December 06, 2024

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.

FCC ID: NU: YETII41-36CNU, CU: YETI41-WXCU
IC ID: NU:9298A-I4236CNU and CU 9298A-I41WXCU

1. 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*

2. ISED Limits:

Limits for Devices Used by the General Public (Uncontrolled Environment (RSS-102 Issue 6 December 15, 2023)

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	$0.158f^{0.5}$	$4.21 \times 10^{-4}\ f^{0.5}$	$6.67 \times 10^{-5}\ f$	$616000/f^{1.2}$

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

3. MPE Calculation Summary using a 20cm separation distance:

Downlink (CU) at 20 cm Separation Distance				
Mode	**Output Power (dBm)**	**Power Density at 20 cm (mW/cm^2)**	**ISED Limit (mW/cm^2)**	**FCC Limit (mW/cm^2**
WCDMA Band 5	16.99	0.00997	0.2686	0.581
LTE Band 4	15.84	0.00997	0.4901	1
LTE Band 12	15.56	0.00997	0.2401	0.488
LTE Band 14	12.40	0.2443373	0.2444	0.508
LTE Band 25	16.86	0.00997	0.4697	1
LTE Band 30	15.15	0.00997	0.5279	1

Uplink (NU) at 65 cm Separation Distance				
Mode	**Output Power (dBm)**	**Power Density at 20 cm (mW/cm^2)**	**ISED Limit (mW/cm^2)**	**FCC Limit (mW/cm^2)**
WCDMA Band 5	21.68	0.01883	0.2613	0.551
LTE Band 4	23.37	0.01883	0.4310	1
LTE Band 12	21.92	0.01883	0.2321	0.468
LTE Band 14	22.13	0.250902	0.2509	0.528
LTE Band 25	23.48	0.01883	0.4485	1
LTE Band 30	21.51	0.01883	0.5210	1
LTE Modem (LTE B12 as worst case)	24.5	0.140841	0.2307	0.467

4. Co-Located Transmitters transmission table:

Each CU is apart from each other at least 10 meters away. Worst case co-located transmission is two bands per CU.

Downlink (CU)		
Transmitter type		**Transmitter type that can transmit at the same time**
CU work with NU Port 1	LTE B4	LTE B12 or LTE B30
	WCDMA B5	LTE B12 or LTE B25
	LTE B12	WCDMA B5 or LTE B25
	LTE B25	LTE B12 or LTE B30
	LTE B30	WCDMA B5. LTE B4 or LTE B25
Note: worst case bands are LTE B12 and WCDMA Band 5		
CU work with NU Port 2	LTE B4	LTE B14
	LTE B14	LTE B4 or LTE B25
	LTE B25	LTE B14
Note: worst case is LTE B14 Mid Channel 10 MHz BW & LTE B25 High Ch 20 MHz		

NU has two Antenna Ports. Each antenna port is assigned to support one operator and has its own Separation donor antennas. The antennas from each port point in different directions and they are apart from each other at least 10 meters away. Worst case co-located transmission is two bands per donor antenna port.

Uplink (CU)		
Transmitter type		**Transmitter type that can transmit at the same time**
NU Port 1	LTE B4	LTE B12 or LTE B30
	WCDMA B5	LTE B12 or LTE B25
	LTE B12	WCDMA B5 or LTE B25
	LTE B25	LTE B12 or LTE B30
	LTE B30	WCDMA B5. LTE B4 or LTE B25
Note: worst case bands are LTE B12 and WCDMA Band 5		
NU Port 2	LTE B4	LTE B14
	LTE B14	LTE B4 or LTE B25
	LTE B25	LTE B14
Note: worst case is LTE B14 Mid Channel 10 MHz BW & LTE B25 High Ch 20 MHz		

5. Worst Case Simultaneous Transmission MPE:

Only ISED limits presented being the more stringent between the two limits

To determine maximum system antenna gain to comply with simultaneous transmission requirement, the following formula was used.

$$G = \frac{S\,(4\pi r^2)}{P}$$

This is the absolute system antenna gain (including cable loss) that can be used with the ***CU Maximum allow antenna gain:***

$$G = \frac{0.1 + 0.1 * (4\pi 0.2^2)}{0.0437\ watt + 0.0162\ watt}$$

$$G = \frac{0.2 * (0.5026)}{0.0599\ watt}$$

$$G = 1.6781\ dBi\ (\boldsymbol{Maximum\ System\ Gain\ Allowed\ NU})$$

NU Maximum allow antenna gain:

$$G = \frac{0.997 + 0.561 * (4\pi 0.2^2)}{0.1706\ watt + 0.0925\ watt}$$

$$G = \frac{1.558 * (0.5026)}{0.2631\ watt}$$

$$G = 2.9762\ dBi\ (\boldsymbol{Maximum\ System\ Gain\ Allowed\ NU})$$

Downlink (CU with NU port 1) at 20 cm Separation Distance			
Transmitter type	**MPE (mw/cm²)**	**ISED Limit (mW/cm²)**	**ISED MPE ratio (MPE/Limit)**
LTE B12	0.00997	0.2401	0.04152
WCDMA B5	0.00997	0.2686	0.03711
		Sum of the ratios (should be <1.0)	0.078638

Downlink (CU with NU port 2) at 20 cm Separation Distance			
Transmitter type	**MPE (mw/cm²)**	**ISED Limit (mW/cm²)**	**ISED MPE ratio (MPE/Limit)**
LTE B14	0.2443373	0.2444	0.989987
LTE B25	0.00997	0.4697	0.000997
		Sum of the ratios (should be <1.0)	0.99098

Uplink (NU Port 1) at 65 cm Separation Distance			
Transmitter type	**MPE (mw/cm²)**	**ISED Limit (mW/cm²)**	**ISED MPE ratio (MPE/Limit)**
LTE B12	0.01883	0.2321	0.081128
WCDMA B5	0.01883	0.2613	0.072062
		Sum of the ratios (should be <1.0)	0.15319

Uplink (NU Port 2) at 65 cm Separation Distance			
Transmitter type	**MPE (mw/cm²)**	**FCC Limit (mW/cm²)**	**FCC MPE ratio (MPE/Limit)**
LTE B14	0.250902	0.2509	0.86788
LTE B25	0.01883	0.4485	0.04198
		Sum of the ratios (should be <1.0)	

LTE Modem in NU at 20 cm Separation Distance			
Transmitter type	**MPE (mw/cm^2)**	**ISED Limit (mW/cm^2)**	**ISED MPE ratio (MPE/Limit)**
LTE Modem worst case LTE Band 12	0.140841	0.2307	0.61049

6. Mobile MPE Calculation using a 20cm separation distance

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

WCDMA Band 5 Downlink at 20 cm Separation Distance:

Maximum peak output power at antenna input terminal:	**16.99**	(dBm)
Maximum peak output power at antenna input terminal:	**50.00**	(mW)
Maximum System Gain	**0.0100**	(dBi)
Maximum System Gain	**1.002**	(numeric)
Prediction distance:	**20**	(cm)
Source Based Time Average Duty Cycle:	**100**	(%)
Prediction frequency:	**876.4**	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	**0.2686**	(mW/cm^2)
Power density at prediction frequency:	**0.009971**	(mW/cm^2)
FCC Margin of Compliance:	**-14.30**	(dB)

LTE Band 4 Downlink at 20 cm Separation Distance:

Maximum peak output power at antenna input terminal:	**15.84**	(dBm)
Maximum peak output power at antenna input terminal:	**38.37**	(mW)
Antenna gain(max):	**1.1600**	(dBi)
Maximum antenna gain:	**1.306**	(numeric)
Prediction distance:	**20**	(cm)
Source Based Time Average Duty Cycle:	**100**	(%)
Prediction frequency:	**2112.5**	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	**0.4901**	(mW/cm^2)
Power density at prediction frequency:	**0.009971**	(mW/cm^2)
FCC Margin of Compliance:	**-16.92**	(dB)

LTE Band 12 Downlink at 20 cm Separation Distance:

Maximum peak output power at antenna input terminal:	**15.56**	(dBm)
Maximum peak output power at antenna input terminal:	**35.97**	(mW)
Maximum System Gain	**1.4400**	(dBi)
Maximum System Gain	**1.393**	(numeric)
Prediction distance:	**20**	(cm)
Source Based Time Average Duty Cycle:	**100**	(%)
Prediction frequency:	**743.5**	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	**0.2401**	(mW/cm^2)
Power density at prediction frequency:	**0.009971**	(mW/cm^2)
FCC Margin of Compliance:	**-13.82**	(dB)

LTE Band 14 Downlink at 20 cm Separation Distance:

Maximum peak output power at antenna input terminal:	**12.40**	(dBm)
Maximum peak output power at antenna input terminal:	**12.40**	(mW)
Antenna gain(max):	**17.38**	(dBi)
Maximum antenna gain:	**18.4500**	(numeric)
Prediction distance:	**69.984**	(cm)
Source Based Time Average Duty Cycle:	**20**	(%)
Prediction frequency:	**100**	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	**763**	(mW/cm^2)
Power density at prediction frequency:	**0.2444**	(mW/cm^2)
FCC Margin of Compliance:	**-0.04**	(dB)

LTE Band 25 Downlink at 20 cm Separation Distance:

Maximum peak output power at antenna input terminal:	**16.86**	(dBm)
Maximum peak output power at antenna input terminal:	**48.53**	(mW)
Antenna gain(max):	**0.1400**	(dBi)
Maximum antenna gain:	**1.033**	(numeric)
Prediction distance:	**20**	(cm)
Source Based Time Average Duty Cycle:	**100**	(%)
Prediction frequency:	**1985**	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	**0.4697**	(mW/cm^2)
Power density at prediction frequency:	**0.009971**	(mW/cm^2)
FCC Margin of Compliance:	**-16.73**	(dB)

LTE Band 30 Downlink at 20 cm Separation Distance:

Maximum peak output power at antenna input terminal:	**15.15**	(dBm)
Maximum peak output power at antenna input terminal:	**32.73**	(mW)
Antenna gain(max):	**1.8500**	(dBi)
Maximum antenna gain:	**1.531**	(numeric)
Prediction distance:	**20**	(cm)
Source Based Time Average Duty Cycle:	**100**	(%)
Prediction frequency:	**2355**	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	**0.5279**	(mW/cm^2)
Power density at prediction frequency:	**0.009971**	(mW/cm^2)
FCC Margin of Compliance:	**-17.24**	(dB)

WCDMA Band 5 Uplink at 65 cm Separation Distance:

Maximum peak output power at antenna input terminal:	**21.68**	(dBm)
Maximum peak output power at antenna input terminal:	**147.23**	(mW)
Antenna gain(max):	**8.3200**	(dBi)
Maximum antenna gain:	**6.792**	(numeric)
Prediction distance:	**65**	(cm)
Source Based Time Average Duty Cycle:	**100**	(%)
Prediction frequency:	**841.6**	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	**0.2613**	(mW/cm^2)
Power density at prediction frequency:	**0.018835**	(mW/cm^2)
FCC Margin of Compliance:	**-11.42**	(dB)

LTE Band 4 Uplink at 65 cm Separation Distance:

Maximum peak output power at antenna input terminal:	**23.37**	(dBm)
Maximum peak output power at antenna input terminal:	**217.27**	(mW)
Antenna gain(max):	**6.6300**	(dBi)
Maximum antenna gain:	**4.603**	(numeric)
Prediction distance:	**65**	(cm)
Source Based Time Average Duty Cycle:	**100**	(%)
Prediction frequency:	**1750**	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	**0.4310**	(mW/cm^2)
Power density at prediction frequency:	**0.018835**	(mW/cm^2)
FCC Margin of Compliance:	**-13.59**	(dB)

LTE Band 12 Uplink at 65 cm Separation Distance:

Maximum peak output power at antenna input terminal:	**21.92**	(dBm)
Maximum peak output power at antenna input terminal:	**155.60**	(mW)
Antenna gain(max):	**8.0800**	(dBi)
Maximum antenna gain:	**6.427**	(numeric)
Prediction distance:	**65**	(cm)
Source Based Time Average Duty Cycle:	**100**	(%)
Prediction frequency:	**707.5**	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	**0.2321**	(mW/cm^2)
Power density at prediction frequency:	**0.018835**	(mW/cm^2)
FCC Margin of Compliance:	**-10.91**	(dB)

LTE Band 14 Uplink at 65 cm Separation Distance:

Maximum peak output power at antenna input terminal:	**23.13**	(dBm)
Maximum peak output power at antenna input terminal:	**205.59**	(mW)
Antenna gain(max):	**17.5000**	(dBi)
Maximum antenna gain:	**56.234**	(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:	**0.217753**	(mW/cm^2)
FCC Margin of Compliance:	**-0.62**	(dB)

LTE Band 25 Uplink at 65 cm Separation Distance:

Maximum peak output power at antenna input terminal:	**23.48**	(dBm)
Maximum peak output power at antenna input terminal:	**222.84**	(mW)
Antenna gain(max):	**6.5200**	(dBi)
Maximum antenna gain:	**4.487**	(numeric)
Prediction distance:	**65**	(cm)
Source Based Time Average Duty Cycle:	**100**	(%)
Prediction frequency:	**1855**	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	**0.4485**	(mW/cm^2)
Power density at prediction frequency:	**0.018835**	(mW/cm^2)
FCC Margin of Compliance:	**-13.77**	(dB)

LTE Band 30 Uplink at 65 cm Separation Distance:

Maximum peak output power at antenna input terminal:	**21.51**	(dBm)
Maximum peak output power at antenna input terminal:	**141.58**	(mW)
Antenna gain(max):	**8.4900**	(dBi)
Maximum antenna gain:	**7.063**	(numeric)
Prediction distance:	**65**	(cm)
Source Based Time Average Duty Cycle:	**100**	(%)
Prediction frequency:	**2310**	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	**0.5210**	(mW/cm^2)
Power density at prediction frequency:	**0.018835**	(mW/cm^2)
FCC Margin of Compliance:	**-14.42**	(dB)

LTE Modem Power Density worst case LTE Band 12

Maximum peak output power at antenna input terminal:	**24.50**	(dBm)
Maximum peak output power at antenna input terminal:	**281.84**	(mW)
Antenna gain(max):	**4.0000**	(dBi)
Maximum antenna gain:	**2.512**	(numeric)
Prediction distance:	**65**	(cm)
Source Based Time Average Duty Cycle:	**100**	(%)
Prediction frequency:	**701.5**	(MHz)
FCC MPE limit for uncontrolled exposure at prediction frequency:	**0.2307**	(mW/cm^2)
Power density at prediction frequency:	**0.140841**	(mW/cm^2)
FCC Margin of Compliance:	**-2.14**	(dB)

7. Power and Calculated Max Antenna Gain per Band

Uplink (NU)		
Band	**Worst Case Conducted Power (dBm)**	**Max Antenna Gain (dBi)**
LTE B4	23.37	6.63
WCDMA B5	21.68	8.32
LTE B12	21.92	8.08
LTE B14	22.13	17.5
LTE B25	23.48	6.52
LTE B30	21.51	8.49

Downlink (CU)		
Band	**Worst Case Conducted Power (dBm)**	**Max Antenna Gain (dBi)**
LTE B4	15.84	1.16
WCDMA B5	16.99	0.01
LTE B12	15.56	1.44
LTE B14	12.40	17.38
LTE B25	16.86	0.14
LTE B30	15.15	1.85

8. Max System Antenna Gain

Port	Max System (Antenna & Cable) Gain
CU	1.16 dBi for LTE Band 4 0.01 dBi for WCDMA Band 5 1.44 dBi for LTE Band 12 17.38 dBi for LTE Band 14 0.14 dBi for LTE Band 25 0.68 dBi for LTE Band 30
NU Port 1	6.63 dBi for LTE Band 4 8.32 dBi for WCDMA Band 5 8.08 dBi for LTE Band 12 6.52 dBi for LTE Band 25 8.49 dBi for LTE Band 30
NU Port 2	6.63 dBi for LTE Band 4 17.5 dBi for LTE Band 14 6.52 dBi for LTE Band 25

Sincerely,

Name: Miguel Angel Rabago Garcia
Authorized Signatory
Title: Wireless Test Engineer