

MPE Report

Applicant : Kaonbroadband CO., LTD
Product Name : WiFi6E XGS-PON Gateway
Trade Name : KAON
Model Number : PG2494
Applicable Standard : 47 CFR § 2.1091
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Issued by

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Revision History

Rev.	Issued Date	Revisions	Revised By
00	Jul. 29, 2022	Initial Issue	Abby Huang

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1. General Information

1.1 Reference Applicable Standard

Standard	Description	Version
IEEE C95.1	American National Standard safety levels with respect to human exposure to radio frequency electromagnetic fields, 300 KHz to 100 GHz, New York.	1992
47 CFR Part §2.1091	Radiofrequency radiation exposure evaluation: mobile devices.	-
47 CFR Part §1.1310	Radiofrequency radiation exposure limits.	-
KDB 447498 D04	RF exposure procedures and equipment authorization policies for mobile and portable devices	v01

2. Description of Equipment under Test (EUT)

Applicant	Kaonbroadband CO., LTD 884-3, Seongnam-daero, Bundang-gu, Seongnam-si, Gyeonggi-do, Republic of Korea
Product Name	WiFi6E XGS-PON Gateway
Trade Name	KAON
Model Number	PG2494
FCC ID	2AXCW-PG2494
Frequency Range	WLAN 2.4 GHz Band : 2412 - 2462 MHz WLAN 5.2 GHz Band : 5180 - 5320 MHz WLAN 5.6 GHz Band : 5500 - 5720 MHz WLAN 5.8 GHz Band : 5745 - 5825 MHz WLAN 6.2 GHz Band : 5955 - 6415 MHz WLAN 6.5 GHz Band : 6435 - 6515 MHz WLAN 6.7 GHz Band : 6535 - 6855 MHz WLAN 7.0 GHz Band : 6875 - 7115 MHz
Supported Modulations	WLAN 2.4 GHz : 802.11b/g/n/ax HT20/HT40/HE20/HE40
	WLAN 5 GHz : 802.11a/n/ac/ax HT20/HT40/VHT20/VHT40/VHT80/HE20/HE40/HE80
	WLAN 6 GHz : 802.11ax HE20 / HE40 / HE80
Device Category	Portable Device

Note:

The above information of DUT was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

EUT Modify Description :

1. Add WIFI 6E band 2. Add Partial RU in 2.4 GHz 3. Add 2A band, 2C band ,Partial RU and straddle channel in 5 GHz
The difference will influence the test results. Therefore, all test items need to be re-evaluated.
Original Report : 2206FS11 Rev.01 Modify : 2206FS27 Rev.00

Antenna Information						
ANT No.	Model	Type	Frequency (MHz)	Max. Gain (dBi)	G _{ant} (dBi)	Directional Gain (dBi)
ANT-0	SW25DEC100P	Internal PCB Antenna	2400~2483.5	1.9	1.9	4.63
ANT-1	SW25DEC200P	Internal PCB Antenna	2400~2483.5	1.9	1.9	4.63
ANT-2	SW25DEC200P	Internal PCB Antenna	2400~2483.5	1.9	1.9	4.63
ANT-3	SW25DEC200P	Internal PCB Antenna	2400~2483.5	1.9	1.9	4.63
ANT-0	SW25DEC100P	Internal PCB Antenna	5150~5875	2.0	2.0	4.81
ANT-1	SW25DEC200P	Internal PCB Antenna	5150~5875	2.0	2.0	4.81
ANT-2	SW25DEC200P	Internal PCB Antenna	5150~5875	2.0	2.0	4.81
ANT-3	SW25DEC200P	Internal PCB Antenna	5150~5875	2.0	2.0	4.81
ANT-0	W6EDEC150P-I37	Internal PCB Antenna	5925~7125	2.7	2.7	5.47
ANT-1	W6EDEC150P-I37	Internal PCB Antenna	5925~7125	2.7	2.7	5.47
ANT-2	W6EDEC150P-I37	Internal PCB Antenna	5925~7125	2.7	2.7	5.47
ANT-3	W6EDEC150P-I37	Internal PCB Antenna	5925~7125	2.7	2.7	5.47
Antenna Diversity						
WLAN 2.4 GHz : 4TX (CDD / Beamforming on) IEEE 802.11a : 4TX (CDD) / 4TX(MIMO / Beamforming on) IEEE 802.11n 5 GHz 20 MHz : 4TX (CDD) / 4TX (MIMO / Beamforming on) IEEE 802.11n 5 GHz 40 MHz : 4TX (CDD) / 4TX (MIMO / Beamforming on) IEEE 802.11ac 5 GHz 20 MHz : 4TX (CDD) / 4TX (MIMO / Beamforming on) IEEE 802.11ac 5 GHz 40 MHz : 4TX (CDD) / 4TX (MIMO / Beamforming on) IEEE 802.11ax 5 GHz 20 MHz : 4TX (CDD) / 4TX (MIMO / Beamforming on) IEEE 802.11ax 5 GHz 40 MHz : 4TX (CDD) / 4TX (MIMO / Beamforming on) IEEE 802.11ax 5 GHz 80 MHz : 4TX (CDD) / 4TX (MIMO / Beamforming on) IEEE 802.11ax 6 GHz 20 MHz : 4TX (CDD) / 4TX (MIMO / Beamforming on) IEEE 802.11ax 6 GHz 40 MHz : 4TX (CDD) / 4TX (MIMO / Beamforming on) IEEE 802.11ax 6 GHz 80 MHz : 4TX (CDD) / 4TX (MIMO / Beamforming on)						

3. RF Exposure Limit

For devices that operate at larger distances from persons, where there are minimal RF coupling interactions between a device and the user or nearby persons, RF exposure compliance using maximum permissible exposure (MPE) limits is applied. The limits for MPE is listed as below:

Limits for General Population / Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm ²)	Averaging Time E ² , H ² or S (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 / 1,500	30
1,500-100,000	-	-	1.0	30
Limits for Occupational / Controlled Exposure				
Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm ²)	Averaging Time E ² , H ² or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1,842 / f	4.89 / f	(900 / f ²)*	6
30-300	61.4	0.163	1.0	6
300-1,500	-	-	F / 300	6
1,500-100,000	-	-	5	6

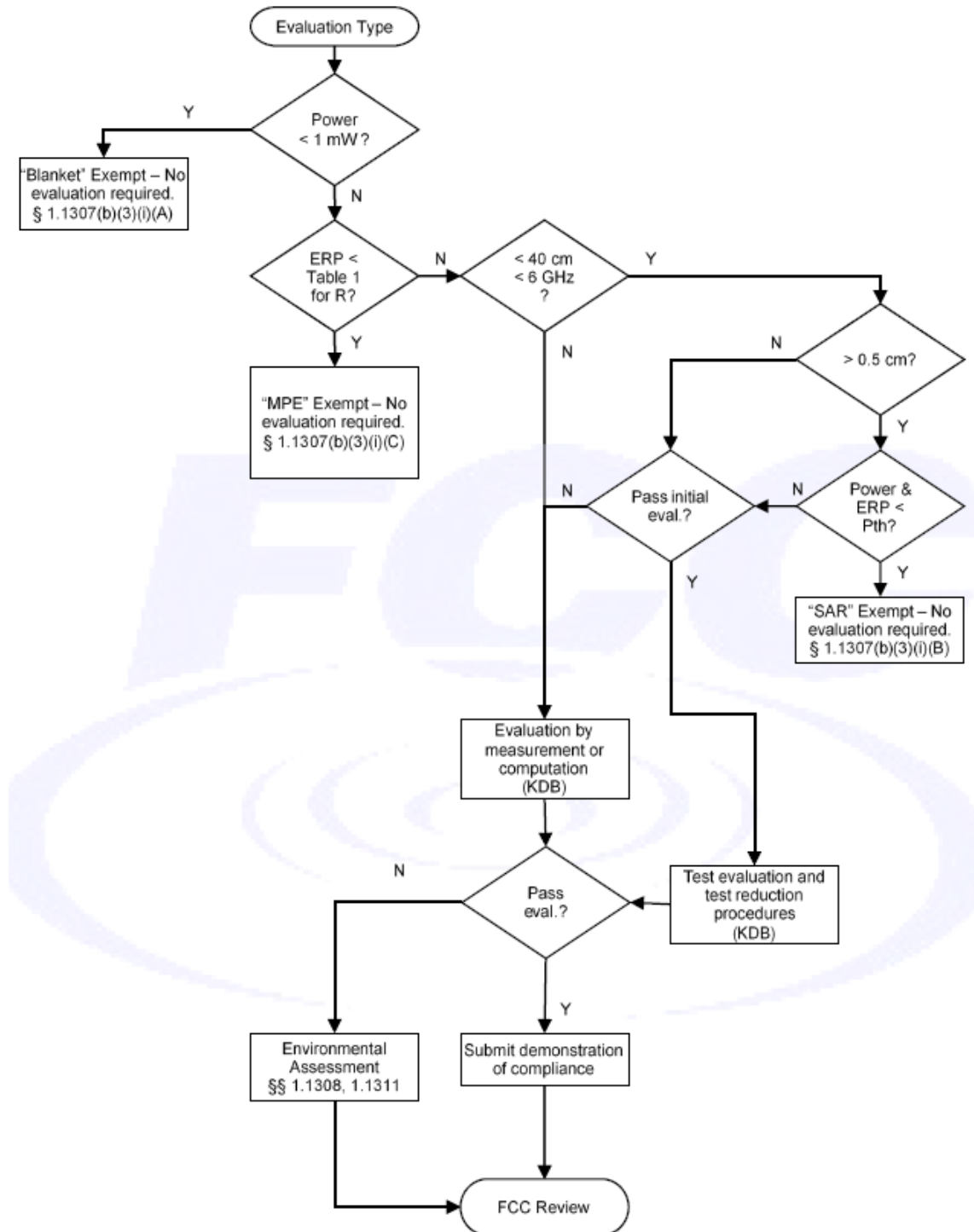
f = frequency in MHz. * = Plane-wave equivalent power density.

4. RF Exposure Assessment

4.1 Exemption Evaluation

Exemption evaluation was performed according to the appendix A and B in KDB447498 D04.

The General Sequence for Determination of Procedure demonstrated in Figure A.1 of KDB447498 D04 was applied.



4.2 Human Exposure Assessment

Due to the design and installation of this product, it is not possible to conduct SAR evaluation. This is because client either manufactures or supplies the antenna(s) that will be used in the installation of this product. Therefore, this product will be evaluated as a mobile device per 47 CFR § 1.1310 titled "Radiofrequency radiation exposure limits", generally referred to as MPE limits.

In 47 CFR § 2.1091, paragraph (b) defines a mobile device as "a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 cm is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons." This product is intended to be installed into a vehicle such that the unit is physically secured at one location. In the installation guide supplied with the product, Client has made the following statement: "IMPORTANT: To meet the FCC's RF Exposure Guidelines, the antenna should be installed so there is at least 20 cm of separation between the body of the user and nearby persons and the antenna". Based on the installation of the transceiver and the antenna, the transmitters radiating structure is more than 20 cm from the user. Thus, this product is a "mobile device" as defined in section § 2.1091 paragraph (b).

Exposure evaluation

$$S_{eirp} = \frac{EIRP}{4\pi d^2} = \frac{PG}{4\pi d^2} (W / m^2)$$

Where

S= Power density in W/m²

EIRP = Equivalent Isotropic Radiated Power in W

P = power of transmitter;

G = the antenna gain;

d = the distance between antennas and evaluation point in m

Total Exposure Ratio (TER):

According to KDB447498, either SAR-based or MPE-based exemption may be considered for test exemption for fixed, mobile, or portable device exposure conditions; therefore, the contributions from each exemption in conjunction with the measured SAR (*Evaluated_k* term) shall be used to determine exemption for simultaneous transmission according to the following formula [repeated from § 1.1307(b)(3)(ii)(B)].

The sum of the ratios of the applicable terms for SAR-based, MPE-based and measured SAR or MPE shall be less than 1, to determine simultaneous transmission exposure compliance.

$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{Evaluated_k}{Exposure Limit_k} \leq 1$	
a	number of fixed, mobile, or portable RF sources claiming exemption using the § 1.1307(b)(3)(i)(B) formula for P _{th} , including existing exempt transmitters and those being added.
b	number of fixed, mobile, or portable RF sources claiming exemption using the applicable § 1.1307(b)(3)(i)(C) Table 1 formula for Threshold ERP, including existing exempt transmitters and those being added.
c	number of existing fixed, mobile, or portable RF sources with known evaluation for the specified minimum distance.
P_i	the available maximum time-averaged power or the ERP, whichever is greater, for fixed, mobile, or portable RF source i at a distance between 0.5 cm and 40 cm (inclusive).
P_{th,i}	the exemption threshold power (P _{th}) according to the § 1.1307(b)(3)(i)(B) formula for fixed, mobile, or portable RF source i.
ERP_j	the available maximum time-averaged power or the ERP, whichever is greater, of fixed, mobile, or portable RF source j.
ERP_{th,j}	exemption threshold ERP for fixed, mobile, or portable RF source j, at a distance of at least λ/2π, according to the applicable § 1.1307(b)(3)(i)(C) Table 1 formula at the location in question.
Evaluated_k	the maximum reported SAR or MPE of fixed, mobile, or portable RF source k either in the device or at the transmitter site from an existing evaluation.
Exposure Limit_k	either the general population/uncontrolled maximum permissible exposure (MPE) or specific absorption rate (SAR) limit for each fixed, mobile, or portable sources, as applicable

5. Maximum Tune-up Power

Beamforming OFF						
Operate Band	Frequency (MHz)	ANT 0	ANT 1	ANT 2	ANT 3	MIMO
2.4 GHz	2412 - 2472	19.5	20	19.5	20	26
5.2 GHz	5150 - 5250	20.5	20.5	20.5	20.5	26.5
5.3 GHz	5250 - 5350	16	15.5	16	15	21
5.6 GHz	5470 - 5725	18	18	17.5	18	24
5.8 GHz	5725 - 5850	23	22	23	22	28
WiFi6E	5925 - 7125	19.5	19.5	19.5	19.5	25.5

Beamforming ON						
Operate Band	Frequency (MHz)	ANT 0	ANT 1	ANT 2	ANT 3	MIMO Beamforming
2.4 GHz	2412 - 2472	19.5	19.5	19.5	19.5	25.5
5.2 GHz	5150 - 5250	21	20.5	20.5	20.5	26.5
5.3 GHz	5250 - 5350	15	15	15.5	15	21
5.6 GHz	5470 - 5725	18	18	17.5	18	23.5
5.8 GHz	5725 - 5850	22.5	22	22.5	22	28
WiFi6E	5925 - 7125	14	14	14	14	20

6. Result

Band	Frequency (MHz)	Distance (cm) [R]	Tune-up Power (dBm) [P]	ANT Gain (dBi)	Numeric Gain [G]	Duty Cycle	Power with Duty cycle (mW) [P]x[G]	Power Density (mW/cm ²) [S]	Standalone Limit (mW/cm ²)	Antenna
2.4 GHz	2412 - 2472	20.0	19.50	1.90	1.55	1	138.14	0.03	1.00	ANT 0
2.4 GHz	2412 - 2472	20.0	20.00	1.90	1.55	1	155.00	0.03	1.00	ANT 1
2.4 GHz	2412 - 2472	20.0	19.50	1.90	1.55	1	138.14	0.03	1.00	ANT 2
2.4 GHz	2412 - 2472	20.0	20.00	1.90	1.55	1	155.00	0.03	1.00	ANT 3
5.2 GHz	5150 - 5250	20.0	20.50	2.00	1.58	1	177.28	0.04	1.00	ANT 0
5.2 GHz	5150 - 5250	20.0	20.50	2.00	1.58	1	177.28	0.04	1.00	ANT 1
5.2 GHz	5150 - 5250	20.0	20.50	2.00	1.58	1	177.28	0.04	1.00	ANT 2
5.2 GHz	5150 - 5250	20.0	20.50	2.00	1.58	1	177.28	0.04	1.00	ANT 3
5.3 GHz	5250 - 5350	20.0	16.00	2.00	1.58	1	62.90	0.01	1.00	ANT 0
5.3 GHz	5250 - 5350	20.0	15.50	2.00	1.58	1	56.06	0.01	1.00	ANT 1
5.3 GHz	5250 - 5350	20.0	16.00	2.00	1.58	1	62.90	0.01	1.00	ANT 2
5.3 GHz	5250 - 5350	20.0	15.00	2.00	1.58	1	49.96	0.01	1.00	ANT 3
5.6 GHz	5470 - 5725	20.0	18.00	2.00	1.58	1	99.69	0.02	1.00	ANT 0
5.6 GHz	5470 - 5725	20.0	18.00	2.00	1.58	1	99.69	0.02	1.00	ANT 1
5.6 GHz	5470 - 5725	20.0	17.50	2.00	1.58	1	88.85	0.02	1.00	ANT 2
5.6 GHz	5470 - 5725	20.0	18.00	2.00	1.58	1	99.69	0.02	1.00	ANT 3
5.8 GHz	5725 - 5850	20.0	23.00	2.00	1.58	1	315.25	0.06	1.00	ANT 0
5.8 GHz	5725 - 5850	20.0	22.00	2.00	1.58	1	250.41	0.05	1.00	ANT 1
5.8 GHz	5725 - 5850	20.0	23.00	2.00	1.58	1	315.25	0.06	1.00	ANT 2
5.8 GHz	5725 - 5850	20.0	22.00	2.00	1.58	1	250.41	0.05	1.00	ANT 3
WIFI 6E	5925 - 7125	20.0	19.50	2.70	1.86	1	165.77	0.03	1.00	ANT 0
WIFI 6E	5925 - 7125	20.0	19.50	2.70	1.86	1	165.77	0.03	1.00	ANT 1
WIFI 6E	5925 - 7125	20.0	19.50	2.70	1.86	1	165.77	0.03	1.00	ANT 2
WIFI 6E	5925 - 7125	20.0	19.50	2.70	1.86	1	165.77	0.03	1.00	ANT 3
2.4 GHz	2412 - 2472	20.0	25.50	4.63	2.90	1	1028.96	0.20	1.00	MIMO Beamforming
5.2 GHz	5150 - 5250	20.0	26.50	4.81	3.03	1	1353.45	0.27	1.00	MIMO Beamforming
5.3 GHz	5250 - 5350	20.0	21.00	4.81	3.03	1	381.45	0.08	1.00	MIMO Beamforming
5.6 GHz	5470 - 5725	20.0	23.50	4.81	3.03	1	678.33	0.13	1.00	MIMO Beamforming
5.8 GHz	5725 - 5850	20.0	28.00	4.81	3.03	1	1911.80	0.38	1.00	MIMO Beamforming
WIFI 6E	5925 - 7125	20.0	20.00	5.47	3.52	1	352.00	0.07	1.00	MIMO Beamforming

Note:

1. Mobile or fixed location transmitters, minimum separation distance is 0.2 m, even if calculations indicate MPE distance is less.
2. The maximum power and directional gain were applied to evaluate MPE for multiple antennas transmitting. If all transmit signals are completely uncorrelated, directional gain = Gant.
3. The Numeric Gain calculated by $10^{(\text{ant. Gain(dBi)} / 10)}$.
4. The device supports CDD mode for Standalone transmission, the power will be reduced when used for simultaneous transmission (Beam forming on).

Simultaneous Transmission :	Total MPE :	TER:
2.4 GHz MIMO Beamforming	0.20 mW/cm ²	0.20
5 GHz MIMO Beamforming	0.38 mW/cm ²	0.38
6 GHz MIMO Beamforming	0.07 mW/cm ²	0.07

7. Conclusion

The result shows that this device is compliance with the exposure limits in 47 CFR §1.1310.

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