



Test report No. : 4789988012-US-R0-V0
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Issued date : 2021/7/23
FCC ID : JNZA00150

RADIO TEST REPORT

Product : Wireless Dongle
Model Name : A00150
FCC ID : JNZA00150
Test Regulation : FCC 47 CFR Part 15 Subpart C (Section 15.247)
Received Date : 2021/6/23
Test Date : 2021/6/23 ~ 2021/7/22
Issued Date : 2021/7/23

Applicant : Logitech Far East Ltd.
#2 Creation Rd. 4, Science-Based Ind. Park Hsinchu
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



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REVISION HISTORY

Original Test Report No.: 4789988012-US-R0-V0

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1. Attestation of Test Results

APPLICANT: Logitech Far East Ltd.
#2 Creation Rd. 4, Science-Based Ind. Park Hsinchu Taiwan,
R.O.C.

MANUFACTURER: Logitech Europe S.A.
EPFL - Quartier de l'Innovation, Daniel Borel Innovation
Center, 1015 Lausanne, Switzerland

EUT DESCRIPTION: Wireless Dongle

BRAND: logitech G

MODEL: A00150

SAMPLE STAGE: Identical Prototype

DATE of TESTED: 2021/6/23 ~ 2021/7/22

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
Project Handler

Date : 2021/7/23

Approved and Authorized By:

Mike Cai
Engineer Project Associate

Date : 2021/7/23

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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 the Radiated Band Edge test plots were recorded in Appendix I, the Radiated Emissions test plots were recorded in Appendix II.

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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. The full scope of accreditation can be viewed at http://accreditation.taftw.org.tw/taf/public/basic/viewApplyItems.action?unitNo=3398

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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	± 3.1 dB
RF Conducted	9 kHz - 40GHz	± 1.9 dB
Radiated disturbance below 30MHz	9 kHz - 30 MHz	± 1.9 dB
Radiated disturbance below 1 GHz	30MHz ~ 1GHz	± 5.4 dB
Radiated disturbance above 1 GHz	1GHz ~ 40GHz	± 4.7 dB

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6. Equipment under Test

6.1. Description of EUT

Product	Wireless Dongle
Brand Name	logitech G
Model Name	A00150
Operating Frequency	2402MHz ~ 2480MHz
Modulation	GFSK and $\pi/4$ -DQPSK
Transfer Rate	Up to 2 Mbps
Number of Channel	79
Maximum Output Power	8.02 dBm
Normal Voltage	5Vdc from host
S/N	NA
Sample ID	Conducted Test: 4018957 Radiated Test: 4027068
Software Version	20210611_Alice_3_0_1_1

Note:

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

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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	-	-

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6.3. Test Condition

Test Item	Test Site No.	Environmental Condition	Input Power	Test Date	Tested by
Antenna Port Conducted Measurement	SR4	22~26°C/ 55~65%RH	5Vdc	2021/06/23~ 2021/07/22	Wayne Chen
Radiated Spurious Emission	966-2	22~26°C/ 55~65%RH	5Vdc	2021/06/23~ 2021/06/28	WaterNil Guan
AC power Line Conducted Emission	SR1	22~26°C/ 55~65%RH	5Vdc	2021/06/23~ 2021/06/28	WaterNil Guan

FCC Test Firm Registration Number: 498077

6.4. Description of Available Antennas

Ant. No.	Transmitter Circuit	Ant. Type	Maximum Gain (dBi)
1	Chain (0)	Monopole	1.37

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.

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6.5. Test Mode Applicability and Tested Channel Detail

- The EUT has one power source types: 5Vdc from Host. Therefore only the test data of the 5Vdc from Host was recorded in this report.
- For AC power line conducted emissions, the pre-scan has been determined by AC power 120Vac/60Hz (worst case)
- 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.
- 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).
- 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	Available Channel	Test Channel	Packet Type
	Type			
Radiated Emissions (Above 1GHz)	GFSK	0 to 78	0,39,78	DH5
	$\pi/4$ -DQPSK	0 to 78	0,39,78	2DH5
Radiated Emissions (Below 1GHz)	$\pi/4$ -DQPSK	0 to 78	0	2DH5
AC Power Line Conducted Emission	$\pi/4$ -DQPSK	0 to 78	0	2DH5
Antenna Port Conducted Measurement	GFSK	0 to 78	0,39,78	DH1*,DH3* DH5*
	$\pi/4$ -DQPSK	0 to 78	0,39,78	2DH1*,2DH3* 2DH5*

* Only for Dwell Time on Each Channel test

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7. Test Equipment

Test Equipment List					
Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Expired date
Radiated Spurious Emission					
Spectrum Analyzer	Keysight	N9010A	MY56070827	2020/11/11	2021/11/10
EMI Test Receiver	Rohde & Schwarz	ESR7	101754	2020/12/11	2021/12/10
Loop Antenna	ETS lindgren	6502	00213440	2020/12/25	2021/12/24
Trilog-Broadband Antenna with 5dB Attenuator	Schwarzbeck & EMCI	VULB 9168 & N-6-05	774 & AT-N0538	2021/1/13	2022/1/12
Horn Antenna (1-18 GHz)	Schwarzbeck	BBHA 9120 D	01690	2020/12/30	2021/12/29
Horn Antenna (18-40 GHz)	Schwarzbeck	BBHA 9170	781	2020/12/30	2021/12/29
Preamplifier (30-1000 MHz)	EMCI	EMC330E	980405	2021/6/8	2022/6/7
Preamplifier (1-18 GHz)	EMCI	EMC051835BE	980406	2021/2/3	2022/2/2
Preamplifier (18-40GHz)	EMCI	EMC184040SEE	980426	2021/5/19	2022/5/18
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-4 & 170425-2	2021/1/22	2022/1/21
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-1 & 170214-2	2021/1/22	2022/1/21

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Test Equipment List					
Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Expired date
Antenna Port Conducted Measurement					
Spectrum Analyzer	Keysight	N9010A	MY56070834	2020/11/6	2021/11/5
Pulse Power Sensor	Anritsu	MA2411B	1531202	2020/12/21	2021/12/20
Power Meter	Anritsu	ML2495A	1645002	2020/12/21	2021/12/20
AC power Line Conducted Emission					
EMI Test Receiver	Rohde & Schwarz	ESR7	101753	2020/11/17	2021/11/16
Two-Line V-Network	Rohde & Schwarz	ENV216	102136	2020/8/19	2021/8/18
Impuls-Begrenzer Pulse Limiter	Rohde & Schwarz	ESH3-Z2	102219-Qt	2020/8/12	2021/8/11
Cables	TITAN	CFD200	T0732ACFD20 020A300-1	2021/3/2	2022/3/1

UL Software		
Description	Name	Version
Radiated measurement	e3	6.191211 (V6)
Conducted measurement	RF Conducted Test Tools	ver 2.4.0.620b
AC power Line Conducted Emission	EZ_EMC	UL-3A1.2

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8. Description of Test Setup

Support Equipment

ID	Equipment	Brand Name	Model Name	S/N	Remark
A	Laptop	DELL	Latitude E5470	CXSKWF2	Provide by Lab
B	Test Tool (Arduino Adapter BS101S FT232RL Module)	Anddoa	30435856860	N/A	Provide by Client

I/O Cables

ID	Equipment	Brand Name	Model Name	Length (m)	Remark
1	Console Cable	taiwaniot	1046C-10	0.41	Provide by Client

Test Setup

Controlled using a bespoke application (AWBTRDLAB 1.0.5.0) 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.

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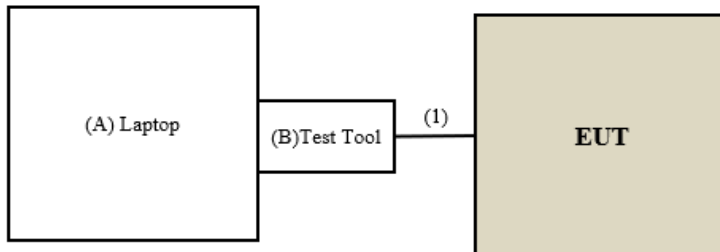
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Setup Diagram for Test



Under Table

Remote Site

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9. Test Results

9.1. Channel Bandwidth

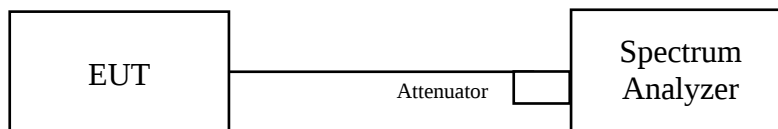
Requirements

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

Test procedure

- Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- 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.
- Measure the frequency difference of two frequencies that were attenuated 20dB from the reference level. Record the frequency difference as the emission bandwidth.
- Repeat above procedures until all frequencies measured were complete.

Test Setup

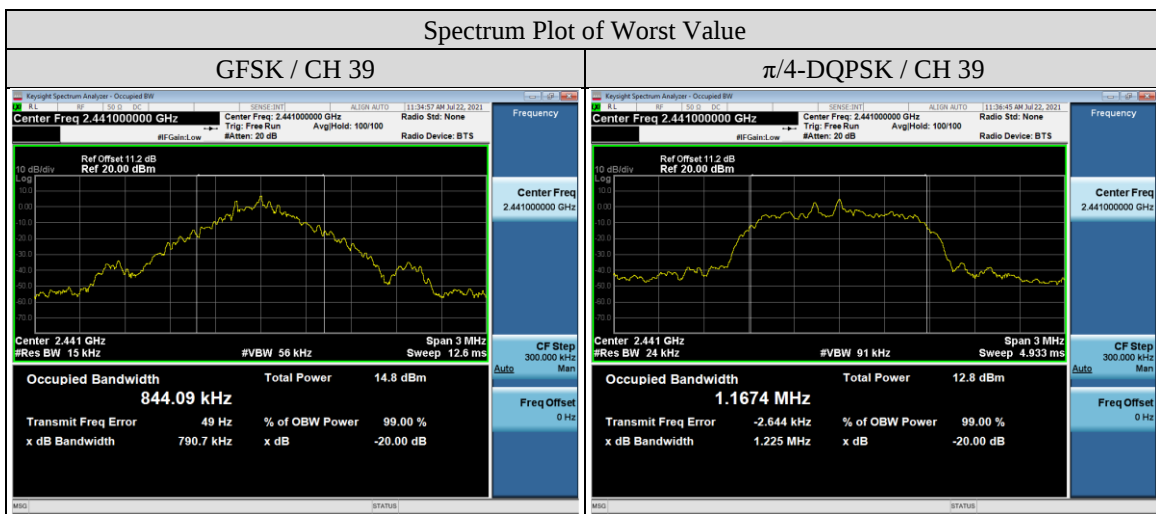


The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.



Test Data

Channel	Frequency (MHz)	20dB Bandwidth (MHz)	
		GFSK	$\pi/4$ -DQPSK
0	2402	0.7897	1.223
39	2441	0.7907	1.225
78	2480	0.7335	1.224





9.2. Conducted Output Power

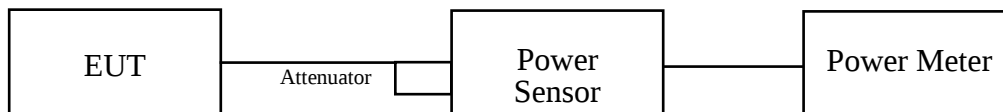
Requirements

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	6.339	8.02	20.97	PASS
19	2440	6.31	8.00	20.97	PASS
39	2480	6.053	7.82	20.97	PASS

BT $\pi/4$ -DQPSK

Channel	Frequency (MHz)	Peak Power (mW)	Peak Power (dBm)	Limit (dBm)	Pass/Fail
0	2402	5.888	7.70	20.97	PASS
19	2440	5.875	7.69	20.97	PASS
39	2480	5.61	7.49	20.97	PASS

Average Power (Reference Only)

BT GFSK

Channel	Frequency (MHz)	Average Power (mW)	Average Power (dBm)
0	2402	6.194	7.92
19	2440	6.166	7.90
39	2480	5.888	7.70

BT $\pi/4$ -DQPSK

Channel	Frequency (MHz)	Average Power (mW)	Average Power (dBm)
0	2402	3.296	5.18
19	2440	3.281	5.16
39	2480	3.133	4.96

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9.3. Hopping Channel Separation

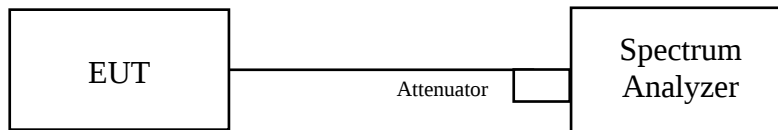
Requirements

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

Test procedure

- Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range.
- By using the MaxHold function record the separation of two adjacent channels.
- 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.

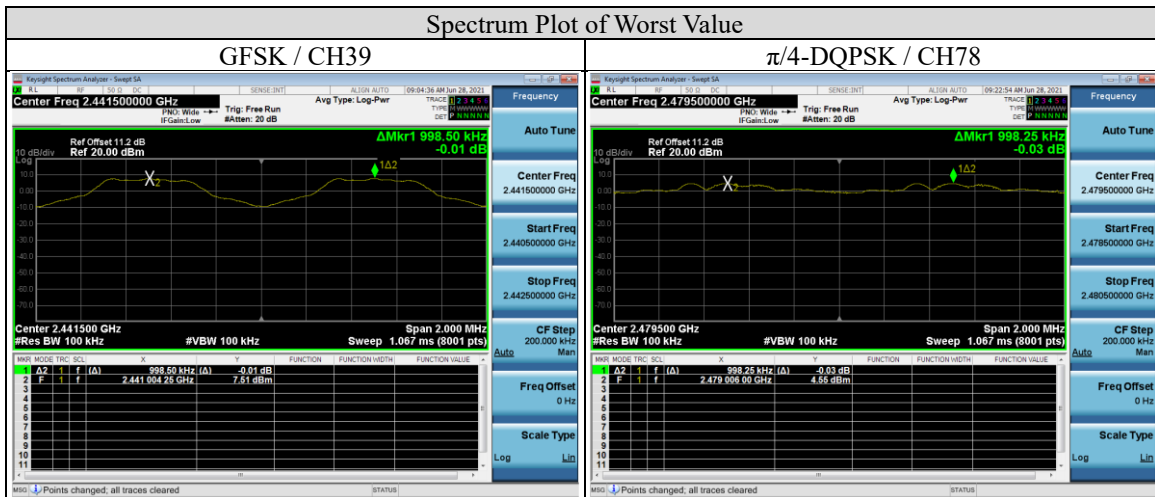


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Test Data

Mode	Channel	Frequency (MHz)	Adjacent Hopping Channel Separation (MHz)	Limit (MHz)	Result
GFSK	00	2402	0.9995	0.52647	PASS
	39	2441	0.9985	0.52713	PASS
	78	2480	1.002	0.48900	PASS
$\pi/4$ -DQPSK	00	2402	1.00025	0.81533	PASS
	39	2441	1.001	0.81667	PASS
	78	2480	0.99825	0.81600	PASS

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



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9.4. Number of Hopping Frequency Used

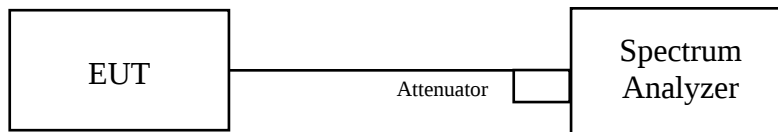
Requirements

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

Test procedure

- Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
- 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.
- 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.
- Set the SA on View mode and then plot the result on SA screen.
- 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.

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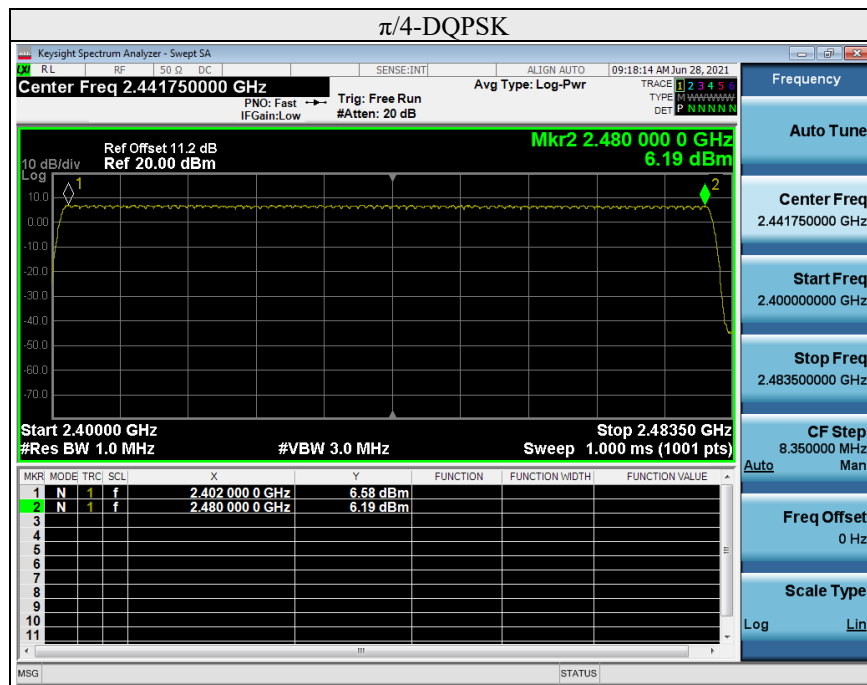
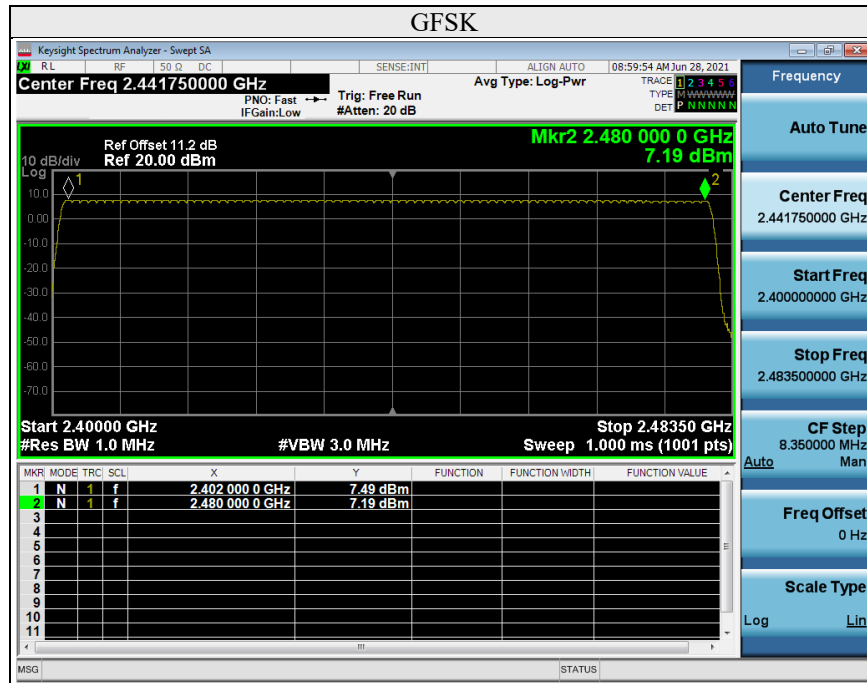
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Test Data

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



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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

- Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
- 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.
- 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.
- Measure the time duration of one transmission on the measured frequency. And then plot the result with time difference of this time duration.
- Repeat above procedures until all different time-slot modes have been completed.
- 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)

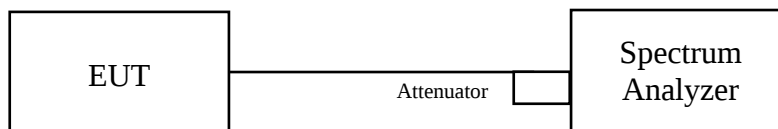
For AFH mode:

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.

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Test Data

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Modulation	Channel	Frequency (MHz)	Length of transmission time (msec)	Result (msec)	Limit (msec)	Result
DH1	39	2441	0.4712	150.784	400	PASS
DH3	39	2441	1.744	279.040	400	PASS
DH5	39	2441	2.98	317.877	400	PASS

$\pi/4$ -DQPSK

Modulation	Channel	Frequency (MHz)	Length of transmission time (msec)	Result (msec)	Limit (msec)	Result
2DH1	39	2441	0.4877	156.064	400	PASS
2DH3	39	2441	1.76	281.600	400	PASS
2DH5	39	2441	2.98	317.877	400	PASS

Note :

1. In normal mode:

DH1 hopping rate is 1600 hops/s with 2 slots in 79 hopping channels. With channel hopping rate (1600 / 2 / 79) in Occupancy Time Limit (0.4 x 79) (s), Hops Over Occupancy Time comes to (1600 / 2 / 79) x (0.4 x 79) = 320 hops.

DH3 hopping rate is 1600 hops/s with 4 slots in 79 hopping channels. With channel hopping rate (1600 / 4 / 79) in Occupancy Time Limit (0.4 x 79) (s), Hops Over Occupancy Time comes to (1600 / 4 / 79) x (0.4 x 79) = 160 hops.

DH5 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).

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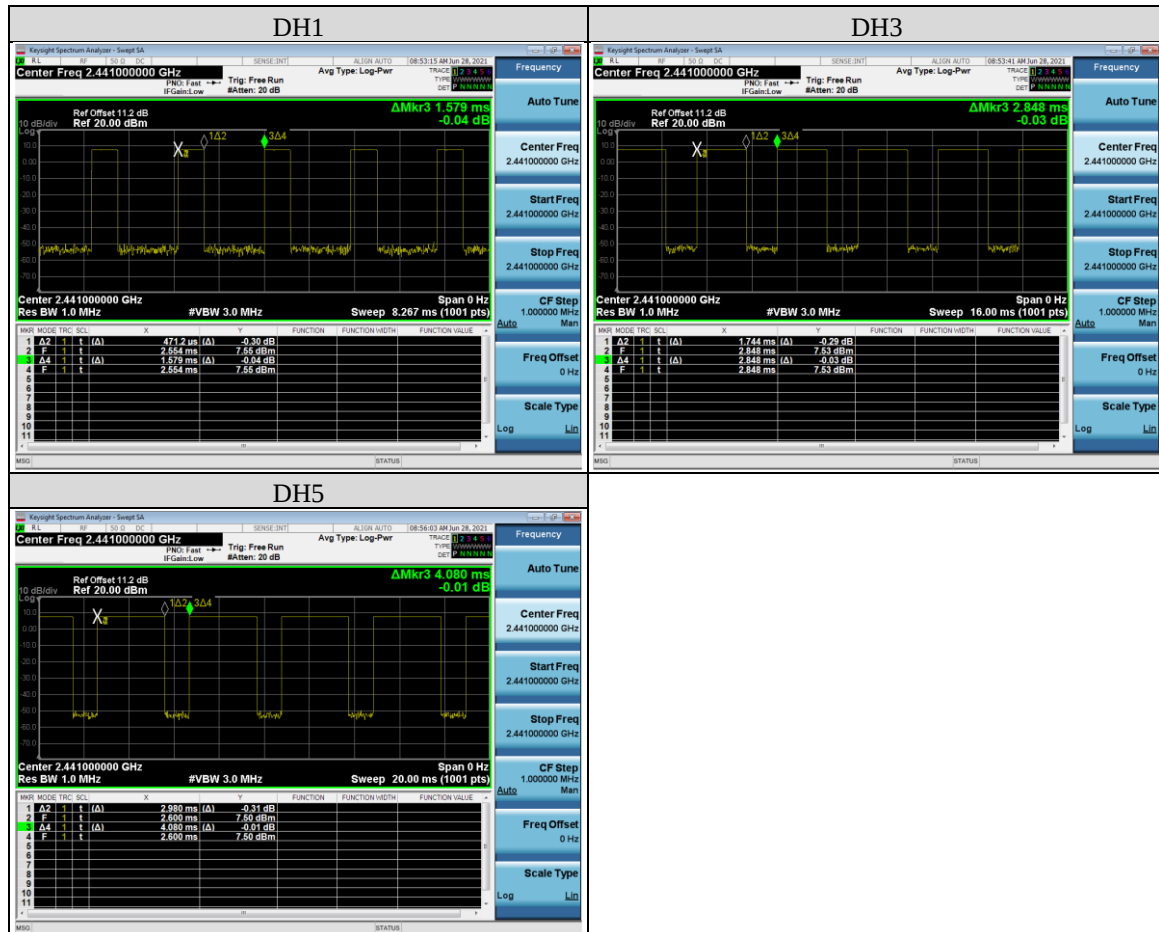
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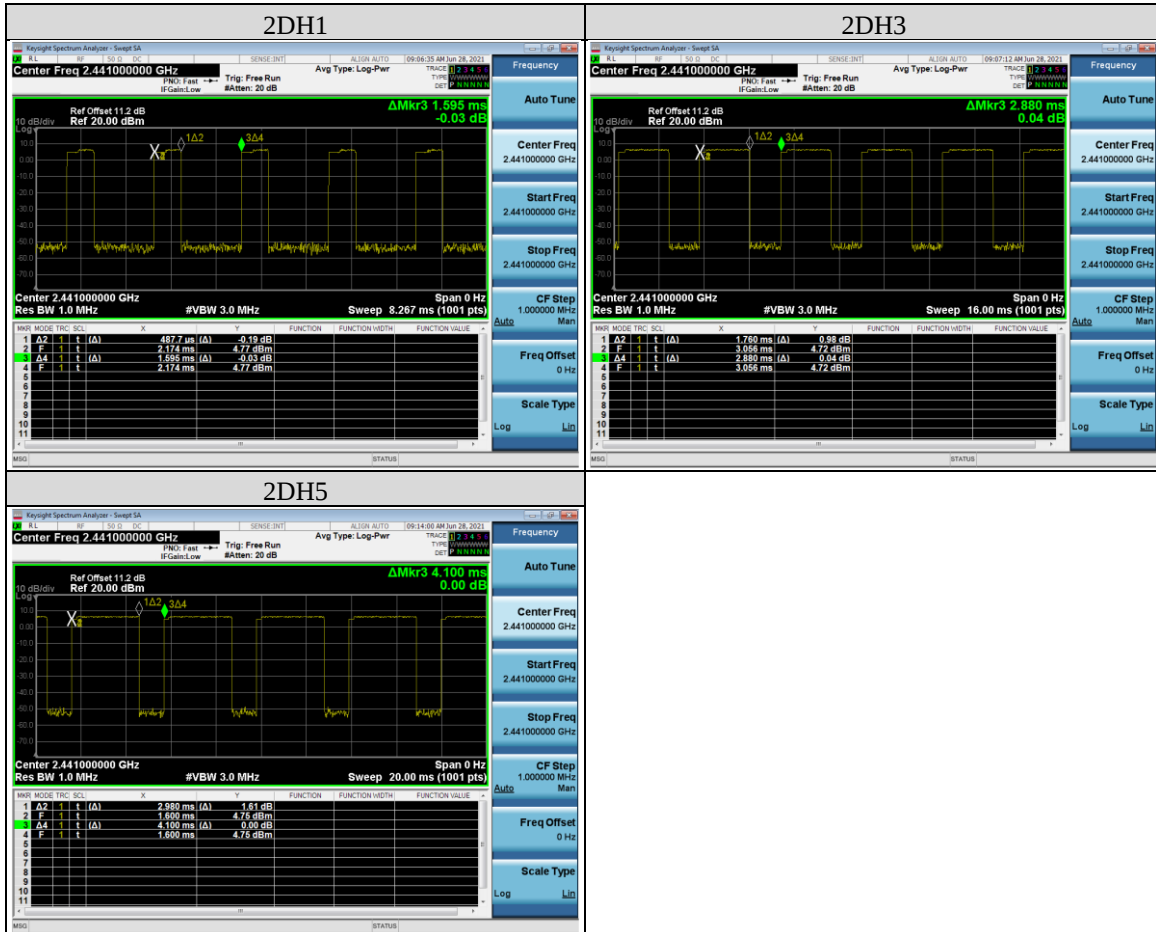
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9.6. Conducted Out of Band Emission

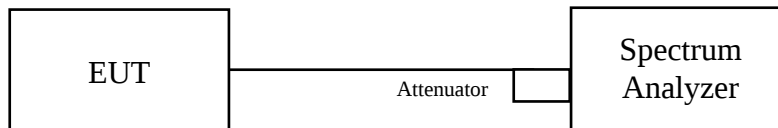
Requirements

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.

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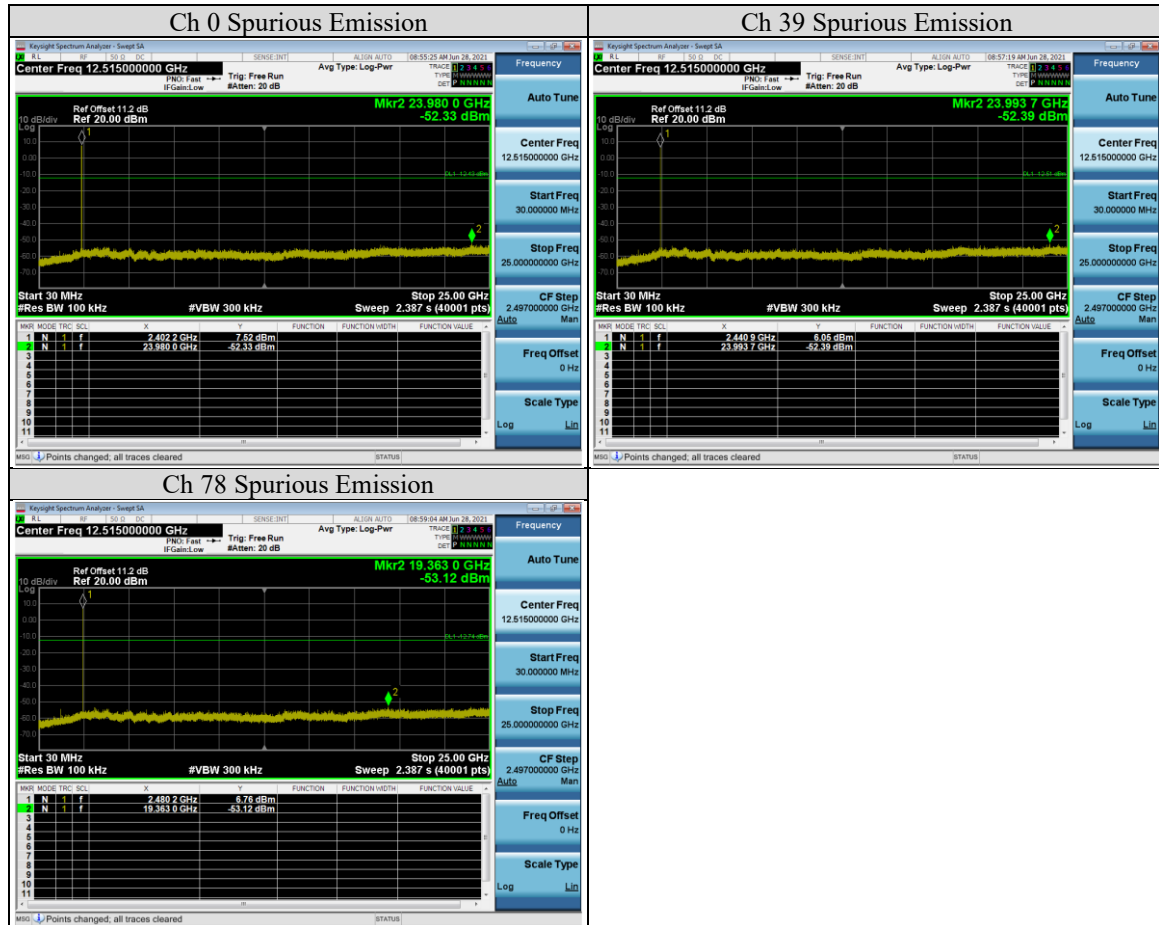
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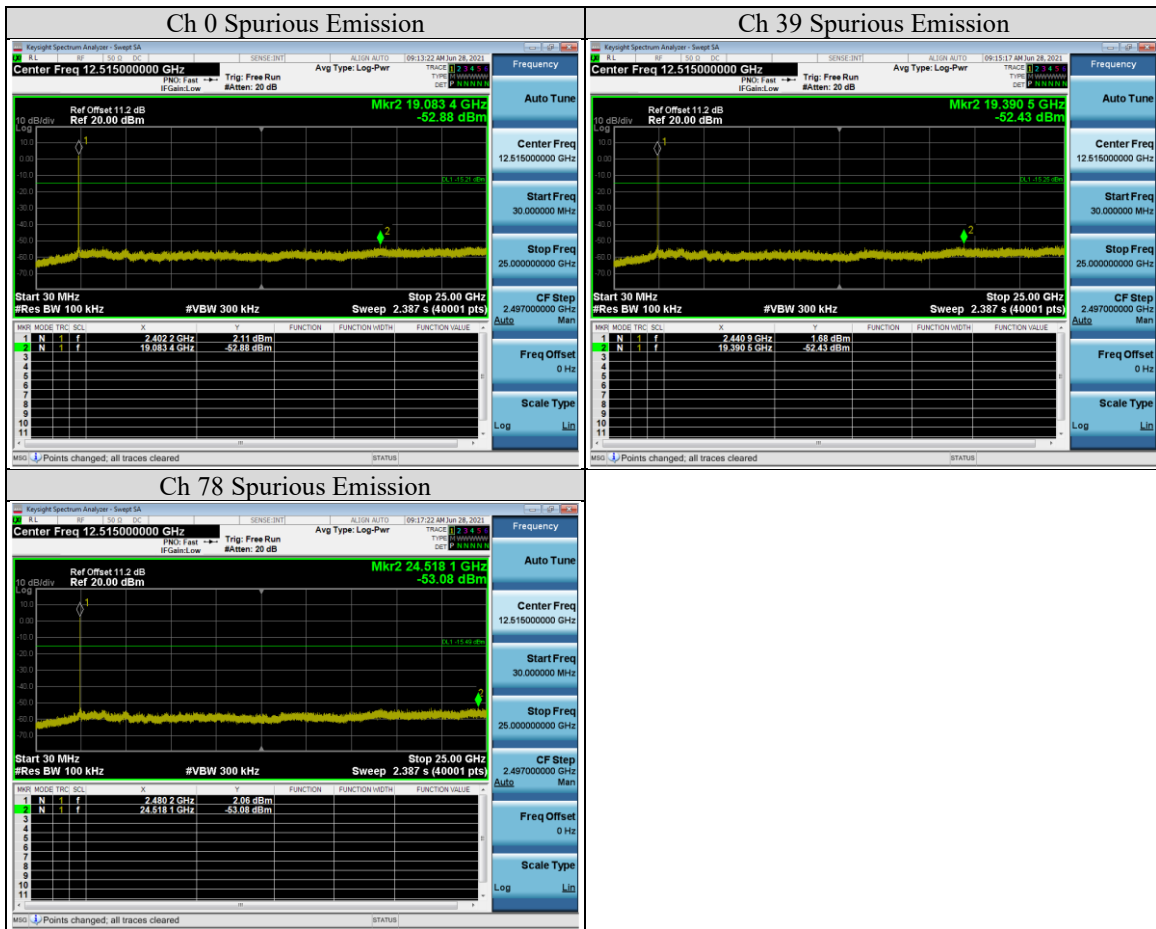
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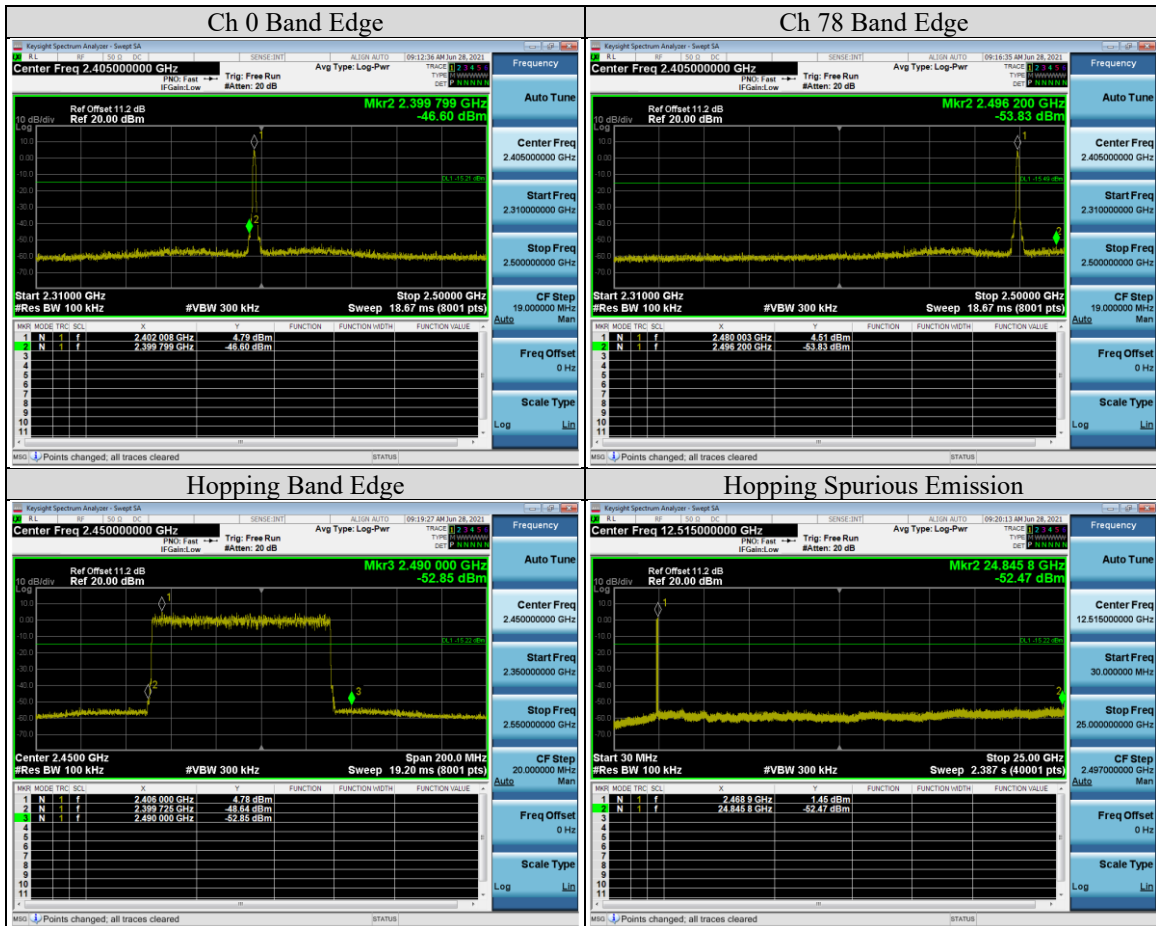
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9.7. Radiated Spurious Emission

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.

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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.

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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 $\geq 1/T$ (Duty cycle $< 98\%$) or 10Hz (Duty cycle $\geq 98\%$) for Average detection (AV) at frequency above 1GHz.

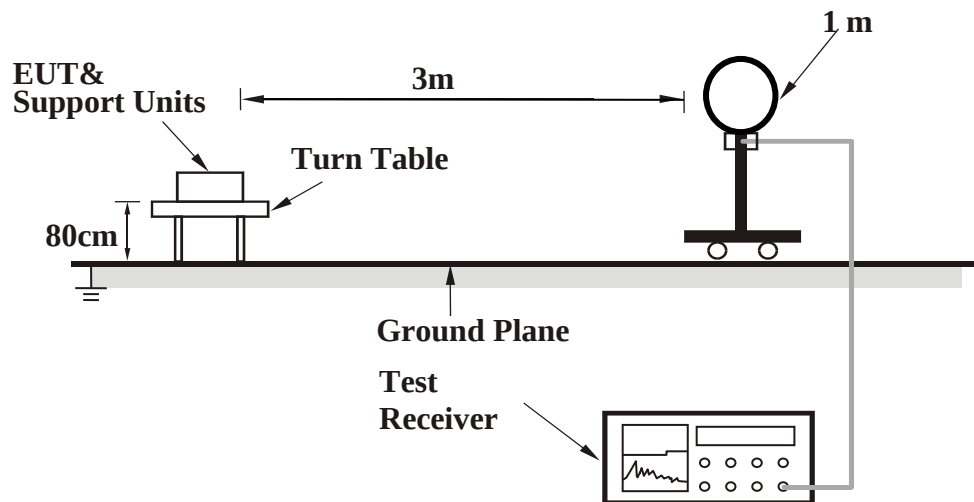
Configuration	Average	
	RBW	VBW
Bluetooth	1MHz	510Hz

Note:

- The BT-GFSK Duty cycle = $(2.98/4.08) \times 100\% = 73.04 < 98\%$, so video bandwidth is $1/2.98 = 0.336$ kHz. Therefore VBW configuration is 510Hz for testing.
 - The BT- $\pi/4$ -DQPSK Duty cycle = $(2.98/4.1) \times 100\% = 72.68 < 98\%$, so video bandwidth is $1/2.98 = 0.336$ kHz. Therefore VBW configuration is 510Hz for testing.
 - Refer to section 9.5 for duty cycle plots.
4. All modes of operation were investigated (includes all external accessories) and the worst-case emissions are reported.

Test Setup

<Frequency Range 9 kHz ~ 30 MHz>



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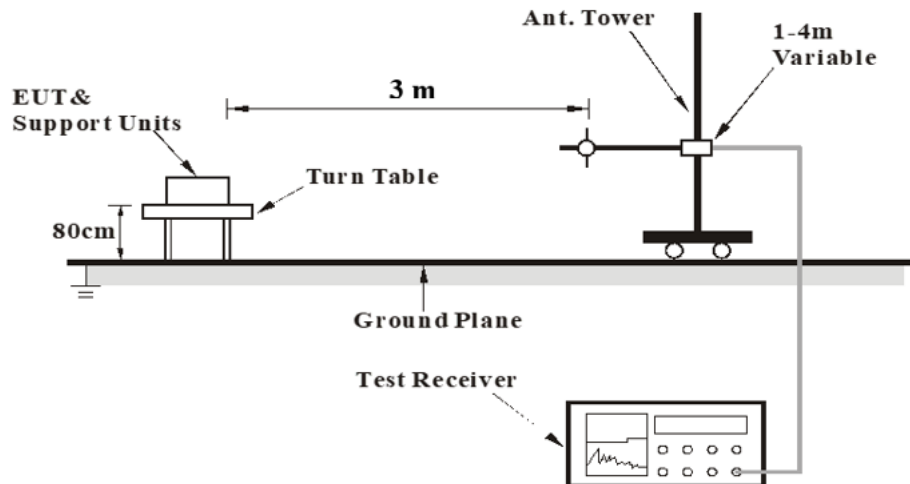
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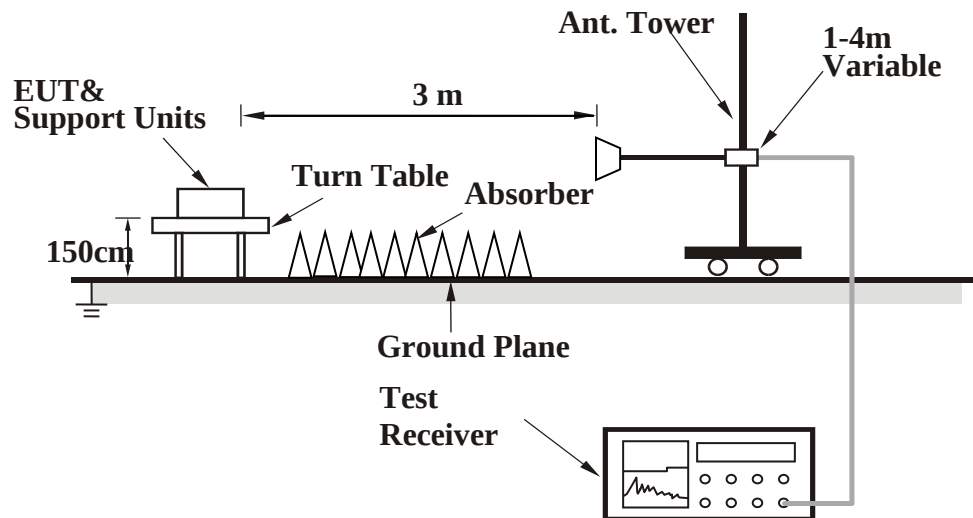
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<Frequency Range 30 MHz ~ 1 GHz >



<Frequency Range above 1 GHz>



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



Test Data

Above 1GHz Data

GFSK

EUT Test Condition		Measurement Detail	
Channel	Channel 0	Frequency Range	1 GHz ~ 26.5 GHz

Antenna Polarity & Test Distance: Horizontal at 3 m							
Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
*	4804	37.27	2.46	39.73	74	-34.27	Peak
-	2388	29.1	16.1	45.2	54	-8.8	Average
@	2402	91.2	16.13	107.33	-	-	Average
-	2325.8	40.86	16.13	56.99	74	-17.01	Peak
@	2402	91.74	16.13	107.87	-	-	Peak
Antenna Polarity & Test Distance: Vertical at 3 m							
Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
*	4804	36.82	2.46	39.28	74	-34.72	Peak
-	2319	28.89	16.17	45.06	54	-8.94	Average
@	2402	81.39	16.13	97.52	-	-	Average
-	2333.8	40.56	16.1	56.66	74	-17.34	Peak
@	2402	82.24	16.13	98.37	-	-	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 peak result under 20 dB above and complies with AVG limit, AVG result is deemed to comply with AVG limit.
6. The other emission levels were very low against the limit.

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EUT Test Condition		Measurement Detail	
Channel	Channel 39	Frequency Range	1 GHz ~ 26.5 GHz

Antenna Polarity & Test Distance: Horizontal at 3 m							
Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
*	4882	36.8	2.66	39.46	74	-34.54	Peak
-	2388.8	29.19	16.1	45.29	54	-8.71	Average
@	2441	91.56	16.11	107.67	-	-	Average
-	2493	29.02	16.1	45.12	54	-8.88	Average
-	2380.4	41.69	16.08	57.77	74	-16.23	Peak
@	2441	91.69	16.11	107.8	-	-	Peak
-	2497.4	40.66	16.1	56.76	74	-17.24	Peak
Antenna Polarity & Test Distance: Vertical at 3 m							
Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
*	4882	37.65	2.66	40.31	74	-33.69	Peak
-	2365.6	28.94	16.06	45	54	-9	Average
@	2441	84.86	16.11	100.97	-	-	Average
-	2491.2	28.94	16.1	45.04	54	-8.96	Average
-	2346.8	40.46	16.04	56.5	74	-17.5	Peak
@	2441	86.15	16.11	102.26	-	-	Peak
-	2491	40.27	16.1	56.37	74	-17.63	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 peak result under 20 dB above and complies with AVG limit, AVG result is deemed to comply with AVG limit.
6. The other emission levels were very low against the limit.

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EUT Test Condition		Measurement Detail	
Channel	Channel 78	Frequency Range	1 GHz ~ 26.5 GHz

Antenna Polarity & Test Distance: Horizontal at 3 m							
Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
*	4960	35.97	2.62	38.59	74	-35.41	Peak
@	2480	89.34	16.1	105.44	-	-	Average
-	2484.2	29.45	16.1	45.55	54	-8.45	Average
@	2480	89.52	16.1	105.62	-	-	Peak
-	2496.6	39.63	16.1	55.73	74	-18.27	Peak
Antenna Polarity & Test Distance: Vertical at 3 m							
Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
*	4960	36.27	2.62	38.89	74	-35.11	Peak
@	2480	85.21	16.1	101.31	-	-	Average
-	2491.4	28.92	16.1	45.02	54	-8.98	Average
@	2480	85.39	16.1	101.49	-	-	Peak
-	2498.6	40.13	16.1	56.23	74	-17.77	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 peak result under 20 dB above and complies with AVG limit, AVG result is deemed to comply with AVG limit.
6. The other emission levels were very low against the limit.

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EUT Test Condition		Measurement Detail	
Channel	Channel 0	Frequency Range	1 GHz ~ 26.5 GHz

Antenna Polarity & Test Distance: Horizontal at 3 m							
Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
*	4804	37.92	2.46	40.38	74	-33.62	Peak
-	2376.2	30.35	16.07	46.42	54	-7.58	Average
@	2402	87.39	16.13	103.52	-	-	Average
-	2360.6	41.58	16.05	57.63	74	-16.37	Peak
@	2402	90.5	16.13	106.63	-	-	Peak
Antenna Polarity & Test Distance: Vertical at 3 m							
Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
*	4804	36.91	2.46	39.37	74	-34.63	Peak
-	2373.8	29.15	16.08	45.23	54	-8.77	Average
@	2402	78.09	16.13	94.22	-	-	Average
-	2324.8	40.61	16.14	56.75	74	-17.25	Peak
@	2402	80.1	16.13	96.23	-	-	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 peak result under 20 dB above and complies with AVG limit, AVG result is deemed to comply with AVG limit.
6. The other emission levels were very low against the limit.

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EUT Test Condition		Measurement Detail	
Channel	Channel 39	Frequency Range	1 GHz ~ 26.5 GHz

Antenna Polarity & Test Distance: Horizontal at 3 m							
Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
*	4882	36.47	2.66	39.13	74	-34.87	Peak
-	2383.6	29.4	16.09	45.49	54	-8.51	Average
@	2441	86.4	16.11	102.51	-	-	Average
-	2490.4	29.39	16.1	45.49	54	-8.51	Average
-	2322.2	40.99	16.15	57.14	74	-16.86	Peak
@	2441	89.26	16.11	105.37	-	-	Peak
-	2497.8	40.79	16.1	56.89	74	-17.11	Peak
Antenna Polarity & Test Distance: Vertical at 3 m							
Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
*	4882	36.27	2.66	38.93	74	-35.07	Peak
-	2326.4	28.92	16.12	45.04	54	-8.96	Average
@	2441	81.93	16.11	98.04	-	-	Average
-	2483.6	29.02	16.1	45.12	54	-8.88	Average
-	2378.2	41.09	16.08	57.17	74	-16.83	Peak
@	2441	84.28	16.11	100.39	-	-	Peak
-	2504.2	40.05	16.1	56.15	74	-17.85	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 peak result under 20 dB above and complies with AVG limit, AVG result is deemed to comply with AVG limit.
6. The other emission levels were very low against the limit.

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EUT Test Condition		Measurement Detail	
Channel	Channel 78	Frequency Range	1 GHz ~ 26.5 GHz

Antenna Polarity & Test Distance: Horizontal at 3 m							
Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
*	4960	36.7	2.62	39.32	74	-34.68	Peak
@	2480	85.25	16.1	101.35	-	-	Average
-	2494.8	30.16	16.1	46.26	54	-7.74	Average
@	2480	87.74	16.1	103.84	-	-	Peak
-	2499.8	41.11	16.1	57.21	74	-16.79	Peak
Antenna Polarity & Test Distance: Vertical at 3 m							
Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
*	4960	37.05	2.62	39.67	74	-34.33	Peak
@	2480	81.25	16.1	97.35	-	-	Average
-	2501.2	29.22	16.1	45.32	54	-8.68	Average
@	2480	83.17	16.1	99.27	-	-	Peak
-	2496.8	40.43	16.1	56.53	74	-17.47	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 peak result under 20 dB above and complies with AVG limit, AVG result is deemed to comply with AVG limit.
6. The other emission levels were very low against the limit.

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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.

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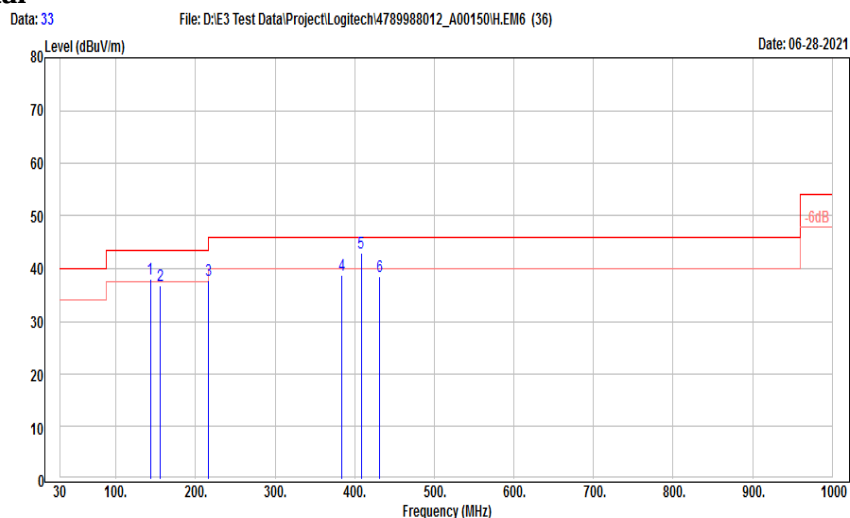


30 MHz ~ 1 GHz Data

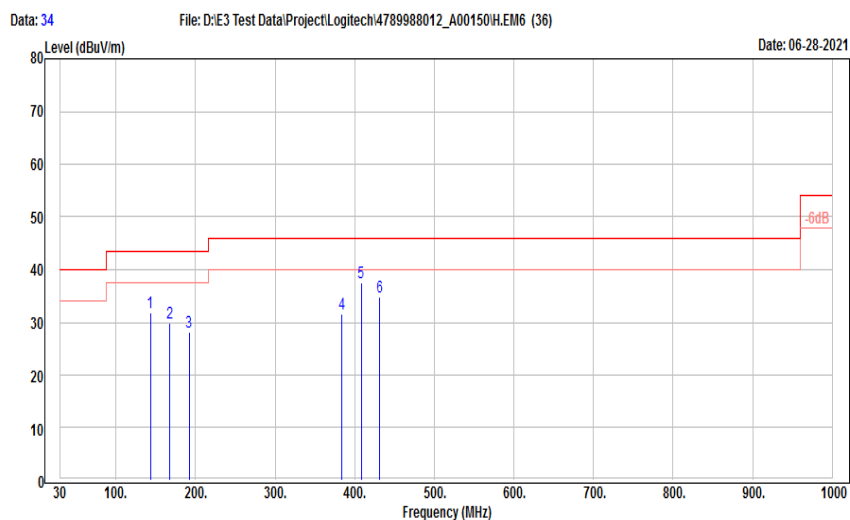
$\pi/4$ -DQPSK

EUT Test Condition		Measurement Detail	
Channel	Channel 0	Frequency Range	30 MHz ~ 1 GHz

Horizontal



Vertical



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Antenna Polarity & Test Distance: Horizontal at 3 m							
Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
-	143.49	49.94	-11.8	38.14	43.5	-5.36	Peak
-	156.1	47.89	-11.21	36.68	43.5	-6.82	Peak
-	216.24	51.21	-13.31	37.9	46	-8.1	Peak
-	384.05	46.23	-7.43	38.8	46	-7.2	Peak
-	408.3	49.82	-6.84	42.98	46	-3.02	Peak
-	431.58	44.76	-6.18	38.58	46	-7.42	Peak
Antenna Polarity & Test Distance: Vertical at 3 m							
Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
-	143.49	43.63	-11.8	31.83	43.5	-11.67	Peak
-	167.74	41.09	-11.2	29.89	43.5	-13.61	Peak
-	191.99	41.38	-13.27	28.11	43.5	-15.39	Peak
-	384.05	39.14	-7.43	31.71	46	-14.29	Peak
-	408.3	44.44	-6.84	37.6	46	-8.4	Peak
-	431.58	40.96	-6.18	34.78	46	-11.22	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. The peak result complies with QP limit, QP result is deemed to comply with QP limit.
5. The other emission levels were very low against the limit.

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9.8. AC Power Line Conducted Emission

Requirements

Frequency (MHz)	Conducted limit (dB μ V)	
	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.

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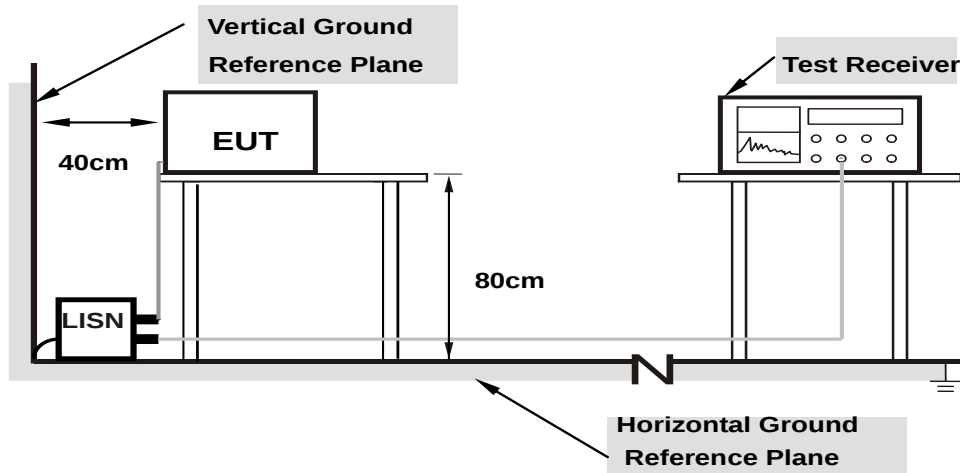
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Test Setup



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

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

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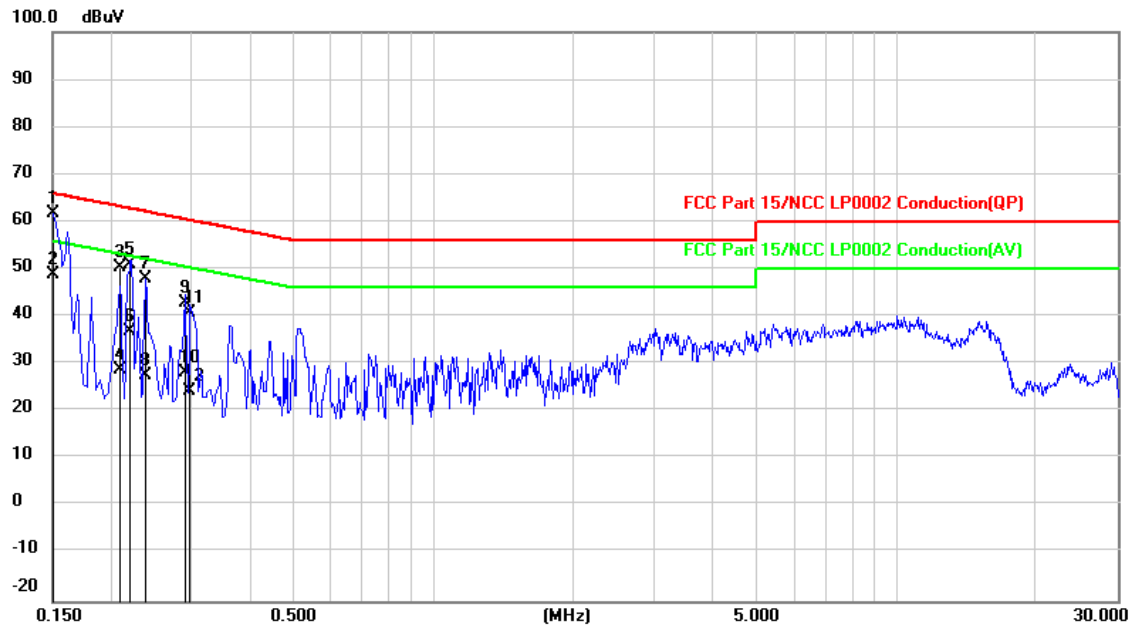


Test Data

$\pi/4$ -DQPSK

EUT Test Condition		Measurement Detail	
Channel	Channel 0	Frequency Range	150 kHz ~ 30 MHz

Phase of Power : Line (L)



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No.	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV)	dB	(dBuV)	(dBuV)	(dB)	
1	0.1500	42.25	19.54	61.79	66.00	-4.21	QP
2	0.1500	29.45	19.54	48.99	56.00	-7.01	AVG
3	0.2100	30.95	19.53	50.48	63.21	-12.73	QP
4	0.2100	9.31	19.53	28.84	53.21	-24.37	AVG
5	0.2220	31.50	19.53	51.03	62.74	-11.71	QP
6	0.2220	17.41	19.53	36.94	52.74	-15.80	AVG
7	0.2380	28.40	19.53	47.93	62.17	-14.24	QP
8	0.2380	7.97	19.53	27.50	52.17	-24.67	AVG
9	0.2900	23.46	19.53	42.99	60.52	-17.53	QP
10	0.2900	8.73	19.53	28.26	50.52	-22.26	AVG
11	0.2980	21.36	19.53	40.89	60.30	-19.41	QP
12	0.2980	4.78	19.53	24.31	50.30	-25.99	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.

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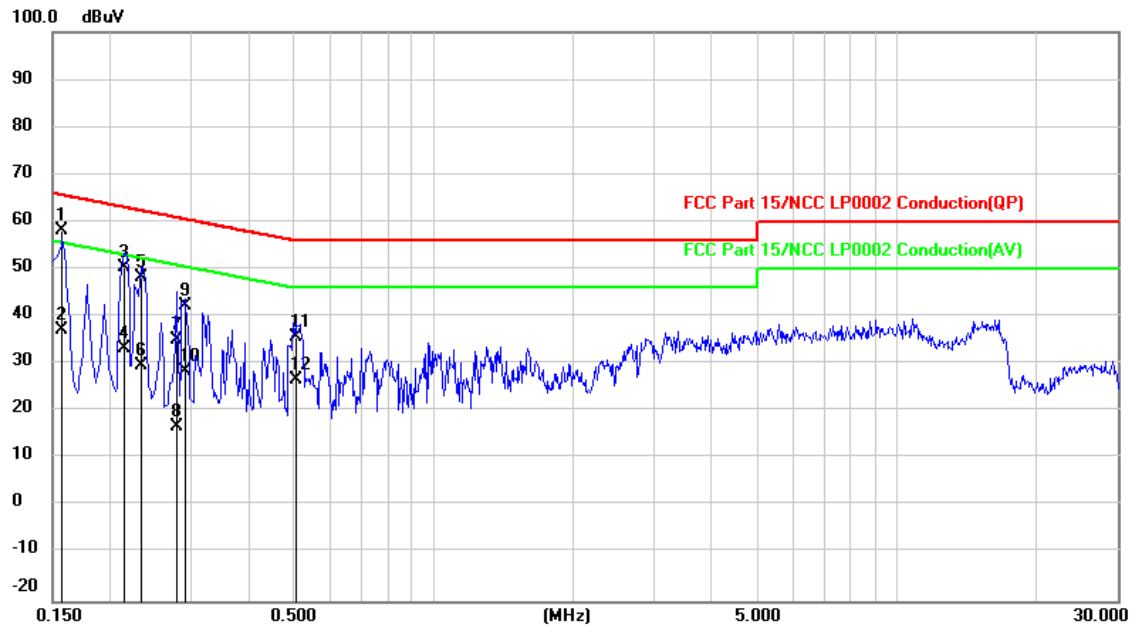
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Phase of Power : Neutral (N)



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No.	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV)	dB	(dBuV)	(dBuV)	(dB)	
1	0.1580	38.72	19.54	58.26	65.57	-7.31	QP
2	0.1580	17.47	19.54	37.01	55.57	-18.56	AVG
3	0.2140	30.76	19.53	50.29	63.05	-12.76	QP
4	0.2140	13.58	19.53	33.11	53.05	-19.94	AVG
5	0.2340	28.65	19.53	48.18	62.31	-14.13	QP
6	0.2340	10.19	19.53	29.72	52.31	-22.59	AVG
7	0.2779	15.66	19.53	35.19	60.88	-25.69	QP
8	0.2779	-2.92	19.53	16.61	50.88	-34.27	AVG
9	0.2900	22.67	19.53	42.20	60.52	-18.32	QP
10	0.2900	9.06	19.53	28.59	50.52	-21.93	AVG
11	0.5060	16.12	19.52	35.64	56.00	-20.36	QP
12	0.5060	7.16	19.52	26.68	46.00	-19.32	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.

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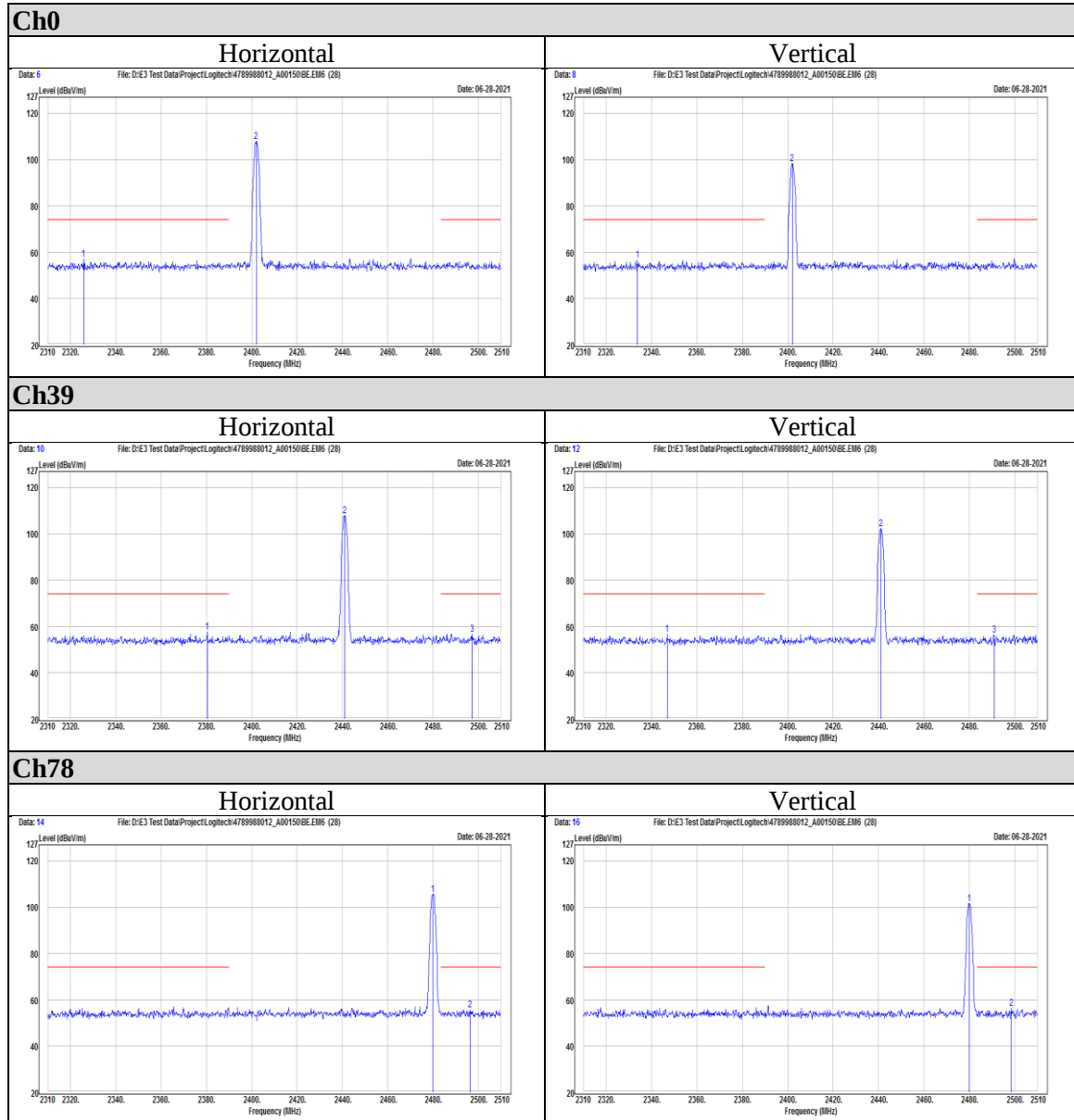
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Appendix I Radiated Band Edge Measurement

GFSK

Peak



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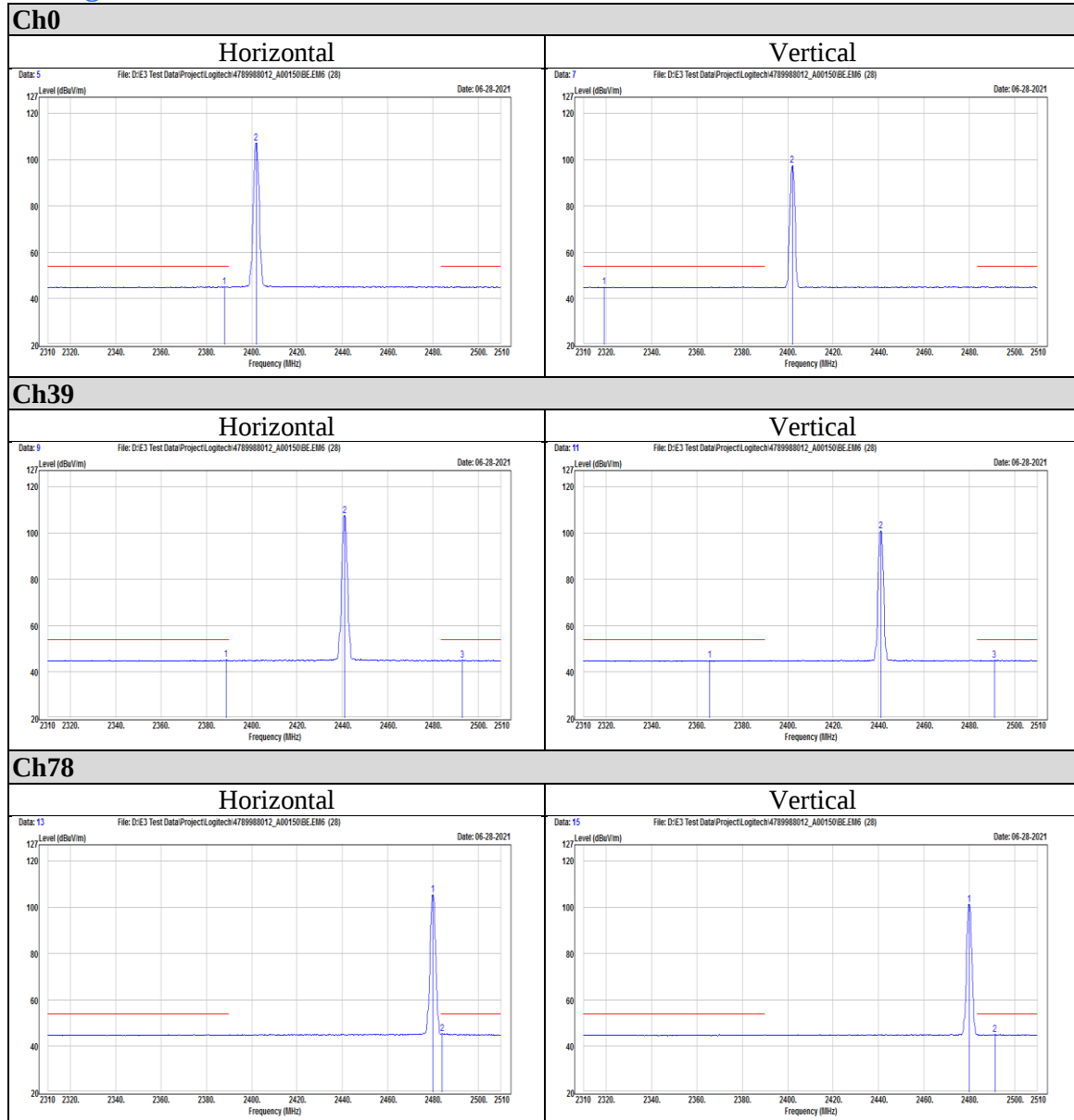
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Average



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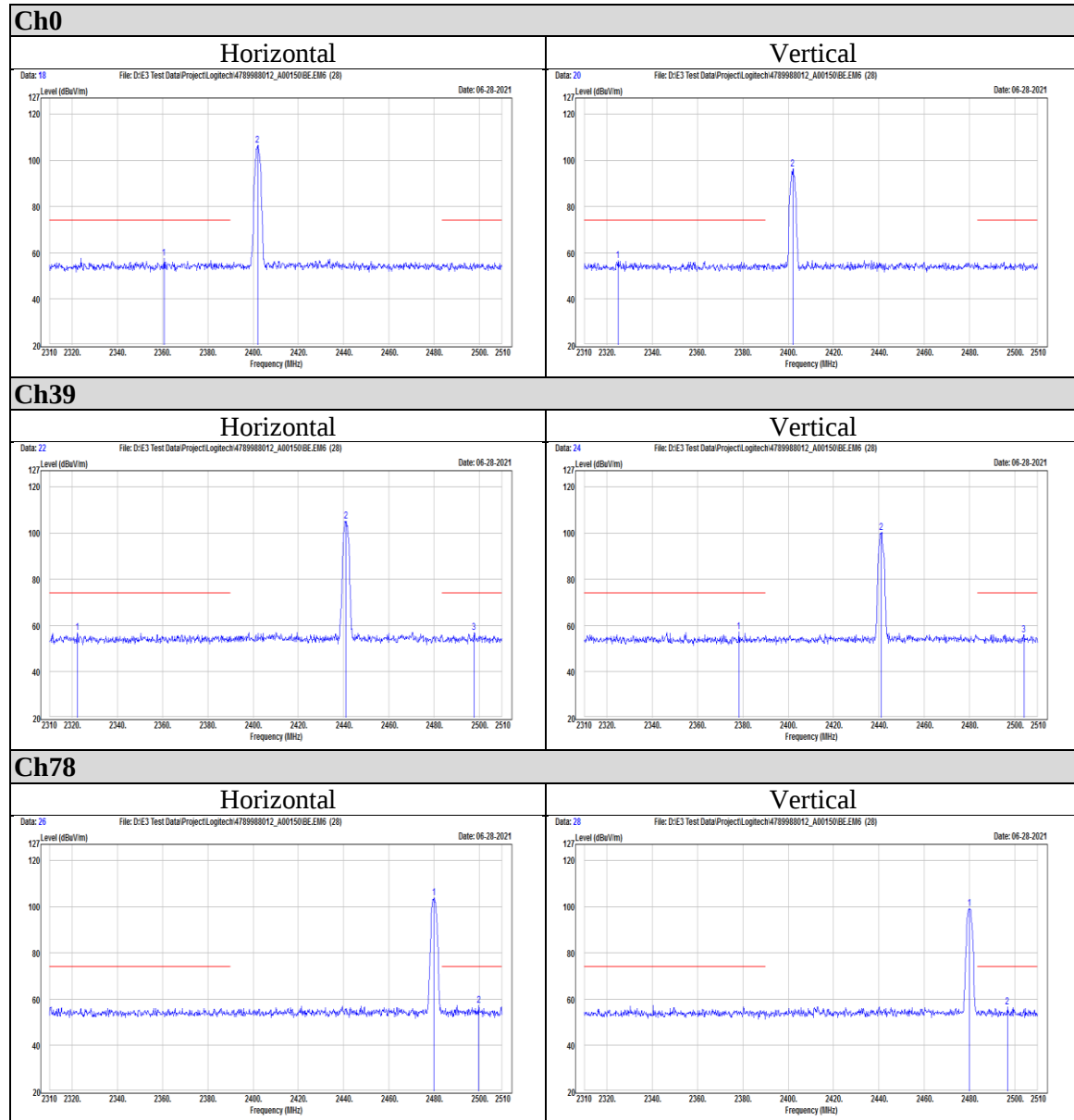
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$\pi/4$ -DQPSK

Peak



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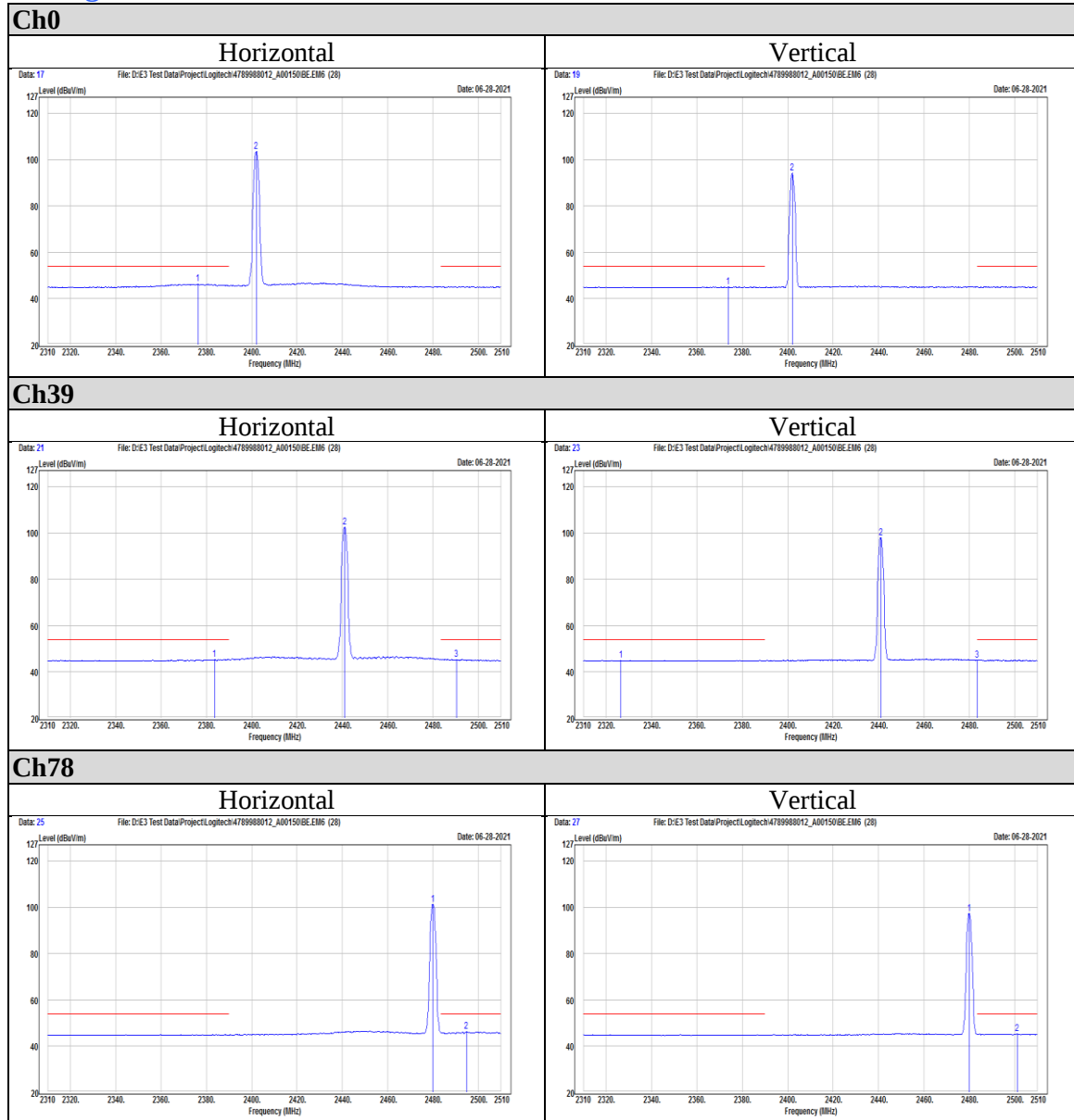
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Average



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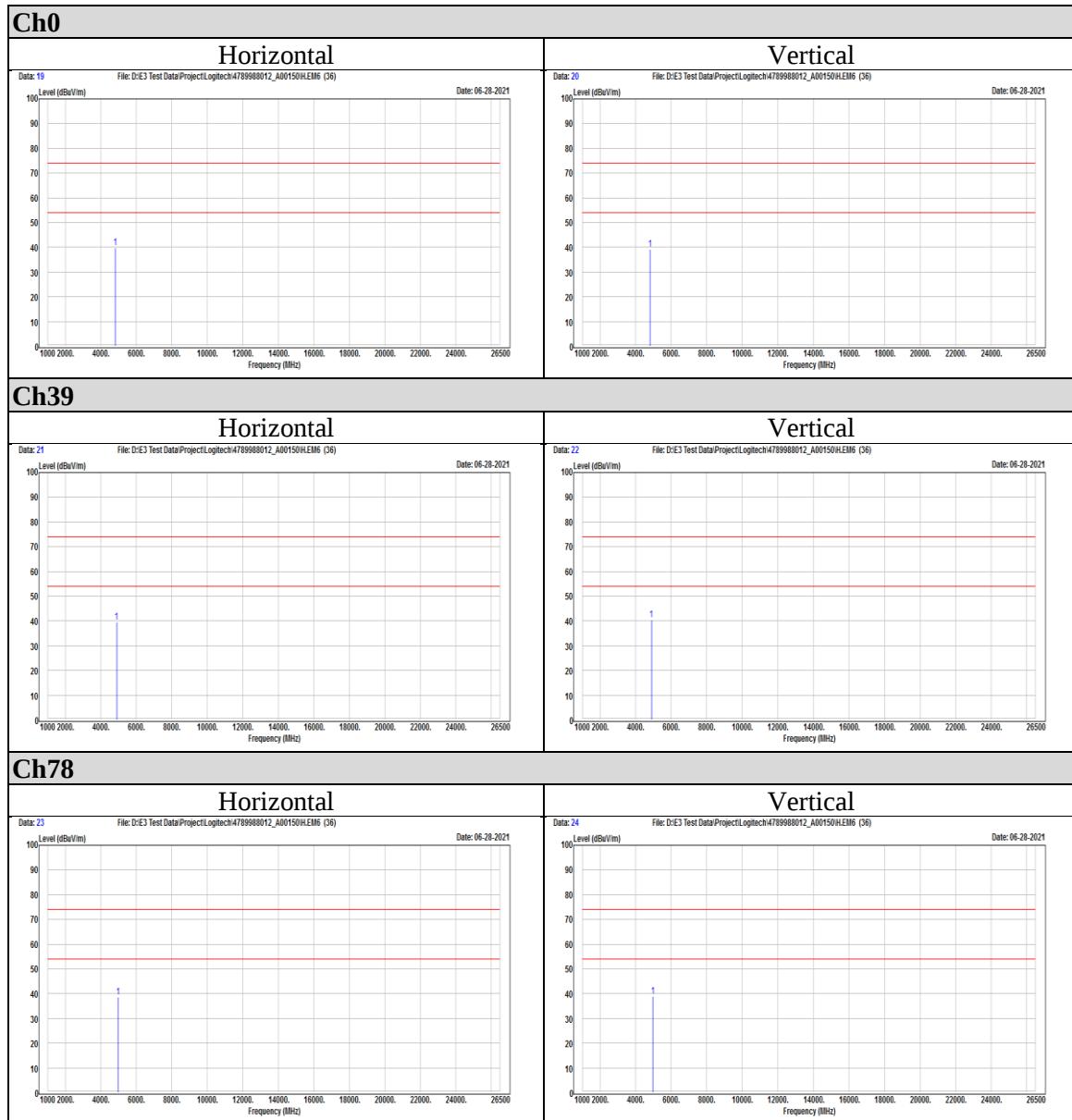
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Appendix II Radiated Spurious Emission Measurement

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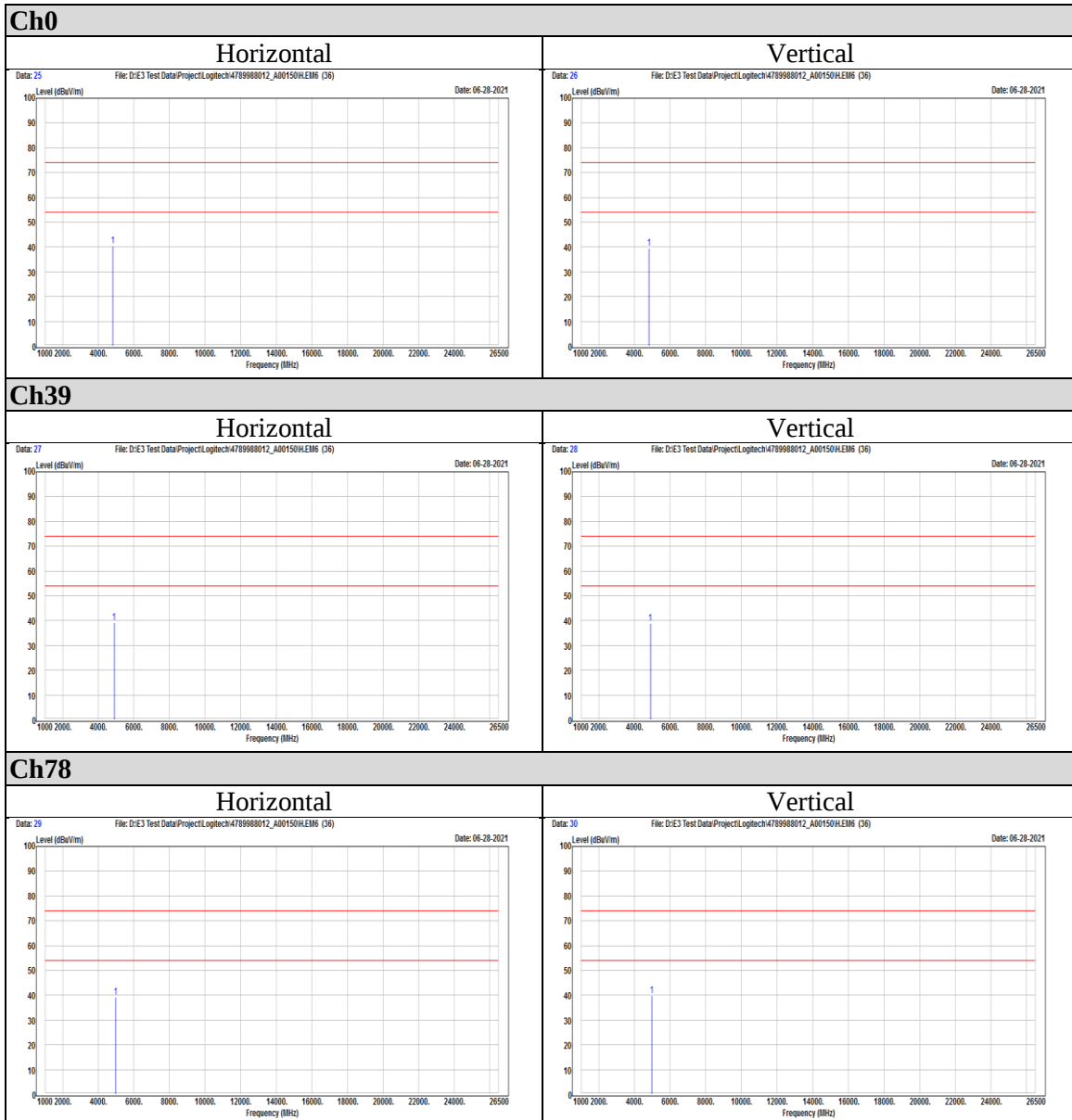
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