

FCC Test Report

FCC ID : I8803935
Equipment : 802.11be (WiFi 7) Triple-Radio Unified Pro
Access Point
Model No. : WBE660S
Brand Name : ZYXEL
Applicant : Zyxel Communications Corporation
Address : No.2 Industry East RD. IX, Hsinchu Science
Park, Hsinchu 30075, Taiwan, R.O.C
Standard : 47 CFR FCC Part 15.407
Equipment Class / Type : 6ID: Indoor access point
 6PP: Subordinate device
 6XD: Client device
Received Date : Jul. 17, 2023
Tested Date : Aug. 08 ~ Aug. 23, 2023

We, International Certification Corporation, would like to declare that the tested sample has been evaluated and in compliance with the requirement of the above standards. The test results contained in this report refer exclusively to the product. It shall not be reproduced except in full without the written approval of our laboratory.

Reviewed by:

Approved by:



Along Chen / Assistant Manager



Gary Chang / Manager

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Release Record

Report No.	Version	Description	Issued Date
FR371702AO	Rev. 01	Initial issue	Sep. 22, 2023

Summary of Test Results

FCC Rules	Test Items	Measured	Result
15.207	AC Power Line Conducted Emissions	[dBuV]: 16.226MHz 43.52 (Margin -6.48dB) - AV	Pass
15.407(b)(5) 15.209	Unwanted Emission	[dBuV/m at 3m]: 5925.00MHz 68.00 (Margin -0.20dB) - AV	Pass
15.407(b)(6)	In-Band Emissions (Mask)	Meet the requirement of limit	Pass
15.407(a)(10)	Emission Bandwidth	Meet the requirement of limit	Pass
15.407(a)(5)	RF Output Power (e.i.r.p)	Max Power [dBm]: Non-beamforming mode 5925-6425MHz: 28.95 6425-6525MHz: 28.88 6525-6875MHz: 26.45 6875-7125MHz: 28.76 Beamforming mode 5925-6425MHz: 22.92 6425-6525MHz: 22.86 6525-6875MHz: 20.43 6875-7125MHz: 22.74	Pass
15.407(a)(5)	Power Spectral Density (e.i.r.p)	Meet the requirement of limit	Pass
15.407(d)(6)	Contention Based Protocol	Meet the requirement of limit	Pass
15.407(g)	Frequency Stability	Meet the requirement of limit	Pass
15.203	Antenna Requirement	Meet the requirement of limit	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:

The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

1 General Description

1.1 Information

1.1.1 Specification of the Equipment under Test (EUT)

RF General Information					
Frequency Range (MHz)	IEEE Std. 802.11	Ch. Freq. (MHz)	Channel Number	Transmit Chains (N _{TX})	Data Rate / MCS
5925 ~ 7125	ax (HE20)	5935 ~ 7115	1 ~ 233 [60]	4	MCS 0-11
5925 ~ 7125	ax (HE40)	5965 ~ 7085	3 ~ 227 [29]	4	MCS 0-11
5925 ~ 7125	ax (HE80)	5985 ~ 7025	7 ~ 215 [14]	4	MCS 0-11
5925 ~ 7125	ax (HE160)	6025 ~ 6985	15 ~ 207 [7]	4	MCS 0-11
5925 ~ 7125	be (EHT20)	5935 ~ 7115	1 ~ 233 [60]	4	MCS 0-13
5925 ~ 7125	be (EHT40)	5965 ~ 7085	3 ~ 227 [29]	4	MCS 0-13
5925 ~ 7125	be (EHT80)	5985 ~ 7025	7 ~ 215 [14]	4	MCS 0-13
5925 ~ 7125	be (EHT160)	6025 ~ 6985	15 ~ 207 [7]	4	MCS 0-13
5925 ~ 7125	be (EHT320)	6105 ~ 6905	31 ~ 191 [6]	4	MCS 0-13

Note 1: BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM and 4096QAM modulation.
Note 2: 802.11ax/be supports beamforming function.

1.1.2 Antenna Details

Brand	Model	Type	Connector	Operating Frequencies (MHz) / Gain (dBi)			
				5925~6425	6425~6525	6525~6875	6875~7125
D047	Antenna 11	PIFA	UFL	6.47	7.53	7.53	6.4
D047	Antenna 12	PIFA	UFL	6.19	5.7	5.7	5.73
D047	Antenna 13	PIFA	UFL	7.37	6.86	6.86	6.75
D047	Antenna 14	PIFA	UFL	7.9	7.64	7.64	6.91
D047	Antenna 15	PIFA	UFL	9.01	7.16	7.16	7.8
D047	Antenna 16	PIFA	UFL	7.16	6.89	6.89	7.85

Note: There are 2 antenna configurations for 5GHz

Configuration 1: Antenna 11/12/13/15

Configuration 2: Antenna 11/12/14/16

1.1.3 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	15Vdc from adapter 56Vdc from PoE injector
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Note: The above power supplies are not bundled in market.

1.1.4 Accessories

N/A

1.1.5 Channel List

ax HE20 / be EHT20							
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
2	5935	57	6235	117	6535	177	6835
1	5955	61	6255	121	6555	181	6855
5	5975	65	6275	125	6575	185	6875
9	5995	69	6295	129	6595	189	6895
13	6015	73	6315	133	6615	193	6915
17	6035	77	6335	137	6635	197	6935
21	6055	81	6355	141	6655	201	6955
25	6075	85	6375	145	6675	205	6975
29	6095	89	6395	149	6695	209	6995
33	6115	93	6415	153	6715	213	7015
37	6135	97	6435	157	6735	217	7035
41	6155	101	6455	161	6755	221	7055
45	6175	105	6475	165	6775	225	7075
49	6195	109	6495	169	6795	229	7095
53	6215	113	6515	173	6815	233	7115

ax HE40 / be EHT40							
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
3	5965	67	6285	131	6605	195	6925
11	6005	75	6325	139	6645	203	6965
19	6045	83	6365	147	6685	211	7005
27	6085	91	6405	155	6725	219	7045
35	6125	99	6445	163	6765	227	7085
43	6165	107	6485	171	6805	---	---
51	6205	115	6525	179	6845	---	---
59	6245	123	6565	187	6885	---	---

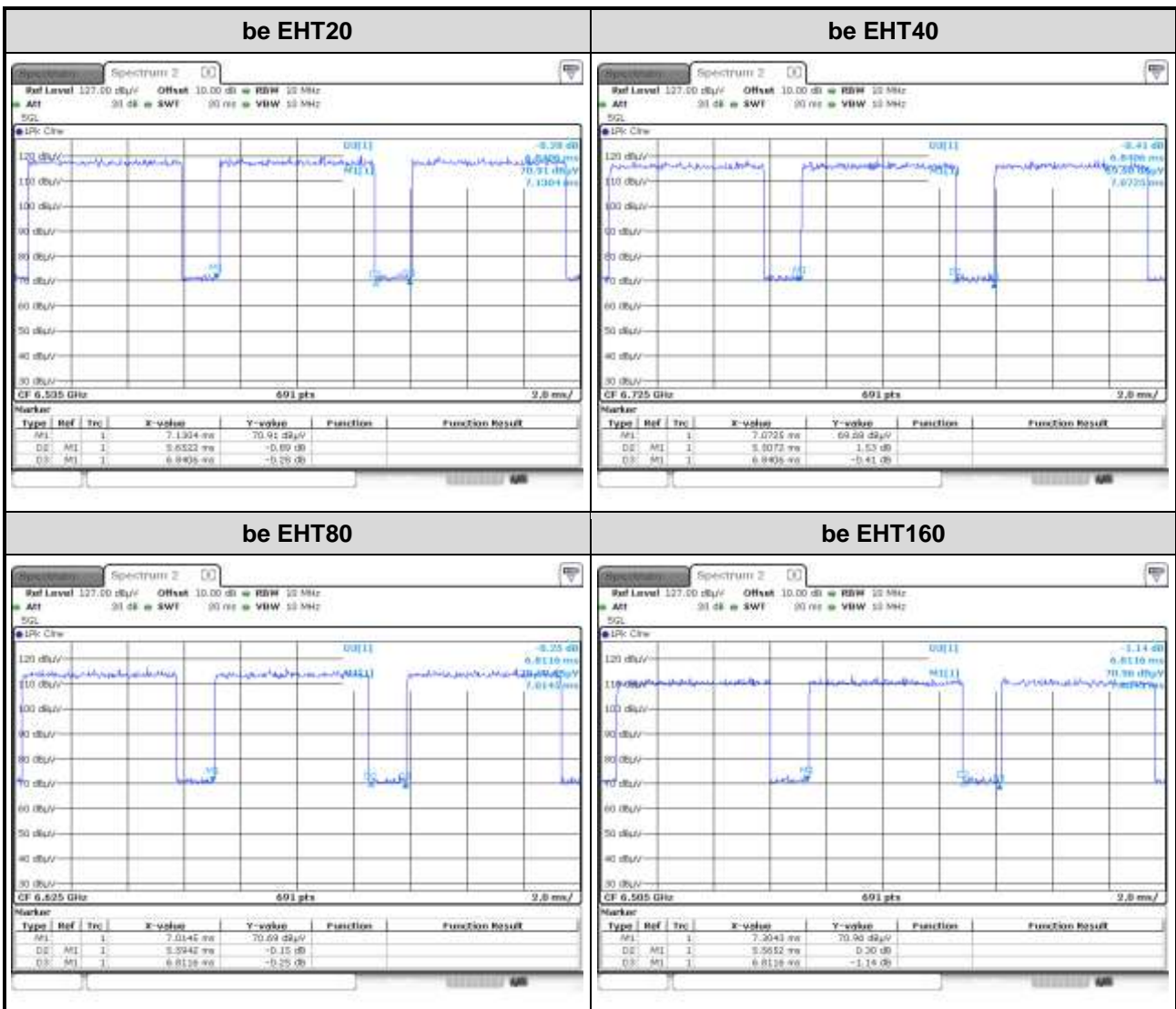
ax HE80 / be EHT80							
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
7	5985	71	6305	135	6625	199	6945
23	6065	87	6385	151	6705	215	7025
39	6145	103	6465	167	6785	---	---
55	6225	119	6545	183	6865	---	---

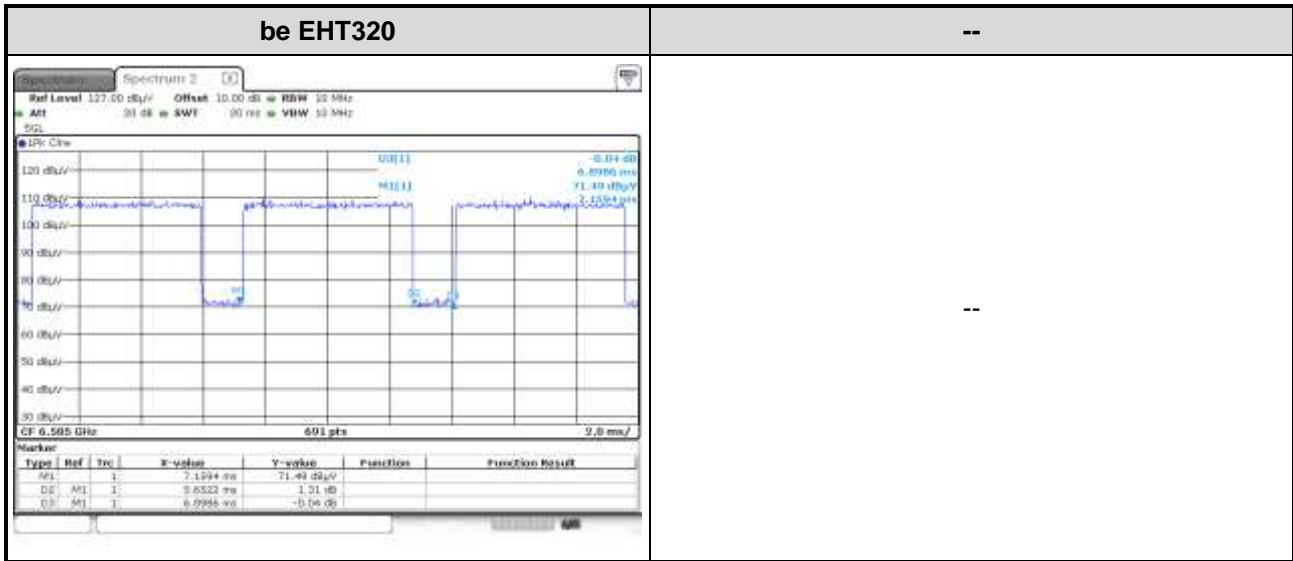
ax HE160 / be EHT160							
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
15	6025	79	6345	143	6665	207	6985
47	6185	111	6505	175	6825	---	---

be EHT320							
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	---	---
31	6105	95	6425	159	6745	---	---
63	6265	127	6585	191	6905	---	---

1.1.6 Test Tool and Duty Cycle

Test Tool	QSPR, version: 5.0-00202		
Duty Cycle and Duty Factor	Mode	Duty Cycle (%)	Duty Factor (dB)
	be EHT20	82.63%	0.83
	be EHT40	80.51%	0.94
	be EHT80	82.13%	0.86
	be EHT160	81.70%	0.88
	be EHT320	81.93%	0.87





1.1.7 Power Index of Test Tool

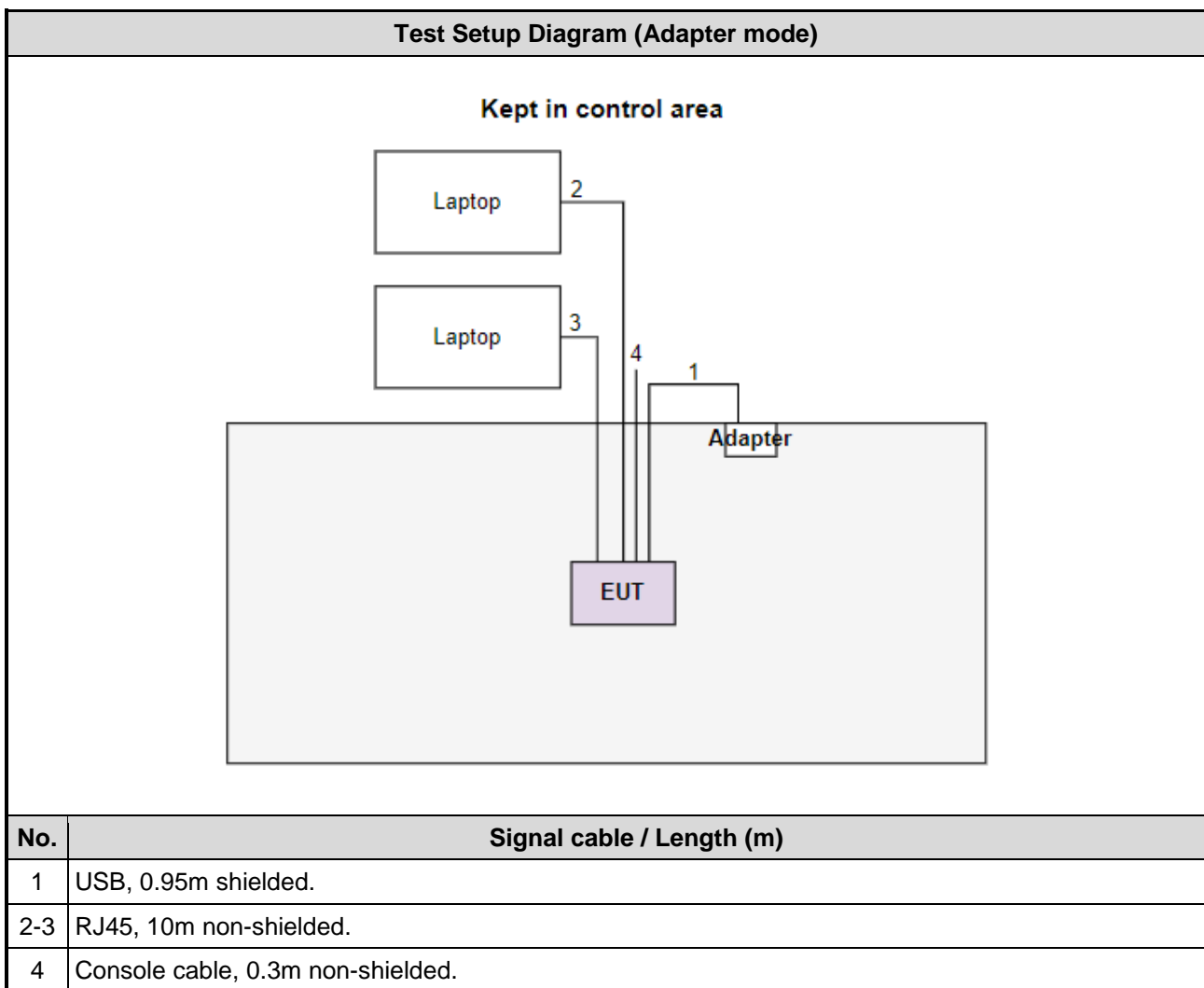
Modulation Mode	Test Frequency (MHz)	Power Index
be EHT20	5935	2
be EHT20	5955	4
be EHT20	6175	5
be EHT20	6415	4
be EHT20	6435	4.5
be EHT20	6475	5
be EHT20	6515	5
be EHT20	6535	5
be EHT20	6715	5
be EHT20	6855	5
be EHT20	6875	5
be EHT20	6895	5
be EHT20	7015	5.5
be EHT20	7095	5
be EHT20	7115	-1
be EHT40	5965	7
be EHT40	6165	7
be EHT40	6405	7
be EHT40	6445	8
be EHT40	6485	8
be EHT40	6525	7.5
be EHT40	6565	7.5

be EHT40	6725	7.5
be EHT40	6845	7.5
be EHT40	6885	7.5
be EHT40	6925	7.5
be EHT40	7005	8
be EHT40	7085	8
be EHT80	5985	10
be EHT80	6145	10
be EHT80	6385	10
be EHT80	6465	10.5
be EHT80	6545	10.5
be EHT80	6625	10.5
be EHT80	6705	11
be EHT80	6785	11
be EHT80	6865	10.5
be EHT80	6945	10.5
be EHT80	7025	11
be EHT160	6025	12.5
be EHT160	6185	12.5
be EHT160	6345	12.5
be EHT160	6505	13
be EHT160	6665	13
be EHT160	6825	13
be EHT160	6985	13
be EHT320	6105	15.5
be EHT320	6265	15.5
be EHT320	6425	16
be EHT320	6585	16
be EHT320	6745	16
be EHT320	6905	16

1.2 Local Support Equipment List

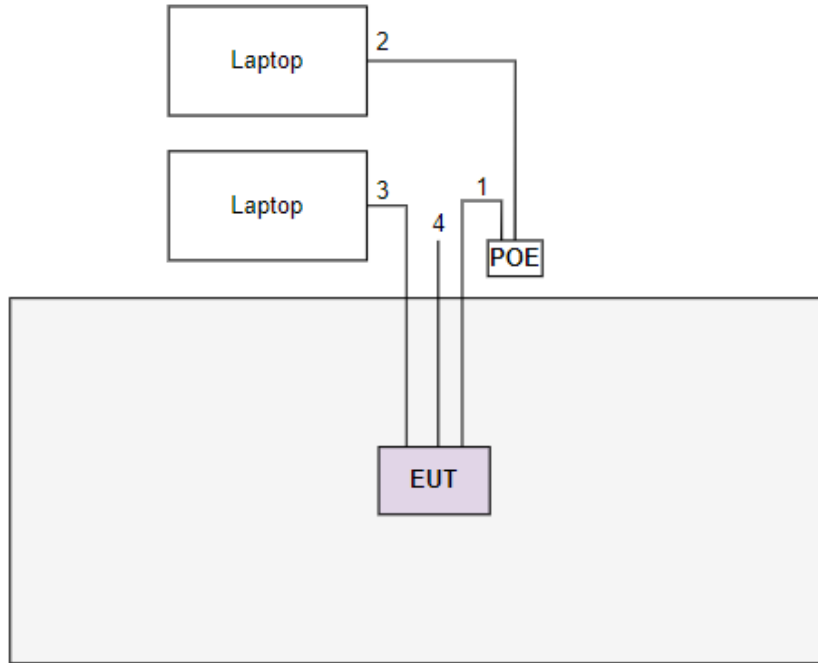
Support Equipment List					
No.	Equipment	Brand	Model	FCC ID	Remarks
1	Laptop	DELL	Latitude 5400	DoC	---
2	Laptop	DELL	Latitude E5470	DoC	---
3	PoE injector	ZYXEL	PoE12-60W	---	Provided by applicant. Remarks: I/P: 100-240V~50-60Hz 2.0A O/P: 56.0V=1.161A, 65.1W
4	Adapter	DEEVAN	DSA-45PDH	---	Provided by applicant. Remarks: I/P: 100-240V~50/60Hz 1.5A O/P: +15.0V=3.0A, 45.0W

1.3 Test Setup Chart



Test Setup Diagram (POE mode)

Kept in control area



No.	Signal cable / Length (m)
1	RJ45, 10m non-shielded.
2	RJ45, 1.3m non-shielded.
3	RJ45, 10m non-shielded.
4	Console cable, 0.3m non-shielded.

1.4 The Equipment List

Test Item	Conducted Emission				
Test Site	Conduction room 1 / (CO01-WS)				
Tested Date	Aug. 23, 2023				
Instrument	Brand	Model No.	Serial No.	Calibration Date	Calibration Until
Receiver	R&S	ESR3	101658	Feb. 17, 2023	Feb. 16, 2024
LISN	R&S	ENV216	101579	May 09, 2023	May 08, 2024
LISN (Support Unit)	SCHWARZBECK	Schwarzbeck 8127	8127667	Jan .03, 2023	Jan .02, 2024
RF Cable-CON	Woken	CFD200-NL	CFD200-NL-001	Oct. 17, 2022	Oct. 16, 2023
50 ohm terminal (Support Unit)	NA	50	01	Jun. 14, 2023	Jun. 13, 2024
Measurement Software	AUDIX	e3	6.120210k	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	Radiated Emission				
Test Site	966 chamber3 / (03CH03-WS)				
Tested Date	Aug. 08 ~ Aug. 17, 2023				
Instrument	Brand	Model No.	Serial No.	Calibration Date	Calibration Until
Receiver	R&S	ESR3	101657	Mar. 03, 2023	Mar. 02, 2024
Spectrum Analyzer	R&S	FSV40	101499	Mar. 16, 2023	Mar. 15, 2024
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 01, 2022	Oct. 31, 2023
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-685	Jul. 04, 2023	Jul. 03, 2024
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1206	Dec. 15, 2022	Dec. 14, 2023
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA 9170517	Oct. 27, 2022	Oct. 26, 2023
Preamplifier	EMC	EMC02325	980187	Jul. 10, 2023	Jul. 09, 2024
Preamplifier	EMC	EMC184045SE	980897	Aug. 01, 2023	Jul. 31, 2024
Preamplifier	EMC	EMC184045SE	980903	Jul. 17, 2023	Jul. 16, 2024
Loop Antenna Cable	KOAX KABEL	101354-BW	101354-BW	Oct. 04, 2022	Oct. 03, 2023
LF cable-0.8M	EMC	EMC8D-NM-NM-800	EMC8D-NM-NM-800-001	Sep. 23, 2022	Sep. 22, 2023
LF cable-3M	EMC	EMC8D-NM-NM-3000	131103	Sep. 23, 2022	Sep. 22, 2023
LF cable-13M	EMC	EMC8D-NM-NM-13000	131104	Sep. 23, 2022	Sep. 22, 2023
RF cable-3M	HUBER+SUHNER	SUCOFLEX104	MY22620/4	Sep. 23, 2022	Sep. 22, 2023
RF cable-8M	EMC	EMC104-SM-SM-8000	181107	Sep. 23, 2022	Sep. 22, 2023
HIGHPASS FILTER 7.5-18G	STI	STI15-9722	STI-HP7.5G-B	Dec. 08, 2022	Dec. 07, 2023
Attenuator	Pasternack	PE7005-10	10-3	Oct. 14, 2022	Oct. 13, 2023
Measurement Software	AUDIX	e3	6.120210g	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	RF Conducted				
Test Site	(TH01-WS)				
Tested Date	Aug. 11 ~ Aug. 19, 2023				
Instrument	Brand	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101910	Apr. 14, 2023	Apr. 13, 2024
Spectrum Analyzer	Agilent	N9010A	MY53400091	Nov. 15, 2022	Nov. 14, 2023
Power Meter	Anritsu	ML2495A	1241002	Nov. 23, 2022	Nov. 22, 2023
Power Sensor	Anritsu	MA2411B	1207366	Nov. 23, 2022	Nov. 22, 2023
TEMP&HUMIDITY CHAMBER	GIANT FORCE	GCT-225-40-SP-SD	MAF1212-002	Jun. 21, 2023	Jun. 20, 2024
AC POWER SOURCE	APC	AFC-500W	F312060012	Dec. 09, 2022	Dec. 08, 2023
Attenuator	Pasternack	PE7005-10	10-2	Oct. 06, 2022	Oct. 05, 2023
Measurement Software	Sporton	SENSE-15407_NII	V5.11	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	CBP (Contention Based Protocol)				
Test Site	(TH01-WS)				
Tested Date	Aug. 16, 2023				
Instrument	Brand	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101910	Apr. 14, 2023	Apr. 13, 2024
AWGN Signal Generator	R&S	SMW200A	109619	Jul. 28, 2023	Jul. 27, 2024
Splitter	woken	0120A02201801O	DOM2AEW1A23	Oct. 13, 2022	Oct. 12, 2023
Directional Coupler	KRYTAR	180120	146890	Oct. 14, 2022	Oct. 13, 2023
RF Cable	WOKEN	woken-S05	S05-141231-110	Aug. 31, 2022	Aug. 30, 2023
RF Cable	EMC	EMC105SFF-SM-SM-2000	210816	Aug. 31, 2022	Aug. 30, 2023
RF Cable	EMC	EMC104-SM-SM-8000	181106	Aug. 31, 2022	Aug. 30, 2023
Attenuator	woken	PE7013-10	10-1	Oct. 14, 2022	Oct. 13, 2023
Attenuator	woken	PE7013-20	20-1	Oct. 14, 2022	Oct. 13, 2023
Measurement Software	NA	NA	NA	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

1.5 Test Standards

47 CFR FCC Part 15.407
ANSI C63.10-2013

1.6 Reference Guidance

FCC KDB 987594 D02 U-NII 6GHz EMC Measurement v02r02
 FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01
 FCC KDB 412172 D01 Determining ERP and EIRP v01r01
 FCC KDB 662911 D01 Multiple Transmitter Output v02r01

1.7 Deviation from Test Standard and Measurement Procedure

None

1.8 Measurement Uncertainty

The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor (k=2)).

Measurement Uncertainty	
Parameters	Uncertainty
Bandwidth	±34.130 Hz
Conducted power	±0.808 dB
Frequency error	±1x10 ⁻⁹
Power density	±0.583 dB
Conducted emission	±2.715 dB
AC conducted emission	±2.92 dB
Unwanted Emission ≤ 1GHz	±3.96 dB
Unwanted Emission > 1GHz	±4.51 dB
Time	±0.1%
Temperature	±0.4 °C

2 Test Configuration

2.1 Testing Facility

Test Laboratory	International Certification Corporation
Test Site	CO01-WS, TH01-WS
Address of Test Site	No.3-1, Lane 6, Wen San 3rd St., Kwei Shan Dist., Tao Yuan City 33381, Taiwan (R.O.C.)
Test Site	03CH03-WS
Address of Test Site	No.14-1, Lane 19, Wen San 3rd St., Kwei Shan Dist., Tao Yuan City 33381, Taiwan (R.O.C.)

- FCC Designation No.: TW0009
- FCC site registration No.: 207696
- ISED#: 10807C
- CAB identifier: TW2732

2.2 Test Worst Modes and Channel Details

Test item	Modulation Mode	Test Frequency (MHz)	Data Rate	Test Configuration
Non-beamforming mode				
AC Power Line Conducted Emissions	be EHT320	6585	MCS 0	1, 2
Unwanted Emissions ≤1GHz	be EHT320	6585	MCS 0	1, 2
Unwanted Emissions >1GHz RF Output Power Emission Bandwidth Power Spectral Density In-Band Emissions	be EHT20	5935 / 5955 / 6175 / 6415 / 6435 / 6475 / 6515 / 6535 / 6715 / 6855 / 6875 / 6895 / 7015 / 7095 / 7115	MCS 0	1
	be EHT40	5965 / 6165 / 6405 / 6445 / 6485 / 6525 / 6565 / 6725 / 6845 / 6885 / 6925 / 7005 / 7085	MCS 0	
	be EHT80	5985 / 6145 / 6385 / 6465 / 6545 / 6625 / 6705 / 6785 / 6865 / 6945 / 7025	MCS 0	
	be EHT160	6025 / 6185 / 6345 / 6505 / 6665 / 6825 / 6985	MCS 0	
	be EHT320	6105 / 6265 / 6425 / 6585 / 6745 / 6905	MCS 0	
Contention Based Protocol	be EHT20	6195 / 6475 / 6695 / 6995	MCS 0	1
	be EHT320	6105 / 6585 / 6905	MCS 0	
Frequency Stability	Un-modulation	6475 / 7015	---	1
Beamforming mode				
RF Output Power	be EHT20	5935 / 5955 / 6175 / 6415 / 6435 / 6475 / 6515 / 6535 / 6715 / 6855 / 6875 / 6895 / 7015 / 7095 / 7115	MCS 0	1
	be EHT40	5965 / 6165 / 6405 / 6445 / 6485 / 6525 / 6565 / 6725 / 6845 / 6885 / 6925 / 7005 / 7085	MCS 0	
	be EHT80	5985 / 6145 / 6385 / 6465 / 6545 / 6625 / 6705 / 6785 / 6865 / 6945 / 7025	MCS 0	
	be EHT160	6025 / 6185 / 6345 / 6505 / 6665 / 6825 / 6985	MCS 0	
	be EHT320	6105 / 6585 / 6905	MCS 0	
NOTE:				
1. The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-plane. The Y-plane results were found as the worst case and were shown in this report.				
2. The EUT had been tested by following test configurations. 1) Configuration 1: Adapter mode 2) Configuration 2: POE mode				
3. Beamforming mode is calculated not measured. The calculation method is conducted power of non-beamforming – 6.02dB.				

4. There are 2 antenna configurations as below
Antenna configuration 1: Antenna 11/12/13/15
Antenna configuration 2: Antenna 11/12/14/16
The antenna configuration 2 results were found as the worst case of radiated emission and were shown in this report.

3 Transmitter Test Results

3.1 Emission Bandwidth

3.1.1 Limit

The maximum transmitter channel bandwidth for U-NII devices in the 5.925-7.125 GHz band is 320 megahertz.

3.1.2 Test Procedures

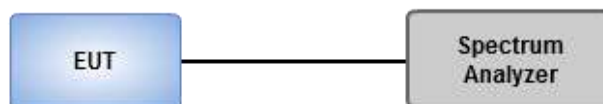
26dB Bandwidth

1. Set RBW = approximately 1% of the emission bandwidth.
2. Set the VBW > RBW, Detector = Peak.
3. Trace mode = max hold.
4. Measure the maximum width of the emission that is 26 dB down from the peak of the emission.

Occupied Bandwidth

1. Set RBW = 1 % to 5 % of the OBW.
2. Set VBW \geq 3 RBW.
3. Sample detection and single sweep mode shall be used.
4. Use the 99 % power bandwidth function of the instrument.

3.1.3 Test Setup



3.1.4 Test Result

Ambient Condition	24-25°C / 64-67%	Tested By	Roger Lu
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Refer to Appendix A.

3.2 RF Output Power

3.2.1 Limit

Frequency Band	Operating Mode	Maximum EIRP Limit
5925 ~ 7125 MHz	<input checked="" type="checkbox"/> Indoor access point	30 dBm
	<input type="checkbox"/> Subordinate device	30 dBm
	<input type="checkbox"/> Client devices	24 dBm

3.2.2 Test Procedures

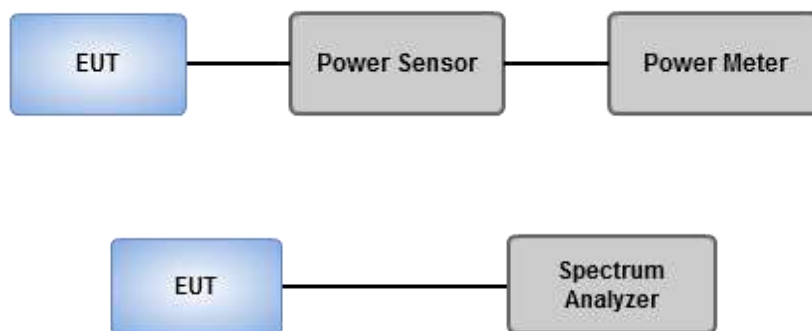
Method PM-G (Measurement using a gated RF average power meter)

1. Measurements is performed using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.
2. $EIRP = \text{Measured conducted power} + \text{Antenna gain}$

Spectrum analyzer (For channel that extends across the 6.525 / 6.875 GHz boundary)

1. Set RBW = 1MHz, VBW = 3MHz, Sweep time = Auto, Detector = RMS.
2. Trace average at least 100 traces in power averaging mode.
3. Compute power by integrating the spectrum across the 26 dB EBW.
4. Add $10 \log(1/X, X:\text{duty cycle})$ if duty cycle is <98%.
5. $EIRP = \text{Measured conducted power} + \text{Antenna gain}$

3.2.3 Test Setup



3.2.4 Test Result

Ambient Condition	24-25°C / 64-67%	Tested By	Roger Lu
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Refer to Appendix B.

3.3 Power Spectral Density

3.3.1 Limit

Frequency Band	Operating Mode	Limit
5925 ~ 7125 MHz	<input checked="" type="checkbox"/> Indoor access point	EIRP: 5 dBm / 1 MHz
	<input type="checkbox"/> Subordinate device	EIRP: 5 dBm / 1 MHz
	<input type="checkbox"/> Client devices	EIRP: -1 dBm / 1 MHz

3.3.2 Test Procedures

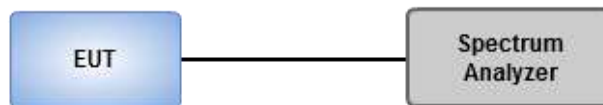
Duty cycle \geq 98 %

1. Set RBW = 1 MHz, VBW = 3 MHz, Sweep time = auto, Detector = RMS.
2. Trace average 100 traces.
3. Use the peak marker function to determine the maximum amplitude level.
4. EIRP PSD = Measured conducted power density + Antenna gain

Duty cycle < 98 %

1. Set RBW = 1 MHz, VBW = 3 MHz, Detector = RMS.
2. Set sweep time $\geq 10 * (\text{number of points in sweep}) * (\text{total on/off period of the transmitted signal})$.
3. Perform a single sweep.
4. Use the peak marker function to determine the maximum amplitude level.
5. Add $10 \log(1/x)$, where x is the duty cycle.
6. EIRP PSD = Measured conducted power density + Antenna gain

3.3.3 Test Setup



3.3.4 Test Result

Ambient Condition	24-25°C / 64-67%	Tested By	Roger Lu
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Refer to Appendix C.

3.4 Unwanted Emissions

3.4.1 Limit of Unwanted Emissions

Restricted Band Emissions Limit			
Frequency Range (MHz)	Field Strength (uV/m)	Field Strength (dBuV/m)	Measure Distance (m)
0.009~0.490	2400/F(kHz)	48.5 - 13.8	300
0.490~1.705	24000/F(kHz)	33.8 - 23	30
1.705~30.0	30	29	30
30~88	100	40	3
88~216	150	43.5	3
216~960	200	46	3
Above 960	500	54	3

Note 1:
Qusai-Peak value is measured for frequency below 1GHz except for 9–90 kHz, 110–490 kHz frequency band. Peak and average value are measured for frequency above 1GHz. The limit on average radio frequency emission is as above table. The limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit

Note 2:
Measurements may be performed at a distance other than what is specified provided. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor as below, Frequency at or above 30 MHz: 20 dB/decade Frequency below 30 MHz: 40 dB/decade.

Un-restricted band emissions above 1GHz Limit		
Operating Band	PK Limit	AV Limit
5.925 – 7.125 GHz	e.i.r.p. -7 dBm [88.2 dBuV/m@3m]	e.i.r.p. -27 dBm [68.2 dBuV/m@3m]

Note 1: Measurements may be performed at a distance other than the limit distance provided they are not performed in the near field and the emissions to be measured can be detected by the measurement equipment. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse of linear distance for field-strength measurements, inverse of linear distance-squared for power-density measurements).

3.4.2 Test Procedures

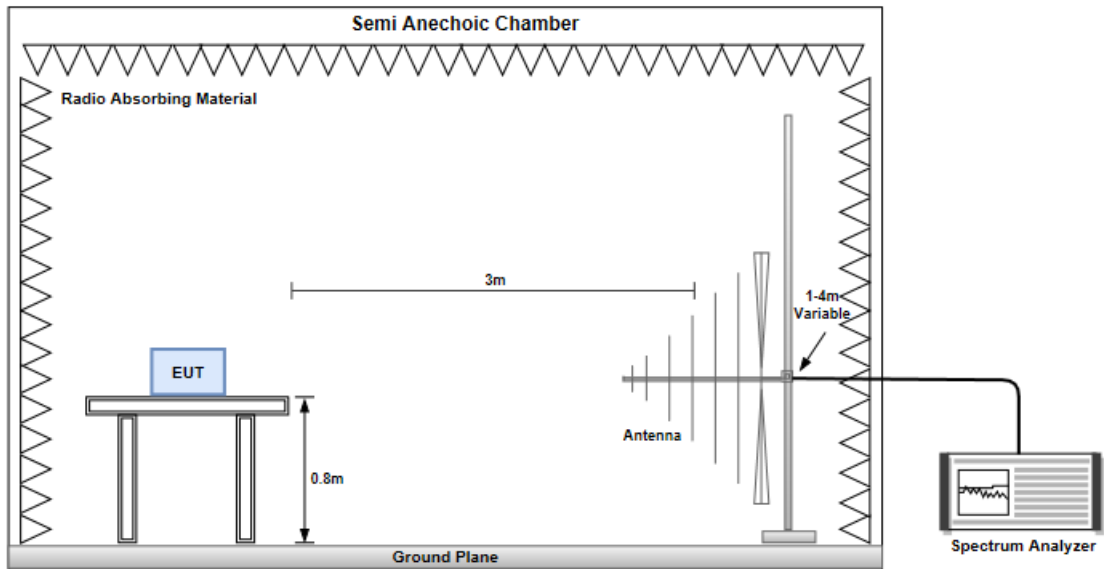
1. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission frequency. The EUT is placed at test table. For emissions testing at or below 1 GHz, the table height is 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height is 1.5 m
2. Measurement is made with the antenna positioned in both the horizontal and vertical planes of polarization. The measurement antenna is varied in height (1m ~ 4m) above the reference ground plane to obtain the maximum signal strength. Distance between EUT and antenna is 3 m.
3. This investigation is performed with the EUT rotated 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations.

Note:

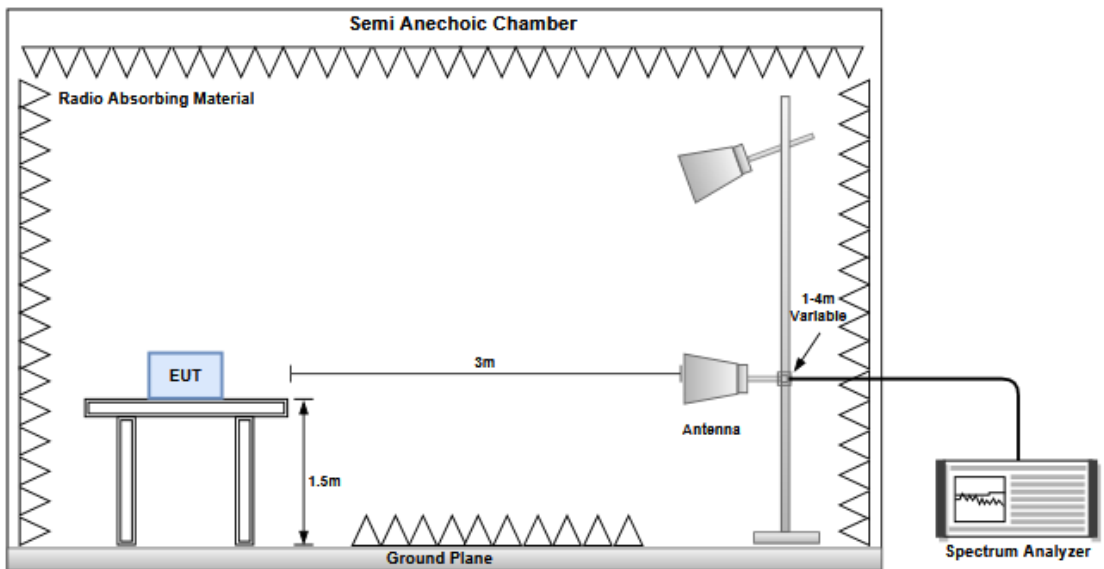
1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.
2. RBW=1MHz, VBW=3MHz and Peak detector is for peak measured value of radiated emission above 1GHz.
3. RBW=1MHz, VBW=1/T and Peak detector is for average measured value of radiated emission above 1GHz.

3.4.3 Test Setup

Radiated Emissions below 1 GHz



Radiated Emissions above 1 GHz



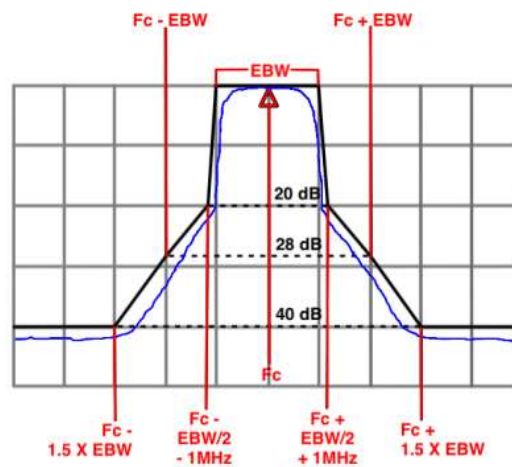
3.4.4 Test Results

Refer to Appendix D.

3.5 In-Band Emissions

3.5.1 Limit

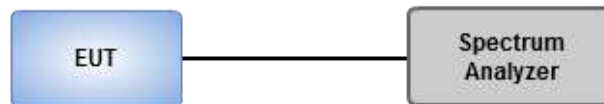
Power spectral density must be suppressed by 20 dB at 1 MHz outside of channel edge, by 28 dB at one channel bandwidth from the channel center, and by 40 dB at one- and one-half times the channel bandwidth away from channel center. At frequencies between one megahertz outside an unlicensed device's channel edge and one channel bandwidth from the center of the channel, the limits must be linearly interpolated between 20 dB and 28 dB suppression, and at frequencies between one and one- and one-half times an unlicensed device's channel bandwidth, the limits must be linearly interpolated between 28 dB and 40 dB suppression. Emissions removed from the channel center by more than one- and one-half times the channel bandwidth must be suppressed by at least 40 dB.



3.5.2 Test Procedures

1. Connect output of the antenna port to a spectrum analyzer
2. Set the reference level of the measuring equipment
3. Measure the 26 dB EBW
4. Measure the power spectral density (which will be used for emissions mask reference) using the following procedure:
 - a) Set the span to encompass the entire 26 dB EBW of the signal.
 - b) Set RBW = same RBW used for 26 dB EBW measurement.
 - c) Set VBW $\geq 3 \times$ RBW
 - d) Number of points in sweep $\geq [2 \times \text{span} / \text{RBW}]$.
 - e) Sweep time = auto.
 - f) Detector = RMS (i.e., power averaging)
 - g) Trace average at least 100 traces in power averaging (rms) mode.
 - h) Use the peak search function on the instrument to find the peak of the spectrum.
5. For the purposes of developing the emission mask, the channel bandwidth is defined as the 26 dB EBW
6. Using the measuring equipment limit line function, develop the emissions mask based on the following requirements. The emissions power spectral density must be reduced below the peak power spectral density (in dB) as follows
 - a. Suppressed by 20 dB at 1 MHz outside of the channel edge. (The channel edge is defined as the 26-dB point on either side of the carrier center frequency.)
 - b. Suppressed by 28 dB at one channel bandwidth from the channel center.
 - c. Suppressed by 40 dB at one- and one-half times the channel bandwidth from the channel center.
7. Adjust the span to encompass the entire mask as necessary
8. Clear trace.
9. Trace average at least 100 traces in power averaging (rms) mode.
10. Adjust the reference level as necessary so that the crest of the channel touches the top of the emission mask

3.5.3 Test Setup



3.5.4 Test Results

Ambient Condition	24-25°C / 64-67%	Tested By	Roger Lu
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Refer to Appendix E.

3.6 Frequency Stability

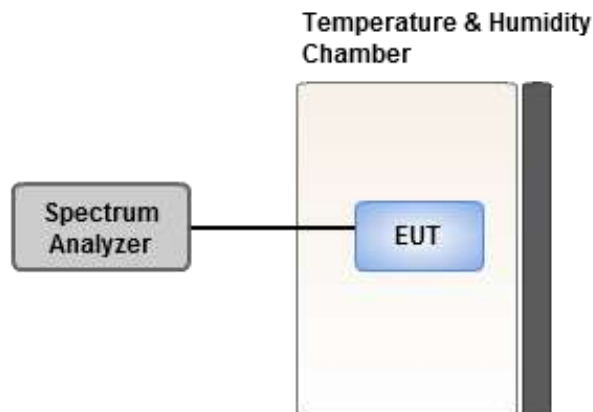
3.6.1 Limit of Frequency Stability

Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual.

3.6.2 Test Procedures

1. The EUT is installed in an environment test chamber with external power source.
2. Set the chamber to operate at 20 centigrade and external power source to output at nominal voltage of EUT.
3. A sufficient stabilization period at each temperature is used prior to each frequency measurement.
4. When temperature is stabled, measure the frequency stability.
5. The test shall be performed under normal and extreme condition for temperature and voltage.

3.6.3 Test Setup



3.6.4 Test Result of Frequency Stability

Ambient Condition	24-25°C / 64-67%	Tested By	Roger Lu
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Refer to Appendix F.

3.7 Contention Based Protocol

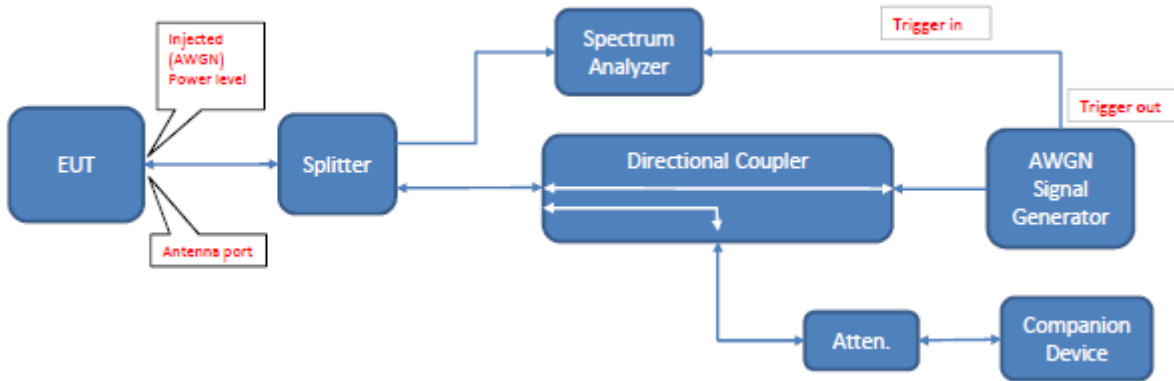
3.7.1 Limit

Unlicensed low-power indoor devices must detect co-channel radio frequency power that is at least -62 dBm or lower. The -62 dBm (or lower) threshold is referenced to a 0 dBi antenna gain. Additionally, low-power indoor devices must detect co-channel energy with 90% or greater certainty

3.7.2 Test Procedure

1. Configure the EUT to transmit with a constant duty cycle
2. Set the operating parameters of the EUT including power level, operating frequency, modulation and bandwidth
3. Set the signal analyzer center frequency to the nominal EUT channel center frequency. The span range of the signal analyzer shall be between two times and five times the OBW of the EUT. Connect the output port of the EUT to the signal analyzer 2, as shown in Figure 2. Ensure that the attenuator 2 provides enough attenuation to not overload the signal analyzer 2 receiver.
4. Monitoring the signal analyzer 2, verify the EUT is operating and transmitting with the parameters set at step two.
5. Using an AWGN signal source, generate (but do not transmit, i.e., RF OFF) a 10 MHz-wide AWGN signal. Use Table 1 to determine the center frequency of the 10 MHz AWGN signal relative to the EUT's channel bandwidth and center frequency.
6. Set the AWGN signal power to an extremely low level (more than 20 dB below the -62 dBm threshold). Connect the AWGN signal source, via a 3-dB splitter, to the signal analyzer 1 and the EUT as shown in Figure 2
7. Transmit the AWGN signal (RF ON) and verify its characteristics on the signal analyzer 1.
8. Monitor the signal analyzer 2 to verify if the AWGN signal has been detected and the EUT has ceased transmission. If the EUT continues to transmit, then incrementally increase the AWGN signal power level until the EUT stops transmitting.
9. (Including all losses in the RF paths) Determine and record the AWGN signal power level (at the EUT's antenna port) at which the EUT ceased transmission. Repeat the procedure at least 10 times to verify the EUT can detect an AWGN signal with 90% (or better) level of certainty.
10. Refer to Table 1 to determine number of times the detection threshold testing needs to be repeated. If testing is required more than once, then go back to step 5, choose a different center frequency for the AWGN signal and repeat the process.

3.7.3 Test Setup



3.7.4 Test Result

Ambient Condition	24°C / 66%	Tested By	Aska Huang
EUT FW version	V6.65(0)b2-2023-07-12		

Refer to Appendix G.

3.8 AC Power Line Conducted Emissions

3.8.1 Limit of AC Power Line Conducted Emissions

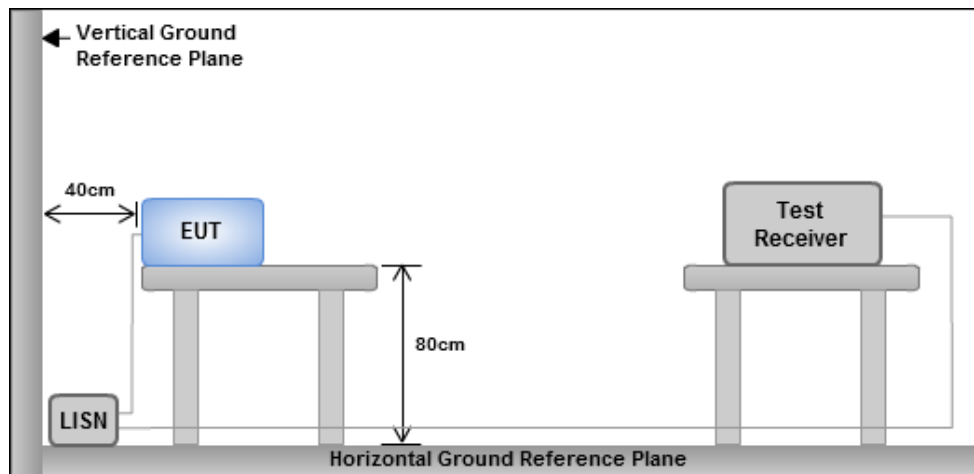
Conducted Emissions Limit		
Frequency Emission (MHz)	Quasi-Peak	Average
0.15-0.5	66 - 56 *	56 - 46 *
0.5-5	56	46
5-30	60	50

Note 1: * Decreases with the logarithm of the frequency.

3.8.2 Test Procedures

1. The device is placed on a test table, raised 80 cm above the reference ground plane. The vertical conducting plane is located 40 cm to the rear of the device.
2. The device is connected to line impedance stabilization network (LISN) and other accessories are connected to other LISN. Measured levels of AC power line conducted emission are across the 50 Ω LISN port.
3. AC conducted emission measurements is made over frequency range from 150 kHz to 30 MHz.
4. This measurement was performed with AC 120V/60Hz

3.8.3 Test Setup



- Note: 1. Support units were connected to second LISN.
 2. Both of LISNs (AMN) are 80 cm from EUT and at least 80 cm from other units and other metal planes

3.8.4 Test Result

Refer to Appendix H.

4 Test laboratory information

Established in 2012, ICC provides foremost EMC & RF Testing and advisory consultation services by our skilled engineers and technicians. Our services employ a wide variety of advanced edge test equipment and one of the widest certification extents in the business.

International Certification Corporation (EMC and Wireless Communication Laboratory), it is our definitive objective is to institute long term, trust-based associations with our clients. The expectation we set up with our clients is based on outstanding service, practical expertise and devotion to a certified value structure. Our passion is to grant our clients with best EMC / RF services by oriented knowledgeable and accommodating staff.

Our Test sites are located at Linkou District and Kwei Shan District. Location map can be found on our website <http://www.icertifi.com.tw>.

Linkou

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District, New Taipei City, Taiwan
(R.O.C.)

Kwei Shan

Tel: 886-3-271-8666

No.3-1, Lane 6, Wen San 3rd
St., Kwei Shan Dist., Tao Yuan
City 33381, Taiwan (R.O.C.)
No.2-1, Lane 6, Wen San 3rd
St., Kwei Shan Dist., Tao Yuan
City 33381, Taiwan (R.O.C.)

Kwei Shan Site II

Tel: 886-3-271-8640

No.14-1, Lane 19, Wen San 3rd
St., Kwei Shan Dist., Tao Yuan
City 33381, Taiwan (R.O.C.)

If you have any suggestion, please feel free to contact us as below information.

Tel: 886-3-271-8666

Fax: 886-3-318-0345

Email: ICC_Service@icertifi.com.tw

==END==