# Electromagnetic Compatibility Test Report

## Tests Performed on a Timekeeping Systems

## ID Badge Transciever, Model Tag-008

## Radiometrics Document RP-9206

ACCREDITED
TESTING CERT #1495.01

| *Product Detail:* |
|---|
| FCC ID: MTD-0009<br>IC: 12375A-0009<br>Equipment type: 2.4 GHz transmitter |
| *Test Standards:* |
| US CFR Title 47, Chapter I, FCC Part 15 Subpart C<br>FCC Part 15 CFR Title 47: 2020<br>Canada ISED; RSS-210, Issue 9: 2016 as required for Category I Equipment<br>IC RSS-GEN Issue 5: 2018<br><br>This report concerns: Original Grant for Certification<br>FCC Part 15.249 |

| *Tests Performed For:* | *Test Facility:* |
|---|---|
| **Timekeeping Systems**<br>30100 Bainbridge Road, Suite H<br>Solon, Ohio 44139 | **Radiometrics Midwest Corporation**<br>12 Devonwood Avenue<br>Romeoville, IL 60446-1349<br>(815) 293-0772 |

| *Test Date(s):* |
|---|
| December 13 to January 3, 2020 |

Document RP-9206 Revisions:

| Rev. | Issue Date | Revised By |
|---|---|---|
| 0 | February 6, 2020 | |
| | | |
| | | |

## Contents



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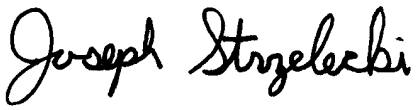
## 1.0 ADMINISTRATIVE DATA

| *Equipment Under Test:* | |
|---|---|
| A Timekeeping Systems, ID Badge<br>Model: Tag-008 Serial Number: None<br>This will be referred to as the EUT in this Report | |
| *Date EUT Received at Radiometrics:* | *Test Dates:* |
| December 12, 2020 | December 13 to January 3, 2020 |
| *Test Report Written and Authorized By:* | *Test Witnessed By:* |
| Joseph Strzelecki<br>Senior EMC Engineer | The tests were not witnessed by personnel from Timekeeping Systems. |
| *Radiometrics' Personnel Responsible for Test:* | *EUT Checked By:* |
|  02/05/2020<br>Date<br>Joseph Strzelecki<br>Senior EMC Engineer<br>NARTE EMC-000877-NE<br><br>Dave Jarvis<br>EMC Technician<br><br>Richard L. Tichgelaar<br>EMC Technician | Joseph Strzelecki<br>Richard Tichgelaar<br>Dave Jarvis<br>Radiometrics |

## 2.0 TEST SUMMARY AND RESULTS

The EUT (Equipment Under Test) is an ID Badge, Model Tag-008, manufactured by Timekeeping Systems. 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 | RSS-210 &<br>FCC Part 15 | Pass |
| Occupied Bandwidth Test | Fundamental Freq. | RSS-210 &<br>FCC Part 15 | Pass |

Since the EUT is battery operated, no AC conducted emissions were performed.

**IEC 17025 Decision Rule:**
The declaration of pass or fail is based on the specifications listed above. The declaration of pass or fail did not consider measurement uncertainty.

## 3.0 EQUIPMENT UNDER TEST (EUT) DETAILS

### 3.1 EUT Description

The EUT is an ID Badge, Model Tag-008, manufactured by Timekeeping Systems. The EUT was in good working condition during the tests, with no known defects. The EUT uses 2.4 GHz transmissions to track locations of personnel wearing the tags.

### 3.1.1 FCC Section 15.203 & RSS-GEN Antenna Requirements

The antenna is permanently attached to the printed circuit board. The antenna is internal to the EUT and it is not readily available to be modified by the end user. 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. The EUT was tested as a stand-alone device. Power was supplied with a new battery.

The device is battery powered with no external cables.

**Tested System Configuration List**

| Item | Description | Type* | Manufacturer | Model Number | Serial Number |
|---|---|---|---|---|---|
| 1 | ID Badge | E | Timekeeping Systems | Tag-008 | None |

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

### 4.2 EUT Operating Modes

The EUT was tested as a stand-alone device, since in the field it is a battery-operated stand-alone product.

### 4.3 Special Accessories

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

### 4.4 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 CFR Title 47 | 2020 | Code of Federal Regulations Title 47, Chapter 1, Federal Communications Commission, Part 15 - Radio Frequency Devices |
| IC RSS-210 Issue 9 | 2016 | Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands) Category I Equipment |
| IC RSS-Gen Issue 5 | 2019 | General Requirements and Information for the Certification of Radiocommunication Equipment (RSS-Gen) |

## 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 |
| 558074 D01 DTS Meas Guidance | 2016 | Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247; v03r04 |

## 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. Details of the site characteristics are on file with the Industry Canada as site number IC 3124A-1.

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. | 01/10/19 |
| AMP-20 | Avantek | Pre-amplifier | SF8-0652 | 15221 | 8-18GHz | 12 Mo | 04/22/19 |
| AMP-59 | Amplitech | Pre-amplifier | APTMP44 | AMP-59 | 18-26 GHz | 12 Mo. | 01/10/19 |
| ANT-08 | RMC | Log-Periodic Ant. | LP1000 | 1002 | 200-1000MHz | 24 Mo. | 11/19/18 |
| ANT-13 | EMCO | Horn Antenna | 3115 | 2502 | 1.0-18GHz | 24 Mo. | 01/16/19 |
| ANT-36 | Ailtech (Eaton) | Horn Antenna | 96001 | 2013 | 1.0-18GHz | 24 Mo. | 11/19/18 |
| ANT-48 | RMC | Std Gain Horn | HW2020 | 1001 | 18-26 GHz | 36 Mo. | 08/09/19 |
| ANT-66 | ETS-Lindgren | Horn Antenna | 3115 | 62580 | 1.0-18GHz | 24 Mo. | 03/05/19 |
| ANT-80 | AH Systems | Bicon Antenna | SAS-540 | 294 | 20-330MHz | 24 Mo. | 12/14/18 |
| CAB-106A | Teledyne | Coaxial Cable | N/A | 106A | DC-2 GHz | 24 Mo. | 05/07/18 |
| CAB-1090 | Teledyne | Coaxial Cable | N/A | 1090 | DC-18 GHz | 24 Mo. | 02/12/19 |
| CAB-160B | Teledyne | Coaxial Cable | N/A | 160B | DC-18 GHz | 24 Mo. | 05/09/18 |
| CAB-090A | Teledyne | Coaxial Cable | N/A | 090A | DC-26 GHz | 24 Mo. | 05/15/18 |
| CAB-295A | Teledyne | Coaxial Cable | N/A | 295A | DC-26 GHz | 24 Mo. | 05/09/18 |
| HPF-01 | Solar | High Pass Filter | 7930-100 | HPF-1 | 0.15-30MHz | 24 Mo. | 03/04/18 |
| REC-11 | HP / Agilent | Spectrum Analyzer | E7405A | US39110103 | 9Hz-26.5GHz | 24 Mo | 04/02/18 |
| REC-21 | Agilent | Spectrum Analyzer | E7405A | MY45118341 | 9Hz-26.5 GHz | 24 Mo. | 01/06/18 |
| REC-22 | Rohde Schwarz | Spectrum Analyzer | ESIB 26 | 100145 | 26.5 GHz | 24 Mo | 09/16/19 |
| REC-43 | Adventest | Spectrum Analyzer | U3772 | 150800305 | 9Hz-43GHz | 24 Mo. | 06/24/19 |
| RNT-17 | Agilent | Spectrum Analyzer | E4440A | MY42510244 | E4440A | 36 Mo. | 07/19/17 |
| THM-03 | Fluke | Temp/Humid Meter | 971 | 95850465 | N/A | 12 Mo. | 04/30/18 |

Note: All calibrated equipment is subject to periodic checks.
The test equipment was in calibration during the tests.

| Software Company | Test Software Name | Version | Applicable Tests |
|---|---|---|---|
| Radiometrics | REREC11D | 07.16.19 | RF Radiated Emissions (FCC Part 15 & EN 55032) |
| Agilent | PSA/ESA-E/L/EMC | 2.4.0.42 | Bandwidth and screen shots |

## 11.0 TEST SECTIONS

### 11.1 Radiated RF Emissions

**Radiated Emissions Field Strength Limits**

| Frequency Range (MHz) | Test Distance (meters) | Class B Limits | |
|---|---|---|---|
| | | uV/m | dB(uV/m) |
| 30 - 88 | 3 | 100 | 40.0 |
| 88 - 216 | 3 | 150 | 43.5 |
| 216 - 960 | 3 | 200 | 46.0 |
| Above 960 | 3 | 500 | 54.0 |

The emission limits shown in the above table are based on measurements using a CISPR quasi-peak detector except for above 1000 MHz which is based on measurements employing an average detector.

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. A 10 dB linearity check is performed prior to start of testing in order to determine if an overload condition exists. Figure 4 herein lists the details of the test equipment used during radiated emissions tests.

In addition, a high pass filter was used to reduce the fundamental emission. High pass filters were not needed above 10 GHz, since the preamplifiers attenuated the fundamental emission. 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 Devonwood Ave. Romeoville, Illinois EMI test lab.

The entire frequency range from 30 to 25,000 MHz was slowly scanned. 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.

#### 11.1.1 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 in dBuV/m
RA = Receiver Amplitude dBuV
AF = Antenna Factor dB/m
CF = Cable Attenuation Factor dB
AG = Amplifier Gain dB
HPF = High pass Filter Loss dB

### 11.1.2 Radiated Emissions Test Results

| | |
|---|---|
| Test Date | December 20, 2019 & January 3, 2020 |
| Test Distance | 3 Meters |
| Specification | FCC Part 15 Subpart C & RSS-210 Section B.10 |
| Notes | |
| Abbreviations | Pol = Antenna Polarization; V = Vertical; H = Horizontal; P = peak; Q = QP |
| Configuration | Constant transmit mode |

This table includes all emissions except Fundamental, Band edge, and harmonics emissions.

| Freq. MHz | Meter Reading dBuV | Dect. | Ant. Pol. | Ant Factor dB/m | Cbl/amp Factors | Dist Fact dB | EUT dBuV/m | Limit dBuV/m | Margin Under Limit dB | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| 41.6 | 9.8 | P | H | 10.7 | 0.7 | 0.0 | 21.2 | 40.0 | 18.8 | |
| 73.6 | 10.0 | P | H | 9.3 | 0.9 | 0.0 | 20.2 | 40.0 | 19.8 | |
| 122.8 | 10.4 | P | H | 11.8 | 1.1 | 0.0 | 23.3 | 43.5 | 20.2 | |
| 198.5 | 10.6 | P | H | 14.2 | 1.5 | 0.0 | 26.3 | 43.5 | 17.2 | |
| 213.4 | 15.3 | P | H | 14.8 | 1.5 | 0.0 | 31.6 | 43.5 | 11.9 | |
| 238.8 | 12.9 | P | H | 15.2 | 1.6 | 0.0 | 29.7 | 46.0 | 16.3 | |
| 286.0 | 10.6 | P | H | 13.5 | 1.8 | 0.0 | 25.9 | 46.0 | 20.1 | |
| 349.0 | 11.7 | P | H | 14.5 | 2.0 | 0.0 | 28.2 | 46.0 | 17.8 | |
| 462.4 | 12.8 | P | H | 16.6 | 2.3 | 0.0 | 31.7 | 46.0 | 14.3 | |
| 553.8 | 11.9 | P | H | 18.2 | 2.5 | 0.0 | 32.6 | 46.0 | 13.4 | |
| 653.8 | 13.6 | P | H | 19.4 | 2.7 | 0.0 | 35.7 | 46.0 | 10.3 | |
| 878.8 | 12.0 | P | H | 22.3 | 3.2 | 0.0 | 37.5 | 46.0 | 8.5 | |
| 32.8 | 10.1 | P | V | 13.0 | 0.6 | 0.0 | 23.7 | 40.0 | 16.3 | |
| 78.1 | 10.0 | P | V | 9.3 | 0.9 | 0.0 | 20.2 | 40.0 | 19.8 | |
| 135.5 | 10.4 | P | V | 12.4 | 1.2 | 0.0 | 24.0 | 43.5 | 19.5 | |
| 214.0 | 10.9 | P | V | 14.8 | 1.5 | 0.0 | 27.2 | 43.5 | 16.3 | |
| 239.4 | 11.3 | P | V | 15.2 | 1.6 | 0.0 | 28.1 | 46.0 | 17.9 | |
| 322.0 | 12.4 | P | V | 14.2 | 1.9 | 0.0 | 28.5 | 46.0 | 17.5 | |
| 414.6 | 13.4 | P | V | 15.6 | 2.1 | 0.0 | 31.2 | 46.0 | 14.8 | |
| 458.0 | 13.5 | P | V | 16.0 | 2.3 | 0.0 | 31.8 | 46.0 | 14.2 | |
| 551.3 | 10.9 | P | V | 18.0 | 2.5 | 0.0 | 31.4 | 46.0 | 14.6 | |
| 755.0 | 10.7 | P | V | 21.5 | 2.9 | 0.0 | 35.1 | 46.0 | 10.9 | |
| 976.3 | 13.2 | P | V | 22.5 | 3.4 | 0.0 | 39.0 | 54.0 | 15.0 | |

Judgment: Passed by 8.5 dB

Tested by: Joseph Strzelecki/Richard Tichgelaar
Test Date: January 3, 2020

Fundammental and Harmonic Emissions FCC 15.249; Three axis

| | Tx | Spectrum Analyzer Readings dBuV | | | | | | | | | EUT | Peak | Ave | Peak | Ave | Margin |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| hrm | Freq | Peak | | | Ave | Peak | | | Ave | Corr. | Emission | Tot. FS | | Limit | | Under |
| | | Vertical Polarization | | | | Horizontal Polarization | | | | Fact | Freq | | | | | Limit |
| # | MHz | X | Y | Z | Max | X | Y | Z | Max | dB/m | MHz | dBuV/m | | dBuV/m | | dB |
| 1 | 2402 | 91.8 | 97.0 | 101.5 | 81.5 | 103.5 | 96.8 | 97.3 | 83.5 | -4.7 | 2402.0 | 98.8 | 78.8 | 114 | 94 | 15.2 |
| BE | 2402 | 43.5 | 46.5 | 51.3 | 33.9 | 53.5 | 48.3 | 48.4 | 39.4 | -4.7 | 2400.0 | 48.8 | 34.7 | 74 | 54 | 19.3 |
| 2 | 2402 | 58.2 | 55.8 | 55.0 | 38.2 | 55.2 | 57.8 | 52.6 | 37.8 | 3.9 | 4804.0 | 62.1 | 42.1 | 74 | 54 | 11.9 |
| 3 | 2402 | 42.9 | 50.0 | 44.3 | 30.0 | 46.7 | 46.0 | 48.2 | 28.2 | 8.5 | 7206.0 | 58.5 | 38.5 | 74 | 54 | 15.5 |
| 4 | 2402 | 36.9 | 36.4 | 36.2 | 16.9 | 33.6 | 37.0 | 36.6 | 17.0 | 10.8 | 9608.0 | 47.8 | 27.8 | 74 | 54 | 26.2 |
| 1 | 2426 | 94.6 | 99.5 | 103.6 | 83.6 | 101.9 | 99.6 | 100.6 | 81.9 | -4.6 | 2426.0 | 99.0 | 79.0 | 114 | 94 | 15.0 |
| 2 | 2426 | 54.1 | 51.3 | 53.3 | 34.1 | 53.4 | 56.0 | 50.1 | 36.0 | 4.0 | 4852.0 | 60.0 | 40.0 | 74 | 54 | 14.0 |
| 3 | 2426 | 45.6 | 51.6 | 46.5 | 31.6 | 47.9 | 47.4 | 48.7 | 28.7 | 8.8 | 7278.0 | 60.4 | 40.4 | 74 | 54 | 13.6 |
| 4 | 2426 | 36.6 | 36.7 | 37.0 | 17.0 | 36.5 | 36.2 | 37.0 | 17.0 | 10.5 | 9704.0 | 47.5 | 27.5 | 74 | 54 | 26.5 |
| 1 | 2480 | 90.7 | 95.2 | 100.3 | 80.3 | 103.0 | 97.6 | 95.7 | 83.0 | -4.7 | 2480.0 | 98.3 | 78.3 | 114 | 94 | 15.7 |
| BE | 2480 | 45.2 | 50.0 | 53.4 | 35.1 | 55.6 | 51.2 | 50.4 | 40.1 | -4.7 | 2483.5 | 50.9 | 35.4 | 74 | 54 | 18.6 |
| 2 | 2480 | 48.8 | 53.5 | 53.6 | 33.6 | 53.4 | 56.0 | 52.7 | 36.0 | 4.2 | 4960.0 | 60.2 | 40.2 | 74 | 54 | 13.8 |
| 3 | 2480 | 44.1 | 48.8 | 45.7 | 28.8 | 44.4 | 45.9 | 45.8 | 25.9 | 9.4 | 7440.0 | 58.2 | 38.2 | 74 | 54 | 15.8 |
| 4 | 2480 | 36.6 | 37.9 | 37.7 | 17.9 | 36.4 | 37.6 | 36.8 | 17.6 | 10.3 | 9920.0 | 48.2 | 28.2 | 74 | 54 | 25.8 |
| Column numbers (see below for explanations) | | | | | | | | | | | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |

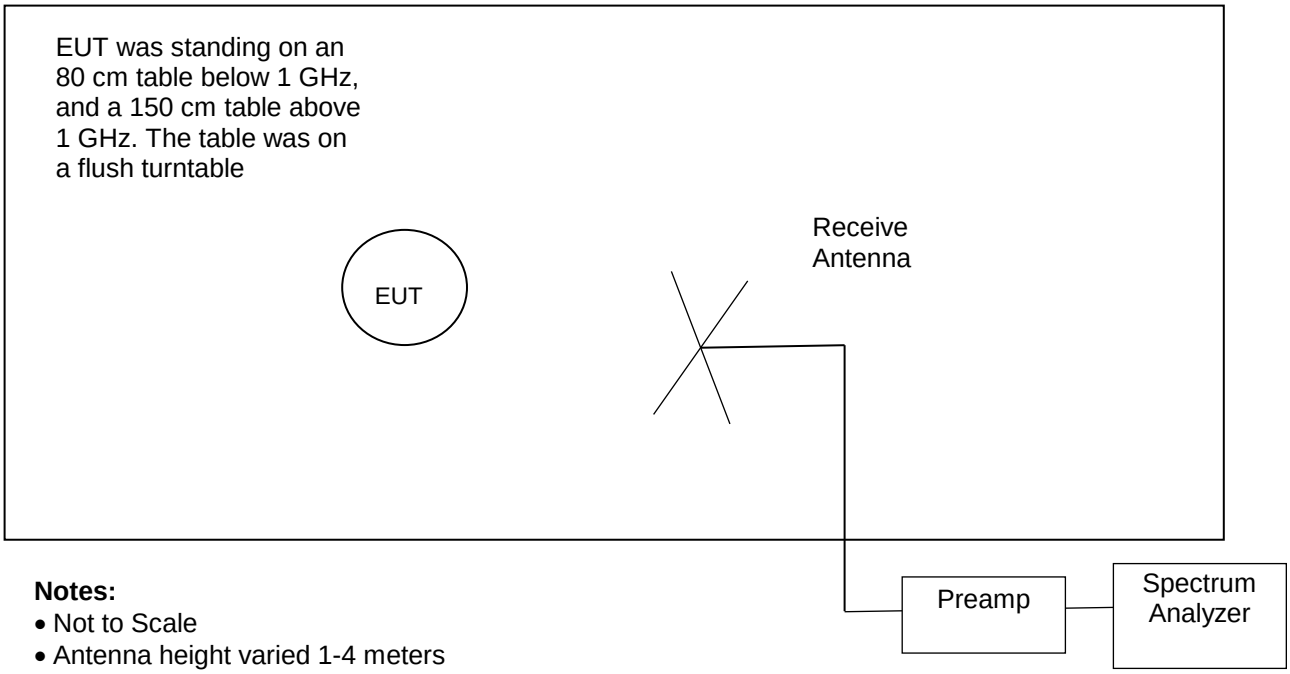
Column #1. hrm = Harmonic; BE = Band Edge emissions
Column #2. Frequency of Transmitter.
Column #3. Uncorrected readings from the spectrum analyzer with First Axis Rotation.
Column #4. Uncorrected readings from the spectrum analyzer with Second Axis Rotation.
Column #5. Uncorrected readings from the spectrum analyzer with Third Axis Rotation.
Column #6. Maximum Average Reading based on peak reading reduced by the Duty cycle correction
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.
Column #16. Average Limit.
Column #17. The margin (last column) is the worst case margin under the peak or average limits for that row.

Overall Judgment: Passed by 8.5 dB

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

**Figure 1. 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
- AC cords not shown. They are connected to AC outlet with low-pass filter on turntable

| Frequency Range | Receive Antenna | Pre-Amplifier | Spectrum Analyzer | High Pass Filter |
|---|---|---|---|---|
| 30 to 200 MHz | ANT-80 | AMP-22 | REC-11 | None* |
| 200 to 1000 MHz | ANT-08 | AMP-22 | REC-11 | None* |
| 1 to 10 GHz | ANT-66 | AMP-05 | REC-21 | HPF-06 |
| 10 to 18 GHz | ANT-66 | AMP-20 | REC-21 | None* |
| 18 to 25 GHz | ANT-48 | AMP-59 | RNT-17 | None* |

* A high pass filter was not needed since the fundamental frequency was outside of the amplifiers pass band.

## 11.2 Occupied Bandwidth Data

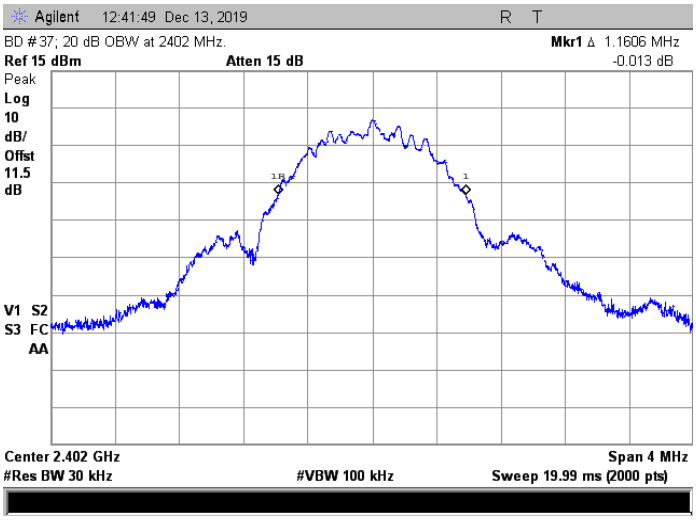
The occupied bandwidth of the RF output was measured using a spectrum analyzer. The bandwidth was measured using the peak detector function. The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation. The marker-to-peak function was set to the peak of the emission. 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.

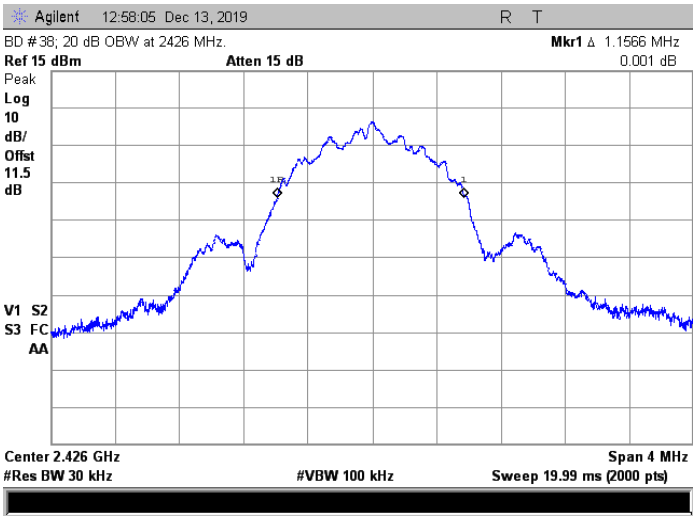
The 20 dB OBW is within the allowed 2400 to 2483.5 MHz authourized band.

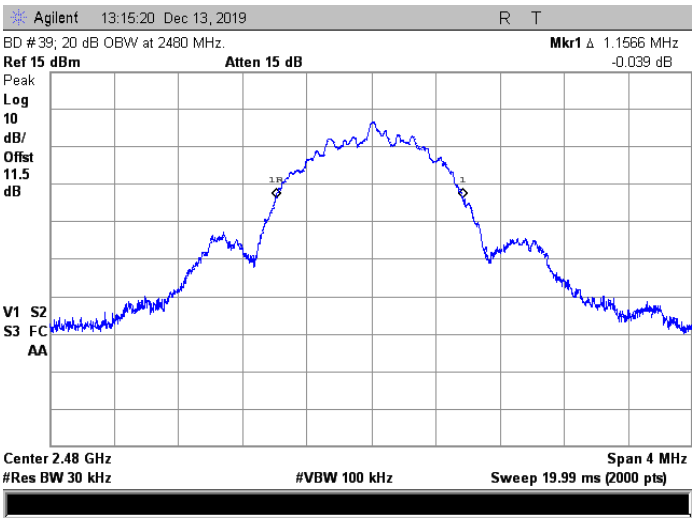
| Channel | 20 dB OBW MHz | 99% EBW MHz |
|---|---|---|
| 2402 | 1.1606 | 1.060 |
| 2426 | 1.1566 | 1.084 |
| 2480 | 1.1566 | 1.072 |

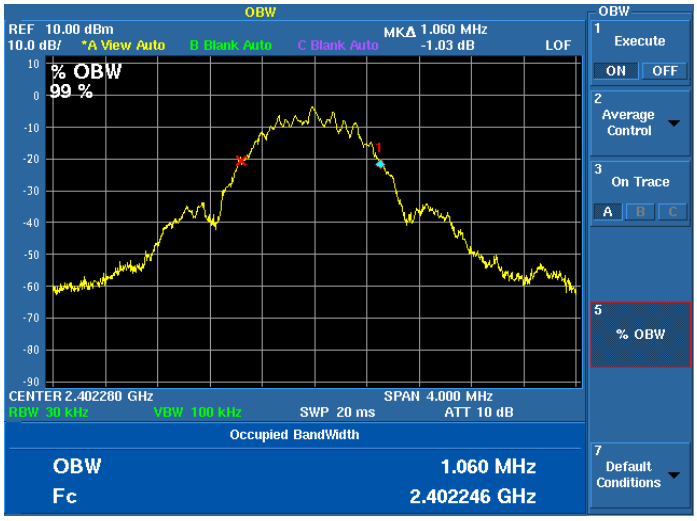
Judgement: Pass

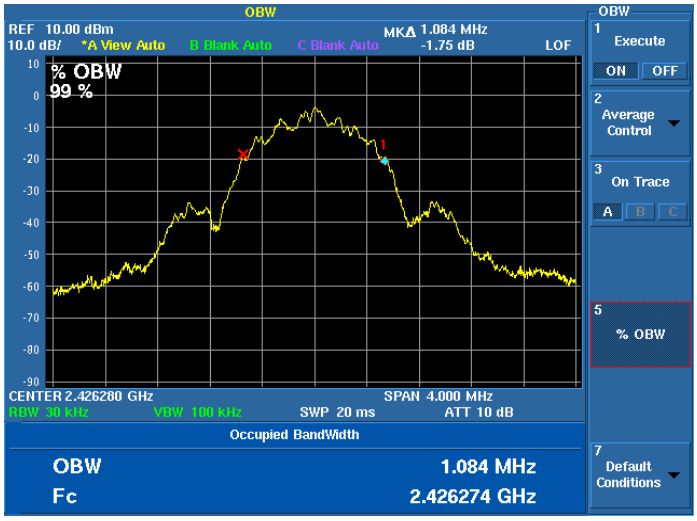
**Figure 2. Occupied Bandwidth Plot**

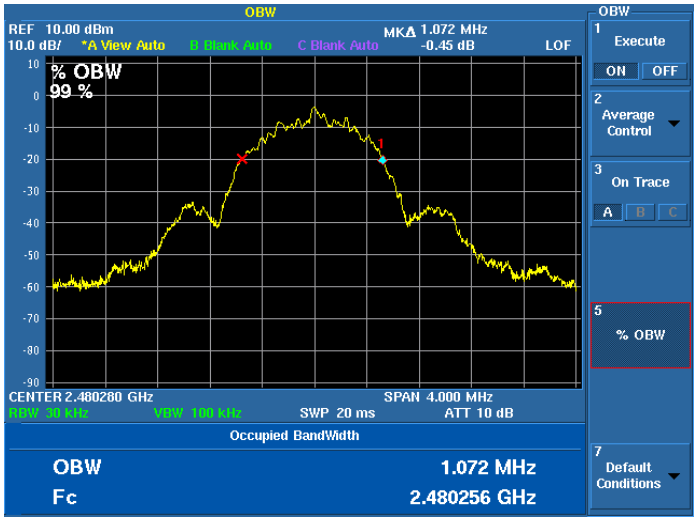





## 11.3 Duty Cycle

The averave value of the pulsed emissions were measured as per section 7.5, formula (10) of of ANSI C63.10-2013.

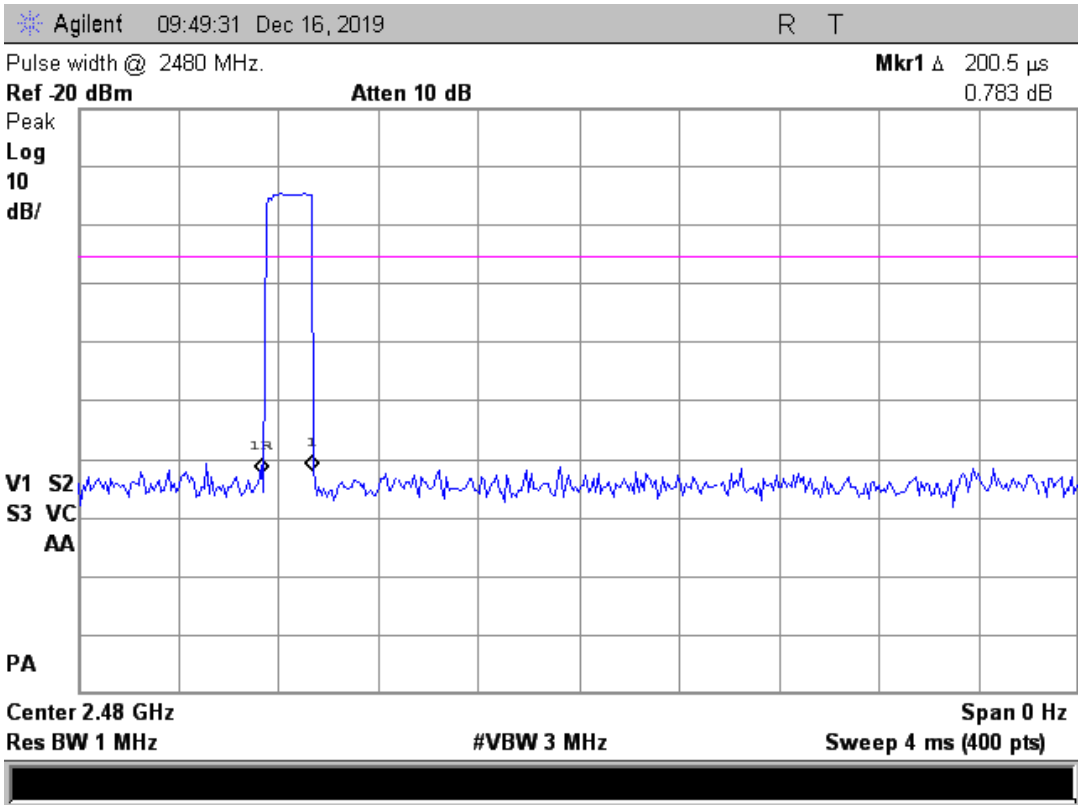
a) The EUT was set to the “worst-case” pulse ON time.
b) The RF output was coupled to the input of a spectrum analyzer by a “near-field” coupling method. The signal received shall be of sufficient level to trigger adequately the spectrum analyzer sweep display.
c) The center frequency of the spectrum analyzer was set to the center of the RF signal.
d) The spectrum analyzer was set for ZERO SPAN.
e) The sweep time was of the analyzer was set to 100 ms and other times to show the duty cycle.
f) Since the pulse train has a period that exceeds 100 ms, or as an alternative to step f), then:
    1) The trigger on the spectrum analyzer was set to capture the greatest amount of pulse “ON time” over 100 ms.
    2) The 100 ms period that contains the maximum “on time” was found.
    3) The duty cycle was determined by dividing the total maximum “ON time” by 100 ms (tON/100 ms).
h) The duty cycle correction factor was used applying Equation (10) of ANSI C63.10 to the duty cycle determined in the preceding steps.

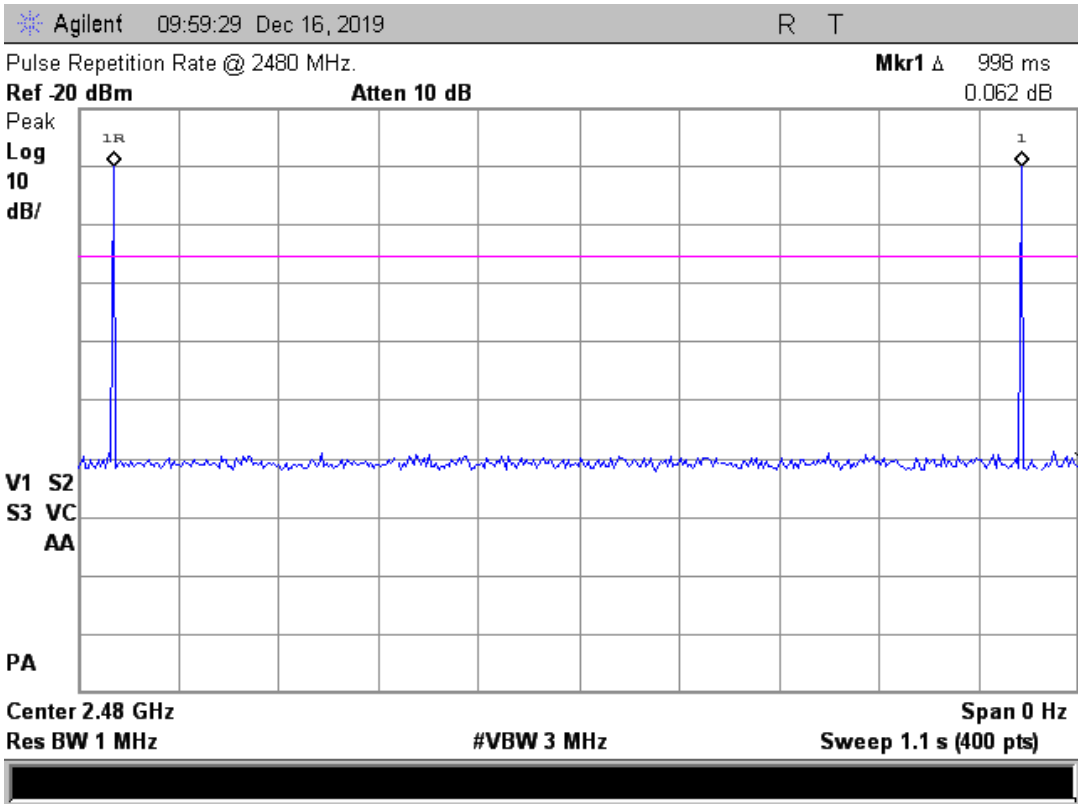
The Peak to average factor is calculated by the highest duty cycle in percent over any 100mS transmission. The factor in dB is 20 * Log(Duty cycle/100). The transmitter operates for a maximum duration of 0.2 ms in any 100 ms interval for a 0.2% maximum duty cycle. 20 Log*(0.2mSec/100mSec) = -54 dB Peak to average Correction factor.

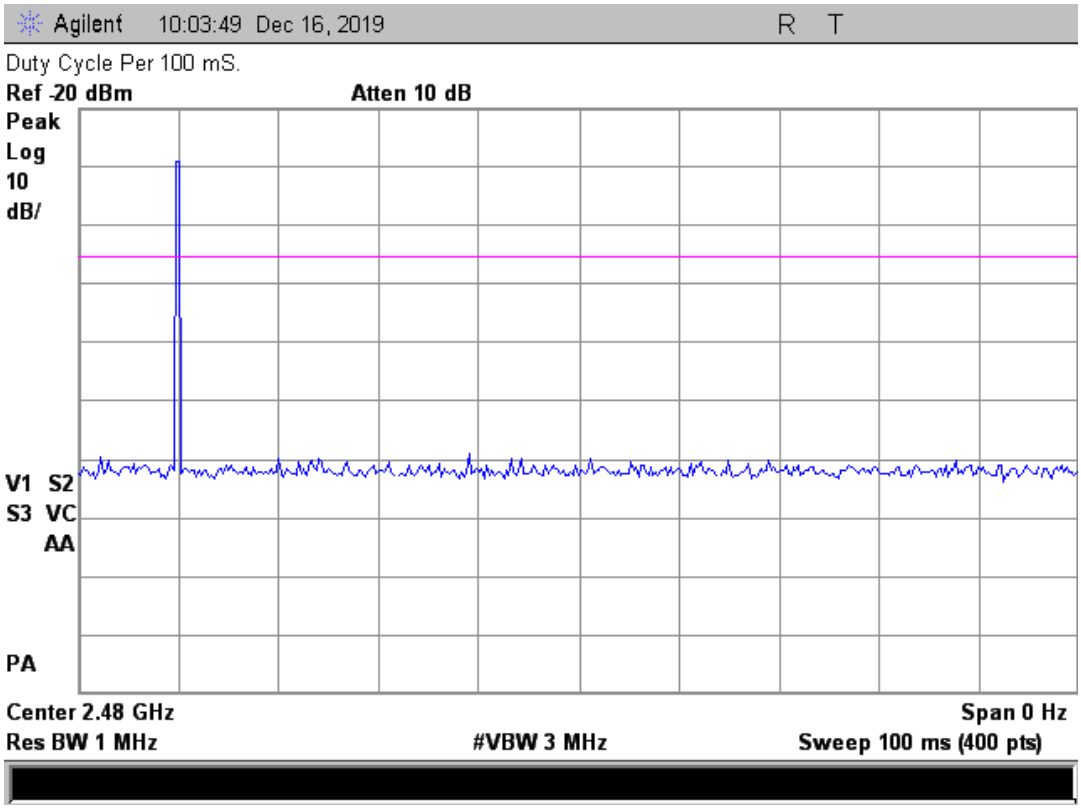
Since the difference between the peak and the average limits are 20 dB, there is no need to use a correction factor of more than 20 dB. Therefore, a 20 dB factor was used.

Tested by: Richard Tichgelaar
Test Date: December 16, 2019

**Figure 3. Duty Cycle Plots**




Agilent 09:59:29 Dec 16, 2019
R T
Pulse Repetition Rate @ 2480 MHz.
Mkr1 Δ 998 ms
0.062 dB
Ref -20 dBm
Atten 10 dB
Peak
Log
10
dB/
1R
1
V1 S2
S3 VC
AA
PA
Center 2.48 GHz
Span 0 Hz
Res BW 1 MHz
#VBW 3 MHz
Sweep 1.1 s (400 pts)


Agilent 10:03:49 Dec 16, 2019
R T
Duty Cycle Per 100 mS.
Ref -20 dBm
Atten 10 dB
Peak
Log
10
dB/
V1 S2
S3 VC
AA
PA
Center 2.48 GHz
Span 0 Hz
Res BW 1 MHz
#VBW 3 MHz
Sweep 100 ms (400 pts)

## 11.4 Peak Output Power

The test procedures were in accordance to FCC DTS Measurement Guideline 558074 D01 & ANSI C63.10-2013 section 11.9.1.2. The EUT antenna port was connected to the Spectrum analyzer Via a low loss coaxial cable. The trace was allowed to stabilize. The indicated level is the peak output power. Since the gain of the antenna is always less than 6 dB, the limit is not reduced.

The spectrum analyzer was set to peak channel power. The EUT antenna port was connected to the Spectrum analyzer Via a low loss coaxial cable. The analyzer was corrected for the attenuator and cable loss. Span = 30 MHz; RBW = 3 MHz; VBW = 10 MHz

Tested by: Joseph Strzelecki/Richard Tichgelaar
Test Date: 12/13/2019

| Mode | Freq. (MHz) | Total Power (dBm) | |
|---|---|---|---|
| | | dBm | Watts |
| 802.11b | 2402 | 3.86 | 0.00243 |
| 802.11b | 2426 | 4.08 | 0.00256 |
| 802.11b | 2480 | 3.73 | 0.00236 |

Overall Test result: N/A
This is for informational purposes only. It is needed for RF exposure

### 11.4.1 Measurement Instrumentation Uncertainty

| Measurement | Uncertainty |
|---|---|
| Radiated Emissions, E-field, 3 meters, 30 to 200 MHz | 4.7 dB |
| Radiated Emissions, E-field, 3 meters, 200 to 1000 MHz | 6.2 dB |
| Radiated Emissions, E-field, 3 meters, 1 to 6 GHz | 5.0 dB |
| Radiated Emissions, E-field, 3 meters, 6 to 18 GHz | 5.5 dB |
| Radiated Emissions, E-field, 3 meters, 18 to 26 GHz | 5.9 dB |
| 99% Occupied Bandwidth using REC-43 | 1% of frequency span |
| 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.

## 12.0 REVISION HISTORY

| Document RP-9206 Revisions: | | | |
|---|---|---|---|
| Rev. | Affected Sections | Description | Rationale |
| | | | |
| | | | |
| | | | |
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