# Analysis of operating and installation requirements to satisfy FCC Regulations for RF exposure compliance for the PMP 450m Product

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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 PMP 450m product with integral antenna.**

## Revision History

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# Operational Parameters of the PMP 450m Product

## 1 Scope

The PMP 450m product is a Point to Multi Point Multi User MIMO µWave product capable of operating in the 5150 to 5925 MHz frequency band, the product is only available with an integral antenna.

The purpose of this brief working paper is to identify the RF power produced by the PMP 450m equipment's while operating in the frequency bands where regulation is covered by the FCC Parts listed below: -

| FCC | Frequency Band (MHz) | |
|---|---|---|
| Part 15E [4] | 5150 | 5250 |
| | 5250 | 5350 |
| | 5470 | 5725 |
| | 5725 | 5850 |

The 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.

PMP 450m product is not available to the general public and is 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 PMP 450m product.

## 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 Subpart E

## 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 rules under Part 15.407.

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 PMP Product Rules and Power

## 4.1 FCC Regulations

The PMP 450m is to be approved as a Point to MultiPoint device under: -

- FCC Part 15E:-
    - UNII-1, 5.1 GHz band, in this operating mode the maximum EIRP is 36dBm
    - UNII-2A, 5.2 GHz band, in this operating mode the maximum EIRP is 30dBm
    - UNII-2C, 5.4 GHz band, in this operating mode the maximum EIRP is 30dBm
    - UNII-3, 5.8 GHz band, in this operating mode the maximum EIRP is 36dBm

## 4.2 PMP 450m Power Capability

This product is fully integrated and does not allow conducted power measurement this assessment is based upon the maximum EIRP permitted by the FCC.

The product EIRP is controlled by using one transceiver as the reference transceiver with it's transmit power detectors calibrated in the factory, the total transmit power control is dealt with via internal tracking loops within the radio that hold the remaining transmitters to +0/- 0.3dB of the reference transmit chain

## 4.3 Dual Polarisation

The PMP 450m product use a seven element integrated dual polarised antenna with each polarisation connected to identical transceiver circuits inside the unit.

## 4.4 Power Control

The power levelling loops in the products measure the transmitted power on each polarisation at all times and limit the product to the Maximum EIRP shown in Para 4.1.

The product operates 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 85 %.

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%.

# 5 Analysis

## 5.1 Radiation Levels

The PMP 450m supports operation with a single integrated antenna, EIRP generated by the PMP 450m is controlled to be within the regulatory EIRP given in Section 4.1.

### 5.1.1 Part 15E (UNII-1, 5150 – 5250 MHz and UNII-3 5725 – 5850 MHz Band)

Calculations are based upon the worst case highest EIRP power supported by these regulatory bands.

#### 5.1.1.1 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$^2$**

| | PMP 450m | |
|---|---|---|
| Transmit EIRP | 36.00 | dBm |
| Duty Cycle Correction (85%) | -0.70 | dBm |
| Total Power in burst | 35.30 | dBm |
| Total Mean Power | 3388 | mW |
| Additional Cable Losses | N/A | dB |
| Antenna Gain | N/A | dBi |
| Total Mean EIRP | 3388 | mW |
| | | |
| Power Density Limit | 1.00 | mW/cm2 |
| Separation Distance at Power Density Limit | 16 | cm |

### 5.1.2 Part 15E (UNII-2A, 5250 – 5350 MHz and UNII-2C, 5470 – 5725 MHz Band)

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

#### 5.1.2.1 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$^2$**

| | PMP 450m | |
|---|---|---|
| Transmit EIRP | 30.00 | dBm |
| Duty Cycle Correction (85%) | -0.70 | dBm |
| Total Power in burst | 29.30 | dBm |
| Total Mean Power | 851 | mW |
| Additional Cable Losses | N/A | dB |
| Antenna Gain | N/A | dBi |
| Total Mean EIRP | 851 | mW |
| | | |
| Power Density Limit | 1.00 | mW/cm2 |
| Separation Distance at Power Density Limit | 8 | cm |

# 6 Conclusion

## 6.1 Part 15E (UNII-1)

When operated in the 5150 – 5250 MHz UNII-1 Band the PMP 450m calculated distance for compliance with the ‘general population/uncontrolled environment’ limit for each antenna type is: - 0.16m

## 6.2 Part 15E (UNII-2A)

When operated in the 5250 – 5350 MHz UNII-2A Band the PMP 450m calculated distance for compliance with the ‘general population/uncontrolled environment’ limit for each antenna type is: - 0.08m

## 6.3 Part 15E (UNII-2C)

When operated in the 5470 – 5725 MHz UNII-2C Band the PMP 450m calculated distance for compliance with the ‘general population/uncontrolled environment’ limit for each antenna type is: - 0.08m

## 6.4 Part 15E (UNII-3)

When operated in the 5725 – 5850 MHz UNII-3 Band the PMP 450m calculated distance for compliance with the ‘general population/uncontrolled environment’ limit for each antenna type is: - 0.16m