GENTEX CORPORATION

# Technical Report to the FCC and ISED Regarding Gentex Corporation - Homelink© VI

## Model: MUAHL6
## FCC ID: NZLMUAHL6
## ISED: 4112A-MUAHL6

## Emission Designator: 1M04L1D
## 10/25/2024

A report concerning approval for Gentex Corporation Homelink® model MUAHL6
Please issue grant immediately upon review.

Measurements Made by:

Bolay.Pacheco Digitally signed by Bolay.Pacheco Date: 2024.10.28 13:43:45 -04'00'

Bolay Pacheco
Laboratory Validation Engineer III
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Report Prepared

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Report Submitted by:

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Report Approved by:

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Jason Vargo
Laboratory Manager I
Gentex Corporation

# Test Report Revision

| REV Number | Date | Author | Description |
|---|---|---|---|
| **1.0** | 9/24/2024 | Patricia Szeszulski | Initial Release |
| **2.0** | 10/25/2024 | Patricia Szeszulski | Revised 2480 radiated data table on page 12. Updated measurement info on page 10. Per ACB's feedback. Updated section A.2 |
| | | | |
| | | | |

Results relate only to the items tested as received.

Compliance has been evaluated based on the Lab Manual section 7.6.2. The decision rule used regarding measurement uncertainty was to determine results solely on whether the measured values met the defined acceptance criteria without factoring in measurement uncertainty values.

# 1. General Information

## 1.1. Product Description

The Gentex Corporation HomeLink® HL6 Universal Garage Door Opener is a low-power transceiver OEM device that is installed into the automotive rearview mirror. The installation is provided by trained technicians during the course of the manufacture of the automobile. It is powered by the 12 Volt system of the automobile.

This Universal Garage Door Opener has the capability to

1. Learn the frequency and bit code format of the user's existing garage door remote control devices
2. Transmit and receive frequency hopping spread spectrum in the 902 to 928 MHz band using an internal antenna as per Federal Communications Commission "Code of Federal Regulations", Title 47, Part 15.247
3. Transmit and receive frequency digital transmission system in the 2402 to 2480MHz band using an internal antenna as per Federal Communications Commission "Code of Federal Regulations", Title 47, Part 15.247.

The unit is designed for the periodic operation of a control signal, which typically activates a garage door opener receiver.

The unit is supplied to the automobile manufacturer without harness. For testing purposes, a typical assembly and 2-conductor cable harness were used to power to the unit.

The three-button HomeLink® unit replaces up to three hand-held transmitters. In addition to the typical operation of the garage door, the unit will learn the radio frequency codes of other transmitter types to activate entry door locks, estate gates, security systems, and home or office lighting.

The antenna system is an integral part of the unit. It cannot be altered nor replaced by the user. The service of this system is only available from the Automobile Manufacturer's Dealerships and Gentex Corporation.

## 1.2. Related Grants

This device will have functionality that is covered under 47 CFR 15.247. The device will have a FCC ID # of NZLMUAHL6 and an ISED ID # of 4112A-MUAHL6 under both rule parts. Separate reports were submitted for functionality covered under 47 CFR 15.231 and 47 CFR 15.247 DSS requirements.

## 1.3. Test Methodology

Radiated Emissions testing was performed according to ANSI C63.10:2013. The power source for this product is a 12V automotive vehicle battery.

Conducted measurements were performed using a power supply.

Measurements were performed per FCC OET KDB 558074.

The unit is supplied to the automobile manufacturer without harness. For testing purposes, a 2-conductor cable harness was used to interface to the unit. The unit ground is provided through the negative terminal of the harness.

## 1.4. Test Facility

The 3-meter semi-anechoic chamber where these measurements were taken, is located on the grounds of Gentex Corporation's Corporate Labs, in the city of Zeeland, county of Ottawa, state of Michigan, United States of America.

For radiated measurements above 1 GHz, RF absorbing material is placed between the antenna and EUT in accordance with ANSI C63.4:2014 Section 5.5 and chamber manufacturer's instructions.

The 3m chamber has been added to our A2LA scope of accreditation on 05/20/2016 and includes accreditation to ANSI C63.4:2014 and ANSI C63.10:2013. The report filed with ISED, dated February 11, 2015, was accepted via a letter dated February 11, 2015. Our 3m chamber is registered with the ISED under Site# 4112A-2 and FCC under registration number 357351.

| Corporate Mailing/Shipping Address | Site Address |
|---|---|
| Gentex Corporation | Gentex Corporation |
| 600 N. Centennial Street | 380 Riley Street |
| Zeeland, MI 49464 | Zeeland, MI 49423 |

## 1.5. Accreditation

The Gentex Corporate EMC Lab is accredited to ISO/IEC 17025 by the American Association for Laboratory Accreditation (A2LA). Our laboratory scope and accreditation certificate #2529.01 are available from their web site www.a2la.org. Our scope of accreditation covers ANSI C63.4:2014, ANSI C63.10:2013, and Radiated Emissions at 3m, FCC 47 CFR Part 15, ISED RSS-210, and ISED RSS-247 Issue 3.

# 2. Product Labeling

## 2.1. Identifiers

The FCC Identifier assigned is FCC ID: NZLMUAHL6. The ISED certification number is 4112A-MUAHL6. These identifiers will be labeled on the product housing.

The label will be placed on the exterior of the HL housing using laser etching that will permanently affix the label.

Because of the small size of the device and because the installation is inside a portion of the automobile, the following statements will appear in the user's manual. Refer to attachment "Users Manual.pdf" for the entire text of the user's manual.

> "This device complies with FCC rules Part 15 and with ISED RSS-247 Issue 3. Operation is subject to the following two conditions:
> (1) This device may not cause harmful interference,
> (2) This device must accept any interference that may be received including interference that may cause undesired operation.
>
> WARNING: The transmitter has been tested and complies with FCC and ISED rules. Changes or modifications not expressly approved by the party responsible for the compliance could void the user's authority to operate the device."

The term “ISED:” before the certification/registration number only signifies that ISED technical specifications were met.

ISED: 4112A-MUAHL6 FCC ID: NZLMUAHL6 MODEL: MUAHL6

## 2.2. Label Drawing and Location on Product

The label drawing and location of the label on the assembly is included in the “Label Location.pdf” attachment.

# 3. Test Configuration

Radiated Emission measurements presented in the report were made in accordance with ANSI C63.10:2013. The EUT was placed on a 1 x 1.5m non-metallic table elevated 80cm above a conducting ground plane for measurements below 1GHz and elevated to 1.5m for measurements above 1GHz. The harness was run down the edge of the test table to a power supply beneath the turntable

For radiated measurements above 1 GHz, RF absorbing material is placed between the antenna and EUT in accordance with ANSI C63.4:2014 Section 5.5 and chamber manufacturer’s instructions.

For conducted measurements, a non-metallic table approximately 80cm x 90cm, 85cm above the floor was used.

# 4. Powerline Conducted Emissions Measurements

Powerline Conducted Measurements are not required for this product as the part is powered via 12V battery.

# 5. Emissions Data

## 5.1. Date(s) Tested: 9/13/2024-9/17/2024

## 5.2. Test Method Deviations: None

## 5.3. Temperature and Humidity conditions

| | Measured Value | Unit |
|---|---|---|
| Temperature | 21.8-23.1 | ºC |
| Humidity | 42-45.5 | %R.H. |

## 5.4. Summary of Results (Part 15.247)

| Measurement | | Margin (dB) | Frequency (MHz) |
|---|---|---|---|
| Worst Case Spurious Emission | 52.41 dBuV/m | 1.59 | 16814 MHz |
| Maximum Peak Conducted Output Power | 6.25 dBm | 23.75 | - |
| Minimum 6dB Bandwidth | 595 kHz | 95 kHz | - |
| Maximum 99% bandwidth | 1042 kHz | - | - |
| Maximum Power Spectral Density | 3.31 dBm | 4.69 | - |

- **DTS (6dB) Bandwidth:** Per FCC 15.247(a)(2) and RSS-247 paragraph 5.2 (a), the minimum 6dB bandwidth shall be at least 500kHz for all systems using digital modulation techniques.
- **Band Edge Measurement Requirement:** Per section 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. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

- **Measurement Uncertainty:** The standard uncertainty of measurement has been determined in accordance with the ISO Guide to the Expression of Uncertainty in Measurements. The estimation of measurement uncertainty reported is the expanded uncertainty for a coverage factor of k=2.26 and confidence interval of approximately 95%.

Expanded Uncertainty $U_{(k=2.26)}$ is as follows:

- Radiated Emissions – Bicon (30-250 MHz): 4.1 dB
- Radiated Emissions – LPA (250-1000 MHz): 5.0 dB
- Radiated Emissions – DRWG (26.5 GHz): 4.2 dB
- Conducted Emissions: 1.04 dB
- Frequency: 0.007 ppm

## 5.5. Test Equipment Setup and Procedure

## 5.5.1. Test Equipment

| Equipment used | | | |
|---|---|---|---|
| **ID / Serial #** | **Manufacturer** | **Description** | **Cal / PM Due Date** |
| 6595 | Rohde and Schwarz | EMI Receiver | 11/13/2024 |
| CF GCL | Megaphase/Pasternack | 3m Chamber Port and Cables | 4/30/2025 |
| 8893 | Com-Power | AH-118 Horn | 4/22/2027 |
| H6192 | EMCO | 3148 Log Periodic RX | 5/13/2027 |
| 7257 | ETS-Lindgren | Model 3116C 10-40GHx | 5/10/2025 |
| Tower 2 | ETS-Lindgren | 2171B Boresight Tower | VBU |
| PJ2246 | ETS-Lindgren | Shielded Enclosure | 12/31/2024 |
| 8292 | Omega | iBTHX-W Virtual | 10/2/2024 |
| HL5 Transceiver-GCL | Gentex | Default Receiver | VBU |
| 6539 | Stanley | Tape Measure | 6/19/2026 |
| H4554 | 87V | Multimeter | 1/11/2025 |
| S/N:419726 | AIM TTI | PL303-P | VBU |
| S/N:2053240 | Miteq | AMF-4D-00501800-24-10P | 3/31/2025 |
| SW30 | Gentex | 3m Chamber Software | 3/31/2025 |
| SW48 | Gentex | Gentex Emissions Measurement Software | 31/2025 |
| CBL146 | Megaphase | Cable | 4/30/2025 |
| CBL 147 | Megaphase | cable | 4/30/2025 |
| 2069595 | Miteq | Amplifier | 10/31/2025 |
| CBL 119 | Pasternack | PE341-60 | 4/30/2025 |
| FLT009 | Mini-Circuits | ZHFG-K4000+, 4500 MHz High Pass Filter, DC - 18 GHz | 1/31/2025 |

# Test Equipment Setup and Procedure

EMI Receiver Settings Emissions:

| | |
|---|---|
| Detector Function | : Peak |
| Resolution Bandwidth | :100kHz (below 1GHz) |
| | :1MHz (above 1GHz) |
| Video Bandwidth: | :300kHz (below 1GHz) |
| | :3MHz (above 1GHz) |

EMI Receiver (in Spectrum Analyzer mode) Settings Occupied Bandwidth:

| | |
|---|---|
| Detector | : Peak |
| Resolution Bandwidth | :1 MHz (to determine peak level) |
| | :10 kHz (to determine occupied bandwidth) |
| Video Bandwidth | :3 MHz (to determine peak level) |
| | :30 kHz (to determine occupied bandwidth) |

Spectrum Analyzer Settings for Conducted measurements:

| | |
|---|---|
| Detector Function | : Peak |
| Resolution Bandwidth | :120kHz (below 1GHz) |
| | :1MHz (above 1GHz) |
| Video Bandwidth: | :300kHZ (below 1GHz) |
| | :3MHz (above 1GHz) |

For the testing, the EUT was placed at the center of a non-conducting table 80cm above the ground plane pursuant to ANSI C63.10:2013 for stand-alone equipment. The 2-conductor harness was routed down the edge of the test table to a power supply beneath the turntable.

Equipment is placed in one of the three orthogonal orientations, End, side, and flat. These orientations are described below in figure 6.2.3.

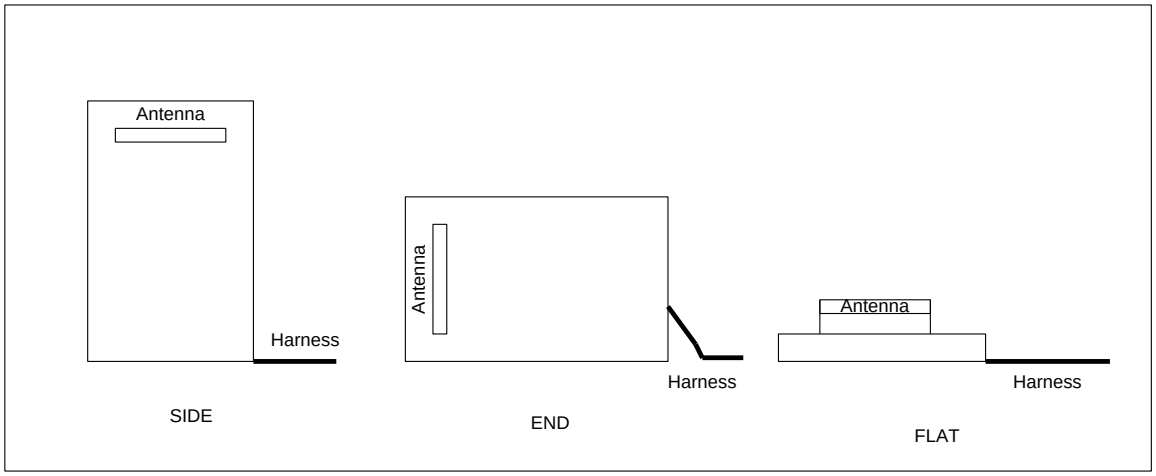



**Figure 6.2.3 EUT Orthogonal Orientations**

While in the prescribed orientation, the vertical antenna positioner sweeps in elevation from 1 to 4m in height until the operator finds the peak. The 3m turntable is then rotated

through 360 degrees until a peak is found. The table is stopped at the peak location and the peak in elevation re-verified. Procedure is repeated for applicable orientations/measurement antenna polarizations. Radiated testing was performed in the in-vehicle position only.

### 5.6. Measured Data – See Appendix A

# 6. Formulas and Sample Calculations

## 6.1. Calculation of ISED Limits from RSS-247and 47 CFR Part 15.247

The Peak Tx Spurious Emissions limit for the fundamental is given by:
Limit dBuV/m= 1W ERP = 127.38 dBuV/m, which is the fundamental limit.

The Rx Spurious Emissions limit for the fundamental is given by:
Limit dBuV/m= 20*Log(200uV/m) =46.0dBuV/m

The Rx Spurious Emissions limit for the harmonics is given by**:**
Limit dBuV/m= 20*Log(500uV/m) =54.0dBuV/m

# Appendix A

## A. Radiated Measurements

### 1. TX Measurements

**Measurement Settings:**
Measurement Frequency: Below 1GHz
Span: 500kHz or greater
RBW: 100/120kHz
VBW: 300kHz or 3 x RBW
Sweep Time: 25ms
Attenuation: Auto
Measurement Frequency: Above 1GHz
Span: 500kHz or greater
RBW: 1MHz
VBW: 3MHz or 3 x RBW
Sweep Time: 25ms
Attenuation: Auto

This measurement is a radiated measurement performed with a receiver. Prior to measurement the EUT is placed into a continuous transmit mode with 100% duty cycle via a communications board attached to the EUT.

## i. DUT Transmitting at 2402MHz (Fundamental)

**Peak/Average Measurement - 2402MHz**

| Frequency (MHz) | Orientation (Flat/End/Side) | Measurement Polarization (H/V) | Peak Measurement (dBuV/m) | Peak Limit (dBuV/m) | Margin (dB) | Average Measurement (dBuV/m) | Average Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 2402 | Side | H | 96.89 | 127.3 | 30.41 | 93.6 | - | - |
| 4804 | Side | H | 41.56 | 74.0 | 32.44 | 29.77 | 54.0 | 24.23 |
| 7206 | Side | 74 | 47.11 | 74.0 | 26.89 | 35.52 | 54.0 | 18.48 |
| 9608 | Side | 74 | 49.95 | 74.0 | 24.05 | 38.21 | 54.0 | 15.79 |
| 12010 | Side | 74 | 56.55 | 74.0 | 17.45 | 44.92 | 54.0 | 9.08 |
| 14412 | Side | 74 | 59.81 | 74.0 | 14.19 | 47.71 | 54.0 | 6.29 |
| 16814 | Side | 74 | 62.37 | 74.0 | **11.63** | 52.41 | 54.0 | **1.59** |
| 19216 | Side | H | 52.32 | 74.0 | 21.68 | 40.32 | 54.0 | 13.68 |
| 21618 | Side | 74 | 50.41 | 74.0 | 23.59 | 40.25 | 54.0 | 13.75 |
| 24020 | Side | 74 | 51.65 | 74.0 | 22.35 | 51.47 | 54.0 | 2.53 |

## ii. DUT Transmitting at 2440MHz (Fundamental)

**Peak/Average Measurement - 2440MHz**

| Frequency (MHz) | Orientation (Flat/End/Side) | Measurement Polarization (H/V) | Peak Measurement (dBuV/m) | Peak Limit (dBuV/m) | Margin (dB) | Average Measurement (dBuV/m) | Average Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 2440 | Side | H | 95.96 | 127.3 | 31.34 | 93.63 | - | - |
| 4880 | Side | H | 41.03 | 74.0 | 32.97 | 28.93 | 54.0 | 25.07 |
| 7320 | Side | H | 47.25 | 74.0 | 26.75 | 35.64 | 54.0 | 18.36 |
| 9760 | Side | H | 51.14 | 74.0 | 22.86 | 39.36 | 54.0 | 14.64 |
| 12200 | Side | H | 56.66 | 74.0 | 17.34 | 44.95 | 54.0 | 9.05 |
| 14640 | Side | H | 58.36 | 74.0 | 15.64 | 46.37 | 54.0 | 7.63 |
| 17080 | Side | 74 | 55.47 | 74.0 | 18.53 | 42.74 | 54.0 | 11.26 |
| 19520 | Side | 74 | 51.32 | 74.0 | 22.68 | 40.36 | 54.0 | 13.64 |
| 21960 | Side | H | 50.36 | 74.0 | 23.64 | 39.35 | 54.0 | 14.65 |
| 24400 | Side | 74 | 52.41 | 74.0 | 21.59 | 41.03 | 54.0 | 12.97 |

## iii. DUT Transmitting at 2480MHz (Fundamental)

**Peak/Average Measurement - 2480MHz**

| Frequency (MHz) | Orientation (Flat/End/Side) | Measurement Polarization (H/V) | Peak Measurement (dBuV/m) | Peak Limit (dBuV/m) | Margin (dB) | Average Measurement (dBuV/m) | Average Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 2480 | Side | H | 97.7 | 127.3 | 29.60 | 95.53 | - | - |
| 4960 | Side | H | 40.6 | 74.0 | 33.40 | 28.75 | 54.0 | 25.25 |
| 7440 | Side | H | 47.9 | 74.0 | 26.10 | 35.95 | 54.0 | 18.05 |
| 9920 | Side | H | 51.46 | 74.0 | 22.54 | 39.6 | 54.0 | 14.40 |
| 12400 | Side | 74 | 57.56 | 74.0 | 16.44 | 45.7 | 54.0 | 8.30 |
| 14880 | Side | H | 58.6 | 74.0 | 15.40 | 46.81 | 54.0 | 7.19 |
| 17360 | Side | 74 | 55.36 | 74.0 | 18.64 | 42.98 | 54.0 | 11.02 |
| 19840 | Side | 74 | 53.47 | 74.0 | 20.53 | 41.36 | 54.0 | 12.64 |
| 22320 | Side | 74 | 52.14 | 74.0 | 21.86 | 39.54 | 54.0 | 14.46 |
| 24800 | Side | 74 | 53.26 | 74.0 | 20.74 | 41.33 | 54.0 | 12.67 |

## 2. Restricted Band-Edge Measurement

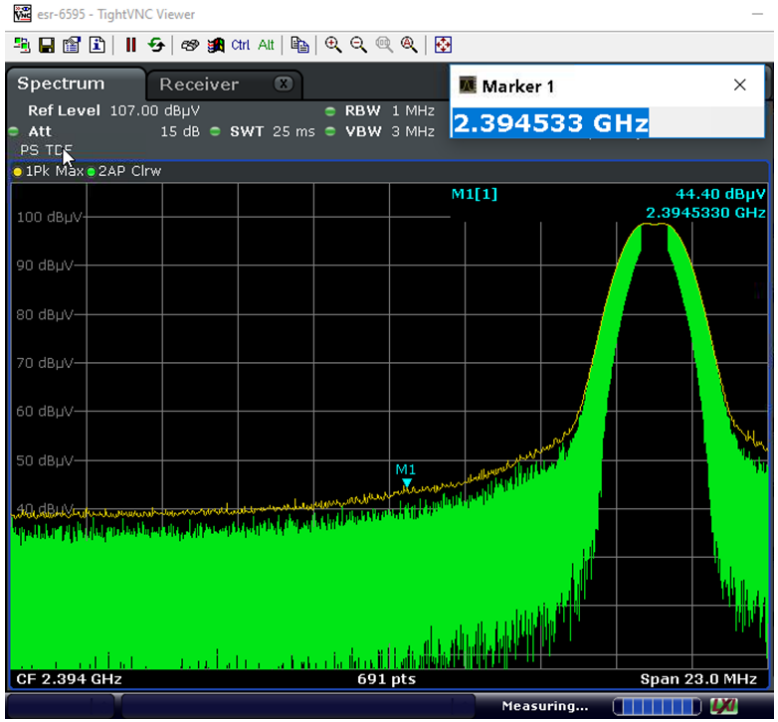
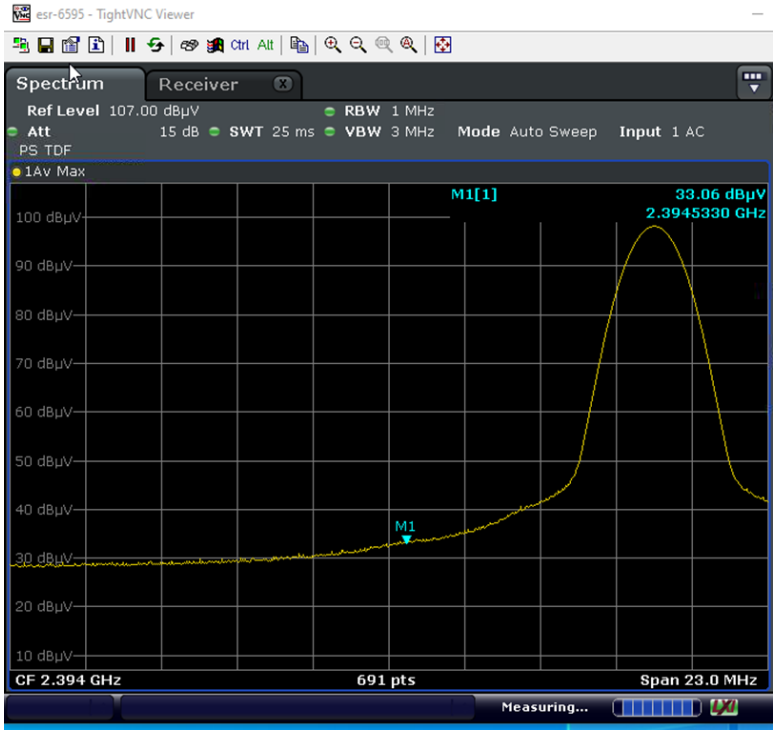
**Measurement Settings:**
RBW:1MHz
VBW: 3x RBW
Sweep time: No faster than Coupled (auto) time
Detector: Peak and Average
Trace: Max Hold

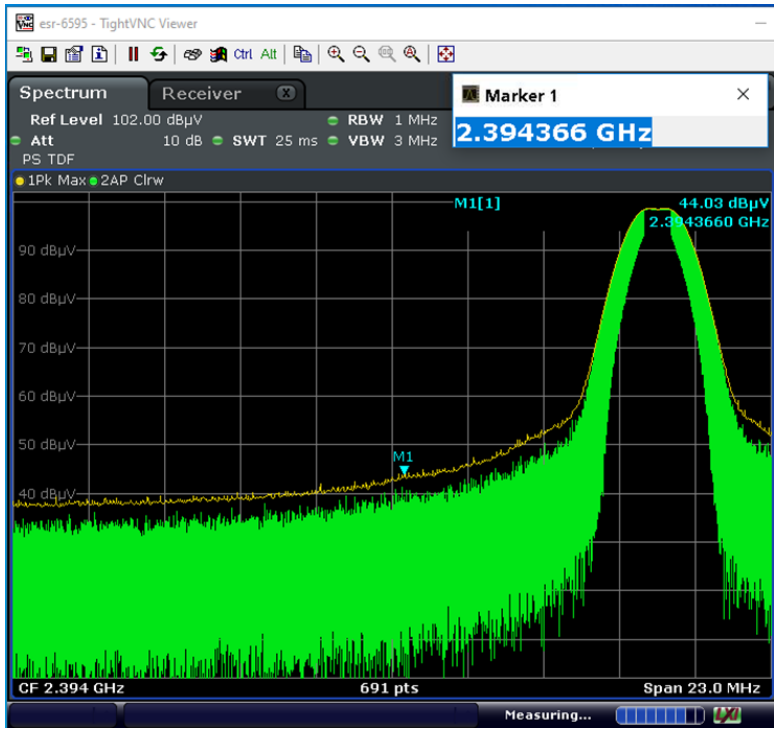
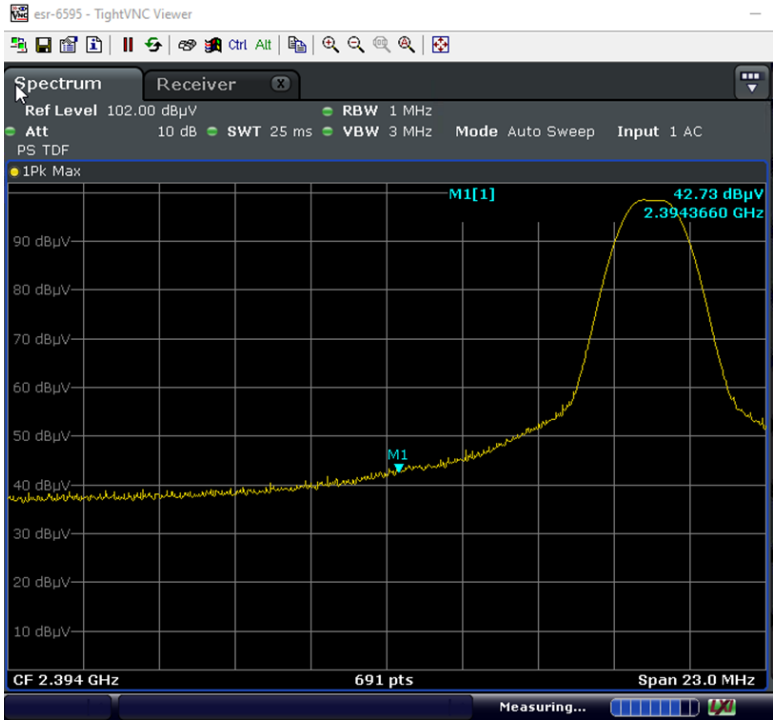
Per section 15.205 only spurious emissions are permitted in the frequency bands 2310-2390MHz and 2483.5-2500MHz and shall not exceed the limits shown in 15.209.

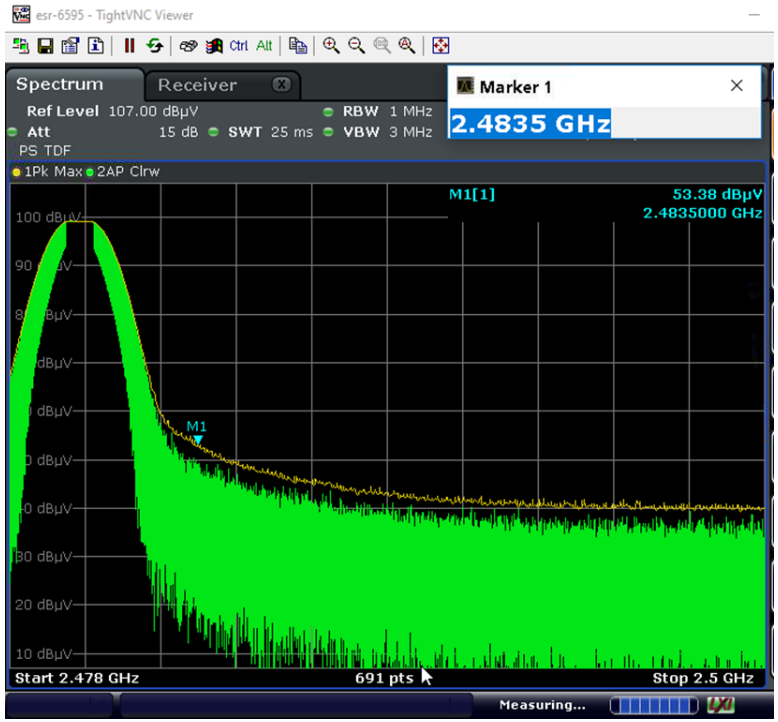
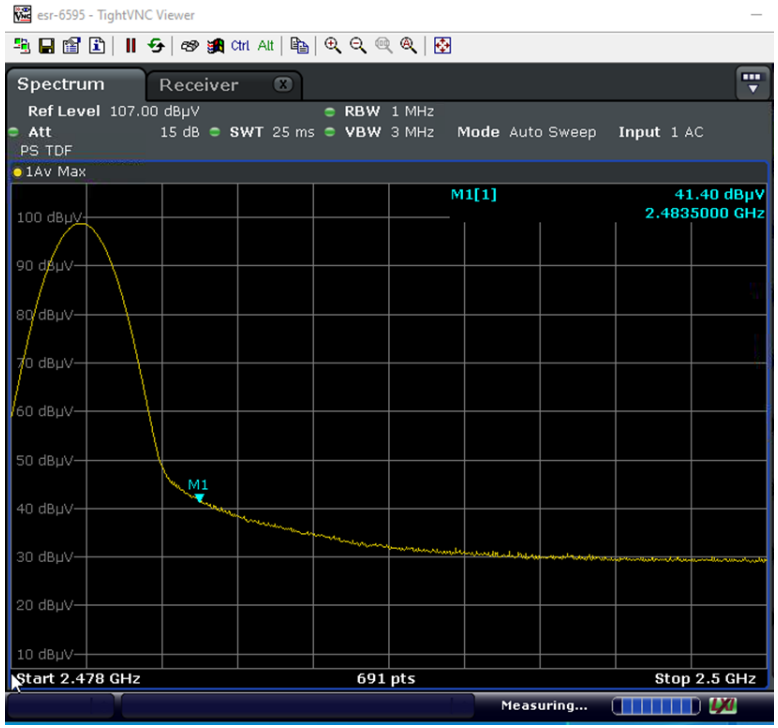
This measurement is a conducted measurement performed with a receiver. Prior to measurement the EUT is placed into a continuous transmit mode via a communications board attached to the EUT.

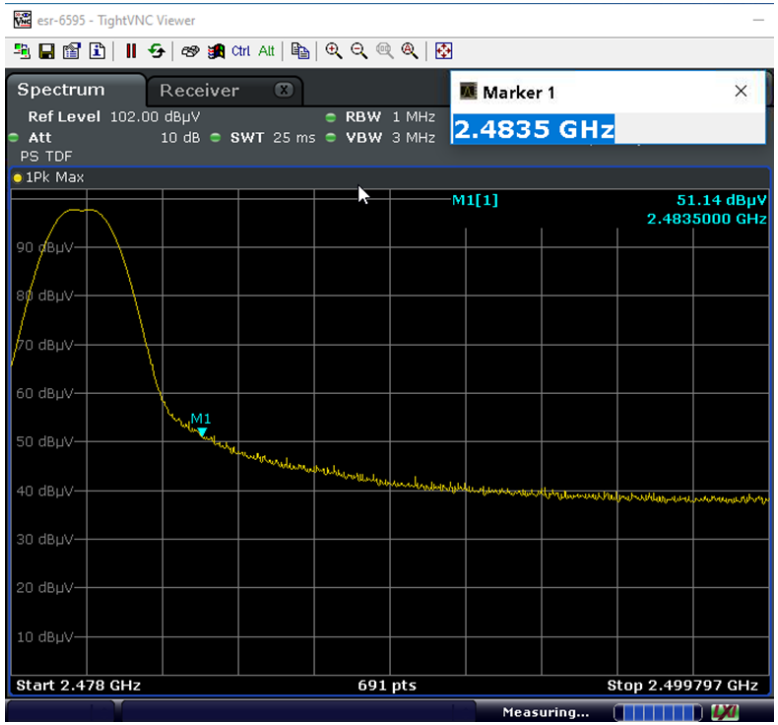
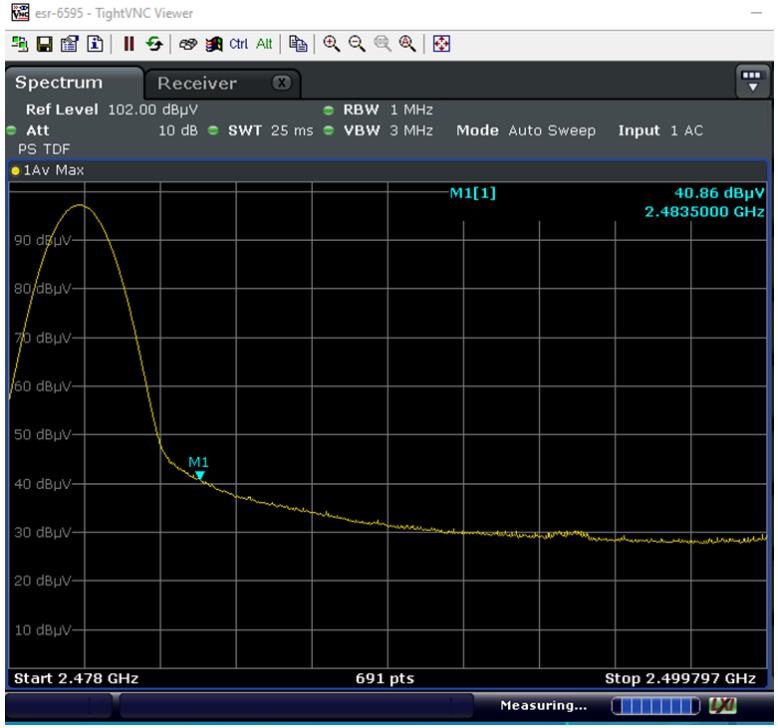
The restricted band edge measurement was performed with the transmitter set separately at 2402MHz and 2480MHz. For each of the measurements the emissions were below the limit

| Measurement Frequency | Antenna Polarization | Measurement (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector |
|---|---|---|---|---|---|
| 2394 | Horizontal | 44.4 | 74 | 29.6 | Peak |
| 2394 | Horizontal | 33.06 | 54 | 20.94 | Average |
| 2394 | Vertical | 44.03 | 74 | 29.97 | Peak |
| 2394 | Vertical | 42.73 | 54 | 11.27 | Average |
| 2483.5 | Horizontal | 53.38 | 74 | 20.62 | Peak |
| 2483.5 | Horizontal | 41.4 | 54 | 12.6 | Average |
| 2483.5 | Vertical | 51.14 | 74 | 22.86 | Peak |
| 2483.5 | Vertical | 40.86 | 54 | 13.14 | Average |

| 2402 MHz Peak Horizontal | 2402 MHz Average Horizontal |
|---|---|
|  |  |

| 2402 MHz Peak Vertical | 2402 MHz Average Vertical |
|---|---|
|  |  |

| 2480 MHz Peak Horizontal | 2480 MHz Average Horizontal |
|---|---|
|  |  |

| 2480 MHz Peak Vertical | 2480 MHz Average Vertical |
|---|---|
|  |  |

# B. Conducted Emissions

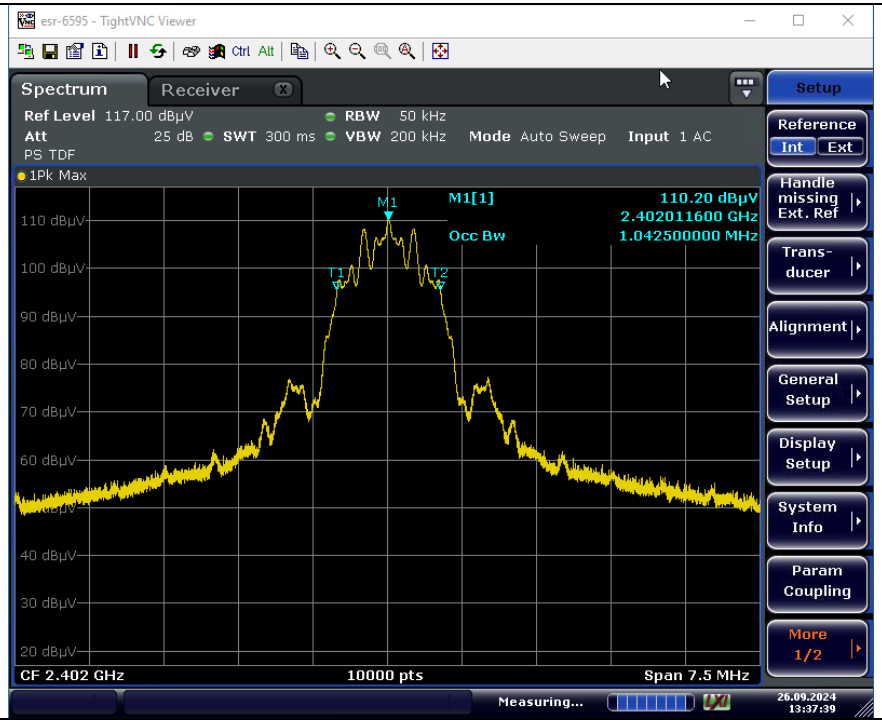
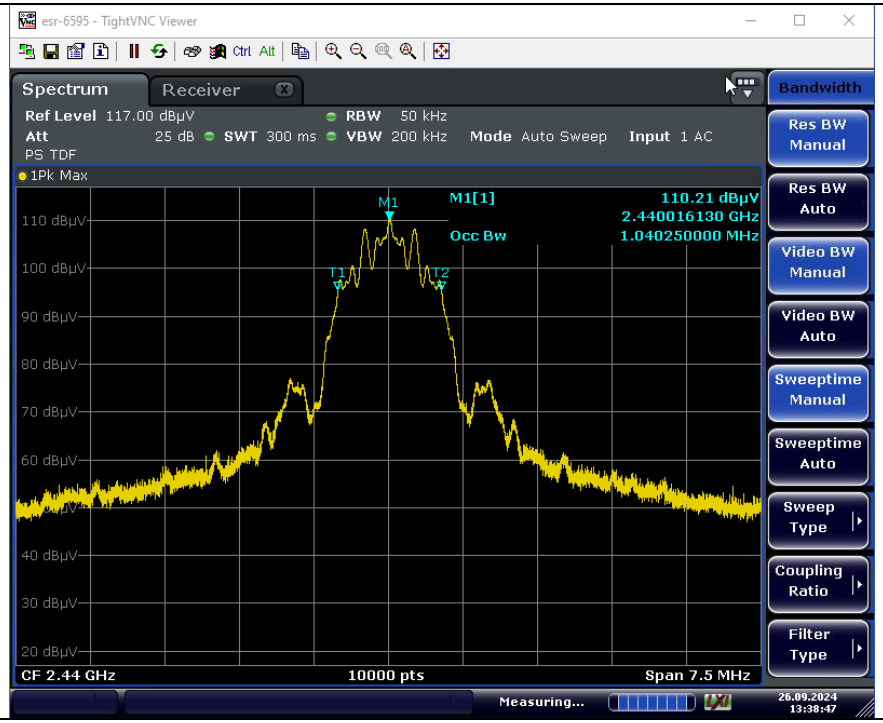
## 1. 99% Bandwidth

**Measurement Settings:**
Frequency Span: 2-5 times the OBW
RBW: 1 to 5% of the OBW
VBW: 3 times the RBW
Detector: Peak
Trace Max Hold

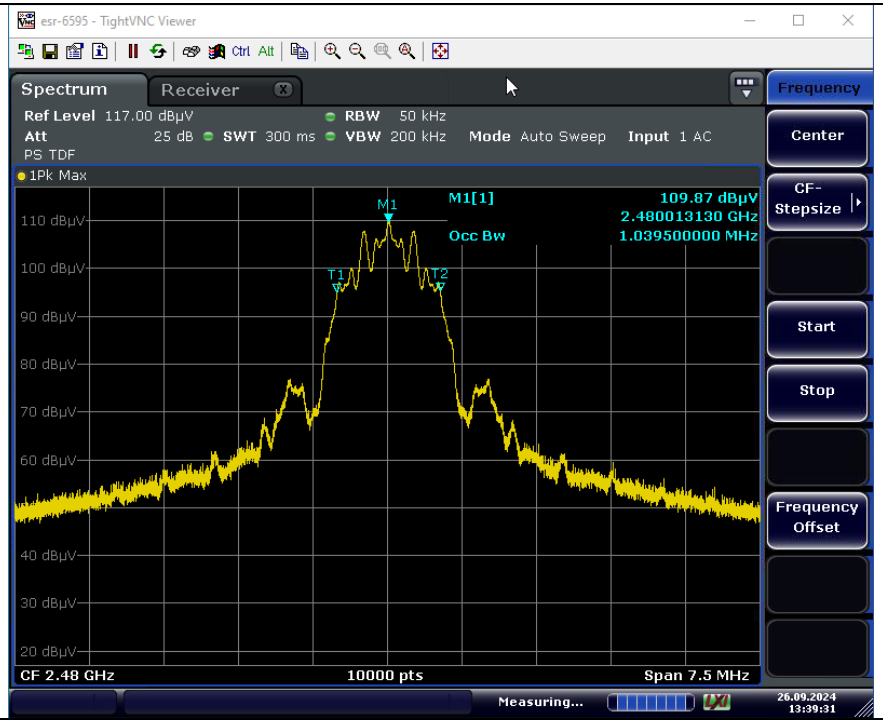
This Measurements is a conducted measurement. Prior to the measurement the EUT is placed into a continuous transmit mode via a communications board attached to the EUT.

In the measurement of the 99% bandwidth, the transmit frequency was set to the low, middle, and high channels of operation.

| Channel # | Frequency (MHz) | Bandwidth (kHz) |
|---|---|---|
| 0 | 2402 | 1042 |
| 19 | 2440 | 1040 |
| 39 | 2480 | 1039 |

| 2402 MHz | 2440 MHz |
|---|---|
|  |  |

**2480 MHz**


esr-6595 - TightVNC Viewer
Spectrum
Receiver
Frequency
Ref Level 117.00 dBµV
RBW 50 kHz
Att 25 dB
SWT 300 ms
VBW 200 kHz
Mode Auto Sweep
Input 1 AC
PS TDF
1Pk Max
M1
M1[1]
109.87 dBµV
2.480013130 GHz
Occ Bw
1.039500000 MHz
T1
T2
110 dBµV
100 dBµV
90 dBµV
80 dBµV
70 dBµV
60 dBµV
40 dBµV
30 dBµV
20 dBµV
CF 2.48 GHz
10000 pts
Span 7.5 MHz
Center
CF-Stepsize
Start
Stop
Frequency Offset
Measuring...
26.09.2024
13:39:31

## 2. 6dB Bandwidth

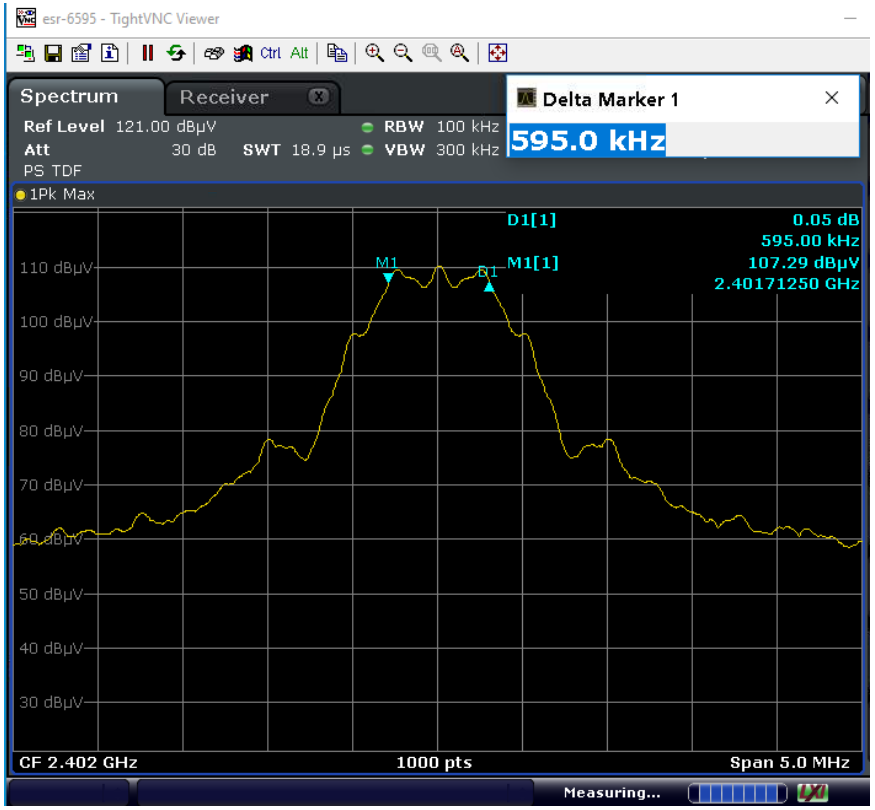
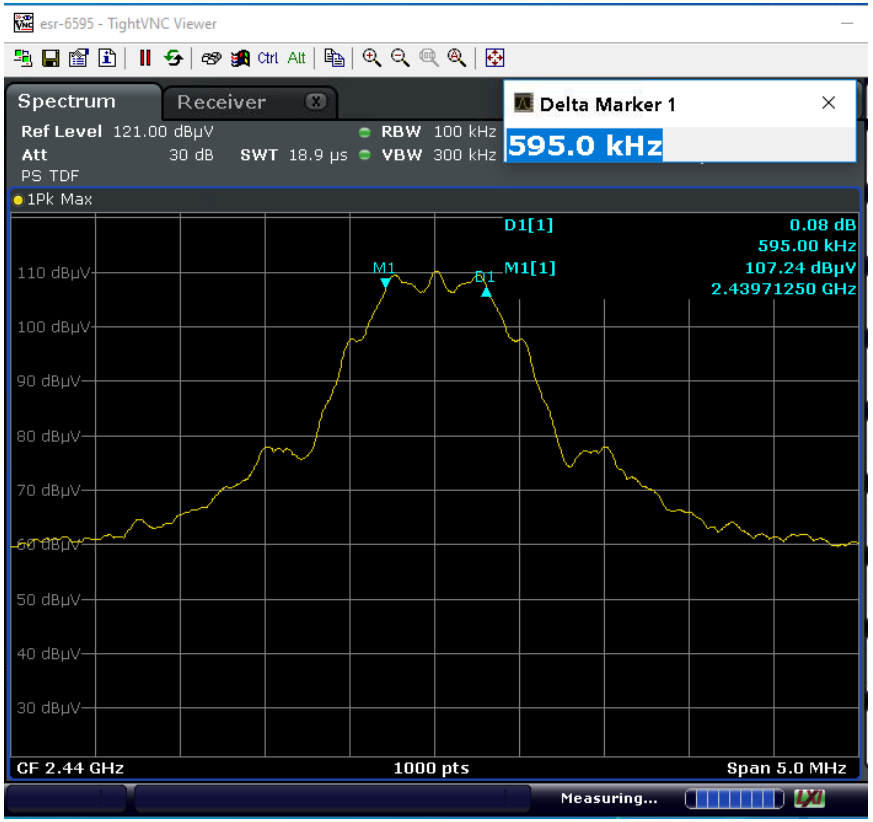
**Measurement Settings:**
RBW: in the range of 1 to 5% of the OBW but not less than 100kHz
VBW: Equal to or greater than 3 times the RBW
Span: Greater than the DTS bandwidth
Sweep time: No faster than the coupled (auto) time
Detector: Peak
Trace mode: Max Hold

**6dB Bandwidth Requirement:** Per 15.247(a)(2), systems using digital modulation may operate in the 2400-2483.5 MHz bands. The minimum 6dB bandwidth shall be at least 500 kHz

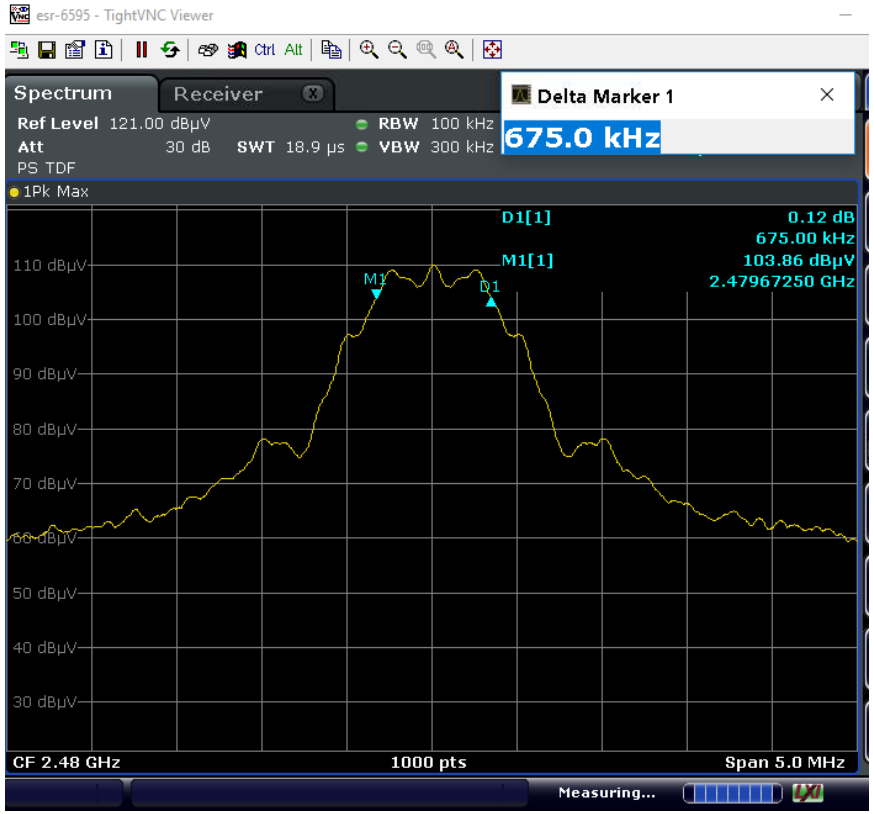
This measurement is a conducted measurement performed with the receiver per test method ANSI C63.10 section 11.8. Prior to measurement the EUT is placed into a continuous transmit mode via a communication board attached to the EUT.

In the measurement of the 6dB bandwidth, the transmit frequency was set to low, middle, and high channels of operation.

| Channel # | Frequency (MHz) | 6dB Bandwidth (kHz) | Limit (kHz) | Margin |
|---|---|---|---|---|
| 0 | 2402 | 595 | >500 | 95 |
| 19 | 2440 | 595 | >500 | 95 |
| 39 | 2480 | 675 | >500 | 175 |

| 2402 MHz | 2440 MHz |
|---|---|
|  |  |

**2480 MHz**


esr-6595 - TightVNC Viewer
Spectrum
Receiver
Delta Marker 1
675.0 kHz
Ref Level 121.00 dBµV
RBW 100 kHz
Att 30 dB
SWT 18.9 µs
VBW 300 kHz
PS TDF
1Pk Max
D1[1]
0.12 dB
675.00 kHz
M1[1]
103.86 dBµV
2.47967250 GHz
M1
D1
110 dBµV
100 dBµV
90 dBµV
80 dBµV
70 dBµV
60 dBµV
50 dBµV
40 dBµV
30 dBµV
CF 2.48 GHz
1000 pts
Span 5.0 MHz
Measuring...

## 3. Peak Output Power

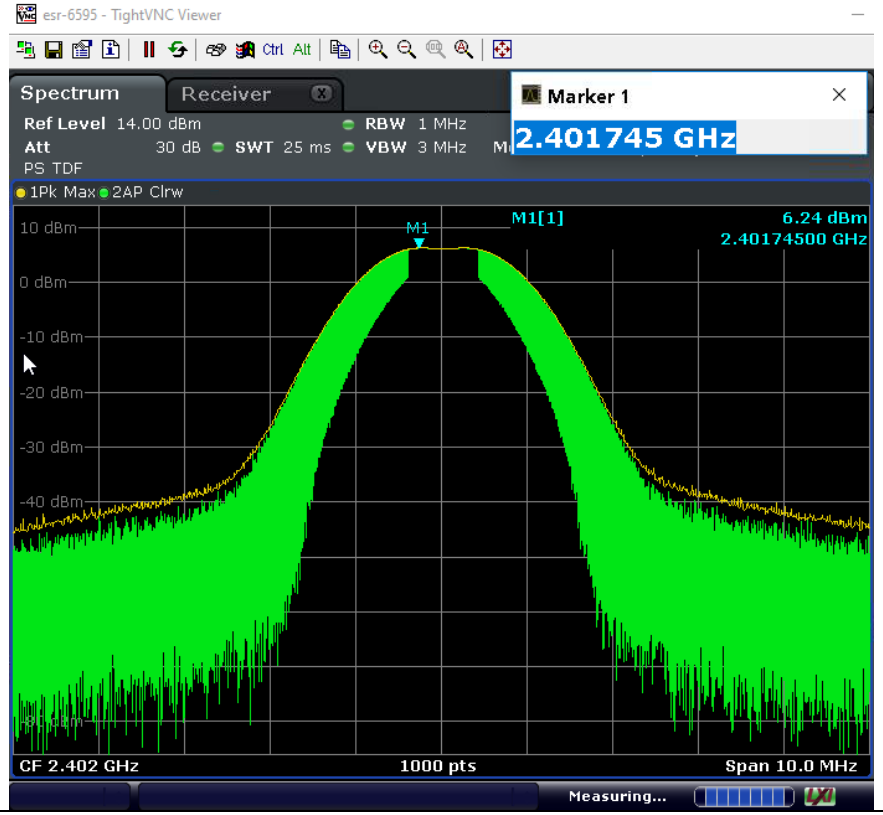
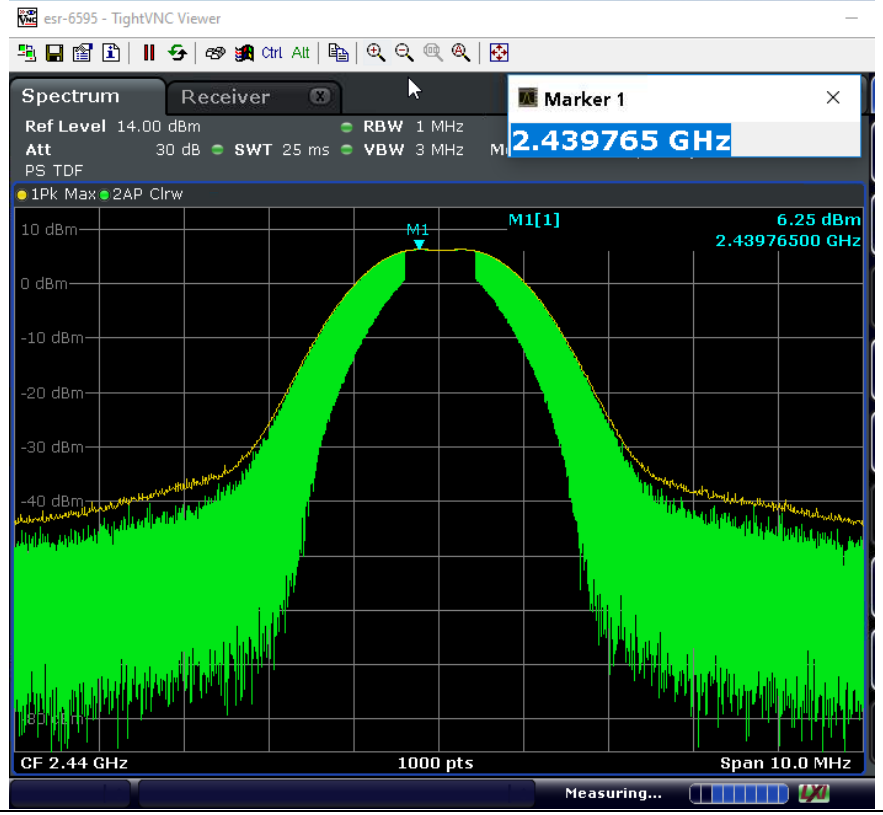
**Measurement Settings:**
RBW: Greater than the worst case DTS occupied bandwidth
VBW: Equal to or greater than 3 times the RBW
Span: Equal to or greater than 3 times the RBW
Sweep time no faster than coupled (auto) time
Detector: Peak

**Peak Output Power Requirement:** Per 15.247(b)(3) The maximum Peak Conducted Output Power of the intentional radiator shall not exceed the 1W (30dBm) for systems using digital modulation in the 2400-2483.5MHz

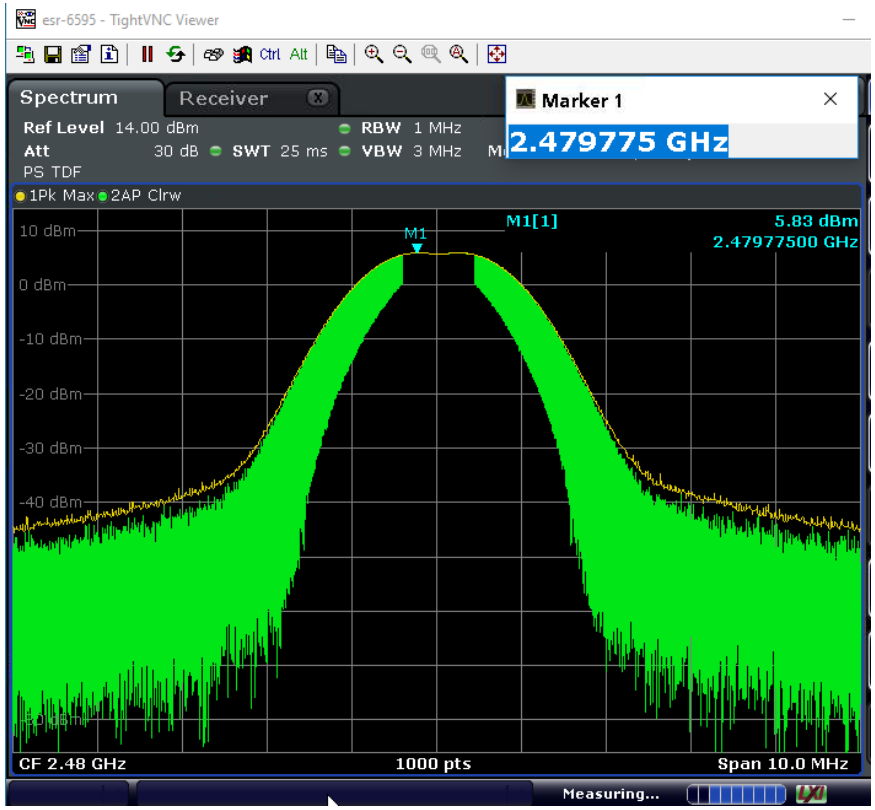
This measurement is a conducted measurement performed with the receiver per test method ANSI C63.10 section 11.9. Prior to measurement the EUT is placed into a continuous transmit mode via a communications board attached to the EUT.

In the measurement of the Peak Output Power, the transmit frequency was set to low, middle, and high channels of operation.

| Channel # | Frequency (MHz) | Power Output (dBm) | Limit (dBm) | Margin |
|---|---|---|---|---|
| 0 | 2402 | 6.24 | 30 | 23.76 |
| 19 | 2440 | 6.25 | 30 | 23.75 |
| 39 | 2480 | 5.83 | 30 | 24.17 |

| 2402 MHz | 2440 MHz |
|---|---|
|  |  |

**2480 MHz**


esr-6595 - TightVNC Viewer
Spectrum
Receiver
Marker 1
2.479775 GHz
Ref Level 14.00 dBm
RBW 1 MHz
Att 30 dB
SWT 25 ms
VBW 3 MHz
PS TDF
1Pk Max
2AP Clrw
M1
M1[1]
5.83 dBm
2.47977500 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
CF 2.48 GHz
1000 pts
Span 10.0 MHz
Measuring...

# 4. Power Spectral Density

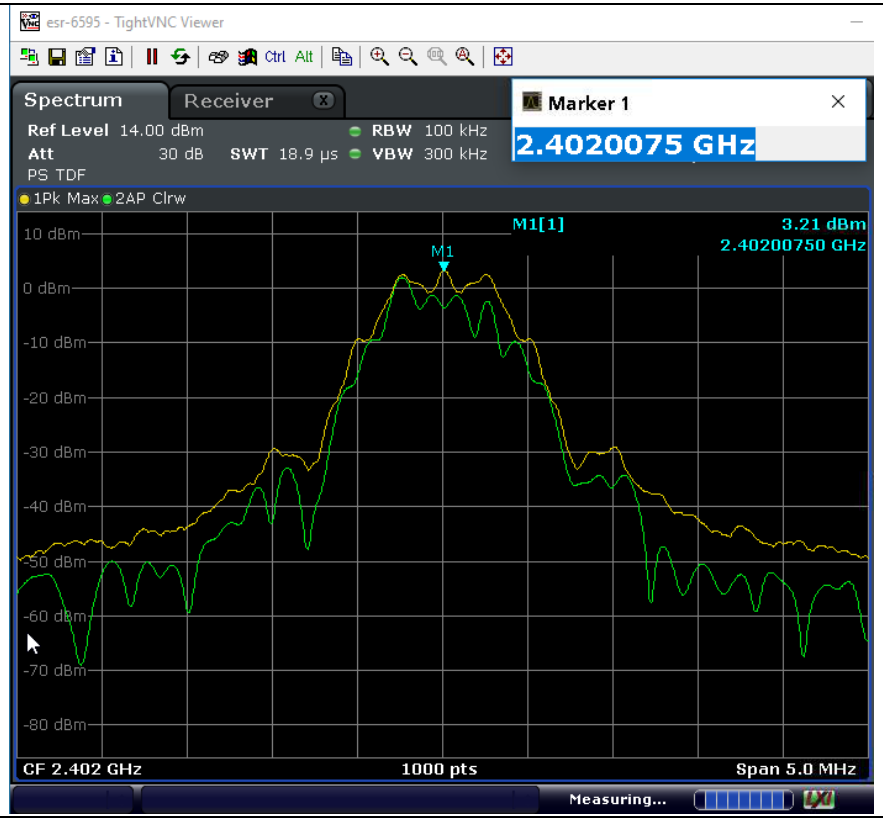
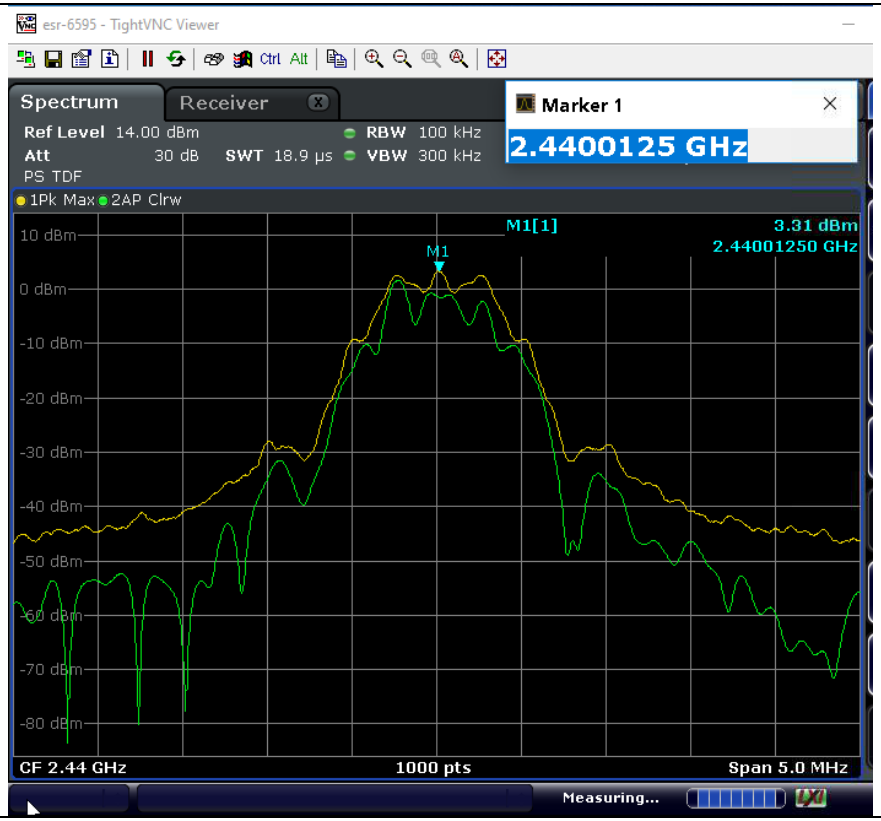
**Measurement Settings:**
Span: Greater than 1.5 times the DTS bandwidth
RBW: set to between 3kHz and 100kHz
VBW: Equal to or greater than 3 times the RBW
Sweep time: No faster than the coupled (auto) time
Detector: Peak
Trace mode: Max hold

**Power Spectral Density requirement:** Per 15.247(e) for digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3kHz band during any time interval of continuous transmission. The same method of determining the conducted output power shall be used to determine the power spectral density.

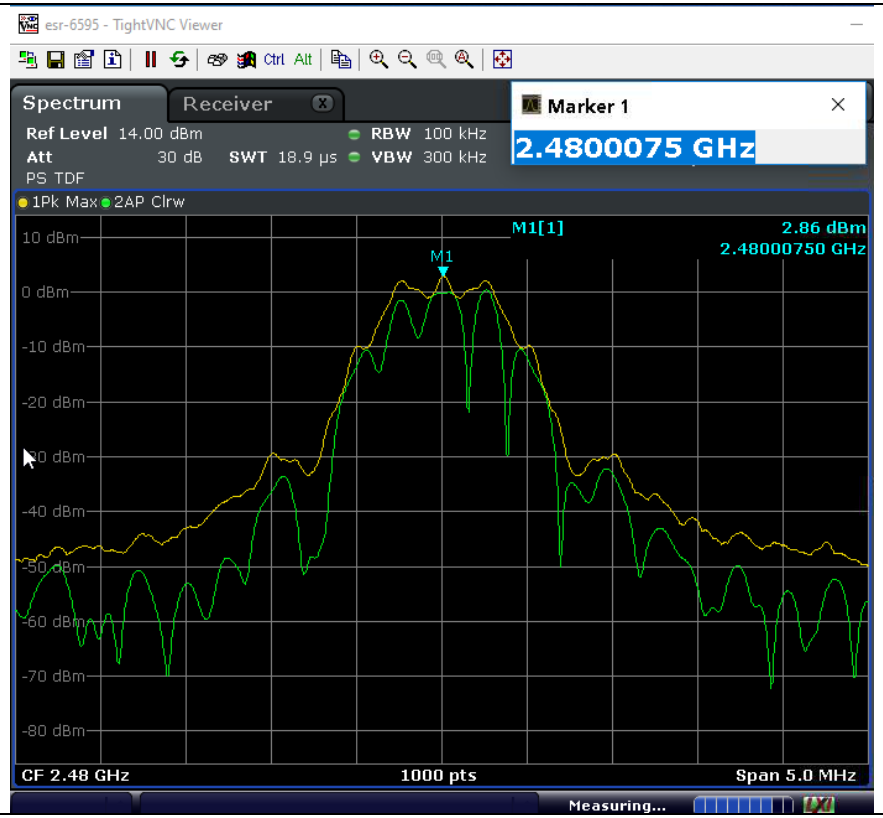
This measurement is a conducted measurement performed with the receiver per test method ANSI C63.10 section 11.10. Prior to measurement the EUT is placed into a continuous transmit mode via communications board attached to the EUT.

In the measurement of the power spectral density, the transmit frequency was set to low, middle, and high channels of operation.

| Channel # | Frequency (MHz) | Measurement PPSD (dBm) | Limit (dBm) | Margin |
|---|---|---|---|---|
| 0 | 2402 | 3.2 | 8 | 4.8 |
| 19 | 2440 | 3.31 | 8 | 4.69 |
| 39 | 2480 | 2.86 | 8 | 5.14 |

| 2402 MHz | 2440MHz |
|---|---|
|  |  |

**2480 MHz**


esr-6595 - TightVNC Viewer
Ctrl Alt
Spectrum
Receiver
Marker 1
2.4800075 GHz
Ref Level 14.00 dBm
RBW 100 kHz
Att 30 dB
SWT 18.9 µs
VBW 300 kHz
PS TDF
1Pk Max
2AP Clrw
M1[1]
2.86 dBm
2.48000750 GHz
M1
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
CF 2.48 GHz
1000 pts
Span 5.0 MHz
Measuring...

## 5. Conducted Emissions Sweep – 30MHz to 25GHz

**Measurement Settings:**
Sweep 1: Peak - 100 kHz
Start Frequency: 30MHz
End Frequency: 1000MHz
Detector: Peak
Sweep Mode: FFT
Attenuator: 5dB
Pre-Amp: On
Max Hold Trace Mode: Off
Bandwidth Filter: EMI (6dB)
RBW: 100kHz
Step Size: Auto (25kHz)
Dwell Time: 10ms

**Measurement Settings:**
Sweep 2: Peak – 1000kHz
Start Frequency: 1000MHz
End Frequency: 18000MHz
Detector: Peak
Sweep Mode: FFT
Attenuator: 5dB
Pre-Amp: On
Max Hold Trace Mode: Off
Bandwidth Filter: EMI (6dB)
RBW: 1000kHz
Step Size: Auto (250kHz)
Dwell Time: 10ms

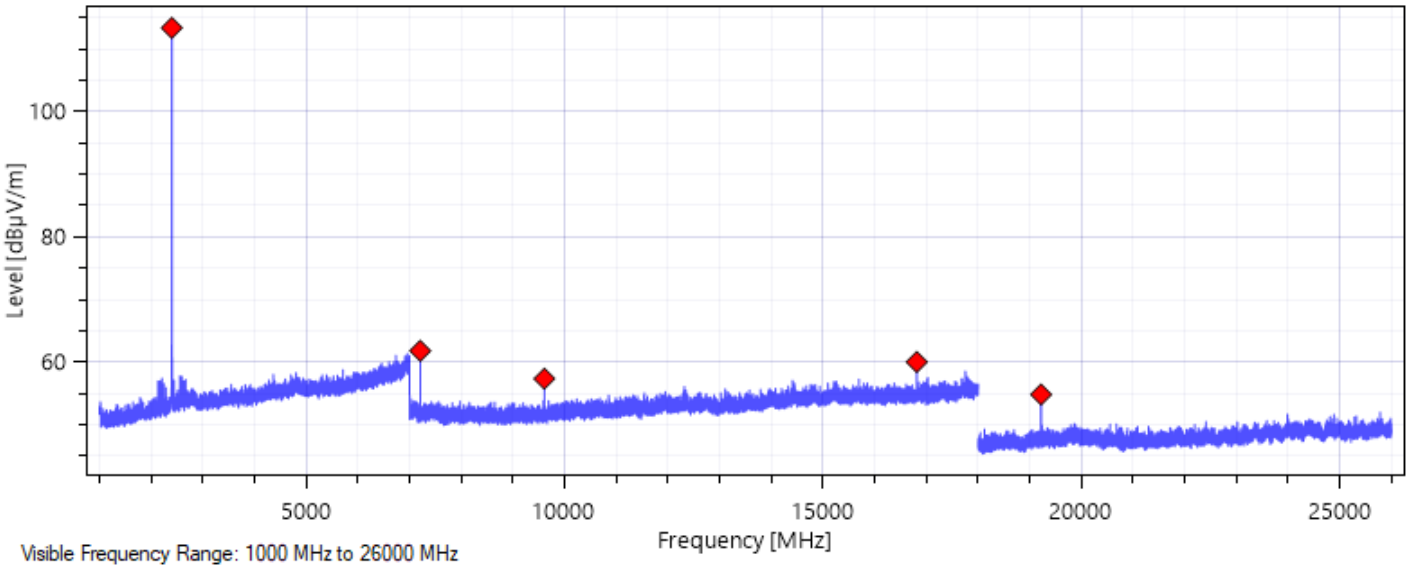
**Measurement Settings:**
Sweep 2: Peak – 1000kHz
Start Frequency: 18000MHz
End Frequency: 26000MHz
Detector: Peak
Sweep Mode: FFT
Attenuator: 5dB
Pre-Amp: On
Max Hold Trace Mode: Off
Bandwidth Filter: EMI (6dB)
RBW: 1000kHz
Step Size: Auto (250kHz)
Dwell Time: 10ms

Per section 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. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

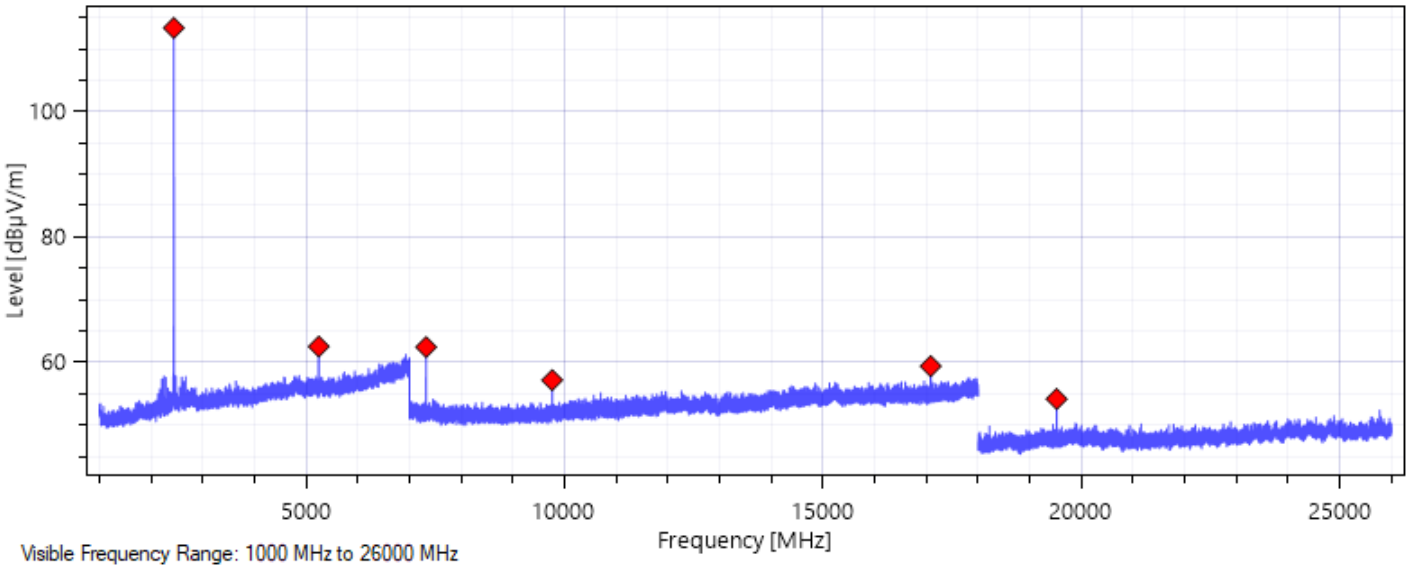
This measurement is a conducted measurement performed with a receiver. Prior to measurement the EUT is placed into a continuous transmit mode via a communications board attached to the EUT.

The band edge measurement was performed with the transmitter set separately at the low, mid, and high channel of operation. For each of the measurements the emissions were greater than 45dB below the peak of the signal.

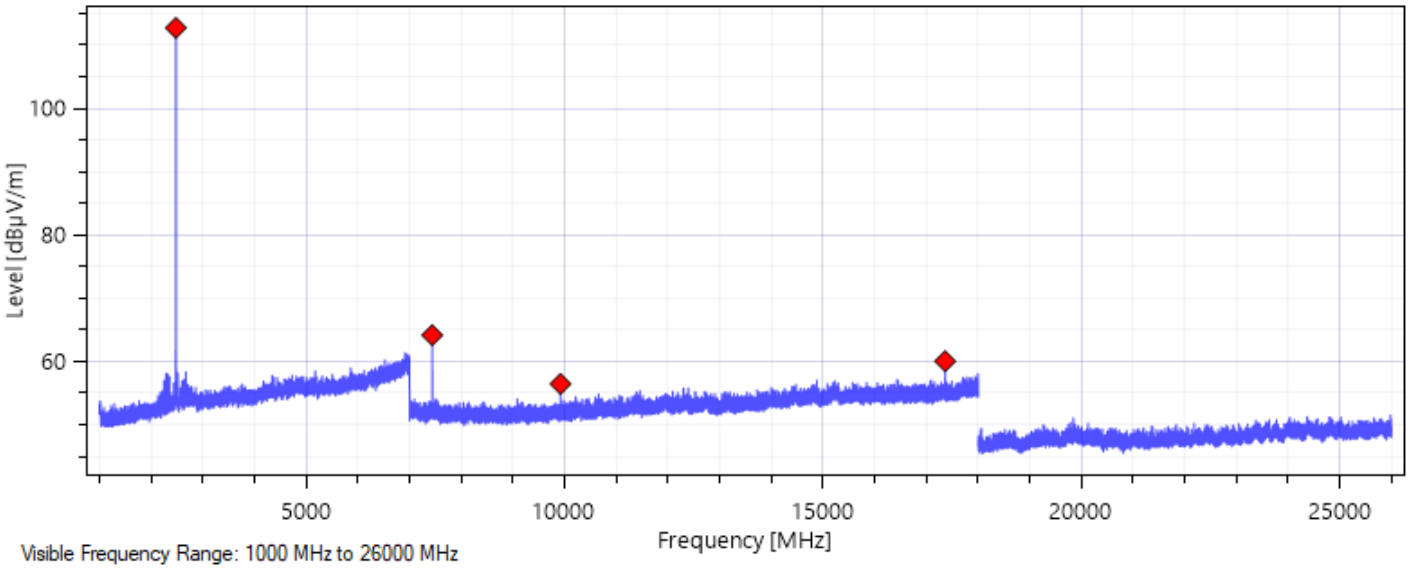
| Channel | Worst-Case Delta (dB) | Limit (dB) | Margin |
|---|---|---|---|
| **Low** | 48.555 | 20 | 28.6 |
| **Mid** | 50.839 | | 30.8 |
| **High** | 51.551 | | 31.6 |




| Frequency (MHz) | Level (dBµV/m) |
|---|---|
| 2,401.75 | 113.39 |
| 7,206.75 | 61.839 |
| 9,608.75 | 57.401 |
| 16,812.50 | 60.06 |
| 19,218.00 | 54.881 |




| Frequency (MHz) | Level (dBµV/m) |
|---|---|
| 2,439.75 | 113.374 |
| 5,244.25 | 62.535 |
| 7,320.75 | 62.449 |
| 9,759.25 | 57.174 |
| 17,081.75 | 59.41 |
| 19,518.25 | 54.168 |




| Frequency (MHz) | Level (dBµV/m) |
|---|---|
| 2,479.75 | 112.739 |
| 7,439.25 | 64.184 |
| 9,921.00 | 56.461 |
| 17,361.75 | 60.064 |