FCC RF Exposure Evaluation

1. Product Information

EUT	:Brivo Gateway
Test Model	:B-Gateway V5-M2
Power Supply	:Input: 5V⎓3A or Battery:3.7V⎓3200mAh Adapter Input: 100-240V~, 50/60Hz, 0.4A Adapter Output: 5V⎓3A
Hardware Version	:V2.4
Software Version	:V1.4.0
Bluetooth	
Frequency Range	:2402MHz-2480MHz
Bluetooth Channel Number	:40 channels for Bluetooth V4.2 (DTS)
Bluetooth Channel Spacing	:2MHz for Bluetooth V4.2 (DTS)
Bluetooth Modulation Type	:GFSK for Bluetooth V4.2 (DTS)
Bluetooth Version	:V4.2
Antenna Description	:PCB Antenna with UFL Connector & Cable, 3.0dBi (Max.)
2.4G WLAN	
Frequency Range	:2412MHz-2462MHz
Channel Number	:11 Channels for 20MHz bandwidth (2412~2462MHz)
Channel Spacing	:5MHz
Modulation Type	:IEEE 802.11b: DSSS (CCK, DQPSK, DBPSK) IEEE 802.11g: OFDM (64QAM, 16QAM, QPSK, BPSK) IEEE 802.11n: OFDM (64QAM, 16QAM, QPSK, BPSK)
Antenna Description	:PCB Antenna with UFL Connector & Cable, 3.0dBi(Max.)
Zigbee	
Frequency Range	:2405MHz-2480MHz
Channel Spacing	:5MHz
Channel Number	:16 Channels
Modulation Type	:O-QPSK
Antenna Description	:Chip Antenna, 1.86dBi (Max.)
Z-Wave	
Frequency Range	:908.4MHz-916MHz
Channel Number	:2
Modulation Type	:FSK/ GFSK
Antenna Description	:PCB Trace Antenna, 0dBi (Max)
Z-Wave	
Frequency Range	:912MHz,920MHz
Channel Number	:2
Modulation Type	:OQPSK
Antenna Description	:PCB Trace Antenna, 0dBi(Max)

2. Evaluation Method

Systems operating under the provisions of FCC 47 CFR section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.
In accordance with 47 CFR FCC Part 2 Subpart J, section 2.1091 this device has been defined as mobile device whereby a distance of 0.2m normally can be maintained between the user and the device, and below RF Permissible Exposure limit shall comply with.

In accordance with KDB447498D01 for Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on the calculated/estimated, numerically modelled or measured field strengths or power density, is ≤ 1.0. The MPE ratio of each antenna is determined at the minimum test separation distance required by the operating configurations and exposure conditions

of the host device, according to the ratio of field strengths or power density to MPE limit, at the test frequency. Either the maximum peak or spatially averaged results from measurements or numerical simulations may be used to determine the MPE ratios. Spatial averaging does not apply when MPE is estimated using simple calculations based on far-field plane-wave equivalent conditions. The antenna installation and operating requirements for the host device must meet the minimum test separation distances required by all antennas, in both standalone and simultaneous transmission operations, to satisfy compliance.

3. Limit

3. 1 Refer Evaluation Method

ANSI C95.1–1999: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.
FCC KDB publication 447498 D01 General 1 RF Exposure Guidance v06: Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.
FCC CFR 47 part1 1.1310: Radiofrequency radiation exposure limits.
FCC CFR 47 part2 2.1091: Radiofrequency radiation exposure evaluation: mobile devices

3. 2 Limit

Limits for Maximum Permissible Exposure (MPE)/Controlled Exposure

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density (mW/cm^2)	Averaging Time (minute)
Limits for Occupational/Controlled Exposure				
0.3 – 3.0	614	1.63	(100) *	6
3.0 – 30	1842/f	4.89/f	($900/f^2$)*	6
30 – 300	61.4	0.163	1.0	6
300 – 1500	/	/	f/300	6
1500 – 100,000	/	/	5	6

Limits for Maximum Permissible Exposure (MPE)/Uncontrolled Exposure

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density (mW/cm^2)	Averaging Time (minute)
Limits for Occupational/Controlled Exposure				
0.3 – 3.0	614	1.63	(100) *	30
3.0 – 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

4. MPE Calculation Method

Predication of MPE limit at a given distance
Equation from page 18 of OET Bulletin 65, Edition 97-01

$S=PG/4\pi R^2$

Where: S=power density
P=power input to antenna
G=power gain of the antenna in the direction of interest relative to an isotropic radiator
R=distance to the center of radiation of the antenna

5. Antenna Information

PCB Antenna can only use antennas certificated as follows provided by manufacturer;

Internal Identification	Antenna type and antenna number	Operate frequency band	Maximum antenna gain	Note
Ant0	PCB Antenna	2400MHz-2500MHz	3.0dBi	BT/ WIFI Antenna
Ant1	PCB Antenna	908MHz-920MHz	0dBi	Z-wave Antenna
Ant2	Chip Antenna	2400MHz-2500MHz	1.86dBi	Zigbee Antenna
Ant3	Ceramic Patch Antenna	698MHz-960MHz	0.50dBi	LTE/NB-IOT Antenna
Ant3	Ceramic Patch Antenna	1700MHz-2700MHz	3.70dBi	LTE/NB-IOT Antenna

6. Conducted Power

< BT LE Max Conducted Power >< Ant0>

Mode	Channel	Frequency (MHz)	Max Conducted Power (dBm)
GFSK	0	2402	1.01
	19	2440	1.49
	39	2480	1.66

<2.4GWLAN Max Conducted Power >< Ant0>

Mode	Channel	Frequency (MHz)	Max Conducted Power (dBm)
IEEE 802.11b	1	2412	16.51
	6	2437	17.84
	11	2462	16.77
IEEE 802.11g	1	2412	13.76
	6	2437	14.02
	11	2462	14.07
IEEE 802.11n HT20	1	2412	11.16
	6	2437	11.39
	11	2462	13.33

< Zigbee Max Conducted Power >< Ant1>

Mode	Channel	Frequency (MHz)	Max Conducted Power (dBm)
O-QPSK	0	2405	15.35
	7	2440	15.03
	15	2480	8.38

< Z-wave Max Conducted Power >< Ant2>

Mode	Frequency (MHz)	Max Conducted Power (dBm)
O-QPSK	912	8.26
	920	7.86

Z-wave((908.4MHz,908.42MHz) FSK/ (916MHz) GFSK) < Ant2>:
TX frequency (the Worst):916MHz
Max. Field Strength: 82.76dBuV/m @3m
EIRP=E-104.7+20logD=82.76-104.7+20log3=-12.40dBm
Maximum Conducted Output Power: -12.40dBm
Turn-up: -12±1

7. Manufacturing Tolerance

<BT LE>< Ant0>

GFSK (Peak)			
Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	1.0	1.0	1.0
Tolerance ±(dB)	1.0	1.0	1.0

<2.4G WIFI>< Ant0>

11B (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	16.0	17.0	16.0
Tolerance ±(dB)	1.0	1.0	1.0
11G (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	13.0	14.0	14.0
Tolerance ±(dB)	1.0	1.0	1.0
11N20SISO (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	11.0	11.0	13.0
Tolerance ±(dB)	1.0	1.0	1.0

<Zigbee>< Ant1>

O-QPSK (Peak)			
Channel	Channel 0	Channel 7	Channel 15
Target (dBm)	15.0	15.0	8.0
Tolerance ±(dB)	1.0	1.0	1.0

<Z-wave>< Ant2>

O-QPSK (Peak)		
Frequency (MHz)	912	920
Target (dBm)	8.0	7.0
Tolerance ±(dB)	1.0	1.0

<LTE/NB-IOT> < Ant3>

<LTE/NB-IOT> maximum output power including tune up tolerance from modular BG95-M2 (FCC ID: XMR2020BG95M2) MPE report No. R1907A0448-M1V1;

Band	Maximum Conducted Output Power including Tune up Tolerance (dBm)
LTE Band 2	22.00
LTE Band 4	22.00
LTE Band 5	22.00
LTE Band 12	22.00
LTE Band 13	22.00
LTE Band 25	22.00
LTE Band 26	22.00
LTE Band 66	22.00
LTE Band 85	22.00
NB-IOT Band 2	22.00
NB-IOT Band 4	22.00
NB-IOT Band 5	22.00
NB-IOT Band 12	22.00
NB-IOT Band 13	22.00
NB-IOT Band 25	22.00
NB-IOT Band 66	22.00
NB-IOT Band 71	22.00
NB-IOT Band 85	22.00

8. Measurement Results

8.1 Standalone MPE

As declared by the Applicant, the EUT is a wireless device used in a fix application, at least 20 cm from any body part of the user or nearby persons; from the maximum EUT RF output power, the minimum separation distance, r =20cm, as well as the gain of the used antenna refer to antenna information, the RF power density can be obtained.

<BT LE>< Ant0>

Band/Mode	RF output power		Antenna Gain (dBi)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW			
GFSK	2.0	1.5849	3.0	0.0006	1.0000

<2.4G WIFI>< Ant0>

Band/Mode	RF output power		Antenna Gain (dBi)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW			
IEEE 802.11b	18.0	63.0957	3.0	0.0250	1.0000
IEEE 802.11g	15.0	31.6228	3.0	0.0126	1.0000
IEEE 802.11n HT20	14.0	25.1189	3.0	0.0100	1.0000

<Zigbee>< Ant1>

Band/Mode	RF output power		Antenna Gain (dBi)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW			
O-QPSK	6.0	3.9811	1.86	0.0012	1.0000

<Z-wave>< Ant2>

Band/Mode	RF output power		Antenna Gain (dBi)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW			
O-QPSK	9.0	3.9811	0	0.0016	0.608

LTE/NB-IOT><Ant3>

Band/Mode	RF output power		Antenna Gain (dBi)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW			
LTE Band 2	22.00	158.4893	3.7	0.0740	1.000
LTE Band 4	22.00	158.4893	3.7	0.0740	1.000
LTE Band 5	22.00	158.4893	0.5	0.0354	0.566
LTE Band 12	22.00	158.4893	0.5	0.0354	0.477
LTE Band 13	22.00	158.4893	0.5	0.0354	0.525
LTE Band 25	22.00	158.4893	3.7	0.0740	1.000
LTE Band 26	22.00	158.4893	0.5	0.0354	0.543
LTE Band 66	22.00	158.4893	3.7	0.0740	1.000
LTE Band 85	22.00	158.4893	0.5	0.0354	0.477
NB-IOT Band 2	22.00	158.4893	3.7	0.0740	1.000
NB-IOT Band 4	22.00	158.4893	3.7	0.0740	1.000
NB-IOT Band 5	22.00	158.4893	0.5	0.0354	0.566
NB-IOT Band 12	22.00	158.4893	0.5	0.0354	0.477
NB-IOT Band 13	22.00	158.4893	0.5	0.0354	0.525
NB-IOT Band 25	22.00	158.4893	3.7	0.0740	1.000
NB-IOT Band 66	22.00	158.4893	3.7	0.0740	1.000
NB-IOT Band 71	22.00	158.4893	0.5	0.0354	0.442
NB-IOT Band 85	22.00	158.4893	0.5	0.0354	0.477

Remark:
1. Output power including tune-up tolerance;
2. MPE evaluate distance is 20cm from user manual provide by manufacturer;

8.2 Simultaneous Transmission MPE

The sample support one LTE/NB-IOT, BT/WLAN, Zigbee, Z-Wave modulars and difference antennas, can support LTE/NB-IOT, BT/WLAN, Zigbee, Z-Wave simultaneously transmission, WLAN and BT share same modular and antenna, WLAN and BT cannot support simultaneously transmission;

Simultaneous transmission MPE
According to KDB447498 for Transmitters used in mobile exposure conditions for simultaneous transmission operations;

∑∑of MPE ratios ≤ 1.0

Mode	WLAN MPE1 (mW/cm^2)	Zigbee MPE (mW/cm^2)	Z-Wave MPE (mW/cm^2)	LTE/NB-IOT MPE (mW/cm^2)	∑MPE ratios	Limit	Results
Ant0+ Ant1+ Ant2+ Ant3	0.0250	0.0012	0.0026	0.0740	0.1028	1.0	PASS

Remark:
1. Output power including turn-up tolerance;
2. Output power is burst average power;
3. MPE evaluate distance is 20cm from user manual provide by manufacturer;
4. MPE values = $PG/4\pi R^2$

9. Conclusion

The measurement results comply with the FCC Limit per 47 CFR 2.1091 for the uncontrolled RF Exposure of mobile device.

.....THE END OF REPORT.....