HERMON LABORATORIES

ELECTRICAL TESTING
0839.01

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# TEST REPORT

**ACCORDING TO: FCC CFR 47 Part 90 subpart Y**

**FOR:**

## Ruggedcom Ltd.

## pBST base station operating in 4.9 GHz band

## Model: WiN7249

## FCC ID:VG5WIN7249

**This report is in conformity with ISO/ IEC 17025. The "A2LA Accredited" symbol endorsement applies only to the tests and calibrations that are listed in the scope of Hermon Laboratories accreditation. The test results relate only to the items tested. This test report shall not be reproduced in any form except in full with the written approval of Hermon Laboratories Ltd.**

# Table of contents

# 1 Applicant information

| | |
|---|---|
| **Client name:** | Ruggedcom Ltd. |
| **Address:** | 32 Maskit Street, P.O.Box 12412, Herzeliya 46733, Israel |
| **Telephone:** | +972 9951 9556 |
| **Fax:** | +972 9951 9557 |
| **E-mail:** | AmnonAssulin@ruggedcom.com |
| **Contact name:** | Mr. Amnon Assulin |

# 2 Equipment under test attributes

| | |
|---|---|
| **Product name:** | Base station operating in 4.9 GHz band |
| **Product type:** | Transceiver |
| **Model(s):** | WiN7249 |
| **Serial number:** | 44912912001 |
| **Hardware version:** | RFID =10 |
| **Software release:** | BS4.3.4621.28 |
| **Receipt date** | 8/20/2012 |

# 3 Manufacturer information

| | |
|---|---|
| **Manufacturer name:** | Ruggedcom Ltd. |
| **Address:** | 32 Maskit Street, P.O.Box 12412, Herzeliya 46733, Israel |
| **Telephone:** | +972 9951 9556 |
| **Fax:** | +972 9951 9557 |
| **E-Mail:** | AmnonAssulin@ruggedcom.com |
| **Contact name:** | Mr. Amnon Assulin |

# 4 Test details

| | |
|---|---|
| **Project ID:** | 23640 |
| **Location:** | Hermon Laboratories Ltd. Harakevet Industrial Zone, Binyamina 30500, Israel |
| **Test started:** | 8/20/2012 |
| **Test completed:** | 9/02/2012 |
| **Test specification(s):** | 47CFR Part 90 subpart Y |

# 5 Tests summary

| Test | Status |
|---|---|
| **Transmitter characteristics** | |
| Section 90.205, 90.1215, Maximum conducted output power | Pass |
| Section 90.1215, Peak power spectral density | Pass |
| Section 90.209, Occupied bandwidth | Pass |
| Section 90.210(l), 90.210(m), Emission mask | Pass |
| Section 90.210(l), 90.210(m), Spurious emissions at RF antenna connector | Pass |
| Section 90.210(l), 90.210(m), Radiated spurious emissions | Pass |
| Section 90.213, Frequency stability | Pass |
| Section 90.1217, RF exposure | 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:** | Mrs. E. Pitt, test engineer | September 2, 2012 | |
| **Reviewed by:** | Mrs. M. Cherniavsky, certification engineer | September 9, 2012 | |
| **Approved by:** | Mr. M. Nikishin, EMC and radio group manager | October 3, 2012 | |

# 6 EUT description

## 6.1 General information

The EUT, base station of WiMAX system operating at 4.9 GHz, comprises an Outdoor Unit (ODU) that includes modem, radio, data processing and management components, serving as an efficient platform for a wide range of services. It provides a wireless connection to the subscriber unit.
The both EUT antennas are driven incoherently and there is no beanforming gain.

## 6.2 Ports and lines

| Port type | Port description | Connected from | Connected to | Qty. | Cable type | Cable length, m |
|---|---|---|---|---|---|---|
| Power | AC power | PoE adapter | AC mains | 1 | Unshielded | 3 |
| Power and telecom | 48 VDC + Ethernet | EUT | PoE adapter | 1 | Shielded | 3 |
| RF | Antenna | EUT | Coupler | 1 | Coax | 1 |

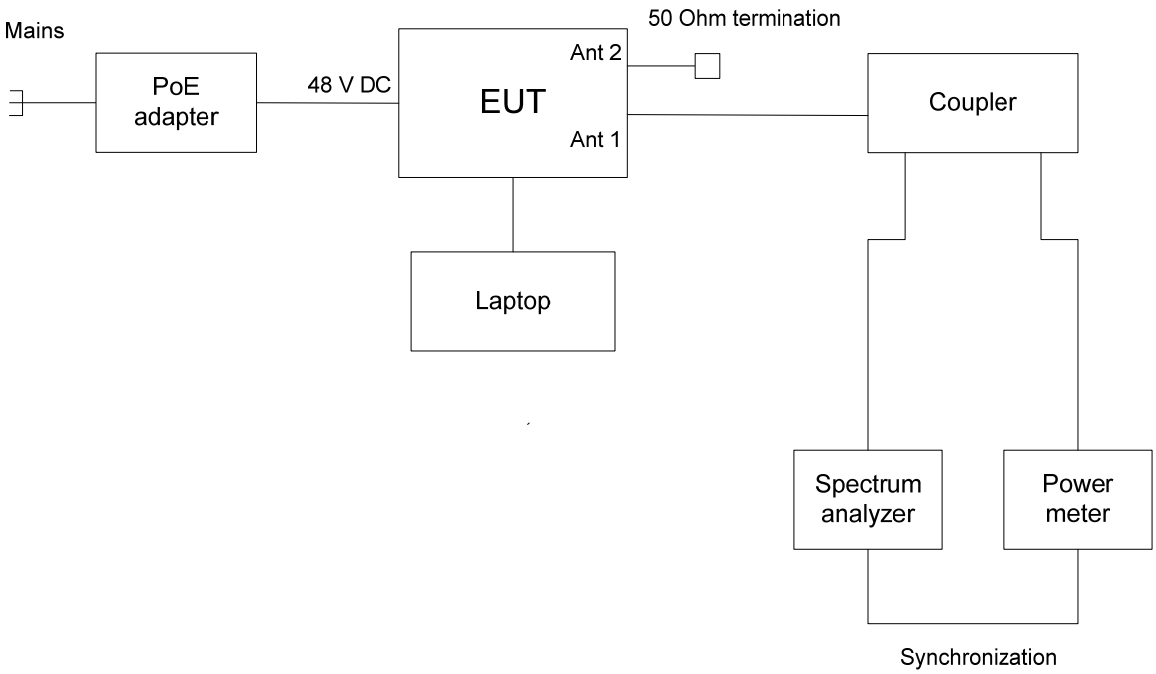
## 6.3 Support and test equipment

| Description | Manufacturer | Model number | Serial number |
|---|---|---|---|
| Laptop | Lenovo | T410 | 2522WZN |
| PoE adapter (CPE) | RuggedWireless Ltd. | WiN1010 (0334B4848) | 0507047 |
| Directional coupler | Narda | 4203-10 | 06978 |

## 6.4 Changes made in EUT

No changes were implemented in the EUT.

## 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) | |

| Intended use | | Condition of use |
|---|---|---|
| V | fixed | Always at a distance more than 2 m from all people |
| | mobile | Always at a distance more than 20 cm from all people |
| | portable | May operate at a distance closer than 20 cm to human body |

| | | | | | |
|---|---|---|---|---|---|
| **Assigned frequency range** | 4940.0 – 4990.0 MHz | | | | |
| **Operating frequency range** | 4942.5 – 4987.5 MHz | | | | |
| **RF channel bandwidth** | 5 MHz, 10 MHz | | | | |
| **Maximum rated output power** | At transmitter 50 Ω RF output connector (total for 2 chains) | | | | 26.56 dBm for 5 MHz CBW<br>26.13 dBm for 10 MHz CBW |
| **Is transmitter output power variable?** | | No | | | |
| | **V** | Yes | | continuous variable | |
| | | | V | stepped variable with stepsize | 0.5 dB |
| | | | minimum RF power | | -21 dBm |
| | | | maximum RF power | | 26.56 dBm |

| Antenna connection | | | | |
|---|---|---|---|---|
| unique coupling | **V** standard connector | Integral | **V** | with temporary RF connector |
| | | | | without temporary RF connector |

| Antenna/s technical characteristics | | | |
|---|---|---|---|
| Type | Manufacturer | Model number | Gain |
| Sector dual slant antenna | MTI Wireless Edge Ltd. | MT – 464018/ND (ANTN0074) | 16 dBi |
| Omnidirectional | MTI Wireless Edge Ltd. | MT–462008/N/A (ANTN0076, N-Female) | 9.5 dBi |

| | |
|---|---|
| **Transmitter 99% power bandwidth** | 5 MHz, 10 MHz |
| **Type of modulation** | QPSK 1/2, 16QAM 3/4, 64QAM 5/6 |

**Transmitter aggregate data rate/s, Mbps**

| Bandwidth, MHz | Direction | QPSK 1/2 | 16QAM 3/4 | 64QAM 5/6 |
|---|---|---|---|---|
| 5 | DL | 4.608 | 13.824 | 23.04 |
| | UL | 1.4688 | 4.4064 | 7.344 |
| 10 | DL | 9.216 | 27.648 | 46.08 |
| | UL | 3.024 | 9.072 | 15.12 |

| | | | | | |
|---|---|---|---|---|---|
| **Type of multiplexing** | OFDMA | | | | |
| **Modulating test signal (baseband)** | PRBS | | | | |
| **Maximum transmitter duty cycle in normal use** | 75% | **Tx ON time** | | **Period** | |
| **Transmitter duty cycle supplied for test** | 60% | **Tx ON time** | | **Period** | |

**Transmitter power source**

| | | | | | |
|---|---|---|---|---|---|
| | | **Nominal rated voltage** | | Battery type | |
| **V** | DC | **Nominal rated voltage** | 48 V (via PoE powered from the mains) | | |
| | AC mains | **Nominal rated voltage** | | Frequency | |

| | | | |
|---|---|---|---|
| **Common power source for transmitter and receiver** | **V** yes | no |

| Test specification: | Section 90.1215, Section 5.3, Maximum conducted output power | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1046; TIA/EIA-603-C, Section 2.2.1 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/23/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1006 hPa | Relative Humidity: 38 % | Power Supply: 120 VAC |
| Remarks: | | | |

# 7 Transmitter tests according to 47CFR part 90 requirements

## 7.1 Maximum conducted output power

### 7.1.1 General

This test was performed to measure the maximum output power at the transmitter RF antenna connector. Specification test limits are given in Table 7.1.1.

**Table 7.1.1 Maximum conducted output power limits**

| Assigned frequency range, MHz | Channel bandwidth, MHz | Maximum peak output power | |
|---|---|---|---|
| | | mW | dBm |
| **High power device** | | | |
| 4940.0 – 4990.0 | 5 | 500 | 27.0 |
| | 10 | 1000 | 30.0 |

*- If transmitting antennas of directional gain greater than 9 dBi are used, the maximum conducted output power limit should be reduced below the stated value as follows:

by the amount in dB that the directional gain of antenna exceeds 9 dBi;

without any corresponding reduction for fixed point-to-point and point-to-multipoint transmitters employing antennas with directional gain up to 26 dBi;

corresponding reduction in the peak output power and peak power spectral density limit should be the amount in dB that the directional gain of antenna exceeds 26 dBi.

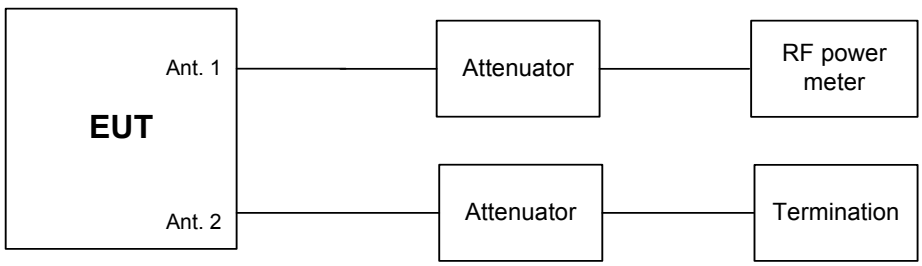
### 7.1.2 Test procedure

**7.1.2.1** The EUT was set up as shown in Figure 7.1.1, energized and its proper operation was checked.

**7.1.2.2** The EUT was adjusted to produce maximum available for end user RF output power.

**7.1.2.3** The peak output power was measured with a power meter as provided in Table 7.1.2.

**Figure 7.1.1 Transmitter output power test setup**



| Test specification: | Section 90.1215, Section 5.3, Maximum conducted output power | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1046; TIA/EIA-603-C, Section 2.2.1 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/23/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1006 hPa | Relative Humidity: 38 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Table 7.1.2 Peak output power test results**

ASSIGNED FREQUENCY RANGE: 4940.0 – 4990.0 MHz
DETECTOR USED: Average (Power meter)
RESOLUTION BANDWIDTH: NA
VIDEO BANDWIDTH: NA
MODULATING SIGNAL: PRBS
TRANSMITTER OUTPUT POWER SETTINGS: Maximum

CHANNEL BANDWIDTH: 5 MHz

| Carrier frequency, MHz | Power meter reading, dBm Ant 1 | Power meter reading, dBm Ant 2 | Total RF output power*, dBm | Limit, dBm | Margin**, dB | Verdict |
|---|---|---|---|---|---|---|
| **QPSK** | | | | | | |
| 4942.5 | 23.45 | 23.15 | 26.31 | 27 | -0.69 | Pass |
| 4962.5 | 23.76 | 23.27 | 26.53 | 27 | -0.47 | Pass |
| 4987.5 | 23.55 | 23.26 | 26.42 | 27 | -0.58 | Pass |
| **64QAM** | | | | | | |
| 4942.5 | 23.41 | 23.21 | 26.32 | 27 | -0.68 | Pass |
| 4962.5 | 23.83 | 23.26 | 26.56 | 27 | -0.44 | Pass |
| 4987.5 | 23.57 | 23.30 | 26.45 | 27 | -0.55 | Pass |

CHANNEL BANDWIDTH: 10MHz

| Carrier frequency, MHz | Power meter reading, dBm Ant 1 | Power meter reading, dBm Ant 2 | Total RF output power* , dBm | Limit, dBm | Margin**, dB | Verdict |
|---|---|---|---|---|---|---|
| **QPSK** | | | | | | |
| 4947.5 | 23.04 | 22.96 | 26.01 | 30 | -3.99 | Pass |
| 4962.5 | 23.09 | 23.00 | 26.06 | 30 | -3.94 | Pass |
| 4982.5 | 23.11 | 23.01 | 26.07 | 30 | -3.93 | Pass |
| **64QAM** | | | | | | |
| 4947.5 | 23.27 | 22.97 | 26.13 | 30 | -3.87 | Pass |
| 4962.5 | 23.09 | 23.02 | 26.07 | 30 | -3.93 | Pass |
| 4982.5 | 23.15 | 23.03 | 26.10 | 30 | -3.90 | Pass |

* - Total RF output power, dBm = 10 log {10^[P(dBm,Ant1)/10] + 10^([P(dBm, Ant2)/10]}
**- Margin, dB = Calculated total power – specified limit.

**Reference numbers of test equipment used**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| HL 3301 | HL 3302 | HL 3786 | HL 4366 | | | | |

Full description is given in Appendix A.

| Test specification: | Section 90.1215, Section 5.3, Peak power spectral density | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1051; TIA/EIA-603-C, Section 2.2.1 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/23/2012 | | |
| Temperature: 23 ºC | Air Pressure: 1006 hPa | Relative Humidity: 38 % | Power Supply: 120 VAC |
| Remarks: | | | |

## 7.2 Peak power spectral density

### 7.2.1 General

This test was performed to measure the peak power spectral density at the transmitter RF antenna connector. Specification test limits are given in Table 7.2.1.

**Table 7.2.1 Peak power spectral density limits**

| Assigned frequency range, MHz | Channel bandwidth, MHz | Peak power spectral density, dBm/MHz |
|---|---|---|
| **High power device** | | |
| 4940.0 – 4990.0 | 5 | 21 |
| | 10 | |

*- If transmitting antennas of directional gain greater than 9 dBi are used, the peak power spectral density limit should be reduced below the stated value as follows:

by the amount in dB that the directional gain of antenna exceeds 9 dBi;

without any corresponding reduction for fixed point-to-point and point-to-multipoint transmitters employing antennas with directional gain up to 26 dBi;

corresponding reduction in the peak output power and peak power spectral density limit should be the amount in dB that the directional gain of antenna exceeds 26 dBi.

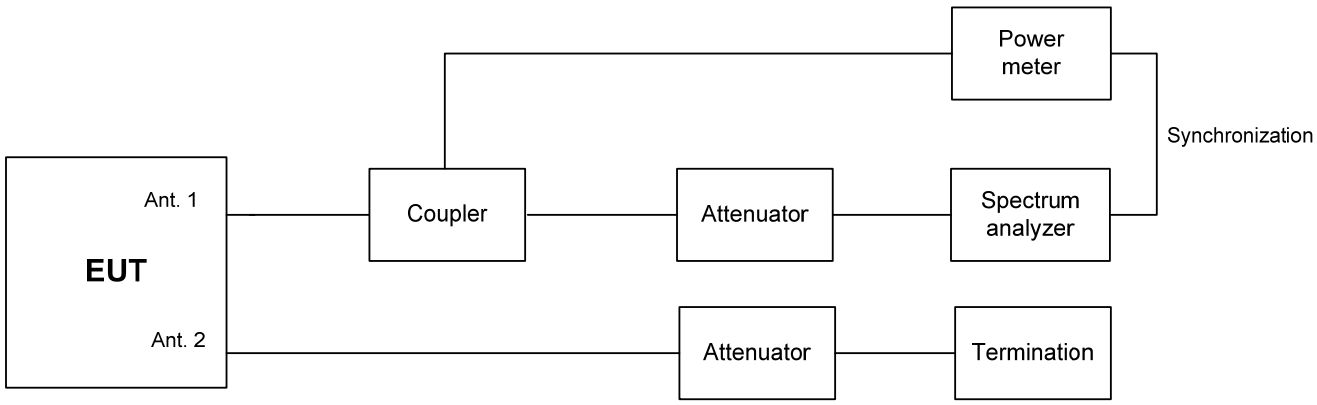
### 7.2.2 Test procedure

**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 EUT was adjusted to produce maximum available for end user RF output power.

**7.2.2.3** The peak output power was measured with a spectrum analyzer as provided in Table 7.2.2 and the associated plots.

**Figure 7.2.1 Power spectral density test setup**



| Test specification: | Section 90.1215, Section 5.3, Peak power spectral density | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1051; TIA/EIA-603-C, Section 2.2.1 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/23/2012 | | |
| Temperature: 23 ºC | Air Pressure: 1006 hPa | Relative Humidity: 38 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Table 7.2.2 Peak power spectral density test results**

ASSIGNED FREQUENCY RANGE: 4940.0 – 4990.0 MHz
DETECTOR USED: Average
RESOLUTION BANDWIDTH: 1 MHz
VIDEO BANDWIDTH: 3 MHz
MODULATING SIGNAL: PRBS
TRANSMITTER OUTPUT POWER SETTINGS: Maximum

CHANNEL BANDWIDTH: 5 MHz

| Carrier frequency, MHz | Spectrum analyzer reading, dBm/MHz Ant 1 | Spectrum analyzer reading, dBm/MHz Ant 2 | Power spectral density*, dBm/MHZ | Limit, dBm/MHz | Margin**, dB | Verdict |
|---|---|---|---|---|---|---|
| **QPSK** | | | | | | |
| 4942.5 | 16.57 | 16.28 | 19.44 | 21 | -1.56 | Pass |
| 4962.5 | 16.98 | 16.42 | 19.72 | 21 | -1.28 | Pass |
| 4987.5 | 16.74 | 16.37 | 19.57 | 21 | -1.43 | Pass |
| **64QAM** | | | | | | |
| 4942.5 | 16.75 | 16.60 | 19.69 | 21 | -1.31 | Pass |
| 4962.5 | 17.36 | 16.64 | 20.03 | 21 | -0.97 | Pass |
| 4987.5 | 17.05 | 16.57 | 19.83 | 21 | -1.17 | Pass |

CHANNEL BANDWIDTH: 10 MHz

| Carrier frequency, MHz | Spectrum analyzer reading, dBm/MHz Ant 1 | Spectrum analyzer reading, dBm/MHz Ant 2 | Power spectral density*, dBm/MHZ | Limit, dBm/MHz | Margin**, dB | Verdict |
|---|---|---|---|---|---|---|
| **QPSK** | | | | | | |
| 4947.5 | 13.37 | 13.22 | 16.31 | 21 | -4.69 | Pass |
| 4962.5 | 13.82 | 13.40 | 16.63 | 21 | -4.37 | Pass |
| 4982.5 | 13.81 | 13.54 | 16.69 | 21 | -4.31 | Pass |
| **64QAM** | | | | | | |
| 4947.5 | 13.79 | 13.68 | 16.75 | 21 | -4.25 | Pass |
| 4962.5 | 14.04 | 13.77 | 16.92 | 21 | -4.08 | Pass |
| 4982.5 | 14.12 | 13.76 | 16.95 | 21 | -4.05 | Pass |

* - Peak power spectral density calculated, dBm/MHz = 10 log{10^[(P(dBm,Ant1)/10]+ 10^[(P(dBm,Ant2))/10]}
**- Margin = Calculated power density – specified limit.

**Reference numbers of test equipment used**

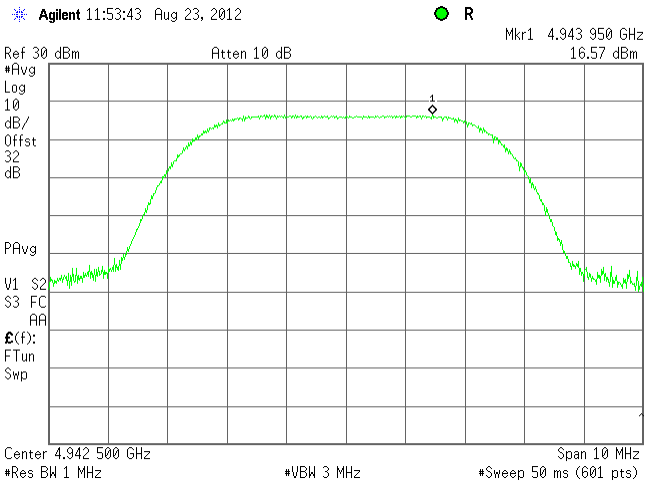
| HL 3301 | HL 3302 | HL 3442 | HL 3786 | HL 3818 | HL 3903 | HL 4366 | |
|---|---|---|---|---|---|---|---|

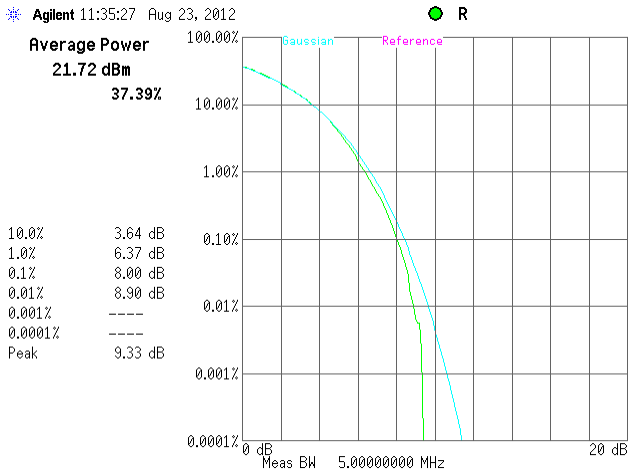
Full description is given in Appendix A.

| Test specification: | Section 90.1215, Section 5.3, Peak power spectral density | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1051; TIA/EIA-603-C, Section 2.2.1 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/23/2012 | | |
| Temperature: 23 ºC | Air Pressure: 1006 hPa | Relative Humidity: 38 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.2.1 Peak output power spectral density test results at low frequency**

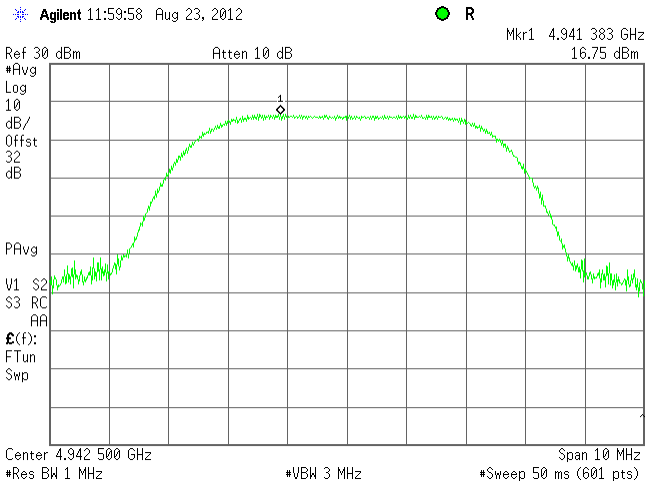
EUT OUTPUT CONNECTOR: Ant 1
CHANNEL BANDWIDTH: 5 MHz
MODULATION: QPSK

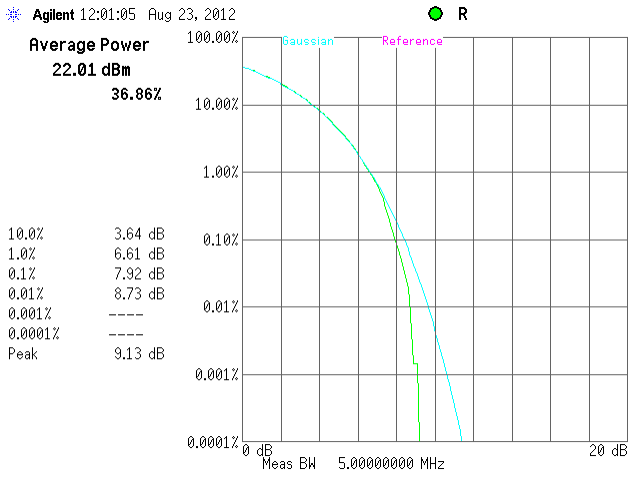



**Plot 7.2.2 Peak output power spectral density test results at low frequency**

EUT OUTPUT CONNECTOR: Ant 1
CHANNEL BANDWIDTH: 5 MHz
MODULATION: 64 QAM

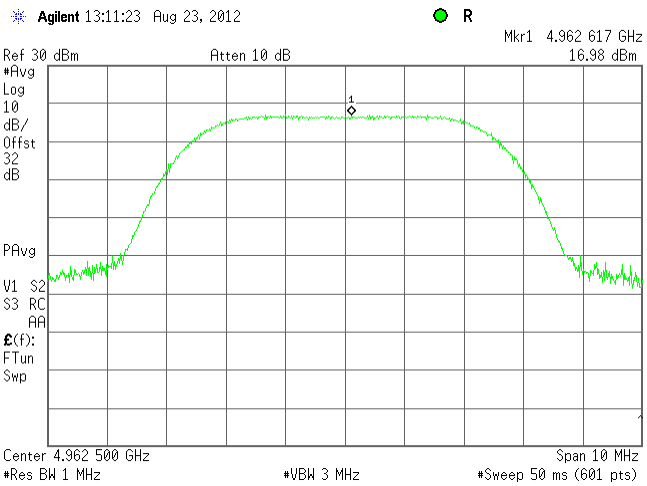


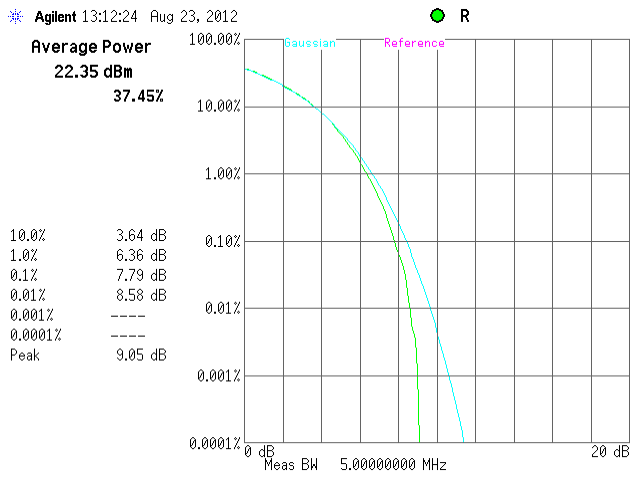



| Test specification: | Section 90.1215, Section 5.3, Peak power spectral density | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1051; TIA/EIA-603-C, Section 2.2.1 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/23/2012 | | |
| Temperature: 23 ºC | Air Pressure: 1006 hPa | Relative Humidity: 38 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.2.3 Peak output power spectral density test results at mid frequency**

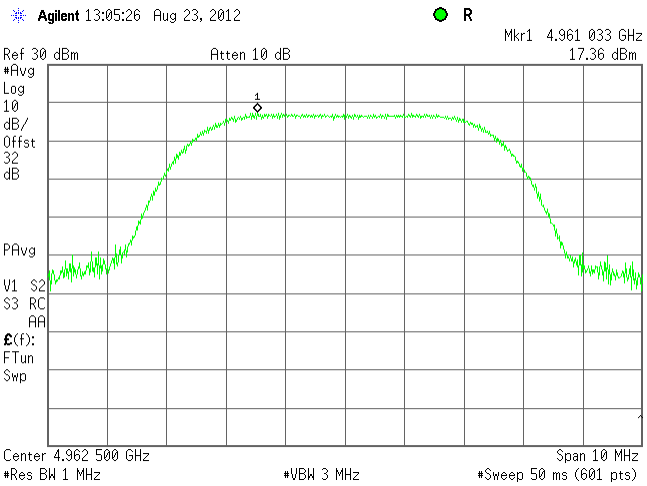
EUT OUTPUT CONNECTOR: Ant 1
CHANNEL BANDWIDTH: 5 MHz
MODULATION: QPSK

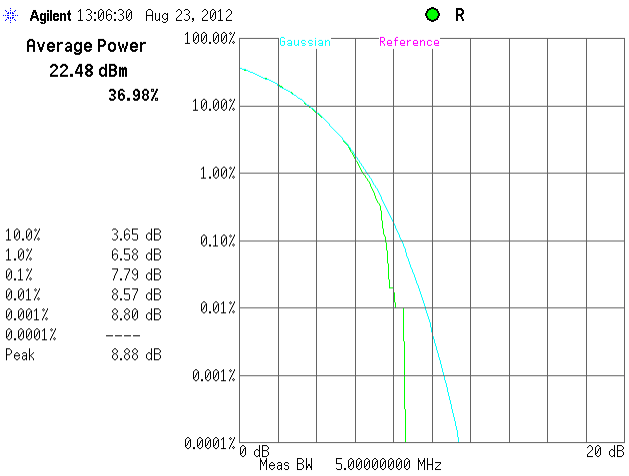



**Plot 7.2.4 Peak output power spectral density test results at mid frequency**

EUT OUTPUT CONNECTOR: Ant 1
CHANNEL BANDWIDTH: 5 MHz
MODULATION: 64 QAM

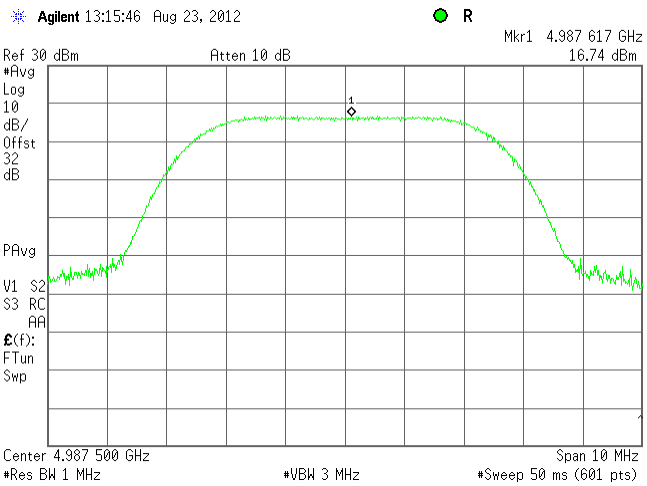


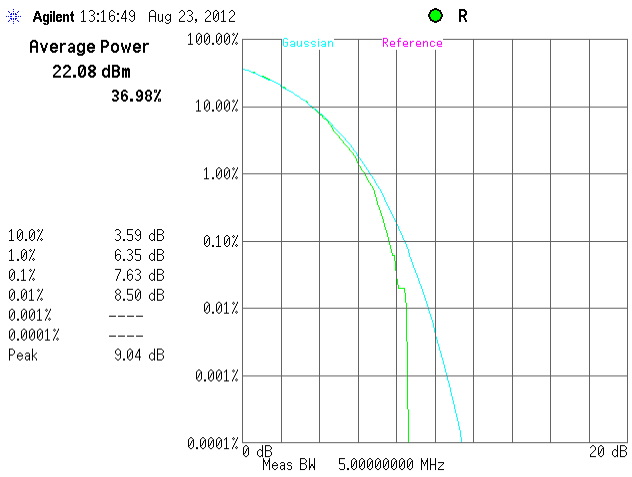



| Test specification: | Section 90.1215, Section 5.3, Peak power spectral density | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1051; TIA/EIA-603-C, Section 2.2.1 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/23/2012 | | |
| Temperature: 23 ºC | Air Pressure: 1006 hPa | Relative Humidity: 38 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.2.5 Peak output power spectral density test results at high frequency**

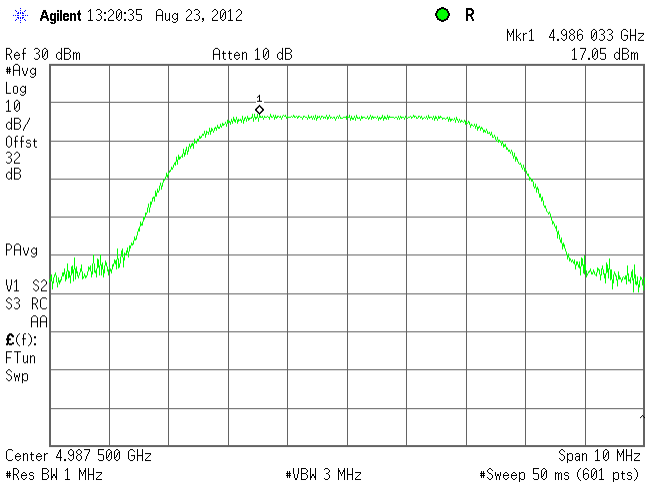
EUT OUTPUT CONNECTOR: Ant 1
CHANNEL BANDWIDTH: 5 MHz
MODULATION: QPSK

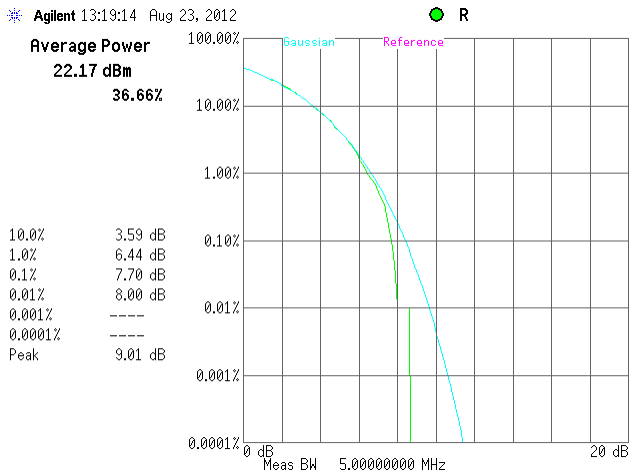



**Plot 7.2.6 Peak output power spectral density test results at high frequency**

EUT OUTPUT CONNECTOR: Ant 1
CHANNEL BANDWIDTH: 5 MHz
MODULATION: 64 QAM

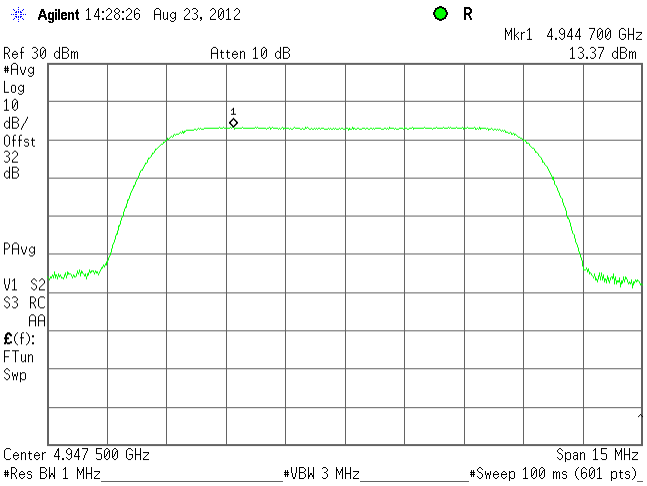


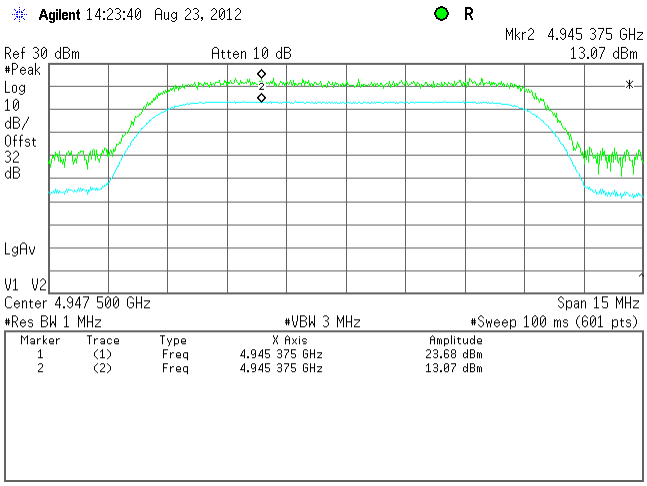



| Test specification: | Section 90.1215, Section 5.3, Peak power spectral density | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1051; TIA/EIA-603-C, Section 2.2.1 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/23/2012 | | |
| Temperature: 23 ºC | Air Pressure: 1006 hPa | Relative Humidity: 38 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.2.7 Peak output power spectral density test results at low frequency**

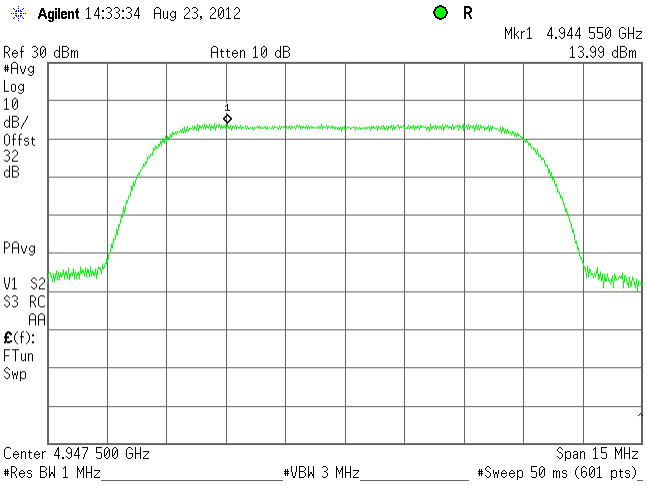
EUT OUTPUT CONNECTOR: Ant 1
CHANNEL BANDWIDTH: 10 MHz
MODULATION: QPSK

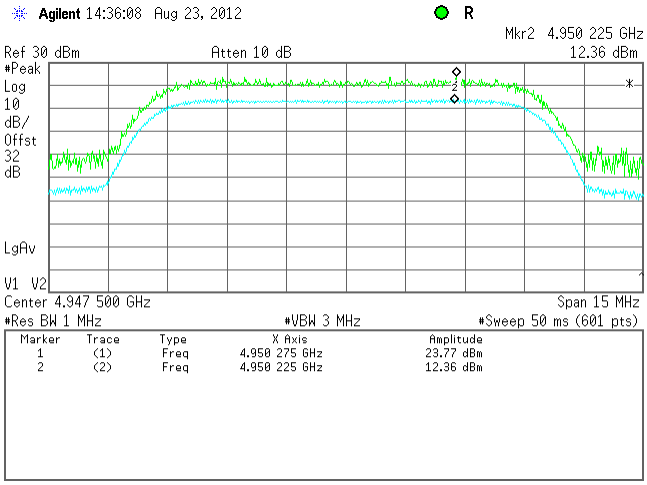



**Plot 7.2.8 Peak output power spectral density test results at low frequency**

EUT OUTPUT CONNECTOR: Ant 1
CHANNEL BANDWIDTH: 10 MHz
MODULATION: 64 QAM

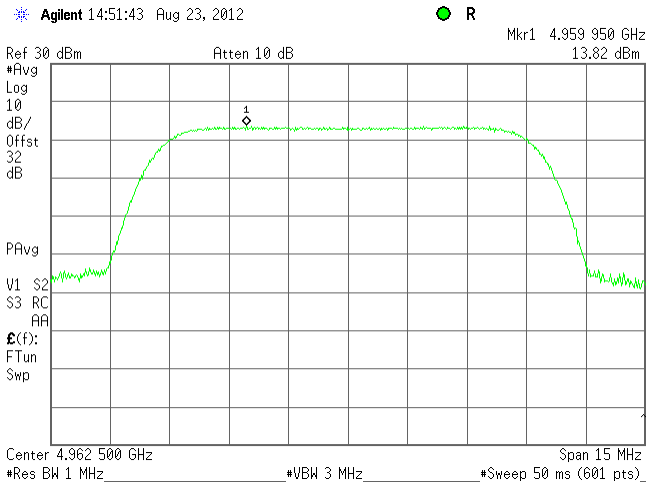


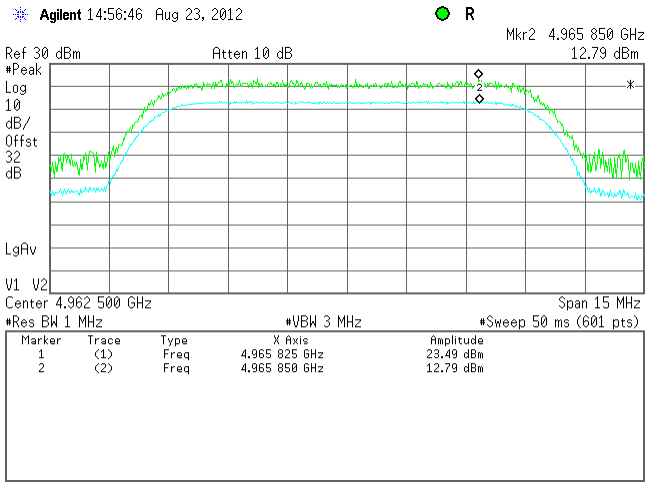



| Test specification: | Section 90.1215, Section 5.3, Peak power spectral density | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1051; TIA/EIA-603-C, Section 2.2.1 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/23/2012 | | |
| Temperature: 23 ºC | Air Pressure: 1006 hPa | Relative Humidity: 38 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.2.9 Peak output power spectral density test results at mid frequency**

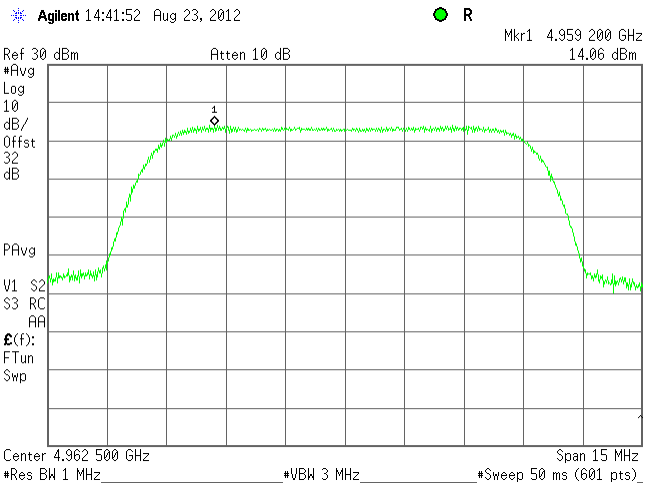
EUT OUTPUT CONNECTOR: Ant 1
CHANNEL BANDWIDTH: 10 MHz
MODULATION: QPSK

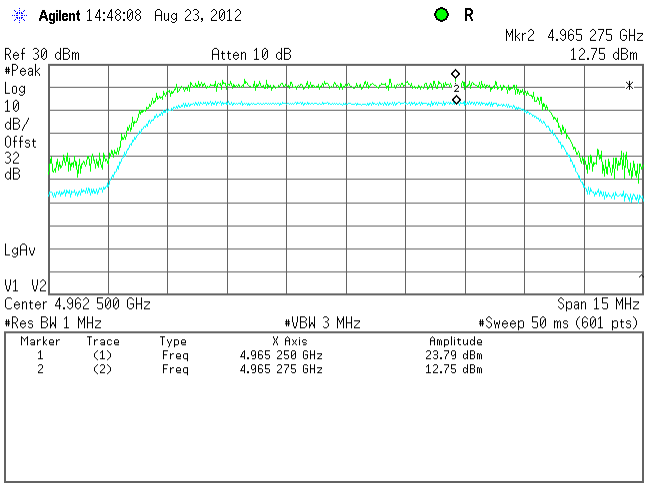



**Plot 7.2.10 Peak output power spectral density test results at mid frequency**

EUT OUTPUT CONNECTOR: Ant 1
CHANNEL BANDWIDTH: 10 MHz
MODULATION: 64 QAM

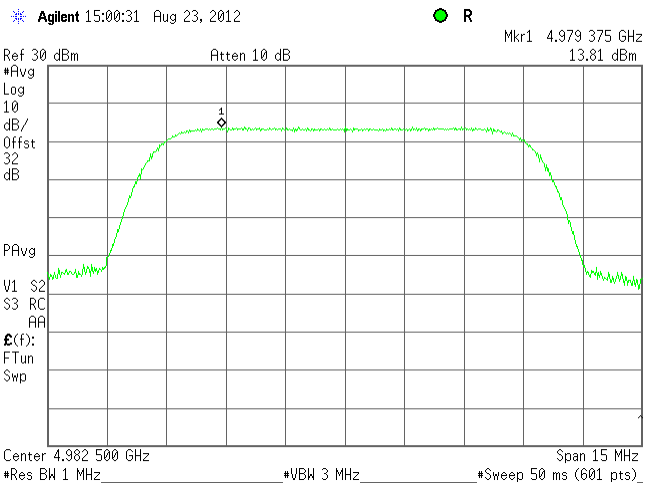


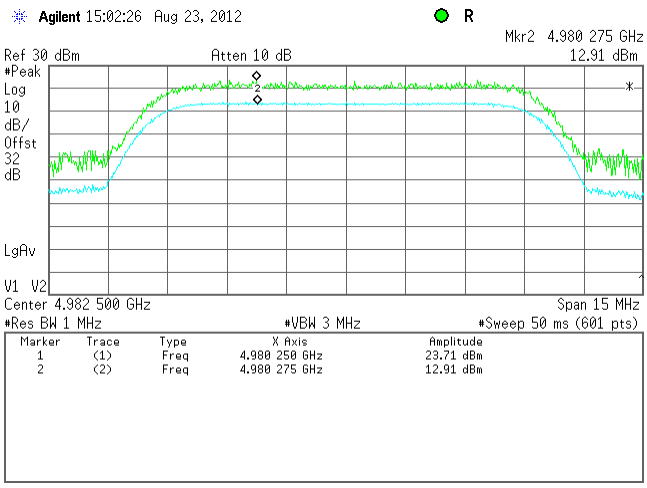



| Test specification: | Section 90.1215, Section 5.3, Peak power spectral density | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1051; TIA/EIA-603-C, Section 2.2.1 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/23/2012 | | |
| Temperature: 23 ºC | Air Pressure: 1006 hPa | Relative Humidity: 38 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.2.11 Peak output power spectral density test results at high frequency**

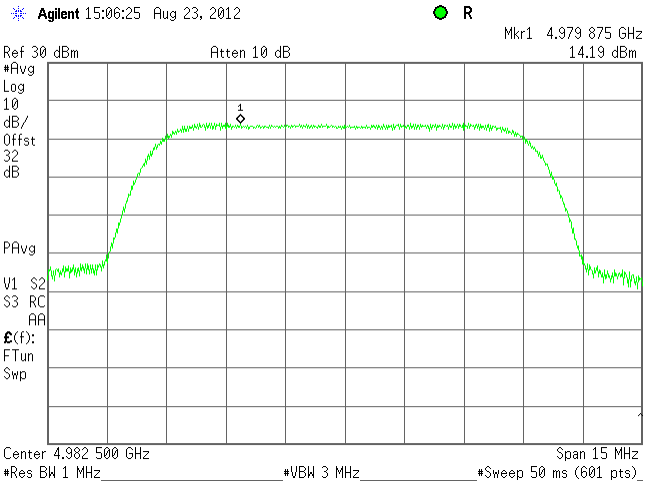
EUT OUTPUT CONNECTOR: Ant 1
CHANNEL BANDWIDTH: 10MHz
MODULATION: QPSK

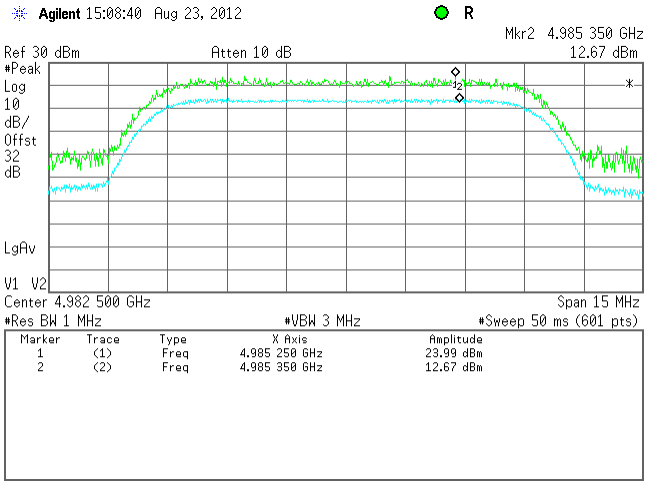



**Plot 7.2.12 Peak output power spectral density test results at high frequency**

EUT OUTPUT CONNECTOR: Ant 1
CHANNEL BANDWIDTH: 10 MHz
MODULATION: 64 QAM

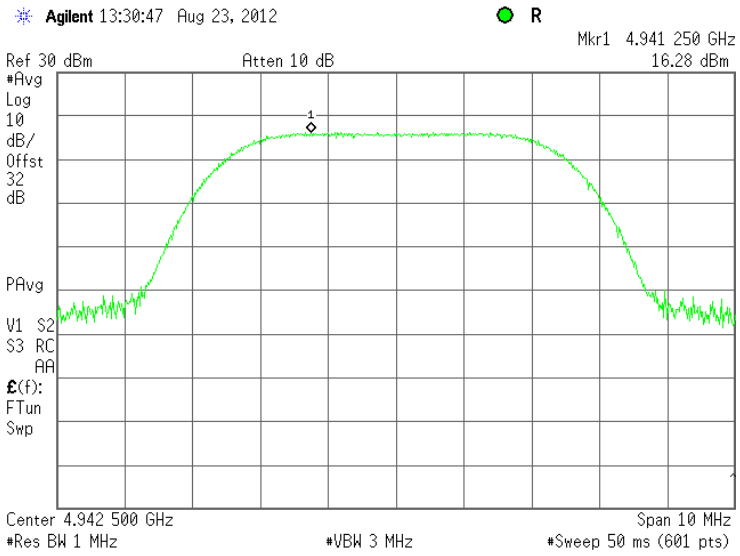


| Test specification: | Section 90.1215, Section 5.3, Peak power spectral density | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1051; TIA/EIA-603-C, Section 2.2.1 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/23/2012 | | |
| Temperature: 23 ºC | Air Pressure: 1006 hPa | Relative Humidity: 38 % | Power Supply: 120 VAC |
| Remarks: | | | |

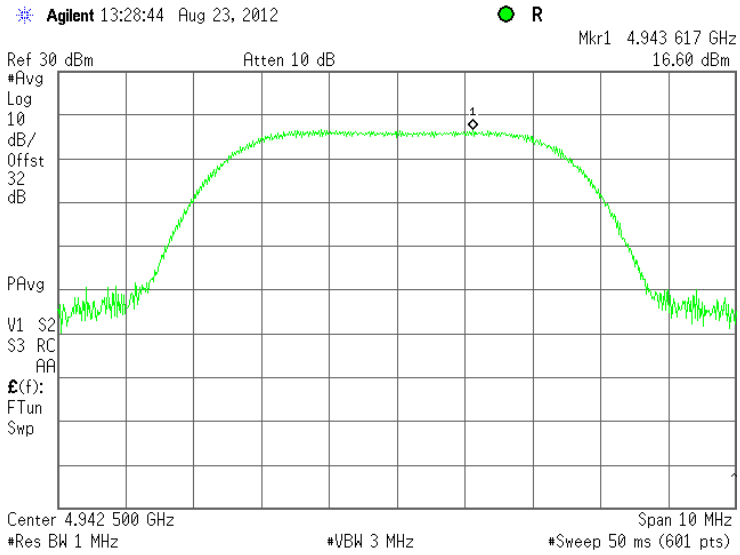
**Plot 7.2.13 Peak output power spectral density test results at low frequency**

EUT OUTPUT CONNECTOR: Ant 2
CHANNEL BANDWIDTH: 5 MHz
MODULATION: QPSK




**Plot 7.2.14 Peak output power spectral density test results at low frequency**

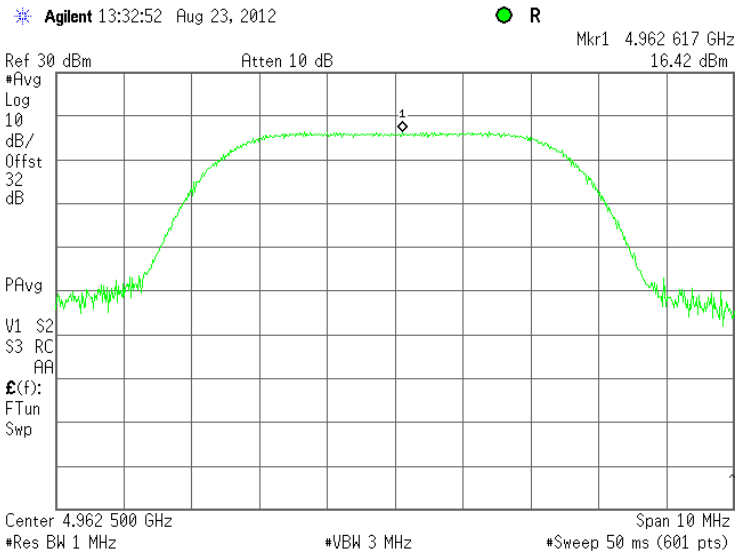
EUT OUTPUT CONNECTOR: Ant 2
CHANNEL BANDWIDTH: 5 MHz
MODULATION: 64 QAM



| Test specification: | Section 90.1215, Section 5.3, Peak power spectral density | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1051; TIA/EIA-603-C, Section 2.2.1 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/23/2012 | | |
| Temperature: 23 ºC | Air Pressure: 1006 hPa | Relative Humidity: 38 % | Power Supply: 120 VAC |
| Remarks: | | | |

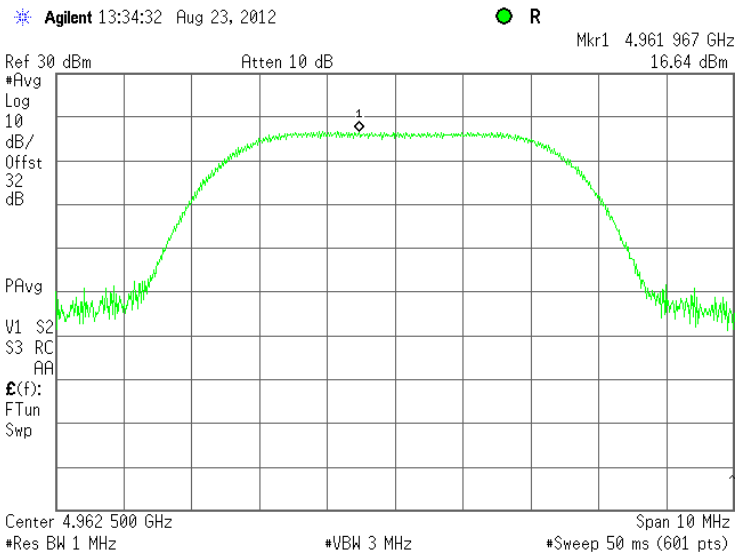
**Plot 7.2.15 Peak output power spectral density test results at mid frequency**

EUT OUTPUT CONNECTOR: Ant 2
CHANNEL BANDWIDTH: 5 MHz
MODULATION: QPSK




**Plot 7.2.16 Peak output power spectral density test results at mid frequency**

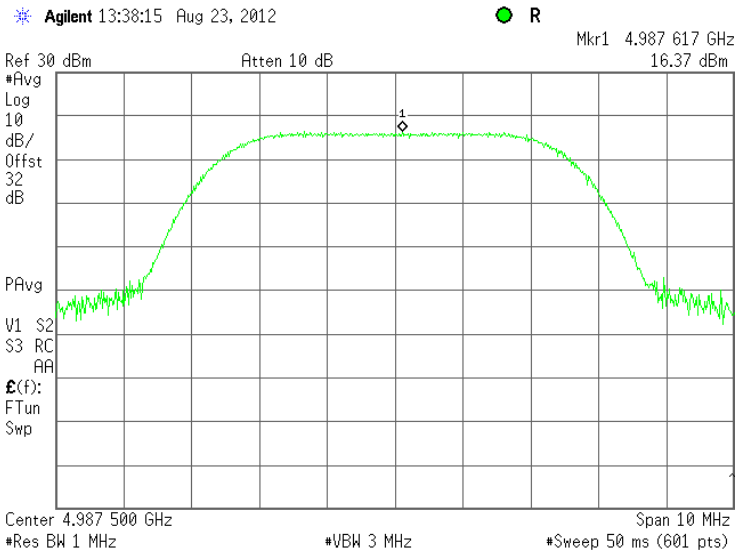
EUT OUTPUT CONNECTOR: Ant 2
CHANNEL BANDWIDTH: 5 MHz
MODULATION: 64 QAM



| Test specification: | Section 90.1215, Section 5.3, Peak power spectral density | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1051; TIA/EIA-603-C, Section 2.2.1 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/23/2012 | | |
| Temperature: 23 ºC | Air Pressure: 1006 hPa | Relative Humidity: 38 % | Power Supply: 120 VAC |
| Remarks: | | | |

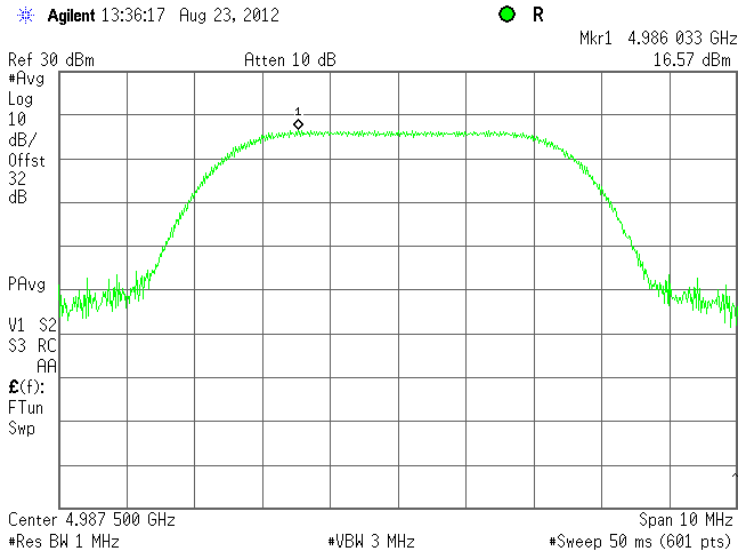
**Plot 7.2.17 Peak output power spectral density test results at high frequency**

EUT OUTPUT CONNECTOR: Ant 2
CHANNEL BANDWIDTH: 5 MHz
MODULATION: QPSK




**Plot 7.2.18 Peak output power spectral density test results at high frequency**

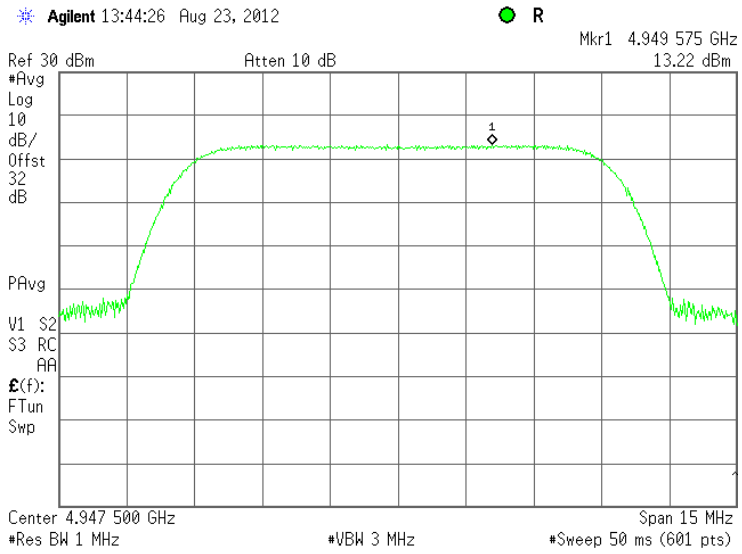
EUT OUTPUT CONNECTOR: Ant 2
CHANNEL BANDWIDTH: 5 MHz
MODULATION: 64 QAM



| Test specification: | Section 90.1215, Section 5.3, Peak power spectral density | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1051; TIA/EIA-603-C, Section 2.2.1 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/23/2012 | | |
| Temperature: 23 ºC | Air Pressure: 1006 hPa | Relative Humidity: 38 % | Power Supply: 120 VAC |
| Remarks: | | | |

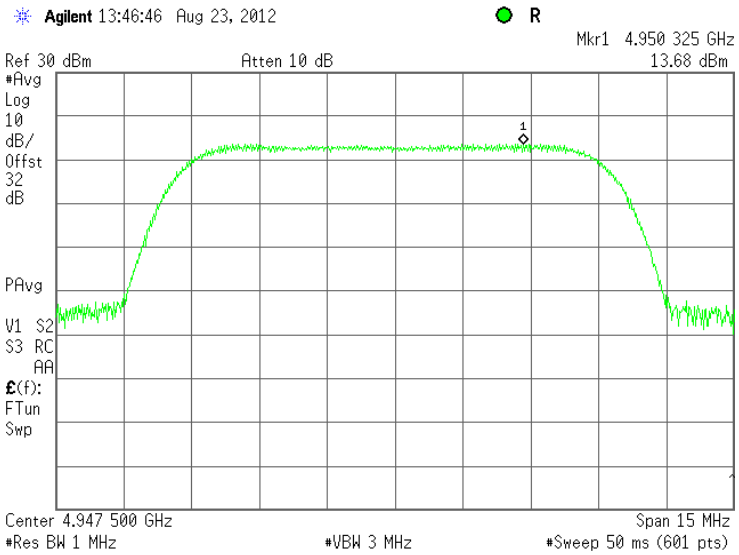
**Plot 7.2.19 Peak output power spectral density test results at low frequency**

EUT OUTPUT CONNECTOR: Ant 2
CHANNEL BANDWIDTH: 10 MHz
MODULATION: QPSK




**Plot 7.2.20 Peak output power spectral density test results at low frequency**

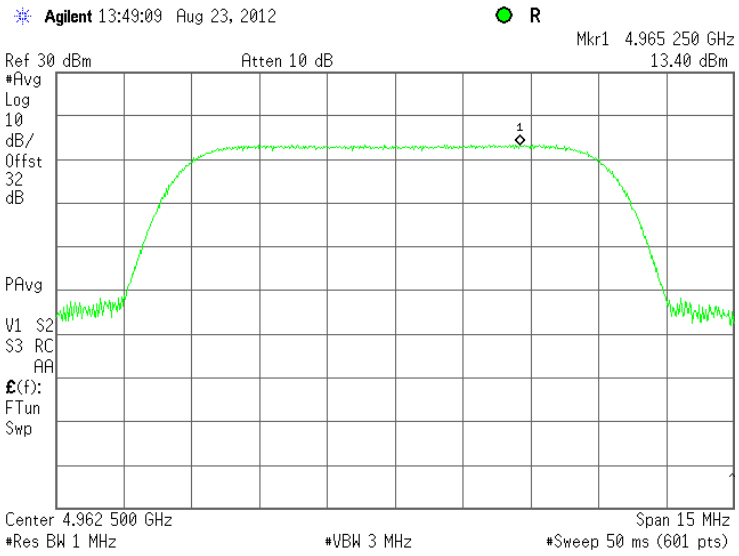
EUT OUTPUT CONNECTOR: Ant 2
CHANNEL BANDWIDTH: 10 MHz
MODULATION: 64 QAM



| Test specification: | Section 90.1215, Section 5.3, Peak power spectral density | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1051; TIA/EIA-603-C, Section 2.2.1 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/23/2012 | | |
| Temperature: 23 ºC | Air Pressure: 1006 hPa | Relative Humidity: 38 % | Power Supply: 120 VAC |
| Remarks: | | | |

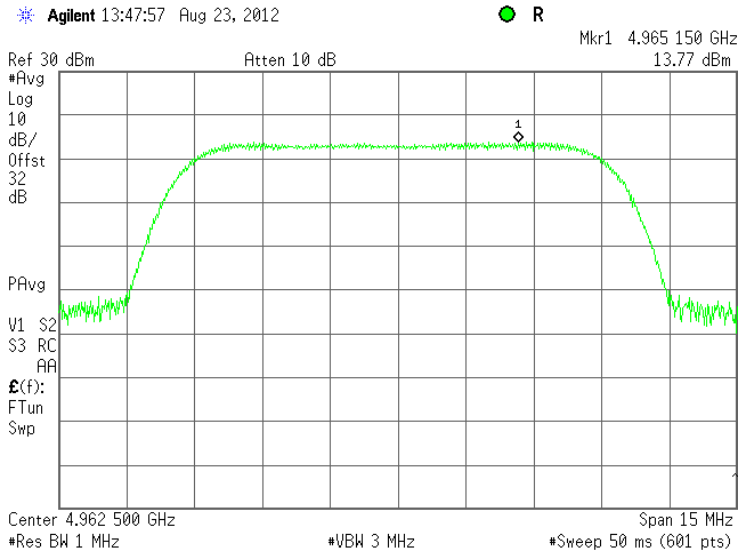
**Plot 7.2.21 Peak output power spectral density test results at mid frequency**

EUT OUTPUT CONNECTOR: Ant 2
CHANNEL BANDWIDTH: 10 MHz
MODULATION: QPSK




**Plot 7.2.22 Peak output power spectral density test results at mid frequency**

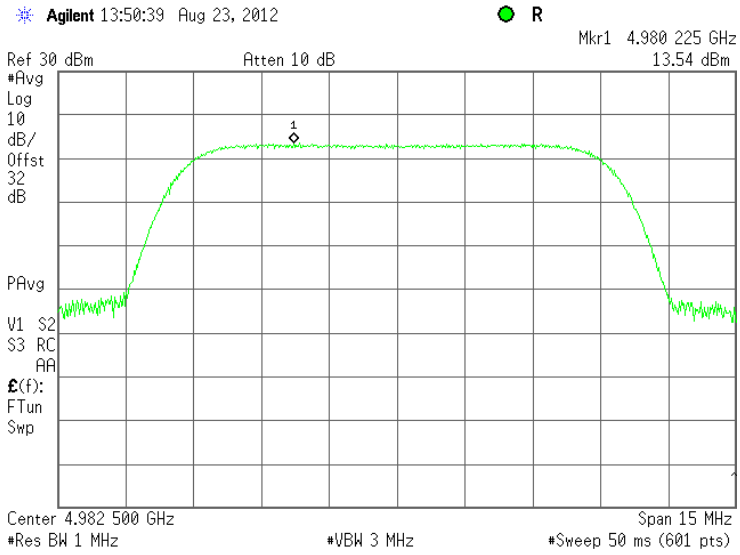
EUT OUTPUT CONNECTOR: Ant 2
CHANNEL BANDWIDTH: 10 MHz
MODULATION: 64 QAM



| Test specification: | Section 90.1215, Section 5.3, Peak power spectral density | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1051; TIA/EIA-603-C, Section 2.2.1 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/23/2012 | | |
| Temperature: 23 ºC | Air Pressure: 1006 hPa | Relative Humidity: 38 % | Power Supply: 120 VAC |
| Remarks: | | | |

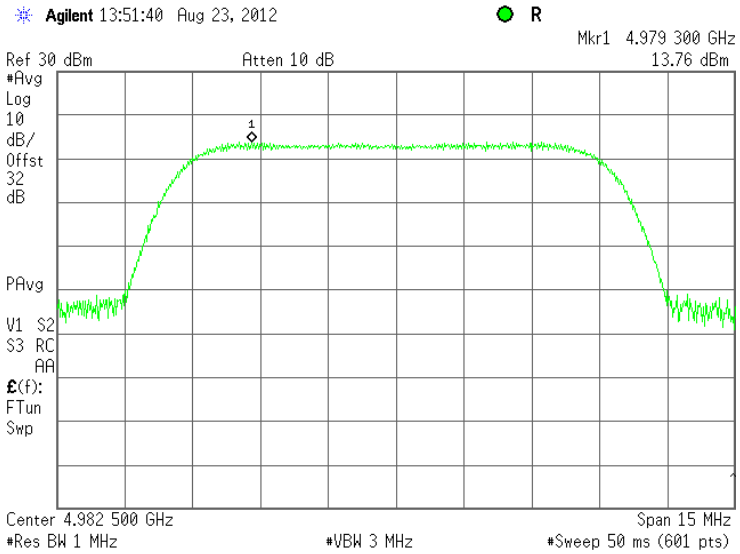
**Plot 7.2.23 Peak output power spectral density test results at high frequency**

EUT OUTPUT CONNECTOR: Ant 2
CHANNEL BANDWIDTH: 10MHz
MODULATION: QPSK




**Plot 7.2.24 Peak output power spectral density test results at high frequency**

EUT OUTPUT CONNECTOR: Ant 2
CHANNEL BANDWIDTH: 10 MHz
MODULATION: 64 QAM



| Test specification: | Section 90.209, Section 5.3, Occupied bandwidth | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1049 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/26/2012 - 8/27/2012 | | |
| Temperature: 26 ºC | Air Pressure: hPa | Relative Humidity: 42 % | Power Supply: 120 VAC |
| Remarks: | | | |

## 7.3 Occupied bandwidth test

### 7.3.1 General

This test was performed to measure transmitter occupied bandwidth. Specification test limits are given in Table 7.3.1.

**Table 7.3.1 Occupied bandwidth limits**

| Assigned frequency, MHz | Modulation envelope reference points*, dBc | Modulation envelope reference points*, % |
|---|---|---|
| 4940.00 – 4990.00 | 26 | 99 |

* - Modulation envelope reference points are provided in terms of attenuation below the average transmitted power.

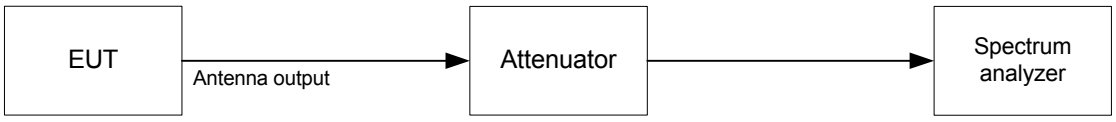
### 7.3.2 Test procedure

**7.3.2.1** The EUT was set up as shown in Figure 7.3.1, energized and its proper operation was checked.

**7.3.2.2** The EUT was set to transmit the normally modulated carrier.

**7.3.2.3** The transmitter occupied bandwidth was measured with spectrum analyzer as a frequency delta between the reference points on modulation envelope and provided in Table 7.3.2 and the associated plots.

**Figure 7.3.1 Occupied bandwidth test setup**



| Test specification: | Section 90.209, Section 5.3, Occupied bandwidth | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1049 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/26/2012 - 8/27/2012 | | |
| Temperature: 26 ºC | Air Pressure: hPa | Relative Humidity: 42 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Table 7.3.2 Occupied bandwidth test results**

DETECTOR USED: Average
RESOLUTION BANDWIDTH: 100 kHz*
VIDEO BANDWIDTH: >RBW
MODULATING SIGNAL: PRBS

ANTENNA ANT.1
CHANNEL BANDWIDTH: 5 MHz

| Modulation | Carrier frequency, MHz | Occupied bandwidth (26 dBc) MHz | Occupied bandwidth (99%) MHz | Verdict |
|---|---|---|---|---|
| QPSK | 4942.5 | 4.839 | 4.5537 | Pass |
| | 4962.5 | 4.828 | 4.5521 | |
| | 4987.5 | 4.829 | 4.5518 | |
| 64 QAM | 4942.5 | 4.944 | 4.5572 | Pass |
| | 4962.5 | 4.944 | 4.5567 | |
| | 4987.5 | 4.945 | 4.5568 | |

CHANNEL BANDWIDTH: 10MHz

| Modulation | Carrier frequency, MHz | Occupied bandwidth (26 dBc) kHz | Occupied bandwidth (99%) kHz | Verdict |
|---|---|---|---|---|
| QPSK | 4947.5 | 9.659 | 9.0602 | Pass |
| | 4962.5 | 9.529 | 9.0578 | |
| | 4982.5 | 9.546 | 9.0597 | |
| 64 QAM | 4947.5 | 9.455 | 9.0610 | Pass |
| | 4962.5 | 9.465 | 9.0612 | |
| | 4982.5 | 9.463 | 9.0561 | |

ANTENNA ANT.2
CHANNEL BANDWIDTH: 5 MHz

| Modulation | Carrier frequency, MHz | Occupied bandwidth (26 dBc) MHz | Occupied bandwidth (99%) MHz | Verdict |
|---|---|---|---|---|
| QPSK | 4942.5 | 4.982 | 4.5479 | Pass |
| | 4962.5 | 4.834 | 4.5455 | |
| | 4987.5 | 4.840 | 4.5468 | |
| 64 QAM | 4942.5 | 4.981 | 4.5479 | Pass |
| | 4962.5 | 4.933 | 4.5469 | |
| | 4987.5 | 4.987 | 4.5471 | |

CHANNEL BANDWIDTH: 10MHz

| Modulation | Carrier frequency, MHz | Occupied bandwidth (26 dBc) kHz | Occupied bandwidth (99%) kHz | Verdict |
|---|---|---|---|---|
| QPSK | 4947.5 | 9.446 | 9.0539 | Pass |
| | 4962.5 | 9.445 | 9.0500 | |
| | 4982.5 | 9.446 | 9.0508 | |
| 64 QAM | 4947.5 | 9.435 | 9.0597 | Pass |
| | 4962.5 | 9.436 | 9.0592 | |
| | 4982.5 | 9.436 | 9.0571 | |

* - RBW ≥ 1% of OBW; 1 % of 5 MHz is 50 kHz, 1 % of 10 MHz is 100 kHz, RBW=100 kHz was chosen for the measurements.

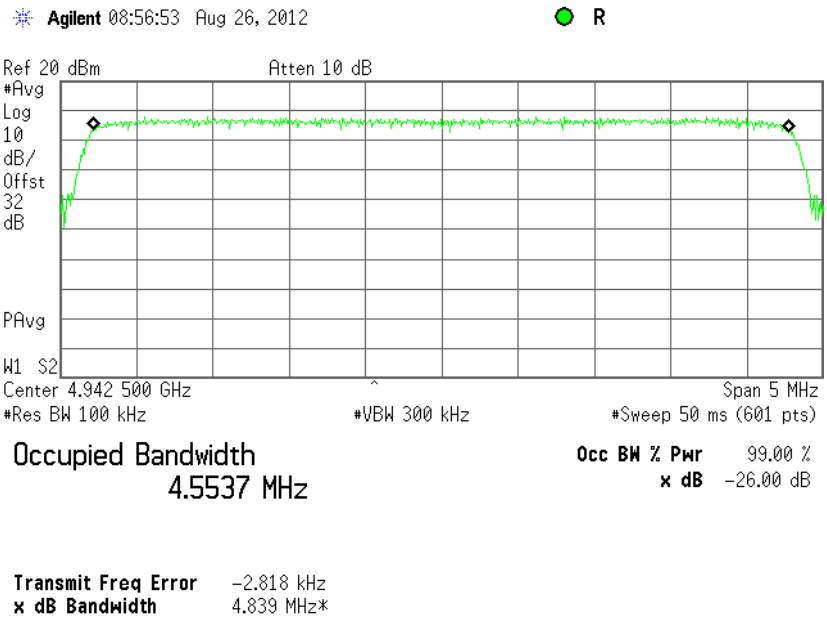
**Reference numbers of test equipment used**

| HL 3301 | HL 3302 | HL 3442 | HL 3786 | HL 3818 | HL 3903 | HL 4366 | |
|---|---|---|---|---|---|---|---|

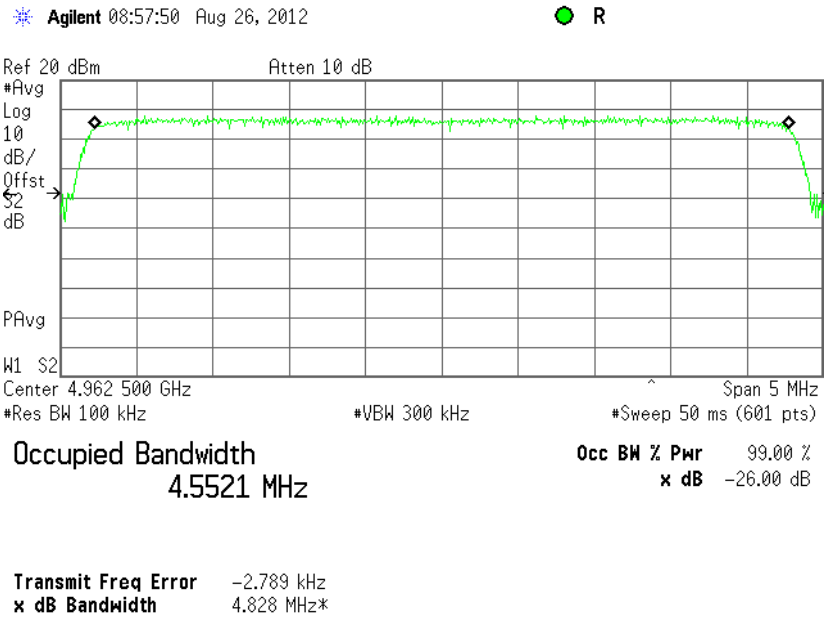
Full description is given in Appendix A.

| Test specification: | Section 90.209, Section 5.3, Occupied bandwidth | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1049 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/26/2012 - 8/27/2012 | | |
| Temperature: 26 ºC | Air Pressure: hPa | Relative Humidity: 42 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.3.1 Occupied bandwidth test result at low frequency, 5 MHz CBW, QPSK, Antenna 1**

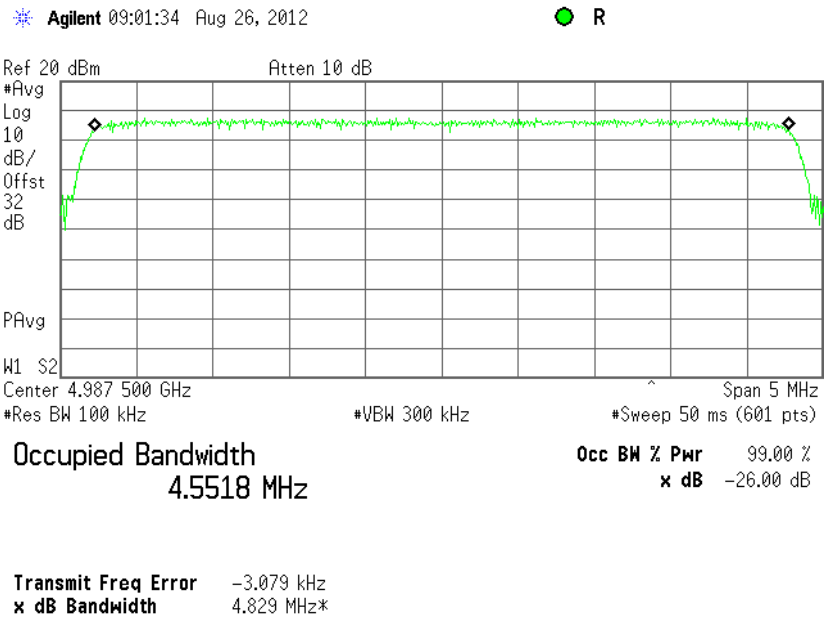



**Plot 7.3.2 Occupied bandwidth test result at mid frequency, 5 MHz CBW, QPSK, Antenna 1**

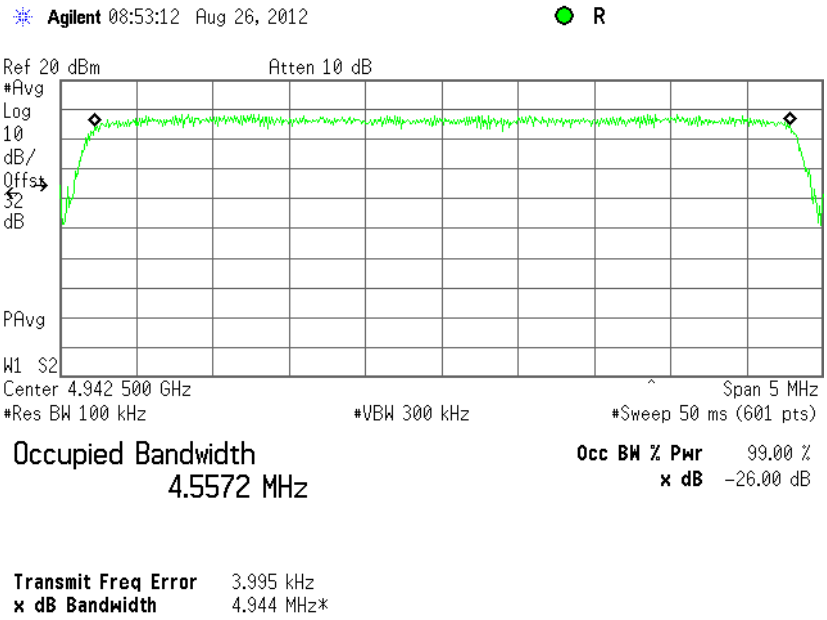


| Test specification: | Section 90.209, Section 5.3, Occupied bandwidth | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1049 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/26/2012 - 8/27/2012 | | |
| Temperature: 26 ºC | Air Pressure: hPa | Relative Humidity: 42 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.3.3 Occupied bandwidth test result at high frequency, 5 MHz CBW, QPSK, Antenna 1**

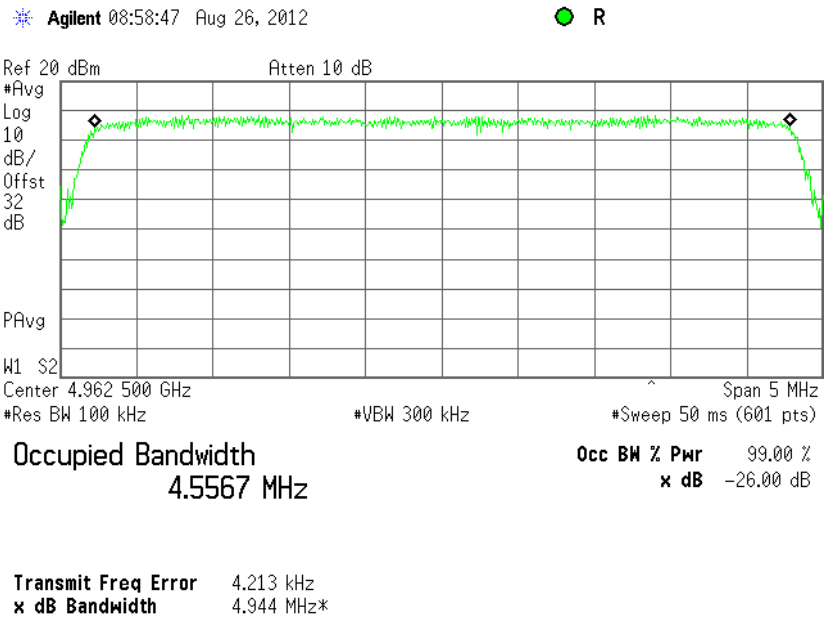



**Plot 7.3.4 Occupied bandwidth test result at low frequency, 5 MHz CBW, 64QAM, Antenna 1**

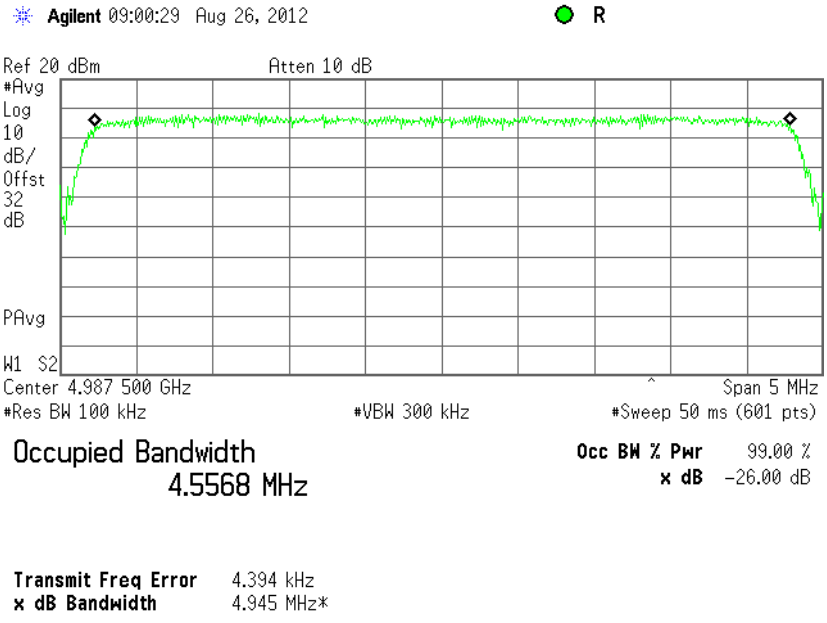


| Test specification: | Section 90.209, Section 5.3, Occupied bandwidth | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1049 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/26/2012 - 8/27/2012 | | |
| Temperature: 26 ºC | Air Pressure: hPa | Relative Humidity: 42 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.3.5 Occupied bandwidth test result at mid frequency, 5 MHz CBW, 64QAM, Antenna 1**

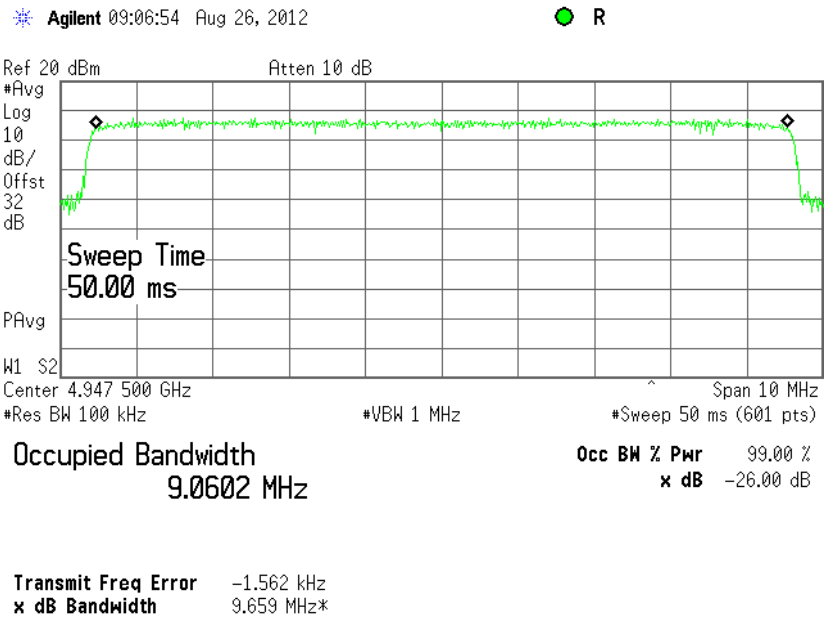



**Plot 7.3.6 Occupied bandwidth test result at high frequency, 5 MHz CBW, 64QAM, Antenna 1**

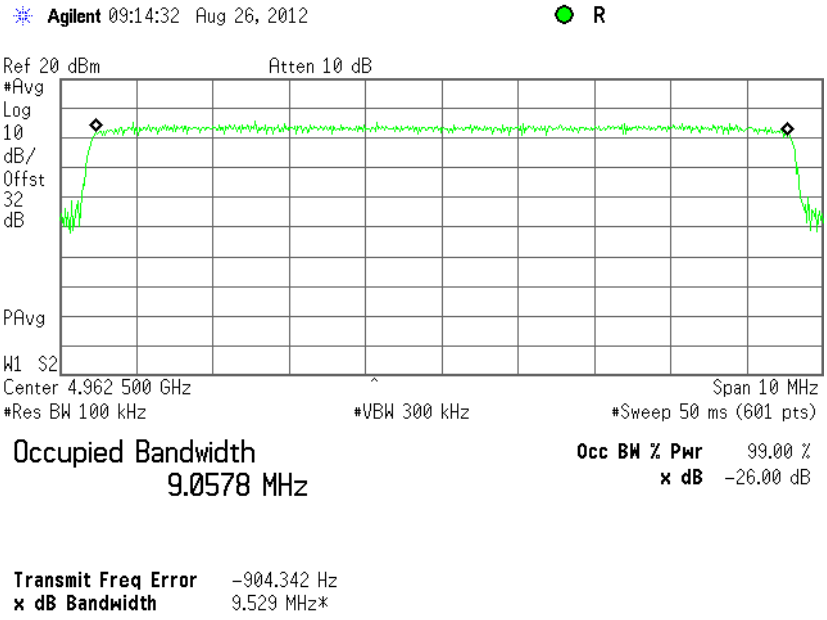


| Test specification: | Section 90.209, Section 5.3, Occupied bandwidth | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1049 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/26/2012 - 8/27/2012 | | |
| Temperature: 26 ºC | Air Pressure: hPa | Relative Humidity: 42 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.3.7 Occupied bandwidth test result at low frequency, 10 MHz CBW, QPSK, Antenna 1**

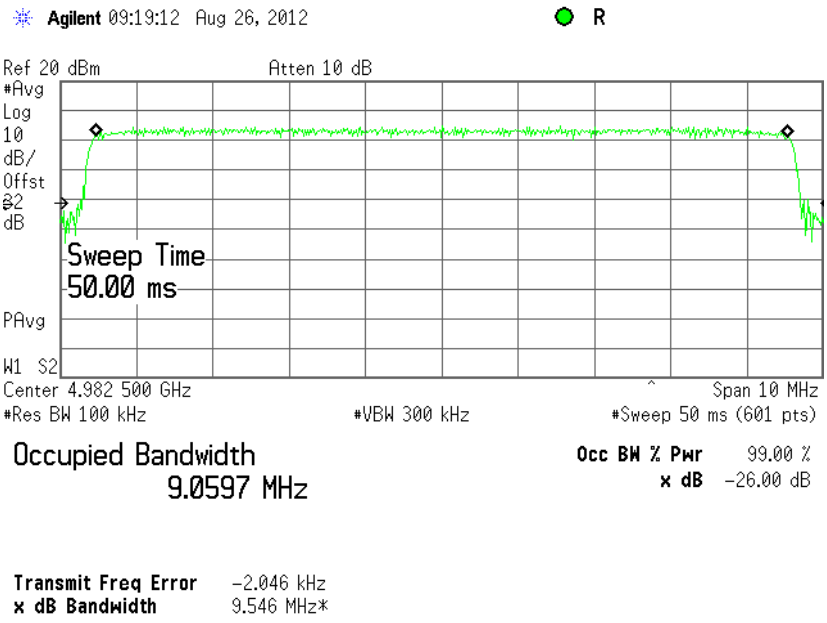



**Plot 7.3.8 Occupied bandwidth test result at mid frequency, 10MHz CBW, QPSK, Antenna 1**

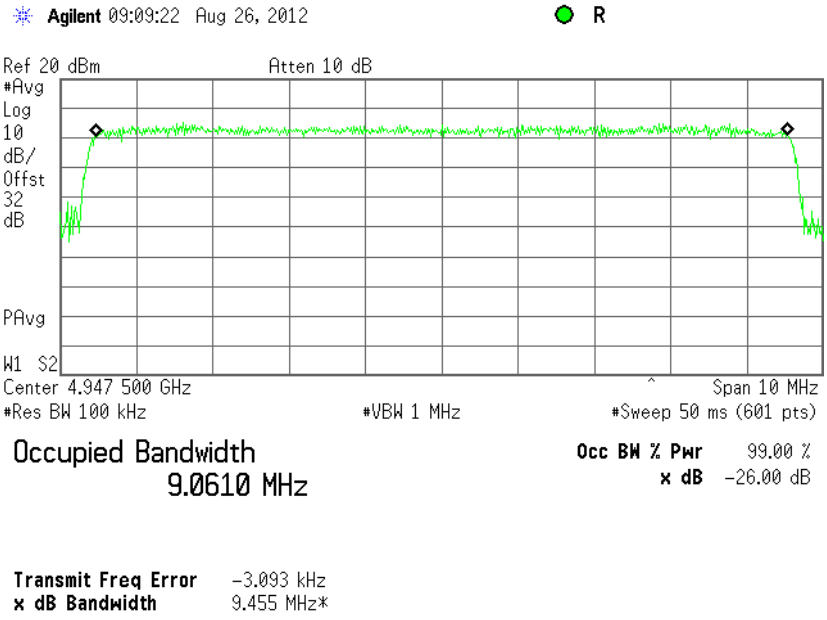


| Test specification: | Section 90.209, Section 5.3, Occupied bandwidth | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1049 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/26/2012 - 8/27/2012 | | |
| Temperature: 26 ºC | Air Pressure: hPa | Relative Humidity: 42 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.3.9 Occupied bandwidth test result at high frequency, 10 MHz CBW, QPSK, Antenna 1**

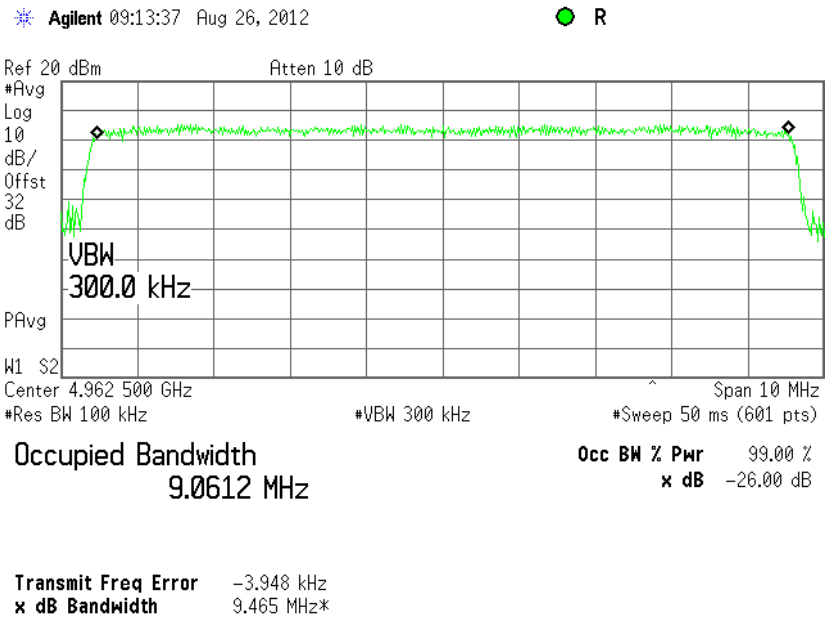



**Plot 7.3.10 Occupied bandwidth test result at low frequency, 10 MHz CBW, 64QAM, Antenna 1**

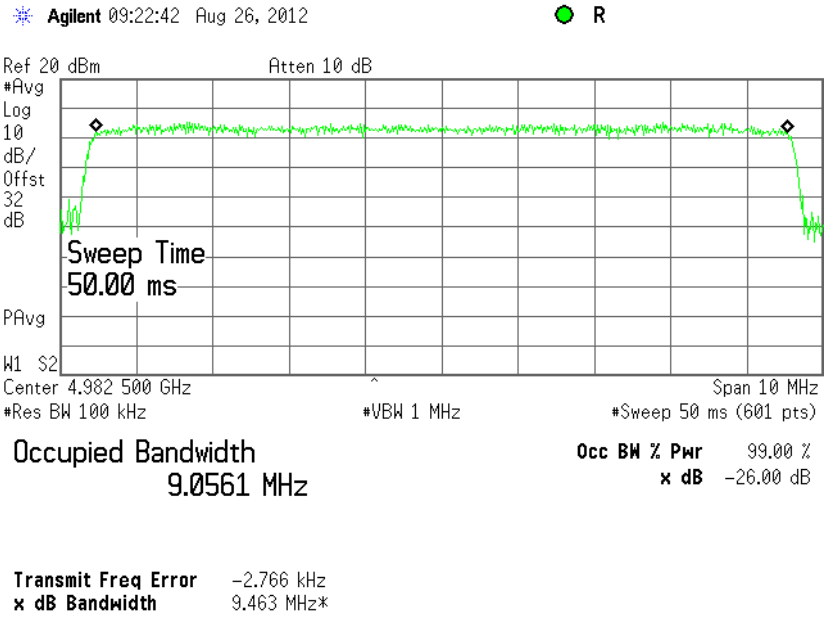


| Test specification: | Section 90.209, Section 5.3, Occupied bandwidth | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1049 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/26/2012 - 8/27/2012 | | |
| Temperature: 26 ºC | Air Pressure: hPa | Relative Humidity: 42 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.3.11 Occupied bandwidth test result at mid frequency, 10 MHz CBW, 64QAM, Antenna 1**

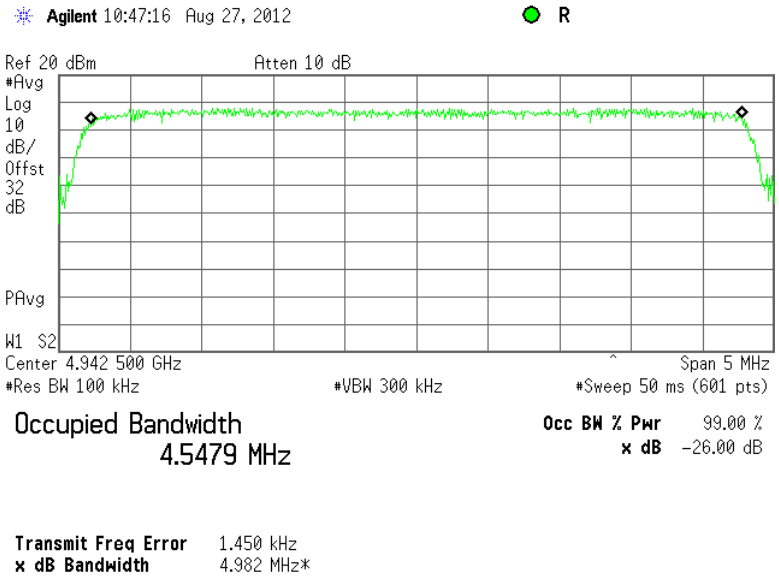



**Plot 7.3.12 Occupied bandwidth test result at high frequency, 10 MHz CBW, 64QAM, Antenna 1**

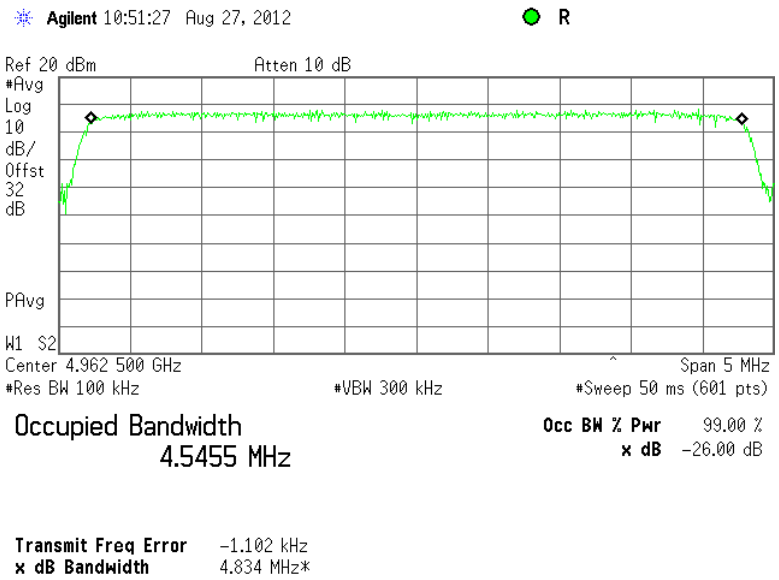


| Test specification: | Section 90.209, Section 5.3, Occupied bandwidth | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1049 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/26/2012 - 8/27/2012 | | |
| Temperature: 26 ºC | Air Pressure: hPa | Relative Humidity: 42 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.3.13 Occupied bandwidth test result at low frequency, 5 MHz CBW, QPSK, Antenna 2**

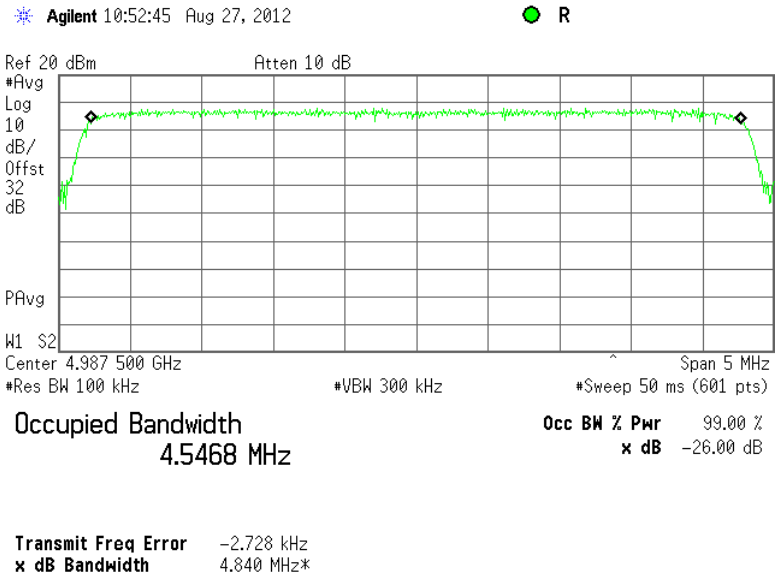



**Plot 7.3.14 Occupied bandwidth test result at mid frequency, 5 MHz CBW, QPSK, Antenna 2**

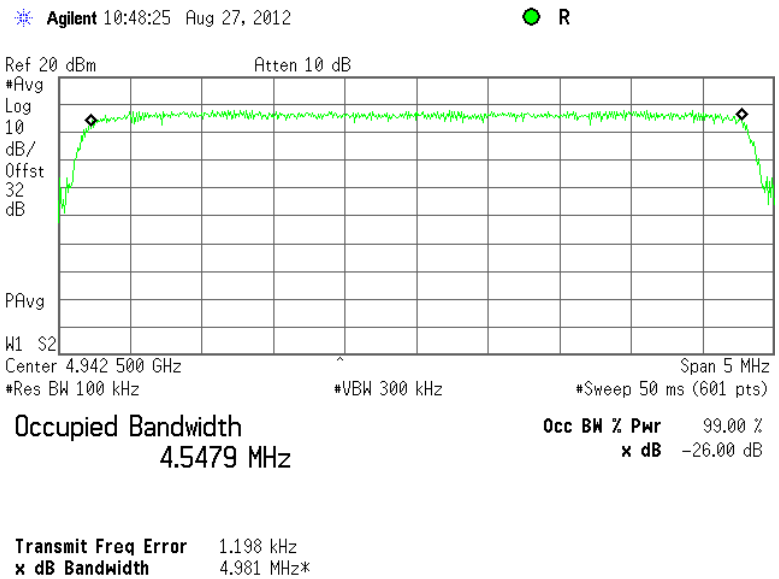


| Test specification: | Section 90.209, Section 5.3, Occupied bandwidth | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1049 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/26/2012 - 8/27/2012 | | |
| Temperature: 26 ºC | Air Pressure: hPa | Relative Humidity: 42 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.3.15 Occupied bandwidth test result at high frequency, 5 MHz CBW, QPSK, Antenna 2**

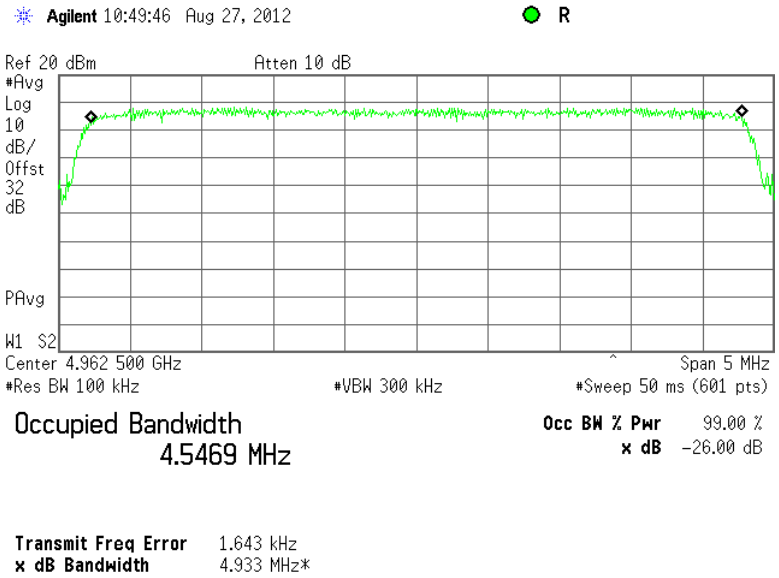



**Plot 7.3.16 Occupied bandwidth test result at low frequency, 5 MHz CBW, 64QAM, Antenna 2**

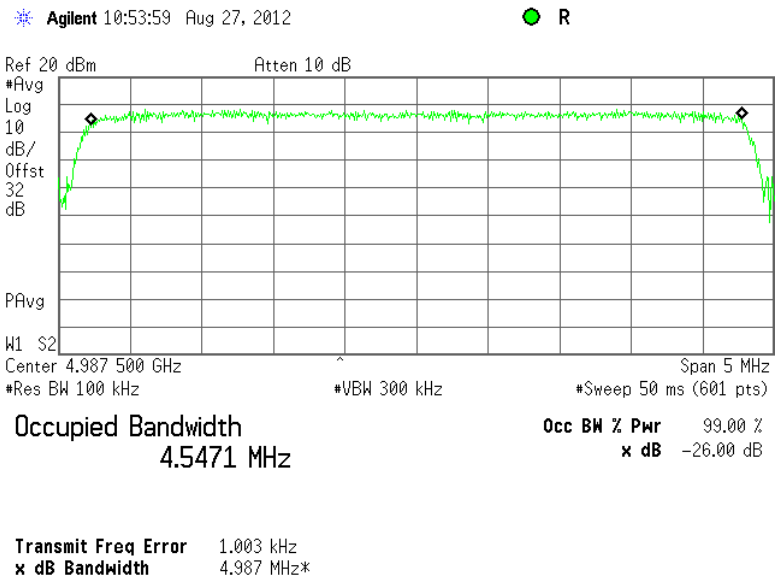


| Test specification: | Section 90.209, Section 5.3, Occupied bandwidth | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1049 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/26/2012 - 8/27/2012 | | |
| Temperature: 26 ºC | Air Pressure: hPa | Relative Humidity: 42 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.3.17 Occupied bandwidth test result at mid frequency, 5 MHz CBW, 64 QAM, Antenna 2**

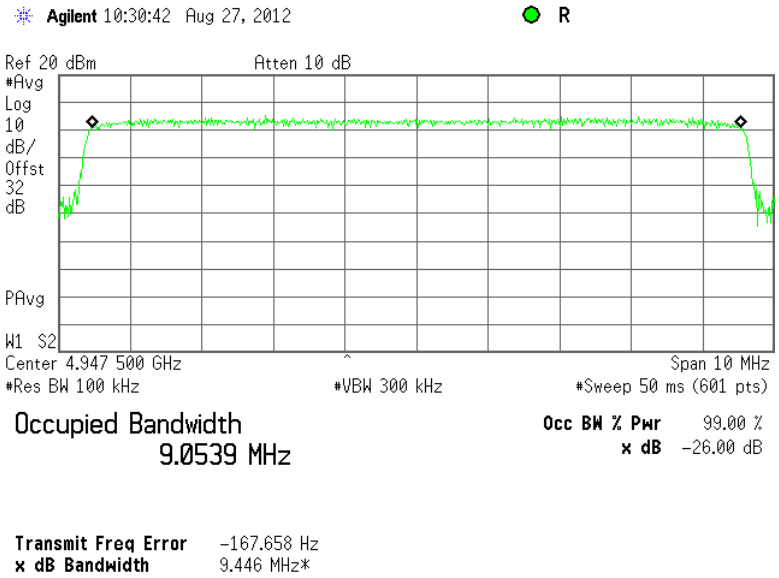



**Plot 7.3.18 Occupied bandwidth test result at high frequency, 5 MHz CBW, 64QAM, Antenna 2**

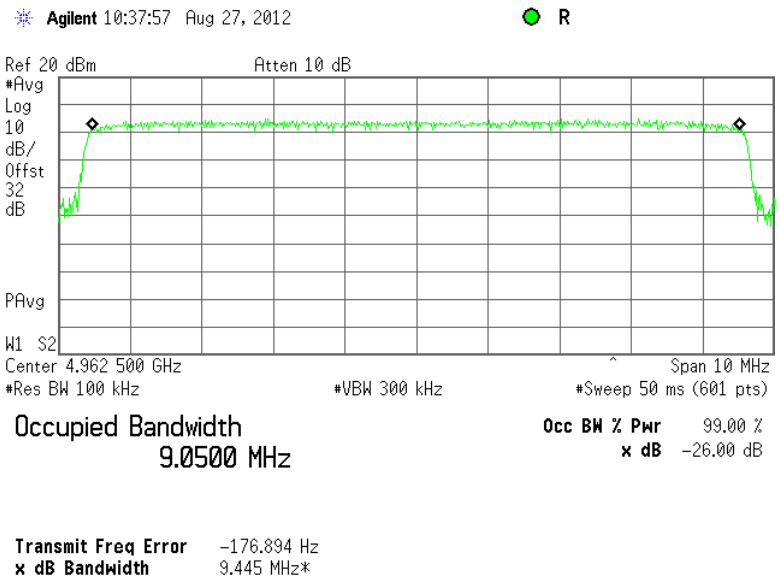


| Test specification: | Section 90.209, Section 5.3, Occupied bandwidth | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1049 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/26/2012 - 8/27/2012 | | |
| Temperature: 26 ºC | Air Pressure: hPa | Relative Humidity: 42 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.3.19 Occupied bandwidth test result at low frequency, 10 MHz CBW, QPSK, Antenna 2**

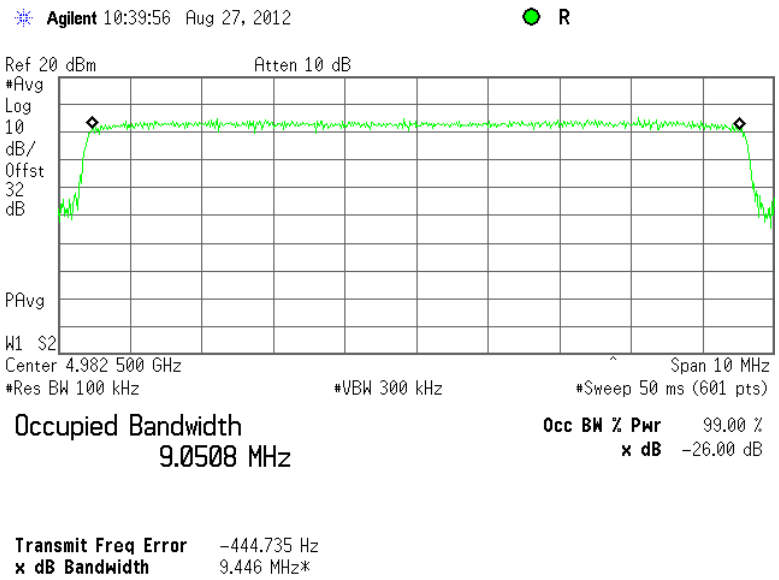



**Plot 7.3.20 Occupied bandwidth test result at mid frequency, 10MHz CBW, QPSK, Antenna 2**

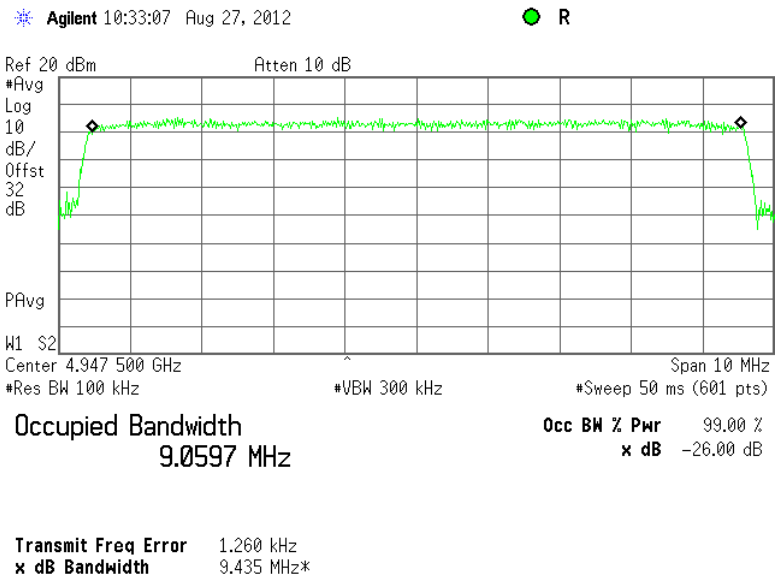


| Test specification: | Section 90.209, Section 5.3, Occupied bandwidth | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1049 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/26/2012 - 8/27/2012 | | |
| Temperature: 26 ºC | Air Pressure: hPa | Relative Humidity: 42 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.3.21 Occupied bandwidth test result at high frequency, 10 MHz CBW, QPSK, Antenna 2**

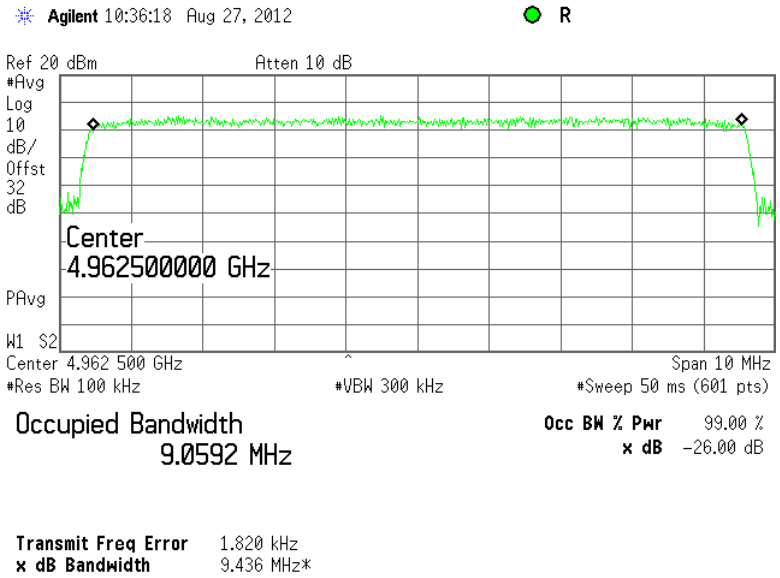



**Plot 7.3.22 Occupied bandwidth test result at low frequency, 10 MHz CBW, 64QAM, Antenna 2**

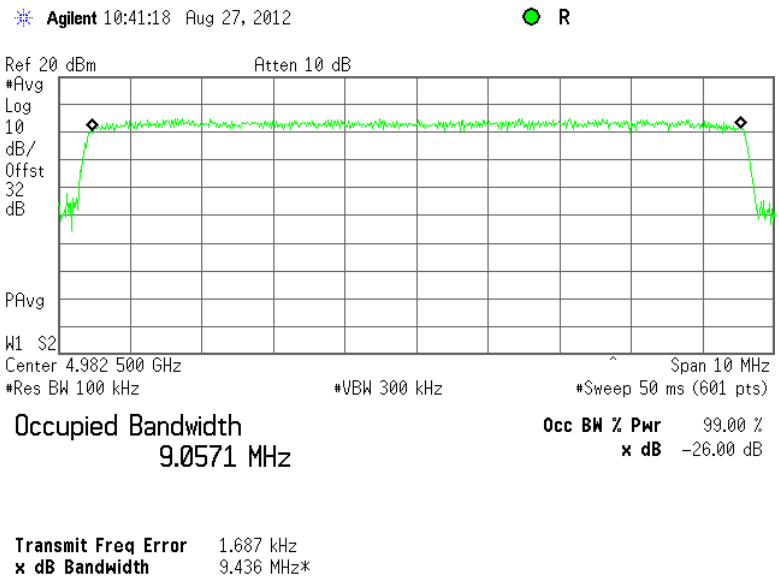


| Test specification: | Section 90.209, Section 5.3, Occupied bandwidth | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1049 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/26/2012 - 8/27/2012 | | |
| Temperature: 26 ºC | Air Pressure: hPa | Relative Humidity: 42 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.3.23 Occupied bandwidth test result at mid frequency, 10 MHz CBW, 64QAM, Antenna 2**




**Plot 7.3.24 Occupied bandwidth test result at high frequency, 10 MHz CBW, 64QAM, Antenna 2**



| Test specification: | Section 90.210, Emission mask | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1051, 2.1047 and 90.210(I); TIA/EIA-603-C, Section 2.2.13 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/26/2012 - 8/30/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1006 hPa | Relative Humidity: 48 % | Power Supply: 120 VAC |
| Remarks: | | | |

## 7.4 Emission mask test

### 7.4.1 General

This test was performed to measure emission mask at RF antenna connector. Specification test limits are given in Table 7.4.1.

**Table 7.4.1 Emission mask limits**

| Frequency displacement from carrier | Attenuation below carrier, dBc |
|---|---|
| Emission mask M (Channel bandwidth 5 MHz) | |
| 0 – 2.25 MHz | 0*** |
| 2.25 – 2.5 MHz | 568log(F*/2.25) |
| 2.5 – 2.75 MHz | 26+145log(F*/2.5) |
| 2.75 – 5.0 MHz | 32+31log(F*/2.75) |
| 5.0 – 7.5 MHz | 40+57log(F*/5.0) |
| More than** 7.5 MHz | 50 or 55+10logP(W) (whichever is the lesser attenuation) |
| Emission mask M (Channel bandwidth 10 MHz) | |
| 0 – 4.5 MHz | 0*** |
| 4.5 – 5 MHz | 568log(F*/4.5) |
| 5 – 5.5 MHz | 26+145log(F*/5.0) |
| 5.5 – 10.0 MHz | 32+31log(F*/5.5) |
| 10.0 – 15 MHz | 40+57log(F*/10.0) |
| More than** 15 MHz | 50 or 55+10logP(W) (whichever is the lesser attenuation) |

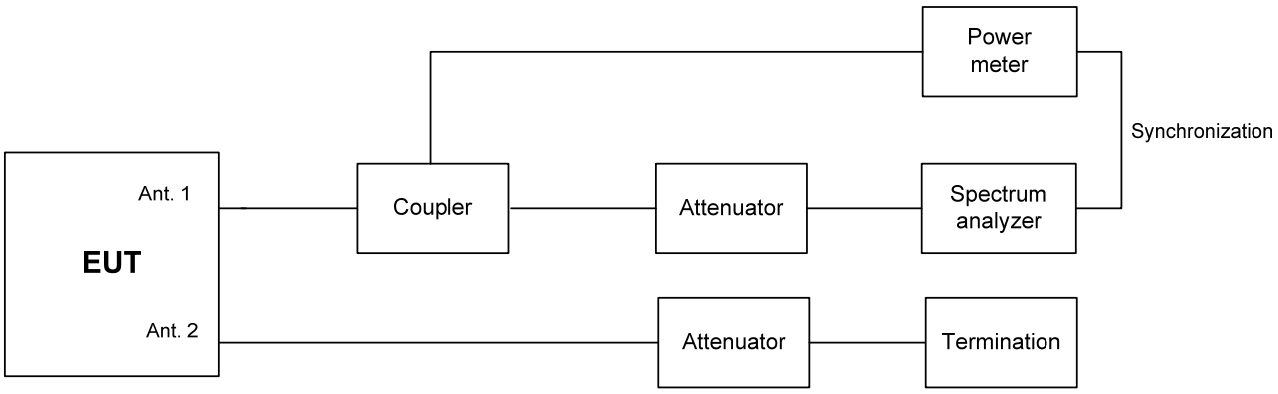
* - F – frequency in MHz removed from center
** - emission mask includes carrier modulation envelope within ± 150 % of the authorized bandwidth; the frequency range removed beyond ± 150 % of the authorized bandwidth from carrier was investigated as spurious emission
*** - Zero dB reference measured relative to the highest average power of the fundamental emission measured across designated channel bandwidth

### 7.4.2 Test procedure

**7.4.2.1** The EUT was set up as shown in Figure 7.4.1, energized and its proper operation was checked.

**7.4.2.2** The emission mask was measured with spectrum analyzer with RBW set to 100 kHz and VBW = 30 kHz as provided in the associated plots. The test results recorded in the associated tables.

**Figure 7.4.1 Emission mask test setup**



| Test specification: | Section 90.210, Emission mask | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1051, 2.1047 and 90.210(I); TIA/EIA-603-C, Section 2.2.13 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/26/2012 - 8/30/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1006 hPa | Relative Humidity: 48 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Table 7.4.2 Emission mask test results QPSK modulation at antenna 1**

| Carrier frequency, MHz | Limit | Reference to Plot | Verdict |
|---|---|---|---|
| **5 MHz** | | | |
| 4942.5 | Emission mask M | 7.4.7 | Pass |
| 4962.5 | | 7.4.9 | |
| 4987.5 | | 7.4.11 | |
| **10 MHz** | | | |
| 4947.5 | Emission mask M | 7.4.1 | Pass |
| 4962.5 | | 7.4.3 | |
| 4982.5 | | 7.4.5 | |

**Table 7.4.3 Emission mask test results 64QAM modulation at antenna 1**

| Carrier frequency, MHz | Limit | Reference to Plot | Verdict |
|---|---|---|---|
| **5 MHz** | | | |
| 4942.5 | Emission mask M | 7.4.8 | Pass |
| 4962.5 | | 7.4.10 | |
| 4987.5 | | 7.4.12 | |
| **10 MHz** | | | |
| 4947.5 | Emission mask M | 7.4.2 | Pass |
| 4962.5 | | 7.4.4 | |
| 4982.5 | | 7.4.6 | |

**Reference numbers of test equipment used**

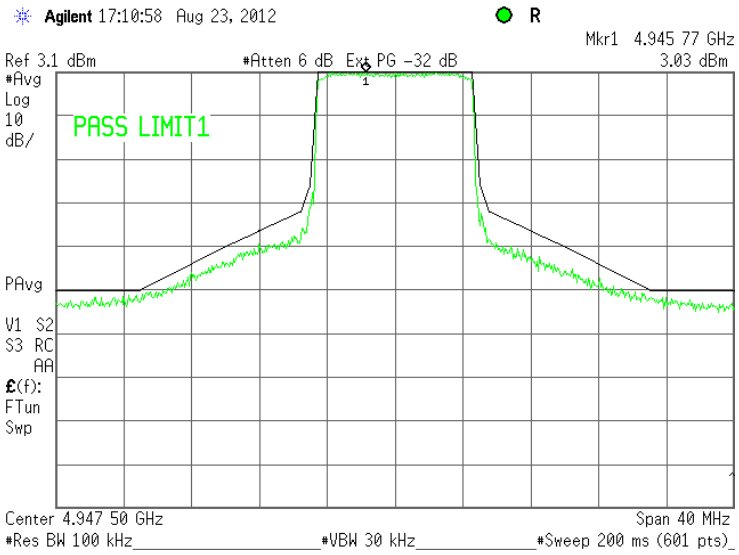
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| HL 3818 | HL 3901 | | | | | | |

Full description is given in Appendix A.

| Test specification: | Section 90.210, Emission mask | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1051, 2.1047 and 90.210(I); TIA/EIA-603-C, Section 2.2.13 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/26/2012 - 8/30/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1006 hPa | Relative Humidity: 48 % | Power Supply: 120 VAC |
| Remarks: | | | |

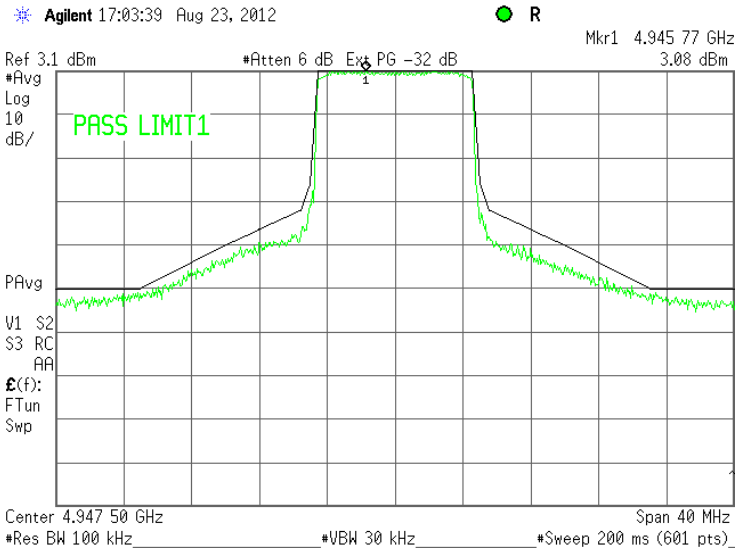
**Plot 7.4.1 Emission mask test results at low carrier frequency**

MODULATION: QPSK
CHANNEL BANDWIDTH: 10




**Plot 7.4.2 Emission mask test results at low carrier frequency**

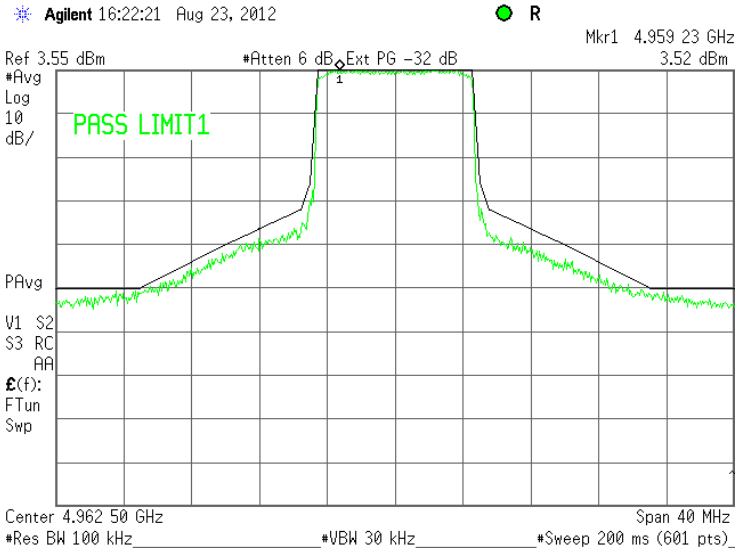
MODULATION: 64QAM
CHANNEL BANDWIDTH: 10



| Test specification: | Section 90.210, Emission mask | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1051, 2.1047 and 90.210(I); TIA/EIA-603-C, Section 2.2.13 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/26/2012 - 8/30/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1006 hPa | Relative Humidity: 48 % | Power Supply: 120 VAC |
| Remarks: | | | |

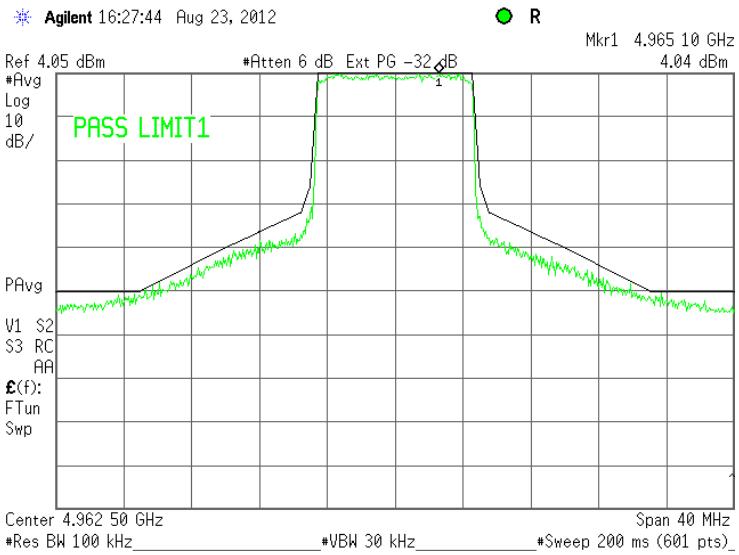
**Plot 7.4.3 Emission mask test results at mid carrier frequency**

MODULATION: QPSK
CHANNEL BANDWIDTH: 10




**Plot 7.4.4 Emission mask test results at mid carrier frequency**

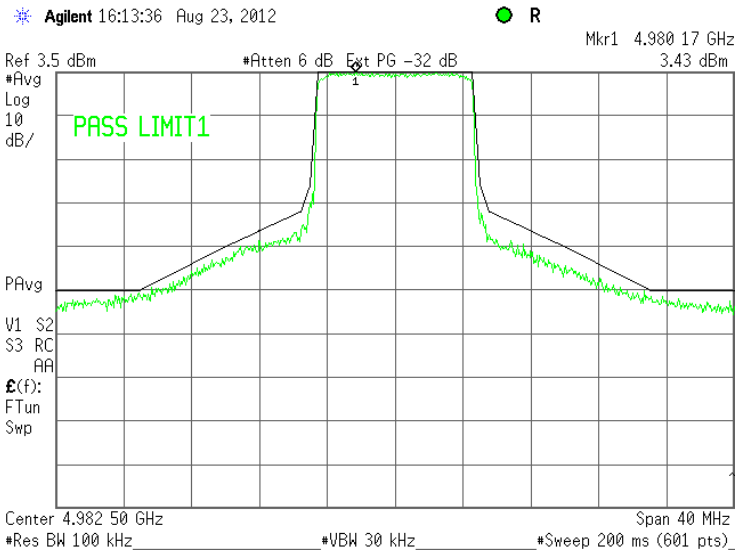
MODULATION: 64 QAM
CHANNEL BANDWIDTH: 10



| Test specification: | Section 90.210, Emission mask | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1051, 2.1047 and 90.210(I); TIA/EIA-603-C, Section 2.2.13 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/26/2012 - 8/30/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1006 hPa | Relative Humidity: 48 % | Power Supply: 120 VAC |
| Remarks: | | | |

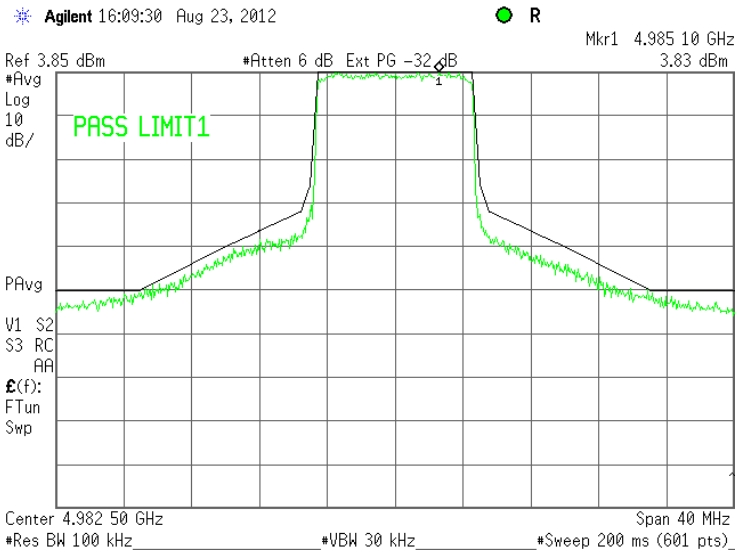
**Plot 7.4.5 Emission mask test results at high carrier frequency**

MODULATION: QPSK
CHANNEL BANDWIDTH: 10




**Plot 7.4.6 Emission mask test results at high carrier frequency**

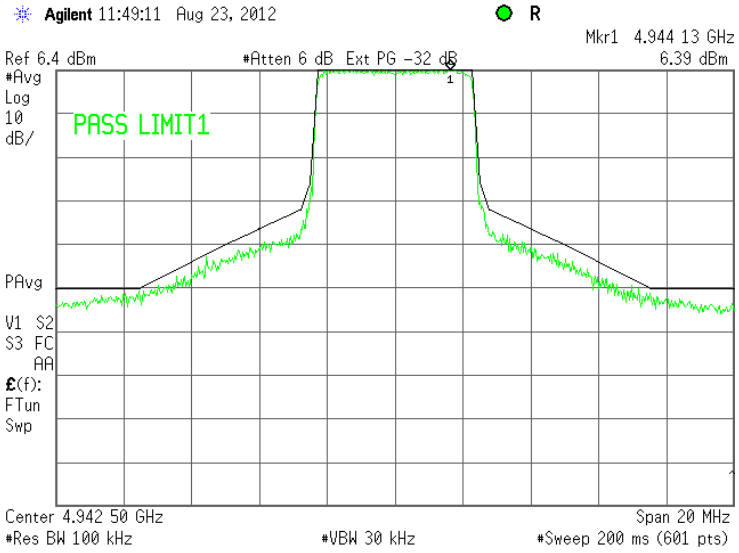
MODULATION: 64 QAM
CHANNEL BANDWIDTH: 10



| Test specification: | Section 90.210, Emission mask | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1051, 2.1047 and 90.210(I); TIA/EIA-603-C, Section 2.2.13 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/26/2012 - 8/30/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1006 hPa | Relative Humidity: 48 % | Power Supply: 120 VAC |
| Remarks: | | | |

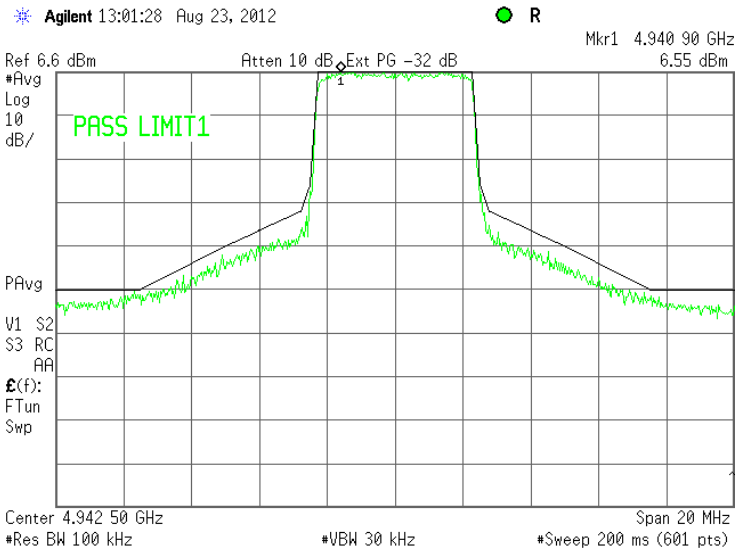
**Plot 7.4.7 Emission mask test results at low carrier frequency**

MODULATION: QPSK
CHANNEL BANDWIDTH: 5




**Plot 7.4.8 Emission mask test results at low carrier frequency**

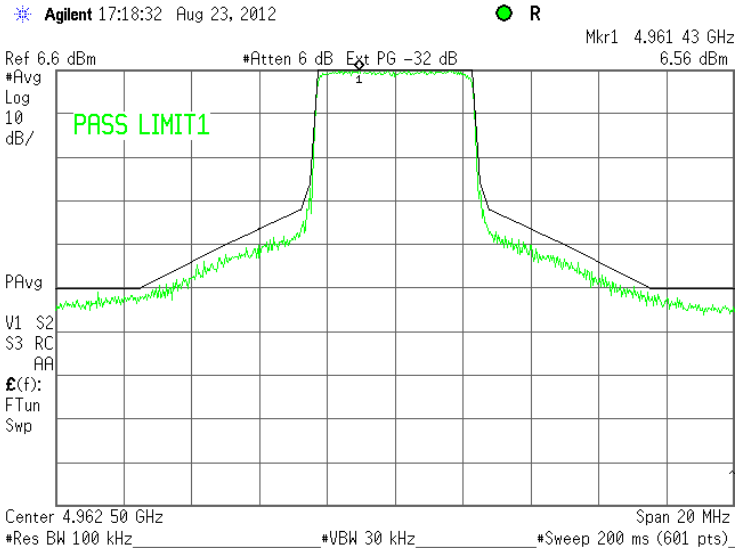
MODULATION: 64 QAM
CHANNEL BANDWIDTH: 5



| Test specification: | Section 90.210, Emission mask | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1051, 2.1047 and 90.210(I); TIA/EIA-603-C, Section 2.2.13 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/26/2012 - 8/30/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1006 hPa | Relative Humidity: 48 % | Power Supply: 120 VAC |
| Remarks: | | | |

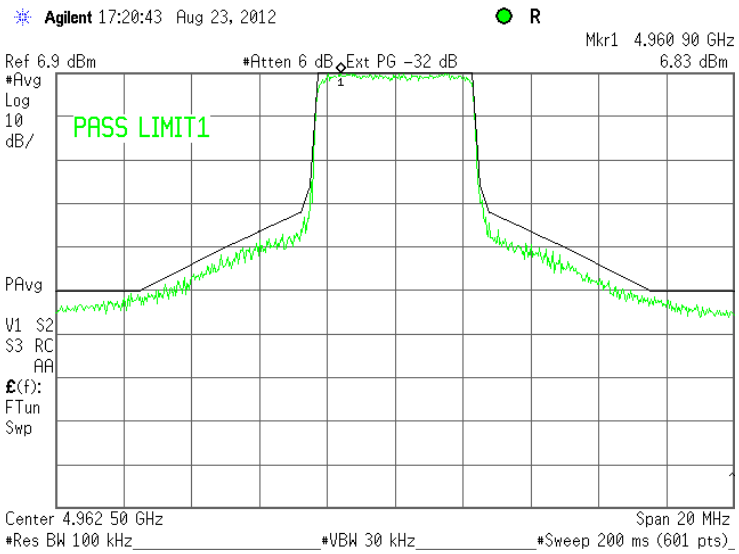
**Plot 7.4.9 Emission mask test results at mid carrier frequency**

MODULATION: QPSK
CHANNEL BANDWIDTH: 5




**Plot 7.4.10 Emission mask test results at mid carrier frequency**

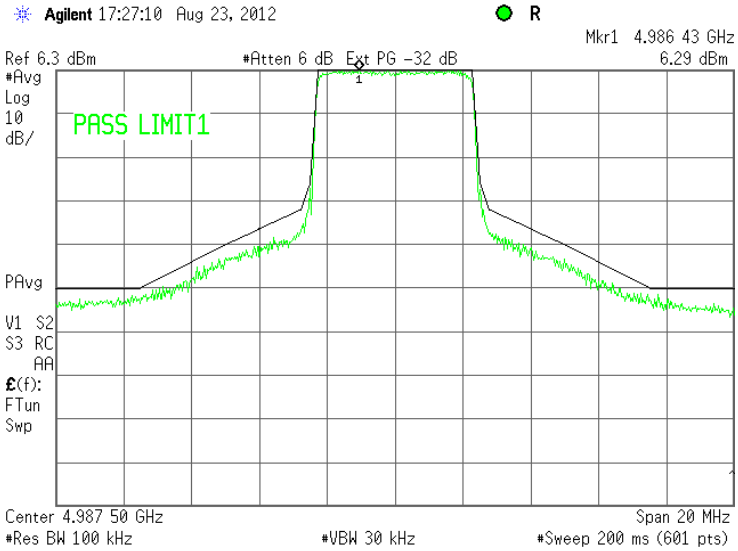
MODULATION: 64 QAM
CHANNEL BANDWIDTH: 5



| Test specification: | Section 90.210, Emission mask | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1051, 2.1047 and 90.210(I); TIA/EIA-603-C, Section 2.2.13 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/26/2012 - 8/30/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1006 hPa | Relative Humidity: 48 % | Power Supply: 120 VAC |
| Remarks: | | | |

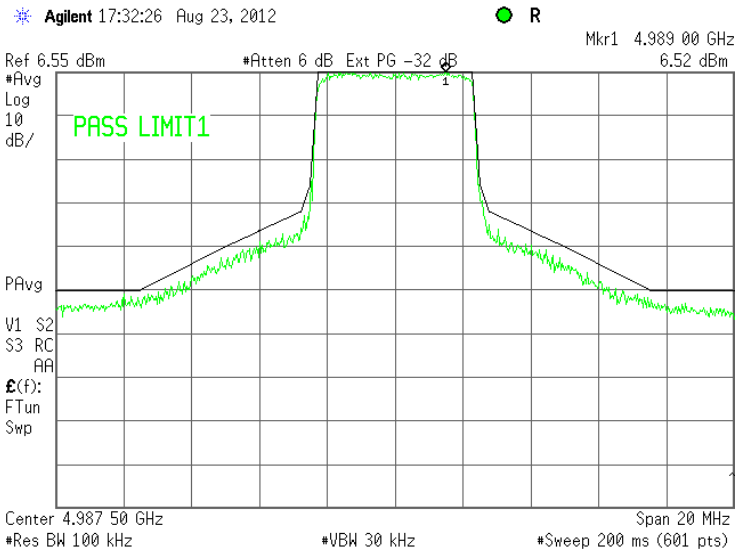
**Plot 7.4.11 Emission mask test results at high carrier frequency**

MODULATION: QPSK
CHANNEL BANDWIDTH: 5




**Plot 7.4.12 Emission mask test results at high carrier frequency**

MODULATION: 64 QAM
CHANNEL BANDWIDTH: 5



| Test specification: | Section 90.210(l), 90.210(m), Section 5.4, Spurious emissions at RF antenna connector | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1051, 90.210(m); TIA/EIA-603-C, Section 2.2.13 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/27/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1006 hPa | Relative Humidity: 37 % | Power Supply: 120 VAC |
| Remarks: | | | |

## 7.5 Spurious emissions at RF antenna connector test

### 7.5.1 General

This test was performed to measure spurious emissions at RF antenna connector. Specification test limits are given in Table 7.5.1.

**Table 7.5.1 Spurious emission limits**

| Frequency, MHz | Attenuation below carrier, dBc | ERP of spurious, dBm |
|---|---|---|
| High power device | | |
| 0.009 – 40000* | 50 or 55+10logP** (mask M, lesser attenuation) | -25.0 |

* - spurious emission limits do not apply to the in band emission within ± 150 % of the authorized bandwidth from the carrier; investigated in course of emission mask testing
** - P is transmitter output power in Watts

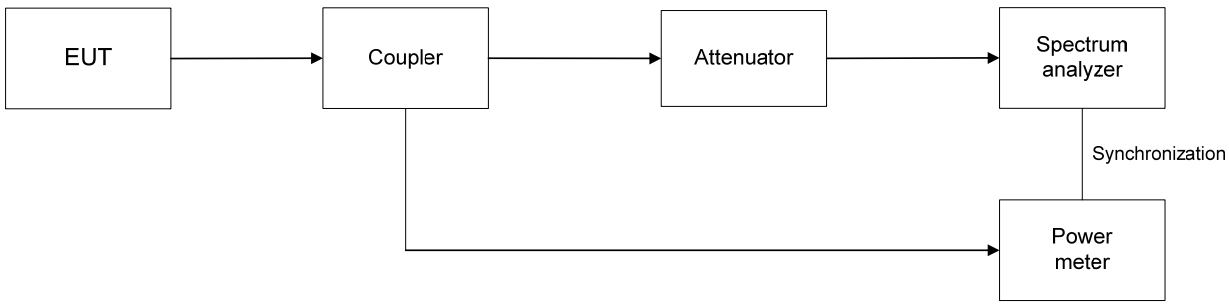
### 7.5.2 Test procedure

**7.5.2.1** The EUT was set up as shown in Figure 7.5.1, energized and its proper operation was checked.

**7.5.2.2** The EUT was adjusted to produce maximum available for end user RF output power.

**7.5.2.3** The spurious emission was measured with spectrum analyzer as provided in Table 7.5.2 and the associated plots.

**Figure 7.5.1 Spurious emission test setup for individual Tx chain**



| **Test specification:** | **Section 90.210(l), 90.210(m), Section 5.4, Spurious emissions at RF antenna connector** | | |
|---|---|---|---|
| **Test procedure:** | 47 CFR, Sections 2.1051, 90.210(m); TIA/EIA-603-C, Section 2.2.13 | | |
| **Test mode:** | Compliance | **Verdict:** | PASS |
| **Date(s):** | 8/27/2012 | | |
| **Temperature:** 24 ºC | **Air Pressure:** 1006 hPa | **Relative Humidity:** 37 % | **Power Supply:** 120 VAC |
| **Remarks:** | | | |

**Table 7.5.2 Spurious emission test results**

ASSIGNED FREQUENCY RANGE: 4940-4990 MHz
INVESTIGATED FREQUENCY RANGE: 0.009 – 40000 MHz
DETECTOR USED: Peak
VIDEO BANDWIDTH: ≥ Resolution bandwidth
MODULATION: 64 QAM
MODULATING SIGNAL: PRBS
CHANNEL BANDWIDTH: 5 MHz (Maximum output power spectral density)
TRANSMITTER OUTPUT POWER AT ANT.1 23.41 dBm at low frequency
23.83 dBm at mid frequency
23.57 dBm at high frequency

| Frequency, MHz | SA reading, dBm | Attenuator, dB | Cable loss, dB | RBW, kHz | Spurious emission, dBm | Limit, dBm | Margin, dB* | Verdict |
|---|---|---|---|---|---|---|---|---|
| **Low carrier frequency** | | | | | | | | |
| 4935.0 | -33.25 | included | included | 1000 | -33.25 | -25 | -8.25 | Pass |
| 4950.4 | -33.18 | included | included | 1000 | -33.18 | -25 | -8.18 | Pass |
| 5033.0 | -42.62 | included | included | 1000 | -42.62 | -25 | -17.62 | Pass |
| **Mid carrier frequency** | | | | | | | | |
| 4955.0 | -34.16 | included | included | 1000 | -34.16 | -25 | -9.16 | Pass |
| 4970.1 | -35.13 | included | included | 1000 | -35.13 | -25 | -10.13 | Pass |
| 5017.0 | -41.84 | included | included | 1000 | -41.84 | -25 | -16.84 | Pass |
| **High carrier frequency** | | | | | | | | |
| 4980.0 | -36.19 | included | included | 1000 | -36.19 | -25 | -11.19 | Pass |
| 5000.0 | -40.08 | included | included | 1000 | -40.08 | -25 | -15.08 | Pass |

*- Margin = Spurious emission – specification limit.

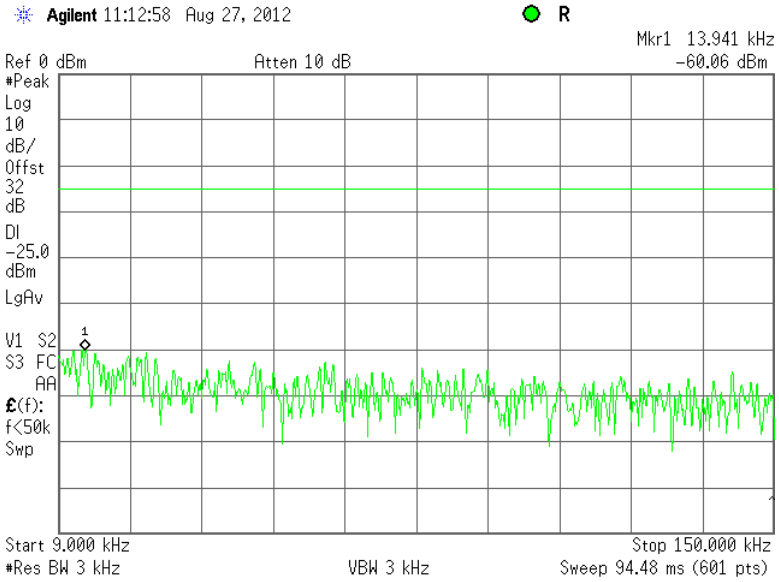
**Reference numbers of test equipment used**

| HL 3301 | HL 3302 | HL 3442 | HL 3455 | HL 3786 | HL 3818 | HL 3903 | HL 4366 |
|---|---|---|---|---|---|---|---|

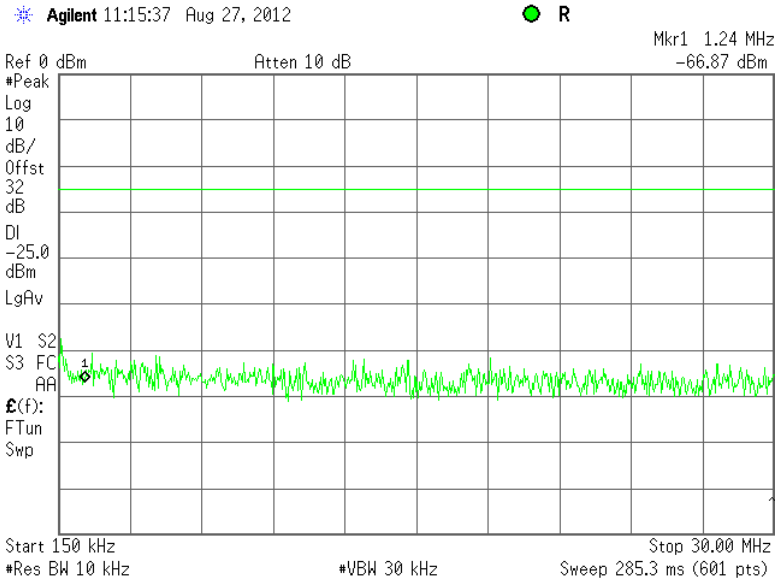
Full description is given in Appendix A.

| Test specification: | Section 90.210(l), 90.210(m), Section 5.4, Spurious emissions at RF antenna connector | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1051, 90.210(m); TIA/EIA-603-C, Section 2.2.13 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/27/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1006 hPa | Relative Humidity: 37 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.5.1 Spurious emission measurements in 9 - 150 kHz range at low, mid and high carrier frequency**

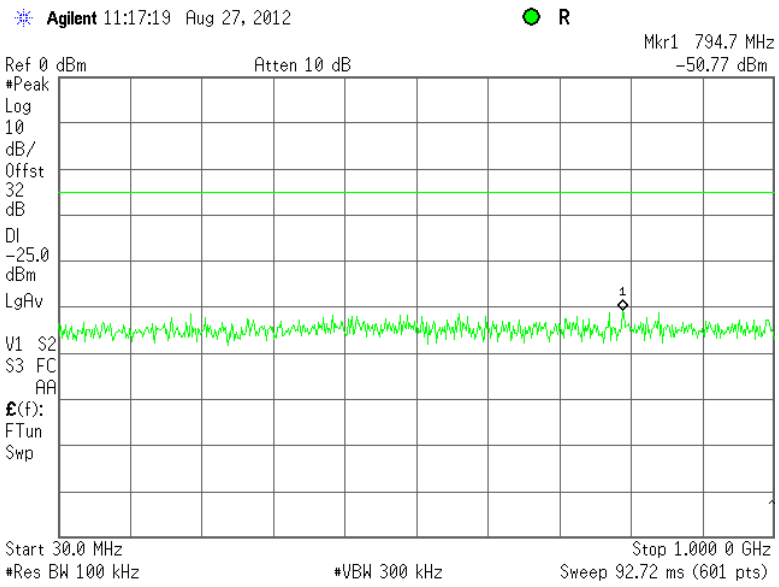



**Plot 7.5.2 Spurious emission measurements in 0.150 - 30.0 MHz range at low, mid and high carrier frequency**

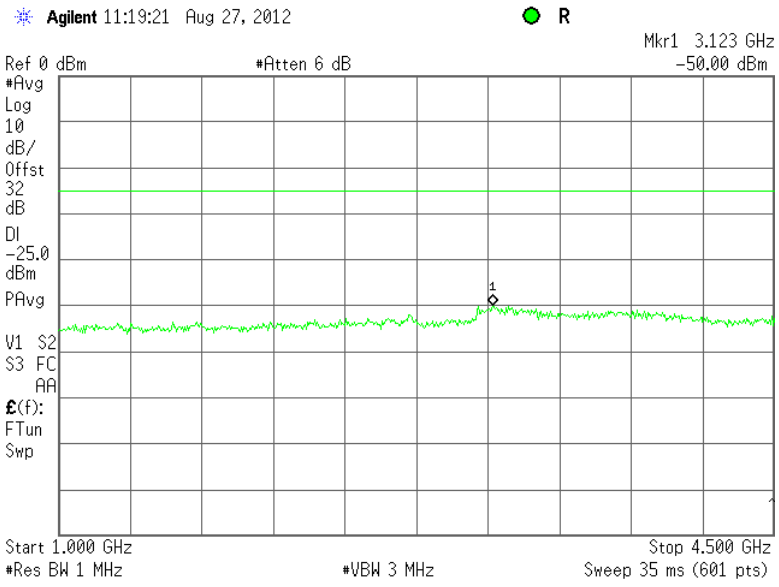


| Test specification: | Section 90.210(l), 90.210(m), Section 5.4, Spurious emissions at RF antenna connector | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1051, 90.210(m); TIA/EIA-603-C, Section 2.2.13 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/27/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1006 hPa | Relative Humidity: 37 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.5.3 Spurious emission measurements in 30.0 - 1000 MHz range at low, mid and high carrier frequency**

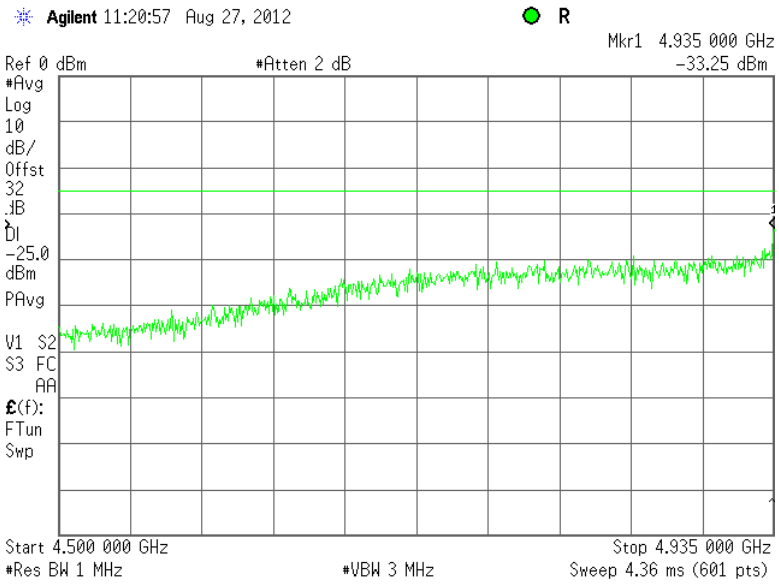



**Plot 7.5.4 Spurious emission measurements in 1000 - 4500 MHz at low, mid and high carrier frequency**

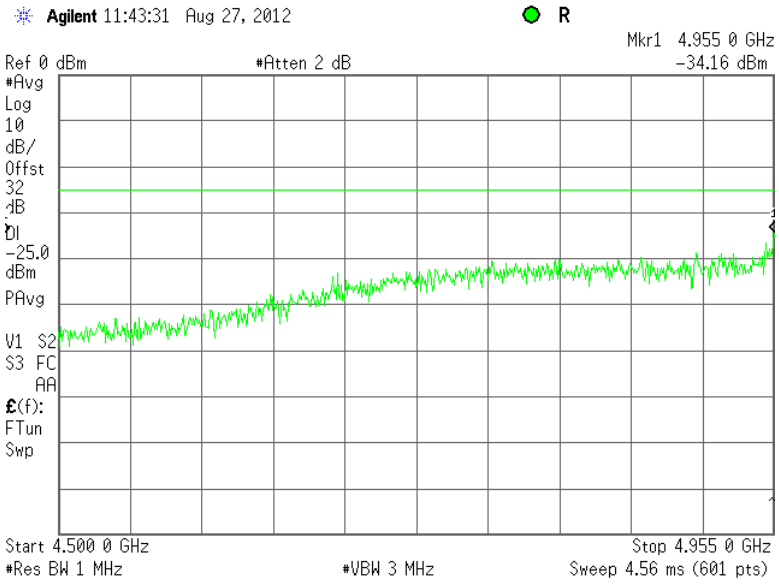


| Test specification: | Section 90.210(l), 90.210(m), Section 5.4, Spurious emissions at RF antenna connector | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1051, 90.210(m); TIA/EIA-603-C, Section 2.2.13 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/27/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1006 hPa | Relative Humidity: 37 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.5.5 Spurious emission measurements in 4500-4935 MHz range at low carrier frequency**

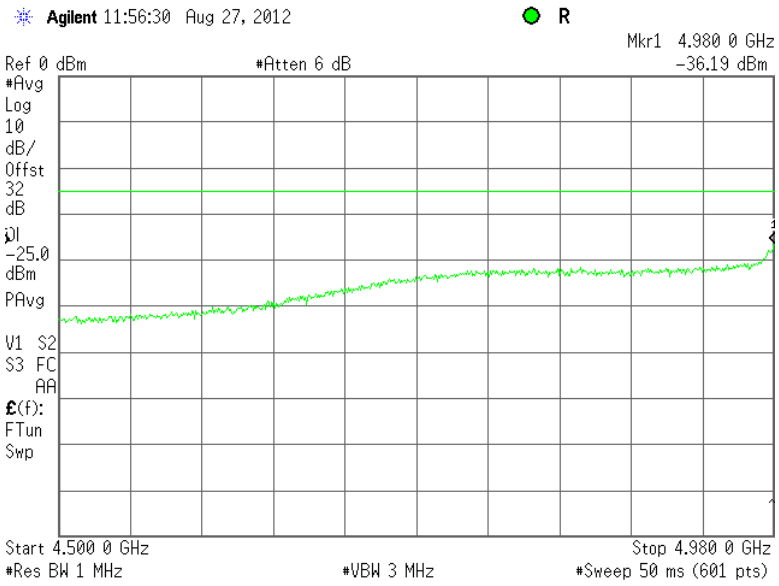



**Plot 7.5.6 Spurious emission measurements in 4500-4955 MHz at mid carrier frequency**

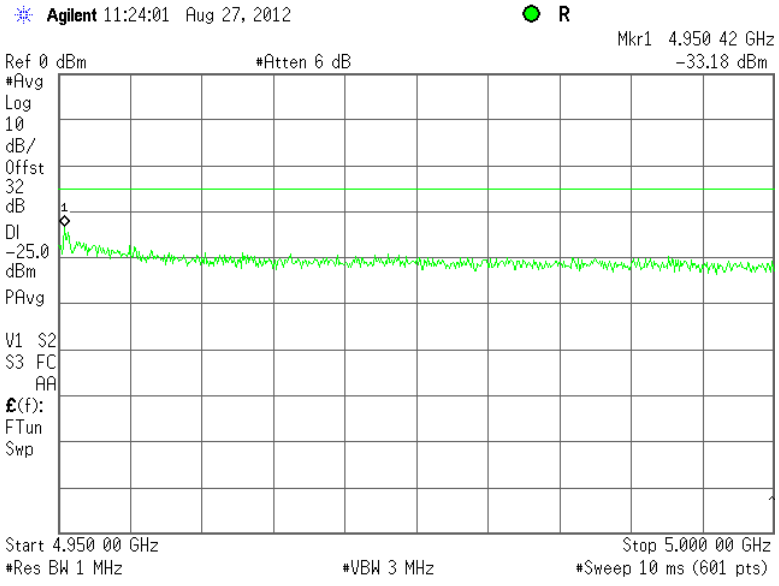


| Test specification: | Section 90.210(l), 90.210(m), Section 5.4, Spurious emissions at RF antenna connector | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1051, 90.210(m); TIA/EIA-603-C, Section 2.2.13 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/27/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1006 hPa | Relative Humidity: 37 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.5.7 Spurious emission measurements in 4500-4980 MHz at high carrier frequency**

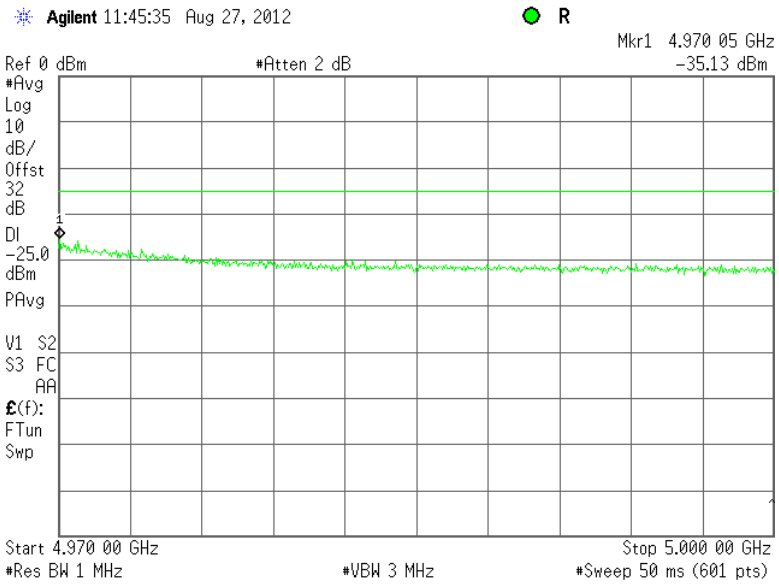



**Plot 7.5.8 Spurious emission measurements in 4950-5000 MHz range at low carrier frequency**

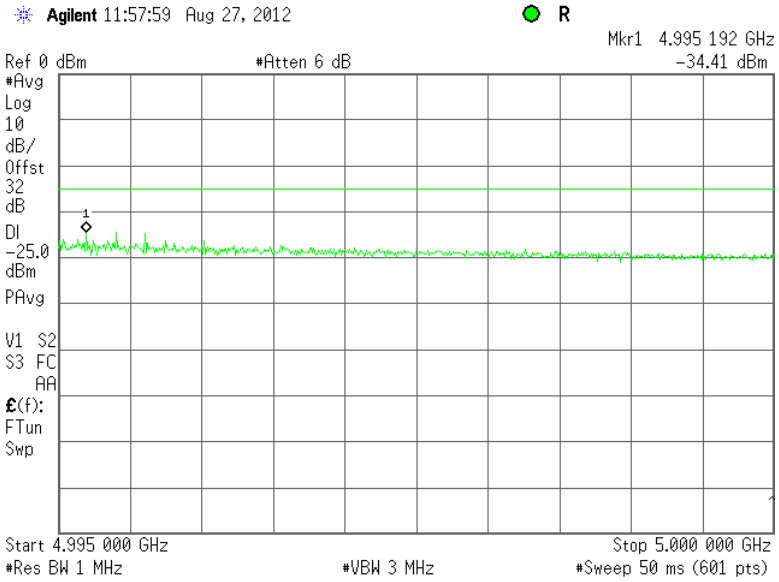


| Test specification: | Section 90.210(l), 90.210(m), Section 5.4, Spurious emissions at RF antenna connector | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1051, 90.210(m); TIA/EIA-603-C, Section 2.2.13 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/27/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1006 hPa | Relative Humidity: 37 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.5.9 Spurious emission measurements in 4970-5000 MHz at mid carrier frequency**

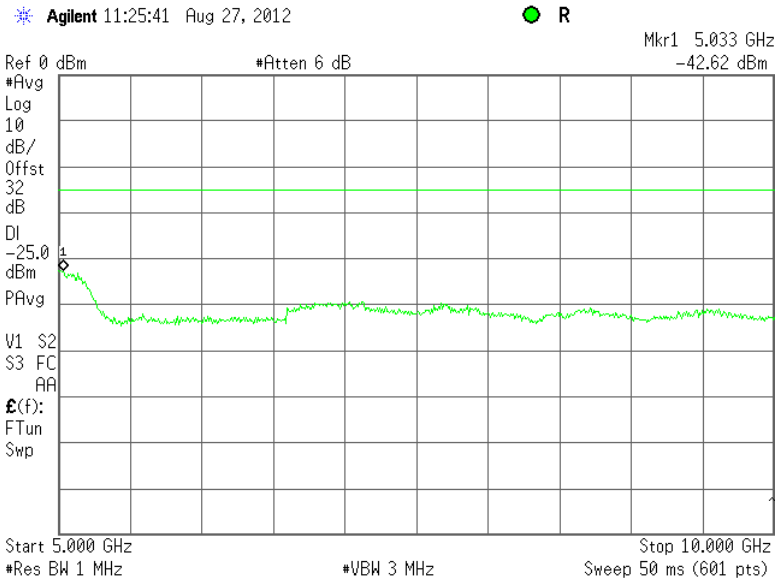



**Plot 7.5.10 Spurious emission measurements in 4995 –5000 MHz at high carrier frequency**

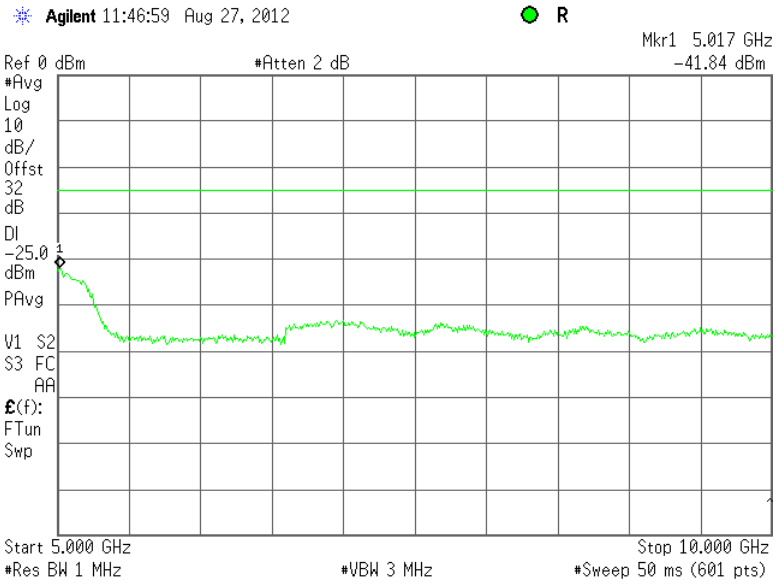


| Test specification: | Section 90.210(l), 90.210(m), Section 5.4, Spurious emissions at RF antenna connector | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1051, 90.210(m); TIA/EIA-603-C, Section 2.2.13 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/27/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1006 hPa | Relative Humidity: 37 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.5.11 Spurious emission measurements in 5000-10000 MHz range at low carrier frequency**

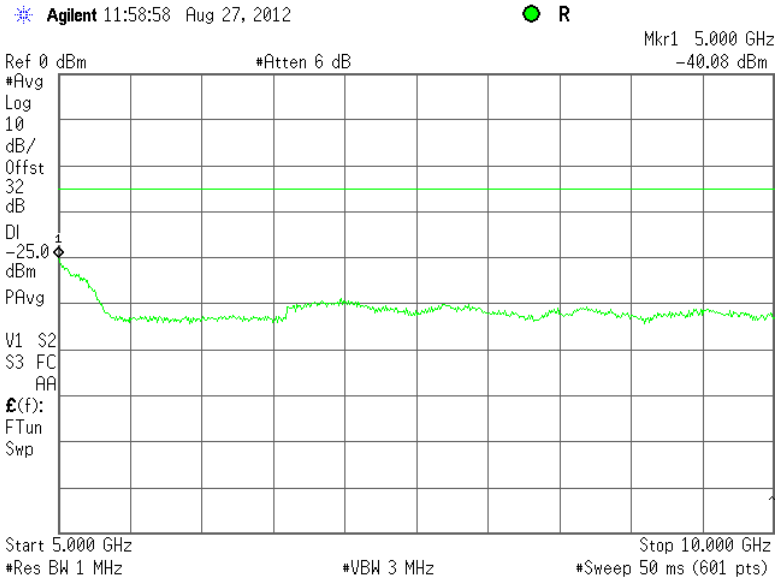



**Plot 7.5.12 Spurious emission measurements in 5000-10000 MHz range at mid carrier frequency**

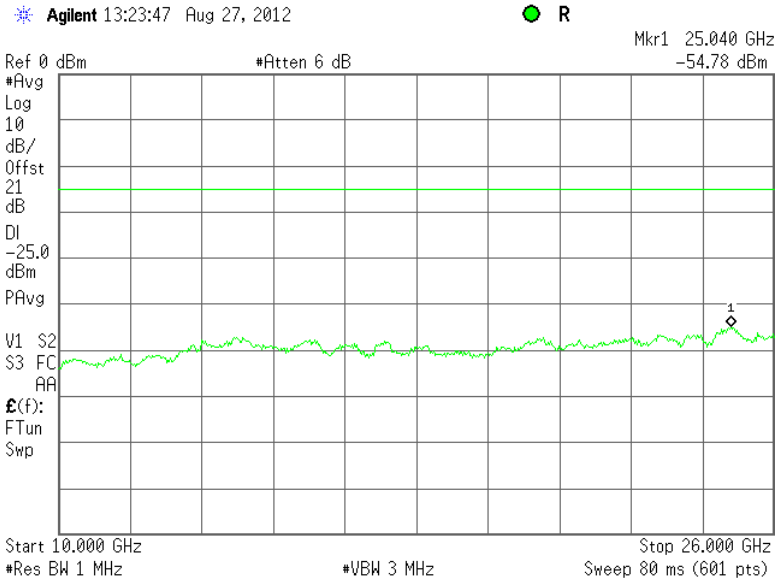


| Test specification: | Section 90.210(l), 90.210(m), Section 5.4, Spurious emissions at RF antenna connector | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1051, 90.210(m); TIA/EIA-603-C, Section 2.2.13 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/27/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1006 hPa | Relative Humidity: 37 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.5.13 Spurious emission measurements in 5000-10000 MHz range at high carrier frequency**

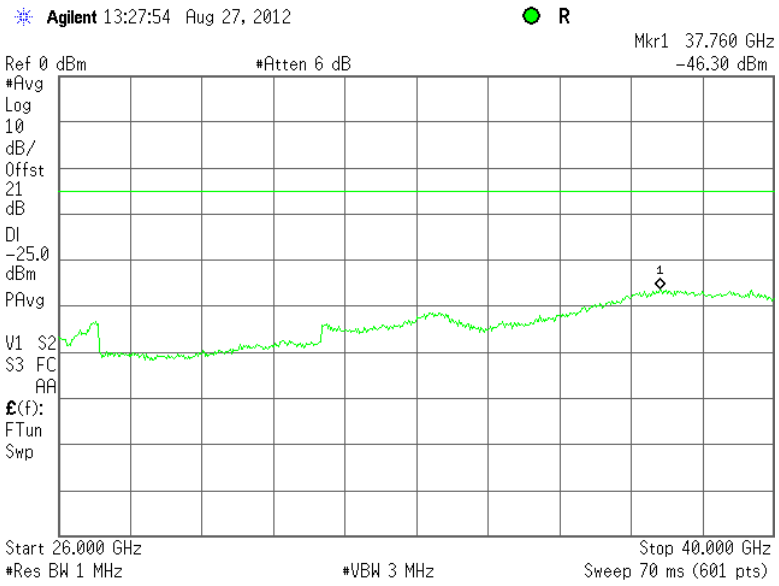



**Plot 7.5.14 Spurious emission measurements in 10000-26000 MHz range at low; mid; high carrier frequency**



| Test specification: | Section 90.210(l), 90.210(m), Section 5.4, Spurious emissions at RF antenna connector | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1051, 90.210(m); TIA/EIA-603-C, Section 2.2.13 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/27/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1006 hPa | Relative Humidity: 37 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.5.15 Spurious emission measurements in 26000 –40000 MHz range at low; mid; high carrier frequency**



| Test specification: | Section 90.210(l), 90.210(m), Section 5.4, Radiated spurious emissions | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1053, 90.210(m); TIA/EIA-603-C, Section 2.2.12 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/28/2012 - 8/30/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1008 hPa | Relative Humidity: 45 % | Power Supply: 120 VAC |
| Remarks: | | | |

## 7.6 Radiated spurious emission measurements

### 7.6.1 General

This test was performed to measure radiated spurious emissions from the EUT. Specification test limits are given in Table 7.6.1.

**Table 7.6.1 Radiated spurious emission test limits**

| Frequency, MHz | Attenuation below carrier, dBc | ERP of spurious, dBm | Equivalent field strength limit @ 3m, dB(μV/m)** |
|---|---|---|---|
| High power device | | | |
| 0.009 – 40000* | 55+10logP | -25 | 72.40 |

ERP of spurious = P (dBm) - {55 + 10 log P (W)} = -25 dBm

* - Excluding the in band emission within ± 150 % of the authorized bandwidth from the carrier

** - Equivalent field strength limit was calculated from maximum allowed ERP of spurious as follows: E=sqrt(30×P×1.64)/r, where P is ERP in Watts, 1.64 is numeric gain of ideal dipole and r is antenna to EUT distance in meters.

### 7.6.2 Test procedure for spurious emission field strength measurements in 9 kHz to 30 MHz band

**7.6.2.1** The EUT was set up as shown in Figure 7.6.1, energized and the performance check was conducted.

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

**7.6.2.3** The worst test results (the lowest margins) were recorded in Table 7.6.2 and shown in the associated plots.

### 7.6.3 Test procedure for spurious emission field strength measurements above 30 MHz

**7.6.3.1** The EUT was set up as shown in Figure 7.6.2, energized and the performance check was conducted.

**7.6.3.2** The specified frequency range was investigated with antenna connected to spectrum analyzer. To find maximum radiation the turntable was rotated $360^0$ and the measuring antenna height was swept from 1 to 4 m in both, vertical and horizontal, polarizations.

**7.6.3.3** The worst test results (the lowest margins) were recorded in Table 7.6.2 and shown in the associated plots.

| Test specification: | Section 90.210(l), 90.210(m), Section 5.4, Radiated spurious emissions | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1053, 90.210(m); TIA/EIA-603-C, Section 2.2.12 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/28/2012 - 8/30/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1008 hPa | Relative Humidity: 45 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Figure 7.6.1 Setup for spurious emission field strength measurements in 9 kHz to 30 MHz band**

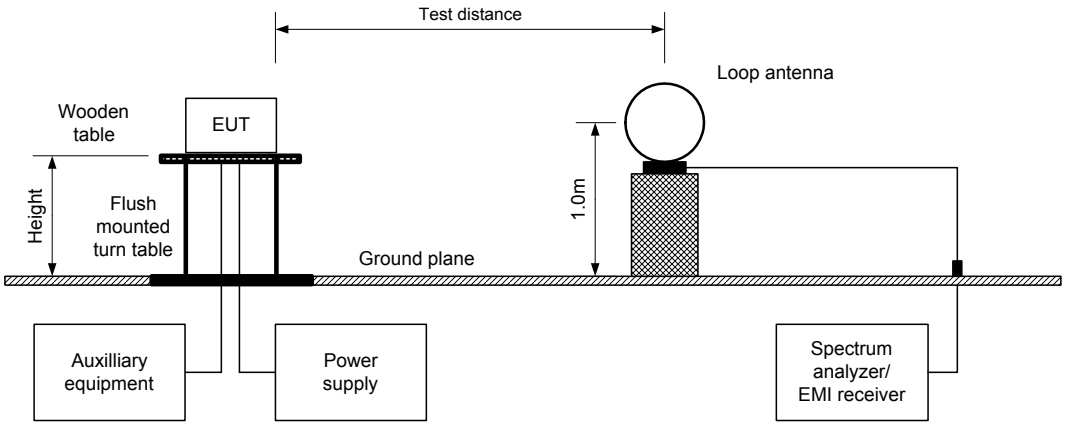
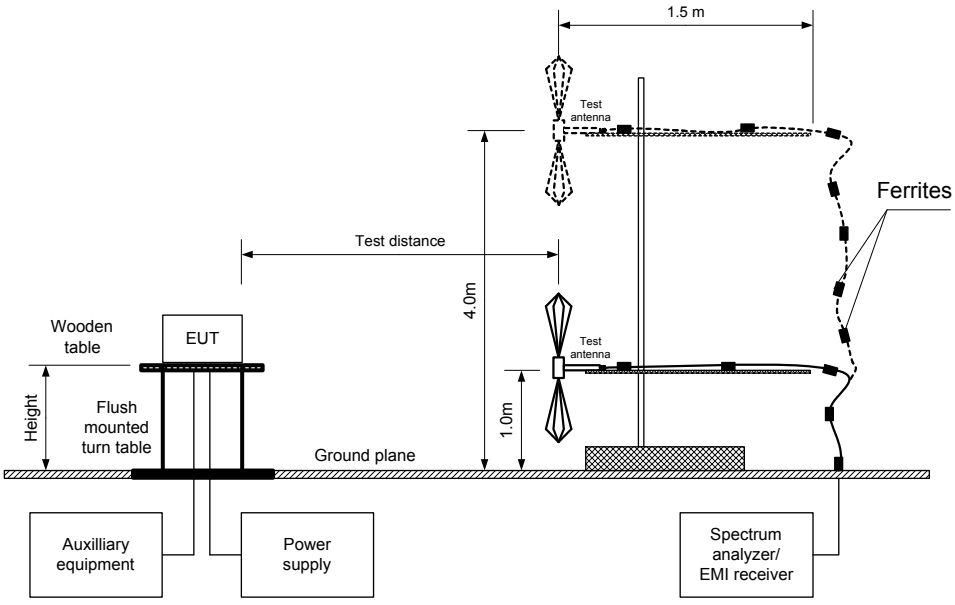



**Figure 7.6.2 Setup for spurious emission field strength measurements above 30 MHz**



| Test specification: | Section 90.210(l), 90.210(m), Section 5.4, Radiated spurious emissions | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1053, 90.210(m); TIA/EIA-603-C, Section 2.2.12 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/28/2012 - 8/30/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1008 hPa | Relative Humidity: 45 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Table 7.6.2 Spurious emission field strength test results**

| | |
|---|---|
| ASSIGNED FREQUENCY RANGE: | 49400 - 4990 MHz |
| TEST DISTANCE: | 3 m |
| TEST SITE: | Semi anechoic chamber |
| EUT HEIGHT: | 0.8 m |
| INVESTIGATED FREQUENCY RANGE: | 0.009 – 40000 MHz |
| DETECTOR USED: | Peak |
| VIDEO BANDWIDTH: | > Resolution bandwidth |
| TEST ANTENNA TYPE: | Active loop (9 kHz – 30 MHz)<br>Biconilog (30 MHz – 1000 MHz)<br>Double ridged guide (above 1000 MHz) |
| MODULATION: | 64QAM |
| MODULATING SIGNAL: | PRBS |
| CHANNEL BANDWIDTH: | 5 MHz |
| TRANSMITTER OUTPUT POWER SETTINGS: | Maximum |

| Frequency, MHz | Field strength, dB(μV/m) | Limit, dB(μV/m) | Margin, dB* | RBW, kHz | Antenna polarization | Antenna height, m | Turn-table position**, degrees |
|---|---|---|---|---|---|---|---|
| No spurious were found | | | | | | | |

**Verdict:Pass**

*- Margin = Field strength of spurious – calculated field strength limit.
**- EUT front panel refers to 0 degrees position of turntable.

**Reference numbers of test equipment used**

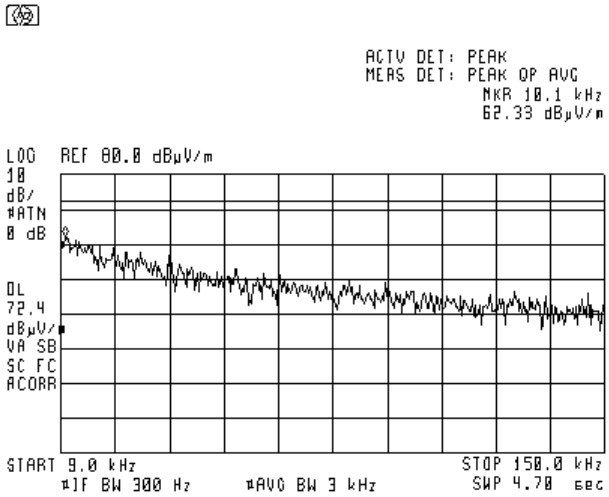
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| HL 0446 | HL 0521 | HL 0604 | HL 0768 | HL 0769 | HL 1424 | HL 3533 | HL 3535 |
| HL 3901 | HL 4114 | HL 4150 | HL 4280 | HL 4352 | HL 4353 | | |

Full description is given in Appendix A.

| **Test specification:** | **Section 90.210(l), 90.210(m), Section 5.4, Radiated spurious emissions** | | |
|---|---|---|---|
| **Test procedure:** | 47 CFR, Sections 2.1053, 90.210(m); TIA/EIA-603-C, Section 2.2.12 | | |
| **Test mode:** | Compliance | **Verdict:** | PASS |
| **Date(s):** | 8/28/2012 - 8/30/2012 | | |
| **Temperature:** 24 ºC | **Air Pressure:** 1008 hPa | **Relative Humidity:** 45 % | **Power Supply:** 120 VAC |
| **Remarks:** | | | |

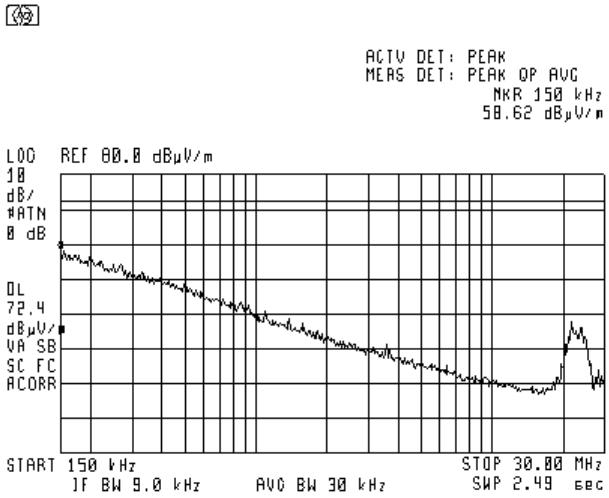
**Plot 7.6.1 Radiated emission measurements in 9 - 150 kHz range**

TEST SITE: Semi anechoic chamber
CARRIER FREQUENCY: Low; mid; high
ANTENNA POLARIZATION: Vertical
TEST DISTANCE: 3 m




**Plot 7.6.2 Radiated emission measurements in 0.15 - 30 MHz range**

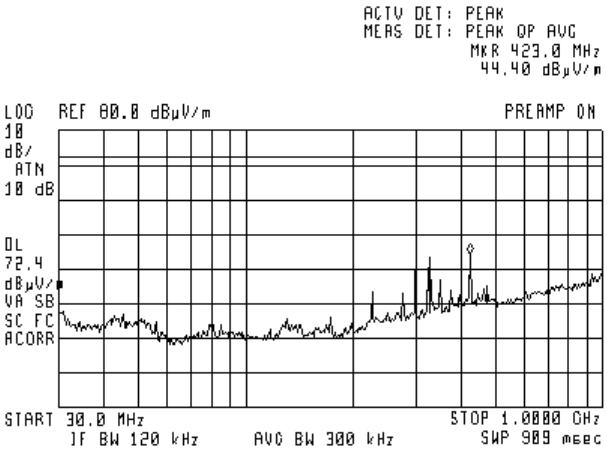
TEST SITE: Semi anechoic chamber
CARRIER FREQUENCY: Low; mid; high
ANTENNA POLARIZATION: Vertical
TEST DISTANCE: 3 m



| **Test specification:** | **Section 90.210(l), 90.210(m), Section 5.4, Radiated spurious emissions** | | |
|---|---|---|---|
| **Test procedure:** | 47 CFR, Sections 2.1053, 90.210(m); TIA/EIA-603-C, Section 2.2.12 | | |
| **Test mode:** | Compliance | **Verdict:** | PASS |
| **Date(s):** | 8/28/2012 - 8/30/2012 | | |
| **Temperature:** 24 ºC | **Air Pressure:** 1008 hPa | **Relative Humidity:** 45 % | **Power Supply:** 120 VAC |
| **Remarks:** | | | |

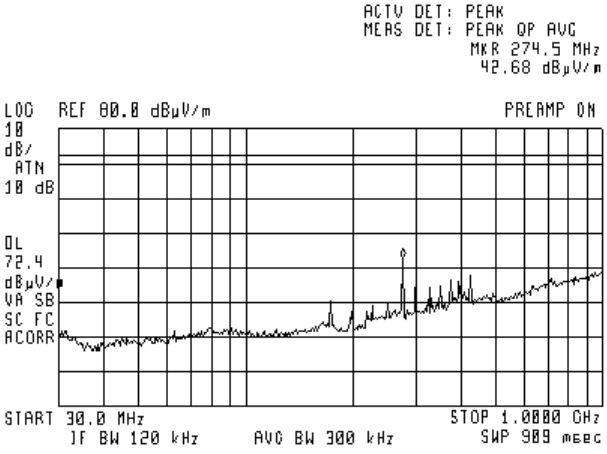
**Plot 7.6.3 Radiated emission measurements in 30 - 1000 MHz range**

TEST SITE: Semi anechoic chamber
ANTENNA POLARIZATION: Vertical
CARRIER FREQUENCY: Low; mid; high
TEST DISTANCE: 3 m




**Plot 7.6.4 Radiated emission measurements in 30 - 1000 MHz range**

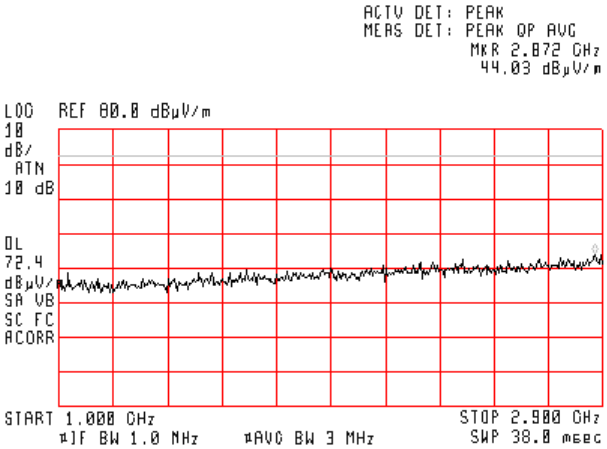
TEST SITE: Semi anechoic chamber
ANTENNA POLARIZATION: Horizontal
CARRIER FREQUENCY: Low; mid; high
TEST DISTANCE: 3 m



| Test specification: | Section 90.210(l), 90.210(m), Section 5.4, Radiated spurious emissions | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1053, 90.210(m); TIA/EIA-603-C, Section 2.2.12 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/28/2012 - 8/30/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1008 hPa | Relative Humidity: 45 % | Power Supply: 120 VAC |
| Remarks: | | | |

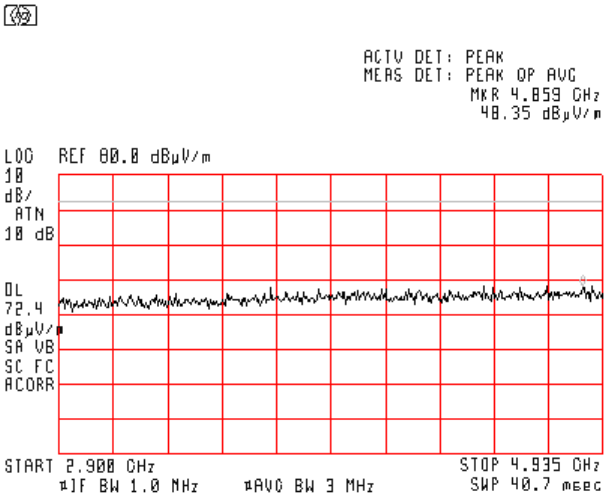
**Plot 7.6.5 Radiated emission measurements in 1000 – 2900 MHz range**

| | |
|---|---|
| TEST SITE: | Semi anechoic chamber |
| CARRIER FREQUENCY: | Low; mid; high |
| ANTENNA POLARIZATION: | Vertical and Horizontal |
| TEST DISTANCE: | 3 m |




**Plot 7.6.6 Radiated emission measurements in 2900 – 4935 MHz range**

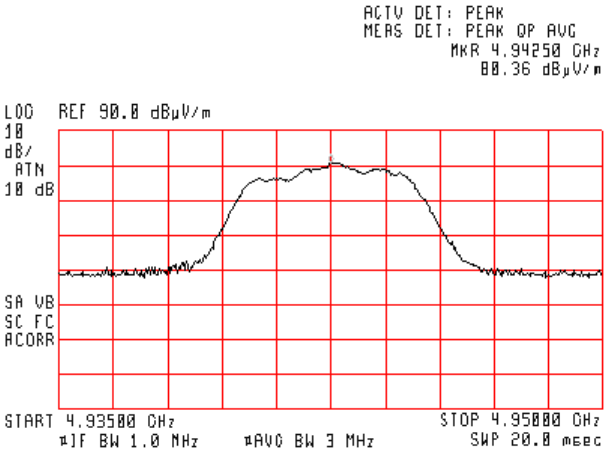
| | |
|---|---|
| TEST SITE: | Semi anechoic chamber |
| CARRIER FREQUENCY: | Low |
| ANTENNA POLARIZATION: | Vertical and Horizontal |
| TEST DISTANCE: | 3 m |



| Test specification: | Section 90.210(l), 90.210(m), Section 5.4, Radiated spurious emissions | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1053, 90.210(m); TIA/EIA-603-C, Section 2.2.12 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/28/2012 - 8/30/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1008 hPa | Relative Humidity: 45 % | Power Supply: 120 VAC |
| Remarks: | | | |

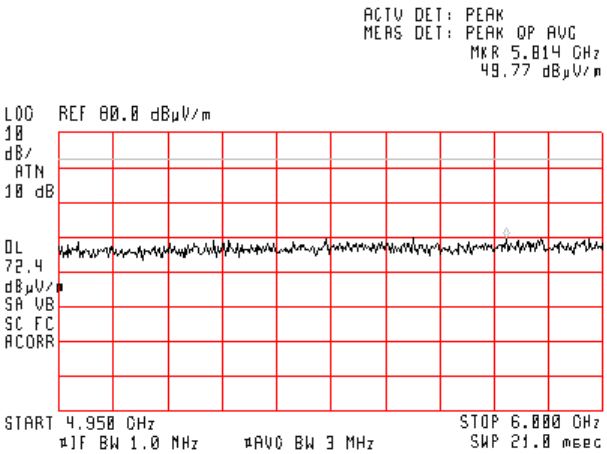
**Plot 7.6.7 Radiated emission measurements in 4935-4950 MHz range (in band)**

| | |
|---|---|
| TEST SITE: | Semi anechoic chamber |
| CARRIER FREQUENCY: | Low |
| ANTENNA POLARIZATION: | Vertical and Horizontal |
| TEST DISTANCE: | 3 m |




**Plot 7.6.8 Radiated emission measurements in 4950 – 6000 MHz range**

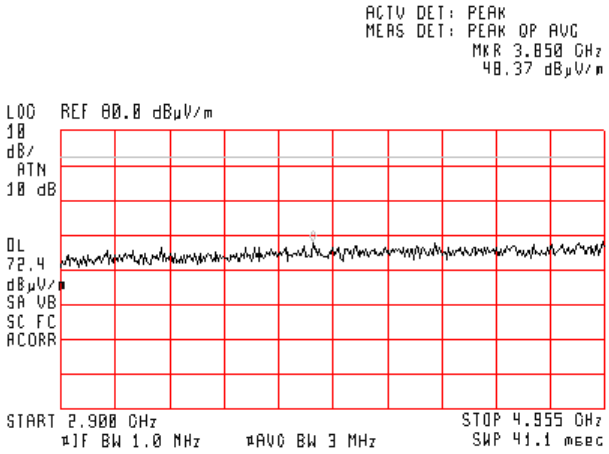
| | |
|---|---|
| TEST SITE: | Semi anechoic chamber |
| CARRIER FREQUENCY: | Low |
| ANTENNA POLARIZATION: | Vertical and Horizontal |
| TEST DISTANCE: | 3 m |



| Test specification: | Section 90.210(l), 90.210(m), Section 5.4, Radiated spurious emissions | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1053, 90.210(m); TIA/EIA-603-C, Section 2.2.12 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/28/2012 - 8/30/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1008 hPa | Relative Humidity: 45 % | Power Supply: 120 VAC |
| Remarks: | | | |

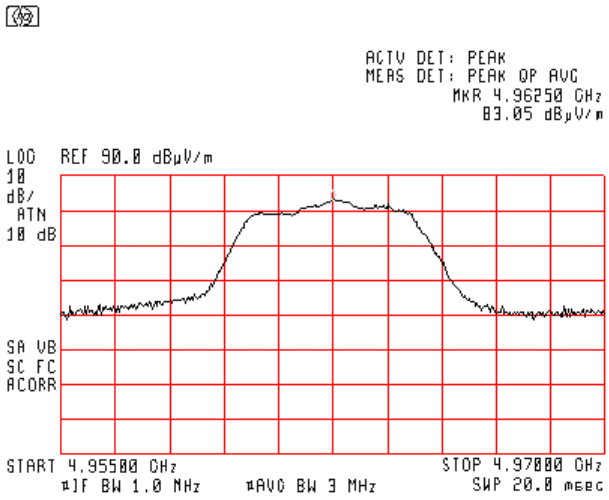
**Plot 7.6.9 Radiated emission measurements in 2900 – 4955 MHz range**

| | |
|---|---|
| TEST SITE: | Semi anechoic chamber |
| CARRIER FREQUENCY: | Mid |
| ANTENNA POLARIZATION: | Vertical and Horizontal |
| TEST DISTANCE: | 3 m |




**Plot 7.6.10 Radiated emission measurements in 4955 – 4970 MHz range (in band)**

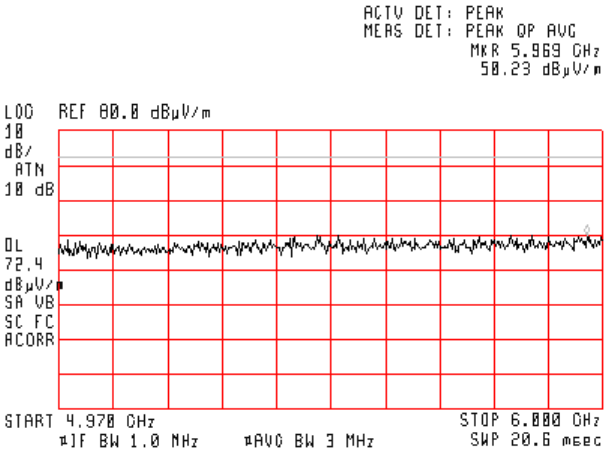
| | |
|---|---|
| TEST SITE: | Semi anechoic chamber |
| CARRIER FREQUENCY: | Mid |
| ANTENNA POLARIZATION: | Vertical and Horizontal |
| TEST DISTANCE: | 3 m |



| Test specification: | Section 90.210(l), 90.210(m), Section 5.4, Radiated spurious emissions | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1053, 90.210(m); TIA/EIA-603-C, Section 2.2.12 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/28/2012 - 8/30/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1008 hPa | Relative Humidity: 45 % | Power Supply: 120 VAC |
| Remarks: | | | |

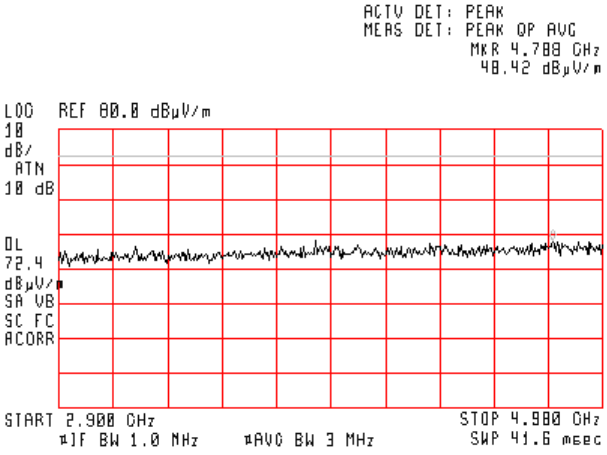
**Plot 7.6.11 Radiated emission measurements in 4970 – 6000 MHz range**

TEST SITE: Semi anechoic chamber
CARRIER FREQUENCY: Mid
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m




**Plot 7.6.12 Radiated emission measurements in 2900-4980 MHz range**

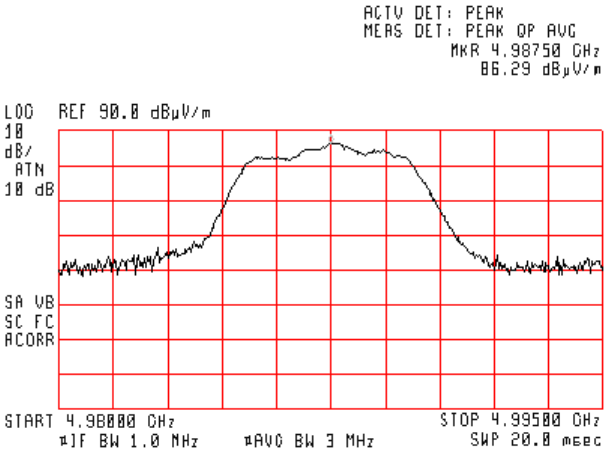
TEST SITE: Semi anechoic chamber
CARRIER FREQUENCY: High
ANTENNA POLARIZATION: Vertical and Horizontal
TEST DISTANCE: 3 m



| Test specification: | Section 90.210(l), 90.210(m), Section 5.4, Radiated spurious emissions | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1053, 90.210(m); TIA/EIA-603-C, Section 2.2.12 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/28/2012 - 8/30/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1008 hPa | Relative Humidity: 45 % | Power Supply: 120 VAC |
| Remarks: | | | |

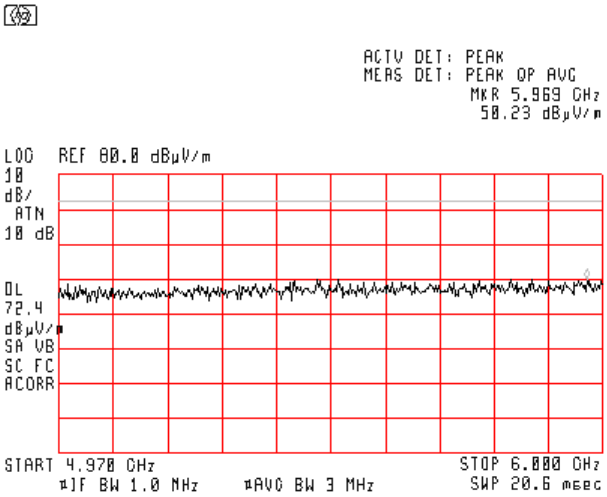
**Plot 7.6.13 Radiated emission measurements in 4980-4995 MHz range (in band)**

| | |
|---|---|
| TEST SITE: | Semi anechoic chamber |
| CARRIER FREQUENCY: | High |
| ANTENNA POLARIZATION: | Vertical and Horizontal |
| TEST DISTANCE: | 3 m |




**Plot 7.6.14 Radiated emission measurements in 4995-6000 MHz range**

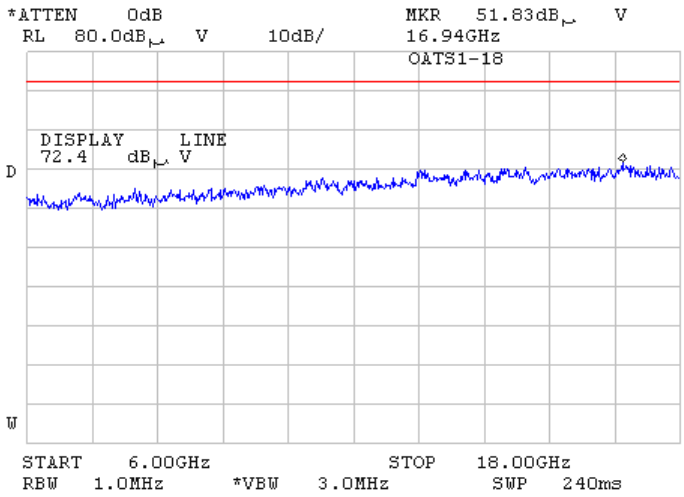
| | |
|---|---|
| TEST SITE: | Semi anechoic chamber |
| CARRIER FREQUENCY: | High |
| ANTENNA POLARIZATION: | Vertical and Horizontal |
| TEST DISTANCE: | 3 m |



| Test specification: | Section 90.210(l), 90.210(m), Section 5.4, Radiated spurious emissions | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1053, 90.210(m); TIA/EIA-603-C, Section 2.2.12 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/28/2012 - 8/30/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1008 hPa | Relative Humidity: 45 % | Power Supply: 120 VAC |
| Remarks: | | | |

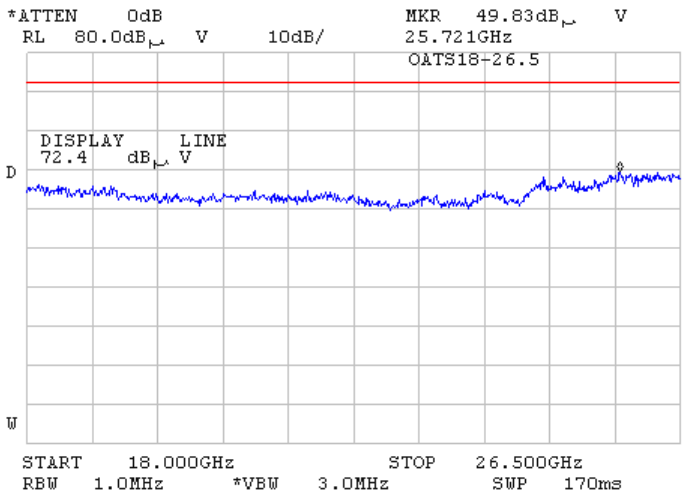
**Plot 7.6.15 Radiated emission measurements in 6000 – 18000 MHz range**

| | |
|---|---|
| TEST SITE: | Semi anechoic chamber |
| CARRIER FREQUENCY: | Low; mid; high |
| ANTENNA POLARIZATION: | Vertical and Horizontal |
| TEST DISTANCE: | 3 m |




**Plot 7.6.16 Radiated emission measurements in 18000 – 26500 MHz range**

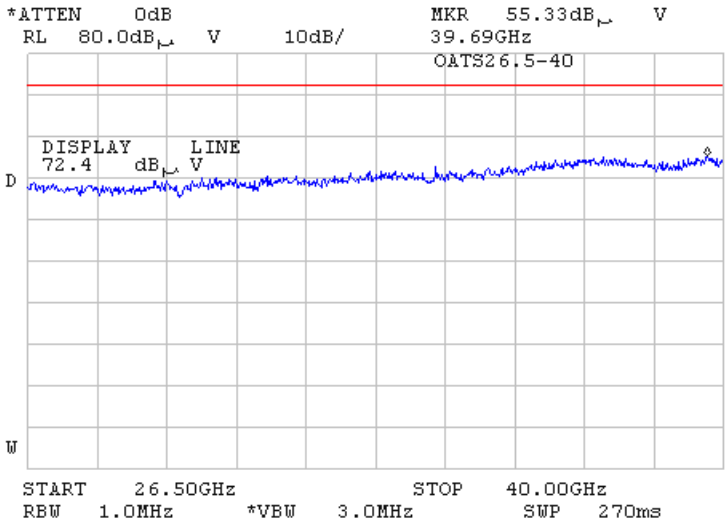
| | |
|---|---|
| TEST SITE: | Semi anechoic chamber |
| CARRIER FREQUENCY: | Low; mid; high |
| ANTENNA POLARIZATION: | Vertical and Horizontal |
| TEST DISTANCE: | 3 m |



| Test specification: | Section 90.210(l), 90.210(m), Section 5.4, Radiated spurious emissions | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Sections 2.1053, 90.210(m); TIA/EIA-603-C, Section 2.2.12 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 8/28/2012 - 8/30/2012 | | |
| Temperature: 24 ºC | Air Pressure: 1008 hPa | Relative Humidity: 45 % | Power Supply: 120 VAC |
| Remarks: | | | |

**Plot 7.6.17 Radiated emission measurements in 26500-40000 MHz range**

| | |
|---|---|
| TEST SITE: | Semi anechoic chamber |
| CARRIER FREQUENCY: | Low; mid; high |
| ANTENNA POLARIZATION: | Vertical and Horizontal |
| TEST DISTANCE: | 3 m |



| Test specification: | Section 90.213, Section 5.2, Frequency stability | | |
|---|---|---|---|
| Test procedure: | 47 CFR, Section 2.1055; TIA/EIA-603-C Section 2.2.2 | | |
| Test mode: | Compliance | Verdict: | PASS |
| Date(s): | 9/02/2012 | | |
| Temperature: 24ºC | Air Pressure: 1008 hPa | Relative Humidity: 51% | Power Supply: 120 VAC |
| Remarks: | | | |

## 7.7 Frequency stability test

### 7.7.1 General

This test was performed to measure frequency stability of transmitter RF carrier. Specification test limits are given in Table 7.7.1.

**Table 7.7.1 Frequency stability limits**

| Assigned frequency, MHz | Maximum allowed frequency displacement | |
|---|---|---|
| | ppm | Hz |
| 4940.0 – 4990.0 | The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation | |

### 7.7.2 Test procedure

**7.7.2.1** The EUT was set up as shown in Figure 7.7.1, energized and its proper operation was checked.

**7.7.2.2** The EUT power was turned off. Temperature within test chamber was set to +30˚C and a period of time sufficient to stabilize all of the oscillator circuit components was allowed.

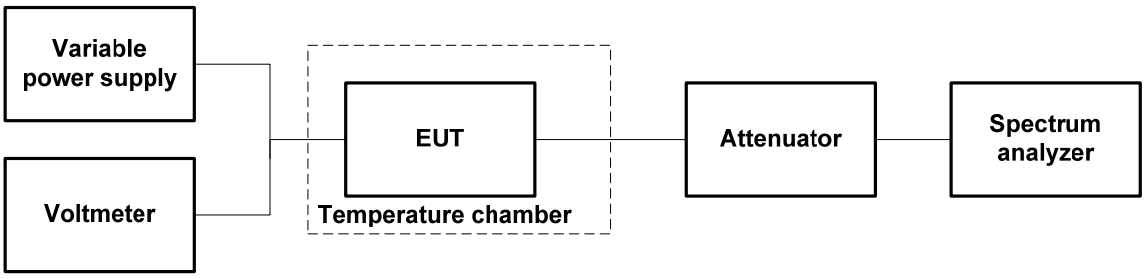
**7.7.2.3** The EUT was powered on and carrier frequency was measured at start up moment and then every minute until frequency had been stabilized or 10 minutes elapsed whichever reached the last. The EUT was powered off.

**7.7.2.4** The above procedure was repeated at 0˚C and at the lowest test temperature.

**7.7.2.5** The EUT was powered on and carrier frequency was measured at start up moment and at the end of stabilization period at the rest of test temperatures and voltages. The EUT was powered off.

**7.7.2.6** Frequency displacement was calculated and compared with the limit as provided in Table 7.7.2.

**Figure 7.7.1 Frequency stability test setup**



| **Test specification:** | **Section 90.213, Section 5.2, Frequency stability** | | |
|---|---|---|---|
| **Test procedure:** | 47 CFR, Section 2.1055; TIA/EIA-603-C Section 2.2.2 | | |
| **Test mode:** | Compliance | **Verdict:** | PASS |
| **Date(s):** | 9/02/2012 | | |
| **Temperature:** 24ºC | **Air Pressure:** 1008 hPa | **Relative Humidity:** 51% | **Power Supply:** 120 VAC |
| **Remarks:** | | | |

**Table 7.7.2 Frequency stability test results**

ASSIGNED FREQUENCY RANGE: 4940.0 – 4990.0 MHz
NOMINAL POWER VOLTAGE: 120 VAC
TEMPERATURE STABILIZATION PERIOD: 20 min
POWER DURING TEMPERATURE TRANSITION: Off
SPECTRUM ANALYZER MODE: Counter
RESOLUTION BANDWIDTH: 1 kHz
VIDEO BANDWIDTH: 1 kHz
MODULATION: Unmodulated

| T, ºC | Voltage, VDC | Frequency, MHz | | | | | | | Max frequency drift, kHz | | Max frequency drift, ppm | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Start up | 1st min | 2nd min | 3rd min | 4th min | 5th min | 10th min | Positive | Negative | Positive | Negative |
| **Low channel 4942.5 MHz** | | | | | | | | | | | | |
| -30 | nominal | 4942.49530 | 4942.49530 | 4942.49529 | 4942.49530 | 4942.49529 | 4942.49529 | 4942.49530 | NA | -1.23 | NA | -0.2488 |
| -20 | nominal | 4942.49585 | 4942.49586 | 4942.49586 | 4942.49586 | 4942.49586 | 4942.49587 | 4942.49588 | NA | -0.65 | NA | -0.1315 |
| -10 | nominal | 4942.49660 | 4942.49659 | 4942.49657 | 4942.49655 | 4942.49654 | 4942.49653 | 4942.49647 | NA | -0.06 | NA | -0.0121 |
| 0 | nominal | 4942.49847 | 4942.49849 | 4942.49849 | 4942.49849 | 4942.49849 | 4942.49850 | 4942.49854 | NA | -0.7 | NA | -0.1416 |
| 10 | nominal | 4942.49905 | 4942.49902 | 4942.49901 | 4942.49901 | 4942.49901 | 4942.49900 | 4942.49900 | NA | -0.17 | NA | -0.0344 |
| 20 | +15%(138 VAC) | 4942.49908 | 4942.49908 | 4942.49908 | 4942.49917 | 4942.49917 | 4942.49917 | 4942.49917 | NA | -0.09 | NA | -0.0182 |
| 20 | Nominal 120 VAC | 4942.49917 | 4942.49917 | 4942.49917 | 4942.49917 | 4942.49917 | 4942.49917 | **4942.49917*** | NA | 0 | NA | NA |
| 20 | -15% (102 VAC) | 4942.49925 | 4942.49917 | 4942.49917 | 4942.49917 | 4942.49917 | 4942.49917 | 4942.49917 | 0.08 | NA | 0.016186 | NA |
| 30 | nominal | 4942.49927 | 4942.49920 | 4942.49918 | 4942.49912 | 4942.49911 | 4942.49908 | 4942.49903 | NA | -0.14 | NA | -0.2833 |
| 40 | nominal | 4942.49871 | 4942.49869 | 4942.49867 | 4942.49866 | 4942.49865 | 4942.49863 | 4942.49860 | NA | -0.57 | NA | -0.1153 |
| 50 | nominal | 4942.49833 | 4942.49834 | 4942.49832 | 4942.49832 | 4942.49831 | 4942.49831 | 4942.49826 | NA | -0.91 | NA | -0.1841 |
| **Mid channel 4962.5 MHz** | | | | | | | | | | | | |
| -30 | nominal | 4962.49536 | 4962.49538 | 4962.49537 | 4962.49534 | 4962.49532 | 4962.49528 | 4962.49513 | NA | -4.2 | NA | -0.8463 |
| -20 | nominal | 4962.49615 | 4962.49616 | 4962.49613 | 4962.49610 | 4962.49606 | 4962.49604 | 4962.49585 | NA | -3.48 | NA | -0.7012 |
| -10 | nominal | 4962.49696 | 4962.49693 | 4962.49690 | 4962.49685 | 4962.49683 | 4962.49679 | 4962.49664 | NA | -2.69 | NA | -0.5420 |
| 0 | nominal | 4962.49816 | 4962.49814 | 4962.49821 | 4962.49825 | 4962.49827 | 4962.49829 | 4962.49840 | NA | -1.19 | NA | -0.2398 |
| 10 | nominal | 4962.49888 | 4962.49893 | 4962.499894 | 4962.49898 | 4962.49899 | 4962.49901 | 4962.49905 | NA | -0.45 | NA | -0.0908 |
| 20 | +15%(138 VAC) | 4962.49917 | 4962.49925 | 4962.49925 | 4962.49925 | 4962.49925 | 4962.49925 | 4962.49925 | NA | -0.16 | NA | -0.0322 |
| 20 | Nominal 120 VAC | 4962.49933 | 4962.49933 | 4962.49933 | 4962.49933 | 4962.49925 | 4962.49933 | **4962.49933*** | NA | -0.08 | NA | -0.0161 |
| 20 | -15% (102 VAC) | 4962.49933 | 4962.49933 | 4962.49933 | 4962.49933 | 4962.49925 | 4962.49925 | 4962.49925 | NA | -0.08 | NA | -0.0161 |
| 30 | nominal | 4962.49897 | 4962.499661 | 4962.49708 | 4962.49887 | 4962.49882 | 4962.49888 | 4962.49883 | 0.331 | NA | 0.0667 | NA |
| 40 | nominal | 4962.49881 | 4962.49883 | 4962.49883 | 4962.49879 | 4962.49879 | 4962.49872 | 4962.49881 | NA | -0.61 | NA | -0.1229 |
| 50 | nominal | 4962.49849 | 4962.49845 | 4962.49843 | 4962.49841 | 4962.49839 | 4962.49838 | 4962.49835 | NA | -0.98 | NA | -0.1974 |
| **High channel 4987.5 MHz** | | | | | | | | | | | | |
| -30 | nominal | 4987.49505 | 4987.49504 | 4987.49526 | 4987.49523 | 4987.49522 | 4987.49521 | 4987.49518 | NA | -4.13 | NA | -0.8280 |
| -20 | nominal | 4987.49775 | 4987.49581 | 4987.49580 | 4987.49578 | 4987.49578 | 4987.49578 | 4987.49574 | NA | -3.43 | NA | -0.6877 |
| -10 | nominal | 4987.49650 | 4987.49651 | 4987.49651 | 4987.49652 | 4987.49650 | 4987.49651 | 4987.49650 | NA | -2.67 | NA | -0.5353 |
| 0 | nominal | 4987.49841 | 4987.49843 | 4987.49843 | 4987.49843 | 4987.49844 | 4987.49845 | 4987.49847 | NA | -0.76 | NA | -0.1523 |
| 10 | nominal | 4987.49904 | 4987.49904 | 4987.49903 | 4987.49903 | 4987.49903 | 4987.49903 | 4987.498901 | NA | -027 | NA | -0.0541 |
| 20 | +15%(138 VAC) | 4987.49917 | 4987.49917 | 4987.49917 | 4987.49917 | 4987.49917 | 4987.49917 | 4987.49917 | NA | 0 | NA | NA |
| 20 | Nominal 120 VAC | 4987.49917 | 4987.49925 | 4987.49917 | 4987.49917 | 4987.49917 | 4987.49917 | **4987.49917*** | 0.08 | NA | 0.0160 | NA |
| 20 | -15% (102 VAC) | 4987.49917 | 4987.49925 | 4987.49925 | 4987.49917 | 4987.49917 | 4987.49917 | 4987.49917 | 0.08 | NA | 0.0160 | NA |
| 30 | nominal | 4987.49967 | 4987.49967 | 4987.49942 | 4987.49942 | 4987.49942 | 4987.49942 | 4987.49942 | 0.25 | NA | 0.0501 | NA |
| 40 | nominal | 4987.49775 | 4987.49742 | 4987.49917 | 4987.49917 | 4987.49917 | 4987.49910 | 4987.49908 | NA | -1.75 | NA | -0.3508 |
| 50 | nominal | 4987.49908 | 4987.49892 | 4987.49890 | 4987.49883 | 4987.49880 | 4987.49875 | 4987.49875 | NA | -0.37 | NA | -0.0741 |

* - Reference frequency
Note1: As no limit is specified by the standard for 4940.0 – 4990.0 MHz band the worst case test results are given for information purpose only.

**Reference numbers of test equipment used**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| HL 1424 | HL 3230 | HL 3442 | HL 3786 | HL 3818 | | | |

Full description is given in Appendix A.

# 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 | 03-Jul-12 | 03-Jul-13 |
| 0521 | EMI Receiver (Spectrum Analyzer) with RF filter section 9 kHz-6.5 GHz | Hewlett Packard | 8546A | 3617A 00319, 3448A002 53 | 29-Aug-11 | 29-Sep-12 |
| 0604 | Antenna BiconiLog Log-Periodic/T Bow-TIE, 26 - 2000 MHz | EMCO | 3141 | 9611-1011 | 20-May-12 | 20-May-14 |
| 0768 | Antenna Standard Gain Horn, 18-26.5 GHz, WR-42, 25 dB gain | Quinstar Technology | QWH-4200-BA | 110 | 03-Feb-12 | 03-Feb-15 |
| 0769 | Antenna Standard Gain Horn, 26.5-40 GHz, WR28, 25 dB gain | Quinstar Technology | QWH-2800-BA | 112 | 03-Feb-12 | 03-Feb-15 |
| 1424 | Spectrum Analyzer, 30 Hz- 40 GHz | Agilent Technologies | 8564EC | 3946A002 19 | 25-Sep-11 | 25-Sep-12 |
| 3230 | Multimeter | Fluke | 115C | 94173028 | 10-Jul-12 | 10-Jul-13 |
| 3301 | Power Meter, P-series, 50 MHz to 40 GHz | Agilent Technologies | N1911A | MY451010 57 | 14-Dec-11 | 14-Dec-12 |
| 3302 | Power sensor, P-Series, 50 MHz to 40 GHz, -35/30 to 20 dBm | Agilent Technologies | N1922A | MY452405 86 | 14-Dec-11 | 14-Dec-12 |
| 3442 | Precision Fixed Attenuator, 50 Ohm, 5 W, 20 dB, DC to 18 GHz | Mini-Circuits | BW-S20W5+ | NA | 07-Mar-12 | 07-Mar-13 |
| 3455 | Medium Power Fixed Coaxial Attenuator DC to 40 GHz, 20 dB, 5 W | Aeroflex / Weinschel | 75A-20-12 | 1182 | 19-Mar-12 | 19-Mar-13 |
| 3533 | Amplifier, low noise, 6 to 18 GHz | Quinstar Technology | QLJ-06184040 -J0 | 111590010 01 | 25-Dec-11 | 25-Dec-12 |
| 3535 | Amplifier, low noise, 18 to 40 GHz | Quinstar Technology | QLJ-18404537 -J0 | 111590030 01 | 10-Jul-12 | 10-Jul-13 |
| 3786 | Precision Fixed Attenuator, 50 Ohm, 5 W, 10 dB, DC to 18 GHz | Mini-Circuits | BW-S10W5+ | NA | 19-Dec-11 | 19-Dec-12 |
| 3818 | PSA Series Spectrum Analyzer, 3 Hz- 44 GHz | Agilent Technologies | E4446A | MY482502 88 | 16-Feb-12 | 16-Feb-13 |
| 3901 | Microwave Cable Assembly, 40.0 GHz, 3.5 m, SMA/SMA | Huber-Suhner | SUCOFLEX 102A | 1225/2A | 08-Feb-12 | 08-Feb-13 |
| 3903 | Microwave Cable Assembly, 40.0 GHz, 1.5 m, SMA/SMA | Huber-Suhner | SUCOFLEX 102A | 1226/2A | 08-Feb-12 | 08-Feb-13 |
| 4114 | Antenna, Double-Ridged Waveguide Horn, 1-18 GHz | ETS Lindgren | 3117 | 00123515 | 23-Jan-12 | 23-Jan-13 |
| 4150 | Preamplifier, 0.1 to 18 GHz, Gain 25 dB, N-type(f) in, N-type(m) out. | Agilent Technologies | 87405C | MY470105 91 | 18-Jun-12 | 18-Jun-13 |
| 4280 | Test Cable , DC-18 GHz, 4.6 m, N/M - N/M | Mini-Circuits | APC-15FT-NMNM+ | 0763A | 01-Jan-12 | 01-Jan-13 |
| 4352 | Low Loss Armored Test Cable, DC - 18 GHz, 6.2 m, N type-M/N type-M | MegaPhase | NC29-N1N1-244 | 12025101 002 | 06-Jun-12 | 06-Mar-13 |
| 4353 | Low Loss Armored Test Cable, DC - 18 GHz, 6.2 m, N type-M/N type-M | MegaPhase | NC29-N1N1-244 | 12025101 003 | 06-Jun-12 | 06-Mar-13 |
| 4366 | Directional coupler, 1 GHz to 18 GHz, 10 dB, SMA Female | Tiger Micro-Electronics Institute | TGD-A1101-10 | 01e-JSDE805-007 | 17-Apr-12 | 17-Apr-14 |

# 9 APPENDIX B Measurement uncertainties

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

| Test description | Expanded uncertainty |
|---|---|
| **Transmitter tests** | |
| Carrier power conducted at antenna connector | ± 1.7 dB |
| Carrier power radiated (substitution method) | ± 4.5 dB |
| Occupied bandwidth | ±8% |
| 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 |
| Spurious emissions radiated 30 MHz – 40 GHz (substitution method) | ± 4.5 dB |
| Frequency error | 30 – 300 MHz: ± 50.5 Hz (1.68 ppm)<br>300 – 1000 MHz: ± 168 Hz (0.56 ppm) |
| Transient frequency behaviour | 187 Hz<br>± 13.9 % |
| Duty cycle, timing (Tx ON / OFF) and average factor measurements | ± 1.0 % |
| **Unintentional radiator tests** | |
| Conducted emissions with LISN | 9 kHz to 150 kHz: ± 3.9 dB<br>150 kHz to 30 MHz: ± 3.8 dB |
| Radiated emissions at 3 m measuring distance<br>Horizontal polarization<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 |

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 listed by the Federal Communications Commission (USA) for all parts of Code of Federal Regulations 47 (CFR 47), Registration Numbers 90624 for OATS and 90623 for the anechoic chamber; by Industry Canada for electromagnetic emissions (file numbers IC 2186A-1 for OATS, IC 2186A-2 for anechoic chamber, IC 2186A-3 for full-anechoic chamber for RE measurements above 1 GHz), certified by VCCI, Japan (the registration numbers are R-808 for OATS, R-1082 for anechoic chamber, G-27 for full-anechoic chamber for RE measurements above 1 GHz, C-845 for conducted emissions site, T-1606 for conducted emissions at telecommunication ports), has a status of a Telefication - Listed Testing Laboratory, Certificate No. L138/00. 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). The FCC Designation Number is US1003.

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Person for contact: Mr. Alex Usoskin, CEO.

# 11 APPENDIX D Specification references

| | |
|---|---|
| FCC 47CFR part 90: 2011 | Private land mobile radio services |
| ANSI C63.2: 1996 | American National Standard for Instrumentation-Electromagnetic Noise and Field Strength, 10 kHz to 40 GHz-Specifications. |
| ANSI C63.4: 2003 | American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz. |
| ANSI/TIA/EIA-603-C:2004 | Land Mobile FM or PM Communications Equipment Measurement and Performance Standards |

# 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 intensity in dB(μV/m).

**Antenna factor**
**Standard gain horn antenna**
**Quinstar Technology**
**Model QWH**
**Ser.No.110/112, HL 0768, HL 0769**

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

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

**Antenna factor**
**Double-ridged waveguide horn antenna**
**ETS Lindgren, Model 3117, serial number: 00123515, HL 4114**

| Frequency, MHz | Antenna factor, dB/m | | |
|---|---|---|---|
| | Measured | Manufacturer | Deviation |
| 1000 | 28.0 | 28.4 | -0.4 |
| 1500 | 28.0 | 27.4 | 0.6 |
| 2000 | 31.2 | 30.9 | 0.3 |
| 2500 | 32.5 | 33.4 | -0.9 |
| 3000 | 32.9 | 32.6 | 0.3 |
| 3500 | 32.7 | 32.8 | -0.1 |
| 4000 | 33.1 | 33.4 | -0.3 |
| 4500 | 33.8 | 33.9 | -0.1 |
| 5000 | 33.8 | 34.1 | -0.3 |
| 5500 | 34.4 | 34.5 | -0.1 |
| 6000 | 35.0 | 35.2 | -0.2 |
| 6500 | 35.4 | 35.5 | -0.1 |
| 7000 | 35.7 | 35.7 | 0.0 |
| 7500 | 35.9 | 35.7 | 0.2 |
| 8000 | 35.8 | 35.8 | 0.0 |
| 8500 | 35.9 | 35.8 | 0.1 |
| 9000 | 36.3 | 36.2 | 0.1 |
| 9500 | 36.6 | 36.6 | 0.0 |
| 10000 | 37.1 | 37.1 | 0.0 |
| 10500 | 37.6 | 37.5 | 0.1 |
| 11000 | 37.9 | 37.7 | 0.2 |
| 11500 | 38.5 | 38.1 | 0.4 |
| 12000 | 39.2 | 38.7 | 0.5 |
| 12500 | 39.0 | 38.9 | 0.1 |
| 13000 | 39.1 | 39.1 | 0.0 |
| 13500 | 38.9 | 38.8 | 0.1 |
| 14000 | 39.0 | 38.8 | 0.2 |
| 14500 | 39.6 | 39.9 | -0.3 |
| 15000 | 39.9 | 39.7 | 0.2 |
| 15500 | 39.9 | 40.1 | -0.2 |
| 16000 | 40.7 | 40.8 | -0.1 |
| 16500 | 41.3 | 41.8 | -0.5 |
| 17000 | 42.5 | 42.1 | 0.4 |
| 17500 | 41.3 | 41.2 | 0.1 |
| 18000 | 41.4 | 40.9 | 0.5 |

Antenna factor is to be added to receiver meter reading in dB(μV) to convert to field strength in dB(μV/meter)

**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**
**Microwave Cable Assembly, Huber-Suhner, 40 GHz, 1.5 m, SMA-SMA, S/N 1226/2A**
**HL 3903**

| Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB |
|---|---|---|---|---|---|
| 10 | -0.02 | 9500 | 1.84 | 21000 | 2.98 |
| 100 | 0.15 | 10000 | 1.86 | 22000 | 3.07 |
| 500 | 0.38 | 10500 | 1.93 | 23000 | 3.13 |
| 1000 | 0.56 | 11000 | 1.99 | 24000 | 3.21 |
| 1500 | 0.69 | 11500 | 2.04 | 25000 | 3.26 |
| 2000 | 0.82 | 12000 | 2.10 | 26000 | 3.48 |
| 2500 | 0.90 | 12500 | 2.15 | 27000 | 3.44 |
| 3000 | 0.98 | 13000 | 2.21 | 28000 | 3.53 |
| 3500 | 1.06 | 13500 | 2.25 | 29000 | 3.59 |
| 4000 | 1.11 | 14000 | 2.29 | 30000 | 3.66 |
| 4500 | 1.17 | 14500 | 2.34 | 31000 | 3.70 |
| 5000 | 1.24 | 15000 | 2.36 | 32000 | 3.79 |
| 5500 | 1.32 | 15500 | 2.40 | 33000 | 3.88 |
| 6000 | 1.40 | 16000 | 2.45 | 34000 | 3.94 |
| 6500 | 1.50 | 16500 | 2.48 | 35000 | 3.91 |
| 7000 | 1.56 | 17000 | 2.56 | 36000 | 4.05 |
| 7500 | 1.62 | 17500 | 2.58 | 37000 | 4.22 |
| 8000 | 1.68 | 18000 | 2.60 | 38000 | 4.25 |
| 8500 | 1.74 | 19000 | 2.84 | 39000 | 4.27 |
| 9000 | 1.78 | 20000 | 2.88 | 40000 | 4.33 |

**Cable loss**
**Test cable, Mini-Circuits, S/N 0763A, 18 GHz, 4.6 m, N/M - N/M**
**APC-15FT-NMNM+, HL 4280**

| Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB |
|---|---|---|---|---|---|---|---|
| 10 | 0.21 | 5000 | 4.27 | 10200 | 6.50 | 15400 | 8.49 |
| 30 | 0.26 | 5100 | 4.32 | 10300 | 6.55 | 15500 | 8.50 |
| 50 | 0.34 | 5200 | 4.35 | 10400 | 6.59 | 15600 | 8.55 |
| 100 | 0.51 | 5300 | 4.41 | 10500 | 6.62 | 15700 | 8.58 |
| 200 | 0.63 | 5400 | 4.43 | 10600 | 6.65 | 15800 | 8.61 |
| 300 | 0.73 | 5500 | 4.49 | 10700 | 6.66 | 15900 | 8.64 |
| 400 | 0.91 | 5600 | 4.54 | 10800 | 6.68 | 16000 | 8.68 |
| 500 | 1.07 | 5700 | 4.58 | 10900 | 6.70 | 16100 | 8.72 |
| 600 | 1.21 | 5800 | 4.63 | 11000 | 6.71 | 16200 | 8.73 |
| 700 | 1.33 | 5900 | 4.67 | 11100 | 6.72 | 16300 | 8.75 |
| 800 | 1.45 | 6000 | 4.73 | 11200 | 6.74 | 16400 | 8.77 |
| 900 | 1.55 | 6100 | 4.76 | 11300 | 6.77 | 16500 | 8.80 |
| 1000 | 1.65 | 6200 | 4.81 | 11400 | 6.81 | 16600 | 8.80 |
| 1100 | 1.75 | 6300 | 4.86 | 11500 | 6.84 | 16700 | 8.82 |
| 1200 | 1.85 | 6400 | 4.89 | 11600 | 6.87 | 16800 | 8.83 |
| 1300 | 1.94 | 6500 | 4.94 | 11700 | 6.89 | 16900 | 8.87 |
| 1400 | 2.03 | 6600 | 4.95 | 11800 | 6.94 | 17000 | 8.92 |
| 1500 | 2.11 | 6700 | 4.99 | 11900 | 7.00 | 17100 | 8.96 |
| 1600 | 2.19 | 6800 | 5.04 | 12000 | 7.05 | 17200 | 9.01 |
| 1700 | 2.27 | 6900 | 5.04 | 12100 | 7.10 | 17300 | 9.07 |
| 1800 | 2.34 | 7000 | 5.09 | 12200 | 7.17 | 17400 | 9.09 |
| 1900 | 2.42 | 7100 | 5.15 | 12300 | 7.23 | 17500 | 9.14 |
| 2000 | 2.49 | 7200 | 5.19 | 12400 | 7.29 | 17600 | 9.17 |
| 2100 | 2.56 | 7300 | 5.25 | 12500 | 7.34 | 17700 | 9.21 |
| 2200 | 2.63 | 7400 | 5.33 | 12600 | 7.38 | 17800 | 9.24 |
| 2300 | 2.69 | 7500 | 5.39 | 12700 | 7.44 | 17900 | 9.28 |
| 2400 | 2.76 | 7600 | 5.42 | 12800 | 7.48 | 18000 | 9.31 |
| 2500 | 2.83 | 7700 | 5.51 | 12900 | 7.55 | | |
| 2600 | 2.89 | 7800 | 5.58 | 13000 | 7.58 | | |
| 2700 | 2.95 | 7900 | 5.62 | 13100 | 7.63 | | |
| 2800 | 3.02 | 8000 | 5.68 | 13200 | 7.67 | | |
| 2900 | 3.08 | 8100 | 5.73 | 13300 | 7.72 | | |
| 3000 | 3.15 | 8200 | 5.78 | 13400 | 7.76 | | |
| 3100 | 3.21 | 8300 | 5.83 | 13500 | 7.81 | | |
| 3200 | 3.27 | 8400 | 5.87 | 13600 | 7.85 | | |
| 3300 | 3.33 | 8500 | 5.92 | 13700 | 7.88 | | |
| 3400 | 3.38 | 8600 | 5.96 | 13800 | 7.93 | | |
| 3500 | 3.44 | 8700 | 6.00 | 13900 | 7.97 | | |
| 3600 | 3.49 | 8800 | 6.04 | 14000 | 8.01 | | |
| 3700 | 3.55 | 8900 | 6.10 | 14100 | 8.05 | | |
| 3800 | 3.60 | 9000 | 6.13 | 14200 | 8.09 | | |
| 3900 | 3.65 | 9100 | 6.17 | 14300 | 8.12 | | |
| 4000 | 3.71 | 9200 | 6.22 | 14400 | 8.15 | | |
| 4100 | 3.75 | 9300 | 6.25 | 14500 | 8.19 | | |
| 4200 | 3.81 | 9400 | 6.28 | 14600 | 8.22 | | |
| 4300 | 3.86 | 9500 | 6.32 | 14700 | 8.26 | | |
| 4400 | 3.93 | 9600 | 6.36 | 14800 | 8.29 | | |
| 4500 | 3.98 | 9700 | 6.37 | 14900 | 8.32 | | |
| 4600 | 4.03 | 9800 | 6.41 | 15000 | 8.36 | | |
| 4700 | 4.08 | 9900 | 6.42 | 15100 | 8.40 | | |
| 4800 | 4.13 | 10000 | 6.45 | 15200 | 8.43 | | |
| 4900 | 4.18 | 10100 | 6.48 | 15300 | 8.44 | | |

**Cable loss**
**Low Loss Armored Test Cable, MegaPhase, 18 GHz, 6.2 m, N type-M/N type-M,**
**NC29-N1N1-244S/N 12025101 002,**
**HL 4352**

| Frequency, MHz | Cable loss, dB | Frequency, MHz | Cable loss, dB |
|---|---|---|---|
| 50 | 0.20 | 9000 | 2.81 |
| 100 | 0.28 | 9500 | 2.89 |
| 300 | 0.49 | 10000 | 3.00 |
| 500 | 0.63 | 10500 | 3.07 |
| 1000 | 0.90 | 11000 | 3.15 |
| 1500 | 1.10 | 11500 | 3.23 |
| 2000 | 1.28 | 12000 | 3.30 |
| 2500 | 1.44 | 12500 | 3.38 |
| 3000 | 1.57 | 13000 | 3.47 |
| 3500 | 1.71 | 13500 | 3.55 |
| 4000 | 1.85 | 14000 | 3.61 |
| 4500 | 1.95 | 14500 | 3.68 |
| 5000 | 2.05 | 15000 | 3.76 |
| 5500 | 2.14 | 15500 | 3.86 |
| 6000 | 2.27 | 16000 | 3.92 |
| 6500 | 2.38 | 16500 | 3.97 |
| 7000 | 2.47 | 17000 | 4.03 |
| 7500 | 2.58 | 17500 | 4.10 |
| 8000 | 2.65 | 18000 | 4.18 |
| 8500 | 2.74 | | |

**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 | | |

# 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