RADIO TEST REPORT

Product	:	VX1 HD Video Doorbell
Model Name	:	CAMW-WDB
FCC ID	:	CFS8DLCAMWWDB1
Test Regulation	:	FCC 47 CFR Part 15 Subpart C (Section 15.247)
Received Date	:	2022/9/7
Test Date	:	2022/9/10 ~ 2022/10/8
Issued Date	:	2023/3/21
Applicant	:	Ademco Inc. 2 Corporate Center Dr, Melville, NY 11747, United States
Issued By	:	Underwriters Laboratories Taiwan Co., Ltd. Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Testing Laboratory
3398

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REVISION HISTORY

Original Test Report No.: 4790533920-US-R3-V0

Rev.	Test report No.	Date	Page revised	Contents
Original	4790533920-US-R3-V0	2023/3/21	-	Initial issue

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1. Attestation of Test Results

APPLICANT:	Ademco Inc. 2 Corporate Center Dr, Melville, NY 11747, United States
MANUFACTURER:	XAVi Technologies Corporation 22F., No.69, Sec.2, Guangfu Rd., Sanchong Dist.,New Taipei City 24158, Taiwan (R.O.C)
EUT DESCRIPTION:	VX1 HD Video Doorbell
BRAND:	resideo
MODEL:	CAMW-WDB
SAMPLE STAGE:	Design Verification Test sample
DATE of TESTED:	2022/9/10 ~ 2022/10/8

APPLICABLE STANDARDS	
STANDARD	**Test Results**
FCC 47 CFR PART 15 Subpart C (Section 15.247)	PASS

Underwriters Laboratories Taiwan Co., Ltd. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by Underwriters Laboratories Taiwan Co., Ltd. based on interpretations and/or observations of test results. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by Underwriters Laboratories Taiwan Co., Ltd. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by Underwriters Laboratories Taiwan Co., Ltd. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Prepared By:

Sally Lu Date : 2023/3/21
Project Handler

Approved and Authorized By:

Eric Lee Date : 2023/3/21
Senior Laboratory Engineer

2. Summary of Test Results

Summary of Test Results		
FCC Clause	**Test Items**	**Result**
15.247(a)(1) (iii)	Number of Hopping Frequency Used	PASS
15.247(a)(1) (iii)	Dwell Time on Each Channel	PASS
15.247(a)(1)	1. Hopping Channel Separation 2. Spectrum Bandwidth of a Frequency Hopping Sequence Spread Spectrum System	PASS
15.247(b)	Conducted Output Power	PASS
15.247(d)	Antenna Port Emission	PASS
15.205 / 15.209 / 15.247(d)	Radiated Emissions and Band Edge Measurement	PASS
15.207	AC Power Conducted Emission	PASS
15.203	Antenna Requirement	PASS

3. Test Methodology and Reference Procedures

The tests documented in this report were performed in accordance with 47 CFR FCC Part 2, KDB558074 D01 Meas Guidance v05r02, KDB414788 D01 Radiated Test Site v01r01, ANSI C63.10-2013.

4. Facilities and Accreditation

Test Location	Underwriters Laboratories Taiwan Co., Ltd.
Address	Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan
Accreditation Certificate	Underwriters Laboratories Taiwan Co., Ltd. is accredited by TAF, Laboratory Code 3398.

5. Measurement Uncertainty

For statement of conformity, accuracy method (Section 8.2.4 and 8.2.5 of ISO Guide 98-4) was applied as decision rule for measurement in this test report.

The following uncertainties have been calculated to provide a confidence level of 95 % using a coverage factor k=2.

Measurement	Frequency	Uncertainty
Conducted disturbance at mains terminals ports	150kHz ~ 30MHz	±2.9 dB
RF Conducted	9 kHz - 40GHz	±2.4 dB
Radiated disturbance below 30MHz	9 kHz - 30 MHz	±1.9 dB
Radiated disturbance below 1 GHz	30MHz ~ 1GHz	±5.8 dB
Radiated disturbance above 1 GHz	1GHz ~ 40GHz	±4.8 dB

6. Equipment under Test

6.1. Description of EUT

Product	VX1 HD Video Doorbell
Brand Name	resideo
Model Name	CAMW-WDB
Operating Frequency	2402MHz ~ 2480MHz
Modulation	GFSK, π/4-DQPSK and 8DPSK
Transfer Rate	Up to 3 Mbps
Number of Channel	79
Maximum Output Power	7.62 dBm
Normal Voltage	24Vac/60Hz from adapter
Sample ID	Conducted Test: 5312255 Radiated Test: 5312256

Note:

1. The EUT have two kind of outer case which for marketing requirement.

2. The EUT contains following accessory devices:

Product	Brand	Model	Description
CAMW-CHA Chime Adapter	resideo	CAMW-CHA	-
Angled Mounting Bracket	resideo	N/A	-
Flat Mounting Bracket	resideo	N/A	-
Trim Ring (Inside BOX)	resideo	N/A	Color: gray and white
Trim Ring (On the Device)	resideo	N/A	Color: gray and white

3. The EUT could be supplied with rechargeable battery as the following table:

Brand Name	Model	Description
Chi Jiun Technologies Co	602025	3.8Vdc, 300mAh
Energy Master Limited	FT602025P	3.7Vdc, 240mAh

4. The above EUT information is declared by manufacturer and for more detailed features description, please refer the manufacturer's or user's manual.

6.2. Channel List

79 channels are provided for BT-EDR mode:

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (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	-	-

6.3. Test Condition

Test Item	Test Site No.	Environmental Condition	Input Power	Test Date	Tested by
Antenna Port Conducted Measurement	SR4	21~26℃/ 51~68%RH	24Vac/60Hz	2022/09/10~ 2022/10/08	WaterNil Guan
Radiated Spurious Emission	966-2	21~26℃/ 51~68%RH	24Vac/60Hz	2022/09/10~ 2022/10/08	WaterNil Guan
AC power Line Conducted Emission	SR1	21~26℃/ 51~68%RH	24Vac/60Hz	2022/10/07~ 2022/10/08	Rex Chen

FCC Test Firm Registration Number: 498077

6.4. Description of Available Antennas

Ant. No.	Transmitter Circuit	Brand Name	Model Name	Ant. Type	Maximum Gain (dBi)
1	Chain (0)	Lynwave	ALX21M 222AA7	PIFA	0.8

Note: The above antenna information was provided from customer and for more detailed features description, please refer the manufacturer's specification or user's manual.

6.5. Test Mode Applicability and Tested Channel Detail

- The fundamental of the EUT was investigated in three orthogonal axes X-Y/Y-Z/X-Z, it was determined that Y-Z plane was worst-case. Therefore, all final radiated testing was performed with the EUT in Y-Z plane.
- The EUT has two batteries: 3.8Vdc from the battery (model: 602025), and 3.7Vdc from the battery (model: FT602025P), and one external power source: 24Vac/60Hz from adapter (model: MODEL-LD-09700).
- The 24Vac/60Hz from adapter (model: MODEL-LD-09700) and 3.8Vdc from battery (model: 602025) were evaluated to be the worst case. Therefore, these combinations were recorded in the test report.
- The Packet Type for DH1, DH3, and DH5 have all been pre-tested, the fundamental worst case of the Packet Type was found in the DH5. Therefore, only DH5 Packet Type is recorded in the report. (Except Dwell Time).
- The modulation and bandwidth are similar for π/4-DQPSK mode and 8DPSK mode, therefore investigated 8DPSK mode to representative mode in test report.
- For Antenna Port Conducted Measurement, this item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
- For below 30MHz testing, investigation was done on three antenna orientations (parallel, perpendicular, and ground-parallel), parallel and perpendicular are the worst orientations, therefore testing was performed on these two orientations only.
- For below 1 GHz radiated emission and AC power line conducted emission have performed all modes of operation were investigated and the worst-case emissions are reported.
- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- Since the DUT is a Bluetooth device, the AFH mode and non-AFH mode follow the Bluetooth timing protocol, and the same timing level has the same time interval, but the non-AFH mode has worse results, therefore only the test data of this type were recorded in this report.

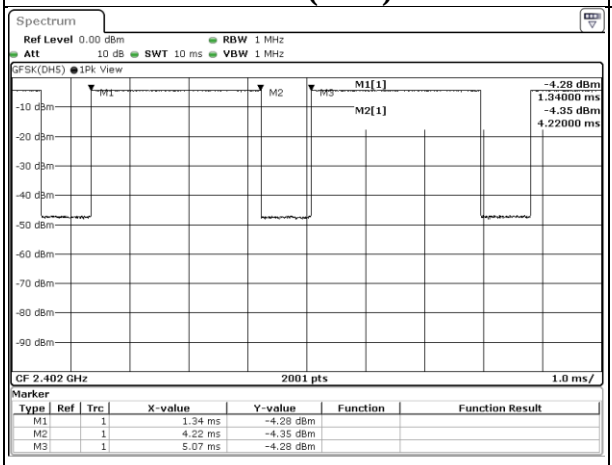
Test item	Modulation Type	Available Channel	Test Channel	Packet Type
Radiated Emissions (Above 1GHz)	GFSK	0 to 78	0,39,78	DH5
	8DPSK	0 to 78	0,39,78	3DH5
Radiated Emissions (Below 1GHz)	8DPSK	0 to 78	0	3DH5
AC Power Line Conducted Emission	8DPSK	0 to 78	0	3DH5
Antenna Port Conducted Measurement	GFSK	0 to 78	0,39,78	DH1*,DH3*, DH5
	8DPSK	0 to 78	0,39,78	3DH1*,3DH3*, 3DH5

* Only for Dwell Time on Each Channel test

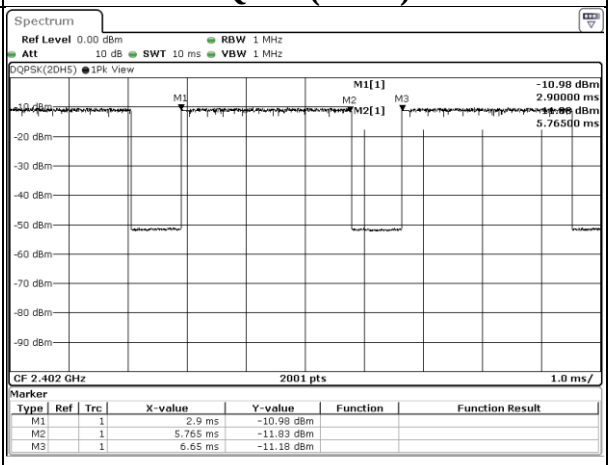
6.6. Duty cycle

Mode	On Time (ms)	On+Off Time (ms)	Duty Cycle	Duty Factor (dB)	VBW Set (above 1GHz)
GFSK(DH5)	2.880	3.730	0.7721	1.12	510Hz
DQPSK(2DH5)	2.865	3.750	0.7640	1.17	510Hz
8DPSK(3DH5)	2.880	3.730	0.7721	1.12	510Hz

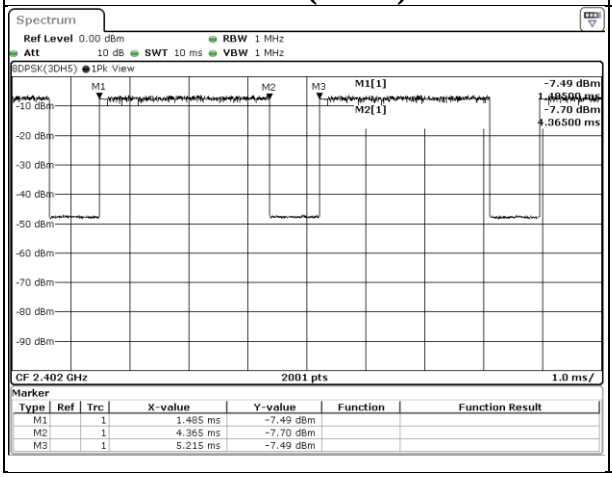
GFSK(DH5)



DQPSK(2DH5)



8DPSK(3DH5)



7. Test Equipment

Test Equipment List					
Equipment	**Manufacturer**	**Model No.**	**Serial No.**	**Cal. Date**	**Expired date**
Radiated Spurious Emission					
Spectrum Analyzer	Keysight	N9010A	MY56070827	2021/11/9	2022/11/8
EMI Test Receiver	Rohde & Schwarz	ESR7	101754	2021/12/10	2022/12/9
Loop Antenna	ETS lindgren	6502	00213440	2021/12/23	2022/12/22
Trilog-Broadband Antenna with 5dB Attenuator	Schwarzbeck & EMCI	VULB 9168 & N-6-05	774 & AT-N0538	2022/2/8	2023/2/7
Horn Antenna (1-18 GHz)	Schwarzbeck	BBHA 9120 D	01690	2021/12/13	2022/12/12
Horn Antenna (18-40 GHz)	Schwarzbeck	BBHA 9170	781	2021/12/17	2022/12/16
Preamplifier (30-1000 MHz)	EMCI	EMC330E	980405	2022/6/7	2023/6/6
Preamplifier (1-18 GHz)	EMCI	EMC051835BE	980406	2022/2/16	2023/2/15
Preamplifier (18-40GHz)	EMCI	EMC184040SEE	980426	2022/5/17	2023/5/16
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-4 & 170425-2	2021/12/3	2022/12/2
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-1 & 170214-2	2021/12/3	2022/12/2

Test Equipment List					
Equipment	**Manufacturer**	**Model No.**	**Serial No.**	**Cal. Date**	**Expired date**
Antenna Port Conducted Measurement					
Spectrum Analyzer	Rohde & Schwarz	FSV40	101490	2022/9/12	2023/9/11
Pulse Power Sensor	Anritsu	MA2411B	1531202	2021/12/22	2022/12/21
Power Meter	Anritsu	ML2495A	1645002	2021/12/22	2022/12/21
AC power Line Conducted Emission					
EMI Test Receiver	Rohde & Schwarz	ESR7	101753	2021/11/15	2022/11/14
Two-Line V-Network	Rohde & Schwarz	ENV216	102136	2022/8/29	2023/8/28
Impuls-Begrenzer Pulse Limiter	Rohde & Schwarz	ESH3-Z2	102219-Qt	2022/8/30	2023/8/29
Cables	TITAN	CFD200	T0732ACFD20 020A300-2	2022/4/9	2023/4/8

UL Software		
Description	**Name**	**Version**
Radiated measurement	e3	6.191211 (V6)
Conducted measurement	RF-Conducted-FCC 15247	ver 1.0
AC power Line Conducted Emission	EZ_EMC	UL-3A1.2

8. Description of Test Setup

Support Equipment

ID	Equipment	Brand Name	Model Name	S/N	Remark
A	Adapter	ZD	MODEL-LD-09700	NA	Supplied by client
B	Laptop	DELL	Latitude E5470	5M2MWF2	Provide by lab
C	Test Tool	N/A	RCD3916_TEST	N/A	Supplied by client
D	Micro SD Card	SanDisk	UHS-I C10	NA	Provide by lab
E	Battery	Chi Jiun Technologies Co	602025	NA	Supplied by client

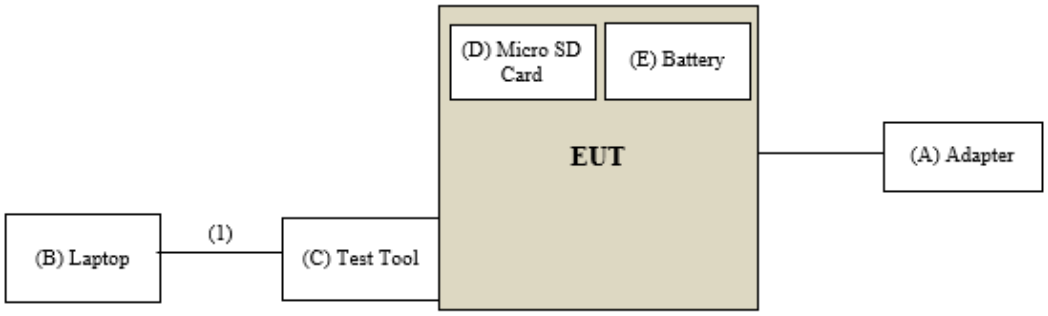
I/O Cables

ID	Equipment	Brand Name	Model Name	Length (m)	Remark
1	Micro USB Cable	N/A	N/A	0.92	Provide by lab

Test Setup

Controlled using a bespoke application (Typing RF command by terminal tool(Putty version 0.76)) on a test Notebook. The application was used to enable a continuous transmission mode and to select the test channels, data rates, modulation schemes and power setting as required.

Setup Diagram for Test



Under Table

Remote Site

9. Test Results

9.1. Channel Bandwidth

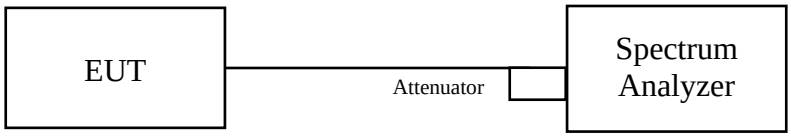
Requirements

For frequency hopping system operating in the 2400-2483.5MHz, If the 20dB bandwidth of hopping channel is greater than 25kHz, two-thirds 20dBbandwidth of hopping channel shall be a minimum limit for the hopping channel separation.

Test procedure

a. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
b. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
c. Measure the frequency difference of two frequencies that were attenuated 20dB from the reference level. Record the frequency difference as the emission bandwidth.
d. Repeat above procedures until all frequencies measured were complete.

Test Setup

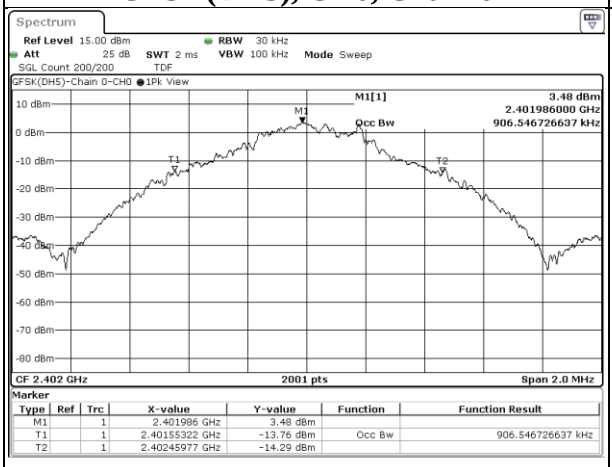


The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

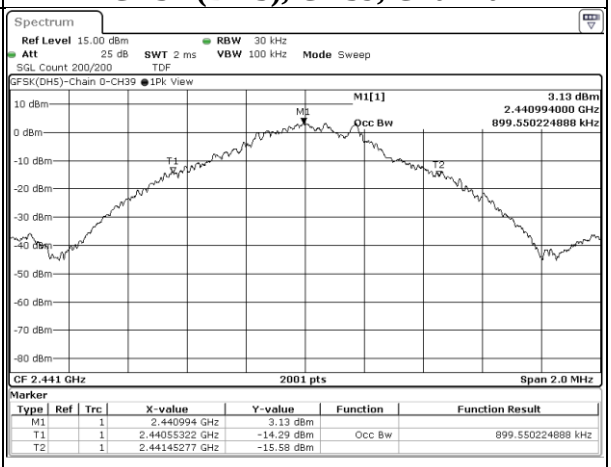
Test Data

Mode	CH	Freq (MHz)	OBW (MHz)	Limit (MHz)	Result
GFSK(DH5)	0	2402	0.907	N/A	Pass
GFSK(DH5)	39	2441	0.9	N/A	Pass
GFSK(DH5)	78	2480	0.908	N/A	Pass
8DPSK(3DH5)	0	2402	1.161	N/A	Pass
8DPSK(3DH5)	39	2441	1.175	N/A	Pass
8DPSK(3DH5)	78	2480	1.172	N/A	Pass

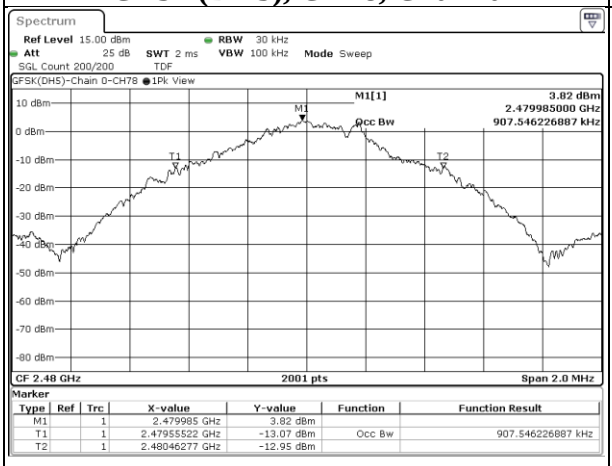
GFSK(DH5), CH0, Chain 0



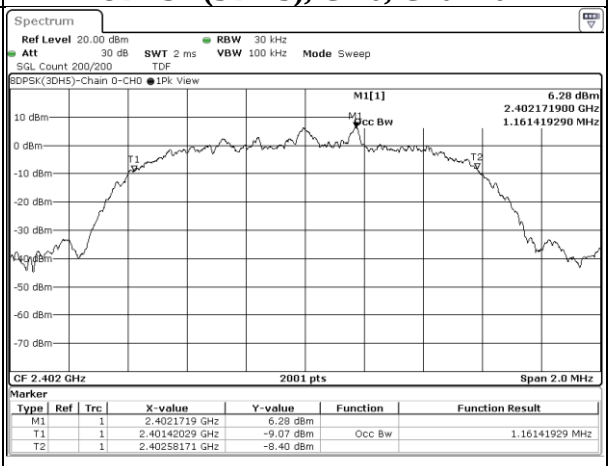
GFSK(DH5), CH39, Chain 0



GFSK(DH5), CH78, Chain 0



8DPSK(3DH5), CH0, Chain 0



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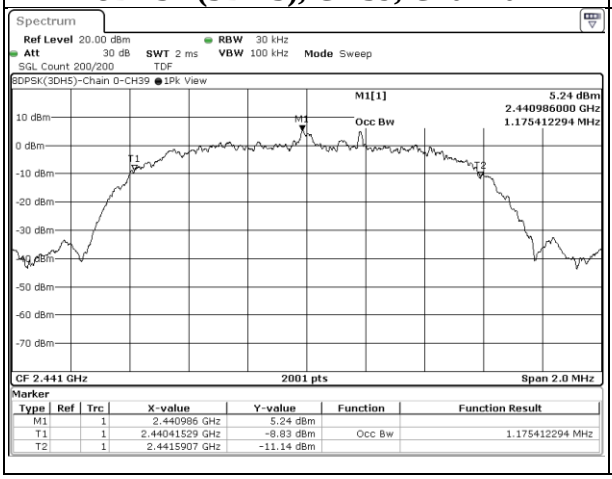
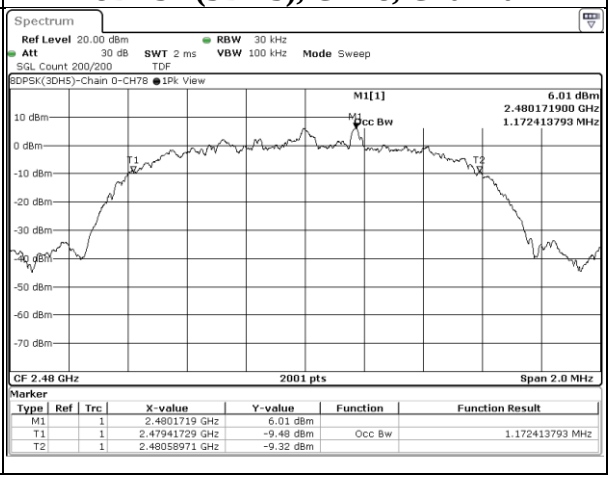


8DPSK(3DH5), CH78, Chain 0



9.2. Conducted Output Power

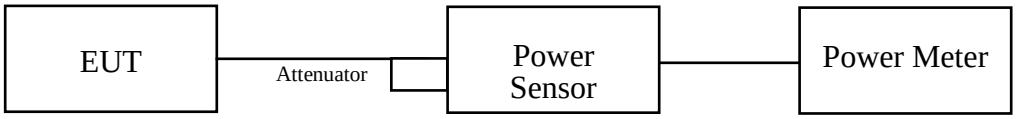
Requirements

The Maximum Output Power Measurement is 125mW.

Test Procedure

A peak power sensor was used on the output port of the EUT. A power meter was used to read the response of the peak power sensor. Record the power level.

Test Setup



The loss between RF output port of the EUT and the input port of the Power Meter has been taken into consideration.

Test Data

Peak Power

BT GFSK

Channel	Frequency (MHz)	Peak Power (mW)	Peak Power (dBm)	Limit (dBm)	Pass/Fail
0	2402	2.985	4.75	20.97	PASS
39	2441	2.891	4.61	20.97	PASS
78	2480	3.214	5.07	20.97	PASS

4-DQPSK

Channel	Frequency (MHz)	Peak Power (mW)	Peak Power (dBm)	Limit (dBm)	Pass/Fail
0	2402	5.2	7.16	20.97	PASS
39	2441	4.977	6.97	20.97	PASS
78	2480	5.035	7.02	20.97	PASS

BT 8DPSK

Channel	Frequency (MHz)	Peak Power (mW)	Peak Power (dBm)	Limit (dBm)	Pass/Fail
0	2402	5.781	7.62	20.97	PASS
39	2441	5.284	7.23	20.97	PASS
78	2480	5.508	7.41	20.97	PASS

Average Power (Reference Only)

BT GFSK

Channel	Frequency (MHz)	Average Power (mW)	Average Power (dBm)
0	2402	2.891	4.61
39	2441	2.805	4.48
78	2480	3.105	4.92

4-DQPSK

Channel	Frequency (MHz)	Average Power (mW)	Average Power (dBm)
0	2402	2.985	4.75
39	2441	2.844	4.54
78	2480	2.825	4.51

BT 8DPSK

Channel	Frequency (MHz)	Average Power (mW)	Average Power (dBm)
0	2402	3.013	4.79
39	2441	2.624	4.19
78	2480	2.825	4.51

9.3. Hopping Channel Separation

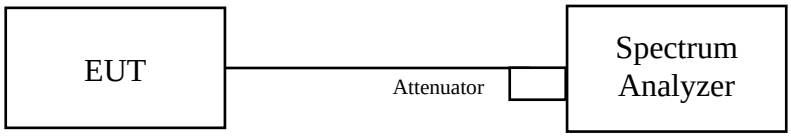
Requirements

At least 25kHz or two-third of 20dB hopping channel bandwidth (whichever is greater).

Test procedure

a. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
b. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range.
c. By using the MaxHold function record the separation of two adjacent channels.
d. Measure the frequency difference of these two adjacent channels by SA MARK function. And then plot the result on SA screen.

Test Setup

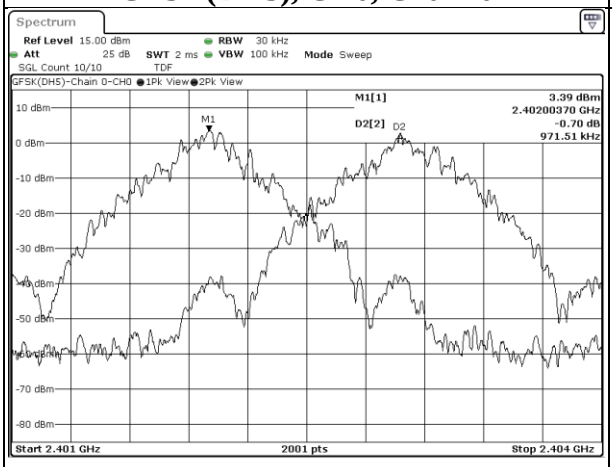


The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

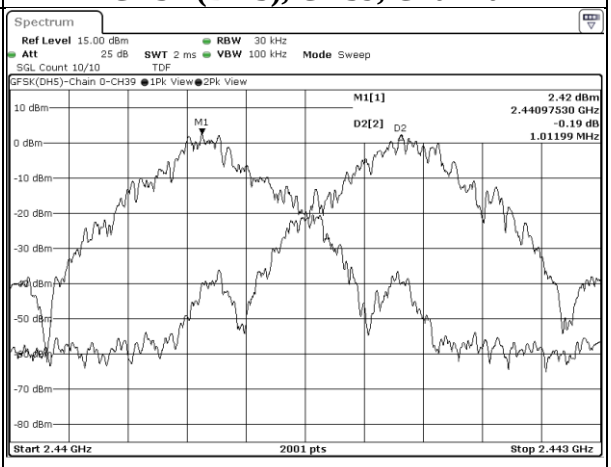
Test Data

Mode	CH	Freq (MHz)	Channel Separation (MHz)	> Limit (MHz)
GFSK(DH5)	0	2402	0.972	0.661
GFSK(DH5)	39	2441	1.012	0.648
GFSK(DH5)	78	2480	0.94	0.66
8DPSK(3DH5)	0	2402	1.03	0.857
8DPSK(3DH5)	39	2441	1.057	0.859
8DPSK(3DH5)	78	2480	1.285	0.859

GFSK(DH5), CH0, Chain 0



GFSK(DH5), CH39, Chain 0



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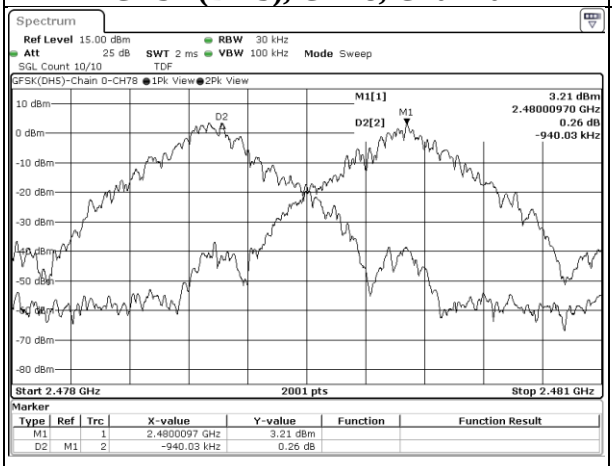
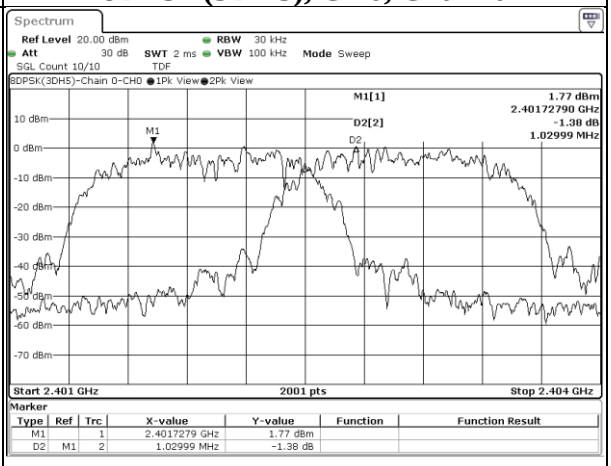
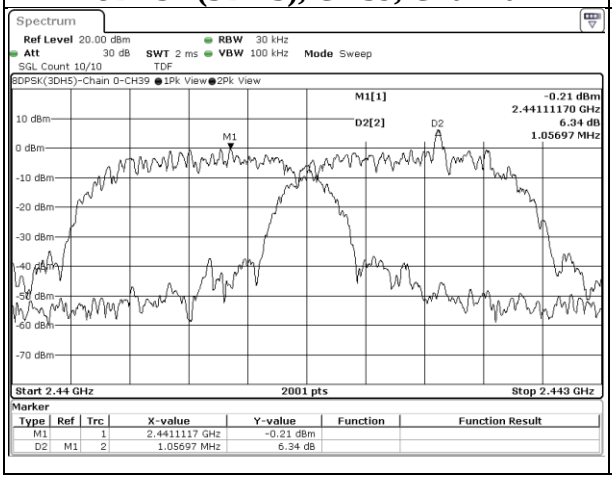


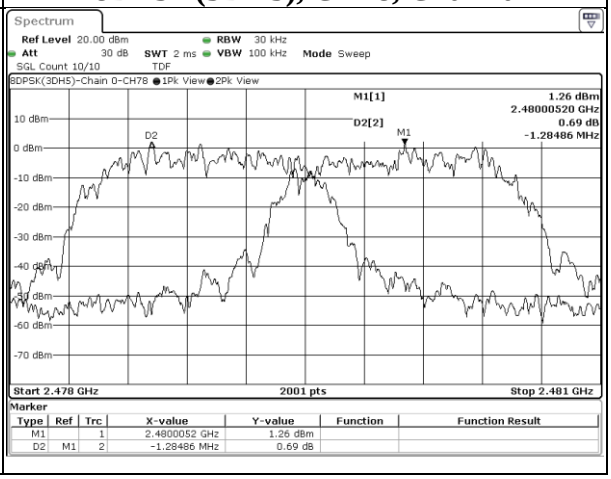
8DPSK(3DH5), CH0, Chain 0



8DPSK(3DH5), CH39, Chain 0



8DPSK(3DH5), CH78, Chain 0



9.4. Number of Hopping Frequency Used

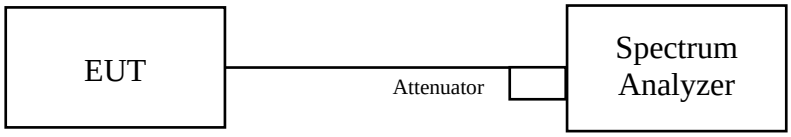
Requirements

At least 15 channels frequencies, and should be equally spaced.

Test procedure

a. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
b. Turn on the EUT and connect its antenna terminal to measurement via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
c. Set the SA on MaxHold Mode, and then keep the EUT in hopping mode. Record all the signals from each channel until each one has been recorded.
d. Set the SA on View mode and then plot the result on SA screen.
e. Repeat above procedures until all frequencies measured were complete.

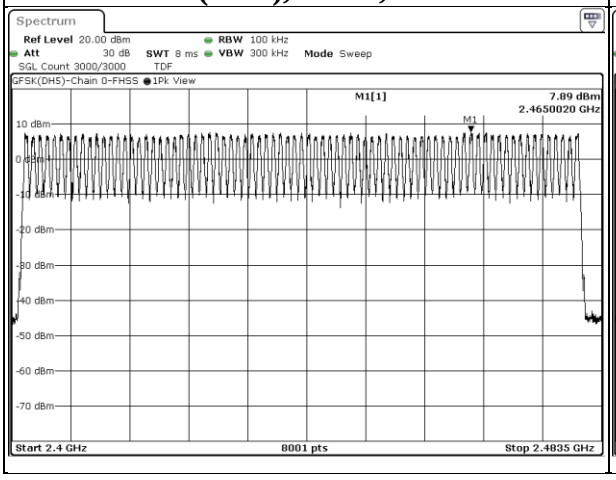
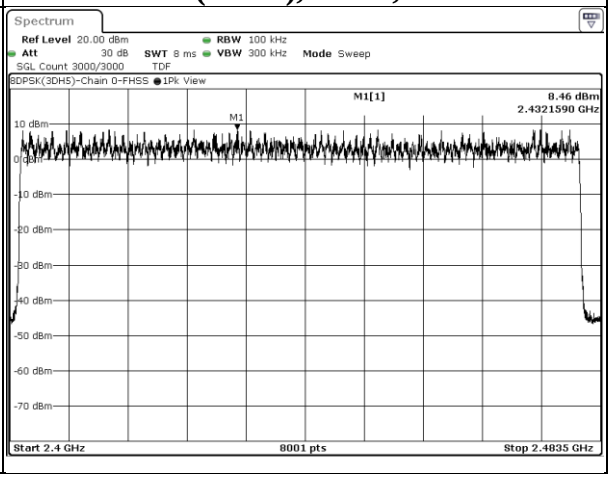
Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

Test Data

There are 79 hopping frequencies in the hopping mode. On the plots, it shows that the hopping frequencies are equally spaced.

GFSK(DH5), FHSS, Chain 0	8DPSK(3DH5), FHSS, Chain 0
	

9.5. Dwell Time on Each Channel

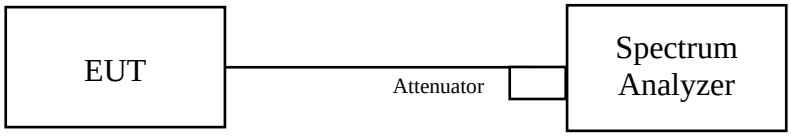
Requirements

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

Test procedure

a. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
b. Turn on the EUT and connect its antenna terminal to measurement via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
c. Adjust the center frequency of SA on any frequency be measured and set SA to zero span mode. And then, set RBW and VBW of spectrum analyzer to proper value.
d. Measure the time duration of one transmission on the measured frequency. And then plot the result with time difference of this time duration.
e. Repeat above procedures until all different time-slot modes have been completed.
f. Measure the maximum time duration of one single pulse.
A Period Time = (channel number)*0.4
For normal mode:
DH1 Time Slot: Reading * (1600/2)*31.6/(channel number)
DH3 Time Slot: Reading * (1600/4)*31.6/(channel number)
DH5 Time Slot: Reading * (1600/6)*31.6/(channel number)
For AFH mode:
DH1 Time Slot: Reading * (800/2)*31.6/(channel number)
DH3 Time Slot: Reading * (800/4)*31.6/(channel number)
DH5 Time Slot: Reading * (800/6)*31.6/(channel number)

Test Setup

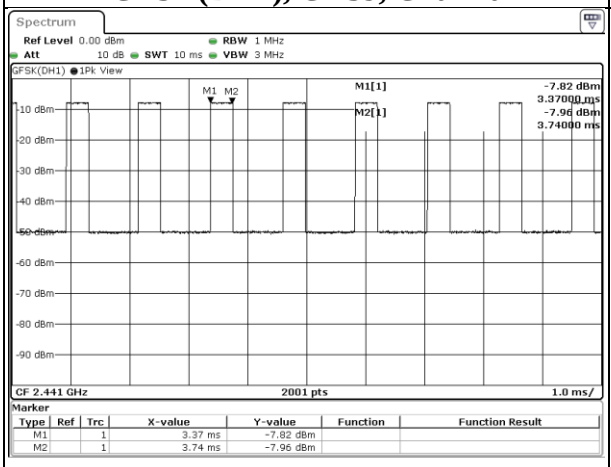


The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

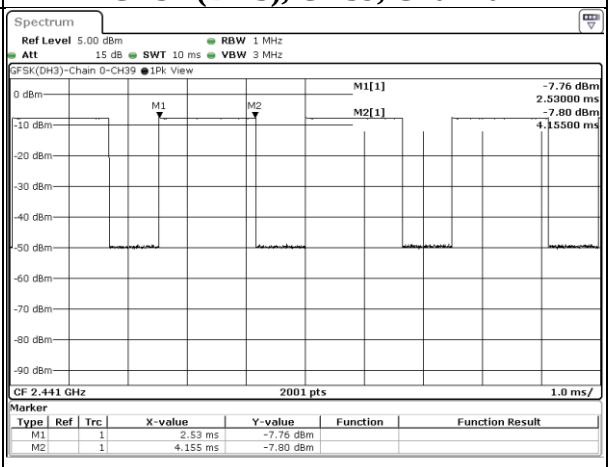
Test Data

Mode	Freq (MHz)	Length of transmission time (ms)	Dwell Time (ms)	Limit (ms)	Result
GFSK(DH1)	2441	0.370	118.400	400	PASS
GFSK(DH3)	2441	1.625	260.000	400	PASS
GFSK(DH5)	2441	2.870	306.133	400	PASS
8DPSK(3DH1)	2441	0.375	120.000	400	PASS
8DPSK(3DH3)	2441	1.625	260.000	400	PASS
8DPSK(3DH5)	2441	2.885	307.733	400	PASS

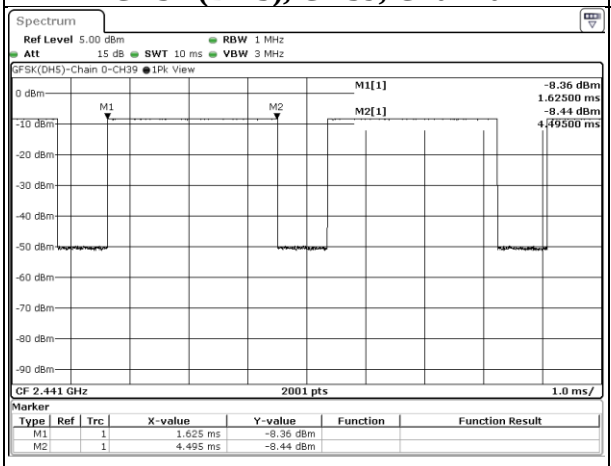
GFSK(DH1), CH39, Chain 0



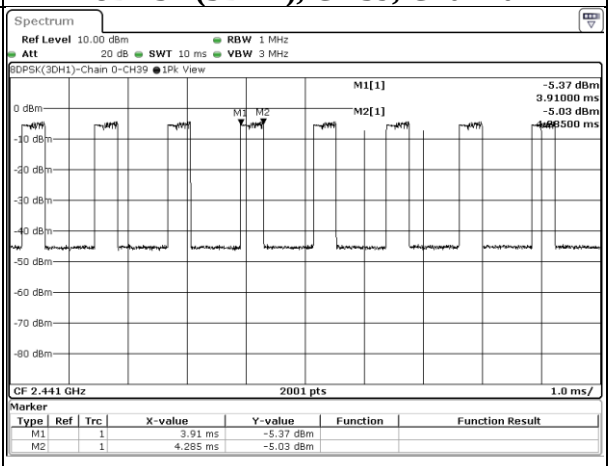
GFSK(DH3), CH39, Chain 0



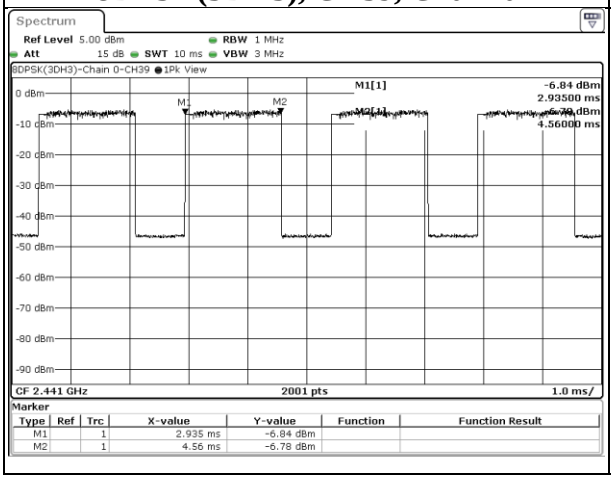
GFSK(DH5), CH39, Chain 0



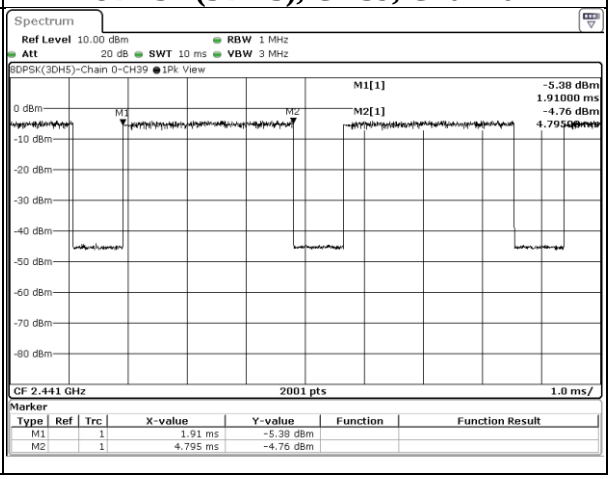
8DPSK(3DH1), CH39, Chain 0



8DPSK(3DH3), CH39, Chain 0



8DPSK(3DH5), CH39, Chain 0



9.6. Conducted Out of Band Emission

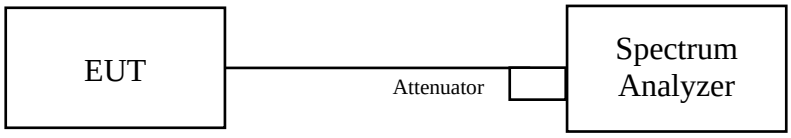
Requirements

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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b) (3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209 (a) is not required.

Test procedure

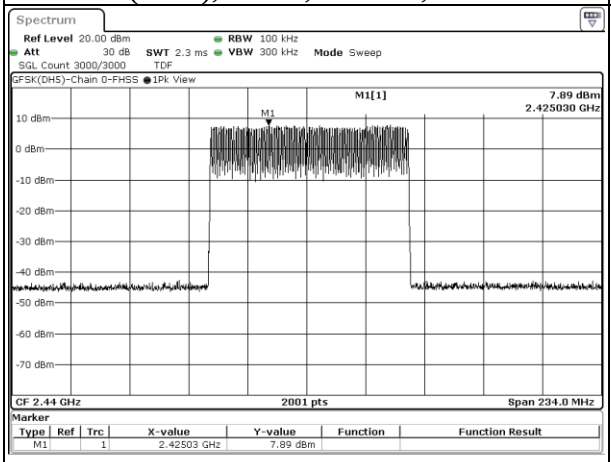
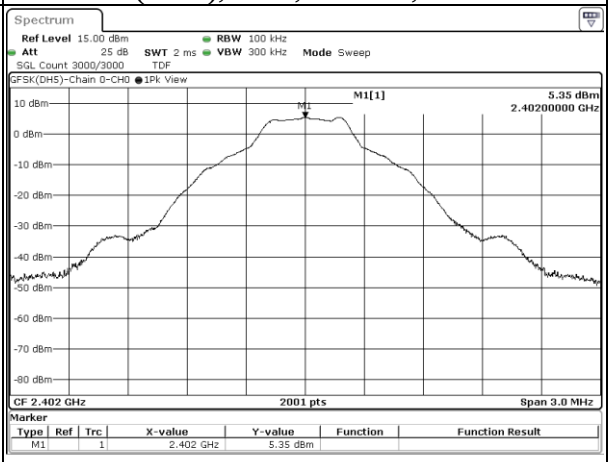
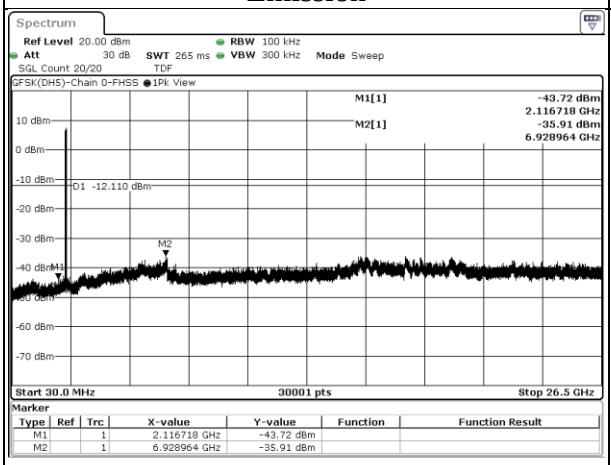
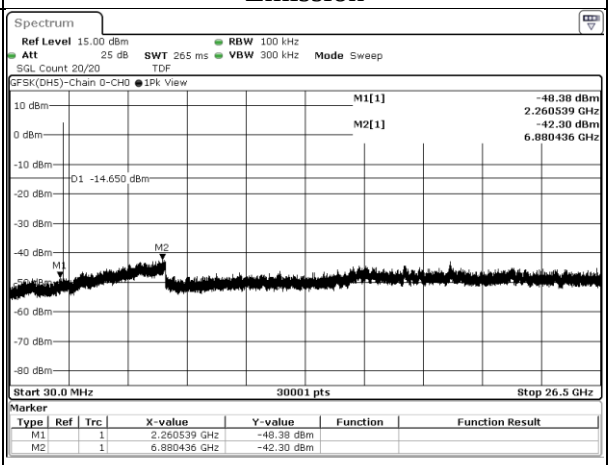
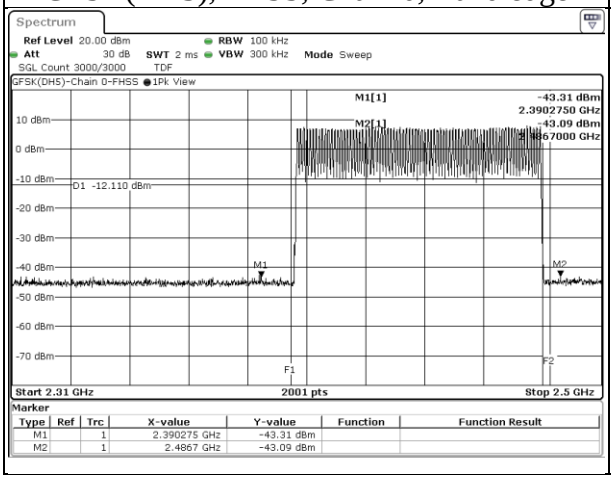
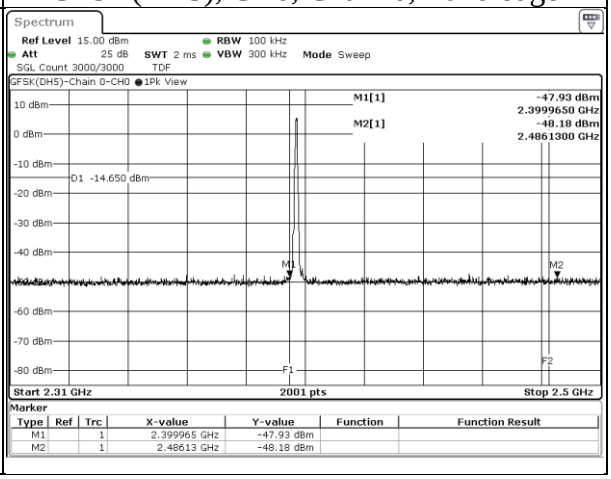
The transmitter output was connected to the spectrum analyzer via a low lose cable. Set both RBW and VBW of spectrum analyzer to 100 kHz and 300 kHz with suitable frequency span including 100 MHz bandwidth from band edge. The band edges was measured and recorded.

Test Setup

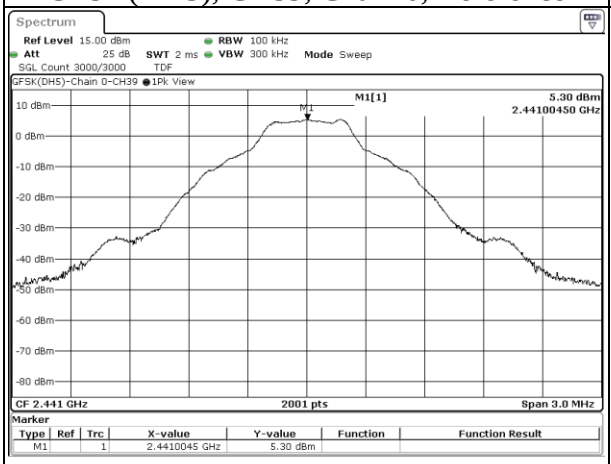


The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

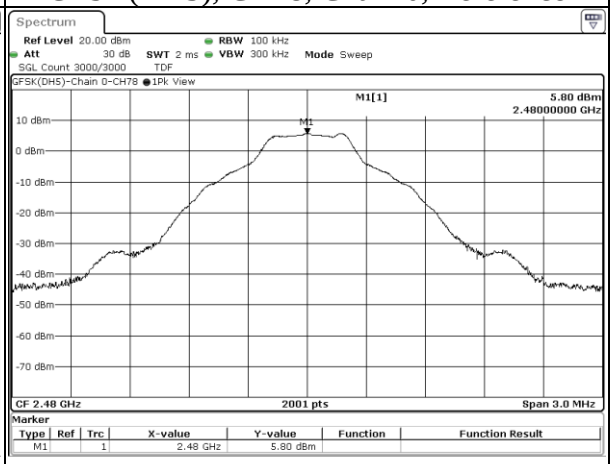
Test Data

GFSK(DH5), FHSS, Chain 0, Reference	GFSK(DH5), CH0, Chain 0, Reference
	
GFSK(DH5), FHSS, Chain 0, Conducted Emission	GFSK(DH5), CH0, Chain 0, Conducted Emission
	
GFSK(DH5), FHSS, Chain 0, Band edge	GFSK(DH5), CH0, Chain 0, Band edge
	

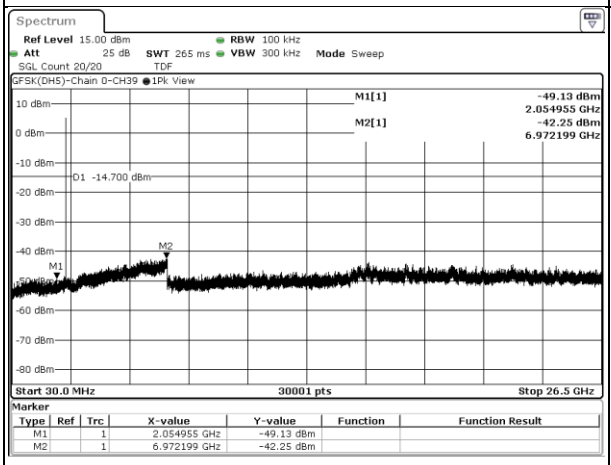
GFSK(DH5), CH39, Chain 0, Reference



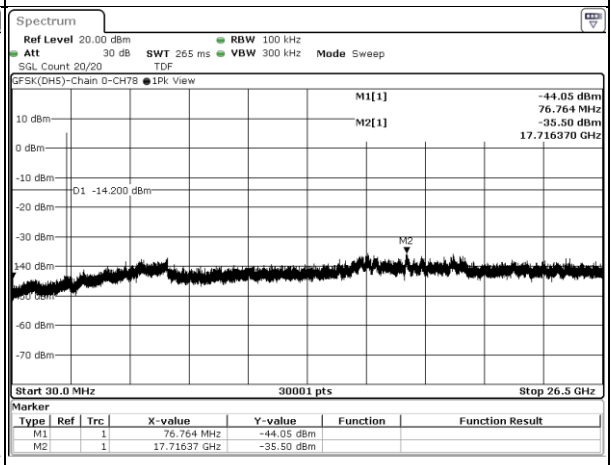
GFSK(DH5), CH78, Chain 0, Reference



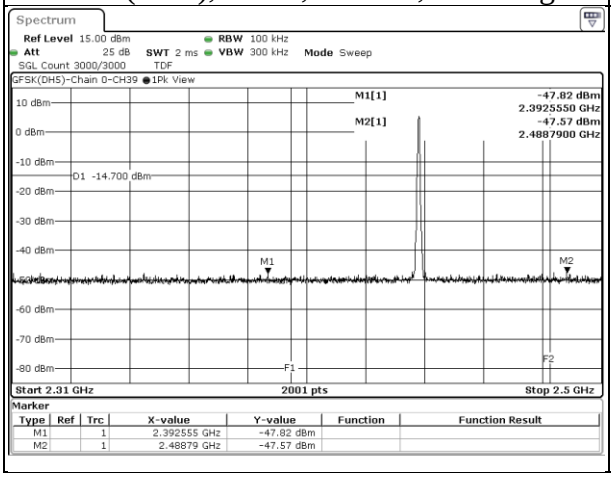
GFSK(DH5), CH39, Chain 0, Conducted Emission



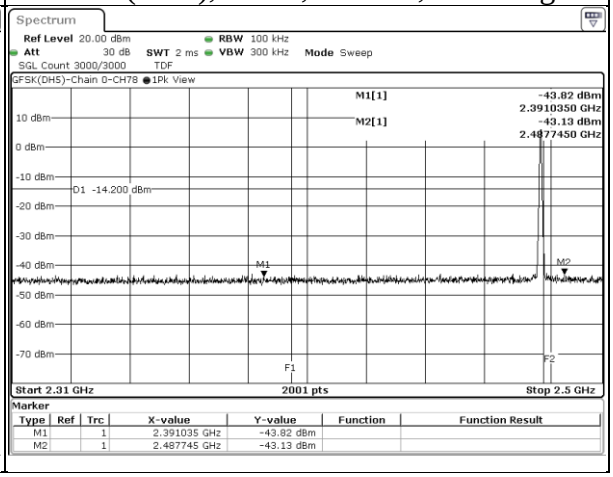
GFSK(DH5), CH78, Chain 0, Conducted Emission



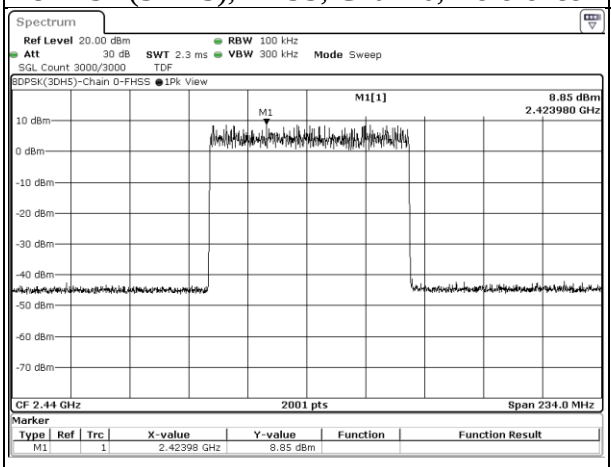
GFSK(DH5), CH39, Chain 0, Band edge



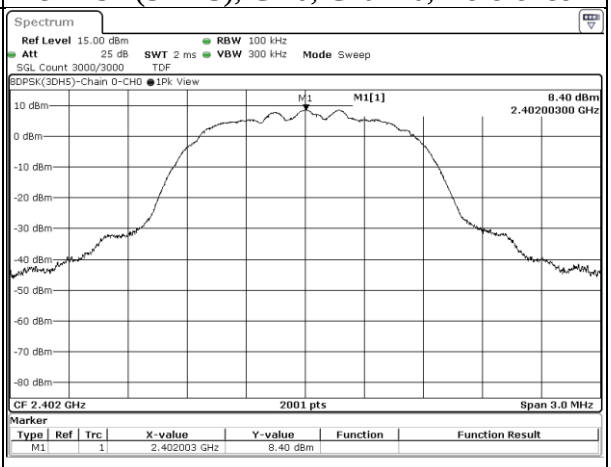
GFSK(DH5), CH78, Chain 0, Band edge



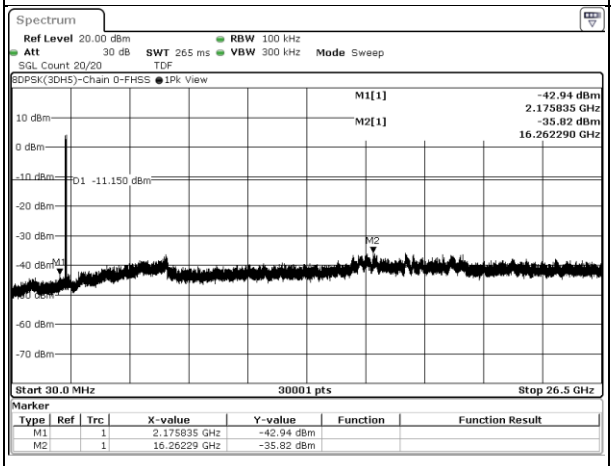
8DPSK(3DH5), FHSS, Chain 0, Reference



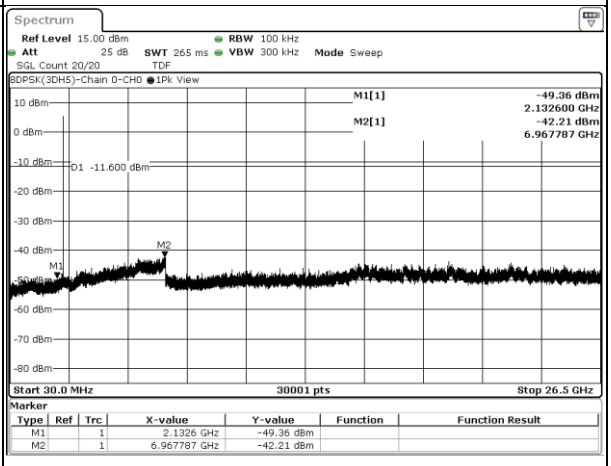
8DPSK(3DH5), CH0, Chain 0, Reference



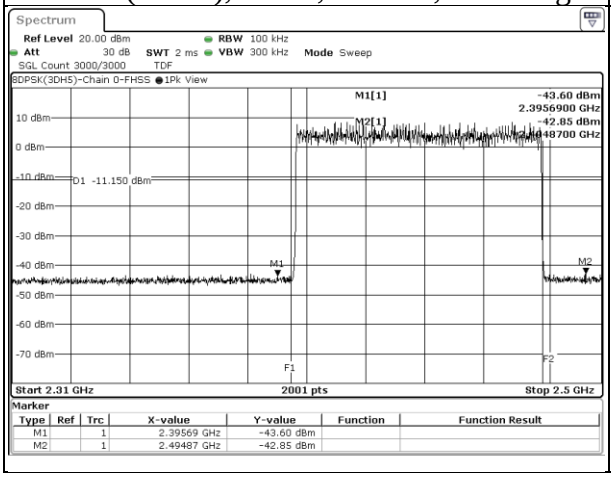
8DPSK(3DH5), FHSS, Chain 0, Conducted Emission



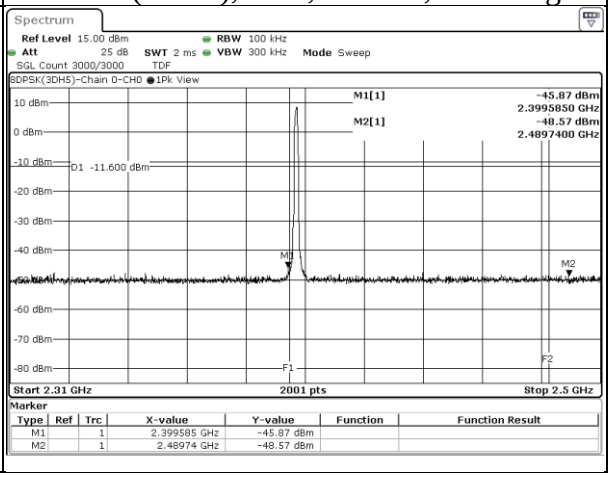
8DPSK(3DH5), CH0, Chain 0, Conducted Emission



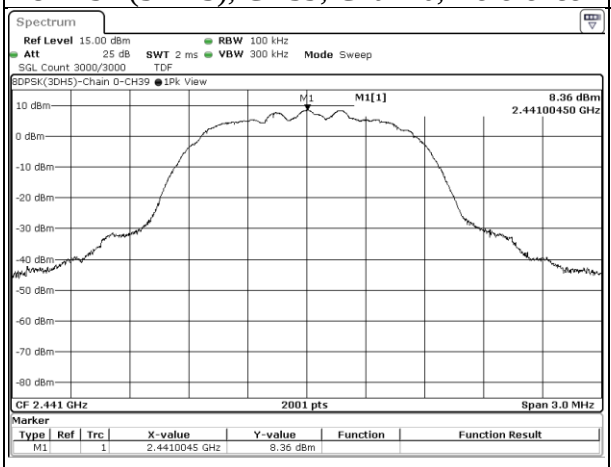
8DPSK(3DH5), FHSS, Chain 0, Band edge



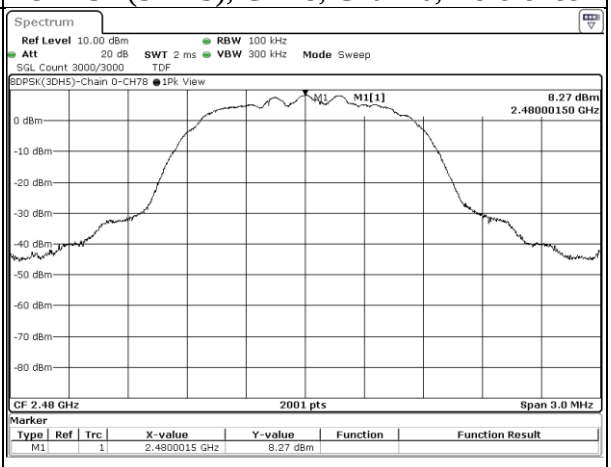
8DPSK(3DH5), CH0, Chain 0, Band edge



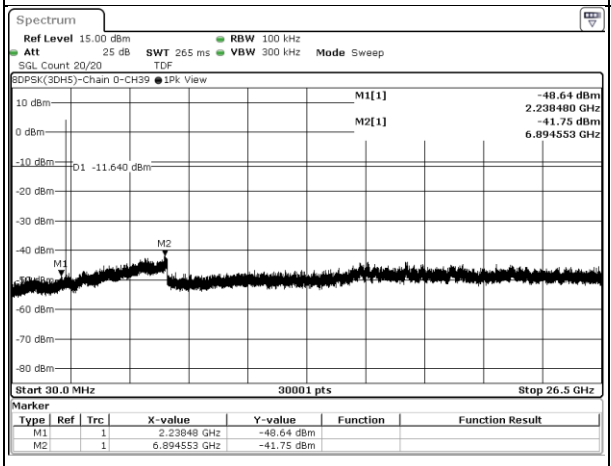
8DPSK(3DH5), CH39, Chain 0, Reference



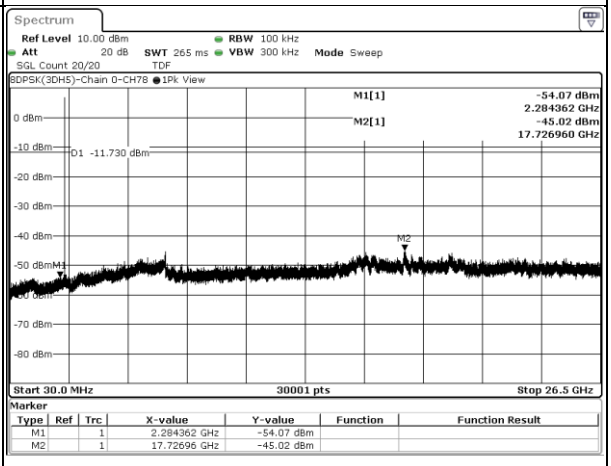
8DPSK(3DH5), CH78, Chain 0, Reference



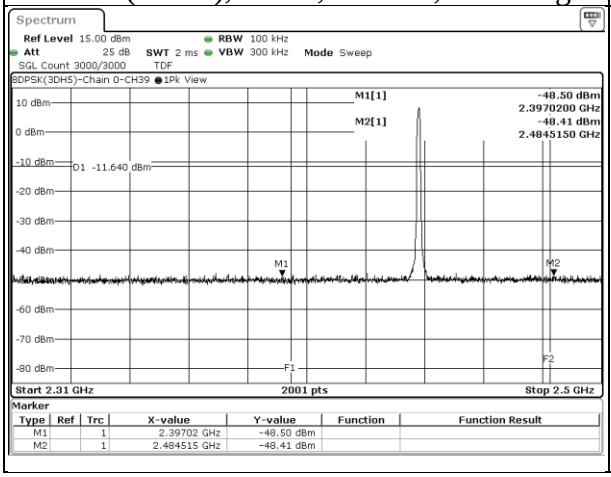
8DPSK(3DH5), CH39, Chain 0, Conducted Emission



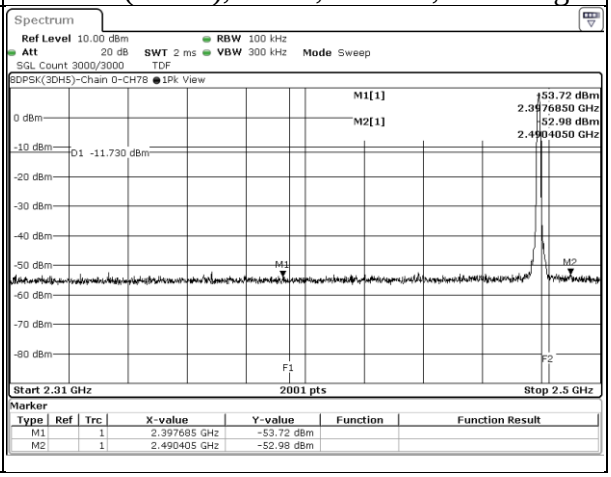
8DPSK(3DH5), CH78, Chain 0, Conducted Emission



8DPSK(3DH5), CH39, Chain 0, Band edge



8DPSK(3DH5), CH78, Chain 0, Band edge



9.7. Radiated Spurious Emission

Requirements

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table. Other emissions shall be at least 20dB below the highest level of the desired power:

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	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 (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

Test Procedures

[For 9 kHz ~ 30 MHz]

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
c. Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.
d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
e. For measurement below 30MHz, the initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured. If the emission level of the EUT measured by the peak detector is lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

NOTE:
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9kHz at frequency below 30MHz.

[For above 30 MHz]

a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
e. For measurement below 1GHz, the initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured. If the emission level of the EUT measured by the peak detector is lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.
f. The test-receiver system was set to peak and average detects function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Note:

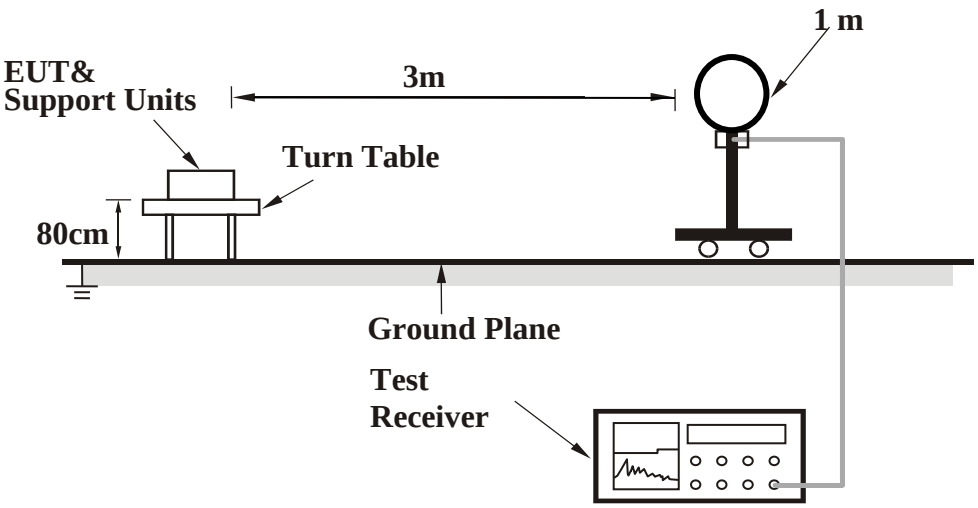
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is ≥ 1/T (Duty cycle < 98%) or 10Hz (Duty cycle ≥ 98%) for Average detection (AV) at frequency above 1GHz.

Configuration	Average	
	RBW	VBW
Bluetooth	1MHz	Refer to section 6.6 for duty cycle.

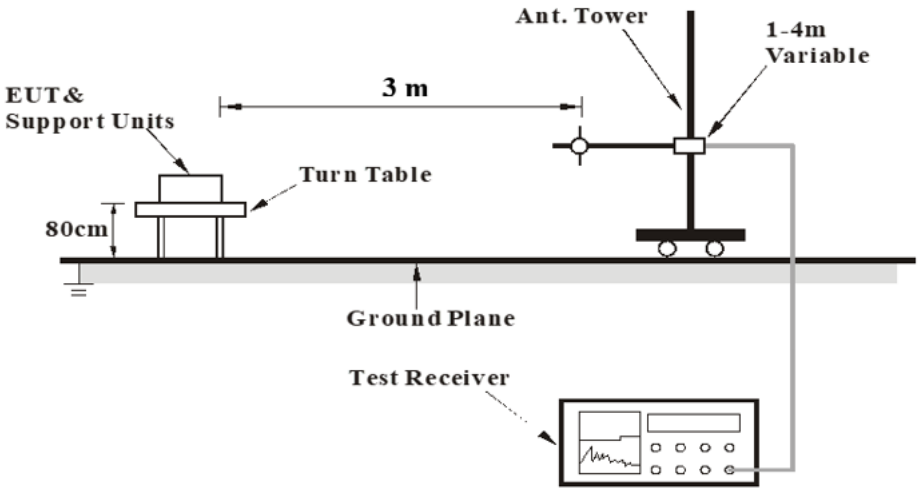
4. All modes of operation were investigated (includes all external accessories) and the worst-case emissions are reported, the other emission levels were low against the limit.
5. Test data of Result value (dBuV/m) = Reading value (dBuV/m) + Correction Factor (dB/m).
6. Test data of Margin(dB) = Result value (dBuV/m) - Limit value (dBuV/m).
7. Test data of Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Loss (dB) - Preamp Factor (dB).
8. Test data of Notation "@" = Fundamental Frequency
9. Test data of Notation " * " = The peak result under 20 dB above and complies with AVG limit, AVG result is deemed to comply with AVG limit.

Test Setup

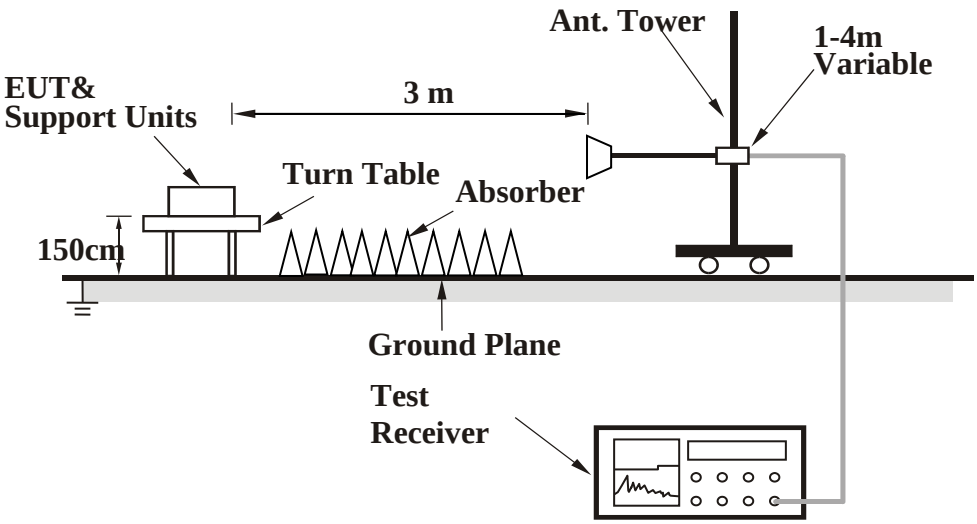
<Frequency Range 9 kHz ~ 30 MHz>



<Frequency Range 30 MHz ~ 1 GHz >



<Frequency Range above 1 GHz>



For the actual test configuration, please refer to the Setup Configurations.

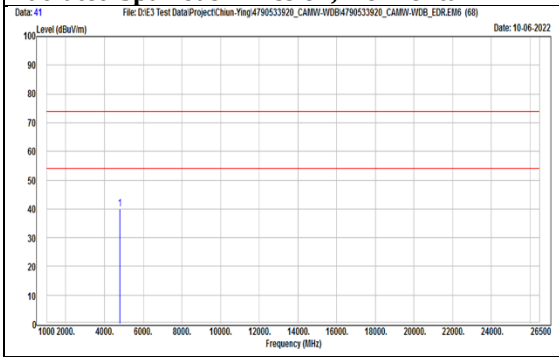
Test Data

Above 1 GHz

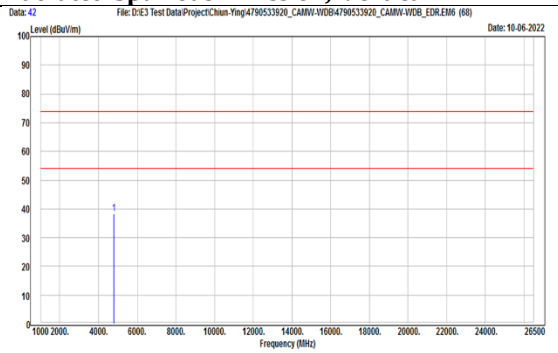
Mode	GFSK	Channel	0

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		2357.88	41.76	5.89	47.65	74	-26.35	PK
		2371.37	28.97	5.85	34.82	54	-19.18	AVG
	@	2402	84.85	5.8	90.65	N/A	N/A	PK
	@	2402	84.2	5.8	90	N/A	N/A	AVG
	*	4804	37.57	2.33	39.9	74	-34.1	PK
Vertical		2310.38	40.7	5.84	46.54	74	-27.46	PK
		2364.15	28.85	5.87	34.72	54	-19.28	AVG
	@	2402	91.04	5.8	96.84	N/A	N/A	PK
	@	2402	90.31	5.8	96.11	N/A	N/A	AVG
	*	4804	35.83	2.33	38.16	74	-35.84	PK

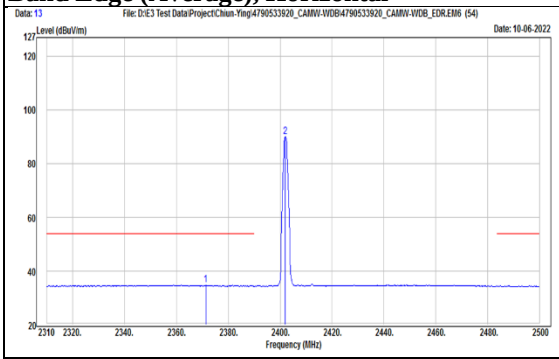
TX, GFSK (Ch 0)
Radiated Spurious Emission, Horizontal



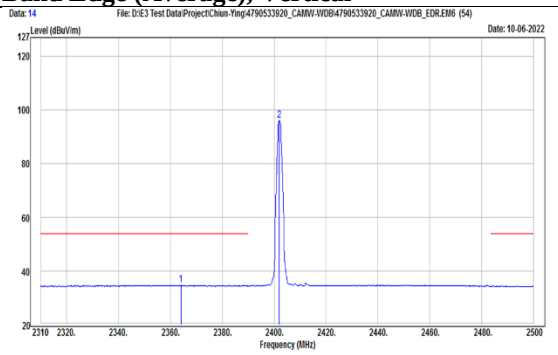
TX, GFSK (Ch 0)
Radiated Spurious Emission, Vertical



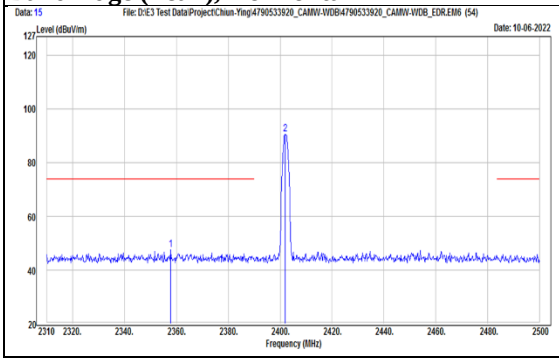
TX, GFSK (Ch 0)
Band Edge (Average), Horizontal



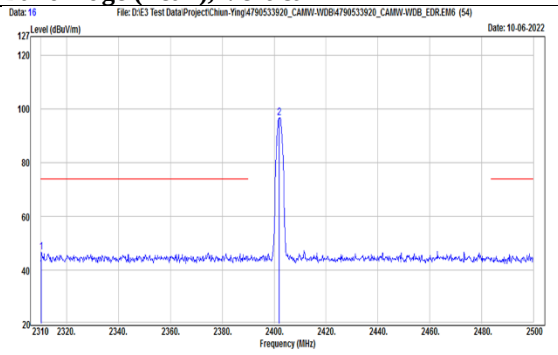
TX, GFSK (Ch 0)
Band Edge (Average), Vertical



TX, GFSK (Ch 0)
Band Edge (Peak), Horizontal



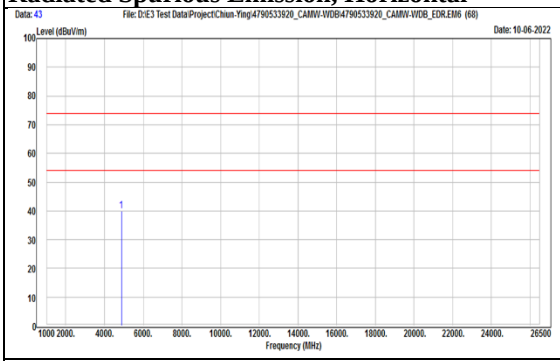
TX, GFSK (Ch 0)
Band Edge (Peak), Vertical



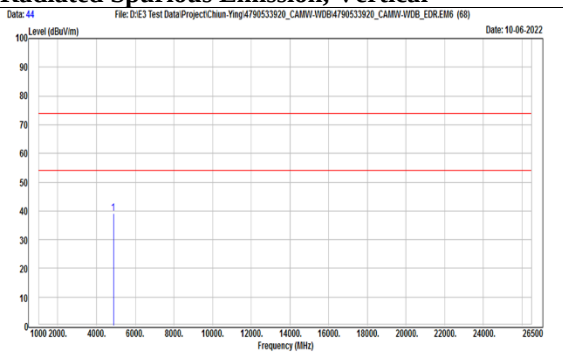
Mode	GFSK	Channel	39

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		2335.27	41.12	5.89	47.01	74	-26.99	PK
		2350.09	28.87	5.9	34.77	54	-19.23	AVG
	@	2441	90.86	5.94	96.8	N/A	N/A	PK
	@	2441	89.98	5.94	95.92	N/A	N/A	AVG
		2487.27	28.89	5.66	34.55	54	-19.45	AVG
		2489.36	39.79	5.64	45.43	74	-28.57	PK
	*	4882	37.49	2.41	39.9	74	-34.1	PK
Vertical		2321.02	40.96	5.86	46.82	74	-27.18	PK
		2358.45	28.81	5.89	34.7	54	-19.3	AVG
	@	2441	91.92	5.94	97.86	N/A	N/A	PK
	@	2441	91.54	5.94	97.48	N/A	N/A	AVG
		2490.31	40.9	5.63	46.53	74	-27.47	PK
		2492.59	28.96	5.61	34.57	54	-19.43	AVG
	*	4882	36.6	2.41	39.01	74	-34.99	PK

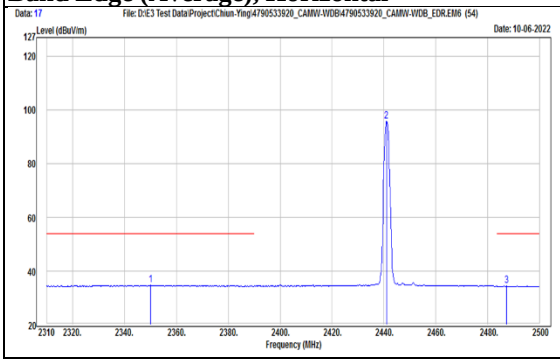
TX, GFSK (Ch 39)
Radiated Spurious Emission, Horizontal



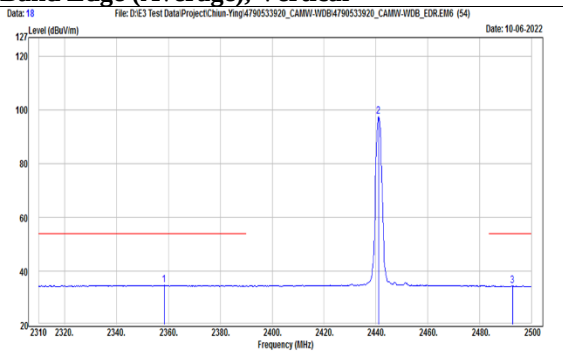
TX, GFSK (Ch 39)
Radiated Spurious Emission, Vertical



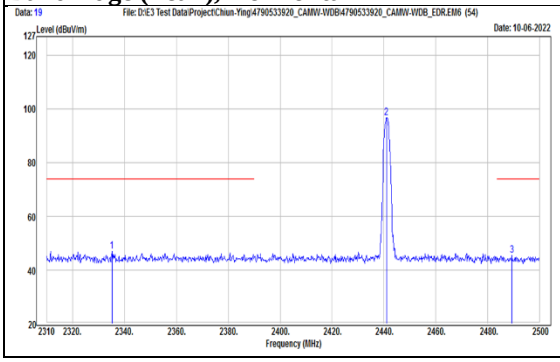
TX, GFSK (Ch 39)
Band Edge (Average), Horizontal



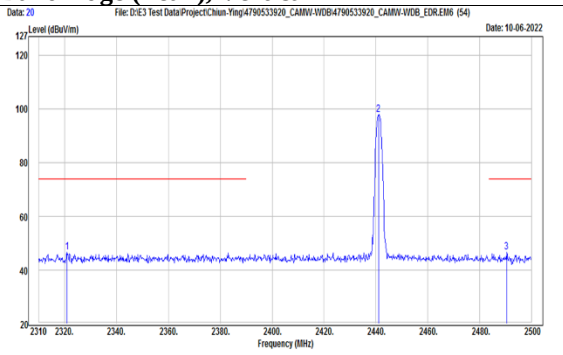
TX, GFSK (Ch 39)
Band Edge (Average), Vertical



TX, GFSK (Ch 39)
Band Edge (Peak), Horizontal



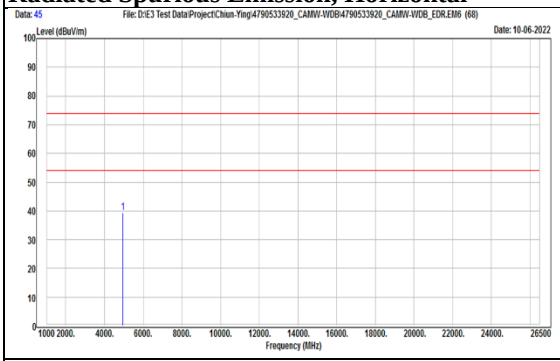
TX, GFSK (Ch 39)
Band Edge (Peak), Vertical



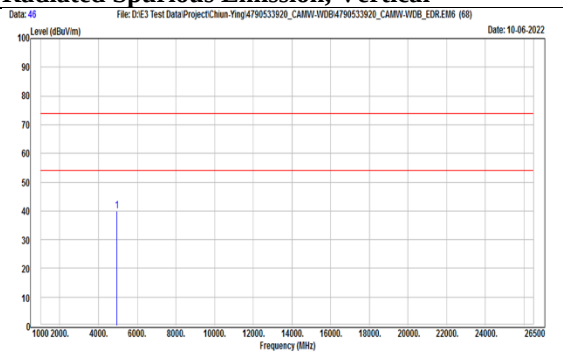
Mode	GFSK	Channel	78

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal	@	2480	91.28	5.72	97	N/A	N/A	PK
	@	2480	90.93	5.72	96.65	N/A	N/A	AVG
		2483.85	30.08	5.68	35.76	54	-18.24	AVG
		2484.23	40.94	5.68	46.62	74	-27.38	PK
	*	4960	36.85	2.43	39.28	74	-34.72	PK
Vertical	@	2480	88.43	5.72	94.15	N/A	N/A	PK
	@	2480	88.33	5.72	94.05	N/A	N/A	AVG
		2483.66	29.48	5.68	35.16	54	-18.84	AVG
		2485.37	40.64	5.67	46.31	74	-27.69	PK
	*	4960	37.45	2.43	39.88	74	-34.12	PK

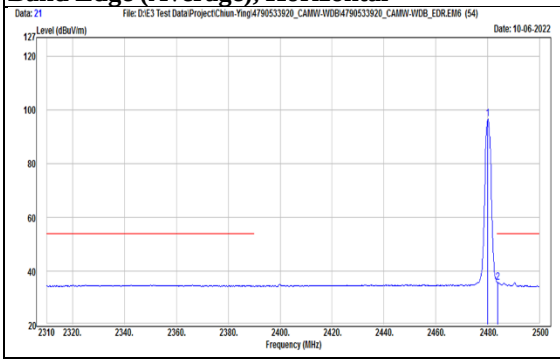
TX, GFSK (Ch 78)
Radiated Spurious Emission, Horizontal



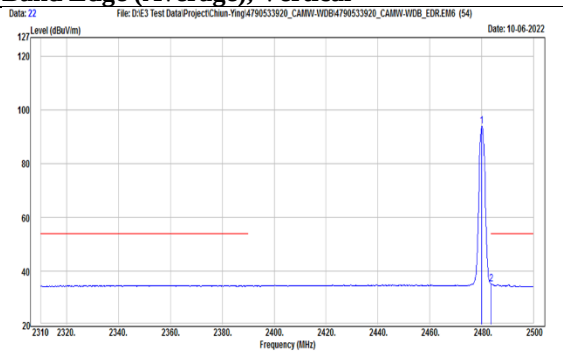
TX, GFSK (Ch 78)
Radiated Spurious Emission, Vertical



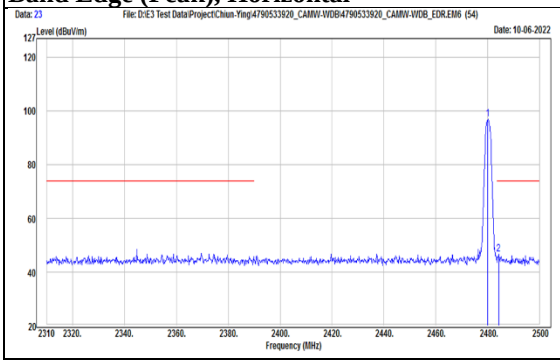
TX, GFSK (Ch 78)
Band Edge (Average), Horizontal



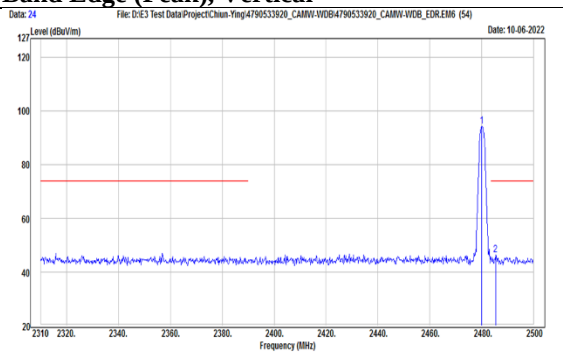
TX, GFSK (Ch 78)
Band Edge (Average), Vertical



TX, GFSK (Ch 78)
Band Edge (Peak), Horizontal



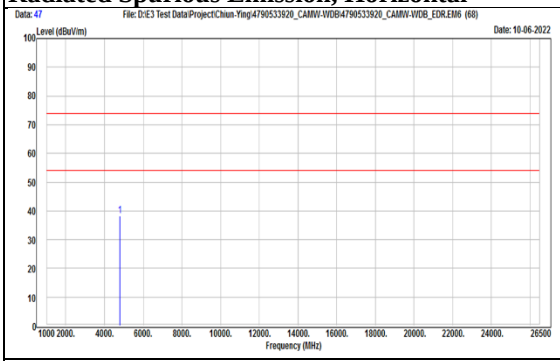
TX, GFSK (Ch 78)
Band Edge (Peak), Vertical



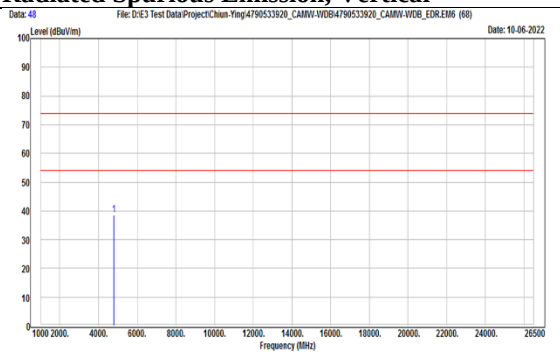
Mode	8DPSK	Channel	0

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		2340.4	28.9	5.9	34.8	54	-19.2	AVG
		2361.49	40.75	5.87	46.62	74	-27.38	PK
	@	2402	85.9	5.8	91.7	N/A	N/A	PK
	@	2402	82.82	5.8	88.62	N/A	N/A	AVG
	*	4804	36.02	2.33	38.35	74	-35.65	PK
Vertical		2317.79	40.71	5.85	46.56	74	-27.44	PK
		2367.38	28.9	5.87	34.77	54	-19.23	AVG
	@	2402	92.4	5.8	98.2	N/A	N/A	PK
	@	2402	89.26	5.8	95.06	N/A	N/A	AVG
	*	4804	36.22	2.33	38.55	74	-35.45	PK

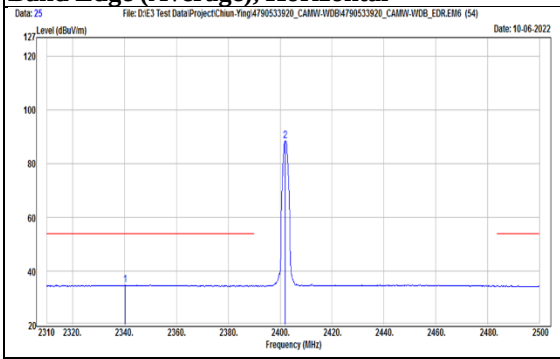
TX, 8DPSK (Ch 0)
Radiated Spurious Emission, Horizontal



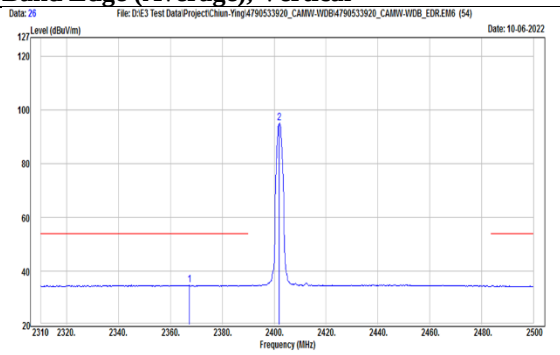
TX, 8DPSK (Ch 0)
Radiated Spurious Emission, Vertical



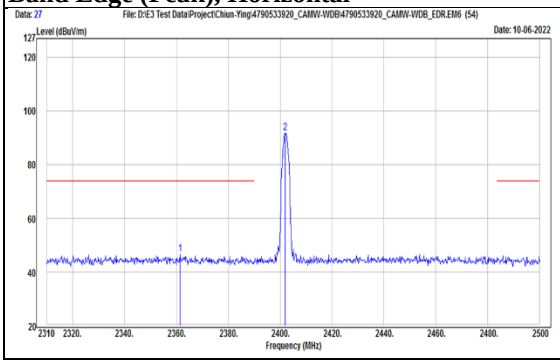
TX, 8DPSK (Ch 0)
Band Edge (Average), Horizontal



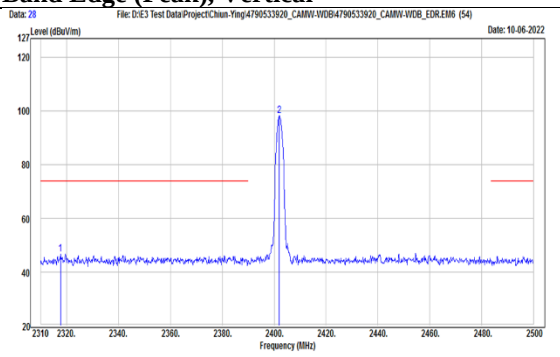
TX, 8DPSK (Ch 0)
Band Edge (Average), Vertical



TX, 8DPSK (Ch 0)
Band Edge (Peak), Horizontal



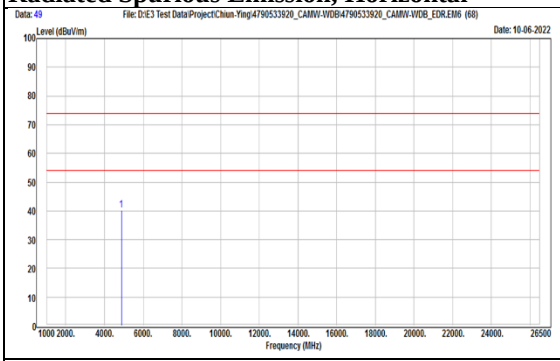
TX, 8DPSK (Ch 0)
Band Edge (Peak), Vertical



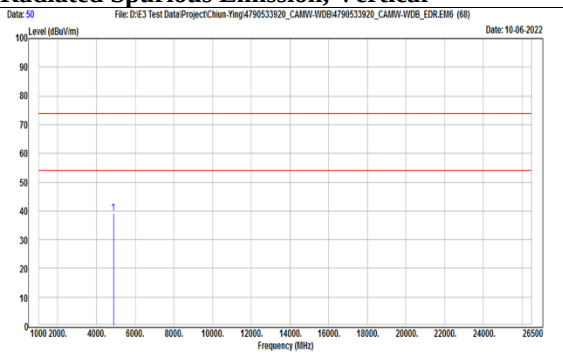
Mode	8DPSK	Channel	39

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		2325.58	28.9	5.87	34.77	54	-19.23	AVG
		2327.1	40.51	5.87	46.38	74	-27.62	PK
	@	2441	92.34	5.94	98.28	N/A	N/A	PK
	@	2441	88.84	5.94	94.78	N/A	N/A	AVG
		2490.31	28.92	5.63	34.55	54	-19.45	AVG
		2492.59	40.52	5.61	46.13	74	-27.87	PK
	*	4882	37.73	2.41	40.14	74	-33.86	PK
Vertical		2336.6	41	5.89	46.89	74	-27.11	PK
		2348.57	28.86	5.9	34.76	54	-19.24	AVG
	@	2441	92.78	5.94	98.72	N/A	N/A	PK
	@	2441	90.02	5.94	95.96	N/A	N/A	AVG
		2487.84	28.82	5.65	34.47	54	-19.53	AVG
		2492.02	40.58	5.62	46.2	74	-27.8	PK
	*	4882	36.59	2.41	39	74	-35	PK

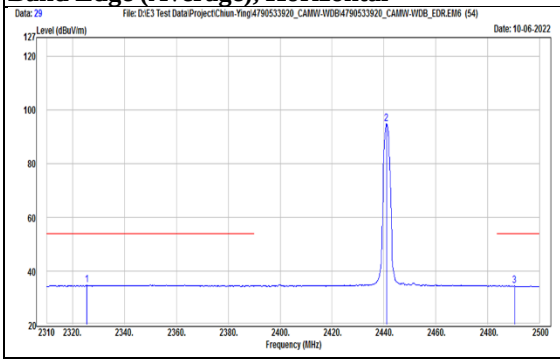
TX, 8DPSK (Ch 39)
Radiated Spurious Emission, Horizontal



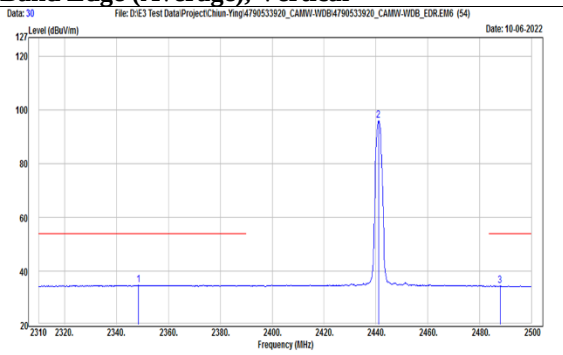
TX, 8DPSK (Ch 39)
Radiated Spurious Emission, Vertical



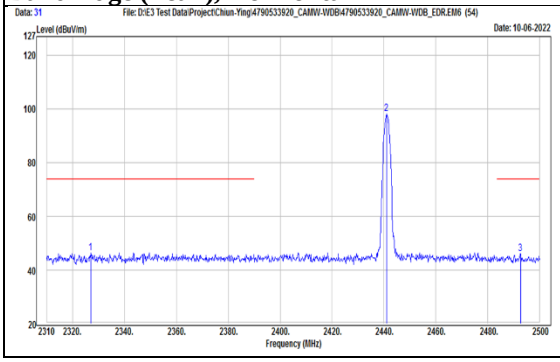
TX, 8DPSK (Ch 39)
Band Edge (Average), Horizontal



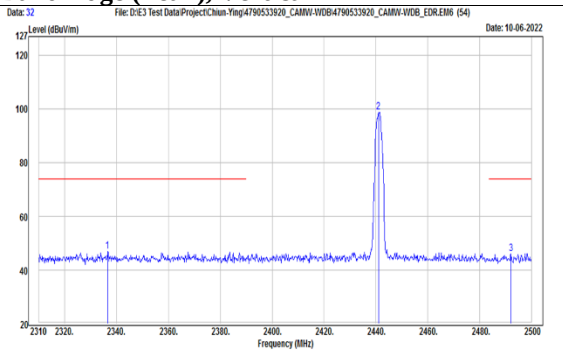
TX, 8DPSK (Ch 39)
Band Edge (Average), Vertical



TX, 8DPSK (Ch 39)
Band Edge (Peak), Horizontal



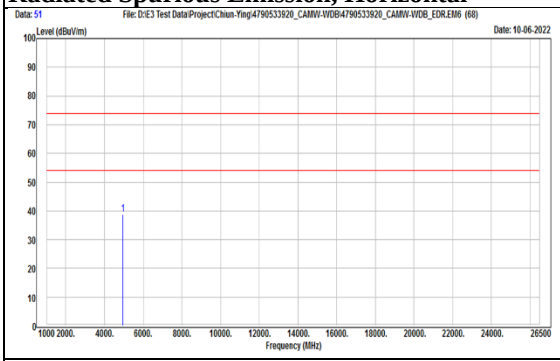
TX, 8DPSK (Ch 39)
Band Edge (Peak), Vertical



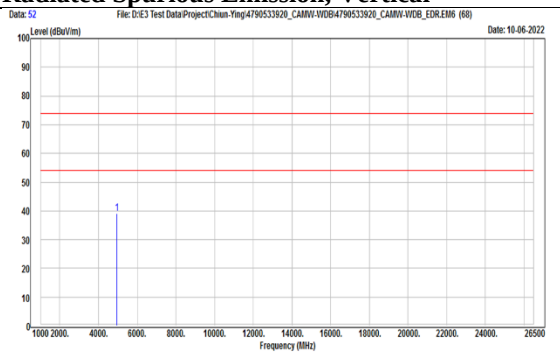
Mode	8DPSK	Channel	78

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal	@	2480	92.63	5.72	98.35	N/A	N/A	PK
	@	2480	88.95	5.72	94.67	N/A	N/A	AVG
		2483.66	30.59	5.68	36.27	54	-17.73	AVG
		2485.75	40.53	5.67	46.2	74	-27.8	PK
	*	4960	36.44	2.43	38.87	74	-35.13	PK
Vertical	@	2480	89.35	5.72	95.07	N/A	N/A	PK
	@	2480	86.34	5.72	92.06	N/A	N/A	AVG
		2483.66	40.07	5.68	45.75	74	-28.25	PK
		2483.66	29.42	5.68	35.1	54	-18.9	AVG
	*	4960	36.66	2.43	39.09	74	-34.91	PK

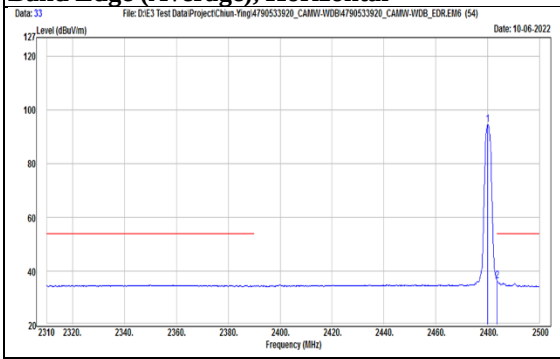
TX, 8DPSK (Ch 78)
Radiated Spurious Emission, Horizontal



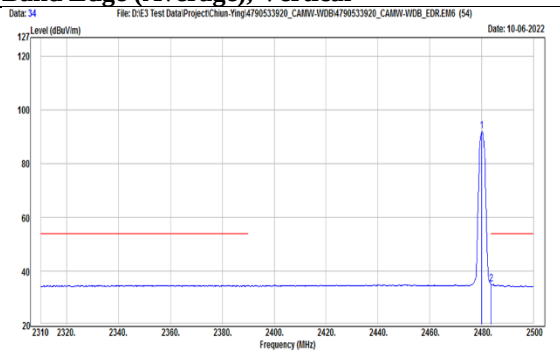
TX, 8DPSK (Ch 78)
Radiated Spurious Emission, Vertical



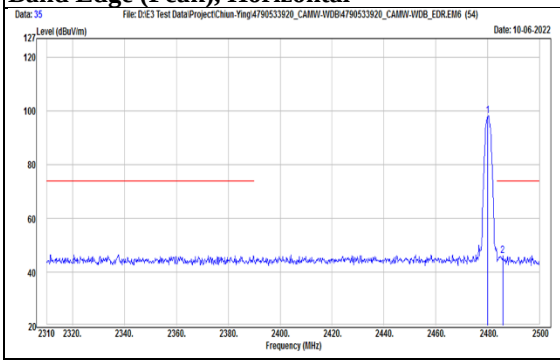
TX, 8DPSK (Ch 78)
Band Edge (Average), Horizontal



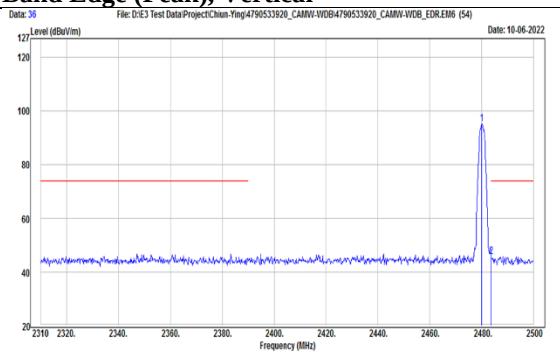
TX, 8DPSK (Ch 78)
Band Edge (Average), Vertical



TX, 8DPSK (Ch 78)
Band Edge (Peak), Horizontal



TX, 8DPSK (Ch 78)
Band Edge (Peak), Vertical

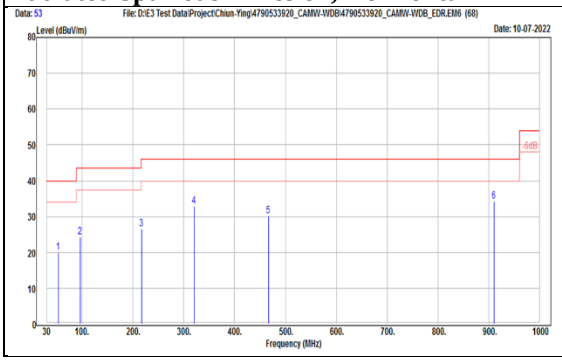


Below 1 GHz

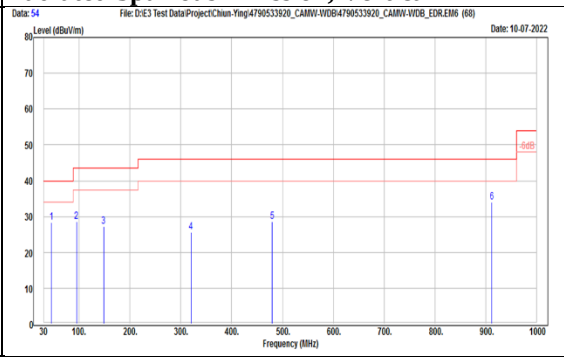
Mode	8DPSK	Channel	0

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		53.28	31.83	-11.78	20.05	40	-19.95	PK
		95.96	41.16	-16.89	24.27	43.5	-19.23	PK
		217.21	40.71	-14.22	26.49	46	-19.51	PK
		320.03	43.12	-10.26	32.86	46	-13.14	PK
		466.5	35.96	-5.93	30.03	46	-15.97	PK
		909.79	31.89	2.3	34.19	46	-11.81	PK
Vertical		45.52	40.24	-12	28.24	40	-11.76	PK
		94.99	45.74	-17.08	28.66	43.5	-14.84	PK
		148.34	39.2	-11.98	27.22	43.5	-16.28	PK
		320.03	35.8	-10.26	25.54	46	-20.46	PK
		480.08	34.42	-5.88	28.54	46	-17.46	PK
		911.73	31.6	2.39	33.99	46	-12.01	PK

TX, 8DPSK (Ch 0)
Radiated Spurious Emission, Horizontal



TX, 8DPSK (Ch 0)
Radiated Spurious Emission, Vertical



9 kHz ~ 30 MHz Data:

For 9 kHz to 30 MHz radiated emission have performed all modes of operation were investigated. The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.

No non-compliance noted:

KDB 414788 D01 OATS and Chamber Correlation Justification

- Base on FCC 15.31 (f) (2): measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field.

- OATs and chamber correlation testing had been performed and chamber measured test results is the worst case test result.

Although these tests were performed other than open area test site, adequate comparison measurements were confirmed against 30m open area test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.

9.8. AC Power Line Conducted Emission

Requirements

Frequency (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15 - 0.5	66 - 56	56 - 46
0.50 - 5.0	56	46
5.0 - 30	60	50

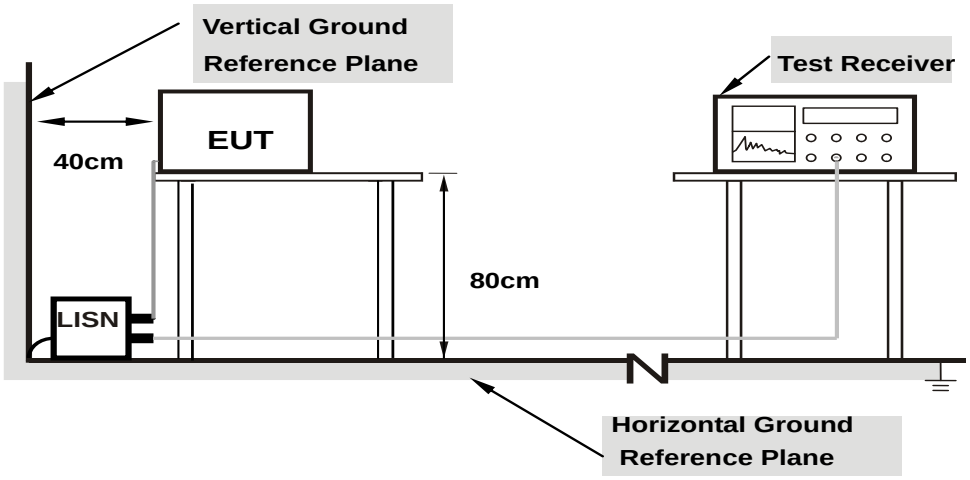
Note:
1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

Test Procedures

a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument.
b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.
c. The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

NOTE:
1. The resolution bandwidth and video bandwidth of test receiver is 9kHz for quasi-peak detection (QP) and average detection (AV) at frequency 0.15MHz-30MHz.
2. All modes of operation were investigated (includes all external accessories) and the worst-case emissions are reported, the other emission levels were low against the limit.
3. Test data of Result value (dBuV) = Reading value (dBuV) + Correction Factor (dB).
4. Test data of Margin(dB) = Result value (dBuV) - Limit value (dBuV).
5. Test data of Correction Factor (dB) = Insertion loss(dB) + Cable loss(dB).

Test Setup



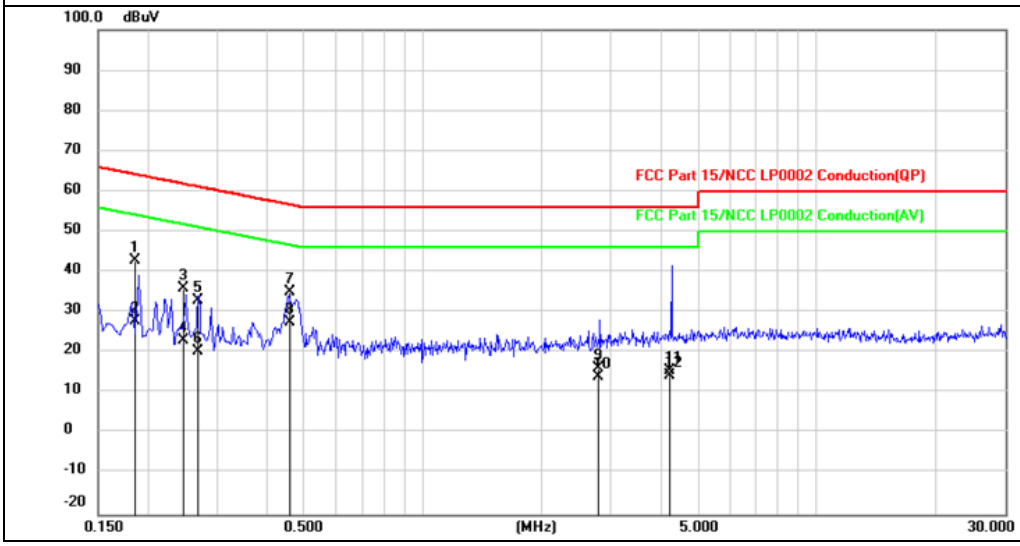
Note: 1.Support units were connected to second LISN.

For the actual test configuration, please refer to the Setup Configurations.

Test Data

Mode	3DH5_TX2402	Channel	0

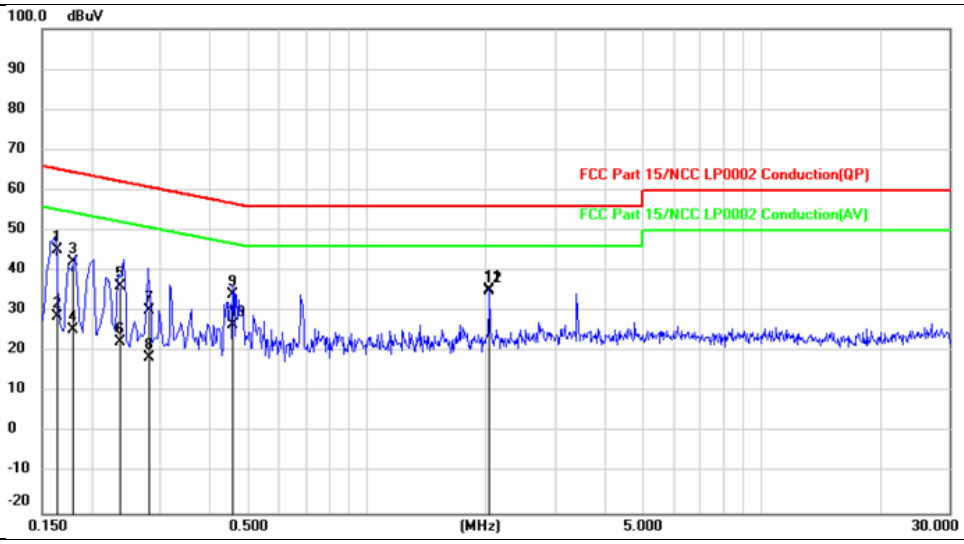
Phase: Line



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Remark
1	0.1859	23.23	19.53	42.76	64.22	-21.46	QP
2	0.1859	8.22	19.53	27.75	54.22	-26.47	AVG
3	0.2466	16.34	19.53	35.87	61.87	-26.00	QP
4	0.2466	3.49	19.53	23.02	51.87	-28.85	AVG
5	0.2689	13.54	19.53	33.07	61.15	-28.08	QP
6	0.2689	0.81	19.53	20.34	51.15	-30.81	AVG
7	0.4588	15.48	19.54	35.02	56.71	-21.69	QP
8	0.4588	8.03	19.54	27.57	46.71	-19.14	AVG
9	2.7961	-3.57	19.59	16.02	56.00	-39.98	QP
10	2.7961	-5.47	19.59	14.12	46.00	-31.88	AVG
11	4.2441	-4.02	19.63	15.61	56.00	-40.39	QP
12	4.2441	-5.23	19.63	14.40	46.00	-31.60	AVG

Mode	3DH5_TX2402	Channel	0

Phase: Neutral



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Remark
1	0.1648	25.85	19.54	45.39	65.22	-19.83	QP
2	0.1648	9.23	19.54	28.77	55.22	-26.45	AVG
3	0.1793	22.75	19.54	42.29	64.52	-22.23	QP
4	0.1793	5.86	19.54	25.40	54.52	-29.12	AVG
5	0.2377	16.80	19.54	36.34	62.18	-25.84	QP
6	0.2377	2.97	19.54	22.51	52.18	-29.67	AVG
7	0.2812	10.86	19.54	30.40	60.78	-30.38	QP
8	0.2812	-1.05	19.54	18.49	50.78	-32.29	AVG
9	0.4573	14.58	19.55	34.13	56.74	-22.61	QP
10	0.4573	7.21	19.55	26.76	46.74	-19.98	AVG
11	2.0405	15.64	19.58	35.22	56.00	-20.78	QP
12	2.0405	15.35	19.58	34.93	46.00	-11.07	AVG

END OF REPORT