SHURE

ELECTROMAGNETIC COMPATIBILITY LABORATORY
TEST REPORT

TEST REPORT TITLE: Electromagnetic Compatibility Tests of the Shure ULXD2 L50A Digital Wireless Transmitter in the 653MHz to 657MHz Band

TEST ITEM DESCRIPTION:

The Shure ULXD2 is a digital wireless microphone transmitter, microprocessor controlled transmitter.

For:	Shure Incorporated 5800 West Touhy Avenue Niles, IL 60714
Project ID Number:	SEL-030/ULXD2 L50A
Date Tested:	June 12, 2017, November 22, 2017, February 13, 26, 27, 2018, March 8, 2018
Test Personnel:	Alex Mishinger, Danny Palaniswami, and Craig Kozokar
Test Specification:	FCC Part 74, Subpart H – Low Power Auxiliary Stations RSS 210 Issue 9, Annex G: Low-Power Radio Apparatus Operating in the Television Bands

TEST REPORT BY:	Craig Kozokar	Global Compliance Engineer	May 1, 2018
APPROVED BY:	Thomas E Beardsley	GC Project Engineer	May 1, 2018
	Signature	Position	Date

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LIST OF APPENDICIES

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

REPORT REVISION HISTORY

Revision	Date	Description
0	March 30, 2018	Initial release
1	November 14, 2018	Updated to include RSS210 certification information

1. INTRODUCTION

1.1. Scope of Tests

This report presents the results of testing per FCC Part 74, Subpart H, 74.861, Radiated RF Spurious Emissions, Power Output, and Necessary Bandwidth as well as RSS 210 Issue 9, Annex G: Low-Power Radio Apparatus Operating in the Television Bands. 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)
ULXD2	L50A	653 - 657	1, 10, and 20

Table 1. EUT Band 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 74, Subpart H, 74.861, radiated spurious emissions 74.861 subsection 6 iii, power output 4 e iii, and occupied bandwidth 74.861 subsection 7 and RSS 210 Issue 9, Annex G: Low-Power Radio Apparatus Operating in the Television Bands.

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 74H RSS210.9	Radiated Spurious Emissions	30 MHz to 10 GHz	A	Pass
FCC Part 74H RSS 210.9	Output Power	655.000MHz	B	Pass
FCC Part 74H RSS 210.9	Necessary Bandwidth Measurements	653.125MHz and 656.875MHz	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 74 Part H, “Low Power Auxiliary Stations”, 74.861

RSS 210 Issue 9, Annex G: Low-Power Radio Apparatus Operating in the Television Bands

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 ULXD2 digital 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 ULXD2 L50A Digital Wireless Transmitter Sample

ULXD2 L50A Serial Numbers
#1

3.3 Operational Mode

All radiated spurious emissions, power output, and necessary bandwidth tests were performed separately in the transmit frequency and output power modes shown in Table 4.

Band	Frequency in MHz	Power Level in mW
L50A	655.000	20

Table 4. EUT Frequencies and Power Levels

All necessary bandwidth tests were performed separately in the transmit frequency and output power modes shown in Table 5.

Band	Frequency in MHz	Power Level in mW
L50A	653.125 and 656.875	20

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 74 Subpart H, 74.861 for Radiated RF Spurious Emissions, Power Output, and Necessary Bandwidth and RSS 210 Issue 9, Annex G: Low-Power Radio Apparatus Operating in the Television Bands.

8. Conclusions:

It was determined that the Shure ULXD2 L50A Digital Wireless Microphone Transmitter did fully comply with the requirements of FCC Part 74 Subpart H, 74.861, Radiated RF Spurious Emissions, Power Output, and Necessary Bandwidth and RSS 210 Issue 9, Annex G: Low-Power Radio Apparatus Operating in the Television Bands.

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 74 Subpart H over the frequency range from 30MHz to 10GHz. An Average detector was used for the measurements.

Requirements:

As stated in FCC Part 74, Subpart H, 74.861, radiated spurious emissions 74.861 subsection 6 iii and in RSS 210 Issue 9, Annex G: Low-Power Radio Apparatus Operating in the Television Bands, 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:

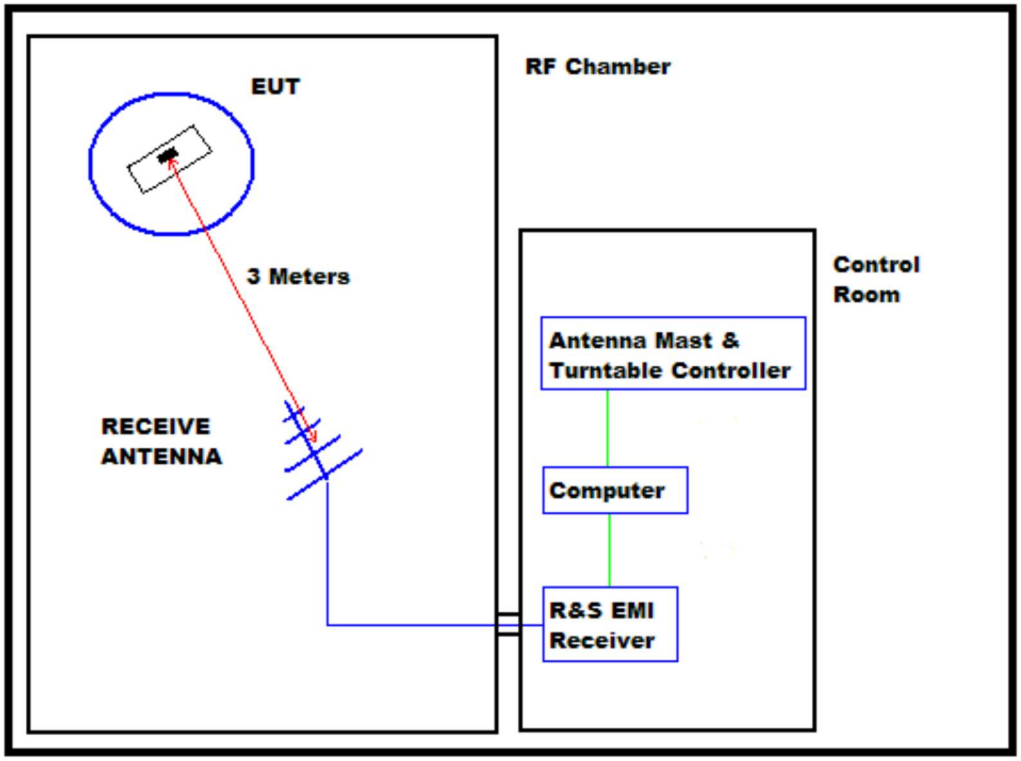
The EUT was powered up and the frequency of the transmitter was selected using the front panel controls. The EUT was checked for proper operation after it was setup on the table. For radiated spurious emission and necessary bandwidth testing, the testing was conducted with the EUT set to the middle frequency within the operating frequency range, and at 20mW 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 peak radiated voltage levels results are presented on page 12 thru page 17. The ERP measurements are shown on page 18. All emissions measured from the EUT were within the ETSI EN 300 422-1 specification limits.

Figure 1: ULXD2 Transmitter Test Setup

Figure 2: ULXD2 Transmitter Test Setup

Appendix A

SHURE Radiated RF Emissions Test Report

Common Information

Test Description:	FCC74H Radiated Emissions 30MHz - 1GHz
EUT	ULXD2 L50A
Serial Number	#1
Operating Conditions:	655.000MHz, 20mW
Date Tested:	Tested November 22, 2017
Operator Name:	Alex Mishinger

EMI Auto Test Template: Bandsaw COMPLIANCE TEST FCC 74H 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 dBµV/m - 125 dBµV/m

Preview Measurements:

Graphics Display:	Show separate traces for horizontal and vertical polarization
Sweep Test Template:	Compliance Test FCC 74 30MHz 1GHz 34790 PREVIEW

Adjustment:

Template for Single Meas.:	COMPLIANCE TEST FCC 74 30 to 1000 MHz 34790 MAX

Final Measurements:

Template for Single Meas.:	COMPLIANCE TEST FCC 74 30 to 1000 MHz 34790 FINAL

Subrange	Step Size	Detectors	IF BW	Meas. Time	Preamp
30 MHz - 1 GHz	30 kHz	PK+	120 kHz	1 s	0 dB

Receiver: [ESR 26]

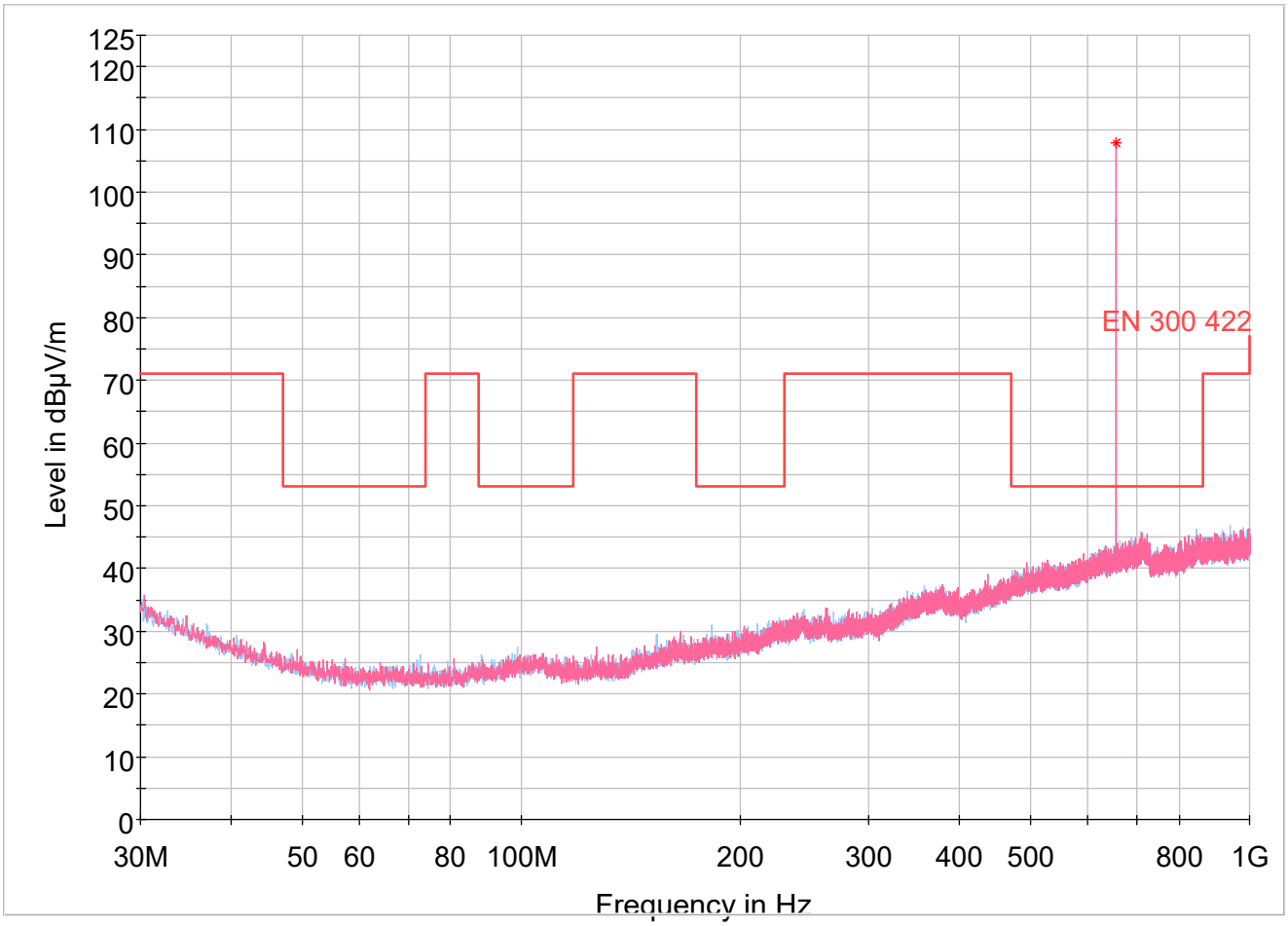
Appendix A

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



Critical Results

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
654.971000	107.94	53.00	-54.94	---	---	150.0	V	159.0	21.9	11:14:51 AM - 11/22/2017

Final Results

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
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Appendix A

SHURE Radiated RF Emissions Test Report

Common Information

Test Description:	FCC74H Radiated Emissions 1GHz - 10GHz
EUT:	ULXD2 L50A
Serial Number:	# 1
Operating Frequency:	655.000MHz
Power Level / Mod Mode:	20mW
Name:	Alex Mishinger
Comments:	Tested February 13, 2018

EMI Auto Test Template: COMPLIANCE TEST FCC15C-EN300422 Transmitter 1GHz to 10GHz 3117-PA 200363

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]					
1 GHz - 18 GHz	250 kHz	AVG	1 MHz	1 s	0 dB

Appendix A

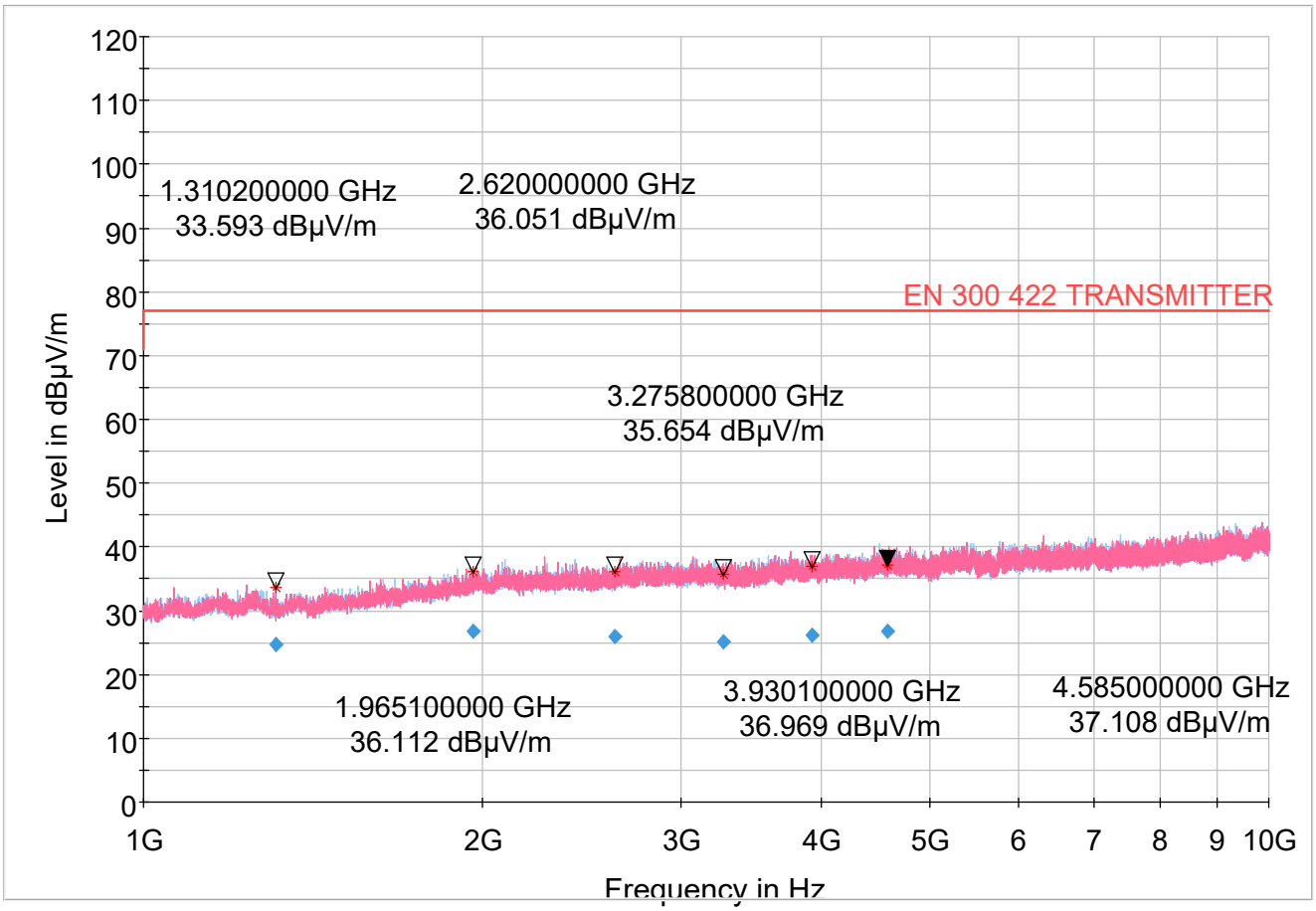
Hardware Setup: EMI radiated\Electric Field Strength 3117-PA 200363 2017 10 17 - [EMI radiated]

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



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)
1310.200000	33.59	77.00	43.41	---	---	108.0	V	180.0	---	5:51:06 PM - 2/13/2018	---
1965.100000	36.11	77.00	40.89	---	---	335.0	V	9.0	---	5:56:09 PM - 2/13/2018	---
2620.000000	36.05	77.00	40.95	---	---	374.0	V	23.0	---	5:54:10 PM - 2/13/2018	---
3275.800000	35.65	77.00	41.35	---	---	224.0	V	288.0	---	5:52:31 PM - 2/13/2018	---
3930.100000	36.97	77.00	40.03	---	---	396.0	V	53.0	---	5:57:12 PM - 2/13/2018	---
4585.000000	37.11	77.00	39.89	---	---	348.0	H	303.0	---	5:49:36 PM - 2/13/2018	---

Final Result

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)
1310.200000	24.76	77.00	52.24	1000.0	1000.000	108.0	V	180.0	-16.1	5:51:16 PM - 2/13/2018	---
1965.100000	26.72	77.00	50.28	1000.0	1000.000	335.0	V	9.0	-13.4	5:56:20 PM - 2/13/2018	---
2620.000000	25.93	77.00	51.07	1000.0	1000.000	375.0	V	23.0	-12.2	5:54:17 PM - 2/13/2018	---
3275.800000	25.16	77.00	51.84	1000.0	1000.000	225.0	V	288.0	-11.0	5:52:38 PM - 2/13/2018	---
3930.100000	26.22	77.00	50.78	1000.0	1000.000	396.0	V	53.0	-9.0	5:57:21 PM - 2/13/2018	---
4585.000000	26.86	77.00	50.14	1000.0	1000.000	348.0	H	303.0	-7.2	5:49:45 PM - 2/13/2018	---

Appendix A

Date: February 27, 2018
EUT: ULXD2
Band: L50A
Serial Number: # 1
Specification: EN 300 422-1, Spurious Radiated Emissions
Comments: Test Distance is 3 meters
Mode: EUT set to High 655.000 MHz
Tested By: Alex Mishinger, February 26 & 27, 2018

Frequency in MHz	Detector Used	Antenna Polarity	Measured Level in dBuV	Matched Sig. Gen. Reading in dBm	Antenna Gain in dB	Cable Loss in dB	ERP Total in dBm	ETSI Limit in dBm
1310.000	Average	H	24.76	-82.0	4.0	3.26	-81.3	-30
1310.000	Average	V	24.76	-82.0	4.0	3.26	-81.3	-30
1965.000	Average	H	26.72	-79.0	5.0	4.01	-77.0	-30
1965.000	Average	V	26.72	-79.0	5.0	4.01	-77.0	-30
2620.000	Average	H	25.93	-80.0	6.4	4.35	-78.0	-30
2620.000	Average	V	25.93	-80.0	6.4	4.35	-78.0	-30
3275.000	Average	H	25.16	-79.0	7.6	4.83	-76.2	-30
3275.000	Average	V	25.16	-79.0	7.6	4.83	-76.2	-30
3930.000	Average	H	26.22	-80.0	8.9	5.09	-77.2	-30
3930.000	Average	V	26.22	-80.0	8.9	5.09	-77.2	-30
4585.000	Average	H	26.86	-80.0	9.3	5.55	-76.3	-30
4585.000	Average	V	26.86	-80.0	9.3	5.55	-76.3	-30

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

Appendix B

B. Power Output

Purpose:
This test performed to determine if the EUT meets the Power Output requirements of the FCC Part74H, Section 74.861 and RSS 210 Issue 9, Annex G.

Requirements:
As stated in FCC 74H Section 74.861 the maximum radiated power in the 600MHz duplex gap: 20mW EIRP.

The requirements for RSS 210 Issue 9, Annex G are listed in table G1 below.

Table G1 — Specification for Low-Power Radio Apparatus

Frequency Bands (MHz)	Transmit e.i.r.p. (mW)	Authorized Bandwidth (kHz)	Frequency Stability (ppm)
54-72 76-88 174-216	50	200	± 50
470-608 614-698[Note]	250	200	± 50

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_{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. 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 middle frequency within the operating frequency range, and at 20mW 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 middle frequency. 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 the middle frequency meets the FCC74H 74.861 and RSS 210 Issue 9, Annex G requirements.

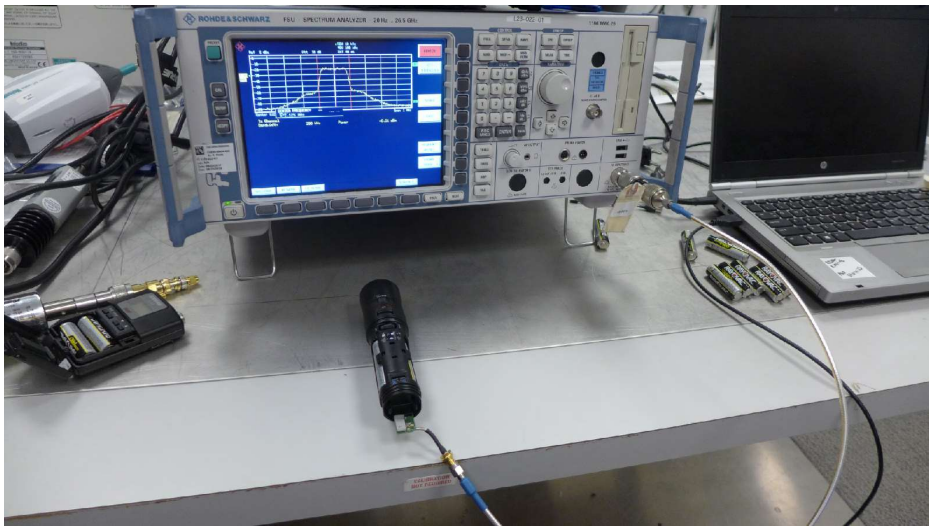


Figure 1: Test setup for Maximum Radiated Output

Appendix B

Test Information

EUT Name:	ULXD2 L50A
Serial Number:	# 1
Test Description:	Maximum Rated Output
Operating Conditions:	Middle Frequency, 655.000MHz, 20mW
Operator Name:	Craig Kozokar
Comment:	FCC Part 74H, Section 74.861, RSS 210 Issue 9, Annex G
Date Tested:	Tested on March 8, 2018

Spectrum Analyzer Measurement in dBm	Measured Antenna Gain in dBi	Cable Loss in dB	EIRP in dBm	EIRP Limit in dBm	Margin In dB
+11.43	-0.60	0.40	11.23	13.00	1.17

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

Measured ULXD1 L50A antenna gain is -0.60dBi

Appendix C

NECESSARY BANDWIDTH MEASUREMENTS

B.1 PURPOSE

This test was performed to determine if the EUT meets the occupied bandwidth requirements of EN 300 422-1, section 8.3.3., with the EUT operating at 653125MHz and 656.875MHz, at 20mW RF Output.

B.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.

B.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.

B.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	**±0.130 %**

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.

B.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 653.125MHz and 656.875MHz, at an output power level of 20mW. The transmitter was modulated per EN300422-1 V1.4.2 (2011-08), clause 7.1.2.

B.6 TEST PROCEDURE

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

Appendix C

B.7 RESULTS

The necessary bandwidth data is presented on pages 24 and 26. 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.

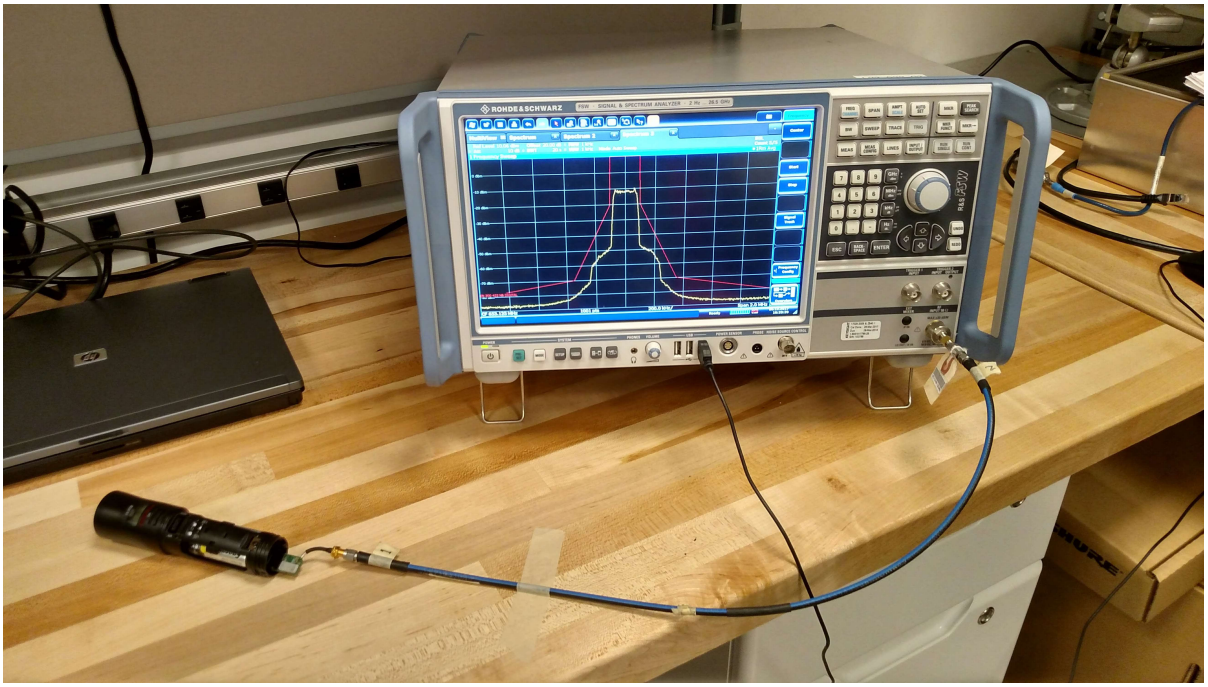
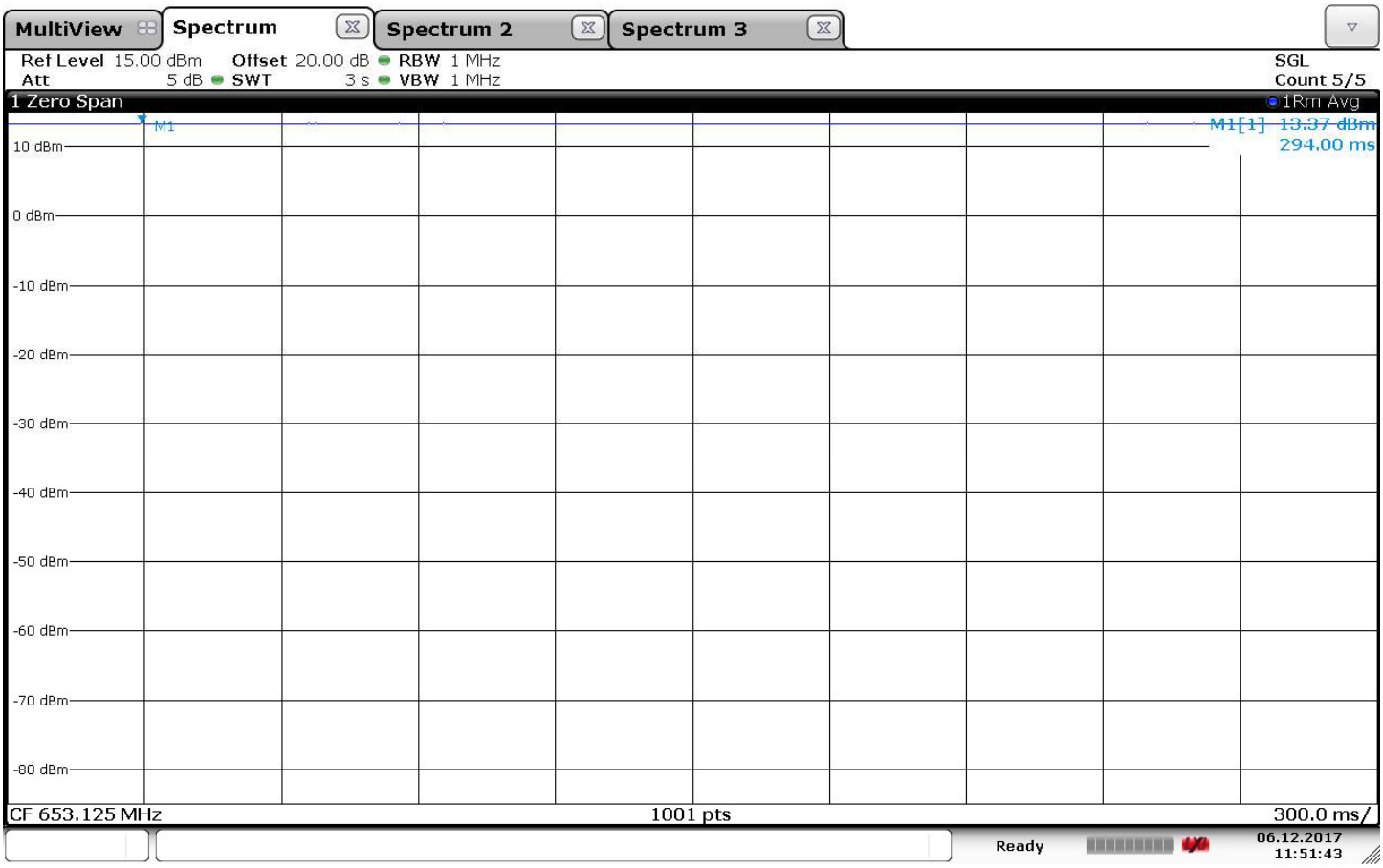


Figure B-1 - Test Setup for Necessary Bandwidth

Appendix C

Test Information

EUT Name:	ULXD2 L50A
Serial Number:	# 1
Test Description:	EN 300 422 Digital Necessary Bandwidth
Operating Conditions:	Low Frequency, 653.125MHz, 20mW
Operator Name:	Danny Palaniswami
Comment:	8.3.3.1: Step 1; Carrier Power
Date Tested:	Tested on June 12, 2017



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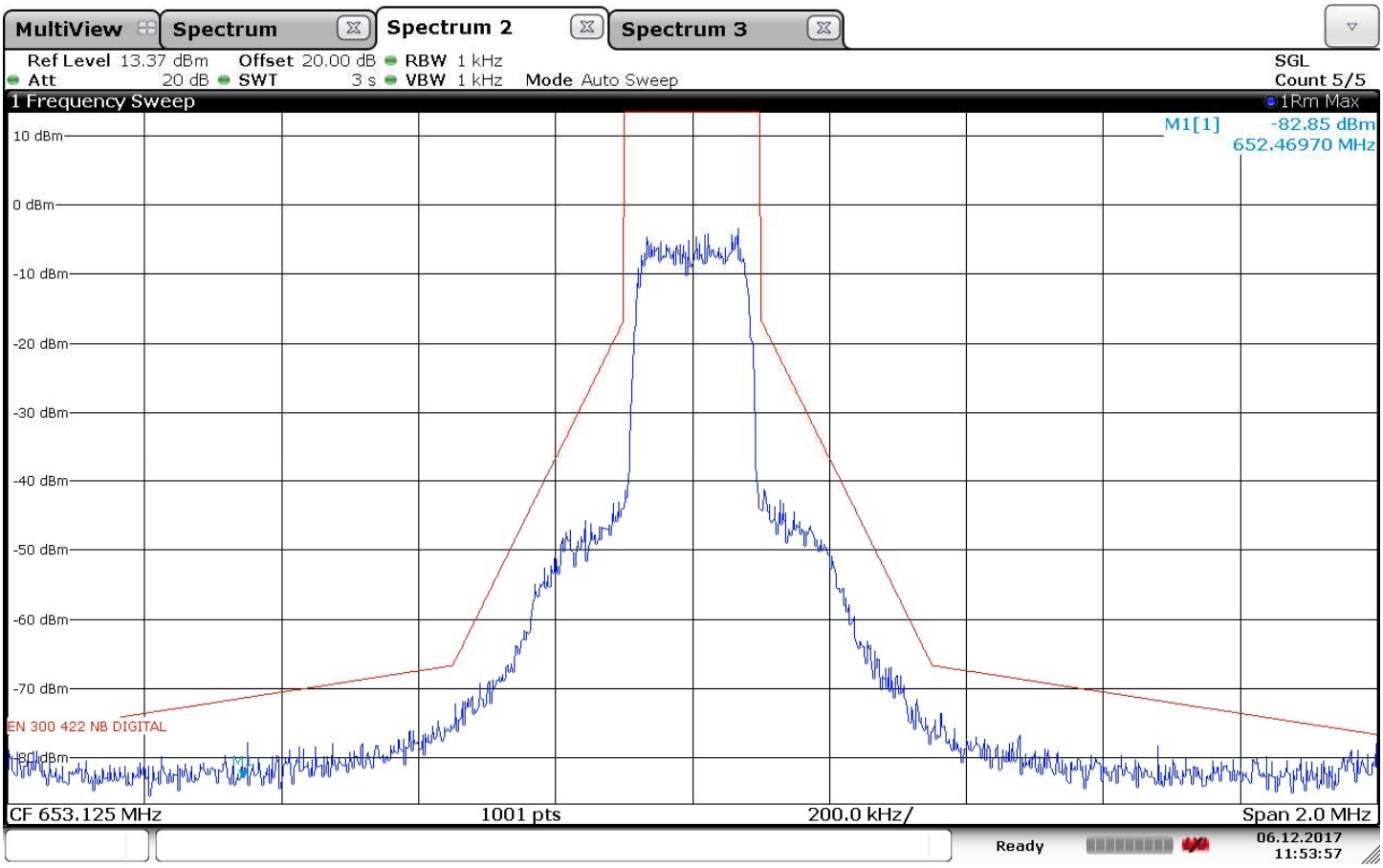
Appendix C

Test Information

EUT Name:	ULXD2 L50A
Serial Number:	# 1
Test Description:	EN 300 422 Digital Necessary Bandwidth
Operating Conditions:	Low Frequency, 653.125MHz, 20mW
Operator Name:	Danny Palaniswami
Comment:	8.3.3.1: Step 2;Maximum Relative Level
Date Tested:	Test on June 12, 2017



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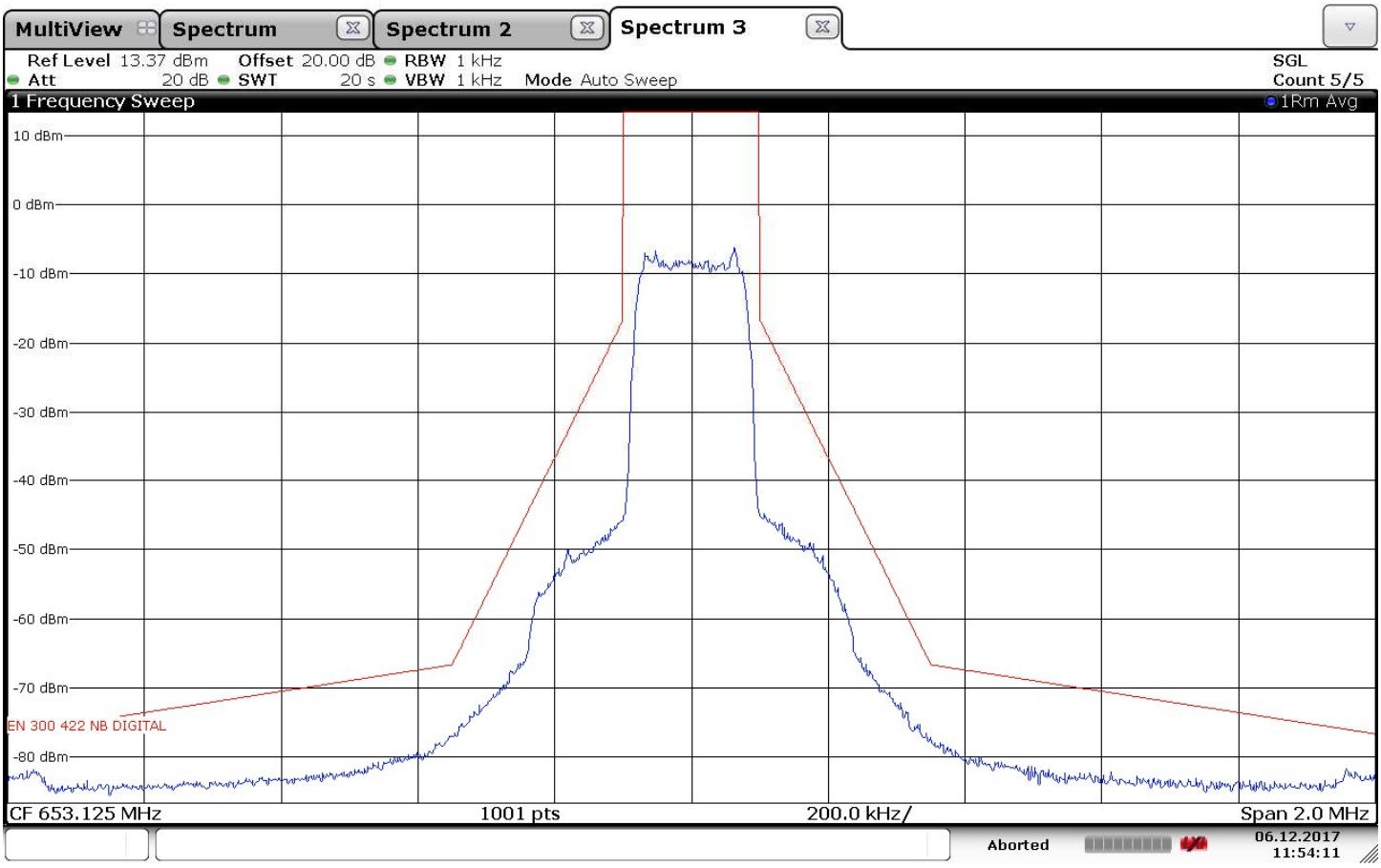
Appendix C

Test Information

EUT Name:	ULXD2 L50A
Serial Number:	# 1
Test Description:	EN 300 422 Digital Necessary Bandwidth
Operating Conditions:	Low Frequency, 653.125MHz, 20mW
Operator Name:	Danny Palaniswami
Comment:	8.3.3.1: Step 3;Lower and upper frequency transmitter Wide band noise floor
Date Tested:	Test on June 12, 2017



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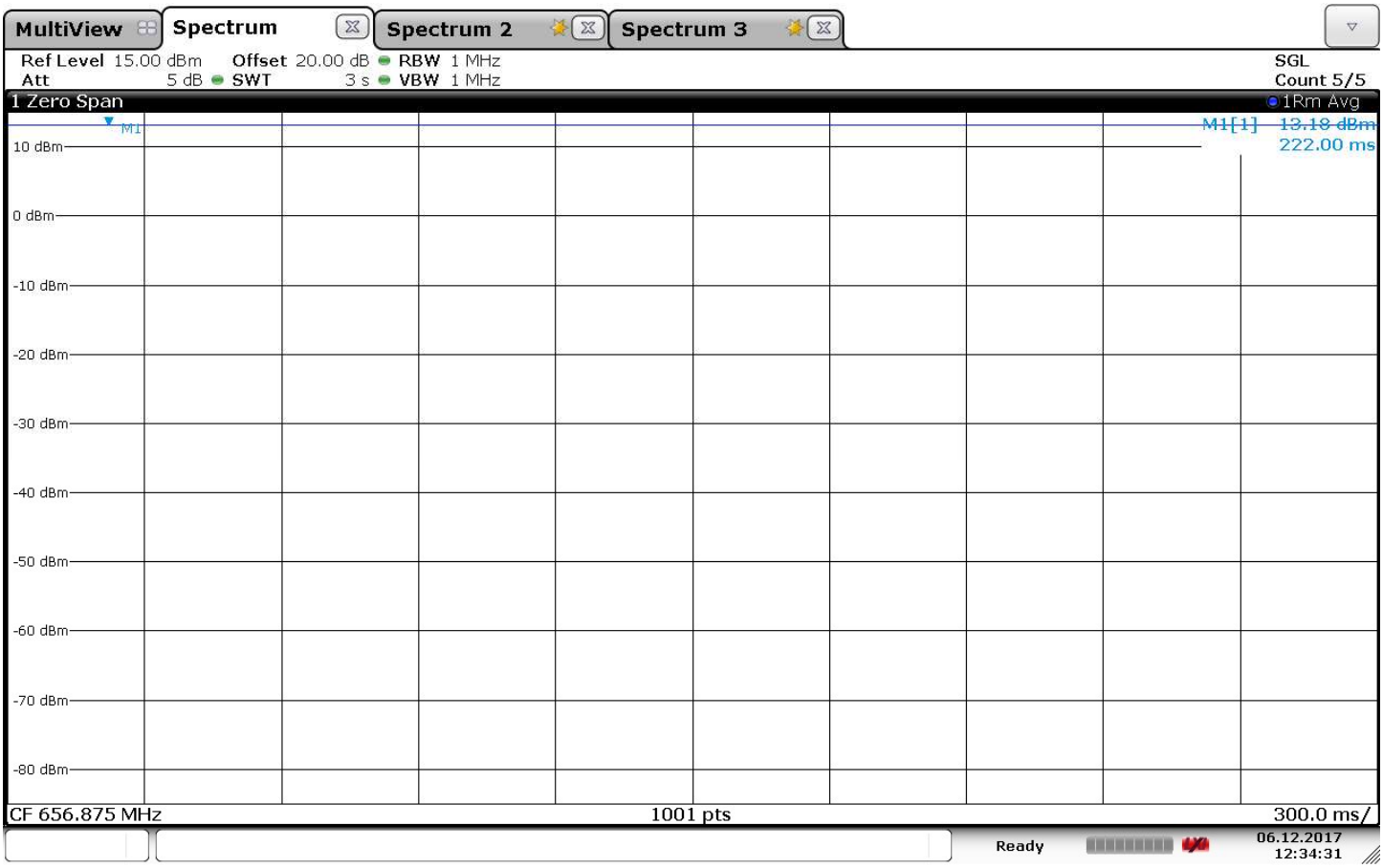
Appendix C

Test Information

EUT Name:	ULXD2 L50A
Serial Number:	# 1
Test Description:	EN 300 422 Digital Necessary Bandwidth
Operating Conditions:	High Frequency, 656.875MHz, 20mW
Operator Name:	Danny Palaniswami
Comment:	8.3.3.1: Step 1; Carrier Power
Date Tested:	Tested on June 12, 2017



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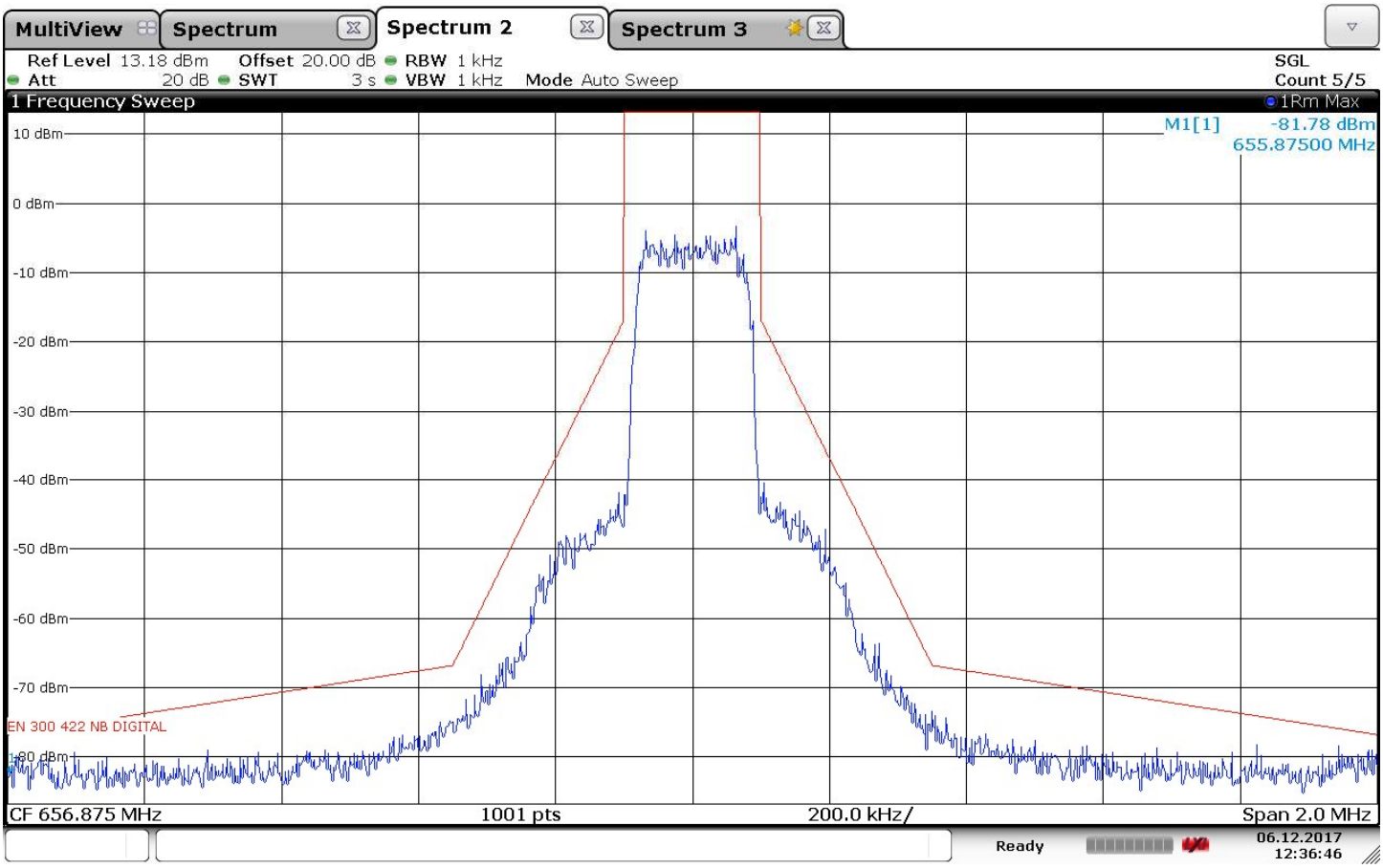
Appendix C

Test Information

EUT Name:	ULXD2 L50A
Serial Number:	# 1
Test Description:	EN 300 422 Digital Necessary Bandwidth
Operating Conditions:	High Frequency, 656.875MHz, 20mW
Operator Name:	Danny Palaniswami
Comment:	8.3.3.1: Step 2;Maximum Relative Level
Date Tested:	Test on June 12, 2017



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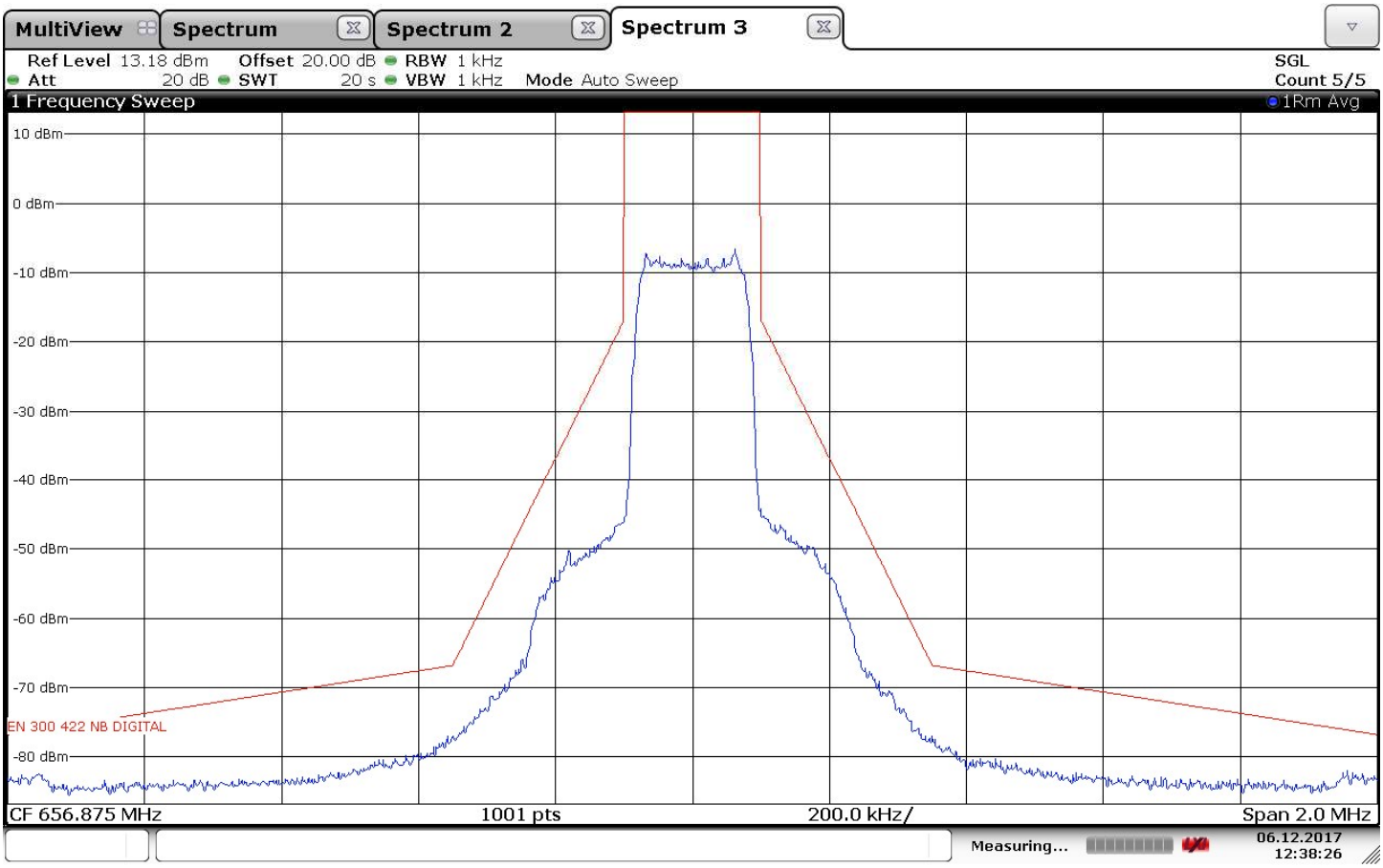
Appendix C

Test Information

EUT Name:	ULXD2 L50A
Serial Number:	# 1
Test Description:	EN 300 422 Digital Necessary Bandwidth
Operating Conditions:	High Frequency, 656.875MHz, 20mW
Operator Name:	Danny Palaniswami
Comment:	8.3.3.1: Step 3;Lower and upper frequency transmitter Wide band noise floor
Date Tested:	Test on June 12, 2017



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