FCC Test Report

Report No: WD-RF-R-200328-B0

Product Name	:	RM300 4-port UHF RFID Reader Module
Model Name	:	RM300
FCC ID	:	HLERM3004PF
Applicant	:	unitech Electronics Co., Ltd.
Received Date	:	Jul. 13, 2020
Tested Date	:	Jul. 29, 2020 ~ Nov. 13, 2020
Applicable Standard	:	47 CFR FCC Part 15, Subpart C (Section 15.247) KDB 558074 D01 DTS Meas. Guidance v05 ANSI C63.10 : 2013

Wendell Industrial Co., Ltd
Wendell EMC & RF Laboratory

Test Report

Issued Date: November 13, 2020

Project No.: 20Q071303

Product Name	RM300 4-port UHF RFID Reader Module
Trade Name	unitech
Model Name	RM300
FCC ID	HLERM3004PF
Applicant	unitech Electronics Co., Ltd.
Manufacturer	unitech Electronics Co., Ltd.
EUT Rated Voltage	DC 5V , 1.5A
EUT Test Voltage	AC 120V / 60Hz
EUT Supports Radios Application	902.75~927.25MHz
Applicable Standard	47 CFR FCC Part 15, Subpart C (Section 15.247) KDB 558074 D01 DTS Meas. Guidance v05 ANSI C63.10 : 2013
Output Power	28.03dBm
Test Result	Complied

Documented : Emma Lu

(Specialist / Emma Lu)

Technical Engineer : Jack Chang

(Deputy Section Manager / Jack Chang)

Approved : Gary Wu

(Project Manager / Gary Wu)

Table of Contents

Document Revision History

Report No.	Issue date	Description
WD-RF-R-200328-B0	November 13, 2020	Initial report

Summary of Test Result

Ref. Std. Clause	Test Items	Result
15.203 15.247(C)	Antenna Requirement	Pass
15.247(b)(1)	Peak Conducted Output Power	Pass
15.247(a)(1)	Number of Hopping Frequency	Pass
15.247(a)(1)	Hopping Channel Separation	Pass
15.247(a)(1)	Dwell Time of Each Channel	Pass
15.247(a)(1)	20dB Bandwidth	Pass
15.247(d)	Conducted Band Edges and Conducted Spurious Emission	Pass
15.247(d)	Radiated Band Edges and Radiated Spurious Emission	Pass
15.207	AC Conducted Emission	Pass

1 Generation Information

1.1 Applicant

unitech Electronics Co., Ltd.
5F., No. 136, Ln. 235, Baoqiao Rd., Xindian Dist., New Taipei City , Taiwan

1.2 Manufacturer

unitech Electronics Co., Ltd.
5F., No. 136, Ln. 235, Baoqiao Rd., Xindian Dist., New Taipei City , Taiwan

1.3 Description of Equipment under Test

Product Name	RM300 4-port UHF RFID Reader Module
Model No.	RM300
FCC ID	HLERM3004PF
Frequency Range	902.75~927.25MHz
Number of Channels	50
Type of Modulation	FHSS
Antenna Information	Refer to the table “Antenna List”
EUT Supports Radios Application	902.75~927.25MHz
EUT Rated Voltage	DC 5V , 1.5A
EUT Test Voltage	AC 120V / 60Hz

Antenna List

No.	Manufacturer	Model No.	Antenna Type	Peak Gain
1	CIROCOMM	03A58B0K00J2120	Patch Antenna	3 dBi

Remark: The antenna of EUT is conforming to FCC 15.203

Channel List

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
01	902.75	14	909.25	27	915.75	40	922.25
02	903.25	15	909.75	28	916.25	41	922.75
03	903.75	16	910.25	29	916.75	42	923.25
04	904.25	17	910.75	30	917.25	43	923.75
05	904.75	18	911.25	31	917.75	44	924.25
06	905.25	19	911.75	32	918.25	45	924.75
07	905.75	20	912.25	33	918.75	46	925.25
08	906.25	21	912.75	34	919.25	47	925.75
09	906.75	22	913.25	35	919.75	48	926.25
10	907.25	23	913.75	36	920.25	49	926.75
11	907.75	24	914.25	37	920.75	50	927.25
12	908.25	25	914.75	38	921.25	--	--
13	908.75	26	915.25	39	921.75	--	--

Test Frequencies in each operating band

Frequency range over which the device operates in each operating band (Note 1)	Number of test frequencies required	Location of test frequencies inside the operating frequency range (Note 1,2)
≤ 1 MHz	1	near centre
> 1 MHz and ≤ 10 MHz	2	1 near high end, 1 near low end
> 10 MHz	3	1 near high end, 1 near centre, and 1 near low end

Note 1: The frequency range over which the device operates in a given operating band is the difference between the highest and lowest frequencies on which the device can be tuned within that given operating band. The frequency range can be smaller than or equal to the operating band, but cannot be greater than the operating band.

Note 2: In the third column of table 1, “near” means as close as possible to or at the centre / low end / high end of the frequency range over which the device operates.

Firmware / Software Version

1	**Product Name**	RM300 4-port UHF RFID Reader Module
2	**Model No.**	RM300
3	**Test SW Version**	IndyTool Ver_2.6.0
4	**RF power setting in TEST SW**	☐ RF power setting was not able to alter during testing. ☒ RF power setting was able to alter during testing. (See the following table)

Parameters of test software setting

Channel	Frequency (MHz)	Set Value
01	902.75	28
25	914.75	28
50	927.25	28

1.4 Test Mode Applicability And Tested Channel Detail

1. This device is a RM300 4-port UHF RFID Reader Module with a built-in 902~928MHz FHSS transceiver.
2. Select low (902.75MHz), medium (914.75MHz) and highest (927.25MHz) operating frequencies to perform the test. The results are shown in this report.
3. These tests were performed on a sample of equipment to demonstrate compliance with 47 CFR FCC Part 15, Subpart C (Section 15.247).
4. Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates, XYZ axis and antenna ports.
5. The worst case was found when positioned on X axis for radiated emission. Following test modes were selected for the final test, and the final worst case is recorded in the report:

EUT Configure Mode	RE < 1G	RE ≥ 1G	ACM	ACP	Description
--	☒	☒	☒	☐	Transmit RFID
--	☐	☐	☐	☒	Normal Link

Note : RE<1G: Radiated Emission below 1GHz RE≥1G: Radiated Emission above 1GHz
ACM: Antenna Port Conducted Measurement ACP: AC Power Line Conducted Emission

Following channel(s) was (were) selected for the final test as listed below:

Radiated Spurious Emission Measurement(Below 1GHz):

EUT Configure Mode	Mode	Available Channel	Tested Channel	Modulation Type	Data Rate (Mbps)
--	RFID	1 ~ 50	25	FHSS	1

Radiated Spurious Emission Measurement(Above 1GHz):

EUT Configure Mode	Mode	Available Channel	Tested Channel	Modulation Type	Data Rate (Mbps)
--	RFID	1 ~ 50	1, 25, 50	FHSS	1
--	RFID	1 ~ 50	1, 25, 50	FHSS	3

Radiated Band Edge Emission Measurement(Above 1GHz):

EUT Configure Mode	Mode	Available Channel	Tested Channel	Modulation Type	Data Rate (Mbps)
--	RFID	1 ~ 50	1, 50	FHSS	1
--	RFID	1 ~ 50	1, 50	FHSS	3

Peak Output Power, Hopping Channel Separation Measurement, 20dB Bandwidth, Conducted Spurious Emission:

EUT Configure Mode	Mode	Available Channel	Tested Channel	Modulation Type	Data Rate (Mbps)
--	RFID	1 ~ 50	1, 25, 50	FHSS	1
--	RFID	1 ~ 50	1, 25, 50	FHSS	3

Number of Hopping Frequency, Dwell Time Measurement, Conducted Band Edges

EUT Configure Mode	Mode	Available Channel	Tested Channel	Modulation Type	Data Rate (Mbps)
--	RFID	1 ~ 50	Hopping	FHSS	1
--	RFID	1 ~ 50	Hopping	FHSS	3

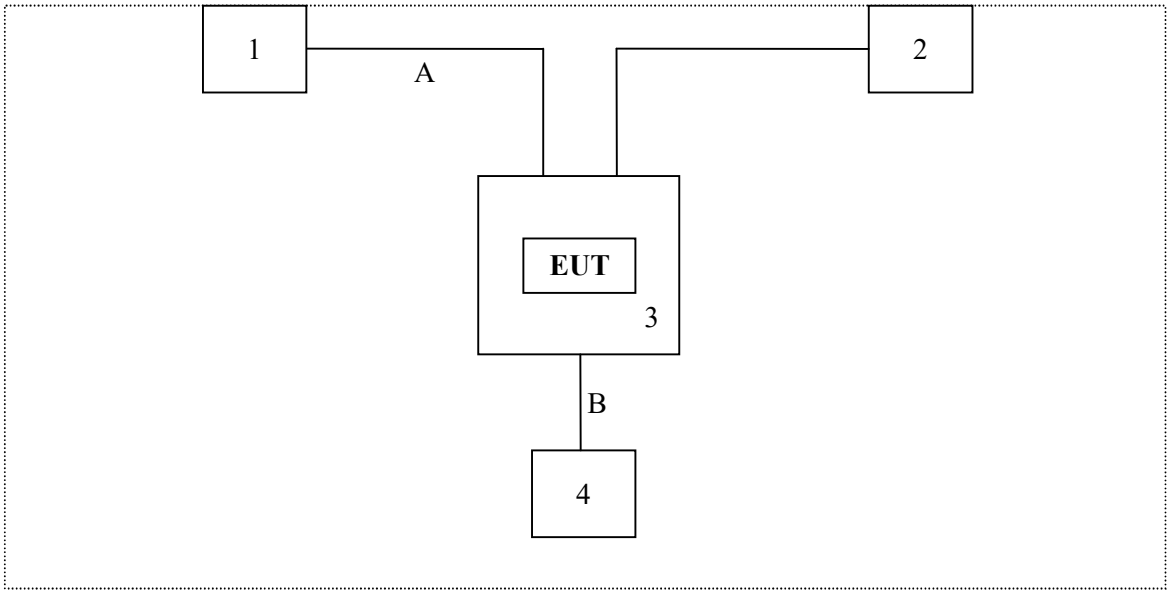
Conducted Band Edges

EUT Configure Mode	Mode	Available Channel	Tested Channel	Modulation Type	Data Rate (Mbps)
--	RFID	1 ~ 50	1, 50	FHSS	1
--	RFID	1 ~ 50	1, 50	FHSS	3

AC Conducted Emission:

EUT Configure Mode	Mode	Available Channel	Tested Channel	Modulation Type	Data Rate (Mbps)
--	RFID	1 ~ 50	Hopping	FHSS	1

1.5 Configuration of Tested System



Test Table

1.6 EUT Exercise Software

1. Setup the EUT as shown in Section 1.5
2. Execute software “IndyTool Ver_2.6.0”.
3. Configure the test mode, the test channel, and the data rate.
4. Press “OK” to start the continuous transmit.
5. Verify that the EUT works properly.

1.7 Tested System Details

The types for all equipment, plus descriptions of all cables used in the tested system (including inserted cards) are:

No.	Product	Manufacturer	Model No.	Serial No.	Power Cord
1	Notebook PC	acer	N16Q1	NXVD4TA023742254707600	Non-shielded, 1 Core, 0.8m
2	Adapter	ENG Electric co., Ltd.	3A-182WP05	N/A	Non-shielded, 1 Core, 1.5m
3	Fixture	unitech	204865G	N/A	N/A
4	Antenna	JOYMAX	GPX-020ASFR9	N/A	N/A
	Antenna	JOYMAX	GPX-020ASFR9	N/A	N/A
	Antenna	JOYMAX	GPX-020ASFR9	N/A	N/A
	Antenna	JOYMAX	GPX-020ASFR9	N/A	N/A

No.	Signal Cable Type	Signal cable Description
A	USB Cable	Shielded, Non-Core, 1.8m
B	RF Cable	Shielded, Non-Core, 10m
	RF Cable	Shielded, Non-Core, 10m
	RF Cable	Shielded, Non-Core, 10m
	RF Cable	Shielded, Non-Core, 10m

1.8 Test Facility

Items	Required (IEC 60068-1)	Actual
Temperature (°C)	15-35	25
Humidity (% RH)	25-75	65
Barometric pressure (mbar)	860-1060	1001

Description: Accredited by TAF
Accredited Number: 2965

Issued by: Wendell Industrial Co., Ltd

Lab Address: 6F/6F-1, No.188, Baoqiao Rd., Xindian Dist.,
New Taipei City 23145, Taiwan R.O.C

Test Lab: Wendell EMC & RF Laboratory

Test Location: 1F., No. 119, Wugong 3rd Rd., Wugu Dist.,
New Taipei City 248, Taiwan (R.O.C.)

Designation Number: TW0025

Test Firm Registration Number: 665221

1.9 Measurement Uncertainty

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence (level based on a coverage factor K=2)

Measurement Project	Measuring Range	Expended Uncertainty
AC Conducted Emission	0.150 ~ 30 MHz	2.9 dB
Radiated Emission	0.009 ~ 30 MHz	4.2 dB
	30 ~ 1000 MHz	3.7 dB
	1000 ~ 18000 MHz	3.8 dB
	18000 ~ 40000 MHz	3.7 dB
RF Power, Conducted	1000 ~ 6000 MHz	0.51 dB
Occupied Bandwidth	1000 ~ 6000 MHz	2.4 %
Power Density	1000 ~ 6000 MHz	1.7 dB
Duty Cycle	1000 ~ 6000 MHz	1.3 %
Conducted Unwanted Emission Strength	1000 ~ 6000 MHz	1.8 dB
Frequency Stability	1000 ~ 6000 MHz	6.3×10^{-8}
DC Power Supply	0.5 ~ 30 V	3.2 %
Temperature	15 ~ 30 ℃	1.1 ℃
Humidity	40 ~ 80 %	3.4 %

Note: Please note that the measurement uncertainty are provided for informational purpose only and are not used in determining the Pass/Fail results.

1.10 List of Test Equipment

For Conducted measurements / RF Conducted Measurement Room

Equipment		Manufacturer	Model No.	Serial No.	Cal. Date	Due Date
✓	Spectrum analyzer	Keysight	N9010A	MY54200737	2020/9/3	2021/9/2
✓	Wideband Peak Power Meter	Anritsu	ML2495A	1733007	2020/9/2	2021/9/1
✓	Pulse Power Sensor + Precision Adaptor	Anritsu	MA2411B	1726022	2020/9/2	2021/9/1
	Temperature Chamber	TAICHY	MHK-225LK	1061121	2020/4/28	2021/4/27
	Wireless Connectivity Tester	R&S	CMW270	101307	2020/5/19	2021/5/18
✓	Attenuator	MVE	MVE2211-10	CT-9-056	2020/9/3	2021/9/2
	Attenuator	MVE	MVE2211-20	CT-9-057	2020/9/3	2021/9/2
	Attenuator	MVE	MVE2211-30	CT-9-058	2020/9/3	2021/9/2
	Power Divider	MVE	MVE8546	170826003	2020/9/3	2021/9/2
	Power Splitter	MVE	MVE8547	170302047	2020/9/3	2021/9/2
	DC Power Supply	GW INSTEK	GPC-3060D	GER817636	2020/9/4	2021/9/3

Remark:

1. All equipments are calibrated every one year.
2. The test instruments marked with "✓" are used to measure the final test results.

For AC Conduction measurements / W01-CE

	Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Due Date
✓	TWO-LINE V-NETWORK	R&S	ENV216	CT-1-025-1	2020/4/29	2021/4/28
✓	Pulse limiter	R&S	ESH3-Z2	CT-2-015	2020/4/27	2021/4/26
✓	EMI Test Receiver	R&S	ESCI	CT-1-024	2020/4/29	2021/4/28
✓	V-LISN	Schwarzbeck	NSLK8127	CT-1-104-1	2020/4/29	2021/4/28
✓	Test Cable	Marvelous Microwave Inc	200200.400LL.500A	CT-10-048-1	2020/4/27	2021/4/26
✓	50ohm Termination	N/A	N/A	CT-1-065-1	2020/4/28	2021/4/27

Remark:

1. All equipments are calibrated every one year.
2. The test instruments marked with "✓" are used to measure the final test results.
3. Test Software version: FARAD EZ-EMC Ver.EMC-CON 3A1

For Radiated measurements / 9x6x6 Semi Anechoic Room

Equipment		Manufacturer	Model No.	Serial No.	Cal. Date	Due Date
✓	Signal Analyzer	KEYSIGHT	N9010A	MY52220228	2020/7/28	2021/7/ 27
✓	EMI Receiver	KEYSIGHT	N9038A	MY56400089	2020/7/30	2021/7/ 29
✓	Pre-Amplifier	EMEC	EMC330	060668	2020/7/28	2021/7/ 29
✓	Pre-Amplifier	JPT	EM01G18G	060648	2020/9/4	2021/9/3
	Pre-Amplifier	EMCI	EMC051845SE	980525	2020/9/4	2021/9/3
	Pre-Amplifier	EMCI	EMC184045SE	980515	2020/9/4	2021/9/3
✓	Loop Antenna	EMCI	LPA600(Loop)+SAS-562 B(Amp)	277 & 282	20209/2	2021/9/1
✓	Trilog Broadband Antenna with 5 dB Attenuator	SCHWARZBECK	VULB 9168 & FAT-NM5NF5T3G2W5	VULB 9168-373	2020/7/29	2021/7/28
✓	Horn Antenna	Schwarzbeck	BBHA 9120D	01557	2020/7/28	2021/7/27
✓	Horn Antenna	Schwarzbeck	BBHA 9170	703	2019/12/4	2020/12/3
✓	Cable	EMCI	EMCCFD400-NM-NM-1000	190642	2020/7/29	2021/7/28
✓	Cable	PEWC	CFD400NL-LW-NM-NM-3000	191001	2020/7/30	2021/7/ 29
✓	Cable	EMCI	EMCCFD400-NM-NM-15000	190643	2020/7/30	2021/7/ 29
✓	Cable	EMCI	EMC104-SM-35M-600	190644	2020/7/30	2021/7/ 29
✓	Cable	EMCI	EMC104-SM-35M-15000	190645	2020/7/30	2021/7/ 29
	Cable	EMCI	EMC102-KM-KM-600	190646	2020/7/30	2021/7/ 29
	Cable	MVE	140140.LL404.700	A40098C	2020/7/30	2021/7/ 29
	RF Filter	EMEC	BRF-2400-2500	002	2020/9/3	2021/9/2
	RF Filter	EMEC	BRF-5150-5350	104	2020/9/3	2021/9/2
	RF Filter	EMEC	BRF-5470-5725	092	2020/9/3	2021/9/2
	RF Filter	EMEC	BRF-5725-5875	091	2020/9/3	2021/9/2
	RF Filter	EMEC	HPF-2800	002	2020/9/3	2021/9/2
	RF Filter	EMEC	HPF-5850	059	2020/9/3	2021/9/2
✓	SMA Notch Filter	MVE	MFN-902.928.S1	190604001	2020/9/3	2021/9/2

Remark:

1. All equipments are calibrated every one year.
2. The test instruments marked with "✓" are used to measure the final test results.
3. Test Software version: FARAD EZ-EMC Ver.WD-03A1-1

2 Test Result

2.1 Antenna Requirement

2.1.1 Applicable Standard

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. 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 provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

An intentional radiator shall be designed to ensure that no antenna other than as furnished by the responsible party shall be used with the device. If transmitting antennas of directional gain greater than 6dBi are using the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi, for compliance to FCC 47CFR 15.247 (c) requirements.

2.1.2 Antenna Connected Construction

Non-standard antenna connector is used.

2.1.3 Antenna Gain

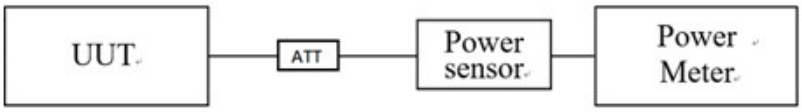
No.	Manufacturer	Model No.	Antenna Type	Peak Gain
1	CIROCOMM	03A58B0K00J2120	Patch Antenna	3 dBi

2.2 Peak Output Power Measurement

2.2.1 Limit

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

2.2.2 Test Setup



2.2.3 Test Procedure

1. Enable the EUT transmit continuously.
2. Measure the conducted output power with cable loss and record the results in the test report.

2.2.4 Test Result

Frequency (MHz)	Peak Power (dBm)	Power Limit (dBm)	Result
902.75	26.67	≤ 30	Pass
914.75	28.03	≤ 30	Pass
927.25	27.06	≤ 30	Pass

Remark:

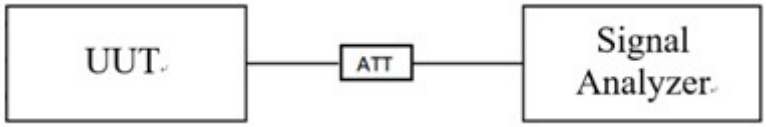
1. Peak Power = Reading value on power meter + cable loss
2. 10 Log(X/mW) = dBm, X=1 watt (Limit)
   1 watt = 30 dBm

2.3 Number of Hopping Frequency

2.3.1 Limit

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies

2.3.2 Test Setup



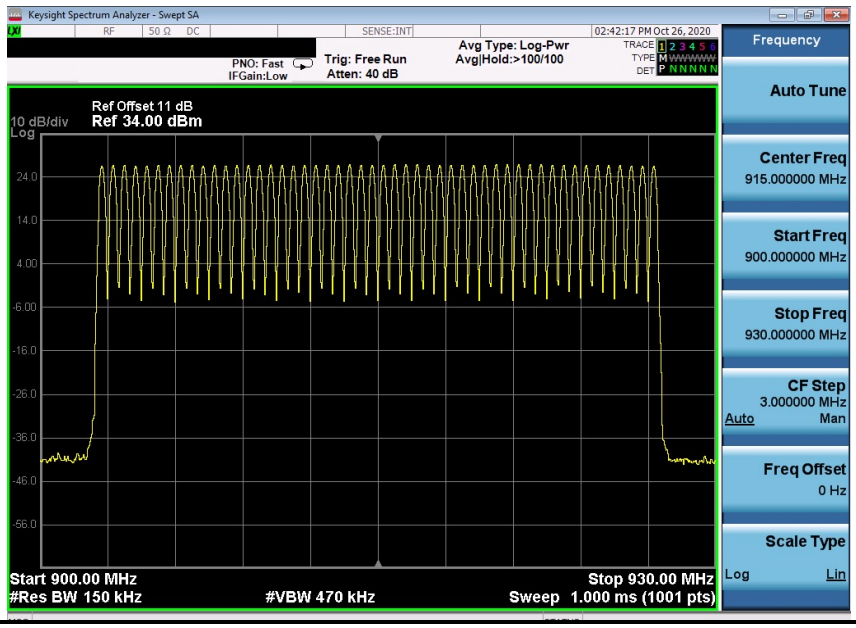
2.3.3 Test Procedure

The EUT was setup to ANSI C63.4, 2014; tested to FHSS test procedure of FCC Public Notice DA 00-705 for compliance to FCC 47CFR 15.247 requirements.

2.3.4 Test Result

Frequency (MHz)	Measurement (Hopping Channel)	Required Limit (Hopping Channel)	Result
902.75~927.25	50.000	≥ 50	Pass

902.75~927.25 MHz

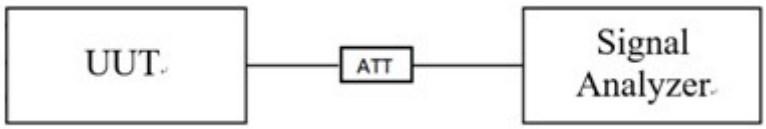


2.4 Hopping Channel Separation Measurement

2.4.1 Limit

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

2.4.2 Test Setup



2.4.3 Test Procedure

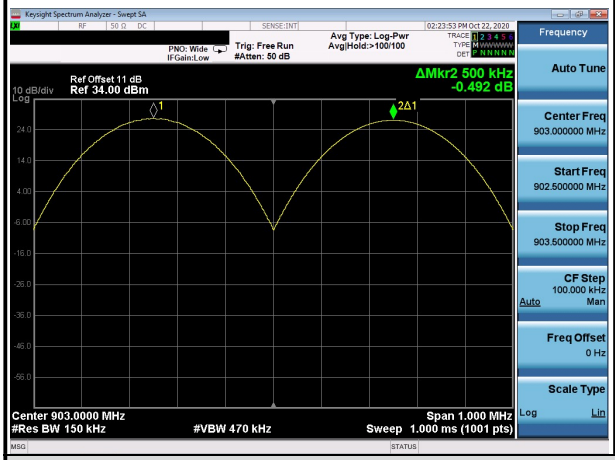
The EUT was setup to ANSI C63.4, 2014; tested to FHSS test procedure of FCC Public Notice DA 00-705 for compliance to FCC 47CFR 15.247 requirements.

2.4.4 Test Result

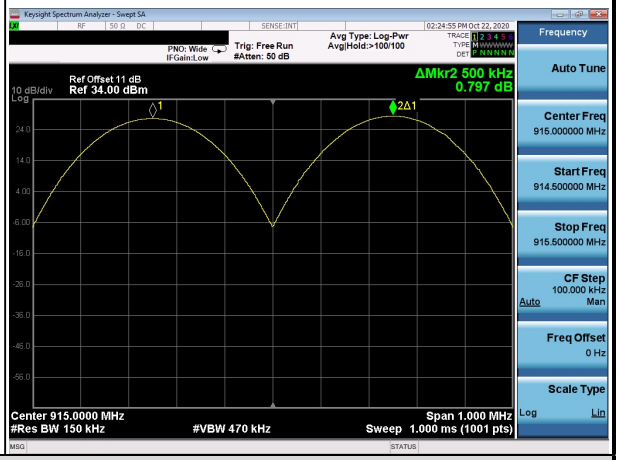
Frequency (MHz)	Measurement (kHz)	Limit (kHz)	Result
902.75	500.000	≥ 78.880	Pass
914.75	500.000	≥ 79.740	Pass
927.25	500.000	≥ 80.160	Pass

Remark: 25kHz < two-thirds of the 20 dB bandwidth , whichever is two-thirds of the 20 dB bandwidth

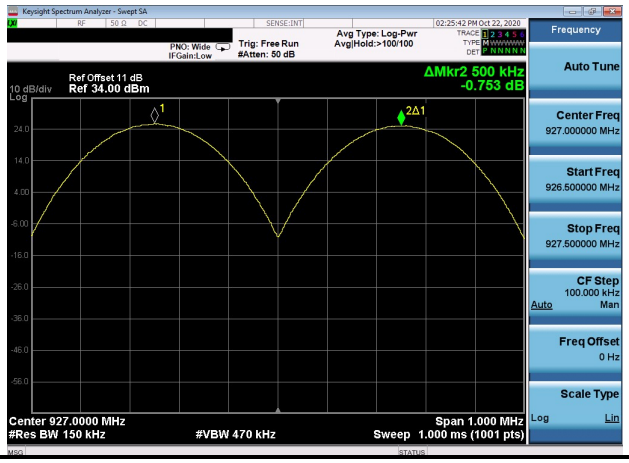
902.75 MHz



914.75 MHz



927.25 MHz

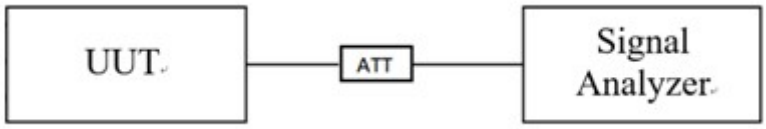


2.5 Dwell Time Measurement

2.5.1 Limit

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second
period.

2.5.2 Test Setup



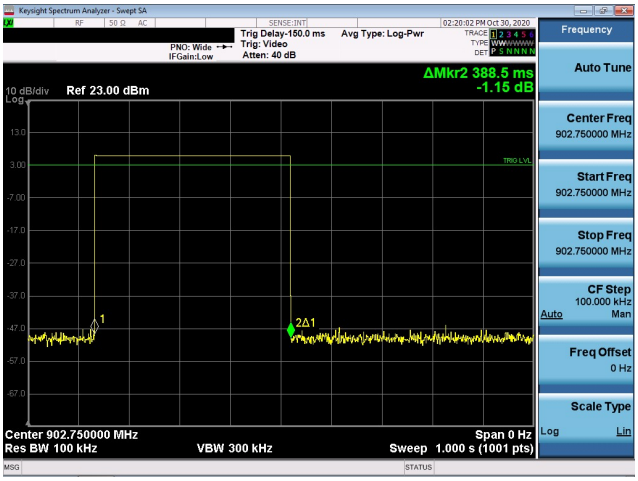
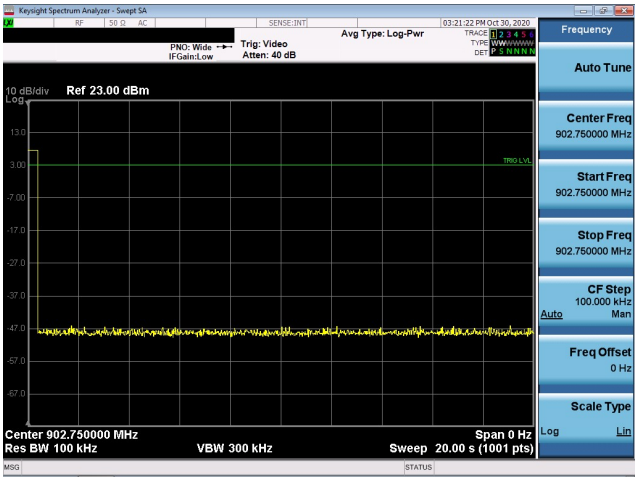
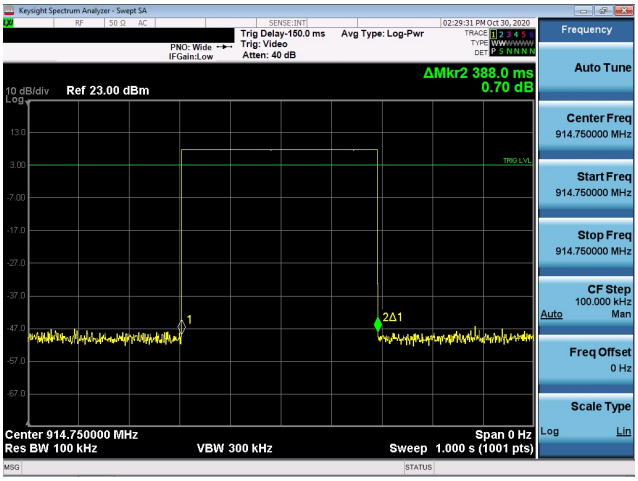
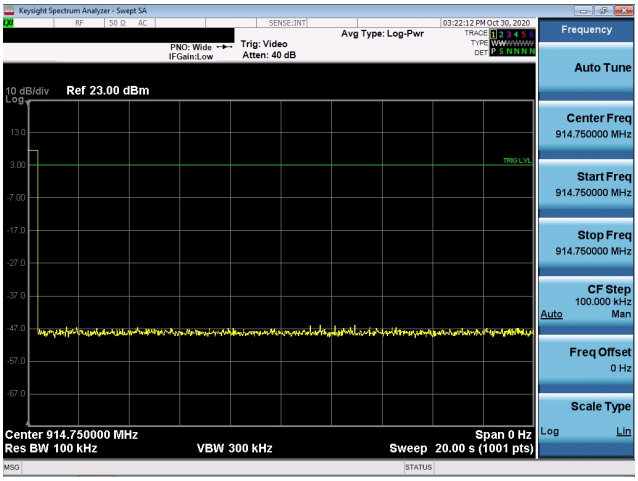
2.5.3 Test Procedure

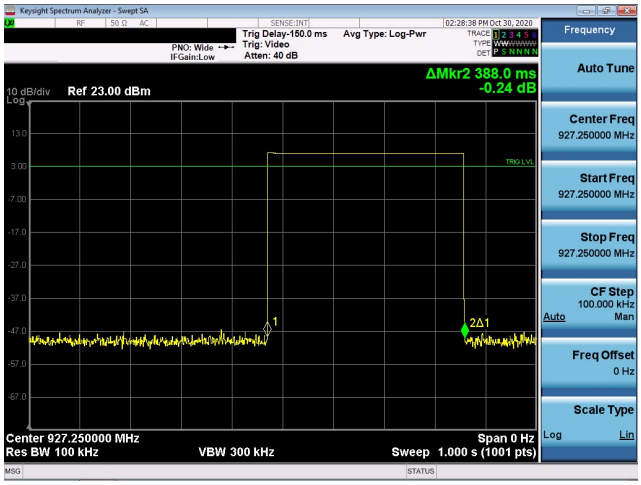
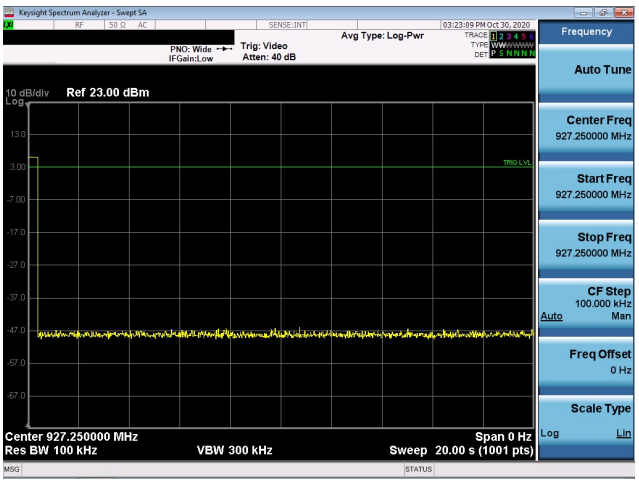
The EUT was setup to ANSI C63.4, 2014; tested to FHSS test procedure of FCC Public Notice DA 00-705 for compliance to FCC 47CFR 15.247 requirements.

2.5.4 Test Result

Frequency (MHz)	Pulse Duration (ms)	Number of hops during the actual observation period	Average time of occupancy (s)	Limit (s)	Result
902.75	388.500	1	0.389	≤ 0.4	Pass
914.75	388.000	1	0.388	≤ 0.4	Pass
927.25	388.000	1	0.388	≤ 0.4	Pass

Remark: Average time of occupancy = Pulse Duration × (Standard Observation period / Number of hops during the actual observation period)

902.75 MHz	
Pulse Duration	**Number of hops during the actual observation period**
	
914.75 MHz	
Pulse Duration	**Number of hops during the actual observation period**
	

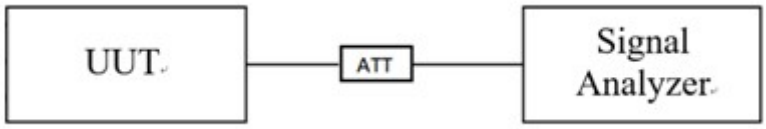
927.25 MHz	
Pulse Duration	**Number of hops during the actual observation period**
	

2.6 20dB Bandwidth Measurement

2.6.1 Limit

The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

2.6.2 Test Setup



2.6.3 Test Procedure

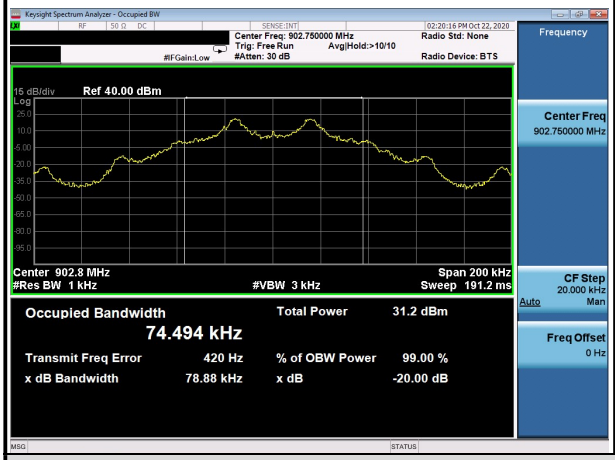
The EUT was setup to ANSI C63.4, 2014; tested to FHSS test procedure of FCC Public Notice DA 00-705 for compliance to FCC 47CFR 15.247 requirements.

2.6.4 Test Result

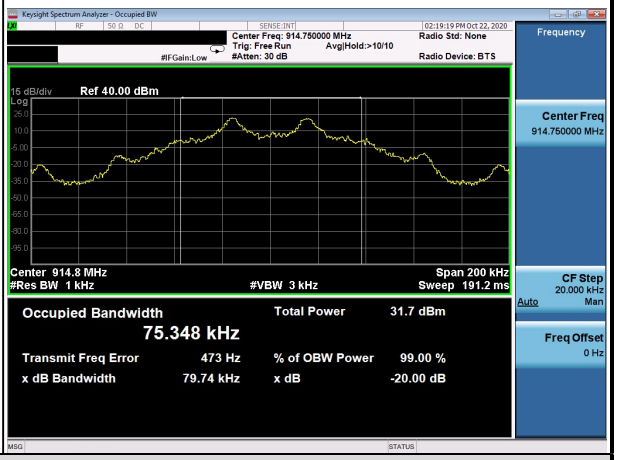
Frequency (MHz)	20dB Bandwidth (kHz)	Limit (kHz)	Result (kHz)
902.75	78.880	≤ 500	Pass
914.75	79.740	≤ 500	Pass
927.25	80.160	≤ 500	Pass

20dB Bandwidth

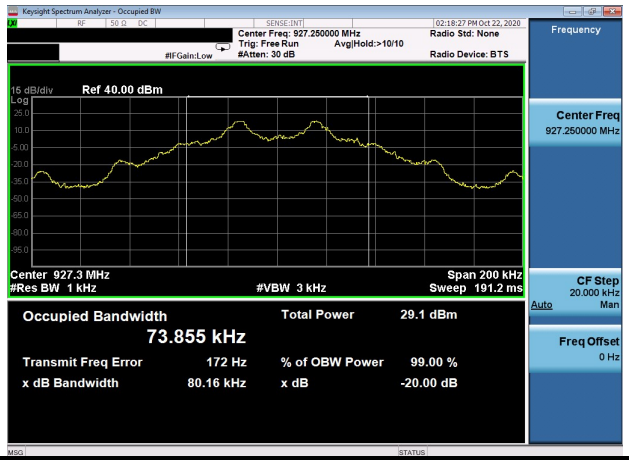
902.75 MHz



914.75 MHz



927.25 MHz

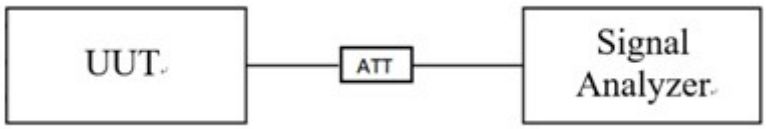


2.7 Conducted Band Edges and Spurious Emission Measurement

2.7.1 Limit

In any 100 KHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator in operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100KHz bandwidth within the band that contains the highest level of the desired power, In addition, radiated emissions which fall in the restricted bands, as defined in must also comply with the radiated emission limits. 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

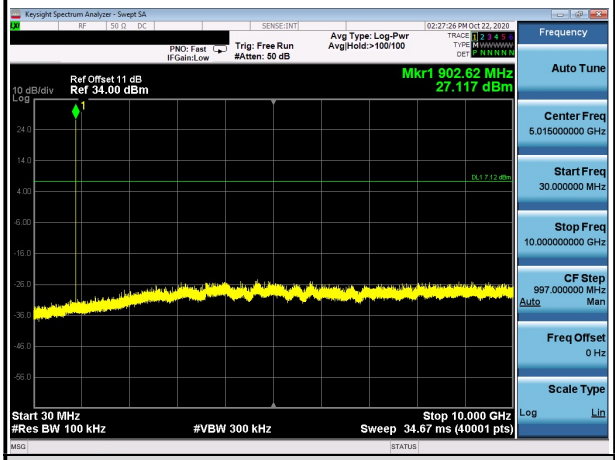
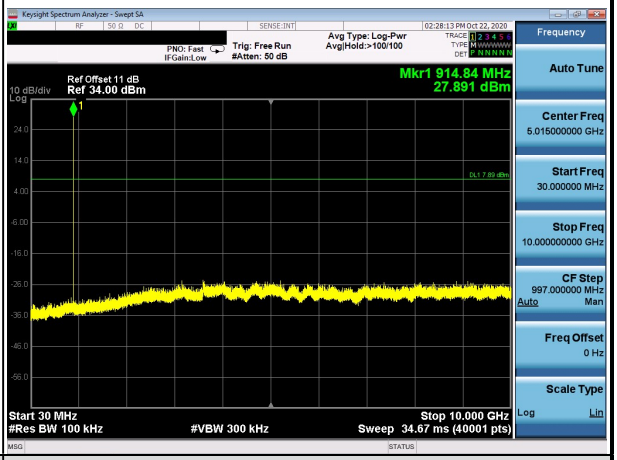
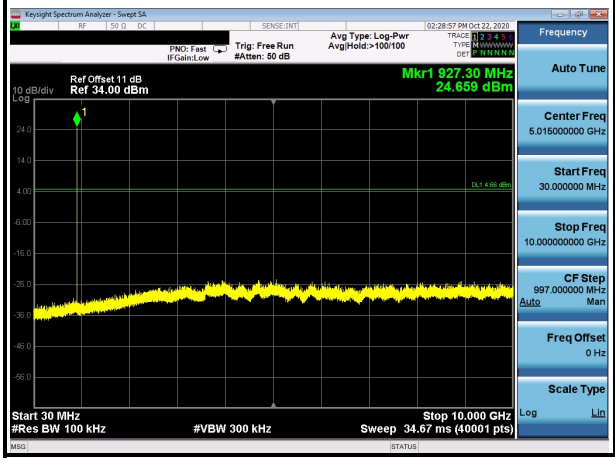
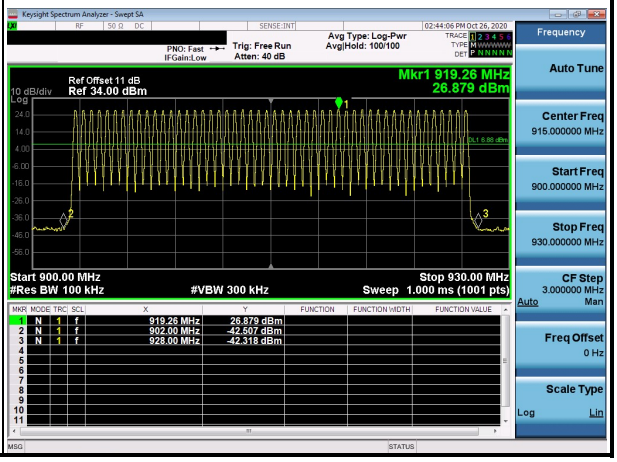
2.7.2 Test Setup



2.7.3 Test Procedure

The EUT was setup to ANSI C63.4, 2014; tested to FHSS test procedure of FCC Public Notice DA 00-705 for compliance to FCC 47CFR 15.247 requirements.

2.7.4 Test Result

902.75 MHz Spurious Emission	914.75 MHz Spurious Emission
	
927.25 MHz Spurious Emission	**Hopping Band Edge**
	

2.8 Radiated Band Edges and Spurious Emission Measurement

2.8.1 Limit

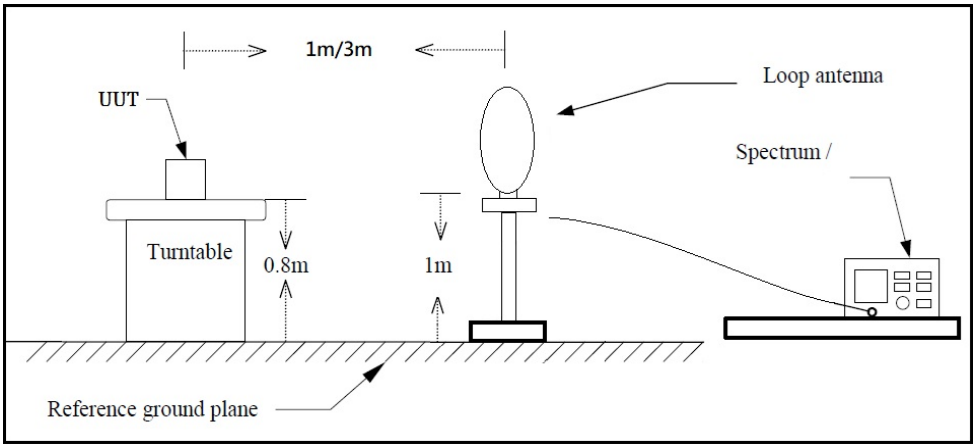
Frequency (MHz)	Field Strength (μV/m)	Measurement Distance (m)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 - 960	200	3
Above 960	500	3

Remarks:

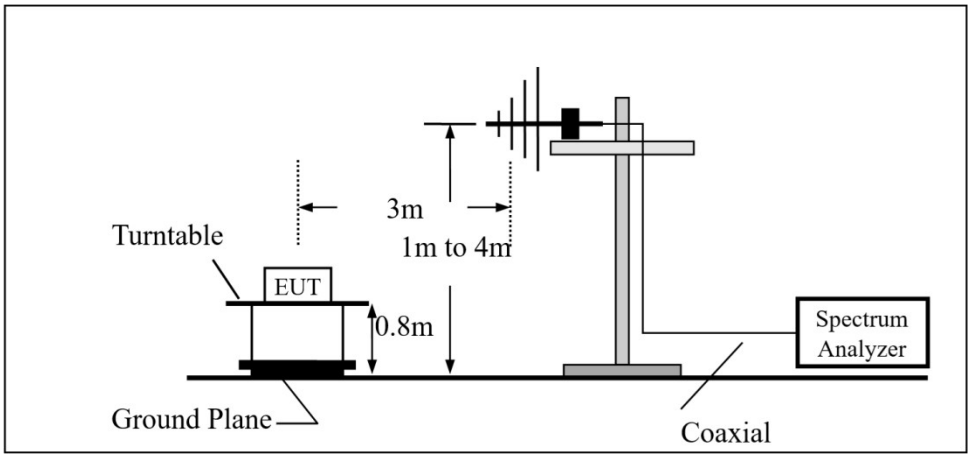
1. RF Voltage (dBuV) = 20 log RF Voltage(uV)
2. In the Above Table, the tighter limit applies at the band edges.
3. Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system

2.8.2 Test Setup

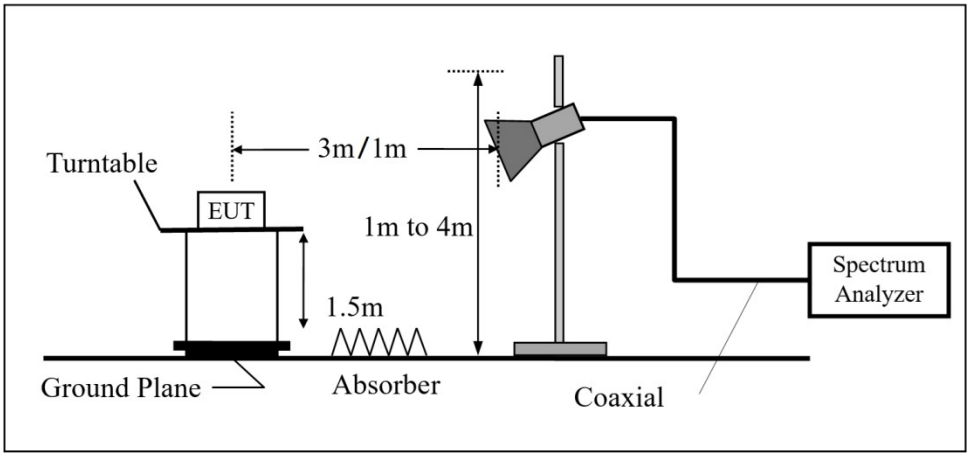
Below 30MHz



30MHz~1GHz



Above 1GHz



2.8.3 Test Procedure

The EUT was setup according to ANSI C63.10, 2013 and tested according test procedure of KDB 558074 for compliance to FCC 47CFR 15.247 requirements.

For Radiated emission below 30MHz

(1) The EUT was placed on the top of a rotating table 0.8 meters above the ground in a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.

(2) The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

(3) Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.

(4) For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

(5) The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

For Radiated emission Above 30MHz

(1) The EUT was placed on the top of a rotating table 0.8 meters (for below 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for the test. The table was rotated 360 degrees to determine the position of the highest radiation.

(2) The EUT was set 3 meters away from the interference-receiving antenna, the height of the antenna is varied from 1 meter to 4 meters above the ground to determine the maximum value of the field strength.

(3) Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.

(4) For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

(5) The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.

(6) The test-receiver system was set to peak and average detect function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets the average limit, measurement with the average detector is unnecessary.

2.8.4 Duty Cycle

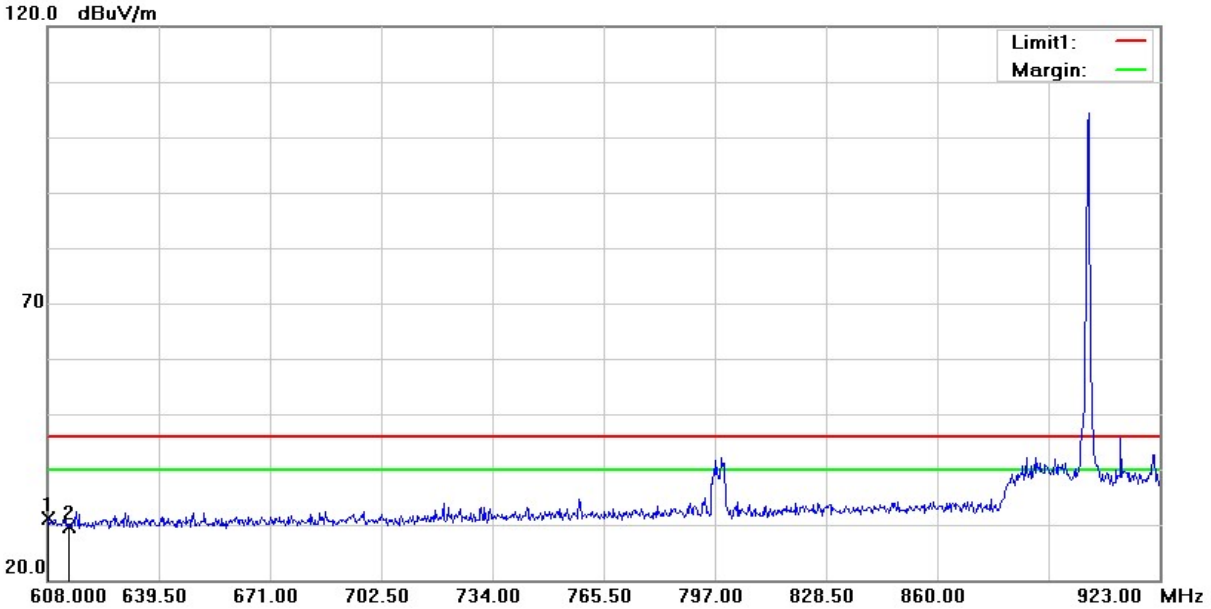
Frequency (MHz)	on time (ms)	on+off time (ms)	Duty cycle	Duty Factor (dB)	1/T Minimum VBW (kHz)
902.75	902.75	1.000	1.000	1.000	0.000

2.8.5 Test Result of Radiated Band Edge Measurement

The following tables for radiated measurement, pre-scanned in three orthogonal panels, X, Y, Z. The worst cases (X axis) were recorded in this report.

Test Frequency	
Tx	902.75 MHz 927.25 MHz

Test Mode :	Transmit	Test Date :	2020/10/21
Test Channel	902.75 MHz	Temperature :	25 ℃
Polarization :	Horizontal	Relative Humidity :	65 %

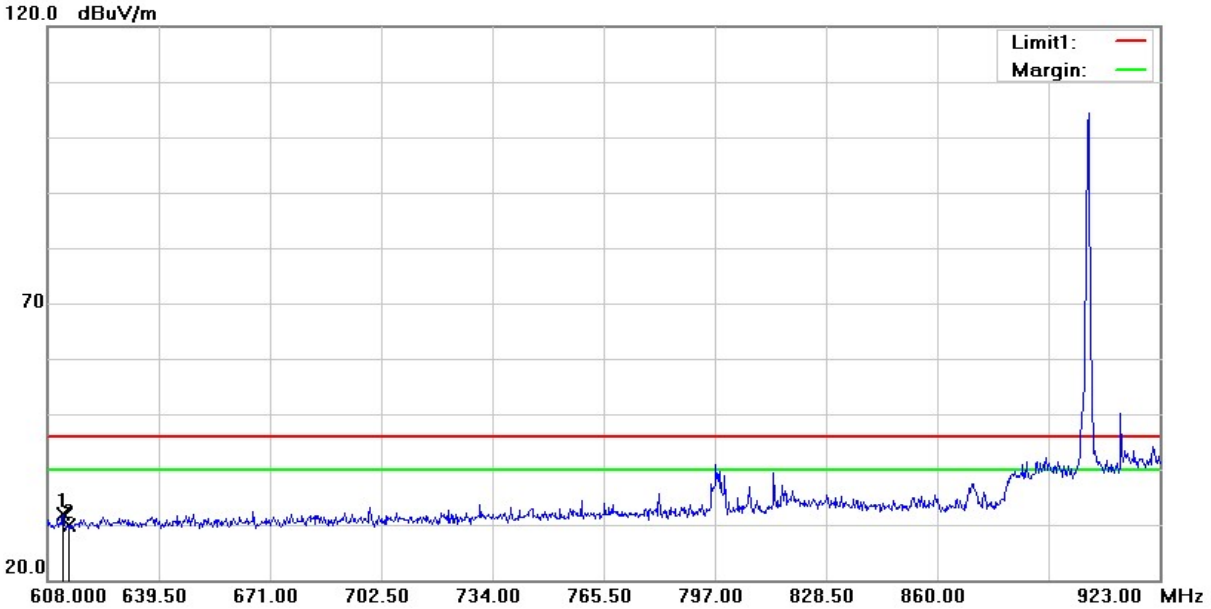


No.	Frequency (MHz)	Reading (dBuV/m)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	608.3150	32.74	-1.55	31.19	46.00	-14.81	peak
2	614.0000	31.18	-1.53	29.65	46.00	-16.35	peak

Remark：

1. Correction Factor = Antenna factor + Cable loss – Amplifier gain
2. Result Value = Reading Level + Correct Factor
3. Margin Level = Result Value – Limit Value
4. The other emission levels were very low against the limit

Test Mode :	Transmit	Test Date :	2020/10/21
Test Channel	902.75 MHz	Temperature :	25 ℃
Polarization :	Vertical	Relative Humidity :	65 %

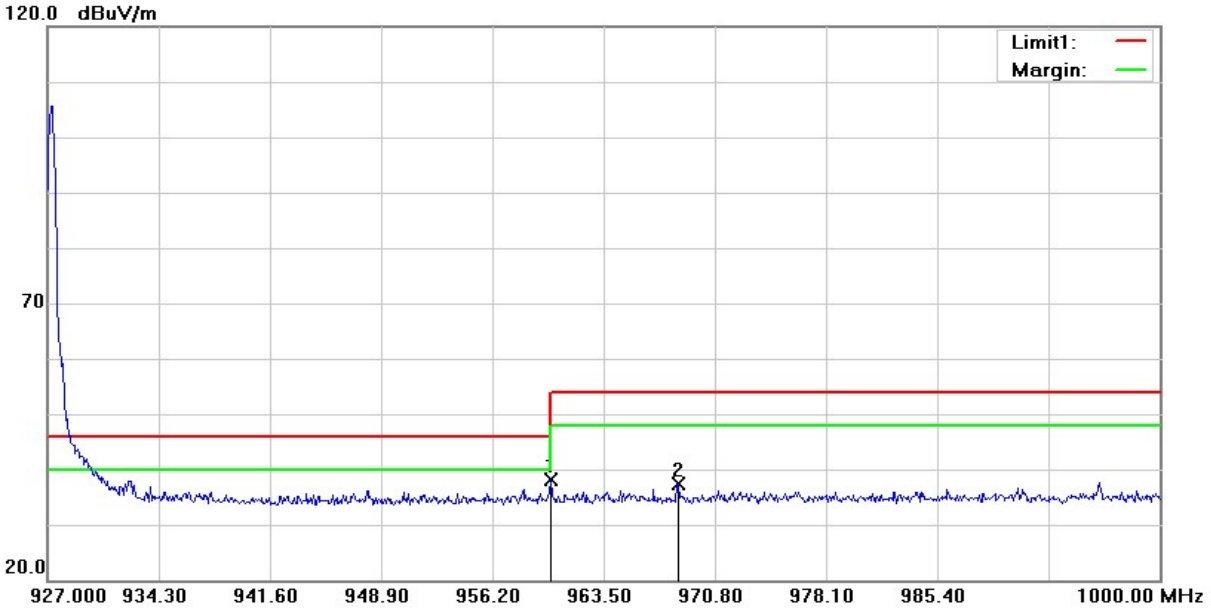


No.	Frequency (MHz)	Reading (dBuV/m)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	612.4100	33.46	-1.54	31.92	46.00	-14.08	peak
2	614.0000	31.45	-1.53	29.92	46.00	-16.08	peak

Remark：

1. Correction Factor = Antenna factor + Cable loss – Amplifier gain
2. Result Value = Reading Level + Correct Factor
3. Margin Level = Result Value – Limit Value
4. The other emission levels were very low against the limit

Test Mode :	Transmit	**Test Date :**	2020/10/21
Test Channel	927.25 MHz	**Temperature :**	25 ℃
Polarization :	Horizontal	**Relative Humidity :**	65 %

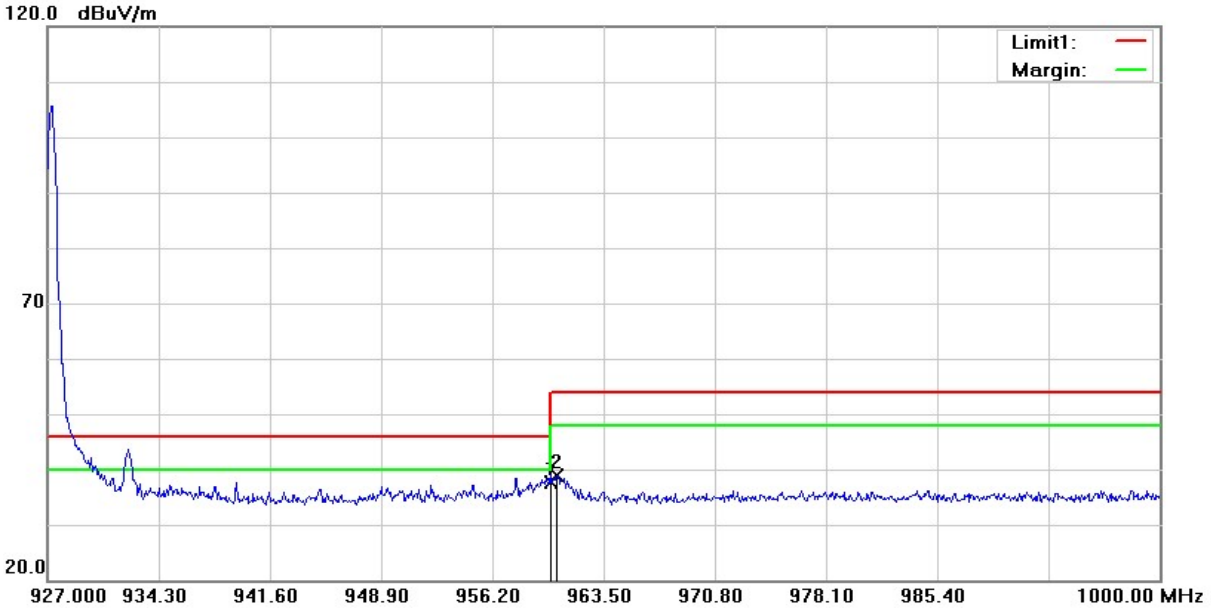


No.	Frequency (MHz)	Reading (dBuV/m)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	960.0000	33.85	4.16	38.01	46.00	-7.99	peak
2	968.3910	32.98	4.34	37.32	53.90	-16.58	peak

Remark：

1. Correction Factor = Antenna factor + Cable loss – Amplifier gain
2. Result Value = Reading Level + Correct Factor
3. Margin Level = Result Value – Limit Value
4. The other emission levels were very low against the limit

Test Mode :	Transmit	Test Date :	2020/10/21
Test Channel	927.25 MHz	Temperature :	25 ℃
Polarization :	Vertical	Relative Humidity :	65 %



No.	Frequency (MHz)	Reading (dBuV/m)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	960.0000	33.56	4.16	37.72	46.00	-8.28	peak
2	960.4340	34.81	4.17	38.98	53.90	-14.92	peak

Remark：

1. Correction Factor = Antenna factor + Cable loss – Amplifier gain
2. Result Value = Reading Level + Correct Factor
3. Margin Level = Result Value – Limit Value
4. The other emission levels were very low against the limit

2.8.6 Test Result of Radiated Spurious Emission Measurement

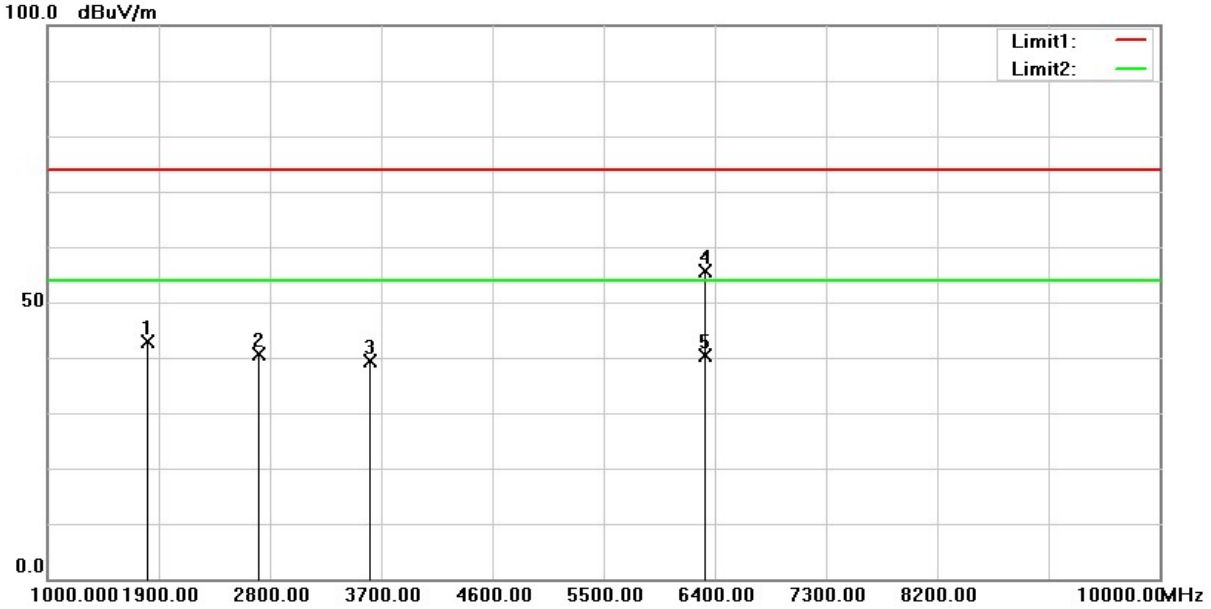
(1) The radiation measurement frequency is 9kHz ~ 30MHz. The interference value of this frequency range is less than the limit value of 20 dB. It is considered that the background noise value is not recorded.

(2) The following table shows the radiation measurement frequency from 30MHz to 26.5GHz, pre-scanning in the X, Y and Z axes. The worst case (X-axis) is documented in this report.

Test Frequency	
Tx	902.75 MHz 914.75 MHz 927.25 MHz

Above 1GHz Data

Test Mode :	Transmit	Test Date :	2020/10/21
Test Channel	902.75 MHz	Temperature :	25 ℃
Polarization :	Horizontal	Relative Humidity :	65 %

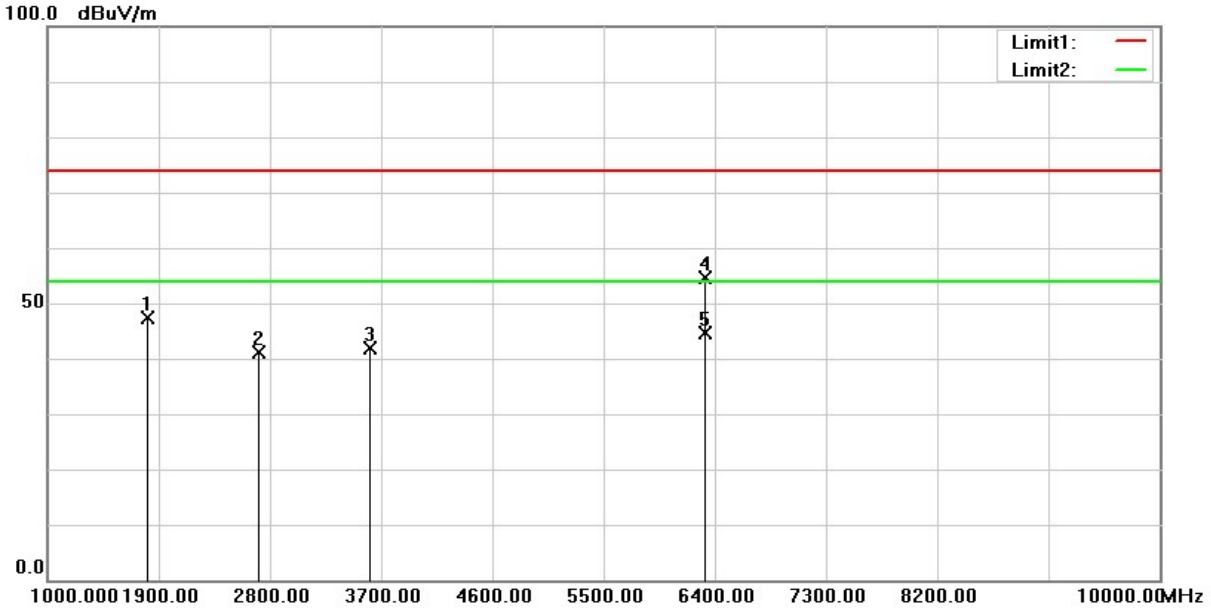


No.	Frequency (MHz)	Reading (dBuV/m)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1805.500	74.38	-31.40	42.98	74.00	-31.02	peak
2	2708.250	67.48	-26.88	40.60	74.00	-33.40	peak
3	3611.000	63.61	-24.25	39.36	74.00	-34.64	peak
4	6319.250	73.60	-17.89	55.71	74.00	-18.29	peak
5	6319.250	58.24	-17.89	40.35	54.00	-13.65	AVG

Remark :

1. Correction Factor = Antenna factor + Cable loss – Amplifier gain
2. Result Value = Reading Level + Correct Factor
3. Margin Level = Result Value – Limit Value
4. The other emission levels were very low against the limit

Test Mode :	Transmit	Test Date :	2020/10/21
Test Channel	902.75 MHz	Temperature :	25 ℃
Polarization :	Vertical	Relative Humidity :	65 %

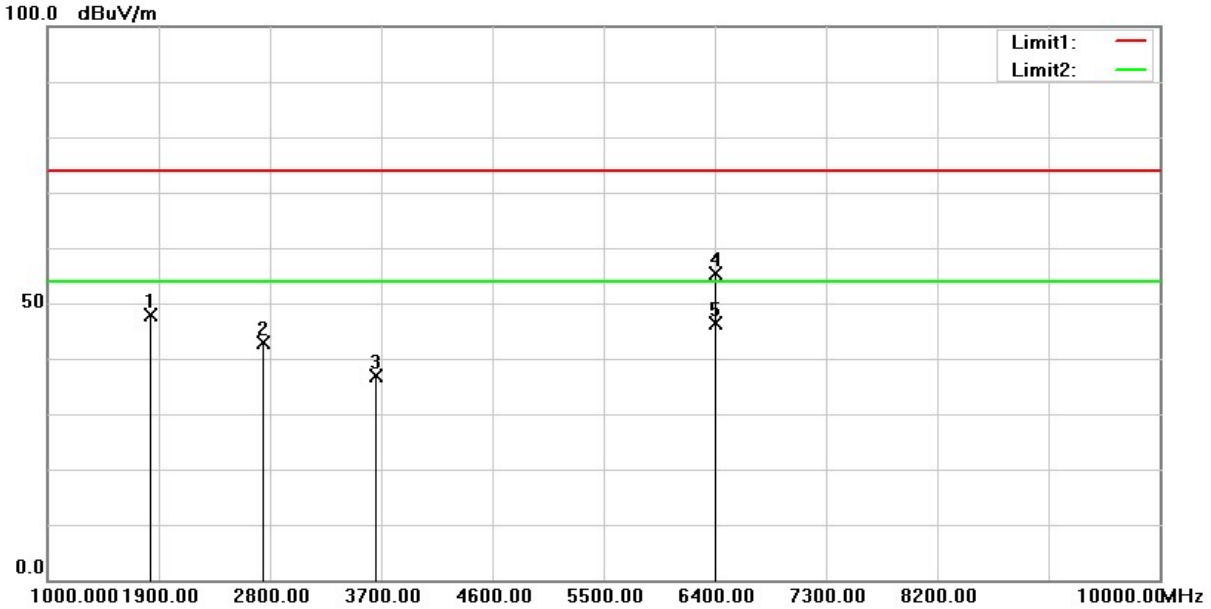


No.	Frequency (MHz)	Reading (dBuV/m)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1805.500	78.89	-31.40	47.49	74.00	-26.51	peak
2	2708.250	68.09	-26.88	41.21	74.00	-32.79	peak
3	3611.000	66.18	-24.25	41.93	74.00	-32.07	peak
4	6319.250	72.42	-17.89	54.53	74.00	-19.47	peak
5	6319.250	62.51	-17.89	44.62	54.00	-9.38	AVG

Remark :

1. Correction Factor = Antenna factor + Cable loss – Amplifier gain
2. Result Value = Reading Level + Correct Factor
3. Margin Level = Result Value – Limit Value
4. The other emission levels were very low against the limit

Test Mode :	Transmit	Test Date :	2020/10/21
Test Channel	914.75 MHz	Temperature :	25 ℃
Polarization :	Horizontal	Relative Humidity :	65 %

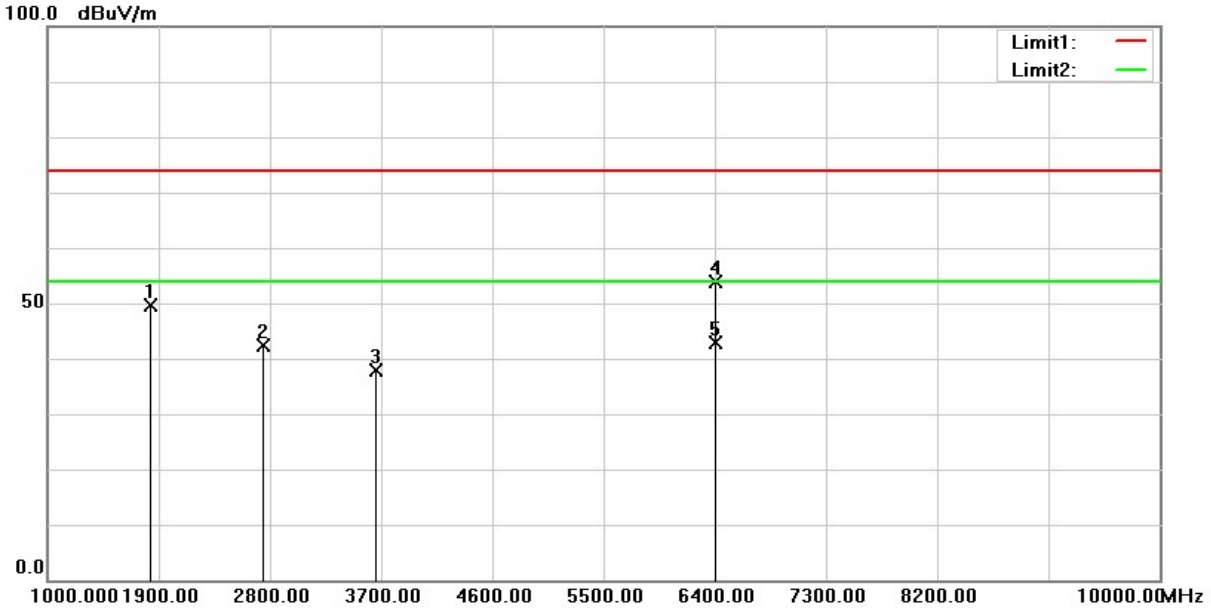


No.	Frequency (MHz)	Reading (dBuV/m)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1829.500	79.31	-31.32	47.99	74.00	-26.01	peak
2	2744.250	69.51	-26.71	42.80	74.00	-31.20	peak
3	3659.000	60.90	-24.04	36.86	74.00	-37.14	peak
4	6403.250	72.62	-17.36	55.26	74.00	-18.74	peak
5	6403.250	63.67	-17.36	46.31	54.00	-7.69	AVG

Remark :

1. Correction Factor = Antenna factor + Cable loss – Amplifier gain
2. Result Value = Reading Level + Correct Factor
3. Margin Level = Result Value – Limit Value
4. The other emission levels were very low against the limit

Test Mode :	Transmit	Test Date :	2020/10/21
Test Channel	914.75 MHz	Temperature :	25 ℃
Polarization :	Vertical	Relative Humidity :	65 %

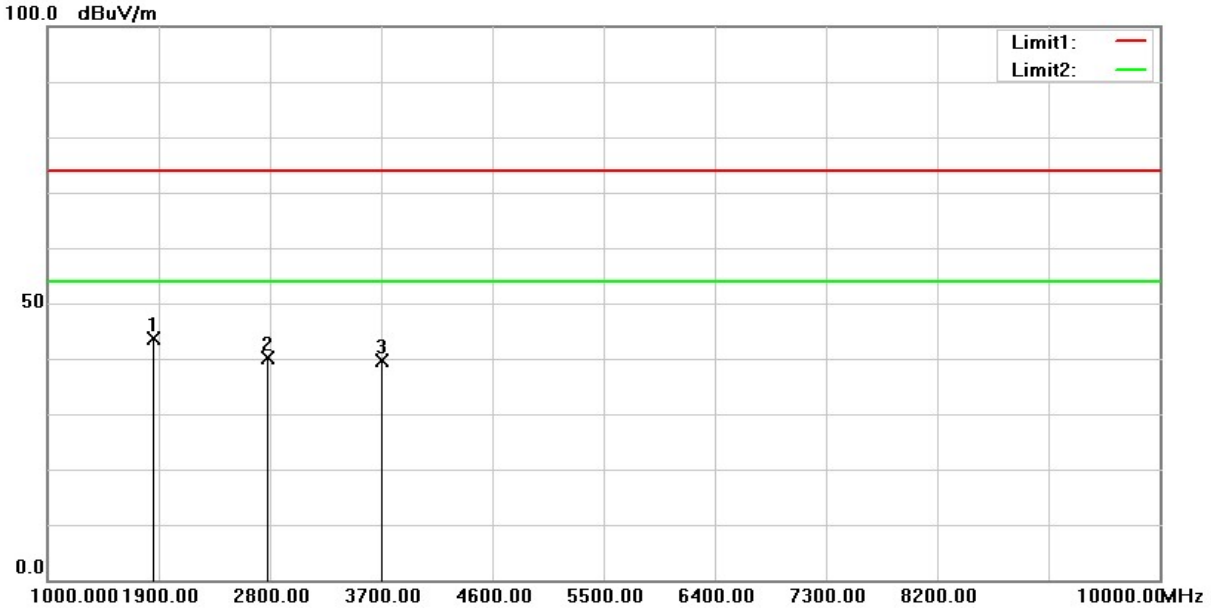


No.	Frequency (MHz)	Reading (dBuV/m)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1829.500	80.95	-31.32	49.63	74.00	-24.37	peak
2	2744.250	69.14	-26.71	42.43	74.00	-31.57	peak
3	3659.000	62.03	-24.04	37.99	74.00	-36.01	peak
4	6403.250	71.22	-17.36	53.86	74.00	-20.14	peak
5	6403.250	60.23	-17.36	42.87	74.00	-31.13	peak

Remark :

1. Correction Factor = Antenna factor + Cable loss – Amplifier gain
2. Result Value = Reading Level + Correct Factor
3. Margin Level = Result Value – Limit Value
4. The other emission levels were very low against the limit

Test Mode :	Transmit	Test Date :	2020/10/21
Test Channel	927.25 MHz	Temperature :	25 ℃
Polarization :	Horizontal	Relative Humidity :	65 %

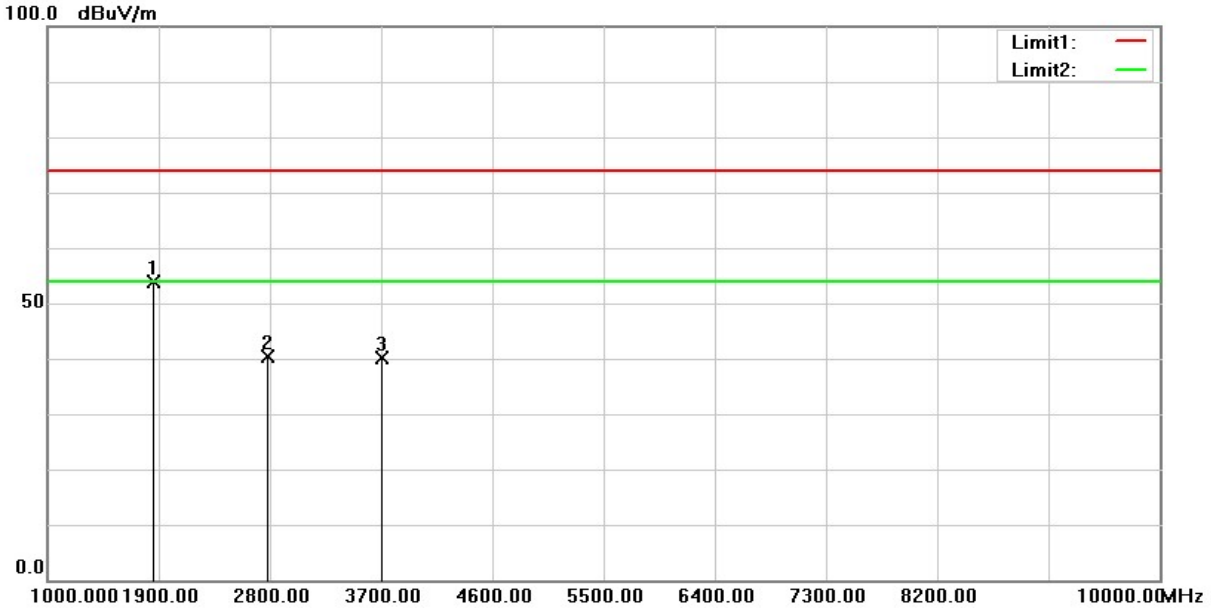


No.	Frequency (MHz)	Reading (dBuV/m)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1854.500	74.76	-31.23	43.53	74.00	-30.47	peak
2	2781.750	66.74	-26.54	40.20	74.00	-33.80	peak
3	3709.000	63.50	-23.95	39.55	74.00	-34.45	peak

Remark：

1. Correction Factor = Antenna factor + Cable loss – Amplifier gain
2. Result Value = Reading Level + Correct Factor
3. Margin Level = Result Value – Limit Value
4. The other emission levels were very low against the limit

Test Mode :	Transmit	Test Date :	2020/10/21
Test Channel	927.25 MHz	Temperature :	25 ℃
Polarization :	Vertical	Relative Humidity :	65 %



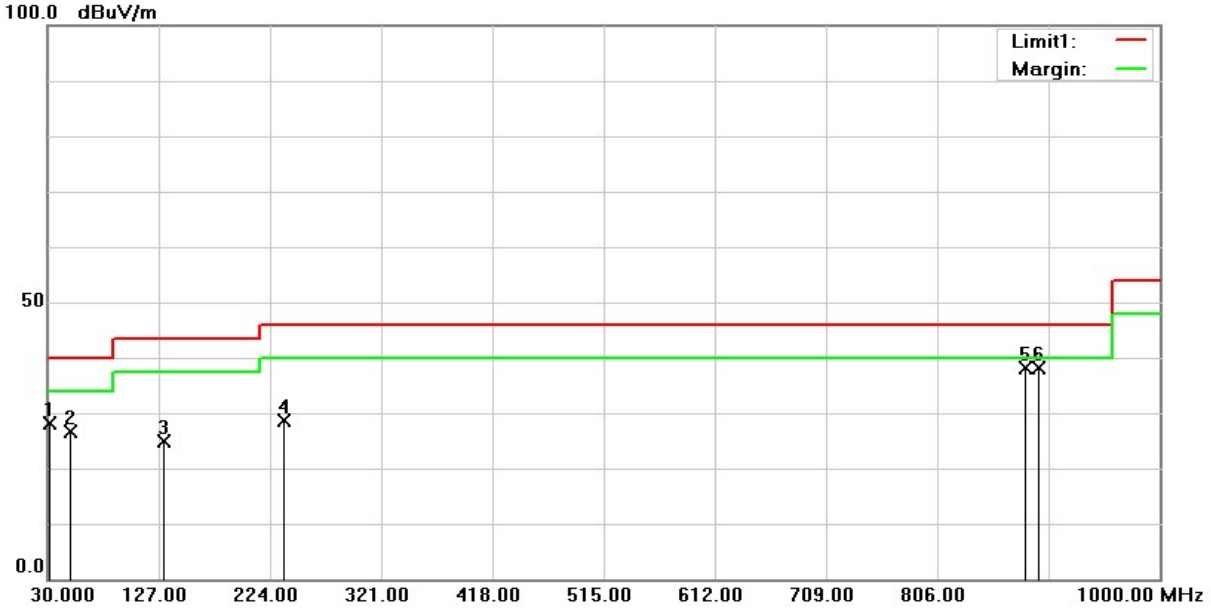
No.	Frequency (MHz)	Reading (dBuV/m)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1854.500	85.10	-31.23	53.87	74.00	-20.13	peak
2	2781.750	66.99	-26.54	40.45	74.00	-33.55	peak
3	3709.000	64.02	-23.95	40.07	74.00	-33.93	peak

Remark：

1. Correction Factor = Antenna factor + Cable loss – Amplifier gain
2. Result Value = Reading Level + Correct Factor
3. Margin Level = Result Value – Limit Value
4. The other emission levels were very low against the limit

Below 1GHz Data

Test Mode :	Transmit	Test Date :	2020/10/21
Test Channel	914.75 MHz	Temperature :	25 ℃
Polarization :	Horizontal	Relative Humidity :	65 %

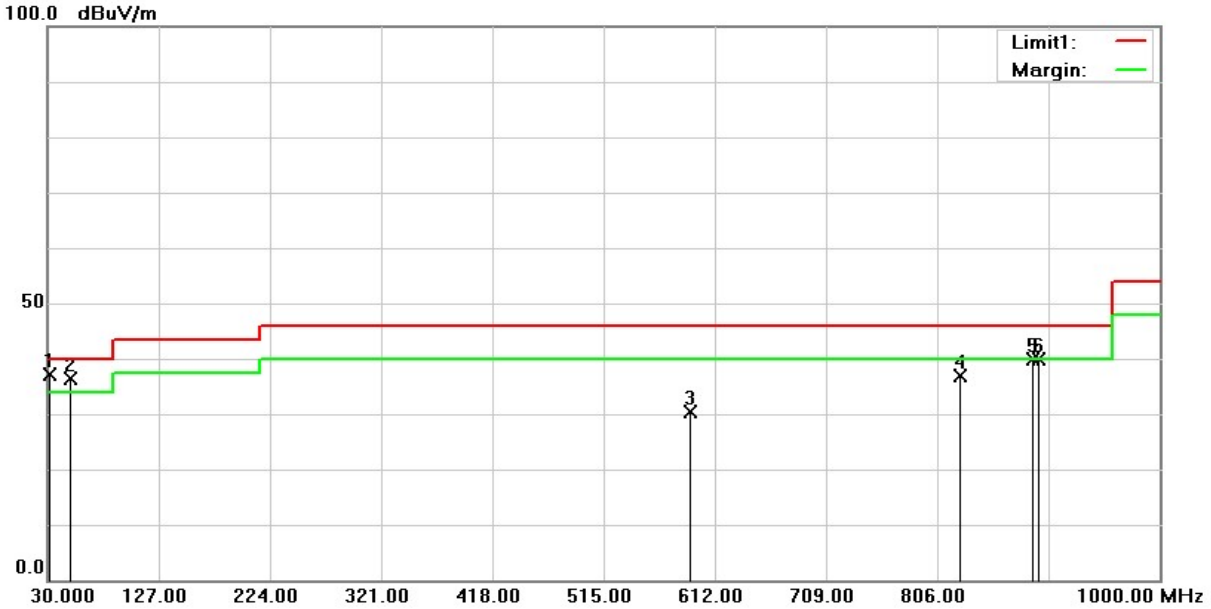


No.	Frequency (MHz)	Reading (dBuV/m)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	31.9400	38.35	-10.18	28.17	40.00	-11.83	QP
2	50.3700	35.87	-9.17	26.70	40.00	-13.30	QP
3	131.8500	34.97	-10.00	24.97	43.50	-18.53	QP
4	236.6100	37.33	-8.81	28.52	46.00	-17.48	QP
5	882.6300	35.44	2.77	38.21	46.00	-7.79	QP
6	894.2700	34.99	3.05	38.04	46.00	-7.96	QP

Remark：

1. Correction Factor = Antenna factor + Cable loss – Amplifier gain
2. Result Value = Reading Level + Correct Factor
3. Margin Level = Result Value – Limit Value
4. The other emission levels were very low against the limit

Test Mode :	Transmit	**Test Date :**	2020/10/21
Test Channel	914.75 MHz	**Temperature :**	25 ℃
Polarization :	Vertical	**Relative Humidity :**	65 %



No.	Frequency (MHz)	Reading (dBuV/m)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	31.9400	47.37	-10.18	37.19	40.00	-2.81	QP
2	50.3700	45.57	-9.17	36.40	40.00	-3.60	QP
3	590.6600	32.22	-1.87	30.35	46.00	-15.65	QP
4	826.3700	34.87	1.99	36.86	46.00	-9.14	QP
5	889.4200	36.90	2.93	39.83	46.00	-6.17	QP
6	894.2700	36.86	3.05	39.91	46.00	-6.09	QP

Remark：

1. Correction Factor = Antenna factor + Cable loss – Amplifier gain
2. Result Value = Reading Level + Correct Factor
3. Margin Level = Result Value – Limit Value
4. The other emission levels were very low against the limit

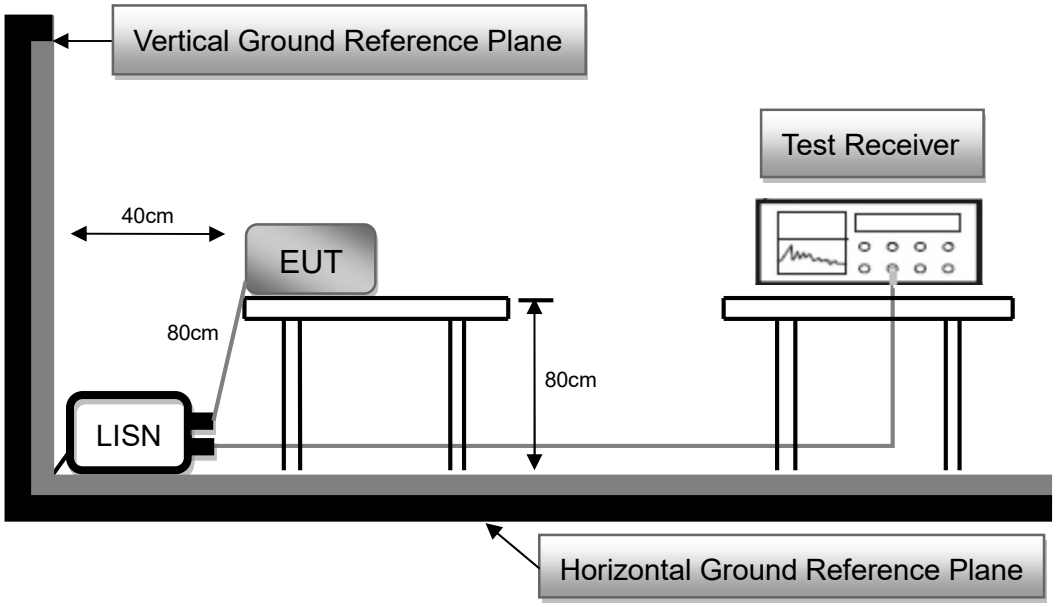
2.9 AC Conducted Emissions Measurement

2.9.1 Limit

Frequency (MHz)	FCC Part 15 Subpart C Paragraph 15.207 (dBμV) Limit	
	Quasi-peak	Average
0.15 to 0.5	66 to 56*	56 to 46*
0.50 to 5.0	56	46
5.0 to 30.0	60	50

*Decreases with the logarithm of the frequency

2.9.2 Test Setup

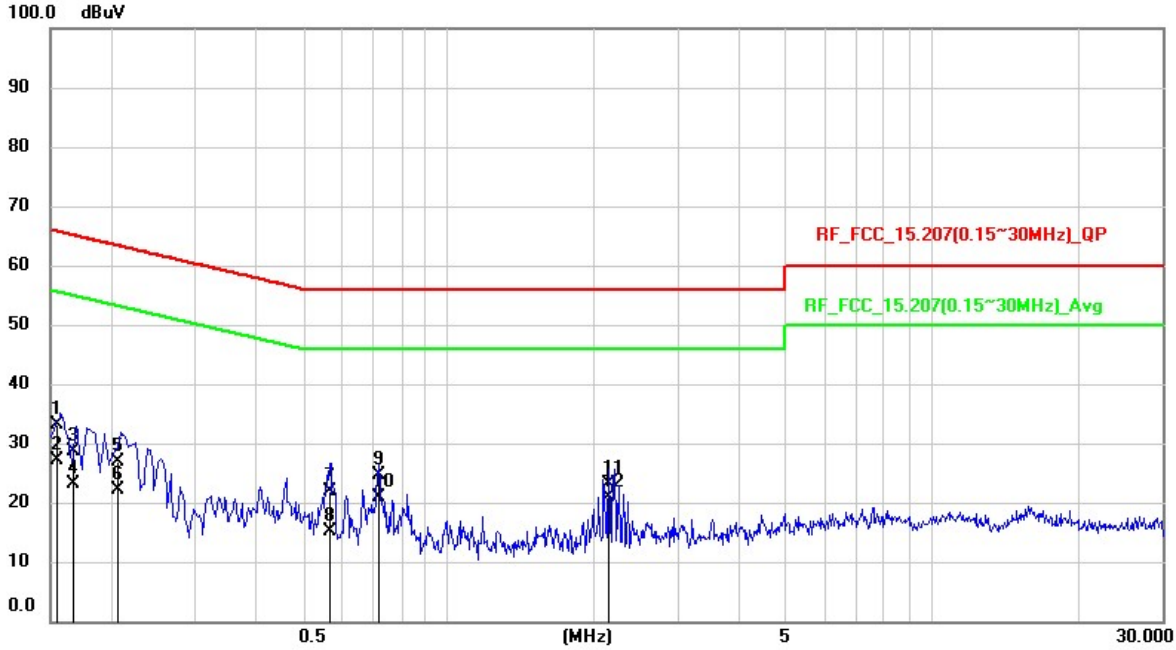


2.9.3 Test Procedure

1. The EUT was placed 0.8 meter height wooden table from the horizontal ground plane with EUT being connected to power source through a line impedance stabilization network (LISN). The LISN at least be 80 cm from nearest chassis of EUT.
2. The line impedance stabilization network (LISN) provides 50 ohm/50uH of coupling impedance for the measuring instrument. All other support equipments powered from additional LISN(s).
3. Interrelating cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle. All I/O cables were positioned to simulate typical usage.
4. All I/O cables that are not connected to a peripheral shall be bundle in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.
5. The EMI test receiver connected to LISN powering the EUT. The actual test configuration, please refer to EUT test photos.
6. The receiver scanned from 150kHz to 30MHz for emissions in each of test modes. A scan was taken on both power lines, Line and Neutral, recording at least six highest emissions.
7. The EUT and cable configuration of the above highest emission levels were recorded. The test data of the worst case was recorded.

2.9.4 Test Result

Test Voltage :	120Vac, 60Hz	**Frequency Range:**	0.15-30 MHz
Test Mode :	Normal Link	**6dB Bandwidth :**	9 kHz
Test Date :	2020/11/12	**Phase :**	L
Temperature :	25℃	**Humidity :**	65 %

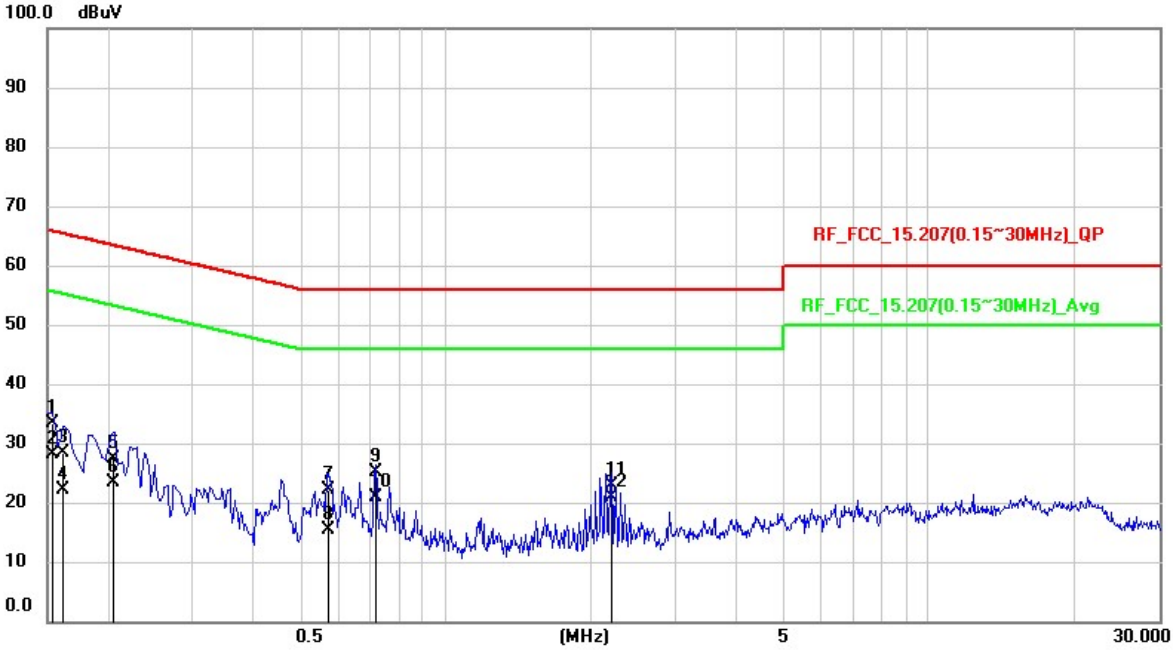


No.	Frequency (MHz)	Reading Level (dBuV)	Correct Factor (dB)	Measurement (dBuV)	Limit (dBuV)	Margin (dB)	Detector
1	0.1542	23.09	9.97	33.06	65.77	-32.71	QP
2	0.1542	17.23	9.97	27.2	55.77	-28.57	AVG
3	0.1668	18.78	9.97	28.75	65.12	-36.37	QP
4	0.1668	13.11	9.97	23.08	55.12	-32.04	AVG
5	0.2071	16.93	9.97	26.9	63.32	-36.42	QP
6	0.2071	12.13	9.97	22.1	53.32	-31.22	AVG
7	0.5676	11.85	9.98	21.83	56	-34.17	QP
8	0.5676	5.27	9.98	15.25	46	-30.75	AVG
9	0.7169	14.72	9.98	24.7	56	-31.3	QP
10	0.7169	10.98	9.98	20.96	46	-25.04	AVG
11	2.15	13.21	10.03	23.24	56	-32.76	QP
12	2.15	10.95	10.03	20.98	46	-25.02	AVG

Remark:

1. QP = Quasi Peak, AVG = Average
2. Correction Factor = Insertion loss of LISN + Cable loss
3. Measurement Value = Reading Level + Correct Factor
4. Margin Level = Result Value – Limit Value

Test Voltage :	120Vac, 60Hz	Frequency Range:	0.15-30 MHz
Test Mode :	Normal Link	6dB Bandwidth :	9 kHz
Test Date :	2020/11/12	Phase :	N
Temperature :	25℃	Humidity :	65 %



No.	Frequency (MHz)	Reading Level (dBuV)	Correct Factor (dB)	Measurement (dBuV)	Limit (dBuV)	Margin (dB)	Detector
1	0.1526	23.49	9.97	33.46	65.86	-32.4	QP
2	0.1526	18.17	9.97	28.14	55.86	-27.72	AVG
3	0.1619	18.29	9.97	28.26	65.37	-37.11	QP
4	0.1619	12.05	9.97	22.02	55.37	-33.35	AVG
5	0.2048	17.43	9.97	27.4	63.41	-36.01	QP
6	0.2048	13.53	9.97	23.5	53.41	-29.91	AVG
7	0.5745	12.07	9.98	22.05	56	-33.95	QP
8	0.5745	5.33	9.98	15.31	46	-30.69	AVG
9	0.7169	15.03	9.98	25.01	56	-30.99	QP
10	0.7169	10.92	9.98	20.9	46	-25.1	AVG
11	2.2014	12.95	10.03	22.98	56	-33.02	QP
12	2.2014	10.79	10.03	20.82	46	-25.18	AVG

Remark:

1. QP = Quasi Peak, AVG = Average
2. Correction Factor = Insertion loss of LISN + Cable loss
3. Measurement Value = Reading Level + Correct Factor
4. Margin Level = Result Value – Limit Value

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