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SOLUTIONS GROUP



Working Paper

Analysis of operating and installation requirements to satisfy FCC Regulations for RF exposure compliance for the OS54100/PTP54600 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 OS54100/PTP54600 range of products with integrated antennas. The guidelines in FCC Bulletin 65 are used for the analysis.

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Revision History

Version	Date	Comments	Author
0.001	15 June 2007	Initial Issue	CF
0.002	8 October 2007	Update to include external antennas	CF

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Operational Parameters of the OS54100/PTP54600 Product

1 Scope

The purpose of this brief working paper is to identify the RF power produced by the OS54100/PTP54600 equipment under various operating conditions. This mean RF power plus the antenna gain used in specific installations identifies the effective power density (dBm/cm²) 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 OS54100/PTP54600 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/cm².

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 OS54100/PTP54600 Specific Issues

4.1 FCC Regulations

The OS54100/PTP54600 is approved under FCC Part 15.407 and this regulation limits the maximum EIRP to 30dBm in a channel bandwidth of approximately 27MHz . The OS54100/PTP54600 products ensure that this power cannot be exceeded.

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4.2 Dual Polarisation

The OS54100 and PTP54600 products use either

- a) an integrated dual polarised antenna with each polarisation connected to an identical transceiver circuit inside the unit, or
- 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 EIRP 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 limit the total EIRP produced, then the calculations below apply equally in the case of both the integrated and external antennas.

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 OS54100/PTP54600 equipments in production is set to not exceed 4dBm to ensure that the Maximum EIRP requirement during the burst (30dBm) is not exceeded when the product is used with the supplied integrated antenna ($G = 23\text{dBi}$). The transmitter power is reduced further when the higher gain external antennas are used in order to comply with the EIRP limits.

The OS54100/PTP54600 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.

4.4 FCC Testing

The testing has confirmed that the maximum conducted power and EIRP limits were not exceeded by the product with either the integrated antenna or the largest of the allowed external dish antennas. 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.

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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 OS54100/PTP54600

Channel BW = 27MHz

Allowance for source-based time-averaging: Maximum Tx duty cycle = 50% or - 3.0dB

Allowed EIRP = 11 + 13 - Actual Antenna Gain + 6 + Actual Antenna Gain = 30dBm

EIRP used for MPE calculation = 30 - 3.0 = 27.0dBm or 501mW

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	-3.0	dB
Total Mean EIRP	501	mW
Power Density Limit	1	mW/cm ²
Radiated Density at 20cm	0.0994	mW/cm ²

6 Conclusion

The equipment meets the limit for general population exposure at a distance of 20cm with a margin of over 10dB. This margin has been calculated using the FCC's maximum EIRP limit and the OS54100/PTP54600 do not exceed that limit.