

January 8, 2020

HID Global Corporation  
6533 Flying Cloud Drive  
Eden Prairie, MN 55344

Dear Robert Cresswell,

Enclosed is the EMC Wireless test report for compliance testing of the HID Global Corporation, Model: 40K as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Part 15 Subpart C for Intentional Radiators.

Thank you for using the services of Eurofins MET Labs, Inc. If you have any questions regarding these results or if MET can be of further service to you, please feel free to contact me.

Sincerely yours,  
EUROFINS MET LABS, INC.



Michelle Tawmging  
Documentation Department

Reference: (\HID Global Corporation\EMCA104938-FCC247 SRD 40K Rev. 4)

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## **Electromagnetic Compatibility Criteria Test Report**

for the

**HID Global Corporation  
HID Signo Reader  
Model: 40K**

**Tested under**  
the FCC Certification Rules  
contained in  
15.247 Subpart C for Intentional Radiators

**MET Report: EMCA104938-FCC247 SRD 40K Rev. 4**

January 8, 2020

**Prepared For:**

**HID Global Corporation  
6533 Flying Cloud Drive  
Eden Prairie, MN 55344**

**Prepared By:**  
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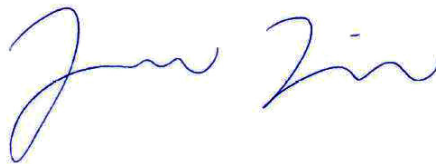


Adan Arab, Project Engineer  
Electromagnetic Compatibility Lab



Michelle Tawmging  
Documentation Department

**Engineering Statement:** The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC Rules Part 15.247 under normal use and maintenance.



Jonathan Tavira,  
Manager, Electromagnetic Compatibility Lab

## Report Status Sheet

| Revision | Report Date       | Reason for Revision                      |
|----------|-------------------|------------------------------------------|
| Ø        | October 22, 2019  | Initial Issue                            |
| 1        | October 24, 2019  | Implemented Customer-Requested Revisions |
| 2        | October 29, 2019  | Implemented Customer-Requested Revisions |
| 3        | November 13, 2019 | Implemented Customer-Requested Revisions |
| 4        | January 8, 2020   | Implemented TCB-Requested Revisions      |

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## List of Terms and Abbreviations

|                              |                                               |
|------------------------------|-----------------------------------------------|
| <b>AC</b>                    | Alternating Current                           |
| <b>ACF</b>                   | Antenna Correction Factor                     |
| <b>Cal</b>                   | Calibration                                   |
| <b>d</b>                     | Measurement Distance                          |
| <b>dB</b>                    | Decibels                                      |
| <b>dB<math>\mu</math>A</b>   | Decibels above one <b>microamp</b>            |
| <b>dB<math>\mu</math>V</b>   | Decibels above one <b>microvolt</b>           |
| <b>dB<math>\mu</math>A/m</b> | Decibels above one <b>microamp per meter</b>  |
| <b>dB<math>\mu</math>V/m</b> | Decibels above one <b>microvolt per meter</b> |
| <b>DC</b>                    | Direct Current                                |
| <b>E</b>                     | Electric Field                                |
| <b>DSL</b>                   | Digital Subscriber Line                       |
| <b>ESD</b>                   | Electrostatic Discharge                       |
| <b>EUT</b>                   | Equipment Under Test                          |
| <b>f</b>                     | Frequency                                     |
| <b>FCC</b>                   | Federal Communications Commission             |
| <b>GRP</b>                   | Ground Reference Plane                        |
| <b>H</b>                     | Magnetic Field                                |
| <b>HCP</b>                   | Horizontal Coupling Plane                     |
| <b>Hz</b>                    | Hertz                                         |
| <b>IEC</b>                   | International Electrotechnical Commission     |
| <b>kHz</b>                   | kilohertz                                     |
| <b>kPa</b>                   | kilopascal                                    |
| <b>kV</b>                    | kilovolt                                      |
| <b>LISN</b>                  | Line Impedance Stabilization Network          |
| <b>MHz</b>                   | Megahertz                                     |
| <b><math>\mu</math>H</b>     | <b>microhenry</b>                             |
| <b><math>\mu</math></b>      | <b>microfarad</b>                             |
| <b><math>\mu</math>s</b>     | <b>microseconds</b>                           |
| <b>NEBS</b>                  | Network Equipment-Building System             |
| <b>PRF</b>                   | Pulse Repetition Frequency                    |
| <b>RF</b>                    | Radio Frequency                               |
| <b>RMS</b>                   | Root-Mean-Square                              |
| <b>TWT</b>                   | Traveling Wave Tube                           |
| <b>V/m</b>                   | Volts <b>per meter</b>                        |
| <b>VCP</b>                   | Vertical Coupling Plane                       |

# I. Executive Summary

## A. Purpose of Test

An EMC evaluation was performed to determine compliance of the HID Global Corporation Model: 40K, with the requirements of Part 15, §15.247. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the Model: 40K. HID Global Corporation should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Model: 40K, has been **permanently** discontinued.

## B. Executive Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, §15.247, in accordance with HID Global Corporation, quote number HID000518. All tests were conducted using measurement procedure ANSI C63.10-2013.

| FCC Reference<br>47 CFR Part 15.247:2005                        | Description                                    | Compliance<br>Model: 40K Pigtail | Compliance<br>Model: 40K Terminal |
|-----------------------------------------------------------------|------------------------------------------------|----------------------------------|-----------------------------------|
| Title 47 of the CFR, Part 15<br>§15.203                         | Antenna Requirement                            | Compliant                        | Compliant                         |
| Title 47 of the CFR, Part 15<br>§15.207(a)                      | Conducted Emission Limits                      | Compliant                        | Compliant                         |
| Title 47 of the CFR, Part 15<br>§15.247(a)(2)                   | 6dB Occupied Bandwidth                         | Compliant                        | Compliant                         |
| Title 47 of the CFR, Part 15<br>§15.247(b)                      | Peak Power Output                              | Compliant                        | Compliant                         |
| Title 47 of the CFR, Part 15<br>§15.247(c)                      | Spurious Emissions in Non-<br>restricted Bands | Compliant                        | Compliant                         |
| Title 47 of the CFR, Part 15<br>§15.247(d); §15.209;<br>§15.205 | Radiated Spurious<br>Emissions Requirements    | Compliant                        | Compliant                         |
| Title 47 of the CFR, Part<br>15; §15.247(e)                     | Peak Power Spectral<br>Density                 | Compliant                        | Compliant                         |
| Title 47 of the CFR, Part 15<br>§15.247(i)                      | RF Human Exposure, SAR<br>Exclusion            | Compliant                        | Compliant                         |

**Figure 1: Executive Summary of EMC Part 15.247 Compliance Testing**

## II. Equipment Configuration

## A. Overview

Eurofins MET Labs, Inc. was contracted by HID Global Corporation to perform testing on the Model: 40K, under HID Global Corporation's quote number HID000518.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the HID Global Corporation, Model: 40K.

The results obtained relate only to the item(s) tested.

|                                       |                                                         |                 |
|---------------------------------------|---------------------------------------------------------|-----------------|
| <b>Models Tested:</b>                 | 40K Pigtail and Terminal                                |                 |
| <b>Models Covered:</b>                | 40K                                                     |                 |
| <b>EUT Specifications:</b>            | Primary Power: 12 VDC                                   |                 |
|                                       | FCC ID: JQ6-SIGNO40K                                    |                 |
|                                       | <b>Type of Modulations:</b>                             | GFSK            |
|                                       | <b>Equipment Code:</b>                                  | DTS             |
|                                       | <b>Peak RF Output Power:</b>                            | 1.23 dBm        |
|                                       | <b>EUT Frequency Ranges:</b>                            | 2400-2483.5 MHz |
|                                       | <b>Transmit Speeds:</b>                                 | 1 Mbps, 2 Mbps  |
|                                       | <b>Antenna Type:</b>                                    | PCB Patch       |
|                                       | <b>Antenna Gain:</b>                                    | -1.7 dBi        |
|                                       | <b>Firmware Version:</b>                                | R9.1.0.19       |
| <b>Analysis:</b>                      | The results obtained relate only to the item(s) tested. |                 |
| <b>Environmental Test Conditions:</b> | Temperature: 15-35° C                                   |                 |
|                                       | Relative Humidity: 30-60%                               |                 |
|                                       | Barometric Pressure: 860-1060 mbar                      |                 |
| <b>Evaluated by:</b>                  | Jonathan Tavira and Adan Arab                           |                 |
| <b>Report Date:</b>                   | January 8, 2020                                         |                 |

Figure 2: EUT Summary Table

## B. References

|                                   |                                                                                                                                                                       |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CFR 47, Part 15, Subpart C</b> | Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: General Rules and Regulations, Allocation, Assignment, and Use of Radio Frequencies |
| <b>ANSI C63.4:2014</b>            | Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz                                |
| <b>ISO/IEC 17025:2017</b>         | General Requirements for the Competence of Testing and Calibration Laboratories                                                                                       |
| <b>ANSI C63.10-2013</b>           | American National Standard for Testing Unlicensed Wireless Devices                                                                                                    |
| <b>KDB 558074 D01 V05r02</b>      | Guidance For Performing Compliance Measurements On Digital Transmission Systems (DTS) Operating Under Section 15.247                                                  |

**Figure 3: References**

## C. Test Site

All testing was performed at Eurofins MET Labs, Inc., 13501 McCallen Pass, Austin, TX 78753. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed in a 3 meter semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at MET Laboratories.

## D. Measurement Uncertainty

| Test Method                                  | Typical Expanded Uncertainty | K | Confidence Level |
|----------------------------------------------|------------------------------|---|------------------|
| <b>RF Frequencies</b>                        | ±4.52 Hz                     | 2 | 95%              |
| <b>RF Power Conducted Emissions</b>          | ±2.32 dB                     | 2 | 95%              |
| <b>RF Power Conducted Spurious Emissions</b> | ±2.25 dB                     | 2 | 95%              |
| <b>RF Power Radiated Emissions</b>           | ±3.01 dB                     | 2 | 95%              |

**Figure 4: Uncertainty Calculations Summary**

## E. Description of Test Sample

The Model: 40K, Equipment Under Test (EUT), is typically installed near doorway as part of physical access system, to control access to that door. A user will approach the door and present a BLE or RFID credentials to the reader with intention of entering the door. The reader will read the credential and send its data to a connected access control panel, which determine whether or not grant the user access to the door. Optionally, a personal identification number (PIN) may also be required, in which case the user will enter the PIN on the reader's keypad.

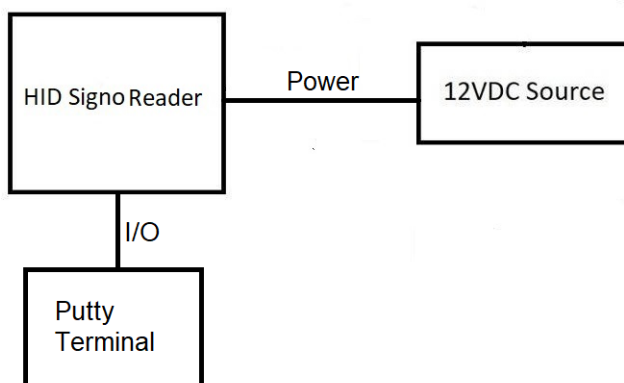


Figure 5: Block Diagram of Test Configuration

## F. Equipment Configuration

The EUT was set up as outlined in **Figure 5**. All cards, racks, etc., incorporated as part of the EUT is included in the following list.

| Ref. ID | Slot # | Name / Description | Model Number | Part Number | Serial Number | Rev. # |
|---------|--------|--------------------|--------------|-------------|---------------|--------|
|         | N/A    | HID Signo Reader   | 40K          | N/A         | N/A           | N/A    |

Figure 6: Equipment List

## G. Support Equipment

Support equipment necessary for the operation and testing of the EUT is included in the following list.

| Ref. ID | Slot # | Name / Description | Model Number     | Part number | Serial Number | Rev. # |
|---------|--------|--------------------|------------------|-------------|---------------|--------|
| N/A     | N/A    | 12VDC Source       | DURACELL Battery | N/A         | N/A           | N/A    |
| N/A     | N/A    | Tablet             | Galaxy Tab 4     | N/A         | N/A           | N/A    |

**Figure 7: Support Equipment**

## H. Ports and Cabling Information

| Ref. ID | Port name on EUT | Cable Description or reason for no cable | Qty | Length as tested (m) | Max Length(m) | Shielded? (Y/N) | Termination Box ID & Port Name |
|---------|------------------|------------------------------------------|-----|----------------------|---------------|-----------------|--------------------------------|
| 1       | +VDC             | Power                                    | 1   | 0.3                  | 0.3           | Y               |                                |
| 2       | GND              | Power                                    | 1   | 0.3                  | 0.3           | Y               |                                |
| 3       | Data1            | Data                                     | 1   | 0.3                  | 0.3           | Y               |                                |
| 4       | Data0            | Data                                     | 1   | 0.3                  | 0.3           | Y               |                                |
| 5       | GLD              | Data                                     | 1   | 0.3                  | 0.3           | Y               |                                |
| 6       | RLY1             | Data                                     | 1   | 0.3                  | 0.3           | Y               |                                |
| 7       | RLY2             | Data                                     | 1   | 0.3                  | 0.3           | Y               |                                |
| 8       | RLED             | Data                                     | 1   | 0.3                  | 0.3           | Y               |                                |
| 9       | HOLD             | Data                                     | 1   | 0.3                  | 0.3           | Y               |                                |
| 10      | Beep             | Data                                     | 1   | 0.3                  | 0.3           | Y               |                                |

**Figure 8: Ports and Cabling Information**

## I. Mode of Operation

A 12V DC provided to the EUT, once booting process done and LED's on readers turn solid RED the unit is ready to be tested. An HF/LF credential were presented to the reader for a continuously operation. The unit will beep every few seconds and LED's flashing constantly means that the unit is reading and data is going back and forth between the credential and the reader. In order to operate the BT radio, a tablet was paired to the unit via BT link and signal information presented via the HID app to insure connection is constant.

## J. Method of Monitoring EUT Operation

BT: a tablet was paired via BT link with the HID app. BT signal data shown on tablet screen through the HID app to ensure link is alive and reader-tablet link is live.

**K. Modifications****a) Modifications to EUT**

No modifications were made to the EUT.

**b) Modifications to Test Standard**

No modifications were made to the test standard.

**L. Disposition of EUT**

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to HID Global Corporation upon completion of testing.

### **III. Electromagnetic Compatibility Criteria for Intentional Radiators**

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.203 Antenna Requirement

**Test Requirement:** § 15.203: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

The structure and application of the EUT were analyzed to determine compliance with Section 15.203 of the Rules. Section 15.203 states that the subject device must meet at least one of the following criteria:

- a.) Antenna must be permanently attached to the unit.
- b.) Antenna must use a unique type of connector to attach to the EUT.
- c.) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

#### Model: 40K Pigtail

**Test Results:** The EUT was tested is **compliant** with § 15.203 Antenna Requirement. The 40K-Pigtail Smart Card Reader uses a PCB etched antenna that is permanently attached. The 40K-Pigtail Smart Card Reader meets all requirements of 15.203.

**Test Engineer:** Jonathan Tavira

**Test Date:** September 18, 2019

#### Model: 40K Terminal

**Test Results:** The EUT was tested is **compliant** with § 15.203 Antenna Requirement. The 40K-Terminal Smart Card Reader uses a PCB etched antenna that is permanently attached. The 40K-Terminal Smart Card Reader meets all requirements of 15.203.

**Test Engineer:** Jonathan Tavira

**Test Date:** September 16, 2019

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.207(a) Conducted Emissions Limits

**Test Requirement(s):** § 15.207 (a): For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30MHz, shall not exceed the limits in the following table, as measured using a 50  $\mu$ H/50  $\Omega$  line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

| Frequency range (MHz) | § 15.207(a), Conducted Limit (dB $\mu$ V) |         |
|-----------------------|-------------------------------------------|---------|
|                       | Quasi-Peak                                | Average |
| * 0.15- 0.5           | 66 - 56                                   | 56 - 46 |
| 0.5 - 5               | 56                                        | 46      |
| 5 - 30                | 60                                        | 50      |

**Figure 9: Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)**

**Test Procedure:** The EUT was placed on a 0.8 m-high wooden table inside a screen room. The EUT was situated such that the back of the EUT was 0.4 m from one wall of the vertical ground plane, and the remaining sides of the EUT were no closer than 0.8 m from any other conductive surface. The EUT was powered from a 50  $\Omega$ /50  $\mu$ H Line Impedance Stabilization Network (LISN). The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. Conducted Emissions measurements were made in accordance with ANSI C63.4-2014 "Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz". The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50  $\Omega$ /50  $\mu$ H LISN as the input transducer to an EMC/field intensity meter. For the purpose of this testing, the transmitter was turned on. Scans were performed with the transmitter on.

#### Sample Calculation:

$$R_r - S = M$$

where:

R<sub>r</sub> = Receiver Reading in dB $\mu$ V  
S = Specification Limit in dB $\mu$ V  
M = Margin to Specification in +/- dB

#### Sample formula for calculating the Corrected Data for the Conducted Emissions Measurements:

| Line | Freq (MHz) | Uncorrected QP** Amplitude (dB $\mu$ V) | LISN IL (dB) | CBL (dB) | Corrected QP** Amplitude (dB $\mu$ V) | QP** Limit (dB $\mu$ V) | Delta (dB) | Results |
|------|------------|-----------------------------------------|--------------|----------|---------------------------------------|-------------------------|------------|---------|
| XYZ  | 0.18       | 42.65                                   | 10           | 0.58     | 53.23                                 | 79                      | -25.77     | Pass    |

Corrected QP\*\* Amplitude (dB $\mu$ V) = Uncorrected Amplitude (dB $\mu$ V) + LISN IL (dB) + CBL (dB) = 42.65 + 10 + 0.58 = 53.23

\*\* Same Calculation applies to Corrected Avg. amplitude as well

### Model: 40K Pigtail

**Test Results:** The EUT was tested is **compliant** with § 15.207(a) Conducted Emissions Limits. Measured emissions were below applicable limits.

**Test Engineer:** Adan Arab

**Test Date:** August 7, 2019

### Test Data, Model: 40K Pigtail

| Meas. Location                                       | Meas. mΩ | Limit    | Pass/Fail |
|------------------------------------------------------|----------|----------|-----------|
| Bonding measurement from LISN ground to ground plane | 0.889    | < 2.5 mΩ | Pass      |

| Line              | Freq (MHz) | QP Amplitude | QP Limit | Delta  | Pass | Average Amplitude | Average Limit | Delta  | Pass |
|-------------------|------------|--------------|----------|--------|------|-------------------|---------------|--------|------|
| Line1_120VAC 60Hz | 0.466      | 49.90        | 56.602   | -6.70  | Pass | 41.10             | 46.600        | -5.50  | Pass |
| Line1_120VAC 60Hz | 0.498      | 46.80        | 56.034   | -9.23  | Pass | 34.50             | 46.030        | -11.53 | Pass |
| Line1_120VAC 60Hz | 0.874      | 37.70        | 56.000   | -18.30 | Pass | 26.30             | 46.000        | -19.70 | Pass |
| Line1_120VAC 60Hz | 1.278      | 41.10        | 56.000   | -14.90 | Pass | 31.40             | 46.000        | -14.60 | Pass |
| Line1_120VAC 60Hz | 0.610      | 40.70        | 56.000   | -15.30 | Pass | 32.50             | 46.000        | -13.50 | Pass |
| Line1_120VAC 60Hz | 2.154      | 37.70        | 56.000   | -18.30 | Pass | 27.00             | 46.000        | -19.00 | Pass |

Figure 10: Conducted Emissions Limits, Pigtail, Phase Line, Test Results

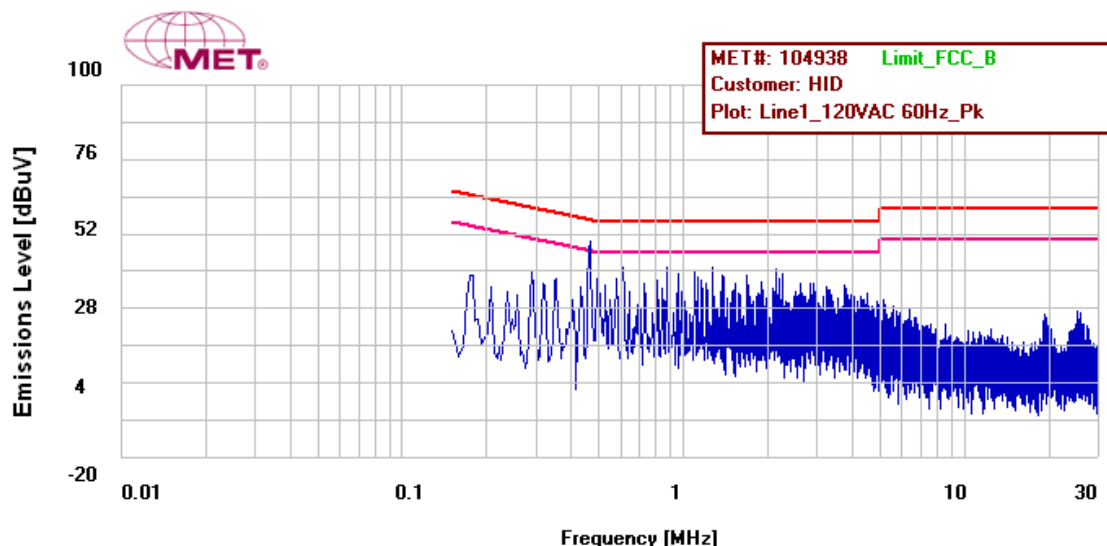


Figure 11: Conducted Emissions Limits, Pigtail, Phase Line, Prescan

| Line                | Freq (MHz) | QP Amplitude | QP Limit | Delta  | Pass | Average Amplitude | Average Limit | Delta  | Pass |
|---------------------|------------|--------------|----------|--------|------|-------------------|---------------|--------|------|
| Neutral_120VAC 60Hz | 0.482      | 32.80        | 56.31    | -23.51 | Pass | 16.90             | 46.313        | -29.41 | Pass |
| Neutral_120VAC 60Hz | 0.522      | 42.60        | 56.00    | -13.40 | Pass | 30.80             | 46.000        | -15.20 | Pass |
| Neutral_120VAC 60Hz | 0.814      | 34.30        | 56.00    | -21.70 | Pass | 23.00             | 46.000        | -23.00 | Pass |
| Neutral_120VAC 60Hz | 0.174      | 40.60        | 64.77    | -24.17 | Pass | 28.40             | 54.771        | -26.37 | Pass |
| Neutral_120VAC 60Hz | 1.338      | 36.80        | 56.00    | -19.20 | Pass | 25.20             | 46.000        | -20.80 | Pass |
| Neutral_120VAC 60Hz | 0.754      | 34.40        | 56.00    | -21.60 | Pass | 23.50             | 46.000        | -22.50 | Pass |

Figure 12: Conducted Emissions Limits, Terminal, Neutral Line, Test Results

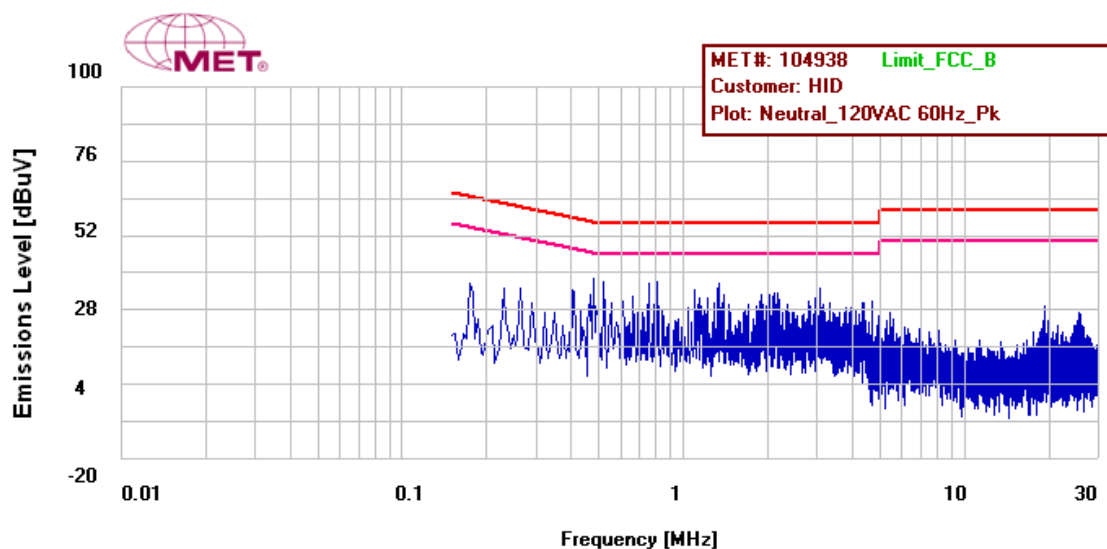


Figure 13: Conducted Emissions Limits, Terminal, Neutral Line, Prescan

### Model: 40K Terminal

**Test Results:** The EUT was tested is **compliant** with § 15.207(a) Conducted Emissions Limits. Measured emissions were below applicable limits.

**Test Engineer:** Adan Arab

**Test Date:** August 5, 2019

### Test Data, Model: 40K Terminal

| Meas. Location                                       | Meas. mΩ | Limit    | Pass/Fail |
|------------------------------------------------------|----------|----------|-----------|
| Bonding measurement from LISN ground to ground plane | 0.876    | < 2.5 mΩ | Pass      |

| Line              | Freq (MHz) | QP Amplitude | QP Limit | Delta  | Pass | Average Amplitude | Average Limit | Delta  | Pass |
|-------------------|------------|--------------|----------|--------|------|-------------------|---------------|--------|------|
| Line1_120VAC 60Hz | 0.438      | 46.00        | 57.124   | -11.12 | Pass | 33.40             | 47.124        | -13.72 | Pass |
| Line1_120VAC 60Hz | 0.526      | 42.40        | 56.000   | -13.60 | Pass | 33.60             | 46.000        | -12.40 | Pass |
| Line1_120VAC 60Hz | 0.466      | 50.30        | 56.602   | -6.30  | Pass | 40.60             | 46.602        | -6.00  | Pass |
| Line1_120VAC 60Hz | 0.406      | 41.80        | 57.752   | -15.95 | Pass | 40.90             | 47.752        | -6.85  | Pass |
| Line1_120VAC 60Hz | 0.234      | 41.90        | 62.317   | -20.42 | Pass | 33.30             | 52.317        | -19.02 | Pass |
| Line1_120VAC 60Hz | 0.350      | 40.90        | 58.982   | -18.08 | Pass | 32.20             | 48.982        | -16.78 | Pass |

Figure 14: Conducted Emissions Limits, Terminal, Phase Line, Test Results

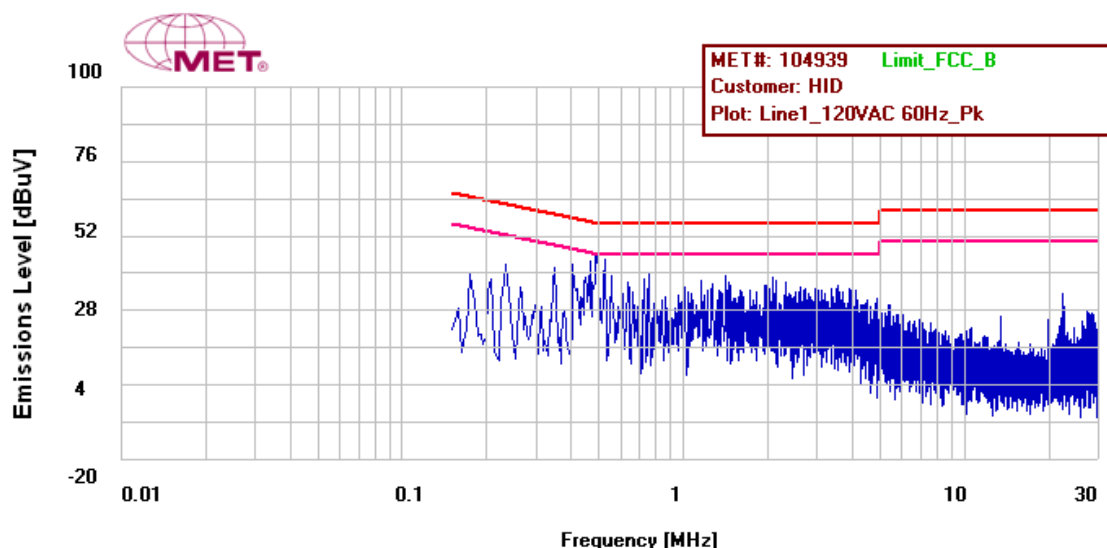


Figure 15: Conducted Emissions Limits, Terminal, Phase Line, Prescan

| Line                | Freq (MHz) | QP Amplitude | QP Limit | Delta  | Pass | Average Amplitude | Average Limit | Delta  | Pass |
|---------------------|------------|--------------|----------|--------|------|-------------------|---------------|--------|------|
| Neutral_120VAC 60Hz | 0.466      | 46.80        | 56.602   | -9.80  | Pass | 35.80             | 46.602        | -10.80 | Pass |
| Neutral_120VAC 60Hz | 0.498      | 40.90        | 56.034   | -15.13 | Pass | 28.80             | 46.034        | -17.23 | Pass |
| Neutral_120VAC 60Hz | 0.482      | 36.90        | 56.313   | -19.41 | Pass | 22.50             | 46.313        | -23.81 | Pass |
| Neutral_120VAC 60Hz | 0.666      | 35.00        | 56.000   | -21.00 | Pass | 25.10             | 46.000        | -20.90 | Pass |
| Neutral_120VAC 60Hz | 0.184      | 43.10        | 64.308   | -21.21 | Pass | 30.10             | 54.308        | -24.20 | Pass |
| Neutral_120VAC 60Hz | 2.090      | 31.90        | 56.000   | -24.10 | Pass | 20.70             | 46.000        | -25.30 | Pass |

Figure 16: Conducted Emissions Limits, Terminal, Neutral Line, Test Results

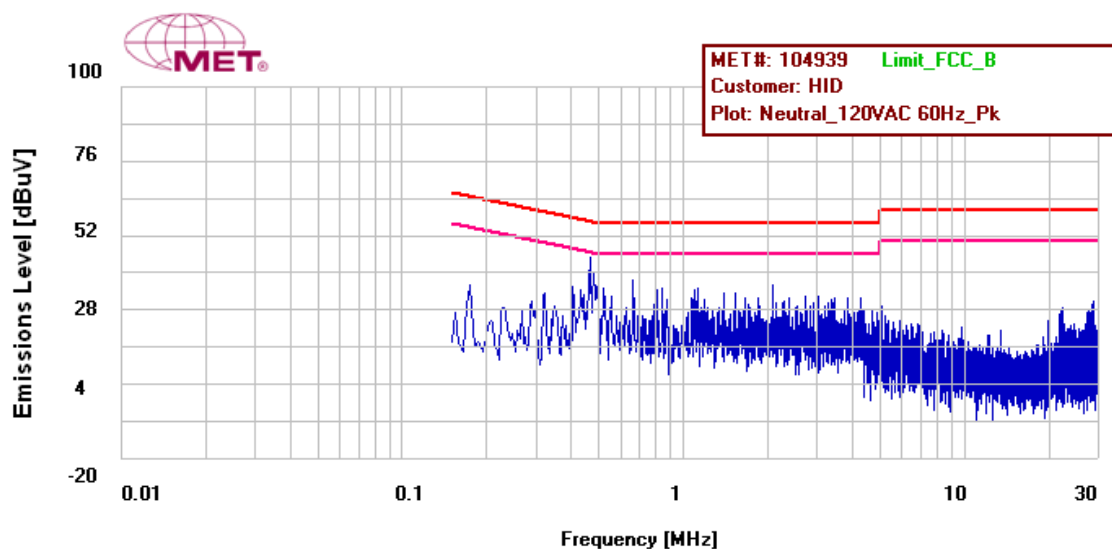


Figure 17: Conducted Emissions Limits, Terminal, Neutral Line, Prescan

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247(a)(2) 6 dB Bandwidth

**Test Requirements:** § 15.247(a)(2): Operation under the provisions of this section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

For systems using digital modulation techniques, the EUT may operate in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands. The minimum 6dB bandwidth shall be at least 500 kHz.

**Test Procedure:** The transmitter was on and transmitting at the highest output power. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW = 100kHz, VBW = 3\*RBW. The 6 dB Bandwidth was measured and recorded. The measurements were performed on the low, mid and high channels.



**Figure 18: Block Diagram, Occupied Bandwidth Test Setup**

### Model: 40K Pigtail

**Test Results:** The EUT was tested is **compliant** with § 15.247(a)(2) 6 dB Bandwidth. No anomalies were noted.

The 6 dB Bandwidth was determined from the plots on the following pages.

**Test Engineer:** Jonathan Tavira

**Test Date:** September 18, 2019

### Test Data, Model: 40K Pigtail

| Mode   | Channel (MHz) | 6 dB Bandwidth (MHz) | Limit (MHz)  |
|--------|---------------|----------------------|--------------|
| 1 Mbps | 2402          | 0.759963             | $\geq 0.500$ |
| 1 Mbps | 2442          | 0.788955             | $\geq 0.500$ |
| 1 Mbps | 2480          | 0.743060             | $\geq 0.500$ |
| 2 Mbps | 2402          | 1.309000             | $\geq 0.500$ |
| 2 Mbps | 2442          | 1.326000             | $\geq 0.500$ |
| 2 Mbps | 2480          | 1.326000             | $\geq 0.500$ |

**Figure 19: 6 dB Bandwidth, Pigtail, Test Results**

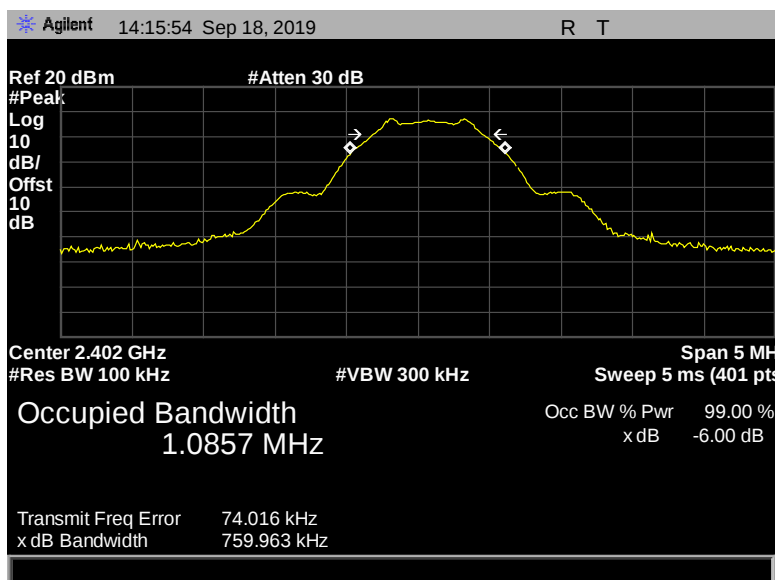


Figure 20: 6 dB Bandwidth, Pigtail, 2402 MHz, 1 Mbps, 759.963 kHz

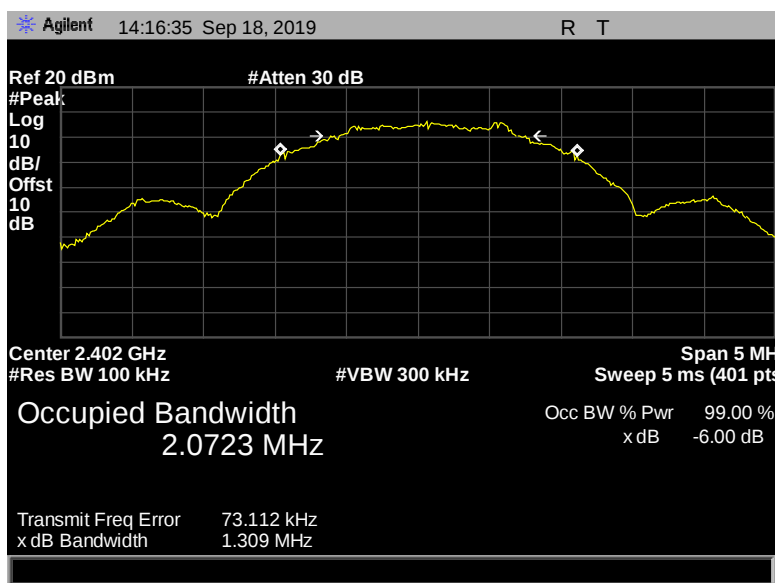


Figure 21: 6 dB Bandwidth, Pigtail, 2402 MHz, 2 Mbps, 1.309 MHz

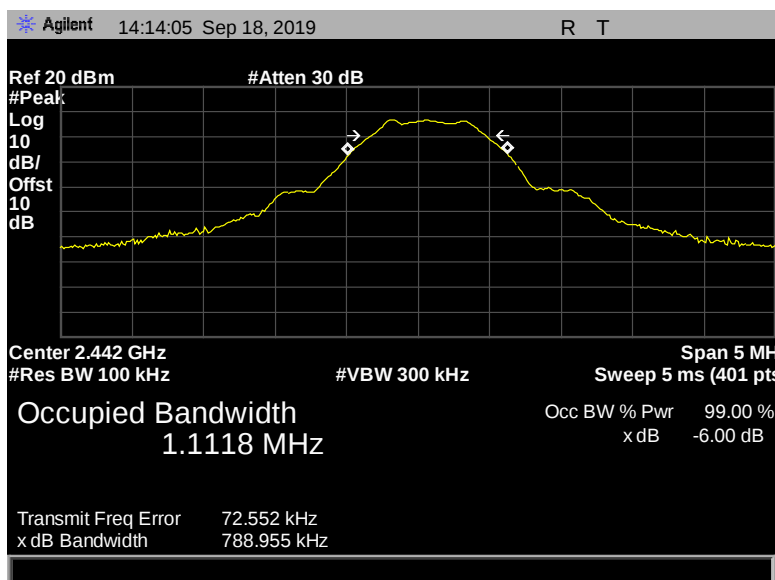


Figure 22: 6 dB Bandwidth, Pigtail, 2442 MHz, 1 Mbps, 788.955 kHz

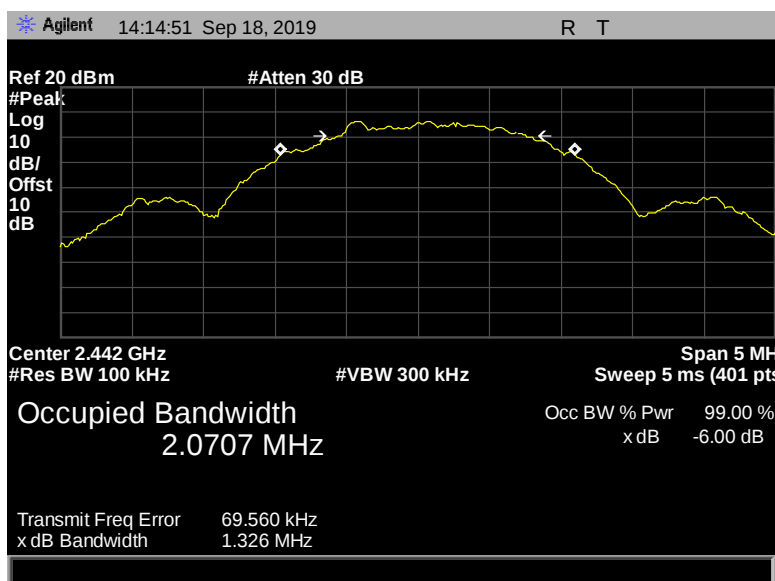


Figure 23: 6 dB Bandwidth, Pigtail, 2442 MHz, 2 Mbps, 1.326 MHz

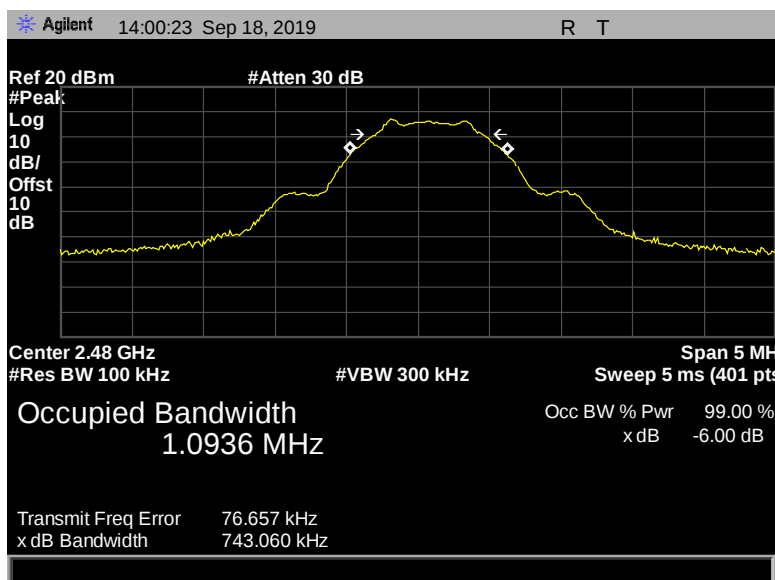


Figure 24: 6 dB Bandwidth, Pigtail, 2480 MHz, 1 Mbps, 743.060 kHz

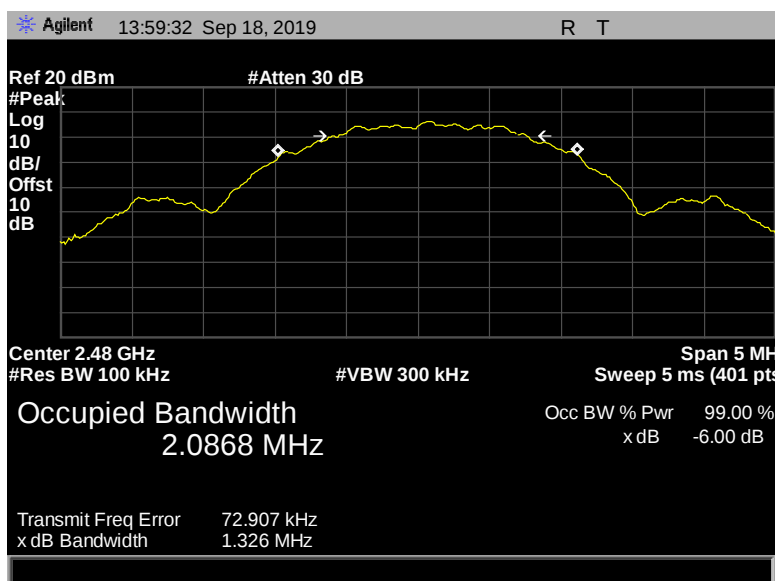


Figure 25: 6 dB Bandwidth, Pigtail, 2480 MHz, 2 Mbps, 1.326 MHz

### Model: 40K Terminal

**Test Results:** The EUT was tested is **compliant** with § 15.247(a)(2) 6 dB Bandwidth. No anomalies were noted.

The 6 dB Bandwidth was determined from the plots on the following pages.

**Test Engineer:** Jonathan Tavira

**Test Date:** September 6, 2019

### Test Data, Model: 40K Terminal

| Mode   | Channel (MHz) | 6 dB Bandwidth (MHz) | Limit (MHz)  |
|--------|---------------|----------------------|--------------|
| 1 Mbps | 2402          | 0.740764             | $\geq 0.500$ |
| 1 Mbps | 2442          | 0.773330             | $\geq 0.500$ |
| 1 Mbps | 2480          | 0.759417             | $\geq 0.500$ |
| 2 Mbps | 2402          | 1.324000             | $\geq 0.500$ |
| 2 Mbps | 2442          | 1.385000             | $\geq 0.500$ |
| 2 Mbps | 2480          | 1.201000             | $\geq 0.500$ |

**Figure 26: 6 dB Bandwidth, 40K Terminal, Test Results**

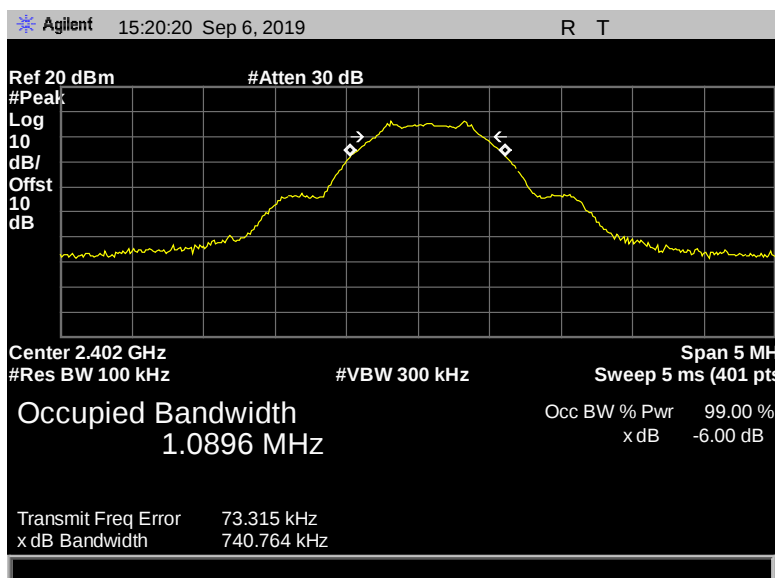


Figure 27: 6 dB Bandwidth, Terminal, 2402 MHz, 1 Mbps, 740.764 kHz

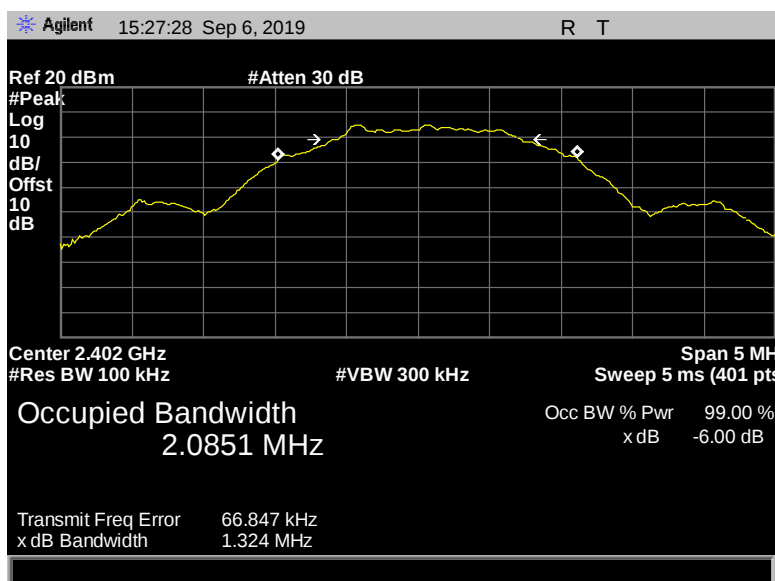


Figure 28: 6 dB Bandwidth, Terminal, 2402 MHz, 2 Mbps, 1.324 MHz

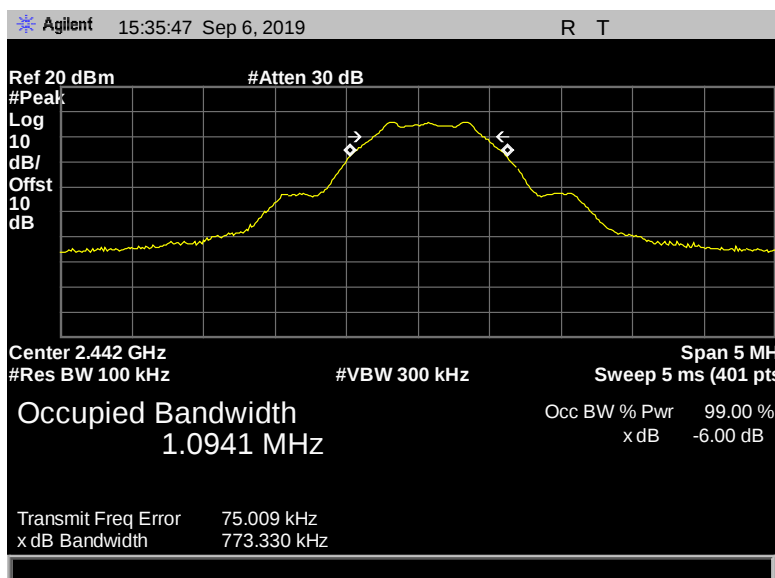


Figure 29: 6 dB Bandwidth, Terminal, 2442 MHz, 1 Mbps, 773.330 kHz

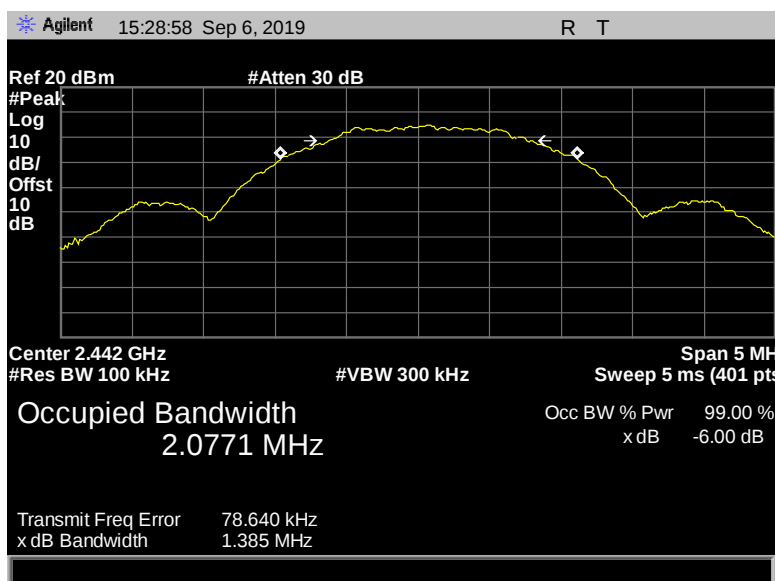


Figure 30: 6 dB Bandwidth, Terminal, 2442 MHz, 2 Mbps, 1.385 MHz

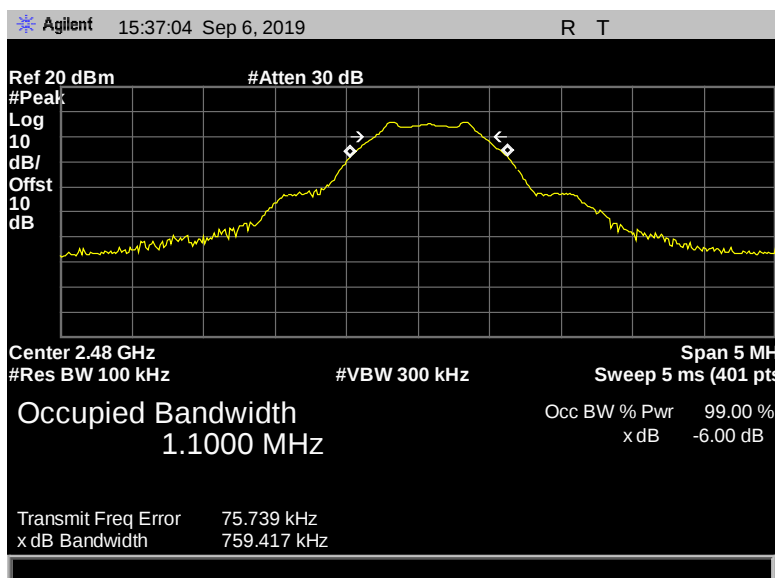


Figure 31: 6 dB Bandwidth, Terminal, 2480 MHz, 1 Mbps, 759.417 kHz

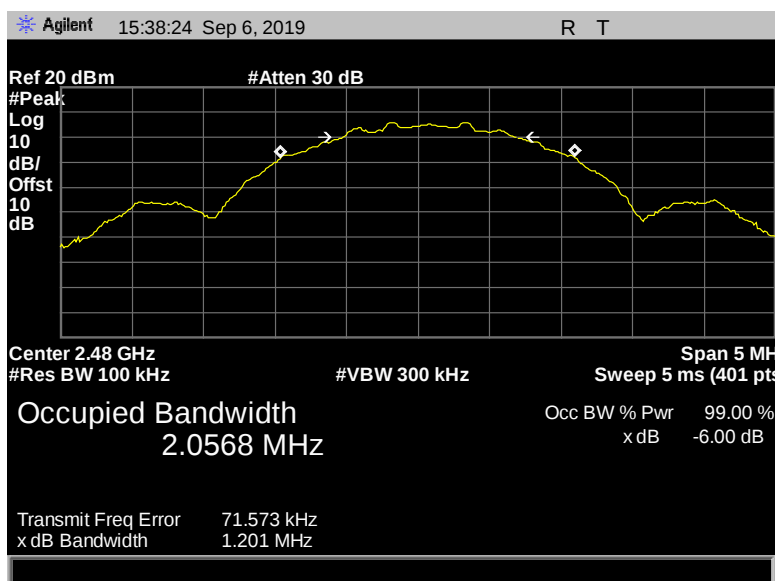


Figure 32: 6 dB Bandwidth, Terminal, 2480 MHz, 2 Mbps, 1.201 MHz

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247(b) Peak Power Output

**Test Requirements:** §15.247(b): The maximum peak output power of the intentional radiator shall not exceed the following:

| Digital Transmission Systems<br>(MHz) | Output Limit<br>(Watts) |
|---------------------------------------|-------------------------|
| 2400–2483.5                           | 1.000                   |

Figure 33: Output Power Requirements from §15.247(b)

§15.247(c): if transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the stated values in the 9, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

**Test Procedure:** The EUT was configured to measure the low, mid and high channels of each band at the maximum power level. Measurements were performed in a conducted setup as shown in figure below.



Figure 34: Block Diagram, Peak Conducted Output Power Test Setup

### Model: 40K Pigtail

**Test Results:** The EUT was tested is **compliant** with § 15.247(b) Peak Power Output. No anomalies were noted.

**Test Engineer:** Jonathan Tavira

**Test Date:** September 18, 2019

### Test Data, Model: 40K Pigtail

| Mode   | Channel (MHz) | Peak Output Power (dBm) |
|--------|---------------|-------------------------|
| 1 Mbps | 2402          | 0.05                    |
| 1 Mbps | 2442          | -0.17                   |
| 1 Mbps | 2480          | -0.47                   |
| 2 Mbps | 2402          | 0.94                    |
| 2 Mbps | 2442          | 0.71                    |
| 2 Mbps | 2480          | 0.41                    |

**Figure 35: Peak Power Output, Pigtail, Test Results**

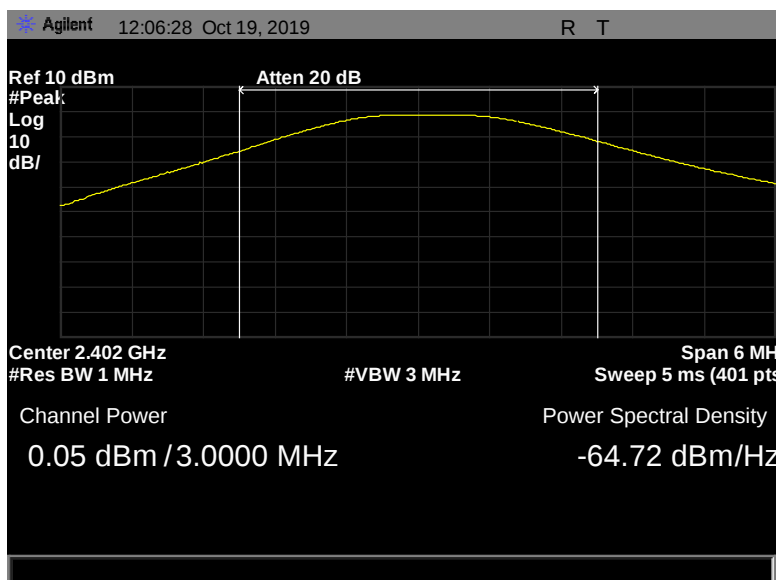


Figure 36: Peak Power Output, Pigtail, 2402 MHz, 1 Mbps, 0.05 dBm

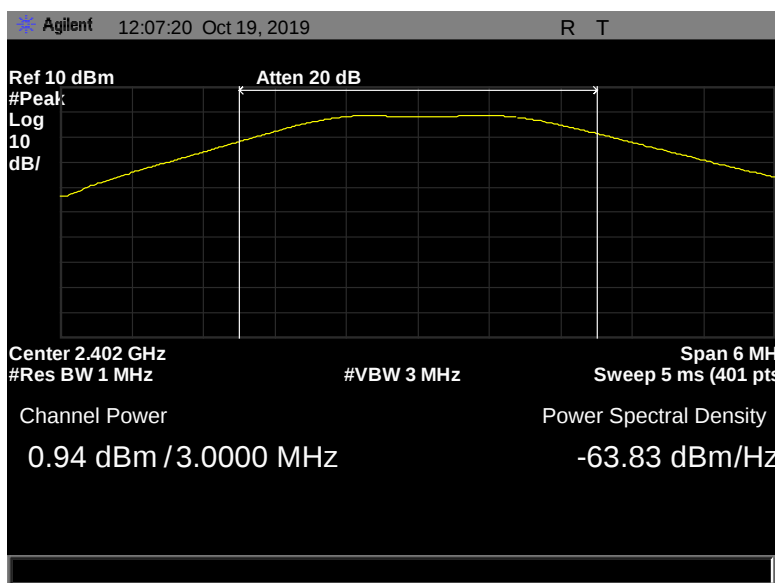


Figure 37: Peak Power Output, Pigtail, 2402 MHz, 2 Mbps, 0.94 dBm

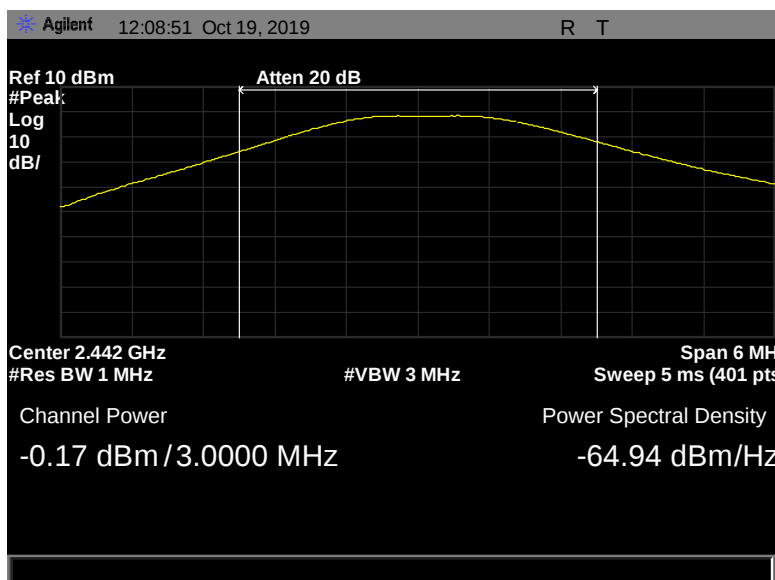


Figure 38: Peak Power Output, Pigtail, 2442 MHz, 1 Mbps, -0.17 dBm

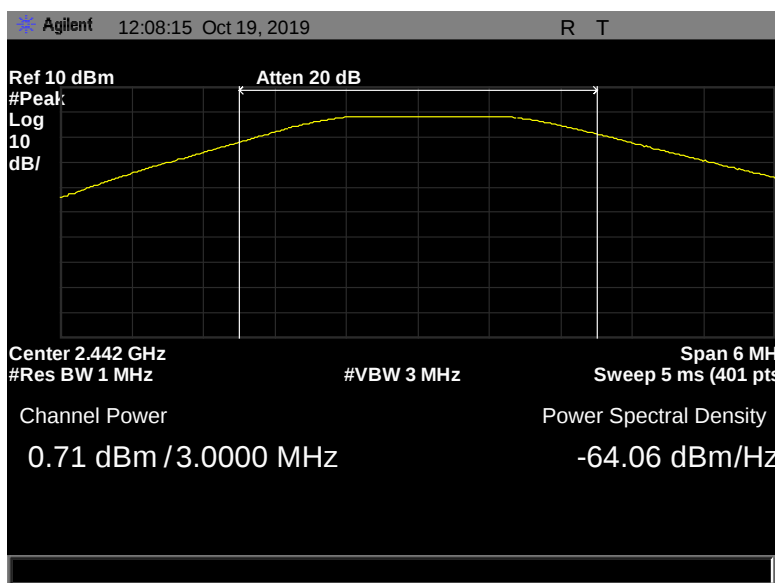


Figure 39: Peak Power Output, Pigtail, 2442 MHz, 2 Mbps, 0.71 dBm

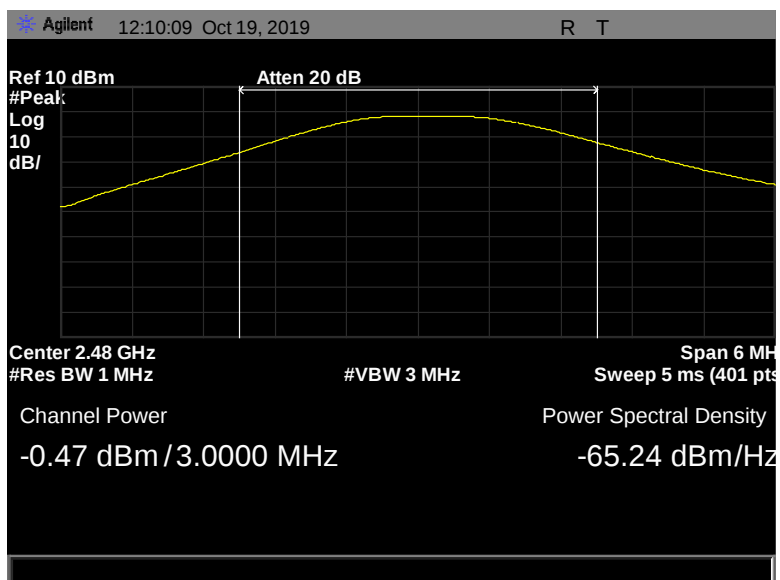


Figure 40: Peak Power Output, Pigtail, 2480 MHz, 1 Mbps, -0.47 dBm

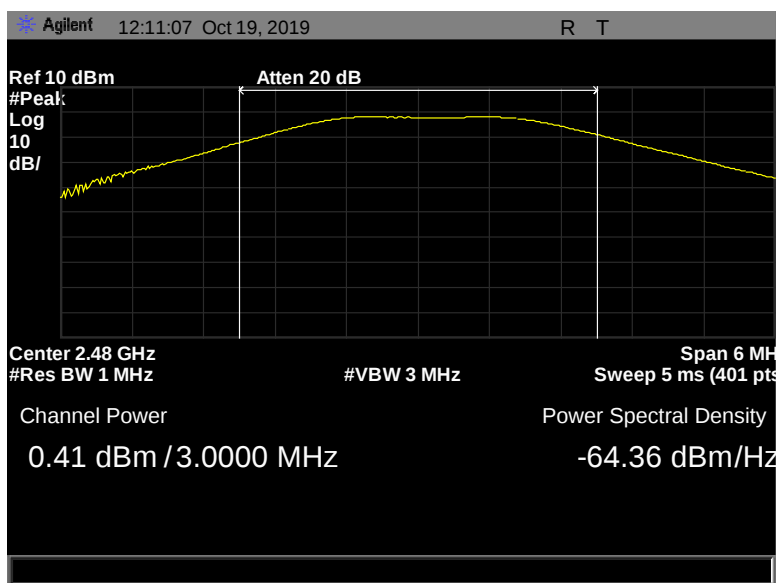


Figure 41: Peak Power Output, Pigtail, 2480 MHz, 2 Mbps, 0.41 dBm

### Model: 40K Terminal

**Test Results:** The EUT was tested is **compliant** with § 15.247(b) Peak Power Output. No anomalies were noted.

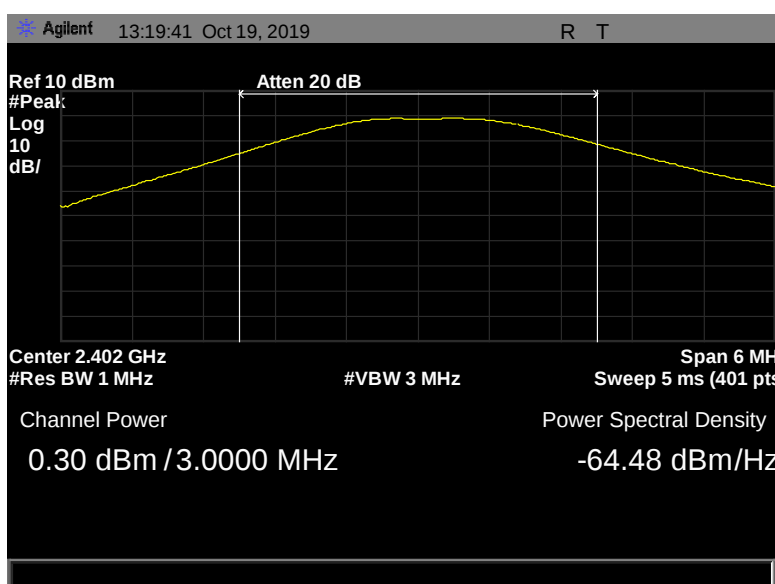
**Test Engineer:** Jonathan Tavira

**Test Date:** September 6, 2019

### Test Data, Model: 40K Terminal

| Mode   | Channel (MHz) | Peak Output Power (dBm) |
|--------|---------------|-------------------------|
| 1 Mbps | 2402          | 0.30                    |
| 1 Mbps | 2442          | 0.09                    |
| 1 Mbps | 2480          | -0.15                   |
| 2 Mbps | 2402          | 1.23                    |
| 2 Mbps | 2442          | 0.99                    |
| 2 Mbps | 2480          | 0.75                    |

**Figure 42: Peak Power Output, Terminal, Test Results**



**Figure 43: Peak Power Output, Terminal, 2402 MHz, 1 Mbps, 0.30 dBm**

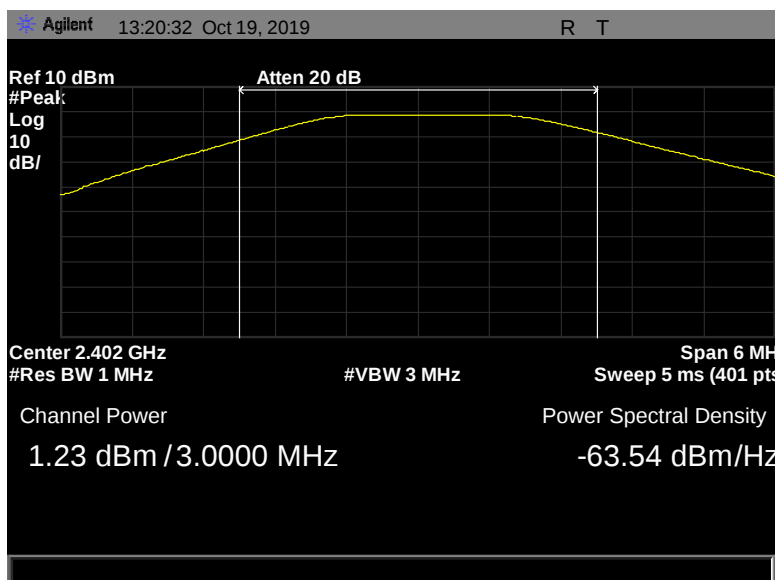


Figure 44: Peak Power Output, Terminal, 2402 MHz, 2 Mbps, 1.23 dBm

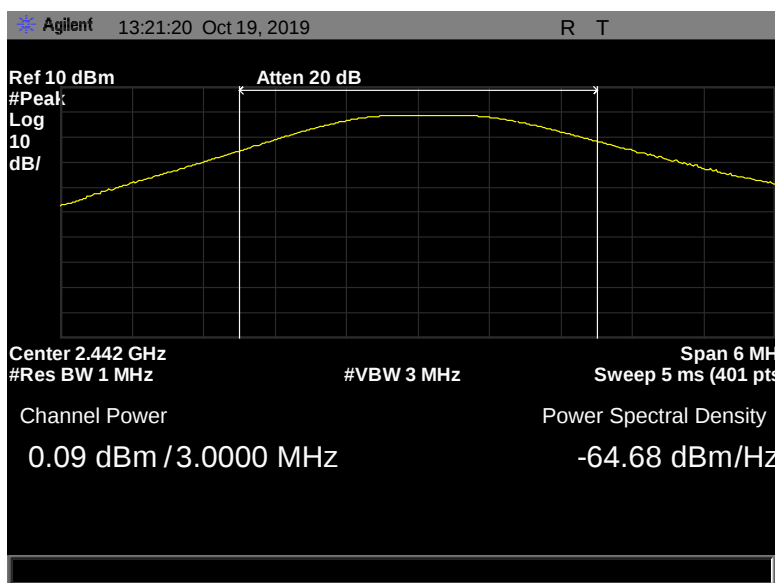


Figure 45: Peak Power Output, Terminal, 2442 MHz, 1 Mbps, 0.09 dBm

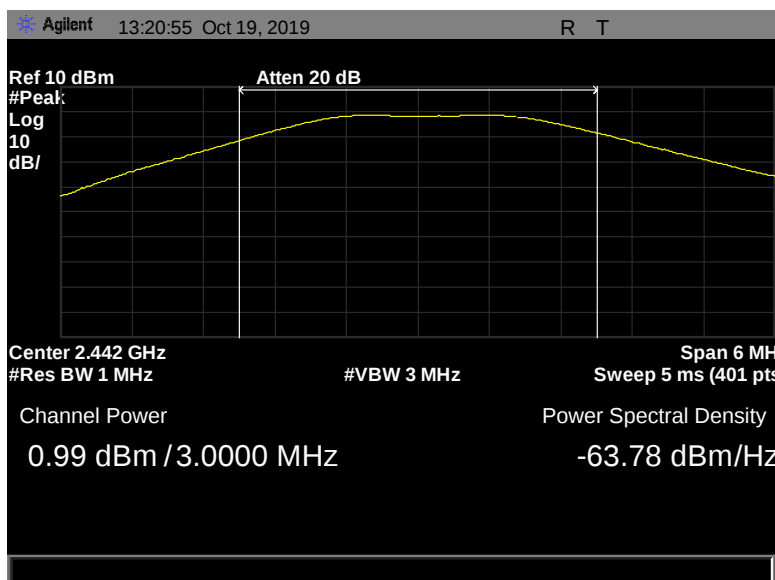


Figure 46: Peak Power Output, Terminal, 2442 MHz, 2 Mbps, 0.99 dBm

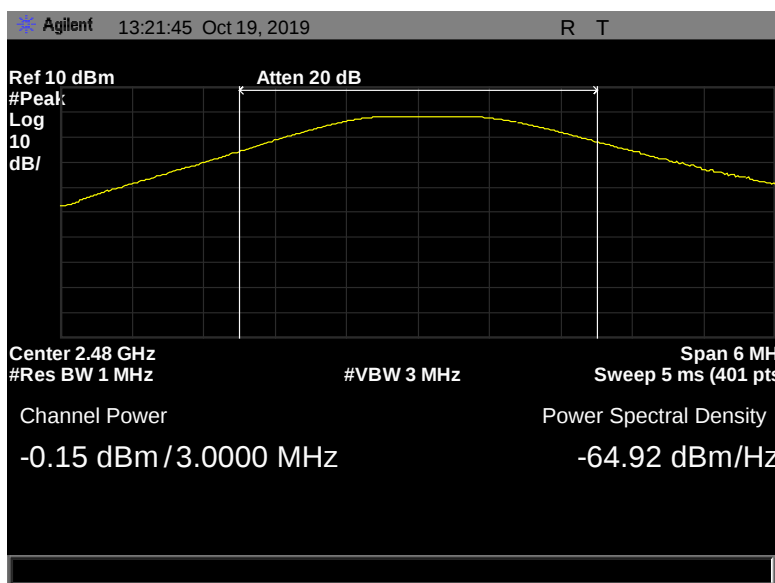


Figure 47: Peak Power Output, Terminal, 2480 MHz, 1 Mbps, -0.15 dBm

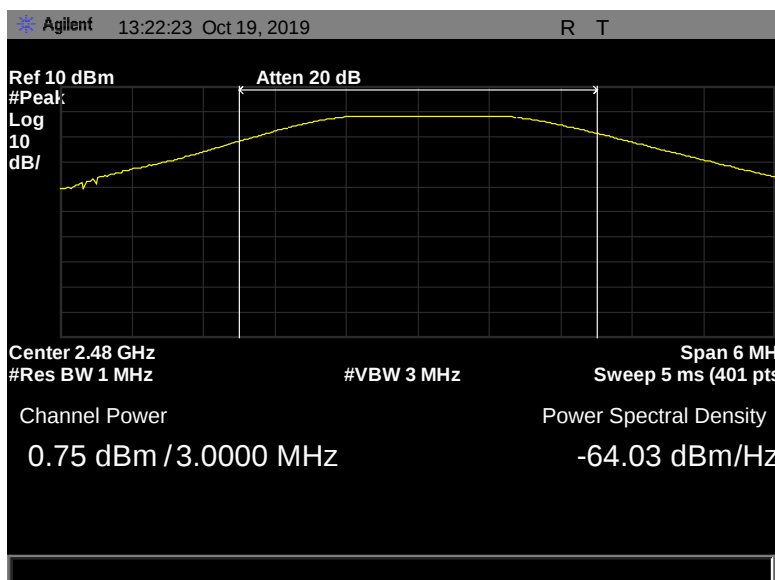


Figure 48: Peak Power Output, Terminal, 2480 MHz, 2 Mbps, 0.75 dBm

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.209 Radiated Spurious Emissions Requirements and Band Edge

**Test Requirements:** §15.247(d); §15.205: Emissions outside the frequency band.

**§15.205(a):** Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

| MHz                           | MHz                 | MHz             | GHz              |
|-------------------------------|---------------------|-----------------|------------------|
| 0.090–0.110-----              | 16.42–16.423        | 399.9–410       | 4.5–5.15         |
| <sup>1</sup> 0.495–0.505----- | 16.69475–16.69525   | 608–614         | 5.35–5.46        |
| 2.1735–2.1905-----            | 16.80425–16.80475   | 960–1240        | 7.25–7.75        |
| 4.125–4.128-----              | 25.5–25.67          | 1300–1427       | 8.025–8.5        |
| 4.17725–4.17775-----          | 37.5–38.25          | 1435–1626.5     | 9.0–9.2          |
| 4.20725–4.20775-----          | 73–74.6             | 1645.5–1646.5   | 9.3–9.5          |
| 6.215–6.218-----              | 74.8–75.2           | 1660–1710       | 10.6–12.7        |
| 6.26775–6.26825-----          | 108–121.94          | 1718.8–1722.2   | 13.25–13.4       |
| 6.31175–6.31225-----          | 123–138             | 2200–2300       | 47–14.5          |
| 8.291–8.294-----              | 149.9–150.05        | 2310–2390       | 15.35–16.2       |
| 8.362–8.366-----              | 156.52475–156.52525 | 2483.5–2500     | 17.7–21.4        |
| 8.37625–8.38675-----          | 156.7–156.9         | 2655–2900       | 22.01–23.12      |
| 8.41425–8.41475-----          | 162.0125–167.17     | 3260–3267       | 23.6–24.0        |
| 12.29–12.293-----             | 167.72–173.2        | 3332–3339       | 31.2–31.8        |
| 12.51975–12.52025-----        | 240–285             | 3345.8–3358 36. | 43–36.5          |
| 12.57675–12.57725-----        | 322–335.4           | 3600–4400       | ( <sup>2</sup> ) |

**Figure 49: Restricted Bands of Operation**

<sup>1</sup> Until February 1, 1999, this restricted band shall be 0.490 – 0.510 MHz.

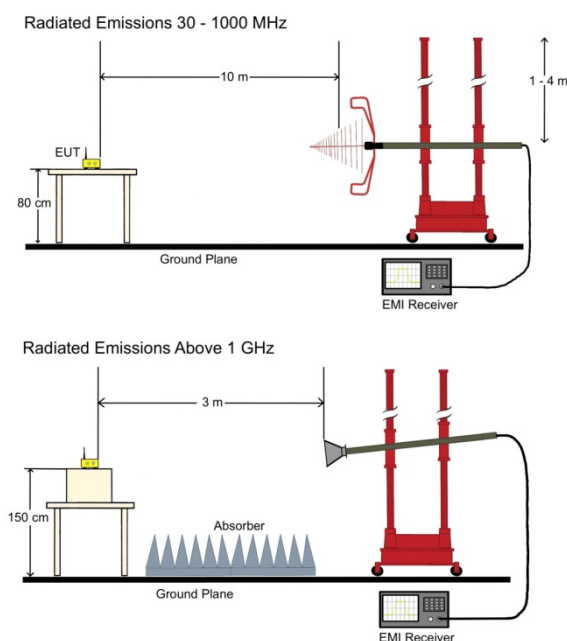
<sup>2</sup> Above 38.6

**Test Requirement(s):** § 15.209 (a): Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in Figure 50:

| Frequency (MHz) | § 15.209(a), Radiated Emission Limits (dBμV) @ 3m |
|-----------------|---------------------------------------------------|
| 30 - 88         | 40.00                                             |
| 88 - 216        | 43.50                                             |
| 216 - 960       | 46.00                                             |
| Above 960       | 54.00                                             |

**Figure 50: Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a)**

**Test Procedures:** The transmitter was turned on. Measurements were performed of the low, mid and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line. Only noise floor was measured above 18 GHz.



**Figure 51: Radiated Emissions Test Setup**

**Sample Calculation for Distance Correction factor (DCF) measurement:**

$$F_d = 20 \cdot \log_{10} (D_m/D_s)$$

where:

$F_d$  = Distance Factor in dB

$D_m$  = Measurement Distance in meters

$D_s$  = Specification Distance in meters

**Sample formula for calculating the Corrected Data for the Radiated Emissions Measurements:**

| Frequency (MHz) | Antenna Polarity | EUT Azimuth (Degrees) | Antenna Height (cm) | Uncorrected Amplitude (dBμV/m) | ACF (dB/m) (+) | Pre Amp Gain + CBL (dB)(-) | DCF (dB) (+) | Corrected Amplitude (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|-----------------|------------------|-----------------------|---------------------|--------------------------------|----------------|----------------------------|--------------|------------------------------|----------------|-------------|
| 249.99          | V                | 359.9                 | 240.7               | 55.46                          | 11.4           | 28.335                     | 10.46        | 38.525                       | 47             | -8.475      |

$$\begin{aligned} \text{Corrected Amplitude (dB}\mu\text{V/m)} &= \text{Uncorrected Amplitude (dB}\mu\text{V/m)} + \text{ACF (dB/m)} - (\text{Preamp Gain (dB)} + \text{CBL (dB)} + \text{DCF (dB)})^{**} \\ &= 55.46 + 11.4 - 28.355 + 10.46 = \mathbf{38.525} \end{aligned}$$

**\*\* DCF Column represents the appropriate correction factor used when the measurement distance differs from the specification distance.**

### Model: 40K Pigtail

**Test Results:** The EUT was tested is **compliant** with § 15.209 Radiated Spurious Emissions Requirements and Band Edge. Based Peak output power and Peak power spectral density measurement, it was determined that the 2 Mbps mod produced the worst-case operating conditions of the EUT. No anomalies were noted.

**Test Engineer:** Jonathan Tavira

**Test Date:** September 26, 2019

### Test Data, Model: 40K Pigtail

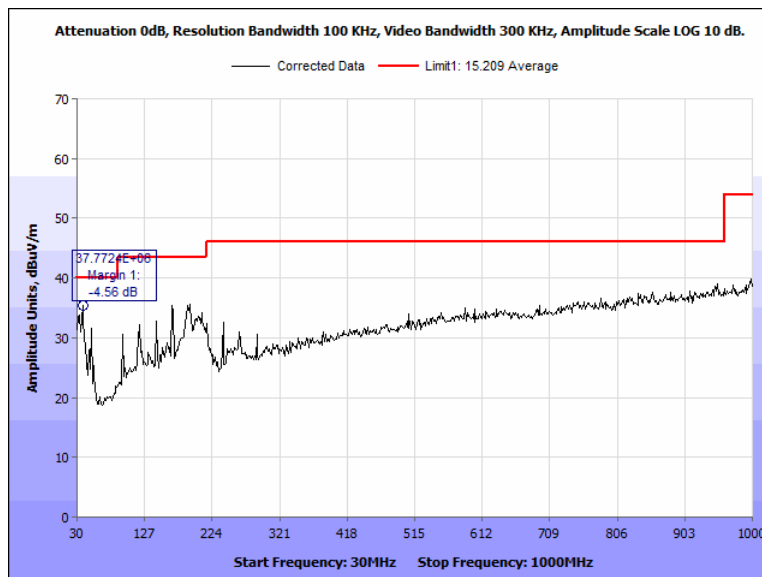


Figure 52: Radiated Spurious Emissions, Pigtail, 2402 MHz, 30 MHz - 1000 MHz, Horizontal

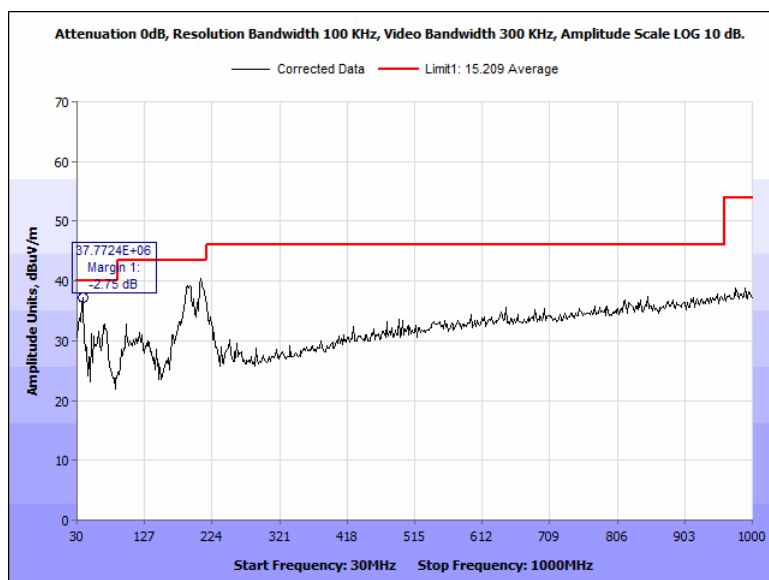


Figure 53: Radiated Spurious Emissions, Pigtail, 2402 MHz, 30 MHz - 1000 MHz, Vertical

| Frequency (MHz) | EUT Azimuth (Degrees) | Antenna Polarity (H/V) | Antenna HEIGHT (m) | Uncorrected EMI Meter Reading (dBμV) | Antenna Correction Factor (dB/m) (+) | Distance Correction Factor (dB) (-) | Cable Loss/Pre-amp (dB) (+) | Corrected Amplitude (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|-----------------|-----------------------|------------------------|--------------------|--------------------------------------|--------------------------------------|-------------------------------------|-----------------------------|------------------------------|----------------|-------------|
| 37.7724         | 180.60                | H                      | 1.52               | 31.12                                | 18.44                                | 10.46                               | -24.58                      | 35.44                        | 40             | -4.56       |
| 33.1090         | 181.20                | H                      | 1.52               | 26.78                                | 21.25                                | 10.46                               | -24.70                      | 33.78                        | 40             | -6.22       |
| 31.5545         | 180.60                | H                      | 1.53               | 25.78                                | 21.92                                | 10.46                               | -24.72                      | 33.44                        | 40             | -6.56       |
| 37.7724         | 180.50                | V                      | 1.67               | 32.93                                | 18.44                                | 10.46                               | -24.58                      | 37.25                        | 40             | -2.75       |
| 207.2115        | 180.50                | V                      | 1.52               | 39.00                                | 13.78                                | 10.46                               | -22.86                      | 40.37                        | 43.5           | -3.13       |
| 208.7660        | 180.60                | V                      | 1.49               | 38.21                                | 13.62                                | 10.46                               | -22.83                      | 39.46                        | 43.5           | -4.04       |

Figure 54: Radiated Spurious Emissions, Pigtail, 2402 MHz, 30 MHz – 1000 MHz

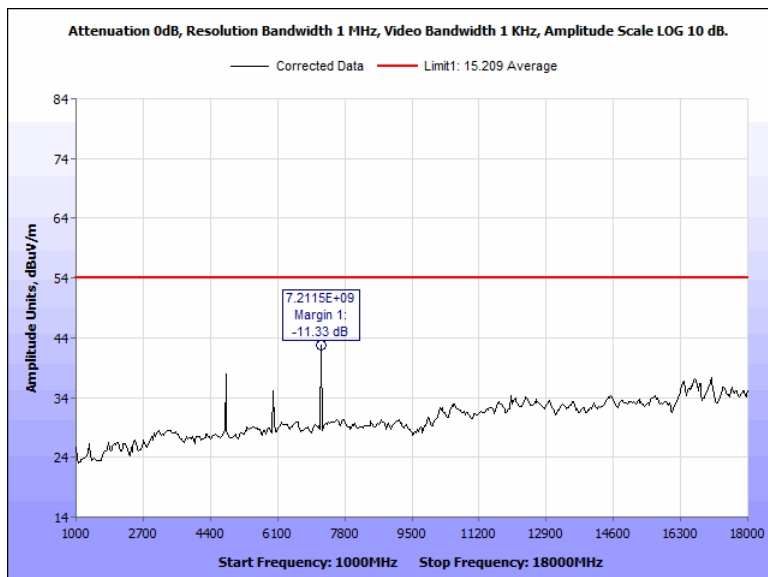


Figure 55: Radiated Spurious Emissions, Pigtail, 2402 MHz, 1 GHz - 18 GHz, Average, Horizontal

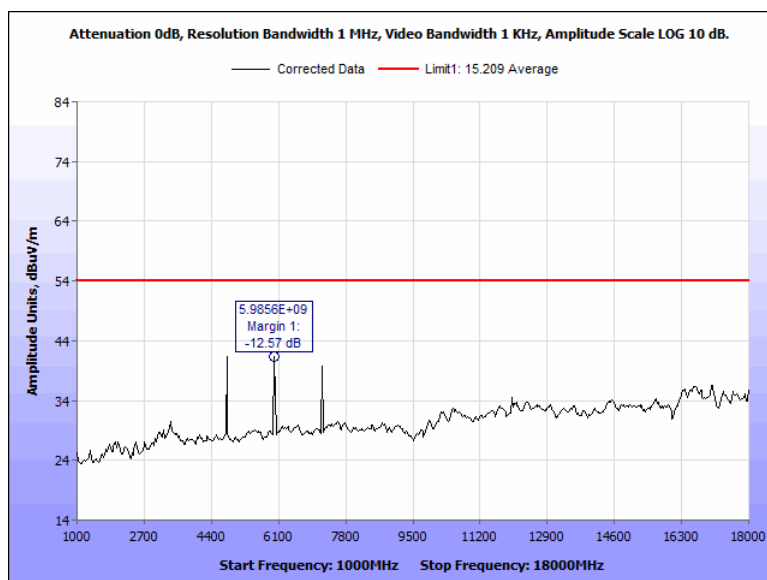


Figure 56: Radiated Spurious Emissions, Pigtail, 2402 MHz, 1 GHz - 18 GHz, Average, Vertical

| Frequency (GHz) | EUT Azimuth (Degrees) | Antenna Polarity (H/V) | Antenna HEIGHT (m) | Uncorrected EMI Meter Reading (dBμV) | Antenna Correction Factor (dB/m) (+) | Distance Correction Factor (dB) (-) | Cable Loss/Pre-amp (dB) (+) | Corrected Amplitude (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|-----------------|-----------------------|------------------------|--------------------|--------------------------------------|--------------------------------------|-------------------------------------|-----------------------------|------------------------------|----------------|-------------|
| 7.2115          | 210.00                | H                      | 2.20               | 47.29                                | 35.38                                | 0.00                                | -40.00                      | 42.67                        | 54             | -11.33      |
| 4.7869          | 187.20                | H                      | 1.80               | 42.61                                | 33.81                                | 0.00                                | -38.46                      | 37.97                        | 54             | -16.03      |
| 17.0737         | 180.60                | H                      | 1.89               | 37.85                                | 40.91                                | 0.00                                | -41.55                      | 37.31                        | 54             | -16.69      |
| 4.7869          | 188.30                | V                      | 1.88               | 46.06                                | 33.81                                | 0.00                                | -39.74                      | 41.41                        | 54             | -12.59      |
| 5.9856          | 180.76                | V                      | 1.82               | 46.24                                | 34.89                                | 0.00                                | -39.69                      | 41.43                        | 54             | -12.57      |
| 7.2115          | 180.60                | V                      | 1.86               | 44.36                                | 35.38                                | 0.00                                | -40.00                      | 39.74                        | 54             | -14.26      |

Figure 57: Radiated Spurious Emissions, Pigtail, 2402 MHz, 1 GHz – 18 GHz, Test Results

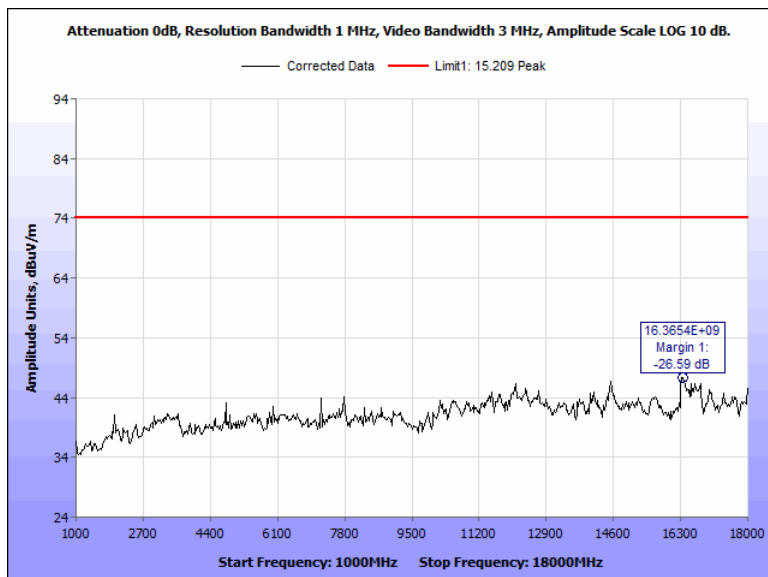


Figure 58: Radiated Spurious Emissions, Pigtail, 2402 MHz, 1 GHz - 18 GHz, Peak, Horizontal

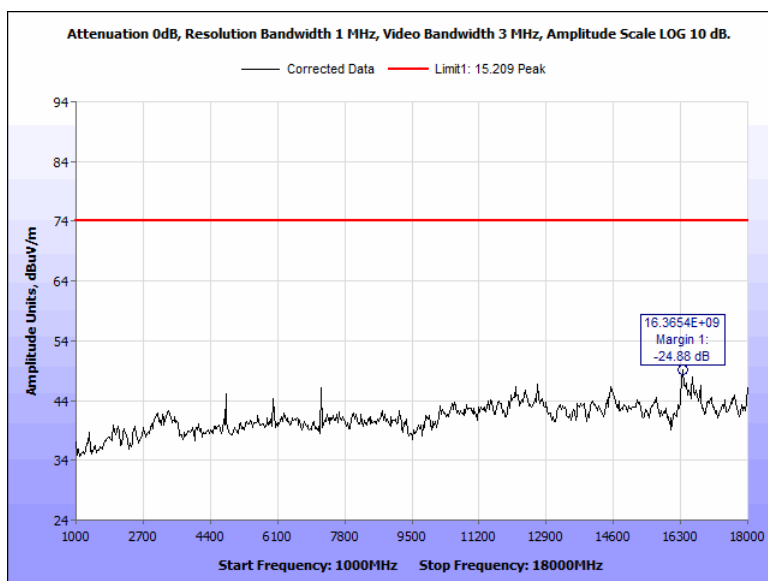
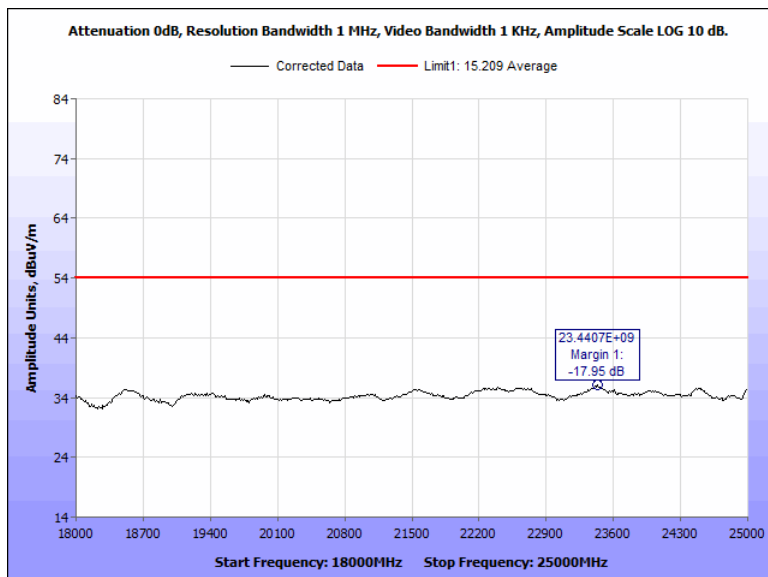
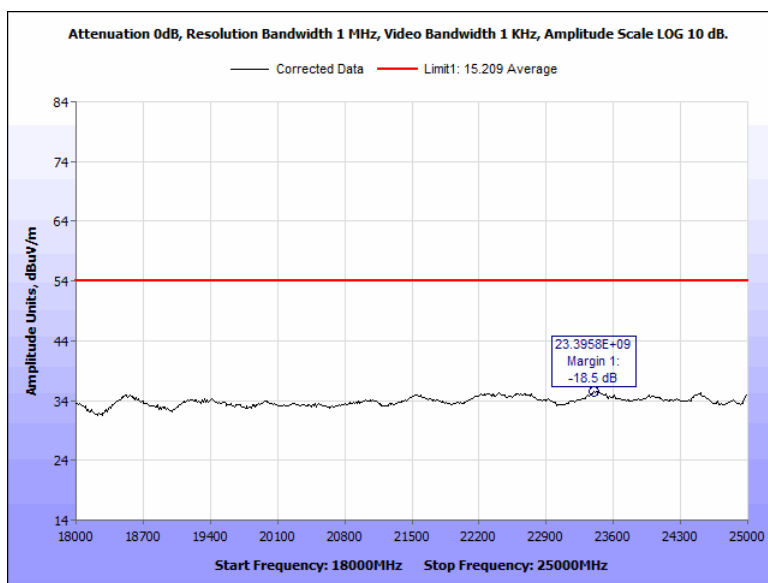


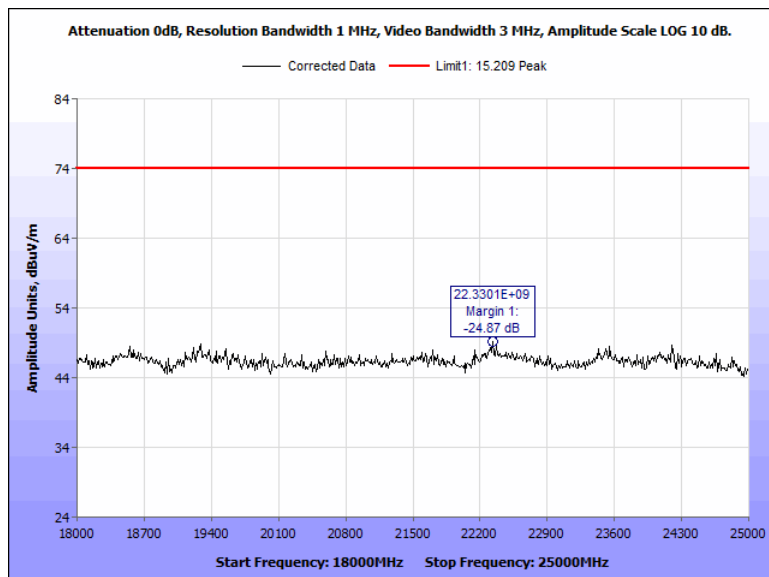
Figure 59: Radiated Spurious Emissions, Pigtail, 2402 MHz, 1 GHz - 18 GHz, Peak, Vertical



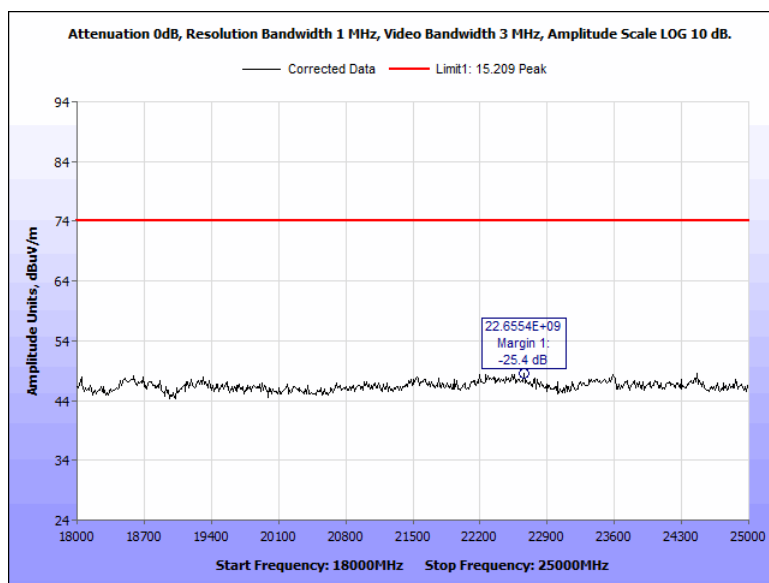
**Figure 60: Radiated Spurious Emissions, Pigtail, 2402 MHz, 18 GHz - 25 GHz, Average, Horizontal**



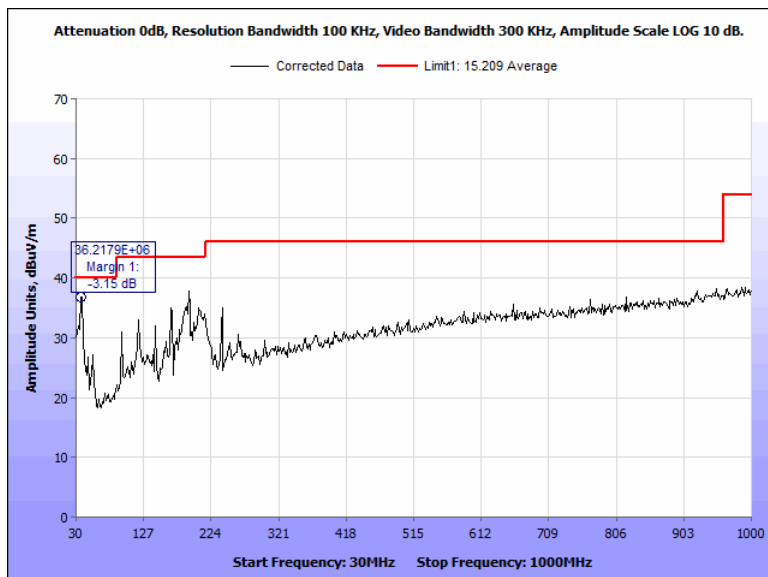
**Figure 61: Radiated Spurious Emissions, Pigtail, 2402 MHz, 18 GHz - 25 GHz, Average, Vertical**



**Figure 62: Radiated Spurious Emissions, Pigtail, 2402 MHz, 18 GHz - 25 GHz, Peak, Horizontal**



**Figure 63: Radiated Spurious Emissions, Pigtail, 2402 MHz, 18 GHz - 25 GHz, Peak, Vertical**



**Figure 64: Radiated Spurious Emissions, Pigtail, 2442 MHz, 30 MHz - 1000 MHz, Horizontal**

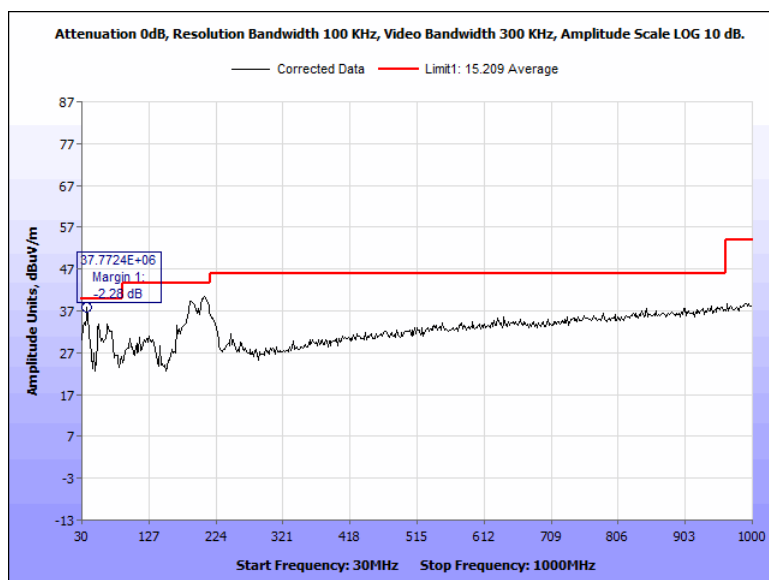


Figure 65: Radiated Spurious Emissions, Pigtail, 2442 MHz, 30 MHz - 1000 MHz, Vertical

| Frequency (MHz) | EUT Azimuth (Degrees) | Antenna Polarity (H/V) | Antenna HEIGHT (m) | Uncorrected EMI Meter Reading (dBμV) | Antenna Correction Factor (dB/m) (+) | Distance Correction Factor (dB) (-) | Cable Loss/Pre-amp (dB) (+) | Corrected Amplitude (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|-----------------|-----------------------|------------------------|--------------------|--------------------------------------|--------------------------------------|-------------------------------------|-----------------------------|------------------------------|----------------|-------------|
| 36.2179         | 180.60                | H                      | 1.52               | 31.1                                 | 19.29                                | 10.46                               | -24.61                      | 36.85                        | 40             | -3.15       |
| 39.3269         | 181.20                | H                      | 1.52               | 33.28                                | 17.54                                | 10.46                               | -24.52                      | 36.75                        | 40             | -3.25       |
| 37.7724         | 180.60                | H                      | 1.53               | 30.61                                | 18.44                                | 10.46                               | -24.58                      | 34.92                        | 40             | -5.08       |
| 37.7724         | 180.50                | V                      | 1.67               | 33.40                                | 18.44                                | 10.46                               | -24.58                      | 37.72                        | 40             | -2.28       |
| 207.2115        | 180.50                | V                      | 1.52               | 39.00                                | 13.78                                | 10.46                               | -22.86                      | 40.37                        | 43.5           | -3.13       |
| 208.7660        | 180.60                | V                      | 1.49               | 38.80                                | 13.62                                | 10.46                               | -22.83                      | 40.06                        | 43.5           | -3.44       |

Figure 66: Radiated Spurious Emissions, Pigtail, 2442 MHz, 30 MHz – 1000 MHz

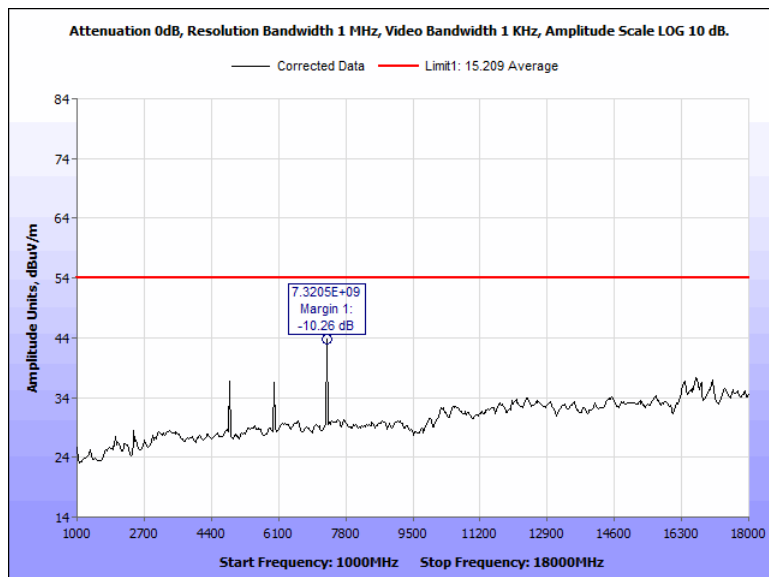


Figure 67: Radiated Spurious Emissions, Pigtail, 2442 MHz, 1 GHz - 18 GHz, Average, Horizontal

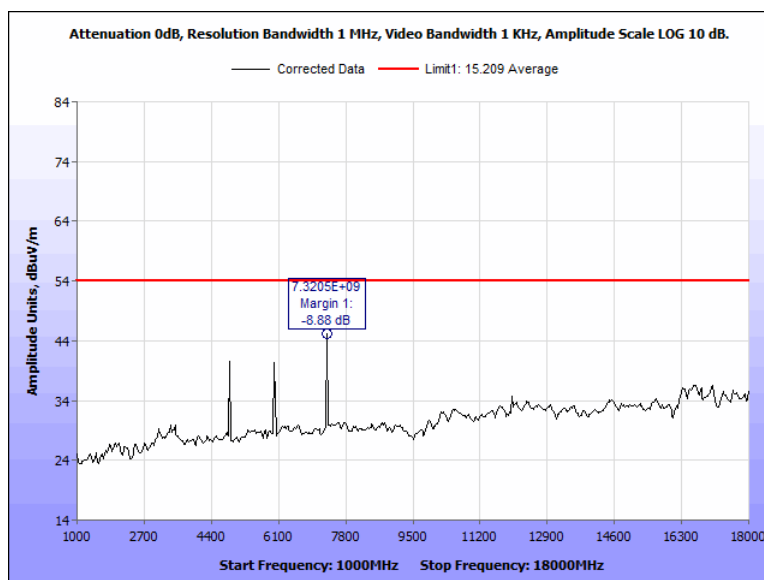


Figure 68: Radiated Spurious Emissions, Pigtail, 2442 MHz, 1 GHz - 18 GHz, Average, Vertical

| Frequency (GHz) | EUT Azimuth (Degrees) | Antenna Polarity (H/V) | Antenna HEIGHT (m) | Uncorrected EMI Meter Reading (dBμV) | Antenna Correction Factor (dB/m) (+) | Distance Correction Factor (dB) (-) | Cable Loss/Pre-amp (dB) (+) | Corrected Amplitude (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|-----------------|-----------------------|------------------------|--------------------|--------------------------------------|--------------------------------------|-------------------------------------|-----------------------------|------------------------------|----------------|-------------|
| 7.3205          | 250.00                | H                      | 2.30               | 48.28                                | 35.38                                | 0.00                                | -39.93                      | 43.74                        | 54             | -10.26      |
| 16.6651         | 176.40                | H                      | 1.70               | 38.22                                | 41.12                                | 0.00                                | -42.10                      | 37.25                        | 54             | -16.75      |
| 16.6923         | 180.60                | H                      | 1.79               | 38.21                                | 41.18                                | 0.00                                | -42.32                      | 37.14                        | 54             | -16.86      |
| 7.3205          | 250.00                | V                      | 2.30               | 49.66                                | 35.38                                | 0.00                                | -39.93                      | 45.12                        | 54             | -8.88       |
| 4.8686          | 180.76                | V                      | 1.82               | 45.48                                | 33.75                                | 0.00                                | -38.67                      | 40.56                        | 54             | -13.44      |
| 5.9856          | 180.60                | V                      | 1.86               | 45.15                                | 34.89                                | 0.00                                | -39.69                      | 40.34                        | 54             | -13.66      |

Figure 69: Radiated Spurious Emissions, Pigtail, 2442 MHz, 1 GHz – 18 GHz, Test Results

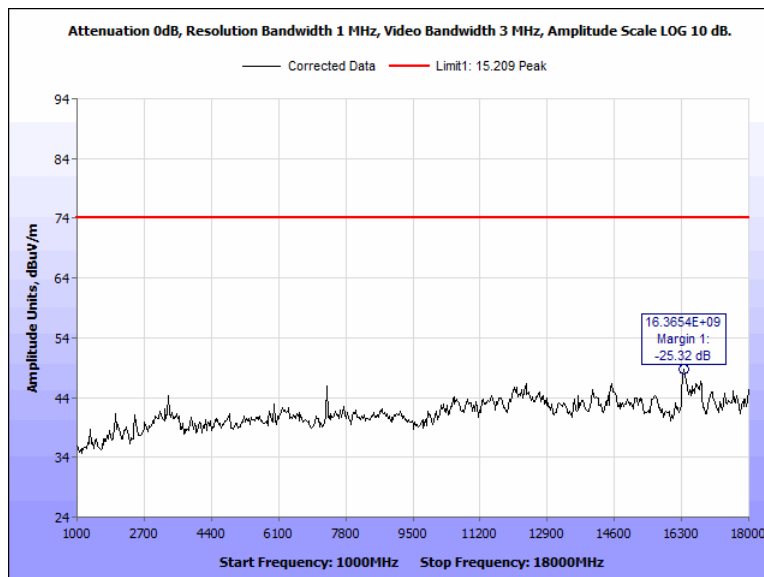


Figure 70: Radiated Spurious Emissions, Pigtail, 2442 MHz, 1 GHz - 18 GHz, Peak, Horizontal

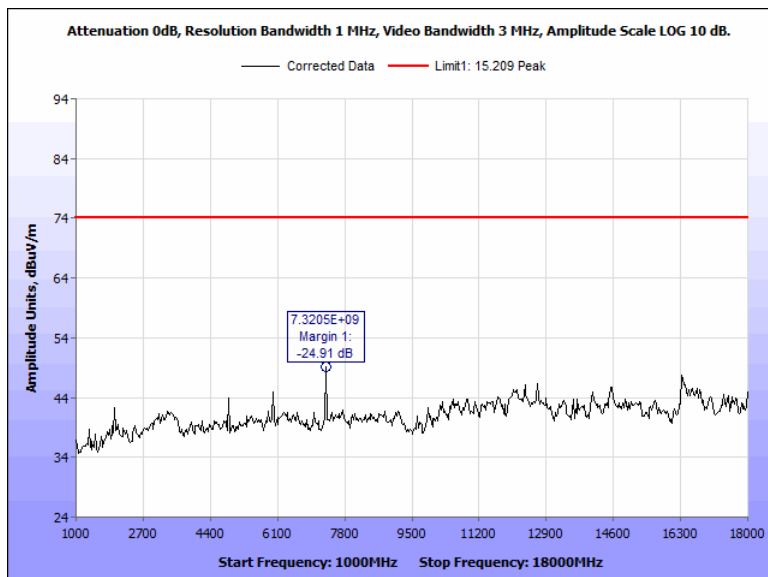


Figure 71: Radiated Spurious Emissions, Pigtail, 2442 MHz, 1 GHz - 18 GHz, Peak, Vertical

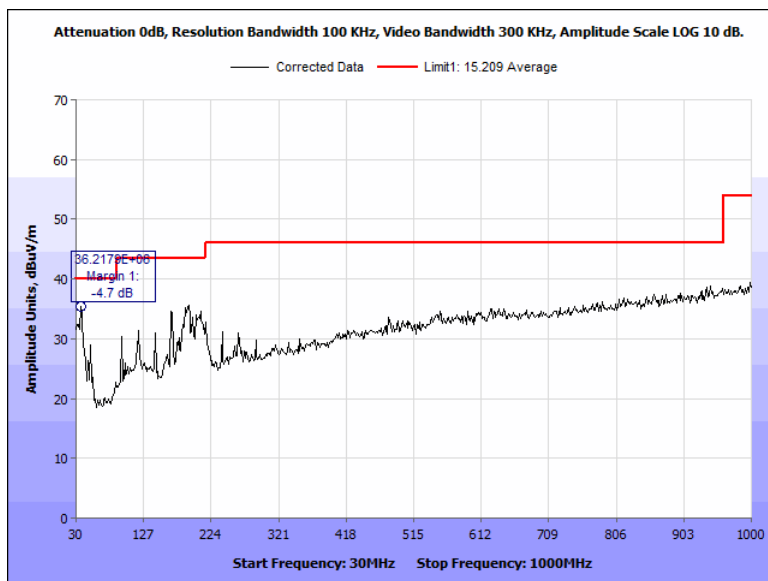


Figure 72: Radiated Spurious Emissions, Pigtail, 2480 MHz, 30 MHz - 1000 MHz, Horizontal

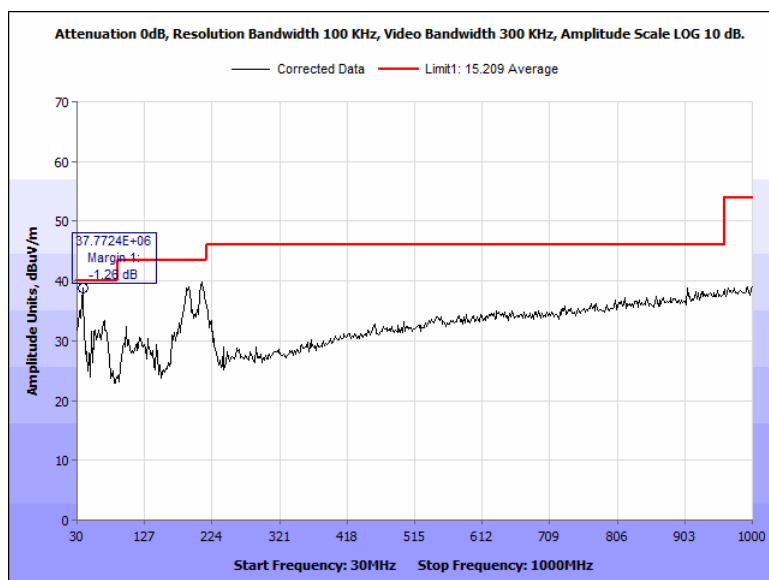


Figure 73: Radiated Spurious Emissions, Pigtail, 2480 MHz, 30 MHz - 1000 MHz, Vertical

| Frequency (MHz) | EUT Azimuth (Degrees) | Antenna Polarity (H/V) | Antenna HEIGHT (m) | Uncorrected EMI Meter Reading (dBμV) | Antenna Correction Factor (dB/m) (+) | Distance Correction Factor (dB) (-) | Cable Loss/Pre-amp (dB) (+) | Corrected Amplitude (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|-----------------|-----------------------|------------------------|--------------------|--------------------------------------|--------------------------------------|-------------------------------------|-----------------------------|------------------------------|----------------|-------------|
| 36.2179         | 180.60                | H                      | 1.52               | 30.16                                | 19.29                                | 10.46                               | -24.61                      | 35.30                        | 40             | -4.70       |
| 37.7724         | 180.60                | H                      | 1.53               | 30.33                                | 18.44                                | 10.46                               | -24.58                      | 34.65                        | 40             | -5.35       |
| 39.3269         | 181.20                | H                      | 1.52               | 29.91                                | 17.54                                | 10.46                               | -24.52                      | 33.39                        | 40             | -6.61       |
| 37.7724         | 180.50                | V                      | 1.67               | 34.43                                | 18.44                                | 10.46                               | -24.58                      | 38.74                        | 40             | -1.26       |
| 36.2179         | 178.50                | V                      | 1.47               | 31.46                                | 19.29                                | 10.46                               | -24.61                      | 36.60                        | 40             | -3.40       |
| 208.7660        | 180.60                | V                      | 1.49               | 38.56                                | 13.62                                | 10.46                               | -22.83                      | 39.81                        | 43.5           | -3.69       |

Figure 74: Radiated Spurious Emissions, Pigtail, 2480 MHz, 30 MHz – 1000 MHz

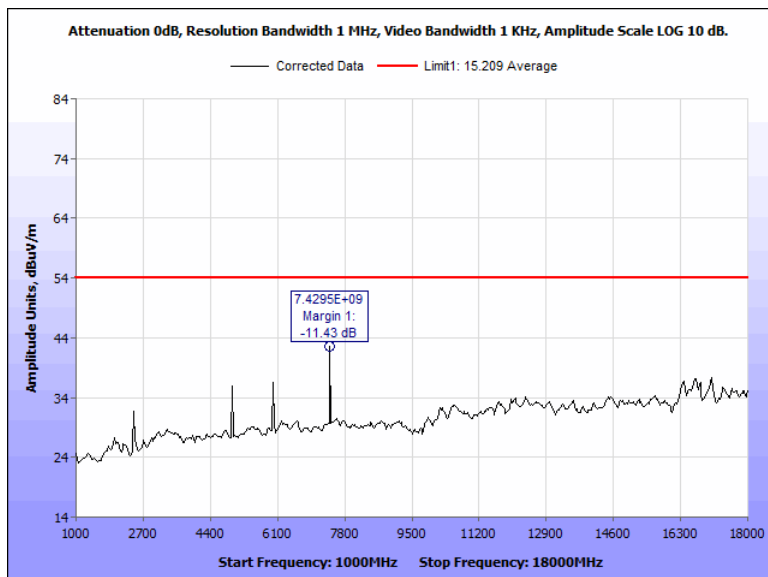


Figure 75: Radiated Spurious Emissions, Pigtail, 2480 MHz, 1 GHz - 18 GHz, Average, Horizontal

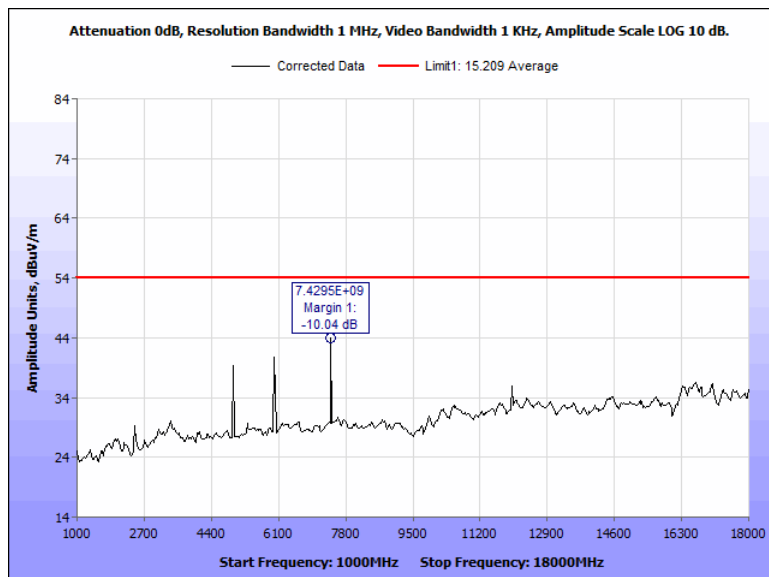


Figure 76: Radiated Spurious Emissions, Pigtail, 2480 MHz, 1 GHz - 18 GHz, Average, Vertical

| Frequency (GHz) | EUT Azimuth (Degrees) | Antenna Polarity (H/V) | Antenna HEIGHT (m) | Uncorrected EMI Meter Reading (dBuV) | Antenna Correction Factor (dB/m) (+) | Distance Correction Factor (dB) (-) | Cable Loss/Pre-amp (dB) (+) | Corrected Amplitude (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|-----------------------|------------------------|--------------------|--------------------------------------|--------------------------------------|-------------------------------------|-----------------------------|------------------------------|----------------|-------------|
| 7.4295          | 250.00                | H                      | 2.30               | 46.74                                | 35.38                                | 0.00                                | -39.55                      | 42.57                        | 54             | -11.43      |
| 17.0737         | 37.69                 | H                      | 2.27               | 37.96                                | 40.91                                | 0.00                                | -41.55                      | 37.32                        | 54             | -16.68      |
| 16.6651         | 176.40                | H                      | 1.70               | 38.06                                | 41.12                                | 0.00                                | -42.10                      | 37.09                        | 54             | -16.91      |
| 7.4295          | 250.00                | H                      | 2.30               | 48.12                                | 35.38                                | 0.00                                | -39.55                      | 43.96                        | 54             | -10.04      |
| 5.9856          | 180.60                | V                      | 1.86               | 45.59                                | 34.89                                | 0.00                                | -39.69                      | 40.79                        | 54             | -13.21      |
| 4.9503          | 230.50                | V                      | 1.84               | 44.47                                | 33.76                                | 0.00                                | -38.80                      | 39.43                        | 54             | -14.57      |

Figure 77: Radiated Spurious Emissions, Pigtail, 2480 MHz, 1 GHz – 18 GHz, Test Results

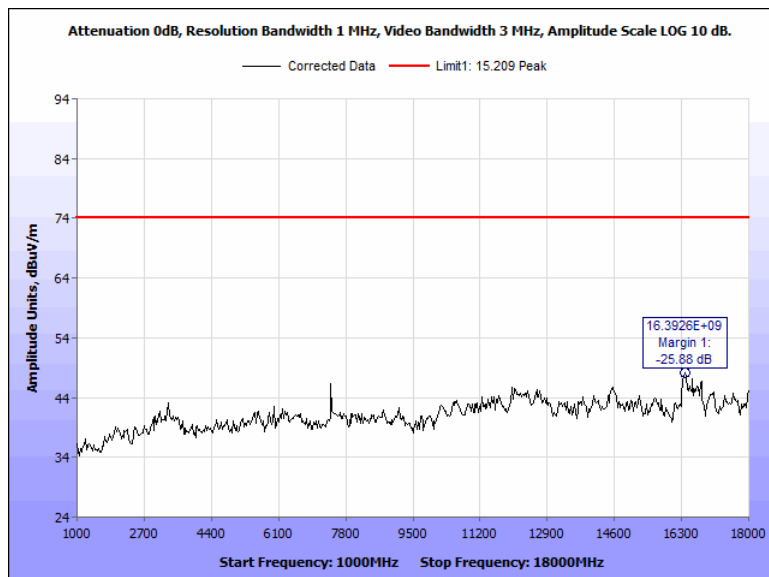


Figure 78: Radiated Spurious Emissions, Pigtail, 2480 MHz, 1 GHz - 18 GHz, Peak, Horizontal

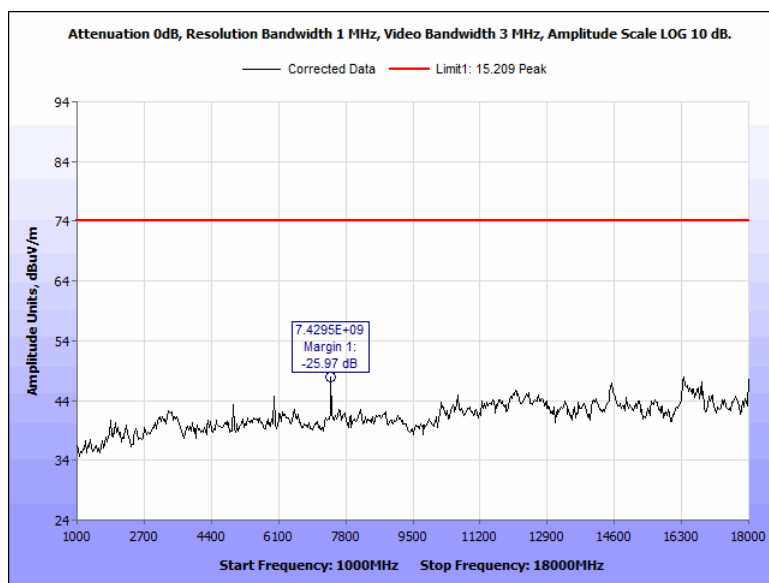


Figure 79: Radiated Spurious Emissions, Pigtail, 2480 MHz, 1 GHz - 18 GHz, Peak, Vertical

### Model: 40K Terminal

**Test Results:** The EUT was tested is **compliant** with § 15.209 Radiated Spurious Emissions Requirements and Band Edge. No anomalies were noted.

**Test Engineer:** Jonathan Tavira

**Test Date:** September 26, 2019

### Test Data, Model: 40K Terminal

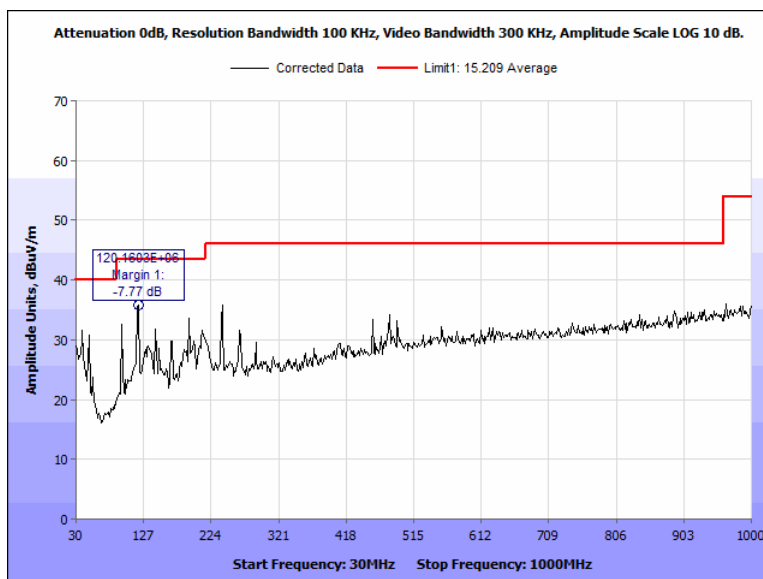


Figure 80: Radiated Spurious Emissions, Terminal, 2402 MHz, 30 MHz - 1000 MHz, Horizontal

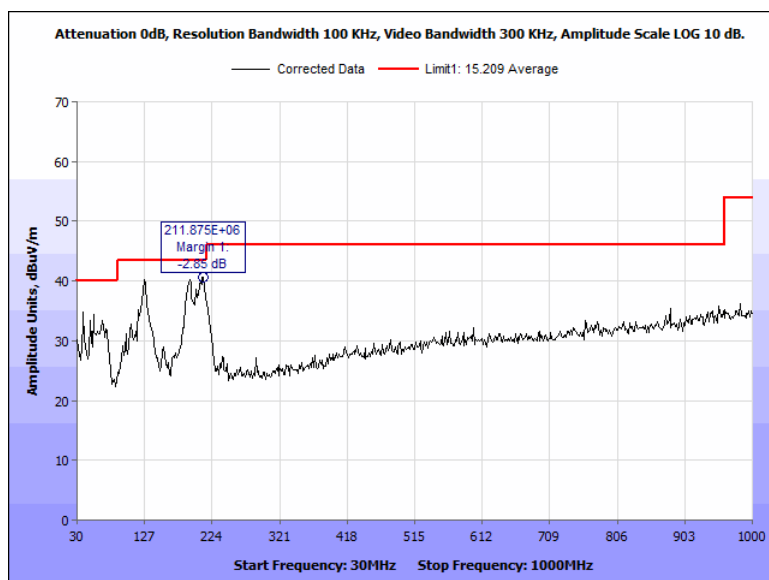


Figure 81: Radiated Spurious Emissions, Terminal, 2402 MHz, 30 MHz - 1000 MHz, Vertical

| Frequency (MHz) | EUT Azimuth (Degrees) | Antenna Polarity (H/V) | Antenna HEIGHT (m) | Uncorrected EMI Meter Reading (dBμV) | Antenna Correction Factor (dB/m) (+) | Distance Correction Factor (dB) (-) | Cable Loss/Pre-amp (dB) (+) | Corrected Amplitude (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|-----------------|-----------------------|------------------------|--------------------|--------------------------------------|--------------------------------------|-------------------------------------|-----------------------------|------------------------------|----------------|-------------|
| 120.1603        | 176.65                | H                      | 2.56               | 32.86                                | 15.92                                | 10.46                               | -23.51                      | 35.73                        | 43.5           | -7.77       |
| 118.6058        | 177.50                | H                      | 2.67               | 32.41                                | 16.04                                | 10.46                               | -23.53                      | 35.39                        | 43.5           | -8.11       |
| 39.3269         | 180.60                | H                      | 1.53               | 28.48                                | 17.14                                | 10.46                               | -24.52                      | 31.55                        | 40             | -8.45       |
| 211.8750        | 180.50                | V                      | 1.67               | 38.79                                | 14.21                                | 10.46                               | -22.81                      | 40.65                        | 43.5           | -2.85       |
| 210.3205        | 180.50                | V                      | 1.52               | 38.56                                | 14.37                                | 10.46                               | -22.80                      | 40.59                        | 43.5           | -2.91       |
| 191.6667        | 179.60                | V                      | 1.72               | 38.83                                | 14.00                                | 10.46                               | -22.98                      | 40.31                        | 43.5           | -3.19       |

Figure 82: Radiated Spurious Emissions, Terminal, 2402 MHz, 30 MHz – 1000 MHz

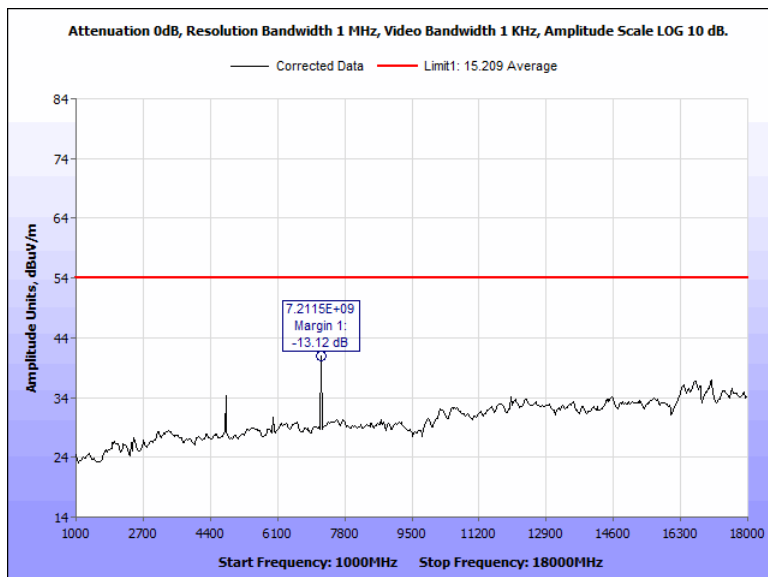


Figure 83: Radiated Spurious Emissions, Terminal, 2402 MHz, 1 GHz - 18 GHz, Average, Horizontal

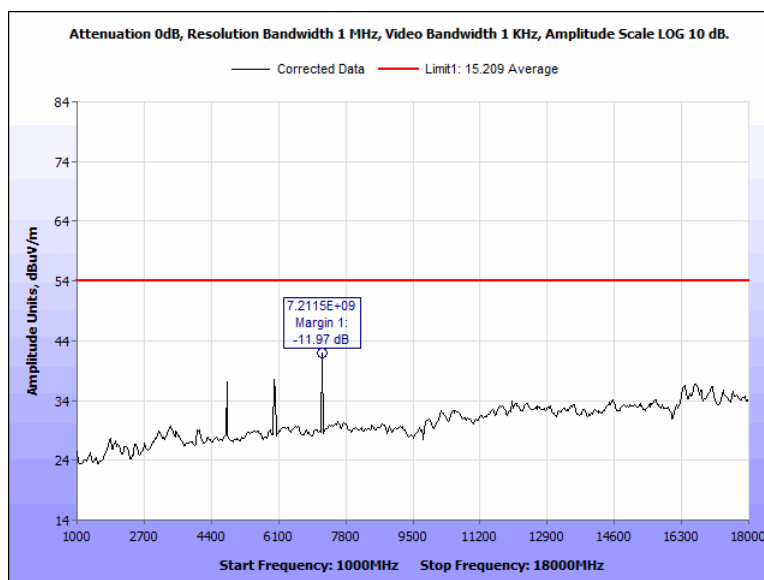
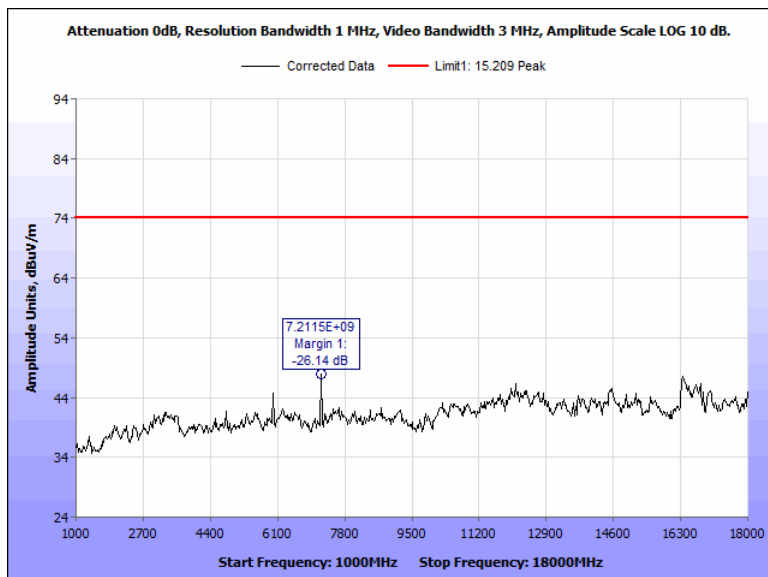


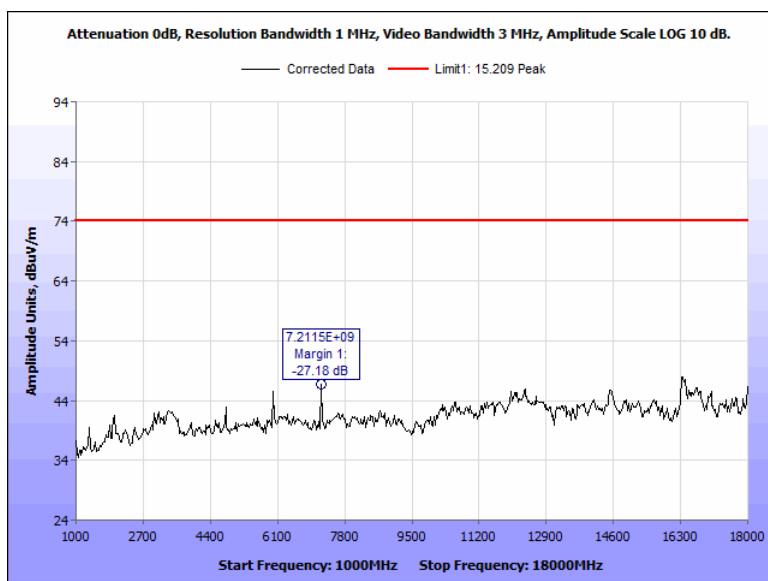
Figure 84: Radiated Spurious Emissions, Terminal, 2402 MHz, 1 GHz - 18 GHz, Average, Vertical

| Frequency (GHz) | EUT Azimuth (Degrees) | Antenna Polarity (H/V) | Antenna HEIGHT (m) | Uncorrected EMI Meter Reading (dBμV) | Antenna Correction Factor (dB/m) (+) | Distance Correction Factor (dB) (-) | Cable Loss/Pre-amp (dB) (+) | Corrected Amplitude (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|-----------------|-----------------------|------------------------|--------------------|--------------------------------------|--------------------------------------|-------------------------------------|-----------------------------|------------------------------|----------------|-------------|
| 7.2115          | 250.00                | H                      | 1.65               | 45.50                                | 35.38                                | 0.00                                | -40.00                      | 40.88                        | 54             | -13.12      |
| 16.3381         | 37.69                 | H                      | 2.27               | 36.26                                | 40.50                                | 0.00                                | -41.16                      | 35.59                        | 54             | -18.41      |
| 16.3654         | 176.40                | H                      | 1.70               | 36.46                                | 40.53                                | 0.00                                | -41.10                      | 35.89                        | 54             | -18.11      |
| 4.7869          | 250.00                | H                      | 1.80               | 41.80                                | 33.81                                | 0.00                                | -38.46                      | 37.15                        | 54             | -16.85      |
| 5.9856          | 180.60                | V                      | 1.86               | 42.35                                | 34.89                                | 0.00                                | -39.69                      | 37.54                        | 54             | -16.46      |
| 7.2115          | 230.50                | V                      | 1.84               | 46.64                                | 35.38                                | 0.00                                | -40.00                      | 42.03                        | 54             | -11.97      |

Figure 85: Radiated Spurious Emissions, Terminal, 2402 MHz, 1 GHz – 18 GHz, Test Results



**Figure 86: Radiated Spurious Emissions, Terminal, 2402 MHz, 1 GHz - 18 GHz, Peak, Horizontal**



**Figure 87: Radiated Spurious Emissions, Terminal, 2402 MHz, 1 GHz - 18 GHz, Peak, Vertical**

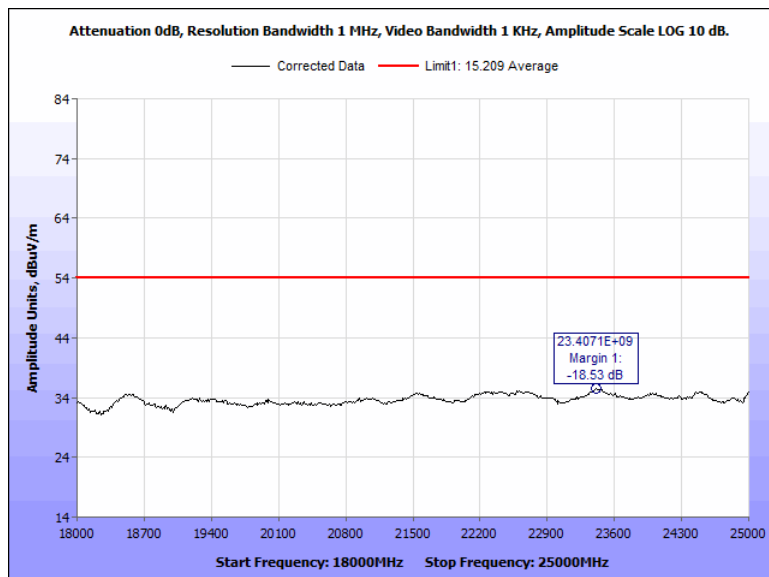


Figure 88: Radiated Spurious Emissions, Terminal, 2402 MHz, 18 GHz - 25 GHz, Average, Horizontal

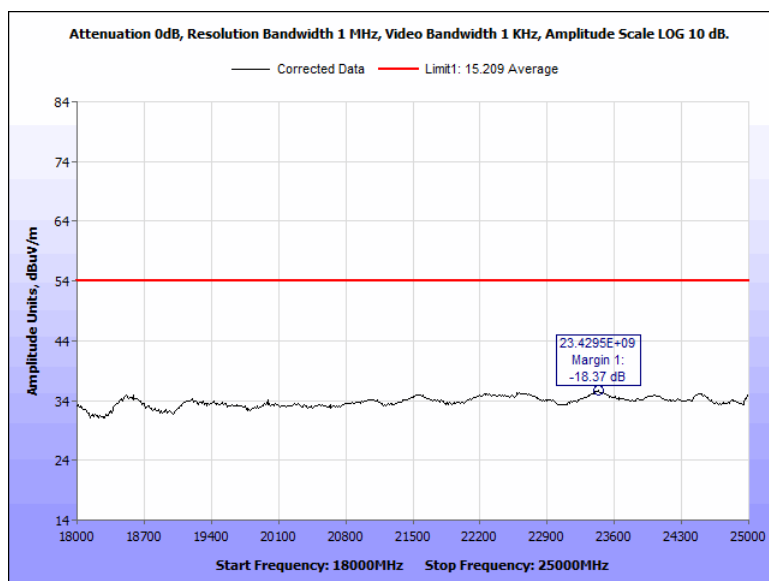


Figure 89: Radiated Spurious Emissions, Terminal, 2402 MHz, 18 GHz - 25 GHz, Average, Vertical

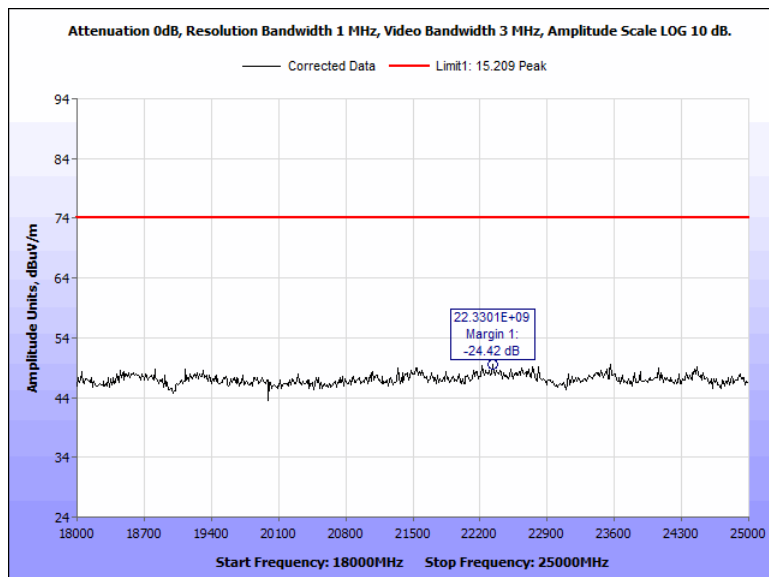


Figure 90: Radiated Spurious Emissions, Terminal, 2402 MHz, 18 GHz - 25 GHz, Peak, Horizontal

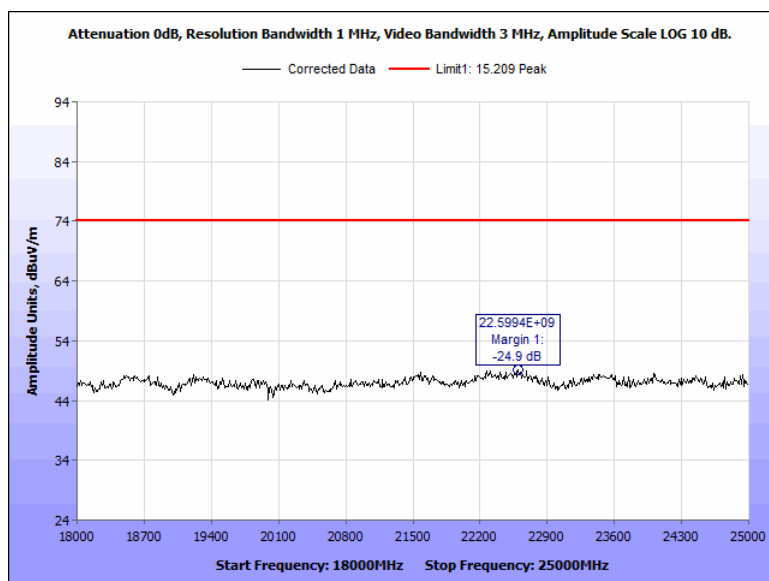


Figure 91: Radiated Spurious Emissions, Terminal, 2402 MHz, 18 GHz - 25 GHz, Peak, Vertical

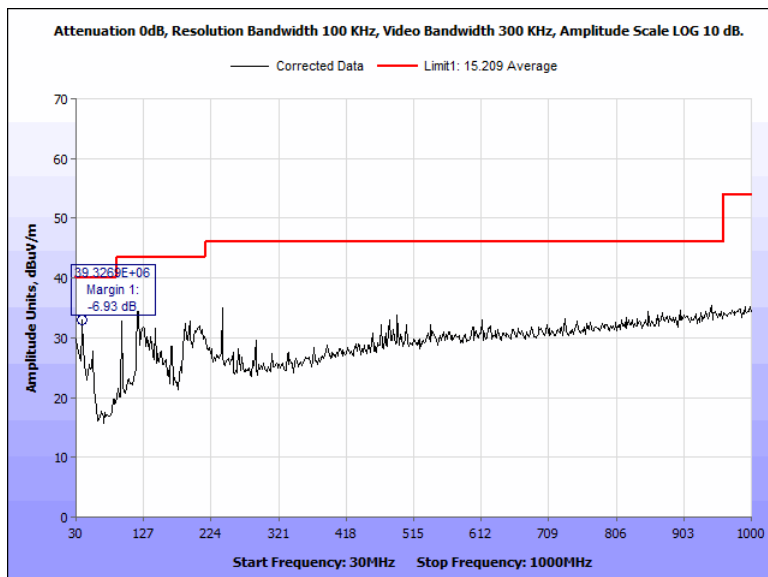


Figure 92: Radiated Spurious Emissions, Terminal, 2442 MHz, 30 MHz - 1000 MHz, Horizontal

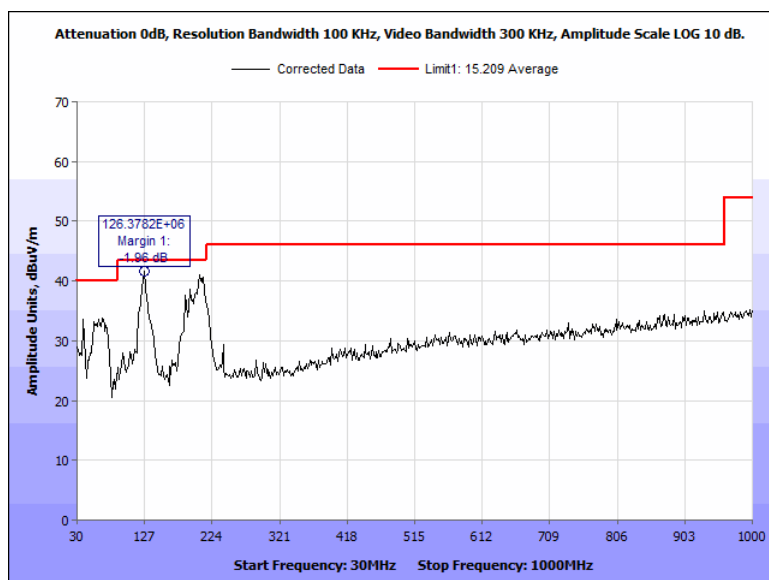


Figure 93: Radiated Spurious Emissions, Terminal, 2442 MHz, 30 MHz - 1000 MHz, Vertical

| Frequency (MHz) | EUT Azimuth (Degrees) | Antenna Polarity (H/V) | Antenna HEIGHT (m) | Uncorrected EMI Meter Reading (dBμV) | Antenna Correction Factor (dB/m) (+) | Distance Correction Factor (dB) (-) | Cable Loss/Pre-amp (dB) (+) | Corrected Amplitude (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|-----------------|-----------------------|------------------------|--------------------|--------------------------------------|--------------------------------------|-------------------------------------|-----------------------------|------------------------------|----------------|-------------|
| 39.3269         | 181.20                | H                      | 1.52               | 29.99                                | 17.54                                | 10.46                               | -24.52                      | 33.07                        | 40             | -6.93       |
| 205.6571        | 156.10                | H                      | 1.64               | 38.98                                | 14.57                                | 10.46                               | -22.90                      | 41.11                        | 43.50          | -2.39       |
| 37.7724         | 180.60                | H                      | 1.53               | 27.59                                | 18.44                                | 10.46                               | -24.58                      | 30.91                        | 40             | -9.09       |
| 126.3782        | 173.60                | V                      | 1.45               | 38.64                                | 15.94                                | 10.46                               | -23.50                      | 41.50                        | 40             | -1.96       |
| 207.2115        | 180.50                | V                      | 1.52               | 39.00                                | 13.78                                | 10.46                               | -22.86                      | 40.37                        | 43.5           | -3.13       |
| 208.7660        | 180.60                | V                      | 1.49               | 38.80                                | 13.62                                | 10.46                               | -22.83                      | 40.06                        | 43.5           | -3.44       |

Figure 94: Radiated Spurious Emissions, Terminal, 2442 MHz, 30 MHz – 1000 MHz

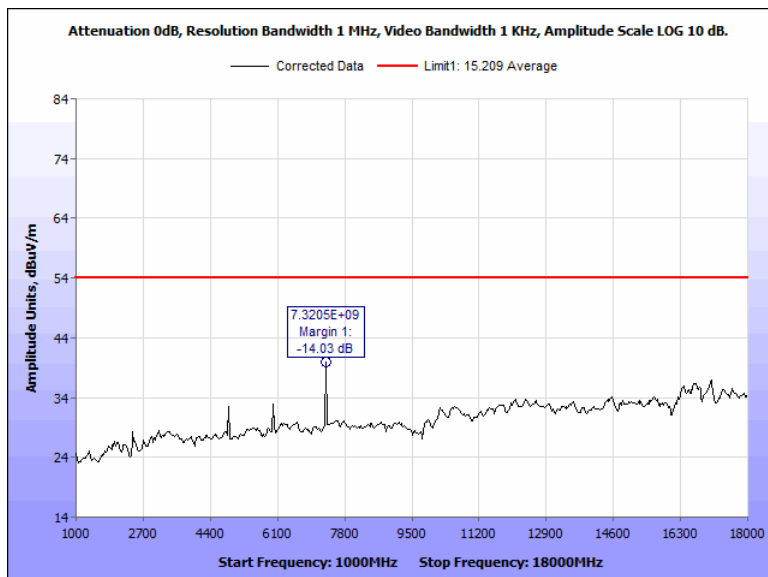


Figure 95: Radiated Spurious Emissions, Terminal, 2442 MHz, 1 GHz - 18 GHz, Average, Horizontal

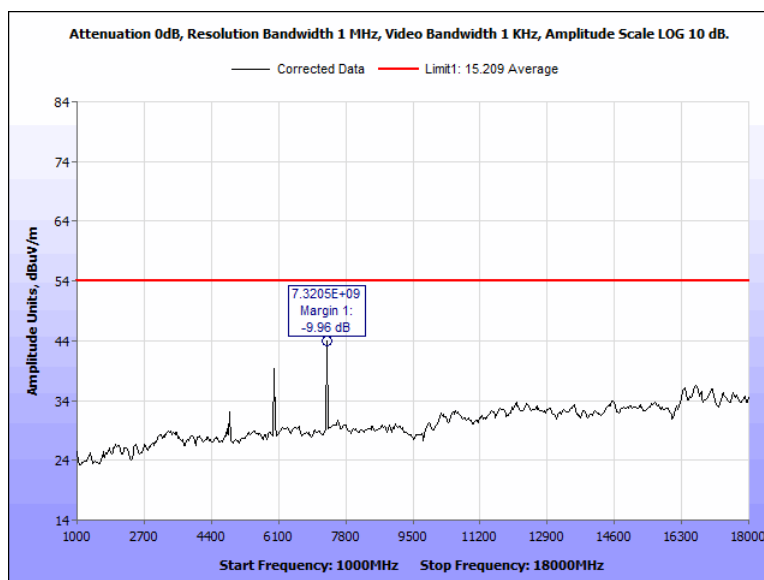
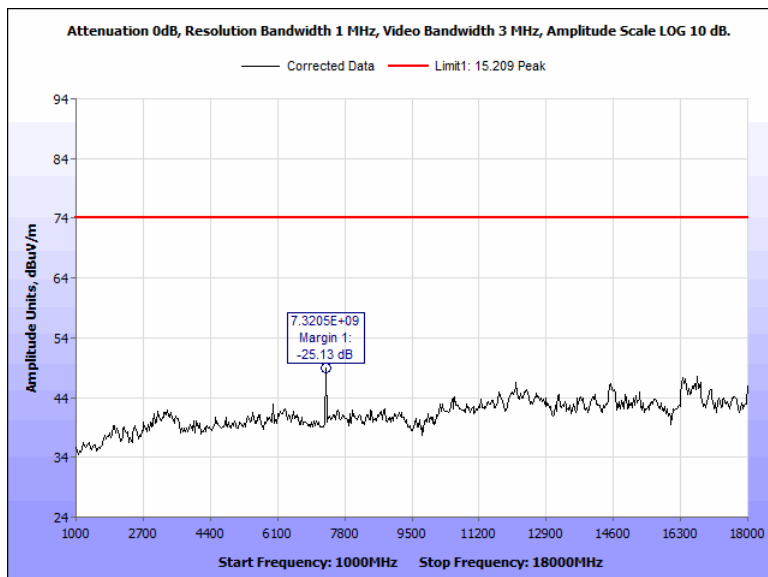


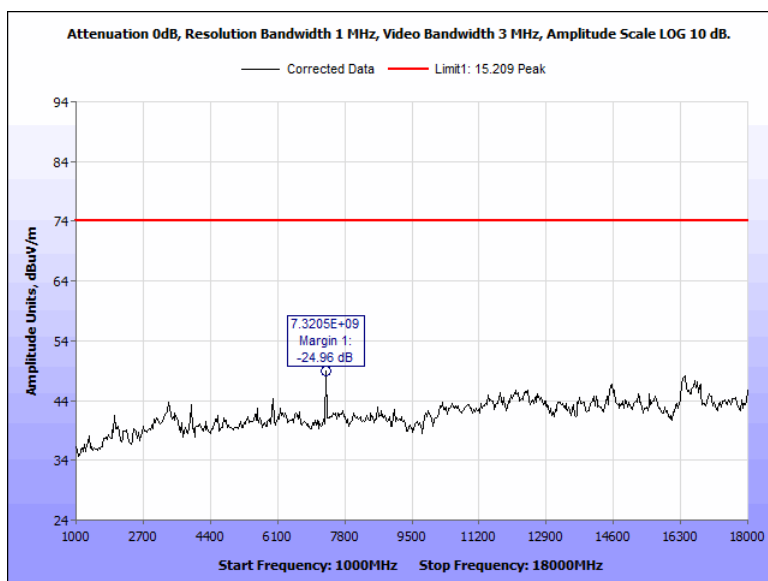
Figure 96: Radiated Spurious Emissions, Terminal, 2442 MHz, 1 GHz - 18 GHz, Average, Vertical

| Frequency (GHz) | EUT Azimuth (Degrees) | Antenna Polarity (H/V) | Antenna HEIGHT (m) | Uncorrected EMI Meter Reading (dBμV) | Antenna Correction Factor (dB/m) (+) | Distance Correction Factor (dB) (-) | Cable Loss/Pre-amp (dB) (+) | Corrected Amplitude (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|-----------------|-----------------------|------------------------|--------------------|--------------------------------------|--------------------------------------|-------------------------------------|-----------------------------|------------------------------|----------------|-------------|
| 7.4295          | 250.00                | H                      | 1.76               | 47.31                                | 35.38                                | 0.00                                | -39.55                      | 43.15                        | 54             | -10.85      |
| 17.0737         | 176.40                | H                      | 1.70               | 37.50                                | 40.91                                | 0.00                                | -41.55                      | 36.87                        | 54             | -17.13      |
| 17.0465         | 180.60                | H                      | 1.79               | 37.19                                | 40.95                                | 0.00                                | -41.60                      | 36.55                        | 54             | -17.45      |
| 7.4295          | 250.00                | V                      | 2.30               | 51.45                                | 35.38                                | 0.00                                | -39.55                      | 47.29                        | 54             | -6.71       |
| 5.9856          | 180.76                | V                      | 1.82               | 43.98                                | 34.89                                | 0.00                                | -39.69                      | 39.18                        | 54             | -14.82      |
| 16.6651         | 180.60                | V                      | 1.86               | 37.66                                | 41.12                                | 0.00                                | -42.10                      | 36.69                        | 54             | -17.31      |

Figure 97: Radiated Spurious Emissions, Terminal, 2442 MHz, 1 GHz – 18 GHz, Test Results



**Figure 98: Radiated Spurious Emissions, Terminal, 2442 MHz, 1 GHz - 18 GHz, Peak, Horizontal**



**Figure 99: Radiated Spurious Emissions, Terminal, 2442 MHz, 1 GHz - 18 GHz, Peak, Vertical**

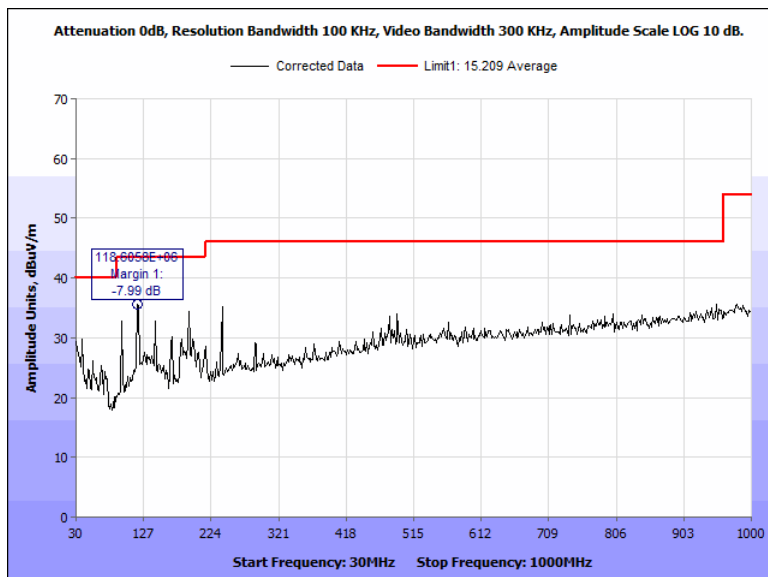


Figure 100: Radiated Spurious Emissions, Terminal, 2480 MHz, 30 MHz - 1000 MHz, Horizontal

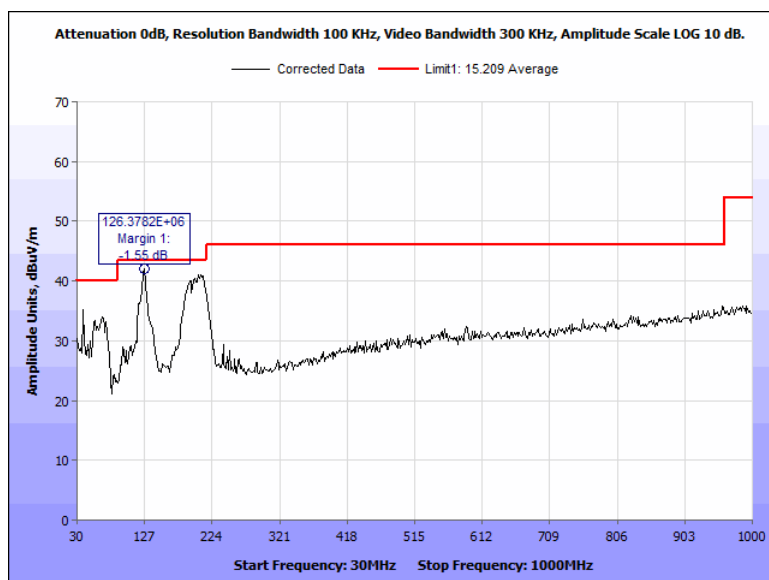


Figure 101: Radiated Spurious Emissions, Terminal, 2480 MHz, 30 MHz - 1000 MHz, Vertical

| Frequency (MHz) | EUT Azimuth (Degrees) | Antenna Polarity (H/V) | Antenna HEIGHT (m) | Uncorrected EMI Meter Reading (dBμV) | Antenna Correction Factor (dB/m) (+) | Distance Correction Factor (dB) (-) | Cable Loss/Pre-amp (dB) (+) | Corrected Amplitude (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|-----------------|-----------------------|------------------------|--------------------|--------------------------------------|--------------------------------------|-------------------------------------|-----------------------------|------------------------------|----------------|-------------|
| 118.6058        | 180.60                | H                      | 1.52               | 32.53                                | 16.04                                | 10.46                               | -23.53                      | 35.51                        | 43.5           | -7.99       |
| 120.1603        | 180.60                | H                      | 1.61               | 32.62                                | 15.92                                | 10.46                               | -23.51                      | 35.49                        | 43.5           | -8.01       |
| 191.6667        | 181.20                | H                      | 1.52               | 32.91                                | 14.00                                | 10.46                               | -22.98                      | 34.39                        | 43.5           | -9.11       |
| 126.3782        | 173.56                | V                      | 1.77               | 39.05                                | 15.94                                | 10.46                               | -23.50                      | 41.95                        | 43.5           | -1.55       |
| 124.8237        | 178.50                | V                      | 1.47               | 38.27                                | 16.00                                | 10.46                               | -23.50                      | 41.23                        | 43.5           | -2.27       |
| 204.1026        | 180.60                | V                      | 1.49               | 39.19                                | 14.41                                | 10.46                               | -22.94                      | 41.13                        | 43.5           | -2.37       |

Figure 102: Radiated Spurious Emissions, Terminal, 2480 MHz, 30 MHz – 1000 MHz

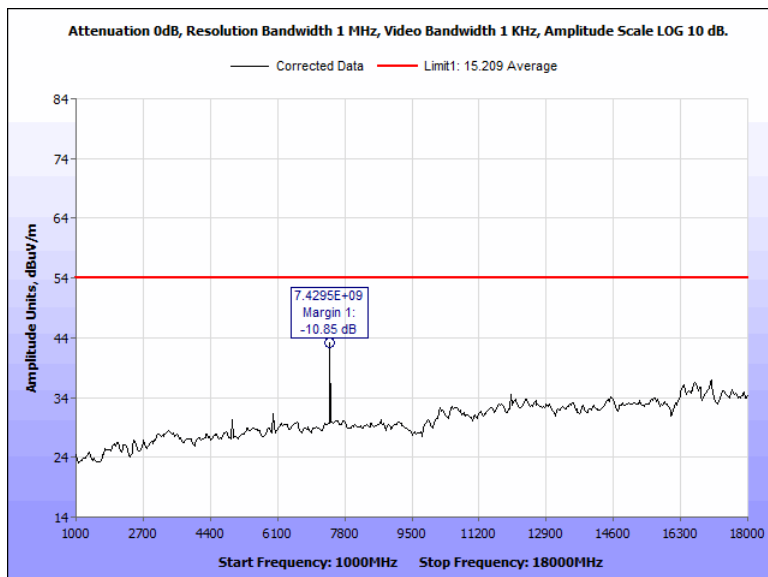


Figure 103: Radiated Spurious Emissions, Terminal, 2480 MHz, 1 GHz - 18 GHz, Average, Horizontal

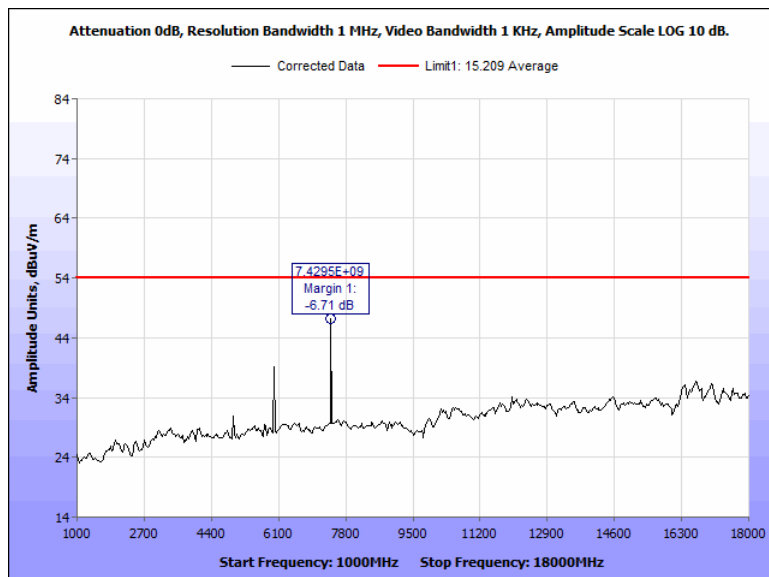
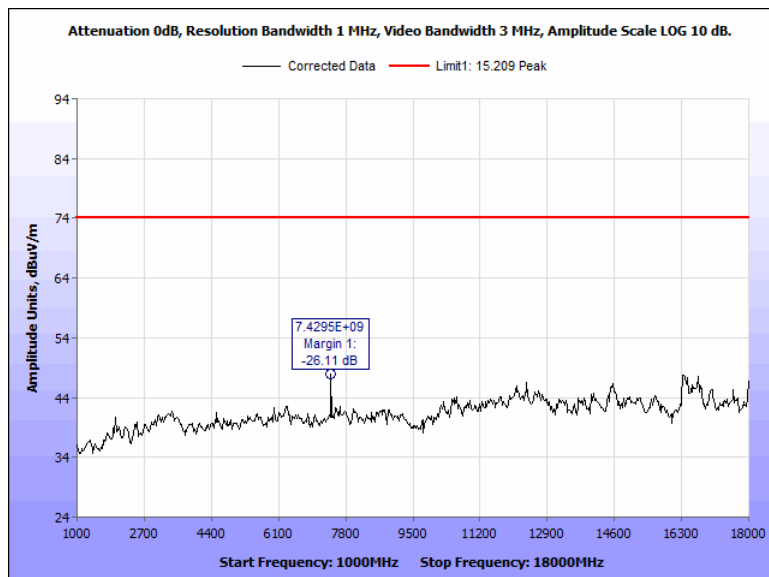


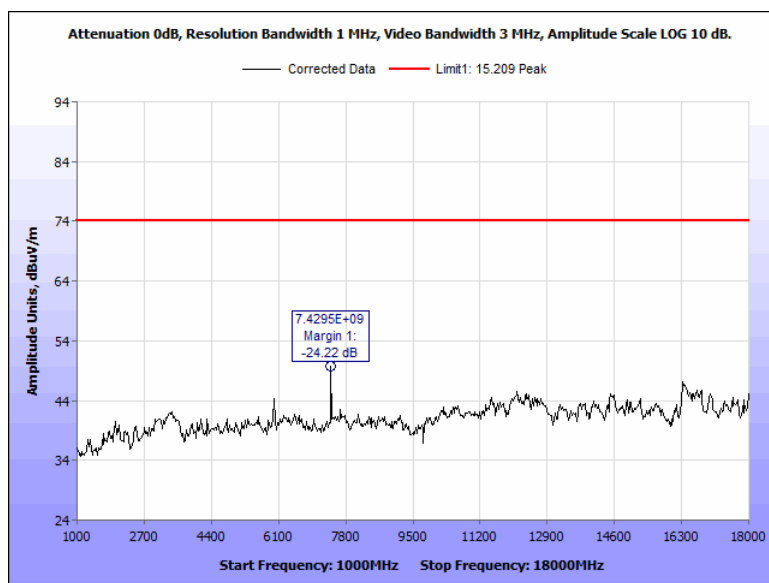
Figure 104: Radiated Spurious Emissions, Terminal, 2480 MHz, 1 GHz - 18 GHz, Average, Vertical

| Frequency (GHz) | EUT Azimuth (Degrees) | Antenna Polarity (H/V) | Antenna HEIGHT (m) | Uncorrected EMI Meter Reading (dBμV) | Antenna Correction Factor (dB/m) (+) | Distance Correction Factor (dB) (-) | Cable Loss/Pre-amp (dB) (+) | Corrected Amplitude (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|-----------------|-----------------------|------------------------|--------------------|--------------------------------------|--------------------------------------|-------------------------------------|-----------------------------|------------------------------|----------------|-------------|
| 7.4295          | 250.00                | H                      | 2.30               | 47.31                                | 35.38                                | 0.00                                | -39.55                      | 43.15                        | 54             | -10.85      |
| 17.0737         | 37.69                 | H                      | 1.65               | 37.50                                | 40.91                                | 0.00                                | -41.55                      | 40.91                        | 54             | -17.13      |
| 17.0465         | 176.40                | H                      | 1.70               | 37.19                                | 40.95                                | 0.00                                | -41.60                      | 36.55                        | 54             | -17.45      |
| 7.4295          | 250.00                | V                      | 2.30               | 51.45                                | 35.38                                | 0.00                                | -39.55                      | 47.29                        | 54             | -6.71       |
| 5.9856          | 180.60                | V                      | 1.86               | 43.98                                | 34.89                                | 0.00                                | -39.69                      | 39.18                        | 54             | -14.82      |
| 16.6651         | 230.50                | V                      | 2.14               | 37.66                                | 41.12                                | 0.00                                | -42.10                      | 36.69                        | 54             | -17.31      |

Figure 105: Radiated Spurious Emissions, Terminal, 2480 MHz, 1 GHz – 18 GHz, Test Results



**Figure 106: Radiated Spurious Emissions, Terminal, 2480 MHz, 1 GHz - 18 GHz, Peak, Horizontal**



**Figure 107: Radiated Spurious Emissions, Terminal, 2480 MHz, 1 GHz - 18 GHz, Peak, Vertical**

## Radiated Band Edge Measurements

**Test Procedures:** The transmitter was turned on. Measurements were performed of the low and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line.

### Model: 40K Pigtail

**Test Results:** The EUT was tested was compliant with § 15.205 Restricted Band requirements. No anomalies noted.

**Test Engineer:** Jonathan Tavira

**Test Date:** September 26, 2019

### Test Data, Model: 40K Pigtail

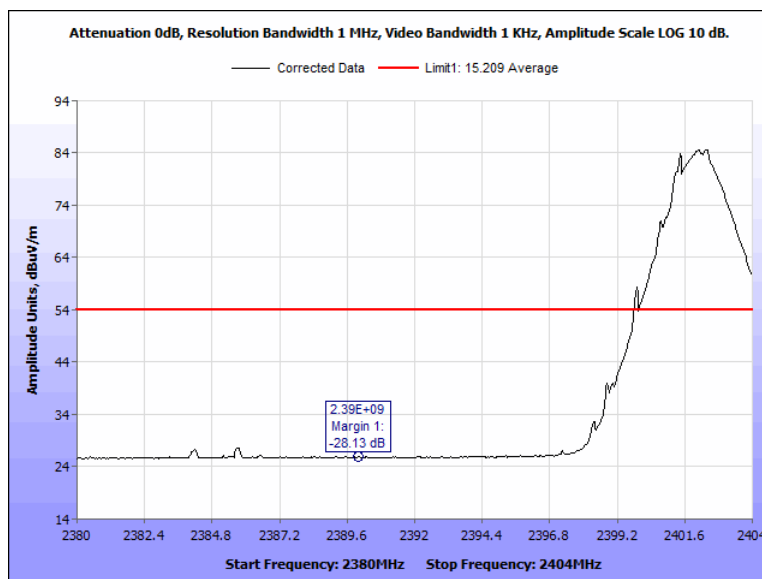


Figure 108: Radiated Band Edge, Pigtail, 2402 MHz, Average, Horizontal

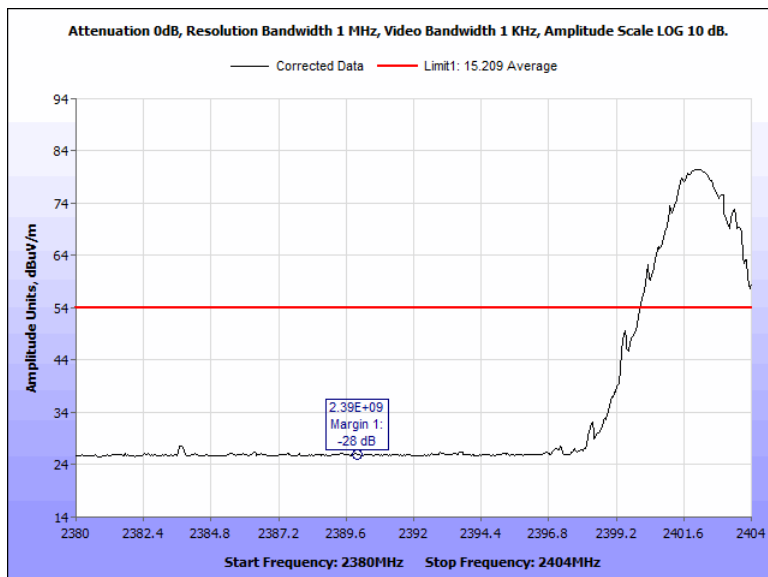


Figure 109: Radiated Band Edge, Pigtail, 2402 MHz, Average, Vertical

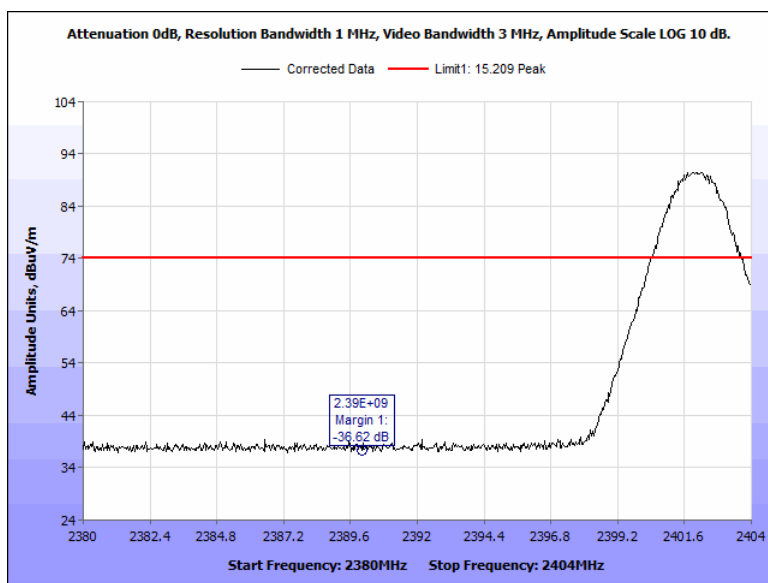


Figure 110: Radiated Band Edge, Pigtail, 2402 MHz, Peak, Horizontal

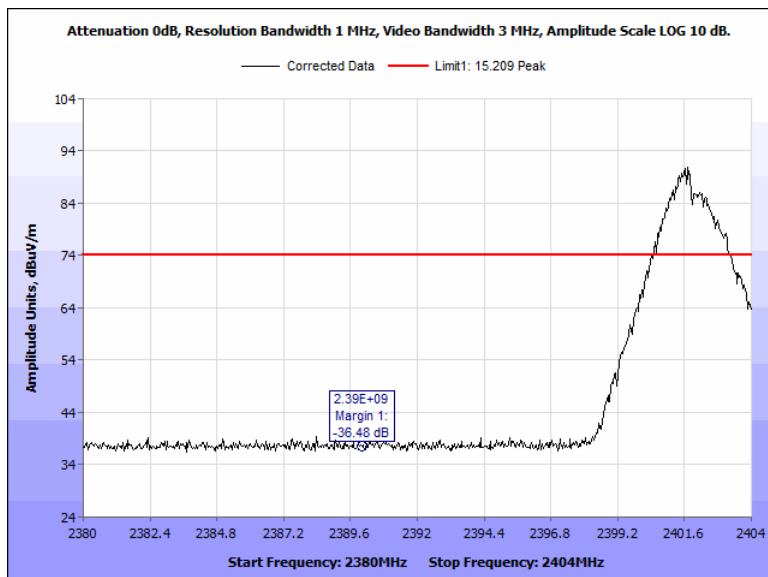


Figure 111: Radiated Band Edge, Pigtail, 2402 MHz, Peak, Vertical

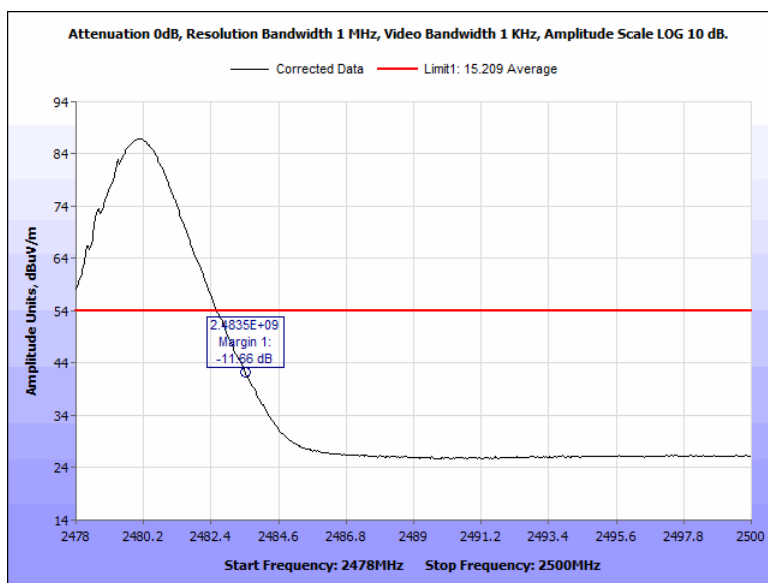
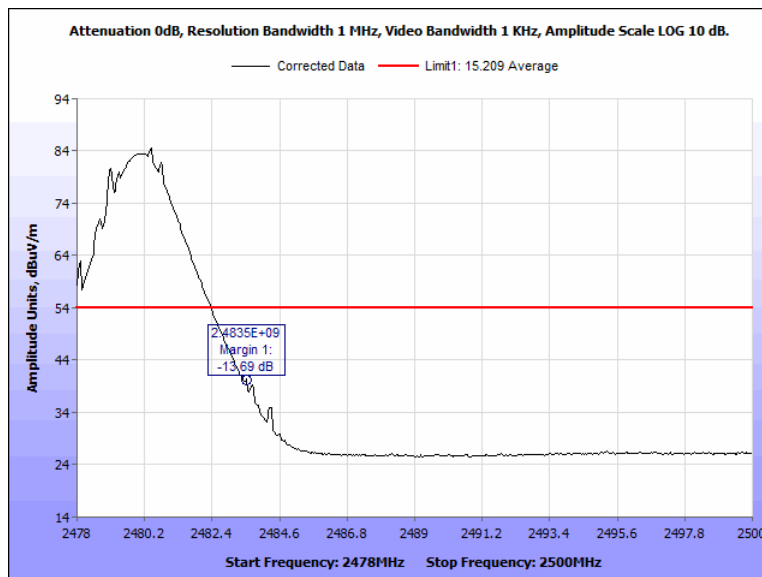
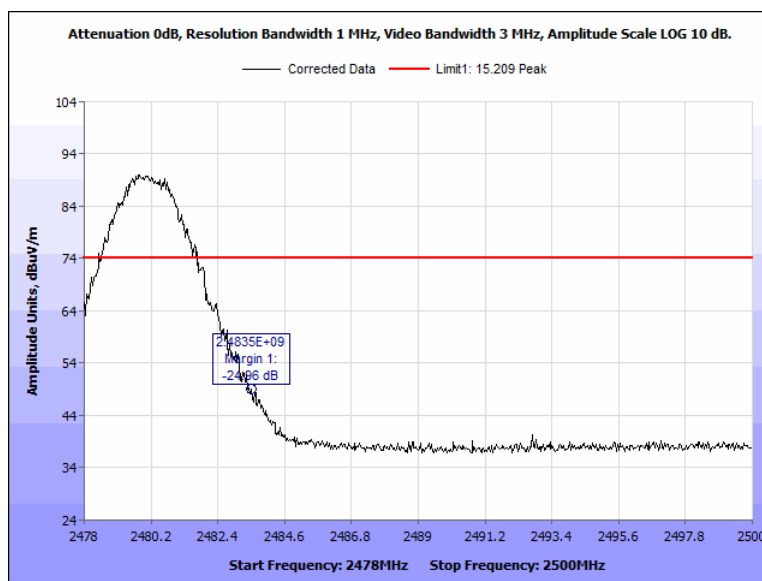


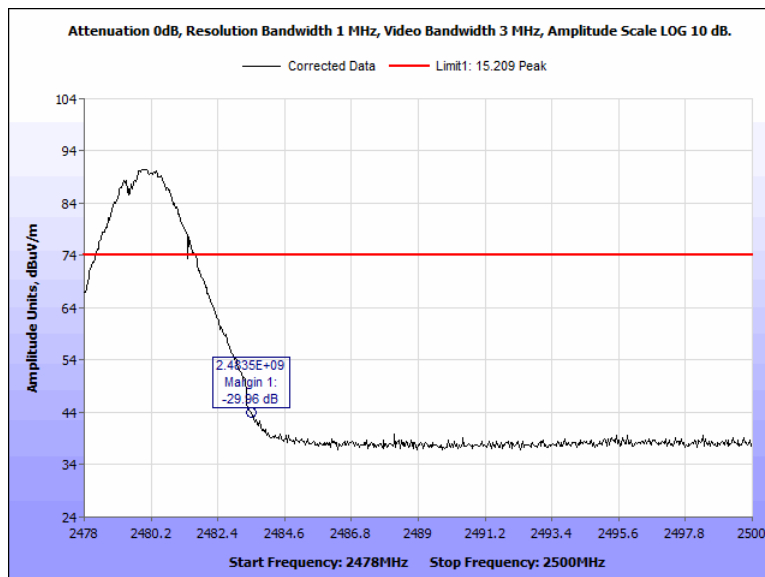
Figure 112: Radiated Band Edge, Pigtail, 2480 MHz, Average, Horizontal



**Figure 113: Radiated Band Edge, Pigtail, 2480 MHz, Average, Vertical**



**Figure 114: Radiated Band Edge, Pigtail, 2480 MHz, Peak, Horizontal**



**Figure 115: Radiated Band Edge, Pigtail, 2480 MHz, Peak, Vertical**

### Model: 40K Terminal

**Test Results:** The EUT was tested was **compliant** with § 15.205 Restricted Band requirements. No anomalies noted.

**Test Engineer:** Jonathan Tavira

**Test Date:** September 26, 2019

### Test Data, Model: 40K Terminal

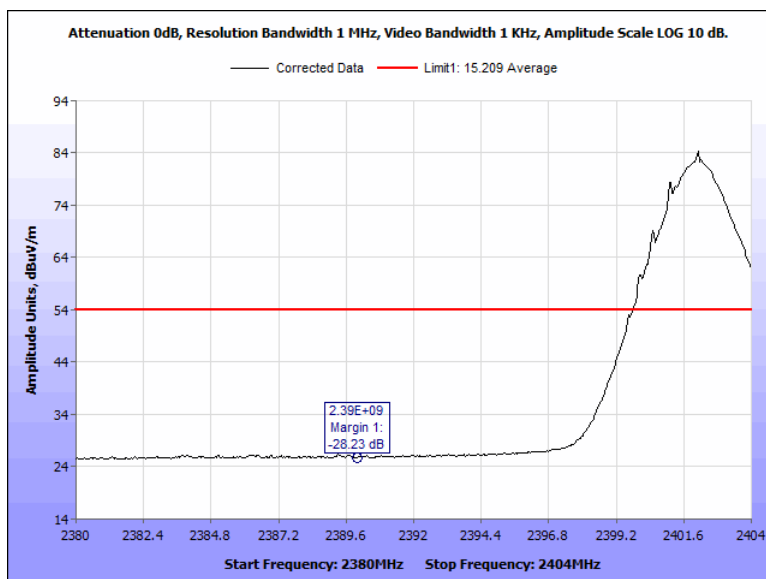
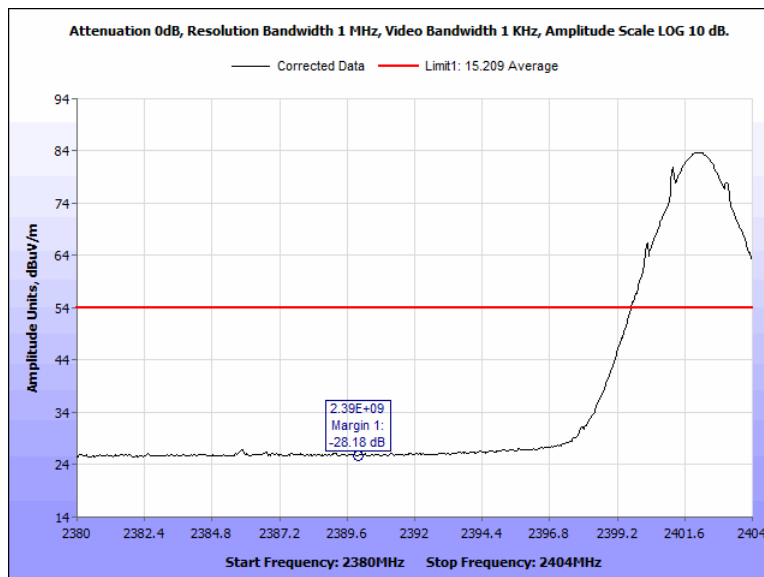
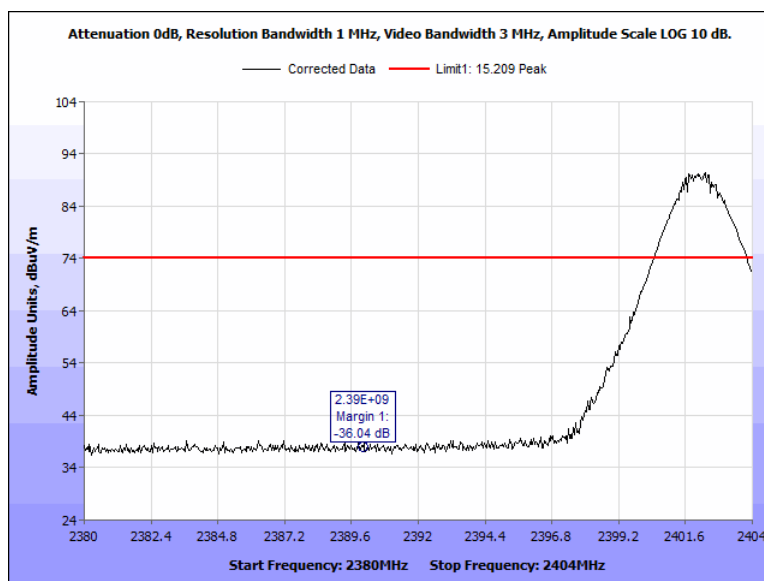


Figure 116: Radiated Band Edge, Terminal, 2402 MHz, Average, Horizontal



**Figure 117: Radiated Band Edge, Terminal, 2402 MHz, Average, Vertical**



**Figure 118: Radiated Band Edge, Terminal, 2402 MHz, Peak, Horizontal**

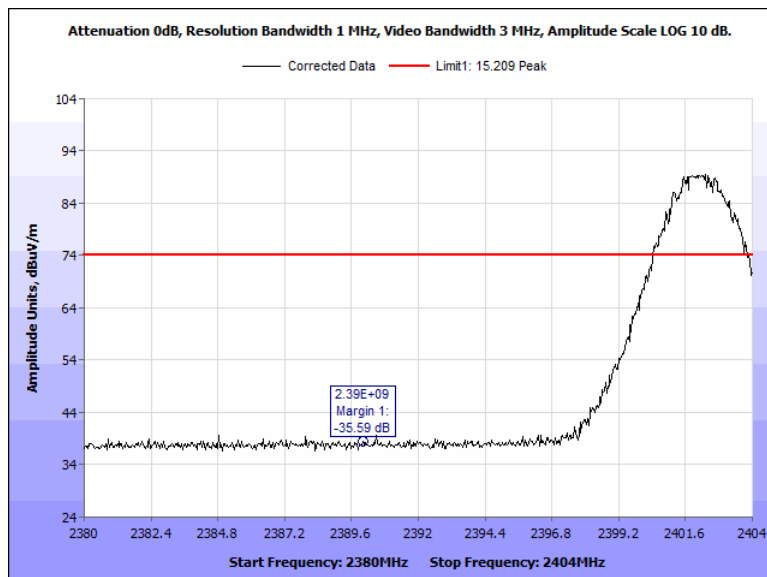


Figure 119: Radiated Band Edge, Terminal, 2402 MHz, Peak, Vertical

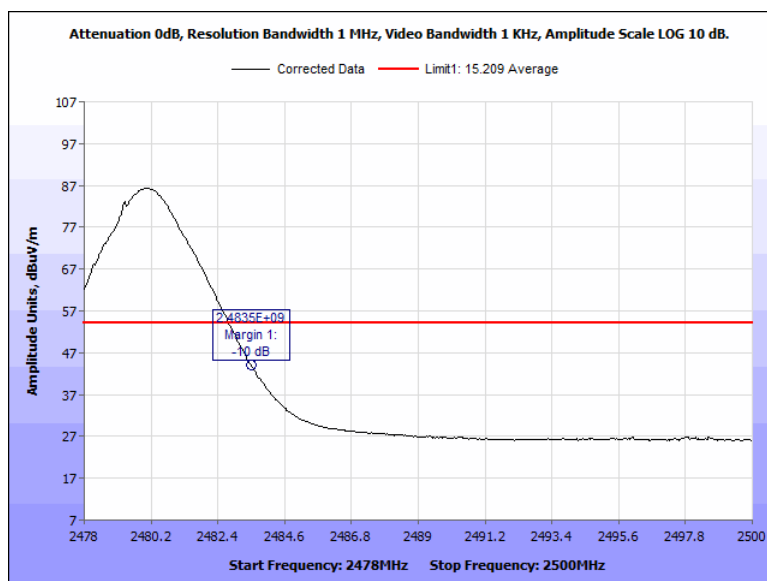


Figure 120: Radiated Band Edge, Terminal, 2480 MHz, Average, Horizontal

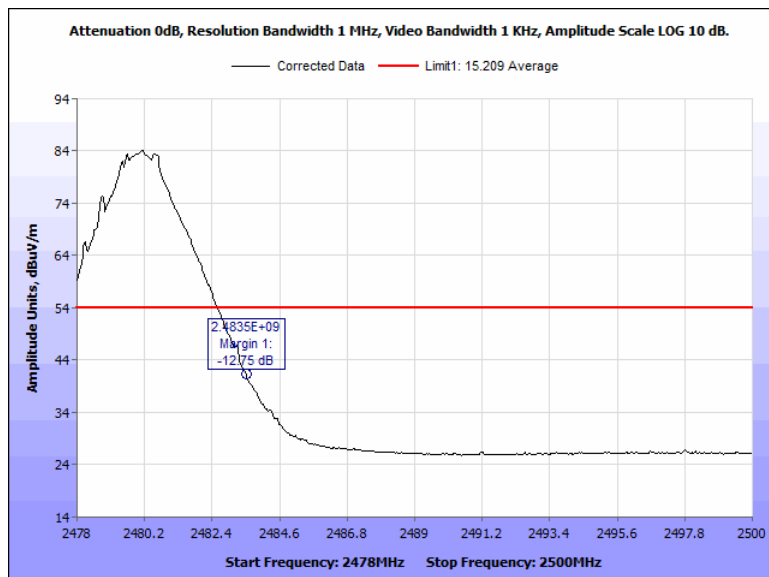


Figure 121: Radiated Band Edge, Terminal, 2480 MHz, Average, Vertical

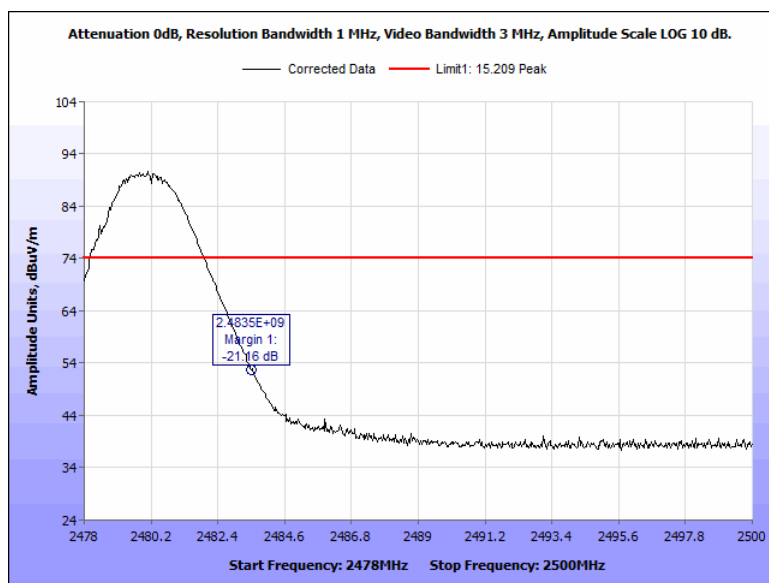
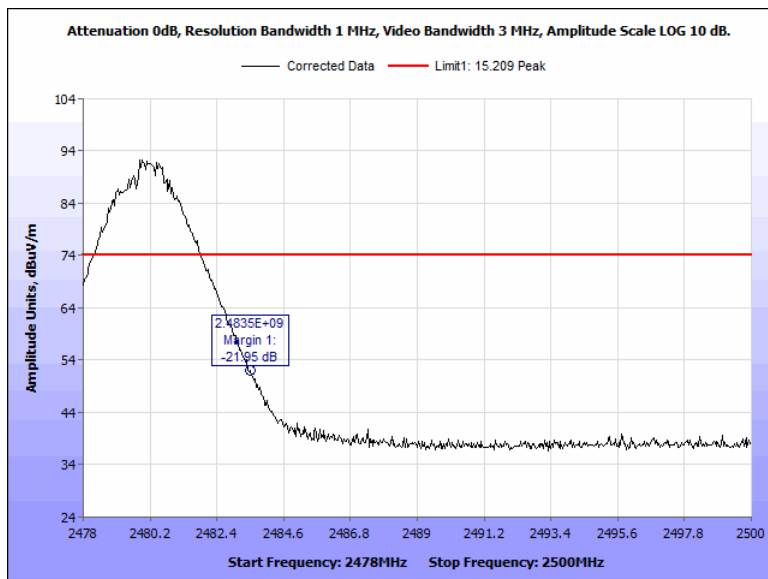


Figure 122: Radiated Band Edge, Terminal, 2480 MHz, Peak, Horizontal



**Figure 123: Radiated Band Edge, Terminal, 2480 MHz, Peak, Vertical**

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247(d) Spurious Emissions in Non-restricted Bands

**Test Requirement:** 15.247(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

**Test Procedure:** For intentional radiators with a digital device portion which operates below 10 GHz, the spectrum was investigated as per §15.33(a)(1) and §15.33(a)(4); i.e., the lowest RF signal generated or used in the device up to the 10<sup>th</sup> harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

Conducted measurements were performed. The plots were corrected for cable loss.



**Figure 124: Block Diagram, Conducted Spurious Emissions Test Setup**

### Model: 40K Pigtail

**Test Results:** The EUT was tested is **compliant** with § 15.247(d) Spurious Emissions in Non-restricted Bands. No anomalies were noted.

**Test Engineer:** Jonathan Tavira

**Test Date:** September 18, 2019

### Test Data, Model: 40K Pigtail

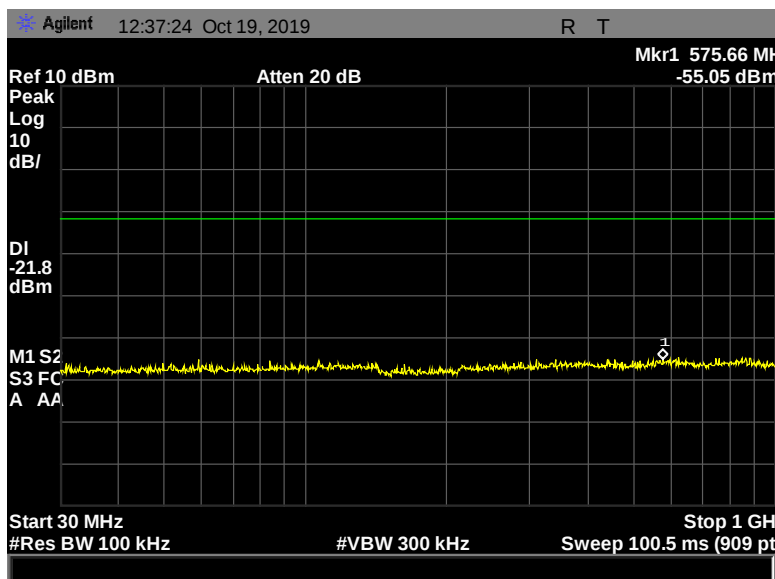


Figure 125: Conducted Spurious Emissions, Pigtail, 2402 MHz, 1 Mbps, 30 MHz - 1000 MHz

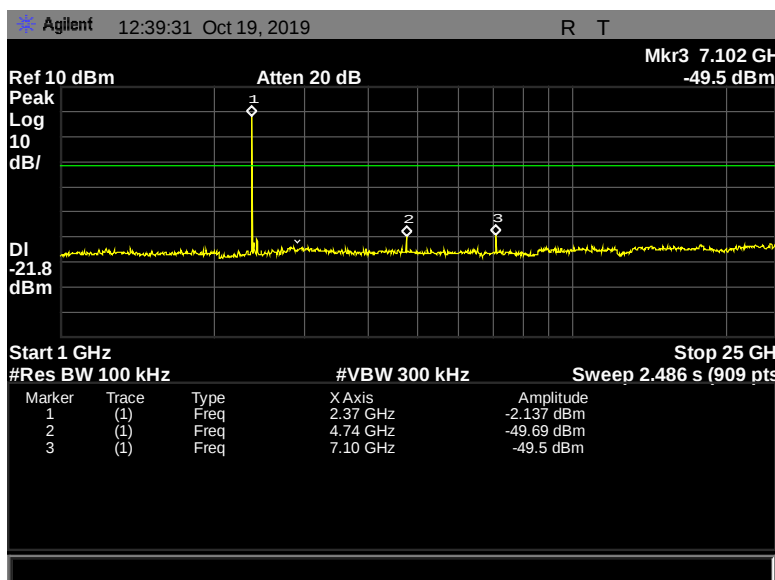


Figure 126: Conducted Spurious Emissions, Pigtail, 2402 MHz, 1 Mbps, 1 GHz - 25 GHz

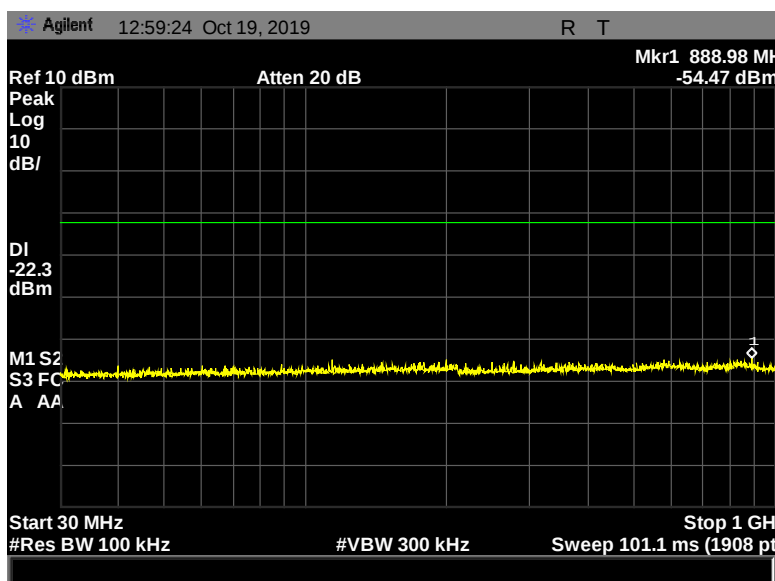


Figure 127: Conducted Spurious Emissions, Pigtail, 2402 MHz, 2 Mbps, 30 MHz - 1000 MHz

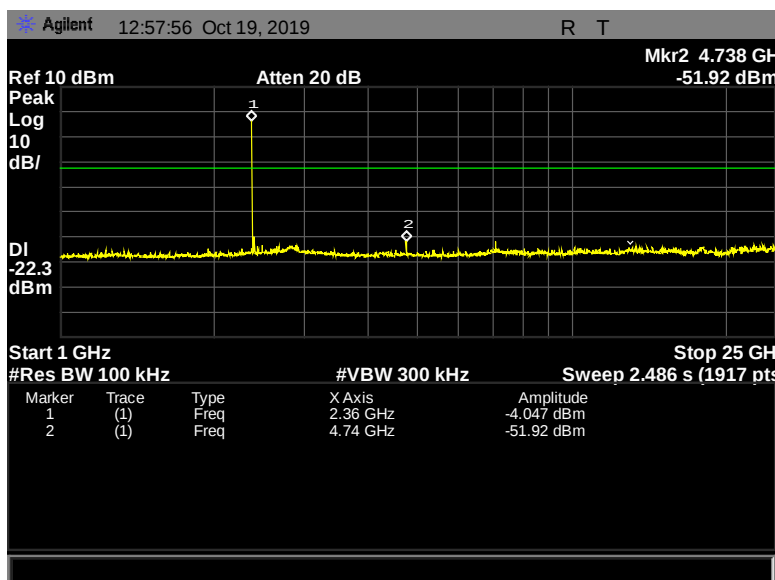


Figure 128: Conducted Spurious Emissions, Pigtail, 2402 MHz, 2 Mbps, 1 GHz - 25 GHz

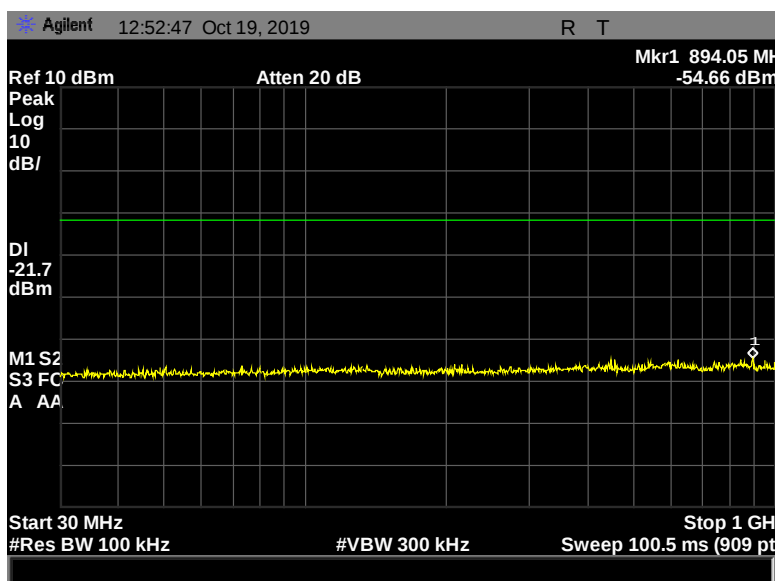


Figure 129: Conducted Spurious Emissions, Pigtail, 2442 MHz, 1 Mbps, 30 MHz - 1000 MHz

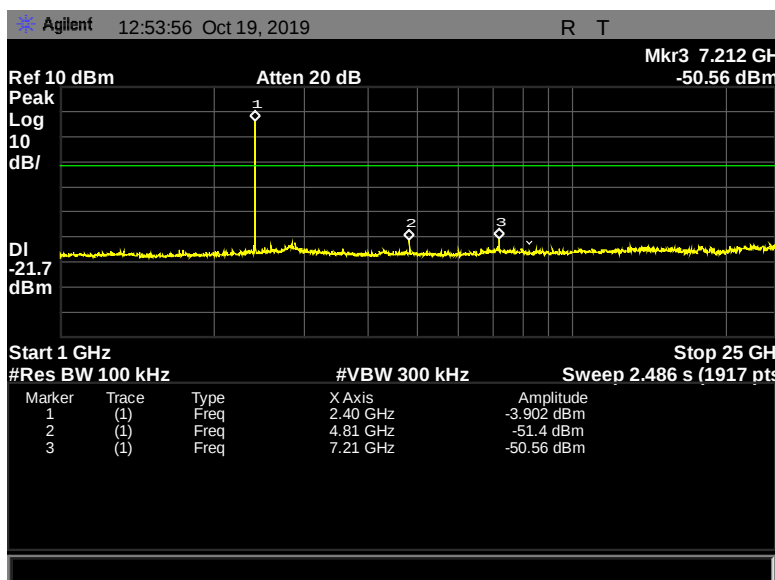


Figure 130: Conducted Spurious Emissions, Pigtail, 2442 MHz, 1 Mbps, 1 GHz - 25 GHz

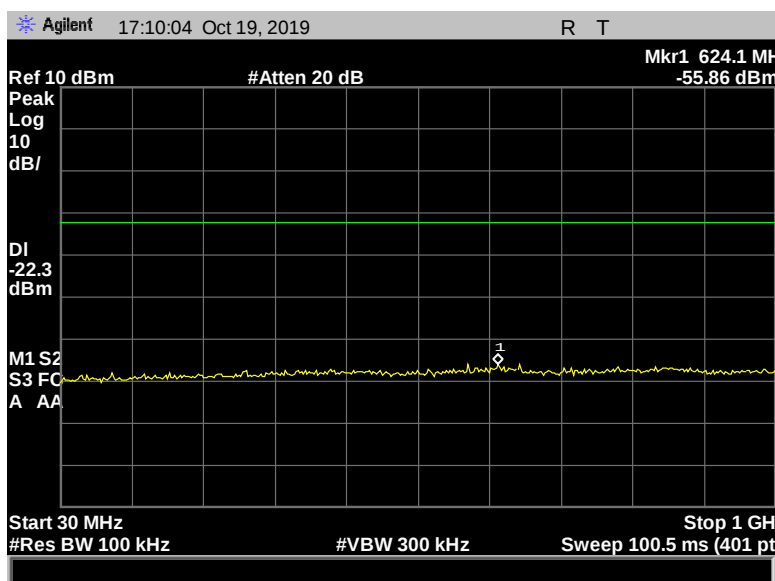


Figure 131: Conducted Spurious Emissions, Pigtail, 2442 MHz, 2 Mbps, 30 MHz - 1000 MHz

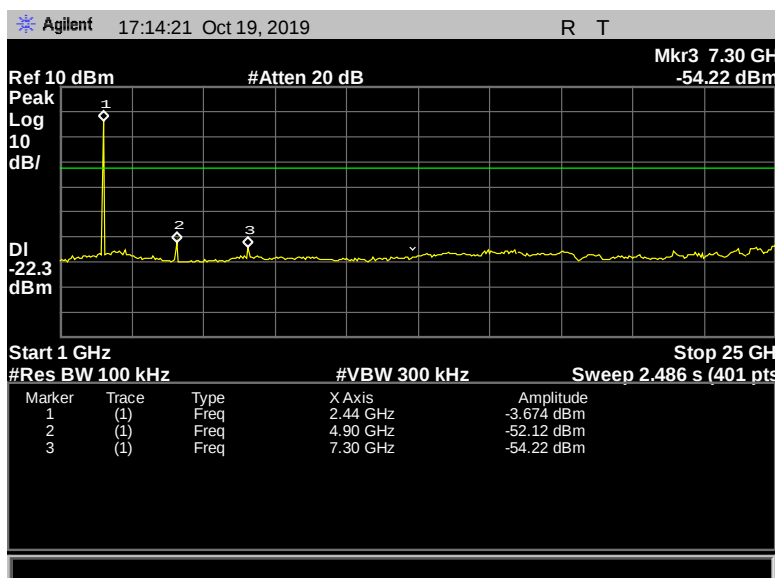


Figure 132: Conducted Spurious Emissions, Pigtail, 2442 MHz, 2 Mbps, 1 GHz - 25 GHz

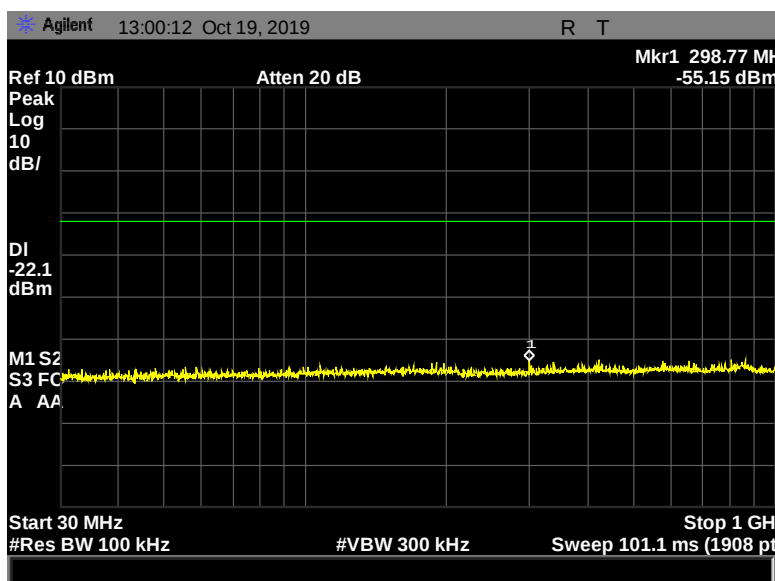


Figure 133: Conducted Spurious Emissions, Pigtail, 2480 MHz, 1 Mbps, 30 MHz - 1000 MHz

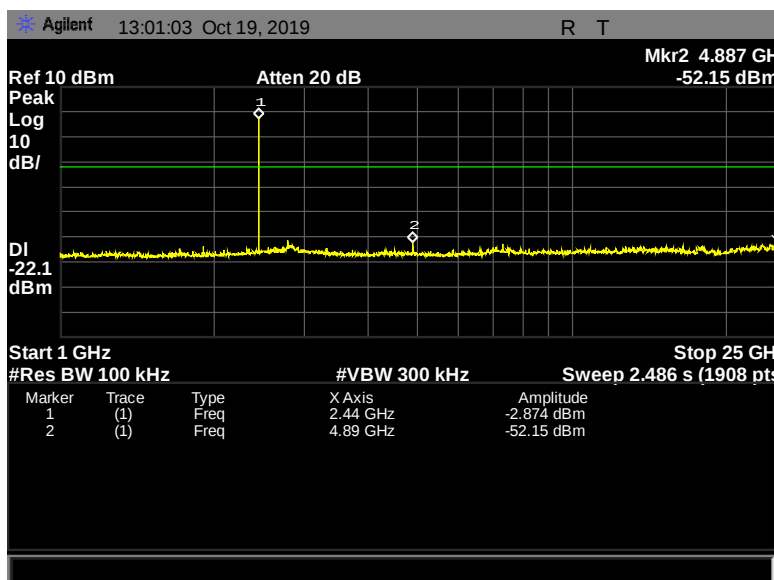


Figure 134: Conducted Spurious Emissions, Pigtail, 2480 MHz, 1 Mbps, 1 GHz - 25 GHz

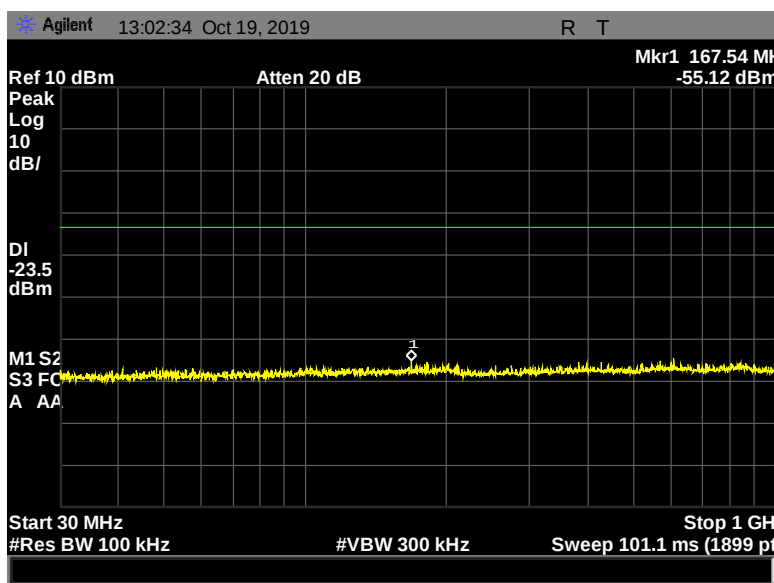


Figure 135: Conducted Spurious Emissions, Pigtail, 2480 MHz, 2 Mbps, 30 MHz - 1000 MHz

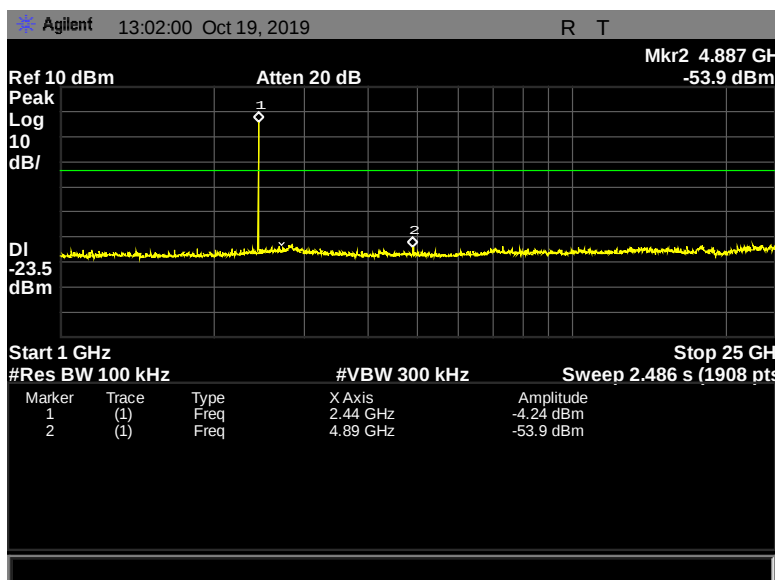


Figure 136: Conducted Spurious Emissions, Pigtail, 2480 MHz, 2 Mbps, 1 GHz - 25 GHz

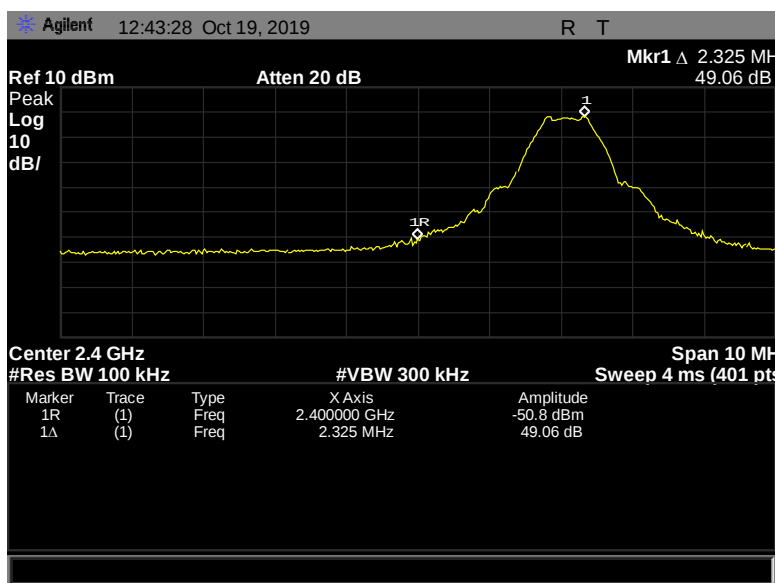


Figure 137: Conducted Band Edge, Pigtail, 2402 MHz, 1 Mbps

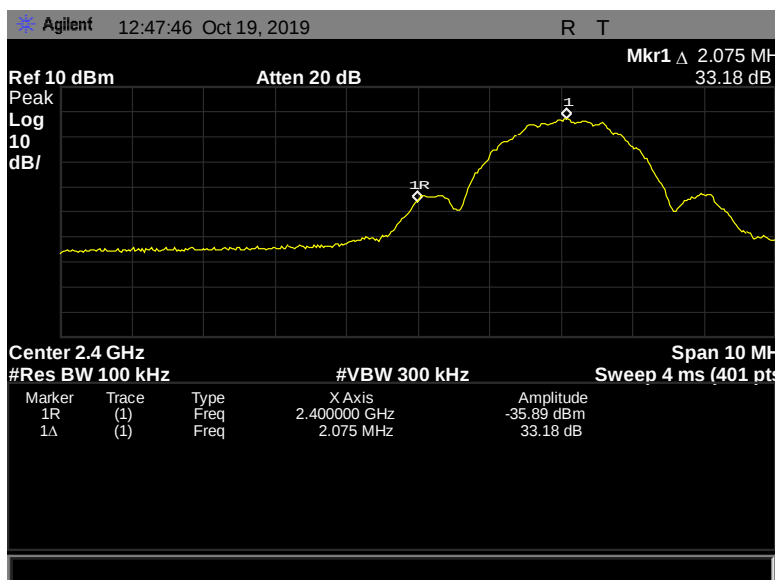


Figure 138: Conducted Band Edge, Pigtail, 2402 MHz, 2 Mbps

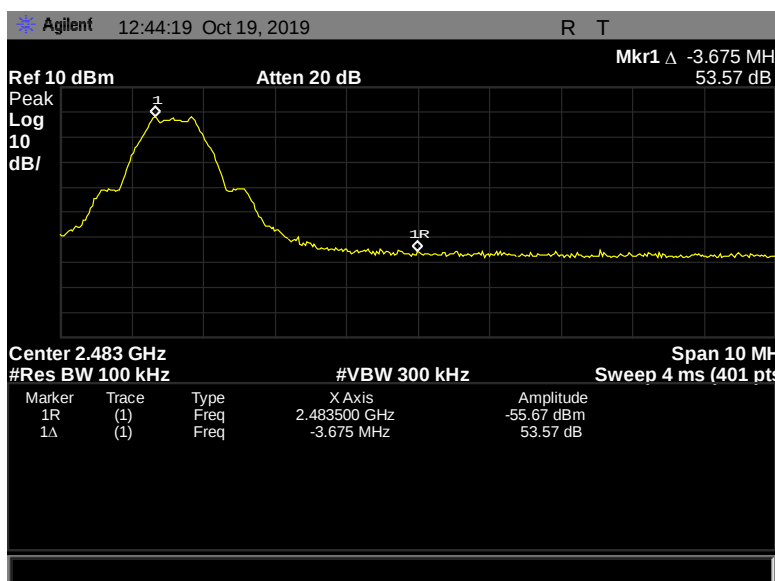


Figure 139: Conducted Band Edge, Pigtail, 2480 MHz, 1 Mbps

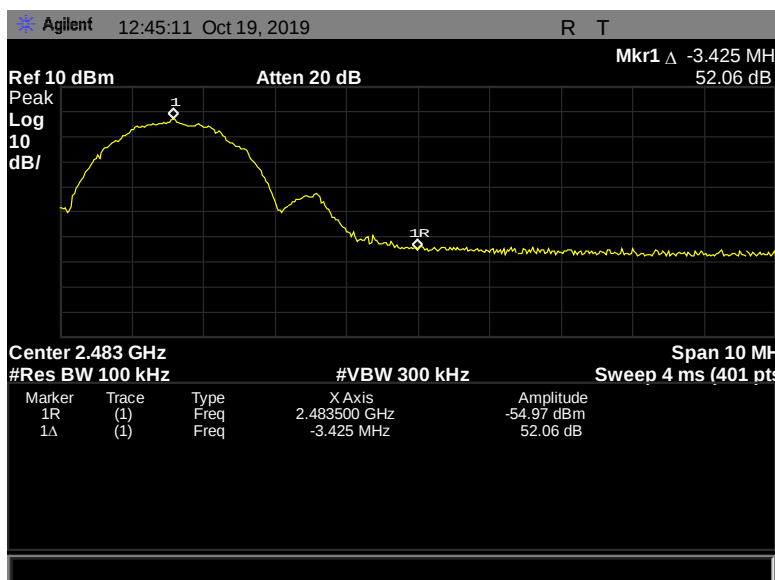


Figure 140: Conducted Band Edge, Pigtail, 2480 MHz, 2 Mbps

### Model: 40K Terminal

**Test Results:** The EUT was tested is **compliant** with § 15.247(d) Spurious Emissions in Non-restricted Bands. No anomalies were noted.

**Test Engineer:** Jonathan Tavira

**Test Date:** September 11, 2019

### Test Data, Model: 40K Terminal

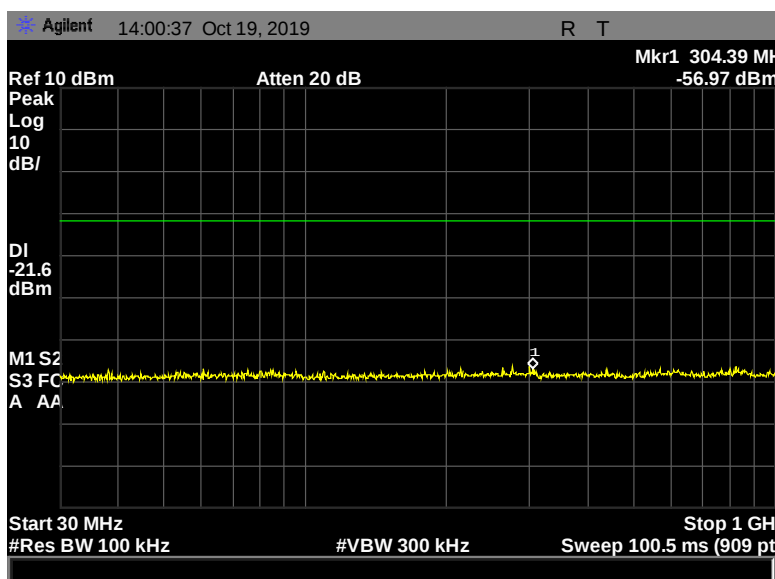


Figure 141: Conducted Spurious Emissions, Terminal, 2402 MHz, 1 Mbps, 30 MHz - 1000 MHz

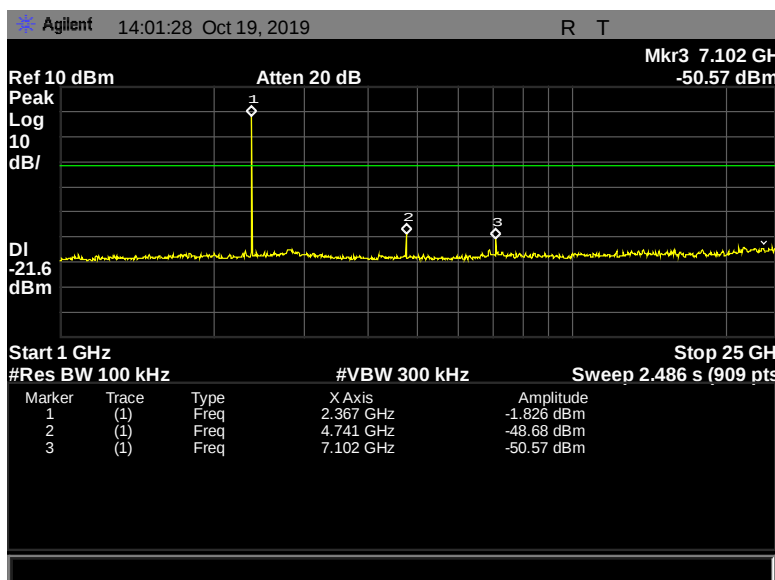


Figure 142: Conducted Spurious Emissions, Terminal, 2402 MHz, 2 Mbps, 1 GHz - 25 GHz

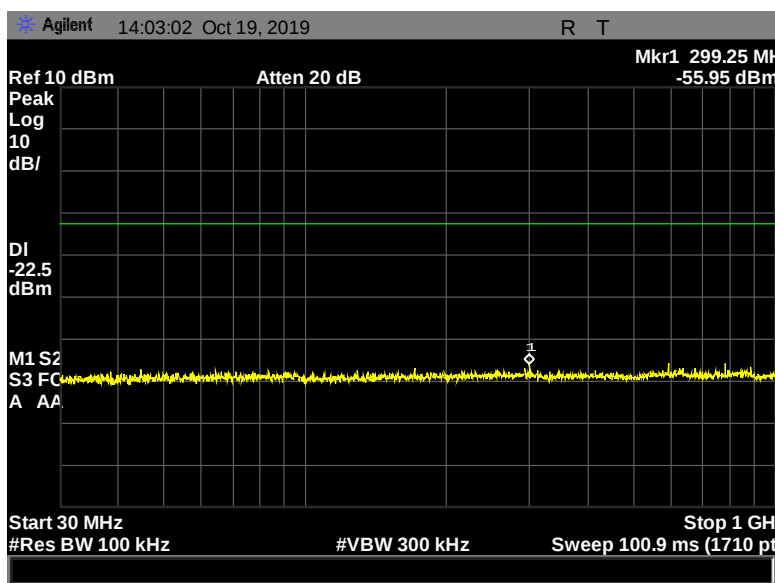


Figure 143: Conducted Spurious Emissions, Terminal, 2402 MHz, 2 Mbps, 30 MHz - 1000 MHz

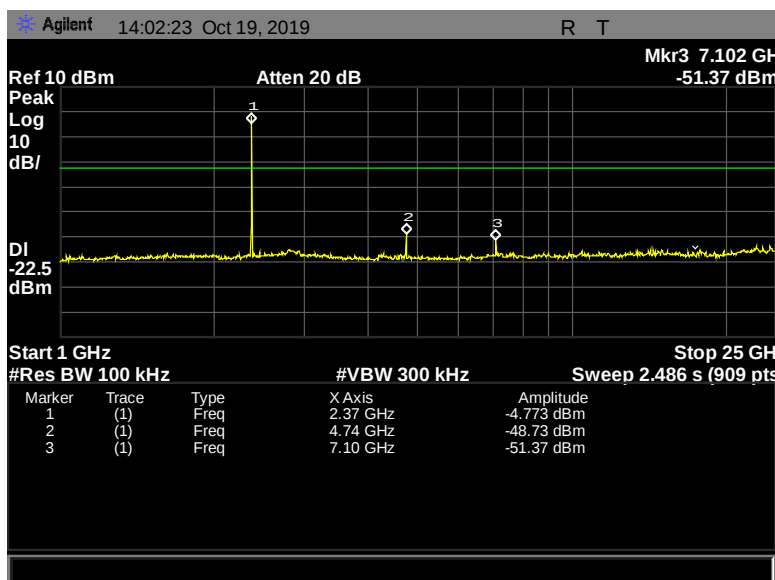


Figure 144: Conducted Spurious Emissions, Terminal, 2402 MHz, 2 Mbps, 1 GHz – 25 GHz

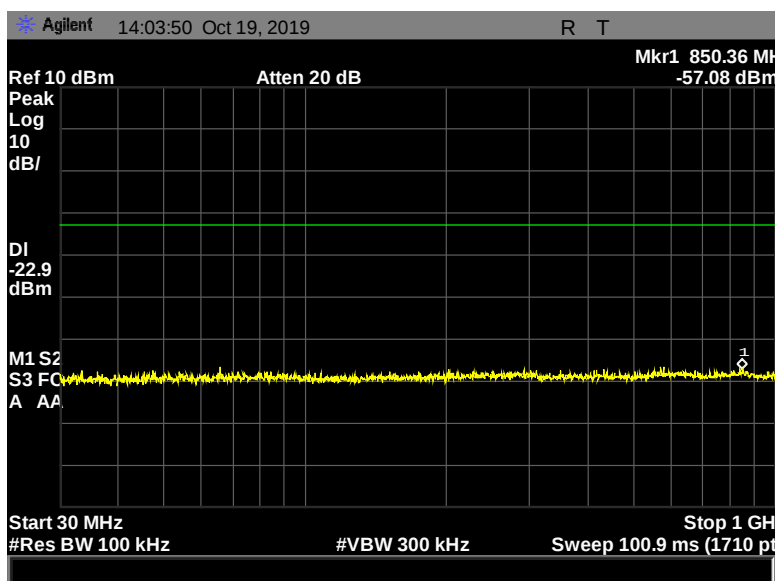


Figure 145: Conducted Spurious Emissions, Terminal, 2442 MHz, 1 Mbps, 30 MHz – 1000 MHz

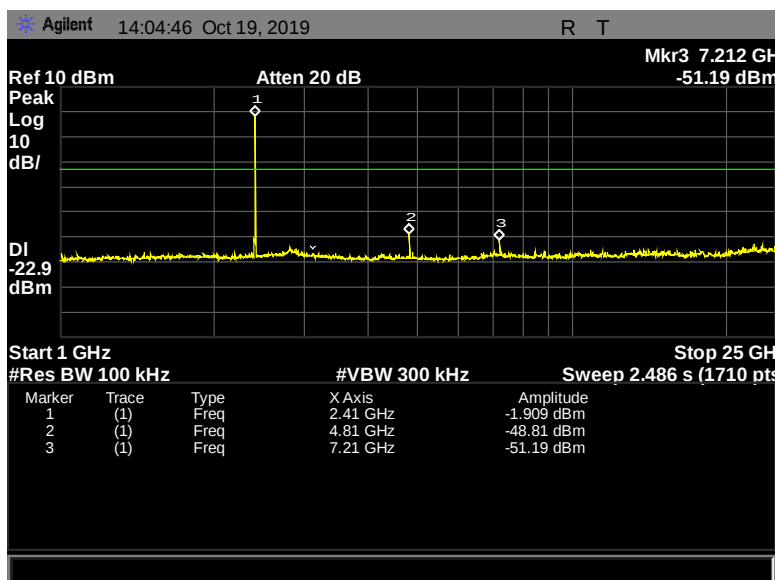


Figure 146: Conducted Spurious Emissions, Terminal, 2442 MHz, 1 Mbps, 1 GHz – 25 GHz

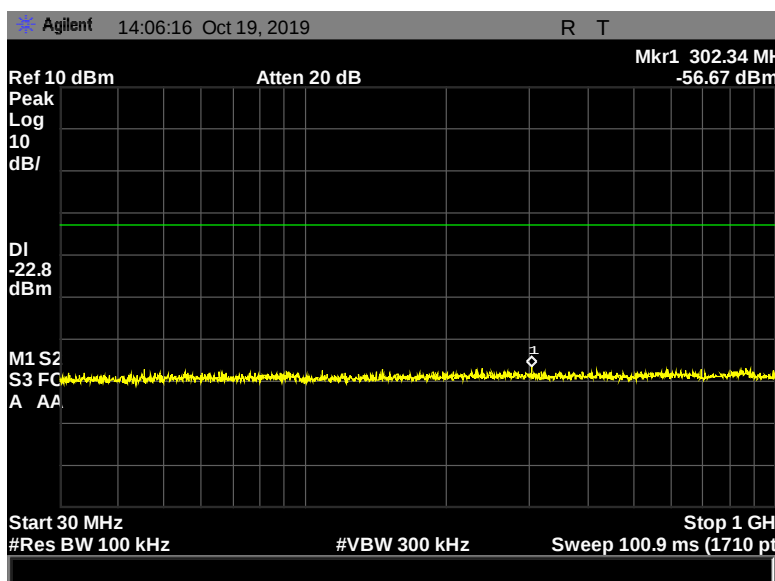


Figure 147: Conducted Spurious Emissions, Terminal, 2442 MHz, 2 Mbps, 30 MHz – 1000 MHz

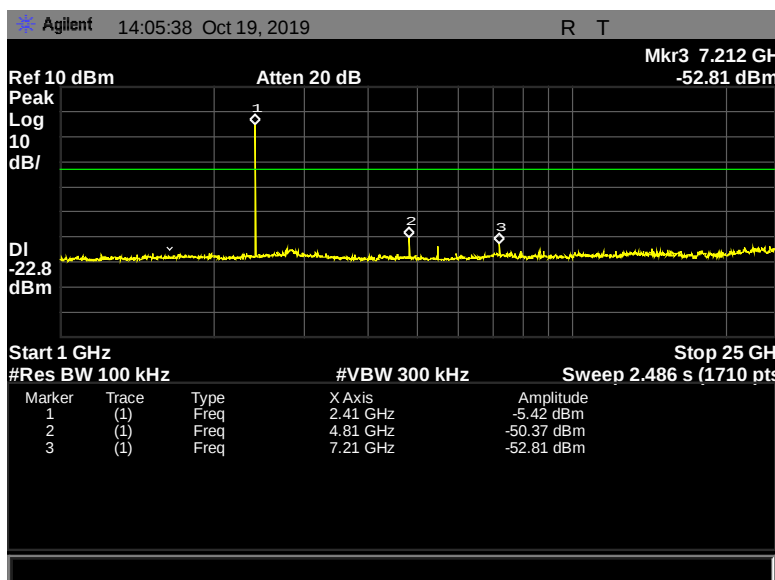


Figure 148: Conducted Spurious Emissions, Terminal, 2442 MHz, 2 Mbps, 1 GHz – 25 GHz

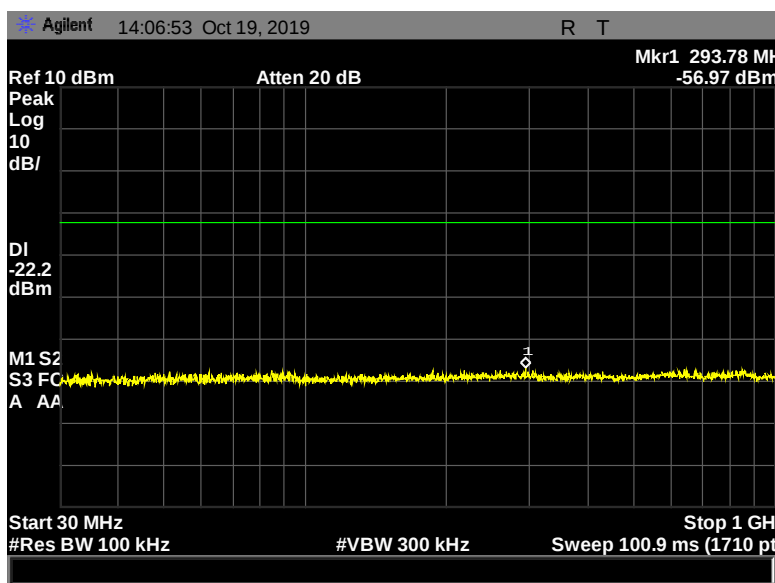


Figure 149: Conducted Spurious Emissions, Terminal, 2480 MHz, 1 Mbps, 30 MHz- 1000 MHz

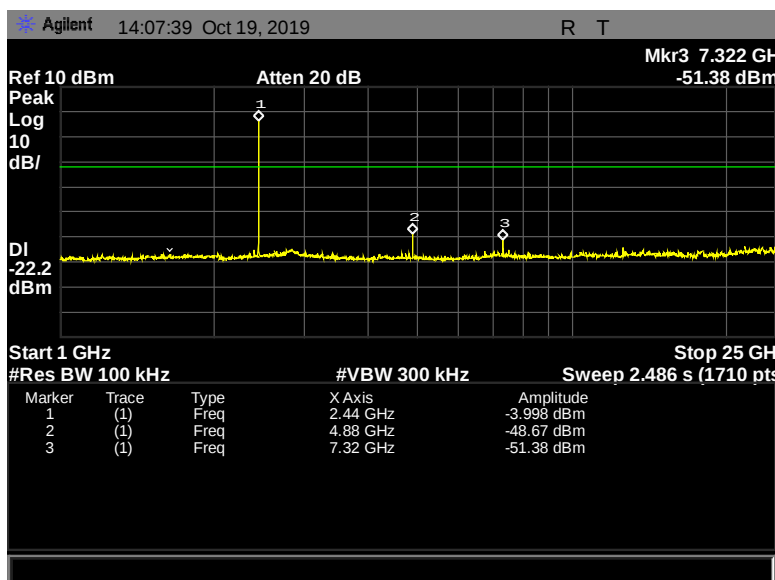


Figure 150: Conducted Spurious Emissions, Terminal, 2480 MHz, 1 Mbps, 1 GHz – 25 GHz

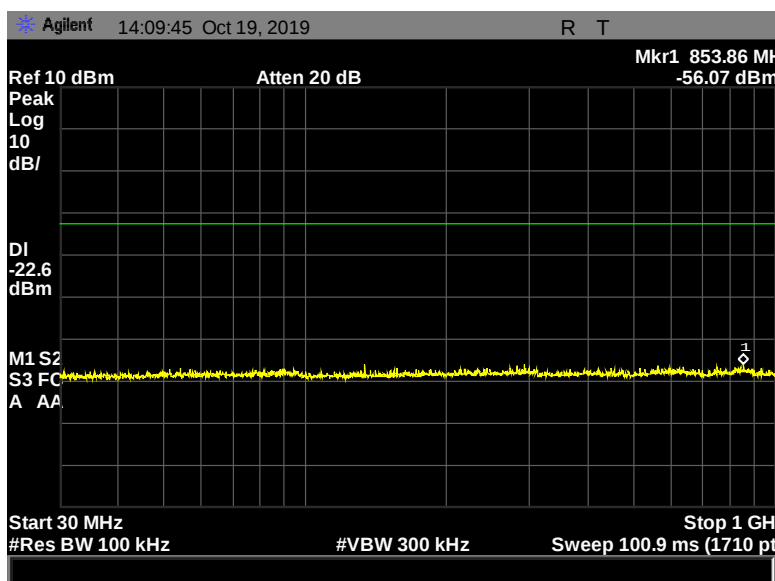
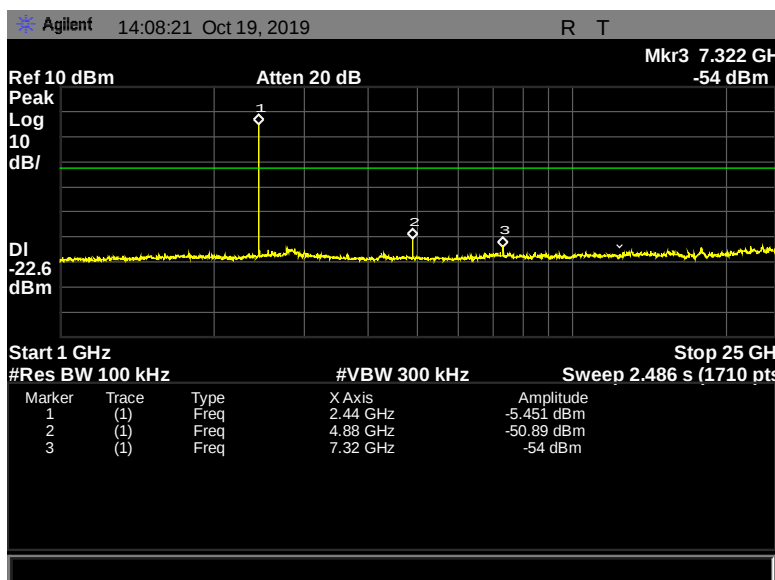
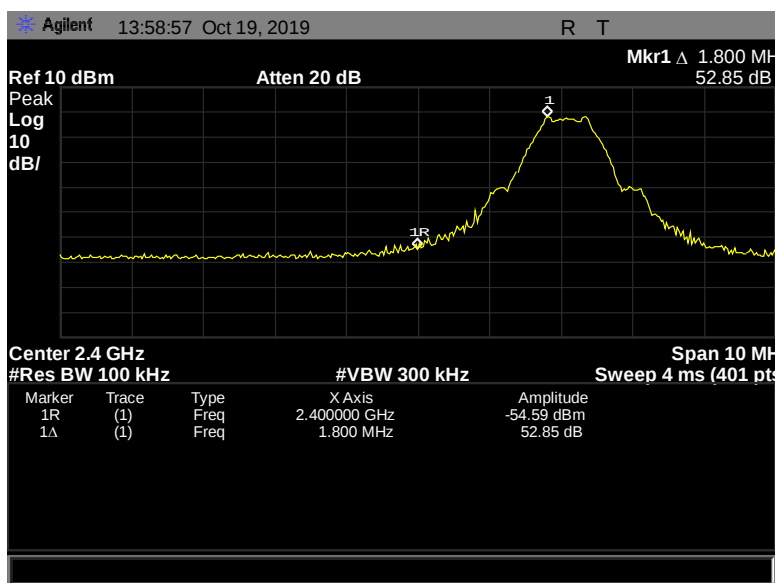


Figure 151: Conducted Spurious Emissions, Terminal, 2480 MHz, 2 Mbps, 30 MHz – 1000 MHz



**Figure 152: Conducted Spurious Emissions, Terminal, 2480 MHz, 2 Mbps, 1 GHz – 25 GHz**



**Figure 153: Conducted Band Edge, Terminal, 2402 MHz, 1 Mbps**

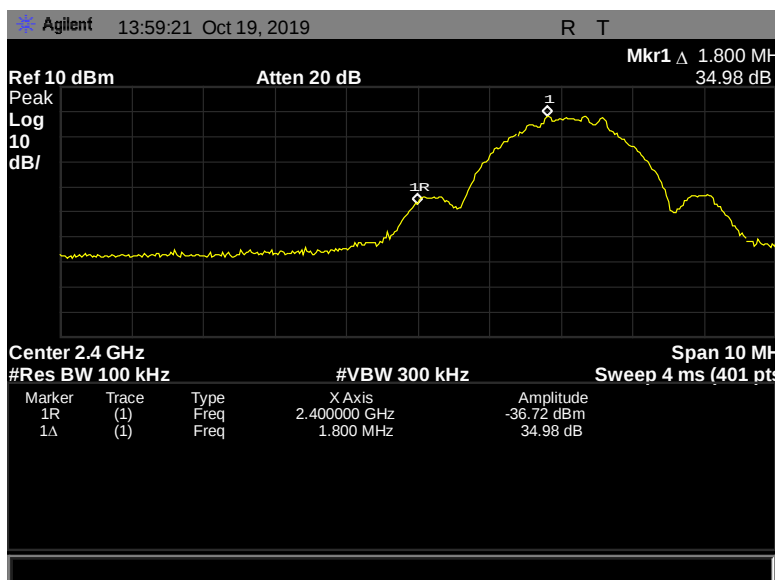


Figure 154: Conducted Band Edge, Terminal, 2402 MHz, 2 Mbps

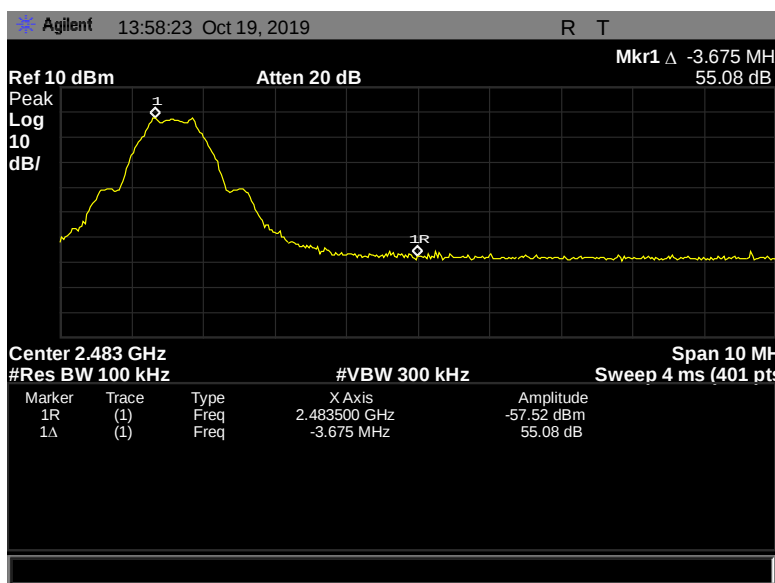


Figure 155: Conducted Band Edge, Terminal, 2480 MHz, 1 Mbps

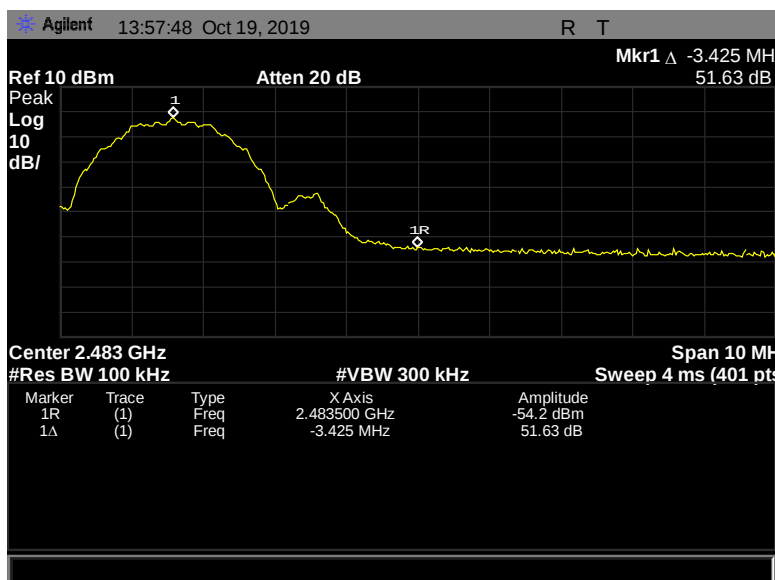


Figure 156: Conducted Band Edge, Terminal, 2480 MHz, 2 Mbps

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247(e) Peak Power Spectral Density

**Test Requirements:** §15.247(e): For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

**Test Procedure:** The power level was set to the maximum level throughout each of the 100 sweeps of power averaging. The RBW was set to 100 kHz and a VBW set to 300 kHz or greater. The spectrum analyzer was set to an auto sweep time and a peak detector was used. Measurements were carried out at the low, mid and high channels.



Figure 157: Block Diagram, Power Spectral Density Test Setup

**Model: 40K Pigtail**

**Test Results:** The EUT was tested is **compliant** with § 15.247(e) Peak Power Spectral Density. No anomalies were noted.

The peak power spectral density was determined from plots on the following page(s).

**Test Engineer:** Jonathan Tavira

**Test Date:** September 18, 2019

**Test Data, Model: 40K Pigtail**

| Mode   | Channel (MHz) | Power Density (dBm) |
|--------|---------------|---------------------|
| 1 Mbps | 2402          | -1.755              |
| 1 Mbps | 2442          | -1.699              |
| 1 Mbps | 2480          | -2.115              |
| 2 Mbps | 2402          | -2.326              |
| 2 Mbps | 2442          | -2.321              |
| 2 Mbps | 2480          | -3.528              |

**Figure 158: Peak Power Spectral Density, Pigtail, Test Results**

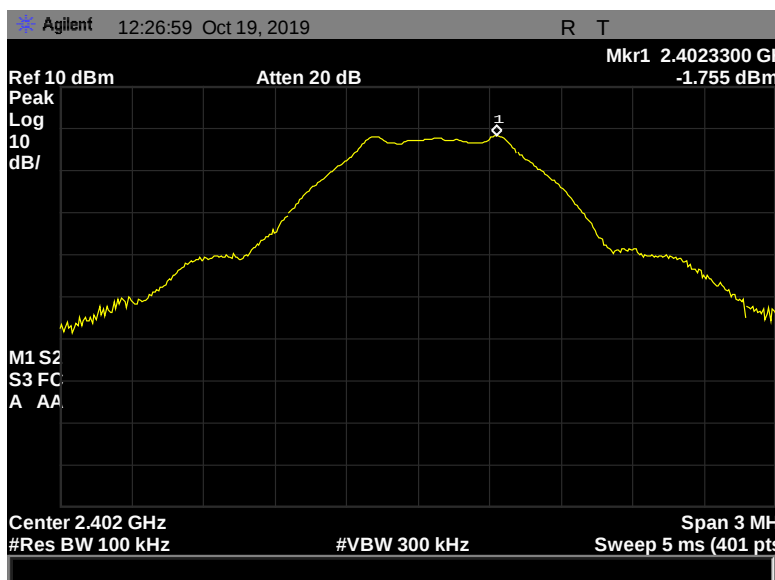


Figure 159: Peak Power Spectral Density, Pigtail, 2402 MHz, 1 Mbps, -1.755 dBm

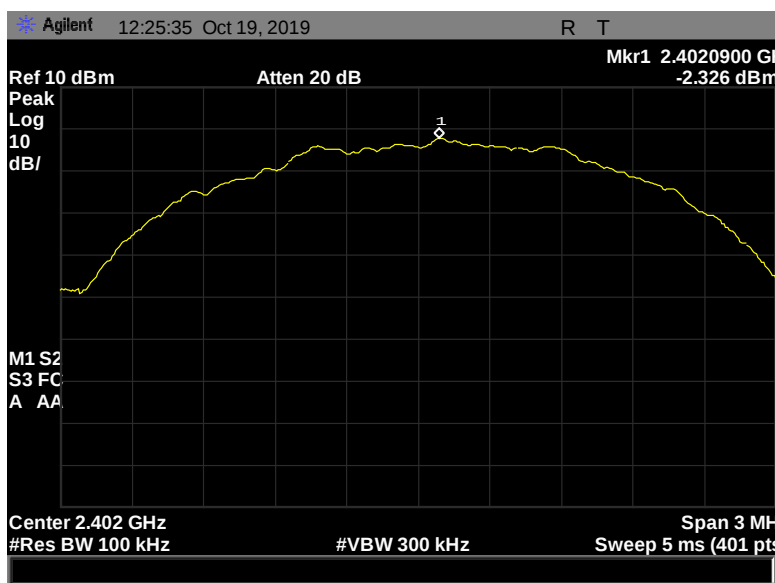


Figure 160: Peak Power Spectral Density, Pigtail, 2402 MHz, 2 Mbps, -2.236 dBm

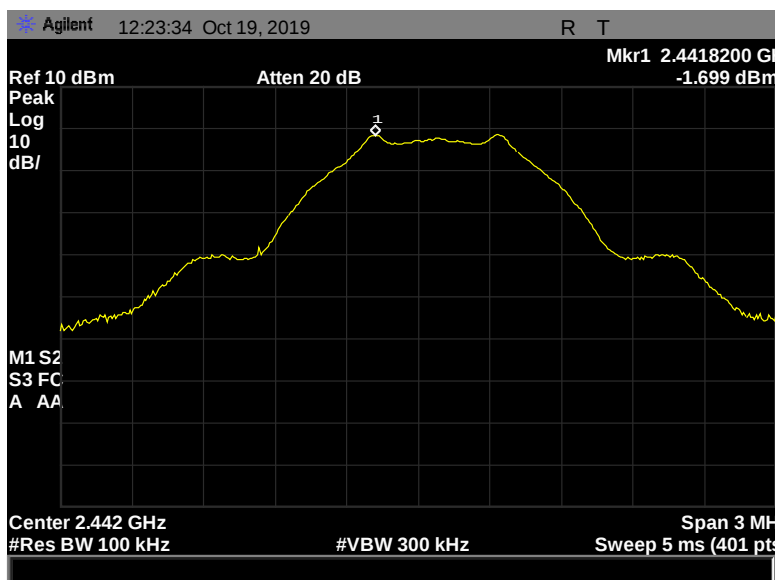


Figure 161: Peak Power Spectral Density, Pigtail, 2442 MHz, 1 Mbps, -1.699 dBm

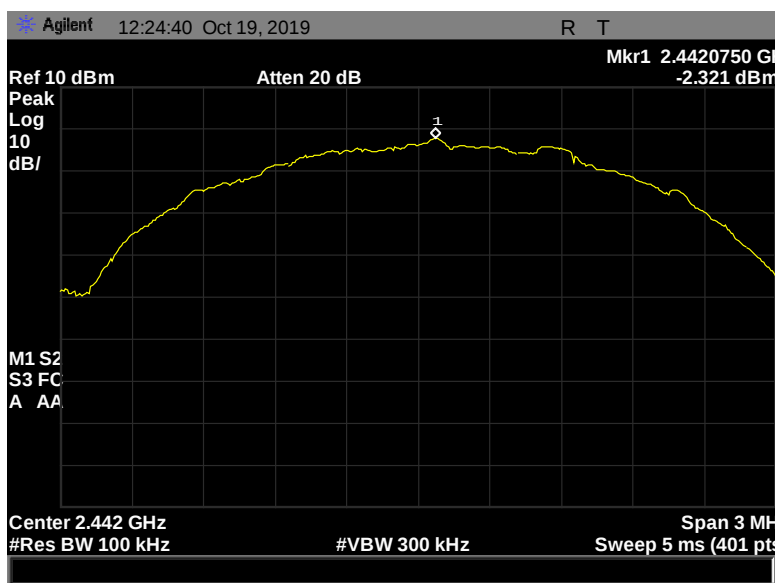


Figure 162: Peak Power Spectral Density, Pigtail, 2442 MHz, 2 Mbps, -2.321 dBm

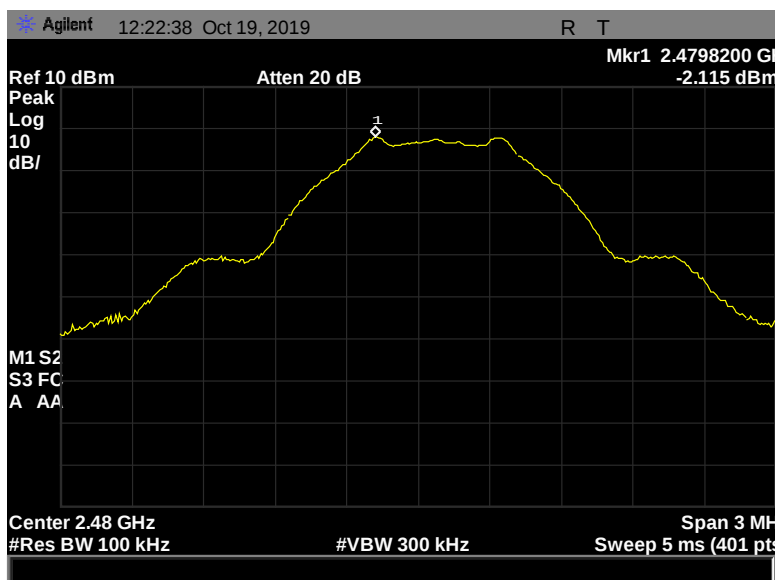


Figure 163: Peak Power Spectral Density, Pigtail, 2480 MHz, 1 Mbps, -2.115 dBm

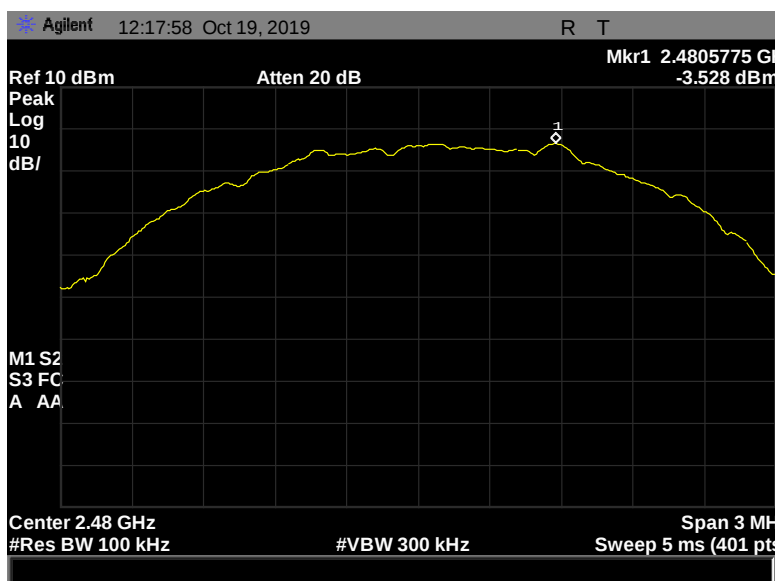


Figure 164: Peak Power Spectral Density, Pigtail, 2480 MHz, 2 Mbps, -3.528 dBm

### Model: 40K Terminal

**Test Results:** The EUT was tested is **compliant** with § 15.247(e) Peak Power Spectral Density. No anomalies were noted.

The peak power spectral density was determined from plots on the following page(s).

**Test Engineer:** Jonathan Tavira

**Test Date:** September 11, 2019

### Test Data, Model: 40K Terminal

| Mode   | Channel (MHz) | Power Density (dBm) |
|--------|---------------|---------------------|
| 1 Mbps | 2402          | -1.624              |
| 1 Mbps | 2442          | -2.288              |
| 1 Mbps | 2480          | -2.222              |
| 2 Mbps | 2402          | -2.543              |
| 2 Mbps | 2442          | -2.843              |
| 2 Mbps | 2480          | -2.609              |

**Figure 165: Peak Power Spectral Density, Terminal, Test Results**

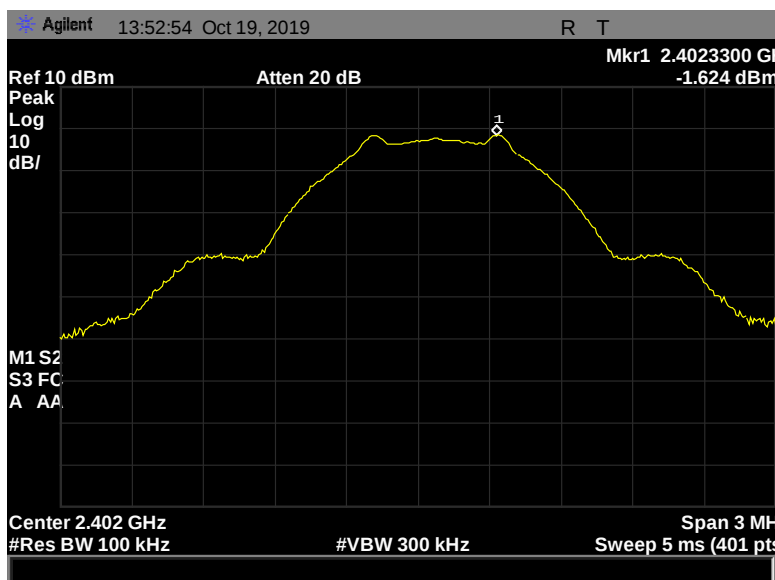


Figure 166: Peak Power Spectral Density, Terminal, 2402 MHz, 1 Mbps, -1.624 dBm

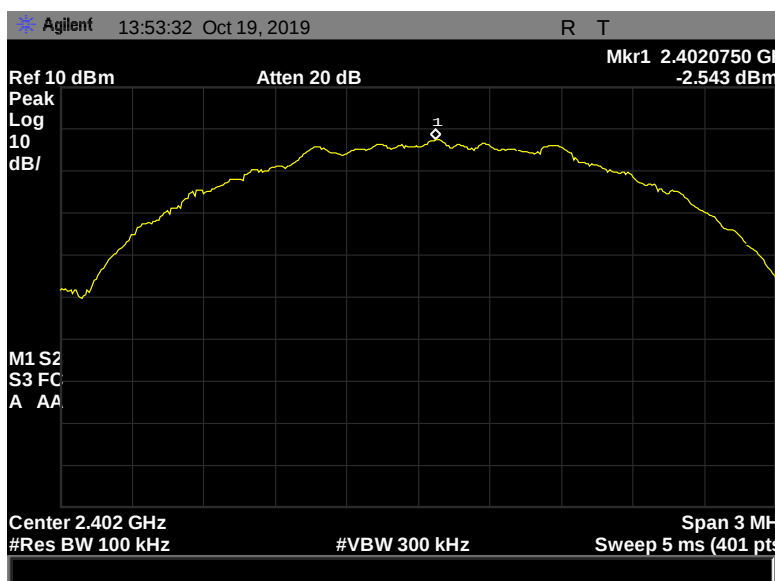


Figure 167: Peak Power Spectral Density, Terminal, 2402 MHz, 2 Mbps, -2.543 dBm

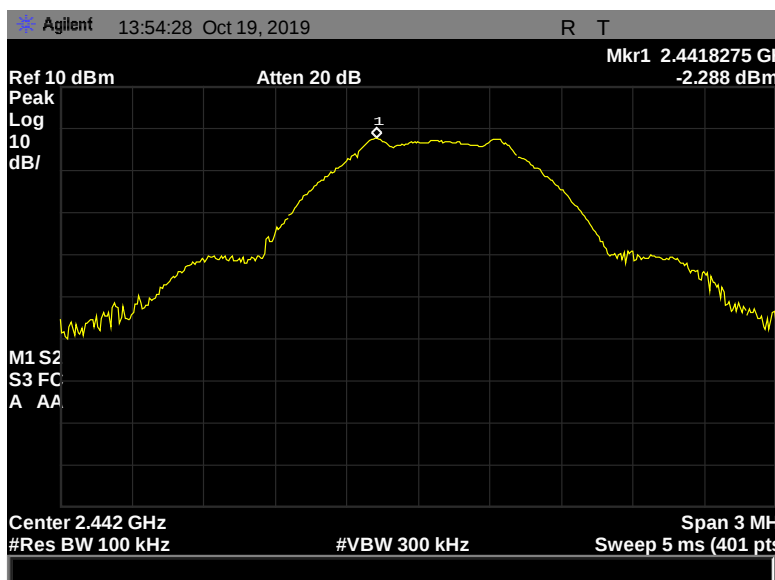


Figure 168: Peak Power Spectral Density, Terminal, 2442 MHz, 1 Mbps, -2.288 dBm

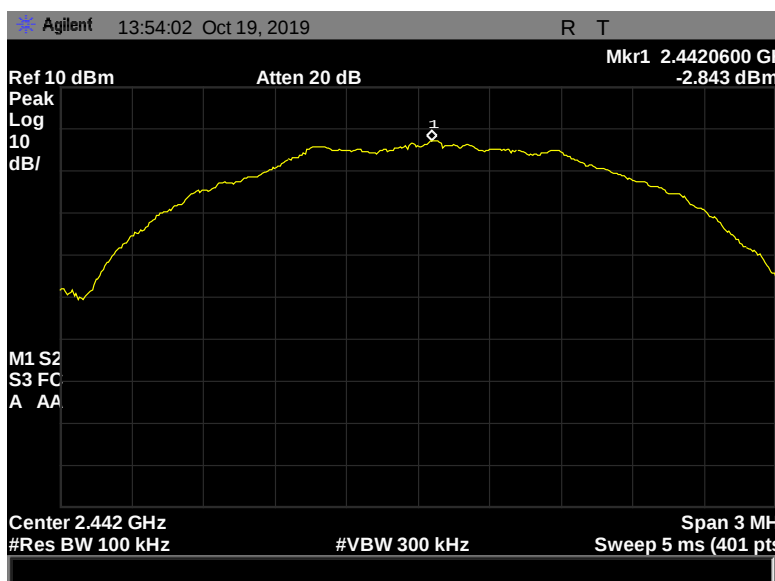


Figure 169: Peak Power Spectral Density, Terminal, 2442 MHz, 2 Mbps, -2.843 dBm

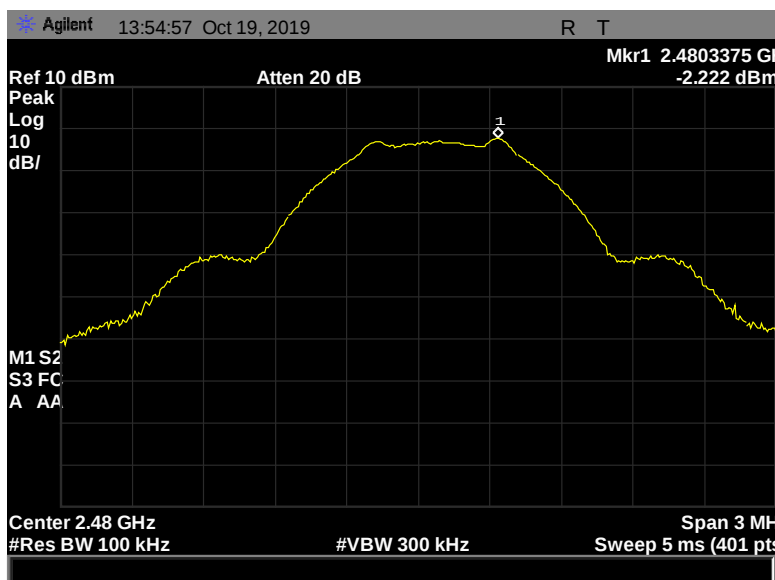


Figure 170: Peak Power Spectral Density, Terminal, 2480 MHz, 1 Mbps, -2.222 dBm

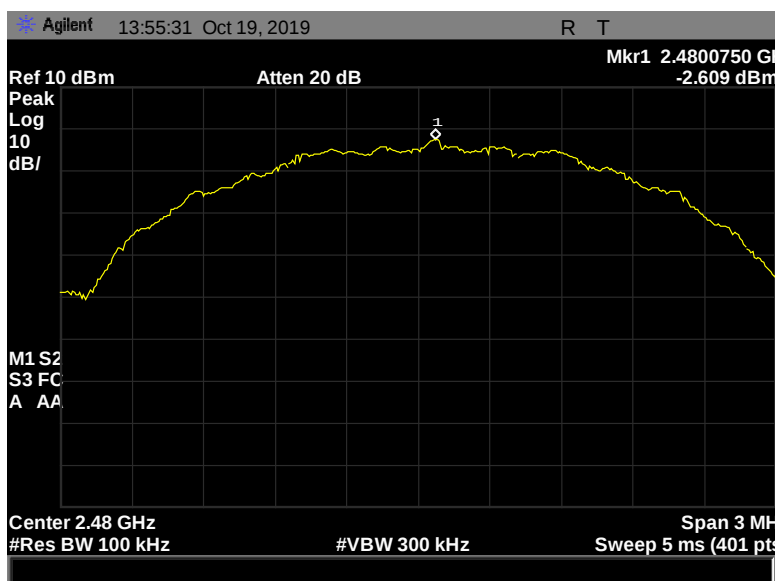


Figure 171: Peak Power Spectral Density, Terminal, 2480 MHz, 2 Mbps, -2.609 dBm

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247(i) RF Human Exposure

#### RF Exposure

##### Requirements:

**§1.1307(b)(1) and §1.1307(b)(2):** Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

#### RF Radiation

##### Exposure Limit:

**§2.1093:** As specified in this section, a portable device is defined as a transmitting device designed to be used so that the radiated structure(s) of the device is within 20 centimeters of the body of the user. Calculations below are in accordance with KDB 447498 D01 General RF Exposure Guidance v06, Section 4.3 General SAR test exclusion guidance. The SAR test exclusion thresholds are 3.0 for 1-g SAR and 7.5 for 10-g extremity SAR

#### Model: 40K Pigtail

##### Test Results:

The EUT was tested is **compliant** with § 15.247(i) RF Human Exposure. No anomalies were noted.

##### Test Engineer:

Jonathan Tavira

##### Test Date:

September 18, 2019

#### Test Data, Model: 40K Pigtail

| Frequency (MHz) | Con. Pwr. (dBm) | Tuneup tolerance (dB) | Con. Pwr. Including Tuneup Tolerance (mW) | Calculated SAR Threshold | 1.0-g SAR Limit | Margin  | Separation Distance Declared (mm) | Result |
|-----------------|-----------------|-----------------------|-------------------------------------------|--------------------------|-----------------|---------|-----------------------------------|--------|
| 2402            | 0.94            | 1.0                   | 1.5631                                    | 0.4845                   | 3.0             | -2.5155 | 5                                 | Pass   |

Figure 172: RF Human Exposure, Pigtail, Test Results

Per KDB 447498, Section 4.3.1 (a), applicable for 100 MHz to 6 GHz and test separation distances  $\leq 50$  mm:

$$\frac{\text{max. power of channel, including tuneup tolerance [mW]}}{\text{min. test separation distance [mm]}} * \sqrt{f [GHz]} \leq 3.0 (1 - g \text{ SAR Limit})$$

$$\frac{1.5631 \text{ mW}}{5 \text{ mm}} * \sqrt{2.402} = 0.4845 \leq 3.0 (1 - g \text{ SAR})$$

### Model: 40K Terminal

**Test Results:** The EUT was tested is **compliant** with § 15.247(i) RF Human Exposure. No anomalies were noted.

**Test Engineer:** Jonathan Tavira

**Test Date:** September 12, 2019

### Test Data, Model: 40K Terminal

| Frequency (MHz) | Con. Pwr. (dBm) | Tuneup tolerance (dB) | Con. Pwr. Including Tuneup Tolerance (mW) | Calculated SAR Threshold | 1.0-g SAR Limit | Margin  | Separation Distance Declared (mm) | Result |
|-----------------|-----------------|-----------------------|-------------------------------------------|--------------------------|-----------------|---------|-----------------------------------|--------|
| 2402            | 1.23            | 1.0                   | 1.6711                                    | 0.5180                   | 3.0             | -2.4820 | 5                                 | Pass   |

**Figure 173: RF Human Exposure, Terminal, Test Results**

Per KDB 447498, Section 4.3.1 (a), applicable for 100 MHz to 6 GHz and test separation distances ≤ 50 mm:

$$\frac{\text{max. power of channel, including tuneup tolerance [mW]}}{\text{min. test separation distance [mm]}} * \sqrt{f \text{ [GHz]}} \leq 3.0 (1 - g \text{ SAR Limit})$$

$$\frac{1.6711 \text{ mW}}{5 \text{ mm}} * \sqrt{2.402} = 0.5180 \leq 3.0 (1 - g \text{ SAR})$$

## IV. Test Equipment

## Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2017.

| MET ASSET # | EQUIPMENT                       | MANUFACTURER    | MODEL                  | LAST CAL DATE | CAL DUE DATE |
|-------------|---------------------------------|-----------------|------------------------|---------------|--------------|
| 1A1065      | EMI RECEIVER                    | ROHDE & SCHWARZ | ESCI                   | 05/01/2019    | 05/01/2020   |
| 1A1177      | ATTENUATOR                      | ROHDE & SCHWARZ | ESH3Z2                 | 11/30/2018    | 11/30/2019   |
| 1A1123      | LISN                            | TESEQ           | NNB 51                 | 07/18/2019    | 08/18/2019   |
| 1A1123      | LISN                            | TESEQ           | NNB 51                 | 09/25/2019    | 09/25/2020   |
| 1A1076      | VARIABLE AC TRANSFORMER         | POWERSTAT       | N/A                    | SEE NOTE      |              |
| 1A1119      | TEST AREA                       | CUSTOM MADE     | N/A                    | SEE NOTE      |              |
| 1A1184      | SPECTRUM ANALYZER               | AGILENT         | E4407B                 | 06/25/2019    | 06/25/2020   |
| 1A1083      | EMI RECIVER                     | ROHDE & SCHWARZ | ESU40                  | 10/10/2019    | 10/10/2020   |
| 1A1050      | HYBRID ANTENNA                  | SCHAFFNER       | CBL 6112D              | 08/29/2018    | 02/29/2020   |
| 1A1183      | DOUBLE RIDGED WAVEGUIDE ANTENNA | ETS-LINDGREN    | 3117                   | 10/10/2018    | 04/10/2020   |
| 1A1088      | PRE-AMP                         | ROHDE & SCHWARZ | TS-PR1                 | SEE NOTE      |              |
| 1A1080      | MULTI-DEVICE CONTROLLER         | ETS-EMCO        | 2090                   | SEE NOTE      |              |
| 1A1180      | PRE-AMP                         | MITEQ           | AMF-7D-01001800-22-10P | SEE NOTE      |              |
| 1A1106      | 10M SEMI-ANECHOIC CHAMBER       | LINDGREN        | N/a                    | SEE NOTE      |              |

**Figure 174: Test Equipment List**

Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing.

## **V. Certification & User's Manual Information**

## Certification & User's Manual Information

### A. Certification Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart I — Marketing of Radio frequency devices:

#### § 2.801 Radio-frequency device defined.

As used in this part, a radio-frequency device is any device which in its operation is capable of Emitting radio-frequency energy by radiation, conduction, or other means. Radio- frequency devices include, but are not limited to:

- (a) The various types of radio communication transmitting devices described throughout this chapter.
- (b) *The incidental, unintentional and intentional radiators defined in Part 15 of this chapter.*
- (c) The industrial, scientific, and medical equipment described in Part 18 of this chapter.
- (d) Any part or component thereof which in use emits radio-frequency energy by radiation, conduction, or other means.

#### § 2.803 Marketing of radio frequency devices prior to equipment authorization.

- (a) Except as provided elsewhere in this chapter, no person shall sell or lease, or offer for sale or lease (including advertising for sale or lease), or import, ship or distribute for the purpose of selling or leasing or offering for sale or lease, any radio frequency device unless:
  - (1) In the case of a device subject to certification, such device has been authorized by the Commission in accordance with the rules in this chapter and is properly identified and labeled as required by §2.925 and other relevant sections in this chapter; or
  - (2) In the case of a device that is not required to have a grant of equipment authorization issued by the Commission, but which must comply with the specified technical standards prior to use, such device also complies with all applicable administrative (including verification of the equipment or authorization under a Declaration of Conformity, where required), technical, labeling and identification requirements specified in this chapter.
- (d) Notwithstanding the provisions of paragraph (a) of this section, the offer for sale solely to business, commercial, industrial, scientific or medical users (but not an offer for sale to other parties or to end users located in a residential environment) of a radio frequency device that is in the conceptual, developmental, design or pre-production stage is permitted prior to equipment authorization or, for devices not subject to the equipment authorization requirements, prior to a determination of compliance with the applicable technical requirements *provided* that the prospective buyer is advised in writing at the time of the offer for sale that the equipment is subject to the FCC rules and that the equipment will comply with the appropriate rules before delivery to the buyer or to centers of distribution.

- (e)(1) Notwithstanding the provisions of paragraph (a) of this section, prior to equipment authorization or determination of compliance with the applicable technical requirements any radio frequency device may be operated, but not marketed, for the following purposes and under the following conditions:
- (i) *Compliance testing;*
  - (ii) Demonstrations at a trade show provided the notice contained in paragraph (c) of this section is displayed in a conspicuous location on, or immediately adjacent to, the device;
  - (iii) Demonstrations at an exhibition conducted at a business, commercial, industrial, scientific or medical location, but excluding locations in a residential environment, provided the notice contained in paragraphs (c) or (d) of this section, as appropriate, is displayed in a conspicuous location on, or immediately adjacent to, the device;
  - (iv) Evaluation of product performance and determination of customer acceptability, provided such operation takes place at the manufacturer's facilities during developmental, design or pre-production states; or
  - (v) Evaluation of product performance and determination of customer acceptability where customer acceptability of a radio frequency device cannot be determined at the manufacturer's facilities because of size or unique capability of the device, provided the device is operated at a business, commercial, industrial, scientific or medical user's site, but not at a residential site, during the development, design or pre-production stages.
- (e)(2) For the purpose of paragraphs (e)(1)(iv) and (e)(1)(v) of this section, the term *manufacturer's facilities* includes the facilities of the party responsible for compliance with the regulations and the manufacturer's premises, as well as the facilities of other entities working under the authorization of the responsible party in connection with the development and manufacture, but not the marketing, of the equipment.
- (f) For radio frequency devices subject to verification and sold solely to business, commercial, industrial, scientific and medical users (excluding products sold to other parties or for operation in a residential environment), parties responsible for verification of the devices shall have the option of ensuring compliance with the applicable technical specifications of this chapter at each end user's location after installation, provided that the purchase or lease agreement includes a proviso that such a determination of compliance be made and is the responsibility of the party responsible for verification of the equipment.

## Certification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart J — Equipment Authorization Procedures:

### § 2.901 Basis and Purpose

- (a) In order to carry out its responsibilities under the Communications Act and the various treaties and international regulations, and in order to promote efficient use of the radio spectrum, the Commission has developed technical standards for radio frequency equipment and parts or components thereof. The technical standards applicable to individual types of equipment are found in that part of the rules governing the service wherein the equipment is to be operated.<sup>1</sup> *In addition to the technical standards provided, the rules governing the service may require that such equipment be verified by the manufacturer or importer, be authorized under a Declaration of Conformity, or receive an equipment authorization from the Commission by one of the following procedures: certification or registration.*
- (b) The following sections describe the verification procedure, the procedure for a Declaration of Conformity, and the procedures to be followed in obtaining certification from the Commission and the conditions attendant to such a grant.

### § 2.907 Certification.

- (a) Certification is an equipment authorization issued by the Commission, based on representation and test data submitted by the applicant.
- (b) Certification attaches to all units subsequently marketed by the grantee which are identical (see Section 2.908) to the sample tested except for permissive changes or other variations authorized by the Commission pursuant to Section 2.1043.

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<sup>1</sup> In this case, the equipment is subject to the rules of Part 15. More specifically, the equipment falls under Subpart B (of Part 15), which deals with unintentional radiators.

## Certification & User's Manual Information

### § 2.948 Description of measurement facilities.

- (a) Each party making measurements of equipment that is subject to an equipment authorization under Part 15 or Part 18 of this chapter, regardless of whether the measurements are filed with the Commission or kept on file by the party responsible for compliance of equipment marketed within the U.S. or its possessions, shall compile a description of the measurement facilities employed.
  - (1) If the measured equipment is subject to the verification procedure, the description of the measurement facilities shall be retained by the party responsible for verification of the equipment.
    - (i) *If the equipment is verified through measurements performed by an independent laboratory, it is acceptable for the party responsible for verification of the equipment to rely upon the description of the measurement facilities retained by or placed on file with the Commission by that laboratory. In this situation, the party responsible for the verification of the equipment is not required to retain a duplicate copy of the description of the measurement facilities.*
    - (ii) If the equipment is verified based on measurements performed at the installation site of the equipment, no specific site calibration data is required. It is acceptable to retain the description of the measurement facilities at the site at which the measurements were performed.
  - (2) If the equipment is to be authorized by the Commission under the certification procedure, the description of the measurement facilities shall be filed with the Commission's Laboratory in Columbia, Maryland. The data describing the measurement facilities need only be filed once but must be updated as changes are made to the measurement facilities or as otherwise described in this section. At least every three years, the organization responsible for filing the data with the Commission shall certify that the data on file is current.

## Certification & User's Manual Information

### 1. Label and User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart A — General:

#### § 15.19 Labeling requirements.

(a) *In addition to the requirements in Part 2 of this chapter, a device subject to certification or verification shall be labeled as follows:*

- (1) Receivers associated with the operation of a licensed radio service, e.g., FM broadcast under Part 73 of this chapter, land mobile operation under Part 90, etc., shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

- (2) A stand-alone cable input selector switch, shall bear the following statement in a conspicuous location on the device:

This device is verified to comply with Part 15 of the FCC Rules for use with cable television service.

- (3) All other devices shall bear the following statement in a conspicuous location on the device:

*This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.*

- (4) Where a device is constructed in two or more sections connected by wires and marketed together, the statement specified under paragraph (a) of this section is required to be affixed only to the main control unit.

- (5) When the device is so small or for such use that it is not practicable to place the statement specified under paragraph (a) of this section on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

#### § 15.21 Information to user.

The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

## Verification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart B — Unintentional Radiators:

### § 15.105 Information to the user.

- (a) For a Class A digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at own expense.

- (b) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

# End of Report