

ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

Applicant: ThirdEye Gen Inc
300 Alexander Park Dr, Princeton, NJ 08540 United States

Product Name: ThirdEye X2

Brand Name: ThirdEye

Model No.: X2 MR Glasses

Model Difference: N/A

Report Number: E2/2019/C0006

FCC ID: 2ANDNX2

FCC Rule Part: §15.247, Cat: DSS

Issue Date: Jan. 09, 2020

Date of Test: Dec. 06, 2019 ~ Dec. 24, 2019

Date of EUT Received: Dec. 06, 2019

We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. Electronics & Communication Laboratory. The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10:2013 and the energy emitted by the sample EUT tested as described in this report is in compliance with conducted and radiated emission limits.

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

Approved By:

Jazz Huang

Jazz Huang / Asst. Supervisor



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Revision History

Revision	Description	Issue Date	Remark
Rev.00	Original.	Jan. 09, 2020	Revised By: Karen Huang

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1 GENERAL INFORMATION

1.1 Product Description

Product Name:	ThirdEye X2	
Brand Name:	ThirdEye	
Model No.:	X2 MR Glasses	
Model Difference:	N/A	
Hardware Version:	N/A	
Software Version:	N/A	
Power Supply:	5V / 9V / 12V from AC/DC Switching Adapter or 5V from USB Port	
	Adapter:	Model No.: DSA-24QFA FUS A, Supplier: DEE VAN ENTERPRISE CO., LTD.

Radio Technology:	Bluetooth BR+EDR
Channel number:	79 channels
Modulation type:	GFSK + $\pi/4$ DQPSK + 8DPSK
Transmit Power:	5.12dBm
Frequency Range:	2.402GHz – 2.480GHz
Dwell Time:	$\leq 0.4s$
Antenna Designation:	Monopole Antenna, Gain: 2.6dBi

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1.2 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247

KDB 558074 D01 v05 DSS Meas. Guidance v05r02

ANSI C63.10:2013

1.3 Test Facility

SGS Taiwan Ltd. Electronics & Communication Laboratory (TAF code 0513)

No.2, Keji 1st Rd., Guishan District, Taoyuan City, Taiwan 333

FCC Designation number: TW0002

1.4 Special Accessories

There is no special accessory used while test was conducted.

1.5 Equipment Modifications

There was no modification incorporated into the EUT.

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

Radiated emission below 30MHz is measured in a 9m*9m*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.

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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 50 μ H/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.

2.4 Measurement Results Explanation Example

For all conducted test items:

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

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2.5 Configuration of Tested System

Fig. 2-1 Conducted (Antenna Port) & Radiated Emission Configuration



Fig 2-2 Conduction (AC Power Line) Emission

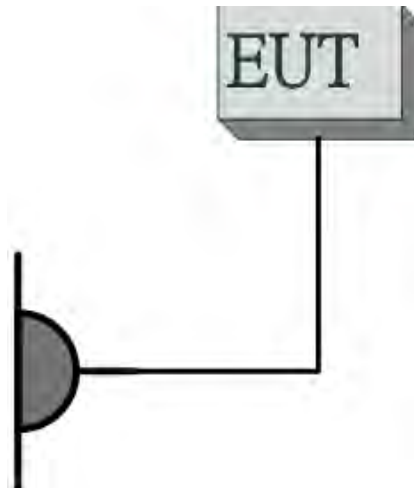


Table 2-1 Equipment Used in Tested System

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Data Cable	Power Cord
1.	Bluetooth Test Software	N/A	N/A	N/A	N/A	N/A
2.	Notebook	Lenovo	T460p	P0001013	N/A	N/A
3.	Notebook	Lenovo	L420	S0011721	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)	20dB Bandwidth	Compliant
§15.205 §15.209 §15.247(d)	Conducted & Radiated Band Edge and Spurious Emission	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

79 channels are provided for Bluetooth

ITEM	FREQUENCY	ITEM	FREQUENCY	ITEM	FREQUENCY	ITEM	FREQUENCY
1	2402 MHz	21	2422 MHz	41	2442 MHz	71	2462 MHz
2	2403 MHz	22	2423 MHz	42	2443 MHz	72	2463 MHz
3	2404 MHz	23	2424 MHz	43	2444 MHz	73	2464 MHz
4	2405 MHz	24	2425 MHz	44	2445 MHz	74	2465 MHz
5	2406 MHz	25	2426 MHz	45	2446 MHz	75	2466 MHz
6	2407 MHz	26	2427 MHz	46	2447 MHz	76	2467 MHz
7	2408 MHz	27	2428 MHz	47	2448 MHz	77	2468 MHz
8	2409 MHz	28	2429 MHz	48	2449 MHz	78	2469 MHz
9	2410 MHz	29	2430 MHz	49	2450 MHz	79	2470 MHz
10	2411 MHz	30	2431 MHz	50	2451 MHz	70	2471 MHz
11	2412 MHz	31	2432 MHz	51	2452 MHz	71	2472 MHz
12	2413 MHz	32	2433 MHz	52	2453 MHz	72	2473 MHz
13	2414 MHz	33	2434 MHz	53	2454 MHz	73	2474 MHz
14	2415 MHz	34	2435 MHz	54	2455 MHz	74	2475 MHz
15	2416 MHz	35	2436 MHz	55	2456 MHz	75	2476 MHz
16	2417 MHz	36	2437 MHz	56	2457 MHz	76	2477 MHz
17	2418 MHz	37	2438 MHz	57	2458 MHz	77	2478 MHz
18	2419 MHz	38	2439 MHz	58	2459 MHz	78	2479 MHz
19	2420 MHz	39	2440 MHz	59	2460 MHz	79	2480 MHz
20	2421 MHz	40	2441 MHz	60	2461 MHz		

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4.2 The Worst Test Modes and Channel Details

- 1 The EUT has been tested under operating condition.
- 2 Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.
- 3 Investigation has been done on all the possible configurations for searching the worst case.

MODE	AVAILABLE FREQUENCY (MHz)	TESTED FREQUENCY (MHz)	MODULATION	PACKET TYPE
RADIATED EMISSION TEST (BELOW 1 GHz)				
Bluetooth	2402 to 2480	2441	GFSK	DH5
RADIATED EMISSION TEST (ABOVE 1 GHz)				
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK	DH5
Note: The field strength of radiation emission was measured as EUT stand-up position (H mode) and lie down position (E1, E2 mode) for Bluetooth BR+EDR Transmitter for channel Low, Mid and High, the worst case E2 position was reported.				

ANTENNA PORT CONDUCTED TEST				
MODE	AVAILABLE FREQUENCY (MHz)	TESTED FREQUENCY (MHz)	MODULATION	PACKET TYPE
Peak Output Power, Occupied Band Width				
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK, $\pi/4$ -DQPSK, 8-DQPK	DH1/DH3/DH5 2DH1/2DH3/2DH5 3DH1/3DH3/3DH5
Band Edge				
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK, 8-DQPK	DH5/3DH5
Frequency Separation				
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK	DH5
Number of hopping frequency				
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK	DH5
Time of Occupancy (Dwell time)				
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK, $\pi/4$ -DQPSK, 8-DQPK	DH1/DH3/DH5 2DH1/2DH3/2DH5 3DH1/3DH3/3DH5

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5 MEASUREMENT UNCERTAINTY

Test Items	Uncertainty
AC Power Line Conducted Emission	+/- 2.586 dB
Peak Output Power	+/- 0.84 dB
20dB Bandwidth	+/- 51.33 Hz
100 KHz Bandwidth Of Frequency Band Edges	+/- 0.84 dB
Frequency Separation	+/- 51.33 Hz
Number of hopping frequency	+/- 51.33 Hz
Time of Occupancy	+/- 51.33 Hz
Temperature	+/- 0.65 °C
Humidity	+/- 4.6 %
DC / AC Power Source	DC= +/- 0.13%, AC= +/- 0.2%

Radiated Spurious Emission Measurement Uncertainty	
Polarization: Vertical	9kHz~30MHz: +/-2.3dB
	30MHz - 180MHz: +/- 3.37dB
	180MHz -417MHz: +/- 3.19dB
	0.417GHz-1GHz: +/- 3.19dB
	1GHz - 18GHz: +/- 4.04dB
	18GHz - 40GHz: +/- 4.04dB
Polarization: Horizontal	9kHz~30MHz: +/-2.3dB
	30MHz - 167MHz: +/- 4.22dB
	167MHz -500MHz: +/- 3.44dB
	0.5GHz-1GHz: +/- 3.39dB
	1GHz - 18GHz: +/- 4.08dB
	18GHz - 40GHz: +/- 4.08dB

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 CONDUCTED EMISSION TEST

6.1 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.

6.2 Measurement Equipment Used

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
LISN	TESEQ	NNB 51	36076	02/13/2019	02/12/2020
EMI Test Receiver	R&S	ESCI	101342	04/26/2019	04/25/2020

6.3 EUT Setup

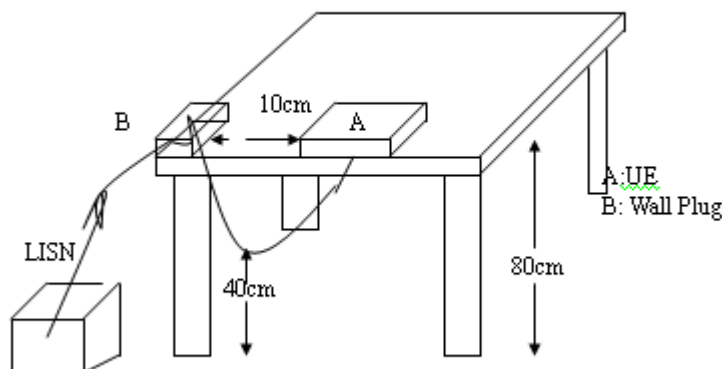
1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI 63.10:2013.
2. The AC/DC Power adaptor of EUT was plug-in LISN. The EUT was placed flushed with the rear of the table.
3. The LISN was connected with 120Vac/60Hz power source.

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6.4 Test SET-UP (Block Diagram of Configuration)



6.5 Measurement Procedure

1. The EUT was placed on a table which is 0.8m above ground plan.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all frequency measured were complete.

6.6 Measurement Result

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

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

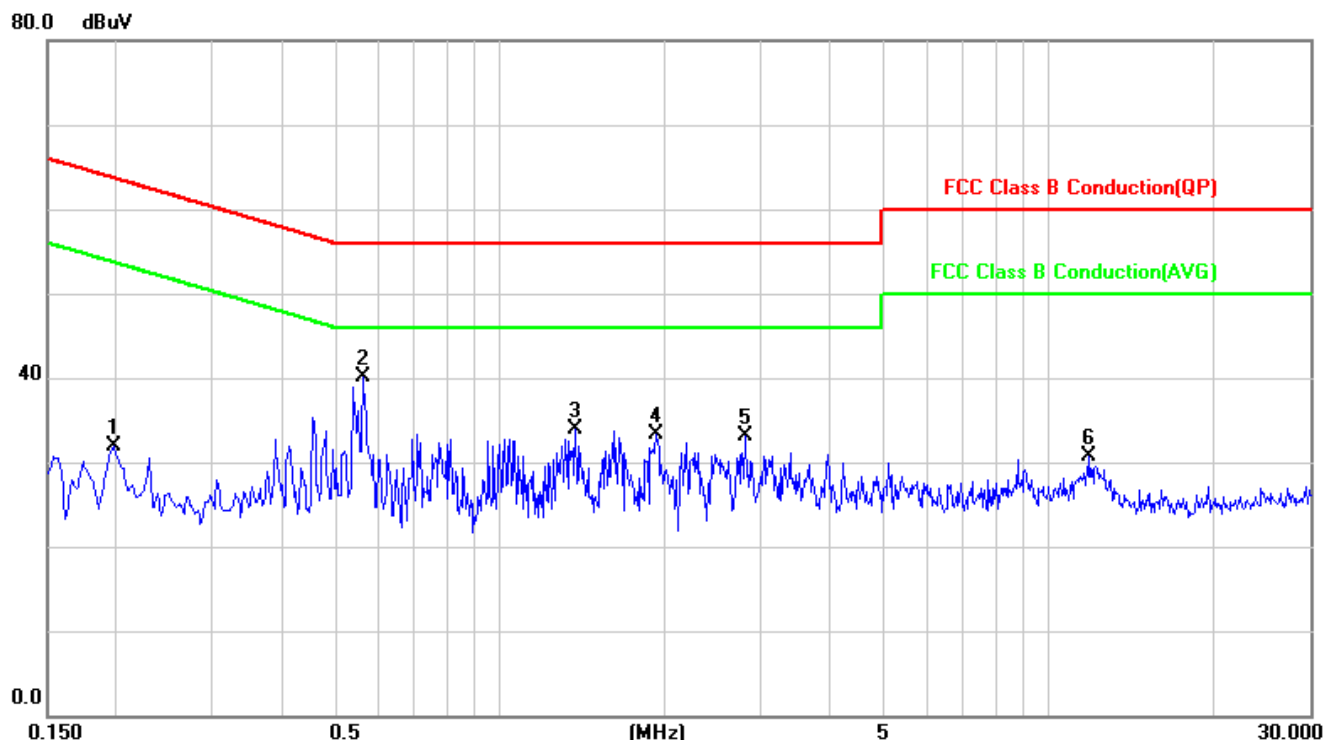
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AC POWER LINE CONDUCTED EMISSION TEST DATA

Description:	Operation	Date:	2019/12/24
Line:	L1	Temp.(°C)/Hum.(%):	23.2(°C)/65%
Test Voltage:	AC 120V/60Hz	Test By:	Kailin
Note:	E2/2019/C0006		



No.	Mk.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Measure- ment (dBuV)	Limit (dBuV)	Over (dB)	Detector	Comment
1		0.1980	12.42	19.55	31.97	63.69	-31.72	peak	
2	*	0.5660	20.40	19.76	40.16	56.00	-15.84	peak	
3		1.3780	13.99	19.85	33.84	56.00	-22.16	peak	
4		1.9340	13.26	19.97	33.23	56.00	-22.77	peak	
5		2.7980	13.22	19.96	33.18	56.00	-22.82	peak	
6		11.8940	10.82	19.97	30.79	60.00	-29.21	peak	

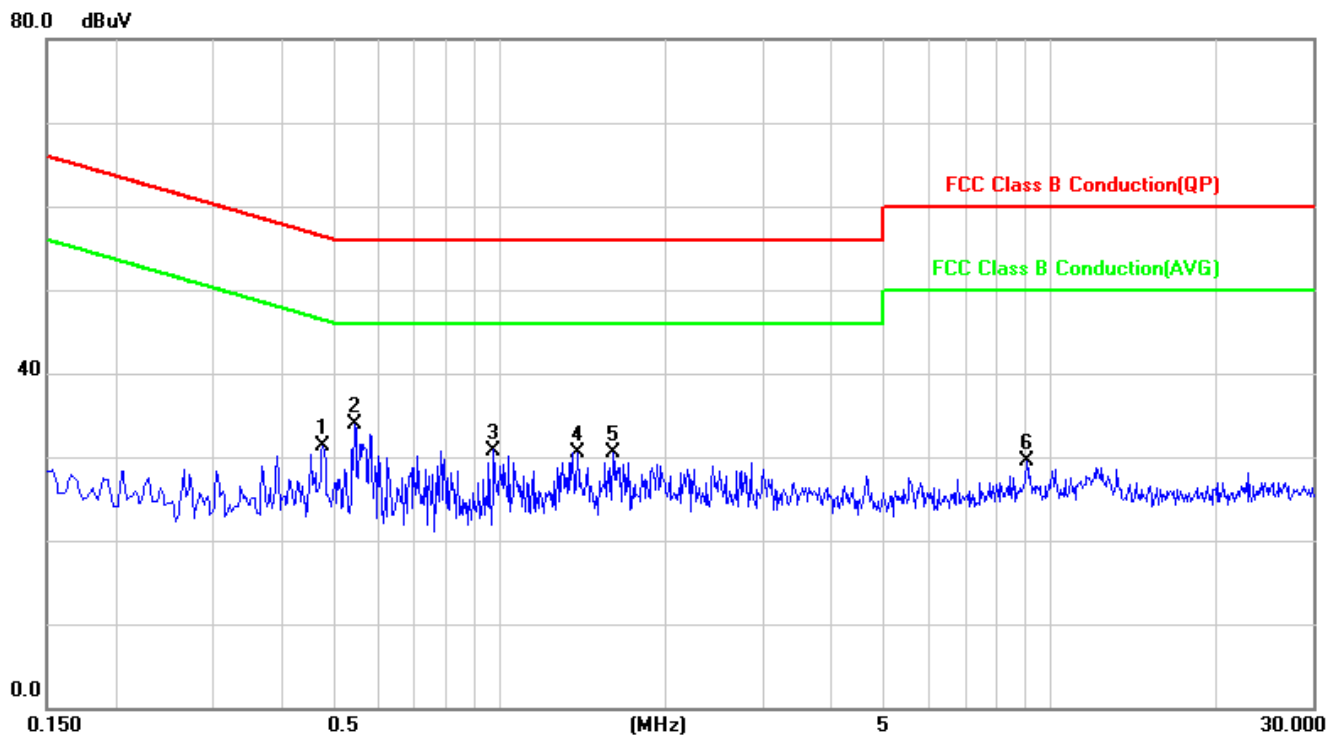
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Description: Operation
Line: L1
Test Voltage: AC 120V/60Hz
Note: E2/2019/C0006

Date: 2019/12/24
Temp.(°C)/Hum.(%): 23.2(°C)/65%
Test By: Kailin



No.	Mk.	Freq.	Reading	Factor	Measure- ment	Limit	Over	Detector	Comment
		(MHz)	(dBuV)	(dB)	(dBuV)	(dBuV)	(dB)		
1		0.4780	11.36	19.96	31.32	56.37	-25.05	peak	
2	*	0.5460	13.99	19.97	33.96	56.00	-22.04	peak	
3		0.9780	10.82	19.98	30.80	56.00	-25.20	peak	
4		1.3820	10.49	20.07	30.56	56.00	-25.44	peak	
5		1.6060	10.30	20.11	30.41	56.00	-25.59	peak	
6		9.0980	9.31	20.19	29.50	60.00	-30.50	peak	

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7 PEAK OUTPUT POWER MEASUREMENT

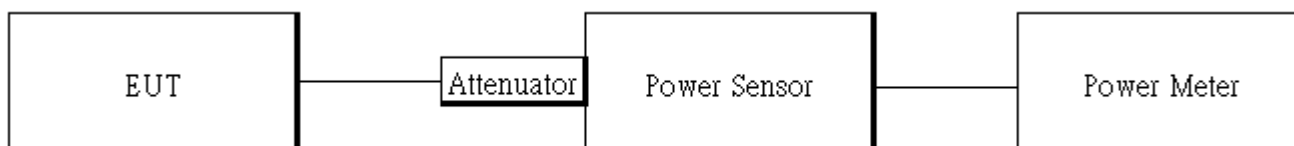
7.1 Standard Applicable

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.

7.2 Measurement Equipment Used

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Power Meter	Anritsu	ML2496A	1326001	08/05/2019	08/04/2020
Power Sensor	Anritsu	MA2411B	1315048	08/05/2019	08/04/2020
Power Sensor	Anritsu	MA2411B	1315049	08/05/2019	08/04/2020
Attenuator	Marvelous	MVE2213-10	RF80	11/20/2019	11/19/2020

7.3 Test Set-up:



7.4 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. 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)
4. Record the max. reading.
5. Repeat above procedures until all default test channel is completed.

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7.5 Peak & Average Power Measurement Result

1M BR mode (Peak):

CH	Freq. (MHz)	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	4.00	2.512	125
Mid	2441	3.88	2.443	125
High	2480	5.12	3.251	125

1M BR mode (Average):

CH	Freq. (MHz)	Max. Output include tune up tolerance Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	3.89	2.451	125
Mid	2441	3.64	2.314	125
High	2480	4.88	3.079	125

2M EDR mode (Peak):

CH	Freq. (MHz)	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	3.14	2.061	125
Mid	2441	3.00	1.995	125
High	2480	4.23	2.649	125

2M EDR mode (Average):

CH	Freq. (MHz)	Max. Avg. Output include tune up tolerance Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	0.44	1.108	125
Mid	2441	0.14	1.034	125
High	2480	1.47	1.404	125

3M EDR mode (Peak):

CH	Freq. (MHz)	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	3.57	2.275	125
Mid	2441	3.45	2.213	125
High	2480	4.63	2.904	125

3M EDR mode (Average):

CH	Freq. (MHz)	Max. Avg. Output include tune up tolerance Power (dBm)	Output Power (mW)	Limit (mW)
Low	2402	0.51	1.124	125
Mid	2441	0.16	1.037	125
High	2480	1.52	1.418	125

NOTE: cable loss as 0.4dB that offsets in the spectrum

*Note: Max. Output include tune up tolerance Power measured by using average detector.

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8 20dB BANDWIDTH MEASUREMENT

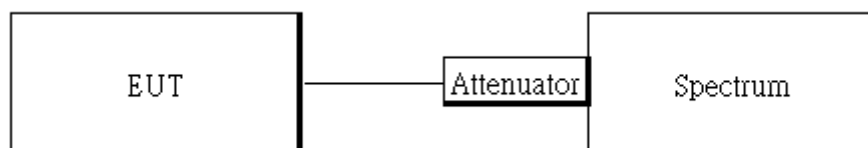
8.1 Standard Applicable

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

8.2 Measurement Equipment Used

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	KEYSIGHT	N9010A	MY57120200	03/06/2019	03/05/2020
DC Block	PASTERNAK	PE8210	RF256	11/20/2019	11/19/2020
Attenuator	Marvelous	MVE2213-10	RF80	11/20/2019	11/19/2020

8.3 Test Set-up



8.4 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=10 kHz (1 % of 20 dB Bandwidth.), VBW = 30 kHz, Span= 3MHz, Sweep=auto, Detector = Peak, and Max hold for 20dB Bandwidth test.
5. Mark the peak frequency and -20dB (upper and lower) frequency
6. Repeat above procedures until all test default channel is completed

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8.5 20dB Bandwidth GFSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
Low	0.8813	0.59
Mid	0.8811	0.59
High	0.8814	0.59

$\pi/4$ -DQPSK

CH	20 dB BW (MHz)	2/3 BW (MHz)
Low	1.255	0.84
Mid	1.253	0.84
High	1.276	0.85

8-DPSK

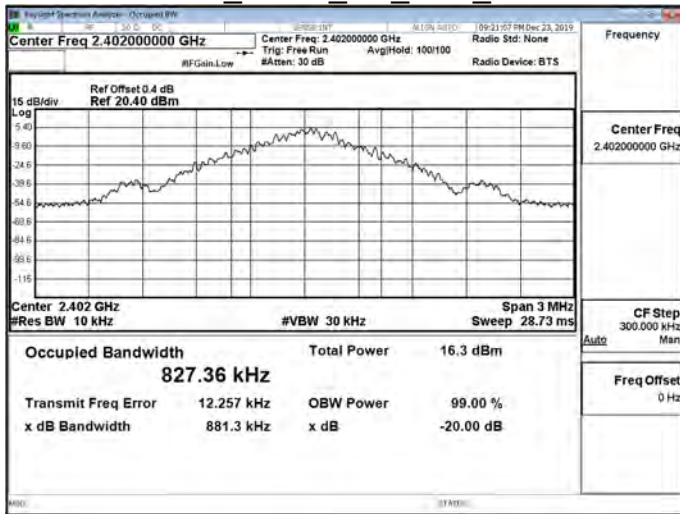
CH	20 dB BW (MHz)	2/3 BW (MHz)
Low	1.254	0.84
Mid	1.254	0.84
High	1.254	0.84

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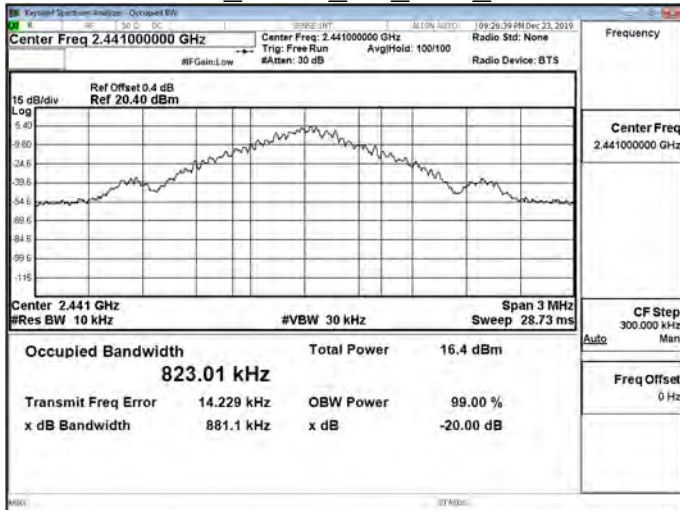
OBW 20dB_GFSK_1M_DH5_2402MHz



OBW 20dB_π/4DQPSK_2M_2402MHz



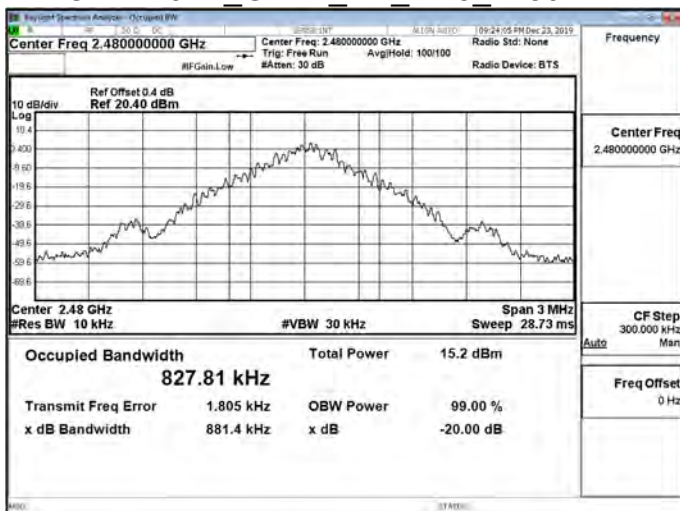
OBW 20dB_GFSK_1M_DH5_2441MHz



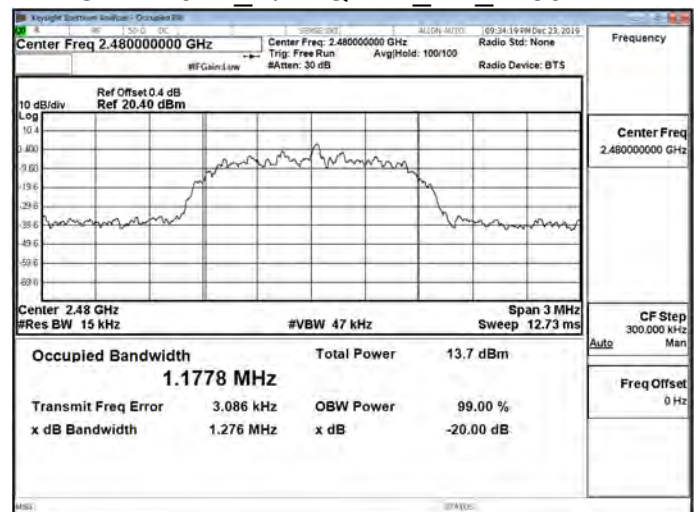
OBW 20dB_π/4DQPSK_2M_2441MHz



OBW 20dB_GFSK_1M_DH5_2480MHz



OBW 20dB_π/4DQPSK_2M_2480MHz

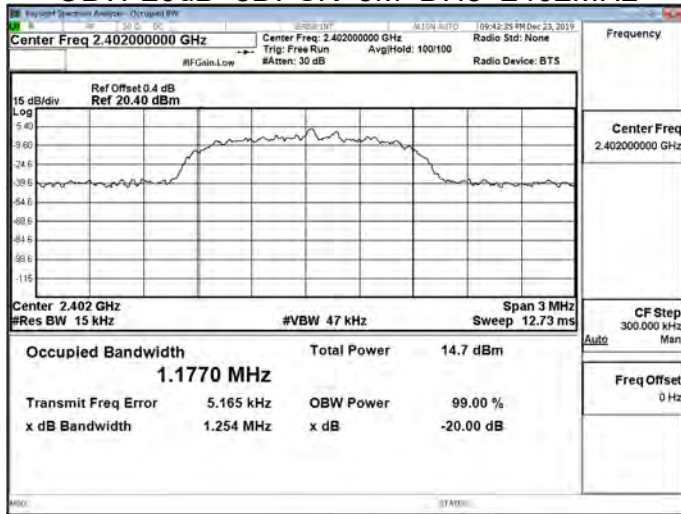


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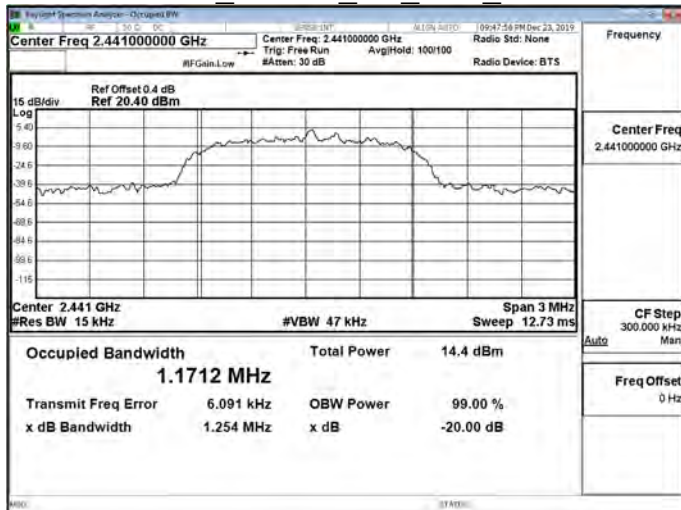
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OBW 20dB 8DPSK 3M DH5 2402MHz



OBW 20dB 8DPSK 3M DH5 2441MHz



OBW 20dB 8DPSK 3M DH5 2480MHz



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9 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

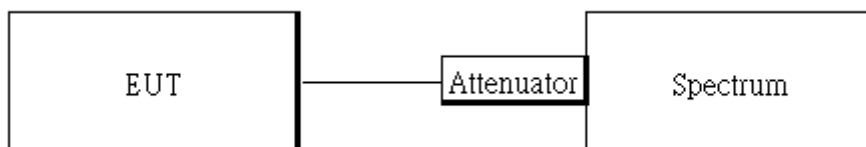
9.1 Standard Applicable

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).

9.2 Measurement Equipment Used

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	KEYSIGHT	N9010A	MY57120200	03/06/2019	03/05/2020
DC Block	PASTERNAK	PE8210	RF256	11/20/2019	11/19/2020
Attenuator	Marvelous	MVE2213-10	RF80	11/20/2019	11/19/2020

9.3 Test SET-UP



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9.4 Measurement Procedure

9.4.1 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, 2.3999GHz and 2.4836GHz and record the max. level.
7. Repeat above procedures until all frequency measured were complete.

9.4.2 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.

9.5 Measurement Result

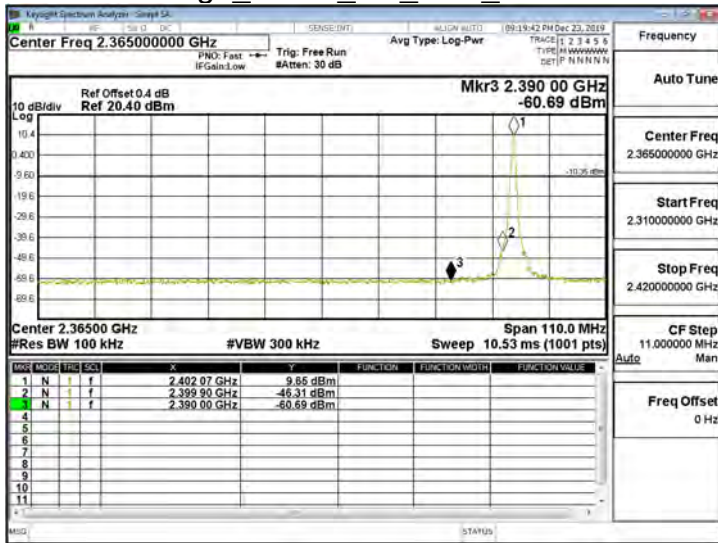
See next page for test plots.

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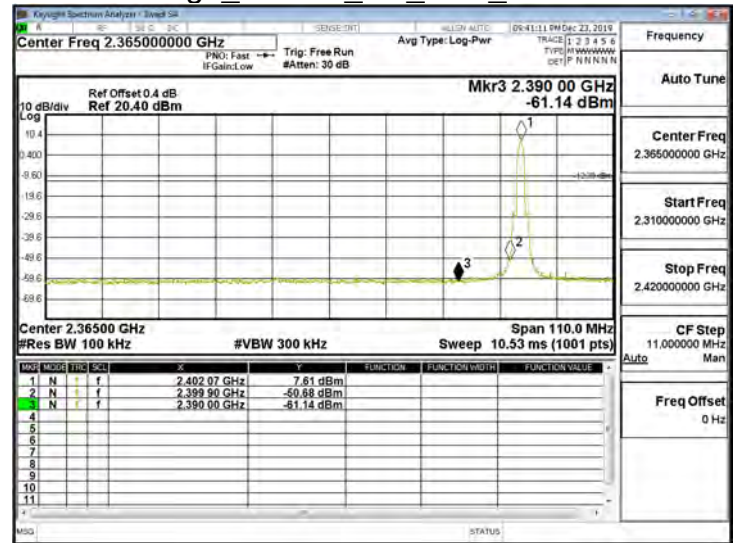
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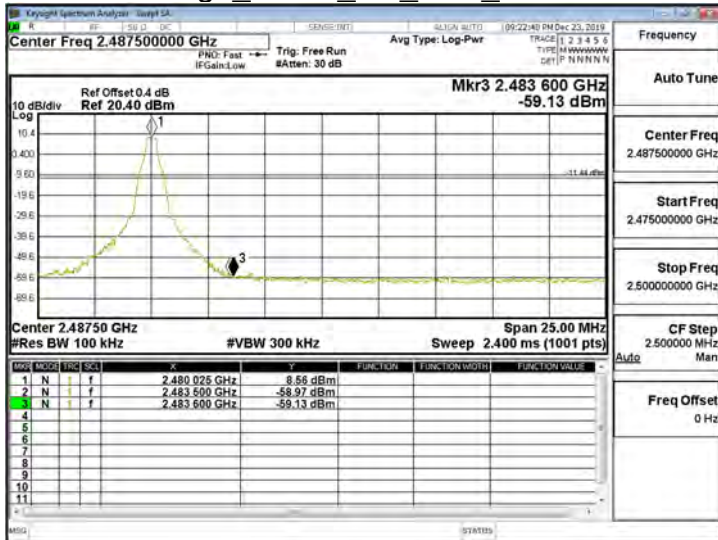
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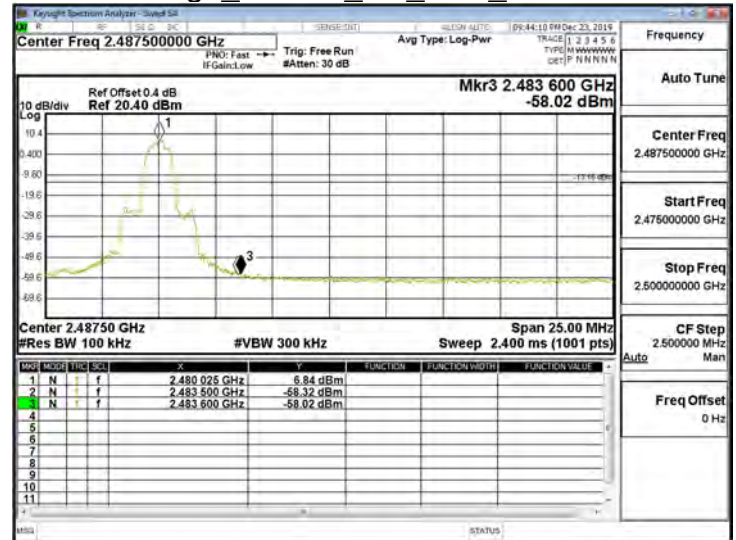
Band Edge_8DPSK_3M_DH5_2402MHz



Band Edge_GFSK_1M_DH5_2480MHz



Band Edge_8DPSK_3M_DH5_2480MHz

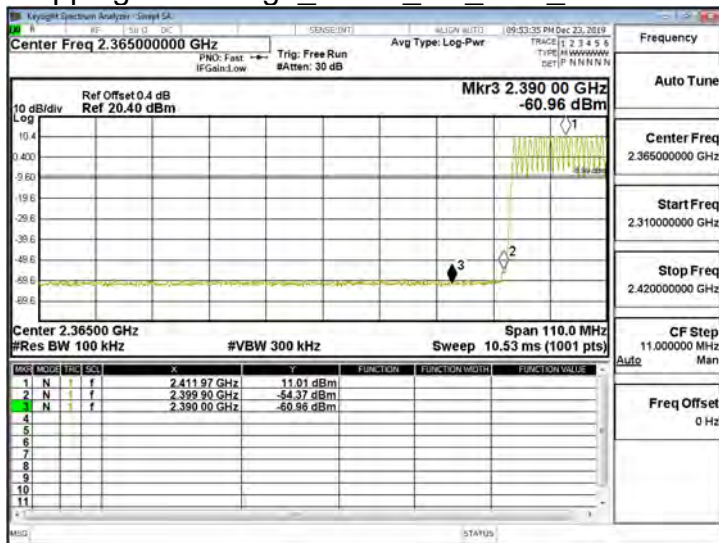


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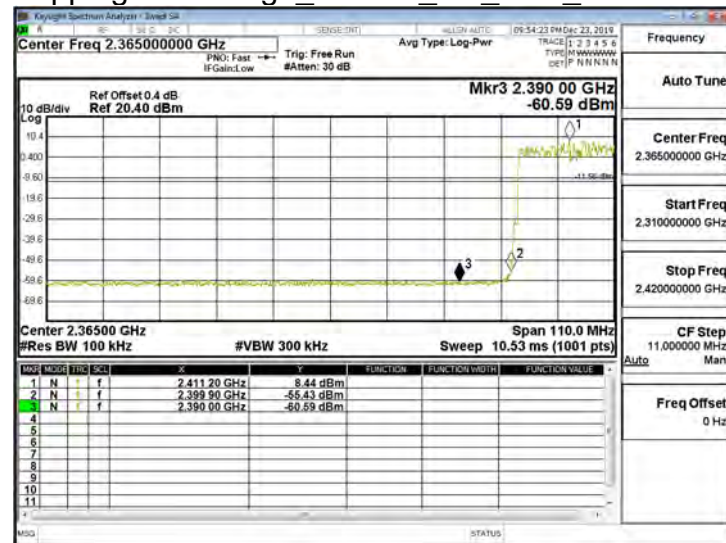
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Hopping Band Edge_GFSK_1M_DH5_2402MHz



Hopping Band Edge_8DPSK_3M_DH5_2402MHz



Hopping Band Edge_GFSK_1M_DH5_2480MHz



Hopping Band Edge_8DPSK_3M_DH5_2480MHz

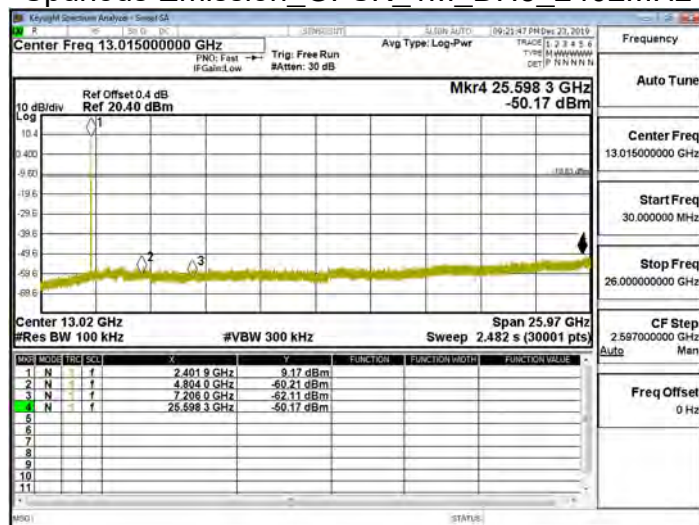


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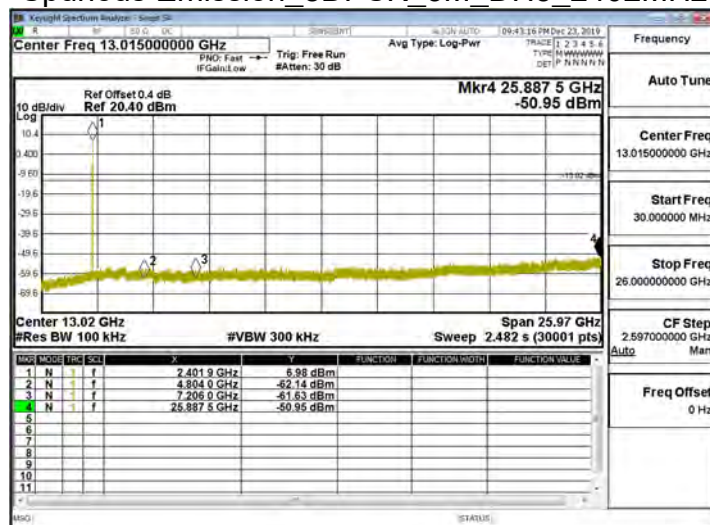
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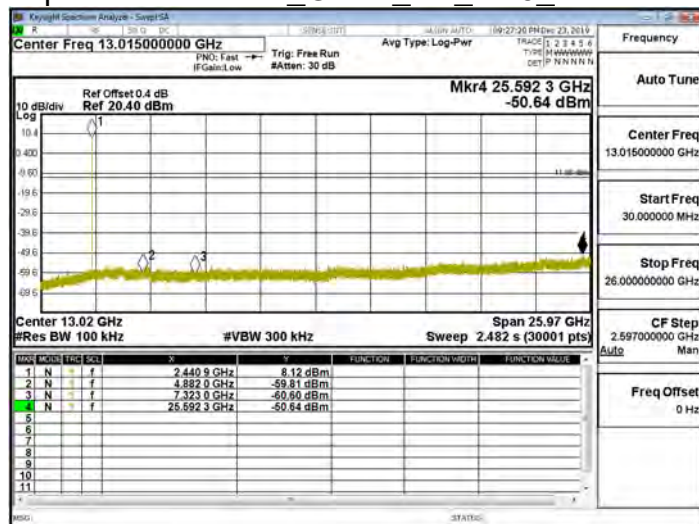
Spurious Emission_GFSK_1M_DH5_2402MHz



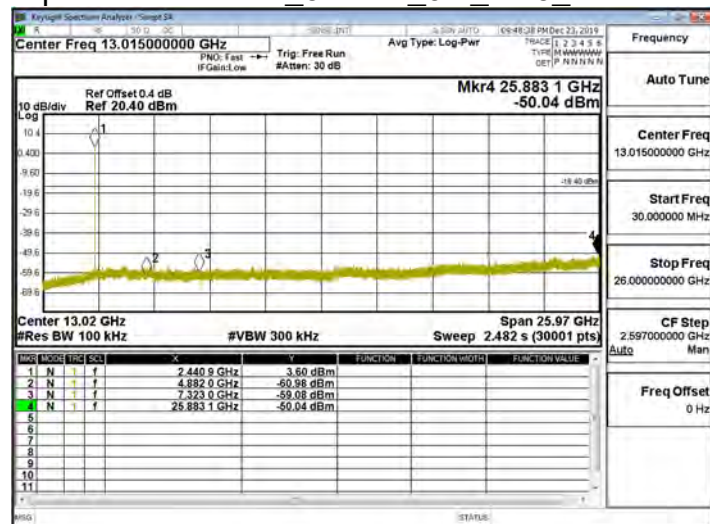
Spurious Emission_8DPSK_3M_DH5_2402MHz



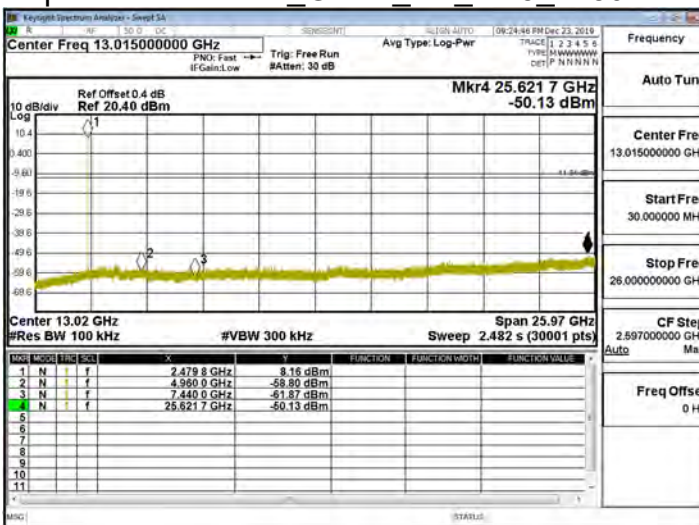
Spurious Emission_GFSK_1M_DH5_2441MHz



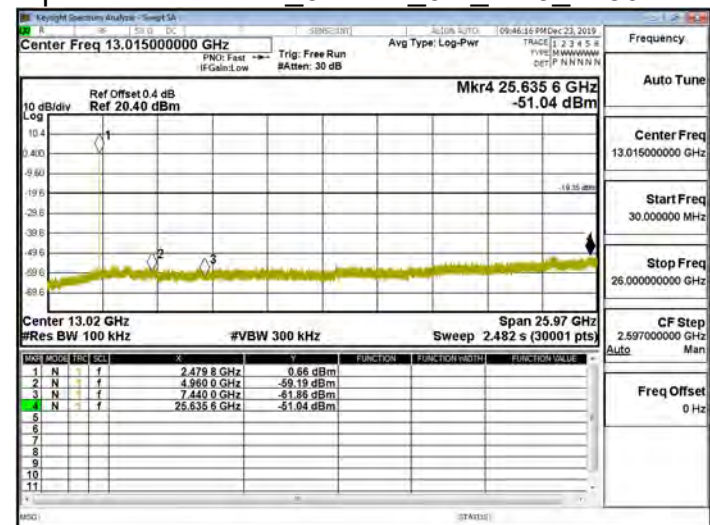
Spurious Emission_8DPSK_3M_DH5_2441MHz



Spurious Emission_GFSK_1M_DH5_2480MHz



Spurious Emission_8DPSK_3M_DH5_2480MHz



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10 RADIATED BANDEGE AND SPURIOUS EMISSION MEASUREMENT

10.1 Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands 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.
2. Emission level (dBμV/m) = 20 log Emission level (dBμV/m)

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10.2 Measurement Equipment Used

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Broadband Antenna	SCHWAZBECK	VULB 9168	9168-617	11/04/2019	11/03/2020
Horn Antenna	Schwarzbeck	BBHA9170	185	08/07/2019	08/06/2020
Horn Antenna	Schwarzbeck	BBHA9120D	1341	06/12/2019	06/11/2020
Loop Antenna	ETS.LIND-GREN	6502	143303	04/25/2019	04/24/2020
3m Site NSA	SGS	966 chamber D	N/A	07/12/2019	07/11/2020
Spectrum Analyzer	KEYSIGHT	N9010A	MY54510568	06/10/2019	06/09/2020
Pre-Amplifier	EMC Instruments	EMC184045B	980135	11/20/2019	11/19/2020
Pre-Amplifier	EMC Instruments	EMC9135	980234	11/20/2019	11/19/2020
Pre-Amplifier	EMC Instruments	EMC12630SE	980271	11/20/2019	11/19/2020
Attenuator	Woken	WATT-218FS-10	RF25	11/20/2019	11/19/2020
High Pass Filter	R&S	F13 HPF 3GHz	RF64	11/20/2019	11/19/2020
Low Pass Filter	EWT	EWT-56-0019	RF46	11/20/2019	11/19/2020
Notch Filter	EWT	EWT-54-0038	RF55	11/20/2019	11/19/2020
Coaxial Cable	Huber Suhner	SUCOFLEX 104	MY17388/4	11/20/2019	11/19/2020
Coaxial Cable	Huber Suhner	RG 214/U	W22.03	11/20/2019	11/19/2020
Coaxial Cable	Huber Suhner	SUCOFLEX 104	MY17413/4	11/20/2019	11/19/2020

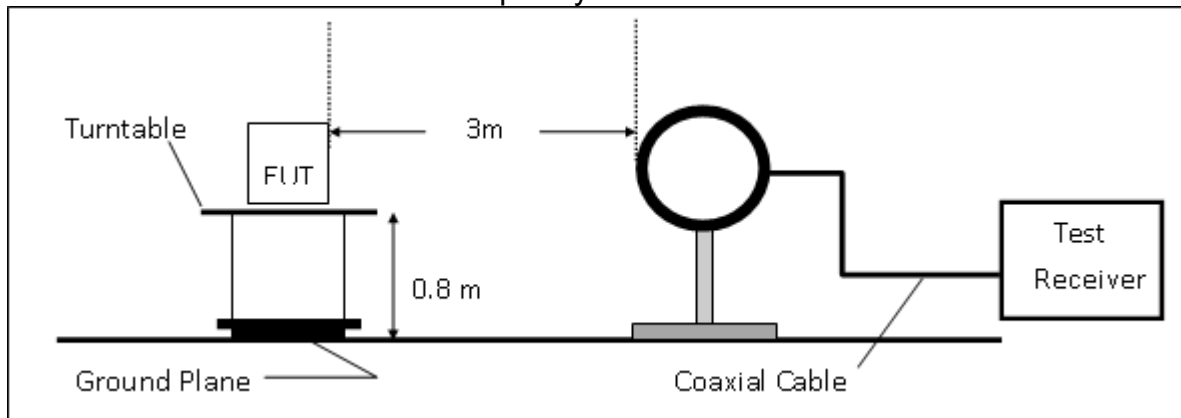
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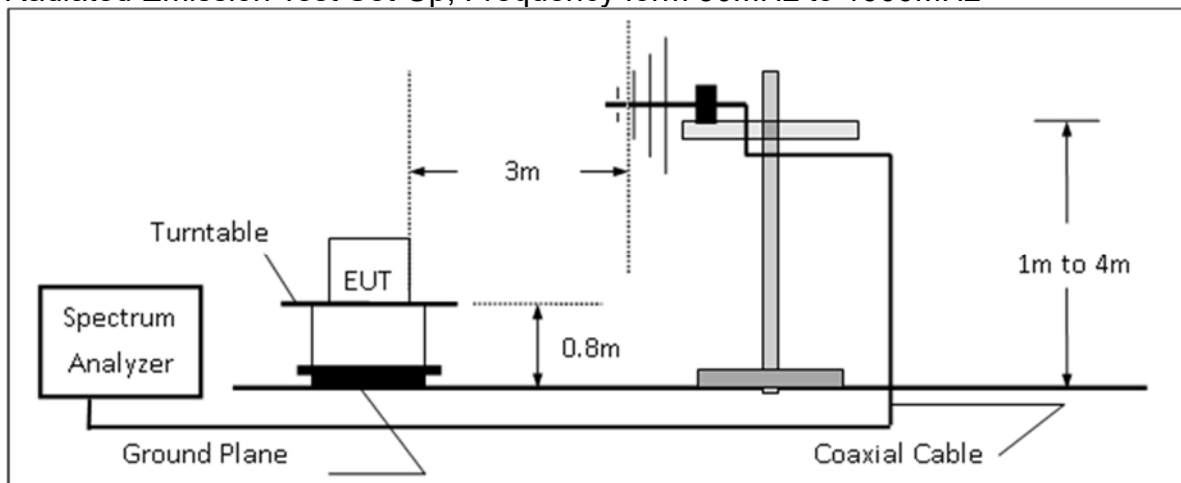
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10.3 Test SET-UP

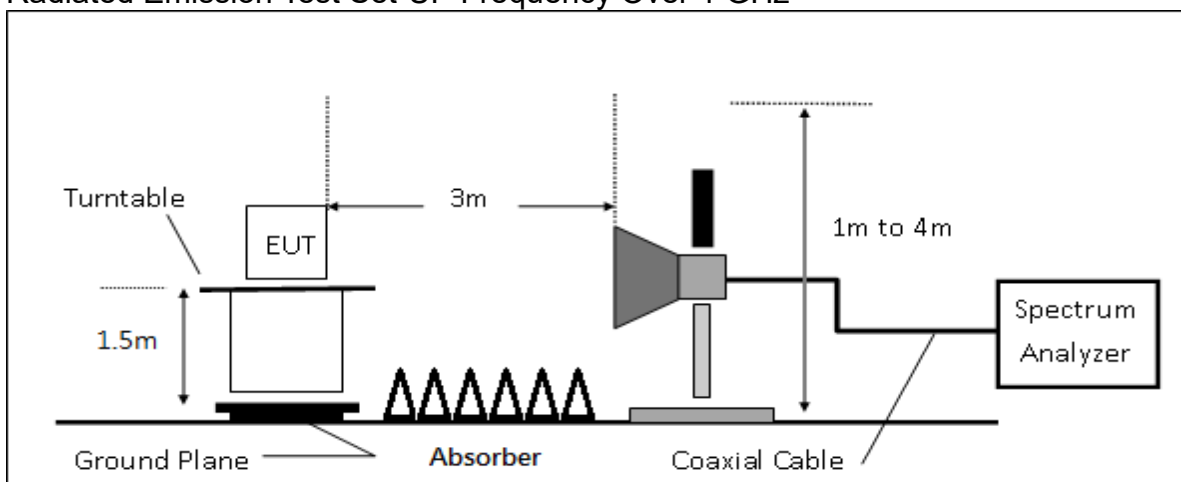
(A) Radiated Emission Test Set-UP Frequency Below 30MHz.



(B) Radiated Emission Test Set-UP, Frequency form 30MHz to 1000MHz



(C) Radiated Emission Test Set-UP Frequency Over 1 GHz



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10.4 Measurement Procedure

10.4.1 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 plan.
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=120 kHz and VBW=300 kHz for Peak Detector (PK) and Quasi-peak (QP) at frequency below 1 GHz.
6. Set the spectrum analyzer as RBW=1 MHz, VBW=3 MHz for Peak Detector at frequency above 1 GHz.
7. Set the spectrum analyzer as RBW=1 MHz, VBW=10 Hz (Duty cycle > 98%) or VBW ≥ 1/T (Duty cycle < 98%) for Average Detector at frequency above 1 GHz.
8. 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.
9. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
10. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. On spectrum, change spectrum mode in linear display mode, and reduce VBW = 10Hz if average reading is measured.
11. Repeat above procedures until all default test channel measured were complete.

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10.5 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)

10.6 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.

10.7 Measurement Result:

Note: Refer to next page spectrum analyzer data chart and tabular data sheets.

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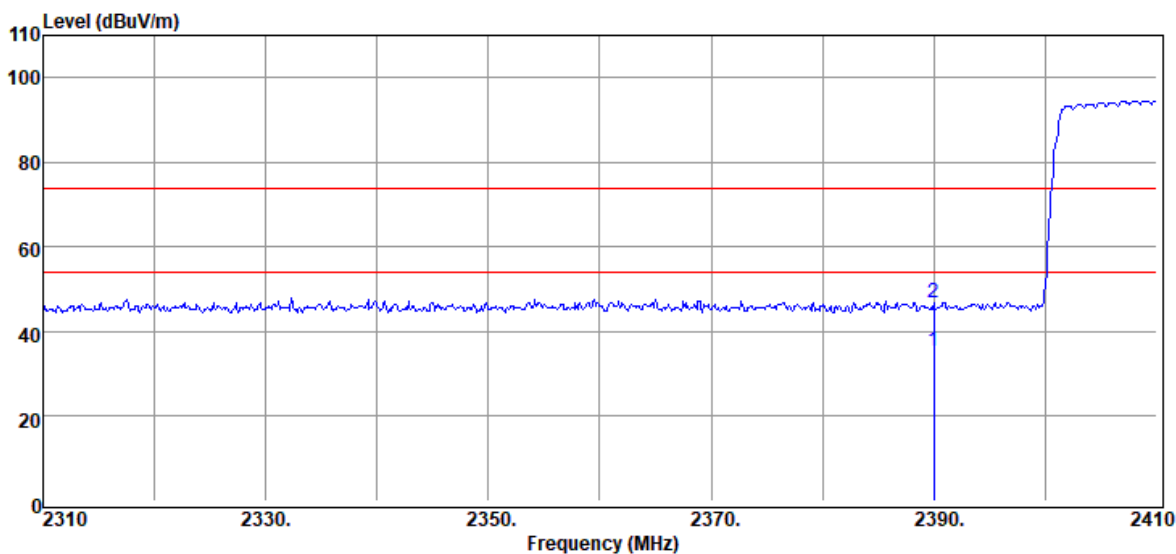
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10.7.1 Radiated Bandedge Result (Hopping Mode)

Report Number :E2/2019/C0006
Operation Mode :BT BR Hopping
Test Channel :2402 MHz
Test Mode :BE CH LOW
EUT Pol :E2 Plan

Test Date :2019-12-23
Temp./Humi. :22.5/63
Antenna Pol. :VERTICAL
Engineer :Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2390.00	Average	40.85	-5.52	35.33	54.00	-18.67
2390.00	Peak	52.51	-5.52	46.99	74.00	-27.01

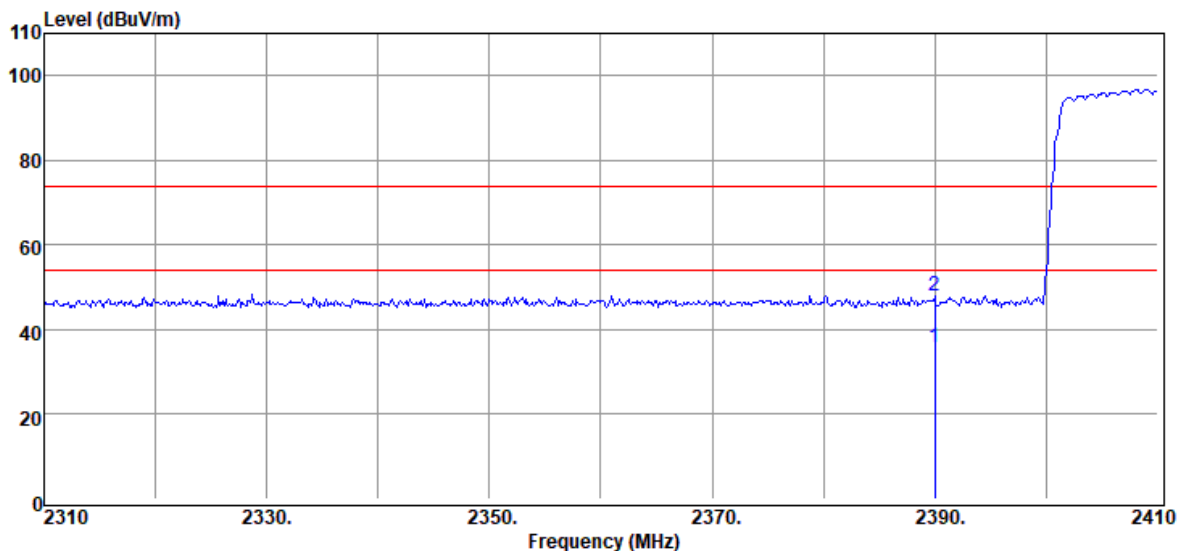
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Report Number :E2/2019/C0006
 Operation Mode :BT BR Hopping
 Test Channel :2402 MHz
 Test Mode :BE CH LOW
 EUT Pol :E2 Plan

Test Date :2019-12-23
 Temp./Humi. :22.5/63
 Antenna Pol. :HORIZONTAL
 Engineer :Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
2390.00	Average	41.29	-5.52	35.77	54.00	-18.23
2390.00	Peak	53.47	-5.52	47.95	74.00	-26.05

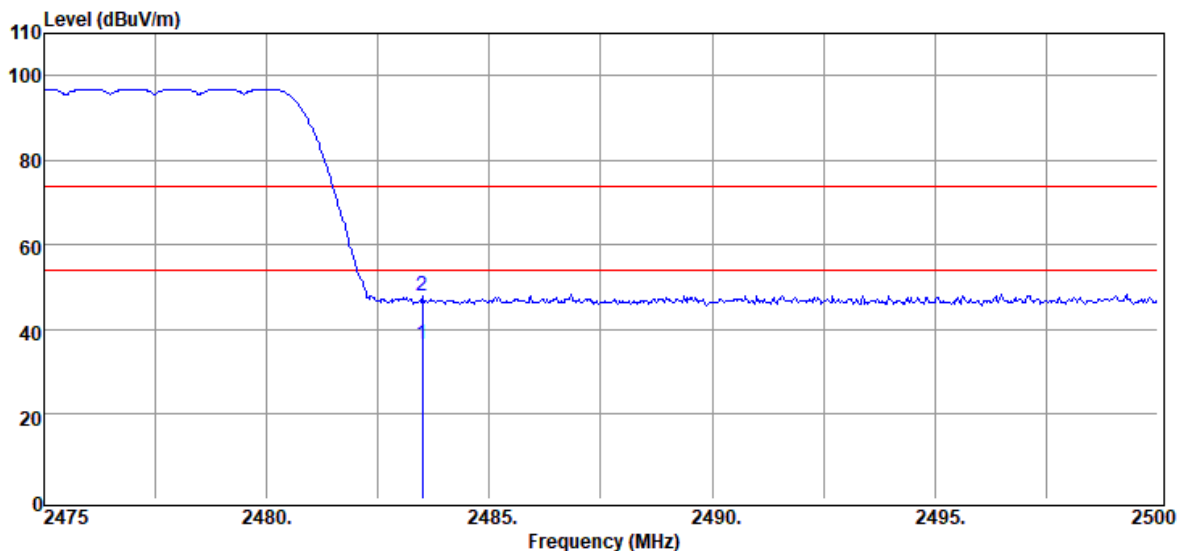
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Report Number :E2/2019/C0006
 Operation Mode :BT BR Hopping
 Test Channel :2480 MHz
 Test Mode :BE CH HIGH
 EUT Pol :E2 Plan

Test Date :2019-12-23
 Temp./Humi. :22.5/63
 Antenna Pol. :VERTICAL
 Engineer :Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
2483.50	Average	41.83	-5.42	36.41	54.00	-17.59
2483.50	Peak	53.53	-5.42	48.11	74.00	-25.89

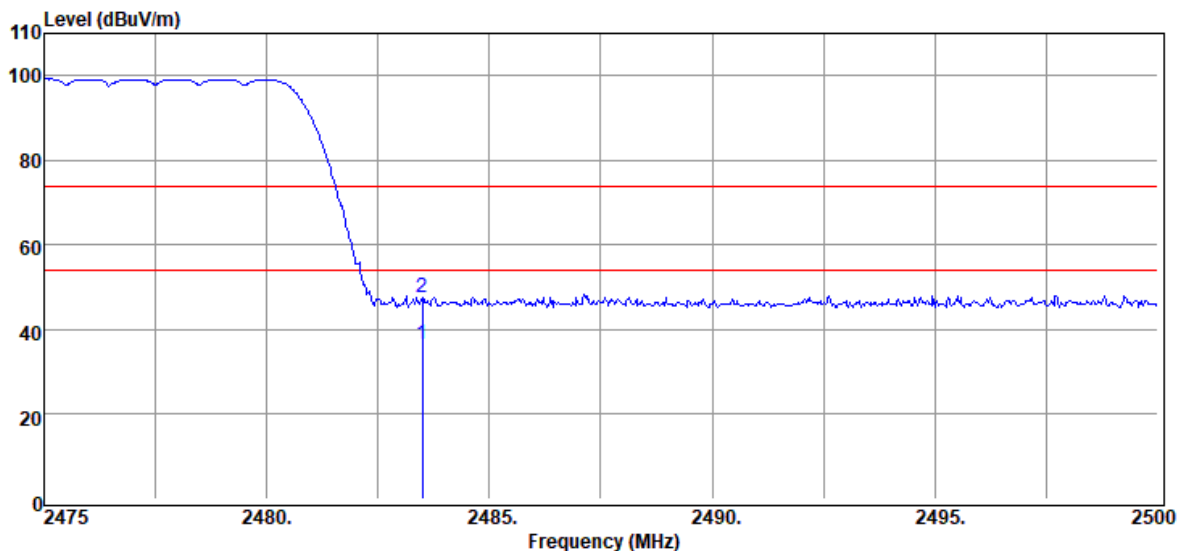
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Report Number :E2/2019/C0006
Operation Mode :BT BR Hopping
Test Channel :2480 MHz
Test Mode :BE CH HIGH
EUT Pol :E2 Plan

Test Date :2019-12-23
Temp./Humi. :22.5/63
Antenna Pol. :HORIZONTAL
Engineer :Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
2483.50	Average	41.94	-5.42	36.52	54.00	-17.48
2483.50	Peak	53.06	-5.42	47.64	74.00	-26.36

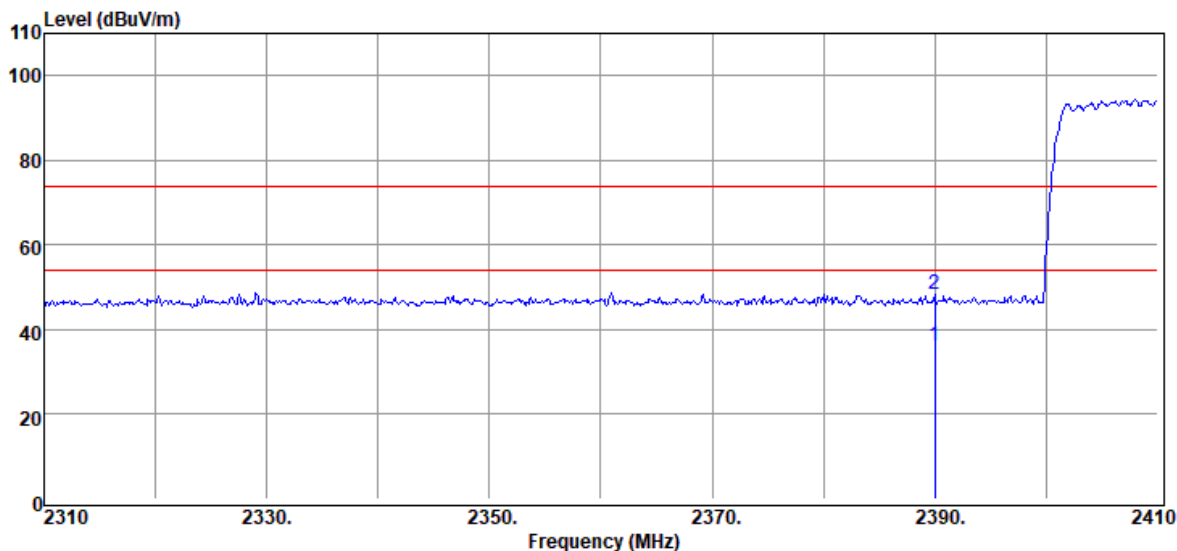
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Report Number :E2/2019/C0006
Operation Mode :BT EDR Hopping
Test Channel :2402 MHz
Test Mode :BE CH LOW
EUT Pol :E2 Plan

Test Date :2019-12-23
Temp./Humi. :22.5/63
Antenna Pol. :VERTICAL
Engineer :Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2390.00	Average	41.78	-5.52	36.26	54.00	-17.74
2390.00	Peak	53.82	-5.52	48.30	74.00	-25.70

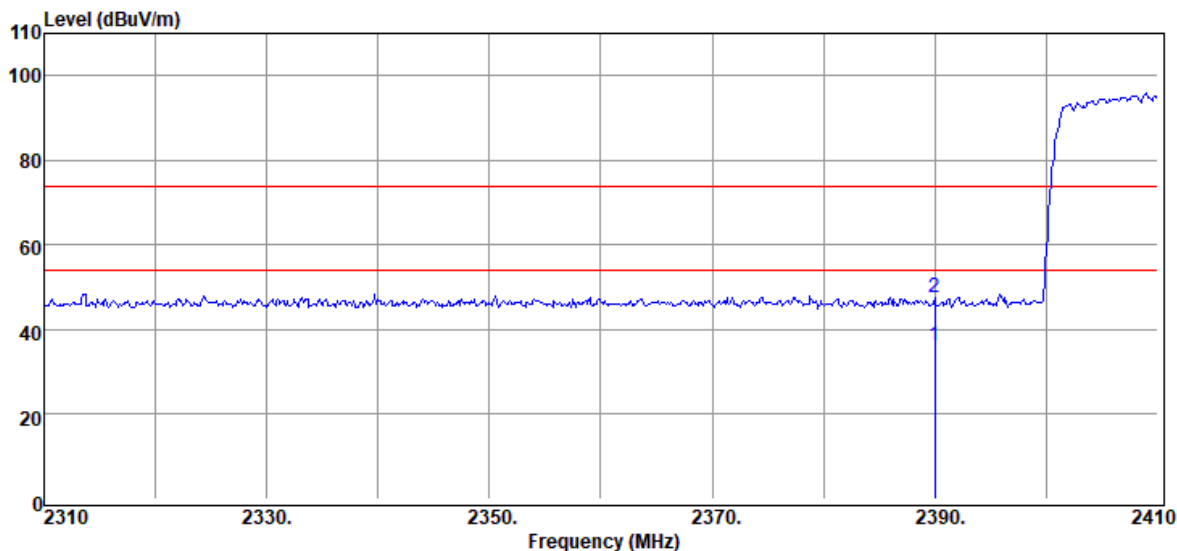
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Report Number :E2/2019/C0006
Operation Mode :BT EDR Hopping
Test Channel :2402 MHz
Test Mode :BE CH LOW
EUT Pol :E2 Plan

Test Date :2019-12-23
Temp./Humi. :22.5/63
Antenna Pol. :HORIZONTAL
Engineer :Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
2390.00	Average	41.85	-5.52	36.33	54.00	-17.67
2390.00	Peak	53.23	-5.52	47.71	74.00	-26.29

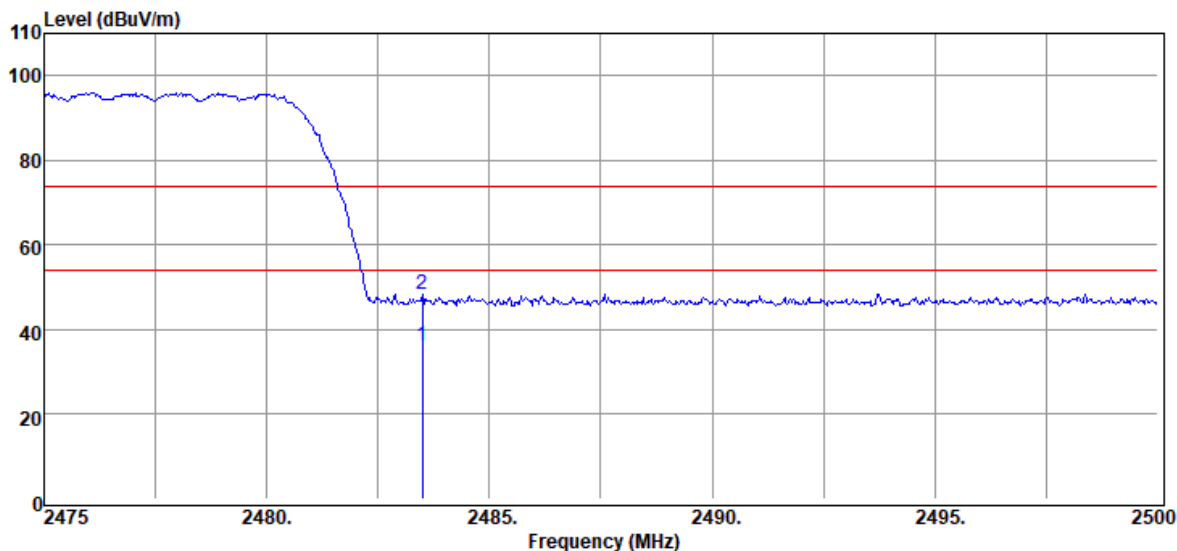
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Report Number :E2/2019/C0006
Operation Mode :BT EDR Hopping
Test Channel :2480 MHz
Test Mode :BE CH HIGH
EUT Pol :E2 Plan

Test Date :2019-12-23
Temp./Humi. :22.5/63
Antenna Pol. :VERTICAL
Engineer :Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
2483.50	Average	41.64	-5.42	36.22	54.00	-17.78
2483.50	Peak	53.63	-5.42	48.21	74.00	-25.79

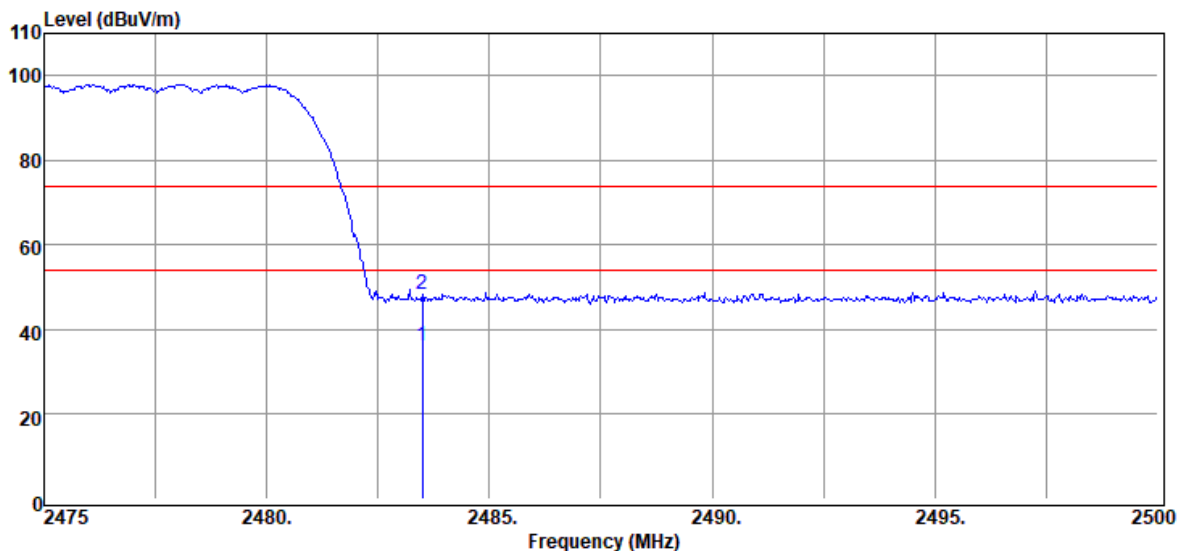
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Report Number :E2/2019/C0006
Operation Mode :BT EDR Hopping
Test Channel :2480 MHz
Test Mode :BE CH HIGH
EUT Pol :E2 Plan

Test Date :2019-12-23
Temp./Humi. :22.5/63
Antenna Pol. :HORIZONTAL
Engineer :Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
2483.50	Average	41.54	-5.42	36.12	54.00	-17.88
2483.50	Peak	53.75	-5.42	48.33	74.00	-25.67

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

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10.7.2 Radiated Bandedge Result (Non-Hopping Mode)

Report Number :E2/2019/C0006

Test Date :2019-12-23

Operation Mode :BT BR

Temp./Humi. :22.5/63

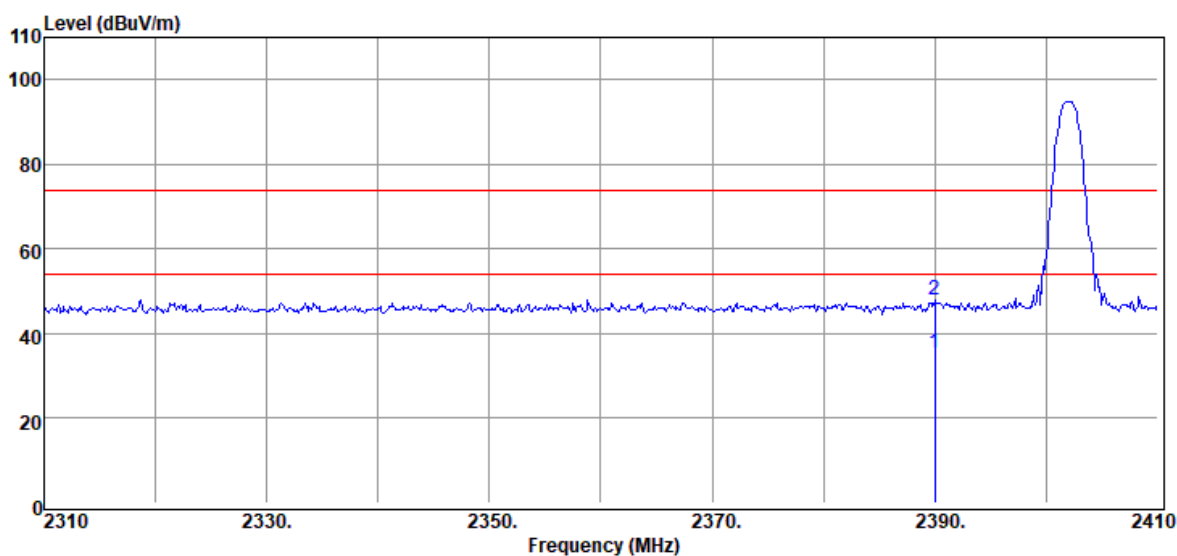
Test Channel :2402 MHz

Antenna Pol. :VERTICAL

Test Mode :BE CH LOW

Engineer :Kailin

EUT Pol :E2 Plan



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2390.00	Average	41.03	-5.52	35.51	54.00	-18.49
2390.00	Peak	53.54	-5.52	48.02	74.00	-25.98

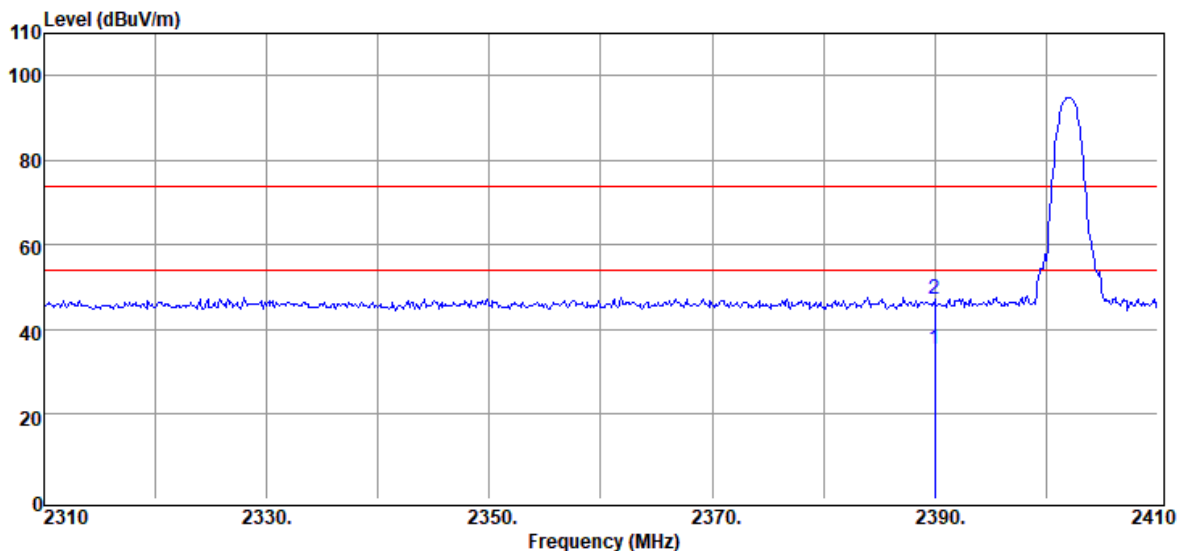
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Report Number :E2/2019/C0006
Operation Mode :BT BR
Test Channel :2402 MHz
Test Mode :BE CH LOW
EUT Pol :E2 Plan

Test Date :2019-12-23
Temp./Humi. :22.5/63
Antenna Pol. :HORIZONTAL
Engineer :Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
2390.00	Average	41.09	-5.52	35.57	54.00	-18.43
2390.00	Peak	52.61	-5.52	47.09	74.00	-26.91

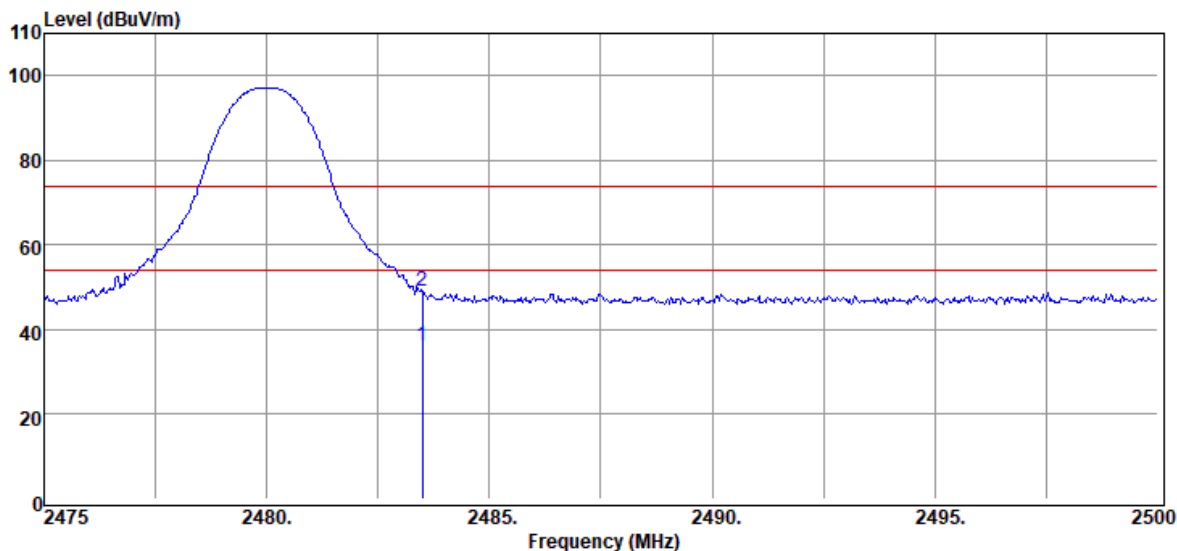
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Report Number :E2/2019/C0006
 Operation Mode :BT BR
 Test Channel :2480 MHz
 Test Mode :BE CH HIGH
 EUT Pol :E2 Plan

Test Date :2019-12-23
 Temp./Humi. :22.5/63
 Antenna Pol. :VERTICAL
 Engineer :Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
2483.50	Average	41.61	-5.42	36.19	54.00	-17.81
2483.50	Peak	54.50	-5.42	49.08	74.00	-24.92

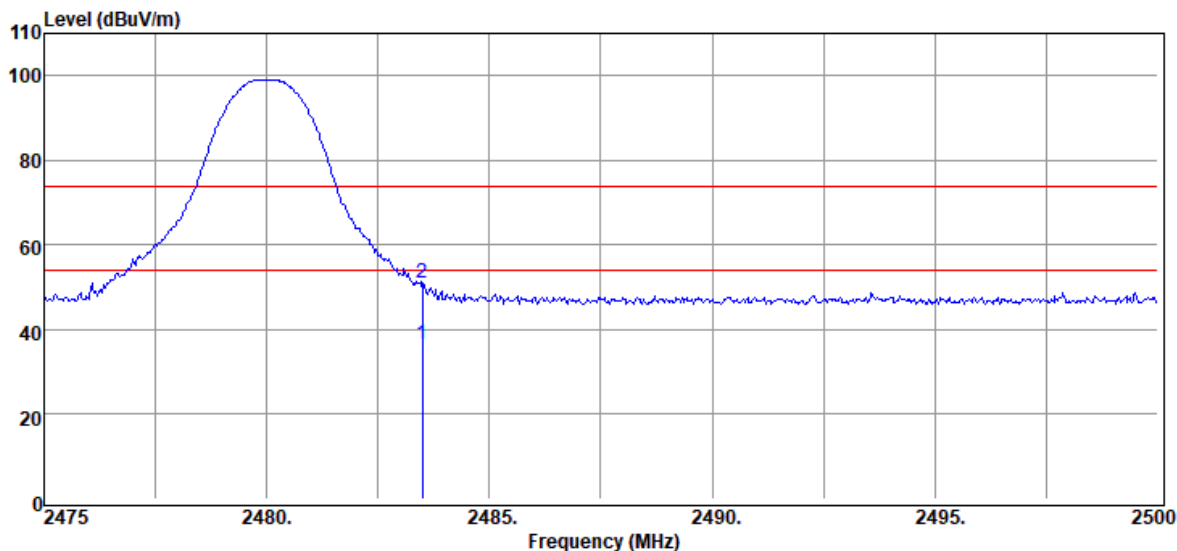
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Report Number :E2/2019/C0006
 Operation Mode :BT BR
 Test Channel :2480 MHz
 Test Mode :BE CH HIGH
 EUT Pol :E2 Plan

Test Date :2019-12-23
 Temp./Humi. :22.5/63
 Antenna Pol. :HORIZONTAL
 Engineer :Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
2483.50	Average	41.91	-5.42	36.49	54.00	-17.51
2483.50	Peak	56.57	-5.42	51.15	74.00	-22.85

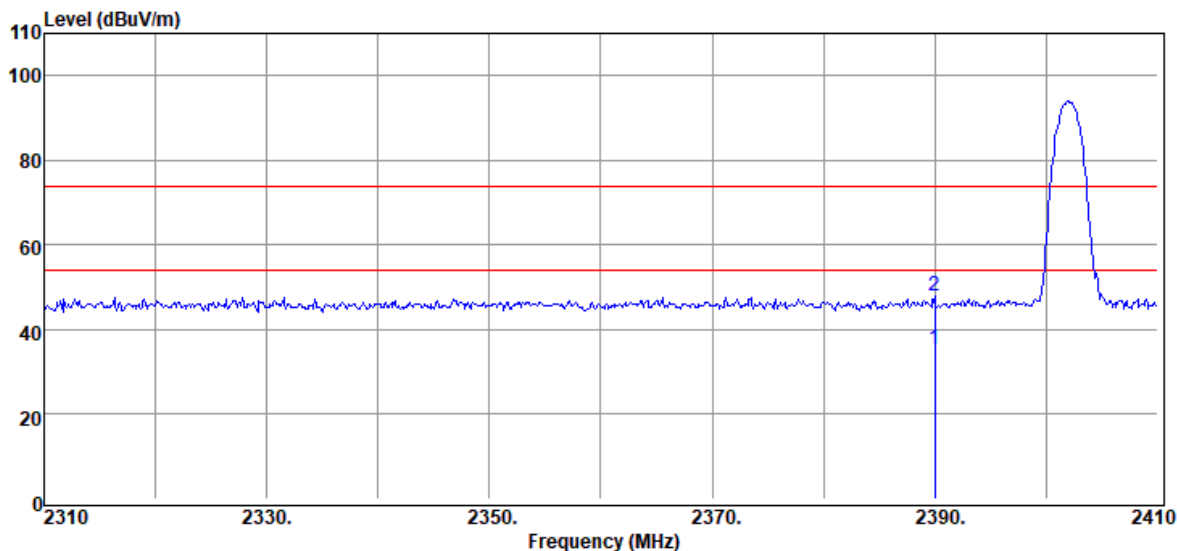
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Report Number :E2/2019/C0006
Operation Mode :BT EDR
Test Channel :2402 MHz
Test Mode :BE CH LOW
EUT Pol :E2 Plan

Test Date :2019-12-23
Temp./Humi. :22.5/63
Antenna Pol. :VERTICAL
Engineer :Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
2390.00	Average	41.08	-5.52	35.56	54.00	-18.44
2390.00	Peak	53.43	-5.52	47.91	74.00	-26.09

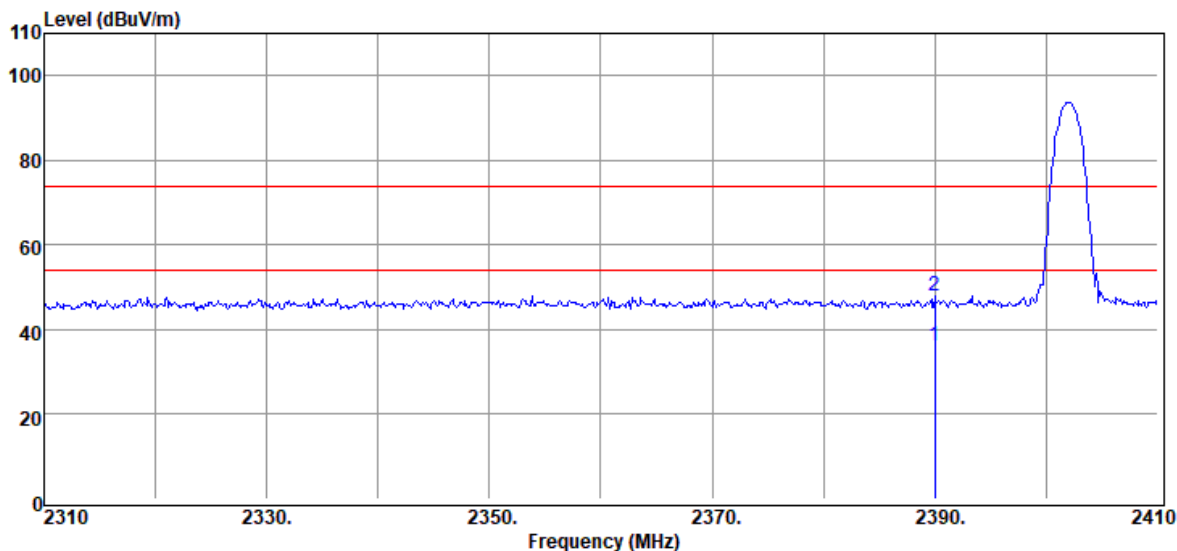
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Report Number :E2/2019/C0006
Operation Mode :BT EDR
Test Channel :2402 MHz
Test Mode :BE CH LOW
EUT Pol :E2 Plan

Test Date :2019-12-23
Temp./Humi. :22.5/63
Antenna Pol. :HORIZONTAL
Engineer :Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
2390.00	Average	41.67	-5.52	36.15	54.00	-17.85
2390.00	Peak	53.30	-5.52	47.78	74.00	-26.22

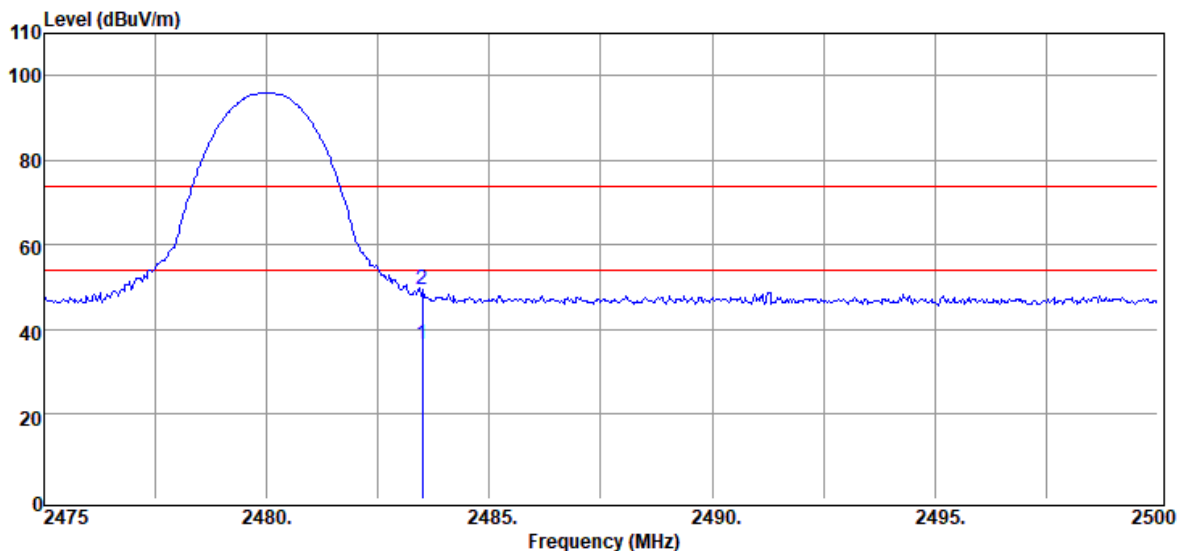
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Report Number :E2/2019/C0006
 Operation Mode :BT EDR
 Test Channel :2480 MHz
 Test Mode :BE CH HIGH
 EUT Pol :E2 Plan

Test Date :2019-12-23
 Temp./Humi. :22.5/63
 Antenna Pol. :VERTICAL
 Engineer :Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBUV	Factor dB	Actual FS dBUV/m	Limit @3m dBUV/m	Margin dB
2483.50	Average	41.91	-5.42	36.49	54.00	-17.51
2483.50	Peak	54.80	-5.42	49.38	74.00	-24.62

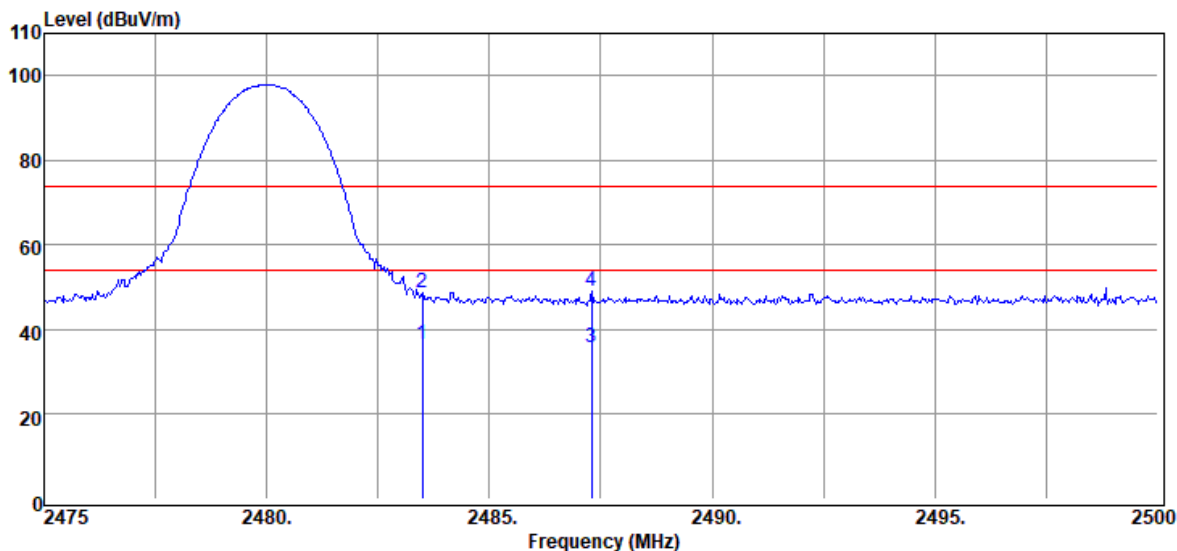
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Report Number :E2/2019/C0006
 Operation Mode :BT EDR
 Test Channel :2480 MHz
 Test Mode :BE CH HIGH
 EUT Pol :E2 Plan

Test Date :2019-12-23
 Temp./Humi. :22.5/63
 Antenna Pol. :HORIZONTAL
 Engineer :Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
2483.50	Average	41.83	-5.42	36.41	54.00	-17.59
2483.50	Peak	54.21	-5.42	48.79	74.00	-25.21
2487.30	Average	41.22	-5.42	35.80	54.00	-18.20
2487.30	Peak	54.39	-5.42	48.97	74.00	-25.03

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10.7.3 Radiated Spurious Emission form 30MHz to 1000MHz:

Report Number :E2/2019/C0006

Test Date :2019-12-23

Operation Mode :BT BR

Temp./Humi. :22.5/63

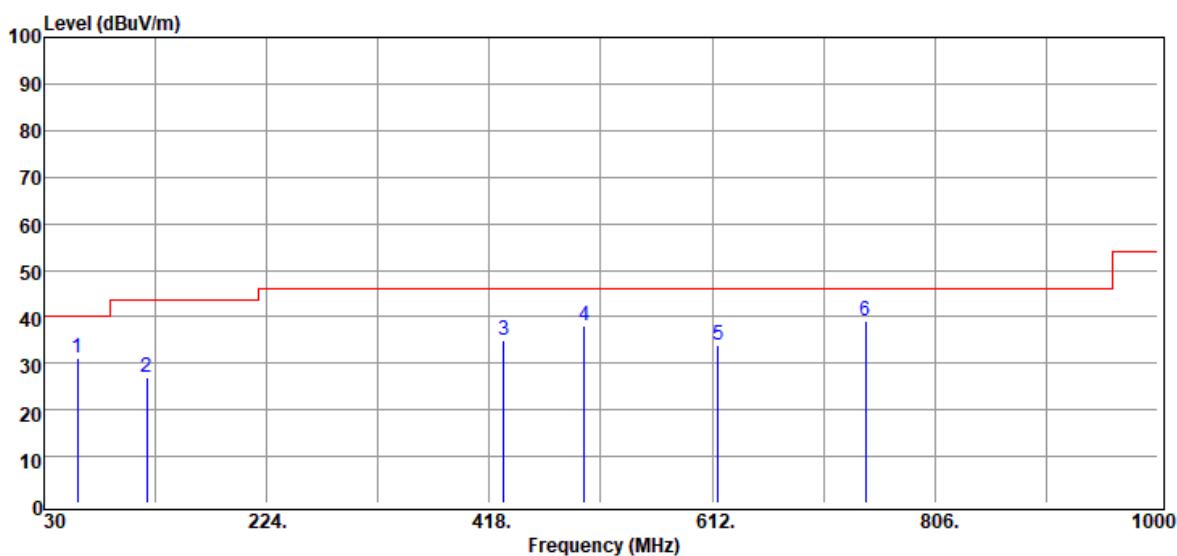
Test Channel :2441 MHz

Antenna Pol. :VERTICAL

Test Mode :TX CH MID

Engineer :Kailin

EUT Pol :E2 Plan



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
59.10	Peak	48.69	-17.41	31.28	40.00	-8.72
119.24	Peak	45.68	-18.85	26.83	43.50	-16.67
430.61	Peak	47.13	-12.02	35.11	46.00	-10.89
500.45	Peak	49.05	-11.11	37.94	46.00	-8.06
616.85	Peak	42.35	-8.30	34.05	46.00	-11.95
745.86	Peak	45.88	-6.86	39.02	46.00	-6.98

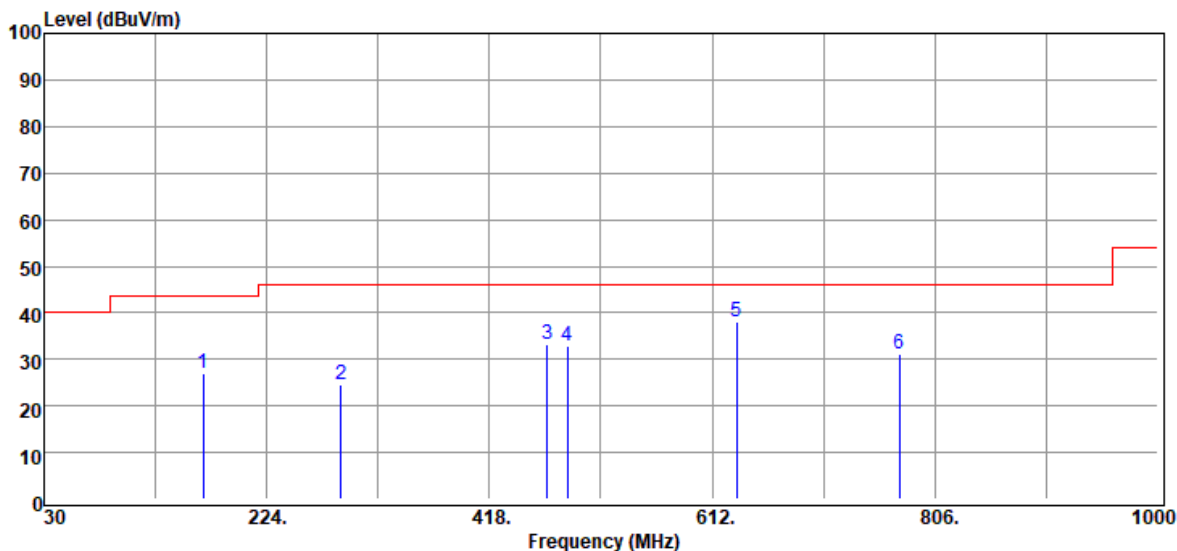
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Report Number :E2/2019/C0006
Operation Mode :BT BR
Test Channel :2441 MHz
Test Mode :TX CH MID
EUT Pol :E2 Plan

Test Date :2019-12-23
Temp./Humi. :22.5/63
Antenna Pol. :HORIZONTAL
Engineer :Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
168.71	Peak	42.96	-16.08	26.88	43.50	-16.62
288.99	Peak	40.08	-15.58	24.50	46.00	-21.50
468.44	Peak	44.46	-11.38	33.08	46.00	-12.92
485.90	Peak	43.89	-11.14	32.75	46.00	-13.25
633.34	Peak	46.04	-8.10	37.94	46.00	-8.06
774.96	Peak	37.86	-6.60	31.26	46.00	-14.74

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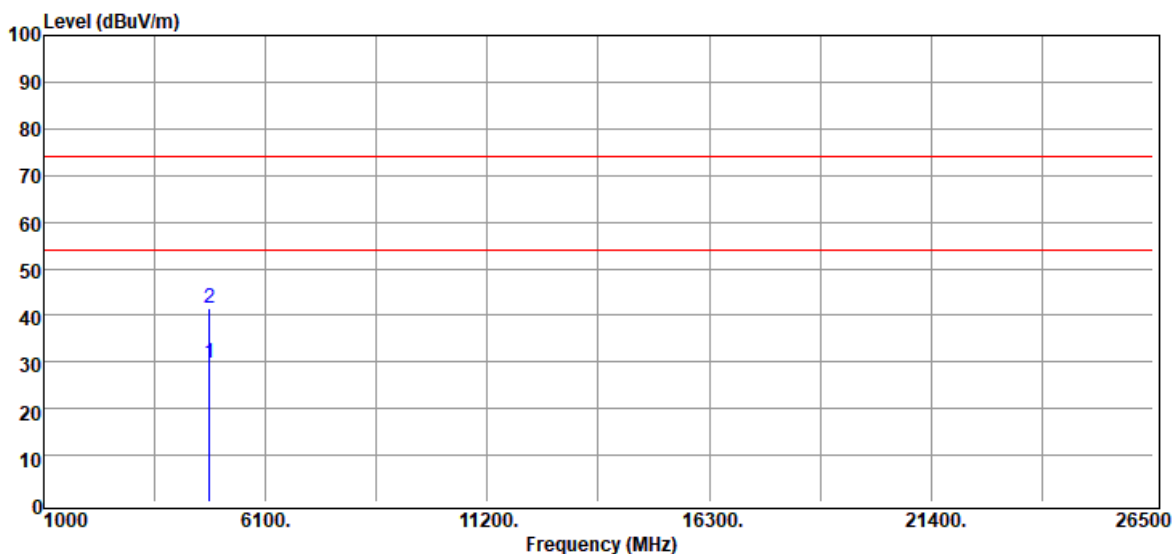
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10.7.4 Radiated Spurious Emission above 1 GHz:

Report Number :E2/2019/C0006
Operation Mode :BT BR
Test Channel :2402 MHz
Test Mode :TX CH LOW
EUT Pol :E2 Plan

Test Date :2019-12-23
Temp./Humi. :22.9/63
Antenna Pol. :VERTICAL
Engineer :Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
4804.00	Average	29.94	-0.35	29.59	54.00	-24.41
4804.00	Peak	41.84	-0.35	41.49	74.00	-32.51

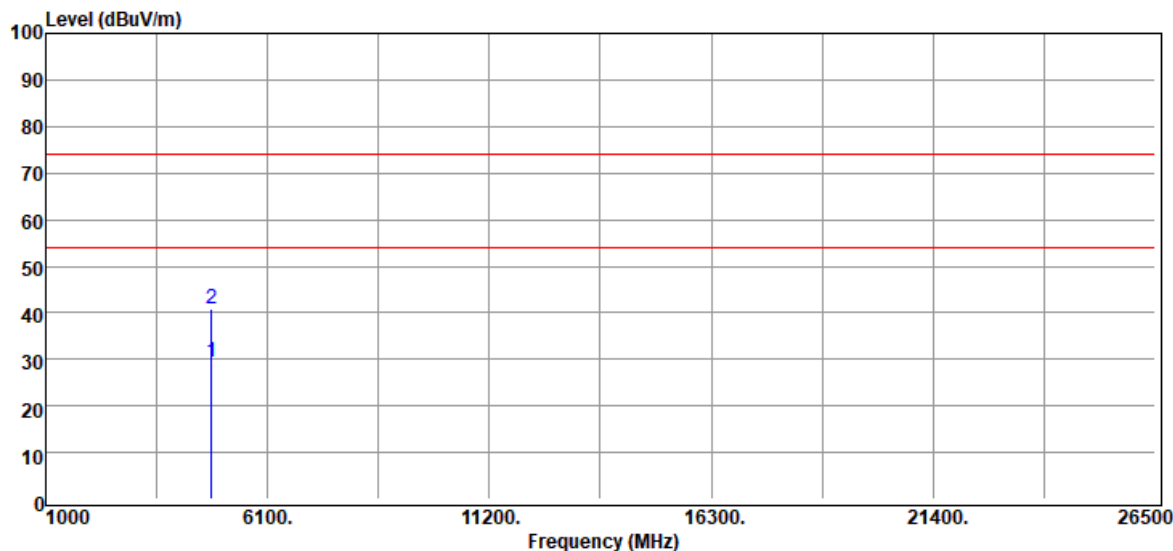
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Report Number :E2/2019/C0006
Operation Mode :BT BR
Test Channel :2402 MHz
Test Mode :TX CH LOW
EUT Pol :E2 Plan

Test Date :2019-12-23
Temp./Humi. :22.9/63
Antenna Pol. :HORIZONTAL
Engineer :Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
4804.00	Average	29.84	-0.35	29.49	54.00	-24.51
4804.00	Peak	41.03	-0.35	40.68	74.00	-33.32

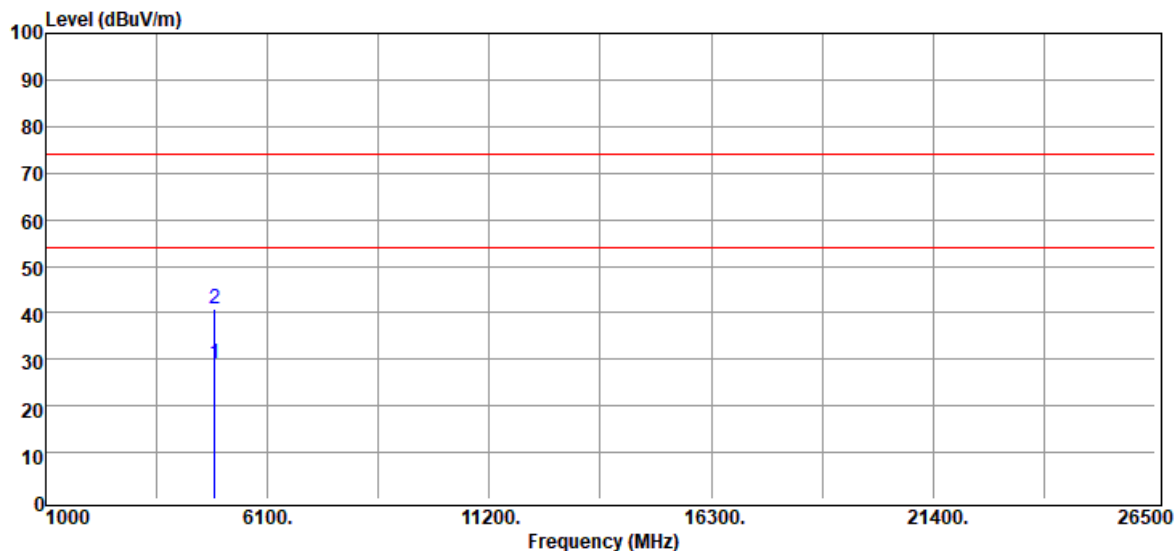
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Report Number :E2/2019/C0006
Operation Mode :BT BR
Test Channel :2441 MHz
Test Mode :TX CH MID
EUT Pol :E2 Plan

Test Date :2019-12-23
Temp./Humi. :22.9/63
Antenna Pol. :VERTICAL
Engineer :Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4882.00	Average	29.33	-0.44	28.89	54.00	-25.11
4882.00	Peak	41.26	-0.44	40.82	74.00	-33.18

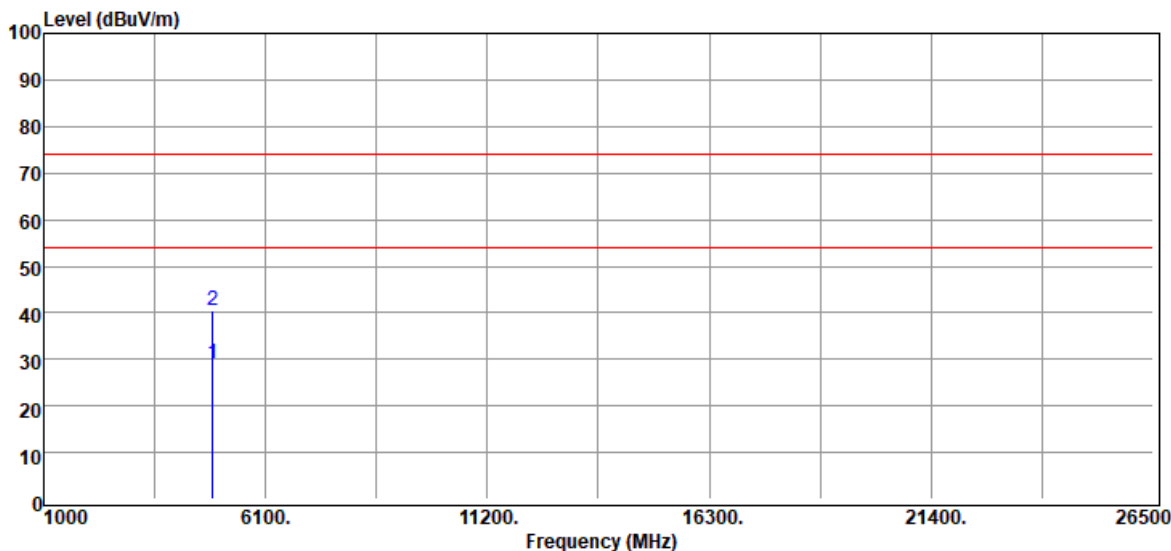
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Report Number :E2/2019/C0006
Operation Mode :BT BR
Test Channel :2441 MHz
Test Mode :TX CH MID
EUT Pol :E2 Plan

Test Date :2019-12-23
Temp./Humi. :22.9/63
Antenna Pol. :HORIZONTAL
Engineer :Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
4882.00	Average	29.41	-0.44	28.97	54.00	-25.03
4882.00	Peak	40.81	-0.44	40.37	74.00	-33.63

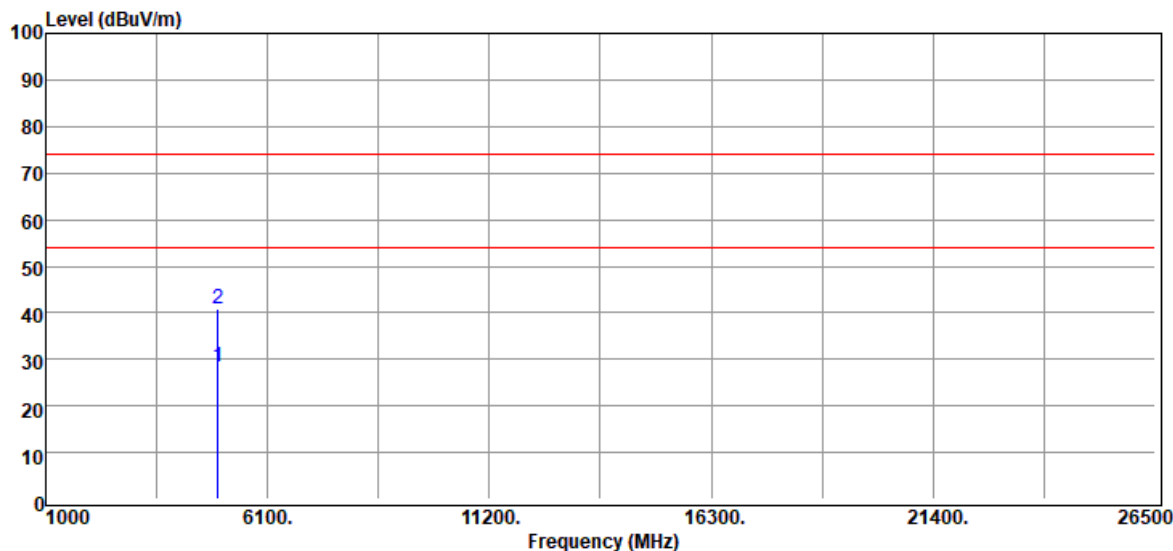
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Report Number :E2/2019/C0006
Operation Mode :BT BR
Test Channel :2480 MHz
Test Mode :TX CH HIGH
EUT Pol :E2 Plan

Test Date :2019-12-23
Temp./Humi. :22.9/63
Antenna Pol. :VERTICAL
Engineer :Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
4960.00	Average	29.16	-0.75	28.41	54.00	-25.59
4960.00	Peak	41.45	-0.75	40.70	74.00	-33.30

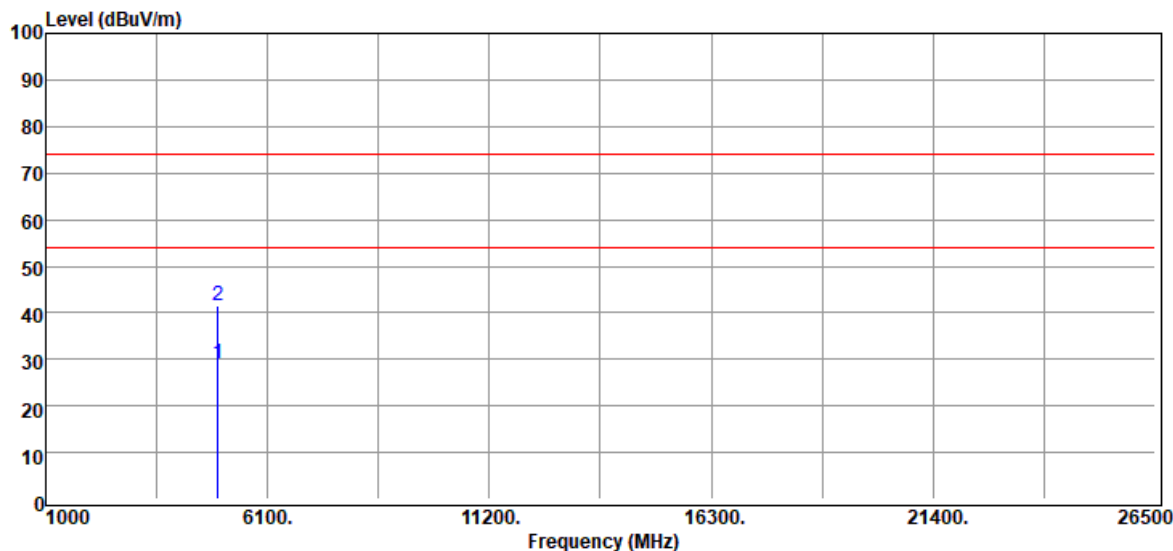
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Report Number :E2/2019/C0006
Operation Mode :BT BR
Test Channel :2480 MHz
Test Mode :TX CH HIGH
EUT Pol :E2 Plan

Test Date :2019-12-23
Temp./Humi. :22.9/63
Antenna Pol. :HORIZONTAL
Engineer :Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
4960.00	Average	29.71	-0.75	28.96	54.00	-25.04
4960.00	Peak	42.32	-0.75	41.57	74.00	-32.43

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11 FREQUENCY SEPARATION

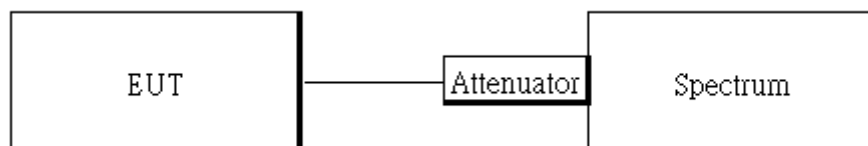
11.1 Standard Applicable

Frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25 kHz or the $2/3 \times 20\text{dB}$ bandwidth of the hopping channel, whichever is greater.

11.2 Measurement Equipment Used

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	KEYSIGHT	N9010A	MY57120200	03/06/2019	03/05/2020
DC Block	PASTERNAK	PE8210	RF256	11/20/2019	11/19/2020
Attenuator	Marvelous	MVE2213-10	RF80	11/20/2019	11/19/2020

11.3 Test Set-up



11.4 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 spectrum analyzer as RBW, VBW=100 kHz, Adjust Span to 5MHz, Sweep = auto.
6. Max hold. Mark 3 Peaks of hopping channel and record the 3 peaks frequency.

11.5 Measurement Result

Channel separation (MHz)	Limit	Result
1	$\geq 25\text{ kHz}$ or $2/3\text{ times } 20\text{dB bandwidth}$	PASS

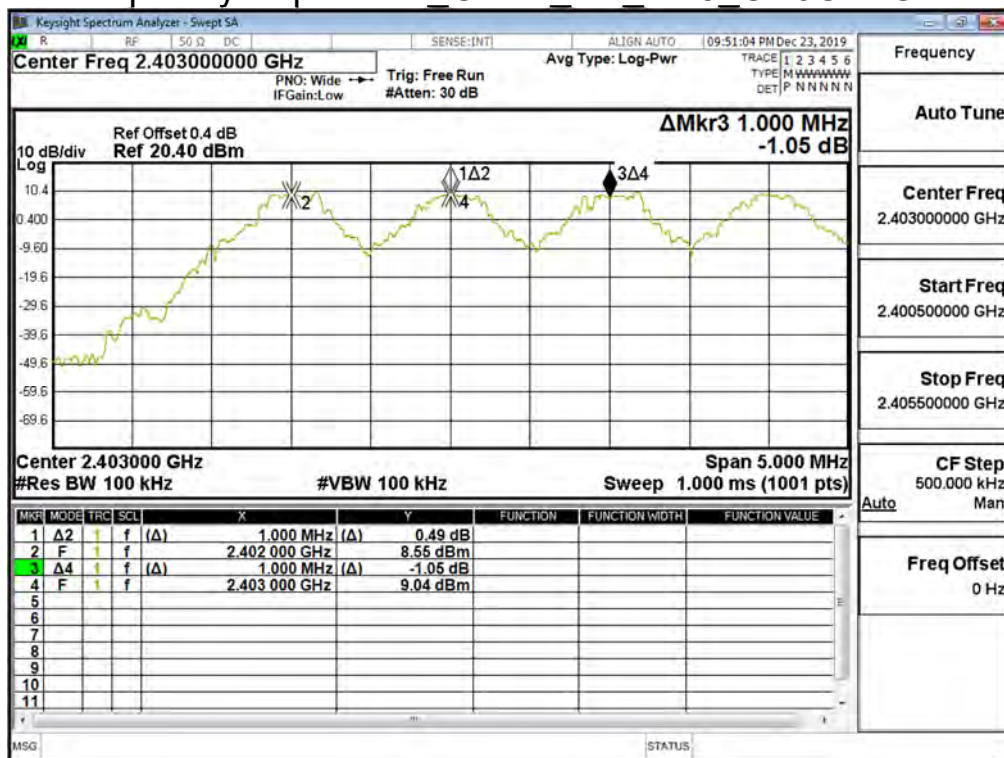
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11.6 Frequency Separation Test Plots

Frequency Separation_GFSK_1M_DH5_CH0CH1CH2



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12 NUMBER OF HOPPING FREQUENCY

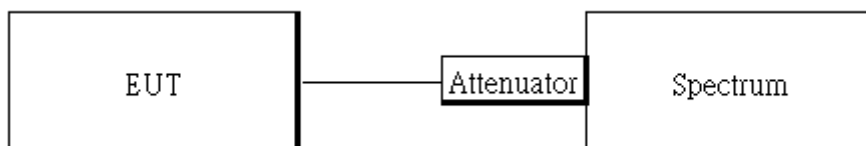
12.1 Standard Applicable

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

12.2 Measurement Equipment Used

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	KEYSIGHT	N9010A	MY57120200	03/06/2019	03/05/2020
DC Block	PASTERNAK	PE8210	RF256	11/20/2019	11/19/2020
Attenuator	Marvelous	MVE2213-10	RF80	11/20/2019	11/19/2020

12.3 Test Set-up



12.4 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=430kHz, VBW=1.5MHz., Detector = Peak
6. Max hold, view and count how many channel in the band.

12.5 Measurement Result

Tabular Data of Total Channel Number

	Channel Number	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	

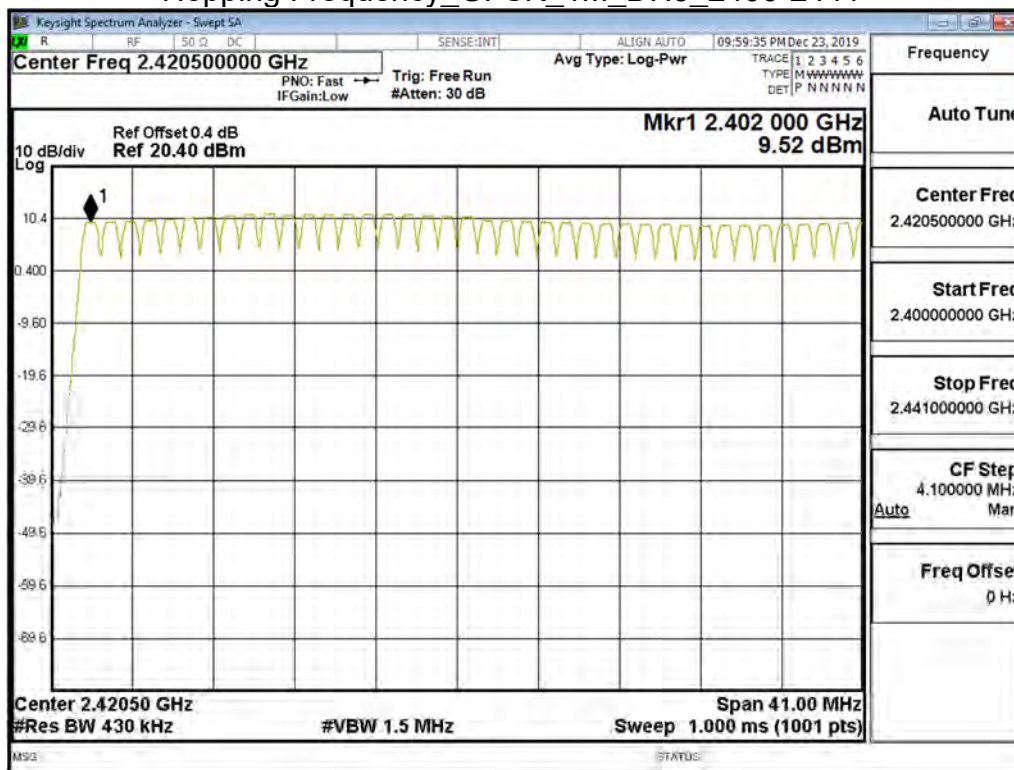
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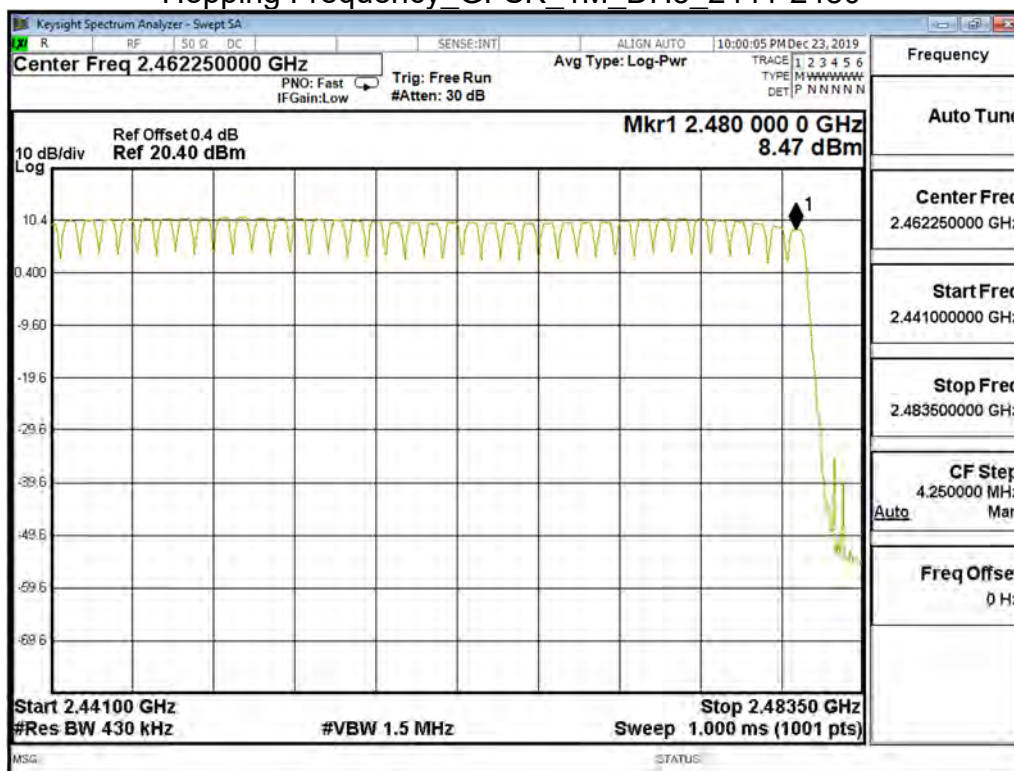
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12.6 Channel Number Test Plots

Hopping Frequency_GFSK_1M_DH5_2400-2441



Hopping Frequency_GFSK_1M_DH5_2441-2480



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13 TIME OF OCCUPANCY (DWELL TIME)

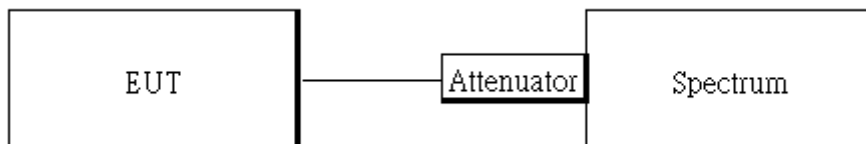
13.1 Standard Applicable

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.

13.2 Measurement Equipment Used

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	KEYSIGHT	N9010A	MY57120200	03/06/2019	03/05/2020
DC Block	PASTERNAK	PE8210	RF256	11/20/2019	11/19/2020
Attenuator	Marvelous	MVE2213-10	RF80	11/20/2019	11/19/2020

13.3 Test Set-up



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13.4 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C6310:2015.
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

In AFH mode, hopping rate is 800 hop/s with 6 slots in 20 hopping channels with channel hopping rate $(800 / 6 / 20)$ in Occupancy Time Limit $(0.4 * 20)$ (S), Hop Over Occupancy Time comes to $(800 / 6 / 20) * (0.4 * 20) = 53.33$

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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13.5 Tabular Result of the Measurement

GFSK (1Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)	1/T (kHz)	VBW setting (kHz)
Low	DH1	123.20	400ms	2.60	3.00
	DH3	262.40	400ms	0.61	1.00
	DH5	308.80	400ms	0.35	1.00
Mid	DH1	123.20	400ms	2.60	3.00
	DH3	260.80	400ms	0.61	1.00
	DH5	308.80	400ms	0.35	1.00
High	DH1	121.60	400ms	2.63	3.00
	DH3	262.40	400ms	0.61	1.00
	DH5	308.80	400ms	0.00	1.00

$\pi/4$ DQPSK (2Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)	1/T (kHz)	VBW setting (kHz)
Mid	2DH1	124.80	400ms	2.56	3.00
	2DH3	262.40	400ms	0.61	1.00
	2DH5	308.80	400ms	0.35	1.00

8-DPSK (3Mbps)

Channel	PACKET TYPE	Measurement Result (ms)	Limit (ms)	1/T (kHz)	VBW setting (kHz)
Mid	3DH1	124.80	400ms	2.56	3.00
	3DH3	262.40	400ms	0.61	1.00
	3DH5	307.20	400ms	0.35	1.00

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GFSK (1Mbps):

CH Low	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	=	2.895	*	(1600/6/79)	*	31.6	=	308.80	(ms)
CH Mid	DH1 time slot	=	0.385	*	(1600/2/79)	*	31.6	=	123.20	(ms)
	DH3 time slot	=	1.630	*	(1600/4/79)	*	31.6	=	260.80	(ms)
	DH5 time slot	=	2.895	*	(1600/6/79)	*	31.6	=	308.80	(ms)
CH High	DH1 time slot	=	0.380	*	(1600/2/79)	*	31.6	=	121.60	(ms)
	DH3 time slot	=	1.640	*	(1600/4/79)	*	31.6	=	262.40	(ms)
	DH5 time slot	=	2.895	*	(1600/6/79)	*	31.6	=	308.80	(ms)

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

CH Mid	2DH1 time slot	=	0.390	*	(1600/2/79)	*	31.6	=	124.80	(ms)
	2DH3 time slot	=	1.640	*	(1600/4/79)	*	31.6	=	262.40	(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	=	2.880	*	(1600/6/79)	*	31.6	=	307.20	(ms)

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

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GFSK (1Mbps) for AFH Mode			
Hopping Channel Number	PACKET TYPE	Measurement Result (ms)	Limit (ms)
20	DH5	154.40	400ms
$\pi/4$ DQPSK (2Mbps) for AFH Mode			
Hopping Channel Number	PACKET TYPE	Measurement Result (ms)	Limit (ms)
20	2DH5	154.40	400ms
8-DPSK (3Mbps) for AFH Mode			
Hopping Channel Number	PACKET TYPE	Measurement Result (ms)	Limit (ms)
20	3DH5	153.60	400ms

13.6 Measurement Result

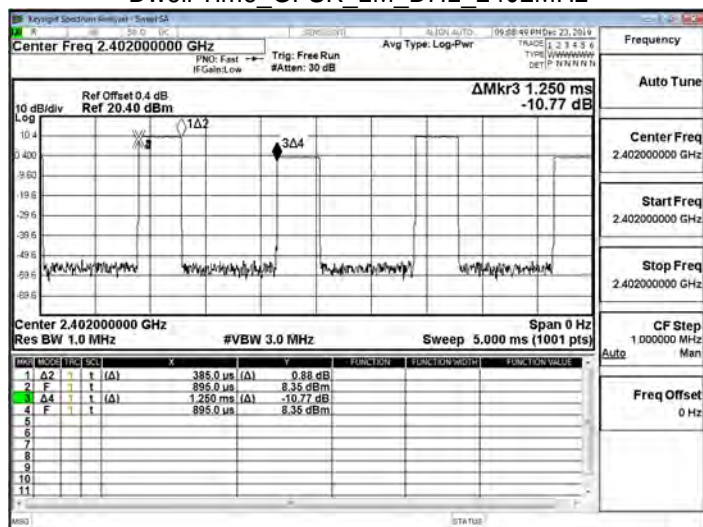
Note: Refer to next page for plots.

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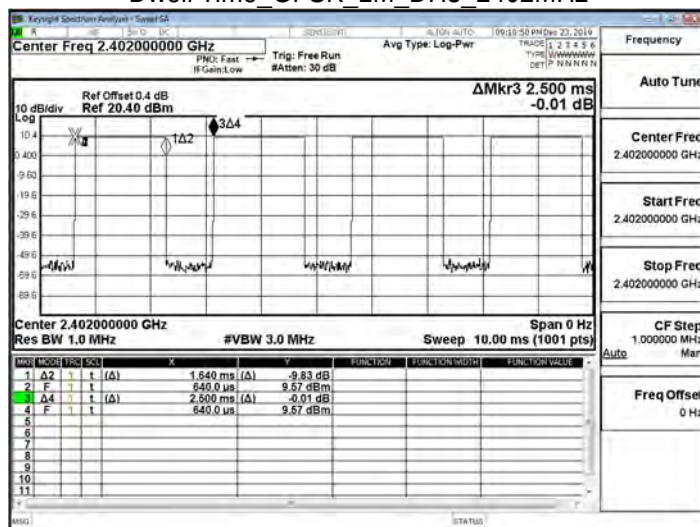
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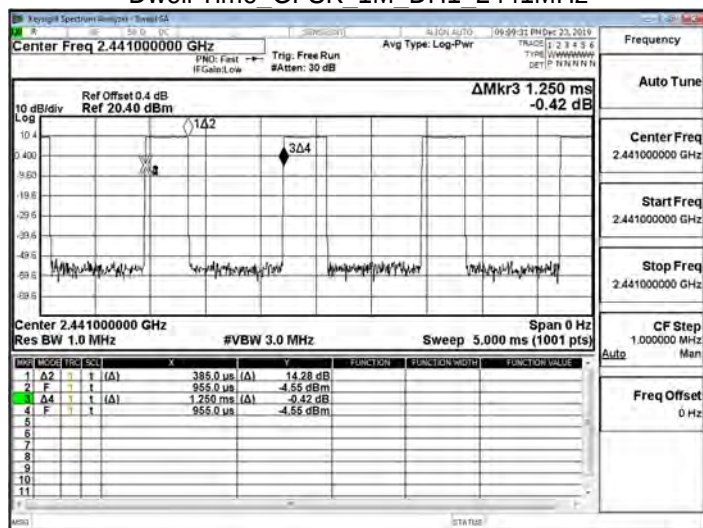
Dwell Time_GFSK_1M_DH1_2402MHz



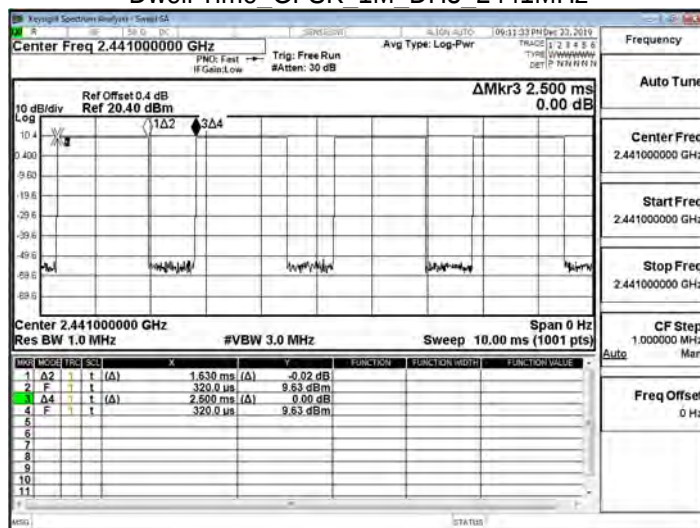
Dwell Time_GFSK_1M_DH3_2402MHz



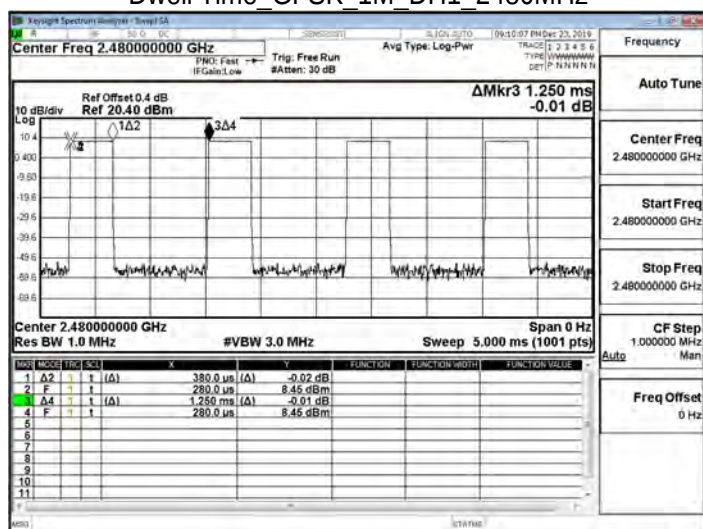
Dwell Time_GFSK_1M_DH1_2441MHz



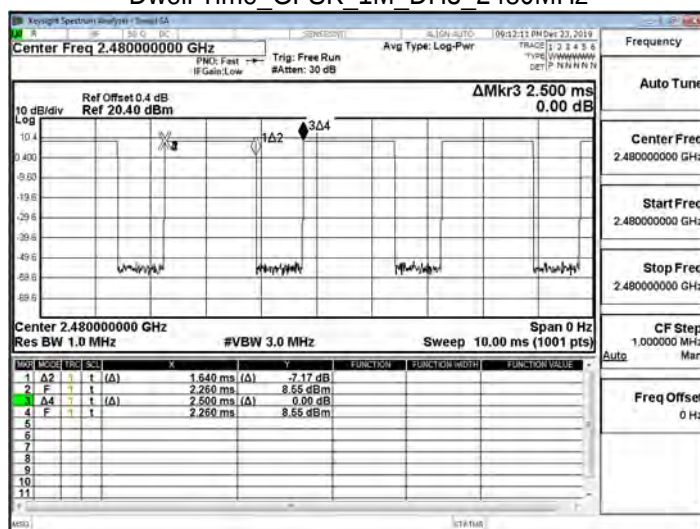
Dwell Time_GFSK_1M_DH3_2441MHz



Dwell Time_GFSK_1M_DH1_2480MHz



Dwell Time_GFSK_1M_DH3_2480MHz

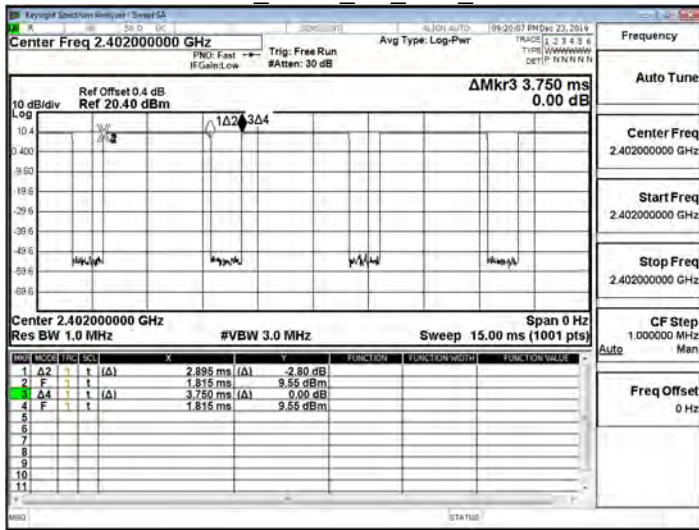


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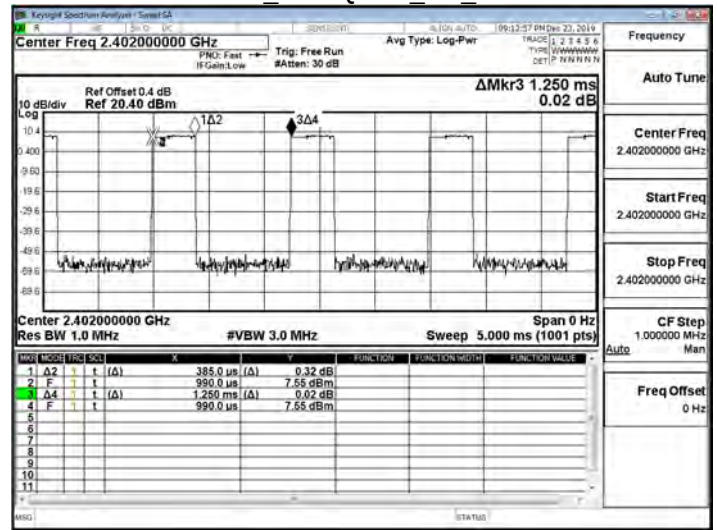
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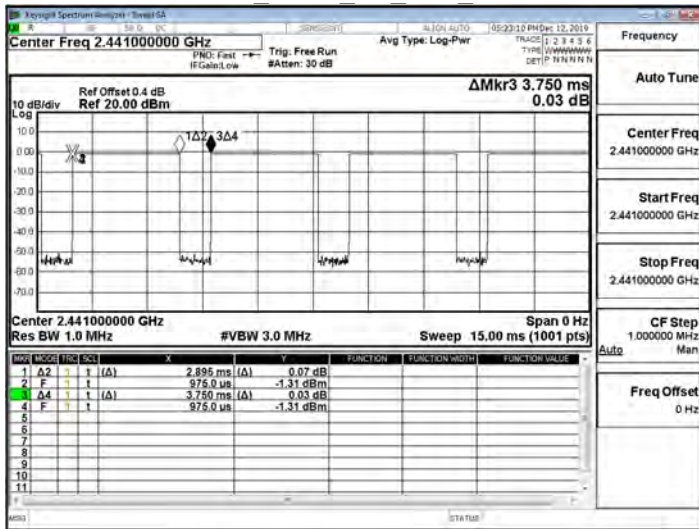
Dwell Time_GFSK_1M_DH5_2402MHz



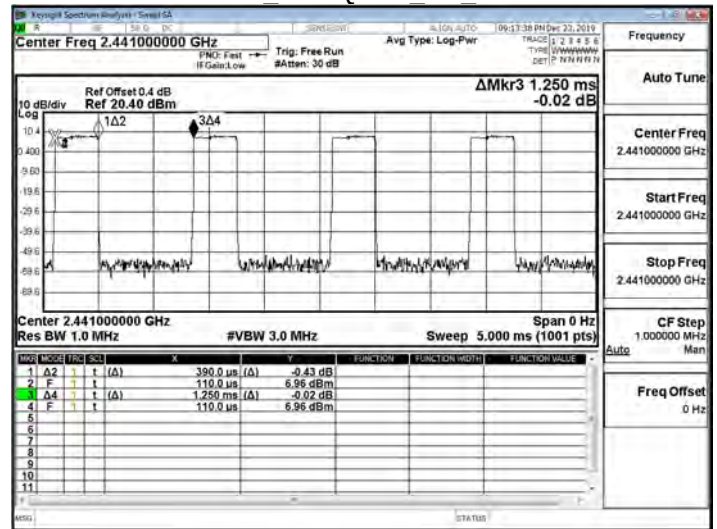
Dwell Time_π/4DQPSK_2M_2402MHz



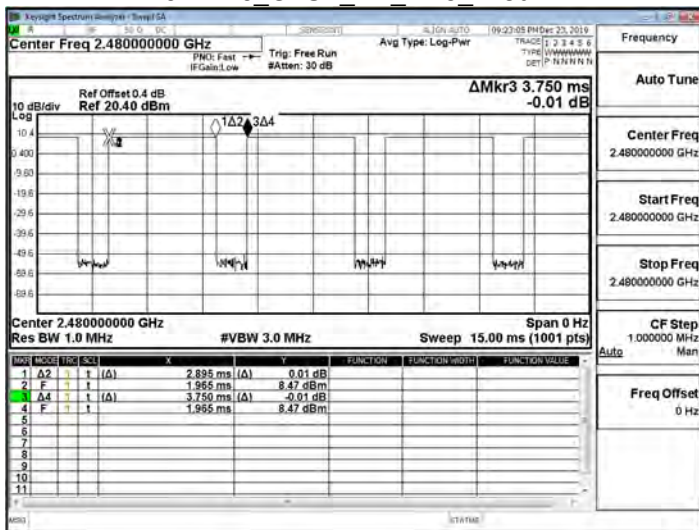
Dwell Time_GFSK_1M_DH5_2441MHz



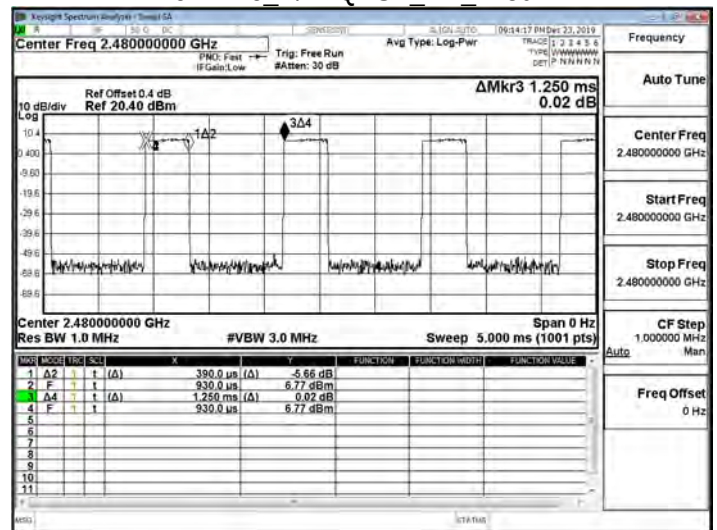
Dwell Time_π/4DQPSK_2M_2441MHz



Dwell Time_GFSK_1M_DH5_2480MHz



Dwell Time_π/4DQPSK_2M_2480MHz

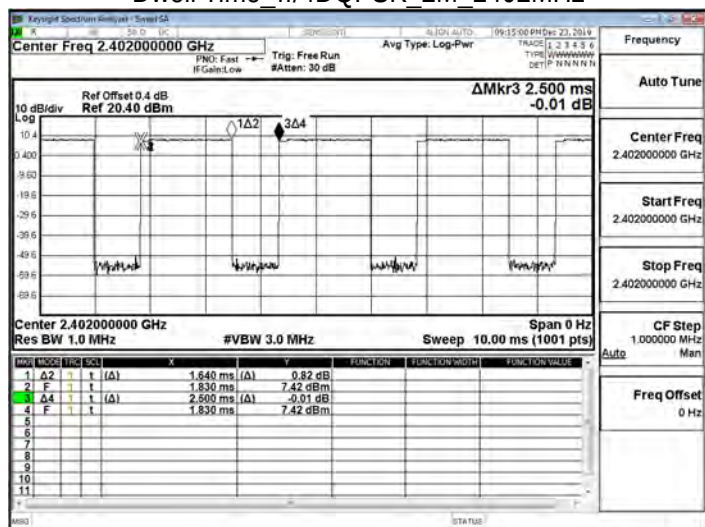
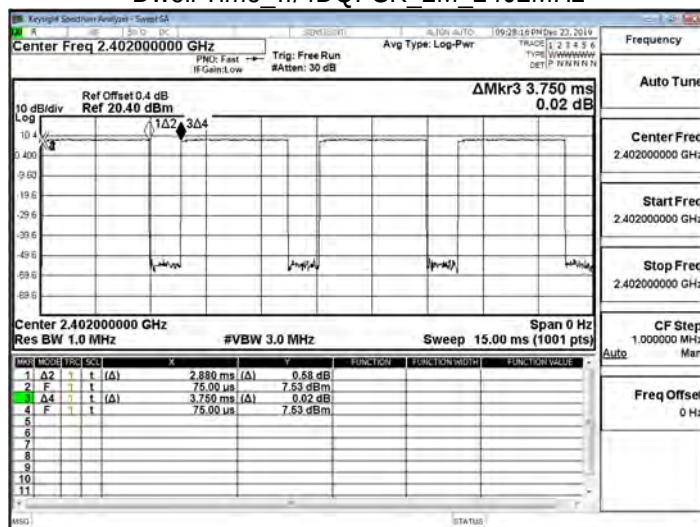
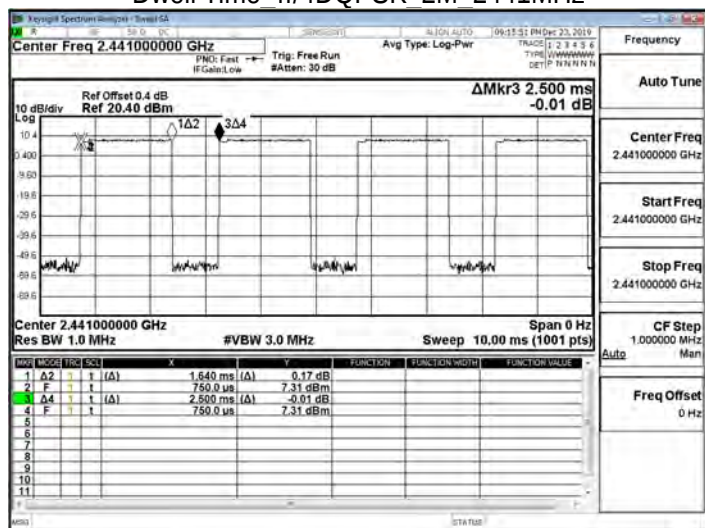
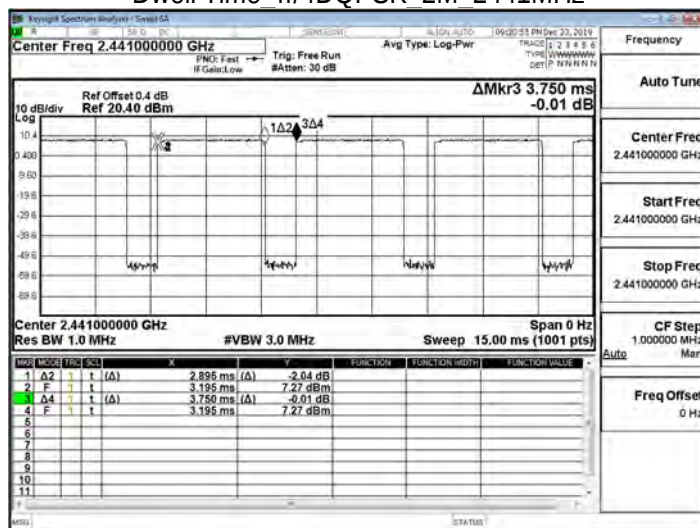
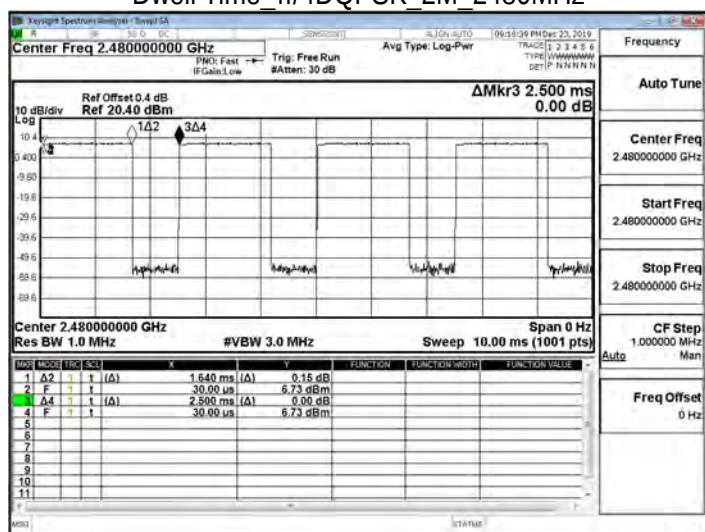
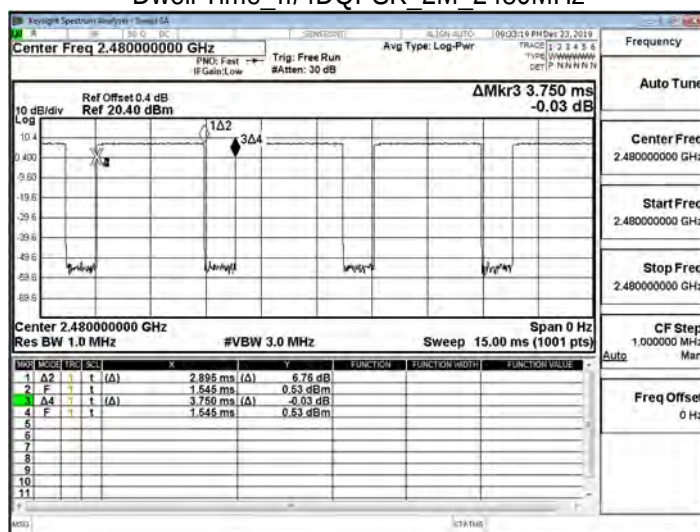


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Dwell Time $\pi/4$ DQPSK 2M 2402MHz

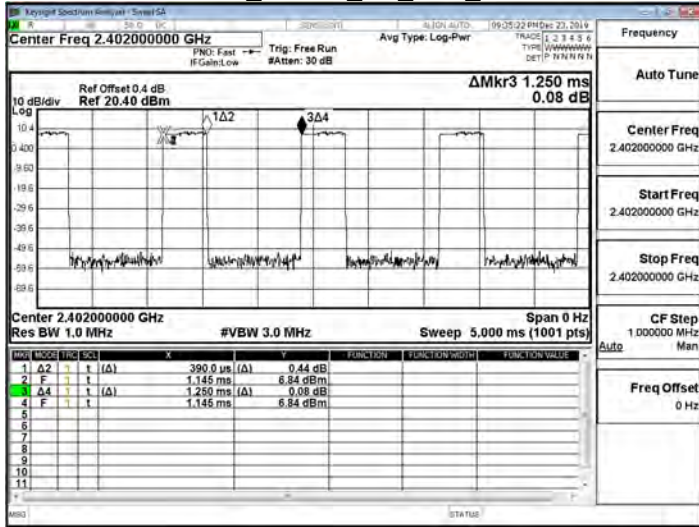
Dwell Time $\pi/4$ DQPSK 2M 2402MHzDwell Time $\pi/4$ DPSK 2M 2441MHzDwell Time $\pi/4$ DPSK 2M 2441MHzDwell Time $\pi/4$ DPSK 2M 2480MHzDwell Time $\pi/4$ DPSK 2M 2480MHz

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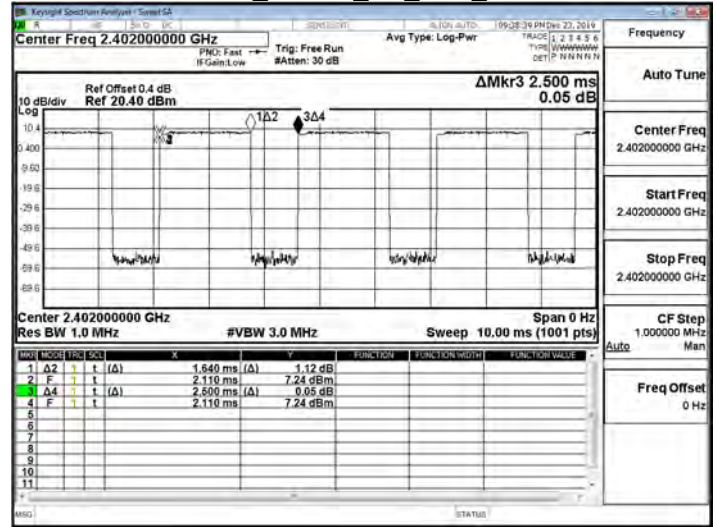
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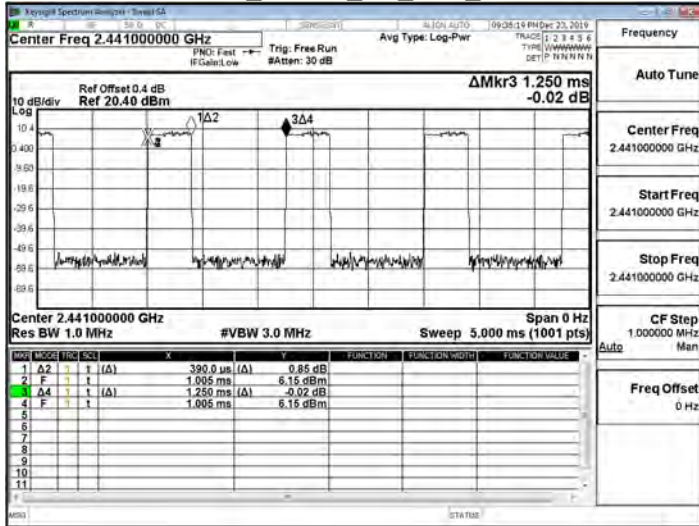
Dwell Time 8DPSK 3M_DH1_2402MHz



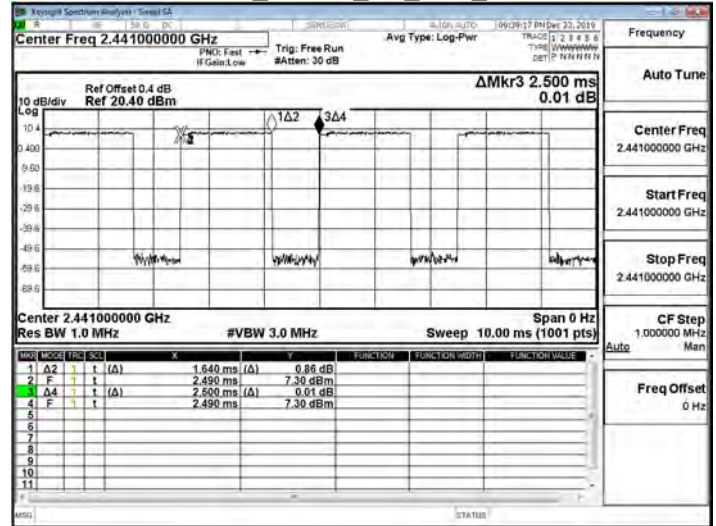
Dwell Time 8DPSK 3M_DH3_2402MHz



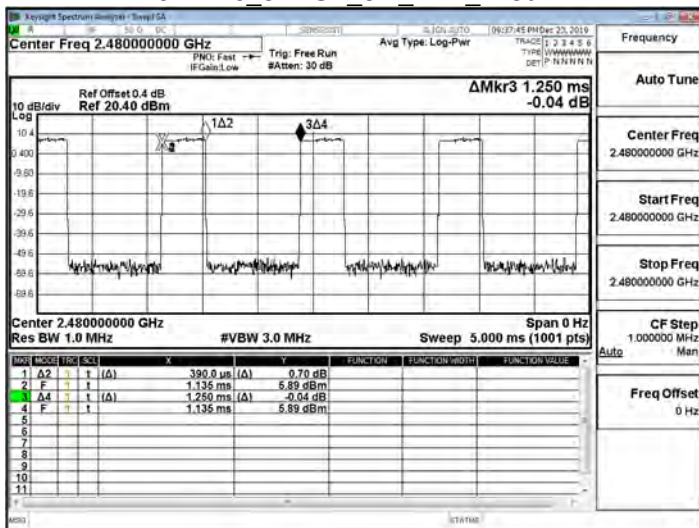
Dwell Time 8DPSK 3M_DH1_2441MHz



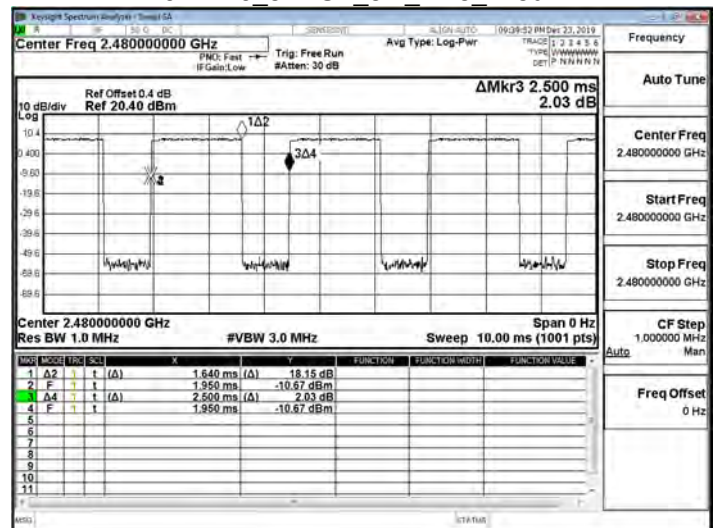
Dwell Time 8DPSK 3M_DH3_2441MHz



Dwell Time 8DPSK 3M_DH1_2480MHz



Dwell Time 8DPSK 3M_DH3_2480MHz

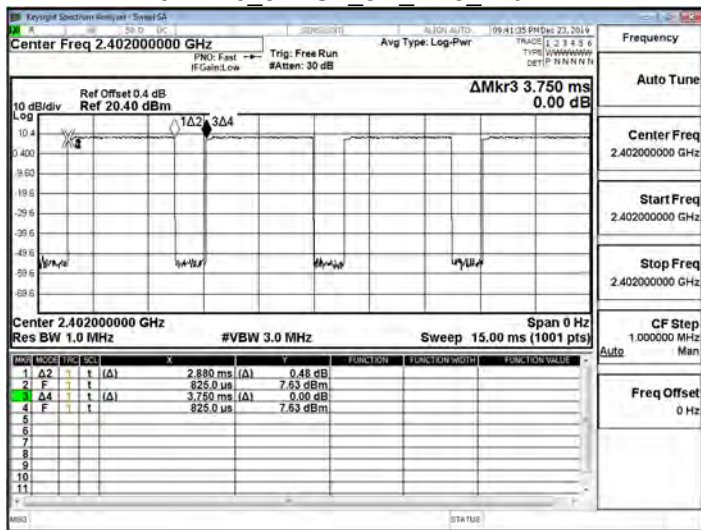


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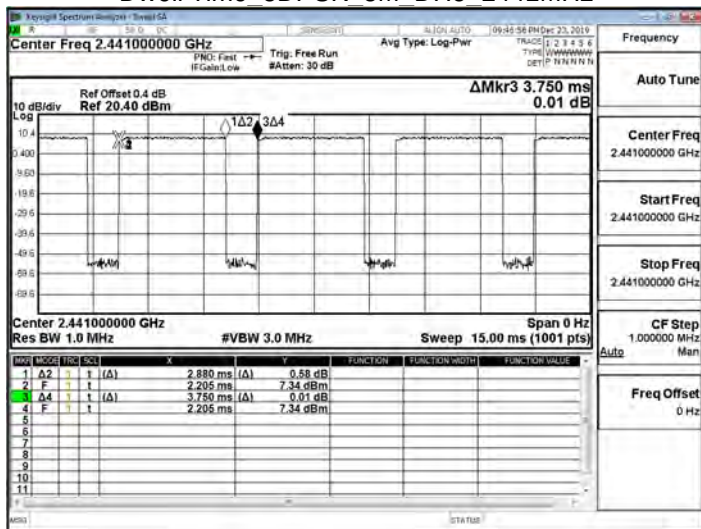
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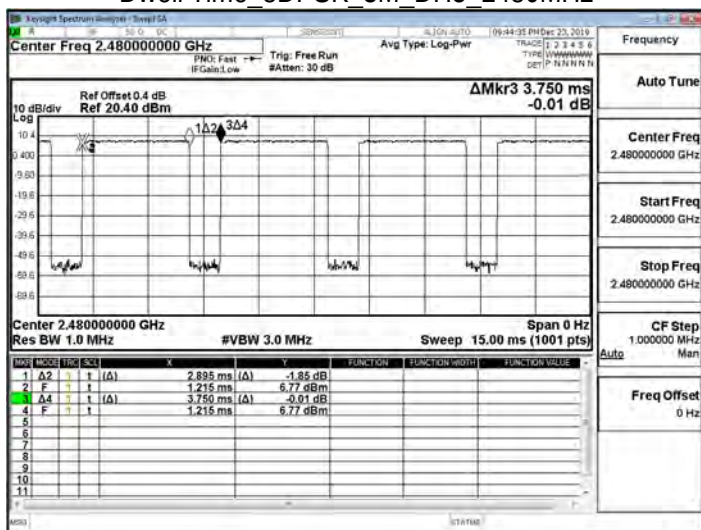
Dwell Time 8DPSK 3M DH5 2402MHz



Dwell Time 8DPSK 3M DH5 2441MHz



Dwell Time 8DPSK 3M DH5 2480MHz



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14 ANTENNA REQUIREMENT

14.1 Standard Applicable

For intentional device, according to §15.203, an intentional radiator shall be designed to ensure that no antenna other than furnished by the responsible party shall be used with the device.

If the transmitting antenna is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi.

14.2 Antenna Connected Construction

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

~ End of Report ~

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