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 OS54XX/PTP54400 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 OS54XX/PTP54400 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	10 Nov 2006	Initial Issue	CF
0.002	23 April 2007	Correct errors, remove reference to connectorised versions	CF
0.003	24 April 2007	Modify to show power density at 20cm	CF
0.004	24 May 2007	Modified to provide clarifications required by FCC	CF
0.005	29 May 2007	Additional modifications required by FCC	CF
0.006	30 May 2007	Modifications required by FCC	CF

Operational Parameters of the OS54XX/PTP54400 Product

1 Scope

The purpose of this brief working paper is to identify the RF power produced by the OS54XX/PTP54400 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.

The two part numbers in the heading above reflect changes in product branding only; the product performance is not affected.

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 OS54XX/PTP54400 products are approved by the FCC under the UNII Rules (Part 15.407). 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 OS54XX/PTP54400 Specific Issues

4.1 FCC Regulations

The OS54XX/PTP54400 is approved under FCC Part 15.407 and this regulation limits the maximum EIRP to 27dBm in a 10MHz channel. The OS54XX/PTP54400 products ensure that this power cannot be exceeded.

4.2 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.

4.3 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 OS54XX/PTP54400 equipments in production is set to not exceed 4dBm to ensure that the Maximum EIRP requirement during the burst (27dBm) is not exceeded when the product is used with the supplied integrated antenna (G = 23dBi).
The OS54XX/PTP54400 equipments operate on a TDD basis using the same frequency for up/down link. The transmit duty cycle resulting from the TDD operation is normally <50%. However some modes of operation do allow a transmit duty cycle of 60% (2.2dB).
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 (in the worst case) by 2.2dB 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.

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.

Example

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 OS54XX/PTP54400
Channel BW = 10MHz
Allowance for source-based time-averaging: Maximum Tx duty cycle = 60% or -2.2dB
Allowed EIRP = 11 + 10 - Actual Antenna Gain + 6 + Actual Antenna Gain = 27dBm
EIRP used for MPE calculation = 27 -2.2 = 24.8dBm or 302mW

5.2 Radiation Levels

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	27	dBm
Less TDD duty cycle	-2.2	dB
Total Mean EIRP	302	mW
Power Density Limit	1	mW/cm2
Radiated Density at 20cm	0.060081	mW/cm2

6 Conclusion

The equipment meets the limit for general population exposure at a distance of 20cm with a margin of over 12dB. This margin has been calculated using the FCC's maximum EIRP limit and the OS54XX/PTP54400 do not exceed that limit.