February 1, 2018

TUV SUD BABT
Octagon House, Concorde Way
Segensworth Rd N, Fareham
PO15 5RL

Attention: Director of Certification

FCC ID: XPY2AGQN4NNN
IC: 8595A-2AGQN4NNN

RE: ***Antenna gain calculation per guidance from KDB 447498 D01 Mobile Portable RF Exposure v06 and RSS-102 Issue 5 March 2015.***

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)	Magnetic 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*

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

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)*

EUT	u-blox AG SARA-R410M-02B LTE Cat-M1/NB1 Module
Input Power of the Antenna	25.0 dBm / 0.316 mW (LTE Band 2, 4, 5, 12 and 13)
Frequency	699.7 - 715.3 MHz (LTE B12)
	1710.7 - 1754.3 (LTE B4)
	777.7 - 786.3 MHz (LTE B13)
	824.7 - 848.3 MHz (LTE B5)
	1850.7 - 1909.3 MHz (LTE B2)
FCC Limit (§1.1310 (d)(4)) (Use lowest frequency as the worst case)	4.66467 W/m^2 @ 699.7 MHz (LTE Band 12)
	10 W/m^2 @ 1710.7 MHz (LTE Band 4)
	5.18467 W/m^2 @ 777.7 MHz (LTE Band 13)
	5.498 W/m^2 @ 824.7 MHz (LTE Band 5)
	10 W/m^2 @ 1805.7 MHz (LTE Band 2)
RSS-102 RF Limits (Use lowest frequency as the worst case)	2.30329 W/m^2 @ 699.7 MHz (LTE Band 12)
	4.2431 W/m^2 @ 1710.7 MHz (LTE Band 4)
	2.4758 W/m^2 @ 777.7 MHz (LTE Band 13)
	2.5771 W/m^2 @ 824.7 MHz (LTE Band 5)
	4.40278 W/m^2 @ 1805.7 MHz (LTE Band 2)
User separation distance	20 cm

Equation for predicting RF field was used to determine the maximum antenna gain that can be used with the EUT and still comply with the requirements:

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

Where: S=the power flux

P=input power of the antenna

G=antenna gain relative to an isotropic antenna

r=distance from the antenna to the point of investigation

From this formula, for LTE Band 12, using 0.230329 mW/cm^2 as *S* (worst case than FCC limit), 20 cm as *r* then the antenna gain *G* is calculated. This is the maximum antenna gain in dBi that can be used with the EUT while still in compliance with the power density requirements.

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

$$G = \frac{4\pi(20\ cm)^2(0.230329\ mW/cm^2)}{316.0\ mW}$$

$$G = \frac{1157.76}{316.0\ mW}$$

$$G = 3.664$$

Therefore:

G = **3.66 dBi** for Band 12,
G = **6.75 dBi** for Band 4
G = **3.94 dBi** for Band 13
G = **4.41 dBi** for Band 5
G = **7.0 dBi** for Band 2

Sincerely,

Ferdie S. Custodio
Name
Authorized Signatory
Title: Senior EMC/Wireless Test Engineer