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

Test Report No.	**: OT-207-RWD-058**
Reception No.	**: 2007002562**
Applicant	**: ROBOTIS**
Address	**: #1505, 1506, Ace High End Tower No.3, 371-50 Gasandong Geumcheongu, Seoul, Korea**
Manufacturer	**: ROBOTIS**
Address	**: #1505, 1506, Ace High End Tower No.3, 371-50 Gasandong Geumcheongu, Seoul, Korea**
Type of Equipment	**: Controller**
FCC ID.	**: SOD-CA-100**
Model Name	**: CA-100**
Multiple Model Name	**: CM-300**
Serial number	**: N/A**
Total page of Report	**: 36 pages (including this page)**
Date of Incoming	**: July 08, 2020**
Date of issue	**: July 30, 2020**

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: Tae-Ho, Kim / Senior Manager
ONETECH Corp.

Approved by: Ki-Hong, Nam / General Manager
ONETECH Corp.

It should not be reproduced except in full, without the written approval of ONETECH Corp.

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

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 6

3. GENERAL INFORMATION **7**

3.1 PRODUCT DESCRIPTION 7

3.2 ALTERNATIVE TYPE(S)/MODEL(S); ALSO COVERED BY THIS TEST REPORT. 7

4. EUT MODIFICATIONS **7**

5. SYSTEM TEST CONFIGURATION **8**

5.1 JUSTIFICATION 8

5.2 PERIPHERAL EQUIPMENT 8

5.3 MODE OF OPERATION DURING THE TEST 9

5.4 CONFIGURATION OF TEST SYSTEM 11

5.5 ANTENNA REQUIREMENT 11

6. PRELIMINARY TEST **11**

6.1 AC POWER LINE CONDUCTED EMISSIONS TESTS 11

6.2 GENERAL RADIATED EMISSIONS TESTS 11

7. MINIMUM 6 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. MAXIMUM PEAK OUTPUT POWER **15**

8.1 OPERATING ENVIRONMENT 15

8.2 TEST SET-UP 15

8.3 TEST EQUIPMENT USED 15

8.4 TEST DATA 16

9. 100 KHZ BANDWIDTH OUTSIDE THE FREQUENCY BAND **18**

It should not be reproduced except in full, without the written approval of ONETECH Corp.

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

9.1 OPERATING ENVIRONMENT 18
9.2 TEST SET-UP FOR CONDUCTED MEASUREMENT 18
9.3 TEST SET-UP FOR RADIATED MEASUREMENT 18
9.4 TEST EQUIPMENT USED 18
9.5 TEST DATA FOR CONDUCTED EMISSION 19
9.6 TEST DATA FOR RADIATED EMISSION 24
9.6.1 Radiated Emission which fall in the Restricted Band *24*
9.6.2 Spurious & Harmonic Radiated Emission *25*
10. PEAK POWER SPECTRAL DENSITY **26**
10.1 OPERATING ENVIRONMENT 26
10.2 TEST SET-UP 26
10.3 TEST EQUIPMENT USED 26
10.4 TEST DATA 27
11. RADIATED EMISSION TEST **29**
11.1 OPERATING ENVIRONMENT 29
11.2 TEST SET-UP 29
11.3 TEST EQUIPMENT USED 31
11.4 TEST DATA 32
11.4.1 Test data for 30 MHz ~ 960 MHz *32*
11.4.2 Test data for Below 30 MHz *33*
11.4.3 Test data for above 1 GHz *33*
12. CONDUCTED EMISSION TEST **34**
12.1 OPERATING ENVIRONMENT 34
12.2 TEST SET-UP 34
12.3 TEST EQUIPMENT USED 34
12.4 TEST DATA 35

It should not be reproduced except in full, without the written approval of ONETECH Corp.

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

Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-207-RWD-058	July 30, 2020	Initial Release	All

It should not be reproduced except in full, without the written approval of ONETECH Corp.

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

1. VERIFICATION OF COMPLIANCE

Applicant : ROBOTIS
Address : #1505, 1506, Ace High End Tower No.3, 371-50 Gasandong Geumcheongu, Seoul, Korea
Contact Person : Eunsung Lee / Research Engineer
Telephone No. : +82-70-8671-2600
FCC ID : SOD-CA-100
Model Name : CA-100
Brand Name : -
Serial Number : N/A
Date : July 30, 2020

EQUIPMENT CLASS	DTS – DIGITAL TRNSMISSION SYSTEM
E.U.T. DESCRIPTION	Controller
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 KDB 558074 D01 15.247 Meas Guidance v05r02
Modifications on the Equipment to Achieve Compliance	None
Final Test was Conducted On	10 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.

It should not be reproduced except in full, without the written approval of ONETECH Corp.

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

2. TEST SUMMARY

2.1 Test items and results

SECTION	TEST ITEMS	RESULTS
15.247 (a) (2)	Minimum 6 dB Bandwidth	Met the Limit / PASS
15.247 (b) (3)	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
15.247 (e)	Peak Power Spectral Density	Met the Limit / PASS
15.209	Radiated Emission Limits	Met the Limit / PASS
15.207	Conducted Limits	Met the Limit / PASS
15.203	Antenna Requirement	Met requirement / PASS

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.

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-11842

ISED (Innovation, Science and Economic Development Canada) – Registration No. Site# 3736A-3

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

FCC (Federal Communications Commission) - Accreditation No. KR0013

RRA (Radio Research Agency) – Designation No. KR0013

It should not be reproduced except in full, without the written approval of ONETECH Corp.

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

3. GENERAL INFORMATION

3.1 Product Description

The ROBOTIS, Model CA-100 (referred to as the EUT in this report) is a Controller. The product specification described herein was obtained from product data sheet or user's manual.

DEVICE TYPE	Controller
Temperature Range	-5 °C ~ 70 °C
OPERATING FREQUENCY	2 402 MHz ~ 2 480 MHz
MODULATION TYPE	GFSK
RF OUTPUT POWER	-17.08 dBm
ANTENNA TYPE	PCB Antenna
ANTENNA GAIN	-2.23 dBi
List of each Osc. or crystal Freq.(Freq. >= 1 MHz)	32 MHz

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

-. The following lists consist of the added model and their differences.

Model Name	Differences	Tested
CA-100	Basic Model	☑
CM-300	The model is identical to basic model except for the model name only.	☐

Note: 1. Applicant consigns only basic model to test. Therefore this test report just guarantees the units, which have been tested.
2. The Applicant/manufacturer is responsible for the compliance of all variants.

4. EUT MODIFICATIONS

-. None

It should not be reproduced except in full, without the written approval of ONETECH Corp. OTC-TRF-RF-001(0)

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	ROBOTIS	CA-100	N/A
Battery	N/A	UFX 804050	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
CA-100	ROBOTIS	Controller (EUT)	-
HP ProtectSmart	HP	Notebook PC	Jig Board
PPP009C	LIE-ON TECHNOLOGY (CHANGZHOU)CO.,LTD.	AC Adaptor	Notebook PC
LN-101	ROBOTIS	Jig Board	EUT

It should not be reproduced except in full, without the written approval of ONETECH Corp.

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

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, 2 440 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 “XZ” axis, but the worst data was recorded in this report.

-. Channel List (Bluetooth LE)

Channel	Frequency[MHz]	Channel	Frequency[MHz]	Channel	Frequency[MHz]
0	2 402.00	14	2 430.00	28	2 458.00
1	2 404.00	15	2 432.00	29	2 460.00
2	2 406.00	16	2 434.00	30	2 462.00
3	2 408.00	17	2 436.00	31	2 464.00
4	2 410.00	18	2 438.00	32	2 466.00
5	2 412.00	19	2 440.00	33	2 468.00
6	2 414.00	20	2 442.00	34	2 470.00
7	2 416.00	21	2 444.00	35	2 472.00
8	2 418.00	22	2 446.00	36	2 474.00
9	2 420.00	23	2 448.00	37	2 476.00
10	2 422.00	24	2 450.00	38	2 478.00
11	2 424.00	25	2 452.00	39	2 480.00
12	2 426.00	26	2 454.00		
13	2 428.00	27	2 456.00		

It should not be reproduced except in full, without the written approval of ONETECH Corp.

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

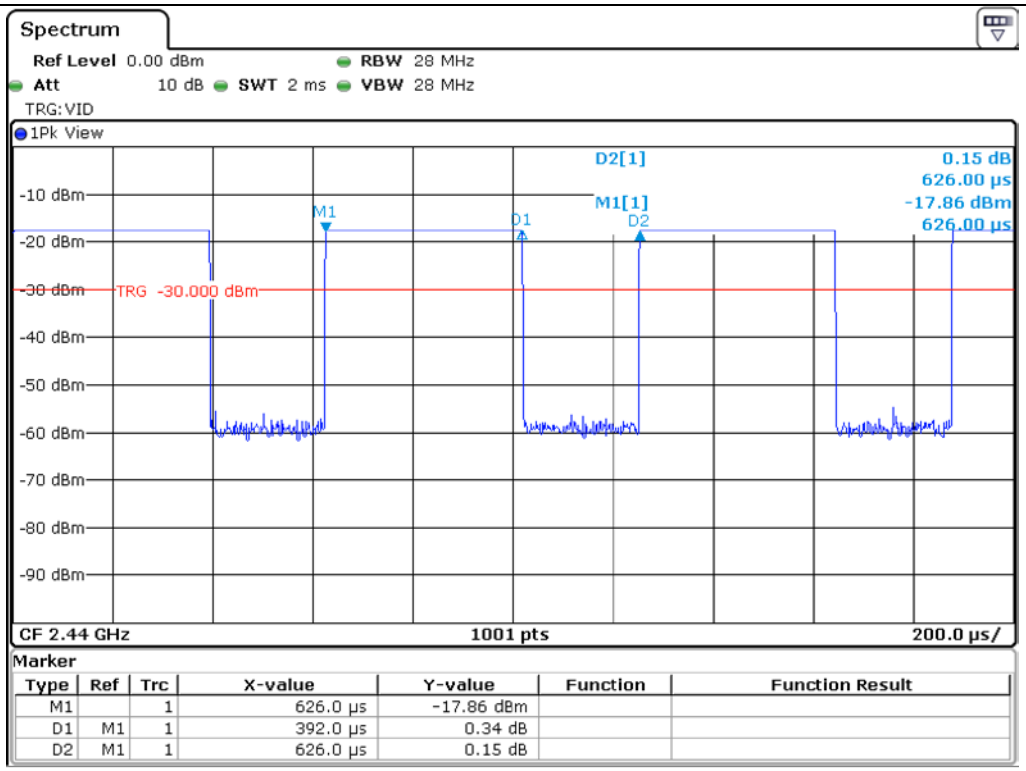
-. Duty Cycle

Mode	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
Bluetooth LE [1 Mbps]	0.392	0.234	62.62	2.03

Note – Duty Cycle : (Tx On Time / (Tx On Time + Tx Off Time)) * 100

Correction Factor : 10 * Log(1 / (Duty Cycle / 100))

-. Test Plot



Bluetooth LE_1 Mbps

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

5.4 Configuration of Test System

Line Conducted Test: The EUT was tested in a Charging & Transmitter mode. The EUT was connected to USB and the Power of USB was Connected to DC Adaptor. All supporting equipments 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: Preliminary radiated emissions test were conducted using the procedure in ANSI C63.10: 2013 to determine the worse operating conditions. Final radiated emission tests were conducted at 10 meter 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 to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

Antenna Construction:

The antenna of the EUT is a PCB Antenna on the main board in the EUT, so no consideration of replacement by the user.

6. PRELIMINARY TEST

6.1 AC Power line Conducted Emissions Tests

During Preliminary Test, the following operating mode was investigated.

Operation Mode	The Worse operating condition (Please check one only)
Charging & Transmitter Mode	X

6.2 General Radiated Emissions Tests

During Preliminary Test, the following operating mode was investigated.

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

It should not be reproduced except in full, without the written approval of ONETECH Corp.

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

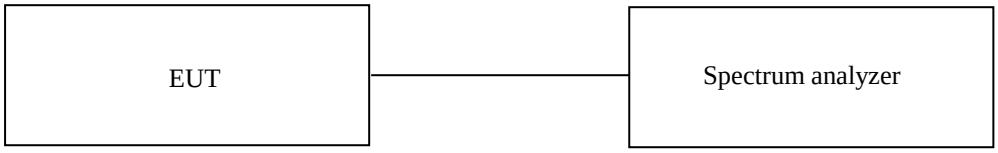
7. MINIMUM 6 dB BANDWIDTH

7.1 Operating environment

Temperature	:	23 °C
Relative humidity	:	45 % 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 100 kHz, and peak detection was used. The 6 dB bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 6 dB.



7.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ -	FSV40	Rohde & Schwarz	Signal Analyzer	101009	Feb. 21, 2020 (1Y)

All test equipment used is calibrated on a regular basis.

It should not be reproduced except in full, without the written approval of ONETECH Corp.

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

7.4 Test data

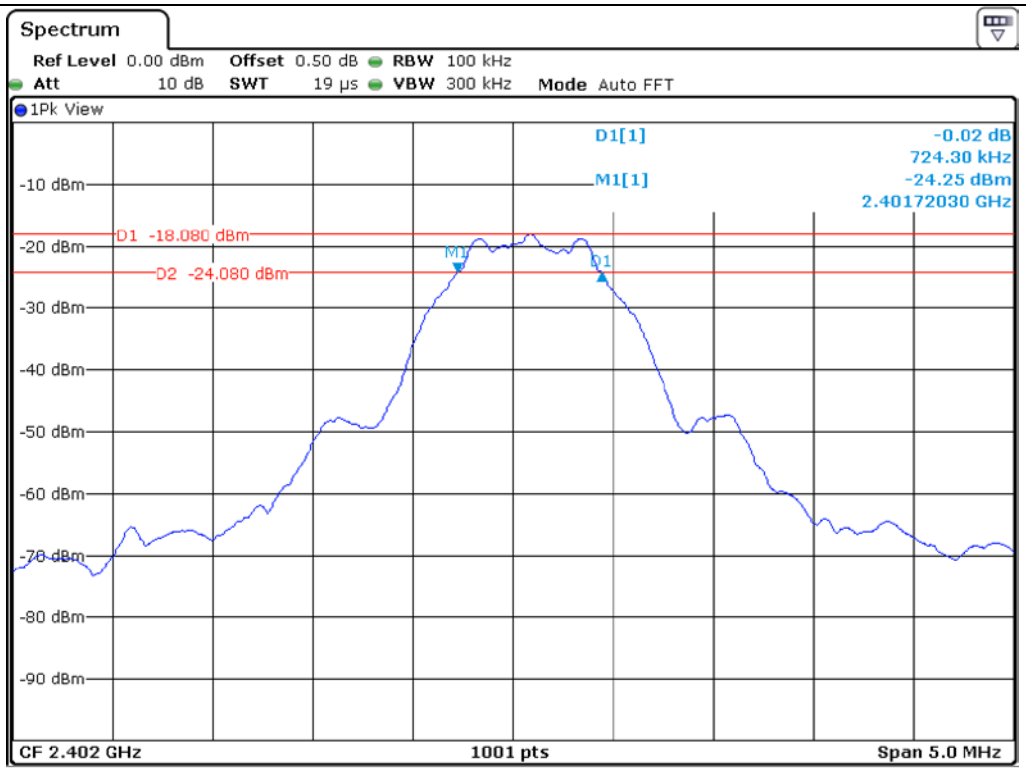
-. Test Date : July 08, 2020 ~ July 13, 2020

-. Test Result : Pass

CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (kHz)	LIMIT (kHz)	MARGIN (kHz)
Low	2 402.00	724.30	500.00	224.30
Middle	2 440.00	709.30	500.00	209.30
High	2 480.00	714.30	500.00	214.30

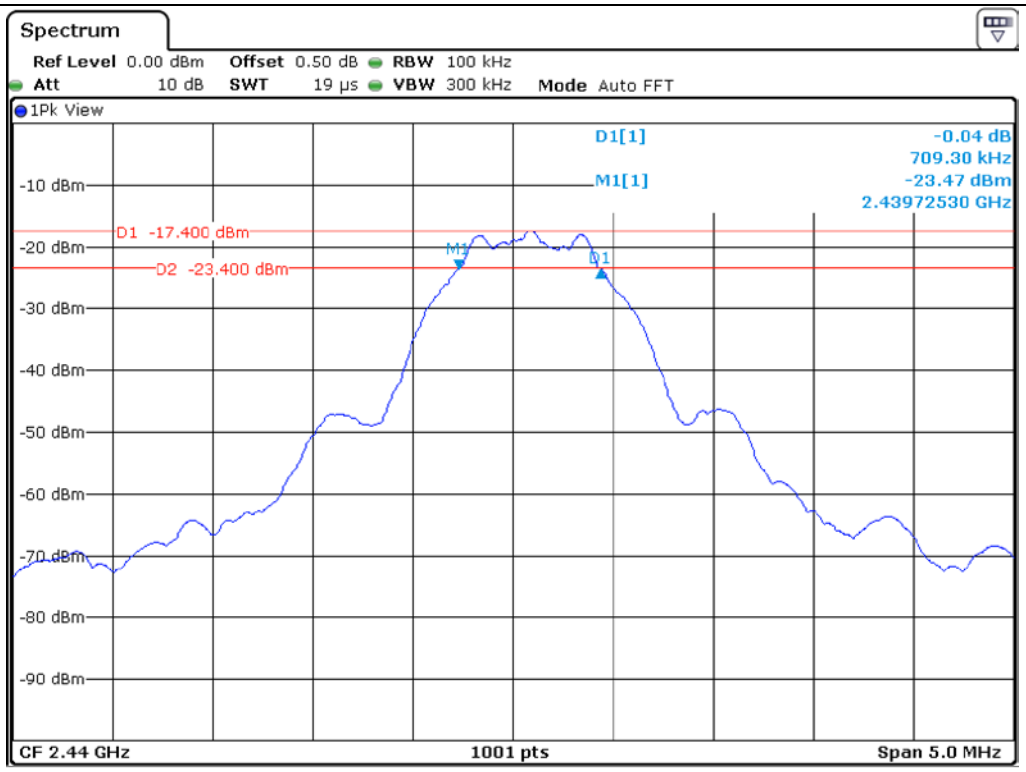
Remark. Margin = Measured Value - Limit

Tested by: Hyung-Kwon, Oh / Manager

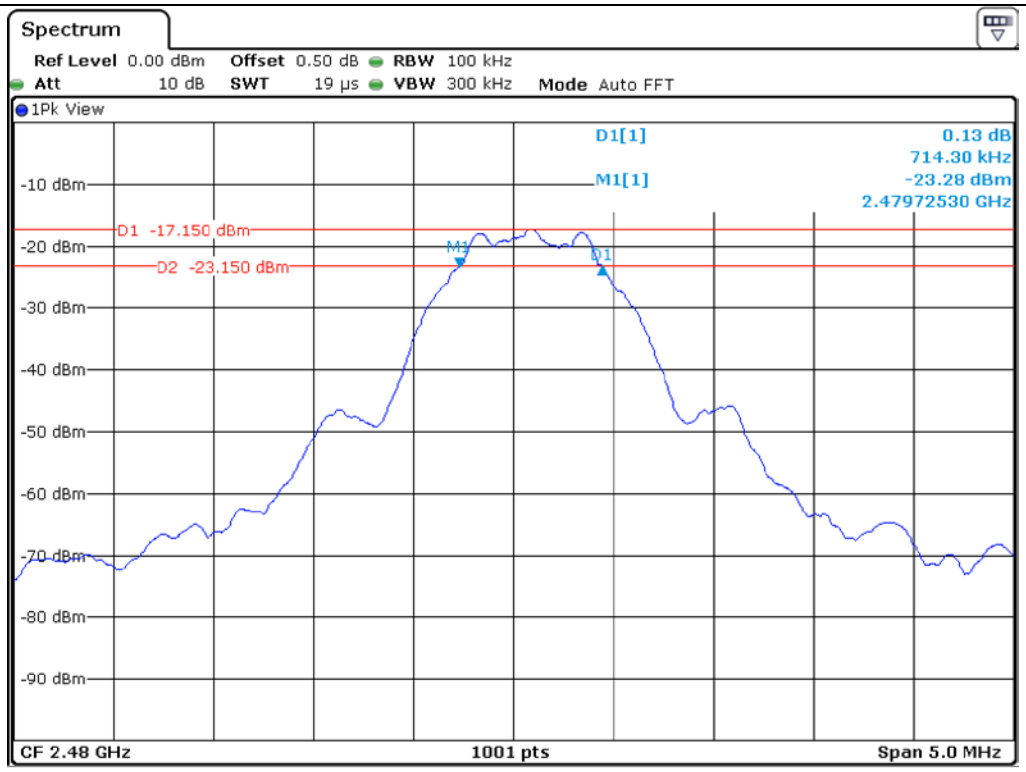


Low Channel

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



High 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)

8. MAXIMUM PEAK OUTPUT POWER

8.1 Operating environment

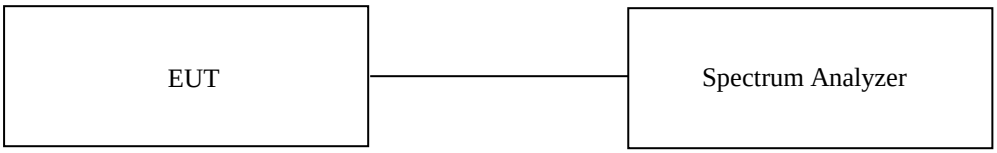
Temperature : 23 °C

Relative humidity : 45 % R.H.

8.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer.

The resolution bandwidth is set to ≥ DTS Bandwidth, the video bandwidth is set to 3 times the resolution bandwidth.



8.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ -	FSV40	Rohde & Schwarz	Signal Analyzer	101009	Feb. 21, 2020 (1Y)

All test equipment used is calibrated on a regular basis.

It should not be reproduced except in full, without the written approval of ONETECH Corp.

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

8.4 Test data

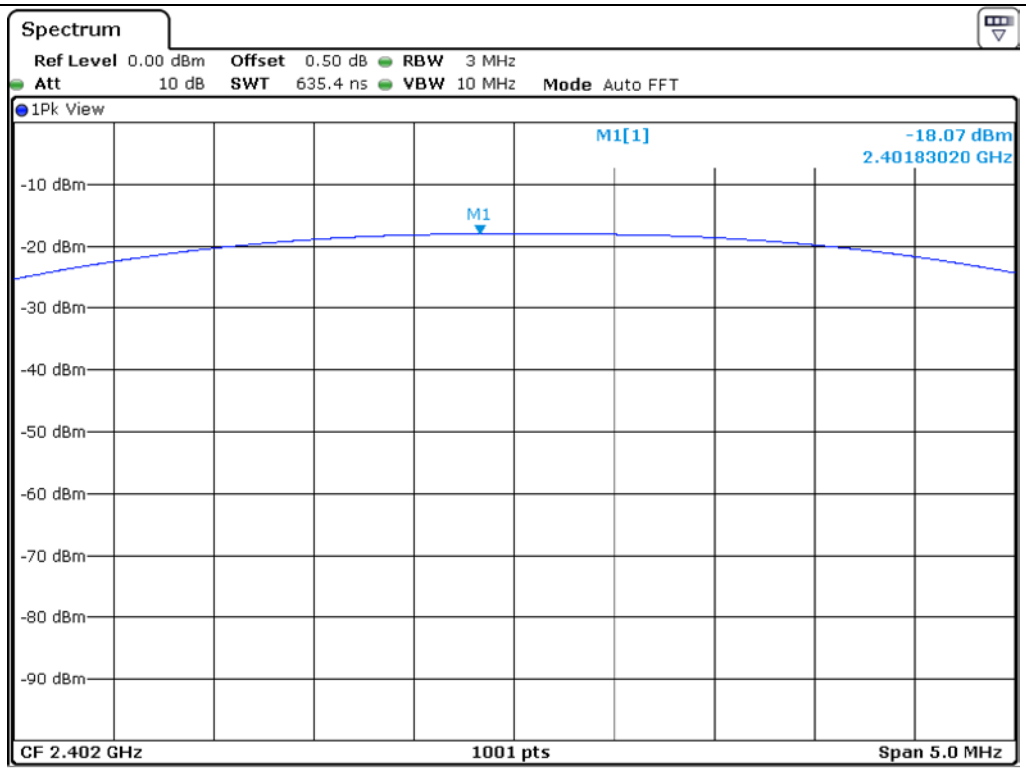
-. Test Date : July 08, 2020 ~ July 13, 2020

-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	-18.07	30.00	48.07
MIDDLE	2 440.00	-17.39	30.00	47.39
HIGH	2 480.00	-17.08	30.00	47.08

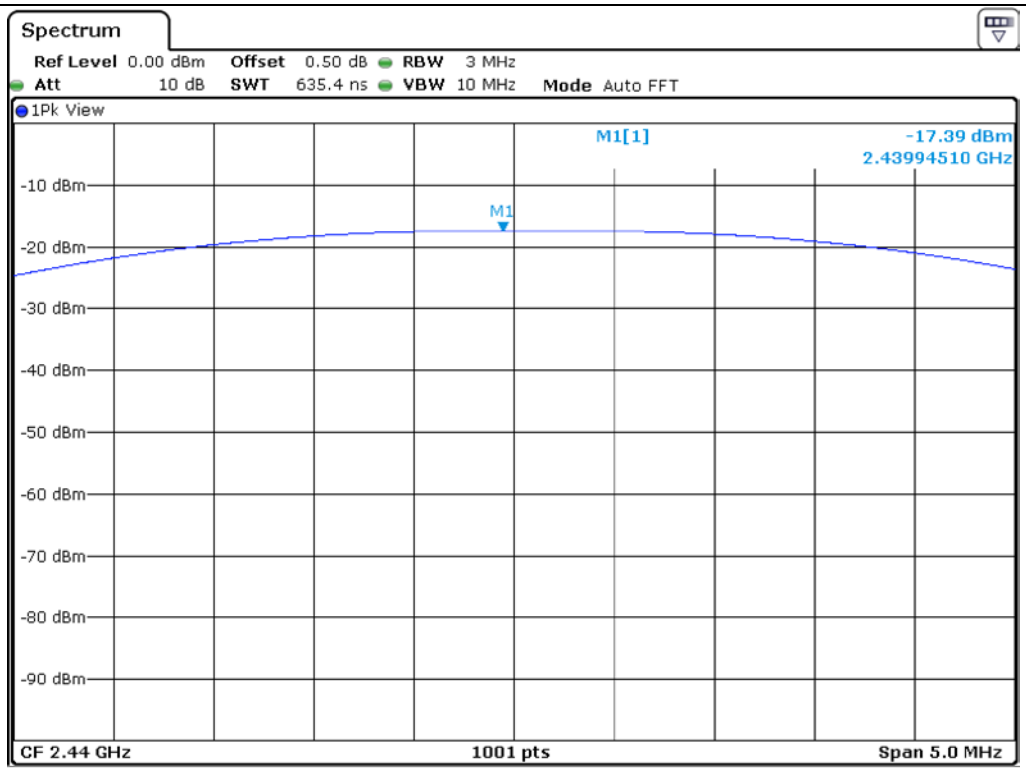
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)

Tested by: Hyung-Kwon, Oh / Manager

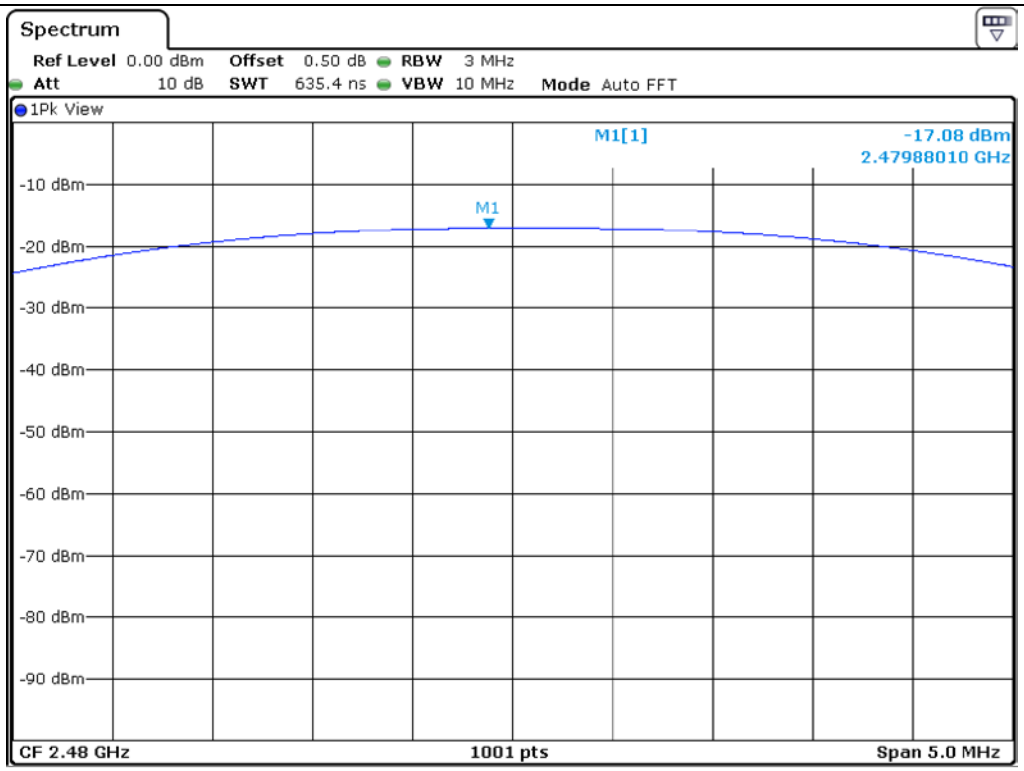


Low Channel

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



High Channel

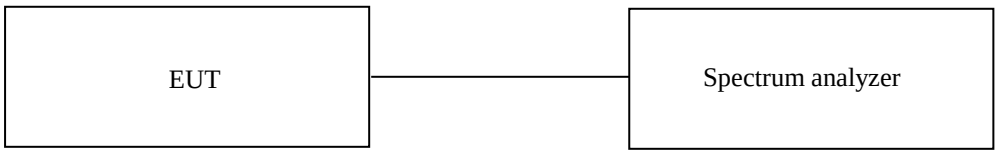
9. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

9.1 Operating environment

Temperature	:	23 °C
Relative humidity	:	45 % R.H.

9.2 Test set-up for conducted measurement

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 100 kHz, the video bandwidth is set to 3 times the resolution bandwidth and peak detection was used.



9.3 Test set-up for radiated measurement

The radiated emissions measurements were performed on the 10 m semi anechoic chamber. The EUT was placed on turntable approximately 1.5 m above the ground plane.

The frequency spectrum from 30 MHz 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 m in order to determine the maximum emission levels. This procedure was performed for horizontal and vertical polarization of the receiving antenna.

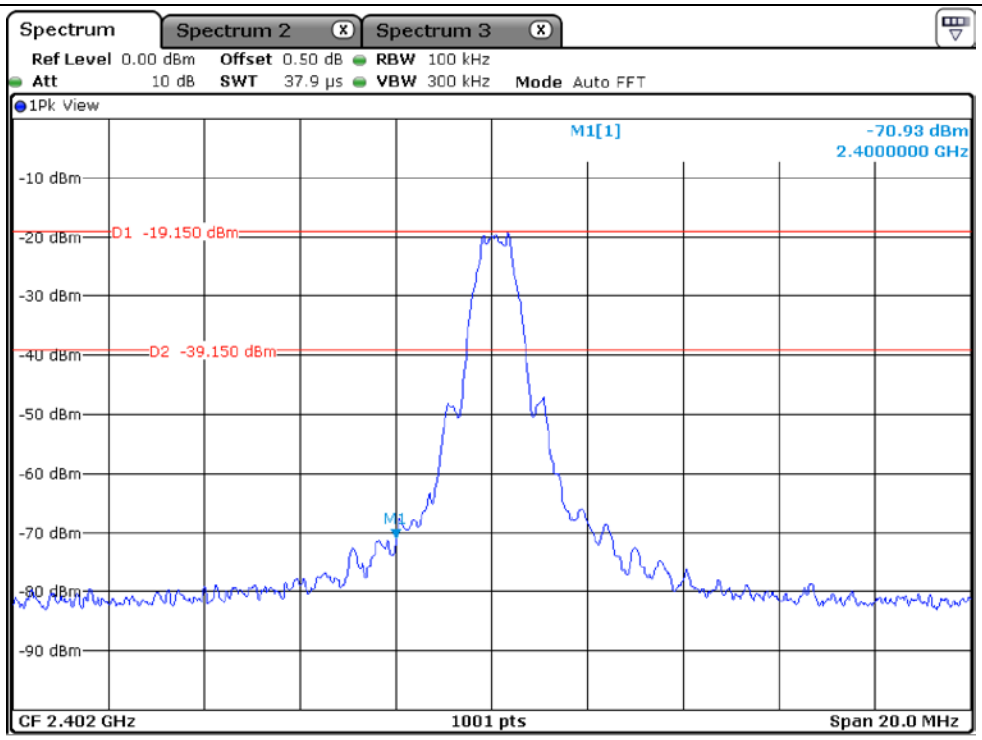
9.4 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ -	FSV40	Rohde & Schwarz	Signal Analyzer	101009	Feb. 21, 2020 (1Y)
■ -	ESW	Rohde & Schwarz	EMI Test Receiver	101851	Aug. 07, 2019 (1Y)
■ -	310N	Sonoma Instrument	Pre-Amplifier	312544	Mar. 16, 2020 (1Y)
■ -	BBV 9718 B	Schwarzbeck	Broadband Preamplifier	00009	Mar. 16, 2020 (1Y)
■ -	SCU40A	Rohde & Schwarz	Signal Conditioning unit	100436	Feb. 20, 2020 (1Y)
■ -	SCU18	Rohde & Schwarz	Signal Conditioning unit	102266	Jul. 24, 2019(1Y)
■ -	DT3000-3t	Innco System	Turn Table	DT3000/093	N/A
■ -	MA-4000XPET	Innco System	Antenna Master	MA4000/509	N/A
■ -	VULB9163	Schwarzbeck	TRILOG Broadband Antenna	777	Apr. 08, 2020 (2Y)
■ -	BBHA9120D	Schwarzbeck	Horn Antenna	9120D-1366	Jul. 16, 2019 (1Y)
■ -	BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170178	Jan. 07, 2020(1Y)

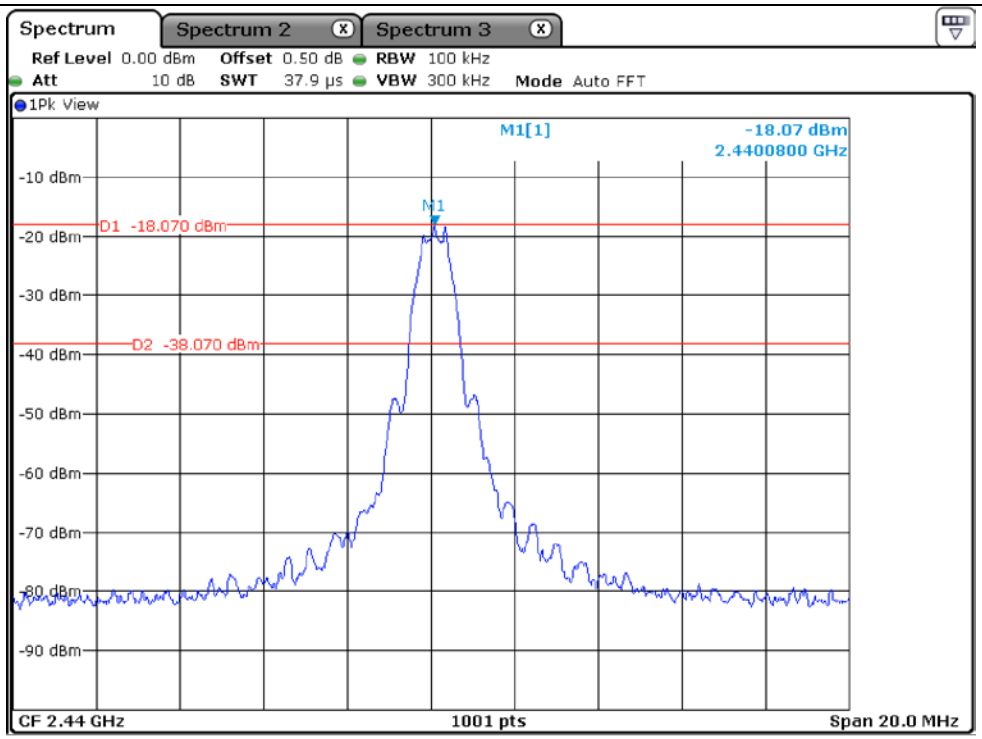
All test equipment used is calibrated on a regular basis.

It should not be reproduced except in full, without the written approval of ONETECH Corp. OTC-TRF-RF-001(0)

9.5 Test data for conducted emission

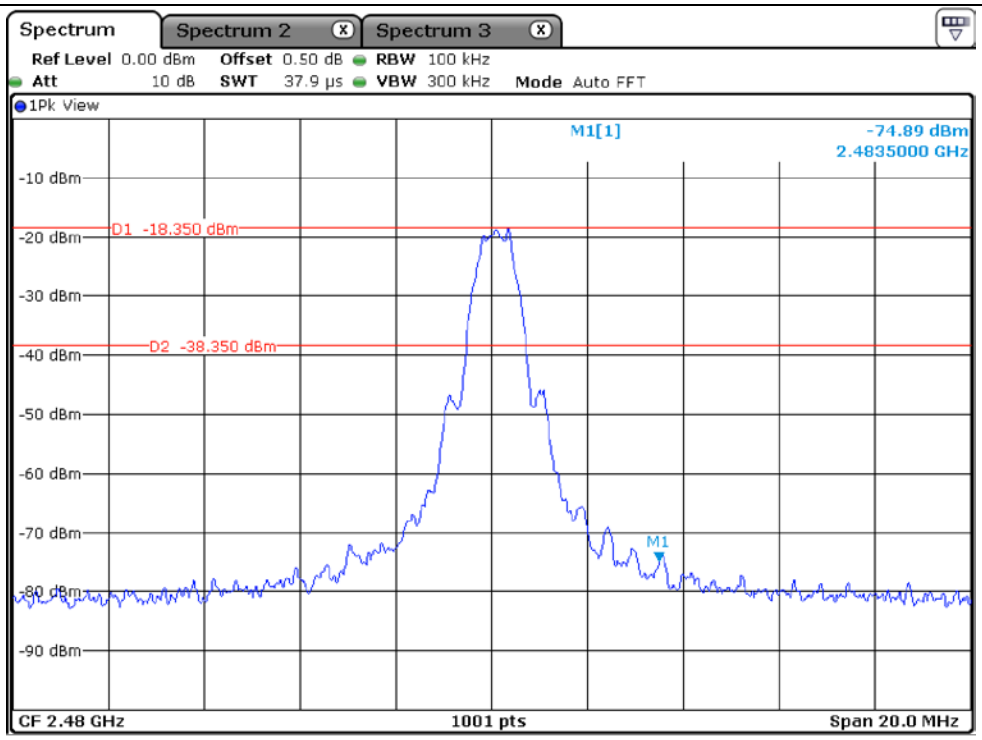


Low Channel



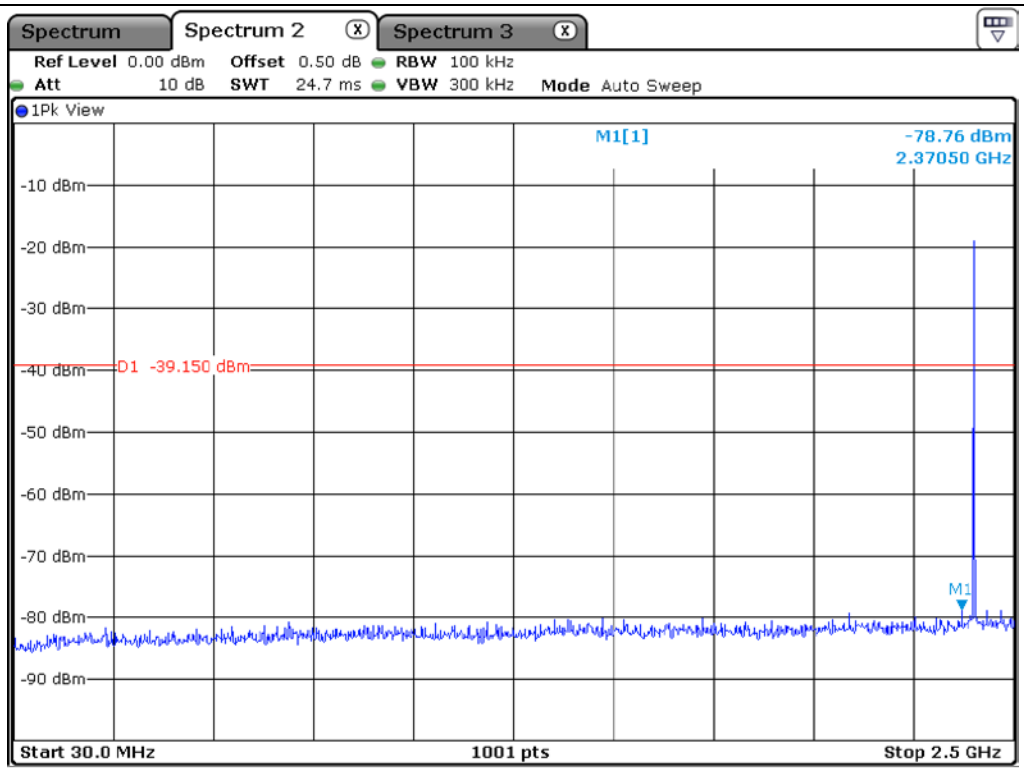
Middle Channel

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

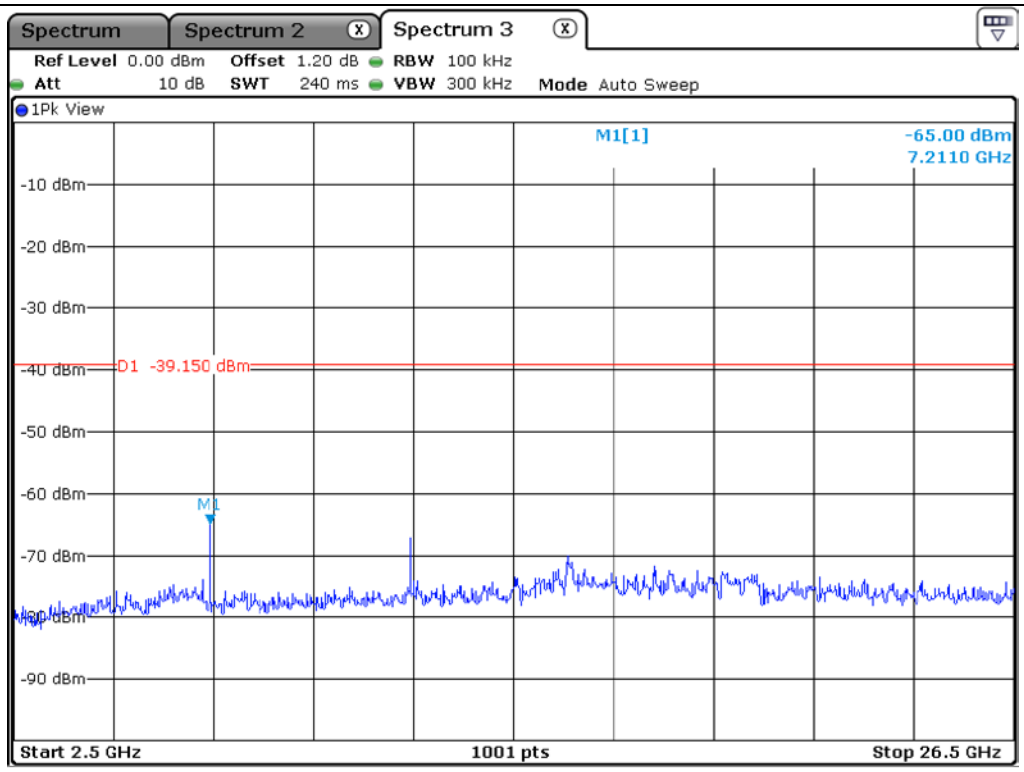


High Channel

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

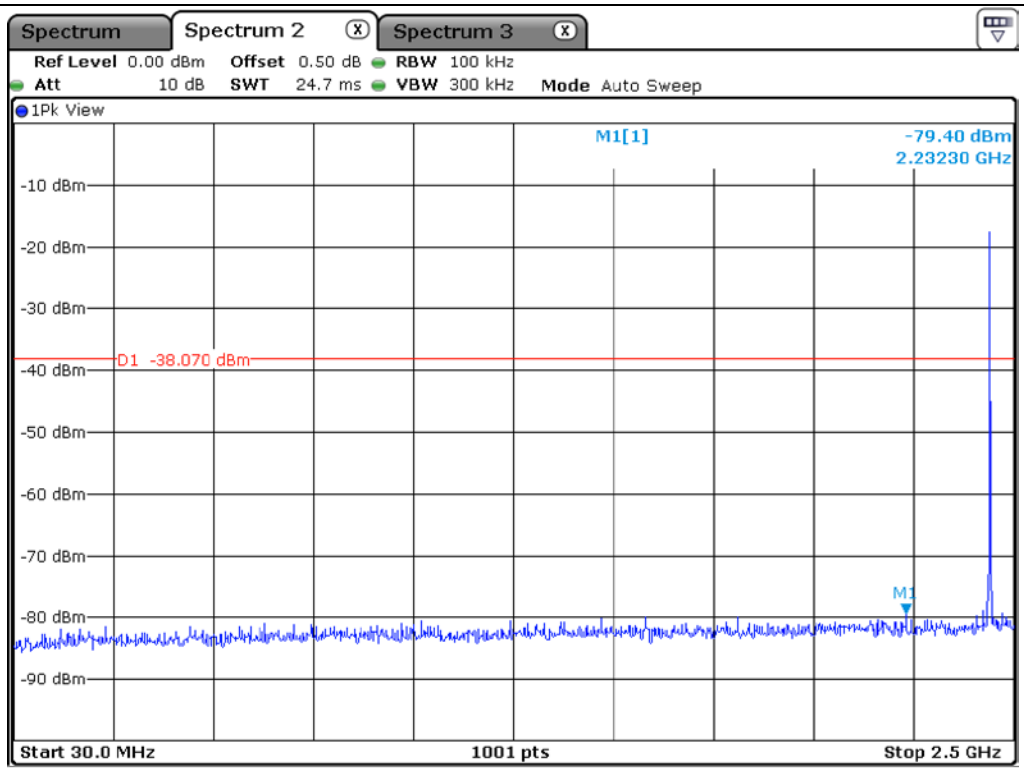


Low Channel

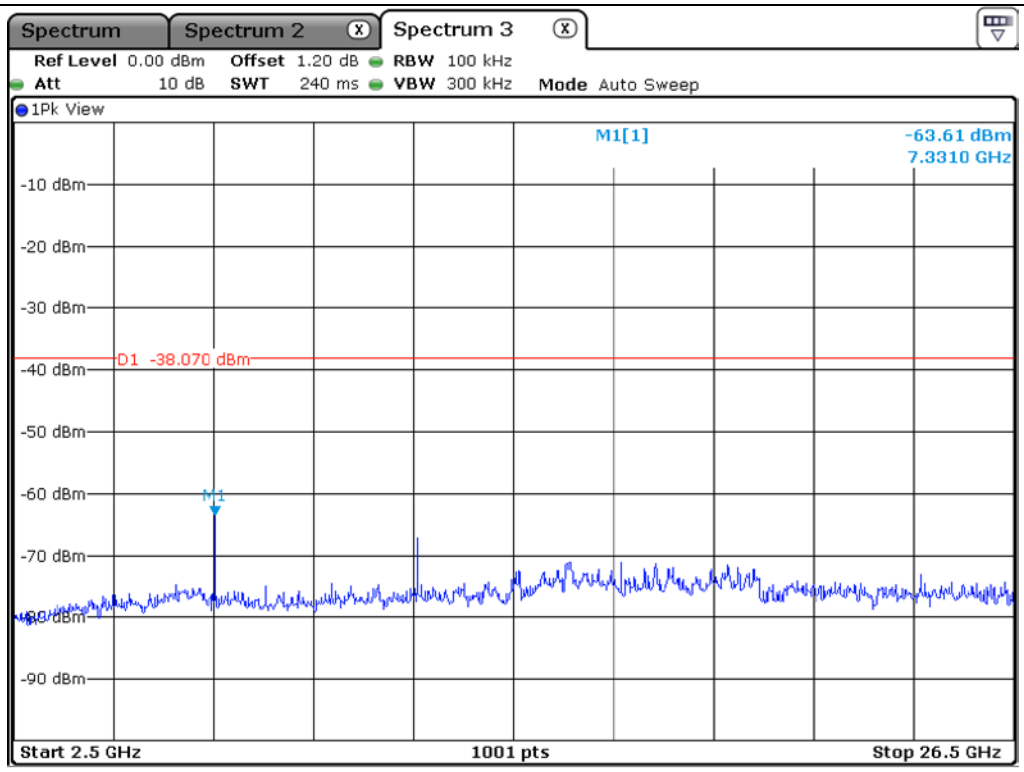


Low Channel

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

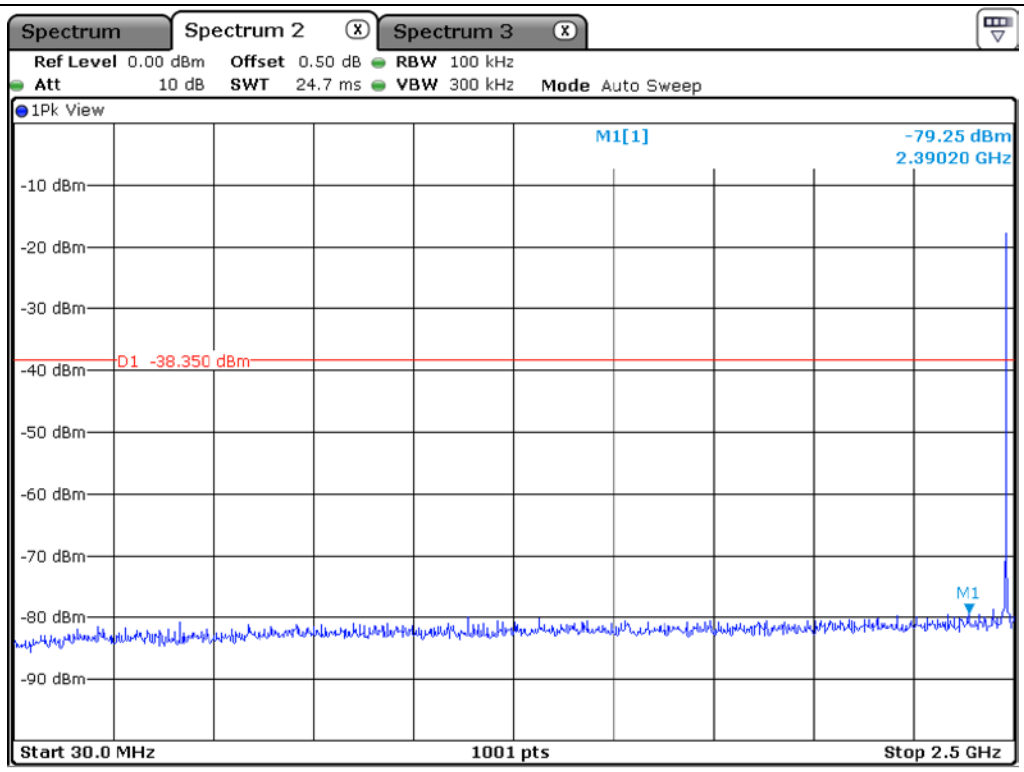


Middle Channel

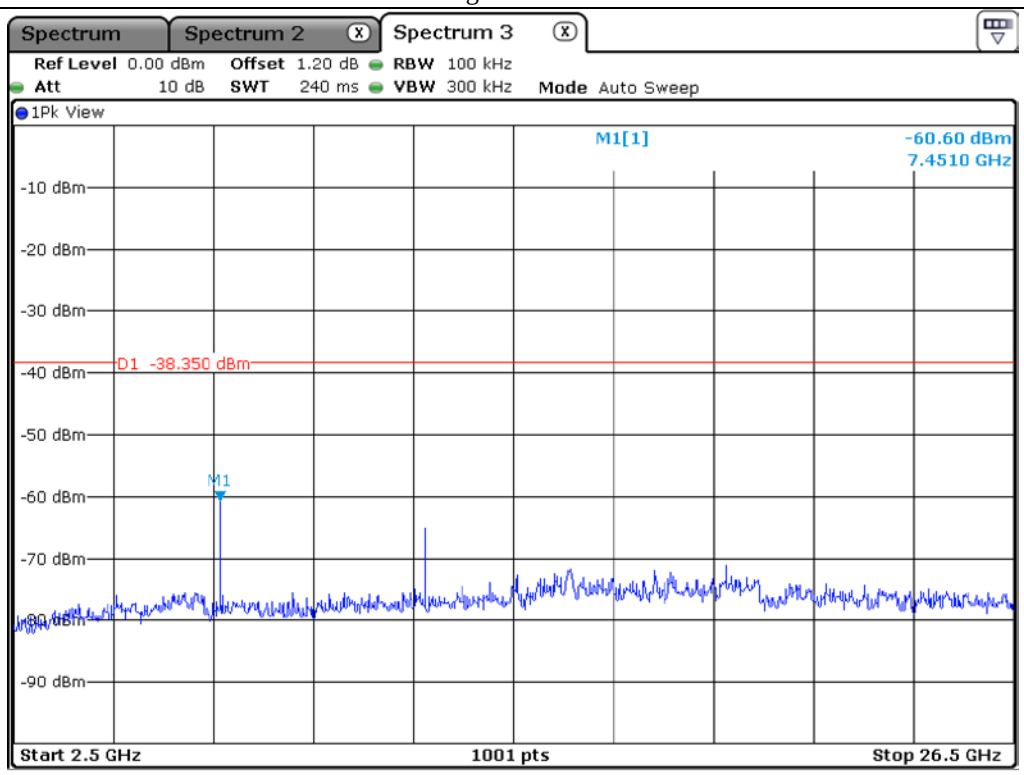


Middle Channel

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



High Channel



High 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)

9.6 Test data for radiated emission

9.6.1 Radiated Emission which fall in the Restricted Band

-. Test Date : July 08, 2020 ~ July 13, 2020

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

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

-. Measurement distance : 3 m

-. Duty Cycle : 62.62 %

-. Result : PASSED

Frequency (MHz)	Reading (dBµV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	C.F (dB)	Total (dBµV/m)	Limits (dBµV/m)	Margin (dB)
Test Data for Low Channel									
2 318.112	18.21	Peak	H	26.94	9.20	-	54.35	74.00	19.65
2 349.121	7.30	Average	H	26.94	9.20	2.03	45.47	54.00	8.53
2 340.809	18.49	Peak	V	26.94	9.20	-	54.63	74.00	19.37
2 339.850	7.64	Average	V	26.94	9.20	2.03	45.81	54.00	8.19
Test Data for High Channel									
2 483.508	21.93	Peak	H	27.47	9.49	-	58.89	74.00	15.11
2 490.745	9.83	Average	H	27.47	9.49	2.03	48.82	54.00	5.18
2 483.508	22.21	Peak	V	27.47	9.49	-	59.17	74.00	14.83
2 483.986	10.02	Average	V	27.47	9.49	2.03	49.01	54.00	4.99

Tabulated test data for Restricted Band

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

Margin (dB) = Limits (dBµV/m) - Total Level (dBµV/m)

Total Level = Reading + Antenna Factor + Cable Loss + Correction Factor

Tested by: Hyung-Kwon, Oh / Manager

It should not be reproduced except in full, without the written approval of ONETECH Corp.

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

9.6.2 Spurious & Harmonic Radiated Emission

-. Test Date : July 08, 2020 ~ July 13, 2020

-. Resolution bandwidth : 1 MHz for Peak and Average Mode for the emissions fall in restricted band,
1 MHz for Peak Mode for the emissions outside restricted band

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

-. Frequency range : 1 GHz ~ 26.5 GHz

-. Measurement distance : 3 m

-. Duty Cycle : 62.62 %

-. Result : PASSED

Frequency (GHz)	Reading (dBµV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	C.F (dB)	Total (dBµV/m)	Limits (dBµV/m)	Margin (dB)
Test Data for Low Channel									
4 804.00	21.26	Peak	H	28.84	10.31	-	60.41	74.00	13.59
4 804.00	9.19	Average	H	28.84	10.31	2.03	50.37	54.00	3.63
4 804.00	21.10	Peak	V	28.84	10.31	-	60.25	74.00	13.75
4 804.00	9.36	Average	V	28.84	10.31	2.03	50.54	54.00	3.46
Test Data for Middle Channel									
4 880.00	21.34	Peak	H	28.01	10.43	-	59.78	74.00	14.22
4 880.00	9.26	Average	H	28.01	10.43	2.03	49.73	54.00	4.27
4 880.00	21.22	Peak	V	28.01	10.43	-	59.66	74.00	14.34
4 880.00	9.48	Average	V	28.01	10.43	2.03	49.95	54.00	4.05
Test Data for High Channel									
4 960.00	21.49	Peak	H	29.15	10.81	-	61.45	74.00	12.55
4 960.00	9.12	Average	H	29.15	10.81	2.03	51.11	54.00	2.89
4 960.00	21.37	Peak	V	29.15	10.81	-	61.33	74.00	12.67
4 960.00	9.07	Average	V	29.15	10.81	2.03	51.06	54.00	2.94

Tabulated test data for Restricted Band

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

Margin (dB) = Limits (dBµV/m) - Total Level (dBµV/m)

Total Level = Reading + Antenna Factor + Cable Loss + Correction Factor

Tested by: Hyung-Kwon, Oh / Manager

It should not be reproduced except in full, without the written approval of ONETECH Corp.

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

10. PEAK POWER SPECTRAL DENSITY

10.1 Operating environment

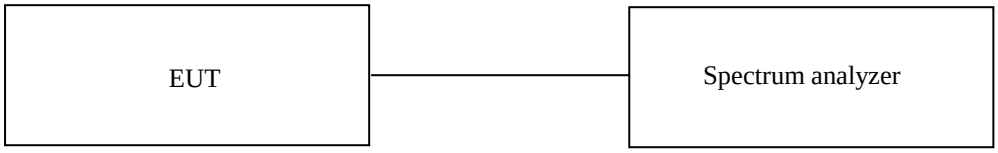
Temperature : 23 °C

Relative humidity : 45 % R.H.

10.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer.

The resolution bandwidth is set to 3 kHz ≤ RBW ≤100 kHz, the video bandwidth is set to 3 times the resolution bandwidth.



10.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ -	FSV40	Rohde & Schwarz	Signal Analyzer	101009	Feb. 21, 2020 (1Y)

All test equipment used is calibrated on a regular basis.

It should not be reproduced except in full, without the written approval of ONETECH Corp.

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

10.4 Test data

-. Test Date : July 08, 2020 ~ July 13, 2020

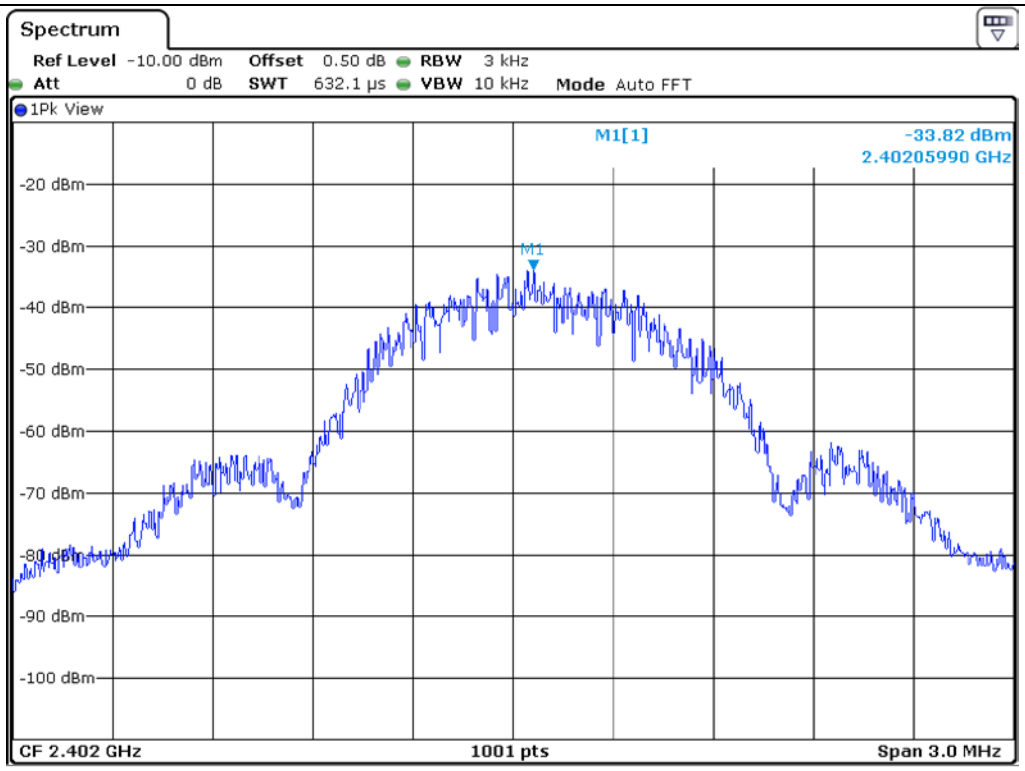
-. Test Result : Pass

-. Operating Condition : Continuous transmitting mode

CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
Low	2 402.00	-33.82	8.00	41.82
Middle	2 440.00	-32.92	8.00	40.92
High	2 480.00	-33.42	8.00	41.42

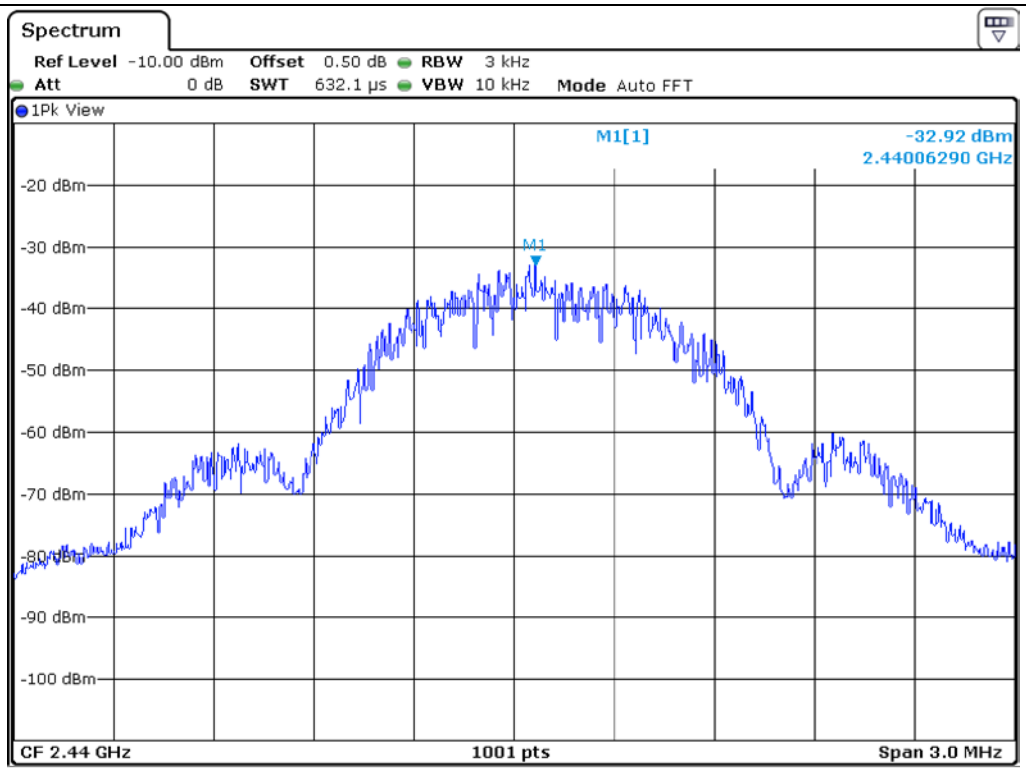
Remark. Margin = Limit – Measured value

Tested by: Hyung-Kwon, Oh / Manager

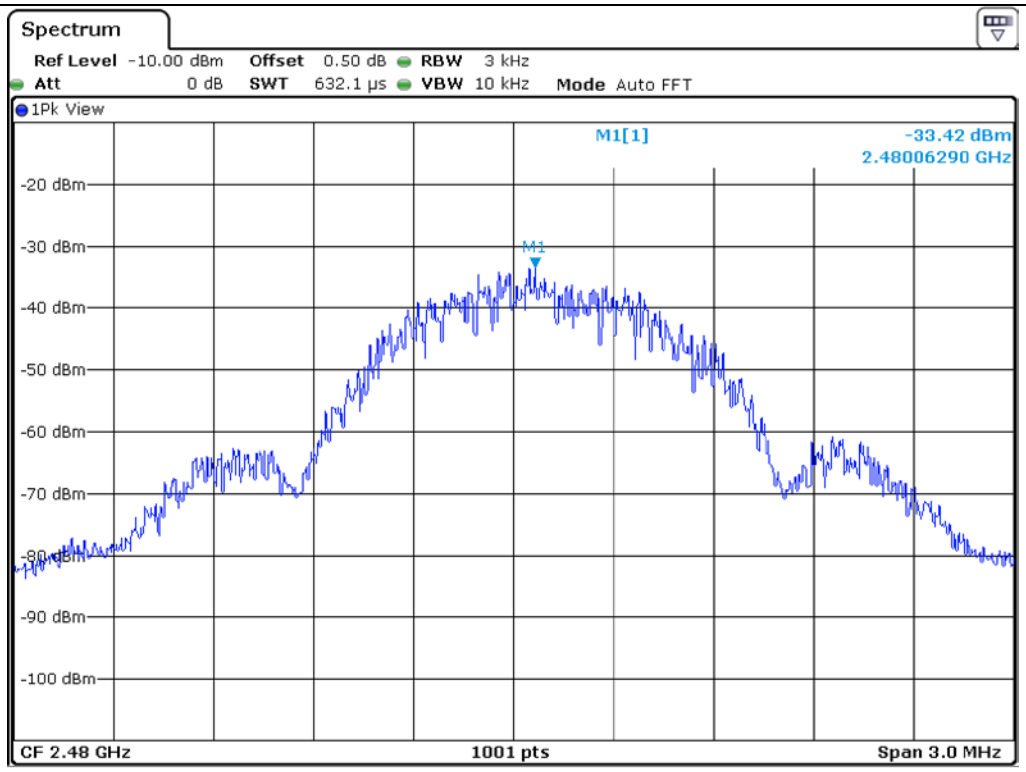


Low Channel

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



High 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)

11. RADIATED EMISSION TEST

11.1 Operating environment

Temperature	:	23 °C
Relative humidity	:	45 % R.H.

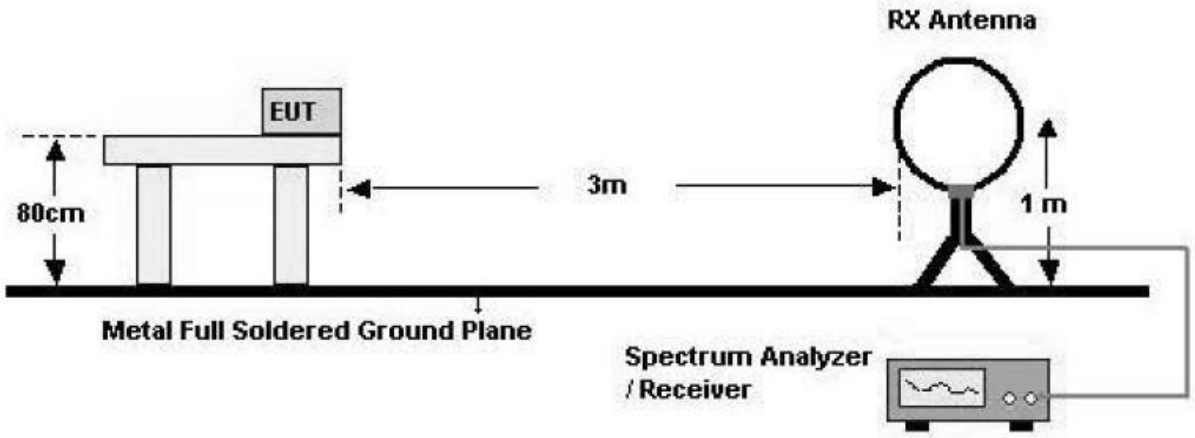
11.2 Test set-up

The radiated emissions measurements were on the 10 m semi anechoic chamber. The EUT and other support equipment were placed on a non-conductive turntable above the ground plane. The interconnecting cables from outside test site were inserted into ferrite clamps at the point where the cables reach the turntable.

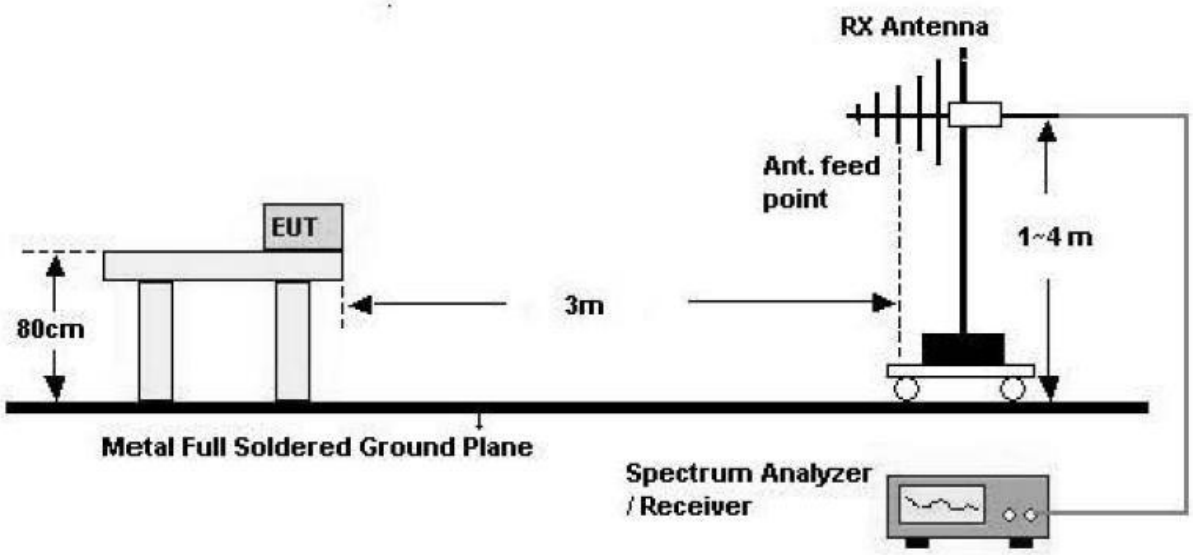
The frequency spectrum from 30 MHz to 26.5 GHz was scanned and emission levels maximized at each frequency recorded. The system was rotated 360°, and the antenna was varied in height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for both horizontal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

- Test Configuration

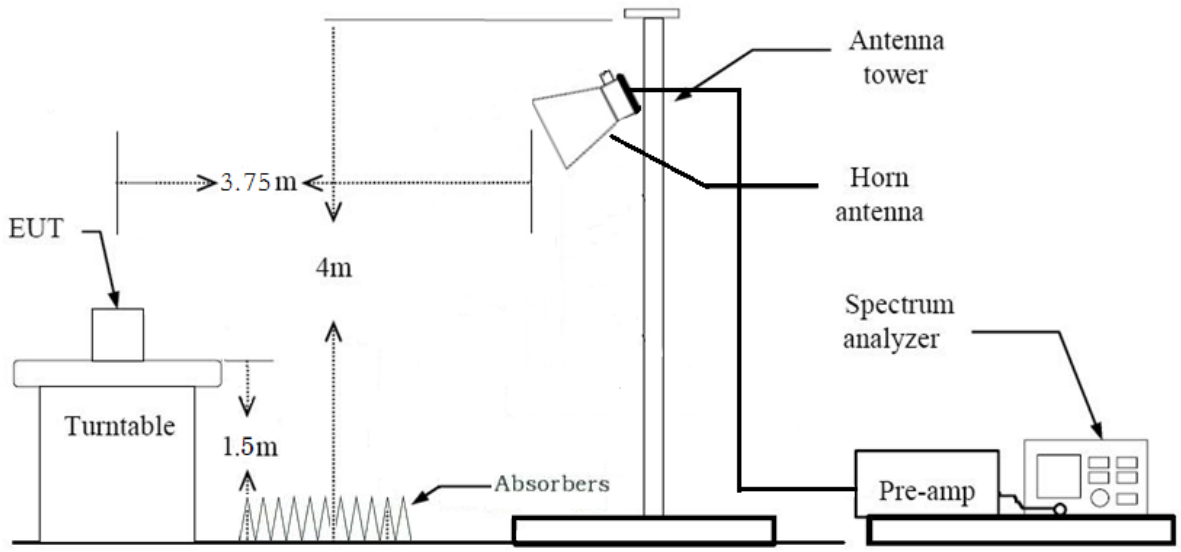
1. Below 30 MHz



2. 30 MHz - 1 GHz



3. Above 1 GHz



11.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ -	FSV40	Rohde & Schwarz	Signal Analyzer	101009	Feb. 21, 2020 (1Y)
■ -	ESW	Rohde & Schwarz	EMI Test Receiver	101851	Aug. 07, 2019 (1Y)
■ -	310N	Sonoma Instrument	Pre-Amplifier	312544	Mar. 16, 2020 (1Y)
■ -	BBV 9718 B	Schwarzbeck	Broadband Preamplifier	00009	Mar. 16, 2020 (1Y)
■ -	SCU40A	Rohde & Schwarz	Signal Conditioning unit	100436	Feb. 20, 2020 (1Y)
■ -	SCU18	Rohde & Schwarz	Signal Conditioning unit	102266	Jul. 24, 2019(1Y)
■ -	DT3000-3t	Innco System	Turn Table	DT3000/093	N/A
■ -	MA-4000XPET	Innco System	Antenna Master	MA4000/509	N/A
■ -	VULB9163	Schwarzbeck	TRILOG Broadband Antenna	777	Apr. 08, 2020 (2Y)
■ -	BBHA9120D	Schwarzbeck	Horn Antenna	9120D-1366	Jul. 16, 2019 (1Y)
■ -	BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170178	Jan. 07, 2020(1Y)

All test equipment used is calibrated on a regular basis.

It should not be reproduced except in full, without the written approval of ONETECH Corp.

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

11.4 Test data

11.4.1 Test data for 30 MHz ~ 960 MHz

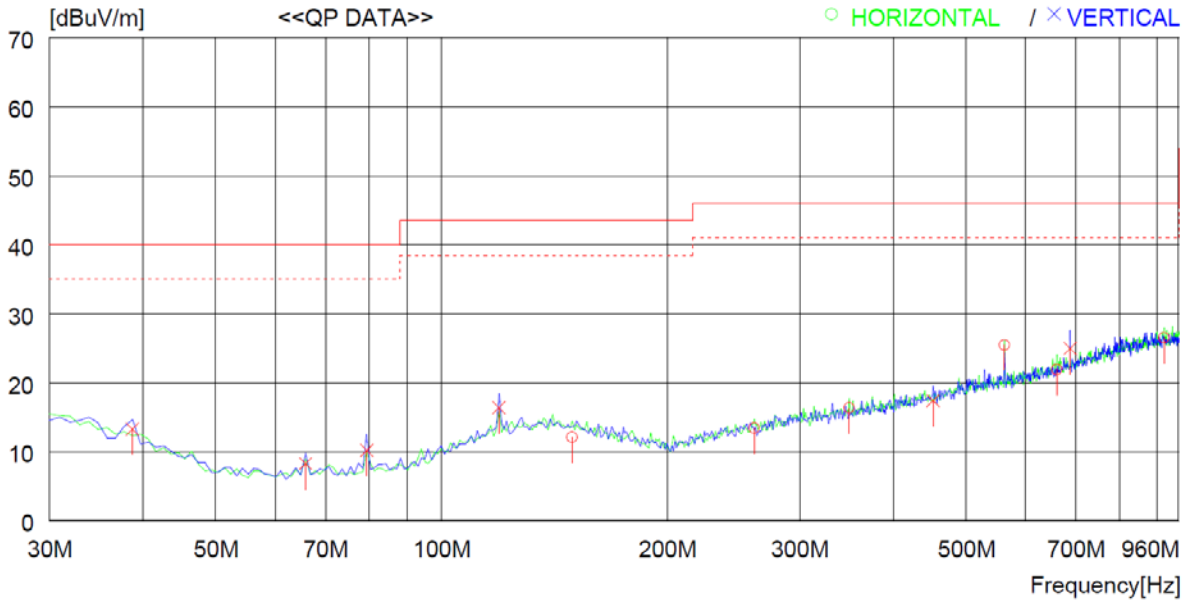
Humidity Level : 45 % R.H. Temperature: 23 °C

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

Result : PASSED

EUT : Controller Date: July 08, 2020 ~ July 13, 2020

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



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	149.310	23.3	18.9	2.4	32.5	12.1	43.5	31.4	100	160
2	260.860	24.8	17.9	3.1	32.4	13.4	46.0	32.6	400	246
3	349.130	25.1	20.3	3.5	32.5	16.4	46.0	29.6	100	68
4	562.529	28.7	24.9	4.5	32.6	25.5	46.0	20.5	100	45
5	660.496	23.1	26.3	5.1	32.6	21.9	46.0	24.1	300	0
6	918.508	22.9	29.1	6.0	31.5	26.5	46.0	19.5	200	237
----- Vertical ------										
7	38.730	25.7	18.7	1.4	32.5	13.3	40.0	26.7	400	0
8	65.890	20.8	18.3	1.7	32.5	8.3	40.0	31.7	400	192
9	79.470	25.4	15.4	1.9	32.5	10.2	40.0	29.8	400	0
10	119.240	30.1	16.6	2.2	32.5	16.4	43.5	27.1	400	259
11	451.951	22.8	23.0	4.0	32.4	17.4	46.0	28.6	100	249
12	687.655	25.7	26.7	5.2	32.6	25.0	46.0	21.0	400	356

Tested by: Hyung-Kwon, Oh / Manager

It should not be reproduced except in full, without the written approval of ONETECH Corp.

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

11.4.2 Test data for Below 30 MHz

-. Test Date : July 08, 2020 ~ July 13, 2020

-. 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

Frequency (MHz)	Reading (dBµV)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss	Emission Level(dBµV/m)	Limits (dBµV/m)	Margin (dB)
Emission from the EUT more than 20 dB below the limit in each frequency range.									

11.4.3 Test data for above 1 GHz

-. Test Date : July 08, 2020 ~ July 13, 2020

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

-. Video bandwidth : 1 MHz for Peak Mode, 10 Hz for Average Mode

-. Frequency range : 1 GHz ~ 26.5 GHz

-. Measurement distance : 3 m

-. Operating mode : Transmitting mode

Frequency (MHz)	Reading (dBµV)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss	Emission Level(dBµV/m)	Limits (dBµV/m)	Margin (dB)
Emission from the EUT more than 20 dB below the limit in each frequency range.									

Tested by: Hyung-Kwon, Oh / Manager

12. CONDUCTED EMISSION TEST

12.1 Operating environment

Temperature : 24 °C

Relative humidity : 43 % R.H.

12.2 Test set-up

The EUT was placed on a wooden table, 0.8 m height above the floor. Power was fed to the EUT through a 50 Ω / 50 μH + 5 Ω Artificial Mains Network (AMN). The ground plane was electrically bonded to the reference ground system and all power lines were filtered from ambient.

12.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal. (Interval)
■ -	ESCI	Rohde & Schwarz	Test Receiver	101012	Oct. 22, 2019 (1Y)
■ -	NSLK8128	Schwarzbeck	AMN(LISN)	8128-216	Mar. 16, 2020 (1Y)
■ -	NNLK 8121	Schwarzbeck	AMN(LISN)	8121-804	Oct. 21, 2019 (1Y)
■ -	ESH3Z2	Rohde & Schwarz	Pulse Limiter	100655	Mar. 16, 2020 (1Y)

All test equipment used is calibrated on a regular basis.

It should not be reproduced except in full, without the written approval of ONETECH Corp.

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

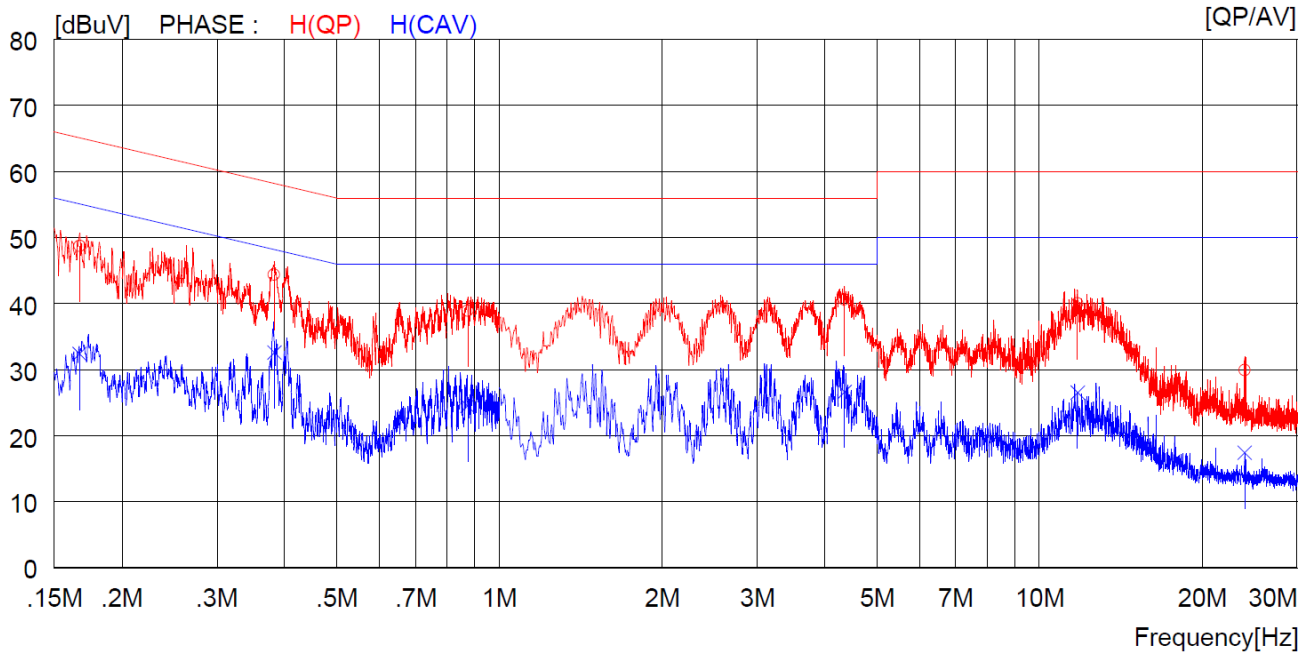
12.4 Test data

-. Test Date : July 08, 2020 ~ July 13, 2020

-. Resolution bandwidth : 9 kHz

-. Frequency range : 0.15 MHz ~ 30 MHz

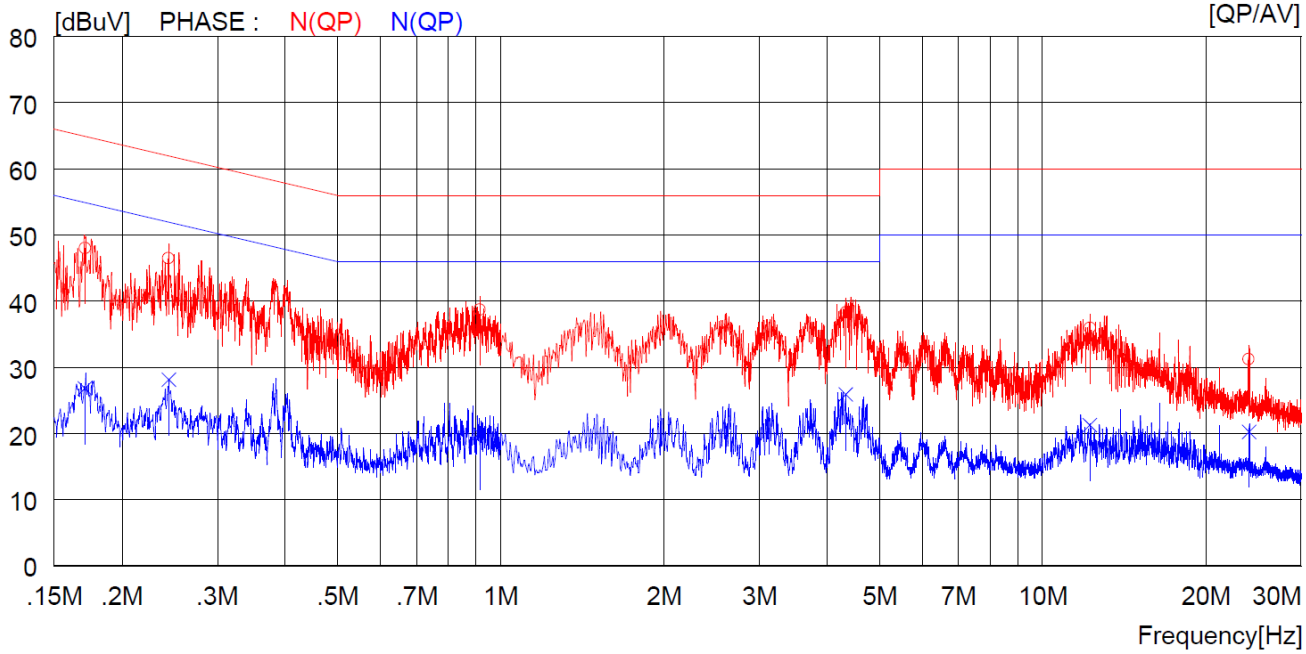
-. Tested Line : HOT LINE



NO	FREQ [MHz]	READING QP [dBuV]	READING AV [dBuV]	C.FACTOR [dB]	RESULT QP [dBuV]	RESULT AV [dBuV]	LIMIT QP [dBuV]	LIMIT AV [dBuV]	MARGIN QP [dBuV]	MARGIN AV [dBuV]	PHASE
1	0.16700	38.7	----	10.0	48.7	----	65.1	----	16.4	----	H(QP)
2	0.38300	34.5	----	9.9	44.4	----	58.2	----	13.8	----	H(QP)
3	0.87300	28.9	----	10.0	38.9	----	56.0	----	17.1	----	H(QP)
4	4.35600	30.5	----	10.1	40.6	----	56.0	----	15.4	----	H(QP)
5	11.76000	29.8	----	10.2	40.0	----	60.0	----	20.0	----	H(QP)
6	23.98000	19.4	----	10.5	29.9	----	60.0	----	30.1	----	H(QP)
7	0.16700	----	22.4	10.0	----	32.4	----	55.1	----	22.7	H(CAV)
8	0.38300	----	22.7	9.9	----	32.6	----	48.2	----	15.6	H(CAV)
9	0.87300	----	14.5	10.0	----	24.5	----	46.0	----	21.5	H(CAV)
10	4.35600	----	16.5	10.1	----	26.6	----	46.0	----	19.4	H(CAV)
11	11.76000	----	16.3	10.2	----	26.5	----	50.0	----	23.5	H(CAV)
12	23.98000	----	6.9	10.5	----	17.4	----	50.0	----	32.6	H(CAV)

It should not be reproduced except in full, without the written approval of ONETECH Corp. OTC-TRF-RF-001(0)

-. Tested Line : NEUTRAL LINE



NO	FREQ [MHz]	READING QP [dBuV]	READING AV [dBuV]	C.FACTOR [dB]	RESULT QP [dBuV]	RESULT AV [dBuV]	LIMIT QP [dBuV]	LIMIT AV [dBuV]	MARGIN QP [dBuV]	MARGIN AV [dBuV]	PHASE
1	0.17100	38.0	----	10.0	48.0	----	64.9	----	16.9	----	N(QP)
2	0.24400	36.6	----	9.9	46.5	----	62.0	----	15.5	----	N(QP)
3	0.91400	28.7	----	10.0	38.7	----	56.0	----	17.3	----	N(QP)
4	4.33200	28.2	----	10.1	38.3	----	56.0	----	17.7	----	N(QP)
5	12.23000	25.8	----	10.2	36.0	----	60.0	----	24.0	----	N(QP)
6	24.03000	20.7	----	10.5	31.2	----	60.0	----	28.8	----	N(QP)
7	0.17100	----	16.8	10.0	----	26.8	----	54.9	----	28.1	N(CAV)
8	0.24400	----	18.2	9.9	----	28.1	----	52.0	----	23.9	N(CAV)
9	0.91400	----	10.0	10.0	----	20.0	----	46.0	----	26.0	N(CAV)
10	4.33200	----	15.8	10.1	----	25.9	----	46.0	----	20.1	N(CAV)
11	12.23000	----	11.1	10.2	----	21.3	----	50.0	----	28.7	N(CAV)
12	24.03000	----	9.8	10.5	----	20.3	----	50.0	----	29.7	N(CAV)

Remark: Margin (dB) = Limit – Level (Result)

The emission level in above table is included the transducer factor that means insertion loss (LISN), cable loss and attenuator.

Tested by: Hyung-Kwon, Oh / Manager

It should not be reproduced except in full, without the written approval of ONETECH Corp.

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