**Produkte**
*Products*

| | | | |
|---|---|---|---|
| **Prüfbericht - Nr.:** *Test Report No.:* | **19660002 001** | | **Seite 1 von 27** *Page 1 of 27* |
| **Auftraggeber:** *Client:* | **ATMEL NORWAY AS**<br>**VESTRE ROSTEN 79**<br>**7075 TILLER**<br>**TRONDHEIM**<br>**NORWAY - 7075** | | |
| **Gegenstand der Prüfung:** *Test item:* | **ATMEGA256RFR2 Xplained Pro** | | |
| **Bezeichnung:** *Identification:* | **ATMEGA256RFR2-XPRO** | **Serien-Nr.:** *Serial No.* | **Engineering Sample** |
| **Wareneingangs-Nr.:** *Receipt No.:* | **1803001664** | **Eingangsdatum:** *Date of receipt:* | **09.04.2013** |
| **Prüfort:** *Testing location:* | **Refer Page 4 of 27 for test facilities** | | |
| **Prüfgrundlage:** *Test specification:* | **FCC Part 15, Subpart C** | | |
| **Prüfergebnis:** *Test Result:* | **Der Prüfgegenstand entspricht oben genannter Prüfgrundlage(n).** *The test items passed the test specification(s).* | | |
| **Prüflaboratorium:** *Testing Laboratory:* | **TÜV Rheinland (India) Pvt. Ltd.**<br>82/A, 3rd Main, West Wing, Electronic City Phase 1<br>Hosur Road, Bangalore – 560 100. India | | |

| **geprüft /** *tested by:* | | | **kontrolliert /** *reviewed by:* | | |
|---|---|---|---|---|---|
| 17.04.2013 | Saibaba Siddapur<br>Test Engineer |  | 25.04.2013 | Raghavendra Kulkarni<br>Manager |  |
| **Datum** *Date* | **Name/Stellung** *Name/Position* | **Unterschrift** *Signature* | **Datum** *Date* | **Name/Stellung** *Name/Position* | **Unterschrift** *Signature* |

**Sonstiges /** *Other Aspects:* **FCC ID : VW4A091784**

| ***Abkürzungen:*** | | | | ***Abbreviations:*** | | | |
|---|---|---|---|---|---|---|---|
| ***P(ass)*** | = | ***entspricht Prüfgrundlage*** | | ***P(ass)*** | = | ***passed*** |
| ***F(ail)*** | = | ***entspricht nicht Prüfgrundlage*** | | ***F(ail)*** | = | ***failed*** |
| ***N/A*** | = | ***nicht anwendbar*** | | ***N/A*** | = | ***not applicable*** |
| ***N/T*** | = | ***nicht getestet*** | | ***N/T*** | = | ***not tested*** |

## Test Result Summary

| Clause | Test Item | Result |
|---|---|---|
| FCC 15.247(b) (3) | Maximum Conducted Peak Output Power | Pass |
| FCC 15.247(a) (2) | 6dB Bandwidth | Pass |
| FCC 15.247(e) | Power Spectral Density | Pass |
| FCC 15.247(d) | Band-edge compliance | Pass |
| FCC 15.209 / FCC 15.205 | Spurious Radiated Emissions and Restricted Bands of Operation | Pass |

# Content

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# List of Type and Measurement Instruments

## TÜV Rheinland (India) Pvt. Ltd, Bangalore

| Equipment | Manufacturer | Model | S/N | Calibration Due Date |
|---|---|---|---|---|
| EMI Test Receiver | Rohde &Schwarz | ESU 40 | 100288 | 04.10.2013 |
| Hybrid Log Periodic antenna | ETS Lindgren | 3142D | 00081354 | 26.07.2013 |
| Broadband Horn Antenna | Frankonia | HAX-18 | HAX18-802 | 23.03.2014 |
| Double-Ridged Waveguide Horn Antenna | ETS Lindgren | 116794 | 00133356 | 01-09-2013 |
| Emission Horn Antenna | ETS Lindgren | 116706 | 00107323 | 24-08-2013 |
| Active Loop Antenna | Frankonia | LAX-10 | LAX-10-800 | 11-04-2014 |
| Spectrum Analyser | Agilent Technologies | E4407B | US41192772 | 21.03.2014 |

**Testing Facilities:**

1) TUV Rheinland (India) Private Limited
No. 108, West Wing
Electronic city Phase I
Bangalore – 560100

# General Product Information

**Product Function and Intended Use**

The ATMEGA256RFR2-XPRO is a reference design for the Atmel ATmega256RFR2 single-chip microcontroller and radio transceiver. The IC integrates a powerful, 8-bit AVR® RISC microcontroller, an IEEE 802.15.4-compliant transceiver, and additional peripheral features. The built-in radio transceiver supports the worldwide accessible 2.4GHz ISM band.

The system is designed to demonstrate standard-based applications such as ZigBee/IEEE 802.15.4, ZigBee RF4CE, and 6LoWPAN, as well as high data rate ISM applications. The SMA antenna connector allows either operation with the antenna provided with the ATMEGA256RFR2-XPRO or conducting RF performance measurements.

**Ratings and System Details**

| | |
|---|---|
| Operating Frequency | 2400MHz – 2483.5MHz |
| No. of channels | 15 |
| Channel Spacing | 5MHz |
| Modulation | DSSS ( O-QPSK) |
| Transmitted Power | 4.20dBm |
| Data Rate | 250 kbps |
| Antenna Type | Refer page 6 of 27 |
| Number of antenna | Refer page 6 of 27 |
| Antenna Gain | Refer page 6 of 27 |
| Supply Voltage | 5 V DC (from USB Port) |
| Dimensions | 60X100X1.6mm |
| Environmental Condition | -40 to +85 degrees C range. |

**Test Conditions:**

**Voltage**: **5 V DC (from USB Port)**

**Environmental conditions:**

**Temperature:** +23 º C **RH:** 62%

# Test Set-up and Operation Mode

**Principle of Configuration Selection**
Transmission was enabled with 100% duty cycle on low, mid and high channel.

**Test Operation and Test Software**
Test software was used to enable the transmission with 100% duty cycle and channels in 2.4 GHz band on the EUT for the tests in this report.

**Special Accessories and Auxiliary Equipment**
- None

**Countermeasures to achieve EMC Compliance**
- None

**Table of frequencies**

| Frequency Band | Channel No. | Frequency (MHz) |
|---|---|---|
| 2400-2483.5 MHz | 11 | 2405 |
| | 12 | 2410 |
| | 13 | 2415 |
| | 14 | 2420 |
| | 15 | 2425 |
| | 16 | 2430 |
| | 17 | 2435 |
| | 18 | 2440 |
| | 19 | 2445 |
| | 20 | 2450 |
| | 21 | 2455 |
| | 22 | 2460 |
| | 23 | 2465 |
| | 24 | 2470 |
| | 25 | 2475 |

**Note: Conducted Parameters are measured at both antenna terminal but maximum power, PSD, Band Edge is observed at antenna 1 port, hence the results of antenna 2 port are not reported.**

**Antenna Used**

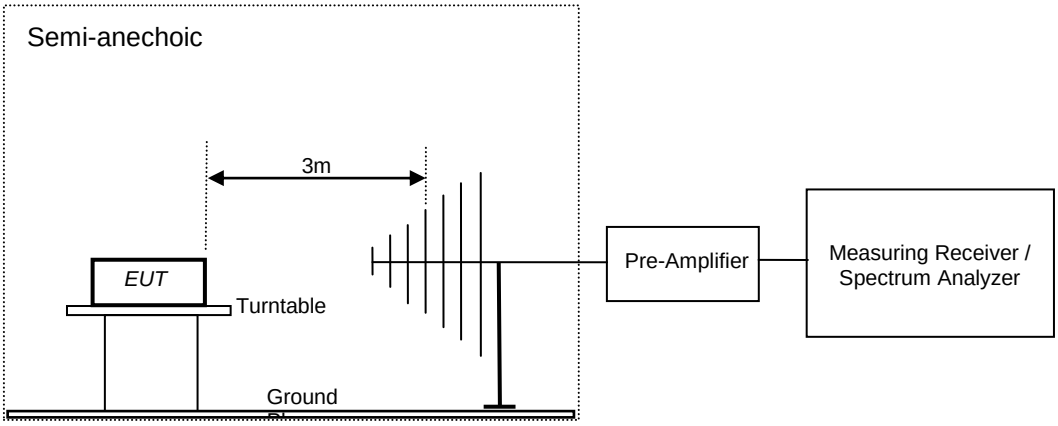
| Antenna Number | Make | Model/Part # | Antenna Gain (dBi) | Type of Antenna |
|---|---|---|---|---|
| Antenna 1 | Johanson Technology | 2450AT18D0100 | 1.5dBi | Ceramic Antenna |
| Antenna 2 | Tekfun Co., Ltd | M01-SS2 | 0dBi | External Antenna |

# Test Methodology

**Radiated Emission Test**

The radiated emission measurement was performed according to the procedures in ANSI C63.4-2003. The equipment under test (EUT) was placed at the middle of the 80 cm high turntable, and the EUT is 3 meters far from the measuring antenna. The turntable was rotated 360˚ for obtaining the maximum emission. The height of the measuring antennas was scanned between 1m and 4m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. Repeat the measurement steps until the maximum emissions were obtained. The measurement above 1000MHz was performed by horn antenna. The measurement below 30MHz was performed by loop antenna.

The EUT was rotated around the X-, Y-, and Z-Axis and the results from worst case axis are recorded.

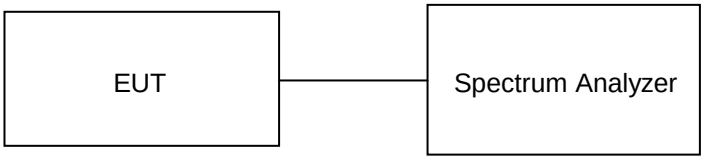


# Test Results

**Maximum Conducted Peak Output Power** **Section 15.247(b) (3)**
**Result** **Pass**

| | |
|---|---|
| Test Specification | FCC Part 15 Subpart C |
| Measurement Bandwidth (RBW) | 1 MHz |
| Detector | Peak |
| Requirement | <1 watt (30dBm). |

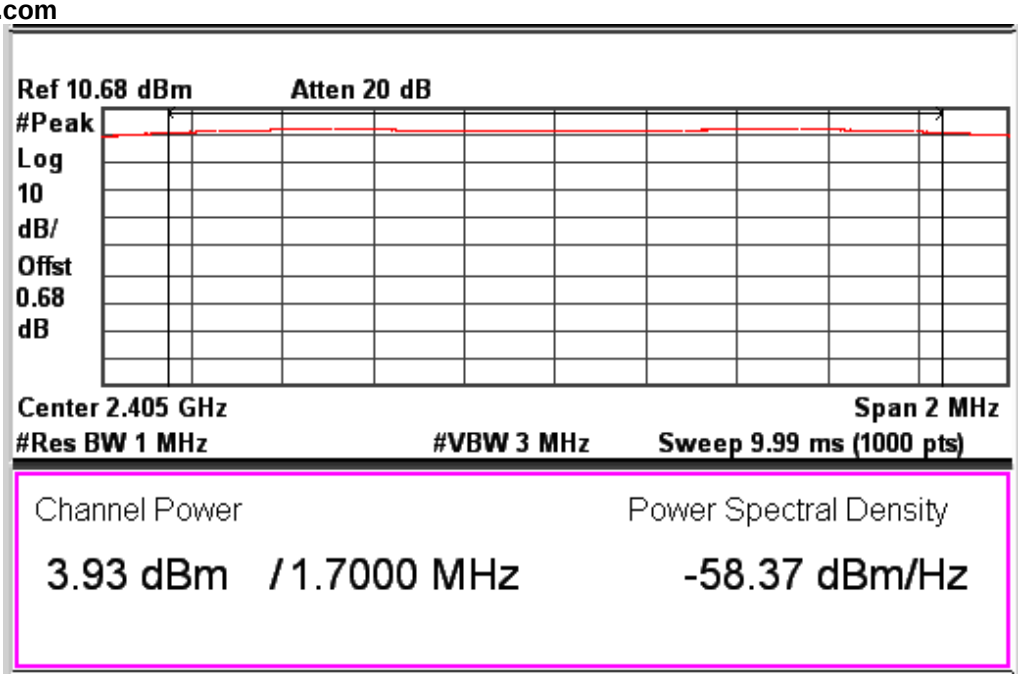
**Test Method:**



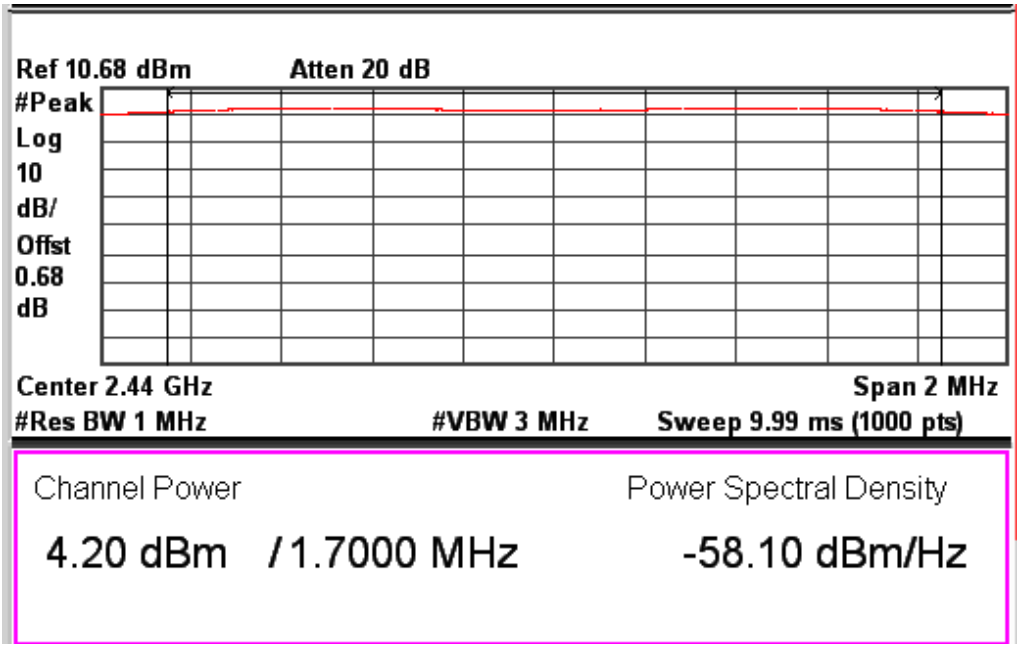

**Note: Conducted Power measured at both antenna terminal but maximum power is observed at antenna 1 port, hence the results of antenna 2 port are not reported.**

**Test Result:**

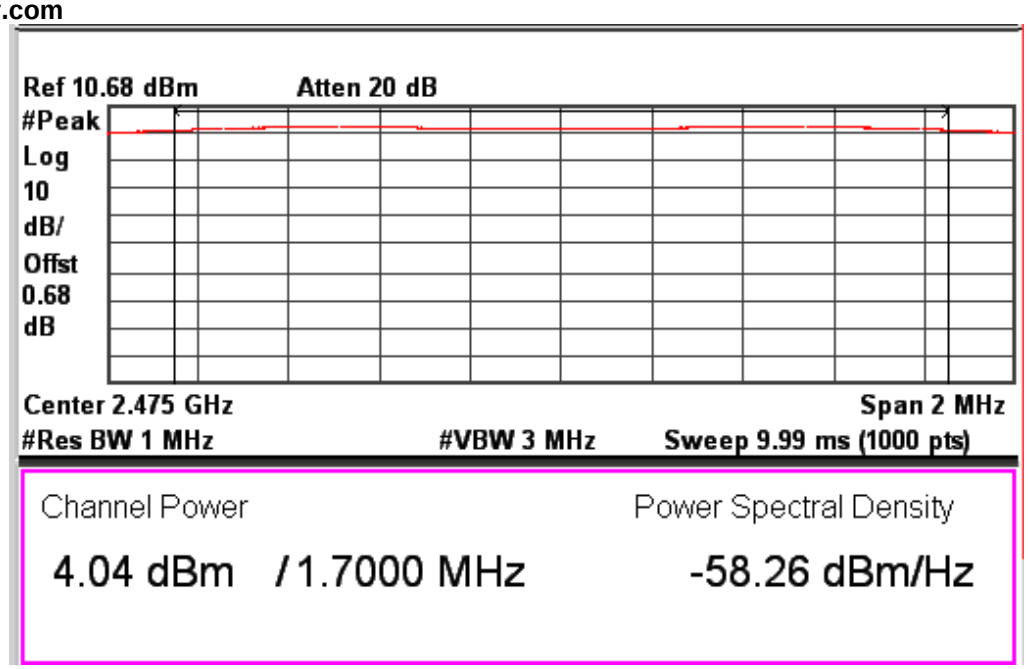
| Frequency (MHz) | Total Output power (dBm) | Limit (dBm) |
|---|---|---|
| 2405 | 3.93 | 30.00 |
| 2440 | 4.20 | 30.00 |
| 2475 | 4.04 | 30.00 |




**Channel Frequency: 2405 MHz**




**Channel Frequency: 2440 MHz**

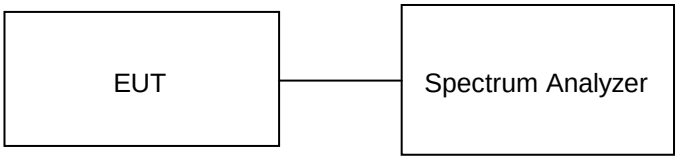



**Channel Frequency: 2475 MHz**

**Power Spectral Density** **Section 15.247(e)**
**Result** **Pass**

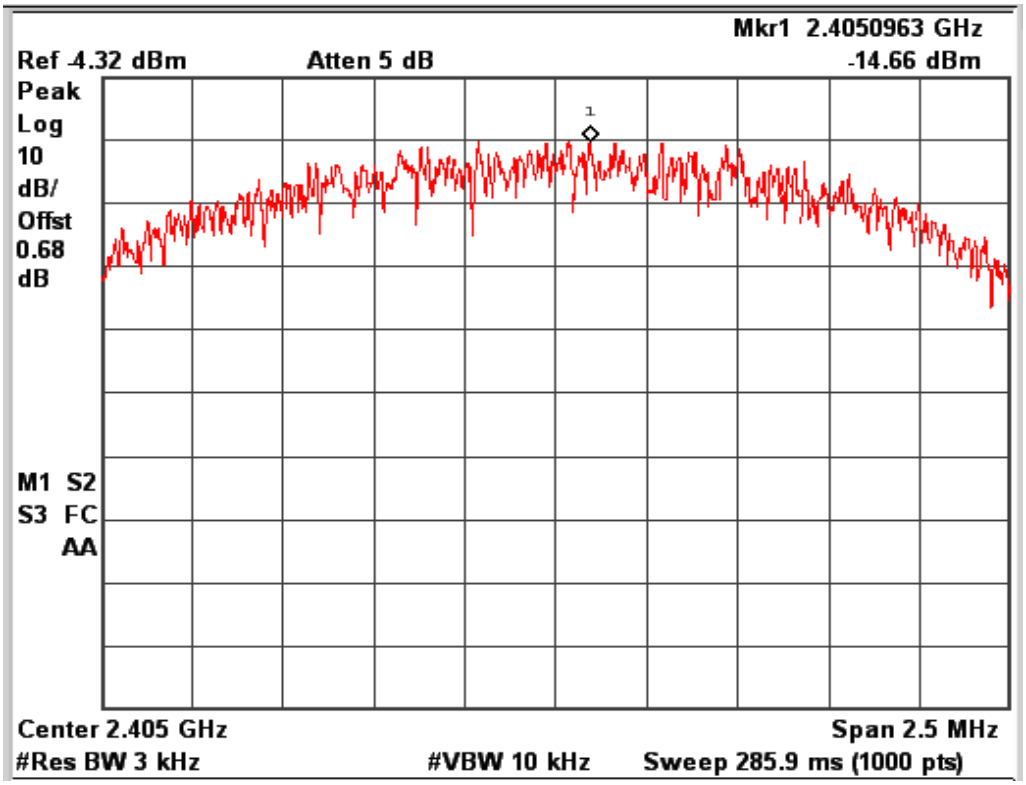
| | |
|---|---|
| Test Specification | FCC Part 15 Subpart C |
| Detector Function | Peak |
| Requirement | For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm. |

**Test Method:**

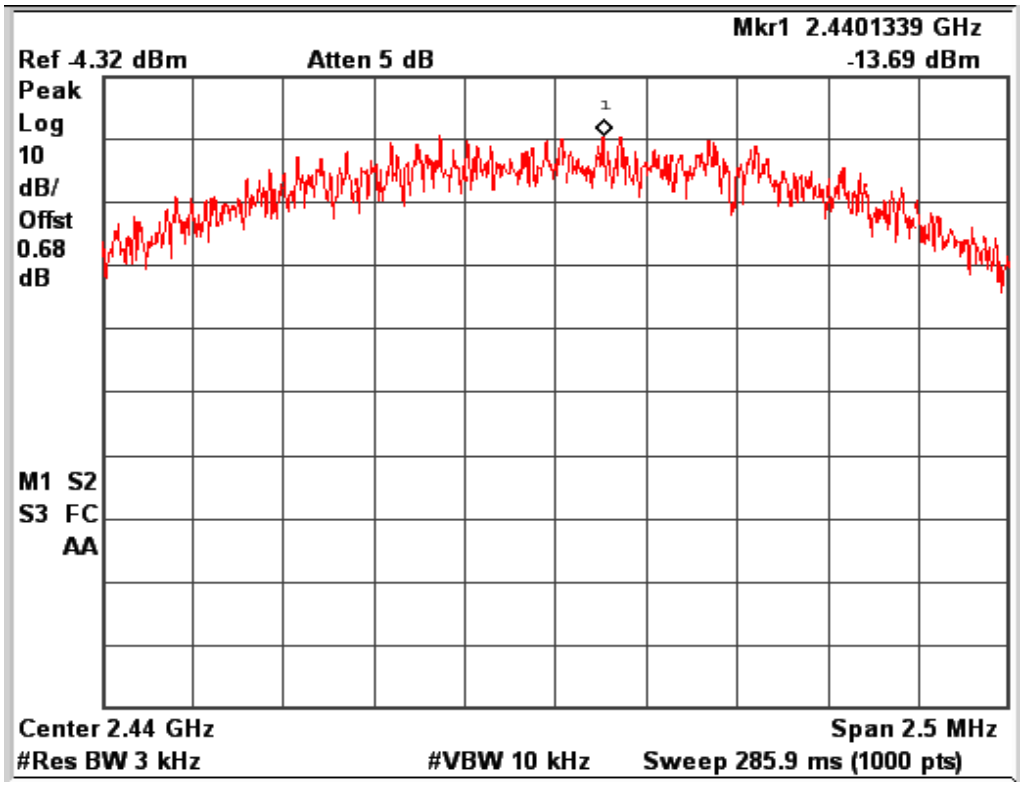



**Test Result:**

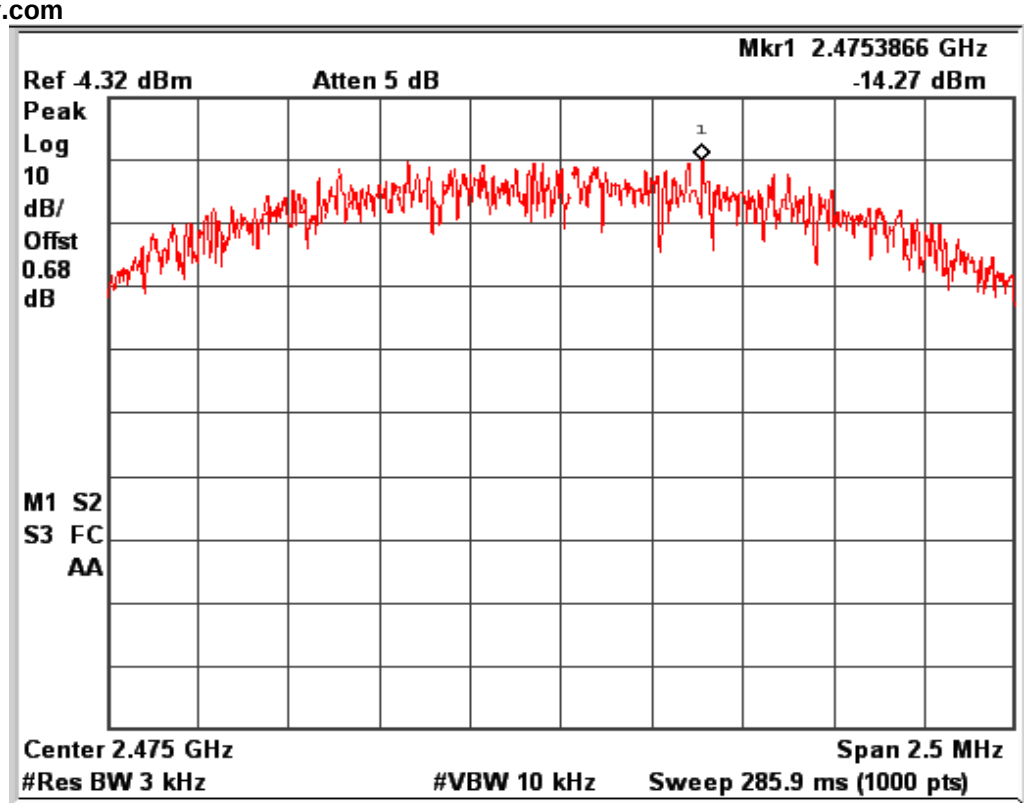
| Frequency (MHz) | Total PSD (dBm) | Limit (dBm) |
|---|---|---|
| 2405 | -14.66 | 8.00 |
| 2440 | -13.69 | 8.00 |
| 2475 | -14.27 | 8.00 |




**Channel Frequency: 2405 MHz**




**Channel Frequency: 2440 MHz**

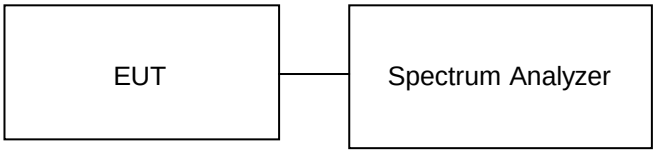



**Channel Frequency: 2475 MHz**

**6 dB Bandwidth** **Section 15.247(a) (2)**
**Result** **Pass**

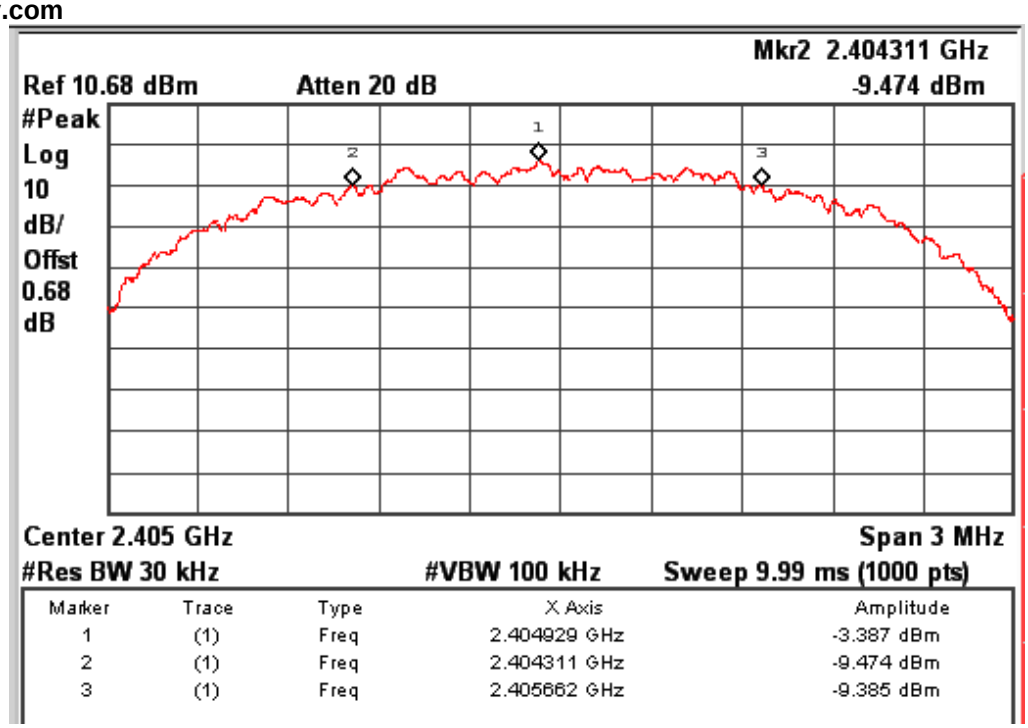
Test Specification FCC Part 15 Subpart C
Requirement The minimum 6 dB bandwidth shall be at least 500 kHz.

**Test Method:**

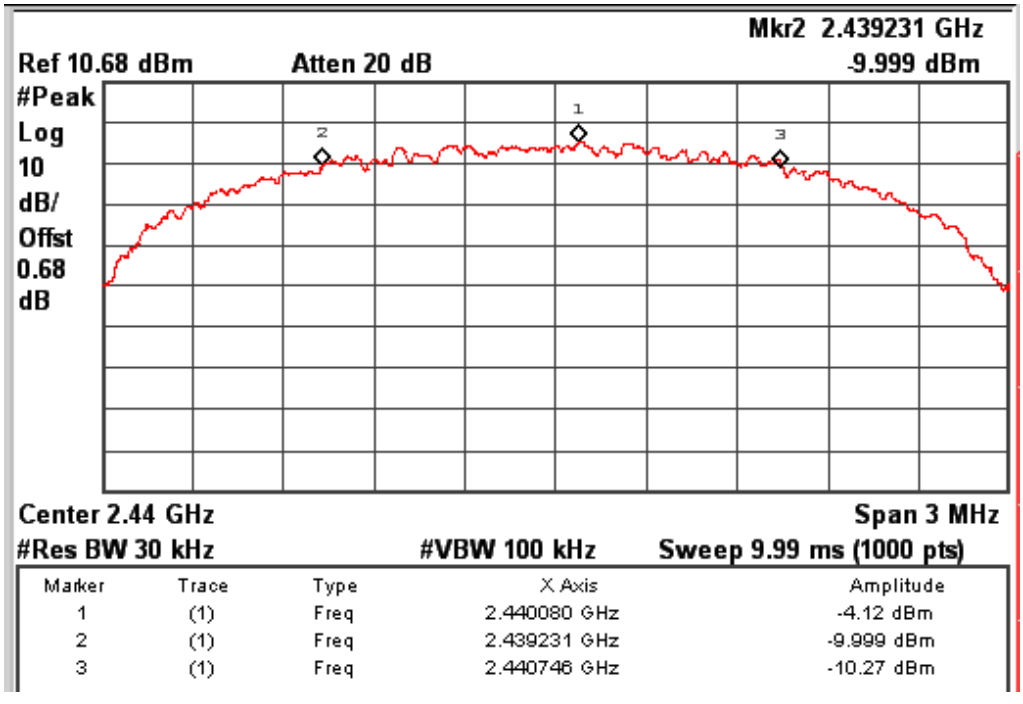



**Test Result:**

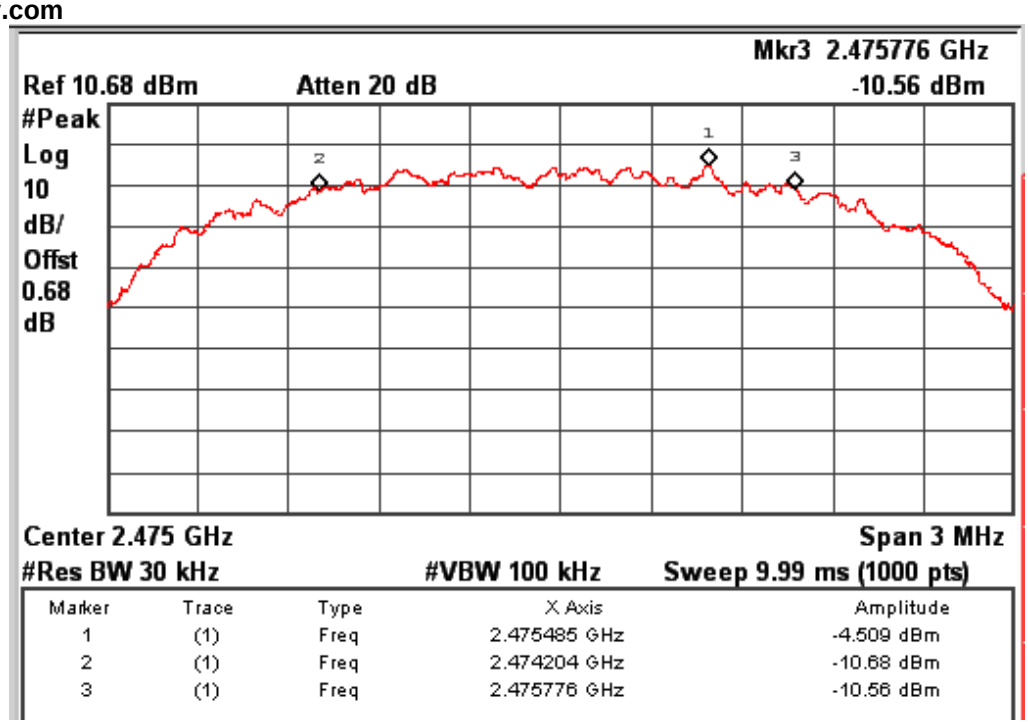
| Frequency (MHz) | Lower Frequency (MHz) | Upper Frequency (MHz) | 6 dB Bandwidth (MHz) | OBW (MHz) |
|---|---|---|---|---|
| 2405 | 2404.31 | 2405.66 | 1.35 | 2.36 |
| 2440 | 2439.23 | 2440.74 | 1.51 | 2.40 |
| 2475 | 2474.2 | 2475.77 | 1.57 | 2.48 |



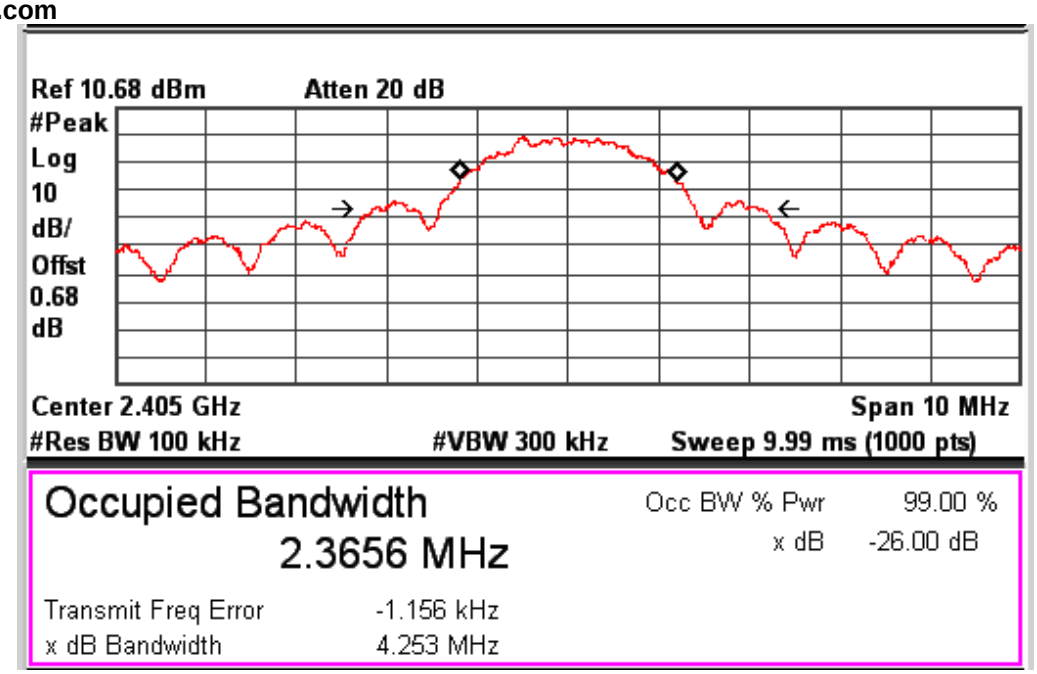

**Channel frequency: 2405 MHz**



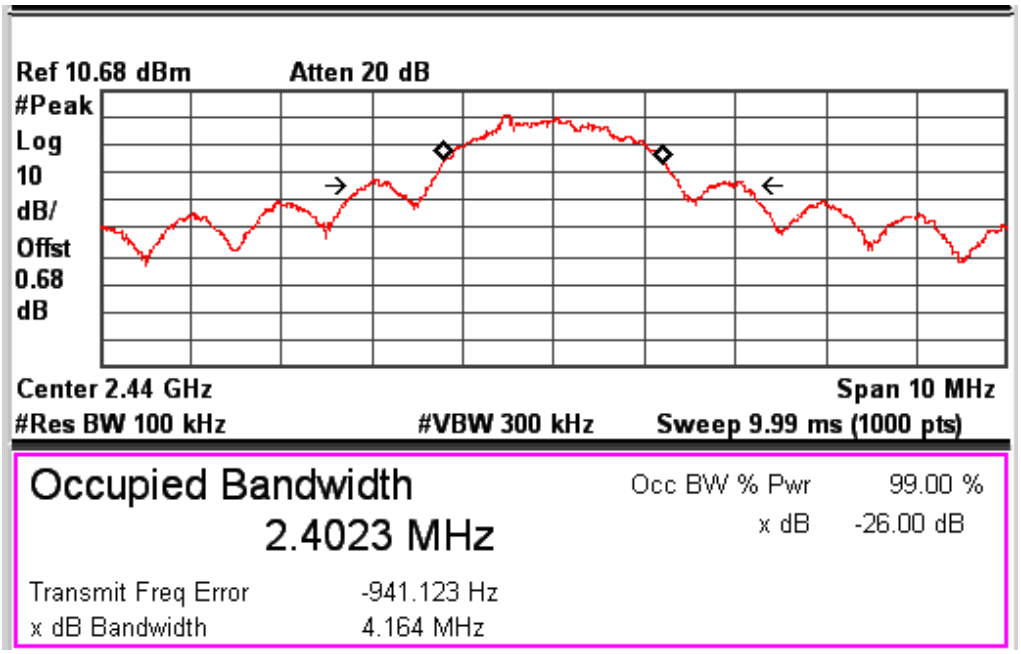

**Channel frequency: 2440 MHz**



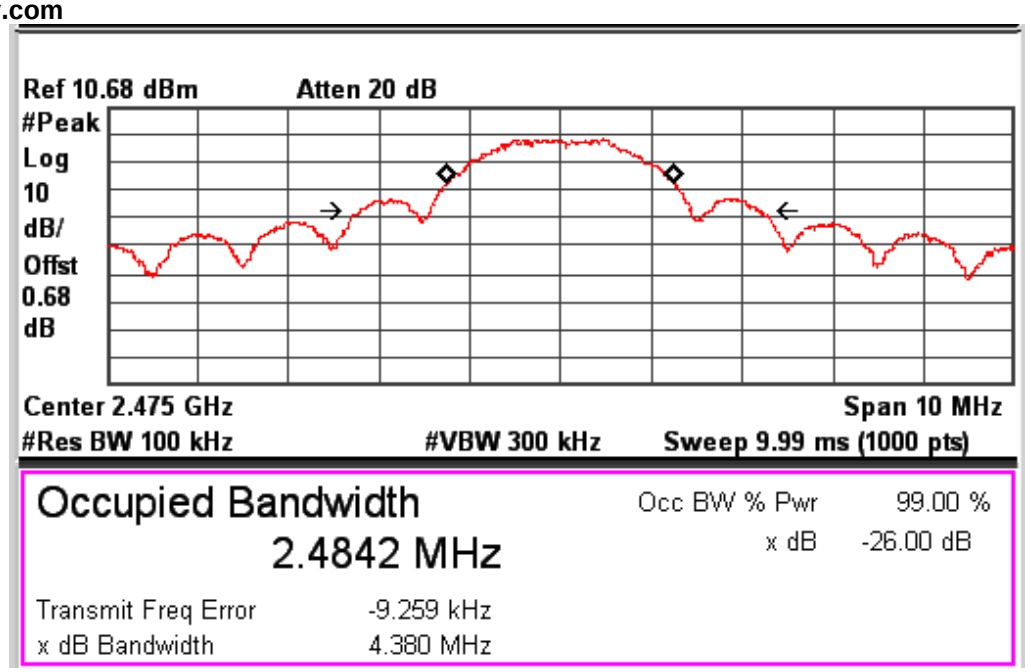

**Channel frequency: 2475 MHz**




**OBW Channel frequency: 2405 MHz**




**OBW Channel frequency: 2440 MHz**



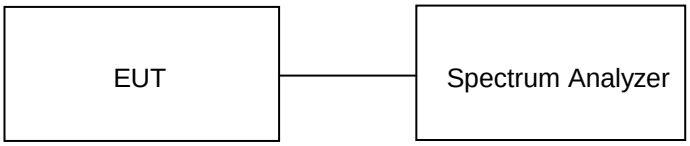

**OBW Channel frequency: 2475 MHz**

**Band-edge Compliance** **Section 15.247(d)**

**Result** **Pass**

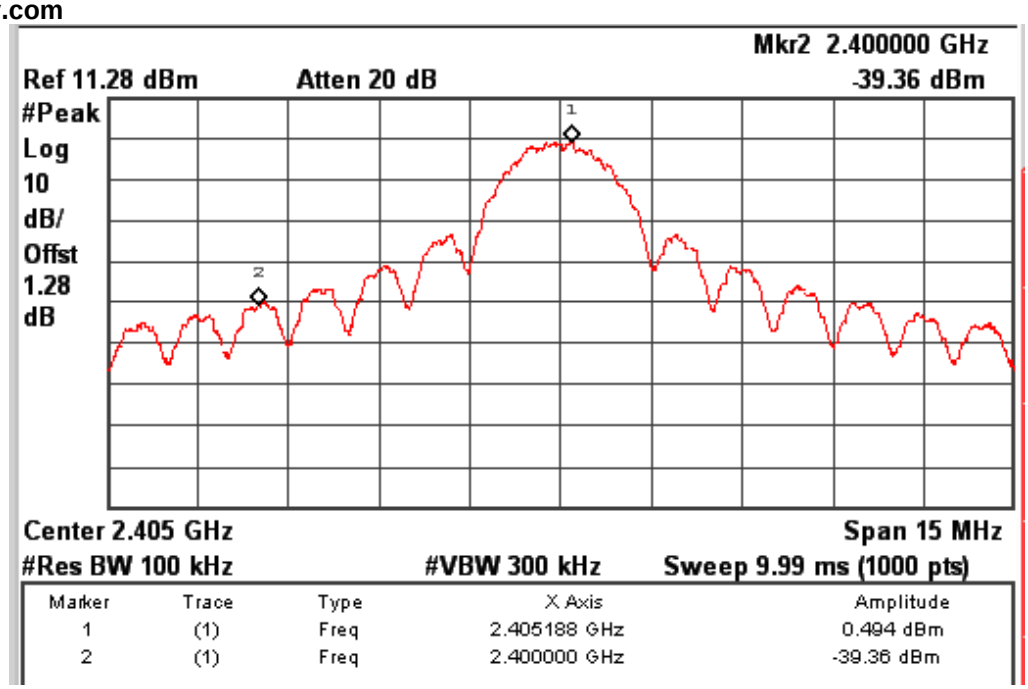
| | |
|---|---|
| Test Specification | FCC Part 15 Subpart C |
| Detector Function | Peak |
| Requirement | If the peak output power procedure is used to measure the fundamental emission power to demonstrate compliance to **15.247(b)(3)** requirements, then the peak conducted output power measured within any 100 kHz outside the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum measured in-band peak PSD level in 100kHz(i.e.20dBc)<br>If the average output power procedure is used to measure the fundamental emission power to demonstrate compliance to 15.247(b)(3) requirements, then the power in any 100 kHz outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum measured in-band average PSD level(i.e.30dBc) |

**Test Method:**

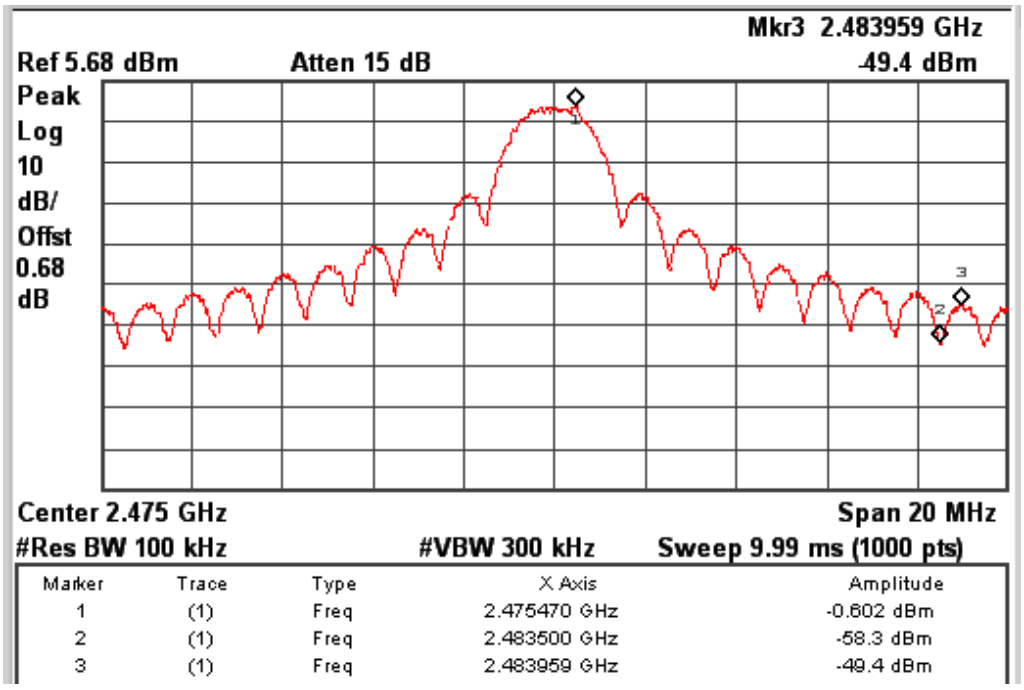



**Test Result:**

| Frequency (MHz) | Value at Band Edge | | Limit (dBc) |
|---|---|---|---|
| | Frequency(MHz) | Value (dBc) | |
| 2405 | 2400.00 | -39.854 | 20.00 |
| 2475 | 2483.50 | -57.698 | 20.00 |



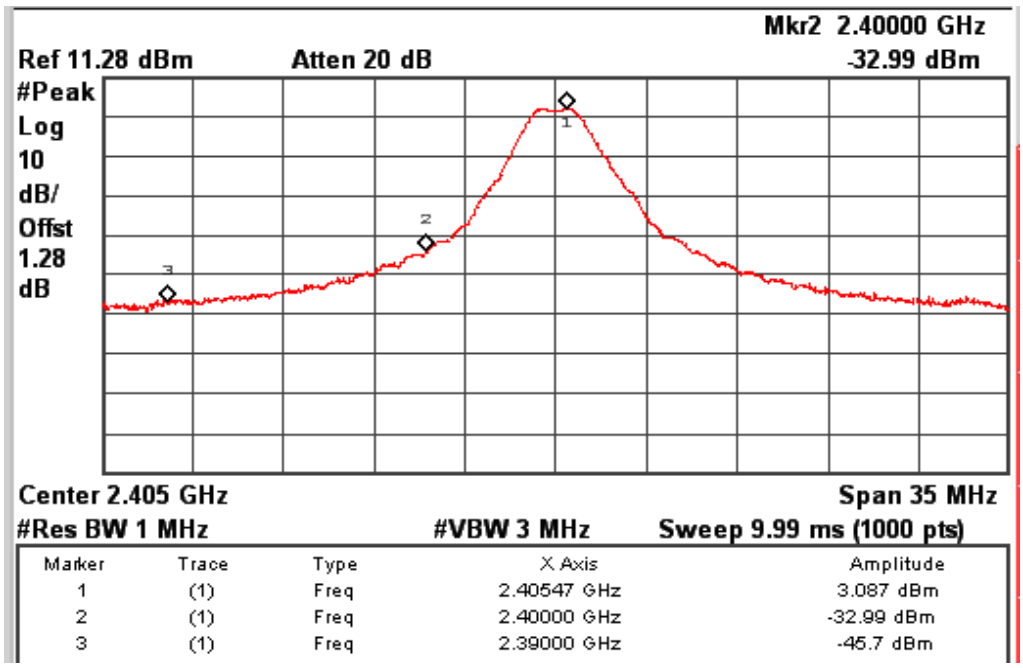

**Channel frequency: 2405 MHz**




**Channel frequency: 2475 MHz**

**Antenna-Port Conducted Emissions Measurements at restricted bands**

**Channel Low**



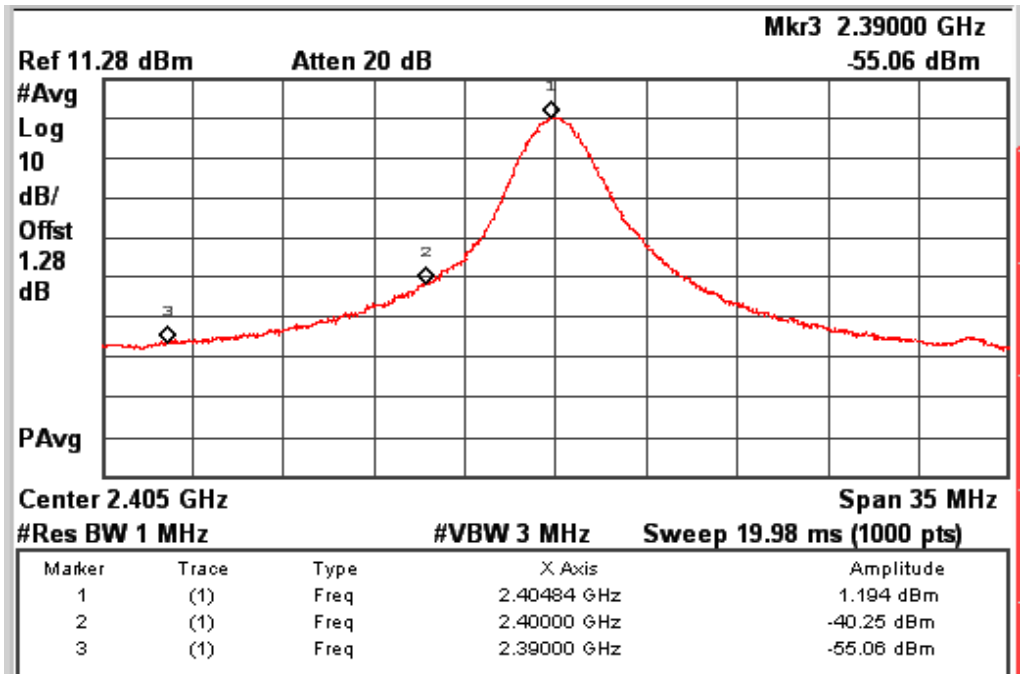

E = EIRP -20log (d) + 104.8

EIRP = the equivalent isotropic radiated power in dBm, i.e. -45.7

E = electric field strength in dBµV/m, i.e. peak limit is 74 dBµV/m

d = measurement distance in meters. I.e. 3m

**E=-45.7-20*log (3) +104.8= 49.56 which is under 74 dBµV/m limit.**



E = EIRP -20log (d) + 104.8

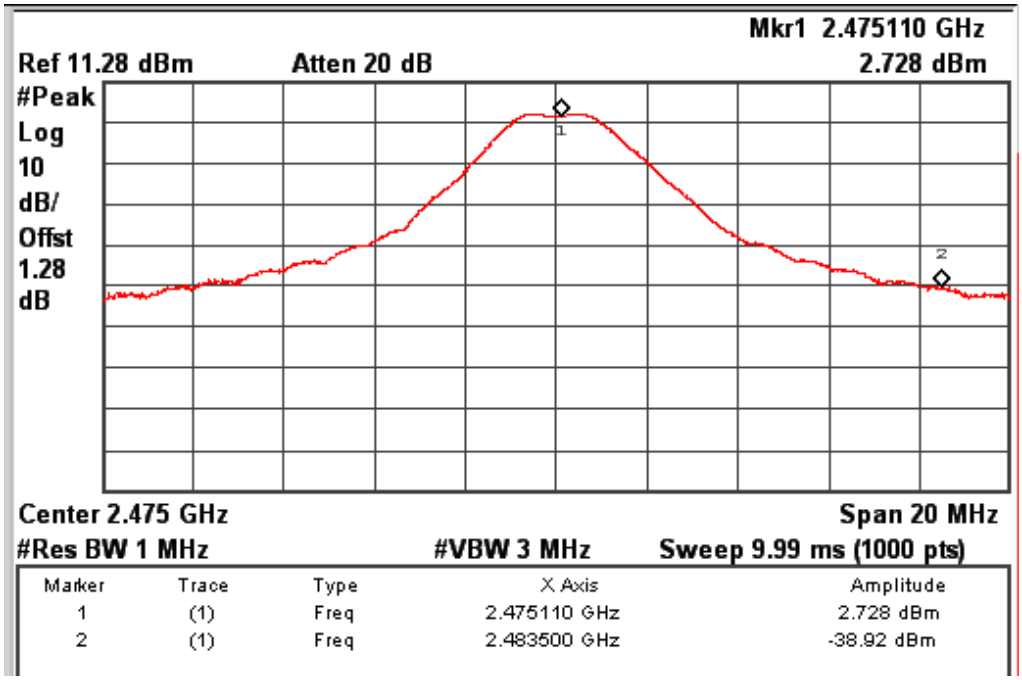
EIRP = the equivalent isotropic radiated power in dBm, i.e. -55.06

E = electric field strength in dBµV/m, i.e. Average limit is 54 dBµV/m

d = measurement distance in meters. I.e. 3m

**E=-55.06-20*log (3) +104.8= 40.19 which is under 54 dBµV/m limit.**

**Channel High**



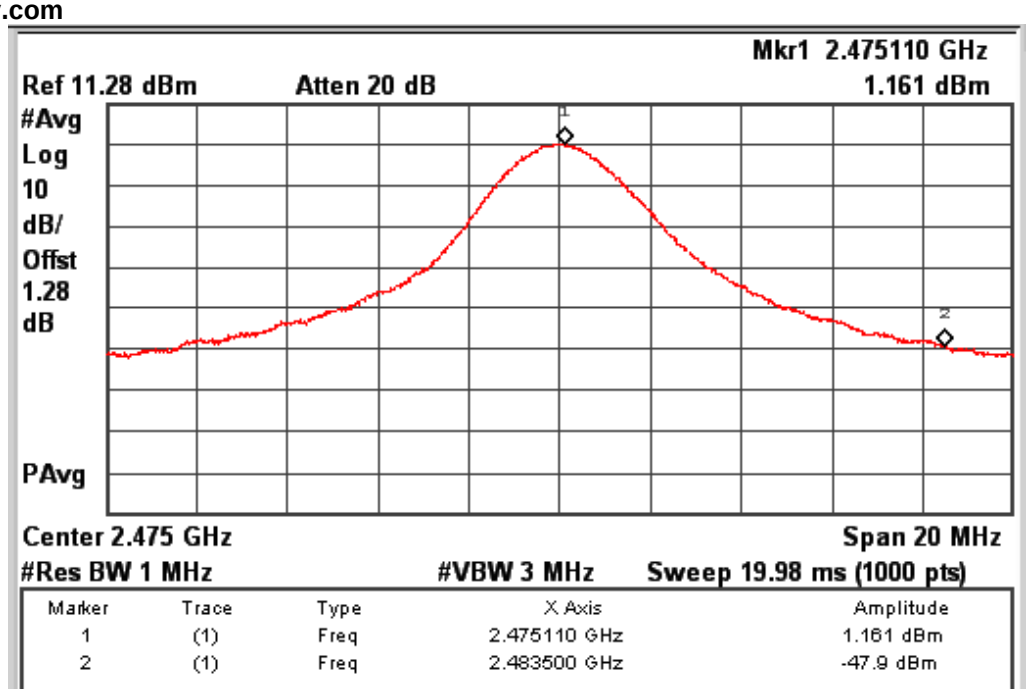

E = EIRP -20log (d) + 104.8

EIRP = the equivalent isotropic radiated power in dBm, i.e. -38.92

E = electric field strength in dBµV/m, i.e. peak limit is 74 dBµV/m

d = measurement distance in meters. I.e. 3m

**E=-38.92-20*log (3) +104.8= 56.33 which is under 74 dBµV/m limit.**




E = EIRP -20log (d) + 104.8

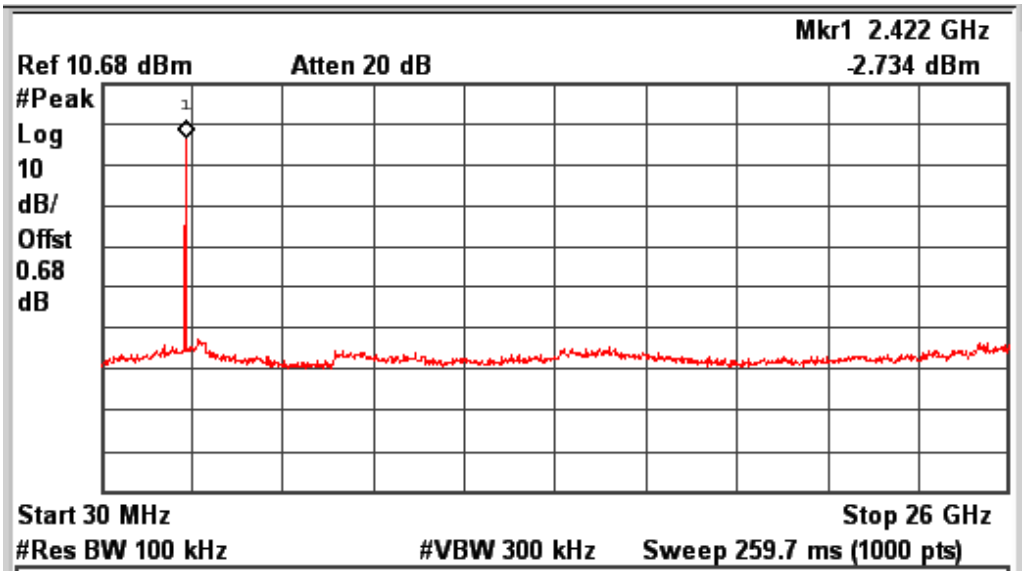
EIRP = the equivalent isotropic radiated power in dBm, i.e. -47.9

E = electric field strength in dBµV/m, i.e. Average limit is 54 dBµV/m

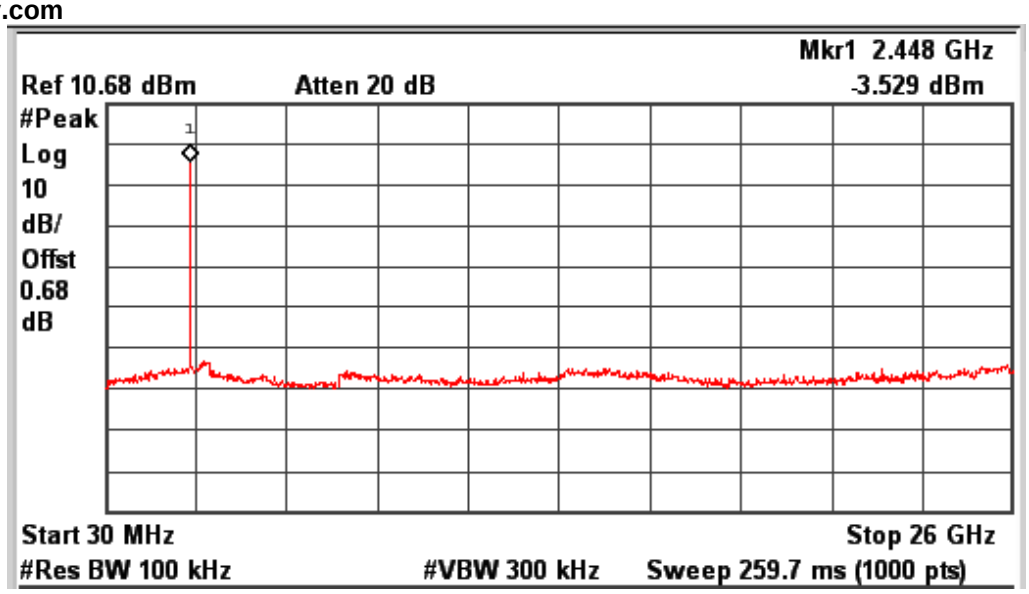
d = measurement distance in meters. I.e. 3m

**E=-47.9-20*log (3) +104.8= 47.35 which is under 54 dBµV/m limit.**

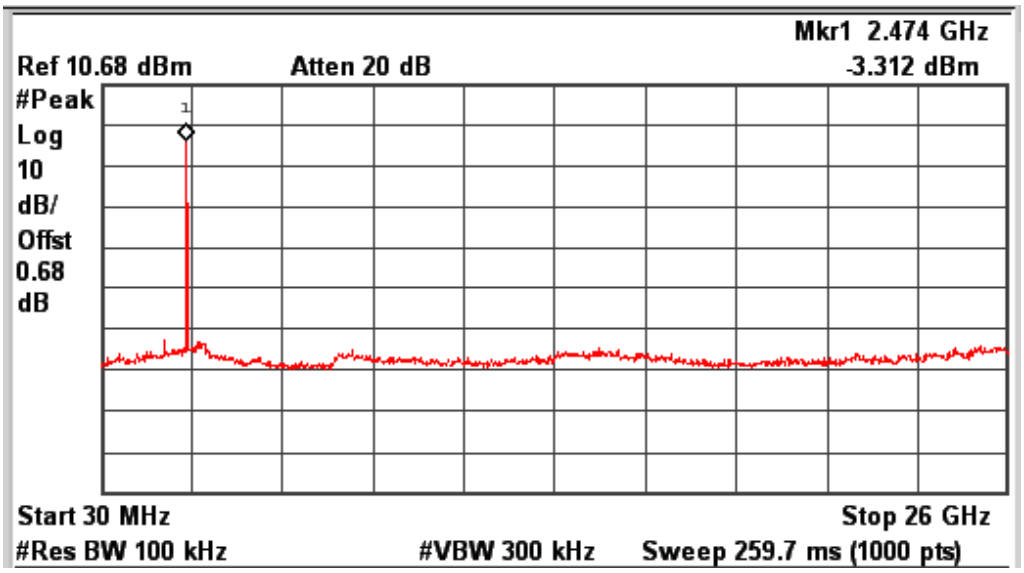
**Conducted Spurious Emission**




**Channel frequency: 2405 MHz**




**Channel frequency: 2440 MHz**




**Channel frequency: 2475 MHz**

**Spurious Radiated Emissions and Restricted Bands of Operation** **Section 15.209 and 15.205**

**Result** **Pass**

| | |
|---|---|
| Test Specification | FCC Part 15 Subpart C |
| Test Method | ANSI C63.4-2003 |
| Measurement Location | Semi Anechoic Chamber |
| Measuring Distance | 3m |
| Detection | QP for frequency below 1GHz, Peak and Average for frequency above 1GHz |
| Requirement | As per the limits mentioned in the bellow table |

**Limit for Radiated Emission of Section 15.209:**

| Frequency (MHz) | Field strength (µV/m) | Field strength (dBµV/m) | Distance of Measurement (m) |
|---|---|---|---|
| 0.009 – 0.490 | 2400/F(kHz) | 48.50 – 13.80 | 300* |
| 0.490 – 1.705 | 24000/F(kHz) | 33.80 – 23.00 | 30* |
| 1.705 -30 | 30 | 29.54 | 30* |
| 30-88 | 100 | 40.0 | 3 |
| 88-216 | 150 | 43.5 | 3 |
| 216-960 | 200 | 46.0 | 3 |
| Above 960 | 500 | 54.0 | 3 |

Remark: * the limit shows in the table above of frequency range 0.009 – 0.490, 0.490 – 1.705 MHz and 1.705-30MHz is at 300 meter, 30 meter and 30 meter range respectively, which corresponds to 88, 50 – 53.80, 53.80 – 43.00 and 49.5dBµV/m at 3m range by extrapolation calculation and the measurement of loop antenna.

The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz Radiated emission limits in these three bands are based on measurements employing an average detector.

## Test result:

**There were no emissions found in the frequency range below 1GHz and hence they are not reported.**

| Antenna | Channel | Polarization | Frequency (MHz) | Field Strength (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|
| Antenna1 | Low | V | 2389.32(Pk) | 44.73 | 74 | -29.27 |
| | | | 2390(Av) | 30.76 | 54 | -23.24 |
| | | | 2405(Pk) | 91.82 | * | - |
| | | | 2405(Av) | 88.66 | * | - |
| | | | 4810(Pk) | 50.7 | 74 | -23.3 |
| | | | 4810(Av) | 38.78 | 54 | -15.22 |
| | | H | 2390(Pk) | 46.42 | 74 | -27.58 |
| | | | 2390(Av) | 38.12 | 54 | -15.88 |
| | | | 2405(Pk) | 101.11 | * | - |
| | | | 2405(Av) | 97.93 | * | - |
| | | | 4810(Pk) | 52.64 | 74 | -21.36 |
| | | | 4810(Av) | 42.69 | 54 | -11.31 |
| | Mid | V | 2440(Pk) | 91.34 | * | - |
| | | | 2440(Av) | 87.96 | * | - |
| | | | 4880(Pk) | 51.12 | 74 | -22.88 |
| | | | 4880(Av) | 38.39 | 54 | -15.61 |
| | | H | 2440(Pk) | 100.22 | * | - |
| | | | 2440(Av) | 96.88 | * | - |
| | | | 4880(Pk) | 51.05 | 74 | -22.95 |
| | | | 4880(Av) | 40.62 | 54 | -13.38 |
| | High | V | 2475(Pk) | 92.65 | * | - |
| | | | 2475(Av) | 89.18 | * | - |
| | | | 2483.5(Pk) | 48.33 | 74 | -25.67 |
| | | | 2483.5(Av) | 39.11 | 54 | -14.89 |
| | | | 4950(Pk) | 49.85 | 74 | -24.15 |
| | | | 4950(Av) | 38.79 | 54 | -15.21 |
| | | H | 2475(Pk) | 100.86 | * | - |
| | | | 2475(Av) | 97.38 | * | - |
| | | | 2483.5(Pk) | 55.92 | 74 | -18.08 |
| | | | 2484(Av) | 47 | 54 | -7 |
| | | | 4950(Pk) | 52.31 | 74 | -21.69 |
| | | | 4950(Av) | 41.34 | 54 | -12.66 |
| Antenna 2 | Low | V | 2390(Pk) | 48.13 | 74 | -25.87 |
| | | | 2390(Av) | 36.2 | 54 | -17.8 |
| | | | 2405(Pk) | 98.2 | * | - |
| | | | 2405(Av) | 98.09 | * | - |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | 4810(Pk) | 50.46 | 74 | -23.54 |
| | | | 4810(Av) | 38.77 | 54 | -15.23 |
| | | H | 2390(Pk) | 45.83 | 74 | -28.17 |
| | | | 2390(Av) | 38.5 | 54 | -15.5 |
| | | | 2405(Pk) | 98.82 | * | - |
| | | | 2405(Av) | 95.8 | * | - |
| | | | 4810(Pk) | 50.39 | 74 | -23.61 |
| | | | 4810(Av) | 39.8 | 54 | -14.2 |
| | Mid | V | 2440(Pk) | 96.53 | * | - |
| | | | 2440(Av) | 93.37 | * | - |
| | | | 4880(Pk) | 50.06 | 74 | -23.94 |
| | | | 4880(Av) | 37.33 | 54 | -16.67 |
| | | H | 2440(Pk) | 96.82 | * | - |
| | | | 2440(Av) | 93.61 | * | - |
| | | | 4880(Pk) | 51.31 | 74 | -22.69 |
| | | | 4880(Av) | 39.48 | 54 | -14.52 |
| | High | V | 2475(Pk) | 94.44 | * | - |
| | | | 2475(Av) | 91.03 | * | - |
| | | | 2483.5(Pk) | 50.65 | 74 | -23.35 |
| | | | 2483.5(Av) | 41.38 | 54 | -12.62 |
| | | | 4950(Pk) | 50.28 | 74 | -23.72 |
| | | | 4950(Av) | 37.91 | 54 | -16.09 |
| | | H | 2475(Pk) | 92.63 | * | - |
| | | | 2475(Av) | 89.09 | * | - |
| | | | 2483.5(Pk) | 48.18 | 74 | -25.82 |
| | | | 2484(Av) | 38.54 | 54 | -15.46 |
| | | | 4950(Pk) | 50.65 | 74 | -23.35 |
| | | | 4950(Av) | 40.19 | 54 | -13.81 |

* - --> Fundamental Frequency
Pk--> Peak Detector
Av--> Average Detector