

**ELECTROMAGNETIC EMISSIONS
COMPLIANCE REPORT**

Applicant: Sonova Consumer Hearing GmbH
Am Labor 1, 30900 Wedemark, Germany
Manufacturer: Sonova Consumer Hearing GmbH
Am Labor 1, 30900 Wedemark, Germany
Product Name: ACCENTUM Open (OTW1)
Brand Name: SENNHEISER
Model No.: OTW1 (Refer to page 2 for more details)
Report Number: TERF2409002876ER
FCC ID 2A3ULOTW1
Date of EUT Received: September 23, 2024
Date of Test: November 20, 2024 ~ December 3, 2024
Issue Date: January 6, 2025

Approved By**Marcus Tseng****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, ANSI C63.10:2020+Cor.1-2023 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
TERF2409002876ER	00	Original	January 6, 2025	Yuri Tsai	

Note:

- 1、The remark "*" indicates modification of the report upon requests from certification body.
- 2、The EUT system ACCENTUM Open (OTW1) contain the following devices:

Item	Brand Name	Device Model No.
Right Earbud	SENNHEISER	OTW1 R
Left Earbud	SENNHEISER	OTW1 L
Charging Case	SENNHEISER	OTW1 C

- * OTW1 R and OTW1 L with BT TX/RX function
 - * Charging case is solely used for charging OTW1 R and OTW1 L only.
- 3、Variant information of main & alternate battery sources is provided by the applicant, test results of this report are applicable to the sample EUT(s) received.

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1 GENERAL INFORMATION

1.1 Product Description

Test Item Description	True Wireless Earphones
Product Name	ACCENTUM Open (OTW1)
Brand Name	SENNHEISER
Serial Number / Status of EUT	Engineering sample
Model No.	OTW1 (Refer to page 2 for more details)
Hardware Version	V03
Firmware Version	Earbuds: V1.0.24 Charging case: V1.0.4
Power Ratings	Earbuds: 3.85Vdc, 35-36 mAh (from battery) Charging case: 5Vdc, 500 mA (from Type-C USB interface) 3.7Vdc, 380-400 mAh (from battery)
Power Supply (Nominal & Testing)	5Vdc (from Type-C USB interface) 3.85Vdc (from battery)
Cable supplied / Device ports	0.4m shielded USB cable without core
Test Software (Name/Version)	WQ TWS RF TOOL

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1.2 RF Specification

Technology	Bluetooth
Operating Frequency	2402 - 2480MHz (for Frequency Band: 2400-2483.5MHz)
Channel number	79 channels
Channel Spacing	1MHz
Channel Bandwidth	79MHz
Data Transfer Rate	BDR: 1Mbps, EDR: 2Mbps/3Mbps
Modulation type	GFSK, $\pi/4$ DQPSK, 8DPSK
Transmission Technology	FHSS
Maximum Transmit Power	7.49 dBm
Dwell Time	$\leq 0.4s$
Operating Temperature range	0°C - +40°C

1.3 Antenna Designation

Antenna Type	Freq. (MHz)	Right / Left earbud	Peak Antenna Gain (dBi)
Monopole	2402~2480	Right	-5.6
		Left	-4.6

Note:

1. Pre-scanned was done on the above antennas, measurements were demonstrated by using the antenna with the highest gain as the worst-case scenarios.
2. 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

ANSI C63.10:2020+Cor.1-2023

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	
		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	TW3702
		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 is no special accessory 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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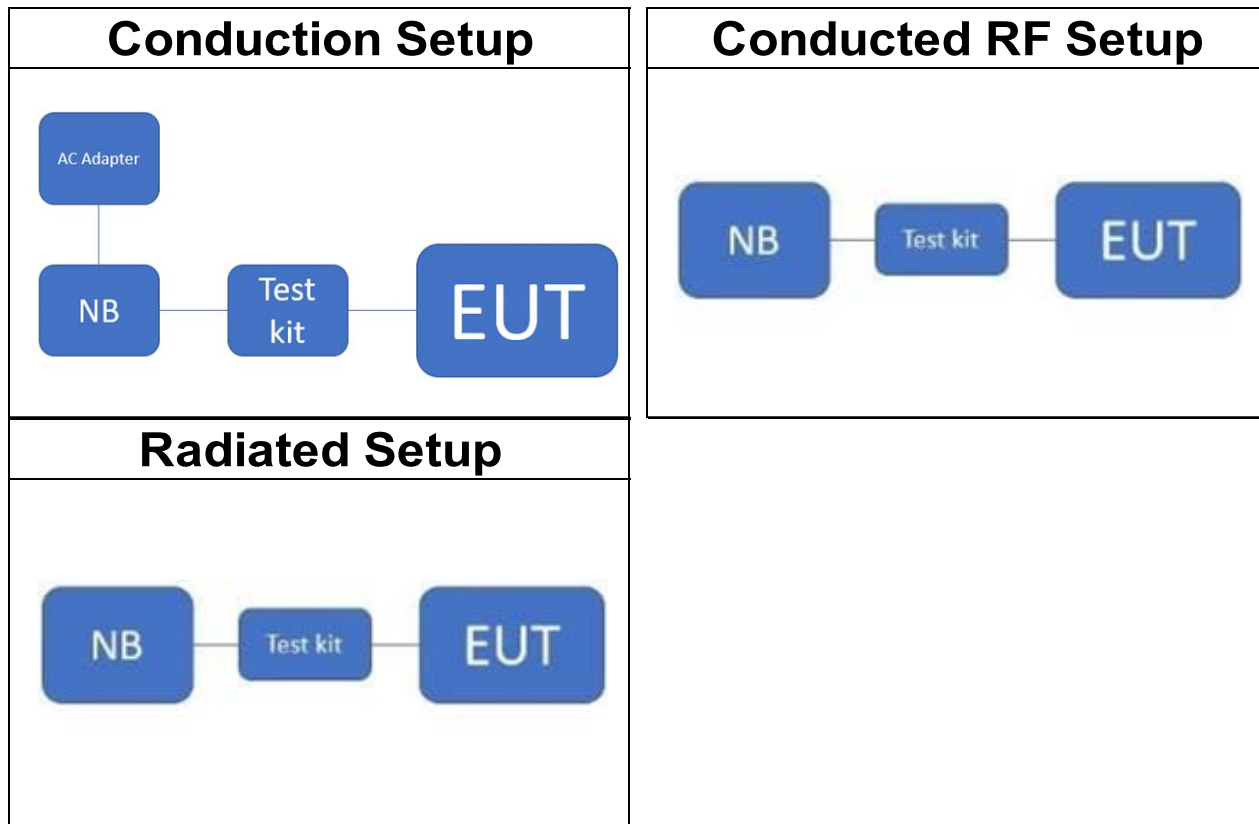
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2.5 Test Configuration



2.6 Control Unit(s)

AC Power-Line Conducted Emission Test Site: Conduction 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
Notebook	Lenovo	L480	PF-1D07MD 19/08	N/A	N/A
AC Adapter	Lenovo	ADLX45YCC3A	N/A	N/A	N/A
Testkit	SENNHEISER	SH-U09C2	N/A	N/A	N/A
Conducted Emission Test Site: Conducted 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
Notebook	Lenovo	L480	PF-1D07MD 19/08	N/A	N/A
Test Kit	SENNHEISER	SH-U09C2	N/A	N/A	N/A
Radiated Emission Test Site: SAC 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
Notebook	Lenovo	L480	PF-1D07MD 19/08	N/A	N/A
Test Kit	SENNHEISER	SH-U09C2	N/A	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)(1)	Peak Output Power	Compliant
§15.247(a)(1)	Emission Bandwidth	Compliant
§15.247(d) §15.209	Conducted Band Edge and Spurious Emission	Compliant
§15.247(d) §15.209	Radiated Band Edge and Spurious Emission	Compliant
§15.205	Restricted Bands	Compliant
§15.247(a)(1)	Frequency Separation	Compliant
§15.247(a)(1)(iii)	Number of hopping frequency Time of Occupancy	Compliant
§15.203	Antenna Requirement	Compliant

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4 DESCRIPTION OF TEST MODES

4.1 Operated in 2400 ~ 2483.5MHz Band

2400~2483.5 MHz							
CH	Freq. (MHz)	CH	Freq. (MHz)	CH	Freq. (MHz)	CH	Freq. (MHz)
0	2402	20	2422	40	2442	60	2462
1	2403	21	2423	41	2443	61	2463
2	2404	22	2424	42	2444	62	2464
3	2405	23	2425	43	2445	63	2465
4	2406	24	2426	44	2446	64	2466
5	2407	25	2427	45	2447	65	2467
6	2408	26	2428	46	2448	66	2468
7	2409	27	2429	47	2449	67	2469
8	2410	28	2430	48	2450	68	2470
9	2411	29	2431	49	2451	69	2471
10	2412	30	2432	50	2452	70	2472
11	2413	31	2433	51	2453	71	2473
12	2414	32	2434	52	2454	72	2474
13	2415	33	2435	53	2455	73	2475
14	2416	34	2436	54	2456	74	2476
15	2417	35	2437	55	2457	75	2477
16	2418	36	2438	56	2458	76	2478
17	2419	37	2439	57	2459	77	2479
18	2420	38	2440	58	2460	78	2480
19	2421	39	2441	59	2461		

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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 radiated 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.

ANTNNA PORT CONDUCTED TEST				
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	PACKET TYPE
Peak Output Power, 20dB Band Width, Spurious Emission				
Bluetooth	0 to 78	0,39,78	GFSK	DH5
	0 to 78	0,39,78	$\pi/4$ -DQPSK	2DH5
	0 to 78	0,39,78	8-DPSK	3DH5
Band Edge				
Bluetooth	0 to 78	0,78	GFSK/ $\pi/4$ -DQPSK	DH5/2DH5
Frequency Separation				
Bluetooth	0 to 78	0,1,2, 38,39,40, 76,77,78	GFSK	DH5
			$\pi/4$ -DQPSK	2DH5
			8-DPSK	3DH5
Number of Hopping Frequency, Hopping Band edge				
Bluetooth	0 to 78	0 to 78	GFSK/ $\pi/4$ -DQPSK	DH5/2DH5
Time of Occupancy(Dwell time)				
Bluetooth	0 to 78	39	GFSK	DH1/DH3/DH5
			$\pi/4$ -DQPSK	2DH1/2DH3/2DH5
			8-DPSK	3DH1/3DH3/3DH5

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MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	PACKET TYPE
TRANSMIT RADIATED EMISSION TEST (BELOW 1 GHz)				
Bluetooth	0 to 78	39	$\pi/4$ -DQPSK	2DH5
TRANSMIT RADIATED EMISSION TEST (ABOVE 1 GHz)				
Bluetooth	0 to 78	0,39,78	GFSK/ $\pi/4$ -DQPSK	DH5/2DH5
Note: The field strength of radiation emission was measured as EUT stand-up position (H mode) and lie down position (E1, E2 mode) for channel Low, Mid and High, the worst case position was reported.				

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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

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5 MEASUREMENT UNCERTAINTY

Test Items	Uncertainty
AC Power Line Conducted Emission	+/- 1.54 dB
Output Power measurement	+/- 0.97 dB
Emission Bandwidth	+/- 1.38 Hz
Conducted emission measurement	+/- 0.77 dB
Frequency Separation	+/- 1.48 Hz
Number of hopping frequency	+/- 1.48 Hz
Time of Occupancy	+/- 1.48 Hz
Temperature	+/- 0.6 °C
Humidity	+/- 3 %
DC / AC Power Source	+/- 1 %

Radiated Spurious Emission Measurement Uncertainty			
Polarization: Vertical	+/-	1.89 dB	9kHz~30MHz
	+/-	4.15 dB	30MHz - 1000MHz
	+/-	3.43 dB	1GHz - 18GHz
	+/-	3.86 dB	18GHz - 40GHz
Polarization: Horizontal	+/-	1.89 dB	9kHz~30MHz
	+/-	4.02 dB	30MHz - 1000MHz
	+/-	3.43 dB	1GHz - 18GHz
	+/-	3.86 dB	18GHz - 40GHz
Radiated Spurious Emission	+/-	2 dB	33GHz-50GHz
	+/-	1.59 dB	50GHz-60GHz
	+/-	1.7 dB	60GHz-90GHz
	+/-	1.64 dB	90GHz-140GHz
	+/-	3.83 dB	140GHz-220GHz

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. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
Coaxial Cables	EMC Instruments Corp.	EMCCFD300-BM-BM-3000	161207	06/22/2024	06/21/2025
EMI Test Receiver	R&S	ESCI 7	100759	08/28/2024	08/27/2025
LISN	SCHWARZBECK	NSLK 8127	1040	09/07/2024	09/06/2025
Pulse Limiter	SCHWARZBECK	VTSD 9561F-N	793	06/22/2024	06/21/2025
Test Software	Audix	e3	Ver. 9.210616	N.C.R	N.C.R

6.2 Conducted Measurement

Conducted Emission Test Site: Conducted 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
DC Block	Mini-Circuits	BLK-18-S+	10	12/12/2023	12/11/2024
EXA Spectrum Analyzer	KEYSIGHT	N9010B	MY59071571	06/04/2024	06/03/2025
Power Meter	Anritsu	ML2496A	1242004	10/23/2024	10/22/2025
Power Sensor	Anritsu	MA2411B	1207365	10/23/2024	10/22/2025
Power Sensor	Anritsu	MA2411B	1207368	10/23/2024	10/22/2025
Test Software	SGS	Radio Test Software	Ver. 21	N.C.R	N.C.R

6.3 Radiated Measurement

Radiated Emission Test Site: SAC 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
4G High Pass Filter	WI	WHKX4.0	24	12/12/2023	12/11/2024
Band Reject Filter 2400-2483.5	EWT	EWT-14-0166	M3	12/12/2023	12/11/2024
Bi-log Antenna	TESEO	CBL 6112D	35242 & AT-N0555	12/18/2023	12/17/2024
Coaxial Cable	EMCI	EMC104-SM-SM-8000+EMC106-SM-SM-7600	RX Cable 9K-18G(160125+150817)	08/30/2024	08/29/2025
Coaxial Cables	Huber Suhner	SUCOFLEX 102	RX Cable 18G-40G MY2630/2+805062/2	08/30/2024	08/29/2025
EMI Test Receiver	R&S	ESCI 7	100759	08/28/2024	08/27/2025
EXA Spectrum Analyzer	KEYSIGHT	N9010B	MY60242081	10/23/2024	10/22/2025
Horn Antenna	RF SPIN	DRH0844	LE2D05A0844	07/10/2024	07/09/2025
Horn Antenna	SCHWARZBECK	BBHA9120D	D803	01/12/2024	01/11/2025
Loop Antenna	COM-POWER	AL-130R	10160104	12/04/2023	12/03/2024
Pre-Amplifier	EMCI	EMC118A45SEE	980933	08/30/2024	08/29/2025
Pre-Amplifier	EMCI	EMC184045SEE	9080939	08/30/2024	08/29/2025
Pre-Amplifier	HP	8447D	2944A09469	08/30/2024	08/29/2025
Site Cal	SGS	SAC 1	N/A	08/30/2024	08/29/2025
Test Software	Audix	e3	Ver. 9.210616	N.C.R	N.C.R

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

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7 CONDUCTED EMISSION TEST

7.1 Standard Applicable

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

Frequency range MHz	Limits dB(uV)	
	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

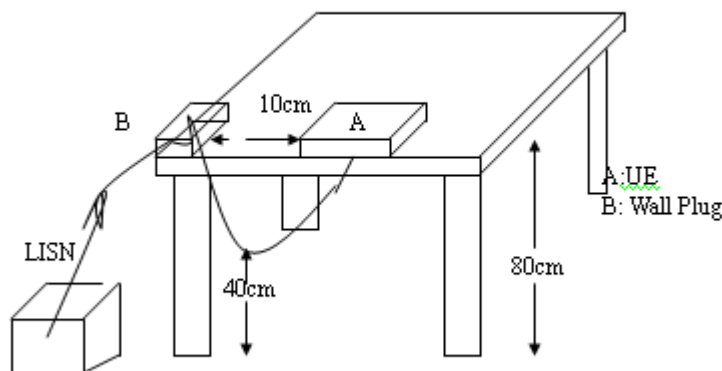
Note

- 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.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all frequency measured were complete.

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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

1st

Report Number :TERF2409002876ER

Operation Mode :BT

Power :120V/60Hz

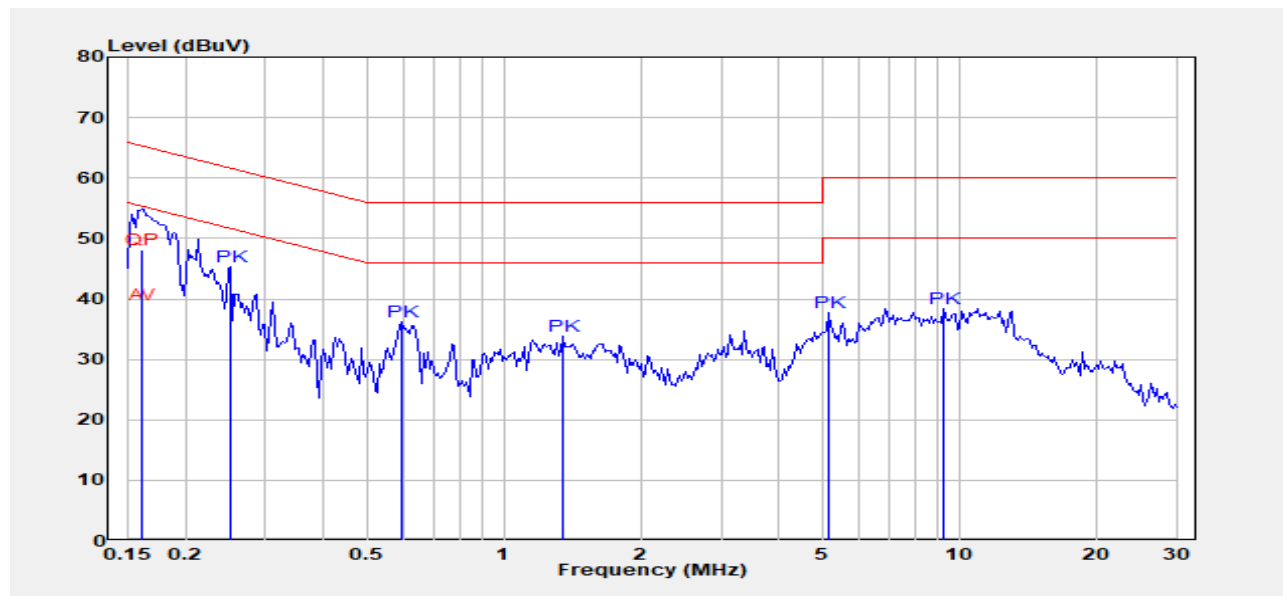
Probe :L

Test Site :Conduction 1

Test Date :2024-11-26

Temp./Humi. :24.1°C/62%

Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV	Limit dBμV	Margin dB
0.160	Average	29.00	10.13	39.13	55.47	-16.34
0.160	QP	37.90	10.13	48.03	65.47	-17.44
0.252	Peak	35.08	10.14	45.22	61.69	-16.47
0.595	Peak	26.03	10.17	36.21	56.00	-19.79
1.345	Peak	23.62	10.20	33.81	56.00	-22.19
5.166	Peak	27.39	10.34	37.73	60.00	-22.27
9.253	Peak	28.04	10.38	38.41	60.00	-21.59

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Report Number :TERF2409002876ER

Operation Mode :BT

Power :120V/60Hz

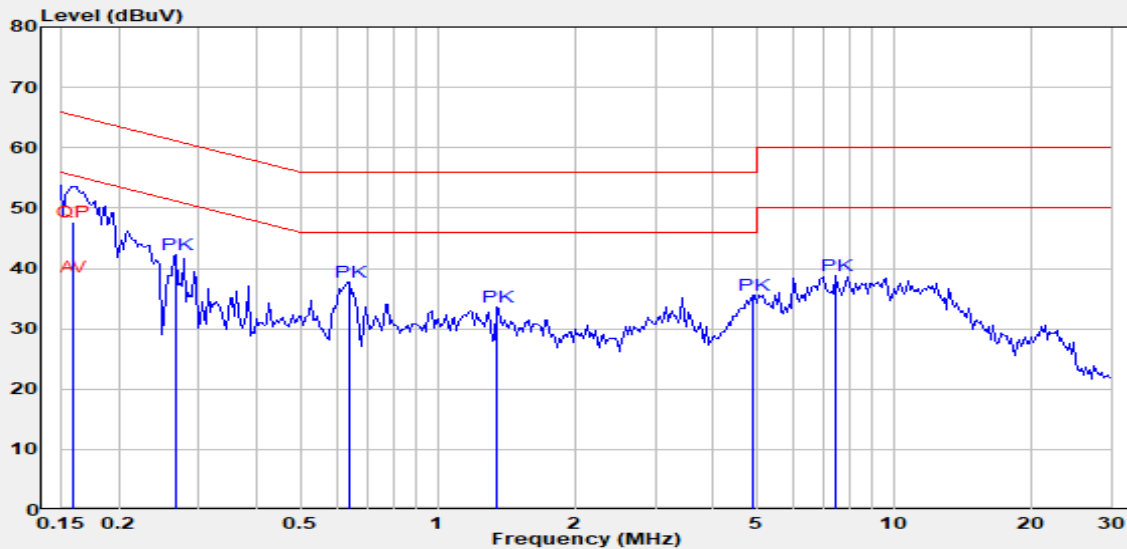
Probe :N

Test Site :Conduction 1

Test Date :2024-11-26

Temp./Humi. :24.1°C/62%

Engineer :WJ Lin



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	Mode	Reading Level		FS		
	PK/QP/AV	dBμV	dB	dBμV	dBμV	dB
0.158	Average	28.40	10.12	38.52	55.56	-17.04
0.158	QP	37.50	10.12	47.62	65.56	-17.94
0.266	Peak	32.08	10.13	42.21	61.25	-19.04
0.641	Peak	27.51	10.17	37.68	56.00	-18.32
1.345	Peak	23.35	10.19	33.54	56.00	-22.46
4.900	Peak	25.30	10.35	35.65	56.00	-20.35
7.486	Peak	28.44	10.38	38.82	60.00	-21.18

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Report Number :TERF2409002876ER

Operation Mode :BT

Power :120V/60Hz

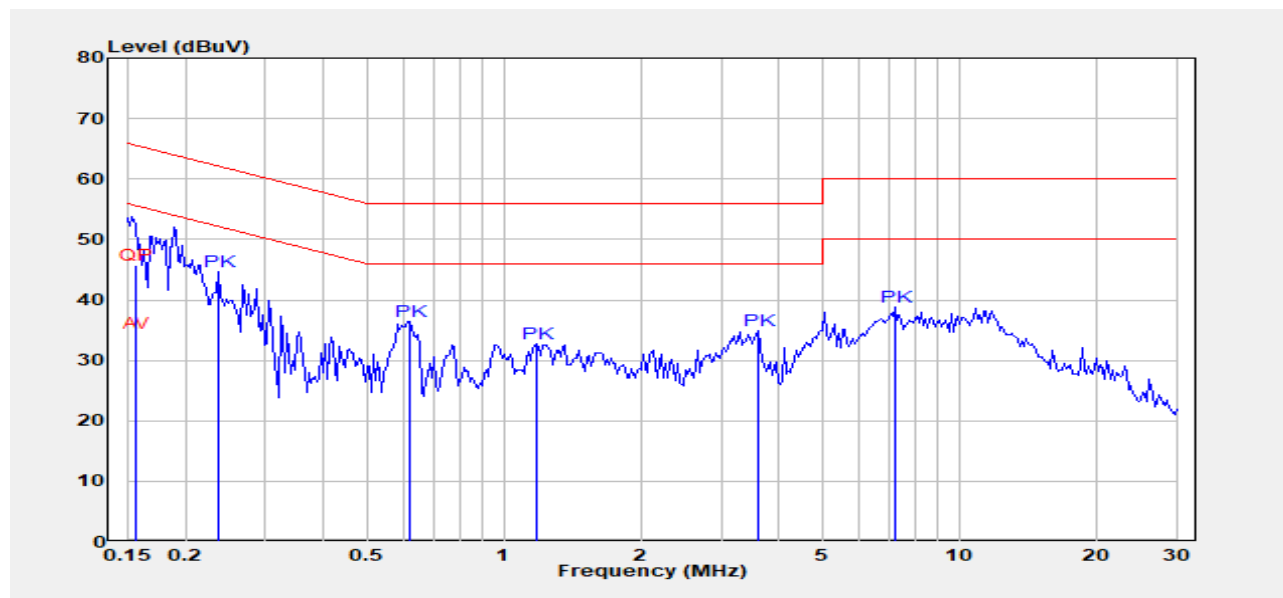
Probe :L

Test Site :Conduction 1

Test Date :2024-11-26

Temp./Humi. :24.1°C/62%

Engineer :WJ Lin



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	Mode	Reading Level		FS		
	PK/QP/AV	dBμV	dB	dBμV	dBμV	dB
0.155	Average	24.40	10.13	34.53	55.74	-21.21
0.155	QP	35.70	10.13	45.83	65.74	-19.91
0.237	Peak	34.43	10.13	44.57	62.22	-17.65
0.621	Peak	26.32	10.18	36.50	56.00	-19.50
1.184	Peak	22.61	10.20	32.81	56.00	-23.19
3.603	Peak	24.63	10.28	34.91	56.00	-21.09
7.252	Peak	28.44	10.36	38.80	60.00	-21.20

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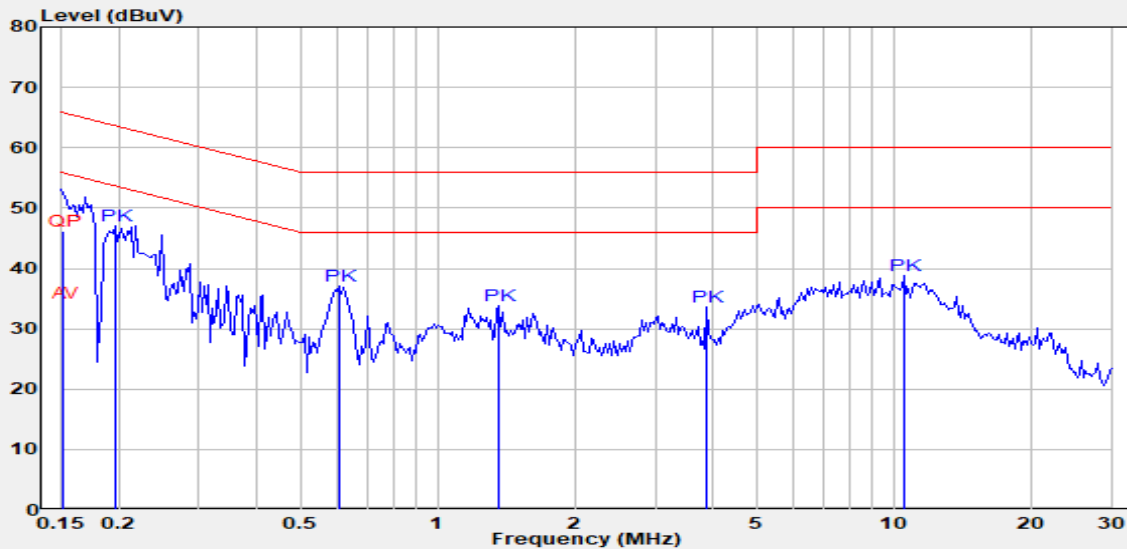
Probe :N

Test Site :Conduction 1

Test Date :2024-11-26

Temp./Humi. :24.1°C/62%

Engineer :WJ Lin



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	Mode	Reading Level		FS		
	PK/QP/AV	dBμV	dB	dBμV	dBμV	dB
0.152	Average	24.20	10.12	34.32	55.91	-21.59
0.152	QP	36.12	10.12	46.24	65.91	-19.67
0.198	Peak	36.98	10.12	47.10	63.71	-16.61
0.608	Peak	26.86	10.17	37.03	56.00	-18.97
1.359	Peak	23.70	10.19	33.89	56.00	-22.11
3.881	Peak	23.27	10.30	33.57	56.00	-22.43
10.508	Peak	28.43	10.41	38.85	60.00	-21.15

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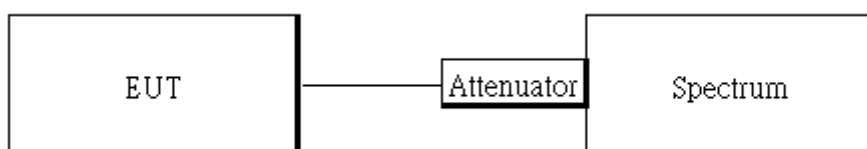
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8 FREQUENCY SEPARATION

8.1 Standard Applicable

Frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

8.2 Test Setup



8.3 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2013.
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 center frequency of spectrum analyzer = middle of hopping channel.
5. Set the RBW approximately 30% of the channel spacing, $VBW \geq RBW$.
6. Adjust Span to Wide enough to capture the peaks of two adjacent channels.
7. Sweep = auto.
8. Max hold. Mark 3 Peaks of hopping channel and record the 3 peaks frequency.

8.4 Measurement Result

Channel separation (MHz)	Limit	Result
1	≥ 25 kHz or 2/3 times 20dB bandwidth	PASS

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FSK_1M_DH5_CH0CH1CH2



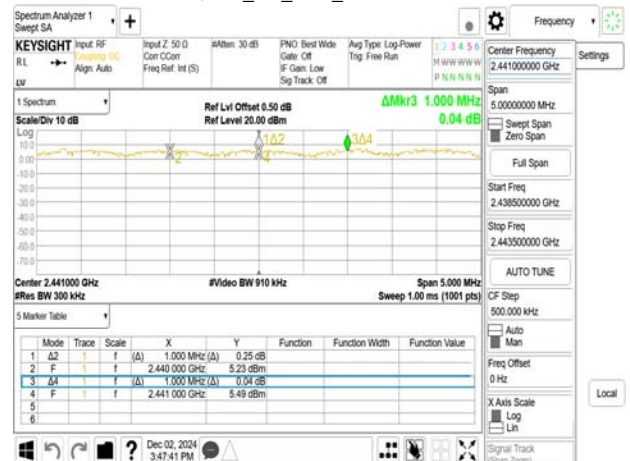
$\pi/4$ DQPSK_2M_DH5_CH0CH1CH2



FSK_1M_DH5_CH38CH39CH40



$\pi/4$ DQPSK_2M_DH5_CH38CH39CH40



FSK_1M_DH5_CH76CH77CH78



$\pi/4$ DQPSK_2M_DH5_CH76CH77CH78

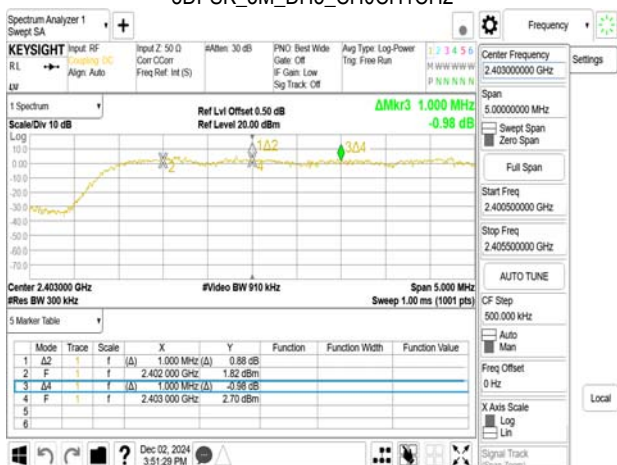


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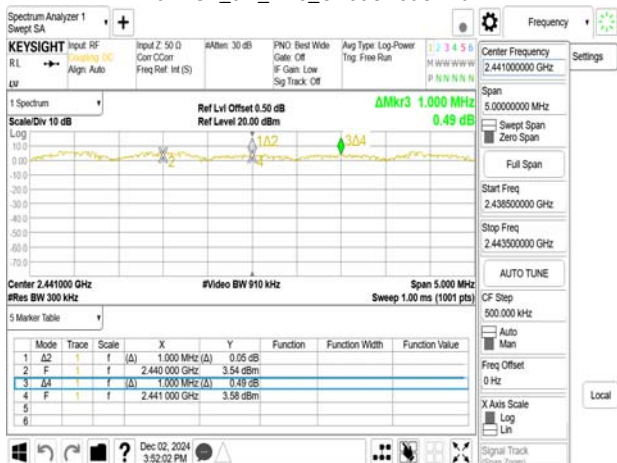
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8DPSK_3M_DH5_CH0CH1CH2



8DPSK_3M_DH5_CH38CH39CH40



8DPSK_3M_DH5_CH76CH77CH78



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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

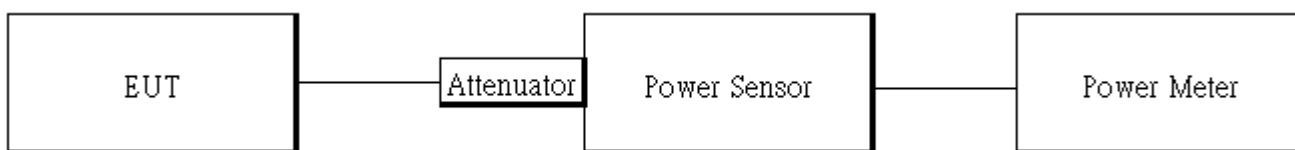
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9 PEAK OUTPUT POWER MEASUREMENT

9.1 Standard Applicable

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels, The Limit: 1Watt. For all other frequency hopping systems in the 2400 – 2483.5MHz band: The Limit: 0.125 Watts. The power limit for 1Mbps is 1watt, and 2Mbps, 3Mbps and AFH mode are 0.125 watts.

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 ANSI C63.10 Measurement Guidelines.
3. Duty cycle of test signal is < 98 %, duty factor shall be considered.
4. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter or spectrum. (Max Hold, Detector = Peak, RBW >=20dB bandwidth)
5. Record the max. reading.
6. Repeat above procedures until all default test channel is completed.

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9.4 Peak & Average Power Measurement Result

	Duty Cycle (%) = Ton / (Ton+Toff)	Duty Factor (dB) =10*log (1/Duty Cycle)
DH5	76.80	1.15
2DH5	77.20	1.12
3DH5	77.20	1.12

1M BR mode (Peak):

CH	Freq. (MHz)	Power Setting	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	3	6.15	4.121	1000
39	2441	3	6.92	4.920	1000
78	2480	3	6.98	4.989	1000

1M BR mode (Average):

CH	Freq. (MHz)	Power Setting	Avg. Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	3	5.98	3.963	1000
39	2441	3	6.71	4.688	1000
78	2480	3	6.77	4.753	1000

2M EDR mode (Peak):

CH	Freq. (MHz)	Power Setting	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	3	6.63	4.603	125
39	2441	3	7.40	5.495	125
78	2480	3	7.49	5.610	125

2M EDR mode (Average):

CH	Freq. (MHz)	Power Setting	Avg. Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	3	4.41	2.761	125
39	2441	3	5.39	3.459	125
78	2480	3	5.47	3.524	125

3M EDR mode (Peak):

CH	Freq. (MHz)	Power Setting	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	3	5.07	3.214	125
39	2441	3	5.90	3.890	125
78	2480	3	5.96	3.945	125

3M EDR mode (Average):

CH	Freq. (MHz)	Power Setting	Avg. Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	3	2.30	1.698	125
39	2441	3	3.27	2.123	125
78	2480	3	3.36	2.168	125

*Note: Avg. output power has been calculated with duty factor.

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t (886-2) 2299-3279

f (886-2) 2298-0488

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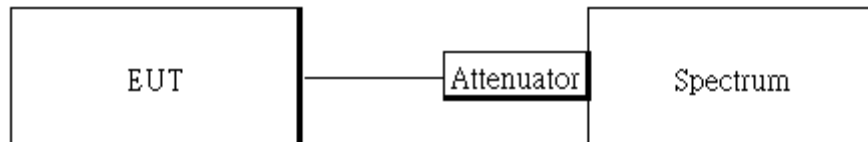
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10 EMISSION BANDWIDTH MEASUREMENT

10.1 Standard Applicable

For frequency hopping systems operating in the 2400 MHz-2483.5 MHz no limit for 20dB bandwidth.

10.2 Test Setup



10.3 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2013.
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= 1 % to 5% of OBW ,
VBW = 3 X RBW,
Span= 2 to 5 times of the OBW,
Sweep=auto,
Detector = Peak, and Max hold for 20dB Bandwidth test.
5. Mark the peak frequency and -20dB (upper and lower) frequency
6. Set the spectrum analyzer as
RBW= 1 % to 5% of 99% Bandwidth ,
VBW \geq 3 X RBW,
Span= large enough to capture all products of the modulation process,
Sweep=auto,
Detector = Peak, and Max hold for 99% Bandwidth test.
7. Mark the peak frequency and 99%dB (upper and lower) frequency
8. Repeat above procedures until all test default channel is completed

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10.4 20dB Bandwidth

GFSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
0	0.9621	0.64
39	0.9593	0.64
78	0.9602	0.64

$\pi/4$ -DQPSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
0	1.364	0.91
39	1.374	0.92
78	1.371	0.91

8-DPSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
0	1.352	0.90
39	1.354	0.90
78	1.353	0.90

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GFSK

CH	99% BW (MHz)
0	0.89023
39	0.87865
78	0.87727

$\pi/4$ -DQPSK

CH	99% BW (MHz)
0	1.1863
39	1.2005
78	1.2009

8-DPSK

CH	99% BW (MHz)
0	1.2080
39	1.2102
78	1.2109

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OBW 20dB_GFSK_1M_DH5_2402MHz



OBW 20dB_π/4DQPSK_2M_DH5_2402MHz



OBW 20dB_GFSK_1M_DH5_2441MHz



OBW 20dB_π/4DQPSK_2M_DH5_2441MHz



OBW 20dB_GFSK_1M_DH5_2480MHz



OBW 20dB_π/4DQPSK_2M_DH5_2480MHz

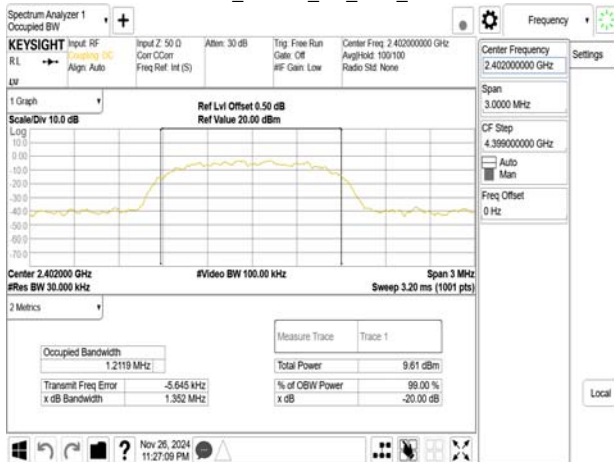


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OBW 20dB_8DPSK_3M_DH5_2402MHz



IC OBW 99%_GFSK_1M_DH5_2402MHz



OBW 20dB_8DPSK_3M_DH5_2441MHz



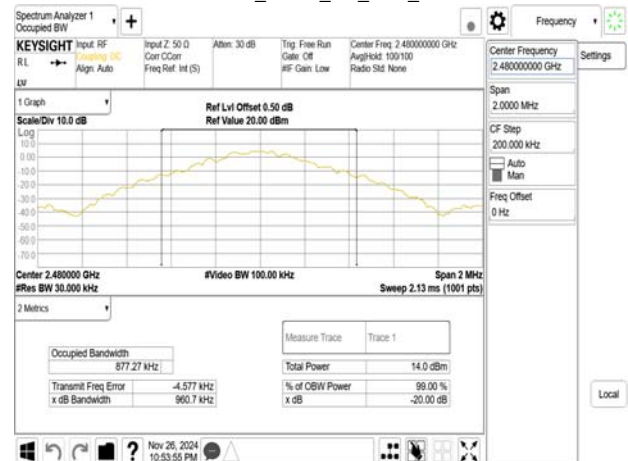
IC OBW 99%_GFSK_1M_DH5_2441MHz



OBW 20dB_8DPSK_3M_DH5_2480MHz



IC OBW 99%_GFSK_1M_DH5_2480MHz



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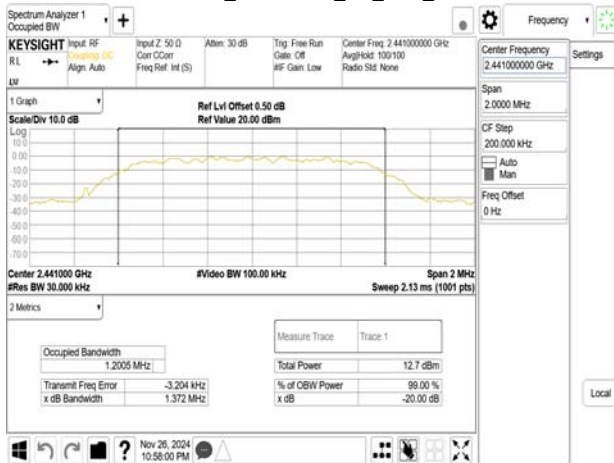
IC OBW 99%_π/4DQPSK_2M_DH5_2402MHz



IC OBW 99%_8DPSK_3M_DH5_2402MHz



IC OBW 99%_π/4DQPSK_2M_DH5_2441MHz



IC OBW 99%_8DPSK_3M_DH5_2441MHz



IC OBW 99%_π/4DQPSK_2M_DH5_2480MHz



IC OBW 99%_8DPSK_3M_DH5_2480MHz



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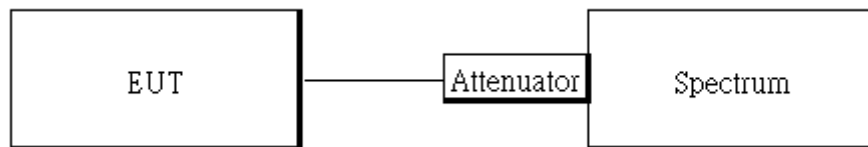
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11 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

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, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

11.2 Test Setup



11.3 Measurement Procedure

11.3.1 Conducted Band Edge:

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2013.
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 center frequency of spectrum analyzer = operating frequency.
5. Set the spectrum analyzer as RBW=100 kHz, VBW=300 kHz, Sweep = auto
6. Mark Peak, below 2.4GHz and above 2.4835GHz and record the max. level.
7. Repeat above procedures until all frequency measured were complete.

11.3.2 Conducted Spurious Emission:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows ANSI C63.10:2013.
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.

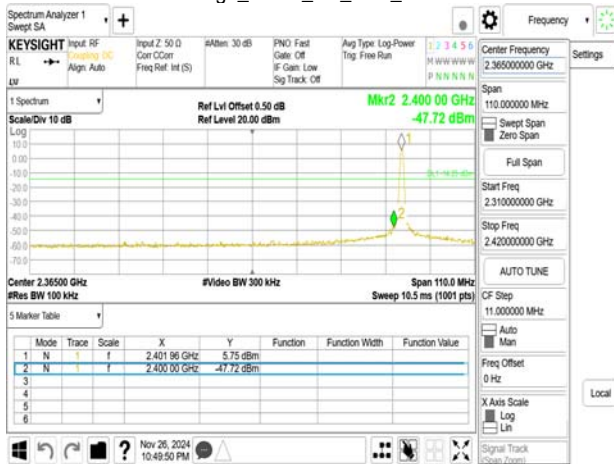
11.4 Measurement Result

See next page for test plots.

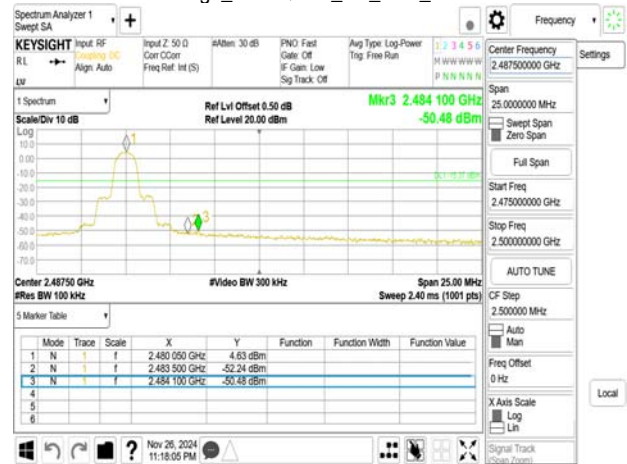
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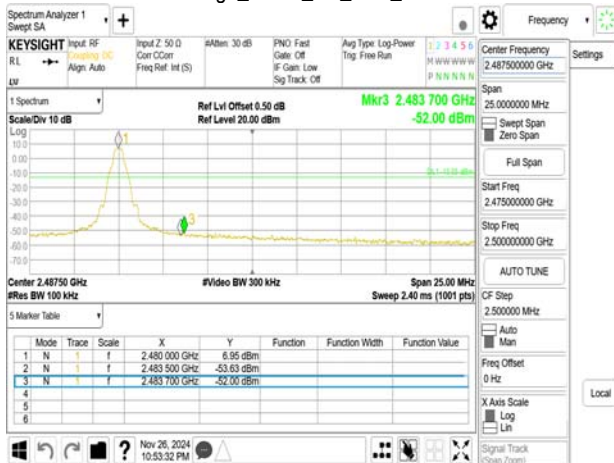
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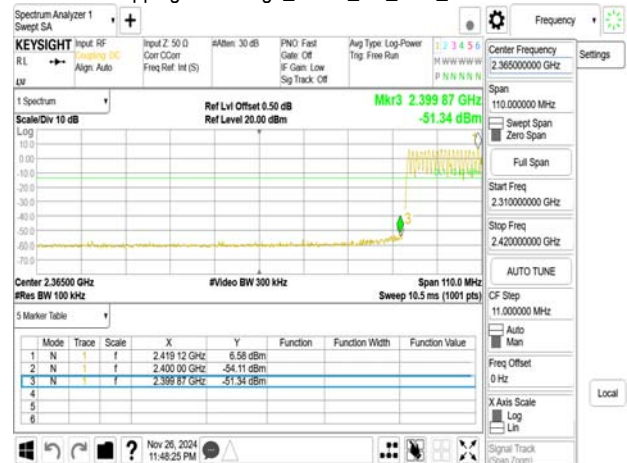
Band Edge_π/4DQPSK_2M_DH5_2480MHz



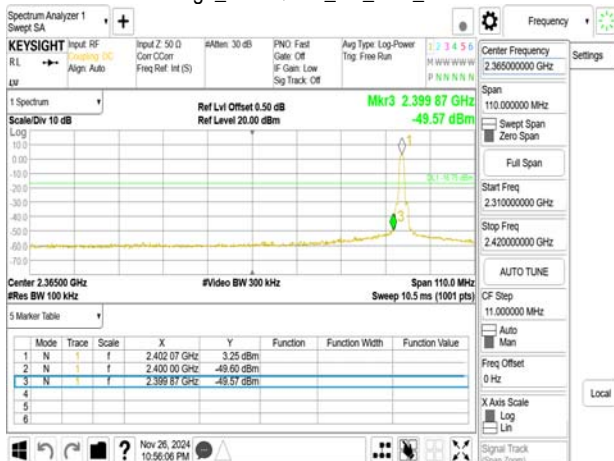
Band Edge_GFSK_1M_DH5_2480MHz



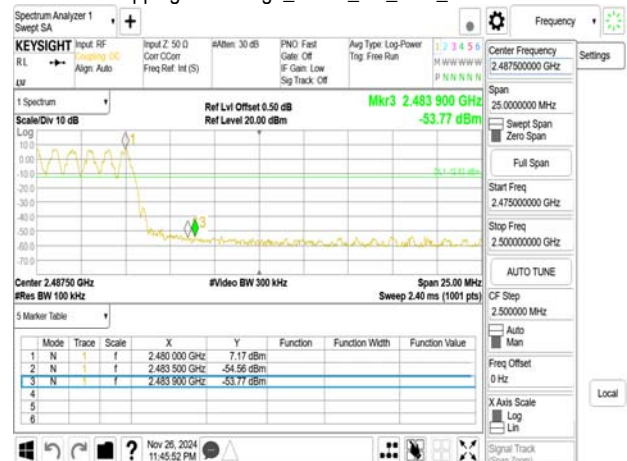
Hopping Band Edge_GFSK_1M_DH5_2402MHz



Band Edge_π/4DQPSK_2M_DH5_2402MHz



Hopping Band Edge_GFSK_1M_DH5_2480MHz



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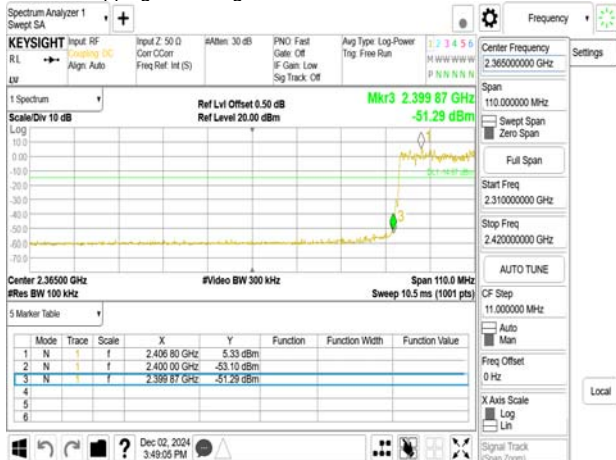
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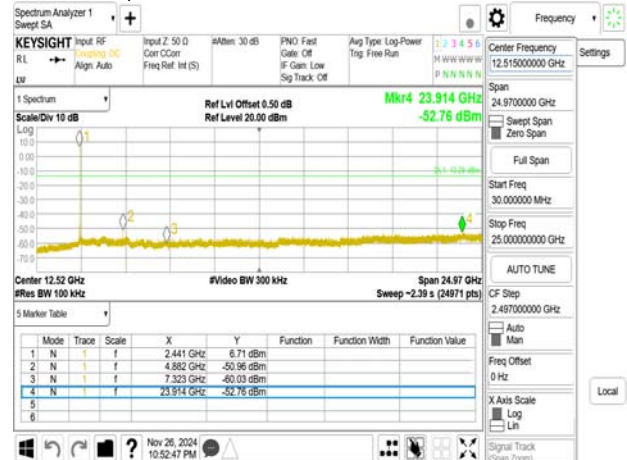
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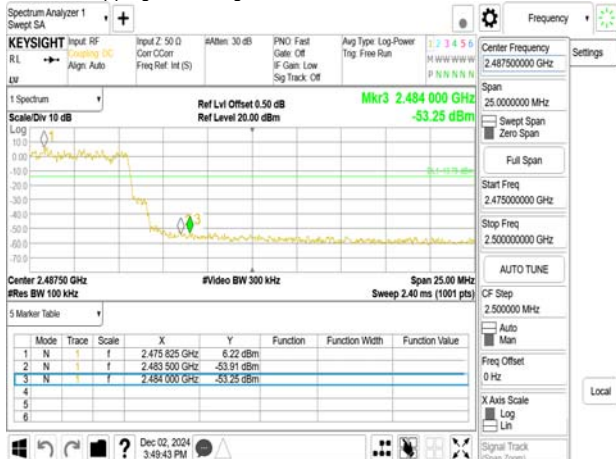
Hopping Band Edge_π/4DQPSK_2M_DH5_2402MHz



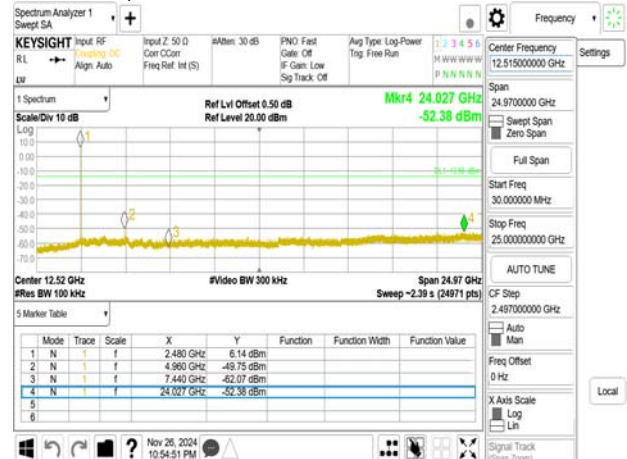
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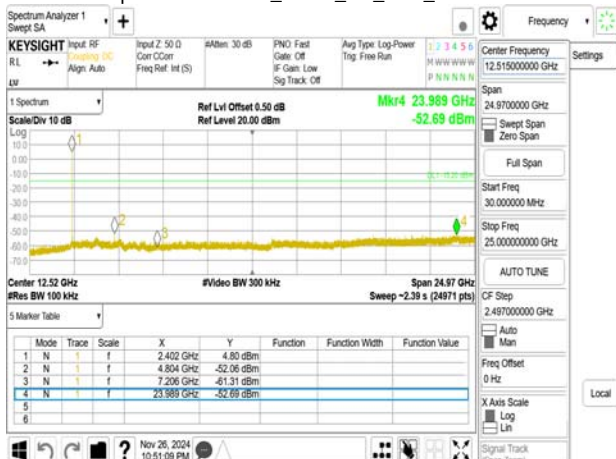
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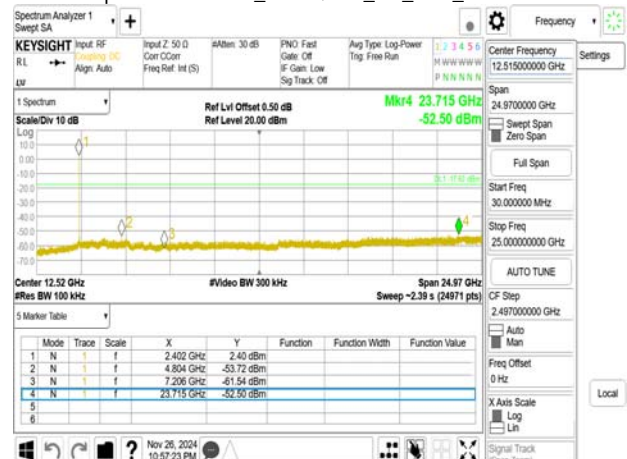
Spurious Emission_GFSK_1M_DH5_2480MHz



Spurious Emission_GFSK_1M_DH5_2402MHz



Spurious Emission_π/4DQPSK_2M_DH5_2402MHz

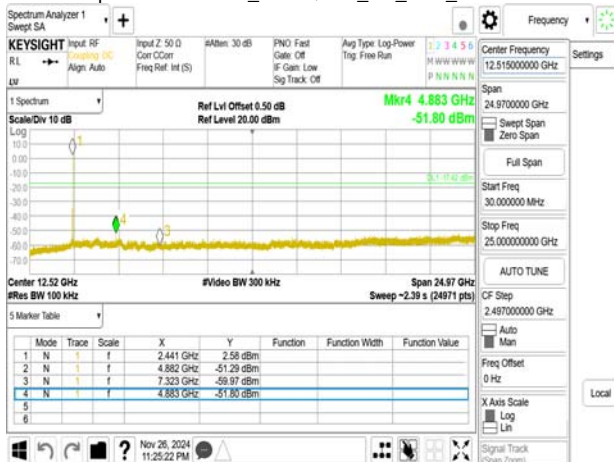


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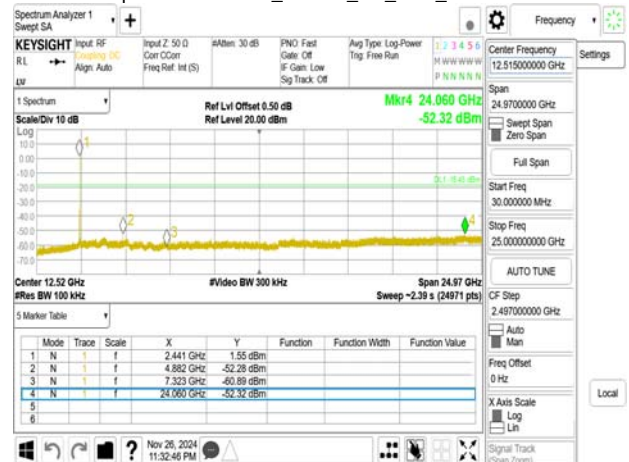
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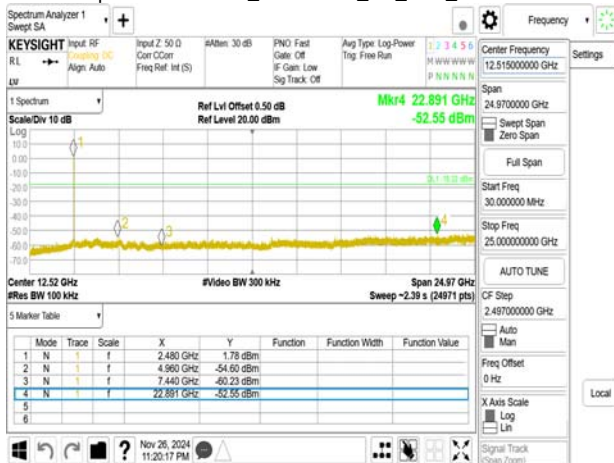
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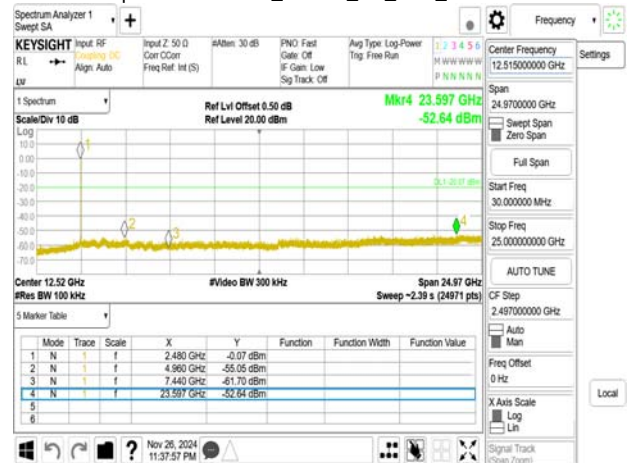
Spurious Emission_8DPSK_3M_DH5_2441MHz



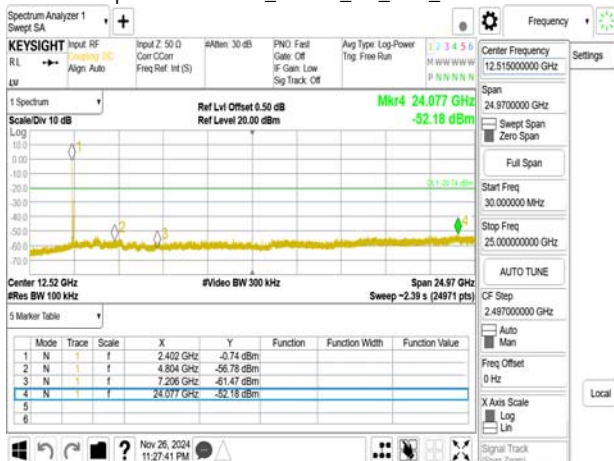
Spurious Emission_π/4QPSK_2M_DH5_2480MHz



Spurious Emission_8DPSK_3M_DH5_2480MHz



Spurious Emission_8DPSK_3M_DH5_2402MHz



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12 RADIATED BANDEDGE AND SPURIOUS EMISSION MEASUREMENT

12.1 Standard Applicable

12.1.1 Duty Cycle Correction Factor

According to 15. 35(c), the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification.

12.1.2 Spurious Emission

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 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:

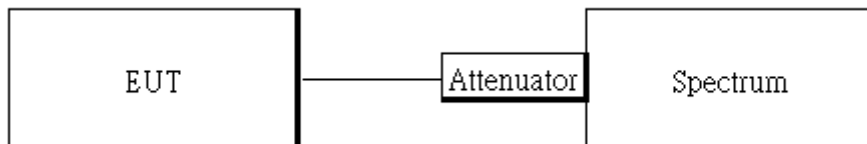
1. The lower limit shall apply at the transition frequencies.

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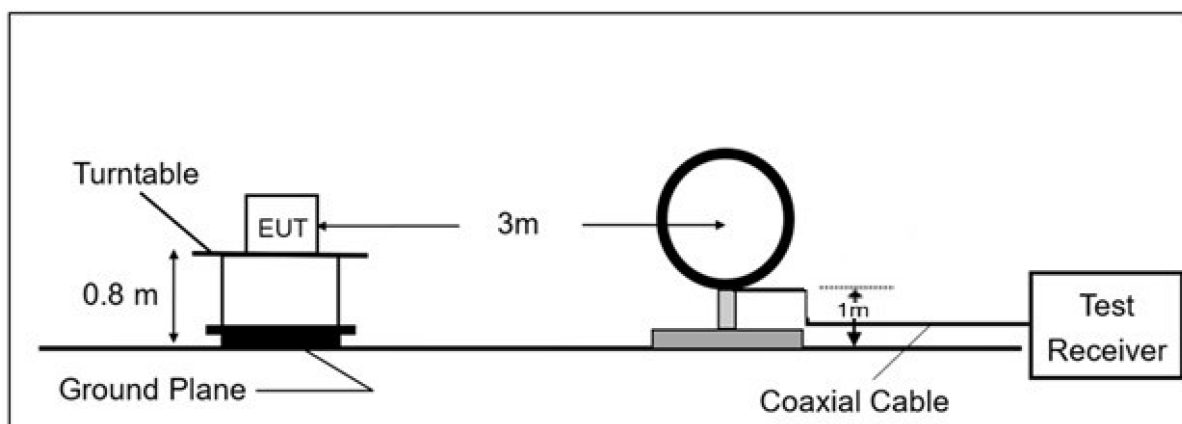
12.2 Test Setup

12.2.1 Duty Cycle Correction Factor

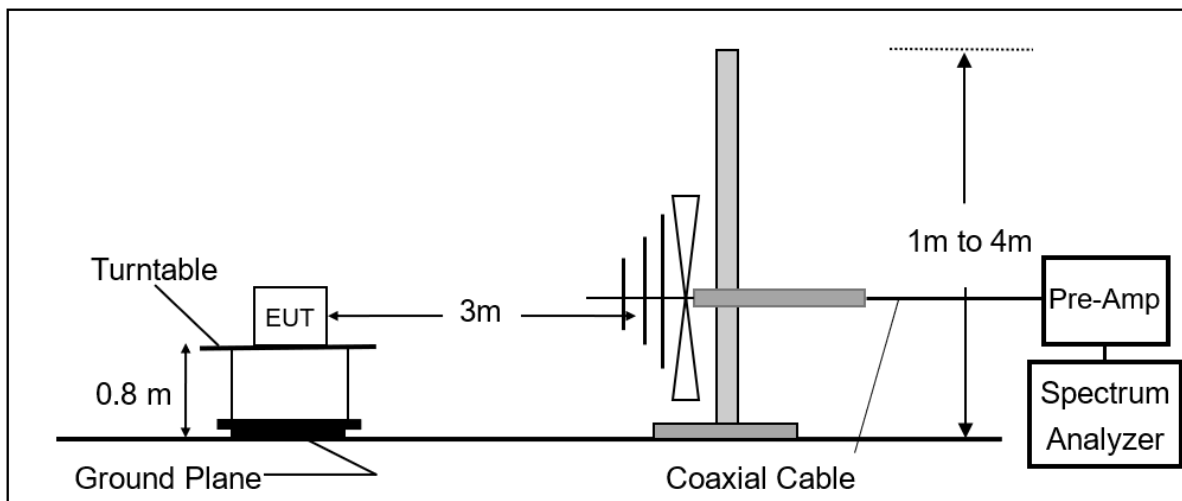


12.2.2 Radiated Emission

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



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



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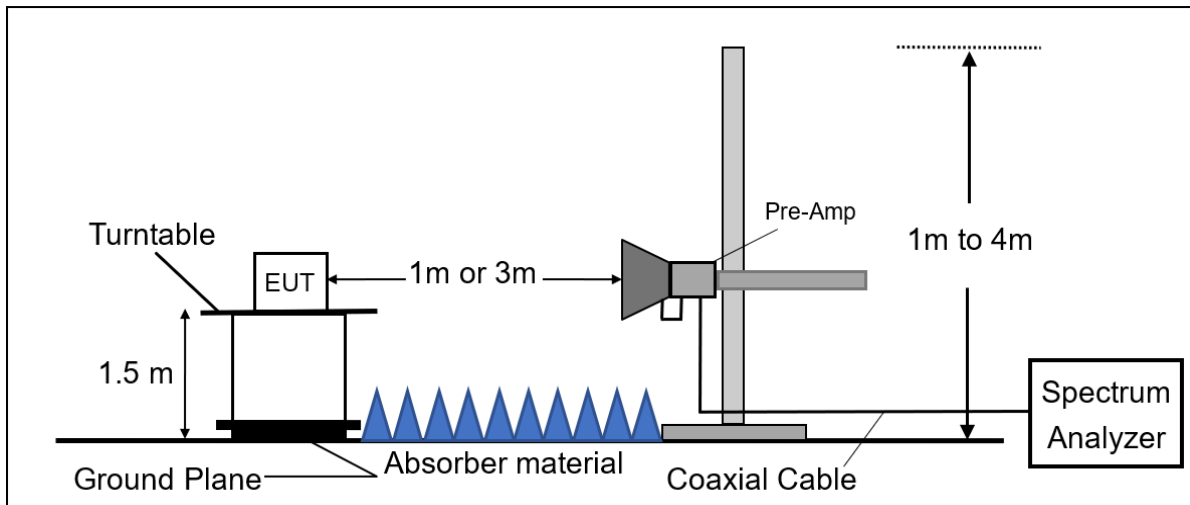
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(C) Radiated Emission Test Set-Up, Frequency Above 1 GHz.



12.3 Measurement Procedure

12.3.1 Duty Cycle Correction Factor

1. Adjust and configure any EUT switches, controls, or input data streams to ensure that the EUT is transmitting or encoded to obtain the “worst-case” pulse ON time.
2. The testing follows ANSI C63.10:2013.
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 center frequency of spectrum analyzer = operating frequency.
5. Set the spectrum analyzer as RBW, VBW=1MHz, 3MHz, Span = 0Hz , Detector = Peak, Adjust Sweep=100ms.
6. Repeat above procedures until all frequency of the interest measured were complete.

12.3.2 Radiated Emission

1. The testing follows the Measurement Procedure of ANSI C63.10:2013.
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. According to C63.10:2013 Section 7.5 Procedure for determining the average value of pulsed emissions with duty cycle correction factor $20 \log (T_{on}/100ms)$.
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.

12.4 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)

Average value(dBμV/m)=Peak Actual FS(dBμV/m)+ Duty Cycle Correction Factor(dB)

Duty Cycle Correction Factor(dB) = $20 \log (T_{on}/100 \text{ ms})$

12.5 Test Results of Radiated Spurious Emissions form 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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12.6 Measurement Result:

12.6.1 Duty Cycle Correction Factor

Bluetooth 1M

Time ON of 100ms: 2.900 ms
Duty Cycle=2.9ms / 100ms= 0.029
Duty Cycle correction factor=20 LOG 0.029 = -30.75 dB

Bluetooth 3M

Time ON of 100ms: 2.900 ms
Duty Cycle=2.9ms / 100ms= 0.029
Duty Cycle correction factor=20 LOG 0.029 = -30.75 dB

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12.6.2 Duty Cycle test plot

BR



EDR



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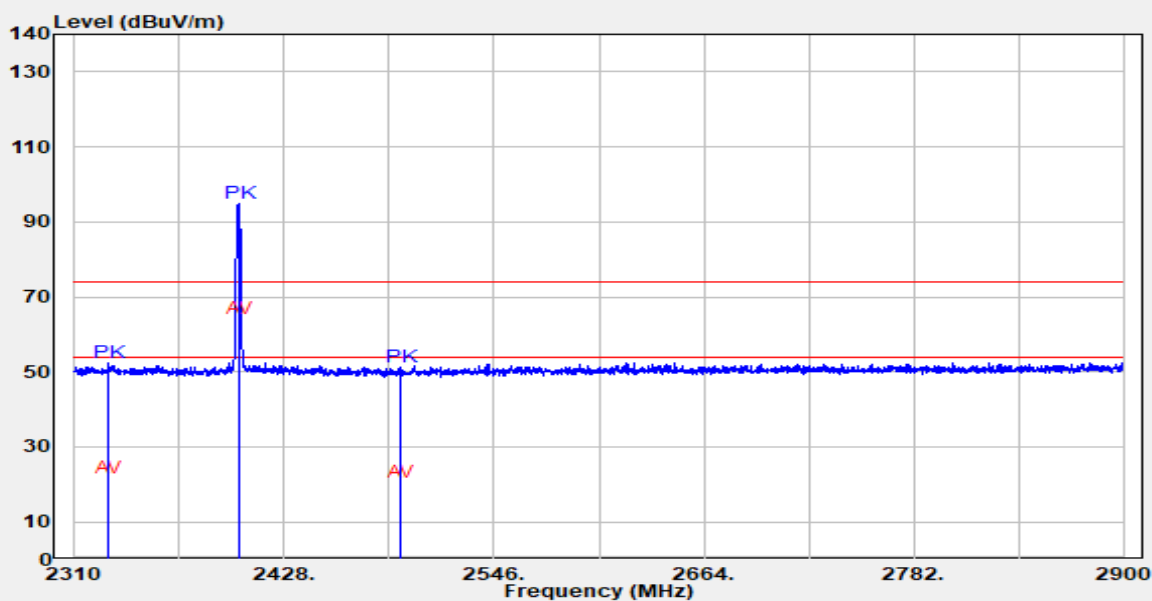
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12.6.3 Bandedge Result

Report Number :TERF2409002876ER
Operation Mode :BR
Test Frequency :2402 MHz
Test Mode :Bandedge
EUT Pol :H Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Vertical
Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2328.69	Average	-	-	21.64	54.00	-32.36
2328.69	Peak	54.19	-1.80	52.39	74.00	-21.61
2402.00	Average	-	-	63.94	-	-
2402.00	Peak	96.65	-1.96	94.69	-	-
2492.76	Average	-	-	20.46	54.00	-33.54
2492.76	Peak	53.31	-2.10	51.21	74.00	-22.79

Average Duty Cycle Factor=-30.75 (dB)

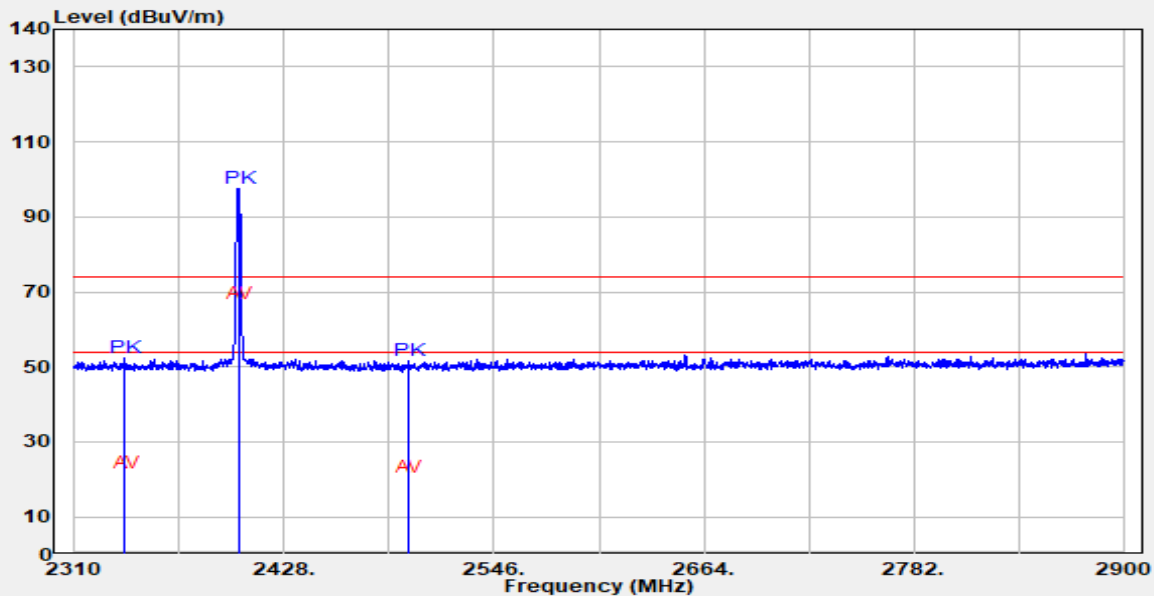
Average Level= Peak Level+ Duty Cycle Factor

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Report Number :TERF2409002876ER
Operation Mode :BR
Test Frequency :2402 MHz
Test Mode :Bandedge
EUT Pol :H Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Horizontal
Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2338.13	Average	-	-	21.73	54.00	-32.27
2338.13	Peak	54.43	-1.95	52.48	74.00	-21.52
2402.00	Average	-	-	66.80	-	-
2402.00	Peak	99.51	-1.96	97.55	-	-
2497.88	Average	-	-	20.66	54.00	-33.34
2497.88	Peak	53.56	-2.15	51.41	74.00	-22.59

Average Duty Cycle Factor=-30.75 (dB)

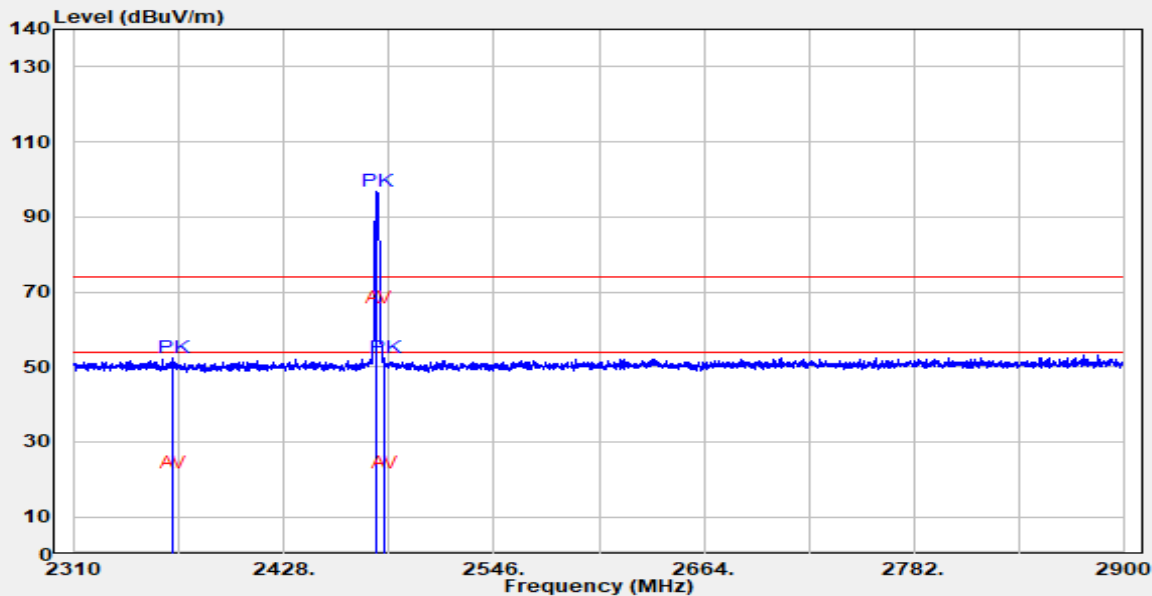
Average Level= Peak Level+ Duty Cycle Factor

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Report Number :TERF2409002876ER
Operation Mode :BR
Test Frequency :2480 MHz
Test Mode :Bandedge
EUT Pol :H Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Vertical
Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2365.09	Average	-	-	21.52	54.00	-32.48
2365.09	Peak	54.16	-1.89	52.27	74.00	-21.73
2480.00	Average	-	-	65.82	-	-
2480.00	Peak	98.73	-2.16	96.57	-	-
2483.72	Average	-	-	21.53	54.00	-32.47
2483.72	Peak	54.41	-2.13	52.28	74.00	-21.72

Average Duty Cycle Factor=-30.75 (dB)

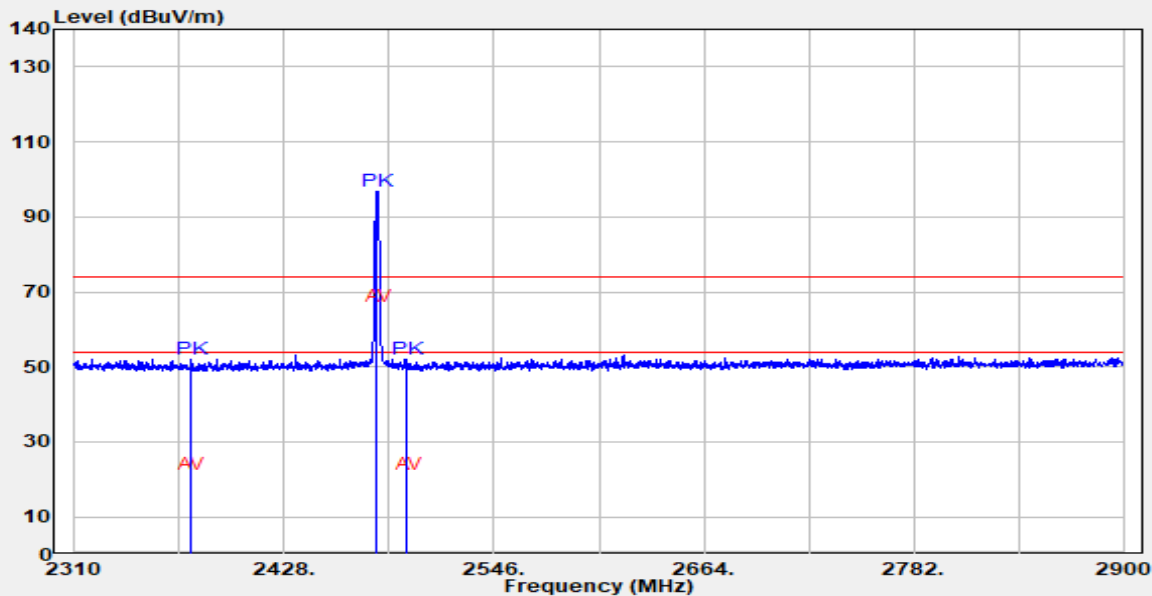
Average Level= Peak Level+ Duty Cycle Factor

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Report Number :TERF2409002876ER
Operation Mode :BR
Test Frequency :2480 MHz
Test Mode :Bandedge
EUT Pol :H Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Horizontal
Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2375.12	Average	-	-	21.23	54.00	-32.77
2375.12	Peak	54.01	-2.03	51.98	74.00	-22.02
2480.00	Average	-	-	65.92	-	-
2480.00	Peak	98.83	-2.16	96.67	-	-
2496.90	Average	-	-	21.32	54.00	-32.68
2496.90	Peak	54.21	-2.14	52.07	74.00	-21.93

Average Duty Cycle Factor=-30.75 (dB)

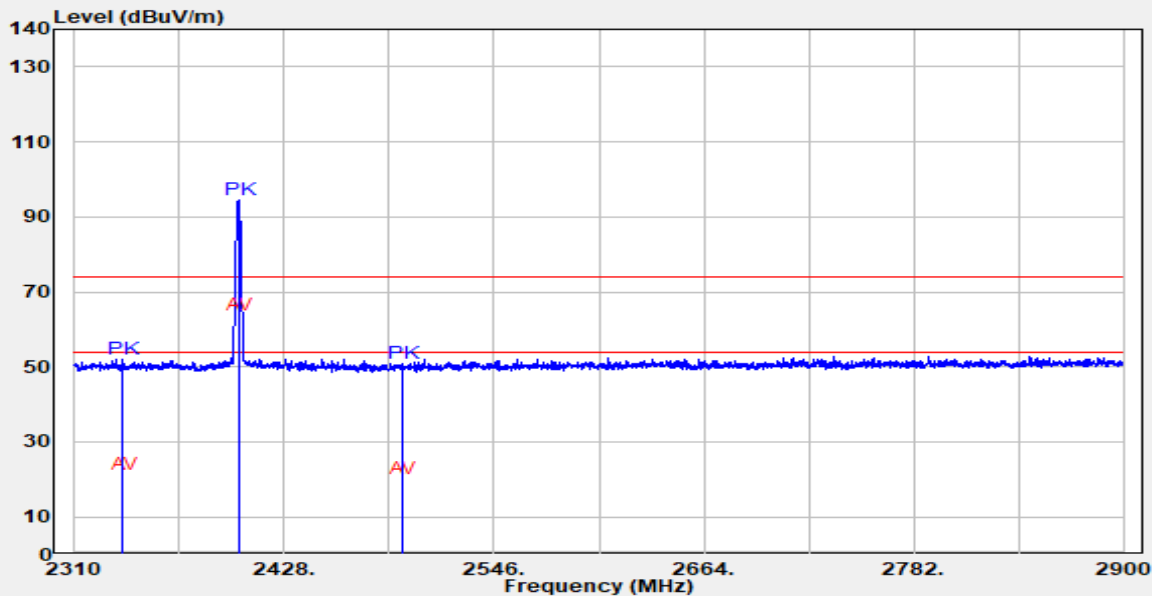
Average Level= Peak Level+ Duty Cycle Factor

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Report Number :TERF2409002876ER
Operation Mode :EDR 2M
Test Frequency :2402 MHz
Test Mode :Bandedge
EUT Pol :H Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Vertical
Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2336.95	Average	-	-	21.32	54.00	-32.68
2336.95	Peak	54.01	-1.94	52.07	74.00	-21.93
2402.00	Average	-	-	63.59	-	-
2402.00	Peak	96.30	-1.96	94.34	-	-
2494.34	Average	-	-	20.28	54.00	-33.72
2494.34	Peak	53.14	-2.11	51.03	74.00	-22.97

Average Duty Cycle Factor=-30.75 (dB)

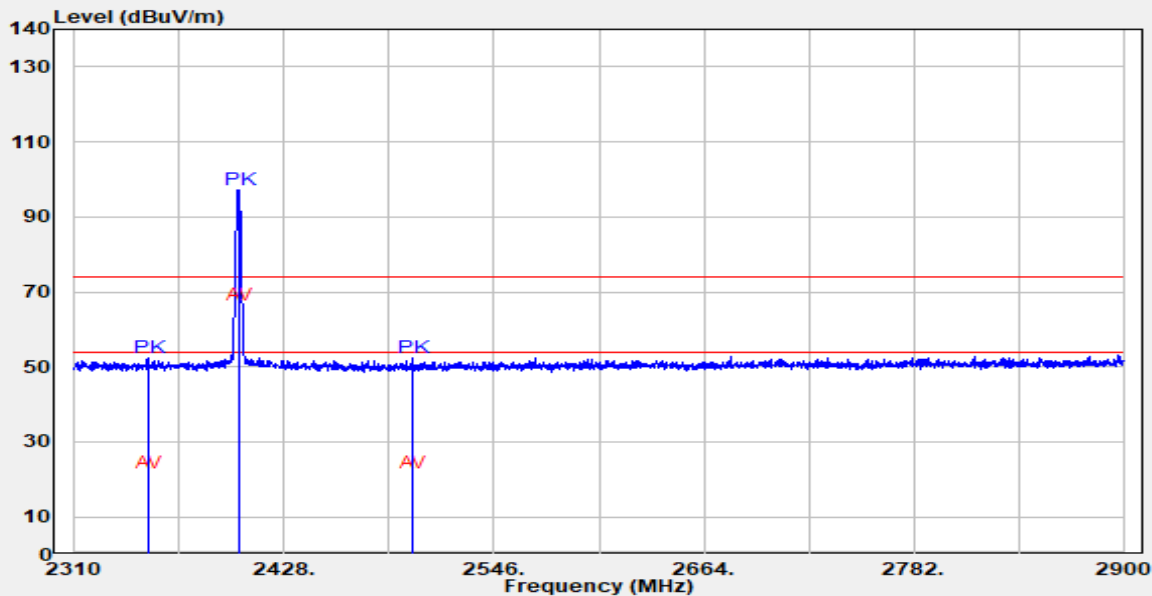
Average Level= Peak Level+ Duty Cycle Factor

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Report Number :TERF2409002876ER
 Operation Mode :EDR 2M
 Test Frequency :2402 MHz
 Test Mode :Bandedge
 EUT Pol :H Plane

Test Site :SAC 1
 Test Date :2024-11-26
 Temp./Humi. :24.8°C/61%
 Antenna Pol. :Horizontal
 Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2351.12	Average	-	-	21.51	54.00	-32.49
2351.12	Peak	54.26	-2.00	52.26	74.00	-21.74
2402.00	Average	-	-	66.34	-	-
2402.00	Peak	99.05	-1.96	97.09	-	-
2500.04	Average	-	-	21.52	54.00	-32.48
2500.04	Peak	54.44	-2.17	52.27	74.00	-21.73

Average Duty Cycle Factor=-30.75 (dB)

Average Level= Peak Level+ Duty Cycle Factor

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台灣檢驗科技股份有限公司

t (886-2) 2299-3279

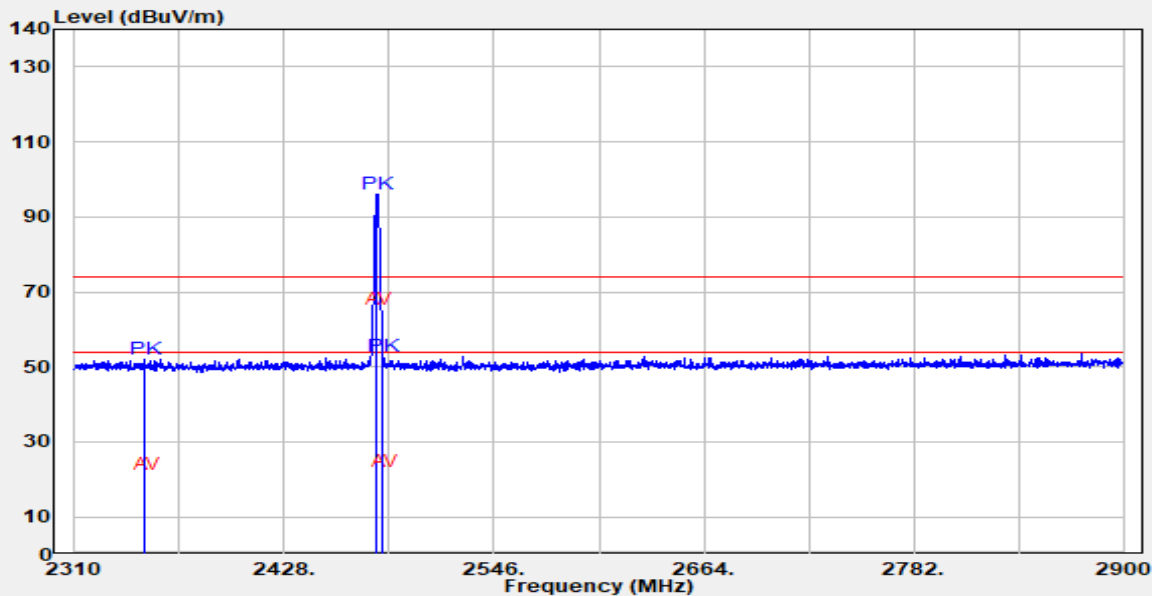
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Report Number :TERF2409002876ER
Operation Mode :EDR 2M
Test Frequency :2480 MHz
Test Mode :Bandedge
EUT Pol :H Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Vertical
Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2349.54	Average	-	-	21.19	54.00	-32.81
2349.54	Peak	53.94	-2.00	51.94	74.00	-22.06
2480.00	Average	-	-	65.37	-	-
2480.00	Peak	98.28	-2.16	96.12	-	-
2483.52	Average	-	-	21.90	54.00	-32.10
2483.52	Peak	54.78	-2.13	52.65	74.00	-21.35

Average Duty Cycle Factor=-30.75 (dB)

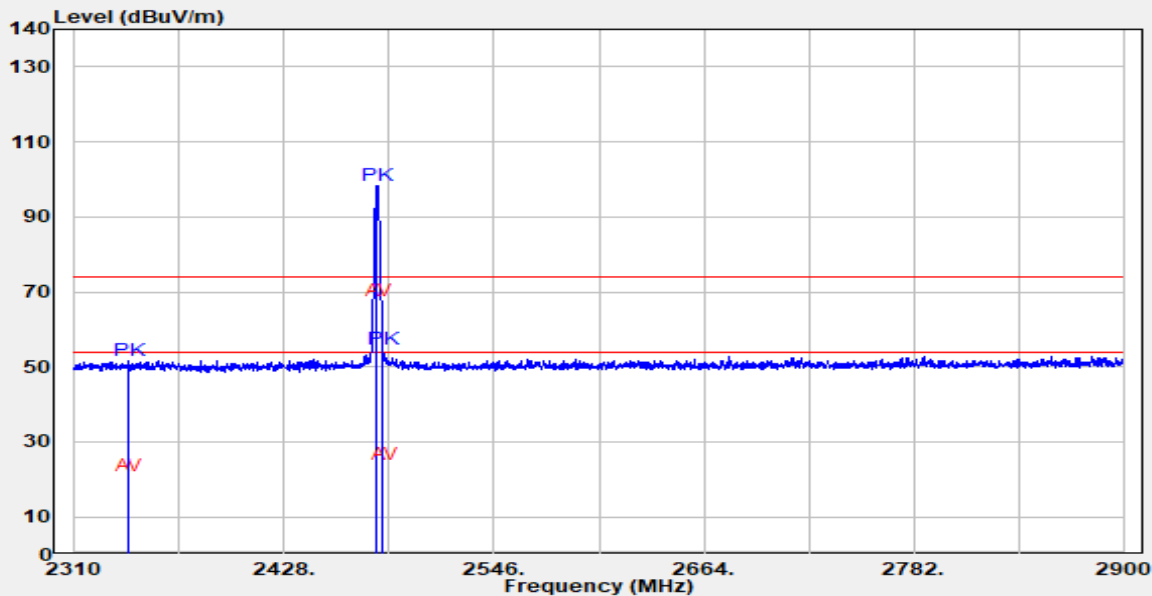
Average Level= Peak Level+ Duty Cycle Factor

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Report Number :TERF2409002876ER
Operation Mode :EDR 2M
Test Frequency :2480 MHz
Test Mode :Bandedge
EUT Pol :H Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Horizontal
Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2340.10	Average	-	-	20.84	54.00	-33.16
2340.10	Peak	53.59	-2.00	51.59	74.00	-22.41
2480.00	Average	-	-	67.42	-	-
2480.00	Peak	100.33	-2.16	98.17	-	-
2483.52	Average	-	-	23.82	54.00	-30.18
2483.52	Peak	56.70	-2.13	54.57	74.00	-19.43

Average Duty Cycle Factor=-30.75 (dB)

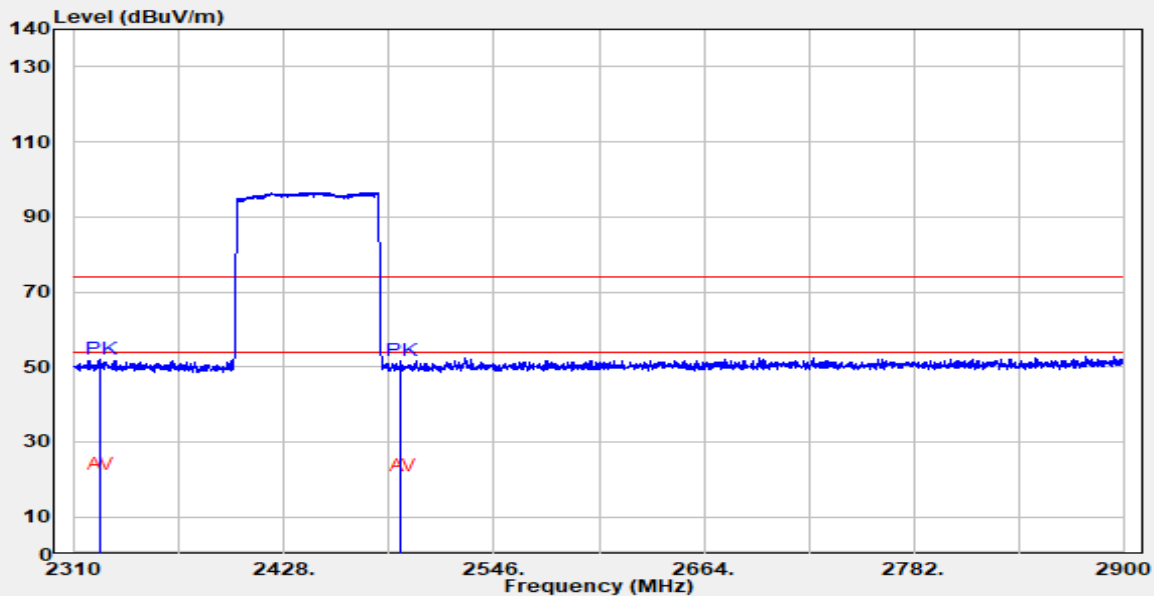
Average Level= Peak Level+ Duty Cycle Factor

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Report Number :TERF2409002876ER
 Operation Mode :BR Hopping
 Test Frequency :2402~2480 MHz
 Test Mode :Bandedge
 EUT Pol :H Plane

Test Site :SAC 1
 Test Date :2024-11-26
 Temp./Humi. :24.8°C/61%
 Antenna Pol. :Vertical
 Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2323.77	Average	-	-	21.30	54.00	-32.70
2323.77	Peak	53.84	-1.79	52.05	74.00	-21.95
2493.55	Average	-	-	20.79	54.00	-33.21
2493.55	Peak	53.65	-2.11	51.54	74.00	-22.46

Average Duty Cycle Factor=-30.75 (dB)

Average Level= Peak Level+ Duty Cycle Factor

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t (886-2) 2299-3279

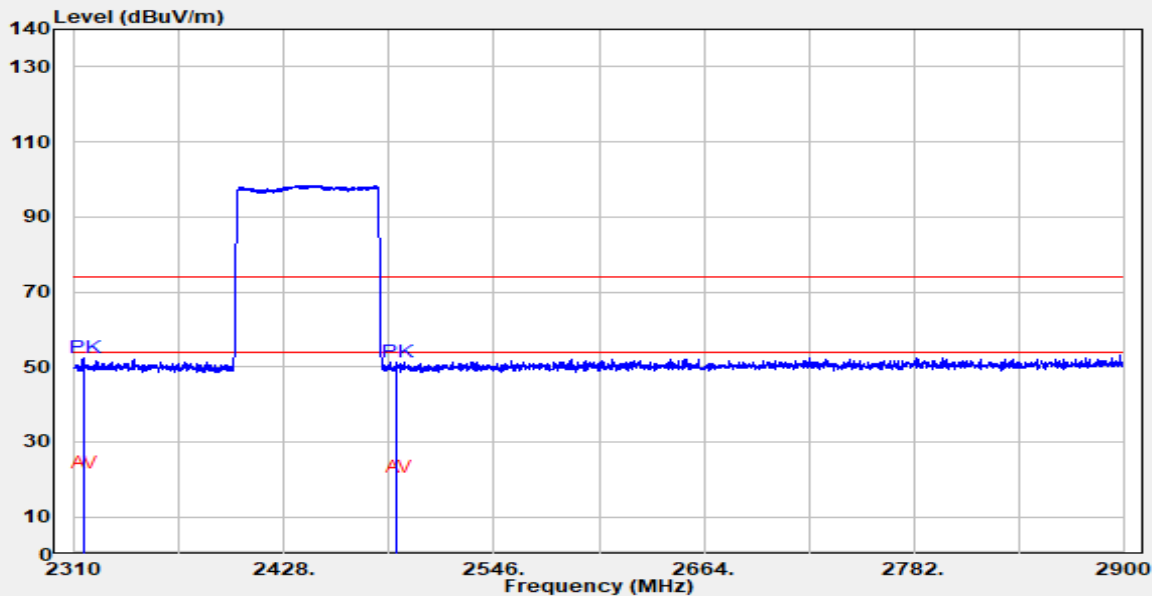
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Report Number :TERF2409002876ER
Operation Mode :BR Hopping
Test Frequency :2402~2480 MHz
Test Mode :Bandedge
EUT Pol :H Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Horizontal
Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2314.72	Average	-	-	21.56	54.00	-32.44
2314.72	Peak	54.09	-1.78	52.31	74.00	-21.69
2491.39	Average	-	-	20.51	54.00	-33.49
2491.39	Peak	53.34	-2.08	51.26	74.00	-22.74

Average Duty Cycle Factor=-30.75 (dB)

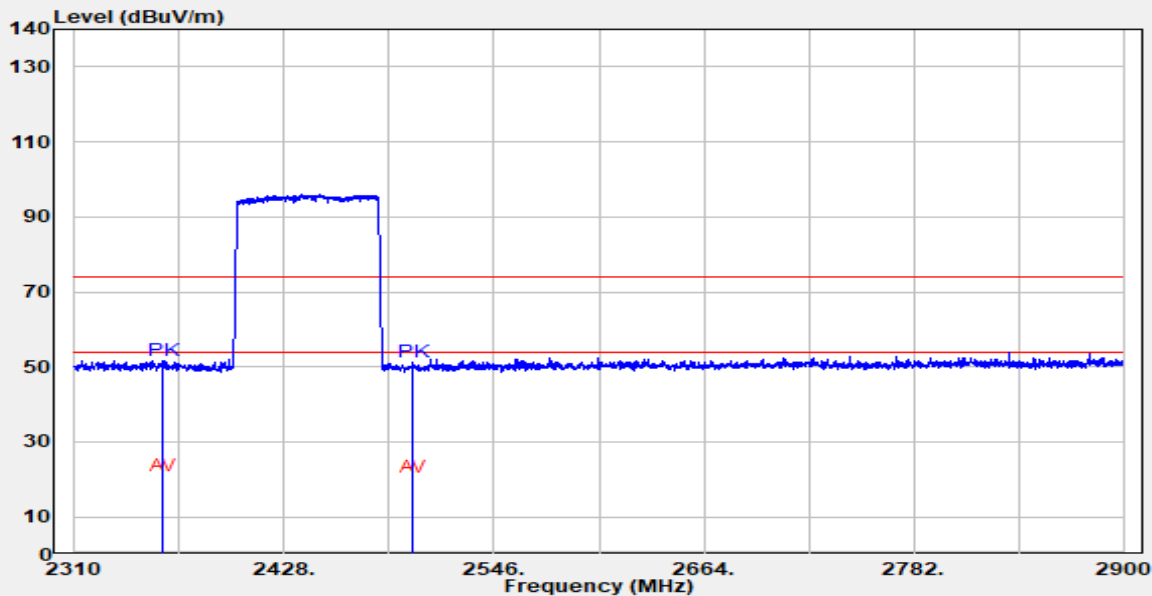
Average Level= Peak Level+ Duty Cycle Factor

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Report Number :TERF2409002876ER
Operation Mode :EDR 2M Hopping
Test Frequency :2402~2480 MHz
Test Mode :Bandedge
EUT Pol :H Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Vertical
Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2359.38	Average	-	-	21.04	54.00	-32.96
2359.38	Peak	53.69	-1.90	51.79	74.00	-22.21
2500.04	Average	-	-	20.37	54.00	-33.63
2500.04	Peak	53.29	-2.17	51.12	74.00	-22.88

Average Duty Cycle Factor=-30.75 (dB)

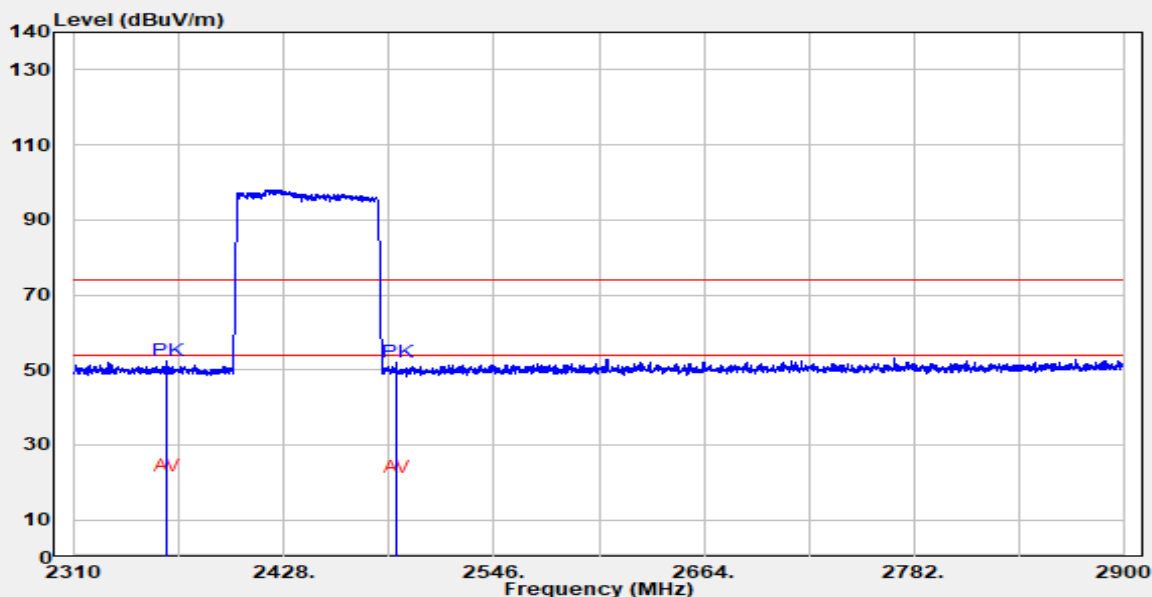
Average Level= Peak Level+ Duty Cycle Factor

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Report Number :TERF2409002876ER
 Operation Mode :EDR 2M Hopping
 Test Frequency :2402~2480 MHz
 Test Mode :Bandedge
 EUT Pol :H Plane

Test Site :SAC 1
 Test Date :2024-11-26
 Temp./Humi. :24.8°C/61%
 Antenna Pol. :Horizontal
 Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
2361.54	Average	-	-	21.55	54.00	-32.45
2361.54	Peak	54.20	-1.90	52.30	74.00	-21.70
2490.80	Average	-	-	21.30	54.00	-32.70
2490.80	Peak	54.13	-2.08	52.05	74.00	-21.95

Average Duty Cycle Factor=-30.75 (dB)

Average Level= Peak Level+ Duty Cycle Factor

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台灣檢驗科技股份有限公司

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f (886-2) 2298-0488

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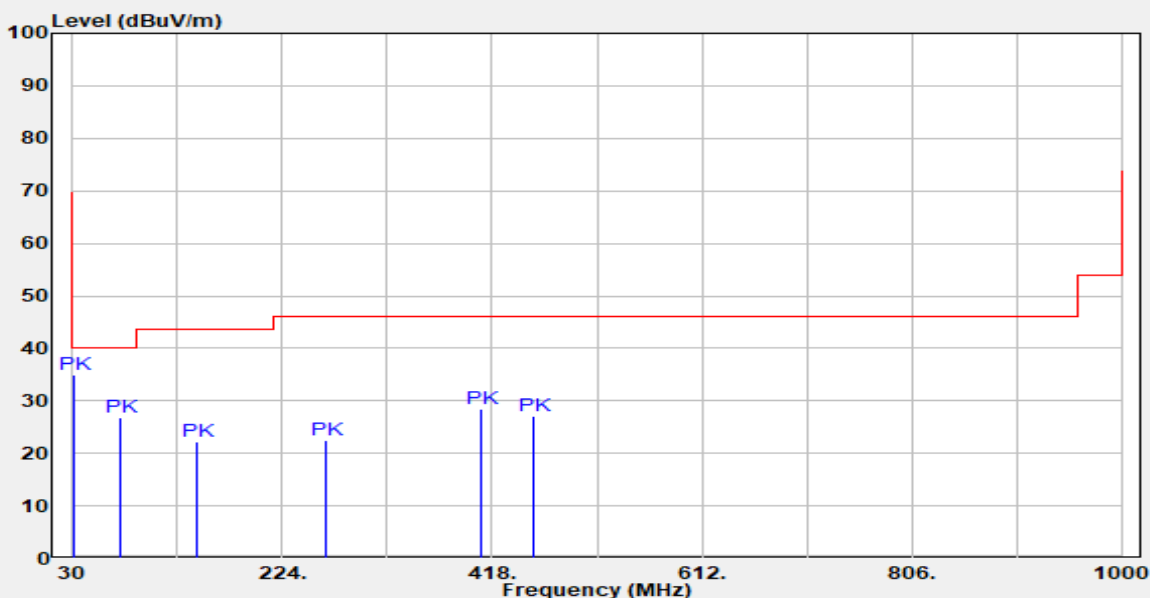
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12.6.4 Radiated Spurious Emission

1st

Report Number :TERF2409002876ER
Operation Mode :EDR 2M
Test Frequency :2441 MHz
Test Mode :Tx
EUT Pol :H Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Vertical
Engineer :WJ Lin



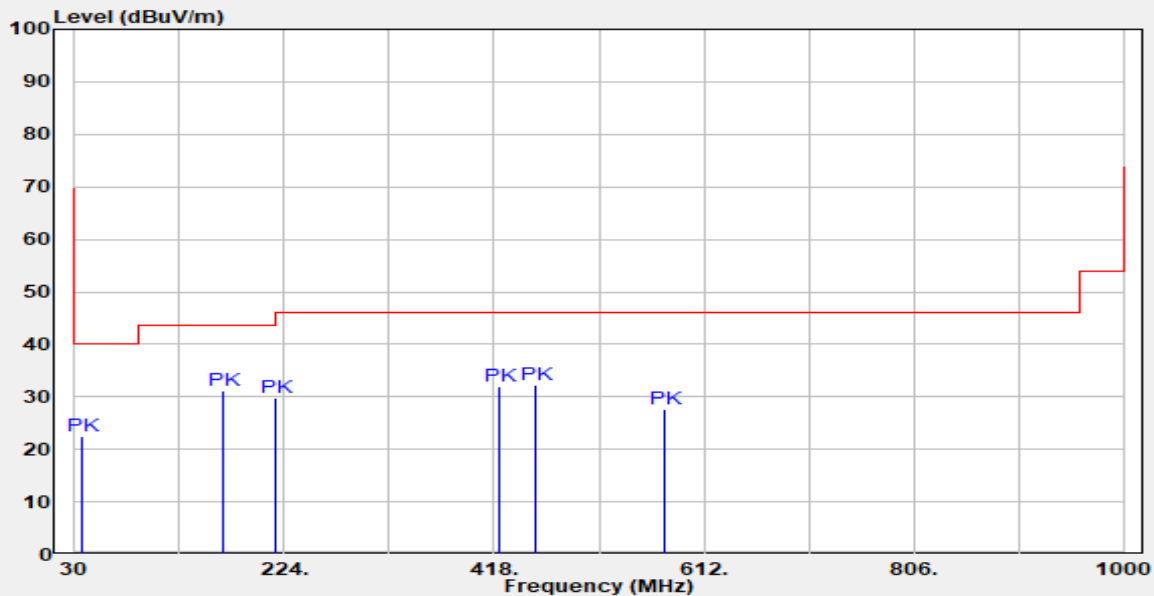
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
31.94	Peak	40.75	-5.66	35.09	40.00	-4.91
74.62	Peak	44.04	-17.29	26.75	40.00	-13.25
144.46	Peak	34.42	-12.10	22.32	43.50	-21.18
263.77	Peak	30.58	-8.22	22.36	46.00	-23.64
408.30	Peak	34.25	-5.81	28.44	46.00	-17.56
455.83	Peak	32.21	-5.21	27.00	46.00	-19.00

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Report Number :TERF2409002876ER
Operation Mode :EDR 2M
Test Frequency :2441 MHz
Test Mode :Tx
EUT Pol :H Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Horizontal
Engineer :WJ Lin



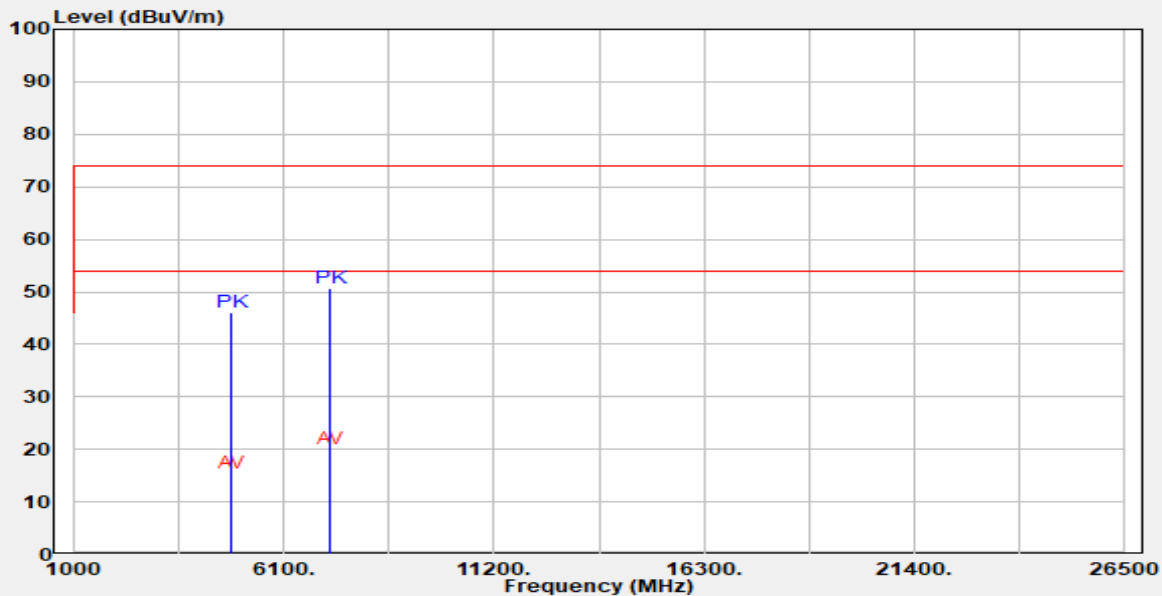
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
36.79	Peak	30.80	-8.27	22.53	40.00	-17.47
167.74	Peak	44.45	-13.25	31.20	43.50	-12.30
216.24	Peak	42.96	-13.23	29.73	46.00	-16.27
421.88	Peak	37.40	-5.37	32.03	46.00	-13.97
455.83	Peak	37.40	-5.21	32.19	46.00	-13.81
576.11	Peak	30.85	-3.09	27.76	46.00	-18.24

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Report Number :TERF2409002876ER
Operation Mode :BR
Test Frequency :2402 MHz
Test Mode :Tx
EUT Pol :E2 Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Vertical
Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBUV	Factor dB	Actual FS dBUV/m	Limit @3m dBUV/m	Margin dB
4804.00	Average	-	-	15.42	54.00	-38.58
4804.00	Peak	43.67	2.50	46.17	74.00	-27.83
7206.00	Average	-	-	20.01	54.00	-33.99
7206.00	Peak	42.01	8.75	50.76	74.00	-23.24

Average Duty Cycle Factor=-30.75 (dB)

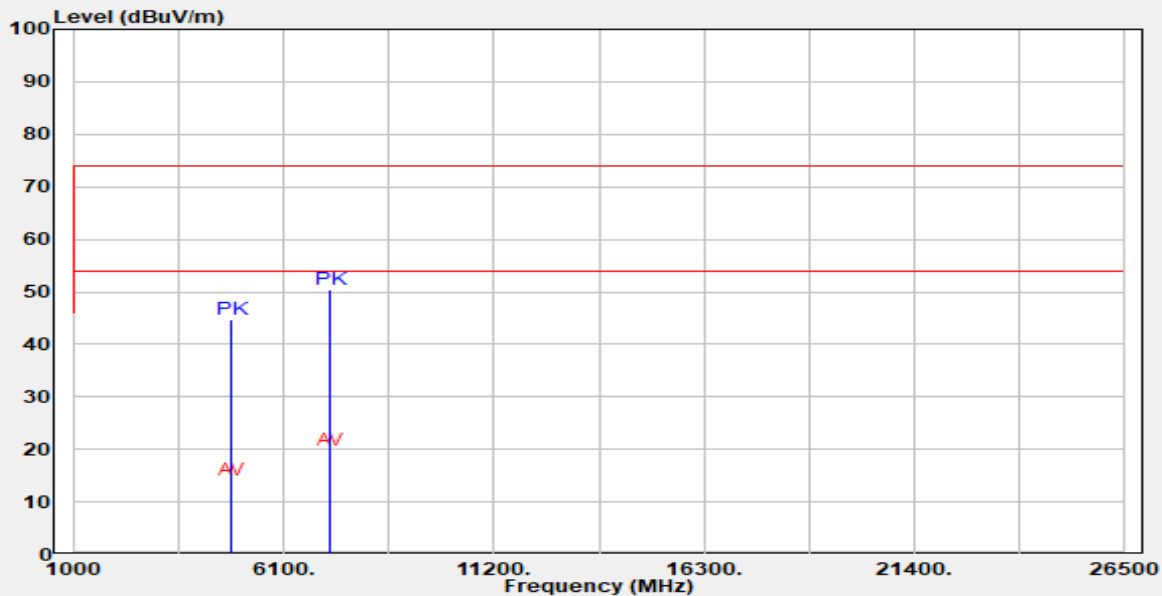
Average Level= Peak Level+ Duty Cycle Factor

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Report Number :TERF2409002876ER
Operation Mode :BR
Test Frequency :2402 MHz
Test Mode :Tx
EUT Pol :E2 Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Horizontal
Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBUV	Factor dB	Actual FS dBUV/m	Limit @3m dBUV/m	Margin dB
4804.00	Average	-	-	14.08	54.00	-39.92
4804.00	Peak	42.33	2.50	44.83	74.00	-29.17
7206.00	Average	-	-	19.65	54.00	-34.35
7206.00	Peak	41.65	8.75	50.40	74.00	-23.60

Average Duty Cycle Factor=-30.75 (dB)

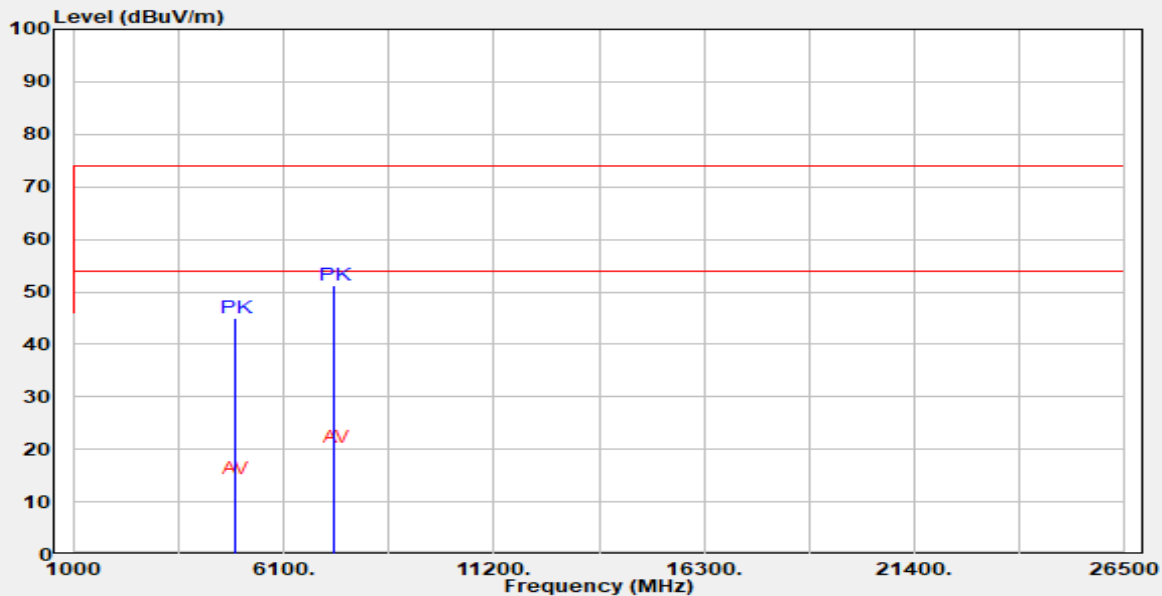
Average Level= Peak Level+ Duty Cycle Factor

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Report Number :TERF2409002876ER
Operation Mode :BR
Test Frequency :2441 MHz
Test Mode :Tx
EUT Pol :E2 Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Vertical
Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
4882.00	Average	-	-	14.28	54.00	-39.72
4882.00	Peak	42.34	2.69	45.03	74.00	-28.97
7323.00	Average	-	-	20.43	54.00	-33.57
7323.00	Peak	42.23	8.95	51.18	74.00	-22.82

Average Duty Cycle Factor=-30.75 (dB)

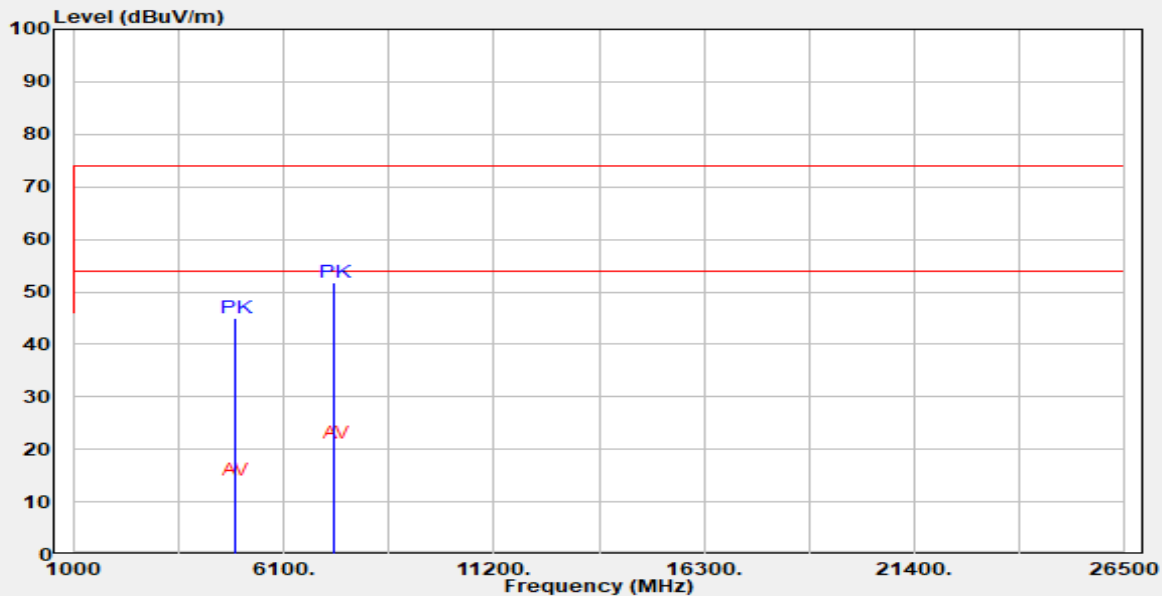
Average Level= Peak Level+ Duty Cycle Factor

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Report Number :TERF2409002876ER
Operation Mode :BR
Test Frequency :2441 MHz
Test Mode :Tx
EUT Pol :E2 Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Horizontal
Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
4882.00	Average	-	-	14.12	54.00	-39.88
4882.00	Peak	42.18	2.69	44.87	74.00	-29.13
7323.00	Average	-	-	21.11	54.00	-32.89
7323.00	Peak	42.91	8.95	51.86	74.00	-22.14

Average Duty Cycle Factor=-30.75 (dB)

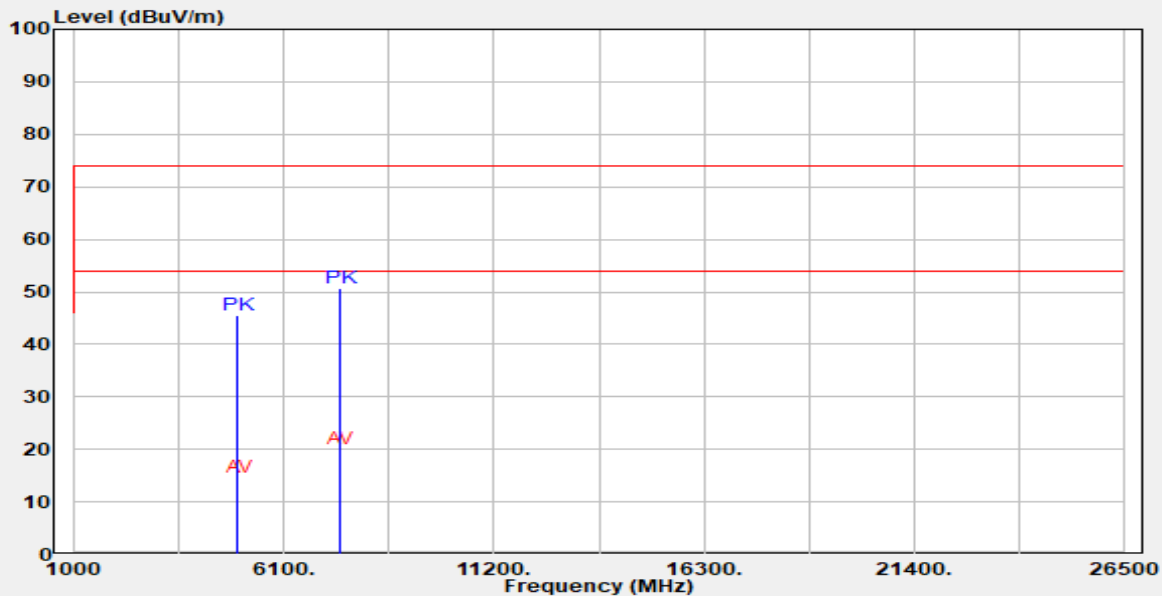
Average Level= Peak Level+ Duty Cycle Factor

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Report Number :TERF2409002876ER
Operation Mode :BR
Test Frequency :2480 MHz
Test Mode :Tx
EUT Pol :E2 Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Vertical
Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
4960.00	Average	-	-	14.65	54.00	-39.35
4960.00	Peak	42.47	2.93	45.40	74.00	-28.60
7440.00	Average	-	-	20.03	54.00	-33.97
7440.00	Peak	41.96	8.82	50.78	74.00	-23.22

Average Duty Cycle Factor=-30.75 (dB)

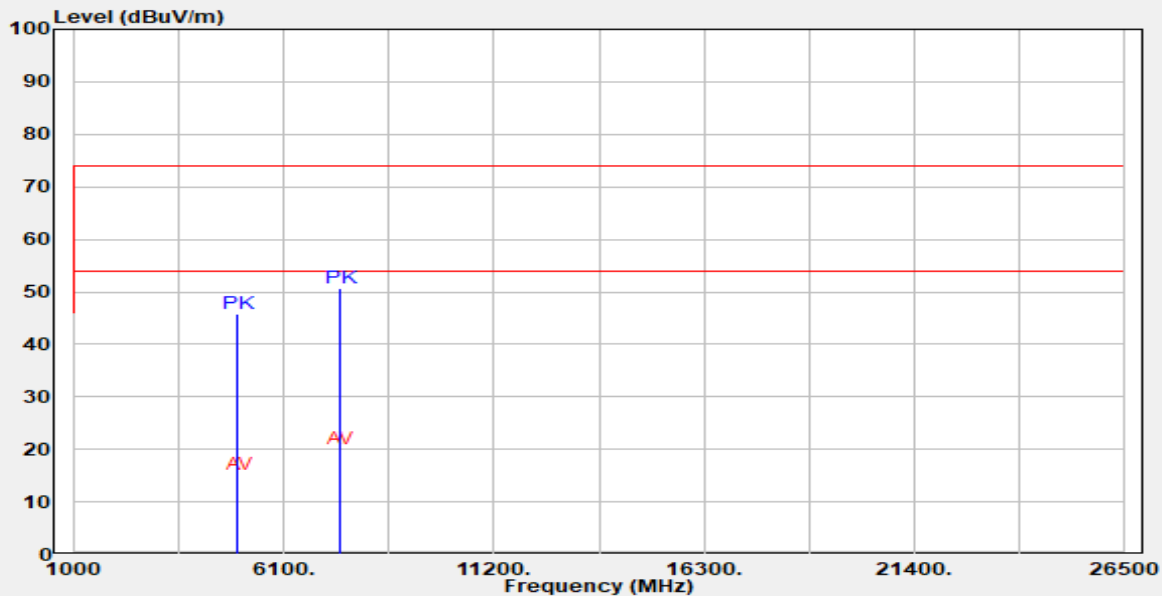
Average Level= Peak Level+ Duty Cycle Factor

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Report Number :TERF2409002876ER
 Operation Mode :BR
 Test Frequency :2480 MHz
 Test Mode :Tx
 EUT Pol :E2 Plane

Test Site :SAC 1
 Test Date :2024-11-26
 Temp./Humi. :24.8°C/61%
 Antenna Pol. :Horizontal
 Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
4960.00	Average	-	-	15.05	54.00	-38.95
4960.00	Peak	42.87	2.93	45.80	74.00	-28.20
7440.00	Average	-	-	20.01	54.00	-33.99
7440.00	Peak	41.94	8.82	50.76	74.00	-23.24

Average Duty Cycle Factor=-30.75 (dB)

Average Level= Peak Level+ Duty Cycle Factor

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SGS Taiwan Ltd.

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台灣檢驗科技股份有限公司

t (886-2) 2299-3279

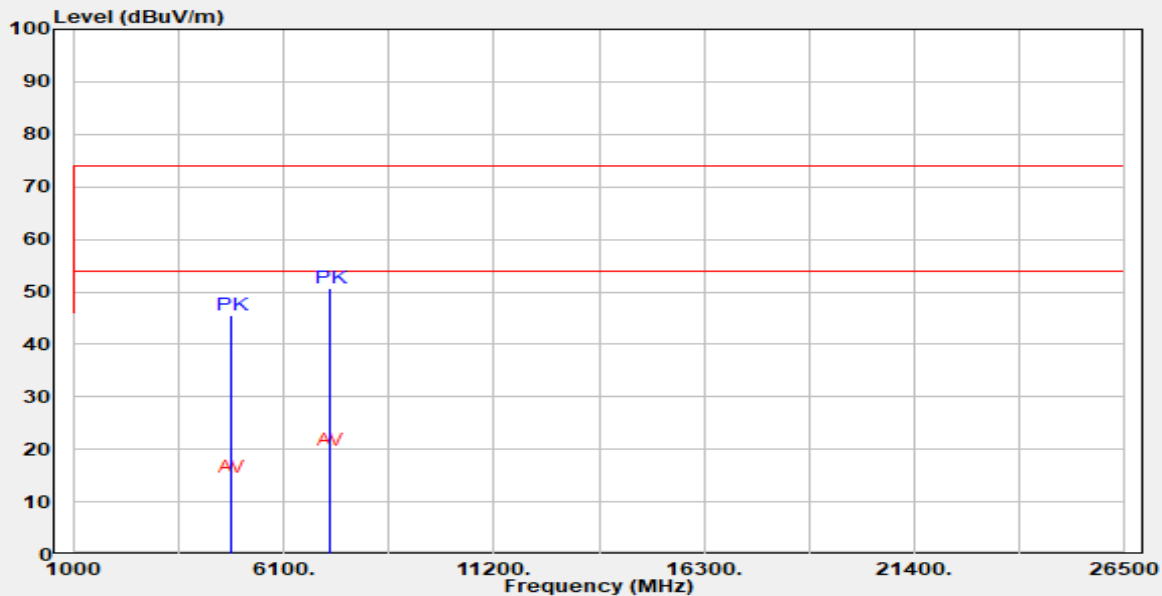
f (886-2) 2298-0488

www.sgs.com.tw

Member of SGS Group

Report Number :TERF2409002876ER
Operation Mode :EDR 2M
Test Frequency :2402 MHz
Test Mode :Tx
EUT Pol :H Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Vertical
Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
4804.00	Average	-	-	14.67	54.00	-39.33
4804.00	Peak	42.92	2.50	45.42	74.00	-28.58
7206.00	Average	-	-	19.85	54.00	-34.15
7206.00	Peak	41.85	8.75	50.60	74.00	-23.40

Average Duty Cycle Factor=-30.75 (dB)

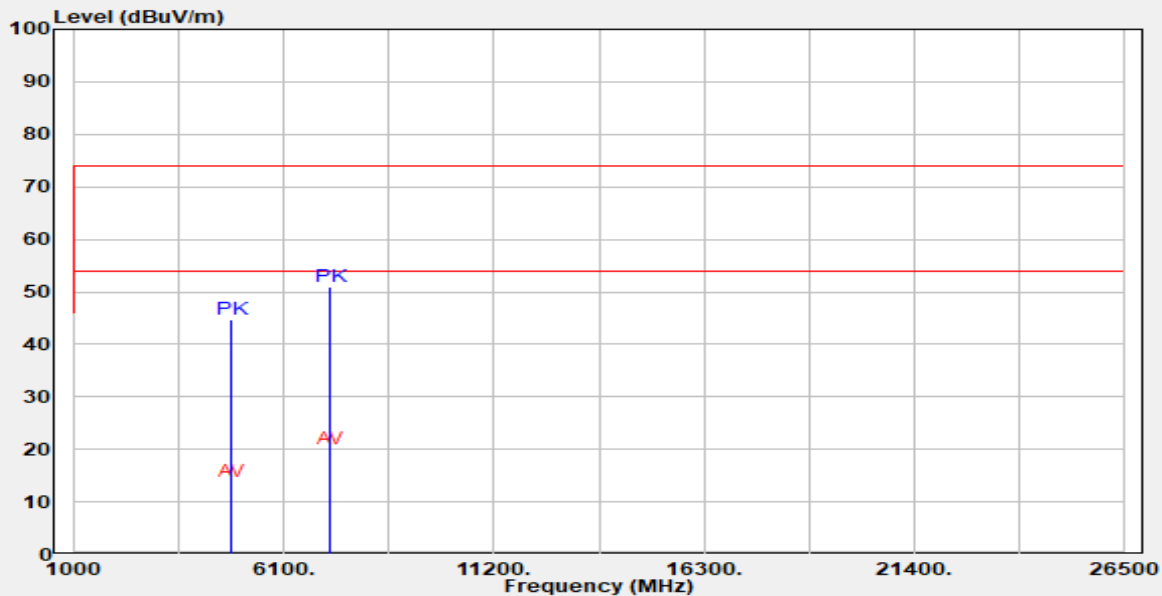
Average Level= Peak Level+ Duty Cycle Factor

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Report Number :TERF2409002876ER
Operation Mode :EDR 2M
Test Frequency :2402 MHz
Test Mode :Tx
EUT Pol :H Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Horizontal
Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
4804.00	Average	-	-	13.95	54.00	-40.05
4804.00	Peak	42.20	2.50	44.70	74.00	-29.30
7206.00	Average	-	-	20.13	54.00	-33.87
7206.00	Peak	42.13	8.75	50.88	74.00	-23.12

Average Duty Cycle Factor=-30.75 (dB)

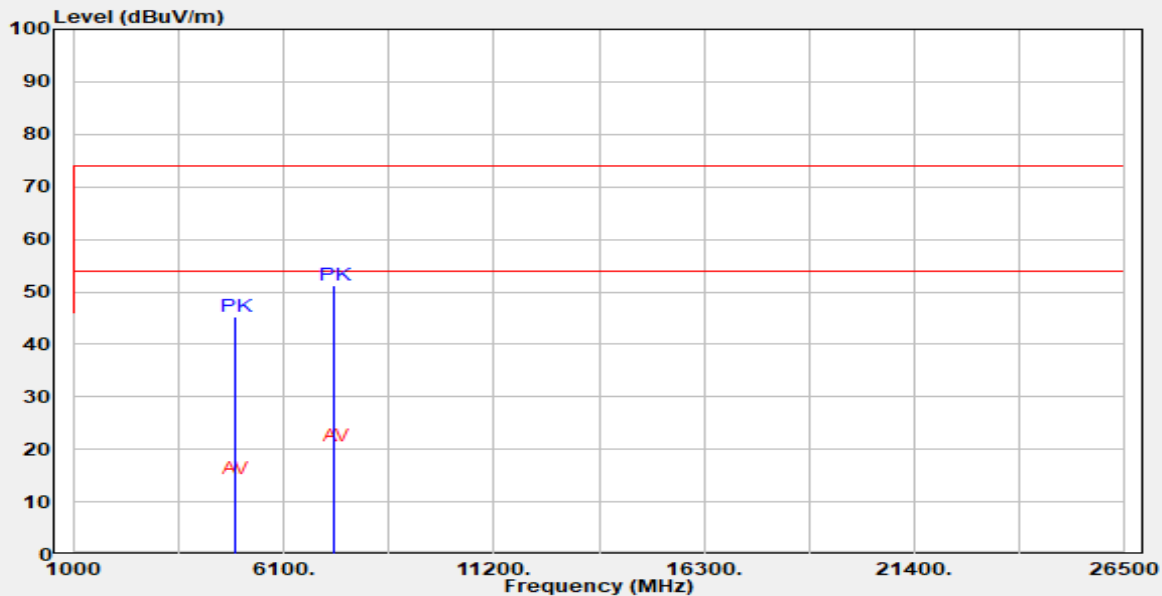
Average Level= Peak Level+ Duty Cycle Factor

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Report Number :TERF2409002876ER
Operation Mode :EDR 2M
Test Frequency :2441 MHz
Test Mode :Tx
EUT Pol :H Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Vertical
Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBUV	Factor dB	Actual FS dBUV/m	Limit @3m dBUV/m	Margin dB
4882.00	Average	-	-	14.48	54.00	-39.52
4882.00	Peak	42.54	2.69	45.23	74.00	-28.77
7323.00	Average	-	-	20.58	54.00	-33.42
7323.00	Peak	42.38	8.95	51.33	74.00	-22.67

Average Duty Cycle Factor=-30.75 (dB)

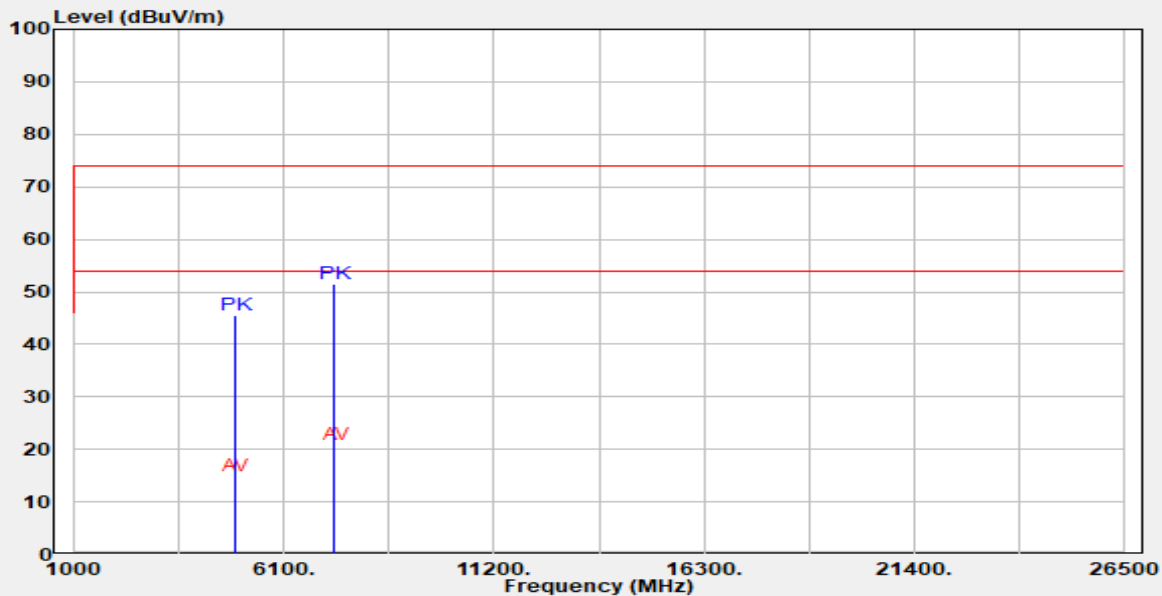
Average Level= Peak Level+ Duty Cycle Factor

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Report Number :TERF2409002876ER
Operation Mode :EDR 2M
Test Frequency :2441 MHz
Test Mode :Tx
EUT Pol :H Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Horizontal
Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
4882.00	Average	-	-	14.84	54.00	-39.16
4882.00	Peak	42.90	2.69	45.59	74.00	-28.41
7323.00	Average	-	-	20.75	54.00	-33.25
7323.00	Peak	42.55	8.95	51.50	74.00	-22.50

Average Duty Cycle Factor=-30.75 (dB)

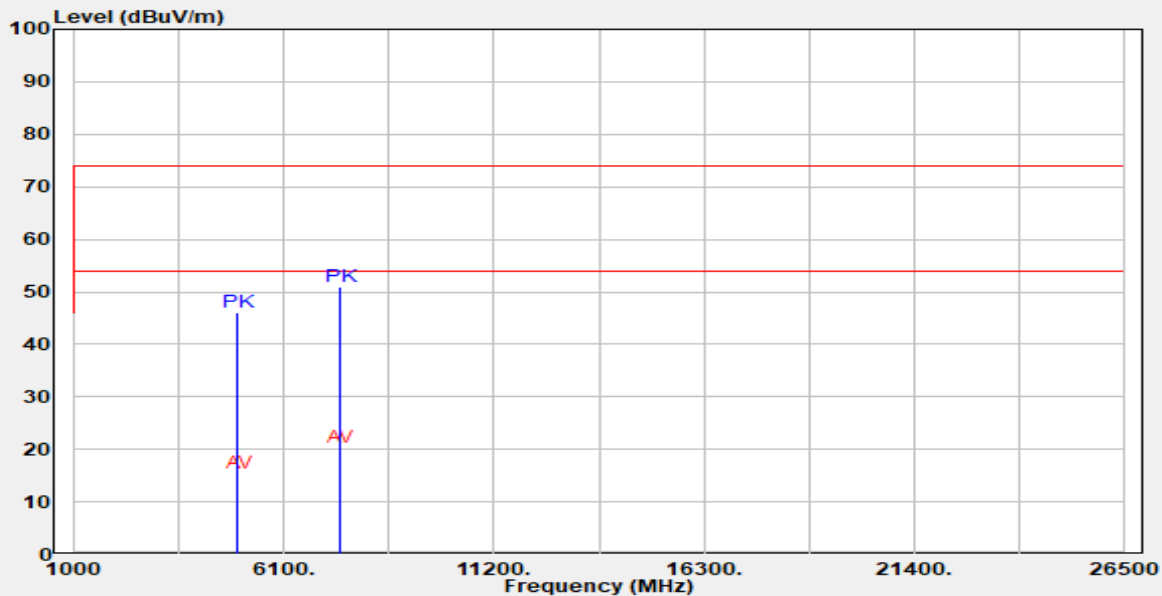
Average Level= Peak Level+ Duty Cycle Factor

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Report Number :TERF2409002876ER
Operation Mode :EDR 2M
Test Frequency :2480 MHz
Test Mode :Tx
EUT Pol :H Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Vertical
Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
4960.00	Average	-	-	15.37	54.00	-38.63
4960.00	Peak	43.19	2.93	46.12	74.00	-27.88
7440.00	Average	-	-	20.21	54.00	-33.79
7440.00	Peak	42.14	8.82	50.96	74.00	-23.04

Average Duty Cycle Factor=-30.75 (dB)

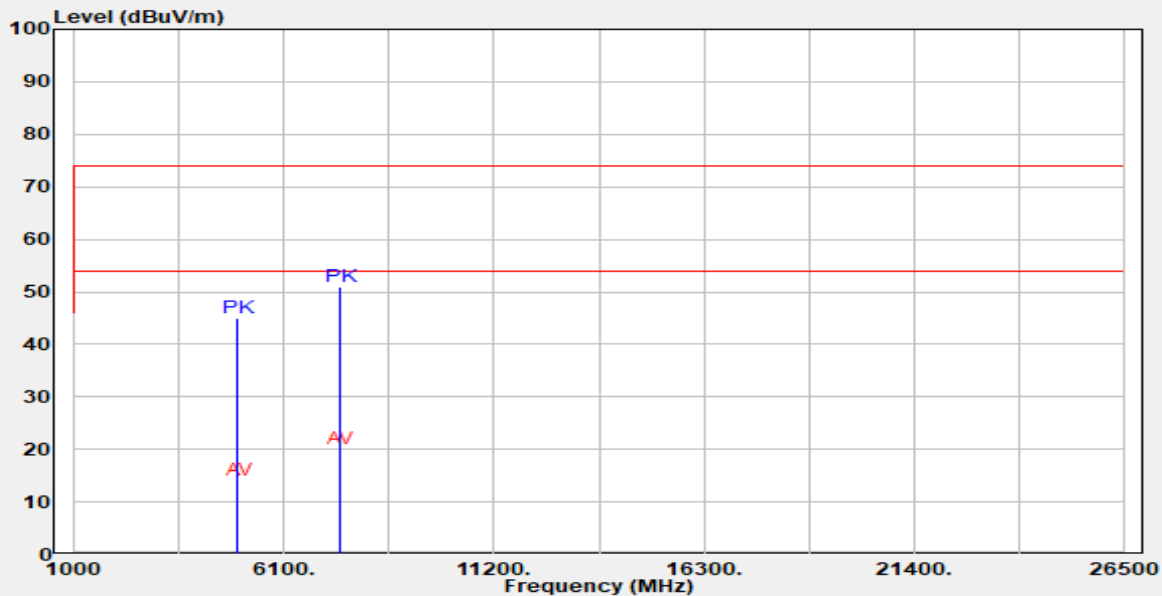
Average Level= Peak Level+ Duty Cycle Factor

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Report Number :TERF2409002876ER
Operation Mode :EDR 2M
Test Frequency :2480 MHz
Test Mode :Tx
EUT Pol :H Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Horizontal
Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
4960.00	Average	-	-	14.22	54.00	-39.78
4960.00	Peak	42.04	2.93	44.97	74.00	-29.03
7440.00	Average	-	-	20.14	54.00	-33.86
7440.00	Peak	42.07	8.82	50.89	74.00	-23.11

Average Duty Cycle Factor=-30.75 (dB)

Average Level= Peak Level+ Duty Cycle Factor

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t (886-2) 2299-3279

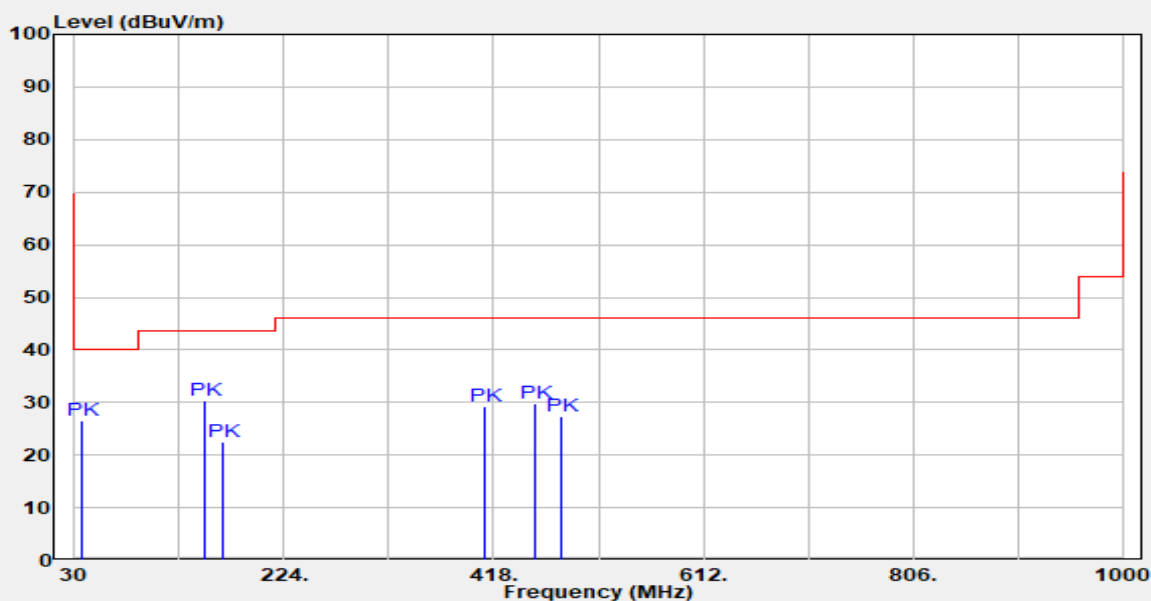
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Report Number :TERF2409002876ER
Operation Mode :EDR 2M
Test Frequency :2441 MHz
Test Mode :Tx
EUT Pol :H Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Vertical
Engineer :WJ Lin



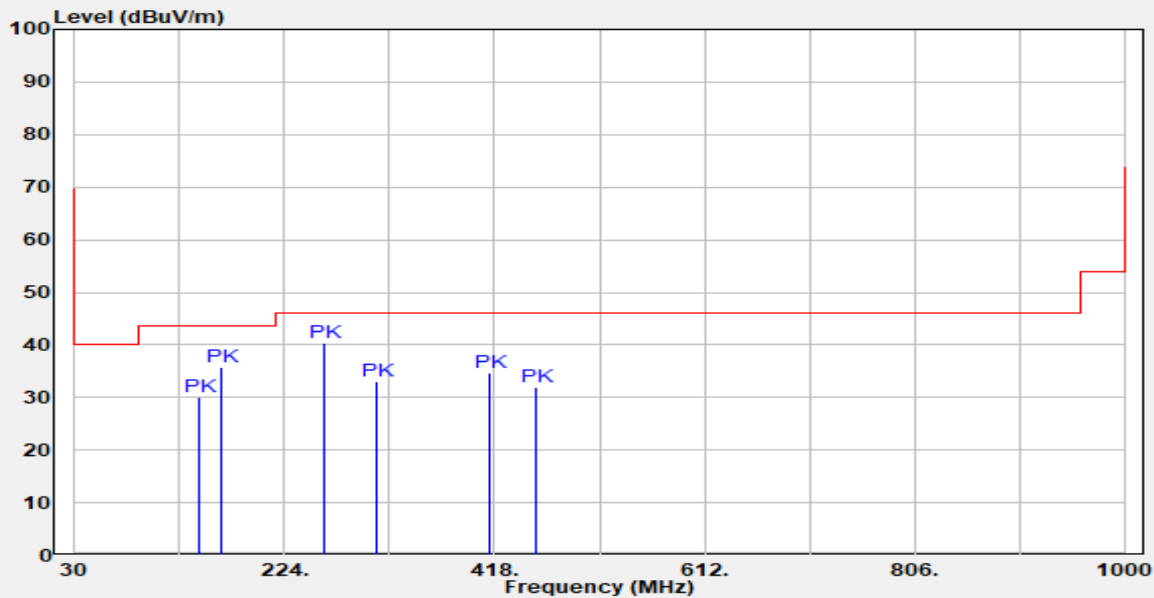
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
36.790	Peak	34.79	-8.27	26.53	40.00	-13.47
151.250	Peak	42.95	-12.64	30.32	43.50	-13.18
167.740	Peak	35.83	-13.26	22.57	43.50	-20.93
409.270	Peak	34.97	-5.77	29.20	46.00	-16.80
455.830	Peak	35.03	-5.21	29.82	46.00	-16.18
480.080	Peak	32.32	-4.83	27.49	46.00	-18.51

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Test Frequency :2441 MHz
Test Mode :Tx
EUT Pol :H Plane

Test Site :SAC 1
Test Date :2024-11-26
Temp./Humi. :24.8°C/61%
Antenna Pol. :Horizontal
Engineer :WJ Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
144.460	Peak	42.13	-12.11	30.02	43.50	-13.48
164.830	Peak	48.86	-13.18	35.69	43.50	-7.81
260.860	Peak	48.29	-8.01	40.27	46.00	-5.73
308.390	Peak	41.56	-8.40	33.17	46.00	-12.83
413.150	Peak	40.31	-5.56	34.75	46.00	-11.25
455.830	Peak	37.18	-5.21	31.97	46.00	-14.03

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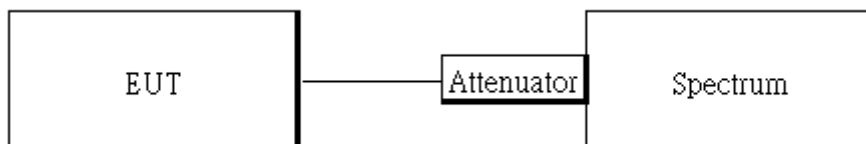
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13 NUMBER OF HOPPING FREQUENCY

13.1 Standard Applicable

Frequency hopping systems operating in the 2400MHz-2483.5 MHz bands shall use at least 15 hopping frequencies.

13.2 Test Setup



13.3 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2013.
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 spectrum analyzer Start=2400MHz, Stop = 2483.5MHz, Sweep = auto.
5. Set the spectrum analyzer as RBW = 30% of the channel spacing, VBW \geq RBW., Detector = Peak
6. Max hold, view and count how many channel in the band.

13.4 Measurement Result

Tabular Data of Total Channel Number

	<i>Channel Number</i>	Limit
2.4 GHz – 2.441 GHz	40	>15
2.441 GHz – 2.4835 GHz	39	
2.4 GHz ~2.4835 GHz	(40+39) = 79	

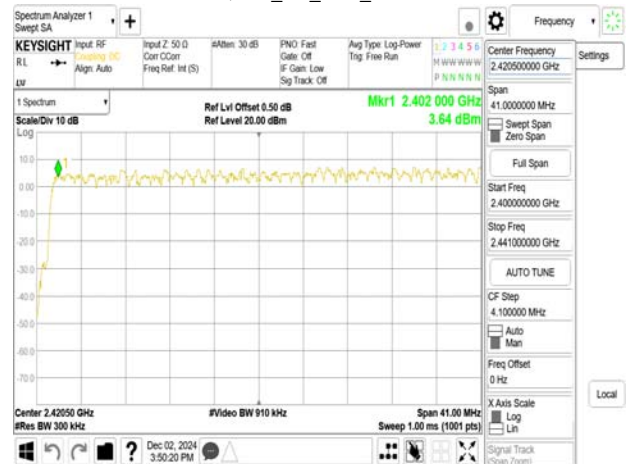
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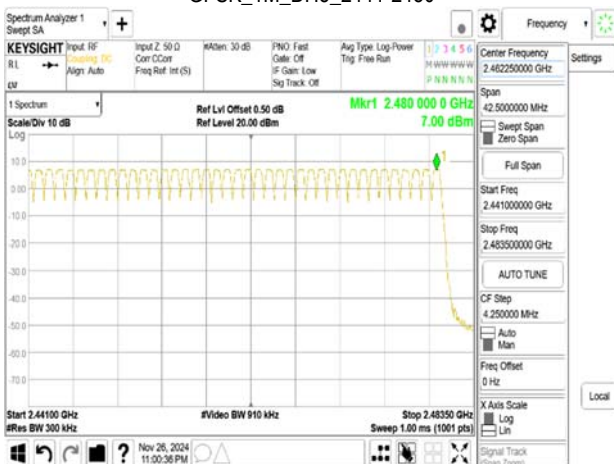
GFSK_1M_DH5_2400-2441



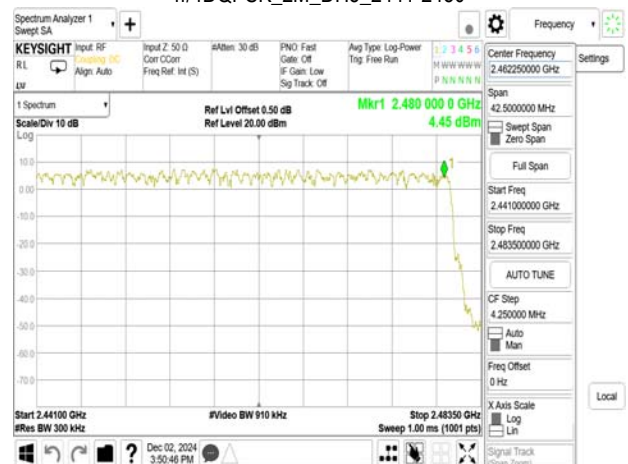
$\pi/4$ DQPSK_2M_DH5_2400-2441



GFSK_1M_DH5_2441-2480



$\pi/4$ DQPSK_2M_DH5_2441-2480



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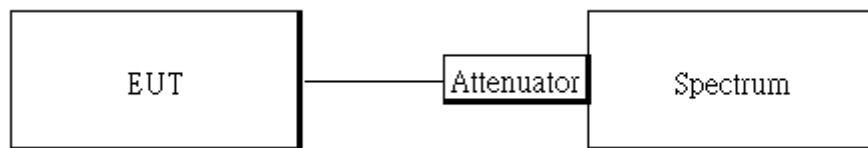
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14 TIME OF OCCUPANCY (DWELL TIME)

14.1 Standard Applicable

Frequency hopping systems operating in the 2400MHz-2483.5MHz. The average time of occupancy on any frequency shall not greater than 0.4 s within period of 0.4 seconds multiplied by the number of hopping channel employed.

14.2 Test Setup



14.3 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2013.
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 center frequency of spectrum analyzer = operating frequency.
5. Set the spectrum analyzer as RBW, VBW=1MHz, 3MHz, Span = 0Hz, Detector = Peak, Adjust Sweep = 2~8ms.
6. Repeat above procedures until all frequency of the interest measured were complete.

Formula Deduced: time occupancy of one time slot X Hopping rate / total slot in one channel / total channel that hops X period of working channels.

Where, standard hopping rate is 1600 hops/s, slot in one channel for DH1, DH3, and DH5 is 2, 4, and 6, respectively.

DH1 consists of single time slot of the uplink, and one slot of the downlink Total Slot: 2

DH3 consists of three time slot of the uplink, and one slot of the downlink. Total Slot: 4

DH5 consists of five time slot of the uplink, and one slot of the downlink. Total Slot: 6

Note: the result of the complete test default channel at 1Mbps is recorded on the test report, 2Mbps, and 3Mbps only records the measurement result at middle channel that reveals no much deviation.

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f (886-2) 2298-0488

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14.4 Measurement Result

GFSK (1Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)
39	DH1	123.20	400
	DH3	262.40	400
	DH5	307.20	400

$\pi/4$ DQPSK (2Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)
39	2DH1	124.80	400
	2DH3	264.00	400
	2DH5	308.80	400

8-DPSK (3Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)
39	3DH1	124.80	400
	3DH3	262.40	400
	3DH5	308.80	400

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GFSK (1Mbps):

CH Mid	DH1 time slot	=	0.385	*	(1600/2/79)	*	31.6	=	123.20 (ms)
	DH3 time slot	=	1.640	*	(1600/4/79)	*	31.6	=	262.40 (ms)
	DH5 time slot	=	2.880	*	(1600/6/79)	*	31.6	=	307.20 (ms)

$\pi/4$ -DQPSK (2Mbps):

CH Mid	2DH1 time slot	=	0.390	*	(1600/2/79)	*	31.6	=	124.80 (ms)
	2DH3 time slot	=	1.650	*	(1600/4/79)	*	31.6	=	264.00 (ms)
	2DH5 time slot	=	2.895	*	(1600/6/79)	*	31.6	=	308.80 (ms)

8-DPSK (3Mbps):

CH Mid	3DH1 time slot	=	0.390	*	(1600/2/79)	*	31.6	=	124.80 (ms)
	3DH3 time slot	=	1.640	*	(1600/4/79)	*	31.6	=	262.40 (ms)
	3DH5 time slot	=	2.895	*	(1600/6/79)	*	31.6	=	308.80 (ms)

A period time = 0.4 (s) * 79 = 31.6 (s)

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Dwell Time_GFSK_1M_DH1_2441MHz



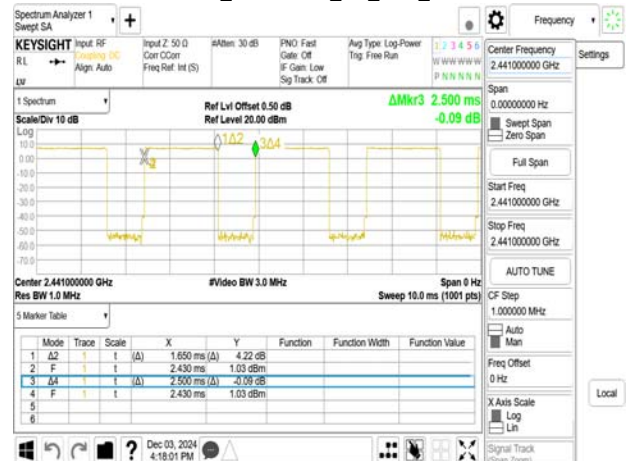
Dwell Time_π/4DQPSK_2M_DH1_2441MHz



Dwell Time_GFSK_1M_DH3_2441MHz



Dwell Time_π/4DQPSK_2M_DH3_2441MHz



Dwell Time_GFSK_1M_DH5_2441MHz



Dwell Time_π/4DQPSK_2M_DH5_2441MHz



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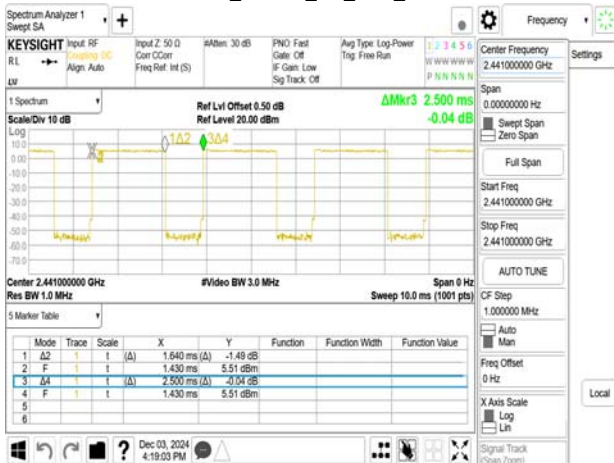
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Dwell Time_8DPSK_3M_DH1_2441MHz



Dwell Time_8DPSK_3M_DH3_2441MHz



Dwell Time_8DPSK_3M_DH5_2441MHz



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f (886-2) 2298-0488

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15 ANTENNA REQUIREMENT

15.1 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.

15.2 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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SGS Taiwan Ltd.

No.134,Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan/新北市五股區新北產業園區五工路 134 號

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

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