# RF TEST REPORT

| | | |
|---|---|---|
| Test Equipment | : | R1M |
| Model Name | : | SP69 |
| FCC ID | : | S7A-SP69 |
| IC | : | 8154A-SP69 |
| Date of receipt | : | 2019.04.15 |
| Test duration | : | 2019.04.18 ~ 2019.04.26 |
| Date of issue | : | 2019.05.03 |

| | | |
|---|---|---|
| Applicant (FCC) | : | SENA TECHNOLOGIES.Inc<br>19, Heolleung-ro 569-gil, Gangnam-gu, Seoul, South Korea |
| Applicant (IC) | : | Sena Technologies, Inc.<br>210 Yangjae-dong, Seocho-gu Seoul 137-130 South Korea (Republic Of) |
| Test Laboratory | : | Lab-T, Inc.<br>2182-42 Baegok-daero, Mohyeon-myeon, Cheoin-gu, Yongin-si Gyeonggi-do 17036, South Korea |

| | | |
|---|---|---|
| Test specification | : | FCC Part 15 Subpart C 15.247 |
| | : | RSS-247 Issue 2 (2017-02), RSS-GEN Issue 5(2018-04) |
| RF Output Power | : | 18.05 dBm |
| Test result | : | Pass |

The above equipment was tested by Lab-T Testing Laboratory for compliance with the requirements of FCC,IC Rules and Regulations.
The test results presented in this test report are limited only to the sample supplied by applicant and the use of this test report is inhibited other than its purpose.
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| | |
|---|---|
| Tested by: | Reviewed by: |
| Engineer<br>Namhyoung Kwon | Technical Manager<br>SangHoon Yu |

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# 1. Client Information

| | | |
|---|---|---|
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| Applicant(IC) | : | Sena Technologies, Inc. |
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| | | |
|---|---|---|
| Manufacturer | : | Sena Technologies, Inc. |
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# 2. Laboratory Information

| | | |
|---|---|---|
| Test Laboratory | : | Lab-T, Inc. |
| Address | : | 2182-42 Baegok-daero, Mohyeon-myeon, Cheoin-gu, Yongin-si Gyeonggi-do 17036, South Korea |
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**Certificate**

| | | |
|---|---|---|
| FCC Designation No. | : | KR0159 |
| FCC Registration No. | : | 133186 |
| IC Site Registration No. | : | 22000 |

# 3. Information About Test Equipment

## 3.1 Equipment Information

| | |
|---|---|
| Equipment type | R1M |
| Equipment model name | SP69 |
| Equipment add model name | - |
| Frequency range | 2 410 MHz ~ 2 475 MHz |
| Modulation type | O-QPSK |
| Modulation technology | Mesh |
| Power supply | DC 3.8 V |
| H/W version | v1.0 |
| S/W version | v1.0 |

Note1: The above EUT information was declared by the manufacturer.

## 3.2 Antenna Information

| | | |
|---|---|---|
| Antenna 1 | Type | PCB Antenna |
| | Gain | 0.52 dBi |
| Antenna 2 | Type | N/A |
| | Gain | N/A |

## 3.3 Test Frequency

| Test mode | Test frequency (MHz) | | |
|---|---|---|---|
| | Lowest frequency | Middle frequency | Highest frequency |
| Mesh | 2 410 | 2 445 | 2475 |

## 3.4 Tested Companion Device Information

| Type | Manufacturer | Model | Note |
|---|---|---|---|
| Adaptor | Samsung | EP-TA20KBK<br>(S/N : R37JBGM0B11SE3) | Used Conducted Emission<br>Input : AC 100 ~ 240 V<br>Output : DC5V, 2.0A<br>DC9V, 1.67A<br>USB version : 3.0 micro usb |
| - | - | - | - |

# 4. Test Report

## 4.1 Summary

| FCC Part 15 & RSS-247 Issue 2 & RSS-GEN Issue 5 | | | | |
|---|---|---|---|---|
| FCC Rule | IC Rule | Parameter | Clause | Status |
| **Transmitter Requirements** | | | | |
| 15.203<br>15.247(b)(4) | - | Antenna Requirement | 5.3.2 | C |
| 15.247(b)(3) | RSS-247 5.4(d) | Maximum Peak Output Power | 5.3.3 | C |
| 15.247(e) | RSS-247 5.2(b) | Peak Power Spectral Density | 5.3.2 | C |
| 15.247(a)(2) | RSS-247 5.2(a) | 6 dB Channel Bandwidth | 5.3.2 | C |
| - | RSS-GEN 6.7 | Occupied Bandwidth | 5.3.7 | C |
| 15.247(d)<br>15.205(a)<br>15.209(a) | RSS-247 5.5<br>RSS-GEN 8.9<br>RSS-GEN 8.10 | Spurious Emission, Band Edge and Restricted bands | 5.3.8 | C |
| 15.207(a) | RSS-GEN 8.8 | Conducted Emissions | 5.3.9 | C |
| NOTE 1 : | C = Comply N/C = Not Comply N/T = Not Tested N/A = Not Applicable | | | |

* The general test methods used to test this device is ANSI C63.10:2013

## 4.2 Measurement Uncertainty

| Mesurement items | Expanded Uncertainty |
|---|---|
| RF Output Power | ±0.72 dB (The confidence level is about 95 %, *k*=2) |
| Power Spectral Density | ±0.91 dB (The confidence level is about 95 %, *k*=2) |
| Occupied Channel Bandwidth | ±11.27 kHz (The confidence level is about 95 %, *k*=2) |
| Conducted Spurious Emissions | ±0.39 dB (The confidence level is about 95 %, *k*=2) |
| Radiated Spurious Emissions (1 GHz under) | ±4.88 dB (The confidence level is about 95 %, *k*=2) |
| Radiated Spurious Emissions (Above 1 GHz) | ±6.14 dB (The confidence level is about 95 %, *k*=2) |
| Conducted emission | ±2.34 dB (The confidence level is about 95 %, *k*=2) |

## 4.3 Test Report Version

| Test Report No. | Date | Description |
|---|---|---|
| TRRFCC19-0025 | 19.05.03 | Initial issue |
| | | |
| | | |
| | | |

## 4.4 Transmitter Requirements

### 4.4.1 Antenna Requirement

4.4.1.1 Regulation

Accoding to §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 provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

Accoding to §15.247(b)(4) e conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

4.4.1.2 Result

Comply
(The transmitter has internal PCB antenna which is connected by a unique connector(U.FL). The directional peak gain of the antenna is 0.52 dBi.)

### 4.4.2 Maximum Peak Output Power

4.4.2.1 Regulation

According to §15.247(b)(3) and RSS-247 §5.4(d) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

According to §15.247(b)(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

4.4.2.2 Measurement Procedure

These test measurement settings are specified in section 9.0 of 558074 D01 DTS Meas Guidance.

4.4.2.2.1 PKPM1 Peak power meter method

The maximum peak conducted output power may be measured using a broadband peak RF power meter.
The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall utilize a fast-responding diode detector

4.4.2.3 Result

Comply (measurement data : refer to the next page)

4.4.2.4 Measurement data

Test mode : Mesh

| Maximum Peak Output Power | | | | Average Power |
|---|---|---|---|---|
| Frequency (MHz) | Result (dBm) | Limit (dBm) | Margin (dB) | Result (dBm) |
| 2 410 | 18.05 | 30.00 | 11.95 | 8.75 |
| 2 445 | 17.95 | 30.00 | 12.05 | 8.27 |
| 2 475 | 17.42 | 30.00 | 12.58 | 7.78 |

Note1 : Since the directional gain of the PCB Antenna declared by the manufacturer, does not exceed 6.0 dBi ,there was no need to reduce the output power.

Note2 : We took the insertion loss of the cable loss into consideration within the measuring instrument.

### 4.4.3 Peak Power Spectral Density

4.4.3.1 Regulation

According to §15.247(e) and RSS-247 §5.2(b) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

4.4.3.2 Measurement Procedure

These test measurement settings are specified in section 10.0 of 558074 D01 DTS Meas Guidance.

4.4.3.2.1 Method PKPSD (peak PSD)

This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance, and is optional if the maximum conducted (average) output power was used to demonstrate compliance.

a) Set analyzer center frequency to DTS channel center frequency.
b) Set the span to 1.5 times the DTS bandwidth.
c) Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
d) Set the VBW ≥ 3 RBW.
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level within the RBW.
j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

4.4.3.3 Result

Comply (measurement data : refer to the next page)

4.4.3.4 Measurement data

Test mode : Mesh

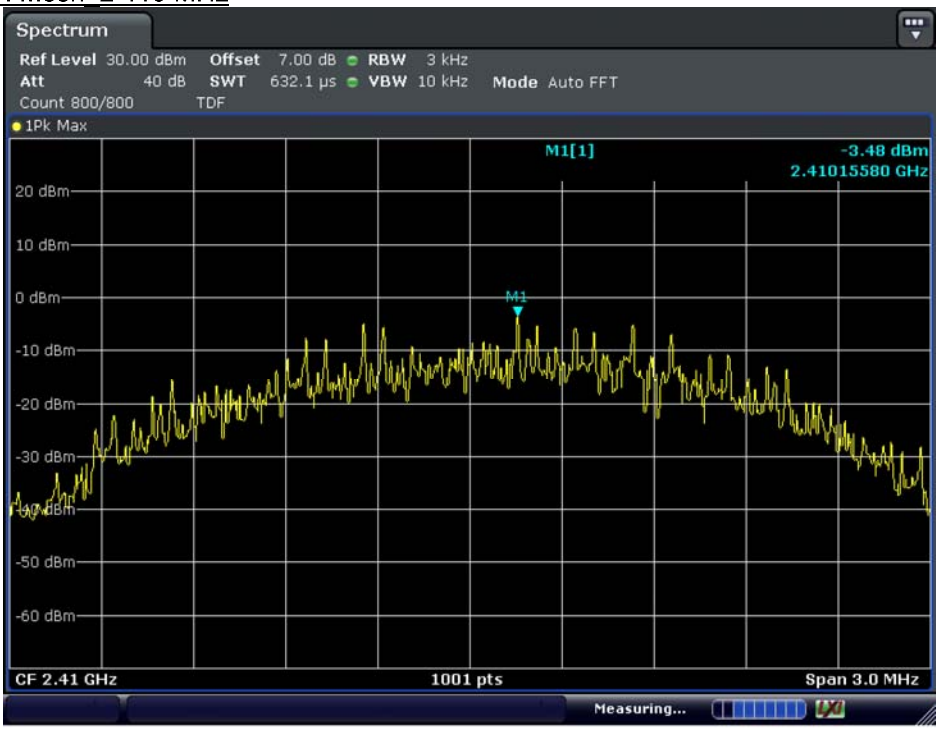
| Frequency (MHz) | Result (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|
| 2 410 | -3.48 | 8.00 | 11.48 |
| 2 445 | -3.81 | 8.00 | 11.81 |
| 2 475 | -4.99 | 8.00 | 12.99 |

Note1 : Since the directional gain of the PCB Antenna declared by the manufacturer, does not exceed 6.0 dBi ,there was no need to reduce the output power.

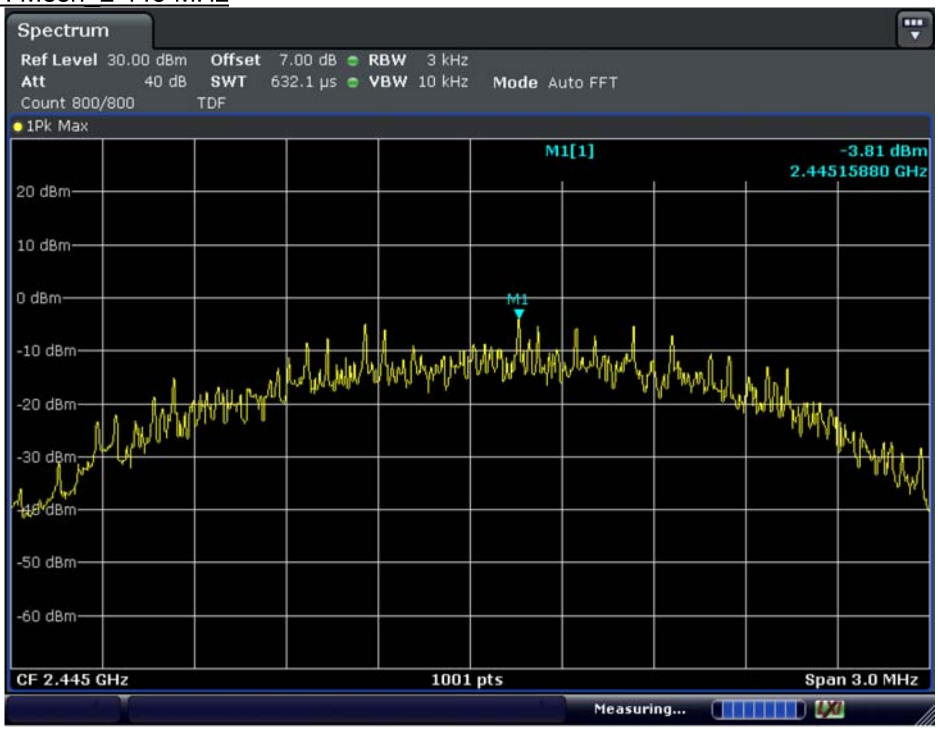
Note2 : We took the insertion loss of the cable loss into consideration within the measuring instrument.

4.4.3.5 Test Plot

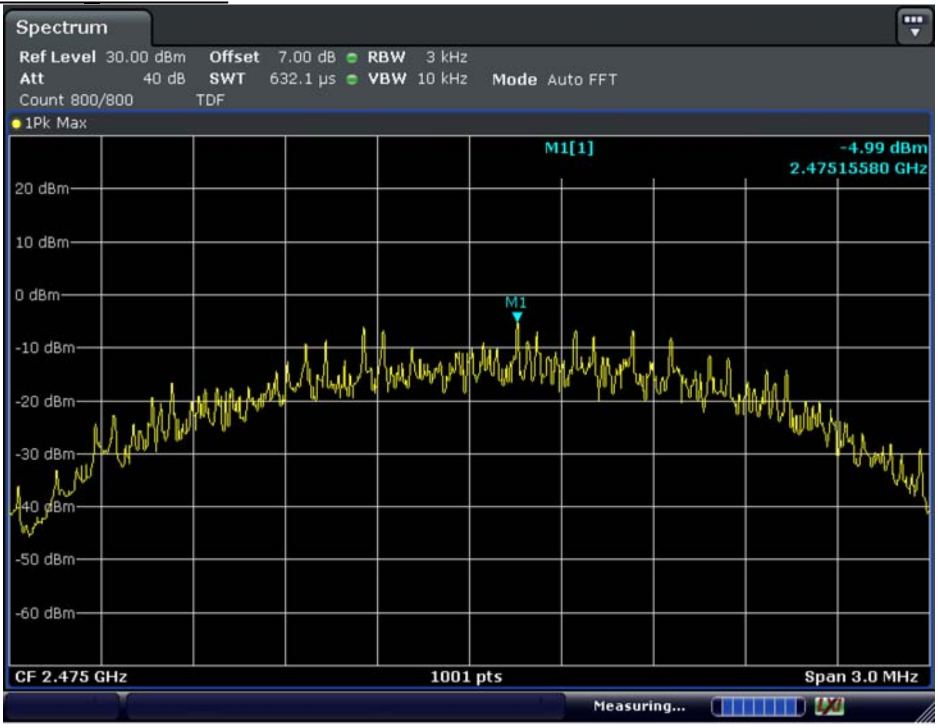
Test mode : Mesh_2 410 MHz




Test mode : Mesh_2 445 MHz



Test mode : Mesh_2 475 MHz



### 4.4.4 6 dB Bandwidth(DTS Bandwidth)

4.4.4.1 Regulation

According to §15.247(e) and RSS-247 §5.2(a) Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

4.4.4.2 Measurement Procedure

These test measurement settings are specified in section 8.0 of 558074 D01 DTS Meas Guidance.

4.4.4.2.1 DTS Channel Bandwidth-Option 1

a) Set RBW = 100 kHz.
b) Set the video bandwidth (VBW) ≥ 3 RBW.
c) Detector = Peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

4.4.4.2.2 DTS Channel Bandwidth Measurement Procedure-Option 2

The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥3 RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

4.4.4.3 Result

Comply (measurement data : refer to the next page)

4.4.4.4 Measurement data

Test mode : Mesh

| Frequency (MHz) | 6 dB Bandwidth (MHz) | Min. Limit (MHz) | Occupied Bandwidth (99 % Bandwith)(MHz) |
|---|---|---|---|
| 2 410 | 1.23 | 0.50 | 2.25 |
| 2 445 | 1.16 | 0.50 | 2.45 |
| 2 475 | 1.48 | 0.50 | 2.27 |

4.4.4.5 Test Plot

Test mode : Mesh / 2 410 MHz_6 dB Bandwidth


| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|---|---|---|---|---|---|---|
| M1 | | 1 | 2.40935846 GHz | 6.72 dBm | | |
| D1 | M1 | 1 | 1.22708 MHz | -0.00 dB | | |
| M2 | | 1 | 2.40966723 GHz | 12.72 dBm | | |

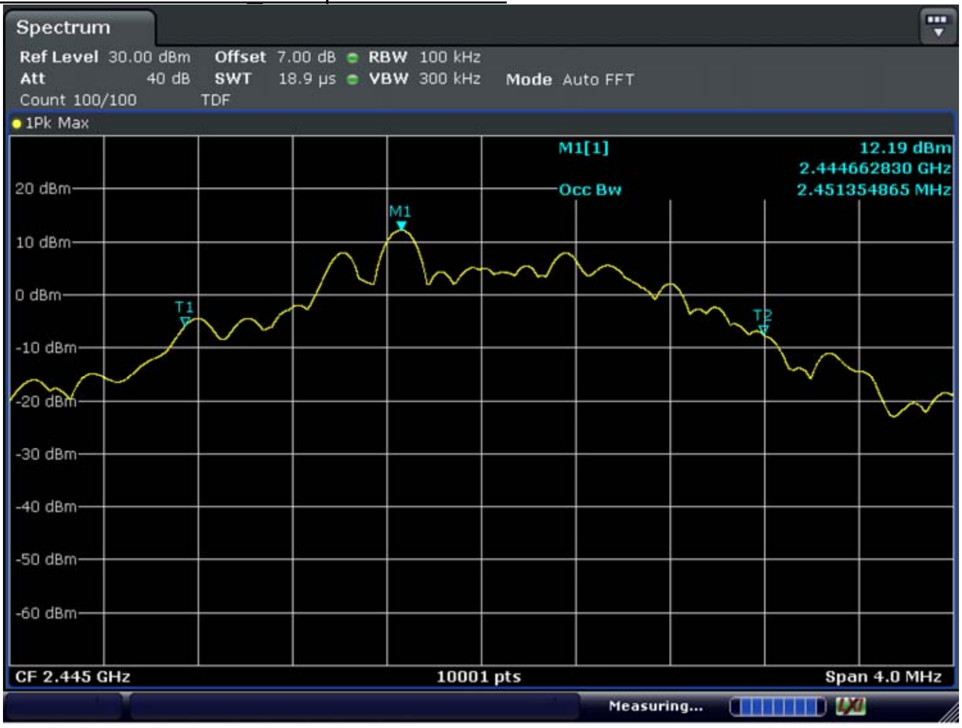
Test mode : Mesh / 2 445 MHz_6 dB Bandwidth


| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|---|---|---|---|---|---|---|
| M1 | | 1 | 2.44435886 GHz | 6.53 dBm | | |
| D1 | M1 | 1 | 1.15748 MHz | -0.01 dB | | |
| M2 | | 1 | 2.44466283 GHz | 12.53 dBm | | |

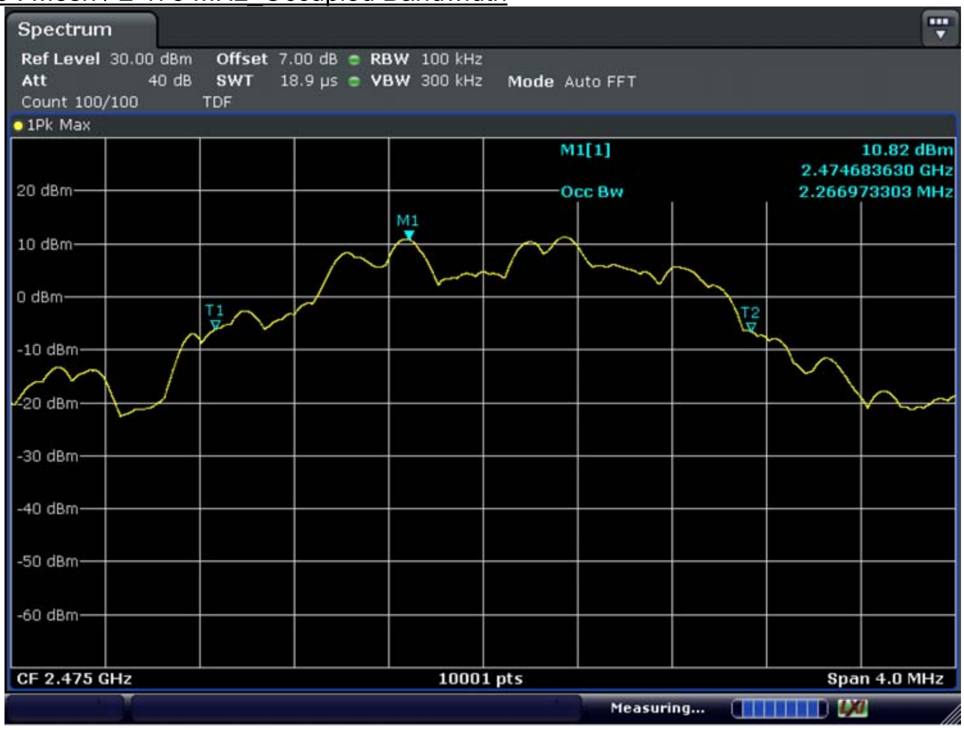
Test mode : Mesh / 2 475 MHz_6 dB Bandwidth


Test mode : Mesh / 2 410 MHz_Occupied Bandwidth

Test mode : Mesh / 2 445 MHz_Occupied Bandwidth




Test mode : Mesh / 2 475 MHz_Occupied Bandwidth



### 4.4.5 Spurious Emission, Band Edge, and Restricted bands

4.4.5.1 Regulation

According to §15.247(d) and RSS-247 §5.5 in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

According to §15.209(a) and RSS-GEN §8.9 Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall notexceed the field strength levels specified in the following table:

| Frequency(MHz) | Field strength(microvolts/meter) | Measurement distance(meters) |
|---|---|---|
| 0.009 - 0.490 | 2 400/F(kHz) | 300 |
| 0.490 - 1.705 | 24 000/F(kHz) | 30 |
| 1.705 - 30.0 | 30 | 30 |
| 30 - 88 | 100** | 3 |
| 88 - 216 | 150** | 3 |
| 216 - 960 | 200** | 3 |
| Above 960 | 500 | 3 |

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shallnot be located in the frequency bands 54–72 MHz, 76–88 MHz, 174–216 MHz or 470–806 MHz. However, operation within these frequency bands is permItted under other sections of this part, e.g., §§15.231 and 15.241.

According to §15.205(a) and (b), and RSS-GEN §8.10 only spurious emissions are permitted in any of the frequency bands listed below:

| MHz | MHz | MHz | GHz |
|---|---|---|---|
| 0.009 - 0.110 | 16.42 - 16.423 | 399.9 - 410 | 4.5 - 5.15 |
| 0.495 - 0.505 | 16.694 75 - 16.695 25 | 608 - 614 | 5.35 - 5.46 |
| 2.173 5 - 2.190 5 | 16.804 25 - 16.804 75 | 960 – 1 240 | 7.25 - 7.75 |
| 4.125 - 4.128 | 25.5 - 25.67 | 1 300 – 1 427 | 8.025 - 8.5 |
| 4.177 25 - 4.177 75 | 37.5 - 38.25 | 1 435 – 1 626.5 | 9.0 - 9.2 |
| 4.207 25 - 4.207 75 | 73 - 74.6 | 1 645.5 – 1 646.5 | 9.3 - 9.5 |
| 6.215 - 6.218 | 74.8 - 75.2 | 1 660 – 1 710 | 10.6 - 12.7 |
| 6.267 75 - 6.268 25 | 108 - 121.94 | 1 718.8 – 1 722.2 | 13.25 - 13.4 |
| 6.311 75 - 6.312 25 | 123 - 138 | 2 200 – 2 300 | 14.47 - 14.5 |
| 8.291 - 8.294 | 149.9 - 150.05 | 2 310 – 2 390 | 15.35 - 16.2 |
| 8.362 - 8.366 | 156.524 75 - 156.525 25 | 2 483.5 – 2 500 | 17.7 - 21.4 |
| 8.376 25 - 8.386 75 | 156.7 - 156.9 | 2 690 – 2 900 | 22.01 - 23.12 |
| 8.414 25 - 8.414 75 | 162.012 5 - 167.17 | 3 260 – 3 267 | 23.6 - 24.0 |
| 12.29 - 12.293 | 167.72 - 173.2 | 3 332 – 3 339 | 31.2 - 31.8 |
| 12.519 75 - 12.520 25 | 240 - 285 | 3 345.8 – 3 358 | 36.43 - 36.5 |
| 12.576 75 - 12.577 25 | 322 - 335.4 | 3 600 – 4 400 | Above 38.6 |
| 13.36 - 13.41 | | | |

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurement

4.4.5.2 Measurement Procedure

<u>4.4.5.2.1 Band-edge Compliance of RF Conducted Emissions</u>

4.4.5.2.1.1 Reference Level Measurement

Establish a reference level by using the following procedure:

1) Set instrument center frequency to DTS channel center frequency.
2) Set the span to ≥ 1.5 times the DTS bandwidth.
3) Set the RBW = 100 kHz.
4) Set the VBW ≥ 3 x RBW.
5) Detector = peak.
6) Sweep time = auto couple.
7) Trace mode = max hold.
8) Allow trace to fully stabilize.
9) Use the peak marker function to determine the maximum PSD level.

4.4.5.2.1.2 Emissions Level Measurement

1) Set the center frequency and span to encompass frequency range to be measured.
2) Set the RBW = 100 kHz.
3) Set the VBW ≥ 3 x RBW.
4) Detector = peak.
5) Ensure that the number of measurement points ≥ span/RBW
6) Sweep time = auto couple.
7) Trace mode = max hold.
8) Allow trace to fully stabilize.
9) Use the peak marker function to determine the maximum amplitude level.

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements specified in 11.1 a) or 11.1 b).
Report the three highest emissions relative to the limit.

4.4.5.2.2 Conducted Spurious Emissions

Set the spectrum analyzer as follows:

1) Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
2) RBW = 100 kHz
3) VBW ≥ 3 x RBW
4) Sweep = auto
5) Detector function = peak
6) Trace = max hold
7) Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded.
8) Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.

4.4.5.2.3 Radiated Spurious Emissions

1) The preliminary and final rdiated measurements were performed to determine the frequency producing the maximum emissions in at a 10m anechoic chamber. The EUT was tested at a distance 3 meters.
2) The EUT was placed on the top of the 0.8 m height or 1.5 m height non-metallic table. To find the maximum emission levels, the height of a measuring antenna was changed and the turntable was rotated 360°.
3) The antenna polarization was also changed from vertical to horizontal. The spectrum was scanned from 9 kHz to 30 MHz using the loop antenna, and from 30 to 1 000 MHz using the TRILOG broadband antenna, and from 1 000 MHz to 26 500 MHz using the horn antenna.
4) Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.

NOTE1 : The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequency below 1 GHz.
NOTE2 : The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz for Peak detection and frequency above 1 GHz.
The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the vide bandwidth is 1 kHz(1/T) for Average detection (AV) at frequency above 1 GHz. (where T= pulse width)
NOTE3 : The 0.8 m height is for below 1 GHz testing, and 1.5 m is for above 1 GHz testing

4.4.5.3 Result

Comply (measurement data : refer to the next page)

#### 4.4.5.4 Measurement data_Radiated Spurious Emissions

Test mode : Below 1 GHz ( Worst case : Mesh / Lowest Frequency)

| Frequency (MHz) | Detector | Pol. (V/H) | Reading (dBμV) | Ant Factor (dB) | Loss (dB) | Result (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 0.997 | QP | H | 73.30 | 11.10 | -29.70 | 54.70 | 67.60 | 12.90 |
| 0.997 | QP | V | 71.10 | 11.10 | -29.70 | 52.50 | 67.60 | 15.10 |
| 425.022 | QP | H | 32.10 | 16.30 | -21.00 | 27.40 | 46.00 | 18.60 |
| 449.998 | QP | H | 31.90 | 16.90 | -21.00 | 27.80 | 46.00 | 18.20 |

Note 1 : Loss : Cable loss - Amp gain
Note 2 : Result : Reading + Ant Factor + Loss

Test mode : Mesh_ Above 1 GHz / Lowest Frequency

| Frequency (MHz) | Detector | Pol. (V/H) | Reading (dBμV) | Factor (dB) | DCCF (dB) | Result (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 2 376.25 | PK | V | 58.20 | -4.94 | - | 53.26 | 74.00 | 20.74 |
| 2 385.00 | PK | H | 67.40 | -4.94 | - | 62.46* | 74.00 | 11.54 |
| | AV | H | 28.50 | -4.94 | -43.78 | -20.22 | 54.00 | 74.22 |
| 2 588.24 | PK | H | 58.80 | -4.34 | - | 54.46 | 74.00 | 19.54 |
| | AV | H | 27.30 | -4.34 | -43.78 | -20.82 | 54.00 | 74.82 |
| 2 607.25 | PK | H | 61.50 | -4.34 | - | 57.16 | 74.00 | 16.84 |
| | AV | H | 27.60 | -4.34 | -43.78 | -20.52 | 54.00 | 74.52 |
| 2 665.30 | PK | H | 60.80 | -4.04 | - | 56.76 | 74.00 | 17.24 |
| | AV | H | 27.40 | -4.04 | -43.78 | -20.42 | 54.00 | 74.42 |
| Above 3 GHz | Not Detected | - | - | - | - | - | - | - |

Note 1 : Factor : Ant Factor + Cable loss - Amp gain + Distance Factor
Note 2 : Peak Result : Reading + Factor
Note 3 : DCCF(Duty Cyle Correction Factor) : $20\log_{10}$( (1 × 0.647ms) / 100 ms ) = -43.78 dBm * Refer to 4.4.5.7
Average Reasult : Reading + Factor + DCCF
Note 4 : Below 1 GHz Measured distance : 3 m, Above 1 GHz Measured distance : 1 m
Above 1 GHz Distance Factor = 20log(1 / 3) = -9.54
Note 5 : Average measurement did not take place because the peak data did not exceed Average Limit.
Note 6 : Not Detected means that peak data does not exceed the average limit.

Test mode : Mesh _ Above 1 GHz / Middle Frequency

| Frequency (MHz) | Detector | Pol. (V/H) | Reading (dBμV) | Factor (dB) | DCCF (dB) | Result (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 2 652.48 | PK | H | 59.70 | -4.14 | - | 55.56 | 74.00 | 18.44 |
| | AV | H | 26.90 | -4.14 | -43.78 | -21.02 | 54.00 | 75.02 |
| 2 664.51 | PK | H | 59.40 | -4.04 | - | 55.36 | 74.00 | 18.64 |
| | AV | H | 27.10 | -4.04 | -43.78 | -20.72 | 54.00 | 74.72 |
| Above 3 GHz | Not Detected | - | - | - | - | - | - | - |

Note 1 : Factor : Ant Factor + Cable loss - Amp gain + Distance Factor
Note 2 : Peak Result : Reading + Factor
Note 3 : DCCF(Duty Cyle Correction Factor) : $20\log_{10}$( (1 × 0.647ms) / 100 ms ) = -43.78 dBm * Refer to 4.4.5.7
Average Reasult : Reading + Factor + DCCF
Note 4 : Below 1 GHz Measured distance : 3 m, Above 1 GHz Measured distance : 1 m
Above 1 GHz Distance Factor = 20log(1 / 3) = -9.54
Note 5 : Average measurement did not take place because the peak data did not exceed Average Limit.
Note 6 : Not Detected means that peak data does not exceed the average limit.

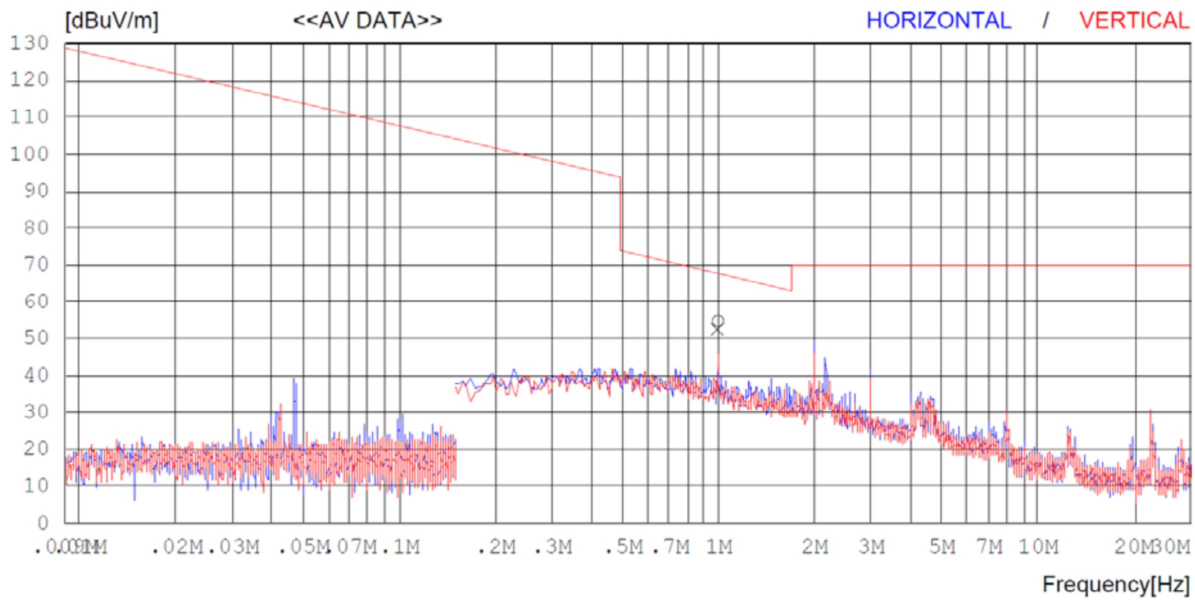
Test mode : Mesh_Above 1 GHz / Highest Frequency

| Frequency (MHz) | Detector | Pol. (V/H) | Reading (dBμV) | Factor (dB) | DCCF (dB) | Result (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 2 489.24 | PK | H | 61.40 | -4.64 | - | 56.76 | 74.00 | 17.24 |
| | AV | H | 28.60 | -4.64 | -43.78 | -19.82 | 54.00 | 73.82 |
| 2 492.75 | PK | H | 63.90 | -4.64 | - | 59.26 | 74.00 | 14.74 |
| | AV | H | 28.00 | -4.64 | -43.78 | -20.42 | 54.00 | 74.42 |
| 2 730.25 | PK | H | 58.90 | -3.94 | - | 54.96 | 74.00 | 19.04 |
| | AV | H | 27.50 | -3.94 | -43.78 | -20.22 | 54.00 | 74.22 |
| 2 487.50 | PK | V | 65.60 | -4.64 | - | 60.96 | 74.00 | 13.04 |
| | AV | V | 28.40 | -4.64 | -43.78 | -20.02 | 54.00 | 74.02 |
| Above 3 GHz | Not Detected | - | - | - | - | - | - | - |

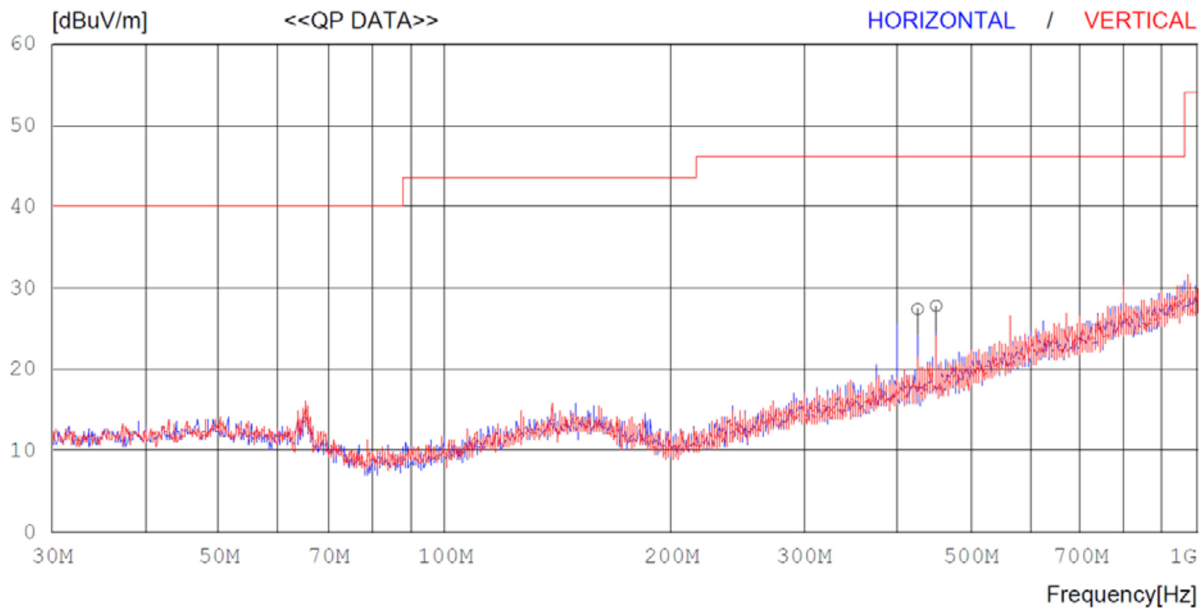
Note 1 : Factor : Ant Factor + Cable loss - Amp gain + Distance Factor
Note 2 : Peak Result : Reading + Factor
Note 3 : DCCF(Duty Cyle Correction Factor) : $20\log_{10}$( (1 × 0.647ms) / 100 ms ) = -43.78 dBm * Refer to 4.4.5.7
Average Reasult : Reading + Factor + DCCF
Note 4 : Below 1 GHz Measured distance : 3 m, Above 1 GHz Measured distance : 1 m
Above 1 GHz Distance Factor = 20log(1 / 3) = -9.54
Note 5 : Average measurement did not take place because the peak data did not exceed Average Limit.
Note 6 : Not Detected means that peak data does not exceed the average limit.

4.4.5.5 Measurement Plot_Radiated Spurious Emissions

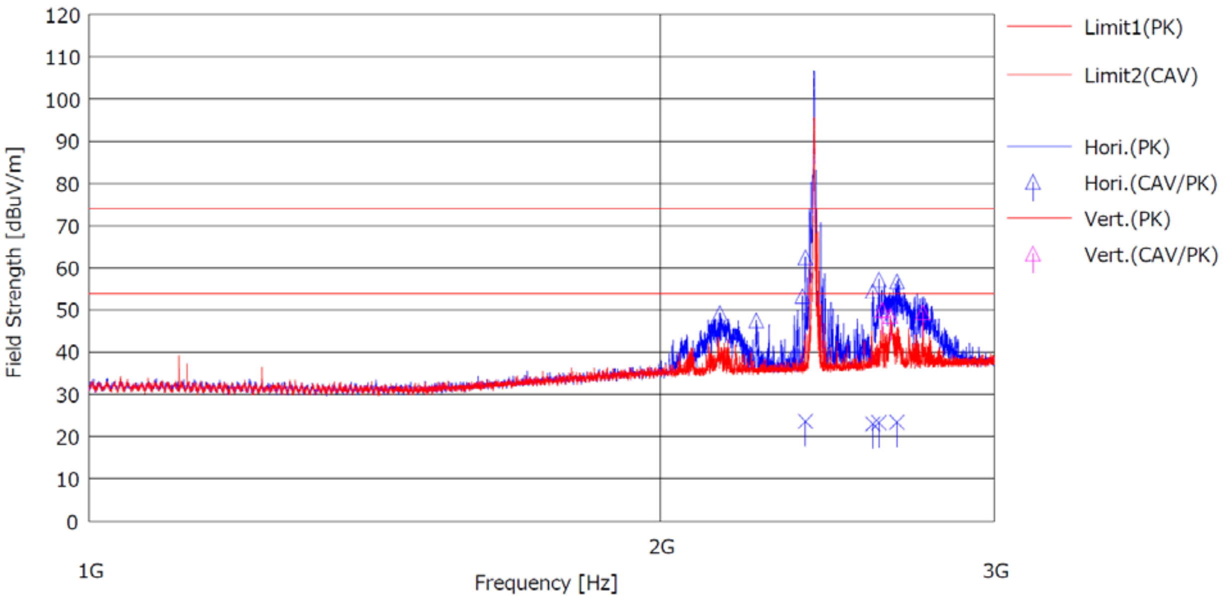
Test mode : 9 kHz ~ 30 MHz ( Worst case : Mesh / Lowest Frequency)




Test mode : 30 MHz ~ 1 GHz ( Worst case : Mesh / Lowest Frequency)

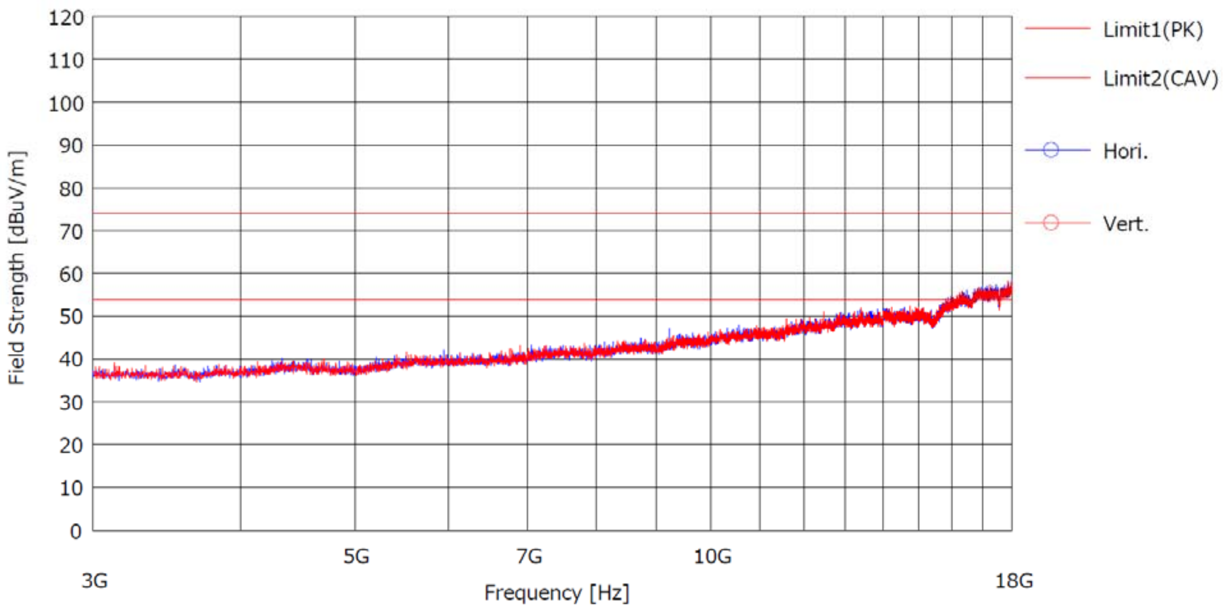


Test mode : 1 GHz ~ 3 GHz_( Worst case : Mesh / Lowest Frequency)



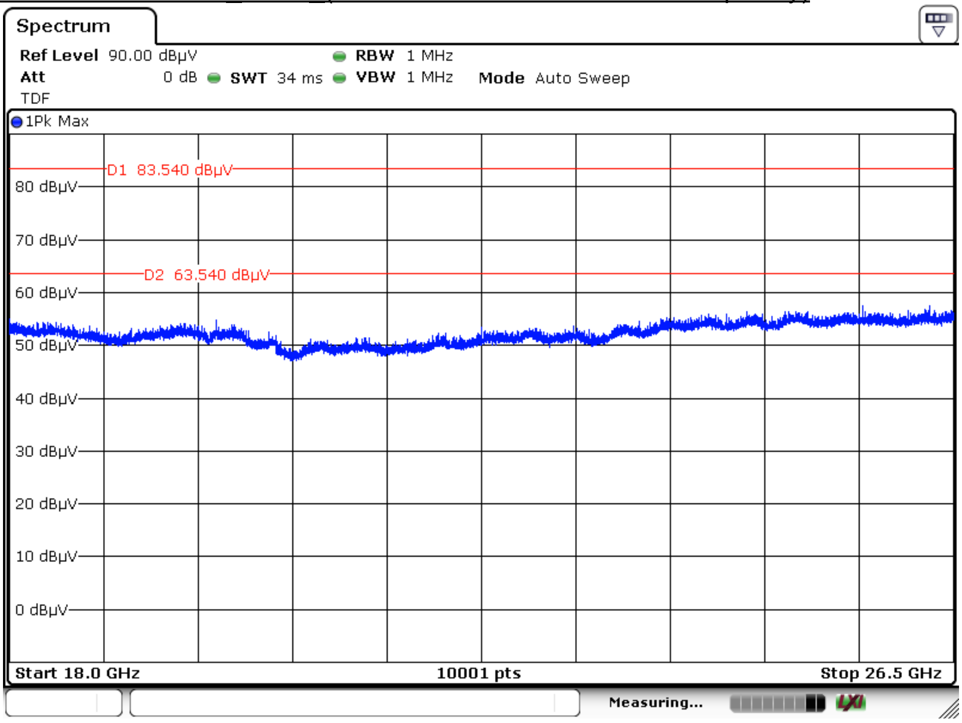

Note 1 : Measured distance : 1 m

Test mode : 3 GHz ~ 18 GHz_Peak _( Worst case : Mesh / Lowest Frequency)




Note 1 : Measured distance : 1 m

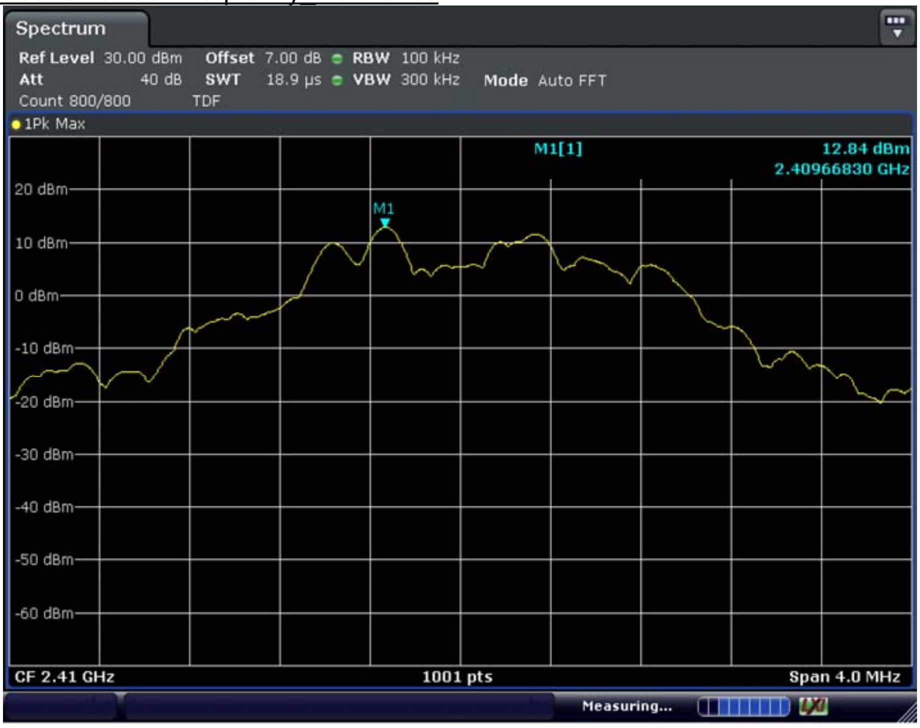
Test mode : 18 GHz ~ 26 GHz_Peak _( Worst case : Mesh / Lowest Frequency)



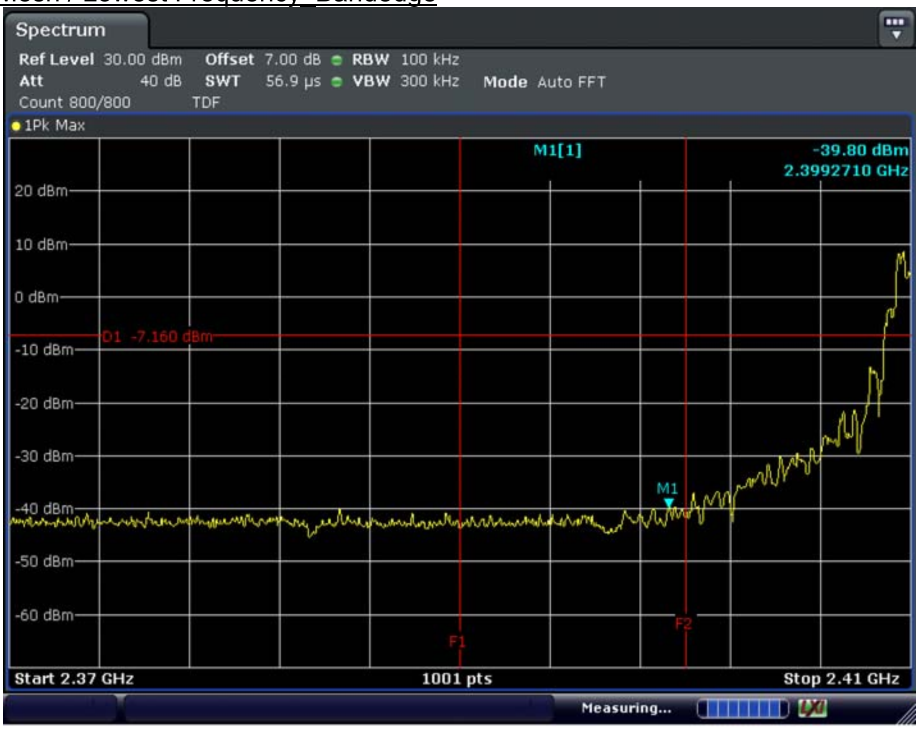

Note 1 : Measured distance : 1 m
Note 2 : Limit : Peak : 83.5 dBµV/m
Average : 63.5 dBµV/m

4.4.5.6 Measurement data_Conducted Spurious Emissions

Test mode : Mesh / Lowest Frequency_Reference

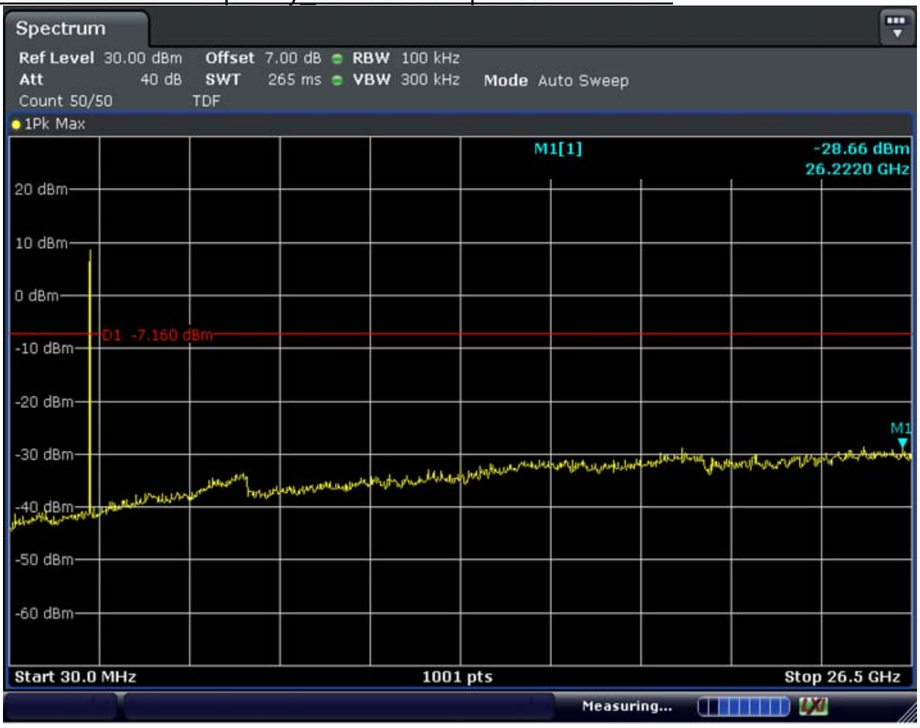



Test mode : Mesh / Lowest Frequency_Bandedge

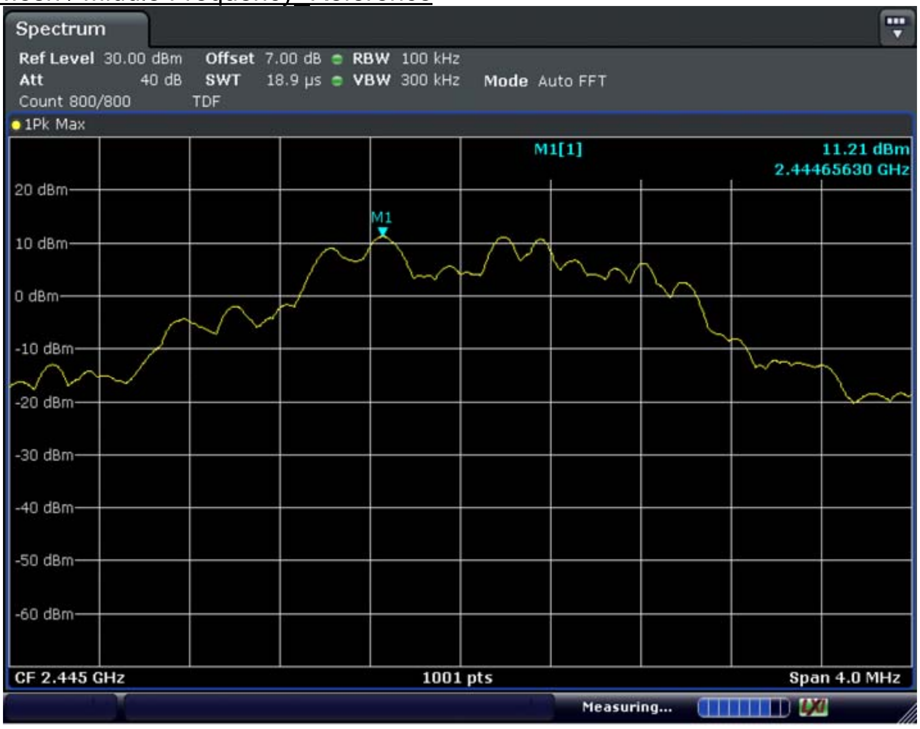



Note: F1 : 2 390 MHz, F2 : 2 400 MHz

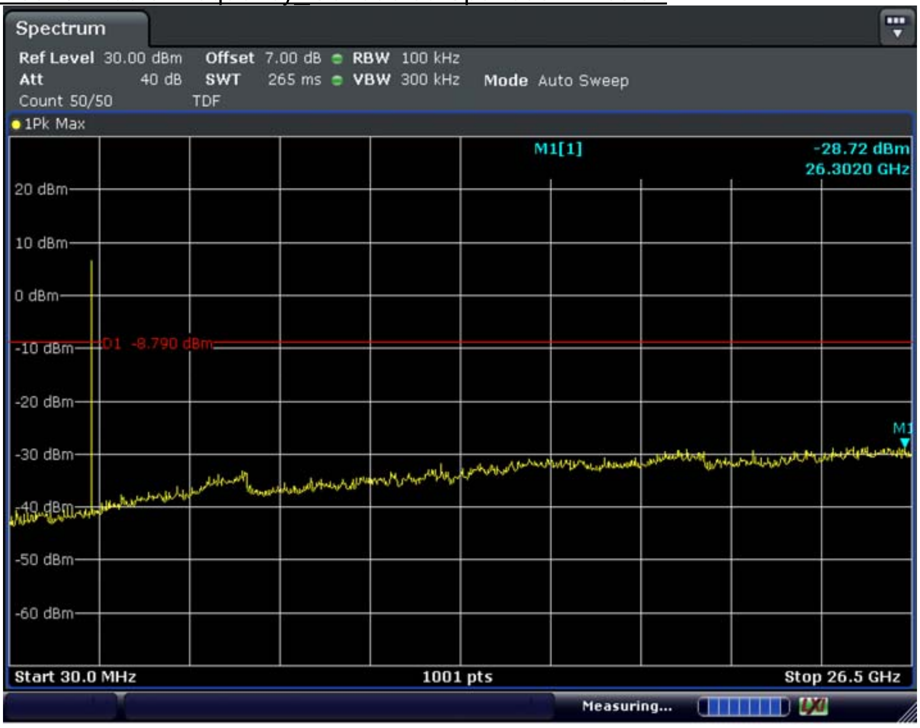
Test mode : Mesh / Lowest Frequency_Conducted Spurious Emission



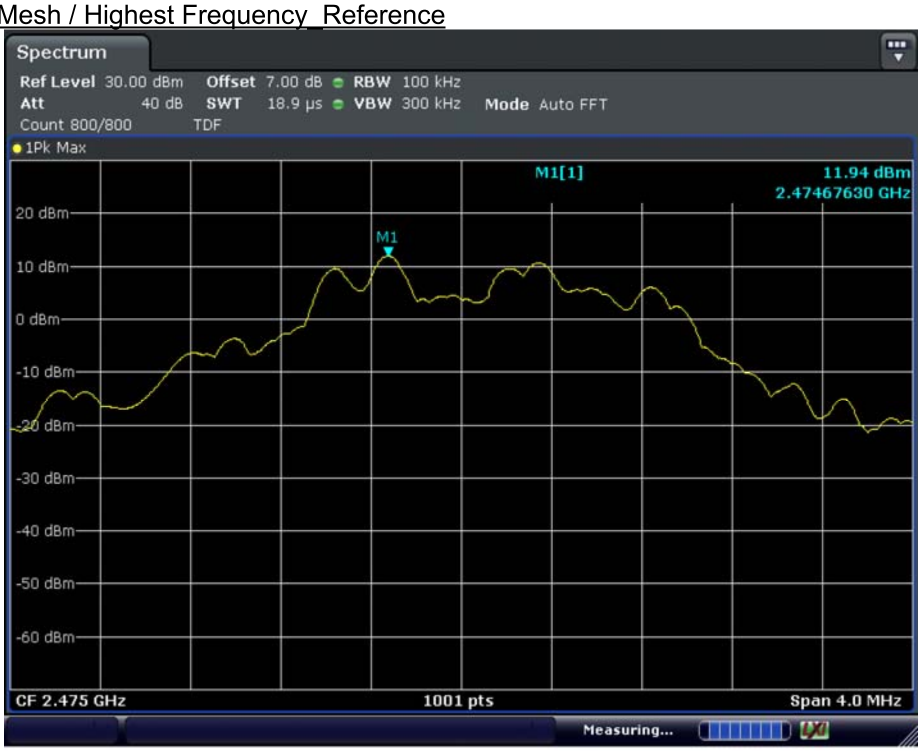

Test mode : Mesh / Middle Frequency_Reference



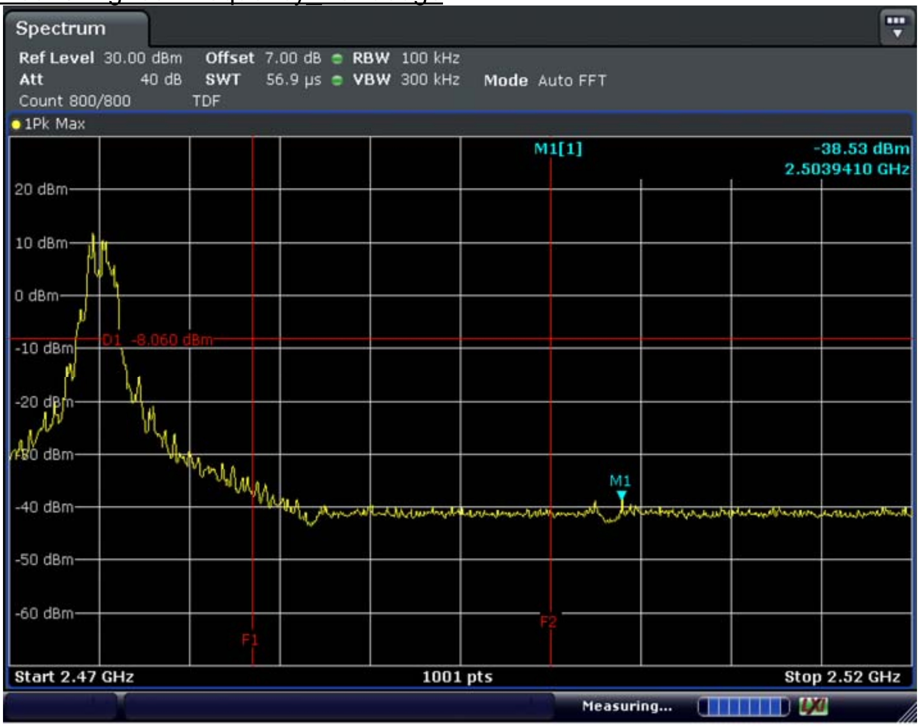
Test mode : Mesh / Middle Frequency_Conducted Spurious Emission




Test mode : Mesh / Highest Frequency_Reference

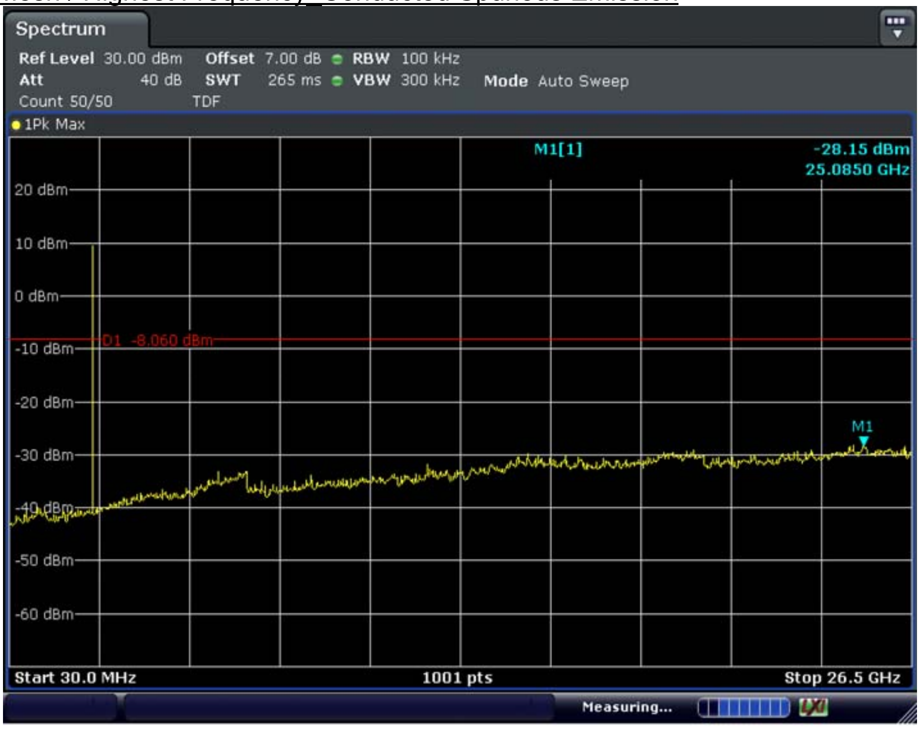


Test mode : Mesh / Highest Frequency_Bandedge



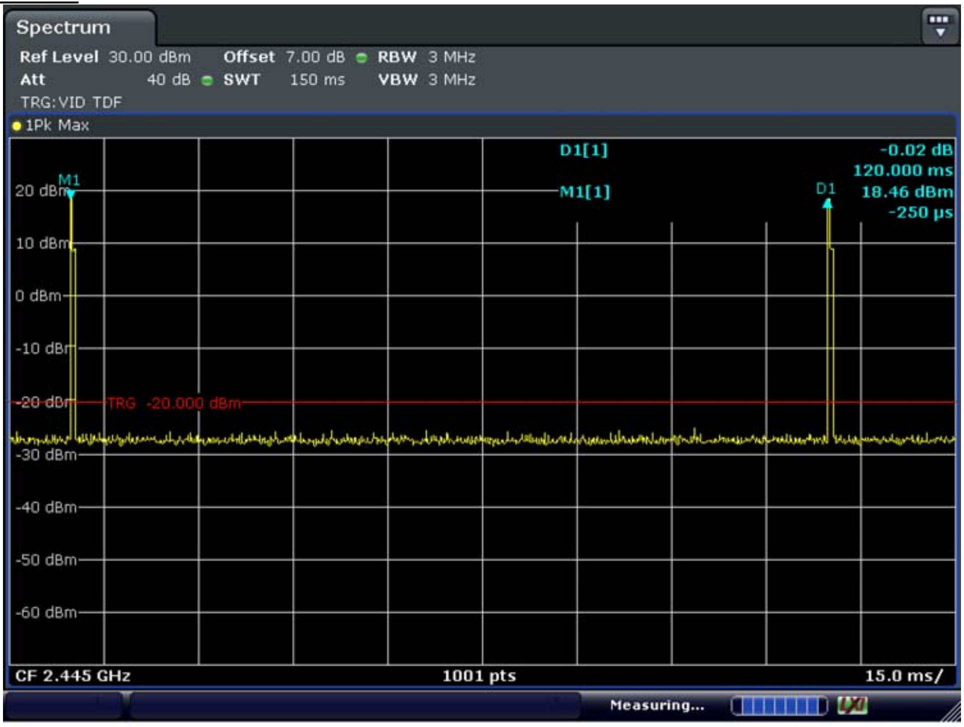

Note: F1 : 2 483.5 MHz, F2 : 2 500 MHz

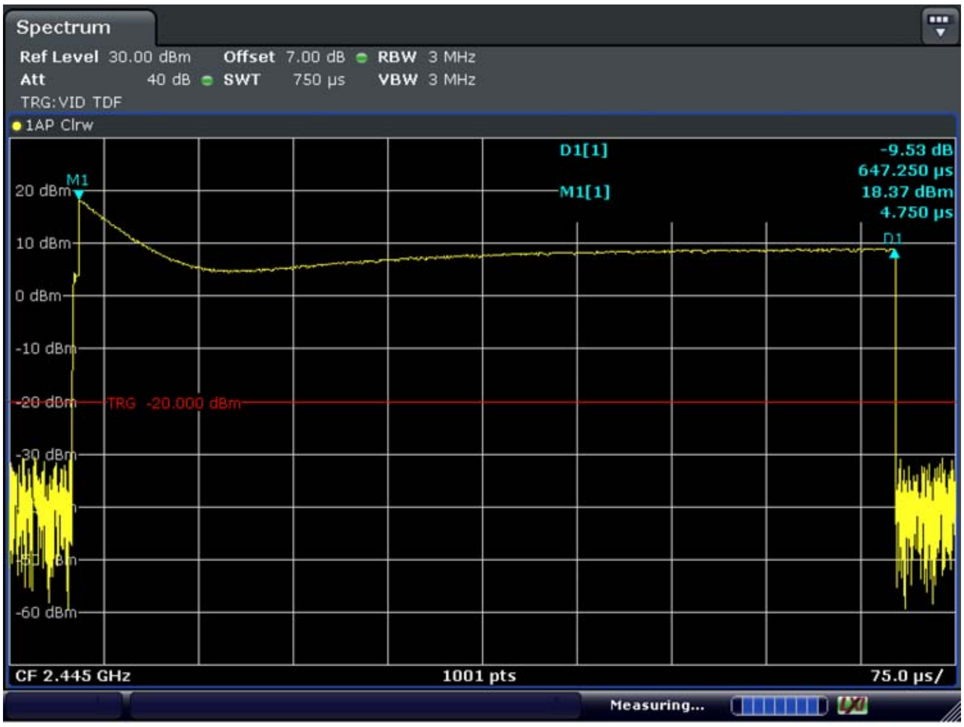
Test mode : Mesh / Highest Frequency_Conducted Spurious Emission



4.4.5.7 Measurement Plot_Dutycycle

Test mode : Mesh




Note DCCF(Duty Cyle Correction Factor) : $20\log_{10}$( Pulse width / Period of the pulse train )
= $20\log_{10}$( (1 × 0.647ms) / 100 ms ) = -43.78 dBm

### 4.4.6 Conducted Emission

4.4.6.1 Regulation

According to §15.207(a), and RSS-GEN §8.8 for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 Ω line impedance stabilization network (LISN).
Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

| Frequency of emission (MHz) | Conducted limit (dBμV) | |
|---|---|---|
| | Qausi-peak | Average |
| 0.15 – 0.5 | 66 to 56 * | 56 to 46 * |
| 0.5 – 5 | 56 | 46 |
| 5 - 30 | 60 | 50 |

* Decreases with the logarithm of the frequency.

According to §15.107(a), for unintentional device, except for Class A digital devices, line conducted emission limits are the same as the above table.

4.4.6.2 Measurement Procedure

1) The EUT was placed on a wooden table of size, 1 m by 1.5 m, raised 80 cm in which is located 40 cm away from the vertical wall and 1.5 m away from the side wall of the shielded room.

2) Each current-carrying conductor of the EUT power cord was individually connected through a 50 Ω/50 μH LISN, which is an input transducer to a Spectrum Analyzer or an EMI/Field Intensity Meter, to the input power source.

3) Exploratory measurements were made to identify the frequency of the emission that had the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable position, and with a typical system equipment configuration and arrangement. Based on the exploratory tests of the EUT, the one EUT cable configuration and arrangement and mode of operation that had produced the emission with the highest amplitude relative to the limit was selected for the final measurement.

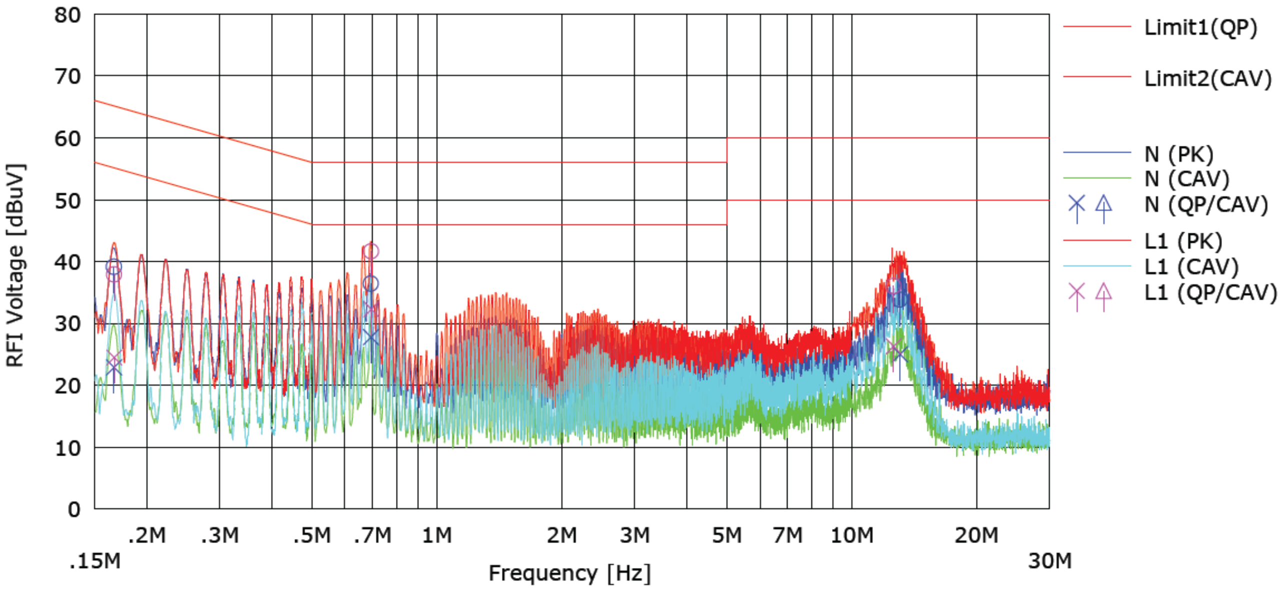
4) The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment is the system) was then performed over the frequency range of 0.15 MHz to 30 MHz.

5) The measurements were made with the detector set to PEAK amplitude within a bandwidth of 10 kHz or to QUASIPEAK and AVERAGE within a bandwidth of 9 kHz. The EUT was in transmitting mode during the measurements.

4.4.6.3 Result

Comply (measurement data : refer to the next page)

4.4.6.4 Measurement data(Worst case : Mesh / Lowest Frequency)




| NO | FREQ | READING | | C.FACTOR | RESULT | | LIMIT | | MARGIN | | PHASE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | QP | CAV | | QP | CAV | QP | CAV | QP | CAV | |
| | [MHz] | [dBuV] | [dBuV] | [dB] | [dBuV] | [dBuV] | [dBuV] | [dBuV] | [dBuV] | [dBuV] | |
| 1 | 0.16689 | 18.8 | 2.6 | 20.3 | 39.1 | 22.9 | 65.1 | 55.1 | 26.0 | 32.2 | N |
| 2 | 0.69406 | 16.2 | 7.6 | 20.2 | 36.4 | 27.8 | 56.0 | 46.0 | 19.6 | 18.2 | N |
| 3 | 13.07287 | 13.4 | 4.6 | 20.4 | 33.8 | 25.0 | 60.0 | 50.0 | 26.2 | 25.0 | N |
| 4 | 0.16697 | 17.5 | 4.1 | 20.4 | 37.9 | 24.5 | 65.1 | 55.1 | 27.2 | 30.6 | L1 |
| 5 | 0.69566 | 21.3 | 12.0 | 20.3 | 41.6 | 32.3 | 56.0 | 46.0 | 14.4 | 13.7 | L1 |
| 6 | 12.61576 | 15.5 | 5.8 | 20.5 | 36.0 | 26.3 | 60.0 | 50.0 | 24.0 | 23.7 | L1 |

# APPENDIX I

## TEST EQUIPMENT USED FOR TESTS

To facilitate inclusion on each page of the test equipment used for related tests, each item of test equipment.

| Equipment | Manufacturer | Model | Serial No. | Cal. Date (yy.mm.dd) | Next Cal.Date (yy.mm.dd) |
|---|---|---|---|---|---|
| FSV Signal Analyzer | ROHDE&SCHWARZ | FSV30 | 103370 | 2018-10-15 | 2019-10-15 |
| Power Sensor | KEYSIGHT | U2022XA | MY55320008 | 2018-08-17 | 2019-08-17 |
| ATTENUATOR | INMET | 26A-6 | TR008 | 2018-10-12 | 2019-10-12 |
| DC Power Supply | HP | 66332A | US37471465 | 2019-01-10 | 2020-01-10 |
| Digital MultiMeter | HP | 34401A | US36025428 | 2019-01-10 | 2020-01-10 |
| Signal Generator | ROHDE&SCHWARZ | SMB100A | 178384 | 2018-10-15 | 2019-10-15 |
| EMI Test Receiver | ROHDE&SCHWARZ | ESU40 | 100445 | 2018-12-14 | 2019-12-14 |
| BiLog Antenna | Schwarzbeck | VULB9160 | 9160-3381 | 2019-04-09 | 2021-04-09 |
| Preamplifier | TSJ | MLA-10k01-b01-27 | 1870369 | 2019-04-23 | 2020-04-23 |
| Antenna Mast(10 m) | TOKIN | 5977 | - | - | - |
| Antenna Mast(10 m) | Innco | MA4640-XPET-0800 | 578 | - | - |
| Controller(10 m) | TOKIN | 5909L | 141909L-1 | - | - |
| Controller(10 m) | Innco | CO3000 | 40040217 | - | - |
| Turn Table(10 m) | TOKIN | 5983-1.5 | - | - | - |
| 10 m Semi-Anechoic Chamber | SY CORPORATION | - | - | - | - |
| Active Loop H-Field | ETS | 6502 | 00150598 | 2017-06-01 | 2019-06-01 |
| Double Ridge Horn Antenna | ETS | 3117 | 00168719 | 2019-04-09 | 2021-04-09 |
| Double Ridge Horn Antenna | A.H Systems, Inc | SAS-574 | 465 | 2019-04-25 | 2021-04-25 |
| PREAMPLIFIER | Agilent | 8449B | 3008A02110 | 2019-01-14 | 2020-01-14 |
| PREAMPLIFIER | A.H Systems, Inc | PAM-1840VH | 166 | 2019-01-14 | 2020-01-14 |
| EMI Test Receiver | ROHDE&SCHWARZ | ESR7 | 101440 | 2018-12-14 | 2019-12-14 |
| LISN | ROHDE&SCHWARZ | ENV216 | 101883 | 2019-04-24 | 2020-04-24 |
| Pulse Limiter | Schwarzbeck | VTSD 9561-F | 9561-F189 | 2019-04-23 | 2020-04-23 |
| Band Reject Filter | wainwright instruments gmbh | WRCGV10-2363.5-2400-2483.5-2520--60SS | 7 | 2018-05-14 | 2019-05-14 |