FCC RADIO TEST REPORT

FCC ID	:	**2AEUPBHAFL031**
Equipment	:	**Floodlight Cam Wired Pro**
Brand Name	:	**Ring**
Model Name	:	**5B28S4**
Applicant	:	**Ring LLC** **1523 26th St Santa Monica, CA 90404 USA**
Manufacturer	:	**Ring LLC** **1523 26th St Santa Monica, CA 90404 USA**
Standard	:	**FCC Part 15 Subpart C §15.247**

The product was received on Feb. 09, 2021 and testing was started from Mar. 10, 2021 and completed on Mar. 20, 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 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 (R.O.C.)
TEL : 886-3-327-3456
FAX : 886-3-328-4978

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History of this test report

Report No.	Version	Description	Issued Date
FR120337E	01	Initial issue of report	Mar. 30, 2021
FR120337E	02	Revise EUT information	May 11, 2021

Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
3.1	15.247(a)(2)	6dB Bandwidth	Pass	
3.1	2.1049	99% Occupied Bandwidth	Reporting only	
3.2	15.247(b)(3)	Output Power	Pass	
3.3	15.247(e)	Power Spectral Density	Pass	
3.4	15.247(d)	Conducted Band Edges and Spurious Emission	Pass	
3.5	15.247(d)	Radiated Band Edges and Spurious Emission	Pass	Under limit 5.53 dB at 115.360 MHz for Quasi-Peak
3.6	15.207	AC Conducted Emission	Pass	Under limit 8.33 dB at 0.831 MHz
3.7	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: Dara Chiu

1 General Description

1.1 Product Feature of Equipment Under Test

Bluetooth-LE, Wi-Fi 2.4GHz 802.11b/g/n, Wi-Fi 5GHz 802.11a/n/ac, LoRa, and 24G Radar.

Product Specification subjective to this standard	
Antenna Type	WLAN: <Ant. 1>: FPC Antenna <Ant. 2>: FPC Antenna Bluetooth-LE: FPC Antenna LoRa: PCB Antenna 24GHz Radar: Patch Antenna

Antenna information		
902 MHz ~ 928 MHz	Peak Gain (dBi)	-0.83

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

1.2 Modification of EUT

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

1.3 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.**
	TH05-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 (R.O.C.) TEL: +886-3-327-0868 FAX: +886-3-327-0855
Test Site No.	**Sporton Site No.**
	03CH11-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 TW0007

1.4 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.

2 Test Configuration of Equipment Under Test

2.1 Carrier Frequency Channel

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)
902 – 928 MHz	1	902.5	22	919.3
	2	903.3	23	920.1
	3	904.1	24	920.9
	4	904.9	25	921.7
	5	905.7	26	922.5
	6	906.5	27	923.3
	7	907.3	28	924.1
	8	908.1	29	924.9
	9	908.9	30	925.7
	10	909.7	31	926.5
	11	910.5		
	12	911.3		
	13	912.1		
	14	912.9		
	15	913.7		
	16	914.5		
	17	915.3		
	18	916.1		
	19	916.9		
	20	917.7		
	21	918.5		

2.2 Test Mode

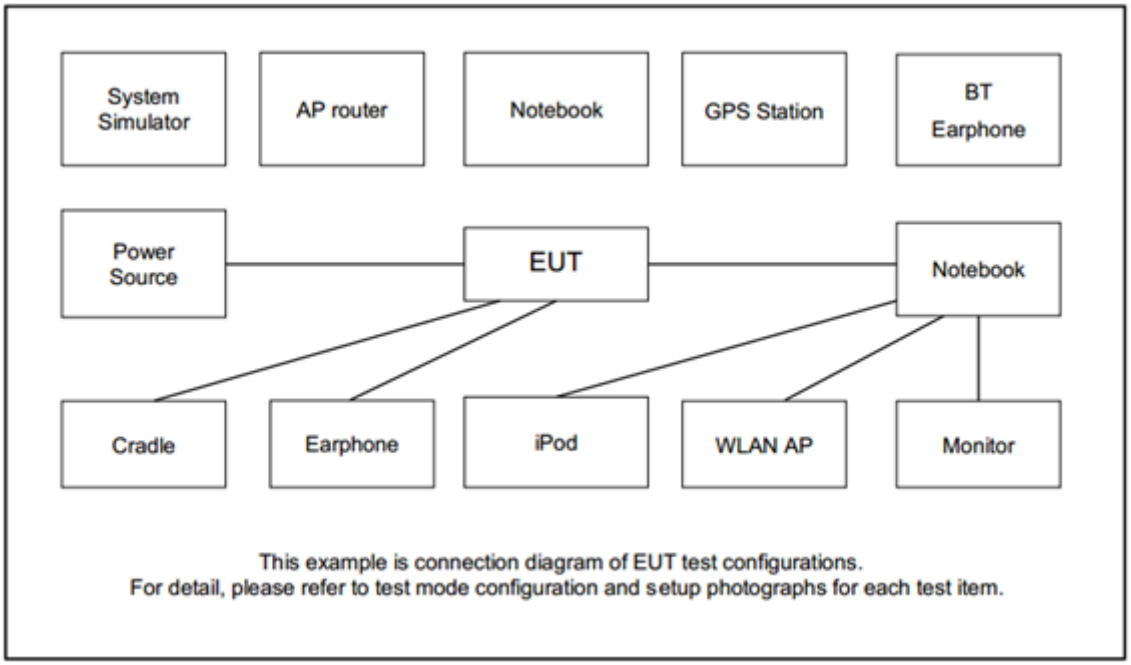
a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: conduction emission (150 kHz to 30 MHz), radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower).

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	**LoRa 500KHz DTS**
Conducted Test Cases	Mode 1: LoRa 500KHz DTS Tx CH01_902.5 MHz Mode 2: LoRa 500KHz DTS Tx CH16_914.5 MHz Mode 3: LoRa 500KHz DTS Tx CH31_926.5 MHz
Radiated Test Cases	Mode 1: LoRa 500KHz DTS Tx CH01_902.5 MHz Mode 2: LoRa 500KHz DTS Tx CH16_914.5 MHz Mode 3: LoRa 500KHz DTS Tx CH31_926.5 MHz
AC Conducted Emission	Mode 1: WLAN (2.4GHz) Tx + Bluetooth Tx + Lora Tx

2.3 Connection Diagram of Test System



2.4 EUT Operation Test Setup

The RF test items, utility “Tera Term Version 4.89 (SVN 6182)” was installed in Notebook which was programmed in order to make the EUT get into the engineering modes to provide channel selection, power level, data rate and the application type and for continuous transmitting signals.

2.5 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 10dB attenuator.

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

= 4.2 + 10 = 14.2 (dB)

3 Test Result

3.1 6dB and 99% Bandwidth Measurement

3.1.1 Limit of 6dB and 99% Bandwidth

The minimum 6 dB bandwidth shall be at least 500 kHz.

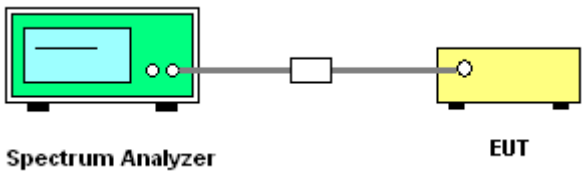
3.1.2 Measuring Instruments

See list of measuring equipment of this test report.

3.1.3 Test Procedures

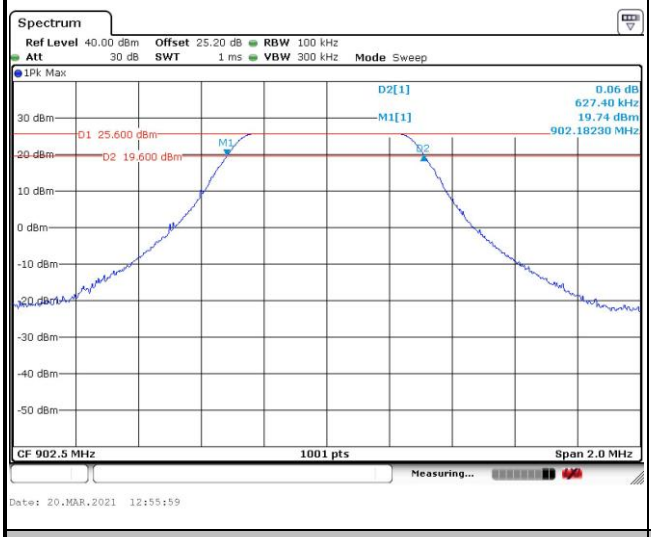
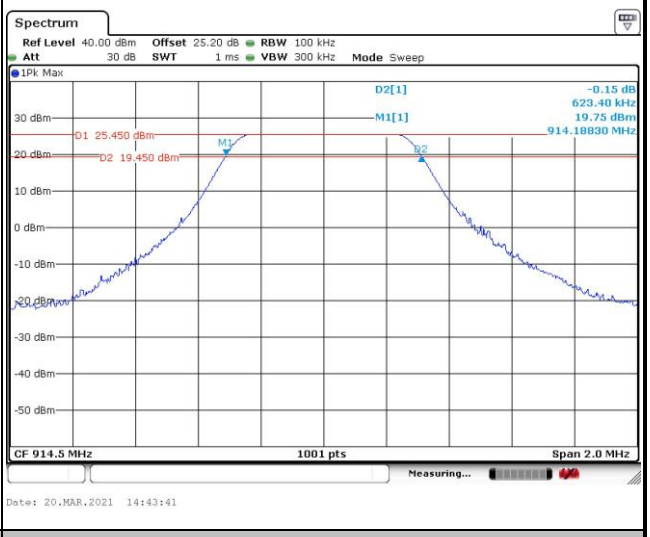
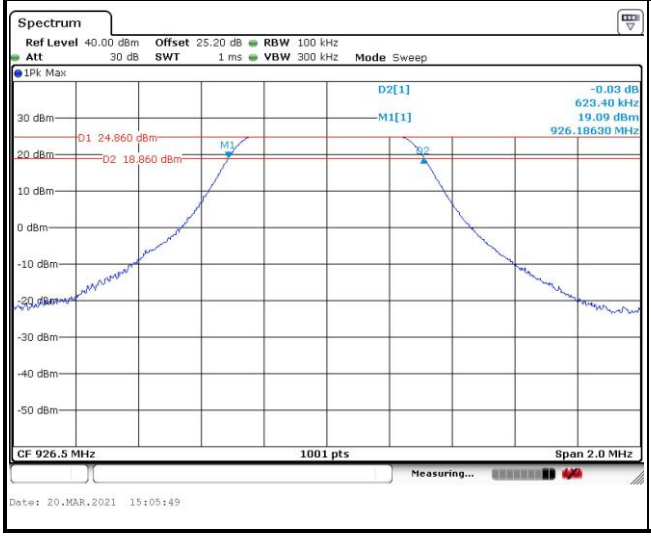
1. The testing follows the ANSI C63.10 Section 6.9.3 (OBW) and 11.8.1 (6dB BW).
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. Set the Video bandwidth (VBW) = 300 kHz. In order to make an accurate measurement. The 6 dB bandwidth must be greater than 500 kHz.
5. For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) is set 1-5% of the emission bandwidth and set the Video bandwidth (VBW) ≥ 3 * RBW.
6. Measure and record the results in the test report.

3.1.4 Test Setup



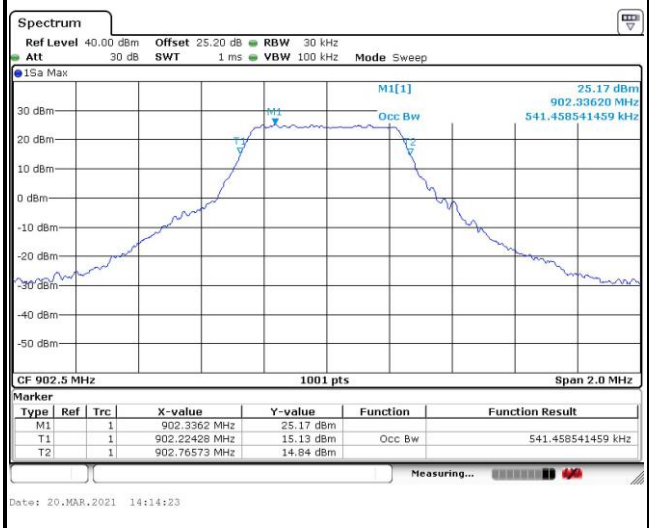
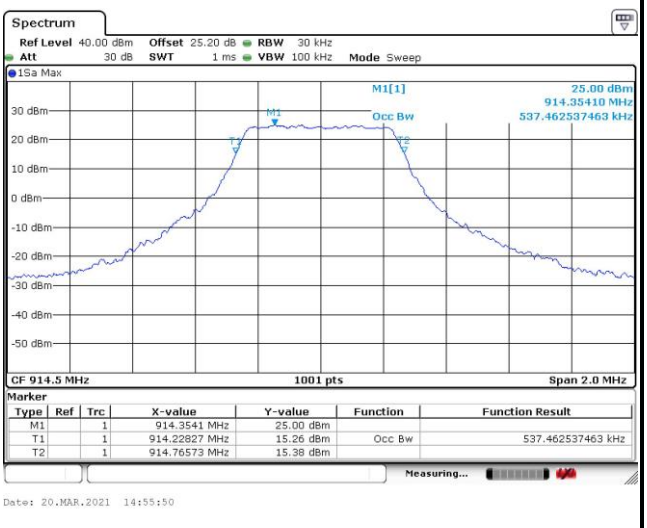
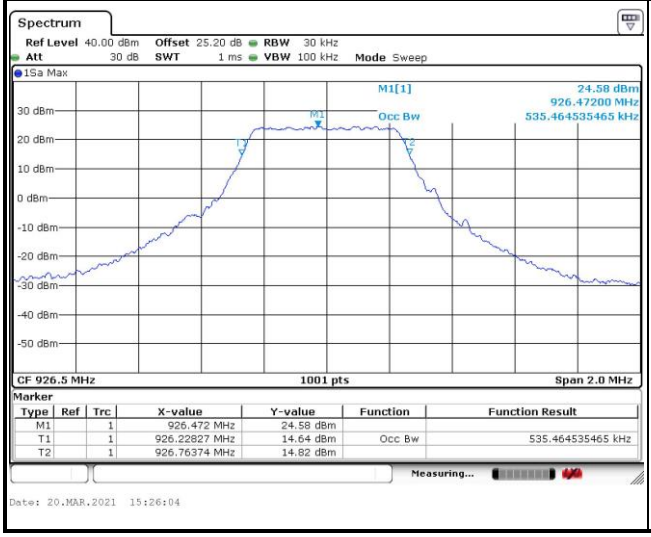
3.1.5 Test Result of 6dB Bandwidth

Please refer to Appendix A.

6 dB Bandwidth Plot on Channel 01	6 dB Bandwidth Plot on Channel 16
	
6 dB Bandwidth Plot on Channel 31	**N/A**
	

3.1.6 Test Result of 99% Occupied Bandwidth

Please refer to Appendix A.

99% Occupied Bandwidth Plot on Channel 01	99% Occupied Bandwidth Plot on Channel 16
	
99% Occupied Bandwidth Plot on Channel 31	**N/A**
	

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

3.2 Output Power Measurement

3.2.1 Limit of Output Power

Section 15.247(b)(3) For systems using digital modulation in the 902-928 MHz, the limit for peak output power is 1 watt.

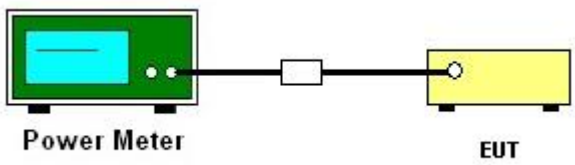
3.2.2 Measuring Instruments

See list of measuring equipment of this test report.

3.2.3 Test Procedures

1. For Peak Power, the testing follows ANSI C63.10 Section 11.9.1.3 PKPM1.
2. For Average Power, the testing follows ANSI C63.10 Section 11.9.2.3.1 Method AVGPM
3. The RF output of EUT was connected to the power meter by RF cable and attenuator.
4. The path loss was compensated to the results for each measurement.
5. Set the maximum power setting and enable the EUT to transmit continuously.
6. Measure the conducted output power and record the results in the test report.

3.2.4 Test Setup



3.2.5 Test Result of Peak Output Power

Please refer to Appendix A.

3.2.6 Test Result of Average Output Power (Reporting Only)

Please refer to Appendix A.

3.3 Power Spectral Density Measurement

3.3.1 Limit of Power Spectral Density

The peak power spectral density shall not be greater than 8dBm in any 3kHz band at any time interval of continuous transmission.

3.3.2 Measuring Instruments

See list of measuring equipment of this test report.

3.3.3 Test Procedures

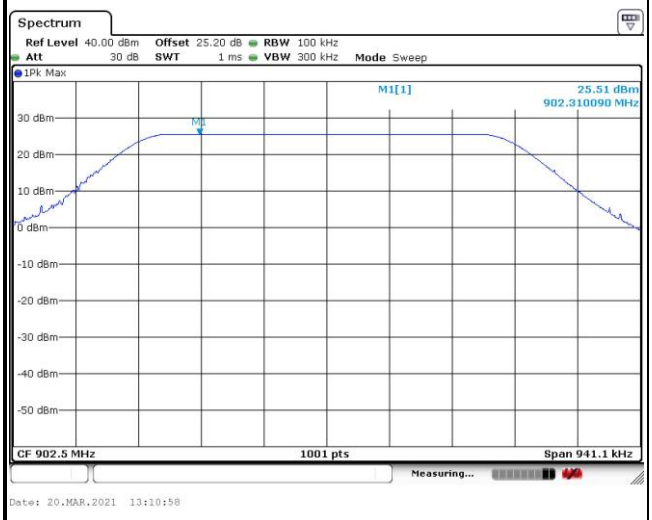
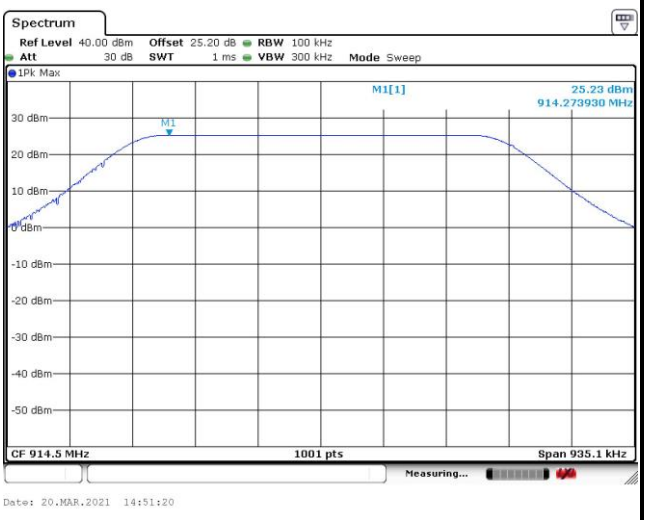
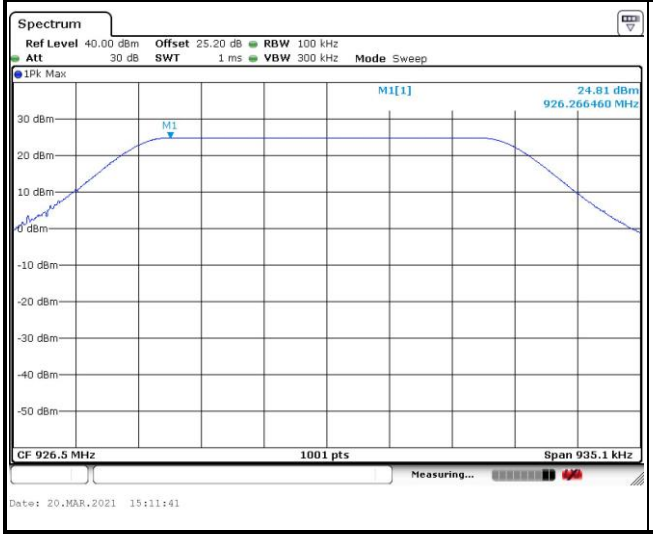
1. The testing follows the ANSI C63.10 Section 11.10.3 Method AVGPSD-1.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 3 kHz. Video bandwidth VBW = 10 kHz In order to make an accurate measurement, set the span to 1.5 times DTS Channel Bandwidth. (6dB BW)
5. Detector = RMS, Sweep time = auto couple, Trace mode = Average, Allow trace to fully stabilize. Use the peak marker function to determine the maximum power level.
6. Measure and record the results in the test report.
7. The Measured power density (dBm)/ 100kHz is a reference level and used as 30dBc down limit line for Conducted Band Edges and Conducted Spurious Emission.

3.3.4 Test Setup

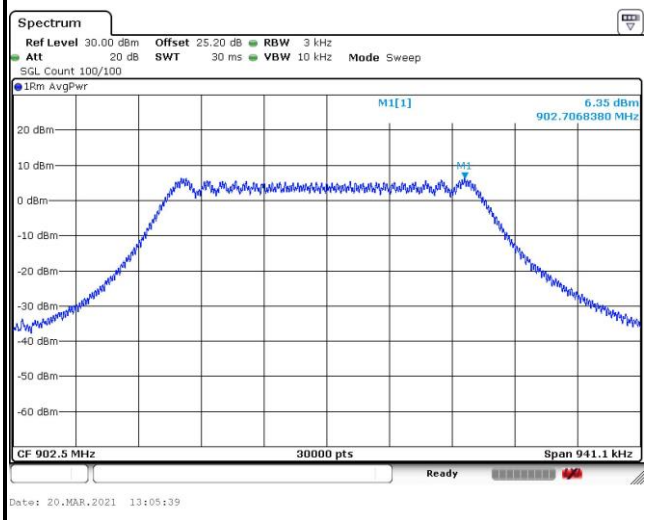
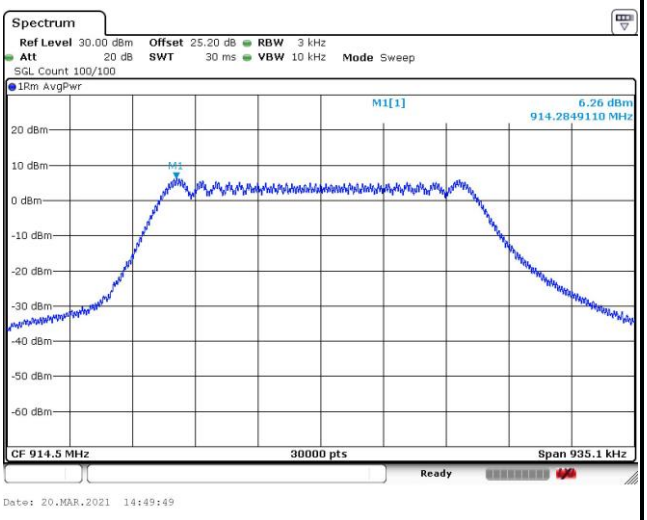
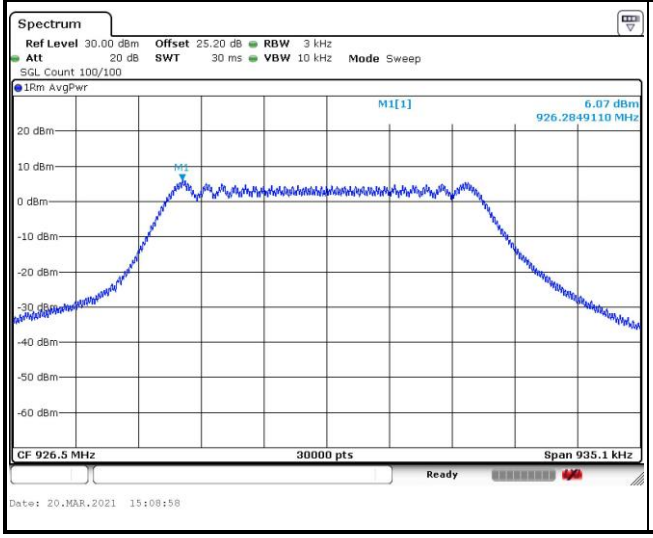
3.3.5 Test Result of Power Spectral Density

Please refer to Appendix A.

3.3.6 Test Result of Power Spectral Density Plots (100kHz)

PSD 100kHz Plot on Channel 01	PSD 100kHz Plot on Channel 16
	
PSD 100kHz Plot on Channel 31	**N/A**
	

3.3.7 Test Result of Power Spectral Density Plots (3kHz)

PSD 3kHz Plot on Channel 01	PSD 3kHz Plot on Channel 16
	
PSD 3kHz Plot on Channel 31	**N/A**
	

3.4 Conducted Band Edges and Spurious Emission Measurement

3.4.1 Limit of Conducted Band Edges and Spurious Emission

All harmonics/spurious must be at least 20 dB down from the highest emission level within the authorized band.

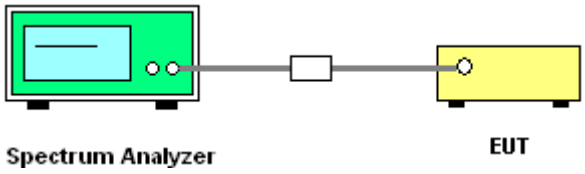
3.4.2 Measuring Instruments

See list of measuring equipment of this test report.

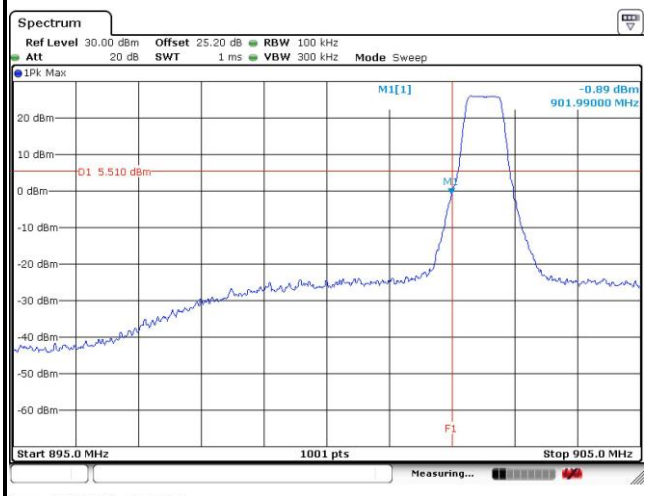
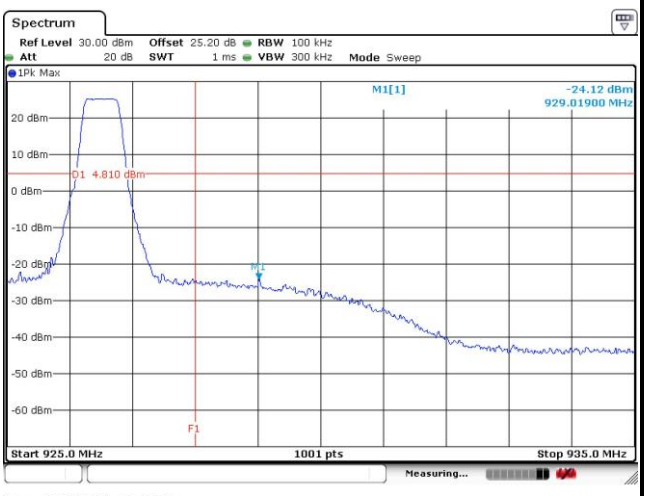
3.4.3 Test Procedure

1. The testing follows the ANSI C63.10 Section 11.11.3 Emission level measurement.
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 to the maximum power setting and enable the EUT transmit continuously.
4. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.
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.

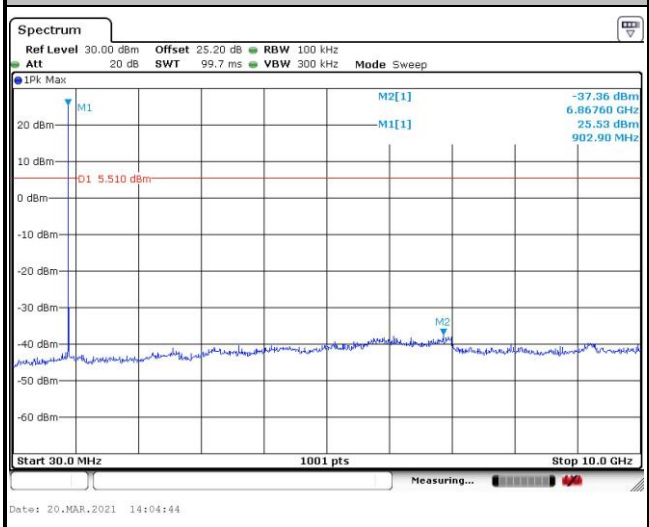
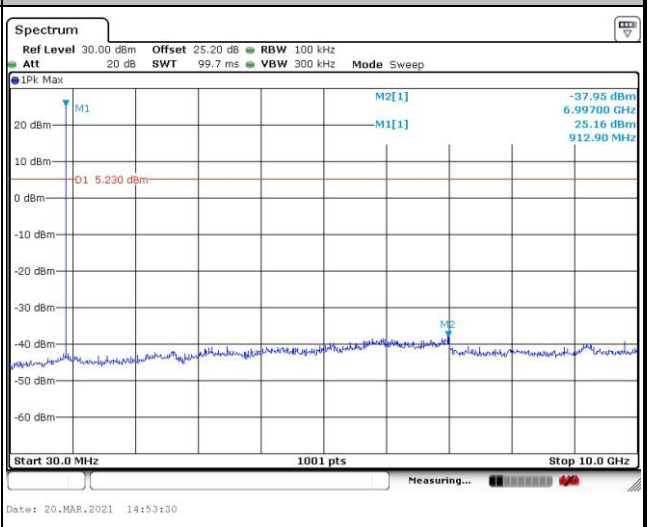
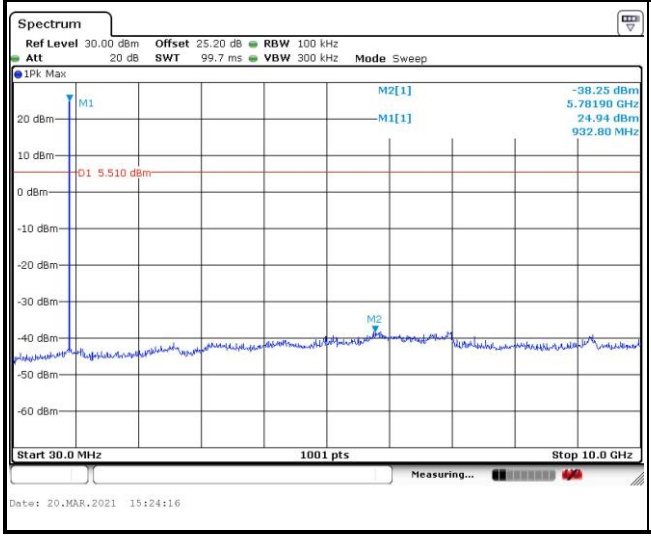
3.4.4 Test Setup



3.4.5 Test Result of Conducted Band Edges Plots

Low Band Edge Plot on Channel 01	High Band Edge Plot on Channel 31
	

3.4.6 Test Result of Conducted Spurious Emission Plots

Conducted Spurious Emission Plot on Channel 01	Conducted Spurious Emission Plot on Channel 16
	
Conducted Spurious Emission Plot on Channel 31	**N/A**
	

3.5 Radiated Band Edges and Spurious Emission Measurement

3.5.1 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. If the output power of this device was measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB. 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

3.5.2 Measuring Instruments

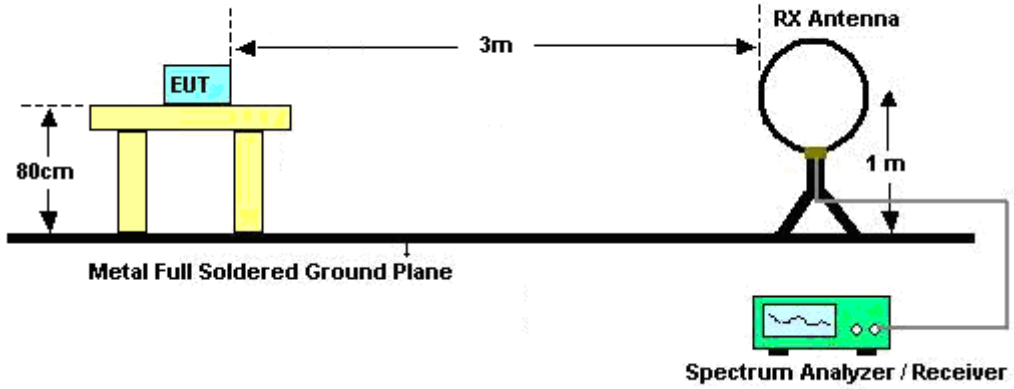
See list of measuring equipment of this test report.

3.5.3 Test Procedures

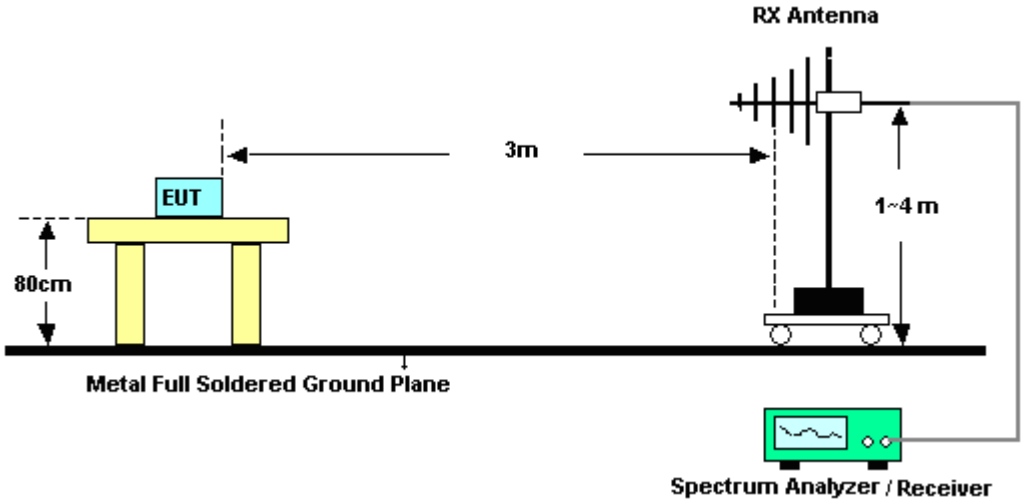
1. The testing follows the ANSI C63.10 Section 11.12.1 Radiated emission measurements.
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
3. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
5. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
6. For testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
7. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than average limit (that means the emission level in average mode also complies with the limit in average mode), then peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.
8. 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; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold;
   (3) Set RBW = 1 MHz, VBW= 3MHz for f ≥ 1 GHz for peak measurement.
   For average measurement:
   - VBW = 10 Hz, when duty cycle is no less than 98 percent.
   - VBW ≥ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

3.5.4 Test Setup

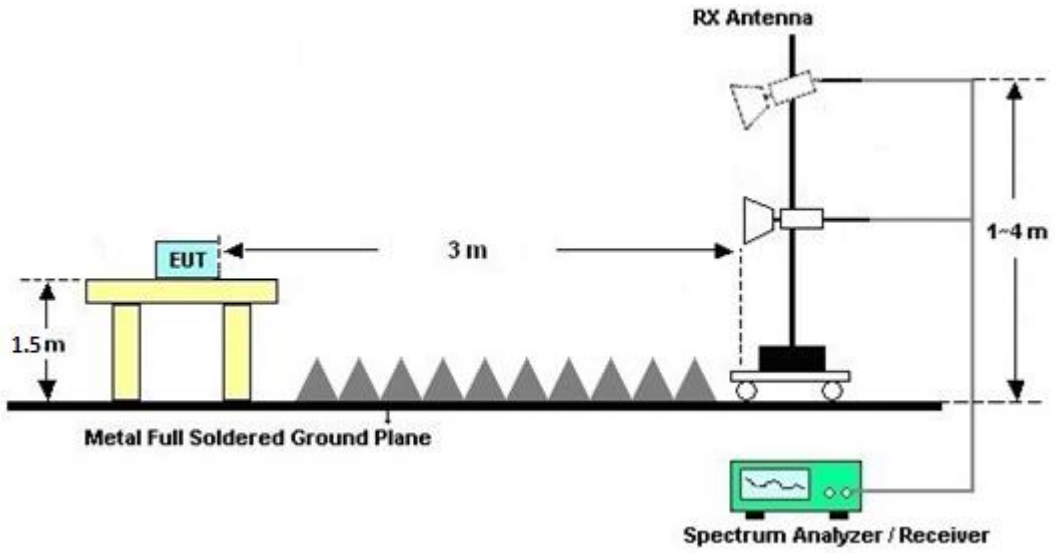
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



3.5.5 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.

3.5.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix C and D.

3.5.7 Duty Cycle

Please refer to Appendix E.

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

Please refer to Appendix C and D.

3.6 AC Conducted Emission Measurement

3.6.1 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.

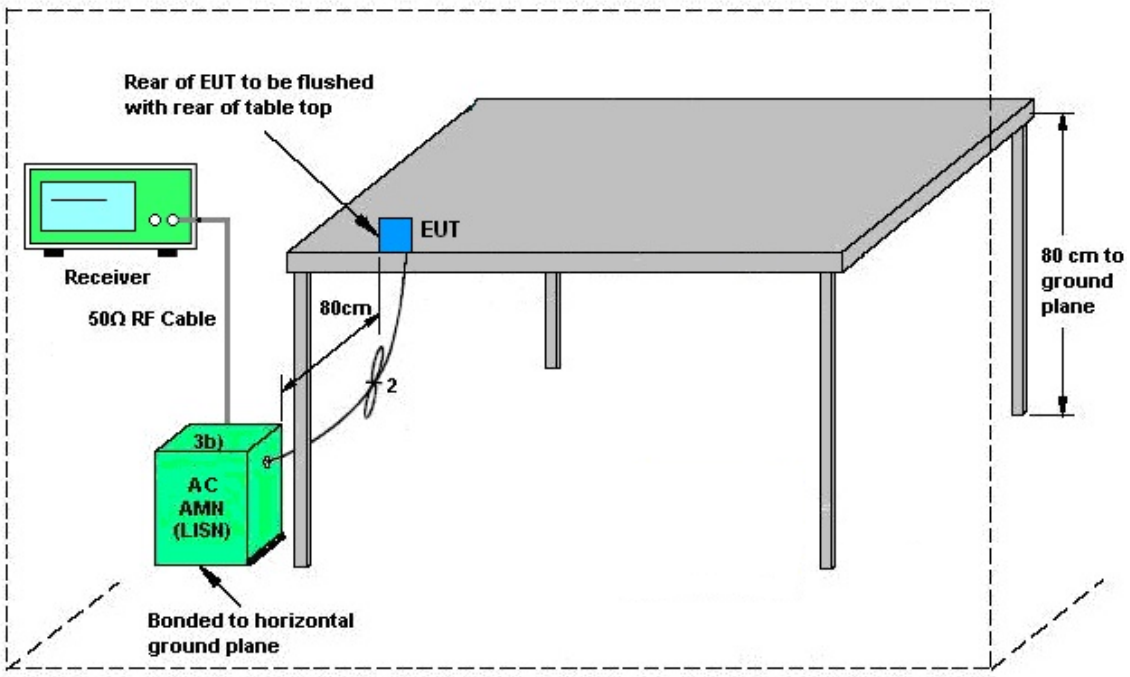
3.6.2 Measuring Instruments

See list of measuring equipment of this test report.

3.6.3 Test Procedures

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

3.6.4 Test Setup



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

3.6.5 Test Result of AC Conducted Emission

Please refer to Appendix B.

3.7 Antenna Requirements

3.7.1 Standard Applicable

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

3.7.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.7.3 Antenna Gain

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

4 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Horn Antenna	SCHWARZBECK	BBHA 9120 D	9120D-1326	1GHz ~ 18GHz	Nov. 03, 2020	Mar. 17, 2021 ~ Mar. 18, 2021	Nov. 02, 2021	Radiation (03CH11-HY)
Bilog Antenna	TESEQ	CBL 6111D & N-6-06	35414 & AT-N0602	30MHz~1GHz	Oct. 11, 2020	Mar. 17, 2021 ~ Mar. 18, 2021	Oct. 10, 2021	Radiation (03CH11-HY)
Preamplifier	Keysight	83017A	MY53270080	1GHz~26.5GHz	Nov. 12, 2020	Mar. 17, 2021 ~ Mar. 18, 2021	Nov. 11, 2021	Radiation (03CH11-HY)
Amplifier	SONOMA	310N	187312	9kHz~1GHz	Dec. 02, 2020	Mar. 17, 2021 ~ Mar. 18, 2021	Dec. 01, 2021	Radiation (03CH11-HY)
Spectrum Analyzer	Keysight	N9010A	MY54200486	10Hz~44GHz	Oct. 23, 2020	Mar. 17, 2021 ~ Mar. 18, 2021	Oct. 22, 2021	Radiation (03CH11-HY)
EMI Test Receiver	Keysight	N9038A(MXE)	MY55420170	20MHz~8.4GHz	May 21, 2020	Mar. 17, 2021 ~ Mar. 18, 2021	May 20, 2021	Radiation (03CH11-HY)
Controller	EMEC	EM 1000	N/A	Control Turn table & Ant Mast	N/A	Mar. 17, 2021 ~ Mar. 18, 2021	N/A	Radiation (03CH11-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1~4m	N/A	Mar. 17, 2021 ~ Mar. 18, 2021	N/A	Radiation (03CH11-HY)
Turn Table	EMEC	TT 2000	N/A	0~360 Degree	N/A	Mar. 17, 2021 ~ Mar. 18, 2021	N/A	Radiation (03CH11-HY)
Software	Audix	E3 6.2009-8-24	RK-001053	N/A	N/A	Mar. 17, 2021 ~ Mar. 18, 2021	N/A	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY9837/4PE	9kHz-30MHz	Mar. 11, 2021	Mar. 17, 2021 ~ Mar. 18, 2021	Mar. 10, 2022	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	MY2859/2	30MHz-40GHz	Mar. 11, 2021	Mar. 17, 2021 ~ Mar. 18, 2021	Mar. 10, 2022	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY9837/4PE	30M-18G	Mar. 11, 2021	Mar. 17, 2021 ~ Mar. 18, 2021	Mar. 10, 2022	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	MY4274/2	30MHz-40GHz	Mar. 11, 2021	Mar. 17, 2021 ~ Mar. 18, 2021	Mar. 10, 2022	Radiation (03CH11-HY)
Filter	Wainwright	WLK4-1000-1530-8000-40SS	SN11	1.53G Low Pass	Sep. 14, 2020	Mar. 17, 2021 ~ Mar. 18, 2021	Sep. 13, 2021	Radiation (03CH11-HY)
Filter	Wainwright	WHKX12-935-1000-15000-40ST	SN1	1GHz High Pass Filter	Apr. 30, 2020	Mar. 17, 2021 ~ Mar. 18, 2021	Apr. 29, 2021	Radiation (03CH11-HY)
Hygrometer	TECPEL	DTM-303B	TP140325	N/A	Nov. 18, 2020	Mar. 17, 2021 ~ Mar. 18, 2021	Nov. 17, 2021	Radiation (03CH11-HY)
AC Power Source	ChainTek	APC-1000W	N/A	N/A	N/A	Mar. 10, 2021	N/A	Conduction (CO05-HY)
EMI Test Receiver	Rohde & Schwarz	ESR3	102388	9kHz~3.6GHz	Nov. 30, 2020	Mar. 10, 2021	Nov. 29, 2021	Conduction (CO05-HY)
Hygrometer	Testo	608-H1	34913912	N/A	Nov. 18, 2020	Mar. 10, 2021	Nov. 17, 2021	Conduction (CO05-HY)
LISN	Rohde & Schwarz	ENV216	100081	9kHz~30MHz	Nov. 16, 2020	Mar. 10, 2021	Nov. 15, 2021	Conduction (CO05-HY)
Software	Rohde & Schwarz	EMC32 V10.30	N/A	N/A	N/A	Mar. 10, 2021	N/A	Conduction (CO05-HY)
Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100851	N/A	Feb. 25, 2021	Mar. 10, 2021	Feb. 24, 2022	Conduction (CO05-HY)
LISN Cable	MVE	RG-400	260260	N/A	N/A	Mar. 10, 2021	N/A	Conduction (CO05-HY)

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Hygrometer	TECPEL	TR-32	HE17XB2468	N/A	Mar. 09. 2021	Mar. 13, 2020 ~ Mar. 20, 2020	Mar. 08. 2022	Conducted (TH05-HY)
Signal Analyzer	Rohde & Schwarz	FSV40	101566	10Hz ~ 40GHz	Jul. 22, 2020	Mar. 13, 2020 ~ Mar. 20, 2020	Jul. 21, 2021	Conducted (TH05-HY)
Power Meter	Anritsu	ML2495A	1218006	N/A	Oct. 18, 2020	Mar. 13, 2020 ~ Mar. 20, 2020	Oct. 17, 2021	Conducted (TH05-HY)
Power Sensor	Anritsu	MA2411B	1207363	300MHz ~ 40GHz	Oct. 18, 2020	Mar. 13, 2020 ~ Mar. 20, 2020	Oct. 17, 2021	Conducted (TH05-HY)
Switch Box & RF Cable	Burgeon	ETF058	EC1300484	N/A	Nov. 19, 2020	Mar. 13, 2020 ~ Mar. 20, 2020	Nov. 18, 2021	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. Test Result of Conducted Test Items

Test Engineer	Tommy Lee	Temperature:	23.1-23.4	°C
Test Date:	2021/03/13~2021/03/20	Relative Humidity:	54.1-54.4	%

TEST RESULTS DATA
6dB and 99% Occupied Bandwidth

Mod.	NTX	CH.	Freq. (MHz)	99% Occupied BW (MHz)	6dB BW (MHz)	6dB BW Limit (MHz)	Pass/Fail
Lora	1	1	902.5	0.541	0.627	0.50	Pass
Lora	1	16	914.5	0.537	0.623	0.50	Pass
Lora	1	31	926.5	0.535	0.623	0.50	Pass

TEST RESULTS DATA
Peak Power Table

Mod.	NTX	CH.	Freq. (MHz)	Paek Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
Lora	1	1	902.5	25.50	30.00	-0.83	24.67	36.00	Pass
Lora	1	16	914.5	25.30	30.00	-0.83	24.47	36.00	Pass
Lora	1	31	926.5	24.86	30.00	-0.83	24.03	36.00	Pass

TEST RESULTS DATA
Average Power Table
(Reporting Only)

Mod.	NTX	CH.	Freq. (MHz)	Duty Factor (dB)	Average Conducted Power (dBm)
Lora	1	1	902.5	0.12	25.44
Lora	1	16	914.5	0.12	25.24
Lora	1	31	926.5	0.12	24.80

TEST RESULTS DATA
Average Power Density

Mod.	NTX	CH.	Freq. (MHz)	Peak PSD (dBm /100kHz)	Average PSD (dBm /3kHz)	DG (dBi)	Average PSD Limit (dBm /3kHz)	Pass/Fail
Lora	1	1	902.5	25.51	6.35	-0.83	8.00	Pass
Lora	1	16	914.5	25.23	6.26	-0.83	8.00	Pass
Lora	1	31	926.5	24.81	6.07	-0.83	8.00	Pass

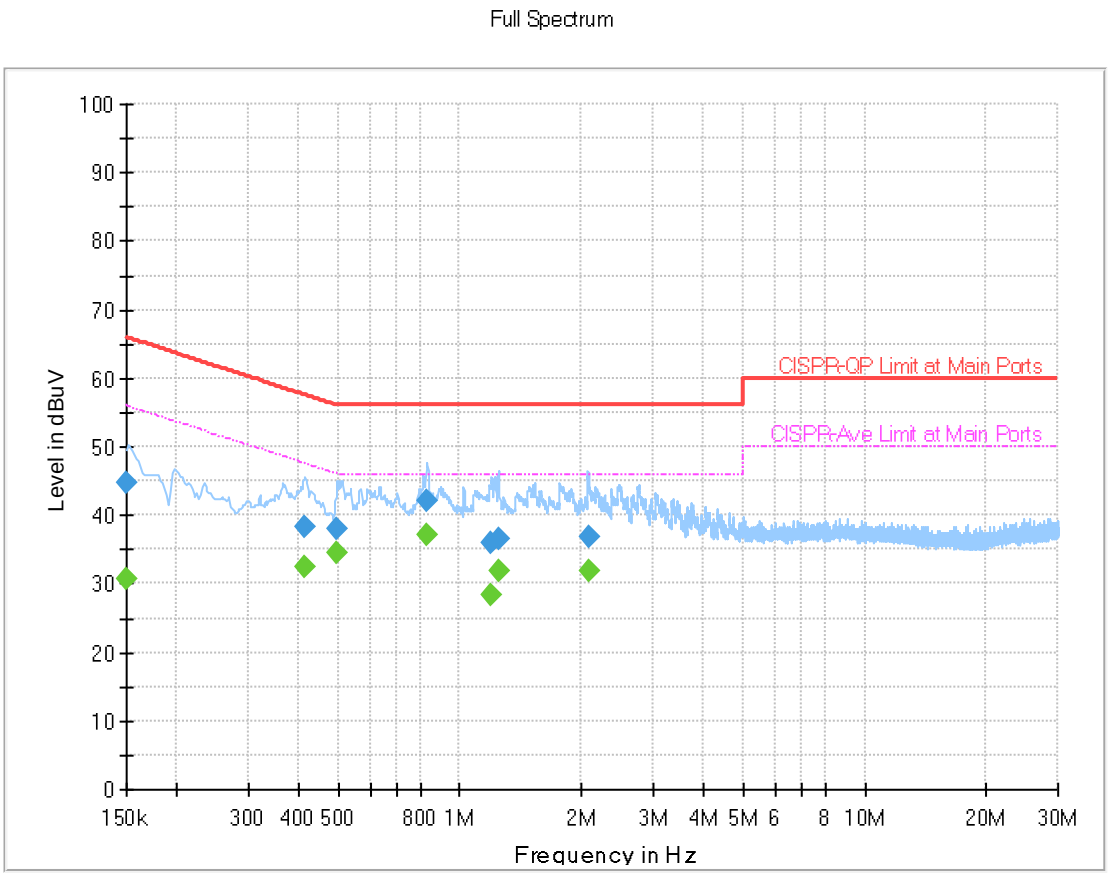
Note: PSD (dBm/ 100kHz) is a reference level used for Conducted Band Edges and Conducted Spurious Emission 30dBc limit.

Appendix B. AC Conducted Emission Test Results

Test Engineer :	Howard Huang	**Temperature :**	23~26℃
		Relative Humidity :	40~50%

EUT Information

Report NO :	120337
Test Mode :	Mode 1
Test Voltage :	120Vac/60Hz
Phase :	Line



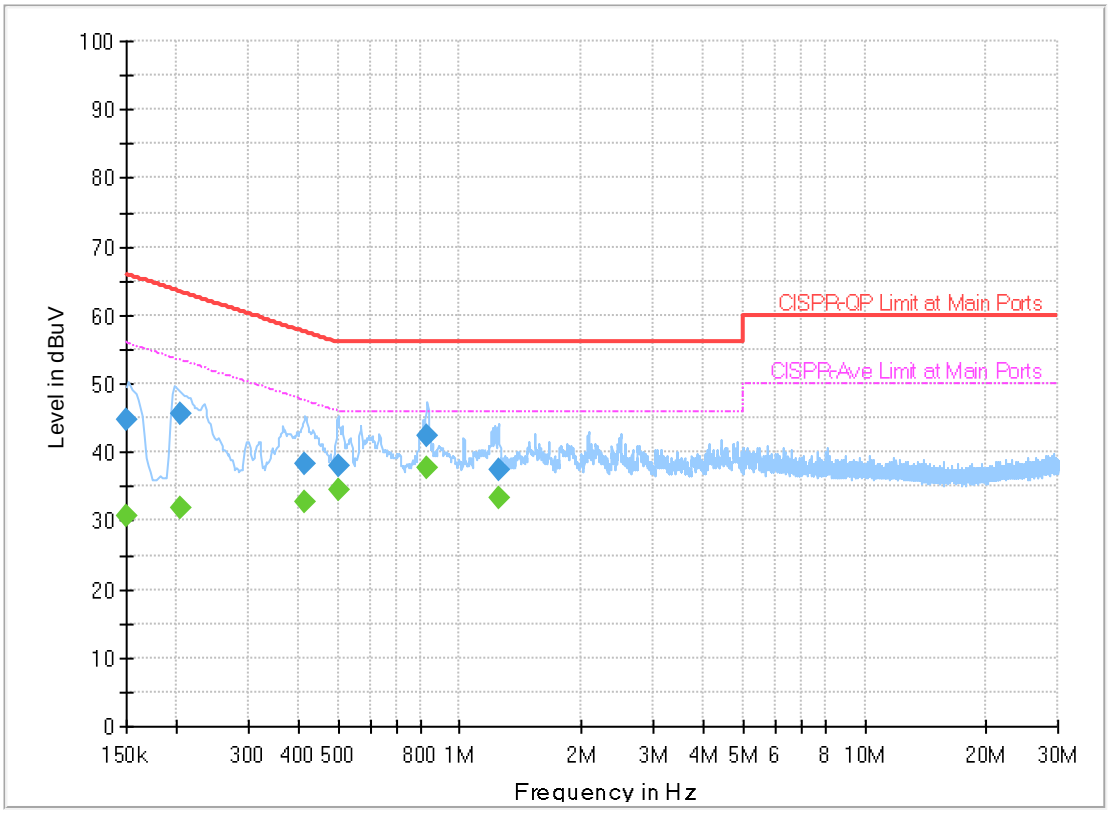
Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Line	Filter	Corr. (dB)
0.150000	---	30.81	56.00	25.19	L1	OFF	19.7
0.150000	44.67	---	66.00	21.33	L1	OFF	19.7
0.415410	---	32.43	47.54	15.11	L1	OFF	19.8
0.415410	38.26	---	57.54	19.28	L1	OFF	19.8
0.498930	---	34.42	46.02	11.60	L1	OFF	19.9
0.498930	38.08	---	56.02	17.94	L1	OFF	19.9
0.829410	---	37.04	46.00	8.96	L1	OFF	20.2
0.829410	42.13	---	56.00	13.87	L1	OFF	20.2
1.196250	---	28.45	46.00	17.55	L1	OFF	20.3
1.196250	35.92	---	56.00	20.08	L1	OFF	20.3
1.242330	---	31.90	46.00	14.10	L1	OFF	20.3
1.242330	36.44	---	56.00	19.56	L1	OFF	20.3
2.076000	---	31.80	46.00	14.20	L1	OFF	20.2
2.076000	36.86	---	56.00	19.14	L1	OFF	20.2

EUT Information

Report NO :	120337
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)
0.150000	---	30.82	56.00	25.18	N	OFF	19.7
0.150000	44.72	---	66.00	21.28	N	OFF	19.7
0.204000	---	31.77	53.45	21.68	N	OFF	19.7
0.204000	45.56	---	63.45	17.89	N	OFF	19.7
0.415230	---	32.61	47.54	14.93	N	OFF	19.8
0.415230	38.34	---	57.54	19.20	N	OFF	19.8
0.501180	---	34.46	46.00	11.54	N	OFF	19.9
0.501180	38.11	---	56.00	17.89	N	OFF	19.9
0.830940	---	37.67	46.00	8.33	N	OFF	20.2
0.830940	42.43	---	56.00	13.57	N	OFF	20.2
1.246740	---	33.25	46.00	12.75	N	OFF	20.3
1.246740	37.57	---	56.00	18.43	N	OFF	20.3

Appendix C. Radiated Spurious Emission

Test Engineer :	Bill Chang and Fu Chen	Temperature :	19.2 ~ 22.8°C
		Relative Humidity :	62.7 ~ 68.3%

Lora 902~928MHz

Lora DTS 500k (Band Edge @ 3m)

Loa	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)
		115.36	37.59	-5.91	43.5	41.42	17.21	11.47	32.51	268	346	QP	H
		186.17	29.27	-14.23	43.5	35.06	14.72	12.02	32.53	-	-	P	H
		478.14	35.58	-10.42	46	30.91	23.62	13.14	32.09	-	-	P	H
		739.07	39.75	-6.25	46	29.96	27.89	13.98	32.08	-	-	P	H
		870.5	48.69	-53.23	101.92	36.31	29.31	14.39	31.32	-	-	P	H
	*	902.5	121.92	-	-	109.48	29.12	14.5	31.18	143	188	P	H
		934.04	46.68	-55.24	101.92	33.27	29.82	14.57	30.98	-	-	P	H
													H
Lora													H
DTS 500k													H
CH 01		43.58	32.06	-7.94	40	36.37	17.3	10.91	32.52	100	80	QP	V
902.5MHz		115.36	30.45	-13.05	43.5	34.28	17.21	11.47	32.51	-	-	P	V
		318.09	29.86	-16.14	46	29.98	19.34	12.6	32.06	-	-	P	V
		709	37.82	-8.18	46	29.56	26.71	13.87	32.32	-	-	P	V
		870.02	44.72	-52.89	97.61	32.33	29.32	14.39	31.32	-	-	P	V
	*	902.5	117.61	-	-	105.17	29.12	14.5	31.18	100	240	P	V
		935.01	45.1	-52.51	97.61	31.62	29.87	14.58	30.97	-	-	P	V
													V
													V
													V

Remark

1. No other spurious found.
2. All results are PASS against limit line.
3. Non restricted band limit is radio frequency level down 20db

Lora	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)
		115.36	37.7	-5.8	43.5	41.53	17.21	11.47	32.51	268	346	QP	H
		171.62	29.44	-14.06	43.5	34.7	15.33	11.94	32.53	-	-	P	H
		440.31	33.33	-12.67	46	29.36	22.91	13	31.94	-	-	P	H
		681.84	38.7	-7.3	46	30.79	26.59	13.8	32.48	-	-	P	H
		882.63	47.41	-54.15	101.56	35.06	29.18	14.44	31.27	-	-	P	H
	*	914.5	121.56	-	-	108.93	29.21	14.53	31.11	150	189	P	H
		946.65	45.62	-55.94	101.56	31.41	30.51	14.6	30.9	-	-	P	H
													H
													H
													H
Lora													H
DTS 500k													H
CH 16		41.64	32.91	-7.09	40	36.1	18.43	10.89	32.51	100	80	QP	V
914.5MHz		54.25	33.8	-6.2	40	42.97	12.35	11.03	32.55	-	-	P	V
		115.36	32.07	-11.43	43.5	35.9	17.21	11.47	32.51	-	-	P	V
		642.07	37.04	-8.96	46	29.6	26.45	13.68	32.69	-	-	P	V
		882.63	44.27	-52.36	96.63	31.92	29.18	14.44	31.27	-	-	P	V
	*	914.5	116.63	-	-	104	29.21	14.53	31.11	100	242	P	V
		946.65	44.21	-52.42	96.63	30	30.51	14.6	30.9	-	-	P	V
													V
													V
													V
													V
													V

Remark

1. No other spurious found.
2. All results are PASS against limit line.
3. Non restricted band limit is radio frequency level down 20db

Lora	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)
		115.36	37.97	-5.53	43.5	41.8	17.21	11.47	32.51	268	348	QP	H
		301.6	29.18	-16.82	46	29.57	19.19	12.54	32.12	-	-	P	H
		553.8	36.12	-9.88	46	29.57	25.68	13.44	32.57	-	-	P	H
		840.92	45.14	-56.03	101.17	33.41	28.87	14.3	31.44	-	-	P	H
		894.27	47.46	-53.71	101.17	35.08	29.12	14.48	31.22	-	-	P	H
	*	926.5	121.17	-	-	108.1	29.54	14.56	31.03	148	188	P	H
		958.29	44.96	-56.21	101.17	30.1	31.06	14.62	30.82	-	-	P	H
													H
													H
													H
Lora													H
DTS 500k													H
CH 31		43.58	32.27	-7.73	40	36.58	17.3	10.91	32.52	100	80	QP	V
926.5MHz		54.25	33.37	-6.63	40	42.54	12.35	11.03	32.55	-	-	P	V
		115.36	31.33	-12.17	43.5	35.16	17.21	11.47	32.51	-	-	P	V
		602.3	36.61	-9.39	46	30.39	25.52	13.59	32.89	-	-	P	V
		894.27	44.91	-52.07	96.98	32.53	29.12	14.48	31.22	-	-	P	V
	*	926.5	116.98	-	-	103.91	29.54	14.56	31.03	100	241	P	V
		958.29	45.49	-51.49	96.98	30.63	31.06	14.62	30.82	-	-	P	V
													V
													V
													V
													V
													V

Remark

1. No other spurious found.
2. All results are PASS against limit line.
3. Non restricted band limit is radio frequency level down 20db

Lora DTS 500k (Harmonic @ 3m)

Lora	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)
		2707.5	48.18	-25.82	74	78.58	28	8.63	67.03	100	0	P	H
		3610	37.07	-36.93	74	64.85	29	9.62	66.4	100	0	P	H
Lora													H
DTS 500k													H
CH 01		2707.5	40.5	-33.5	74	70.9	28	8.63	67.03	100	0	P	V
902.5MHz		3610	36.46	-37.54	74	64.24	29	9.62	66.4	100	0	P	V
													V
													V
		2743.5	44.59	-29.41	74	74.92	28	8.69	67.02	100	0	P	H
		3658	35.95	-38.05	74	63.67	29.02	9.67	66.41	100	0	P	H
Lora													H
DTS 500k													H
CH 16		2743.5	42.32	-31.68	74	72.65	28	8.69	67.02	100	0	P	V
914.5MHz		3658	37.1	-36.9	74	64.82	29.02	9.67	66.41	100	0	P	V
													V
													V
		2779.5	47.64	-26.36	74	77.79	28.12	8.74	67.01	100	0	P	H
		3706	36.41	-37.59	74	64.04	29.1	9.7	66.43	100	0	P	H
Lora													H
DTS 500k													H
CH 31		2779.5	40.08	-33.92	74	70.23	28.12	8.74	67.01	100	0	P	V
926.5MHz		3706	36.54	-37.46	74	64.17	29.1	9.7	66.43	100	0	P	V
													V
													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:

BLE	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)
BLE 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)

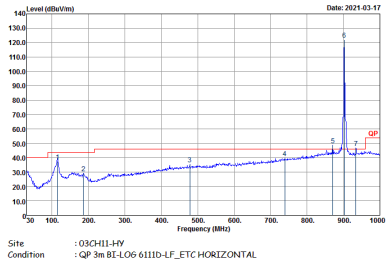
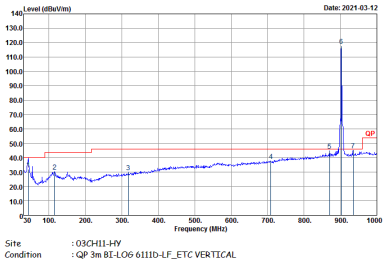
Both peak and average measured complies with the limit line, so test result is “PASS”.

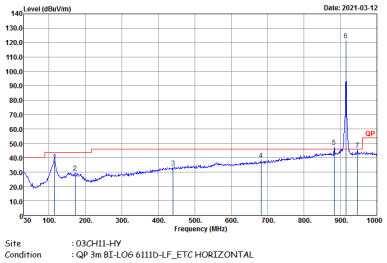
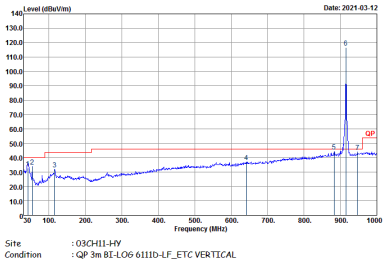
Appendix D. Radiated Spurious Emission Plots

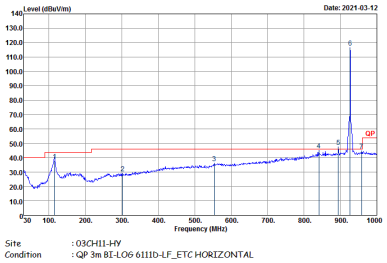
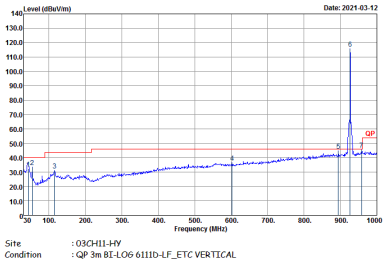
Test Engineer :	Bill Chang and Fu Chen	Temperature :	19.2 ~ 22.8°C
		Relative Humidity :	62.7 ~ 68.3%

Lora 902~928MHz

Lora DTS 500k (Band Edge @ 3m)

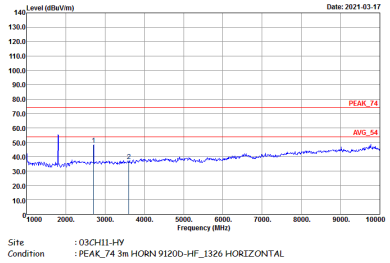
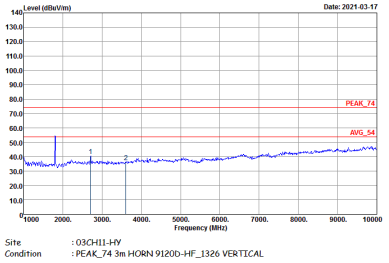
Lora	Lora 902~928MHz	
	Lora DTS 500k Ch01 902.5Mhz	
	Horizontal	Vertical
QP / Peak		

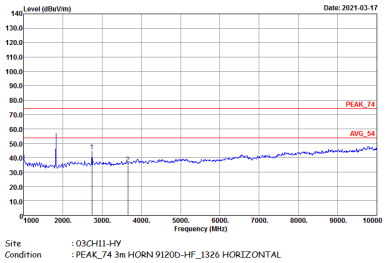
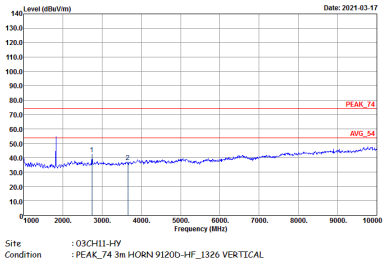
Lora	Lora 920~928MHz	
	Lora DTS 500k Ch16 914.5MHz	
	Horizontal	Vertical
QP / Peak		

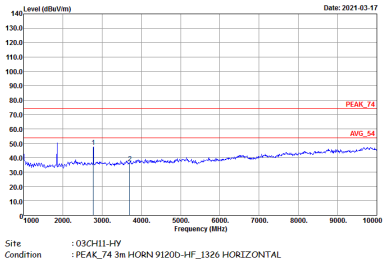
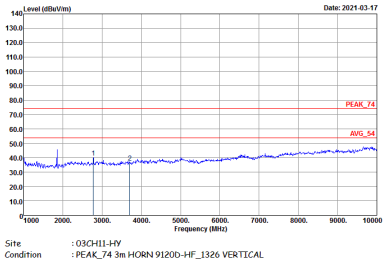
Lora	Lora 902~928MHz	
	Lora DTS 500k Ch31 926.5MHz	
	Horizontal	Vertical
Peak Avg.		

Lora 902~928MHz

Lora DTS 500k (Harmonic @ 3m)

Lora	Lora 902~928MHz	
	Lora DTS 500k Ch01 902.5Mhz	
	Horizontal	Vertical
Peak Avg.		

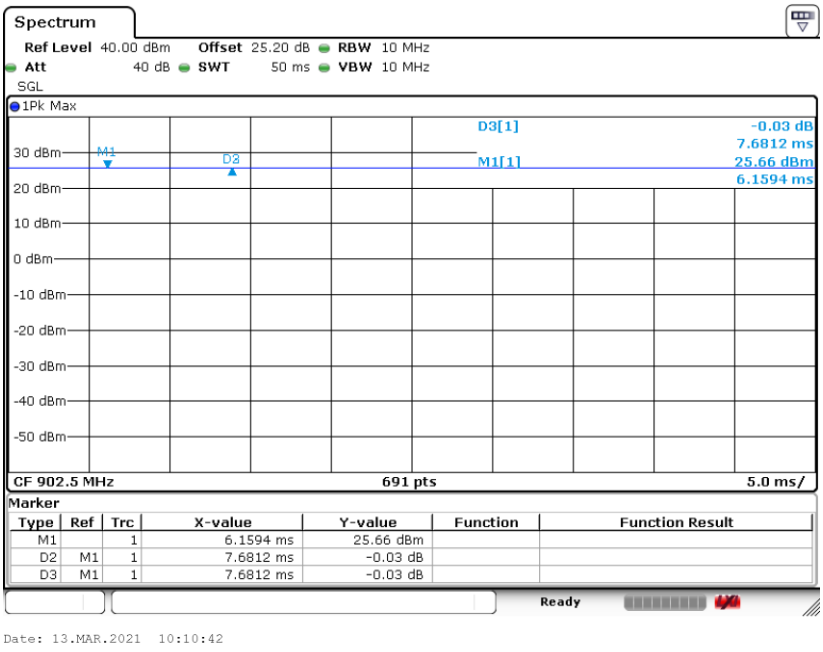
Lora	Lora 902~928MHz	
	Lora DTS 500k Ch16 914.5MHz	
	Horizontal	Vertical
Peak Avg.		

Lora	Lora 902~928MHz	
	Lora DTS 500k Ch31 926.5MHz	
	Horizontal	Vertical
Peak Avg.		

Appendix E. Duty Cycle Plots

Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting	Duty Factor(dB)
LoRa (DTS)	100.00	-	-	10Hz	0.00

LoRa (DTS)



————THE END————