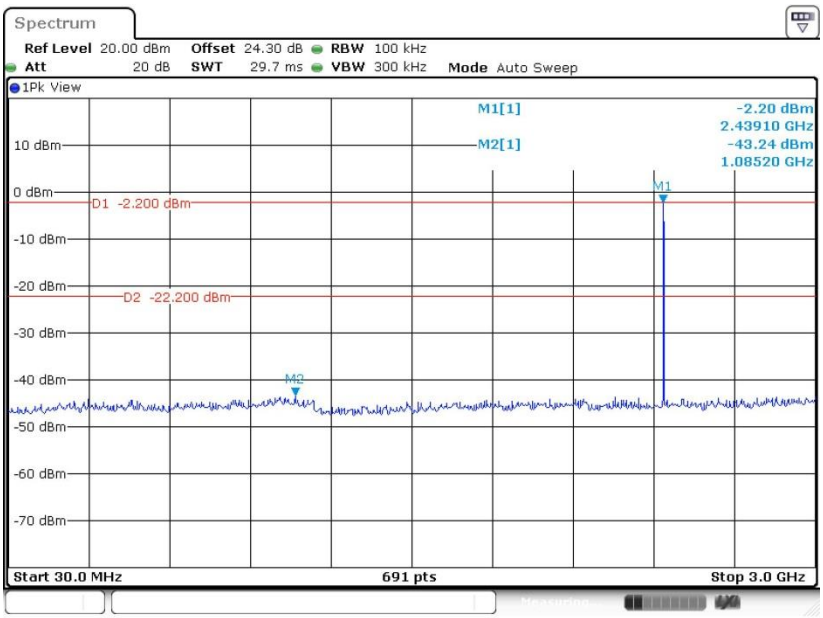
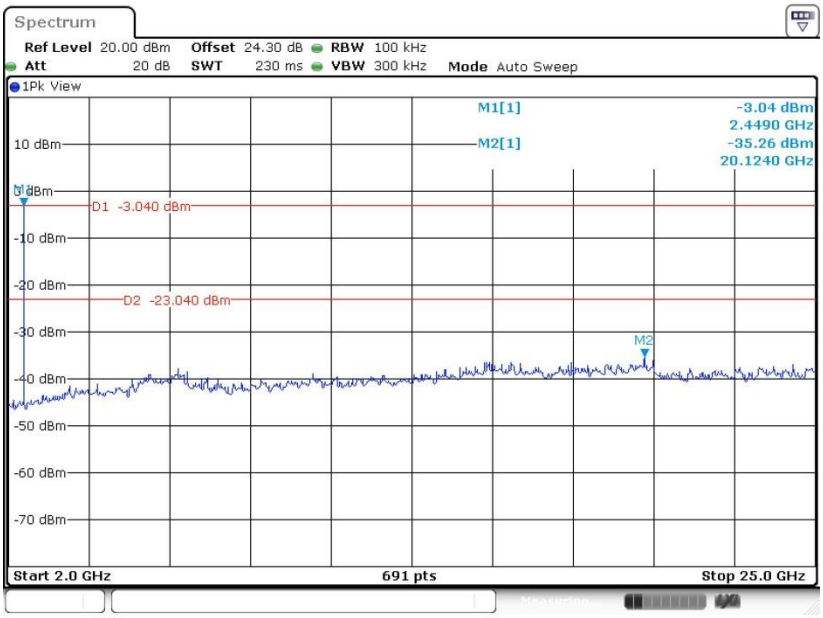
CSE Plot on Ch 39 between 30MHz ~ 3 GHz



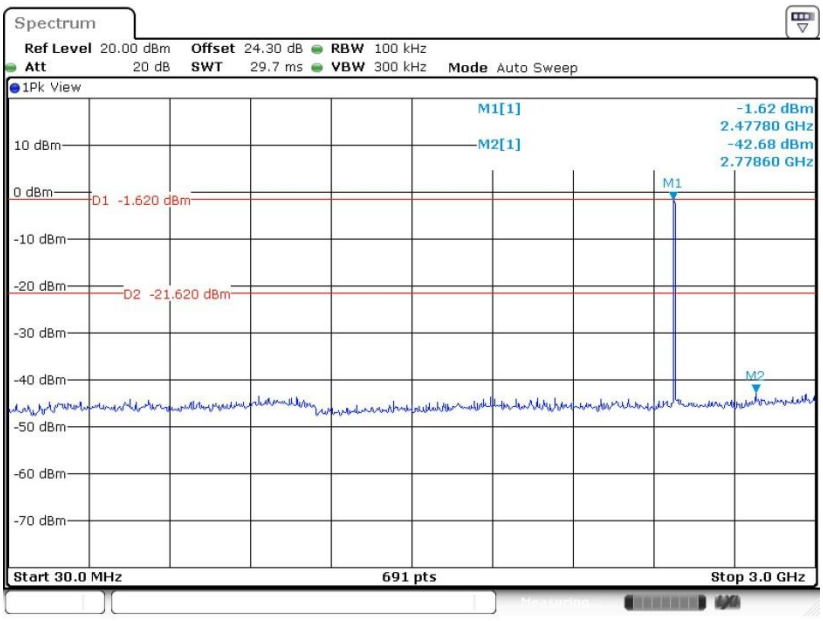
Date: 10.AUG.2018 00:32:13

CSE Plot on Ch 39 between 2 GHz ~ 25 GHz



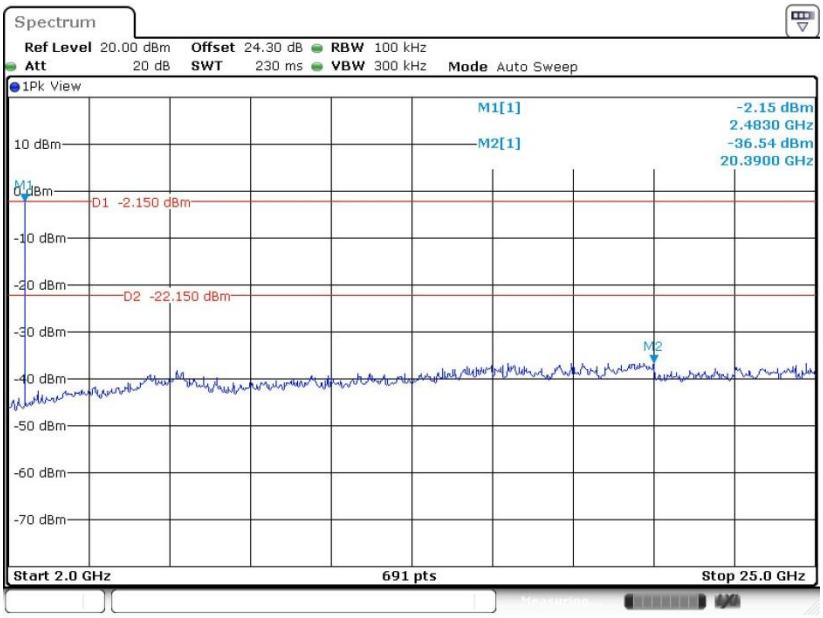
Date: 10.AUG.2018 00:32:39

CSE Plot on Ch 78 between 30MHz ~ 3 GHz



Date: 10.AUG.2018 00:33:54

CSE Plot on Ch 78 between 2 GHz ~ 25 GHz



Date: 10.AUG.2018 00:34:24

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 NCC LP0002 section 2.8 limits as below.

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

3.8.2 Measuring Instruments

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

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 average 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.

<Sample 1>

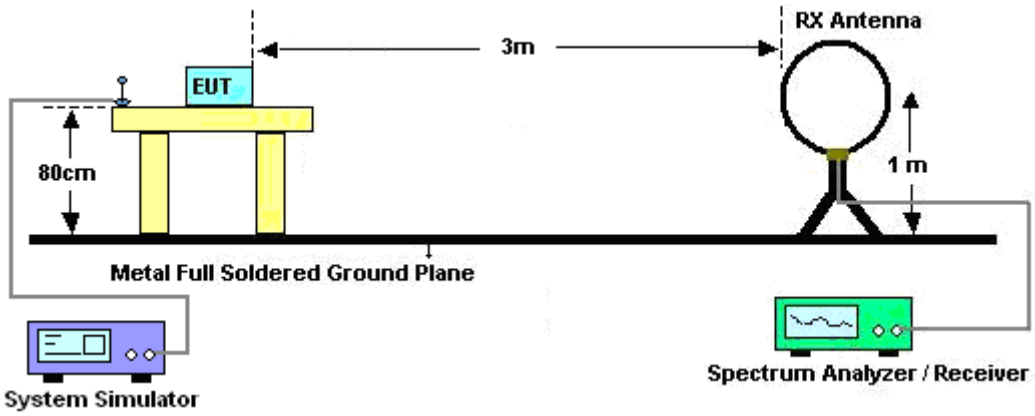
Note: The average levels were calculated from the peak level corrected with duty cycle correction factor (-24.87dB) derived from 20log (dwell time/100ms). This correction is only for signals that hop with the fundamental signal, such as band-edge and harmonic. Other spurious signals that are independent of the hopping signal would not use this correction.

<Sample 2>

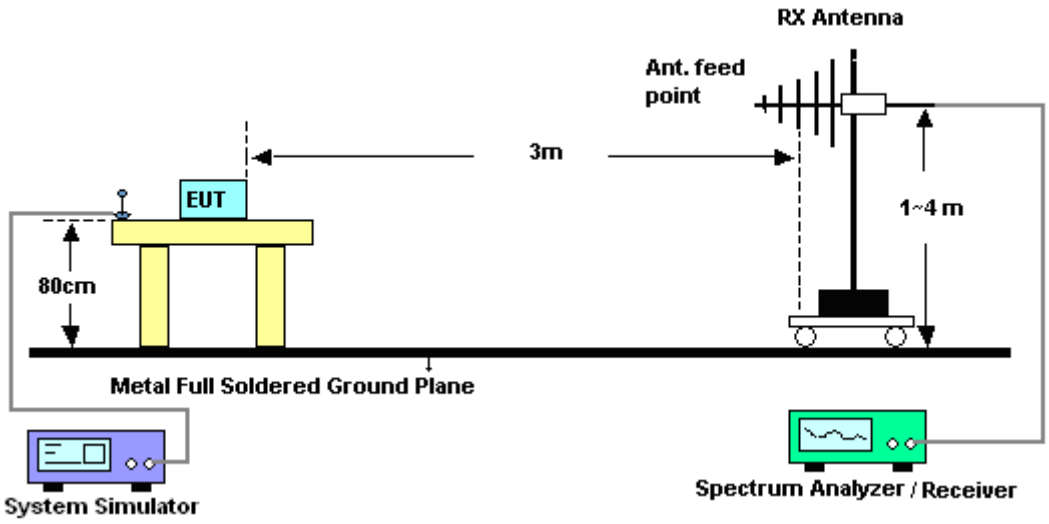
Note: The average levels were calculated from the peak level corrected with duty cycle correction factor (-24.73dB) derived from 20log (dwell time/100ms). This correction is only for signals that hop with the fundamental signal, such as band-edge and harmonic. Other spurious signals that are independent of the hopping signal would not use this correction.

3.8.4 Test Setup

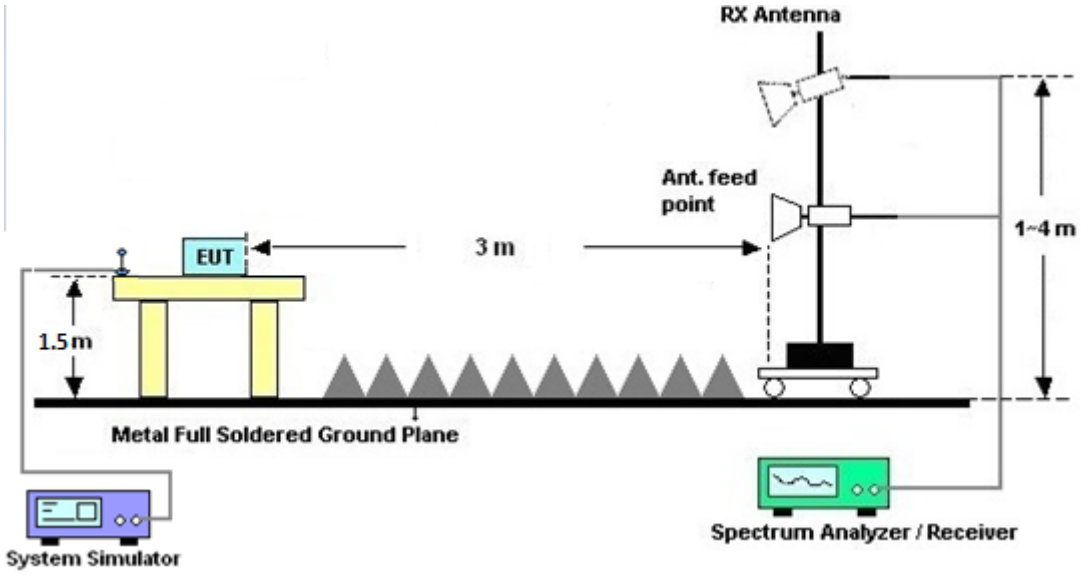
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



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 per NCC LP0002 section 5.13 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 B and C.

3.8.7 Duty Cycle

Please refer to Appendix D.

3.8.8 Test Result of Radiated Spurious Emission (30MHz ~ 10th Harmonic)

Please refer to Appendix B and C.

3.9 Test of Receiver Radiated Emission Measurement

3.9.1 Limit of Receiver Radiated Emission

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

3.9.2 Measuring Instruments

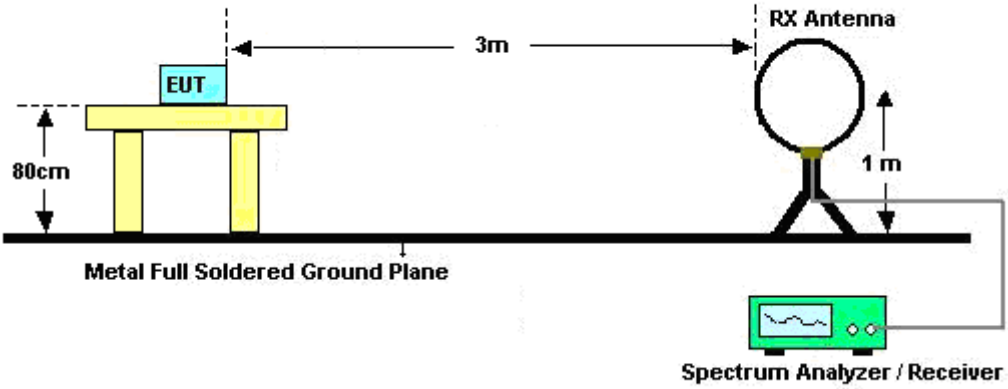
The measuring equipment is listed in the section 4 of this test report.

3.9.3 Test Procedures

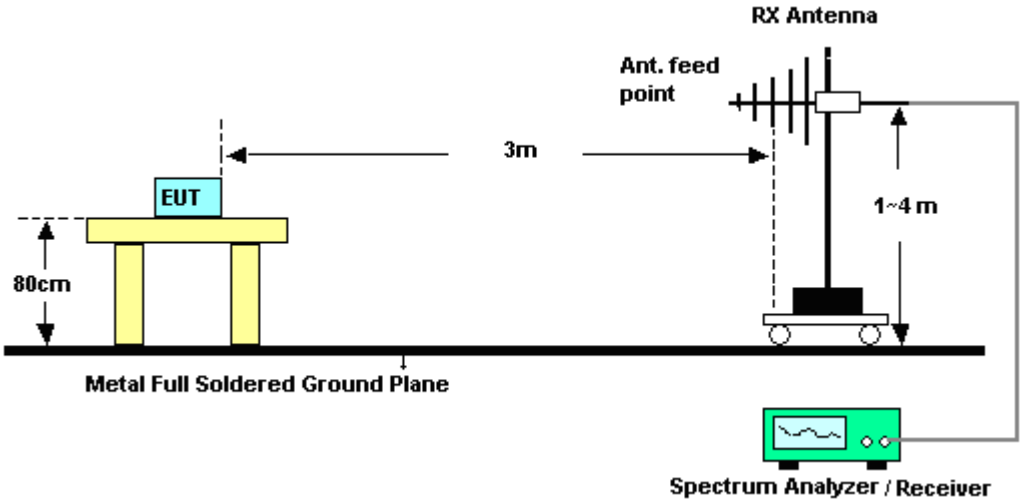
1. The EUT was placed on a turntable with 0.8 meter above ground.
2. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
3. The table was rotated 360 degrees to determine the position of the highest radiation.
4. The antenna is a Bi-Log antenna and its height is adjusted between one to four meters above ground to find the maximum value of the field strength for both horizontal polarization and vertical polarization of the antenna.
5. 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.
6. Set the test-receiver system to Peak Detect Function and specified bandwidth with Maximum Hold Mode (RBW=120kHz/VBW=300kHz for frequency below 1GHz; RBW=1MHz VBW=3MHz (Peak), RBW=1MHz/VBW=10Hz (Average) for frequency above 1GHz).
7. If the emission level of the EUT in peak mode was 3 dB lower than the limit specified, peak values of EUT will be reported. Otherwise, the emission will be repeated by using the quasi-peak method and reported.
8. Emission level (dBμV/m) = 20 log Emission level (μV/m)
9. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level

3.9.4 Test Setup

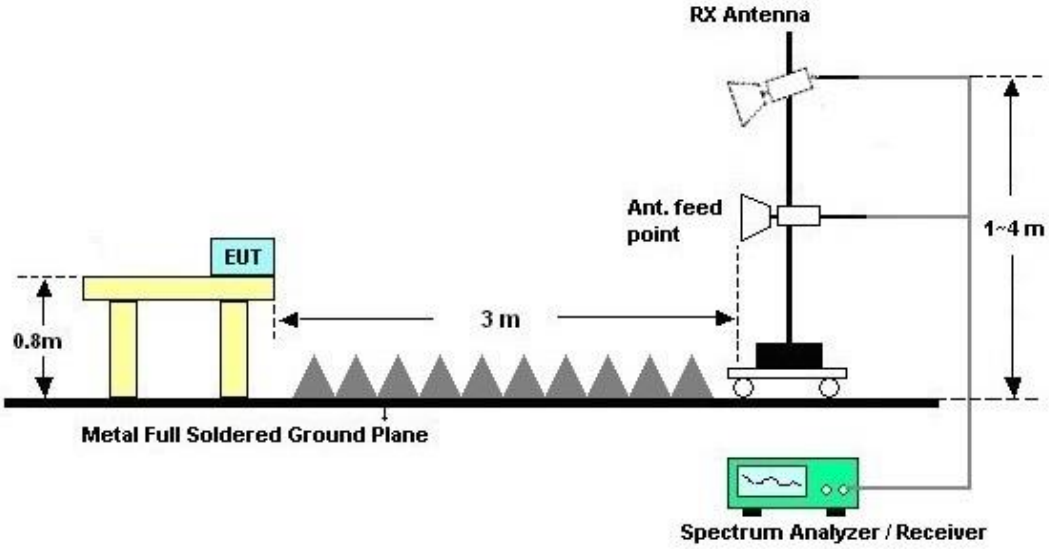
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



3.9.5 Test Result of Receiver Radiated Spurious Emissions (9kHz ~ 30MHz)

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line per NCC LP0002 clause 5.13 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.

3.9.6 Test Result of Receiver Radiated Spurious Emission (30MHz ~ 5th Harmonic)

Please refer to Appendix C.

3.10 AC Conducted Emission Measurement

3.10.1 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.

Frequency of emission (MHz)	Conducted limit (dBμV)	
	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.

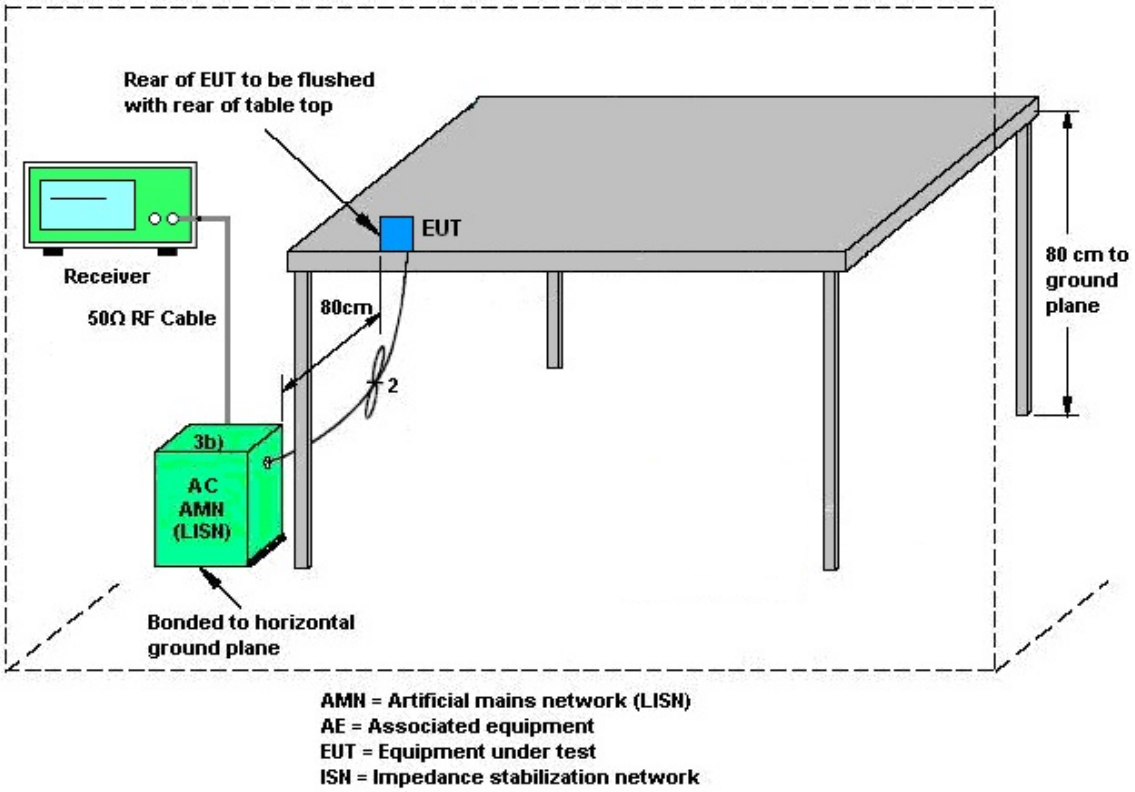
3.10.2 Measuring Instruments

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

3.10.3 Test Procedures

1. 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.

3.10.4 Test Setup



3.10.5 Test Result of AC Conducted Emission

Please refer to Appendix A.

3.11 Antenna Requirements

3.11.1 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 LP0002 Section 2.2, Section 3.10.1.3, and Section 3.10.1.4.

3.11.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.11.3 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.

4 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Power Meter	Agilent	E4416A	GB41292344	N/A	Dec. 20, 2017	Aug. 08, 2018~ Aug. 10, 2018	Dec. 19, 2018	Conducted (TH05-HY)
Power Sensor	Agilent	E9327A	US40441548	50MHz~18GHz	Dec. 20, 2017	Aug. 08, 2018~ Aug. 10, 2018	Dec. 19, 2018	Conducted (TH05-HY)
Signal Analyzer	Rohde & Schwarz	FSV40	101397	10Hz~40GHz	Nov. 07, 2017	Aug. 08, 2018~ Aug. 10, 2018	Nov. 06, 2018	Conducted (TH05-HY)
BT Base Station (Measure)	Rohde & Schwarz	CBT	101136	BT 3.0	Sep. 20, 2017	Aug. 08, 2018~ Aug. 10, 2018	Sep. 19, 2018	Conducted (TH05-HY)
Switch Box & RF Cable	Burgeon	ETF-058	EC1300484	N/A	Mar. 01, 2018	Aug. 08, 2018~ Aug. 10, 2018	Feb. 28, 2019	Conducted (TH05-HY)
AC Power Source	ChainTek	APC-1000W	N/A	N/A	N/A	Aug. 04, 2018	N/A	Conduction (CO05-HY)
EMI Test Receiver	Rohde & Schwarz	ESR3	102388	9KHz~3.6GHz	Dec. 08, 2017	Aug. 04, 2018	Dec. 07, 2018	Conduction (CO05-HY)
LISN	Rohde & Schwarz	ENV216	100080	9kHz~30MHz	Nov. 30, 2017	Aug. 04, 2018	Nov. 29, 2018	Conduction (CO05-HY)
Software	Rohde & Schwarz	EMC32 V10.30	N/A	N/A	N/A	Aug. 04, 2018	N/A	Conduction (CO05-HY)
LF Cable	HUBER + SUHNER	RG-214/U	LF01	N/A	Jan. 03, 2018	Aug. 04, 2018	Jan. 02, 2019	Conduction (CO05-HY)
Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100851	N/A	Jan. 03, 2018	Aug. 04, 2018	Jan. 02, 2019	Conduction (CO05-HY)
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100488	9 kHz~30 MHz	Nov. 23, 2017	Aug. 28, 2018~ Sep. 10, 2018	Nov. 22, 2018	Radiation (03CH12-HY)
Bilog Antenna	TESEQ	CBL 6111D&00800N1D01N-06	37059&01	30MHz~1GHz	Oct. 14, 2017	Aug. 28, 2018~ Sep. 10, 2018	Oct. 13, 2018	Radiation (03CH12-HY)
Horn Antenna	SCHWARZBECK	BBHA 9120D	9120D-1328	1GHz ~ 18GHz	Oct. 20, 2017	Aug. 28, 2018~ Sep. 10, 2018	Oct. 19, 2018	Radiation (03CH12-HY)
SHF-EHF Horn Antenna	SCHWARZBECK	BBHA 9170	BBHA9170584	18GHz ~ 40GHz	Nov. 27, 2017	Aug. 28, 2018~ Sep. 10, 2018	Nov. 26, 2018	Radiation (03CH12-HY)
Preamplifier	COM-POWER	PA-103	161075	10MHz~1GHz	Mar. 26, 2018	Aug. 28, 2018~ Sep. 10, 2018	Mar. 25, 2019	Radiation (03CH12-HY)
Preamplifier	Keysight	83017A	MY53270148	1GHz~26.5GHz	Jan. 15, 2018	Aug. 28, 2018~ Sep. 10, 2018	Jan. 14, 2019	Radiation (03CH12-HY)
Preamplifier	MITEQ	AMF-7D-00101800-30-10P	1590074	1GHz~18GHz	May 21, 2018	Aug. 28, 2018~ Sep. 10, 2018	May 20, 2019	Radiation (03CH12-HY)
Preamplifier	EMEC	EM18G40G	060715	18GHz ~ 40GHz	Dec. 05, 2017	Aug. 28, 2018~ Sep. 10, 2018	Dec. 04, 2018	Radiation (03CH12-HY)
EMI Test Receiver	Rohde & Schwarz	ESU26	100390	20Hz~26.5GHz	Dec. 25, 2017	Aug. 28, 2018~ Sep. 10, 2018	Dec. 24, 2018	Radiation (03CH12-HY)
Filter	Wainwright	WHKX12-2700-3000-18000-60ST	SN2	3 GHz Highpass	Mar. 21, 2018	Aug. 28, 2018~ Sep. 10, 2018	Mar. 20, 2019	Radiation (03CH12-HY)
Filter	Wainwright	WLJ4-1000-1530-6000-40ST	SN3	1.53 GHz Lowpass	Mar. 21, 2018	Aug. 28, 2018~ Sep. 10, 2018	Mar. 20, 2019	Radiation (03CH12-HY)

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY15539/4	30M-18G	Mar. 14, 2018	Aug. 28, 2018~ Sep. 10, 2018	Mar. 13, 2019	Radiation (03CH12-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	505134/2	30M~40GHz	Oct. 17, 2017	Aug. 28, 2018~ Sep. 10, 2018	Oct. 16, 2018	Radiation (03CH12-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	800740/2	30M~40GHz	Oct. 17, 2017	Aug. 28, 2018~ Sep. 10, 2018	Oct. 16, 2018	Radiation (03CH12-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1m~4m	N/A	Aug. 28, 2018~ Sep. 10, 2018	N/A	Radiation (03CH12-HY)
Turn Table	EMEC	TT2000	N/A	0~360 Degree	N/A	Aug. 28, 2018~ Sep. 10, 2018	N/A	Radiation (03CH12-HY)
Software	Audix	E3 6.2009-8-24	RK-000989	N/A	N/A	Aug. 28, 2018~ Sep. 10, 2018	N/A	Radiation (03CH12-HY)

5 Uncertainty of Evaluation

Uncertainty of Conducted Emission Measurement (150 kHz ~ 30 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	2.7

Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

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

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

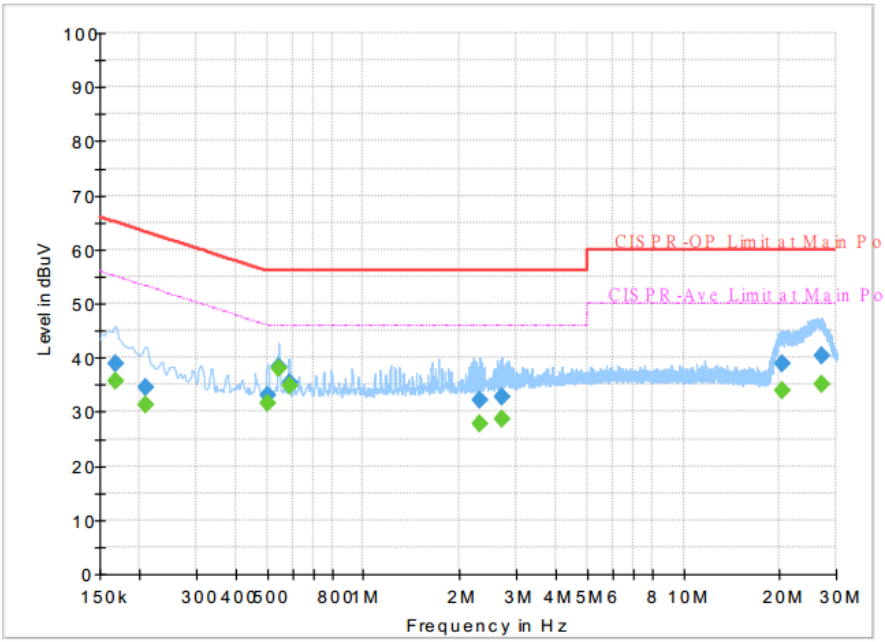
Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	5.2

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	4.7

Appendix A. AC Conducted Emission Test Results

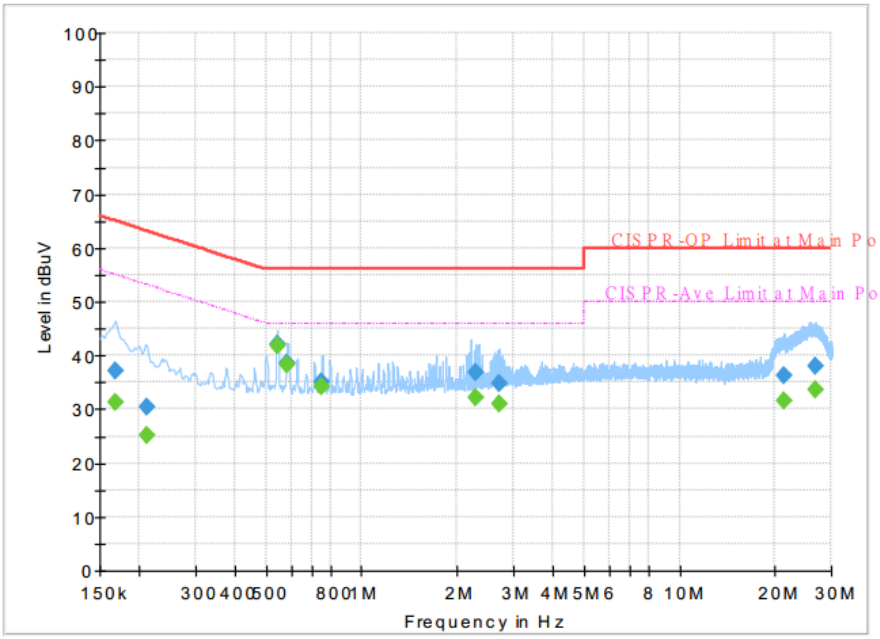
Test Engineer :	Arthur Hsieh	**Temperature :**	25~27℃
		Relative Humidity :	50~52%
Test Voltage :	120Vac / 60Hz	**Phase :**	Line
Remark :	All emissions not reported here are more than 10 dB below the prescribed limit.		



Final Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Line	Filter	Corr. (dB)
0.168000	---	35.77	55.06	19.29	L1	OFF	19.5
0.168000	38.96	---	65.06	26.10	L1	OFF	19.5
0.208500	---	31.40	53.27	21.87	L1	OFF	19.5
0.208500	34.59	---	63.27	28.68	L1	OFF	19.5
0.503250	---	31.47	46.00	14.53	L1	OFF	19.5
0.503250	32.91	---	56.00	23.09	L1	OFF	19.5
0.543750	---	37.87	46.00	8.13	L1	OFF	19.5
0.543750	38.30	---	56.00	17.70	L1	OFF	19.5
0.586500	---	34.85	46.00	11.15	L1	OFF	19.5
0.586500	35.36	---	56.00	20.64	L1	OFF	19.5
2.305500	---	27.91	46.00	18.09	L1	OFF	19.5
2.305500	32.09	---	56.00	23.91	L1	OFF	19.5
2.715000	---	28.74	46.00	17.26	L1	OFF	19.6
2.715000	32.74	---	56.00	23.26	L1	OFF	19.6
20.334750	---	33.96	50.00	16.04	L1	OFF	20.3
20.334750	38.88	---	60.00	21.12	L1	OFF	20.3
27.084750	---	35.23	50.00	14.77	L1	OFF	20.4
27.084750	40.22	---	60.00	19.78	L1	OFF	20.4

Test Engineer :	Arthur Hsieh	**Temperature :**	25~27℃
		Relative Humidity :	50~52%
Test Voltage :	120Vac / 60Hz	**Phase :**	Neutral
Remark :	All emissions not reported here are more than 10 dB below the prescribed limit.		



Final Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Line	Filter	Corr. (dB)
0.168000	37.08	---	65.06	27.98	N	OFF	19.5
0.168000	---	31.30	55.06	23.76	N	OFF	19.5
0.210750	30.27	---	63.18	32.91	N	OFF	19.5
0.210750	---	25.16	53.18	28.02	N	OFF	19.5
0.543750	42.01	---	56.00	13.99	N	OFF	19.5
0.543750	---	41.80	46.00	4.20	N	OFF	19.5
0.584250	38.70	---	56.00	17.30	N	OFF	19.5
0.584250	---	38.17	46.00	7.83	N	OFF	19.5
0.750750	35.01	---	56.00	20.99	N	OFF	19.6
0.750750	---	34.12	46.00	11.88	N	OFF	19.6
2.296500	36.76	---	56.00	19.24	N	OFF	19.5
2.296500	---	32.19	46.00	13.81	N	OFF	19.5
2.715000	34.75	---	56.00	21.25	N	OFF	19.6
2.715000	---	31.14	46.00	14.86	N	OFF	19.6
21.358500	36.25	---	60.00	23.75	N	OFF	20.4
21.358500	---	31.44	50.00	18.56	N	OFF	20.4
26.769750	37.94	---	60.00	22.06	N	OFF	20.6
26.769750	---	33.49	50.00	16.51	N	OFF	20.6

Appendix B. Radiated Spurious Emission

Test Engineer :	Jack Cheng, Lance Chiang, and Peter Liao	Temperature :	22~25°C
		Relative Humidity :	53~62%

<For Sample 1>

2.4GHz 2400~2483.5MHz

BT (Band Edge @ 3m)

BT	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Path Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
		(MHz)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
BT CH00 2402MHz		2360.925	46.42	-27.58	74	44.32	27.07	6.61	31.58	110	159	P	H
		2360.925	21.55	-32.45	54	-	-	-	-	-	-	A	H
	*	2402	95.95	-	-	93.7	27.15	6.67	31.57	110	159	P	H
	*	2402	71.08	-	-	-	-	-	-	-	-	A	H
													H
													H
		2344.44	46.48	-27.52	74	44.44	27.03	6.59	31.58	310	288	P	V
		2344.44	21.61	-32.39	54	-	-	-	-	-	-	A	V
	*	2402	96.13	-	-	93.88	27.15	6.67	31.57	310	288	P	V
	*	2402	71.26	-	-	-	-	-	-	-	-	A	V
													V
													V

BT	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
BT CH 39 2441MHz		2369.22	46.63	-27.37	74	44.48	27.11	6.62	31.58	129	170	P	H
		2369.22	21.76	-32.24	54	-	-	-	-	-	-	A	H
	*	2441	96.49	-	-	94.04	27.28	6.73	31.56	129	170	P	H
	*	2441	71.62	-	-	-	-	-	-	-	-	A	H
		2483.55	47.44	-26.56	74	44.85	27.36	6.79	31.56	129	170	P	H
		2483.55	22.57	-31.43	54	-	-	-	-	-	-	A	H
		2372.16	47.05	-26.95	74	44.89	27.11	6.63	31.58	308	318	P	V
		2372.16	22.18	-31.82	54	-	-	-	-	-	-	A	V
	*	2441	97.19	-	-	94.74	27.28	6.73	31.56	308	318	P	V
	*	2441	72.32	-	-	-	-	-	-	-	-	A	V
		2487.75	50.85	-23.15	74	48.21	27.4	6.8	31.56	308	318	P	V
		2487.75	25.98	-28.02	54	-	-	-	-	-	-	A	V
BT CH 78 2480MHz	*	2480	95.9	-	-	93.31	27.36	6.79	31.56	121	160	P	H
	*	2480	71.03	-	-	-	-	-	-	-	-	A	H
		2490.4	46.18	-27.82	74	43.54	27.4	6.8	31.56	121	160	P	H
		2490.4	21.31	-32.69	54	-	-	-	-	-	-	A	H
													H
													H
	*	2480	97.89	-	-	95.3	27.36	6.79	31.56	364	310	P	V
	*	2480	73.02	-	-	-	-	-	-	-	-	A	V
		2494.92	46.83	-27.17	74	44.17	27.4	6.81	31.55	364	310	P	V
		2494.92	21.96	-32.04	54	-	-	-	-	-	-	A	V
													V
													V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

2.4GHz 2400~2483.5MHz

BT (Harmonic @ 3m)

BT	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
BT CH 00 2402MHz		4804	39.88	-34.12	74	55.73	31.32	10.42	57.59	100	0	P	H
		4804	15.01	-38.99	54	-	-	-	-	-	-	A	H
													H
													H
		4804	43.4	-30.6	74	59.25	31.32	10.42	57.59	100	0	P	V
		4804	18.53	-35.47	54	-	-	-	-	-	-	A	V
													V
													V
BT CH 39 2441MHz		4882	40.59	-33.41	74	56.1	31.46	10.47	57.44	100	0	P	H
		4882	15.72	-38.28	54	-	-	-	-	-	-	A	H
		7323	44.82	-29.18	74	53.18	36.15	12.78	57.29	100	0	P	H
		7323	19.95	-34.05	54	-	-	-	-	-	-	A	H
		4882	40.5	-33.5	74	56.01	31.46	10.47	57.44	100	0	P	V
		4882	15.63	-38.37	54	-	-	-	-	-	-	A	V
		7323	45.16	-28.84	74	53.52	36.15	12.78	57.29	100	0	P	V
		7323	20.29	-33.71	54	-	-	-	-	-	-	A	V
BT CH 78 2480MHz		4960	43.43	-30.57	74	58.57	31.63	10.51	57.28	100	0	P	H
		4960	18.56	-35.44	54	-	-	-	-	-	-	A	H
		7440	44.85	-29.15	74	53.01	36.47	12.8	57.43	100	0	P	H
		7440	19.98	-34.02	54	-	-	-	-	-	-	A	H
		4960	40.07	-33.93	74	55.21	31.63	10.51	57.28	100	0	P	V
		4960	15.2	-38.8	54	-	-	-	-	-	-	A	V
		7440	44.89	-29.11	74	53.05	36.47	12.8	57.43	100	0	P	V
		7440	20.02	-33.98	54	-	-	-	-	-	-	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

Emission below 1GHz

2.4GHz BT (LF)

BT	Note	Frequency	Level	Over	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
2.4GHz BT LF		51.33	19.28	-20.72	40	34.99	13.77	0.99	30.47	-	-	P	H
		80.76	23.85	-16.15	40	39.71	13.3	1.29	30.45	-	-	P	H
		96.96	27.5	-16	43.5	41.12	15.41	1.4	30.43	-	-	P	H
		619.2	27.95	-18.05	46	28.38	25.7	3.48	29.61	-	-	P	H
		762.7	30.38	-15.62	46	27.94	27.95	3.87	29.38	-	-	P	H
		953.8	32.98	-13.02	46	26.82	30.7	4.44	28.98	100	0	P	H
													H
													H
													H
													H
													H
													H
		45.39	30.17	-9.83	40	43.4	16.25	0.93	30.41	-	-	P	V
		51.33	31.07	-8.93	40	46.78	13.77	0.99	30.47	100	0	P	V
		126.39	32.79	-10.71	43.5	44.14	17.47	1.58	30.4	-	-	P	V
		586.3	27.32	-18.68	46	28.02	25.56	3.39	29.65	-	-	P	V
		676.6	28.91	-17.09	46	28.48	26.34	3.64	29.55	-	-	P	V
		921.6	32.55	-13.45	46	27.88	29.42	4.33	29.08	-	-	P	V
													V
													V
													V
													V
													V
													V
Remark	1. No other spurious found. 2. All results are PASS against limit line.												

<For Sample 2>

2.4GHz 2400~2483.5MHz

BT (Band Edge @ 3m)

BT	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Path Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
BT CH 39 2441MHz		2371.46	47.05	-26.95	74	44.89	27.11	6.63	31.58	108	163	P	H
		2371.46	22.32	-31.68	54	-	-	-	-	-	-	A	H
	*	2441	96.12	-	-	93.67	27.28	6.73	31.56	108	163	P	H
	*	2441	71.39	-	-	-	-	-	-	-	-	A	H
		2485.58	45.98	-28.02	74	43.39	27.36	6.79	31.56	108	163	P	H
		2485.58	21.25	-32.75	54	-	-	-	-	-	-	A	H
		2343.6	46.13	-27.87	74	44.09	27.03	6.59	31.58	338	306	P	V
		2343.6	21.4	-32.6	54	-	-	-	-	-	-	A	V
	*	2441	98.23	-	-	95.78	27.28	6.73	31.56	338	306	P	V
	*	2441	73.5	-	-	-	-	-	-	-	-	A	V
		2493.14	45.89	-28.11	74	43.23	27.4	6.81	31.55	338	306	P	V
		2493.14	21.16	-32.84	54	-	-	-	-	-	-	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

2.4GHz 2400~2483.5MHz

BT (Harmonic @ 3m)

BT	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
BT CH 39 2441MHz		4882	39.74	-34.26	74	55.25	31.46	10.47	57.44	100	0	P	H
		4882	15.01	-38.99	54	-	-	-	-	-	-	A	H
		7323	45.81	-28.19	74	54.17	36.15	12.78	57.29	100	0	P	H
		7323	21.08	-32.92	54	-	-	-	-	-	-	A	H
		4882	40.55	-33.45	74	56.06	31.46	10.47	57.44	100	0	P	V
		4882	15.82	-38.18	54	-	-	-	-	-	-	A	V
		7323	45.12	-28.88	74	53.48	36.15	12.78	57.29	100	0	P	V
		7323	20.39	-33.61	54	-	-	-	-	-	-	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

Emission below 1GHz

2.4GHz BT (LF)

BT	Note	Frequency	Level	Over	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
2.4GHz BT LF		66.45	25.57	-14.43	40	42.91	11.97	1.15	30.46	-	-	P	H
		118.29	25.37	-18.13	43.5	37.09	17.17	1.52	30.41	-	-	P	H
		167.16	26.37	-17.13	43.5	39.04	15.76	1.93	30.36	-	-	P	H
		720.7	31.51	-14.49	46	30.25	26.98	3.75	29.47	-	-	P	H
		794.2	32.56	-13.44	46	29.94	27.96	3.96	29.3	-	-	P	H
		885.9	40.74	-5.26	46	36.72	28.97	4.21	29.16	100	0	P	H
													H
													H
													H
													H
													H
													H
		44.85	33.53	-6.47	40	46.33	16.67	0.93	30.4	-	-	P	V
		51.87	29.77	-10.23	40	45.87	13.37	1	30.47	-	-	P	V
		66.72	36.33	-3.67	40	53.67	11.97	1.15	30.46	100	0	P	V
		787.9	33.01	-12.99	46	30.45	27.95	3.93	29.32	-	-	P	V
		857.2	34.12	-11.88	46	30.24	28.96	4.12	29.2	-	-	P	V
		938.4	35.5	-10.5	46	30.07	30.08	4.38	29.03	-	-	P	V
													V
													V
													V
													V
													V
													V
Remark	1. No other spurious found. 2. All results are PASS against limit line.												

Note symbol

*	**Fundamental Frequency** which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
!	Test result is **over limit** line.
P/A	**P**eak or **A**verage
H/V	**H**orizontal or **V**ertical

A calculation example for radiated spurious emission is shown as below:

BT	Note	Frequency	Level	Over	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
BT CH 00 2402MHz		2390	55.45	-18.55	74	54.51	32.22	4.58	35.86	103	308	P	H
		2390	43.54	-10.46	54	42.6	32.22	4.58	35.86	103	308	A	H

1. Path Loss(dB) = Cable loss(dB) + Filter loss(dB) + Attenuator loss(dB)
2. Level(dBμV/m) =

Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

3. Over Limit(dB) = Level(dBμV/m) – Limit Line(dBμV/m)

For Peak Limit @ 2390MHz:

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 54.51(dBμV) – 35.86 (dB)

= 55.45 (dBμV/m)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 55.45(dBμV/m) – 74(dBμV/m)

= -18.55(dB)

For Average Limit @ 2390MHz:

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 42.6(dBμV) – 35.86 (dB)

= 43.54 (dBμV/m)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 43.54(dBμV/m) – 54(dBμV/m)

= -10.46(dB)

Both peak and average measured complies with the limit line, so test result is “PASS”.

Appendix C. Radiated Spurious Emission Plots

Test Engineer :	Jack Cheng, Lance Chiang, and Peter Liao	**Temperature :**	22~25°C
		Relative Humidity :	53~62%

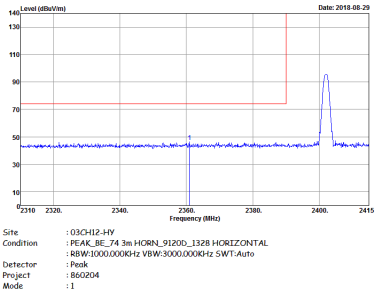
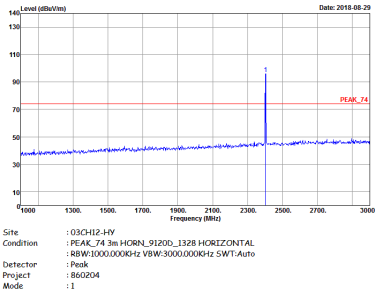
Note symbol

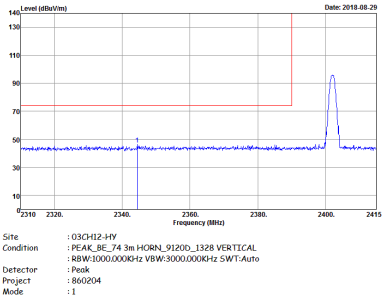
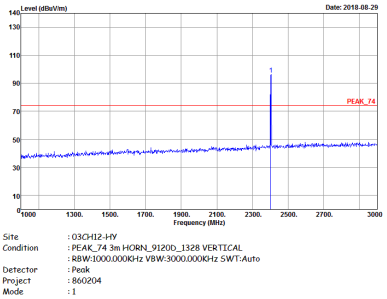
-L	**Low channel location**
-R	**High channel location**

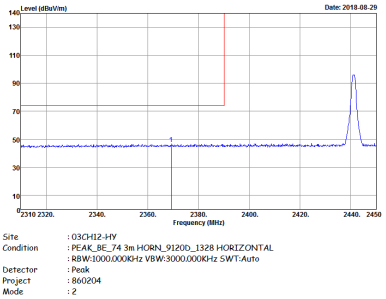
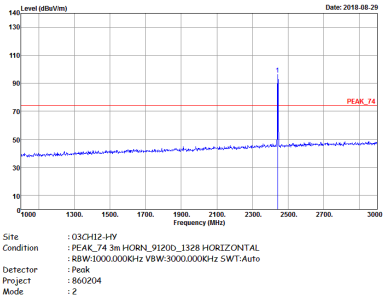
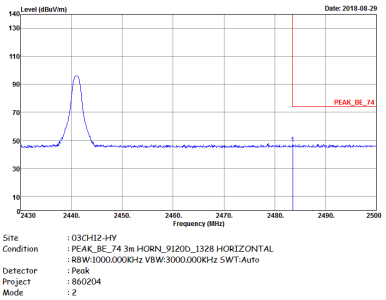
<For Sample 1>

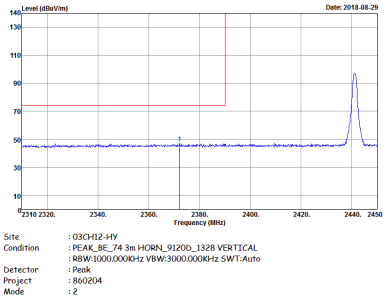
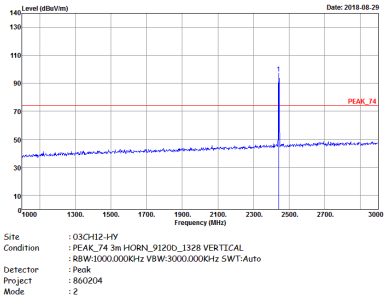
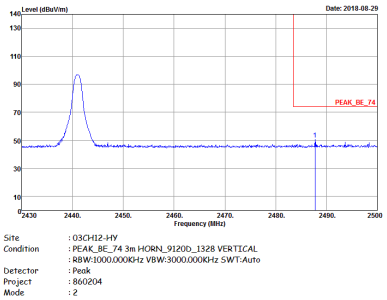
2.4GHz 2400~2483.5MHz

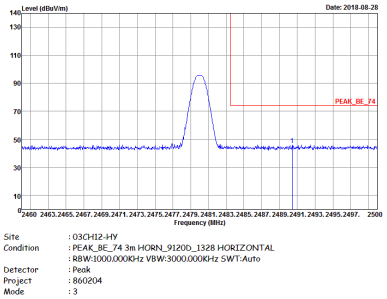
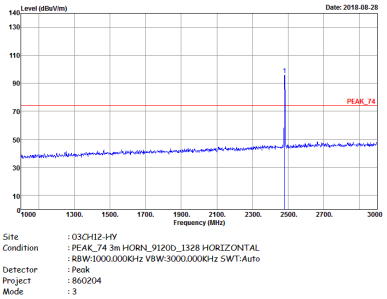
BT (Band Edge @ 3m)

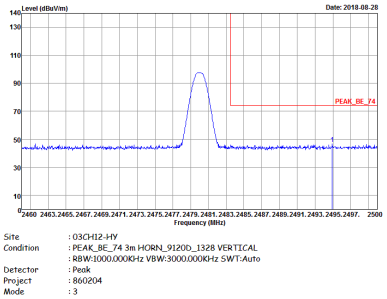
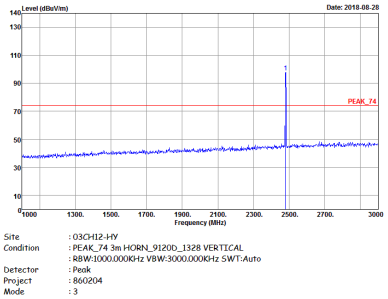
BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BT CH00 2402MHz	
1	Horizontal	Fundamental
Peak		

BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BT CH00 2402MHz	
1	Vertical	Fundamental
Peak		

BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BT CH39 2441MHz	
1	Horizontal	Fundamental
Peak		
Peak		Left blank

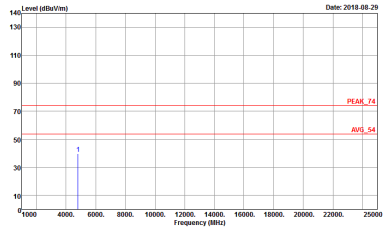
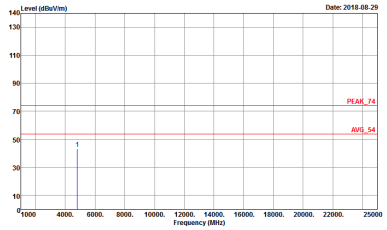
BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BT CH39 2441MHz	
1	Vertical	Fundamental
Peak		
Peak		Left blank

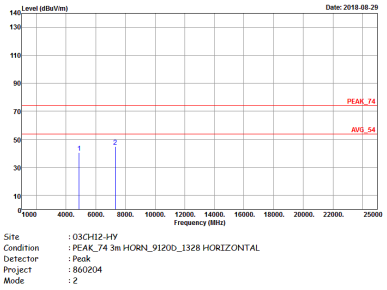
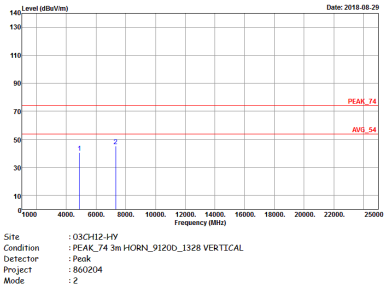
BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BT CH78 2480MHz	
1	Horizontal	Fundamental
Peak		

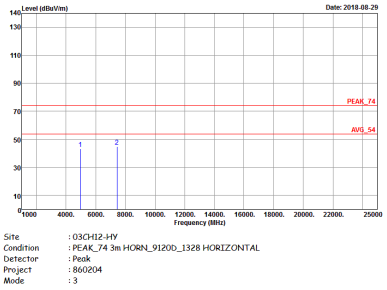
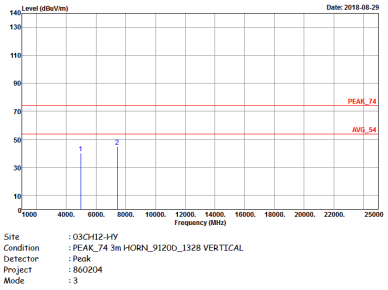
BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BT CH78 2480MHz	
1	Vertical	Fundamental
Peak		

2.4GHz 2400~2483.5MHz

BT (Harmonic @ 3m)

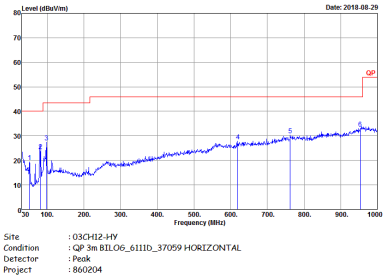
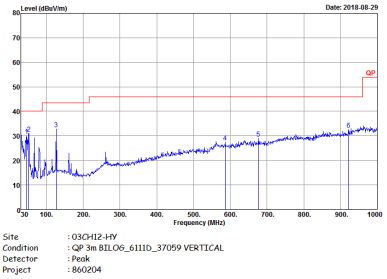
BT	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
ANT	BT CH00 2402MHz	
1	Horizontal	Vertical
Peak Avg.	 Site : 03CH12-HY Condition : PEAK_74 3m HORN_9120D_1328 HORIZONTAL Detector : Peak Project : 860204 Mode : 1	 Site : 03CH12-HY Condition : PEAK_74 3m HORN_9120D_1328 VERTICAL Detector : Peak Project : 860204 Mode : 1

BT	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
ANT	BT CH39 2441MHz	
1	Horizontal	Vertical
Peak Avg.		

BT	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
ANT	BT CH78 2480MHz	
1	Horizontal	Vertical
Peak Avg.		

Emission below 1GHz

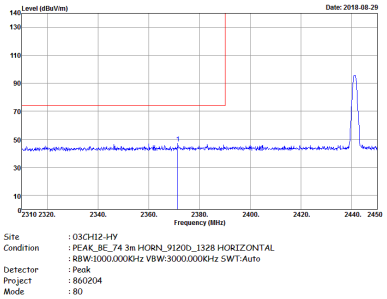
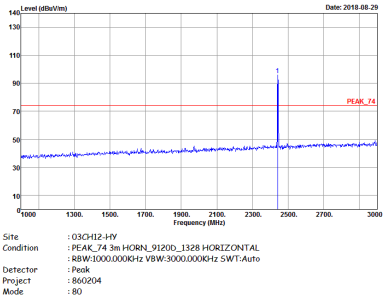
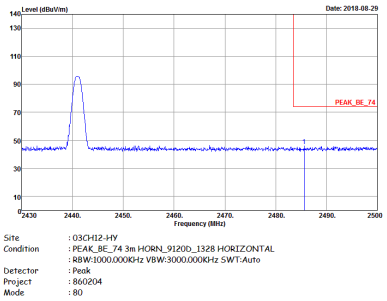
2.4GHz BT (LF)

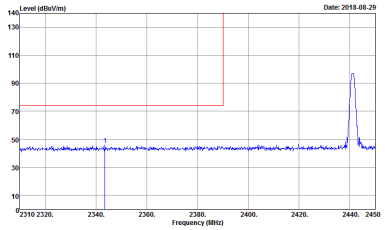
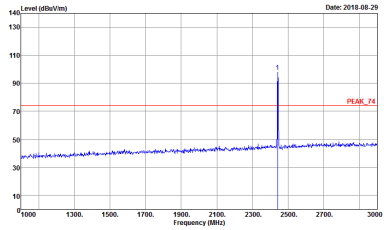
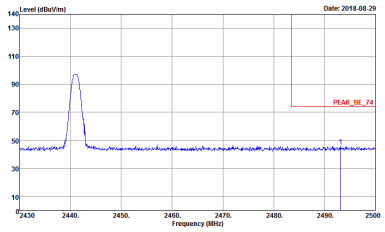
BT	2.4GHz 2400~2483.5MHz	
ANT	BT LF	
1	Horizontal	Vertical
QP / Peak		

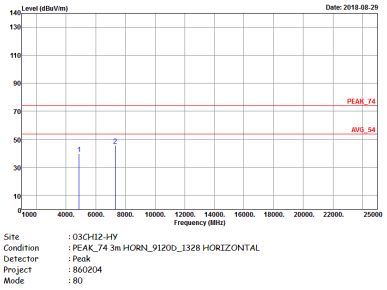
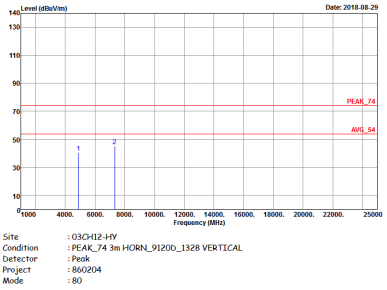
<For Sample 2>

2.4GHz 2400~2483.5MHz

BT (Band Edge @ 3m)

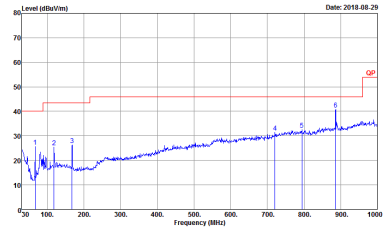
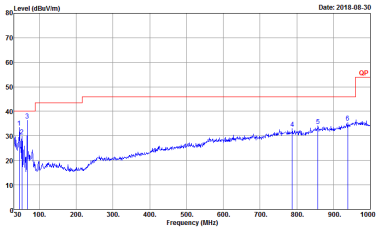
BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BT CH39 2441MHz	
1	Horizontal	Fundamental
Peak		
Peak		Left blank

BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BT CH39 2441MHz	
1	Vertical	Fundamental
Peak	 Site : 03CH12-HY Condition : PEAK_BE_74 3m HORN_9120D_1328 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 860204 Mode : 80	 Site : 03CH12-HY Condition : PEAK_74 3m HORN_9120D_1328 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 860204 Mode : 80
Peak	 Site : 03CH12-HY Condition : PEAK_BE_74 3m HORN_9120D_1328 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 860204 Mode : 80	Left blank

BT	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
ANT	BT CH39 2441MHz	
1	Horizontal	Vertical
Peak Avg.	 Site : 03CH12-HY Condition : PEAK_74 3m HORN_9120D_1328 HORIZONTAL Detector : Peak Project : 860204 Mode : 80	 Site : 03CH12-HY Condition : PEAK_74 3m HORN_9120D_1328 VERTICAL Detector : Peak Project : 860204 Mode : 80

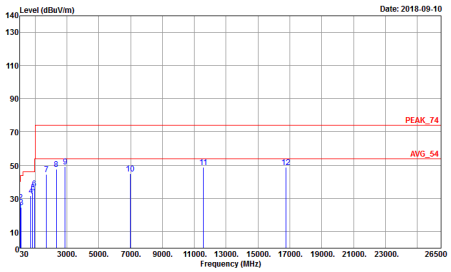
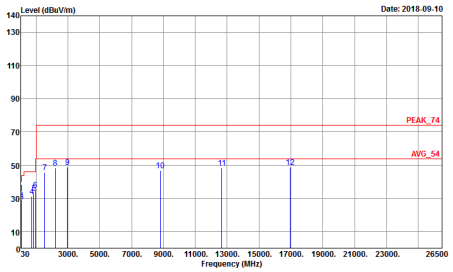
Emission below 1GHz

2.4GHz BT (LF)

BT	2.4GHz 2400~2483.5MHz	
ANT	BT LF	
1	Horizontal	Vertical
QP / Peak	 Site : 03CH12-HY Condition : QP 3m BILOG_6111D_37059 HORIZONTAL Detector : Peak Project : 860204 Mode : 80	 Site : 03CH12-HY Condition : QP 3m BILOG_6111D_37059 VERTICAL Detector : Peak Project : 860204 Mode : 80

<For Sample 1>

Bluetooth Idle

	Bluetooth Idle	
	Horizontal	**Vertical**
Peak **Avg.**	 Site : 03CH12-HY Condition : PEAK_74 3m HORN_9120D_1328 HORIZONTAL Detector : Peak Project : 860204 Mode : 4	 Site : 03CH12-HY Condition : PEAK_74 3m HORN_9120D_1328 VERTICAL Detector : Peak Project : 860204 Mode : 4

Horizontal:

	Freq	Level	Over Limit	Limit Line	ReadAntenna Level	Factor	Cable Loss	Preamp Factor	A/Pos	T/Pos	Remark
	MHz	dBuV/m	dB	dBuV/m	dBuV	dB/m	dB	dB	cm	deg	
1	46.20	21.33	-18.67	40.00	34.98	15.84	0.93	30.43	---	---	Peak
2	88.59	27.87	-15.63	43.50	42.63	14.34	1.28	30.44	---	---	Peak
3	126.39	24.43	-19.07	43.50	35.78	17.47	1.54	30.40	---	---	Peak
4	727.00	31.44	-14.56	46.00	29.86	27.27	3.67	29.46	---	---	Peak
5	846.70	33.48	-12.52	46.00	29.87	28.75	3.96	29.22	---	---	Peak
6	955.20	35.77	-10.23	46.00	29.54	30.77	4.20	28.98	100	0	Peak
7	1710.00	44.36	-29.64	74.00	44.91	25.80	5.62	31.97	---	---	Peak
8	2336.00	47.72	-26.28	74.00	45.71	27.03	6.57	31.59	---	---	Peak
9	2874.00	48.95	-25.05	74.00	44.91	28.28	7.30	31.54	100	0	Peak
10	6960.00	44.76	-29.24	74.00	53.86	35.22	12.13	56.82	---	---	Peak
11	11580.00	48.93	-25.07	74.00	48.84	39.93	16.05	56.30	---	---	Peak
12	16755.00	48.88	-25.12	74.00	44.39	40.17	19.71	55.90	---	---	Peak

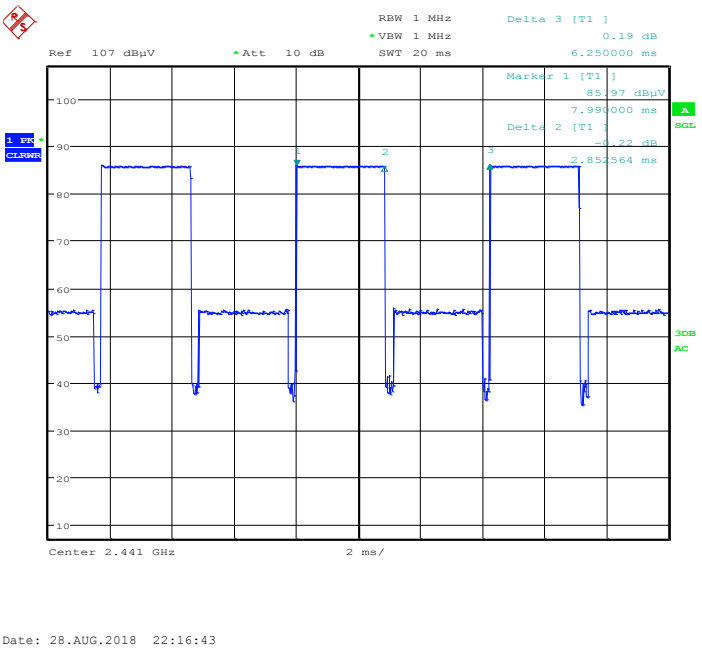
Vertical:

	Freq	Level	Over Limit	Limit Line	ReadAntenna Level	Factor	Cable Loss	Preamp Factor	A/Pos	T/Pos	Remark
	MHz	dBuV/m	dB	dBuV/m	dBuV	dB/m	dB	dB	cm	deg	
1	46.47	33.16	-6.84	40.00	46.81	15.84	0.93	30.43	100	0	Peak
2	64.29	29.17	-10.83	40.00	46.74	11.76	1.09	30.46	---	---	Peak
3	87.78	27.88	-12.12	40.00	42.64	14.34	1.28	30.44	---	---	Peak
4	736.10	31.34	-14.66	46.00	29.33	27.66	3.69	29.44	---	---	Peak
5	853.70	33.15	-12.85	46.00	29.34	28.92	3.98	29.21	---	---	Peak
6	957.30	35.03	-10.97	46.00	28.72	30.84	4.20	28.97	---	---	Peak
7	1538.00	45.76	-28.24	74.00	47.04	25.57	5.32	32.17	---	---	Peak
8	2220.00	48.23	-25.77	74.00	46.70	26.74	6.40	31.61	---	---	Peak
9	2958.00	48.85	-25.15	74.00	44.48	28.48	7.42	31.53	100	0	Peak
10	8805.00	46.86	-27.14	74.00	51.94	37.36	13.72	56.50	---	---	Peak
11	12660.00	48.35	-25.65	74.00	49.01	38.73	16.97	56.76	---	---	Peak
12	16965.00	48.78	-25.22	74.00	43.81	40.62	19.90	56.07	---	---	Peak

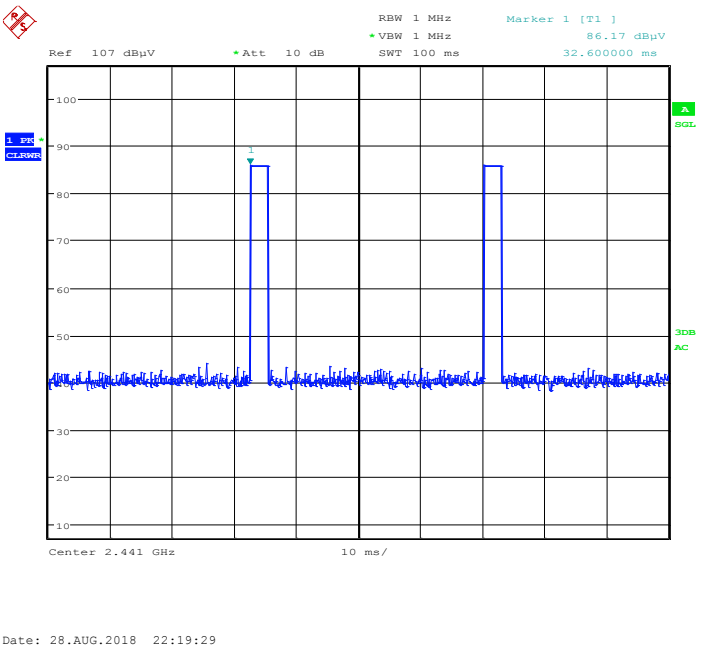
Appendix D. Duty Cycle Plots

<For Sample 1>

DH5 on time (One Pulse) Plot on Channel 39



on time (Count Pulses) Plot on Channel 39



Note:

1. Worst case Duty cycle = on time/100 milliseconds = 2 * 2.85 / 100 = 5.7 %
2. Worst case Duty cycle correction factor = 20*log(Duty cycle) = -24.87 dB
3. **DH5** has the highest duty cycle worst case and is reported.

Duty Cycle Correction Factor Consideration for AFH mode:

Bluetooth normal hopping rate is 1600Hz and reduced to 800Hz in AFH mode; due to the reduced number of hopping frequencies, with the same packet configuration the dwell time in each channel frequency within 100msec period is longer in AFH mode than normal mode.

In AFH mode, the minimum hopping frequencies are 20, to get the longest dwell time DH5 packet is observed; the period to have DH5 packet completing one hopping sequence is

2.85 ms x 20 channels = 57 ms

There cannot be 2 complete hopping sequences within 100ms period, considering the random hopping behavior, maximum 2 hops can be possibly observed within the period. [100ms / 57.6ms] = 2 hops

Thus, the maximum possible ON time:

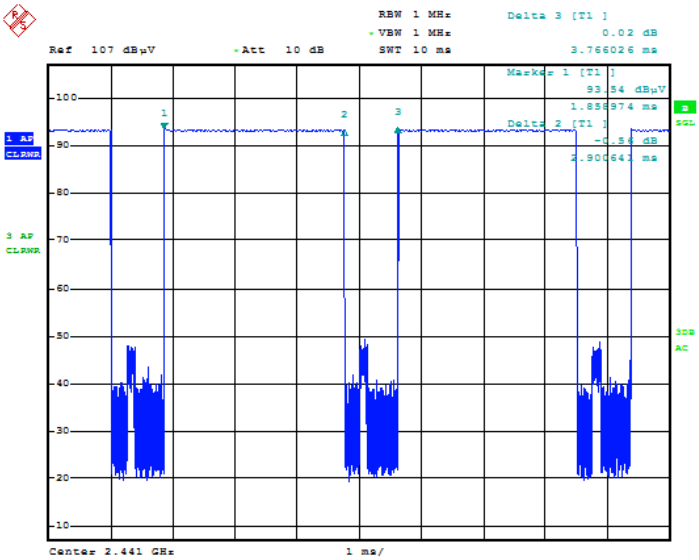
2.85 ms x 2 = 5.7 ms

Worst case Duty Cycle Correction factor, which is derived from the maximum possible ON time,

20 x log(5.7 ms/100ms) = -24.87 dB

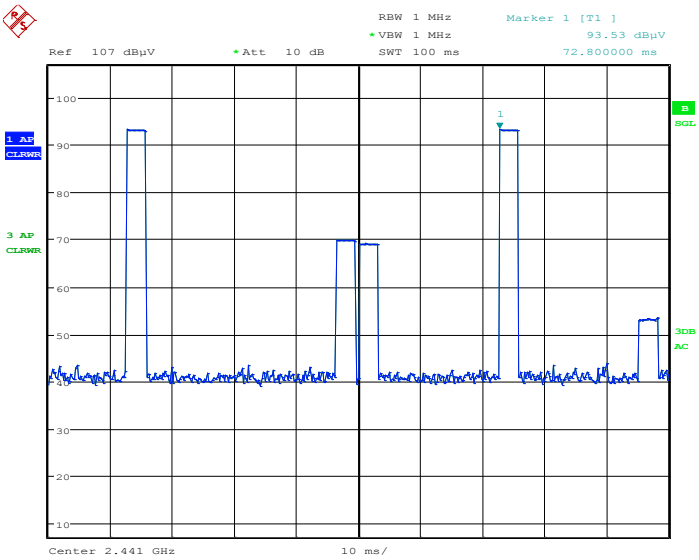
<For Sample 2>

DH5 on time (One Pulse) Plot on Channel 39



Date: 29.AUG.2018 22:15:23

on time (Count Pulses) Plot on Channel 39



Date: 29.AUG.2018 22:18:23

Note:

4. Worst case Duty cycle = on time/100 milliseconds = 2 * 2.90 / 100 = 5.8 %
5. Worst case Duty cycle correction factor = 20*log(Duty cycle) = -24.73 dB
6. **DH5** has the highest duty cycle worst case and is reported.

Duty Cycle Correction Factor Consideration for AFH mode:

Bluetooth normal hopping rate is 1600Hz and reduced to 800Hz in AFH mode; due to the reduced number of hopping frequencies, with the same packet configuration the dwell time in each channel frequency within 100msec period is longer in AFH mode than normal mode.

In AFH mode, the minimum hopping frequencies are 20, to get the longest dwell time DH5 packet is observed; the period to have DH5 packet completing one hopping sequence is

2.90 ms x 20 channels = 58 ms

There cannot be 2 complete hopping sequences within 100ms period, considering the random hopping behavior, maximum 2 hops can be possibly observed within the period. [100ms / 57.6ms] = 2 hops

Thus, the maximum possible ON time:

2.90 ms x 2 = 5.8 ms

Worst case Duty Cycle Correction factor, which is derived from the maximum possible ON time,

20 x log(5.8 ms/100ms) = -24.73 dB