

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

Test Report No. : OT-203-RWD-051

AGR No. : A201A-244

Applicant : Remote Solution Co., Ltd.

Address : 92, Chogokri, Nammyun, Kimchon City, Kyungbuk, 740-871, South Korea

Manufacturer : Remote Solution Co., Ltd.

Address : 326-14, Apo-daero, Nam-myeon, Gimcheon-si, Gyeongsangbuk-do, Republic of Korea

Type of Equipment : Zigbee Module

FCC ID. : TX4MC85A00

Model Name : MC85A00

Multiple Model Name : MC85B00

Serial number : N/A

Total page of Report : 37 pages (including this page)

Date of Incoming : February 24, 2020

Date of issue : March 13, 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.

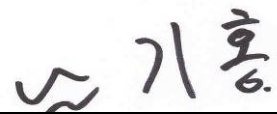
It is not a generally valid assessment of the features of the respective products of the mass-production.

Reviewed by:



Tae-Ho, Kim / Senior Manager
ONETECH Corp.

Approved by:



Ki-Hong, Nam / General Manager
ONETECH Corp.

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 | 8 |
| 5.4 CONFIGURATION OF TEST SYSTEM..... | 9 |
| 6. PRELIMINARY TEST | 10 |
| 6.1 AC POWER LINE CONDUCTED EMISSIONS TESTS..... | 10 |
| 6.2 GENERAL RADIATED EMISSIONS TESTS | 10 |
| 7. MINIMUM 6 DB BANDWIDTH..... | 11 |
| 7.1 OPERATING ENVIRONMENT | 11 |
| 7.2 TEST SET-UP | 11 |
| 7.3 TEST EQUIPMENT USED..... | 11 |
| 7.4 TEST DATA..... | 12 |
| 8. MAXIMUM PEAK OUTPUT POWER..... | 14 |
| 8.1 OPERATING ENVIRONMENT | 14 |
| 8.2 TEST SET-UP | 14 |
| 8.3 TEST EQUIPMENT USED..... | 14 |
| 8.4 TEST DATA..... | 15 |
| 9. 100 KHZ BANDWIDTH OUTSIDE THE FREQUENCY BAND..... | 17 |
| 9.1 OPERATING ENVIRONMENT | 17 |

| | |
|--|----|
| 9.2 TEST SET-UP FOR CONDUCTED MEASUREMENT | 17 |
| 9.3 TEST SET-UP FOR RADIATED MEASUREMENT..... | 17 |
| 9.4 TEST EQUIPMENT USED..... | 17 |
| 9.5 TEST DATA FOR CONDUCTED EMISSION | 18 |
| 9.6 TEST DATA FOR RADIATED EMISSION | 23 |
| 9.6.1 Radiated Emission which fall in the Restricted Band..... | 23 |
| 9.6.2 Spurious & Harmonic Radiated Emission..... | 24 |
| 9.6.3 Radiated Emission which fall in the Band Edge | 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..... | 29 |
| 11.4 TEST DATA FOR 30 MHZ ~ 1 GHZ..... | 30 |
| 11.4.1 Test data for MC85A00 (Basic Model) | 30 |
| 11.4.2 Test data for MC85B00 (Multiple Model)..... | 33 |
| 11.5 TEST DATA FOR BELOW 30 MHZ | 34 |
| 11.6 TEST DATA FOR ABOVE 1 GHZ | 34 |
| 12. CONDUCTED EMISSION TEST..... | 35 |
| 12.1 OPERATING ENVIRONMENT | 35 |
| 12.2 TEST SET-UP | 35 |
| 12.3 TEST EQUIPMENT USED..... | 35 |
| 12.4 TEST DATA..... | 36 |

Revision History

| Rev. No. | Issue Report No. | Issued Date | Revisions | Section Affected |
|----------|------------------|-------------------|----------------------|---------------------------------------|
| 0 | W17NR-D082 | November 30, 2017 | Initial Release | All |
| 1 | OT-203-RWD-051 | March 13, 2020 | Added multiple model | All and 11. RADIATED EMISSION TEST |
| | | | | |

1. VERIFICATION OF COMPLIANCE

Applicant : Remote Solution Co., Ltd.
 Address : 92, Chogokri, Nammyun, Kimchon City, Kyungbuk, 740-871, South Korea
 Contact Person : Shin Sang Hyun / Researcher
 Telephone No. : +82-54-420-4517
 FCC ID : TX4MC85A00
 Model Name : MC85A00
 Brand Name : -
 Serial Number : N/A
 Date : March 13, 2020

| | |
|--|--------------------------------------|
| EQUIPMENT CLASS | DTS – DIGITAL TRNSMISSION SYSTEM |
| E.U.T. DESCRIPTION | Zigbee Module |
| 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.

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-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

3. GENERAL INFORMATION

3.1 Product Description

The Remote Solution Co., Ltd., Model MC85A00 (referred to as the EUT in this report) is a Zigbee Module. The product specification described herein was obtained from product data sheet or user’s manual.

| | |
|--|---|
| Device Type | Zigbee Module |
| Temperature Range | -40 °C ~ 80 °C |
| Operating Frequency | 2 405 MHz ~ 2 480 MHz |
| RF Output Power | -0.24 dBm |
| Number of Channel | 16 Channel |
| Modulation Type | O-QPSK (Zigbee) |
| Antenna Type | MC85A00(Basic Model): PCB Pattern Antenna |
| | MC85B00(Multiple Model): Omni Antenna |
| Antenna Gain | MC85A00(Basic Model): 2.55 dBi |
| | MC85B00(Multiple Model): -0.04 dBi |
| List of each Osc. or crystal Freq.(Freq. >= 1 MHz) | 32.768 kHz, 24 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 |
|------------|--|-------------------------------------|
| MC85A00 | Basic Model (PCB Pattern Antenna) | <input type="checkbox"/> |
| MC85B00 | These models are identical to the basic model except for the antenna. (Omni Antenna) | <input checked="" type="checkbox"/> |

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

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 | Remote Solution Co., Ltd. | 1BL-3079A | 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 |
|----------------------------|--------------------------------|---------------------|--------------|
| MC85A00 | Remote Solution Co., Ltd. | Zigbee Module (EUT) | - |
| Probook | H.P | Notebook PC | - |
| SmartRF06 Evaluation Board | Texas Instruments Incorporated | Jig board | EUT |

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 2 405 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.

5.4 Configuration of Test System

Line Conducted Test: The EUT was connected to Jig Board and the power of USB was connected to Notebook PC. 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 3 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 Pattern Antenna & Omni 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 Tests, the following operating mode was investigated

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

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 |

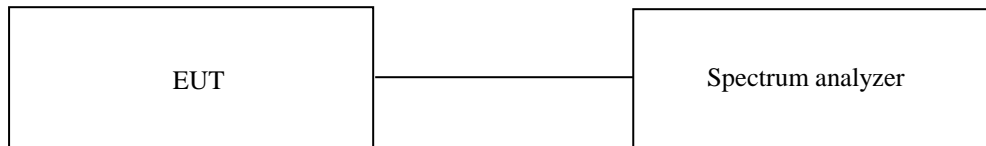
7. MINIMUM 6 dB BANDWIDTH

7.1 Operating environment

Temperature : 24.3 °C
 Relative humidity : 43.9 % 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 | Apr. 05, 2017 (1Y) |

All test equipment used is calibrated on a regular basis.

7.4 Test data

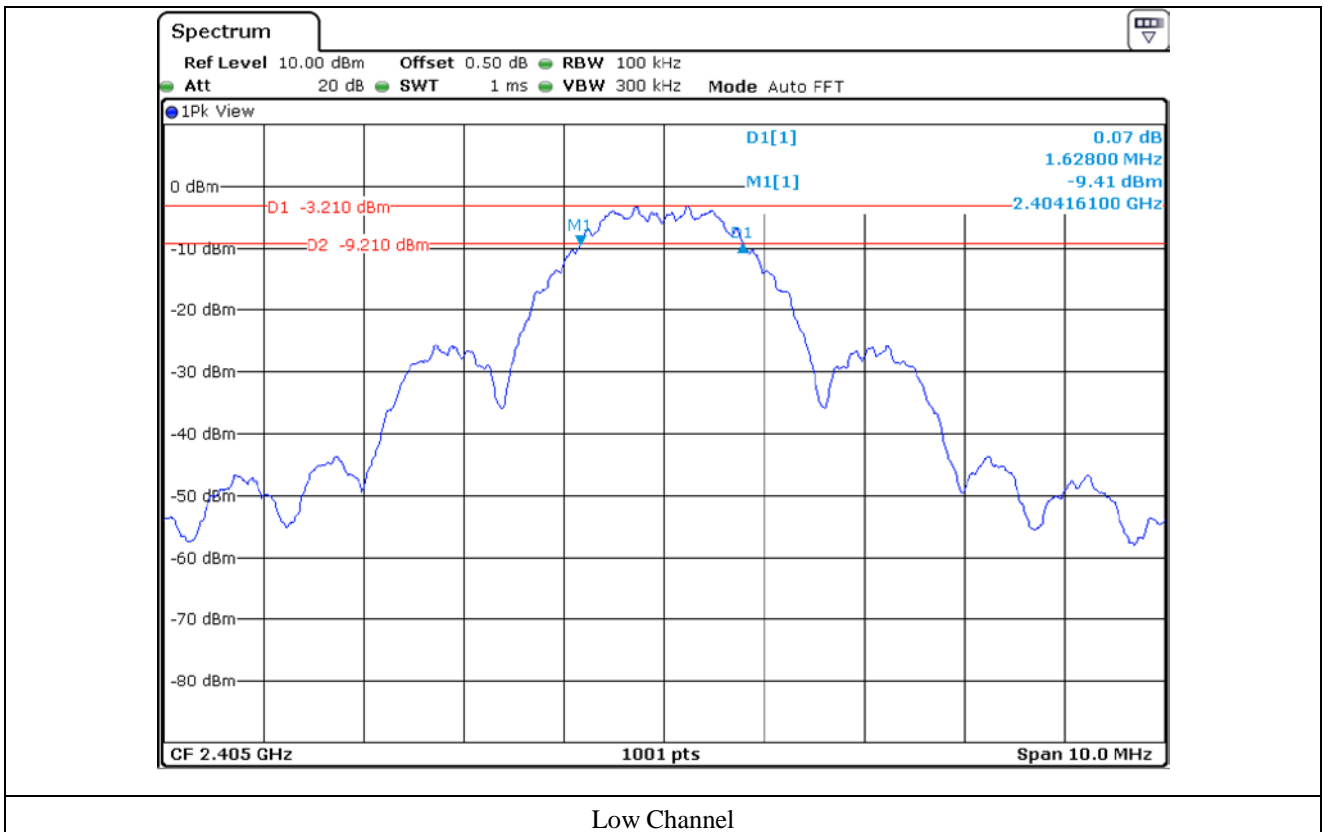
- Test Date : November 22, 2017 ~ November 24, 2017
- Test Result : Pass

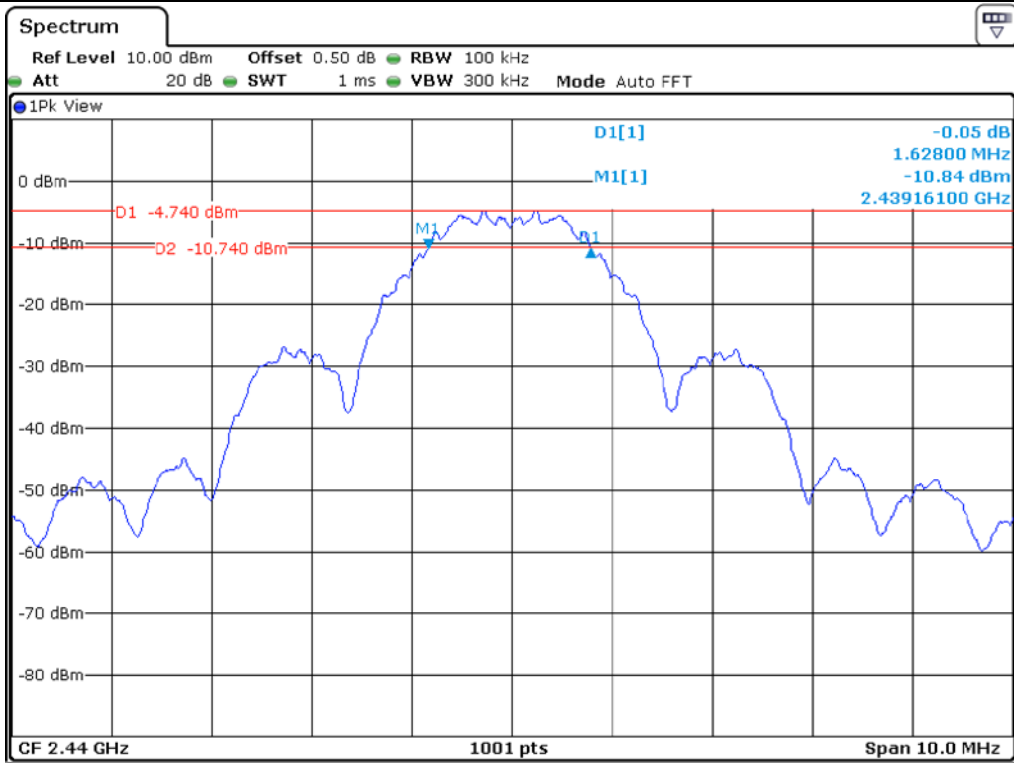
| CHANNEL | FREQUENCY(MHz) | MEASURED VALUE (MHz) | LIMIT (MHz) | MARGIN (MHz) |
|---------|----------------|----------------------|-------------|--------------|
| Low | 2 405.00 | 1.63 | 0.50 | 1.13 |
| Middle | 2 440.00 | 1.63 | 0.50 | 1.13 |
| High | 2 480.00 | 1.62 | 0.50 | 1.12 |

Remark. Margin = Measured Value - Limit

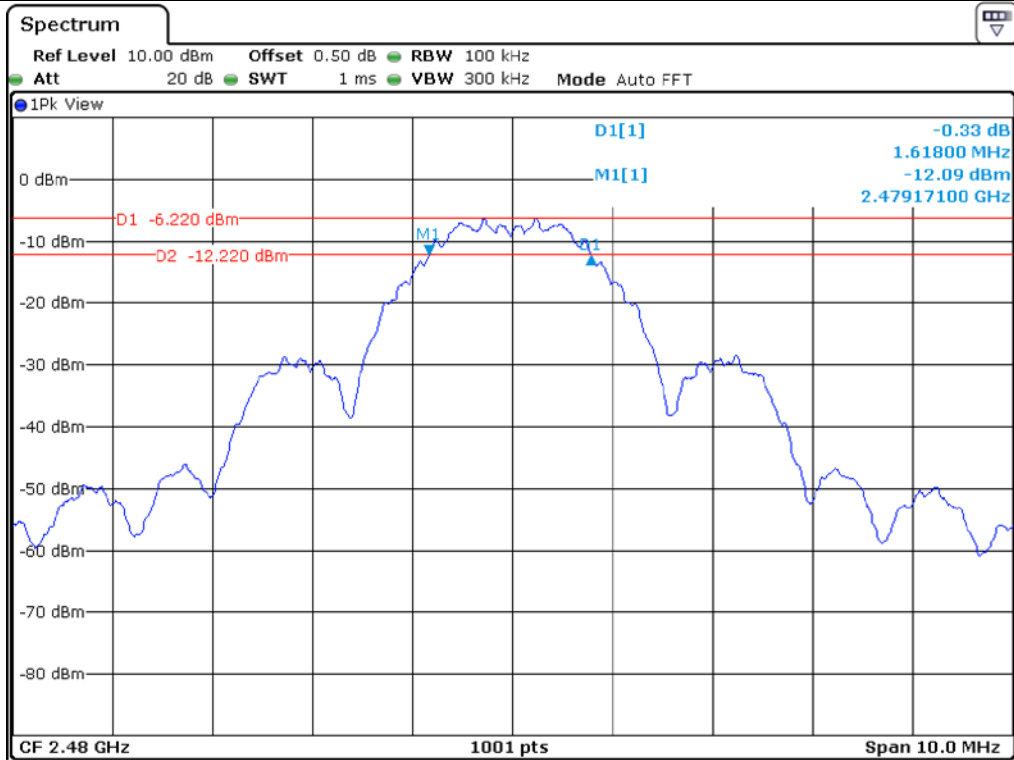


Tested by: Hyung-Kwon, Oh / Assistant Manager





Middle Channel



High Channel

8. MAXIMUM PEAK OUTPUT POWER

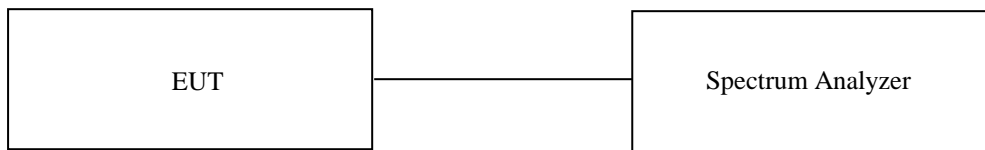
8.1 Operating environment

Temperature : 24.3 °C
 Relative humidity : 43.9 % 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 \geq 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 | Apr. 05, 2017 (1Y) |

All test equipment used is calibrated on a regular basis.

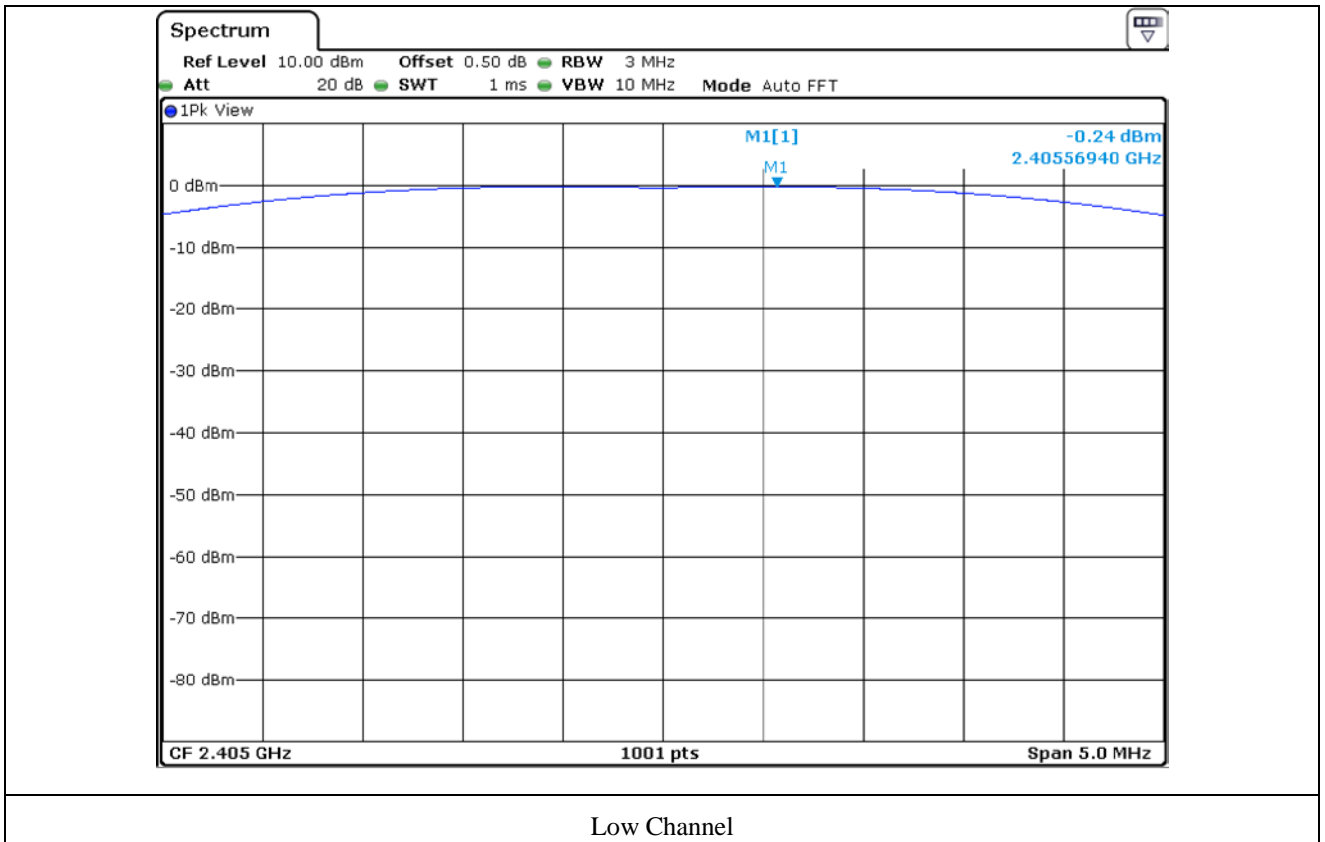
8.4 Test data

- Test Date : November 22, 2017 ~ November 24, 2017
- Test Result : Pass

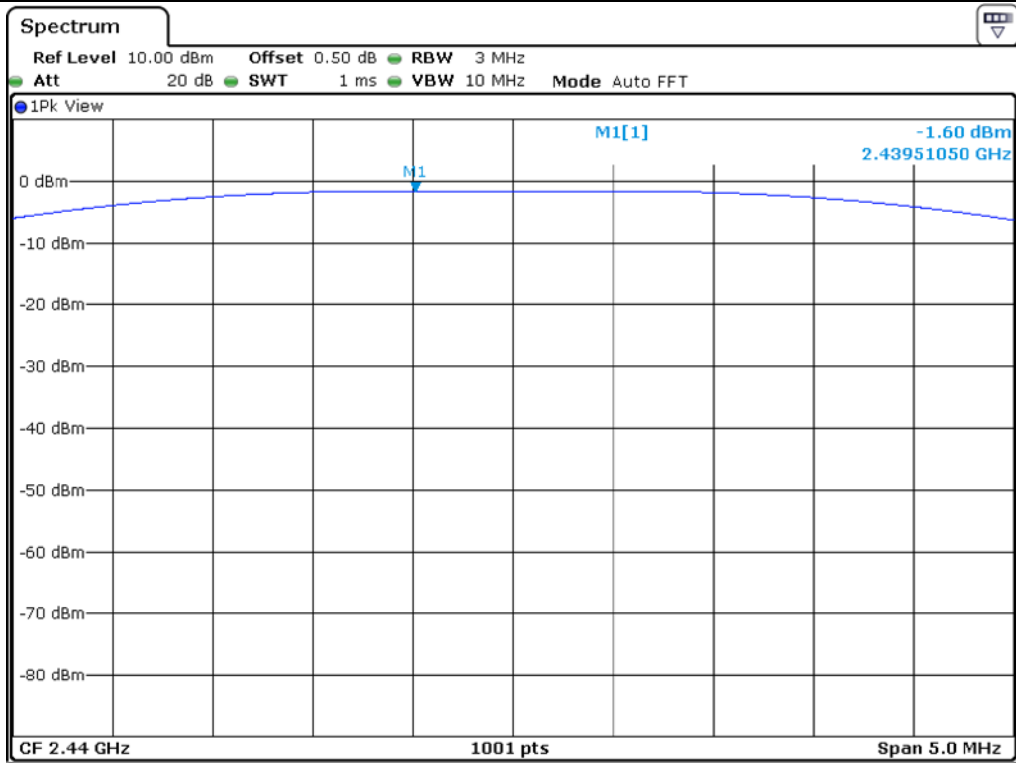
| CHANNEL | FREQUENCY (MHz) | DTS (MHz) | MEASURED VALUE (dBm) | LIMIT (dBm) | MARGIN (dB) |
|---------|-----------------|-----------|----------------------|-------------|-------------|
| LOW | 2 405.00 | 1.63 | -0.24 | 30.00 | 30.24 |
| MIDDLE | 2 440.00 | 1.63 | -1.60 | 30.00 | 31.60 |
| HIGH | 2 480.00 | 1.62 | -2.91 | 30.00 | 32.91 |

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

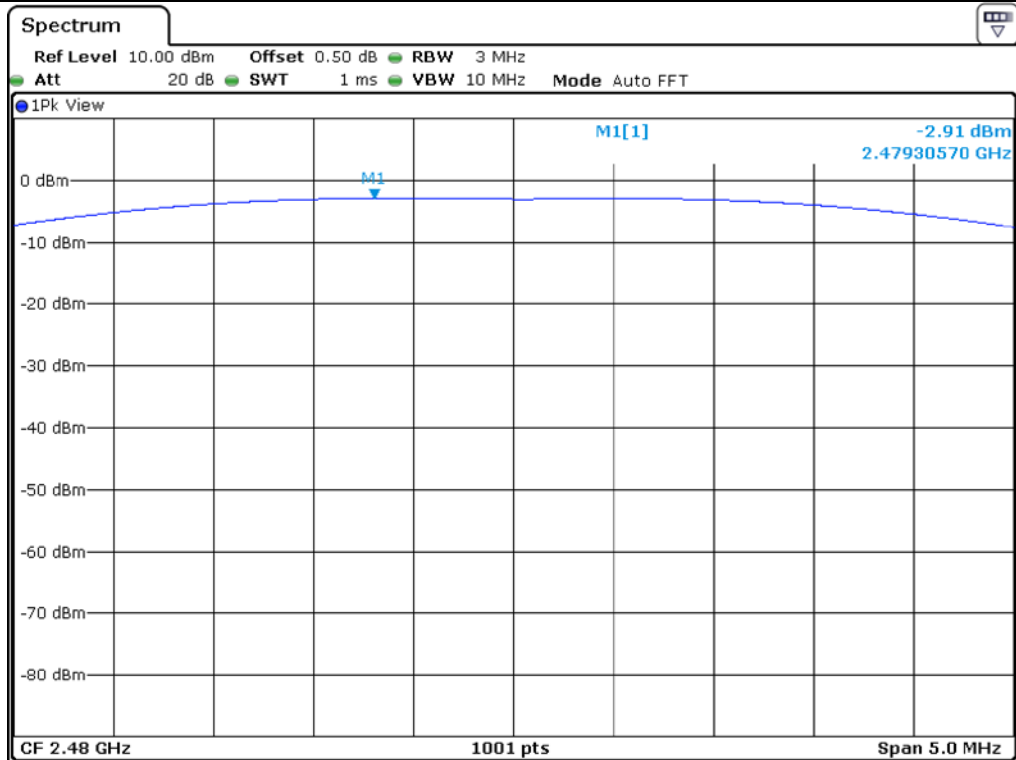
Tested by: Hyung-Kwon, Oh / Assistant Manager



Low Channel



Middle Channel



High Channel

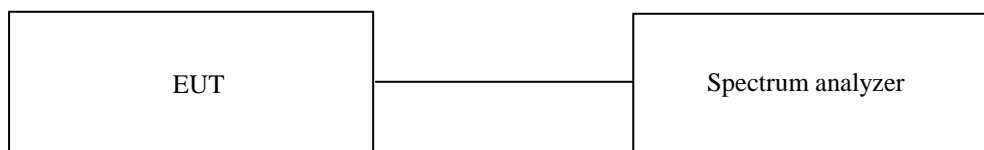
9. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

9.1 Operating environment

Temperature : 24.3 °C
 Relative humidity : 43.9 % 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 3 m semi anechoic chamber. The EUT was placed on turntable approximately 1.5 m above the ground plane.

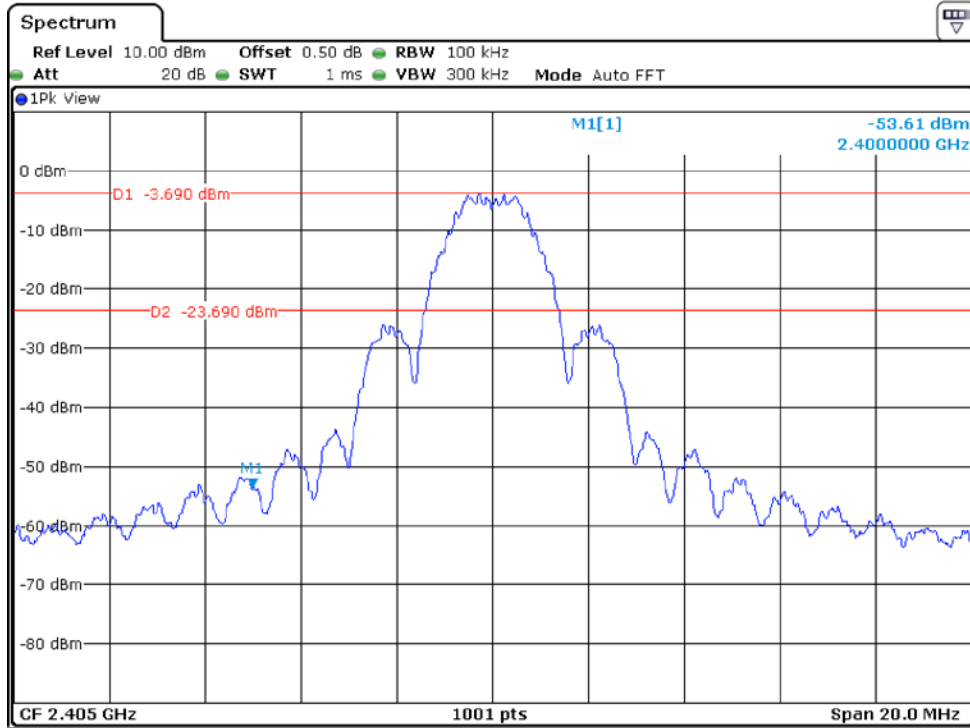
The frequency spectrum from 30 MHz to 26.5 GHz was scanned and maximum emission levels at each frequency recorded. The system was rotated 360°, and the antenna was varied in the height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for horizontal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

9.4 Test equipment used

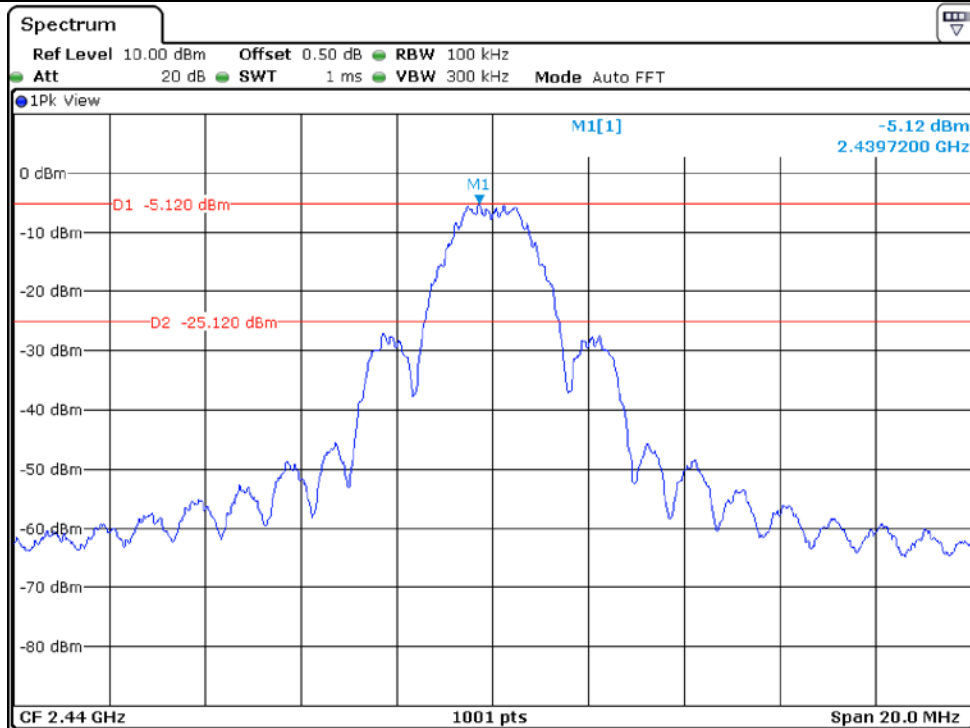
| Model Number | Manufacturer | Description | Serial Number | Last Cal. |
|-----------------|-------------------|--------------------------|---------------|--------------------|
| ■ - FSV40 | Rohde & Schwarz | Signal Analyzer | 101009 | Apr. 05, 2017 (1Y) |
| ■ - ESU | Rohde & Schwarz | EMI Test Receiver | 100261 | Apr. 06, 2017 (1Y) |
| ■ - 310N | Sonoma Instrument | Pre-Amplifier | 312544 | Apr. 05, 2017 (1Y) |
| ■ - BBV9718 | Schwarzbeck | Amplifier | 310 | Sep. 01, 2017 (1Y) |
| ■ - SCU40A | Rohde & Schwarz | Signal Conditioning unit | 100436 | Apr. 04, 2017 (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 | 9163-421 | Apr. 15, 2016 (2Y) |
| ■ - BBHA9120D | Schwarzbeck | Horn Antenna | BBHA9120D295 | May 26, 2017 (2Y) |
| ■ - BBHA9170 | Schwarzbeck | Horn Antenna | BBHA9170179 | Jul. 28, 2017 (2Y) |

All test equipment used is calibrated on a regular basis.

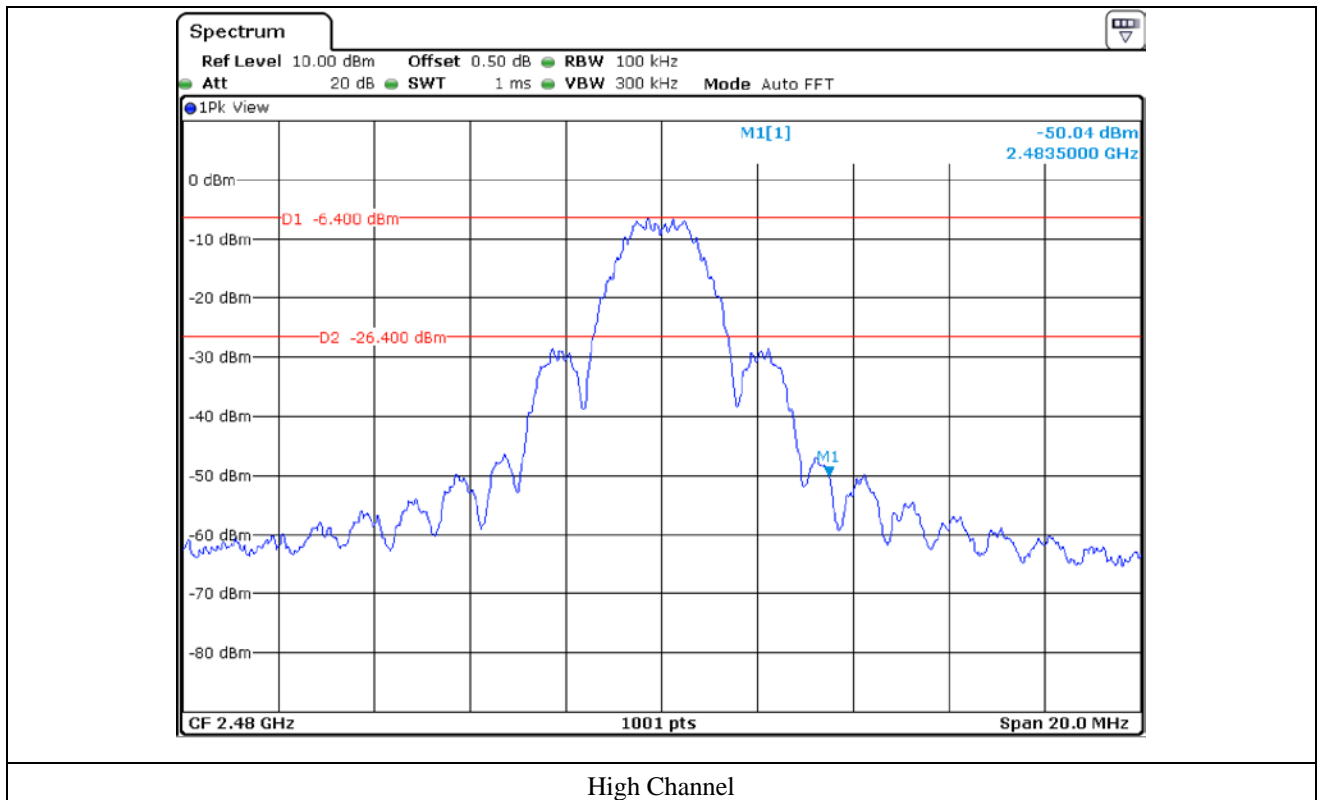
9.5 Test data for conducted emission

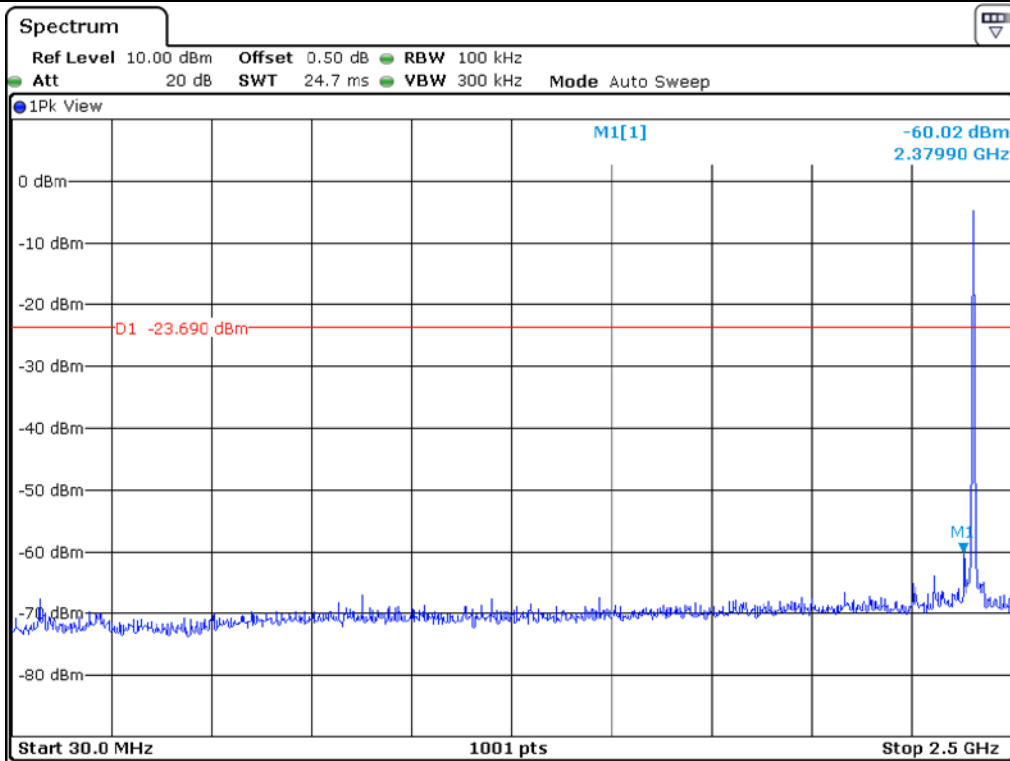


Low Channel

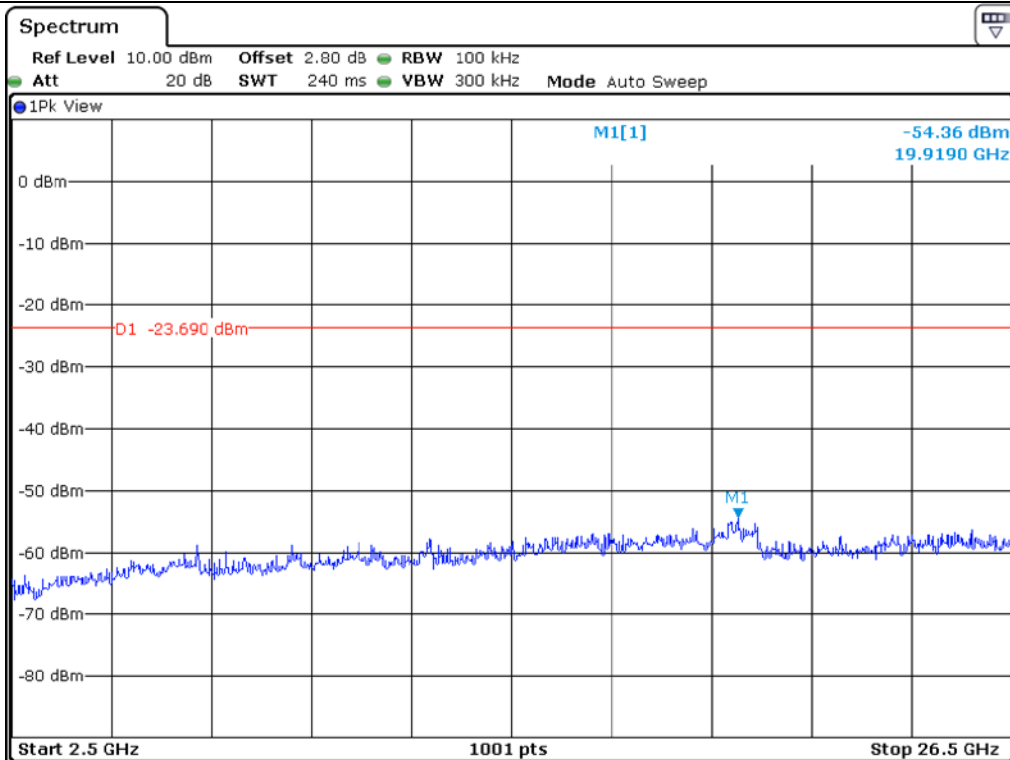


Middle Channel

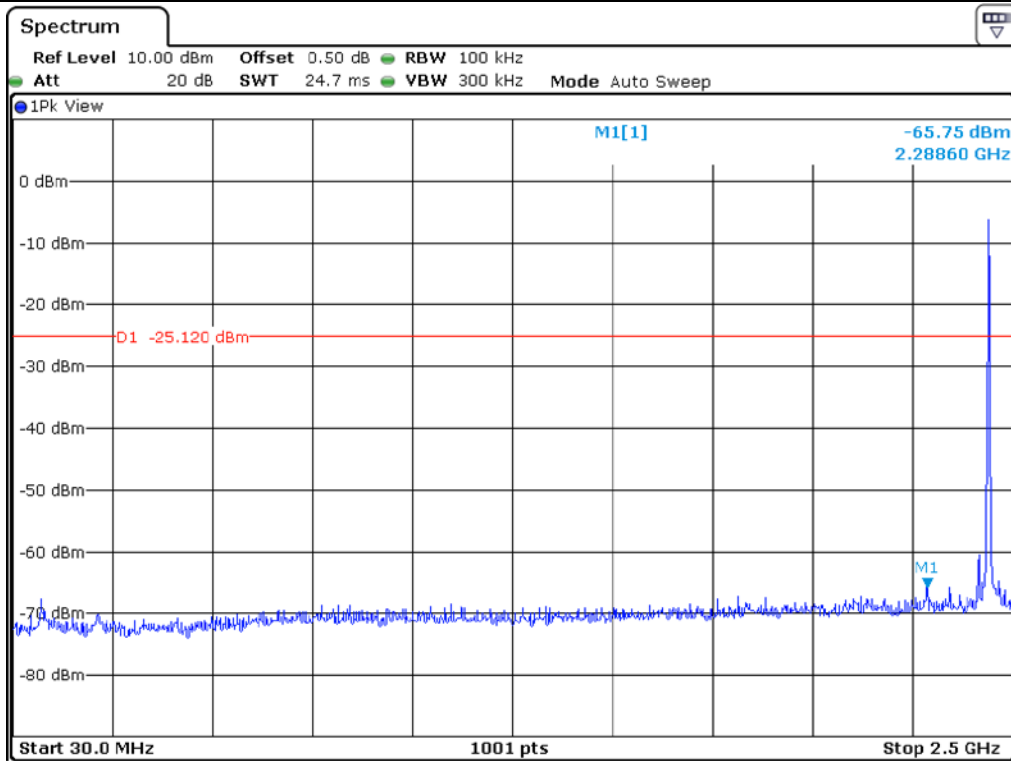




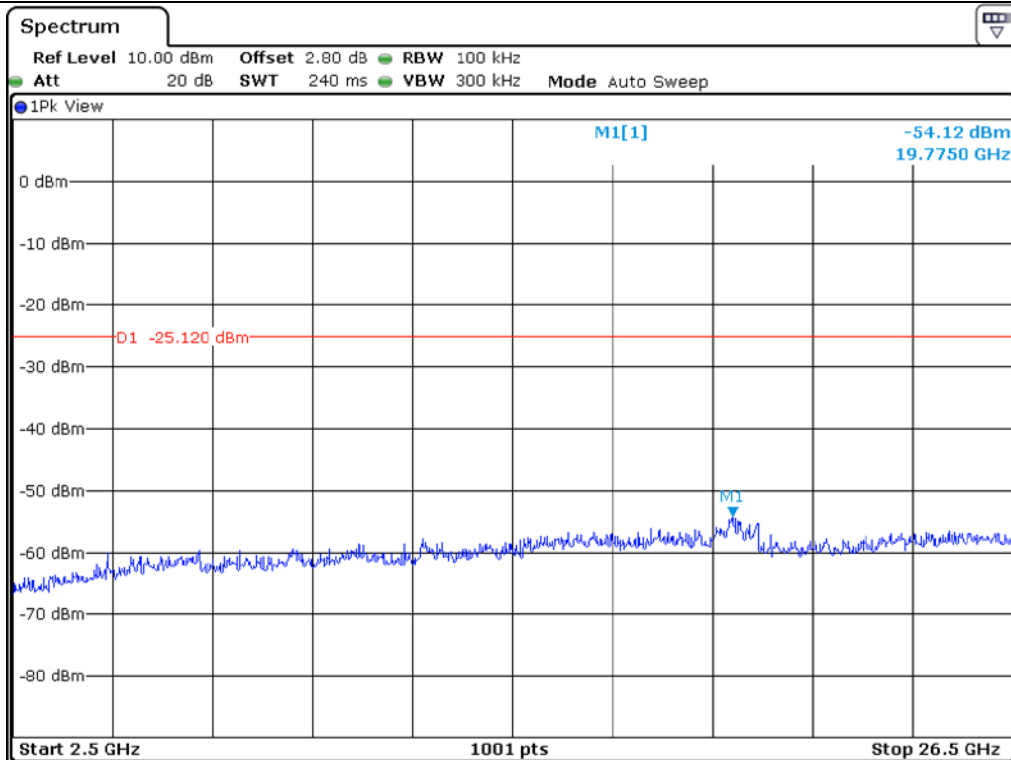
Low Channel



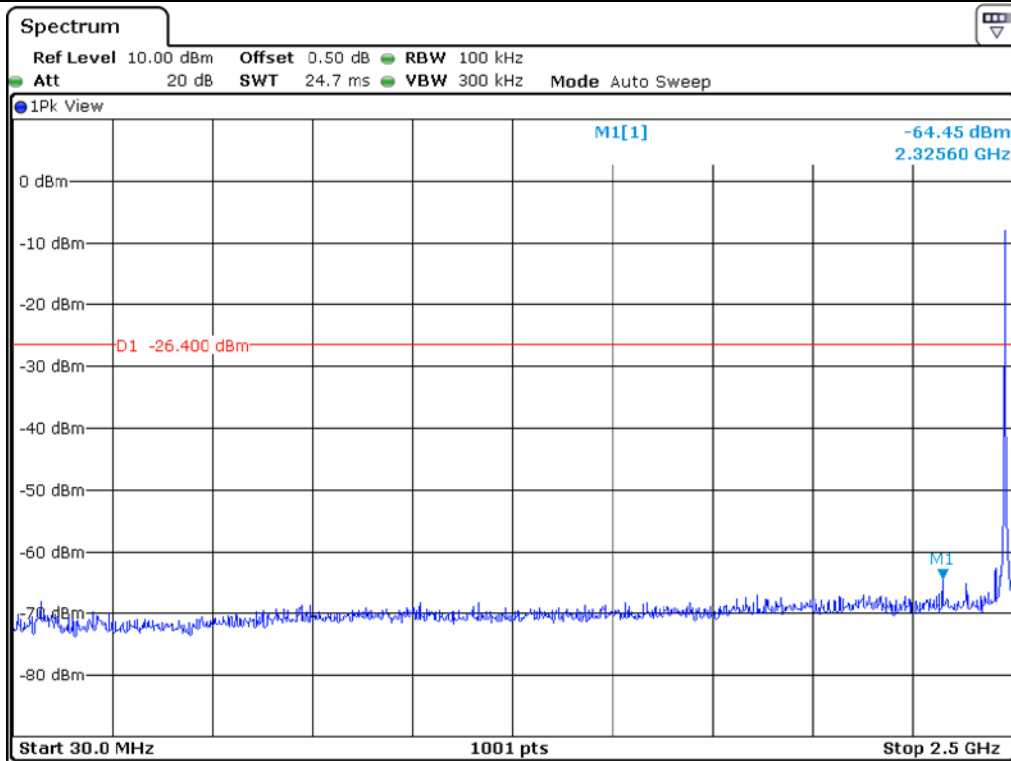
Low Channel



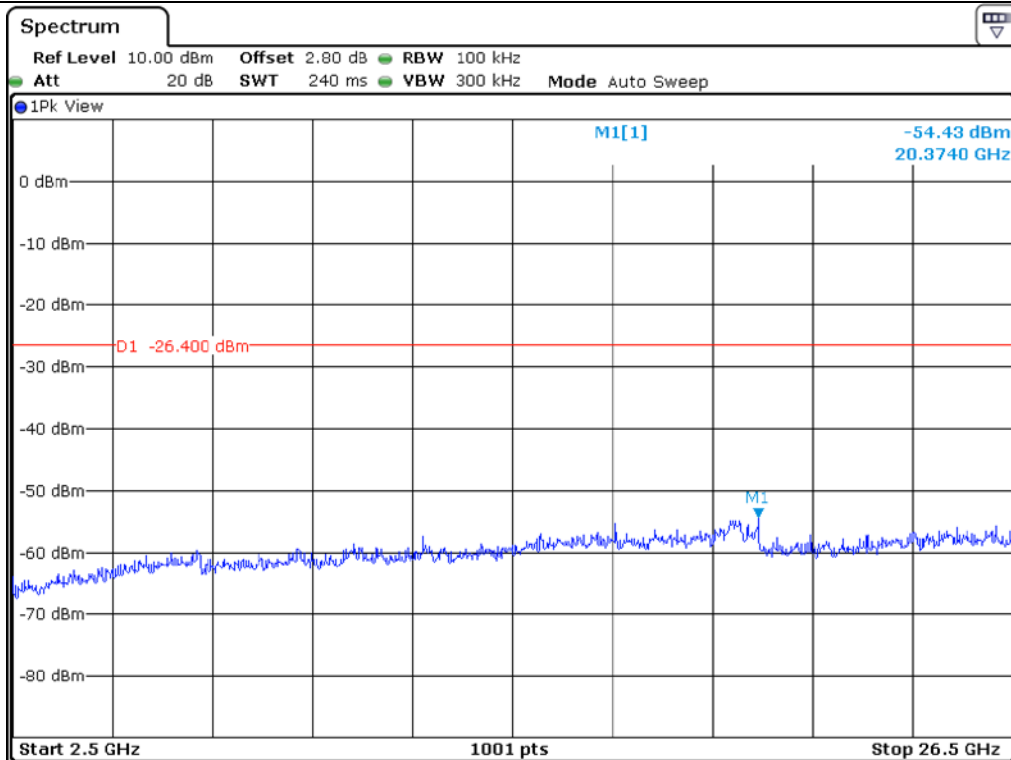
Middle Channel



Middle Channel



High Channel



High Channel

9.6 Test data for radiated emission

9.6.1 Radiated Emission which fall in the Restricted Band

- Test Date : November 22, 2017 ~ November 24, 2017
- 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 : > 98 %
- 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 | | | | | | | | | |
| 2.382 318 | 41.34 | Peak | H | 26.94 | 9.20 | 34.76 | 42.72 | 74.00 | 31.28 |
| 2.380 769 | 30.69 | Average | H | | | | 32.07 | 54.00 | 21.93 |
| 2.380 450 | 44.13 | Peak | V | | | | 45.51 | 74.00 | 28.49 |
| 2.381 089 | 36.56 | Average | V | | | | 37.94 | 54.00 | 16.06 |
| Test Data for High Channel | | | | | | | | | |
| 2.483 513 | 48.38 | Peak | H | 27.47 | 9.49 | 35.51 | 49.83 | 74.00 | 24.17 |
| 2.483 508 | 41.43 | Average | H | | | | 42.88 | 54.00 | 11.12 |
| 2.483 515 | 55.80 | Peak | V | | | | 57.25 | 74.00 | 16.75 |
| 2.483 504 | 49.20 | Average | V | | | | 50.65 | 54.00 | 3.35 |

Tabulated test data for Restricted Band

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Pre-Amplifier Gain}$$



Tested by: Hyung-Kwon, Oh / Assistant Manager

9.6.2 Spurious & Harmonic Radiated Emission

- Test Date : November 22, 2017 ~ November 24, 2017
- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode for the emissions fall in restricted band,
1 MHz and RMS Detector for Average Mode for the emissions fall in restricted band
100 kHz 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 : > 98 %
- 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 | | | | | | | | | |
| 4 810.00 | 42.71 | Peak | H | 30.84 | 12.31 | 35.74 | 50.12 | 73.98 | 23.86 |
| | 31.76 | Average | H | | | | 39.17 | 53.98 | 14.81 |
| | 45.51 | Peak | V | | | | 52.92 | 73.98 | 21.06 |
| | 38.09 | Average | V | | | | 45.50 | 53.98 | 8.48 |
| Test Data for Middle Channel | | | | | | | | | |
| 4 880.00 | 42.38 | Peak | H | 30.01 | 12.43 | 35.80 | 49.02 | 73.98 | 24.96 |
| | 31.60 | Average | H | | | | 38.24 | 53.98 | 15.74 |
| | 45.34 | Peak | V | | | | 51.98 | 73.98 | 22.00 |
| | 38.11 | Average | V | | | | 44.75 | 53.98 | 9.23 |
| Test Data for High Channel | | | | | | | | | |
| 4 960.00 | 41.93 | Peak | H | 31.15 | 12.81 | 35.96 | 49.93 | 73.98 | 24.05 |
| | 31.31 | Average | H | | | | 39.31 | 53.98 | 14.67 |
| | 45.21 | Peak | V | | | | 53.21 | 73.98 | 20.77 |
| | 38.13 | Average | V | | | | 46.13 | 53.98 | 7.85 |

Tabulated test data for Restricted Band

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Pre-Amplifier Gain}$$



Tested by: Hyung-Kwon, Oh / Assistant Manager

9.6.3 Radiated Emission which fall in the Band Edge

- . Test Date : November 22, 2017 ~ November 24, 2017
- . Resolution bandwidth : 100 kHz and Peak Detector for Peak Mode
100 kHz and RMS Detector for Average Mode
- . Video bandwidth : 300 kHz for Peak and Average Mode
- . Measurement distance : 3 m
- . Duty Cycle : > 98 %
- . 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 | | | | | | | | | |
| 2.400 000 | 36.88 | Peak | H | 27.20 | 9.35 | 34.81 | 38.62 | 74.00 | 35.38 |
| | 29.22 | Average | H | | | | 30.96 | 54.00 | 23.04 |
| | 46.49 | Peak | V | | | | 48.23 | 74.00 | 25.77 |
| | 38.87 | Average | V | | | | 40.61 | 54.00 | 13.39 |

Tabulated test data for Restricted Band

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

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Pre-Amplifier Gain}$$



Tested by: Hyung-Kwon, Oh / Assistant Manager

10. PEAK POWER SPECTRAL DENSITY

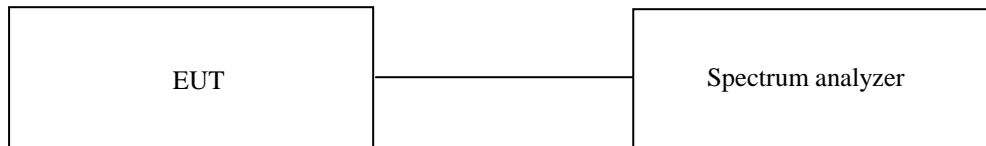
10.1 Operating environment

Temperature : 24.3 °C
 Relative humidity : 43.9 % 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 $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$, 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 | Apr. 05, 2017 (1Y) |

All test equipment used is calibrated on a regular basis.

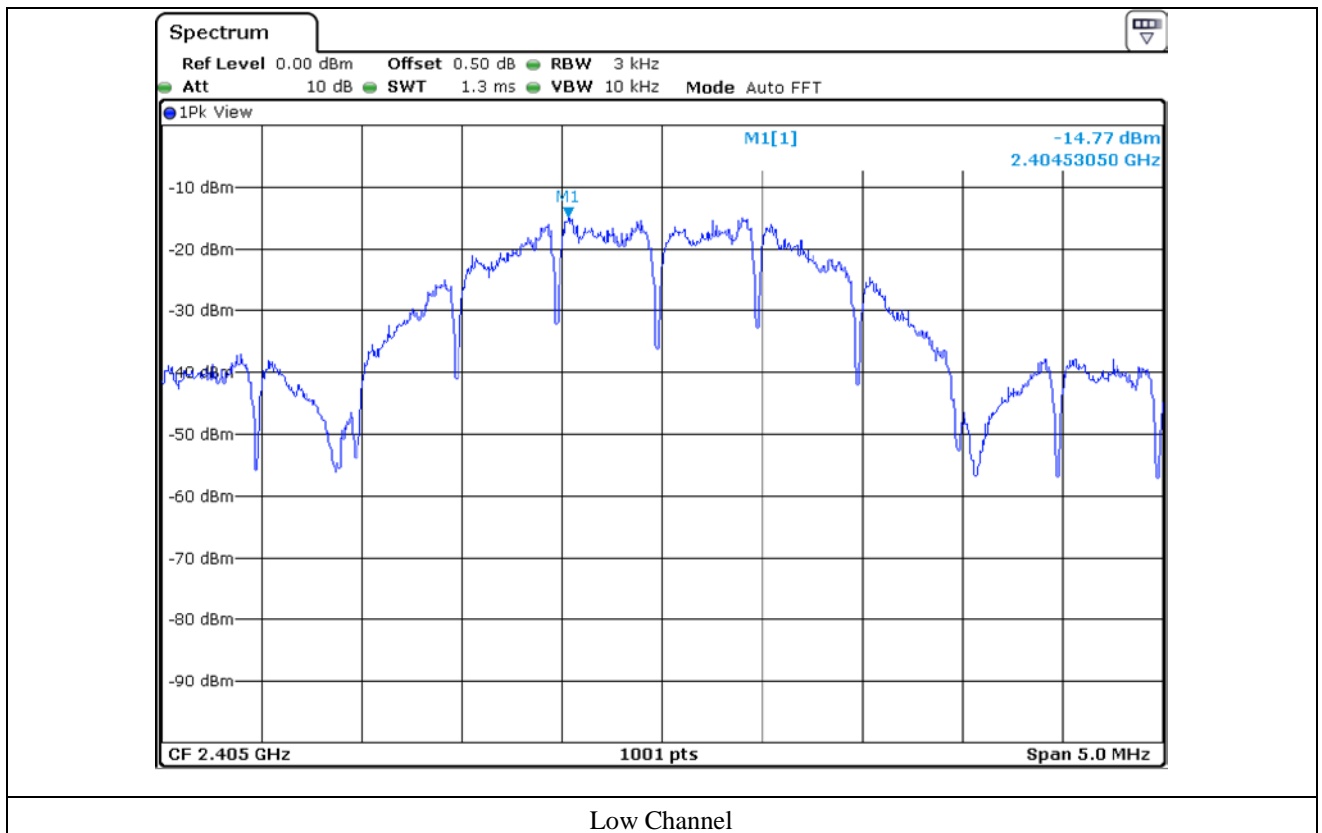
10.4 Test data

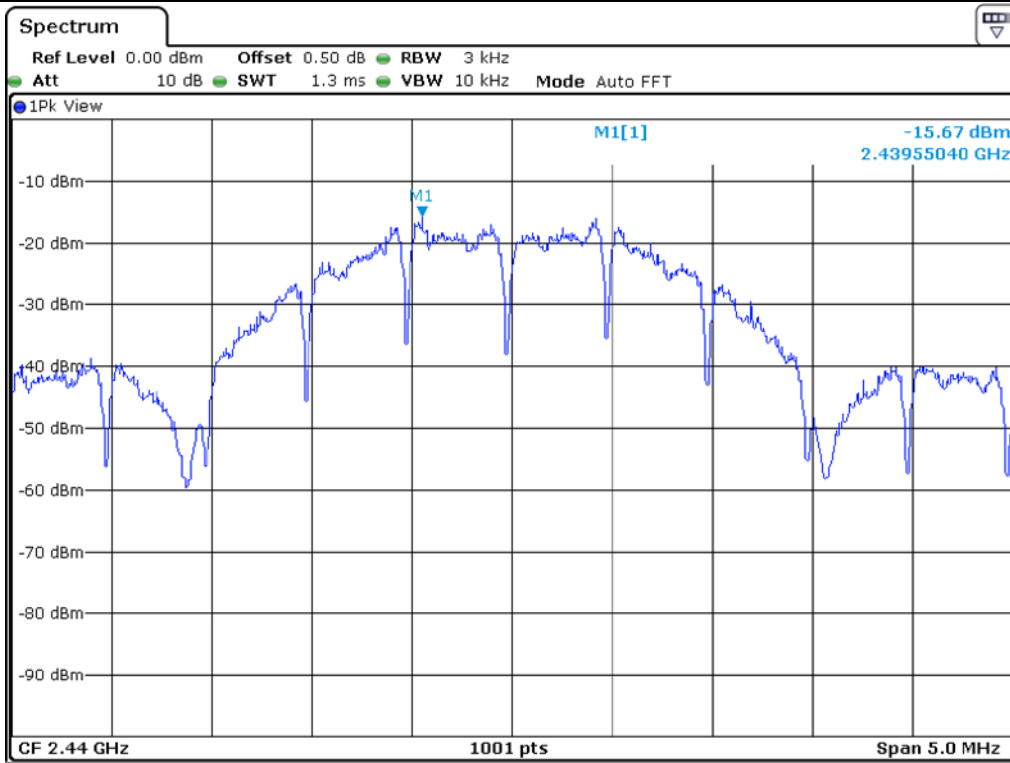
- Test Date : November 22, 2017 ~ November 24, 2017
- Test Result : Pass
- Operating Condition : Continuous transmitting mode

| CHANNEL | FREQUENCY(MHz) | MEASURED VALUE (dBm) | LIMIT (dBm) | MARGIN (dB) |
|---------|----------------|----------------------|-------------|-------------|
| Low | 2 405.00 | -14.77 | 8.00 | 22.77 |
| Middle | 2 440.00 | -15.67 | 8.00 | 23.67 |
| High | 2 480.00 | -16.47 | 8.00 | 24.47 |

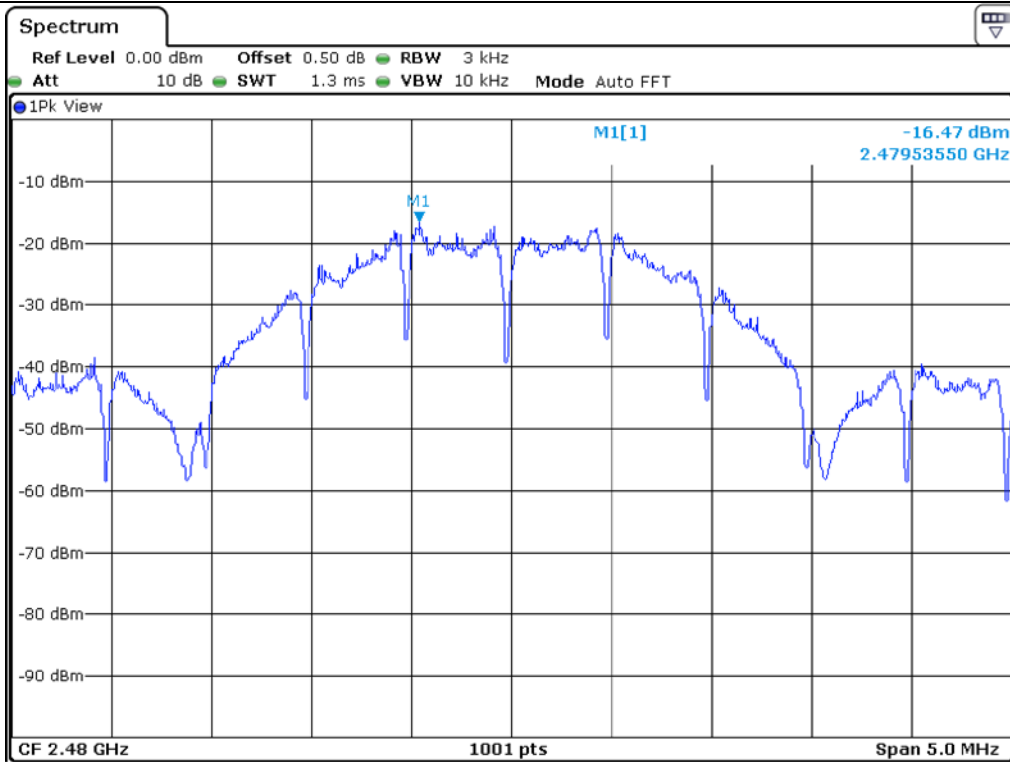
Remark. Margin = Limit – Measured value

Tested by: Hyung-Kwon, Oh / Assistant Manager





Middle Channel



High Channel

11. RADIATED EMISSION TEST

11.1 Operating environment

Temperature : 22 °C
 Relative humidity : 46 % R.H.

11.2 Test set-up

The radiated emissions measurements were on the 3 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.

11.3 Test equipment used

| Model Number | Manufacturer | Description | Serial Number | Last Cal. |
|-----------------|-------------------|--------------------------|---------------|--------------------|
| ■ - FSV30 | Rohde & Schwarz | Signal Analyzer | 101372 | Jul. 24, 2019 (1Y) |
| ■ - ESW | Rohde & Schwarz | EMI Test Receiver | 101851 | Aug. 07, 2019 (1Y) |
| ■ - 310N | Sonoma Instrument | Pre-Amplifier | 312544 | Mar. 18, 2019 (1Y) |
| ■ - BBV 9718B | Schwarzbeck | Amplifier | 009 | Mar. 20, 2019 (1Y) |
| ■ - SCU40A | Rohde & Schwarz | Signal Conditioning unit | 100436 | Mar. 11, 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. 13, 2018 (2Y) |
| ■ - BBHA9120D | Schwarzbeck | Horn Antenna | 9120D-1366 | Jul. 16, 2019 (1Y) |
| ■ - BBHA9170 | Schwarzbeck | Horn Antenna | BBHA9170179 | Jan. 20, 2020 (1Y) |
| ■ - VAMP9243 | Schwarzbeck | ROD ANTENNA | VAMP9243 | Mar. 14, 2019 (2Y) |

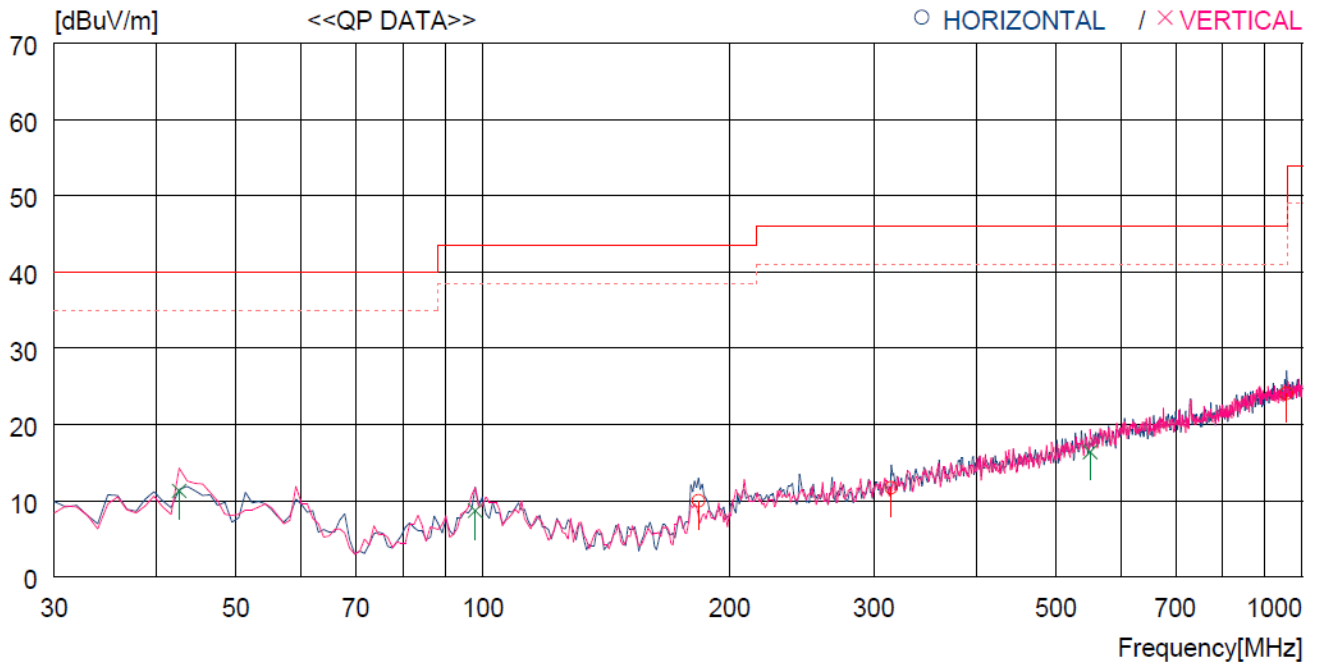
All test equipment used is calibrated on a regular basis.

11.4 Test data for 30 MHz ~ 1 GHz

11.4.1 Test data for MC85A00 (Basic Model)

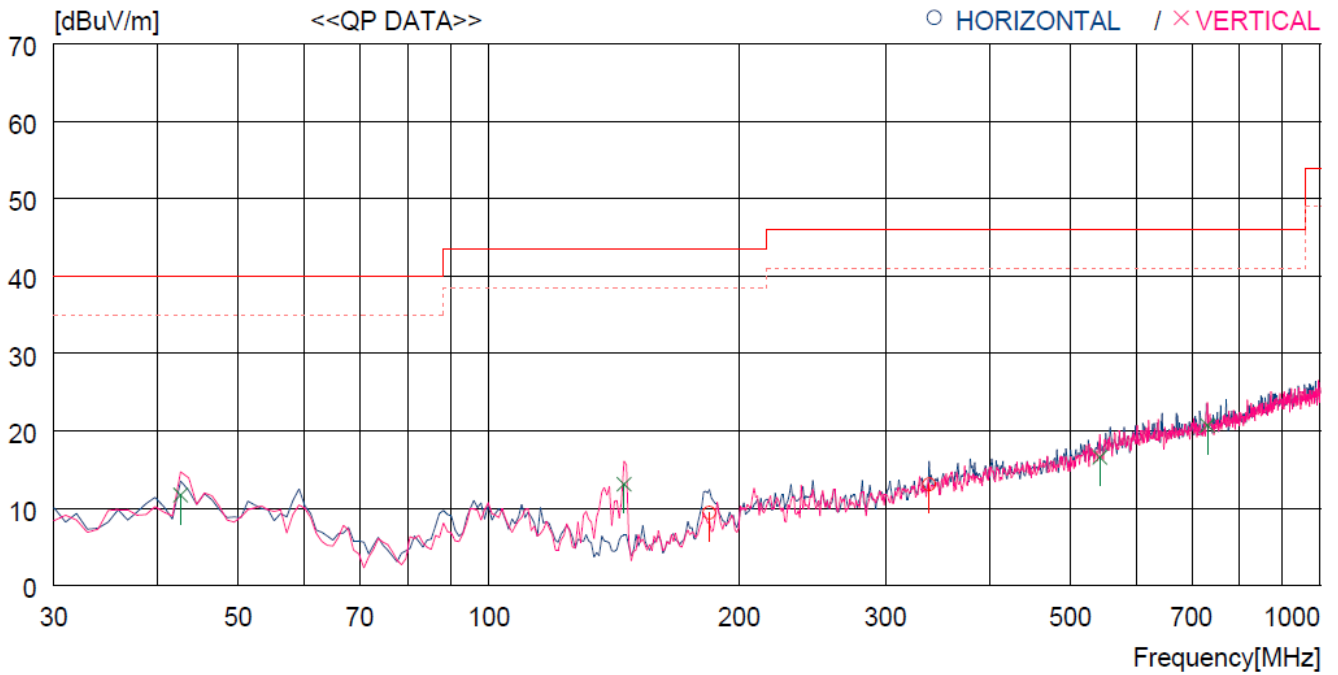
Humidity Level : 44 % R.H. Temperature: 24°C
 Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247
 Result : PASSED

EUT : Zigbee Module Date: November 23, 2017
 Detector : CISPR Quasi-Peak (6 dB Bandwidth: 120 kHz)
 Operating condition : Low Channel



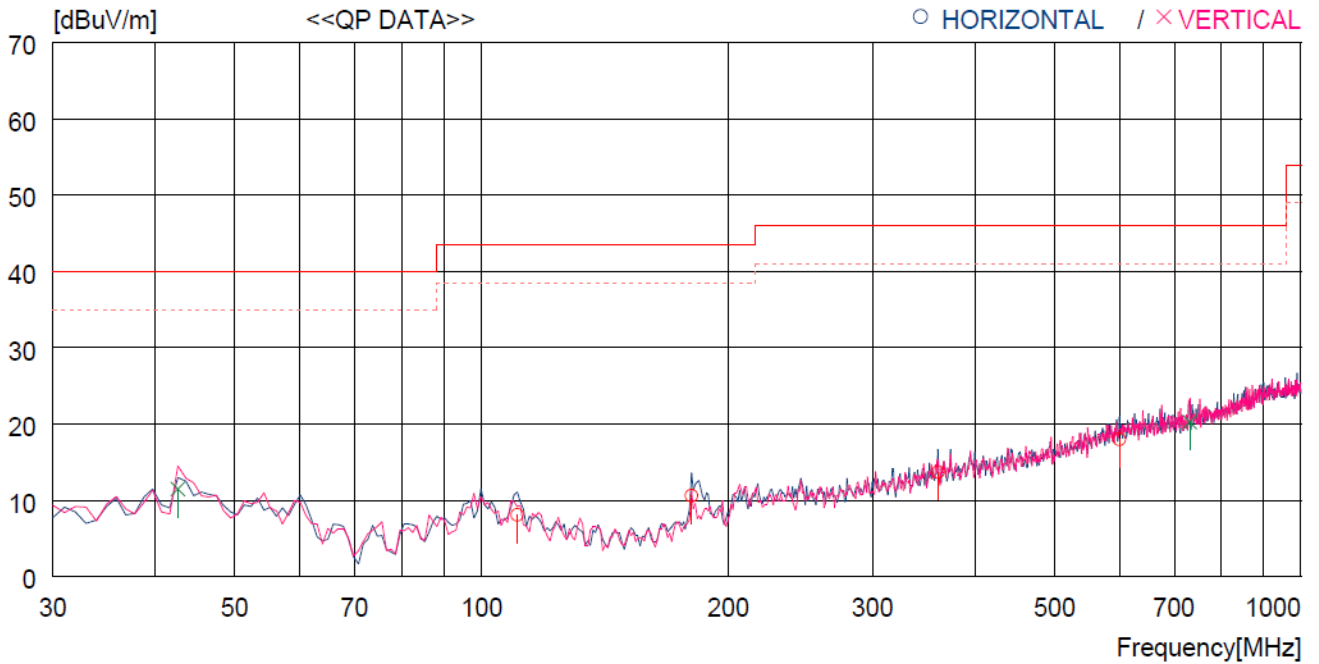
| No. | FREQ [MHz] | READING QP [dBuV] | ANT FACTOR [dB] | LOSS [dB] | GAIN [dB] | RESULT [dBuV/m] | LIMIT [dBuV/m] | MARGIN [dB] | ANTENNA [cm] | TABLE [DEG] |
|------------------------|---------------|-------------------------|-----------------------|--------------|--------------|--------------------|-------------------|----------------|-----------------|----------------|
| ----- Horizontal ----- | | | | | | | | | | |
| 1 | 183.260 | 30.1 | 9.8 | 3.2 | 33.1 | 10.0 | 43.5 | 33.5 | 400 | 359 |
| 2 | 315.180 | 27.1 | 13.5 | 4.1 | 33.0 | 11.7 | 46.0 | 34.3 | 400 | 356 |
| 3 | 956.337 | 27.0 | 22.0 | 7.2 | 32.1 | 24.1 | 46.0 | 21.9 | 400 | 81 |
| ----- Vertical ----- | | | | | | | | | | |
| 4 | 42.610 | 29.0 | 13.7 | 1.7 | 33.1 | 11.3 | 40.0 | 28.7 | 400 | 0 |
| 5 | 97.900 | 27.8 | 11.5 | 2.4 | 33.0 | 8.7 | 43.5 | 34.8 | 400 | 0 |
| 6 | 550.889 | 26.8 | 17.5 | 5.4 | 33.3 | 16.4 | 46.0 | 29.6 | 400 | 0 |

Operating condition : Middle Channel



| 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 | 184.230 | 29.4 | 9.9 | 3.2 | 33.1 | 9.4 | 43.5 | 34.1 | 300 | 359 |
| 2 | 338.460 | 27.3 | 14.6 | 4.3 | 33.1 | 13.1 | 46.0 | 32.9 | 400 | 131 |
| ----- Vertical ----- | | | | | | | | | | |
| 3 | 42.610 | 29.4 | 13.7 | 1.7 | 33.1 | 11.7 | 40.0 | 28.3 | 400 | 204 |
| 4 | 145.430 | 35.3 | 7.8 | 2.9 | 32.9 | 13.1 | 43.5 | 30.4 | 400 | 307 |
| 5 | 543.130 | 27.1 | 17.5 | 5.3 | 33.3 | 16.6 | 46.0 | 29.4 | 400 | 0 |
| 6 | 731.304 | 27.9 | 20.0 | 6.2 | 33.4 | 20.7 | 46.0 | 25.3 | 400 | 4 |

Operating condition : High Channel



| 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 | 110.510 | 27.1 | 11.5 | 2.5 | 33.0 | 8.1 | 43.5 | 35.4 | 400 | 235 |
| 2 | 180.350 | 31.1 | 9.4 | 3.2 | 33.1 | 10.6 | 43.5 | 32.9 | 400 | 0 |
| 3 | 360.770 | 28.0 | 14.4 | 4.4 | 33.1 | 13.7 | 46.0 | 32.3 | 400 | 294 |
| 4 | 600.358 | 26.4 | 19.3 | 5.6 | 33.3 | 18.0 | 46.0 | 28.0 | 400 | 354 |
| ----- Vertical ----- | | | | | | | | | | |
| 5 | 42.610 | 29.2 | 13.7 | 1.7 | 33.1 | 11.5 | 40.0 | 28.5 | 400 | 359 |
| 6 | 731.304 | 27.5 | 20.0 | 6.2 | 33.4 | 20.3 | 46.0 | 25.7 | 400 | 359 |

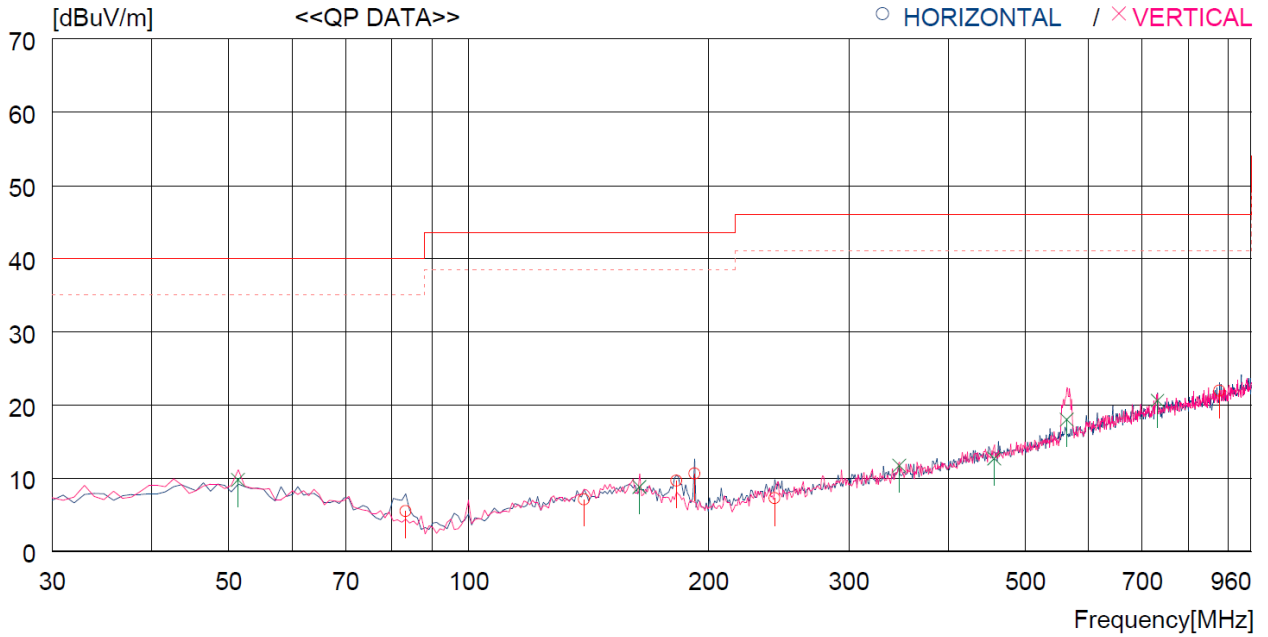
Tested by: Hyung-Kwon, Oh / Assistant Manager

11.4.2 Test data for MC85B00 (Multiple Model)

Humidity Level : 46 % R.H. Temperature: 22 °C
 Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247
 Result : PASSED

EUT : Zigbee Module Date: February 25, 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 TABLE [cm] | [DEG] |
|------------------------|---------------|-------------------------|-----------------------|--------------|--------------|--------------------|-------------------|----------------|--------------------------|-------|
| ----- Horizontal ----- | | | | | | | | | | |
| 1 | 83.350 | 28.4 | 8.3 | 1.9 | 33.1 | 5.5 | 40.0 | 34.5 | 300 | 103 |
| 2 | 139.610 | 25.4 | 12.4 | 2.3 | 33.0 | 7.1 | 43.5 | 36.4 | 300 | 359 |
| 3 | 182.290 | 28.6 | 11.5 | 2.6 | 33.1 | 9.6 | 43.5 | 33.9 | 400 | 0 |
| 4 | 191.990 | 30.3 | 10.7 | 2.7 | 33.1 | 10.6 | 43.5 | 32.9 | 200 | 96 |
| 5 | 242.430 | 25.5 | 11.7 | 3.0 | 33.0 | 7.2 | 46.0 | 38.8 | 400 | 179 |
| 6 | 876.800 | 25.8 | 23.1 | 5.7 | 32.7 | 21.9 | 46.0 | 24.1 | 400 | 0 |
| ----- Vertical ----- | | | | | | | | | | |
| 7 | 51.340 | 27.7 | 13.7 | 1.5 | 33.1 | 9.8 | 40.0 | 30.2 | 100 | 0 |
| 8 | 163.860 | 26.4 | 13.0 | 2.4 | 33.0 | 8.8 | 43.5 | 34.7 | 300 | 248 |
| 9 | 347.190 | 26.7 | 14.6 | 3.5 | 33.1 | 11.7 | 46.0 | 34.3 | 400 | 359 |
| 10 | 456.801 | 24.9 | 16.9 | 4.0 | 33.1 | 12.7 | 46.0 | 33.3 | 300 | 190 |
| 11 | 563.499 | 27.7 | 19.2 | 4.5 | 33.4 | 18.0 | 46.0 | 28.0 | 200 | 359 |
| 12 | 732.274 | 27.0 | 21.6 | 5.3 | 33.3 | 20.6 | 46.0 | 25.4 | 200 | 340 |

Tested by: Hyung-Kwon, Oh / Assistant Manager

11.5 Test data for Below 30 MHz

- . Test Date : February 25, 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 (dB μ V) | Ant. Pol. (H/V) | Ant. Height (m) | Angle (°) | Ant. Factor (dB/m) | Cable Loss | Emission Level(dB μ V/m) | Limits (dB μ V/m) | Margin (dB) |
|---|----------------------|-----------------|-----------------|-----------|--------------------|------------|------------------------------|-----------------------|-------------|
| It was not observed any emissions from the EUT. | | | | | | | | | |

11.6 Test data for above 1 GHz

- . Test Date : February 25, 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 (dB μ V) | Ant. Pol. (H/V) | Ant. Height (m) | Angle (°) | Ant. Factor (dB/m) | Cable Loss | Emission Level(dB μ V/m) | Limits (dB μ V/m) | Margin (dB) |
|---|----------------------|-----------------|-----------------|-----------|--------------------|------------|------------------------------|-----------------------|-------------|
| It was not observed any emissions from the EUT. | | | | | | | | | |



Tested by: Hyung-Kwon, Oh / Assistant Manager

12. CONDUCTED EMISSION TEST

12.1 Operating environment

Temperature : 24 °C
 Relative humidity : 44 % 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.

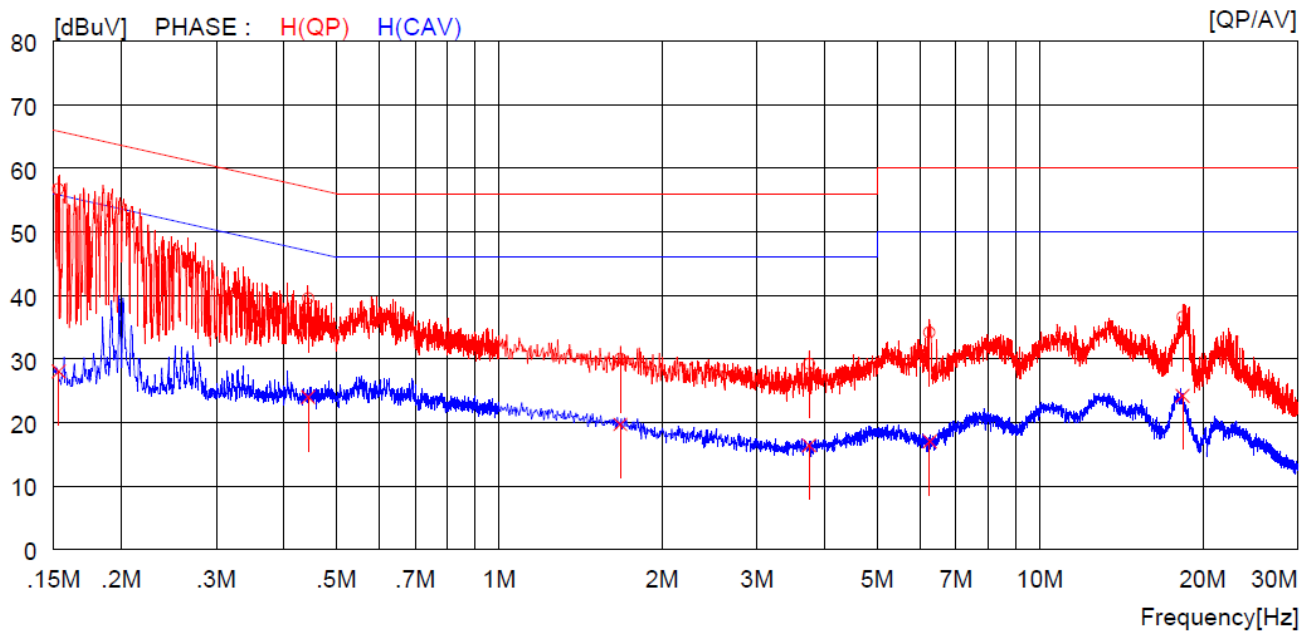
12.3 Test equipment used

| Model Number | Manufacturer | Description | Serial Number | Last Cal. (Interval) |
|--------------|-----------------|---------------|---------------|----------------------|
| ■ - ESPI | Rohde & Schwarz | Test Receiver | 101012 | Oct. 27, 2017 (1Y) |
| □ - ESHS10 | Rohde & Schwarz | Test Receiver | 834467/007 | Apr. 03, 2017 (1Y) |
| □ - NSLK8128 | Schwarzbeck | AMN | 8128-216 | Apr. 05, 2017 (1Y) |
| ■ - NSLK8126 | Schwarzbeck | AMN | 8126-404 | Apr. 03, 2017 (1Y) |
| □ - 3825/2 | EMCO | AMN | 9109-1869 | Apr. 06, 2017 (1Y) |
| ■ - 3825/2 | EMCO | AMN | 9109-1867 | Apr. 07, 2017 (1Y) |

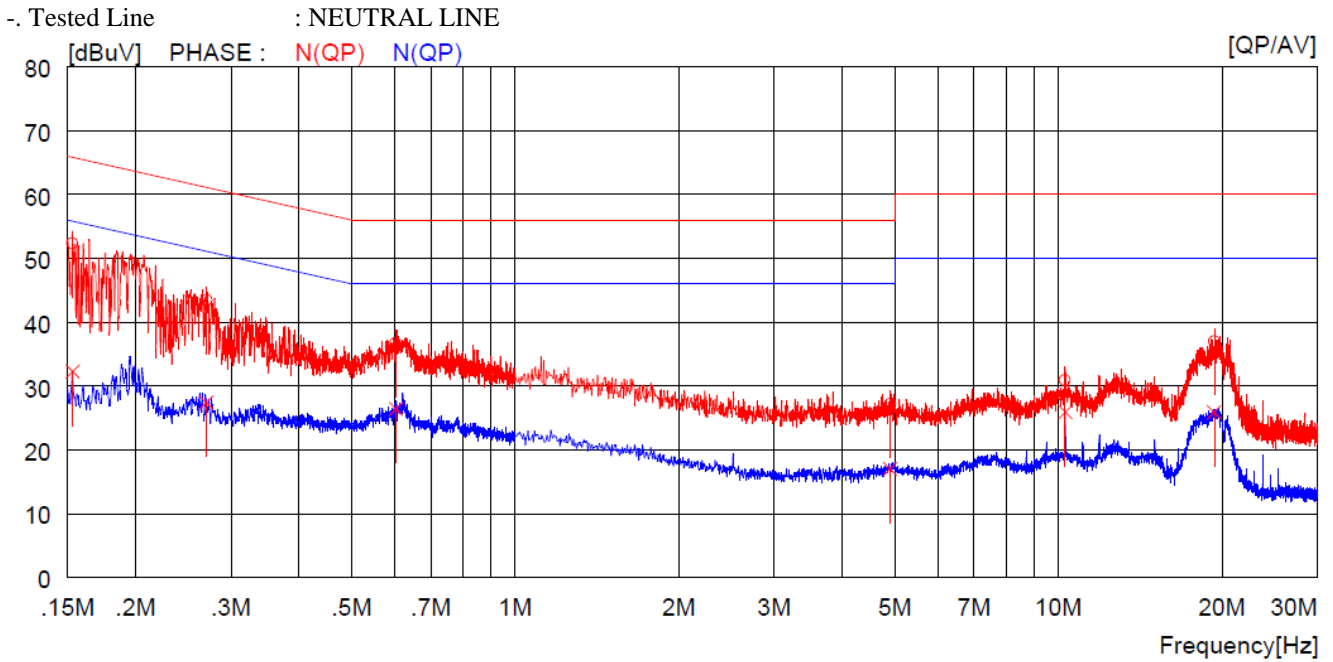
All test equipment used is calibrated on a regular basis.

12.4 Test data

- Test Date : November 23, 2017
- Resolution bandwidth : 9 kHz
- Frequency range : 0.15 MHz ~ 30 MHz
- Tested Line : HOT LINE



| NO | FREQ [MHz] | READING | | C. FACTOR [dB] | RESULT | | LIMIT | | MARGIN | | PHASE |
|----|---------------|--------------|--------------|-------------------|--------------|--------------|--------------|--------------|--------------|--------------|---------|
| | | QP [dBuV] | AV [dBuV] | | QP [dBuV] | AV [dBuV] | QP [dBuV] | AV [dBuV] | QP [dBuV] | AV [dBuV] | |
| 1 | 0.15300 | 46.7 | ---- | 10.0 | 56.7 | ---- | 65.8 | ---- | 9.1 | ---- | H (QP) |
| 2 | 0.44300 | 29.5 | ---- | 10.0 | 39.5 | ---- | 57.0 | ---- | 17.5 | ---- | H (QP) |
| 3 | 1.67600 | 19.9 | ---- | 10.1 | 30.0 | ---- | 56.0 | ---- | 26.0 | ---- | H (QP) |
| 4 | 3.74000 | 19.0 | ---- | 10.2 | 29.2 | ---- | 56.0 | ---- | 26.8 | ---- | H (QP) |
| 5 | 6.25500 | 23.9 | ---- | 10.3 | 34.2 | ---- | 60.0 | ---- | 25.8 | ---- | H (QP) |
| 6 | 18.36000 | 25.9 | ---- | 10.7 | 36.6 | ---- | 60.0 | ---- | 23.4 | ---- | H (QP) |
| 7 | 0.15300 | ---- | 18.0 | 10.0 | ---- | 28.0 | ---- | 55.8 | ---- | 27.8 | H (CAV) |
| 8 | 0.44300 | ---- | 14.0 | 10.0 | ---- | 24.0 | ---- | 47.0 | ---- | 23.0 | H (CAV) |
| 9 | 1.67600 | ---- | 9.6 | 10.1 | ---- | 19.7 | ---- | 46.0 | ---- | 26.3 | H (CAV) |
| 10 | 3.74000 | ---- | 6.2 | 10.2 | ---- | 16.4 | ---- | 46.0 | ---- | 29.6 | H (CAV) |
| 11 | 6.25500 | ---- | 6.7 | 10.3 | ---- | 17.0 | ---- | 50.0 | ---- | 33.0 | H (CAV) |
| 12 | 18.36000 | ---- | 13.5 | 10.7 | ---- | 24.2 | ---- | 50.0 | ---- | 25.8 | H (CAV) |



| NO | FREQ [MHz] | READING | | C. FACTOR [dB] | RESULT | | LIMIT | | MARGIN | | PHASE |
|----|---------------|--------------|--------------|-------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------|
| | | QP [dBuV] | AV [dBuV] | | QP [dBuV] | AV [dBuV] | QP [dBuV] | AV [dBuV] | QP [dBuV] | AV [dBuV] | |
| 1 | 0.15300 | 42.3 | ---- | 10.0 | 52.3 | ---- | 65.8 | ---- | 13.5 | ---- | N(QP) |
| 2 | 0.27000 | 33.5 | ---- | 10.0 | 43.5 | ---- | 61.1 | ---- | 17.6 | ---- | N(QP) |
| 3 | 0.60300 | 26.6 | ---- | 10.1 | 36.7 | ---- | 56.0 | ---- | 19.3 | ---- | N(QP) |
| 4 | 4.90000 | 17.0 | ---- | 10.2 | 27.2 | ---- | 56.0 | ---- | 28.8 | ---- | N(QP) |
| 5 | 10.29000 | 20.5 | ---- | 10.4 | 30.9 | ---- | 60.0 | ---- | 29.1 | ---- | N(QP) |
| 6 | 19.36000 | 26.3 | ---- | 10.7 | 37.0 | ---- | 60.0 | ---- | 23.0 | ---- | N(QP) |
| 7 | 0.15300 | ---- | 22.3 | 10.0 | ---- | 32.3 | ---- | 55.8 | ---- | 23.5 | N(CAV) |
| 8 | 0.27000 | ---- | 17.4 | 10.0 | ---- | 27.4 | ---- | 51.1 | ---- | 23.7 | N(CAV) |
| 9 | 0.60300 | ---- | 16.3 | 10.1 | ---- | 26.4 | ---- | 46.0 | ---- | 19.6 | N(CAV) |
| 10 | 4.90000 | ---- | 6.8 | 10.2 | ---- | 17.0 | ---- | 46.0 | ---- | 29.0 | N(CAV) |
| 11 | 10.29000 | ---- | 15.5 | 10.4 | ---- | 25.9 | ---- | 50.0 | ---- | 24.1 | N(CAV) |
| 12 | 19.36000 | ---- | 15.2 | 10.7 | ---- | 25.9 | ---- | 50.0 | ---- | 24.1 | 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 / Assistant Manager