Analysis of operating and installation requirements to satisfy FCC Regulations for RF exposure compliance for the PTP 700 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 PTP 700 products with either integral or dedicated external antennas.

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1 Scope

The PTP 700 product is a Point to Point micro Wave system capable of operating in the 4400 to 5925MHz frequency band, the product is available with either integral or dedicated external antennas.

The purpose of this brief working paper is to identify the RF power produced by the PTP 700 equipment's while operating in the frequency bands where regulation is covered by the FCC Parts listed below: -

FCC	Frequency Band (MHz)	
Part 15.247 [4]	5725	5850

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

PTP 700 products are not available to the general public and are professionally installed while the installations are expected to be remote from the 'general population' exposure limits are calculate to provide guidance to installers on the minimum distances for safe operation of PTP 700 products.

2 References

Evaluating Compliance with FCC Guidelines for Human Exposure to Radio frequency Electromagnetic Fields:

[1] First R&O further Notice of Proposed Rule Making and notice of inquiry, FCC No. 13-39
[2] KDB 447498 D01 General RF Exposure Guidance v05r02
[3] OET Bulletin 65, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields," and supplements to Bulletin 65
[4] CFR Title 47 Telecommunications Part 15.247 Subpart C

3 Background

Reference [3]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

$$S = \frac{P.G}{4\pi R^2}$$

Rearranging the terms to solve the distance for compliance with the limit: -

$$R = \sqrt{\frac{P.G}{4\pi.S}}$$

The limit allowed for S depends on whether the exposure risk is to a member of the public or not. The products concerned are approved by the FCC under the Part 15.247 (ISM) Rules.

The general regulatory requirements for the USA and Canada is that all products approved as intentional radiators under Part 15 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 or 10W/m^2.
It is clear from [3] that the power to be used should be the maximum transmitted power, subject to any allowance for source-based time-averaging.

4 PTP Product Specific Issues

4.1 FCC Regulations

The PTP 700 is to be approved under: -

- FCC Part 15.247 [4], in this operating mode the maximum conducted transmit power limit of 1W is given in subpart 15.247(b)(3).

  Note: For Fixed Point to Point operation, unlimited antenna gain is allowed as defined in subpart 247(c)(1)(ii).

4.2 PTP 700 Power Capability

This product does not have the capability to generate the full 1W, 30dBm, conducted power during the transmitter burst. The Maximum Transmit Power (conducted) from the products is limited to 29 dBm in the Part 15.247 [4]band.

This transmit power is measured as an average value across a transmit burst and is the combined power from both antenna ports. Calibrated power control loops ensure that this power is not exceeded on either product.

4.3 Dual Polarisation

The PTP 700 products use either: -

a) An integrated dual polarised antenna with each polarisation connected to an identical transceiver circuit inside the unit.
b) A connector plate to allow the connection of external dish antennas with each polarisation connected to an identical transceiver circuit inside the unit.

In order to comply with the FCC limits, the design of the products reduces by 3dB the conducted power and EIRP of each of the two individual polarisations in each of the above cases.

As the regulations effectively limit the total EIRP produced, then the calculations below apply equally in the case of both the integrated and external antennas.

4.4 Power Control

The power levelling loops in the products measure the transmitted power on each polarisation at all times and limit each to the Maximum Transmit Power shown in Para 4.2, less 3dB.

The products operate on a TDD basis using the same frequency for up/down link. The transmit duty cycle resulting from the TDD operation is typically just less than 50% but for asymmetric data flow, it may be up to 80%.

The FCC regulations allow source-based time averaging to be used in working out the EIRP value for the exposure calculation. This reduces the effective mean conducted power and EIRP from the levels of conducted power and EIRP that would be applicable if the products were to transmit with a duty cycle of 100%.

It should be noted that this is very much a worst case analysis as the products operate with Receiver driven Transmit power control. The power levels quoted in this document are those applicable to the lowest order modulation modes (BPSK) whereas the normal operating modes are up to 256QAM or above with power levels reduced by up to an additional 4dB compared to the levels shown above.

4.5 Antenna Cable Losses

In the case of external antennas, the need to adjust azimuth and elevation of the antennas imposes minimum limits on the cable losses that can be achieved between the products and the antennas. This limitation is approximately 0.9dB.

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.

5.2 Radiation Levels

The PTP 700 supports operation with the antenna types and manufactures declared gain given below, for these assessments the worst case combination of transmit power and gain has been applied.

Antenna Type	Manufacturers Gain (dBi)
6’ Parabolic Dish	38.1
Flat Plate	28.5
Sectorised	17.0
OMNI	13.0

5.2.1 Part 15.247 (5.8GHz Band)

Calculations are based upon the worst case highest conducted transmit power and highest gain for each antenna type/configuration supported by the product.

	Parabolic Dish	Flat Plate	Sectorized	OMNI
Transmit Power (dBm)	29	29	20	24
Antenna Gain (dBi)	38.1	28.5	17	13

5.2.1.1 Calculations at the Exposure Limit

The table below shows the result of calculating the radiated power density using the formula given in Ref [1] in order to find out the minimum spacing from the antenna at which the radiation has fallen to the 'general population/uncontrolled environment' limit.

Limits in mW/cm^2

	6' Dish	Flat Plate	Sectorized	OMNI	
Transmit Power	29.0	29.0	20.0	24.0	dBm
Duty Cycle Correction	0.8	0.8	0.8	0.8	
Total Power in burst	28.0	28.0	19.0	23.0	dBm
Total Mean Power	635	635	80	201	mW
Additional Cable Losses	0.9	0.9	0.9	0.9	dB
Antenna Gain	38.1	28.5	17.0	13.0	dBi
Total Mean EIRP	3334955	365671	3259	3259	mW
Power Density Limit	1.0	1.0	1.0	1.0	mW/cm2
Separation Distance at Power Density Limit	515	171	16	16	cm

Limits in W/m^2

	6' Dish	Flat Plate	Sectorized	OMNI	
Transmit Power	29.0	29.0	20.0	24.0	dBm
Duty Cycle Correction	0.8	0.8	0.8	0.8	
Total Power in burst	28.0	28.0	19.0	23.0	dBm
Total Mean Power	0.635	0.635	0.080	0.201	W
Additional Cable Losses	0.9	0.9	0.9	0.9	dB
Antenna Gain	38.1	28.5	17.0	13.0	dBi
Total Mean EIRP	3334.96	365.67	3.26	3.26	W
Power Density Limit	10.0	10.0	10.0	10.0	W/m2
Separation Distance at Power Density Limit	5.15	1.71	0.16	0.16	m

6 Conclusion

6.1 Part 15.247

When operated at 5.8GHz the PTP 700 calculated distance for compliance with the ‘general population/uncontrolled environment’ limit for each antenna type is: -

Antenna Type	Compliant Distance (m)
Parabolic Dish	5.15
Flat Plate	1.71
Sectorized	0.16
OMNI	0.16