

ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT



Applicant: Universal Electronics Inc.
15147 North Scottsdale Road, Suite 300, Scottsdale Arizona
85254 USA

Manufacturer: Universal Electronics Inc.
15147 North Scottsdale Road, Suite 300, Scottsdale Arizona
85254 USA

Product Name: Voice Remote Control

Brand Name: Sony

Model No.: RMF-TX920U

Model Difference: N/A

Report Number: TERF2309002220ER

FCC ID MG3-TX920U

IC: 2575A-TX920U

Date of EUT Received: September 12, 2023

Date of Test: September 13, 2023~September 22, 2023

Issue Date: October 06, 2023

Approved By

Jim Chang

We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. Central RF Lab The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10:2013 and the energy emitted by the sample EUT comply with FCC rule part §15.247, ISSED RSS-247.

The results of this report relate only to the sample identified in this report.

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Revision History

Report Number	Revision	Description	Issue Date	Revised By	Remark
TERF2309002220ER	00	Original	October 06, 2023	Tiffany Kao	

Note:

- 1、The remark "*" indicates modification of the report upon requests from certification body.

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1 GENERAL INFORMATION

1.1 Product Description

Product Name:	Voice Remote Control
Brand Name:	Sony
Model No.:	RMF-TX920U
Model Difference:	N/A
Hardware Version:	60302-2469000 A00
Firmware Version:	7155.00.07
EUT Series No.:	Conducted: E4:A6:34:78:54:07; Radiated: E4:A6:34:78:53:F4
Power Supply:	3.85Vdc from Rechargeable Li-ion Battery
Test Software (Name/Version)	RadioControlConsole 3.1.0.0

1.2 RF Specification

Radio Technology:	Zigbee
Frequency Range:	2425 – 2475MHz
Channel number:	3 channels
Modulation type:	O-QPSK
Transmit Power:	7.97 dBm

1.3 Antenna Designation

Antenna Type	Supplier	Antenna Part No.	Freq. (MHz)	Peak Antenna Gain (dBi)
PCB	Universal Electronic Inc.	Sony FY24	2400-2480	1.82

Note:

1. Antenna information is provided by the applicant.

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1.4 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247

FCC KDB 558074 D01 15.247 Meas Guidance v05r02

RSS-247 issue 3 Aug. 2023

RSS-Gen, Issue 5 April 2018

ANSI C63.10:2013

1.5 Test Facility

Laboratory	Test Site Address	Test Site Name	FCC Designation number	IC CAB identifier
SGS Taiwan Ltd. Central RF Lab. (TAF code 3702)	No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan.	SAC 1	TW0027	TW3702
		SAC 2		
		SAC 3		
		Conduction 1		
		Conducted 1		
		Conducted 2		
		Conducted 3		
		Conducted 4		
		Conducted 5		
		Conducted 6		
	No.2, Keji 1st Rd., Guishan District, Taoyuan City, Taiwan 333	Conduction C	TW0028	
		SAC C		
		SAC D		
		SAC G		
		Conducted A		
		Conducted B		
		Conducted C		
		Conducted D		
		Conducted E		
		Conducted F		
Conducted G				
Note: Test site name is remarked on the equipment list in each section of this report as an indication where measurements occurred in specific test site and address.				

1.6 Special Accessories

There are no special accessories used while test was conducted.

1.7 Equipment Modifications

There was no modification incorporated into the EUT.

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2 SYSTEM TEST CONFIGURATION

2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

2.2 EUT Exercise

An engineering test mode (software/firmware) that applicant provided was utilized to manipulate the EUT into transmit, selection of the test channel, and modulation scheme.

2.3 Test Procedure

2.3.1 Conducted Emissions

The EUT is placed on a table which is 0.8 m above ground plane. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz. The CISPR Quasi-Peak and Average detector mode is employed. The two LISNs provide 50uH/50 ohm of coupling impedance for the measuring instrument. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

2.3.2 Conducted Test (RF)

The active antenna port of the unlicensed wireless device is connected to the spectrum analyzer with attenuator to protect the instrumentation. If a second antenna port is available, it is tested at one operating frequency, with other port(s) appropriately terminated, to verify it has similar output characteristics as the fully tested port.

2.3.3 Radiated Emissions

The EUT is placed on a turn table. For emissions testing at or below 1 GHz, the table height shall be 0.8 m above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this transmitter (EUT) was rotated through three orthogonal axes and measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made "while keeping the antenna in the 'cone of radiation' from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response." is still within the 3dB illumination BW of the measurement antenna.

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2.4 Measurement Results Explanation Example

2.4.1 Radiated Emission Test Sites For Measurements From 9 kHz To 30 MHz

Radiated emission below 30MHz is measured in a 9m*6m*6m semi-anechoic chamber, the measurements correspond to those obtained at an open-field test site.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

2.4.2 For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuation factor between EUT conducted port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly EUT RF output level.

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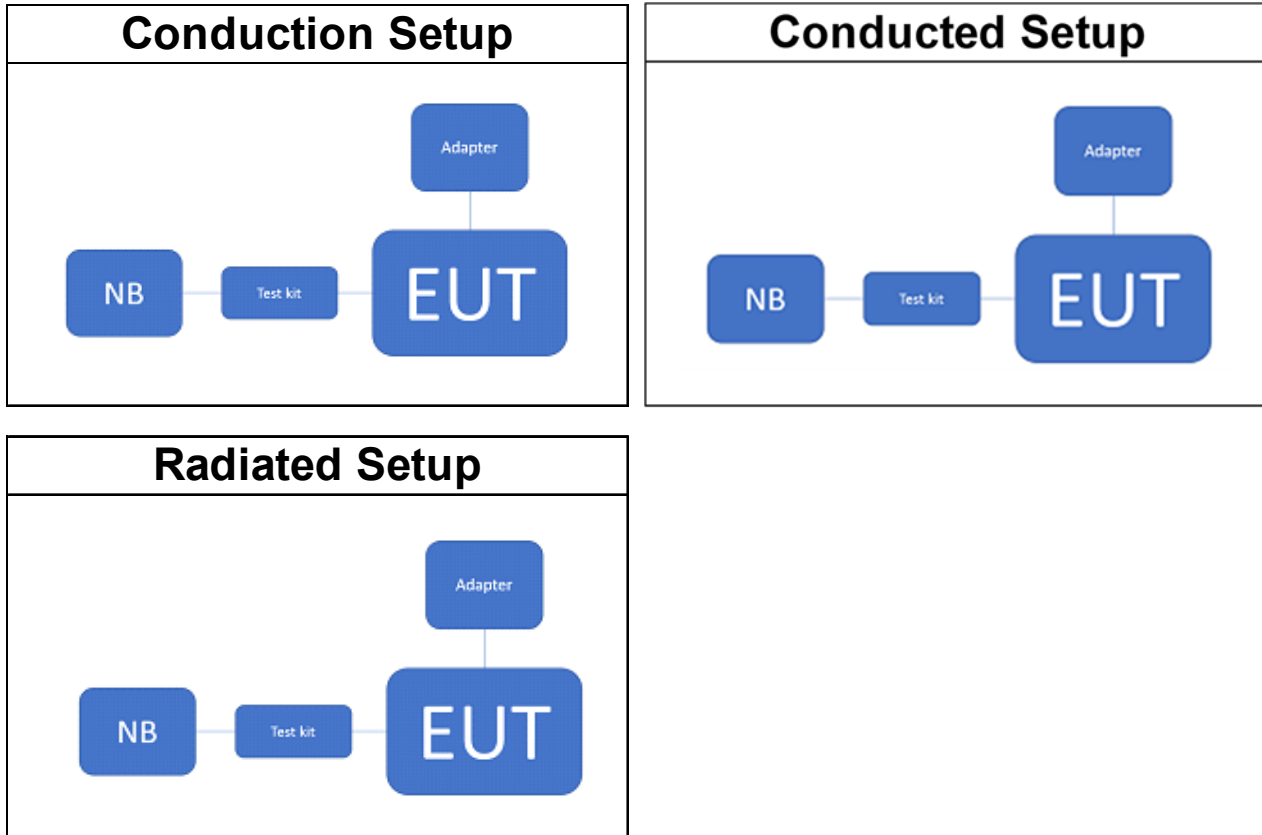
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2.5 Test Configuration



2.6 Control Unit(s)

AC Power-Line Conducted Emission Test Site: Conduction 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Adapter	SONY	AC-0540-JP	3222W51607429	N/A	N/A
Notebook	Lenovo	T440P	PC-01FYE9 14/10	N/A	N/A
Conducted Emission Test Site: Conducted 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Adapter	SONY	AC-0540-JP	3222W51607429	N/A	N/A
Notebook	Lenovo	L430	R9-WGNK5 13/01	N/A	N/A
Radiated Emission Test Site: SAC 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Adapter	SONY	AC-0540-JP	3222W51607429	N/A	N/A
Notebook	Lenovo	T440P	PC-01FYE9 14/10	N/A	N/A

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3 SUMMARY OF TEST RESULTS

FCC Rules	ISED Rules	Description Of Test	Result
§15.207(a)	RSS-Gen §8.8	AC Power Line Conducted Emission	Compliant
§15.247(b) (3)	RSS-247 §5.4 d	Peak Output Power	Compliant
§15.247(a)(2)	RSS-247 §5.2 a RSS-Gen §6.7	Emission Bandwidth	Compliant
§15.247(d) §15.205 §15.209	RSS-247 §5.5 RSS-Gen §8.9 RSS-Gen §8.10	Radiated & Conducted Band Edge and Spurious Emission	Compliant
§15.247(e)	RSS-247 §5.2 b	Peak Power Density	Compliant
§15.203	N/A	Antenna Requirement	Compliant
§15.205	RSS-Gen § 8.10	Restricted Bands	Compliant

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4 DESCRIPTION OF TEST MODES

4.1 Operating Frequencies

ITEM	FREQUENCY
15	2425 MHz
20	2450 MHz
25	2475 MHz

4.2 The Worst Test Modes and Channel Details

1. The EUT has been tested under operating condition.
2. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.
3. The field strength of radiation emission was measured as the EUT positioned in different orthogonal planes (E1/E2/H) based on actual usage of the EUT to pre-scan the emissions for determining the worst case scenario.
4. Investigation has been done on all the possible configurations for searching the worst case.

CONDUCTED TEST				
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)
Zigbee	15 to 25	15,20,25	O-QPSK	0.25

TRANSMIT RADIATED EMISSION TEST (BELOW 1 GHz)				
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)
Zigbee	15 to 25	20	O-QPSK	0.25
TRANSMIT RADIATED EMISSION TEST (ABOVE 1 GHz)				
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)
Zigbee	15 to 25	15,20,25	O-QPSK	0.25

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5 MEASUREMENT UNCERTAINTY

Test Items	Uncertainty
AC Power Line Conducted Emission	+/- 2.32 dB
Output Power measurement	+/- 1 dB
Emission Bandwidth	+/- 1.53 Hz
Undesignable radiated emission measurement	+/- 1.68 dB
Peak Power Density	+/- 2.16 dB
Temperature	+/- 0.7 °C
Humidity	+/- 3 %
DC / AC Power Source	+/- 1 %

Radiated Spurious Emission Measurement Uncertainty			
Polarization: Vertical	+/- 2.8 dB	9kHz~30MHz	
	+/- 4.82 dB	30MHz - 1000MHz	
	+/- 4.37 dB	1GHz - 18GHz	
	+/- 4.21 dB	18GHz - 40GHz	
Polarization: Horizontal	+/- 2.8 dB	9kHz~30MHz	
	+/- 4.54 dB	30MHz - 1000MHz	
	+/- 4.37 dB	1GHz - 18GHz	
	+/- 4.21 dB	18GHz - 40GHz	

Note:

1. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.
2. The conformity assessment statement in this report is based solely on the test results, measurement uncertainty is excluded.

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6 MEASUREMENT EQUIPMENT USED

6.1 Emission from AC power line

AC Power-Line Conducted Emission Test Site: Conduction 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Test Software	Audix	e3	Ver. 9.210616	N.C.R	N.C.R
LISN	SCHWARZBECK	NSLK 8127	1040	09/06/2023	09/05/2024
Coaxial Cables	EMC Instruments Corp.	EMCCFD300-BM-BM-3000	161207	06/22/2023	06/21/2024
Pulse Limiter	SCHWARZBECK	VTSD 9561F-N	793	06/22/2023	06/21/2024
EMI Test Receiver	R&S	ESCI 7	100759	08/21/2023	08/20/2024

6.2 Conducted Measurement

Conducted Emission Test Site: Conducted 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EXA Spectrum Analyzer	KEYSIGHT	N9010B	MY59071571	06/07/2023	06/06/2024
Test Software	SGS	Radio Test Software	Ver. 21	N.C.R	N.C.R
Power Meter	Anritsu	ML2496A	1242004	10/26/2022	10/25/2023
Power Sensor	Anritsu	MA2411B	1207365	10/26/2022	10/25/2023
Power Sensor	Anritsu	MA2411B	1207368	10/26/2022	10/25/2023
DC Block	Mini-Circuits	BLK-18-S+	1	12/13/2022	12/12/2023

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6.3 Radiated Measurement

Radiated Emission Test Site: SAC 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Loop Antenna	ETS.LINDGREN	6502	148045	10/05/2022	10/04/2023
Horn Antenna	RF SPIN	DRH0844	LE2D05A0844	07/03/2023	07/02/2024
Horn Antenna	SCHWARZBECK	BBHA9120D	D803	12/30/2022	12/29/2023
Bi-log Antenna	TESEO	CBL 6112D	35242 & AT-N0555	12/27/2022	12/26/2023
Spectrum Analyzer	Agilent	E4446A	MY51100003	10/28/2022	10/27/2023
Test Software	Audix	e3	Ver. 9.210616	N.C.R	N.C.R
EMI Test Receiver	R&S	ESCI 7	100759	08/21/2023	08/20/2024
Site Cal	SGS	SAC 1	N/A	08/31/2023	08/30/2024
Pre-Amplifier	EMCI	EMC184045B	980135	08/31/2023	08/30/2024
Pre-Amplifier	HP	8447D	2944A09469	08/31/2023	08/30/2024
Pre-Amplifier	EMCI	EMC118A45SEE	980933	07/31/2023	07/30/2024
Bandreject Filter 2400-2483.5	EWT	EWT-14-0166	M1	12/13/2022	12/12/2023
4GHz High Pass Filter	WI	WHKX4.0/18G-10SS	22	12/13/2022	12/12/2023
Coaxial Cables	Huber Suhner	SUCOFLEX 102	RX Cable 18G-40G MY2630/2+805062/2	08/31/2023	08/30/2024
Coaxial Cable	EMCI	EMC104-SM-SM- 8000+EMC106-SM- SM-7600	RX Cable 9K- 18G(160125+150817)	09/12/2023	09/11/2024

NOTE: N.C.R refers to Not Calibrated Required.

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7 CONDUCTED EMISSION TEST

7.1 Standard Applicable:

Frequency range within 150kHz to 30MHz shall not exceed the Limit table as below.

Frequency range MHz	Limits (dB μ V)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

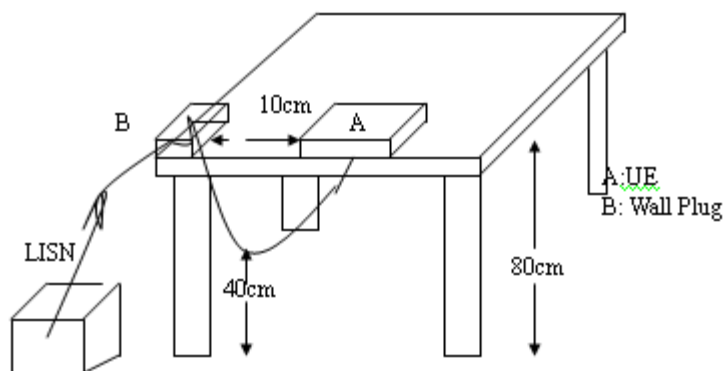
Note

- 1.The lower limit shall apply at the transition frequencies
- 2.The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

7.2 EUT Setup:

1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI C63.10:2013.
2. The AC/DC Power adaptor of EUT was plug-in LISN. The EUT was placed flushed with the rear of the table.
3. The LISN was connected with 120Vac/60Hz power source.

7.3 Test Setup



7.4 Measurement Procedure:

1. The EUT was placed on a table which is 0.8m above ground plane.

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2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all phases of power being supplied by given UE are completed

7.5 Measurement Result:

Note: Refer to next page for measurement data and plots.

Note2: The * reveals the worst-case results that closest to the limit.

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AC POWER LINE CONDUCTED EMISSION TEST DATA

Report Number : TERF2309002220ER

Test Site : Conduction 1

Operation Mode : ZigBee

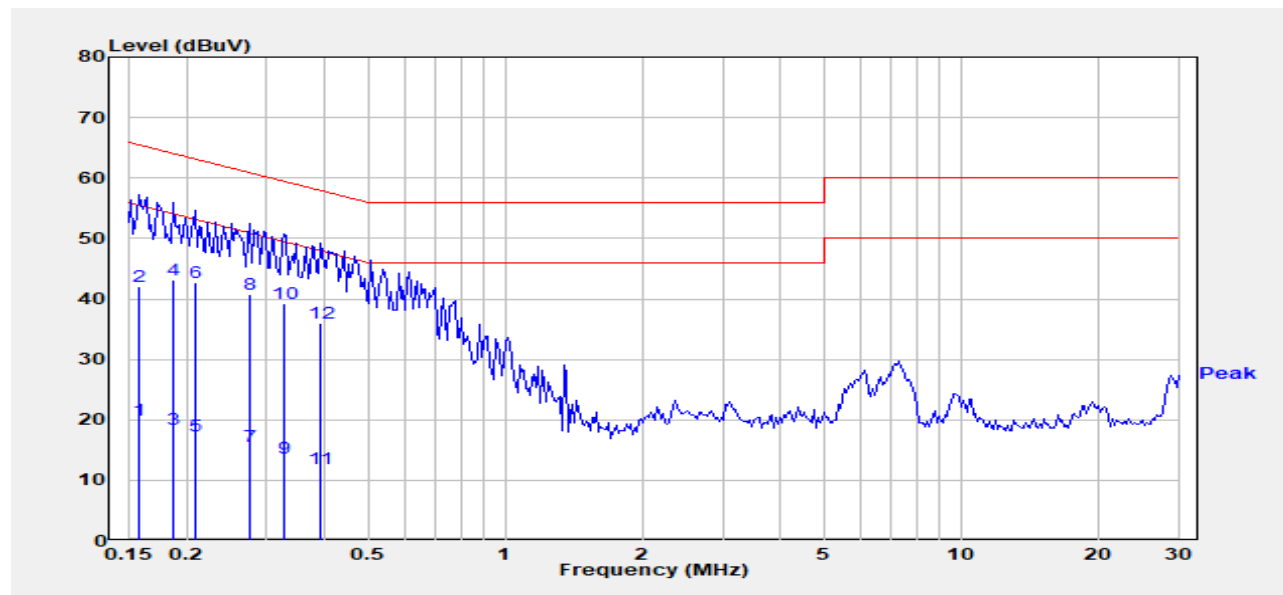
Test Date : 2023-09-22

Power : 120V/60Hz

Temp./Humi. : 25.1°C/61%

Probe : L

Engineer : Cooper Hsu



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV	Limit dBμV	Margin dB
0.156	Average	9.72	10.13	19.85	55.65	-35.80
0.156	QP	32.02	10.13	42.15	65.65	-23.50
0.187	Average	8.32	10.13	18.45	54.15	-35.70
0.187	QP	32.92	10.13	43.05	64.15	-21.10
0.208	Average	7.12	10.13	17.25	53.27	-36.02
0.208	QP	32.52	10.13	42.65	63.27	-20.62
0.274	Average	5.41	10.14	15.55	50.98	-35.43
0.274	QP	30.61	10.14	40.75	60.98	-20.23
0.329	Average	3.51	10.14	13.65	49.49	-35.84
0.329	QP	29.11	10.14	39.25	59.49	-20.24
0.393	Average	1.80	10.15	11.95	47.99	-36.04
0.393	QP	25.80	10.15	35.95	57.99	-22.04

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Report Number :TERF2309002220ER

Operation Mode :ZigBee

Power :120V/60Hz

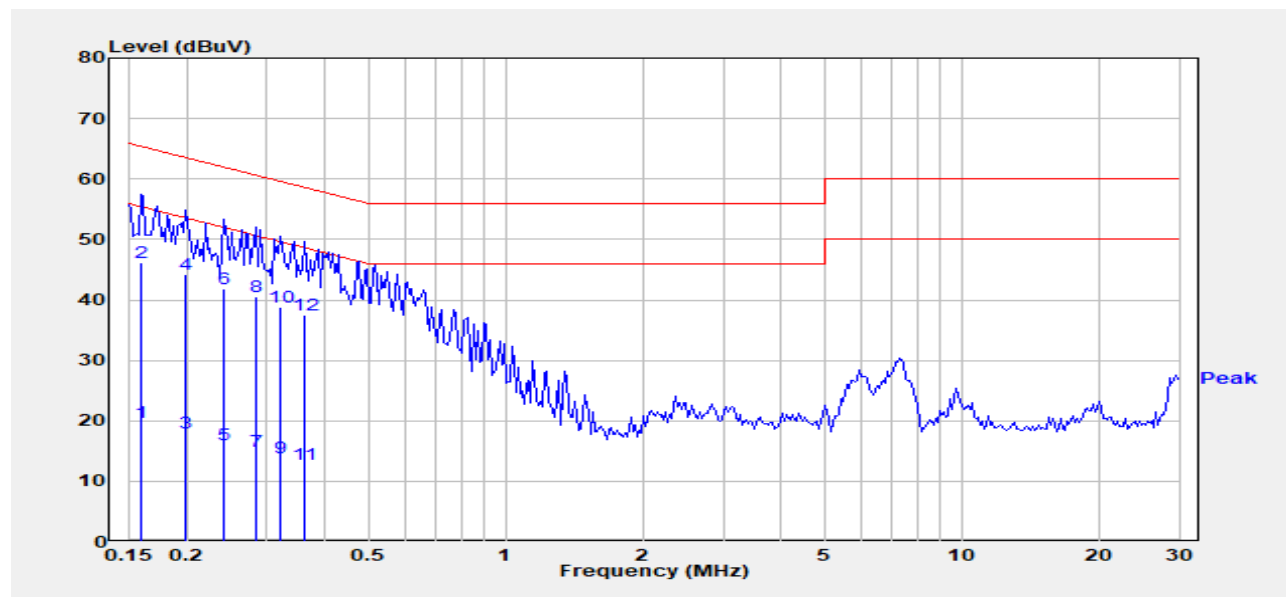
Probe :N

Test Site :Conduction 1

Test Date :2023-09-22

Temp./Humi. :25.1°C/61%

Engineer :Cooper Hsu



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV	Limit dBμV	Margin dB
0.158	Average	9.63	10.12	19.75	55.56	-35.81
0.158	QP	36.03	10.12	46.15	65.56	-19.41
0.200	Average	7.83	10.12	17.95	53.62	-35.67
0.200	QP	34.13	10.12	44.25	63.62	-19.37
0.242	Average	6.02	10.13	16.15	52.04	-35.89
0.242	QP	31.82	10.13	41.95	62.04	-20.09
0.283	Average	4.81	10.14	14.95	50.72	-35.77
0.283	QP	30.51	10.14	40.65	60.72	-20.07
0.322	Average	3.71	10.14	13.85	49.66	-35.81
0.322	QP	28.61	10.14	38.75	59.66	-20.91
0.361	Average	2.70	10.15	12.85	48.69	-35.84
0.361	QP	27.30	10.15	37.45	58.69	-21.24

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8 PEAK OUTPUT POWER MEASUREMENT

8.1 Standard Applicable:

8.1.1 Duty Cycle

Pre-analysis Check: While conducting average power measurement, duty cycle of each mode shall be checked to ensure its duty cycle in order to compensate for the loss due to insufficient ratio of duty cycle.

All duty cycle is pre-scanned, and result as obtained below shows only the most representative ones where duty cycle is conducted as the given transmission with given virtual operation that expresses the percentage.

8.1.2 FCC

For systems using digital modulation in the 2400-2483.5 MHz bands, the limit for peak output power is 1Watt.

If the transmitting antenna of directional gain greater than 6dBi are used the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the Antenna exceeds 6dBi.

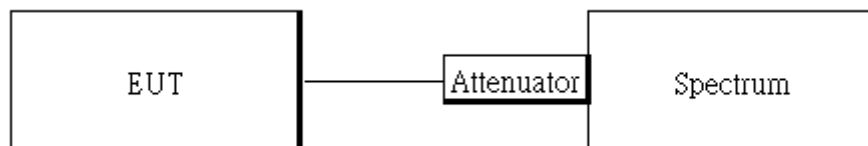
In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of Antenna exceeds 6dBi.

8.1.3 ISED

For systems using digital modulation in the 2400-2483.5 MHz bands, the limit for peak output power is 1Watt and the e.i.r.p. shall not exceed 4 W.

8.2 Test Setup

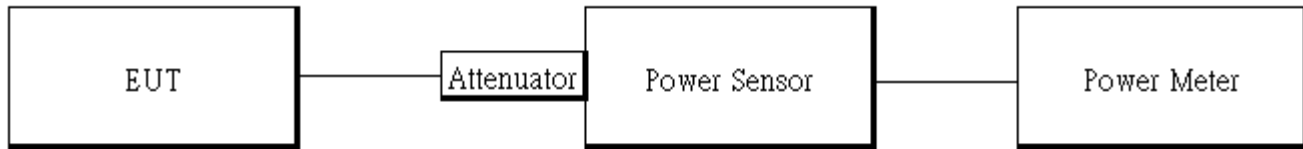
8.2.1 Duty Cycle



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8.2.2 Output Power



8.3 Measurement Procedure:

8.3.1 Duty Cycle

1. Place the EUT on the table and set it in transmitting mode.
2. Set span = Zero
3. RBW = 8MHz, VBW = 8MHz,
4. Detector = Peak

8.3.2 Output Power

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter.
4. Record the max. Reading as observed from Power Meter.
5. Repeat above procedures until all test default channel measured was complete.

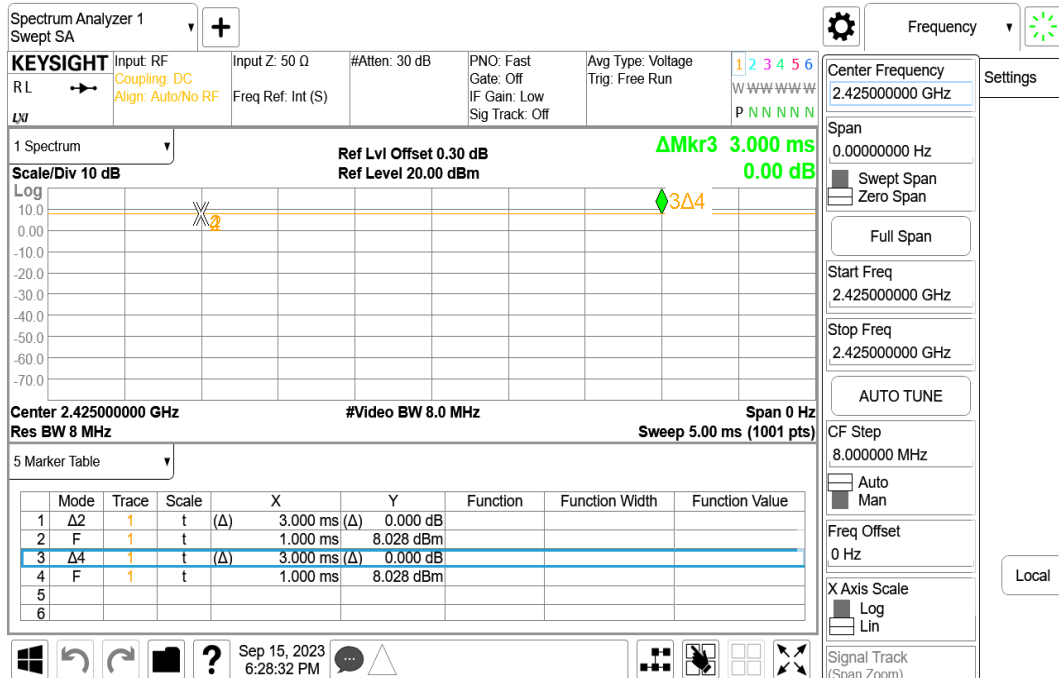
8.4 Duty Factor:

	Duty Cycle (%) = Ton / (Ton+Toff)	Duty Factor (dB) =10*log (1/Duty Cycle)	1/T (kHz)	VBW setting (kHz)
Zigbee	100.00	0.00	0.33	0.01

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Zigbee_LowCH15-2425MHz



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8.5 Output Power:

8.5.1 Peak & Avg

Zigbee mode:

CH	Frequency (MHz)	Power set	Peak Output Power (dBm)	Required Limit (dBm)
Low	2425	8	7.76	30
Mid	2450	8	7.89	30
High	2475	8	7.97	30
CH	Frequency (MHz)	Power set	Avg. Output Power (dBm)	Required Limit (dBm)
Low	2425	8	7.72	30
Mid	2450	8	7.85	30
High	2475	8	7.93	30

*Note:

1.Measured by power meter, cable loss 0.3 dB + Duty cycle factor has been offseted to the power meter for Avg. power and cable loss has been offseted for Peak power measurement.

8.5.2 EIRP

EIRP Zigbee mode

CH	Frequency (MHz)	Power set	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit
Low	2425	8	7.72	1.82	9.54	4W= 36 dBm
Mid	2450	8	7.85	1.82	9.67	4W= 36 dBm
High	2475	8	7.93	1.82	9.75	4W= 36 dBm

* Note: EIRP = Average Power + Gain

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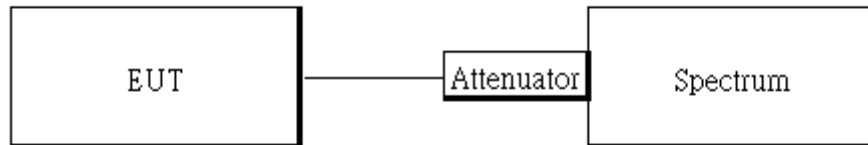
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9 EMISSION BANDWIDTH MEASUREMENT

9.1 Standard Applicable

The minimum 6 dB bandwidth shall be at least 500 kHz .

9.2 Test Setup



9.3 Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.

9.3.1 FCC measurements

1. The testing follows the Measurement Procedure of the KDB 558074 D01.
2. Set the spectrum analyzer as
RBW= 100 kHz ,
VBW = 3 X RBW,
Span= 2 to 5 times of the OBW,
Sweep=auto, Detector = Peak, and Max hold.
3. Mark the upper and lower frequencies of -6dB.
4. Repeat above procedures until all test default channel is completed.

9.3.2 ISSED measurements

1. The testing follows the Measurement Procedure of the RSS-Gen section 6.7.
2. Set the spectrum analyzer as
RBW= 1 % to 5% of 99% and -6dB Bandwidth ,
VBW $\geq$ 3 X RBW,
Span= large enough to capture all products of the modulation process
Sweep=auto, Detector = Peak, and Max hold.
3. Mark the upper and lower frequencies of 99% and -6dB.
4. Repeat above procedures until all test default channel is completed.

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9.4 Measurement Result:

Zigbee mode

Frequency (MHz)	6dB BW (MHz)	Required BW (MHz)	Result
2425	1.587	≥ 0.5	PASS
2450	1.591	≥ 0.5	PASS
2475	1.594	≥ 0.5	PASS

Zigbee mode

Frequency (MHz)	99%Bandwidth (MHz)
2425	2.3231
2450	2.3428
2475	2.3429

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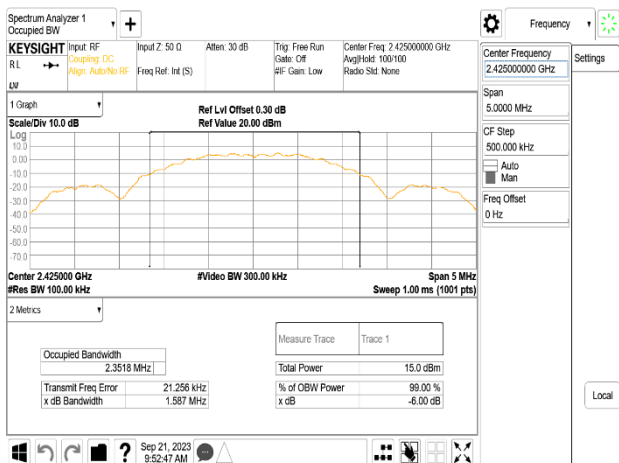
t (886-2) 2299-3279

f (886-2) 2298-0488

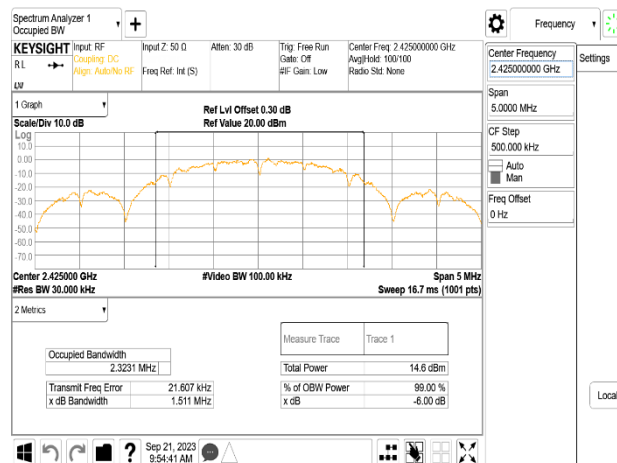
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OBW_Zigbee_LowCH15-2425MHz



IC OBW_Zigbee_LowCH15-2425MHz



OBW_Zigbee_MidCH20-2450MHz



IC OBW_Zigbee_MidCH20-2450MHz



OBW_Zigbee_HighCH25-2475MHz



IC OBW_Zigbee_HighCH25-2475MHz



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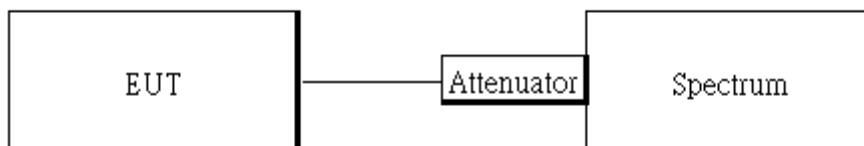
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10 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

10.1 Standard Applicable

In any 100 kHz 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 20 dB below that in the 100 kHz 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. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a) & RSS-Gen §8.10, must also comply with the radiated emission limits specified in §15.209(a) & RSS-Gen §8.9.

10.2 Test Setup



10.3 Measurement Procedure

10.3.1 Reference Level of Emission Limit:

1. Set analyzer center frequency to DTS channel center frequency.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Set the span to 1.5 times the DTS channel bandwidth.
4. Set the RBW = 100kHz & VBW = 300 kHz.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level.

10.3.2 Conducted Band Edge:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.

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4. Set start to edge frequency, and stop frequency of spectrum analyzer so as to encompass the spectrum to be examined.
5. Set the spectrum analyzer as RBW=100 kHz, VBW=300 kHz, Detector = Peak, Sweep = auto
6. Set DL as the limit = reading on marker of reference level measurement – 20dBm
7. Mark the highest readings of the emissions outside of 2400MHz~2483.5MHz.
8. Repeat above procedures until all default test channel (low and high) was complete.

10.3.3 Conducted Spurious Emission:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Set RBW = 100 kHz & VBW=300 kHz, Detector =Peak, Sweep = Auto
4. Allow trace to fully stabilize.
5. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.
6. Repeat above procedures until all default test channel measured were complete.

10.4 Measurement Result

Zigbee_Reference Level of Limit

Frequency (MHz)	RF Power Density (dBm)	Reference Level of Limit = PSD - 20dB (dBm)
2425	4.88	-15.12
2450	4.87	-15.13
2475	4.76	-15.24

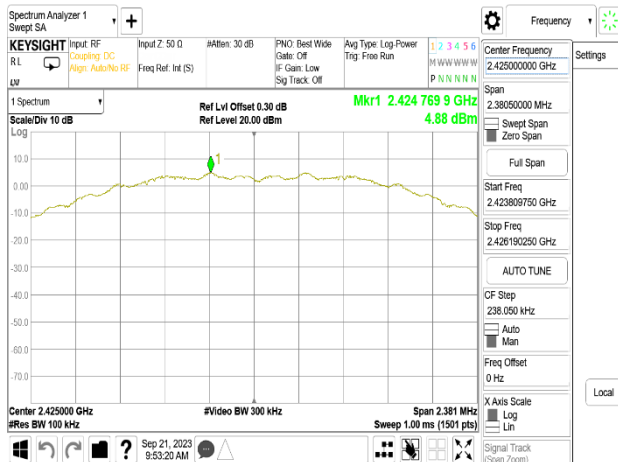
***Note:**

- 1.cable loss as 0.3dB that offsets in the spectrum
- 2.Refer to next page for plots.

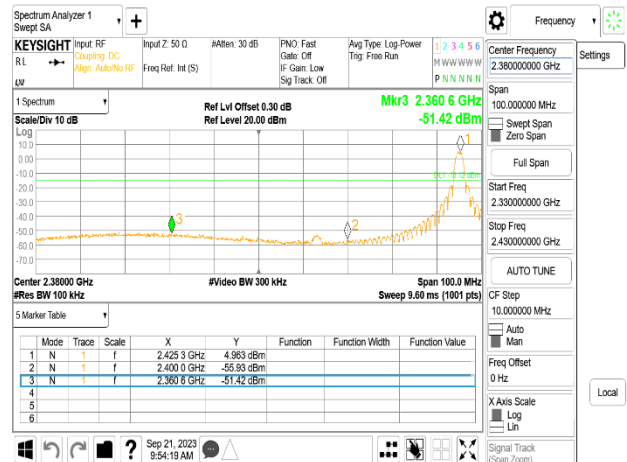
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Reference Level_Zigbee_LowCH15-2425MHz



Band Edge_Zigbee_LowCH15-2425MHz



Reference Level_Zigbee_MidCH20-2450MHz



Band Edge_Zigbee_HighCH25-2475MHz



Reference Level_Zigbee_HighCH25-2475MHz



Spurious Emission_Zigbee_LowCH15-2425MHz

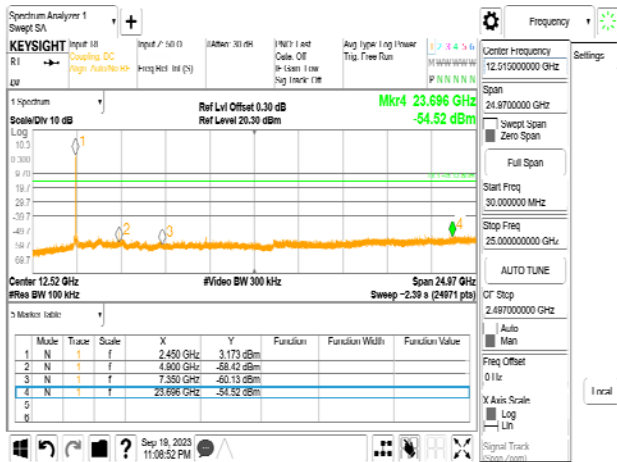


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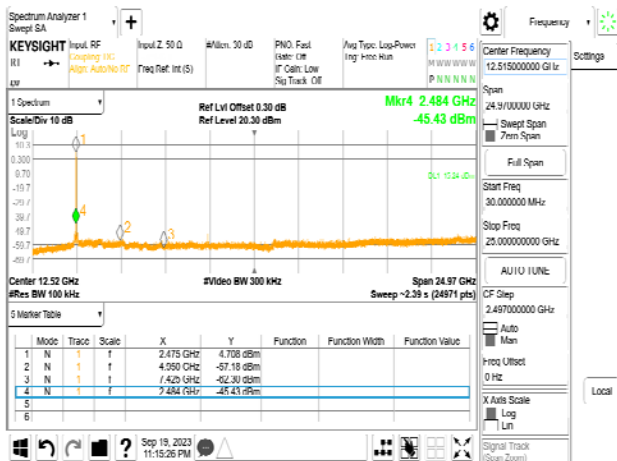
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Spurious Emission_Zigbee_MidCH20-2450MHz



Spurious Emission_Zigbee_HighCH25-2475MHz



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11 RADIATED BANDEDGE AND SPURIOUS EMISSION MEASUREMENT

11.1 Standard Applicable

In any 100 kHz 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 20 dB below that in the 100 kHz 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. In addition, radiated emissions which fall in the restricted bands must also comply with the §15.209 and RSS-Gen §8.9 Table 5 and 6 limit as below.

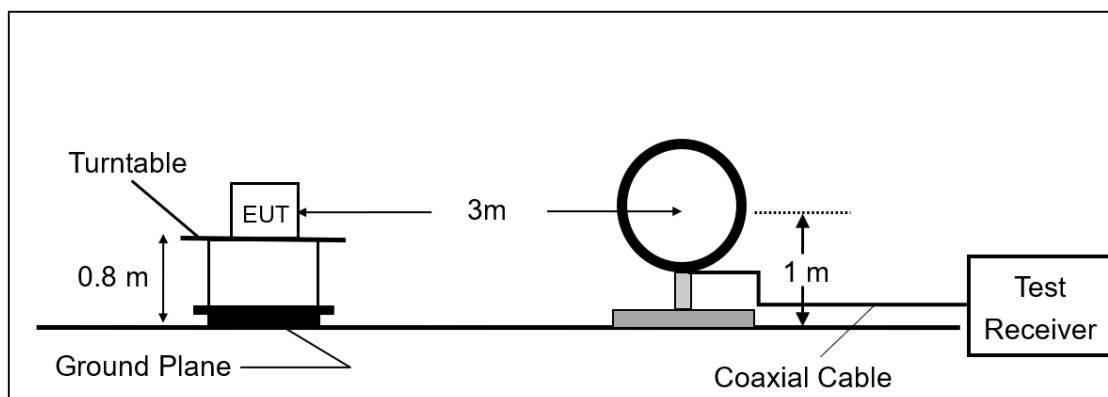
And according to §15.33(a) (1) & RSS-Gen §6.13.2.a for an intentional radiator operates below 10GHz, the frequency range of measurements: to the tenth harmonic of the highest fundamental frequency or to 40GHz, whichever is lower.

Frequency (MHz)	Field strength (microvolts/meter)	Distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Note: The lower limit shall apply at the transition frequencies.

11.2 Test Setup

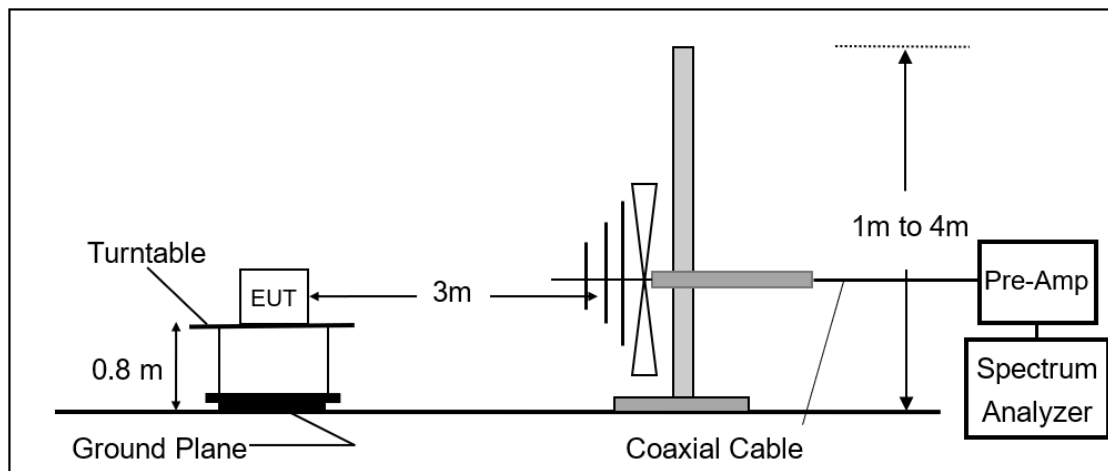
(A) Radiated Emission Test Set-Up, Frequency Below 30MHz.



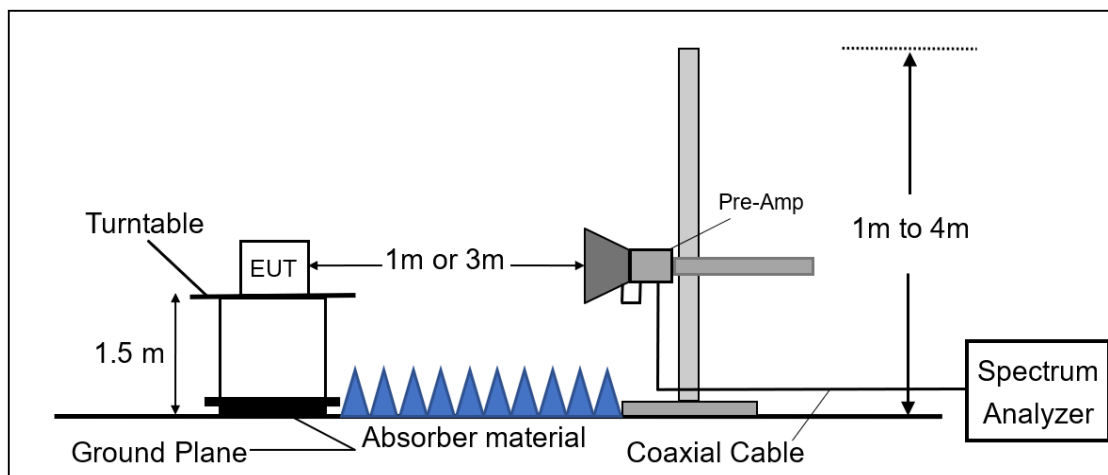
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(B) Radiated Emission Test Set-Up, Frequency From 30MHz to 1000MHz.



(C) Radiated Emission Test Set-Up, Frequency Above 1GHz.



11.3 Measurement Procedure

1. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
2. The EUT was placed on a turn table with 0.8m for frequency < 1GHz and 1.5m for frequency > 1GHz above ground plane.
3. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
4. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
5. Set the spectrum analyzer as RBW=100 kHz and VBW=300 kHz for Peak Detector (PK) at frequency between 30MHz and 1 GHz.
6. Use receiver mode as RBW=120 kHz for Quasi-peak (QP) at frequency between 30MHz and 1 GHz.

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7. Set the spectrum analyzer as RBW=1 MHz, VBW=3 MHz for Maximum Emission Measurements at frequency above 1 GHz.
8. Set the spectrum analyzer as RBW=1 MHz, VBW=10 Hz (Duty cycle > 98%) or VBW ≥ 1/T (Duty cycle < 98%) for Average Emission Measurements at frequency above 1 GHz.
9. When measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” is still within the 3dB illumination BW of the measurement antenna.
10. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
11. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
12. Repeat above procedures until all default test channel measured were complete.

11.4 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CL - AG$$

Where *FS = Field Strength* *CL = Cable Attenuation Factor (Cable Loss)*
RA = Reading Amplitude *AG = Amplifier Gain*
AF = Antenna Factor

The limit of the emission level is expressed in dBuV/m, which converts $20 \cdot \log(uV/m)$

Actual FS(dBμV/m) = SPA. Reading level(dBμV) + Factor(dB)

Factor(dB) = Antenna Factor(dBμV/m) + Cable Loss(dB) – Pre_Amplifier Gain(dB)

11.5 Test Results of Radiated Spurious Emissions from 9 kHz to 30 MHz

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit per 15.31(o) & RSS-GEN §6.13.2 was not reported.

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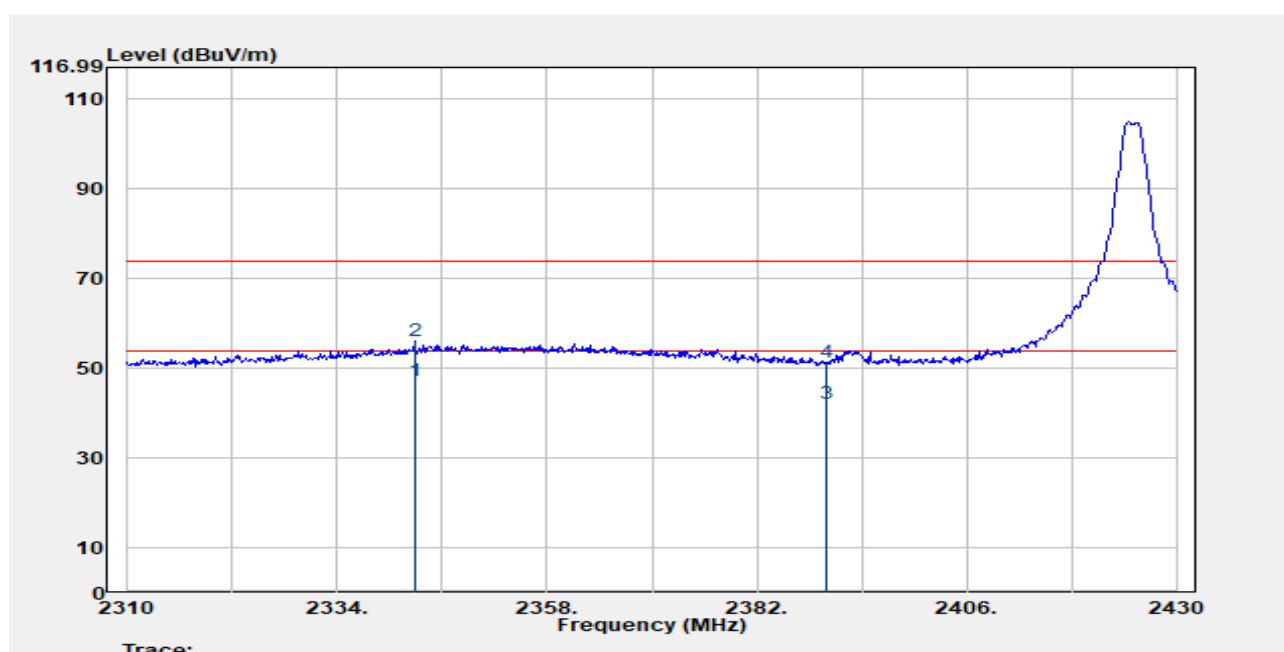
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11.6 Measurement Result:

11.6.1 Radiated Band Edge Measurement Result

Report Number :TERF2309002220ER
 Operation Mode :ZigBee
 Test Frequency :2425 MHz
 Test Mode :Bandedge
 EUT Pol :E1 Plane

Test Site :SAC 1
 Test Date :2023-09-22
 Temp./Humi. :24.6°C/62%
 Antenna Pol. :Vertical
 Engineer :Cooper Hsu



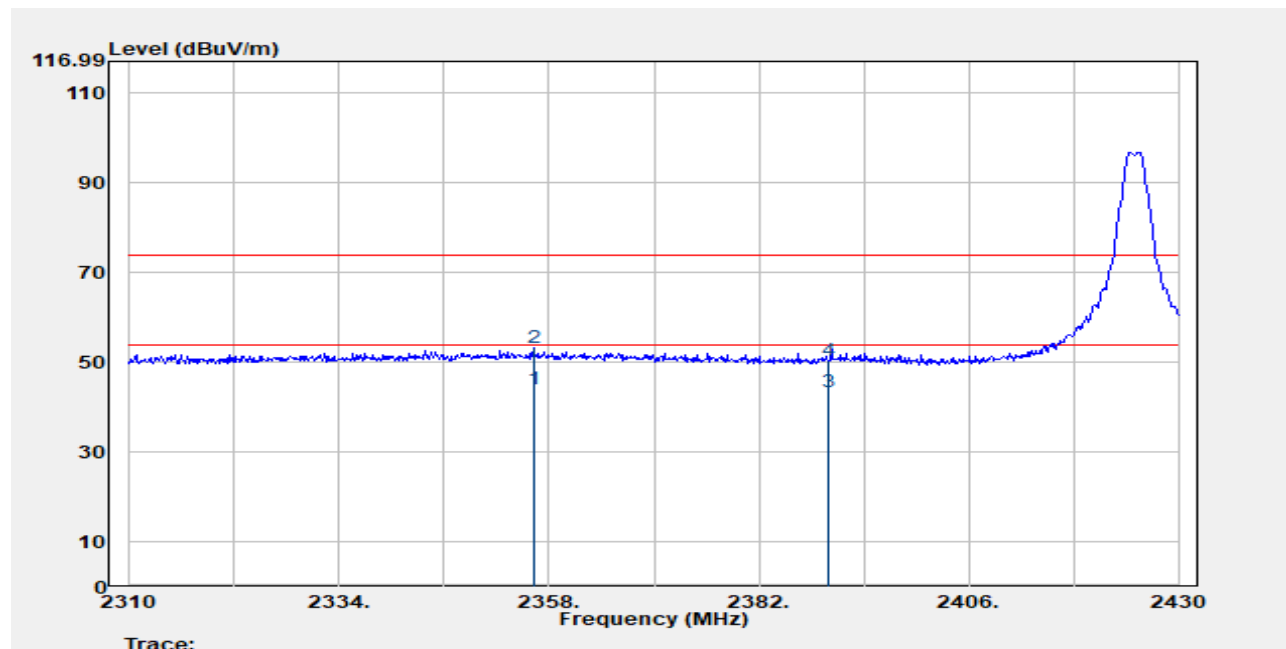
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBUV	Factor dB	Actual FS dBUV/m	Limit @3m dBUV/m	Margin dB
2342.88	Average	50.33	-3.20	47.13	54.00	-6.87
2342.88	Peak	59.33	-3.20	56.13	74.00	-17.87
2390.00	Average	45.51	-3.42	42.09	54.00	-11.91
2390.00	Peak	54.79	-3.42	51.37	74.00	-22.63

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Report Number :TERF2309002220ER
Operation Mode :ZigBee
Test Frequency :2425 MHz
Test Mode :Bandedge
EUT Pol :E1 Plane

Test Site :SAC 1
Test Date :2023-09-22
Temp./Humi. :24.6°C/62%
Antenna Pol. :Horizontal
Engineer :Cooper Hsu



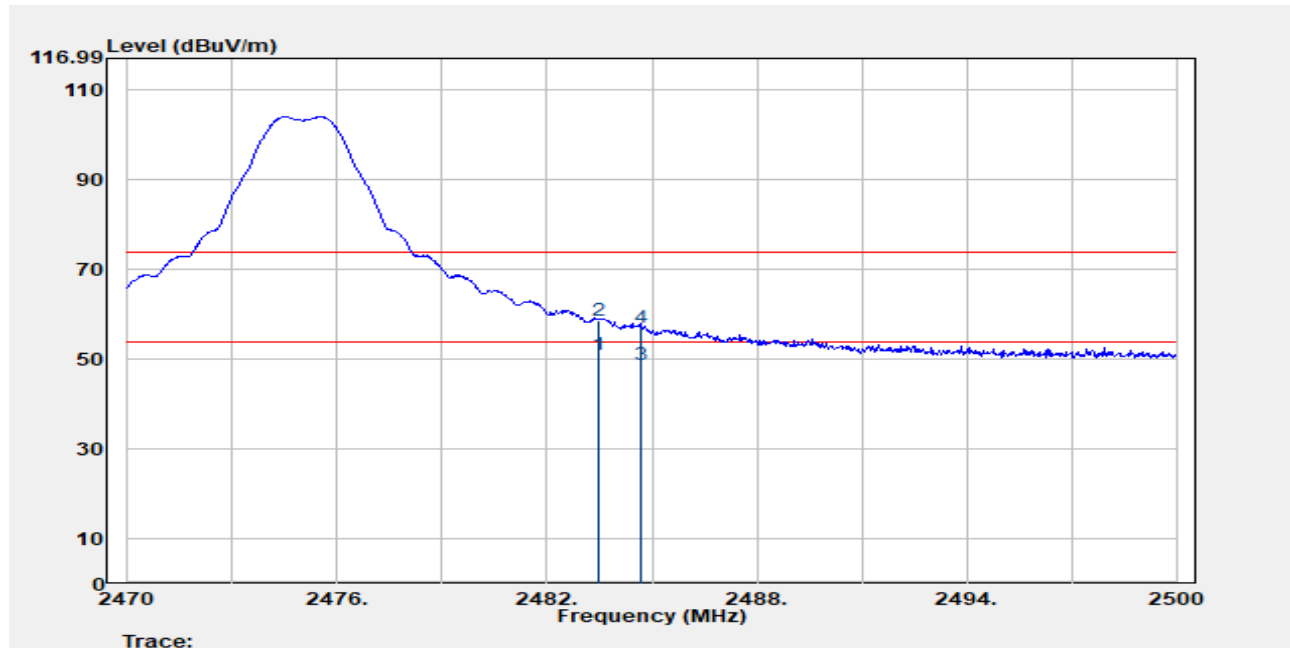
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2356.20	Average	47.33	-3.24	44.09	54.00	-9.91
2356.20	Peak	56.49	-3.24	53.25	74.00	-20.75
2390.00	Average	46.81	-3.42	43.39	54.00	-10.61
2390.00	Peak	53.88	-3.42	50.46	74.00	-23.54

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Report Number :TERF2309002220ER
 Operation Mode :ZigBee
 Test Frequency :2475 MHz
 Test Mode :Bandedge
 EUT Pol :E1 Plane

Test Site :SAC 1
 Test Date :2023-09-22
 Temp./Humi. :24.6°C/62%
 Antenna Pol. :Vertical
 Engineer :Cooper Hsu



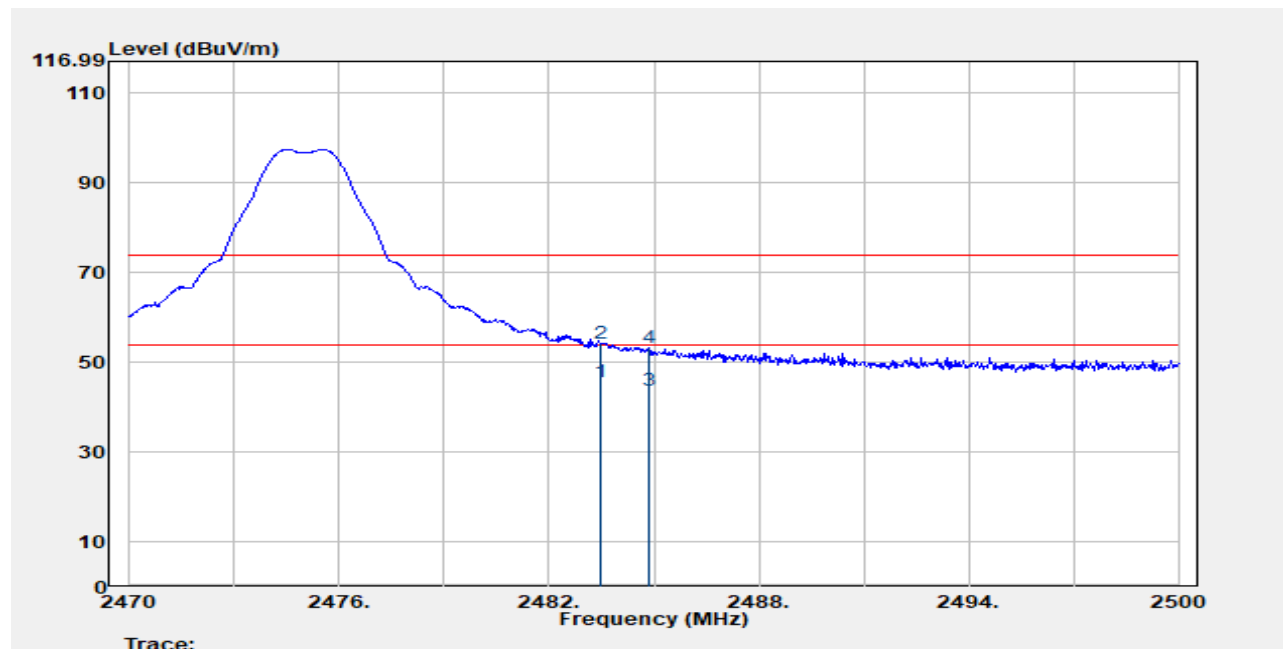
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2483.50	Average	54.36	-3.45	50.91	54.00	-3.09
2483.50	Peak	62.16	-3.45	58.71	74.00	-15.29
2484.67	Average	52.14	-3.44	48.70	54.00	-5.30
2484.67	Peak	60.55	-3.44	57.11	74.00	-16.89

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Report Number :TERF2309002220ER
 Operation Mode :ZigBee
 Test Frequency :2475 MHz
 Test Mode :Bandedge
 EUT Pol :E1 Plane

Test Site :SAC 1
 Test Date :2023-09-22
 Temp./Humi. :24.6°C/62%
 Antenna Pol. :Horizontal
 Engineer :Cooper Hsu



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2483.50	Average	49.00	-3.45	45.55	54.00	-8.45
2483.50	Peak	57.62	-3.45	54.17	74.00	-19.83
2484.88	Average	47.19	-3.44	43.75	54.00	-10.25
2484.88	Peak	56.62	-3.44	53.18	74.00	-20.82

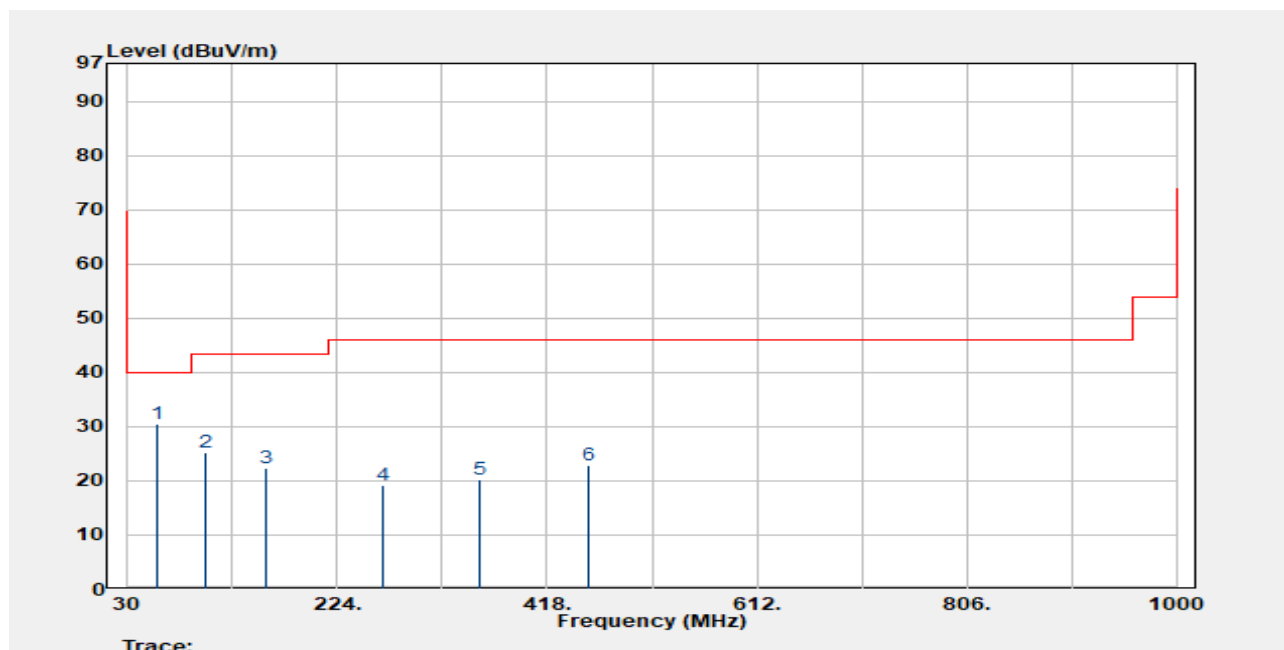
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11.6.2 Radiated Spurious Emission

Report Number :TERF2309002220ER
 Operation Mode :ZigBee
 Test Frequency :2450 MHz
 Test Mode :Tx
 EUT Pol :E1 Plane

Test Site :SAC 1
 Test Date :2023-09-22
 Temp./Humi. :24.6°C/62%
 Antenna Pol. :Vertical
 Engineer :Cooper Hsu



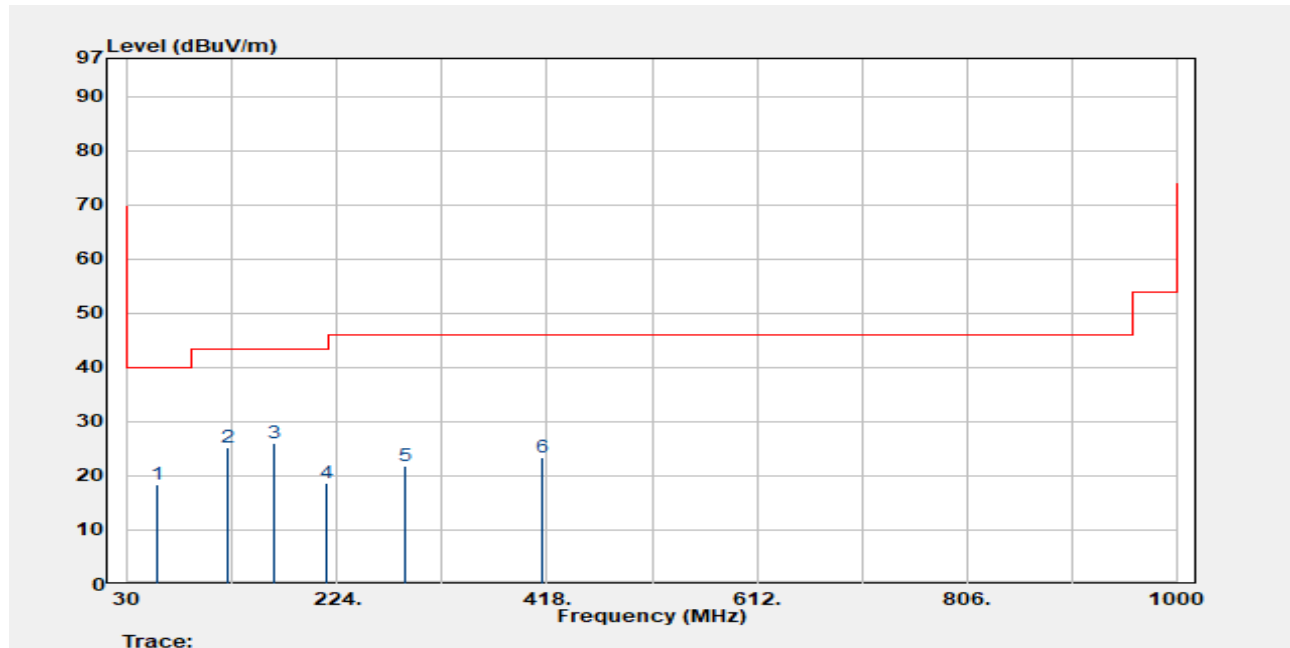
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
57.16	Peak	48.79	-18.21	30.58	40.00	-9.42
102.75	Peak	38.28	-13.11	25.17	43.50	-18.33
158.04	Peak	35.74	-13.47	22.27	43.50	-21.23
265.71	Peak	28.15	-9.09	19.06	46.00	-26.94
355.92	Peak	28.01	-7.82	20.19	46.00	-25.81
456.80	Peak	28.94	-6.18	22.75	46.00	-23.25

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Report Number :TERF2309002220ER
 Operation Mode :ZigBee
 Test Frequency :2450 MHz
 Test Mode :Tx
 EUT Pol :E1 Plane

Test Site :SAC 1
 Test Date :2023-09-22
 Temp./Humi. :24.6°C/62%
 Antenna Pol. :Horizontal
 Engineer :Cooper Hsu



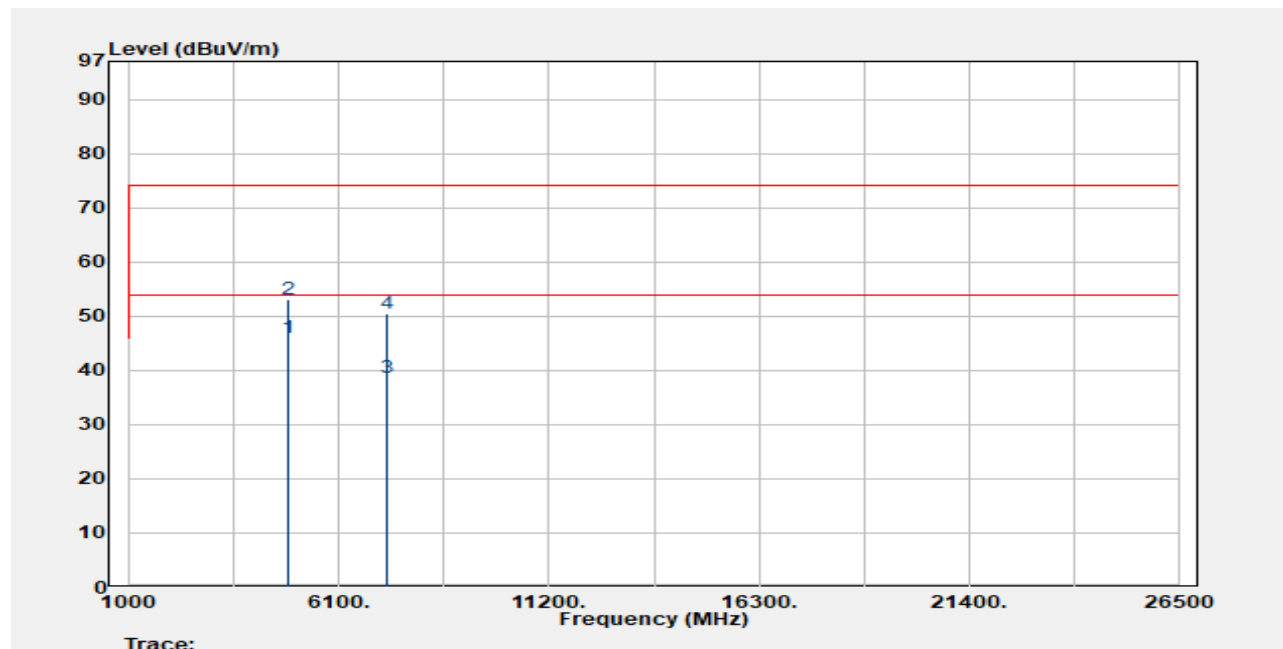
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
57.16	Peak	36.67	-18.21	18.46	40.00	-21.54
123.12	Peak	36.96	-11.85	25.11	43.50	-18.39
164.83	Peak	39.76	-13.69	26.07	43.50	-17.43
213.33	Peak	32.47	-13.87	18.60	43.50	-24.90
286.08	Peak	31.42	-9.57	21.85	46.00	-24.15
413.15	Peak	29.73	-6.34	23.39	46.00	-22.61

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Report Number :TERF2309002220ER
 Operation Mode :ZigBee
 Test Frequency :2425 MHz
 Test Mode :Tx
 EUT Pol :E1 Plane

Test Site :SAC 1
 Test Date :2023-09-22
 Temp./Humi. :24.6°C/62%
 Antenna Pol. :Vertical
 Engineer :Cooper Hsu



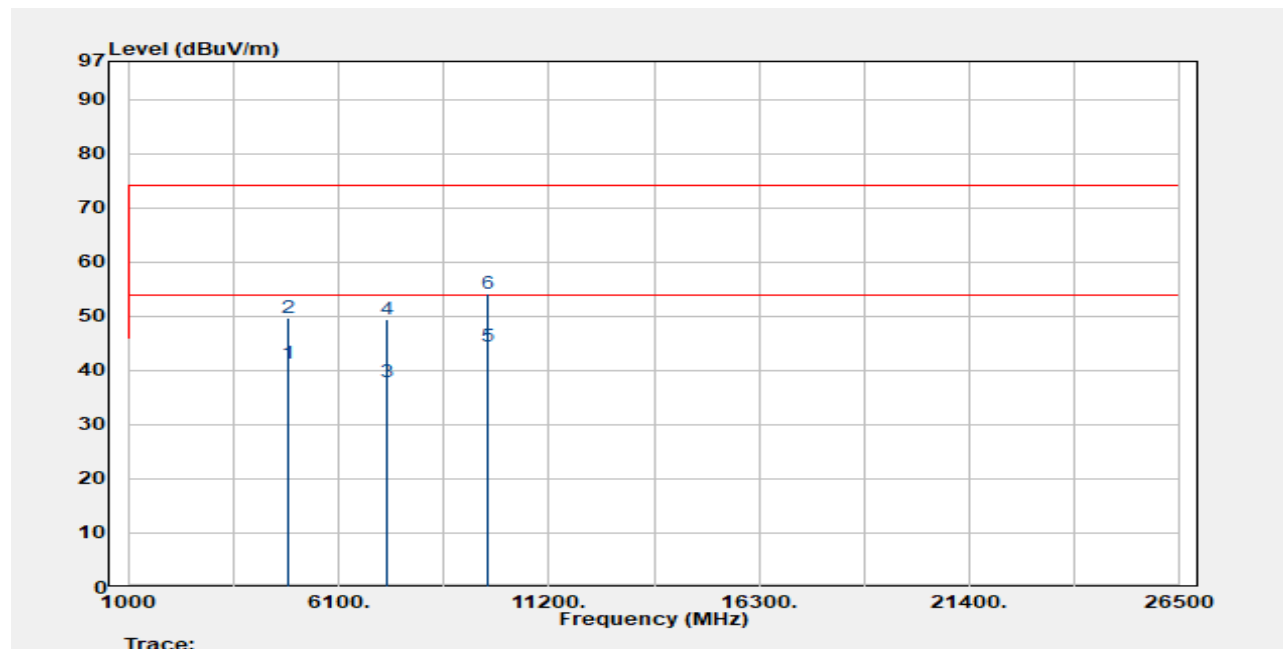
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
4850.00	Average	44.04	2.05	46.09	54.00	-7.91
4850.00	Peak	51.07	2.05	53.12	74.00	-20.88
7275.00	Average	31.11	7.60	38.71	54.00	-15.29
7275.00	Peak	42.87	7.60	50.47	74.00	-23.53

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Report Number :TERF2309002220ER
 Operation Mode :ZigBee
 Test Frequency :2425 MHz
 Test Mode :Tx
 EUT Pol :E1 Plane

Test Site :SAC 1
 Test Date :2023-09-22
 Temp./Humi. :24.6°C/62%
 Antenna Pol. :Horizontal
 Engineer :Cooper Hsu



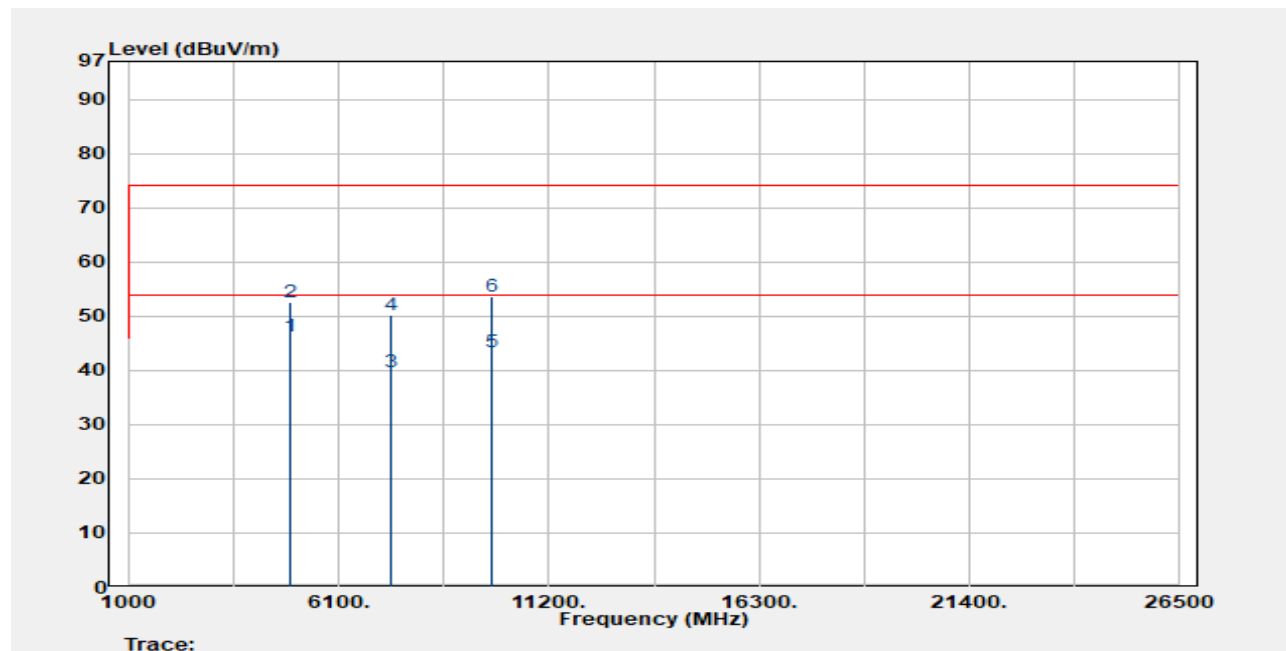
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
4850.00	Average	39.11	2.05	41.16	54.00	-12.84
4850.00	Peak	47.52	2.05	49.57	74.00	-24.43
7275.00	Average	30.34	7.60	37.94	54.00	-16.06
7275.00	Peak	41.92	7.60	49.52	74.00	-24.48
9700.00	Average	36.11	8.30	44.41	54.00	-9.59
9700.00	Peak	45.74	8.30	54.04	74.00	-19.96

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Report Number :TERF2309002220ER
 Operation Mode :ZigBee
 Test Frequency :2450 MHz
 Test Mode :Tx
 EUT Pol :E1 Plane

Test Site :SAC 1
 Test Date :2023-09-22
 Temp./Humi. :24.6°C/62%
 Antenna Pol. :Vertical
 Engineer :Cooper Hsu



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
4900.00	Average	44.05	2.11	46.16	54.00	-7.84
4900.00	Peak	50.54	2.11	52.65	74.00	-21.35
7350.00	Average	32.02	7.79	39.81	54.00	-14.19
7350.00	Peak	42.46	7.79	50.25	74.00	-23.75
9800.00	Average	34.42	8.88	43.30	54.00	-10.70
9800.00	Peak	44.76	8.88	53.64	74.00	-20.36

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台灣檢驗科技股份有限公司

t (886-2) 2299-3279

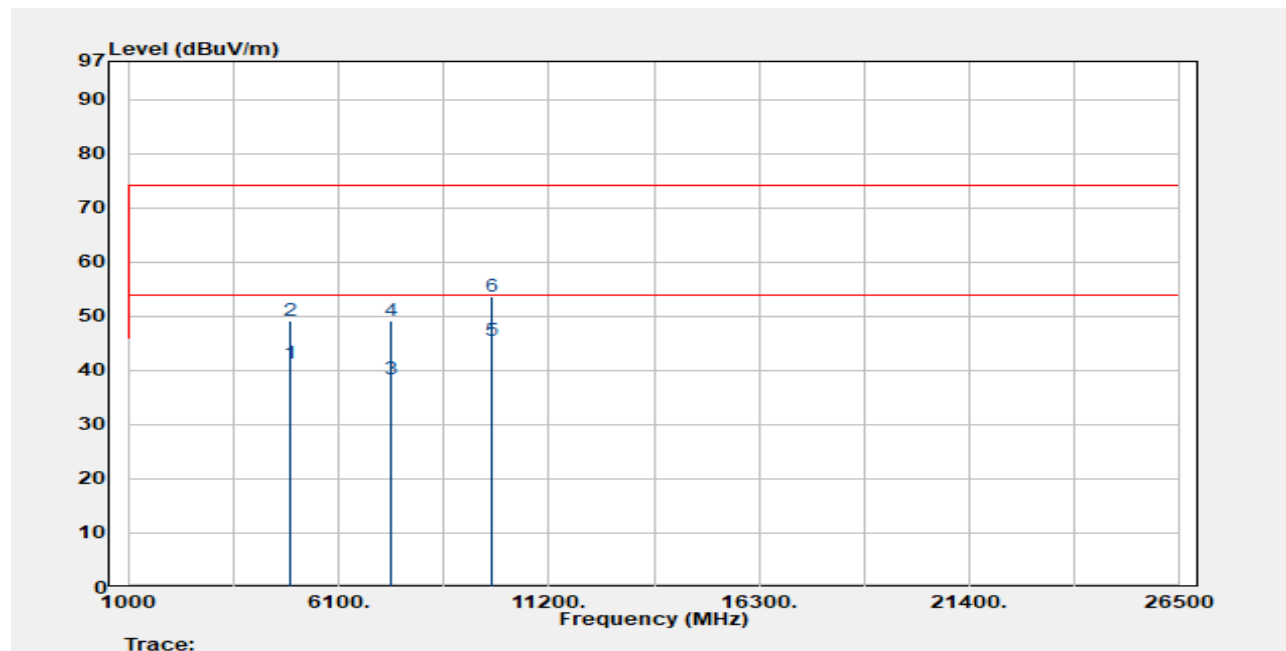
f (886-2) 2298-0488

www.sgs.com.tw

Member of SGS Group

Report Number :TERF2309002220ER
 Operation Mode :ZigBee
 Test Frequency :2450 MHz
 Test Mode :Tx
 EUT Pol :E1 Plane

Test Site :SAC 1
 Test Date :2023-09-22
 Temp./Humi. :24.6°C/62%
 Antenna Pol. :Horizontal
 Engineer :Cooper Hsu



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
4900.00	Average	39.21	2.11	41.32	54.00	-12.68
4900.00	Peak	46.96	2.11	49.07	74.00	-24.93
7350.00	Average	30.50	7.79	38.29	54.00	-15.71
7350.00	Peak	41.39	7.79	49.18	74.00	-24.82
9800.00	Average	36.47	8.88	45.35	54.00	-8.65
9800.00	Peak	44.71	8.88	53.59	74.00	-20.41

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台灣檢驗科技股份有限公司

t (886-2) 2299-3279

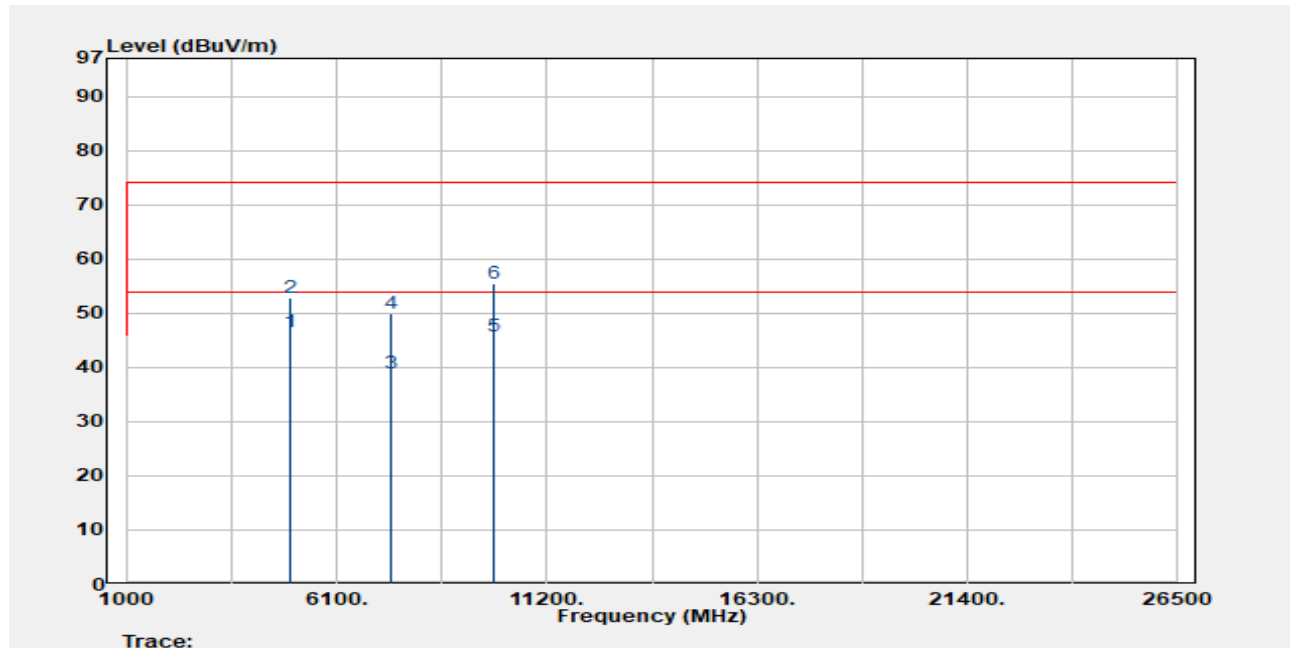
f (886-2) 2298-0488

www.sgs.com.tw

Member of SGS Group

Report Number :TERF2309002220ER
Operation Mode :ZigBee
Test Frequency :2475 MHz
Test Mode :Tx
EUT Pol :E1 Plane

Test Site :SAC 1
Test Date :2023-09-22
Temp./Humi. :24.6°C/62%
Antenna Pol. :Vertical
Engineer :Cooper Hsu



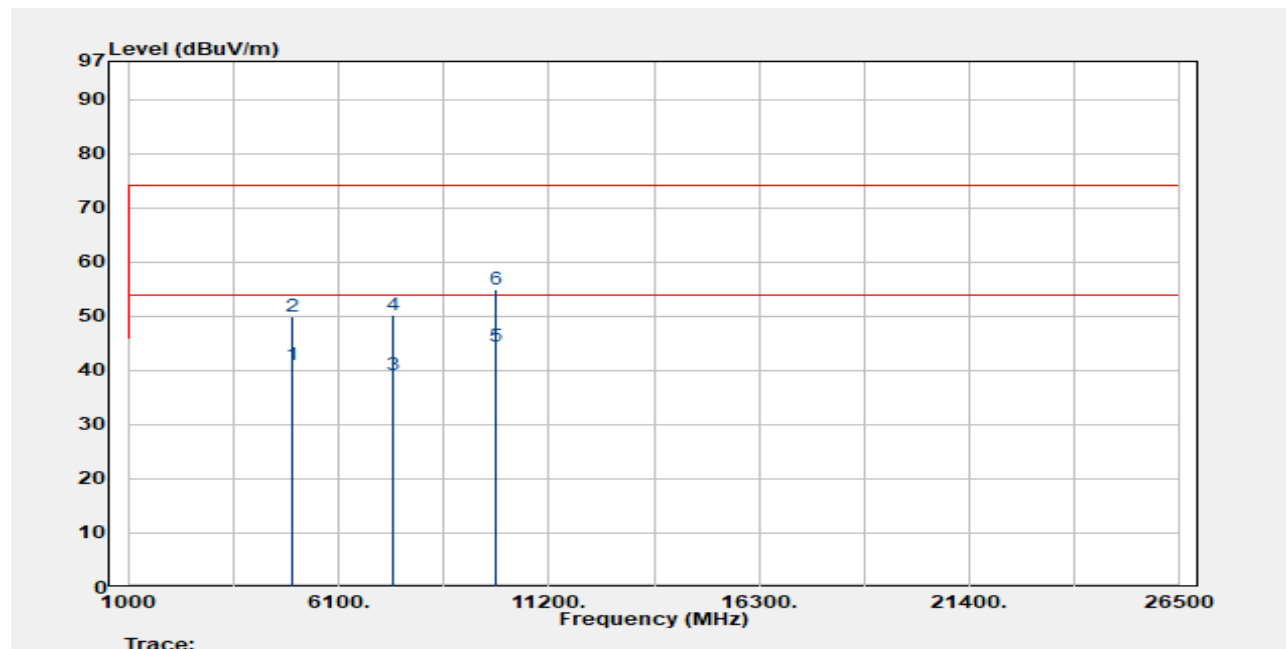
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
4950.00	Average	44.16	2.29	46.45	54.00	-7.55
4950.00	Peak	50.52	2.29	52.81	74.00	-21.19
7425.00	Average	31.21	7.77	38.98	54.00	-15.02
7425.00	Peak	42.24	7.77	50.01	74.00	-23.99
9900.00	Average	36.87	8.75	45.62	54.00	-8.38
9900.00	Peak	46.64	8.75	55.39	74.00	-18.61

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Report Number :TERF2309002220ER
 Operation Mode :ZigBee
 Test Frequency :2475 MHz
 Test Mode :Tx
 EUT Pol :E1 Plane

Test Site :SAC 1
 Test Date :2023-09-22
 Temp./Humi. :24.6°C/62%
 Antenna Pol. :Horizontal
 Engineer :Cooper Hsu



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
4950.00	Average	38.73	2.29	41.02	54.00	-12.98
4950.00	Peak	47.75	2.29	50.04	74.00	-23.96
7425.00	Average	31.33	7.77	39.10	54.00	-14.90
7425.00	Peak	42.37	7.77	50.14	74.00	-23.86
9900.00	Average	35.75	8.75	44.50	54.00	-9.50
9900.00	Peak	46.20	8.75	54.95	74.00	-19.05

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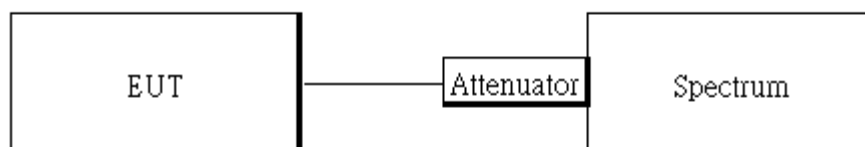
12 POWER SPECTRAL DENSITY

12.1 Standard Applicable:

Per Part 15.247 (e) & RSS-247 section 5.2 b

The power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

12.2 Test Setup



12.3 Measurement Procedure:

1. Set analyzer center frequency to DTS channel center frequency.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Set the span to 1.5 times the DTS channel bandwidth.
4. Set the RBW = 3 kHz. & the VBW = 10 kHz
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level.

12.4 Measurement Result:

Zigbee mode

Frequency (MHz)	RF Power Density (dBm/3kHz)	Maximum Limit (dBm/3kHz)	Result
2425	-6.88	8	PASS
2450	-7.12	8	PASS
2475	-7.06	8	PASS

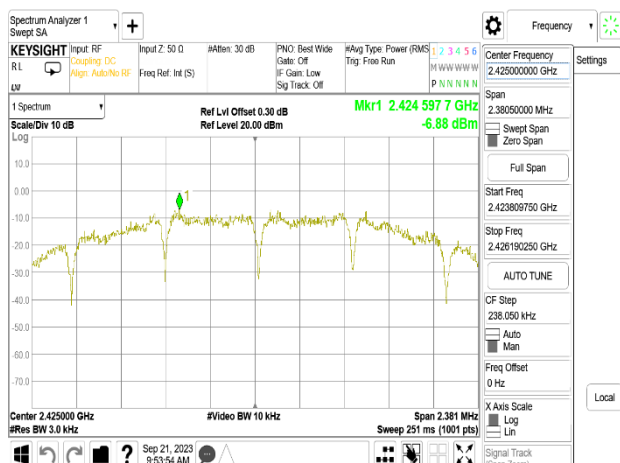
*Note:

1.cable loss as 0.3dB that offsets in the spectrum

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 90 days only.
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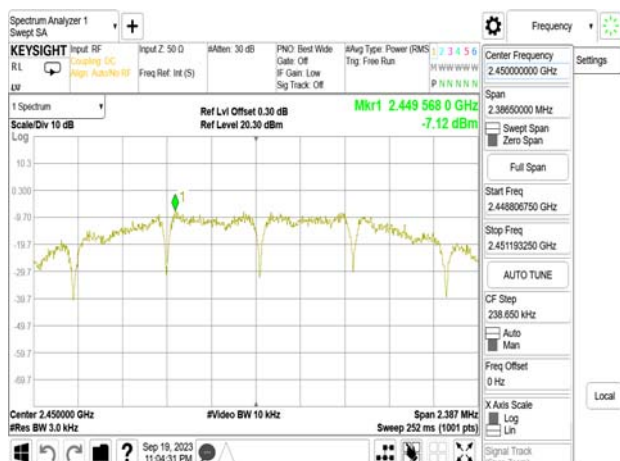
PSD_Zigbee_LowCH15-2425MHz



PSD_Zigbee_HighCH25-2475MHz



PSD_Zigbee_MidCH20-2450MHz



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13 ANTENNA REQUIREMENT

13.1 Standard Applicable:

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. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §§ 15.211, 15.213, 15.217, 15.219, 15.221, or § 15.236. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with § 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

13.2 Antenna Connected Construction:

The antenna complies with this requirement and no consideration of replacement. Please see EUT photo for details.

~ End of Report ~

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