RADIO TEST REPORT

Product	:	Smart Gateway
Model Name	:	SHC301
FCC ID	:	2AQJEGC01
Test Regulation	:	FCC 47 CFR Part 15 Subpart C (Section 15.247)
Received Date	:	May 28, 2018
Test Date	:	May 29, 2018 ~ July 12, 2018
Issued Date	:	October 1, 2018
Applicant	:	GalaThings Technology Inc. 9F.-6, NO.65, Gaotie 7th Rd., Zhubei City,Hsinchu County 302, Taiwan (R.O.C.)
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

The results reported herein have been performed in accordance with the laboratory's terms of accreditation. This report shall not be reproduced except in full without the written approval of the Laboratory. The results in this report apply to the test sample(s) mentioned above at the time of the testing period only and are not to be used to indicate applicability to other similar products. This report does not imply that the product(s) has met the criteria for certification.

REVISION HISTORY

Original Test Report No.: 4788408771-US-R3-V0

Rev.	Test report No.	Date	Page revised	Contents
Original	4788408771-US-R3-V0	Oct. 1, 2018	-	Initial issue

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1. Attestation of Test Results

APPLICANT:	GalaThings Technology Inc. 9F.-6, NO.65, Gaotie 7th Rd., Zhubei City,Hsinchu County 302, Taiwan (R.O.C.)
MANUFACTURER	WHA YU INDUSTRIAL CO., LTD No.326,Sec 2,Kung Tao 5 Road,Hsin Chu City,Taiwan
EUT DESCRIPTION:	Smart Gateway
BRAND:	Mercu
MODEL:	SHC301
SAMPLE STAGE:	Identical Prototype
DATE of TESTED:	May 29, 2018 ~ July 12, 2018

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. Measurement Uncertainties were not taken into account and are published for informational purposes only. 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: Evelyn Lee

Evelyn Lee Date : October 1, 2018
Project Handler

Approve By: John Cheng

John Cheng Date : October 1, 2018
Project Engineer

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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

Note:
1. For FCC Clause 15.247(d), the Radiated Band Edge test plots were recorded in Appendix I.
2. If The Frequency Hopping System operating in 2400-2483.5MHz band and the output power less than 125mW. The hopping channel carrier frequencies separated by a minimum of 25kHz or two-thirds of the 20dB bandwidth of hopping channel whichever is greater.

3. Test Methodology

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, KDB414788 D01 Radiated Test Site v01, 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. The full scope of accreditation can be viewed at http://accreditation.taftw.org.tw/taf/public/basic/viewApplyItems.action?unitNo=3398

5. Measurement Uncertainty

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

Test Item	Measurement Frequency Range	K	U(dB)
Conducted disturbance at mains terminals ports	0.15MHz ~ 30MHz	2	2.6
RF Conducted	9 kHz - 40GHz	2	1.0
Radiated disturbance below 30MHz	9 kHz - 30 MHz	2	2.4
Radiated disturbance below 1 GHz	30MHz ~ 1GHz	2	5.5
Radiated disturbance above 1GHz	1GHz ~ 40GHz	2	5.0

6. Equipment under Test

6.1. Description of EUT

Product	Smart Gateway
Brand Name	Mercu
Model Name	SHC301
Operating Frequency	2402MHz ~ 2480MHz
Modulation	GFSK, π/4-DQPSK and 8DPSK
Transfer Rate	Up to 3 Mbps
Number of Channel	79
Maximum Output Power	4.01 dBm
Normal Voltage	5Vdc (adapter or host equipment)
Hardware Version	N/A
Software Version	N/A

Note:

1. The EUT contains following accessory devices Product Brand Model Description USB Cable

Product	Brand	Model	Description
AC Adapter	PHIHONG	PSAF10A-050Q	I/P: 100-240Vac, 280mA, O/P: 5Vdc, 2000mA
AC Adapter	FLYPOWER	PS10I050K2000UU	I/P: 100-240Vac, 350mA, 50/60Hz O/P: 5Vdc, 2000mA
USB Cable	N/A	N/A	3 meter, non-shielded cable

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

6.3. Test Condition

Test Item	Test Site No.	Environmental Condition	Input Power	Tested by
Antenna Port Conducted Measurement	SR4	25°C / 65%RH	120 Vac / 60 Hz	Wayne Chen
Radiated Spurious Emission	966-2	26°C / 60%RH	120 Vac / 60 Hz	Wayne Chen
AC power Line Conducted Emission	SR1	26°C / 54%RH	120 Vac / 60 Hz	Wayne Chen

FCC Test Firm Registration Number: 498077

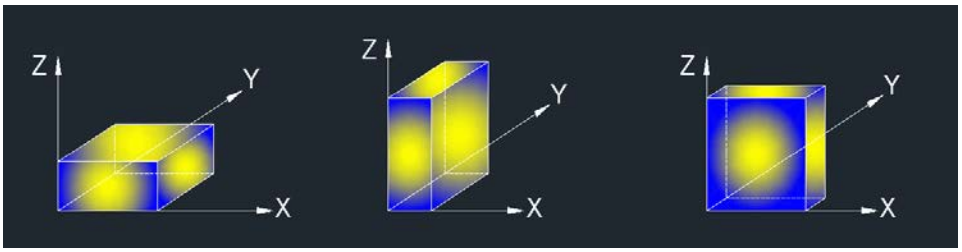
6.4. Description Of Available Antennas

Antenna	Brand Name	Model Name	Antenna Type	Antenna Gain(dBi)
Chain(0)	M.gear	C1920-510002-A(SRF2017850)	PCB	2.9

6.5. Operating Mode and Worst Case of EUT

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)	GFSK	0 to 78	78	DH5
AC Power Line Conducted Emission	GFSK	0 to 78	78	DH5
Antenna Port Conducted Measurement	GFSK	0 to 78	0,39,78	DH5
	8DPSK	0 to 78	0,39,78	3DH5

Note:
1. 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).
2. For below 1 GHz radiated emission and AC power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case.
3. X axis, Y axis, Z axis positions:



The fundamental of the EUT was investigated in three orthogonal axes X/Y/Z, it was determined that X axis was worst-case . Therefore, all final radiated testing was performed with the EUT in X axis.

7. Test Equipment

Test Equipment List					
Equipment	**Manufacturer**	**Model No.**	**Serial No.**	**Cal. Date**	**Cal. Interval**
Radiated Spurious Emission					
Spectrum Analyzer	Keysight	N9010A	MY56070821	Nov. 28, 2017	1 year
Loop Antenna	ETS lindgren	6502	00213440	Dec. 7, 2017	1 year
Trilog-Broadband Antenna with 5dB Attenuator	Schwarzbeck & EMCI	VULB 9168 & N-6-05	VULB 9168-773 & AT-N0539	Feb. 12, 2018	1 year
Horn Antenna (1-18 GHz)	Schwarzbeck	BBHA 9120 D	BBHA 9120D-01686	Jan. 23, 2018	1 year
Horn Antenna(18-40 GHz)	Schwarzbeck	BBHA 9170	BBHA9170750	Jan.12, 2018	1 year
Preamplifier (30-1000 MHz)	EMCI	RMC330E	980404	Jan. 9, 2018	1 year
Preamplifier (1-18 GHz)	EMCI	EMC051835BE	980407	Jan. 10, 2018	1 year
Preamplifier (18-40GHz)	EMCI	EMC184040SEE	980408	Mar. 13, 2018	1 year
RF Cable (9 KHz~18 GHz)	UltraPhase & EMC Instrument	A1K50-UP0358-A1K50-1500&EMC106-NM-SM-2500/8000	170111-3&170104/170223	Feb. 1, 2018	1 year
RF Cable (18 GHz~40 GHz)	UltraPhase	K1K50-UP0264-K1K50-500/2500/4000	170214-3/170214-3/170214-1	Feb. 1, 2018	1 year

Test Equipment List					
Equipment	**Manufacturer**	**Model No.**	**Serial No.**	**Cal. Date**	**Cal. Interval**
Antenna Port Conducted Measurement					
Spectrum Analyzer	Keysight	N9010A	MY56070834	Nov. 20, 2017	1 year
Power meter	Anrisu	MA2411B	1531202	Dec. 14, 2017	1 year
Power sensor	Anrisu	ML2495A	1645002	Dec. 14, 2017	1 year
AC power Line Conducted Emission					
EMI Test Receiver	Rohde & Schwarz	ESR7	101753	Nov. 28, 2017	1 year
Two-Line V-Network	Rohde & Schwarz	ENV216	102136	Aug. 2, 2017	1 year
Impuls-Begrenzer Pulse Limiter	Rohde & Schwarz	ESH3-Z2	102219-Qt	July 31, 2017	1 year
Cables	Huber+Suhner	RG 214/U	FCC-BCICF-4_RF	Feb. 1, 2018	1 year

UL Software		
Description	**Name**	**Version**
Radiated measurement	EMC-RI	1.0.0.0
Conducted measurement	Keysight.TestSystem	1.0.0.0
AC power Line Conducted Emission	EZ_EMC	1.1.4.2

8. Description of Test Setup

Support Equipment

Item	Equipment	Brand Name	Model Name	P/N
N/A	N/A	N/A	N/A	N/A

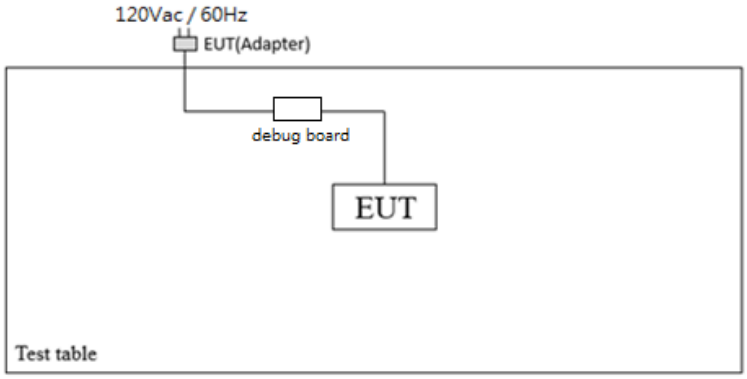
Accessory

Item	Accessory	Brand Name	Model Name	Description
N/A	N/A	N/A	N/A	N/A

Test Setup

The EUT was worked in engineering mode to transmit signal.

Setup Diagram for Test



9. Test Results

9.1. Channel Bandwidth

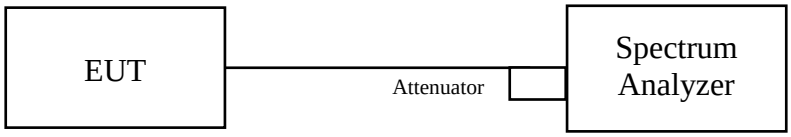
Requirements

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 shell 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

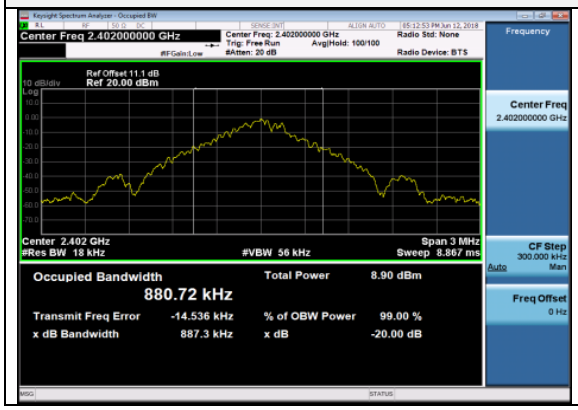


Test Data

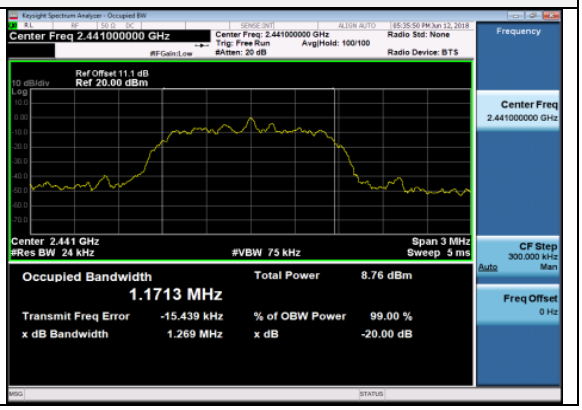
Channel	Frequency (MHz)	20dB Bandwidth (MHz)	
		GFSK	8DPSK
0	2402	0.8873	1.2600
39	2441	0.8868	1.2690
78	2480	0.8861	1.2640

Spectrum Plot of Worst Value

GFSK / CH 0



8DPSK / CH 39



9.2. Conducted output power

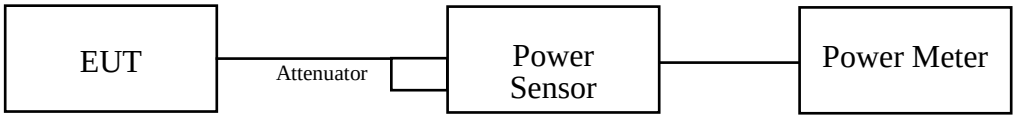
Requirements

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



Test Data

Channel	Frequency (MHz)	Output Power (mW)		Output Power (dBm)		Power Limit (mW)	Pass / Fail
		GFSK	8DPSK	GFSK	8DPSK		
0	2402	2.33	2.04	3.67	3.09	125	Pass
39	2441	2.41	2.11	3.82	3.25	125	Pass
78	2480	2.52	2.21	4.01	3.44	125	Pass

9.3. Hopping Channel Separation

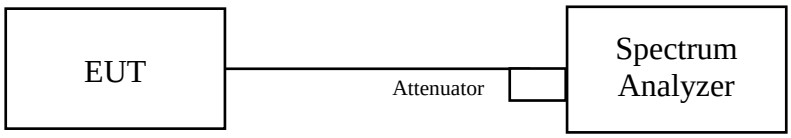
Requirements

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.

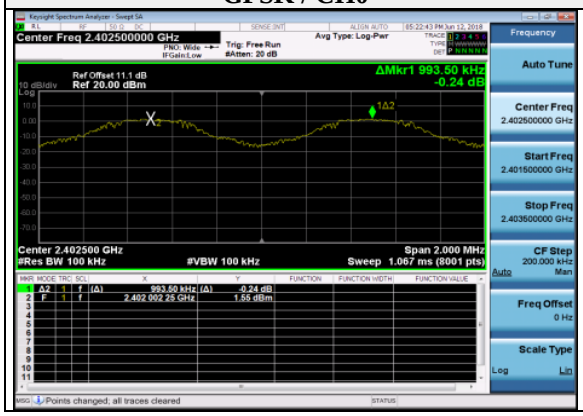
Test Setup



Test Data

Mode	Channel	Frequency (MHz)	Adjacent Hopping Channel Separation (MHz)	Limit (MHz)	Result
GFSK	00	2402	0.9935	0.5915	PASS
	39	2441	0.9935	0.5912	PASS
	78	2480	1.0028	0.5907	PASS
8-DPSK	00	2402	1.0015	0.8400	PASS
	39	2441	1.0168	0.8460	PASS
	78	2480	1.0028	0.8427	PASS

Note: Limit (MHz) = two/three of 20dB Bandwidth

Spectrum Plot of Worst Value	
GFSK / CH0	8DPSK / CH78
	

9.4. Number of Hopping Frequency Used

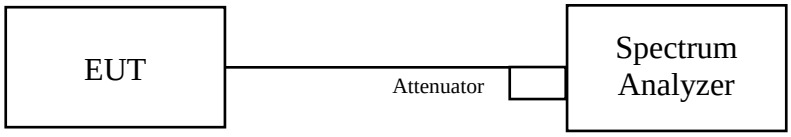
Requirements

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.

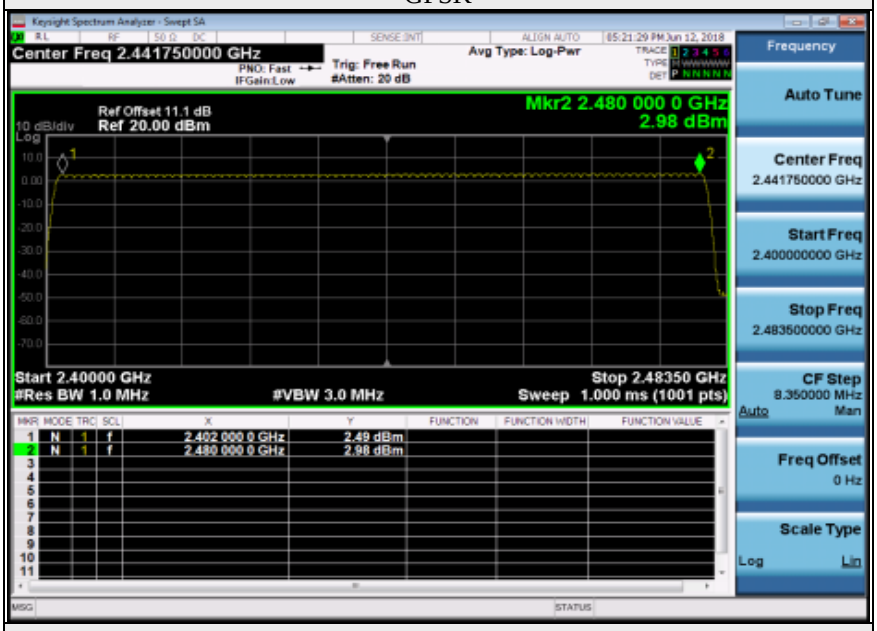
Test Setup



Test Data

There are 79 hopping frequencies in the hopping mode. Please refer to next page for the test result. On the plots, it shows that the hopping frequencies are equally spaced.

GFSK



8DPSK

9.5. Dwell Time on Each Channel

Requirements

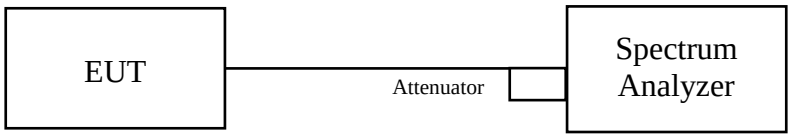
The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

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
   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)

.

Test Setup



Test Data

GFSK

Modulation	Channel	Frequency (MHz)	Length of transmission time (msec)	Result (msec)	Limit (msec)	Result
DH1	0	2402	0.389	41.44	≦400	PASS
DH3	0	2402	1.648	175.79	≦400	PASS
DH5	0	2402	2.900	309.34	≦400	PASS

8DPSK

Modulation	Channel	Frequency (MHz)	Length of transmission time (msec)	Result (msec)	Limit (msec)	Result
3DH1	0	2402	0.397	42.33	≦400	PASS
3DH3	0	2402	1.690	180.27	≦400	PASS
3DH5	0	2402	2.440	260.27	≦400	PASS

Note：

1. In normal mode, hopping rate is 1600 hops/s with 6 slots in 79 hopping channels. With channel hopping rate (1600 / 6 / 79) in Occupancy Time Limit (0.4 x 79) (s),Hops Over Occupancy Time comes to (1600 / 6 / 79) x (0.4 x 79) = 106.67 hops.
2. Dwell time (ms) = Hops Over Occupancy Time (hops) x Length of transmission time (ms).

AFH mode

GFSK

Modulation	Channel	Frequency (MHz)	Length of transmission time (msec)	Result (msec)	Limit (msec)	Result
DH1	0	2402	0.389	20.745	400	PASS
DH3	0	2402	1.648	87.888	400	PASS
DH5	0	2402	2.900	154.657	400	PASS

8DPSK

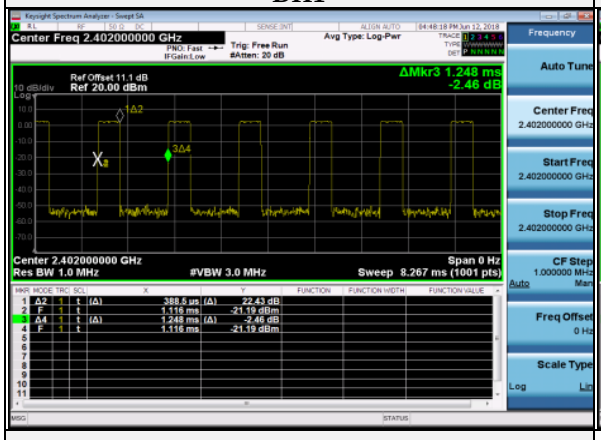
Modulation	Channel	Frequency (MHz)	Length of transmission time (msec)	Result (msec)	Limit (msec)	Result
3DH1	0	2402	0.397	21.172	400	PASS
3DH3	0	2402	1.690	90.128	400	PASS
3DH5	0	2402	2.440	130.125	400	PASS

Note：

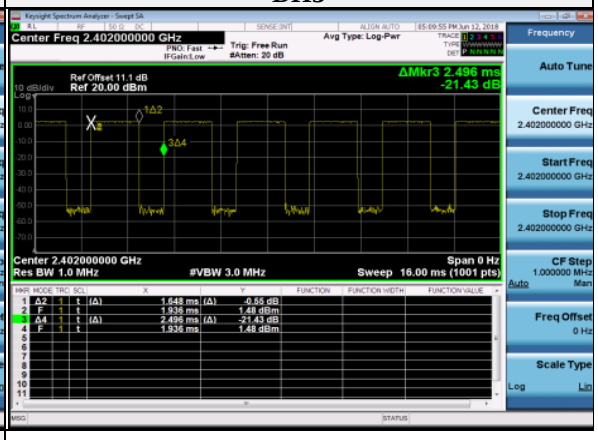
1. In AFH mode, hopping rate is 800 hops/s with 6 slots in 20 hopping channels. With channel hopping rate (800 / 6 / 20) in Occupancy Time Limit (0.4 x 20) (s),
   Hops Over Occupancy Time comes to (800 / 6 / 20) x (0.4 x 20) = 53.33 hops.
2. Dwell time (ms) = Hops Over Occupancy Time (hops) x Length of transmission time (ms).

GFSK

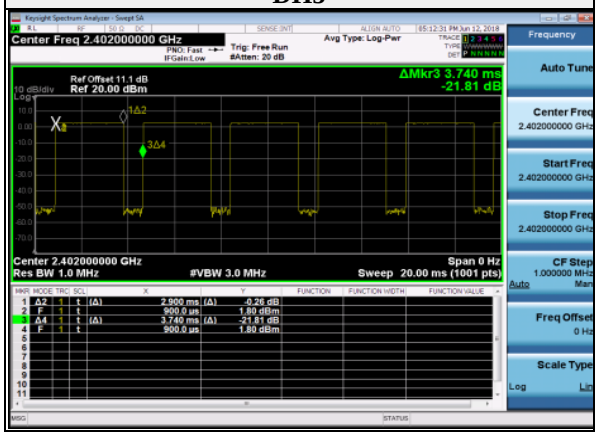
DH1



DH3

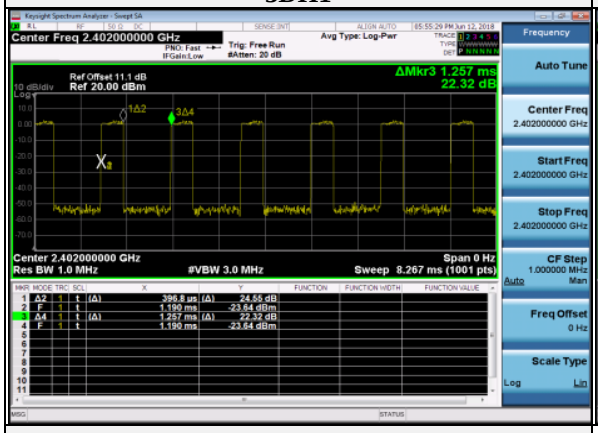


DH5

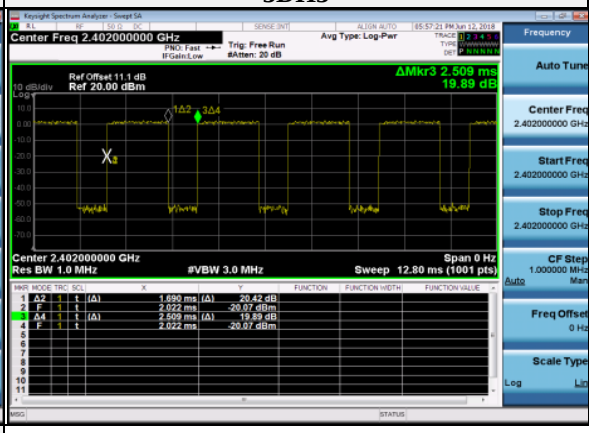


8DPSK

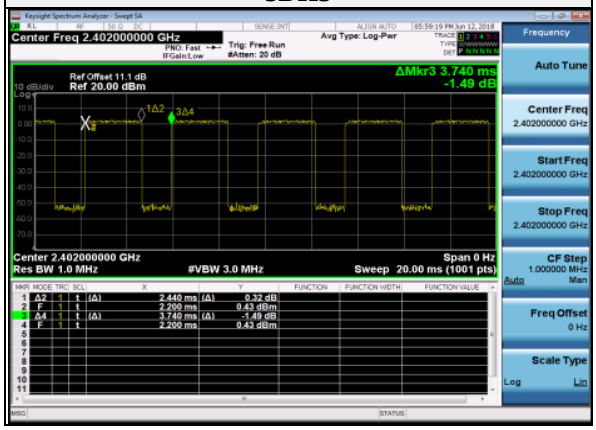
3DH1



3DH3



3DH5



9.6. Conducted Out of Band Emission

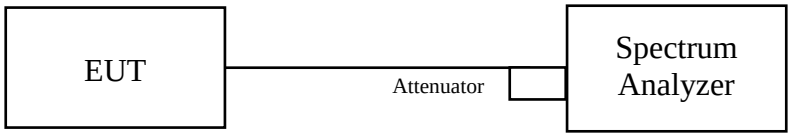
Requirements

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.

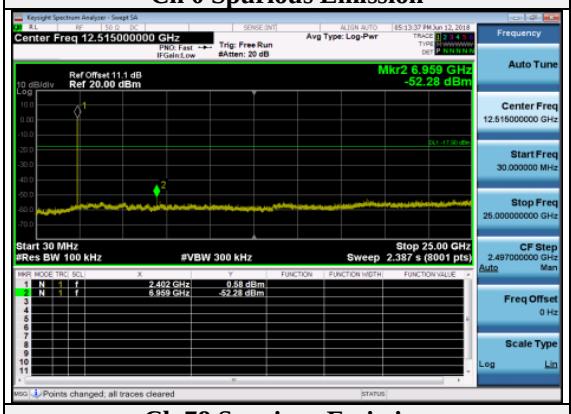
Test Setup



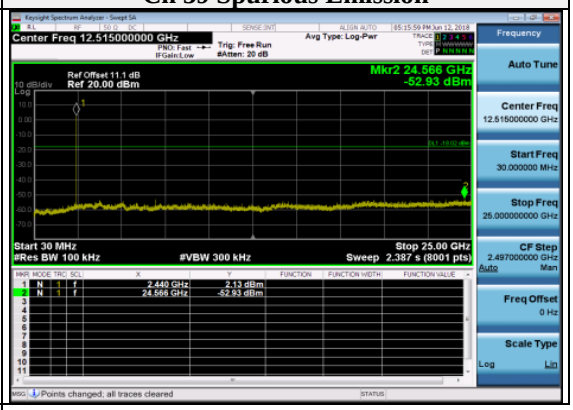
Test Data

GFSK

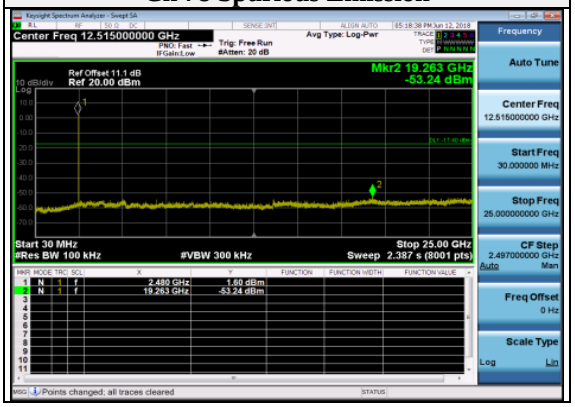
Ch 0 Spurious Emission



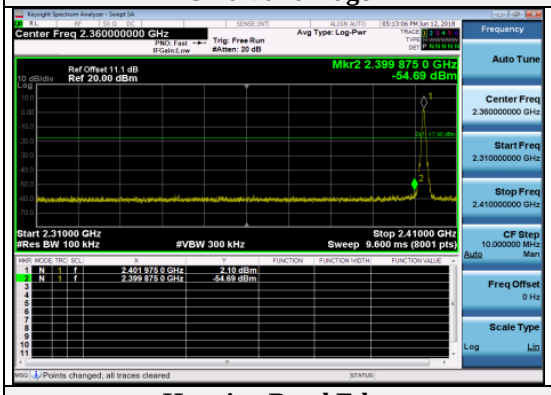
Ch 39 Spurious Emission



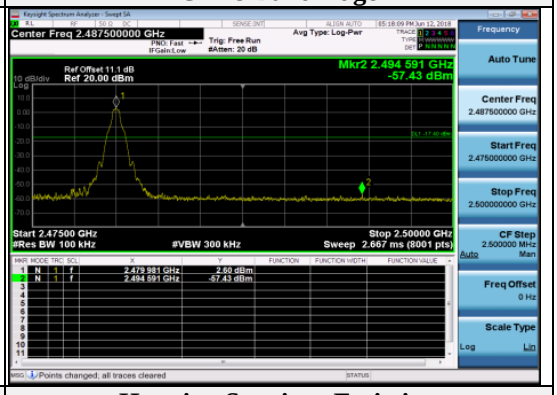
Ch 78 Spurious Emission



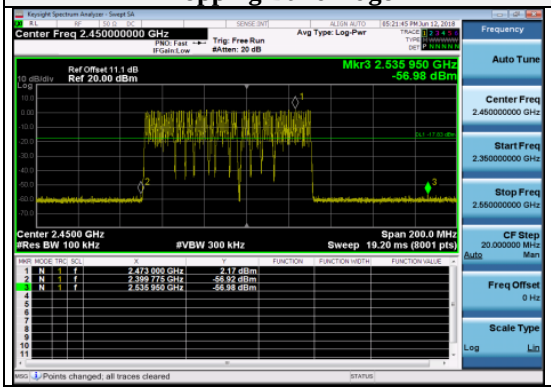
Ch 0 Band Edge



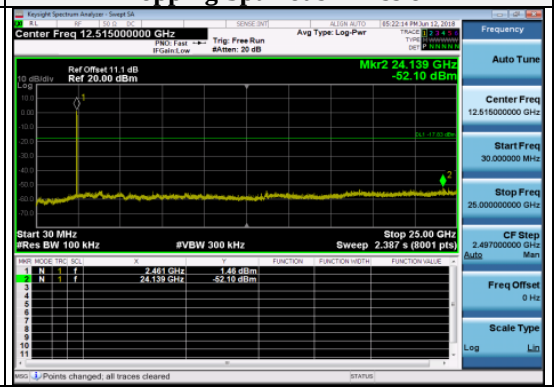
Ch 78 Band Edge



Hopping Band Edge

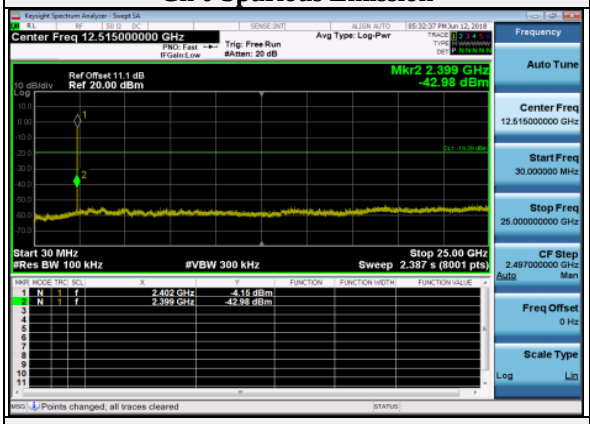


Hopping Spurious Emission

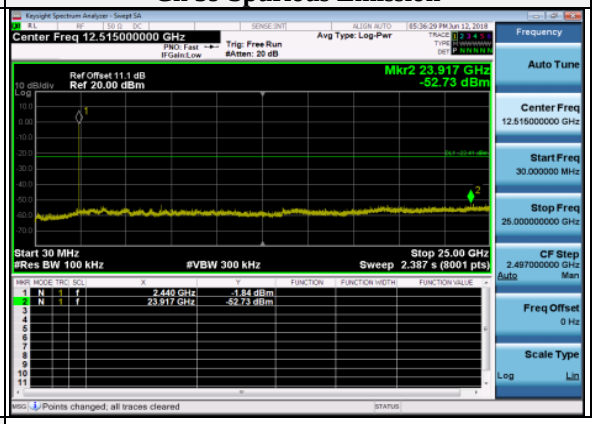


8DPSK

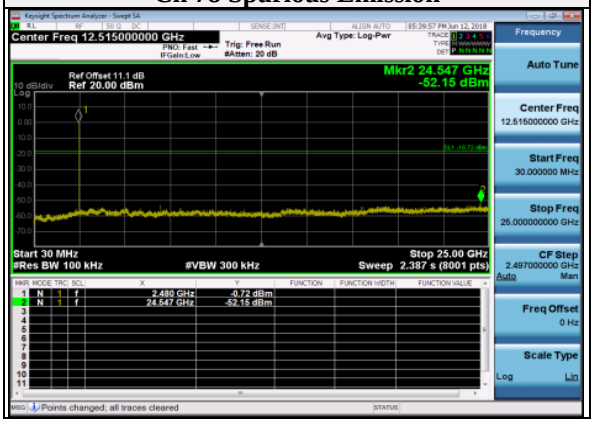
Ch 0 Spurious Emission



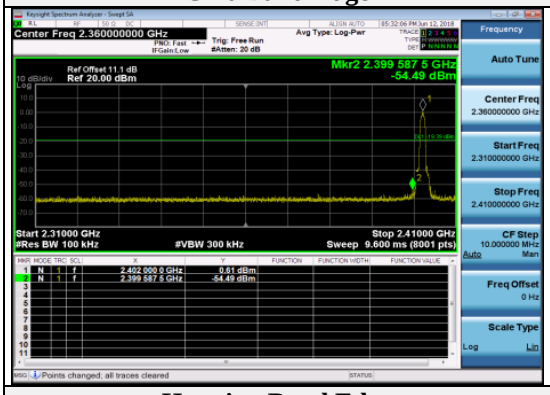
Ch 39 Spurious Emission



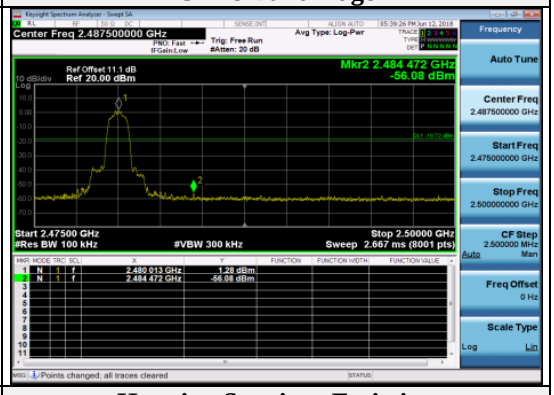
Ch 78 Spurious Emission



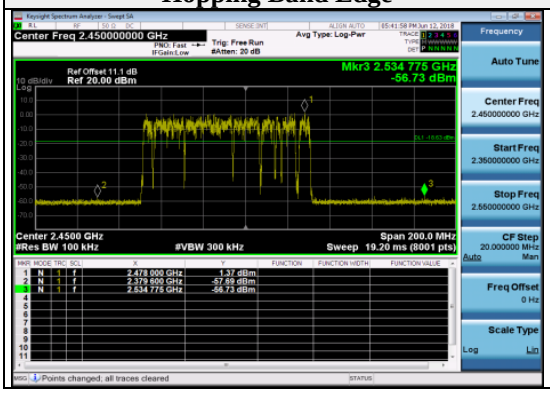
Ch 0 Band Edge



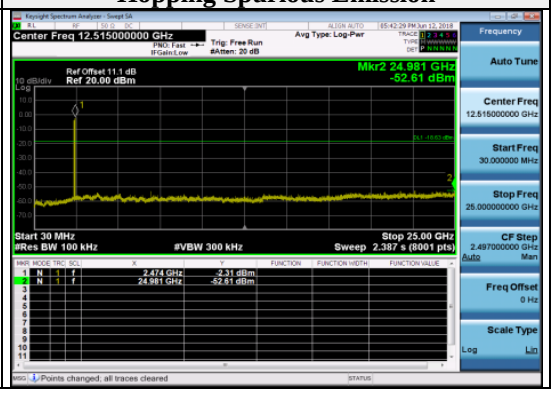
Ch 78 Band Edge



Hopping Band Edge



Hopping Spurious Emission



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]

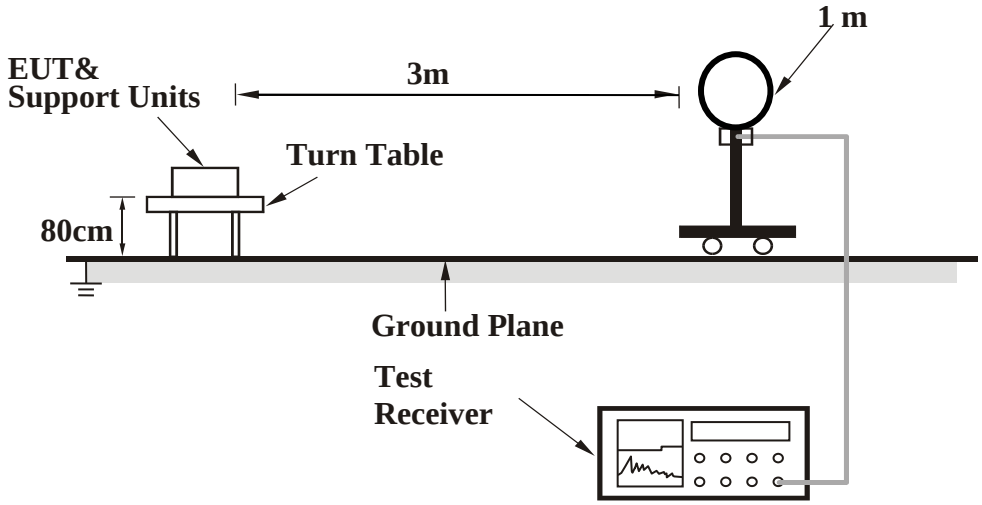
a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
b. The EUT was set 3 meters away from the interference-receiving 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:

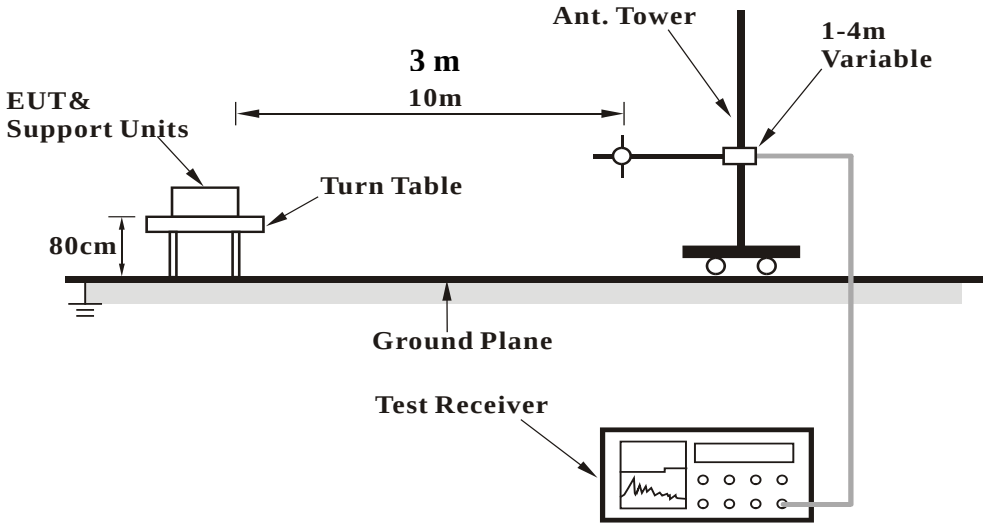
a. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
b. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
c. 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.
d. All modes of operation were investigated and the worst-case emissions are reported.

Test Setup

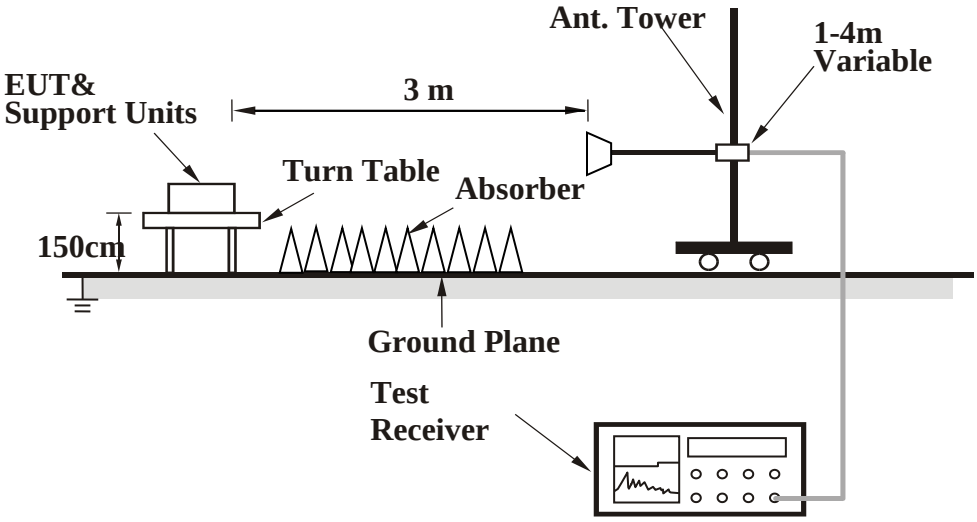
<Frequency Range 9 kHz ~ 30 MHz>



<Frequency Range 30 MHz ~ 1 GHz >



<Frequency Range above 1 GHz>



For the actual test configuration, please refer to the attached file (Test Setup Photo).

Test Data

Above 1GHz Data :

GFSK

EUT Test Condition		Measurement Detail	
Channel	Channel 0	**Frequency Range**	1 GHz ~ 25 GHz

Antenna Polarity & Test Distance: Horizontal at 3 m							
No.	**Frequency**	**Reading**	**Correct**	**Result**	**Limit**	**Margin**	**Remark**
	(MHz)	**(dBuV/m)**	**dB/m**	**(dBuV/m)**	**(dBuV/m)**	**(dB)**	
1	2390.000	48.33	-8.47	39.86	74.00	-34.14	peak
@2	2401.853	96.04	-8.47	87.57	-	-	peak
3	2390.000	37.82	-8.47	29.35	54.00	-24.65	AVG
@4	2401.993	95.42	-8.47	86.95	-	-	AVG
5	4804.000	46.23	-4.39	41.84	74.00	-32.16	peak
Antenna Polarity & Test Distance: Vertical at 3 m							
No.	**Frequency**	**Reading**	**Correct**	**Result**	**Limit**	**Margin**	**Remark**
	(MHz)	**(dBuV/m)**	**dB/m**	**(dBuV/m)**	**(dBuV/m)**	**(dB)**	
1	2390.000	48.57	-8.47	40.10	74.00	-33.90	peak
@2	2402.047	101.23	-8.47	92.76	-	-	peak
3	2390.000	37.16	-8.47	28.69	54.00	-25.31	AVG
@4	2402.033	100.28	-8.47	91.81	-	-	AVG
5	4804.000	46.58	-4.39	42.19	74.00	-31.81	peak

Remarks:

1. Result value (dBuV/m) = Reading value (dBuV/m) + Correction Factor (dB/m).
2. Margin(dB) = Result value (dBuV/m) - Limit value (dBuV/m).
3. Correction Factor (dB/m) = Antenna Factor (dBuV/m) + Cable Loss (dB) - Preamp Factor (dB).
4. "@": Fundamental Frequency.
5. " # ": The radiated frequency is out of the restricted band.
6. The other emission levels were very low against the limit.

EUT Test Condition		Measurement Detail	
Channel	Channel 39	**Frequency Range**	1 GHz ~ 25 GHz

Antenna Polarity & Test Distance: Horizontal at 3 m							
No.	**Frequency**	**Reading**	**Correct**	**Result**	**Limit**	**Margin**	**Remark**
	(MHz)	**(dBuV/m)**	**dB/m**	**(dBuV/m)**	**(dBuV/m)**	**(dB)**	
1	2390.000	48.40	-8.47	39.93	74.00	-34.07	peak
@2	2440.853	96.11	-8.51	87.60	-	-	peak
3	2483.500	48.49	-8.55	39.94	74.00	-34.06	peak
4	2390.000	37.32	-8.47	28.85	54.00	-25.15	AVG
@5	2441.067	94.95	-8.51	86.44	-	-	AVG
6	2483.500	37.98	-8.55	29.43	54.00	-24.57	AVG
7	4882.000	46.37	-4.21	42.16	74.00	-31.84	peak
Antenna Polarity & Test Distance: Vertical at 3 m							
No.	**Frequency**	**Reading**	**Correct**	**Result**	**Limit**	**Margin**	**Remark**
	(MHz)	**(dBuV/m)**	**dB/m**	**(dBuV/m)**	**(dBuV/m)**	**(dB)**	
1	2390.000	48.09	-8.47	39.62	74.00	-34.38	peak
@2	2440.853	100.33	-8.51	91.82	-	-	peak
3	2483.500	48.84	-8.55	40.29	74.00	-33.71	peak
4	2390.000	37.28	-8.47	28.81	54.00	-25.19	AVG
@5	2440.967	99.97	-8.51	91.46	-	-	AVG
6	2483.500	37.50	-8.55	28.95	54.00	-25.05	AVG
7	4882.000	47.33	-4.21	43.12	74.00	-30.88	peak

Remarks:

1. Result value (dBuV/m) = Reading value (dBuV/m) + Correction Factor (dB/m).
2. Margin(dB) = Result value (dBuV/m) - Limit value (dBuV/m).
3. Correction Factor (dB/m) = Antenna Factor (dBuV/m) + Cable Loss (dB) - Preamp Factor (dB).
4. "@": Fundamental Frequency.
5. " # ": The radiated frequency is out of the restricted band.
6. The other emission levels were very low against the limit.

EUT Test Condition		Measurement Detail	
Channel	Channel 78	**Frequency Range**	1 GHz ~ 25 GHz

Antenna Polarity & Test Distance: Horizontal at 3 m							
No.	**Frequency**	**Reading**	**Correct**	**Result**	**Limit**	**Margin**	**Remark**
	(MHz)	**(dBuV/m)**	**dB/m**	**(dBuV/m)**	**(dBuV/m)**	**(dB)**	
1	2483.500	48.93	-8.55	40.38	74.00	-33.62	peak
@2	2480.000	96.25	-8.53	87.72	-	-	peak
@3	2480.027	95.41	-8.53	86.88	-	-	AVG
4	2483.500	39.08	-8.55	30.53	54.00	-23.47	AVG
5	4960.000	46.74	-4.04	42.70	74.00	-31.30	peak
Antenna Polarity & Test Distance: Vertical at 3 m							
No.	**Frequency**	**Reading**	**Correct**	**Result**	**Limit**	**Margin**	**Remark**
	(MHz)	**(dBuV/m)**	**dB/m**	**(dBuV/m)**	**(dBuV/m)**	**(dB)**	
@1	2480.153	99.22	-8.53	90.69	-	-	peak
2	2483.500	49.17	-8.55	40.62	74.00	-33.38	peak
@3	2479.967	98.89	-8.53	90.36	-	-	AVG
4	2483.500	38.38	-8.55	29.83	54.00	-24.17	AVG
5	4960.000	47.16	-4.04	43.12	74.00	-30.88	peak

Remarks:

1. Result value (dBuV/m) = Reading value (dBuV/m) + Correction Factor (dB/m).
2. Margin(dB) = Result value (dBuV/m) - Limit value (dBuV/m).
3. Correction Factor (dB/m) = Antenna Factor (dBuV/m) + Cable Loss (dB) - Preamp Factor (dB).
4. "@": Fundamental Frequency.
5. " # ": The radiated frequency is out of the restricted band.
6. The other emission levels were very low against the limit.

8DPSK

EUT Test Condition		Measurement Detail	
Channel	Channel 0	**Frequency Range**	1 GHz ~ 25 GHz

Antenna Polarity & Test Distance: Horizontal at 3 m							
No.	**Frequency**	**Reading**	**Correct**	**Result**	**Limit**	**Margin**	**Remark**
	(MHz)	**(dBuV/m)**	**dB/m**	**(dBuV/m)**	**(dBuV/m)**	**(dB)**	
1	2390.000	48.98	-8.47	40.51	74.00	-33.49	peak
@2	2401.807	96.28	-8.47	87.81	-	-	peak
3	2390.000	37.01	-8.47	28.54	54.00	-25.46	AVG
@4	2402.093	93.64	-8.47	85.17	-	-	AVG
5	4804.000	47.78	-4.39	43.39	74.00	-30.61	peak
Antenna Polarity & Test Distance: Vertical at 3 m							
No.	**Frequency**	**Reading**	**Correct**	**Result**	**Limit**	**Margin**	**Remark**
	(MHz)	**(dBuV/m)**	**dB/m**	**(dBuV/m)**	**(dBuV/m)**	**(dB)**	
1	2390.000	48.60	-8.47	40.13	74.00	-33.87	peak
@2	2401.987	100.90	-8.47	92.43	-	-	peak
3	2390.000	37.97	-8.47	29.50	54.00	-24.50	AVG
@4	2401.947	98.45	-8.47	89.98	-	-	AVG
5	4804.000	46.03	-4.39	41.64	74.00	-32.36	peak

Remarks:

1. Result value (dBuV/m) = Reading value (dBuV/m) + Correction Factor (dB/m).
2. Margin(dB) = Result value (dBuV/m) - Limit value (dBuV/m).
3. Correction Factor (dB/m) = Antenna Factor (dBuV/m) + Cable Loss (dB) - Preamp Factor (dB).
4. "@": Fundamental Frequency.
5. " # ": The radiated frequency is out of the restricted band.
6. The other emission levels were very low against the limit.

EUT Test Condition		Measurement Detail	
Channel	Channel 39	**Frequency Range**	1 GHz ~ 25 GHz

Antenna Polarity & Test Distance: Horizontal at 3 m							
No.	**Frequency**	**Reading**	**Correct**	**Result**	**Limit**	**Margin**	**Remark**
	(MHz)	**(dBuV/m)**	**dB/m**	**(dBuV/m)**	**(dBuV/m)**	**(dB)**	
1	2390.000	47.97	-8.47	39.50	74.00	-34.50	peak
@2	2440.913	96.35	-8.51	87.84	-	-	peak
3	2483.500	48.83	-8.55	40.28	74.00	-33.72	peak
4	2390.000	37.95	-8.47	29.48	54.00	-24.52	AVG
@5	2441.073	93.84	-8.51	85.33	-	-	AVG
6	2483.500	37.51	-8.55	28.96	54.00	-25.04	AVG
7	4882.000	46.77	-4.21	42.56	74.00	-31.44	peak
Antenna Polarity & Test Distance: Vertical at 3 m							
No.	**Frequency**	**Reading**	**Correct**	**Result**	**Limit**	**Margin**	**Remark**
	(MHz)	**(dBuV/m)**	**dB/m**	**(dBuV/m)**	**(dBuV/m)**	**(dB)**	
1	2390.000	48.76	-8.47	40.29	74.00	-33.71	peak
@2	2441.067	100.89	-8.51	92.38	-	-	peak
3	2483.500	48.64	-8.55	40.09	74.00	-33.91	peak
4	2390.000	37.28	-8.47	28.81	54.00	-25.19	AVG
@5	2441.093	98.59	-8.50	90.09	-	-	AVG
6	2483.500	37.47	-8.55	28.92	54.00	-25.08	AVG
7	4882.000	46.26	-4.21	42.05	74.00	-31.95	peak

Remarks:

1. Result value (dBuV/m) = Reading value (dBuV/m) + Correction Factor (dB/m).
2. Margin(dB) = Result value (dBuV/m) - Limit value (dBuV/m).
3. Correction Factor (dB/m) = Antenna Factor (dBuV/m) + Cable Loss (dB) - Preamp Factor (dB).
4. "@": Fundamental Frequency.
5. " # ": The radiated frequency is out of the restricted band.
6. The other emission levels were very low against the limit.

EUT Test Condition		Measurement Detail	
Channel	Channel 78	**Frequency Range**	1 GHz ~ 25 GHz

Antenna Polarity & Test Distance: Horizontal at 3 m							
No.	**Frequency**	**Reading**	**Correct**	**Result**	**Limit**	**Margin**	**Remark**
	(MHz)	**(dBuV/m)**	**dB/m**	**(dBuV/m)**	**(dBuV/m)**	**(dB)**	
@1	2479.973	96.06	-8.53	87.53	-	-	peak
2	2483.500	49.41	-8.55	40.86	74.00	-33.14	peak
@3	2479.933	92.82	-8.53	84.29	-	-	AVG
4	2483.500	37.52	-8.55	28.97	54.00	-25.03	AVG
5	4960.000	45.98	-4.04	41.94	74.00	-32.06	peak
Antenna Polarity & Test Distance: Vertical at 3 m							
No.	**Frequency**	**Reading**	**Correct**	**Result**	**Limit**	**Margin**	**Remark**
	(MHz)	**(dBuV/m)**	**dB/m**	**(dBuV/m)**	**(dBuV/m)**	**(dB)**	
@1	2479.827	99.59	-8.53	91.06	-	-	peak
2	2483.500	52.16	-8.55	43.61	74.00	-30.39	peak
@3	2479.960	97.41	-8.53	88.88	-	-	AVG
4	2483.500	38.75	-8.55	30.20	54.00	-23.80	AVG
5	4960.000	46.57	-4.04	42.53	74.00	-31.47	peak

Remarks:

1. Result value (dBuV/m) = Reading value (dBuV/m) + Correction Factor (dB/m).
2. Margin(dB) = Result value (dBuV/m) - Limit value (dBuV/m).
3. Correction Factor (dB/m) = Antenna Factor (dBuV/m) + Cable Loss (dB) - Preamp Factor (dB).
4. "@": Fundamental Frequency.
5. " # ": The radiated frequency is out of the restricted band.
6. The other emission levels were very low against the limit.

Below 1GHz Data：

9 kHz ~ 30 MHz Data:

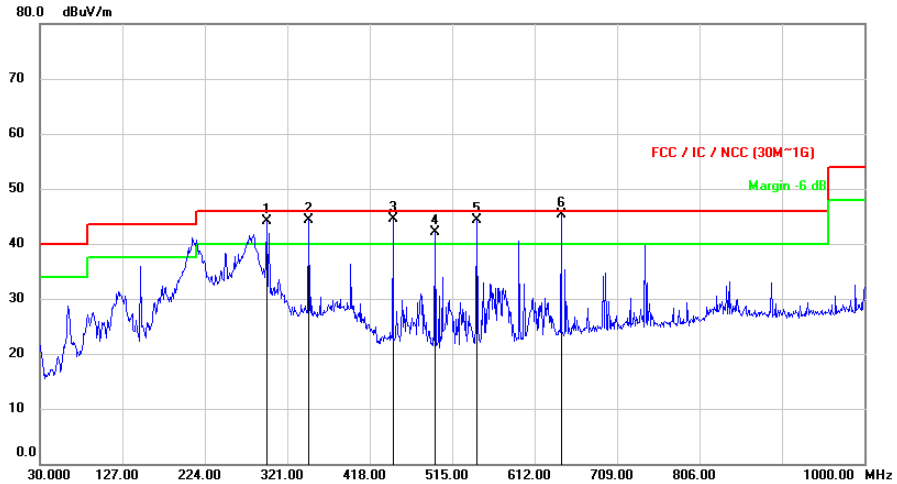
The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.

30 MHz ~ 1 GHz Data:

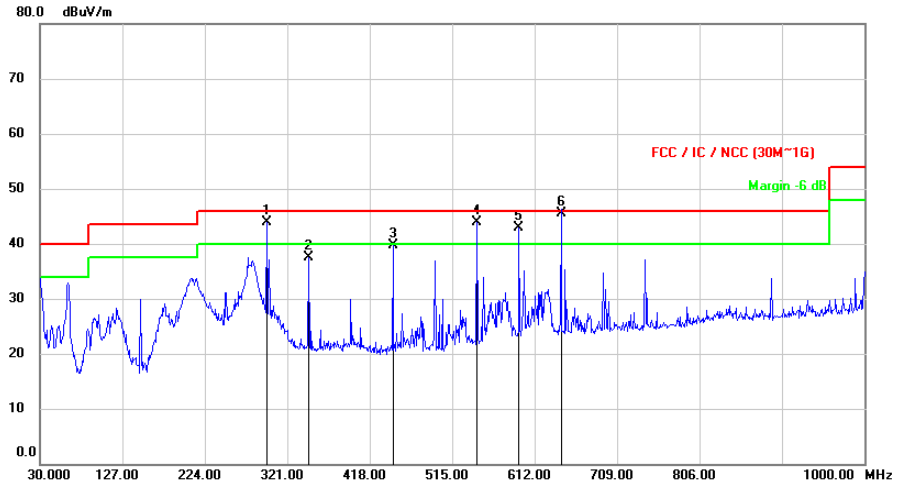
GFSK

EUT Test Condition		Measurement Detail	
Channel	Channel 78	**Frequency Range**	30 MHz ~ 1 GHz

Horizontal



Vertical



Antenna Polarity & Test Distance: Horizontal at 3 m							
No.	**Frequency**	**Reading**	**Correct**	**Result**	**Limit**	**Margin**	**Remark**
	(MHz)	**(dBuV/m)**	**dB/m**	**(dBuV/m)**	**(dBuV/m)**	**(dB)**	
1	296.9762	58.55	-14.53	44.02	46.00	-1.98	peak
2	346.4785	57.75	-13.46	44.29	46.00	-1.71	peak
3	445.4832	55.18	-10.74	44.44	46.00	-1.56	peak
4	494.9855	52.02	-9.92	42.10	46.00	-3.90	peak
5	544.4880	53.31	-8.94	44.37	46.00	-1.63	peak
6	643.4926	52.13	-6.86	45.27	46.00	-0.73	peak
Antenna Polarity & Test Distance: Vertical at 3 m							
No.	**Frequency**	**Reading**	**Correct**	**Result**	**Limit**	**Margin**	**Remark**
	(MHz)	**(dBuV/m)**	**dB/m**	**(dBuV/m)**	**(dBuV/m)**	**(dB)**	
1	297.0086	58.36	-14.53	43.83	46.00	-2.17	peak
2	346.4786	50.92	-13.46	37.46	46.00	-8.54	peak
3	445.4833	50.50	-10.74	39.76	46.00	-6.24	peak
4	544.4880	52.75	-8.94	43.81	46.00	-2.19	peak
5	593.9903	50.52	-7.60	42.92	46.00	-3.08	peak
6	643.4926	52.36	-6.86	45.50	46.00	-0.50	QP

Remarks:

1. Result value (dBuV/m) = Reading value (dBuV/m) + Correction Factor (dB/m).
2. Margin(dB) = Result value (dBuV/m) - Limit value (dBuV/m).
3. Correction Factor (dB/m) = Antenna Factor (dBuV/m) + Cable Loss (dB) - Preamp Factor (dB).
4. The other emission levels were very low against the limit.

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

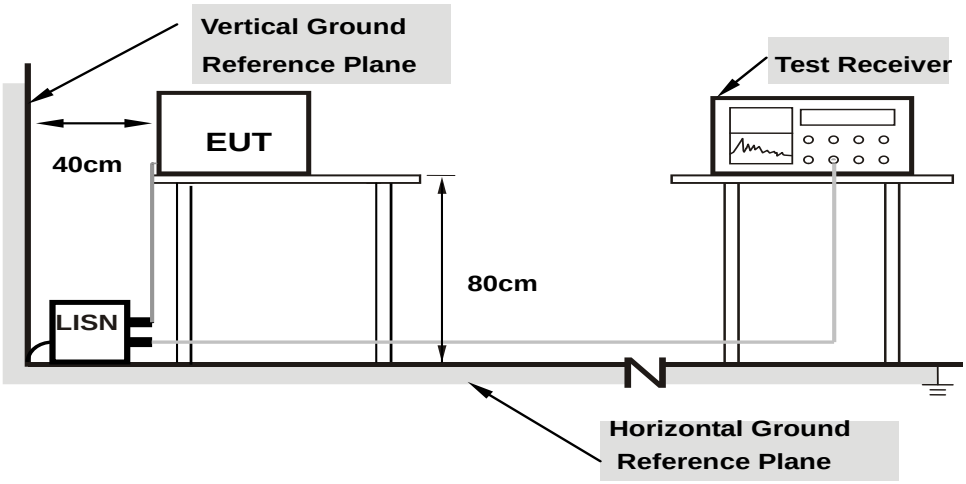
Note:
1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

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: 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.

Test Setup



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

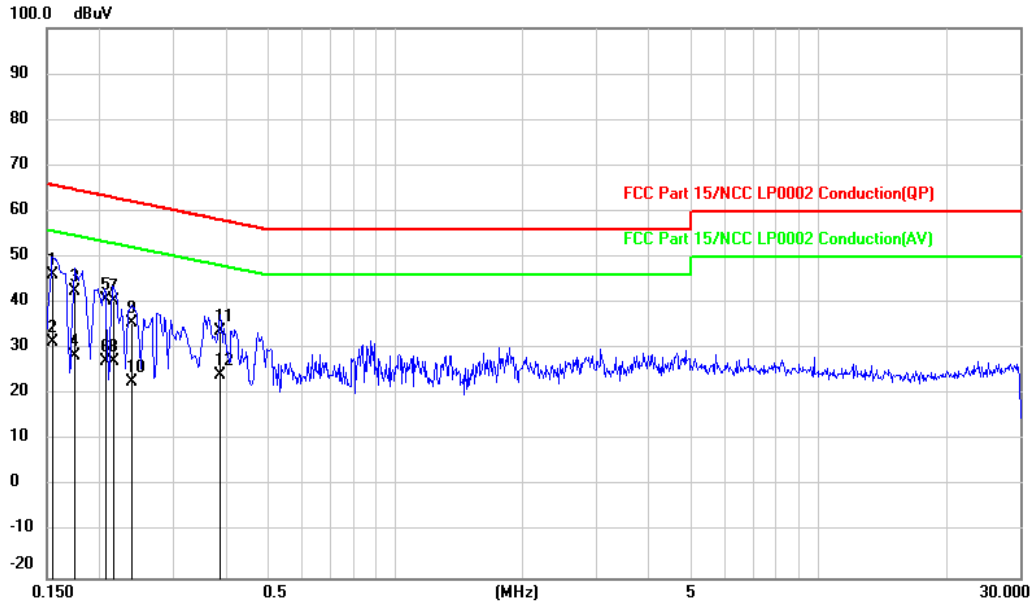
For the actual test configuration, please refer to the attached file (Test Setup Photo).

Test Data

GFSK

EUT Test Condition		Measurement Detail	
Channel	Channel 78	**Frequency Range**	150 kHz ~ 30 MHz

Phase of Power：Line (L)

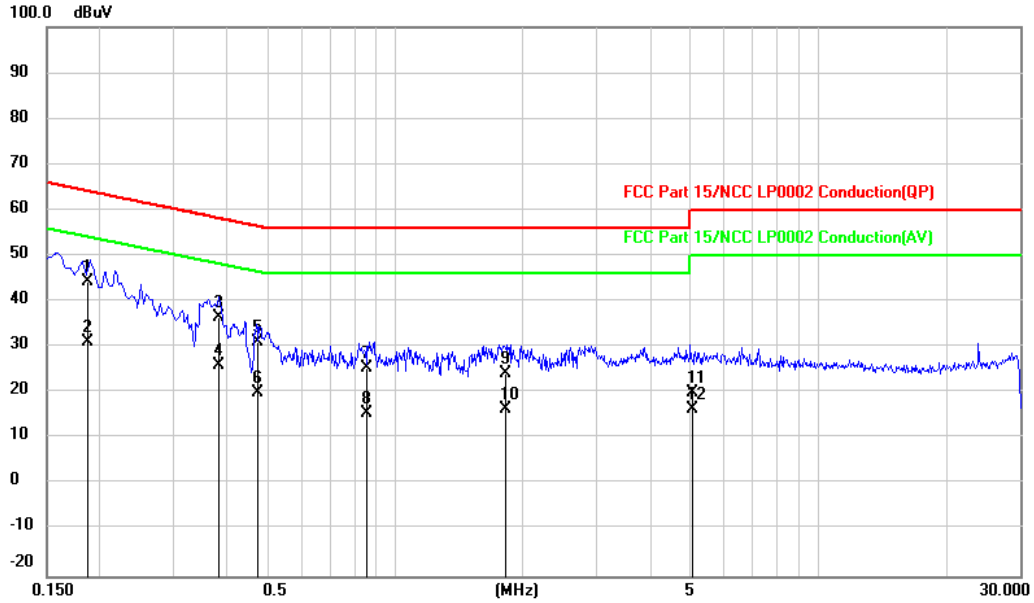


No.	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV)	dB	(dBuV)	(dBuV)	(dB)	
1	0.1554	26.53	19.57	46.10	65.71	-19.61	QP
2	0.1554	11.95	19.57	31.52	55.71	-24.19	AVG
3	0.1746	22.86	19.57	42.43	64.74	-22.31	QP
4	0.1746	8.93	19.57	28.50	54.74	-26.24	AVG
5	0.2079	21.31	19.58	40.89	63.29	-22.40	QP
6	0.2079	7.64	19.58	27.22	53.29	-26.07	AVG
7	0.2157	20.93	19.59	40.52	62.98	-22.46	QP
8	0.2157	7.67	19.59	27.26	52.98	-25.72	AVG
9	0.2389	16.09	19.59	35.68	62.13	-26.45	QP
10	0.2389	3.17	19.59	22.76	52.13	-29.37	AVG
11	0.3840	14.18	19.59	33.77	58.19	-24.42	QP
12	0.3840	4.53	19.59	24.12	48.19	-24.07	AVG

Remarks:

1. Result value (dBuV) = Reading value (dBuV) + Correction Factor (dB)
2. Margin(dB) = Result value (dBuV) - Limit value (dBuV)
3. Correction Factor(dB) = Insertion loss(dB) + Cable loss(dB)
4. The other emission levels were very low against the limit.

Phase of Power：Neutral (N)



No.	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV)	dB	(dBuV)	(dBuV)	(dB)	
1	0.1870	24.82	19.59	44.41	64.17	-19.76	QP
2	0.1870	11.48	19.59	31.07	54.17	-23.10	AVG
3	0.3806	17.06	19.62	36.68	58.27	-21.59	QP
4	0.3806	6.49	19.62	26.11	48.27	-22.16	AVG
5	0.4715	11.51	19.61	31.12	56.49	-25.37	QP
6	0.4715	0.49	19.61	20.10	46.49	-26.39	AVG
7	0.8650	5.87	19.62	25.49	56.00	-30.51	QP
8	0.8650	-4.07	19.62	15.55	46.00	-30.45	AVG
9	1.8276	4.44	19.72	24.16	56.00	-31.84	QP
10	1.8276	-3.40	19.72	16.32	46.00	-29.68	AVG
11	5.0661	0.25	19.82	20.07	60.00	-39.93	QP
12	5.0661	-3.43	19.82	16.39	50.00	-33.61	AVG

Remarks:

1. Result value (dBuV) = Reading value (dBuV) + Correction Factor (dB)
2. Margin(dB) = Result value (dBuV) - Limit value (dBuV)
3. Correction Factor(dB) = Insertion loss(dB) + Cable loss(dB)
4. The other emission levels were very low against the limit.

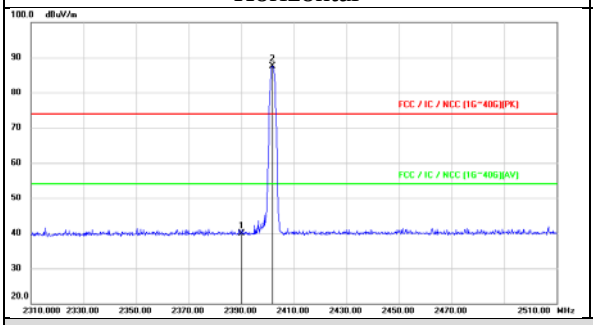
Appendix I Radiated Band Edge Measurement

GFSK

Peak

Ch0

Horizontal



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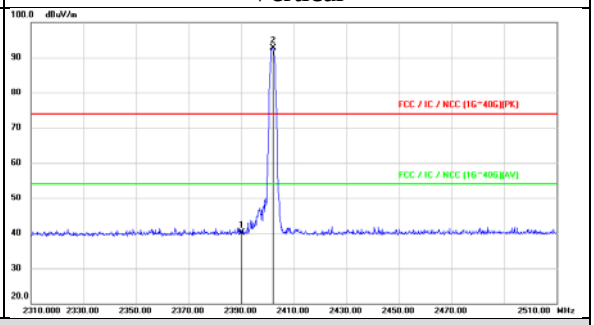
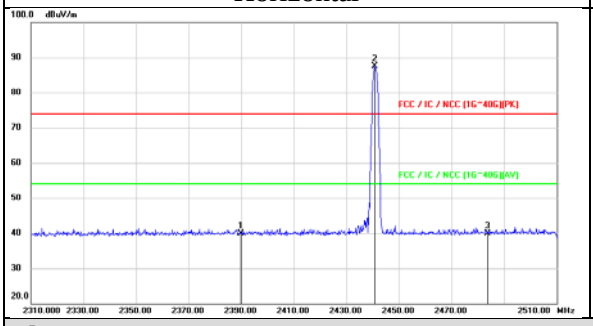


Ch39

Horizontal



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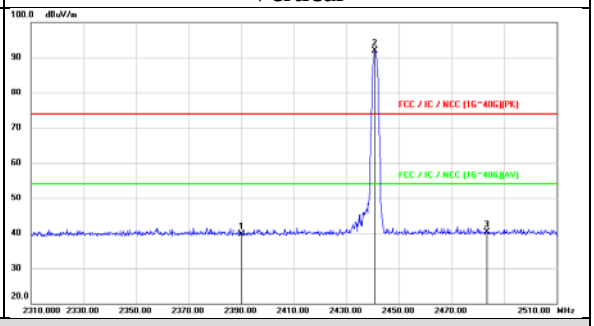
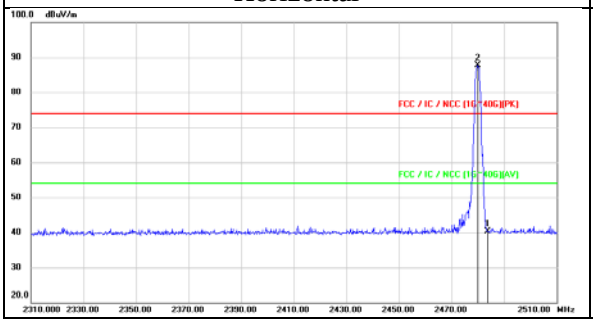
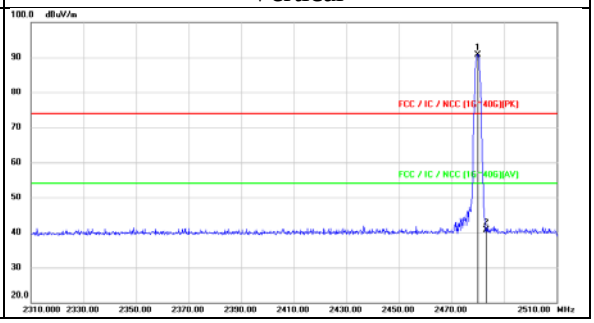


Ch78

Horizontal

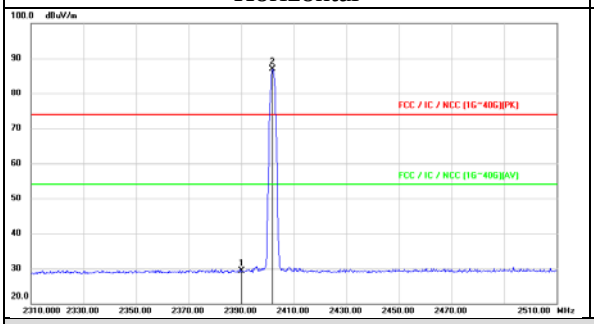
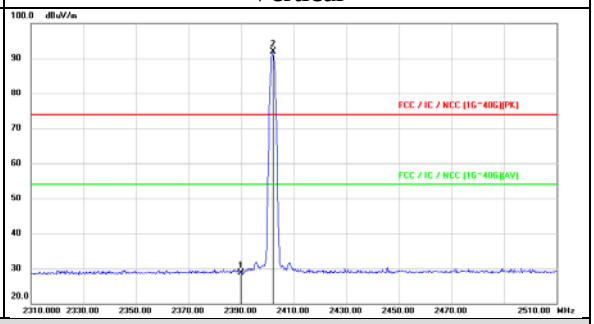


Vertical

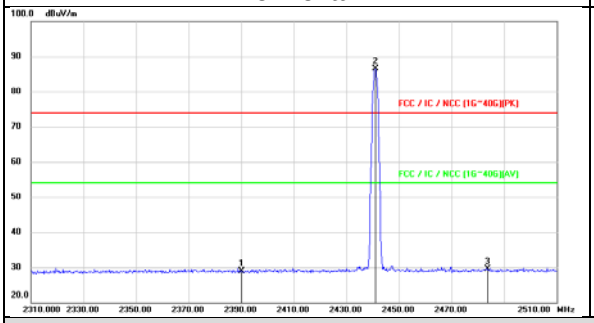
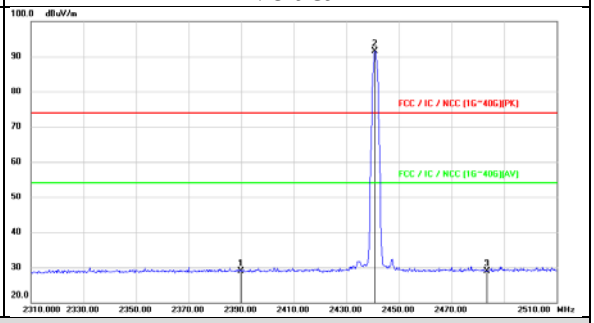


Average

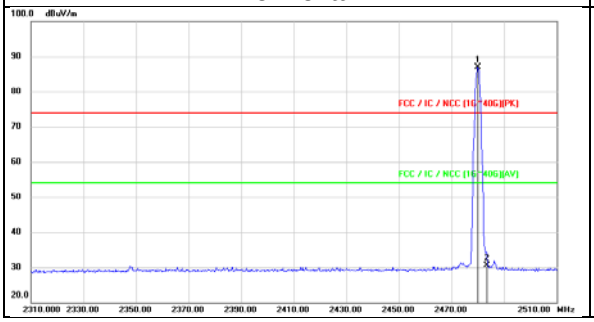
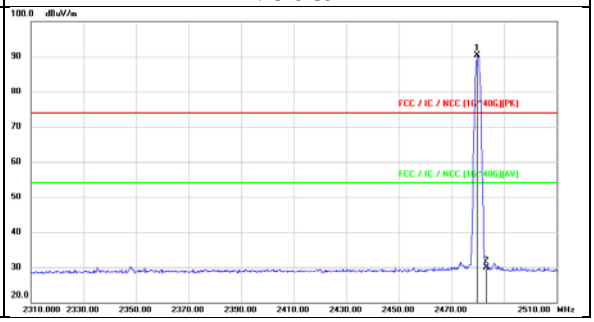
Ch0

Horizontal	Vertical
	

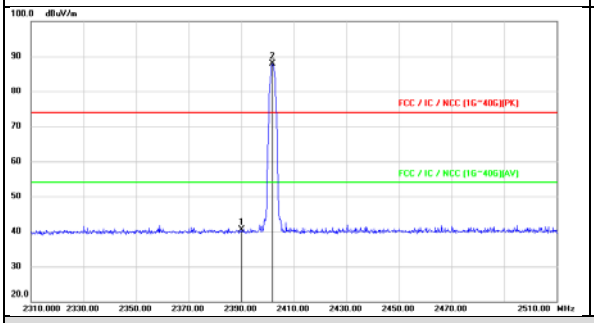
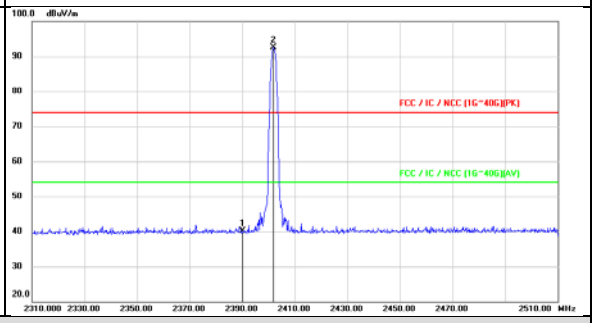
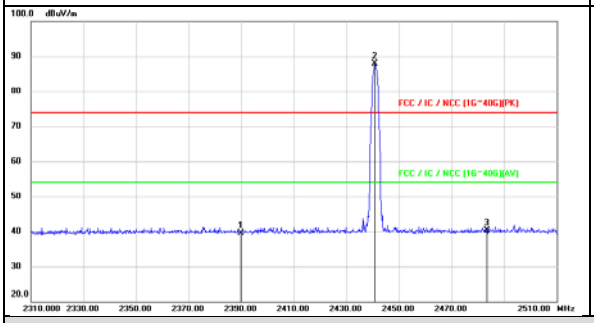
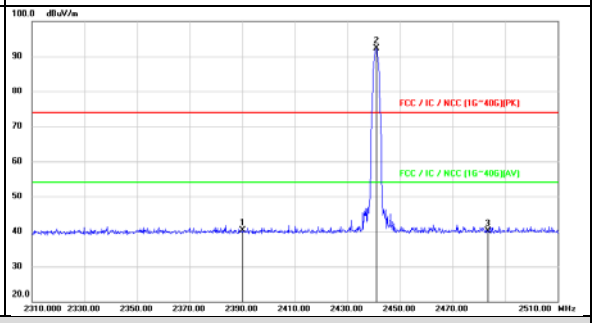
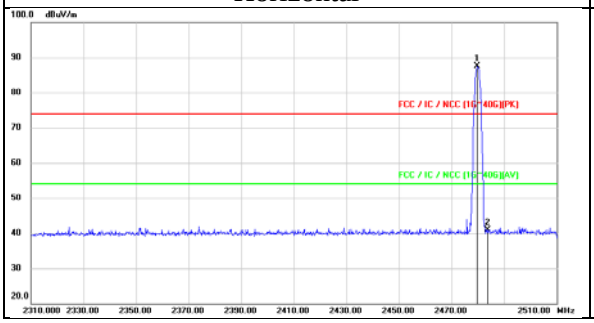
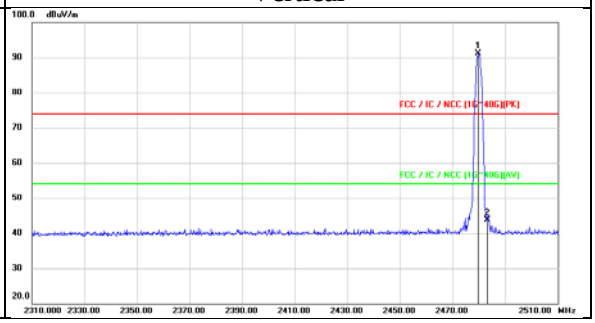
Ch39

Horizontal	Vertical
	

Ch78

Horizontal	Vertical
	

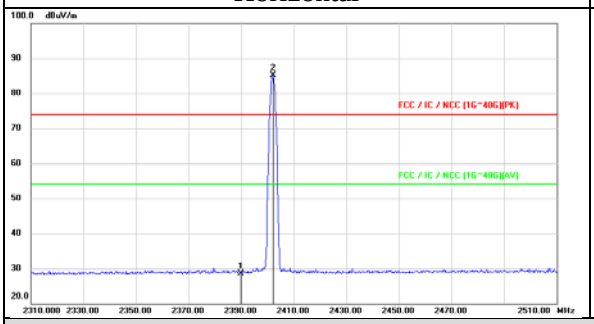
8DPSK
Peak

Ch0	
Horizontal	Vertical
	
Ch39	
Horizontal	Vertical
	
Ch78	
Horizontal	Vertical
	

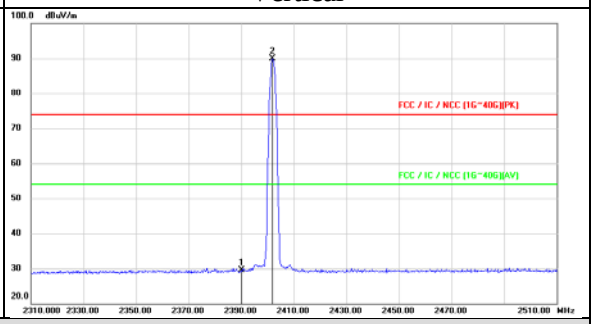
Average

Ch0

Horizontal

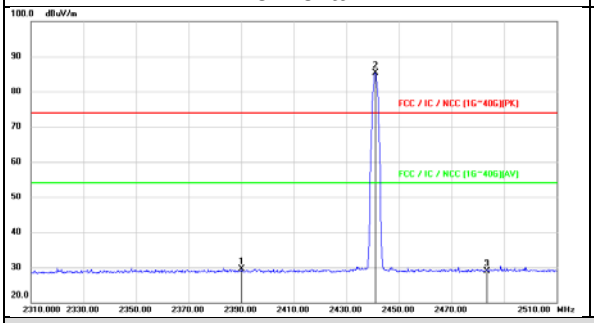


Vertical



Ch39

Horizontal



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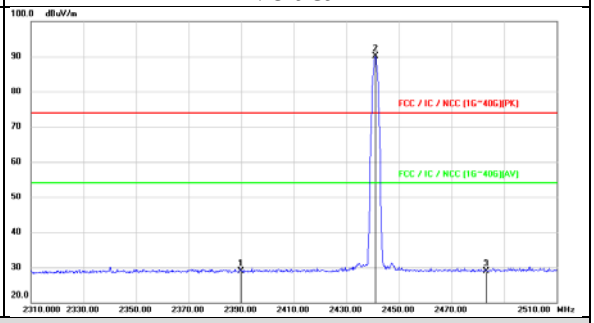
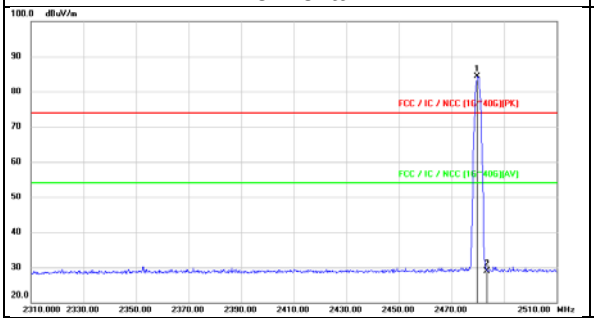
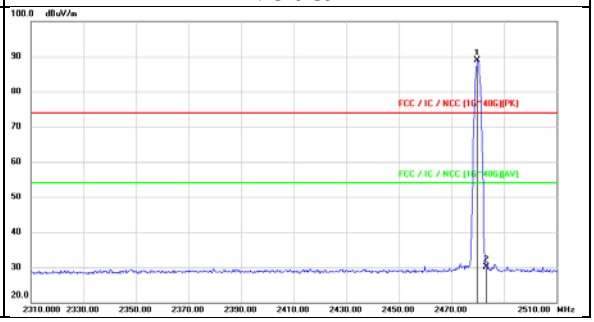


Ch78

Horizontal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