# Collocated MPE Calculations

# QDS-BRCM1020 with N7N-MC5725-H

Systems operating under the provision of 47 CFR 1.1307(b)(1) shall be operated in a manor 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 antennas and the body of the user or nearby persons and can therefore be considered a mobile transmitter per 47 CFR 2.1091(b).

The EUT contains a PCS Licensed Transmitter, FCC Identifier N7N-MC5725-H, covered under FCC parts 24E and 22H of CFR part 47.

The details for this transmitter are shown in Table 1 below.

| FCC Rule Parts | Range (MHz) | Maximum Conducted Output, Watts | Duty Cycle | Peak Antenna Gain to be used for collocated MPE, dBi |
|---|---|---|---|---|
| 24E | 1850.2 – 1909.8 | 0.3048 | 1.0 | 4.15 |
| 22H | 824.2 – 848.8 | 0.3258 | 0.25 | 5.1 |

**Table 1**

The EUT contains a transmitter, with FCC Identifier QDS-BRCM1020, operating in the Unlicensed IMS bands covered under part 15C of CFR part 47. The details for this transmitter are shown below in Table 2.

| FCC Rule Parts | Range (MHz) | Max Output, Watts | Peak Antenna Gain to be used for collocated MPE, dBi |
|---|---|---|---|
| 15C | 2412.0 – 2462.0 | 0.414 | 3.00 |

**Table 2**

# Equations

The equations used are based on methods described in OET Bulletin 65 and appendices.

Given

$$E = \sqrt{(30 * P * DC * G) / d}$$

And

$$S = E^2 / 3770$$

Where

E = Field Strength in Volts/meter
P = Power in Watts
DC = Duty cycle, dimensionless
G = Numeric antenna gain
d = Distance in meters
S = Power Density in milli-watts/square centimeter

Combining equations and rearranging the terms to express the Power Density in terms of the other variables yields,

$$S = (30 * P * DC * G) / (3770 * d^2)$$

Changing the units of Power to mW and Distance to cm, using,

P (mW) = 1000 * P (W)
d (cm) =100 * d (m)

Yields,

$$S = ( 30 * ( P/1000 ) * DC * G) / ( 3770 * ( d/100 )^2 )$$

Or,

$$S = (0.0795756 * P * DC * G) / ( d^2 )$$

Where

d = distance in cm
P = Power in mW
DC = Duty cycle, dimensionless
G = Numeric antenna gain
S = Power Density in mW/cm^2

# FCC Limits for Maximum Permissible Exposure (MPE)

**(B) Limits for General Population/Uncontrolled Exposure**

| Frequency Range (MHz) | Electric Field Strength (E) (V/m) | Magnetic Field Strength (H) (A/m) | Power Density (S) ($mW/cm^2$) | Averaging Time $|E|^2$, $|H|^2$ or S (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

The MPE calculations for d = 20cm are shown below for the possible combinations of transmit frequency bands.

Per OET Bulletin 65, for frequency bands with the same MPE limits, the Power Densities produced by each transmitter are summed. The summation must be under the limit for the band.

Per OET Bulletin 65, for frequency bands with different limits the Power Densities are calculated separately for each band, divided by the limit for the band and the results are then summed. The summation must be less than 1.

For the frequency band 824.2 – 848.8 MHz the worst case (lowest) limit is used. The limit is calculated as follows,

$$824.2 / 1500 = 0.55 \text{ mW/cm}^2$$

# Collocated MPE Calculations

| Transmitter Frequency Band, MHz | Power, Watts | Power, milli-Watts | Duty Cycle | Peak Antenna Gain, dBi | Peak Antenna Gain, Dimensionless | Power Density at 20cm, $mW/cm^2$ $(0.0795756*P*DC*G) / (d^2)$ | Fraction of Limit, Dimensionless |
|---|---|---|---|---|---|---|---|
| 824.2 – 848.8 | 0.3258 | 325.8 | 1.0 | 5.1 | 3.24 | NA | 0.21/0.55 =0.38 |
| 1850.2 – 1909.8 | 0.3048 | 304.8 | 1.0 | 4.15 | 2.60 | 0.16 | NA |
| 2412.0 – 2462.0 | 0.4140 | 414.0 | 1.00 | 3.00 | 2.00 | 0.16 | 0.16/1 = 0.16 |

| Active Transmitter Bands, MHz | 2412.0 – 2462.0 | Unit | Limit |
|---|---|---|---|
| **824.2 – 848.8** | 0.38+0.16= 0.54 | **Dimensionless** | **1** |
| **1850.2 – 1908.8** | 0.16+0.16= 0.32 | **mW/cm2** | **1** |

Calculated worse case MPE numbers are below required limits.