

# ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT



**Applicant:** GOOGLE LLC  
1600 Amphitheatre Parkway Mountain View, CA 94043  
**Manufacturer:** GOOGLE LLC  
1600 Amphitheatre Parkway Mountain View, CA 94043  
**Product Name:** Wireless product  
**Brand Name:** GOOGLE  
**Model No.:** G6ZUC  
**Report Number:** ER/2022/30036  
**FCC ID** A4R-G6ZUC  
**Date of EUT Received:** March 10, 2022  
**Date of Test:** March 14, 2022 ~ March 21, 2022  
**Issue Date:** June 14, 2022

Approved By

Blue Yang

## 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.

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
ER/2022/30036	00	Original	May 23, 2022	Violetta Tang	*
ER/2022/30036	01	Correct antenna type information on page 4	June 14, 2022	Violetta Tang	

**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:	Wireless product
Brand Name:	GOOGLE
Model No.:	G6ZUC
EUT Series No.:	GG1937366 / GG1935428
Power Supply:	10V from AC Adapter
Test Software (Name/Version)	Windows 10

### 1.2 RF Specification

Radio Technology:	Thread 2.4G
Frequency Range:	2405 – 2475MHz
Channel number:	15 channels
Modulation type:	O-QPSK
Transmit Power:	20.25 dBm (Peak)

### 1.3 Antenna Designation

Antenna Type	Part No.	Freq. (MHz)	Peak Antenna Gain (dBi)
PIFA	ANT1	2402~2480	3.30

**Note:** 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

ANSI C63.10:2013

#### 1.5 Test Facility

Laboratory	Test Site Address	Test Site Name	FCC Designa- tion 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 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:

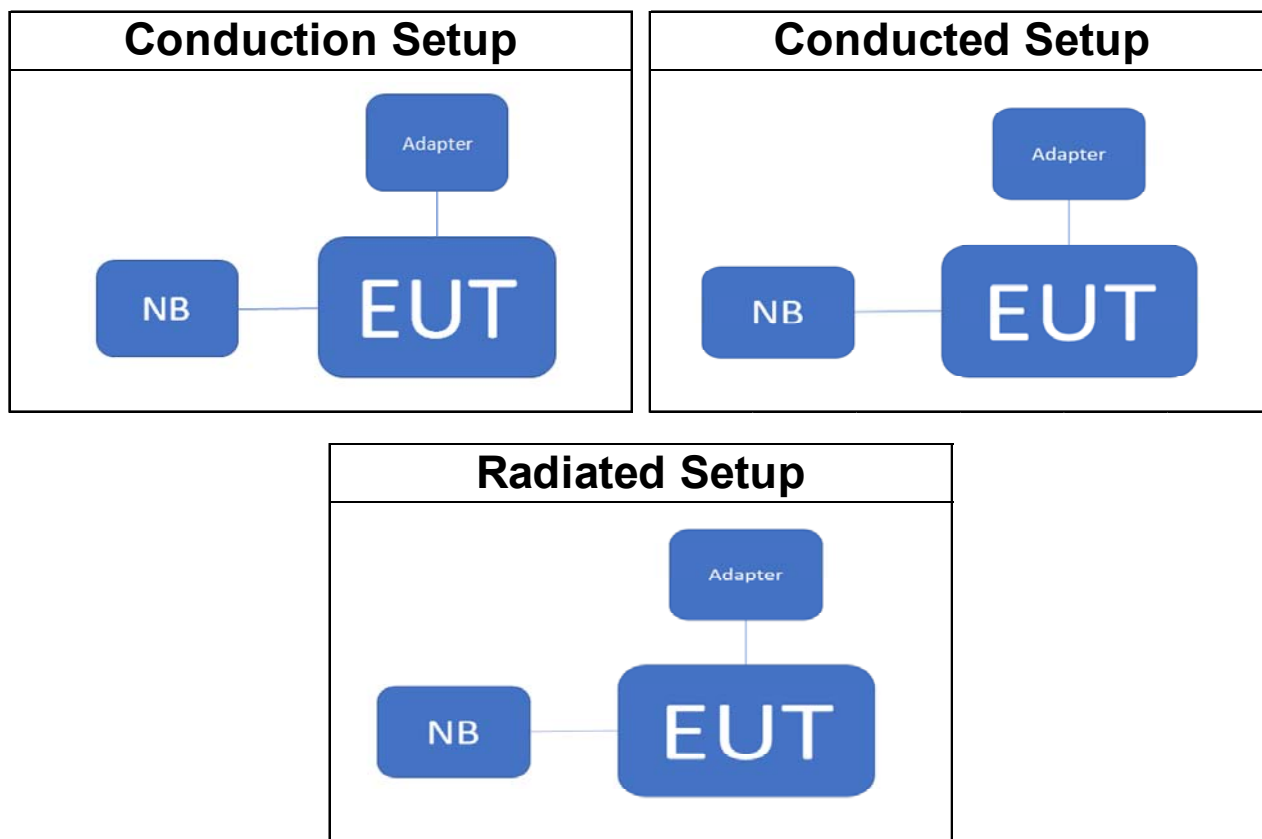
The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuation factor between EUT conducted port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly EUT RF output level.

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## 2.5 Test Configuration



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## 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.
Notebook	Lenovo	T440P	PC-01FYE9	N/A	N/A
Adapter	Shenzhen Honor Electronic Co., Ltd.	GKC2H	1HV00217NO00F011B	N/A	N/A
Test Software	Audix	e3	Ver. 9.210322	N.C.R	N.C.R

Conducted Emission Test Site: Conducted 2					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Test Software	SGS	Radio Test Software	Ver. 21	N.C.R	N.C.R
Adapter	Shenzhen Honor Electronic Co., Ltd.	GKC2H	1HV0021NO00A891B	N/A	N/A
Notebook	Lenovo	L480	PF-1S9NT5	N/A	N/A

Radiated Emission Test Site: SAC 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Test Software	Audix	e3	Ver. 9.210322	N.C.R	N.C.R
Adapter	Shenzhen Honor Electronic Co. Ltd.	GKC2H	1HV00217NO00F011B	N/A	N/A
Notebook	Lenovo	T440P	PC-01FYE9	N/A	N/A

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### 3 SUMMARY OF TEST RESULTS

FCC Rules	Description Of Test	Result
§15.207(a)	AC Power Line Conducted Emission	Compliant
§15.247(b) (3)	Peak Output Power	Compliant
§15.247(a)(2)	Emission Bandwidth	Compliant
§15.247(d) §15.205 §15.209	Radiated & Conducted Band Edge and Spurious Emission	Compliant
§15.247(e)	Peak Power Density	Compliant
§15.203	Antenna Requirement	Compliant

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## 4 DESCRIPTION OF TEST MODES

### 4.1 Operating Frequencies

ITEM	FREQUENCY
11	2405 MHz
12	2410 MHz
13	2415 MHz
14	2420 MHz
15	2425 MHz
16	2430 MHz
17	2435 MHz
18	2440 MHz
19	2445 MHz
20	2450 MHz
21	2455 MHz
22	2460 MHz
23	2465 MHz
24	2470 MHz
25	2475 MHz

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#### 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.

RADIATED EMISSION TEST (BELOW 1 GHz)				
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)
Thread	11 to 25	19	GFSK	N/A
RADIATED EMISSION TEST (ABOVE 1 GHz)				
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)
Thread	11 to 25	11,19,25	GFSK	N/A

CONDUCTED TEST				
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)
Thread	11 to 25	11,19,25	GFSK	N/A

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## 5 MEASUREMENT UNCERTAINTY

Test Items	Uncertainty
AC Power Line Conducted Emission	+/- 2.34 dB
Output Power measurement	+/- 1 dB
Emission Bandwidth	+/- 1.53 Hz
Undesignable radiated emission measurement	+/- 1.68 dB
Peak Power Density	+/- 1.62 dB
Temperature	+/- 0.4 °C
Humidity	+/- 3.5 %
DC / AC Power Source	+/- 1 %

Radiated Spurious Emission Measurement Uncertainty			
Polarization: Vertical	+/-	2.57 dB	9kHz~30MHz
	+/-	4.85 dB	30MHz - 1000MHz
	+/-	4.45 dB	1GHz - 18GHz
	+/-	4.24 dB	18GHz - 40GHz
Polarization: Horizontal	+/-	2.57 dB	9kHz~30MHz
	+/-	4.37 dB	30MHz - 1000MHz
	+/-	4.45 dB	1GHz - 18GHz
	+/-	4.24 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.
LISN	SCHWARZBECK	NSLK 8127	1040	08/10/2021	08/09/2022
Coaxial Cables	N/A	Coaxial Cable	161207	12/07/2021	12/06/2022
EMI Test Receiver	R&S	ESCI 7	100759	08/26/2021	08/25/2022

### 6.2 Conducted Measurement

Conducted Emission Test Site: Conducted 2					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EXA Spectrum Analyzer	KEYSIGHT	N9010B	MY60242081	09/30/2021	09/29/2022
Power Meter	Anritsu	ML2496A	2138003	11/12/2021	11/11/2022
Power Sensor	Anritsu	MA2411B	1911393	09/21/2021	09/20/2022
Power Sensor	Anritsu	MA2411B	1911394	09/21/2021	09/20/2022
Attenuator	Mini-Circuit	BW-S10W2+	4	12/14/2021	12/13/2022
DC Block	Mini-Circuits	BLK-18-S+	1	12/14/2021	12/13/2022

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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.
Horn Antenna	SCHWARZBECK	BBHA9120D	D803	12/20/2021	12/19/2022
Bi-log Antenna	TESEO	CBL 6112D	35242 & AT-N0555	01/03/2022	01/02/2023
Horn Antenna	SCHWARZBECK	BBHA9170	184	12/16/2021	12/15/2022
Loop Antenna	ETS.LINDGREN	6502	148045	09/29/2021	09/28/2022
Site Cal	SGS	SAC I chamber	N/A	01/01/2022	12/31/2022
EXA Spectrum Analyzer	Agilent	N9010A	MY50420195	05/12/2021	05/11/2022
EMI Test Receiver	R&S	ESCI 7	100759	08/26/2021	08/25/2022
Pre-Amplifier	EMC Instruments	EMC184045B	980135	10/27/2021	10/26/2022
Pre-Amplifier	HP	8449B	3008A01973	12/16/2021	12/15/2022
Pre-Amplifier	HP	8447D	2944A09469	12/16/2021	12/15/2022
Attenuator	Mini-Circuit	BW-S10W2+	4	12/14/2021	12/13/2022
Bandreject Filter 2400-2483.5	EWT	EWT-14-0166	M1	12/14/2021	12/13/2022
3.2GHz High Pass Filter	WI	WHKX10-2624-80SS	3	12/14/2021	12/13/2022
Coaxial Cable	Huber Suhner	succoflex 102	MY2622/2	12/16/2021	12/15/2022
Coaxial Cable	Huber Suhner	succoflex 104A	800086/4a	12/16/2021	12/15/2022
Coaxial Cable	Huber Suhner	EMC 104-SM-SM-2000	160123	12/16/2021	12/15/2022
Coaxial Cable	Huber Suhner	SUCOFLEX 102	MY2630/2	12/16/2021	12/15/2022
Coaxial Cable	Huber Suhner	SUCOFLEX 102	MY22962/2	12/16/2021	12/15/2022

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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 $\mu$ 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

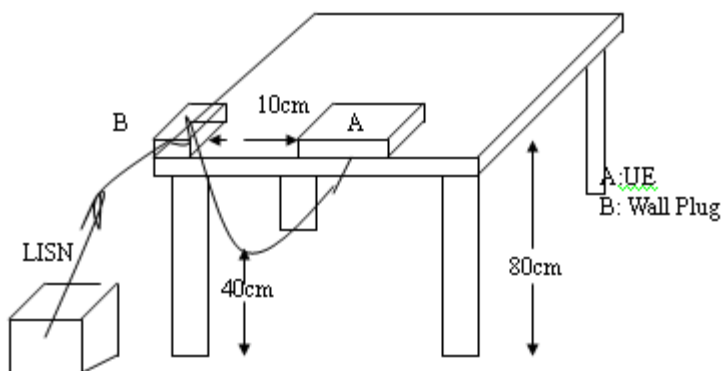
Note

- 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



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#### 7.4 Measurement Procedure:

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

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## AC POWER LINE CONDUCTED EMISSION TEST DATA

Report Number :ER/2022/30036

Test Site :Conduction 1

Test Mode :Thread

Test Date :2022-03-15

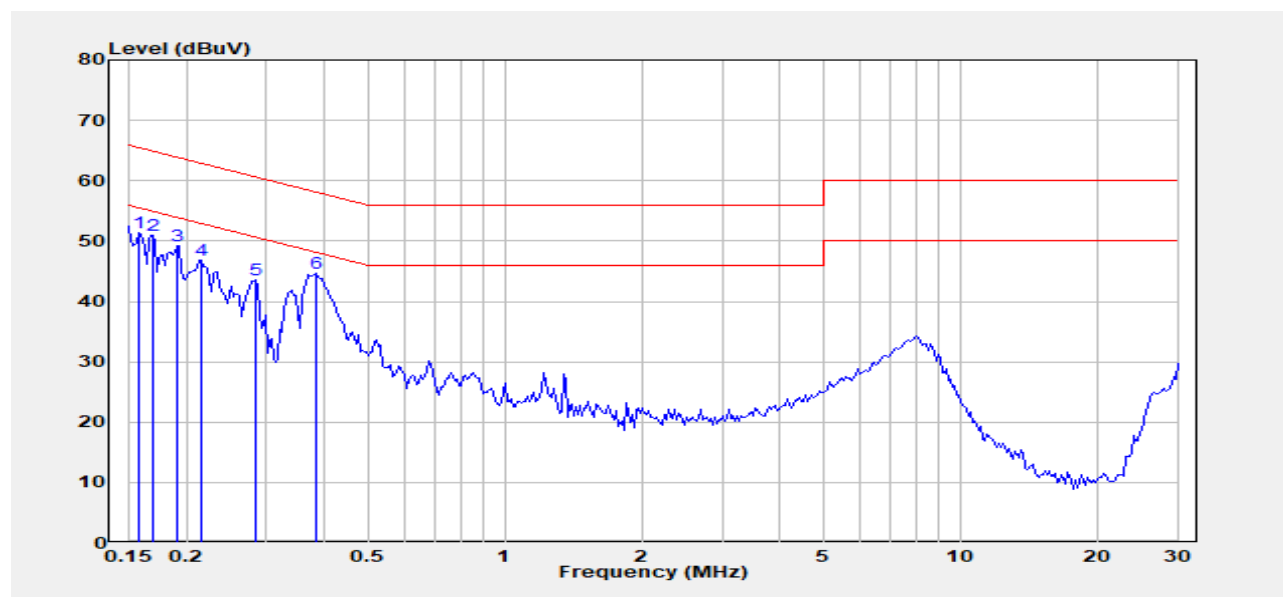
Power :120V/60Hz

Temp./Humi. :22.5/57

Probe :L

Engineer :GN Lin

Note: :



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV	Limit dBμV	Margin dB
0.156	Peak	51.41	0.02	51.43	65.65	-14.22
0.169	Peak	50.96	0.02	50.98	65.03	-14.05
0.191	Peak	49.22	0.02	49.24	63.98	-14.73
0.215	Peak	46.86	0.02	46.88	63.01	-16.13
0.283	Peak	43.65	0.02	43.67	60.72	-17.05
0.385	Peak	44.50	0.07	44.57	58.17	-13.60

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Report Number :ER/2022/30036

Test Mode :Thread

Power :120V/60Hz

Probe :N

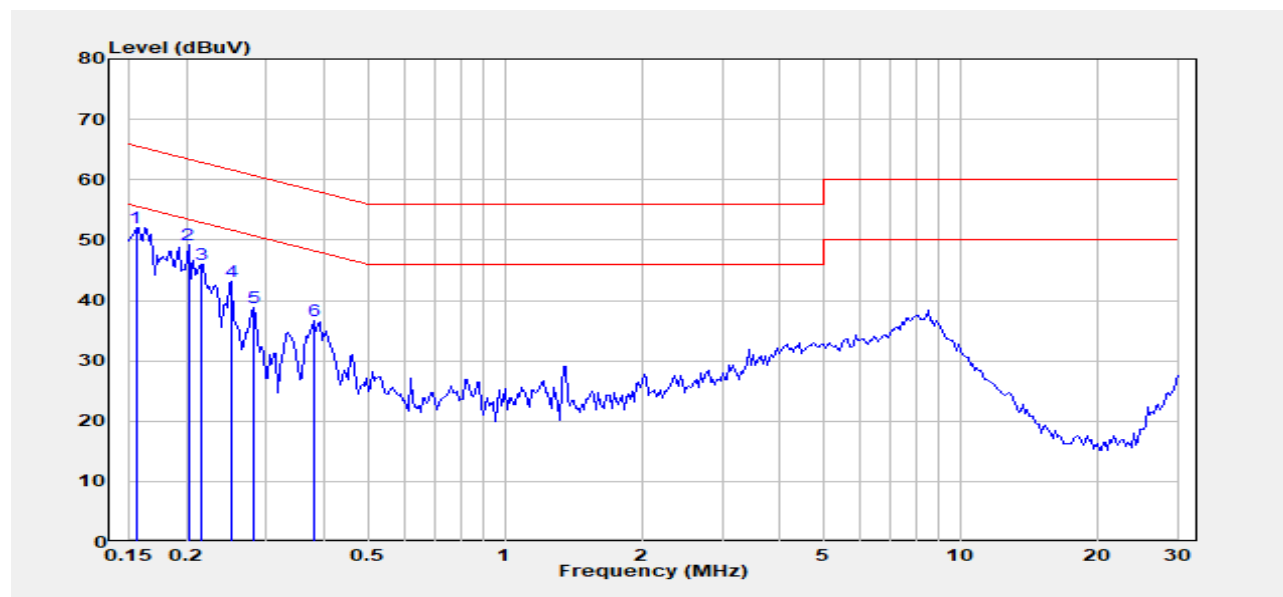
Note :

Test Site :Conduction 1

Test Date :2022-03-15

Temp./Humi. :22.5/57

Engineer :GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV	Limit dBμV	Margin dB
0.155	Peak	52.05	0.04	52.09	65.74	-13.64
0.202	Peak	49.06	0.20	49.26	63.54	-14.27
0.215	Peak	45.77	0.18	45.95	63.01	-17.06
0.252	Peak	42.93	0.14	43.07	61.69	-18.62
0.280	Peak	38.75	0.11	38.86	60.81	-21.95
0.381	Peak	36.54	0.08	36.62	58.25	-21.63

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## 8 PEAK OUTPUT POWER MEASUREMENT

### 8.1 Standard Applicable:

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.

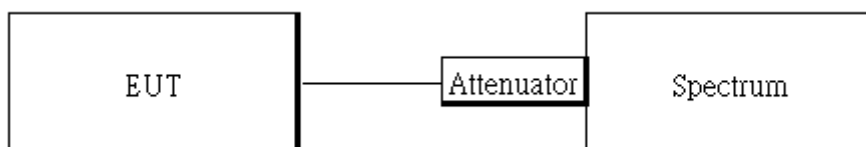
In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of Antenna exceeds 6dBi.

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.

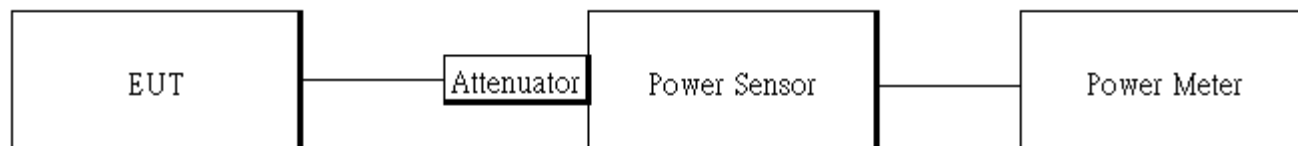
All duty cycle is pre-scanned, and result as obtained below shows only the most representative ones where duty cycle is conducted as the given transmission with given virtual operation that expresses the percentage.

### 8.2 Test Setup

#### 8.2.1 Duty Cycle



#### 8.2.2 Output Power



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### 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.

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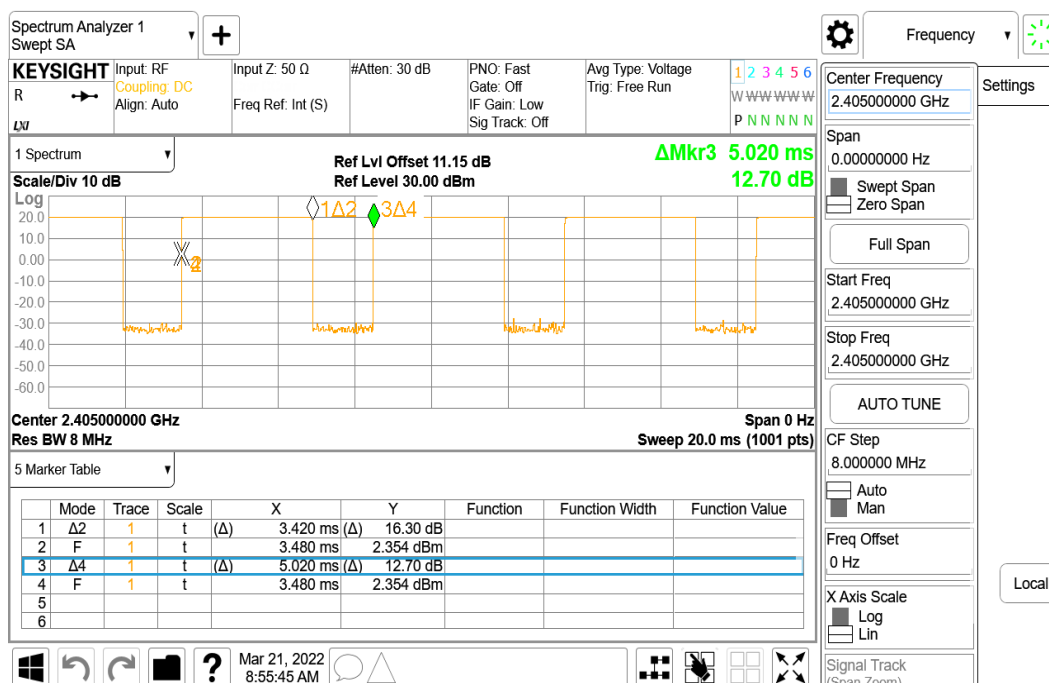
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## 8.4 Duty Factor:

	Duty Cycle (%) = Ton / (Ton+Toff)	Duty Factor (dB) = 10*log ( 1/Duty Cycle )	1/T (kHz)	VBW setting (kHz)
Thread	68.13	1.67	0.29	1.00

Thread\_LowCH11-2405



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## 8.5 Output Power:

### 8.5.1 Peak & Avg

Thread mode:

CH	Frequency (MHz)	Power set	Peak Power Output (dBm)	Required Limit (dBm)
Low	2405	i31	20.25	30
Mid	2445	i31	20.21	30
High	2475	i26	17.74	30
CH	Frequency (MHz)	Power set	Avg. Output Power (dBm)	Required Limit (dBm)
Low	2405	i31	20.20	30
Mid	2445	i31	20.18	30
High	2475	i26	16.80	30

*\*Note: Measured by power meter, cable loss 11.15 dB + Duty cycle factor has been offsetted to the power meter for Avg. power and cable loss has been offsetted for Peak power measurement.*

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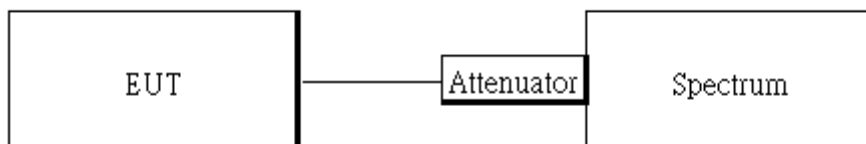
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## 9 EMISSION BANDWIDTH MEASUREMENT

### 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. 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.
4. 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 for -6dB Bandwidth test.
5. Repeat above procedures until all test default channel is completed

### 9.4 Measurement Result:

#### Thread mode

Frequency (MHz)	6dB BW (MHz)	Required BW (MHz)	Result
2405	1.464	$\geq 0.5$	PASS
2445	1.481	$\geq 0.5$	PASS
2475	1.56	$\geq 0.5$	PASS

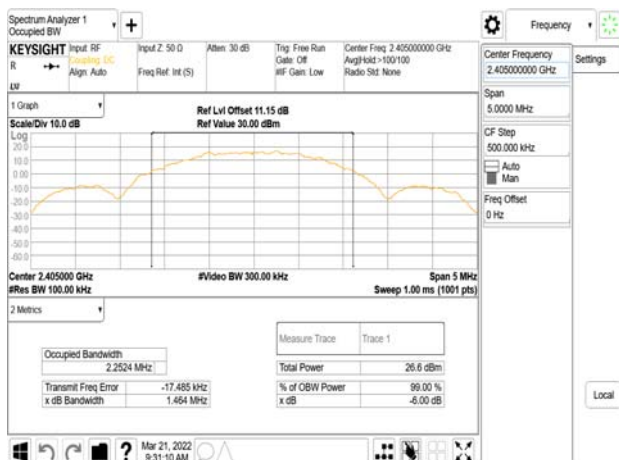
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OBW\_Thread\_LowCH11-2405MHz



OBW\_Thread\_LowCH19-2445MHz



OBW\_Thread\_LowCH25-2475MHz



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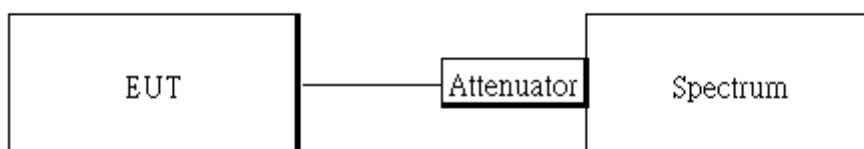
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## 10 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

### 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), must also comply with the radiated emission limits specified in §15.209(a).

### 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.

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**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.
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****Thread\_Reference Level of Limit**

Frequency (MHz)	RF Power Density (dBm)	Reference Level of Limit = PSD - 20dB (dBm)
2405	16.92	-3.08
2445	16.71	-3.29
2475	13.04	-6.96

*NOTE: cable loss as 11.15dB that offsets in the spectrum*

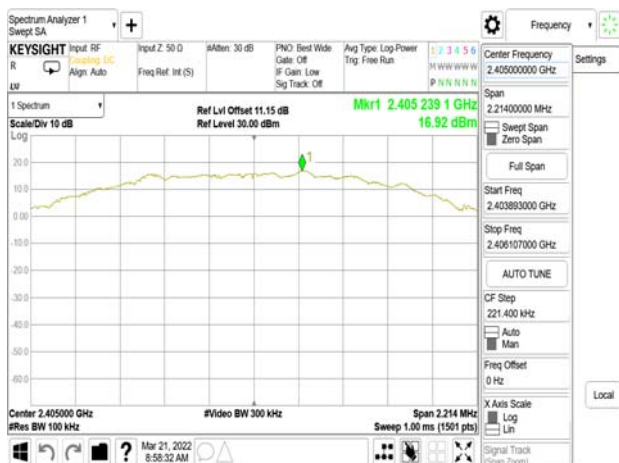
*NOTE: Refer to next page for plots.*

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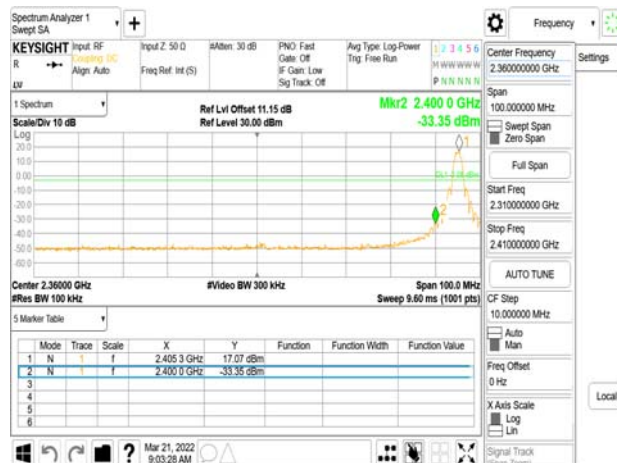
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Reference Level\_Thread\_LowCH11-2405MHz



Band Edge\_Thread\_LowCH11-2405MHz



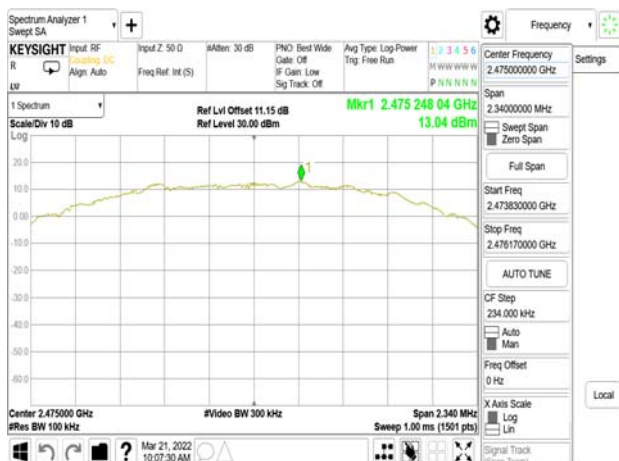
Reference Level\_Thread\_LowCH19-2445MHz



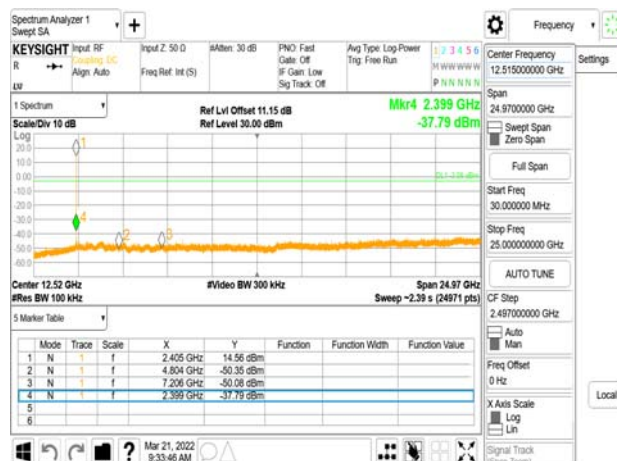
Band Edge\_Thread\_LowCH25-2475MHz



Reference Level\_Thread\_LowCH25-2475MHz



Spurious Emission\_Thread\_LowCH11-2405MHz



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## Spurious Emission\_Thread\_LowCH19-2445MHz



## Spurious Emission\_BLE 1M\_Thread\_LowCH25-2475MHz



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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 limit as below.

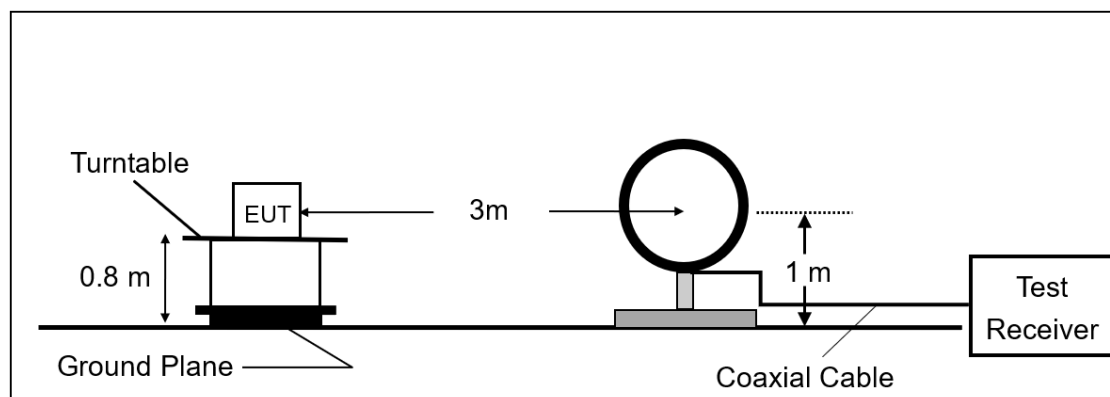
And according to §15.33(a) (1) for an intentional radiator operates below 10GHz, the frequency range of measurements: to the tenth harmonic of the highest fundamental frequency or to 40GHz, whichever is lower.

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.

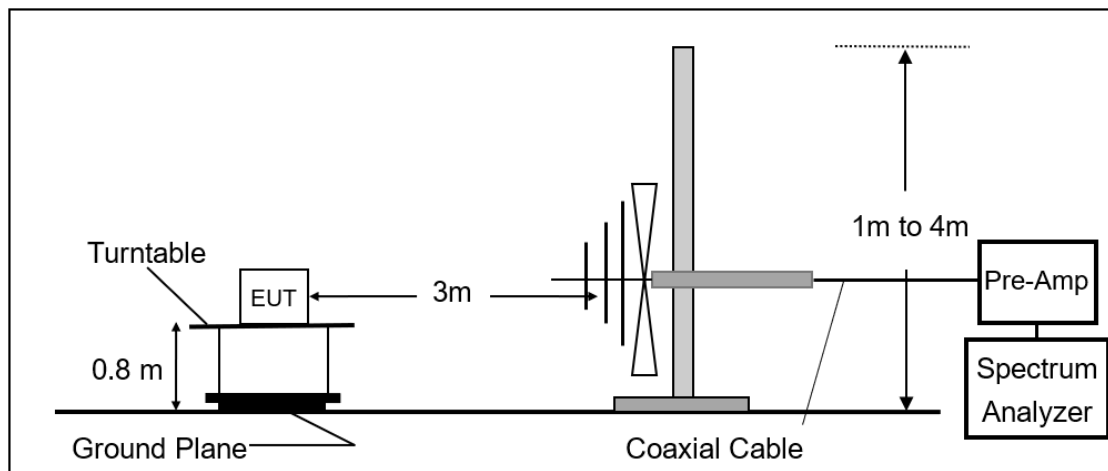


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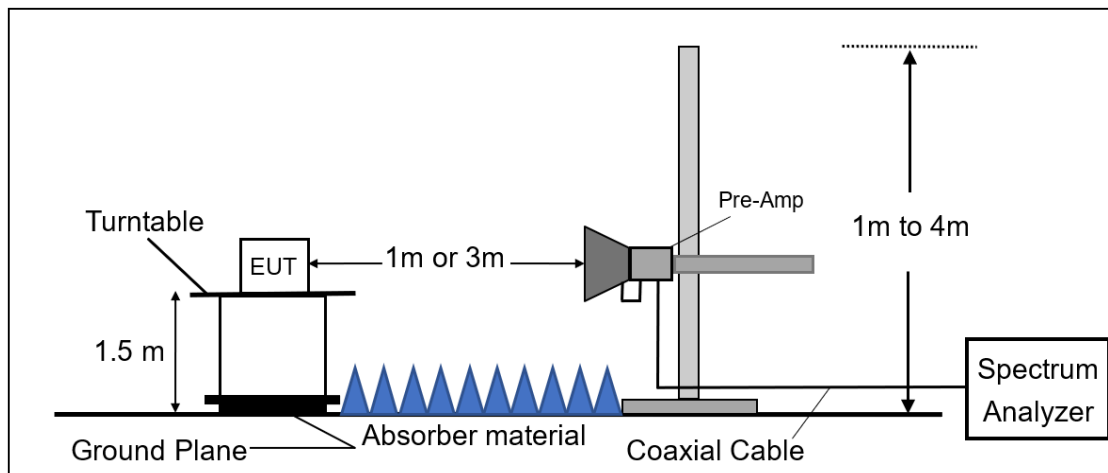
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### (B) Radiated Emission Test Set-Up, Frequency From 30MHz to 1000MHz.



### (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  $\geq 1/T$  (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(dBuV/m) = SPA. Reading level(dBuV) + Factor(dB)*

*Factor(dB) = Antenna Factor(dBuV/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) was not reported.

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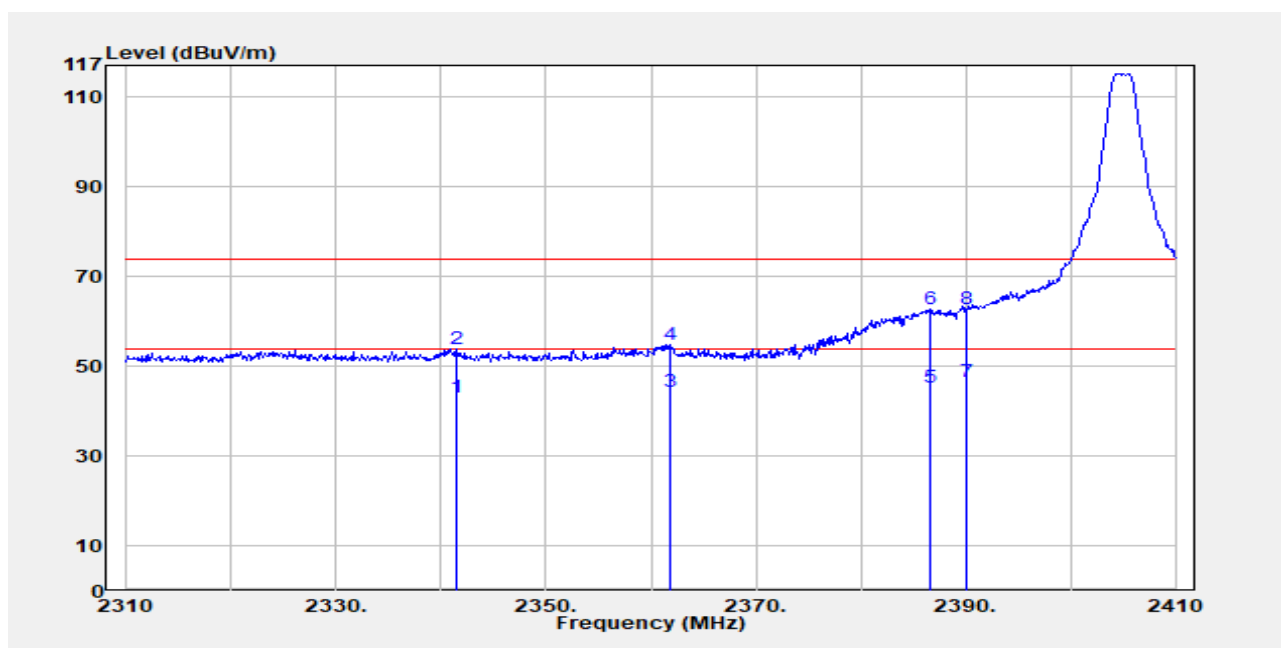
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## 11.6 Measurement Result:

### 11.6.1 Radiated Band Edge Measurement Result

Report Number	:ER/2022/30036	Test Site	:SAC 1
Operation Mode	:Thread	Test Date	:2022-03-14
Test Frequency	:2405 MHz	Temp./Humi.	:23.8/62
Test Mode	:Bandedge CH Low	Antenna Pol.	:VERTICAL
EUT Pol	:E2 Plane	Engineer	:GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2341.40	Average	43.13	0.02	43.15	54.00	-10.85
2341.40	Peak	53.88	0.02	53.89	74.00	-20.11
2361.90	Average	44.33	-0.02	44.31	54.00	-9.69
2361.90	Peak	54.96	-0.02	54.94	74.00	-19.06
2386.70	Average	45.31	-0.11	45.20	54.00	-8.80
2386.70	Peak	62.79	-0.11	62.68	74.00	-11.32
2390.00	Average	46.63	-0.12	46.51	54.00	-7.49
2390.00	Peak	62.88	-0.12	62.76	74.00	-11.24

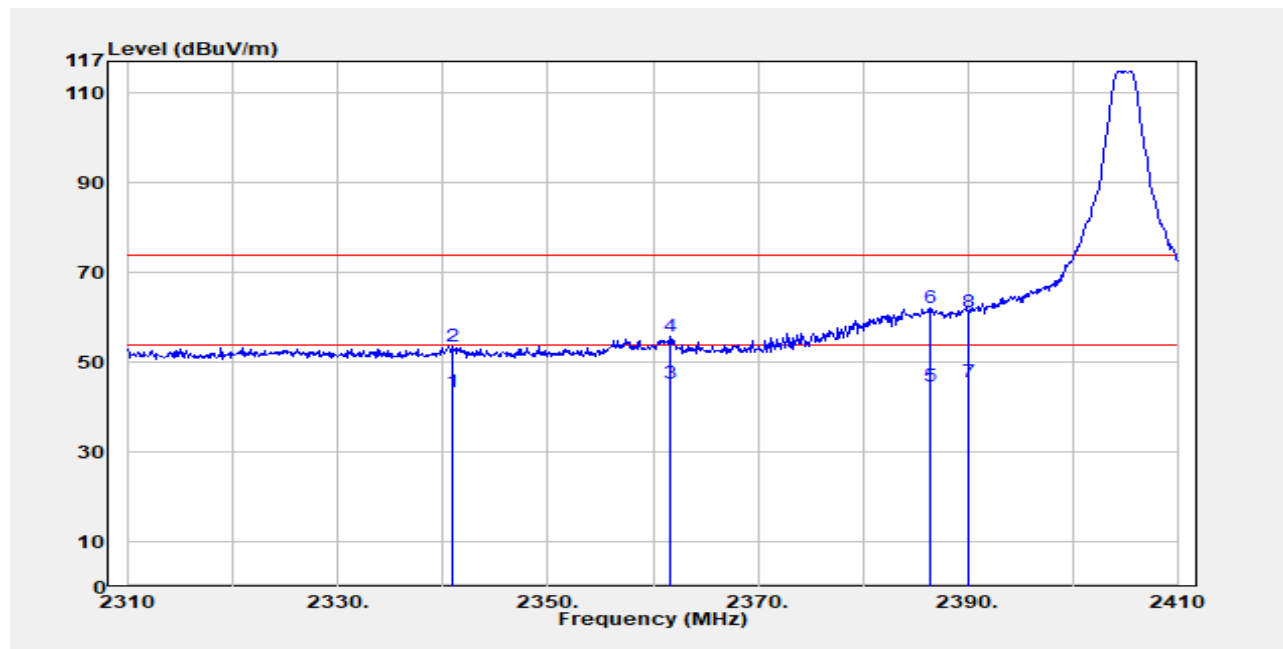
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Report Number :ER/2022/30036  
Operation Mode :Thread  
Test Frequency :2405 MHz  
Test Mode :Bandedge CH Low  
EUT Pol :E2 Plane

Test Site :SAC 1  
Test Date :2022-03-14  
Temp./Humi. :23.8/62  
Antenna Pol. :HORIZONTAL  
Engineer :GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2340.80	Average	43.35	0.02	43.37	54.00	-10.63
2340.80	Peak	53.70	0.02	53.72	74.00	-20.28
2361.70	Average	45.23	-0.02	45.21	54.00	-8.79
2361.70	Peak	55.98	-0.02	55.96	74.00	-18.04
2386.40	Average	44.90	-0.11	44.79	54.00	-9.21
2386.40	Peak	62.33	-0.11	62.22	74.00	-11.78
2390.00	Average	45.85	-0.12	45.73	54.00	-8.27
2390.00	Peak	61.16	-0.12	61.04	74.00	-12.96

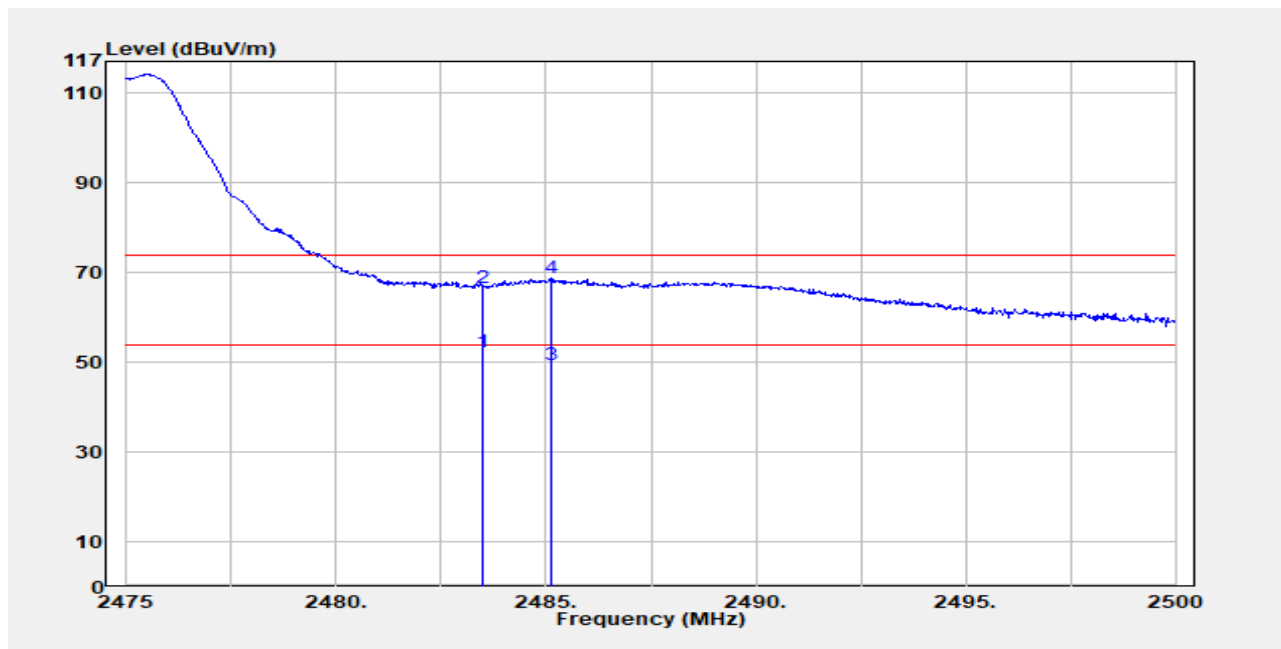
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Report Number :ER/2022/30036  
Operation Mode :Thread  
Test Frequency :2475 MHz  
Test Mode :Bandedge CH High  
EUT Pol :E2 Plane

Test Site :SAC 1  
Test Date :2022-03-14  
Temp./Humi. :23.8/62  
Antenna Pol. :VERTICAL  
Engineer :GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2483.50	Average	52.38	-0.16	52.22	54.00	-1.78
2483.50	Peak	66.75	-0.16	66.59	74.00	-7.41
2485.10	Average	49.57	-0.16	49.41	54.00	-4.59
2485.10	Peak	68.90	-0.16	68.74	74.00	-5.26

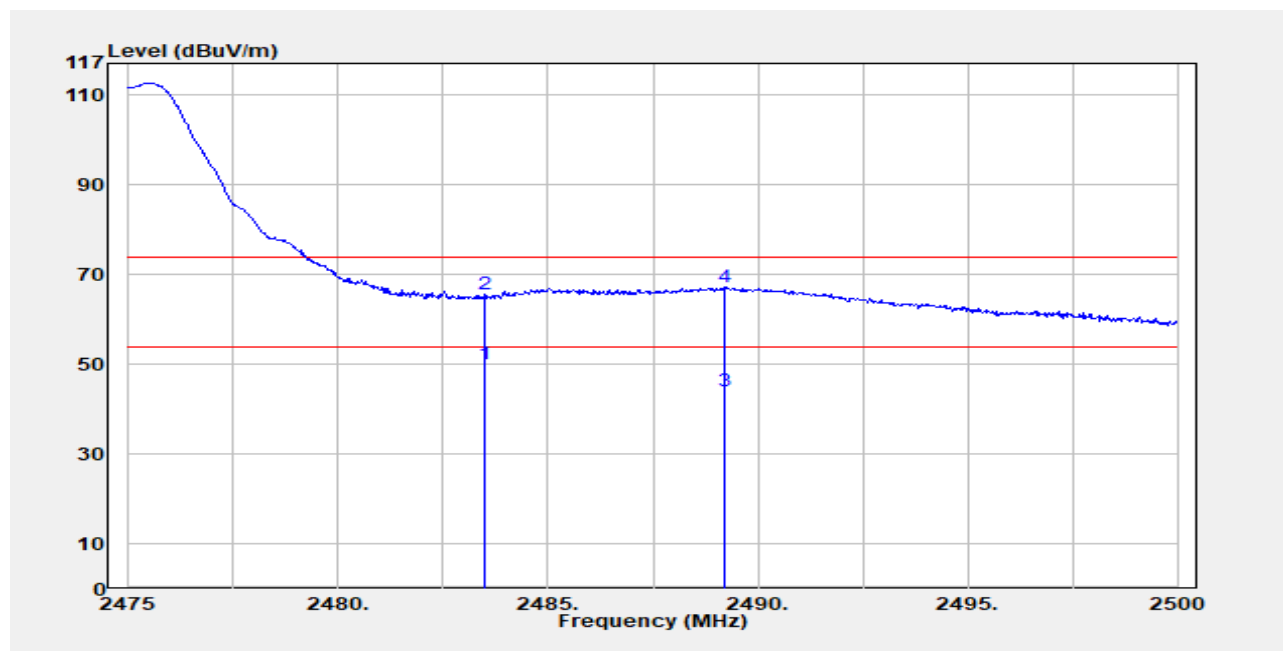
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Report Number :ER/2022/30036  
Operation Mode :Thread  
Test Frequency :2475 MHz  
Test Mode :Bandedge CH High  
EUT Pol :E2 Plane

Test Site :SAC 1  
Test Date :2022-03-14  
Temp./Humi. :23.8/62  
Antenna Pol. :HORIZONTAL  
Engineer :GN Lin



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	50.24	-0.16	50.08	54.00	-3.92
2483.50	Peak	65.74	-0.16	65.58	74.00	-8.42
2489.23	Average	44.28	-0.16	44.12	54.00	-9.88
2489.23	Peak	67.47	-0.16	67.32	74.00	-6.68

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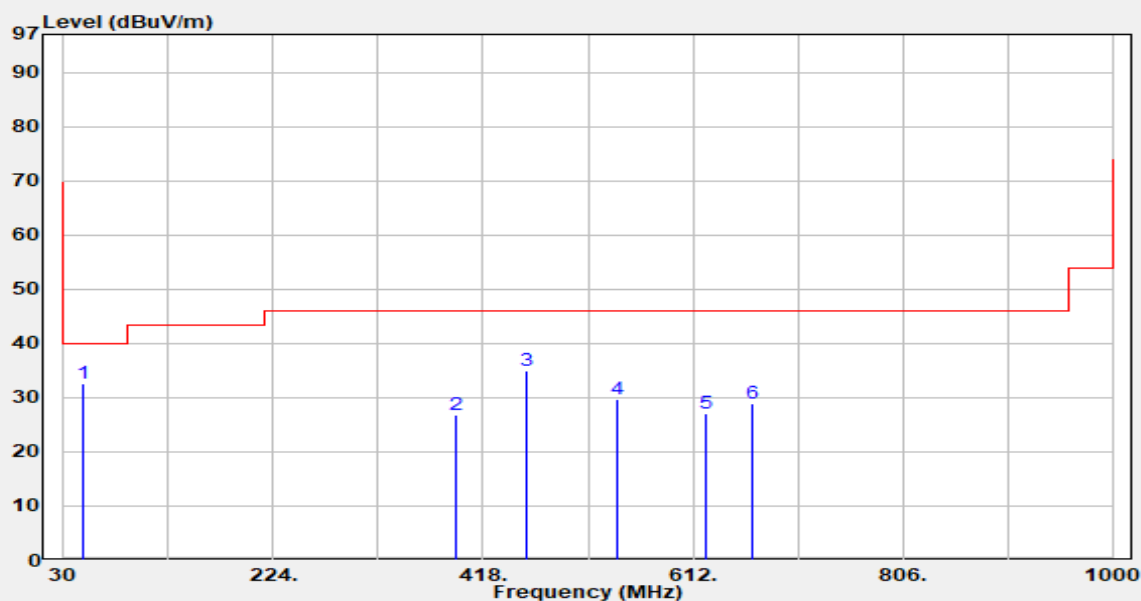
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## 11.6.2 Radiated Spurious Emission

Report Number :ER/2022/30036  
 Operation Mode :Thread  
 Test Frequency :2445 MHz  
 Test Mode :Tx CH Mid  
 EUT Pol :E2 Plane

Test Site :SAC 1  
 Test Date :2022-03-14  
 Temp./Humi. :23.8/62  
 Antenna Pol. :VERTICAL  
 Engineer :GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dB $\mu$ V	Factor dB	Actual FS dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB
47.78	QP	47.13	-14.53	32.60	40.00	-7.40
393.75	Peak	34.24	-7.31	26.93	46.00	-19.07
458.42	Peak	40.93	-6.07	34.86	46.00	-11.14
542.48	Peak	33.39	-3.66	29.73	46.00	-16.27
624.93	Peak	30.52	-3.53	27.00	46.00	-19.00
666.97	Peak	32.14	-3.34	28.80	46.00	-17.20

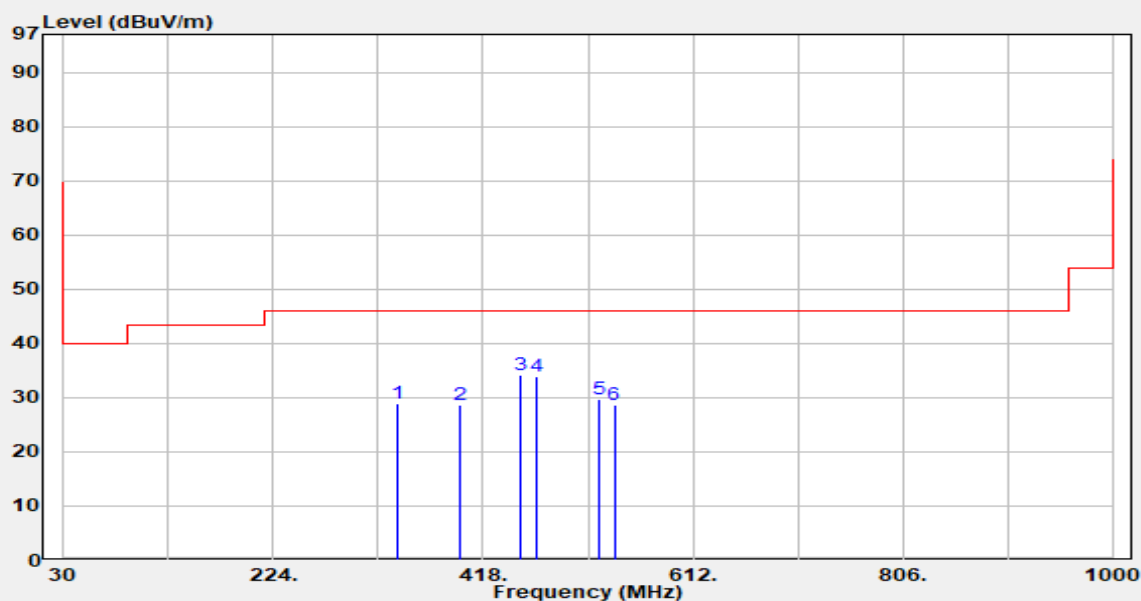
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Report Number :ER/2022/30036  
 Operation Mode :Thread  
 Test Frequency :2445 MHz  
 Test Mode :Tx CH Mid  
 EUT Pol :E2 Plane

Test Site :SAC 1  
 Test Date :2022-03-14  
 Temp./Humi. :23.8/62  
 Antenna Pol. :HORIZONTAL  
 Engineer :GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
338.78	Peak	37.32	-8.37	28.95	46.00	-17.05
396.98	Peak	35.71	-7.12	28.59	46.00	-17.41
451.95	Peak	40.29	-6.12	34.18	46.00	-11.82
468.12	Peak	39.94	-6.10	33.84	46.00	-12.16
524.70	Peak	34.80	-5.21	29.59	46.00	-16.41
539.25	Peak	32.33	-3.81	28.52	46.00	-17.48

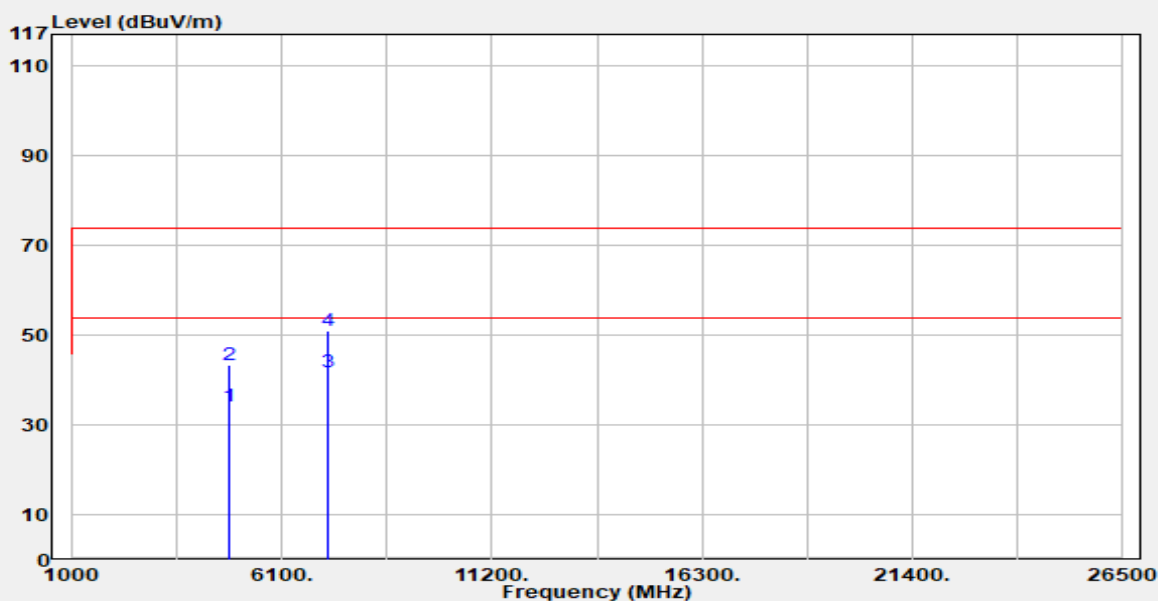
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Report Number :ER/2022/30036  
 Operation Mode :Thread  
 Test Frequency :2405 MHz  
 Test Mode :Tx CH Low  
 EUT Pol :E2 Plane

Test Site :SAC 1  
 Test Date :2022-03-14  
 Temp./Humi. :23.8/62  
 Antenna Pol. :VERTICAL  
 Engineer :GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4810.00	Average	27.29	7.09	34.38	54.00	-19.62
4810.00	Peak	36.31	7.09	43.41	74.00	-30.59
7215.00	Average	26.44	15.47	41.91	54.00	-12.09
7215.00	Peak	35.51	15.47	50.98	74.00	-23.02

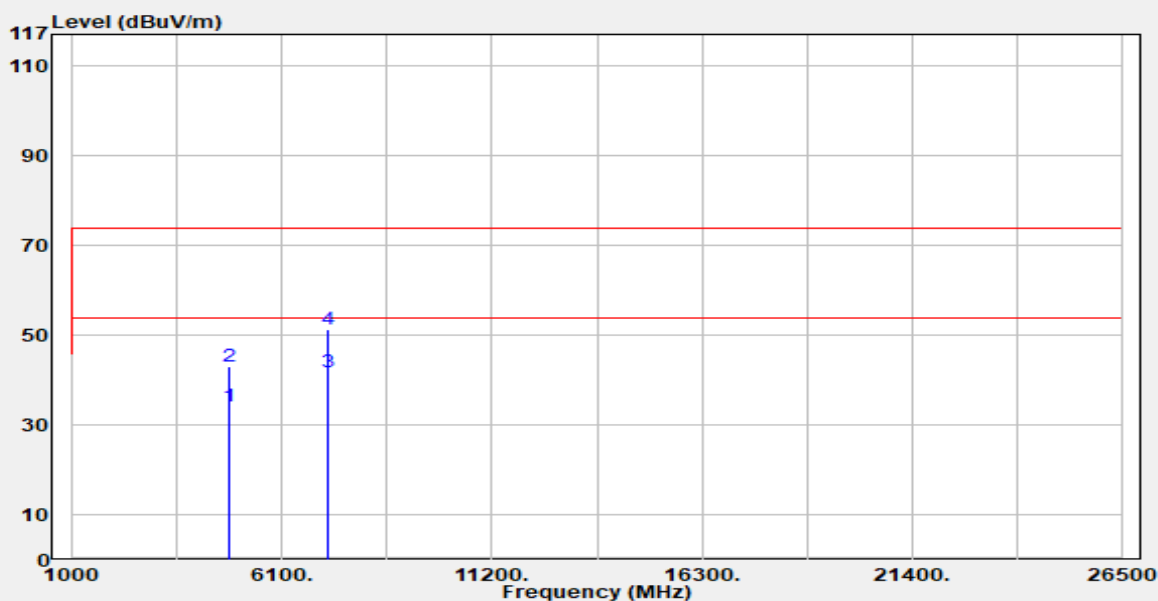
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Report Number :ER/2022/30036  
Operation Mode :Thread  
Test Frequency :2405 MHz  
Test Mode :Tx CH Low  
EUT Pol :E2 Plane

Test Site :SAC 1  
Test Date :2022-03-14  
Temp./Humi. :23.8/62  
Antenna Pol. :HORIZONTAL  
Engineer :GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4810.00	Average	27.26	7.09	34.35	54.00	-19.65
4810.00	Peak	36.17	7.09	43.26	74.00	-30.74
7215.00	Average	26.49	15.47	41.96	54.00	-12.04
7215.00	Peak	35.79	15.47	51.26	74.00	-22.74

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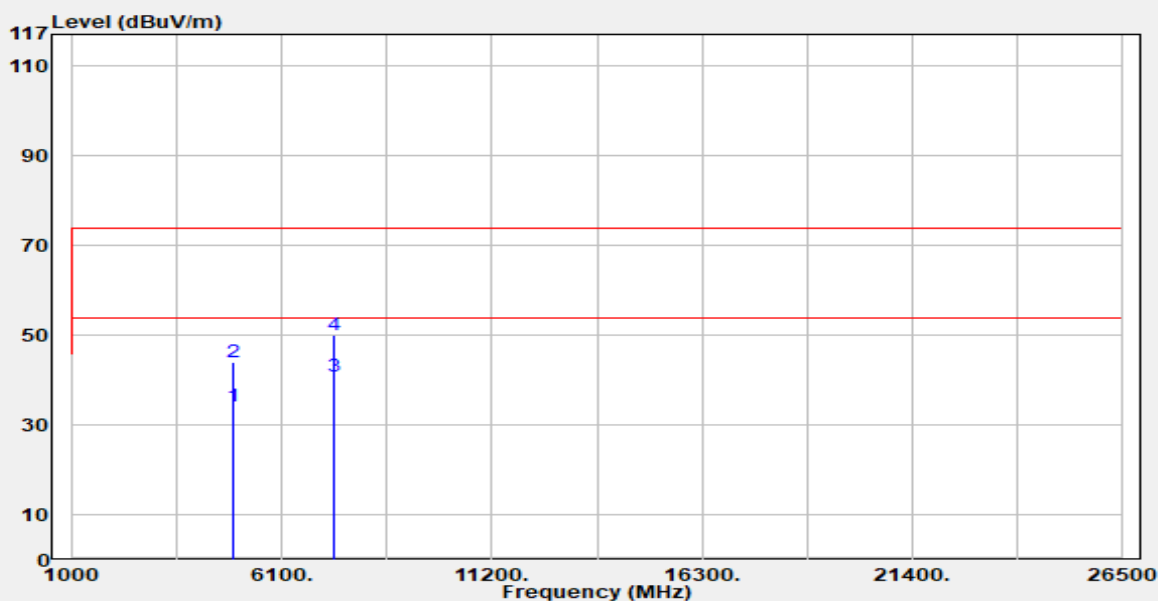
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Report Number :ER/2022/30036  
Operation Mode :Thread  
Test Frequency :2445 MHz  
Test Mode :Tx CH Mid  
EUT Pol :E2 Plane

Test Site :SAC 1  
Test Date :2022-03-14  
Temp./Humi. :23.8/62  
Antenna Pol. :VERTICAL  
Engineer :GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4890.00	Average	27.12	7.06	34.18	54.00	-19.82
4890.00	Peak	37.04	7.06	44.10	74.00	-29.90
7335.00	Average	26.10	14.92	41.02	54.00	-12.98
7335.00	Peak	35.23	14.92	50.14	74.00	-23.86

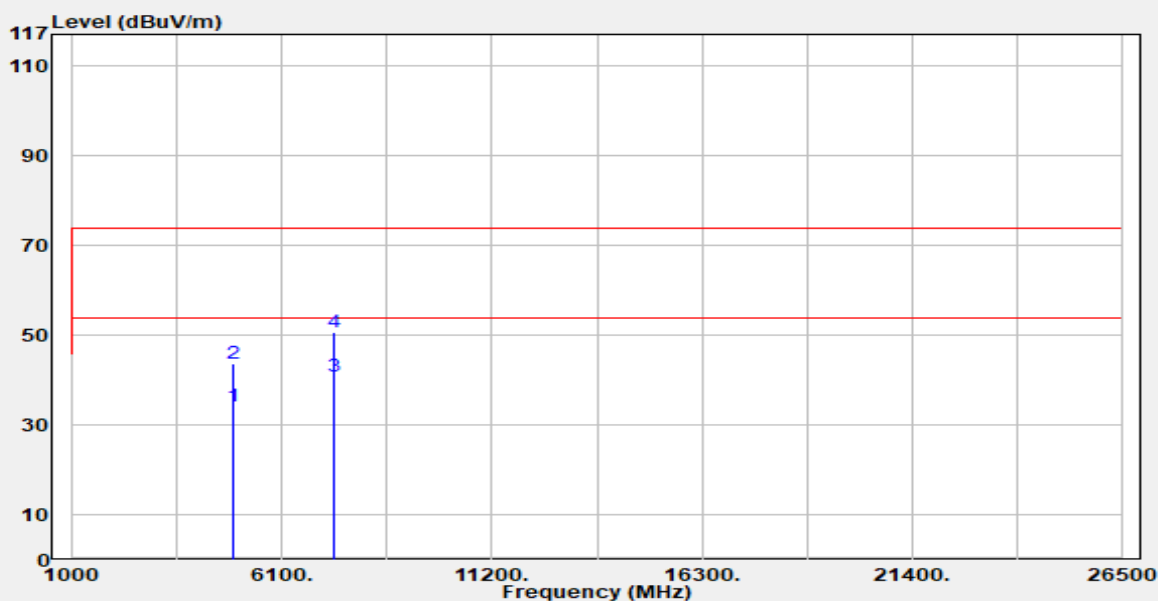
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Report Number :ER/2022/30036  
Operation Mode :Thread  
Test Frequency :2445 MHz  
Test Mode :Tx CH Mid  
EUT Pol :E2 Plane

Test Site :SAC 1  
Test Date :2022-03-14  
Temp./Humi. :23.8/62  
Antenna Pol. :HORIZONTAL  
Engineer :GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4890.00	Average	27.07	7.06	34.13	54.00	-19.87
4890.00	Peak	36.83	7.06	43.89	74.00	-30.11
7335.00	Average	26.12	14.92	41.04	54.00	-12.96
7335.00	Peak	35.72	14.92	50.64	74.00	-23.36

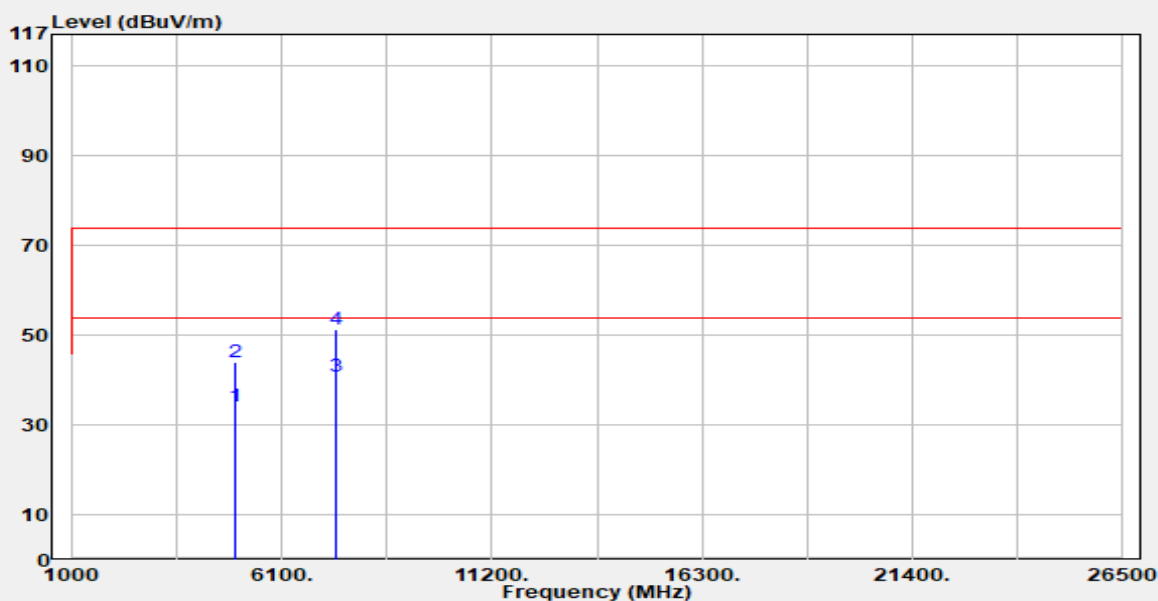
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Report Number :ER/2022/30036  
 Operation Mode :Thread  
 Test Frequency :2475 MHz  
 Test Mode :Tx CH High  
 EUT Pol :E2 Plane

Test Site :SAC 1  
 Test Date :2022-03-14  
 Temp./Humi. :23.8/62  
 Antenna Pol. :VERTICAL  
 Engineer :GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4950.00	Average	26.89	7.37	34.26	54.00	-19.74
4950.00	Peak	36.76	7.37	44.12	74.00	-29.88
7425.00	Average	26.46	14.58	41.04	54.00	-12.96
7425.00	Peak	36.66	14.58	51.24	74.00	-22.76

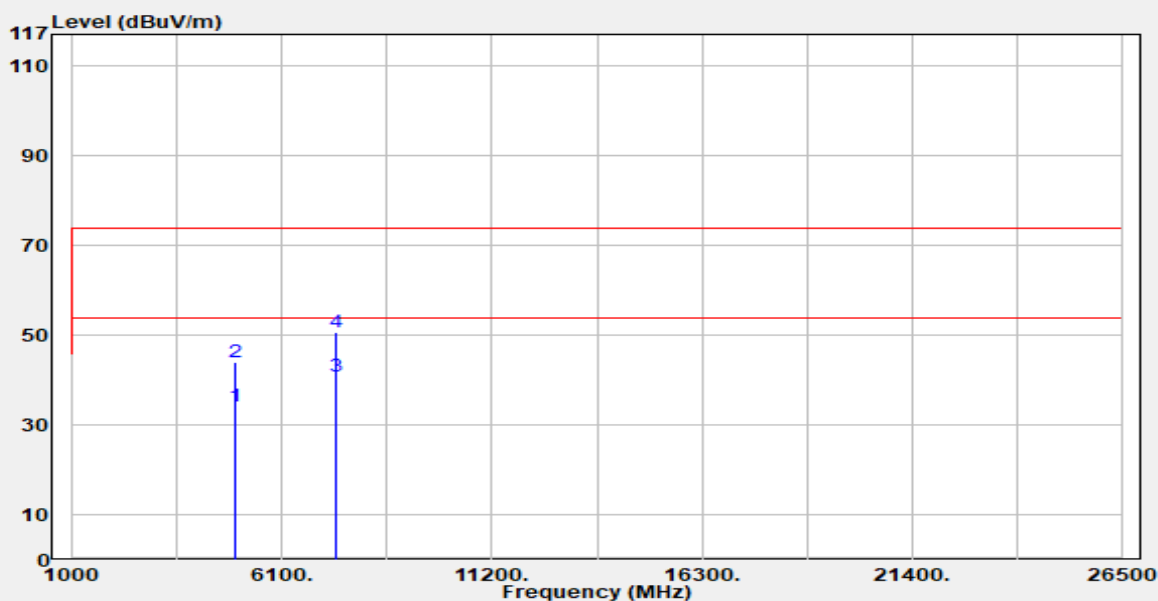
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Report Number :ER/2022/30036  
 Operation Mode :Thread  
 Test Frequency :2475 MHz  
 Test Mode :Tx CH High  
 EUT Pol :E2 Plane

Test Site :SAC 1  
 Test Date :2022-03-14  
 Temp./Humi. :23.8/62  
 Antenna Pol. :HORIZONTAL  
 Engineer :GN Lin



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	26.92	7.37	34.29	54.00	-19.71
4950.00	Peak	36.60	7.37	43.96	74.00	-30.04
7425.00	Average	26.38	14.58	40.96	54.00	-13.04
7425.00	Peak	36.31	14.58	50.89	74.00	-23.11

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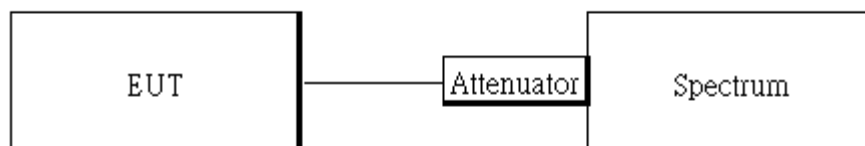
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## 12 POWER SPECTRAL DENSITY

### 12.1 Standard Applicable:

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:

#### Thread mode

Frequency (MHz)	RF Power Density (dBm/3kHz)	Maximum Limit (dBm/3kHz)	Result
2405	7.880	8	PASS
2445	7.310	8	PASS
2475	3.570	8	PASS

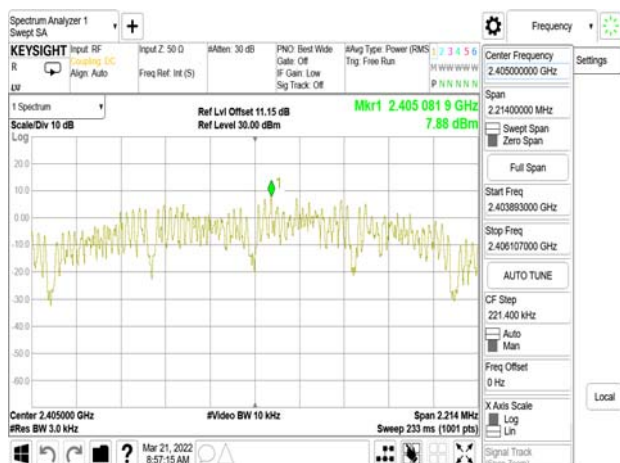
*NOTE: cable loss as 11.15dB that offsets in the spectrum*

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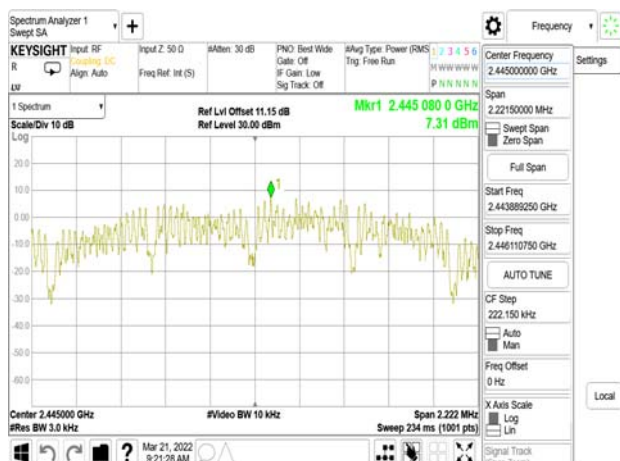
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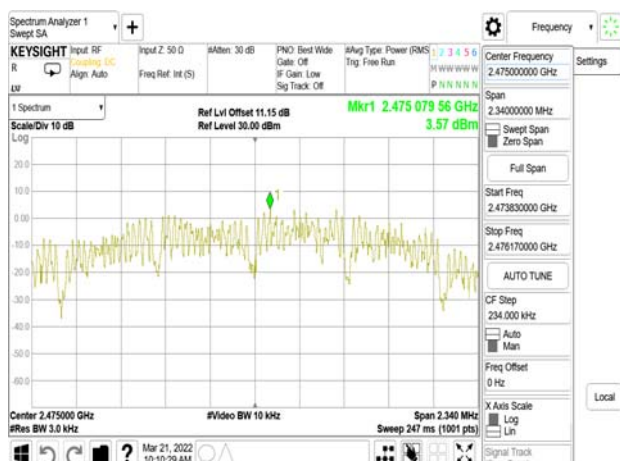
PSD\_Thread\_LowCH11-2405MHz



PSD\_Thread\_LowCH19-2445MHz



PSD\_Thread\_LowCH25-2475MHz



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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 is designed as permanently attached and no consideration of replacement. Please see EUT photo for details.

*~ End of Report ~*

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