

ELECTROMAGNETIC EMISSIONS **COMPLIANCE REPORT**



Applicant:	Qualcomm Technologies, Inc. 5775 Morehouse Drive, San Diego, CA 92121-1714, United States
Manufacturer:	Qualcomm Technologies, Inc. 5775 Morehouse Drive, San Diego, CA 92121-1714, United States
Product Name:	Tri-Radio LGA Module for IoT applications
Brand Name:	Qualcomm
Model No.:	QCC744M-0
Report Number:	TERF2411003344E2
FCC ID	J9C-QCC744M0
Date of EUT Received:	Nov. 06, 2024
Date of Test:	Nov. 07, 2024~Nov. 29, 2024
Issue Date:	Dec. 13, 2024

by the

Approved By

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 C63.10:2020 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 I								
TERF2411003344E2	00	Original	Dec. 09, 2024	Yami Kuo				
TERF2411003344E2	01	Revise address	Dec. 13, 2024	Yami Kuo	*			

Note:

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

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GENERAL INFORMATION 1

1.1 **Product Description**

Product Name:	Tri-Radio LGA Module for IoT applications
Brand Name:	Qualcomm
Model No.:	QCC744M-0
HW SKU:	QCC744M-0U, QCC744M-0B, QCC748M-0U, QCC748M-0B
Hardware Version:	N/A
Firmware Version:	N/A
EUT Series No.:	03B221949800GL
Power Supply:	3.3Vdc
Test Software (Name/Version)	QConn RCT 1.8.9

1.2 **RF** Specification

-	
Radio Technology:	BT BR+EDR
Channel number:	79 channels
Modulation type:	GFSK + π/4DQPSK + 8DPSK
Transmit Power:	12.65 dBm
Frequency Range:	2.402GHz – 2.480GHz
Dwell Time:	\leq 0.4s

HW SKU Difference Table: 1.3

HW SKU	Antenna Type	Impedance	Chip design
QCC744M-0U	3 types: PIFA, Monopole, Dipole	C21=1.86pF,	Does not support USB
		C20=1.89pF	pinout
QCC744M-0B	1 type: PCB	C21=1.52pF,	Does not support USB
	т туре. РСБ	C20=2.05pF	pinout
QCC748M-0U	2 types: DIEA Menopole Dipole	C21=1.86pF,	Support LICP pipout
	3 types: PIFA, Monopole, Dipole	C20=1.89pF	Support USB pinout
			Support LISP pipout
QCC748M-0B	1 type: PCB	C20=2.05pF	Support USB pinout

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1.4 Antenna Designation

Antenna Type	Antenna Model No.	Freq. (MHz)	Peak Antenna Gain (dBi)
PCB Antenna	RFIQM0744010NB001		2.52
PIFA Antenna	RFPCA441010EMABY01	2.4GHz	3.19
Dipole Antenna	RFPCA521010EMABY01	2.4002	3.37
Monopole Antenna	RFPCA501010EMABY01		3.12

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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Test Methodology of Applied Standards 1.5

FCC Part 15, Subpart C §15.247 FCC KDB 558074 D01 15.247 Meas. Guidance v05r02 ANSI C63.10:2020

Test Facility 1.6

Laboratory	Test Site Address	Test Site Name	FCC Designa- tion number	IC CAB identifier
		SAC 1		
		SAC 2		
		SAC 3		
	No. 404 Markers Deed Now Tringi	Conduction 1		
	No.134, Wu Kung Road, New Taipei	Conducted 1	T\0007	
	Industrial Park, Wuku District, New	Conducted 2	TW0027	TW3702
	Taipei City, Taiwan.	Conducted 3	- - - -	
		Conducted 4		
		Conducted 5		
SGS Taiwan Ltd.		Conducted 6		
Central RF Lab.		Conduction C		
(TAF code 3702)		SAC C	TW0028	
		SAC D		
		SAC G		
	No 2, Koji 1st Pd., Cujshan District	Conducted A		
	No.2, Keji 1st Rd., Guishan District, Taoyuan City, Taiwan 333	Conducted B		
	Tabydan City, Taiwan 555	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.

1.7 **Special Accessories**

There is no special accessory used while test was conducted.

1.8 Equipment Modifications

There was no modification incorporated into the EUT.

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SYSTEM TEST CONFIGURATION 2

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.

Test Procedure 2.3

2.3.1**Conducted Emissions**

The EUT is a 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 a 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-ane choic 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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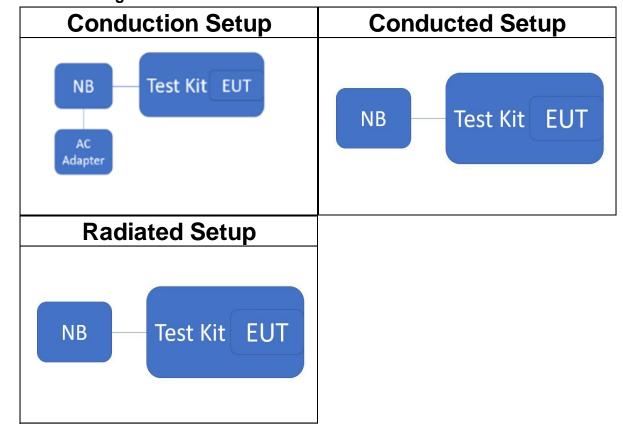
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2.5 **Test Configuration**



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2.6 Control Unit(s)

AC Power-Line Conducted Emission Test Site: Conduction C							
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.		
Notebook	Lenovo	T470	P0001293	N/A	N/A		
Adapter	Lenovo	ADLX65YLC3D	N/A	N/A	N/A		
QCC74X Module Development Kit Board	Walsin	QCC744-DVK	N/A	N/A	N/A		
USB Cable	Fong Hua	USB-C18	128342	N/A	N/A		
	C	onducted Emission T	est Site: Conducted	C			
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)		
Notebook	Lenovo	T14	P0003332	N/A	N/A		
USB Cable	Mcdodo	CA-6390	N/A	N/A	N/A		
QCC74X Module Development Kit Board	Walsin	QCC744-DVK	N/A	N/A	N/A		
		Radiated Emissio	n Test Site: SAC D				
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.		
Notebook	Lenovo	T470	P0001293	N/A	N/A		
QCC74X Module Development Kit Board	Walsin	QCC744-DVK	N/A	N/A	N/A		
USB Cable	Fong Hua	USB-C18	128342	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 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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DESCRIPTION OF TEST MODES 4

4.1 Operated in 2400 ~ 2483.5MHz Band

2400~2483.5 MHz							
СН	Freq. (MHz)	СН	Freq. (MHz)	СН	Freq. (MHz)	СН	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.
- Investigation has been done on all the possible configurations for searching the worst case. 4

	ANTN	INA PORT CONDUC	TED TEST	
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	PACKET TYPE
	Peak Output Pov	wer, 20dB Band Wid	th, Spurious Emissio	n
	0 to 78	0,39,78	GFSK	DH5
Bluetooth	0 to 78	0,39,78	π/4-DQPSK	2DH5
	0 to 78	0,39,78	8-DPSK	3DH5
		Band Edge		
Bluetooth	0 to 78	0,78	GFSK/8-DPSK	DH5/3DH5
		Frequency Separa	tion	
		0,1,2,	GFSK	DH5
Bluetooth	0 to 78	38,39,40,	π/4-DQPSK	2DH5
		76,77,78	8-DPSK	3DH5
	Number of Ho	opping Frequency, H	lopping Band edge	
Bluetooth	0 to 78	0 to 78	GFSK/8-DPSK	DH5/3DH5
	Tir	ne of Occupancy(Dv	vell time)	
		39	GFSK	DH1/DH3/DH5
Bluetooth	0 to 78		π/4-DQPSK	2DH1/2DH3/2DH5
			8-DPSK	3DH1/3DH3/3DH5
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	PACKET TYPE
	TRANS	AIT EMISSION TEST (I	BELOW 1 GHz)	
Bluetooth	0 to 78	39	8-DPSK	3DH5
	TRANS	AIT EMISSION TEST (A	ABOVE 1 GHz)	
Bluetooth	0 to 78	0,39,78	GFSK/8-DPSK	DH5/3DH5
NOTE:				
position (E1, E2 mo	de) for channel Low, I		stand-up position (H mod case position was repo a port	,
		terrinator on antonn	~ – ~	

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MEASUREMENT UNCERTAINTY 5

Test Items		ncertair	nty
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					
	+/-	1.89	dB	9kHz~30MHz	
Polarization: Vertical	+/-	4.15	dB	30MHz - 1000MHz	
Polarization: Vertical	+/-	3.43	dB	1GHz - 18GHz	
	+/-	3.86	dB	18GHz - 40GHz	
	+/-	1.89	dB	9kHz~30MHz	
Polarization: Horizontal	+/-	4.02	dB	30MHz - 1000MHz	
Polarization: Horizontal	+/-	3.43	dB	1GHz - 18GHz	
	+/-	3.86	dB	18GHz - 40GHz	
	+/-	2	dB	33GHz-50GHz	
	+/-	1.59	dB	50GHz-60GHz	
Radiated Spurious Emission	+/-	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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MEASUREMENT EQUIPMENT USED 6

Emission from AC power line 6.1

AC Power-Line Conducted Emission Test Site: Conduction C						
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.	
Coaxial Cable	EC Lab	RF-HY-CAB-250	RF-HY-CAB-250-01	03/27/2024	03/26/2025	
EMI Test Receiver	R&S	ESCI	101342	04/29/2024	04/28/2025	
LISN	SCHWARZBECK Mess-Elektronik	NSLK8127	973	04/22/2024	04/21/2025	
Pulse Limiter	EC Lab	VTSD 9561F-N	485	03/27/2024	03/26/2025	
TEMPERATURE	N/A	EC-RFHY-05	N/A	05/22/2024	05/21/2025	
SMA Termination	RF Microwave WOKEN	WTER-18S2	N/A	N/A	N/A	
Test Software	audix	е3	E3 20923 SGS Ver.9 (C)	N.C.R	N.C.R	

6.2 **Conducted Measurement**

Conducted Emission Test Site: Conducted C						
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)	
Attenuator	Woken	WATT-218FS-10	RF19	11/15/2023	11/14/2024	
Attenuator	Woken	WATT-218FS-10	RF19	11/14/2024	11/13/2025	
DC Block	PASTERNACK	PE8210	RF155	11/15/2023	11/14/2024	
DC Block	PASTERNACK	PE8210	RF155	11/14/2024	11/13/2025	
Power Meter	Anritsu	ML2496A	1804002	04/26/2024	04/25/2025	
Power Sensor	Anritsu	MA2411B	1726105	04/26/2024	04/25/2025	
Power Sensor	Anritsu	MA2411B	1726106	04/26/2024	04/25/2025	
Spectrum Analyzer	KEYSIGHT	N9010B	MY59071570	06/25/2024	06/24/2025	
Test Software	SGS Taiwan	Radio Test Software	Ver.21	N.C.R	N.C.R	

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Radiated Measurement 6.3

	Radiated Emission Test Site: SAC D					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.	
3m Site NSA	SGS	966 chamber D	N/A	04/30/2024	04/29/2025	
Active Loop Antenna	COM-POWER	AL-130R	10160105	12/04/2023	12/03/2024	
Attenuator	Woken	WATT-218FS-10	RF17	11/14/2024	11/13/2025	
Band Rejection Filter	Micro-Tronics	G008	RF205	11/14/2024	11/13/2025	
Broadband Antenna	SCHWARZBECK	VULB 9168	9168-617	12/14/2023	12/13/2024	
Coaxial Cable	Huber+Suhner	EMC106-SM-SM- 7200	150703	11/14/2024	11/13/2025	
Coaxial Cable	Huber+Suhner	RG 214/U	W21.01	11/14/2024	11/13/2025	
Highpass Filter	R&S	F13 HPF 3GHz	RF175	11/14/2024	11/13/2025	
Horn Antenna	Schwarzbeck	BBHA9120D	1341	05/30/2024	05/29/2025	
Horn Antenna	Schwarzbeck	BBHA9170	184	12/28/2023	12/27/2024	
Lowpass Filter	Woken	EWT-56-0019	RF173	11/14/2024	11/13/2025	
Pre-Amplifier	EMC Instruments	EMC12630SE	980273	11/14/2024	11/13/2025	
Pre-Amplifier	EMC Instruments	EMC9135	980234	11/14/2024	11/13/2025	
Spectrum Analyzer	KEYSIGHT	N9010A	MY57120200	04/03/2024	04/02/2025	
SMA Termination	RF Microwave WOKEN	WTER-18S2	N/A	N/A	N/A	
Test Software	audix	е3	E3 20923 SGS Ver.9 (C)	N.C.R	N.C.R	

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

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CONDUCTED EMISSION TEST 7

7.1 **Standard Applicable**

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

Frequency range	Limits dB(uV)		
MHz	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			

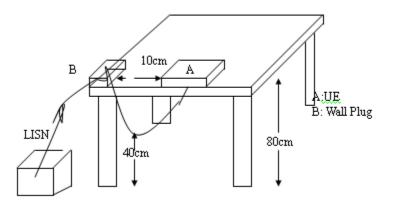
1. The lower limit shall apply at the transition frequencies

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 C63.10:2020.
- 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

Report Number Test Mode Power Probe	:TERF2411003344 :EDR 3M :120V/60Hz :L1	Test	Date :2 o./Humi. :2	onduction C 024-11-18 1.5℃/62% ony Chen	
80 Level (dBuV	n]
70					
60					
50					
40	3				
30	Miland		5	6	
20	MMMMAN MY	mon man	Mar Marine	human	
10					
0.15 0.2	0.5 1	2 Frequency (MHz)	5	10 20 30	1
Freq.	Detector Spectro		Actual FS	Limit	Margin
MHz F	Mode Reading PK/QP/AV dBμV		F3 dBμV	dBμV	dB
0.450		7 40.05	54.00		40.04
0.158 0.211	Peak 41.27 Peak 28.97		51.92 39.56	65.56 63.18	-13.64 -23.63
0.502	Peak 25.2		35.88	56.00	-23.03
1.848	Peak 10.72		21.48	56.00	-34.52
7.646	Peak 14.82		25.78	60.00	-34.22
11.317	Peak 14.73	3 11.00	25.73	60.00	-34.27

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f (886-2) 2298-0488



Report Number	:TERF2411003344	E2 Test S	Site :Co	onduction C	
Test Mode	:EDR 3M	Test I	Date :20	24-11-18	
Power	:120V/60Hz	Temp	./Humi. :21	.5℃/62%	
Probe	:N	Engir		ony Chen	
80 Level (dBuV	<u>n</u>				1
70					
60					
50 2					
40					
	dan wal				
30	WWWWWW		Mamm	web-yby	
20	TY YAMA WWW YA	Marin Walnut	WWW	- Co	
10				and a second	
o					
0.15 0.2	0.5 1	2 Frequency (MHz)	5 1	10 20 30	
Freq.	Detector Spectru		Actual	Limit	Margin
N 41 I.—	Mode Reading L		FS	JDV	
MHz F	PK/QP/AV dBμV	dB	dBµV	dBµV	dB
0.153	Peak 39.20	10.66	49.86	65.82	-15.96
0.183	Peak 35.35		46.00	64.33	-18.33
0.502	Peak 25.60		36.20	56.00	-19.80
0.697	Peak 13.61	10.63	24.25	56.00	-31.75
5.744	Peak 15.92	2 10.94	26.86	60.00	-33.14
14.138	Peak 8.80	11.05	19.86	60.00	-40.14

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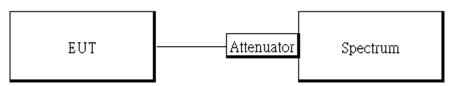


FREQUENCY SEPARATION

Standard Applicable 8.1

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.

Test Setup 8.2



8.3 Measurement Procedure

- 1. Place the EUT on the table and set it in transmitting mode.
- 2. The testing follows ANSI C63.10:2020.
- 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**

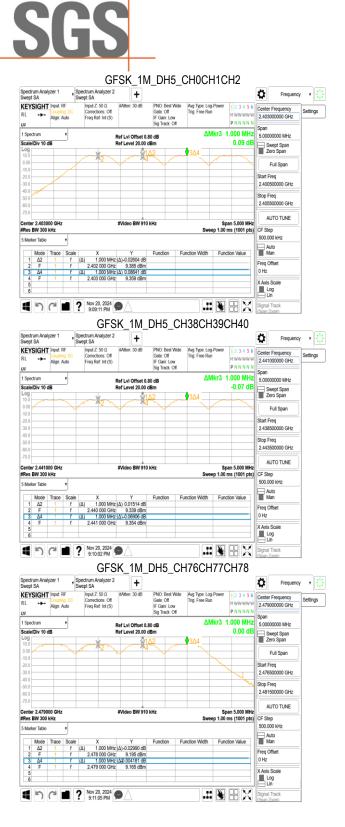
Channel separation (MHz)	Limit	Result
1	≧25 kHz or 2/3 times 20dB bandwidth	PASS

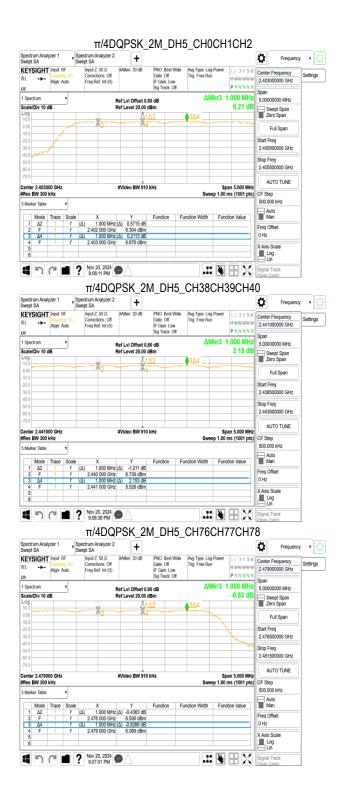
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Report No.: TERF2411003344E2 Page: 23 of 70

8DPSK 3M DH5 CH0CH1CH2

KEYSIGHT Input: RF	Spectrum Analyzer 2 Swept SA	+				Ö	Frequency	3
RL ++ Coupling DC Align: Auto		Atten: 30 dB	PNO: Best Wide Gate: Off IF Gain: Low Sin Track: Off	Avg Type: Log-F Trig: Free Run	Power 1 2 3 4 5 6	Centerr	Frequency 00000 GHz	Settings
Na V			Sig Track: Off		kr3 1.000 MHz	Span 5.00000	0000 MHz	
Scale/Div 10 dB		f Lvi Offset 0.8 f Level 20.00 d			1.45 dB	Sw	ept Span	
Log 10.0	many	§1/	12	♦3∆4		Zen	o Span	
-10.0	~m_	4				FI	ull Span	
-20.0						Start Fre 2.40050	eq D0000 GHz	
-40.0						Stop Fre	eq 00000 GHz	
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RL + Coupling: DC	Corrections: Off	Atten: 30 dB	PNO: Best Wide Gate: Off	Avg Type: Log-F Trig: Free Run	Power 1 2 3 4 5 6		requency 00000 GHz	Settings
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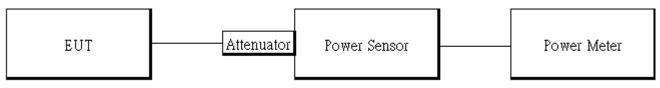


PEAK OUTPUT POWER MEASUREMENT

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, test methodology follow 14.3.
- 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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Peak & Average Power Measurement Result 9.4

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

1M BR mode (Peak):

СН	Freq. (MHz)	Power Setting	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	10	9.37	8.650	1000
39	2441	10	9.68	9.290	1000
78	2480	10	9.36	8.630	1000

1M BR mode (Average):					
СН	Freq. (MHz)	Power Setting	Avg. Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	10	9.34	8.583	1000
39	2441	10	9.65	9.218	1000
78	2480	10	9.32	8.544	1000

2M EDR mode (Peak):

СН	Freq. (MHz)	Power Setting	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	10	11.82	15.205	125
39	2441	10	12.12	16.293	125
78	2480	10	11.79	15.101	125

2M	EUD	mode	(Average	۱.
211		IIIUue	IAVEIAUE	

СН	Freq. (MHz)	Power Setting	Avg. Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	10	9.45	8.803	125
39	2441	10	9.75	9.433	125
78	2480	10	9.44	8.783	125

3M EDR mode (Peak):

СН	Freq. (MHz)	Power Setting	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	10	12.36	17.219	125
39	2441	10	12.65	18.408	125
78	2480	10	12.33	17.100	125

3M EDR mode (Average):

сн	Freq. (MHz)	Power Setting	Avg. Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402	10	9.50	8.905	125
39	2441	10	9.77	9.476	125
78	2480	10	9.46	8.823	125

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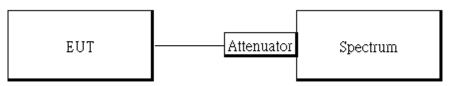


10 EMISSION BANDWIDTH MEASUREMENT

Standard Applicable 10.1

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

10.2 Test Setup



Measurement Procedure 10.3

- 1. Place the EUT on the table and set it in transmitting mode.
- 2. The testing follows ANSI C63.10:2020.
- 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 RBWSpan= 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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GFSK

СН	20 dB BW (MHz)	2/3 BW (MHz)
0	0.9323	0.62
39	0.932	0.62
78	0.9315	0.62

π/4-DQPSK

СН	20 dB BW (MHz)	2/3 BW (MHz)
0	1.286	0.86
39	1.285	0.86
78	1.286	0.86

8-DPSK

CECK

СН	20 dB BW (MHz)	2/3 BW (MHz)
0	1.302	0.87
39	1.302	0.87
78	1.301	0.87

10.5 99% Bandwidth

Gran				
СН	99% BW			
СП	(MHz)			
0	0.81842			
39	0.81952			
78	0.81817			

π/4-DQPSK

сп	99% BW
СН	(MHz)
0	1.1804
39	1.1819
78	1.1810

8-DPSK

СН	99% BW
СП	(MHz)
0	1.1829
39	1.1825
78	1.1828

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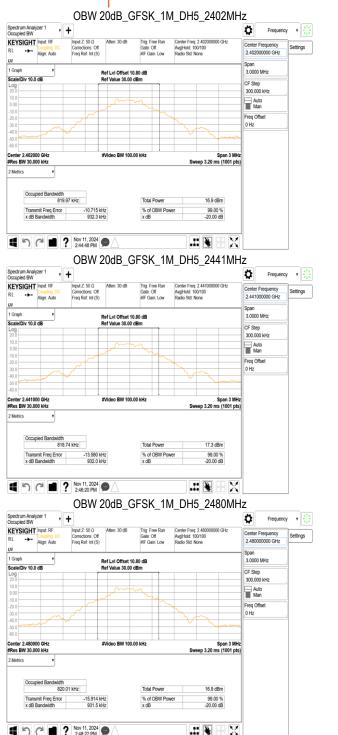
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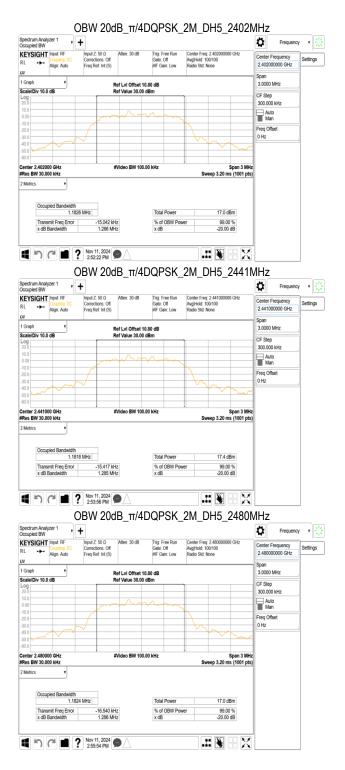
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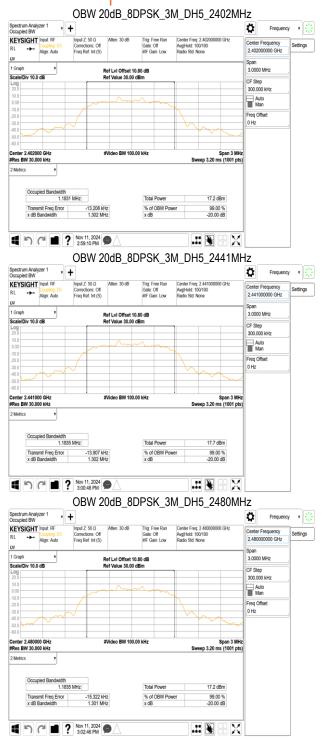
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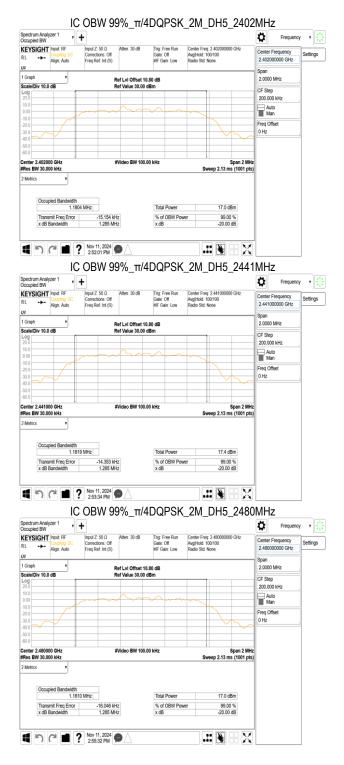
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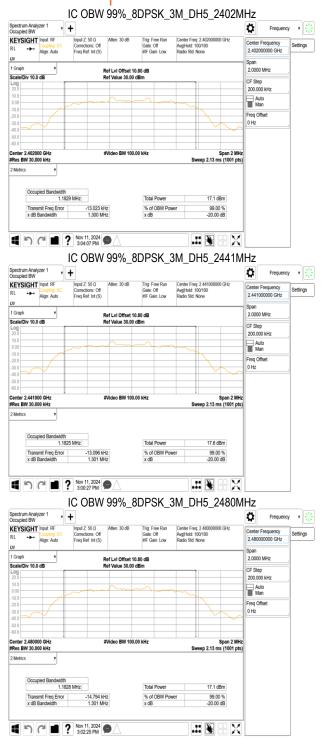
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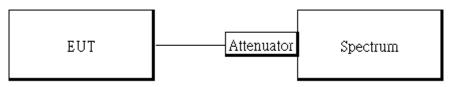


11 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

Standard Applicable 11.1

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



Measurement Procedure 11.3

11.3.1 **Conducted Band Edge:**

In any 100 kHz bandwidth outside the frequency band

- 1. Place the EUT on the table and set it in transmitting mode.
- 2. The testing follows ANSI C63.10:2020.
- 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=300 kHz, Sweep = auto
- 5. Mark Peak, below 2.4GHz and above 2.4835GHz and record the max, level.
- 6. 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 C63.10:2020.
- 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.

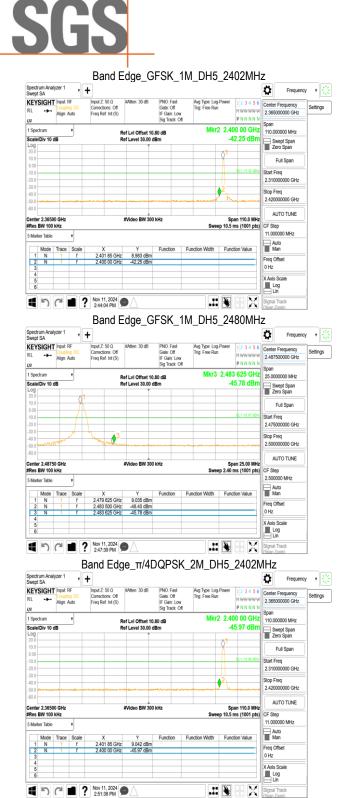
Measurement Result 11.4

See next page for test plots.

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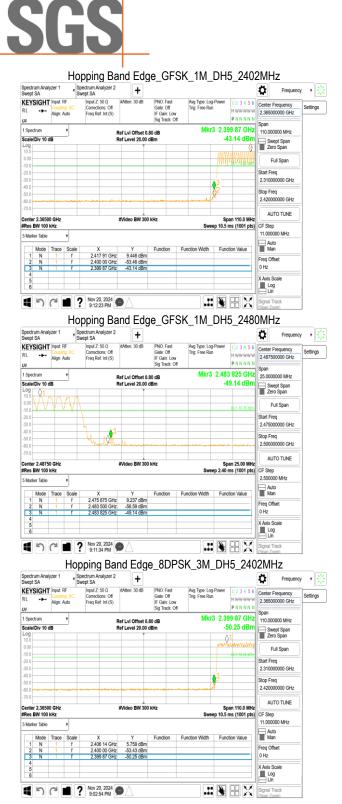
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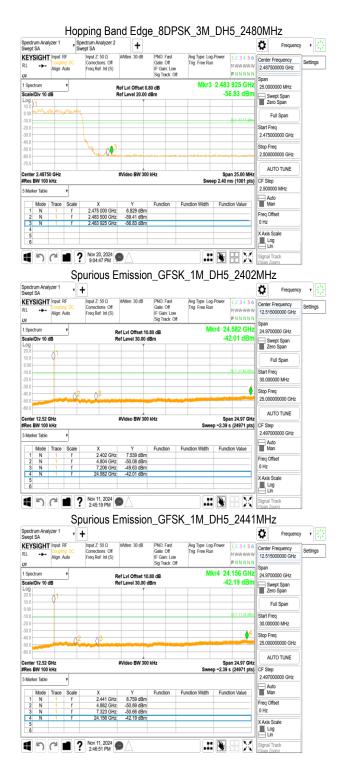
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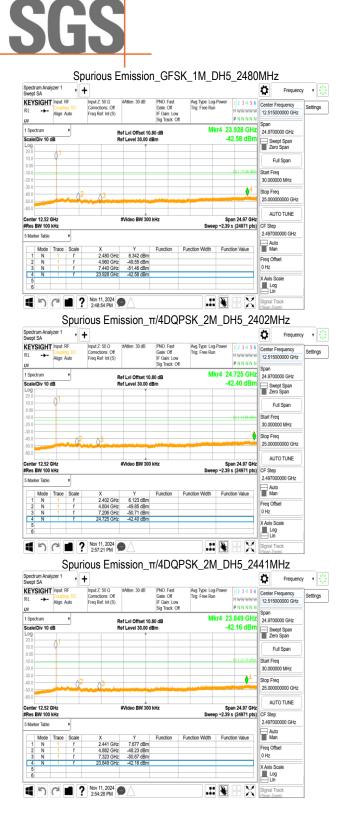
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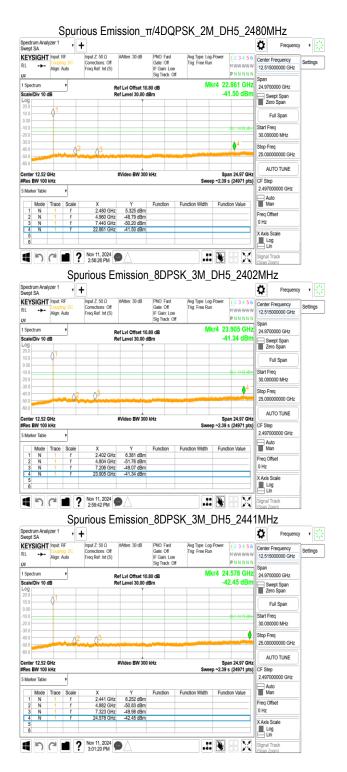
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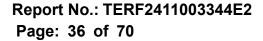
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12 BANDEDGE AND SPURIOUS EMISSION MEASUREMENT

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 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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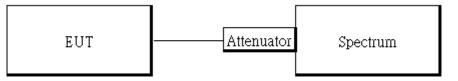
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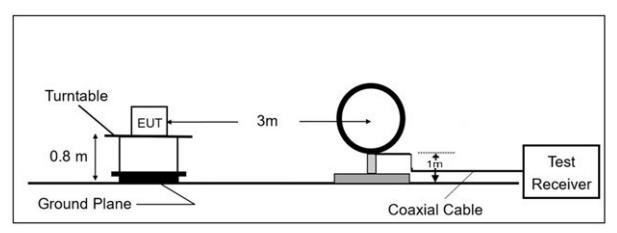
Test Setup 12.2

12.2.1 **Duty Cycle Correction Factor, Band edge, Emission**

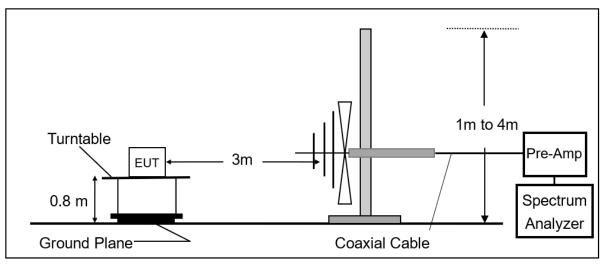


12.2.2 **Radiated Emission**

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



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



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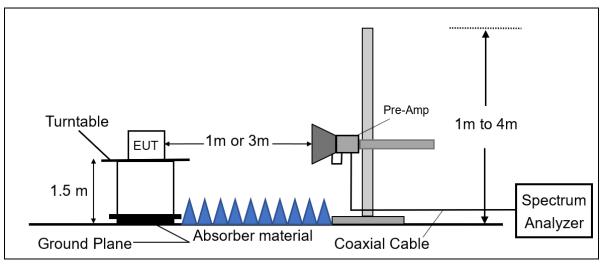
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(C) Radiated Emission Test Set-Up, Frequency Above 1 GHz.



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 C63.10:2020.
- 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 Band edge and Spurious Emission

- 1. Set the spectrum analyzer as RBW=100 kHz and VBW=300 kHz for Peak Detector (PK) at frequency between 30MHz and 1 GHz.
- 2. Use receiver mode as RBW=120 kHz for Quasi-peak (QP) at frequency between 30MHz and 1 GHz.
- 3. Set the spectrum analyzer as RBW=1 MHz, VBW=3 MHz, Detector = Peak for Maximum Emission Measurements at frequency above 1 GHz.
- 4. According to C63.10:2020 Section 7.5 Procedure for determining the average value of pulsed emissions with duty cycle correction factor 20 log (Ton/100ms)

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12.3.3 Radiated Spurious Emissions measurements

- 1. The testing follows the Measurement Procedure of ANSI C63.10:2020.
- 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. 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.
- 6. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
- 7. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
- 8. 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 RA = Reading Amplitude AF = Antenna Factor *CL* = *Cable Attenuation Factor (Cable Loss) AG* = *Amplifier Gain*

The limit of the emission level is expressed in dBuV/m, which converts 20*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($dB\mu V/m$)=Peak Actual FS($dB\mu V/m$)+ 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 BR

Time ON of 100ms: 5.800 ms

Duty Cycle=5.8ms / 100ms= 0.058

Duty Cycle correction factor=20 LOG 0.058 = -24.73 dB

Bluetooth 3M EDR

Time ON of 100ms: 5.800 ms

Duty Cycle=5.8ms / 100ms= 0.058

Duty Cycle correction factor=20 LOG 0.058 = -24.73 dB

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12.6.2 **Duty Cycle test plot**

BR

Keysight Spectrum Analyzer - Swept SA 10:31:56 AM Nov 20, 2024 TRACE 1 2 3 4 5 6 TYPE WWWWW DET P N N N N N SENSE:INT ALIGN OFF Frequency Center Freg 2.402000000 GHz Trig: Free Run #Atten: 30 dB PNO: Fast IFGain:Low -Auto Tune ΔMkr3 2.900 ms 0.13 dB Ref 20.00 dBm 10 dB/div 10.0 **Center Freq** 2.402000000 GHz 0.00 10.0 14 **▲**3∆4 Ж2 -20.0 Start Freq -30.0 2.402000000 GHz .40 1 -50.0 وجواده وترجير والمطل أيجر والمراجا والاله ليتله VAR IN THE وراستهتم بالشاهدم لتقاطله Stop Freq -60.0 2.402000000 GHz 70. Center 2.402000000 GHz Span 0 Hz CF Step Sweep 100.0 ms (1001 pts) 1.000000 MHz Man Res BW 1.0 MHz #VBW 3.0 MHz Auto MKR MODE TRC SCL -0.07 dB -18.36 dBm 0.13 dB t (Δ) t t (Δ) 2.900 ms (Δ) 12.90 ms 2.900 ms (Δ) 1 Δ2 2 E Freq Offset Δ4 2.900 ms 0.13 dB -27.05 dBm 4 F t 0 Hz Scale Type 10 Lin _og

STATUS

EDR

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-20.0 - -30.0 - -40.0 -)	×2	<u>}</u> וב	12				>>	4	3∆	4										2	2.402		nt Fre 00 GH
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MSG										-											STAT	US)					

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12.6.3 CBE

BT_1M_BR

Channel	Frequency (MHz)	Raw Value(dBm) Chain 0	Duty factor (dB)	Antenna Peak Gain (dBi) Chain 0	EIRP (dBm)	Emission Level (dBuV/m)	Margin (dB)	Lir (dBu	nit V/m)
0	2402	-47.290	-	3.37	-43.92	51.28	-22.72	74	PK
U	2402	-	-24.73	3.37	-68.65	26.55	-27.45	54	AV
78	2480	-30.700	-	3.37	-27.33	67.87	-6.13	74	PK
10	2400	-	-24.73	3.37	-52.06	43.14	-10.86	54	AV

Average Duty Factor=-24.73(dB) Average Level=Peak Level+Duty Factor BT 3M EDR

Channel	Frequency (MHz)	Raw Value(dBm) Chain 0	Duty factor (dB)	Antenna Peak Gain (dBi) Chain 0	EIRP (dBm)	Emission Level (dBuV/m)	Margin (dB)		nit V/m)
0	2402	-47.410	-	3.37	-44.04	51.16	-22.84	74	PK
U	2402	-	-24.73	3.37	-68.77	26.43	-27.57	54	AV
78	2480	-36.080	-	3.37	-32.71	62.49	-11.51	74	PK
10	2400	-	-24.73	3.37	-57.44	37.76	-16.24	54	AV

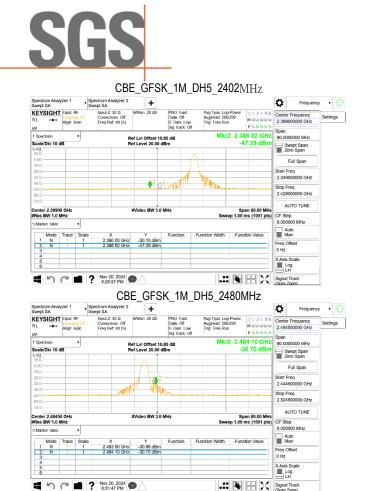
Average Duty Factor=-24.73(dB)

Average Level=Peak Level+Duty Factor

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12.6.4 Conducted Emission

BT 3DH5

Channel	Frequency (MHz)	Raw Value(dBm)	Correction Factor(dB)	EIRP (dBm)	Emission Level (dBuV/m)	Margin (dB)		mit IV/m)
		Chain 0	Chain 0					
		-82.040	8.07	-73.97	21.23	-18.77	40	PK
		-78.800	8.07	-70.73	24.47	-19.03	43.5	PK
39	2441	-86.220	8.07	-78.15	17.05	-28.95	46	PK
39	2441	-65.950	8.07	-57.88	37.32	-8.68	46	PK
		-86.800	8.07	-78.73	16.47	-29.53	46	PK
		-83.670	8.07	-75.60	19.60	-34.40	54	PK

Note:

Correction Factor=maximum ground reflection factor+Antenna Gain BT DH5

כחע_ום									
Channel	Frequency	Raw Value(dBm)	Duty factor	Antenna Peak Gain (dBi)	EIRP	Emission Level	Margin		mit
	(MHz)	Chain 0	(dB)	Chain 0	(dBm)	(dBuV/m)	(dB)	(arr	ıV/m)
0	2402	-43.070	-	3.37	-39.70	55.50	-18.50	74	PK
U	2402	-	-24.73	3.37	-64.43	30.77	-23.23	54	A٧
39	2441	-41.780	-	3.37	-38.41	56.79	-17.21	74	PK
39	2441	-	-24.73	3.37	-63.14	32.06	-21.94	54	A۱
78	2480	-42.670	-	3.37	-39.30	55.90	-18.10	74	Pł
10	2400	-	-24.73	3.37	-64.03	31.17	-22.83	54	A١
BT_3DH5					•	•		•	
	Frequency	Raw Value(dBm)	Duty	Antenna Peak	EIRP	Emission	Margin	1.5	
Channel	Frequency		factor	Gain (dBi)		Level	Margin		mit
	(MHz)	Chain 0	(dB)	Chain 0	(dBm)	(dBuV/m)	(dB)	(авс	ıV/m)
0	2402	-41.950	-	3.37	-38.58	56.62	-17.38	74	PK
U	2402	-	-24.73	3.37	-63.31	31.89	-22.11	54	A۱
39	2441	-42.860	-	3.37	-39.49	55.71	-18.29	74	Pł
29	2441	-	-24.73	3.37	-64.22	30.98	-23.02	54	A١
78	2480	-42.160	-	3.37	-38.79	56.41	-17.59	74	Pł
10	2480		04 70	2.27	62.52	24.69	22.22	54	۵۱

-24.73

3.37

-63.52

31.68

-22.32

54

AV

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Peak (30MHz~1GHz)

Swept SA		.5 Spectrum Analyzer Swept SA	Swept SA		Swept SA	· ·	Frequence	y •
EYSIGH	Coupling: DC Align: Auto	Input Z: 50 Q Corrections: Off Freq Ref: Int (S)	#Allen: 10 dB	PNO: Fast Gate: Off IF Gain: Low Sig Track: Off	#Avg Type: Po Avg[Hold: 5/5 Trig: Free Run	wer (RMS 1 2 3 4 5 6 M WWWWW P N N N N N	Center Frequency 515.000000 MHz	Settings
Spectrum	•		Ref Lvi Offset 0.1	30 dB	Mkr	6 991.755 MHz	Span 970.000000 MHz	
cale/Div 10	dB		Ref Level 0.80 di	Bm		-83.67 dBm	Swept Span	
og Trac	e 1 Pass		T				Zero Span	
9.2	5 I F 855						Full Span	
9.2							Start Freq	
9.2							30.000000 MHz	
i0.2 i0.2 i0.2	\ <mark>2</mark>	A3			0	A5 🖗	Stop Freq 1.00000000 GHz	
ie 2		d de Martin de la contra de la	#Video BW 300			Stop 1.0000 GHz	AUTO TUNE	
Res BW 100			#41060 844 300	KHZ	Sweep -	~93.5 ms (10001 pts)	CF Step	
Marker Table							97.000000 MHz	
Walker Table							Auto	
	Trace Scal		Y	Function	Function Width	Function Value	Man Man	
Mode	1 f	39.991 MHz	-82.04 dBm				Freq Offset	
1 N		159.974 MHz	-78.80 dBm				0 Hz	
1 N 2 N	1 1		-86.22 dBm				Unz	
1 N 2 N 3 N	1 f	266.680 MHz						
1 N 2 N 3 N 4 N	1 f 1 f	813.760 MHz	-65.95 dBm				X Axis Scale	
1 N 2 N 3 N			-86.80 dBm				X Axis Scale Log	

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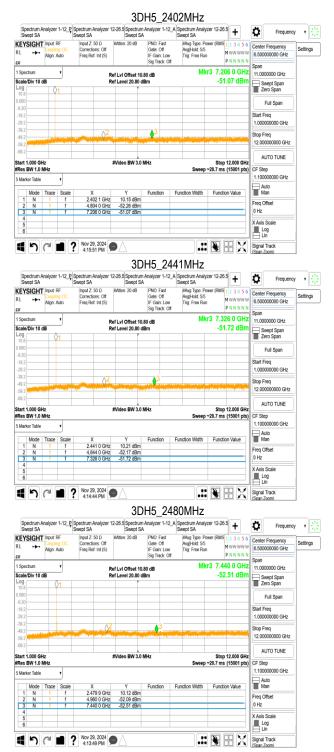
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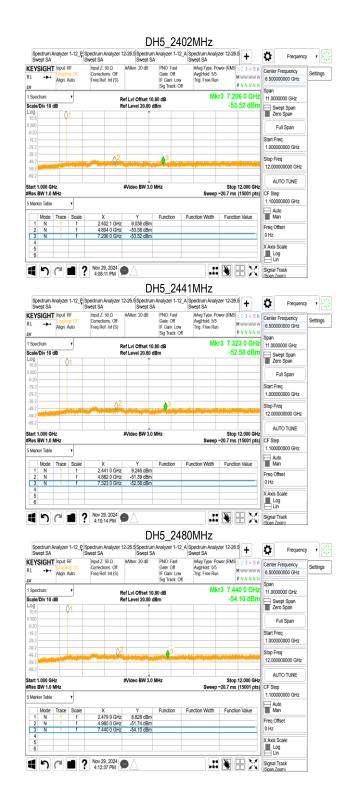
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Peak (1~12GHz)





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