Radio Frequency Exposure

LIMIT

For 2.4G Band: According to §15.247(i), 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 levels in excess of the Commission's guidelines. See § 1.1307(b)(1) of this chapter.

For 5.0G Band: According to FCC §1.1310, The criteria listed in the following table shall be used to evaluate the environment impact of human exposure to radio frequency (RF) radiation as specified in § 1.1307(b).

EUT Specification

EUT	Dual-Band Wireless AC/N VDSL2 Combo WAN Gigabit Gateway with USB
Frequency band (Operating)	☒ WLAN: 2.412GHz ~ 2.462GHz ☒ WLAN: 5.150GHz ~ 5.250GHz ☒ WLAN: 5.745GHz ~ 5.825GHz ☐ Bluetooth: 2.402GHz ~ 2.480 GHz
Device category	☐ Portable (<20cm separation) ☒ Mobile (>20cm separation)
Exposure classification	☐ Occupational/Controlled exposure (S = 5mW/cm^2) ☒ General Population/Uncontrolled exposure (S=1mW/cm^2)
Antenna diversity	☐ Single antenna ☒ Multiple antennas ☐ Tx diversity ☐ Rx diversity ☒ Tx/Rx diversity
Max. output power for 2.4G Band	IEEE802.11b: 24.47 dBm (0.2799W) IEEE802.11g: 23.40 dBm (0.2188W) IEEE802.11n HT20: 25.30 dBm (0.3388W) IEEE802.11n HT40: 25.89 dBm (0.3882W)
Max. output power for 5.150-5.250GHz	IEEE802.11a: 25.37 dBm (0.3443W) IEEE802.11ac(20MHz): 26.07 dBm (0.4046W) IEEE802.11ac(40MHz): 25.48 dBm (0.3532W) IEEE802.11ac(80MHz): 19.45 dBm (0.0881W)
Max. output power for 5.745-5.850GHz	IEEE802.11a: 26.24 dBm (0.4207W) IEEE802.11ac(20MHz): 25.88 dBm (0.3873W) IEEE802.11ac(40MHz): 25.14 dBm (0.3266W) IEEE802.11ac(80MHz): 25.49 dBm (0.3540W)
Antenna gain (Max)	3.4dBi for 2.4G Band 5.45dBi for 5.150-5.250GHz 6.63dBi for 5.745-5.850GHz
Evaluation applied	☒ MPE Evaluation* ☐ SAR Evaluation ☐ N/A

Remark:

1. *The maximum output power is 25.89dBm (0.3882W) at 2437MHz (with numeric 2.188antenna gain.) for2.4G band*
   The maximum output power is 26.07dBm (0.4046W) at 5240MHz (with numeric 3.508antenna gain.)
   The maximum output power is 26.24dBm (0.4207W) at 5785MHz (with numeric 4.603antenna gain.)
2. *DTS device is not subject to routine RF evaluation; MPE estimate is used to justify the compliance.*
3. *For mobile or fixed location transmitters, no SAR consideration applied. The maximum power density is 1.0 mW/cm^2 even if the calculation indicates that the power density would be larger.*

**Note: Simultaneous transmission is not applicable for this EUT.*

TEST RESULTS FOR 2.4G BAND

No non-compliance noted.

Calculation

Given $E = \frac{\sqrt{30 \times P \times G}}{d}$ & $S = \frac{E^2}{3770}$

Where *E = Field strength in Volts / meter*
P = Power in Watts
G = Numeric antenna gain
d = Distance in meters
S = Power density in milliwatts / square centimeter

Combining equations and re-arranging the terms to express the distance as a function of the remaining variables yields:

$$S = \frac{30 \times P \times G}{3770 d^2}$$

Changing to units of mW and cm, using:

P (mW) = P (W) / 1000 and
d (cm) = d(m) / 100

Yields

$$S = \frac{30 \times (P/1000) \times G}{3770 \times (d/100)^2} = 0.0796 \times \frac{P \times G}{d^2}$$ ***Equation 1***

Where *d = Distance in cm*
P = Power in mW
G = Numeric antenna gain
S = Power density in mW / cm²

Maximum Permissible Exposure

Modulation Mode	Frequency band (MHz)	Max. Conducted output power(dBm)	Antenna gain (dBi)	Distance (cm)	Power density (mW/cm2)	Limit (mW/cm2)
IEEE802.11b	2412-2462	24.47	3.4	20	0.1219	1
IEEE802.11g	2412-2462	23.40	3.4	20	0.0953	1
IEEE802.11n HT20	2412-2462	25.30	3.4	20	0.1475	1
IEEE802.11n HT40	2422-2452	25.89	3.4	20	0.1690	1

TEST RESULTS FOR 5150-5250MHZ

No non-compliance noted.

Calculation

Given $E = \frac{\sqrt{30 \times P \times G}}{d}$ & $S = \frac{E^2}{3770}$

Where *E = Field strength in Volts / meter*
P = Power in Watts
G = Numeric antenna gain
d = Distance in meters
S = Power density in milliwatts / square centimeter

Combining equations and re-arranging the terms to express the distance as a function of the remaining variables yields:

$$S = \frac{30 \times P \times G}{3770 d^2}$$

Changing to units of mW and cm, using:

P (mW) = P (W) / 1000 and
d (cm) = d(m) / 100

Yields

$$S = \frac{30 \times (P/1000) \times G}{3770 \times (d/100)^2} = 0.0796 \times \frac{P \times G}{d^2}$$ ***Equation 1***

Where *d = Distance in cm*
P = Power in mW
G = Numeric antenna gain
S = Power density in mW / cm²

Maximum Permissible Exposure

Modulation Mode	Frequency band (MHz)	Max. Conducted output power(dBm)	Antenna gain (dBi)	Distance (cm)	Power density (mW/cm2)	Limit (mW/cm2)
IEEE802.11a	5180-5240	25.37	5.45	20	0.2403	1
IEEE802.11ac(20MHz)	5180-5240	26.07	5.45	20	0.2823	1
IEEE802.11ac(40MHz)	5190-5230	25.48	5.45	20	0.2465	1
IEEE802.11ac(80MHz)	5210	19.45	5.45	20	0.0615	1

TEST RESULTS FOR 5745-5825MHZ

No non-compliance noted.

Calculation

Given $E = \frac{\sqrt{30 \times P \times G}}{d}$ & $S = \frac{E^2}{3770}$

Where *E = Field strength in Volts / meter*
P = Power in Watts
G = Numeric antenna gain
d = Distance in meters
S = Power density in milliwatts / square centimeter

Combining equations and re-arranging the terms to express the distance as a function of the remaining variables yields:

$$S = \frac{30 \times P \times G}{3770 d^2}$$

Changing to units of mW and cm, using:

P (mW) = P (W) / 1000 and
d (cm) = d(m) / 100

Yields

$$S = \frac{30 \times (P/1000) \times G}{3770 \times (d/100)^2} = 0.0796 \times \frac{P \times G}{d^2}$$ ***Equation 1***

Where *d = Distance in cm*
P = Power in mW
G = Numeric antenna gain
S = Power density in mW / cm²

Maximum Permissible Exposure

Modulation Mode	Frequency band (MHz)	Max. Conducted output power(dBm)	Antenna gain (dBi)	Distance (cm)	Power density (mW/cm2)	Limit (mW/cm2)
IEEE802.11a	5745-5825	26.24	6.63	20	0.3854	1
IEEE802.11ac(20MHz)	5745-5825	25.88	6.63	20	0.3546	1
IEEE802.11ac(40MHz)	5755-5795	25.14	6.63	20	0.2990	1
IEEE802.11ac(80MHz)	5775	25.49	6.63	20	0.3241	1

NOTE:

Total (Chain0+Chain1) , the formula of calculated the MPE is:

CPD1 / LPD1 + CPD2 / LPD2 + ……etc. < 1

CPD = Calculation power density

LPD = Limit of power density