



# SHURE

## ELECTROMAGNETIC COMPATIBILITY LABORATORY TEST REPORT

**TEST REPORT TITLE:** Electromagnetic Compatibility Tests of the Shure AXT200 L3A Digital Wireless Transmitter in the 657MHz to 663MHz Bands

**TEST ITEM DESCRIPTION:**

The Shure AXT200 is a wireless microphone transmitter, microprocessor controlled transmitter.

For: Shure Incorporated  
5800 West Touhy Avenue  
Niles, IL 60714

Project ID Number: SEL-030/AXT200 L3A

Date Tested: February 8, 20, 26, 27, 2018, March 13, 21, 2018

Test Personnel: Juan Castrejon, Alex Mishinger, and Craig Kozokar

Test Specification: FCC Part 15C, Section 15.236g

TEST REPORT BY: Craig Kozokar

Global Compliance Engineer

MAY 1, 2018

APPROVED BY: Thomas E. Blaxter  
Signature

GC Project Engineer  
Position

5/1/18  
Date



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**LIST OF APPENDICIES**

| APPENDIX | TEST DESCRIPTION                                             |
|----------|--------------------------------------------------------------|
| A        | Radiated RF Spurious Emissions Measurement, 30 MHz to 10 GHz |
| B        | Maximum Radiated Power                                       |
| C        | Necessary Bandwidth                                          |



**REPORT REVISION HISTORY**

| Revision | Date           | Description     |
|----------|----------------|-----------------|
| 0        | March 30, 2018 | Initial release |
|          |                |                 |
|          |                |                 |
|          |                |                 |
|          |                |                 |



## 1. INTRODUCTION

### 1.1. Scope of Tests

This report presents the results of testing per FCC Part 15C, Section 236g, Radiated RF Spurious Emissions, Necessary Bandwidth, and Maximum Radiated Power. The following data was taken following the measurement method as described in the document section(s) listed on page 1 of this document. Provided is the data for the test sample. Also included is a summary of the measurements made and a description of the measurement setup. The test sample meet the requirements of the above standards. The equipment under test (EUT) contained a transmitter that was designed to transmit in the UHF TV frequency bands shown in Table 1.

| Model  | Band | Frequency (MHz) | Output Power (mW) |
|--------|------|-----------------|-------------------|
| AXT200 | L3A  | 657 to 663      | 10                |

**Table 1. EUT Frequencies and Power Levels**

### 1.2. Purpose

This series of testing was performed to determine if the test item would meet the requirements of FCC Part 15C, Section 236g.

### 1.3. Deviations, Additions and Exclusions

None

### 1.4. EMC Laboratory Identification

The electromagnetic compatibility tests were performed at the Shure Electromagnetic Laboratory, Shure Incorporated, 5800 West Touhy Ave, Niles, Illinois 60714-4608. This laboratory is registered with Industry Canada as Site # 616A-1. The Shure Electromagnetic Laboratory is accredited by the National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP). The NVLAP Lab Code is: 200946-0.

**1.5. Summary of Tests Performed**

The following electromagnetic compatibility tests (Table 2) were performed on the test item in accordance with ETSI specifications.

**Table 2. Summary of tests performed**

| Test Spec    | Description                      | Tested Frequency       | Appendix | Test Results |
|--------------|----------------------------------|------------------------|----------|--------------|
| FCC Part 15C | Radiated Spurious Emissions      | 30 MHz to 10 GHz       | A        | Pass         |
| FCC Part 15C | Maximum Radiated Power           | 657.125MHz, 662.875MHz | B        | Pass         |
| FCC Part 15C | Necessary Bandwidth Measurements | 657.125MHz, 662.875MHz | C        | Pass         |

**2. APPLICABLE DOCUMENTS**

The following documents of the exact issue designated form part of this document to the extent specified herein:

FCC Part 15C, Section 236g

EN 300 422-1 v1.4.2 (2011-08), "Wireless Microphone "Electromagnetic Compatibility and Radio spectrum Matters (ERM); Wireless microphones in the 25MHz to 3GHz frequency range; Part 1; Technical characteristics and methods of measurements"

ANSI C63.4 (2014), "American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz"

**3. EUT SET-UP AND OPERATION****3.1. General Description**

The test sample used was Shure AXT200 wireless microphone transmitter. The EUT was arranged and tested per individual Appendices.

**3.2 Test Sample**

The following product sample was tested:

**Table 3: Shure AXT200 L3A Wireless Transmitter Sample**

| AXT200 L3A Serial Numbers |
|---------------------------|
| #1                        |



### 3.3 Operational Mode

All necessary bandwidth tests were performed at the below transmit frequency and output power modes shown in Table 4.

| Band | Frequency in MHz | L/M/H | Power Level in mW |
|------|------------------|-------|-------------------|
| L3A  | 657.125          | Low   | 10                |
| L3A  | 662.875          | High  | 10                |

**Table 4. EUT Frequencies and Power Levels**

All radiated spurious emissions and maximum radiated power tests were performed at the below transmit frequency and output power modes shown in Table 5.

| Band | Frequency in MHz | L/M/H | Power Level in mW |
|------|------------------|-------|-------------------|
| L3A  | 657.125          | Low   | 10                |
| JL3A | 662.875          | High  | 10                |

**Table 5. EUT Frequencies and Power Levels**

### 4. Test Instrumentation

A list of the test equipment used can be found in Table 10-1. All equipment used was within calibration during and throughout the duration of the tests. All calibrations are traceable to the National Institute of Standards and Technology (NIST).

### 5. Procedure

The specific test procedures are presented in the individual appendices.

### 6. Other Test Conditions:

#### 6.1. Test Personnel

All EMC tests were performed by qualified personnel from the Shure EMC Laboratory.

#### 6.2. Disposition of the EUT

The EUTs and all associated equipment were returned to Shure Incorporated upon completion of the tests.

### 7. Results of Tests:

The results are presented in Appendices. It was found that the EUT meet the requirements of FCC Part 15C, Section 236g for Radiated RF Spurious Emissions, Maximum Radiated Output, and Necessary Bandwidth.

### 8. Conclusions:

It was determined that the Shure AXT200 L3A Wireless Microphone Transmitter did fully comply with the requirements of FCC Part 15C, Section 236g, Radiated RF Spurious Emissions, Maximum Radiated Output, and Necessary Bandwidth.



9. **Certification:**

Shure EMC Laboratory certifies that the information contained in this report was obtained under conditions which meet or exceed those specified in the test specifications.

The data presented in this test report pertains to the EUTs at the test date. Any electrical or mechanical modification made to the EUTs subsequent to the specified test date will serve to invalidate the data and void this certification.

This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government.



## 10. Equipment List

Table 10-1 Test Equipment

| L# or ID   | Description                     | Manufacturer    | Model #               | Serial #  | Frequency Range | Cal Date  | Due Date  |
|------------|---------------------------------|-----------------|-----------------------|-----------|-----------------|-----------|-----------|
| L23-011-01 | 3 meter RF Chamber              | ETS Lindgren    | FACT-3                | AJ640     | 25MHz - 18GHz   | 8/8/2017  | 8/8/2018  |
| L23-011-02 | Electric Powered Turntable      | ETS Lindgren    | 2088                  | N/A       | N/A             | N/A       | N/A       |
| L23-011-08 | Controller                      | EMCO            | 2090                  | 29799     | N/A             | N/A       | N/A       |
| L23-011-09 | Antenna Positioner              | ETS Lindgren    | 2071-2                | 35500     | N/A             | N/A       | N/A       |
| L23-011-15 | BiConiLog Antenna               | ETS Lindgren    | 3142C                 | 34790     | 25MHz-1GHz      | 6/22/2017 | 6/22/2018 |
| L23-011-44 | BiConiLog Antenna               | ETS Lindgren    | 3142C                 | 79899     | 25MHz-1GHz      | 2/27/2017 | 2/27/2018 |
| L23-011-54 | EMI Test Receiver               | Rohde & Schwarz | ESR26                 | 100220    | 9kHz-26GHz      | 3/30/2017 | 3/30/2018 |
| L23-011-31 | EMI/EMS Test Software           | Rohde & Schwarz | EMC32                 | V 9.21.00 | N/A             | N/A       | N/A       |
| L23-011-55 | Horn antenna with pre-amplifier | ETS Lindgren    | 3117-PA               | 206583    | 1GHz to 18 GHz  | 4/27/2017 | 4/27/2018 |
| L23-011-41 | Horn Antenna                    | ETS Lindgren    | 3117                  | 123511    | 1GHz to 18 GHz  | 5/7/2017  | 5/7/2018  |
| L23-011-57 | High Pass Filter                | K&L             | 11SH10-940/X10000-0/0 | 3         | 940MHz – 10GHz  | 3/31/2017 | 3/31/2018 |
| L23-022-02 | Spectrum Analyzer               | Rohde & Schwarz | FSW26                 | 103788    | 9kHz-26GHz      | 3/28/2017 | 3/28/2018 |
| L23-022-01 | Spectrum Analyzer               | Rohde & Schwarz | FSU26                 | 201043    | 9kHz-26GHz      | 8/23/2017 | 8/23/2018 |
| L23-040-09 | 20dB attenuator                 | Mini-Circuits   | BW-S20W2              | N/A       | 20MHz to 18GHz  | 2/21/2017 | 2/21/2018 |
| L23-040-04 | 20dB attenuator                 | Mini-Circuits   | BW-S20W5              | 1133      | 20MHz to 18GHz  | 7/18/2017 | 7/18/2018 |
| L23-034-05 | Temperature Hygrometer          | Extech          | 445703                | 48254-66  | N/A             | 9/15/2016 | 9/15/2018 |
| L23-034-04 | Temperature Hygrometer          | Extech          | 445703                | 48254-13  | N/A             | 9/15/2016 | 9/15/2018 |
| L23-023-01 | RF Signal Generator             | Rohde & Schwarz | SMF100A               | 101553    | 20Hz to 26.5GHz | 8/23/2017 | 8/23/2018 |



## Appendix A

**A. RADIATED RF SPURIOUS EMISSIONS – 30 MHz TO 10 GHz****Purpose:**

This test performed to determine if the EUT meets the radiated RF emission requirements of the FCC Part 15C section 236g over the frequency range from 30MHz to 10GHz. A Quasi-Peak and Average detectors were used for the measurements.

**Requirements:**

As stated in FCC 15C section 236g, spurious emissions must meet the limits specified in section 8.4 of ETSI EN 300 422-1 V1.4.2 (2011-08)

**Measurement Uncertainty:**

All measurements are an estimate of their true value. The measurement uncertainty characterizes, with a specified confidence level, the spread of values which may be possible for a given measurement system.

Values of Expanded Measurement Uncertainty (95% Confidence)

| Measurement Type                                                                                                      | $U_{lab}$ | $U_{ETSI}$ |
|-----------------------------------------------------------------------------------------------------------------------|-----------|------------|
| Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz) | 4.12 dB   | 6.00 dB    |
| Radiated disturbance (electric field strength on an open area test site or alternative test site) (1 GHz – 13 GHz)    | 4.56 dB   | 6.00 dB    |

$U_{lab}$  = Determined for Shure EMC Laboratory

$U_{ETSI}$  = From ETSI EN 300 422-1 Table 6

Since  $U_{lab}$  is less than or equal to  $U_{ETSI}$ :

- Compliance is deemed to occur if no measured disturbance exceeds the disturbance limit;  
Non-compliance is deemed to occur if any measured disturbance exceeds the disturbance limit.

**Test Setup and Instrumentation:**

Photographs of the test setup are shown in Figure 1 and Figure 2. The test instrumentation can be determined from Table 10-1.

**EUT Operation:**

The EUT was powered up and the frequency of the transmitter was selected using the front panel controls. The EUT was checked for proper operation after it was setup on the table. For radiated spurious emissions the testing was conducted with the EUT set to the low and high frequencies, at 10mW RF output.

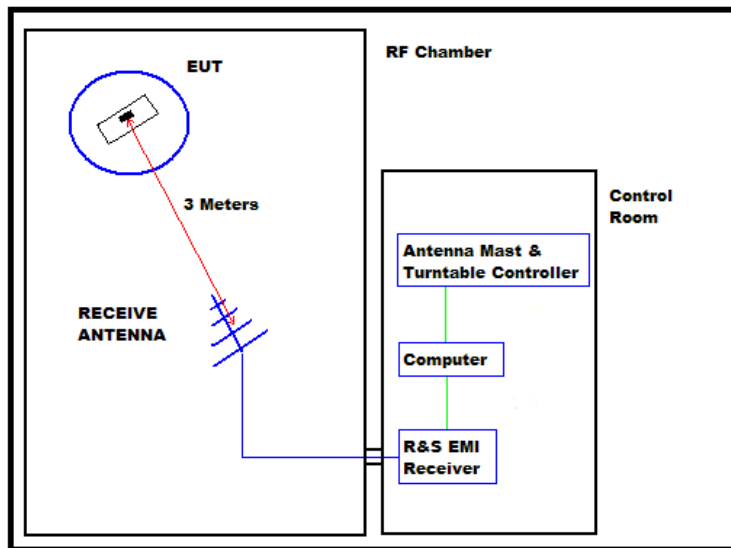


## Appendix A

### Specific Test Procedures:

All tests were performed in a 28ft. x 20ft. x 18.5ft. 3m semi-anechoic test chamber. The walls and ceiling of the shielded chamber are lined with ferrite tiles. Anechoic absorber material is installed over the ferrite tile. The floor of the chamber is used as the ground plane. The chamber complies with ANSI C63.4-2003 for site attenuation.

The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All power lines and signal lines entering the enclosure pass through filters on the enclosure wall. The power line filters prevent extraneous signals from entering the enclosure on these leads.



**BLOCK DIAGRAM OF SHIELDED ENCLOSURE**

Preliminary radiated measurements were performed to determine the frequencies where the significant emissions might be found. With the EUT at one set position and the measurement antenna at a set height (i.e. without maximizing), the radiated emissions were measured using a peak detector and automatically plotted. The BiConiLog measuring antenna was positioned at a 3 meter distance from the EUT.

## Appendix A

All significant broadband and narrowband signals found in the preliminary sweeps were then measured using a peak detector at a test distance of 3 meters. The measurements were made with a BiConiLog antenna over the frequency range of 30 MHz to 1 GHz, and a double ridged waveguide antenna over the frequency range of 1 GHz to 10 GHz.

To ensure that maximum emission levels were measured, the following steps were taken:

- i. The EUT was rotated so that all of its sides were exposed to the receiving antenna.
- ii. Since the measuring antennas are linearly polarized, both horizontal and vertical field components were measured.
- iii. The measuring antenna was raised and lowered from 1 to 4 meters for each antenna polarization to maximize the readings.

The equivalent power was determined from the field intensity levels measured at 3 meters using the substitution method. To determine the emission power, another antenna was set in place of the EUT and connected to a calibrated signal generator. (A tuned dipole was used for all measurements below 1GHz and a double ridged waveguide antenna was used for all measurements above 1GHz.) The output of the signal generator was adjusted to match the received level at the EMI receiver. The signal level was recorded. The reading was corrected to compensate for cable loss and antenna gain.

### Results:

The plots of the peak preliminary radiated voltage levels and maximized quasi-peak radiated voltage levels results are presented on page 13 thru page 24. The ERP measurements are shown on pages 25 thru page 26. All emissions measured from the EUT were within the ETSI EN 300 422-1 specification limits.



Figure 1: AXT200 Transmitter Test Setup



Figure 2: AXT200 Transmitter Test Setup



## Appendix A

## SHURE Radiated RF Emissions Test Report

### Common Information

Test Description: FCC 15C Radiated Emissions 30MHz - 1GHz  
EUT: AXT200 L3A  
Serial Number: # 1  
Operating Conditions: 657.125MHz, 10mW  
Tested on March 13, 2017  
Operator Name: Alex Mishinger

### EMI Auto Test Template: Bandsaw COMPLIANCE TEST FCC 15C 30MHz to 1GHz 34790 FCC

Hardware Setup: Electric Field Strength 34790  
Measurement Type: Open-Area-Test-Site  
Frequency Range: 30 MHz - 1 GHz  
Graphics Level Range: 0 dB $\mu$ V/m - 125 dB $\mu$ V/m

Preview Measurements:  
Graphics Display: Show separate traces for horizontal and vertical polarization  
Sweep Test Template: Compliance Test FCC 30MHz 1GHz 34790 PREVIEW

Adjustment:  
Template for Single Meas.: COMPLIANCE TEST FCC 15B 30 to 1000 MHz 34790 MAX

Final Measurements:  
Template for Single Meas.: COMPLIANCE TEST FCC 15B 30 to 1000 MHz 34790 FINAL

| Subrange           | Step Size | Detectors | IF BW   | Meas. Time | Preamp |
|--------------------|-----------|-----------|---------|------------|--------|
| Receiver: [ESR 26] |           |           |         |            |        |
| 25 MHz - 30 MHz    | 2.25 kHz  | PK+ ; QPK | 9 kHz   | 1 s        | 0 dB   |
| 30 MHz - 1 GHz     | 30 kHz    | PK+ ; QPK | 120 kHz | 2 s        | 0 dB   |



Appendix A

**Hardware Setup: EMI radiated\Electric Field Strength 34790 - [EMI radiated]**

Subrange 1

Frequency Range: 25 MHz - 1 GHz

Receiver: ESR 26 [ESR 26]  
@ GPIB0 (ADR 20), SN 1316.3003K26/101347, FW 2.26, CAL  
5/28/2016

Signal Path: Receiver-EMI to 1 GHz  
FW 1.0  
Correction Table: Receiver-EMI Antenna 18GHz L23\_041\_38 8m

Antenna: ETS 3142C 34790  
SN 34790, CAL 6/3/2017  
Correction Table (vertical): BiconiLog 3142C Hor-34790 2017 06  
17  
Correction Table (horizontal): BiconiLog 3142C Hor-34790 2017  
06 17

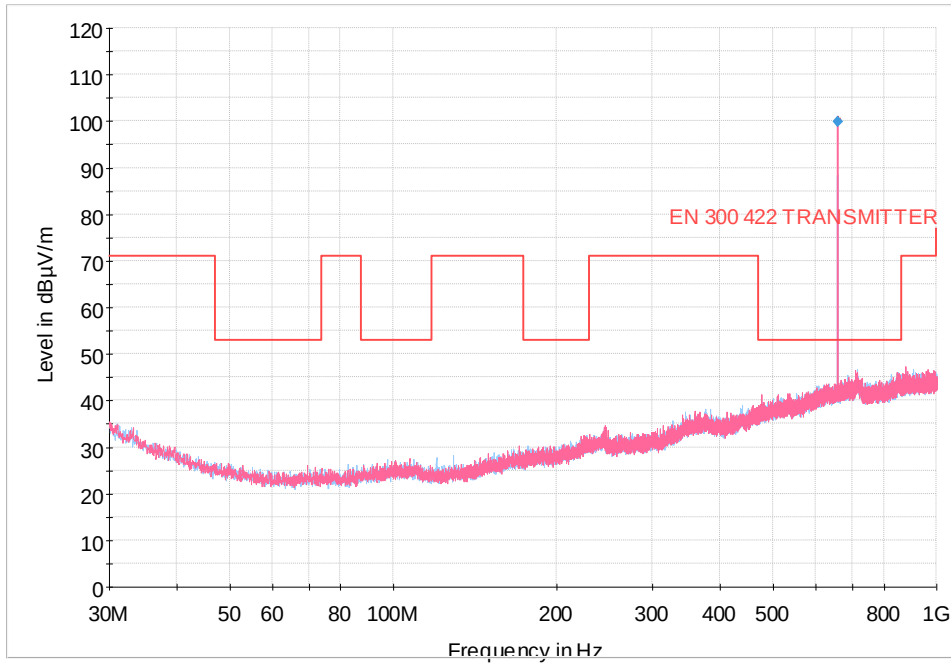
Antenna Tower: Tower [EMCO 2090 Antenna Tower]  
@ GPIB0 (ADR 8), FW REV 3.21

Turntable: Turntable [EMCO Turntable]  
@ GPIB0 (ADR 9), SN 29799, FW REV 3.21



## Appendix A

## Full Spectrum



## Critical Results

| Frequency (MHz) | MaxPeak (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) | Comment                | Corr. (dB) |
|-----------------|------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|------------------------|------------|
| 657.137333      | 100.23           | 53.00          | -47.23      | ---             | ---             | 328.0       | V   | 31.0          | ---          | 2:35:42 PM - 3/13/2018 | ---        |

## Final Results

| Frequency (MHz) | QuasiPeak (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) | Comment                | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|------------------------|------------|
| 657.137333      | 99.81              | 53.00          | -46.81      | 1000.0          | 120.000         | 328.0       | V   | 31.0          | 22.0         | 2:35:52 PM - 3/13/2018 | ---        |



## Appendix A

## SHURE Radiated RF Emissions Test Report

### Common Information

Test Description: FCC15C Radiated Emissions 1GHz - 10GHz EU  
EUT: AXT200 L3A  
Serial Number: # 1  
Operating Frequency: 657.125MHz  
Power Level / Mod Mode: 10mW  
Name: Alex Mishinger  
Comments: Tested on February 20, 2018

### EMI Auto Test Template: COMPLIANCE TEST FCC 15C 1GHz to 10GHz 3117-PA 200363 FCC

Hardware Setup: Electric Field Strength 3117-PA 200363 2017 10 17  
Measurement Type: Open-Area-Test-Site  
Frequency Range: 1 GHz - 10 GHz  
Graphics Level Range: 0 dBμV/m - 120 dBμV/m

Preview Measurements:  
Antenna height: 100 - 400 cm , Step Size = 50 cm , Positioning Speed = 6  
Polarization: H + V  
Turntable position: 0 - 360 deg , Continuously , Measuring Speed = 5  
Graphics Display: Show separate traces for horizontal and vertical polarization  
Sweep Test Template: COMPLIANCE TEST EN300422 Transmitter 1-18 GHz 3117-PA 200363 PREVIEW

Adjustment:  
Antenna height: Range = 50 cm , Measuring Speed = 1  
Turntable position: Range = 90 deg , Measuring Speed = 5  
Template for Single Meas.: COMPLIANCE TEST EN300422 Transmitter 1 to 18 GHz 3117-PA 200363 MAX

Final Measurements:  
Template for Single Meas.: COMPLIANCE TEST EN300422 Transmitter 1 to 18 GHz 3117-PA 200363 FINAL

| Subrange                             | Step Size | Detectors | IF BW | Meas. Time | Preamp |
|--------------------------------------|-----------|-----------|-------|------------|--------|
| Receiver: [ESR 26]<br>1 GHz - 18 GHz | 250 kHz   | AVG       | 1 MHz | 1 s        | 0 dB   |



Appendix A

**Hardware Setup: EMI radiated\Electric Field Strength 3117-PA 200363 - [EMI radiated]**

Subrange 1

Frequency Range: 1 GHz - 18 GHz

Receiver: ESR 26 [ESR 26]  
@ GPIB0 (ADR 20), SN 1316.3003K26/101347, FW 2.26, CAL 5/28/2016

Signal Path: Receiver-EMI to 18 GHz  
FW 1.0  
Correction Table: Receiver-EMI Antenna TEMP 2016 11 23

Antenna: EMI3117-PA 200385  
SN 200385, CAL 10/16/2018  
Correction Table (vertical): Horn ETS 3117-PA 200363 2017 10 16  
Correction Table (horizontal): Horn ETS 3117-PA 200363 2017 10 16  
Correction Table (vertical): L23\_041\_47 Cable  
Correction Table (horizontal): L23\_041\_47 Cable

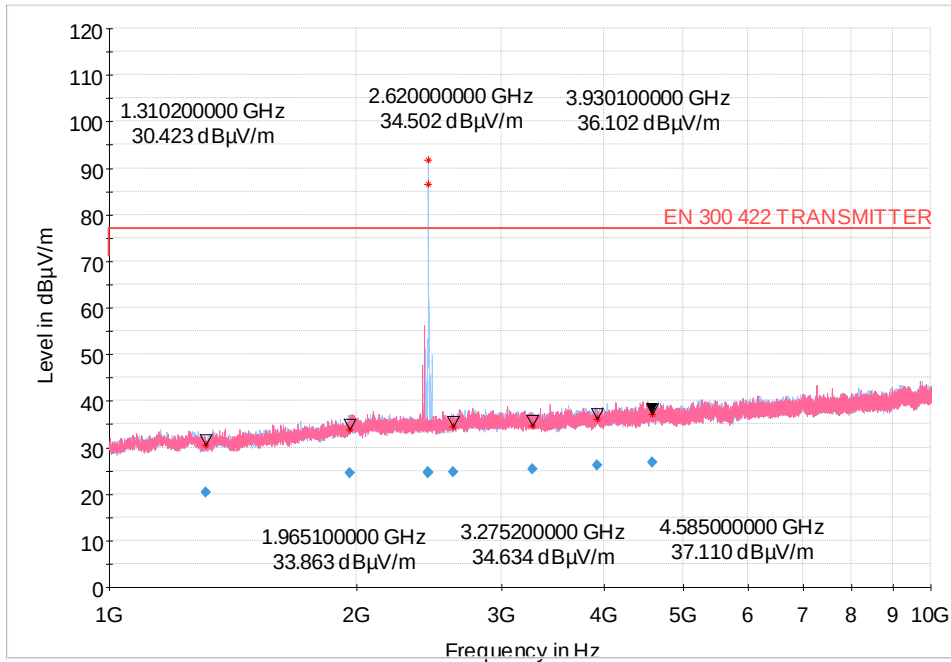
Antenna Tower: Tower [EMCO 2090 Antenna Tower]  
@ GPIB0 (ADR 8), FW REV 3.21

Turntable: Turntable [EMCO Turntable]  
@ GPIB0 (ADR 9), SN 29799, FW REV 3.21



## Appendix A

Full Spectrum



NOTE: The emissions at 2.4GHz are from the AXT200 ZigBee transmitter.

## Critical Frequencies

| Frequency (MHz) | MaxPeak (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) | Comment                | Corr. (dB) |
|-----------------|------------------------|----------------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|------------------------|------------|
| 1310.200000     | 30.42                  | 77.00                | 46.58       | ---             | ---             | 325.0       | V   | 49.0          | ---          | 2:49:36 PM - 2/20/2018 | ---        |
| 1965.100000     | 33.86                  | 77.00                | 43.14       | ---             | ---             | 356.0       | H   | 135.0         | ---          | 2:50:55 PM - 2/20/2018 | ---        |
| 2620.000000     | 34.50                  | 77.00                | 42.50       | ---             | ---             | 387.0       | V   | 168.0         | ---          | 2:54:08 PM - 2/20/2018 | ---        |
| 3275.200000     | 34.63                  | 77.00                | 42.37       | ---             | ---             | 371.0       | V   | 45.0          | ---          | 2:55:18 PM - 2/20/2018 | ---        |
| 3930.100000     | 36.10                  | 77.00                | 40.90       | ---             | ---             | 398.0       | V   | 155.0         | ---          | 2:56:20 PM - 2/20/2018 | ---        |
| 4585.000000     | 37.11                  | 77.00                | 39.89       | ---             | ---             | 399.0       | V   | 89.0          | ---          | 2:57:24 PM - 2/20/2018 | ---        |

## Final Result

| Frequency (MHz) | Average (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) | Comment                | Corr. (dB) |
|-----------------|------------------------|----------------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|------------------------|------------|
| 1310.200000     | 20.30                  | 77.00                | 56.70       | 1000.0          | 1000.000        | 325.0       | V   | 49.0          | -16.1        | 2:49:42 PM - 2/20/2018 | ---        |
| 1965.100000     | 24.40                  | 77.00                | 52.60       | 1000.0          | 1000.000        | 356.0       | H   | 135.0         | -13.4        | 2:51:04 PM - 2/20/2018 | ---        |
| 2620.000000     | 24.75                  | 77.00                | 52.25       | 1000.0          | 1000.000        | 387.0       | V   | 168.0         | -12.2        | 2:54:16 PM - 2/20/2018 | ---        |
| 3275.200000     | 25.23                  | 77.00                | 51.77       | 1000.0          | 1000.000        | 371.0       | V   | 45.0          | -11.0        | 2:55:26 PM - 2/20/2018 | ---        |
| 3930.100000     | 26.06                  | 77.00                | 50.94       | 1000.0          | 1000.000        | 400.0       | V   | 155.0         | -9.0         | 2:56:27 PM - 2/20/2018 | ---        |
| 4585.000000     | 26.70                  | 77.00                | 50.30       | 1000.0          | 1000.000        | 400.0       | V   | 89.0          | -7.2         | 2:57:31 PM - 2/20/2018 | ---        |



## Appendix A

## SHURE Radiated RF Emissions Test Report

### Common Information

Test Description: FCC 15C Radiated Emissions 30MHz - 1GHz  
EUT: AXT200 L3A  
Serial Number: # 1  
Operating Frequency: 662.875MHz  
Power Level / Mod Mode: 10mW  
Name: Alex Mishinger  
Comments: Tested on March 21, 2018

### EMI Auto Test Template: COMPLIANCE TEST FCC15C-EN300422 Transmitter 30MHz to 1GHz 34790 EU

Hardware Setup: Electric Field Strength 34790  
Measurement Type: Open-Area-Test-Site  
Frequency Range: 30 MHz - 1 GHz  
Graphics Level Range: 0 dBμV/m - 120 dBμV/m

Preview Measurements:  
Antenna height: 100 - 400 cm , Step Size = 50 cm , Positioning Speed = 6  
Polarization: H + V  
Turntable position: 0 - 360 deg , Continuously , Measuring Speed = 5  
Graphics Display: Show separate traces for horizontal and vertical polarization  
Sweep Test Template: Compliance Test EN300422 Transmitter 25MHz 1GHz 34790  
PREVIEW

Adjustment:  
Antenna height: Range = 50 cm , Measuring Speed = 1  
Turntable position: Range = 90 deg , Measuring Speed = 5  
Template for Single Meas.: COMPLIANCE TEST EN300422 Transmitter 25 to 1000 MHz  
34790 FINAL

Final Measurements:  
Template for Single Meas.: COMPLIANCE TEST EN300422 Transmitter 25 to 1000 MHz  
34790 FINAL

| Subrange           | Step Size | Detectors | IF BW   | Meas. Time | Preamp |
|--------------------|-----------|-----------|---------|------------|--------|
| Receiver: [ESR 26] |           |           |         |            |        |
| 25 MHz - 30 MHz    | 2.25 kHz  | QPK       | 9 kHz   | 1 s        | 0 dB   |
| 30 MHz - 1 GHz     | 30 kHz    | QPK       | 120 kHz | 1 s        | 0 dB   |



Appendix A

**Hardware Setup: EMI radiated\Electric Field Strength 34790 - [EMI radiated]**

Subrange 1  
Frequency Range: 25 MHz - 1 GHz

Receiver: ESR 26 [ESR 26]  
@ GPIB0 (ADR 20), SN 1316.3003K26/101347, FW 2.26, CAL  
5/28/2016

Signal Path: Receiver-EMI to 1 GHz  
FW 1.0  
Correction Table: Receiver-EMI Antenna 18GHz L23\_041\_38 8m

Antenna: ETS 3142C 34790  
SN 34790, CAL 6/3/2017  
Correction Table (vertical): BiconiLog 3142C Hor-34790 2017 06  
17  
Correction Table (horizontal): BiconiLog 3142C Hor-34790 2017  
06 17

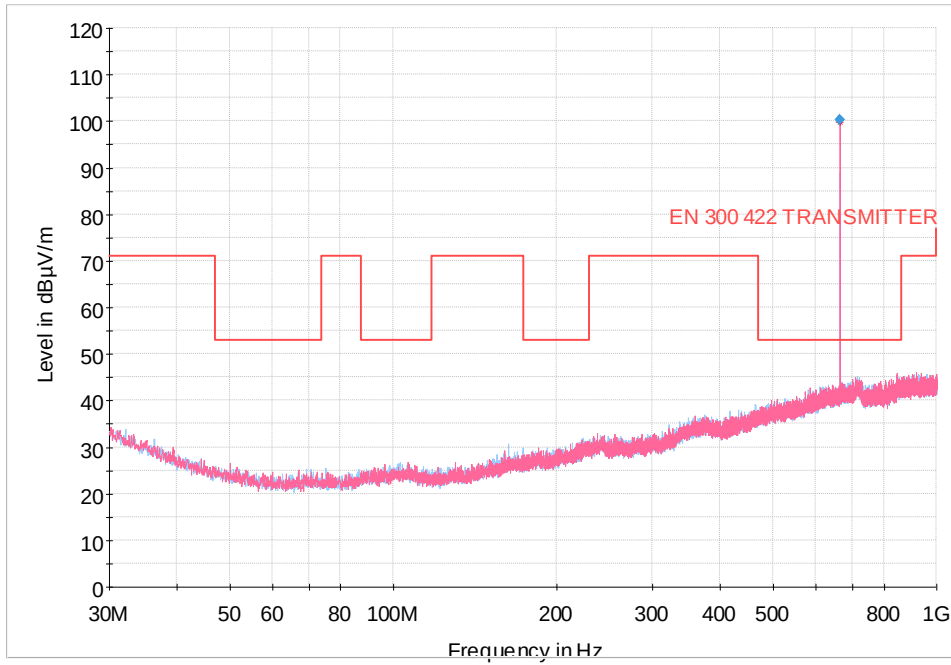
Antenna Tower: Tower [EMCO 2090 Antenna Tower]  
@ GPIB0 (ADR 8), FW REV 3.21

Turntable: Turntable [EMCO Turntable]  
@ GPIB0 (ADR 9), SN 29799, FW REV 3.21



## Appendix A

## Full Spectrum



## Critical Frequencies

| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) | Comment                | Corr. (dB) |
|-----------------|------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|------------------------|------------|
| 662.892667      | 99.89            | 53.00          | -46.89      | ---             | ---             | 328.0       | V   | 151.0         | ---          | 2:12:58 PM - 3/21/2018 | ---        |

## Final Frequencies

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) | Comment                | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|------------------------|------------|
| 662.892667      | 100.30             | 53.00          | -47.30      | 1000.0          | 120.000         | 328.0       | V   | 151.0         | 22.2         | 2:13:08 PM - 3/21/2018 | ---        |



## Appendix A

## SHURE Radiated RF Emissions Test Report

### Common Information

Test Description: FCC15C Radiated Emissions 1GHz - 10GHz  
EUT: AXT200 L3A  
Serial Number: # 1  
Operating Frequency: 662.875MHz  
Power Level / Mod Mode: 10mW  
Name: Alex Mishinger  
Comments: Tested on February 20, 2018

### EMI Auto Test Template: COMPLIANCE TEST EN300422 Transmitter 1GHz to 10GHz 3117-PA 200363 EU

Hardware Setup: Electric Field Strength 3117-PA 200363 2017 10 17  
Measurement Type: Open-Area-Test-Site  
Frequency Range: 1 GHz - 10 GHz  
Graphics Level Range: 0 dBμV/m - 120 dBμV/m  
Preview Measurements:  
Antenna height: 100 - 400 cm , Step Size = 50 cm , Positioning Speed = 6  
Polarization: H + V  
Turntable position: 0 - 360 deg , Continuously , Measuring Speed = 5  
Graphics Display: Show separate traces for horizontal and vertical polarization  
Sweep Test Template: COMPLIANCE TEST EN300422 Transmitter 1-18 GHz 3117-PA 200363 PREVIEW

Adjustment:  
Antenna height: Range = 50 cm , Measuring Speed = 1  
Turntable position: Range = 90 deg , Measuring Speed = 5  
Template for Single Meas.: COMPLIANCE TEST EN300422 Transmitter 1 to 18 GHz 3117-PA 200363 MAX

Final Measurements:  
Template for Single Meas.: COMPLIANCE TEST EN300422 Transmitter 1 to 18 GHz 3117-PA 200363 FINAL

| Subrange                             | Step Size | Detectors | IF BW | Meas. Time | Preamp |
|--------------------------------------|-----------|-----------|-------|------------|--------|
| Receiver: [ESR 26]<br>1 GHz - 18 GHz | 250 kHz   | AVG       | 1 MHz | 1 s        | 0 dB   |



Appendix A

**Hardware Setup: EMI radiated\Electric Field Strength 3117-PA 200363 - [EMI radiated]**

Subrange 1

Frequency Range: 1 GHz - 18 GHz

Receiver: ESR 26 [ESR 26]  
@ GPIB0 (ADR 20), SN 1316.3003K26/101347, FW 2.26, CAL 5/28/2016

Signal Path: Receiver-EMI to 18 GHz  
FW 1.0  
Correction Table: Receiver-EMI Antenna TEMP 2016 11 23

Antenna: EMI3117-PA 200385  
SN 200385, CAL 10/16/2018  
Correction Table (vertical): Horn ETS 3117-PA 200363 2017 10 16  
Correction Table (horizontal): Horn ETS 3117-PA 200363 2017 10 16  
Correction Table (vertical): L23\_041\_47 Cable  
Correction Table (horizontal): L23\_041\_47 Cable

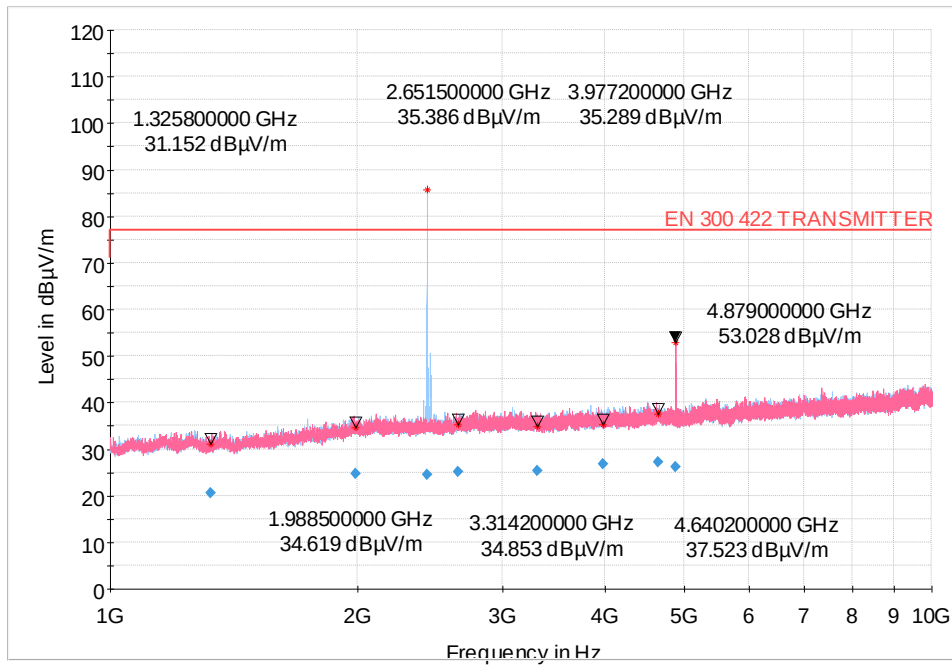
Antenna Tower: Tower [EMCO 2090 Antenna Tower]  
@ GPIB0 (ADR 8), FW REV 3.21

Turntable: Turntable [EMCO Turntable]  
@ GPIB0 (ADR 9), SN 29799, FW REV 3.21



## Appendix A

Full Spectrum



NOTE: Emissions around 2.4GHz were caused by the AXT200 ZigBee transmitter.

## Critical Frequencies

| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) | Comment                | Corr. (dB) |
|-----------------|------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|------------------------|------------|
| 1325.800000     | 31.15            | 77.00          | 45.85       | ---             | ---             | 106.0       | H   | 71.0          | ---          | 3:24:09 PM - 2/20/2018 | ---        |
| 1988.500000     | 34.62            | 77.00          | 42.38       | ---             | ---             | 137.0       | V   | 220.0         | ---          | 3:25:25 PM - 2/20/2018 | ---        |
| 2651.500000     | 35.39            | 77.00          | 41.61       | ---             | ---             | 171.0       | H   | 229.0         | ---          | 3:28:20 PM - 2/20/2018 | ---        |
| 3314.200000     | 34.85            | 77.00          | 42.15       | ---             | ---             | 385.0       | V   | 294.0         | ---          | 3:29:31 PM - 2/20/2018 | ---        |
| 3977.200000     | 35.29            | 77.00          | 41.71       | ---             | ---             | 119.0       | V   | 6.0           | ---          | 3:31:17 PM - 2/20/2018 | ---        |
| 4640.200000     | 37.52            | 77.00          | 39.48       | ---             | ---             | 158.0       | H   | 310.0         | ---          | 3:32:41 PM - 2/20/2018 | ---        |

## Final Frequencies

| Frequency (MHz) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) | Comment                | Corr. (dB) |
|-----------------|------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|------------------------|------------|
| 1325.800000     | 20.47            | 77.00          | 56.53       | 1000.0          | 1000.000        | 106.0       | H   | 71.0          | -16.2        | 3:24:18 PM - 2/20/2018 | ---        |
| 1988.500000     | 24.62            | 77.00          | 52.38       | 1000.0          | 1000.000        | 137.0       | V   | 220.0         | -13.1        | 3:25:35 PM - 2/20/2018 | ---        |
| 2651.500000     | 25.21            | 77.00          | 51.79       | 1000.0          | 1000.000        | 171.0       | H   | 229.0         | -11.9        | 3:28:29 PM - 2/20/2018 | ---        |
| 3314.200000     | 25.38            | 77.00          | 51.62       | 1000.0          | 1000.000        | 385.0       | V   | 294.0         | -11.0        | 3:29:40 PM - 2/20/2018 | ---        |
| 3977.200000     | 26.84            | 77.00          | 50.16       | 1000.0          | 1000.000        | 119.0       | V   | 6.0           | -8.8         | 3:31:25 PM - 2/20/2018 | ---        |
| 4640.200000     | 27.10            | 77.00          | 49.90       | 1000.0          | 1000.000        | 158.0       | H   | 310.0         | -7.1         | 3:32:50 PM - 2/20/2018 | ---        |



## Appendix A

Date: February 27, 2018  
EUT: AXT200  
Band: L3A  
Serial Number: # 1  
Specification: EN 300 422-1, Spurious Radiated Emissions  
Comments: Test Distance is 3 meters  
Mode: EUT set to Low 657.125 MHz  
Tested By: Alex Mishinger, February 26 & 27, 2018

| Frequency<br>in MHz | Detector<br>Used | Antenna<br>Polarity | Measured<br>Level in<br>dBuV | Matched<br>Sig. Gen.<br>Reading<br>in dBm | Antenna<br>Gain<br>in dB | Cable<br>Loss<br>in dB | ERP<br>Total<br>in dBm | ETSI<br>Limit<br>in dBm |
|---------------------|------------------|---------------------|------------------------------|-------------------------------------------|--------------------------|------------------------|------------------------|-------------------------|
| 1310.200            | Average          | H                   | 20.30                        | -76.0                                     | 3.8                      | 2.86                   | -75.1                  | -30                     |
| 1310.200            | Average          | V                   | 20.30                        | -76.0                                     | 3.8                      | 2.86                   | -75.1                  | -30                     |
| 1965.100            | Average          | H                   | 24.40                        | -73.0                                     | 5.3                      | 3.63                   | -71.3                  | -30                     |
| 1965.100            | Average          | V                   | 24.40                        | -73.0                                     | 5.3                      | 3.63                   | -71.3                  | -30                     |
| 2620.000            | Average          | H                   | 24.75                        | -73.0                                     | 6.0                      | 4.18                   | -71.2                  | -30                     |
| 2620.000            | Average          | V                   | 24.75                        | -73.0                                     | 6.0                      | 4.18                   | -71.2                  | -30                     |
| 3275.200            | Average          | H                   | 25.23                        | -73.0                                     | 7.0                      | 4.34                   | -70.3                  | -30                     |
| 3275.200            | Average          | V                   | 25.23                        | -73.0                                     | 7.0                      | 4.34                   | -70.3                  | -30                     |
| 3930.100            | Average          | H                   | 26.06                        | -73.0                                     | 8.2                      | 4.99                   | -69.8                  | -30                     |
| 3930.100            | Average          | V                   | 26.06                        | -73.0                                     | 8.2                      | 4.99                   | -69.8                  | -30                     |
| 4585.000            | Average          | H                   | 26.70                        | -73.0                                     | 9.3                      | 5.23                   | -68.9                  | -30                     |
| 4585.000            | Average          | V                   | 26.70                        | -73.0                                     | 9.3                      | 5.23                   | -68.9                  | -30                     |

Total (dBm) = Matched Signal. Generator Reading (dBm) + Antenna Gain (dB) – Cable Loss (dB)



## Appendix A

Date: February 27, 2018  
EUT: AXT200  
Band: L3A  
Serial Number: # 1  
Specification: EN 300 422-1, Spurious Radiated Emissions  
Comments: Test Distance is 3 meters  
Mode: EUT set to High 662.875 MHz  
Tested By: Alex Mishinger, February 26 & 27, 2018

| Frequency<br>in MHz | Detector<br>Used | Antenna<br>Polarity | Measured<br>Level in<br>dBuV | Matched<br>Sig. Gen.<br>Reading<br>in dBm | Antenna<br>Gain<br>in dB | Cable<br>Loss<br>in dB | ERP<br>Total<br>in dBm | ETSI<br>Limit<br>in dBm |
|---------------------|------------------|---------------------|------------------------------|-------------------------------------------|--------------------------|------------------------|------------------------|-------------------------|
| 1325.800            | Average          | H                   | 20.47                        | -77.0                                     | 3.8                      | 3.79                   | -77.0                  | -30                     |
| 1325.800            | Average          | V                   | 20.47                        | -77.0                                     | 3.8                      | 3.79                   | -77.0                  | -30                     |
| 1988.500            | Average          | H                   | 24.62                        | -75.0                                     | 5.3                      | 3.53                   | -73.2                  | -30                     |
| 1988.500            | Average          | V                   | 24.62                        | -75.0                                     | 5.3                      | 3.53                   | -73.2                  | -30                     |
| 2651.500            | Average          | H                   | 25.21                        | -76.0                                     | 6.0                      | 4.23                   | -74.2                  | -30                     |
| 2651.500            | Average          | V                   | 25.21                        | -76.0                                     | 6.0                      | 4.23                   | -74.2                  | -30                     |
| 3314.200            | Average          | H                   | 25.38                        | -74.0                                     | 7.0                      | 4.37                   | -71.4                  | -30                     |
| 3314.200            | Average          | V                   | 25.38                        | -74.0                                     | 7.0                      | 4.37                   | -71.4                  | -30                     |
| 3977.200            | Average          | H                   | 26.84                        | -75.0                                     | 8.2                      | 5.00                   | -71.8                  | -30                     |
| 3977.200            | Average          | V                   | 26.84                        | -75.0                                     | 8.2                      | 5.00                   | -71.8                  | -30                     |
| 4640.200            | Average          | H                   | 27.10                        | -72.0                                     | 9.3                      | 5.55                   | -68.3                  | -30                     |
| 4640.200            | Average          | V                   | 27.10                        | -72.0                                     | 9.3                      | 5.55                   | -68.3                  | -30                     |

Total (dBm) = Matched Signal. Generator Reading (dBm) + Antenna Gain (dB) – Cable Loss (dB)

**Appendix B****B. Maximum Radiated Power****Purpose:**

This test performed to determine if the EUT meets the Maximum Radiated Power requirements of the FCC Part15C, Section 15.236.

**Requirements:**

As stated in FCC 15C Section 15.236 (6)(2), the maximum radiated power in the 600MHz guard band and the 600MHz duplex gap: 20mW EIRP.

**Measurement Uncertainty:**

All measurements are an estimate of their true value. The measurement uncertainty characterizes, with a specified confidence level, the spread of values which may be possible for a given measurement system.

Values of Expanded Measurement Uncertainty (95% Confidence)

| Measurement Type                           | $U_{lab}$ |
|--------------------------------------------|-----------|
| Conducted measurements (30 MHz – 1000 MHz) | 1.24 dB   |

$U_{lab}$  = Determined for Shure EMC Laboratory

Since  $U_{lab}$  is less than or equal to  $U_{ETSJ}$ :

- Compliance is deemed to occur if no measured disturbance exceeds the disturbance limit;  
Non-compliance is deemed to occur if any measured disturbance exceeds the disturbance limit.

**Test Setup and Instrumentation:**

Photographs of the test setup are shown in Figure 1. The test instrumentation can be determined from Table 10-1.

**EUT Operation:**

The EUT was powered up and the frequency of the transmitter was selected using the front panel controls. For rated output power, the testing was conducted with the EUT set to the low and high frequencies, at 10mW RF output.



## Appendix B

### Specific Test Procedures:

The output of the EUT was connected to a spectrum analyzer through 20dB of attenuation. The EUT was set to transmit on the low and high frequencies. The channel power was measured.

The spectrum analyzer was set to:

- RBW 10kHz
- VBW 100kHz
- Channel BW 200kHz
- Span 1MHz
- Detector Average
- State Average

### Results:

The EIRP for all frequencies measured meets the FCC15C 15.236 requirements.

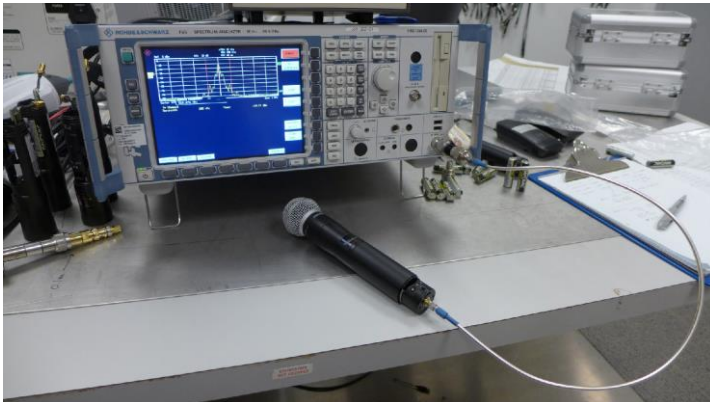


Figure 1: Test setup for Maximum Radiated Output



## Appendix B

## Test Information

EUT Name: AXT200 L3A  
Serial Number: # 1  
Test Description: Maximum Rated Output  
Operating Conditions: Low Frequency, 657.125MHz, 10mW  
Operator Name: Craig Kozokar  
Comment: FCC Part15C, Section 15.236  
Date Tested: Tested on March 13, 2018

| Power Meter<br>Measurement<br>in dBm | Measured Antenna<br>Gain<br>in dBi | Cable Loss<br>in dB | EIRP<br>in dBm | EIRP<br>Limit<br>in dBm | Margin<br>In dB |
|--------------------------------------|------------------------------------|---------------------|----------------|-------------------------|-----------------|
| +9.19                                | 1.00                               | 0.40                | +10.59         | 13.00                   | 2.41            |

EIRP (dBm) = Measurement (dBm) + Measured Antenna Gain (dB) + Cable Loss (dB)

Measured AXT200 L3A antenna gain is 1.00dBi

## Test Information

EUT Name: AXT200 L3A  
Serial Number: # 1  
Test Description: Maximum Rated Output  
Operating Conditions: High Frequency, 662.875MHz, 10mW  
Operator Name: Craig Kozokar  
Comment: FCC Part15C, Section 15.236  
Date Tested: Tested on March 13, 2018

| Power Meter<br>Measurement<br>in dBm | Measured Antenna<br>Gain<br>in dBi | Cable Loss<br>in dB | EIRP<br>in dBm | EIRP<br>Limit<br>in dBm | Margin<br>In dB |
|--------------------------------------|------------------------------------|---------------------|----------------|-------------------------|-----------------|
| +10.04                               | 1.00                               | 0.40                | +11.44         | 13.00                   | 1.56            |

EIRP (dBm) = Measurement (dBm) + Measured Antenna Gain (dB) + Cable Loss (dB)

Measured AXT200 L3A antenna gain is 1.00dBi



## Appendix C

**NECESSARY BANDWIDTH MEASUREMENTS****C.1 PURPOSE**

This test was performed to determine if the EUT meets the necessary bandwidth requirements of EN 300 422-1, section 8.3.3., with the EUT operating at 657.125MHz and 662.875MHz.

**C.2 REQUIREMENTS**

As stated in EN 300 422-1, section 8.3.3, the emission mask given in section 8.3.3.2 shall not be exceeded.

**C.3 TEST SETUP AND INSTRUMENTATION**

A photograph of the test setup is shown in Figure B-1. The test instrumentation can be determined from Table 10-1.

**C.4 MEASUREMENT UNCERTAINTY**

All measurements are an estimate of their true value. The measurement uncertainty characterizes, with a specified confidence level, the spread of values which may be possible for a given measurement system.

Values of Expanded Measurement Uncertainty (95% Confidence):

| Measurement Type    | $U_{LAB}$                        |
|---------------------|----------------------------------|
| Necessary Bandwidth | <b><math>\pm 0.130 \%</math></b> |

$U_{lab}$  = Determined for Shure EMC Laboratory

Since  $U_{LAB}$  is less than or equal to  $U_{ETSI}$ :

- Compliance is deemed to occur if no measured disturbance exceeds the disturbance limit;
- Non-compliance is deemed to occur if any measured disturbance exceeds the disturbance limit.

**C.5 EUT OPERATION**

The EUT was powered up and the transmit frequency and power output of the EUT were selected. The EUT was checked for proper operation after it was setup for the test. Testing was conducted with the EUT set to transmit at 657.125 and 662.875 MHz, at an output power level of 10mW. The transmitter was modulated per EN300422-1 V1.4.2 (2011-08), clause 7.1.2.

**C.6 TEST PROCEDURE**

The test procedure followed is shown in EN300422-1 V1.4.2 (2011-08), section 8.3.3.1.



## Appendix C

### C.7 RESULTS

The necessary bandwidth data is presented on pages 32 and 35. Data is shown on the figures for each transmitter. The figure shows the maximum relative level within the emission mask with modulation. As shown by the test data, the necessary bandwidth of the EUT meets the requirements of EN 300 422-1, section 8.3.3.

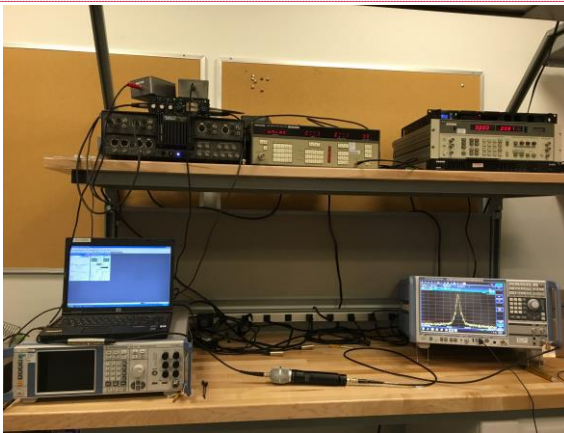


Figure B-1 - Test Setup for Necessary Bandwidth

Commented [KC1]:

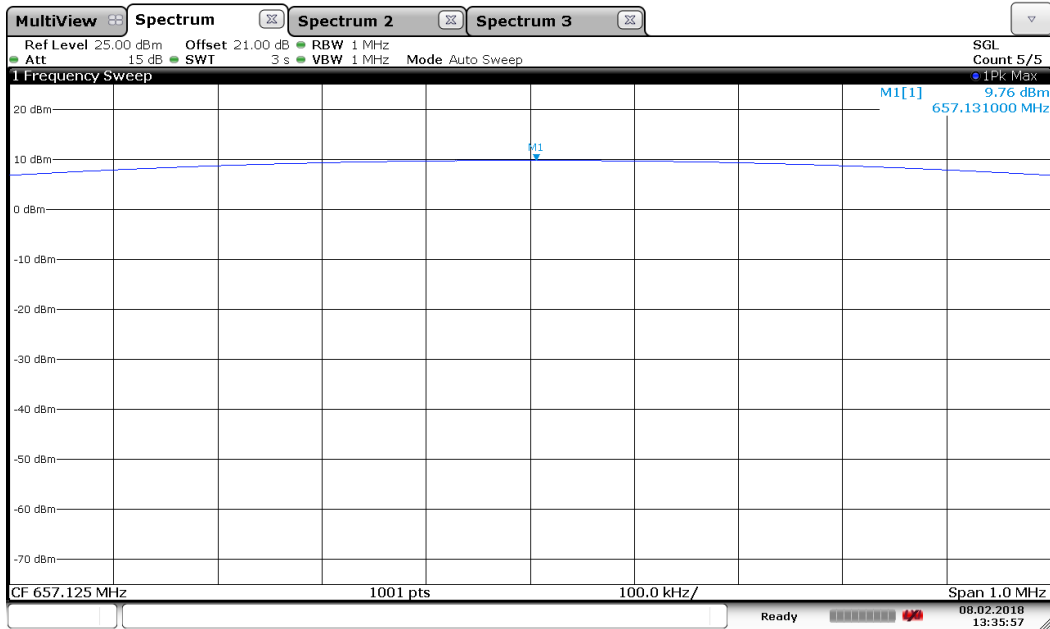
Commented [KC2R1]:



Appendix C

Test Information

EUT Name: AXT200 L3A  
Serial Number: # 1  
Test Description: EN 300 422 Digital Necessary Bandwidth  
Operating Conditions: Low Frequency, 657.125MHz, 10mW  
Operator Name: Juan Castrejon  
Comment: 8.3.3.1: Step 1; Carrier Power  
Date Tested: Tested on February 8, 2018



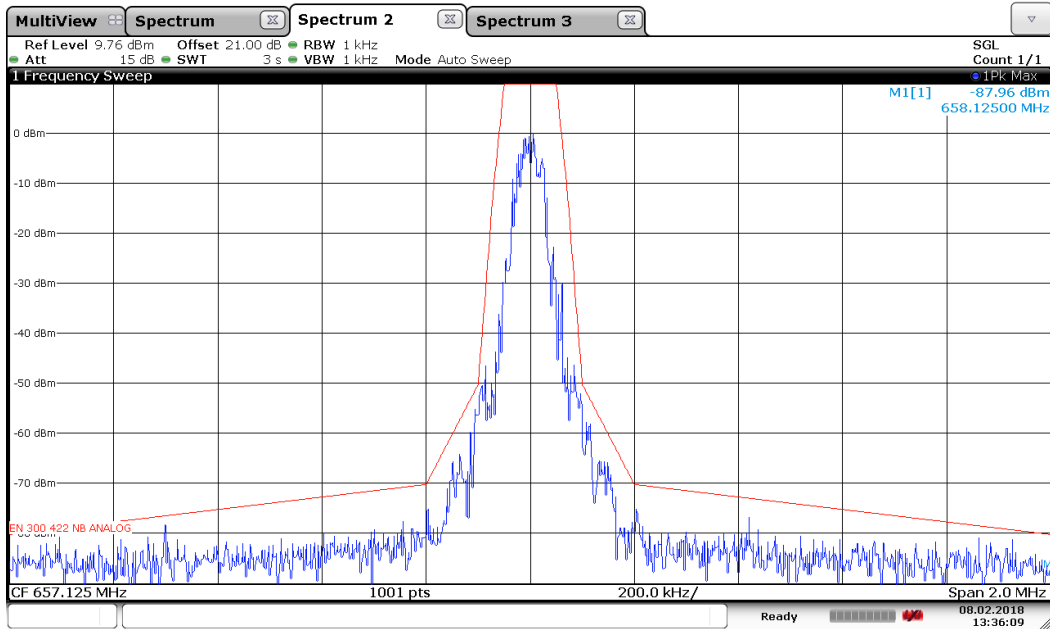
13:35:57 08.02.2018



## Appendix C

### Test Information

EUT Name: AXT200 L3A  
Serial Number: # 1  
Test Description: EN 300 422 Digital Necessary Bandwidth  
Operating Conditions: Low Frequency, 657.125MHz, 10mW  
Operator Name: Juan Castrejon  
Comment: 8.3.3.1: Step 2;Maximum Relative Level  
Date Tested: Test on February 8, 2018



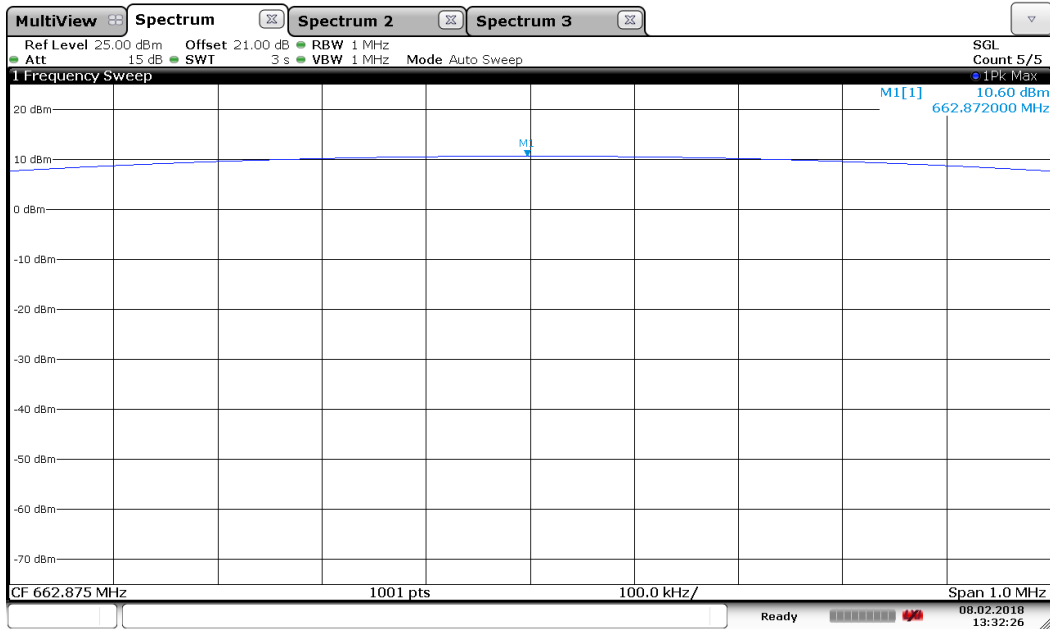
13:36:09 08.02.2018



Appendix C

Test Information

EUT Name: AXT200 L3A  
Serial Number: # 1  
Test Description: EN 300 422 Digital Necessary Bandwidth  
Operating Conditions: High Frequency, 662.875MHz, 10mW  
Operator Name: Juan Castrejon  
Comment: 8.3.3.1: Step 1; Carrier Power  
Date Tested: Tested on February 8, 2018



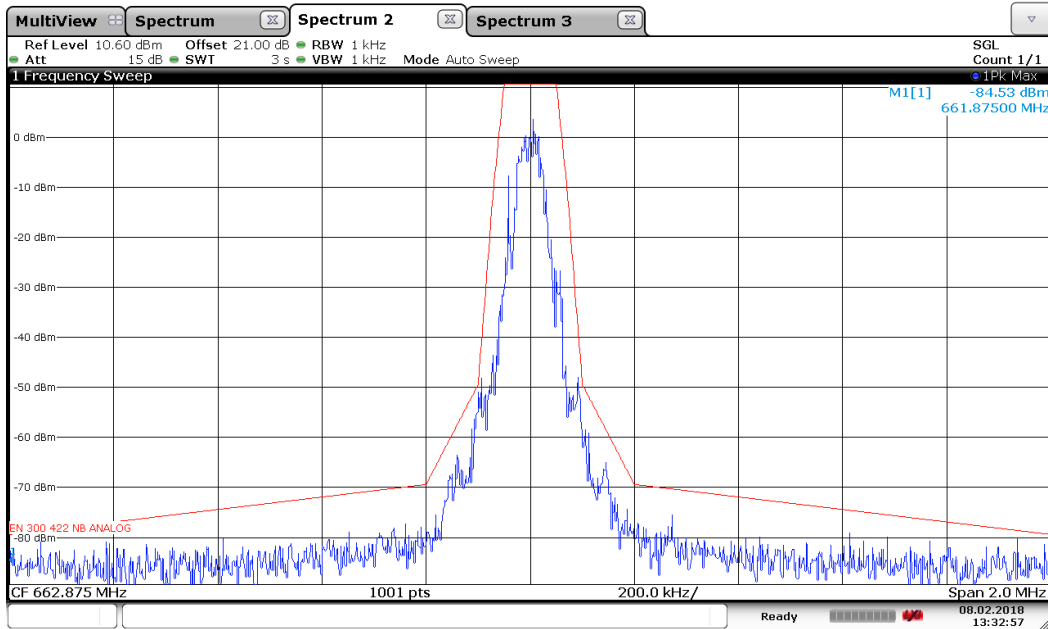
13:32:27 08.02.2018



## Appendix C

### Test Information

EUT Name: AXT200 L3A  
Serial Number: # 1  
Test Description: EN 300 422 Digital Necessary Bandwidth  
Operating Conditions: High Frequency, 662.875MHz, 10mW  
Operator Name: Juan Castrejon  
Comment: 8.3.3.1: Step 2;Maximum Relative Level  
Date Tested: Test on February 8, 2018



13:32:57 08.02.2018