



MPE Calculations

Systems operating under the provision of 47 CFR 1.1307(b)(1) shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the FCC guidelines.

The EUT will only be used with a separation of 20 centimeters or greater between the antenna and the body of the user or nearby persons and can therefore be considered a mobile transmitter per 47 CFR 2.1091(b). The MPE calculation for this exposure is shown below.

Using the Antennas with highest output power: Ethertronics & Wistron NeWeb Corp. Antennas

The peak radiated output power (EIRP) is calculated as follows:

<i>Antenna</i>	<i>Frequency (GHz)</i>	<i>Power input to the antenna (P) (dBm)</i>	<i>Power gain of the antenna (G) (dBi)</i>	<i>EIRP (P+G) (dBm)</i>	<i>EIRP $\text{Log}^{-1}(\text{dBm}/10)$ (mW)</i>
Ethertronics (Chain A)	2.4	23.84	3.00	26.84	483.06
Ethertronics (Chain A)	5	24.04	5.00	29.04	801.68
Ethertronics (Chain B)	2.4	23.84	3.00	26.84	483.06
Ethertronics (Chain B)	5	24.64	5.00	29.64	920.45
Ethertronics (Chain C)	2.4	24.04	3.00	27.04	505.82
Ethertronics (Chain C)	5	24.54	5.00	29.54	899.50
Wistron NeWeb Corp (Chain A)	2.4	23.84	4.96	28.80	758.58
Wistron NeWeb Corp (Chain A)	5	24.04	4.87	28.91	778.04
Wistron NeWeb Corp (Chain B)	2.4	23.84	4.96	28.80	758.58
Wistron NeWeb Corp (Chain B)	5	24.64	4.87	29.51	893.31
Wistron NeWeb Corp (Chain C)	2.4	24.04	4.96	29.00	794.33
Wistron NeWeb Corp (Chain C)	5	24.54	4.87	29.41	872.97

$\text{EIRP} = P + G$

Where

P = Power input to the antenna (mW).

G = Power gain of the antenna (dBi)



The numeric gain (G) of the antenna with a gain specified in dB is determined by:

<i>Antenna</i>	<i>Frequency (GHz)</i>	<i>Antenna Gain (G) (dBi)</i>	<i>Numeric Antenna Gain $\text{Log}^{-1}(\text{dBm}/10)$ (dB)</i>
Ethertronics (Chain A)	2.4	3.00	2.00
Ethertronics (Chain A)	5	5.00	3.16
Ethertronics (Chain B)	2.4	3.00	2.00
Ethertronics (Chain B)	5	5.00	3.16
Ethertronics (Chain C)	2.4	3.00	2.00
Ethertronics (Chain C)	5	5.00	3.16
Wistron NeWeb Corp (Chain A)	2.4	4.96	3.13
Wistron NeWeb Corp (Chain A)	5	4.87	3.07
Wistron NeWeb Corp (Chain B)	2.4	4.96	3.13
Wistron NeWeb Corp (Chain B)	5	4.87	3.07
Wistron NeWeb Corp (Chain C)	2.4	4.96	3.13
Wistron NeWeb Corp (Chain C)	5	4.87	3.07

$G = \text{Log}^{-1}(\text{dB antenna gain}/10)$

**Power density at the specific separation:**

<i>Antenna</i>	<i>Frequency (GHz)</i>	<i>Power input to the antenna (P) (mW)</i>	<i>Numeric Power Gain of the Antenna (G) (dB)</i>	<i>Maximum Power Spectral Density $S=PG/(4R^2\pi)$ (mW/cm²)</i>	<i>Maximum Power Spectral Density Limit (mW/cm²)</i>
Ethertronics (Chain A)	2.4	242.10	2.00	0.096	1.00
Ethertronics (Chain A)	5	253.51	3.16	0.159	1.00
Ethertronics (Chain B)	2.4	242.10	2.00	0.096	1.00
Ethertronics (Chain B)	5	291.07	3.16	0.183	1.00
Ethertronics (Chain C)	2.4	253.51	2.00	0.101	1.00
Ethertronics (Chain C)	5	284.45	3.16	0.179	1.00
Wistron NeWeb Corp (Chain A)	2.4	242.10	3.13	0.151	1.00
Wistron NeWeb Corp (Chain A)	5	253.51	3.07	0.155	1.00
Wistron NeWeb Corp (Chain B)	2.4	242.10	3.13	0.151	1.00
Wistron NeWeb Corp (Chain B)	5	291.07	3.07	0.178	1.00
Wistron NeWeb Corp (Chain C)	2.4	253.51	3.13	0.158	1.00
Wistron NeWeb Corp (Chain C)	5	284.45	3.07	0.174	1.00

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

Where

S = Maximum power density (mW/cm²)

P = Power input to the antenna (mW).

G = Numeric power gain of the antenna

R = Distance to the center of the radiation of the antenna (20cm = limit for MPE)

The maximum permissible exposure (MPE) for the general population is 1mW/cm².

The power density at 20cm does not exceed the 1mW/cm² limit. Therefore, the exposure condition is compliant with FCC rules.

Aggregate Maximum Power Spectral Density:

<i>Antenna</i>	<i>Frequency (GHz)</i>	<i>Maximum Power Spectral Density Chain A (dBi)</i>	<i>Maximum Power Spectral Density Chain B (dBi)</i>	<i>Maximum Power Spectral Density Chain C (dBi)</i>	<i>Maximum Power Spectral Density Aggregate Chain A, B, & C (dBi)</i>	<i>Maximum Power Spectral Density Limit (mW/cm²)</i>
Ethertronics	2.4	0.096	0.096	0.101	0.098	1.00
Ethertronics	5	0.159	0.183	0.179	0.174	1.00
Wistron NeWeb Corp	2.4	0.151	0.151	0.158	0.153	1.00
Wistron NeWeb Corp	5	0.155	0.178	0.174	0.169	1.00



WWAN Co-Location

The module may be co-located with the following **FCC ID(s): PKRNVWE725 or VV7-MBMF3507G-D**. The rf exposure evaluation for these devices co-located with the WiFi module are addressed below.

The WWAN module **VV7-MBMF3507G-D** is also designed be installed into laptop hosts. The installation of this module by Dell will use the various antennas that have a maximum gain of 2.1dBi in the 800MHz band and 1.2dBi in the 1.9GHz band. The gain data for these antennas is attached to the end of this document. Using the output powers listed in the RF exposure calculations for the various operating modes, and the appropriate protocol-limited (source-based) duty cycle the power density 20cm from the device for each operating mode is shown in the table below.

<i>Modulation</i>	<i>MPE Limit (mW/cm2)</i>	<i>Output Power (mW)</i>	<i>Duty Cycle (%)</i>	<i>Output Power (mW)</i>	<i>Antenna Gain (dBi)2</i>	<i>EIRP (mW)</i>	<i>Pd at 20cm (mW/cm2)</i>	<i>% of limit</i>
824.2 – 848.8 MHz Band								
GPRS	0.55	2000.0	25	500.0	2.1	810.9	0.16	29.3%
EDGE	0.55	1259.0	25	314.8	2.1	510.5	0.10	18.5%
WCDMA	0.55	435.0	100	435.0	2.1	705.5	0.14	25.5%
HSDPA	0.55	435.0	100	435.0	2.1	705.5	0.14	25.5%
HSUPA	0.55	435.0	100	435.0	2.1	705.5	0.14	25.5%
1850.2 – 1909.8 MHz Band								
GPRS	1	871.0	25	217.8	1.2	287.1	0.06	5.7%
EDGE	1	742.0	25	185.5	1.2	244.5	0.05	4.9%
WCDMA	1	387.0	100	387.0	1.2	510.2	0.10	10.1%
HSDPA	1	387.0	100	387.0	1.2	510.2	0.10	10.1%
HSUPA	1	387.0	100	387.0	1.2	510.2	0.10	10.1%

Output powers used for the rf exposure calculations were taken from the grant for FCC ID VV7-MBMF3507G as there appears to be an error on the grant for module VV7- MBMF3507G-D for output power in Edge mode, 800MHz band. VV7-MBMF3507G grant lists the power as 1.25 9 Watts, module VV7-MBMF3507G-D grant lists the power as 0.259 Watts. As module VV7-MBMF3507G-D approval was obtained through a Change in ID from module VV7-MBMF3507G it is assumed that module VV7-MBMF3507G lists the correct power.

The maximum power spectral density 20cm from the antenna relative to the limit is 29.3% of the limit. When the two devices are co-located the total power density 20cm from both antennas, expressed as a ratio of the allowable rf exposure, is the sum of the individual percentages of the limits for each module. This sum is 47.6%. As this value is below 100% of the limit the two devices may be collocated and used in applications with a separation distance of at least 20cm from persons.

**WWAN Co-Location (Continued)**

The WWAN module **PKRNVWE725** is also designed be installed into laptop hosts. The MPE calculation submitted as part of its approval is shown below.

<i>Band</i>	<i>Channel</i>	<i>Frequency (MHz)</i>	<i>Power (mW)</i>	<i>Antenna Gain (dBi)</i>	<i>Pd at 20cm (mW/cm2)</i>	<i>MPE Limit (mW/cm2)</i>	<i>Pd as % of limit</i>
Cellular CDMA	1013	824.70	285.80	2.00	0.114	0.55	20.7%
	384	836.52	291.10	1.90	0.110	0.558	19.7%
	777	848.31	269.80	1.98	0.106	0.566	18.7%
PCS CDMA	25	1851.25	278.00	2.10	0.116	1	11.6%
	600	1880.00	277.30	1.96	0.108	1	10.8%
	1175	1908.75	289.70	1.82	0.105	1	10.5%

The highest power density relative to the MPE limit is 20.7% of the limit at a distance 20cm from the module's antenna. When the two devices are co-located the total power density 20cm from both antennas, expressed as a ratio of the allowable rf exposure, is the sum of the individual percentages of the limits for each module. This sum is 39.0%. As this value is below 100% of the limit the two devices may be collocated and used in applications with a separation distance of at least 20cm from persons.