

FCC RF Exposure Exemption report
for
802.11ac/abgn 2T2R Half Mini-PCI-Express Module
Model No.: AWM5820
FCC ID: RPV-AWM5820

of

Applicant: ATOP Technologies, Inc
Address: 1F, No. 30 R&D Rd. II, Science-Based Industrial Park,
Hsinchu 30076, Taiwan R.O.C.

Tested and Prepared

by

Worldwide Testing Services (Taiwan) Co., Ltd.

FCC Registration No.: TW1477, TW1072

Industry Canada filed test laboratory Reg. No.: 20037, 5107A



Report No.: W6M22403-23316-EE



Registration number: W6M22403-23316-EE
FCC ID: RPV-AWM5820

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1 General Information

1.1 Notes

The purpose of conformity testing is to increase the probability of adherence to the essential requirements or conformity specifications, as appropriate.

The complexity of the technical specifications, however, means that full and thorough testing is impractical for both technical and economic reasons.

Furthermore, there is no guarantee that a test sample which has passed all the relevant tests conforms to a specification.

Neither is there any guarantee that such a test sample will interwork with other genuinely open systems.

The existence of the tests nevertheless provides the confidence that the test sample possesses the qualities as maintained and that its performance generally conforms to representative cases of communications equipment.

Laboratory disclaimer-

1. The test results of this test report relate exclusively to the item tested as specified in 1.5.
2. The test report may only be reproduced or published in full.
3. Reproduction or publication of extracts from the report requires the prior written approval of the Worldwide Testing Services(Taiwan) Co., Ltd.
4. Antenna gain is provided by applicant and laboratory issue relevant data and results.

Tester:

April 18, 2024

Ken Kang

Date

WTS-Lab.

Name

Signature

Technical responsibility for area of testing:

April 18, 2024

Kevin Wang

Date

WTS

Name

Signature



Registration number: W6M22403-23316-EE

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1.2 Testing laboratory

1.2.1 Location

10m OATS

No.5-1, Lishui, Shuang Sing Village, Wanli Dist.,
New Taipei City 207, Taiwan (R.O.C.)

3 meter semi-anechoic chamber

No.35, Aly. 21, Ln. 228, Ankang Rd., Neihu Dist.,
Taipei City 114, Taiwan (R.O.C.)

Tel: 886-2-6613-0228

Worldwide Testing Services (Taiwan) Co., Ltd.

6F., No. 58, Ln. 188, Ruiguang Rd., Neihu Dist.,
Taipei City 114, Taiwan (R.O.C.)

Tel: 886-2-6606-8877

1.2.2 Details of accreditation status

Accredited testing laboratory

FCC filed test laboratory Reg. No.: TW1477, TW1072

Industry Canada filed test laboratory Reg. No.: 20037, 5107A

Test location, where different from Worldwide Testing Services (Taiwan) Co., Ltd. :

Name: ./.

Accredited no.: ./.

Street: ./.

Town: ./.

Country: ./.

1.3 Application details

Approval holder

Name: ATOP Technologies, Inc

Street: 1F, No. 30 R&D Rd. II, Science-Based Industrial Park,

Town: Hsinchu 30076,

Country: Taiwan R.O.C.

Manufacturer: (if applicable)

Name: ./.

Street: ./.

Town: ./.

Country: ./.



Registration number: W6M22403-23316-EE
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Date of receipt of test item: March 19, 2024

Date of test: from March 20, 2024 to April 17, 2024

1.4 General information of Test item

Type of test item: 802.11ac/abgn 2T2R Half Mini-PCI-Express Module
Model no.: AWM5820
Multi-listing model no.: ./.
Brand name: ATOP
Power supply: 3.3Vd.c.
Type of antenna: #614X Replacement Antenna
Antenna gain: WLAN 2.4G
ANT 1 & ANT 2: 3dBi
WLAN 5G
ANT 1 & ANT 2: 5dBi
Directional gain: WLAN 2.4G: 6.01dBi
WLAN 5G: 8.01dBi

Technical data:

WLAN 2.4G		
Mode	Channel	Conducted Power (dBm)
802.11b	Ch 1 : 2412 MHz	11.11
	Ch 6 : 2437 MHz	10.93
	Ch 11 : 2462 MHz	10.65
802.11g	Ch 1 : 2412 MHz	12.35
	Ch 6 : 2437 MHz	11.65
	Ch 11 : 2462 MHz	11.30
802.11n 20MHz	Ch 1 : 2412 MHz	13.60
	Ch 6 : 2437 MHz	13.11
	Ch 11 : 2462 MHz	12.71
802.11n 40MHz	Ch 1 : 2422 MHz	13.14
	Ch 4 : 2437 MHz	12.75
	Ch 7 : 2452 MHz	12.53



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WLAN 5G			
Band	Mode	Channel	Conducted Power (dBm)
NII-1	802.11a	Ch 36 : 5180 MHz	3.63
		Ch 44 : 5220 MHz	3.23
		Ch 48 : 5240 MHz	6.25
	802.11n 20MHz	Ch 36 : 5180 MHz	2.41
		Ch 44 : 5220 MHz	4.94
		Ch 48 : 5240 MHz	7.49
	802.11n 40MHz	Ch 38 : 5190 MHz	2.11
		Ch 46 : 5230 MHz	7.22
	802.11n 80MHz	Ch 42 : 5210 MHz	7.75
NII-3	802.11a	Ch 149 : 5745 MHz	8.74
		Ch 157 : 5785 MHz	10.47
		Ch 165 : 5825 MHz	10.56
	802.11n 20MHz	Ch 149 : 5745 MHz	11.37
		Ch 157 : 5785 MHz	12.57
		Ch 165 : 5825 MHz	12.45
	802.11n 40MHz	Ch 151 : 5755 MHz	10.97
		Ch 159 : 5795 MHz	11.52
	802.11n 80MHz	Ch 155 : 5775 MHz	11.10

Operation modes: Duplex
 Modulation type: DSSS/OFDM
 Sample no.: #01
 Special statement: ./.
 Classification:

Fixed Device	<input type="checkbox"/>
Mobile Device (Human Body distance > 20cm)	<input checked="" type="checkbox"/>
Portable Device (Human Body distance < 20cm)	<input type="checkbox"/>



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1.5 Duty cycle and factor

The duty factor is computed as $[10 \log (1 / D)]$, where D is the duty cycle.

WLAN 2.4G

Mode	T _{on} (ms)	T _{on} +T _{off} (ms)	Duty cycle (%)	Duty Factor (dB)	1/T - VBW (kHz)
802.11b	23.87821	23.918269	99.83%	0.01	0.01
802.11g	23.87821	23.918269	99.83%	0.01	0.01
802.11n 20MHz	23.87821	23.926282	99.80%	0.01	0.01
802.11n 40MHz	23.87019	23.918269	99.80%	0.01	0.01

WLAN 5G

Mode	T _{on} (ms)	T _{on} +T _{off} (ms)	Duty cycle (%)	Duty Factor (dB)	1/T - VBW (kHz)
802.11a	23.89423	23.894231	100.00%	0.00	0.01
802.11n 20MHz	23.94231	23.942308	100.00%	0.00	0.01
802.11n 40MHz	23.89423	23.894231	100.00%	0.00	0.01
802.11ac 80MHz	23.89423	23.942308	99.80%	0.01	0.01



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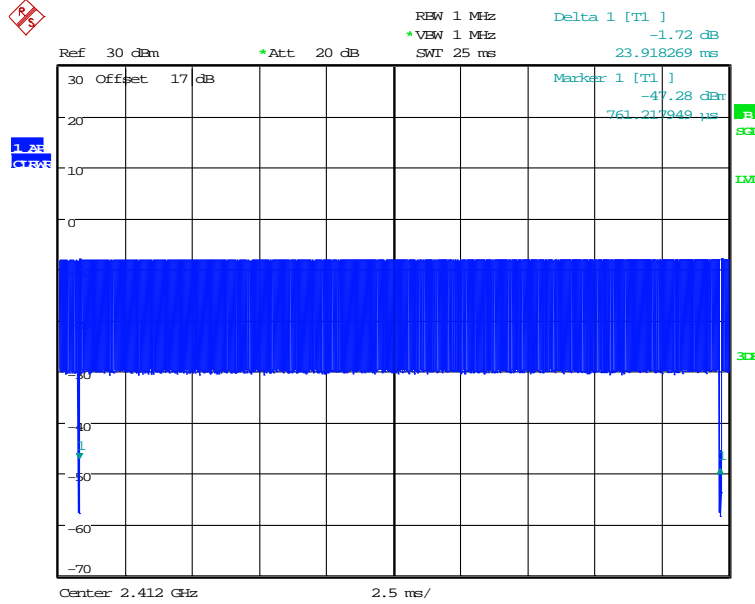
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FCC ID: RPV-AWM5820

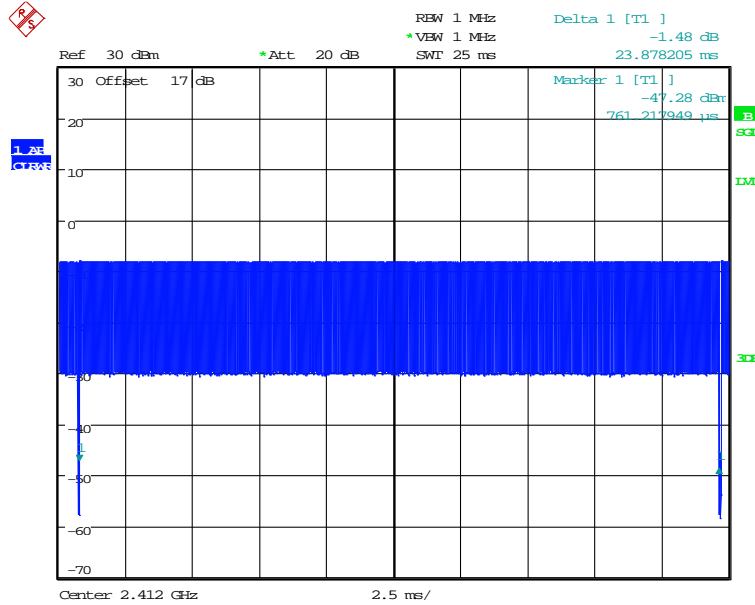
Duty cycle plot

WLAN 2.4G

802.11b



DUTY 802.11B T
Date: 22.MAR.2024 15:32:21



DUTY 802.11B TON
Date: 22.MAR.2024 15:31:46

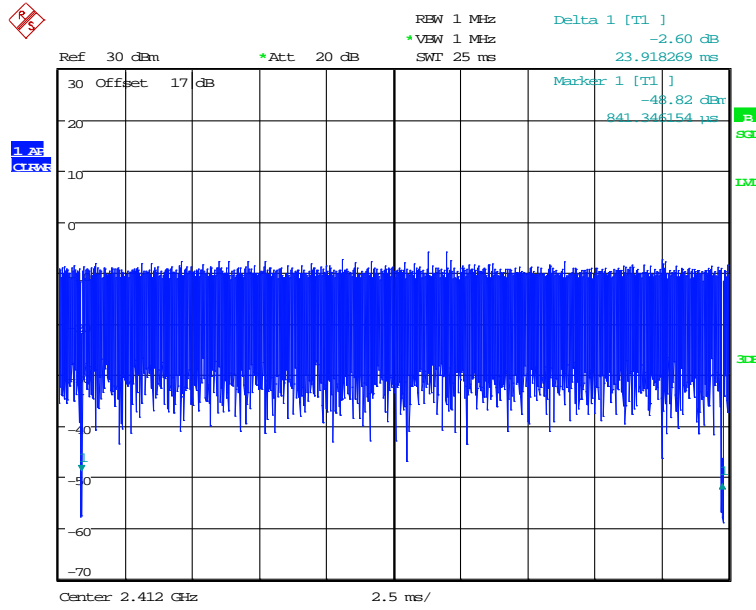


Worldwide Testing Services(Taiwan) Co., Ltd.

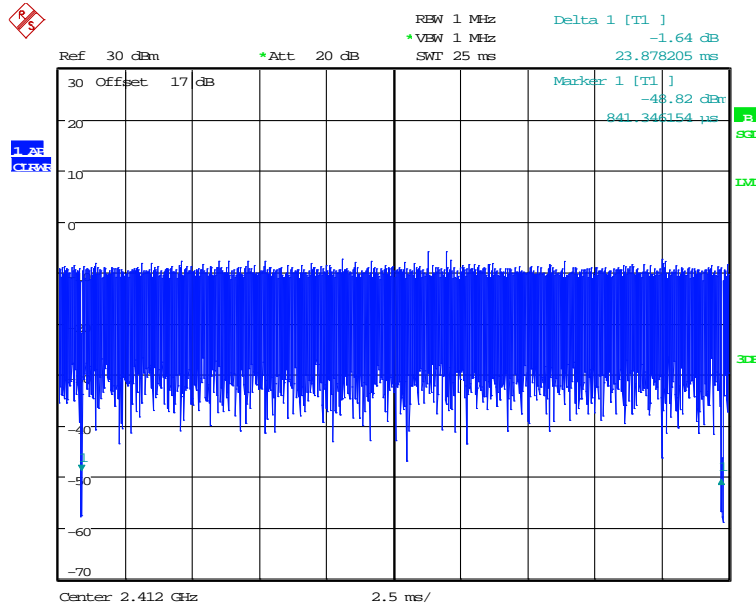
Registration number: W6M22403-23316-EE

FCC ID: RPV-AWM5820

802.11g



DUTY 802.11G T
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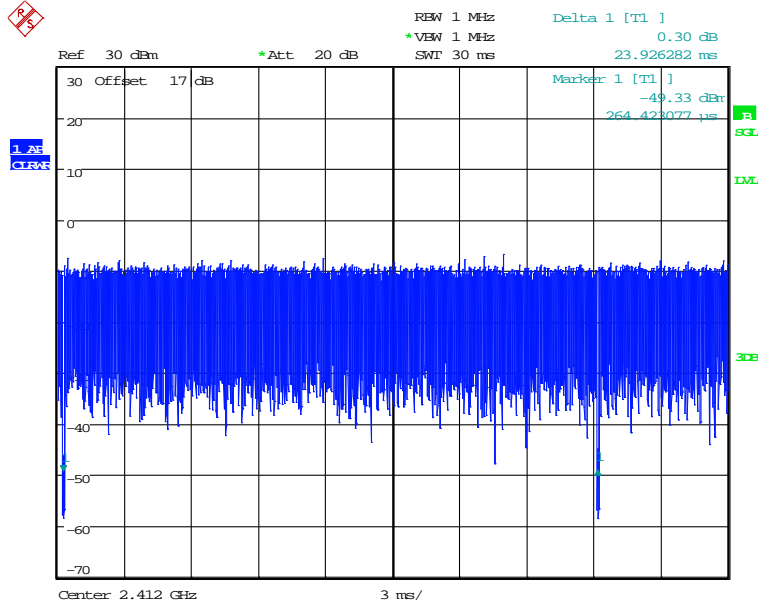


DUTY 802.11G TON
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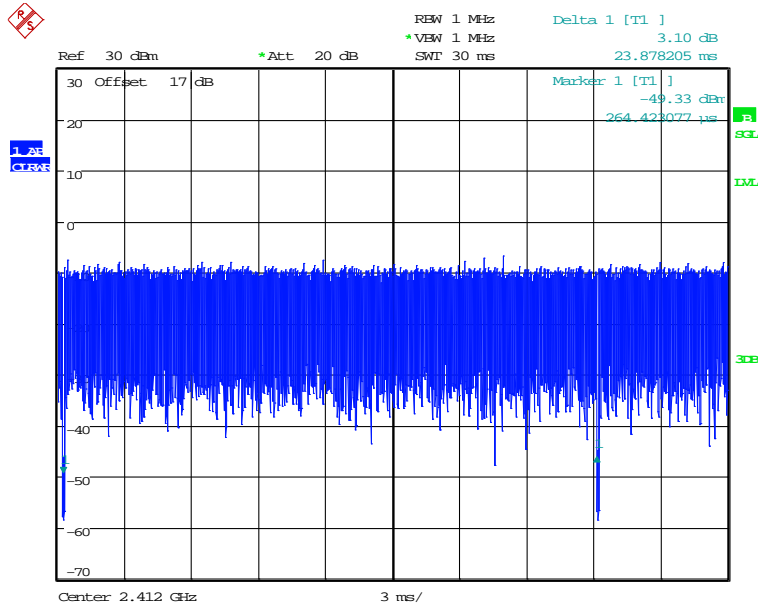


Worldwide Testing Services(Taiwan) Co., Ltd.

Registration number: W6M22403-23316-EE
FCC ID: RPV-AWM5820
802.11n 20MHz



DUTY 802.11N20 T
Date: 22.MAR.2024 15:38:22

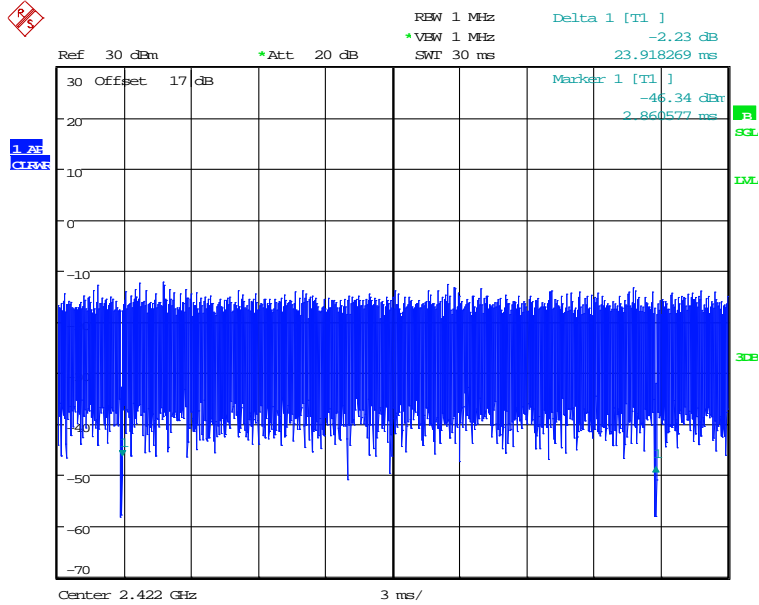


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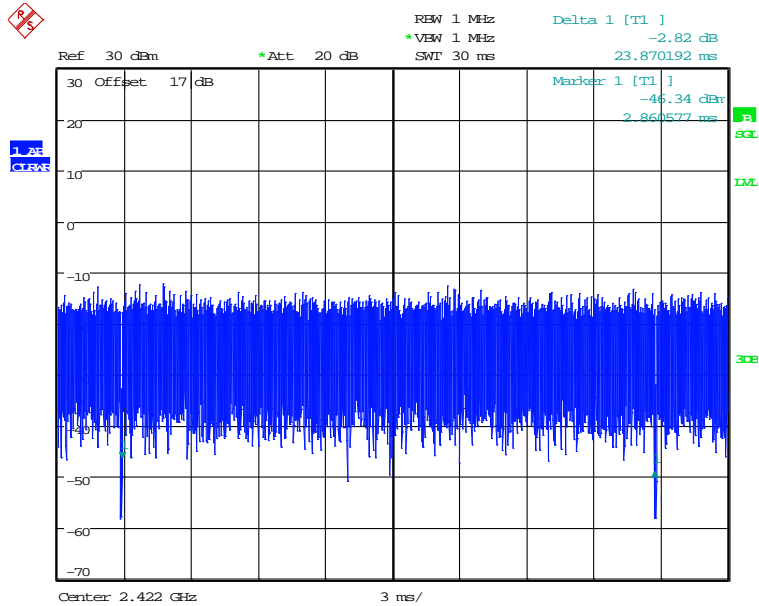


Worldwide Testing Services(Taiwan) Co., Ltd.

Registration number: W6M22403-23316-EE
FCC ID: RPV-AWM5820
802.11n 40MHz



DUTY 802.11N40 T
Date: 22.MAR.2024 15:39:54

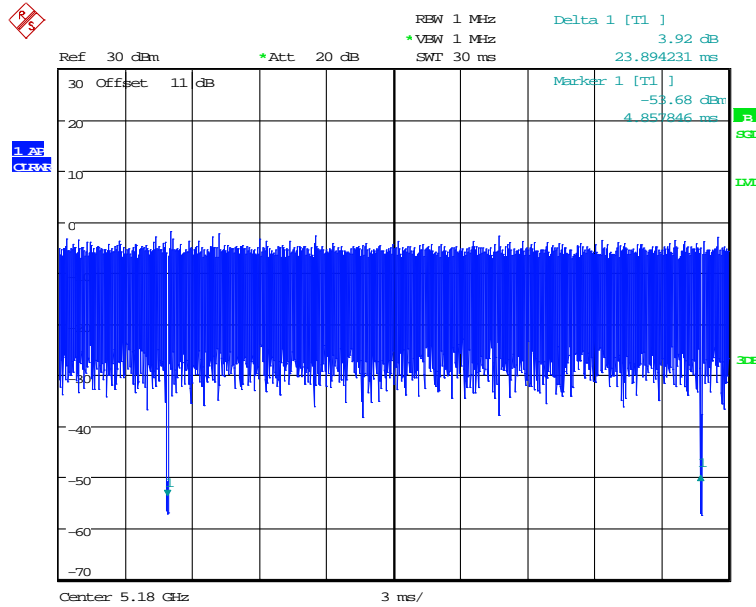


DUTY 802.11N40 TON
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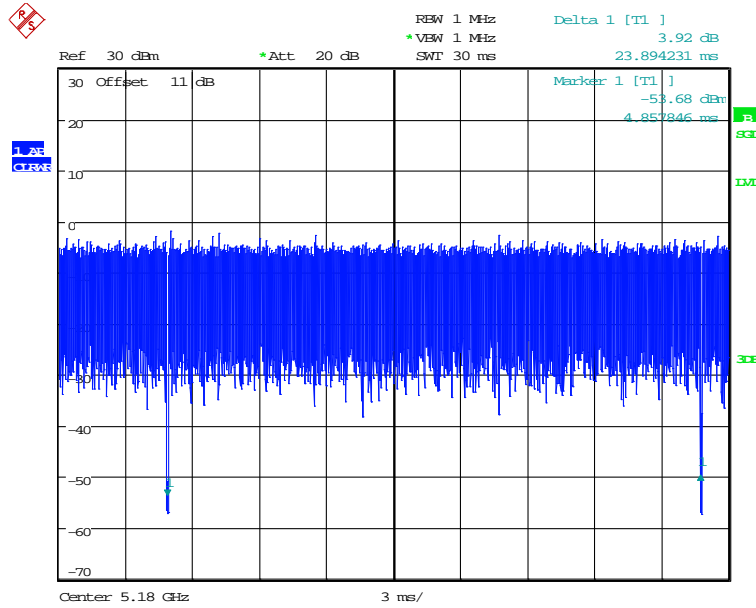


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Registration number: W6M22403-23316-EE
FCC ID: RPV-AWM5820
WLAN 5G



DUTY A T
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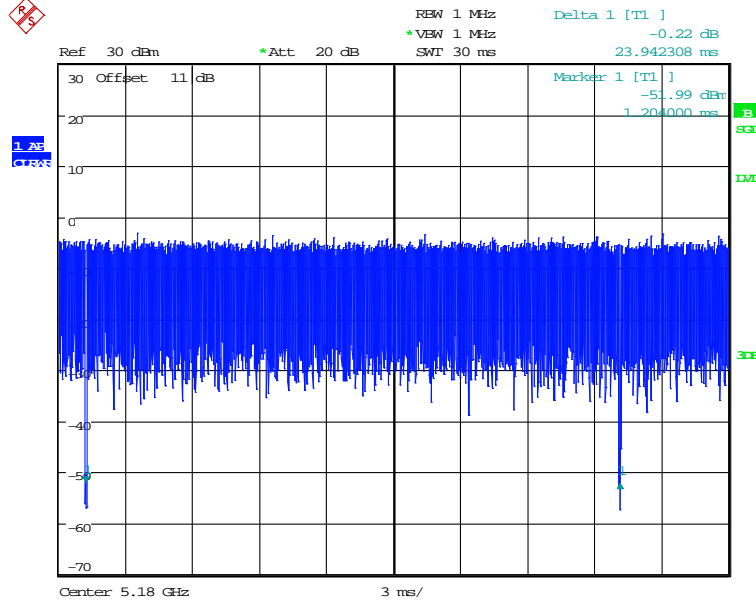


DUTY A TON
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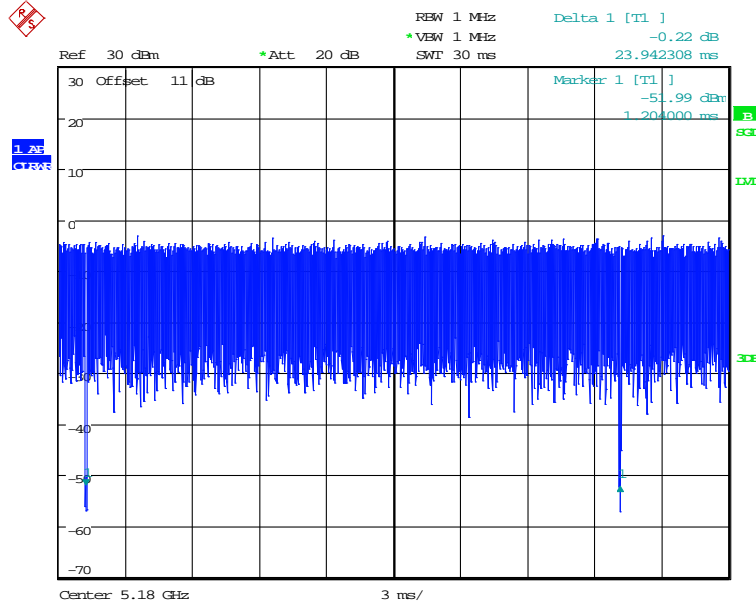


Worldwide Testing Services(Taiwan) Co., Ltd.

Registration number: W6M22403-23316-EE
FCC ID: RPV-AWM5820



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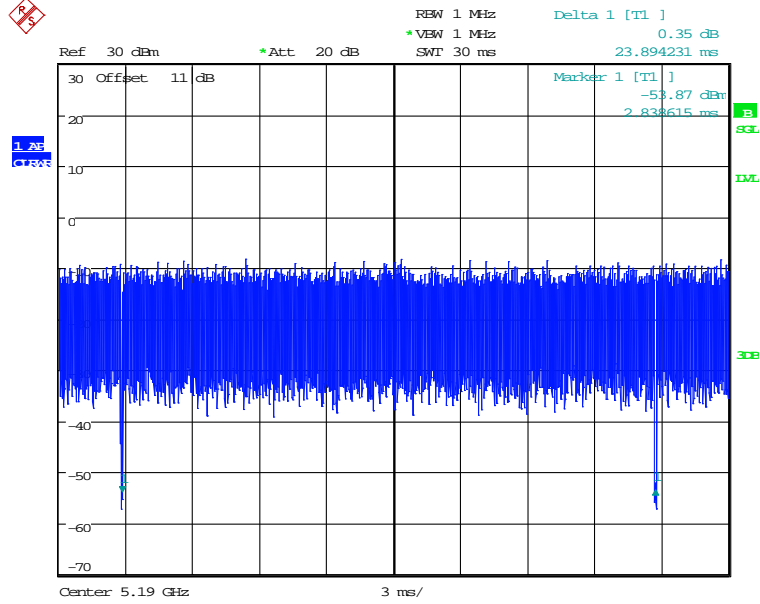


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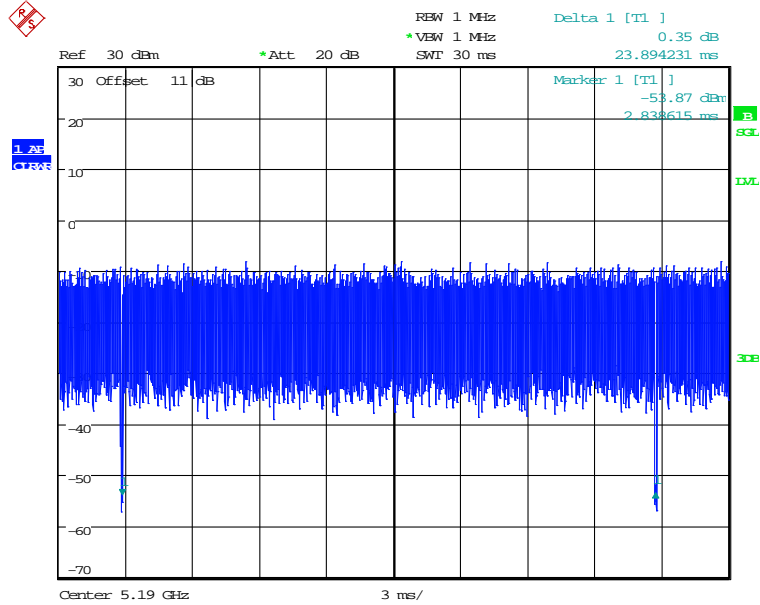


Worldwide Testing Services(Taiwan) Co., Ltd.

Registration number: W6M22403-23316-EE
FCC ID: RPV-AWM5820



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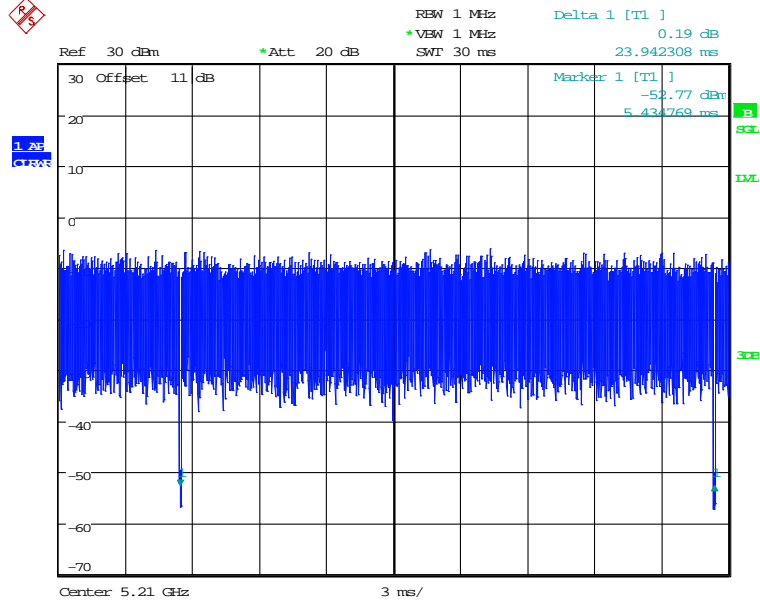


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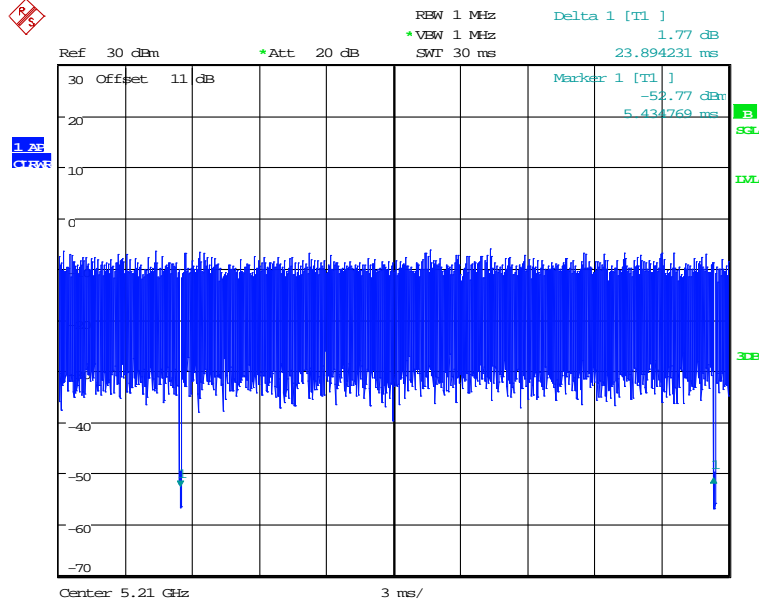


Worldwide Testing Services(Taiwan) Co., Ltd.

Registration number: W6M22403-23316-EE
FCC ID: RPV-AWM5820



DUTY AC80 T
Date: 9.APR.2024 11:15:01



DUTY AC80 TON
Date: 9.APR.2024 11:15:20



Registration number: W6M22403-23316-EE

FCC ID: RPV-AWM5820

1.7 Test standards

47 CFR FCC Part 2.1093

447498 D04 Interim General RF Exposure Guidance v01

2 Test configuration

2.1 Test environment

Relative humidity content: 20 ... 75 %

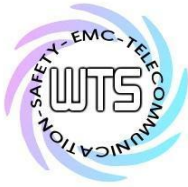
Air pressure: 86 ... 103 kPa

Extreme conditions parameters: ./.

2.2 Measurement uncertainty

Test item Name	Uncertainty
Estimation Result of Uncertainty of Conducted Output Power Measurement (Peak Output Power (transmitter))	Expanded Uncertainty : 1.64 dB

The decision rule is: Measurement uncertainty is not included in the calculation of test results.



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2.3 Test Equipment List

Code No.	Test equipment	Mode No.	Serial No.	Brand	Cal. Date	Next Cal. Date
ETSTW-RE 050	Attenuator 10dB	50HF-010-1	None	JFW	2024/2/16	2025/2/15
ETSTW-RE 055	SPECTRUM ANALYZER	FSU 26	200074	R&S	2024/3/7	2025/3/6
ETSTW-RE 099	DC Block	50DB-007-1	None	JFW	2024/2/16	2025/2/15
ETSTW-Cable 030	Microwave Cable	SUCOFLEX 104 (S_Cable 9)	279067	HUBER+SUHNER	2024/2/16	2025/2/15



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3 Equivalent Isotropic Radiated Power (EIRP)

3.1 Exemption Limits for Routine Evaluation

according to 47 CFR FCC Part 2 Subpart J, section 2.1091

FCC OET Bulletin 65 Edition 97.01 determines the equations for predicting RF fields and applicable limits.

The prediction for power density in the far-field but will over-predict power density in the near field, where it could be used for walking a “worst case” or conservative prediction.

Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess limit for maximum permissible exposure. In accordance with 47 CFR FCC Part 2 Subpart J, section 2.1091 this device has been defined as a mobile device whereby a distance of 20 cm normally can be maintained between the user and the device.

MPE Calculation Method

(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 (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 (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

f = frequency in MHz

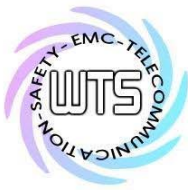
*Plane-wave equivalent power density

E = Electric field (V/m) P = output power (W) G = EUT Antenna numeric gain (numeric)

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

The formula can be changed to

$$Pd = \frac{30 \times P \times G}{377 \times d^2} \text{ mW/cm}^2.$$



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WLAN 2.4G

Mode	Channel/Frequency (MHz)	Conducted Power (dBm)	Antenna 1 Gain (dBi)	Antenna 2 Gain (dBi)	Directional gain (dBi)	Power density (mW/cm ²)	Limit (mW/cm ²)	Ratio
802.11b	Ch 1 : 2412 MHz	11.11	3	--	--	0.0051	1	0.0051
	Ch 6 : 2437 MHz	10.93	3	--	--	0.0049	1	0.0049
	Ch 11 : 2462 MHz	10.65	3	--	--	0.0046	1	0.0046
802.11g	Ch 1 : 2412 MHz	12.35	--	3	--	0.0068	1	0.0068
	Ch 6 : 2437 MHz	11.65	--	3	--	0.0058	1	0.0058
	Ch 11 : 2462 MHz	11.30	3	--	--	0.0054	1	0.0054
802.11n 20MHz	Ch 1 : 2412 MHz	13.60	--	--	6.01	0.0182	1	0.0182
	Ch 6 : 2437 MHz	13.11	--	--	6.01	0.0162	1	0.0162
	Ch 11 : 2462 MHz	12.71	--	--	6.01	0.0148	1	0.0148
802.11n 40MHz	Ch 1 : 2422 MHz	13.14	--	--	6.01	0.0164	1	0.0164
	Ch 4 : 2437 MHz	12.75	--	--	6.01	0.0149	1	0.0149
	Ch 7 : 2452 MHz	12.53	--	--	6.01	0.0142	1	0.0142

WLAN 5G

Band 1

Mode	Channel/Frequency (MHz)	Conducted Power (dBm)	Antenna 1 Gain (dBi)	Antenna 2 Gain (dBi)	Directional gain (dBi)	Power density (mW/cm ²)	Limit (mW/cm ²)	Ratio
802.11a	Ch 36 : 5180 MHz	3.63	5	--	--	0.0014	1	0.0014
	Ch 44 : 5220 MHz	3.23	5	--	--	0.0013	1	0.0013
	Ch 48 : 5240 MHz	6.25	--	5	--	0.0026	1	0.0026
802.11n 20MHz	Ch 36 : 5180 MHz	2.41	--	--	8.01	0.0021	1	0.0021
	Ch 44 : 5220 MHz	4.94	--	--	8.01	0.0039	1	0.0039
	Ch 48 : 5240 MHz	7.49	--	--	8.01	0.0070	1	0.0070
802.11n 40MHz	Ch 38 : 5190 MHz	2.11	--	--	8.01	0.0020	1	0.0020
	Ch 46 : 5230 MHz	7.22	--	--	8.01	0.0066	1	0.0066
802.11ac 80MHz	Ch 42 : 5210 MHz	7.75	--	--	8.01	0.0075	1	0.0075



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Band 4

Mode	Channel/Frequency (MHz)	Conducted Power (dBm)	Antenna 1 Gain (dBi)	Antenna 2 Gain (dBi)	Directional gain (dBi)	Power density (mW/cm ²)	Limit (mW/cm ²)	Ratio
802.11a	Ch 149 : 5745 MHz	8.74	--	5	--	0.0047	1	0.0047
	Ch 157 : 5785 MHz	10.47	--	5	--	0.0070	1	0.0070
	Ch 165 : 5825 MHz	10.56	--	5	--	0.0072	1	0.0072
802.11 n20MHz	Ch 149 : 5745 MHz	11.37	--	--	8.01	0.0172	1	0.0172
	Ch 157 : 5785 MHz	12.57	--	--	8.01	0.0227	1	0.0227
	Ch 165 : 5825 MHz	12.45	--	--	8.01	0.0221	1	0.0221
802.11 n40MHz	Ch 151 : 5755 MHz	10.97	--	--	8.01	0.0157	1	0.0157
	Ch 159 : 5795 MHz	11.52	--	--	8.01	0.0179	1	0.0179
802.11 ac 80MHz	Ch 155 : 5775 MHz	11.10	--	--	8.01	0.0162	1	0.0162

From the peak EUT RF output power, the minimum mobile separation distance, $d = 20$ cm, as well as the gain of the used antenna, the RF power density can be obtained.