

## The Derivation of Maximum Allowable Gain

### The Justification How Gain is Derived:

This submittal(s) (test report) is intended to comply with Section Part 27, subpart C & subpart L of the FCC CFR 47 Rules. As per FCC's ruling part, 1.1310, the power density limit for General Population/Uncontrolled Exposure is f/1500 mW/cm<sup>2</sup> through 300MHz to 1500MHz, and 1.0 mW/cm<sup>2</sup> through 1.5 GHz to 100 GHz, respectively. Since this related application is characterized as mobile application as defined by FCC, the MPE is obtained at 20cm in determination for its compliance with the power density limit.

The formula listing as follows is applied in determination of Power Density:

$$S = (P * G) / (4\pi * R^2)$$

Where,

S = Power Density

P = Conducted Output Power Measured at Antenna Port

G = Gain of Maximum Transmitting Antenna (linear gain)

R = Separating Distance from Transmitting Antenna

This related radio application is classified as mobile device in operation of general population / uncontrolled exposure condition.

### Limitation

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm <sup>2</sup> )	Averaging Time (minute)
Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f <sup>2</sup> )	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	F/1500	30
1500-15000	/	/	1.0	30

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 90 days only.

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**Maximum Linear Gain Determination using MPE**

Re-arrange the formula of Power Density in terms of maximum gain,

It yields,

$$G = S \cdot (4 \pi R^2) / P$$

Where,

$S = F/150W/m^2$  (300MHz -1500MHz) or  $10W/m^2$  (1.5GHz-150GHz)

$P$  = Conducted Output Power Measured at Antenna Port with respect to applied band.

$G$  = Maximum Linear Gain

$R = 20cm$

**Maximum Linear Gain Determination using ERP/EIRP**

As per 27.50 (d)(2) , 27.50 (c)(9) ERP/EIRP is limited as 1W,30W, Maximum allowable gain that complies with them can be obtained by the following relationship.

**EIRP/ERP = Maximum Allowable Gain + Maximum Burst Power as measured at antenna terminal.**

Re-arrange the above equation in terms of Maximum Allowable Gain, *It yields,*

**Maximum Allowable Gain = EIRP/ERP – Maximum Burst Power as measured at antenna terminal**

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**Maximum Source-based Time Average power for LTE mode:**

24.58dBm (1720.0MHz) for band 4, 23.43dBm (782.0 MHz) for band 13.

**The Computation of Maximum Allowable Linear Gain using MPE limit**Operation in LTE band 4

Given the maximum source-based time-averaged power as 24.58dBm, and MPE limit as  $1\text{W}/\text{m}^2$ . Therefore, antenna gain is calculated as 12.43dBi

Operation in LTE band 13

Given the maximum source-based time-averaged power as 23.43dBm, and MPE limit as  $0.52\text{W}/\text{m}^2$ . Therefore, antenna gain is calculated as 10.75dBi

**The Computation of Maximum Allowable Linear Gain using ERP/EIRP limit**Operation in LTE band 4

Given the maximum source-based time-averaged power as 24.58dBm, and EIRP limit as 1W  
Therefore, antenna gain is calculated as 5.42dBi

Operation in LTE band 13

Given the maximum source-based time-averaged power as 23.43dBm, and ERP limit as 30W  
Therefore, antenna gain is calculated as 21.34dBi

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