FCC RADIO TEST REPORT

FCC ID	:	**UZ7TC520L**
Equipment	:	**Touch Computer**
Brand Name	:	**Zebra**
Model Name	:	**TC520L**
Applicant	:	**Zebra Technologies Corporation 1 Zebra Plaza, Holtsville, NY 11742**
Manufacturer	:	**Zebra Technologies Corporation 1 Zebra Plaza, Holtsville, NY 11742**
Standard	:	**FCC Part 15 Subpart C §15.247**

The product was received on Feb. 19, 2021 and testing was started from Mar. 26, 2021 and completed on May 11, 2021. We, Sporton International Inc. Wensan 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 report apply exclusively to the tested model / sample. Without written approval of Sporton International Inc. Wensan Laboratory, the test report shall not be reproduced except in full.

Louis Wu

Reviewed by: Louis Wu

Sporton International Inc. Wensan Laboratory

No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan (R.O.C.)

Table of Contents

History of this test report

Report No.	Version	Description	Issued Date
FR122002A	01	Initial issue of report	May 27, 2021

Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
3.1	15.247(a)(1)	Number of Channels	Pass	-
3.2	15.247(a)(1)	Hopping Channel Separation	Pass	-
3.3	15.247(a)(1)	Dwell Time of Each Channel	Pass	-
3.4	15.247(a)(1)	20dB Bandwidth	Pass	-
3.4	2.1049	99% Occupied Bandwidth	Reporting only	-
3.5	15.247(b)(1)	Peak Output Power	Pass	-
3.6	15.247(d)	Conducted Band Edges	Pass	-
3.7	15.247(d)	Conducted Spurious Emission	Pass	-
3.8	15.247(d)	Radiated Band Edges and Radiated Spurious Emission	Pass	Under limit 7.17 dB at 37.760 MHz
3.9	15.207	AC Conducted Emission	Pass	Under limit 14.97 dB at 0.501 MHz
3.10	15.203 & 15.247(b)	Antenna Requirement	Pass	-

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: Wii Chang

Report Producer: Celery Wei

1 General Description

1.1 Product Feature of Equipment Under Test

Product Feature	
Equipment	Touch Computer
Brand Name	Zebra
Model Name	TC520L
FCC ID	UZ7TC520L
EUT supports Radios application	NFC WLAN 11b/g/n HT20 WLAN 11a/n HT20/HT40 WLAN 11ac VHT20/VHT40/VHT80 WLAN 11ax HE20/HE40/HE80 Bluetooth BR/EDR/LE
HW Version	DV
SW Version	11-09-22.00-RG-U00-PRD-HEL-04
FW Version	FUSION_SA_2_1.1.0.012_R
MFD	07APR21
EUT Stage	Identical Prototype

Remark: The above EUT's information was declared by manufacturer.

Specification of Accessories				
Adapter	**Brand Name**	Zebra	**Part Number**	PWR-WUA5V12W0US
Battery 1	**Brand Name**	Zebra	**Part Number**	BT-000314-01
Battery 2	**Brand Name**	Zebra	**Part Number**	BT-000314-50
Rugged Charge/USB cable	**Brand Name**	Zebra	**Part Number**	CBL-TC51-USB1-01
Headset Jumper 1	**Brand Name**	Zebra	**Part Number**	CBL-TC51-HDST25-01
Headset Jumper 2	**Brand Name**	Zebra	**Part Number**	CBL-TC51-HDST35-01
2.5mm Earphone	**Brand Name**	Zebra	**Part Number**	HDST-25MM-PTVP-01
3.5mm Earphone	**Brand Name**	Zebra	**Part Number**	HDST-35MM-PTVP-01
Exoskeleton	**Brand Name**	Zebra	**Part Number**	SG-TC51-EX01-01
Trigger Handle	**Brand Name**	Zebra	**Part Number**	TRG-TC51-SNP1-01
Soft Holster	**Brand Name**	Zebra	**Part Number**	SG-TC51-HLSTR1-01
Hand strap	**Brand Name**	Zebra	**Part Number**	SG-TC51-BHDSTP1-03
USB-C Adaptor	**Brand Name**	Zebra	**Part Number**	ADPTR-TC56-USBC-01
USB Type C cable	**Brand Name**	Zebra	**Part Number**	N/A

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	**<Class I>** Bluetooth BR(1Mbps) : 7.46 dBm (0.0056 W) Bluetooth EDR (2Mbps) : 9.47 dBm (0.0089 W) Bluetooth EDR (3Mbps) : 9.79 dBm (0.0095 W) **<Class II>** Bluetooth BR(1Mbps) : 3.82 dBm (0.0024 W) Bluetooth EDR (2Mbps) : 6.00 dBm (0.0040 W) Bluetooth EDR (3Mbps) : 6.25 dBm (0.0042 W)
99% Occupied Bandwidth	Bluetooth BR(1Mbps) : 0.885 MHz Bluetooth EDR (2Mbps) : 1.189 MHz Bluetooth EDR (3Mbps) : 1.178 MHz
Antenna Type / Gain	PIFA Antenna with gain 2.10 dBi
Type of Modulation	Bluetooth BR (1Mbps) : GFSK Bluetooth EDR (2Mbps) : π /4-DQPSK Bluetooth EDR (3Mbps) : 8-DPSK

Remark: The above EUT's information was declared by manufacturer. Please refer to Comments and Explanations in report summary.

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 (R.O.C.) TEL: +886-3-327-3456 FAX: +886-3-328-4978
Test Site No.	**Sporton Site No.**
	CO05-HY (TAF Code: 1190)
Remark	The AC Conducted Emission test item subcontracted to Sporton International Inc. EMC & Wireless Communications Laboratory.

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 (R.O.C.) TEL: +886-3-327-0868 FAX: +886-3-327-0855
Test Site No.	**Sporton Site No.**
	TH05-HY 03CH11-HY

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
- FCC KDB 414788 D01 Radiated Test Site v01r01
- 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.
3. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.

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

<Class I>

Channel	Frequency	Bluetooth Average Output Power		
		GFSK / 1Mbps		
		DH1	DH3	DH5
Ch00	2402MHz	7.24 dBm	7.26 dBm	7.24 dBm
Ch39	2441MHz	**7.27 dBm**	7.16 dBm	7.09 dBm
Ch78	2480MHz	6.99 dBm	6.98 dBm	6.97 dBm

Channel	Frequency	Bluetooth Average Output Power		
		π/4-DQPSK / 2Mbps		
		2DH1	2DH3	2DH5
Ch00	2402MHz	6.57 dBm	6.55 dBm	6.54 dBm
Ch39	2441MHz	**7.37 dBm**	7.36 dBm	7.24 dBm
Ch78	2480MHz	7.10 dBm	6.97 dBm	6.96 dBm

Channel	Frequency	Bluetooth Average Output Power		
		8-DPSK / 3Mbps		
		3DH1	3DH3	3DH5
Ch00	2402MHz	6.59 dBm	6.56 dBm	6.55 dBm
Ch39	2441MHz	**7.37 dBm**	7.36 dBm	7.32 dBm
Ch78	2480MHz	7.09 dBm	7.08 dBm	7.05 dBm

Channel	Frequency	Bluetooth Peak Output Power		
		GFSK / 1Mbps		
		DH1	DH3	DH5
Ch00	2402MHz	7.44 dBm	7.43 dBm	7.42 dBm
Ch39	2441MHz	**7.46 dBm**	7.44 dBm	7.35 dBm
Ch78	2480MHz	7.29 dBm	7.28 dBm	7.26 dBm

Channel	Frequency	Bluetooth Peak Output Power		
		π/4-DQPSK / 2Mbps		
		2DH1	2DH3	2DH5
Ch00	2402MHz	8.51 dBm	8.49 dBm	8.47 dBm
Ch39	2441MHz	**9.47 dBm**	9.46 dBm	9.45 dBm
Ch78	2480MHz	9.20 dBm	9.15 dBm	9.14 dBm

Channel	Frequency	Bluetooth Peak Output Power		
		8-DPSK / 3Mbps		
		3DH1	3DH3	3DH5
Ch00	2402MHz	8.76 dBm	8.75 dBm	8.73 dBm
Ch39	2441MHz	9.79 dBm	9.76 dBm	9.72 dBm
Ch78	2480MHz	9.52 dBm	9.51 dBm	9.50 dBm

Remark: The data rate was set in 3Mbps for all the test items due to the highest RF output power.

<Class II>

Channel	Frequency	Bluetooth Average Output Power		
		GFSK / 1Mbps		
		DH1	DH3	DH5
Ch00	2402MHz	1.11 dBm	1.24 dBm	1.26 dBm
Ch39	2441MHz	1.14 dBm	1.25 dBm	1.28 dBm
Ch78	2480MHz	2.09 dBm	2.16 dBm	**2.18 dBm**

Channel	Frequency	Bluetooth Average Output Power		
		π/4-DQPSK / 2Mbps		
		2DH1	2DH3	2DH5
Ch00	2402MHz	1.24 dBm	1.37 dBm	1.42 dBm
Ch39	2441MHz	1.29 dBm	1.43 dBm	1.47 dBm
Ch78	2480MHz	3.03 dBm	3.13 dBm	**3.14 dBm**

Channel	Frequency	Bluetooth Average Output Power		
		8-DPSK / 3Mbps		
		3DH1	3DH3	3DH5
Ch00	2402MHz	1.25 dBm	1.38 dBm	1.42 dBm
Ch39	2441MHz	1.27 dBm	1.40 dBm	1.46 dBm
Ch78	2480MHz	3.02 dBm	3.03 dBm	**3.06 dBm**

Channel	Frequency	Bluetooth Peak Output Power		
		GFSK / 1Mbps		
		DH1	DH3	DH5
Ch00	2402MHz	3.09 dBm	3.21 dBm	3.22 dBm
Ch39	2441MHz	3.11 dBm	3.18 dBm	3.19 dBm
Ch78	2480MHz	3.72 dBm	3.80 dBm	**3.82 dBm**

Channel	Frequency	Bluetooth Peak Output Power		
		π/4-DQPSK / 2Mbps		
		2DH1	2DH3	2DH5
Ch00	2402MHz	4.54 dBm	4.70 dBm	4.75 dBm
Ch39	2441MHz	4.73 dBm	4.74 dBm	4.87 dBm
Ch78	2480MHz	5.89 dBm	5.98 dBm	**6.00 dBm**

Channel	Frequency	Bluetooth Peak Output Power		
		8-DPSK / 3Mbps		
		3DH1	3DH3	3DH5
Ch00	2402MHz	4.69 dBm	4.73 dBm	4.82 dBm
Ch39	2441MHz	5.00 dBm	5.02 dBm	5.05 dBm
Ch78	2480MHz	6.17 dBm	6.19 dBm	**6.25 dBm**

Remark: The class II was tested with power only.

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 (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, pre-scanned in three orthogonal panels, X, Y, Z. The worst cases (Z plane) were recorded in this report, and the worst mode of radiated spurious emissions is Bluetooth 3Mbps mode, and recorded in this report.

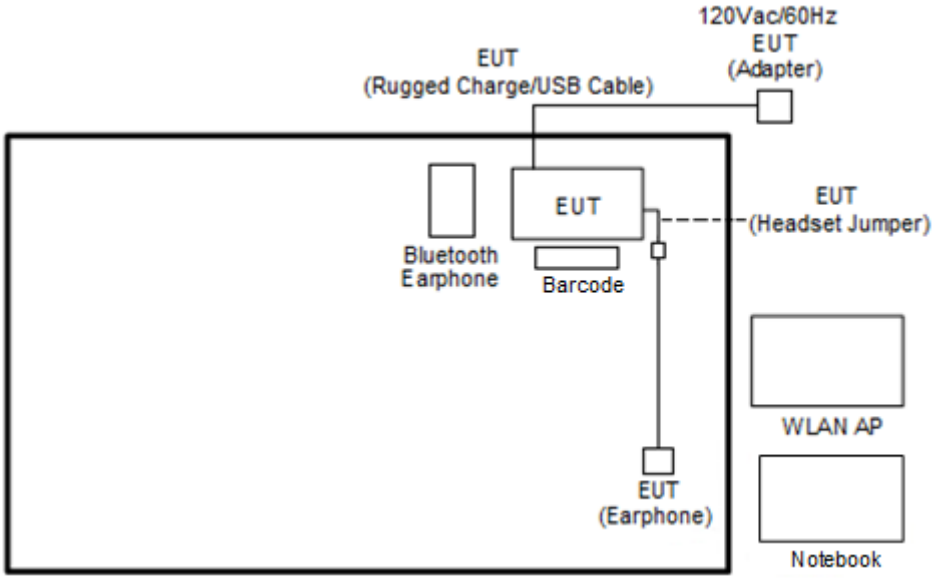
b. AC power line Conducted Emission was tested under maximum output power.

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

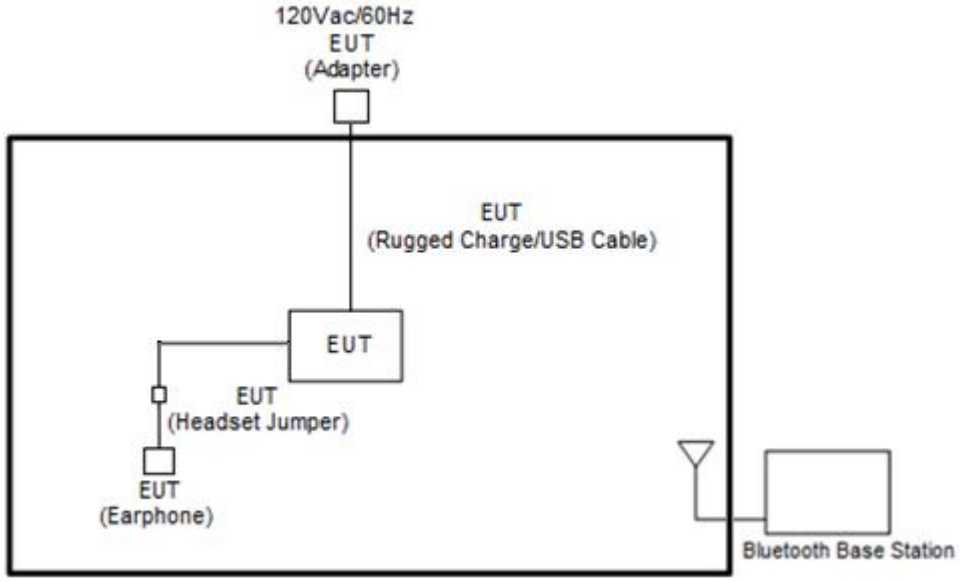
<table>
<tr><th colspan="4">Summary table of Test Cases</th></tr>
<tr><th>Test Item</th><th colspan="3">Data Rate / Modulation</th></tr>
<tr><td rowspan="4">Conducted Test Cases</td><td>Bluetooth BR 1Mbps GFSK</td><td>Bluetooth EDR 2Mbps π/4-DQPSK</td><td>Bluetooth EDR 3Mbps 8-DPSK</td></tr>
<tr><td>Mode 1: CH00_2402 MHz</td><td>Mode 4: CH00_2402 MHz</td><td>Mode 7: CH00_2402 MHz</td></tr>
<tr><td>Mode 2: CH39_2441 MHz</td><td>Mode 5: CH39_2441 MHz</td><td>Mode 8: CH39_2441 MHz</td></tr>
<tr><td>Mode 3: CH78_2480 MHz</td><td>Mode 6: CH78_2480 MHz</td><td>Mode 9: CH78_2480 MHz</td></tr>
<tr><td rowspan="4">Radiated Test Cases</td><td colspan="3">Bluetooth EDR 3Mbps 8-DPSK</td></tr>
<tr><td colspan="3">Mode 1: CH00_2402 MHz</td></tr>
<tr><td colspan="3">Mode 2: CH39_2441 MHz</td></tr>
<tr><td colspan="3">Mode 3: CH78_2480 MHz</td></tr>
<tr><td>AC Conducted Emission</td><td colspan="3">Mode 1 : WLAN (2.4GHz) Link + Bluetooth Link + Battery 1 + Scanner + Headset Jumper 1 + 2.5mm Earphone + Rugged Charge/USB cable (Charging from Adapter)</td></tr>
<tr><td colspan="4">Remark:
1. For Radiated Test Cases, the worst mode data rate 3Mbps 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 3Mbps, and no other significantly frequencies found in conducted spurious emission.
2. For Radiated Test Cases, the tests were performed with Battery 1, Headset Jumper 2 and 3.5mm Earphone.</td></tr>
</table>

2.3 Connection Diagram of Test System

<AC Conducted Emission Mode>



<Bluetooth Tx Mode>



2.4 Support Unit used in test configuration and system

Item	Equipment	Brand Name	Model Name	FCC ID	Data Cable	Power Cord
1.	Bluetooth Earphone	Sony Ericsson	MW600	PY7DDA-2029	N/A	N/A
2.	WLAN AP	ASUS	RT-AC66U	MSQ-RTAC66U	N/A	Unshielded, 1.8 m
3.	Notebook	DELL	Latitude E6320	FCC DoC/ Contains FCC ID: QDS-BRCM1054	N/A	AC I/P: Unshielded, 1.2 m DC O/P: Shielded, 1.8 m
4.	SD Card	SanDisk	MicroSD HC	FCC DoC	N/A	N/A
5.	Bluetooth Base Station	R&S	101135	N/A	N/A	N/A
6.	Notebook	DELL	Latitude 3400	FCC DoC	N/A	AC I/P：Unshielded, 1.2m DC O/P：Shielded, 1.8m
7.	Notebook	DELL	PP42L	FCC DoC	N/A	AC I/P: Unshielded, 0.8 m DC O/P: Shielded, 1.77 m
8.	Barcode	N/A	N/A	N/A	N/A	N/A

2.5 EUT Operation Test Setup

The RF test items, utility “cmd” 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.

2.6 Measurement Results Explanation Example

For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Example:
The spectrum analyzer offset is derived from RF cable loss and attenuator factor.
Offset = RF cable loss + attenuator factor.
Following shows an offset computation example with cable loss 4.2 dB and 10 dB attenuator.

Offset(dB) = RF cable loss(dB) + attenuator factor(dB).
= 4.2 + 10 = 14.2 (dB)

3 Test Result

3.1 Number of Channel Measurement

3.1.1 Limits of Number of Hopping Frequency

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

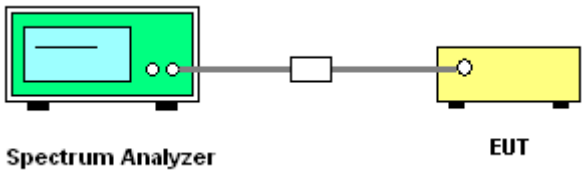
3.1.2 Measuring Instruments

See list of measuring equipment of this test report.

3.1.3 Test Procedure

1. The testing follows ANSI C63.10-2013 clause 7.8.3.
2. The RF output of EUT was connected to the spectrum analyzer 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. Enable the EUT hopping function.
5. Use the following spectrum analyzer settings: Span = the frequency band of operation; RBW = 300 kHz; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold.
6. The number of hopping frequency used is defined as the number of total channel.
7. Record the measurement data derived from spectrum analyzer.

3.1.4 Test Setup

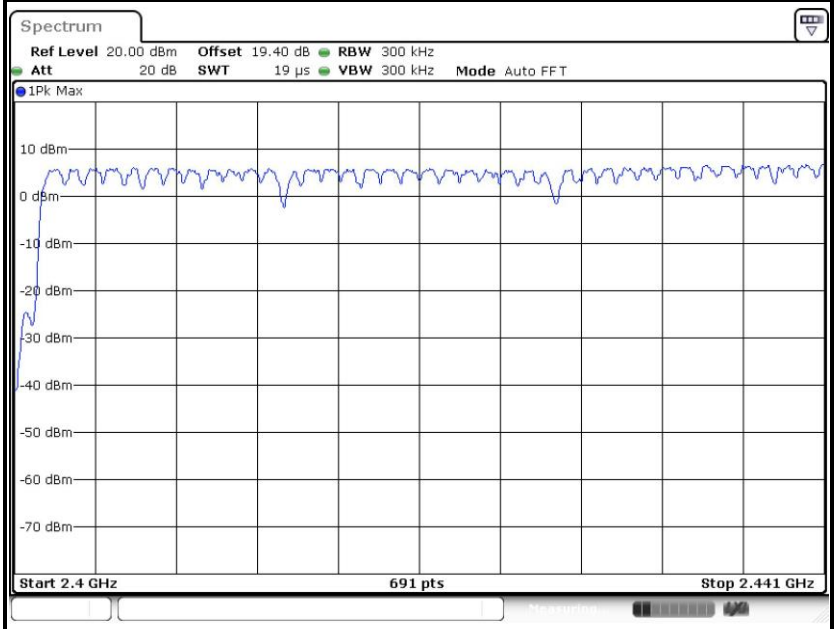


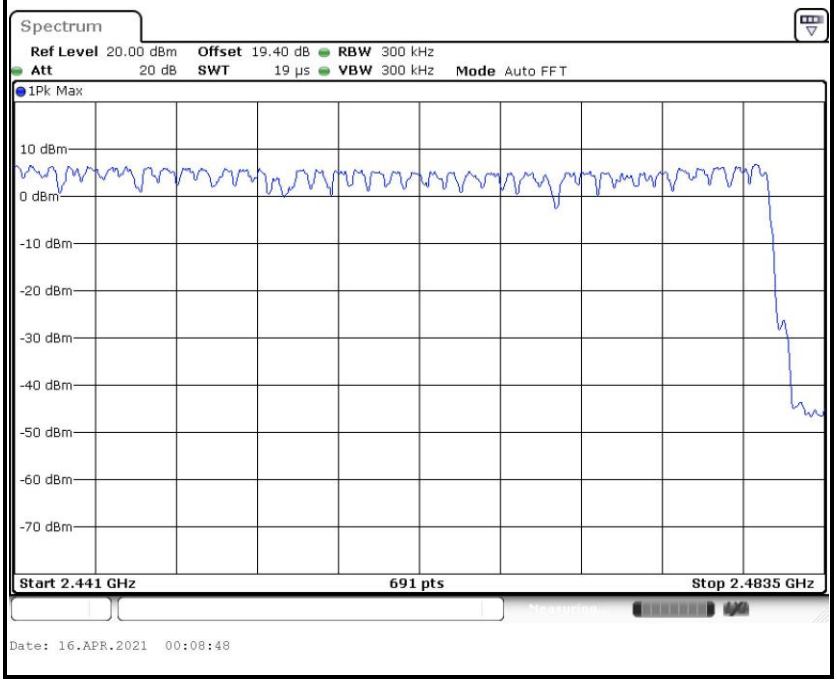
3.1.5 Test Result of Number of Hopping Frequency

Test Engineer :	Ching Chen, Derek Hsu and Hank Hsu	Temperature :	21.6~22.9℃
		Relative Humidity :	46.9~51.4%

Number of Hopping (Channel)	Adaptive Frequency Hopping (Channel)	Limits (Channel)	Pass/Fail
79	20	> 15	Pass

Number of Hopping Channel Plot on Channel 00 - 78





3.2 Hopping Channel Separation Measurement

3.2.1 Limit of Hopping Channel Separation

Frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater.

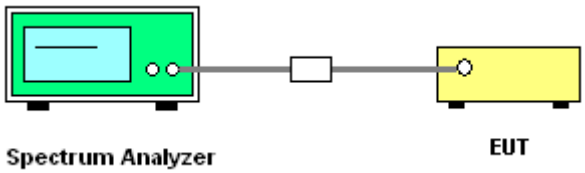
3.2.2 Measuring Instruments

See list of measuring equipment of this test report.

3.2.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.2.
2. The RF output of EUT was connected to the spectrum analyzer 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. Enable the EUT hopping function.
5. Use the following spectrum analyzer settings:
   Span = wide enough to capture the peaks of two adjacent channels;
   RBW = 300 kHz; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold.
6. Measure and record the results in the test report.

3.2.4 Test Setup

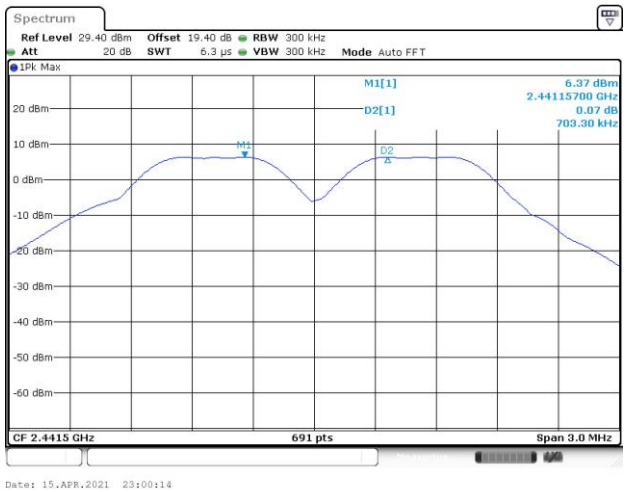
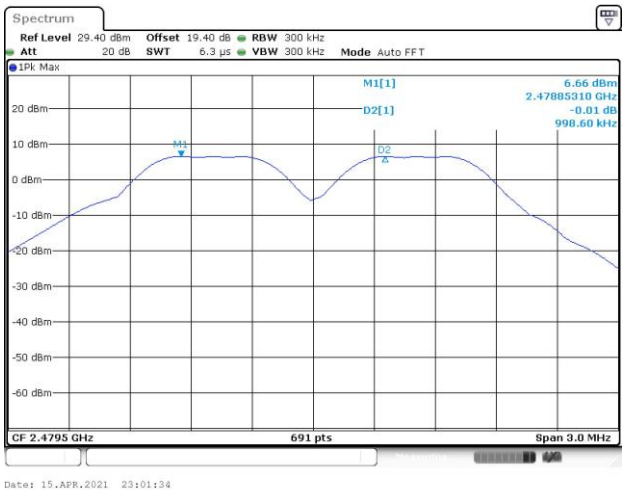


3.2.5 Test Result of Hopping Channel Separation

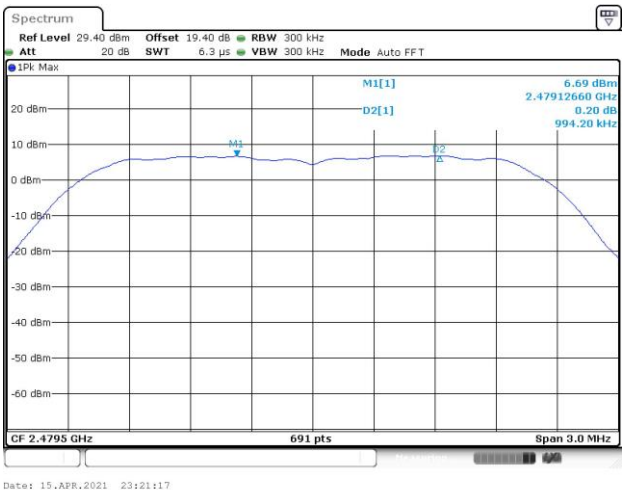
Test Engineer :	Ching Chen, Derek Hsu and Hank Hsu	Temperature :	21.6~22.9℃
		Relative Humidity :	46.9~51.4%

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Hopping Channel Separation Measurement (MHz)	Hopping Channel Separation Measurement Limit (MHz)	Pass/Fail
DH	1Mbps	1	0	2402	0.998	0.5880	Pass
DH	1Mbps	1	39	2441	0.703	0.6653	Pass
DH	1Mbps	1	78	2480	0.998	0.6633	Pass
2DH	2Mbps	1	0	2402	1.002	0.8567	Pass
2DH	2Mbps	1	39	2441	0.989	0.8940	Pass
2DH	2Mbps	1	78	2480	0.994	0.8940	Pass
3DH	3Mbps	1	0	2402	0.998	0.8593	Pass
3DH	3Mbps	1	39	2441	0.998	0.8593	Pass
3DH	3Mbps	1	78	2480	1.002	0.8567	Pass

<1Mbps>

Channel Separation Plot on Channel 00 - 01	Channel Separation Plot on Channel 39 - 40
	
Channel Separation Plot on Channel 77 - 78	**N/A**
	

<2Mbps>

Channel Separation Plot on Channel 00 - 01	Channel Separation Plot on Channel 39 - 40
	
Channel Separation Plot on Channel 77 - 78	**N/A**
	

<3Mbps>

Channel Separation Plot on Channel 00 - 01	Channel Separation Plot on Channel 39 - 40
	
Channel Separation Plot on Channel 77 - 78	**N/A**
	

3.3 Dwell Time Measurement

3.3.1 Limit of Dwell Time

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

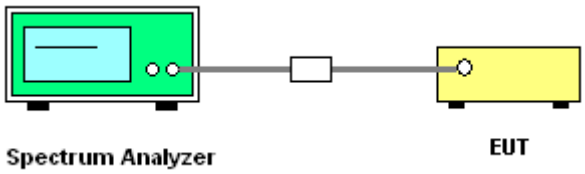
3.3.2 Measuring Instruments

See list of measuring equipment of this test report.

3.3.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.4.
2. The RF output of EUT was connected to the spectrum analyzer 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. Enable the EUT hopping function.
5. Use the following spectrum analyzer settings: Span = zero span, centered on a hopping channel; RBW = 1 MHz; VBW ≥ RBW; Sweep = as necessary to capture the entire dwell time per hopping channel; Detector function = peak; Trace = max hold.
6. Measure and record the results in the test report.

3.3.4 Test Setup

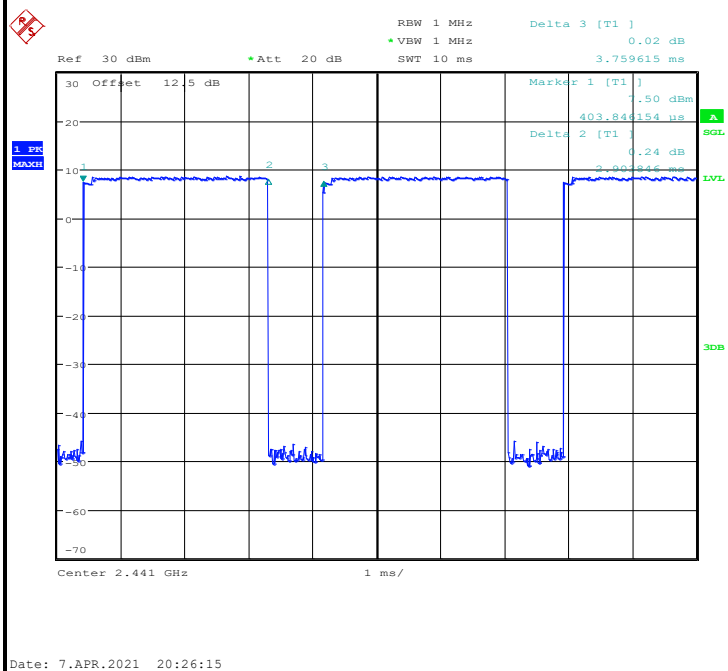


3.3.5 Test Result of Dwell Time

Test Engineer :	Ching Chen, Derek Hsu and Hank Hsu	Temperature :	21.6~22.9℃
		Relative Humidity :	46.9~51.4%

Mod.	Hopping Channel Number Rate	Hops Over Occupancy Time(hops)	Package Transfer Time (msec)	Dwell Time (sec)	Limits (sec)	Pass/Fail
Nomal	79	106.67	2.90	0.31	0.4	Pass
AFH	20	53.33	2.90	0.15	0.4	Pass

Package Transfer Time Plot



Remark:

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

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

3. Dwell Time(s) = Hops Over Occupancy Time (hops) x Package Transfer Time

3.4 20dB and 99% Bandwidth Measurement

3.4.1 Limit of 20dB and 99% Bandwidth

Reporting only

3.4.2 Measuring Instruments

See list of measuring equipment of this test report.

3.4.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 6.9.2 and 6.9.3.
2. The RF output of EUT was connected to the spectrum analyzer 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. Use the following spectrum analyzer settings for 20 dB Bandwidth measurement.
   Span = approximately 2 to 5 times the 20 dB bandwidth, centered on a hopping channel;
   RBW ≥ 1% of the 20 dB bandwidth; VBW ≥ RBW; Sweep = auto; Detector function = peak;
   Trace = max hold.
5. Use the following spectrum analyzer settings for 99 % Bandwidth measurement.
   Span = approximately 1.5 to 5 times the 99% bandwidth, centered on a hopping channel;
   RBW ≥ 1-5% of the 99% bandwidth; VBW ≥ 3 * RBW; Sweep = auto; Detector function = peak;
   Trace = max hold.
6. Measure and record the results in the test report.

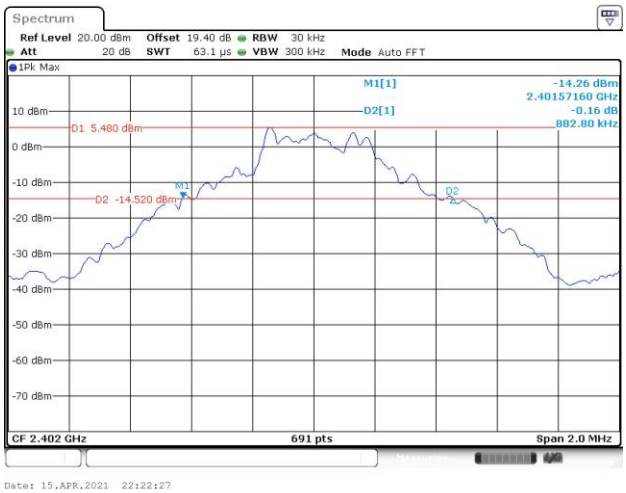
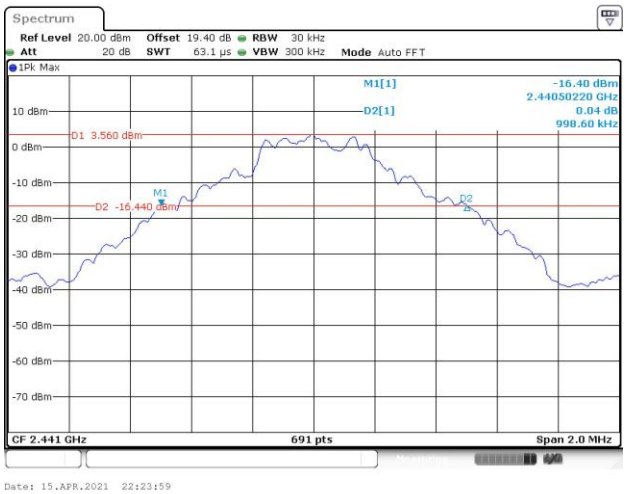
3.4.4 Test Setup

3.4.5 Test Result of 20dB Bandwidth

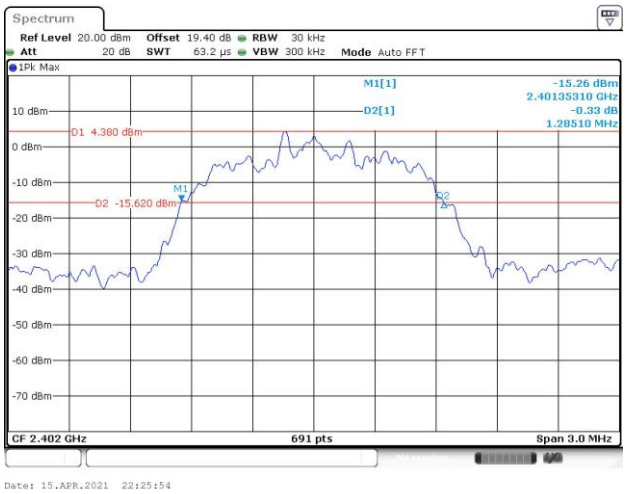
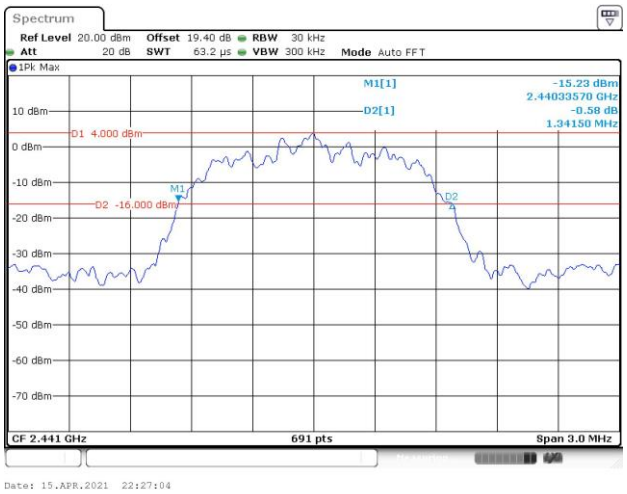
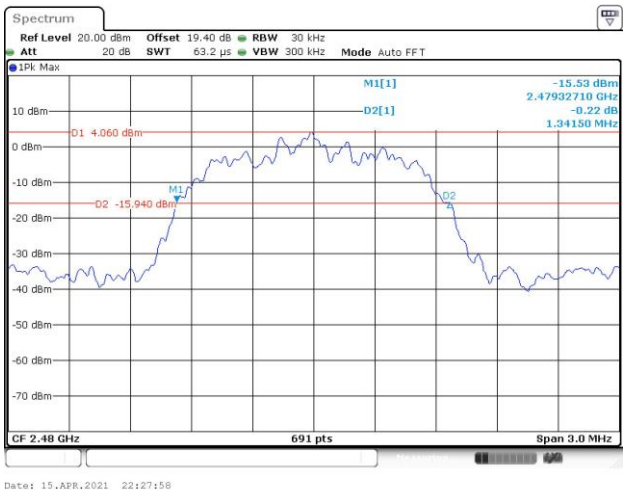
Test Engineer :	Ching Chen, Derek Hsu and Hank Hsu	Temperature :	21.6~22.9℃
		Relative Humidity :	46.9~51.4%

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	20db BW (MHz)	Pass/Fail
DH	1Mbps	1	0	2402	0.882	Pass
DH	1Mbps	1	39	2441	0.998	Pass
DH	1Mbps	1	78	2480	0.995	Pass
2DH	2Mbps	1	0	2402	1.285	Pass
2DH	2Mbps	1	39	2441	1.341	Pass
2DH	2Mbps	1	78	2480	1.341	Pass
3DH	3Mbps	1	0	2402	1.289	Pass
3DH	3Mbps	1	39	2441	1.289	Pass
3DH	3Mbps	1	78	2480	1.285	Pass

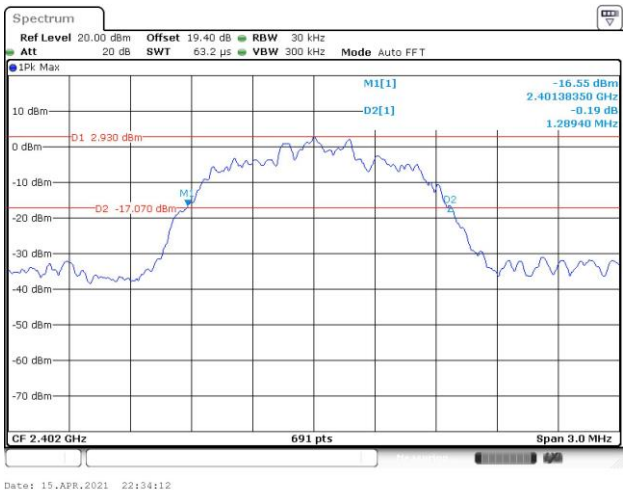
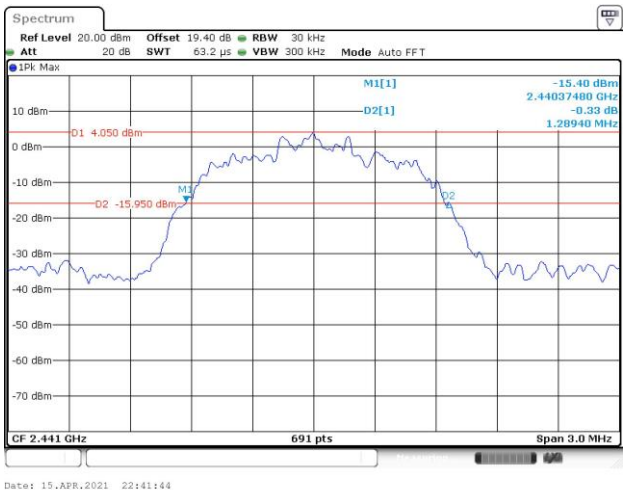
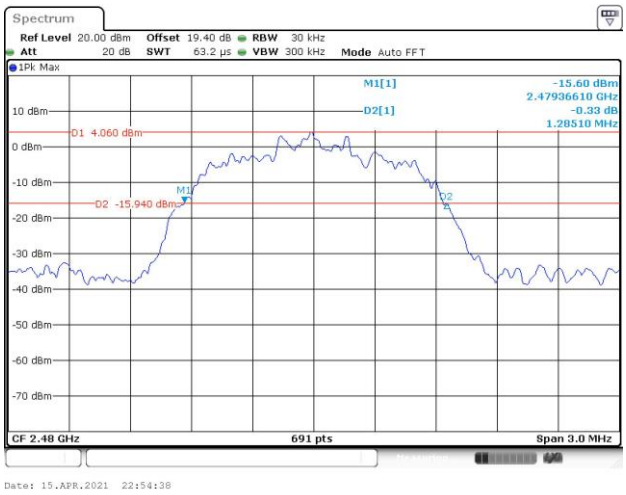
<1Mbps>

20 dB Bandwidth Plot on Channel 00	20 dB Bandwidth Plot on Channel 39
	
20 dB Bandwidth Plot on Channel 78	**N/A**
	

<2Mbps>

20 dB Bandwidth Plot on Channel 00	20 dB Bandwidth Plot on Channel 39
	
20 dB Bandwidth Plot on Channel 78	**N/A**
	

<3Mbps>

20 dB Bandwidth Plot on Channel 00	20 dB Bandwidth Plot on Channel 39
	
20 dB Bandwidth Plot on Channel 78	**N/A**
	

3.4.6 Test Result of 99% Occupied Bandwidth

Test Engineer :	Ching Chen, Derek Hsu and Hank Hsu	Temperature :	21.6~22.9℃
		Relative Humidity :	46.9~51.4%

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	99% Bandwidth (MHz)	Pass/Fail
DH	1Mbps	1	0	2402	0.865	Pass
DH	1Mbps	1	39	2441	0.885	Pass
DH	1Mbps	1	78	2480	0.885	Pass
2DH	2Mbps	1	0	2402	1.183	Pass
2DH	2Mbps	1	39	2441	1.189	Pass
2DH	2Mbps	1	78	2480	1.189	Pass
3DH	3Mbps	1	0	2402	1.178	Pass
3DH	3Mbps	1	39	2441	1.175	Pass
3DH	3Mbps	1	78	2480	1.175	Pass

<1Mbps>

99% Occupied Bandwidth Plot on Channel 00	99% Occupied Bandwidth Plot on Channel 39
	
99% Occupied Bandwidth Plot on Channel 78	**N/A**
	

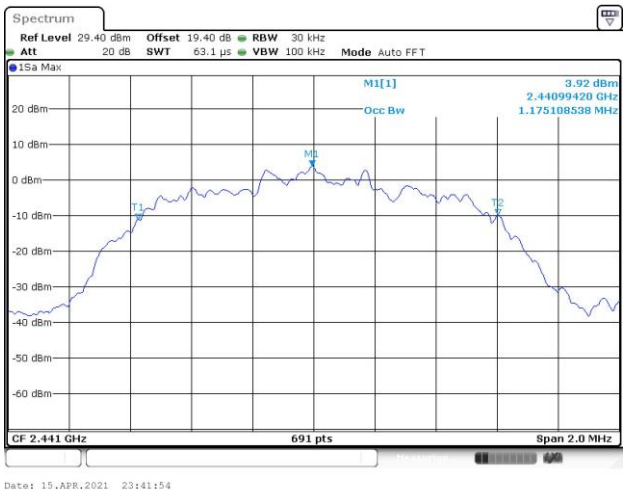
Note: The occupied channel bandwidth is maintained within the band of operation for all of the modulations.

<2Mbps>

99% Occupied Bandwidth Plot on Channel 00	99% Occupied Bandwidth Plot on Channel 39
	
99% Occupied Bandwidth Plot on Channel 78	**N/A**
	

Note: The occupied channel bandwidth is maintained within the band of operation for all of the modulations.

<3Mbps>

99% Occupied Bandwidth Plot on Channel 00	99% Occupied Bandwidth Plot on Channel 39
	
99% Occupied Bandwidth Plot on Channel 78	**N/A**
	

Note: The occupied channel bandwidth is maintained within the band of operation for all of the modulations.

3.5 Output Power Measurement

3.5.1 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.

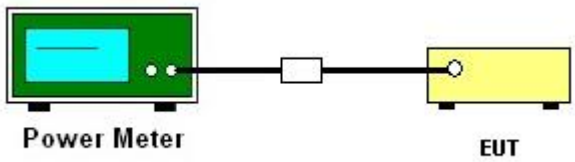
3.5.2 Measuring Instruments

See list of measuring equipment of this test report.

3.5.3 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.

3.5.4 Test Setup



3.5.5 Test Result of Peak Output Power

Test Engineer :	Ching Chen, Derek Hsu and Hank Hsu	Temperature :	21.6~22.9℃
		Relative Humidity :	46.9~51.4%

<Class I>

DH	CH.	NTX	Peak Power (dBm)	Power Limit (dBm)	Test Result
DH1	0	1	7.44	20.97	Pass
	39	1	**7.46**	20.97	Pass
	78	1	7.29	20.97	Pass
2DH1	0	1	8.51	20.97	Pass
	39	1	**9.47**	20.97	Pass
	78	1	9.20	20.97	Pass
3DH1	0	1	8.76	20.97	Pass
	39	1	**9.79**	20.97	Pass
	78	1	9.52	20.97	Pass

<Class II>

DH	CH.	NTX	Peak Power (dBm)	Power Limit (dBm)	Test Result
DH5	0	1	3.22	20.97	Pass
	39	1	3.19	20.97	Pass
	78	1	**3.82**	20.97	Pass
2DH5	0	1	4.75	20.97	Pass
	39	1	4.87	20.97	Pass
	78	1	**6.00**	20.97	Pass
3DH5	0	1	4.82	20.97	Pass
	39	1	5.05	20.97	Pass
	78	1	**6.25**	20.97	Pass

3.5.6 Test Result of Average Output Power (Reporting Only)

Test Engineer :	Ching Chen, Derek Hsu and Hank Hsu	Temperature :	21.6~22.9℃
		Relative Humidity :	46.9~51.4%

<Class I>

DH	CH.	NTX	Average Power (dBm)	Duty Factor (dB)
DH1	0	1	7.24	5.16
	39	1	**7.27**	5.16
	78	1	6.99	5.16
2DH1	0	1	6.57	5.09
	39	1	**7.37**	5.09
	78	1	7.10	5.09
3DH1	0	1	6.59	5.12
	39	1	**7.37**	5.12
	78	1	7.09	5.12

<Class II>

DH	CH.	NTX	Average Power (dBm)	Duty Factor (dB)
DH5	0	1	1.26	1.14
	39	1	1.28	1.14
	78	1	**2.18**	1.14
2DH5	0	1	1.42	1.14
	39	1	1.47	1.14
	78	1	**3.14**	1.14
3DH5	0	1	1.42	1.12
	39	1	1.46	1.12
	78	1	**3.06**	1.12

3.6 Conducted Band Edges Measurement

3.6.1 Limit of Band Edges

In any 100 kHz bandwidth outside the intentional radiation frequency band, the radio frequency power shall be at least 20 dB below the highest level of the radiated power. In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits.

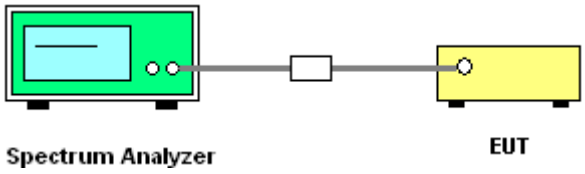
3.6.2 Measuring Instruments

See list of measuring equipment of this test report.

3.6.3 Test Procedures

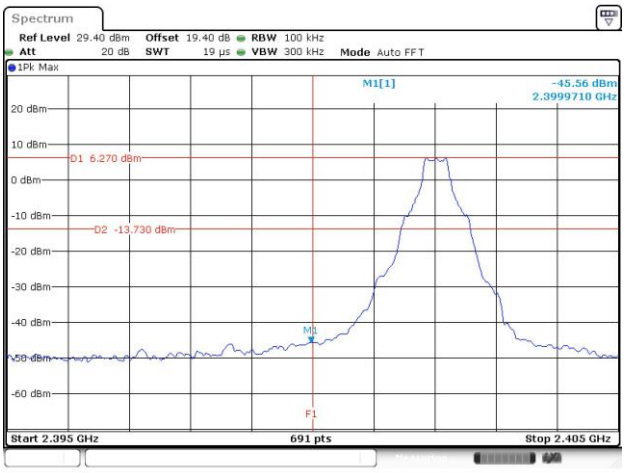
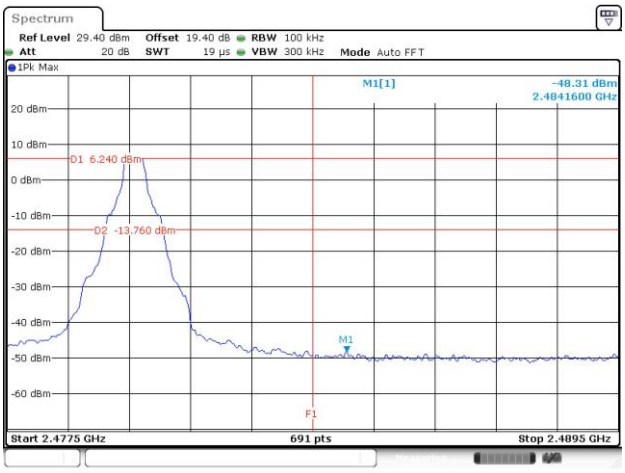
1. The testing follows ANSI C63.10-2013 clause 7.8.6.
2. Set the maximum power setting and enable the EUT to transmit continuously.
3. Set RBW = 100 kHz, VBW = 300 kHz. Band edge emissions must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100 kHz RBW. The attenuation shall be 30 dB instead of 20 dB when RMS conducted output power procedure is used.
4. Enable hopping function of the EUT and then repeat step 2 and 3.
5. Measure and record the results in the test report.

3.6.4 Test Setup

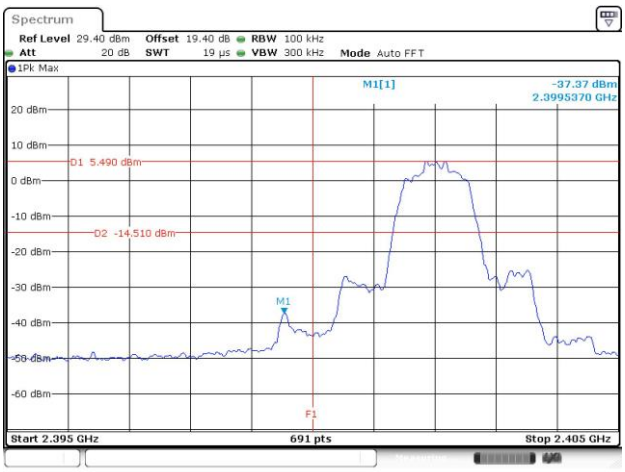
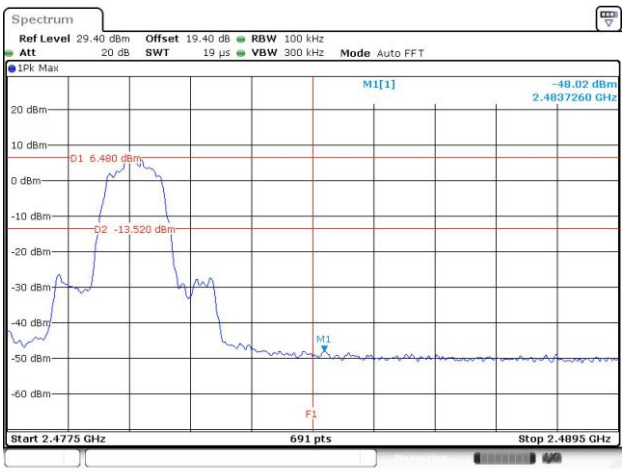


3.6.5 Test Result of Conducted Band Edges

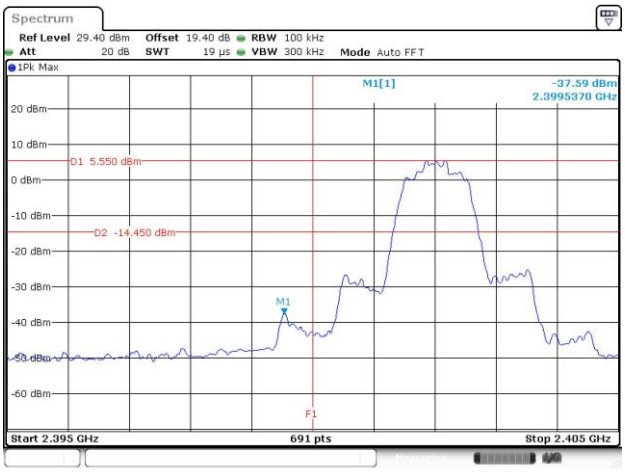
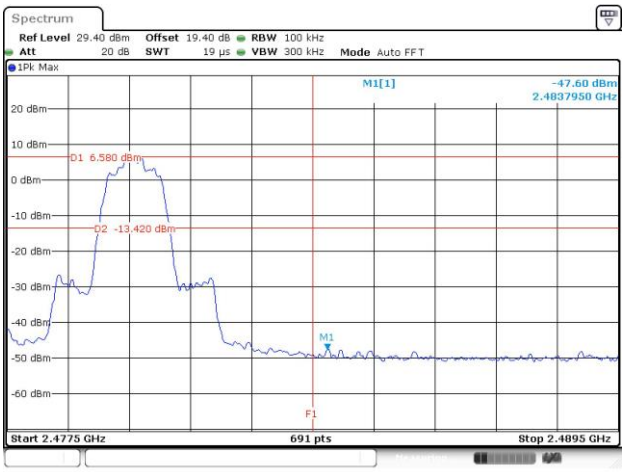
<1Mbps>

Low Band Edge Plot on Channel 00	High Band Edge Plot on Channel 78
	

<2Mbps>

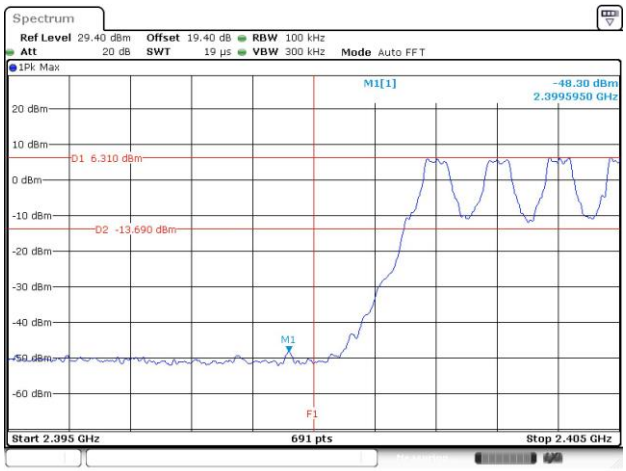
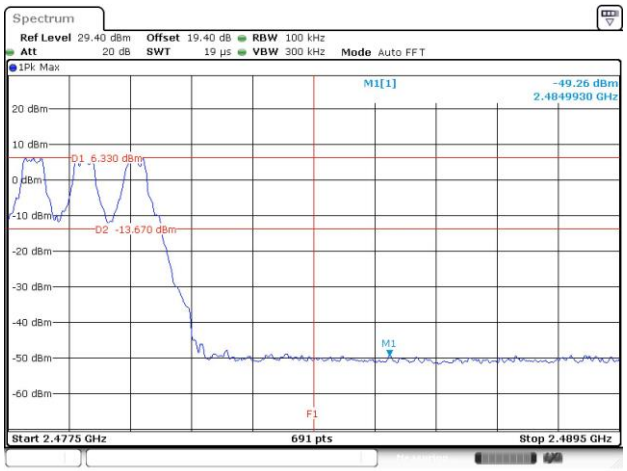
Low Band Edge Plot on Channel 00	High Band Edge Plot on Channel 78
	

<3Mbps>

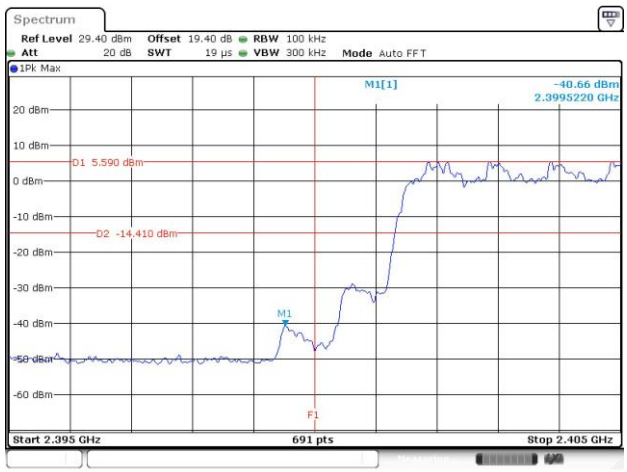
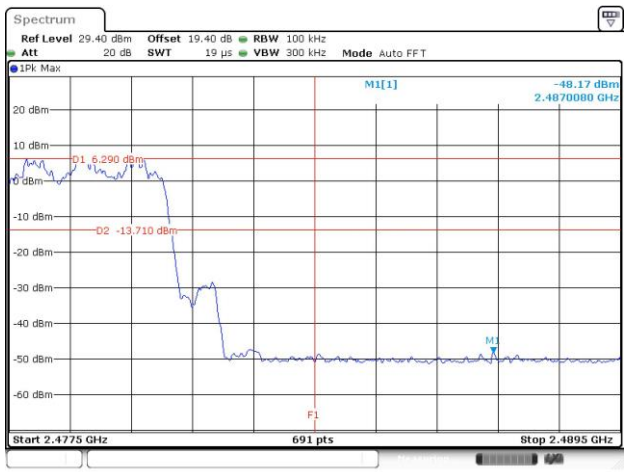
Low Band Edge Plot on Channel 00	High Band Edge Plot on Channel 78
	

3.6.6 Test Result of Conducted Hopping Mode Band Edges

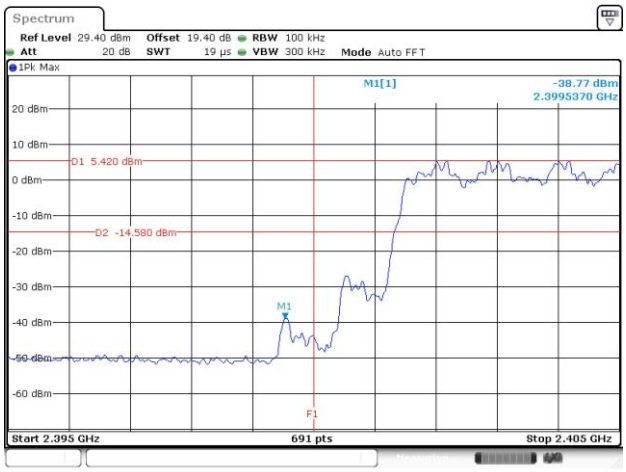
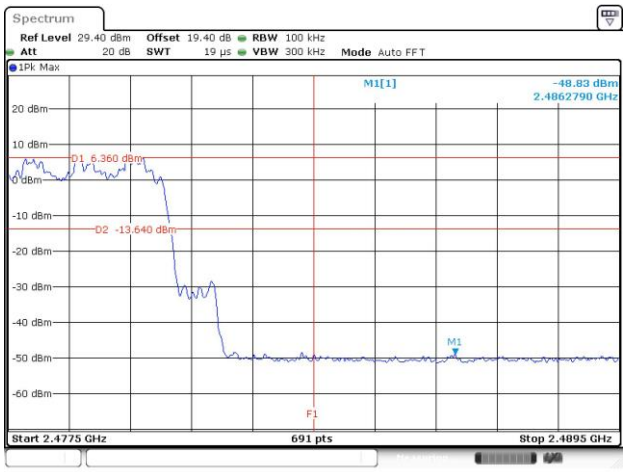
<1Mbps>

Hopping Mode Low Band Edge Plot	Hopping Mode High Band Edge Plot
	

<2Mbps>

Hopping Mode Low Band Edge Plot	Hopping Mode High Band Edge Plot
	

<3Mbps>

Hopping Mode Low Band Edge Plot	Hopping Mode High Band Edge Plot
	

3.7 Conducted Spurious Emission Measurement

3.7.1 Limit of Spurious Emission Measurement

In any 100 kHz bandwidth outside the intentional radiation frequency band, the radio frequency power shall be at least 20 dB below the highest level of the radiated power. In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits.

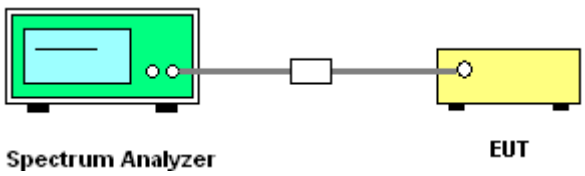
3.7.2 Measuring Instruments

See list of measuring equipment of this test report.

3.7.3 Test Procedure

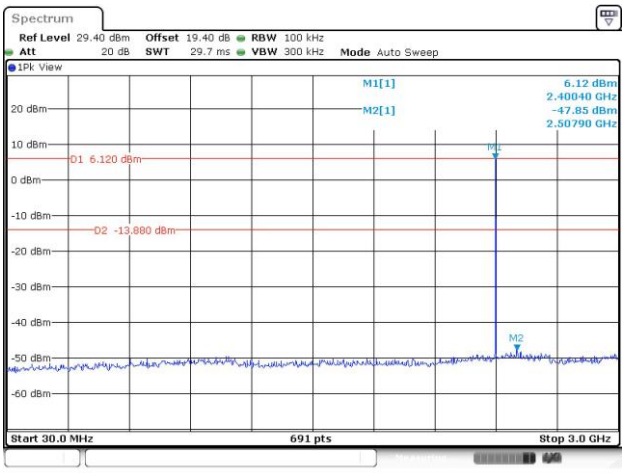
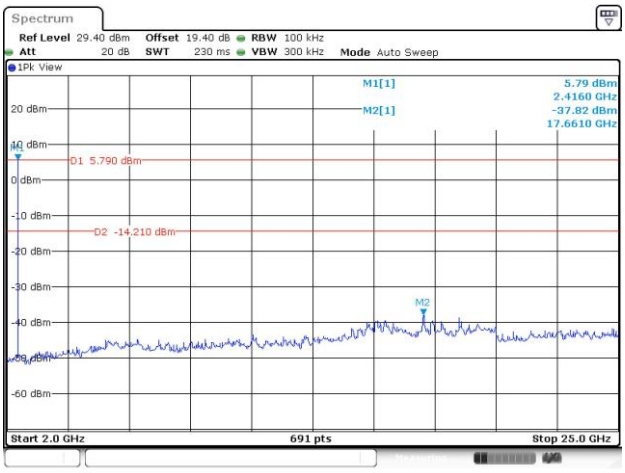
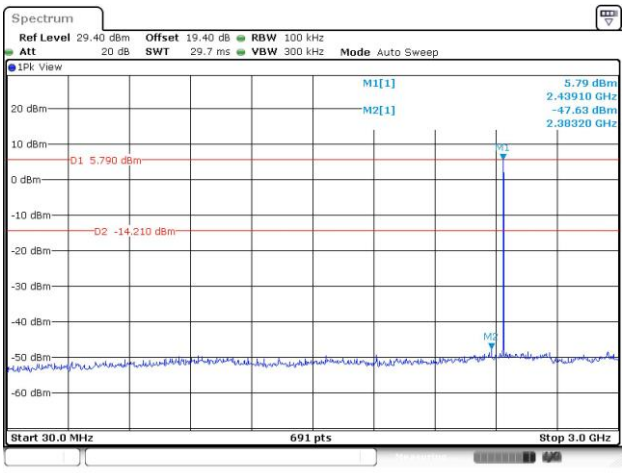
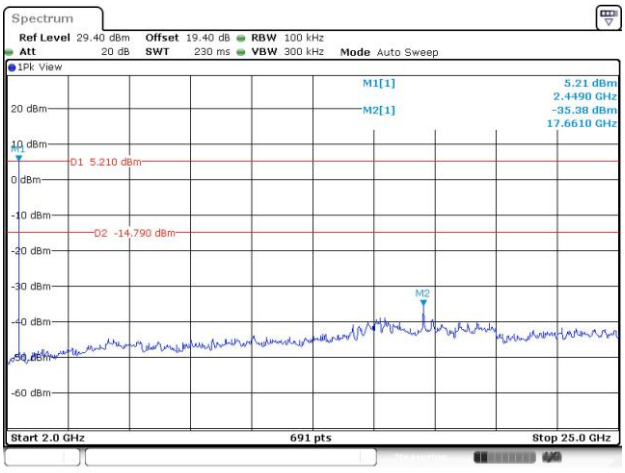
1. The testing follows ANSI C63.10-2013 clause 7.8.8.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Set RBW = 100 kHz, VBW = 300 kHz, scan up through 10th harmonic. All harmonics / spurious must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100 kHz RBW.
5. Measure and record the results in the test report.
6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

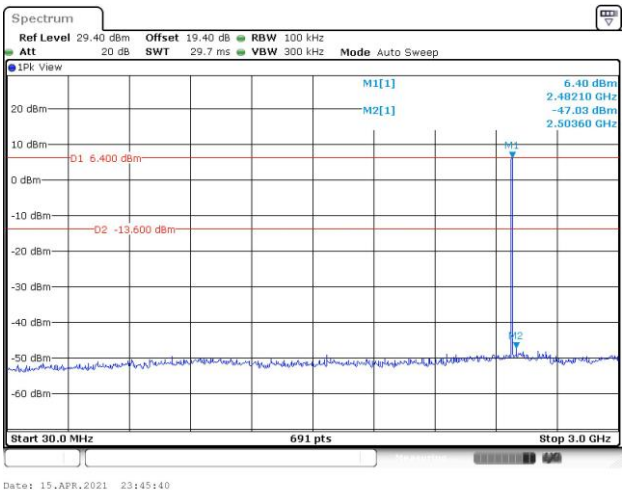
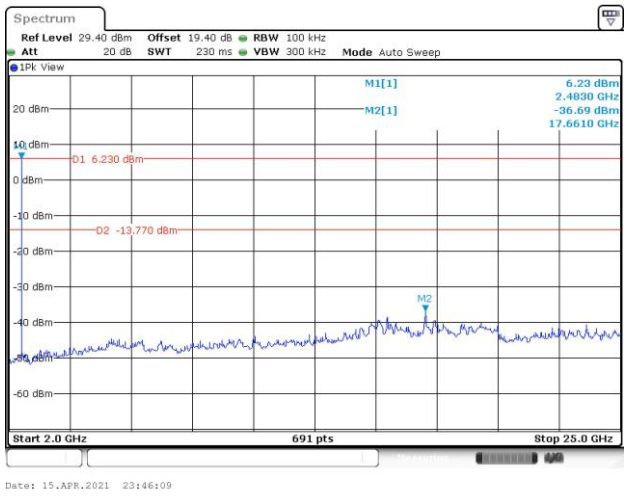
3.7.4 Test Setup



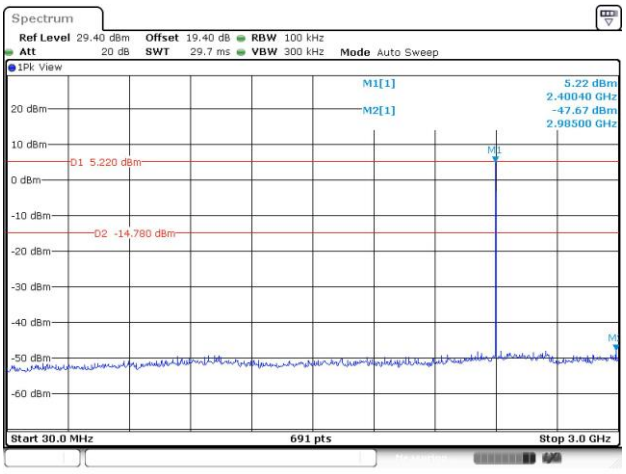
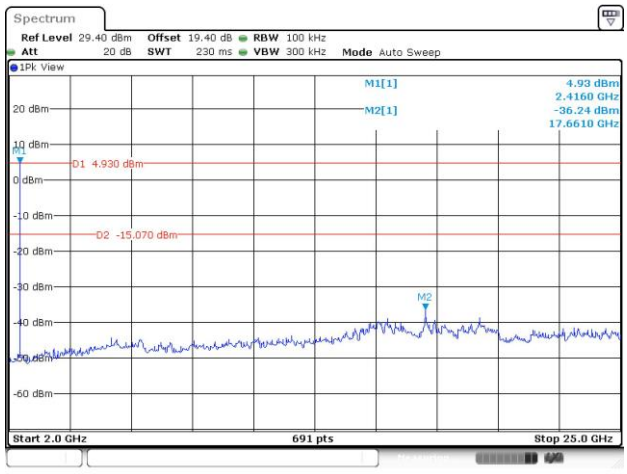
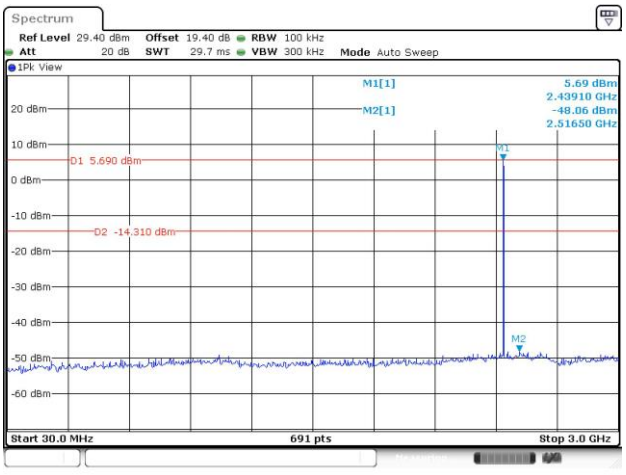
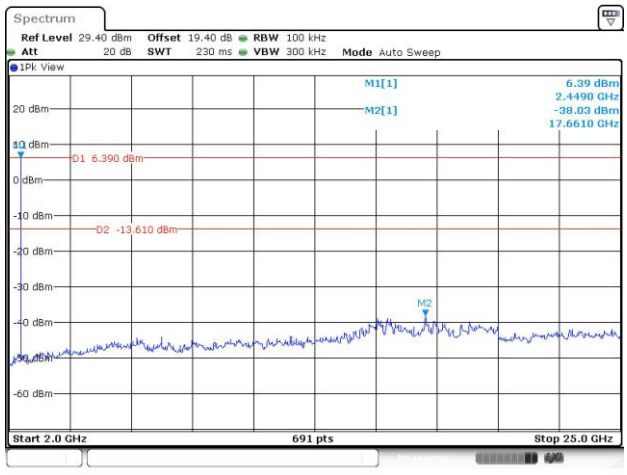
3.7.5 Test Result of Conducted Spurious Emission

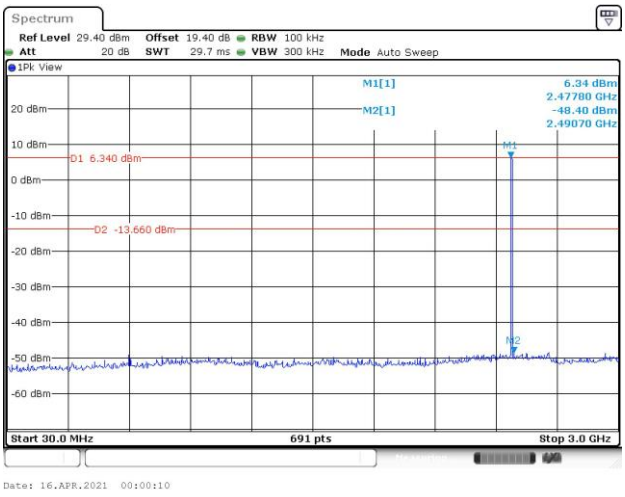
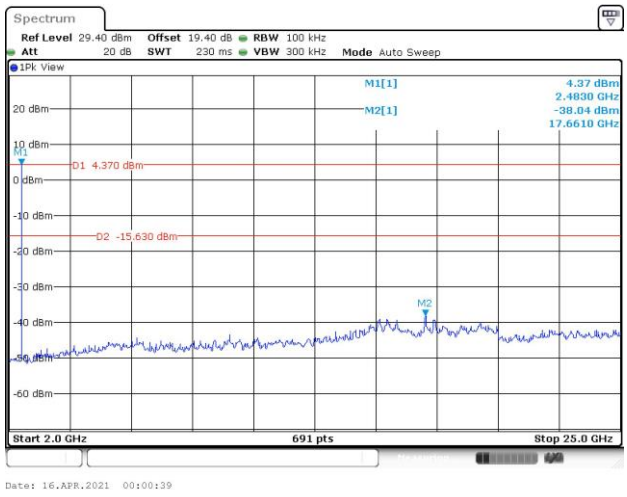
<1Mbps>

CSE Plot on CH 00 between 30 MHz ~ 3 GHz	CSE Plot on CH 00 between 2 GHz ~ 25 GHz
	
CSE Plot on CH 39 between 30 MHz ~ 3 GHz	**CSE Plot on CH 39 between 2 GHz ~ 25 GHz**
	

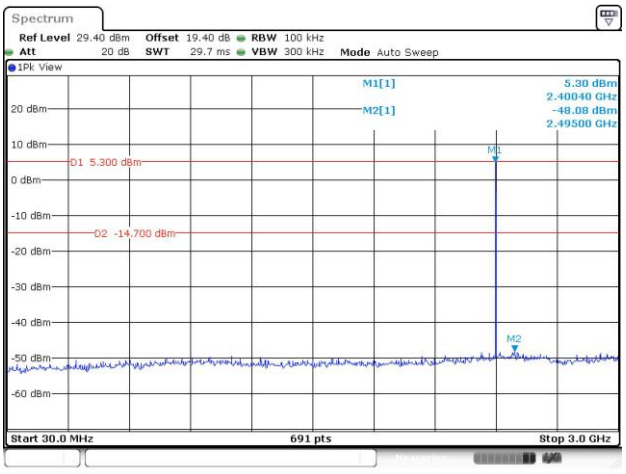
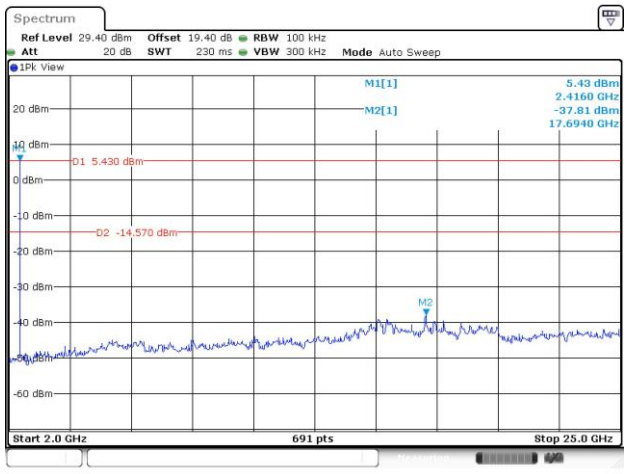
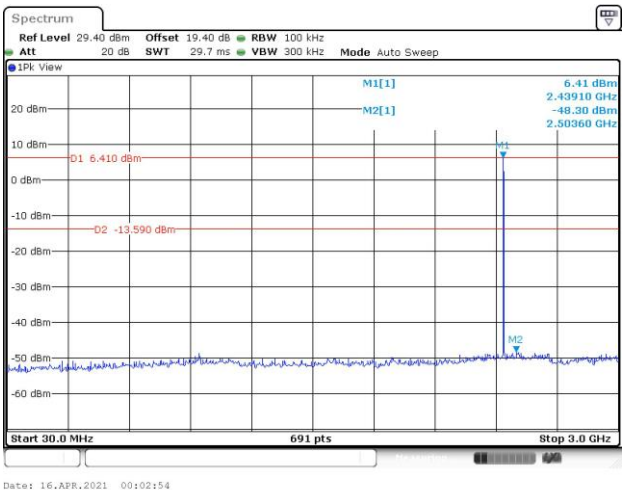
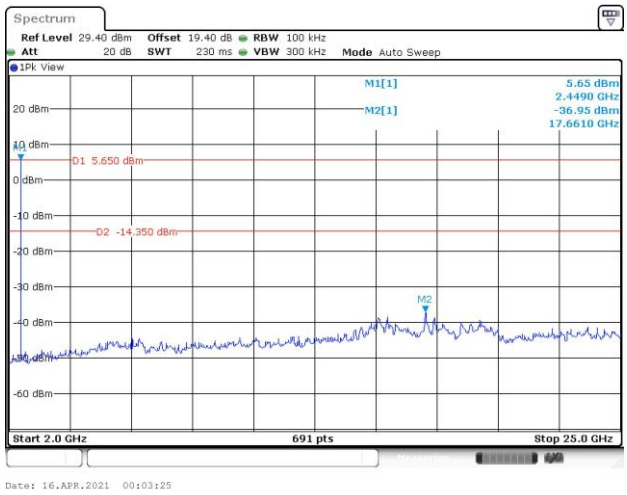
CSE Plot on CH 78 between 30 MHz ~ 3 GHz	CSE Plot on CH 78 between 2 GHz ~ 25 GHz
	

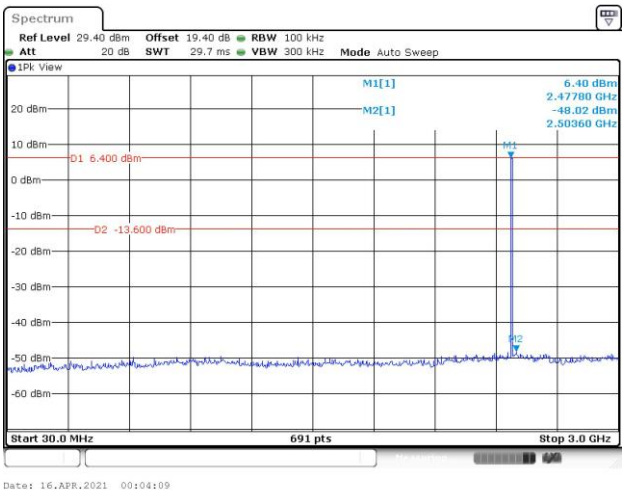
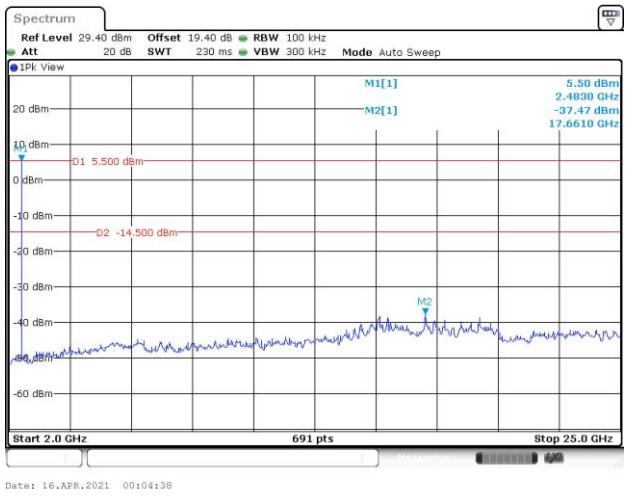
<2Mbps>

CSE Plot on CH 00 between 30 MHz ~ 3 GHz	CSE Plot on CH 00 between 2 GHz ~ 25 GHz
	
CSE Plot on CH 39 between 30 MHz ~ 3 GHz	**CSE Plot on CH 39 between 2 GHz ~ 25 GHz**
	

CSE Plot on CH 78 between 30 MHz ~ 3 GHz	CSE Plot on CH 78 between 2 GHz ~ 25 GHz
	

<3Mbps>

CSE Plot on CH 00 between 30 MHz ~ 3 GHz	CSE Plot on CH 00 between 2 GHz ~ 25 GHz
	
CSE Plot on CH 39 between 30 MHz ~ 3 GHz	**CSE Plot on CH 39 between 2 GHz ~ 25 GHz**
	

CSE Plot on CH 78 between 30 MHz ~ 3 GHz	CSE Plot on CH 78 between 2 GHz ~ 25 GHz
	

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 (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

See list of measuring equipment of this test report.

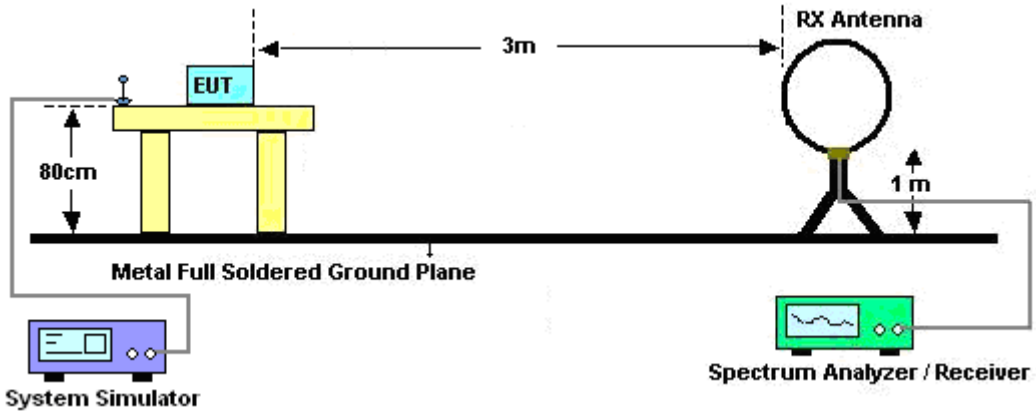
3.8.3 Test Procedures

1. The EUT was placed on a turntable with 0.8 meter for frequency below 1 GHz and 1.5 meter for frequency above 1 GHz 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 the maximum power setting and enable the EUT to 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 = 1 MHz for f>1 GHz ; 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 1 GHz, 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 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.

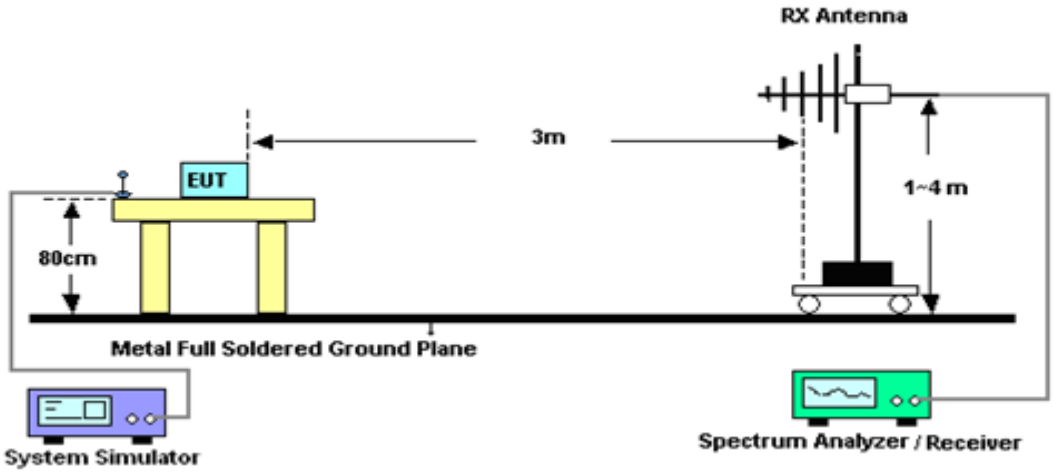
Note: The average levels were calculated from the peak level corrected with duty cycle correction factor (-24.76dB) derived from 20log (dwell time/100ms). This correction is only for signals that hop with the fundamental signal, such as band-edge and harmonic. Other spurious signals that are independent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

3.8.4 Test Setup

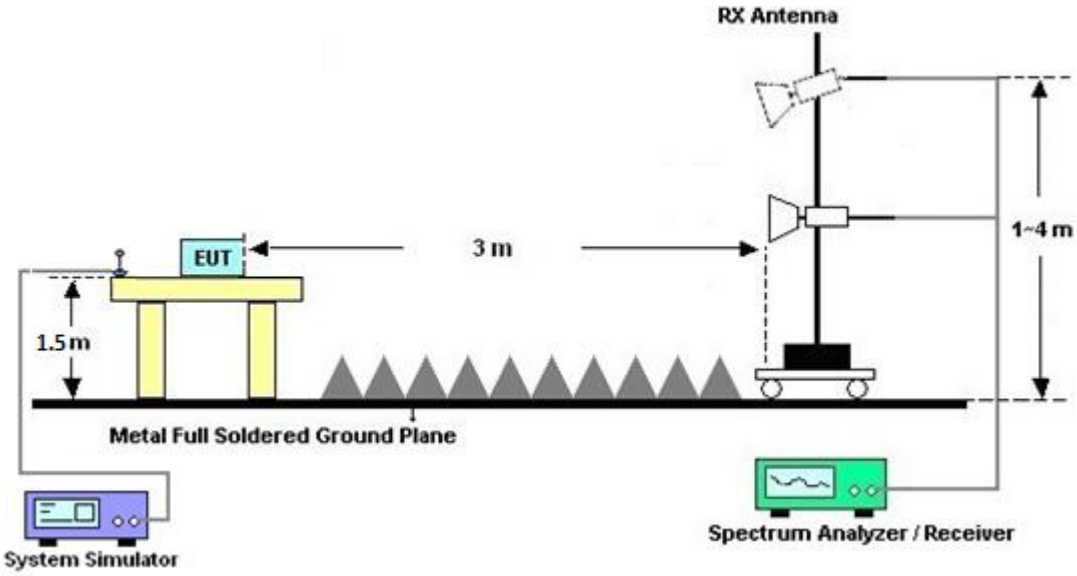
For radiated test below 30MHz



For radiated test from 30MHz to 1GHz



For radiated test 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 was not reported.

There is a comparison data of both open-field test site and alternative test site - semi-Anechoic chamber according to 414788 D01 Radiated Test Site v01r01, 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 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.

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.

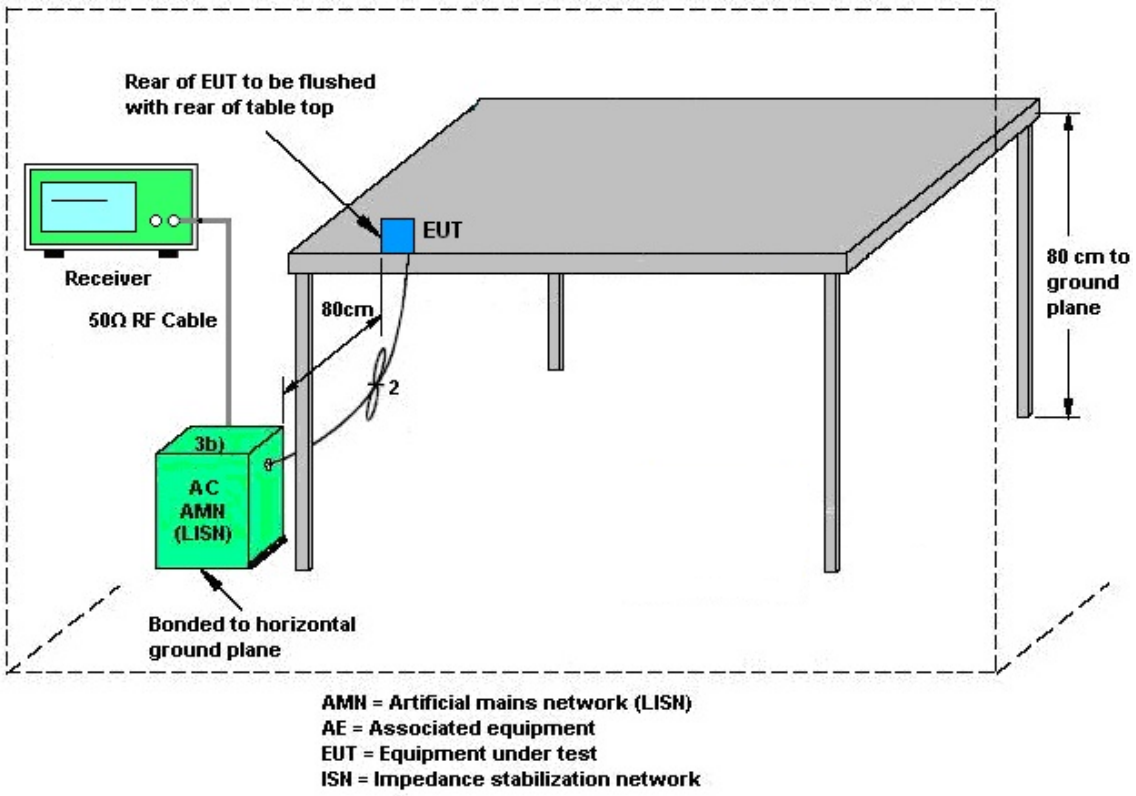
3.9.2 Measuring Instruments

See list of measuring equipment of this test report.

3.9.3 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.

3.9.4 Test Setup



AMN = Artificial mains network (LISN)
AE = Associated equipment
EUT = Equipment under test
ISN = Impedance stabilization network

3.9.5 Test Result of AC Conducted Emission

Please refer to Appendix A.

3.10 Antenna Requirements

3.10.1 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.

3.10.2 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.

4 List of Measuring Equipment

Instrument	Brand Name	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100315	9 kHz~30 MHz	Jan. 04, 2021	Apr. 01, 2021~ Apr. 30, 2021	Jan. 03, 2022	Radiation (03CH11-HY)
Bilog Antenna	TESEQ	CBL 6111D & N-6-06	35414 & AT-N0602	30MHz~1GHz	Oct. 11, 2020	Apr. 01, 2021~ Apr. 30, 2021	Oct. 10, 2021	Radiation (03CH11-HY)
Horn Antenna	SCHWARZBECK	BBHA 9120 D	9120D-1326	1GHz ~ 18GHz	Nov. 03, 2020	Apr. 01, 2021~ Apr. 30, 2021	Nov. 02, 2021	Radiation (03CH11-HY)
SHF-EHF Horn Antenna	SCHWARZBECK	BBHA9170	00994	18GHz~40GHz	Nov. 19, 2020	Apr. 01, 2021~ Apr. 30, 2021	Nov. 18, 2021	Radiation (03CH11-HY)
Amplifier	SONOMA	310N	187312	9kHz~1GHz	Dec. 02, 2020	Apr. 01, 2021~ Apr. 30, 2021	Dec. 01, 2021	Radiation (03CH11-HY)
Preamplifier	EMEC	EM1G18G	060812	1GHz~18GHz	Oct. 27, 2020	Apr. 01, 2021~ Apr. 30, 2021	Oct. 26, 2021	Radiation (03CH11-HY)
Preamplifier	Keysight	83017A	MY53270080	1GHz~26.5GHz	Nov. 12, 2020	Apr. 01, 2021~ Apr. 30, 2021	Nov. 11, 2021	Radiation (03CH11-HY)
Preamplifier	EMEC	EM18G40G	060801	18GHz~40GHz	Jun. 15, 2020	Apr. 01, 2021~ Apr. 30, 2021	Jun. 14, 2021	Radiation (03CH11-HY)
Spectrum Analyzer	Keysight	N9010A	MY54200486	10Hz~44GHz	Oct. 23, 2020	Apr. 01, 2021~ Apr. 30, 2021	Oct. 22, 2021	Radiation (03CH11-HY)
EMI Test Receiver	Keysight	N9038A(MXE)	MY55420170	20MHz~8.4GHz	May 21, 2020	Apr. 01, 2021~ Apr. 30, 2021	May 20, 2021	Radiation (03CH11-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1~4m	N/A	Apr. 01, 2021~ Apr. 30, 2021	N/A	Radiation (03CH11-HY)
Turn Table	EMEC	TT 2000	N/A	0~360 Degree	N/A	Apr. 01, 2021~ Apr. 30, 2021	N/A	Radiation (03CH11-HY)
Software	Audix	E3 6.2009-8-24	RK-001053	N/A	N/A	Apr. 01, 2021~ Apr. 30, 2021	N/A	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY9837/4PE	9kHz-30MHz	Mar. 11, 2021	Apr. 01, 2021~ Apr. 30, 2021	Mar. 10, 2022	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	MY2859/2	30MHz-40GHz	Mar. 11, 2021	Apr. 01, 2021~ Apr. 30, 2021	Mar. 10, 2022	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY9837/4PE	30M-18G	Mar. 11, 2021	Apr. 01, 2021~ Apr. 30, 2021	Mar. 10, 2022	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	MY4274/2	30MHz-40GHz	Mar. 11, 2021	Apr. 01, 2021~ Apr. 30, 2021	Mar. 10, 2022	Radiation (03CH11-HY)
Filter	Wainwright	WLK4-1000-1530-8000-40SS	SN11	1.53G Low Pass	Sep. 14, 2020	Apr. 01, 2021~ Apr. 30, 2021	Sep. 13, 2021	Radiation (03CH11-HY)
Filter	Wainwright	WHKX12-2700-3000-18000-60SS	SN3	3GHz High Pass Filter	Sep. 14, 2020	Apr. 01, 2021~ Apr. 30, 2021	Sep. 13, 2021	Radiation (03CH11-HY)
Hygrometer	TECPEL	DTM-303B	TP140325	N/A	Nov. 18, 2020	Apr. 01, 2021~ Apr. 30, 2021	Nov. 17, 2021	Radiation (03CH11-HY)
Hygrometer	TECPEL	DTM-303B	TP200880	QA-3-031	Oct. 22, 2020	Apr. 01, 2021~ Apr. 30, 2021	Oct. 21, 2021	Radiation (03CH11-HY)

Instrument	Brand Name	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
AC Power Source	ChainTek	APC-1000W	N/A	N/A	N/A	Mar. 26, 2021	N/A	Conduction (CO05-HY)
EMI Test Receiver	Rohde & Schwarz	ESR3	102388	9kHz~3.6GHz	Nov. 30, 2020	Mar. 26, 2021	Nov. 29, 2021	Conduction (CO05-HY)
Hygrometer	Testo	608-H1	34913912	N/A	Nov. 18, 2020	Mar. 26, 2021	Nov. 17, 2021	Conduction (CO05-HY)
LISN	Rohde & Schwarz	ENV216	100081	9kHz~30MHz	Nov. 16, 2020	Mar. 26, 2021	Nov. 15, 2021	Conduction (CO05-HY)
Software	Rohde & Schwarz	EMC32 V10.30	N/A	N/A	N/A	Mar. 26, 2021	N/A	Conduction (CO05-HY)
Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100851	N/A	Feb. 25, 2021	Mar. 26, 2021	Feb. 24, 2022	Conduction (CO05-HY)
LISN Cable	MVE	RG-400	260260	N/A	Dec. 31, 2020	Mar. 26, 2021	Dec. 30, 2021	Conduction (CO05-HY)
Power Meter	Agilent	E4416A	GB41292344	N/A	Jan. 14, 2021	Apr. 07, 2021~ May 11, 2021	Jan. 13, 2022	Conducted (TH05-HY)
Power Sensor	Agilent	E9327A	US40441548	50MHz~18GHz	Jan. 14, 2021	Apr. 07, 2021~ May 11, 2021	Jan. 13, 2022	Conducted (TH05-HY)
Signal Analyzer	Rohde & Schwarz	FSV40	101566	10Hz ~ 40GHz	Jul. 22, 2020	Apr. 07, 2021~ May 11, 2021	Jul. 21, 2021	Conducted (TH05-HY)
Spectrum Analyzer	Rohde & Schwarz	FSQ	200578/026	20Hz-26.5GHz	Jul. 17, 2020	Apr. 07, 2021~ May 11, 2021	Jul. 16, 2021	Conducted (TH05-HY)
Switch Box & RF Cable	EM Electronics	EMSW18SE	SW200302	N/A	Mar. 17, 2021	Apr. 07, 2021~ May 11, 2021	Mar. 16, 2022	Conducted (TH05-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**

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**4.4**

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))	**5.1**

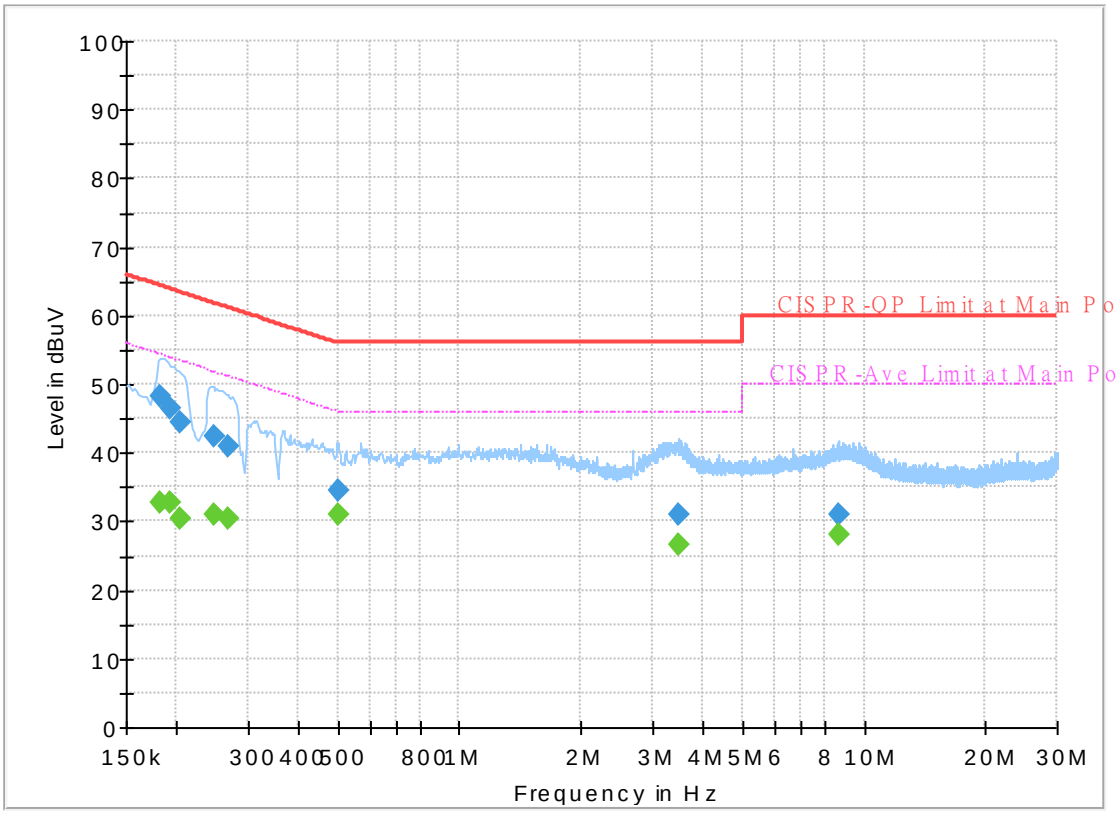
Appendix A. AC Conducted Emission Test Results

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

EUT Information

Report NO :	122002
Test Mode :	Mode 1
Test Voltage :	120Vac/60Hz
Phase :	Line

Full Spectrum



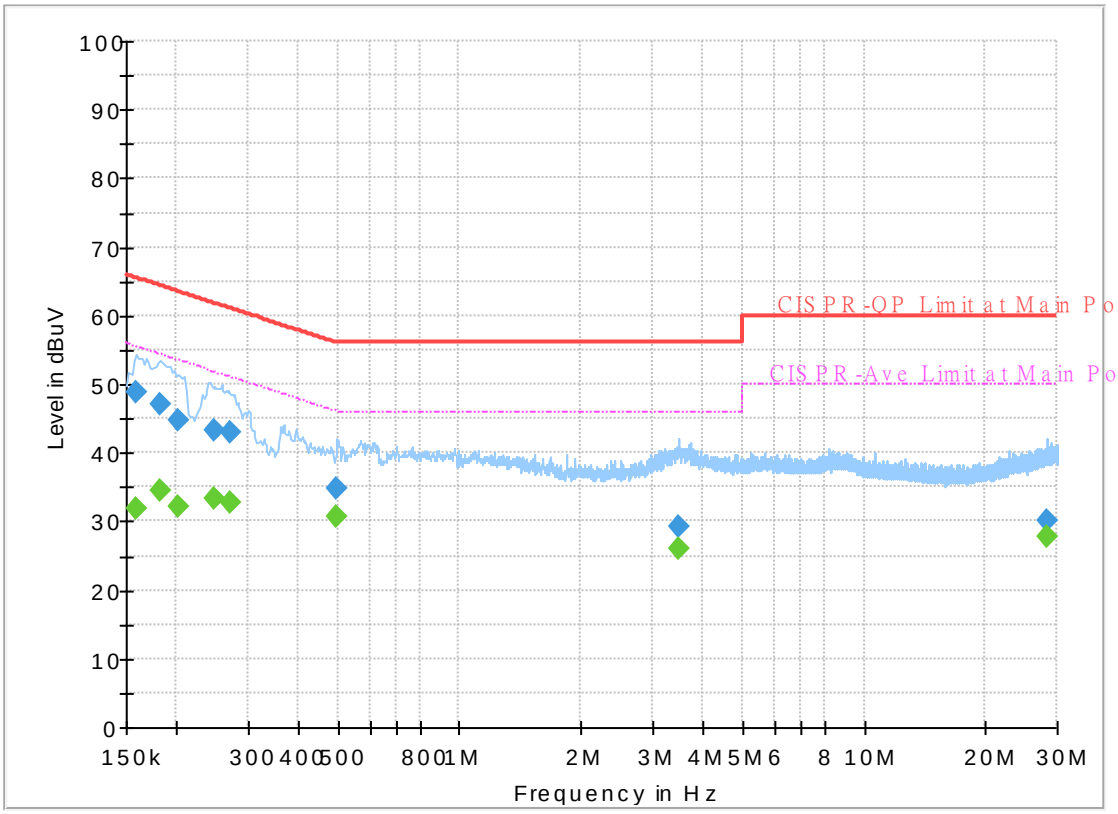
Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Line	Filter	Corr. (dB)
0.181500	---	32.68	54.42	21.74	L1	OFF	19.7
0.181500	48.22	---	64.42	16.20	L1	OFF	19.7
0.192750	---	32.88	53.92	21.04	L1	OFF	19.7
0.192750	46.53	---	63.92	17.39	L1	OFF	19.7
0.204000	---	30.28	53.45	23.17	L1	OFF	19.7
0.204000	44.31	---	63.45	19.14	L1	OFF	19.7
0.246750	---	30.97	51.87	20.90	L1	OFF	19.7
0.246750	42.45	---	61.87	19.42	L1	OFF	19.7
0.269250	---	30.54	51.14	20.60	L1	OFF	19.7
0.269250	40.94	---	61.14	20.20	L1	OFF	19.7
0.501000	---	31.03	46.00	14.97	L1	OFF	19.9
0.501000	34.58	---	56.00	21.42	L1	OFF	19.9
3.486750	---	26.49	46.00	19.51	L1	OFF	20.1
3.486750	30.98	---	56.00	25.02	L1	OFF	20.1
8.616750	---	28.17	50.00	21.83	L1	OFF	20.2
8.616750	31.04	---	60.00	28.96	L1	OFF	20.2

EUT Information

Report NO :	122002
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)
0.159000	---	31.96	55.52	23.56	N	OFF	19.7
0.159000	48.70	---	65.52	16.82	N	OFF	19.7
0.181500	---	34.50	54.42	19.92	N	OFF	19.7
0.181500	46.99	---	64.42	17.43	N	OFF	19.7
0.201750	---	32.23	53.54	21.31	N	OFF	19.7
0.201750	44.77	---	63.54	18.77	N	OFF	19.7
0.249000	---	33.42	51.79	18.37	N	OFF	19.8
0.249000	43.22	---	61.79	18.57	N	OFF	19.8
0.271500	---	32.88	51.07	18.19	N	OFF	19.8
0.271500	43.01	---	61.07	18.06	N	OFF	19.8
0.498750	---	30.77	46.02	15.25	N	OFF	19.9
0.498750	34.91	---	56.02	21.11	N	OFF	19.9
3.498000	---	26.01	46.00	19.99	N	OFF	20.1
3.498000	29.29	---	56.00	26.71	N	OFF	20.1
28.232250	---	27.75	50.00	22.25	N	OFF	20.9
28.232250	30.07	---	60.00	29.93	N	OFF	20.9

Appendix B. Radiated Spurious Emission

Test Engineer :	Bill Chang, Fu Chen and Troye Hsieh	Temperature :	18.2~24.2°C
		Relative Humidity :	43.2~70.1%

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		2357.145	43.61	-30.39	74	42.39	27.59	7.1	33.47	150	333	P	H
		2357.145	18.85	-35.15	54	-	-	-	-	-	-	A	H
	*	2402	103.37	-	-	102.18	27.5	7.14	33.45	150	333	P	H
		2402	78.61			-	-	-	-	-	-	A	H
													H
		2374.89	43.82	-30.18	74	42.61	27.55	7.12	33.46	109	113	P	V
		2374.89	19.06	-34.94	54	-	-	-	-	-	-	A	V
	*	2402	104.11	-	-	102.92	27.5	7.14	33.45	109	113	P	V
		2402	79.35			-	-	-	-	-	-	A	V
													V
BT CH 39 2441MHz		2324.98	43.5	-30.5	74	42.27	27.65	7.07	33.49	145	332	P	H
		2324.98	18.74	-35.26	54	-	-	-	-	-	-	A	H
	*	2442	105.77	-	-	104.49	27.5	7.21	33.43	145	332	P	H
		2442	81.01			-	-	-	-	-	-	A	H
		2489.85	43.93	-30.07	74	42.64	27.42	7.28	33.41	145	332	P	H
		2489.85	19.17	-34.83	54	-	-	-	-	-	-	A	H
		2317.98	43.45	-30.55	74	42.21	27.66	7.07	33.49	100	111	P	V
		2317.98	18.69	-35.31	54	-	-	-	-	-	-	A	V
	*	2442	104.45	-	-	103.17	27.5	7.21	33.43	100	111	P	V
		2442	79.69			-	-	-	-	-	-	A	V
		2490.55	44.14	-29.86	74	42.84	27.42	7.28	33.4	100	111	P	V
		2490.55	19.38	-34.62	54	-	-	-	-	-	-	A	V

BT CH 78 2480MHz	*	2480	104.16	-	-	102.87	27.44	7.26	33.41	150	329	P	H
		2480	79.4			-	-	-	-	-	-	A	H
													H
													H
													H
													H
		2483.56	49.87	-24.13	74	48.58	27.43	7.27	33.41	150	329	P	V
		2483.56	25.11	-28.89	54	-	-	-	-	-	-	A	V
													V
													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	37.78	-36.22	74	61.77	31	11.18	66.17	100	0	P	H
		4804	13.02	-40.98	54	-	-	-	-	-	-	A	H
													H
													H
													H
													H
		4804	37.94	-36.06	74	61.93	31	11.18	66.17	100	0	P	V
		4804	13.18	-40.82	54	-	-	-	-	-	-	A	V
													V
													V
													V
													V
BT CH 39 2441MHz		4882	38.56	-35.44	74	61.75	31.58	11.34	66.11	100	0	P	H
		4882	13.8	-40.2	54	-	-	-	-	-	-	A	H
		7323	42.06	-31.94	74	57.92	36.4	13.46	65.72	100	0	P	H
		7323	17.3	-36.7	54	-	-	-	-	-	-	A	H
													H
													H
		4882	39.66	-34.34	74	62.85	31.58	11.34	66.11	100	0	P	V
		4882	14.9	-39.1	54	-	-	-	-	-	-	A	V
		7323	40.84	-33.16	74	56.7	36.4	13.46	65.72	100	0	P	V
		7323	16.08	-37.92	54	-	-	-	-	-	-	A	V
													V
													V

BT CH 78 2480MHz		4960	39.06	-34.94	74	62.55	31.06	11.51	66.06	100	0	P	H
		4960	14.3	-39.7	54	-	-	-	-	-	-	A	H
		7440	41.57	-32.43	74	57.06	36.56	13.74	65.79	100	0	P	H
		7440	16.81	-37.19	54	-	-	-	-	-	-	A	H
													H
													H
		4960	39.4	-34.6	74	62.89	31.06	11.51	66.06	100	0	P	V
		4960	14.64	-39.36	54	-	-	-	-	-	-	A	V
		7440	41.12	-32.88	74	56.61	36.56	13.74	65.79	100	0	P	V
		7440	16.36	-37.64	54	-	-	-	-	-	-	A	V
													V
													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		110.51	30.27	-13.23	43.5	44.4	16.77	1.6	32.5	100	0	P	H
		175.5	27.33	-16.17	43.5	42.77	15.02	2.07	32.53	-	-	P	H
		321.97	28	-18	46	37.92	19.41	2.72	32.05	-	-	P	H
		428.67	29.6	-16.4	46	35.62	22.77	3.1	31.89	-	-	P	H
		716.76	27.44	-18.56	46	28.77	26.92	4.01	32.26	-	-	P	H
		857.41	31.5	-14.5	46	29.19	29.27	4.41	31.37	-	-	P	H
													H
													H
													H
													H
													H
													H
		37.76	32.83	-7.17	40	43.95	20.42	0.95	32.49	100	169	Q	V
		83.35	30.34	-9.66	40	47.91	13.57	1.38	32.52	-	-	P	V
		112.45	31.14	-12.36	43.5	45.08	16.95	1.61	32.5	-	-	P	V
		426.73	27.84	-18.16	46	33.88	22.75	3.09	31.88	-	-	P	V
		773.99	29.02	-16.98	46	28.51	28.15	4.17	31.81	-	-	P	V
		951.5	31.55	-14.45	46	26.97	30.75	4.7	30.87	-	-	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)

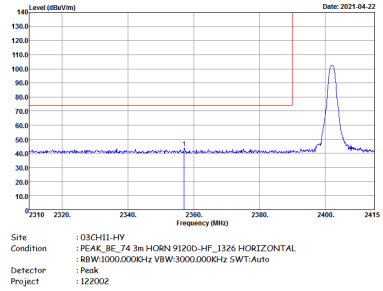
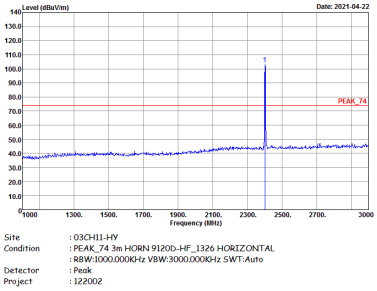
Both peak and average measured complies with the limit line, so test result is “PASS”.

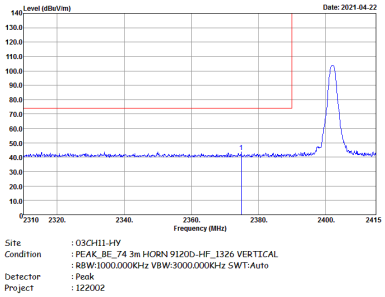
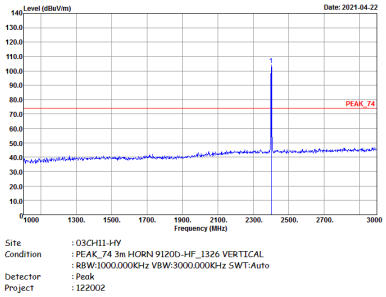
Appendix C. Radiated Spurious Emission Plots

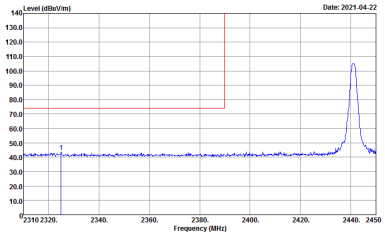
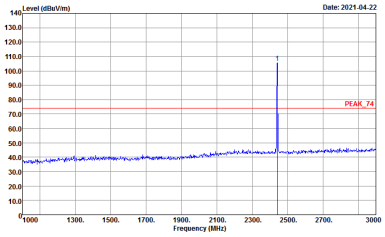
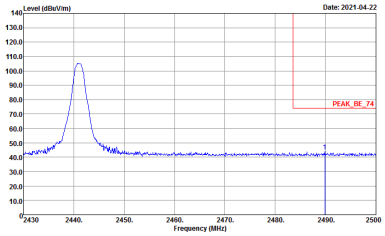
Test Engineer :	Bill Chang, Fu Chen and Troye Hsieh	**Temperature :**	18.2~24.2°C
		Relative Humidity :	43.2~70.1%

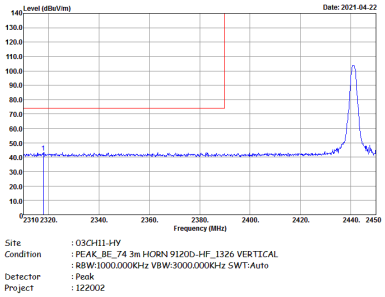
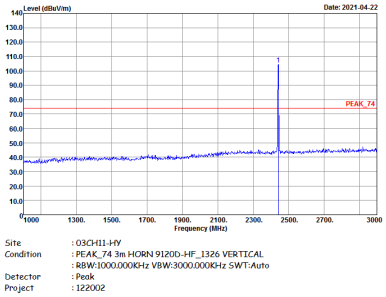
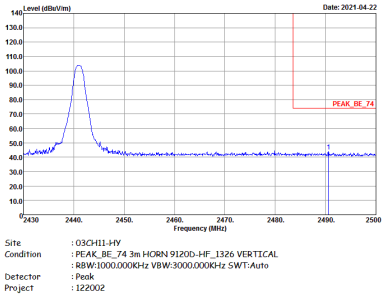
2.4GHz 2400~2483.5MHz

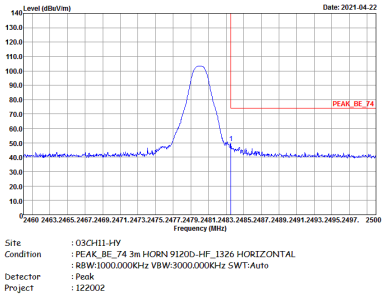
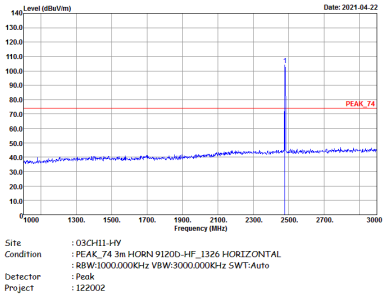
BT (Band Edge @ 3m)

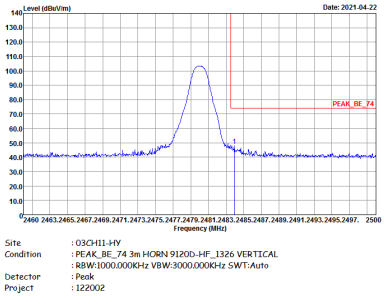
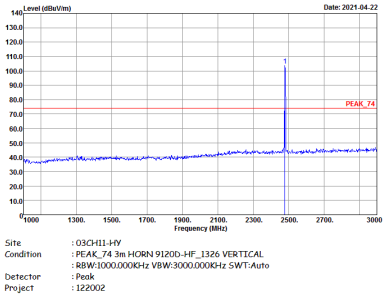
BT	**2.4GHz 2400~2483.5MHz Band Edge @ 3m**	
	BT CH00 2402MHz	
	Horizontal	**Fundamental**
Peak		

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

BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BT CH39 2441MHz	
	Horizontal	Fundamental
Peak	 Site : 03CH11-HY Condition : PEAK_BE_74 3m HORN 9120D-HF_1326 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 122002	 Site : 03CH11-HY Condition : PEAK_74 3m HORN 9120D-HF_1326 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 122002
Peak	 Site : 03CH11-HY Condition : PEAK_BE_74 3m HORN 9120D-HF_1326 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 122002	Left blank

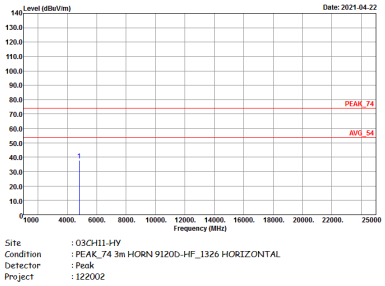
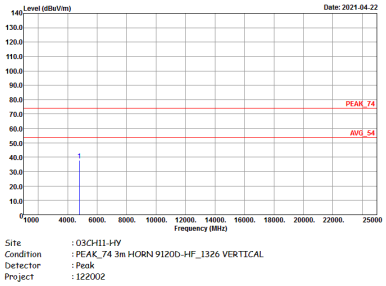
BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BT CH39 2441MHz	
	Vertical	Fundamental
Peak		
Peak		Left blank

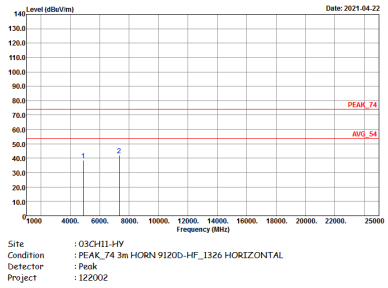
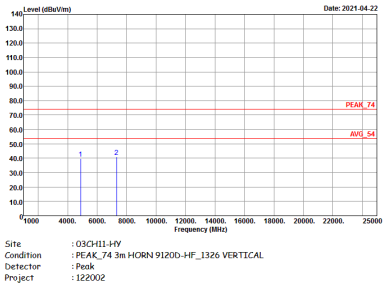
BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BT CH78 2480MHz	
	Horizontal	Fundamental
Peak		

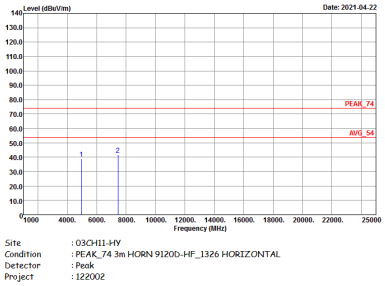
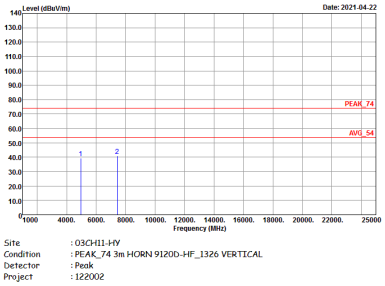
BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BT CH78 2480MHz	
	Vertical	Fundamental
Peak		

2.4GHz 2400~2483.5MHz

BT (Harmonic @ 3m)

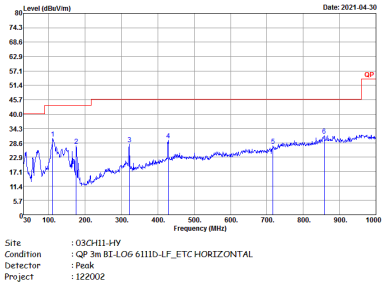
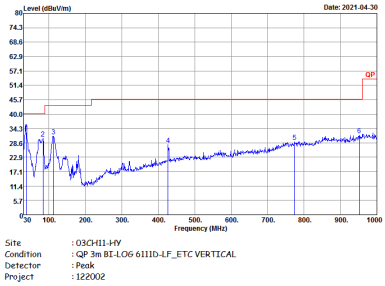
BT	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	BT CH00 2402MHz	
	Horizontal	Vertical
Peak Avg.		

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

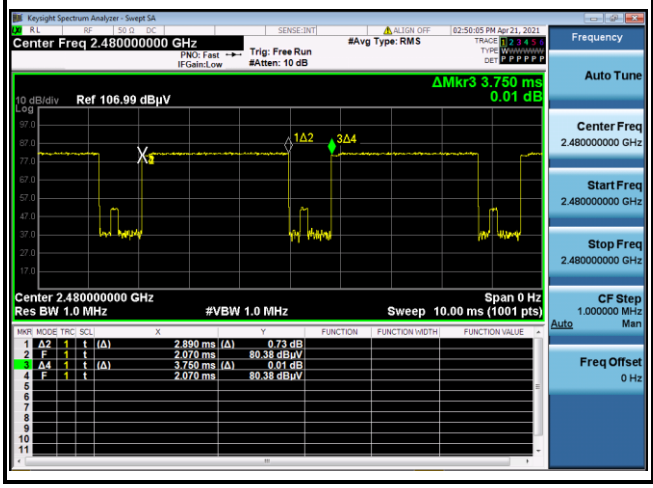
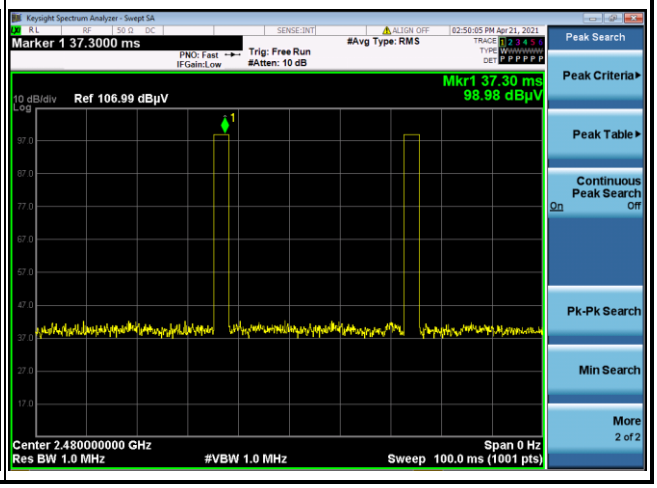
BT	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	BT CH78 2480MHz	
	Horizontal	Vertical
Peak Avg.		

Emission below 1GHz

2.4GHz BT (LF)

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

Appendix D. Duty Cycle Plots

3DH5 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 * 2.89 / 100 = 5.78 %
2. Worst case Duty cycle correction factor = 20*log(Duty cycle) = -24.76 dB
3. 3DH5 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

2.89 ms x 20 channels = 57.8 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 ms / 57.8 ms] = 2 hops

Thus, the maximum possible ON time:

2.89 ms x 2 = 5.78 ms

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

20 x log(5.78 ms/100 ms) = -24.76 dB