



December 4, 2023

TUV SUD America CB
10 Centennial Drive FL2
Peabody, MA 01960

Attention: Director of Certification

RE: Analysis of RF Exposure for Mobile and Portable Device per KDB 447498 D01 General RF Exposure Guidance v06 and RSS-102 Issue 5 March 2015, A1 February 2021.

Max System Gain calculations for Downlink and Uplink Band 2, 4, 5, 25 and 14 were made to ensure compliance to the signal booster MPE limits for simultaneous transmission (Section 9).

FCC ID: YETIG41-CE
IC Number: 9298A-41CE

1. MPE Limits

1.1 FCC MPE LIMITS

Limits for General Population/Uncontrolled Exposure (Title 47 Subpart J §2.1091 and KDB 447498 D01 referring to limits under §1.1310)

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Electric Field Strength (H) (A/m)	Power Density (S) (mW/cm ²)	Averaging Time (minutes)
0.3 - 1.34	614	1.63	*(100)	30
1.34 - 30	824/f	2.19/f	*(180/f ²)	30
30 - 300	27.5	0.073	0.2	30
300 - 1500	-	-	f/1500	30
1500 - 100,000	-	-	1.0	30

f = frequency in MHz

**Plane-wave equivalent power density*



1.2 ISED MPE LIMITS

Limits for Devices Used by the General Public (Uncontrolled Environment (RSS-102 Issue 5 March 2015, A1 February 2021))

Frequency Range (MHz)	Electric Field Strength (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/f	-	6**
1.1 - 10	87/f ^{0.5}	-	-	6**
10 - 20	27.46	0.0728	2	6
20 - 48	-58.07/f ^{0.25}	0.1540/f ^{0.25}	8.944/f ^{0.5}	6
48 - 300	22.06	0.05852	1.291	6
300 - 6000	3.142 f ^{0.3417}	0.008335 f ^{0.3417}	0.02619 f ^{0.6834}	6
6000 - 15000	61.4	0.163	10	6
15000 - 150000	61.4	0.163	10	616000/f ^{1.2}
150000 - 300000	0.158f ^{0.5}	4.21 x 10 ⁻⁴ f ^{0.5}	6.67 x 10 ⁻⁵ f	616000/f ^{1.2}

f is frequency in MHz

*Based on nerve stimulation (NS)

** Based on specific absorption rate (SAR)



2. MPE Calculation Summary, Downlink at 20 cm and Uplink at 65 cm distance

Downlink (CU) at 20 cm Separation Distance					
Mode	Output Power(dBm)	*Max System (Antenna + Cable) gain (dBi)	Power Density at 20 cm (mW/cm ²)	ISED Limit (mW/cm ²)	MPE ratio (MPE/Limit)
LTE Band 2	15.41	15.04	0.2453	0.4624	0.5305
LTE Band 4	15.4	15.04	0.2300	0.4913	0.4681
LTE Band 5	10.52	15.04	0.1029	0.2681	0.3838
LTE Band 14	12.27	15.04	0.1070	0.2444	0.4378
LTE Band 25	13.89	15.04	0.1555	0.4661	0.3336

Note: Max system gain number used to comply with LTE simultaneous transmission (See section 6).

Uplink (NU) at 65 cm Separation Distance					
Mode	Output Power(dBm)	*Max System (Antenna + Cable) gain (dBi)	Power Density at 65 cm (mW/cm ²)	ISED Limit (mW/cm ²)	MPE ratio (MPE/Limit)
LTE Band 2	21.59	17.6	0.1663	0.4567	0.3641
LTE Band 4	22.06	17.6	0.1849	0.4305	0.4295
LTE Band 5	19.57	17.6	0.1002	0.2623	0.3820
LTE Band 14	21.08	17.6	0.1389	0.2509	0.5536
LTE Band 25	21.60	17.6	0.1566	0.4530	0.3457

Note: Max system gain number used to comply with LTE simultaneous transmission (See section 7).

Bluetooth LE 20 cm Separation Distance			
Mode	Output Power (dBm)	Power Density at 20 cm (mW/cm ²)	ISED Limit (mW/cm ²)
Bluetooth LE	-1.8	0.000026	1



3. Co-Located Transmitters transmission table:

Downlink (CU)		
Transmitter type		Transmitter type that can transmit at the same time
CU	LTE B2	LTE B14, B4, B5
	LTE B4	LTE B2, B14, B5
	LTE B5	LTE B2, B4, B14
	LTE B14	LTE B2, B4, B5
Note: worst case is LTE B2 & LTE B4		

Uplink (NU)		
Transmitter type		Transmitter type that can transmit at the same time
NU	LTE B2	LTE B14, B4, B5
	LTE B4	LTE B2, B14, B5
	LTE B5	LTE B2, B4, B14
	LTE B14	LTE B2, B4, B5
Note: worst case is LTE B4 & LTE 14		

4. Worst Case Simultaneous Transmission MPE:

Downlink CU Port at 20 cm Separation Distance			
Transmitter type	MPE (mw/cm ²)	ISED Limit (mW/cm ²)	ISED MPE ratio (MPE/Limit)
LTE B2	0.2453	0.4624	0.5305
LTE B4	0.2300	0.4913	0.4681
Sum of the ratios (should be <1.0)			0.9986

Note: Utilizing results from section 6.

Uplink NU Port at 65 cm Separation Distance			
Transmitter type	MPE (mw/cm ²)	ISED Limit (mW/cm ²)	ISED MPE ratio (MPE/Limit)
LTE B4	0.1849	0.4305	0.4295
LTE B14	0.1389	0.2509	0.5536
Sum of the ratios (should be <1.0)			0.9831

Note: Utilizing results from section 7.

Bluetooth LE 20 cm Separation Distance			
Transmitter type	MPE (mw/cm ²)	ISED Limit (mW/cm ²)	ISED MPE ratio (MPE/Limit)
Bluetooth LE	0.000026	1	0.000026
Sum of the ratios (should be <1.0)			0.000026



5. Mobile MPE Calculation Formula:

Using Power Density formula:

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density

P = power input to the antenna

G = power gain of the antenna in the direction of interest relative to isotropic

R = distance to the center of radiation of the antenna

6. Calculation using a 20cm separation distance:

LTE Band 2 Downlink at 20 cm Separation Distance:

Maximum peak output power at antenna input terminal:	15.87	(dBm)
Maximum peak output power at antenna input terminal:	38.64	(mW)
Maximum System Gain	15.04	(dBi)
Maximum System Gain	31.915	(numeric)
Prediction distance:	20	(cm)
Source Based Time Average Duty Cycle:	100	(%)
Prediction frequency:	1940	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	0.4624	(mW/cm ²)
Power density at prediction frequency:	0.24532	(mW/cm ²)
FCC Margin of Compliance:	-2.75	(dB)

LTE Band 4 Downlink at 20 cm Separation Distance:

Maximum peak output power at antenna input terminal:	15.59	(dBm)
Maximum peak output power at antenna input terminal:	36.22	(mW)
Maximum System Gain	15.04	(dBi)
Maximum System Gain	31.915	(numeric)
Prediction distance:	20	(cm)
Source Based Time Average Duty Cycle:	100	(%)
Prediction frequency:	2120	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	0.4913	(mW/cm ²)
Power density at prediction frequency:	0.23000	(mW/cm ²)
FCC Margin of Compliance:	-3.30	(dB)



LTE Band 5 Downlink at 20 cm Separation Distance:

Maximum peak output power at antenna input terminal:	12.10	(dBm)
Maximum peak output power at antenna input terminal:	16.22	(mW)
Maximum System Gain	15.04	(dBi)
Maximum System Gain	31.915	(numeric)
Prediction distance:	20	(cm)
Source Based Time Average Duty Cycle:	100	(%)
Prediction frequency:	874	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	0.2681	(mW/cm2)
Power density at prediction frequency:	0.10297	(mW/cm2)
FCC Margin of Compliance:	-4.16	(dB)

LTE Band 14 Downlink at 20 cm Separation Distance:

Maximum peak output power at antenna input terminal:	12.27	(dBm)
Maximum peak output power at antenna input terminal:	16.87	(mW)
Antenna gain(max):	15.04	(dBi)
Maximum System Gain	31.915	(numeric)
Maximum System Gain	20	(cm)
Source Based Time Average Duty Cycle:	100	(%)
Prediction frequency:	763	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	0.2444	(mW/cm2)
Power density at prediction frequency:	0.10709	(mW/cm2)
FCC Margin of Compliance:	-3.58	(dB)

LTE Band 25 Downlink at 20 cm Separation Distance:

Maximum peak output power at antenna input terminal:	13.89	(dBm)
Maximum peak output power at antenna input terminal:	24.49	(mW)
Maximum System Gain	15.04	(dBi)
Maximum System Gain	31.915	(numeric)
Prediction distance:	20	(cm)
Source Based Time Average Duty Cycle:	100	(%)
Prediction frequency:	1962.5	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	0.4661	(mW/cm2)
Power density at prediction frequency:	0.15550	(mW/cm2)
FCC Margin of Compliance:	-4.77	(dB)



7. Mobile MPE Calculation using a 65cm separation distance:

LTE Band 2 Uplink at 65 cm Separation Distance:

Maximum peak output power at antenna input terminal:	21.86	(dBm)
Maximum peak output power at antenna input terminal:	153.46	(mW)
Maximum System Gain	17.60	(dBi)
Maximum System Gain	57.544	(numeric)
Prediction distance:	65	(cm)
Source Based Time Average Duty Cycle:	100	(%)
Prediction frequency:	1905	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	0.4567	(mW/cm ²)
Power density at prediction frequency:	0.16633	(mW/cm ²)
FCC Margin of Compliance:	-4.39	(dB)

LTE Band 4 Uplink at 65 cm Separation Distance:

Maximum peak output power at antenna input terminal:	22.32	(dBm)
Maximum peak output power at antenna input terminal:	170.61	(mW)
Maximum System Gain	17.60	(dBi)
Maximum System Gain	57.544	(numeric)
Prediction distance:	65	(cm)
Source Based Time Average Duty Cycle:	100	(%)
Prediction frequency:	1747.5	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	0.4305	(mW/cm ²)
Power density at prediction frequency:	0.18491	(mW/cm ²)
FCC Margin of Compliance:	-3.67	(dB)

LTE Band 5 Uplink at 65 cm Separation Distance:

Maximum peak output power at antenna input terminal:	19.66	(dBm)
Maximum peak output power at antenna input terminal:	92.47	(mW)
Maximum System Gain	17.60	(dBi)
Maximum System Gain	57.544	(numeric)
Prediction distance:	65	(cm)
Source Based Time Average Duty Cycle:	100	(%)
Prediction frequency:	846.5	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	0.2623	(mW/cm ²)
Power density at prediction frequency:	0.10022	(mW/cm ²)
FCC Margin of Compliance:	-4.18	(dB)



LTE Band 14 Uplink at 65 cm Separation Distance:

Maximum peak output power at antenna input terminal:	21.08	(dBm)
Maximum peak output power at antenna input terminal:	128.23	(mW)
Maximum System Gain	17.60	(dBi)
Maximum System Gain	57.544	(numeric)
Prediction distance:	65	(cm)
Source Based Time Average Duty Cycle:	100	(%)
Prediction frequency:	793	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	0.2509	(mW/cm ²)
Power density at prediction frequency:	0.13898	(mW/cm ²)
FCC Margin of Compliance:	-2.57	(dB)

LTE Band 25 Uplink at 65 cm Separation Distance:

Maximum peak output power at antenna input terminal:	21.60	(dBm)
Maximum peak output power at antenna input terminal:	144.54	(mW)
Maximum System Gain	17.60	(dBi)
Maximum System Gain	57.544	(numeric)
Prediction distance:	65	(cm)
Source Based Time Average Duty Cycle:	100	(%)
Prediction frequency:	1882.5	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	0.4530	(mW/cm ²)
Power density at prediction frequency:	0.15666	(mW/cm ²)
FCC Margin of Compliance:	-4.61	(dB)

Test Results Bluetooth LE @ 20 cm distance (CU Only):

Maximum peak output power at antenna input terminal:	-1.80	(dBm)
Maximum peak output power at antenna input terminal:	0.66	(mW)
Maximum System Gain	-7.1000	(dBi)
Maximum System Gain	0.195	(numeric)
Prediction distance:	20	(cm)
Source Based Time Average Duty Cycle:	100	(%)
Prediction frequency:	2480	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	1.0000	(mW/cm ²)
Power density at prediction frequency:	0.000026	(mW/cm ²)
FCC Margin of Compliance:	-45.91	(dB)



8. Max System Gain (Antenna & cable) for simultaneous transmission

To determine maximum system antenna gain to comply with simultaneous transmission requirement, the following number were applied; from formula in section 5

$G = 15.04 \text{ dBi}$ (Maximum System Gain Allowed CU) at 20 cm distance

$G = 17.60 \text{ dBi}$ (Maximum System Gain Allowed NU) at 65 cm distance

9. Power and Calculated Max System Gain (Antenna & Cable) for Simultaneous Transmission

Downlink (CU) at 20 cm Distance		
Band	Worst Case Conducted Power (dBm)	Max Antenna Gain* (dBi)
LTE B2	15.41	15.04
LTE B4	15.4	
LTE B5	10.52	
LTE B14	12.27	
LTE B25	13.89	

Uplink (NU) at 65 cm Distance		
Band	Worst Case Conducted Power (dBm)	Max Antenna Gain* (dBi)
LTE B2	21.59	17.6
LTE B4	22.06	
LTE B5	19.57	
LTE B14	21.08	
LTE B25	21.6	



10. Max System Gain (Antenna & Cable) for Simultaneous Transmission

Port	Max System (Antenna & Cable) Gain
Server Port At 20 cm Distance	15.04 dBi for LTE Band 2 15.04 dBi for LTE Band 4 15.04 dBi for LTE Band 5 15.04 dBi for LTE Band 14 15.04 dBi for LTE Band 25
Donor Port At 65 cm Distance	17.6 dBi for LTE Band 2 17.6 dBi for LTE Band 4 17.6 dBi for LTE Band 5 17.6 dBi for LTE Band 14 17.6 dBi for LTE Band 25

Sincerely,

Miguel Angel Rabago Garcia

A handwritten signature in blue ink, appearing to be 'MAR', written over a horizontal line.

Name

Authorized Signatory

Title: JR EMC/Wireless Engineer