ELECTROMAGNETIC EMISSION COMPLIANCE REPORT FOR LOW-POWER, NON-LICENSED TRANSMITTER

Test Report No.	**: OT-198-RWD-021**
AGR No.	**: A194A-422R**
Applicant	**: Cufit Inc.**
Address	**: 705, HumanTeco, 57, Achasan17gil, Seongdong-gu, Seoul 04799, Republic of Korea**
Manufacturer	**: InfosTechnology**
Address	**: 2F Gubo bldg, 133 Nonhyun-ro, Seocho-gu, Seoul, 137-890, Korea**
Type of Equipment	**: OPENRIDER R1**
FCC ID.	**: 2AUADR1-200-GE**
Model Name	**: R1-200-GE**
Multiple Model Name:	**N/A**
Serial number	**: N/A**
Total page of Report	**: 38 pages (including this page)**
Date of Incoming	**: January 23, 2019**
Date of issue	**: August 08, 2019**

SUMMARY

The equipment complies with the regulation; ***FCC PART 15 SUBPART C Section 15.247***

This test report only contains the result of a single test of the sample supplied for the examination.

It is not a generally valid assessment of the features of the respective products of the mass-production.

Reviewed by: Yu-Seog Sim / Assistant Manager
ONETECH Corp.

Approved by: Jae-Ho Lee / Chief Engineer
ONETECH Corp.

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CONTENTS

PAGE

1. VERIFICATION OF COMPLIANCE **5**

2. TEST SUMMARY **6**

2.1 TEST ITEMS AND RESULTS 6

2.2 ADDITIONS, DEVIATIONS, EXCLUSIONS FROM STANDARDS 6

2.3 RELATED SUBMITTAL(S) / GRANT(S) 6

2.4 PURPOSE OF THE TEST 6

2.5 TEST METHODOLOGY 6

2.6 TEST FACILITY 7

3. GENERAL INFORMATION **8**

3.1 PRODUCT DESCRIPTION 8

3.2 ALTERNATIVE TYPE(S)/MODEL(S); ALSO COVERED BY THIS TEST REPORT. 9

4. EUT MODIFICATIONS **9**

5.1 JUSTIFICATION 9

5.2 PERIPHERAL EQUIPMENT 9

5.3 MODE OF OPERATION DURING THE TEST 10

5.4 CONFIGURATION OF TEST SYSTEM 10

5.5 ANTENNA REQUIREMENT 10

6. PRELIMINARY TEST **11**

6.1 AC POWER LINE CONDUCTED EMISSIONS TESTS 11

6.2 GENERAL RADIATED EMISSIONS TESTS 11

7. MINIMUM 20 DB BANDWIDTH **12**

7.1 OPERATING ENVIRONMENT 12

7.2 TEST SET-UP 12

7.3 TEST EQUIPMENT USED 12

7.4 TEST DATA 13

8. HOPPING FREQUENCY SEPARATION **15**

8.1 OPERATING ENVIRONMENT 15

8.2 TEST SET-UP 15

8.3 TEST EQUIPMENT USED 15

8.4 TEST DATA 16

9. NUMBER OF HOPPING CHANNELS **17**

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9.1 OPERATING ENVIRONMENT 17
9.2 TEST SET-UP 17
9.3 TEST EQUIPMENT USED 17
9.4 TEST DATA 18
10. TIME OF OCCUPANCY **21**
10.1 OPERATING ENVIRONMENT 21
10.2 TEST SET-UP 21
10.3 TEST EQUIPMENT USED 21
10.4 TEST DATA 22
11. MAXIMUM PEAK OUTPUT POWER **24**
11.1 OPERATING ENVIRONMENT 24
11.2 TEST SET-UP 24
11.3 TEST EQUIPMENT USED 24
11.4 TEST DATA 25
12. 100 KHZ BANDWIDTH OUTSIDE THE FREQUENCY BAND **28**
12.1 OPERATING ENVIRONMENT 28
12.2 TEST SET-UP FOR CONDUCTED MEASUREMENT 28
12.3 TEST SET-UP FOR RADIATED MEASUREMENT 28
12.4 TEST EQUIPMENT USED 28
12.5 TEST DATA FOR CONDUCTED EMISSION 29
12.6 TEST DATA FOR TRANSMITTING MODE RADIATED EMISSION 35
12.6.1 Radiated Emission which fall in the Restricted Band *35*
12.6.2 Spurious & Harmonic Radiated Emission above 1 GHz *36*
12.6.3 Spurious Radiated Emission *37*

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Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-198-RWD-021	August 08, 2019	Initial Issue	All

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1. VERIFICATION OF COMPLIANCE

Applicant	: Cufit Inc.
Address	: 705, HumanTeco, 57, Achasan17gil, Seongdong-gu, Seoul 04799, Republic of Korea
CONTACT PERSON	: Haeng-ro Choi / Senior Manager
Telephone No.	: +82-10-6316-0364
FCC ID	: 2AUADR1-200-GE
Model Name	: R1-200-GE
Brand Name	: OPENRIDER
Serial Number	: N/A
DATE	: August 08, 2019

EQUIPMENT CLASS	***DSS – PART 15 SPREAD SPECTRUM TRANSMITTER***
KIND OF EQUIPMENT	OPENRIDER R1
THIS REPORT CONCERNS	Original Grant
MEASUREMENT PROCEDURES	ANSI C63.10: 2013
TYPE OF EQUIPMENT TESTED	Pre-Production
KIND OF EQUIPMENT AUTHORIZATION REQUESTED	Certification
EQUIPMENT WILL BE OPERATED UNDER FCC RULES PART(S)	FCC PART 15 SUBPART C Section 15.247
MODIFICATIONS ON THE EQUIPMENT TO ACHIEVE COMPLIANCE	None
FINAL TEST WAS CONDUCTED ON	3 m Semi Anechoic Chamber

-. The above equipment was tested by ONETECH Corp. for compliance with the requirement set forth in the FCC Rules and Regulations. This said equipment in the configuration described in this report, shows the maximum emission levels emanating from equipment are within the compliance requirements.

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2. TEST SUMMARY

2.1 Test items and results

SECTION	TEST ITEMS	RESULTS
15.247 (a) (1)	Carrier Frequency Separation	Met the Limit / PASS
15.247 (a) (1) (iii)	Minimum Number of Hopping Channels	Met the Limit / PASS
15.247 (a) (1) (iii)	Average Time of Occupancy	Met the Limit / PASS
15.247 (b) (1)	Maximum Peak Conducted Output Power	Met the Limit / PASS
15.247 (d)	100 kHz Bandwidth Outside the Frequency Band	Met the Limit / PASS
15.247 (d)	Radiated Emission which fall in the Restricted Band	Met the Limit / PASS
15.209	Radiated Emission Limits, General Requirement	Met the Limit / PASS
15.207	Conducted Limits	N/A (See Note)
15.203	Antenna Requirement	Met requirement / PASS

Note: This test is not performed because the EUT is operated by DC battery.

2.2 Additions, deviations, exclusions from standards

No additions, deviations or exclusions have been made from standard.

2.3 Related Submittal(s) / Grant(s)

Original submittal only

2.4 Purpose of the test

To determine whether the equipment under test fulfills the requirements of the regulation stated in FCC PART 15 SUBPART C Section 15.247

2.5 Test Methodology

Both conducted and radiated testing was performed according to the procedures in ANSI C63.10: 2013. Radiated testing was performed at a distance of 3 m from EUT to the antenna.

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2.6 Test Facility

The Onetech Corp. has been designated to perform equipment testing in compliance with ISO/IEC 17025.

The Electromagnetic compatibility measurement facilities are located at 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea

-. Site Filing:

VCCI (Voluntary Control Council for Interference) – Registration No. R-4112/ C-14617/ G-10666 / T-1842

IC (Industry Canada) – Registration No. Site# 3736A-3

-. Site Accreditation:

KOLAS (Korea Laboratory Accreditation Scheme) - Accreditation NO. KT085

FCC (Federal Communications Commission) - Accreditation No. KR0013

RRA (Radio Research Agency) – Designation No. KR0013

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3. GENERAL INFORMATION

3.1 Product Description

The Cufit Inc., Model R1-200-GE (referred to as the EUT in this report) is a OPENRIDER R1. The product specification described herein was obtained from product data sheet or user's manual.

DEVICE TYPE	OPENRIDER R1	
OPERATING FREQUENCY	Bluetooth LE	2 402 MHz ~ 2 480 MHz
	ANT+	2 402 MHz ~ 2 480 MHz
	NFC	860 ~960 MHz (Rx Only)
RF OUTPUT POWER	Bluetooth LE	0.57 dBm
	ANT+	-1.18 dBm
NUMBER OF CHANNEL	Bluetooth LE	40 Channels
	ANT+	79 Channels
MODULATION TYPE	Bluetooth LE	GFSK
	ANT+	
	NFC	DSB-ASK, SSB-ASK, or PR-ASK
ANTENNA TYPE	Bluetooth LE	MULTILAYER CERAMIC ANTENNA
	ANT+	
	NFC	Combination of loop and dipole(Blade antenna) Antenna
ANTENNA GAIN	2.12 dBi	
LIST OF EACH OSC. OR CRYSTAL. FREQ.(FREQ.>=1 MHz)	16 MHz, 32.768 kHz	
RATED SUPPLY VOLTAGE	DC 3.0 V	

3.2 Alternative type(s)/model(s); also covered by this test report.

-. None

4. EUT MODIFICATIONS

-. None

5. SYSTEM TEST CONFIGURATION

5.1 Justification

This device was configured for testing in a typical way as a normal customer is supposed to be used. During the test, the following components were installed inside of the EUT.

DEVICE TYPE	MANUFACTURER	MODEL/PART NUMBER	FCC ID
Main Board	N/A	N/A	-
Battery	N/A	N/A	-

5.2 Peripheral equipment

Defined as equipment needed for correct operation of the EUT, but not considered as tested:

Model	Manufacturer	Description	Connected to
U180	MSI	NoteBook PC	EUT
PA-1400-12	LITEON	AC/DC Adapter	Notebook PC

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5.3 Mode of operation during the test

For the testing, software used to control the EUT for staying in continuous transmitting is programmed.

For final testing, the EUT was set at 2 402 MHz, 2 441 MHz, and 2 480 MHz to get a maximum emission levels from the EUT. The EUT was moved throughout the XY, XZ, and YZ planes and the worst case is "XY" axis, but the worst data was recorded in this report.

5.4 Configuration of Test System

Line Conducted Test: The EUT was tested in the Transmitting mode. All supporting equipment were connected to another LISN. Preliminary Power line Conducted Emission test was performed by using the procedure in ANSI C63.10: 2013 to determine the worse operating conditions.

Radiated Emission Test: The EUT was tested in the Transmitting mode. Preliminary radiated emissions test was conducted using the procedure in ANSI C63.10: 2013 to determine the worse operating conditions. Final radiated emission tests were conducted at 3 m Semi Anechoic Chamber. The turntable was rotated through 360 degrees and the EUT was tested by positioned three orthogonal planes to obtain the highest reading on the field strength meter. Once maximum reading was determined, the search antenna was raised and lowered in both vertical and horizontal polarization.

5.5 Antenna Requirement

For intentional device, according to section 15.203, an intentional radiator shall be designed as to be attached permanently to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

Antenna Construction:

The transmitter antenna of the EUT is a MULTILAYER CERAMIC ANTENNA, so no consideration of replacement by the user.

6. PRELIMINARY TEST

6.1 AC Power line Conducted Emissions Tests

- As this product is only using DC power, AC conducted emission test has not been performed.

6.2 General Radiated Emissions Tests

During Preliminary Tests, the following operating modes were investigated

Operation Mode	The Worse operating condition (Please check one only)
Transmitting mode.	X

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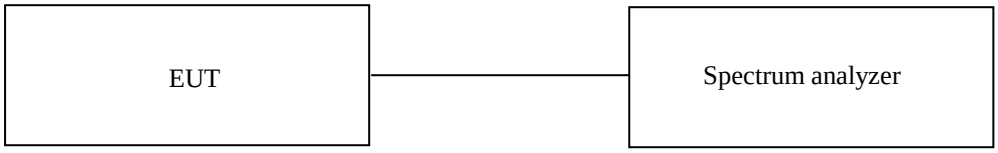
7. MINIMUM 20 dB BANDWIDTH

7.1 Operating environment

Temperature	:	24 ℃
Relative humidity	:	48 % R.H.

7.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 10 kHz, and peak detection was used. The 20 dB bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 20 dB.



7.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101199	Mar. 11, 2019 (1Y)

All test equipment used is calibrated on a regular basis.

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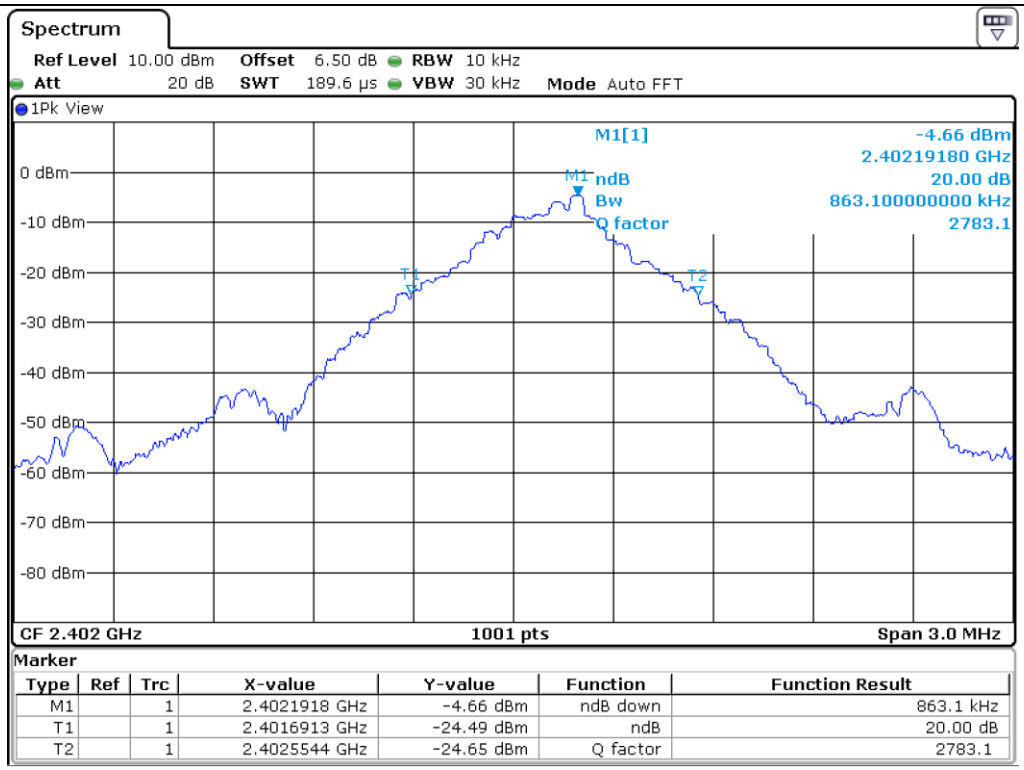
7.4 Test data

-. Test Date : July 23, 2019

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402	863.10
Middle	2 441	932.10
High	2 480	950.00

Tested by: Ha-Ram Lee / Assistant Manager



Low Channel

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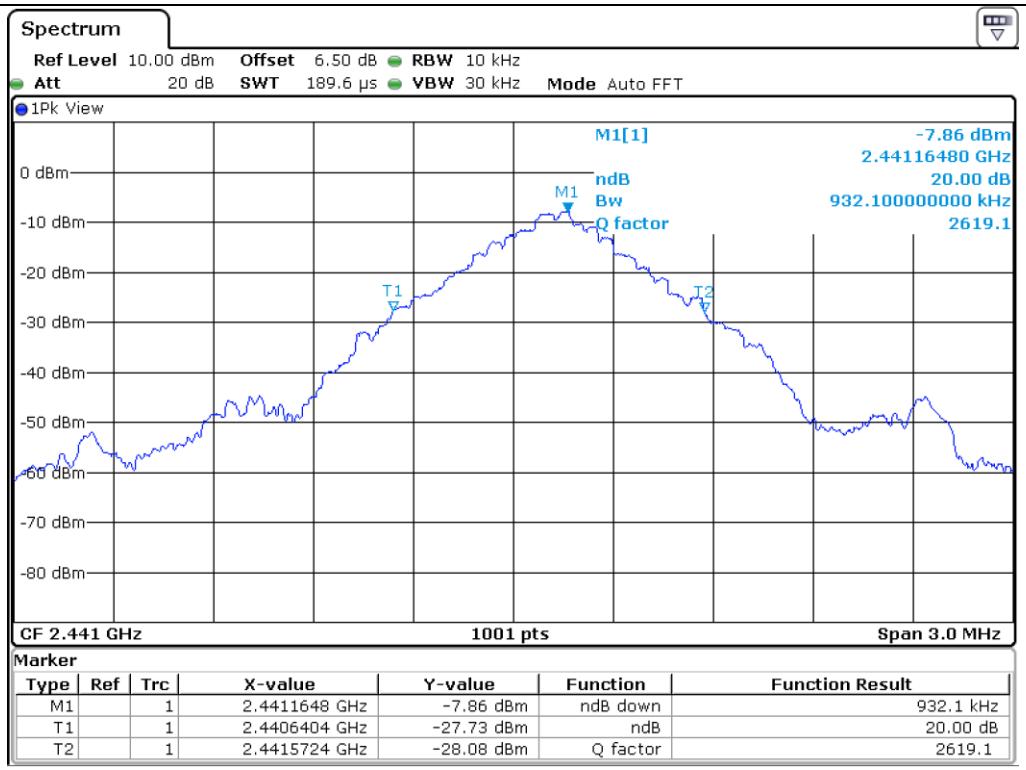
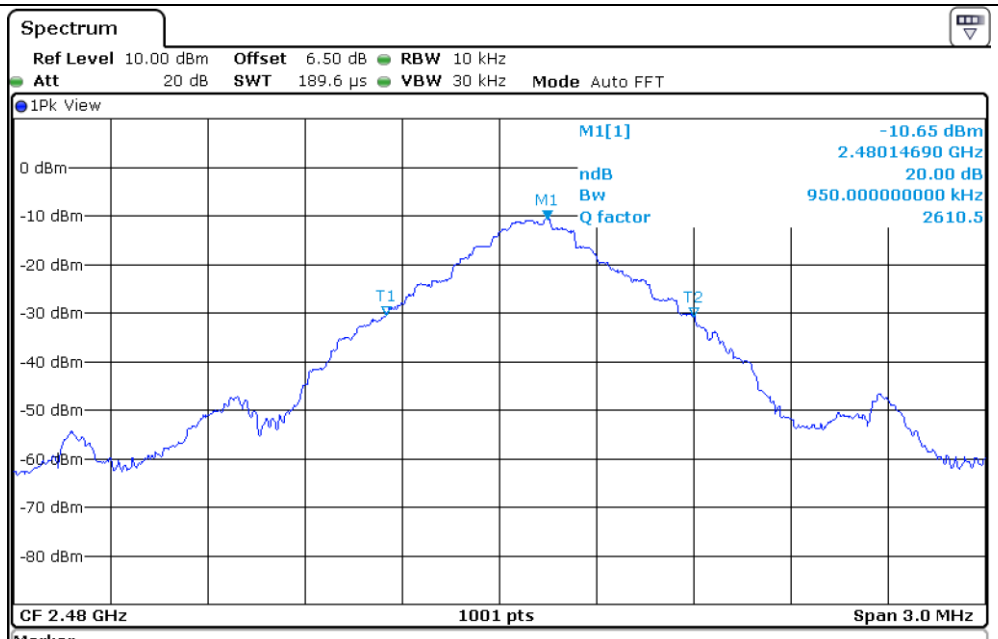


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4411648 GHz	-7.86 dBm	ndB down	932.1 kHz
T1		1	2.4406404 GHz	-27.73 dBm	ndB	20.00 dB
T2		1	2.4415724 GHz	-28.08 dBm	Q factor	2619.1

Middle Channel



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4801469 GHz	-10.65 dBm	ndB down	950.0 kHz
T1		1	2.4796494 GHz	-30.59 dBm	ndB	20.00 dB
T2		1	2.4805994 GHz	-30.65 dBm	Q factor	2610.5

High Channel

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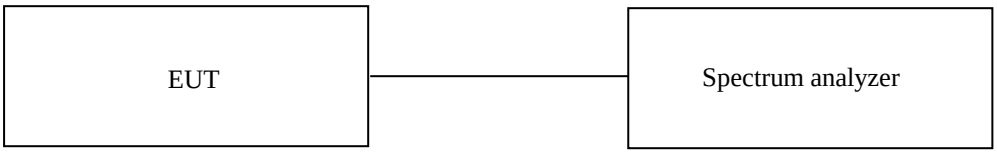
8. HOPPING FREQUENCY SEPARATION

8.1 Operating environment

Temperature	:	24 ℃
Relative humidity	:	48 % R.H.

8.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The frequency span is set to 10 MHz. The analyzer is set to peak hold then a pseudo-random hopping sequence of the transmitter is captured. The mark delta function was used to measure the frequency separation between two adjacent hopping channels.



8.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101199	Mar. 11, 2019 (1Y)

All test equipment used is calibrated on a regular basis.

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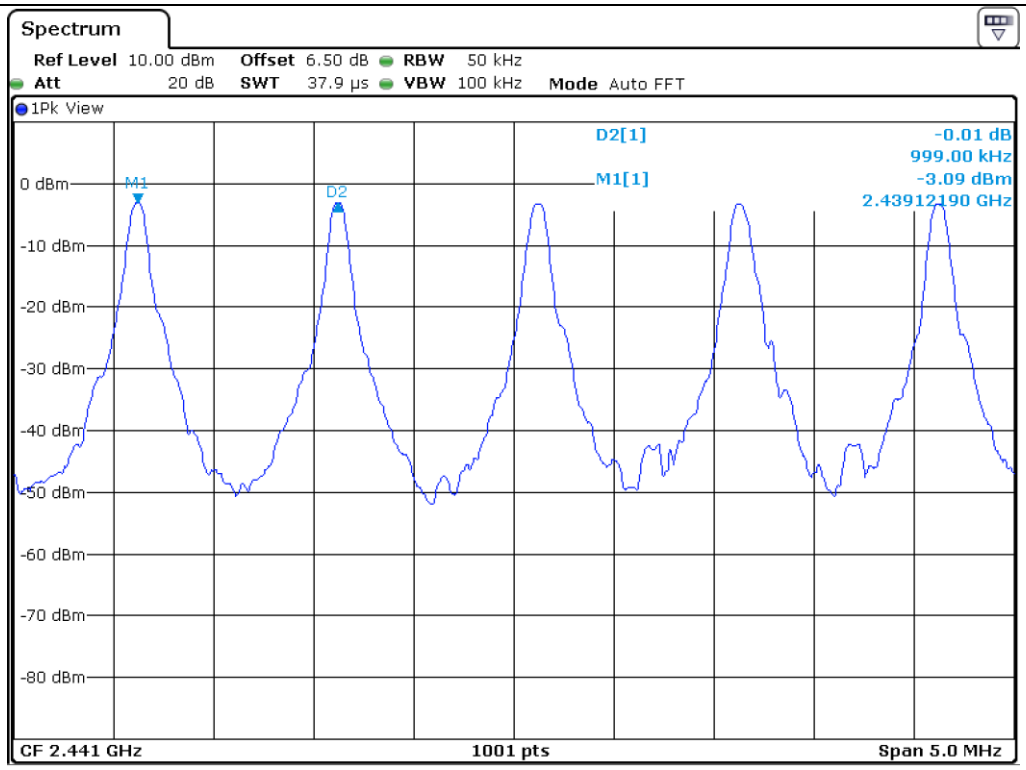
8.4 Test data

-. Test Date : July 23, 2019

-. Test Result : Pass

MEASURED VLAUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
999.00	621.40	Separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater.

Tested by: Ha-Ram Lee / Assistant Manager



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9. NUMBER OF HOPPING CHANNELS

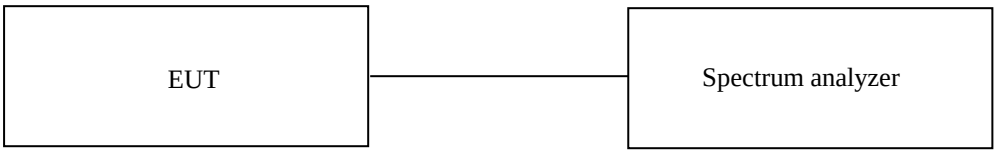
9.1 Operating environment

Temperature : 24 ℃

Relative humidity : 48 % R.H.

9.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The frequency span is set to 100 MHz and the resolution bandwidth is set to 1 MHz. The analyzer is set to peak hold and then complete pseudo-random hopping sequence of the transmitter is captured.



9.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101199	Mar. 11, 2019 (1Y)

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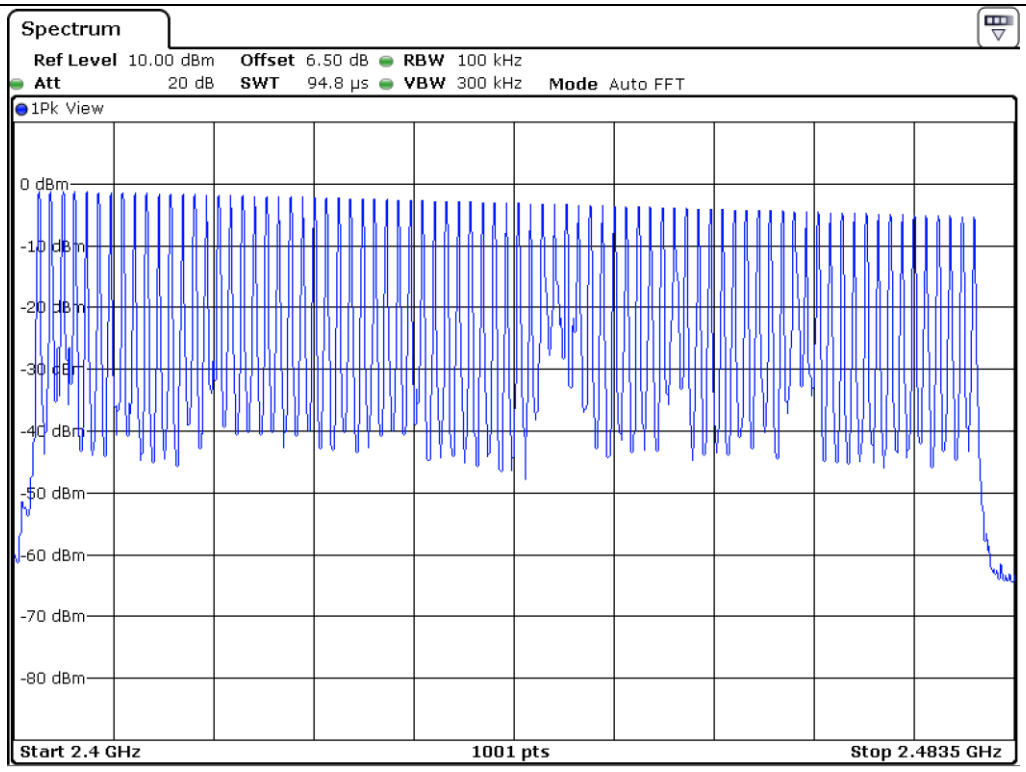
9.4 Test data

-. Test Date : July 23, 2019

-. Test Result : Pass

Data Transfer Rate	Measured value (Number)	Limit (Number)	Margin (Number)
1 Mbps	79	Minimum of 15	64

Tested by: Ha-Ram Lee / Assistant Manager



Total number of hopping channel: 28+30+21 = 79

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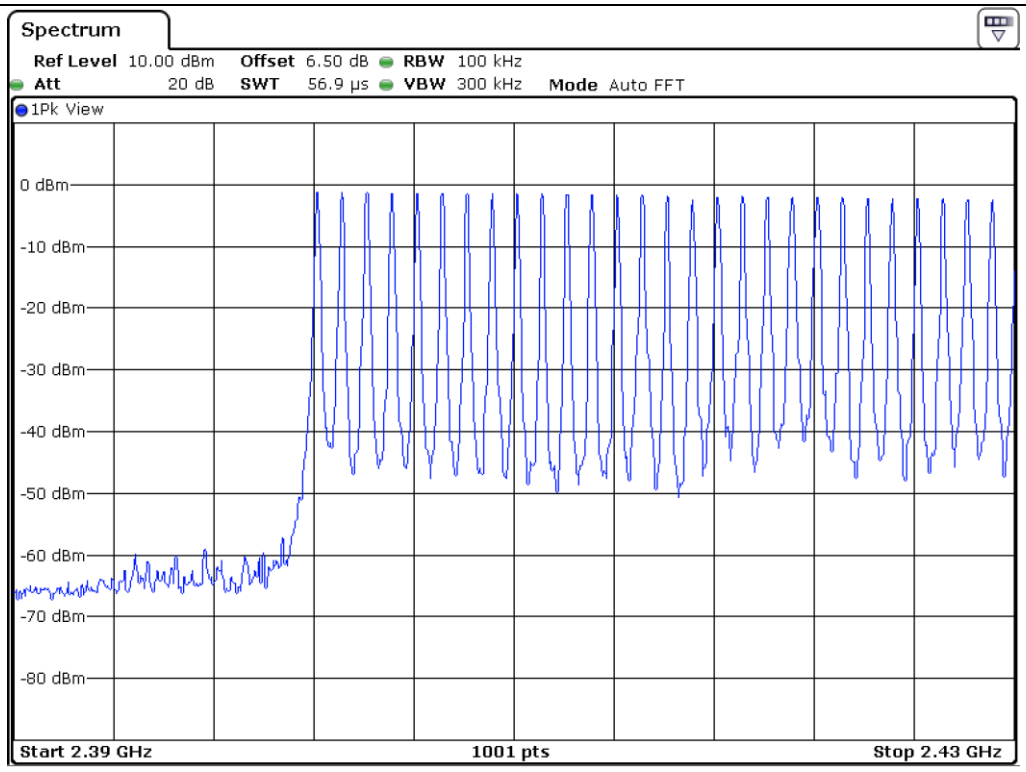
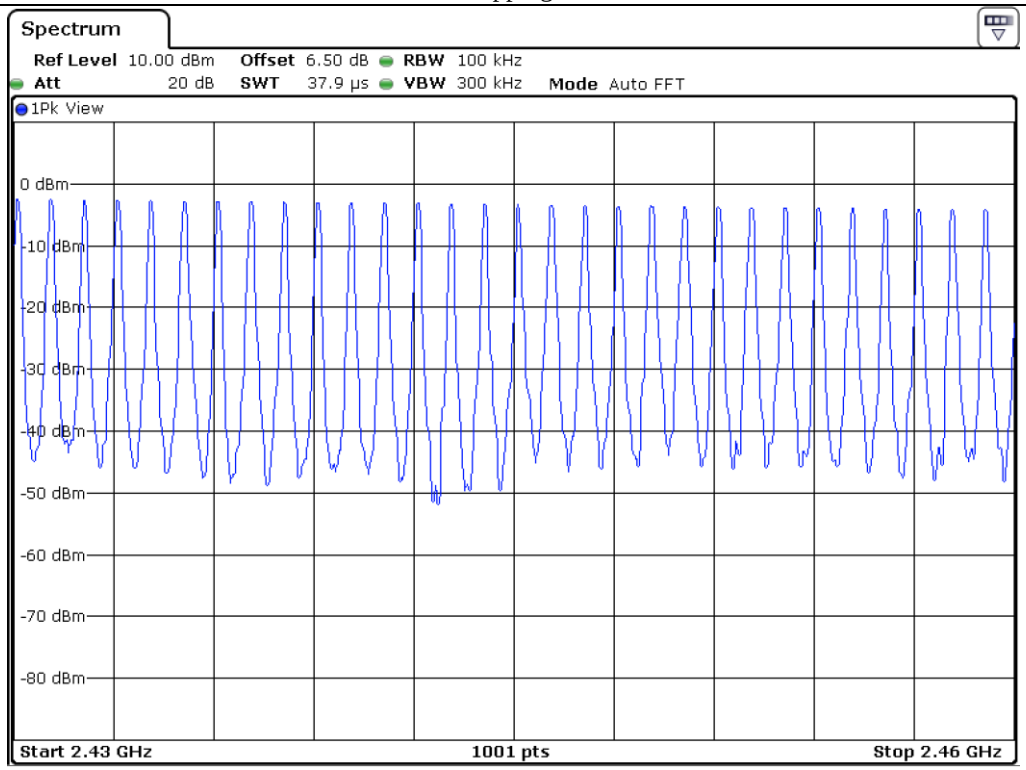


Number of hopping channel: 28



Number of hopping channel: 30

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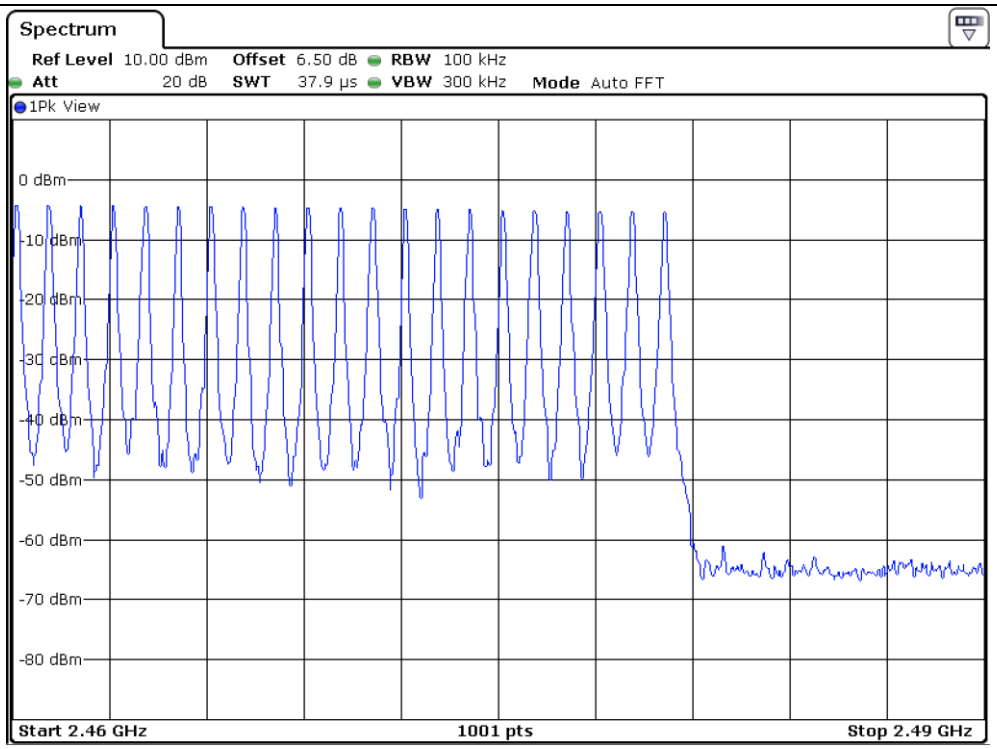

Number of hopping channel: 21

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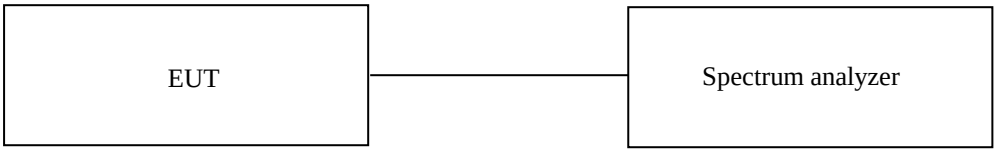
10. TIME OF OCCUPANCY

10.1 Operating environment

Temperature	:	24 ℃
Relative humidity	:	48 % R.H.

10.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The transmitter is set to operate in its normal frequency hopping mode. The center frequency of the spectrum analyzer is set to one of hopping channels near the center of the operating band and span is set to zero Hz. The sweep time is set to display one complete pulse. The mark delta function is used to measure the duration of the pulses.



10.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101199	Mar. 11, 2019 (1Y)

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10.4 Test data

-. Test Date : July 23, 2019

The system makes worst case 1 600 hops per second or 1 time slot has a length of 625 µs with 79 channels.

For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So The EUT has each channel for 10.13 times per second (= 1 600/2/79) for DH1, and 5.06 times (= 1 600/4/79) for DH3, and 3.38 times (= 1 600/6/79) for DH5.

Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (s)	Total Dwell Time (ms)	Limit (ms)	Test Result
GFSK	2.900	2.53	31.6	231.85	400	PASS

Total dwell time is calculated as following.

Total Dwell Time = Pulse time * Hops per second with channels * period time

Remark: See next page for an overview sweep performed with peak detector.

Tested by: Ha-Ram Lee / Assistant Manager

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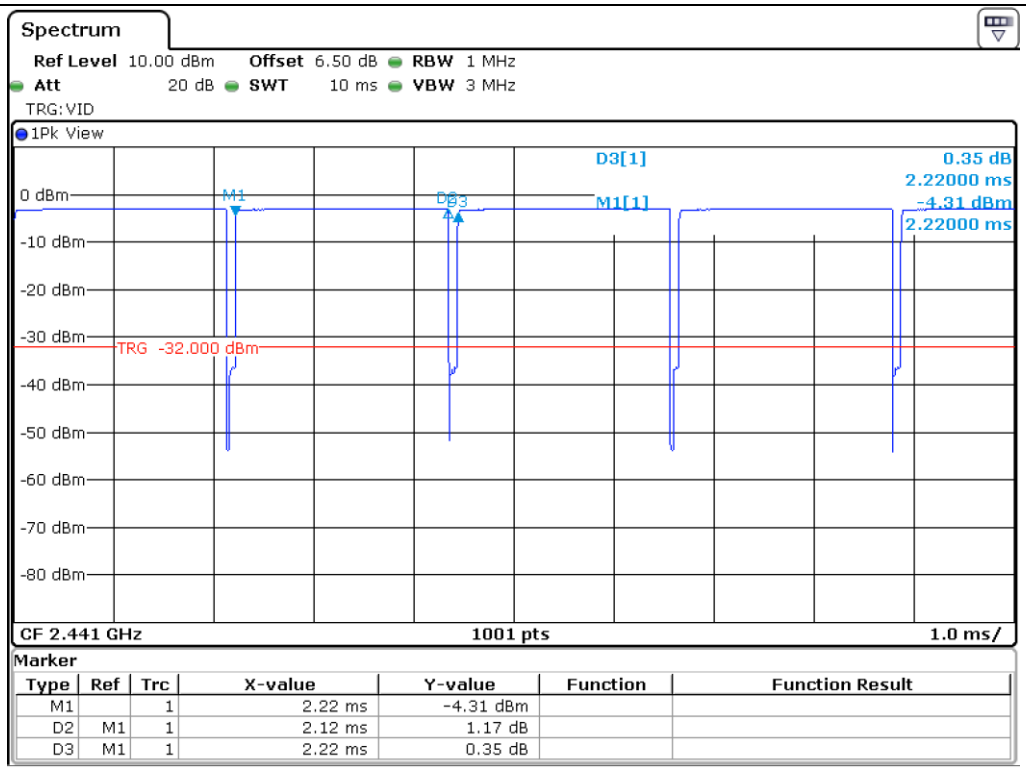

Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.22 ms	-4.31 dBm		
D2	M1	1	2.12 ms	1.17 dB		
D3	M1	1	2.22 ms	0.35 dB		

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11. MAXIMUM PEAK OUTPUT POWER

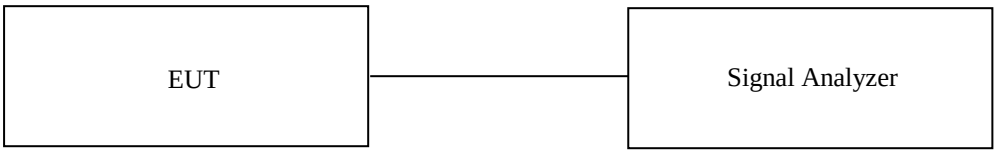
11.1 Operating environment

Temperature : 24 ℃

Relative humidity : 48 % R.H

11.2 Test set-up

The maximum peak output power was measured with the spectrum analyzer connected to the antenna output of the EUT. The EUT was operating in transmit mode at the appropriate center frequency.



11.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101199	Mar. 11, 2019 (1Y)

All test equipment used is calibrated on a regular basis.

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11.4 Test data

-. Test Date : July 23, 2019

-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402	-1.18	21.00	22.18
MIDDLE	2 441	-3.10	21.00	24.10
HIGH	2 480	-5.28	21.00	26.28

Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)

Tested by: Ha-Ram Lee / Assistant Manager

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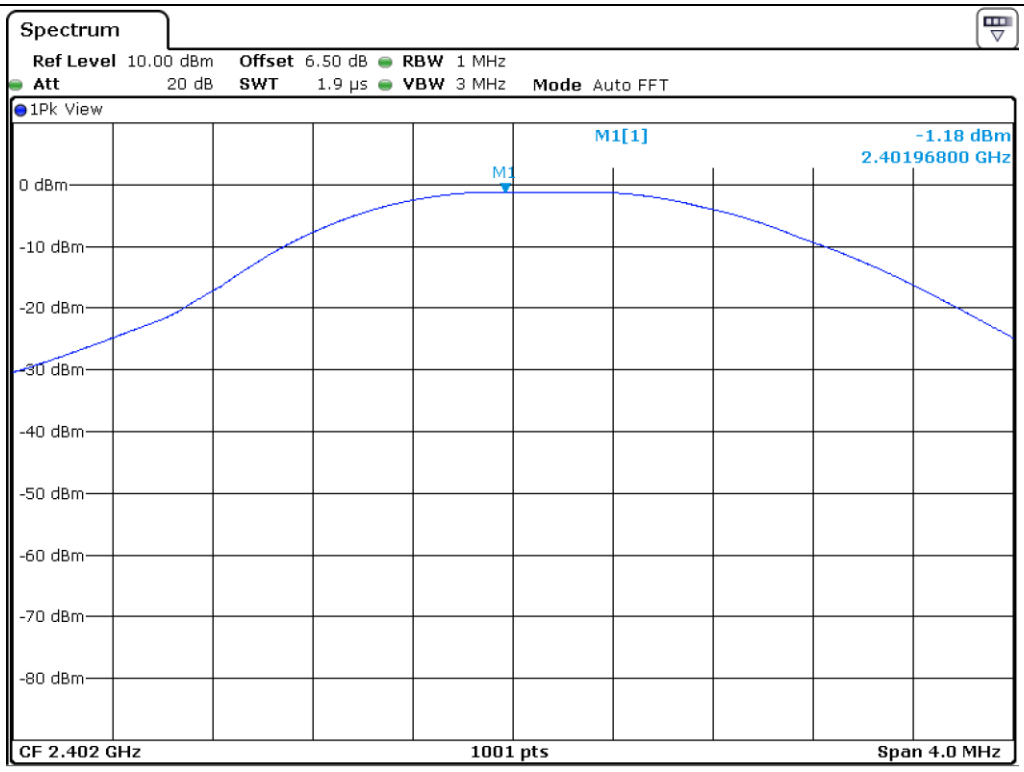
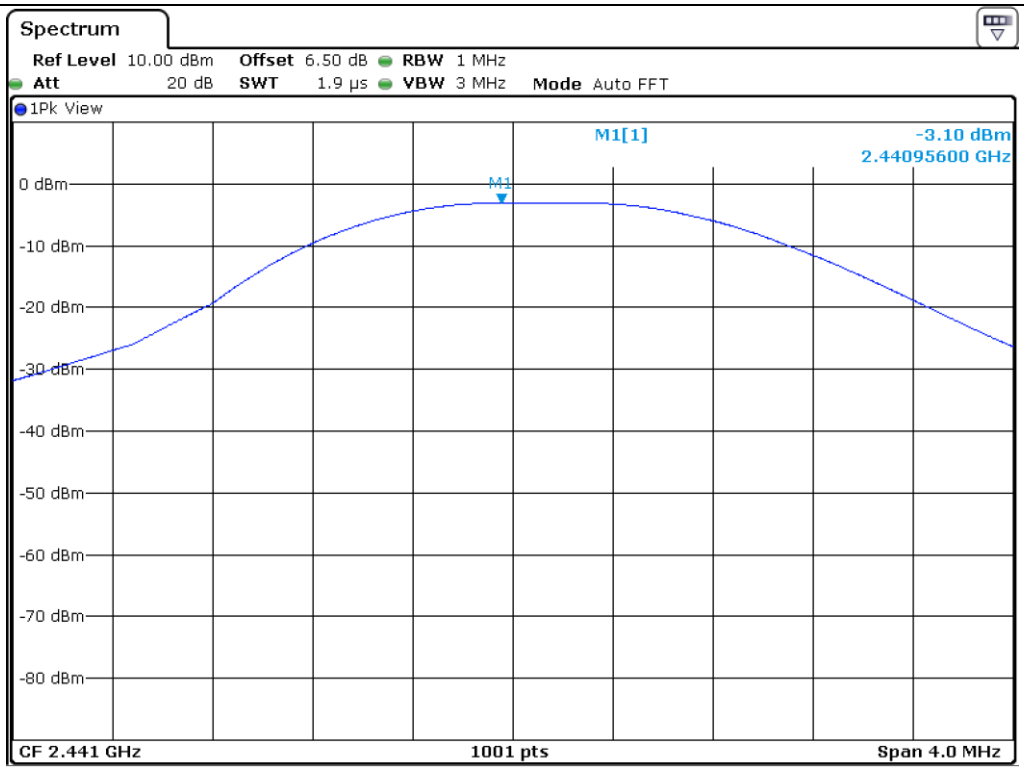


Low Channel



Middle Channel

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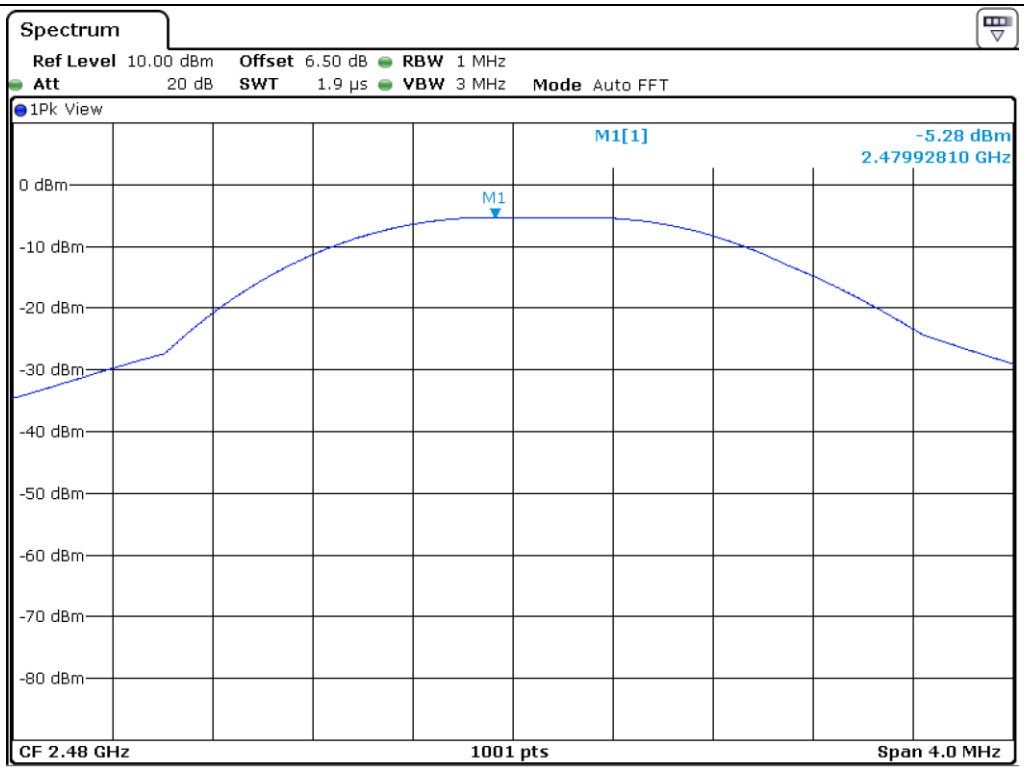

High Channel

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12. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

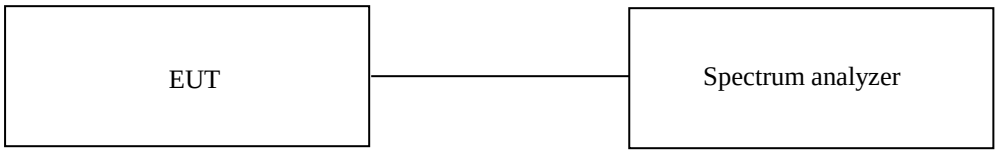
12.1 Operating environment

Temperature : 24 ℃

Relative humidity : 48 % R.H

12.2 Test set-up for conducted measurement

The antenna output of the EUT was connected to the spectrum analyzer. The resolution and video bandwidth is set to 100 kHz, and peak detection was used.



12.3 Test set-up for radiated measurement

The radiated emissions measurements were performed on the 3 m, open-field test site. The EUT was placed on a non-conductive turntable approximately 0.8 m above the ground plane.

The frequency spectrum from 30 kHz to 26.5 GHz was scanned and maximum emission levels at each frequency recorded. The system was rotated 360°, and the antenna was varied in the height between 1.0 m and 4.0 ms in order to determine the maximum emission levels. This procedure was performed for horizontal and vertical polarization of the receiving antenna.

12.4 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal. (Interval)
☐ -	ESCI	Rohde & Schwarz	EMI Test Receiver	101012	Oct. 22, 2018 (1Y)
■ -	ESR	Rohde & Schwarz	EMI Test Receiver	101470	Oct. 22, 2018 (1Y)
■ -	310N	Sonoma Instrument	AMPLIFIER	312544	Mar. 18, 2019 (1Y)
☐ -	FSV30	Rohde & Schwarz	Signal Analyzer	101200	Aug. 23, 2018 (1Y)
■ -	BBV 9718 B	Schwarzbeck	Broadband Pre-Amplifier	009	Mar. 20, 2019 (1Y)
■ -	MA240	HD GmbH	Antenna Master	N/A	N/A
☐ -	HD100	HD GmbH	Position Controller	N/A	N/A
■ -	DS420S	HD GmbH	Turn Table	N/A	N/A
☐ -	FMZB 1513	Schwarzbeck	LOOP ANTENNA	1513-235	May. 13, 2018 (2Y)
■ -	VULB9163	Schwarzbeck	TRILOG Broadband Antenna	9163-255	Jun. 05, 2018 (2Y)
■ -	BBHA9120D	Schwarzbeck	Horn Antenna	BBHA9120D295	Aug. 16, 2017 (2Y)
☐ -	BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170178	Dec. 04, 2017 (2Y)
☐ -	83051A	Agilent	Microwave System Preamplifer	3950M00201	Mar. 12, 2019 (1Y)

All test equipment used is calibrated on a regular basis.

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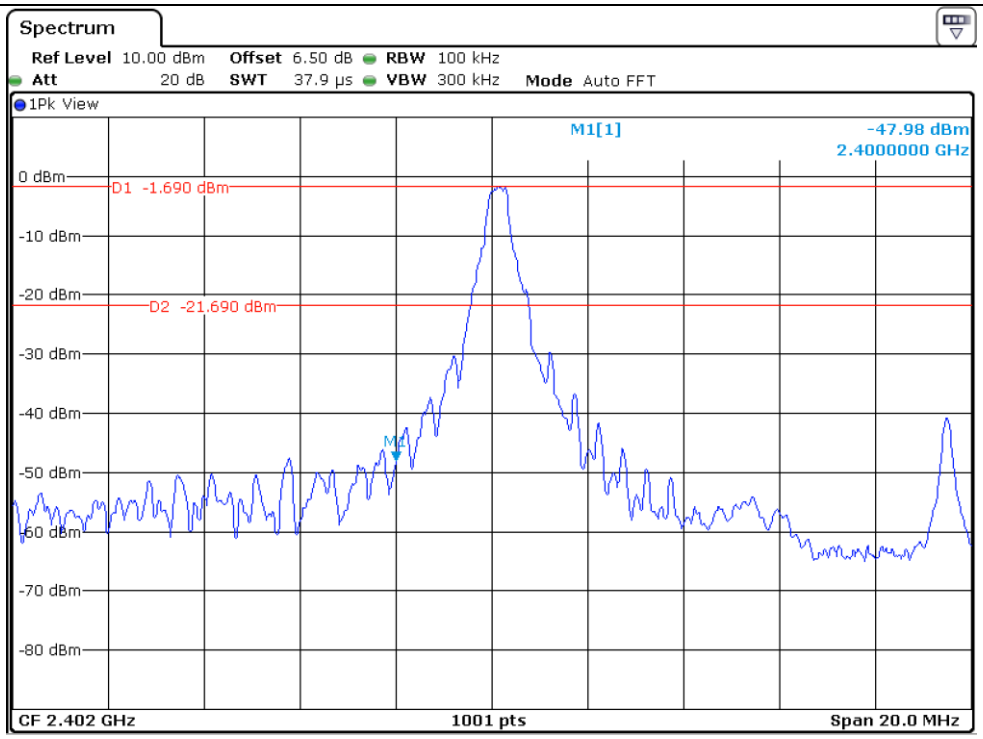
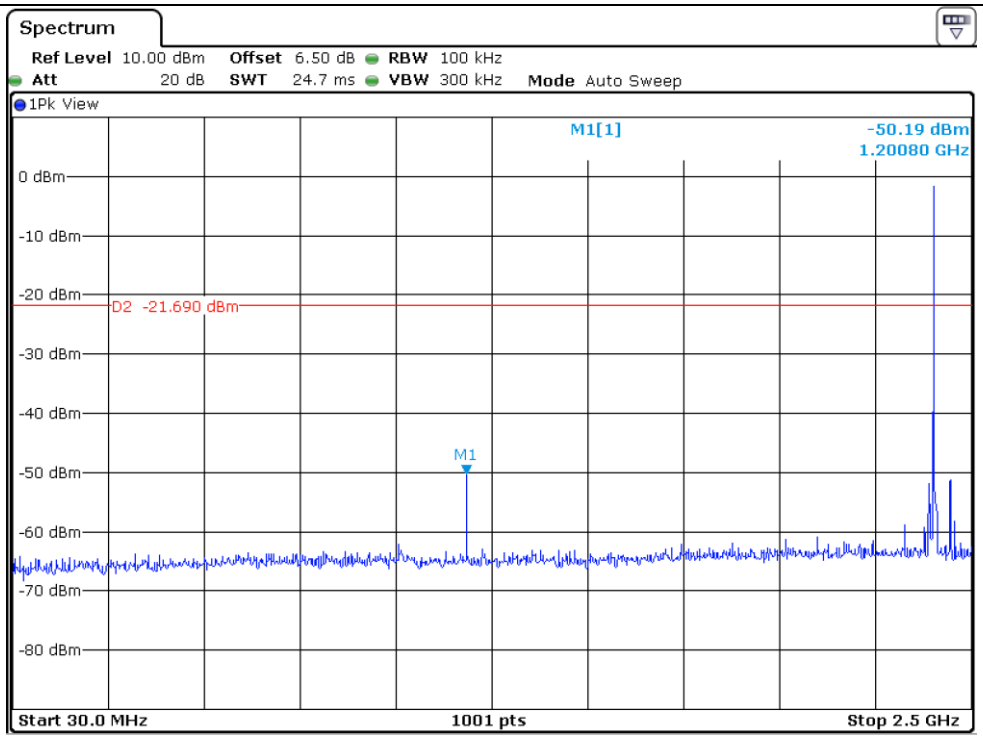
12.5 Test data for conducted emission



Low Channel



Low Channel

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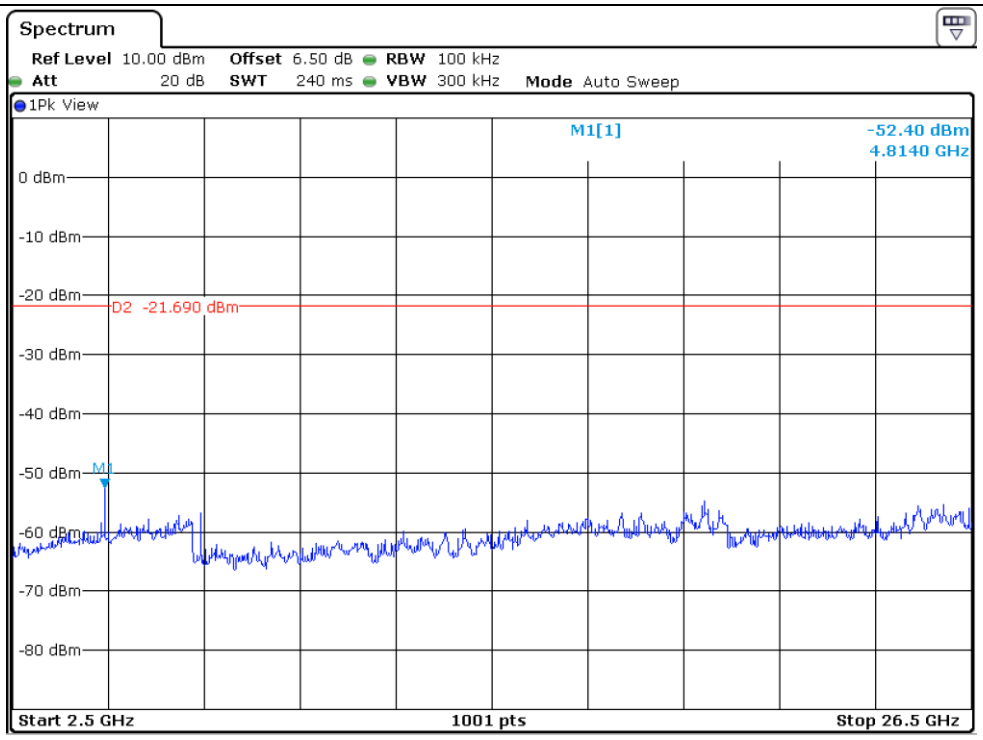
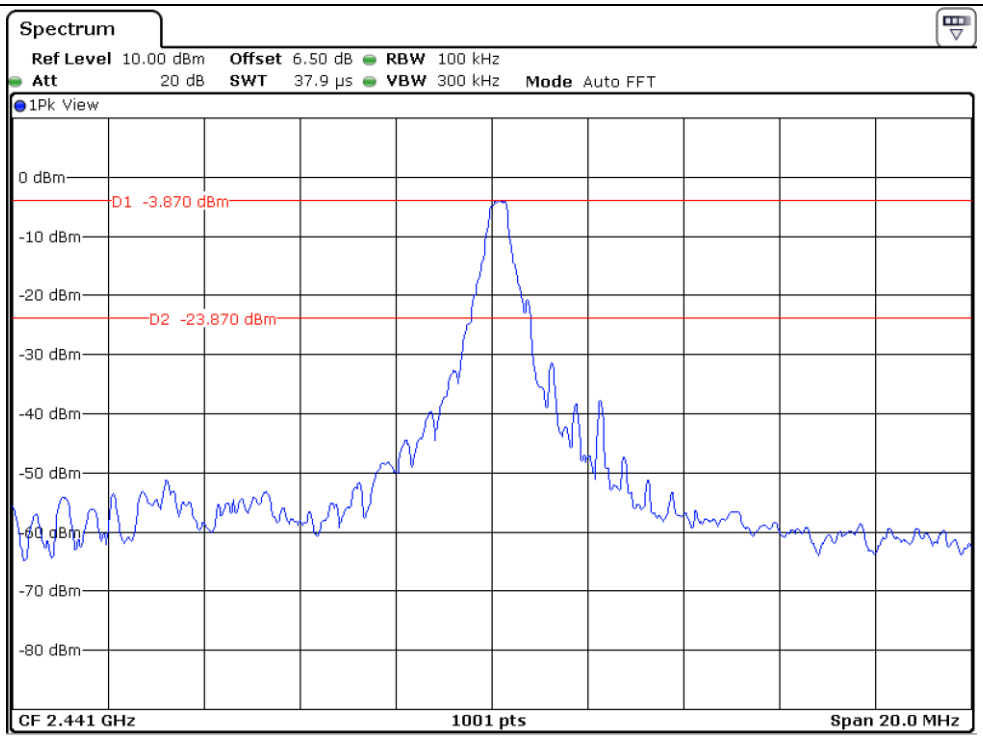
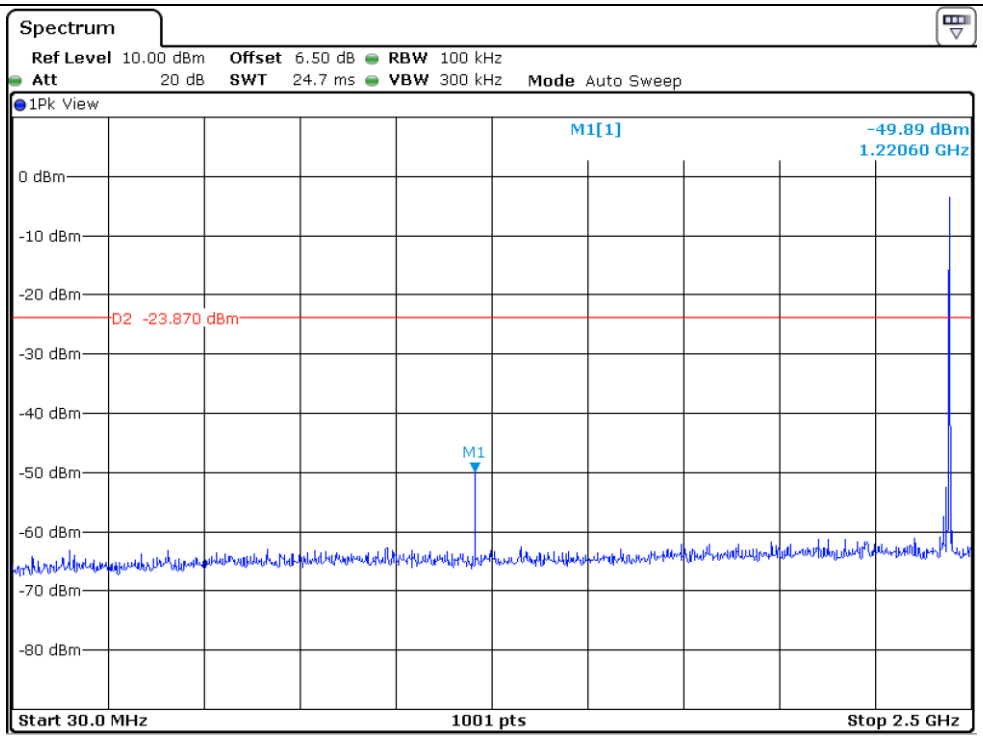


Low Channel

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)



Middle Channel



Middle Channel

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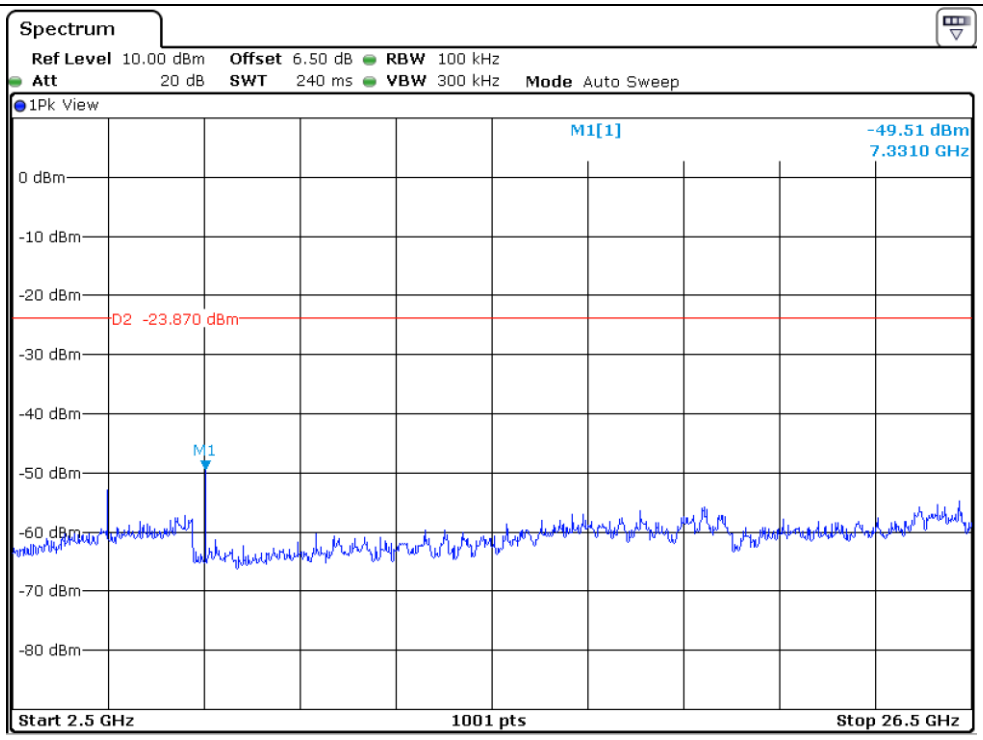

Middle Channel

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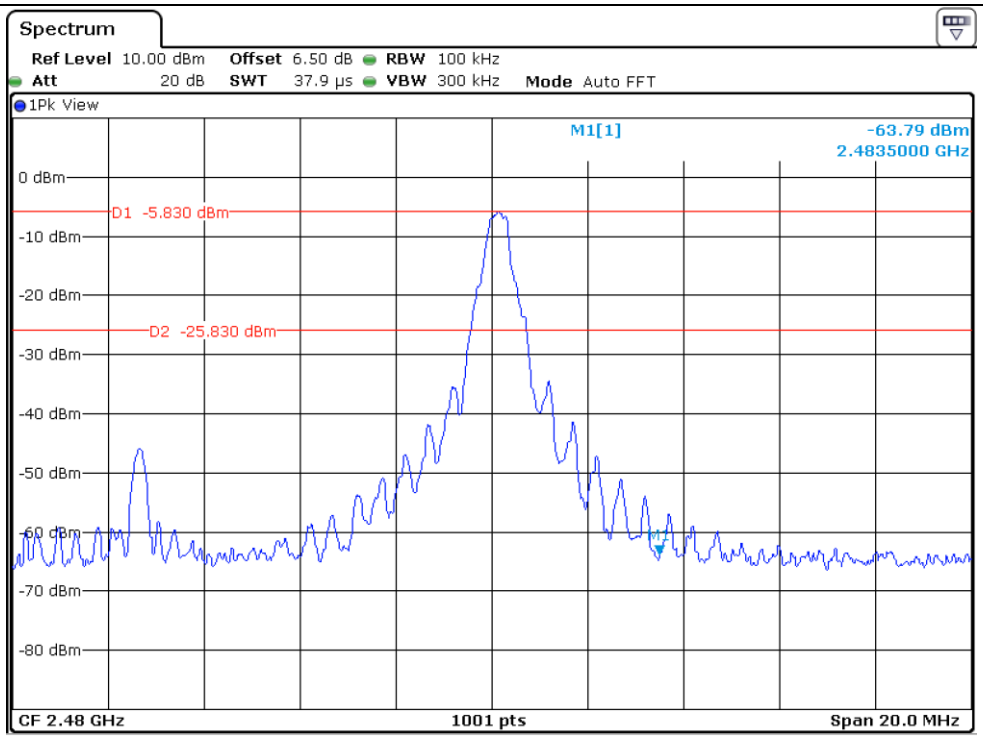
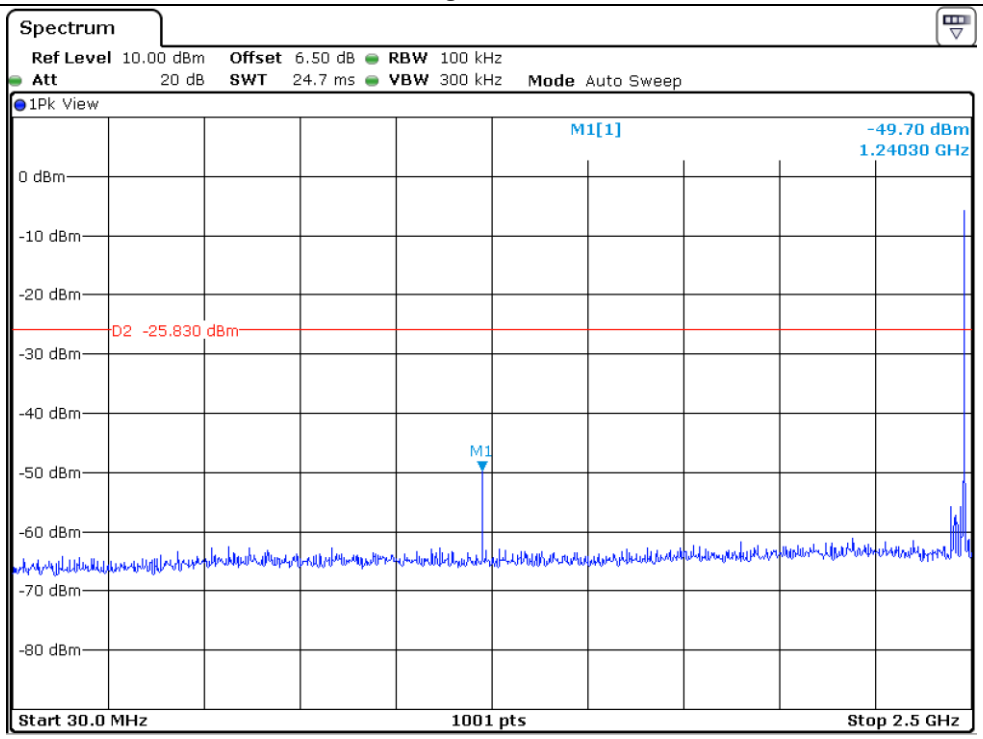


High Channel



High Channel

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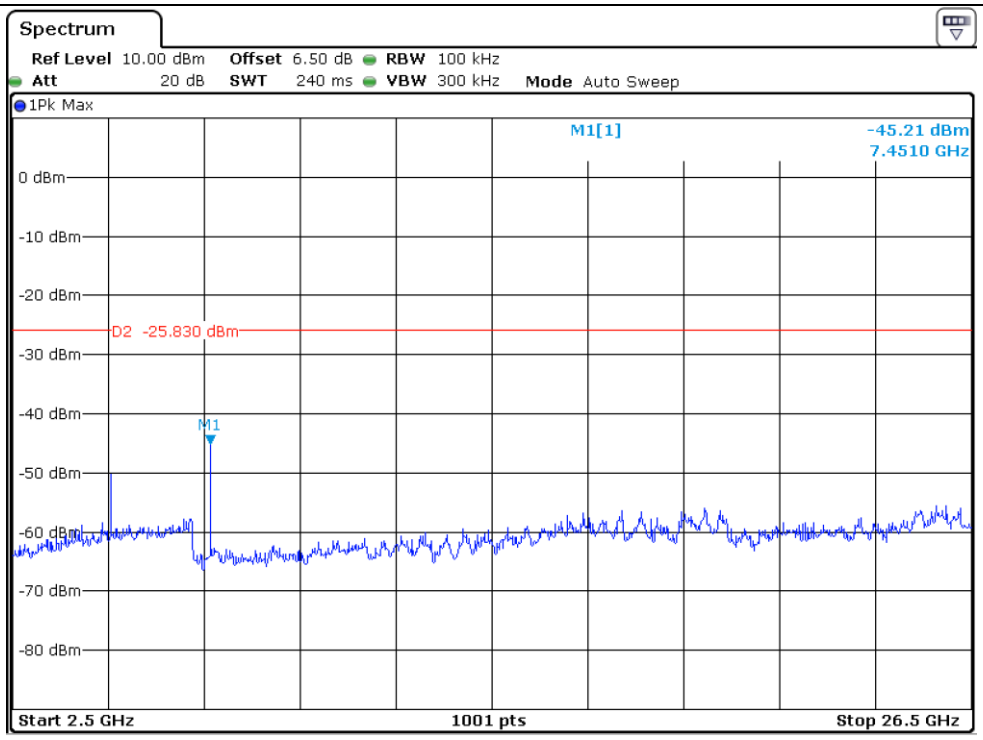

High Channel

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12.6 Test data for Transmitting Mode radiated emission

12.6.1 Radiated Emission which fall in the Restricted Band

12.6.1.1 Test data

-. Test Date : July 26 2019

-. Resolution bandwidth : 1 MHz for Peak and Average Mode

-. Video bandwidth : 3 MHz for Peak and Average Mode

-. Detector : Peak Mode(Peak), Average Mode(RMS)

-. Measurement distance : 3 m

-. Operating Condition : Highest Output Power Transmitting Mode(Low Channel and High Channel)

-. Result : PASSED

Frequency (MHz)	Reading (dBµV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dBµV/m)	Limits (dBµV/m)	Margin (dB)
Test Data for Low Channel									
2 486.86	44.28	Peak	H	27.80	8.80	33.48	47.40	74.00	26.60
2 491.61	32.01	Average	H				35.13	54.00	18.87
2 486.47	43.81	Peak	V				46.93	74.00	27.07
2 490.63	31.74	Average	V				34.86	54.00	19.14
Test Data for High Channel									
2 380.45	44.01	Peak	H	27.80	8.80	33.48	47.13	74.00	26.87
2 335.53	31.15	Average	H				34.27	54.00	19.73
2 367.25	43.81	Peak	V				46.93	74.00	27.07
2 374.31	31.11	Average	V				34.23	54.00	19.77

Tabulated test data for Restricted Band

Remark: “H”: Horizontal, “V”: Vertical

Tested by: Ha-Ram Lee / Assistant Manager

12.6.2 Spurious & Harmonic Radiated Emission above 1 GHz

12.6.2.1 Test data

-. Test Date : July 26 2019

-. Resolution bandwidth : 1 MHz for Peak and Average Mode

-. Video bandwidth : 3 MHz for Peak and Average Mode

-. Detector : Peak Mode(Peak), Average Mode(RMS)

-. Frequency range : 1 GHz ~ 26.5 GHz

-. Measurement distance : 3 m

-. Operating Condition : Highest Output Power Transmitting Mode

-. Result : PASSED

Frequency (GHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
4 804.00	44.49	Peak	H	31.20	13.30	33.17	55.82	74.00	18.18
	31.09	Average	H				42.42	54.00	11.58
	43.46	Peak	V				54.79	74.00	19.21
	30.73	Average	V				42.06	54.00	11.94
Test Data for Middle Channel									
4 882.00	43.38	Peak	H	31.20	13.50	33.17	54.91	74.00	19.09
	30.41	Average	H				41.94	54.00	12.06
	42.67	Peak	V				54.20	74.00	19.80
	30.54	Average	V				42.07	54.00	11.93
Test Data for High Channel									
4 960.00	43.64	Peak	H	31.20	13.70	33.17	55.37	74.00	18.63
	30.10	Average	H				41.83	54.00	12.17
	42.33	Peak	V				54.06	74.00	19.94
	30.55	Average	V				42.28	54.00	11.72

Tabulated test data for Restricted Band

Remark: “H”: Horizontal, “V”: Vertical, “*” Frequency fall in restricted band

Tested by: Ha-Ram Lee / Assistant Manager

12.6.3 Spurious Radiated Emission

12.6.3.1 Test Data for 30 MHz ~ 1 GHz

Humidity Level : 48 % R.H. Temperature: 24 ℃

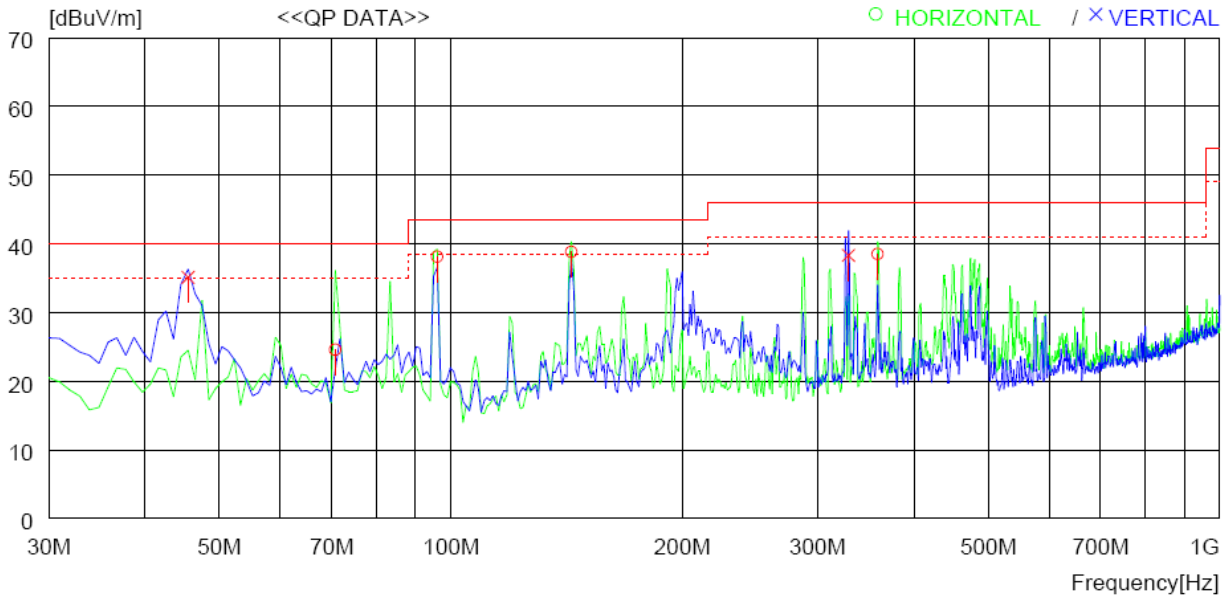
Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247

Result : PASSED

EUT : OPENRIDER R1 Date: July 26 2019

Detector : CISPR Quasi-Peak (6 dB Bandwidth: 120 kHz)

Operating mode : Transmitting mode



No.	FREQ [MHz]	READING QP [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal ------										
1	70.740	45.5	9.2	3.0	33.1	24.6	40.0	15.4	300	0
2	95.960	56.6	12.0	2.6	33.1	38.1	43.5	5.4	300	140
3	143.490	60.3	8.5	3.0	33.0	38.8	43.5	4.7	200	359
4	358.830	51.7	15.0	5.0	33.2	38.5	46.0	7.5	100	19
----- Vertical ------										
5	45.520	51.9	14.5	1.8	33.1	35.1	40.0	4.9	100	359
6	328.760	52.6	14.2	4.6	33.1	38.3	46.0	7.7	100	179

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12.6.3.2 Test Data for Below 30 MHz

-. Test Date : July 26 2019

-. Resolution bandwidth : 200 Hz (from 9 kHz to 0.15 MHz), 9 kHz (from 0.15 MHz to 30 MHz)

-. Frequency range : 9 kHz ~ 30 MHz

-. Measurement distance : 3 m

-. Operating mode : Transmitting mode

-. Result : PASSED

Frequency (MHz)	Reading (dBµV)	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss	Amp Gain	Emission Level(dBµV/m)	Limits (dBµV/m)	Margin (dB)
All emissions observed were 20dB below the limit.								

12.6.3.3 Test Data for above 1 GHz

-. Test Date : July 26 2019

-. Resolution bandwidth : 1 MHz for Peak and Average Mode

-. Frequency range : 1 GHz ~ 26.5 GHz

-. Measurement distance : 3 m

-. Operating mode : Transmitting mode

-. Result : PASSED

Frequency (MHz)	Reading (dBµV)	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss	Amp Gain	Emission Level(dBµV/m)	Limits (dBµV/m)	Margin (dB)
All emissions observed were 20dB below the limit.								

Tested by: Ha-Ram Lee / Assistant Manager