# Electromagnetic Compatibility Test Report

## Tests Performed on a Landis + Gyr, Inc.

## Utility Meter Transceiver, Model P450 ClUnit

## Radiometrics Document RP-8780

| *Product Detail:* |
|---|
| FCC ID: ROV-P450IHEM<br>Equipment type: DXX<br>Low power transmitter FCC 15.249 |
| *Test Standards:* |
| US CFR Title 47, Chapter I, FCC Part 15 Subpart C<br>FCC Part 15 CFR Title 47: 2017<br><br>This report concerns: Original Grant for Certification |

| *Tests Performed For:* | *Test Facility:* |
|---|---|
| **Landis + Gyr, Inc.**<br>2800 Duncan Rd.<br>Lafayette, IN 47904-5012 | **Radiometrics Midwest Corporation**<br>12 Devonwood Avenue<br>Romeoville, IL 60446-1349<br>(815) 293-0772 |

| *Test Date(s): (Month-Day-Year)* |
|---|
| September 20 thru December 18, 2017 |

Document RP-8780 Revisions:

| Rev. | Issue Date | Affected Sections | Revised By |
|---|---|---|---|
| 0 | March 20, 2018 | | |
| 1 | March 28, 2018 | 10 & 11.3 | Joseph Strzelecki |
| 2 | March 29, 2018 | 11.3 | Joseph Strzelecki |

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## 1.0 ADMINISTRATIVE DATA

| *Equipment Under Test:* | |
|---|---|
| A Landis + Gyr, Inc., Meter Transceiver<br>Model: P450 CIUnit Serial Number: none<br>This will be referred to as the EUT in this Report | |
| *Date EUT Received at Radiometrics: (Month-Day-Year)* | *Test Date(s): (Month-Day-Year)* |
| September 19, 2017 | September 20 thru December 18, 2017 and March 28, 2018 |
| *Test Report Written By:* | *Test Witnessed By:* |
| Joseph Strzelecki<br>Senior EMC Engineer | The tests were not witnessed byLandis + Gyr, Inc. |
| *Radiometrics' Personnel Responsible for Test:* | *Test Report Approved By* |
| Joseph Strzelecki 03/29/2018<br>Joseph Strzelecki<br>Senior EMC Engineer<br>NARTE EMC-000877-NE | Chris W. Carlson 03/29/2018<br>Chris W. Carlson<br>Director of Engineering<br>NARTE EMC-000921-NE |

## 2.0 TEST SUMMARY AND RESULTS

The EUT (Equipment Under Test) is a Meter Transceiver, Model P450 CIUnit, manufactured by Landis + Gyr, Inc. The detailed test results are presented in a separate section. The following is a summary of the test results.

**Emissions Tests Results**

| Environmental Phenomena | Frequency Range | Basic Standard | Test Result |
|---|---|---|---|
| RF Radiated Emissions | 30-25,000 MHz | FCC Part 15.249 | Pass |
| Occupied Bandwidth Test | Fundamental Freq. | FCC Part 15 | Pass |
| Conducted Emissions, AC Mains | 0.15 - 30 MHz | FCC Part 15 | Pass |

### 2.1 RF Exposure Compliance Requirements

Since the power output is less than 3 mW, the EUT meets the FCC requirement for RF exposure and it is exempt from RF exposure evaluations. There are no power level adjustments available to the end user. The antenna is permanently attached. The detailed calculations for RF Exposure are presented in a separate document.

## 3.0 EQUIPMENT UNDER TEST (EUT) DETAILS

### 3.1 EUT Description

The EUT is a Meter Transceiver, Model P450 CIUnit, manufactured by Landis + Gyr, Inc. The EUT was in good working condition during the tests, with no known defects.

### 3.1.1 FCC Section 15.203 Antenna Requirements

The antenna is permanently attached to the printed circuit board. Therefore, it meets the 15.203 requirements.

## 4.0 TESTED SYSTEM DETAILS

### 4.1 Tested System Configuration

The system was configured for testing in a typical fashion. The EUT was placed on an 80-cm or 150-cm high, nonconductive test stand. The testing was performed in conditions as close as possible to installed conditions. Wiring was consistent with manufacturer's recommendations.

Since the EUT is wall mounted or table mounted, it was placed in an upright and table-mounted configuration during the tests. Power was supplied with a new battery.

The identification for all equipment, plus descriptions of all cables used in the tested system, are:

**Tested System Configuration List**

| Item | Description | Type* | Manufacturer | Model Number | Serial Number |
|---|---|---|---|---|---|
| 1 | Meter Transceiver | E | Landis + Gyr | P450 CIUnit | Sample 24 |
| 2 | Power Supply | E | Phihong | PSAC05R-050 | D343001860A2 |

* Type: E = EUT, P = Peripheral, S = Support Equipment; H = Host Computer

**List of System Cables**

| QTY | Length (m) | Cable Description | Shielded? |
|---|---|---|---|
| 1 | 1.0 | DC Cord to battery | No |
| 1 | 1.8 | Ethernet cable to router or termination | No |

### 4.2 Special Accessories

No special accessories were used during the tests in order to achieve compliance.

### 4.3 Equipment Modifications

No modifications were made to the EUT at Radiometrics' test facility in order to comply with the standards listed in this report.

## 5.0 TEST SPECIFICATIONS

| Document | Date | Title |
|---|---|---|
| FCC<br>CFR Title 47 | 2017 | Code of Federal Regulations Title 47, Chapter 1, Federal Communications Commission, Part 15 - Radio Frequency Devices |

## 6.0 TEST PROCEDURE DOCUMENTS

The tests were performed using the procedures from the following specifications:

| Document | Date | Title |
|---|---|---|
| ANSI C63.4-2014 | 2014 | Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |
| ANSI C63.10-2013 | 2013 | American National Standard for Testing Unlicensed Wireless Devices |

## 7.0 RADIOMETRICS' TEST FACILITIES

The results of these tests were obtained at Radiometrics Midwest Corp. in Romeoville, Illinois, USA. Radiometrics is accredited by A2LA (American Association for Laboratory Accreditation) to conform to ISO/IEC 17025: 2005 "General Requirements for the Competence of Calibration and Testing Laboratories". Radiometrics' Lab Code is 121191 and Certification Number is 1495.01. Radiometrics' scope of accreditation includes all of the test methods listed herein. A copy of the accreditation can be accessed on our web site (www.radiomet.com). Radiometrics accreditation status can be verified at A2LA's web site (www.a2la2.org).

The following is a list of shielded enclosures located in Romeoville, Illinois used during the tests:

Chamber E: Is a custom made anechoic chamber that measures 52' L X 30' W X 18' H. The walls and ceiling are fully lined with RF absorber. Pro-shield of Collinsville, Oklahoma manufactured the chamber. The floor has a 9' x 9' section of microwave absorber for testing above 1 GHz.

Test Station F: Is an area that measures 10' D X 12' W X 10' H. The floor and back wall are metal shielded. This area is used for conducted emissions measurements.

A separate ten-foot long, brass plated, steel ground rod attached via a 6-inch copper braid grounds each of the above chambers. Each enclosure is also equipped with low-pass power line filters.

The FCC has accepted these sites as test site number US1065. The FCC test site Registration Number is 732175.

A complete list of the test equipment is provided herein. The calibration due dates are indicated on the equipment list. The equipment is calibrated in accordance to ANSI/NCSL Z540-1 with traceability to the National Institute of Standards and Technology (NIST).

## 8.0 DEVIATIONS AND EXCLUSIONS FROM THE TEST SPECIFICATIONS

There were no deviations or exclusions from the test specifications.

## 9.0 CERTIFICATION

Radiometrics Midwest Corporation certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specification and the data contained herein was taken with calibrated test equipment. The results relate only to the EUT listed herein.

## 10.0 TEST EQUIPMENT TABLE

| RMC ID | Manufacturer | Description | Model No. | Serial No. | Frequency Range | Cal Period | Cal Date |
|---|---|---|---|---|---|---|---|
| AMP-05 | RMC/Celeritek | Pre-amplifier | MW110G | 1001 | 1.0-12GHz | 12 Mo. | 01/09/17 |
| AMP-20 | Avantek | Pre-amplifier | SF8-0652 | 15221 | 8-18GHz | 12 Mo | 04/11/17 |
| AMP-22 | Anritsu | Pre-amplifier | MH648A | M23969 | 0.1-1200MHz | 12 Mo. | 01/09/17 |
| AMP-59 | Amplitech | Pre-amplifier | APTMP44 | AMP-59 | 18-26 GHz | 12 Mo. | 01/04/17 |
| ANT-04 | Tensor | Biconical Antenna | 4104 | 2246 | 20-250MHz | 24 Mo. | 05/16/16 |
| ANT-06 | EMCO | Log-Periodic Ant. | 3146 | 1248 | 200-1000MHz | 24 Mo. | 11/25/15 |
| ANT-07 | RMC | Log-Periodic Ant. | LP1000 | 1001 | 200-1000MHz | 24 Mo. | 08/10/16 |
| ANT-13 | EMCO | Horn Antenna | 3115 | 2502 | 1.0-18GHz | 24 Mo. | 12/28/16 |
| ANT-48 | RMC | Std Gain Horn | HW2020 | 1001 | 18-26 GHz | 36 Mo. | 12/15/15 |
| ANT-66 | ETS-Lindgren | Horn Antenna | 3115 | 62580 | 1.0-18GHz | 12 Mo. | 02/15/17 |
| CAB-106A | Teledyne | Coaxial Cable | N/A | 106A | DC-2 GHz | 24 Mo. | 04/21/16 |
| CAB-1090 | Teledyne | Coaxial Cable | N/A | 1090 | DC-18 GHz | 24 Mo. | 04/19/16 |
| CAB-160B | Teledyne | Coaxial Cable | N/A | 160B | DC-18 GHz | 24 Mo. | 04/21/16 |
| CAB-090A | Teledyne | Coaxial Cable | N/A | 090A | DC-26 GHz | 24 Mo. | 01/04/17 |
| CAB-295A | Teledyne | Coaxial Cable | N/A | 295A | DC-26 GHz | 24 Mo. | 01/04/17 |
| LSN-01 | Electrometrics | 50 uH LISN | FCC/VDE 50/2 | 1001 | 0.01-30MHz | 24 Mo. | 06/30/17 |
| REC-20 | HP / Agilent | Spectrum Analyzer | 85460A/84562A | 33330A00135<br>3410A00178 | 30Hz-6GHz | 24 Mo. | 07/13/16 |
| REC-21 | Agilent | Spectrum Analyzer | E7405A | MY45118341 | 9Hz-26.5 GHz | 24 Mo. | 12/22/15<br>01/06/18 |
| THM-03 | Fluke | Temp/Humid Meter | 971 | 95850465 | N/A | 24 Mo. | 02/20/17 |

Note: All calibrated equipment is subject to periodic checks.
All equipment was in calibration during the time it was used for the tests herein.

| Software Company | Test Software Name | Version | Applicable Tests |
|---|---|---|---|
| Radiometrics | REREC11D | 02.28.17 | RF Radiated Emissions (FCC Part 15 & EN 55011/22) |
| Agilent | PSA/ESA-E/L/EMC | 2.4.0.42 | Bandwidth and screen shots |

## 11.0 TEST SECTIONS

### 11.1 AC Conducted Emissions

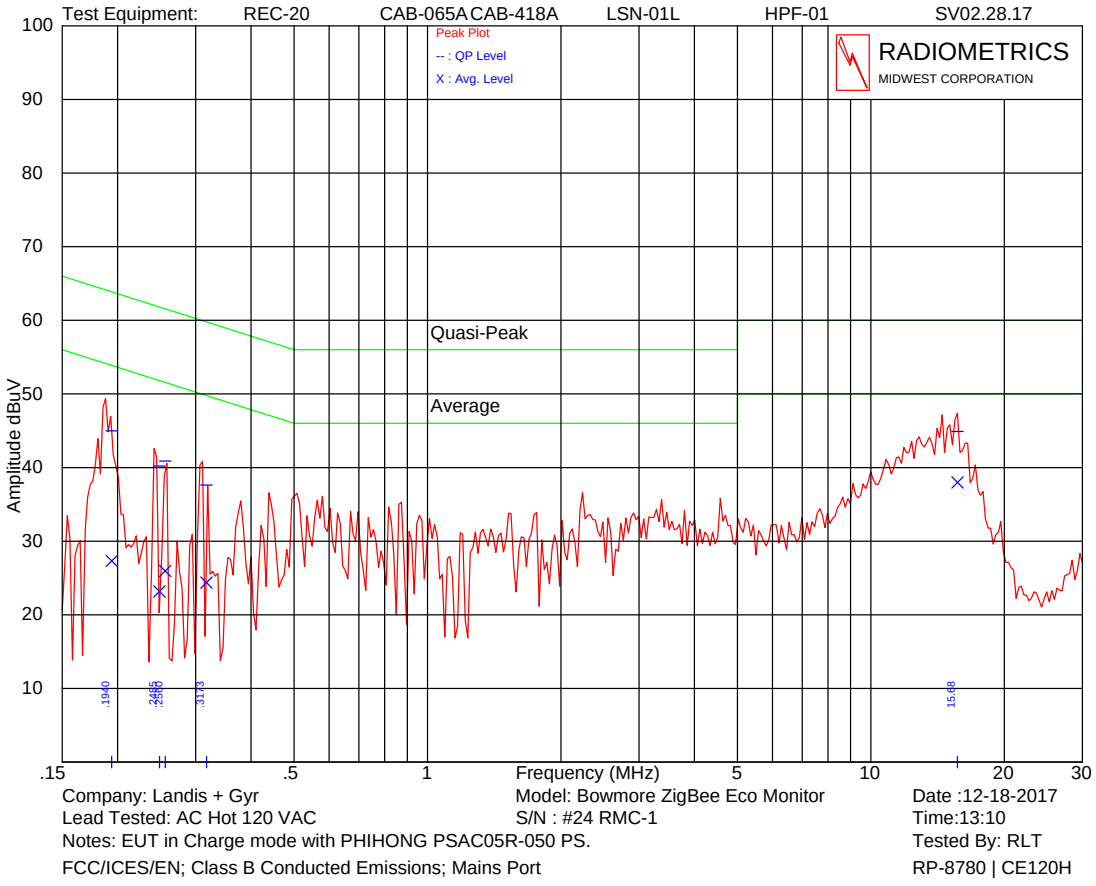
The tests and limits are in accordance with FCC section 15.207. A computer-controlled analyzer was used to perform the conducted emissions measurements. The frequency range was divided into 500 subranges equally spaced on a logarithmic scale. The computer recorded the peak of each subrange. This data was then plotted on a semi-log graph generated by the computer. Adjusting the positions of the cables and orientation of the test system then maximizes the highest emissions.

Mains Conducted emission measurements were performed using a 50 Ohm/50 uH Line Impedance Stabilization Network (LISN) as the pick-up device. Measurements were repeated on both leads within the power cord. If the EUT power cord exceeded 80 cm in length, the excess length of the power cord was made into a 30 to 40 cm bundle near the center of the cord. The LISN was placed on the floor at the base of the test platform and electrically bonded to the ground plane.

The initial step in collecting conducted data is a peak detector scan and the plotting of the measurement range. Significant peaks are then marked as shown on the following table, and these signals are then measured with the quasi-peak detector. The following represents the worst case emissions from the USB power supply with the EUT connected, after testing all modes of operation.

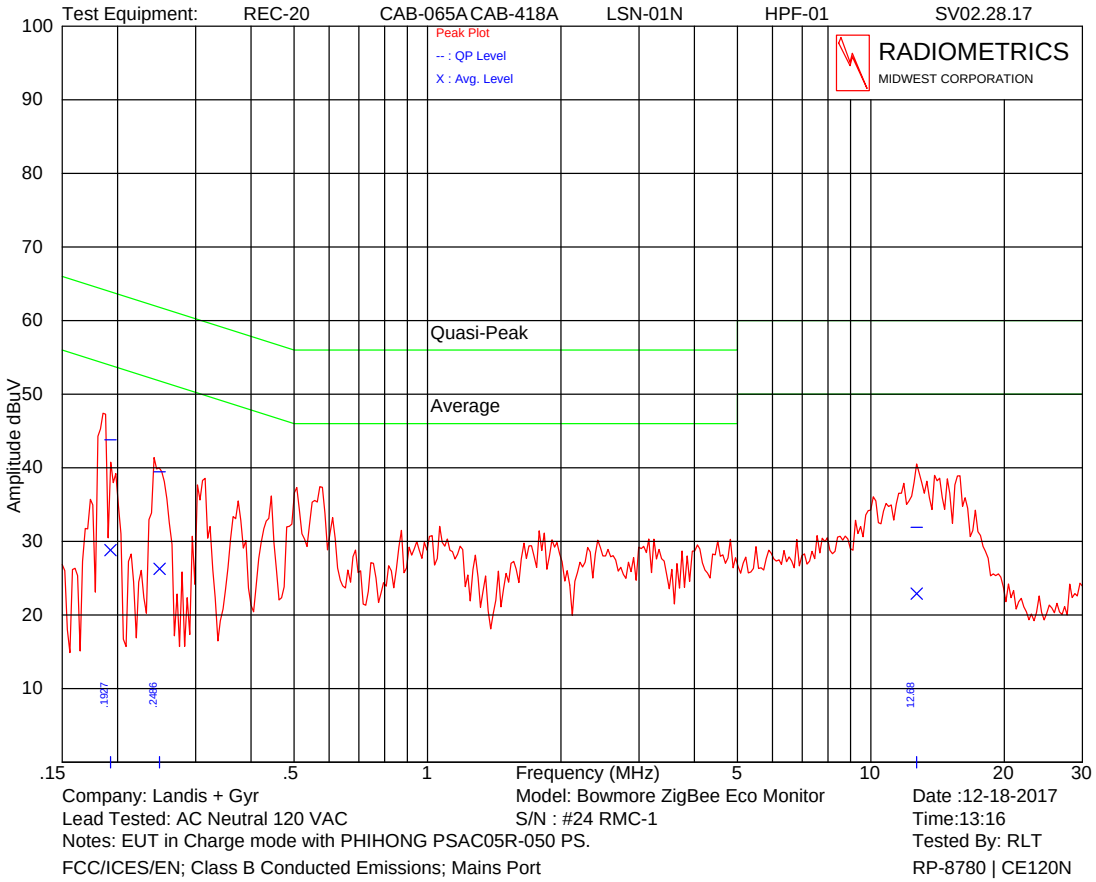
**FCC Limits of Conducted Emissions at the AC Mains Ports**

| Frequency Range (MHz) | Class B Limits (dBuV) | |
|---|---|---|
| | Quasi-Peak | Average |
| 0.150 - 0.50* | 66 - 56 | 56 - 46 |
| 0.5 – 5.0 | 56 | 46 |
| 5.0 - 30 | 60 | 50 |
| * The limit decreases linearly with the logarithm of the frequency in this range. | | |



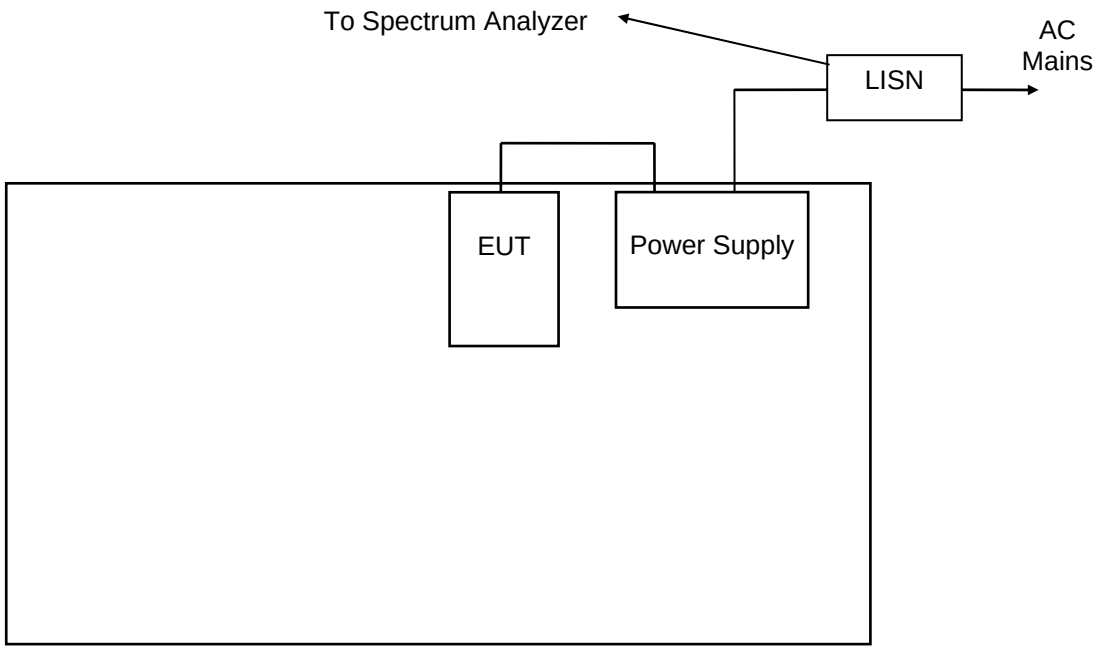

| Frequency (MHz) | QP Amplitude (dBuV) | QP Limit (dBuV) | Average Amplitude (dBuV) | Average Limit (dBuV) | Margin (dB) |
|---|---|---|---|---|---|
| 0.194 | 45.0 | 63.9 | 27.3 | 53.9 | 18.9 |
| 0.249 | 40.2 | 61.8 | 23.2 | 51.8 | 21.6 |
| 0.256 | 40.9 | 61.6 | 26.0 | 51.6 | 20.7 |
| 0.317 | 37.6 | 59.8 | 24.4 | 49.8 | 22.2 |
| 15.681 | 44.9 | 60.0 | 38.0 | 50.0 | 12.0 |

Testing of the Landis + Gyr, Inc., Model P450 CIUnit




| Frequency (MHz) | QP Amplitude (dBuV) | QP Limit (dBuV) | Average Amplitude (dBuV) | Average Limit (dBuV) | Margin (dB) |
|---|---|---|---|---|---|
| 0.193 | 43.8 | 63.9 | 28.8 | 53.9 | 20.1 |
| 0.249 | 39.5 | 61.8 | 26.3 | 51.8 | 22.3 |
| 12.687 | 31.9 | 60.0 | 22.9 | 50.0 | 27.1 |

**Figure 1. Conducted Emissions Test Setup**




**Notes:**
- LISN's at least 80 cm from EUT chassis
- Vertical conductive plane 40 cm from rear of table top
- EUT power cord bundled

## 11.2 Radiated RF Emissions

Radiated emission measurements were performed with linearly polarized broadband antennas. The results obtained with these antennas can be correlated with results obtained with a tuned dipole antenna. The radiated emission measurements were performed with a spectrum analyzer. The bandwidth used from 150 kHz to 30 MHz is 9 or 10 kHz and the bandwidth from 30 MHz to 1000 MHz is 100 or 120 kHz. Above 1 GHz, a 1 MHz bandwidth is used. Average readings were performed above 1 GHz. A 10 dB linearity check is performed prior to start of testing in order to determine if an overload condition exists. A harmonic mixer was used from 18 to 25 GHz. Figure 4 herein lists the details of the test equipment used during radiated emissions tests.

The EUT was rotated through three orthogonal axis as per 5.10.1 of ANSI C63.10 during the radiated tests.

Final radiated emissions measurements were performed inside of an anechoic chamber at a test distance of 3 meters. The anechoic chamber is designated as Chamber E. This Chamber meets the Site Attenuation requirements of ANSI C63.4 and CISPR 16-1. Chamber E is located at 12 East Devonwood Ave. Romeoville, Illinois EMI test lab.

The entire frequency range from 30 to 25,000 MHz was slowly scanned with particular attention paid to those frequency ranges which appeared high. Measurements were performed using two antenna polarizations, (vertical and horizontal). The worst case emissions were recorded. All measurements may be performed using either the peak, average or quasi-peak detector functions. If the peak detector data exceeds or is marginally close to the limits, the measurements are repeated using a quasi-peak detector or average function as required by the specification for final determination of compliance. The QP and average detectors have a linear response.

The detected emission levels were maximized by rotating the EUT, adjusting the positions of all cables, and by scanning the measurement antenna from 1 to 4 meters above the ground.

### 11.2.1 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and by subtracting the Amplifier Gain from the measured reading. The basic equation is as follows:

FS = RA + AF + CF - AG

Where: FS = Field Strength
RA = Receiver Amplitude
AF = Antenna Factor
CF = Cable Attenuation Factor
AG = Amplifier Gain

Note: The actual FCC limits are in uV/m. The data in the results table coverted the limits to dBuV/m.
100 uV/m = 40.0 dBuV/m
150 uV/m = 43.5 dBuV/m
200 uV/m = 46.0 dBuV/m
500 uV/m = 54.0 dBuV/m

### 11.2.2 Radiated Emissions Test Results

| | |
|---|---|
| Test Date | December 15 and 18, 2018 |
| Test Distance | 3 Meters |
| Tested by | Richard Tichgelaar |
| Specification | FCC Part 15; Subpart B; Class B |
| Abbreviations | Pol = Antenna Polarization; V = Vertical; H = Horizontal; P = peak; Q = QP |
| Notes | Sample #24 tested; The EUT is in the transmit mode with the receiver on |

All emissions except fundamental and harmonics

| Freq. MHz | Meter Reading dBuV | Dect. | Ant. Pol. | Ant Factor | Cable & Amp Factors | Dist. Fact dB | EUT dBuV/m | Limit dBuV/m | Margin Under Limit dB | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| 32.6 | 16.9 | P | H | 11.3 | 0.5 | 0.0 | 28.7 | 40.0 | 11.3 | |
| 35.2 | 16.1 | P | H | 11.5 | 0.5 | 0.0 | 28.1 | 40.0 | 11.9 | |
| 62.7 | 10.1 | P | H | 8.4 | 0.6 | 0.0 | 19.1 | 40.0 | 20.9 | |
| 109.6 | 12.5 | P | H | 12.4 | 0.9 | 0.0 | 25.7 | 43.5 | 17.8 | |
| 117.3 | 12.7 | P | H | 12.5 | 0.9 | 0.0 | 26.1 | 43.5 | 17.4 | |
| 131.9 | 13.6 | P | H | 11.7 | 1.0 | 0.0 | 26.3 | 43.5 | 17.2 | |
| 136.2 | 18.4 | P | H | 11.6 | 1.0 | 0.0 | 31.0 | 43.5 | 12.5 | |
| 143.1 | 16.9 | P | H | 12.1 | 1.0 | 0.0 | 30.0 | 43.5 | 13.5 | |
| 149.1 | 16.6 | P | H | 13.0 | 1.0 | 0.0 | 30.6 | 43.5 | 12.9 | |
| 162.4 | 11.8 | P | H | 15.2 | 1.1 | 0.0 | 28.0 | 43.5 | 15.5 | |
| 174.1 | 10.6 | P | H | 16.5 | 1.1 | 0.0 | 28.2 | 43.5 | 15.3 | |

| Freq. MHz | Meter Reading dBuV | Dect. | Ant. Pol. | Ant Factor | Cable & Amp Factors | Dist. Fact dB | EUT dBuV/m | Limit dBuV/m | Margin Under Limit dB | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| 204.5 | 14.4 | P | H | 11.1 | 1.2 | 0.0 | 26.7 | 43.5 | 16.8 | |
| 265.7 | 13.2 | P | H | 12.6 | 1.4 | 0.0 | 27.2 | 46.0 | 18.8 | |
| 324.6 | 16.3 | P | H | 14.2 | 1.5 | 0.0 | 32.0 | 46.0 | 14.0 | |
| 399.3 | 16.3 | P | H | 14.9 | 1.7 | 0.0 | 32.9 | 46.0 | 13.1 | |
| 425.7 | 12.5 | P | H | 16.1 | 1.8 | 0.0 | 30.3 | 46.0 | 15.7 | |
| 452.9 | 10.4 | P | H | 16.7 | 1.8 | 0.0 | 28.9 | 46.0 | 17.1 | |
| 458.2 | 11.9 | P | H | 16.9 | 1.8 | 0.0 | 30.6 | 46.0 | 15.4 | |
| 499.0 | 11.4 | P | H | 18.7 | 1.9 | 0.0 | 32.0 | 46.0 | 14.0 | |
| 532.5 | 11.2 | P | H | 17.0 | 2.0 | 0.0 | 30.1 | 46.0 | 15.9 | |
| 665.0 | 17.2 | P | H | 19.4 | 2.3 | 0.0 | 38.8 | 46.0 | 7.2 | |
| 728.8 | 12.1 | P | H | 21.7 | 2.3 | 0.0 | 36.2 | 46.0 | 9.8 | |
| 735.0 | 13.7 | P | H | 20.9 | 2.3 | 0.0 | 36.9 | 46.0 | 9.1 | |
| 798.8 | 12.8 | P | H | 20.8 | 2.5 | 0.0 | 36.2 | 46.0 | 9.8 | |
| 842.5 | 12.7 | P | H | 21.1 | 2.5 | 0.0 | 36.3 | 46.0 | 9.7 | |
| 867.5 | 12.8 | P | H | 22.9 | 2.6 | 0.0 | 38.2 | 46.0 | 7.8 | |
| 903.8 | 9.7 | P | H | 22.2 | 2.6 | 0.0 | 34.5 | 46.0 | 11.5 | |
| 925.0 | 9.5 | P | H | 23.2 | 2.7 | 0.0 | 35.4 | 46.0 | 10.6 | |
| 935.0 | 11.1 | P | H | 23.5 | 2.7 | 0.0 | 37.3 | 46.0 | 8.7 | |
| 973.8 | 10.2 | P | H | 22.4 | 2.7 | 0.0 | 35.3 | 54.0 | 18.7 | |
| 997.5 | 8.9 | P | H | 22.8 | 2.8 | 0.0 | 34.4 | 54.0 | 19.6 | |
| 1330.0 | 52.9 | P | H | 25.5 | -32.5 | 0.0 | 45.9 | 74.0 | 28.1 | 1 |
| 1825.0 | 48.4 | P | H | 27.0 | -32.0 | 0.0 | 43.4 | 74.0 | 30.6 | 1 |
| 1827.5 | 45.9 | P | H | 27.1 | -32.0 | 0.0 | 41.0 | 74.0 | 33.0 | 1 |
| 2657.5 | 50.1 | P | H | 28.9 | -31.0 | 0.0 | 48.0 | 74.0 | 26.0 | 1 |
| 3000.0 | 43.3 | P | H | 30.0 | -30.0 | 0.0 | 43.3 | 74.0 | 30.7 | 1 |
| 3442.5 | 39.5 | P | H | 31.1 | -29.6 | 0.0 | 41.0 | 74.0 | 33.0 | 1 |
| 3947.5 | 39.0 | P | H | 32.8 | -29.1 | 0.0 | 42.7 | 74.0 | 31.3 | 1 |
| 4165.0 | 36.5 | P | H | 32.6 | -27.9 | 0.0 | 41.2 | 74.0 | 32.8 | 1 |
| 4600.0 | 36.9 | P | H | 33.4 | -27.9 | 0.0 | 42.3 | 74.0 | 31.7 | 1 |
| 5035.0 | 36.3 | P | H | 33.5 | -26.7 | 0.0 | 43.1 | 74.0 | 30.9 | 1 |
| 5545.0 | 37.3 | P | H | 34.3 | -25.5 | 0.0 | 46.1 | 74.0 | 27.9 | 1 |
| 5592.5 | 34.6 | P | H | 34.2 | -25.6 | 0.0 | 43.3 | 74.0 | 30.7 | 1 |
| 5770.0 | 37.4 | P | H | 34.2 | -26.1 | 0.0 | 45.5 | 74.0 | 28.5 | 1 |
| 6140.0 | 34.1 | P | H | 34.8 | -24.4 | 0.0 | 44.5 | 74.0 | 29.5 | 1 |
| 6420.0 | 34.1 | P | H | 34.5 | -25.2 | 0.0 | 43.3 | 74.0 | 30.7 | 1 |
| 6622.5 | 33.8 | P | H | 34.8 | -24.5 | 0.0 | 44.0 | 74.0 | 30.0 | 1 |
| 31.3 | 18.6 | P | V | 11.2 | 0.5 | 0.0 | 30.3 | 40.0 | 9.7 | |
| 32.6 | 19.8 | P | V | 11.3 | 0.5 | 0.0 | 31.6 | 40.0 | 8.4 | |
| 35.2 | 15.5 | P | V | 11.5 | 0.5 | 0.0 | 27.5 | 40.0 | 12.5 | |
| 43.3 | 16.7 | P | V | 12.0 | 0.5 | 0.0 | 29.2 | 40.0 | 10.8 | |
| 48.9 | 11.0 | P | V | 11.5 | 0.6 | 0.0 | 23.1 | 40.0 | 16.9 | |
| 56.7 | 17.8 | P | V | 10.0 | 0.6 | 0.0 | 28.4 | 40.0 | 11.6 | |
| 63.1 | 18.7 | P | V | 8.3 | 0.6 | 0.0 | 27.6 | 40.0 | 12.4 | |
| 73.9 | 19.3 | P | V | 6.3 | 0.7 | 0.0 | 26.4 | 40.0 | 13.6 | |
| 78.6 | 20.7 | P | V | 6.6 | 0.7 | 0.0 | 28.1 | 40.0 | 11.9 | |
| 82.0 | 8.1 | P | V | 7.4 | 0.8 | 0.0 | 16.2 | 40.0 | 23.8 | |
| 89.3 | 16.0 | P | V | 9.6 | 0.8 | 0.0 | 26.4 | 43.5 | 17.1 | |
| 94.1 | 13.7 | P | V | 10.7 | 0.8 | 0.0 | 25.2 | 43.5 | 18.3 | |
| 102.7 | 14.3 | P | V | 12.0 | 0.8 | 0.0 | 27.1 | 43.5 | 16.4 | |
| 110.4 | 14.1 | P | V | 12.4 | 0.9 | 0.0 | 27.4 | 43.5 | 16.1 | |
| 116.9 | 14.4 | P | V | 12.5 | 0.9 | 0.0 | 27.8 | 43.5 | 15.7 | |
| 118.6 | 18.8 | P | V | 12.4 | 0.9 | 0.0 | 32.1 | 43.5 | 11.4 | |
| 120.7 | 16.9 | P | V | 12.4 | 0.9 | 0.0 | 30.2 | 43.5 | 13.3 | |

| Freq. MHz | Meter Reading dBuV | Dect. | Ant. Pol. | Ant Factor | Cable & Amp Factors | Dist. Fact dB | EUT dBuV/m | Limit dBuV/m | Margin Under Limit dB | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| 131.9 | 20.0 | P | V | 11.7 | 1.0 | 0.0 | 32.7 | 43.5 | 10.8 | |
| 144.4 | 15.4 | P | V | 12.2 | 1.0 | 0.0 | 28.6 | 43.5 | 14.9 | |
| 172.8 | 14.8 | P | V | 16.4 | 1.1 | 0.0 | 32.3 | 43.5 | 11.2 | |
| 187.4 | 11.9 | P | V | 17.1 | 1.1 | 0.0 | 30.2 | 43.5 | 13.3 | |
| 211.3 | 19.4 | P | V | 10.9 | 1.2 | 0.0 | 31.5 | 43.5 | 12.0 | |
| 221.9 | 15.8 | P | V | 10.5 | 1.2 | 0.0 | 27.5 | 46.0 | 18.5 | |
| 224.9 | 18.2 | P | V | 10.6 | 1.2 | 0.0 | 30.0 | 46.0 | 16.0 | |
| 238.5 | 15.5 | P | V | 11.0 | 1.3 | 0.0 | 27.8 | 46.0 | 18.2 | |
| 256.6 | 15.6 | P | V | 11.9 | 1.3 | 0.0 | 28.8 | 46.0 | 17.2 | |
| 303.4 | 12.8 | P | V | 15.2 | 1.5 | 0.0 | 29.5 | 46.0 | 16.5 | |
| 325.3 | 12.7 | P | V | 14.2 | 1.5 | 0.0 | 28.4 | 46.0 | 17.6 | |
| 348.7 | 12.0 | P | V | 14.2 | 1.6 | 0.0 | 27.7 | 46.0 | 18.3 | |
| 398.6 | 15.4 | P | V | 14.9 | 1.7 | 0.0 | 32.0 | 46.0 | 14.0 | |
| 460.5 | 14.2 | P | V | 17.0 | 1.8 | 0.0 | 33.1 | 46.0 | 12.9 | |
| 532.5 | 15.2 | P | V | 17.0 | 2.0 | 0.0 | 34.2 | 46.0 | 11.8 | |
| 572.5 | 16.0 | P | V | 18.5 | 2.1 | 0.0 | 36.5 | 46.0 | 9.5 | |
| 613.8 | 11.4 | P | V | 18.9 | 2.1 | 0.0 | 32.4 | 46.0 | 13.6 | |
| 627.5 | 11.8 | P | V | 19.1 | 2.2 | 0.0 | 33.1 | 46.0 | 12.9 | |
| 665.0 | 11.4 | P | V | 19.4 | 2.3 | 0.0 | 33.0 | 46.0 | 13.0 | |
| 735.0 | 10.3 | P | V | 20.9 | 2.3 | 0.0 | 33.6 | 46.0 | 12.4 | |
| 798.8 | 10.8 | P | V | 20.8 | 2.5 | 0.0 | 34.1 | 46.0 | 11.9 | |
| 825.0 | 8.8 | P | V | 21.5 | 2.6 | 0.0 | 32.9 | 46.0 | 13.1 | |
| 860.0 | 11.6 | P | V | 22.7 | 2.6 | 0.0 | 36.9 | 46.0 | 9.1 | |
| 925.0 | 8.2 | P | V | 23.2 | 2.7 | 0.0 | 34.1 | 46.0 | 11.9 | |
| 931.3 | 11.0 | P | V | 23.5 | 2.7 | 0.0 | 37.2 | 46.0 | 8.8 | |
| 977.5 | 9.4 | P | V | 22.5 | 2.7 | 0.0 | 34.6 | 54.0 | 19.4 | |
| 1330.0 | 52.6 | P | V | 25.5 | -32.5 | 0.0 | 45.6 | 74.0 | 28.4 | 1 |
| 1660.0 | 53.6 | P | V | 25.8 | -32.5 | 0.0 | 47.0 | 74.0 | 27.0 | 1 |
| 1742.5 | 49.2 | P | V | 26.4 | -32.2 | 0.0 | 43.4 | 74.0 | 30.6 | 1 |
| 1825.0 | 50.9 | P | V | 27.0 | -32.0 | 0.0 | 45.9 | 74.0 | 28.1 | 1 |
| 1945.0 | 50.1 | P | V | 27.6 | -31.8 | 0.0 | 46.0 | 74.0 | 28.0 | 1 |
| 2025.0 | 48.2 | P | V | 27.7 | -31.8 | 0.0 | 44.1 | 74.0 | 29.9 | 1 |
| 2072.5 | 50.6 | P | V | 27.7 | -31.9 | 0.0 | 46.4 | 74.0 | 27.6 | 1 |
| 2152.5 | 48.3 | P | V | 27.6 | -31.9 | 0.0 | 44.0 | 74.0 | 30.0 | 1 |
| 2260.0 | 45.7 | P | V | 27.7 | -31.8 | 0.0 | 41.6 | 74.0 | 32.4 | 1 |
| 2392.5 | 43.8 | P | V | 28.4 | -31.3 | 0.0 | 40.9 | 74.0 | 33.1 | 1 |
| 2660.0 | 46.7 | P | V | 28.9 | -31.0 | 0.0 | 44.6 | 74.0 | 29.4 | 1 |
| 2742.5 | 42.0 | P | V | 28.9 | -31.0 | 0.0 | 39.9 | 74.0 | 34.1 | 1 |
| 3575.0 | 37.8 | P | V | 31.4 | -29.0 | 0.0 | 40.1 | 74.0 | 33.9 | 1 |
| 3925.0 | 37.5 | P | V | 32.8 | -29.1 | 0.0 | 41.1 | 74.0 | 32.9 | 1 |
| 4055.0 | 39.5 | P | V | 32.7 | -28.6 | 0.0 | 43.6 | 74.0 | 30.4 | 1 |
| 4655.0 | 37.5 | P | V | 33.3 | -27.7 | 0.0 | 43.1 | 74.0 | 30.9 | 1 |
| 5107.5 | 37.5 | P | V | 33.7 | -26.7 | 0.0 | 44.5 | 74.0 | 29.5 | 1 |
| 5575.0 | 35.6 | P | V | 34.2 | -25.5 | 0.0 | 44.3 | 74.0 | 29.7 | 1 |
| 5582.5 | 35.8 | P | V | 34.2 | -25.5 | 0.0 | 44.4 | 74.0 | 29.6 | 1 |
| 5970.0 | 35.7 | P | V | 34.5 | -25.1 | 0.0 | 45.0 | 74.0 | 29.0 | 1 |
| 6000.0 | 36.3 | P | V | 34.6 | -24.9 | 0.0 | 45.9 | 74.0 | 28.1 | 1 |
| 6127.5 | 33.6 | P | V | 34.8 | -24.4 | 0.0 | 44.0 | 74.0 | 30.0 | 1 |
| 6262.5 | 33.6 | P | V | 34.7 | -24.7 | 0.0 | 43.6 | 74.0 | 30.4 | 1 |
| 6547.5 | 33.5 | P | V | 34.6 | -24.8 | 0.0 | 43.3 | 74.0 | 30.7 | 1 |

Note 1: Peak Reading under the Average limit, therefore no Average reading is required.
Judgment: Passed by at least 7.0 dB

**Fundammental and Harmonic Emissions FCC 15.249; Three axis tested**

| | | Spectrum Analyzer Readings | | | | | | | | | EUT | Peak | Ave | Peak | Ave | Margin |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| hrm | Tx | Peak | | | Ave | Peak | | | Ave | Corr. | Emission | Tot. FS | | Limit | | Under |
| | | Vertical Polarization | | | | Horizontal Polarization | | | | | Freq | | | | | |
| # | Freq | X | Y | Z | Max | X | Y | Z | Max | Fact. | MHz | dBuV/m | | dBuV/m | | Limit |
| 1 | 2405 | 92.4 | 97.0 | 101.8 | 94.0 | 96.2 | 99.6 | 96.3 | 92.2 | -2.8 | 2405.0 | 99.0 | 91.2 | 114 | 94 | 2.8 |
| BE | 2405 | 44.4 | 49.0 | 53.8 | 46.0 | 48.2 | 51.6 | 48.3 | 44.2 | -2.8 | 2390.0 | 51.0 | 43.2 | 74 | 54 | 10.8 |
| 2 | 2405 | 44.5 | 48.5 | 47.9 | 40.3 | 45.7 | 49.6 | 47.0 | 42.5 | 6.7 | 4810.0 | 56.3 | 49.2 | 74 | 54 | 4.8 |
| 3 | 2405 | 41.5 | 42.2 | 41.9 | 29.1 | 42.3 | 41.3 | 42.0 | 26.3 | 11.8 | 7215.0 | 54.1 | 40.9 | 74 | 54 | 13.1 |
| 1 | 2445 | 90.9 | 94.9 | 100.6 | 92.5 | 94.5 | 98.2 | 97.7 | 90.7 | -2.4 | 2445.0 | 98.2 | 90.1 | 114 | 94 | 3.9 |
| 2 | 2445 | 44.4 | 48.7 | 45.7 | 39.1 | 44.1 | 47.5 | 45.2 | 39.2 | 8.1 | 4890.0 | 56.8 | 47.3 | 74 | 54 | 6.7 |
| 3 | 2445 | 41.0 | 41.1 | 41.4 | 26.8 | 42.3 | 41.6 | 41.6 | 27.0 | 12.8 | 7335.0 | 55.1 | 39.8 | 74 | 54 | 14.2 |
| 1 | 2480 | 93.2 | 98.4 | 99.8 | 87.1 | 96.9 | 97.6 | 99.6 | 89.3 | -2.5 | 2480.0 | 97.3 | 86.8 | 114 | 94 | 7.2 |
| BE | 2480 | 57.5 | 62.7 | 64.1 | 51.4 | 61.2 | 61.9 | 63.9 | 53.6 | -2.5 | 2483.5 | 61.6 | 51.1 | 74 | 54 | 2.9 |
| 2 | 2480 | 44.5 | 47.8 | 46.0 | 39.4 | 44.7 | 46.7 | 48.5 | 39.5 | 8.3 | 4960.0 | 56.8 | 47.8 | 74 | 54 | 6.2 |
| 3 | 2480 | 41.6 | 41.5 | 41.5 | 29.0 | 41.7 | 40.7 | 41.5 | 28.0 | 13.0 | 7440.0 | 54.7 | 42.0 | 74 | 54 | 12.0 |
| Column numbers (see below for explanations) | | | | | | | | | | | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |

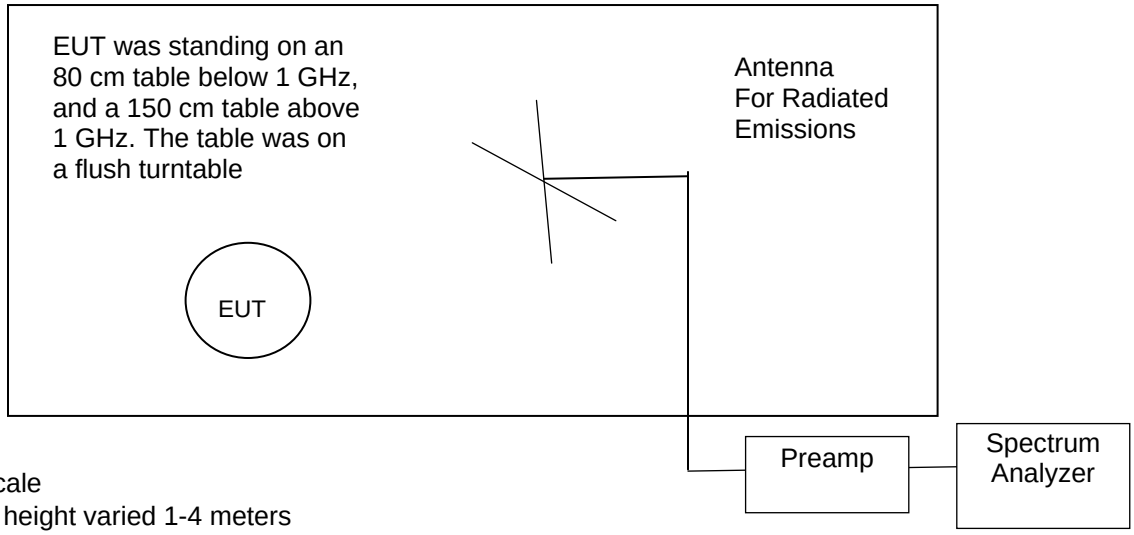
Column #1. hrm = Harmonic; BE = Band Edge emissions
Column #2. Frequency of Transmitter.
Column #3. Uncorrected readings from the spectrum analyzer with First Axis Rotation.
Column #4. Uncorrected readings from the spectrum analyzer with Second Axis Rotation.
Column #5. Uncorrected readings from the spectrum analyzer with Third Axis Rotation.
Column #6. Highes Vertical Average Reading u
Column #7. Uncorrected readings from the spectrum analyzer with First Axis Rotation.
Column #8. Uncorrected readings from the spectrum analyzer with Second Axis Rotation.
Column #9. Uncorrected readings from the spectrum analyzer with Third Axis Rotation.
Column #10. Average Reading based on peak reading reduced by the Duty cycle correction
Column #11. Corr. Factors = Cable Loss – Preamp Gain + Antenna Factor
Column #12. Frequency of Tested Emission
Column #13. Highest peak field strength at listed frequency.
Column #14. Highest Average field strength at listed frequency.
Column #15. Peak Limit. (Fundamental limit is 15.249, Harmonics are 15.209)
Column #16. Average Limit. (Fundamental limit is 15.249, Harmonics are 15.209)
Column #17. The margin (last column) is the worst case margin under the peak or average limits for that row.

Overall Judgment: Passed by 2.8 dB

No other Emissions were detected from 30 to 25,000 MHz within 10 dB of the limits.

**Figure 2. Drawing of Radiated Emissions Setup**

Chamber E, anechoic




**Notes:**
- Not to Scale
- Antenna height varied 1-4 meters
- Distance from antenna to tested system is 3 meters

| Frequency Range | Receive Antenna | Pre-Amplifier | Spectrum Analyzer | High Pass Filter |
|---|---|---|---|---|
| 30 to 200 MHz | ANT-04 | AMP-22 | REC-21 | None |
| 200 to 1000 MHz | ANT-06 | AMP-22 | REC-21 | None |
| 1 to 10 GHz | ANT-66 | AMP-05 | REC-21 | None |
| 10 to 18 GHz | ANT-66 | AMP-20 | REC-21 | None |
| 18 to 26 GHz | ANT-48 | AMP-59 | REC-21 | None |

A high pass filter was not needed since the EIRP is less than 3 mW.

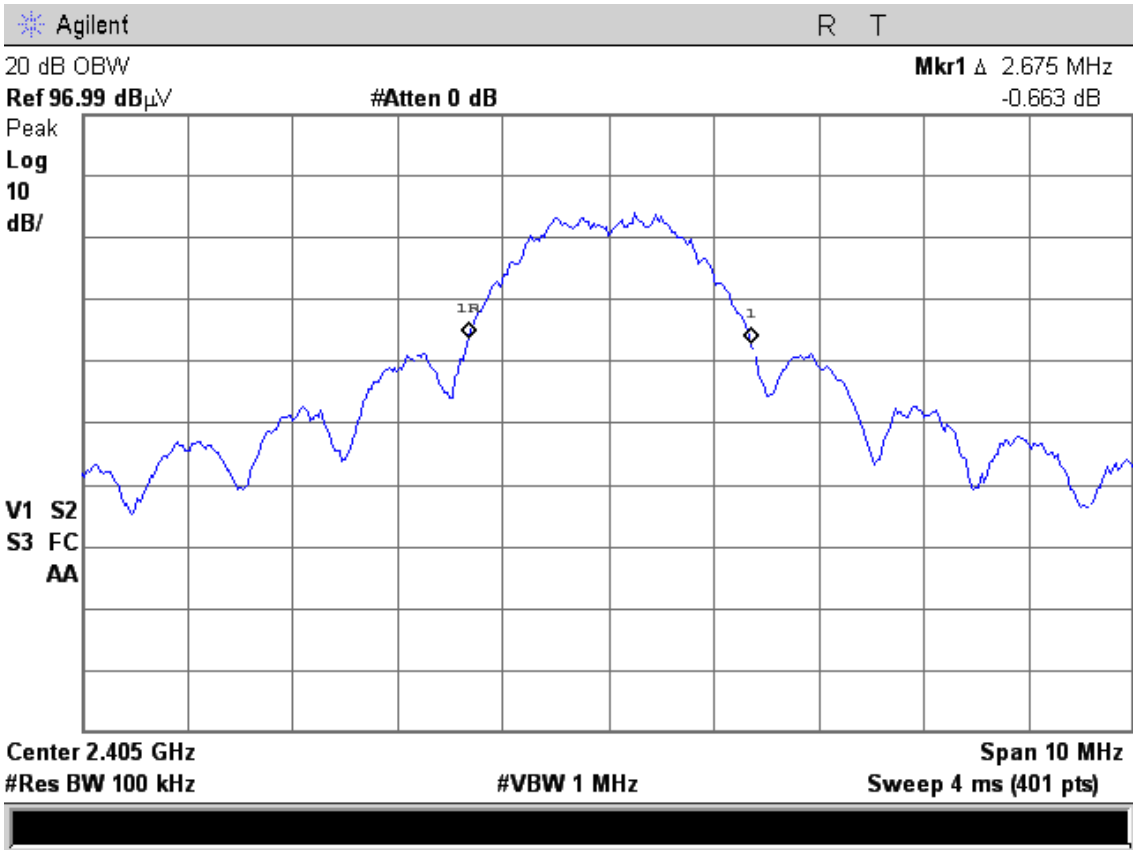
## 11.3 Occupied Bandwidth Data (20 dB)

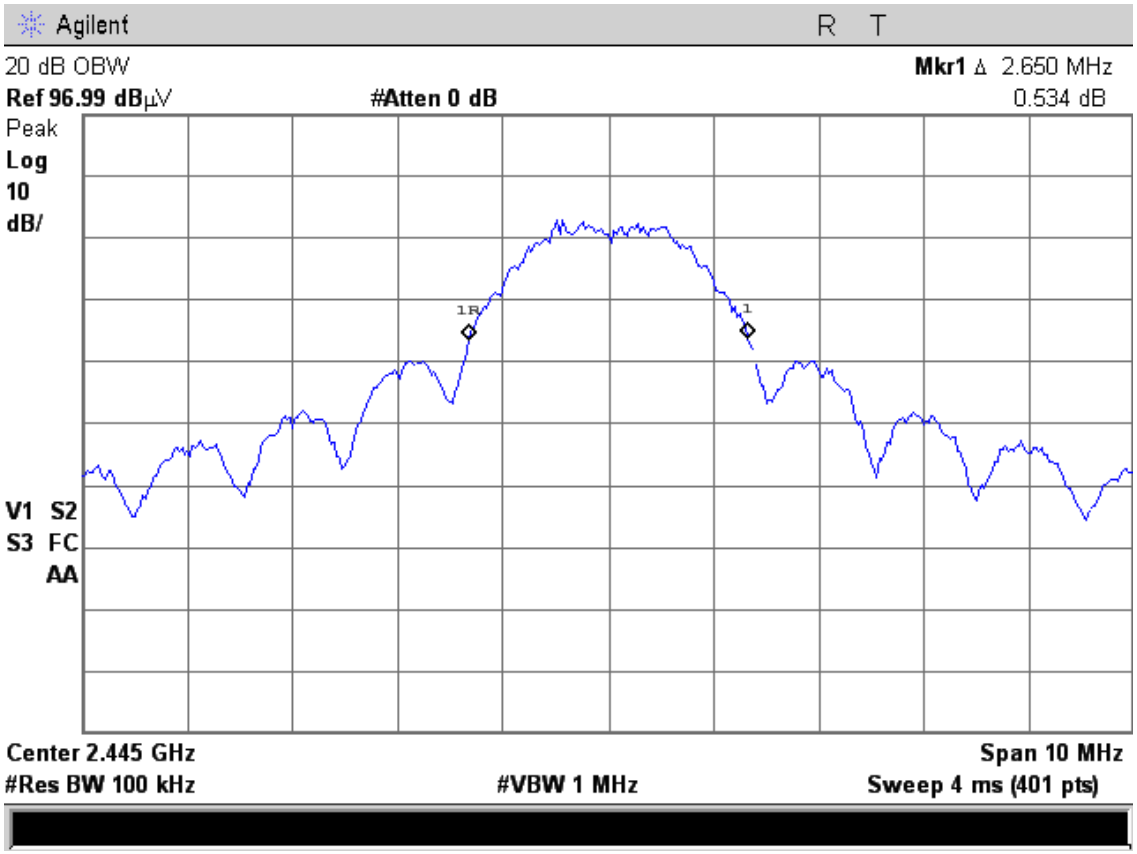
The occupied bandwidth of the RF output was measured using a spectrum analyzer. The bandwidth was measured using the peak detector function. The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation. The marker-to-peak function was set to the peak of the emission. Then the marker-delta function was used to measure 20 dB down one side of the emission. The marker-delta function was reset and then moved to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the bandwidth of the emission. The plots of the occupied bandwidth for the EUT are supplied on the following pages.

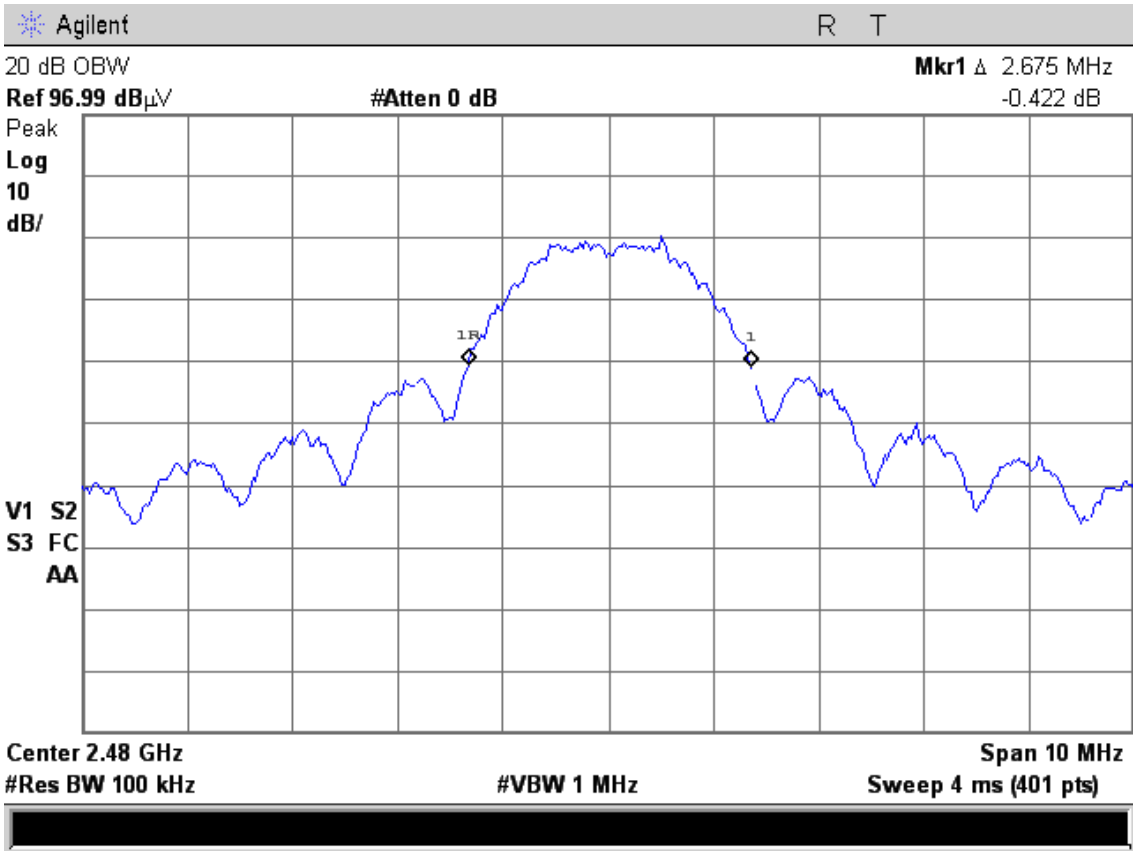
| Channel MHz | 20 dB OBW MHz |
|---|---|
| 2405 | 2.675 |
| 2445 | 2.650 |
| 2480 | 2.675 |

Judgement: Pass
The 20 dB OBW is within the allowed 2400 to 2483.5 MHz authourized band.

**Figure 3. 20 dB Occupied Bandwidth Plots**






### 11.3.1 Measurement Instrumentation Uncertainty

| Measurement | Uncertainty |
|---|---|
| Conducted LISN method (150kHz to 30 MHz) | 2.7 dB |
| Radiated Emissions, H-field, 3 meters, 150kHz to 30 MHz | 2.7 dB |
| Radiated Emissions, E-field, 3 meters, 30 to 1000 MHz | 5.3 dB |
| Radiated Emissions, E-field, 3 meters, 1 to 6 GHz | 5.5 dB |
| Radiated Emissions, E-field, 3 meters, 6 to 26 GHz | 5.9 dB |
| 99% Occupied Bandwidth using REC-43 | 1% of frequency span |
| Bandwidth using marker delta method at a span of 10 MHz | 4 kHz |
| Temperature THM-02 | 0.6 Deg C |

The uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k=2 in accordance with CISPR 16-4-2.