

FCC §15.247 (i), §2.1091 & §1.1307(b)(1) - Maximum Permissible Exposure (MPE)

Applicable Standard

According to subpart 15.247(i) and subpart §1.1310, systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

(B) Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (minutes)
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
1500–100,000	-	-	1.0	30

f = frequency in MHz; * = Plane-wave equivalent power density;

According to §1.1310 and §2.1091 RF exposure is calculated.

Calculated Formulary:

Predication of MPE limit at a given distance

$$S = PG/4\pi R^2$$

Where:

S = power density (in appropriate units, e.g. mW/cm²);

P = power input to the antenna (in appropriate units, e.g., mW);

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain;

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

The host VT-M2M-LV may contain 3 RF modules: one 3G module (FCC ID: R17HE910, FCC ID: R17DE910-DUAL & FCC ID: R17GE910Q3), one Zigbee module (FCC ID: MCQ-XBS2C) & one WLAN module. The rated output power and antenna gain in the below table:

WIFI+Zigbee+GSM (FCC ID: R17HE910)

Mode	Frequency	Antenna Gain		Conducted Power		Evaluation Distance	Power Density	Limit	MPE Ratios
	MHz	dBi	numeric	dBm	mW	cm	mW/cm ²	mW/cm ²	(%)
WIFI	2412-2462	2	1.58	17.26	53.21	20	0.017	1.0	1.7
	2422-2452	2	1.58	14.03	25.29	20	0.010	1.0	1.0
Zigbee	2405-2480	2	1.58	10.08	10.19	20	0.003	1.0	0.3
GSM	824-849	1	1.26	24.00	251.19	20	0.063	0.55	11.5
	1850-1910	1	1.26	20.90	123.03	20	0.031	1.0	3.1
Total sum of MPE ratios (%)									13.5

For WIFI and Zigbee module transmit simultaneously, the worst case for MPE was chosen to be added up.

For GSM mode, the worst case for MPE was chosen to be added up

Result: 13.5%<1, the device meet FCC MPE at 20 cm distance.

WIFI+Zigbee+EGPRS (FCC ID: R17HE910)

Mode	Frequency		Antenna Gain		Conducted Power		Evaluation Distance	Power Density	Limit	MPE Ratios
	MHz		dBi	numeric	dBm	mW	cm	mW/cm ₂	mW/cm ₂	(%)
WIFI	2412-2462		2	1.58	17.26	53.21	20	0.017	1.0	1.7
	2422-2452		2	1.58	14.03	25.29	20	0.010	1.0	1.0
Zigbee	2405-2480		2	1.58	10.08	10.19	20	0.003	1.0	0.3
EGPRS	824-849	slot 1	1	1.26	20.90	123.03	20	0.031	0.55	5.6
		slot 2	1	1.26	23.70	234.42	20	0.059	0.55	10.7
		slot 3	1	1.26	24.50	281.84	20	0.071	0.55	12.9
		slot 4	1	1.26	25.50	354.81	20	0.089	0.55	16.2
	1850-1910	slot 1	1	1.26	19.60	91.20	20	0.023	1.0	2.3
		slot 2	1	1.26	22.40	173.78	20	0.044	1.0	4.4
		slot 3	1	1.26	23.50	223.87	20	0.056	1.0	5.6
		slot 4	1	1.26	24.20	263.03	20	0.066	1.0	6.6
Total sum of MPE ratios (%)										18.2

For WIFI and Zigbee module transmit simultaneously, the worst case for MPE was chosen to be added up.

For EGPRS mode, the worst case for MPE was chosen to be added up

Result: 18.2%<1, the device meet FCC MPE at 20 cm distance.

WIFI+Zigbee+WCDMA (FCC ID: RI7HE910)

Mode	Frequency	Antenna Gain		Conducted Power		Evaluati on Distance	Power Density	Limit	MPE Ratios
	MHz	dBi	numer ic	dBm	mW	cm	mW/cm ²	mW/cm ²	(%)
WIFI	2412-2462	2	1.58	17.26	53.21	20	0.017	1.0	1.7
	2422-2452	2	1.58	14.03	25.29	20	0.008	1.0	0.8
Zigbee	2405-2480	2	1.58	10.08	10.19	20	0.003	1.0	0.3
WCDMA	1850-1910	1	1.26	26.39	435.51	20	0.109	1.0	10.9
	824-849	1	1.26	26.63	460.26	20	0.115	0.55	20.9
Total sum of MPE ratios (%)									22.9

For WIFI and Zigbee module transmit simultaneously, the worst case for MPE was chosen to be added up.

For WCDMA mode, the worst case for MPE was chosen to be added up

Result: 22.9%<1, the device meet FCC MPE at 20 cm distance.

WIFI+Zigbee+GPRS(FCC ID: RI7HE910)

Mode	Frequency		Antenna Gain		Conducted Power		Evaluati on Distance	Power Density	Limit	MPE Ratios
	MHz		dBi	numer ic	dBm	mW	cm	mW/cm ²	mW/cm ²	(%)
WIFI	2412-2462		2	1.58	17.26	53.21	20	0.017	1.0	1.7
	2422-2452		2	1.58	14.03	25.29	20	0.010	1.0	1.0
Zigbee	2405-2480		2	1.58	10.08	10.19	20	0.003	1.0	0.3
GPRS	824-849	slot 1	1	1.26	24.00	251.19	20	0.063	0.55	11.5
		slot 2	1	1.26	26.40	436.52	20	0.109	0.55	19.8
		slot 3	1	1.26	27.40	549.54	20	0.138	0.55	25.1
		slot 4	1	1.26	27.80	602.56	20	0.151	0.55	27.5
	1850-1910	slot 1	1	1.26	20.90	123.03	20	0.031	1.0	3.1
		slot 2	1	1.26	23.40	218.78	20	0.055	1.0	5.5
		slot 3	1	1.26	24.50	281.84	20	0.071	1.0	7.1
		slot 4	1	1.26	24.80	302.00	20	0.076	1.0	7.6
Total sum of MPE ratios (%)										29.5

For WIFI and Zigbee module transmit simultaneously, the worst case for MPE was chosen to be added up.

For GPRS mode, the worst case for MPE was chosen to be added up

Result: 29.5%<1, the device meet FCC MPE at 20 cm distance.

WIFI+Zigbee+CDMA (FCC ID: RI7DE910-DUAL)

Mode	Frequency	Antenna Gain		Conducted Power		Evaluati on Distance	Power Density	Limit	MPE Ratios
	MHz	dBi	numeric	dBm	mW	cm	mW/cm ²	mW/cm ²	(%)
WIFI	2412-2462	2	1.58	17.26	53.21	20	0.017	1.0	1.7
	2422-2452	2	1.58	14.03	25.29	20	0.008	1.0	0.8
Zigbee	2405-2480	2	1.58	10.08	10.19	20	0.003	1.0	0.3
CDMA	1850-1910	1	1.26	24.74	297.85	20	0.075	1.0	7.5
	824-849	1	1.26	24.37	273.53	20	0.069	0.55	12.5
Total sum of MPE ratios (%)									14.5

For WIFI and Zigbee module transmit simultaneously, the worst case for MPE was chosen to be added up.

For CDMA mode, the worst case for MPE was chosen to be added up

Result: 14.5%<1, the device meet FCC MPE at 20 cm distance.

WIFI+Zigbee+GSM (FCC ID: RI7GE910Q3)

Mode	Frequency	Antenna Gain		Conducted Power		Evaluati on Distance	Power Density	Limit	MPE Ratios
	MHz	dBi	numeric	dBm	mW	cm	mW/cm ²	mW/cm ²	(%)
WIFI	2412-2462	2	1.58	17.26	53.21	20	0.017	1.0	1.7
	2422-2452	2	1.58	14.03	25.29	20	0.008	1.0	0.8
Zigbee	2405-2480	2	1.58	10.08	10.19	20	0.003	1.0	0.3
GSM	824-849	1	1.26	23.13	205.59	20	0.052	0.55	9.5
Total sum of MPE ratios (%)									11.5

For WIFI and Zigbee module transmit simultaneously, the worst case for MPE was chosen to be added up.

For GSM mode, the worst case for MPE was chosen to be added up

Result: 11.5%<1, the device meet FCC MPE at 20 cm distance.

WIFI+Zigbee+GPRS (FCC ID: RI7GE910Q3)

Mode	Frequency		Antenna Gain		Conducted Power		Evaluati on Distance	Power Density	Limit	MPE Ratios
	MHz		dBi	numeric	dBm	mW	cm	mW/cm ₂	mW/cm ²	(%)
WIFI	2412-2462		2	1.58	17.26	53.21	20	0.017	1.0	1.7
	2422-2452		2	1.58	14.03	25.29	20	0.008	1.0	0.8
Zigbee	2405-2480		2	1.58	10.08	10.19	20	0.003	1.0	0.3
GPRS	824-849	slot 1	1	1.26	23.10	204.17	20	0.051	0.55	9.3
		slot 2	1	1.26	25.68	369.83	20	0.093	0.55	16.9
	1850-1910	slot 1	1	1.26	20.93	123.88	20	0.031	1.0	3.1
		slot 2	1	1.26	23.72	235.50	20	0.059	1.0	5.9
Total sum of MPE ratios (%)										18.9

For WIFI and Zigbee module transmit simultaneously, the worst case for MPE was chosen to be added up.

For GPRS mode, the worst case for MPE was chosen to be added up

Result: 18.9%<1, the device meet FCC MPE at 20 cm distance.