Radio Exposure Evaluation Report

FCC ID	:	**TVE-3111BB056**
Equipment	:	**Secured Wireless Access Point**
Brand Name	:	**FORTINET**
Model Name	:	**FortiAP U431Fxxxxxx, FAP-U431Fxxxxxx, FORTIAP-U431Fxxxxxx , FortiAP U433Fxxxxxx, FAP-U433Fxxxxxx, FORTIAP-U433Fxxxxxx** **(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	:	**Universal Global Scientific Industrial Co., Ltd** **141, Lane 351, Sec. 1, Taiping Road, Tsaotuen, Nantou 54261, Taiwan**
Standard	:	**47 CFR Part 2.1091**

The product was received on Mar. 11, 2019, and testing was started from Apr. 20, 2019 and completed on May 17, 2019. We, SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory, would like to declare that the tested sample has been evaluated in accordance with the procedures given in 47 CFR Part 2.1091 and shown compliance with the applicable technical standards.

The report must not be used by the client to claim product certification, approval, or endorsement by TAF or any agency of United States government.

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

Approved by: Allen Lin

SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory

No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.)

Table of Contents

History of this test report

Report No.	Version	Description	Issued Date
FA931106	01	Initial issue of report	May 27, 2019
FA931106	02	Antenna information was added	May 29, 2019

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: Jackson Tsai

Report Producer: Debby Hung

1 General Description

1.1 EUT General Information

The EUT has three radio chip.

Function	Radio 1	Radio 2	Radio 3
WiFi 2.4G	X	V	V
WiFi 5G	V	V	V (Only RX)
Bluetooth	X	X	V

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) 802.11ac: OFDM (BPSK, QPSK, 16QAM, 64QAM, 256QAM) 802.11ax: OFDMA (BPSK, QPSK, 16QAM, 64QAM, 256QAM)
5GHz WLAN	5150-5250 5725-5850	5180-5240 5745-5825	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)
Bluetooth	2400-2483.5	2402-2480	BR / EDR: FHSS (GFSK / π/4-DQPSK / 8DPSK) LE: DSSS (GFSK)

1.2 Table for Multiple Listing

Brand Name	Model Name	Description
FORTINET	FortiAP U431Fxxxxxx	Internal Antenna
	FAP-U431Fxxxxxx	
	FORTIAP-U431Fxxxxxx	
	FortiAP U433Fxxxxxx	External Antenna
	FAP-U433Fxxxxxx	
	FORTIAP-U433Fxxxxxx	

Notes: All the models are electrically identical, difference model names for marketing purpose.

1.3 Testing Location

Testing Location			
☒	HWA YA	ADD : No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.)	
		TEL : 886-3-327-3456	FAX : 886-3-327-0973
Test site Designation No. TW1190 with FCC.			
☐	JHUBEI	ADD : No.8, Ln. 724, Bo'ai St., Zhubei City, Hsinchu County, Taiwan (R.O.C.)	
		TEL : 886-3-656-9065	FAX : 886-3-656-9085
Test site Designation No. TW0006 with FCC.			

1.4 Antenna Information

Model: FAP-U433F

Ant.	Radio	Brand	Model Name	Antenna Type	Connector
1-4	1	ARISTOTLE	RFA-05-C53-U-B32C255	Dipole Antenna	Reversed-SMA
5-8	2	ARISTOTLE	RFA-25-C53-U-B32C255	Dipole Antenna	Reversed-SMA
9-10	3	ARISTOTLE	RFA-25-C53-U-B32C255	Dipole Antenna	Reversed-SMA
11	3	ARISTOTLE	RFA-BT-G402-79-200	PIFA Antenna	IPEX

Ant.	Gain (dBi)			
	Radio 1	Radio 2 & Radio 3		Radio 3
	5G	2.4G	5G	BT
1-4	4.3	-	-	-
5-8	-	3.5	5.0	-
9-10	-	3.5	5.0	-
11	-	-	-	3.0

Model: FAP-U431F

Ant.	Radio	Brand	Model Name	Antenna Type	Connector
1-4	1	ARISTOTLE	RFA-9953	PIFA Antenna	IPEX
5-8	2	ARISTOTLE	RFA-9953	PIFA Antenna	IPEX
9-10	3	ARISTOTLE	RFA-9953	PIFA Antenna	IPEX
11	3	ARISTOTLE	RFA-BT-G402-79-200	PIFA Antenna	IPEX

Ant.	Gain (dBi)			
	Radio 1	Radio 2 & Radio 3		Radio 3
	5G	2.4G	5G	BT
1-4	6.0	-	-	-
5-8	-	4.0	6.0	-
9-10	-	4.0	6.0	-
11	-	-	-	3.0

Ant.	BF Gain (dBi)
	Radio 1 & 2
-	6.02

Directional gain = $G_{ANT\ MAX}$ + 10 log(N_{ANT}/N_{SS}) dBi, where N_{SS} = the number of independent spatial streams of data and $G_{ANT\ MAX}$ is.the gain of the antenna having the highest gain (in dBi).

For 2.4GHz function:

For IEEE 802.11 b/g/n/ac/ax mode

Radio 2 : Ant. 5 to Ant. 8 could transmit/receive simultaneously. (4TX/4RX)

Radio 3 : Ant. 9 and Ant. 10 could transmit/receive simultaneously.(2TX/2RX)

For 5GHz function:

For IEEE 802.11 a/n/ac/ax mode

Radio 1 : Ant. 1 to Ant. 4 could transmit/receive simultaneously. (4TX/4RX)

Radio 2 : Ant. 5 to Ant. 8 could transmit/receive simultaneously. (4TX/4RX)

Radio 3 : Ant. 9 and Ant. 10 could transmit/receive simultaneously. (2RX)

For Bluetooth function:

For IEEE 802.15.1 Bluetooth mode

Radio 3 : Ant. 11 could transmit/receive simultaneously. (1TX/1RX)

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/ cm²)	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/ cm²)	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

2.2 MPE Calculation Method

The MPE was calculated at 32 cm to show compliance with the power density limit.

The following formula was used to calculate the Power Density:

E (V/m) = $\frac{\sqrt{30 \times P \times G}}{d}$ Power Density: *Pd* (W/m²) = $\frac{E^2}{377}$

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

2.3 Calculated Result and Limit

Exposure Environment: General Population / Uncontrolled Exposure

WLAN 2.4G Function:

<Non-Beamforming>

Radio	Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	Tolerance (dB)	Tune-up EIRP (dBm)	Tune-up EIRP (W)	Distance (cm)	S (mW/cm^2)	S Limit (mW/cm^2)
2	2.4G;G1D	4.00	28.99	32.99	0.50	33.49	2.23357	32	0.17358	1.00000
2	2.4G;D1D	4.00	25.81	29.81	0.50	30.31	1.07399	32	0.08346	1.00000
3	2.4G;G1D	4.00	25.39	29.39	0.50	29.89	0.97499	32	0.07577	1.00000
3	2.4G;D1D	4.00	24.56	28.56	0.50	29.06	0.80538	32	0.06259	1.00000

< Beamforming>

Radio	Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	Tolerance (dB)	Tune-up EIRP (dBm)	Tune-up EIRP (W)	Distance (cm)	S (mW/cm^2)	S Limit (mW/cm^2)
2	2.4G;D1D	10.02	24.56	34.58	0.50	35.08	3.22107	32	0.25032	1.00000

WLAN 5G Function:

<Non-Beamforming>

Radio	Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	Tolerance (dB)	Tune-up EIRP (dBm)	Tune-up EIRP (W)	Distance (cm)	S (mW/cm^2)	S Limit (mW/cm^2)
1	5.2G;D1D	6.00	24.83	30.83	0.50	31.33	1.35831	32	0.10556	1.00000
1	5.8G;D1D	6.00	27.73	33.73	0.50	34.23	2.64850	32	0.20582	1.00000
2	5.8G;D1D	6.00	24.31	30.31	0.50	30.81	1.20504	32	0.09365	1.00000

< Beamforming>

Radio	Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	Tolerance (dB)	Tune-up EIRP (dBm)	Tune-up EIRP (W)	Distance (cm)	S (mW/cm^2)	S Limit (mW/cm^2)
1	5.2G;D1D	12.02	23.20	35.22	0.50	35.72	3.73250	32	0.29006	1.00000
1	5.8G;D1D	12.02	23.47	35.49	0.50	35.99	3.97192	32	0.30867	1.00000
2	5.8G;D1D	12.02	23.47	35.49	0.50	35.99	3.97192	32	0.30867	1.00000

Bluetooth Function:

Radio	Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	Tolerance (dB)	Tune-up EIRP (dBm)	Tune-up EIRP (W)	Distance (cm)	S (mW/cm^2)	S Limit (mW/cm^2)
3	2.4G;BT-LE	3.00	7.87	10.87	0.50	11.37	0.01371	32	0.00107	1.00000
3	2.4G;BT-BR	3.00	11.96	14.96	0.50	15.46	0.03516	32	0.00273	1.00000
3	2.4G;BT-EDR	3.00	8.38	11.38	0.50	11.88	0.01542	32	0.00120	1.00000

Co-location:

Radio 1 (5G) + Radio 2 (5G) + Radio 2 (2.4G) + Radio 3 (2.4G) + BT Function:

Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	Tolerance (dB)	Tune-up EIRP (dBm)	Tune-up EIRP (W)	Distance (cm)	S (mW/cm^2)	S Limit (mW/cm^2)	Ratio (S/Limit)
5.8G;D1D	12.02	23.47	35.49	0.50	35.99	3.97192	32	0.30867	1.00000	0.30867
5.8G;D1D	12.02	23.47	35.49	0.50	35.99	3.97192	32	0.30867	1.00000	0.30867
2.4G;D1D	10.02	24.56	34.58	0.50	35.08	3.22107	32	0.25032	1.00000	0.25032
2.4G;G1D	4.00	25.39	29.39	0.50	29.89	0.97499	32	0.07577	1.00000	0.07577
2.4G;BT-BR	3.00	11.96	14.96	0.50	15.46	0.03516	32	0.00273	1.00000	0.00273
									Sum Ratio	0.94616
									Ratio Limit	1

———THE END———