# FCC CFR47 Part 15 Subpart C
# Certification Test Report

## For the

| | |
|---|---|
| **Product** | **: Smart Card Reader** |
| **Model** | **: DE-ABCM5** |
| **FCC ID** | **: SWUDEABCM5** |
| **Applicant** | **: DUALi Inc.** |
| **FCC Rule** | **: CFR 47 Part 15 Subpart C** |

We hereby certify that the above product has been tested by us with the listed rules and found in compliance with the regulation. The test data and results are issued on the test report no. **TR-W1807-004**

Signature

Choi, Yeong-min / Technical Manager
Date: 2018-07-06

## Test Laboratory: ENG Co., Ltd.

# FCC CERTIFICATION
# TEST REPORT

| | |
|---|---|
| **Project Number** | **: EA1806C-109** |
| **Test Report Number** | **: TR-W1807-004** |
| **Type of Equipment** | **: Smart Card Reader** |
| **Model Name** | **: DE-ABCM5** |
| **FCC ID** | **: SWUDEABCM5** |
| **Multiple Model Name** | **: N/A** |
| **Applicant** | **: DUALi Inc.** |
| **Address** | **: 1-309 Innoplex, 552 Woncheon-dong, Yeongtong-gu, Suwon, Gyeonggi-do, Korea** |
| **Manufacturer** | **: DUALi Inc.** |
| **Address** | **: 1-309 Innoplex, 552 Woncheon-dong, Yeongtong-gu, Suwon, Gyeonggi-do, Korea** |
| **Regulation** | **: FCC Part 15 Subpart C Section 15.225** |
| **Total page of Report** | **: 26 Pages** |
| **Date of Receipt** | **: 2018-06-19** |
| **Date of Issue** | **: 2018-07-06** |
| **Test Result** | **: PASS** |

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.

Prepared by Song, In-young / Senior Engineer _____ (Signature) 2018-07-06 (Date)

Reviewed by Choi, Yeong-min / Technical Manager _____ (Signature) 2018-07-06 (Date)


ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942 Report Form_01 (Rev.0)
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## Release Control Record

| Issue Report No. | Issued Date | Details/Revisions |
|---|---|---|
| TR-W1807-004 | 2018-07-06 | Initial Release |
| - | - | - |


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# 1. TEST SUMMARY

## 1.1 Regulations and results

The sample submitted for evaluation (Referred to below as the EUT) has been tested in accordance with the following regulations or standards.

| FCC Reference Section | Description | P | F | N.T. | Note |
|---|---|---|---|---|---|
| 15.205, 15.209(a) & 15.225(d) | Radiated Spurious Emissions | P | | | |
| 15.207 | AC Power-line Conducted Emissions | P | | | |
| 15.225(a) | Field strength within the band (13.553-13.567) MHz | P | | | |
| 15.225(b) & 15.225(c) | Field strength within the band (13.410-13.553) MHz &(13.567-13.710) MHz (13.110-13.410) MHz & (13.710-14.010) MHz | P | | | |
| 15.225(e) | Frequency Tolerance of Carrier Signal | P | | | |
| 15.215 | 20 dB Bandwidth | P | | | |

**Remark:**
P means Passed F means Failed N.T. means Not Tested

## 1.2 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 15.225.

## 1.3 Test Methodology

The tests mentioned in clause 1.1 in this test report were performed according to FCC CFR 47 Part 2, CFR 47 Part 15, and ANSI C63.10-2013.

## 1.3 Additions, deviations, exclusions from standards

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

## 1.4 Test Facility

The measurement facilities are located at 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do 12813, Korea. Description details of test facilities were submitted to the FCC and IC, designated by the RRA (Radio Research Agency), and accredited by Korea and accredited by KOLAS (Korea Laboratory Accreditation Scheme) in Korea according to the requirement of ISO 17025.

| Agency Name | Registration No. | Mark |
|---|---|---|
| FCC | KR0160 | |
| ISED(Canada) | IC 12721A | |
| RRA | KR0160 | |
| Korean Agency for Technology and Standards | KT733 | |

## 2. EUT (Equipment Under Test) INFORMATION

### 2.1 General Description

The DUALi Inc., Model DE-ABCM5 (referred to as the EUT in this report) is a Smart Card Reader and supports USB communication via HOST. The EUT support all NFC forum standard and ISO-7816 contact SIM/SAM. The product specification described herein was obtained from product data sheet or user's manual.

| | |
|---|---|
| Operating Frequency | 13.56 MHz |
| KIND OF CLASS | DXT- Part 15 Low Power Transceiver, Rx Verified |
| Modulation Types | ASK |
| Generated or used Freq. in EUT | 27.12 MHz |
| Type of Antenna | ■ Integrated Type □ Dedicated Type |
| | PCB Pattern Antenna (50 x 70 mm, 2 turns) |
| IC Card | ISO 7816 Smart Card Interface IC |
| Communication | USB |
| Operating Temperature | -20 °C ~ + 55 °C |
| Normal Test Voltage | USB Power DC 5.00 V |
| Extreme voltage test Rating | DC 4.25 V – DC 5.75 V |
| External Port(s) | N/A |
| Test SW Version | DualCard.exe, Ver 1.20120413.01 |
| Software Version | Ver 1.0 |
| Hardware Version | Ver 1.0 |

### 2.2 Additional Model

None

# 3. TEST CONDITION

## 3.1 Equipment Used During Test

The following peripheral devices and/or interface cables were connected during the measurement:

| Description | Model No. | Serial No. | Manufacturer. |
|---|---|---|---|
| Smart Card Reader (EUT) | DE-ABCM5 | N/A | DUALi Inc. |
| Notebook PC | E5470 | ZU10190-15008 | DELL |
| Notebook PC Adapter | LA65NM130 | N/A | DELL |
| RFID Card (Type A & B) | - | - | - |

## 3.2 Mode of operation during the test

The EUT was connected to Notebook PC and then transmitting RF signals continuously using software provided by an applicant. The EUT has 2 different card types, so the test was performed at each card type.

## 3.3 Preliminary Testing for Worst case configuration

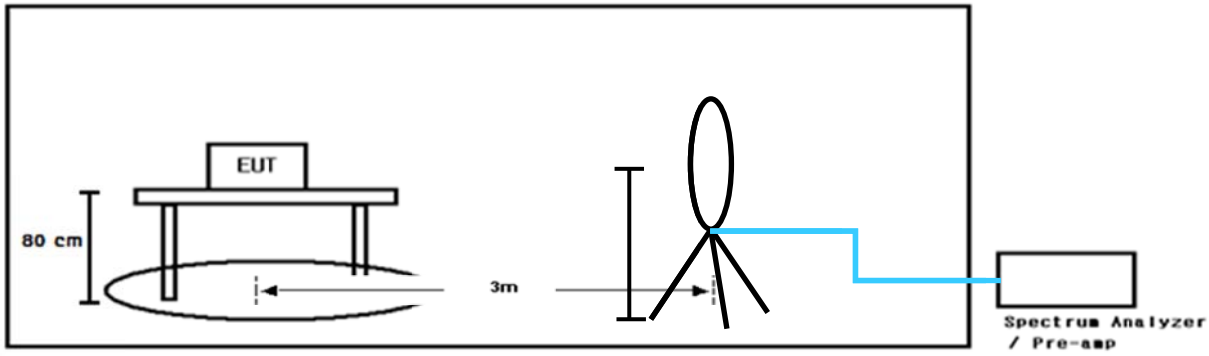
For finding worst case configuration and operating mode, preliminary testing was performed and radiated emission and conducted emission tests were performed with the EUT set to transmit at the channel with the highest output power as worst case scenario. All spurious emission tests were performed in X, Y and Z axis direction. And the worst Y-axis (9 kHz – 30 MHz), and X-axis (30 MHz – 1 GHz) test condition was recorded in this test report.

### 3.3.1 Test Channel and Frequency

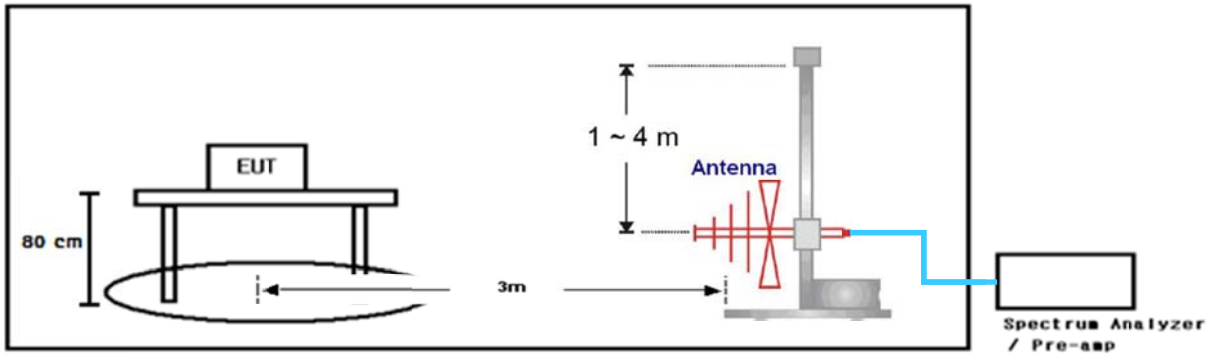
| Test Channel | Channel | Frequency |
|---|---|---|
| Center Channel | - | 13.56 MHz |

## 3.4 Test Setup Drawing

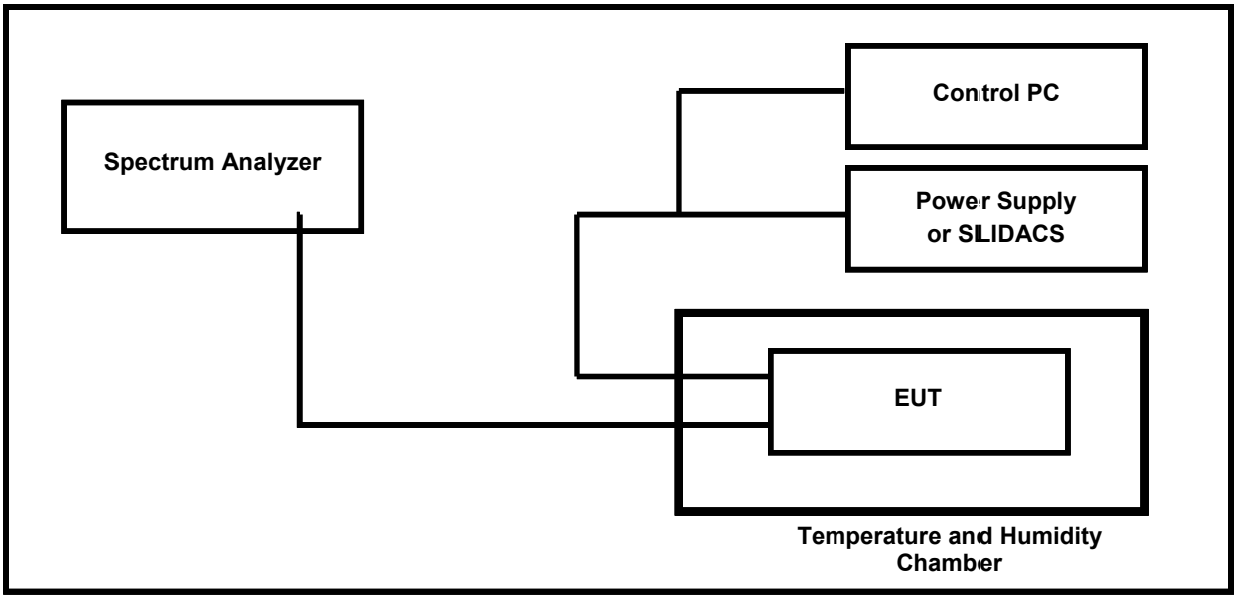
### (Radiated Test below 30 MHz)




### (Radiated Test below 1 GHz)




### (Frequency Tolerance of Carrier Signal Test)




## 3.5 EUT Modifications

- No EMC Relevant Modifications were performed by this test laboratory.

# 4. ANTENNA REQUIREMENT

According to FCC CFR 47 Part 15 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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provision of this section. The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31 (d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

## 4.1 Conclusion

The EUT has an integral PCB loop antenna, so there is no consideration of replacement by the user.

# 5. TEST RESULT

## 5.1 Radiated emissions

### 5.1.1 Regulation

Acc. To section 15.225, and 15.209 following table shall be applied.

| Frequency (MHz) | Field strength limit (μV/m) @ 30 m | Field strength limit (dBμV/m) @ 30 m | Field strength limit (dBμV/m) @ 3 m |
|---|---|---|---|
| 13.110 – 13.410 | 106 | 40.5 | 80.5 |
| 13.410 – 13.553 | 334 | 50.5 | 90.5 |
| 13.553 – 13.567 | 15,848 | 84.0 | 124.0 |
| 13.567 – 13.710 | 334 | 50.5 | 90.5 |
| 13.710 – 14.010 | 106 | 40.5 | 80.5 |

| Frequency (MHz) | Field strength limit (μV/m) | Field strength limit (dBμV/m) | Measurement Distance (m) |
|---|---|---|---|
| 0.009 – 0.490 | 2400/F (kHz) = 266.7 – 4.9 | 48.5 – 13.8 | 300 |
| 0.490 – 1.705 | 24000/F (kHz) = 49.0 – 14.1 | 33.8 - 23.0 | 30 |
| 1.705 – 30.0 | 30 | 29.5 | 30 |
| 30 – 88 | 100 | 40.0 | 3 |
| 88 - 216 | 150 | 43.5 | 3 |
| 216 - 960 | 200 | 46.0 | 3 |
| Above 960 | 500 | 54.0 | 3 |

**Note:** The emission limits shown in the above table are based on measurement instrumentation employing a CISPR quasi-peak detector. For the frequency bands 9 – 90 kHz, 110 – 490 kHz and above 1000 MHz, the radiated emission limits are based on measurements employing an average detector.

### 5.1.2 Method of Measurement

The preliminary radiated emission test was performed using the procedure in ANSI C63.10 2013 to determine the worse operating conditions. The radiated emissions measurements were performed on the 10 m Semi Anechoic Chamber

**Radiated Emissions Test, 9 kHz to 30 MHz (Magnetic Field Test)**

For frequencies from 150 kHz to 30 MHz measurements were made of the magnetic H field. The EUT was placed on the top of the 0.8-meter height, 1 × 1.5 meter non-metallic table. The measuring antenna is an electrically screened loop antenna. Emissions from the EUT are maximized by adjusting the orientation of the Loop antenna and rotating the EUT on the turntable. Manipulating the system cables also maximizes EUT emissions if applicable. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.

**Radiated Emissions Test, below 1 000 MHz**

The frequency spectrum from 30 MHz to 1 000 MHz was scanned and maximum emission levels maximized at each frequency recorded. The system 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 both horizontal and vertical polarization of the receiving antenna. The EUT is situated in three orthogonal planes(if appropriate)

### 5.1.3 Test Site Requirement for KDB 937606

Acc. to KDB 937606, Semi Anechoic Chamber (SAC) shall be verified test results below 30 MHz with Open Area Test Site (OATS), so we compared test results between the measurements from our SAC and an OATS and found test results almost same, so we declare test result for below 30 MHz from our SAC is valid and met the requirement acc. to KDB 937606.

### 5.1.4 Measurement Uncertainty

Measurement uncertainties were not taken into account and following uncertainty levels have been estimated for tests performed on the apparatus. The measurement uncertainties are given with at least 95 % confidence.

| Frequency Range | Uncertainty | Frequency Range | Uncertainty |
|---|---|---|---|
| 9 kHz ~ 30 MHz | ± 2.1 dB | 30 MHz ~ 1 GHz | ± 4.7 dB |

### 5.1.5 Sample Calculated Example

At 80 MHz Limit = 40.0 dBuV/m

Result =Receiver reading value + Antenna Factor + Cable Loss – Pre-amplifier gain = 30 dBuV/m

Margin = Limit – Result = 40 – 30 = 10 so the EUT has 10.0 dB margin at 80 MHz

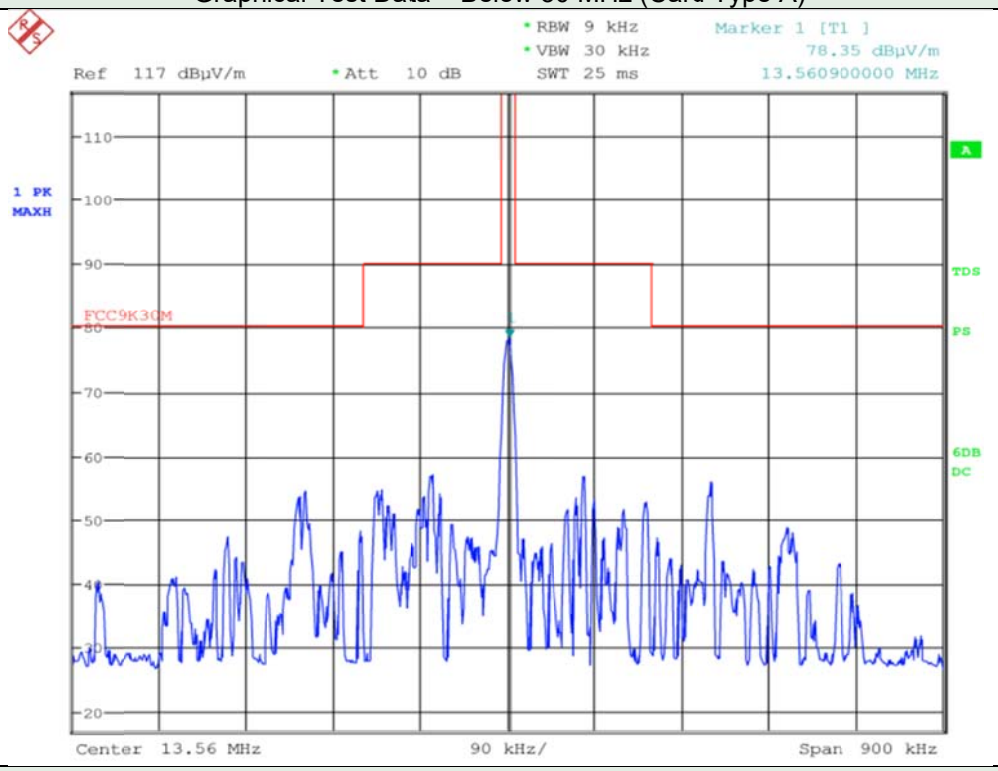
### 5.1.6 Test Data

| | | | |
|---|---|---|---|
| Date of Test | 2018-06-23 | Temperature | (23.2 ± 2.7) °C |
| | | Relative humidity | (54.3 ± 5.9) % R.H. |
| ***Measurement Frequency Range*** | | 9 kHz ~ 1 GHz | |
| ***Test Result*** | ***PASS*** | Tested By | Do-heon Kim |

| Frequency range | Detector Mode | Resolution BW | Video BW | Video Filtering | Measurement distance |
|---|---|---|---|---|---|
| Below 30 MHz | Peak or Q.P. | 9 kHz | 30 kHz | - | 3 m |
| 30 MHz ~ 1 000 MHz | Peak or Q.P. | 100 kHz | 300 kHz | - | 3 m |

### 5.1.6.1 Test Data below 30 MHz

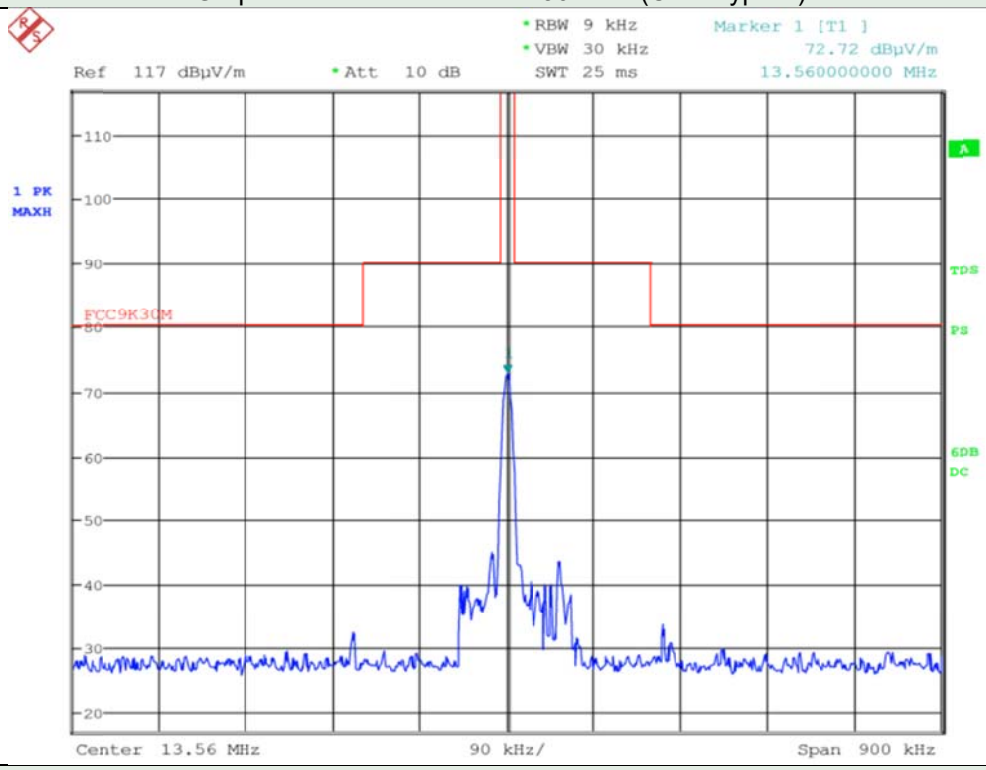
Graphical Test Data – Below 30 MHz (Card Type A)




Tabulated Test Data under 15.225(a), (b)&(c)

| Frequency (MHz) | Detector Mode | Pol. | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Height (cm) | Azimuth (Degree) |
|---|---|---|---|---|---|---|---|
| 13.560 | Peak | H | 78.35 | 124.00 | 45.65 | 100 | 178 |

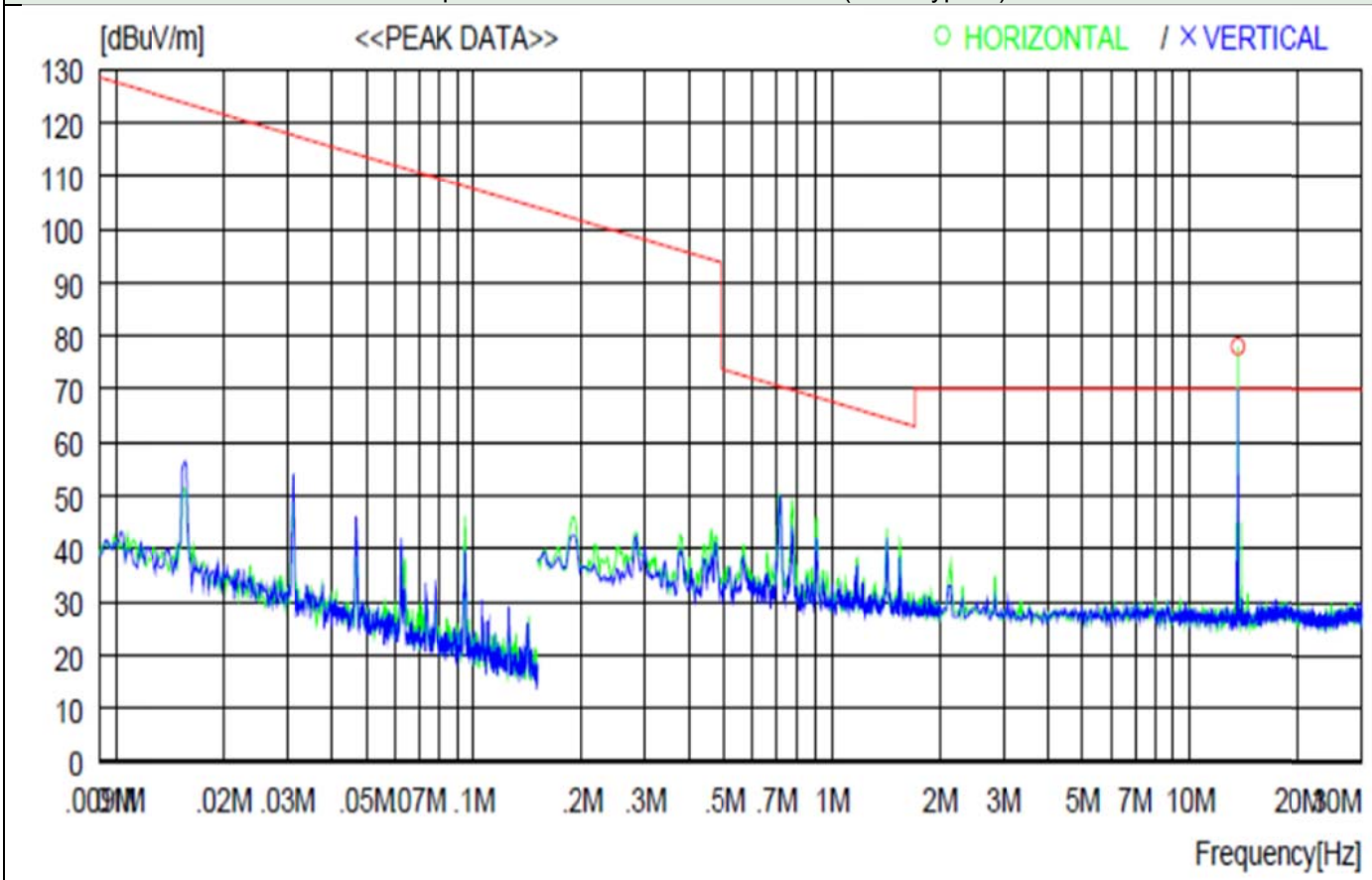
Graphical Test Data – Below 30 MHz (Card Type B)




Tabulated Test Data under 15.225(a), (b)&(c)

| Frequency (MHz) | Detector Mode | Pol. | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Height (cm) | Azimuth (Degree) |
|---|---|---|---|---|---|---|---|
| 13.560 | Peak | H | 72.72 | 124.00 | 51.28 | 100 | 175 |

Graphical Test Data – Below 30 MHz (Card Type A)

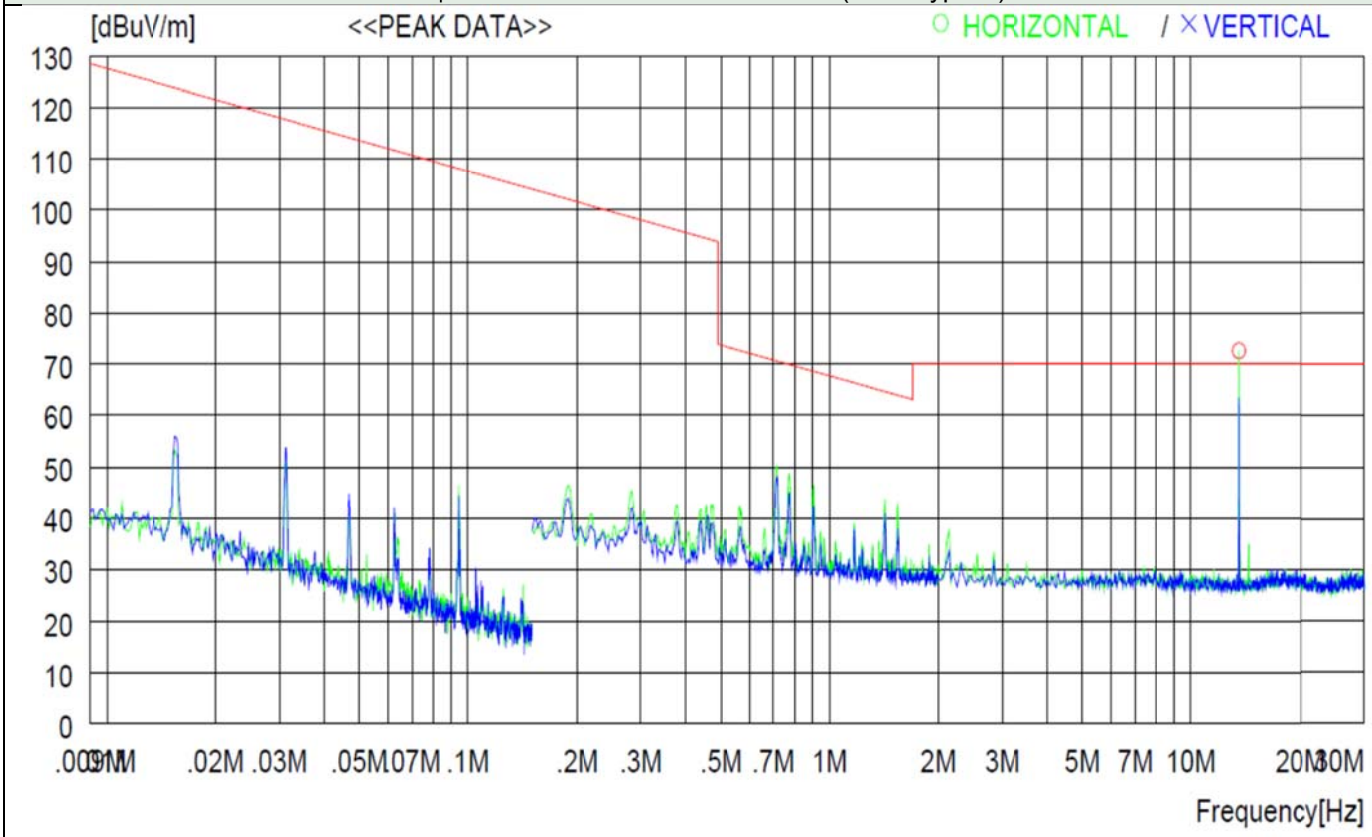



Tabulated Test Data under 15.225(d), 15.209

| Frequency (MHz) | Receiver Reading (dBuV) | Detector Mode | Pol. | Ant. Factor (dB/m) | Corr. Factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Height (cm) | Azimuth (Degree) |
|---|---|---|---|---|---|---|---|---|---|---|

* Spurious emissions that 20 dB below the limits didn't be recorded

Graphical Test Data – Below 30 MHz (Card Type B)



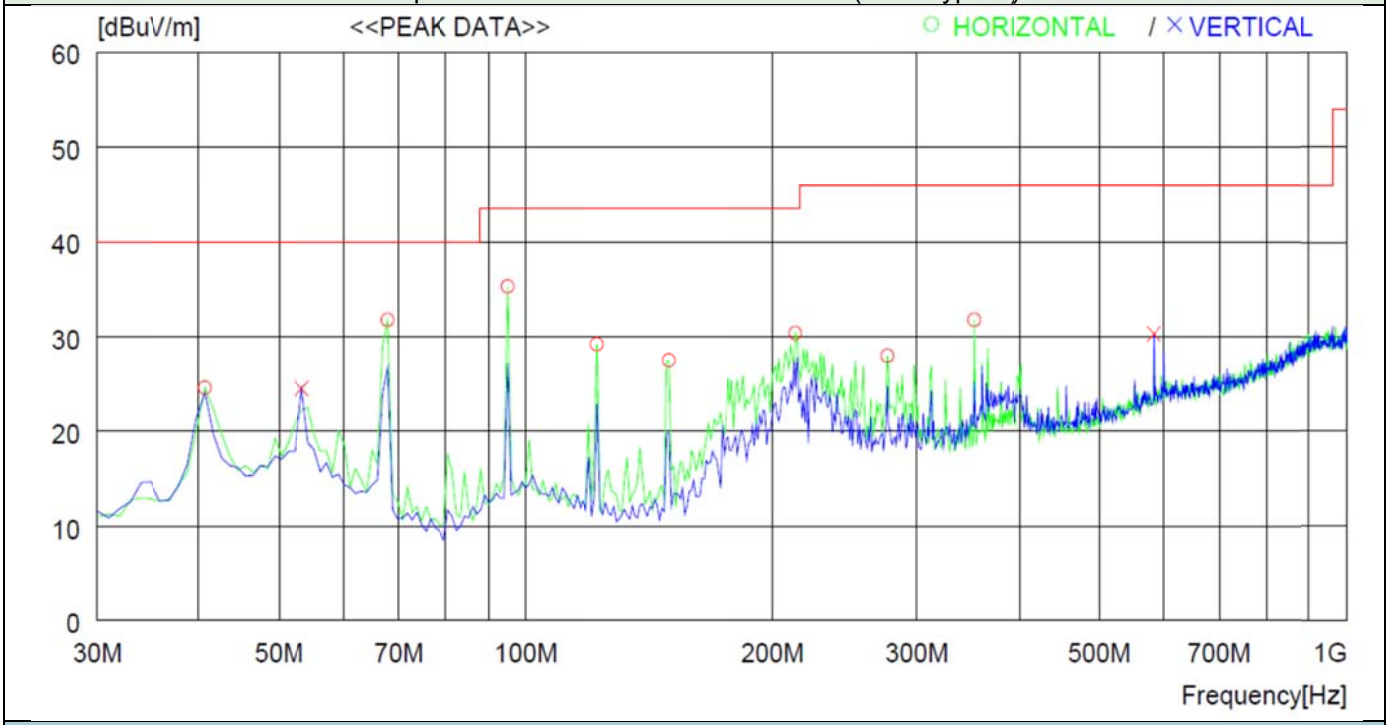

Tabulated Test Data under 15.225(d), 15.209

| Frequency (MHz) | Receiver Reading (dBuV) | Detector Mode | Pol. | Ant. Factor (dB/m) | Corr. Factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Height (cm) | Azimuth (Degree) |
|---|---|---|---|---|---|---|---|---|---|---|

* Spurious emissions that 20 dB below the limits didn't be recorded

### 5.1.6.2 Test Data from 30 MHz to 1 GHz

Graphical Test Data – Below 1 000 MHz (Card Type A)

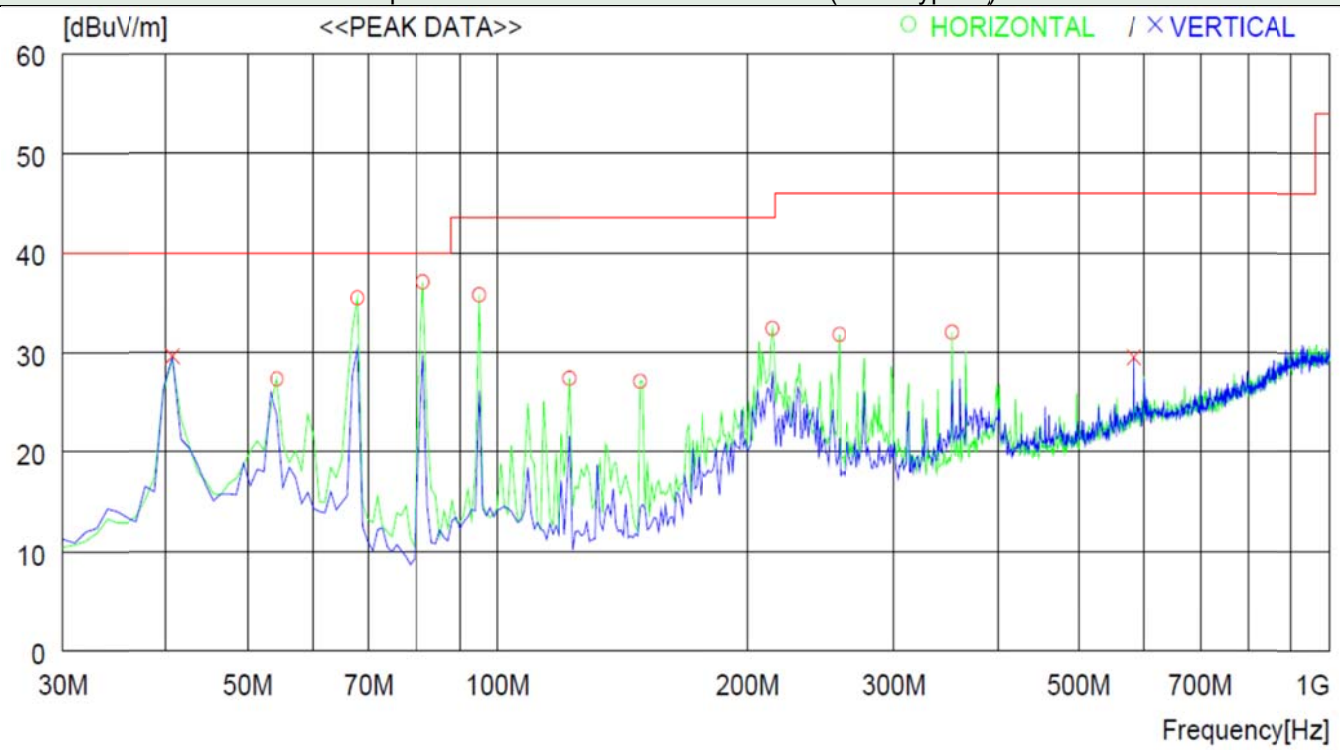



Tabulated Test Data under 15.205(a), 15.209

| Frequency (MHz) | Receiver Reading (dBuV) | Detector Mode | Pol. | Ant. Factor (dB/m) | Corr. Factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Height (cm) | Azimuth (Degree) |
|---|---|---|---|---|---|---|---|---|---|---|
| 40.67 | 37.3 | Peak | H | 12.9 | 25.6 | 24.6 | 40.0 | 15.4 | 200 | 0 |
| 53.280 | 36.4 | Peak | V | 13.5 | 25.4 | 24.5 | 40.0 | 15.5 | 100 | 135 |
| 67.830 | 47.6 | Peak | H | 9.4 | 25.2 | 31.8 | 40.0 | 8.2 | 300 | 212 |
| 94.990 | 48.9 | Peak | H | 11.2 | 24.8 | 35.3 | 43.5 | 8.2 | 200 | 0 |
| 122.150 | 45.0 | Peak | H | 8.7 | 24.5 | 29.2 | 43.5 | 14.3 | 200 | 174 |
| 149.310 | 43.9 | Peak | H | 7.9 | 24.3 | 27.5 | 43.5 | 16.0 | 200 | 116 |
| 213.330 | 42.2 | Peak | H | 11.8 | 23.6 | 30.4 | 43.5 | 13.1 | 200 | 231 |
| 276.380 | 38.1 | Peak | H | 13.1 | 23.2 | 28.0 | 46.0 | 18.0 | 100 | 359 |
| 352.040 | 39.9 | Peak | H | 14.7 | 22.8 | 31.8 | 46.0 | 14.2 | 100 | 136 |
| 582.898 | 32.8 | Peak | V | 19.3 | 21.8 | 30.3 | 46.0 | 15.7 | 100 | 83 |

**Note:** "H" means Horizontal polarity, "V" means Vertical polarity

Graphical Test Data – Below 1 000 MHz (Card Type B)




Tabulated Test Data under 15.205(a), 15.209

| Frequency (MHz) | Receiver Reading (dBuV) | Detector Mode | Pol. | Ant. Factor (dB/m) | Corr. Factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Height (cm) | Azimuth (Degree) |
|---|---|---|---|---|---|---|---|---|---|---|
| 40.670 | 42.3 | Peak | V | 12.9 | 25.6 | 29.6 | 40.0 | 10.4 | 100 | 126 |
| 54.250 | 39.3 | Peak | H | 13.3 | 25.3 | 27.3 | 40.0 | 12.7 | 300 | 359 |
| 67.830 | 51.3 | Peak | H | 9.4 | 25.2 | 35.5 | 40.0 | 4.5 | 300 | 359 |
| 81.410 | 54.9 | Peak | H | 7.2 | 25.0 | 37.1 | 40.0 | 2.9 | 200 | 179 |
| 94.990 | 49.4 | Peak | H | 11.2 | 24.8 | 35.8 | 43.5 | 7.7 | 200 | 202 |
| 122.150 | 43.2 | Peak | H | 8.7 | 24.5 | 27.4 | 43.5 | 16.1 | 200 | 165 |
| 148.340 | 43.5 | Peak | H | 7.9 | 24.3 | 27.1 | 43.5 | 16.4 | 200 | 126 |
| 214.300 | 44.2 | Peak | H | 11.8 | 23.6 | 32.4 | 43.5 | 11.1 | 200 | 74 |
| 257.950 | 42.2 | Peak | H | 12.9 | 23.3 | 31.8 | 46.0 | 14.2 | 100 | 359 |
| 352.040 | 40.1 | Peak | H | 14.7 | 22.8 | 32.0 | 46.0 | 14.0 | 100 | 359 |
| 582.898 | 32.0 | Peak | V | 19.3 | 21.8 | 29.5 | 46.0 | 16.5 | 100 | 58 |

**Note:** “H” means Horizontal polarity, “V” means Vertical polarity

## 5.2 20 dB bandwidth

### 5.2.1 Method of Measurement

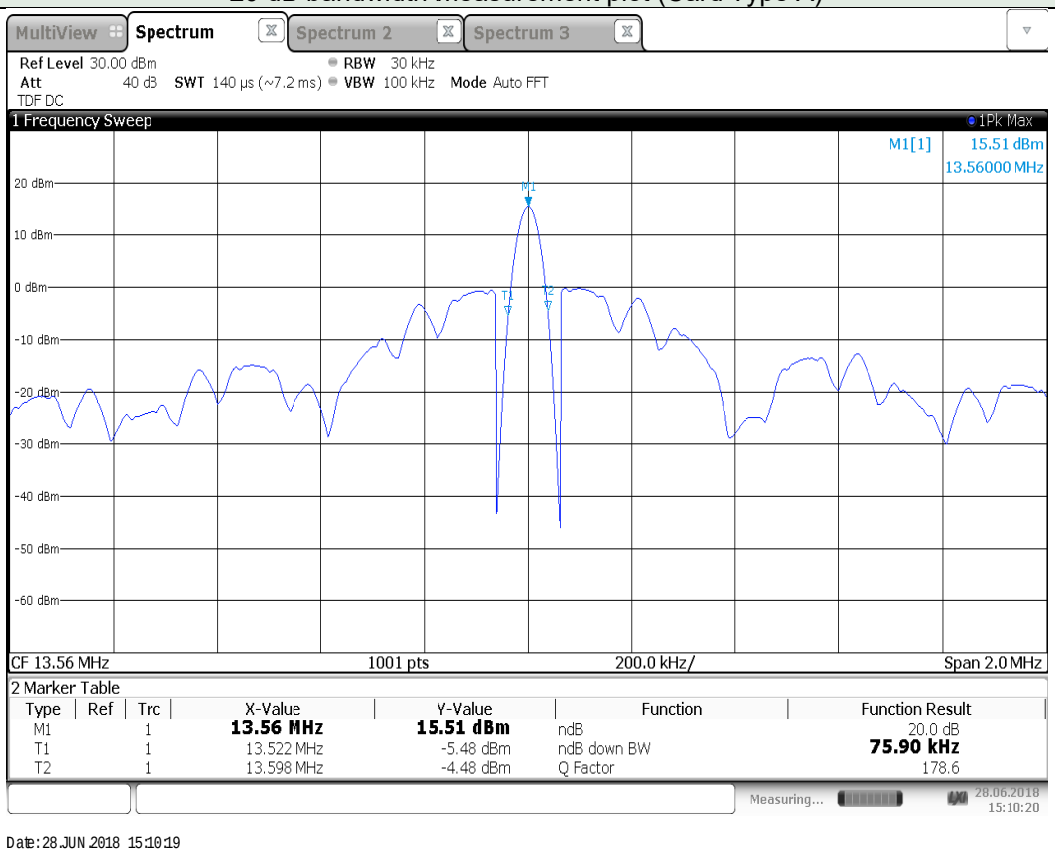
The antenna output of the EUT was connected to the spectrum analyzer. The resolution is set to 30 kHz, and peak detection was used. The 20 dB bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 20 dB.

### 5.2.2 Test Data

| | | | |
|---|---|---|---|
| Date of Test | 2018-06-28 | Temperature | (24.4 ± 1.0) °C |
| | | Relative humidity | (70.1 ± 3.0) % R.H. |
| ***Test Result*** | ***PASS*** | Tested by | Do-heon Kim |

| Operating Frequency (MHz) | Measured Value (MHz) | Limit |
|---|---|---|
| 13.560 | 13.522 | $F_L$ > 13.110 MHz |
| | 13.598 | $F_H$ < 14.010 MHz |

20 dB bandwidth measurement plot (Card Type A)

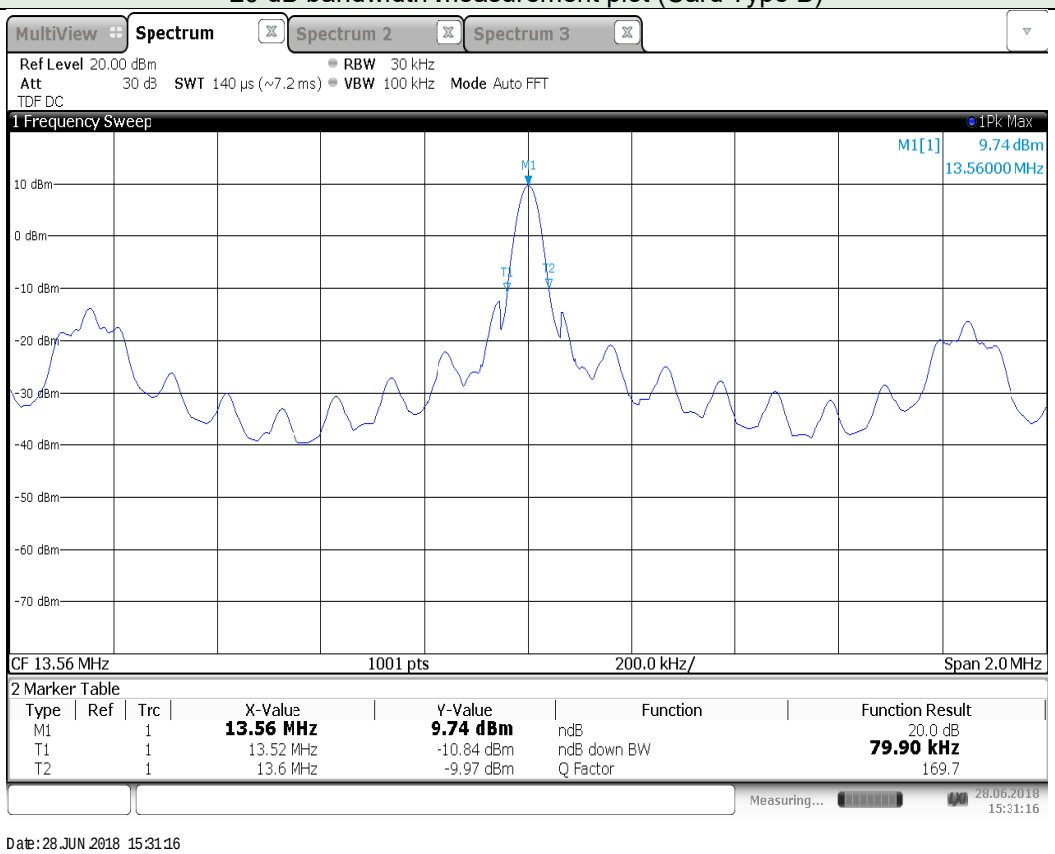



Note: $F_L$ : Lowest frequency at 20 dB bandwidth

$F_H$ : Highest frequency at 20 dB bandwidth

| Operating Frequency (MHz) | Measured Value (MHz) | Limit |
|---|---|---|
| 13.560 | 13.520 | $F_L$ > 13.110 MHz |
| | 13.600 | $F_H$ < 14.010 MHz |

20 dB bandwidth measurement plot (Card Type B)




Note: $F_L$ : Lowest frequency at 20 dB bandwidth

$F_H$ : Highest frequency at 20 dB bandwidth

## 5.3 Frequency tolerance of carrier signal

### 5.3.1 Regulation

**FCC 47CFR15-15.225(e)**

The frequency tolerance of the carrier signal shall be maintained within +/- 0.01% of the operating frequency over a temperature variation of –20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery-operated equipment, the equipment tests shall be performed using a new battery.

### 5.3.2 Method of Measurement

The EUT output was connected to the spectrum analyzer through an attenuator. Turn EUT off and set chamber temperature to -20 °C and then allow sufficient time (approximately 20 to 30 minutes after chamber reach the assigned temperature) for EUT to stabilize. Turn on EUT and measured EUT operating frequency and turn off the EUT after the measurement. The temperature was raised 10 °C step from -20 °C to +50 °C. Repeat above method for frequency measurement every 10 °C step and then record all measured frequencies on each temperature step.

An external DC power supply was connected to the input of the EUT. The voltage of EUT set to 115 % of the nominal value and then was reduced to 85 % of nominal voltage. The output frequency was recorded at each step.

### 5.3.3 Test Data

| | | | |
|---|---|---|---|
| Date of Test | 2018-06-28 | Temperature | (24.4 ± 1.0) °C |
| | | Relative humidity | (70.1 ± 3.0) % R.H. |
| ***Test Result*** | ***PASS*** | Tested by | Do-heon Kim |

Reference Frequency: 13.560 000 MHz, LIMIT: within ±1 356 Hz

| Temp. (°C) | Volt. (V) | Carrier Frequency Measured with Time Elapsed | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Start Up | | 2 minutes | | 5 minutes | | 10 minutes | |
| | | (MHz) | Err (Hz) | (MHz) | Err (Hz) | (MHz) | Err (Hz) | (MHz) | Err (Hz) |
| +50 | 5.00 | 13.560 393 | 393 | 13.560 398 | 398 | 13.560 398 | 398 | 13.560 399 | 399 |
| +40 | 5.00 | 13.560 425 | 425 | 13.560 432 | 432 | 13.560 433 | 433 | 13.560 433 | 433 |
| +30 | 5.00 | 13.560 442 | 442 | 13.560 443 | 443 | 13.560 443 | 443 | 13.560 443 | 443 |
| +20 | 5.75 | 13.560 429 | 429 | 13.560 429 | 429 | 13.560 426 | 426 | 13.560 426 | 426 |
| | 5.00 | 13.560 442 | 442 | 13.560 439 | 439 | 13.560 438 | 438 | 13.560 438 | 438 |
| | 4.25 | 13.560 429 | 429 | 13.560 427 | 427 | 13.560 426 | 426 | 13.560 427 | 427 |
| +10 | 5.00 | 13.560 431 | 431 | 13.560 428 | 428 | 13.560 427 | 427 | 13.560 427 | 427 |
| 0 | 5.00 | 13.560 420 | 420 | 13.560 417 | 417 | 13.560 417 | 417 | 13.560 417 | 417 |
| -10 | 5.00 | 13.560 414 | 414 | 13.560 415 | 415 | 13.560 416 | 416 | 13.560 416 | 416 |
| -20 | 5.00 | 13.560 421 | 421 | 13.560 429 | 429 | 13.560 431 | 431 | 13.560 433 | 433 |

## 5.4 AC Power Line Conducted Emission

### 5.4.1 Limit

Acc. to section 15.207 (a), following table shall be applied.

| Frequency Range (MHz) | Quasi-Peak (dBuV) | Average (dBuV) |
|---|---|---|
| 0.15 - 0.5 | 66 to 56 | 56 to 46 |
| 0.5 - 5 | 56 | 46 |
| 5 -30 | 60 | 50 |

### 5.4.2 Method of Measurement

The EUT was placed on a wooden table, 0.8 m height above the horizontal ground plane and 40 cm from the vertical ground plane. 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.

The receiver is set to a resolution bandwidth of 9 kHz. Peak detection is used unless otherwise noted as quasi-peak or average.

The test was performed for both Neutral and Hot lines.

### 5.4.3 Measurement Uncertainty

Measurement uncertainties were not taken into account and following uncertainty levels have been estimated for tests performed on the apparatus. The measurement uncertainties are given with at least 95 % confidence.

| Frequency Range | Uncertainty | Frequency Range | Uncertainty |
|---|---|---|---|
| 9 kHz ~ 150 kHz | ± 2.00 dB | 150 kHz ~ 30 MHz | ± 2.00 dB |

### 5.4.4 Sample Calculated Example

At 5.31 MHz QP Limit = 60.0 dBuV

Correction Factor (C. Factor) of LISN, Pulse Limiter and cable loss at 5.31 MHz = 9.7 dB

Q.P Reading from the Test receiver = 20.8 dBuV

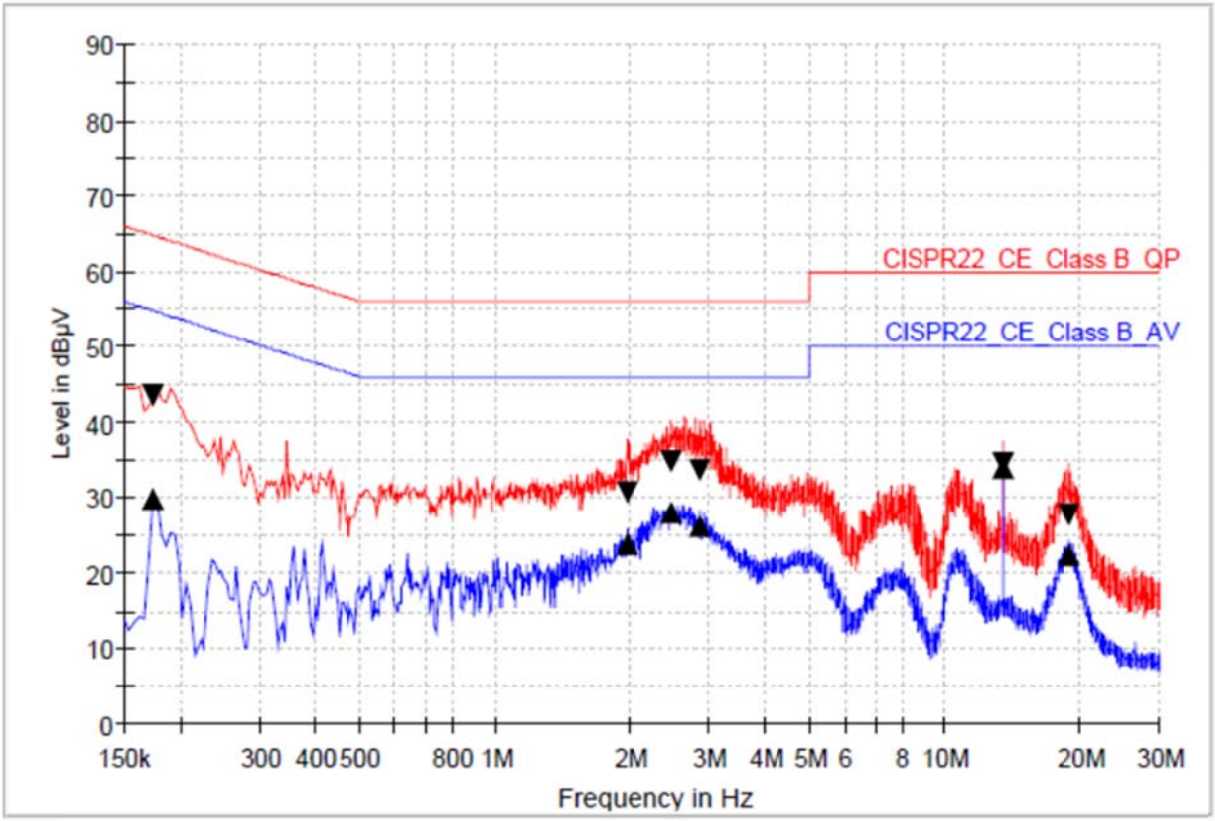
(Calculated value for system losses by software EMC32 manufactured by Rohde & Schwarz)

Therefore Q.P Margin = 60 - 20.8 = 39.2 so the EUT has 39.2 dB margin at 5.31 MHz

### 5.4.5 Worst Case Test Data

| | | | |
|---|---|---|---|
| Date of Test | 2018-06-26 | Temperature | (23.8 ± 2.7) °C |
| | | Relative humidity | (51.3 ± 5.9) % R.H. |
| ***Measurement Frequency Range*** | | 9 kHz ~ 30MHz | |
| ***Test Result*** | ***PASS*** | Tested By | Do-heon Kim |

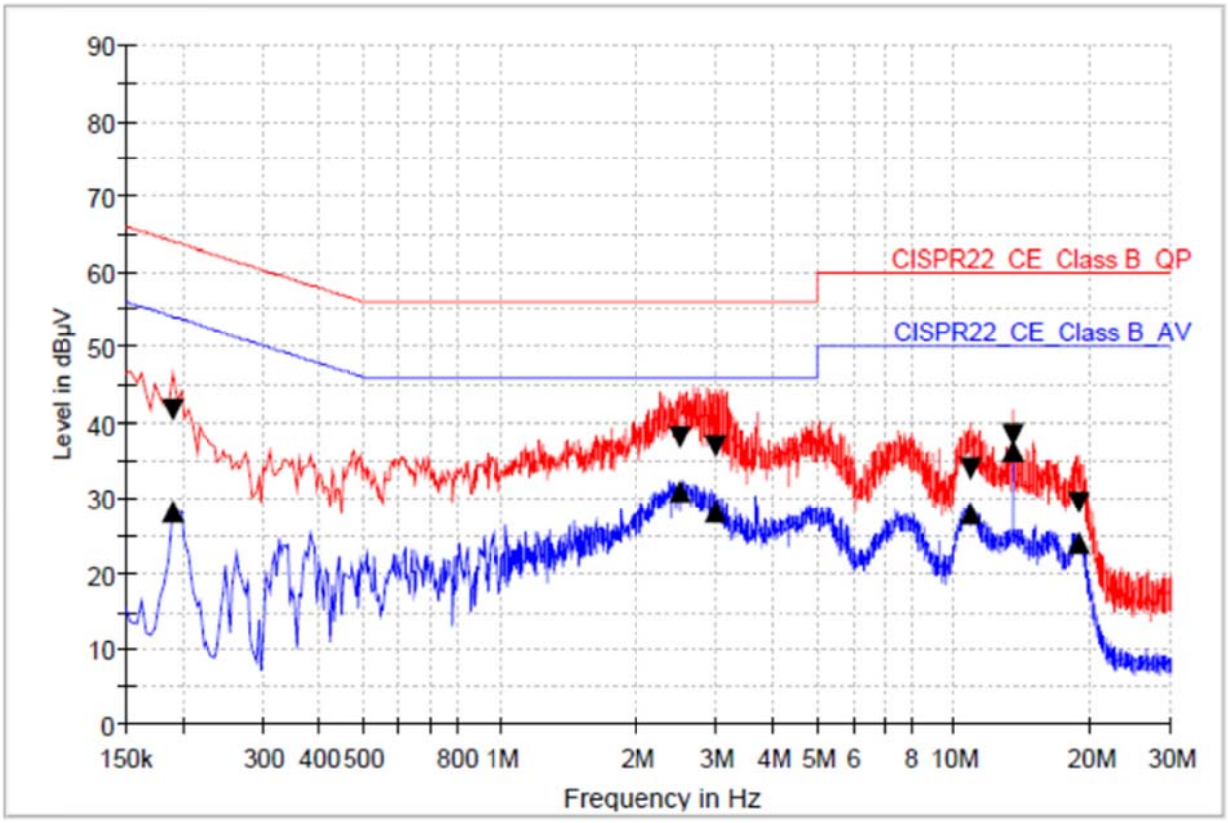
Hot Line (Card Type A)




## Limit and Margin1

| Frequency (MHz) | QuasiPeak (dBµV) | CAverage (dBµV) | Bandwidth (kHz) | Line | Corr. (dB) | Margin - QPK (dB) | Limit - QPK (dBµV) | Margin - CAV (dB) | Limit - CAV (dBµV) |
|---|---|---|---|---|---|---|---|---|---|
| 0.174000 | 43.5 | 29.7 | 9.000 | L1 | 9.6 | 21.3 | 64.8 | 25.1 | 54.8 |
| 1.978000 | 30.7 | 23.7 | 9.000 | L1 | 9.6 | 25.3 | 56.0 | 22.3 | 46.0 |
| 2.466000 | 34.9 | 28.0 | 9.000 | L1 | 9.7 | 21.1 | 56.0 | 18.0 | 46.0 |
| 2.874000 | 33.6 | 26.2 | 9.000 | L1 | 9.7 | 22.4 | 56.0 | 19.8 | 46.0 |
| 13.558000 | 34.5 | 34.1 | 9.000 | L1 | 9.8 | 25.5 | 60.0 | 15.9 | 50.0 |
| 18.946000 | 27.8 | 22.2 | 9.000 | L1 | 9.9 | 32.2 | 60.0 | 27.8 | 50.0 |

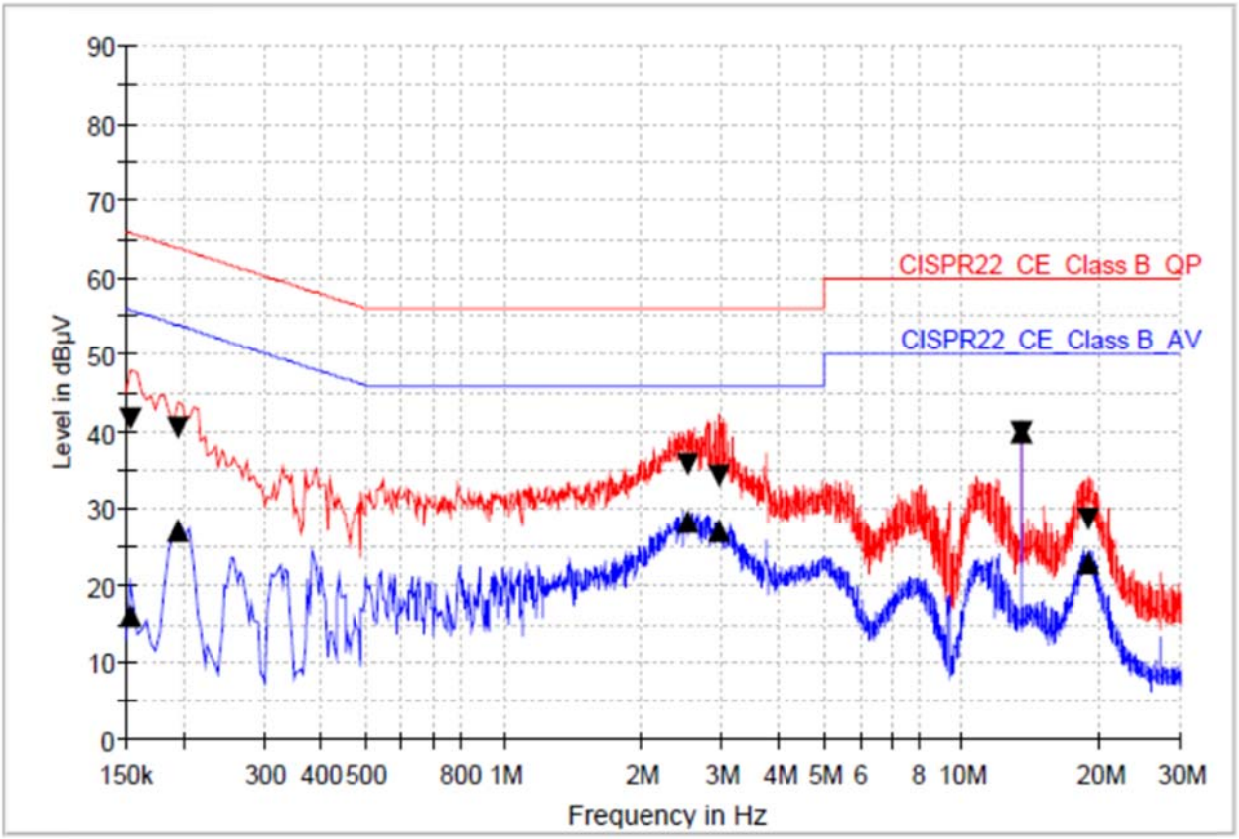
Neutral Line (Card Type A)




## Limit and Margin1

| Frequency (MHz) | QuasiPeak (dBµV) | CAverage (dBµV) | Bandwidth (kHz) | Line | Corr. (dB) | Margin - QPK (dB) | Limit - QPK (dBµV) | Margin - CAV (dB) | Limit - CAV (dBµV) |
|---|---|---|---|---|---|---|---|---|---|
| 0.190000 | 41.7 | 28.4 | 9.000 | N | 9.6 | 22.3 | 64.0 | 25.6 | 54.0 |
| 2.486000 | 38.1 | 30.9 | 9.000 | N | 9.7 | 17.9 | 56.0 | 15.1 | 46.0 |
| 2.990000 | 36.8 | 28.3 | 9.000 | N | 9.7 | 19.2 | 56.0 | 17.7 | 46.0 |
| 10.874000 | 34.0 | 28.1 | 9.000 | N | 9.8 | 26.0 | 60.0 | 21.9 | 50.0 |
| 13.562000 | 38.4 | 36.5 | 9.000 | N | 9.8 | 21.6 | 60.0 | 13.5 | 50.0 |
| 18.886000 | 29.6 | 24.2 | 9.000 | N | 9.9 | 30.4 | 60.0 | 25.8 | 50.0 |

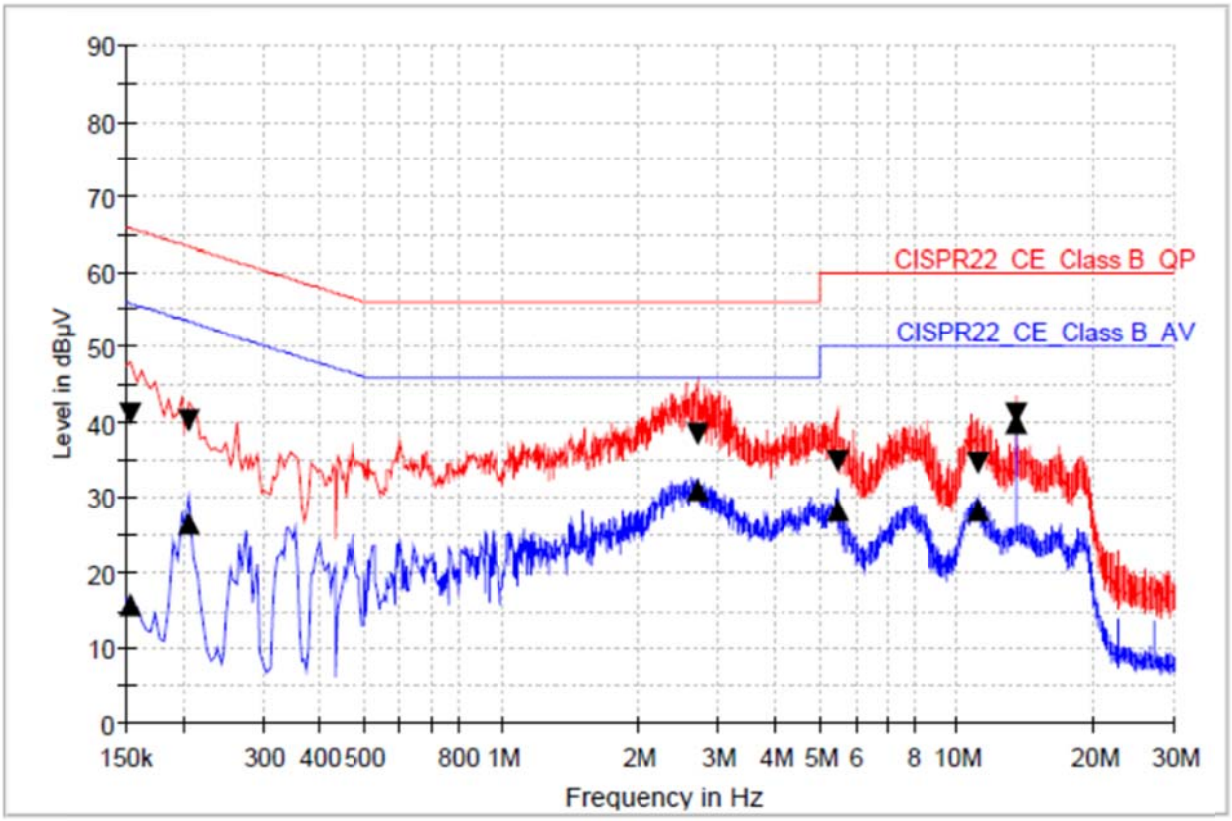
Hot Line (Card Type B)




## Limit and Margin1

| Frequency (MHz) | QuasiPeak (dBµV) | CAverage (dBµV) | Bandwidth (kHz) | Line | Corr. (dB) | Margin - QPK (dB) | Limit - QPK (dBµV) | Margin - CAV (dB) | Limit - CAV (dBµV) |
|---|---|---|---|---|---|---|---|---|---|
| 0.154000 | 41.7 | 16.1 | 9.000 | L1 | 9.6 | 24.1 | 65.8 | 39.7 | 55.8 |
| 0.194000 | 40.6 | 27.2 | 9.000 | L1 | 9.6 | 23.3 | 63.9 | 26.6 | 53.9 |
| 2.518000 | 35.7 | 28.4 | 9.000 | L1 | 9.7 | 20.3 | 56.0 | 17.6 | 46.0 |
| 2.950000 | 34.4 | 27.2 | 9.000 | L1 | 9.7 | 21.6 | 56.0 | 18.8 | 46.0 |
| 13.562000 | 39.8 | 39.8 | 9.000 | L1 | 9.8 | 20.2 | 60.0 | 10.2 | 50.0 |
| 18.986000 | 28.5 | 23.0 | 9.000 | L1 | 9.9 | 31.5 | 60.0 | 27.0 | 50.0 |

Neutral Line (Card Type B)




## Limit and Margin1

| Frequency (MHz) | QuasiPeak (dBµV) | CAverage (dBµV) | Bandwidth (kHz) | Line | Corr. (dB) | Margin - QPK (dB) | Limit - QPK (dBµV) | Margin - CAV (dB) | Limit - CAV (dBµV) |
|---|---|---|---|---|---|---|---|---|---|
| 0.154000 | 41.1 | 15.7 | 9.000 | N | 9.6 | 24.7 | 65.8 | 40.1 | 55.8 |
| 0.206000 | 40.1 | 26.4 | 9.000 | N | 9.6 | 23.3 | 63.4 | 27.0 | 53.4 |
| 2.710000 | 38.3 | 30.9 | 9.000 | N | 9.7 | 17.7 | 56.0 | 15.1 | 46.0 |
| 5.458000 | 35.0 | 28.4 | 9.000 | N | 9.7 | 25.0 | 60.0 | 21.6 | 50.0 |
| 11.130000 | 34.4 | 28.3 | 9.000 | N | 9.8 | 25.6 | 60.0 | 21.7 | 50.0 |
| 13.562000 | 41.1 | 40.0 | 9.000 | N | 9.8 | 18.9 | 60.0 | 10.0 | 50.0 |

## Appendix I – Test Instrumentation

| Description | Model No. | Serial No. | Manufacturer. | Due for Cal Date |
|---|---|---|---|---|
| Signal & Spectrum Analyzer | FSW 43 | 100578 | Rohde & Schwarz | 2019-04-26 |
| Attenuator | 56-10 | 58769 | WEINSCHEL | 2019-01-22 |
| Temperature & Humidity Chamber | SM-1.0-3800 | 38025 | THERMOTRON | 2018-07-04 |
| DC Power Supply | 6032A | SG41000637 | AGILENT | 2019-03-29 |
| Test Receiver | ESU 26 | 100303 | Rohde & Schwarz | 2019-01-18 |
| Loop Antenna | HFH2-Z2 | 100341 | Rohde & Schwarz | 2019-04-21 |
| TRILOG Broadband Antenna | VULB9163 | 9163.799 | Schwarzbeck | 2019-09-14 |
| Attenuator | 6dB | 272.4110.50 | Rohde & Schwarz | 2019-01-18 |
| Pre-Amplifier | 310N | 344015 | Sonoma Instrument | 2019-01-18 |
| Turn Table | DT3000-3t | 1310814 | INNCO SYSTEM | N/A |
| Antenna Master | MA4000-EP | 4600814 | INNCO SYSTEM | N/A |
| Camera Controller | HDCon4102 | 6531445048 | PONTIS | N/A |
| CO3000 Controller | Co3000-4Port | CO3000/806/ 34130814/L | INNCO SYSTEM | N/A |

The measuring equipment utilized to perform the tests documented in this test report has been calibrated in accordance with manufacturer's recommendations, and is traceable to recognized national standards.