Maximum Permissible Exposure Report

1. Product Information

EUT	: KE2 Edge Manager Plus
Test Model	: KE2EM-Plus
Additional Models No.	: /
Models Declaration	: /
Power Supply	: Input: DC 12V/1.5A by adapter Adapter input: AC 100-240V, 50/60Hz, 0.8A
Hardware Version	: V2.0
Software Version	: 3.104
Bluetooth	
Frequency Range	: 2402MHz ~ 2480MHz
Bluetooth Version	: V4.0
Bluetooth Channel Number	: 40 channels for Bluetooth V4.0 (BT LE)
Bluetooth Channel Spacing	: 2MHz for Bluetooth V4.0 (BT LE)
Bluetooth Modulation Type	: GFSK for Bluetooth V4.0 (BT LE)
Antenna Description	: External Antenna, 0.2dBi(Max.)
WIFI(2.4G Band)	
Frequency Range	: 2412MHz ~ 2462MHz
Channel Number	: 11 Channels for 20MHz bandwidth (2412MHz ~ 2462MHz) 7 Channels for 40MHz bandwidth (2422MHz ~ 2452MHz)
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	: One PCB Antenna(ANT0) used for 2.4G WLAN, 2.7dBi(max.) One PCB Antenna(ANT1) used for 2.4G WLAN, 2.7dBi(max.)
WIFI(5.2G Band)	
Frequency Range	: 5180MHz-5240MHz
Channel Number	: 4 channels for 20MHz bandwidth(5180MHz-5240MHz) 2 channels for 40MHz bandwidth(5190MHz~5230MHz) 1 channels for 80MHz bandwidth(5210MHz)
Modulation Type	: IEEE 802.11a/n/ac: OFDM(64QAM, 16QAM, QPSK, BPSK)
WIFI(5.8G Band)	
Frequency Range	: 5745MHz-5825MHz
Channel Number	: 5 channels for 20MHz bandwidth(5745MHz-5825MHz) 2 channels for 40MHz bandwidth(5755MHz~5795MHz) 1 channels for 80MHz bandwidth(5775MHz)
Modulation Type	: IEEE 802.11a/n/ac: OFDM(64QAM, 16QAM, QPSK, BPSK)
Antenna Description	: Internal Antenna, 6.0dBi(Max.)
Exposure category	General population/uncontrolled environment
EUT Type	Production Unit
Device Type	Mobile Device

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 C95.1–2019: IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz 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/Uncontrolled 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

KE2EM-Plus can only use antennas certificated as follows provided by manufacturer;

Internal/External Identification	Antenna type and antenna number	Operate frequency band	Maximum antenna gain	Notes
2.4GWIFI Antenna1	PCB antenna	2400-2500 MHz	2.7 dBi	WIFI Antenna
2.4GWIFI Antenna2	PCB antenna	2400-2500 MHz	2.7 dBi	WIFI Antenna
BT Antenna	External antenna	2400-2500 MHz	0.2 dBi	BT Antenna
5GWIFI Antenna	Internal antenna	5000-6000 MHz	6.0 dBi	5G Antenna

6. Conducted Power

[BT LE]

Mode	Channel	Frequency (MHz)	Peak Conducted Output Power (dBm)
GFSK	00	2402	16.188
	19	2441	16.309
	39	2480	16.226

[2.4G WLAN]

Mode	Channel	Frequency (MHz)	Peak Conducted Output Power (dBm)	
			ANT0	ANT1
IEEE 802.11b	1	2412	18.13	18
	6	2437	18.71	18.54
	11	2462	18.95	18.58
IEEE 802.11g	1	2412	19.99	19.97
	6	2437	20.84	20.75
	11	2462	21.04	20.78
IEEE 802.11n HT20	1	2412	19.65	19.59
	6	2437	20.46	20.41
	11	2462	20.65	20.58
IEEE 802.11n HT40	3	2422	19.36	19.29
	6	2437	19.76	19.66
	9	2452	20.53	20.5

[5GHz WLAN Band 1]

Mode	Channel	Frequency (MHz)	Average Conducted Output Power (dBm)
IEEE 802.11a	36	5180	18.58
	40	5200	18.85
	48	5240	19.8
IEEE 802.11n HT20	36	5180	18.54
	40	5200	16.94
	48	5240	18.94
IEEE 802.11n HT40	38	5190	18.18
	46	5230	18.83
IEEE 802.11ac VHT20	36	5180	18.1
	40	5200	18.59
	48	5240	19.08
IEEE 802.11ac VHT40	38	5190	18.15
	46	5230	18.69
IEEE 802.11ac VHT80	42	5210	20.29

[5GHz WLAN Band 3]

Mode	Channel	Frequency (MHz)	Average Conducted Output Power (dBm)
IEEE 802.11a	149	5745	18.64
	157	5785	19.13
	165	5825	19.92
IEEE 802.11n HT20	149	5745	18.49
	157	5785	19.27
	165	5825	19.86
IEEE 802.11n HT40	151	5755	18.27
	159	5795	19.29
IEEE 802.11ac VHT20	149	5745	18.10
	157	5785	18.59
	165	5825	19.08
IEEE 802.11ac VHT40	151	5755	18.15
	159	5795	18.69
IEEE 802.11ac VHT80	155	5775	21.04

7. Manufacturing Tolerance

BT LE						
Channel	Channel 00		Channel 19		Channel 39	
Target (dBm)	16.0		16.0		16.0	
Tolerance ± (dB)	1.0		1.0		1.0	
2.4GWLAN						
IEEE 802.11b (Peak)						
Channel	Channel 1		Channel 6		Channel 11	
	ANT 0	ANT 1	ANT 0	ANT 1	ANT 0	ANT 1
Target (dBm)	18.0	18.0	18.0	18.0	18.0	18.0
Tolerance ±(dB)	1.0		1.0		1.0	
IEEE 802.11g (Peak)						
Channel	Channel 1		Channel 6		Channel 11	
	ANT 0	ANT 1	ANT 0	ANT 1	ANT 0	ANT 1
Target (dBm)	19.0	19.0	20.0	20.0	21.0	20.0
Tolerance ±(dB)	1.0		1.0		1.0	
IEEE 802.11n HT20 (Peak)						
Channel	Channel 1		Channel 6		Channel 11	
	ANT 0	ANT 1	ANT 0	ANT 1	ANT 0	ANT 1
Target (dBm)	19.0	19.0	20.0	20.0	20.0	20.0
Tolerance ±(dB)	1.0		1.0		1.0	
IEEE 802.11n HT40 (Peak)						
Channel	Channel 3		Channel 6		Channel 9	
	ANT 0	ANT 1	ANT 0	ANT 1	ANT 0	ANT 1
Target (dBm)	19.0	19.0	19.0	19.0	20.0	20.0
Tolerance ±(dB)	1.0		1.0		1.0	
[5GHz WLAN Band 1]						
IEEE 802.11a (Average)						
Channel	Channel 36		Channel 40		Channel 48	
Target (dBm)	18.0		18.0		19.0	
Tolerance ± (dB)	1.0		1.0		1.0	
IEEE 802.11n HT20 (Average)						
Channel	Channel 36		Channel 40		Channel 48	
Target (dBm)	18.0		16.0		18.0	
Tolerance ± (dB)	1.0		1.0		1.0	
IEEE 802.11n HT40 (Average)						
Channel	Channel 38				Channel 46	
Target (dBm)	18.0				18.0	
Tolerance ± (dB)	1.0				1.0	
IEEE 802.11ac VHT20 (Average)						

Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	18.0	18.0	19.0
Tolerance ± (dB)	1.0	1.0	1.0
IEEE 802.11ac VHT40 (Average)			
Channel	Channel 38	Channel 46	
Target (dBm)	18.0	18.0	
Tolerance ± (dB)	1.0	1.0	
IEEE 802.11ac VHT80(Average)			
Channel	Channel 42		
Target (dBm)	20.0		
Tolerance ± (dB)	1.0		
[5GHz WLAN Band 3]			
IEEE 802.11a (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	18.0	19.0	19.0
Tolerance ± (dB)	1.0	1.0	1.0
IEEE 802.11n HT20 (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	18.0	19.0	19.0
Tolerance ± (dB)	1.0	1.0	1.0
IEEE 802.11n HT40 (Average)			
Channel	Channel 151	Channel 159	
Target (dBm)	18.0	19.0	
Tolerance ± (dB)	1.0	1.0	
IEEE 802.11ac VHT20 (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	18.0	18.0	19.0
Tolerance ± (dB)	1.0	1.0	1.0
IEEE 802.11ac VHT40 (Average)			
Channel	Channel 151	Channel 159	
Target (dBm)	18.0	18.0	
Tolerance ± (dB)	1.0	1.0	
IEEE 802.11ac VHT80(Average)			
Channel	Channel 155		
Target (dBm)	21.0		
Tolerance ± (dB)	1.0		

8. Measurement Results

8.1 Standalone MPE Evaluation

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]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
BT LE	17.0	50.1187	0.2	1.0471	0.010446	1.0000

[2.4GWLAN-ANT 1]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
IEEE 802.11b	19.0	79.4328	2.7	1.8621	0.029441	1.0000
IEEE 802.11g	21.0	125.8925	2.7	1.8621	0.046661	1.0000
IEEE 802.11n HT20	21.0	125.8925	2.7	1.8621	0.046661	1.0000
IEEE 802.11n HT40	21.0	125.8925	2.7	1.8621	0.046661	1.0000

[2.4GWLAN-ANT 2]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
IEEE 802.11b	19.0	79.4328	2.7	1.8621	0.029441	1.0000
IEEE 802.11g	21.0	125.8925	2.7	1.8621	0.046661	1.0000
IEEE 802.11n HT20	21.0	125.8925	2.7	1.8621	0.046661	1.0000
IEEE 802.11n HT40	21.0	125.8925	2.7	1.8621	0.046661	1.0000

[5GHz WLAN Band 1]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
IEEE 802.11a	19.0	79.4328	6.0	3.9811	0.062943	1.0000
IEEE 802.11n HT20	19.0	79.4328	6.0	3.9811	0.062943	1.0000
IEEE 802.11n HT40	19.0	79.4328	6.0	3.9811	0.062943	1.0000
IEEE 802.11ac VHT20	20.0	100.0000	6.0	3.9811	0.079241	1.0000
IEEE 802.11ac VHT40	19.0	79.4328	6.0	3.9811	0.062943	1.0000
IEEE 802.11ac VHT80	21.0	125.8925	6.0	3.9811	0.099759	1.0000

[5GHz WLAN Band 3]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
IEEE 802.11a	20.0	100.0000	6.0	3.9811	0.079241	1.0000
IEEE 802.11n HT20	20.0	100.0000	6.0	3.9811	0.079241	1.0000
IEEE 802.11n HT40	20.0	100.0000	6.0	3.9811	0.079241	1.0000
IEEE 802.11ac VHT20	20.0	100.0000	6.0	3.9811	0.079241	1.0000
IEEE 802.11ac VHT40	19.0	79.4328	6.0	3.9811	0.062943	1.0000
IEEE 802.11ac VHT80	22.0	158.4893	6.0	3.9811	0.125589	1.0000

Remark:
1. Output power including turn-up tolerance;
2. Output power was adjust to duty cycle at 100% if measured duty cycle less than 98%;
3. MPE evaluate distance is 20cm from user manual provide by manufacturer.

8.2 Simultaneous Transmission MPE Evaluation

The EUT equiped with one 2.4GWLAN module and one 5GWLAN module and one BT module. Each module has its own antenna and 2.4GWLAN has two antennas which supports MIMO technology, All module transmit at the same time. So need consider simultaneous transmission.
According to KDB447498 D01 General RF Exposure Guidance v06 for Transmitters used in mobile exposure conditions for simultaneous transmission operations;
∑ of MPE ratios ≤ 1.0

Simultaneous Transmission MPE						
BT LE	*2.4GWLAN-ANT1*	*2.4GWLAN-ANT2*	*5GHz WLAN*	∑ MPE ratios	Limit	Results
0.01	0.05	0.05	0.13	0.24	1.0000	PASS

9. Conclusion

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

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