Testing Cert #1007.01

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# Atlas Compliance & Engineering, Inc.

# FCC
# Test Report

**FCC CFR 47 Part 15.207, 15.209 and 15.247 COMPLIANCE**

*Brilliant Home Technology, Inc.*
*155 Bovet Road Suite 500*
*San Mateo, CA 94402, USA*

*Product:*
*Brilliant Smart Dimmer Switch*
*Model:*
*BHS120US-WH1*

| | |
|---|---|
| FCC ID: | 2APQV-BHS120US |
| Test Report Number: | 1950BRNsw_fcc247 |
| Date of Report: | February 13, 2020 |

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# Change History

## 1950BRNsw_fcc247

| Rev. | Change Description | Reason/Application | Date | Appvd. |
|---|---|---|---|---|
| Draft | Report for review | Applies to BHS120US-WH1 | 2-13-2020 | MEB |
| C1 | Release of report | Applies to BHS120US-WH1 | 3-12-2020 | MEB |
| C2 | Removed photographs | Confidentiality | 4-14-2020 | MEB |
| C3 | Removed photographs | Confidentiality | 4-15-2020 | MEB |
| C4 | Corrected base model number | Base model number | 4-16-2020 | MEB |
| C5 | Added radiated data plots and data, KDB reference, updated conducted measurements | Review update | 5-1-2020 | MEB |
| C6 | Updated report | TCB review update | 6-4-2020 | MEB |
| C7 | Updated report | TCB review update | 6-10-2020 | MEB |
| C8 | Updated report | TCB review | 6-11-2020 | MEB |

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# General Information

| | |
|---|---|
| Test Report Number: | 1950BRNsw_fcc247 |
| Date Product Tested: | February 3-May 1, 2020 |
| Date of Report: | February 13, 2020 |
| Applicant: | Brilliant Home Technology, Inc.<br>155 Bovet Road Suite 500<br>San Mateo, CA 94402, USA |
| Contact Person | Michelle Pillainayagam |
| Equipment Tested: | Brilliant Smart Dimmer Switch |
| Transmitter Frequency: | 2402 – 2480 MHz, 40 Channels, 2 MHz spacing |
| Modulation: | GFSK |
| Trade Name: | Brilliant Home Technology, Inc. |
| Model: | BHS120US-WH1 |
| Purpose of Test: | To demonstrate the compliance of the Brilliant Smart Dimmer Switch, BHS120US-WH1, with the requirements of FCC CFR 47 Part 15 Rules and Regulations to the limits of Subpart C 15.207, 15.209 and 15.247 using the procedure stated in ANSI C63.10 and FCC KDB 558074 D01 |
| Frequency Range Investigated: | 9 KHz to 24.835 GHz |
| FRN: | 0027502764 |
| FCC ID: | 2APQV-BHS120US |
| Test Site Locations: | Field Strength Measurement Facility:<br>Atlas Compliance & Engineering, Inc.<br>726 Hidden Valley Road<br>Royal Oaks, California 95076<br>Conducted Measurement Facility:<br>Atlas Compliance & Engineering, Inc.<br>1792 Little Orchard Street<br>San Jose, California 95125 |
| Test Personnel: | Bruce Smith<br>EMC Engineer |

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# Test Equipment

**The following list contains the test equipment that was utilized in making the measurements in this report.**

| Description _ Model | Serial | Manufacturer | Calibration Due |
|---|---|---|---|
| BiLog Antenna with SA3NS-04 Attn CHL072.1 30-2000MHz _ CBL6112B | 2783 | Chase Electronics Ltd. | 1/16/22 |
| Active Loop Antenna _ 6502 | 9108-2669 | EMCO | 5/18/20 |
| Double Ridge Guide Horn Antenna 1-18GHz _ 3115 | 9003-3340 | EMCO | 4/4/20 |
| Double Ridge Active Horn Antenna 18-40GHz _ AHA-840 | 10100003 | Com-Power | 10/29/20 |
| Pre amp 9kHz-2GHz _ CPA9231A | 3259 | Schaffner | 12/3/20 |
| EMI Test Receiver 9 kHz - 2500 MHz _ ESPC | DE15934 845296/0024 | Rohde & Schwarz | 3/28/20 |
| Pre amp 1Ghz-26.5GHz _ 8449B | 3008A00910 | HP | 4/9/20 |
| Signal Analyzer 10Hz - 40GHz option B4, B5, B24, B29, K54 Firmware 3.40 _ FSV40 | 101735 | Rohde & Schwarz | 3/20/20 |
| Temperature and humidity probe _ RH-20F | 200-97-082591 | Omega Engineering | 4/10/20 |
| RF Cable 45 ft. _ NPS-2301-5400-NPS | 0110 | IW Microwave | 4/3/20 |
| RF Cable 19m _ NPS-2801-1900M-NPS | 1805 | IW Microwave | 4/3/20 |
| 10dB attenuator | 1 | | CBU |

CBU – characterized before use

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# Test Configuration

| | |
|---|---|
| Customer: | Brilliant Home Technology, Inc. |
| Test Date: | February 3-12, 2020 |
| Specification: | FCC CRF 47 Part 15.247 Limits, ANSI C63.10 Methods |

## Operational Description:

The Brilliant Smart Dimmer Switch is a Decora form factor light switch with a capacitive touch surface for multi-gesture control and a touch groove for dimming loads. This is a companion switch that complements and works in concert with the Brilliant Control. The capacitive touch surface offers easy interactions for the user - a basic tap anywhere on the front for turning lights on and off, as well as a double-tap to trigger scenes as configured by the user. It is also equipped with a PIR sensor that offers users customizability around motion sensing, which can be utilized in a wide variety of scenarios based on a user's preferences.

The Brilliant Smart Dimmer Switch uses a chip antenna to provide connectivity to the Brilliant ecosystem via Bluetooth mesh, which is built upon the Bluetooth Low Energy (BLE) specification. The switch acts as a node in a Bluetooth mesh network that is comprised of all Brilliant devices in a user's home, allowing for communication between these devices. Bluetooth mesh operates in the standard Bluetooth 2.4GHz ISM frequency band, but implements a frequency hopping spread spectrum scheme that transmits data over 40 channels, with 2 MHz spacing. It uses Gaussian frequency shift keying (GFSK) modulation and has lower power consumption in contrast to that of traditional Bluetooth.

The BLE radio used on the switch operates with a data rate of 1 Mbps and outputs +4dBm of TX power which allows for a large transmission distance. This, in turn, provides better coverage and connectivity in a user's home. The absolute maximum RF input level for the radio used in the switch is 10 dBm.

The switch has dimensions of 40mm x 103mm x 33mm, allowing it to fit into a standard electrical box. It connects to a standard 120VAC, 60Hz input to power the device. A Brilliant Control as well as neutral and ground wires are required for installation. The switch supports LED, CFL, halogen, and incandescent bulbs and works with dimmable lighting.

Maximum load ratings – Incandescent: 500W; CFL/LED: 200W

## EUT Description / Note:

The EUT, BHS120US-WH1, a Brilliant Smart Dimmer Switch was powered up and the BLE transmitter was in a continuous transmitting mode at full power for emissions measurements. The EUT interface was through the host circuits to send commands to place it in the different operating modes. The power for the EUT was supplied by the AC mains. The chip antenna on the BLE transmitter is a Multilayer Ceramic Antenna P/N: RFANT3216120A5T. The peak gain of the antenna is 2.93dBi.

## EUT Support Program

The EUT was tested at lowest channel, 2402 MHz, mid channel, 2440 MHz, and highest channel, 2480 MHz in a continuous transmit mode. The transmitter was at full power and 100% modulation. The test software commands were set with data_rate ble_1Mbit, output_power pos4dBm, start_channel (2 or 40 or 80), start_tx_modulated_carrier. The EUT was then operated to find worst case levels of unwanted emissions. Preliminary radiated tests were performed to identify which operating mode produced the worst case (maximum) transmit level. Using this mode the EUT was tested to find maximum transmit level. Tests were performed while attached to a host computer to place the EUT in the different transmit channels.

## EUT Modifications for Compliance

There were no modifications performed on the EUT. The test results state the emission levels of the EUT in the condition as it was received.

## Measurement Uncertainty

Measurement uncertainty is caused by random effects and imperfect correction of systematic effects. The measurement uncertainties stated were calculated with a confidence level of approximately 95%, using a coverage factor of k = 2.

Expanded Measurement Uncertainty at 95% confidence probability;

Radiated emissions = ±3.92dB
Conducted emissions = ±1.16dB

## EUT Support Devices

*Table 1 – Support Equipment Used For Test*

| Model: | Description: | S/N | FCC ID# |
|---|---|---|---|
| Inspiron 5720 | Dell Laptop computer | DZ53DT1 | NA |

## I/O Ports and Cables

*Table 2 – EUT Port Termination's*

| I/O Port | Cable Type | Length | Connector | Termination |
|---|---|---|---|---|
| NA | | | | |

*Table 3 – Host Port Termination's*

| I/O Port | Cable Type | Length | Connector | Termination |
|---|---|---|---|---|
| USB | Shielded | 1 M | USB | USB-to-serial |

# Equipment Under Test

Removed for confidentiality

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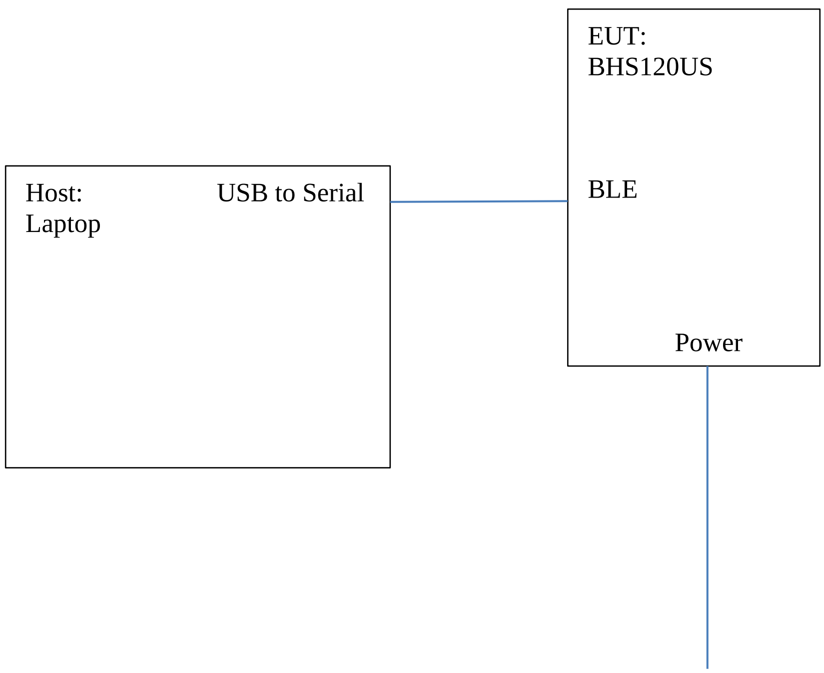
# Equipment Block Diagram

Following is the block diagram of the test setup. Refer to TEST CONFIGURATION pages for port connections and information.

*Figure 1 – Test Setup Diagram*



## Test Methods for Emissions

The test procedure stated in ANSI C63.10-2013 was used to collect the test data. The emission data of the EUT was taken with the Rohde & Schwarz EMI Test Receiver and Rohde & Schwarz FSV40. Incorporating the application of correction factors programmed into the Test Receiver and verified for distance, antenna, cable loss, and amplifier gain, the data was reduced as shown in the Sample Calculations. These correction factors are available upon request. The corrected data was then compared to the emission limits to determine compliance.

During radiated emission testing between 9 kHz to 1000 MHz, the EUT was placed on a nonconductive rotating table 0.8 meter above the conductive grid. The nonconductive table dimensions were 1 meter deep by 1.5 meters wide at 0.8 meter high. The EUT is centered on the tabletop and the measurement antenna was placed 3 meters from the EUT as noted in the test data.

For emissions testing, scans in the frequency range of 9 kHz to 24.835 GHz were made. Measurement bandwidths and detectors stated in ANSI C63.10 4.1.4 were used.

Measurements were made at 3 meters. Tests were performed with the measurement antenna in both horizontal and vertical orientations.

## Conducted Emission Testing

The EUT was powered by the AC mains and conducted emissions testing was performed.

For the conducted emissions testing, the EMCO LISN, Model No. 3825/2, was used for the EUT. During conducted emission testing the EUT was located on a wooden test bench measuring 0.8 meter high, 1 meter deep, and 1.5 meters in width. The vertical conducting surface was 0.4 meter from the back of the test bench. The LISNs were placed on the ground plane of the test area in accordance with ANSI C63.10-2013.

The metal plane used for conducted emission testing was grounded to the earth by a heavy gage braided wire attached to the plane. All other objects were kept a minimum of 1 meter away from the EUT during the conducted test.

For conducted emissions testing a scan of the frequency band 150 kHz to 30 MHz was made stepping every 5 kHz. Each frequency was measured at a bandwidth of 10 kHz for 20 msec. All readings within 25 dB of the limits were recorded, and those emissions were then measured using the CISPR quasi-peak and average detectors at a bandwidth of 10 kHz for a 2 second measurement time. All emissions within 6 dB of the limit were examined with additional measurements to ensure compliance with the limits. The results of the conducted emissions test are shown in test tables below.

## Temperature and Humidity

The ambient temperature of the actual EUT was within the range of 10° to 40° C (50° to 104° F) unless the particular equipment requirements specify testing over a different temperature range. The humidity levels were within the range of 10% to 90% relative humidity unless the EUT operating requirements call for a different level.

## Sample Calculations

An example of how the EMI Test Receiver reading is converted using correction factors is given for the emissions recorded. These correction factors are programmed into the EMI Test Receiver and verified. For radiated emissions in dBµV/m, the EMI Test Receiver reading in dBµV is corrected by using the following formula:

| | |
|---|---|
| 33.90 | Meter Reading (dBµV) |
| 34.01 | - Pre amp Gain (dB) |
| 12.48 | + Cable Loss (dB) |
| 33.12 | + Antenna Factor (dB/m) |
| 45.49 | = Corrected Reading (dBµV/m) |

This reading is then compared to the applicable specification limits and the difference will determine compliance.

# Test setup for conducted measurements

**Characterization of cable and attenuator**

The RF cable and external attenuator used during the conducted measurements was characterized as follows:

Cable Loss = 1.21dB
Attenuator = 10.14db

Correction factor = 11.35dB

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# Minimum -6dB Bandwidth

**§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.**

(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(2) 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.

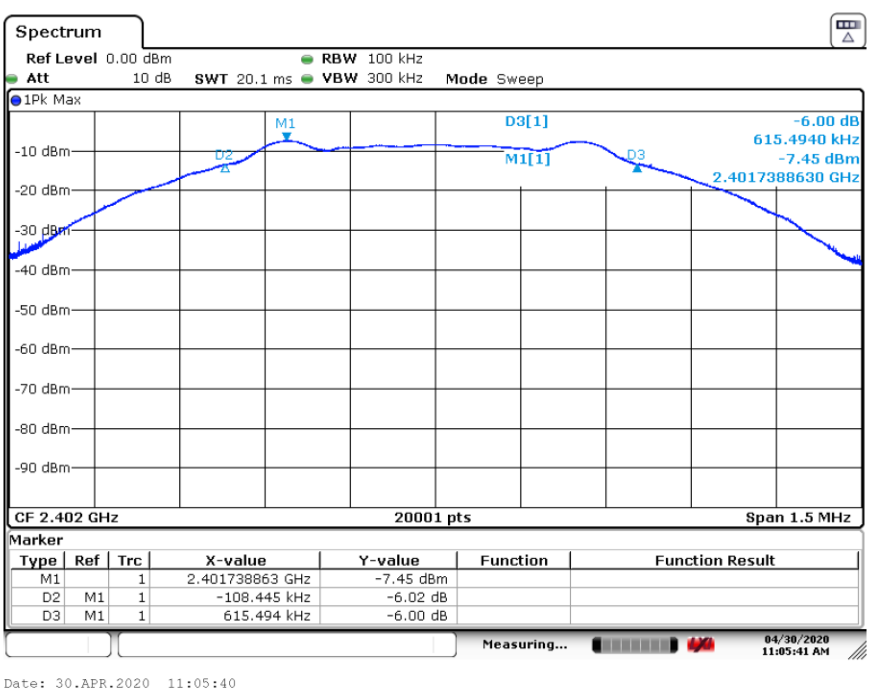
**ANSI C63.10 11.8.1 Option 1**

The steps for the first option are as follows:

a) Set RBW = 100 kHz.
b) Set the VBW ≥ [3 × RBW].
c) Detector = peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

*Table 4 – Minimum -6 dB Bandwidth*

| Channel | Frequency (MHz) | Bandwidth (kHz) | Limit (kHz) | Result |
|---|---|---|---|---|
| **Low** | **2402** | **723.9** | **>500** | **Pass** |
| **Mid** | **2440** | **742.2** | | **Pass** |
| **High** | **2480** | **719.0** | | **Pass** |



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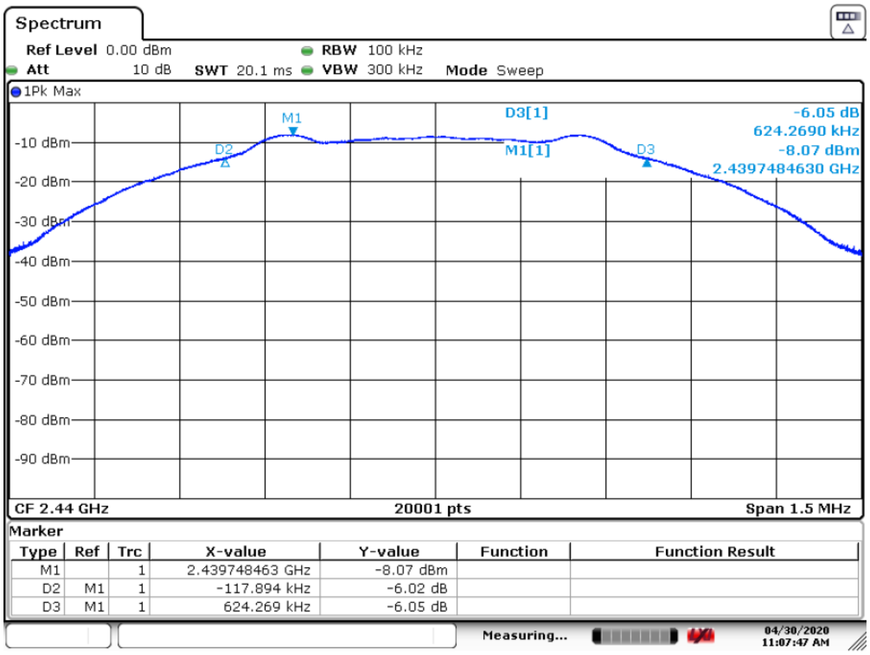


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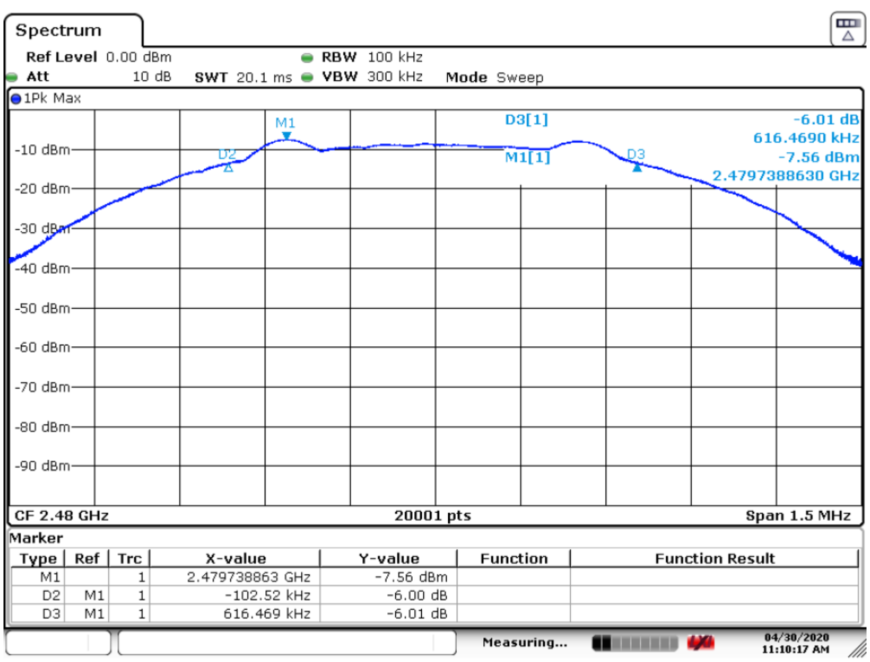


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# Peak Power Spectral Density

**§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.**

(e) 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. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

**ANSI C63.10 11.10.2 Method PKPSD (peak PSD)**

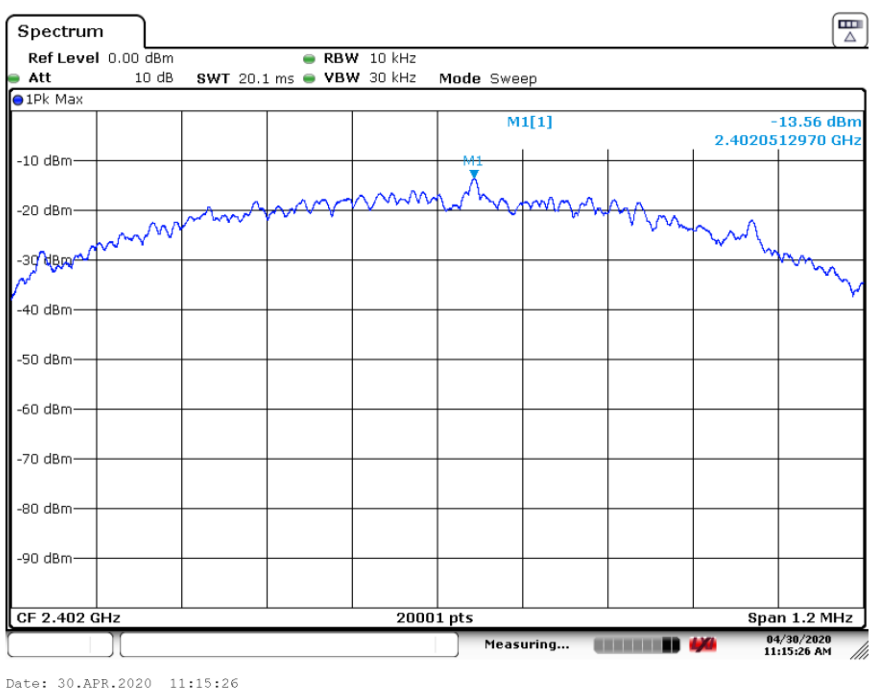
The following procedure shall be used if maximum peak conducted output power was used to determine compliance, and it is optional if the maximum conducted (average) output power was used to determine compliance:

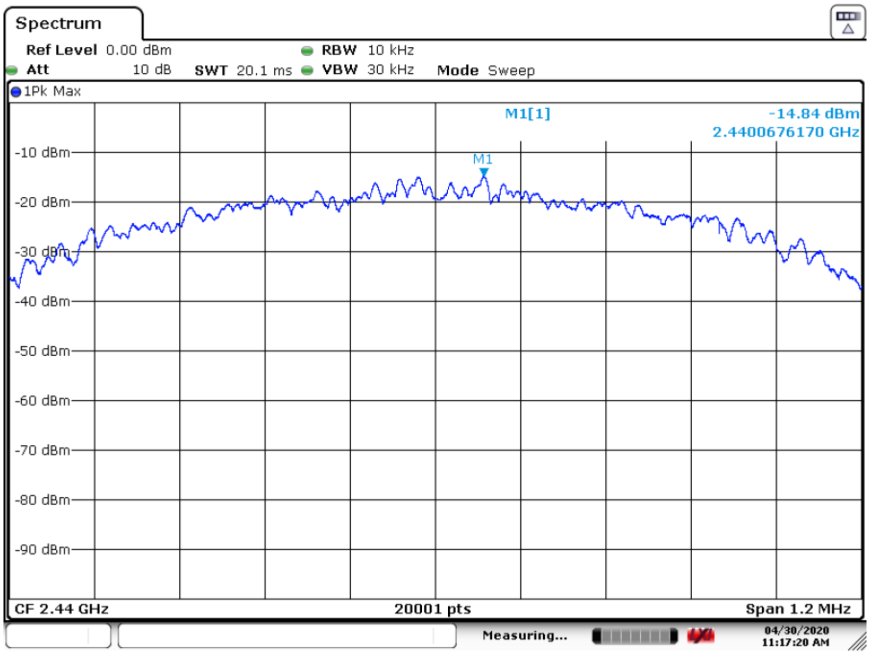
a) Set analyzer center frequency to DTS channel center frequency.
b) Set the span to 1.5 times the DTS bandwidth.
c) Set the RBW to 3 kHz ≤ RBW ≤ 100 kHz.
d) Set the VBW ≥ [3 × RBW].
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level within the RBW.
j) If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat.

*Table 5 – Peak Power Spectral Density*

| Channel | Frequency (MHz) | PPSD (dBm) | Limit (dBm) | Result |
|---|---|---|---|---|
| Low | 2402 | -2.21 | 8 | Pass |
| Mid | 2440 | -3.49 | | Pass |
| High | 2480 | -4.73 | | Pass |

*Measurement bandwidth used was 10 kHz, attenuator and cable correction factor 11.35dB*



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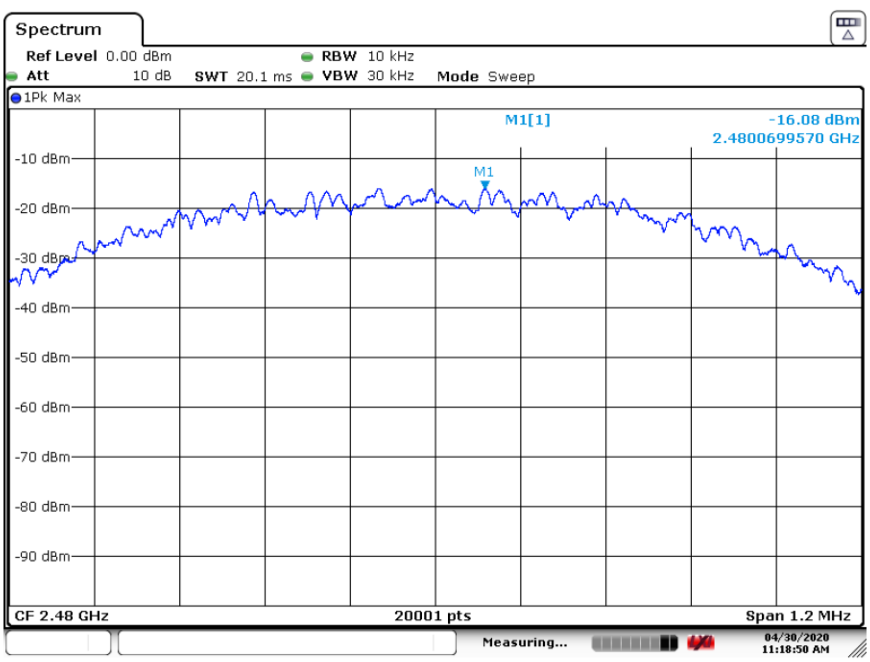


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## Maximum Peak Output Power

**§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.**

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

**558074 D01 15.247 Meas Guidance v05r02**

8.3.1.1 RBW ≥ DTS bandwidth

Subclause 11.9.1.1 of ANSI C63.10 is applicable.

**ANSI C63.10 11.9.1.1 RBW ≥ DTS bandwidth**

The following procedure shall be used when an instrument with a resolution bandwidth that is greater than the DTS bandwidth is available to perform the measurement:

a) Set the RBW ≥ DTS bandwidth.
b) Set VBW ≥ [3 × RBW].
c) Set span ≥ [3 × RBW].
d) Sweep time = auto couple.
e) Detector = peak.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use peak marker function to determine the peak amplitude level.

*Table 6 – Maximum Peak Output Power*

| Channel | Frequency (MHz) | Maximum Transit Power (dBm) | Limit | | Result |
|---|---|---|---|---|---|
| | | | dBm | Watts | |
| Low | 2402 | 4.05 | 30 | 1 | Pass |
| Mid | 2440 | 3.97 | | | Pass |
| High | 2480 | 3.90 | | | Pass |

*Attenuator and cable correction factor 11.35dB*

FCC 15.31(e) For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

No change in RF power was observed when the input voltage is varied between 85% to 115% of the nominal rated supply voltage.

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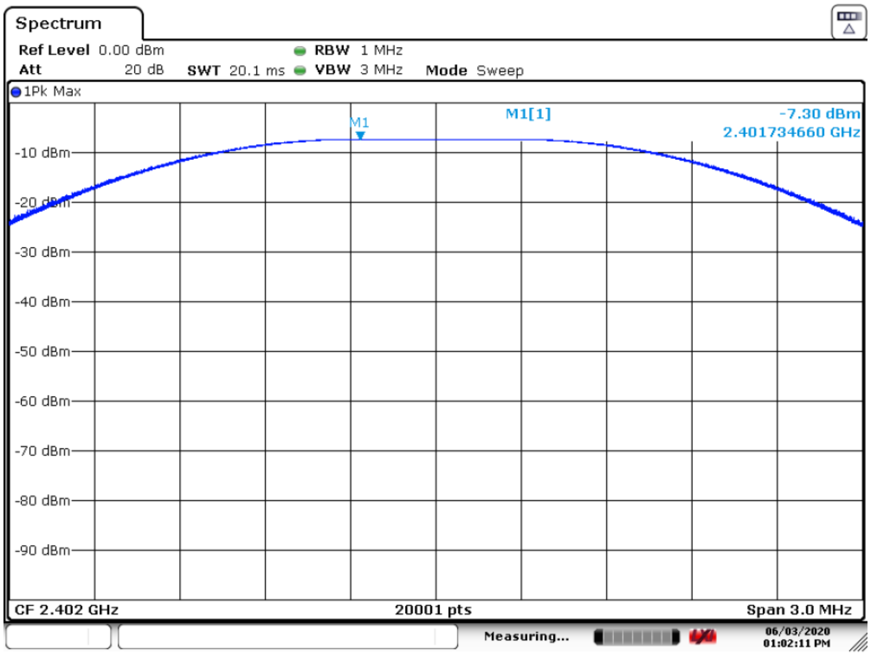


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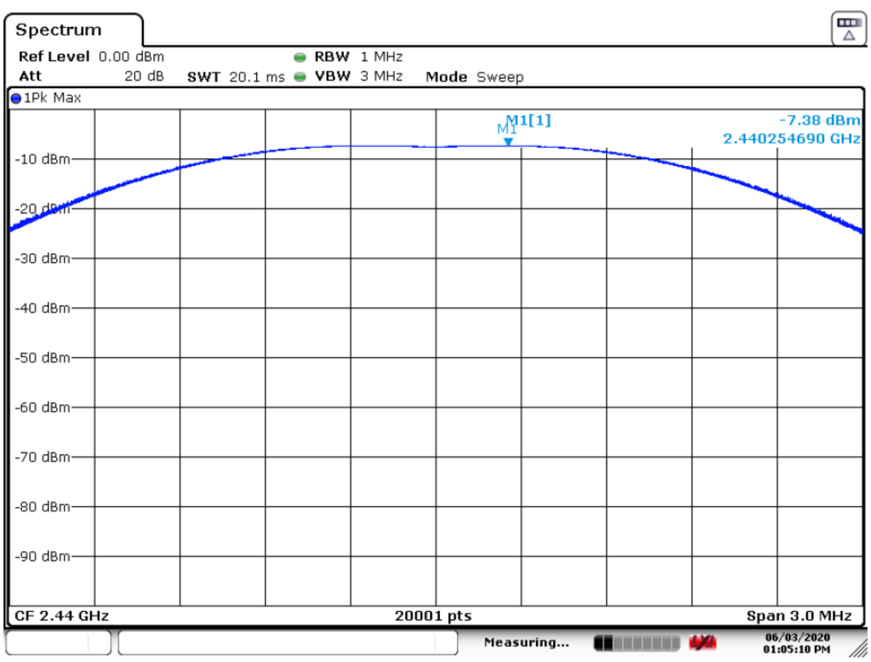


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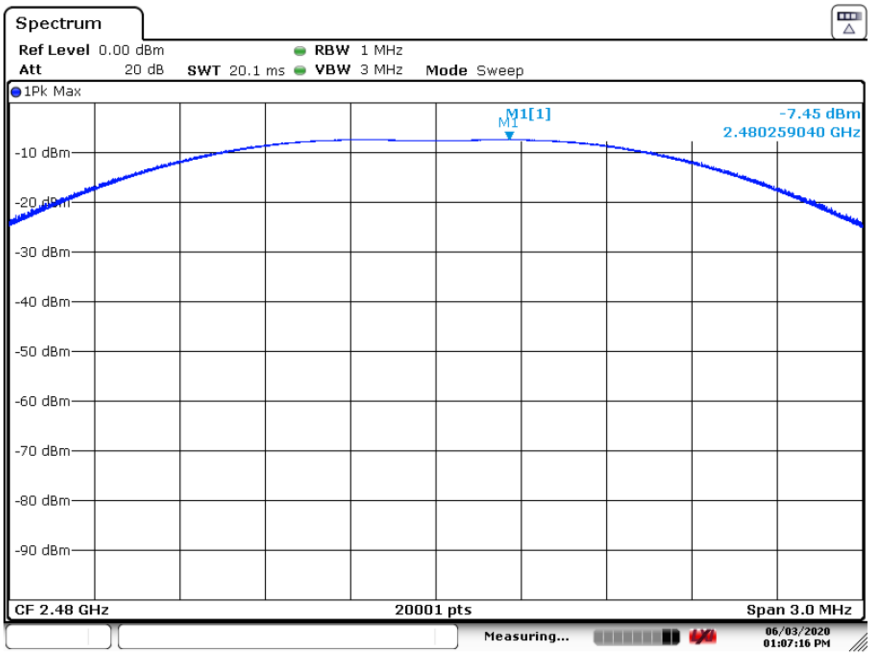


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# Equivalent Isotropically Radiated Power

**ANSI C63.10 G.3 Power approach (logarithmic terms)**

ERP/EIRP = $P_T + G_T - L_C$ (G.3)

where

ERP/EIRP is the equivalent (or effective) radiated power [in same units as $P_T$, typically dBW, dBm, or power spectral density (psd)], relative to either a dipole antenna (ERP) or an isotropic antenna (EIRP)

$P_T$ is the transmitter output power, in dBW, dBm, or psd (power over a specified reference bandwidth)

$G_T$ is the gain of the transmitting antenna, in dBd (ERP) or dBi (EIRP)

$L_C$ is the signal attenuation in the connecting cable between the transmitter and the antenna, in dB

**G.4 Relationship between ERP and EIRP**

The numeric gain of an ideal half-wave dipole antenna is 1.64, and the numeric gain of an ideal isotropic antenna is 1.0. The gain of an ideal half-wave dipole antenna relative to an ideal isotropic antenna is [10 log (1.64)] or 2.15 dBi. Therefore, if the antenna gain in dBd is unknown, it may be determined from the gain in dBi via the following relationship in Equation (G.4):

$G_T$(dBd) = $G_T$(dBi) – 2.15 dB (G.4)

Alternatively, the EIRP may be determined from Equation (G.3) and then converted to ERP based on the maximum antenna gain relationship by applying Equation (G.5):

ERP = EIRP – 2.15dB (G.5)

Similarly, the EIRP may be determined from the ERP as follows in Equation (G.6):

EIRP =ERP +2.15dB (G.6)

The antenna used is Multilayer Ceramic Antenna part number RFANT3216120A5T with 2.93 dBi gain. The antenna is manufactured by Walsin Technology Corporation.

**EIRP = 4.05dBm + 2.93dBi - 0 = 6.98 dBm = 0.0049888448746 Watts**

# Unwanted Emissions

**§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.**

(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) (see §15.205(c)).

**ANSI C63.10 11.11.2 Reference level measurement**

Establish a reference level by using the following procedure:
a) Set instrument center frequency to DTS channel center frequency.
b) Set the span to ≥ 1.5 times the DTS bandwidth.
c) Set the RBW = 100 kHz.
d) Set the VBW ≥ [3 × RBW].
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum PSD level.

Note that the channel found to contain the maximum PSD level can be used to establish the reference level.

**ANSI C63.10 11.11.3 Emission level measurement**

Establish an emission level by using the following procedure:
a) Set the center frequency and span to encompass frequency range to be measured.
b) Set the RBW = 100 kHz.
c) Set the VBW ≥ [3 × RBW].
d) Detector = peak.
e) Sweep time = auto couple.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use the peak marker function to determine the maximum amplitude level.

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) is attenuated by at least the minimum requirements specified in 11.11. Report the three highest emissions relative to the limit.

Testing was performed at the lowest, middle, and highest transmitter frequency. All data is reported in tables below.

**ANSI C63.10 11.12 Emissions in restricted frequency bands**

Typical regulatory requirements for DTS specify that emissions that fall into restricted frequency bands shall comply with the general radiated emission limits. §15.205 Restricted bands of operation.

**ANSI C63.10 11.12.1 Radiated emission measurements**

Because the typical emission requirements are specified in terms of radiated field strength levels, measurements performed to determine compliance have traditionally relied on a radiated test configuration. Radiated measurements remain the principal method for determining compliance to the specified requirements; however antenna-port conducted measurements are also now acceptable to determine compliance (see 11.12.2 for details). When radiated measurements are utilized, test site requirements and procedures for maximizing and measuring radiated emissions that are described in 6.3, 6.5, and 6.6 shall be followed.

Frequency Band 2400-2483.5 MHz

Restricted Bands:

| MHz | MHz | MHz | GHz |
|---|---|---|---|
| 0.090-0.110 | 16.42-16.423 | 399.9-410 | 4.5-5.15 |
| 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 | 14.47-14.5 |
| 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 | 2690-2900 | 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 | Above 38.6 |
| 13.36-13.41 | | | |

*Table 7 – Unwanted Emissions*

| | Frequency (MHz) | Within the frequency band (dB) | Outside the frequency band (dB) | dB Below >20 | Result |
|---|---|---|---|---|---|
| **Low** | **2399.99** | **3.42** | **-44.89** | **48.31** | **Pass** |
| **Low** | **2399.91** | **3.42** | **-45.02** | **48.44** | **Pass** |
| **Low** | **2399.73** | **3.42** | **-45.50** | **48.92** | **Pass** |
| **Low** | **2306.24** | **3.42** | **-55.63** | **59.05** | **Pass** |
| **Low** | **2305.75** | **3.42** | **-55.68** | **59.10** | **Pass** |
| **Low** | **2307.66** | **3.42** | **-56.77** | **60.19** | **Pass** |
| **Low** | **2145.78** | **3.42** | **-58.91** | **62.33** | **Pass** |
| **Low** | **2081.93** | **3.42** | **-62.30** | **65.72** | **Pass** |
| **Low** | **2192.29** | **3.42** | **-62.47** | **65.89** | **Pass** |
| **High** | **2529.97** | **3.42** | **-48.42** | **51.84** | **Pass** |
| **High** | **2517.99** | **3.42** | **-54.62** | **58.04** | **Pass** |
| **High** | **2540.27** | **3.42** | **-54.75** | **58.17** | **Pass** |
| **High** | **2512.05** | **3.42** | **-55.06** | **58.48** | **Pass** |
| **High** | **2658.26** | **3.42** | **-58.05** | **61.47** | **Pass** |
| **No other emissions were observed** | | | | | |

*Attenuator and cable correction factor 11.35dB*

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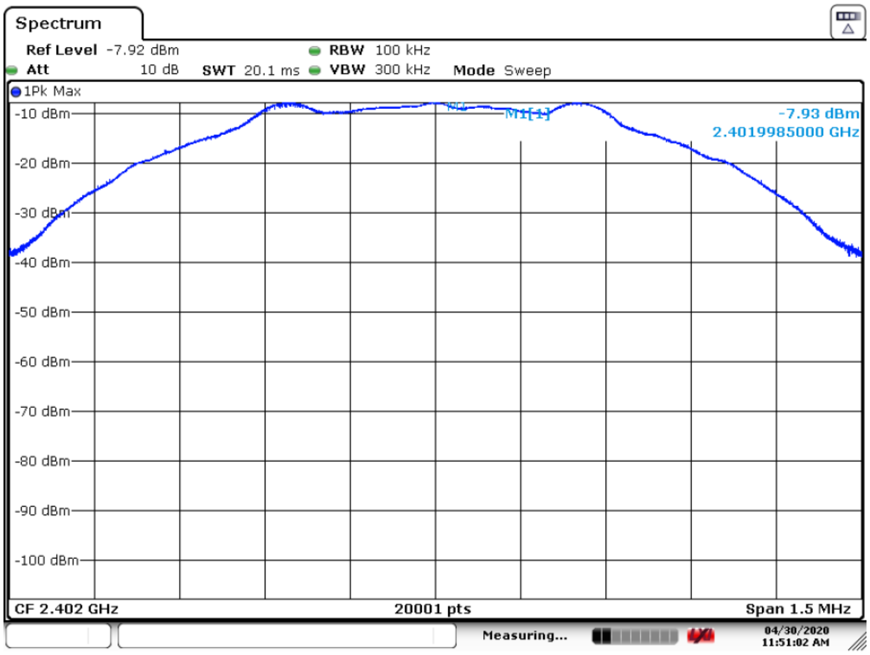
Reference level measurement




Date: 30.APR.2020 11:51:02

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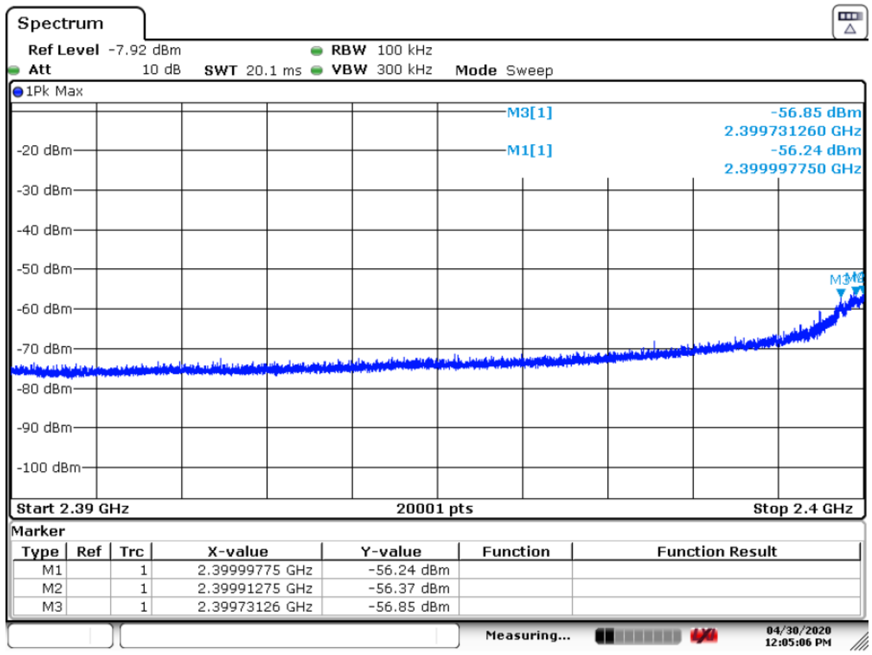
Emission level measurement

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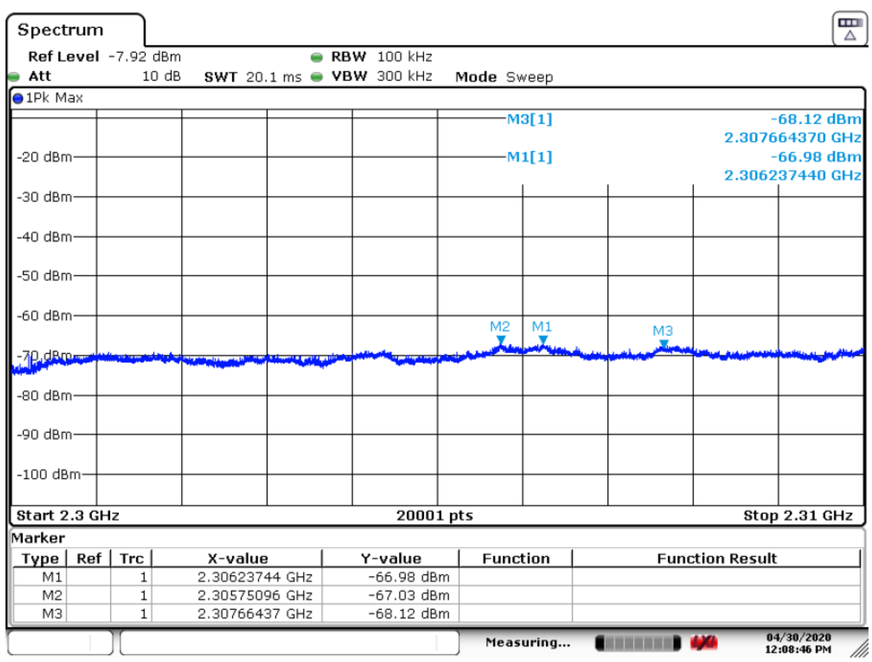
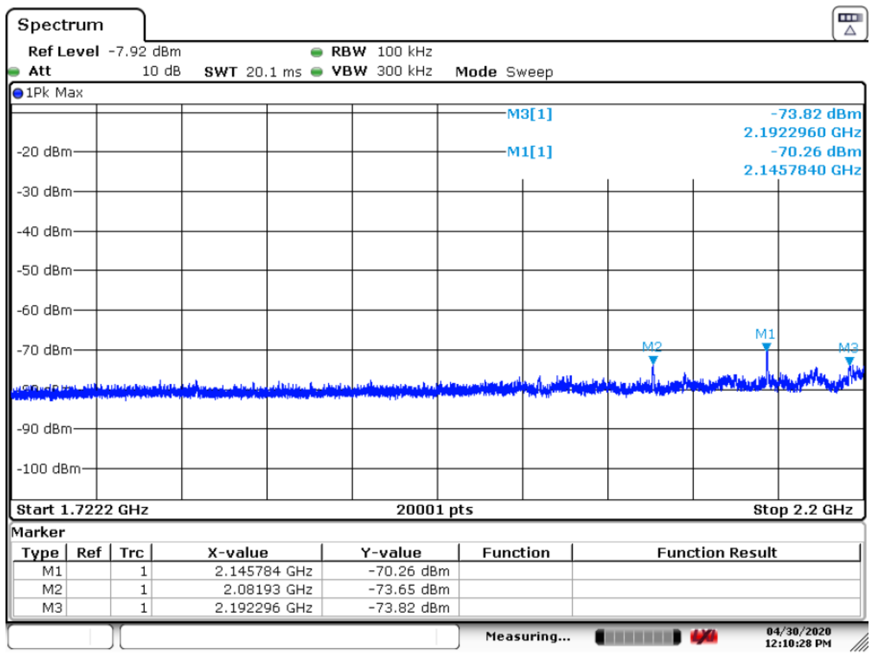
Emission level measurement




Date: 30.APR.2020 12:08:46

Emission level measurement

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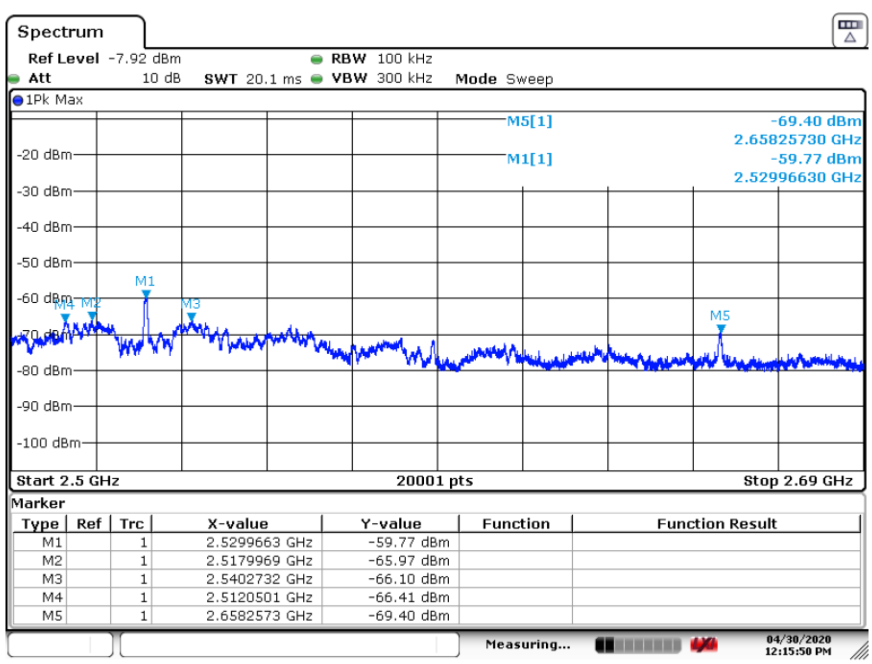
Emission level measurement



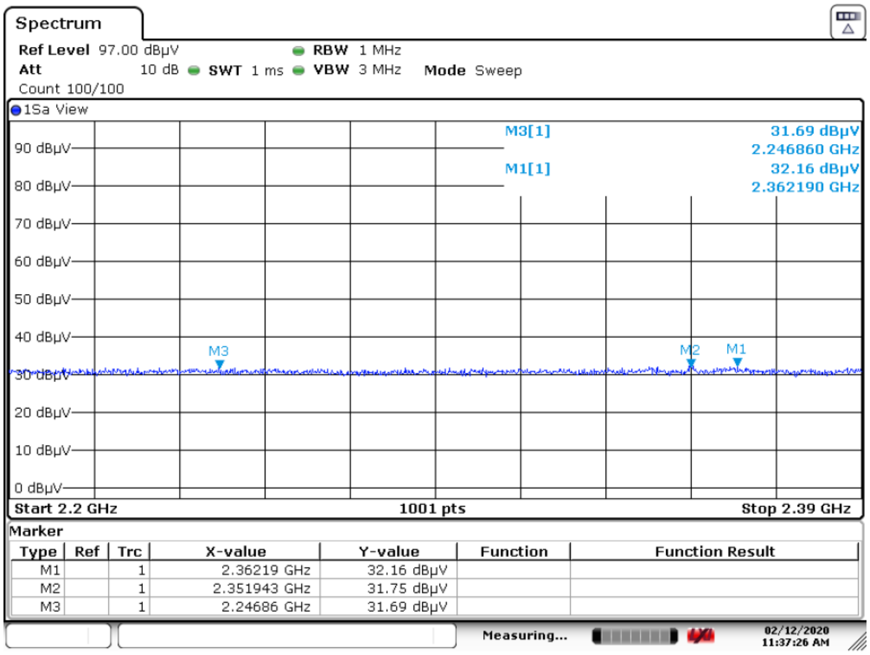

Date: 30.APR.2020 12:15:50

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) (see §15.205(c)). The peak measurements of all radiated emissions levels meet the requirement of 74dBuV/m at 3 meter distance, FCC 15.35(b).

*Table 8 – Restricted Bands – Radiated Measurements*

| Polarization, H or V | Emission Frequency MHz | Measured Level dBuV/m | Site CF dB | Corrected Level dBuV/m | 3 Meter Limit | Level vs Limit |
|---|---|---|---|---|---|---|
| H | 2362.19 | 32.16 | 2.75 | 34.91 | 54.00 | -19.09 |
| H | 2351.94 | 31.75 | 2.76 | 34.51 | 54.00 | -19.49 |
| H | 2246.86 | 31.69 | 2.65 | 34.34 | 54.00 | -19.66 |
| H | 2493.76 | 32.17 | 2.93 | 35.10 | 54.00 | -18.90 |
| H | 2487.49 | 31.69 | 2.92 | 34.61 | 54.00 | -19.39 |
| H | 2484.61 | 31.81 | 2.92 | 34.73 | 54.00 | -19.27 |
| H | 2764.79 | 32 | 3.16 | 35.16 | 54.00 | -18.84 |
| H | 2714.73 | 31.44 | 3.23 | 34.67 | 54.00 | -19.33 |
| H | 2864.02 | 31.79 | 3.41 | 35.20 | 54.00 | -18.80 |
| V | 2351.75 | 33.09 | 2.76 | 35.85 | 54.00 | -18.15 |
| V | 2363.77 | 31.96 | 2.75 | 34.71 | 54.00 | -19.29 |
| V | 2343.14 | 31.88 | 2.77 | 34.65 | 54.00 | -19.35 |
| V | 2494.94 | 31.79 | 2.93 | 34.72 | 54.00 | -19.28 |
| V | 2487.74 | 30.81 | 2.92 | 33.73 | 54.00 | -20.27 |
| V | 2485.32 | 31.28 | 2.92 | 34.20 | 54.00 | -19.80 |
| V | 2693.04 | 31.87 | 3.13 | 35.00 | 54.00 | -19.00 |
| V | 2784.05 | 31.52 | 3.17 | 34.69 | 54.00 | -19.31 |
| V | 2801.08 | 31.27 | 3.37 | 34.64 | 54.00 | -19.36 |
| Band Edge | | | | | | |
| H | 2400 | 47.74 | 2.91 | 50.65 | 54.00 | -3.35 |
| H | 2390 | 30.57 | 2.73 | 33.30 | 54.00 | -20.70 |
| H | 2300 | 30.61 | 2.80 | 33.41 | 54.00 | -20.59 |
| H | 2483.5 | 31.29 | 2.92 | 34.21 | 54.00 | -19.79 |
| V | 2483.5 | 31.18 | 2.92 | 34.14 | 54.00 | -19.86 |
| V | 2400 | 44.38 | 2.91 | 47.29 | 54.00 | -6.71 |
| V | 2390 | 30.39 | 2.73 | 33.12 | 54.00 | -20.88 |
| V | 2300 | 30.59 | 2.80 | 33.39 | 54.00 | -20.61 |

Restricted Bands – Radiated Measurements Horizontal

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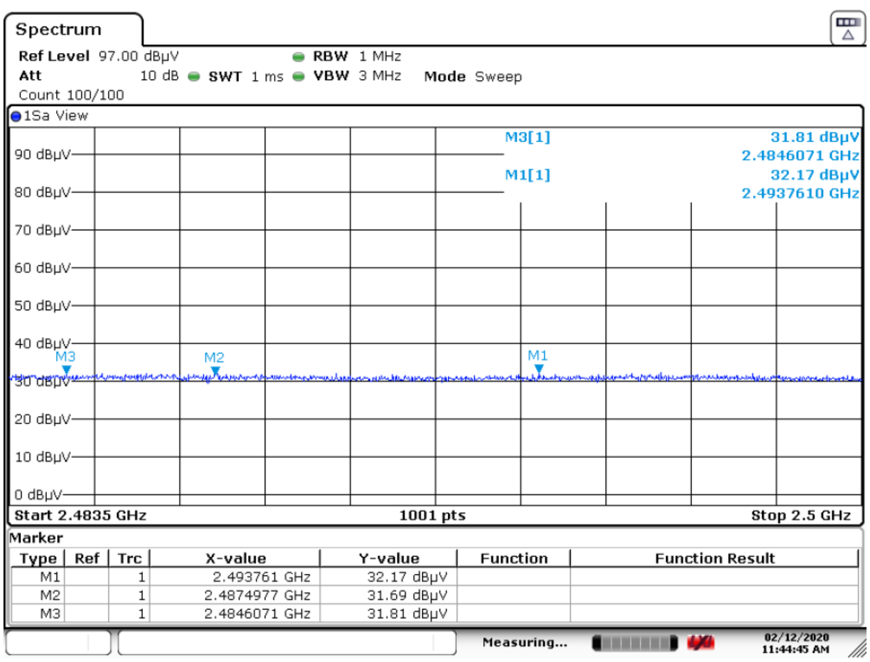
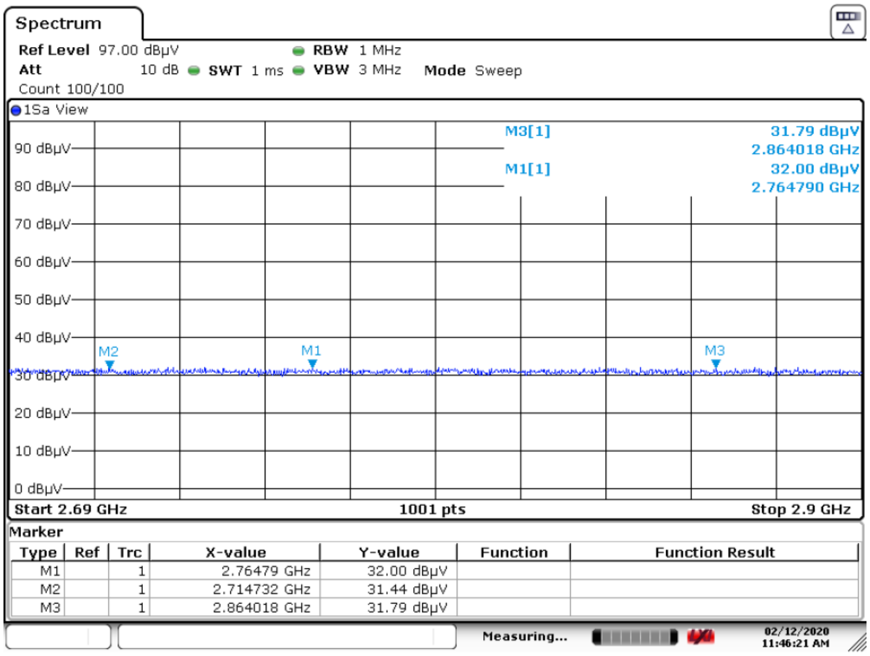
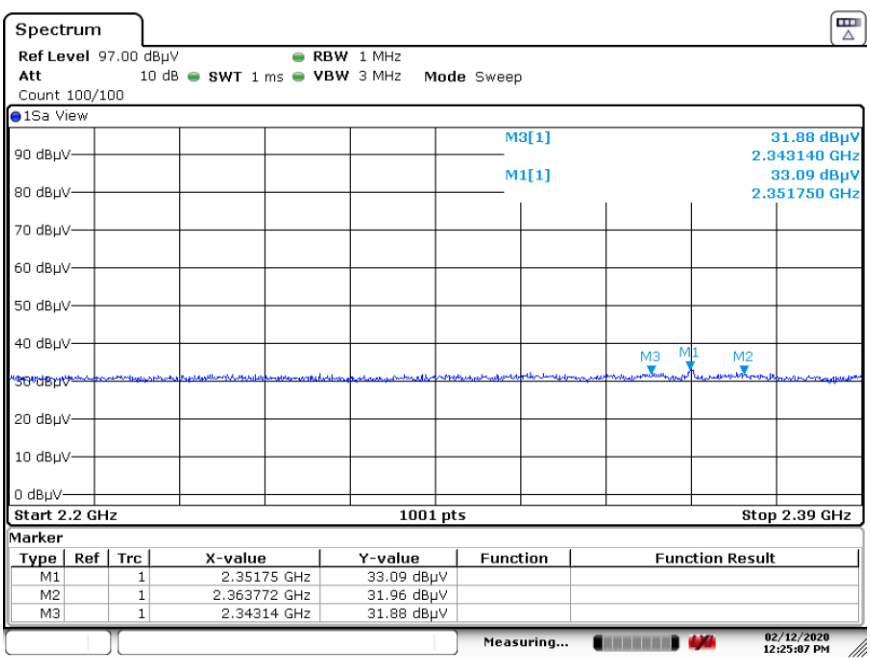



Date: 12.FEB.2020 11:44:45

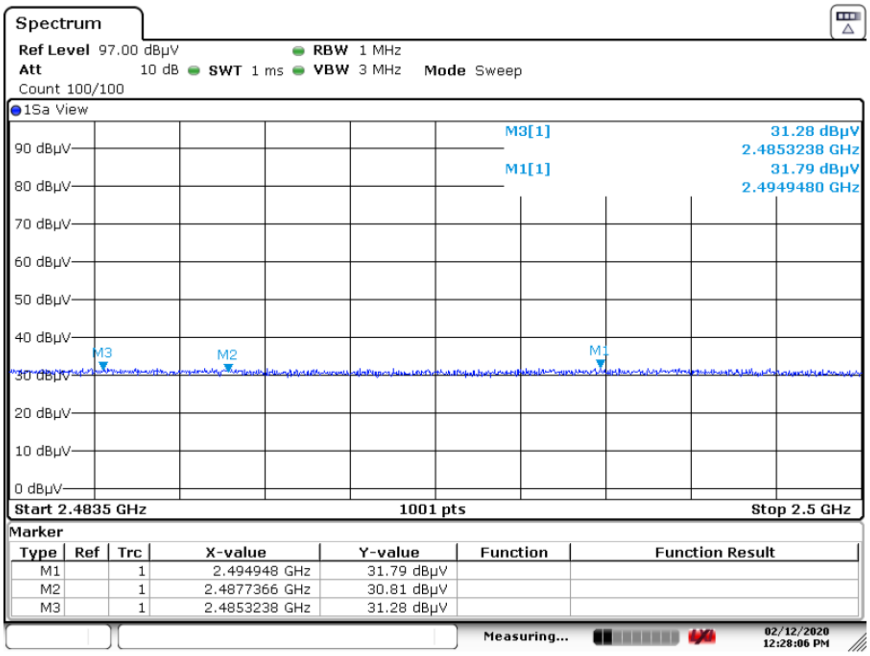



Date: 12.FEB.2020 11:46:22

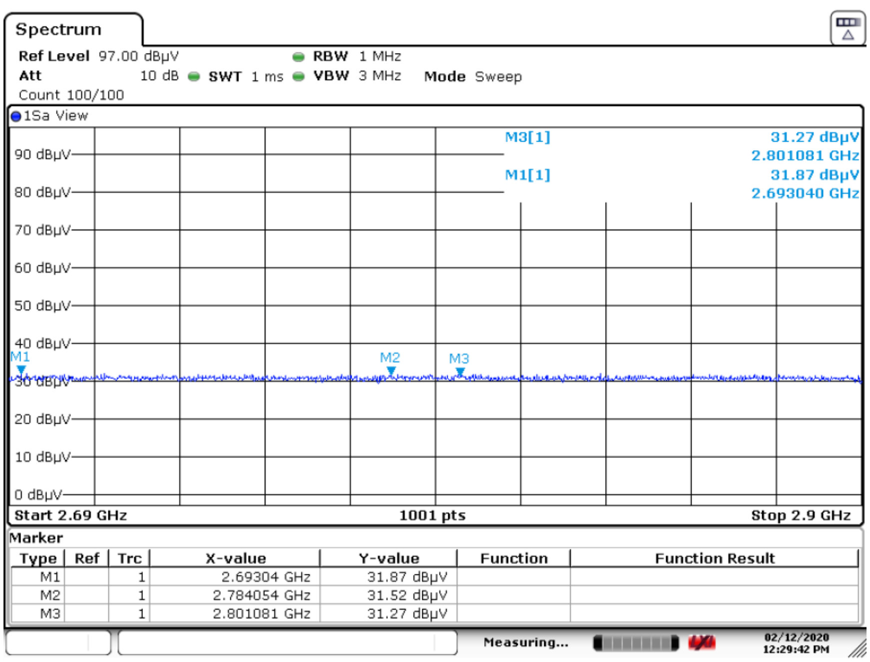
Restricted Bands – Radiated Measurements Vertical




Date: 12.FEB.2020 12:25:07

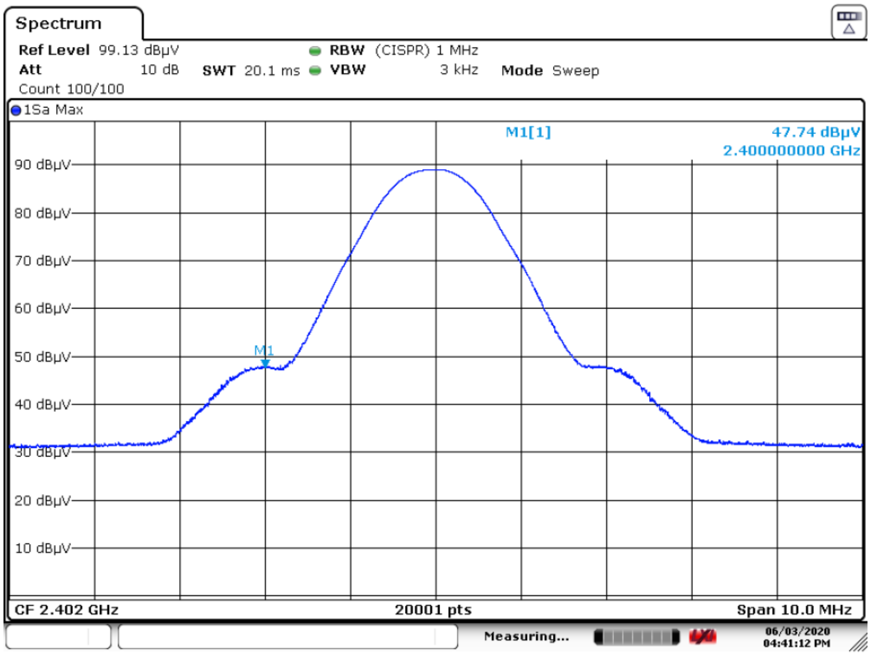



Date: 12.FEB.2020 12:28:07



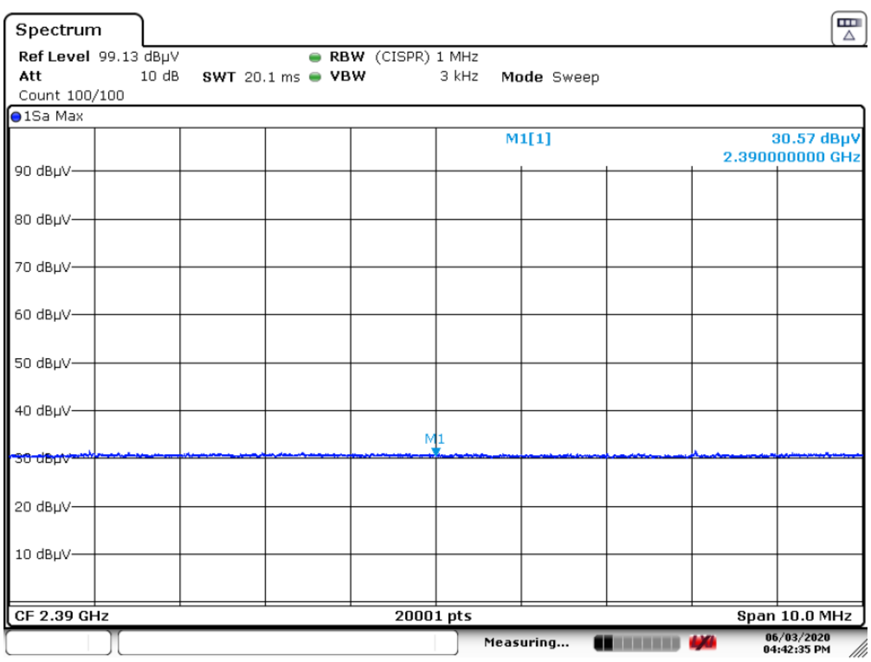

Date: 12.FEB.2020 12:29:43

Band Edge – Radiated Measurements Horizontal



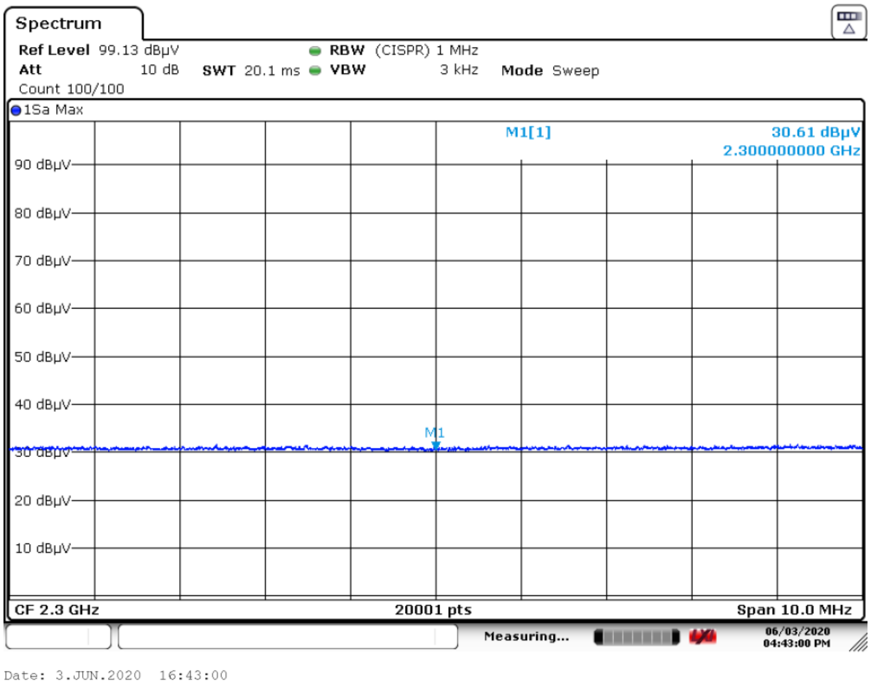

Date: 3.JUN.2020 16:41:13

Band Edge – Radiated Measurements Horizontal

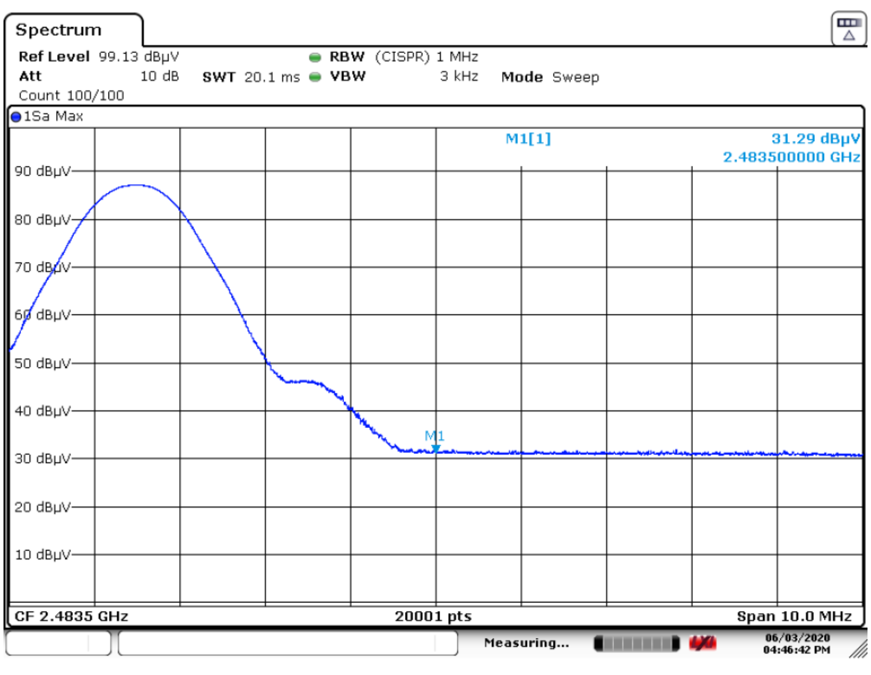



Date: 3.JUN.2020 16:42:36

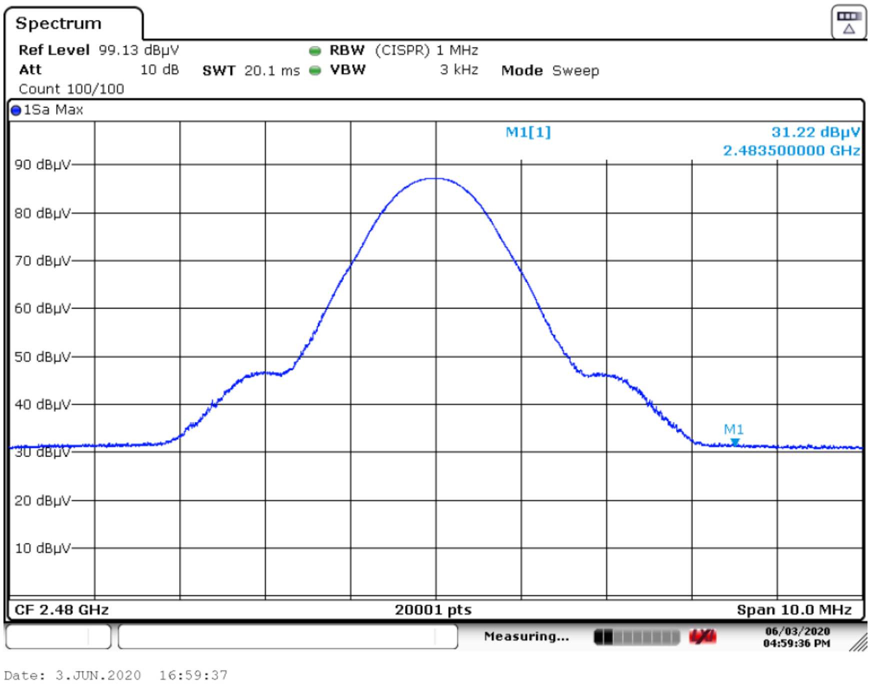
Band Edge – Radiated Measurements Horizontal



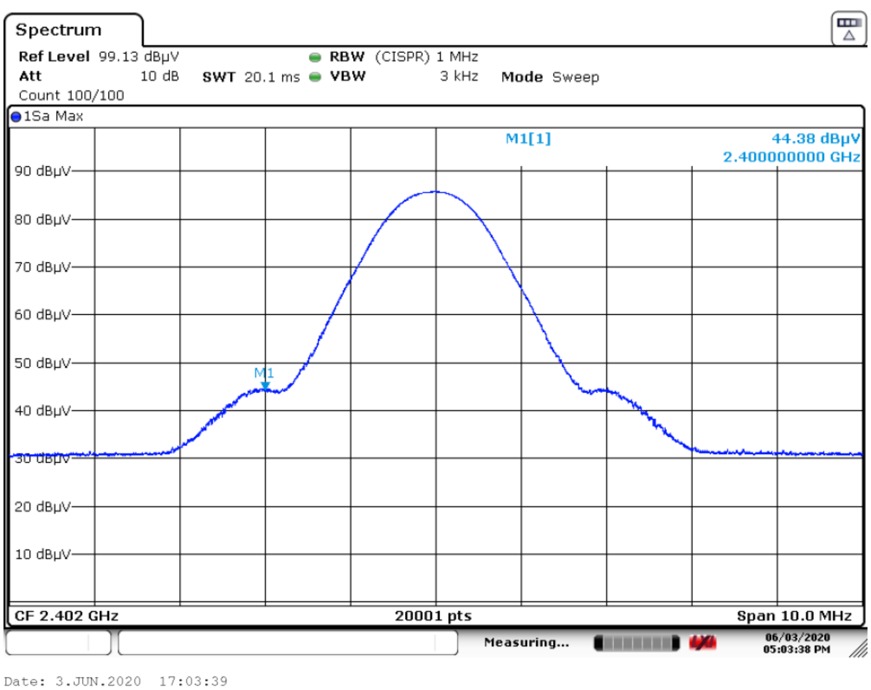

Band Edge – Radiated Measurements Horizontal



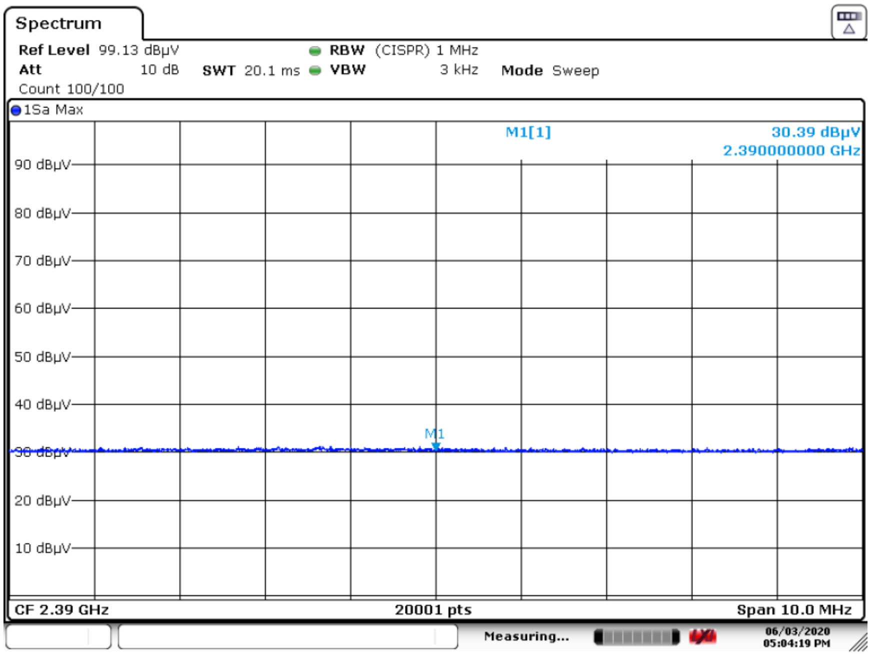
Band Edge – Radiated Measurements Vertical




Band Edge – Radiated Measurements Vertical

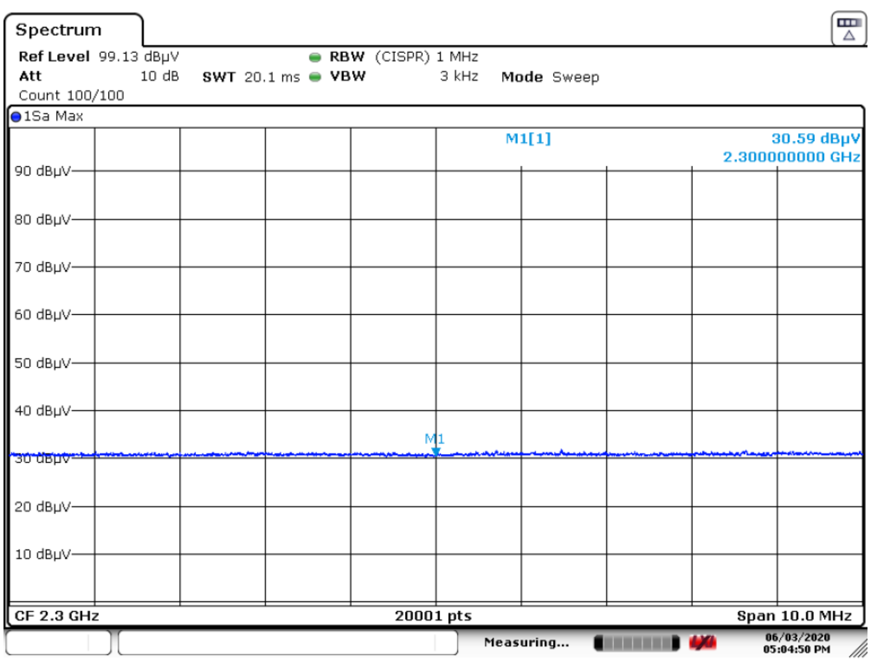


Band Edge – Radiated Measurements Vertical




Date: 3.JUN.2020 17:04:20

Band Edge – Radiated Measurements Vertical



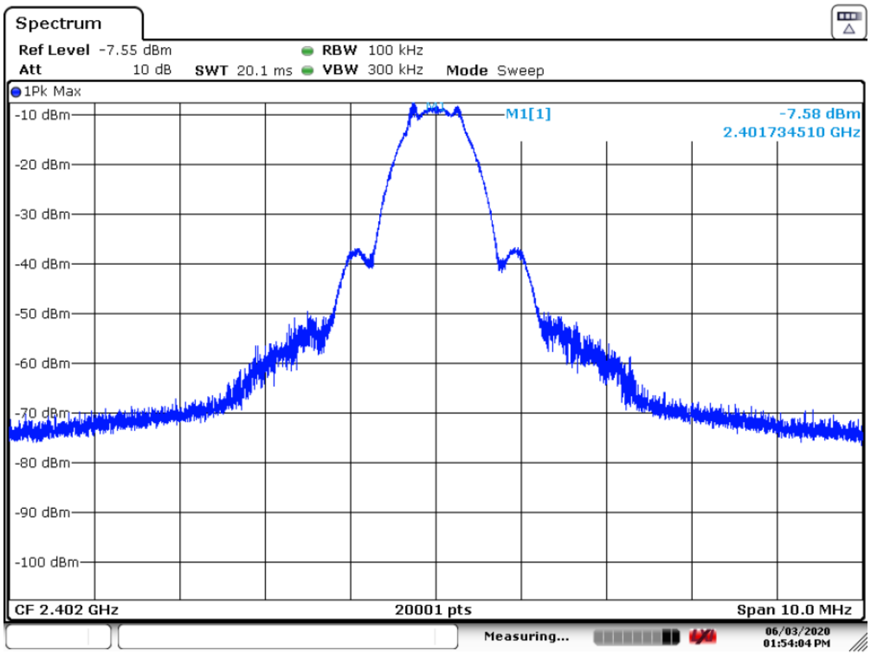

Date: 3.JUN.2020 17:04:51

*Table 9 – Band Edge - Antenna-Port Conducted Measurements*

| Frequency (MHz) | Within the frequency band (dB) | Outside the frequency band (dB) | dB Below >20 | Result |
|---|---|---|---|---|
| **2400** | **3.77** | **-48.59** | **52.36** | **Pass** |
| **2399.86** | **3.77** | **-45.19** | **48.96** | **Pass** |
| **2300** | **3.77** | **-62.68** | **66.45** | **Pass** |
| **2483.5** | **3.47** | **-58.19** | **61.66** | **Pass** |

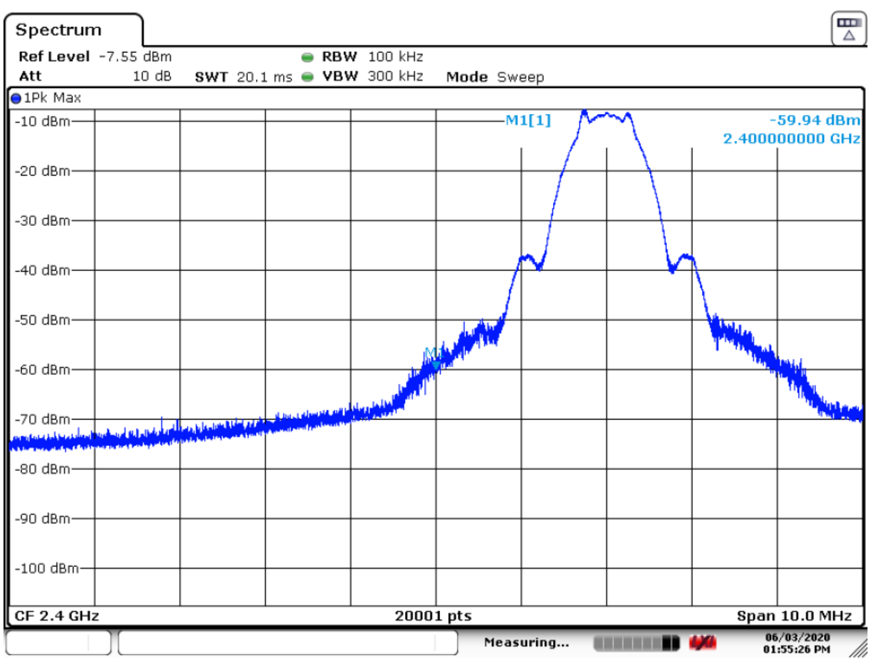
*Attenuator and cable correction factor 11.35dB*

Antenna Port Conducted Measurements
Reference level



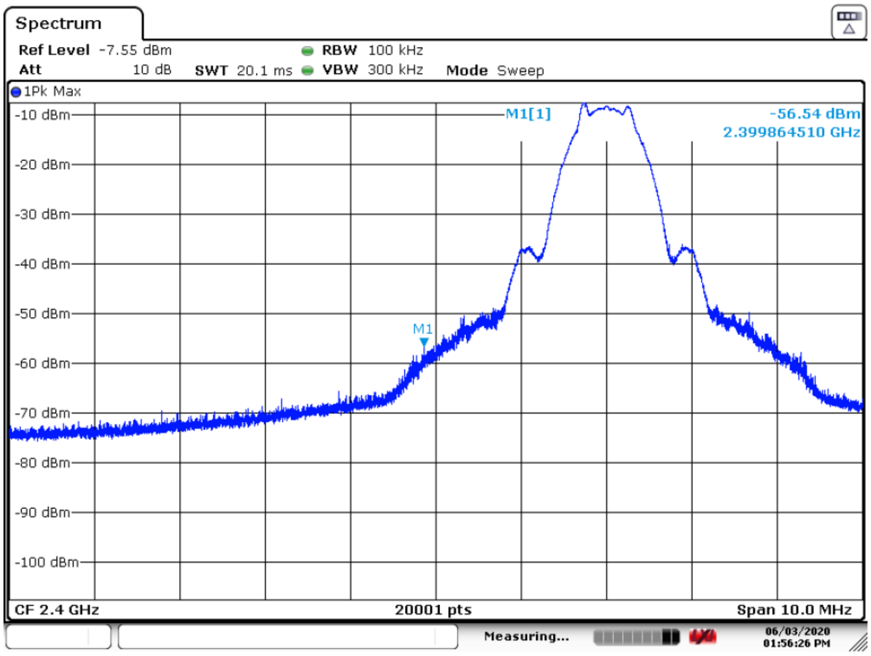

Date: 3.JUN.2020 13:54:04

Band Edge Antenna-Port Conducted Measurements



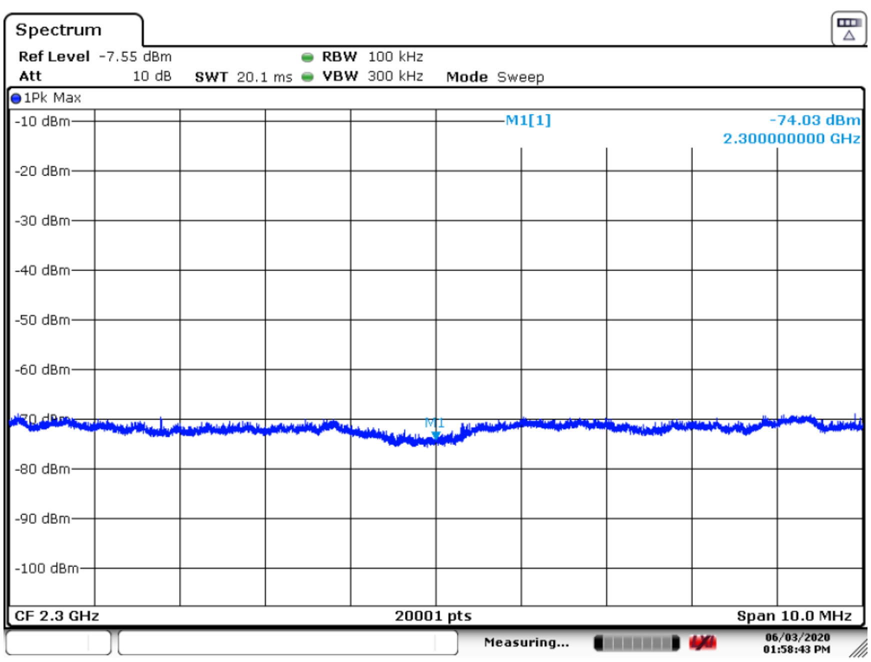

Date: 3.JUN.2020 13:55:26

Band Edge Antenna-Port Conducted Measurements



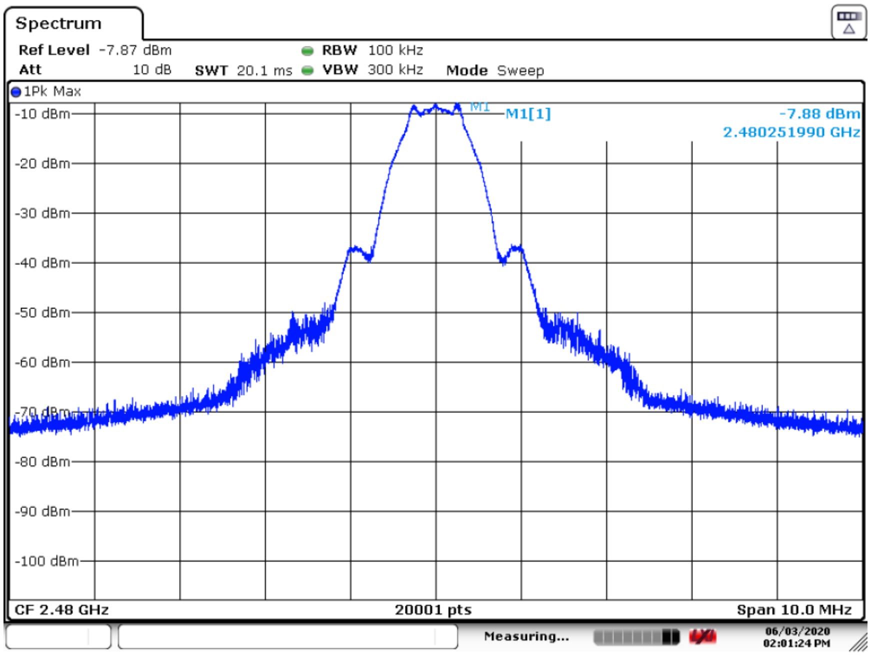

Date: 3.JUN.2020 13:56:26

Band Edge Antenna-Port Conducted Measurements



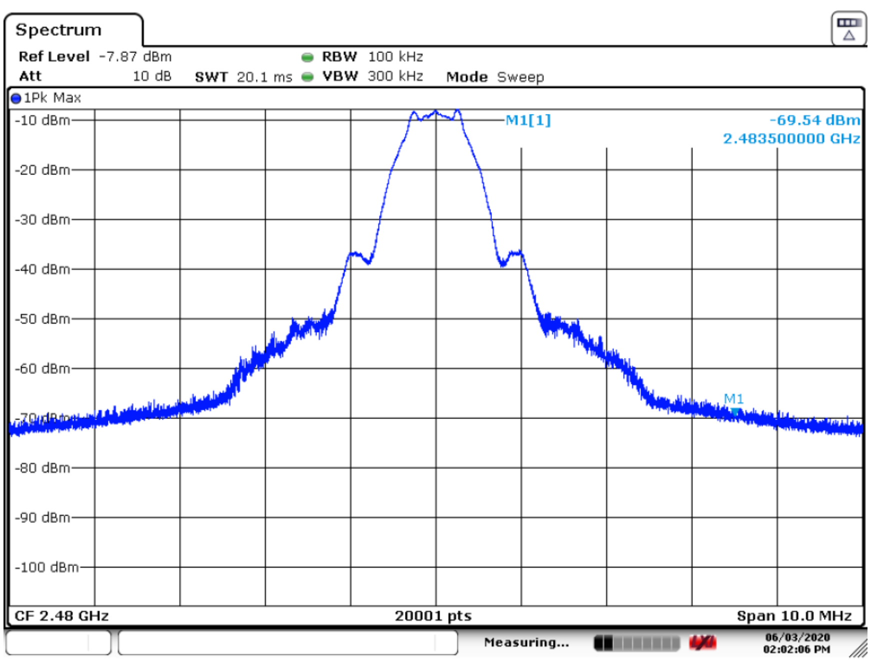

Date: 3.JUN.2020 13:58:43

Reference level




Date: 3.JUN.2020 14:01:24

Band Edge Antenna-Port Conducted Measurements




Date: 3.JUN.2020 14:02:06

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# Occupied Bandwidth (99% emissions bandwidth)

**ANSI C63.10 6.9.3 Occupied bandwidth—power bandwidth (99%) measurement procedure**

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. The following procedure shall be used for measuring 99% power bandwidth:

a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.

b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.

c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.

d) Step a) through step c) might require iteration to adjust within the specified range.

e) Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.

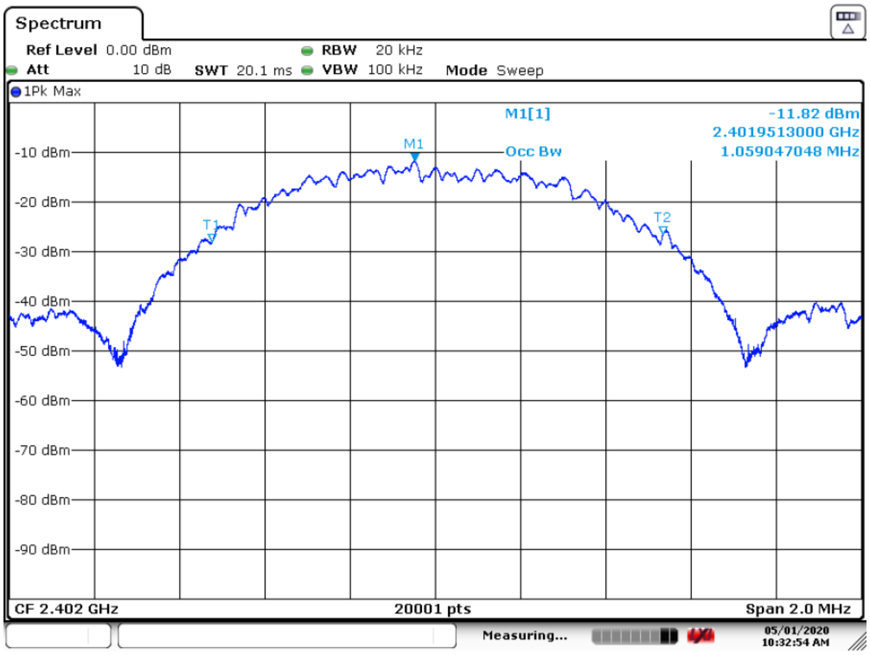
f) Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.

g) If the instrument does not have a 99% power bandwidth function, then the trace data points are recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% power bandwidth is the difference between these two frequencies.

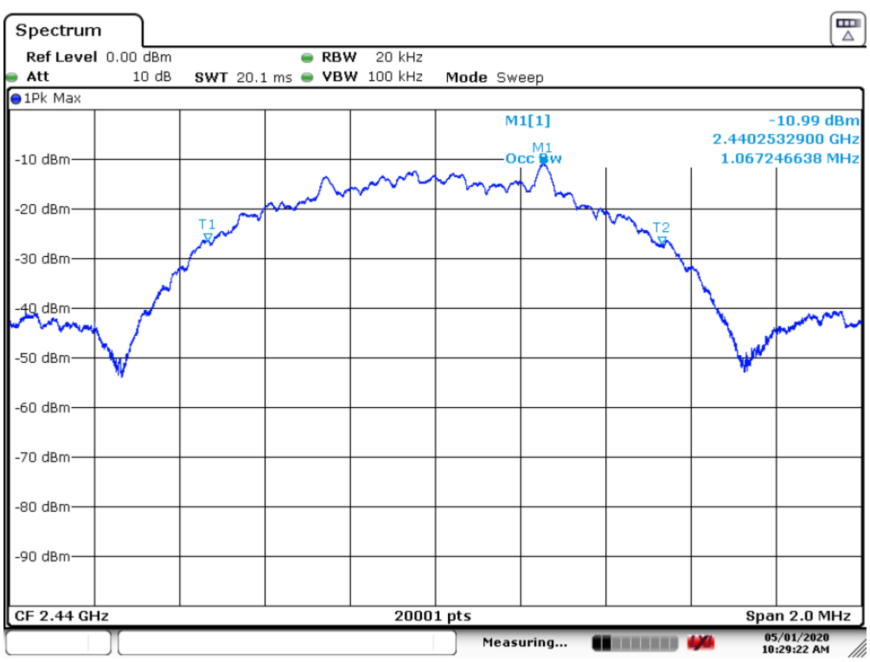
h) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

*Table 10 – 99% Occupied Bandwidth*

| Channel | Frequency (MHz) | Bandwidth (kHz) | Limit (kHz) | Result |
|---|---|---|---|---|
| Low | 2402 | 1059 | >500 | Pass |
| Mid | 2440 | 1067 | | Pass |
| High | 2480 | 1061 | | Pass |




Date: 1.MAY.2020 10:32:55




Date: 1.MAY.2020 10:29:23

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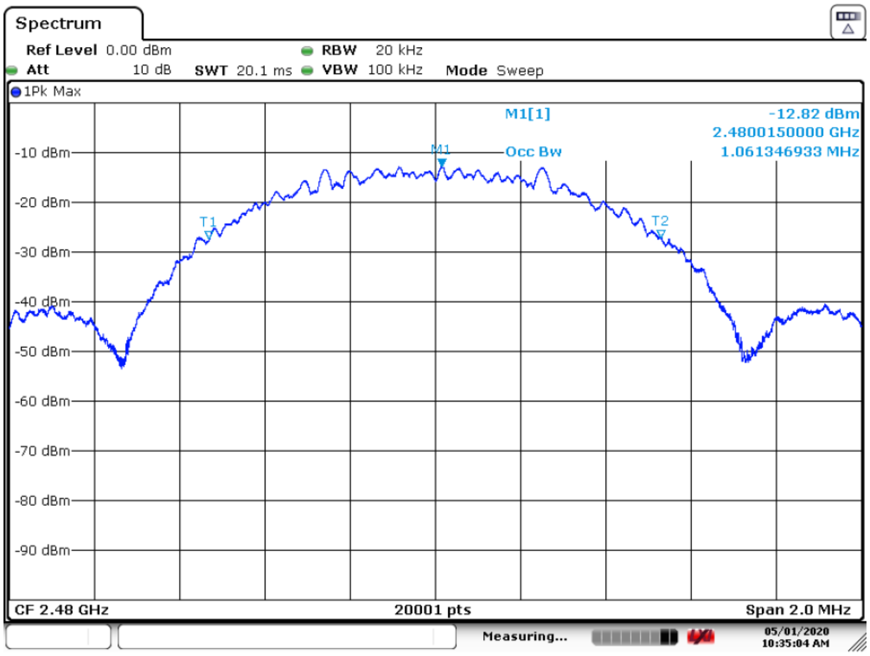


Date: 1.MAY.2020 10:35:04

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# AC Power Line Conducted Emissions

**§15.207 Conducted limits.**

(c) Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provisions for, the use of battery chargers which permit operating while charging, AC adapters or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

**AC Power Line Conducted Emissions Limits**

| | **Conducted limit (dBµV)** | |
|---|---|---|
| **Frequency of emission (MHz)** | **Quasi-peak** | **Average** |
| 0.15 – 0.5 | 66 to 56* | 56 to 46* |
| 0.5 - 5 | 56 | 46 |
| 5 - 30 | 60 | 50 |

* The level decreases linearly with the logarithm of the frequency.

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# AC Power Line Conducted Data for Line

*Figure 2 – Line Scan*

Blue Trace: Peak Measurement Green Trace: Average Measurement
Final Measurement: x = QP / + = AV at 2 second measurement time.

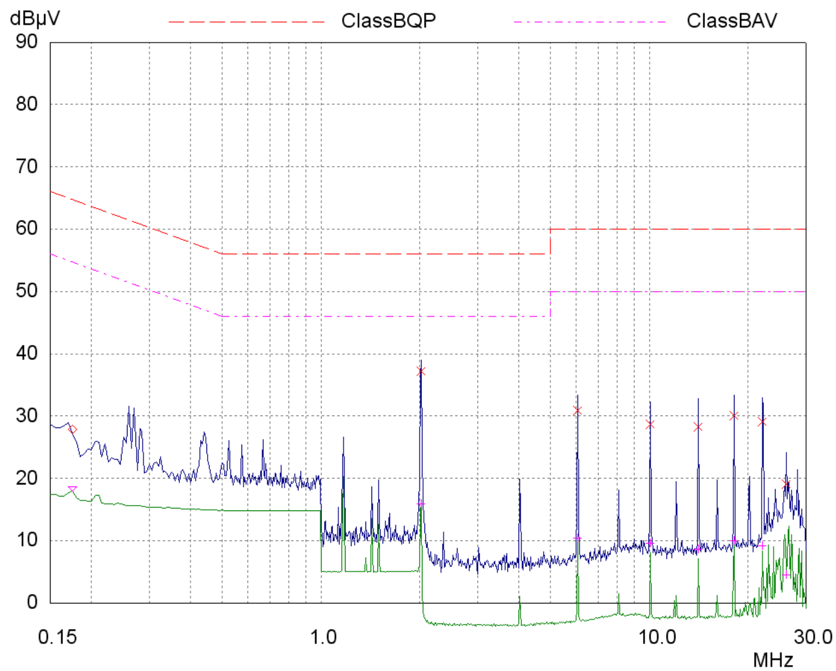


*Table 11 – Line Scan Data*

| Frequency MHz | Level dBµV | Detector | Limit dBµV | Margin dB | Phase | PE |
|---|---|---|---|---|---|---|
| 2.02 | 37.26 | QP | 56.00 | 18.74 | L1 | gnd |
| 6.06 | 30.92 | QP | 60.00 | 29.08 | L1 | gnd |
| 10.1 | 28.64 | QP | 60.00 | 31.36 | L1 | gnd |
| 14.13 | 28.23 | QP | 60.00 | 31.77 | L1 | gnd |
| 18.175 | 30.10 | QP | 60.00 | 29.90 | L1 | gnd |
| 22.21 | 29.10 | QP | 60.00 | 30.90 | L1 | gnd |
| 26.255 | 19.02 | QP | 60.00 | 40.98 | L1 | gnd |
| 2.02 | 15.83 | AV | 46.00 | 30.17 | L1 | gnd |
| 6.06 | 10.34 | AV | 50.00 | 39.66 | L1 | gnd |
| 10.1 | 9.60 | AV | 50.00 | 40.40 | L1 | gnd |
| 14.13 | 8.68 | AV | 50.00 | 41.32 | L1 | gnd |
| 18.175 | 10.01 | AV | 50.00 | 39.99 | L1 | gnd |
| 22.21 | 9.22 | AV | 50.00 | 40.78 | L1 | gnd |
| 26.255 | 4.50 | AV | 50.00 | 45.50 | L1 | gnd |

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# AC Power Line Conducted Data for Neutral

*Figure 3 – Neutral Scan*

Blue Trace: Peak Measurement Green Trace: Average Measurement

Final Measurement: x = QP / + = AV at 2 second measurement time.

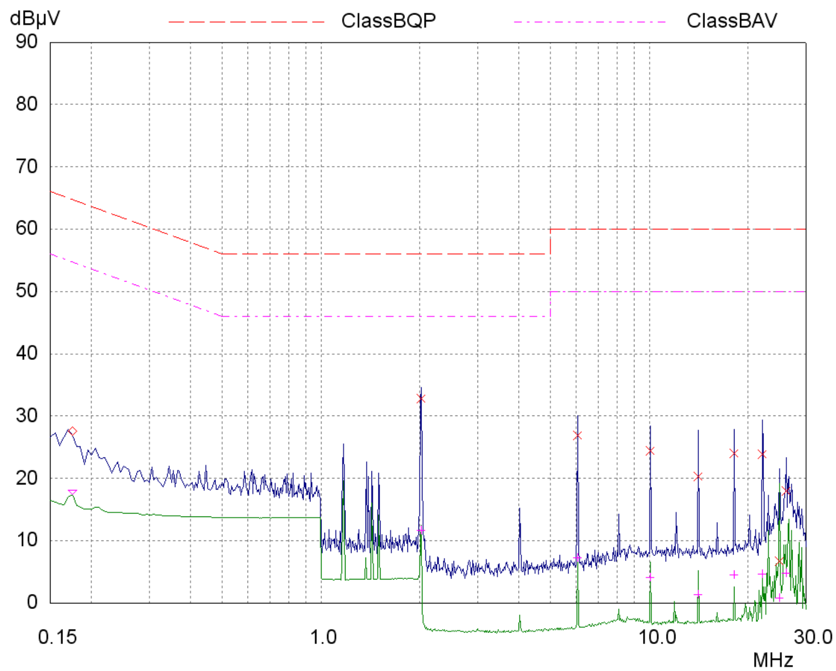



*Table 12 – Neutral Scan Data*

| Frequency MHz | Level dBµV | Detector | Limit dBµV | Margin dB | Phase | PE |
|---|---|---|---|---|---|---|
| 2.02 | 32.86 | QP | 56.00 | 23.14 | N | gnd |
| 6.06 | 26.83 | QP | 60.00 | 33.17 | N | gnd |
| 10.1 | 24.42 | QP | 60.00 | 35.58 | N | gnd |
| 14.14 | 20.33 | QP | 60.00 | 39.67 | N | gnd |
| 18.165 | 24.07 | QP | 60.00 | 35.93 | N | gnd |
| 22.215 | 23.86 | QP | 60.00 | 36.14 | N | gnd |
| 24.93 | 6.74 | QP | 60.00 | 53.26 | N | gnd |
| 26.25 | 18.02 | QP | 60.00 | 41.98 | N | gnd |
| 2.02 | 11.63 | AV | 46.00 | 34.37 | N | gnd |
| 6.06 | 7.24 | AV | 50.00 | 42.76 | N | gnd |
| 10.1 | 4.14 | AV | 50.00 | 45.86 | N | gnd |
| 14.14 | 1.28 | AV | 50.00 | 48.72 | N | gnd |
| 18.165 | 4.56 | AV | 50.00 | 45.44 | N | gnd |
| 22.215 | 4.67 | AV | 50.00 | 45.33 | N | gnd |
| 24.93 | 0.85 | AV | 50.00 | 49.15 | N | gnd |
| 26.25 | 4.78 | AV | 50.00 | 45.22 | N | gnd |

## Transmitter Emission

**§15.209 Radiated emission limits; general requirements.**

(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

| **Frequency (MHz)** | **Field strength (microvolts/meter)** | **Measurement distance (meters)** |
|---|---|---|
| 0.009 – 0.490 | 2400/F(kHz) | 300 |
| 0.490 – 1.705 | 24000/F(kHz) | 30 |
| 1.705 – 30.0 | 30 | 30 |
| 30 – 88 | 100 | 3 |
| 88 – 216 | 150 | 3 |
| 216 – 960 | 200 | 3 |
| Above 960 | 500 | 3 |

(b) In the emission table above, the tighter limit applies at the band edges.

(c) The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.

(d) The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 990 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

(e) The provisions in §§15.31, 15.33, and 15.35 for measuring emissions at distances other than the distances specified in the above table, determining the frequency range over which radiated emissions are to be measured, and limiting peak emissions apply to all devices operated under this part. i.e. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

(f) In accordance with §15.33(a), in some cases the emissions from an intentional radiator must be measured to beyond the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator because of the incorporation of a digital device. If measurements above the tenth harmonic are so required, the radiated emissions above the tenth harmonic shall comply with the general radiated emission limits applicable to the incorporated digital device, as shown in §15.109 and as based on the frequency of the emission being measured, or, except for emissions contained in the restricted frequency bands shown in §15.205, the limit on spurious emissions specified for the intentional radiator, whichever is the higher limit. Emissions which must be measured above the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator and which fall within the restricted bands shall comply with the general radiated emission limits in §15.109 that are applicable to the incorporated digital device.

(g) Perimeter protection systems may operate in the 54-72 MHz and 76-88 MHz bands under the provisions of this section. The use of such perimeter protection systems is limited to industrial, business and commercial applications.

## Report of Measurements Radiated Data

Radiated emissions measurements were performed from 9 kHz to 30 MHz at 3-meter distance. The loop antenna was placed at 1-meter height and was rotated about its vertical axis. The EUT was also rotated 360 degrees in front of the measurement antenna. **No emissions were observed from the EUT in this frequency range.**

Measurements were performed in the frequency range of 30 MHz to 1 GHz at 3-meter distance. The Bilog antenna was searched from 1 to 4 meters in height in both horizontal and vertical orientation. The EUT was also rotated 360 degrees in front of the measurement antenna.

Measurements were performed in the frequency range of 1 GHz to 24.835 GHz at 3-meter distance. The Horn antenna was in both horizontal and vertical orientation. The EUT was also rotated 360 degrees in front of the measurement antenna. Only the second harmonic of the transmitter was observed, all others were baseline of the noise floor measurements. No emissions were observed above the third harmonic of the fundamental frequency.

Exploratory radiated emissions measurements of the transmitter frequencies were made to determine the maximum transmit level of the EUT. All frequencies were searched for any emissions from the EUT. No other emissions were observed.

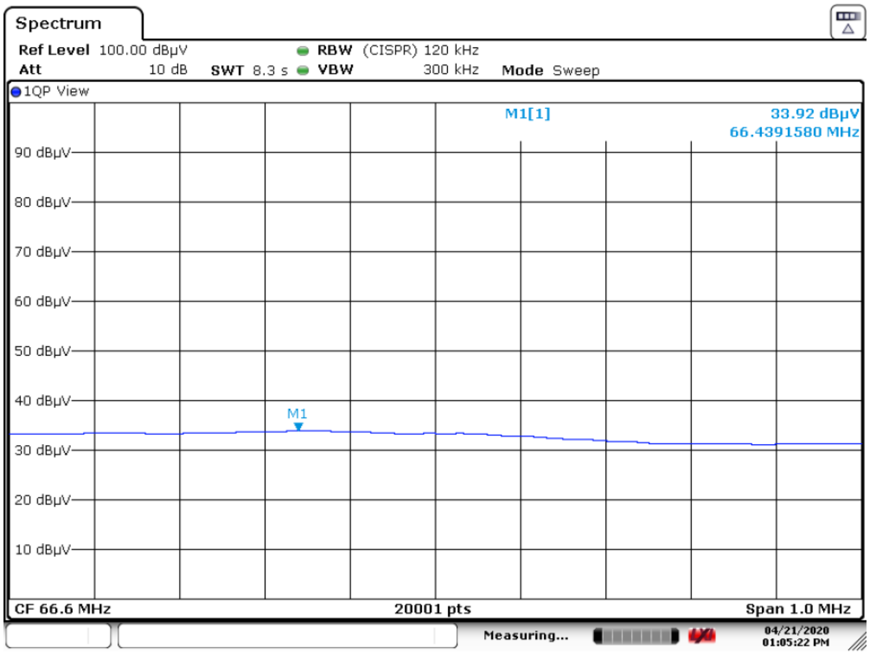
## Radiated Data

*Table 13 – Radiated Data*

| Frequency MHz | Quasi-Peak Level dBµV/m | Site CF | Corrected Level dBµV/m | Limit | Margin dB | Antenna, Polarization Azimuth, Height |
|---|---|---|---|---|---|---|
| 66.44 | 33.28 | -19.08 | 14.20 | 40.00 | -25.80 | H, 180, 2.2 |
| 93.1 | 32.83 | -15.63 | 17.20 | 43.50 | -26.30 | H, 225, 2 |
| 103.29 | 30.42 | -13.90 | 16.52 | 43.50 | -26.98 | H, 202, 2 |
| 110.8 | 26.89 | -13.34 | 13.55 | 43.50 | -29.95 | H, 112, 2.1 |
| 118.65 | 26.15 | -13.01 | 13.14 | 43.50 | -30.36 | H, 112, 2.1 |
| 240 | 35.23 | -13.68 | 21.55 | 46.00 | -24.45 | H, 157, 1.8 |
| 660 | 26.11 | -4.64 | 21.47 | 46.00 | -24.53 | H, 202, 1.4 |
| 54 | 31.24 | -18.46 | 12.78 | 40.00 | -27.22 | V, 247, 1.2 |
| 61.95 | 33.56 | -19.24 | 14.32 | 40.00 | -25.68 | V, 247, 1.2 |
| 66.25 | 32.82 | -19.10 | 13.72 | 40.00 | -26.28 | V, 90, 1.2 |
| 115.05 | 27.69 | -13.11 | 14.58 | 43.50 | -28.92 | V, 270, 1.1 |
| 119.8 | 26.71 | -13.01 | 13.70 | 43.50 | -29.80 | V, 270, 1.14 |
| 140 | 29.52 | -14.09 | 15.43 | 43.50 | -28.07 | V, 45, 1.1 |
| 240.55 | 30.51 | -13.63 | 16.88 | 46.00 | -29.12 | V, 225, 1.2 |

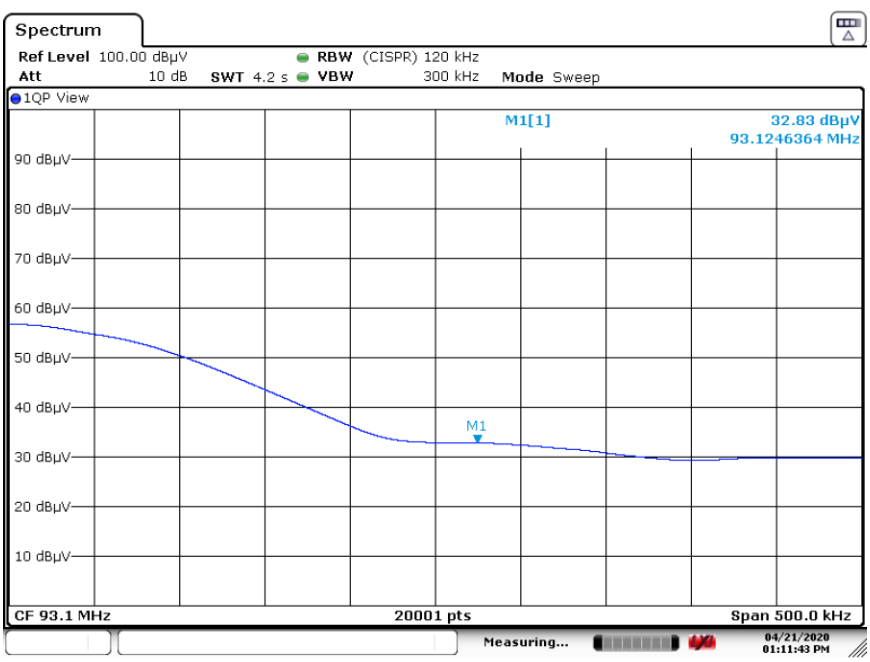
Site CF = antenna factor, cable loss, preamp gain

Antenna horizontal orientation plots




Date: 21.APR.2020 13:05:22

Antenna horizontal orientation plots

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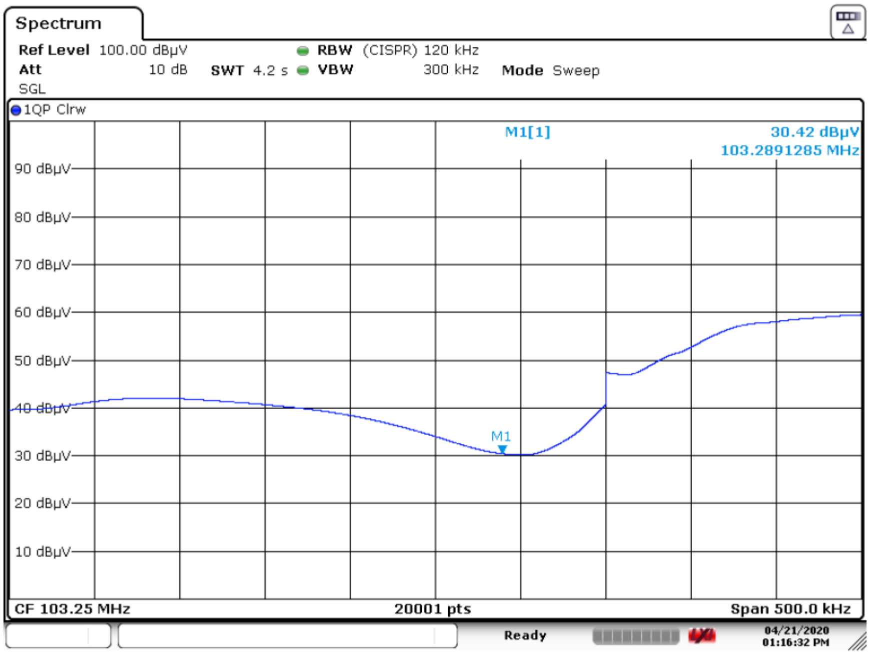


Date: 21.APR.2020 13:16:32

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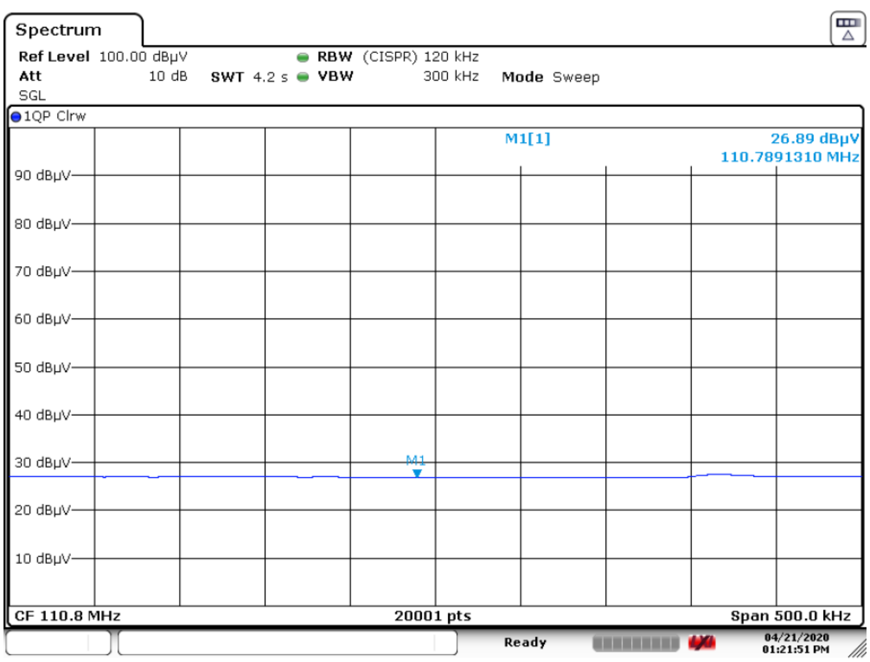
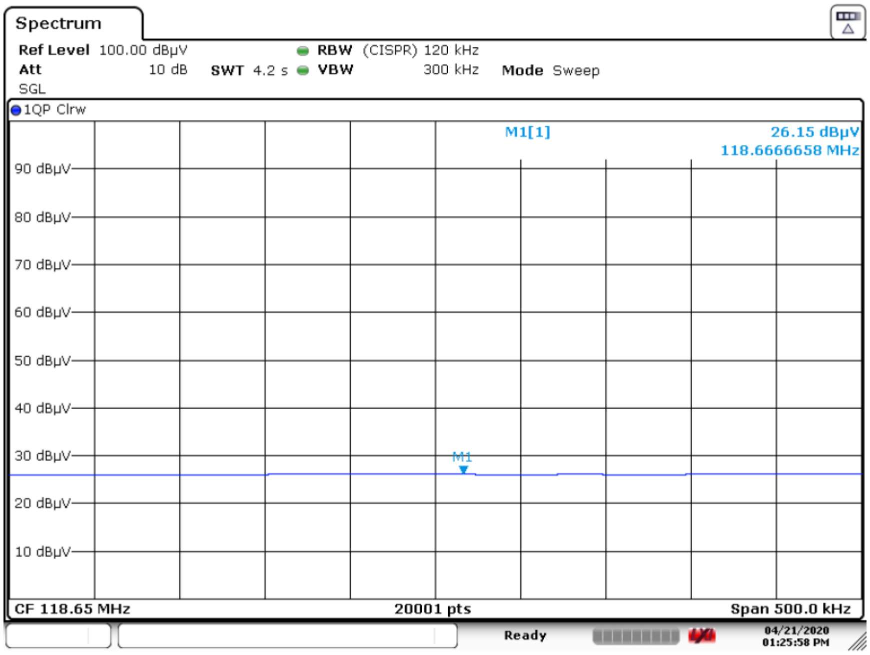


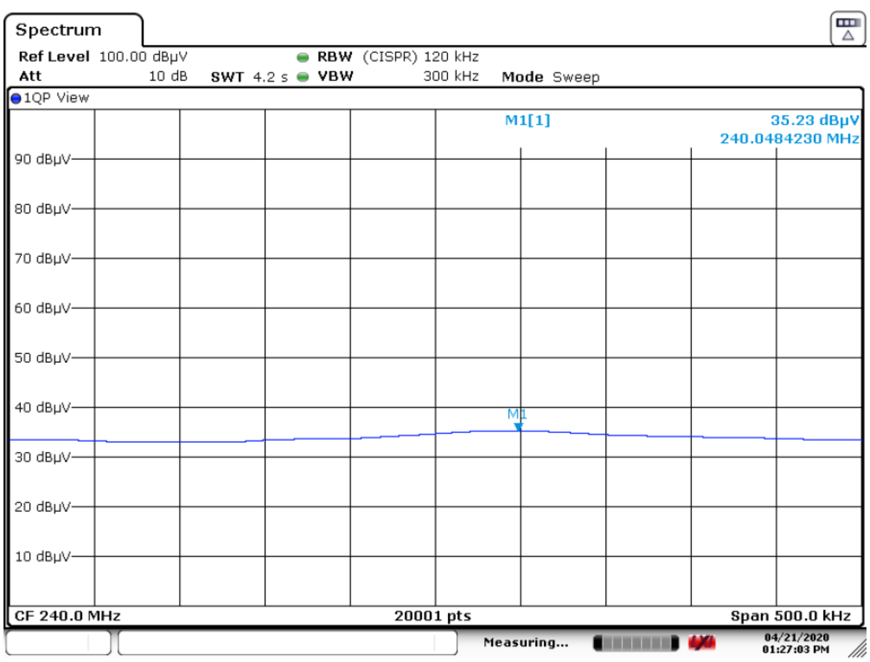

Date: 21.APR.2020 13:21:51

Antenna horizontal orientation plots




Date: 21.APR.2020 13:25:59

Antenna horizontal orientation plots




Date: 21.APR.2020 13:27:04

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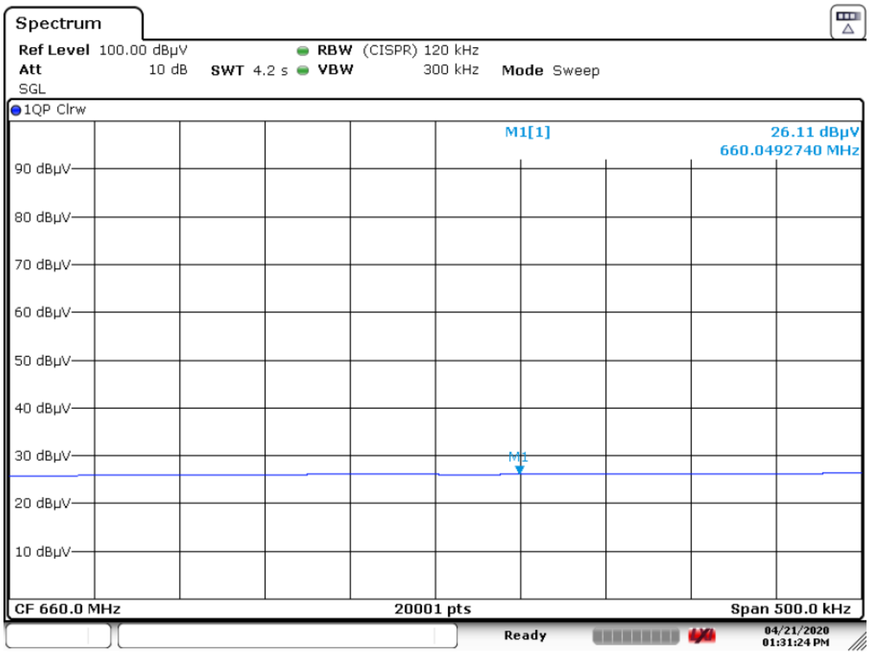
Antenna horizontal orientation plots

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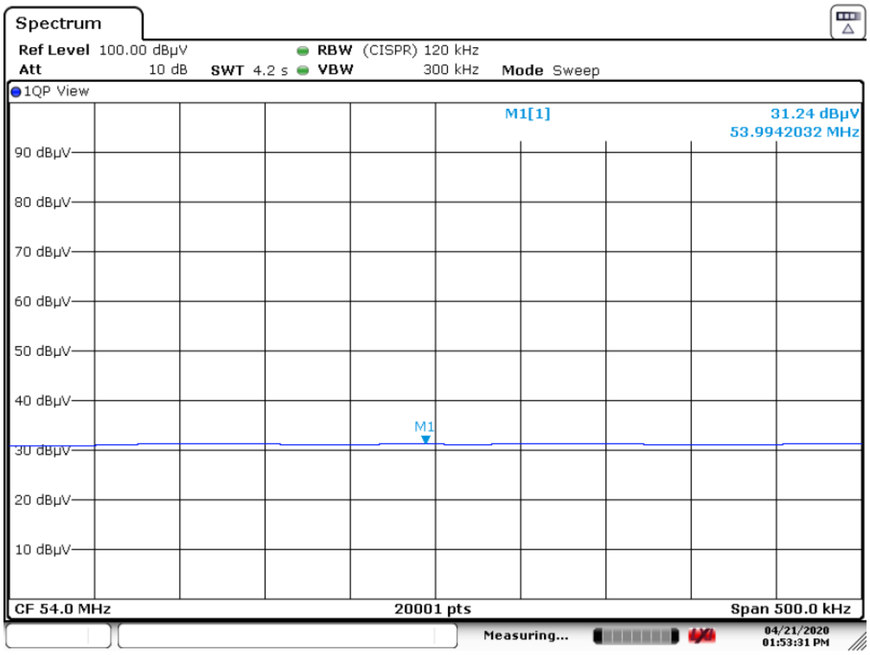
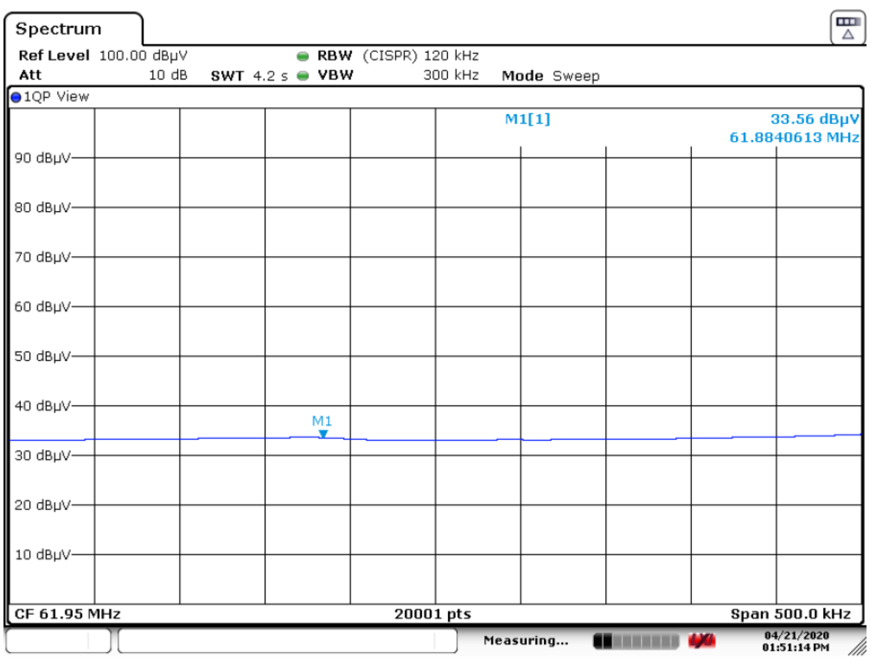
Antenna vertical orientation plots




Date: 21.APR.2020 13:53:32

Antenna vertical orientation plots

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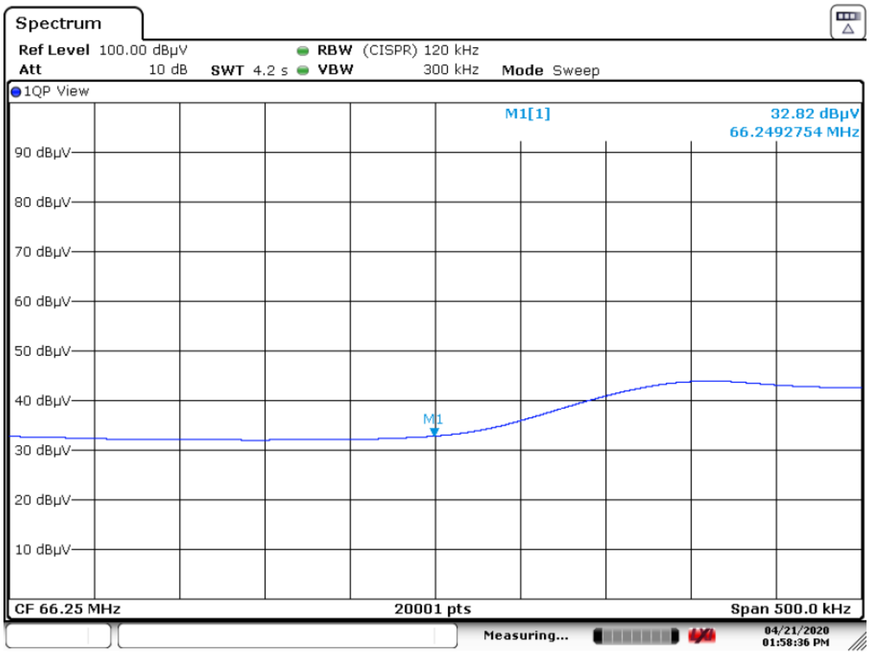
Antenna vertical orientation plots

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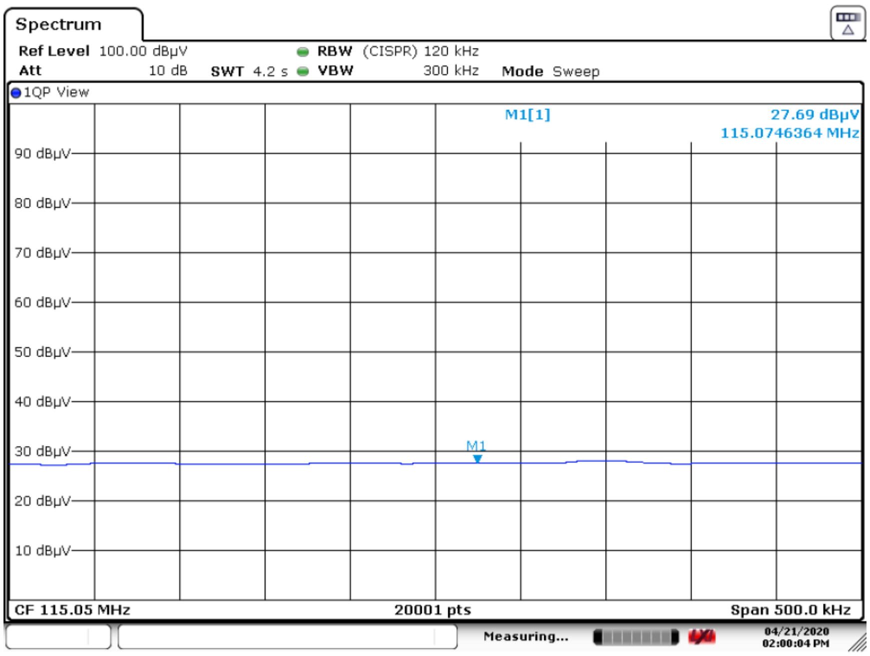
Antenna vertical orientation plots

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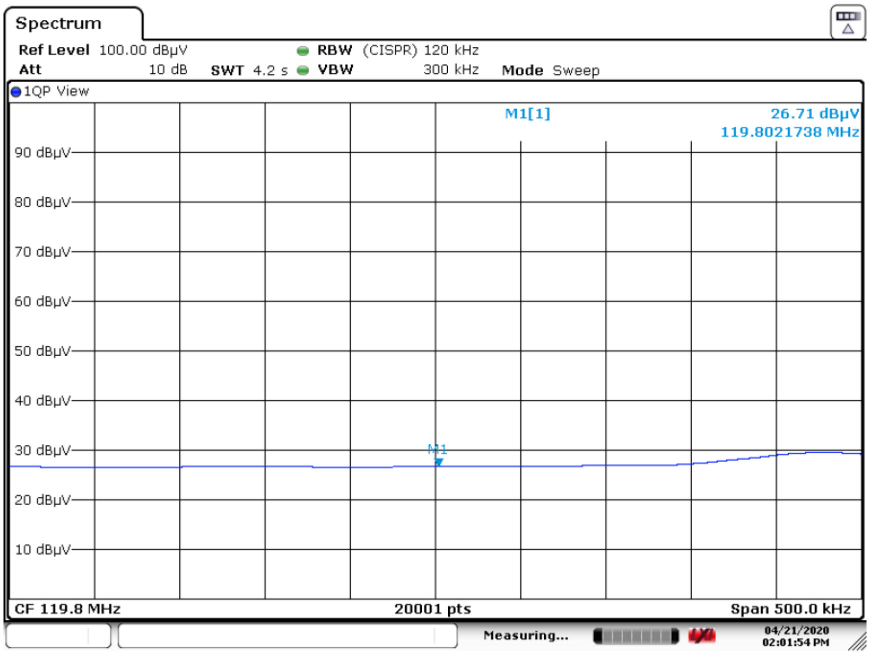
Antenna vertical orientation plots

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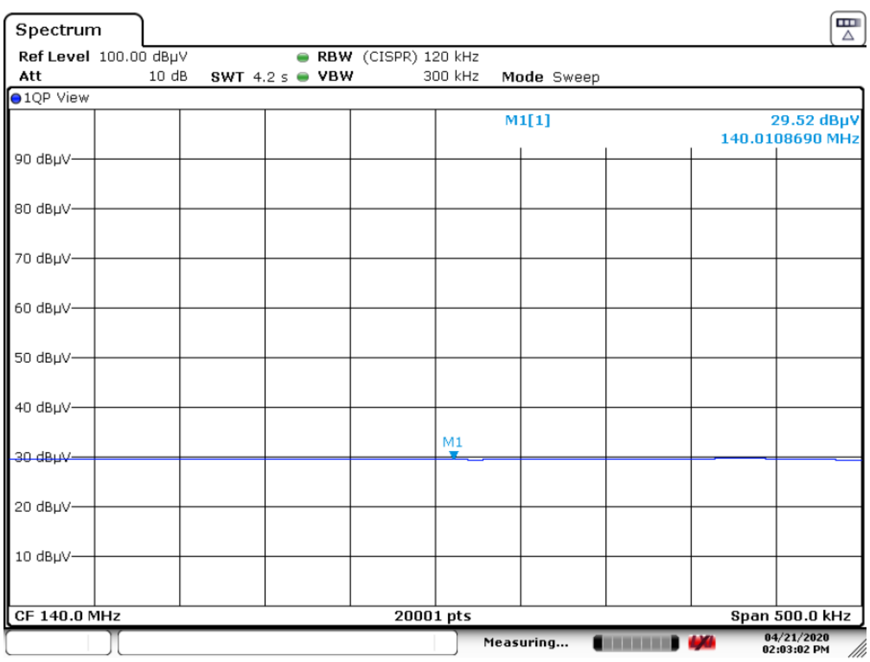


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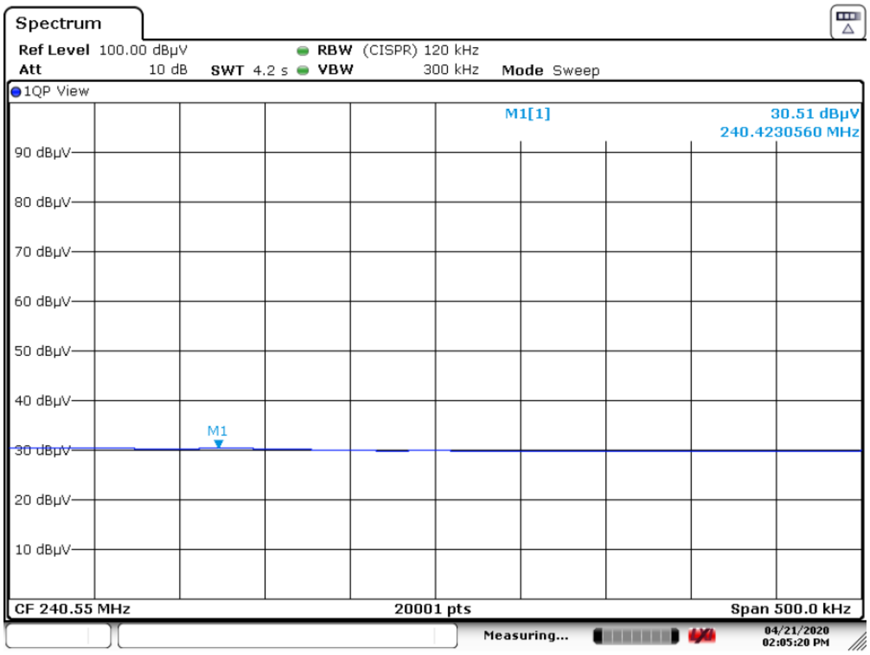
Antenna vertical orientation plots




Date: 21.APR.2020 14:05:20

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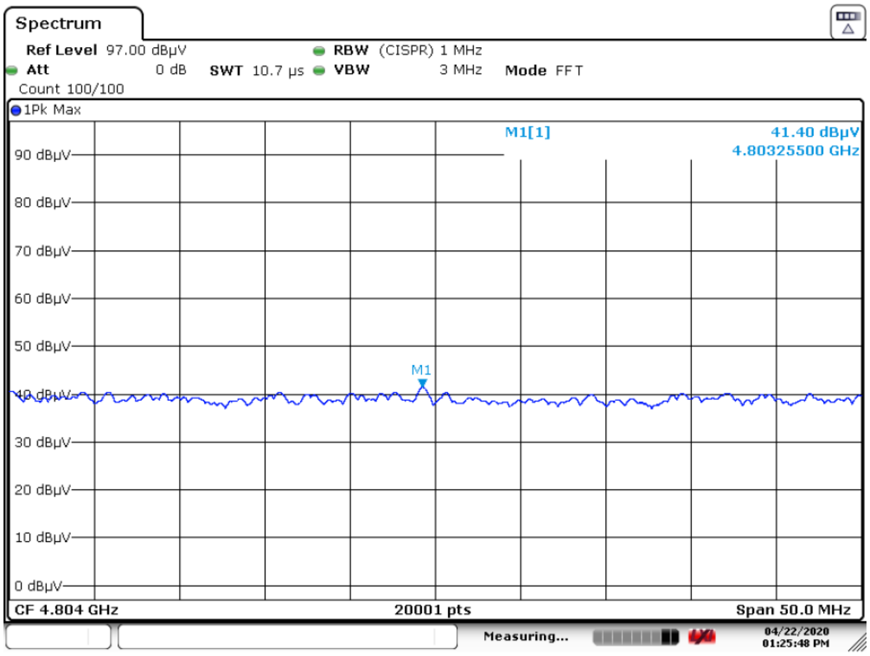
*Table 14 – Radiated Data*

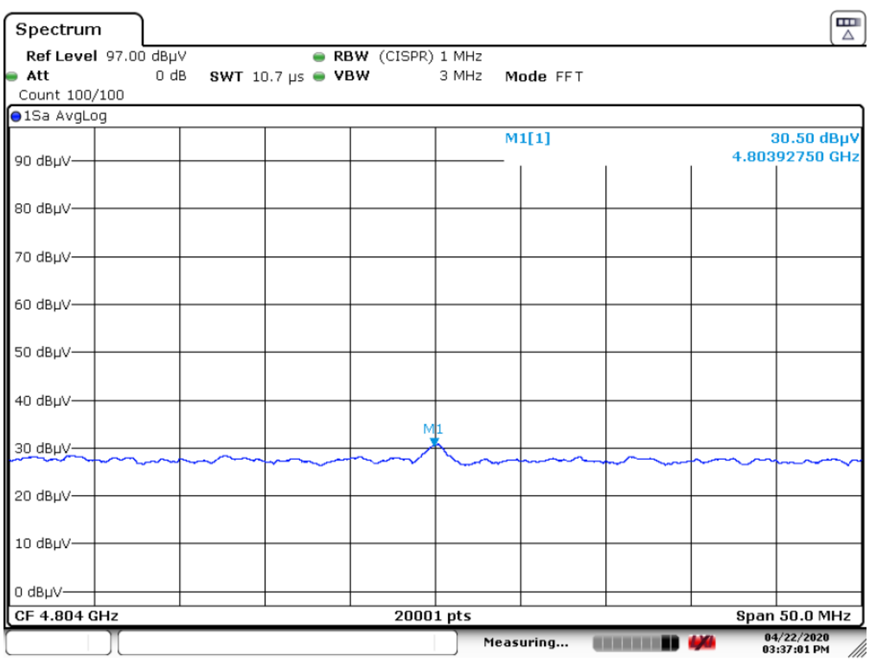
| The data below is at 3-meter distance | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Azimuth, Height** | **Polarization H or V** | **Emission Frequency MHz** | **Measured Level dBuV** | **Site CF dBuV/m** | **Corrected Level dBuV/m** | **3 Meter Limit dBuV/m** | **Level vs Limit dB** |
| **Lowest Channel** | | | | | | | |
| 135, 2 | H-pk | 4804 | 41.4 | 6.28 | 47.68 | 74.00 | -26.32 |
| 135, 2 | H-av | 4804 | 30.5 | 6.28 | 36.78 | 54.00 | -17.22 |
| 135, 2 | H-pk | 7206 | 40.98 | 8.77 | 49.75 | 74.00 | -24.25 |
| 135, 2 | H-av | 7206 | 28.37 | 8.77 | 37.14 | 54.00 | -16.86 |
| 135, 2 | H-pk | 9608 | 39.53 | 10.33 | 49.86 | 74.00 | -24.14 |
| 135, 2 | H-av | 9608 | 28.55 | 10.33 | 38.88 | 54.00 | -15.12 |
| 248, 1.5 | V-pk | 4804 | 41.75 | 6.28 | 48.03 | 74.00 | -25.97 |
| 248, 1.5 | V-av | 4804 | 32.24 | 6.28 | 38.52 | 54.00 | -15.48 |
| 248, 1.5 | V-pk | 7206 | 38.82 | 8.77 | 47.59 | 74.00 | -26.41 |
| 248, 1.5 | V-av | 7206 | 28.22 | 8.77 | 36.99 | 54.00 | -17.01 |
| 248, 1.5 | V-pk | 9608 | 39.91 | 10.33 | 50.24 | 74.00 | -23.76 |
| 248, 1.5 | V-av | 9608 | 29.15 | 10.33 | 39.48 | 54.00 | -14.52 |
| **Middle Channel** | | | | | | | |
| 135, 2 | H-pk | 4880 | 43.14 | 6.46 | 49.60 | 74.00 | -24.40 |
| 135, 2 | H-av | 4880 | 31.72 | 6.46 | 38.18 | 54.00 | -15.82 |
| 135, 2 | H-pk | 7320 | 40.52 | 8.86 | 49.38 | 74.00 | -24.62 |
| 135, 2 | H-av | 7320 | 29.27 | 8.86 | 38.13 | 54.00 | -15.87 |
| 135, 2 | H-pk | 9760 | 41.6 | 10.47 | 52.07 | 74.00 | -21.93 |
| 135, 2 | H-av | 9760 | 30.02 | 10.47 | 40.49 | 54.00 | -13.51 |
| 292, 1.4 | V-pk | 4880 | 44.79 | 6.46 | 51.25 | 74.00 | -22.75 |
| 292, 1.4 | V-av | 4880 | 32.23 | 6.46 | 38.69 | 54.00 | -15.31 |
| 292, 1.4 | V-pk | 7320 | 40.1 | 8.86 | 48.96 | 74.00 | -25.04 |
| 292, 1.4 | V-av | 7320 | 28.65 | 8.86 | 37.51 | 54.00 | -16.49 |
| 292, 1.4 | V-pk | 9760 | 41.6 | 10.47 | 52.07 | 74.00 | -21.93 |
| 292, 1.4 | V-av | 9760 | 29.61 | 10.47 | 40.08 | 54.00 | -13.92 |
| **Highest Channel** | | | | | | | |
| 135, 2 | H-pk | 4960 | 43.87 | 6.65 | 50.52 | 74.00 | -23.48 |
| 135, 2 | H-av | 4960 | 31.75 | 6.65 | 38.40 | 54.00 | -15.60 |
| 135, 2 | H-pk | 7440 | 42.88 | 8.95 | 51.83 | 74.00 | -22.17 |
| 135, 2 | H-av | 7440 | 30.54 | 8.95 | 39.49 | 54.00 | -14.51 |
| 135, 2 | H-pk | 9920 | 40.52 | 10.50 | 51.02 | 74.00 | -22.98 |
| 135, 2 | H-av | 9920 | 29.14 | 10.50 | 39.64 | 54.00 | -14.36 |
| 292, 1.3 | V-pk | 4960 | 46.28 | 6.65 | 52.93 | 74.00 | -21.07 |
| 292, 1.3 | V-av | 4960 | 32.11 | 6.65 | 38.76 | 54.00 | -15.24 |
| 292, 1.3 | V-pk | 7440 | 40.76 | 8.95 | 49.71 | 74.00 | -24.29 |
| 292, 1.3 | V-av | 7440 | 28.99 | 8.95 | 37.94 | 54.00 | -16.06 |
| 292, 1.3 | V-pk | 9920 | 40.48 | 10.50 | 50.98 | 74.00 | -23.02 |
| 292, 1.3 | V-av | 9920 | 29.46 | 10.50 | 39.96 | 54.00 | -14.04 |
| No other emissions were observed | | | | | | | |
| Operating mode of the transmitter was GFSK modulation. Only baseline noise floor was observed above the third harmonic. Note: pk – peak readings, av – average readings, H – horizontal polarization, V – vertical polarization, Site CF = antenna factor + cable loss – preamp gain | | | | | | | |

Lowest channel horizontal peak reading 2nd harmonic



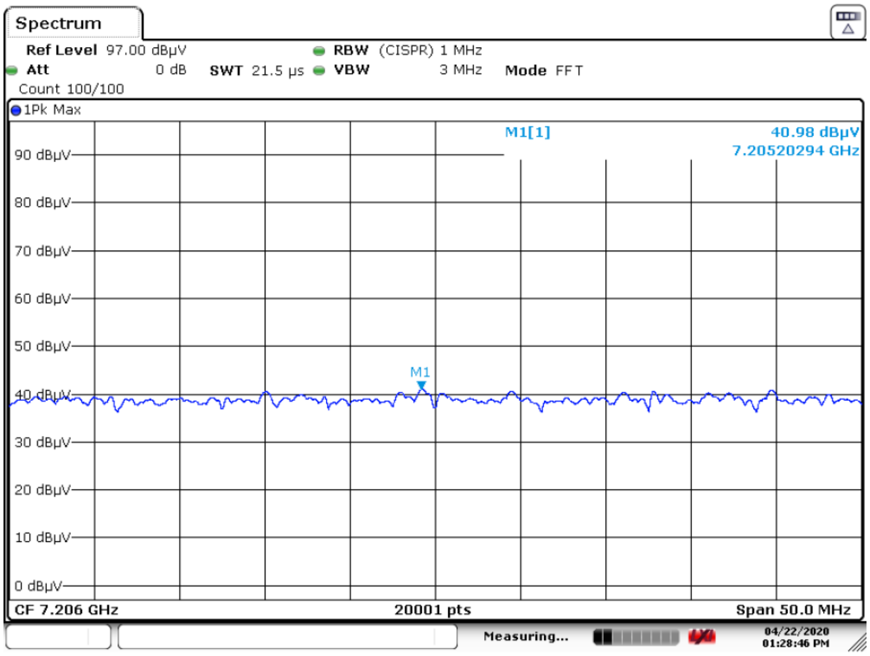

Date: 22.APR.2020 13:25:48

Lowest channel horizontal average reading 2nd harmonic




Date: 22.APR.2020 15:37:01

Lowest channel horizontal peak reading 3rd harmonic – only noise floor measurement

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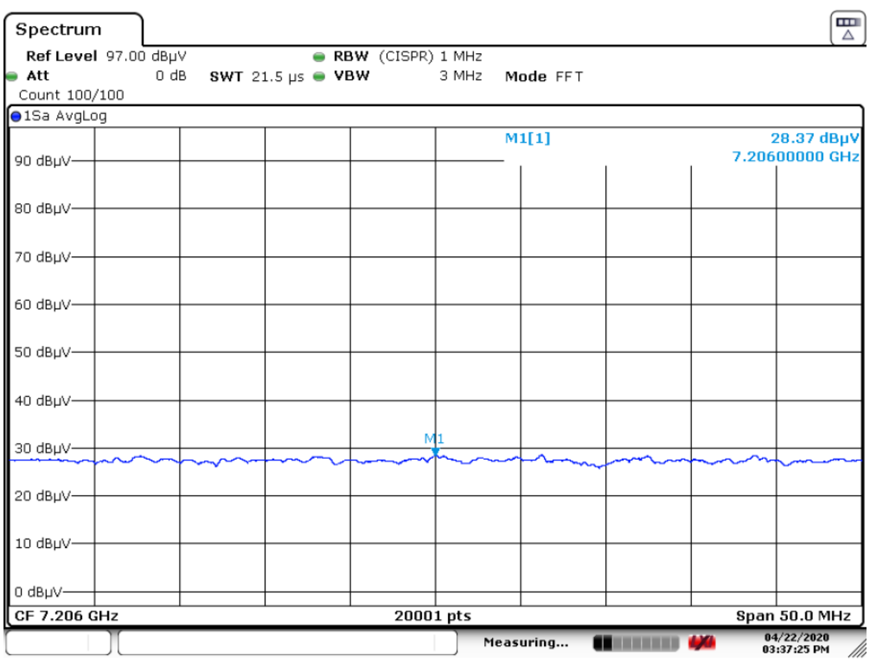
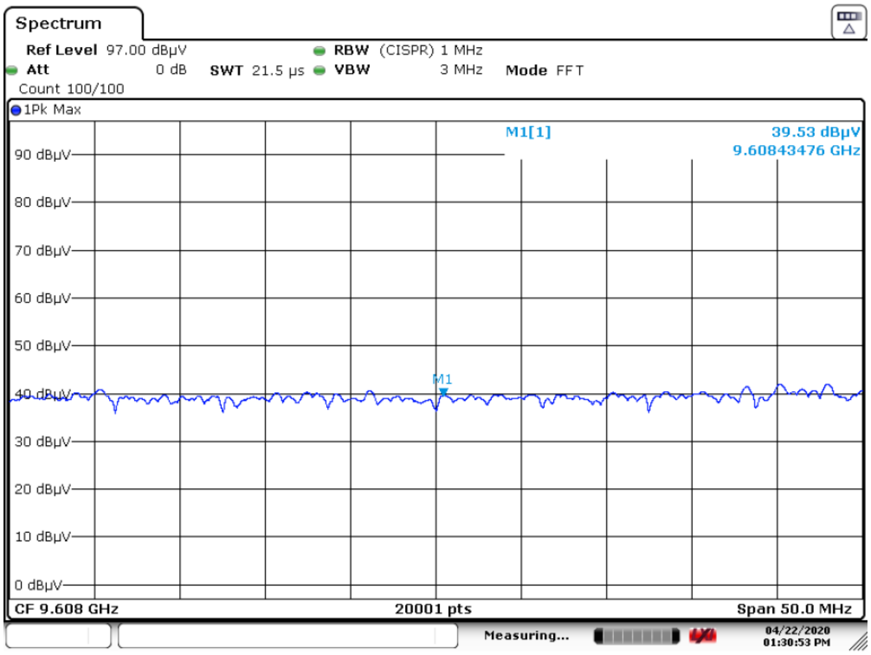
Lowest channel horizontal average reading 3rd harmonic – only noise floor measurement




Date: 22.APR.2020 15:37:25

Lowest channel horizontal peak reading 4th harmonic – only noise floor measurement

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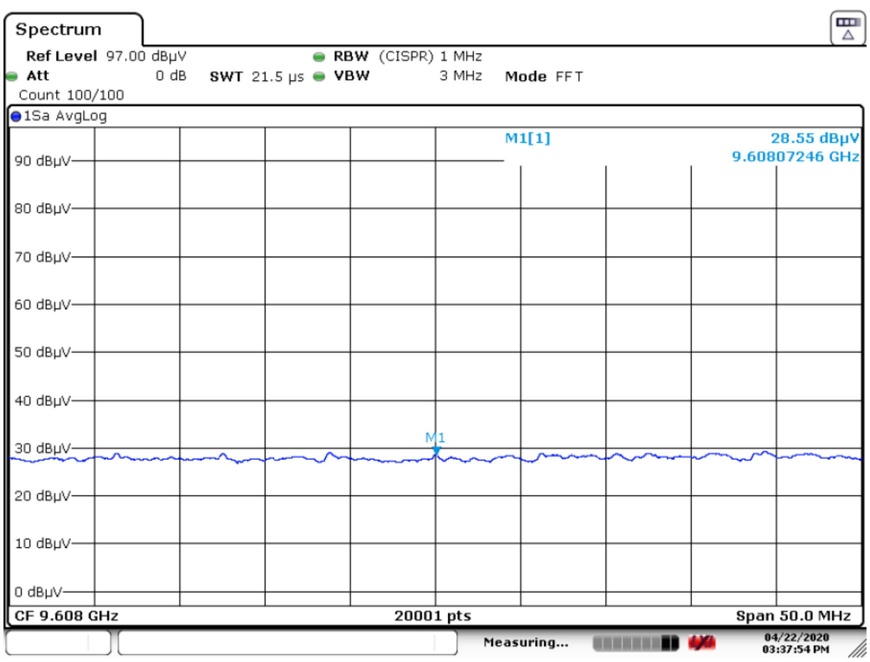
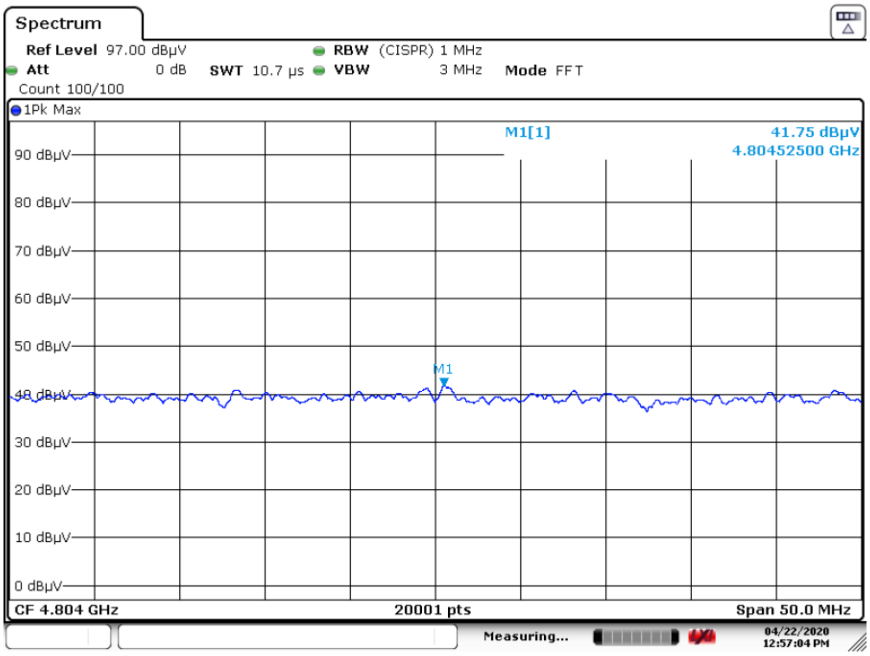
Lowest channel horizontal average reading 4th harmonic – only noise floor measurement



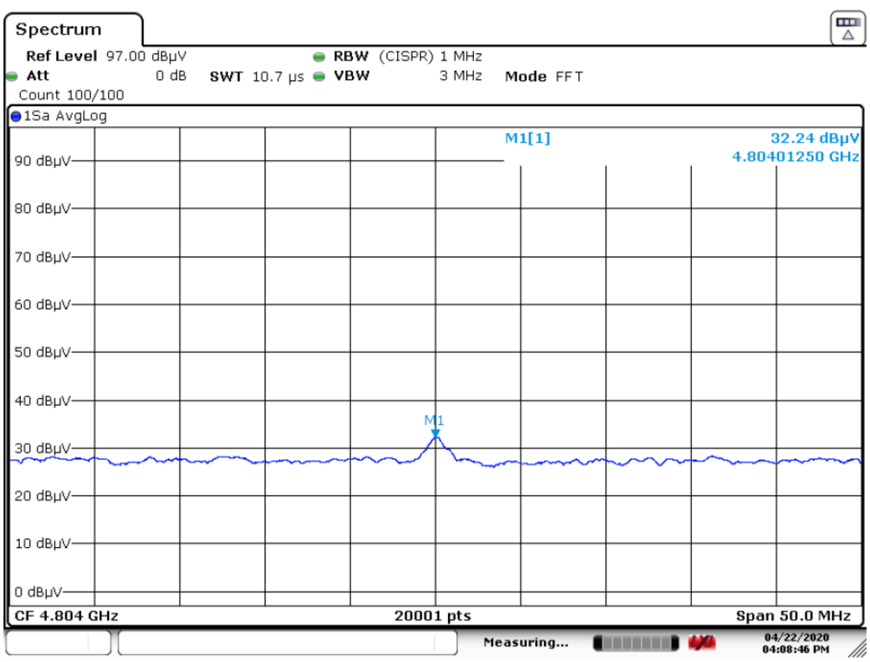

Date: 22.APR.2020 15:37:54

Lowest channel vertical peak reading 2nd harmonic



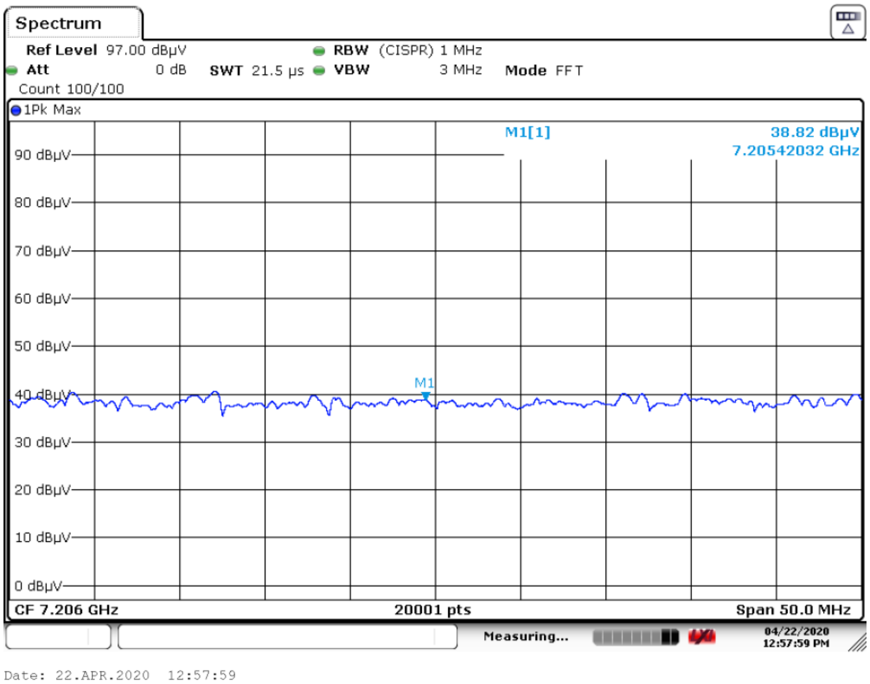

Date: 22.APR.2020 12:57:04

Lowest channel vertical average reading 2nd harmonic

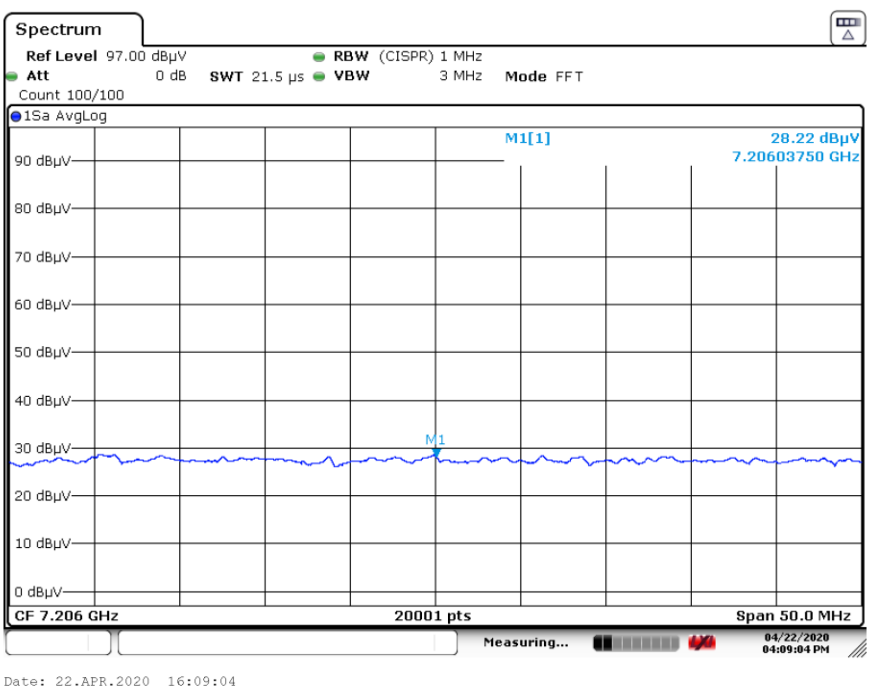



Date: 22.APR.2020 16:08:47

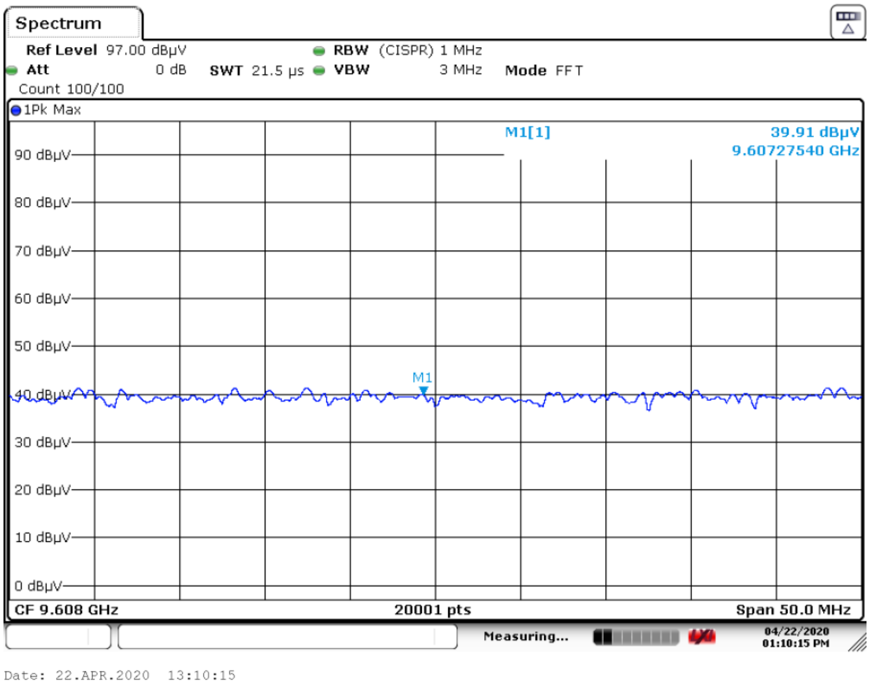
Lowest channel vertical peak reading 3rd harmonic – only noise floor measurement



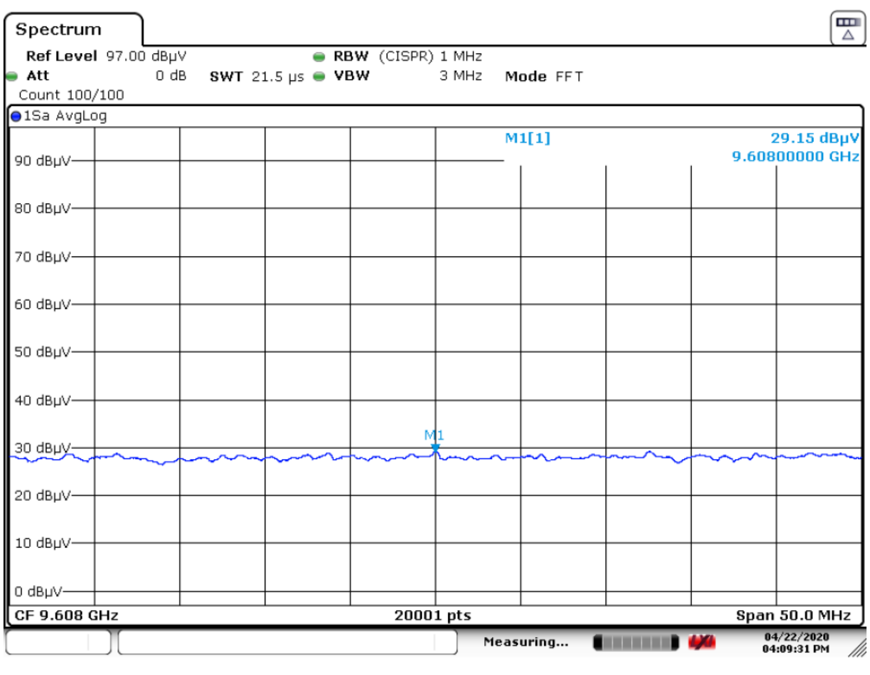

Lowest channel vertical average reading 3rd harmonic – only noise floor measurement



Lowest channel vertical peak reading 4th harmonic – only noise floor measurement




Lowest channel vertical average reading 4th harmonic – only noise floor measurement



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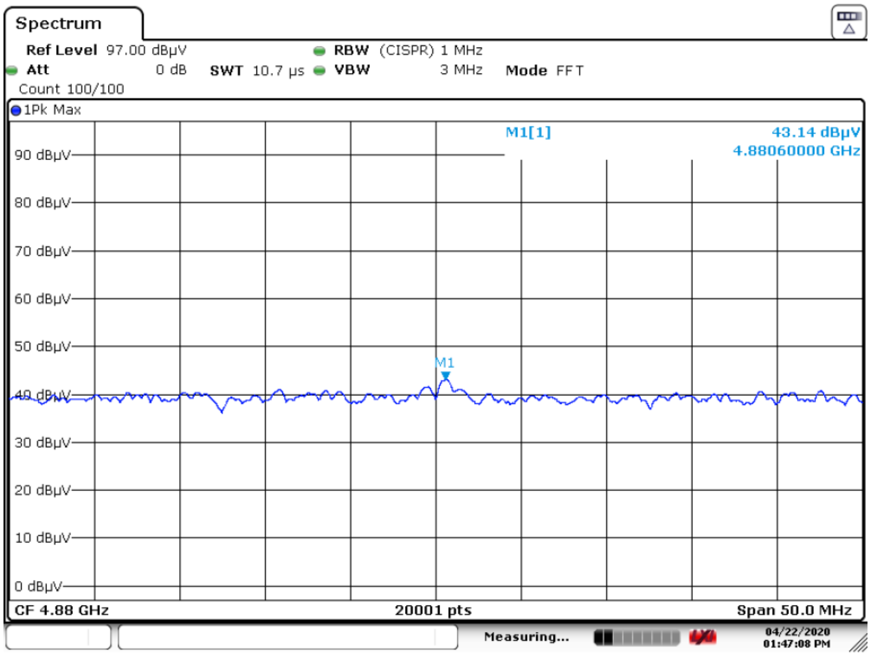
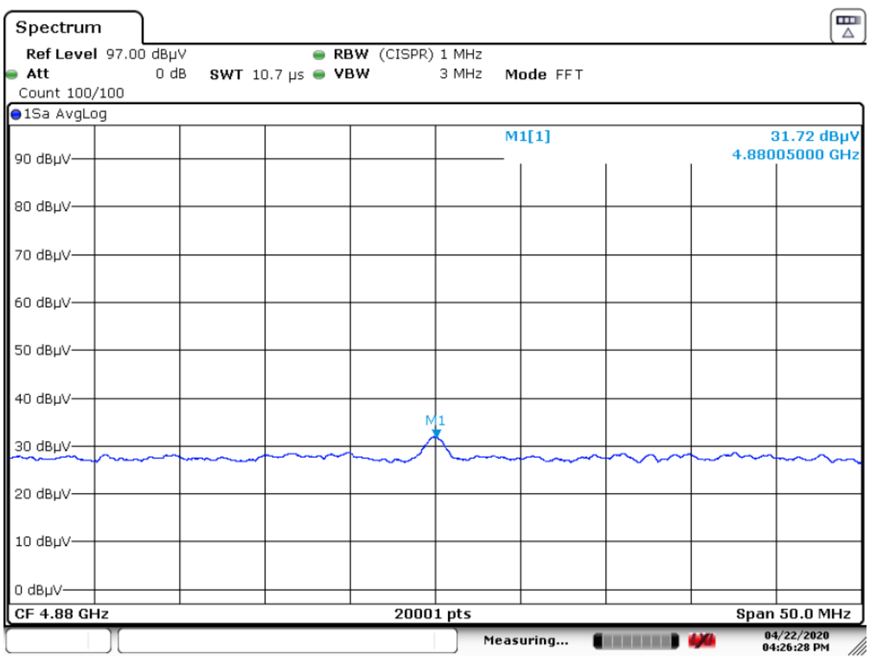
Middle channel horizontal peak reading 2nd harmonic



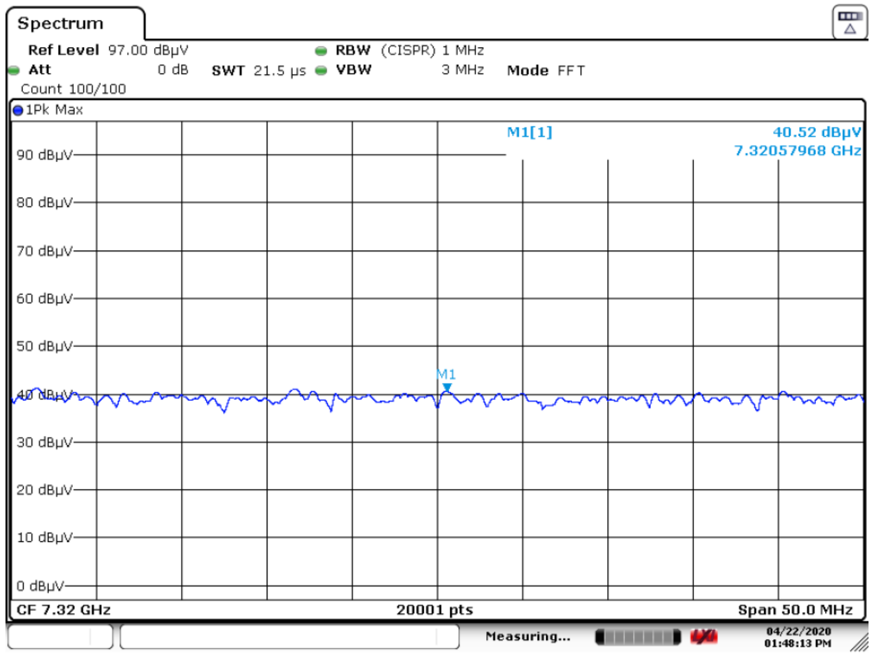

Date: 22.APR.2020 13:47:08

Middle channel horizontal average reading 2nd harmonic




Date: 22.APR.2020 16:26:29

Middle channel horizontal peak reading 3rd harmonic – only noise floor measurement

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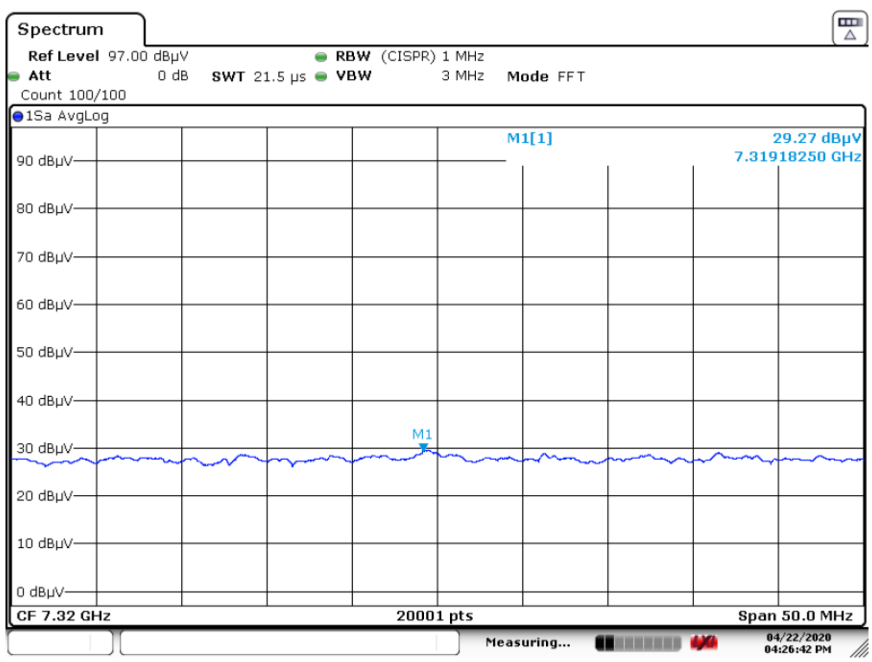
Middle channel horizontal average reading 3rd harmonic – only noise floor measurement

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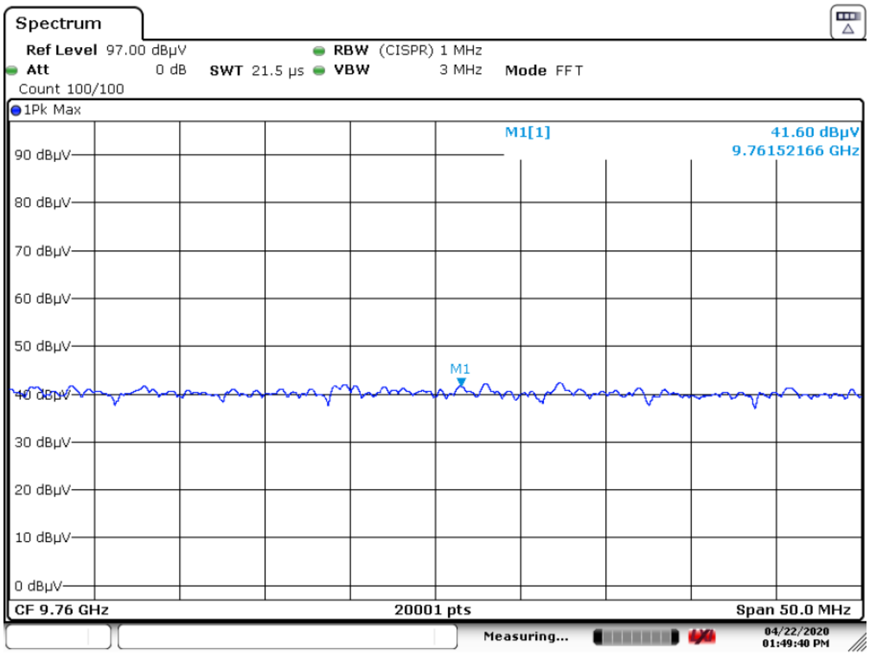
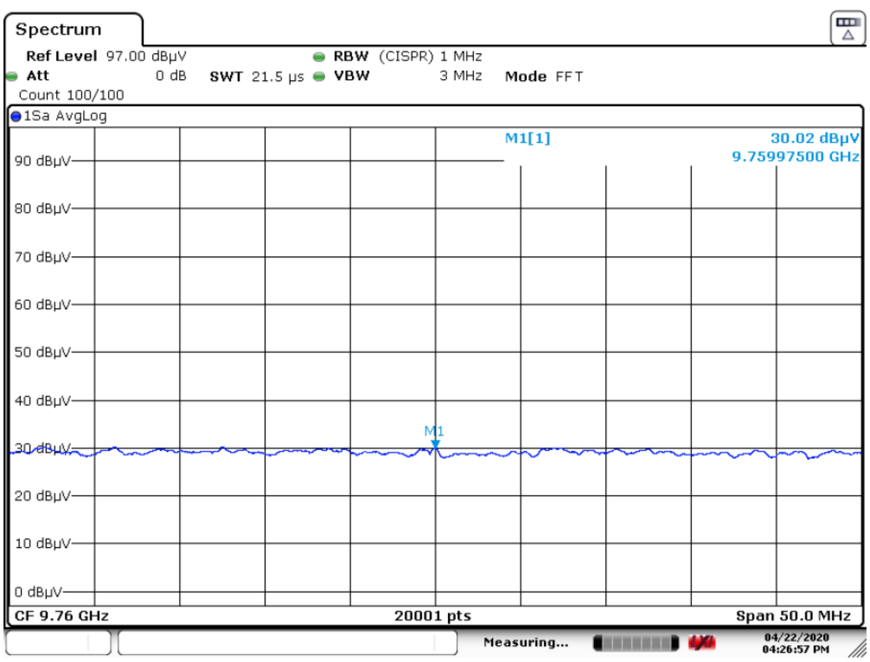
Middle channel horizontal peak reading 4th harmonic – only noise floor measurement



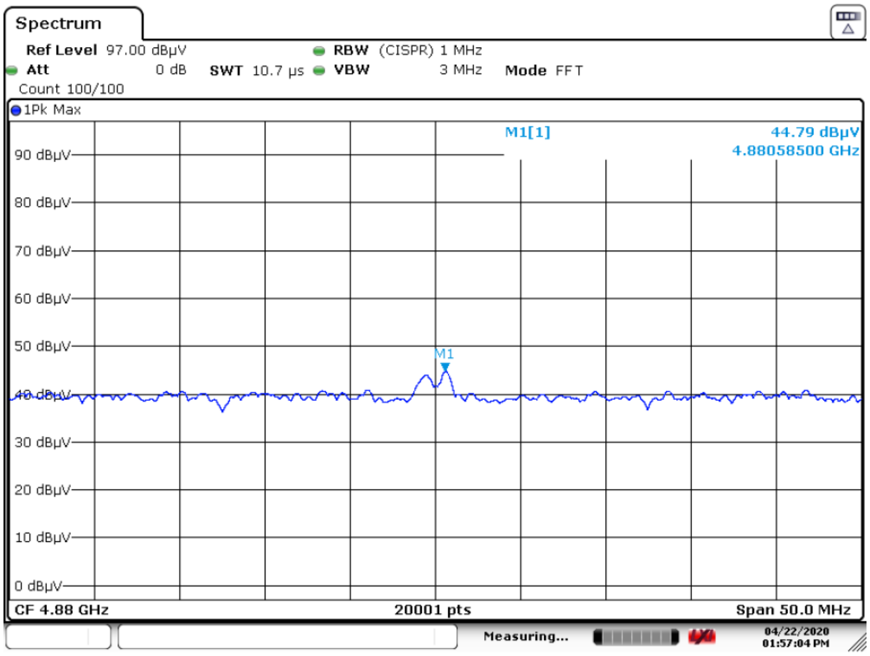

Date: 22.APR.2020 13:49:40

Middle channel horizontal average reading 4th harmonic – only noise floor measurement



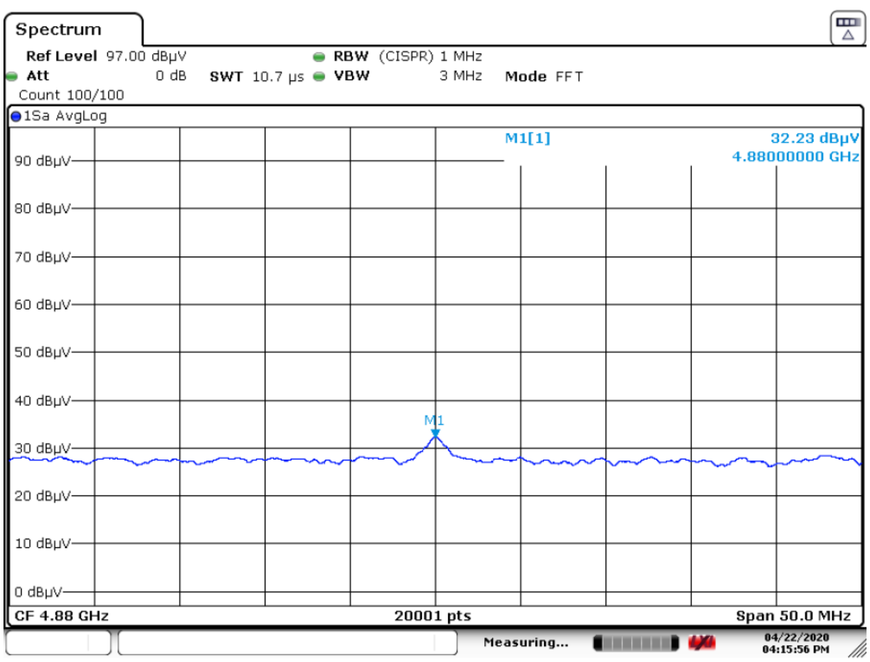

Date: 22.APR.2020 16:26:58

Middle channel vertical peak reading 2nd harmonic



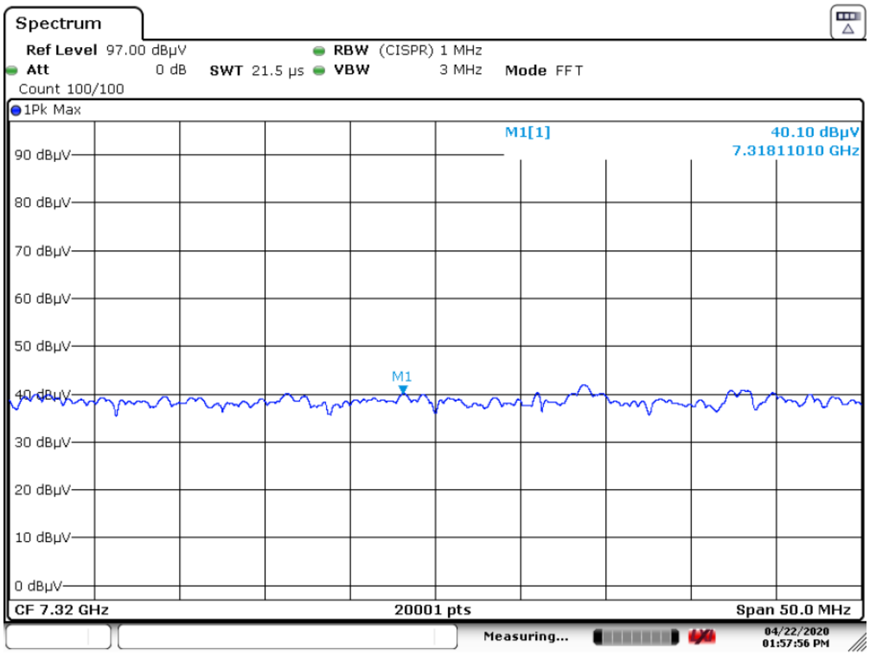

Date: 22.APR.2020 13:57:04

Middle channel vertical average reading 2nd harmonic



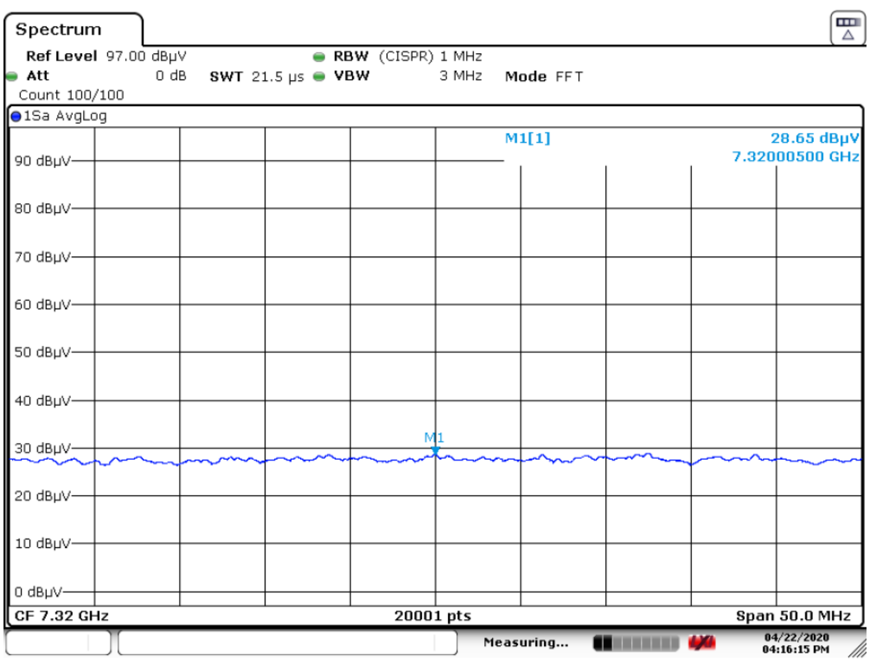

Date: 22.APR.2020 16:15:56

Middle channel vertical peak reading 3rd harmonic – only noise floor measurement



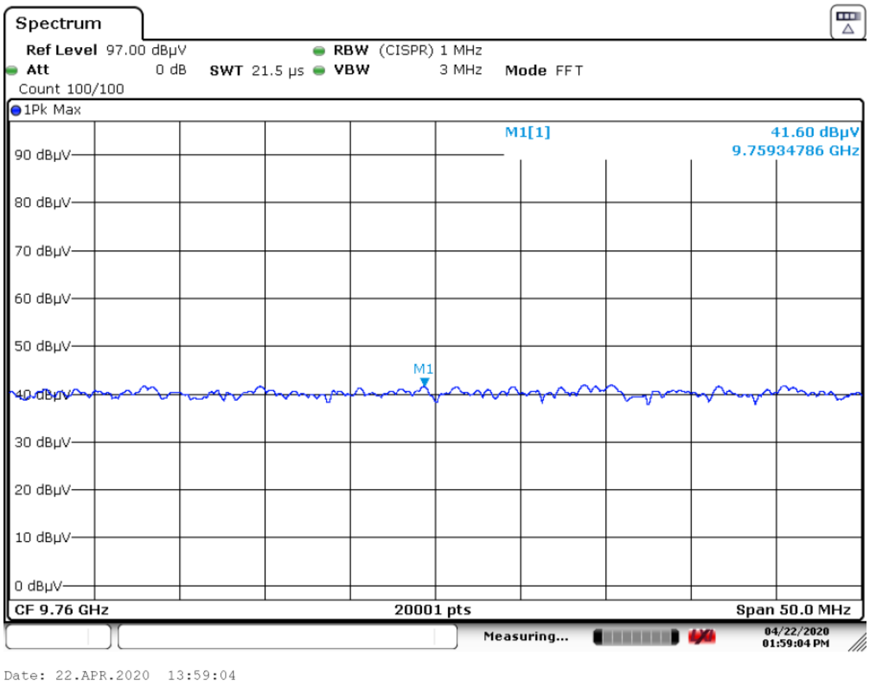

Date: 22.APR.2020 13:57:56

Middle channel vertical average reading 3rd harmonic – only noise floor measurement

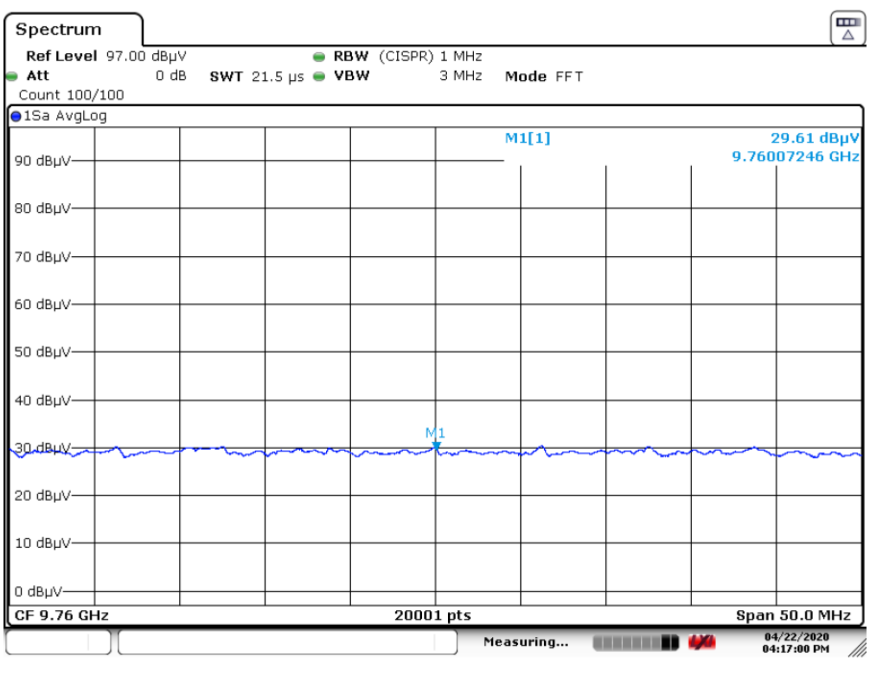



Date: 22.APR.2020 16:16:15

Middle channel vertical peak reading 4th harmonic – only noise floor measurement




Middle channel vertical average reading 4th harmonic – only noise floor measurement



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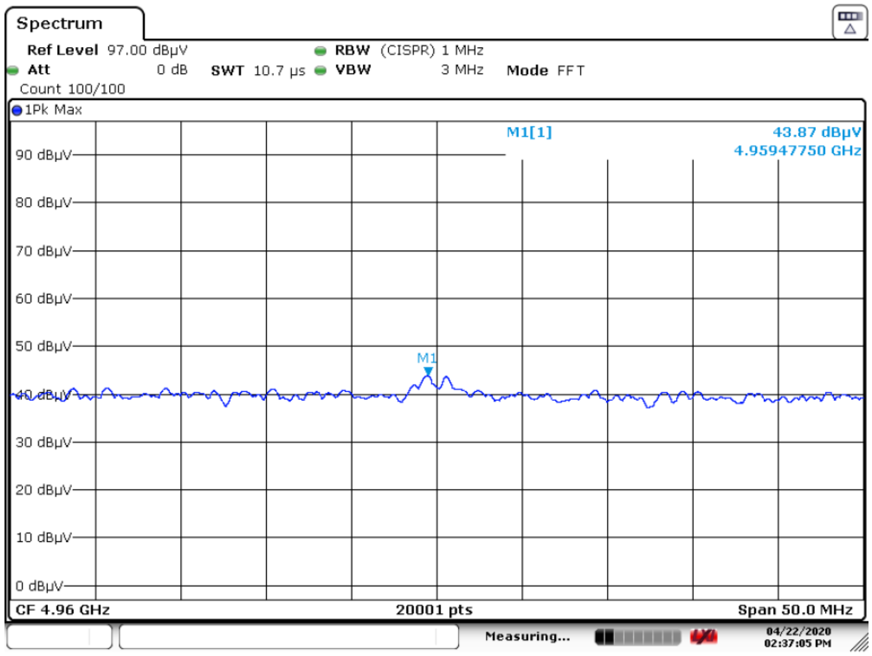
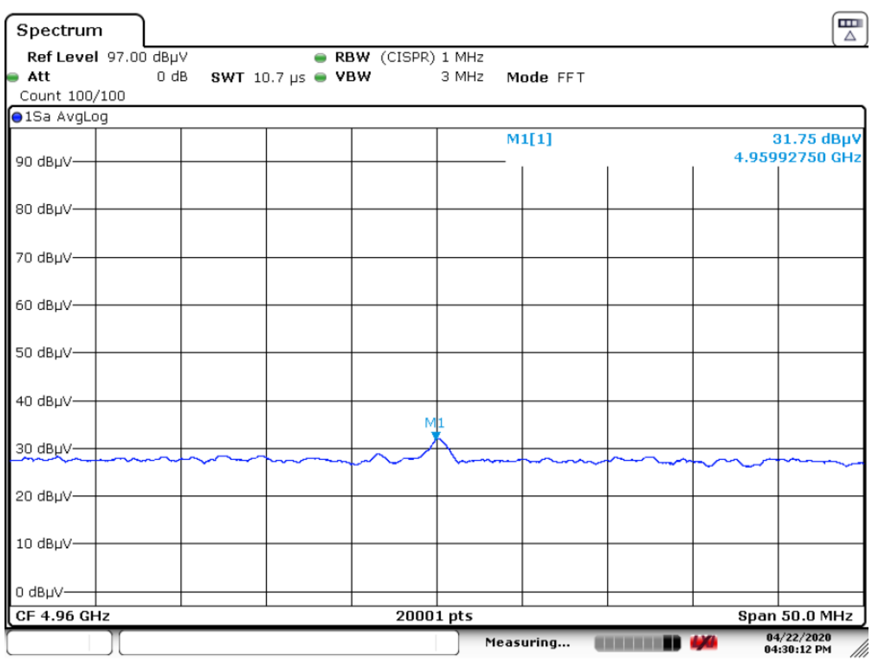
Highest channel horizontal peak reading 2nd harmonic



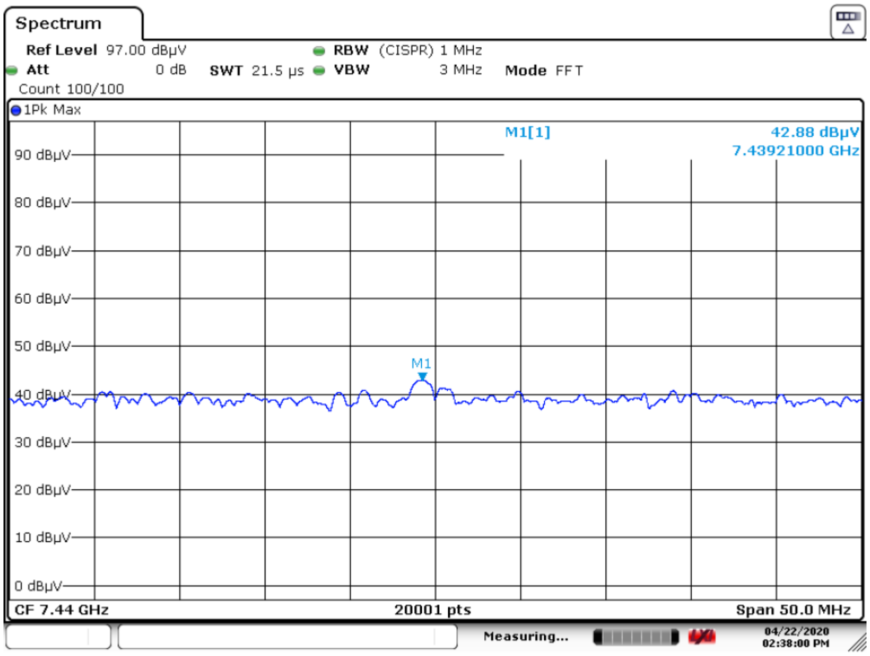

Date: 22.APR.2020 14:37:05

Highest channel horizontal average reading 2nd harmonic



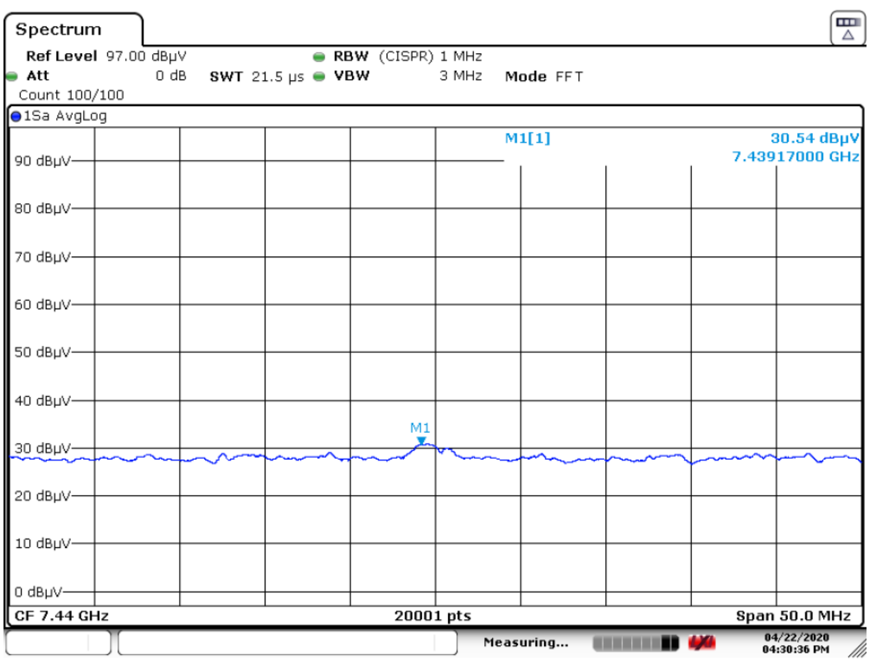

Date: 22.APR.2020 16:30:13

Highest channel horizontal peak reading 3rd harmonic




Date: 22.APR.2020 14:38:00

Highest channel horizontal average reading 3rd harmonic




Date: 22.APR.2020 16:30:36

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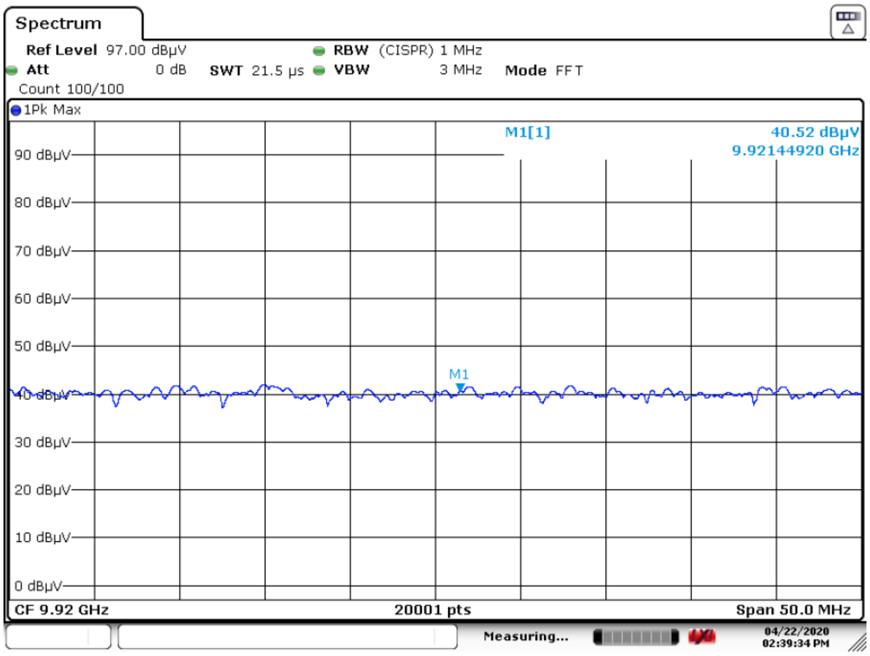
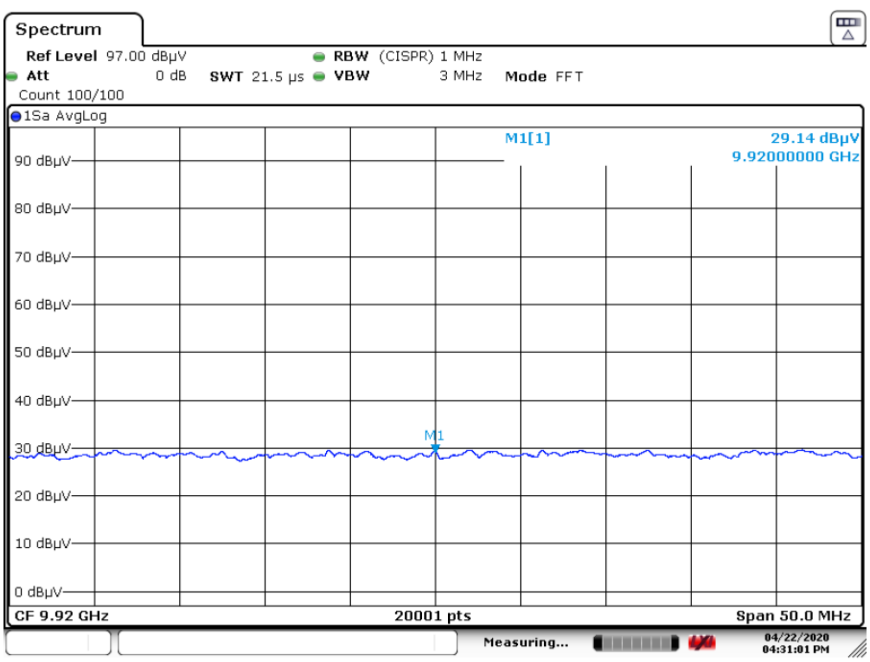
Highest channel horizontal peak reading 4th harmonic – only noise floor measurement



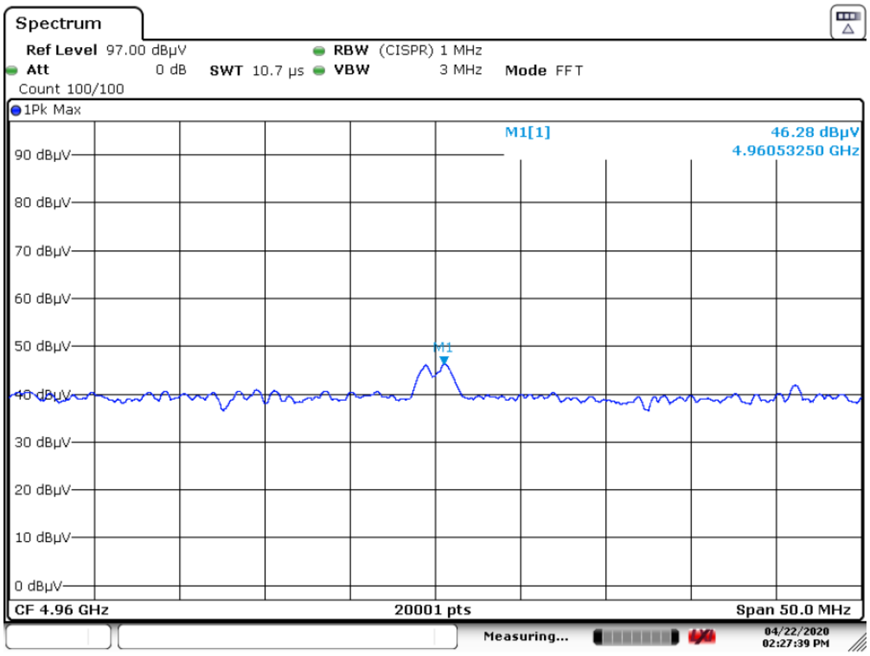

Date: 22.APR.2020 14:39:34

Highest channel horizontal average reading 4th harmonic – only noise floor measurement



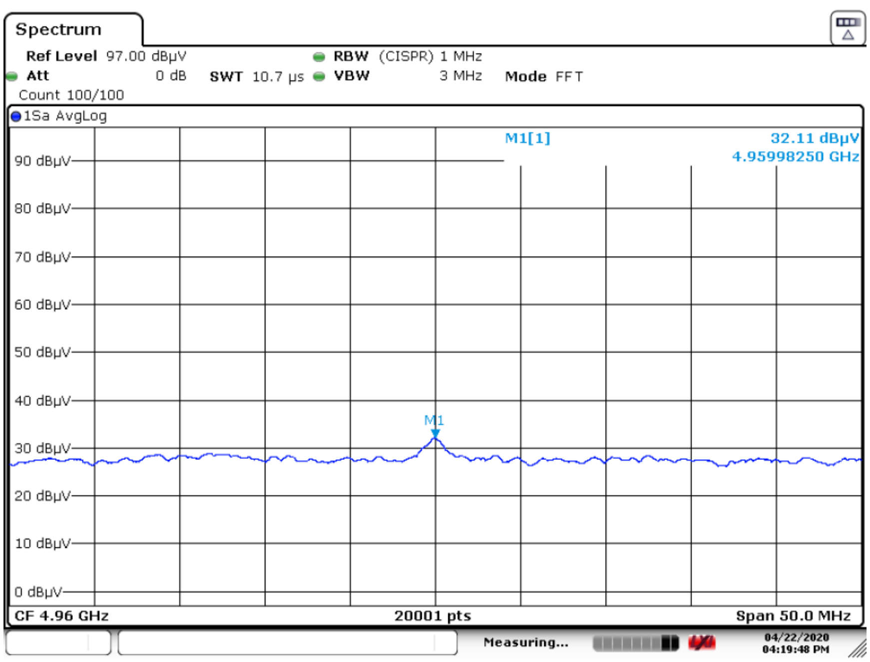

Date: 22.APR.2020 16:31:02

Highest channel vertical peak reading 2nd harmonic



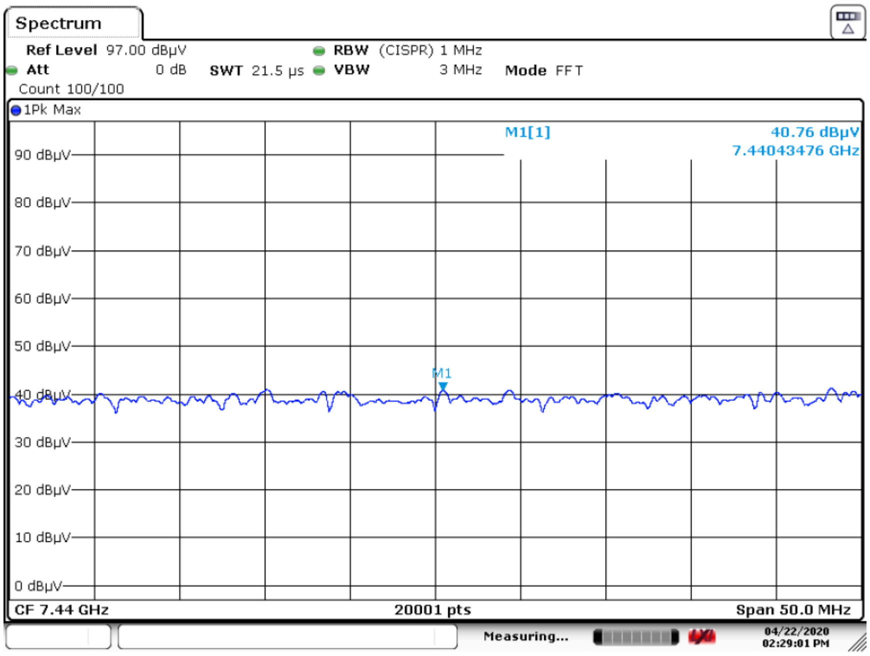

Date: 22.APR.2020 14:27:39

Highest channel vertical average reading 2nd harmonic



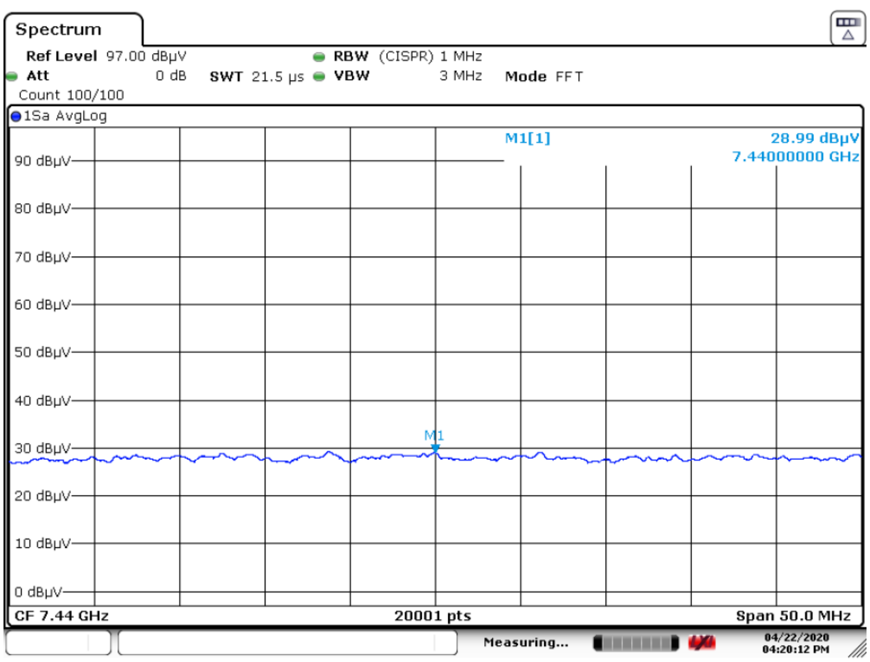

Date: 22.APR.2020 16:19:48

Highest channel vertical peak reading 3rd harmonic – only noise floor measurement



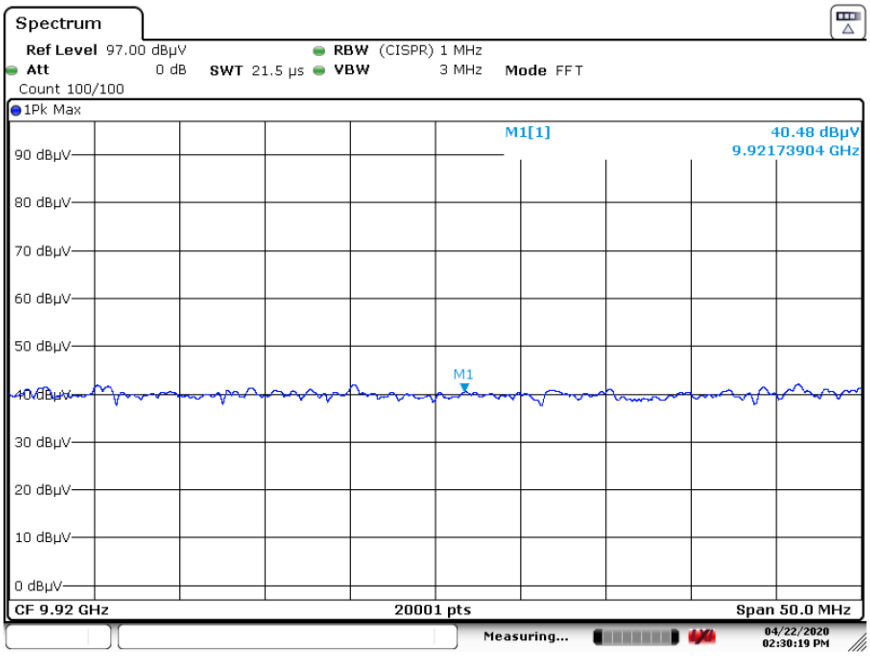

Date: 22.APR.2020 14:29:01

Highest channel vertical average reading 3rd harmonic – only noise floor measurement



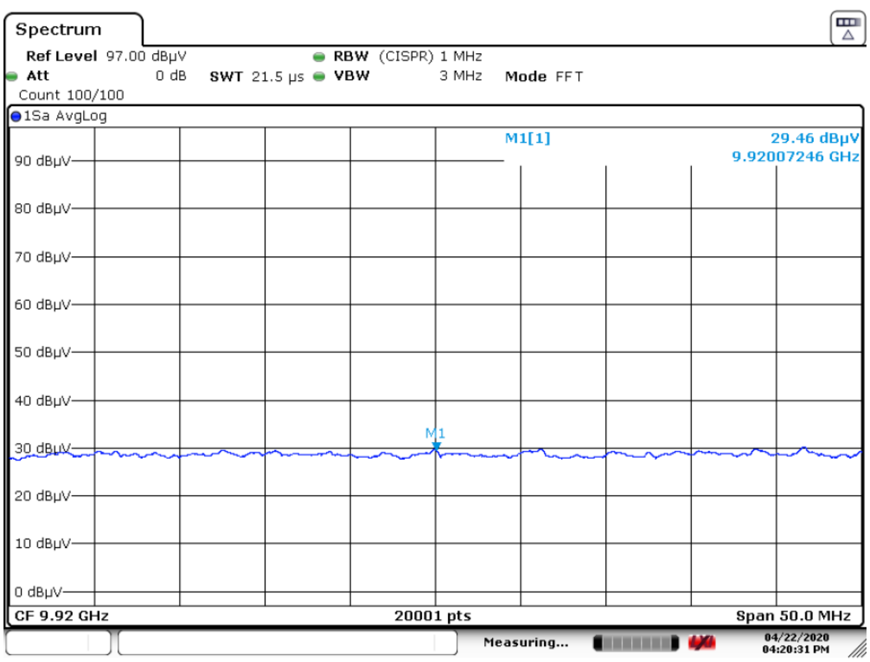

Date: 22.APR.2020 16:20:12

Highest channel vertical peak reading 4th harmonic – only noise floor measurement




Date: 22.APR.2020 14:30:19

Highest channel vertical average reading 4th harmonic – only noise floor measurement




Date: 22.APR.2020 16:20:31

# Frequency Stability

**§15.215 Additional provisions to the general radiated emission limitations. (c)**

The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

**ANSI C63.10 6.8 Frequency stability tests**

Some unlicensed wireless device requirements specify frequency stability tests with variation of supply voltage and temperature; the requirements can be found in the regulatory specifications for each type of unlicensed wireless device. The procedures listed in 6.8.1 and 6.8.2 shall be used for frequency stability tests.

**ANSI C63.10 6.8.1 Frequency stability with respect to ambient temperature**

a) Supply the EUT with a nominal ac voltage or install a new or fully charged battery in the EUT. If possible, a dummy load shall be connected to the EUT because an antenna near the metallic walls of an environmental test chamber could affect the output frequency of the EUT. If the EUT is equipped with a permanently attached, adjustable-length antenna, then the EUT shall be placed in the center of the chamber with the antenna adjusted to the shortest length possible. Turn ON the EUT and tune it to one of the number of frequencies shown in 5.6.

b) Couple the unlicensed wireless device output to the measuring instrument by connecting an antenna to the measuring instrument with a suitable length of coaxial cable and placing the measuring antenna near the EUT (e.g., 15 cm away), or by connecting a dummy load to the measuring instrument, through an attenuator if necessary.

c) Adjust the location of the measurement antenna and the controls on the measurement instrument to obtain a suitable signal level (i.e., a level that will not overload the measurement instrument but is strong enough to allow measurement of the operating or fundamental frequency of the EUT).

d) Turn the EUT OFF and place it inside the environmental temperature chamber. For devices that have oscillator heaters, energize only the heater circuit.

e) Set the temperature control on the chamber to the highest specified in the regulatory requirements for the type of device and allow the oscillator heater and the chamber temperature to stabilize.

f) While maintaining a constant temperature inside the environmental chamber, turn the EUT ON and record the operating frequency at startup, and at 2 minutes, 5 minutes, and 10 minutes after the EUT is energized. Four measurements in total are made.

g) Measure the frequency at each of frequencies specified in 5.6.

h) Switch OFF the EUT but do not switch OFF the oscillator heater.

i) Lower the chamber temperature by not more than 10 °C, and allow the temperature inside the chamber to stabilize.

j) Repeat step f) through step i) down to the lowest specified temperature.

**ANSI C63.10 6.8.2 Frequency stability when varying supply voltage**

Unless otherwise specified, these tests shall be made at ambient room temperature (+15 °C to +25 °C). An antenna shall be connected to the antenna output terminals of the EUT if possible. If the EUT is equipped with or uses an adjustable-length antenna, then it shall be fully extended.

a) Supply the EUT with nominal voltage or install a new or fully charged battery in the EUT. Turn ON the EUT and couple its output to a frequency counter or other frequency-measuring instrument.

NOTE—An instrument that has an adequate level of accuracy as specified by the procuring or regulatory agency is the recommended measuring instrument.

b) Tune the EUT to one of the number of frequencies required in 5.6. Adjust the location of the measurement antenna and the controls on the measurement instrument to obtain a suitable signal level (i.e., a level that will not overload the measurement instrument but is strong enough to allow measurement of the operating or fundamental frequency of the EUT).

c) Measure the frequency at each of the frequencies specified in 5.6.

d) Repeat the above procedure at 85% and 115% of the nominal supply voltage as described in 5.13.

*Table 15 – Frequency stability with temperature*

| Channel Frequency kHz | Time | -20 C kHz | 20 C kHz | 50 C kHz | | Change kHz | |
|---|---|---|---|---|---|---|---|
| **2402000** | **0 min** | **2401960.9** | **2401975.4** | **2401969.6** | | **14.5** | **Pass** |
| | **2 min** | **2401960.9** | **2401975.4** | **2401969.6** | | | |
| | **5 min** | **2401960.9** | **2401975.4** | **2401969.6** | | | |
| | **10 min** | **2401960.9** | **2401975.4** | **2401969.6** | | | |
| **2440000** | **0 min** | **2439959.5** | **2439974.0** | **2439969.6** | | **14.5** | **Pass** |
| | **2 min** | **2439959.5** | **2439974.0** | **2439969.6** | | | |
| | **5 min** | **2439959.5** | **2439974.0** | **2439969.6** | | | |
| | **10 min** | **2439959.5** | **2439974.0** | **2439969.6** | | | |
| **2480000** | **0 min** | **2479959.5** | **2479974.0** | **2479969.6** | | **14.5** | **Pass** |
| | **2 min** | **2479959.5** | **2479974.0** | **2479969.6** | | | |
| | **5 min** | **2479959.5** | **2479974.0** | **2479969.6** | | | |
| | **10 min** | **2479959.5** | **2479974.0** | **2479969.6** | | | |

FCC 15.31(e) For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

*Table 16 – Frequency stability with varying voltage supply*

| | |
|---|---|
| **No change in radiated signal level was observed by varying the nominal voltage to 85% and 115%.** | **Pass** |

Testing Cert #1007.01

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# COMPLIANCE VERIFICATION REPORT

# TEST CERTIFICATE

| | |
|---|---|
| APPLICANT: | Brilliant Home Technology, Inc.<br>155 Bovet Road Suite 500<br>San Mateo, CA 94402, USA |
| Trade Name: | Brilliant Home Technology, Inc. |
| Model: | BHS120US-WH1 |

I HEREBY CERTIFY THAT:

The measurements shown in this report were made in accordance with the procedures indicated and that the energy emitted by this equipment, as received, was found to be within the FCC CFR 47 Part 15 Rules and Regulations Subpart C requirements. Additionally, it should be noted that the results in this report apply only to the items tested, as identified herein.

I FURTHER CERTIFY THAT:

On the basis of the measurements taken at the test site, the equipment tested is capable of operation in compliance with the requirements set forth in FCC CFR 47 Part 15.207, 15.209 and 15.247 Rules and Regulations.

On this Date: February 13, 2020

Bruce Smith
Atlas Compliance & Engineering, Inc.