

TEST REPORT

Reference No...... : WTX24X10240772W002
FCC ID : 2AKIT-WSK02E
Applicant : Lumi United Technology Co., Ltd
Address : B1, Chongwen Park, Nanshan iPark, Liuxian Avenue, Taoyuan Residential District, Nanshan District, Shenzhen 518000, China
Manufacturer : The same as Applicant
Address : The same as Applicant
Product Name : Light Switch H2 US (4 Buttons, 3 Channels), Light Switch H2 US (2 Buttons, 2 Channels), Light Switch H2 US (2 Buttons, 1 Channel)
Model No...... : WS-K04E
Standards : FCC Part 15.247
Date of Receipt sample : 2024-10-18
Date of Test..... : 2024-10-18 to 2024-11-14
Date of Issue : 2024-11-14
Test Report Form No. : WTX_Part 15_247W
Test Result..... : **Pass**

Remarks:

The results shown in this test report refer only to the sample(s) tested, this test report cannot be reproduced, except in full, without prior written permission of the company. The report would be invalid without specific stamp of test institute and the signatures of approver.

Prepared By:

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Report version

Version No.	Date of issue	Description
Rev.00	2024-11-14	Original
/	/	/

1. GENERAL INFORMATION

1.1 Product Description for Equipment Under Test (EUT)

General Description of EUT	
Product Name:	Light Switch H2 US (4 Buttons, 3 Channels), Light Switch H2 US (2 Buttons, 2 Channels), Light Switch H2 US (2 Buttons, 1 Channel)
Trade Name:	Aqara
Model No.:	WS-K04E
Adding Model(s):	WS-K03E, WS-K02E
Rated Voltage:	AC120V
<i>Note: The test data is gathered from a production sample provided by the manufacturer. The appearance of others models listed in the report is different from main-test model WS-K04E, but the circuit and the electronic construction do not change, declared by the manufacturer.</i>	

Technical Characteristics of EUT	
Frequency Range:	2405-2480MHz
RF Output Power:	5.62dBm (Conducted)
Type of Modulation:	QPSK
Quantity of Channels:	16
Channel Separation:	5MHz
Type of Antenna:	Integral Antenna
Antenna Gain:	1dBi
<i>Note The Antenna Gain is provided by the customer and can affect the validity of results.</i>	

1.2 Test Standards

The tests were performed according to following standards:

FCC Rules Part 15.247: Frequency Hopping, Direct Spread Spectrum and Hybrid Systems that are in operation within the bands of 902-928MHz, 2400-2483.5MHz, and 5725-5850MHz.

558074 D01 DTS Meas Guidance v05r02: Guidance for performing Compliance Measurement on Digital Transmission Systems operating under section 15.247.

ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product, which result in lowering the emission, should be checked to ensure compliance has been maintained.

1.3 Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, KDB 558074 D01 DTS Meas Guidance v05r02.

The equipment under test (EUT) was configured to measure its highest possible emission level. The test modes were adapted accordingly in reference to the Operating Instructions.

1.4 Test Facility

Address of the test laboratory

Laboratory: Waltek Testing Group (Shenzhen) Co., Ltd.

Address: 1/F., Room 101, Building 1, Hongwei Industrial Park, Liuxian 2nd Road, Block 70 Bao'an District, Shenzhen, Guangdong, China

FCC – Registration No.: 125990

Waltek Testing Group (Shenzhen) Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the FCC (Federal Communications Commission). The acceptance letter from the FCC is maintained in our files. The Designation Number is CN5010, and Test Firm Registration Number is 125990.

Industry Canada (IC) Registration No.: 11464A

The 3m Semi-anechoic chamber of Waltek Testing Group (Shenzhen) Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 11464A and the CAB identifier is CN0057.

1.5 EUT Setup and Test Mode

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. All testing shall be performed under maximum output power condition, with a duty cycle equal to 100%, and to measure its highest possible emissions level, more detailed description as follows:

Test Mode List		
Test Mode	Description	Remark
TM1	Low	2405MHz
TM2	Middle	2440MHz
TM3	High	2480MHz

Test Conditions	
Temperature:	22~25 °C
Relative Humidity:	45~75 %
ATM Pressure:	1019 mbar

EUT Cable List and Details			
Cable Description	Length (m)	Shielded/Unshielded	With / Without Ferrite
/	/	/	/

Special Cable List and Details			
Cable Description	Length (m)	Shielded/Unshielded	With / Without Ferrite
AC Cable	1.0	Unshielded	Without Ferrite

Auxiliary Equipment List and Details			
Description	Manufacturer	Model	Serial Number
/	/	/	/

1.6 Measurement Uncertainty

Measurement uncertainty		
Parameter	Conditions	Uncertainty
RF Output Power	Conducted	$\pm 0.42\text{dB}$
Occupied Bandwidth	Conducted	$\pm 1.5\%$
Power Spectral Density	Conducted	$\pm 1.8\text{dB}$
Conducted Spurious Emission	Conducted	$\pm 2.17\text{dB}$
Conducted Emissions	Conducted	9-150kHz $\pm 3.74\text{dB}$
		0.15-30MHz $\pm 3.34\text{dB}$
Transmitter Spurious Emissions	Radiated	30-200MHz $\pm 4.52\text{dB}$
		0.2-1GHz $\pm 5.56\text{dB}$
		1-6GHz $\pm 3.84\text{dB}$
		6-26GHz $\pm 3.92\text{dB}$

1.7 Test Equipment List and Details

Fixed asset Number	Description	Manufacturer	Model	Serial No.	Cal Date	Due. Date
WTXE1041A 1001	Communication Tester	Rohde & Schwarz	CMW500	148650	2024-02-24	2025-02-23
WTXE1022A 1002	GSM Tester	Rohde & Schwarz	CMU200	114403	2024-02-27	2025-02-26
WTXE1005A 1005	Spectrum Analyzer	Agilent	N9020A	US471401 02	2024-03-19	2025-03-18
WTXE1084A 1001	Spectrum Analyzer	Agilent	N9020A	MY543205 48	2024-02-24	2025-02-23
WTXE1044A 1001	Signal Generator	Agilent	83752A	3610A014 53	2024-02-24	2025-02-23
WTXE1045A 1001	Vector Signal Generator	Agilent	N5182A	MY470702 02	2024-02-24	2025-02-23
WTXE1018A 1001	Power Divider	Weinschel	1506A	PM204	2024-02-29	2025-02-28
WTXE1103A 1003	Attenuator	Pasternack	PE4007-4	/	2024-02-24	2025-02-23
WTXE1003A 1-005	Coaxial Cable	/	0M4RFC	/	2024-07-03	2025-01-03
☐ Chamber A: Below 1GHz						
WTXE1005A 1003	Spectrum Analyzer	Rohde & Schwarz	FSP30	836079/03 5	2024-02-24	2025-02-23
WTXE1001A 1001	EMI Test Receiver	Rohde & Schwarz	ESPI	101611	2024-03-19	2025-03-18
WTXE1007A 1001	Amplifier	HP	8447F	2805A034 75	2024-02-24	2025-02-23
WTXE1010A 1007	Loop Antenna	Schwarz beck	FMZB 1516	9773	2024-02-26	2025-02-25
WTXE1010A 1006	Broadband Antenna	Schwarz beck	VULB9163	9163-333	2024-02-24	2025-02-23
WTXE1104A 1032-1	Coaxial Cable	/	RC_6G-N-M	/	2024-03-15	2025-03-14
WTXE1104A 1032-2	Coaxial Cable	/	RC_6G-N-M	/	2024-03-15	2025-03-14
WTXE1104A 1032-3	Coaxial Cable	/	RC_6G-N-M	/	2024-03-15	2025-03-14
☐ Chamber A: Above 1GHz						
WTXE1005A 1003	Spectrum Analyzer	Rohde & Schwarz	FSP30	836079/03 5	2024-02-24	2025-02-23

WTXE1001A 1001	EMI Test Receiver	Rohde & Schwarz	ESPI	101611	2024-03-19	2025-03-18
WTXE1065A 1001	Amplifier	C&D	PAP-1G18	2002	2024-02-27	2025-02-26
WTXE1010A 1005	Horn Antenna	ETS	3117	00086197	2024-02-26	2025-02-25
WTXE1010A 1010	DRG Horn Antenna	A.H. SYSTEMS	SAS-574	571	2024-03-17	2025-03-16
WTXE1003A 1001	Pre-amplifier	Schwarzbeck	BBV 9721	9721-031	2024-02-29	2025-02-28
WTXE1104A 1033-1	Coaxial Cable	/	C16-07-07	/	2024-03-15	2025-03-14
WTXE1104A 1033-2	Coaxial Cable	/	C16-07-07	/	2024-03-15	2025-03-14
WTXE1104A 1033-3	Coaxial Cable	/	C16-07-07	/	2024-03-15	2025-03-14
☐ Chamber B:Below 1GHz						
WTXE1010A 1006	Trilog Broadband Antenna	Schwarz beck	VULB9163(B)	9163-635	2024-03-17	2027-03-16
WTXE1038A 1001	Amplifier	Agilent	8447D	2944A10457	2024-02-24	2025-02-23
WTXE1001A 1002	EMI Test Receiver	Rohde & Schwarz	ESPI	101391	2024-02-24	2025-02-23
WTXE1104A 1031-1	Coaxial Cable	/	1.5MRFC-LWB3	/	2024-07-03	2025-07-02
WTXE1104A 1031-2	Coaxial Cable	/	RG 316	/	2024-07-03	2025-07-02
WTXE1104A 1031-3	Coaxial Cable	/	RG 316	/	2024-07-03	2025-07-02
☒ Chamber C:Below 1GHz						
WTXE1093A 1001	EMI Test Receiver	Rohde & Schwarz	ESIB 26	100401	2024-02-27	2025-02-26
WTXE1010A 1013-1	Trilog Broadband Antenna	Schwarz beck	VULB 9168	1194	2024-04-18	2027-04-17
WTXE1007A 1002	Amplifier	HP	8447F	2944A03869	2024-02-24	2025-02-23
WTXE1010A 1007	Loop Antenna	Schwarz beck	FMZB 1516	9773	2024-02-26	2025-02-25
WTXE1104A 1034-1	Coaxial Cable	/	RC_6G-N-M	/	2024-07-03	2025-07-02

WTXE1104A 1034-2	Coaxial Cable	/	RC_6G-N-M	/	2024-07-03	2025-07-02
WTXE1104A 1034-3	Coaxial Cable	/	RC_6G-N-M	/	2024-07-03	2025-07-02
☒ Chamber C: Above 1GHz						
WTXE1093A 1001	EMI Test Receiver	Rohde & Schwarz	ESIB 26	100401	2024-02-27	2025-02-26
WTXE1103A 1005	Horn Antenna	POAM	RTF-118A	1820	2023-03-10	2026-03-09
WTXE1103A 1006	Amplifier	Tonscend	TAP01018050	AP22E806 235	2024-02-27	2025-02-26
WTXE1010A 1010	DRG Horn Antenna	A.H. SYSTEMS	SAS-574	571	2024-03-17	2025-03-16
WTXE1003A 1001	Pre-amplifier	Schwarzbeck	BBV 9721	9721-031	2024-02-29	2025-02-28
WTXE1104A 1035-1	Coaxial Cable	/	RC-18G-N-M	/	2024-07-03	2025-07-02
WTXE1104A 1035-2	Coaxial Cable	/	RC-18G-N-M	/	2024-07-03	2025-07-02
WTXE1104A 1035-3	Coaxial Cable	/	RC-18G-N-M	/	2024-07-03	2025-07-02
☐ Conducted Room 1#						
WTXE1104A 1029	EMI Test Receiver	Rohde & Schwarz	ESCI	100525	2023-12-12	2024-12-11
WTXE1002A 1001	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100911	2024-02-24	2025-02-23
WTXE1003A 1001	AC LISN	Schwarz beck	NSLK8126	8126-279	2024-02-24	2025-02-23
WTXE1104A 1036	Coaxial Cable	/	RG 316	/	2024-07-03	2025-07-02
WTXE1104A 1038	Coaxial Cable	/	6MRFC-DP	/	2024-07-03	2025-07-02
☒ Conducted Room 2#						
WTXE1001A 1004	EMI Test Receiver	Rohde & Schwarz	ESPI	101259	2024-02-24	2025-02-23
WTXE1003A 1003	LISN	Rohde & Schwarz	ENV 216	100097	2024-02-24	2025-02-23
WTXE1104A 1037	Coaxial Cable	/	RG 316	/	2024-07-03	2025-07-02

Software List			
Description	Manufacturer	Model	Version
EMI Test Software (Radiated Emission A)	Farad	EZ-EMC	RA-03A1 (1.1.4.2)
EMI Test Software (Radiated Emission B)	Farad	EZ-EMC	RA-03A1 (1.1.4.2)
EMI Test Software (Radiated Emission C)	Farad	EZ-EMC	RA-03A1-2 (1.1.4.2)
EMI Test Software (Conducted Emission Room 1#)	Farad	EZ-EMC	3A1*CE-RE 1.1.4.3
EMI Test Software (Conducted Emission Room 2#)	Farad	EZ-EMC	3A1*CE-RE 1.1.4.3

*Remark: indicates software version used in the compliance certification testing.

2. SUMMARY OF TEST RESULTS

FCC Rules	Description of Test Item	Result
§15.203; §15.247(b)(4)(i)	Antenna Requirement	Compliant
§15.205	Restricted Band of Operation	Compliant
§15.207(a)	Conducted Emission	Compliant
§15.247(e)	Power Spectral Density	Compliant
§15.247(a)(2)	6 dB Bandwidth	Compliant
§15.247(b)(3)	RF Output Power	Compliant
§15.209(a)	Radiated Emission	Compliant
§15.247(d)	Band Edge (Out of Band Emissions)	Compliant

N/A: Not applicable.

3. Antenna Requirement

3.1 Standard Applicable

According to FCC Part 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

3.2 Evaluation Information

This product has an Integral antenna, fulfill the requirement of this section.

4. Power Spectral Density

4.1 Standard Applicable

According to 15.247(a)(1)(iii), for digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3kHz band during any time interval of continuous transmission.

4.2 Test Setup Block Diagram



4.3 Test Procedure

According to the KDB 558074, such specifications require that the same method as used to determine the conducted output power shall also be used to determine the power spectral density. The test method of power spectral density as below:

- Set instrument center frequency to DTS channel center frequency.
- Set span to at least 1.5 times the OBW.
- Set RBW to: $3\text{kHz} \leq \text{RBW} \leq 100\text{kHz}$.
- Set VBW $\geq 3 \times \text{RBW}$.
- Detector = power averaging (RMS) or sample detector (when RMS not available).
- Ensure that the number of measurement points in the sweep $\geq 2 \times \text{span}/\text{RBW}$.
- Sweep time = auto couple.
- Employ trace averaging (RMS) mode over a minimum of 100 traces.
- Use the peak marker function to determine the maximum amplitude level.
- If measured value exceeds limit, reduce RBW (no less than 3kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span in order to meet the minimum measurement point requirement as the RBW is reduced).

5.4 Summary of Test Results/Plots

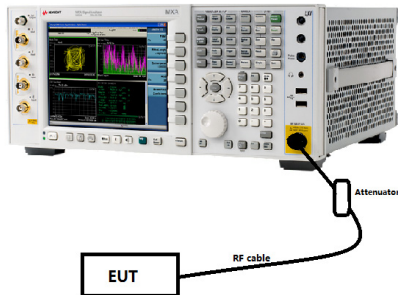
Please refer to Appendix A

5. 6dB Bandwidth

5.1 Standard Applicable

According to 15.247(a)(2), systems using digital modulation techniques may operate in the 902–928MHz, 2400–2483.5MHz, and 5725–5850MHz bands. The minimum 6dB bandwidth shall be at least 500kHz.

5.2 Test Setup Block Diagram



5.3 Test Procedure

- Set RBW = 100kHz.
- Set the video bandwidth (VBW) $\geq 3 \times$ RBW.
- Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Allow the trace to stabilize.
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6dB relative to the maximum level measured in the fundamental emission.

5.4 Summary of Test Results/Plots

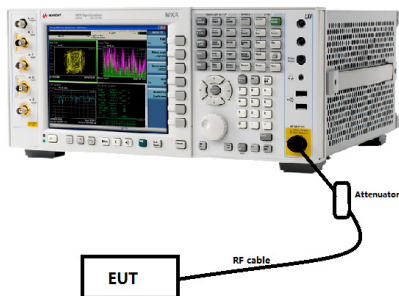
Please refer to Appendix B

6. RF Output Power

6.1 Standard Applicable

According to 15.247(b)(3), for systems using digital modulation in the 902–928MHz, 2400–2483.5MHz, and 5725–5850MHz bands: 1 Watt.

6.2 Test Setup Block Diagram



6.3 Test Procedure

- Set the RBW $\geq$ DTS bandwidth.
- Set VBW $\geq$ 3RBW.
- Set span $\geq$ 3RBW.
- Sweep time = auto couple.
- Detector = peak.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use peak marker function to determine the peak amplitude level.

6.4 Summary of Test Results/Plots

Please refer to Appendix C

7. Field Strength of Spurious Emissions

7.1 Standard Applicable

According to §15.247(d), in any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30dB instead of 20dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

The emission limit in this paragraph is based on measurement instrumentation employing an average detector. The provisions in §15.35 for limiting peak emissions apply. Spurious Radiated Emissions measurements starting below or at the lowest crystal frequency.

7.2 Test Procedure

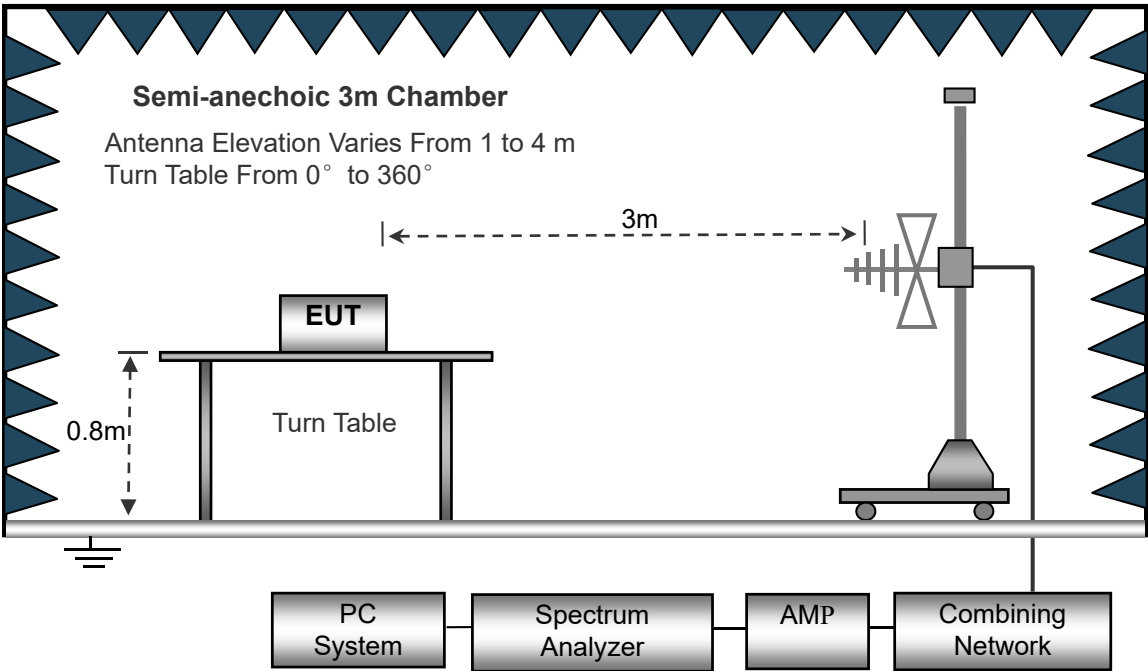
The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.205 15.247(a) and FCC Part 15.209 Limit.

The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle. The spacing between the peripherals was 10cm.

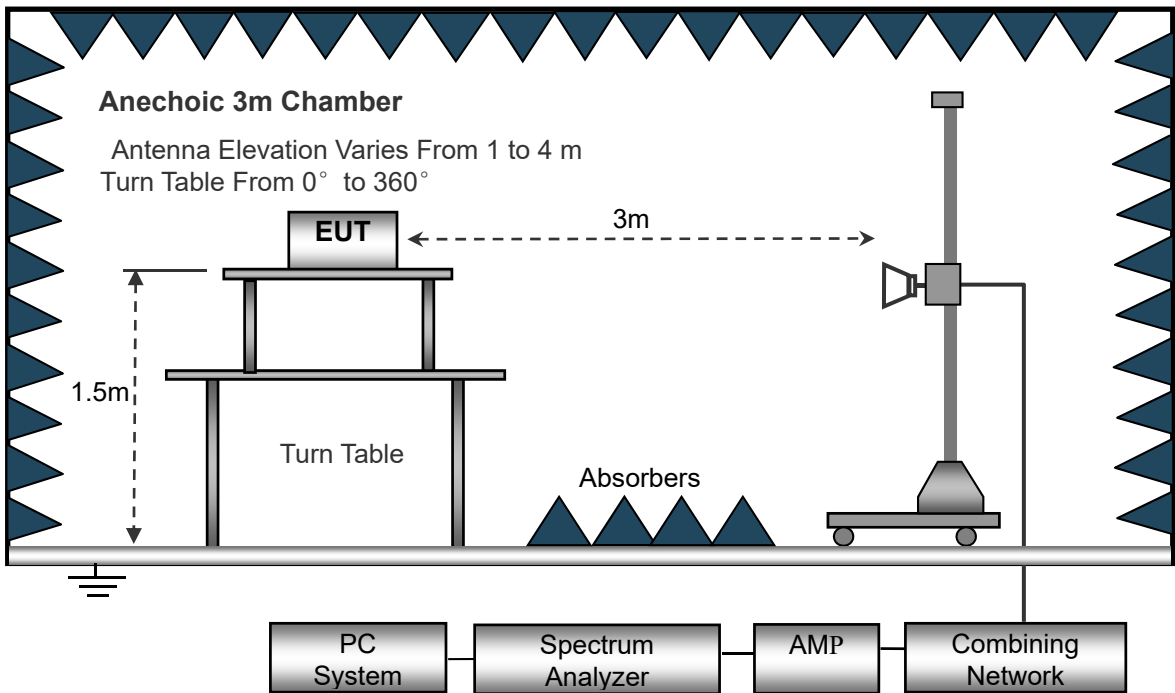
The test setup for emission measurement below 30MHz.



The test setup for emission measurement from 30MHz to 1GHz.



The test setup for emission measurement above 1GHz.



Frequency :9kHz-30MHz
RBW=10KHz,
VBW =30KHz
Sweep time= Auto
Trace = max hold
Detector function = peak

Frequency :30MHz-1GHz
RBW=120KHz,
VBW=300KHz
Sweep time= Auto
Trace = max hold
Detector function = peak, QP

Frequency :Above 1GHz
RBW=1MHz,
VBW=3MHz(Peak), 10Hz(AV)
Sweep time= Auto
Trace = max hold
Detector function = peak, AV

7.3 Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and the Cable Factor, and subtracting the Amplifier Gain from the Amplitude reading. The basic equation is as follows:

$$\text{Corr. Ampl.} = \text{Indicated Reading} + \text{Ant. Factor} + \text{Cable Loss} - \text{Ampl. Gain}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -6dB μ V means the emission is 6dB μ V below the maximum limit. The equation for margin calculation is as follows:

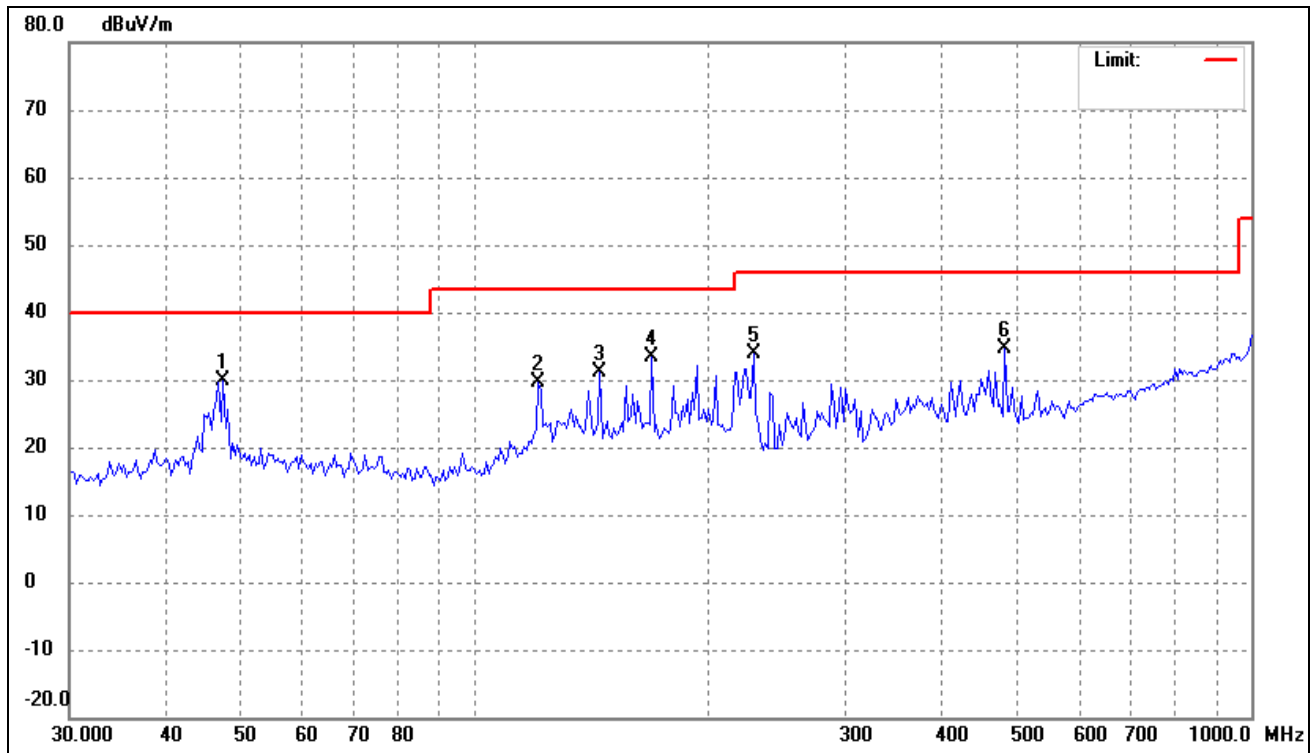
$$\text{Margin} = \text{Corr. Ampl.} - \text{FCC Part 15 Limit}$$

7.4 Summary of Test Results/Plots

Note: this EUT was tested in 3 orthogonal positions and the worst case position data was reported.

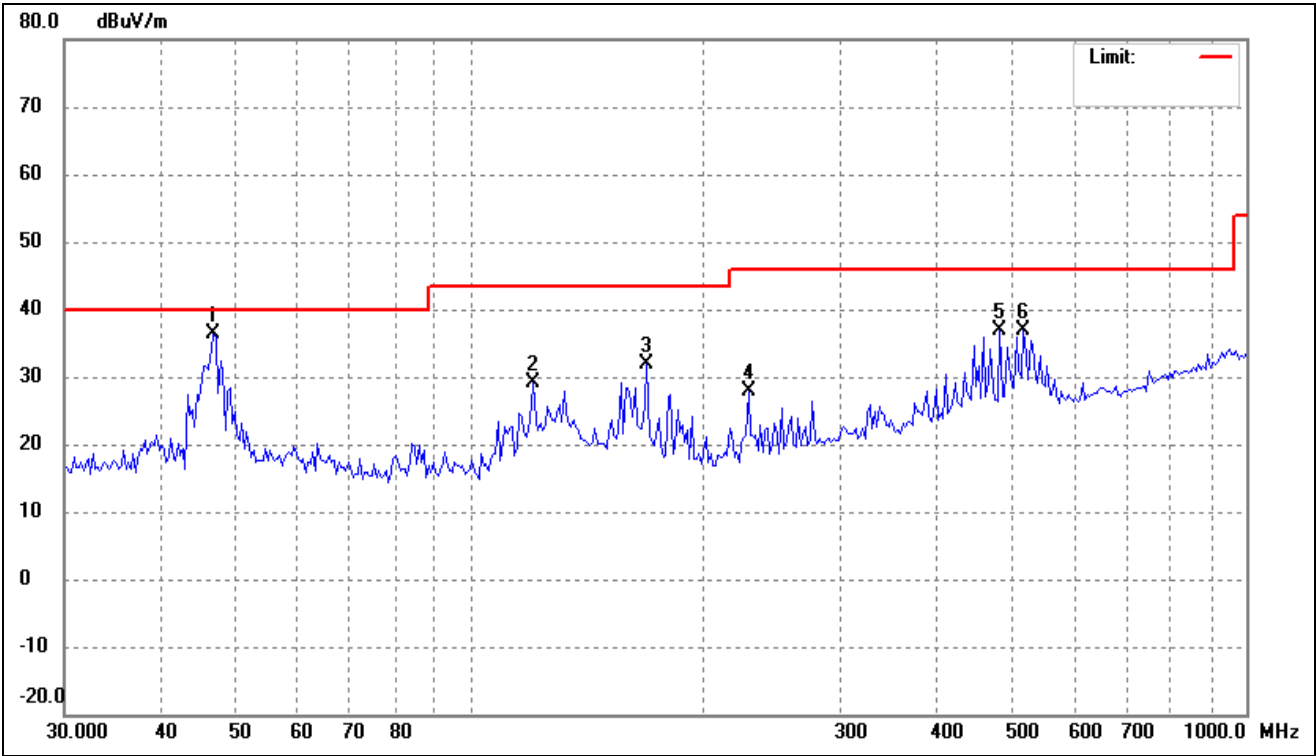
- Spurious Emissions Below 1GHz
- Model: WS-K04E

Test Channel	Low(worst case)	Polarity:	Horizontal
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No.	Frequency (MHz)	Reading (dBuV/m)	Correct dB/m	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Degree (°)	Height (cm)	Remark
1	47.3688	37.62	-7.78	29.84	40.00	-10.16	-	-	peak
2	120.6118	39.53	-9.97	29.56	43.50	-13.94	-	-	peak
3	144.7899	39.50	-8.49	31.01	43.50	-12.49	-	-	peak
4	168.9970	41.77	-8.29	33.48	43.50	-10.02	-	-	peak
5	228.6173	45.15	-11.15	34.00	46.00	-12.00	-	-	peak
6	481.5112	39.57	-4.94	34.63	46.00	-11.37	-	-	peak

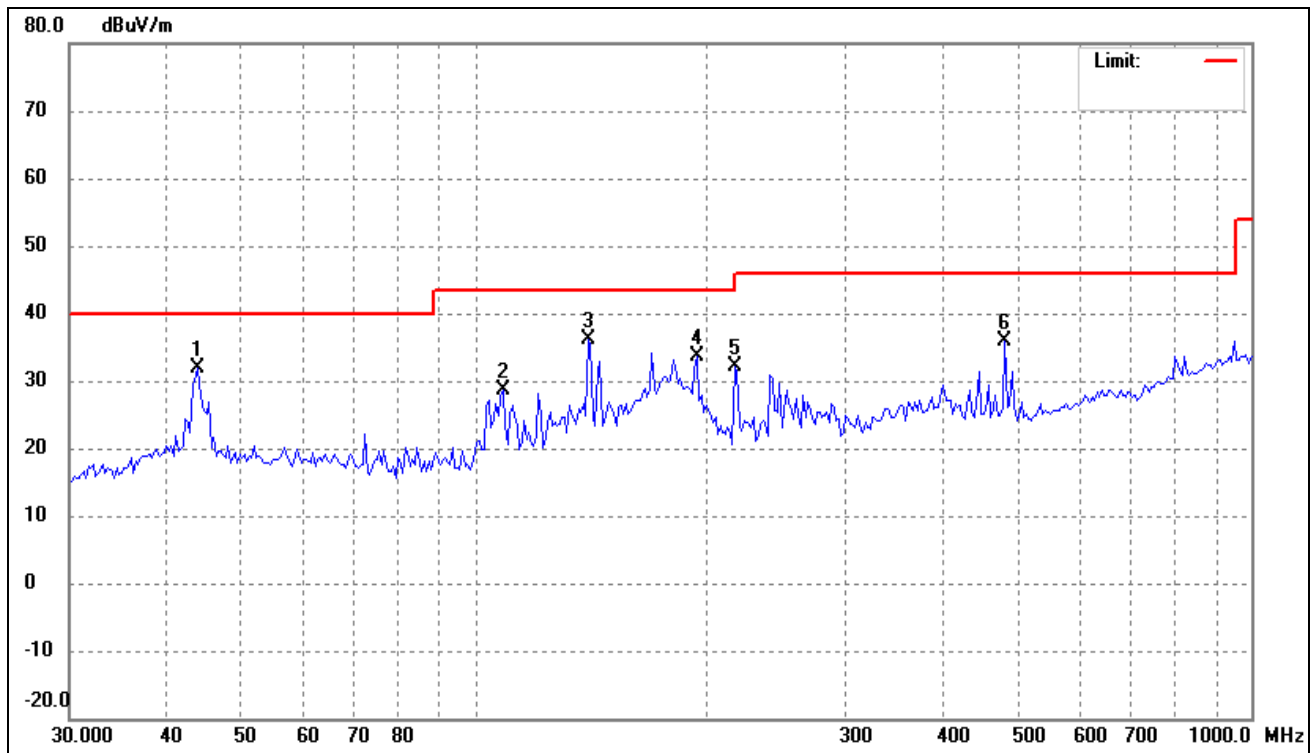
Test Channel	Low(worst case)	Polarity:	Vertical
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No.	Frequency (MHz)	Reading (dBuV/m)	Correct dB/m	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Degree (°)	Height (cm)	Remark
1	46.7077	44.30	-7.83	36.47	40.00	-3.53	-	-	peak
2	120.6118	39.22	-9.97	29.25	43.50	-14.25	-	-	peak
3	168.9970	40.20	-8.29	31.91	43.50	-11.59	-	-	peak
4	228.6173	38.95	-11.15	27.80	46.00	-18.20	-	-	peak
5	481.5112	41.71	-4.94	36.77	46.00	-9.23	-	-	peak
6	516.5651	41.32	-4.48	36.84	46.00	-9.16	-	-	peak

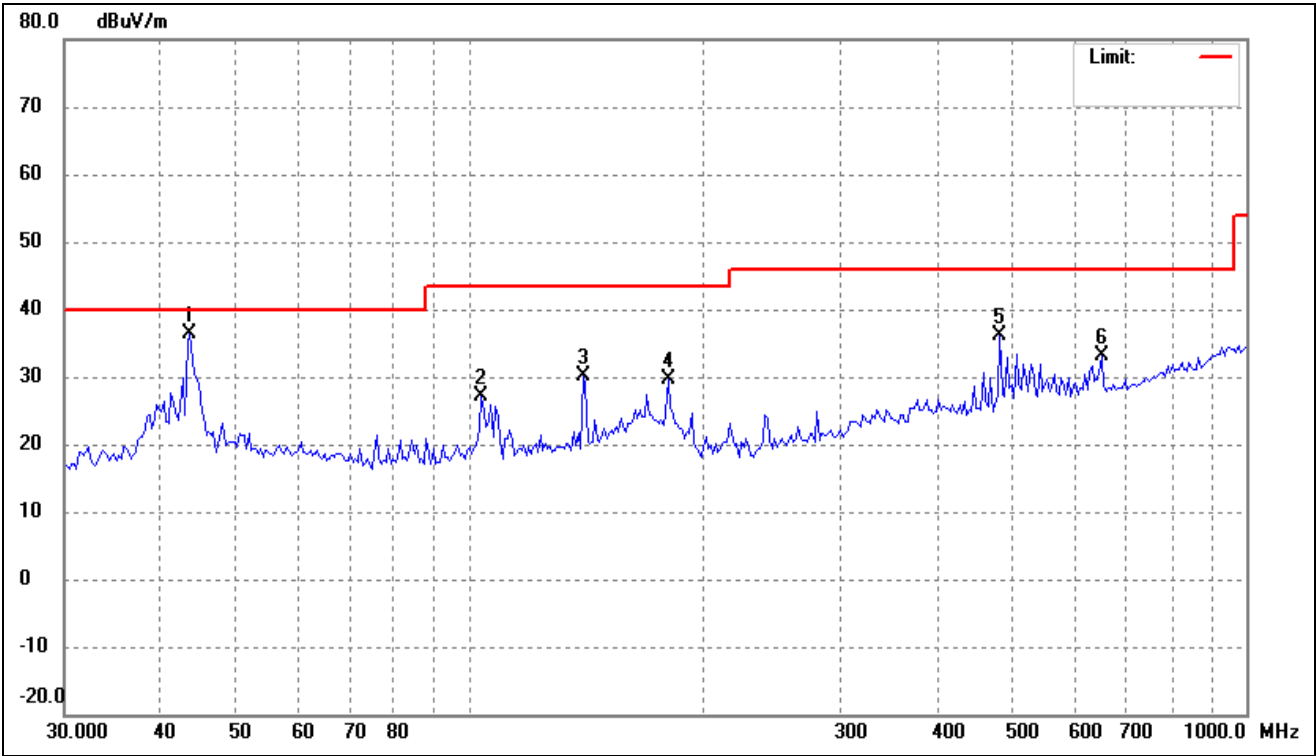
➤ Model: WS-K02E

Test Channel	Low(worst case)	Polarity:	Horizontal
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No.	Frequency (MHz)	Reading (dBuV/m)	Correct dB/m	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Degree (°)	Height (cm)	Remark
1	43.8452	39.86	-7.96	31.90	40.00	-8.10	-	-	peak
2	108.5455	39.83	-11.21	28.62	43.50	-14.88	-	-	peak
3	139.7909	44.95	-8.90	36.05	43.50	-7.45	-	-	peak
4	193.1366	44.58	-11.00	33.58	43.50	-9.92	-	-	peak
5	216.1197	43.79	-11.55	32.24	46.00	-13.76	-	-	peak
6	481.5112	40.93	-4.94	35.99	46.00	-10.01	-	-	peak

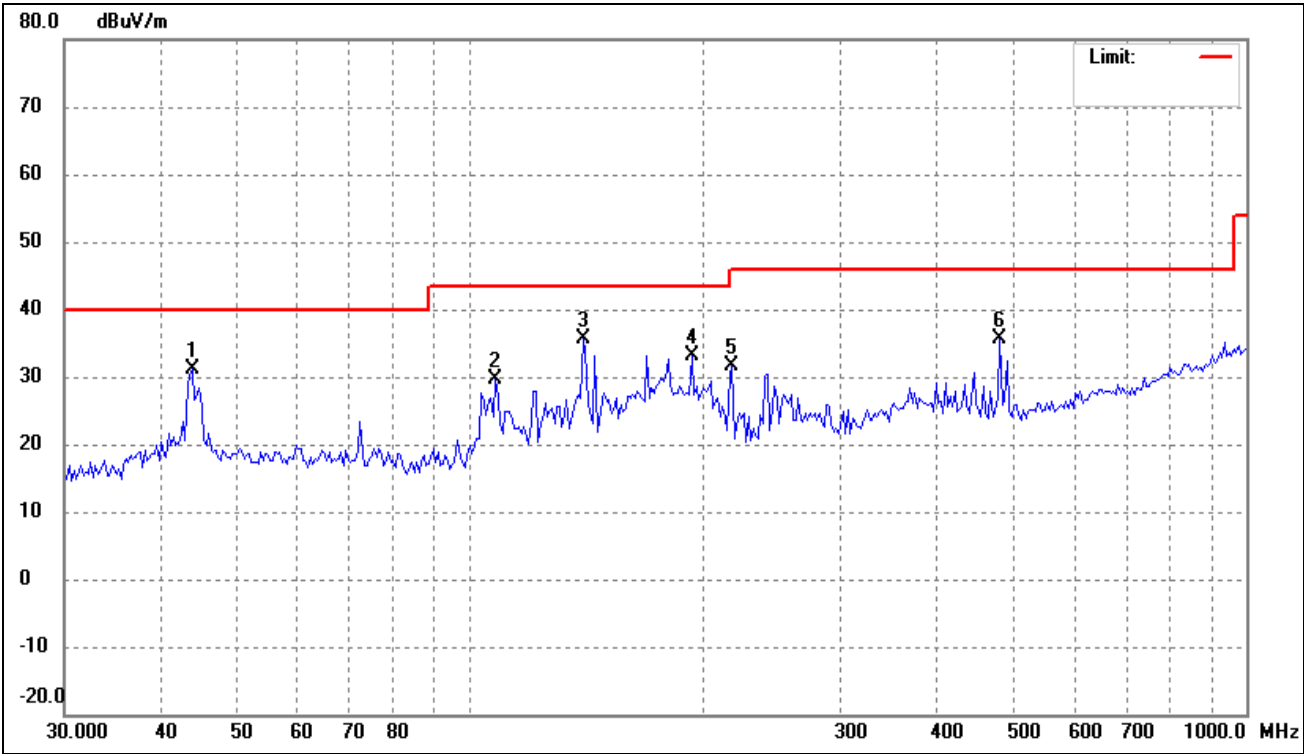
Test Channel	Low(worst case)	Polarity:	Vertical
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No.	Frequency (MHz)	Reading (dBuV/m)	Correct dB/m	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Degree (°)	Height (cm)	Remark
1	43.5380	44.24	-7.95	36.29	40.00	-3.71	-	-	peak
2	103.3353	38.92	-11.68	27.24	43.50	-16.26	-	-	peak
3	139.7909	39.00	-8.90	30.10	43.50	-13.40	-	-	peak
4	180.0304	39.32	-9.74	29.58	43.50	-13.92	-	-	peak
5	481.5112	41.02	-4.94	36.08	46.00	-9.92	-	-	peak
6	651.3831	34.75	-1.54	33.21	46.00	-12.79	-	-	peak

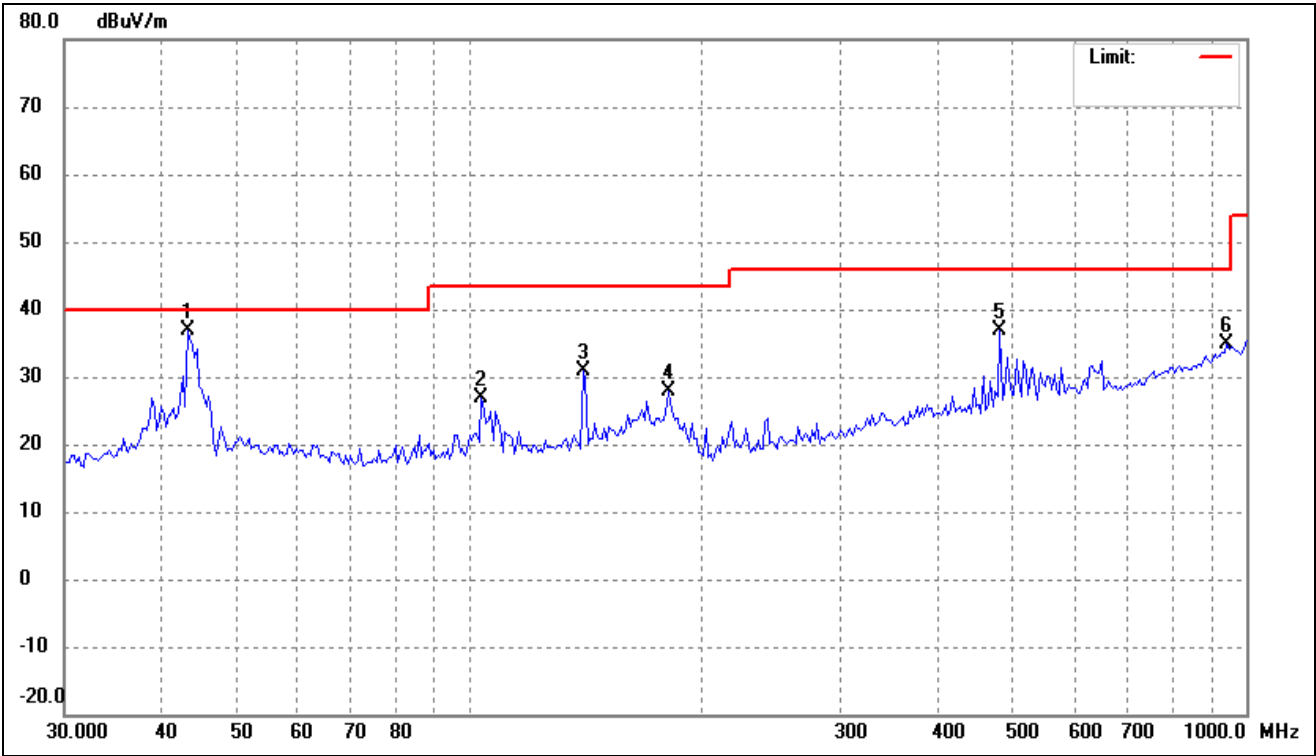
➤ Model: WS-K03E

Test Channel	Low(worst case)	Polarity:	Horizontal
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No.	Frequency (MHz)	Reading (dBuV/m)	Correct dB/m	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Degree (°)	Height (cm)	Remark
1	43.8452	39.06	-7.96	31.10	40.00	-8.90	-	-	peak
2	107.7854	40.78	-11.27	29.51	43.50	-13.99	-	-	peak
3	139.7909	44.65	-8.90	35.75	43.50	-7.75	-	-	peak
4	193.1366	44.04	-11.00	33.04	43.50	-10.46	-	-	peak
5	217.6437	43.05	-11.52	31.53	46.00	-14.47	-	-	peak
6	481.5112	40.69	-4.94	35.75	46.00	-10.25	-	-	peak

Test Channel	Low(worst case)	Polarity:	Vertical
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No.	Frequency (MHz)	Reading (dBuV/m)	Correct dB/m	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Degree (°)	Height (cm)	Remark
1	43.2333	44.94	-7.95	36.99	40.00	-3.01	-	-	peak
2	103.3353	38.66	-11.68	26.98	43.50	-16.52	-	-	peak
3	139.7909	39.84	-8.90	30.94	43.50	-12.56	-	-	peak
4	180.0304	37.55	-9.74	27.81	43.50	-15.69	-	-	peak
5	481.5112	41.78	-4.94	36.84	46.00	-9.16	-	-	peak
6	945.3336	31.65	3.19	34.84	46.00	-11.16	-	-	peak

Remark: '-Means' the test Degree and Height are not recorded by the test software and only show the worst case in the test report.

➤ Spurious Emissions Above 1GHz

Model: WS-K04E

Frequency	Reading	Correct	Result	Limit	Margin	Polar	Detector
(MHz)	(dBuV/m)	dB	(dBuV/m)	(dBuV/m)	(dB)	H/V	
Low Channel-2405MHz							
4810.000	64.14	-13.50	50.64	74.00	-23.36	H	PK
7215.000	54.70	-7.39	47.31	74.00	-26.69	H	PK
4810.000	65.14	-13.50	51.64	74.00	-22.36	V	PK
7215.000	55.95	-7.39	48.56	74.00	-25.44	V	PK
Middle Channel-2445MHz							
4870.396	61.75	-13.44	48.31	74.00	-25.69	H	PK
7320.000	54.22	-7.72	46.50	74.00	-27.50	H	PK
4870.396	64.30	-13.44	50.86	74.00	-23.14	V	PK
7320.000	54.90	-7.72	47.18	74.00	-26.82	V	PK
High Channel-2480MHz							
4960.000	59.51	-13.32	46.19	74.00	-27.81	H	PK
7440.000	55.19	-8.08	47.11	74.00	-26.89	H	PK
4960.000	65.65	-13.32	52.33	74.00	-21.67	V	PK
7440.000	54.58	-8.08	46.50	74.00	-27.50	V	PK

Model: WS-K02E

Frequency	Reading	Correct	Result	Limit	Margin	Polar	Detector
(MHz)	(dBuV/m)	dB	(dBuV/m)	(dBuV/m)	(dB)	H/V	
Low Channel-2405MHz							
4810.000	64.94	-13.50	51.44	74.00	-22.56	H	PK
7215.000	54.88	-7.39	47.49	74.00	-26.51	H	PK
4810.000	65.02	-13.50	51.52	74.00	-22.48	V	PK
7215.000	55.74	-7.39	48.35	74.00	-25.65	V	PK
Middle Channel-2445MHz							
4870.396	64.90	-13.44	51.46	74.00	-22.54	H	PK
7320.000	54.12	-7.72	46.40	74.00	-27.60	H	PK
4870.396	64.82	-13.44	51.38	74.00	-22.62	V	PK
7320.000	54.75	-7.72	47.03	74.00	-26.97	V	PK
High Channel-2480MHz							
4960.000	62.06	-13.32	48.74	74.00	-25.26	H	PK
7440.000	54.35	-8.08	46.27	74.00	-27.73	H	PK
4960.000	62.33	-13.32	49.01	74.00	-24.99	V	PK
7440.000	54.14	-8.08	46.06	74.00	-27.94	V	PK

Model: WS-K03E

Frequency	Reading	Correct	Result	Limit	Margin	Polar	Detector
(MHz)	(dBuV/m)	dB	(dBuV/m)	(dBuV/m)	(dB)	H/V	
Low Channel-2405MHz							
4810.000	63.80	-13.50	50.30	74.00	-23.70	H	PK
7215.000	54.70	-7.39	47.31	74.00	-26.69	H	PK
4810.000	64.42	-13.50	50.92	74.00	-23.08	V	PK
7215.000	55.74	-7.39	48.35	74.00	-25.65	V	PK
Middle Channel-2445MHz							
4870.396	63.93	-13.44	50.49	74.00	-23.51	H	PK
7320.000	54.60	-7.72	46.88	74.00	-27.12	H	PK
4870.396	64.68	-13.44	51.24	74.00	-22.76	V	PK
7320.000	54.63	-7.72	46.91	74.00	-27.09	V	PK
High Channel-2480MHz							
4960.000	61.41	-13.32	48.09	74.00	-25.91	H	PK
7440.000	54.21	-8.08	46.13	74.00	-27.87	H	PK
4960.000	62.54	-13.32	49.22	74.00	-24.78	V	PK
7440.000	53.91	-8.08	45.83	74.00	-28.17	V	PK

Note: Testing is carried out with frequency rang 9kHz to the tenth harmonics, other than listed in the table above are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

8. Out of Band Emissions

8.1 Standard Applicable

According to §15.247 (d), in any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30dB instead of 20dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

8.2 Test Procedure

According to the KDB 558074, the band-edge radiated test method as follows:

Set span = wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation (2310MHz to 2420MHz for low bandedge, 2460MHz to 2500MHz for the high bandedge)

RBW = 1MHz, VBW = 1MHz for peak value measured

RBW = 1MHz, VBW = 10Hz for average value measured

Sweep = auto; Detector function = peak/average; Trace = max hold

All the trace to stabilize, set the marker on the emission at the bandedge, or on the highest modulation product outside of the band, if this level is greater than that at the bandedge. Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission. Those emission must comply with the 15.209 limit for fall in the restricted bands listed in section 15.205. Note that the method of measurement KDB publication number: 913591 may be used for the radiated bandedge measurements.

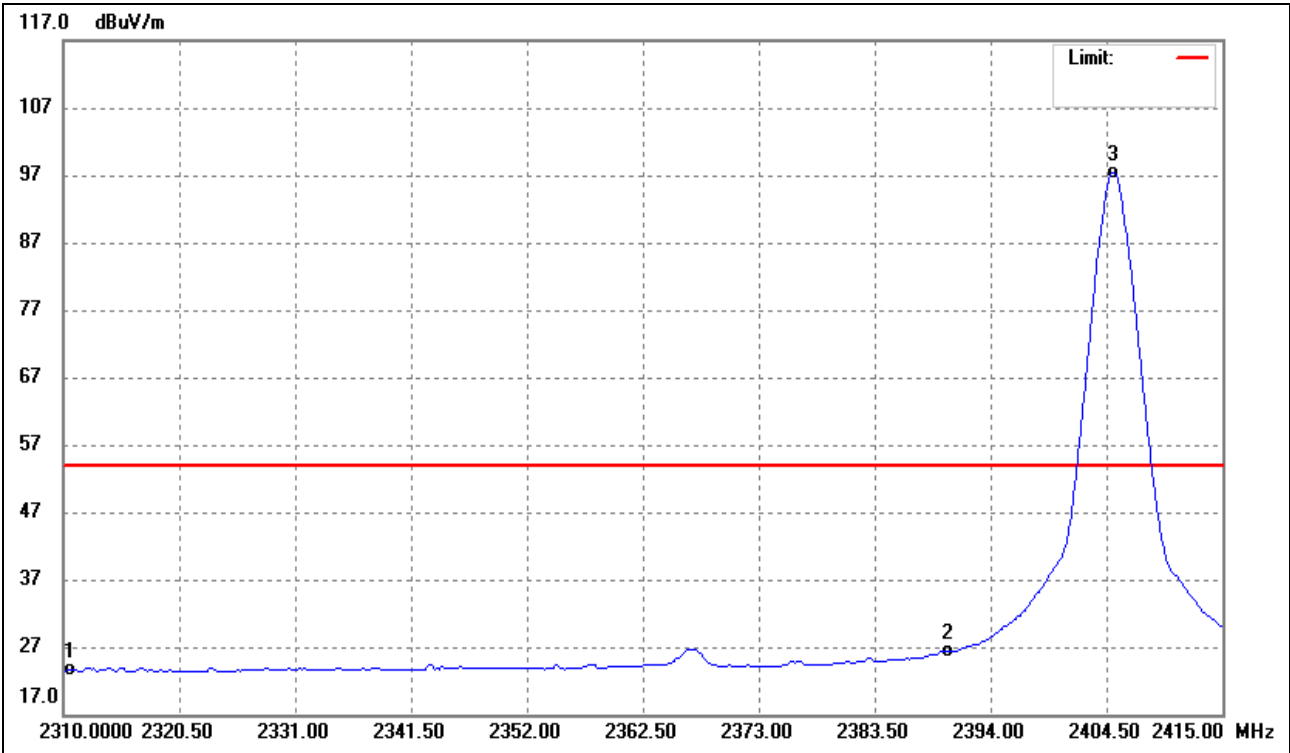
According to the KDB 558074, the conducted spurious emissions test method as follows:

1. Set start frequency to DTS channel edge frequency.
2. Set stop frequency so as to encompass the spectrum to be examined.
3. Set RBW = 100kHz.
4. Set VBW $\geq$ 300kHz.
5. Detector = peak.
6. Trace Mode = max hold.
7. Sweep = auto couple.
8. Allow the trace to stabilize (this may take some time, depending on the extent of the span).
9. Use peak marker function to determine maximum amplitude of all unwanted emissions within any 100kHz bandwidth.

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements specified in section 8.1. Report the three highest emissions relative to the limit.

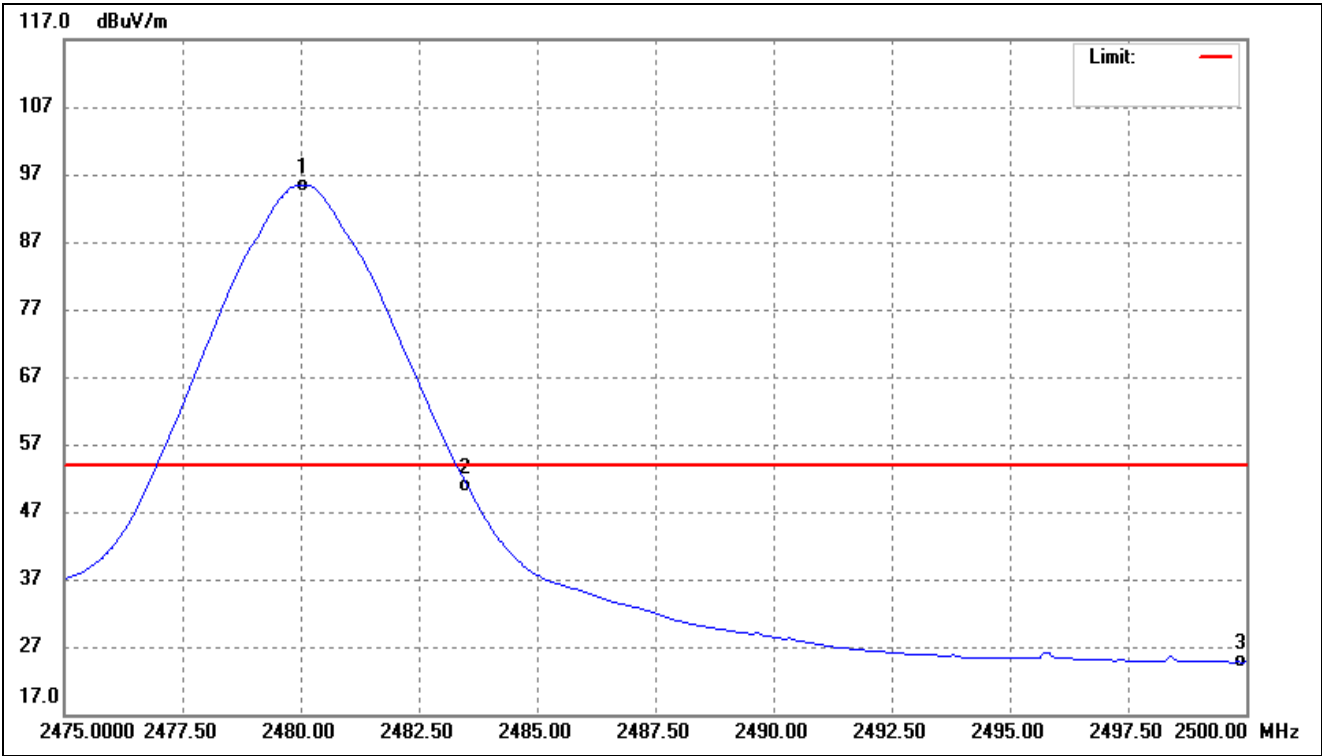
8.3 Summary of Test Results/Plots

Test Channel	Low	Polarity:	Horizontal(worst case)
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No.	Frequency (MHz)	Reading (dBuV/m)	Correct dB/m	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	2310.000	43.23	-19.67	23.56	54.00	-30.44	Average Detector
	2310.000	56.36	-19.67	36.69	74.00	-37.31	Peak Detector
2	2390.000	45.77	-19.49	26.28	54.00	-27.72	Average Detector
	2390.000	59.25	-19.49	39.76	74.00	-34.24	Peak Detector
3	2405.110	116.95	-19.47	97.48	/	/	Average Detector
	2404.479	119.57	-19.47	100.10	/	/	Peak Detector

Test Channel	High	Polarity:	Horizontal(worst case)
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No.	Frequency (MHz)	Reading (dBuV/m)	Correct Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	2480.010	114.77	-19.29	95.48	/	/	Average Detector
	2480.511	117.22	-19.29	97.93	/	/	Peak Detector
2	2483.500	70.21	-19.29	50.92	54.00	-3.08	Average Detector
	2483.500	81.17	-19.29	61.88	74.00	-12.12	Peak Detector
3	2500.000	44.05	-19.25	24.80	54.00	-29.20	Average Detector
	2500.000	57.04	-19.25	37.79	74.00	-36.21	Peak Detector

➤ Conducted test
Please refer to Appendix D

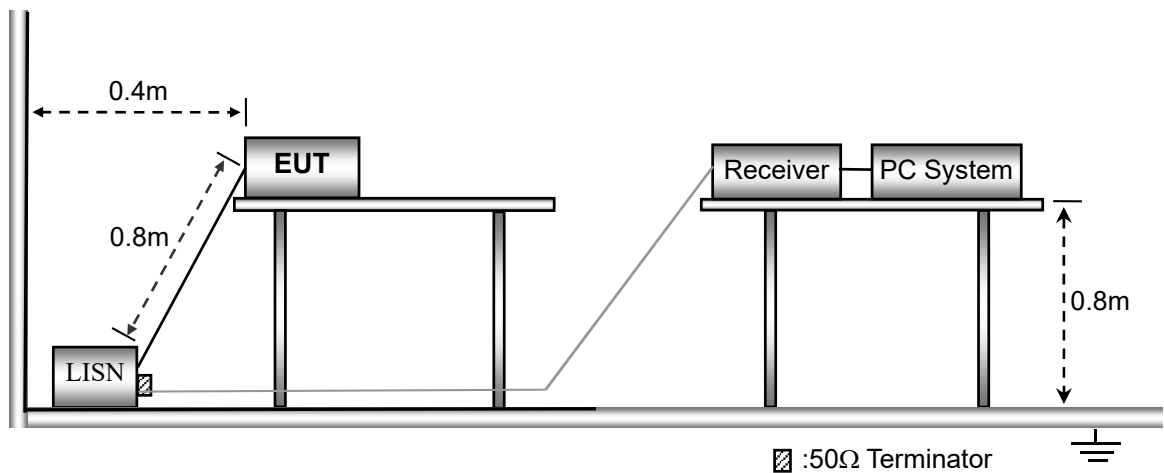
9. Conducted Emissions

9.1 Test Procedure

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 Limit.

The external I/O cables were draped along the test table and formed a bundle 30 to 40cm long in the middle. The spacing between the peripherals was 10cm.

9.2 Basic Test Setup Block Diagram



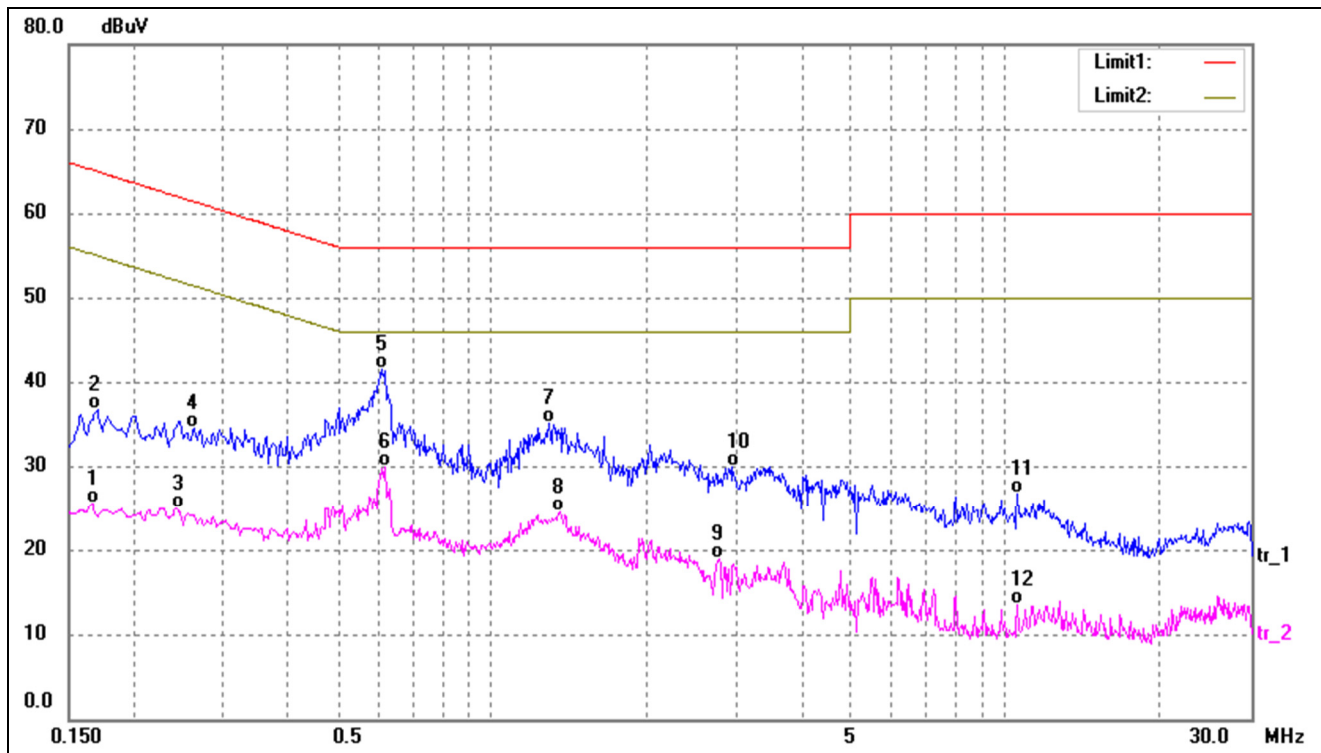
9.3 Test Receiver Setup

During the conducted emission test, the test receiver was set with the following configurations:

Start Frequency	150kHz
Stop Frequency	30MHz
Sweep Speed	Auto
IF Bandwidth.....	10kHz
Quasi-Peak Adapter Bandwidth	9kHz
Quasi-Peak Adapter Mode	Normal

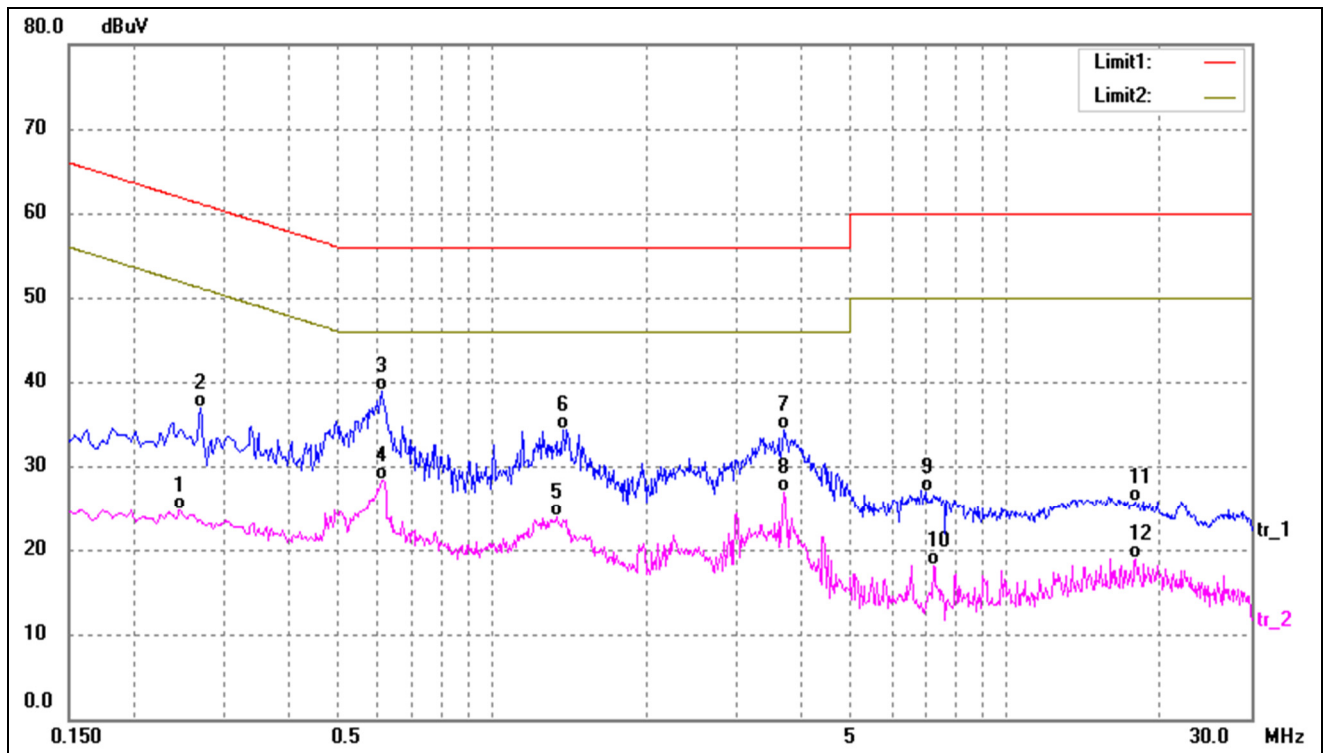
9.4 Summary of Test Results/Plots

Test Mode	Communication	AC120V 60Hz	Polarity:	Neutral
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No.	Frequency (MHz)	Reading (dBuV)	Correct (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Detector
1	0.1660	15.88	9.70	25.58	55.15	-29.57	AVG
2	0.1700	27.01	9.69	36.70	64.96	-28.26	QP
3	0.2420	15.33	9.60	24.93	52.02	-27.09	AVG
4	0.2620	24.92	9.61	34.53	61.36	-26.83	QP
5*	0.6100	31.84	9.71	41.55	56.00	-14.45	QP
6	0.6180	20.22	9.71	29.93	46.00	-16.07	AVG
7	1.2900	25.41	9.66	35.07	56.00	-20.93	QP
8	1.3580	14.80	9.65	24.45	46.00	-21.55	AVG
9	2.7659	9.26	9.62	18.88	46.00	-27.12	AVG
10	2.9219	20.26	9.62	29.88	56.00	-26.12	QP
11	10.5260	16.75	9.88	26.63	60.00	-33.37	QP
12	10.5260	3.69	9.88	13.57	50.00	-36.43	AVG

Test Mode	Communication	AC120V 60Hz	Polarity:	Line
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No.	Frequency (MHz)	Reading (dBuV)	Correct (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Detector
1	0.2460	15.18	9.60	24.78	51.89	-27.11	AVG
2	0.2700	27.32	9.62	36.94	61.12	-24.18	QP
3*	0.6100	29.17	9.71	38.88	56.00	-17.12	QP
4	0.6100	18.62	9.71	28.33	46.00	-17.67	AVG
5	1.3340	14.18	9.65	23.83	46.00	-22.17	AVG
6	1.3740	24.63	9.65	34.28	56.00	-21.72	QP
7	3.7180	24.56	9.66	34.22	56.00	-21.78	QP
8	3.7180	17.24	9.66	26.90	46.00	-19.10	AVG
9	7.0060	17.04	9.79	26.83	60.00	-33.17	QP
10	7.2500	8.27	9.79	18.06	50.00	-31.94	AVG
11	17.8700	15.66	10.12	25.78	60.00	-34.22	QP
12	17.8700	8.87	10.12	18.99	50.00	-31.01	AVG

APPENDIX SUMMARY

Project No.	WTX24X10240772W	Test Engineer	Timi Huang
Start date	2024/10/30	Finish date	2024/10/30
Temperature	22.5℃	Humidity	51%
RF specifications	Zigbee		

APPENDIX	Description of Test Item	Result
A	Power Spectral Density	Compliant
B	DTS Bandwidth 99% Bandwidth	Compliant
C	RF Output Power	Compliant
D	Conducted Out of Band Emissions	Compliant

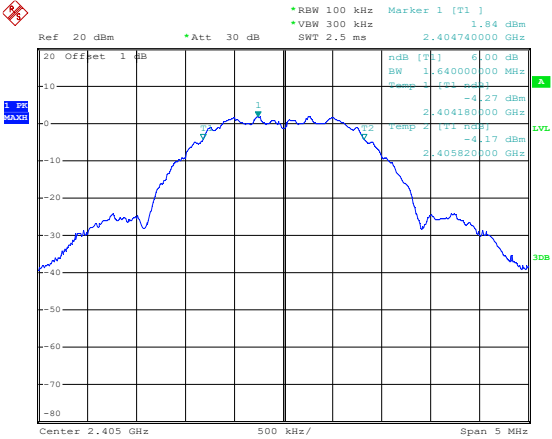
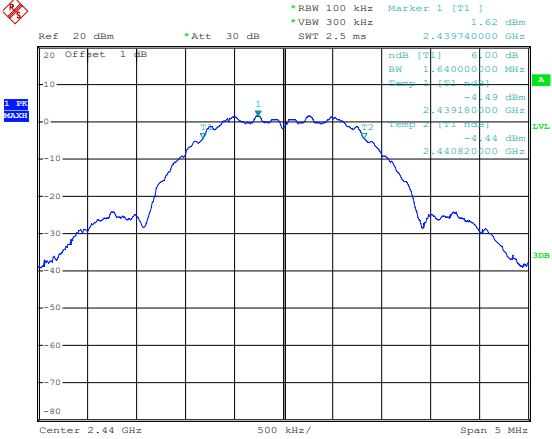
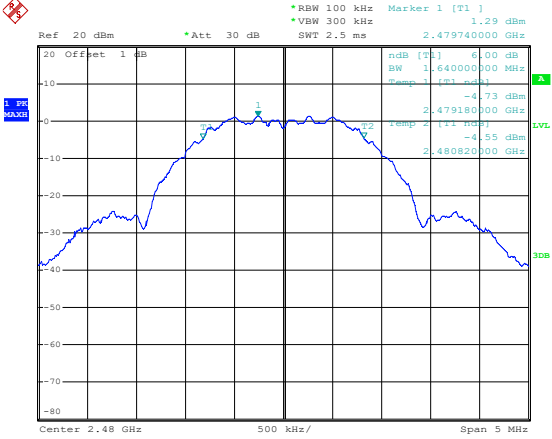
APPENDIX A

Power Spectral Density			
Test Mode	Test Channel	Power Spectral Density dBm/3kHz	Limit dBm/3kHz
Zigbee	Low	-9.66	8
	Middle	-9.90	8
	High	-10.48	8

Low	Date: 30.OCT.2024 15:26:52
Middle	Date: 30.OCT.2024 15:25:33
High	Date: 30.OCT.2024 15:20:28

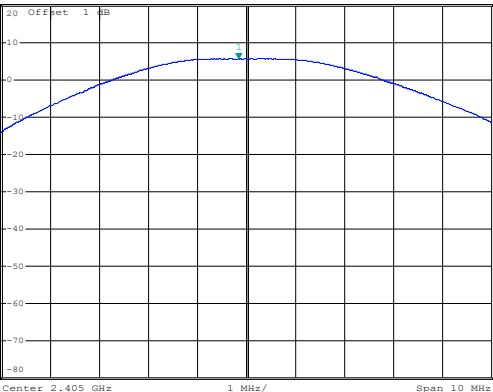
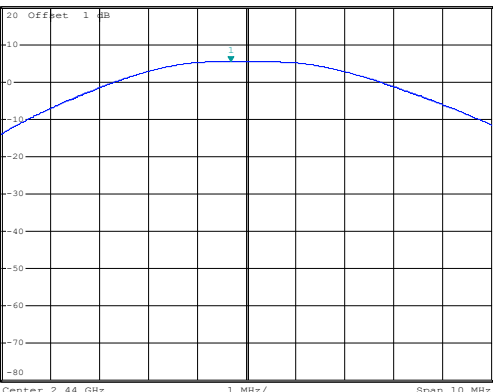
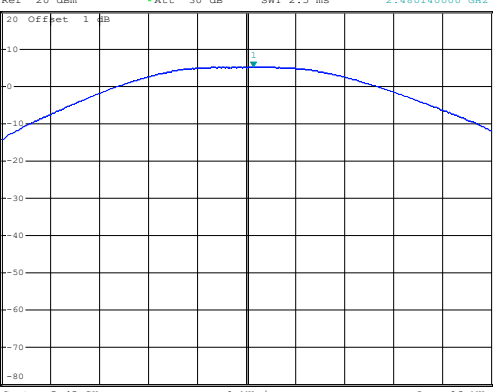
APPENDIX B

DTS Bandwidth			
Test Mode	Test Channel	6 dB Bandwidth kHz	Limit kHz
Zigbee	Low	1640	≥500
	Middle	1640	≥500
	High	1640	≥500

Low	 Ref 20 dBm *Att 30 dB *RBW 100 kHz Marker 1 [T1] 1.84 dBm *VBW 300 kHz 2.404740000 GHz SWT 2.5 ms ndB [T1] 6.00 dB BW 1.640000000 MHz Temp 1 [T1] -4.27 dBm 2.404180000 GHz Temp 2 [T1] -4.17 dBm 2.405820000 GHz Center 2.405 GHz 500 kHz/ Span 5 MHz Date: 30.OCT.2024 15:30:05
Middle	 Ref 20 dBm *Att 30 dB *RBW 100 kHz Marker 1 [T1] 1.62 dBm *VBW 300 kHz 2.439740000 GHz SWT 2.5 ms ndB [T1] 6.00 dB BW 1.640000000 MHz Temp 1 [T1] -4.49 dBm 2.439180000 GHz Temp 2 [T1] -4.44 dBm 2.440820000 GHz Center 2.44 GHz 500 kHz/ Span 5 MHz Date: 30.OCT.2024 15:31:35
High	 Ref 20 dBm *Att 30 dB *RBW 100 kHz Marker 1 [T1] 1.29 dBm *VBW 300 kHz 2.479740000 GHz SWT 2.5 ms ndB [T1] 6.00 dB BW 1.640000000 MHz Temp 1 [T1] -4.73 dBm 2.479180000 GHz Temp 2 [T1] -4.55 dBm 2.480820000 GHz Center 2.48 GHz 500 kHz/ Span 5 MHz Date: 30.OCT.2024 15:37:19

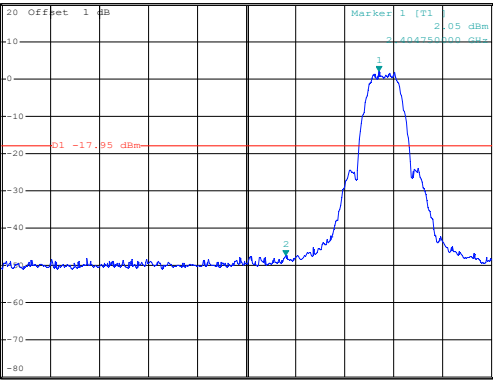
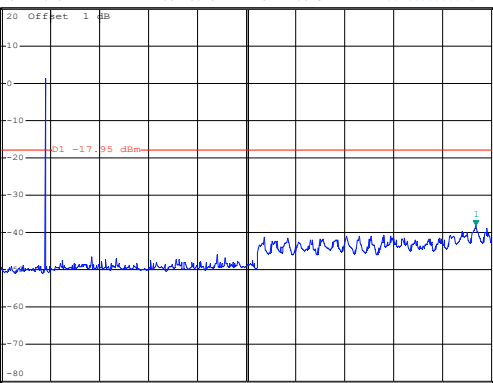
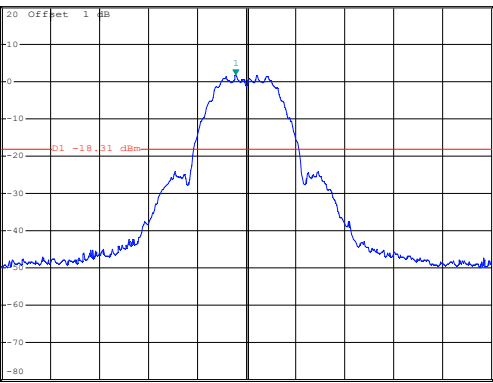
APPENDIX C

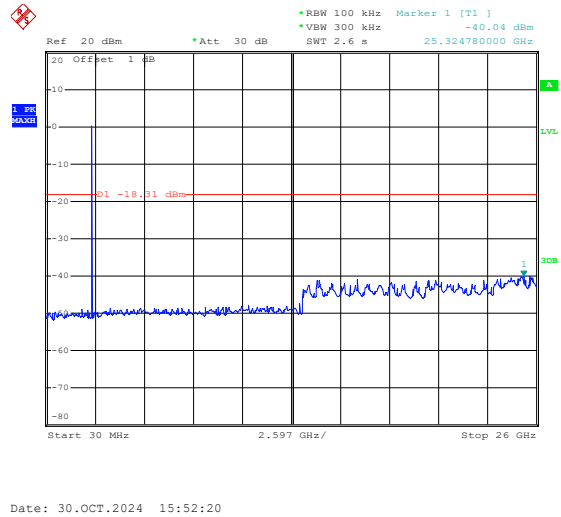
RF Output Power			
Test Mode	Test Channel	Reading dBm	Limit dBm
Zigbee	Low	5.62	30.00
	Middle	5.41	30.00
	High	5.08	30.00

Low	 Ref 20 dBm *Att 30 dB *RBW 3 MHz *VBW 10 MHz Marker 1 [T1] 5.62 dBm SWT 2.5 ms 2.404840000 GHz 20 Offset 1 dB 1 20 MAX LVL 30dB Center 2.405 GHz 1 MHz/ Span 10 MHz Date: 30.OCT.2024 15:14:04
Middle	 Ref 20 dBm *Att 30 dB *RBW 3 MHz *VBW 10 MHz Marker 1 [T1] 5.41 dBm SWT 2.5 ms 2.439680000 GHz 20 Offset 1 dB 1 20 MAX LVL 30dB Center 2.44 GHz 1 MHz/ Span 10 MHz Date: 30.OCT.2024 15:15:58
High	 Ref 20 dBm *Att 30 dB *RBW 3 MHz *VBW 10 MHz Marker 1 [T1] 5.08 dBm SWT 2.5 ms 2.480140000 GHz 20 Offset 1 dB 1 20 MAX LVL 30dB Center 2.48 GHz 1 MHz/ Span 10 MHz Date: 30.OCT.2024 15:19:30

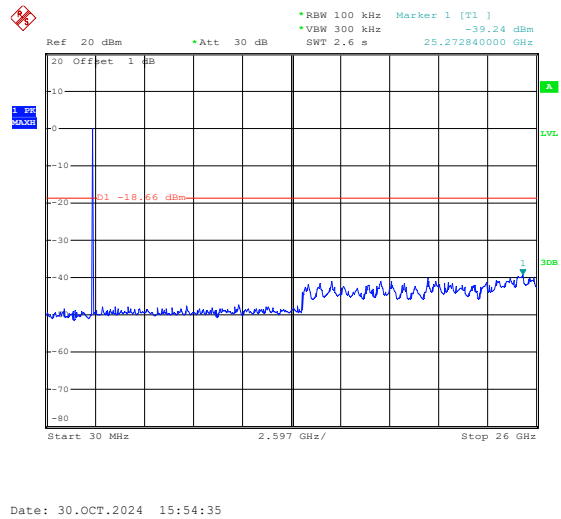
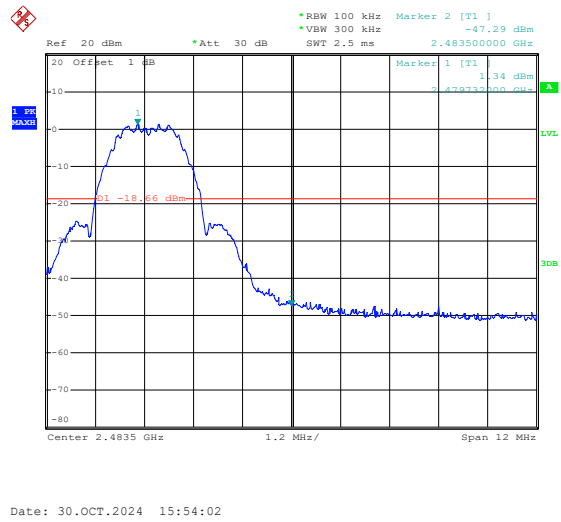
APPENDIX D

Conducted Out of Band Emissions

Low	 Ref 20 dBm *Att 30 dB RBW 100 kHz Marker 2 [T1] -47.25 dBm VBW 300 kHz 2.40000000 GHz SWT 2.5 ms Marker 1 [T1] 2.05 dBm 2.404760000 GHz Offset 1 dB Center 2.398 GHz 2.5 MHz/ Span 25 MHz Date: 30.OCT.2024 15:47:58
	 Ref 20 dBm *Att 30 dB RBW 100 kHz Marker 1 [T1] -38.25 dBm VBW 300 kHz 25.168960000 GHz SWT 2.6 s Offset 1 dB Start 30 MHz 2.597 GHz/ Stop 26 GHz Date: 30.OCT.2024 15:48:35
Middle	 Ref 20 dBm *Att 30 dB RBW 100 kHz Marker 1 [T1] 1.69 dBm VBW 300 kHz 2.439736000 GHz SWT 2.5 ms Offset 1 dB Center 2.44 GHz 1.2 MHz/ Span 12 MHz Date: 30.OCT.2024 15:52:00



High



APPENDIX PHOTOGRAPHS

Please refer to “ANNEX”

***** END OF REPORT *****