MOTOROLA POINT TO POINT FIXED WIRELESS SOLUTIONS GROUP


# Working Paper

## Analysis of operating and installation requirements to satisfy FCC Regulations for RF exposure compliance for the PTP25600 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 PTP25600 range of products with integrated antennas. The guidelines in FCC Bulletin 65 are used for the analysis.**

**Revision History**

| Version | Date | Comments | Author |
|---|---|---|---|
| 0.001 | 25 June 2007 | Initial Issue | CF |

# Operational Parameters of the PTP25600 Product

## 1 Scope

The purpose of this brief working paper is to identify the RF power produced by the PTP25600 equipment under various operating conditions. This mean 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.
Whilst these products are professionally installed and the installations are expected to be remote from the 'general population' it is sensible to calculate the expected exposure limits to provide guidance to installers.

## 2 References

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

## 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 PTP25600 products are approved by the FCC under the Part27 Rules (Part 27.50 controls the Transmit Power and EIRP requirements). This requires (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 PTP25600 Specific Issues

### 4.1 FCC Regulations

The PTP25600 is approved under FCC Part 27 with the power/EIRP limits being given in subpart 27.50(h)(1)(ii).
"If a main or booster station sectorizes or otherwise uses one or more transmitting antennas with a non-omnidirectional horizontal plane radiation pattern, the maximum EIRP in dBW in a given direction shall be determined by the following formula:

EIRP = 33 dBW + 10 log(X/Y) dBW + 10 log(360/beamwidth) dBW, where X is the actual channel width in MHz, Y is either (i) 6 MHz if prior to transition or the station is in the MBS following transition or (ii) 5.5 MHz if the station is in the LBS and UBS following transition, and beamwidth is the total horizontal plane beamwidth of the individual transmitting antenna for the station or any sector measured at the half-power points."
It should be noted that the Part 27 Regulations are written in terms of the Peak Power which is not relevant to the calculation of radiation exposure.

### 4.2 PTP25600 Power Capability

The PTP25600 products do not have the capability to generate this much EIRP with the standard antenna. The Maximum Transmit Power (conducted) from the PTP25600 is nominally 24dBm measured as an average value across a transmit burst and is the combined power from both antenna ports. A calibrated power control loop ensures this power is not exceeded.
The integrated antenna supplied on some units has a maximum gain of 18dBi.

### 4.3 Dual Polarisation

The OS54XX and PTP54400 products use 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.

### 4.4 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 PTP25600 equipments in production is set to not exceed 24dBm.
The PTP25600 equipments operate on a TDD basis using the same frequency for up/down link. The transmit duty cycle resulting from the TDD operation is fixed at <50% .
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 by at least 3dB 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 as the product operates Receiver driven Transmit power control.

# 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

### 5.2.1 Calculations at 20cm Spacing

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 Power in burst | 24 | dBm |
| Less TDD duty cycle | -3.0 | dB |
| Total Mean Power | 126 | mW |
| Total Mean EIRP (18dBi Antenna) | 7.92 | W |
| Power Density Limit | 1 | mW/cm2 |
| Radiated Density at 20cm | 1.58 | mW/cm2 |

### 5.2.2 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.

| | | |
|---|---|---|
| Total Power in burst | 24 | dBm |
| Less TDD duty cycle | -3.0 | dB |
| Total Mean Power | 126 | mW |
| Total Mean EIRP (18dBi Antenna) | 7.92 | W |
| Power Density Limit | 1 | $mW/cm^2$ |
| Distance at which Radiation = $1mW/cm^2$ | 0.25 | m |

# 6 Conclusion

The equipment meets the limit for general population exposure at a distance of 25cm. Installers must ensure that all installations provide at least this level of separation from the antenna face and anyone from the ‘general population’.
If higher gain antennas are to be used, the separation distance must be increased by a factor of 1.414 for every 3dB that the antenna gain exceeds 18dBi.