Analysis of operating and installation requirements to satisfy FCC and Canada Regulations for RF exposure compliance for the 5.4/5.8GHz PTP5X250 Products

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Abstract

This document analyses the operating and installation requirements to ensure limits for RF Exposure compliance are not exceeded by the 5.4/5.8GHz PTP58250 products with integrated antenna or external antennas. The guidelines in FCC Bulletin 65 are used for the analysis.

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Copyright Information

Revision History

Version	Date	Comments	Author
000v001	27.7.2011	Initial Issue	John Sharman
000V002	12.10.2011	Updated to include 5.8GHz operation	Clem Fisher

OPERATIONAL PARAMETERS OF THE PTP5X250 PRODUCT

1 Scope

The purpose of this brief working paper is to identify the RF power produced by the PTP5X250 equipments under various operating conditions in both the 5.4GHz and 5.8GHz bands. There are two versions of the product identical apart from whether an integrated flat plate antenna is fitted or a connector plate is fitted allowing the connection of a range of external antennas:

North America region PTP250 Integrated Antenna version	WB4200
North America region PTP250 Connectorised version	WB4201

The mean conducted RF power plus the antenna gain used in specific installations identifies the effective power density (dBm/cm^2) that is to be compared against allowed limits for human exposure.

2 References

[1] Evaluating Compliance with FCC Guidelines for Human Exposure to Radio frequency Electromagnetic Fields: OET Bulletin 65, Edition 97-01, August 1997

[2] Radio Frequency Exposure Compliance of Radiocommunication Apparatus: RSS 102

3 Background

Reference [1] identifies how the radiated power density should be calculated for different distances from the antenna. The variables used are Radiated Power Density (S), conducted power (P), Antenna Gain (G) and distance (R). The formula given is

$$S= (P * G)/ (4 * Pi * R^2)$$

The limit allowed for S depends on whether the exposure risk is to a member of the public or not. The PTP5X250 products are approved by the FCC under the Part 15 rules which requires (for example, Part 15.407(f)) that all products meet the radio frequency radiation requirements for the "general population/uncontrolled environment" case. At the frequency of operation of these products, this requires that the value of S to be used is $1mW/cm^2$.

It is clear from [1] that the power to be used should be the maximum transmitted power, subject to any allowance for source-based time-averaging.

Notes

a) the FCC require that the power density be calculated at a minimum distance of 20cm

b) the value of P * G is the same as the transmitted EIRP.

4 PTP250 Specific Issues

4.1 FCC Regulations

The PTP5X250 is approved under

a) FCC Part 15.407 for operation at 5.4GHz and this regulation limits the maximum EIRP to 30.0dBm in a any channel bandwidth, the product uses 20 and 40MHz. The PTP250 products ensure that this power cannot be exceeded.
b) FCC Part 15.247 for operation at 5.8GHz and this regulation limits the conducted power to 30dBm. As this is a product for point to point, the product is allowed unlimited antenna gain in this band, but the approval of the product in this band limits the antenna gain to 37.6dBi less 1dB external feeder loss and 1dB internal cable loss (35.6dBi effective gain)

4.2 Dual Polarisation

The PTP250 product WB4200 uses an integrated dual polarised antenna, with each polarisation connected to an identical transceiver circuit inside the unit. In order to comply with the FCC EIRP limits, the design of the products reduces by 3dB the conducted power and EIRP of each of the two individual polarisations.

The PTP250 product WB4201 replaces the integrated antenna with a connector plate which feeds the H/ V radio frequency outputs either to an external dual polar antenna or two single polar antennas. The maximum antenna gain and minimum feeder losses are defined in the User Guide such that the total EIRP cannot exceed 30dBm at 5.4GHz when the conducted output power of the radio is adjusted by the professional installer as instructed.

4.3 Power Control

The power levelling loops in the product measure the transmitted power on each polarisation at all times and limit each to the Maximum Transmit Power –3dB. The Maximum Transmit Power during the transmit period (total for both polarisations) for PTP5X250 equipments is set in production to not exceed 7dBm (5.4GHz operation) and to ensure that the Maximum EIRP requirement during the burst (30 dBm) is not exceeded when the product is used with the supplied integrated antenna (G = 23dBi less 1.5dBi internal cable losses).
When operated at 5.8GHz, the peak conducted power of both antenna ports combined does not exceed 25.3dBm when measured over the transmit burst (see Sporton Report No: FR052615-01).

The PTP250 equipments operate on a TDD basis using the same frequency for up/down link. The transmit duty cycle resulting from the TDD operation varies with traffic loading up to near 100% at maximum data loading

The FCC regulations allow source-based time averaging to be used in working out the EIRP value for the exposure calculation. This gives a reduction in the effective mean conducted power and EIRP as the duty cycle is always less than 100%. However, in the following analysis we have taken a very worst case view that the duty cycle is 100% transmit.

4.4 FCC Testing

The testing has confirmed that the maximum conducted power and EIRP limits were not exceeded by the product. The effect of the dual polarised antenna on the EIRP was calculated by taking the linear sum of the results for each polarisation.

5 Analysis

5.1 Transmitted Levels

The Radiated Power Density can be assessed on the basis of the antenna gain for each polarisation and the linear sum of the transmitter powers on the two polarisations. More simply it could be based on the total EIRP allowed by the FCC regulations (as the test reports show that the linear sum of the EIRPs from each of the two polarisations on the product is less than this limit). This would present a conservative assessment as the calculated power density levels would be less using the actual test results. This is the approach that is used for the analysis below.

5.1.1 5.4GHz Operation

Example of Calculations
Channel BW = BW
*Allowed Conducted Power = 11dBm + 10*Log(BW) - (Actual Antenna Gain - 6dBi)*
Antenna Gain = Antenna Gain of each polarisation
Allowed EIRP = Allowed Conducted Power + Actual Antenna Gain
EIRP used for Radiated Power Density Calculation = Allowed Conducted Power - Allowance for source-based time-averaging in the product TDD structure

In the case of PTP 5.4GHz band PTP250

Channel BW = 20MHz or 40MHz.

For 20MHz BW

Allowance for source-based time-averaging: Maximum Tx duty cycle = 100% = 0dB
Allowed EIRP = 11 + 13 - Actual Antenna Gain + 6 + Actual Antenna Gain = 30 dBm

The total EIRP is applied as 27dBm to each polarisation of the antenna whether the antenna is the integrated flat plate antenna or an external higher gain dish as described in section 4.2 above.

For 40MHz BW
Allowed EIRP = 8 +16 - Actual Antenna Gain + 6 + Actual Antenna Gain = 30dBm

Therefore, EIRP used for MPE calculation for both bandwidths = 30 dBm or 1000mW

5.1.2 5.8GHz Operation

In this case the conducted power is limited to 20.59dBm and there are two antenna gain levels to be considered.
WB4200 – Antenna Gain = 21.5dBi
WB4201 – Maximum Allowed Antenna Gain = 35.6dBi

5.2 Radiation Levels

5.2.1 5.4GHz Operation

The table below shows the result of calculating the radiated power density using the formula given in Ref [1] at a distance of 20cm from the antenna and confirms that the power density level is below the limit given in Ref [1] for general population/ uncontrolled environments at that distance.

Total EIRP in burst	30	dBm
Less TDD duty cycle	0	dB
Total Mean EIRP	1000	mW
Power Density Limit	1	mW/cm2
Radiated Density at 20cm	0.2	mW/cm2
Margin at 20cm	7	dB

5.2.2 5.8GHz Operation

The use of high gain antennas dictates an additional calculation as the peak of beam gain does not allow margin at 20cm – an additional clearance is required.

	Integrated Antenna	Connectorised Antenna	
Total Conducted Power in burst	25.3	25.3	dBm
Antenna Gain dBi	21.5	35.6	
Total EIRP in Burst (dBm)	46.8	60.9	
Less TDD duty cycle	0	0	dB
Total Mean EIRP	47863.00923	1230268.771	mW
Power Density Limit	1		mW/cm2
Radiated Density at 20cm	9.522043138	244.7541953	mW/cm2
Margin at 20cm	N/A	N/A	dB
Distance to reduce radiation to 1mW/cm2 limit	61.72	312.89	cm
	0.62	3.13	m

6 Conclusion

When operated at 5.4GHz, PTP5X250 meets the limit for general population exposure at a distance of 20cm with a margin of 7dB. The power density at 20cm has been calculated using the FCC's maximum EIRP limit, the PTP250 radiated power in the 5.4GHz band is less than this EIRP limit even under extreme worst case conditions.

When operated at 5.8GHz, PTP5X250 exceeds the limit for general population exposure at 20cm and therefore the user guide recommends clearance distances to be maintained for all deployments. The distances recommended are conservative compared to the calculated limits.