm)
5MHz BW LTE-Band 4 (QPSK RB 1 Offset 24)	1712.5	19975	E2	V	18.83	4.39	-5.40	17.82	30.00
				H	16.68	4.79	-5.40	16.07	30.00
	1732.5	20175	E2	V	18.94	4.35	-5.42	17.86	30.00
				H	17.97	4.78	-5.42	17.33	30.00
	1752.5	20375	E2	V	21.82	4.31	-5.44	20.69	30.00
				H	18.21	4.76	-5.44	17.53	30.00

$$\text{EIRP} = 20.69\text{dBm} = 117.22\text{mW}$$

$$\begin{aligned} \text{Power Density} &= \text{ERP} * \text{Duty Cycle} / (4 * R^2) \\ &= 117.22 * 1 / (4 * 20^2) = 0.02332 \text{ mW/cm}^2 \end{aligned}$$

where Duty Cycle is 1 for LTE band 4 5MHz /QPSK/RB 1 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 VTC6110-ATT4 in cellular band is compliant with the FCC rules on RF exposure.

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Operation in LTE band (1712.5 – 1752.5 MHz)

The EIRP of VTC6110-ATT4 in **LTE band 4 5MHz /16QAM/RB 1** band is 24.82dBm. max. The resulted power density at a distance of 20 cm can be deducted as follows:

EUT Mode	Frequency (MHz)	CH	EUT Pol.	Antenna Pol.	S.G. Output (dBm)	Antenna Gain (dBi)	Cable Loss (dB)	EIRP (dBm)	Limit (dBm)
5MHz BW LTE-Band 4 (16QAM RB 1 Offset 24))	1712.5	19975	E2	V	25.33	4.39	-5.40	24.32	30.00
				H	23.15	4.79	-5.40	22.54	30.00
	1732.5	20175	E2	V	25.90	4.35	-5.42	24.82	30.00
				H	22.62	4.78	-5.42	21.98	30.00
	1752.5	20375	E2	V	23.46	4.31	-5.44	22.33	30.00
				H	22.30	4.76	-5.44	21.63	30.00

$$\text{EIRP} = 23.34 \text{ dBm} = 303.39 \text{ mW}$$

$$\begin{aligned} \text{Power Density} &= \text{EIRP} \times \text{Duty Cycle} / (4 \pi R^2) \\ &= 303.39 \times 1 / (4 \pi \times 20^2) = 0.0604 \text{ mW/cm}^2 \end{aligned}$$

where Duty Cycle is 1 for LTE band 4 5MHz /16QAM/RB 1 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 VTC6110-ATT4 in PCS band is compliant with the FCC rules on RF exposure.

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Operation in LTE band (1715 – 1750 MHz)

The EIRP of VTC6110-ATT4 **LTE band 14 10MHz /QPSK/RB 1** band is 21.05 dBm. max. The resulted power density at a distance of 20 cm can be deducted as follows:

EUT Mode	Frequency (MHz)	CH	EUT Pol.	Antenna Pol.	S.G. Output (dBm)	Antenna Gain (dBd)	Cable Loss (dB)	EIRP (dBm)	Limit (dBm)
10MHz BW LTE-Band 4 (QPSK RB 1 Offset 49)	1715	20000	E2	V	18.81	4.38	-5.40	17.79	30.00
				H	17.14	4.79	-5.40	16.53	30.00
	1732.5	20175	E2	V	19.06	4.34	-5.42	17.98	30.00
				H	17.61	4.78	-5.42	16.96	30.00
	1750	20350	E2	V	22.18	4.31	-5.44	21.05	30.00
				H	21.47	4.76	-5.44	20.79	30.00

$$\text{EIRP} = 21.05\text{dBm} = 127.35\text{mW}$$

$$\begin{aligned} \text{Power Density} &= \text{ERP} \times \text{Duty Cycle} / (4 \times R^2) \\ &= 127.35 \times 1 / (4 \times 20^2) = 0.02534 \text{ mW/cm}^2 \end{aligned}$$

where Duty Cycle is 1 for LTE band 14 10MHz /QPSK/RB 1 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 VTC6110-ATT4 in LTE band is compliant with the FCC rules on RF exposure.

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Operation in LTE band (1715 – 1750 MHz)

The EIRP of VTC6110-ATT4 in **LTE band 4 10MHz /16QAM/RB 1** is 23.95 dBm 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.	S.G. Output (dBm)	Antenna Gain (dBd)	Cable Loss (dB)	EIRP (dBm)	Limit (dBm)
10MHz BW LTE-Band 4 (16QAM RB 1 Offset 49)	1715	20000	E2	V	24.97	4.38	-5.40	23.95	30.00
				H	22.39	4.79	-5.40	21.78	30.00
	1732.5	20175	E2	V	24.69	4.34	-5.42	23.61	30.00
				H	21.41	4.78	-5.42	20.76	30.00
	1750	20350	E2	V	23.10	4.31	-5.44	21.97	30.00
				H	22.49	4.76	-5.44	21.81	30.00

$$\text{EIRP} = 23.95\text{dBm} = 248.31\text{mW}$$

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

$$= 248.31 \times 1 / (4 \times 20^2) = 0.0494 \text{ mW/cm}^2$$

where Duty Cycle is 1 for LTE band 4 10MHz /16QAM/RB 1 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 VTC6110-ATT4 in LTE band is compliant with the FCC rules on RF exposure.

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Operation in LTE band (706.5 – 713.5 MHz)

The ERP of VTC6110-ATT4 in **LTE band 17 5MHz /QPSK/RB 1** is 15.36dBm 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.	S.G. Output (dBm)	Antenna Gain (dBd)	Cable Loss (dB)	ERP (dBm)	Limit (dBm)
5MHz BW LTE-Band 17 (QPSK RB 1 Offset 24)	706.5	23755	E2	V	13.87	4.10	-3.98	13.98	34.70
				H	13.40	4.10	-3.98	13.52	34.70
	710	23790	E2	V	15.08	4.05	-3.98	15.15	34.70
				H	13.81	4.05	-3.98	13.88	34.70
	713.5	23825	E2	V	15.34	4.01	-3.98	15.36	34.70
				H	14.15	4.01	-3.98	14.18	34.70

$$\text{ERP} = 15.36\text{dBm} = 34.36\text{mW}$$

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

$$= 34.36 \times 1 / (4 \times 20^2) = 0.00684 \text{ mW/cm}^2$$

where Duty Cycle is 1 for LTE band 17 5MHz /QPSK/RB 1 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:

$$\text{MPE limit} = 706.5 / 1500 = 0.471 \text{ mW/cm}^2$$

As we can see the resulted power density is below the MPE limit, therefore VTC6110-ATT4 in LTE band is compliant with the FCC rules on RF exposure.

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 90 days only.

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Operation in LTE band (706.5 – 713.5 MHz)

The ERP of VTC6110-ATT4 in **LTE band 17 5MHz /16QAM/RB 1** is 15.86dBm 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.	S.G. Output (dBm)	Antenna Gain (dBd)	Cable Loss (dB)	ERP (dBm)	Limit (dBm)
5MHz BW LTE-Band 17 (16 QAM RB 1 Offset 24)	706.5	23755	E2	V	15.80	4.05	-3.98	15.86	34.70
				H	14.40	4.04	-3.98	14.45	34.70
	710	23790	E2	V	15.77	4.00	-3.98	15.79	34.70
				H	14.77	4.00	-3.98	14.78	34.70
	713.5	23825	E2	V	15.14	3.95	-3.98	15.11	34.70
				H	14.33	3.95	-3.98	14.30	34.70

$$\text{ERP} = 15.86\text{dBm} = 38.55\text{mW}$$

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

$$= 38.55 \times 1 / (4 \times 20^2) = 0.00767 \text{ mW/cm}^2$$

where Duty Cycle is 1 for LTE band 17 5MHz /16QAM/RB 1 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:

$$\text{MPE limit} = 706.5/1500 = 0.471 \text{ mW/cm}^2$$

As we can see the resulted power density is below the MPE limit, therefore VTC6110-ATT4 in LTE band is compliant with the FCC rules on RF exposure.

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Operation in LTE band (709 – 711 MHz)

The ERP of VTC6110-ATT4 in **LTE band 17 10MHz /QPSK/RB 1** is 16.30dBm 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.	S.G. Output (dBm)	Antenna Gain (dBd)	Cable Loss (dB)	ERP (dBm)	Limit (dBm)
10MHz BW LTE-Band 17 (16 QPSK RB 1 Offset 49)	709	23780	E2	V	15.14	3.98	-3.98	15.14	34.70
				H	14.06	3.98	-3.98	14.06	34.70
	710	23790	E2	V	16.31	3.97	-3.98	16.30	34.70
				H	14.20	3.97	-3.98	14.19	34.70
	711	23800	E2	V	15.25	3.95	-3.98	15.22	34.70
				H	14.39	3.96	-3.98	14.37	34.70

$$\text{ERP} = 16.30\text{dBm} = 42.66\text{mW}$$

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

$$= 42.66 \times 1 / (4 \pi \times 20^2) = 0.00849 \text{ mW/cm}^2$$

where Duty Cycle is 1 for LTE band 17 10MHz /QPSK/RB 1 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:

$$\text{MPE limit} = 709/1500 = 0.473 \text{ mW/cm}^2$$

As we can see the resulted power density is below the MPE limit, therefore VTC6110-ATT4 in cellular band is compliant with the FCC rules on RF exposure.

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Operation in LTE band (709 – 711 MHz)

The ERP of VTC6110-ATT4 in **LTE band 17 10MHz /16QAM/RB 1** is 16.17dBm 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.	S.G. Output (dBm)	Antenna Gain (dBd)	Cable Loss (dB)	ERP (dBm)	Limit (dBm)
10MHz BW LTE-Band 17 (16 QPSK RB 1 Offset 49)	709	23780	E2	V	16.17	3.98	-3.98	16.17	34.70
				H	15.07	3.98	-3.98	15.07	34.70
	710	23790	E2	V	15.78	3.97	-3.98	15.77	34.70
				H	14.31	3.97	-3.98	14.30	34.70
	711	23800	E2	V	15.80	3.96	-3.98	15.77	34.70
				H	14.40	3.96	-3.98	14.38	34.70

$$\text{ERP} = 16.17\text{dBm} = 41.40\text{mW}$$

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

$$= 41.40 \times 1 / (4 \times 20^2) = 0.00824 \text{ mW/cm}^2$$

where Duty Cycle is 1 for LTE band 17 10MHz /16QAM/RB 1 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:

$$\text{MPE limit} = 709/1500 = 0.473 \text{ mW/cm}^2$$

As we can see the resulted power density is below the MPE limit, therefore VTC6110-ATT4 in cellular band is compliant with the FCC rules on RF exposure.

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