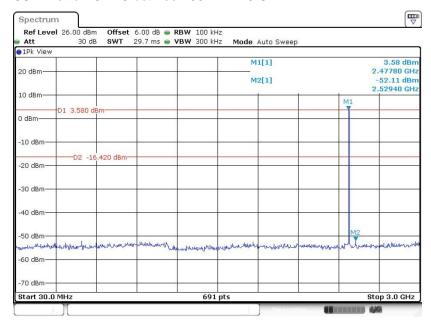
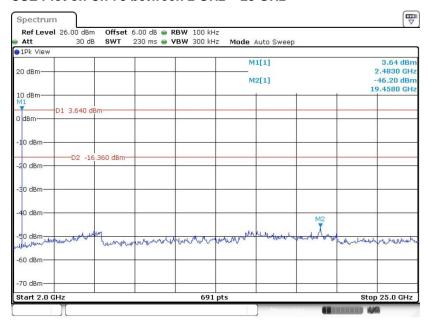
CSE Plot on Ch 78 between 30MHz ~ 3 GHz



Date: 17.NOV.2022 12:18:16

CSE Plot on Ch 78 between 2 GHz ~ 25 GHz



Date: 17.NOV.2022 12:18:46

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3.8 Radiated Band Edges and Spurious Emission Measurement

3.8.1 Limit of Radiated Band Edges and Spurious Emission

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. In addition, radiated emissions which fall in the restricted bands must also comply with the limits as below.

Frequency	Field Strength	Measurement Distance
(MHz)	(microvolts/meter)	(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

3.8.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

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3.8.3 Test Procedures

- 1. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
- 2. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
- 3. For each suspected emission, the EUT was arranged to its worst case and then tune the Antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level to comply with the guidelines.
- 4. Set to the maximum power setting and enable the EUT transmit continuously.
- 5. Use the following spectrum analyzer settings:
 - (1) Span shall wide enough to fully capture the emission being measured;
 - (2) Set RBW=100 kHz for f < 1 GHz, RBW=1MHz for f>1GHz; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold for peak
 - (3) For average measurement: use duty cycle correction factor method per 15.35(c).

Duty cycle = On time/100 milliseconds

On time = $N_1*L_1+N_2*L_2+...+N_{n-1}*LN_{n-1}+N_n*L_n$

Where N_1 is number of type 1 pulses, L_1 is length of type 1 pulses, etc.

Average Emission Level = Peak Emission Level + 20*log(Duty cycle)

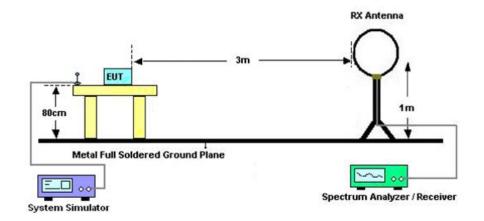
- 6. Corrected Reading: Antenna Factor + Cable Loss + Read Level Preamp Factor = Level
- 7. For testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
- 8. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than peak limit (that means the emission level in average mode also complies with the limit in average mode), then peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.

Note: The average levels were calculated from the peak level corrected with duty cycle correction factor (-24.76dB) derived from 20log (dwell time/100ms). This correction is only for signals that hop with the fundamental signal, such as band-edge and harmonic. Other spurious signals that are independent of the hopping signal would not use this correction.

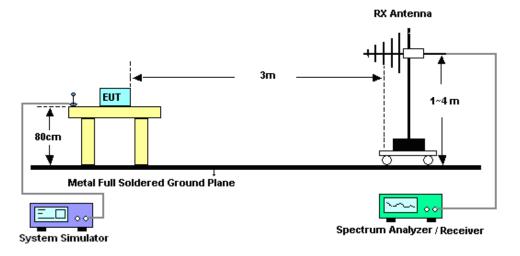
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3.8.4 Test Setup

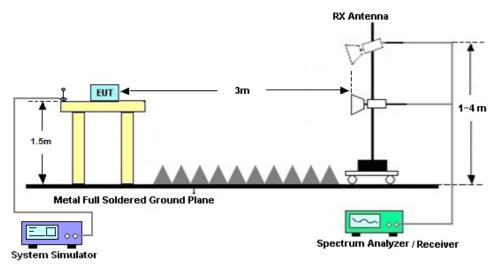
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



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3.8.5 Test Results of Radiated Spurious Emissions (9 kHz ~ 30 MHz)

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line was not reported.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

3.8.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix C.

3.8.7 Test Result of Radiated Spurious Emission (30MHz ~ 10th Harmonic or 40GHz, whichever is lower)

Please refer to Appendix C.

3.8.8 Duty cycle correction factor for average measurement

Please refer to Appendix D.

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3.9 AC Conducted Emission Measurement

3.9.1 Limit of AC Conducted Emission

For equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table.

Eroquency of emission (MUz)	Conducted limit (dBμV)			
Frequency of emission (MHz)	Quasi-peak	Average		
0.15-0.5	66 to 56*	56 to 46*		
0.5-5	56	46		
5-30	60	50		

^{*}Decreases with the logarithm of the frequency.

3.9.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

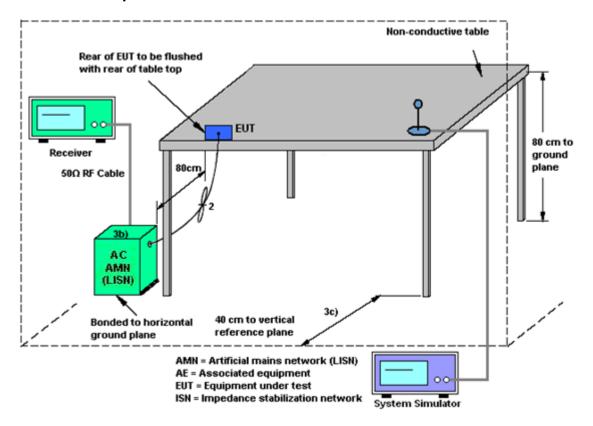
3.9.3 Test Procedures

- The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
- 2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
- 3. All the support units are connecting to the other LISN.
- 4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
- 5. The FCC states that a 50 ohm, 50 microhenry LISN should be used.
- 6. Both sides of AC line were checked for maximum conducted interference.
- 7. The frequency range from 150 kHz to 30 MHz was searched.
- 8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

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3.9.4 Test Setup



3.9.5 Test Result of AC Conducted Emission

Please refer to Appendix B.

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3.10 Antenna Requirements

3.10.1 Standard Applicable

If directional gain of transmitting antennas is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the rule.

3.10.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.10.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.

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4 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Spectrum Analyzer	R&S	FSV40	101040	10Hz~40GHz	Oct. 12, 2022	Nov. 03, 2022~ Dec. 01, 2022	Oct. 11, 2023	Conducted (TH01-KS)
Pulse Power Senor	Anritsu	MA2411B	0917070	300MHz~40GH z	Jan. 05, 2022	Nov. 03, 2022~ Dec. 01, 2022	Jan. 04, 2023	Conducted (TH01-KS)
Power Meter	Anritsu	ML2495A	1005002	50MHz Bandwidth	Jan. 05, 2022	Nov. 03, 2022~ Dec. 01, 2022	Jan. 04, 2023	Conducted (TH01-KS)
EMI Test Receiver	Keysight	N9038A	MY564000 04	3Hz~8.5GHz;M ax 30dBm	Oct. 13, 2022	Dec. 07, 2022	Oct. 12, 2023	Radiation (03CH04-KS)
EXA Spectrum Analyzer	Keysight	N9010B	MY574710 79	10Hz-44G,MAX 30dB	Oct. 12, 2022	Dec. 07, 2022	Oct. 11, 2023	Radiation (03CH04-KS)
Loop Antenna	R&S	HFH2-Z2	100321	9kHz~30MHz	Oct. 16, 2022	Dec. 07, 2022	Oct. 15, 2023	Radiation (03CH04-KS)
Bilog Antenna		CBL6111D	49922	30MHz-1GHz	May 24, 2022	Dec. 07, 2022	May 23, 2023	Radiation (03CH05-KS)
Horn Antenna		BBHA9120D	1284	1GHz~18GHz	Jan. 05, 2022	Dec. 07, 2022	Jan. 04, 2023	Radiation (03CH04-KS)
SHF-EHF Horn	Com-power	AH-840	101070	18GHz~40GHz	Jan. 05, 2022	Dec. 07, 2022	Jan. 04, 2023	Radiation (03CH04-KS)
Amplifier	SONOMA	310N	187289	9KHz-1GHz	Jan. 05, 2022	Dec. 07, 2022	Jan. 04, 2023	Radiation (03CH04-KS)
Amplifier	MITEQ	EM18G40GG A	060728	18~40GHz	Jan. 05, 2022	Dec. 07, 2022	Jan. 04, 2023	Radiation (03CH04-KS)
high gain Amplifier	EM	EM01G18GA	060840	1Ghz-18Ghz	Oct. 12, 2022	Dec. 07, 2022	Oct. 11, 2023	Radiation (03CH04-KS)
Amplifier	Agilent	8449B	3008A023 70	1Ghz-18Ghz	Oct. 12, 2022	Dec. 07, 2022	Oct. 11, 2023	Radiation (03CH04-KS)
AC Power Source	Chroma	61601	F1040900 04	N/A	NCR	Dec. 07, 2022	NCR	Radiation (03CH04-KS)
Turn Table	ChamPro	EM 1000-T	060762-T	0~360 degree	NCR	Dec. 07, 2022	NCR	Radiation (03CH04-KS)
Antenna Mast	ChamPro	EM 1000-A	060762-A	1 m~4 m	NCR	Dec. 07, 2022	NCR	Radiation (03CH04-KS)
EMI Receiver	R&S	ESR7	101630	9kHz~7GHz;	Jul. 07, 2022	Nov. 25, 2022	Jul. 06, 2023	Conduction (CO01-SZ)
AC LISN	R&S	ENV216	100063	9kHz~30MHz	Sep. 15, 2022	Nov. 25, 2022	Sep. 14, 2023	Conduction (CO01-SZ)
AC LISN (for auxiliary equipment)	EMCO	3816/2SH	00103892	9kHz~30MHz	Oct. 17, 2022	Nov. 25, 2022	Oct. 16, 2023	Conduction (CO01-SZ)
AC Power Source	Chroma	61602	616020000 891	100Vac~250Vac	Jul. 07, 2022	Nov. 25, 2022	Jul. 06, 2023	Conduction (CO01-SZ)

NCR: No Calibration Required

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5 Uncertainty of Evaluation

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI 63.10-2013. All the measurement uncertainty value were shown with a coverage K=2 to indicate 95% level of confidence. The measurement data show herein meets or exceeds the CISPR measurement uncertainty values specified in CISPR 16-4-2 and can be compared directly to specified limit to determine compliance.

Uncertainty of Conducted Measurement

Test Item	Uncertainty		
Conducted Power	±0.56 dB		
Conducted Emissions	±0.92 dB		
Occupied Channel Bandwidth	±0.03 %		

<u>Uncertainty of Conducted Emission Measurement (150 kHz ~ 30 MHz)</u>

Measuring Uncertainty for a Level of Confidence	2.2dB
of 95% (U = 2Uc(y))	2.206

<u>Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)</u>

Measuring Uncertainty for a Level of Confidence	5.0dB
of 95% (U = 2Uc(y))	3.0dB

Uncertainty of Radiated Emission Measurement (1000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence	5.1dB
of 95% (U = 2Uc(y))	3.1 0 B

Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

Measuring Uncertainty for a Level of Confidence	5.1dB
of 95% (U = 2Uc(y))	5.10B

----- THE END -----

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Appendix A. Conducted Test Results

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Bluetooth

Test Engineer:	Jacob Zhang	Temperature:	20~26	°C
Test Date:	2022/11/3~2022/12/1	Relative Humidity:	40~51	%

TEST RESULTS DATA 20dB and 99% Occupied Bandwidth and Hopping Channel Separation

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	20db BW (MHz)	99% Bandwidth (MHz)	Hopping Channel Separation Measurement (MHz)	Hopping Channel Separation Measurement Limit (MHz)	Pass/Fail
DH	1Mbps	1	0	2402	0.947	0.865	1002.900	0.6310	Pass
DH	1Mbps	1	39	2441	0.949	0.865	976.800	0.6329	Pass
DH	1Mbps	1	78	2480	0.949	0.863	998.600	0.6329	Pass
2DH	2Mbps	1	0	2402	1.237	1.166	998.600	0.8249	Pass
2DH	2Mbps	1	39	2441	1.259	1.166	1002.900	0.8393	Pass
2DH	2Mbps	1	78	2480	1.259	1.166	924.700	0.8393	Pass
3DH	3Mbps	1	0	2402	1.237	1.149	998.600	0.8249	Pass
3DH	3Mbps	1	39	2441	1.237	1.149	968.200	0.8249	Pass
3DH	3Mbps	1	78	2480	1.233	1.149	1002.900	0.8220	Pass

TEST RESULTS DATA

Dwell Time

Mod.	Hopping Channel Number Rate	Hops Over Occupancy Time(hops)	Package Transfer Time (msec) (MHz)	Dwell Time (sec)	Limits (sec)	Pass/Fail
Nomal	79	106.67	2.9101	0.31	0.4	Pass
AFH	20	53.33	2.9101	0.16	0.4	Pass

TEST RESULTS DATA Peak Power Table

DH	CH.	NTX	Peak Power (dBm)	Power Limit (dBm)	Test Result
	0	1	11.03	20.97	Pass
DH1	DH1 39	1	11.28	20.97	Pass
	78	1	11.08	20.97	Pass

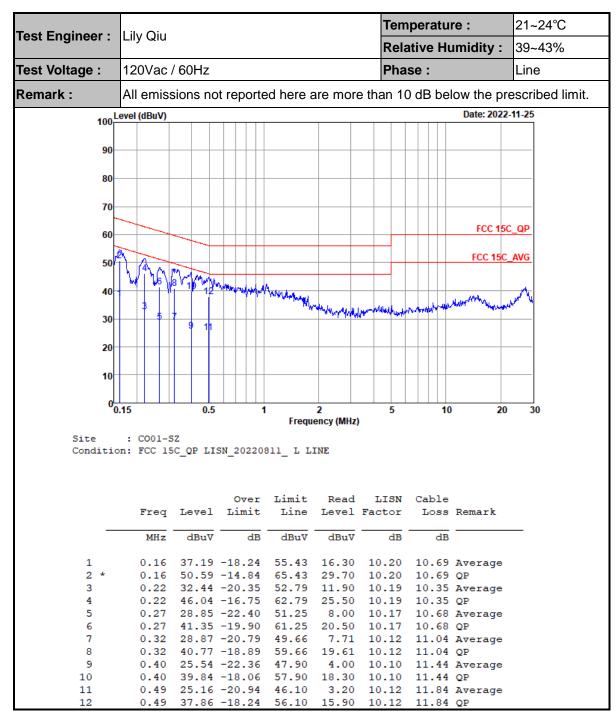
2DH	CH.	NTX	Peak Power	Power Limit	Test
			(dBm)	(dBm)	Result
	0	1	5.99	20.97	Pass
2DH1	39	1	6.28	20.97	Pass
	78	1	6.51	20.97	Pass

3DH	CH.	NTX	Peak Power	Power Limit	Test
		INIA	(dBm)	(dBm)	Result
	0	1	6.36	20.97	Pass
3DH1 39		1	6.58	20.97	Pass
	78	1	6.81	20.97	Pass

<u>TEST RESULTS DATA</u> <u>Number of Hopping Frequency</u>

Number of Hopping (Channel)	Adaptive Frequency Hopping (Channel)	Limits (Channel)	Pass/Fail
79	79	> 15	Pass

Appendix B. AC Conducted Emission Test Results



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Temperature: 21~24°C Test Engineer: Lily Qiu Relative Humidity: 39~43% Test Voltage: 120Vac / 60Hz Phase: Neutral Remark: All emissions not reported here are more than 10 dB below the prescribed limit. 100 Level (dBuV) Date: 2022-11-25 90 80 60 FCC 15C_AVG 50 Whitehard warm 30 20 0.15 10 Frequency (MHz)

site :	COOL	-54					
Condition:	FCC	15C_	QP	LISN	20220811_	N	NEUTRAL

			Over	Limit	Read	LISN	Cable	
	Freq	Level	Limit	Line	Level	Factor	Loss	Remark
	MHz	dBu₹	dB	dBuV	dBu∀	dB	dB	
1	0.17	35.62	-19.59	55.21	14.70	10.31	10.61	Average
2 *	0.17	48.42	-16.79	65.21	27.50	10.31	10.61	QP
3	0.22	33.08	-19.80	52.88	12.49	10.27	10.32	Average
4	0.22	43.98	-18.90	62.88	23.39	10.27	10.32	QP
5	0.29	28.55	-22.04	50.59	7.50	10.22	10.83	Average
6	0.29	41.75	-18.84	60.59	20.70	10.22	10.83	QP
7	0.40	29.63	-18.27	47.90	8.00	10.19	11.44	Average
8	0.40	40.63	-17.27	57.90	19.00	10.19	11.44	QP
9	0.46	23.80	-22.87	46.67	1.90	10.19	11.71	Average
10	0.46	39.00	-17.67	56.67	17.10	10.19	11.71	QP
11	0.51	25.60	-20.40	46.00	3.60	10.20	11.80	Average
12	0.51	37.70	-18.30	56.00	15.70	10.20	11.80	QP

Note:

- 1. Level($dB\mu V$) = Read Level($dB\mu V$) + LISN Factor(dB) + Cable Loss(dB)
- 2. Over Limit(dB) = Level(dB μ V) Limit Line(dB μ V)

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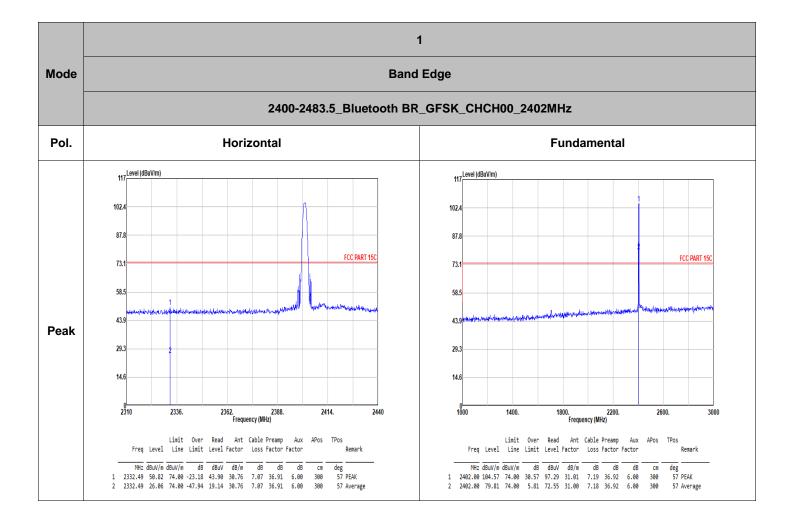
Appendix C. Radiated Spurious Emission Test Data

Mode	Band (MHz)	Modulation	Channel	Frequency	Data Rate	Remark
Mode 1	2400-2483.5	Bluetooth BR_GFSK	CH00	2402	1Mbps	-
Mode 2	2400-2483.5	Bluetooth BR_GFSK	CH39	2441	1Mbps	-
Mode 3	2400-2483.5	Bluetooth BR_GFSK	CH78	2480	1Mbps	-
Mode 4	2400-2483.5	Bluetooth BR_GFSK	CH78	2480	1Mbps	LF

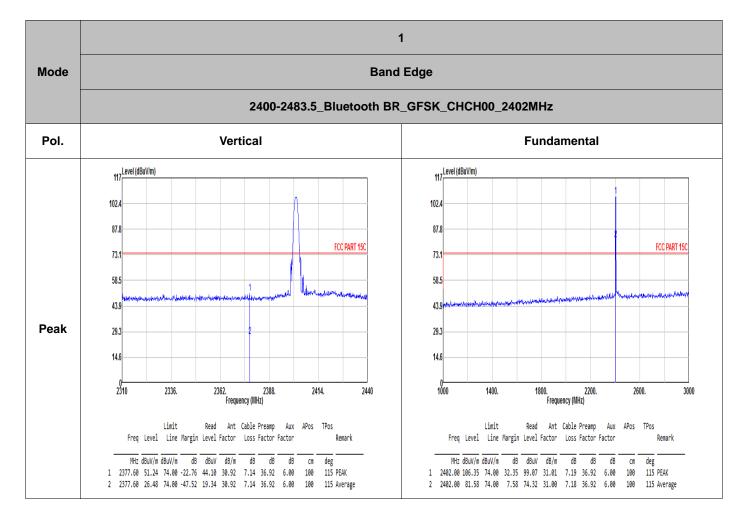


Summary of each worse mode

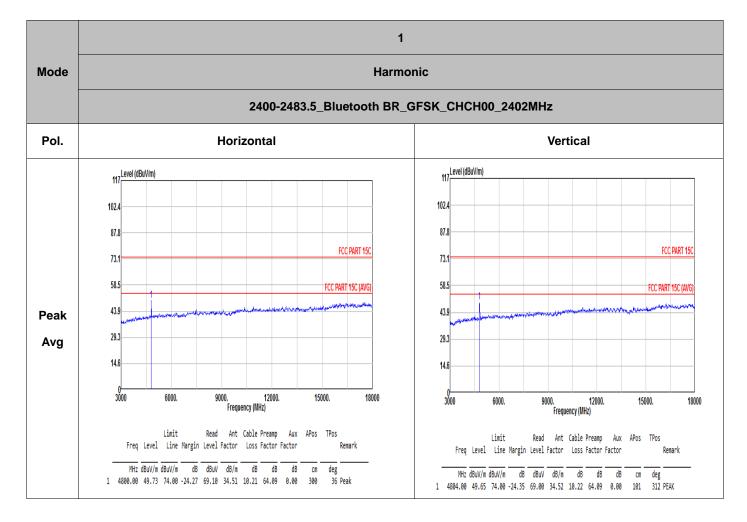
Mode	Modulation	Ch.	Freq.	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Pol.	Peak Avg.	Result	Remark
1	Bluetooth BR_GFSK	CH00	2377.60	51.24	74.00	-22.76	V	PEAK	Pass	Band Edge
1	Bluetooth BR_GFSK	CH00	4804	49.73	74	-24.27	V	PEAK	Pass	Harmonic
2	Bluetooth BR_GFSK	CH39	-	-	-	-	-	-	-	Band Edge
	Bluetooth BR_GFSK	CH39	4882.00	50.94	74.00	-23.06	V	PEAK	Pass	Harmonic
	Bluetooth BR_GFSK	CH78	2483.60	61.42	74.00	-12.58	V	PEAK	Pass	Band Edge
3	Bluetooth BR_GFSK	CH78	4960.00	50.12	74.00	-23.88	V	PEAK	Pass	Harmonic
4	Bluetooth BR_GFSK	CH78	48.43	31.10	40	-8.90	V	PEAK	Pass	LF



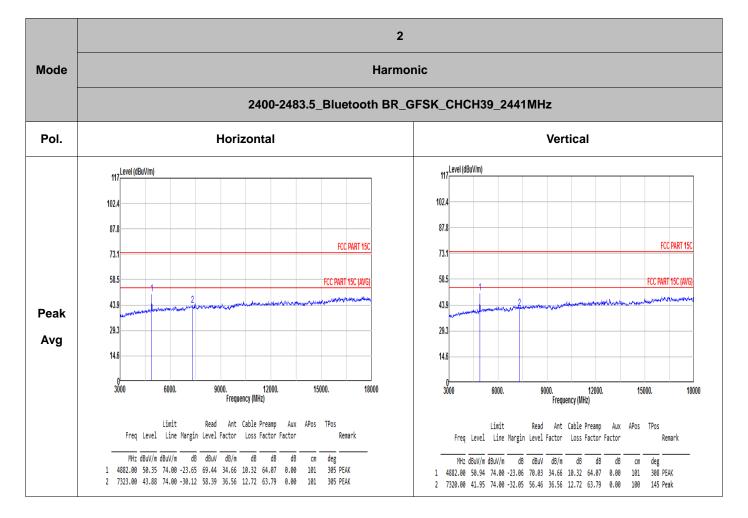
CC RF Test Report No. :FR2O2911A



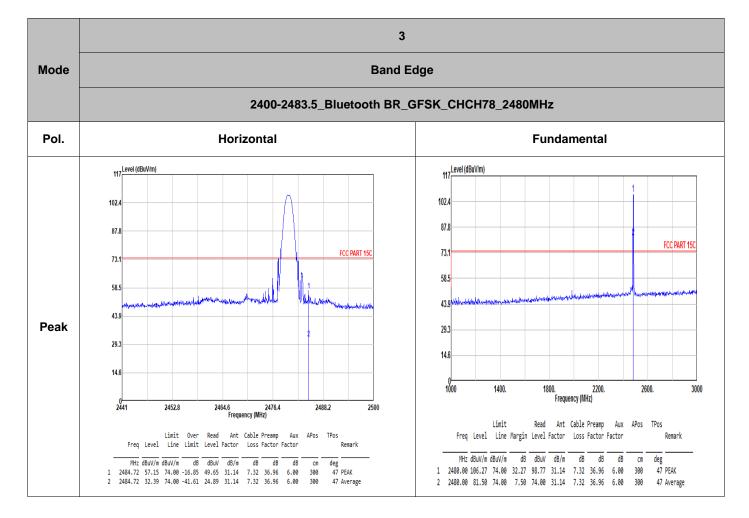
F Test Report No. :FR2O2911A



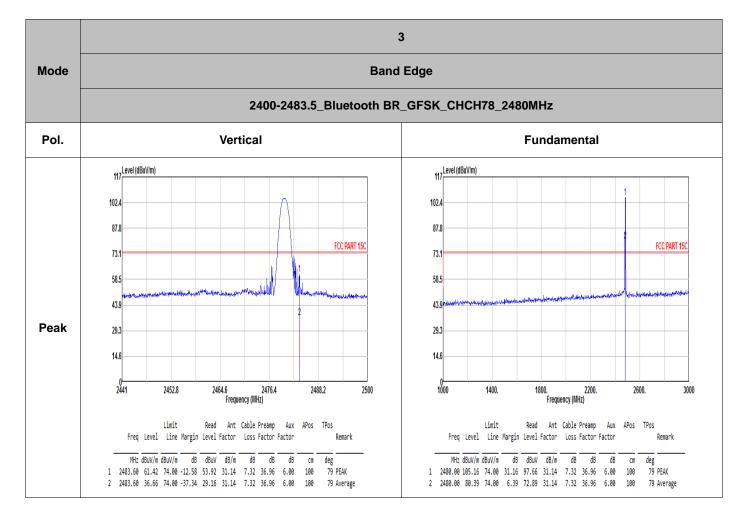
C RF Test Report No. :FR2O2911A



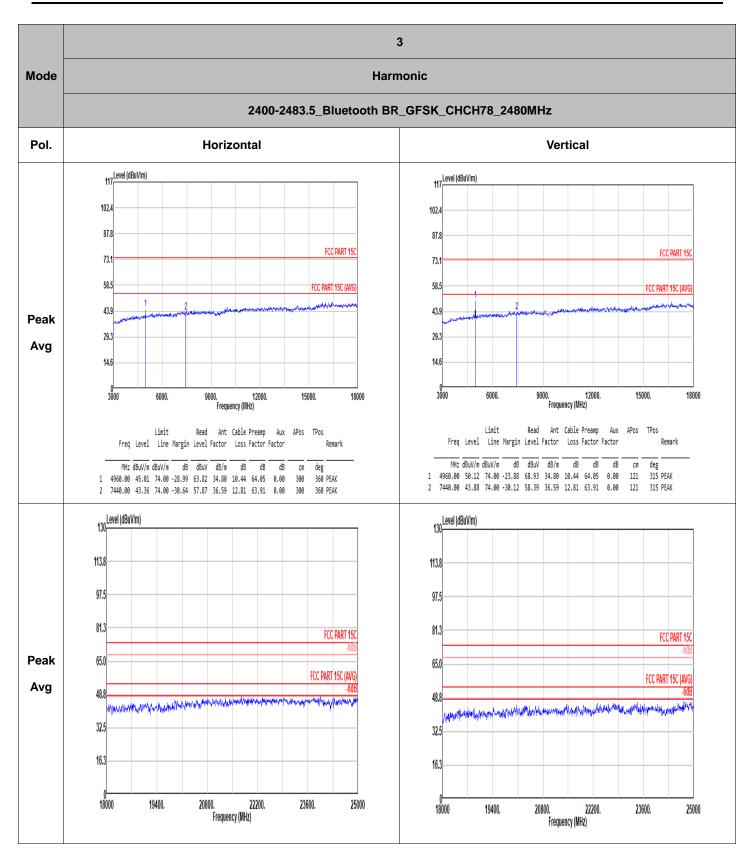
C RF Test Report No. :FR2O2911A



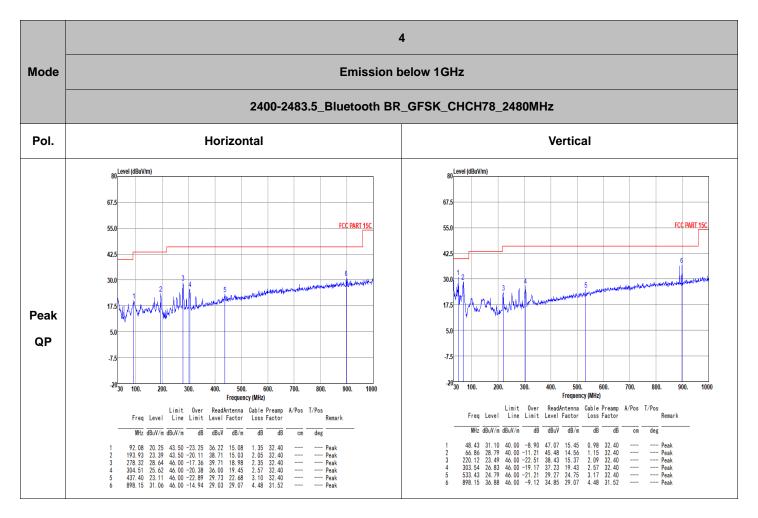
C RF Test Report No. :FR2O2911A



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CRF Test Report No.:FR2O2911A

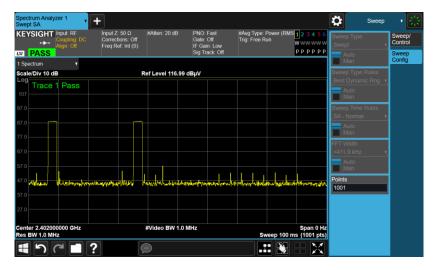


Appendix D. Duty Cycle Plots

DH5 on time (One Pulse) Plot on Channel 39



DH5 on time (Count Pulses) Plot on Channel 39



Note:

- 1. Worst case Duty cycle = on time/100 milliseconds = $2 \times 2.89 / 100 = 5.78 \%$
- 2. Worst case Duty cycle correction factor = 20*log(Duty cycle) = -24.76 dB
- 3. DH5 has the highest duty cycle worst case and is reported.

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