

1 RF Exposure Report

This test report shall be used with main report no.: ULR-TC568819300000067F

1.1 RF Exposure Measurement

The limit for Maximum Permissible Exposure (MPE) specified in FCC 1.1310 & RSS-102 issue 5 is followed. The gain of the antennas used in the product is extracted from the Antenna data sheets provided and also the maximum total power input to the antenna is measured. Through the Friis transmission formula and the maximum gain of the antenna, we can calculate the distance, away from the product, where the limit of MPE is reached.

Although the Friis Transmission formula is far field assumption, the calculated result of that is an over-prediction for near field power density. It is taken as worst case to specify the safety range.

1.2 RF Exposure Limit

According to FCC 1.1310: The criteria listed in the following table shall be used to evaluate the environmental impact of the human exposure to radio-frequency (RF) radiation as specified in 1.1307 (b) showed in Table 1.

Table 1: Limits for Maximum Permissible Exposure (MPE) as per FCC

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)
Limits for Occupational / controlled Exposures			
300 - 1500	--	--	F/300
1500 – 100000	--	--	5.0
Limits for General population / Uncontrolled Exposure			
300 - 1500	--	--	F/1500
1500 – 100000	--	--	1.0

F or f = Frequency in MHz

According to IC RSS 102 : The criteria listed in the following table shall be used to evaluate the environmental impact of the human exposure to radio-frequency (RF) radiation as specified in section 4 showed in Table 2.

Table 2: Limits for Maximum Permissible Exposure (MPE) as per RSS

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Reference Period (minutes)
0.003-10 ²¹	83	90	-	Instantaneous*
0.1-10	-	0.73/ <i>f</i>	-	6**
1.1-10	87/ <i>f</i> ^{0.5}	-	-	6**
10-20	27.46	0.0728	2	6
20-48	58.07/ <i>f</i> ^{0.25}	0.1540/ <i>f</i> ^{0.25}	8.944/ <i>f</i> ^{0.5}	6
48-300	22.06	0.05852	1.291	6
300-6000	3.142 <i>f</i> ^{0.3417}	0.008335 <i>f</i> ^{0.3417}	0.02619 <i>f</i> ^{0.6834}	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ <i>f</i> ^{1.2}
150000-300000	0.158 <i>f</i> ^{0.5}	4.21 x 10 ⁻⁴ <i>f</i> ^{0.5}	6.67 x 10 ⁻⁵ <i>f</i>	616000/ <i>f</i> ^{1.2}

Note: *f* is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

1.2.1 Friss Formula

Friss Transmission Formula: $P_d = (P_{out} * G) / (4 * \pi * r^2)$

Where

P_d = power density in mW/cm²

P_{out} = output power to antenna in mW

G = gain of antenna in linear scale

π = 3.1416

R = Distance between observation point and the center of radiator in cm

If we know the maximum gain of the antenna and the total output power to the antenna, through calculation, we will know MPE value at distance 20cm.

1.3 Compliance criteria

The Radio frequency Human Exposure Evaluation specification, method and procedures for IM11- PRT is in accordance with the following standard FCC 1.1310 and RSS 102 Issue 5

1.4 Test Results

Protocol: RFID
Data Rate: 320 kbps

Antenna types	Antenna gain
Compact yagi antenna	+6 dBi
Microstrip antenna coupler	-19.96 dBi
Microstrip antenna coupler	-24.0 dBi

MPE calculations : For FCC 1.1307 (b)

Frequency (MHz)	Measured Pout (dBm)	Output Power to Antenna (mW)	Output Power to Antenna After duty cycle correction (mW)	Antenna Gain (dBi)	Antenna gain (dBd)	Tune up (dB)	Maximum Pout including Tune-up (mW)	Power Density (Pd) (mW/cm ²)	FCC Limit (mW/cm ²)
927.25	29.76	946.2372	236.5920	6.00	3.9811	±0.5	265.4606	0.2102	0.43285

MPE calculations : For RSS 102 Issue 5

Frequency (MHz)	Measured Pout (dBm)	Output Power to Antenna (mW)	Output Power to Antenna After duty cycle correction (mW)	Antenna Gain (dBi)	Antenna gain (dBd)	Tune up (dB)	Maximum Pout including Tune-up (mW)	Power Density (Pd) (mW/cm ²)	IC Limit (mW/cm ²)
927.25	29.76	946.2372	236.5920	6.00	3.9811	±0.5	265.4606	0.2102	0.2792

Note:

1. Tune up tolerance of ± 0.5 dB is considered for MPE calculation, this value is declared by manufacturer.
2. MPE evaluation is performed for 20 cm separation distance
3. MPE evaluation is performed for highest antenna gain of 6 dBi
4. Manufacturer has declared the maximum duty cycle of 25%, hence duty cycle correction factor is considered for 25% as shown in below formula

Duty Cycle Correction Factor Calculation

$10 \cdot \text{LOG} (1/X)$ Where X is Duty Cycle

Duty cycle correction factor = 6.020 dB

1.5 Conclusion:

The Power density of the EUT is less than defined limit as shown above, hence EUT is exempted from routine SAR evaluation, this evaluation is only applicable to RF ID transmission