RF Exposure Evaluation - Maximum Permissible Exposure (MPE)

1. Introduction

This document attempts to prove the safety of radiation generated by RF devices to the human body. The limit for Maximum Permissible Exposure (MPE), specified in FCC 1.1210, is listed below. The power generated by this product is measured by a power meter. Through use of the Friis transmission formula and the maximum gain of the antenna, the distance from the product at which compliance with the MPE limit is achieved may be calculated. Alternatively, near field measurements may be performed to demonstrate compliance at a specific measurement distance.

Near field probe: Wandel & Goltermann EMR-20.

2. RF Exposure Limit

According to FCC 1.1310: the criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (Minutes)
(A) Limits For Occupational / Control Exposures				
30-300	61.4	.163	1.0	6
300-1500	…	…	F/300	6
1500-100,000	…	…	5	6
(B) Limits For General Population / Uncontrolled Exposure				
30-300	27.5	.073	.2	30
300-1500	…	…	F/1500	30
1500-100,000	…	…	1.0	30

F = Frequency in MHz

3. Friis Formula

Friis transmission formula: $Pd = (P_{out} * G) / (4pr^2)$

Where:

Pd = power density in mW/cm^2 (MPE limit)
P_{out} = output power to antenna in mW
G = gain of antenna in linear scale
p = 3.1416
r = distance between observation point and center of the radiator in cm

Ref.: David K. Cheng, Field and Wave Electromagnetics, Second Edition, Page 640, Eq. (11.133)

4. EUT Operating Condition

Software provided by the client enabled the EUT to transmit and receive data at lowest, middle, and highest channels individually.

5. Climate Condition

The temperature and relative humidity: 22°C and 78% RH

6. Measurement Results

Frequency (MHz)	Level (dBm)	Measurement Distance	Front MPE reading mW/cm^2	Rear MPE reading mW/cm^2	Right MPE reading mW/cm^2	Left MPE reading mW/cm^2	Limit
824.20	31.07	20cm	.351	.350	.111	.381	.537
2412	17.26	20 cm					
2402	-1.73	20 cm					

Frequency (MHz)	Level (dBm)	Measurement Distance	Front MPE reading mW/cm^2	Rear MPE reading mW/cm^2	Right MPE reading mW/cm^2	Left MPE reading mW/cm^2	Limit
835.6	30.93	20cm	.366	.351	.0932	.382	.543
2437	17.26	20 cm					
2437	-1.43	20 cm					

Frequency (MHz)	Level (dBm)	Measurement Distance	Front MPE reading mW/cm^2	Rear MPE reading mW/cm^2	Right MPE reading mW/cm^2	Left MPE reading mW/cm^2	Limit
849.8	30.98	20cm	.353	.344	.082	.392	.547
2462	17.06	20 cm					
2480	-1.73	20 cm					

1. Data taken with all transmitters operating simultaneously

7. Conclusion

The device meets the mobile 20cm separation distance as specified in Section 2.1091 of the FCC Rules. An appropriate RF exposure compliance statement will be placed in the user's manual.

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8. EUT Operating Condition

Software provided by the client enabled the EUT to transmit and receive data at lowest, middle, and highest channels individually.

9. Climate Condition

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10. Measurement Results

Frequency (MHz)	Level (dBm)	Measurement Distance	Front MPE reading mW/cm^2	Rear MPE reading mW/cm^2	Right MPE reading mW/cm^2	Left MPE reading mW/cm^2	Limit
1850.20	32.08	20cm	.342	.315	.111	.323	.537
2412	17.26	20 cm					
2402	-1.73	20 cm					

Frequency (MHz)	Level (dBm)	Measurement Distance	Front MPE reading mW/cm^2	Rear MPE reading mW/cm^2	Right MPE reading mW/cm^2	Left MPE reading mW/cm^2	Limit
1880	31.95	20cm	.338	.330	.092	.326	.543
2437	17.26	20 cm					
2437	-1.43	20 cm					

Frequency (MHz)	Level (dBm)	Measurement Distance	Front MPE reading mW/cm^2	Rear MPE reading mW/cm^2	Right MPE reading mW/cm^2	Left MPE reading mW/cm^2	Limit
1909.80	32.92	20cm	.335	.320	.084	.340	.547
2462	17.06	20 cm					
2480	-1.73	20 cm					

1. Data taken with all transmitters operating simultaneously

11. Conclusion

The device meets the mobile 20cm separation distance as specified in Section 2.1091 of the FCC Rules. An appropriate RF exposure compliance statement will be placed in the user's manual.