HERMON LABORATORIES

ELECTRICAL TESTING
0839.01

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# TEST REPORT

**ACCORDING TO: FCC 47 CFR PART 15 subpart C, section 15.249**

**FOR:**

## Elta Systems Ltd.
## Outdoor radar
## Model: ELM-2114
## P/N 1024Y010-001
## FCC ID:XWR2114





Report ID: ELTRAD_FCC.28562.docx
Date of Issue: 22-Feb-17

# Table of contents

# 1 Applicant information

| | |
|---|---|
| **Client name:** | Elta Systems Ltd. |
| **Address:** | 100 Yitzchak Hanasi Blvd., P.O.B. 330, Ashdod, 77102, Israel |
| **Telephone:** | +972 8857 2333 |
| **Fax:** | +972 8856 3930 |
| **E-mail:** | eliezer.melamed@gmail.com |
| **Contact name:** | Mr. Eliezer Melamed |

# 2 Equipment under test attributes

| | |
|---|---|
| **Product name:** | Outdoor radar |
| **Product type:** | Transceiver |
| **Model(s):** | ELM-2114 |
| **Part number:** | 1024Y010-001 |
| **Serial number:** | 112 |
| **Hardware version:** | 1024Y010-001C |
| **Software release:** | Ver.02b |
| **Receipt date** | 11-Jan-17 |

# 3 Manufacturer information

| | |
|---|---|
| **Manufacturer name:** | Elta Systems Ltd |
| **Address:** | 100 Yitzchak Hanasi Blvd |
| **Telephone:** | +972 8857 2333 |
| **Fax:** | +972 8856 3930 |
| **E-Mail:** | eliezer.melamed@gmail.com |
| **Contact name:** | Mr. Eliezer Melamed |

# 4 Test details

| | |
|---|---|
| **Project ID:** | 28562 |
| **Location:** | Hermon Laboratories Ltd. Harakevet Industrial Zone, Binyamina 30500, Israel |
| **Test started:** | 11-Jan-17 |
| **Test completed:** | 12-Jan-17 |
| **Test specification(s):** | FCC 47 CFR Part 15, subpart C, §15.249 |

# 5 Tests summary

| Test | Status |
|---|---|
| **Transmitter characteristics** | |
| Section 15.249(a)(d), Field strength of emissions | Pass |
| Section 15.215(c), Occupied bandwidth | Pass |
| Section 15.249(d), Band edge emissions | Pass |
| Section 15.207(a), Conducted emission | Not required |
| Section 15.203, Antenna requirement | Pass |

Testing was completed against all relevant requirements of the test standard. The results obtained indicate that the product under test complies in full with the requirements tested.
The test results relate only to the items tested. Pass/ fail decision was based on nominal values.

| | Name and Title | Date | Signature |
|---|---|---|---|
| **Tested by:** | Mr. K. Zushchyk, test engineer | January 12, 2017 | |
| **Reviewed by:** | Mrs. M. Cherniavsky, certification engineer | January 29, 2017 | |
| **Approved by:** | Mr. M. Nikishin, EMC and Radio group manager | February 22, 2017 | |

# 6 EUT description

## 6.1 General information

The EUT, model name ELM-2114**,** is a solid state, linear frequency modulation continuous wave (LFMCW) Radar operating in ISM K-frequency band.
The ELM-2114 radar uses concurrent multiple beams in azimuth to create a broad field of view (90˚), thereby avoiding the need for mechanical or electronic scanning to cover the area of interest. The radar uses signal-to-signal integration to achieve an effective signal-to-noise ratio. To cover higher azimuth angles (360˚/270˚/180˚), additional units (4/3/2) can be installed or the Radar can be mounted on a positioner.

## 6.2 Ports and lines

| Port type | Port description | Connected from | Connected to | Qty. | Cable type | Cable length | Indoor / outdoor |
|---|---|---|---|---|---|---|---|
| Telecom & power | Ethernet & 48VDC | EUT | PoE adapter | 1 | FTP | 3.5 m* | Outdoor |

* Always shorter than 90 m.

## 6.3 Support and test equipment

| Description | Manufacturer | Model number | Serial number |
|---|---|---|---|
| PoE adapter | PLANET | POE-163(V2) | AF 00415A00487 |
| PC | HP | CompaqElite 8300 Microtower | TRF4070872 |
| Monitor | NEC | MultiSync LCD2090UXi | 87158962YA |

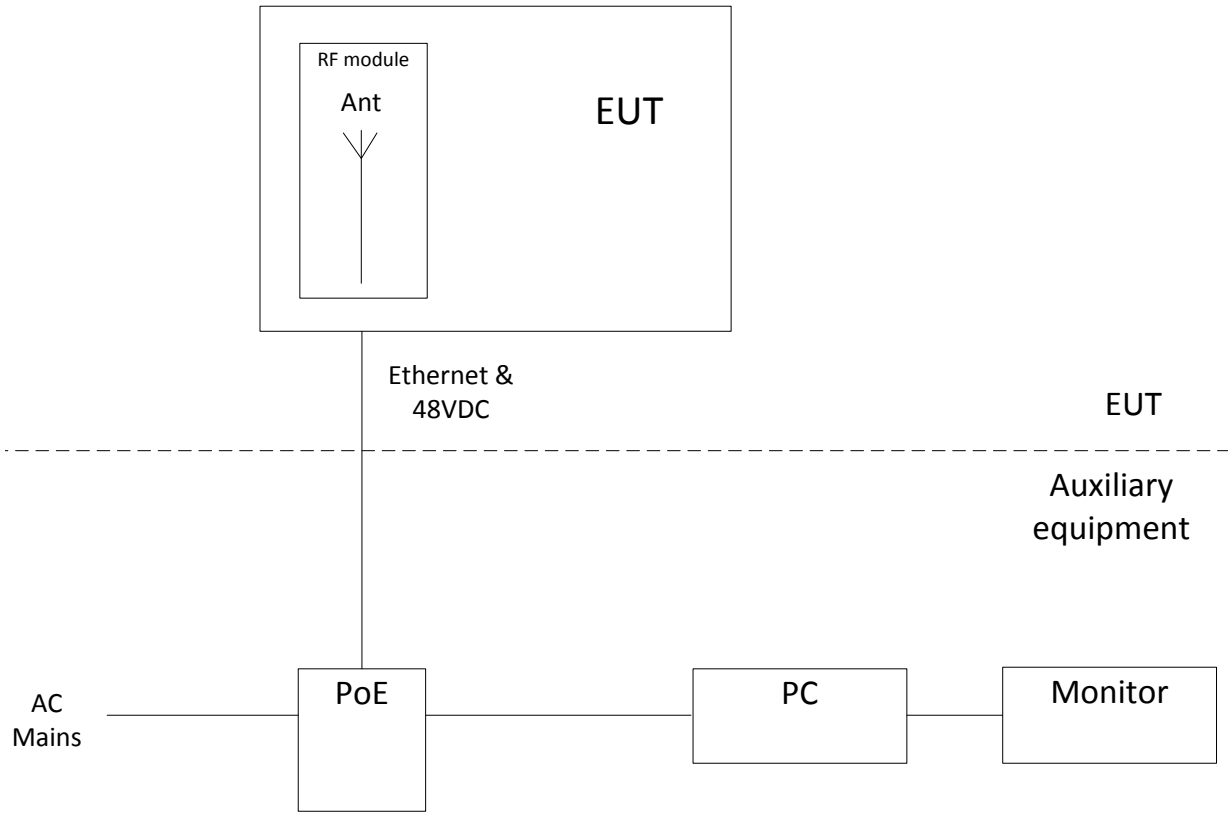
## 6.4 Changes made in EUT

To withstand the standard requirements, the following changes were made in the EUT during the testing.

Two capacitors C549 & C548 were removed.

It is manufacturer responsibility to implement the changes in the production version of the EUT. In any case the test report applies to the tested item only.

## 6.5 Test configuration



## 6.6 Transmitter characteristics

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Type of equipment** | | | | | | | |
| **V** | Stand-alone (Equipment with or without its own control provisions) | | | | | | |
| | Combined equipment (Equipment where the radio part is fully integrated within another type of equipment) | | | | | | |
| | Plug-in card (Equipment intended for a variety of host systems) | | | | | | |
| **Assigned frequency range** | 24000 – 24250 MHz | | | | | | |
| **Operating frequency range** | 24100 – 24232MHz | | | | | | |
| **Maximum field strength of carrier** | Peak 115.73 dBµV/m, average 106.65 dBµV/m at 3 m distance | | | | | | |
| **Is transmitter output power variable?** | **V** | No | | | | | |
| | | Yes | | continuous variable | | | |
| | | | | stepped variable with stepsize | dB | | |
| | | | | minimum RF power | dBm | | |
| | | | | maximum RF power | dBm | | |
| **Antenna connection** | | | | | | | |
| unique coupling | standard connector | **V** | Integral | with temporary RF connector | | | |
| | | | | **V** without temporary RF connector | | | |

**Antenna/s technical characteristics**

| Type | Manufacturer | Model number | Gain |
|---|---|---|---|
| Integral | InnoSent | DBF-102 | 12 dBi |

| | |
|---|---|
| **Type of modulation** | LFMCW |
| **Modulating test signal (baseband)** | PRBS |

**Transmitter power source**

| | | | | | |
|---|---|---|---|---|---|
| | Battery | **Nominal rated voltage** | | Battery type | |
| **V** | DC | **Nominal rated voltage** | 48 VDC via PoE | | |
| | AC mains | **Nominal rated voltage** | | Frequency | Hz |

| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

# 7 Transmitter tests according to 47CFR part 15 subpart C requirements

## 7.1 Field strength of emissions

### 7.1.1 General

This test was performed to measure field strength of fundamental and spurious emissions from the EUT. Specification test limits are given in Table 7.1.1, Table 7.1.2 and Table 7.1.3, Table 7.1.4.

**Table 7.1.1 Radiated fundamental emission limits**

| Fundamental frequency, MHz | Field strength at 3 m, dB(μV/m) | | |
|---|---|---|---|
| | Peak | Average | Quasi-Peak |
| 24000 – 24250 | 128.0 | 108.0 | NA |

**Table 7.1.2 Harmonics limits**

| Fundamental frequency, MHz | Field strength at 3 m, dB(μV/m) | |
|---|---|---|
| | Peak | Average |
| 24000 – 24250 | 88.0 | 68.0 |

**Table 7.1.3 Radiated spurious emissions limits (other than harmonics)**

| Frequency, MHz | Field strength at 3 m, dB(μV/m)* | | | |
|---|---|---|---|---|
| | Peak | Quasi Peak | Average | Attenuation below carrier |
| 0.009 – 0.090 | 148.5 – 128.5 | NA | 128.5 – 108.5** | 50 dBc (whichever is the less stringent) |
| 0.090 – 0.110 | NA | 108.5 – 106.8** | NA | |
| 0.110 – 0.490 | 126.8 – 113.8 | NA | 106.8 – 93.8** | |
| 0.490 – 1.705 | NA | 73.8 – 63.0** | NA | |
| 1.705 – 30.0* | | 69.5 | | |
| 30 – 88 | | 40.0 | | |
| 88 – 216 | | 43.5 | | |
| 216 – 960 | | 46.0 | | |
| 960 - 1000 | | 54.0 | | |
| Above 1000 | 74.0 | NA | 54.0 | |

*- The limit for 3 m test distance was calculated using the inverse square distance extrapolation factor as follows:

$$Lim_{S2} = Lim_{S1} + 20 \log (S_1/S_2),$$

where $S_1$ and $S_2$ – standard defined and test distance respectively in meters.

**- The limit decreases linearly with the logarithm of frequency.

*Note:* The above field strength limits applied from the lowest radio frequency generated in the device, without going below 9 kHz up to the tenth harmonic of the highest fundamental frequency but not exceeding 40 GHz for intentional radiators operated below 10 GHz and up to the fifth harmonic of the highest fundamental frequency but not exceeding 100 GHz for intentional radiators operated above 10 GHz.

| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

**Table 7.1.4 Radiated spurious emissions limits (other than harmonics)**

| Frequency, GHz | Distance, m | Field strength dB(μV/m)*, peak | Field strength dB(μV/m)*, average |
|---|---|---|---|
| 40 - 60 | 0.50 | 89.56* | 69.56* |
| 60 - 75 | 0.10 | 103.54* | 83.54* |
| 75 - 100 | 0.03 | 114.00* | 94.00* |

*- The limit for other test distance was calculated using the inverse distance extrapolation factor as follows:

LimS2 = LimS1 + 20 log (S1/S2),

where S1 and S2 – standard defined and test distance respectively in meters.

| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

**7.1.2 Test procedure for spurious emission field strength measurements in 9 kHz to 30 MHz band**

**7.1.2.1** The EUT was set up as shown in Figure 7.1.1, energized and the performance check was conducted.

**7.1.2.2** The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated $360^0$ and the measuring antenna was rotated around its vertical axis.

**7.1.2.3** The worst test results (the lowest margins) were recorded in the associated tables and shown in the associated plots.

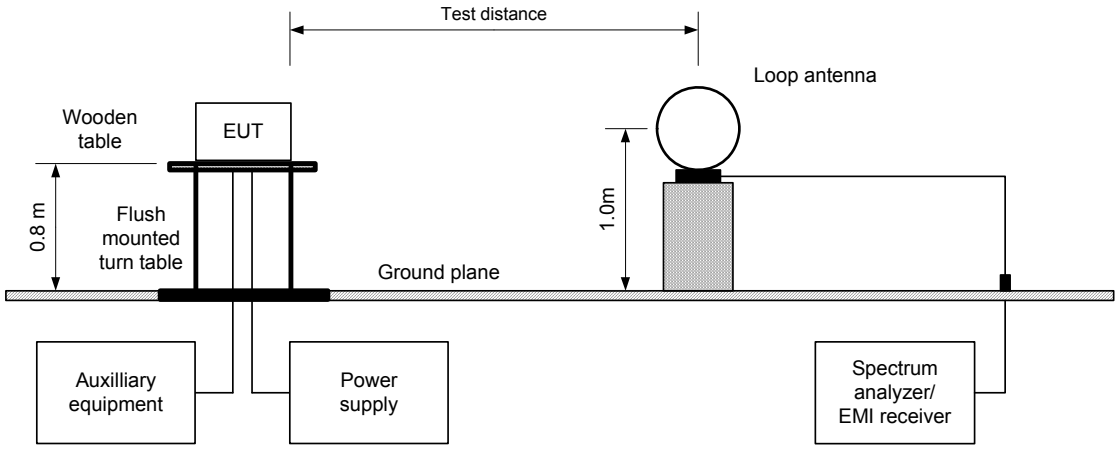
**7.1.3 Test procedure for spurious emission field strength measurements above 30 MHz**

**7.1.3.1** The EUT was set up as shown in Figure 7.1.2, Figure 7.1.3, energized and the performance check was conducted.

**7.1.3.2** The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated $360^0$, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal.

**7.1.3.3** The worst test results (the lowest margins) were recorded in the associated tables and shown in the associated plots.

**Figure 7.1.1 Setup for spurious emission field strength measurements below 30 MHz**



| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

**Figure 7.1.2 Setup for spurious emission field strength measurements in 30 -1000 MHz**

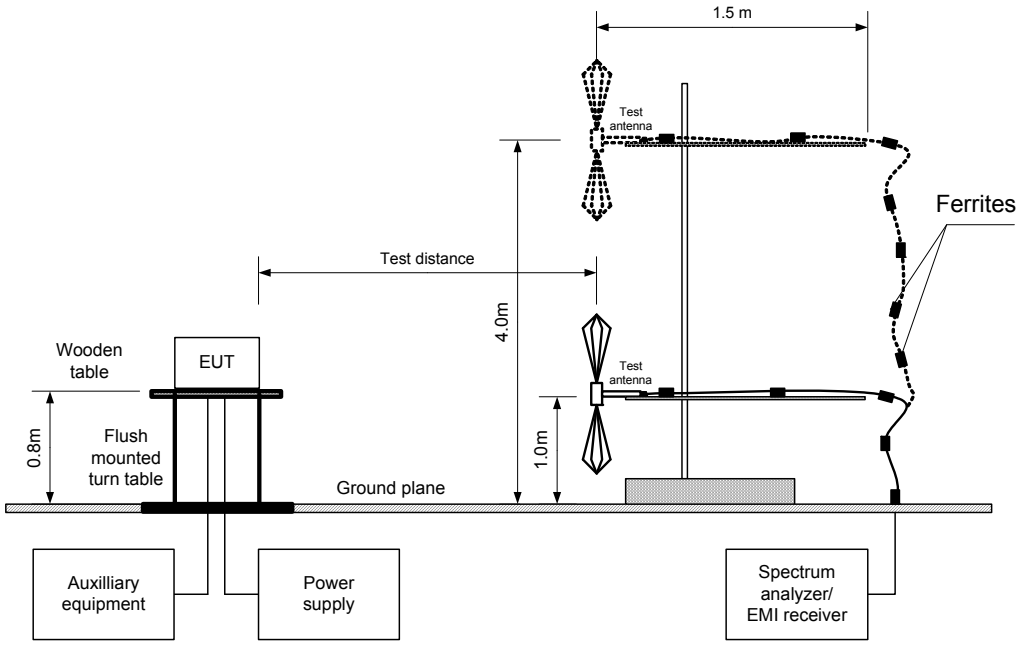
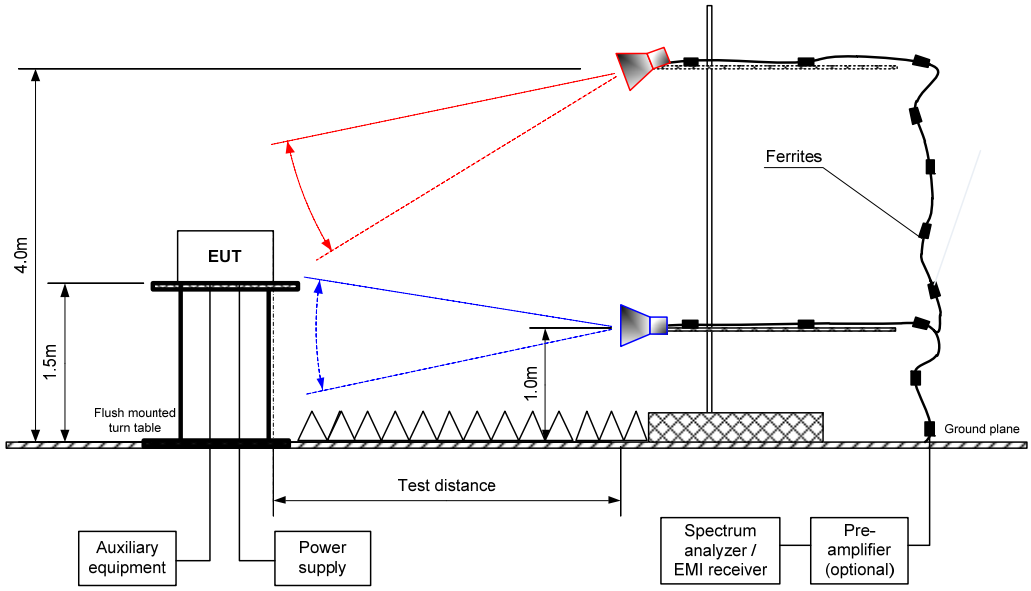



**Figure 7.1.3 Setup for spurious emission field strength measurements above1000 MHz**



| **Test specification:** | **Section 15.249(a)(d), Field strength of emissions** | | |
|---|---|---|---|
| **Test procedure:** | ANSI C63.10 sections 6.5, 6.6 | | |
| **Test mode:** | Compliance | **Verdict:** | PASS |
| **Date(s):** | 11-Jan-17 | | |
| **Temperature:** 25 ºC | **Relative Humidity:** 44 % | **Air Pressure:** 1022 hPa | **Power:** 48 VDC |
| **Remarks:** | | | |

**Table 7.1.5 Field strength of fundamental emission and spurious emissions**

| | |
|---|---|
| TEST DISTANCE: | 3 m |
| EUT POSITION: | Vertical (typical) |
| MODULATION: | FMCW |
| INVESTIGATED FREQUENCY RANGE: | 0.009 MHz – 100GHz |
| DETECTOR USED: | Peak |
| RESOLUTION BANDWIDTH: | 1.0 kHz (9 kHz – 150 kHz)<br>9.0 kHz (150 kHz – 30 MHz)<br>120 kHz (30 MHz – 1000 MHz)<br>1.0 MHz (above 1000 MHz) |
| VIDEO BANDWIDTH: | ≥ Resolution bandwidth |
| TEST ANTENNA TYPE: | Active loop (9 kHz – 30 MHz)<br>Log periodic (200 MHz – 1000 MHz)<br>Biconilog (30 MHz – 1000 MHz)<br>Double ridged guide (above 1000 MHz) |

| F, MHz | Antenna | | Azimuth, degrees* | Peak field strength | | | Avr factor, dB | Average field strength | | | Verdict |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pol. | Height, m | | Measured, dB(μV/m) | Limit, dB(μV/m) | Margin, dB** | | Measured, dB(μV/m) | Limit, dB(μV/m) | Margin, dB** | |
| **Fundamental emission** | | | | | | | | | | | |
| 24100.4 | V | 1.7 | 30 | 112.68 | 128.00 | -15.32 | NA | 104.14 | 108.00 | -3.86 | Pass |
| 24161.2 | V | 1.7 | 30 | 115.73 | 128.00 | -12.27 | NA | 106.65 | 108.00 | -1.35 | |
| 24232.0 | V | 1.6 | 30 | 113.06 | 128.00 | -14.94 | NA | 104.80 | 108.00 | -3.20 | |
| **Spurious emissions** | | | | | | | | | | | |
| 22590.0 | V | 1.7 | 30 | 48.90 | 74.00 | -25.10 | NA | 42.50 | 54.00 | -11.50 | Pass |
| 22655.3 | V | 1.7 | 30 | 50.10 | 74.00 | -23.90 | NA | 42.30 | 54.00 | -11.70 | |
| 22717.4 | V | 1.8 | 30 | 55.20 | 74.00 | -18.80 | NA | 45.60 | 54.00 | -8.40 | |
| 25596.8 | V | 1.7 | 30 | 49.70 | 74.00 | -24.30 | NA | 42.40 | 54.00 | -11.60 | |
| 25658.0 | V | 1.7 | 30 | 52.80 | 74.00 | -21.20 | NA | 40.80 | 54.00 | -13.20 | |

*- EUT front panel refers to 0 degrees position of turntable.
**- Margin, dB =Measured (calculated) value, dB(μV/m)-Limit, dB(μV/m).

**Table 7.1.6 Average factor calculation**

| Transmission pulse | | Transmission burst | | Transmission train duration, ms | Average factor, dB |
|---|---|---|---|---|---|
| Duration, ms | Period, ms | Duration, ms | Period, ms | | |
| NA | NA | NA | NA | NA | NA |

*- Average factor was calculated as follows

for pulse train shorter than 100 ms: $$Average\ factor = 20 \times \log_{10}\left(\frac{Pulse\ duration}{Pulse\ period} \times \frac{Burst\ duration}{Train\ duration} \times Number\ of\ bursts\ within\ pulse\ train\right)$$

for pulse train longer than 100 ms: $$Average\ factor = 20 \times \log_{10}\left(\frac{Pulse\ duration}{Pulse\ period} \times \frac{Burst\ duration}{100\ ms} \times Number\ of\ bursts\ within\ 100\ ms\right)$$

**Reference numbers of test equipment used**

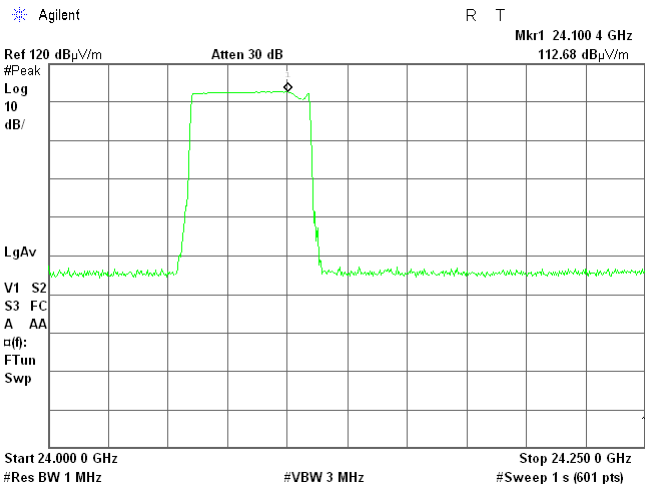
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| HL 0446 | HL 0521 | HL 0604 | HL 0770 | HL 0771 | HL 0772 | HL 1301 | HL 1984 |
| HL 2909 | HL 3235 | HL 3294 | HL 3305 | HL 3306 | HL 3433 | HL 3434 | HL 3818 |
| HL 3901 | HL 4353 | HL 4932 | HL 5101 | HL 5107 | HL 5110 | | |

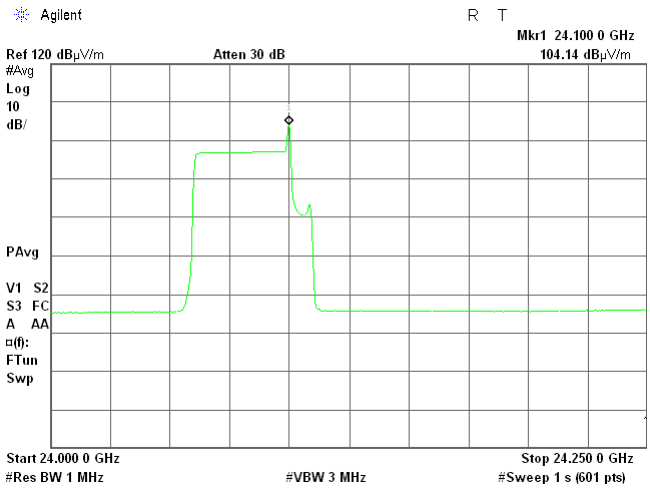
Full description is given in Appendix A.

| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

**Plot 7.1.1 Radiated emission measurements at the low fundamental frequency**

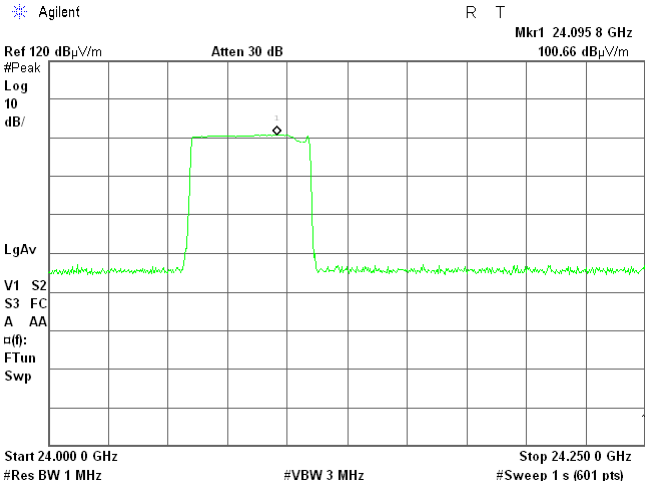
TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: Typical (Vertical)

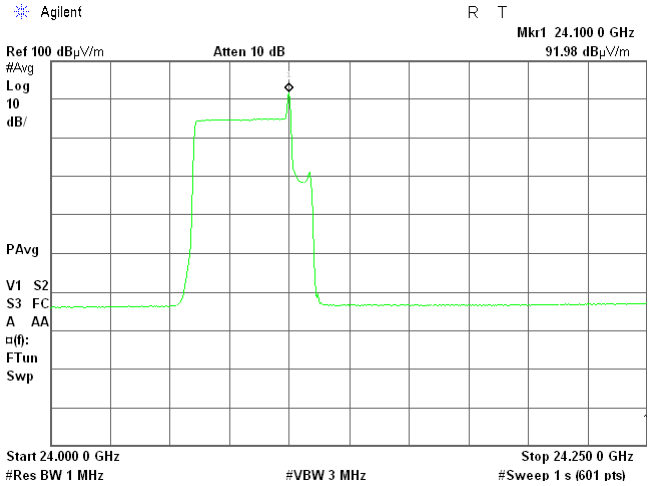



**Plot 7.1.2 Radiated emission measurements at the low fundamental frequency**

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Horizontal
EUT POSITION: Typical (Vertical)

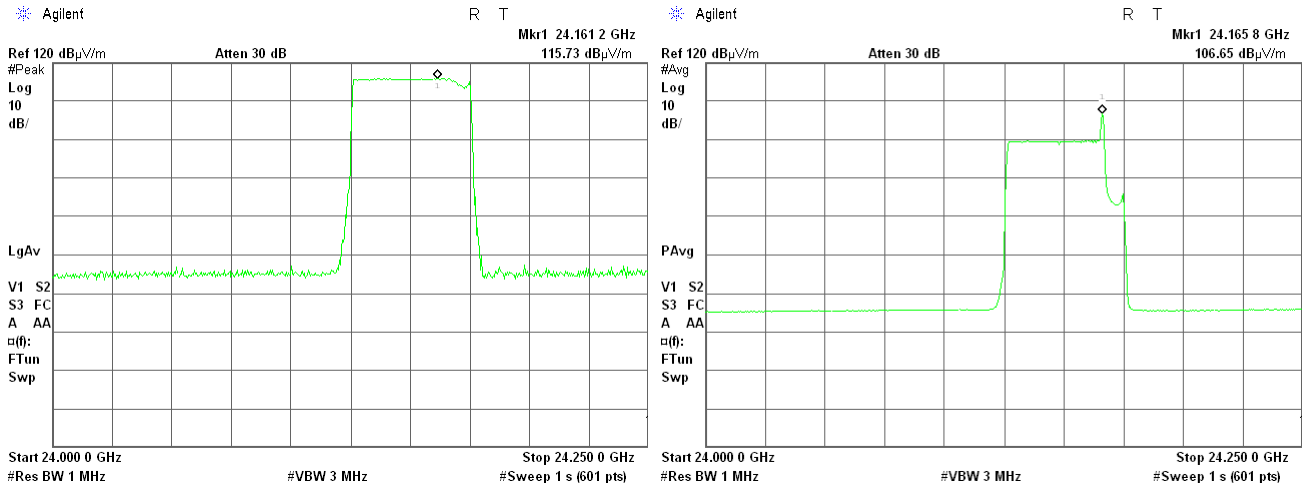


| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

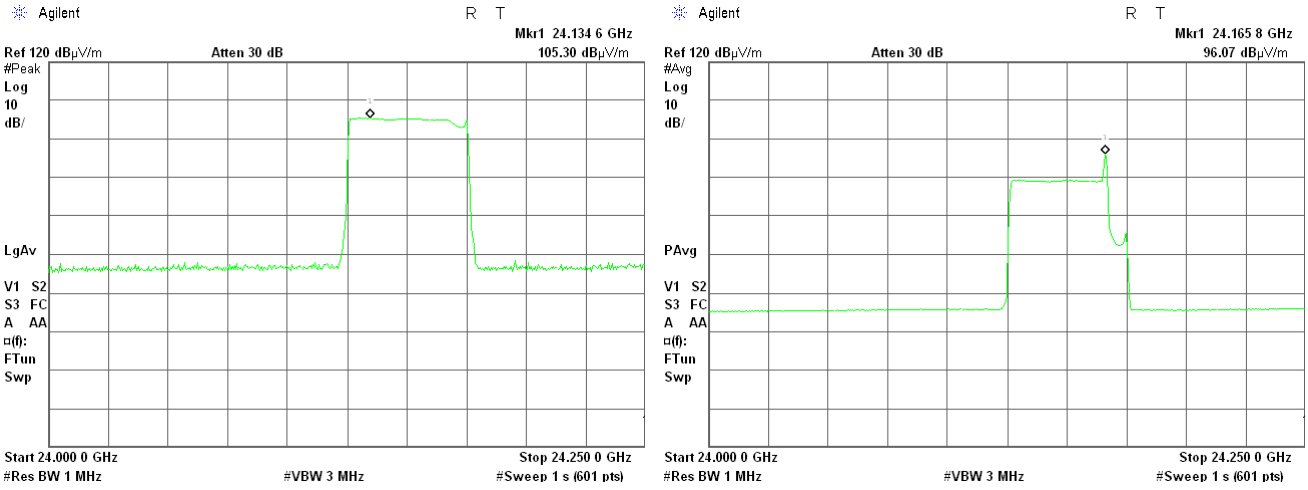
**Plot 7.1.3 Radiated emission measurements at the mid fundamental frequency**

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: Typical (Vertical)




**Plot 7.1.4 Radiated emission measurements at the mid fundamental frequency**

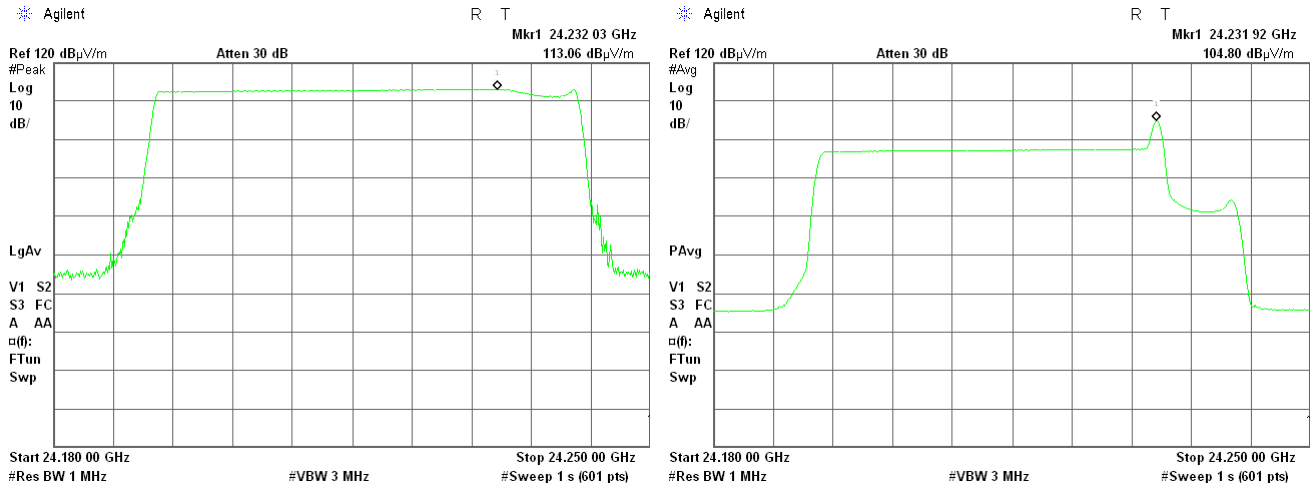
TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Horizontal
EUT POSITION: Typical (Vertical)



| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

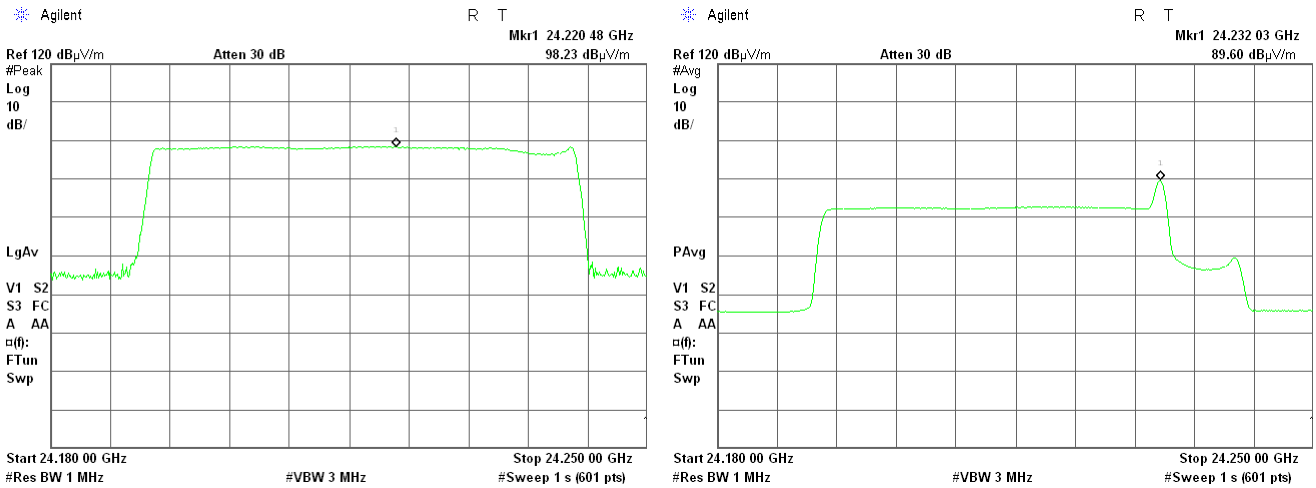
**Plot 7.1.5 Radiated emission measurements at the high fundamental frequency**

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: Typical (Vertical)




**Plot 7.1.6 Radiated emission measurements at the high fundamental frequency**

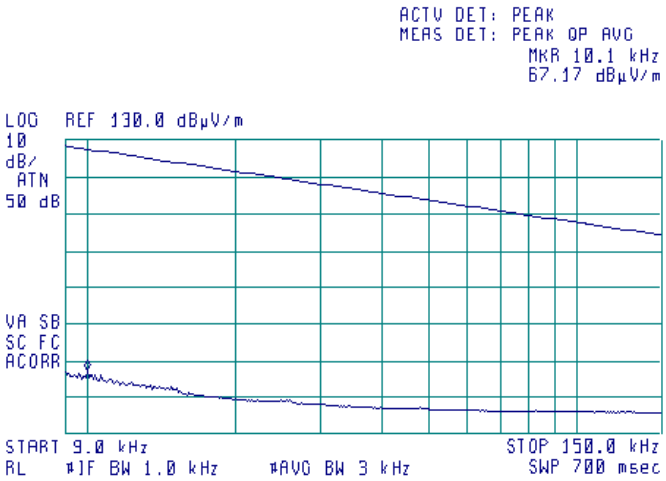
TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Horizontal
EUT POSITION: Typical (Vertical)



| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

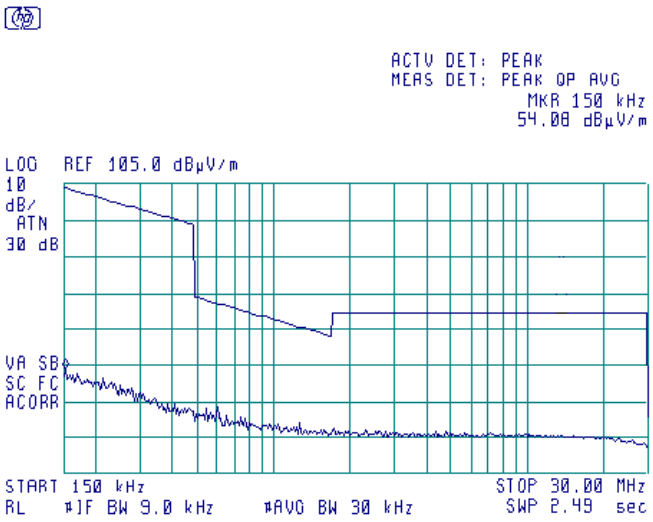
**Plot 7.1.7 Radiated emission measurements from 9 to 150 kHz at low, mid, high frequency**

TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m
EUT POSITION: Typical (Vertical)




**Plot 7.1.8 Radiated emission measurements from 0.15 to 30 MHz at low, mid, high frequency**

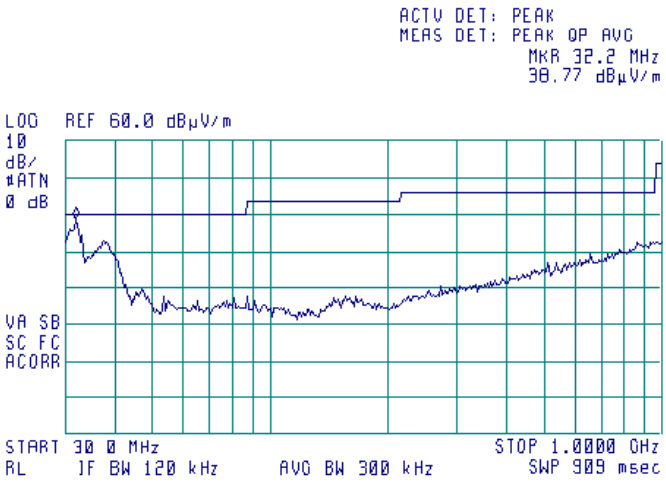
TEST SITE: Anechoic chamber
TEST DISTANCE: 3 m
EUT POSITION: Typical (Vertical)



| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

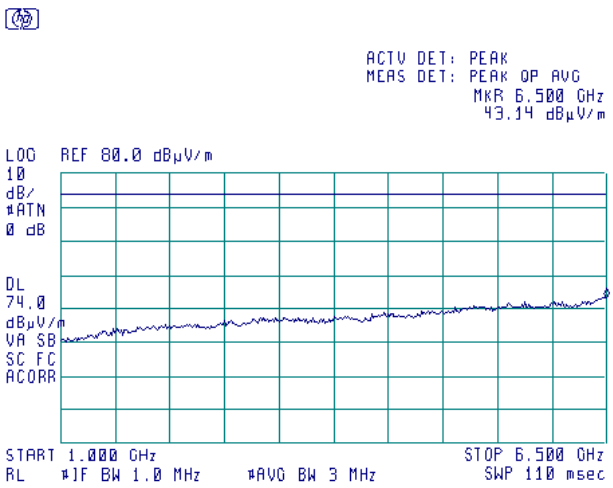
**Plot 7.1.9 Radiated emission measurements from 30 to 1000 MHz at low, mid, high frequency**

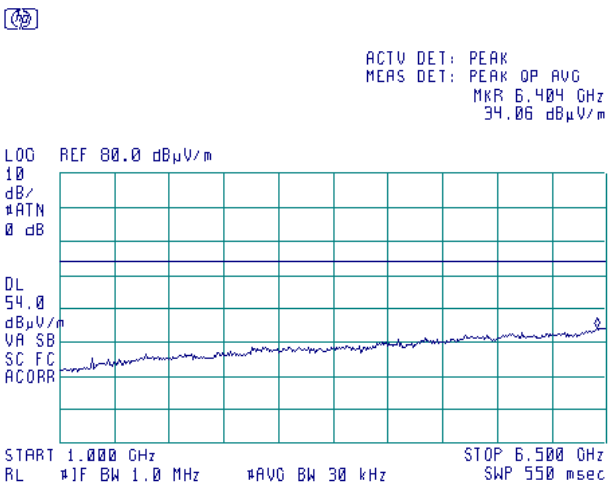
TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)




**Plot 7.1.10 Radiated emission measurements from 1.0 to 6.5 MHz at low, mid, high frequency**

TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)

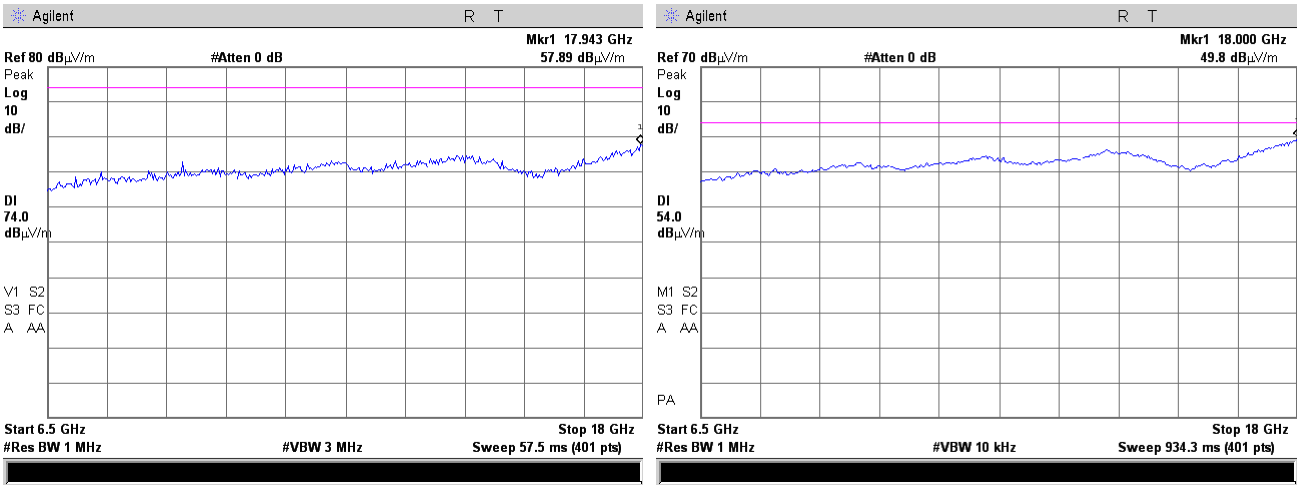


| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

**Plot 7.1.11 Radiated emission measurements from 6.5 to 18.0 GHz at low, mid, high frequency**

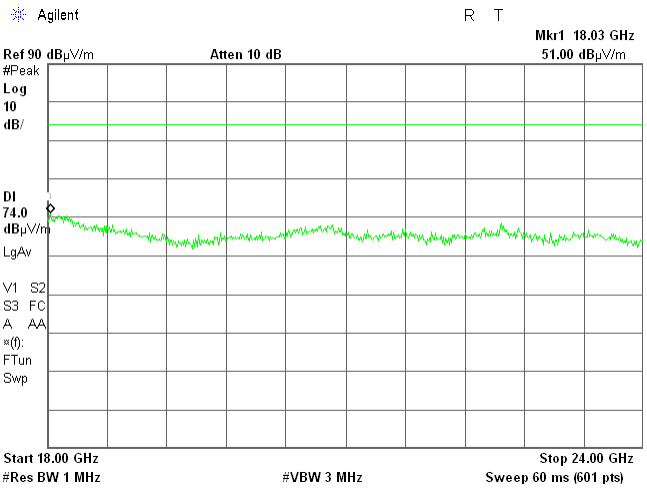
| | |
|---|---|
| TEST SITE: | Anechoic chamber |
| TEST DISTANCE: | 3 m |
| ANTENNA POLARIZATION: | Vertical and Horizontal |
| EUT POSITION: | Typical (Vertical) |

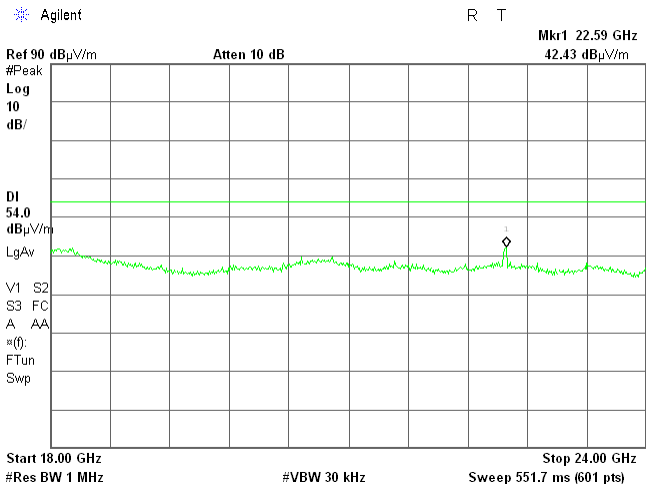


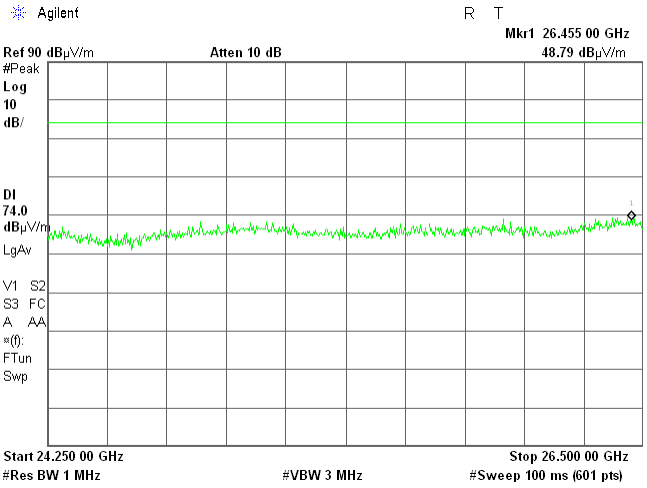
| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

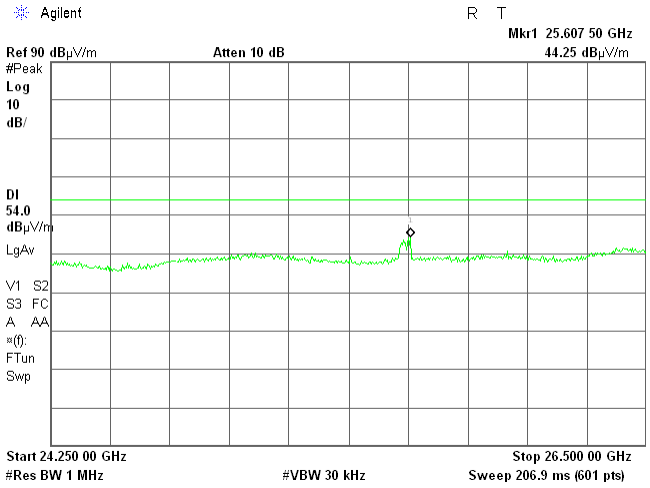
**Plot 7.1.12 Radiated emission measurements from 18.0 to 26.5 GHz at low frequency**

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



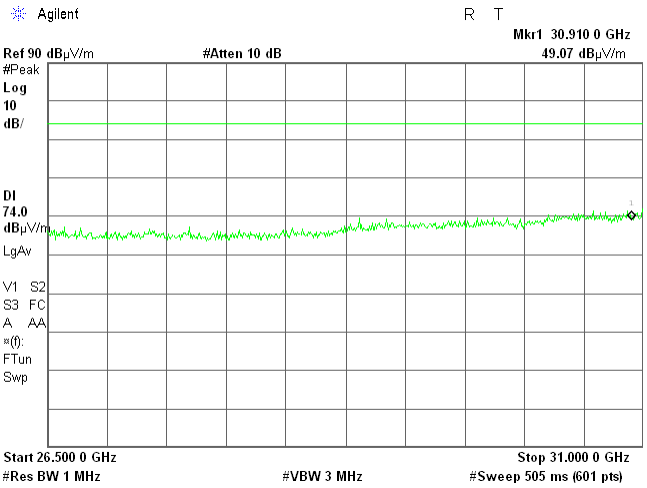



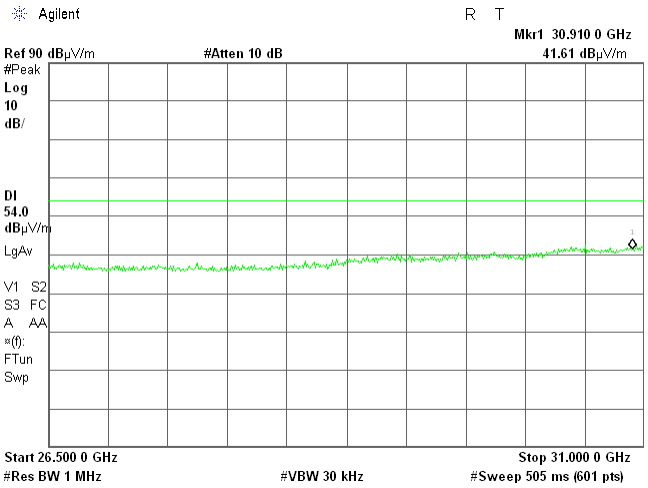



| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

**Plot 7.1.13 Radiated emission measurements from 26.5 to 31.0 GHz at low frequency**

| | |
|---|---|
| TEST SITE: | OATS |
| TEST DISTANCE: | 3 m |
| ANTENNA POLARIZATION: | Vertical and Horizontal |
| EUT POSITION: | Typical (Vertical) |

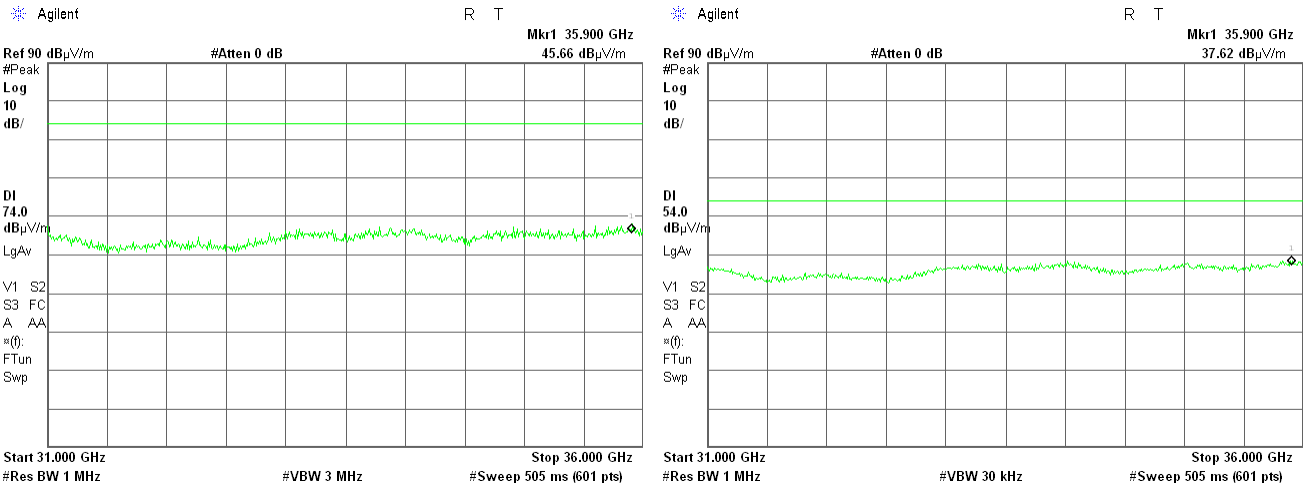


| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

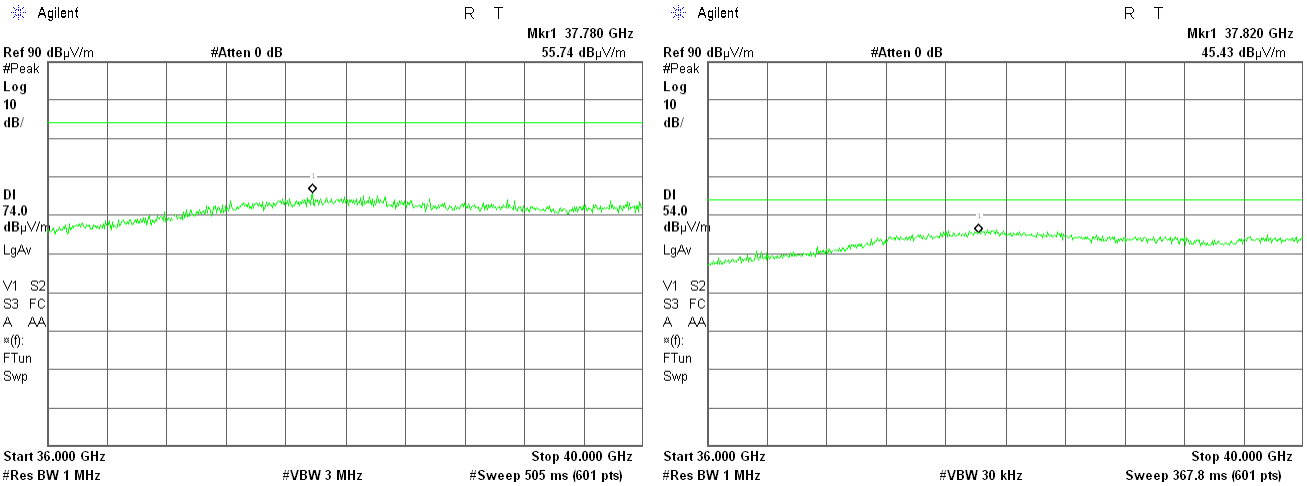
**Plot 7.1.14 Radiated emission measurements from 31.0 to 36.0 GHz at low frequency**

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)




**Plot 7.1.15 Radiated emission measurements from 36.0 to 40.0 GHz at low frequency**

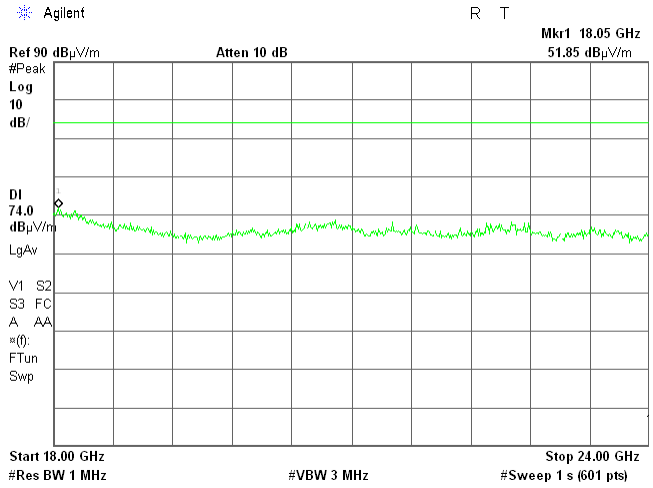
TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)

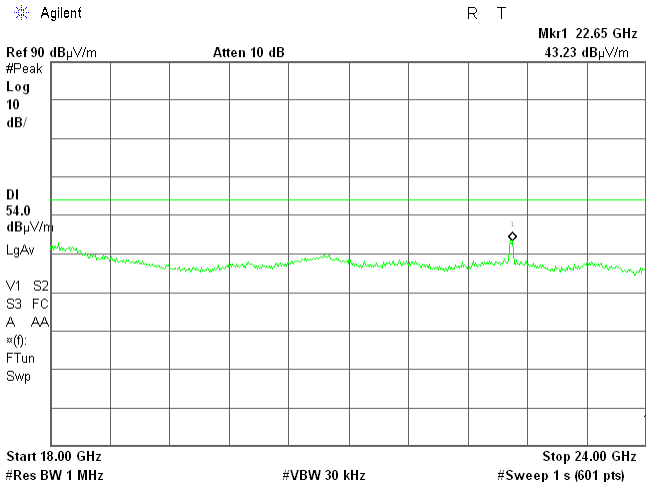


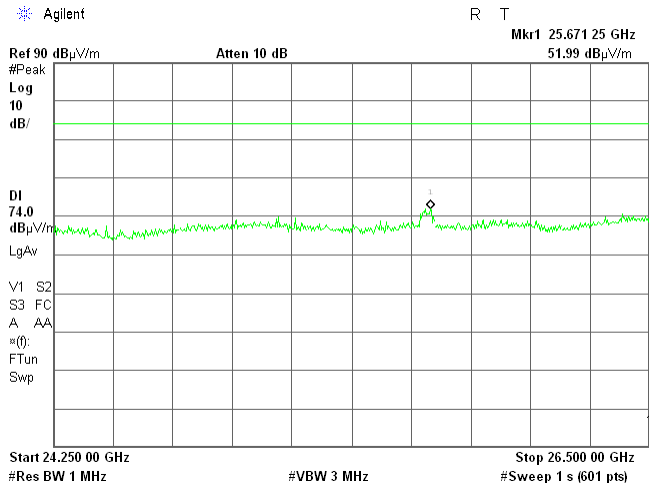
| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

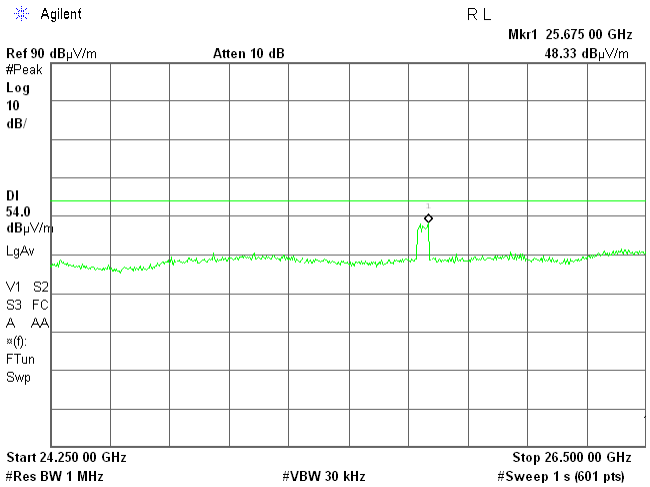
**Plot 7.1.16 Radiated emission measurements from 18.0 to 26.5 GHz at mid frequency**

| | |
|---|---|
| TEST SITE: | OATS |
| TEST DISTANCE: | 3 m |
| ANTENNA POLARIZATION: | Vertical and Horizontal |
| EUT POSITION: | Typical (Vertical) |



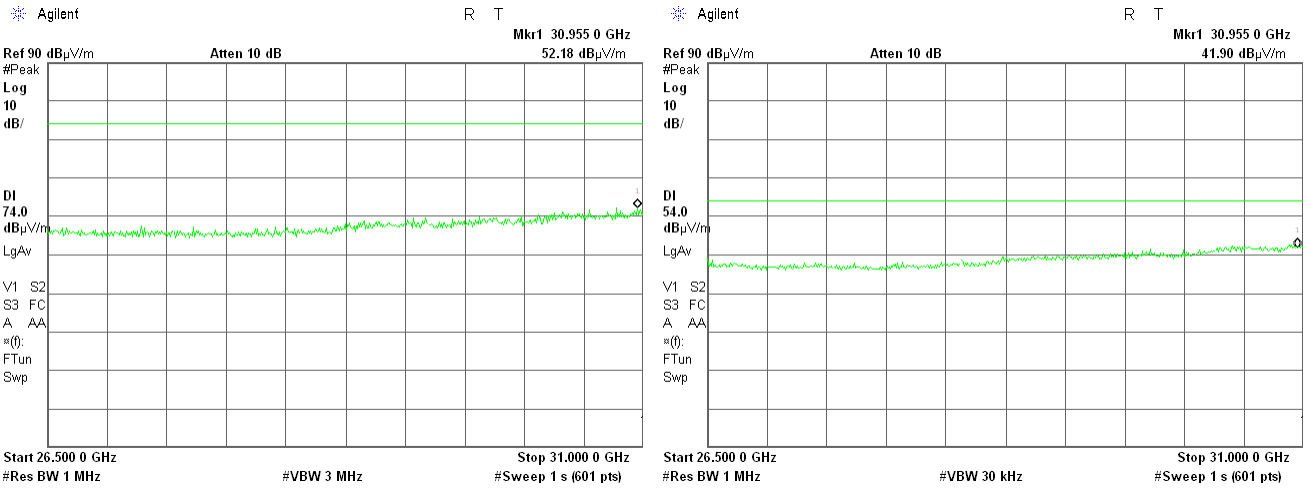



| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

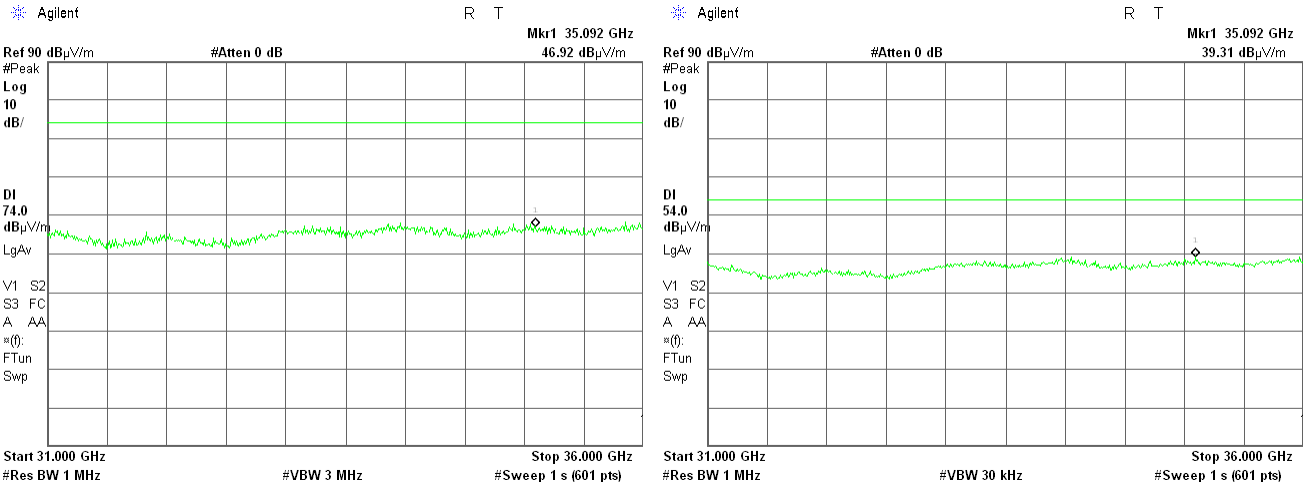
**Plot 7.1.17 Radiated emission measurements from 26.5 to 31.0 GHz at mid frequency**

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)




**Plot 7.1.18 Radiated emission measurements from 31.0 to 36.0 GHz at mid frequency**

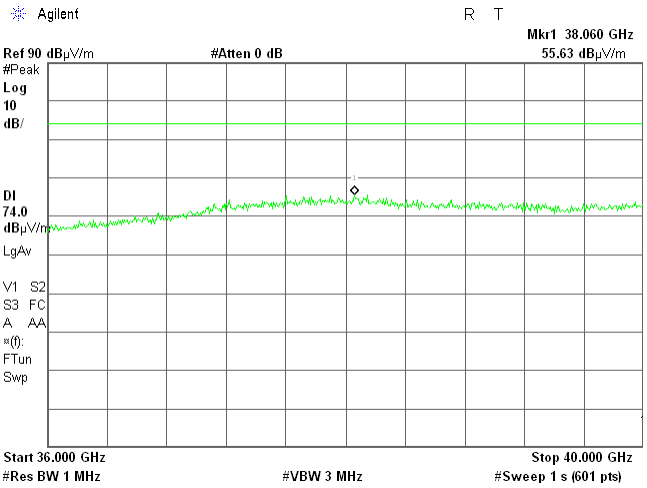
TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)

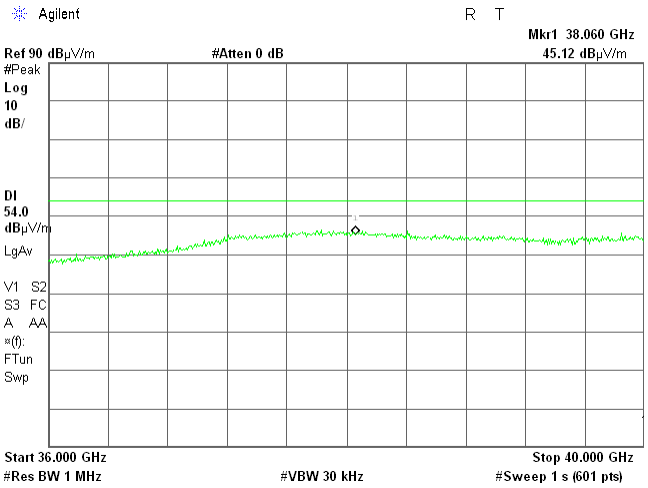


| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

**Plot 7.1.19 Radiated emission measurements from 36.0 to 40.0 GHz at mid frequency**

| | |
|---|---|
| TEST SITE: | OATS |
| TEST DISTANCE: | 3 m |
| ANTENNA POLARIZATION: | Vertical and Horizontal |
| EUT POSITION: | Typical (Vertical) |

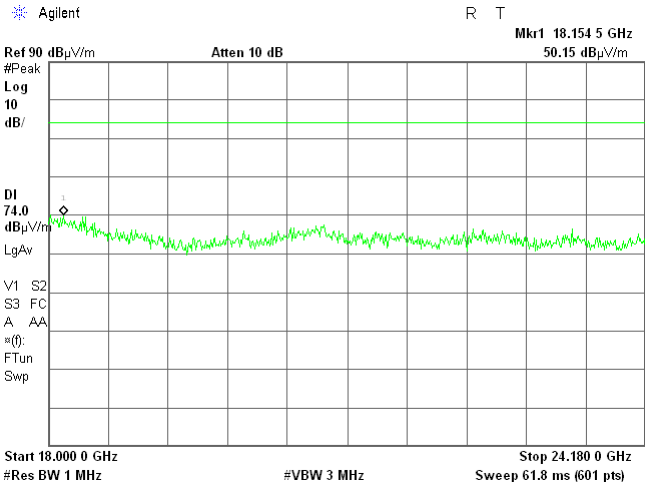


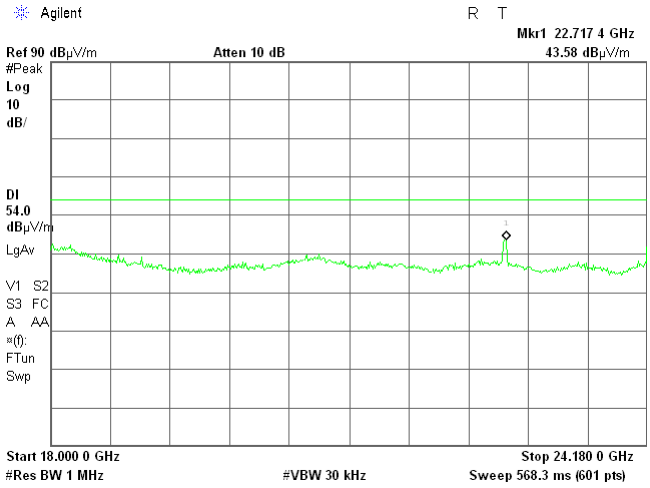



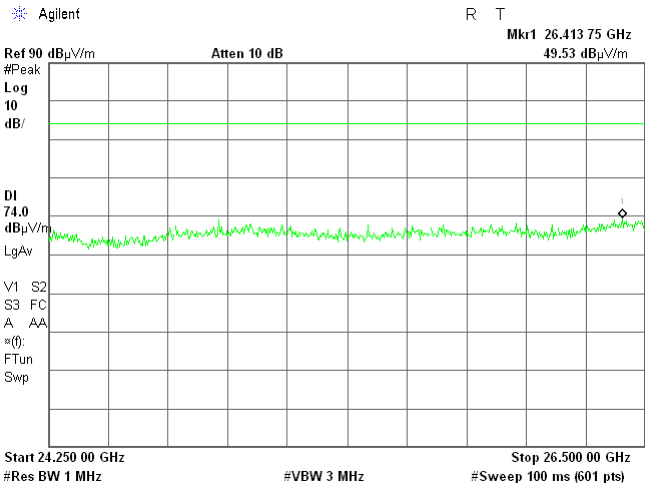
| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

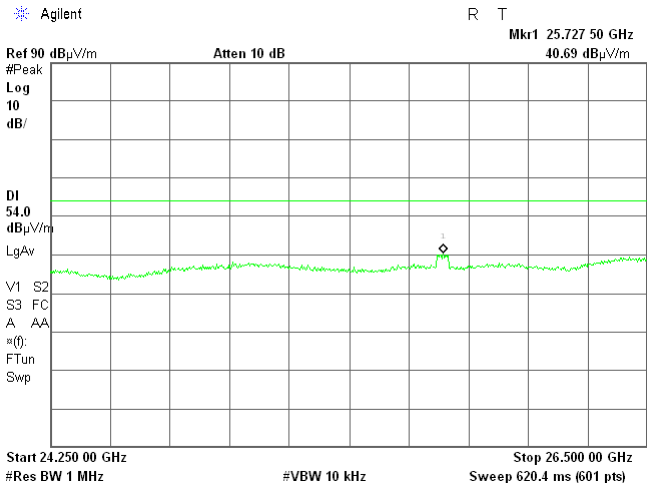
**Plot 7.1.20 Radiated emission measurements from 18.0 to 26.5 GHz at high frequency**

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



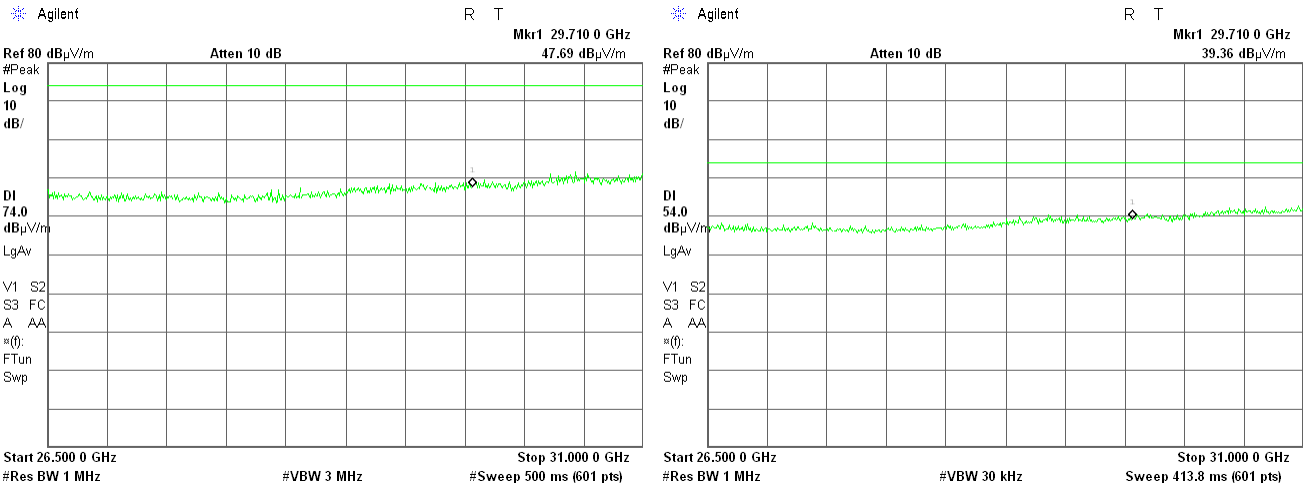



| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

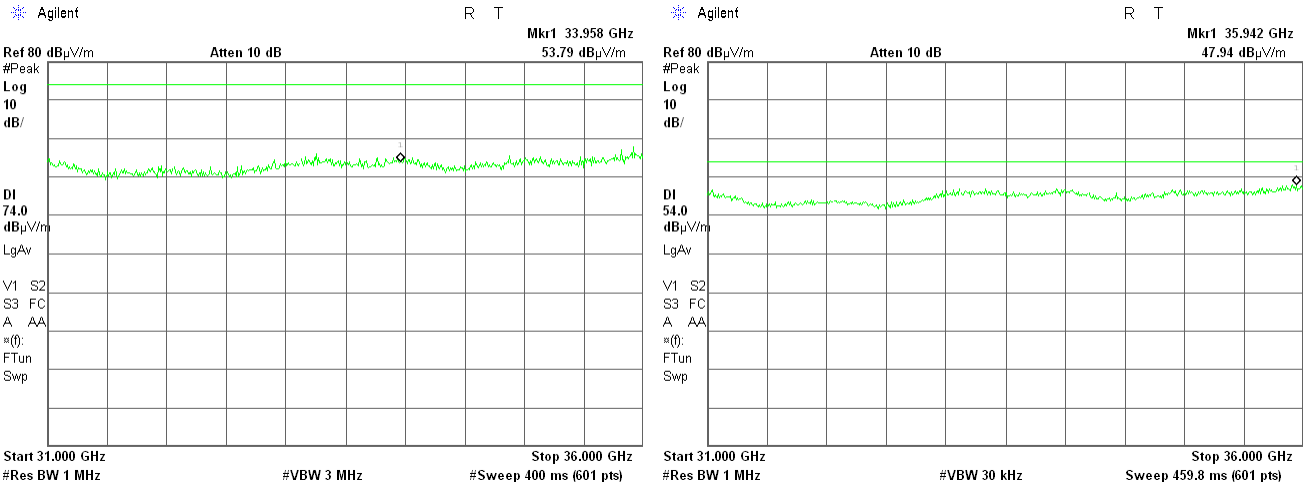
**Plot 7.1.21 Radiated emission measurements from 26.5 to 31.0 GHz**

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)




**Plot 7.1.22 Radiated emission measurements from 31.0 to 36.0 GHz**

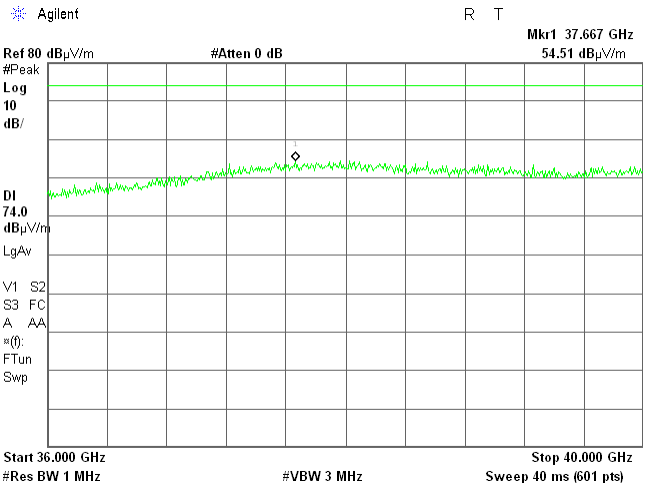
TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)

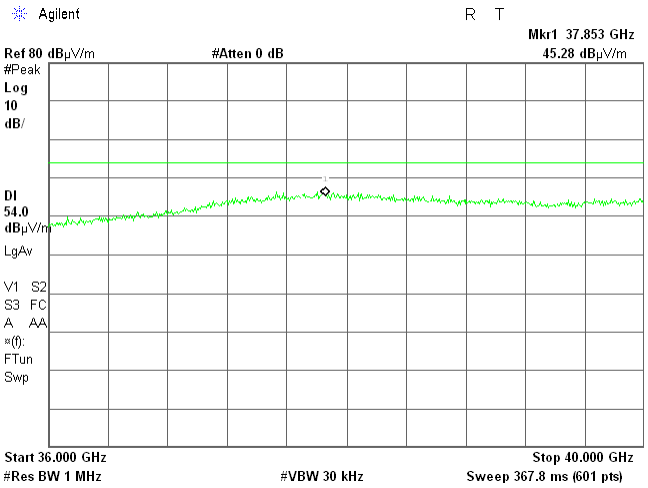


| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

**Plot 7.1.23 Radiated emission measurements from 36.0 to 40.0 GHz**

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)

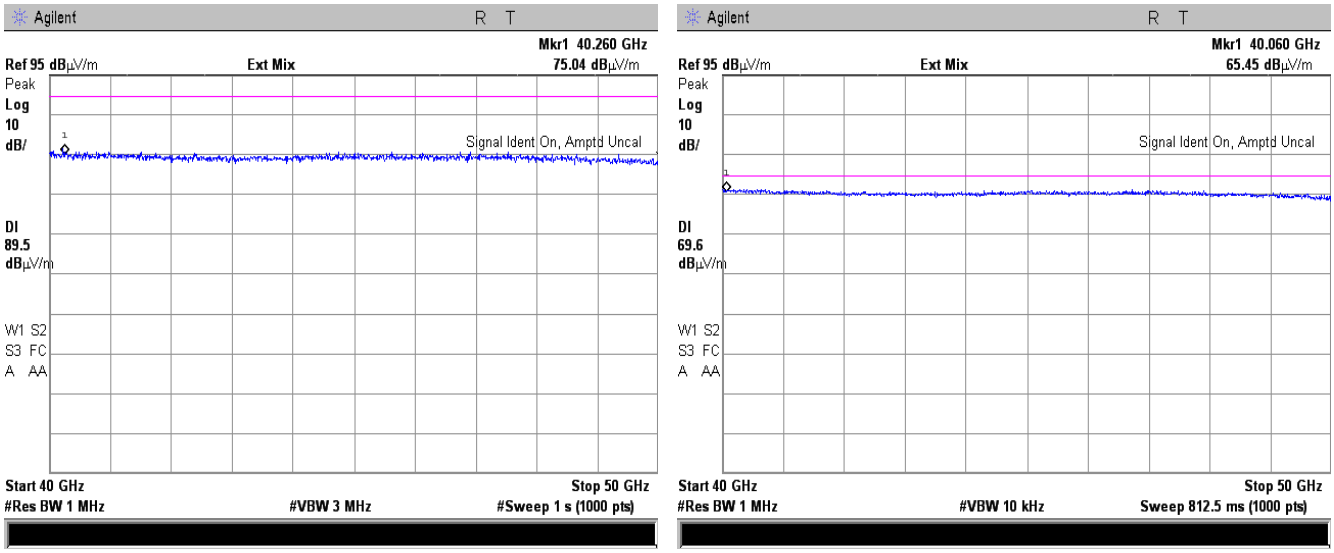


| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

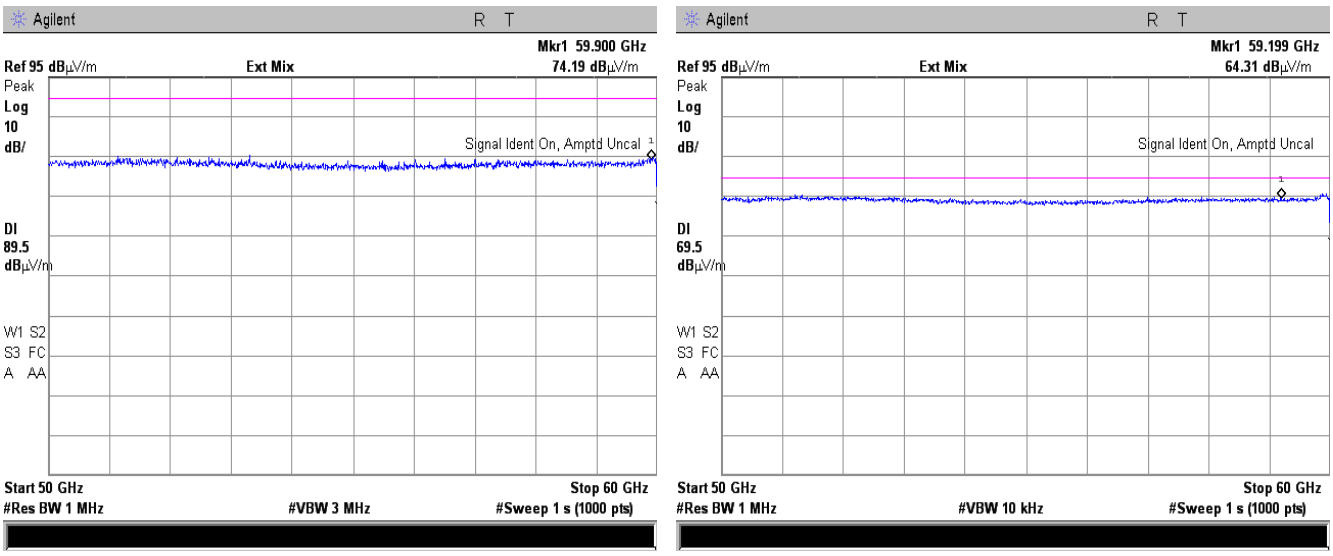
**Plot 7.1.24 Radiated emission measurements from 40.0 to 50.0 GHz at low, mid, high frequency**

TEST SITE: OATS
TEST DISTANCE: 0.5 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)




**Plot 7.1.25 Radiated emission measurements from 50.0 to 60.0 GHz at low, mid, high frequency**

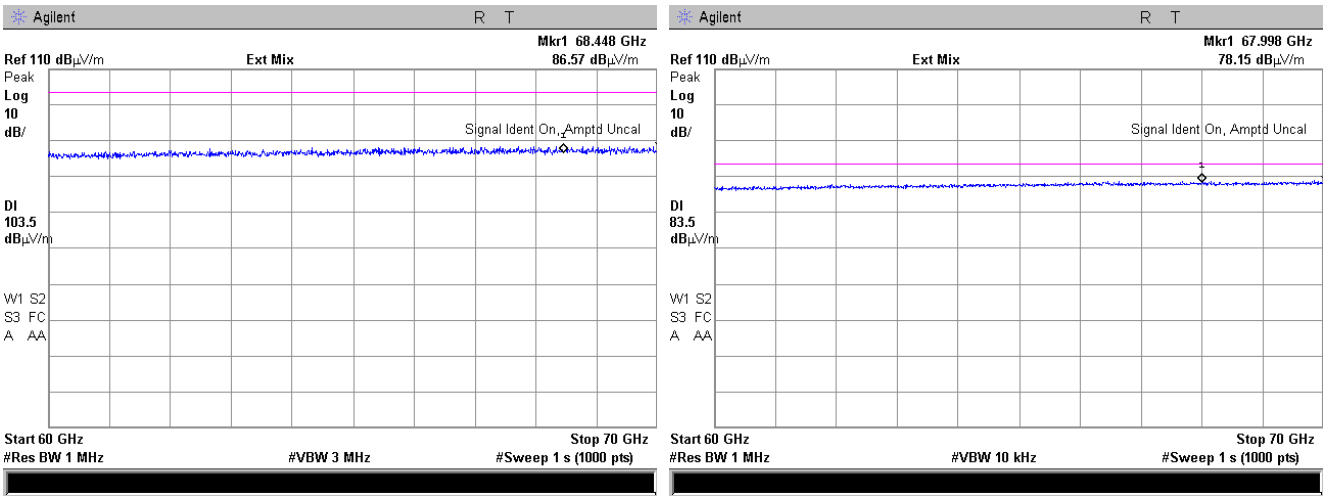
TEST SITE: OATS
TEST DISTANCE: 0.5 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

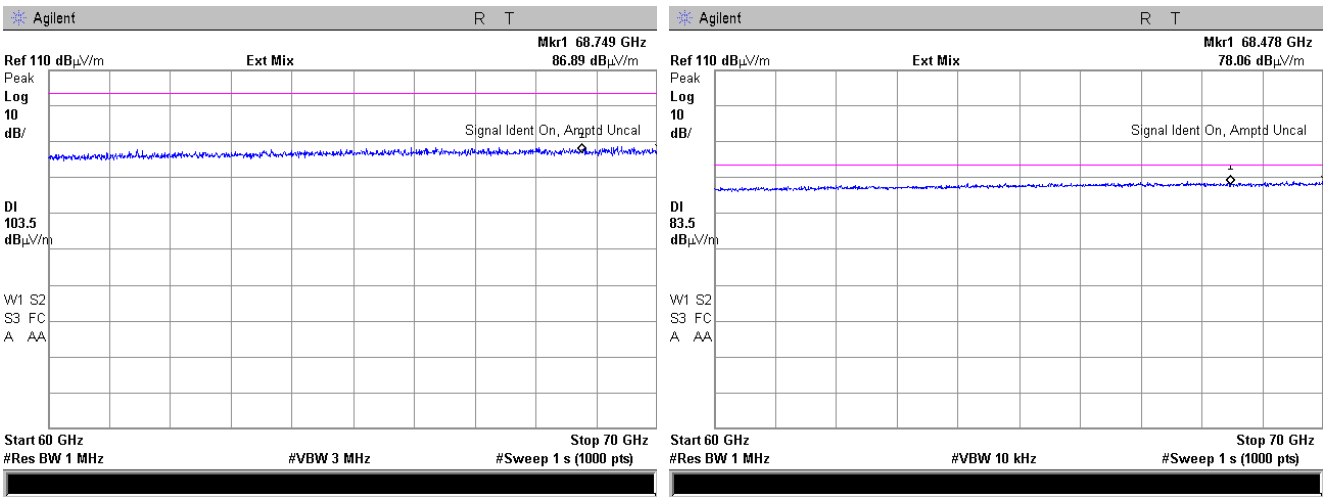
**Plot 7.1.26 Radiated emission measurements from 60.0 to 70.0 GHz at low frequency**

TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.1 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)




**Plot 7.1.27 Radiated emission measurements from 60.0 to 70.0 GHz at mid frequency**

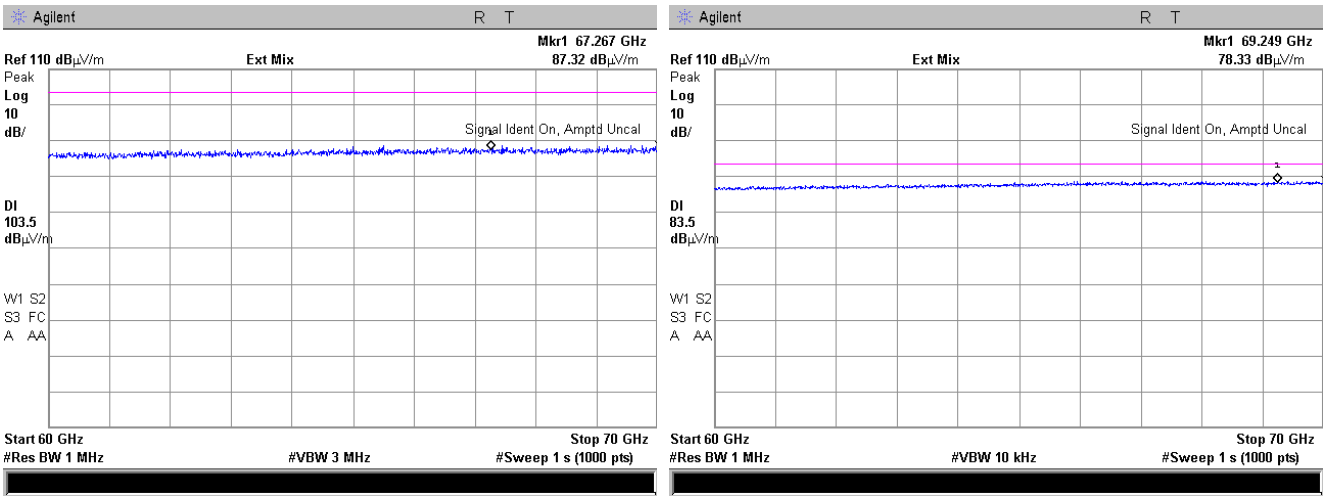
TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.1 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

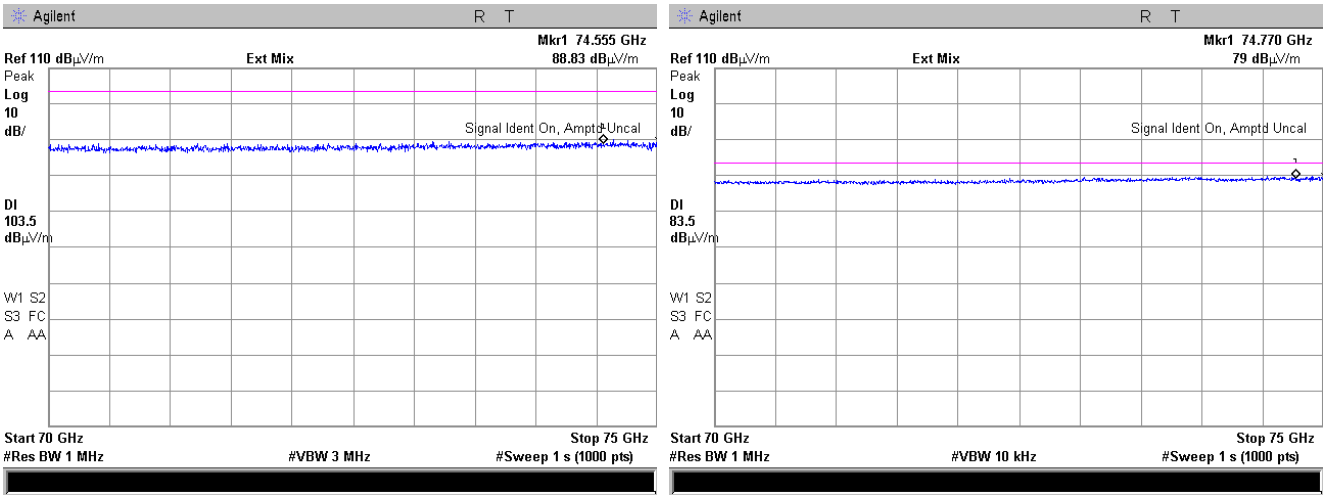
**Plot 7.1.28 Radiated emission measurements from 60.0 to 70.0 GHz at high frequency**

TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.1 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)




**Plot 7.1.29 Radiated emission measurements from 70.0 to 75.0 GHz at low frequency**

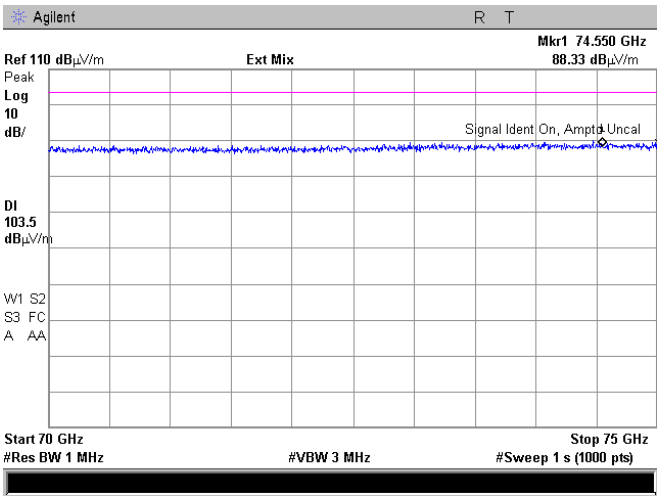
TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.1 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)

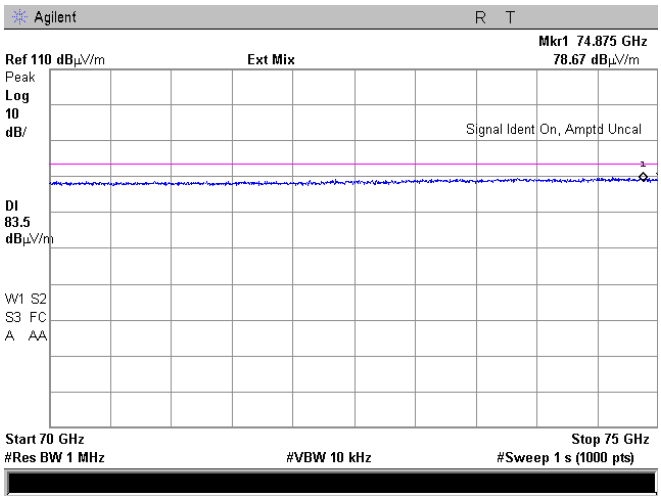


| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

**Plot 7.1.30 Radiated emission measurements from 70.0 to 75.0 GHz at mid frequency**

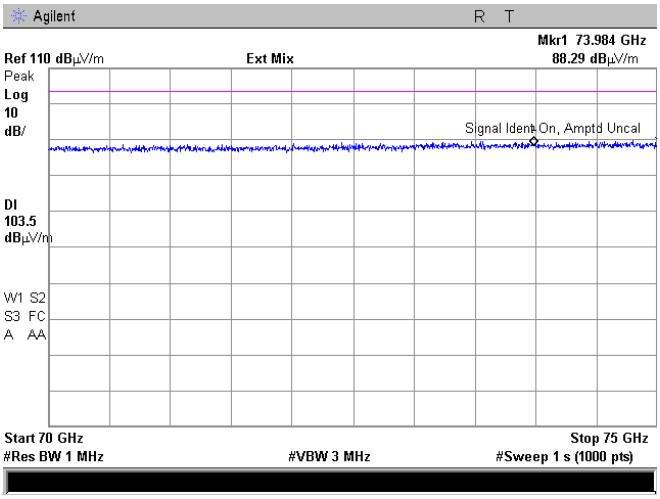
TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.1 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)

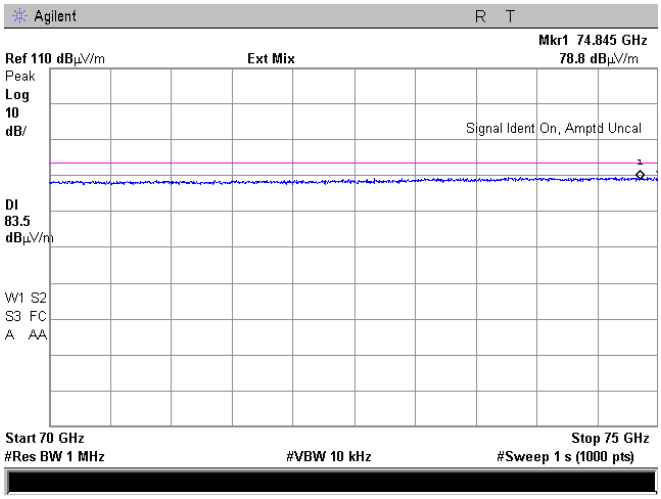



**Plot 7.1.31 Radiated emission measurements from 70.0 to 75.0 GHz at high frequency**

TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.1 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)

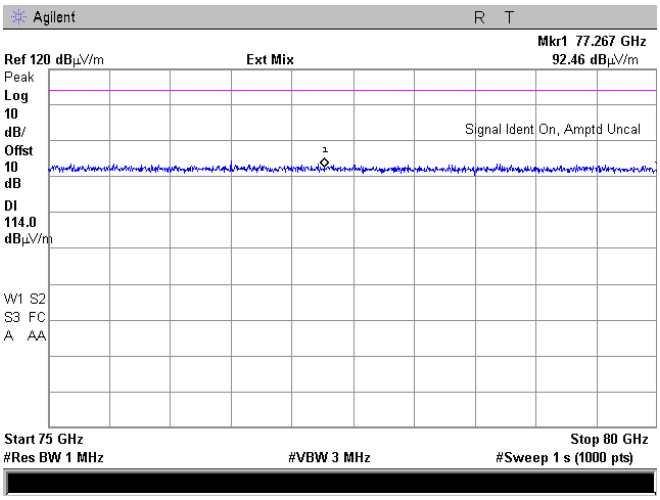


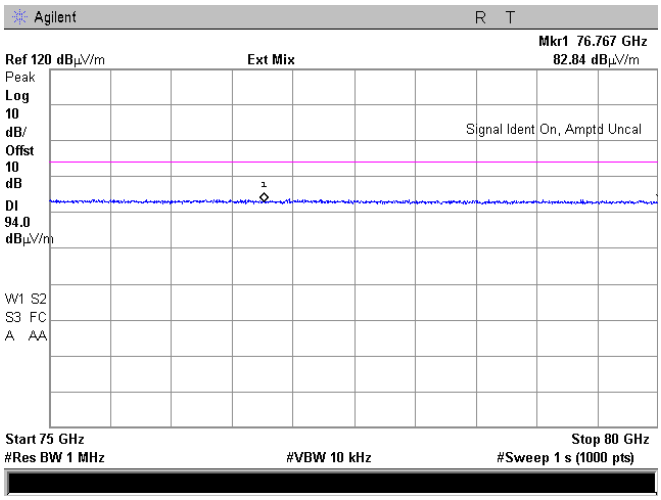



| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

**Plot 7.1.32 Radiated emission measurements from 75.0 to 80.0 GHz at low frequency**

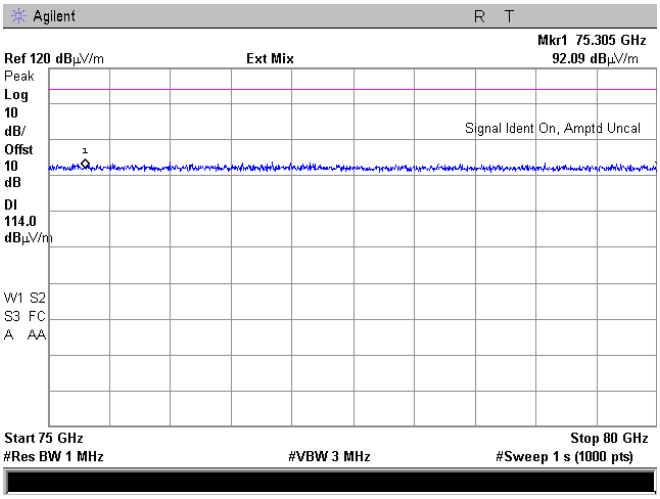
TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.03 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)

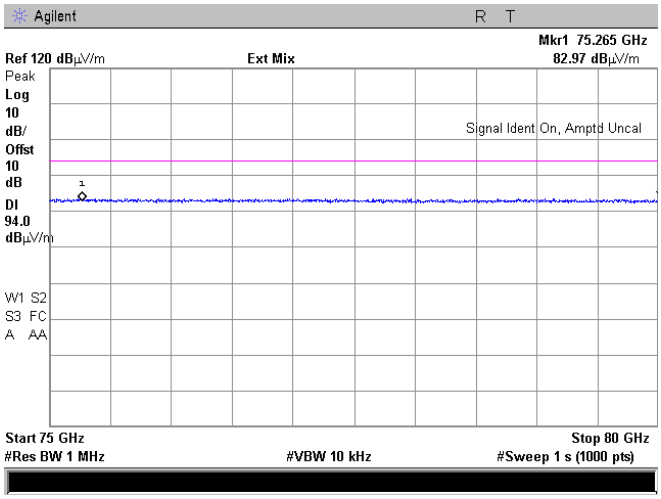



**Plot 7.1.33 Radiated emission measurements from 75.0 to 80.0 GHz at mid frequency**

TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.03 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)

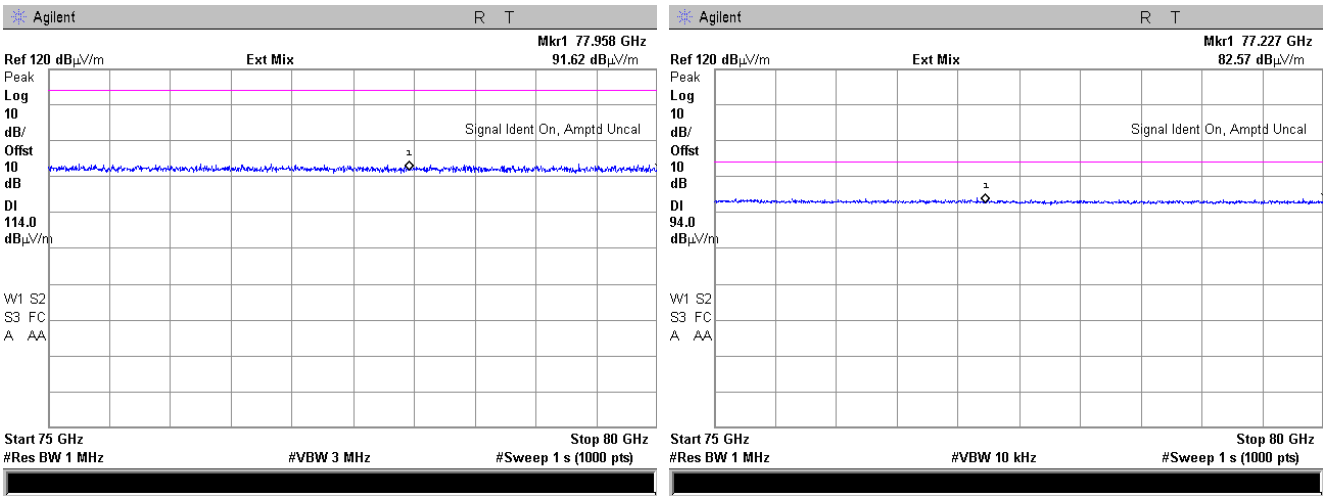


| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

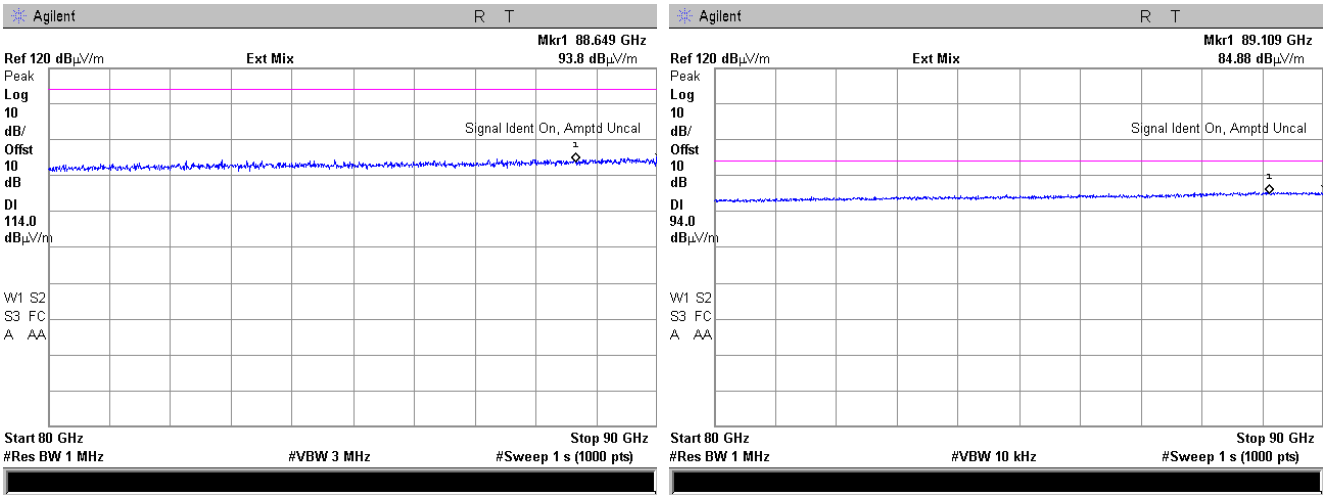
**Plot 7.1.34 Radiated emission measurements from 75.0 to 80.0 GHz at high frequency**

TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.03 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)




**Plot 7.1.35 Radiated emission measurements from 80.0 to 90.0 GHz at low frequency**

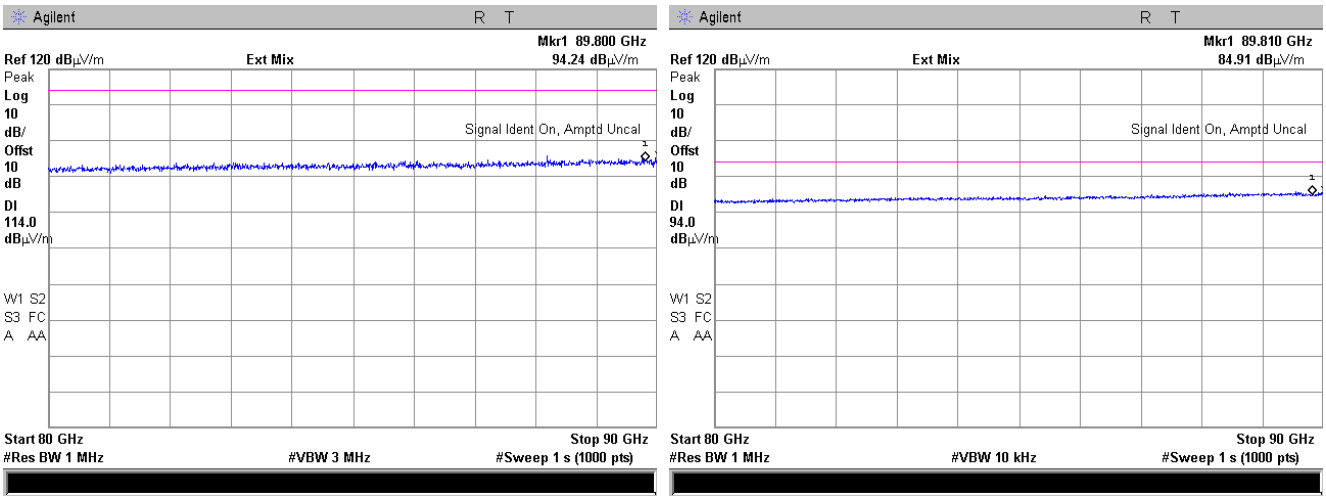
TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.03 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

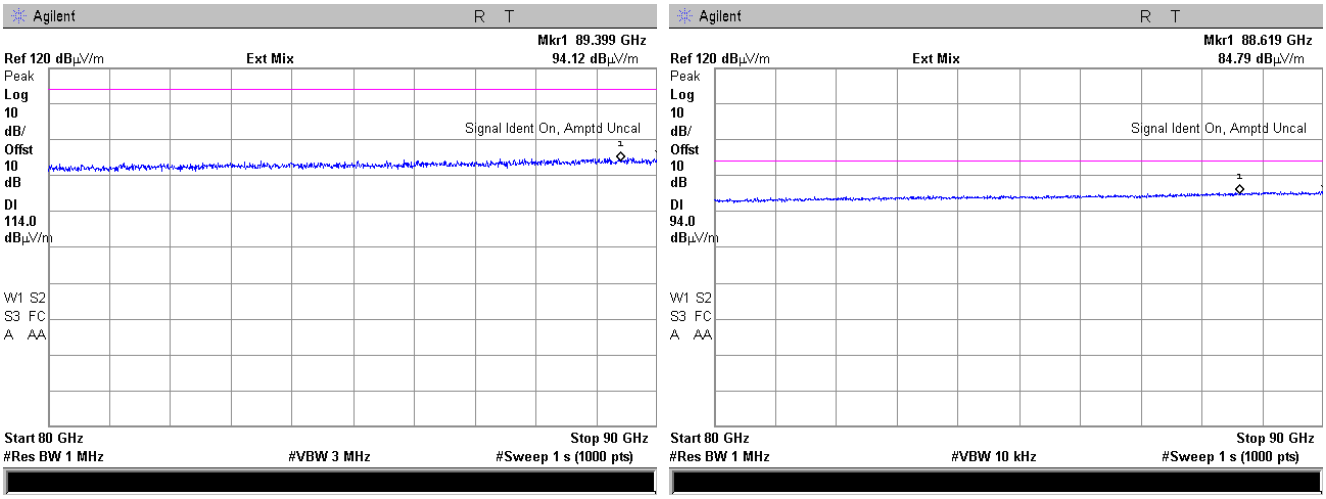
**Plot 7.1.36 Radiated emission measurements from 80.0 to 90.0 GHz at mid frequency**

TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.03 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)




**Plot 7.1.37 Radiated emission measurements from 80.0 to 90.0 GHz at high frequency**

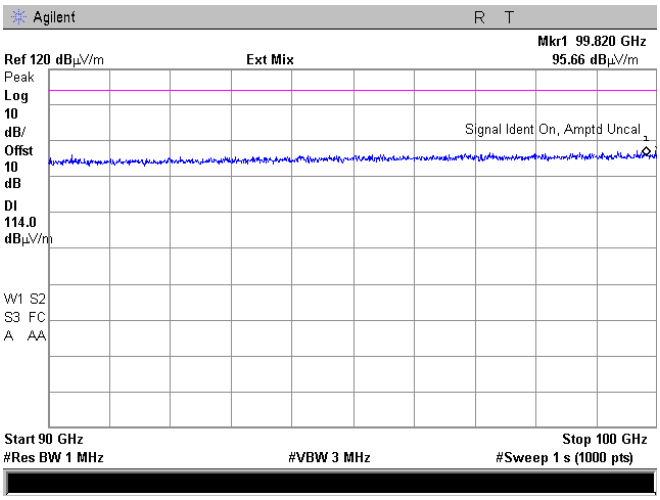
TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.03 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)

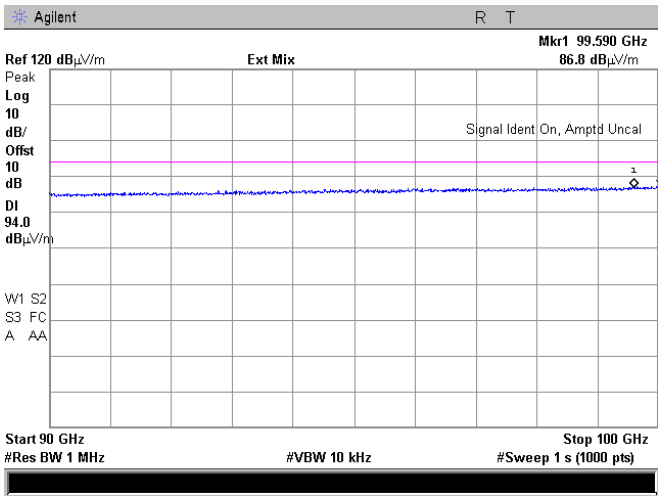


| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

**Plot 7.1.38 Radiated emission measurements from 90.0 to 100.0 GHz at low frequency**

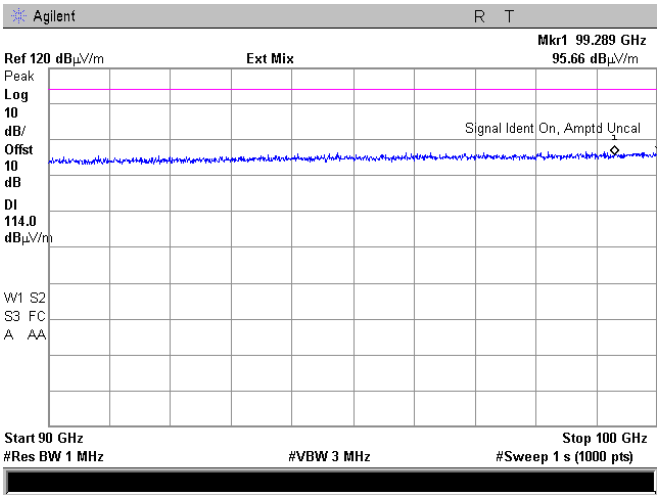
TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.03 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)

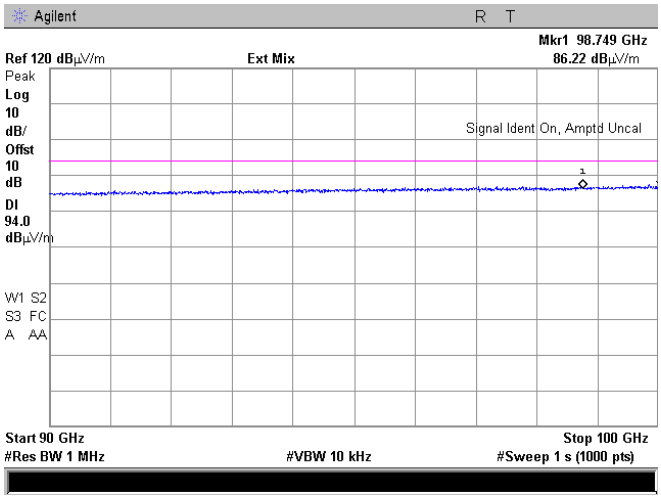



**Plot 7.1.39 Radiated emission measurements from 90.0 to 100.0 GHz at mid frequency**

TEST SITE: Semi-anechoic chamber
TEST DISTANCE: 0.03 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)

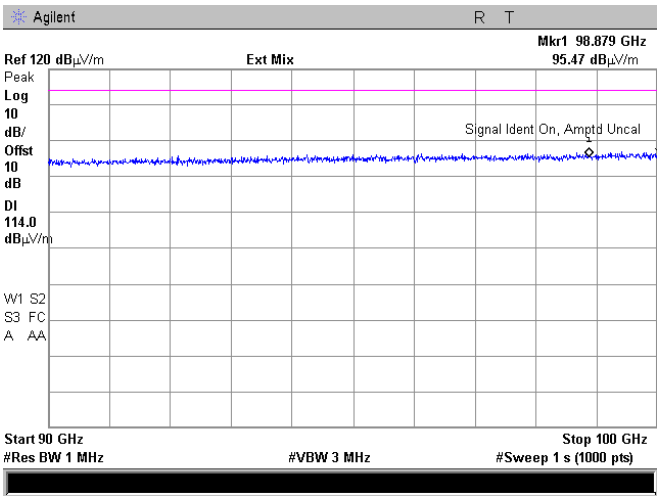


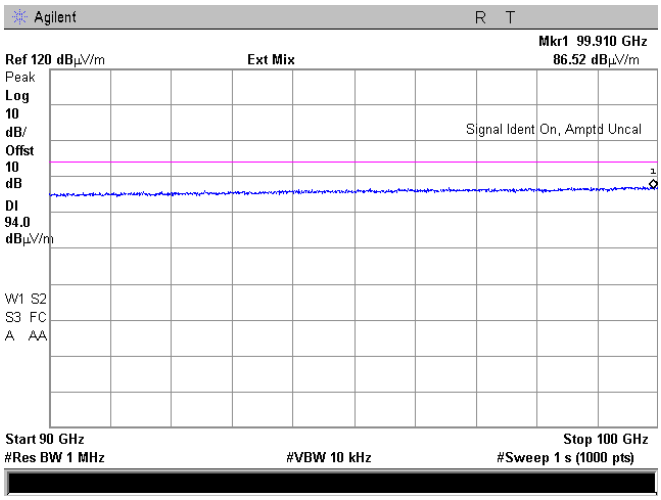



| Test specification: | Section 15.249(a)(d), Field strength of emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 sections 6.5, 6.6 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

**Plot 7.1.40 Radiated emission measurements from 90.0 to 100.0 GHz at high frequency**

| | |
|---|---|
| TEST SITE: | Semi-anechoic chamber |
| TEST DISTANCE: | 0.03 m |
| ANTENNA POLARIZATION: | Vertical and Horizontal |
| EUT POSITION: | Typical (Vertical) |



| Test specification: | Section 15.215(c), Occupied bandwidth | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 section 6.9.2 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 12-Jan-17 | | |
| Temperature: 24 ºC | Relative Humidity: 45 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

## 7.2 Occupied bandwidth test

### 7.2.1 General

This test was performed to verify that the 20 dB bandwidth of the emissions was contained within the standard specified frequency band according to FCC §15.215 requirements. Specification test limits are given in Table 7.2.1.

**Table 7.2.1 Occupied bandwidth limits**

| Assigned frequency, MHz | Modulation envelope reference points*, dBc |
|---|---|
| 902 - 928 | 20.0 |
| 2400 – 2483.5 | |
| 5725 – 5875 | |
| 24000 – 24250 | |

*- Modulation envelope reference points provided in terms of attenuation below modulated carrier.

### 7.2.2 Test procedure

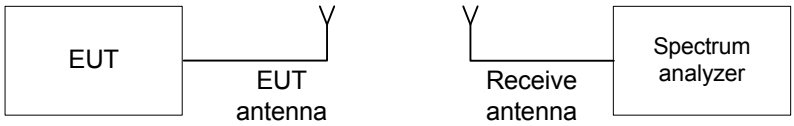
**7.2.2.1** The EUT was set up as shown in Figure 7.2.1, energized and its proper operation was checked.

**7.2.2.2** The spectrum analyzer sweep time and bandwidth were set to capture all major modulation sidebands of emission and sweep time was set sufficiently slow to ensure peak measurements. Spectrum analyzer was set in peak hold mode and time sufficient for trace stabilization was allowed.

**7.2.2.3** The peak of emission was measured. The transmitter occupied bandwidth was measured with spectrum analyzer as frequency delta between reference points on modulation envelope and provided in Table 7.2.1 and associated plots.

**7.2.2.4** Modulation bandwidth was calculated by adding of the negative frequency drift to the lower measured frequency and the positive frequency drift to the higher measured frequency. The obtained modulation bandwidth was verified to be within the allowed frequency range.

**Figure 7.2.1 Occupied bandwidth test setup**



| **Test specification:** | **Section 15.215(c), Occupied bandwidth** | | |
|---|---|---|---|
| **Test procedure:** | ANSI C63.10 section 6.9.2 | | |
| **Test mode:** | Compliance | **Verdict:** | PASS |
| **Date(s):** | 12-Jan-17 | | |
| **Temperature:** 24 ºC | **Relative Humidity:** 45 % | **Air Pressure:** 1022 hPa | **Power:** 48 VDC |
| **Remarks:** | | | |

**Table 7.2.2 Occupied bandwidth test results**

OPERATING FREQUENCY RANGE: 24000 – 24250 MHz
DETECTOR USED: Peak

| Frequency, MHz | Modulation | Occupied bandwidth 99%, MHz | Occupied bandwidth 20 dBc MHz | Verdict |
|---|---|---|---|---|
| 24085 | FMCW | 49.418 | 52.416 | Pass |
| 24150 | | 49.421 | 52.463 | Pass |
| 25215 | | 49.574 | 52.619 | Pass |

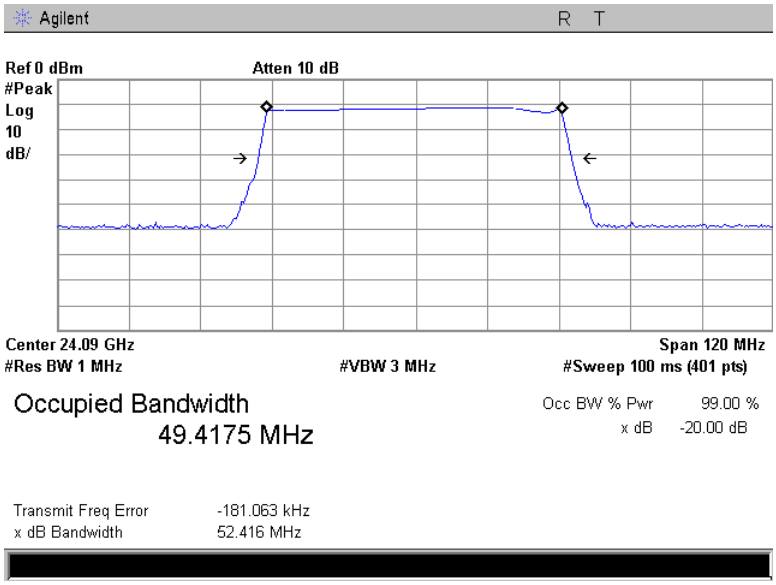
**Reference numbers of test equipment used**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| HL 2909 | | | | | | | | |

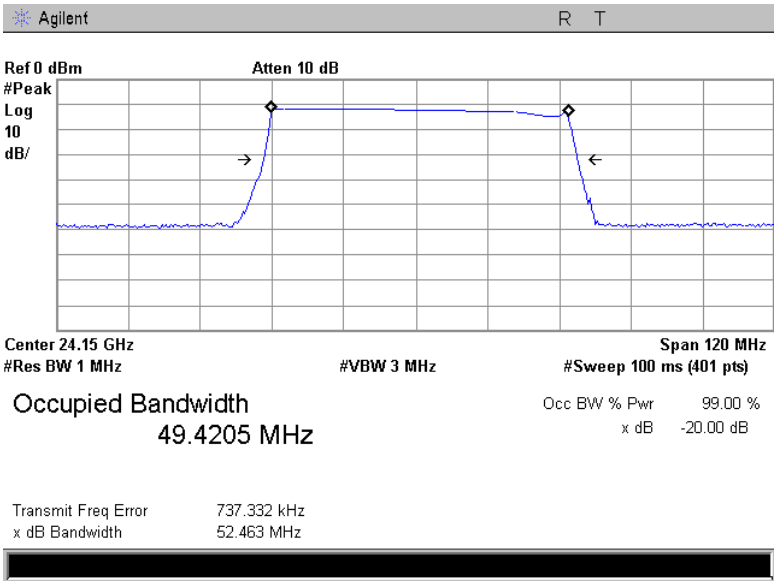
Full description is given in Appendix A.

| Test specification: | Section 15.215(c), Occupied bandwidth | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 section 6.9.2 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 12-Jan-17 | | |
| Temperature: 24 ºC | Relative Humidity: 45 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

**Plot 7.2.1 Occupied bandwidth test result at low frequency**

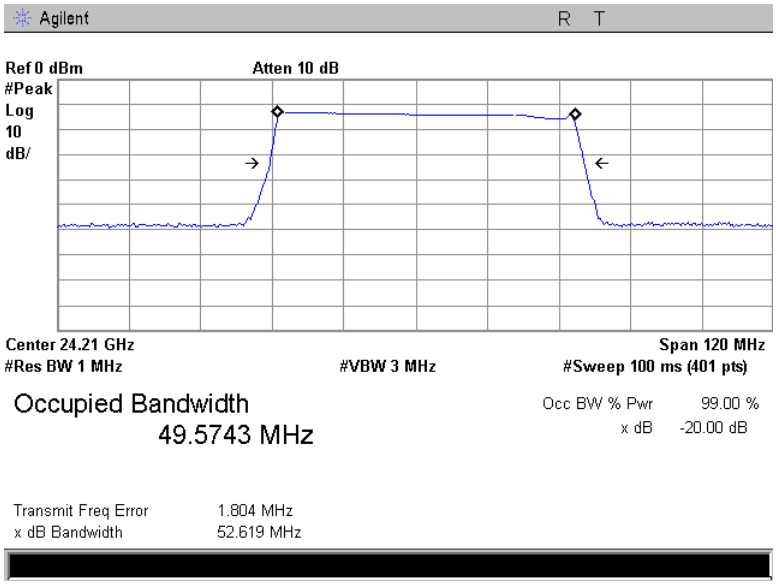



**Plot 7.2.2 Occupied bandwidth test result at mid frequency**



| Test specification: | Section 15.215(c), Occupied bandwidth | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 section 6.9.2 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 12-Jan-17 | | |
| Temperature: 24 ºC | Relative Humidity: 45 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

**Plot 7.2.3 Occupied bandwidth test result at high frequency**



| Test specification: | Section 15.249(d), Band edge emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 section 6.10 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

## 7.3 Band edge emission

### 7.3.1 General

This test was performed to verify the EUT band edge emission including all associated side bands was attenuated at least 50 dB below the unmodulated carrier level or below the general spurious emission limit. Specification test limits are given in Table 7.3.1.

**Table 7.3.1 Band edge emission limits**

| Frequency band, MHz | Field strength limit at 3 m, dBµV/m | | Attenuation below carrier, dBc |
|---|---|---|---|
| | Peak | Average | |
| 24000 – 24250 | 74.0 | 54.0 | 50 |

### 7.3.2 Test procedure

**7.3.2.1** The EUT was set up as shown in Figure 7.3.1, energized and the performance check was conducted.

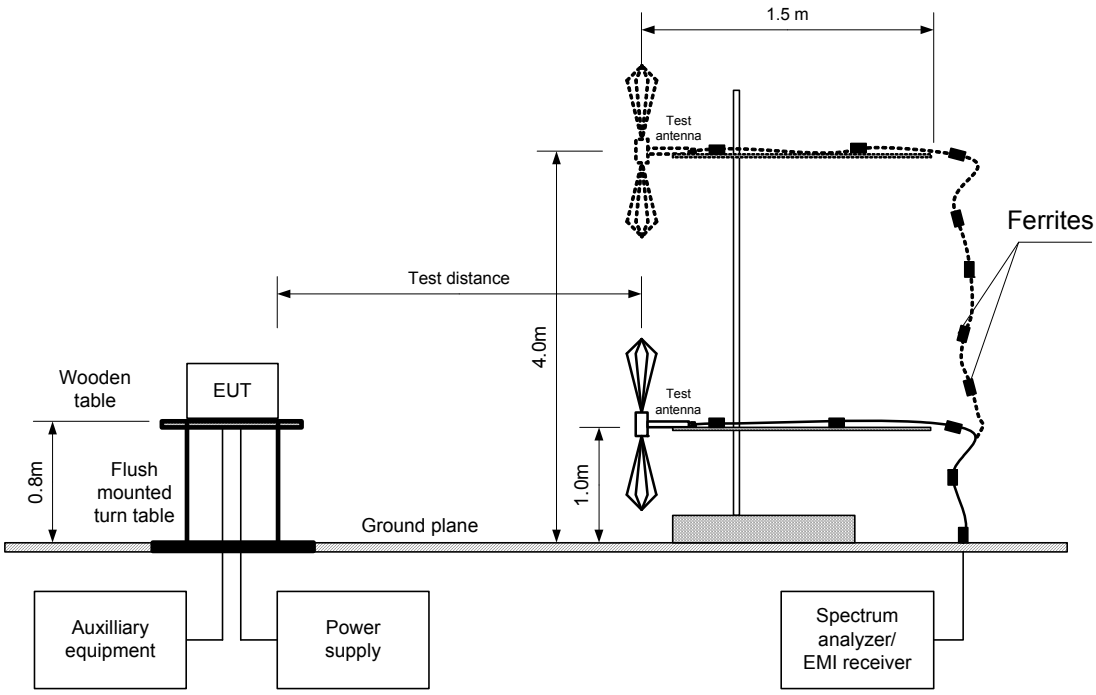
**7.3.2.2** The spectrum analyzer frequency span was set to capture all major modulation sidebands of emission and sweep time was set sufficiently slow to ensure peak measurements. Spectrum analyzer was set in peak hold mode and time sufficient for trace stabilization was allowed.

**7.3.2.3** The frequency of modulation envelope points beyond which power level drops below the band edge emission limit was measured.

**7.3.2.4** The test results were recorded in Table 7.3.2 and shown in the associated plots.

| Test specification: | Section 15.249(d), Band edge emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 section 6.10 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

**Figure 7.3.1 Band edge emission measurement set up**



| **Test specification:** | **Section 15.249(d), Band edge emissions** | | |
|---|---|---|---|
| **Test procedure:** | ANSI C63.10 section 6.10 | | |
| **Test mode:** | Compliance | **Verdict:** | PASS |
| **Date(s):** | 11-Jan-17 | | |
| **Temperature:** 25 ºC | **Relative Humidity:** 44 % | **Air Pressure:** 1022 hPa | **Power:** 48 VDC |
| **Remarks:** | | | |

**Table 7.3.2 Band edge emission test results**

OPERATING FREQUENCY RANGE: 24000 – 24250 MHz
DETECTOR USED: Peak hold
RESOLUTION BANDWIDTH: 1 MHz
VIDEO BANDWIDTH: 3 MHz
MODULATION: FMCW
TRANSMITTER OUTPUT POWER SETTINGS: Maximum

| Modulation envelope | | | Band edge limit (peak), MHz | Margin, (peak) MHz** | Band edge limit (Average), MHz | Margin, (Average) kHz** | Verdict |
|---|---|---|---|---|---|---|---|
| **Edge** | **Cross point frequency (peak), MHz*** | **Cross point frequency (average), MHz*** | | | | | |
| Low | 24055.36 | 24054.40 | 24000.00 | -55.36 | 24000.00 | -54.40 | Pass |
| High | 24245.75 | 24239.13 | 24250.00 | 4.25 | 24250.00 | 10.87 | Pass |

* - Measured frequency beyond which the emission dropped 50 dB below the carrier emission or below the field strength limit whichever was a less stringent
** - Margin = Band edge limit – Cross point frequency

**Reference numbers of test equipment used**

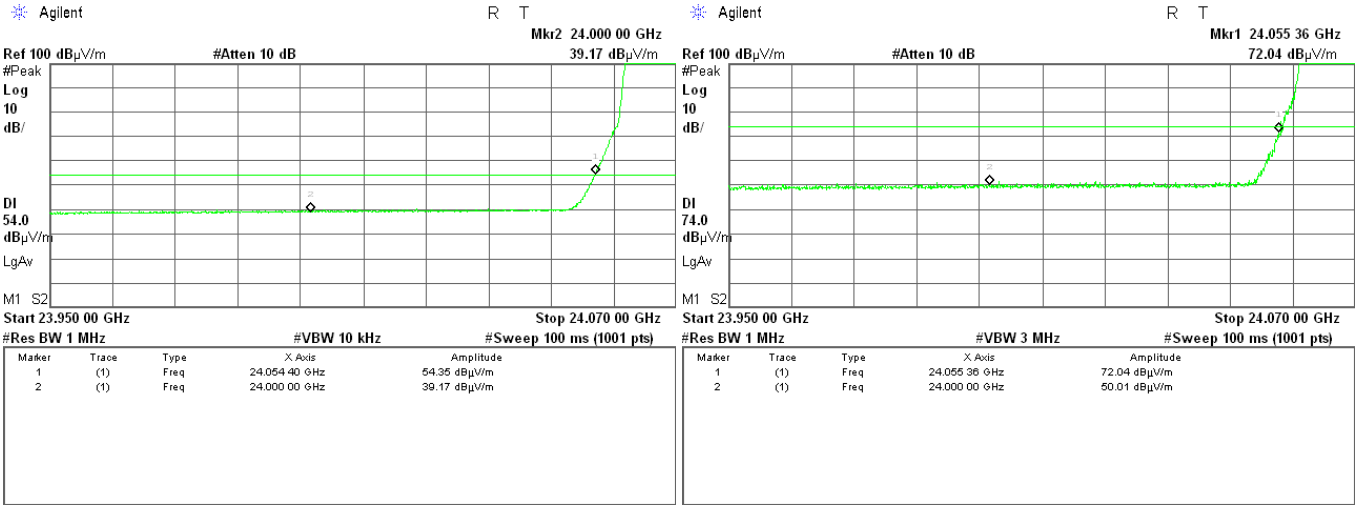
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| HL 3818 | HL 4956 | HL 5111 | | | | | |

Full description is given in Appendix A.

| Test specification: | Section 15.249(d), Band edge emissions | | |
|---|---|---|---|
| Test procedure: | ANSI C63.10 section 6.10 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 11-Jan-17 | | |
| Temperature: 25 ºC | Relative Humidity: 44 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

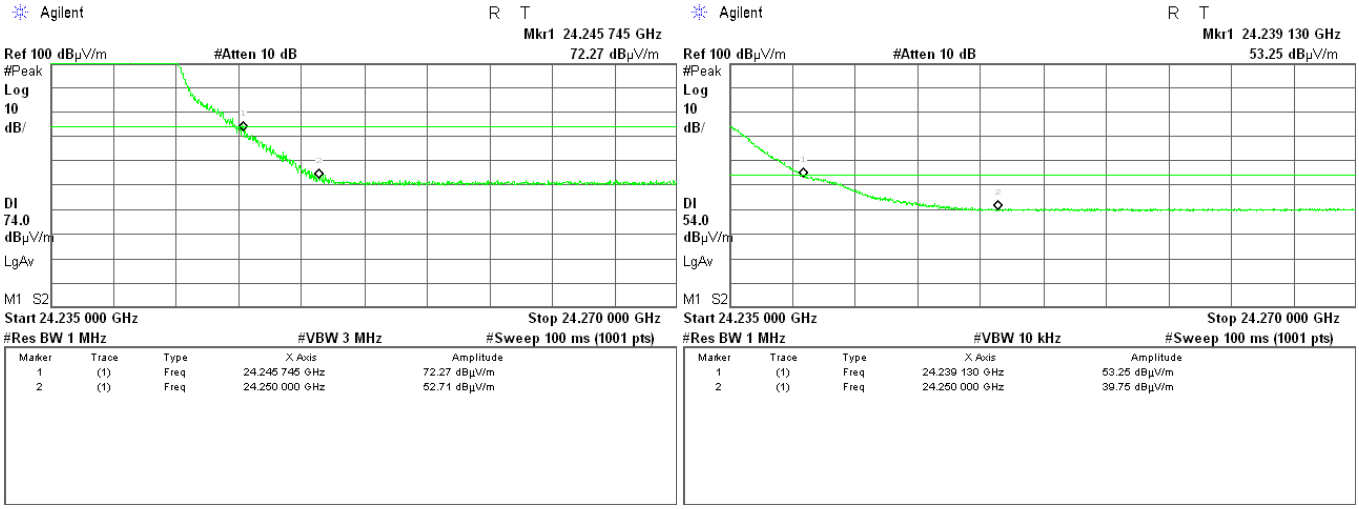
**Plot 7.3.1 Low band edge emission test result**

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Vertical




**Plot 7.3.2 High band edge emission test result**

TEST SITE: OATS
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Vertical



| Test specification: | Section 15.203, Antenna requirement | | |
|---|---|---|---|
| Test procedure: | Visual inspection / supplier declaration | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 12-Jan-17 | | |
| Temperature: 24 ºC | Relative Humidity: 45 % | Air Pressure: 1022 hPa | Power: 48 VDC |
| Remarks: | | | |

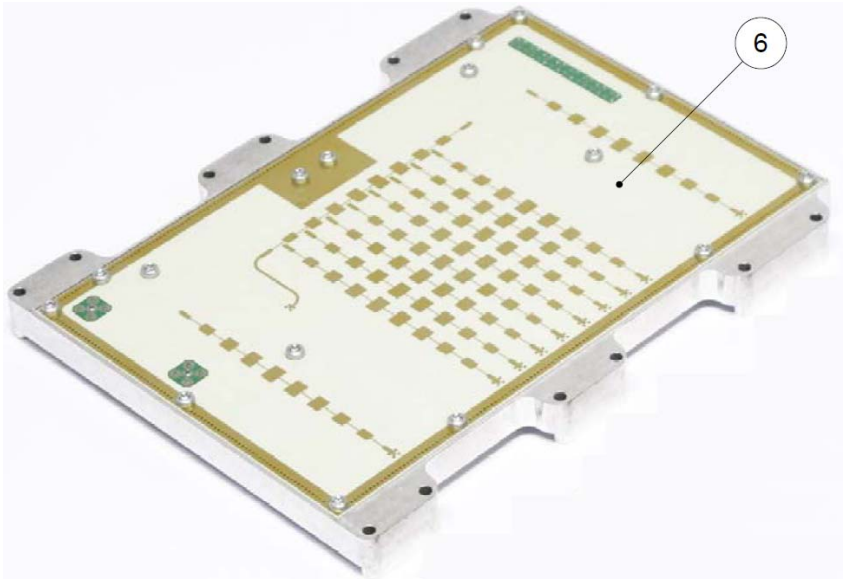
## 7.4 Antenna requirements

The EUT was verified for compliance with antenna requirements. A transmitter shall be designed to ensure that no antenna other than that furnished by the responsible party will be used with the device. It may be either permanently attached or employs a unique antenna connector for every antenna proposed for use with the EUT. This requirement does not apply to professionally installed transmitters.
The rationale for compliance with the above requirements was either visual inspection results or supplier declaration. The summary of results is provided in Table 7.4.1.

**Table 7.4.1 Antenna requirements**

| Requirement | Rationale | Verdict |
|---|---|---|
| **The transmitter antenna is permanently attached** | **Visual inspection** | Comply |
| The transmitter employs a unique antenna connector | NA | |
| The transmitter requires professional installation | Supplier declaration | |

**Photograph 7.4.1 Antenna assembly**



# 8 APPENDIX A Test equipment and ancillaries used for tests

| HL No | Description | Manufacturer | Model | Ser. No. | Last Cal./ Check | Due Cal./ Check |
|---|---|---|---|---|---|---|
| 0446 | Antenna, Loop, Active, 10 kHz - 30 MHz | EMCO | 6502 | 2857 | 19-Jan-17 | 19-Jan-18 |
| 0521 | EMI Receiver (Spectrum Analyzer) with RF filter section 9 kHz-6.5 GHz | Hewlett Packard | 8546A | 3617A 00319, 3448A00253 | 27-Oct-16 | 27-Oct-17 |
| 0604 | Antenna BiconiLog Log-Periodic/T Bow-TIE, 26 - 2000 MHz | EMCO | 3141 | 9611-1011 | 10-May-16 | 10-May-17 |
| 0770 | Antenna Standard Gain Horn, 40-60 GHz WR-19, U-band, 24 dB mid-band gain | Quinstar Technology | QWH-1900-AA | 118 | 17-Jul-16 | 17-Jul-17 |
| 0771 | Antenna Standard Gain Horn, 60-90 GHz, WR-12, 24 dB mid-band gain | Quinstar Technology | QWH-1200-AA | 111 | 14-Jul-16 | 14-Jul-17 |
| 0772 | Antenna Standard Gain Horn, 75-110 GHz, WR-10, 24 dB mid-band gain | Quinstar Technology | QWH-0800-AA | 110 | 14-Jul-16 | 14-Jul-17 |
| 1301 | Transition waveguide ET28S -12R | Custom Microwave | ET28S -12R | 1301 | 30-Jul-15 | 30-Jul-18 |
| 1984 | Antenna, Double-Ridged Waveguide Horn, 1 to 18 GHz, 300 W | EMC Test Systems | 3115 | 9911-5964 | 28-Mar-16 | 28-Mar-17 |
| 2909 | Spectrum analyzer, ESA-E, 100 Hz to 26.5 GHz | Agilent Technologies | E4407B | MY41444762 | 21-Feb-16 | 21-Feb-17 |
| 3235 | Harmonic mixer 40 to 60 GHz | Agilent Technologies | 11970U | MY30030182 | 16-Aug-16 | 16-Aug-19 |
| 3294 | Tapered transition, WR-28, UG-599 to WR-15, UG-385 (26.5-40 GHz to 50-75 GHz) | Quinstar Technology | QWP-AV0000 | 10381004 | 30-Jul-15 | 30-Jul-18 |
| 3305 | Harmonic mixer 50 to 75 GHz | Agilent Technologies | 11970V | MY30030149 | 16-Aug-16 | 16-Aug-19 |
| 3306 | Harmonic mixer 75 to 110 GHz | Agilent Technologies | 11970W | MY25210273 | 16-Aug-16 | 16-Aug-19 |
| 3433 | Test Cable , DC-18 GHz, 1.5 m, SMA - SMA | Mini-Circuits | CBL-5FT-SMSM+ | 25679 | 20-Mar-16 | 20-Mar-17 |
| 3434 | Test Cable , DC-18 GHz, 1.5 m, SMA - SMA | Mini-Circuits | CBL-5FT-SMSM+ | 25683 | 20-Mar-16 | 20-Mar-17 |
| 3818 | PSA Series Spectrum Analyzer, 3 Hz- 44 GHz | Agilent Technologies | E4446A | MY48250288 | 03-May-16 | 03-May-17 |
| 3901 | Microwave Cable Assembly, 40.0 GHz, 3.5 m, SMA/SMA | Huber-Suhner | SUCOFLEX 102A | 1225/2A | 15-Feb-16 | 15-Feb-17 |
| 4353 | Low Loss Armored Test Cable, DC - 18 GHz, 6.2 m, N type-M/N type-M | MegaPhase | NC29-N1N1-244 | 12025101003 | 15-Mar-16 | 15-Mar-17 |
| 4932 | Microwave preamplifier, 500 MHz to 18 GHz, 40 dB Gain | Com-Power Corporation | PAM-118A | 551029 | 01-Sep-16 | 01-Sep-17 |
| 4956 | Active horn antenna, 18 to 40 GHz | Com-Power Corporation | AHA-840 | 105004 | 17-Jan-17 | 17-Jan-18 |
| 5101 | RF cable, 18 GHz, 6 m, N-type | Huber-Suhner | SF106A/11N/11N/6000MM | 500847/6A | 26-Jul-16 | 26-Jul-17 |

| HL No | Description | Manufacturer | Model | Ser. No. | Last Cal./ Check | Due Cal./ Check |
|---|---|---|---|---|---|---|
| 5107 | RF cable, 18 GHz, 4.5 m, N-type | Huber-Suhner | SF106A/11N/11N/4500MM | 500845/6A | 26-Jul-16 | 26-Jul-17 |
| 5110 | RF cable, 18 GHz, 3 m, N-type | Huber-Suhner | ST18A/Nm/Nm/3000 | 600818/18A | 26-Jul-16 | 26-Jul-17 |
| 5111 | RF cable, 40 GHz, 5.5 m, K-type | Huber-Suhner | SF102EA/11SK/11SK/5500MM | 502493/2EA | 26-Jul-16 | 26-Jul-17 |

# 9 APPENDIX B Measurement uncertainties

**Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements**

| Test description | Expanded uncertainty |
|---|---|
| Radiated emissions at 10 m measuring distance<br>Horizontal polarization<br><br><br><br>Vertical polarization | <br>Biconilog antenna: ± 5.0 dB<br>Biconical antenna: ± 5.0 dB<br>Log periodic antenna: ± 5.1 dB<br>Double ridged horn antenna: ± 5.3 dB<br>Biconilog antenna: ± 5.5 dB<br>Biconical antenna: ± 5.5 dB<br>Log periodic antenna: ± 5.6 dB<br>Double ridged horn antenna: ± 5.8 dB |
| Radiated emissions at 3 m measuring distance<br>Horizontal polarization<br><br><br><br>Vertical polarization | <br>Biconilog antenna: ± 5.3 dB<br>Biconical antenna: ± 5.0 dB<br>Log periodic antenna: ± 5.3 dB<br>Double ridged horn antenna: ± 5.3 dB<br>Biconilog antenna: ± 6.0 dB<br>Biconical antenna: ± 5.7 dB<br>Log periodic antenna: ± 6.0 dB<br>Double ridged horn antenna: ± 6.0 dB |
| Conducted emissions at RF antenna connector | 9 kHz to 2.9 GHz: ± 2.6 dB<br>2.9 GHz to 6.46 GHz: ± 3.5 dB<br>6.46 GHz to 13.2 GHz: ± 4.3 dB<br>13.2 GHz to 22.0 GHz: ± 5.0 dB<br>22.0 GHz to 26.8 GHz: ± 5.5 dB<br>26.8 GHz to 40.0 GHz: ± 4.8 dB |
| Duty cycle, timing (Tx ON / OFF) and average factor measurements | ± 1.0 % |
| Occupied bandwidth | ± 8.0 % |

Hermon Laboratories is accredited by A2LA for calibration according to present requirements of ISO/IEC 17025 and NCSL Z540-1. The accreditation is granted to perform calibration of parameters that are listed in the Scope of Hermon Laboratories Accreditation.
Hermon Laboratories calibrates its reference and transfer standards by calibration laboratories accredited to ISO/IEC 17025 by a mutually recognized Accreditation Body or by a recognized national metrology institute. All reference and transfer standards used in the calibration system are traceable to national or international standards.
In-house calibration of all test and measurement equipment is performed on a regular basis according to Hermon Laboratories calibration procedures, manufacturer calibration/verification procedures or procedures defined in the relevant standards. The Hermon Laboratories test and measurement equipment is calibrated within the tolerances specified by the manufacturers and/or by the relevant standards.

# 10 APPENDIX C Test laboratory description

Tests were performed at Hermon Laboratories Ltd., which is a fully independent, private, EMC, safety, environmental and telecommunication testing facility.
Hermon Laboratories is recognized and accredited by the Federal Communications Commission (USA) for 1, 2, 15, 18 parts of Code of Federal Regulations 47 (CFR 47), Test Firm Registration Number is 927748, Designation Number is IL1001; registered by Industry Canada for electromagnetic emissions, file number IC 2186A-1 for OATS, certified by VCCI, Japan (the registration numbers are R-808 for OATS, R-1082 for anechoic chamber, G-869 for RE measurements above 1 GHz, C-845 for conducted emissions site, T-1606 for conducted emissions at telecommunication ports). The laboratory is accredited by American Association for Laboratory Accreditation (USA) according to ISO/IEC 17025 for electromagnetic compatibility, product safety, telecommunications testing and environmental simulation (for exact scope please refer to Certificate No. 839.01).

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# 11 APPENDIX D Specification references

| | |
|---|---|
| FCC 47CFR part 15: 2015 | Radio Frequency Devices |
| ANSI C63.10: 2013 | American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices |
| ANSI C63.2: 1996 | American National Standard for Instrumentation-Electromagnetic Noise and Field Strength, 10 kHz to 40 GHz-Specifications |

# 12 APPENDIX E Test equipment correction factors

**Antenna factor**
**Active loop antenna**
**Model 6502, S/N 2857, HL 0446**

| Frequency, MHz | Magnetic antenna factor, dB | Electric antenna factor, dB |
|---|---|---|
| 0.009 | -32.8 | 18.7 |
| 0.010 | -33.8 | 17.7 |
| 0.020 | -38.3 | 13.2 |
| 0.050 | -41.1 | 10.4 |
| 0.075 | -41.3 | 10.2 |
| 0.100 | -41.6 | 9.9 |
| 0.150 | -41.7 | 9.8 |
| 0.250 | -41.6 | 9.9 |
| 0.500 | -41.8 | 9.8 |
| 0.750 | -41.9 | 9.7 |
| 1.000 | -41.4 | 10.1 |
| 2.000 | -41.5 | 10.0 |
| 3.000 | -41.4 | 10.2 |
| 4.000 | -41.4 | 10.1 |
| 5.000 | -41.5 | 10.1 |
| 10.000 | -41.9 | 9.6 |
| 15.000 | -41.9 | 9.6 |
| 20.000 | -42.2 | 9.3 |
| 25.000 | -42.8 | 8.7 |
| 30.000 | -44.0 | 7.5 |

Antenna factor in dB(1/m) is to be added to receiver meter reading in dB(μV) to convert it into field strength in dB(μV/m).

**Antenna factor**
**Standard gain horn antenna**
**Quinstar Technology**
**Model QWH**
**Ser.No.112, HL 0768, 0769, 0770, 0771, 0772**

| Frequency min, GHz | Frequency max, GHz | Antenna factor, dB(1/m) |
|---|---|---|
| 18.000 | 26.500 | 32.01 |
| 26.500 | 40.000 | 35.48 |
| 40.000 | 60.000 | 39.03 |
| 60.000 | 90.000 | 42.55 |
| 90.000 | 140.000 | 46.23 |
| 140.000 | 220.000 | 50.11 |

Antenna factor in dB(1/m) is to be added to receiver meter reading in dB(μV) to convert it into field intensity in dB(μV/m).

**Antenna factor**
**Biconilog antenna EMCO Model 3141**
**Ser.No.1011, HL 0604**

| Frequency, MHz | Antenna factor, dB(1/m) | Frequency, MHz | Antenna factor, dB(1/m) | Frequency, MHz | Antenna factor, dB(1/m) |
|---|---|---|---|---|---|
| 26 | 7.8 | 580 | 20.6 | 1320 | 27.8 |
| 28 | 7.8 | 600 | 21.3 | 1340 | 28.3 |
| 30 | 7.8 | 620 | 21.5 | 1360 | 28.2 |
| 40 | 7.2 | 640 | 21.2 | 1380 | 27.9 |
| 60 | 7.1 | 660 | 21.4 | 1400 | 27.9 |
| 70 | 8.5 | 680 | 21.9 | 1420 | 27.9 |
| 80 | 9.4 | 700 | 22.2 | 1440 | 27.8 |
| 90 | 9.8 | 720 | 22.2 | 1460 | 27.8 |
| 100 | 9.7 | 740 | 22.1 | 1480 | 28.0 |
| 110 | 9.3 | 760 | 22.3 | 1500 | 28.5 |
| 120 | 8.8 | 780 | 22.6 | 1520 | 28.9 |
| 130 | 8.7 | 800 | 22.7 | 1540 | 29.6 |
| 140 | 9.2 | 820 | 22.9 | 1560 | 29.8 |
| 150 | 9.8 | 840 | 23.1 | 1580 | 29.6 |
| 160 | 10.2 | 860 | 23.4 | 1600 | 29.5 |
| 170 | 10.4 | 880 | 23.8 | 1620 | 29.3 |
| 180 | 10.4 | 900 | 24.1 | 1640 | 29.2 |
| 190 | 10.3 | 920 | 24.1 | 1660 | 29.4 |
| 200 | 10.6 | 940 | 24.0 | 1680 | 29.6 |
| 220 | 11.6 | 960 | 24.1 | 1700 | 29.8 |
| 240 | 12.4 | 980 | 24.5 | 1720 | 30.3 |
| 260 | 12.8 | 1000 | 24.9 | 1740 | 30.8 |
| 280 | 13.7 | 1020 | 25.0 | 1760 | 31.1 |
| 300 | 14.7 | 1040 | 25.2 | 1780 | 31.0 |
| 320 | 15.2 | 1060 | 25.4 | 1800 | 30.9 |
| 340 | 15.4 | 1080 | 25.6 | 1820 | 30.7 |
| 360 | 16.1 | 1100 | 25.7 | 1840 | 30.6 |
| 380 | 16.4 | 1120 | 26.0 | 1860 | 30.6 |
| 400 | 16.6 | 1140 | 26.4 | 1880 | 30.6 |
| 420 | 16.7 | 1160 | 27.0 | 1900 | 30.6 |
| 440 | 17.0 | 1180 | 27.0 | 1920 | 30.7 |
| 460 | 17.7 | 1200 | 26.7 | 1940 | 30.9 |
| 480 | 18.1 | 1220 | 26.5 | 1960 | 31.2 |
| 500 | 18.5 | 1240 | 26.5 | 1980 | 31.6 |
| 520 | 19.1 | 1260 | 26.5 | 2000 | 32.0 |
| 540 | 19.5 | 1280 | 26.6 | | |
| 560 | 19.8 | 1300 | 27.0 | | |

Antenna factor in dB(1/m) is to be added to receiver meter reading in dB($\mu$V) to convert it into field strength in dB($\mu$V/m).

**Antenna factor**
**Double-ridged wave guide horn antenna**
**Model 3115, S/N 9911-5964, HL1984**

| Frequency, MHz | Antenna factor, dB(1/m) |
|---|---|
| 1000.0 | 24.7 |
| 1500.0 | 25.7 |
| 2000.0 | 27.6 |
| 2500.0 | 28.9 |
| 3000.0 | 31.2 |
| 3500.0 | 32.0 |
| 4000.0 | 32.5 |
| 4500.0 | 32.7 |
| 5000.0 | 33.6 |
| 5500.0 | 35.1 |
| 6000.0 | 35.4 |
| 6500.0 | 34.9 |
| 7000.0 | 36.1 |
| 7500.0 | 37.8 |
| 8000.0 | 38.0 |
| 8500.0 | 38.1 |
| 9000.0 | 39.1 |
| 9500.0 | 38.3 |
| 10000.0 | 38.6 |
| 10500.0 | 38.2 |
| 11000.0 | 38.7 |
| 11500.0 | 39.5 |
| 12000.0 | 40.0 |
| 12500.0 | 40.4 |
| 13000.0 | 40.5 |
| 13500.0 | 41.1 |
| 14000.0 | 41.6 |
| 14500.0 | 41.7 |
| 15000.0 | 38.7 |
| 15500.0 | 38.2 |
| 16000.0 | 38.8 |
| 16500.0 | 40.5 |
| 17000.0 | 42.5 |
| 17500.0 | 45.9 |
| 18000.0 | 49.4 |

Antenna factor in dB(1/m) is to be added to receiver meter reading in dB(μV) to convert it into field strength in dB(μV/m).

**Antenna factor, HL 4956**

COM-POWER CORPORATION

## Active Horn Antenna Factor Calibration

18 GHz to 40 GHz

| | |
|---|---|
| **Equipment:** | **ACTIVE HORN ANTENNA** |
| **Model:** | **AHA-840** |
| **Serial Number:** | **105004** |
| **Calibration Distance:** | **3 meter** |
| **Polarization:** | **Horizontal** |
| **Calibration Date:** | **1/26/2015** |

| Frequency (GHz) | Preamplifier Gain (dB) | Antenna Factor with pre-amp (dB/m) | Frequency (GHz) | Preamplifier Gain (dB) | Antenna Factor with pre-amp (dB/m) |
|---|---|---|---|---|---|
| 18 | 38.83 | -1.06 | 29.5 | 42.47 | -5.33 |
| 18.5 | 39.34 | -2.65 | 30 | 41.91 | -4.86 |
| 19 | 39.71 | -3.88 | 30.5 | 41.60 | -4.64 |
| 19.5 | 39.87 | -4.35 | 31 | 41.52 | -4.60 |
| 20 | 39.98 | -3.97 | 31.5 | 41.56 | -4.79 |
| 20.5 | 40.42 | -3.68 | 32 | 41.80 | -5.21 |
| 21 | 41.12 | -4.06 | 32.5 | 42.29 | -5.54 |
| 21.5 | 41.74 | -5.46 | 33 | 42.79 | -5.63 |
| 22 | 42.14 | -6.22 | 33.5 | 42.88 | -5.38 |
| 22.5 | 42.35 | -6.42 | 34 | 42.62 | -4.76 |
| 23 | 42.50 | -6.59 | 34.5 | 42.63 | -4.84 |
| 23.5 | 42.65 | -6.82 | 35 | 43.15 | -5.13 |
| 24 | 42.81 | -7.01 | 35.5 | 43.91 | -5.83 |
| 24.5 | 42.86 | -7.37 | 36 | 44.59 | -6.39 |
| 25 | 42.73 | -7.53 | 36.5 | 45.04 | -6.64 |
| 25.5 | 42.77 | -7.45 | 37 | 45.08 | -6.40 |
| 26 | 42.85 | -7.21 | 37.5 | 44.82 | -5.75 |
| 26.5 | 42.98 | -7.17 | 38 | 44.16 | -4.58 |
| 27 | 43.14 | -7.22 | 38.5 | 42.90 | -2.66 |
| 27.5 | 43.18 | -7.32 | 39 | 42.39 | -1.71 |
| 28 | 43.04 | -7.10 | 39.5 | 43.76 | -2.49 |
| 28.5 | 43.01 | -6.73 | 40 | 45.98 | -5.21 |

*Calibration per ANSI C63.5: 2006*

***Standard Site Method, Equations 1-6 (3-antenna)***

Corrected Reading (dBµV/m) = Meter Reading (dBµV) + AFE(dB/m)

**Cable loss**
**Test Cable, Mini-Circuits, CBL-5FT-SMSM+, SMA-SMA, 18 GHz, 1.5 m**
**Mini-Circuits, HL 3433**

| Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB |
|---|---|---|---|
| 10.0 | 0.06 | 9000 | 2.01 |
| 100 | 0.17 | 9500 | 2.06 |
| 500 | 0.41 | 10000 | 2.05 |
| 1000 | 0.58 | 10500 | 2.18 |
| 1500 | 0.72 | 11000 | 2.26 |
| 2000 | 0.86 | 11500 | 2.28 |
| 2500 | 0.96 | 12000 | 2.43 |
| 3000 | 1.04 | 12500 | 2.53 |
| 3500 | 1.13 | 13000 | 2.52 |
| 4000 | 1.23 | 13500 | 2.56 |
| 4500 | 1.31 | 14000 | 2.60 |
| 5000 | 1.41 | 14500 | 2.59 |
| 5500 | 1.49 | 15000 | 2.67 |
| 6000 | 1.55 | 15500 | 2.76 |
| 6500 | 1.63 | 16000 | 2.86 |
| 7000 | 1.71 | 16500 | 2.91 |
| 7500 | 1.78 | 17000 | 2.95 |
| 8000 | 1.86 | 17500 | 3.02 |
| 8500 | 1.92 | 18000 | 3.07 |

**Cable loss**
**Test Cable, Mini-Circuits, CBL-5FT-SMSM+, SMA-SMA, 18 GHz, 1.5 m, S/N 25683**
**Mini-Circuits, HL 3434**

| Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB |
|---|---|---|---|
| 10.0 | 0.06 | 9000 | 1.96 |
| 100 | 0.16 | 9500 | 2.01 |
| 500 | 0.40 | 10000 | 2.01 |
| 1000 | 0.57 | 10500 | 2.14 |
| 1500 | 0.72 | 11000 | 2.21 |
| 2000 | 0.85 | 11500 | 2.24 |
| 2500 | 0.95 | 12000 | 2.36 |
| 3000 | 1.03 | 12500 | 2.47 |
| 3500 | 1.11 | 13000 | 2.46 |
| 4000 | 1.21 | 13500 | 2.50 |
| 4500 | 1.29 | 14000 | 2.53 |
| 5000 | 1.39 | 14500 | 2.53 |
| 5500 | 1.46 | 15000 | 2.62 |
| 6000 | 1.52 | 15500 | 2.70 |
| 6500 | 1.60 | 16000 | 2.80 |
| 7000 | 1.68 | 16500 | 2.86 |
| 7500 | 1.75 | 17000 | 2.88 |
| 8000 | 1.83 | 17500 | 2.94 |
| 8500 | 1.88 | 18000 | 3.00 |

**Cable loss**
**Microwave Cable Assembly, Huber-Suhner, 40 GHz, 3.5 m, SMA-SMA, S/N 1225/2A**
**HL 3901**

| Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB |
|---|---|---|---|---|---|
| 10 | 0.09 | 9500 | 4.29 | 21000 | 6.67 |
| 100 | 0.41 | 10000 | 4.40 | 22000 | 6.92 |
| 500 | 0.93 | 10500 | 4.52 | 23000 | 7.00 |
| 1000 | 1.33 | 11000 | 4.64 | 24000 | 7.18 |
| 1500 | 1.63 | 11500 | 4.76 | 25000 | 7.29 |
| 2000 | 1.90 | 12000 | 4.87 | 26000 | 7.55 |
| 2500 | 2.12 | 12500 | 4.99 | 27000 | 7.70 |
| 3000 | 2.33 | 13000 | 5.11 | 28000 | 7.88 |
| 3500 | 2.50 | 13500 | 5.20 | 29000 | 8.02 |
| 4000 | 2.67 | 14000 | 5.31 | 30000 | 8.15 |
| 4500 | 2.82 | 14500 | 5.42 | 31000 | 8.35 |
| 5000 | 2.99 | 15000 | 5.51 | 32000 | 8.40 |
| 5500 | 3.16 | 15500 | 5.58 | 33000 | 8.62 |
| 6000 | 3.32 | 16000 | 5.68 | 34000 | 8.73 |
| 6500 | 3.51 | 16500 | 5.78 | 35000 | 8.78 |
| 7000 | 3.65 | 17000 | 5.91 | 36000 | 8.94 |
| 7500 | 3.79 | 17500 | 5.99 | 37000 | 9.21 |
| 8000 | 3.92 | 18000 | 6.07 | 38000 | 9.37 |
| 8500 | 4.04 | 19000 | 6.36 | 39000 | 9.45 |
| 9000 | 4.18 | 20000 | 6.49 | 40000 | 9.52 |

**Cable loss**
**Low Loss Armored Test Cable, MegaPhase, 18 GHz, 6.2 m, N type-M/N type-M,**
**NC29-N1N1-244S/N 12025101 003,**
**HL 4353**

| Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB |
|---|---|---|---|
| 50 | 0.20 | 9000 | 2.71 |
| 100 | 0.27 | 9500 | 2.81 |
| 300 | 0.47 | 10000 | 2.90 |
| 500 | 0.61 | 10500 | 2.97 |
| 1000 | 0.87 | 11000 | 3.06 |
| 1500 | 1.07 | 11500 | 3.13 |
| 2000 | 1.24 | 12000 | 3.20 |
| 2500 | 1.39 | 12500 | 3.26 |
| 3000 | 1.53 | 13000 | 3.34 |
| 3500 | 1.65 | 13500 | 3.39 |
| 4000 | 1.77 | 14000 | 3.47 |
| 4500 | 1.89 | 14500 | 3.54 |
| 5000 | 1.99 | 15000 | 3.62 |
| 5500 | 2.07 | 15500 | 3.69 |
| 6000 | 2.20 | 16000 | 3.76 |
| 6500 | 2.30 | 16500 | 3.83 |
| 7000 | 2.39 | 17000 | 3.86 |
| 7500 | 2.51 | 17500 | 3.94 |
| 8000 | 2.58 | 18000 | 4.02 |
| 8500 | 2.65 | | |

**Cable loss**
**RF Cable, Huber-Suhner, 18 GHz, 6 m, N- type,**
**SF106A/11N/11N/6000MM, S/N 500847/6A**
**HL 5101**

| Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB |
|---|---|---|---|
| 0.1 | 0.01 | 5500 | 2.42 |
| 50 | 0.22 | 6000 | 2.53 |
| 100 | 0.31 | 6500 | 2.65 |
| 200 | 0.43 | 7000 | 2.76 |
| 300 | 0.53 | 7500 | 2.86 |
| 400 | 0.62 | 8000 | 2.96 |
| 500 | 0.69 | 8500 | 3.06 |
| 600 | 0.76 | 9000 | 3.16 |
| 700 | 0.82 | 9500 | 3.26 |
| 800 | 0.87 | 10000 | 3.35 |
| 900 | 0.93 | 10500 | 3.44 |
| 1000 | 0.98 | 11000 | 3.54 |
| 1100 | 1.03 | 11500 | 3.62 |
| 1200 | 1.08 | 12000 | 3.70 |
| 1300 | 1.12 | 12500 | 3.80 |
| 1400 | 1.17 | 13000 | 3.88 |
| 1500 | 1.21 | 13500 | 3.97 |
| 1600 | 1.25 | 14000 | 4.04 |
| 1700 | 1.29 | 14500 | 4.13 |
| 1800 | 1.33 | 15000 | 4.22 |
| 1900 | 1.37 | 15500 | 4.31 |
| 2000 | 1.41 | 16000 | 4.39 |
| 2500 | 1.59 | 16500 | 4.47 |
| 3000 | 1.75 | 17000 | 4.54 |
| 3500 | 1.90 | 17500 | 4.61 |
| 4000 | 2.04 | 18000 | 4.68 |
| 4500 | 2.17 | | |
| 5000 | 2.30 | | |

**Cable loss**
**RF Cable, Huber-Suhner, 18 GHz, 6 m, N- type,**
**SF106A/11N/11N/4500MM, S/N 500845/6A**
**HL 5107**

| Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB |
|---|---|---|---|
| 0.1 | 0.01 | 5500 | 1.75 |
| 50 | 0.16 | 6000 | 1.84 |
| 100 | 0.22 | 6500 | 1.92 |
| 200 | 0.31 | 7000 | 2.00 |
| 300 | 0.38 | 7500 | 2.07 |
| 400 | 0.44 | 8000 | 2.15 |
| 500 | 0.49 | 8500 | 2.23 |
| 600 | 0.54 | 9000 | 2.29 |
| 700 | 0.58 | 9500 | 2.38 |
| 800 | 0.63 | 10000 | 2.43 |
| 900 | 0.67 | 10500 | 2.50 |
| 1000 | 0.71 | 11000 | 2.57 |
| 1100 | 0.74 | 11500 | 2.63 |
| 1200 | 0.77 | 12000 | 2.69 |
| 1300 | 0.81 | 12500 | 2.76 |
| 1400 | 0.84 | 13000 | 2.82 |
| 1500 | 0.87 | 13500 | 2.87 |
| 1600 | 0.91 | 14000 | 2.93 |
| 1700 | 0.93 | 14500 | 3.00 |
| 1800 | 0.96 | 15000 | 3.06 |
| 1900 | 0.99 | 15500 | 3.12 |
| 2000 | 1.01 | 16000 | 3.18 |
| 2500 | 1.14 | 16500 | 3.22 |
| 3000 | 1.26 | 17000 | 3.28 |
| 3500 | 1.37 | 17500 | 3.36 |
| 4000 | 1.47 | 18000 | 3.43 |
| 4500 | 1.57 | | |
| 5000 | 1.66 | | |

**Cable loss**
**RF Cable, Huber-Suhner, 18 GHz, 3 m, N- type,**
**ST18A/Nm/Nm/3000, S/N 600818/18A**
**HL 5110**

| Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB |
|---|---|---|---|
| 0.1 | 0.01 | 5500 | 1.99 |
| 50 | 0.17 | 6000 | 2.10 |
| 100 | 0.24 | 6500 | 2.20 |
| 200 | 0.34 | 7000 | 2.29 |
| 300 | 0.42 | 7500 | 2.38 |
| 400 | 0.48 | 8000 | 2.47 |
| 500 | 0.54 | 8500 | 2.57 |
| 600 | 0.59 | 9000 | 2.65 |
| 700 | 0.64 | 9500 | 2.74 |
| 800 | 0.69 | 10000 | 2.83 |
| 900 | 0.73 | 10500 | 2.91 |
| 1000 | 0.77 | 11000 | 2.99 |
| 1100 | 0.82 | 11500 | 3.07 |
| 1200 | 0.86 | 12000 | 3.14 |
| 1300 | 0.89 | 12500 | 3.22 |
| 1400 | 0.93 | 13000 | 3.29 |
| 1500 | 0.96 | 13500 | 3.37 |
| 1600 | 1.00 | 14000 | 3.45 |
| 1700 | 1.03 | 14500 | 3.52 |
| 1800 | 1.06 | 15000 | 3.59 |
| 1900 | 1.10 | 15500 | 3.66 |
| 2000 | 1.13 | 16000 | 3.74 |
| 2500 | 1.28 | 16500 | 3.80 |
| 3000 | 1.41 | 17000 | 3.88 |
| 3500 | 1.54 | 17500 | 4.00 |
| 4000 | 1.66 | 18000 | 4.02 |
| 4500 | 1.78 | | |
| 5000 | 1.89 | | |

**Cable loss**
**RF Cable, Huber-Suhner, 40 GHz, 5.5 m, K type,**
**SF102EA/11SK/11SK/5500MM, S/N 502493/2EA**
**HL 5111**

| Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB |
|---|---|---|---|
| 100 | 0.68 | 20500 | 10.17 |
| 200 | 0.97 | 21000 | 10.30 |
| 300 | 1.18 | 21500 | 10.43 |
| 500 | 1.52 | 22000 | 10.58 |
| 1000 | 2.14 | 22500 | 10.73 |
| 1500 | 2.62 | 23000 | 10.85 |
| 2000 | 3.03 | 23500 | 10.98 |
| 2500 | 3.39 | 24000 | 11.11 |
| 3000 | 3.72 | 24500 | 11.20 |
| 3500 | 4.03 | 25000 | 11.32 |
| 4000 | 4.32 | 25500 | 11.47 |
| 4500 | 4.59 | 26000 | 11.59 |
| 5000 | 4.84 | 26500 | 11.72 |
| 5500 | 5.09 | 27000 | 11.83 |
| 6000 | 5.32 | 27500 | 11.94 |
| 6500 | 5.55 | 28000 | 12.04 |
| 7000 | 5.77 | 28500 | 12.16 |
| 7500 | 5.99 | 29000 | 12.28 |
| 8000 | 6.19 | 29500 | 12.40 |
| 8500 | 6.40 | 30000 | 12.50 |
| 9000 | 6.60 | 30500 | 12.59 |
| 9500 | 6.79 | 31000 | 12.68 |
| 10000 | 6.98 | 31500 | 12.80 |
| 10500 | 7.16 | 32000 | 12.94 |
| 11000 | 7.34 | 32500 | 13.09 |
| 11500 | 7.51 | 33000 | 13.23 |
| 12000 | 7.68 | 33500 | 13.32 |
| 12500 | 7.84 | 34000 | 13.44 |
| 13000 | 8.00 | 34500 | 13.54 |
| 13500 | 8.15 | 35000 | 13.68 |
| 14000 | 8.31 | 35500 | 13.81 |
| 14500 | 8.46 | 36000 | 13.90 |
| 15000 | 8.62 | 36500 | 13.99 |
| 15500 | 8.76 | 37000 | 14.12 |
| 16000 | 8.91 | 37500 | 14.22 |
| 16500 | 9.06 | 38000 | 14.33 |
| 17000 | 9.21 | 38500 | 14.47 |
| 17500 | 9.35 | 39000 | 14.54 |
| 18000 | 9.49 | 39500 | 14.62 |
| 18500 | 9.62 | 40000 | 14.75 |
| 19000 | 9.76 | | |
| 19500 | 9.90 | | |
| 20000 | 10.05 | | |

# 13 APPENDIX F Abbreviations and acronyms

| | |
|---|---|
| A | ampere |
| AC | alternating current |
| A/m | ampere per meter |
| AM | amplitude modulation |
| AVRG | average (detector) |
| cm | centimeter |
| dB | decibel |
| dBm | decibel referred to one milliwatt |
| dB(μV) | decibel referred to one microvolt |
| dB(μV/m) | decibel referred to one microvolt per meter |
| dB(μA) | decibel referred to one microampere |
| DC | direct current |
| EIRP | equivalent isotropically radiated power |
| ERP | effective radiated power |
| EUT | equipment under test |
| F | frequency |
| GHz | gigahertz |
| GND | ground |
| H | height |
| HL | Hermon laboratories |
| Hz | hertz |
| k | kilo |
| kHz | kilohertz |
| LO | local oscillator |
| m | meter |
| MHz | megahertz |
| min | minute |
| mm | millimeter |
| ms | millisecond |
| μs | microsecond |
| NA | not applicable |
| NB | narrow band |
| OATS | open area test site |
| Ω | Ohm |
| PM | pulse modulation |
| PS | power supply |
| ppm | part per million ($10^{-6}$) |
| QP | quasi-peak |
| RE | radiated emission |
| RF | radio frequency |
| rms | root mean square |
| Rx | receive |
| s | second |
| T | temperature |
| Tx | transmit |
| V | volt |
| WB | wideband |

END OF DOCUMENT