



FCC RADIO TEST REPORT

FCC ID : PU5-TP00114C
Equipment : Notebook Computer
Brand Name : Lenovo
Model Name : TP00114C
Applicant : Wistron Corporation
21F, No. 88, Sec. 1, Hsin Tai Wu Rd., Hsichih
Dist, New Taipei City 221, Taiwan
Manufacturer : Lenovo PC HK Limited
23/F, Lincoln House, Taikoo Place, 979 King's
Road, Quarry Bay, Hong Kong, P.R. China
Standard : FCC Part 15 Subpart C §15.247

Equipment: Intel AX200NGW tested inside of Lenovo Notebook Computer

The product was received on Apr. 08, 2021 and testing was started from Jun. 10, 2021 and completed on Jun. 14, 2021. We, Sporton International Inc. EMC & Wireless Communications Laboratory, would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this partial report apply exclusively to the tested model / sample. Without written approval of Sporton International Inc. EMC & Wireless Communications Laboratory, the test report shall not be reproduced except in full.

Louis Wu

Approved by: Louis Wu

Sporton International Inc. EMC & Wireless Communications Laboratory

No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333, Taiwan



Table of Contents

History of this test report.....	3
Summary of Test Result.....	4
1 General Description.....	5
1.1 Product Feature of Equipment Under Test.....	5
1.2 Product Specification of Equipment Under Test.....	6
1.3 Modification of EUT	6
1.4 Testing Location	6
1.5 Applicable Standards.....	7
2 Test Configuration of Equipment Under Test.....	8
2.1 Carrier Frequency Channel	8
2.2 Test Mode.....	9
2.3 Connection Diagram of Test System.....	10
2.4 Support Unit used in test configuration and system	10
2.5 EUT Operation Test Setup	10
3 Test Result.....	11
3.1 Output Power Measurement.....	11
3.2 Radiated Band Edges and Spurious Emission Measurement	12
3.3 AC Conducted Emission Measurement.....	15
3.4 Antenna Requirements.....	17
4 List of Measuring Equipment	18
5 Uncertainty of Evaluation.....	19
Appendix A. Conducted Test Results	
Appendix B. AC Conducted Emission Test Result	
Appendix C. Radiated Spurious Emission	
Appendix D. Radiated Spurious Emission Plots	
Appendix E. Duty Cycle Plots	
Appendix F. Setup Photographs	



History of this test report

Report No.	Version	Description	Issued Date
FR140857-01A	01	Initial issue of report	Jun. 15, 2021

Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
-	15.247(a)(1)	Number of Channels	-	See Note
-	15.247(a)(1)	Hopping Channel Separation	-	See Note
-	15.247(a)(1)	Dwell Time of Each Channel	-	See Note
-	15.247(a)(1)	20dB Bandwidth	-	See Note
-	2.1049	99% Occupied Bandwidth	-	See Note
3.1	15.247(b)(1)	Peak Output Power	Pass	-
-	15.247(d)	Conducted Band Edges	-	See Note
-	15.247(d)	Conducted Spurious Emission	-	See Note
3.2	15.247(d)	Radiated Band Edges and Radiated Spurious Emission	Pass	Under limit 16.95 dB at 2483.520 MHz
3.3	15.207	AC Conducted Emission	Pass	Under limit 9.79 dB at 4.729 MHz
3.4	15.203 & 15.247(b)	Antenna Requirement	Pass	-

Note: The module (Model: AX200NGW) makes no difference after verifying output power, this report reuses test data from the module report.

Declaration of Conformity:

The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.

Comments and Explanations:

The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

Reviewed by: Sheng Kuo

Report Producer: Ruby Zou

1 General Description

1.1 Product Feature of Equipment Under Test

Product Feature	
Equipment	Notebook Computer
Brand Name	Lenovo
Model Name	TP00114C
FCC ID	PU5-TP00114C
Sample 1	EUT with High-Tek Antenna
Sample 2	EUT with AWAN Antenna
EUT supports Radios application	WLAN 11a/b/g/n HT20/HT40 WLAN 11ac VHT20/VHT40/VHT80/VHT160 WLAN 11ax HE20/HE40/HE80/HE160 Bluetooth BR/EDR/LE
EUT Stage	Identical Prototype

Remark:

1. The above EUT's information was declared by manufacturer.
2. Equipment: Intel AX200NGW tested inside of Lenovo Notebook Computer.

Antenna Information			
Antenna 1 (WLAN)	Manufacturer	High-Tek	
	Antenna Type	PIFA Antenna	PIFA Antenna
	Part number	025.901JG.0011	025.901JH.0011
	Peak gain (dBi)	Main Antenna :	Aux. Antenna :
		WLAN(2.4G):-0.89	Bluetooth: -1.97 WLAN(2.4G):-1.97
Antenna 2 (WLAN)	Manufacturer	AWAN	
	Antenna Type	PIFA Antenna	PIFA Antenna
	Part number	025.901JG.0021	025.901JH.0021
	Peak gain (dBi)	Main Antenna :	Aux. Antenna :
		WLAN(2.4G):-1.69	Bluetooth: -2.55 WLAN(2.4G):-2.55

Remark:

1. The above EUT's information was declared by manufacturer. Please refer to Comments and Explanations in report summary.
2. For Radiated Test Cases, the tests were performed with "High-Tek Antenna"

1.2 Product Specification of Equipment Under Test

Product Specification subjective to this standard	
Tx/Rx Frequency Range	2402 MHz ~ 2480 MHz
Number of Channels	79
Carrier Frequency of Each Channel	2402+n*1 MHz; n=0~78
Maximum Output Power to Antenna	Bluetooth BR (1Mbps): 10.69 dBm / 0.0117 W Bluetooth EDR (2Mbps): 10.08 dBm / 0.0102 W Bluetooth EDR (3Mbps): 10.14 dBm / 0.0103 W
Type of Modulation	Bluetooth BR (1Mbps) : GFSK Bluetooth EDR (2Mbps) : $\pi/4$ -DQPSK Bluetooth EDR (3Mbps) : 8-DPSK

Remark: For other wireless features of this EUT, test report will be issued separately.

1.3 Modification of EUT

No modifications are made to the EUT during all test items.

1.4 Testing Location

Test Site	Sporton International Inc. EMC & Wireless Communications Laboratory
Test Site Location	No.52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333, Taiwan
Test Site No.	Sporton Site No.
	TH02-HY, CO05-HY

Note: The test site complies with ANSI C63.4 2014 requirement.

Test Site	Sporton International Inc. Wensan Laboratory
Test Site Location	No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan
Test Site No.	Sporton Site No.
	03CH12-HY (TAF Code: 3786)
Remark	The Radiated Spurious Emission test item subcontracted to Sporton International Inc. Wensan Laboratory.

Note: The test site complies with ANSI C63.4 2014 requirement.

FCC designation No.: TW1190 and TW3786



1.5 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- ♦ FCC Part 15 Subpart C §15.247
- ♦ FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05r02
- ♦ ANSI C63.10-2013

Remark:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. The TAF code is not including all the FCC KDB listed without accreditation.

2 Test Configuration of Equipment Under Test

2.1 Carrier Frequency Channel

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
2400-2483.5 MHz	0	2402	27	2429	54	2456
	1	2403	28	2430	55	2457
	2	2404	29	2431	56	2458
	3	2405	30	2432	57	2459
	4	2406	31	2433	58	2460
	5	2407	32	2434	59	2461
	6	2408	33	2435	60	2462
	7	2409	34	2436	61	2463
	8	2410	35	2437	62	2464
	9	2411	36	2438	63	2465
	10	2412	37	2439	64	2466
	11	2413	38	2440	65	2467
	12	2414	39	2441	66	2468
	13	2415	40	2442	67	2469
	14	2416	41	2443	68	2470
	15	2417	42	2444	69	2471
	16	2418	43	2445	70	2472
	17	2419	44	2446	71	2473
	18	2420	45	2447	72	2474
	19	2421	46	2448	73	2475
	20	2422	47	2449	74	2476
	21	2423	48	2450	75	2477
	22	2424	49	2451	76	2478
	23	2425	50	2452	77	2479
	24	2426	51	2453	78	2480
	25	2427	52	2454	-	-
	26	2428	53	2455	-	-

2.2 Test Mode

- a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: conduction emission (150 kHz to 30 MHz), radiation emission (1GHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, pre-scanned in Tablet type (three orthogonal panels, X, Y, Z) and Notebook type. The worst cases (Z plane) were recorded in this report, and the worst mode of radiated spurious emissions is Bluetooth 1Mbps mode, and recorded in this report.
- b. AC power line Conducted Emission was tested under maximum output power.

The following summary table is showing all test modes to demonstrate in compliance with the standard.

Summary table of Test Cases	
Test Item	Data Rate / Modulation
Radiated Test Cases	Bluetooth BR 1Mbps GFSK
	Mode 1: CH00_2402 MHz
	Mode 2: CH39_2441 MHz
	Mode 3: CH78_2480 MHz
AC Conducted Emission	Mode 1 :Bluetooth Link + WLAN (2.4GHz) Link + TC + TF + Adapter
Remark: - For Radiated Test Cases, the worst mode data rate 1Mbps was reported only since the highest RF output power in the preliminary tests. The conducted spurious emissions and conducted band edge measurement for other data rates were not worse than 1Mbps, and no other significantly frequencies found in conducted spurious emission. - TF stands for test function, and consists of H-Pattern, MPEG4, Camera and fingerprint - TC stands for test configuration, and consists of Earphone + Mic, Micro SD Card, USB HD (Data Link) (USB *2), LCD Monitor (HDMI out) and LAN Link - HDMI Cable means media application transferred between EUT and external display. - Data Link with USB Storage device means data application transferred mode between EUT and USB Storage device.	

2.3 Connection Diagram of Test System



2.4 Support Unit used in test configuration and system

Item	Equipment	Brand Name	Model Name	FCC ID	Data Cable	Power Cord
1.	Bluetooth Base Station	R&S	CBT32	N/A	N/A	Unshielded, 1.8 m
2.	Bluetooth Earphone	Sony Ericsson	MW600	PY7DDA-2029	N/A	N/A
3.	WLAN AP	ASUS	RT-AC66U	MSQ-RTAC66U	N/A	Unshielded, 1.8 m
4.	iPod Earphone	Apple	N/A	Verification	Unshielded, 1.0 m	N/A
5.	Notebook	Dell	Latitude 3400	FCC DoC	N/A	AC I/P: Unshielded, 1.2 m DC O/P: Shielded, 1.8 m
6.	LCD Monitor	Asus	PB27UQ	FCC DoC	Shielded, 1.6m	Unshielded, 1.8m
7.	USB HD	ADATA	HV620S-1T	FCC DoC	Shielded, 1.0m	N/A
8.	SD Card	SanDisk	MicroSD HC	FCC DoC	N/A	N/A

2.5 EUT Operation Test Setup

The RF test items, utility “DRTU 12.1947.0-10428” was installed in Notebook which was programmed in order to make the EUT get into the engineering modes to contact with base station to provide channel selection, power level, data rate and the application type and for continuous transmitting signals.

3 Test Result

3.1 Output Power Measurement

3.1.1 Limit of Output Power

The maximum peak conducted output power of the intentional radiator shall not exceed the following:
For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band 0.125 watts.

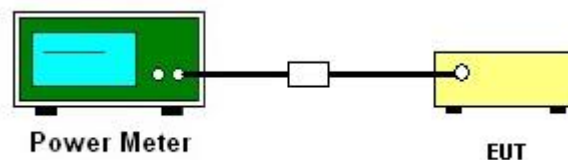
3.1.2 Measuring Instruments

See list of measuring equipment of this test report.

3.1.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.5.
2. The RF output of EUT was connected to the power meter by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Measure the conducted output power with cable loss and record the results in the test report.
5. Measure and record the results in the test report.

3.1.4 Test Setup



3.1.5 Test Result of Peak Output Power

Please refer to Appendix A.

3.1.6 Test Result of Average Output Power (Reporting Only)

Please refer to Appendix A.

3.2 Radiated Band Edges and Spurious Emission Measurement

3.2.1 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 (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

3.2.2 Measuring Instruments

See list of measuring equipment of this test report.

3.2.3 Test Procedures

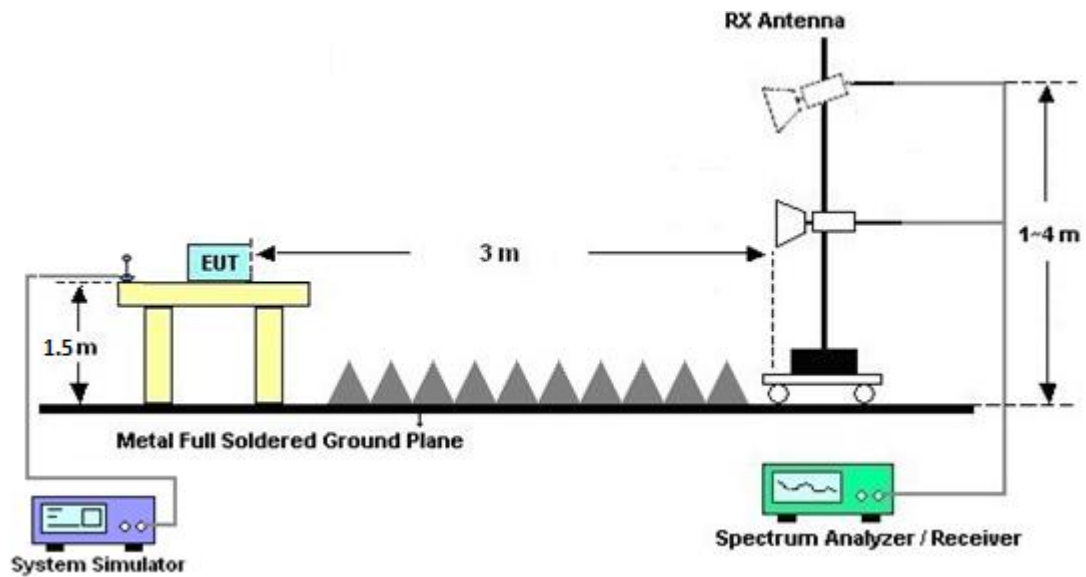
1. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
2. For each suspected emission, the EUT was arranged to its worst case and then tune the Antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to 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.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. 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 = 1 MHz for $f > 1$ GHz ; VBW $\geq$ 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
$$\text{On time} = N_1 * L_1 + N_2 * L_2 + \dots + N_{n-1} * L_{n-1} + N_n * L_n$$

Where N_1 is number of type 1 pulses, L_1 is length of type 1 pulses, etc.
Average Emission Level = Peak Emission Level + $20 * \log(\text{Duty cycle})$
5. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
6. For testing above 1 GHz, the emission level of the EUT in peak mode was 20 dB 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.

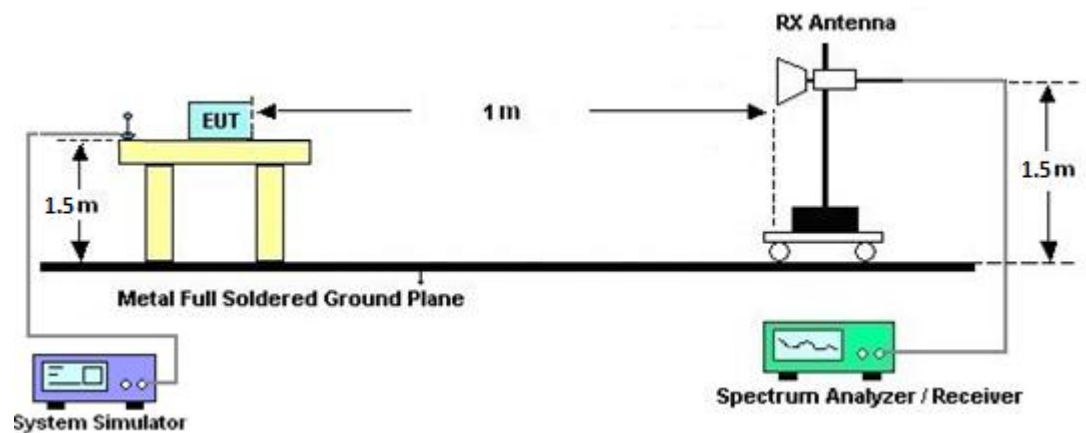
Note: The average levels were calculated from the peak level corrected with duty cycle correction factor (-24.88dB) derived from $20 \log(\text{dwell time}/100\text{ms})$. This correction is only for signals that hop with the fundamental signal, such as band-edge and harmonic. Other spurious signals that are independent of the hopping signal would not use this correction.

3.2.4 Test Setup

For radiated test from 1GHz to 18GHz



For radiated test above 18GHz



3.2.5 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix C and D.

3.2.6 Duty Cycle

Please refer to Appendix E.

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

Please refer to Appendix C and D.

3.3 AC Conducted Emission Measurement

3.3.1 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 (dB μ V)	
	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.

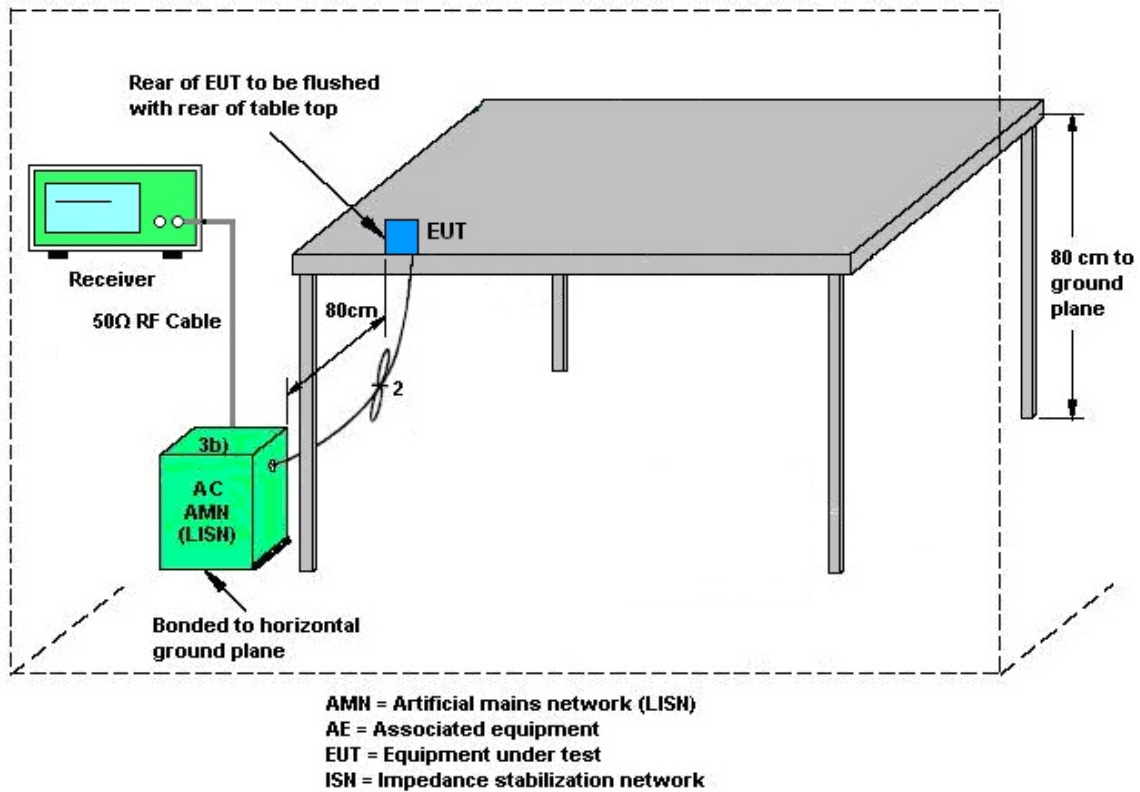
3.3.2 Measuring Instruments

See list of measuring equipment of this test report.

3.3.3 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 shall 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.

3.3.4 Test Setup



3.3.5 Test Result of AC Conducted Emission

Please refer to Appendix B.

3.4 Antenna Requirements

3.4.1 Standard Applicable

If directional gain of transmitting antennas is greater than 6 dBi, the power shall be reduced by the same level in dB comparing to gain minus 6 dBi. 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.

3.4.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.4.3 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	Brand Name	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Horn Antenna	SCHWARZBECK	BBHA 9120 D	9120D-1328	1GHz~18GHz	Nov. 23, 2020	Jun. 10, 2021~Jun. 14, 2021	Nov. 22, 2021	Radiation (03CH12-HY)
SHF-EHF Horn Antenna	SCHWARZBECK	BBHA 9170	00993	18GHz~40GHz	Nov. 19, 2020	Jun. 10, 2021~Jun. 14, 2021	Nov. 18, 2021	Radiation (03CH12-HY)
Preamplifier	Keysight	83017A	MY57280120	1GHz~26.5GHz	Jul. 20, 2020	Jun. 10, 2021~Jun. 14, 2021	Jul. 19, 2021	Radiation (03CH12-HY)
Preamplifier	E-INSTRUMENT TECH LTD.	ERA-100M-18G-56-01-A70	EC1900249	1GHz-18GHz	Dec. 05, 2020	Jun. 10, 2021~Jun. 14, 2021	Dec. 04, 2021	Radiation (03CH12-HY)
Preamplifier	EMEC	EM18G40G	060715	18GHz~40GHz	Dec. 11, 2020	Jun. 10, 2021~Jun. 14, 2021	Dec. 10, 2021	Radiation (03CH12-HY)
Spectrum Analyzer	Agilent	N9010A	MY53470118	10Hz~44GHz	Jan. 15, 2021	Jun. 10, 2021~Jun. 14, 2021	Jan. 14, 2022	Radiation (03CH12-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 126E	0058/126E	30MHz~18GHz	Dec. 11, 2020	Jun. 10, 2021~Jun. 14, 2021	Dec. 10, 2021	Radiation (03CH12-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	505134/2	30MHz~40GHz	Feb. 22, 2021	Jun. 10, 2021~Jun. 14, 2021	Feb. 21, 2022	Radiation (03CH12-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	800740/2	30MHz~40GHz	Feb. 22, 2021	Jun. 10, 2021~Jun. 14, 2021	Feb. 21, 2022	Radiation (03CH12-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1m~4m	N/A	Jun. 10, 2021~Jun. 14, 2021	N/A	Radiation (03CH12-HY)
Turn Table	EMEC	TT2000	N/A	0~360 Degree	N/A	Jun. 10, 2021~Jun. 14, 2021	N/A	Radiation (03CH12-HY)
Software	Audix	E3 6.2009-8-24	RK-000989	N/A	N/A	Jun. 10, 2021~Jun. 14, 2021	N/A	Radiation (03CH12-HY)
Filter	Wainwright	WLKS1200-12SS	SN2	1.2GHz Low Pass Filter	Mar. 17, 2021	Jun. 10, 2021~Jun. 14, 2021	Mar. 16, 2022	Radiation (03CH12-HY)
Filter	Wainwright	WHKX12-2700-3000-18000-60ST	SN2	3GHz High Pass Filter	Jul. 14, 2020	Jun. 10, 2021~Jun. 14, 2021	Jul. 13, 2021	Radiation (03CH12-HY)
AC Power Source	ChainTek	APC-1000W	N/A	N/A	N/A	Jun. 12, 2021	N/A	Conduction (CO05-HY)
EMI Test Receiver	Rohde & Schwarz	ESR3	102388	9kHz~3.6GHz	Nov. 30, 2020	Jun. 12, 2021	Nov. 29, 2021	Conduction (CO05-HY)
LISN	Rohde & Schwarz	ENV216	100080	9kHz~30MHz	Dec. 01, 2020	Jun. 12, 2021	Nov. 30, 2021	Conduction (CO05-HY)
LISN	Rohde & Schwarz	ENV216	100081	9kHz~30MHz	Nov. 16, 2020	Jun. 12, 2021	Nov. 15, 2021	Conduction (CO05-HY)
Software	Rohde & Schwarz	EMC32 V10.30	N/A	N/A	N/A	Jun. 12, 2021	N/A	Conduction (CO05-HY)
Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100851	N/A	Feb. 25, 2021	Jun. 12, 2021	Feb. 24, 2022	Conduction (CO05-HY)
LISN Cable	MVE	RG-400	260260	N/A	Dec. 31, 2020	Jun. 12, 2021	Dec. 30, 2021	Conduction (CO05-HY)
Power Meter	Agilent	E4416A	GB41292344	N/A	Jan. 14, 2021	Jun. 10, 2021	Jan. 13, 2022	Conducted (TH02-HY)
Power Sensor	Agilent	E9327A	US40441548	50MHz~18GHz	Jan. 14, 2021	Jun. 10, 2021	Jan. 13, 2022	Conducted (TH02-HY)
Spectrum Analyzer	Rohde & Schwarz	FSQ	200578/026	20Hz-26.5GHz	Jul. 17, 2020	Jun. 10, 2021	Jul. 16, 2021	Conducted (TH02-HY)
Switch Box & RF Cable	EM Electronics	EMSW18SE	SW200302	N/A	Mar. 17, 2021	Jun. 10, 2021	Mar. 16, 2022	Conducted (TH02-HY)



5 Uncertainty of Evaluation

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

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	2.3 dB
--	--------

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

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.6 dB
--	--------

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

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	4.9 dB
--	--------

Appendix A. Test Result of Conducted Test Items

Test Engineer:	Ching Chen	Temperature:	24~25	°C
Test Date:	2021/6/10	Relative Humidity:	51~54	%

TEST RESULTS DATA**Peak Power Table**

DH	CH.	NTX	Peak Power (dBm)	Power Limit (dBm)	Test Result
DH1	0	1	10.19	20.97	Pass
	39	1	10.40	20.97	Pass
	78	1	10.69	20.97	Pass
2DH1	0	1	9.71	20.97	Pass
	39	1	10.04	20.97	Pass
	78	1	10.08	20.97	Pass
3DH1	0	1	9.76	20.97	Pass
	39	1	9.94	20.97	Pass
	78	1	10.14	20.97	Pass

TEST RESULTS DATA**Average Power Table*****(Reporting Only)***

DH	CH.	NTX	Average Power (dBm)	Duty Factor (dB)
DH1	0	1	10.10	5.13
	39	1	10.47	5.13
	78	1	10.57	5.13
2DH1	0	1	7.45	5.05
	39	1	7.90	5.05
	78	1	7.99	5.05
3DH1	0	1	7.42	5.06
	39	1	7.76	5.06
	78	1	8.06	5.06



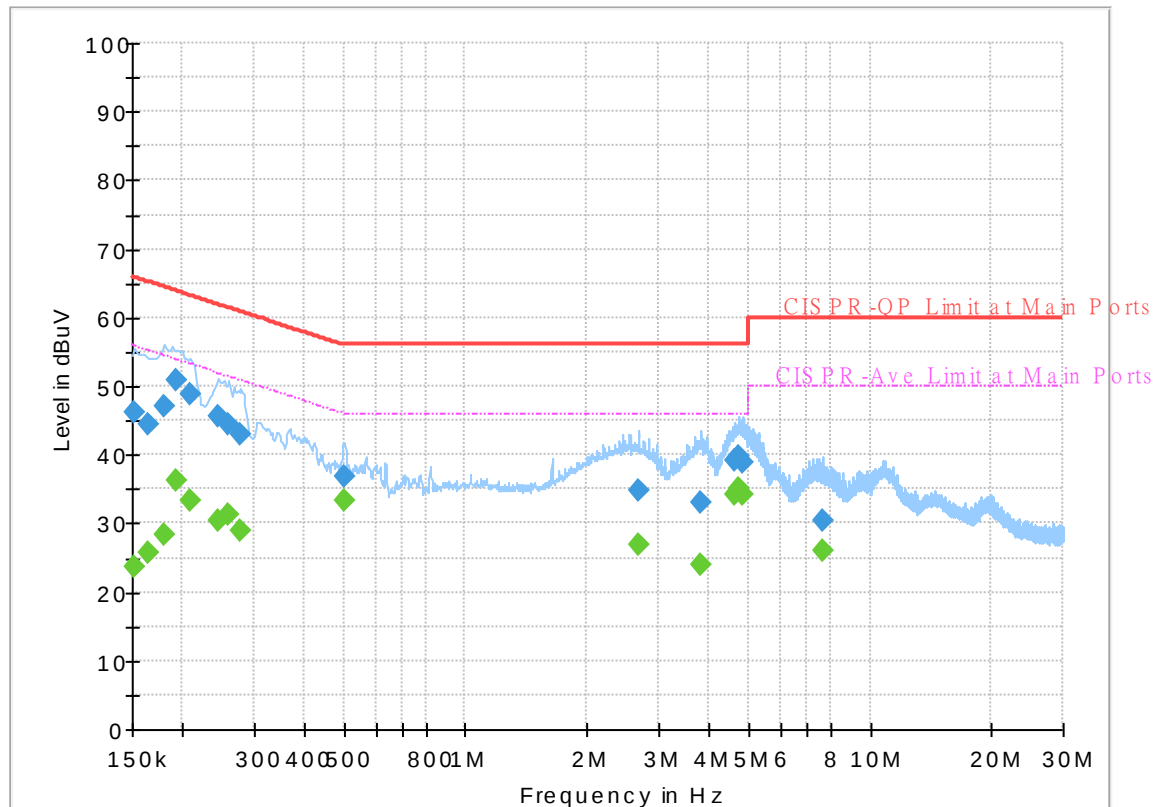
Appendix B. AC Conducted Emission Test Results

Test Engineer :	Tom Lee	Temperature :	23~26℃
		Relative Humidity :	40~50%

EUT Information

Report NO : 140857-01
 Test Mode : Mode 1
 Test Voltage : 120Vac/60Hz
 Phase : Line

Full Spectrum



Final_Result

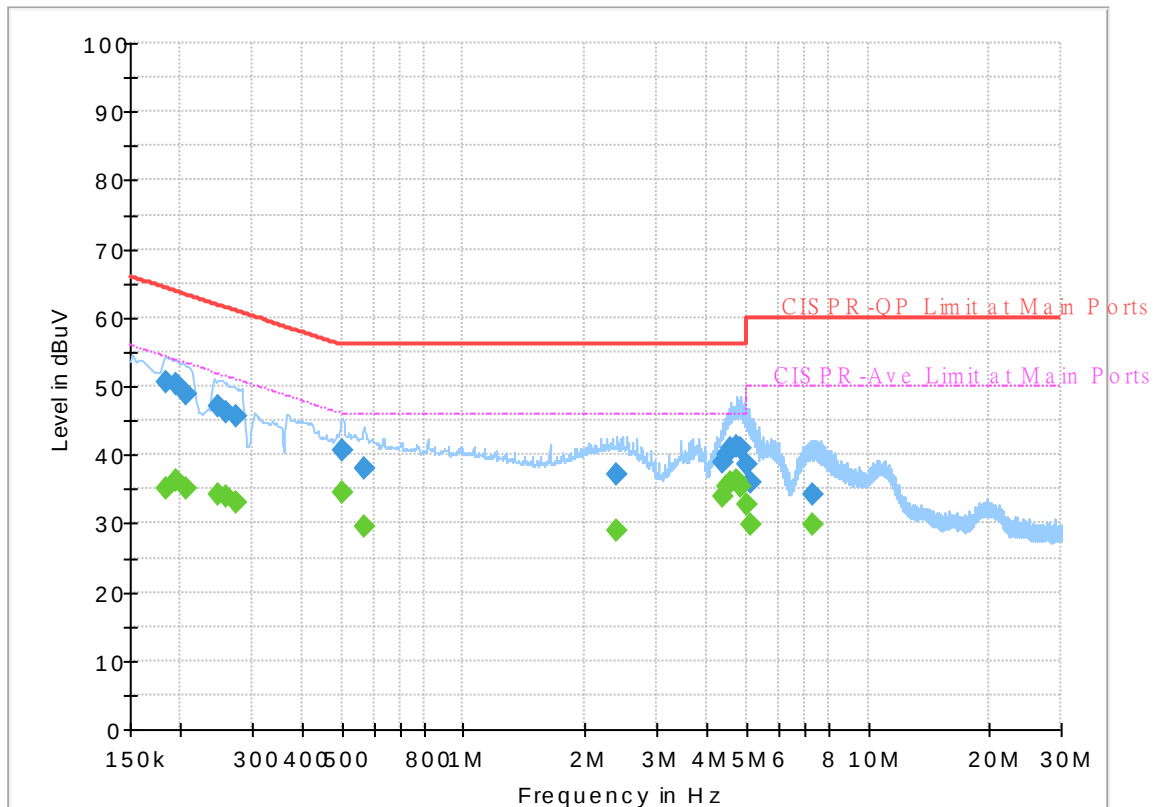
Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Line	Filter	Corr. (dB)
0.152250	---	23.68	55.88	32.20	L1	OFF	19.6
0.152250	46.18	---	65.88	19.70	L1	OFF	19.6
0.163500	---	25.78	55.28	29.50	L1	OFF	19.6
0.163500	44.39	---	65.28	20.89	L1	OFF	19.6
0.179250	---	28.51	54.52	26.01	L1	OFF	19.6
0.179250	47.01	---	64.52	17.51	L1	OFF	19.6
0.192750	---	36.17	53.92	17.75	L1	OFF	19.6
0.192750	50.98	---	63.92	12.94	L1	OFF	19.6
0.208500	---	33.38	53.27	19.89	L1	OFF	19.6
0.208500	48.78	---	63.27	14.49	L1	OFF	19.6
0.244500	---	30.40	51.94	21.54	L1	OFF	19.6
0.244500	45.56	---	61.94	16.38	L1	OFF	19.6
0.260250	---	31.20	51.42	20.22	L1	OFF	19.6
0.260250	44.48	---	61.42	16.94	L1	OFF	19.6
0.278250	---	29.04	50.87	21.83	L1	OFF	19.6
0.278250	43.07	---	60.87	17.80	L1	OFF	19.6
0.501000	---	33.31	46.00	12.69	L1	OFF	19.7
0.501000	36.92	---	56.00	19.08	L1	OFF	19.7
2.683500	---	26.99	46.00	19.01	L1	OFF	20.0
2.683500	34.82	---	56.00	21.18	L1	OFF	20.0
3.817500	---	23.86	46.00	22.14	L1	OFF	19.9

3.817500	32.93	---	56.00	23.07	L1	OFF	19.9
4.616250	---	34.31	46.00	11.69	L1	OFF	19.9
4.616250	39.20	---	56.00	16.80	L1	OFF	19.9
4.740000	---	34.95	46.00	11.05	L1	OFF	19.9
4.740000	39.64	---	56.00	16.36	L1	OFF	19.9
4.868250	---	34.13	46.00	11.87	L1	OFF	19.9
4.868250	38.84	---	56.00	17.16	L1	OFF	19.9
7.635750	---	25.95	50.00	24.05	L1	OFF	20.0
7.635750	30.52	---	60.00	29.48	L1	OFF	20.0

EUT Information

Report NO : 140857-01
 Test Mode : Mode 1
 Test Voltage : 120Vac/60Hz
 Phase : Neutral

Full Spectrum



Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Line	Filter	Corr. (dB)
0.183750	---	35.09	54.31	19.22	N	OFF	19.6
0.183750	50.68	---	64.31	13.63	N	OFF	19.6
0.195000	---	36.30	53.82	17.52	N	OFF	19.6
0.195000	50.20	---	63.82	13.62	N	OFF	19.6
0.206250	---	34.97	53.36	18.39	N	OFF	19.6
0.206250	48.74	---	63.36	14.62	N	OFF	19.6
0.246750	---	34.08	51.87	17.79	N	OFF	19.6
0.246750	46.94	---	61.87	14.93	N	OFF	19.6
0.260250	---	33.99	51.42	17.43	N	OFF	19.6
0.260250	46.29	---	61.42	15.13	N	OFF	19.6
0.273750	---	33.00	51.00	18.00	N	OFF	19.6
0.273750	45.65	---	61.00	15.35	N	OFF	19.6
0.501000	---	34.53	46.00	11.47	N	OFF	19.7
0.501000	40.62	---	56.00	15.38	N	OFF	19.7
0.566250	---	29.46	46.00	16.54	N	OFF	19.8
0.566250	37.95	---	56.00	18.05	N	OFF	19.8
2.400000	---	29.08	46.00	16.92	N	OFF	20.0
2.400000	37.01	---	56.00	18.99	N	OFF	20.0
4.371000	---	33.82	46.00	12.18	N	OFF	19.9
4.371000	38.93	---	56.00	17.07	N	OFF	19.9
4.490250	---	35.35	46.00	10.65	N	OFF	19.9

4.490250	40.11	---	56.00	15.89	N	OFF	19.9
4.587000	---	35.85	46.00	10.15	N	OFF	19.9
4.587000	40.80	---	56.00	15.20	N	OFF	19.9
4.728750	---	36.21	46.00	9.79	N	OFF	19.9
4.728750	41.22	---	56.00	14.78	N	OFF	19.9
4.863750	---	35.33	46.00	10.67	N	OFF	19.9
4.863750	40.85	---	56.00	15.15	N	OFF	19.9
5.010000	---	32.61	50.00	17.39	N	OFF	19.9
5.010000	38.69	---	60.00	21.31	N	OFF	19.9
5.142750	---	29.79	50.00	20.21	N	OFF	20.0
5.142750	36.04	---	60.00	23.96	N	OFF	20.0
7.334250	---	29.83	50.00	20.17	N	OFF	20.0
7.334250	34.26	---	60.00	25.74	N	OFF	20.0



Appendix C. Radiated Spurious Emission

Test Engineer :	Jack Cheng , Lance Chiang and Chuan Chu	Temperature :	21.8~26.8°C
		Relative Humidity :	53.6~68.2%



2.4GHz 2400~2483.5MHz

BT (Band Edge @ 3m)

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 CH00 2402MHz		2373.21	43.36	-30.64	74	43.13	27.7	6.69	34.16	193	88	P	H
		2373.21	18.48	-35.52	54	-	-	-	-	-	-	A	H
	*	2402	96.63	-	-	96.34	27.7	6.73	34.14	193	88	P	H
	*	2402	71.75	-	-	-	-	-	-	-	-	A	H
													H
													H
		2388.855	45.75	-28.25	74	45.49	27.7	6.71	34.15	250	348	P	V
		2388.855	20.87	-33.13	54	-	-	-	-	-	-	A	V
	*	2402	105.09	-	-	104.8	27.7	6.73	34.14	250	348	P	V
	*	2402	80.21	-	-	-	-	-	-	-	-	A	V
													V
													V
BT CH 78 2480MHz	*	2480	97.64	-	-	97.42	27.48	6.83	34.09	189	91	P	H
	*	2480	72.76	-	-	-	-	-	-	-	-	A	H
		2483.6	48.39	-25.61	74	48.17	27.47	6.84	34.09	189	91	P	H
		2483.6	23.51	-30.49	54	-	-	-	-	-	-	A	H
													H
													H
	*	2480	107.68	-	-	107.46	27.48	6.83	34.09	295	334	P	V
	*	2480	82.8	-	-	-	-	-	-	-	-	A	V
		2483.52	57.05	-16.95	74	56.83	27.47	6.84	34.09	295	334	P	V
		2483.52	32.17	-21.83	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 39 2441MHz		4874	40.5	-33.5	74	64.86	31	11.37	66.73	100	0	P	H
		4874	15.62	-38.38	54	-	-	-	-	-	-	A	H
		7323	44.58	-29.42	74	60.57	36.25	13.16	65.4	100	0	P	H
		7323	19.7	-24.58	54	-	-	-	-	-	-	A	H
		4874	41.64	-32.36	74	66	31	11.37	66.73	100	0	P	V
		4874	16.76	-37.24	54	-	-	-	-	-	-	A	V
		7323	44.42	-29.58	74	60.41	36.25	13.16	65.4	100	0	P	V
		7323	19.54	-24.42	54	-	-	-	-	-	-	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average 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 D. Radiated Spurious Emission Plots

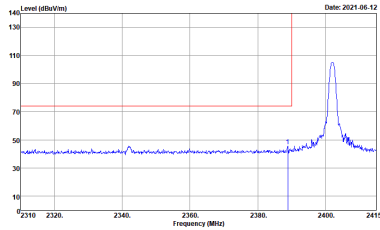
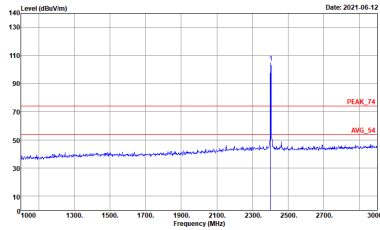
Test Engineer :	Jack Cheng , Lance Chiang and Chuan Chu	Temperature :	21.8~26.8°C
		Relative Humidity :	53.6~68.2%

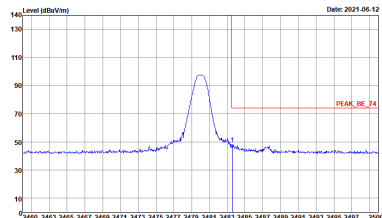
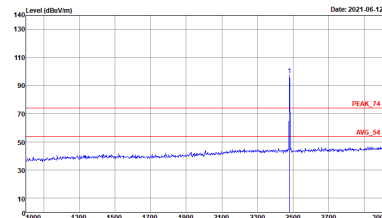
2.4GHz 2400~2483.5MHz

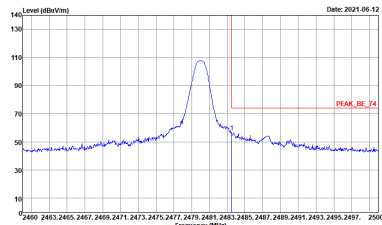
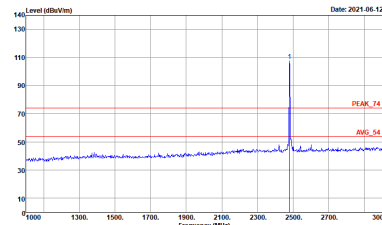
BT (Band Edge @ 3m)

BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BT CH00 2402MHz	
	Horizontal	Fundamental
Peak	Site : 03CH2-HY Condition : PEAK_SE_74 3m HORN_91200_1328 HORIZONTAL : RBW:1000.000kHz VBW:3000.000kHz SWT:Auto	Site : 03CH2-HY Condition : PEAK_74 3m HORN_91200_1328 HORIZONTAL : RBW:1000.000kHz VBW:3000.000kHz SWT:Auto

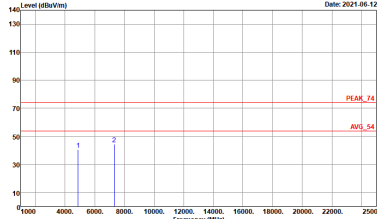
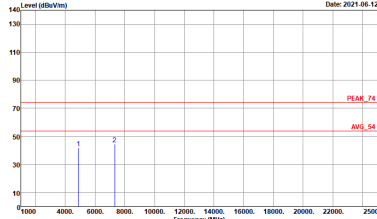


BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BT CH00 2402MHz	
	Vertical	Fundamental
Peak	 Site : 03CH12-HY Condition : PEAK_BE_74 3m HORN_91200_1328 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT-Auto	 Site : 03CH12-HY Condition : PEAK_74 3m HORN_91200_1328 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT-Auto

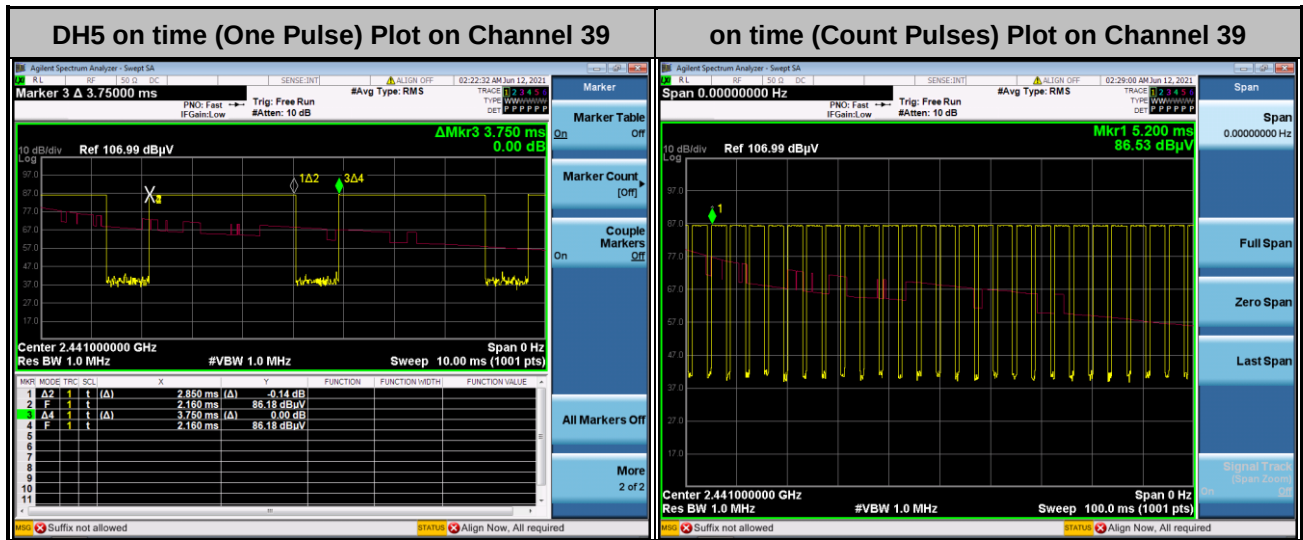
BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BT CH78 2480MHz	
	Horizontal	Fundamental
Peak	 Site : 03CH12-HY Condition : PEAK_BE_74 3m HORN_91200_1328 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto	 Site : 03CH12-HY Condition : PEAK_74 3m HORN_91200_1328 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto

BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BT CH78 2480MHz	
	Vertical	Fundamental
Peak	 Site : 03CH12-HY Condition : PEAK_BE_74 3m HORN_91200_1328 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto	 Site : 03CH12-HY Condition : PEAK_74 3m HORN_91200_1328 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto

2.4GHz 2400~2483.5MHz
BT (Harmonic @ 3m)

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

Appendix E. Duty Cycle Plots



Note:

1. Worst case Duty cycle = on time/100 milliseconds = $2 * 2.85 / 100 = 5.7 \%$
2. Worst case Duty cycle correction factor = $20 * \log(\text{Duty cycle}) = -24.88 \text{ dB}$
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

$$2.85 \text{ ms} \times 20 \text{ channels} = 57 \text{ ms}$$

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. $[100 \text{ ms} / 57 \text{ ms}] = 2 \text{ hops}$

Thus, the maximum possible ON time:

$$2.85 \text{ ms} \times 2 = 5.7 \text{ ms}$$

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

$$20 \times \log(5.7 \text{ ms}/100 \text{ ms}) = -24.88 \text{ dB}$$