

ReferenceTest Report No: ULR-TC568821300000109F
ULR-TC568821300000110F
ULR-TC568821300000111F
ULR-TC568821300000112F
ULR-TC568821300000113F
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1 Radio Frequency Human Exposure Evaluation:

1.1 RF Exposure Measurement

The limit for Maximum Permissible Exposure (MPE) specified in FCC 1.1310 and RSS 102, Issue 5, Section 2.5.2 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 And as per the RSS 102, Issue 5, Section 2.5.2 the MPE limits mentioned in Table 2.

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/cm²)
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

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

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m²)
Limits for Occupational / controlled Exposures			
100-6000	$15.60f^{0.25}$	$0.04138f^{0.25}$	$0.6455f^{0.5}$
Limits for General population / Uncontrolled Exposure			
300-6000	$3.142 f^{0.3417}$	$0.008335f^{0.3417}$	$0.02619f^{0.6834}$

F or f = Frequency in MHz

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1.2.1 Friis Formula

Friis Formula is used for assessment of power density.

Friis 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 = Minimum 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 (MPE evaluation performed with minimum separation distance from the User is 20cm).

1.2.2 EUT Operation condition

EUT was enabled to transmit and receive at lowest, middle and highest channels.

1.2.3 Classification

The antenna of this product, under normal use condition, is at least 20cm away from the body of the user. Warning statement to the user for keeping at least 20cm or more separation distance from the antenna should be included in the User manual. So, this device is classified as fixed device.

1.3 Assessment Conditions:

***Note:** Manufacturer declared TuneUp tolerance of ± 1 dB is considered in the calculation for wifi

Antenna gain :

For Wi-fi 2.4GHz = 2.2 dBi

For Wi-fi 5GHz = 5.2 dBi

1. Protocol: WI-FI 2.4GHz

Antenna Gain (dBi)	Antenna gain in linear scale	Channel Frequency (MHz)	Maximum output power (e.i.r.p) (dBm)	Tune up Value in (dB)	Maximum output power including Tune-up value (e.i.r.p) (mW)	Power Density (mW/cm ²)	FCC Limit (mW/cm ²)	ISED Limit (mW/cm ²)
2.2	1.6595	2412	19.47	1	111.429	0.02216	1	0.536

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2. Protocol: WI-FI 5GHz (UNII-1)

Antenna Gain (dBi)	Antenna gain in linear scale	Channel Frequency (MHz)	Maximum output power (e.i.r.p) (dBm)	Tune up Value in (dB)	Maximum output power including Tune-up value (e.i.r.p) (mW)	Power Density (mW/cm ²)	FCC Limit (mW/c m ₂)	ISED Limit (mW/cm ²)
5.2	3.3113	5180	19.68	1	116.949	0.0232	1	0.904

3. Protocol: WI-FI 5GHz (UNII-3)

Antenna Gain (dBi)	Antenna gain in linear scale	Channel Frequency (MHz)	Maximum output power (dBm)	Tune up Value in (dB)	Maximum output power including Tune-up value (e.i.r.p) (mW)	Power Density (mW/cm ²)	FCC Limit (mW/c m ₂)	ISED Limit (mW/cm ²)
5.2	3.3113	5755	19.56	1	113.762	0.0226	1	0.977

4. Cellular (WCDMA and LTE)

Antenna Type	Frequency Range (MHz)	Antenna Gain (dBi)
Chip Antenna	617-698	0.81
	698-960	1.1
	1710-2690	2.4
External/ Diversity Antenna	617 - 698	-1.1
	698 - 806	1.8
	824 - 960	2.8
	1427 - 1518	1.6
	1710 - 2200	3.0
	2300 - 2690	4.7

Protocol	Frequency band (MHz)	RF output power at antenna terminal (dBm)	Tune-up tolerance
WCDMA	B2,B4,B5	24	±1.7dB
LTE	B2,B4,B5,B12,B13,B14,B66,B71	23	±2.7dB

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Protocol	Frequency band (MHz)	RF output Power (dBm)	Tune-up tolerance	Output power (e.i.r.p) including tune-up tolerance (mW)	Antenna gain in linear scale	Power density (mw/cm2)	FCC Limit (mW/cm²)	ISED Limit (mW/cm²)
WCDMA B2	1852.4-1907.6	24	±1.7dB	371.535	1.7378	0.1284	1.00	0.448
WCDMA B4	1712.4-1752.6	24	±1.7dB	371.535	1.7378	0.1284	1.00	0.424
WCDMA B5	826.4-846.6	24	±1.7dB	371.535	1.2882	0.0952	0.55	0.258
FDD 2	1850-1909.9	23	±2.7dB	371.535	1.7378	0.1284	1.00	0.447
FDD 4	1710-1754.9	23	±2.7dB	371.535	1.7378	0.1284	1.00	0.424
FDD 5	824-848.9	23	±2.7dB	371.535	1.2882	0.0952	0.55	0.257
FDD 12	699-715.9	23	±2.7dB	371.535	1.2882	0.0952	0.47	0.230
FDD 13	746-755.9	23	±2.7dB	371.535	1.2882	0.0952	0.52	0.240
FDD 14	758-767.9	23	±2.7dB	371.535	1.2882	0.0952	0.53	0.243
TDD 66	1710-1779.9	23	±2.7dB	371.535	1.7378	0.1284	1.00	0.424
TDD 71	617-651.90	23	±2.7dB	371.535	1.2050	0.0890	0.45	0.211

5. Exemption calculation for simultaneous mode operation of WCDMA + Wi-Fi 2.4Ghz and LTE + Wi-Fi 2.4GHz

RF Protocol	Total Calculated Power density (mw/cm2)	Final Power density (mw/cm2)	FCC Limit (mW/cm²)	ISED Limit (mW/cm²)
WCDMA Band 4 + Wi-Fi 2.4GHz	=(0.1284)+(0.02216)	0.15056	1	0.424
LTE Band 2+ Wi-Fi 2.4GHz	=(0.1284)+(0.02216)	0.15056	1	0.447

Note :

1. For above table, to calculate EIRP For simultaneous operation following formula is used

$$\text{EIRP RF 1} / \text{EIRP Limit of RF 1} + \text{EIRP RF2} / \text{EIRP Limit of RF 2} + \dots + \text{EIRP of RFn} / \text{EIRP Limit of RFn} < 1$$

Conclusion: The Power density of the EUT is less than defined limit as shown above, hence EUT is exempted from routine SAR evaluation.