

FCC/ISED RF Test Report
As per

RSS-247 Issue 2

FCC Part 15.247 Subpart C

Unlicensed Intentional Radiators
(FHSS)
ZX Motion Sensor

IC:8410A-ZXMS; FCC ID: XEY-ZX-MS

Prepared to:

Verdant. Environmental Technologies, Inc.

1850 – 55th Avenue, Lachine, Quebec, H8T 3J5
CANADA



Product Service

**Choose certainty.
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| RESPONSIBLE FOR | NAME | DATE | SIGNATURE |
|----------------------|---------------------|------------|-----------|
| Test Specialist | Abderrahmane Ferhat | 12-09-2019 | |
| Authorised Signatory | Scott Drysdale | 12-09-2019 | |

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD Product Service document control rules.

EXECUTIVE SUMMARY

A sample of this product was tested and found to be in compliance with FCC Part 15.247 Subpart C/ ICES 003 Issue 6 and RSS-247 Issue 2.



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1 Report Summary

Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

| Issue | Description of Change | Date of Issue |
|-------|-----------------------|----------------|
| 1 | First Issue | April 22, 2020 |

Table 1 – Modification Records

Acronyms & Definitions

The following definitions and acronyms are applicable in this report. See also ANSI C63.14.

Acronyms

| | |
|--------------|--|
| AM | Amplitude Modulation |
| DTS | Digital Transmission System |
| EIRP | Equivalent Isotropical Radiated Power |
| ETSI | European Telecommunications Standards Institute |
| EUT | Equipment Under Test |
| FVIN | Firmware Version Identification Number |
| HVIN | Hardware Version Identification Number(s) |
| OOB | Out of Band |
| PKPSD | Peak Power Spectrum Density |
| RBW | Resolution Bandwidth |
| RF | Radio Frequency of oscillation rate of electromagnetic fields (e.g. radio waves: 9kHz to 300GHz) |
| RMS | Root mean square, i.e., $V_p / \sqrt{2}$ |
| Rx | Referred as antennae for receiving RF signals |
| SD | Spurious Domain |
| TR | Technical Report |
| Tx | Referred as antenna for transmitting RF signals |
| VBW | Video Bandwidth |
| Vp | Peak Voltage |



2 Introduction

| | |
|---------------------------------------|--|
| Applicant: | Verdant Environmental Technologies, Inc. |
| Manufacturer: | Verdant Environmental Technologies, Inc. |
| Number of Samples Tested: | 1 |
| Test Specification/Issue/Date: | RSS-247 Issue 2 : February 2017 FCC Part 15 Subpart C.247 2016 ICES 003 Issue 6:2019 |
| Test Plan/Issue/Date: | N/A |
| Project Number: | 716900571 |
| Date: | 2019-02-26 |
| Date of Receipt of EUT: | 2019-02-10 |
| Start of Test: | 2019-02-26 |
| Finish of Test: | 2019-03-21 |
| Name of Tester(s): | Abdoulaye Ndiaye Jose Martinez-Ortega |
| Related Documents: | ANSI C63.10:2013 FCC 15. Subpart 15 Subpart C/RSS-247 |



Brief Summary of Results

A brief summary of the tests carried out in accordance with RSS-247 Issue 2, FCC Part 15 Subpart 15.247, FCC Part 15 Subpart 15.207 & FCC Part 15 Subpart 15.209 is summarized in Table 2.

| Report Section | FCC Rule | IC Rule | Description | Class/Limit | Result |
|--------------------|-----------------|-----------------|---------------------------------------|-------------------------|--------|
| 6 | 15.247(a)(1)(i) | RSS-247.5.1 | 99% Bandwidth Hopping System | ≤500kHz | Pass |
| 7 | 15.247(a)(1)(i) | RSS 247 5.1 (c) | Hopping Channels | ≥50 | Pass |
| 8 | 15.247(a)(1) | RSS 247 5.1 (2) | Channel Separation | > 25 kHz or 20 dB BW | Pass |
| 90 | 15.247(a)(1)(i) | RSS 247 5.1 (c) | Time of occupancy | <0.4 s in 20s period | Pass |
| 10 | 15.247(b)(2) | RSS-247.5.4(a) | Maximum Peak Output Power (FHSS) | < 1W | Pass |
| 11 | §15.247(d) | RSS-247 5.5 | Band-Edge Spurious Conducted Emission | ≤ 20dBc | Pass |
| 12 | §15.209(a) | RSS-247 5.5 | Tx Spurious Radiated Emission | Quasi-Peak Average | Pass |
| - | 15.247(h) | RSS 247 5.1 | FHSS Intelligence | Note 3 | Pass |
| - | 15.247 (i) | RSS-102 | RF Exposure | Note 4 | Pass |
| - | 15.247(b)(4) | RSS 247 5.4 (3) | Antenna Gain | <6dBi <Note 2> | Pass |



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| - | 15.203 & 15.247(b) | RSS-210 | Antenna Requirement | Note 1 | Not Applicable |
|--|--------------------|---------|---------------------|--------|----------------|
| <p>Note 1: Manufacture uses a SMA antenna connector for unique coupling to the intentional radiator</p> <p>Note 2: For the Antenna requirement specified in FCC 15.203 (RSS-247 section 5.5), the unit uses a trace antenna with a gain of less than 6 dBi.</p> <p>Note 3: The EUT does not coordinate transmission with any other FHSS to avoid simultaneous occupation of hopping frequencies</p> <p>Note 4: For maximum permissible exposure, this device operates at less than 1 Watt at 902 - 928MHz and at 2.4GHz – 2.48GHz. It is designed to operate less than 20 cm from any personnel during normal operation. No testing is required; however, it complies with SAR exemption evaluation as determined the RF Exposure exhibits</p> | | | | | |

Table 2 – Test Summary Table



Declaration of Build Status

This report addresses the Radio verification testing and test results of the ZX MOTION SENSOR and is herein referred to as EUT (Equipment Under Test). The EUT was tested for compliance against the following standards:

RSS-247 Issue 2:2017

FCC Part 15 Subpart C 15.247:2016

ICES 003 Issue 6: 2019

Test procedures, results, justifications, and engineering considerations, if any, follow later in this report.

This report does not imply product endorsement by any government, accreditation agency, or TÜV SÜD Canada Inc.

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For a more detailed list of the standards and the revision used, see the "Applicable Standards, Specifications and Methods" section of this report.

Notes, Justification

The following notes, justifications for tests not performed or deviations from the above listed specifications apply:

For the Antenna requirement specified in FCC 15.203 (RSS-247 section 5.5), the unit uses a trace antenna with a gain 0dbi.

For the Restricted Bands of operation, the EUT is designed to only operate between 902 – 907.6 MHz.



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The EUT does not coordinate transmission with any other FHSS to avoid simultaneous occupation of hopping frequencies.

For maximum permissible exposure, this device operates at less than 1 Watt at 902 - 928MHz. It is designed to operate less than 20 cm from any personnel during normal operation. No testing is required; however, it complies with SAR exemption evaluation as determined the RF Exposure exhibits.

For the scope of this test report, the EUT was mounted in three orthogonal axes to maximize emissions. Worst case results are presented



3 EUT: ZX MOTION SENSOR

3.1 Radio Specifications:

| | |
|-----------------------|---|
| PRODUCT NAME: | ZX Motion Sensor |
| MANUFACTURER: | Verdant Environmental Technologies, Inc |
| MODEL | MS |
| FREQUENCY RANGE (MHz) | 902-928 |
| VOLTAGE RATING: | 5Vdc |
| HVIN | MS |
| FVIN | V1.00 |

Table 3 – EUT – ZX MOTION SENSOR – Radio Specifications



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| Channels | Frequency (MHz) |
|----------|-----------------|
| #0 | 902.46 |
| #1 | 902.84 |
| #2 | 903.22 |
| #3 | 903.6 |
| #4 | 903.98 |
| #5 | 904.36 |
| #6 | 904.74 |
| #7 | 905.12 |
| #8 | 905.5 |
| #9 | 905.88 |
| #10 | 906.26 |
| #11 | 906.64 |
| #12 | 907.02 |
| #13 | 907.4 |
| #14 | 907.78 |
| #15 | 908.16 |
| #16 | 908.54 |
| #17 | 908.92 |
| #18 | 909.3 |
| #19 | 909.68 |
| #20 | 910.06 |
| #21 | 910.44 |
| #22 | 910.82 |
| #23 | 911.2 |
| #24 | 911.58 |
| #25 | 911.96 |
| #26 | 912.34 |
| #27 | 912.72 |
| #28 | 913.1 |
| #29 | 913.48 |
| #30 | 913.86 |

| Channels | Frequency (MHz) |
|----------|-----------------|
| #31 | 914.24 |
| #32 | 914.62 |
| #33 | 915 |
| #34 | 915.38 |
| #35 | 915.76 |
| #36 | 916.14 |
| #37 | 916.52 |
| #38 | 916.90 |
| #39 | 917.28 |
| #40 | 917.66 |
| #41 | 918.04 |
| #42 | 918.42 |
| #43 | 918.8 |
| #44 | 919.18 |
| #45 | 919.56 |
| #46 | 919.94 |
| #47 | 920.32 |
| #48 | 920.7 |
| #49 | 921.08 |
| #50 | 921.46 |
| #51 | 921.84 |
| #52 | 922.22 |
| #53 | 922.6 |
| #54 | 922.98 |
| #55 | 923.36 |
| #56 | 923.74 |
| #57 | 924.12 |
| #58 | 924.5 |
| #59 | 924.88 |
| #60 | 925.26 |
| #61 | 925.64 |

| Channels | Frequency (MHz) |
|----------|-----------------|
| #62 | 926.02 |
| #63 | 926.4 |
| #64 | 926.78 |
| #65 | 927.16 |
| #66 | 927.54 |
| #67 | 927.92 |

Table 4 List of Channels for Zx Motion Sensor 900 MHz Band



3.2 Modes of Operation

The ZX MOTION SENSOR is operating at 915 MHz and for operation, wireless was configured to transmit at 100% duty cycle:

The transmitter was provided in 2 different settings:

- A configuration with special test firmware was installed on the EUT to control hopping through its pseudo random sequence and single channel
- A configuration with low, medium and high channels transmitting continuously at a 100% duty cycle.

3.3 Setup Diagram

During the EUT was exercised by powering to the rated voltage and connecting according to Figure 1.

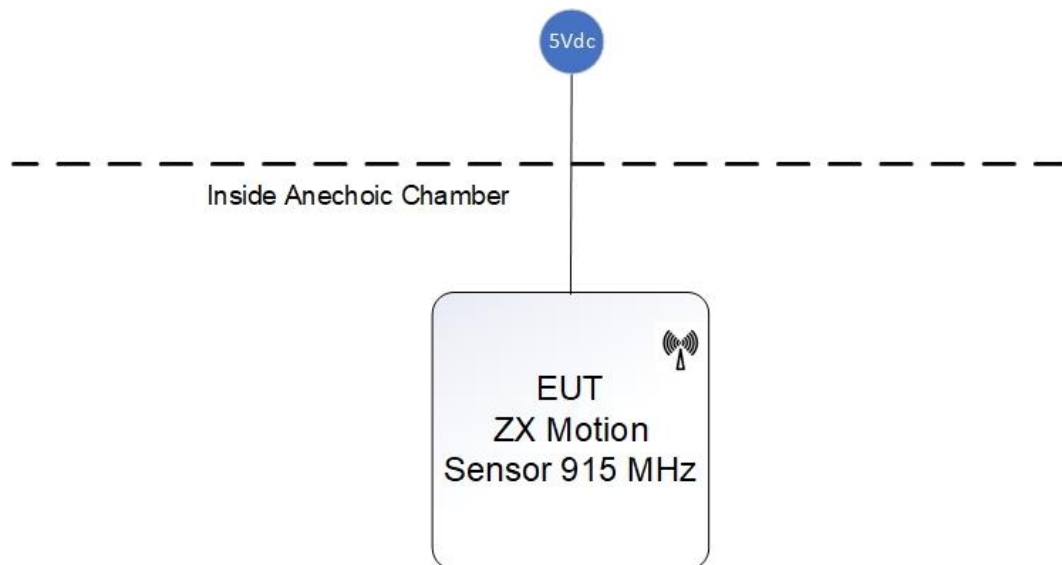


Figure 1: EUT Setup Diagram – ZX MOTION SENSOR – Spurious emissions



4 Deviations from the Standard

No deviations from the applicable test standard were made during testing.

5 Measurement Uncertainty

The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2. For instance, for the range of 0.15MHz-30MHz, 30MHz – 1GHz and 1GHz – 18GHz is ± 3.3 dB, ± 4.25 dB and ± 4.93 dB, respectively with a 'k=2' coverage factor and a 95% confidence level.

| Parameter | Uncertainty |
|-----------------------------------|-------------------------|
| Occupied channel Bandwidth | $\pm 5\%$ |
| RF output power, conducted | ± 1.5 dB |
| Power Spectral Density, conducted | ± 3 dB |
| Unwanted Emission, conducted | ± 3 dB |
| All emission, radiated | ± 6 dB |
| Temperature | $\pm 3^{\circ}\text{C}$ |
| Time Occupancy | $\pm 3\%$ |

Table 5 Acceptable Uncertainties



6 99% Bandwidth

6.1 Purpose & Methods

The Purpose & Methods of this test is to ensure that the bandwidth occupied exceeds a stated minimum. This helps ensure the utilization of the frequency allocation is sufficiently wide. This also helps prevent corruption of data by ensuring adequate data separation to distinguish the reception of the intended information. The test method is defined in ANSI C63.10.

6.2 Test Specifications

| | |
|---|--|
| REFERENCE STANDARD | FCC 15.247(a)(1) ANSI C63.10-2013 Clause 6.9 RSS-247.5.1 |
| SPECIFICATIONS | |
| Limit – Bandwidth (kHz) | ≤500 |
| Frequency range (MHz) | 902.46 915 927.54 |
| RBW (kHz): | Set to 1% to 3% of the 99% bandwidth |
| VBW (kHz) | 3xRBW |
| EUT | |
| Identification | ZX Motion Sensor |
| Voltage Input | 5Vdc |
| ENVIROMENTAL & TEST INFO | |
| Test Date (YYYY-MM-DD) | 2019-03-22 |
| Temperature (°C) | 23.4± 2 |
| Humidity (%) | 36.3 ± 5 |
| Atmospheric Pressure kPa (For Info Only) | 109.7 |
| Tester | Abderrahmane Ferhat |
| Client Witness | No Witness |



6.3 Test Results

Zx Motion Sensor (900MHz)

The Channel #0 gave a maximum of 181.89 kHz for 99% BW. Details are depicted in Table 6.

| Channel | Frequency (MHz) | 20 dB Bandwidth (kHz) | Limits (kHz) | Results |
|-----------------|-----------------|-----------------------|--------------|---------|
| Low channel | 902.46 | 181.09 | ≤500 | Pass |
| Middle Channel | 915 | 180.29 | ≤500 | Pass |
| Highest Channel | 927.52 | 181.89 | ≤500 | Pass |

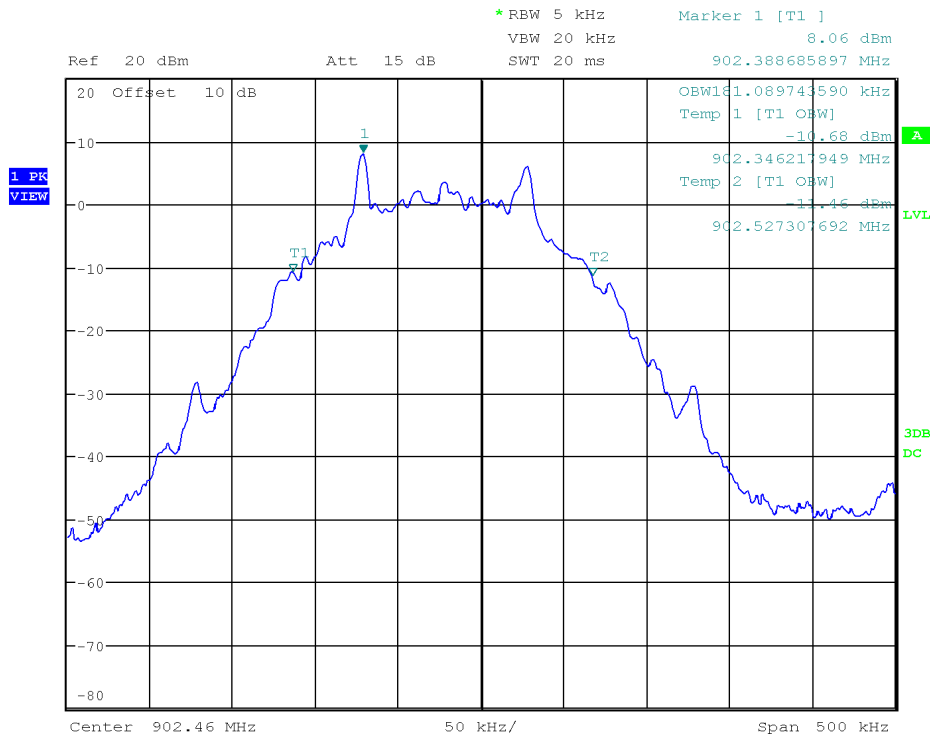
Table 6 – 99% Bandwidth Results



ZX Motion Sensor

6.4 Graphs

The graphs showed below show the OBW during the operation of the device. This is measured by a max hold on the spectrum analyzer and the highest resolution bandwidth that is sufficiently low to exhibit the 99% bandwidth of a channel during operation of the EUT. Max hold is performed for a duration of not less than 1 minute. No attenuator was used between the EUT and the Spectrum Analyzer.

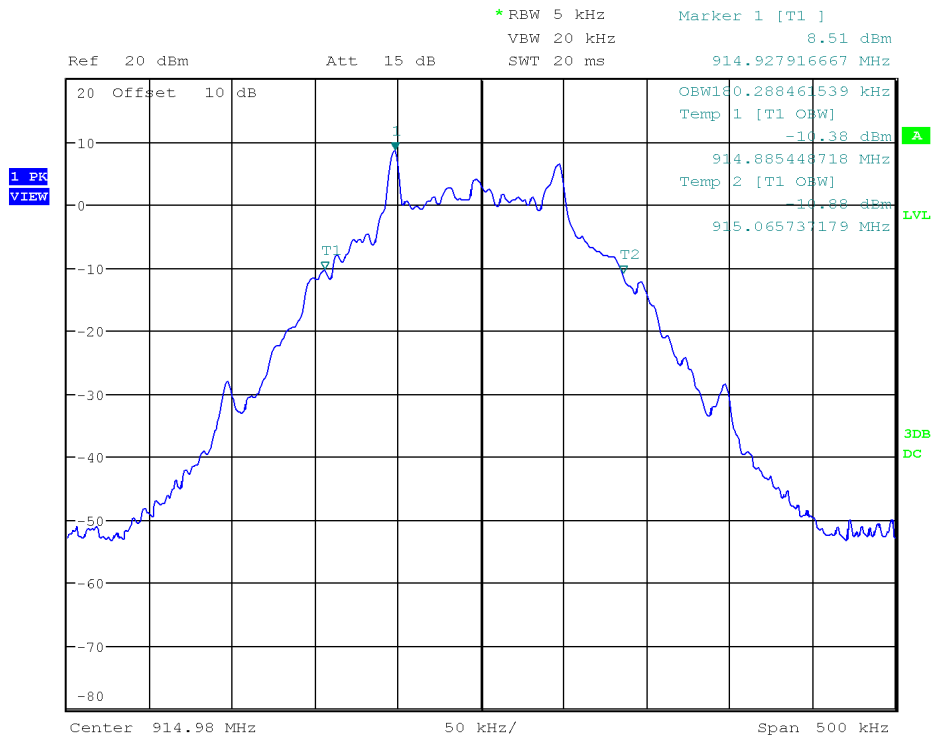


Date: 21.MAR.2019 16:57:01

Graph 1 Test Results – 99% Bandwidth Results – Low Channel Zx Motion Sensor (900MHz)



ZX Motion Sensor



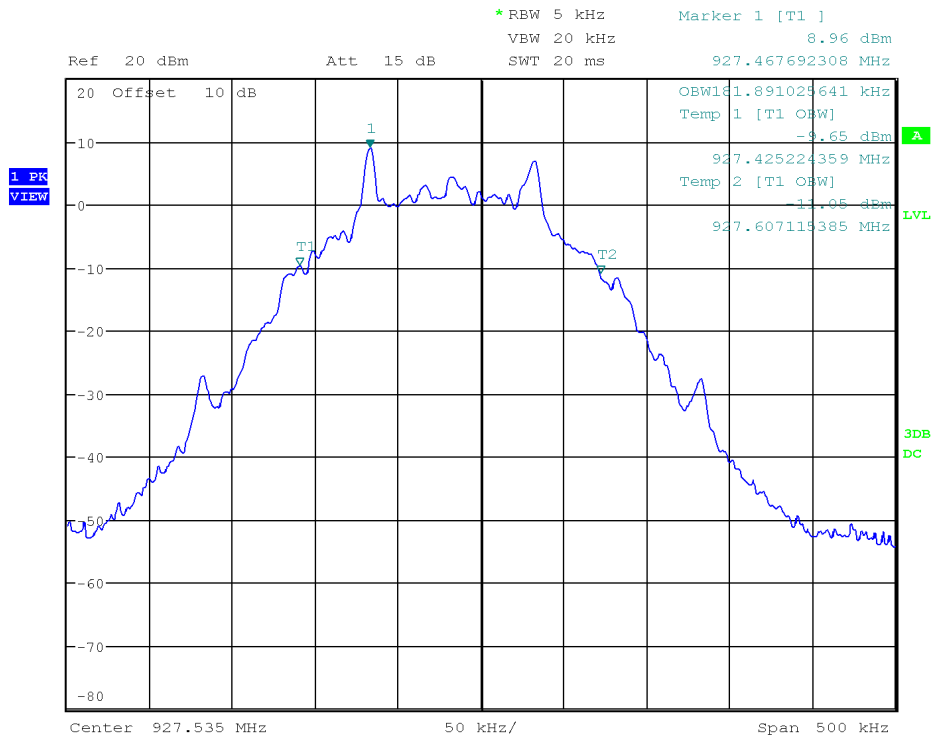
Date: 21.MAR.2019 17:12:01

Graph 2 Test Results – 99% Bandwidth Results – Mid Channel Zx Motion Sensor (900MHz)



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Date: 21.MAR.2019 17:20:33

Graph 3 Test Results – 99% Bandwidth Results – High Channel Zx Motion Sensor(900MHz)

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6.5 Test Instruments

This test was carried out in Laval test location. Instrumentation used is depicted in Table 7.

| Equipment | Model No. | Manufacturer | Calibration Period (months) | Calibration Due (YYY-MM-DD) | Asset No: LAVE |
|---------------------|-----------|-----------------|-----------------------------|-----------------------------|-------------------|
| Spectrum Analyzer | ESU-40 | Rohde & Schwarz | 24 | 2019-04-20 | 4092 |
| Attenuator 10 dB | 4779-10 | Narda | NCR | NCR | 4096 |

Table 7: 99%BW Test Equipment



7 Hopping Channel

7.1 Purpose & Methods

The Purpose & Methods of this test is to ensure that the RF energy of frequency hopping systems is sufficiently spread over a spectrum and that the radio energy is not overly dense. This limit helps allow for other spread spectrum devices to co-exist in the same frequency spectrum. This also helps prevent corruption of data by ensuring adequate channel separation to distinguish the reception of the intended information. The test method is a defined in ANSI C63.10.

7.2 Test Specifications

| | |
|---------------------------|---|
| REFERENCE STANDARD | FCC Part 15.247(a)(1)(i) RSS 247 5.1 (c) |
|---------------------------|---|

SPECIFICATIONS

| | |
|---------------|--------------------------|
| Limits | See Section 15.247(a)(1) |
|---------------|--------------------------|

| | |
|------------------------------|-------------------------|
| Test Frequency (MHz): | 902.46 915 927.52 |
|------------------------------|-------------------------|

| | |
|------------------|-----|
| RBW (kHz) | 200 |
|------------------|-----|

| | |
|------------------|-----|
| VBW (kHz) | 500 |
|------------------|-----|

EUT

| | |
|-----------------------|------------------|
| Identification | ZX Motion Sensor |
|-----------------------|------------------|

| | |
|----------------------|------|
| Voltage Input | 5Vdc |
|----------------------|------|

| | |
|----------------------|-------------------|
| Environmental | Normal Conditions |
|----------------------|-------------------|

| | |
|-------------------------------|------------|
| Test Date (YYYY-MM-DD) | 2019-03-21 |
|-------------------------------|------------|

| | |
|-------------------------|----------|
| Temperature (°C) | 23.4 ± 1 |
|-------------------------|----------|

| | |
|---------------------|----------|
| Humidity (%) | 36.3 ± 5 |
|---------------------|----------|

| | |
|---|-------|
| Atmospheric Pressure kPa (For Info Only) | 109.7 |
|---|-------|

| | |
|------------------|---------------------|
| Tester(s) | Abderrahmane Ferhat |
|------------------|---------------------|



Client Witness

No witness

7.3 Limits

The limits are as defined in 47 CFR FCC Part 15 Section 15.247(a)(1) and depicted in Table 8. The test method is defined in ANSI C63.10.

| Frequency Band (MHz) | 20 dB Bandwidth of the hopping channel | Hopping Number |
|----------------------|--|----------------|
| 902 – 928 | ≤250kHz | ≥ 50 channels |
| | ≥250 kHz | ≥ 25 channels |
| | ≥250 kHz | ≥ 75 channels |

Table 8 – Hopping Channel Results

7.4 Test Results

The EUT passed the requirements of the number of channels. The number of channels occupied by the EUT and 64 channels in the allocation band of 902 MHz to 928 MHz. Results are depicted in Table 9.

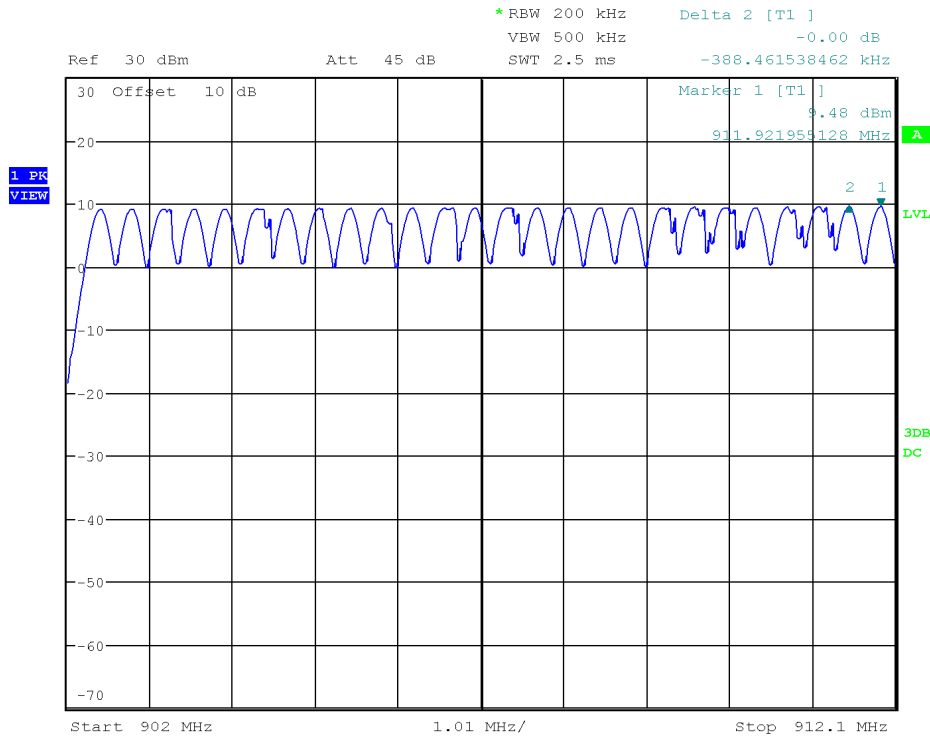
| Channel | Range (MHz) | Number of Hopping Measured | Limits | Results |
|-----------------|-------------|----------------------------|--------------|---------|
| Middle Channel: | 902 - 928 | 64 | ≥50 channels | Pass |

Table 9 – Hopping Channel Results



7.5 Graphs

The graphs below show the number of occupied channels during the operation of the device. This is measured by a max hold on the spectrum analyser and the highest resolution bandwidth that is sufficiently low to exhibit the channel spacing of the signal being measured. This measurement is a peak measurement. Max hold is performed for a duration of not less than 10 minutes, or as sufficient to capture the channels occupied.



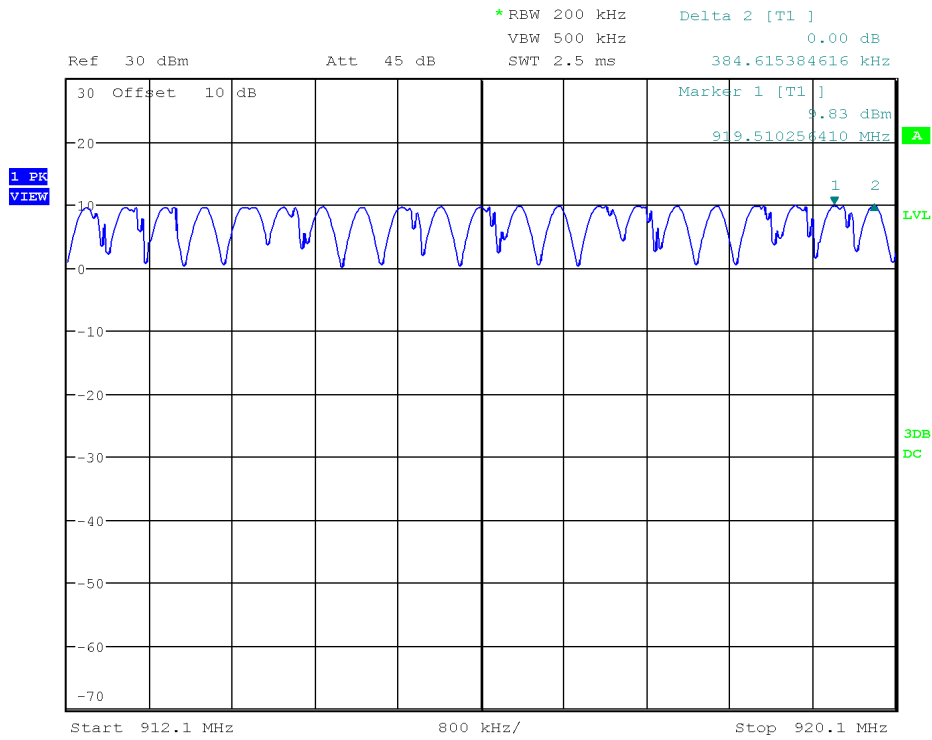
Date: 21.MAR.2019 16:24:09

Graph 4: Hopping Channel – ZX Motion Sensor –902MHz to 912.1MHz



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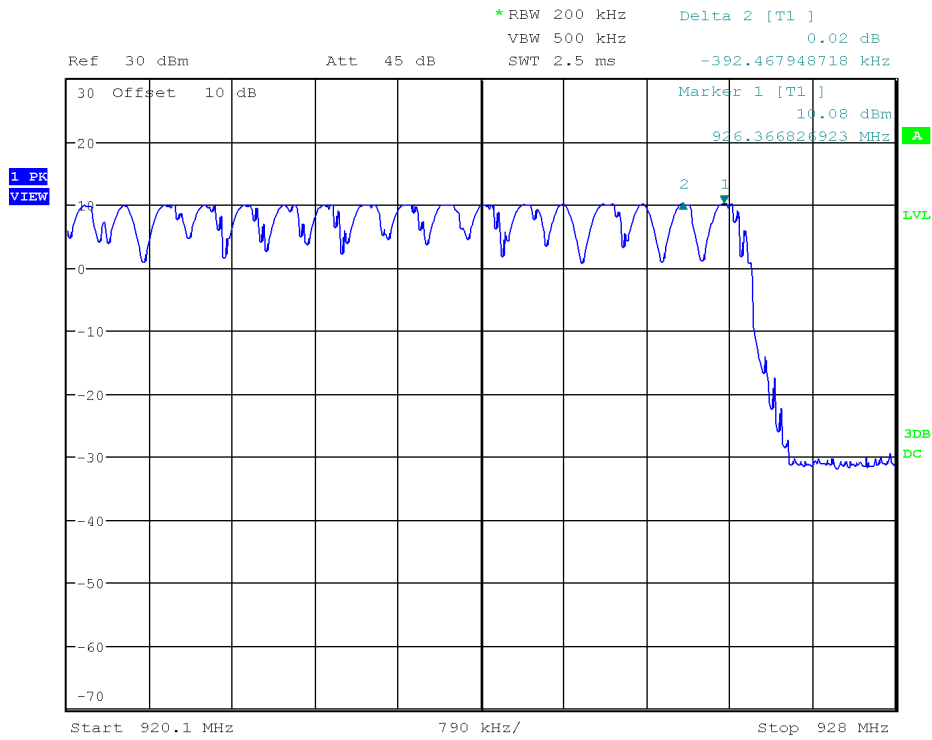
Date: 21.MAR.2019 16:32:29

Graph 5: Hopping Channel – ZX Motion Sensor – 912.1MHz – 920.1MHz



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Date: 21.MAR.2019 16:44:20

Graph 6: Hopping Channel – ZX Motion Sensor – 920.1MHz – 928MHz



7.6 Test Instruments

This test was carried out in Laval test location. Instrumentation used is depicted in Table 10.

| Equipment | Model No. | Manufacturer | Calibration Period (months) | Calibration Due (YYY-MM-DD) | Asset No: LAVE |
|---------------------|-----------|-----------------|-----------------------------|-----------------------------|-------------------|
| Spectrum Analyzer | ESU-40 | Rohde & Schwarz | 24 | 2019-04-20 | 4092 |
| Attenuator 10 dB | 4779-10 | Narda | NCR | NCR | 4096 |

Table 10: Hopping Channel Test Equipment



8 Channel Separation

8.1 Purpose & Methods

The Purpose & Methods of this test is to ensure that the RF energy of frequency hopping systems is sufficiently spread over a spectrum and that the radio energy is not overly dense. This limit helps allow for other spread spectrum devices to co-exist in the same frequency spectrum. This also helps prevent corruption of data by ensuring adequate channel separation to distinguish the reception of the intended information. The test method is a defined in ANSI C63.10.

8.2 Test Specifications

| | |
|---|---|
| REFERENCE STANDARD | FCC Part 15.247(a)(1). RSS 247 5.1 (2) |
| SPECIFICATIONS | |
| Limit | ≥20 dB Bandwidth |
| Frequency range (MHz) | 902.46 915 927.52 |
| RBW (kHz): | 100 |
| VBW (kHz) | 300 |
| EUT | |
| Identification | ZX MOTION SENSOR |
| Voltage Input | 24 Vdc |
| ENVIROMENTAL & TEST INFO | |
| Test Date (YYYY-MM-DD) | 2019-03-21 |
| Temperature (°C) | 23.4 ± 1 |
| Humidity (%) | 36.3 ± 5 |
| Atmospheric Pressure kPa (For Info Only) | 109.7 |
| Tester | Abderrahmane Ferhat |
| Client Witness | No Witness |



8.3 Limits

The limits are as defined in 47 CFR FCC Part 15 Section 15.247(a)(1). The test method is defined in ANSI C63.10 as shown in the Table 11, below.

| Frequency Band | 20 dB Bandwidth of the hopping channel | Limits <Note 1> |
|----------------|--|--|
| 902 - 928 | ≤250kHz | 25kHz or 20dB BW |
| 2400 - 2483.5 | ≤250kHz | 25kHz or 20dB BW |
| | ≤125mW | 25 kHz or 2/3 of 20 dB BW ¹ |
| 5275 - 5850 | ≤250kHz | 25kHz or 20dB BW |

Note 1: The minimum channel separation is given by the greater of 25 kHz or 20 dB BW for unconditional operation. The 20 dB BW of the system was measured to be 184.63 kHz. Therefore, a channel separation limit of 182.7kHz applies.

Table 11 – Channel Separation Results

8.4 Test Results

The results of the EUT are detailed in Table 12.

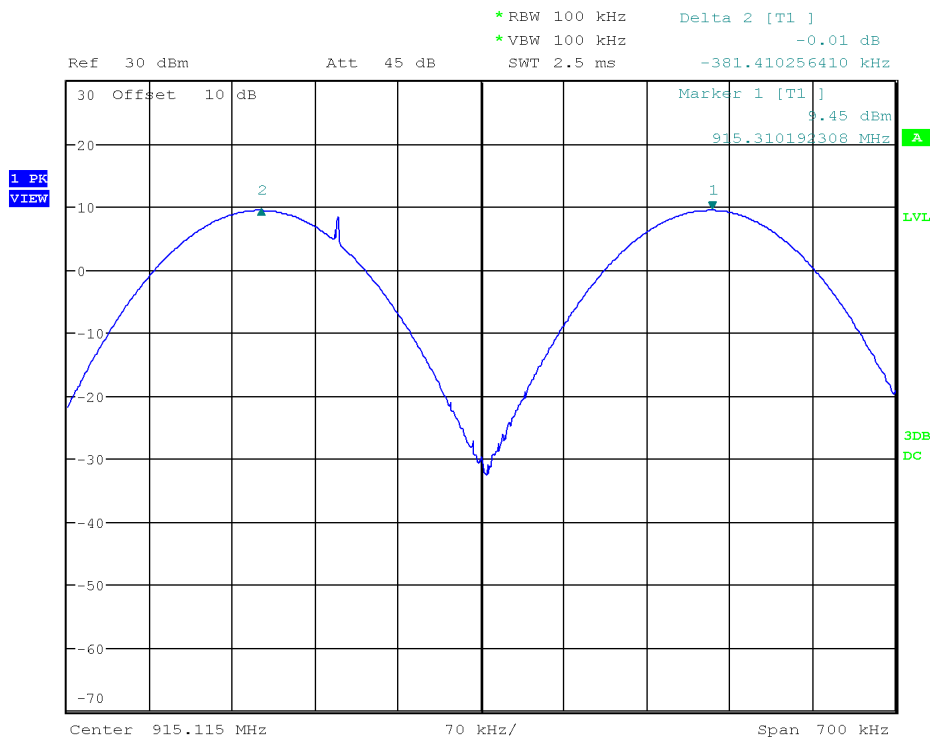
| Channel | Range (MHz) | Channel Separation Measured (kHz) | Limits < kHz> | Results |
|-----------------|-------------|-----------------------------------|---------------|---------|
| Middle Channel: | 902 - 915 | 381.41 | ≥182.7 | Pass |

Table 12 – Channel Separation Results



8.5 Graphs

The graphs shown below shows the channel spacing during the operation of the device. This is measured by a max hold on the spectrum analyser and the highest resolution bandwidth that is sufficiently low to exhibit the channel spacing of the signal being measured. This measurement is a peak measurement. Max hold is performed for a duration of not less than 1 minute, as the device is stepping through its hopping table.



Date: 21.MAR.2019 16:16:08

Graph 7: Channel Separation – ZX Motion Sensor



8.6 Test Instruments

This test was carried out in Laval test location. Instrumentation used is depicted in Table 13.

| Equipment | Model No. | Manufacturer | Calibration Period (months) | Calibration Due (YYY-MM-DD) | Asset No: LAVE |
|---------------------|-----------|-----------------|-----------------------------|-----------------------------|-------------------|
| Spectrum Analyzer | ESU-40 | Rohde & Schwarz | 24 | 2019-04-20 | 4092 |
| Attenuator 10 dB | 4779-10 | Narda | NCR | NCR | 4096 |

Table 13: Channel Separation Test Equipment



9 Time of Occupancy

9.1 Purpose & Methods

The purpose of this test is to ensure that the RF energy of frequency hopping systems is hopping at a minimum defined rate. This helps ensure sufficient time off to enable other frequency hopping devices to co-operate within this allocated band.

9.2 Test Specifications

| | |
|---|---|
| REFERENCE STANDARD | FCC Part 15.247(a)(1). RSS 247 5.1 (2) |
| SPECIFICATIONS | |
| Limit | See FCC 15.247(a)(1)(i). |
| Frequency range (MHz) | 902.46 915 927.52 |
| RBW (kHz): | 200 |
| VBW (kHz) | 500 |
| EUT | |
| Identification | ZX MOTION SENSOR |
| Voltage Input | 24 Vdc |
| ENVIROMENTAL & TEST INFO | |
| Test Date (YYYY-MM-DD) | 2019-03-21 |
| Temperature (°C) | 23.4 ± 1 |
| Humidity (%) | 36.3 ± 5 |
| Atmospheric Pressure kPa (For Info Only) | 109.7 |
| Tester | Abderrahmane Ferhat |
| Client Witness | No Witness |



9.3 Limits

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

9.4 Test Results

The EUT cycles through its pseudo-random generated list of hopping frequencies. There are 64 channels occupied in total. The average transmit time is 4.5 ms per channel and each channel is repeated approximately every 1s. Average time of occupancy = $20 \times 4.5 \text{ ms} = 90 \text{ ms}$. Results are depicted in Table 14.

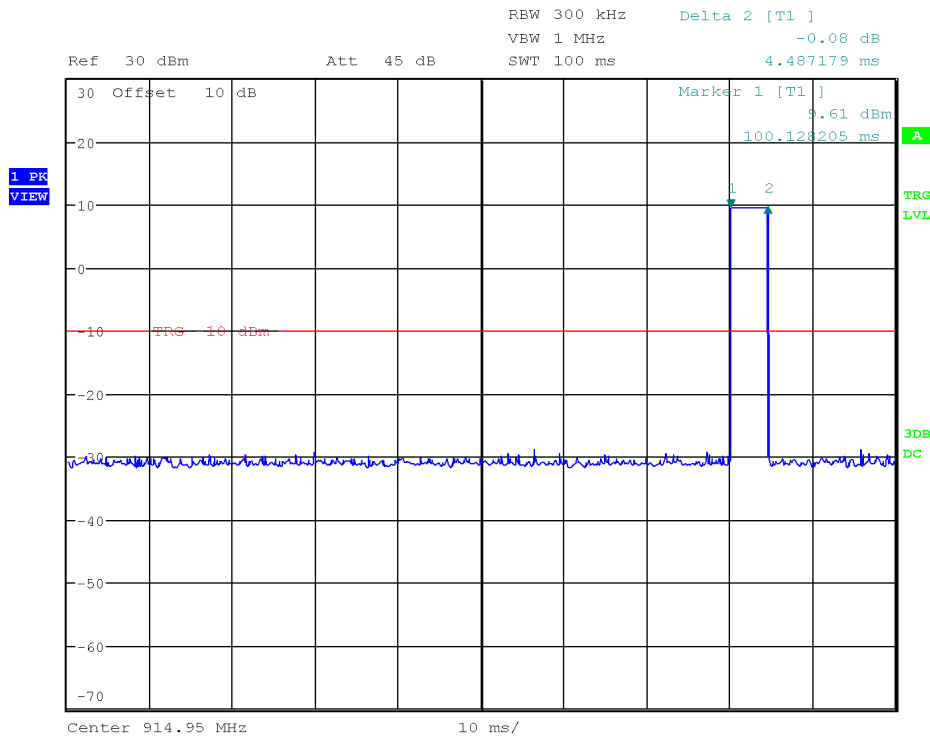
| Channel | Frequency (MHz) | Average Transmit Time/ Channel (ms) | Number of Hops in 20s | Average Time of Occupancy (ms) | Limit (ms) | Results |
|---------------------|-----------------|-------------------------------------|-----------------------|--------------------------------|------------|---------|
| Middle Channel: #34 | 915.38 | 4.5 | 20 | 90 | ≤400 | Pass |

Table 14 – Time Occupancy Results



9.5 Graphs

The graphs shown below shows the Time of Occupancy during the operation of the device. This is measured by a max hold on the spectrum analyser and the highest resolution bandwidth that is sufficiently low to exhibit the Time of Occupancy of the signal being measured. This measurement is a peak measurement.



Date: 21.MAR.2019 16:10:21

Graph 8: Time of Occupancy – ZX Motion Sensor



9.6 Test Instruments

This test was carried out in Laval test location. Instrumentation used is depicted in Table 15.

| Equipment | Model No. | Manufacturer | Calibration Period (months) | Calibration Due (YYY-MM-DD) | Asset No: LAVE |
|---------------------|-----------|-----------------|-----------------------------|-----------------------------|-------------------|
| Spectrum Analyzer | ESU-40 | Rohde & Schwarz | 24 | 2019-04-20 | 4092 |
| Attenuator 10 dB | 4779-10 | Narda | NCR | NCR | 4096 |

Table 15: Time of Occupancy Test Equipment



10 Maximum Peak Envelope Conducted Power – Digital Modulated

10.1 Purpose & Methods

The purpose of this test is to ensure that the maximum power conducted to the radiating element does not exceed the limits specified. The test method is defined in ANSI C63.10.

10.2 Test Specifications

| | |
|---|--|
| REFERENCE STANDARD | FCC Part 15.247(b)(3) FCC Part 15.247(b)(2) RSS-247.5.4(d) ANSI C63.10. Clause 11.9.1 |
| SPECIFICATIONS | |
| Limit – Power (W) | <1 |
| Frequencies (MHz) | 902.46 915 927.52 |
| RBW (MHz): | 0.2 |
| VBW (MHz) | 0.5 |
| Span (MHz) | 1.5 |
| EUT | |
| Identification | ZX MOTION SENSOR |
| Voltage Input | 24 Vdc |
| ENVIRONMENTAL | Normal Conditions |
| Test Date (YYYY-MM-DD) | 2019-03-22 |
| Temperature (°C) | 23.4 ± 2 |
| Humidity (%) | 36.3± 5 |
| Atmospheric Pressure kPa (For Info Only) | 109.7 |
| Tester | Abderrahmane Ferhat |
| Client Witness | No Witness |



10.3 Limits

The limits are defined in 15.247(b)(2) and 15.247(b)(3). For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.

10.4 Tests Results

Zx Motion Sensor

The High Channel gave a maximum Peak Power of 10.73 dBm (11.83mW). The peak power measurements of channels tested are depicted in Table 16.

| Channel | Frequency (MHz) | Measured Peak Power (dBm) | Peak Power (mW) | Limit (mW) | Result |
|---------|-----------------|---------------------------|-----------------|------------|--------|
| Low | 902.46 | 9.82 | 9.59 | 1000 | Pass |
| Middle | 914.98 | 10.27 | 10.64 | 1000 | Pass |
| High | 927.535 | 10.73 | 11.83 | 1000 | Pass |

Table 16 – Test Results Peak-Power Measurements ZX Motion Sensor

10.5 Graphs

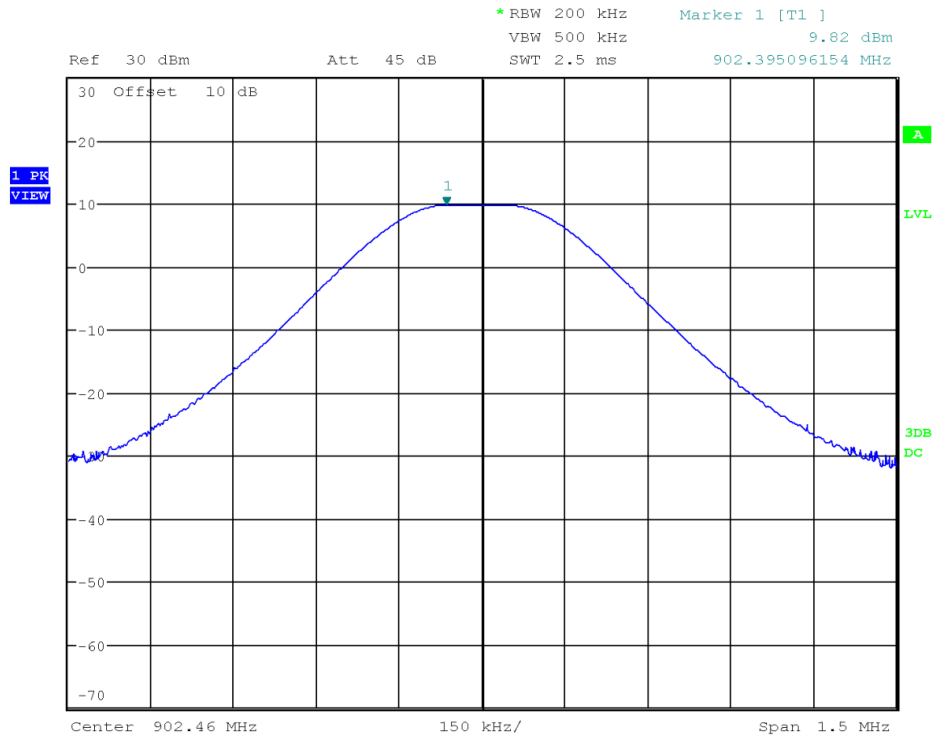
The plots shown below show the Peak Power Output of the device during the antenna conducted measurements during transmit operation of the EUT. Note that no attenuator was used between the EUT and the Spectrum Analyzer.



Product Service

ZX Motion Sensor

ZX Motion Sensor (900MHz)



Date: 21.MAR.2019 16:54:57

Graph 9 Test Results – Conducted Peak Power Measurements – Low Channel

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10.6 Test Instruments

This test was carried out in Laval test location. Instrumentation used is depicted in Table 17.

| Equipment | Model No. | Manufacturer | Calibration Period (months) | Calibration Due (YYY-MM-DD) | Asset No: LAVE |
|---------------------|-----------|-----------------|-----------------------------|-----------------------------|-------------------|
| Spectrum Analyzer | ESU-40 | Rohde & Schwarz | 24 | 2019-04-20 | 4092 |
| Attenuator 10 dB | 4779-10 | Narda | NCR | NCR | 4096 |

Table 17: Conducted Peak Power Test Equipment



11 Band Edge Spurious Emission (-20 dBc Requirement)

11.1 Purpose & Methods

The Purpose of this test is to ensure that the maximum power conducted to the radiating element at frequencies outside of the authorized spectrum does not exceed the limits specified. This ensures that the only the intended signal is delivered to the radiating element. The method applied is described in ANSI C63.10-2013 in Clause 11.11.1.

11.2 Test Specifications

| | |
|---|---|
| REFERENCE STANDARD | FCC Part 15.247(d) RSS-247 5.5 ANSI C63.10 Clause 11.11.1 |
| SPECIFICATIONS | |
| Limit (dBc) | <20 |
| Frequencies (MHz) | 902.46 915 927.52 |
| EUT | |
| Identification | ZX MOTION SENSOR |
| Voltage Input | 24 Vdc |
| ENVIROMENTAL & TEST INFO | |
| Test Date (YYYY-MM-DD) | 2019-03-20 |
| Temperature (°C) | 23.4 ± 2 |
| Humidity (%) | 36.3 ± 5 |
| Atmospheric Pressure kPa (For Info Only) | 109.7 |
| Tester | Abderrahmane Ferhat |
| Client Witness | No Witness |



11.3 Limits

The limits are defined in 15.247(d). In any 100 kHz band, the peak spurious harmonics emissions must be at least 20 dB below the fundamental. Band Edge is to be evaluated up to the 10th harmonic. This -20 dBc requirement also applies at the 'band edge' of 2.4 GHz and 2.4835 GHz.

11.4 Test Setup

The Setup for the Maximum Peak Power testing is identical to the 99% Bandwidth setup.

11.5 Test Results

ZX MOTION SENSOR (900MHz)

The EUT was tested on: Low, medium, and high bands. The worst-case value is -34.65 dBm on Middle channel. The peak power of channels tested are depicted in Table 18.

| Frequency Band (MHz) | Channel | Frequency (MHz) | Measured Spurious Conducted (dBm) | Results <Note 1> |
|----------------------|---------|-----------------|-----------------------------------|------------------|
| 902 – 907.6 | Low | 0.009-0.15 | -48.85 | Pass |
| | Low | 0.15-30 | -48.85 | Pass |
| | Low | 30-1000 | -48.85 | Pass |
| | Low | 900-902.46 | -33.73 | Pass |
| | Middle | 902 - 928 | -34.65 | Pass |
| | High | 1000 - 10000 | -38.49 | Pass |

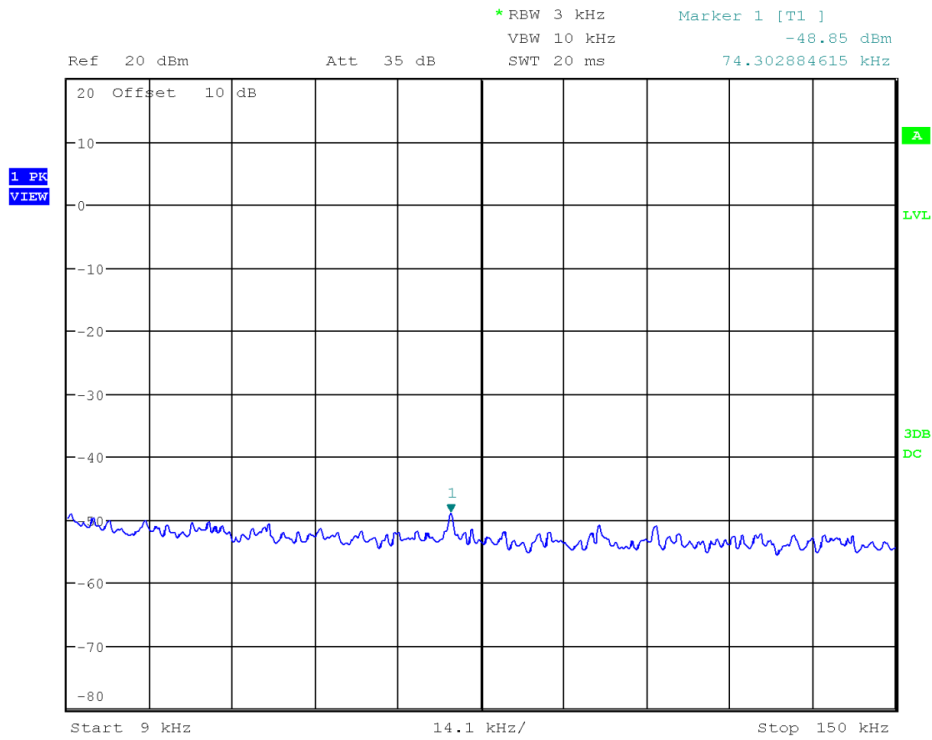
Note 1. The highest level of the fundamental is 10.73dBm based on RF output Power results (see [Table 16](#))

Table 18- Results – ZX Motion Sensor – Band Edge



Product Service

ZX Motion Sensor



Date: 21.MAR.2019 17:01:28

Graph 13 Test Results – Band Edge –150kHz to 30MHz – Low Channel

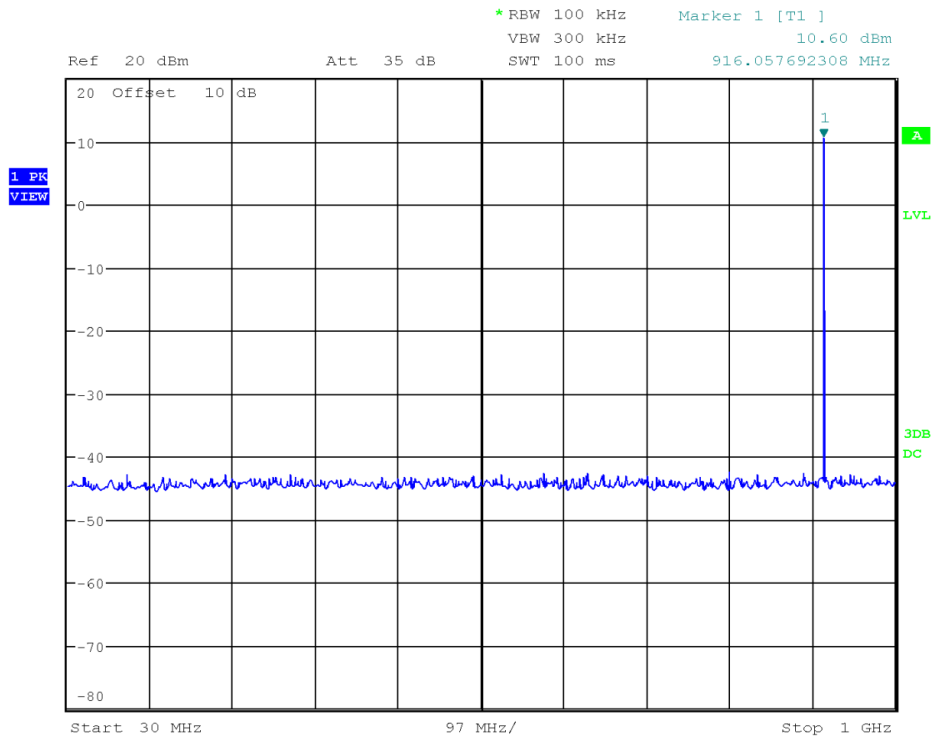
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ZX Motion Sensor



Date: 21.MAR.2019 17:05:30

Graph 14 Test Results – Band Edge –30MHz to 1GHz – Low Channel

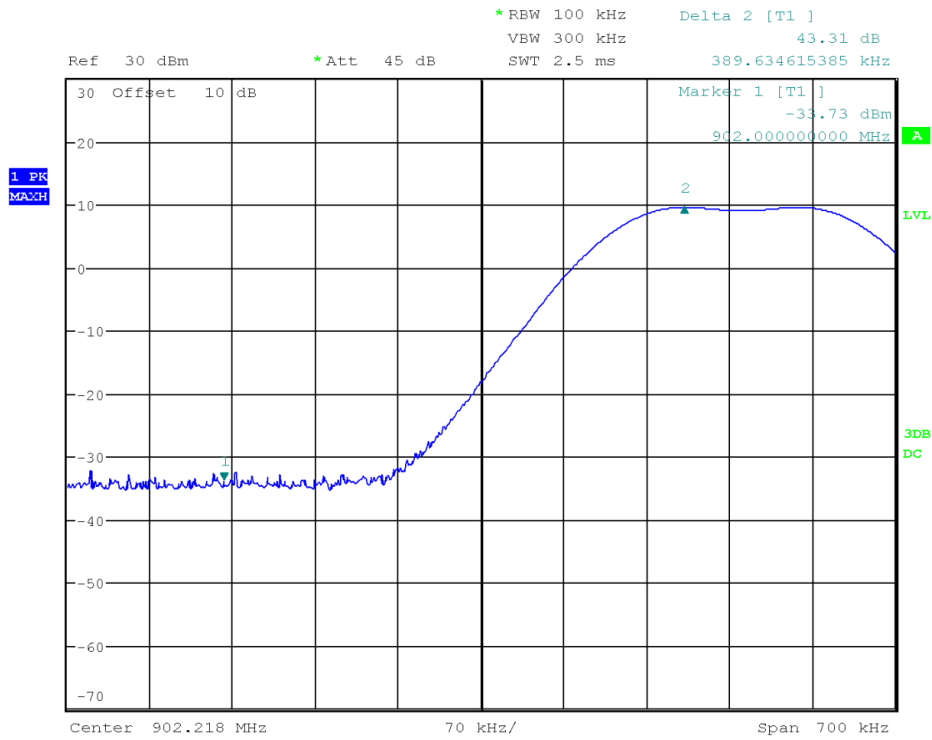
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ZX Motion Sensor



Date: 20.MAR.2019 13:42:43

Graph 15 Test Results – Band Edge – 902.22 MHz– Mid Channel

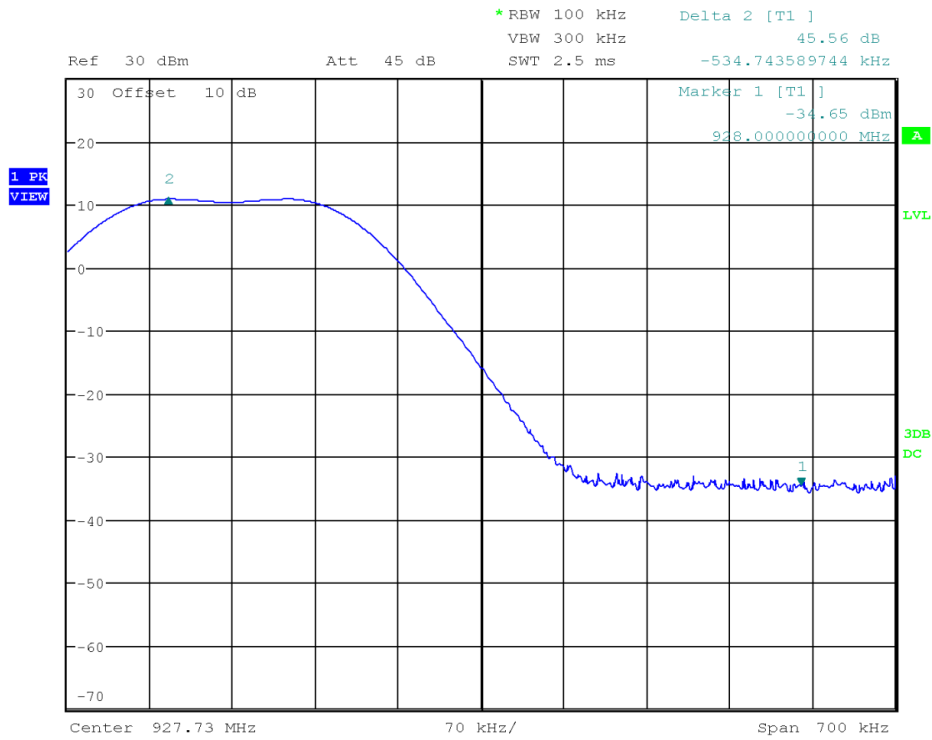
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Product Service

ZX Motion Sensor



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Graph 16 Test Results – Band Edge – 927.73MHz to 928.43MHz– Mid Channel

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11.7 Test Instruments

This test was carried out in Laval test location. Instrumentation used is depicted in Table 19.

| Equipment | Model No. | Manufacturer | Calibration Period (months) | Calibration Due (YYY-MM-DD) | Asset No: LAVE |
|---------------------|-----------|-----------------|-----------------------------|-----------------------------|-------------------|
| Spectrum Analyzer | ESU-40 | Rohde & Schwarz | 24 | 2019-04-20 | 4092 |
| Attenuator 10 dB | 4779-10 | Narda | NCR | NCR | 4096 |

Table 19 – Test Instrumentation – Band Edge



12 Tx Spurious Radiated Emissions

12.1 Purpose & Methods

The Purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT does not exceed the limits listed below as defined in the applicable test standard, as measured from a receiving antenna. This helps protect broadcast radio services such as television, FM radio, pagers, cellular telephones, emergency services, and so on, from unwanted interference. The method is as defined in Section 12.1 of FCC KDB 558074 and ANSI C63.10.

All unintentional emissions must also meet the 'Spurious Conducted Emissions' requirements of -20 dBc or greater. See also '[Band Edge](#)' for further details. Limits are depicted in Table 20.

| Frequency | Limit |
|---|---|
| 0.009 MHz – 0.490 MHz | 2400/F(kHz) uV/m at 300m ⁽¹⁾ |
| 0.490 MHz – 1.705 MHz | 24000/F(kHz) uV/m at 30m ⁽¹⁾ |
| 1.705 MHz – 30 MHz | 30 uV/m at 30m ⁽¹⁾ |
| 30 MHz – 88 MHz | 100 uV/m (40.0 dBuV/m) at 3m ⁽¹⁾ |
| 88 MHz – 216 MHz | 150 uV/m (43.5 dBuV/m) at 3m ⁽¹⁾ |
| 216 MHz – 960 MHz | 200 uV/m (46.0 dBuV/m) at 3m ⁽¹⁾ |
| Above 960 MHz | 500 uV/m (54.0 dBuV/m) at 3m ⁽¹⁾ |
| Above 1000 MHz | 500 uV/m (54 dBuV/m) at 3m ⁽²⁾ |
| Above 1000 MHz | 500 uV/m (74 dBuV/m) at 3m ⁽³⁾ |
| ¹ Limit is with Quasi Peak detector with bandwidths as defined in CISPR-16-1-1 | |
| ² Limit is with 1 MHz measurement bandwidth and using an Average detector | |
| ³ Limit is with 1 MHz measurement bandwidth and using a Peak detector | |

Table 20 Limits – Tx Spurious

Based on ANSI C63.4 Section 4.2, if the Peak detector measurements do not exceed the Quasi-Peak limits, where defined, then the EUT is deemed to have passed the requirements.



12.2 Test Specifications

| | | | |
|---|---|------------|------------|
| REFERENCE STANDARD | FCC Part 15.209(a) RSS-247 5.5 ANSI C63.10 Clause 5.5 | | |
| SPECIFICATIONS | | | |
| Limit (dBuV/m) | Table 20 | | |
| Frequencies (MHz) | 902.46 915 927.52 | | |
| EUT | | | |
| Identification | ZX Motion Sensor | | |
| Voltage Input | 24 Vdc | | |
| ENVIROMENTAL & TEST INFO | | | |
| Test Date (YYYY-MM-DD) | 2019-02-26 | 2019-03-13 | 2019-03-14 |
| Temperature (°C) | 243 ± 2 | 23.3 ± 2 | 23 ± 2 |
| Humidity (%) | 14 ± 5 | 24 ± 5 | 20 ± 5 |
| Atmospheric Pressure kPa (For Info Only) | 101.6 | 102.6 | 101 |
| Tester | Abderrahmane Ferhat | | |
| Client Witness | No Witness | | |



12.3 Limits

The limits, as defined in 15.247(d) for intentional radiated emissions, apply for those emissions that fall in the restricted bands, as defined in Section 15.205(a). These emissions must comply with the radiated emission limits specified in Section 15.209(a).

12.4 Results

The EUT passed. Low, medium, and high bands were tested. The worst-case are only presented and final measurements are given in [Appendix A](#).

| Channel | Frequency Range (MHz) | Frequency (MHz) | Polarization | Detector | Limit | Margin | Results <Note 2> | |
|---------|-----------------------|-----------------|--------------|----------|------------------------------|----------|------------------|------|
| Low | 0.009 – 0.015 | - | - | - | See Table 20 | <Note 1> | Pass | |
| | 0.015 – 30 | | | | | | Pass | |
| | 30 – 1000 | | | | | | Pass | |
| | >1000 | | | | | | Pass | |
| Mid | 0.009 – 0.015 | - | - | - | | | <Note 1> | Pass |
| | 0.015 – 30 | | | | | | | Pass |
| | 30 – 1000 | 825.52 | Vertical | Peak | | | 6.8 | Pass |
| | >1000 | 2455.74 | Horizontal | Peak | | | 3.7 | Pass |
| High | 0.009 – 0.015 | - | - | - | | <Note 1> | Pass | |
| | 0.015 – 30 | | | - | | | Pass | |
| | 30 – 1000 | | | - | | | Pass | |
| | >1000 | | | - | | | Pass | |

Note 1: No significant emission, i.e., 10dB below the limit was measured.
 Note 2: For Worst cases based on Peak measurements can be found in [Appendix A](#): Table A1 to Table A6.

Table 21 – Test Results for Tx Spurious Emission – Lowest Margin – Peak Measurements (Worst Case Scenario)



12.5 Graphs

The graphs shown below are maximized peak measurement graphs measured with a resolution bandwidth greater than or equal to the final required detector over a full 0-360°. This peaking process is done as a worst-case measurement and enables the detection of frequencies of concern for final measurement. For final measurements with the appropriate detector, where applicable, please refer to the tables under Final Measurements.

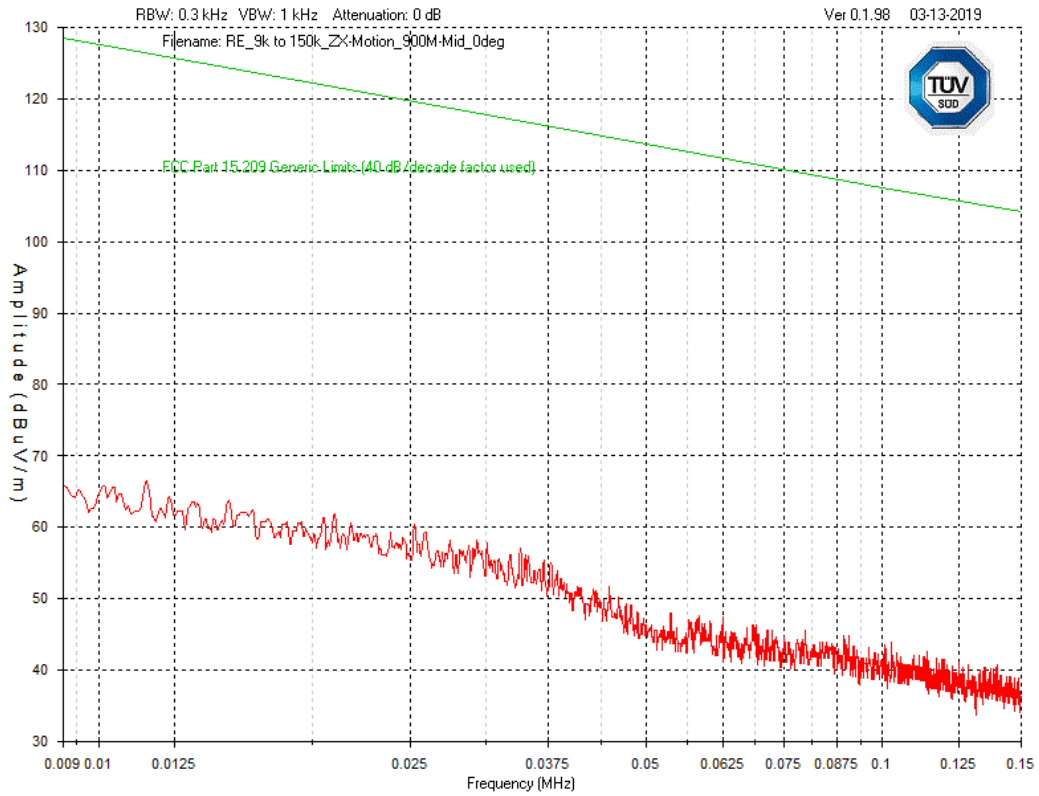
Devices scanned may be scanned at alternate test distances and in accordance with FCC Part 15, Subpart A, Section 15.31, an extrapolation factor of 20 dB/decade was used above 30 MHz and 40 dB/decade below 30 MHz for example, for 1-meter measurements, an extrapolation factor 9.5 dB from 20 Log (1m / 3m) is applied.

Low, middle and high channels. However, the worst-case graphs are presented.



ZX Motion Sensor

Frequency range from 9kHz to 150kHz

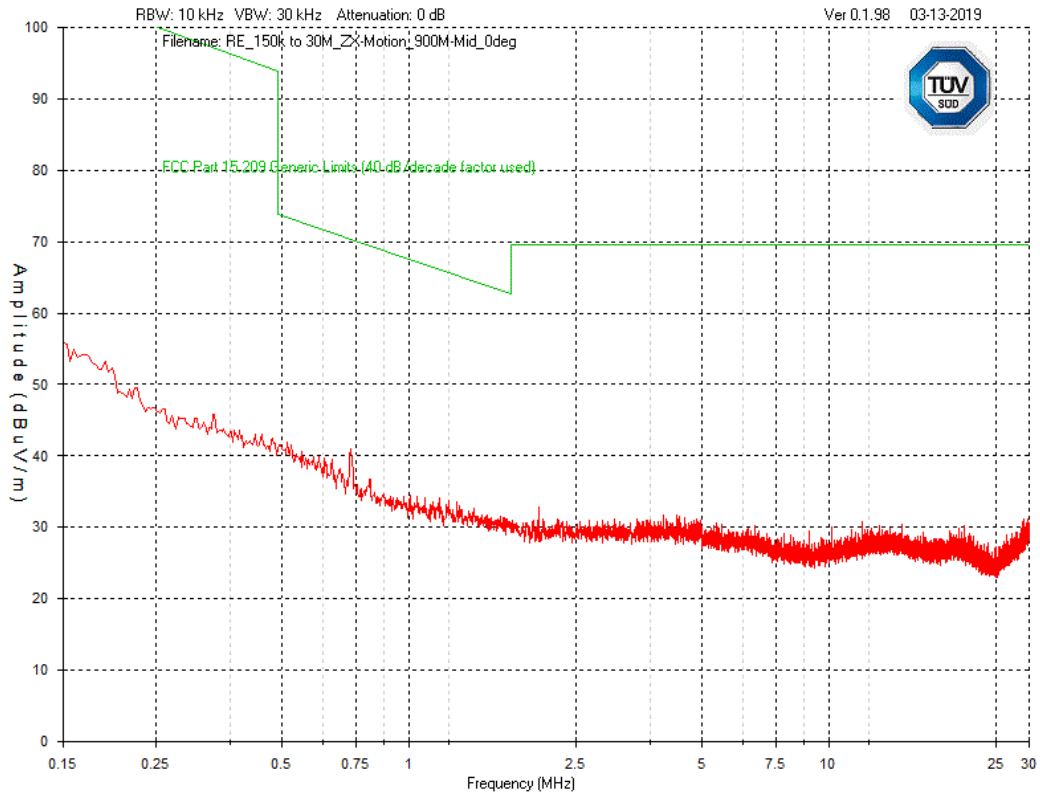


Graph 18 Test Results – Tx Spurious 9kHz to 150kHz – Mid Channel



ZX Motion Sensor

Frequency range from 150kHz to 30MHz

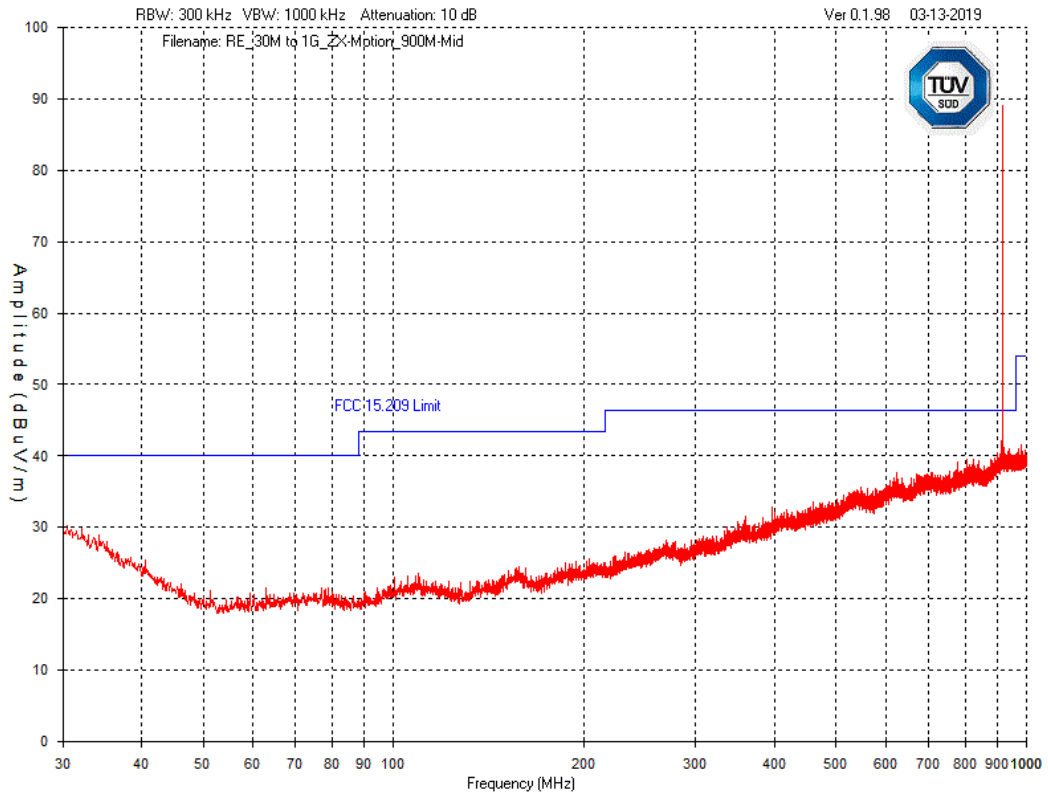


Graph 19 Test Results – Tx Spurious Emission 150kHz – 30MHz – Mid Channel



ZX Motion Sensor

Frequency Range from 30MHz to 1GHz – Worst case – Mid Channel

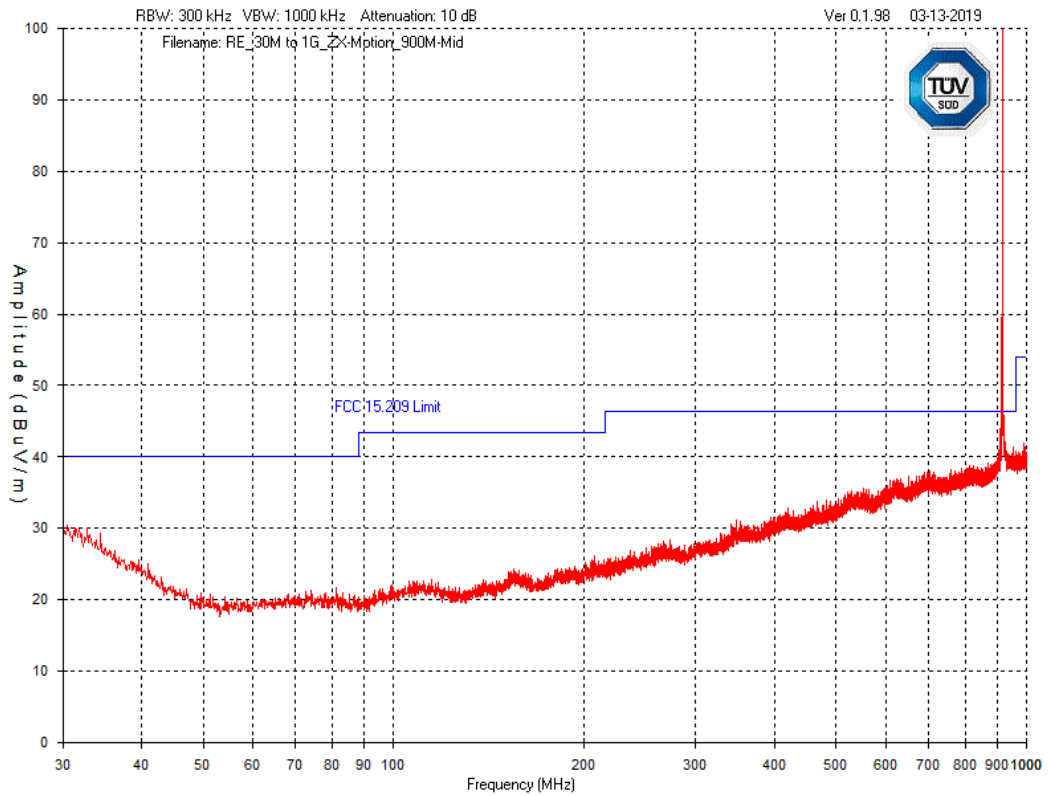


Graph 20 Test Results – Tx Spurious Emission 30MHz to 1GHz – Mid Channel – Vertical Polarization



Product Service

ZX Motion Sensor

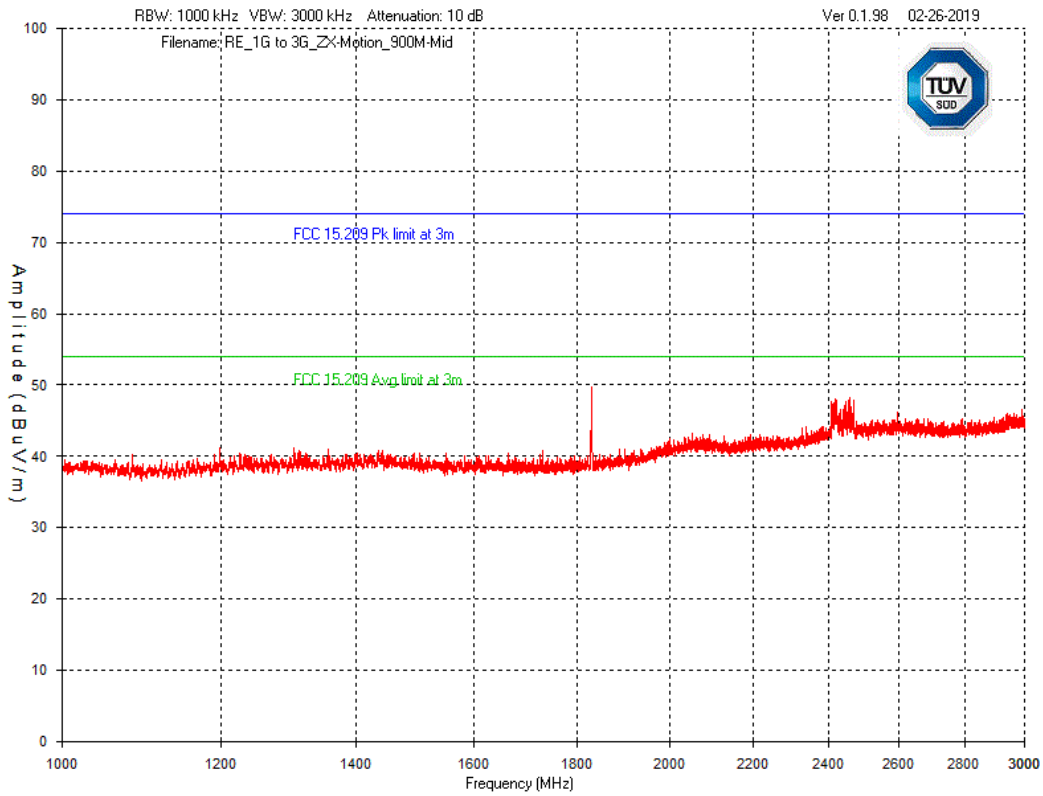


Graph 21 Test Results – Tx Spurious emission 30MHz to 1GHz – Mid Channel – Horizontal Polarization



ZX Motion Sensor

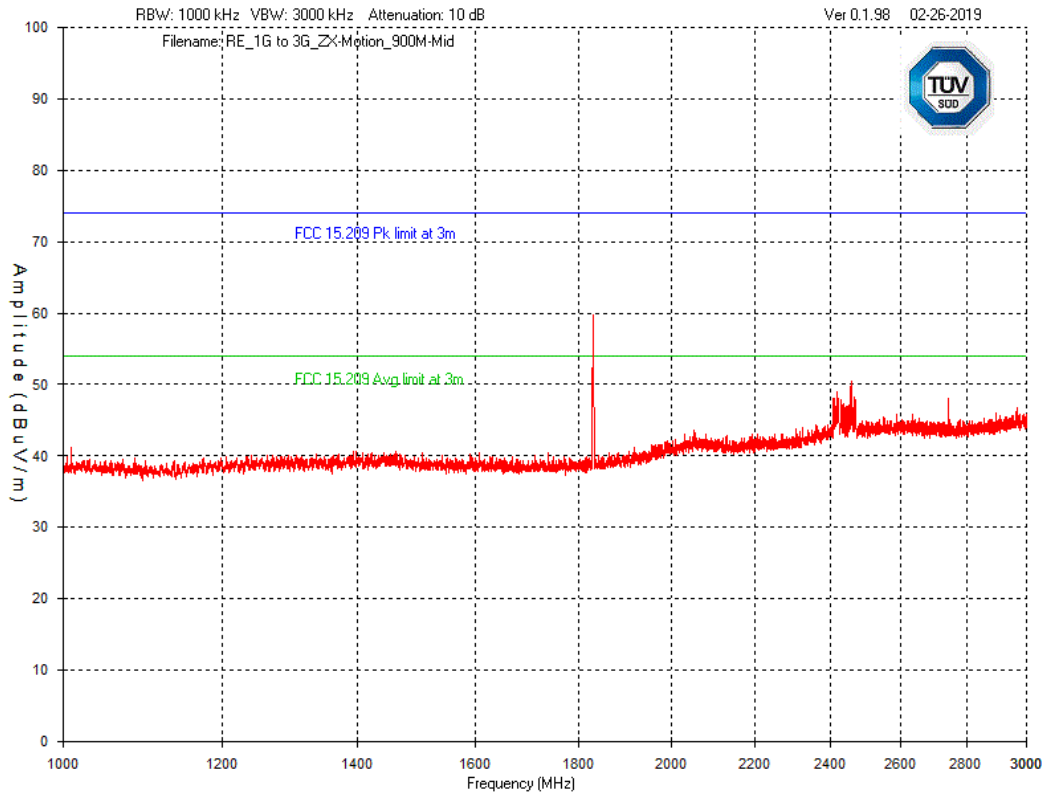
Frequency Range from 1GHz to 3GHz – Worst case – Mid Channel



Graph 22 Test Results – Tx Spurious emission 1GHz to 3GHz – Mid Channel – Vertical Polarization



ZX Motion Sensor

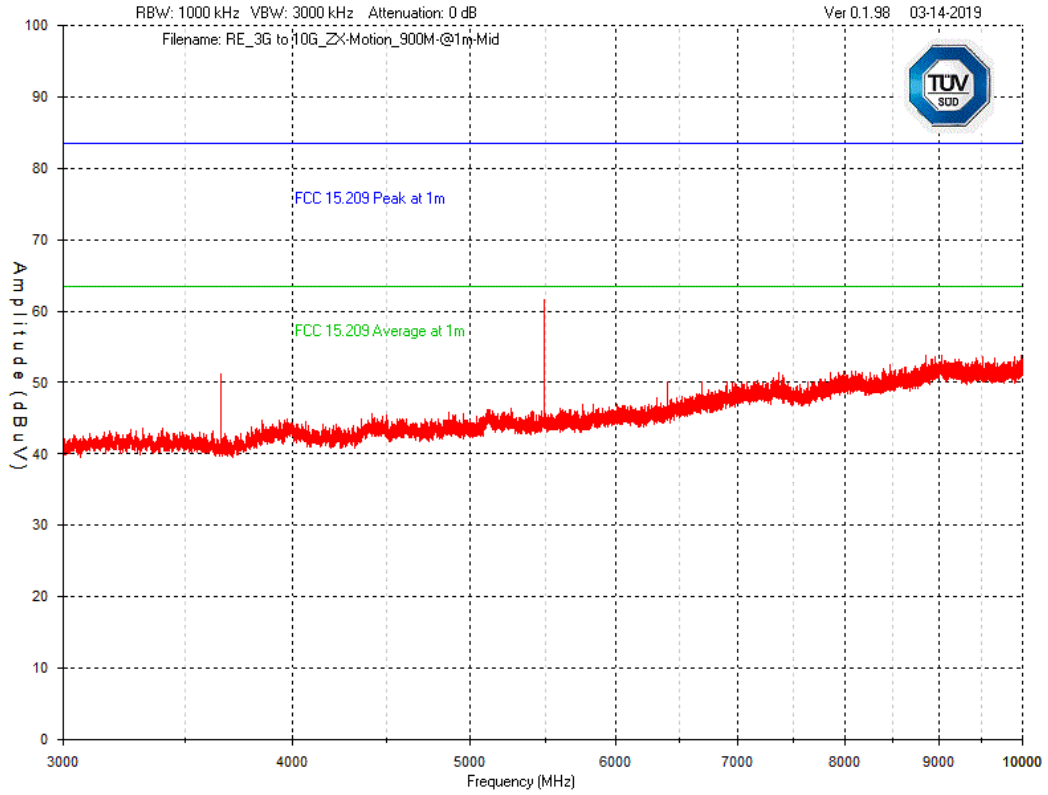


Graph 23 Test Results – Tx Spurious emission 1GHz – 3GHz – Mid Channel – Horizontal Polarization



ZX Motion Sensor

Frequency Range from 3GHz – 10GHz – Worst case – Mid Channel

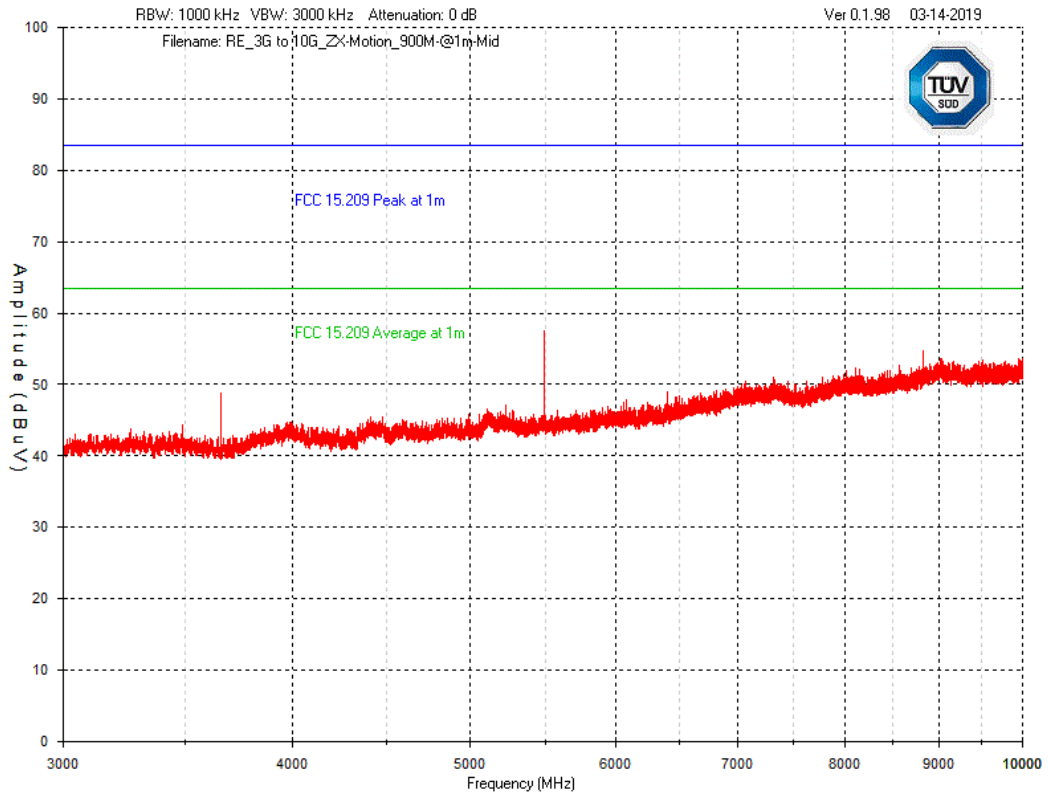


Graph 24 Test Results – Tx Spurious emission 3GHz – 10GHz – Mid Channel – Vertical Polarization



Product Service

ZX Motion Sensor



Graph 25 Test Results – Tx Spurious emission 3GHz – 10GHz – Mid Channel – Vertical polarisation



12.6 Test Instruments

This test was carried out in Laval test location. Instrumentation used is depicted in Table 22.

| Equipment | Model No. | Manufacturer | Calibration Period (months) | Calibration Due (YYY-MM-DD) | Asset No LAV0 |
|----------------------|-------------------------|-----------------|-----------------------------|-----------------------------|---------------|
| Spectrum Analyzer | ESU-40 | Rohde & Schwarz | 24 | 2019-04-20 | 4092 |
| BiLog Antenna | 3142-E | ETS | 24 | 2020-11-29 | 4002 |
| Horn Antenna | ATH1G18G | AR | 24 | 2019-04-25 | 4003 |
| Biconical Antenna | EM-6913 | Electro-Metrics | 24 | 2019-05-02 | 4060 |
| Log Periodic Antenna | LPA-25 | Electro-Metrics | 24 | 2019-04-20 | 4087 |
| Loop Antenna | EM 6879 | Electro-Metrics | 24 | 2019-04-19 | 4040 |
| Attenuator 3 dB | FP-50-3 | Trilithic | NCR | NCR | 4028 |
| LNA pre-amp | LNA-1450 | RF Bay Inc. | 24 | 2019-07-22 | 4089 |
| 1-26.5GHz preamp | 8449B | Agilent | 24 | 2019-09-09 | 4006 |
| RF Cable 10m | LMR-400-10M-50OHM-MN-MN | LexTec | NCR | NCR | 4025 |
| RF Cable 7m | LMR-400-7M-50OHM-MN-MN | LexTec | NCR | NCR | 4026 |
| Emission software | 0.1.97 | Global EMC | NCR | NCR | 58 |

Table 22 – Test Instrumentation – Tx Spurious Emission



APPENDIX A: Tx Spurious Emissions – Worst Cases



Product Service

ZX WIRED THERMOSTAT

| Frequency (MHz) | Detector | Raw Reading | Antenna Factor (dB/m) | Atten Factor (dB) | Cable Factor (dB) | Pre-Amp (dB) | Level | FCC 15.209 Limit | FCC 15.209 Limit Margin |
|-----------------|----------|-------------|-----------------------|-------------------|-------------------|--------------|-------|------------------|-------------------------|
| 825.517 | Peak | 39.2 | 27 | 4 | 2.2 | -32.8 | 39.6 | 46.4 | 6.8 |
| 805.903 | Peak | 39.3 | 26.9 | 4 | 2.1 | -32.9 | 39.4 | 46.4 | 7 |
| 777.065 | Peak | 39.6 | 26.4 | 4 | 2.1 | -32.9 | 39.2 | 46.4 | 7.2 |
| 622.486 | Peak | 39.4 | 25.7 | 4 | 1.9 | -33.2 | 37.8 | 46.4 | 8.6 |
| 30 | Peak | 37 | 21.4 | 4 | 0.5 | -32.4 | 30.5 | 40 | 9.5 |
| 30.5826 | Peak | 37.2 | 21.1 | 4 | 0.5 | -32.4 | 30.4 | 40 | 9.6 |

Table A.1 Tx Spurious Emission Mid Channel – 30MHz- 1GHz – Vertical Polarization-Peak Measurements

| Frequency (MHz) | Detector | Raw Reading | Antenna Factor (dB/m) | Atten Factor (dB) | Cable Factor (dB) | Pre-Amp (dB) | Level | FCC 15.209 Limit | FCC 15.209 Limit Margin |
|-----------------|----------|-------------|-----------------------|-------------------|-------------------|--------------|-------|------------------|-------------------------|
| 647.926 | Peak | 39.7 | 25.1 | 4 | 1.9 | -33.1 | 37.6 | 46.4 | 8.8 |
| 620.253 | Peak | 39 | 25.7 | 4 | 1.8 | -33.2 | 37.3 | 46.4 | 9.1 |
| 30.1942 | Peak | 37.4 | 21.3 | 4 | 0.5 | -32.4 | 30.8 | 40 | 9.2 |
| 30 | Peak | 36.2 | 21.4 | 4 | 0.5 | -32.4 | 29.7 | 40 | 10.3 |
| 528.399 | Peak | 39.1 | 24.3 | 4 | 1.7 | -33.2 | 35.9 | 46.4 | 10.5 |
| 969.317 | Peak | 39.3 | 28 | 4 | 2.4 | -32 | 41.7 | 54 | 12.3 |
| 647.926 | Peak | 39.7 | 25.1 | 4 | 1.9 | -33.1 | 37.6 | 46.4 | 8.8 |

Table A.2 Tx Spurious Emission Mid Channel – 30MHz – 1GHz – Horizontal Polarization- Peak Measurement



ZX WIRED THERMOSTAT

| Frequency (MHz) | Detector | Raw Reading | Antenna Factor (dB/m) | Atten Factor (dB) | Cable Factor (dB) | Pre-Amp (dB) | Level | FCC 15.209 Limit | FCC 15.209 Limit Margin |
|-----------------|----------|-------------|-----------------------|-------------------|-------------------|--------------|-------|------------------|-------------------------|
| 1830.54 | Peak | 54.3 | 24.9 | 3.3 | 0.2 | -33.1 | 49.6 | 54 | 4.4 |
| 2455.74 | Peak | 48.4 | 28.3 | 4.1 | 0.3 | -33.1 | 48 | 54 | 6 |
| 2417.7 | Peak | 48.5 | 28.2 | 4.1 | 0.3 | -33.1 | 48 | 54 | 6 |
| 2446.59 | Peak | 48.1 | 28.3 | 4.1 | 0.3 | -33.1 | 47.7 | 54 | 6.3 |
| 1855.14 | Peak | 44 | 25.1 | 3.4 | 0.3 | -33.1 | 39.7 | 54 | 14.3 |
| 1000 | Peak | 43.6 | 23.5 | 2.4 | 3.1 | -34.4 | 38.2 | 54 | 15.8 |

Table A.5 Tx Spurious Emission Mid Channel (2.4GHz) –30MHz – 1GHz: Vertical Polarization – Peak Measurements

| Frequency (MHz) | Detector | Raw Reading | Antenna Factor (dB/m) | Atten Factor (dB) | Cable Factor (dB) | Pre-Amp (dB) | Level | FCC 15.209 Limit | FCC 15.209 Limit Margin |
|-----------------|-----------------|-------------|-----------------------|-------------------|-------------------|--------------|-------|------------------|-------------------------|
| 1830.26 | AVG <Note 1> | 44.4 | 24.9 | 3.3 | 0.2 | -33.1 | 58.8 | 54 | 14.3 |
| 2455.74 | Peak | 50.7 | 28.3 | 4.1 | 0.3 | -33.1 | 50.3 | 54 | 3.7 |
| 2417.42 | Peak | 49.4 | 28.2 | 4.1 | 0.3 | -33.1 | 48.9 | 54 | 5.1 |
| 2463.75 | Peak | 48.5 | 28.4 | 4.2 | 0.3 | -33.1 | 48.3 | 54 | 5.7 |
| 2744.6 | Peak | 47.6 | 28.8 | 4.4 | 0.4 | -33.1 | 48.1 | 54 | 5.9 |
| 2428.57 | Peak | 48.2 | 28.2 | 4.1 | 0.3 | -33.1 | 47.7 | 54 | 6.3 |

Note 1. Average detector used.

Table A.6 Tx Spurious Emission Mid Channel (2.4GHz) –30MHz – 1GHz: Horizontal Polarization – Peak Measurements