# COMPLIANCE WORLDWIDE INC.
# TEST REPORT 288-20R1

**In Accordance with the Requirements of**

## FCC PART 15.247, SUBPART C
## Innovation, Science and Economic Development Canada
## RSS-247, Issue 2

**Issued to**

**Philips Medical Systems**
**3000 Minuteman Drive**
**Andover, MA 01810**
**978-659-2800**

**for the**

**MX40 CTS Radio**

**Model**
**FCC ID: PQC-MX40SH2C4**
**IC: 3549B- MX40SH2C4**

**Report Issued on April 7, 2021**
**Revision R1 Issued on May 16, 2022**

**Tested by**

Brian F. Breault

Reviewed by

Larry K. Stillings

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## 1. Scope

This test report certifies that the Philips Medical Systems MX40 2.4 GHz CTS Radio, as tested, meets the FCC Part 15, Subpart C and Industry Canada RSS 247, Issue 2 requirements. The scope of this test report is limited to the test sample provided by the client, only in as much as that sample represents other production units. If any significant changes are made to the unit, the changes shall be evaluated, and a retest may be required. Revision R1 corrects the antenna gain in Section 7.5 and updates the report for using pulsed emissions and duty cycle calculation in sections 7.8, 7.11 and time averaged powers in section 7.12

## 2. Product Details

| | |
|---|---|
| **2.1. Manufacturer:** | Philips Medical Systems |
| **2.2. Model Number:** | Model 865351/MX40-2B4 |
| **2.3 Serial Number:** | US156Z7318 (conducted), US156Z7319 (radiated) |
| **2.4 Description of EUT:** | Wireless ECG/SpO2 patient monitor |
| **2.5 Power Source:** | 3 AA batteries |
| **2.6 Hardware Revision:** | B.01.02 |
| **2.7 Software Revision:** | C.01.54 |
| **2.8 Firmware Revision:** | A.06.40 |
| **2.9. Modulation Type:** | Smart Hopping, GFSK |
| **2.10. Operating Freq.:** | 2400 MHz to 2483.5 MHz |
| **2.11. EMC Modifications:** | None |

## 3. Product Configuration

### 3.1. Operational Characteristics & Software

The MX40 transmits to the Philips Clinical Network located outside the field of test. Patient information will be displayed on an IntelliVue Information Center also located outside the field of test.

### 3.2. Operating Instructions

The MX40 will be in normal monitoring mode transmitting patient data and waveforms to a frequency corresponding wireless access point where the patient data will be transferred through the IntelliVue Telemetry infrastructure and displayed on the IntelliVue Information Center display. Patient waveforms and data are also displayed on the MX40 display for local monitoring.

For Radiated Emissions testing, fan out the ECG leads and connect them to a termination plate. Extend the SpO2 transducer across the table opposite the ECG leads. The SpO2 transducer will be connected to an SpO2 simulator. Ensure the SpO2 function is set to continuous:

Select "**PATIENT WINDOW**" for the bed being monitored on the PIIC display. From the menu button choices across the bottom of the display, select "**Telemetry Setup**". A window will open and in the "**SpO2 Equipped Devices Only**" section, select the "**Enable SpO2**" checkbox. Below that checkbox, under "**SpO2 Mode**" click the dropdown menu and select "**Continuous**". Below that, ensure the "**Pleth**", "**Pulse**" and "**SpO2 Alarm**" boxes are also checked. For all other tests, the ECG leads will be connected to an ECG simulator.



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## 3. Product Configuration (continued)

### 3.2. Operating Instructions (continued)

**Channel Selection:**

1. Press Alt + F11 – A list of menu items and a "Login to access Windows Desktop Access" window will appear. Enter the username: PhilipsBD[1] (case sensitive) and password: <<Removed>>. The Taskbar should appear at the bottom of the screen.
2. Click the Start button at the left side of Taskbar and select Internet Explorer from the list.
3. Either use the Internet Explorer dropdown or manually enter the Access Point Controller address: 172.31.225.8[1]. The System Access Configuration screen should appear.
4. Click on the access point controller in the list on the left side of the window to expand the list and then click on the access point. The 2.4 GHz Smart Hopping AP Configuration should be available on the right side of the window.
5. At the bottom of the window, select the "click here to access advanced channel configuration options. The channel selection check boxes should appear. Click on the corresponding box to the channel you wish to select. If the channel is selected, click to deselect. Once complete, click save. The access point will reset to the selected channels.

### 3.3. EUT Hardware

| Block Diag. # | Manufacturer | Model/Part # / Options | Serial Number/ Other | Input Voltage Range (V) | Input Freq. Range (Hz) | Description/Function |
|---|---|---|---|---|---|---|
| 1a | Philips | 865351/MX40-2C4/ C01, C03, J46, M02, S02 | US156Z7318 | 3.7 - 4.5 | DC | 2.4 GHz CTS Patient Worn telemetry transceiver |
| 1b | Philips | 865351/MX40-2C4/ C01 C03 J46 M02 S02 | US156Z7319 ` | 3.7 - 4.5 | DC | 2.4 GHz CTS Patient Worn telemetry transceiver |

### 3.4. EUT Cables/Transducers

| Diagram Block Letter | Manufacturer | Model/Part # | Length (m) | Shield Y/N | Description/Function |
|---|---|---|---|---|---|
| **A** | PHILIPS | 989803171871 | 0.9 | Y | ECG 6 LEAD /SPO2 LEAD SET |
| **B** | PHILIPS | M11191A | 2.5 | N | $SPO_2$ TRANSDUCER |



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# 3. Product Configuration

## 3.5. Support Equipment

| Diagram Block # | Manufacturer | Model/Part # / Options | Input Voltage Range | Input Freq. Range (Hz) | Description/Function |
|---|---|---|---|---|---|
| **2** | Cisco | WS-C2960+24PC-S V02 | 100-240 | 50-60 | Power Over LAN Ethernet Switch S/N FOC2137Y584 |
| **3** | Philips | 453564195161/ ITS3171A | 100-240 | 50-60 | Access Point Controller (2.4 GHz) S/N SG71509672 |
| **4** | Philips | 989803171221 | 48 | DC | 2.4 GHz CTS Access Point S/N US51736275 |
| **5** | Philips | 453564195161 | 100-240 | 50-60 | Philips IntelliVue Information Center S/N 2UA8081BX0 |
| **6** | AXM | AXM2418 | 12 | DC | 24" Monitor JTA2017010045 |
| **7** | Pronk Tech | OxiTest Ox-2 | 1.5 | DC | SpO2 simulator S/N OX5497 |
| **8** | Biotek | LionHeart2 | 9 | DC | ECG simulator S/N 158997 |

## 3.6. Support Equipment Cables / Transducers

| Diagram Block # | Manufacturer | Model/Part # | Length (m) | Shield Y/N | Description/Function |
|---|---|---|---|---|---|
| **D** | N/A | N/A | Various | N | Cat 5 UTP LAN cable |



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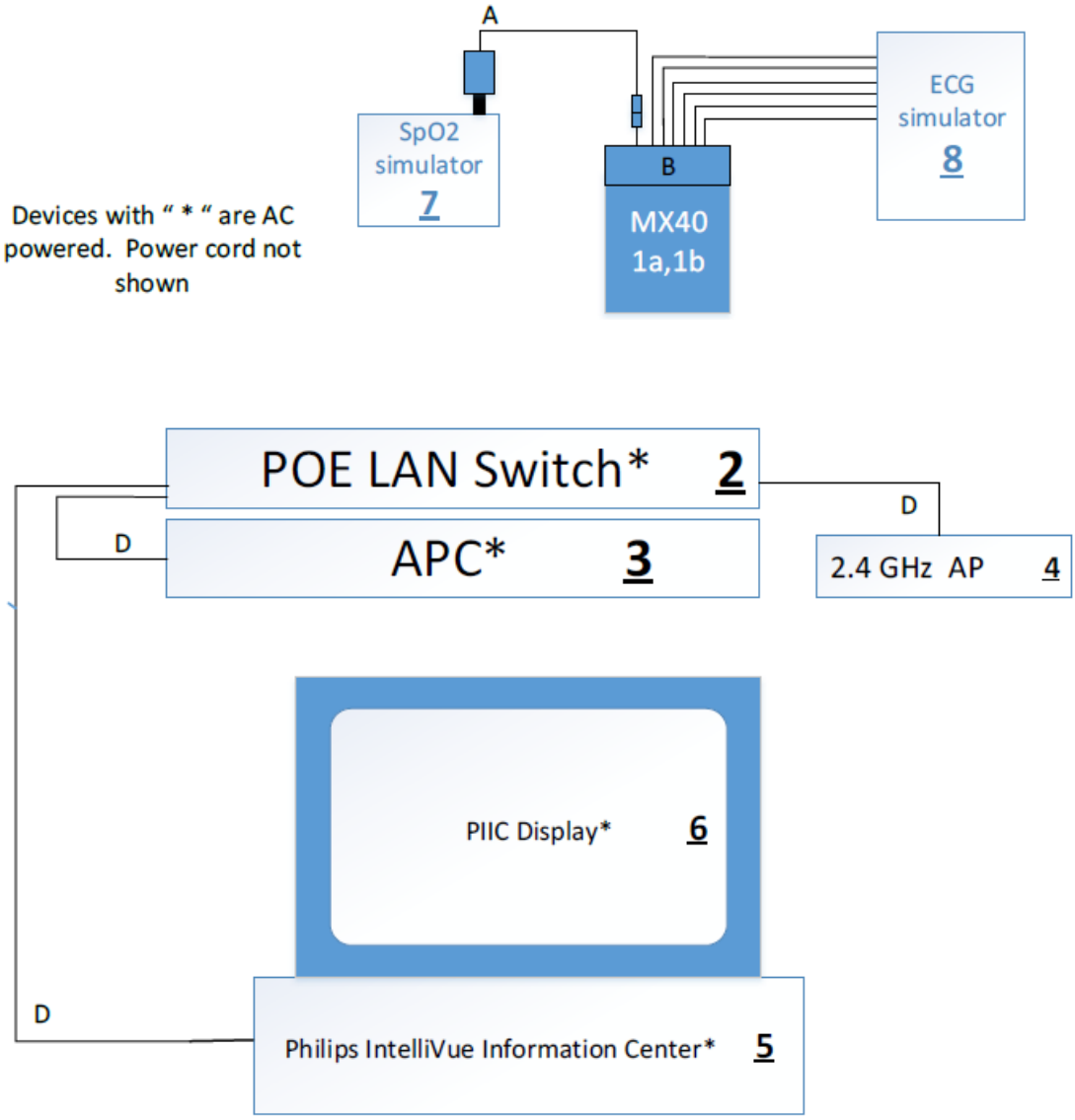
## 3. Product Configuration (continued)

### 3.7. Block Diagram



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# 4. Measurements Parameters

## 4.1. Measurement Equipment Used to Perform Test

| Device | Manufacturer | Model No. | Serial No. | Cal Due | Interval |
|---|---|---|---|---|---|
| EMI Test Receiver, 9kHz - 7GHz [1] | Rohde & Schwarz | ESR7 | 101156 | 10/16/2022 | 2 Years |
| EMI Test Receiver, 10 Hz - 7GHz [1] | Rohde & Schwarz | ESR7 | 101770 | 7/17/2022 | 2 Years |
| Spectrum Analyzer, 2 Hz to 26.5 GHz[2] | Rohde & Schwarz | FSW26 | 102057 | 9/13/2021 | 3 Years |
| Spectrum Analyzer, 9 kHz to 40 GHz[3] | Rohde & Schwarz | FSV40 | 100899 | 8/12/2022 | 2 Years |
| Spectrum Analyzer 10 Hz – 40 GHz4 | Rohde & Schwarz | FSVR40 | 100909 | 9/18/2022 | 2 Years |
| Loop Antenna 9 kHz - 30 MHz | EMCO | 6512 | 9309-1139 | 1/28/2022 | 3 Years |
| Biconilog Antenna, 30 MHz - 2 GHz | Sunol Sciences | JB1 | A050913 | 6/5/2021 | 2 Years |
| Dbl Ridged Guide Antenna 1- 18 GHz | ETS-Lindgren | 3117 | 00143292 | 3/21/2022 | 2 Years |
| Horn Antenna, 18 to 40 GHz | Com-Power | AH-840 | 101032 | 9/28/2021 | 3 Years |
| Preamplifier, 1 GHz to 26.5 GHz | Hewlett Packard | 8449B | 3008A01323 | 9/11/2021 | 3 Years |
| Power Splitter/Combiner, to 4.2 GHz | RF Bay, Inc. | 4195 | 14110124 | 6/16/2021 | 1 Year |
| Power Splitter/Combiner, 1-26.5 GHz | Mini Circuits | ZC2PD-01263-S+ | 961225 | 4/1/2022 | 1 Year |
| Digital Barometer | Control Company | 4195 | ID236 | 4/30/2021 | 3 Years |
| Digital Multimeter with Temp Probe | Fluke | 187 | 80350579 | 9/18/2021 | 1 Year |
| Temperature Chamber | Associated Environmental | SD-308 | 10782 | CNR | N/A |

[1] ESR7 Firmware revision: V3.48 SP3, Date installed: 09/30/2020 Previous V3.48 SP2, installed 07/23/2020.
[2] FSW26 Firmware revision: V4.71 SP1, Date installed: 11/16/2020 Previous V4.61, installed 08/11/2020.
[3] FSV40 Firmware revision: V2.30 SP4, Date installed: 05/04/2016 Previous V2.30 SP1, installed 10/22/2014.
[4] FSVR40 Firmware revision: V2.23 SP1, Date installed: 08/19/2016 Previous V2.23, installed 10/22/2014.

## 4.2. Software Used to Perform Test

| Manufacturer | Software Description | Title or Model # | Rev. | Report Sections |
|---|---|---|---|---|
| Compliance Worldwide | Test Report Generation Software | Test Report Generator | 1.0 | Not required for the equipment under test |



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# 4. Measurements Parameters

## 4.3. Measurement & Equipment Setup

| | |
|---|---|
| Test Dates: | 11/4/2020 - 11/20/2020, 4/7/2021 |
| Test Engineers: | Brian Breault, Sean Defelice |
| Normal Site Temperature (15 - 35°C): | 21.2 |
| Relative Humidity (20 -75%RH): | 35 |
| Frequency Range: | 10 kHz to 25 GHz |
| Measurement Distance: | 3 Meters |
| EMI Receiver IF Bandwidth: | 200 Hz - 9 kHz to 150 kHz<br>9 kHz - 150 kHz to 30 MHz<br>120 kHz - 30 MHz to 1 GHz<br>1 MHz - Above 1 GHz |
| EMI Receiver Average Bandwidth: | ≥3 x RBW (IFBw) |
| Detector Function: | Peak, Quasi-Peak & average |



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# 4. Measurements Parameters

## 4.4. Measurement Procedure

Testing was performed in accordance with the requirements detailed in ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices. In addition, FCC OET 558074, D01: 15.247 Measurement Guidance v05r02, April 2, 2019 was referenced for the testing detailed in this report.

Test measurements were made in accordance with FCC Part 15.247, ANSI C63.10-2013 and ISED RSS-247 Annex A.

The test methods used to generate the data in this test report is in accordance with ANSI C63.10-2013, American National Standard for Testing Unlicensed Wireless

The device under test can utilize 48 channels. In accordance with ANSI C63.10, section 5.6, three channel frequencies were selected for measurement:

| | |
|---|---|
| Channel 0 | 2401.056 MHz (Low) |
| Channel 24 | 2442.520 MHz (Middle) |
| Channel 47 | 2482.252 MHz (High) |

During all radiated mode measurement testing, the MX40 was mounted on a polystyrene form to facilitate rotating the device through three orthogonal axes as required by ANSI C63.10-2013, section 5.10.1, for a handheld or body worn device. The three axes were defined as follows:

X-Axis Horizontal with the top of the MX40 facing to the left. The front of MX40 was facing the antenna at 0º turntable azimuth.

Y-Axis Vertical with the top of MX40 facing up. The front of the MX40 was facing the antenna at 0º turntable azimuth.

Z-Axis The front of the MX40 was facing up. The bottom of the MX40 was facing the antenna at 0º turntable azimuth.

X-Axis

Y-Axis

Z-Axis



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# 4. Measurements Parameters

## 4.5. Measurement Uncertainty

The following uncertainties are expressed for an expansion/coverage factor of K=2.

| | |
|---|---|
| RF Frequency | $\pm$ 1x10$^{-8}$ |
| Radiated Emission of Transmitter | $\pm$ 4.55 dB |
| Radiated Emission of Receiver | $\pm$ 4.55 dB |
| Temperature | $\pm$ 0.91$^{o}$ C |
| Humidity | $\pm$ 5% |

# 5. Choice of Equipment for Test Suits

## 5.1 Choice of Model

This test report is based on the test sample supplied by the manufacturer and is reported by the manufacturer to be equivalent to the production units.

## 5.2 Presentation

This test sample was tested complete with all required ancillary equipment. Refer to Section 3 of this report for product equipment configuration.

## 5.3 Choice of Operating Frequencies

The Philips MX40 IntelliVue Patient Worn Monitor, as tested, utilizes 48 channels. Refer to Section 4.3 for the selected test frequencies.

## 5.4 Modes of Operation

The Philips MX40 IntelliVue Patient Worn Monitor has a single mode of operation which is determined by the system software.



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## 6. Measurement Summary

| Test Requirement | FCC Rule Reference | IC Rule Reference | Test Report Section | Result |
|---|---|---|---|---|
| Antenna Requirement | 15.203 | RSS-GEN 7.1.2 | 7.1 | Compliant |
| Minimum 6 dB Bandwidth | 15.247 (a) (2) | RSS-247 5.2 (1) | 7.2 | Compliant |
| Bandwidth of Momentary Signals (99% Bandwidth) | N/A | RSS-GEN 4.6.1 | 7.3 | Compliant |
| Maximum Peak Conducted Output Power | 15.247 (b) (1) | RSS-247 5.4 (4) | 7.4 | Compliant |
| Operation with directional antenna gains greater than 6 dBi | 15.247 (b) (4) | RSS-GEN 7.1.2 | 7.5 | N/A |
| Spurious Radiated Emissions | 15.247 (d) | RSS-GEN 8.9 | 7.6 | Compliant |
| Emissions in Non-Restricted Frequency Bands | 15.247 (d) | RSS-247 5.5 | 7.7 | Compliant |
| Harmonic Emissions in the Restricted Bands of Operation | 15.247 (d) | N/A | 7.8 | Compliant |
| Band Edge and Restricted Band Measurements | 15.247 (d) | RSS-247 5.5 | 7.9 | Compliant |
| Peak Power Spectral Density | 15.247(e) | RSS-247 5.2 (2) | 7.10 | Compliant |
| Duty Cycle Correction Factor | 15.247(e) | RSS-247 5.2 (2) | 7.11 | Compliant |
| Public Exposure to Radio Frequency Energy Levels | 15.247(i) 1.1307 (b) (1) | RSS-GEN 5.5 RSS-102 | 7.12 | Compliant |



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# 7. Measurement Data

## 7.1. Antenna Requirement (15.203, RSS-GEN 7.1.2)

Requirement: 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.

Status: The MX40 utilizes internal, inaccessible antennas. The housing of the device under test is completely sealed.

## 7.2. Minimum 6 dB Bandwidth (15.247 (a) (2), RSS-247 5.2(1))

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

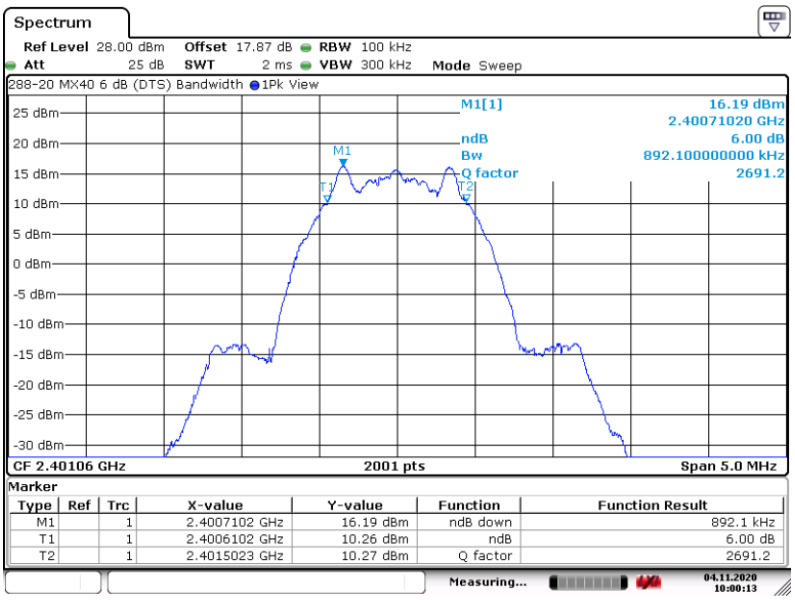
Procedure: Performed in accordance with FCC 558074 D01 DTS Measurement Guidance, v05r02, April 2, 2019, §8.2: DTS bandwidth.

Conclusion: The device under test meets the minimum 500 kHz 6 dB bandwidth requirement.

Measurement Results - Minimum 6 dB Bandwidth

| Channel | Frequency (MHz) | -6 dB Bandwidth (kHz) | Min. -6 dB Bandwidth (kHz) | Result |
|---|---|---|---|---|
| Low | 2401.060 | 892.1 | >500 | Compliant |
| Middle | 2442.520 | 867.1 | >500 | Compliant |
| High | 2482.252 | 869.6 | >500 | Compliant |

### 7.2.1. -6 dB Bandwidth, Low Channel 0



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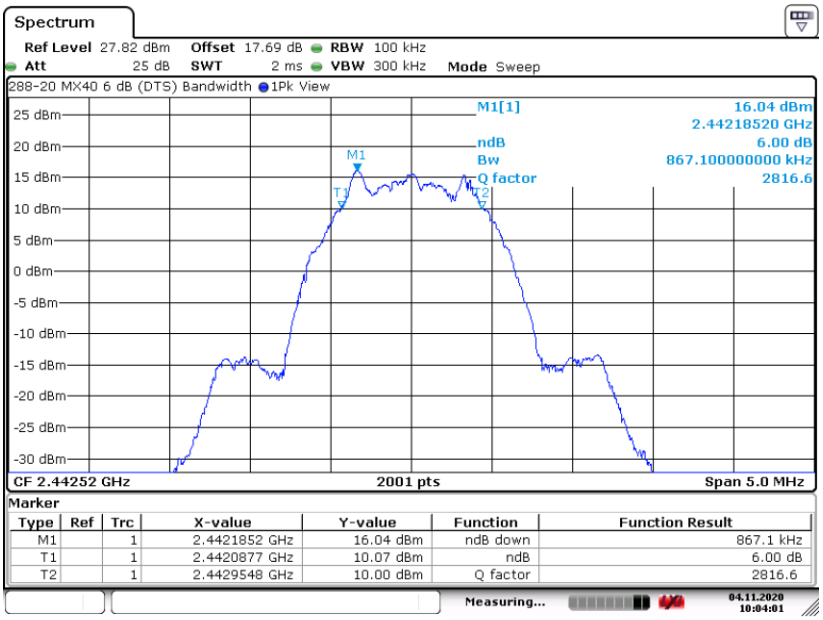
# 7. Measurement Data

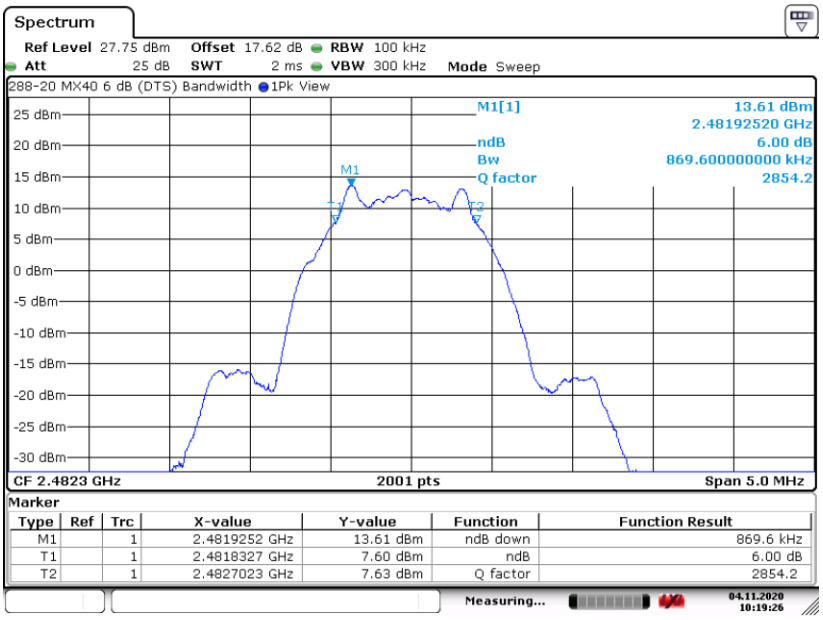
## 7.2. Minimum 6 dB Bandwidth (15.247 (a) (2), RSS-247 5.2 (1)) (continued)

### 7.2.2. -6 dB Bandwidth, Middle Channel 24




Date: 4.NOV.2020 10:04:01

### 7.2.3. -6 dB Bandwidth, High Channel 47




Date: 4.NOV.2020 10:19:26



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# 7. Measurement Data (continued)

## 7.3. Bandwidth of Momentary Signals

Requirement: When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99% emission bandwidth, as calculated or measured.
The resolution bandwidth shall be set to as close to 1% of the selected span as is possible without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth.

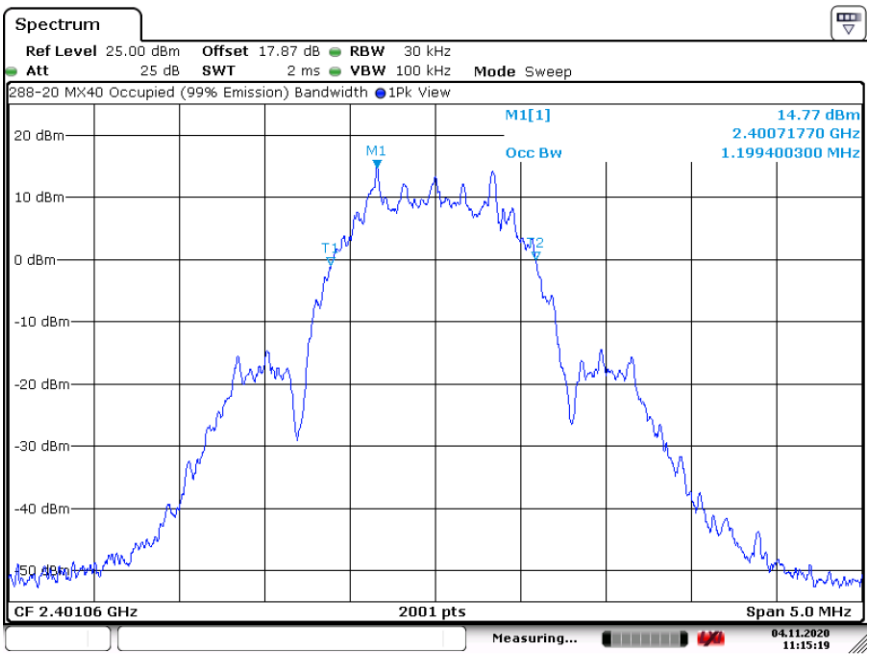
Procedure: This test was performed utilizing the automated 99% bandwidth function of the spectrum analyzer.

Conclusion: Compliant, for informational purposes.

Measurement Results - 99% Bandwidth

| Channel | Channel Frequency (MHz) | 99% Power Bandwidth (MHz) |
|---|---|---|
| Low | 2401.060 | 1.1994 |
| Middle | 2442.520 | 1.1919 |
| High | 2482.252 | 1.1969 |

7.3.1. 99% Bandwidth, Low Channel 0




Date: 4.NOV.2020 11:15:19



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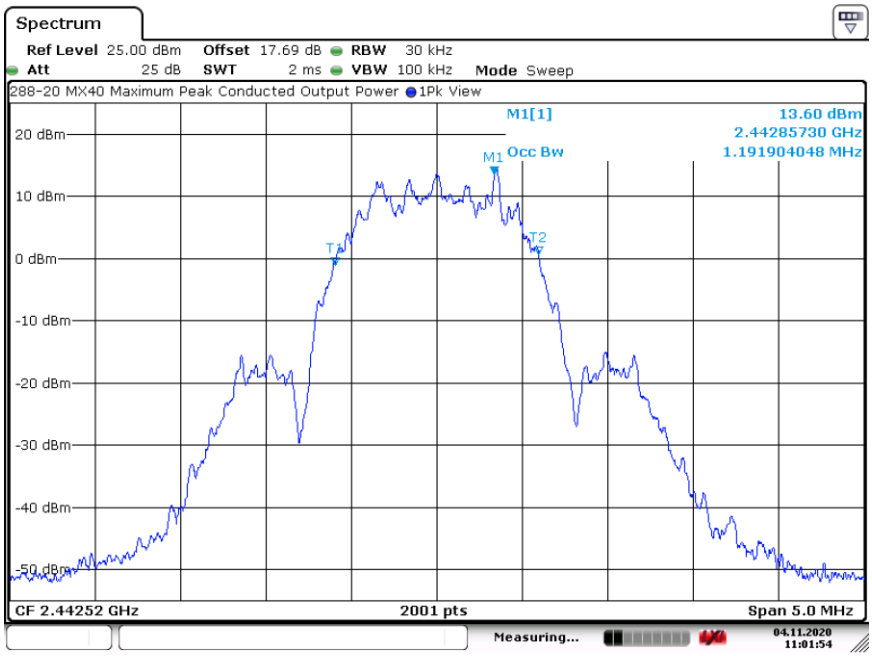
# 7. Measurement Data (continued)

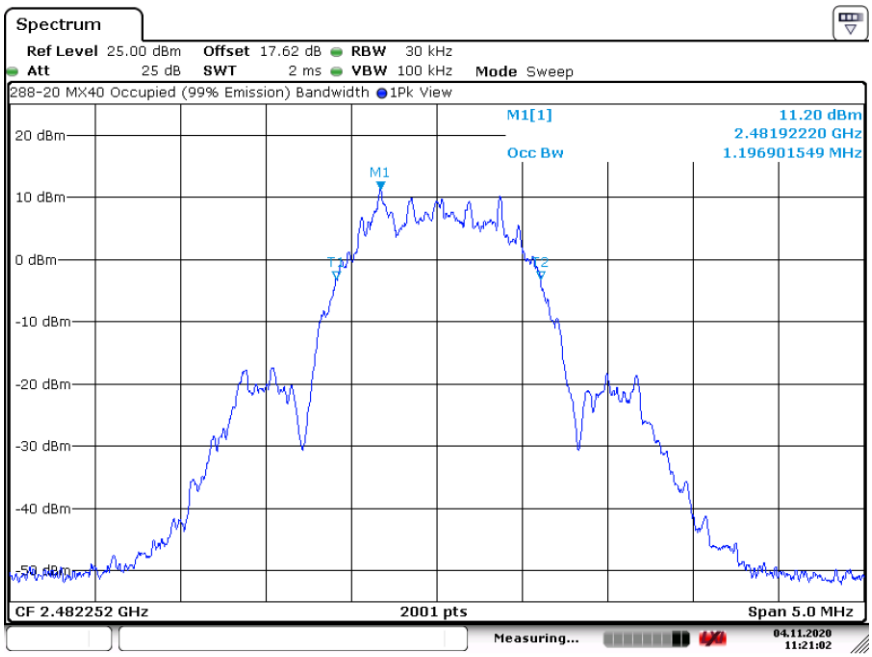
## 7.3. Bandwidth of Momentary Signals

### 7.3.2. 99% Bandwidth, Middle Channel 24




Date: 4.NOV.2020 11:01:54

### 7.3.3. 99% Bandwidth, High Channel 47




Date: 4.NOV.2020 11:21:02



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# 7. Measurement Data (continued)

## 7.4. Maximum Peak Conducted Output Power (15.247 (b) (1), RSS-247 5.4 (4))

Requirement: The maximum peak conducted output power of the intentional radiator shall not exceed the following: For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt.

Procedure: FCC 558074 D01 DTS Measurement Guidance, v05r02, April 2, 2019, Section 8.3.1: Maximum peak conducted output power, RBW ≥ DTS bandwidth, was referenced for the maximum peak conducted output power measurements detailed in this section of this report.

Test Notes: The maximum peak conducted output power measurements were performed as conducted mode measurements. All insertion loss factors are included in the test measurements and factored as amplitude offset values.

EIRP Measurement Results

| Frequency | Measured Peak Output Power | | Output Power Limit | Result |
|---|---|---|---|---|
| (MHz) | (dBm) | (mW) | (mW) | |
| 2401.060 | 16.86 | 48.53 | 1000.0 | Compliant |
| 2442.520 | 16.57 | 45.39 | 1000.0 | Compliant |
| 2482.252 | 14.20 | 26.30 | 1000.0 | Compliant |



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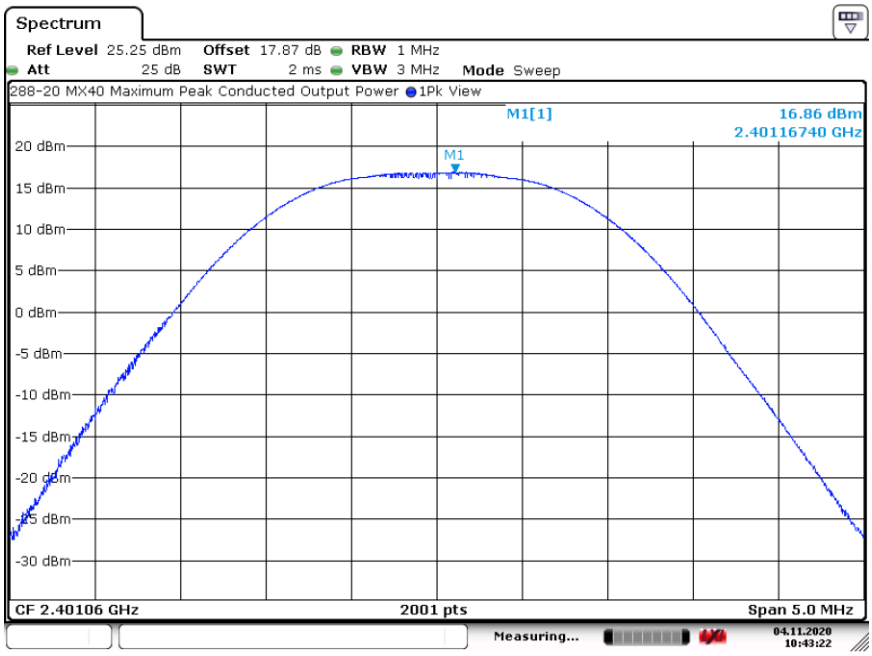
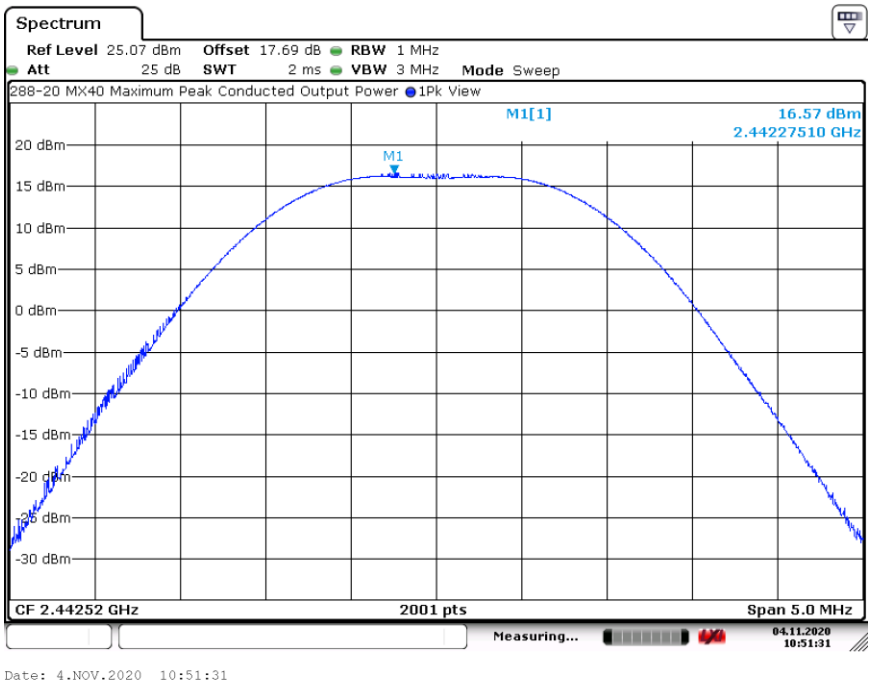
# 7. Measurement Data (continued)

## 7.4. Maximum Peak Conducted Output Power (15.247 (b) (3), RSS-247 5.4 (4)) (cont.)

### 7.4.1. Maximum Peak Field Strength, Low Channel 0




### 7.4.2. Maximum Peak Field Strength, Middle Channel 24



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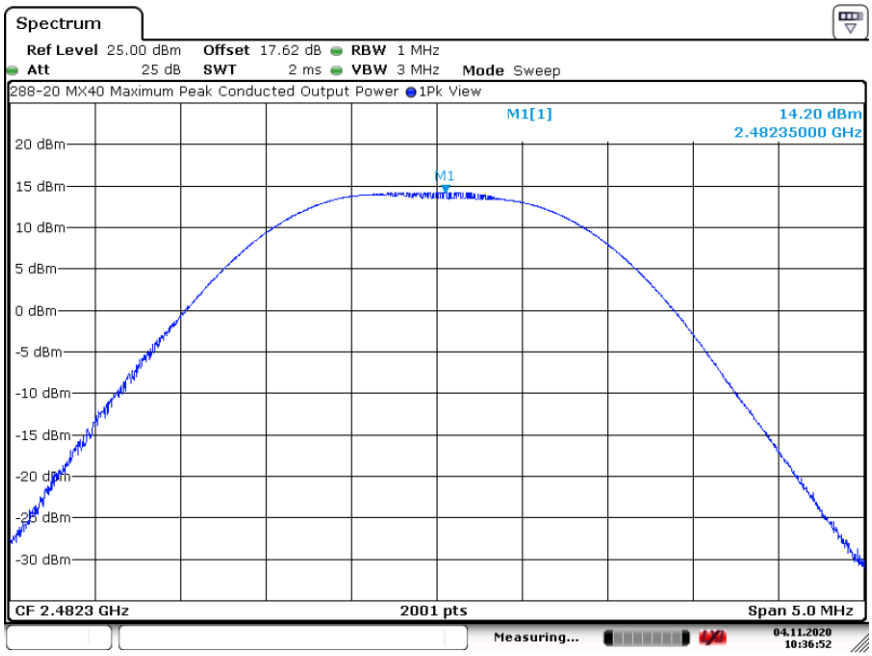
# 7. Measurement Data (continued)

## 7.4. Maximum Peak Conducted Output Power (15.247 (b) (3), RSS-247 5.4 (4)) (cont.)

### 7.4.3. Maximum Peak Field Strength, High Channel 47



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## 7. Measurement Data (continued)

### 7.5. Operation with directional antenna gains greater than 6 dBi (15.247 (b)(4))

Requirement: If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of FCC Part 15.247, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 2400 – 2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

Conclusion: Based on the antenna manufacturer's specifications, the antenna used with the DUT has a gain of -3.00 dBi Omni-directional pattern. Therefore Part 15.247, section (b)(4)) does not apply.



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# 7. Measurement Data (continued)

## 7.6. Transmitter Spurious Radiated Emissions (30 kHz to 30 GHz)

Requirement: (15.209) The Emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

| Frequency Range (MHz) | Distance (Meters) | Limit (dBµV/m) |
|---|---|---|
| 0.009 to 0.490 | 3 | 128.5 to 93.8 |
| 0.490 to 1.705 | 3 | 73.8 to 63.0 |
| 1.705 to 30 | 3 | 69.5 |
| 30 to 88 | 3 | 40.0 |
| 88 to 216 | 3 | 43.5 |
| 216 to 960 | 3 | 46.0 |
| >960 | 3 | 54.0 |

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

Procedure: This test was performed in accordance with the procedure detailed in ANSI C63.10:2013, section 6.3: Radiated emissions testing—general requirements and FCC 47 CFR Part 15.209: Radiated Emission Limits; General Requirements.

Test measurements were made in accordance with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

Test Note: The measurements were performed with the device in three orthogonal positions in accordance with ANSI C63.10-2013, sections 5.10.1. Reference section 4.3 of this report for additional information.

Conclusion: The Emissions from the DUT did not exceed the FCC Part 15,209 field strength levels specified in the above table. Reference Appendix A for the transmitter spurious emission data.

Worst Case Measurements

| Range | Frequency | Peak Field Strength | FCC 15.209 Limit | Margin | Result | Appendix A Reference |
|---|---|---|---|---|---|---|
| (MHz) | (MHz) | (dBµV/m) | (dBµV/m) | (dB) | | |
| 0.03 to 0.15 | 0.0303 | 69.56 | 117.960 | -48.40 | Compliant | A1.3.9 |
| 0.15 to 30.0 | 0.1725 | 64.05 | 82.840 | -18.79 | Compliant | A2.1.8 |
| 30 to 1000 | 953.58 | 39.85 | 46.000 | -6.15 | Compliant | A3.1.3 |
| 1000 to 2400 | 2296.28 | 42.35 | 54.000 | -11.65 | Compliant | A4.2.3 |
| 2483.5 to 10000 | 11960.27 | 44.95 | 54.000 | -9.05 | Compliant | A5.1.1 |
| 10000 to 18000 | 17024.46 | 44.91 | 54.000 | -9.09 | Compliant | A6.1.5 |
| 18000 to 25000 | 24162.67 | 47.11 | 54.000 | -6.89 | Compliant | A7.1.1 |



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# 7. Measurement Data (continued)

## 7.7. Emissions in Non-Restricted Frequency Bands (15.247(d), RSS-247 5.4 (5))

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

Procedure: The procedure detailed in FCC 558074 D01 DTS Measurement Guidance, v05r02, April 2, 2019, Section 8.5: DTS Emissions in non-restricted frequency bands was used to perform the following measurements.

Test Notes: Reference Section 7.2, Screen Capture 7.2.3 for the in-band reference used to set the -20 dB limit for the measurements taken in this section. The Channel 26 100 kHz measurement level of 82.13 dBµV/m was used as the reference for the out of band measurements.

Reference Appendix B for the emissions in non-restricted frequency bands screen captures.

Worst Case Measurements

| Range | Frequency | Peak Power | W/C In-Band -20 dB | Margin | Result | Appendix B Reference |
|---|---|---|---|---|---|---|
| (MHz) | (MHz) | (dBm) | (dBm) | (dB) | | |
| 30 to 2400 | 2399.925 | -14.96 | 16.19 | -31.15 | Compliant | 1.1 |
| 2483.5 to 12000 | 2484.325 | -51.38 | 16.19 | -67.57 | Compliant | 3.2 |
| 12000 to 20000 | 19769.266 | -53.03 | 16.19 | -69.22 | Compliant | 2.3 |
| 20000 to 25000 | 20205.93 | -53.96 | 16.19 | -70.15 | Compliant | 2.4 |



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# 7. Measurement Data (continued)

## 7.8. Harmonic Emissions in the Restricted Bands of Operation (15.247 (d))

Measurement Results – Worst Case Harmonic Emissions

| Freq. (MHz) | Field Strength (dBµV/m) | Duty Cycle Correction | Field Strength (dBµV/m) | Limit (dBµV/m) | | Margin (dBµV/m) | | Antenna Polarity | Result |
|---|---|---|---|---|---|---|---|---|---|
| | Peak | | Average | Peak | Average | Peak | Average | (H/V) | |
| 4802.120 | 54.59 | -18.82 | 35.77 | 74.00 | 54.00 | -19.41 | -18.23 | H | Compliant |
| 4885.040 | 54.40 | -18.82 | 35.58 | 74.00 | 54.00 | -19.60 | -18.42 | H | Compliant |
| 4964.504 | 53.42 | -18.82 | 34.60 | 74.00 | 54.00 | -20.58 | -19.40 | V | Compliant |
| 7327.560 | 52.19 | -18.82 | 33.37 | 74.00 | 54.00 | -21.81 | -20.63 | H | Compliant |
| 7446.756 | 52.51 | -18.82 | 33.69 | 74.00 | 54.00 | -21.49 | -20.31 | V | Compliant |
| 12005.300 | 59.62 | -18.82 | 40.80 | 74.00 | 54.00 | -14.38 | -13.20 | H | Compliant |
| 12212.600 | 60.27 | -18.82 | 41.45 | 74.00 | 54.00 | -13.73 | -12.55 | V | Compliant |
| 12411.260 | 59.72 | -18.82 | 40.90 | 74.00 | 54.00 | -14.28 | -13.10 | V | Compliant |
| 19208.480 | 60.28 | -18.82 | 41.46 | 74.00 | 54.00 | -13.72 | -12.54 | V | Compliant |
| 19540.160 | 60.68 | -18.82 | 41.86 | 74.00 | 54.00 | -13.32 | -12.14 | H | Compliant |
| 19858.016 | 61.43 | -18.82 | 42.61 | 74.00 | 54.00 | -12.57 | -11.39 | H | Compliant |
| 22340.268 | 61.87 | -18.82 | 43.05 | 74.00 | 54.00 | -12.13 | -10.95 | H | Compliant |

**Note**: A Duty Cycle correction value for each fundamental frequencies tested in Section 7.11 of this report was used to determine the average value for pulsed emissions for the device.



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## 7. Measurement Data (continued)

### 7.9. Band Edge and Restricted Band Measurements (15.247 d))

Requirement: Lower Band Edge

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. Attenuation below the general limits specified in Section 15.209(a) is not required.

Upper Band Edge

Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a).

Procedures: Lower Band Edge - ANSI C63.10:2013, section 6.10.4: Authorized-band band-edge measurements (-20 dB delta relative method).

Upper Band Edge – ANSI C63.10:2013, section 6.10.5: Restricted-band edge, marker delta method measurement. The EUT uppermost frequency falls within two standard bandwidths of the band edge.

Conclusion: The device under test meets the band edge requirements



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# 7. Measurement Data (continued)

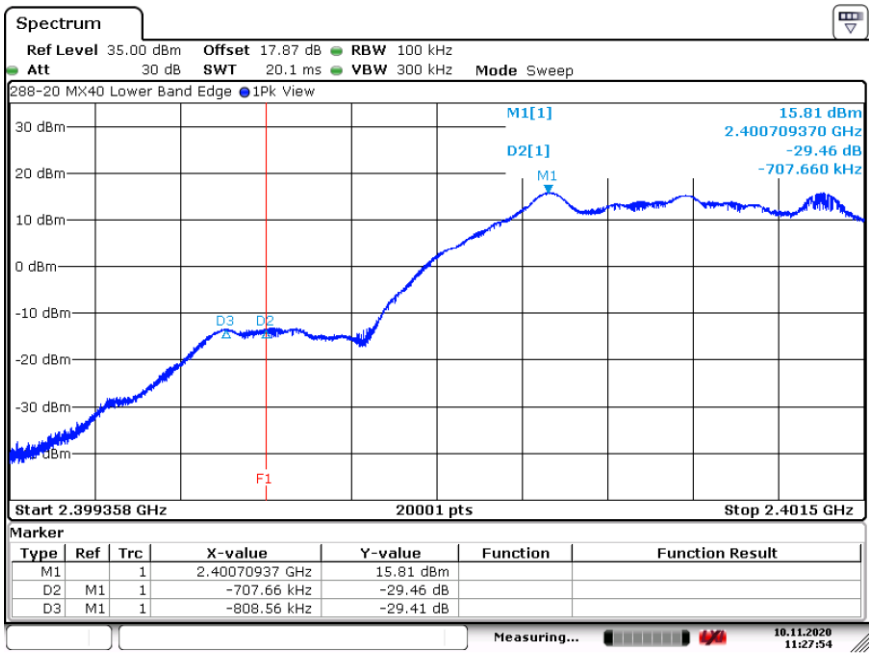
## 7.9. Band Edge and Restricted Band Measurements (15.247 d))

### 7.9.1. Lower Band Edge

Measurement Results

| Lowest Channel (MHz) | In-Band Peak Measurement (dBm) | | Band Edge Frequency (MHz) | Band Edge Measurement (dBm) | | Required Offset (dB) | Actual Offset (dB) | Result |
|---|---|---|---|---|---|---|---|---|
| | Peak | Average | | Peak | Average | | | |
| 2401.060 | 15.81 | --- | 2400 | -29.46 | --- | >20 | 45.27 | Compliant |

#### 7.9.1.1. Lower Band Edge

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# 7. Measurement Data (continued)

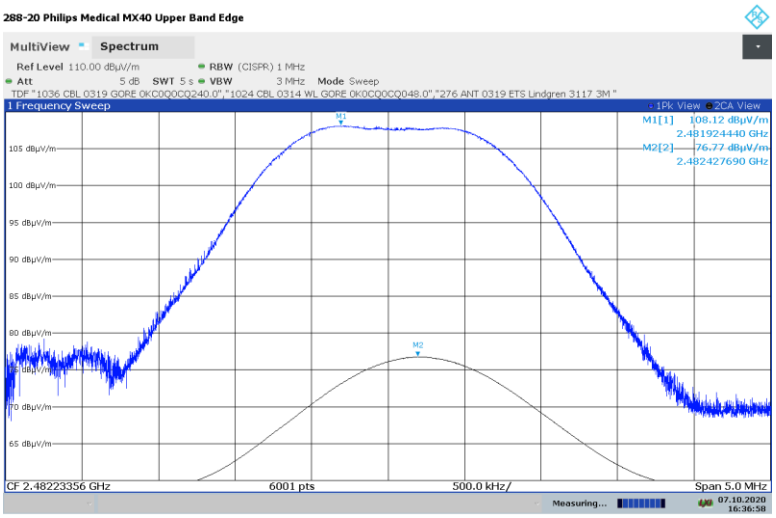
## 7.9. Band Edge and Restricted Band Measurements (15.247 d))

### 7.9.2. Upper Band Edge

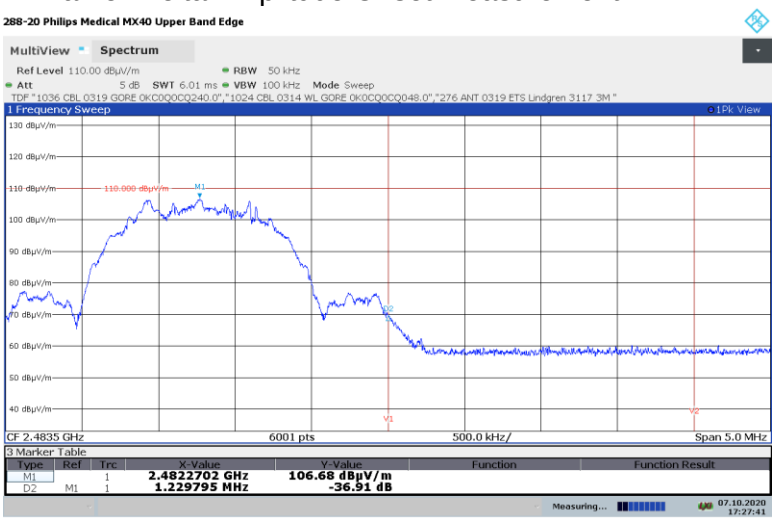
Measurement Results

| Highest Channel Frequency (MHz) | Maximum Field Strength (dBµV/m) | | 50 kHz RBW Marker Delta Amplitude Offset (dB) | Band Edge Field Strength (dBµV/m) | | FCC Part 15.209 Limit (dBµV/m) | | Margin (dB) | | Result |
|---|---|---|---|---|---|---|---|---|---|---|
| | Peak | Average | | Peak | Average | Peak | Average | Peak | Average | |
| (A) | (B) | (C) | (D) | (E) (B+D) | (F) (C+D) | (G) | (H) | (E-G) | (F-H) | |
| 2482.252 | 108.12 | 76.77 | -36.91 | 71.21 | 39.86 | 74 | 54 | -2.79 | -14.14 | Compliant |

#### 7.9.2.1. In-Band Field Strength Measurement of the Fundamental Emission




#### 7.9.2.2. Marker-Delta Amplitude Offset Measurement



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# 7. Measurement Data (continued)

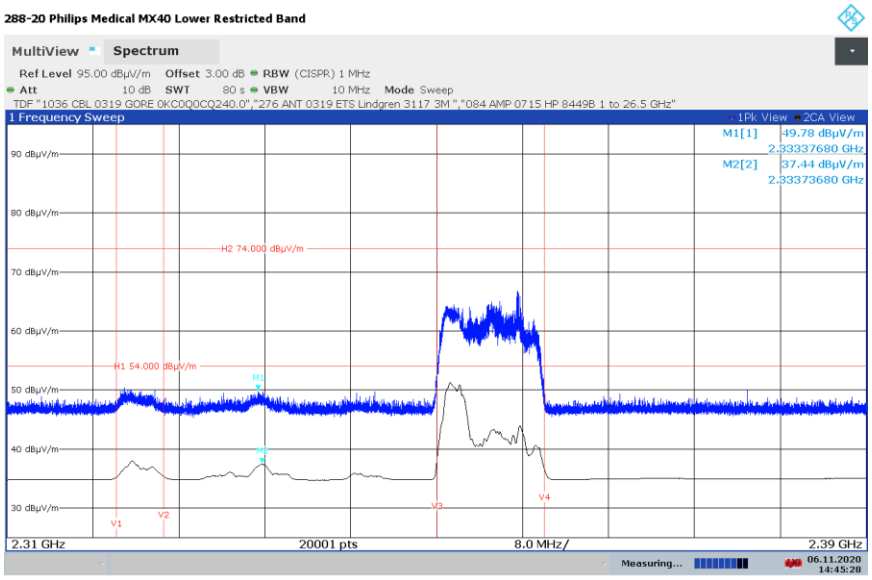
## 7.9. Band Edge and Restricted Band Measurements (15.247 d))

### 7.9.3. Lower Restricted Band

Measurement Results

| Frequency (MHz) | Field Strength (dBµV/m) | | FCC Part 15.209 Limit (dBµV/m) | | Margin (dB) | | Result |
|---|---|---|---|---|---|---|---|
| | Peak | Average | Peak | Average | Peak | Average | |
| 2333.3737 | 49.78 | 37.44 | 74.00 | 54.00 | -24.22 | -16.56 | Compliant |

#### 7.9.3.1. Lower Restricted Band




Note about the non-EUT transmissions in this band:

The emissions enclosed in the first pair of vertical markers was due to a transmission in the Wireless Communications Service (WCS) B Block (2310 MHz to 2315 MHz). The emission enclosed in the second pair of vertical markers was due to a transmission in the WCS A and B Blocks (2350 MHz to 2360 MHz). A real-time observation of the Lower Restricted Band confirmed that there were no emissions contributed by the EUT in either of these WCS Blocks during the absence of the ambient signals. However, due to the measurement time requirements of the CISPR average detector, this could not be realized on the spectrum analyzer for display purposes. Markers 1 and 2 represent the peak and CISPR average values of the worst-case emission contributed by the EUT.



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# 7. Measurement Data (continued)

## 7.9. Band Edge and Restricted Band Measurements (15.247 d))

### 7.9.4. Upper Restricted Band

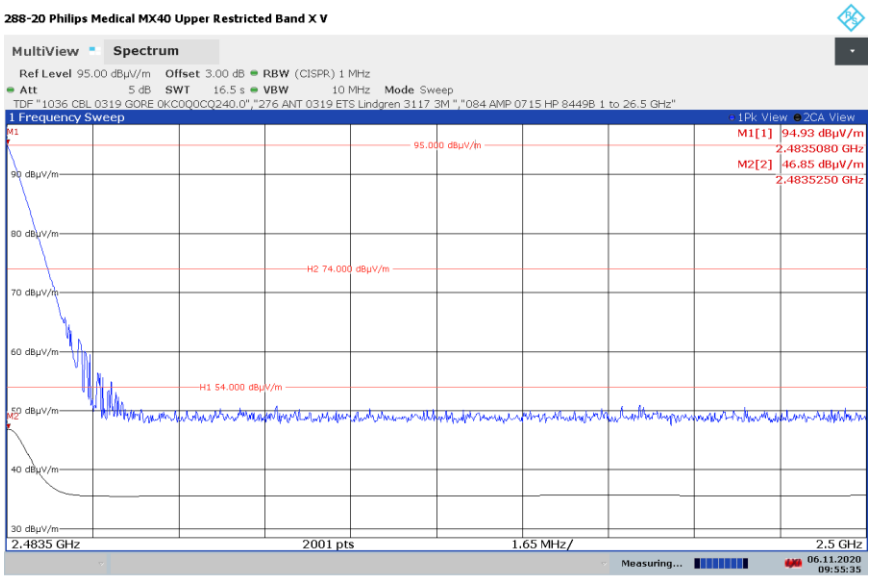
Measurement Results

| Frequency[1] (MHz) | Maximum Field Strength (dBµV/m) | | 50 kHz RBW Marker Delta Amplitude Offset (dB) | Band Edge Field Strength (dBµV/m)[2] | | FCC Part 15.209 Limit (dBµV/m) | | Margin (dB)[2] | | Result |
|---|---|---|---|---|---|---|---|---|---|---|
| | Peak | Average | | Peak | Average | Peak | Average | Peak | Average | |
| (A) | (B) | (C) | (D) | (E) (B+D) | (F) (F = C) | (G) | (H) | (E-G) | (F-H) | |
| 2483.5012 | 94.93 | 46.85 | -36.91 | 58.02 | 46.85 | 74 | 54 | -15.98 | -7.15 | Compliant |

[1] Measured frequency falls within two standard bandwidths of the restricted band edge (ANSI C63.10-2013, Section 6.10.6.1).

[2] CISPR average field strength met the 54 dBµV/m field strength limit without correction.

#### 7.9.4.1. Upper Restricted Band



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## 7. Measurement Data (continued)

### 7.10. Peak Power Spectral Density (15.247(e), RSS-247 5.2 (2))

Requirement: For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Procedure: This measurement was performed in accordance with FCC OET 558074 D01 DTS Measurement Guidance, v05r02, dated April 9, 2019, section 8.4: Method PKPSD (peak PSD).

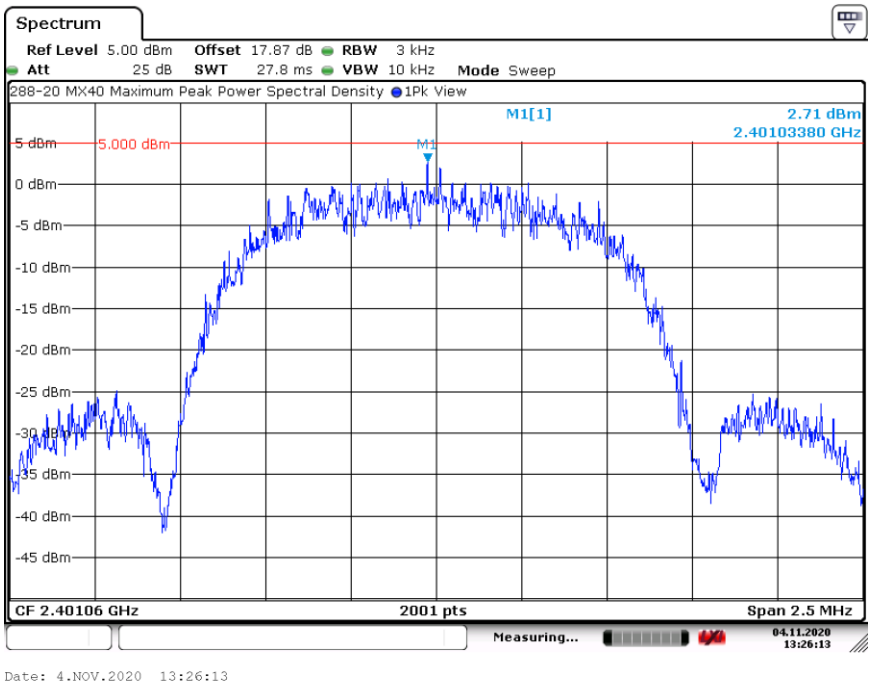
Test Notes: Conducted mode measurements were taken for this section of the report.

Conclusion: The DUT meets the Part 15.247(e) power spectral density requirement.

Measurement Results – Power Spectral Density

| Channel Frequency | Measured Frequency | Peak Power Spectral Density | Output Power Limit | Margin | Result |
|---|---|---|---|---|---|
| (MHz) | (MHz) | (dBm) | (dBm) | (dB) | |
| 2401.060 | 2401.0338 | 2.71 | 8.0 | -5.3 | Compliant |
| 2442.520 | 2442.5425 | 2.48 | 8.0 | -5.5 | Compliant |
| 2482.252 | 2482.2860 | 1.04 | 8.0 | -7.0 | Compliant |

7.10.1. Peak Power Spectral Density, Low Channel 0



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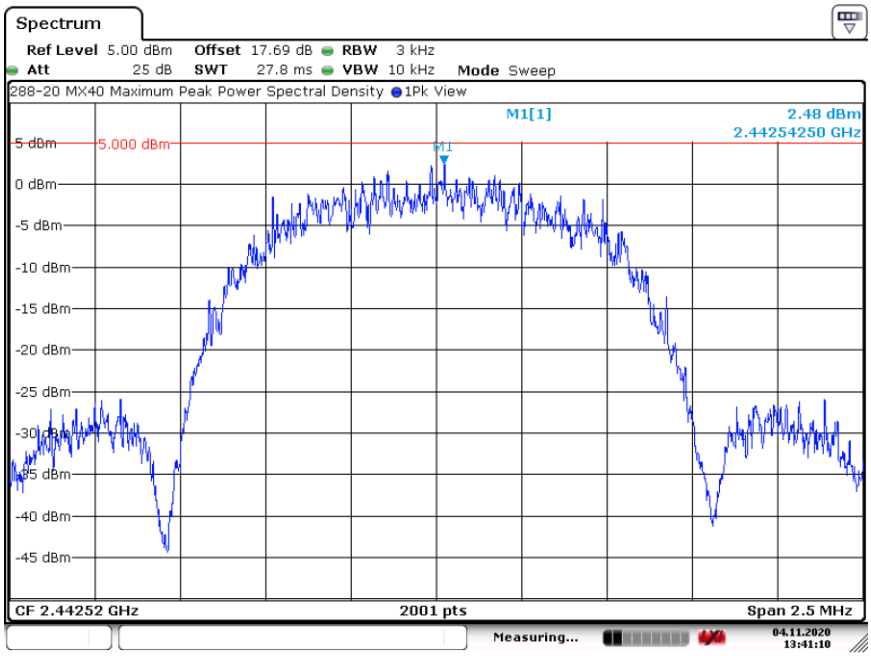
# 7. Measurement Data (continued)

## 7.10. Peak Power Spectral Density (15.247(e), RSS-247 5.2 (2)) (continued)

### 7.10.2. Peak Power Spectral Density, Middle Channel 24

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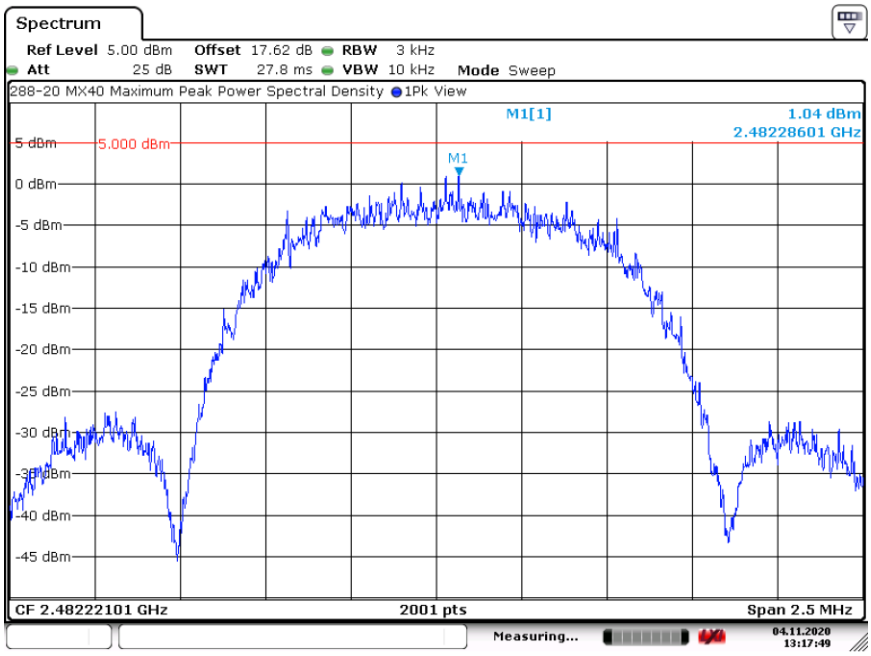
### 7.10.3. Peak Power Spectral Density, High Channel 47

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## 7. Measurement Data (continued)

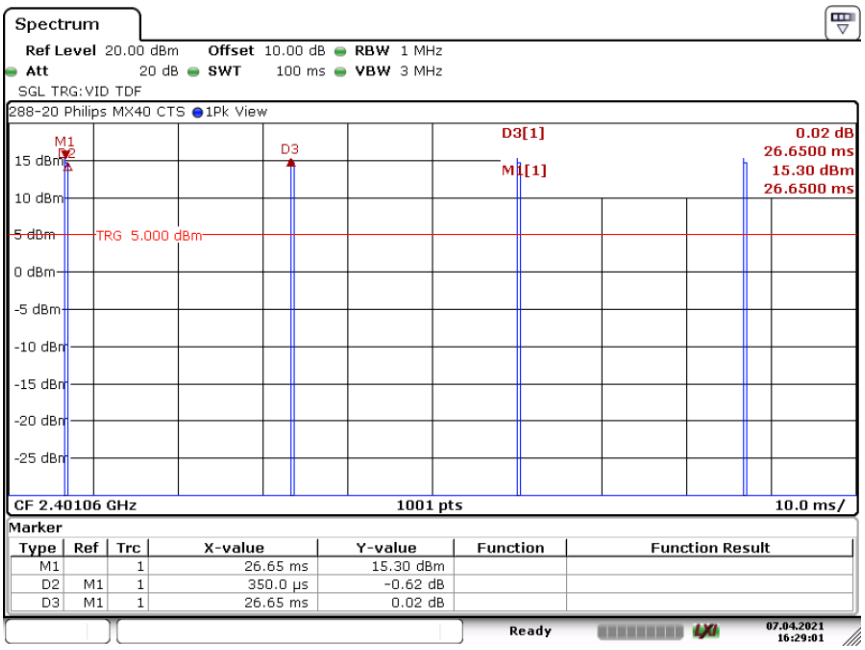
### 7.11. Duty Cycle Correction Factor

Requirement: FCC Part 15.247, Subpart C requires that the maximum peak conducted output power of the intentional radiator shall not exceed the following: For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt. However, this data does not provide the levels for determining $P_{MAX}$ in order to determine the SAR exclusion.

Procedure: The duty cycle correction was determined using the information provided in ANSI C63.10-2013, Section 7.5: Procedure for determining the average value of pulsed emissions. Note: This is the maximum duty cycle allowed by the operational software/firmware for the device.

| Channel Frequency | Time On | Time per Period | Duty Cycle (DC) | | Maximum Peak Conducted Power | Duty Cycle Correction (10 log(DC)) | Corrected Conducted Power | |
|---|---|---|---|---|---|---|---|---|
| | $T_{on}$ | $T_{on} + T_{off}$ | | | | | | |
| (MHz) | (mS) | (mS) | $T_{on}/(T_{on} + T_{off})$ | (%) | (dBm) | dB | dBm | mW |
| 2401.060 | 0.350 | 26.65 | 0.01313 | 1.3 | 16.86 | -18.82 | -1.9563 | 0.6373 |
| 2442.520 | 0.350 | 26.65 | 0.01313 | 1.3 | 16.57 | -18.82 | -2.2463 | 0.5962 |
| 2482.252 | 0.350 | 26.65 | 0.01313 | 1.3 | 14.20 | -18.82 | -4.6163 | 0.3454 |

7.11.1. $T_{on}$ and $T_{on} + T_{off}$, Lowest Channel, 0

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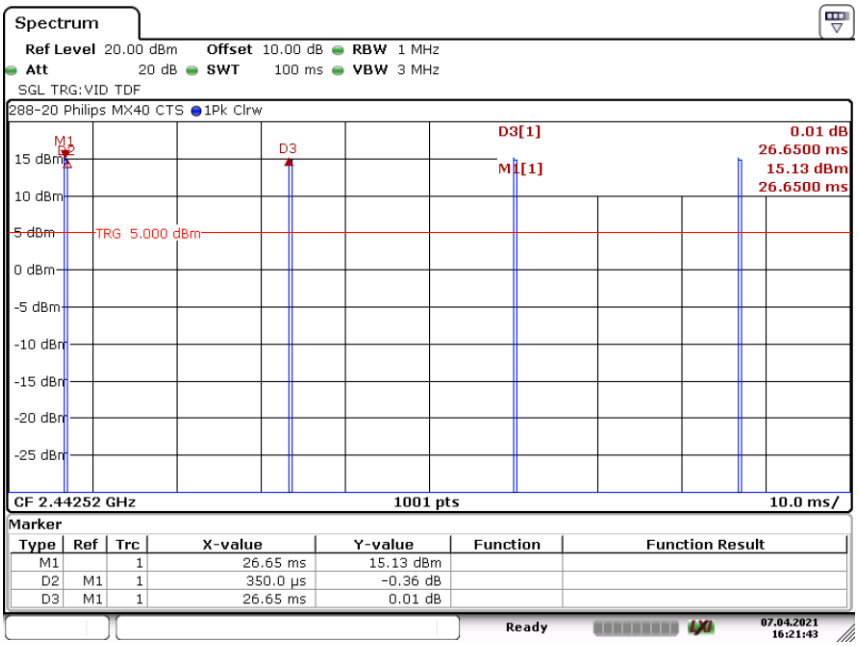
# 7. Measurement Data (continued)

## 7.11. Duty Cycle Correction Factor

### 7.11.2. $T_{on}$ and $T_{on}$ + $T_{off}$, Middle Channel, 24

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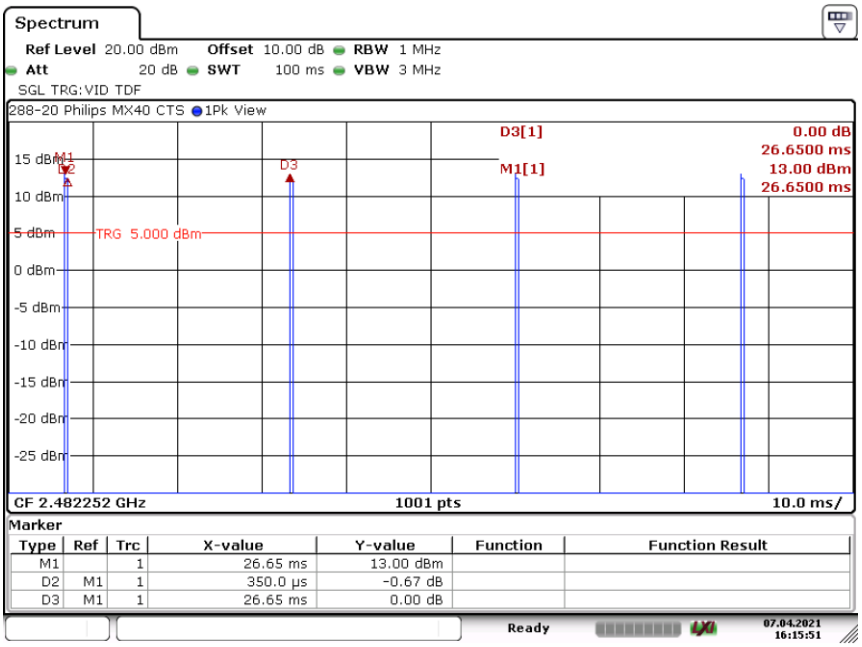
### 7.11.3. $T_{on}$ and $T_{on}$ + $T_{off}$, Upper Channel, 47

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# 7. Measurement Data (continued)

## 7.12. Public Exposure to Radio Frequency Energy Levels (15.247(i) (1.1307 (b)(1)) RSS-GEN, ISSUE 4 5.5, RSS 102)

### 7.12.1. 15.247(i) (1.1307 (b)(1) Requirements

Requirement: Portable devices are subject to radio frequency radiation exposure requirements.

For a 1-g SAR, the test exclusion result must be ≤ 3.0.

Test Notes: The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by the following formula:

$$\text{SAR Test Exclusion} = \frac{P_{MAX}}{d_{MIN}} \times \sqrt{f_{(GHz)}} \qquad (1)$$

| | | |
|---|---|---|
| $P_{MAX}$ | mW | Maximum power of channel, including tune-up tolerance |
| $d_{MIN}$ | mm | Minimum test separation distance, mm (≤ 50 mm) |
| $f_{(GHz)}$ | GHz | $f_{(GHz)}$ is the RF channel transmit frequency in GHz (>100 MHz and <6 GHz) |

(1) FCC OET 447498 - Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

Conclusion: The device under test meets the exclusion requirement detailed in FCC OET 447498.

| | | | | | |
|---|---|---|---|---|---|
| **Input:** | $P_{MAX}$[1] | (mW) | 0.6373 | 0.5962 | 0.3454 |
| | $d_{MIN}$ | (mm) | 5.00 | 5.00 | 5.00 |
| | $f_{(GHz)}$ | | 2.40106 | 2.44252 | 2.48225 |
| **Test Exclusion:** | | | **0.1975** | **0.1863** | **0.1088** |
| **Limit Exemption:** | | | **3.00** | **3.00** | **3.00** |

[1] Taken from column 9 of the table in Section 7.11 of this test report.

### 7.12.2. RSS-102 Issue 5 Requirements

Requirement: SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in Table 1. Portable devices are subject to radio frequency radiation exposure requirements.

Test Notes: The limit was taken from Table 1 of RSS-102 Issue 5.

| Frequency (MHz) | Separation Distance (mm) | Maximum Power (mW) | RSS-102 Limit (mW) | Result |
|---|---|---|---|---|
| 2401.1 | ≤5 | 0.6373 | 4.27 | Compliant |
| 2442.5 | ≤5 | 0.5962 | 4.04 | Compliant |
| 2482.3 | ≤5 | 0.3454 | 3.94 | Compliant |



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# 7. Measurement Data (continued)

## 7.12. Public Exposure to Radio Frequency Energy Levels (15.247(i) (1.1307 (b)(1)), RSS 102 Co-located Radios)

### 7.12.3. 15.247(i) (1.1307 (b)(1) Requirements

Requirement: Portable devices are subject to radio frequency radiation exposure requirements.

For a 1-g SAR, the test exclusion result must be ≤ 3.0.

Test Notes: The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by the following formula:

$$\text{SAR Test Exclusion} = \cancel{\frac{P_{MAX}}{d_{MIN}}} \times \sqrt{f_{(GHz)}} \qquad (1)$$

| | | |
|---|---|---|
| $P_{MAX}$ | mW | Maximum power of channel, including tune-up tolerance |
| $d_{MIN}$ | mm | Minimum test separation distance, mm (≤ 50 mm) |
| $f_{(GHz)}$ | GHz | $f_{(GHz)}$ is the RF channel transmit frequency in GHz (>100 MHz and <6 GHz) |

(1) FCC OET 447498 - Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

Conclusion: The device under test meets the exclusion requirement detailed in FCC OET 447498.

| | | SRR | CTS | |
|---|---|---|---|---|
| **Input:** | $P_{MAX}$ | 0.0248 | 0.6373 | |
| | $d_{MIN}$ | 5.00 | 5.00 | |
| | $f_{(GHz)}$ | 2.48 | 2.40106 | **SUM** |
| **Test Exclusion:** | | **0.0078** | **0.1975** | **0.21** |
| **Limit Exemption:** | | **3.00** | **3.00** | **3.00** |

### 7.12.4. RSS-102 Issue 5 Requirements

Requirement: SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in Table 1. Portable devices are subject to radio frequency radiation exposure requirements.

Test Notes: The limit was taken from Table 1 of RSS-102 Issue 5.

| Radio | Frequency | Separation Distance | Maximum Power | RSS-102 Limit | Result |
|---|---|---|---|---|---|
| | MHz | mm | mW | mW | |
| SRR | 2480 | ≤5 | 0.0248 | 3.94 | Compliant |
| CTS | 2401.06 | ≤5 | 0.6373 | 4.27 | Compliant |
| | | **SUM** | **0.6621** | | |



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## 8. Test Setup Images

8.1. Radiated Emissions – Front View 30 kHz to 1 GHz

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## 8. Test Setup Images

8.2. Radiated Emissions – Rear View Below 30 MHz

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## 8. Test Setup Images

8.3. Radiated Emissions – Rear View 30 MHz to 1 GHz

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## 8. Test Setup Images

8.4. Microwave Emissions – Front View Above 1 GHz

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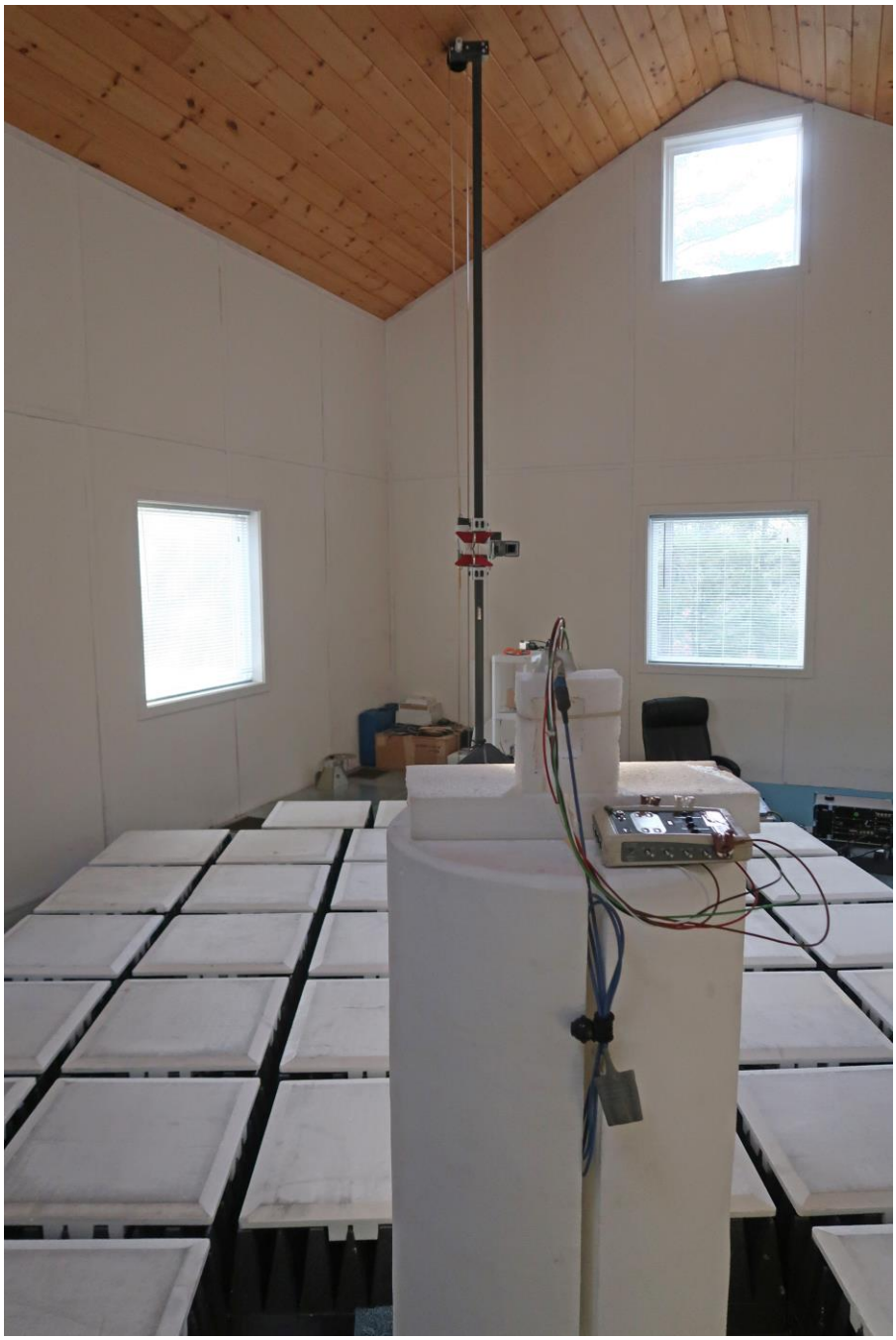
## 8. Test Setup Images

8.5. Microwave Emissions – Rear View 1GHz to 18 GHz





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## 8. Test Setup Images

8.6. Microwave Emissions – Rear View Above 18 GHz

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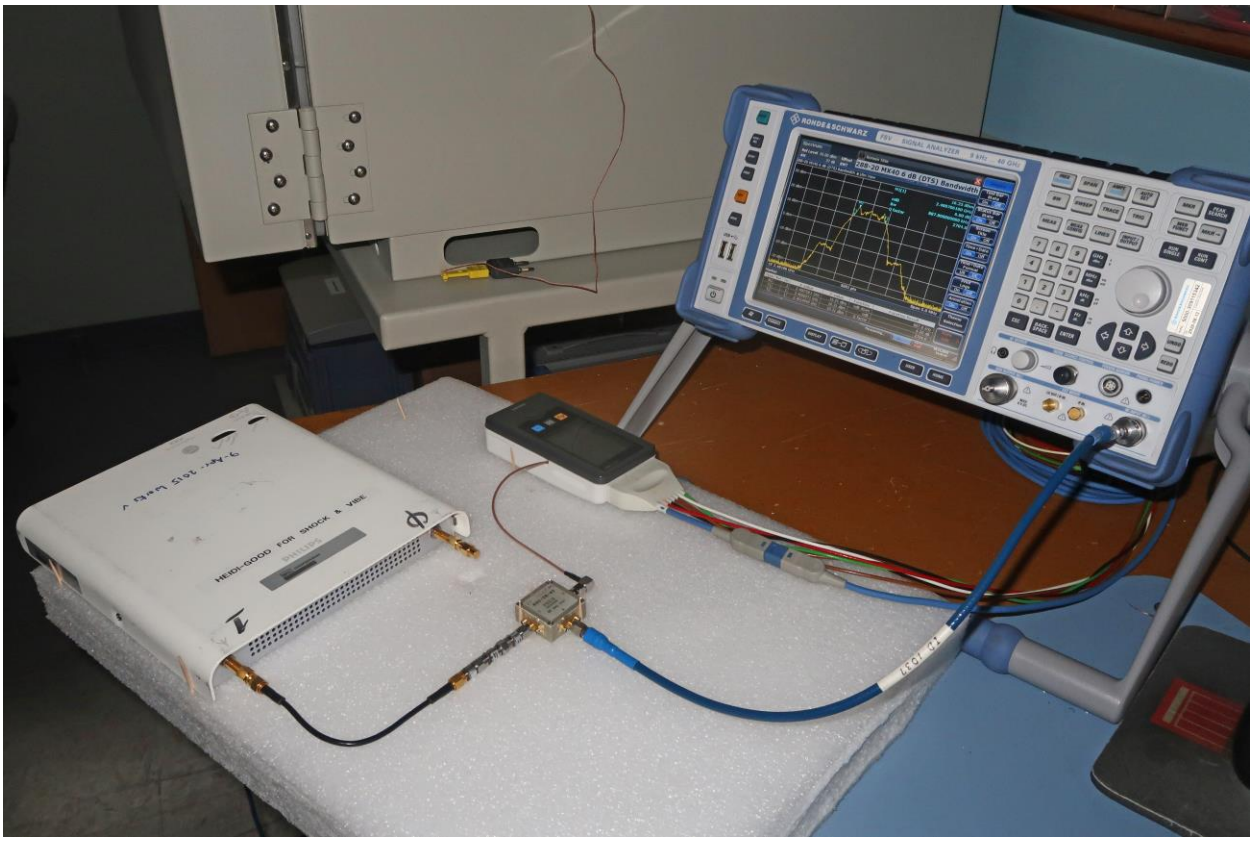
## 8. Test Setup Images

8.7. Conducted Mode Measurements



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## 9. Test Site Description

Compliance Worldwide is located at 357 Main Street in Sandown, New Hampshire. The test sites at Compliance Worldwide are used for conducted and radiated emissions testing in accordance with the Federal Communications Commission (FCC) and Industry Canada standards. Through our American Association for Laboratory Accreditation (A2LA) ISO Guide 17025 Accreditation our test sites are designated with the FCC (designation number **US1091**), Industry Canada (file number **IC 3023A-1)** and VCCI (Member number 3168) under registration number A-0274.

Compliance Worldwide is also designated as a Phase 1 CAB under APEC-MRA (US0132) for Australia/New Zealand AS/NZS CISPR 22, Chinese-Taipei (Taiwan) BSMI CNS 13438 and Korea (RRA) KN 11, KN 13, KN 14-1, KN 22, KN 32, KN 61000-6-3, KN 61000-6-4.

The radiated emissions test site is a 3 and 10 meter enclosed open area test site (OATS). Personnel, support equipment and test equipment are located in the basement beneath the OATS ground plane.

The conducted emissions site is part of a 16' x 20' x 12' ferrite tile chamber and uses one of the walls for the vertical ground plane. A second conducted emissions site is also located in the basement of the OATS site with a 2.3 x 2.5 meter ground plane and a 2.4 x 2.4 meter vertical wall.

The radiated emissions test site for measurements above 1GHz is a 3 Meter open area test site (OATS) with a 3.6 by 3.6 meter anechoic absorber floor patch to achieve a quasi-free space measurement environment per ANSI C63.4/C63.10 and CISPR 16-1-4 standards.

The sites are designed to test products or systems 1.5 meters W x 1.5 meters L x 2.0 meters H, floor standing or table top.



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