

# 15. The Derivation of Maximum Allowable Gain

## **15.1. The Justification How Gain is Derived:**

This submittal(s) (test report) is intended to comply with Section Part 22, subpart H and Part 24, subpart E 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/cm2 through 300MHz to 1500MHz, and 1.0 mW/cm2 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:

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

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	Electric Field	Magnetic Field	Power Density	Averaging Time
(MHz)	Strength (V/m)	Strength (A/m)	(mW/cm2)	(minute)
Limits for General	Population/Uncontr	olled Exposure		
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f2)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	F/1500	30
1500-15000	/	/	1.0	30

F = frequency in MHz

\* = Plane-wave equipment power density

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## 15.2. Maximum Linear Gain Determination using MPE

Re-arrange the formula of Power Density in terms of maximum gain, It yields,  $G = S^*(4 \ *R^2) / P$ Where, S = F/1500 mW/cm2 (300-1500 Mhz) or 1.0 mW/cm2 (1.5 GHz-100 GHz) P = Conducted Output Power Measured at Antenna Port with respect to applied band. G = Maximum Linear GainR = 20 cm

## Maximum Linear Gain Determination using ERP/EIRP

As per 22.913a) and 24.232 (b), 27.50 (d)(4), 27.50 (c)(9), 27.50 (h)(2) ERP/EIRP is limited as 7W, 2W, 1W, 30W, 2W, respectively. 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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## **Conducted Power Measured at Antenna Terminal:**

		1 Time S	lot			2 Time Slot			
<b>_</b>		GMSK Mode		8-PSK M	lode	GMSK N	Iode	8-PSK M	lode
Frequency	СН	Peak	AV	Peak	AV	Peak	AV	Peak	AV
(MHz)		Power	Power	Power	Power	Power	Power	Power	Power
		(dBm)	(dBm)	(dBm)	(dBm)	(dBm)	(dBm)	(dBm)	(dBm)
824.2	128	32.60	32.50	30.00	27.00	29.50	29.40	26.80	23.50
836.6	190	32.60	32.50	29.70	26.60	29.50	29.40	26.40	23.10
848.8	251	32.60	32.50	29.80	26.80	29.60	29.40	26.40	23.10
1850.2	512	28.70	28.50	28.20	25.20	26.10	25.90	25.00	21.60
1880.0	661	28.60	28.50	28.20	25.10	26.00	25.80	24.90	21.50
1909.8	810	28.60	28.40	27.70	24.50	25.80	25.70	24.30	21.00

		3 Time S	3 Time Slot			4 Time Slot			
		GMSK Mode		8-PSK M	lode	GMSK N	Iode 8-PSK Mode		lode
Frequency (MHz)	СН	Peak	AV	Peak	AV	Peak	AV	Peak	AV
(MHz)		Power	Power	Power	Power	Power	Power	Power	Power
		(dBm)	(dBm)	(dBm)	(dBm)	(dBm)	(dBm)	(dBm)	(dBm)
824.2	128	27.60	27.50	24.70	21.30	26.50	26.40	23.40	20.00
836.6	190	27.70	27.60	24.20	21.00	26.50	26.40	22.90	19.60
848.8	251	28.70	27.60	24.40	21.20	26.60	26.40	23.20	19.80
1850.2	512	24.20	24.10	23.60	20.10	23.10	22.90	22.20	18.80
1880.0	661	24.10	24.00	23.50	20.00	22.90	22.80	22.30	18.90
1909.8	810	24.00	23.80	22.90	19.40	22.80	22.60	21.70	18.20

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Maximum Source-Based	<b>Time Average Power</b>	calculated by	<b>Time-Slot Factor:</b>

		1 Time Slot		2 Time Slot		
Frequency	Frequency	GMSK Mode	8-PSK Mode	GMSK Mode	8-PSK Mode	
(MHz)	СН	AV Power	AV Power	AV Power	AV Power	
		(dBm)	(dBm)	(dBm)	(dBm)	
824.2	128	23.5	18.0	23.4	17.5	
836.6	190	23.5	17.6	23.4	17.1	
848.8	251	23.5	17.8	23.4	17.1	
1850.2	512	19.5	16.2	19.9	15.6	
1880.0	661	19.5	16.1	19.8	15.5	
1909.8	810	19.4	15.5	19.7	15.0	

		3 Time Slot		4 Time Slot		
Frequency	Frequency	GMSK Mode 8-PSK Mode		GMSK Mode	8-PSK Mode	
(MHz)	СН	AV Power	AV Power	AV Power	AV Power	
		(dBm)	(dBm)	(dBm)	(dBm)	
824.2	128	23.2	17.0	17.0	17.0	
836.6	190	23.3	16.7	16.7	16.6	
848.8	251	23.3	16.9	16.9	16.8	
1850.2	512	19.8	15.8	15.8	15.8	
1880.0	661	19.7	15.7	15.7	15.9	
1909.8	810	19.5	15.1	15.1	15.2	

### Where,

Maximum Source-based Time Average is determined by "Burst Power" minus slot factor:

	1TX	2TX	3TX	4TX
power:	0.125	0.25	0.375	0.5
power (dBm):	-9.0309	-6.0206	-4.25969	-3.0103

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# Maximum Source-based Time Average power for WCDMA mode:

Refer to page 32, 22.71dBm for band II, 23.41dBm for band V

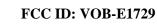
# Maximum Source-based Time Average power for LTE mode:

*Refer to page 37, 24.76dBm (1902.5MHz) for band II, page 40, 24.25dBm (847.5MHz) for band 5, page 47 24.22dBm (1717.5MHz) for band 4, 23.67dBm (2502.5MHz) for band 7, page 53 for 24.30dBm (713.5Mhz) for band 17* 

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## 15.3. The Computation of Maximum Allowable Linear Gain using MPE limit

#### Operation in cellular band (824 - 849 MHz)

Given the maximum source-based time-averaged power as 23.50dBm, and MPE limit as 0.55 mW/cm^2. Therefore, antenna gain is calculated as 12.34dBi

#### Operation in PCS band (1850 - 1910 MHz)

Given the maximum source-based time-averaged power as 19.9dBm, and MPE limit as 1 mW/cm^2. Therefore, antenna gain is calculated as 51.44dBi

#### Operation in WCDMA Band II (1850 - 1910MHz)

Given the maximum source-based time-averaged power as 22.71dBm, and MPE limit as 1.0 mW/cm^2. Therefore, antenna gain is calculated as 14.81dBi

#### Operation in WCDMA Band V (824 - 850MHz)

Given the maximum source-based time-averaged power as 23.41dBm, and MPE limit as 0.55 mW/cm^2. Therefore, antenna gain is calculated as 12.60dBi

Operation in LTE band II

Given the maximum source-based time-averaged power as 24.76dBm, and MPE limit as 1 mW/cm^2. Therefore, antenna gain is calculated as 16.80dBi

Operation in LTE band 5

Given the maximum source-based time-averaged power as 24.75dBm, and MPE limit as 0.57 mW/cm^2. Therefore, antenna gain is calculated as 9.51dBi

Operation in LTE band 4

Given the maximum source-based time-averaged power as 24.22dBm, and MPE limit as 1.0 mW/cm^2. Therefore, antenna gain is calculated as 19.02dBi

Operation in LTE band 7

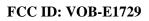
Given the maximum source-based time-averaged power as 23.76dBm, and MPE limit as 1.0 mW/cm^2. Therefore, antenna gain is calculated as 21.59dBi

Operation in LTE band 17

Given the maximum source-based time-averaged power as 24.30dBm, and MPE limit as 0.48mW/cm^2. Therefore, antenna gain is calculated as 10.90dBi

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### 15.4. The Computation of Maximum Allowable Linear Gain using ERP/EIRP limit

<u>Operation in cellular band (824 – 849 MHz)</u> Given the maximum burst power as 32.50dBm, and ERP limit as 7W Therefore, antenna gain is calculated as 5.95dBi

<u>Operation in PCS band (1850 – 1910 MHz)</u> Given the maximum burst power r as 28.50dBm, and EIRP limit as 2W Therefore, antenna gain is calculated as 4.51dBi

<u>Operation in WCDMA Band II (1850 – 1910MHz)</u> Given the maximum burst averaged power as 22.71dBm, and EIRP limit as 2W Therefore, antenna gain is calculated as 10.30dBi

<u>Operation in WCDMA Band V (824 – 850MHz)</u> Given the maximum burst power as 23.41dBm, and ERP limit as 7W Therefore, antenna gain is calculated as 15.04dBi

Operation in LTE band II

Given the maximum source-based time-averaged power as 24.76dBm, and EIRP limit as 2W Therefore, antenna gain is calculated as 8.25dBi

Operation in LTE band 5

Given the maximum source-based time-averaged power as 24.75dBm, and ERP limit as 7W Therefore, antenna gain is calculated as 13.70dBi

<u>Operation in LTE band 4</u> Given the maximum source-based time-averaged power as 24.22dBm, and EIRP limit as 1W. Therefore, antenna gain is calculated as 5.78dBi

<u>Operation in LTE band 7</u> Given the maximum source-based time-averaged power as 23.76dBm, and EIRP limit as 2W Therefore, antenna gain is calculated as 9.25dBi

<u>Operation in LTE band 17</u> Given the maximum source-based time-averaged power as 24.30dBm, and ERP limit as 30W Therefore, antenna gain is calculated as 20.47dBi

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