Testing Laboratory 3787

RADIO EXPOSURE TEST REPORT

FCC ID	:	UDX-60093011
Equipment	:	4x4 Wi-Fi 6 Access Point with External Antennas
Brand Name	:	Cisco
Model Name	:	MR46E-HW
Applicant	:	Cisco Systems, Inc. 170 West Tasman Drive, San Jose, CA 95134 USA
Manufacturer	:	Cisco Systems, Inc. 170 West Tasman Drive, San Jose, CA 95134 USA
Standard	:	47 CFR Part 2.1091

The product was received on Jun. 20, 2019, and testing was started from Jul. 03, 2019 and completed on Aug. 03, 2023. We, Sporton International Inc. Hsinchu 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 test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International Inc. Hsinchu Laboratory, the test report shall not be reproduced except in full.

Approved by: Sam Chen

Sporton International Inc. Hsinchu Laboratory
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History of this test report

Report No.	Version	Description	Issued Date
FA960317-14	01	Initial issue of report	Oct. 06, 2023

Summary of Test Result

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

Conformity Assessment Condition:
1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented against the regulation limits or in accordance with the requirements stipulated by the applicant/manufacturer who shall bear all the risks of non-compliance that may potentially occur if measurement uncertainty is taken into account. 2. The measurement uncertainty please refer to each test result in the chapter "Measurement Uncertainty".
Disclaimer:
The product specifications of the EUT presented in the test report that may affect the test assessments are declared by the manufacturer who shall take full responsibility for the authenticity.

Reviewed by: Sam Chen

Report Producer: Viola Huang

1 General Description

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) 802.11ax: OFDMA (BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM)
5GHz WLAN	5150-5250 5250-5350 5470-5725 5725-5850	5180-5240 5260-5320 5500-5720 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	LE: GFSK

1.2 Antenna Information

Set	Brand	Official Model Number	Antenna Type	Connector	Gain (dBi)
1	Cisco	MA-ANT-3-A6	Dipole antenna	RP-TNC	Note 1
2	Cisco	MA-ANT-3-B6	Dipole antenna	RP-TNC	
3	Cisco	MA-ANT-3-C6	Panel antenna	RP-TNC	
4	Cisco	MA-ANT-3-D6	Panel antenna	RP-TNC	
5	Cisco	MA-ANT-3-E6	Wide patch antenna	RP-TNC	
6	Cisco	MA-ANT-3-F6	Narrow patch antenna	RP-TNC	

Note1:

Radio 1 (2.4GHz)												
Set	Antenna Gain (dBi)				Cable Loss (dB)				True Gain (dBi)			
	Port 1	Port 2	Port 3	Port 4	Port 1	Port 2	Port 3	Port 4	Port 1	Port 2	Port 3	Port 4
1	3.80	3.80	3.80	3.80	1.01	0.41	0.41	1.00	2.79	3.39	3.39	2.80
2	3.00	3.00	3.00	3.00	1.01	0.41	0.41	1.00	1.99	2.59	2.59	2.00
3	4.90	4.90	4.90	4.90	1.01	0.41	0.41	1.00	3.89	4.49	4.49	3.90
4	2.90	2.90	2.90	2.90	1.01	0.41	0.41	1.00	1.89	2.49	2.49	1.90
5	7.00	7.00	7.00	7.00	1.01	0.41	0.41	1.00	5.99	6.59	6.59	6.00
6	11.20	11.20	11.20	11.20	1.01	0.41	0.41	1.00	10.19	10.79	10.79	10.20

Radio 2 (5GHz)												
Set	Antenna Gain (dBi)				Cable Loss (dB)				True Gain (dBi)			
	Port 1	Port 2	Port 3	Port 4	Port 1	Port 2	Port 3	Port 4	Port 1	Port 2	Port 3	Port 4
1	5.5	5.5	5.5	5.5	1.53	0.66	0.61	1.54	3.97	4.84	4.89	3.96
2	5.7	5.7	5.7	5.7	1.53	0.66	0.61	1.54	4.17	5.04	5.09	4.16
3	4.9	4.9	4.9	4.9	1.53	0.66	0.61	1.54	3.37	4.24	4.29	3.36
4	3.7	3.7	3.7	3.7	1.53	0.66	0.61	1.54	2.17	3.04	3.09	2.16
5	6.3	6.3	6.3	6.3	1.53	0.66	0.61	1.54	4.77	5.64	5.69	4.76
6	10.8	10.8	10.8	10.8	1.53	0.66	0.61	1.54	9.27	10.14	10.19	9.26

Radio 3 (2.4GHz + 5GHz)						
Set	Antenna Gain (dBi)		Cable Loss (dB)		True Gain (dBi)	
	Port 1		Port 1		Port 1	
	2.4GHz	5GHz	2.4GHz	5GHz	2.4GHz	5GHz
1	3.80	5.50	0.68	1.09	3.12	4.41
2	3.00	5.70	0.68	1.09	2.32	4.61
3	4.90	4.90	0.68	1.09	4.22	3.81
4	2.90	3.70	0.68	1.09	2.22	2.61
5	7.00	6.30	0.68	1.09	6.32	5.21
6	11.20	10.80	0.68	1.09	10.52	9.71

Radio 4 (Bluetooth)			
Set	Antenna Gain (dBi)	Cable Loss (dB)	True Gain (dBi)
	Port 1	Port 1	Port 1
1	3.80	0.56	3.24
2	3.00	0.56	2.44
3	4.90	0.56	4.34
4	2.90	0.56	2.34
5	7.00	0.56	6.44
6	11.20	0.56	10.64

Note2: The above information was declared by manufacturer.
Note3: The EUT has six set antennas.
The EUT has four radios, Radio 1 supports WLAN 2.4GHz (802.11b/g/n/ax mode), Radio 2 supports WLAN 5GHz (802.11a/n/ac/ax mode), Radio 3 supports WLAN 2.4GHz + 5GHz (scanning radio) and Radio 4 supports Bluetooth function.
Set 1 and Set 2 antennas are the same type antennas, only the highest gain antennas Set 1 for 2.4GHz, Set 2 for 5GHz were tested.

Note 4: Directional gain information

Type	Maximum Output Power	Power Spectral Density
Non-BF	Directional gain = Max.gain + array gain. For power measurements on IEEE 802.11 devices Array Gain = 0 dB (i.e., no array gain) for N ANT ≤ 4	$DirectionalGain = 10 \cdot \log\left[\frac{\sum_{j=1}^{N_{sm}}\left[\sum_{k=1}^{N_{ant}} g_{j,k}\right]^2}{N_{ANT}}\right]$
BF	$DirectionalGain = 10 \cdot \log\left[\frac{\sum_{j=1}^{N_{sm}}\left[\sum_{k=1}^{N_{ant}} g_{j,k}\right]^2}{N_{ANT}}\right]$	$DirectionalGain = 10 \cdot \log\left[\frac{\sum_{j=1}^{N_{sm}}\left[\sum_{k=1}^{N_{ant}} g_{j,k}\right]^2}{N_{ANT}}\right]$

Ex.

Directional Gain (NSS1) formula : $DirectionalGain = 10 \cdot \log\left[\frac{\sum_{j=1}^{N_{sm}}\left[\sum_{k=1}^{N_{ant}} g_{j,k}\right]^2}{N_{ANT}}\right]$

NSS1(g1,1) = $10^{G1/20}$; NSS1(g1,2)= $10^{G2/20}$; NSS1(g1,2)= $10^{G3/20}$; NSS1(g1,2)= $10^{G4/20}$

gj,k =(Nss1(g1,1) + Nss1(g1,2) + Nss1(g1,3) + Nss1(g1,4))^2

DG = 10 log[(Nss1(g1,1) + Nss1(g1,2) + Nss1(g1,3) + Nss1(g1,4))^2 / N_{ANT}] => 10 log[($10^{G1/20}$ + $10^{G2/20}$ + $10^{G3/20}$ + $10^{G4/20}$)^2 / N_{ANT}]

Where ;

Antenna Set 1

2.4G G1= 2.79 dBi ; G2= 3.39 dBi ; G3= 3.39 dBi ; G4= 2.8 dBi ;

4TX DG= 9.12dBi ;2TX DG= 6.11dBi

Antenna Set 2

5G G1= 4.17 dBi ; G2= 5.04 dBi ; G3= 5.09 dBi ; G4= 4.16 dBi ;

4TX DG= 10.65dBi ; 2TX DG= 7.63dBi

Antenna Set 3

2.4G G1= 3.89 dBi ; G2= 4.49 dBi ; G3= 4.49 dBi ; G4= 3.9 dBi ;

4TX DG= 10.22dBi ; 2TX DG= 7.21dBi

5G G1= 3.37 dBi ; G2= 4.24 dBi ; G3= 4.29 dBi ; G4= 3.36 dBi ;

4TX DG= 9.85dBi ; 2TX DG= 6.83dBi

Antenna Set 4

2.4G G1= 1.89 dBi ; G2= 2.49 dBi ; G3= 2.49 dBi ; G4= 1.9 dBi ;

4TX DG= 8.22dBi ; 2TX DG= 5.21dBi

5G G1= 2.17 dBi ; G2= 3.04 dBi ; G3= 3.09 dBi ; G4= 2.16 dBi ;

4TX DG= 8.65dBi ; 2TX DG= 5.63dBi

Antenna Set 5

2.4G G1= 5.99 dBi ; G2= 6.59 dBi ; G3= 6.59 dBi ; G4= 6 dBi ;

4TX DG= 12.32dBi ; 2TX DG= 9.31dBi

5G G1= 4.77 dBi ; G2= 5.64 dBi ; G3= 5.69 dBi ; G4= 4.76 dBi ;

4TX DG= 11.25dBi ; 2TX DG= 8.23dBi

Antenna Set 6

2.4G G1= 10.19 dBi ; G2= 10.79 dBi ; G3= 10.79 dBi ; G4= 10.2 dBi ;

4TX DG= 16.52dB i; 2TX DG= 13.51dBi

5G G1= 9.27 dBi ; G2= 10.14 dBi ; G3= 10.19 dBi ; G4= 9.26 dBi ;

4TX DG= 15.75dBi ; 2TX DG= 12.73dBi

<For Radio 1 (2.4GHz Functions) and Radio 2 (5GHz Functions)>

For 1TX/4RX:

Only Port 1 can be use as transmitting antenna

Port 1, Port 2, Port 3 and Port 4 can be used as receiving antennas.

Port 1, Port 2, Port 3 and Port 4 could receive simultaneously.

For 2TX/4RX:

Only Port 1 and Port 2 can be use as transmitting antenna

Port 1, Port 2, Port 3 and Port 4 can be used as receiving antennas.

Port 1, Port 2, Port 3 and Port 4 could receive simultaneously.

For 4TX/4RX:

Port 1, Port 2, Port 3 and Port 4 can be use as transmitting/receiving antenna

Port 1, Port 2, Port 3 and Port 4 could receive simultaneously.

<For Radio 3 / 2.4GHz + 5GHz Functions>

Only Port 1 can be used as receiving antennas.

<For Radio 4 / Bluetooth Functions>

Only Port 1 can be use as transmitting/receiving antenna.

1.3 Accessories

Accessories				
Equipment Name	**Brand Name**	**Model Name**	**P/N**	**Rating**
Adapter 1	CISCO	KSAS0361200250HU	-	Input: 100-240V, 50/60Hz, 1.0A Output: 12V, 2.5A
Adapter 2	CISCO	MA-PWR-30W-US	640-39010-A	Input: 100-240V, 50-60Hz, 0.8A Max. Output: 12V, 2.5A 30W
Other				
Wall-mounted rack*1				

1.4 Applicable Standards

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

- 47 CFR Part 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

1.5 Testing Location

Testing Location Information		
Test Lab.：Sporton International Inc. Hsinchu Laboratory		
Hsinchu	ADD: No.8, Ln. 724, Bo'ai St., Zhubei City, Hsinchu County 302010, Taiwan (R.O.C.)	
(TAF: 3787)	TEL: 886-3-656-9065	FAX: 886-3-656-9085
	Test site Designation No. TW3787 with FCC.	
	Conformity Assessment Body Identifier (CABID) TW3787 with ISED.	

Note: The tested sample of the power test item was received on Sep. 22, 2022.

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/f²)	<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/f²)	<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 54 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 MPE Exemption

Option (A): 1.1307(b)(3)(i)(A): Available maximum time-averaged power is < 1 mW

Option (B): 1.1307(b)(3)(i)(B): Device operates between 300 MHz and 6 GHz and the maximum time-averaged power or effective radiated power (ERP), whichever is greater, <= Pth.

$$P_{th}\ (\text{mW}) = \begin{cases} ERP_{20\ cm}(d/20\ \text{cm})^{x} & d \le 20\ \text{cm} \\ ERP_{20\ cm} & 20\ \text{cm} < d \le 40\ \text{cm} \end{cases}$$

Where

$$x = -\log_{10}\left(\frac{60}{ERP_{20\ cm}\sqrt{f}}\right) \text{ and } f \text{ is in GHz;}$$

and

$$ERP_{20\ cm}\ (\text{mW}) = \begin{cases} 2040f & 0.3\ \text{GHz} \le f < 1.5\ \text{GHz} \\ 3060 & 1.5\ \text{GHz} \le f \le 6\ \text{GHz} \end{cases}$$

d = the separation distance (cm);

Option (C): 1.1307(b)(3)(i)(C): ERP is below a threshold calculated based on the distance R between the person and the antenna / radiating structure, where R > λ / 2 π.

Single RF Sources Subject to Routine Environmental Evaluation	
RF Source frequency (MHz)	**Threshold ERP (watts)**
0.3-1.34	1,920 R^2.
1.34-30	3,450 R^2/f^2.
30-300	3.83 R^2.
300-1,500	0.0128 R^2f.
1,500-100,000	19.2R^2.
Note: R is in meters, f is in MHz.	

2.4 Calculated Result and Limit

Exposure Environment: General Population / Uncontrolled Exposure

MPE / Antenna / Set 1 and Set 2

Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	Tolerance (dB)	Tune-up EIRP (dBm)	Distance (cm)	S (mW/cm^2)	S Limit (mW/cm^2)
2.4G;D1D (Radio 1)	3.39	28.51	31.90	0.50	32.40	54	0.04742	1
5.2G;D1D (Radio 2)	10.65	24.29	34.94	0.50	35.44	54	0.09550	1
5.3G;D1D (Radio 2)	7.63	21.91	29.54	0.45	29.99	54	0.02723	1
5.6G;D1D (Radio 2)	7.63	21.92	29.55	0.44	29.99	54	0.02723	1
5.8G;D1D (Radio 2)	10.65	24.71	35.36	0.17	35.53	54	0.09750	1
2.4G;BT-LE (Radio 4)	3.24	19.01	22.25	0.50	22.75	54	0.00527	1

MPE / Antenna / Set 3

Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	Tolerance (dB)	Tune-up EIRP (dBm)	Distance (cm)	S (mW/cm^2)	S Limit (mW/cm^2)
2.4G;D1D (Radio 1)	4.49	29.92	34.41	0.50	34.91	54	0.08453	1
5.2G;D1D (Radio 2)	9.85	26.10	35.95	0.04	35.99	54	0.10839	1
5.3G;D1D (Radio 2)	9.85	20.06	29.91	0.08	29.99	54	0.02723	1
5.6G;D1D (Radio 2)	9.85	19.68	29.53	0.46	29.99	54	0.02723	1
5.8G;D1D (Radio 2)	9.85	25.56	35.41	0.50	35.91	54	0.10641	1
2.4G;BT-LE (Radio 4)	4.34	19.12	23.46	0.50	23.96	54	0.00679	1

MPE / Antenna / Set 4

Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	Tolerance (dB)	Tune-up EIRP (dBm)	Distance (cm)	S (mW/cm^2)	S Limit (mW/cm^2)
2.4G;D1D (Radio 1)	2.49	29.92	32.41	0.50	32.91	54	0.05333	1
5.2G;D1D (Radio 2)	8.65	27.26	35.91	0.08	35.99	54	0.10839	1
5.3G;D1D (Radio 2)	8.65	21.31	29.96	0.03	29.99	54	0.02723	1
5.6G;D1D (Radio 2)	8.65	21.31	29.96	0.03	29.99	54	0.02723	1
5.8G;D1D (Radio 2)	8.65	27.33	35.98	0.01	35.99	54	0.10839	1
2.4G;BT-LE (Radio 4)	2.34	19.01	29.65	0.50	30.15	54	0.02825	1

MPE / Antenna / Set 5

Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	Tolerance (dB)	Tune-up EIRP (dBm)	Distance (cm)	S (mW/cm^2)	S Limit (mW/cm^2)
2.4G;D1D (Radio 1)	6.59	28.42	35.01	0.50	35.51	54	0.09705	1
5.2G;D1D (Radio 2)	11.25	24.29	35.54	0.45	35.99	54	0.10839	1
5.3G;D1D (Radio 2)	5.69	23.91	29.60	0.39	29.99	54	0.02723	1
5.6G;D1D (Radio 2)	5.69	23.97	29.66	0.33	29.99	54	0.02723	1
5.8G;D1D (Radio 2)	5.69	29.98	35.67	0.32	35.99	54	0.10839	1
2.4G;BT-LE (Radio 4)	6.44	19.01	25.45	0.50	25.95	54	0.01074	1

MPE / Antenna / Set 6

Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	Tolerance (dB)	Tune-up EIRP (dBm)	Distance (cm)	S (mW/cm^2)	S Limit (mW/cm^2)
2.4G;D1D (Radio 1)	10.79	24.93	35.72	0.27	35.99	54	0.10839	1
5.2G;D1D (Radio 2)	9.27	26.70	35.97	0.02	35.99	54	0.10839	1
5.3G;D1D (Radio 2)	9.27	20.69	29.96	0.50	30.46	54	0.03034	1
5.6G;D1D (Radio 2)	9.27	20.69	29.96	0.50	30.46	54	0.03034	1
5.8G;D1D (Radio 2)	9.27	26.36	35.63	0.36	35.99	54	0.10839	1
2.4G;BT-LE (Radio 4)	10.64	19.01	29.65	0.50	30.15	54	0.02825	1

MPE Exemption Option C							
Frequency (MHz)	λ/2π (m)	R (m)	Tune-up EIRP (dBm)	Tune-up ERP (dBm)	Tune-up ERP (W)	ERP Threshold (W)	MPE Exemption
2402	0.0199	0.54	30.15	28.00	0.631	5.599	Complies
2462	0.0194		35.99	33.84	2.421	5.599	Complies
5745	0.0083		35.99	33.84	2.421	5.599	Complies

Simultaneous Transmission Analysis Mode:

Radio 1 (2.4GHz) + Radio 2 (5GHz) + Radio 4 (BT4.0)

Simultaneous Transmissions Option C							
Frequency (MHz)	R (m)	Tune-up EIRP (dBm)	Tune-up ERP (dBm)	Tune-up ERP (W)	ERP Threshold (W)	Simultaneous Transmissions	Simultaneous Transmissions Limit
2402	0.54	30.15	28.00	0.631	5.599	0.98	**<= 1**
2462		35.99	33.84	2.421	5.599		
5745		35.99	33.84	2.421	5.599		

Note: The above antenna gain was declared by manufacturer.

———THE END———