

Radio Exposure Evaluation Report

FCC ID : TVE-512178E8741
Equipment : Secured Wireless Access Point
Brand Name : FORTINET
Model Name : FortiAP 441Kxxxxxx, FAP-441Kxxxxxx, FORTIAP-441Kxxxxxx
(Where "x" can be used as "A-Z", or "0-9", or "-", or blank for software changes or marketing purposes only)
Applicant : Fortinet, Inc.
899 Kifer Road, Sunnyvale, CA 94086, USA
Manufacturer : Fortinet, Inc.
899 Kifer Road, Sunnyvale, CA 94086, USA
Standard : 47 CFR FCC Part 2 Subpart J, section 2.1091

The product was received on Jul. 11, 2023, and testing was started from Jul. 20, 2023 and completed on Oct. 18, 2023. We, SPORTON INTERNATIONAL INC. Hsinhua Laboratory, would like to declare that the tested sample has been evaluated in accordance with the procedures given in 47 CFR FCC Part 2 Subpart J, section 2.1091 and shown compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC. Hsinhua Laboratory, the test report shall not be reproduced except in full.



Approved by: Jackson Tsai

SPORTON INTERNATIONAL INC. Hsinhua Laboratory
No.52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333411, Taiwan (R.O.C.)



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History of this test report

Report No.	Version	Description	Issued Date
FA370714	01	Initial issue of report	Nov. 02, 2023



Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
2	-	Exposure evaluation	PASS	-

Declaration of Conformity:

The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.

Comments and Explanations:

None

Reviewed by: Barry Hsiao

Report Producer: Ann Hou

1 General Description

1.1 Information

1.1.1 EUT General Information

RF General Information			
Evaluation Mode	Frequency Range (MHz)	Operating Frequency (MHz)	Modulation Type
2.4GHz WLAN	2400-2483.5	2412-2462	802.11b: DSSS (DBPSK, DQPSK, CCK) 802.11g/n: OFDM (BPSK, QPSK, 16QAM, 64QAM) VHT: OFDM (BPSK, QPSK, 16QAM, 64QAM, 256QAM) 802.11ax: OFDMA (BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM)
5GHz WLAN	5150-5250 5725-5850 5850-5895	5180-5240 5745-5825 5835-5885	802.11a/n: OFDM (BPSK, QPSK, 16QAM, 64QAM) 802.11ac: OFDM (BPSK, QPSK, 16QAM, 64QAM, 256QAM) 802.11ax: OFDMA (BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM) 802.11be: OFDMA (BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM, 4096QAM)
Bluetooth	2400-2483.5	2402-2480	LE: DSSS (GFSK)
ZigBee	2400-2483.5	2405-2480	DSSS (O-QPSK)
6GHz WLAN	5925-7125	5955-7115	802.11ax: OFDMA (BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM) 802.11be: OFDMA (BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM, 4096QAM)



1.1.2 Antenna Information

Ant.	Brand	Model Name	Antenna Type	Connector	Support	Radio
1	Senao	5718A0730300	PIFA	I-Pex	2.4G	Radio 1
					5G	Radio 2
2	Senao	5718A0731300	PIFA	I-Pex	2.4G	Radio 1
					5G	Radio 2
3	Senao	5718A0732300	PIFA	I-Pex	2.4G	Radio 1
					5G	Radio 2
4	Senao	5718A0733300	PIFA	I-Pex	2.4G	Radio 1
					5G	Radio 2
5	AWAN	7102A0657000	Alford Loop	I-Pex	6E	Radio 3
6	AWAN	7102A0659000	Alford Loop	I-Pex	6E	Radio 3
7	AWAN	7102A0660000	Alford Loop	I-Pex	6E	Radio 3
8	AWAN	7102A0658000	Alford Loop	I-Pex	6E	Radio 3
9	Senao	5718A0734300	PIFA	I-Pex	2.4G/5G/6E	Scan radio
10	Senao	5718A0735300	PIFA	I-Pex	2.4G/5G/6E	Scan radio
11	Senao	5718A0736300	PIFA	I-Pex	BT& Zigbee	-
12	Quectel	7102A0656000	Patch	I-Pex	GPS	-
13	Quectel	Y4SEN00A1EA	Patch	Reverse SMA	GPS	-

Ant.	Port	Gain (dBi)				
		2.4G	5G	6E	BT/Zigbee	GPS
1	1	2.95	5.28	-	-	-
2	2	3.38	2.9	-	-	-
3	3	2.05	6.22	-	-	-
4	4	2.18	4.55	-	-	-
5	1	-	-	4.26	-	-
6	2	-	-	5.89	-	-
7	3	-	-	5.27	-	-
8	4	-	-	4.86	-	-
9	1	1.76	5.11	4.41	-	-
10	2	1.17	2.91	4.43	-	-
11	1	-	-	-	4.5	-
12	1	-	-	-	-	-0.5
13	2	-	-	-	-	1.4



Composite Gain (dBi)										
	2.4G	UNII-1	UNII-2A	UNII-2C	UNII-3	5.885G	6.175G	6.475G	6.695G	6.995G
DG [1SS]	6.91	5.35	5.46	6.04	7.23	7.22	9.32	8.48	8.63	8.56
DG [2SS]	3.91	4.2	4.7	4.49	6.22	5.92	6.32	5.48	5.63	5.89
DG [4SS]	3.38	4.2	4.7	4.49	6.22	5.92	5.24	4.19	4.64	5.89

Note 1: The EUT has thirteen antennas.

Note 2: The antenna 13 mentioned above will not be sold with the EUT in the market

Note 3: The composite gain is derived as KDB 662911 D03 v01 which was used as directional gain. For more detail information, please refer to the Antenna Pattern Report AP370714.

For 2.4GHz function:

For IEEE 802.11 b/g/n/VHT/ax mode (4TX/4RX)

Ant. 1 (port 1) , Ant. 2 (port 2) , Ant. 3 (port 3) and Ant. 4 (port 4) could transmit/receive simultaneously.

For IEEE 802.11 b/g/n/VHT/ax mode (2RX)

Ant. 9 (port 1) and Ant. 10 (port 2) could receive simultaneously.

For 5GHz function:

For IEEE 802.11 a/n/ac/ax/be mode (4TX/4RX)

Ant. 1 (port 1) , Ant. 2 (port 2) , Ant. 3 (port 3) and Ant. 4 (port 4) could transmit/receive simultaneously.

For IEEE 802.11 a/n/ac/ax/be mode (2RX)

Ant. 9 (port 1) and Ant. 10 (port 2) could receive simultaneously.

For 6GHz function:

For IEEE 802.11 ax/be mode (4TX/4RX)

Ant. 5 (port 1) , Ant. 6 (port 2) , Ant. 7 (port 3) and Ant. 8 (port 4) could transmit/receive simultaneously.

For IEEE 802.11ax/be mode (2RX)

Ant. 9 (port 1) and Ant. 10 (port 2) could receive simultaneously.

For BT function:

For IEEE 802.15.1 Bluetooth mode (1TX/1RX)

Ant. 11 (port 1) could transmit/receive.

For 802.15.4 function:

For IEEE 802.15.4 mode (1TX/1RX)

Ant. 11 (port 1) could transmit/receive.

1.1.3 Table for Multiple Listing

The model names in the following table are all refer to the identical product.

Model Name	Description
FortiAP 441Kxxxxxx, FAP-441Kxxxxxx, FORTIAP-441Kxxxxxx (Where "x" can be used as "A-Z", or "0-9", or "-", or blank for software changes or marketing purposes only)	All the models are identical, the different model served as marketing strategy.

From the above models, model: FAP-441K was selected as representative model for the test and its data was recorded in this report.

1.1.4 Accessories

Accessories				
Bracket ceiling mount 1	Brand Name	DRAGONJET CORPORTION	Model Name	CLIP CEILING 9/16 LFP
Bracket ceiling mount 2	Brand Name	DRAGONJET CORPORTION	Model Name	CLIP CEILING 15/16 LFP

Reminder: Regarding to more detail and other information, please refer to user manual.

1.2 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- ♦ 47 CFR FCC Part 2 Subpart J, section 2.1091
 - ♦ KDB 447498 D04 Interim General RF Exposure Guidance v01
- The following reference test guidance is not within the scope of accreditation of TAF.
- ♦ 47 CFR Part 1.1307
 - ♦ 47 CFR Part 1.1310

1.3 Testing Location

Test Lab. : Sporton International Inc. Hsinhua Laboratory		
☒ Hsinhua (TAF: 3785)	ADD: No.52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333411, Taiwan (R.O.C.)	
	TEL: 886-3-327-3456	FAX: 886-3-327-0973
Test site Designation No. TW3785 with FCC.		
☐ Wen 33rd.St. (TAF: 3785)	ADD: No.14-1, Ln. 19, Wen 33rd St., Guishan Dist., Taoyuan City 333010, Taiwan (R.O.C.)	
	TEL: 886-3-318-0787	FAX: 886-3-318-0287
Test site Designation No. TW0008 with FCC.		

2 Maximum Permissible Exposure

2.1 Limit of Maximum Permissible Exposure

(A) 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	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

(B) 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/1500	30
1500-100,000	-	-	1.0	30

Note: f = frequency in MHz ; *Plane-wave equivalent power density

Multiple Transmitters Condition

Co-location as simultaneously transmitting (co-transmitting) and the evaluation shall be consider that simultaneous transmissions from co-located devices the individual transmitters are evaluated separately. After sum of the individual value (basic restriction / reference level) are measured/calculated also have to under basic restriction / reference level.

Co-transmitting mode:

1. Radio 1_2.4G+Radio 2_5G+Radio 3_6E+Bluetooth
2. Radio 1_2.4G+Radio 2_5G+Radio 3_6E+Zigbee

2.2 RF Exposure Exempt Measurement

Option	Refer Std.	Exemption Exposure Thresholds (TL)
A	§1.1307(b)(3)(i)(A)	Available maximum time-averaged power is no more than 1 mW
B	§1.1307(b)(3)(i)(B)	$P_{th}(mW) = \begin{cases} ERP_{20cm} (d / 20cm)^x \rightarrow d \leq 20cm \\ ERP_{20cm} \rightarrow 20cm < d \leq 40cm \end{cases}$ $x = -\log_{10} \left(\frac{60}{ERP_{20cm} \sqrt{f}} \right) \text{ and } f \text{ is in GHz}$ $\begin{cases} ERP_{20cm} : 0.3GHz \leq f < 1.5GHz \rightarrow 2040 f (mW) \\ ERP_{20cm} : 1.5GHz \leq f \leq 6GHz \rightarrow 3060 (mW) \end{cases}$
C	§1.1307(b)(3)(i)(C)	$\begin{cases} 0.3 \sim 1.34MHz \rightarrow ERP(W) = 1920R^2 \\ 1.34 \sim 30MHz \rightarrow ERP(W) = 3450R^2 / f^2 \\ 30 \sim 300MHz \rightarrow ERP(W) = 3.83R^2 \\ 300 \sim 1500MHz \rightarrow ERP(W) = 0.0128R^2 f \\ 1500 \sim 100000MHz \rightarrow ERP(W) = 19.2R^2 \end{cases}$ f is in MHz; R is in m; $R > \lambda / 2\pi$

2.3 Multiple RF Sources Exposure

Refer Std.	Exemption Exposure Thresholds (TL)
§1.1307(b)(3)(ii)(A)	The available maximum time-averaged power of each source is no more than 1 mW and there is a separation distance of two centimeters between any portion of a radiating structure operating and the nearest portion of any other radiating structure in the same device, except if the sum of multiple sources is less than 1 mW during the time-averaging period, in which case they may be treated as a single source (separation is not required)
§1.1307(b)(3)(ii)(B)	$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{Evaluated_k}{ExposureLimit_k} \leq 1$ a = number of fixed, mobile, or portable RF sources claiming exemption using paragraph §1.1307(b)(3)(i)(B) of this section for P , including existing exempt transmitters and those being added. b = number of fixed, mobile, or portable RF sources claiming exemption using paragraph §1.1307(b)(3)(i)(C) of this section 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 including existing evaluated transmitters. 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 paragraph §1.1307(b)(3)(i)(B) of this section for fixed, mobile, or portable RF source i. ERP_j = the ERP 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 $\lambda/2\pi$ according to the applicable formula of paragraph §1.1307(b)(3)(i)(C) of this section. $Evaluated_k$ = 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 at the location of exposure. $Evaluated Limit_k$ = either the general population/uncontrolled maximum permissible exposure (MPE) or specific absorption rate (SAR) limit for each fixed, mobile, or portable RF source k, as applicable from § 1.1310 of this chapter.

2.4 MPE Calculation Method

The MPE was calculated at 53 cm to show compliance with the power density limit.
The following formula was used to calculate the Power Density:

$$E \text{ (V/m)} = \frac{\sqrt{30 \times P \times G}}{d} \qquad \text{Power Density: } Pd \text{ (W/m}^2\text{)} = \frac{E^2}{377}$$

E = Electric field (V/m)

P = RF output power (W)

G = EUT Antenna numeric gain (numeric)

d = Separation distance between radiator and human body (m)

The formula can be changed to

$$Pd = \frac{30 \times P \times G}{377 \times d^2}$$

2.5 Calculated Result and Limit

Exposure Environment: General Population / Uncontrolled Exposure

Radio 1 2.4G Non-Beamforming

Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	Tolerance (dB)	Tune-up ERP (mW)	Distance (cm)	S (mW/cm ²)	S Limit (mW/cm ²)	Option	TL ERP (mW)	TL Ratio
2.4G;G1D	3.38	29.16	32.54	0.50	1227.75	53	0.05705	1.00000	C	5393.280	0.22764
2.4G;D1D	3.38	29.42	32.80	0.50	1303.50	53	0.06057	1.00000	C	5393.280	0.24169

Radio 2 5G Non-Beamforming

Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	Tolerance (dB)	Tune-up ERP (mW)	Distance (cm)	S (mW/cm ²)	S Limit (mW/cm ²)	Option	TL ERP (mW)	TL Ratio
5.2G;D1D	6.22	28.62	34.84	0.50	2085.02	53	0.09688	1.00000	C	5393.280	0.38660
5.8G;D1D	6.22	29.26	35.48	0.50	2416.07	53	0.11226	1.00000	C	5393.280	0.44798
5.81G;D1D	6.22	29.18	35.40	0.50	2371.97	53	0.11021	1.00000	C	5393.280	0.43980

Radio 3 6E Non-Beamforming

Mode	EIRP (dBm)	Tolerance (dB)	Tune-up ERP (mW)	Distance (cm)	S (mW/cm ²)	S Limit (mW/cm ²)	Option	TL ERP (mW)	TL Ratio
6.2G;D1D	28.40	0.50	473.27	53	0.02199	1.00000	C	5393.280	0.08775
6.4G;D1D	27.15	0.50	354.90	53	0.01649	1.00000	C	5393.280	0.06580
6.7G;D1D	26.93	0.50	337.37	53	0.01568	1.00000	C	5393.280	0.06255
7.0G;D1D	22.91	0.50	133.69	53	0.00621	1.00000	C	5393.280	0.02479

Radio 1 2.4G Beamforming

Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	Tolerance (dB)	Tune-up ERP (mW)	Distance (cm)	S (mW/cm ²)	S Limit (mW/cm ²)	Option	TL ERP (mW)	TL Ratio
2.4G;D1D	6.91	28.34	35.25	0.50	2291.45	53	0.10647	1.00000	C	5393.280	0.42487

Radio 2 5G Beamforming

Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	Tolerance (dB)	Tune-up ERP (mW)	Distance (cm)	S (mW/cm ²)	S Limit (mW/cm ²)	Option	TL ERP (mW)	TL Ratio
5.2G;D1D	7.23	28.20	35.43	0.50	2388.42	53	0.11098	1.00000	C	5393.280	0.44285
5.8G;D1D	7.23	28.11	35.34	0.50	2339.43	53	0.10870	1.00000	C	5393.280	0.43377
5.81G;D1D	7.23	28.06	35.29	0.50	2312.65	53	0.10746	1.00000	C	5393.280	0.42880

Radio 3 6E Beamforming

Mode	EIRP (dBm)	Tolerance (dB)	Tune-up ERP (mW)	Distance (cm)	S (mW/cm ²)	S Limit (mW/cm ²)	Option	TL ERP (mW)	TL Ratio
6.2G;D1D	29.29	0.50	580.91	53	0.02699	1.00000	C	5393.280	0.10771
6.4G;D1D	28.16	0.50	447.83	53	0.02081	1.00000	C	5393.280	0.08303
6.7G;D1D	28.63	0.50	499.01	53	0.02319	1.00000	C	5393.280	0.09252
7.0G;D1D	26.33	0.50	293.84	53	0.01365	1.00000	C	5393.280	0.05448



Bluetooth

Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	Tolerance (dB)	Tune-up ERP (mW)	Distance (cm)	S (mW/cm ²)	S Limit (mW/cm ²)	Option	TL ERP (mW)	TL Ratio
2.4G;BT-LE	4.50	10.12	14.62	0.50	19.82	53	0.00092	1.00000	C	5393.280	0.00367

Zigbee

Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	Tolerance (dB)	Tune-up ERP (mW)	Distance (cm)	S (mW/cm ²)	S Limit (mW/cm ²)	Option	TL ERP (mW)	TL Ratio
2.4G;G1D	4.50	10.14	14.64	0.50	19.91	53	0.00093	1.00000	C	5393.280	0.00369

Note 1: Option A, B and C refer as clause 2.2

Note 2: For option B, Pth(mW) convert to TL ERP(mW); For option C, ERP(W) convert to TL ERP(mW)

Note 3: TL Ratio=Tune-up ERP(mW)/TL ERP(mW)

Simultaneous Transmission Analysis Mode: Radio 1_2.4G+Radio 2_5G+Radio 3_6E+Bluetooth

Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	Tolerance (dB)	Tune-up ERP (mW)	Distance (cm)	S (mW/cm ²)	S Limit (mW/cm ²)	Option	TL ERP (mW)	TL Ratio
2.4G;D1D	6.91	28.34	35.25	0.50	2291.45	53	0.10647	1.00000	C	5393.280	0.42487
5.8G;D1D	6.22	29.26	35.48	0.50	2416.07	53	0.11226	1.00000	C	5393.280	0.44798
6.2G;D1D	-	-	29.29	0.50	580.91	53	0.02699	1.00000	C	5393.280	0.10771
2.4G;BT-LE	4.50	10.12	14.62	0.50	19.82	53	0.00092	1.00000	C	5393.280	0.00367
Sum Ratio	0.98423										
Ratio Limit	1.00000										

Simultaneous Transmission Analysis Mode: Radio 1_2.4G+Radio 2_5G+Radio 3_6E+Zigbee

Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	Tolerance (dB)	Tune-up ERP (mW)	Distance (cm)	S (mW/cm ²)	S Limit (mW/cm ²)	Option	TL ERP (mW)	TL Ratio
2.4G;D1D	6.91	28.34	35.25	0.50	2291.45	53	0.10647	1.00000	C	5393.280	0.42487
5.8G;D1D	6.22	29.26	35.48	0.50	2416.07	53	0.11226	1.00000	C	5393.280	0.44798
6.2G;D1D	-	-	29.29	0.50	580.91	53	0.02699	1.00000	C	5393.280	0.10771
2.4G;G1D	4.50	10.14	14.64	0.50	19.91	53	0.00093	1.00000	C	5393.280	0.00369
Sum Ratio	0.98425										
Ratio Limit	1.00000										

Note 1: Option A, B and C refer as clause 2.2

Note 2: For option B, Pth(mW) convert to TL ERP(mW); For option C, ERP(W) convert to TL ERP(mW)

Note 3: TL Ratio=Tune-up ERP(mW)/TL ERP(mW)

Note 4: Refer as clause 2.3 Multiple RF Sources Exposure. Please follow below option and sum TL ration table.

Option	Sum TL Ratio_B	Option	Sum TL Ratio_C	Option	Sum TL Ratio_E
B	$\sum_{i=1}^a \frac{P_i}{P_{th,i}}$	C	$\sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}}$	E	$\sum_{k=1}^c \frac{Evaluated_k}{ExposureLimit_k}$

Note: The above antenna gain was declared by manufacturer.

————THE END————