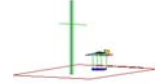




# PCTEST ENGINEERING LABORATORY, INC.

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<http://www.pctestlab.com>



## MEASUREMENT REPORT FCC PART 15.247 900MHz ISM

**Applicant Name:**  
Device Solutions Inc.  
3211 Moorefields Road  
Hillsborough, NC 27278  
United States

**Date of Testing:**  
6/6-6/14/2017  
**Test Site/Location:**  
PCTEST Lab, Columbia, MD, USA  
**Test Report Serial No.:**  
1M1706070191-02.OXW

<b>FCC ID:</b>	<b>OXW-PA0053</b>
<b>APPLICANT:</b>	<b>Device Solutions Inc.</b>



**Application Type:** Certification  
**Model:** PA0053  
**EUT Type:** LoRa2 Radio Module  
**Frequency Range:** 907 - 923MHz  
**FCC Classification:** Digital Transmission System (DTS)  
**FCC Rule Part(s):** Part 15 Subpart C (15.247)  
**Test Procedure(s):** KDB 558074 D01 v04

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in KDB 558074 D01 v04. Test results reported herein relate only to the item(s) tested.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

  
Randy Ortanez  
President



<b>FCC ID:</b> OXW-PA0053		<b>FCC Pt. 15.247 900MHz ISM TEST REPORT (CERTIFICATION)</b>		<b>Approved by:</b> Quality Manager
<b>Test Report S/N:</b> 1M1706070191-02.OXW	<b>Test Dates:</b> 6/6-6/14/2017	<b>EUT Type:</b> LoRa2 Radio Module	Page 1 of 38	

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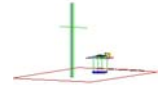
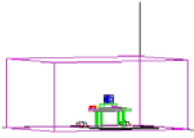
05/19/2017

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# MEASUREMENT REPORT

## FCC Part 15.247

### § 2.1033 General Information

**APPLICANT:** Device Solutions Inc.

**APPLICANT ADDRESS:** 3211 Moorefields Road  
Hillsborough, NC 27278, United States

**TEST SITE:** PCTEST ENGINEERING LABORATORY, INC.

**TEST SITE ADDRESS:** 7185 Oakland Mills Road, Columbia, MD 21046 USA

**FCC RULE PART(S):** Part 15.247

**BASE MODEL:** PA0053

**FCC ID:** OXW-PA0053

**FCC CLASSIFICATION:** Digital Transmission System (DTS)

**Test Device Serial No.:** FCC COND, FCC RAD1,  Production  Pre-Production  Engineering  
FCC RAD2

**DATE(S) OF TEST:** 6/6-6/14/2017

**TEST REPORT S/N:** 1M1706070191-02.OXW

### Test Facility / Accreditations

Measurements were performed at PCTEST Engineering Lab located in Columbia, MD 21046, U.S.A.



- PCTEST facility is an FCC registered (PCTEST Reg. No. 159966) test facility with the site description report on file and has met all the requirements specified in Section 2.948 of the FCC Rules and Industry Canada (2451B-1).
- PCTEST Lab is accredited to ISO 17025 by U.S. National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP Lab code: 100431-0) in EMC, FCC and Telecommunications.
- PCTEST Lab is accredited to ISO 17025-2005 by the American Association for Laboratory Accreditation (A2LA) in Specific Absorption Rate (SAR) testing, Hearing Aid Compatibility (HAC) testing, CTIA Test Plans, and wireless testing for FCC and Industry Canada Rules.
- PCTEST Lab is a recognized U.S. Conformity Assessment Body (CAB) in EMC and R&TTE (n.b. 0982) under the U.S.-EU Mutual Recognition Agreement (MRA).
- PCTEST TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC Guide 65 by the American National Standards Institute (ANSI) in all scopes of FCC Rules and Industry Canada Standards (RSS).
- PCTEST facility is an IC registered (2451B-1) test laboratory with the site description on file at Industry Canada.
- PCTEST is a CTIA Authorized Test Laboratory (CATL) for AMPS, CDMA, and EvDO wireless devices and for Over-the-Air (OTA) Antenna Performance testing for AMPS, CDMA, GSM, GPRS, EGPRS, UMTS (W-CDMA), CDMA 1xEVDO, and CDMA 1xRTT.

<b>FCC ID:</b> OXW-PA0053	<b>FCC Pt. 15.247 900MHz ISM TEST REPORT (CERTIFICATION)</b>	<b>DeviceSolutions</b>	<b>Approved by:</b> Quality Manager
<b>Test Report S/N:</b> 1M1706070191-02.OXW	<b>Test Dates:</b> 6/6-6/14/2017	<b>EUT Type:</b> LoRa2 Radio Module	Page 3 of 38

# 1.0 INTRODUCTION

## 1.1 Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission and the Industry Canada Certification and Engineering Bureau.

## 1.2 PCTEST Test Location

The map below shows the location of the PCTEST LABORATORY, its proximity to the FCC Laboratory, the Columbia vicinity area, the Baltimore-Washington Intern't'l (BWI) airport, the city of Baltimore and the Washington, DC area. (See Figure 1-1).

These measurement tests were conducted at the PCTEST Engineering Laboratory, Inc. facility located at 7185 Oakland Mills Road, Columbia, MD 21046. The site coordinates are 39° 10'23" N latitude and 76° 49'50" W longitude. The facility is 0.4 miles North of the FCC laboratory, and the ambient signal and ambient signal strength are approximately equal to those of the FCC laboratory. The detailed description of the measurement facility was found to be in compliance with the requirements of § 2.948 according to ANSI C63.4-2014 on January 22, 2015.

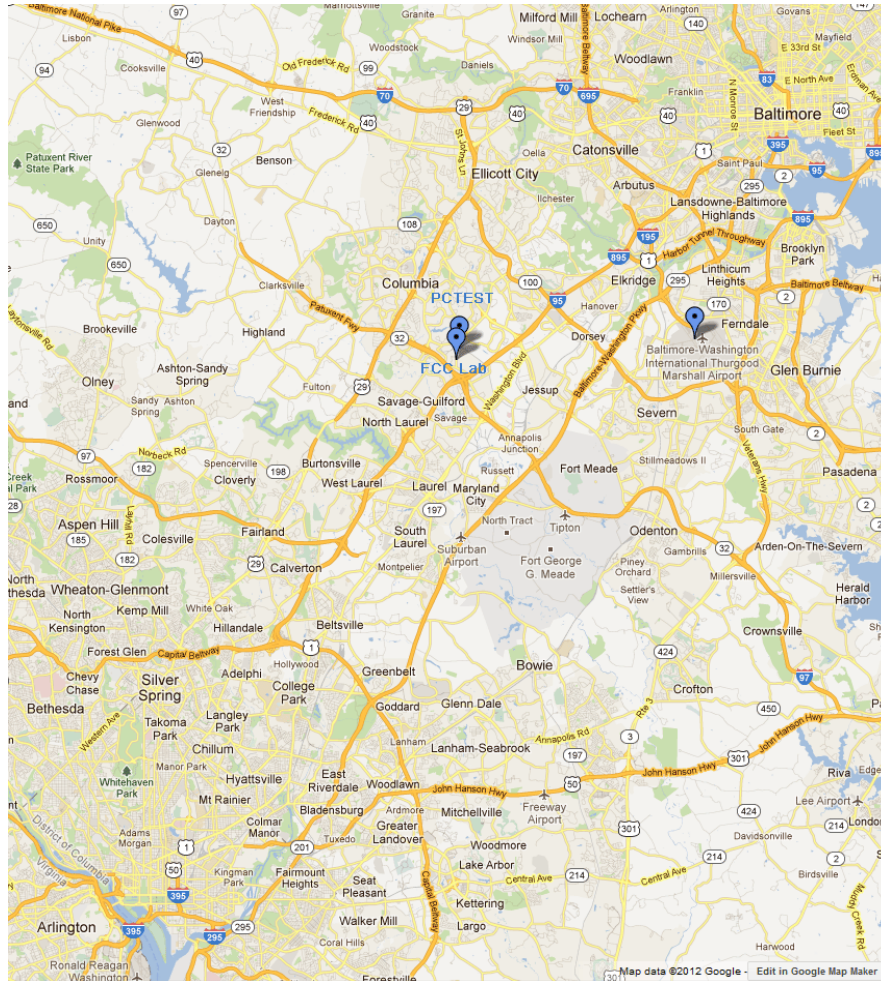


Figure 1-1. Map of the Greater Baltimore and Metropolitan Washington, D.C. area

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## 2.0 PRODUCT INFORMATION

### 2.1 Equipment Description

The Equipment Under Test (EUT) is the **Device Solutions LoRa2 Radio Module FCC ID: OXW-PA0053**. The test data contained in this report pertains only to the emissions due to the EUT's 900Mhz ISM (DTS) transmitter.

### 2.2 Device Capabilities

This device contains the following capabilities:

900MHz ISM

Ch.	Frequency (MHz)
Low	907
:	:
Mid	913
:	:
High	923



Table 2-1. Frequency / Channel Operations

### 2.3 Test Configuration

The EUT was tested per the guidance of KDB 558074 D01 v04. ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing. See Sections 7.7 and 7.8 for radiated emissions test setups, and 7.2, 7.3, 7.4, 7.5, and 7.6 for antenna port conducted emissions test setups.

### 2.4 EMI Suppression Device(s)/Modifications

No EMI suppression device(s) were added and/or no modifications were made during testing.

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## 3.0 DESCRIPTION OF TESTS

### 3.1 Evaluation Procedure

The measurement procedures described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013) and the guidance provided in KDB 558074 D01 v04 were used in the measurement of the EUT.

**Deviation from measurement procedure.....None**

### 3.2 Radiated Emissions



The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. The test site inside the chamber is a 6m x 5.2m elliptical, obstruction-free area in accordance with Figure 5.7 of Clause 5 in ANSI C63.4-2014. A raised turntable is used for radiated measurement. It is a continuously rotatable, remote-controlled, metallic turntable and 2 meters (6.56 ft.) in diameter. The turn table is flush with the raised floor of the chamber in order to maintain its function as a ground plane. Absorbers are arranged on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections for measurements above 1GHz. A 72.4cm high PVC support structure is placed on top of the turntable. A 3" (~7.6cm) sheet of high density polystyrene is used as the table top and is placed on top of the PVC supports to bring the total height of the table to 80cm. For measurements above 1GHz, a high density expanded polystyrene block is placed on top of the test table to bring the total table height to 1.5m.

For all measurements, the spectrum was scanned through all EUT azimuths and from 1 to 4 meter receive antenna height using a broadband antenna from 30MHz up to the upper frequency shown in 15.33(b)(1) depending on the highest frequency generated or used in the device or on which the device operates or tunes. For frequencies above 1GHz, linearly polarized double ridge horn antennas were used. For frequencies below 30MHz, a calibrated loop antenna was used. When exploratory measurements were necessary, they were performed at 1 meter test distance inside the semi-anechoic chamber using broadband antennas, broadband amplifiers, and spectrum analyzers to determine the frequencies and modes producing the maximum emissions. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The test set-up was placed on top of the 1 x 1.5 meter table. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Appropriate precaution was taken to ensure that all emissions from the EUT were maximized and investigated. The system configuration, mode of operation, turntable azimuth, and receive antenna height was noted for each frequency found.

Final measurements were made in the semi-anechoic chamber using calibrated, linearly polarized broadband and horn antennas. The test setup was configured to the setup that produced the worst case emissions. The spectrum analyzer was set to investigate all frequencies required for testing to compare the highest radiated disturbances with respect to the specified limits. The turntable containing the EUT was rotated through 360 degrees and the height of the receive antenna was varied 1 to 4 meters and stopped at the azimuth and height producing the maximum emission. Each emission was maximized by changing the orientation of the EUT through three orthogonal planes and changing the polarity of the receive antenna, whichever produced the worst-case emissions.

### 3.3 Environmental Conditions

The temperature is controlled within range of 15°C to 35°C. The relative humidity is controlled within range of 10% to 75%. The atmospheric pressure is monitored within the range 86-106kPa (860-1060mbar).

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## 4.0 ANTENNA REQUIREMENTS



**Excerpt from §15.203 of the FCC Rules/Regulations:**

“An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.”

- The antenna(s) of the EUT are **permanently attached**.
- There are no provisions for connection to an external antenna.

**Conclusion:**



The EUT complies with the requirement of §15.203.

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## 5.0 MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013. All measurement uncertainty values are shown with a coverage factor of  $k = 2$  to indicate a 95% level of confidence. The measurement uncertainty shown below meets or exceeds the  $U_{CISPR}$  measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Contribution	Expanded Uncertainty ( $\pm$ dB)
Conducted Bench Top Measurements	1.13
Radiated Disturbance (<1GHz)	4.98
Radiated Disturbance (>1GHz)	5.07
Radiated Disturbance (>18GHz)	5.09

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## 6.0 TEST EQUIPMENT CALIBRATION DATA

Test Equipment Calibration is traceable to the National Institute of Standards and Technology (NIST). Measurements antennas used during testing were calibrated in accordance to the requirements of ANSI C63.5-2006.

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
-	RE1	Radiated Emissions Cable Set (UHF/EHF)	7/11/2016	Annual	7/11/2017	RE1
-	WL25-1	Conducted Cable Set (25GHz)	10/3/2016	Annual	10/3/2017	WL25-1
Agilent	N9030A	PXA Signal Analyzer (26.5GHz)	7/20/2016	Annual	7/20/2017	MY49432391
Com-Power	AL-130	9kHz - 30MHz Loop Antenna	7/30/2015	Biennial	7/30/2017	121034
Com-Power	PAM-103	Pre-Amplifier (1-1000MHz)	7/6/2016	Annual	7/6/2017	441119
Com-Power	PAM-118A	Pre-Amplifier	8/9/2016	Annual	8/9/2017	551079
Emco	3115	Horn Antenna (1-18GHz)	3/10/2016	Biennial	3/10/2018	9704-5182
ETS Lindgren	3117	1-18 GHz DRG Horn (Medium)	4/26/2016	Biennial	4/26/2018	125518
K & L	13SH10-1000/U1000	N Type High Pass Filter	7/6/2016	Annual	7/6/2017	13SH10-1000/U1000-1
PCTEST	-	EMC Switch System	7/11/2016	Annual	7/11/2017	NM1
Rohde & Schwarz	ESU26	EMI Test Receiver (26.5GHz)	4/19/2017	Annual	4/19/2018	100342
Seekonk	NC-100	Torque Wrench 5/16", 8" lbs	3/2/2016	Biennial	3/2/2018	N/A
Sunol	JB5	Bi-Log Antenna (30M - 5GHz)	3/14/2016	Biennial	3/14/2018	A051107

**Table 6-1. Annual Test Equipment Calibration Schedule**

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## 7.0 TEST RESULTS

### 7.1 Summary



Company Name: Device Solutions Inc.  
 FCC ID: OXW-PA0053  
 FCC Classification: Digital Transmission System (DTS)

FCC Part Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
15.247(a)(2)	6dB Bandwidth	> 500kHz	CONDUCTED	PASS	Section 7.2
15.247(b)(3)	Transmitter Output Power	< 1 Watt		PASS	Sections 7.3
15.247(e)	Transmitter Power Spectral Density	< 8dBm / 3kHz Band		PASS	Section 7.4
15.247(d)	Band Edge / Out-of-Band Emissions	≥ 20dBc		PASS	Sections 7.5, 7.6
15.205 15.209	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Emissions in restricted bands must meet the radiated limits detailed in 15.209	RADIATED	PASS	Sections 7.7, 7.8

**Table 7-1. Summary of Test Results**

#### Notes:

- All modes of operation were investigated. The test results shown in the following sections represent the worst case emissions.
- The analyzer plots shown in this section were all taken with a correction table loaded into the analyzer. The correction table was used to account for the losses of the cables and attenuators used as part of the system to connect the EUT to the analyzer at all frequencies of interest.
- All antenna port conducted emissions testing was performed on a test bench with the antenna port of the EUT connected to the spectrum analyzer through calibrated cables and attenuators.

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## 7.2 6dB Bandwidth Measurement

### §15.247(a.2)

#### Test Overview and Limit

The bandwidth at 6dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the transmitter antenna terminal of the EUT while the EUT is operating at maximum power and at the appropriate frequencies. All modes of operation were investigated and the worst case configuration results are reported in this section.

***The minimum permissible 6dB bandwidth is 500 kHz.***

#### Test Procedure Used

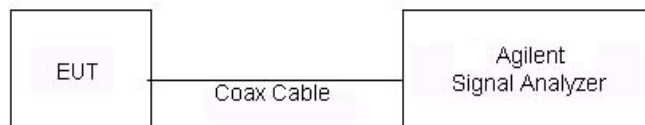
KDB 558074 D01 v04 – Section 8.2 Option 2

#### Test Settings

1. The signal analyzers' automatic bandwidth measurement capability of the spectrum analyzer was used to perform the 6dB bandwidth measurement. The "X" dB bandwidth parameter was set to X = 6. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. RBW = 100kHz
3. VBW  $\geq 3 \times$  RBW
4. Detector = Peak
5. Trace mode = max hold
6. Sweep = auto couple
7. The trace was allowed to stabilize

#### Test Setup



The EUT and measurement equipment were set up as shown in the diagram below.



**Figure 7-1. Test Instrument & Measurement Setup**

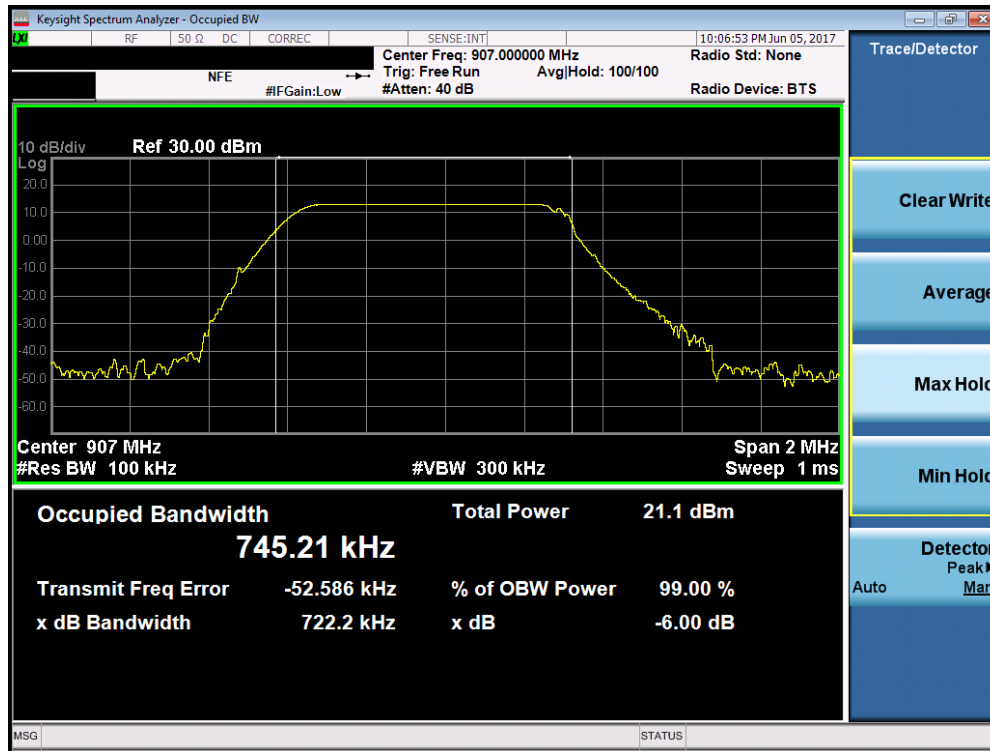
#### Test Notes

None

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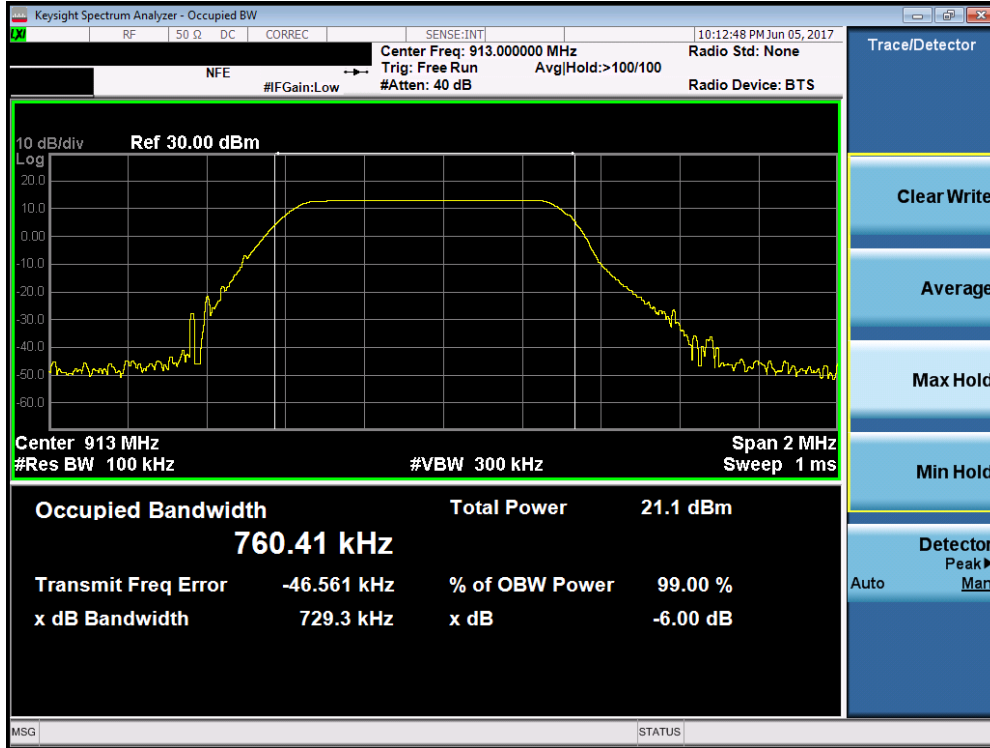
Frequency [MHz]	Channel No.	Measured Bandwidth [kHz]	Minimum Bandwidth [kHz]	Pass / Fail
907	Low	722.2	500	Pass
913	Mid	729.3	500	Pass
923	High	713.3	500	Pass

**Table 7-2. Conducted Bandwidth Measurements**

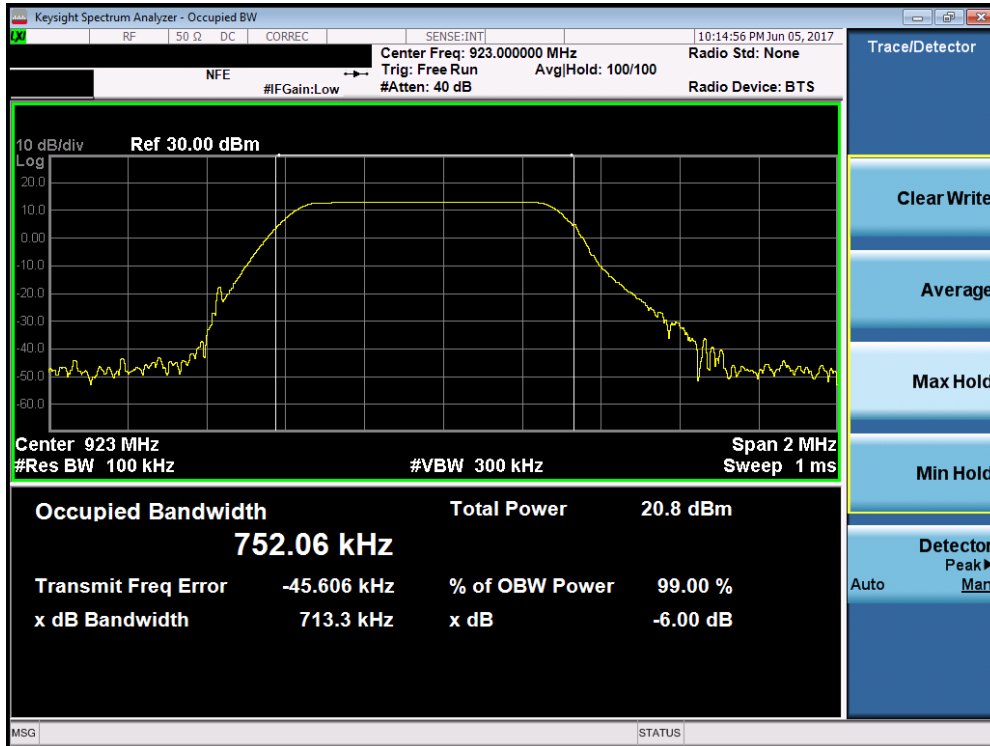


**Plot 7-1. 6dB Bandwidth Plot (Low Channel)**

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Plot 7-2. 6dB Bandwidth Plot (Mid Channel)



Plot 7-3. 6dB Bandwidth Plot (High Channel)

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### 7.3 Output Power Measurement §15.247(b.3)

#### Test Overview and Limits

The transmitter antenna terminal of the EUT is connected to the input of a spectrum analyzer. Measurements are made while the EUT is operating at maximum power and at the appropriate frequencies.

***The maximum permissible conducted output power is 1 Watt.***

#### Test Procedure Used

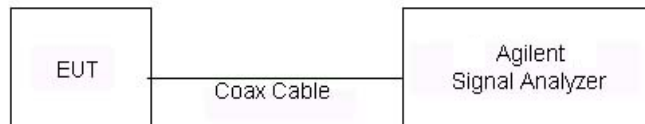
KDB 558074 D01 v04 – Section 9.1.1

#### Test Settings

1. RBW = 1MHz
2. VBW = 3MHz
3. Span  $\geq 3 \times$  RBW
4. Sweep = auto couple
5. Detector = Peak
6. Trace mode = max hold
7. The trace was allowed to stabilize

#### Test Setup



The EUT and measurement equipment were set up as shown in the diagram below.



**Figure 7-2. Test Instrument & Measurement Setup**

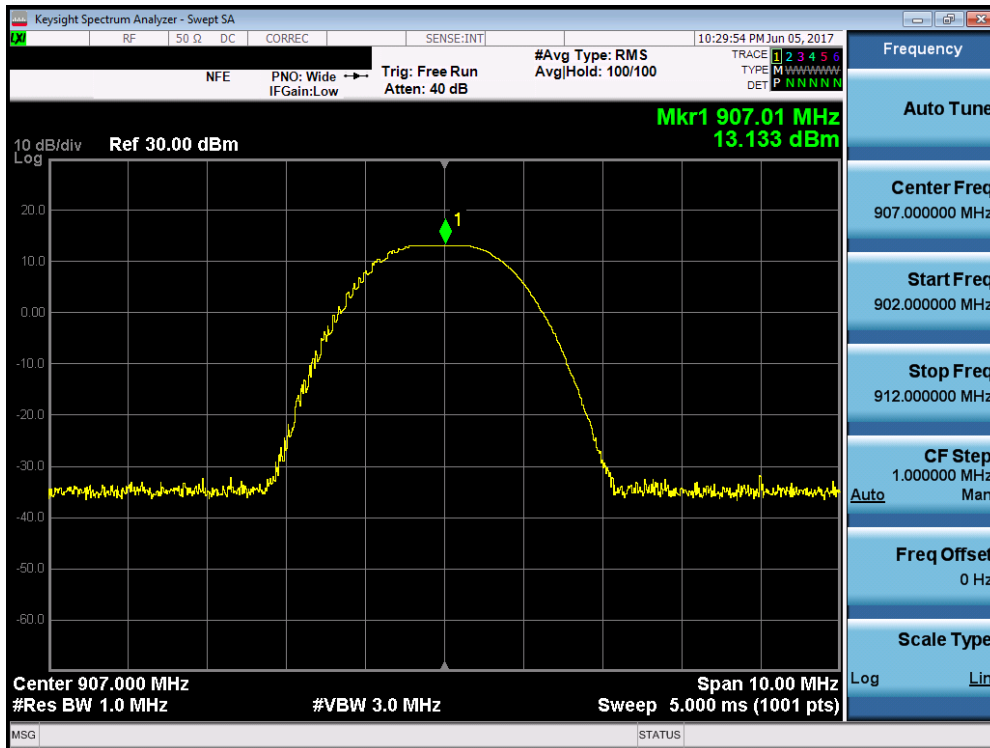
#### Test Notes

None

FCC ID: OXW-PA0053		FCC Pt. 15.247 900MHz ISM TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
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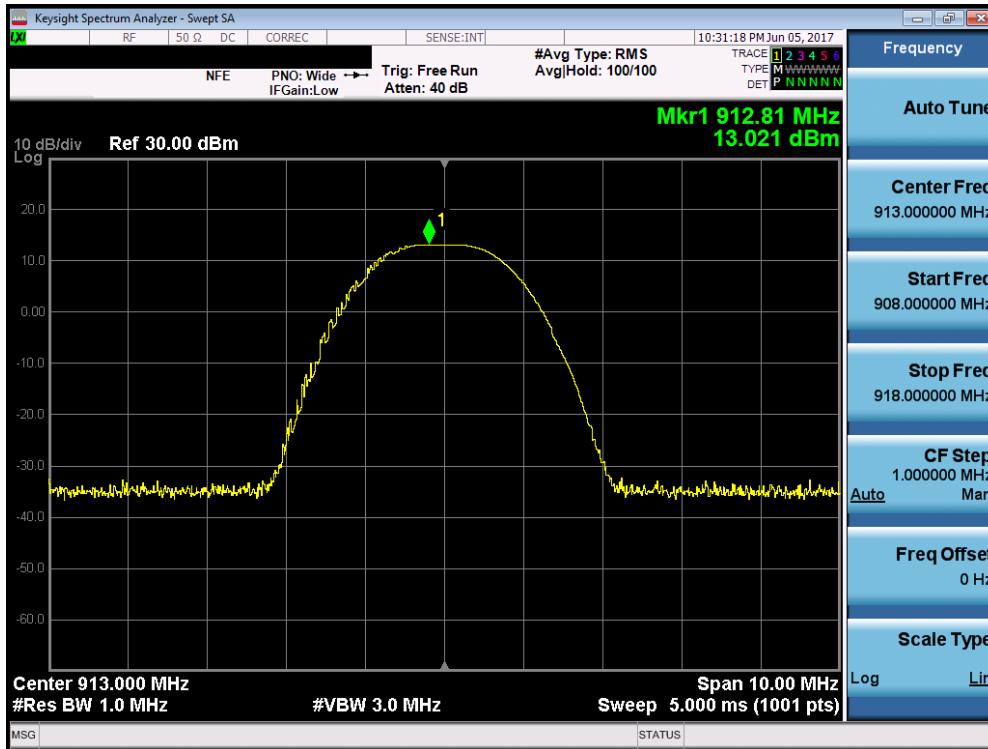
Frequency [MHz]	Channel No.	Peak Conducted Power	
		[dBm]	[mW]
907	Low	13.13	20.573
913	Mid	13.02	20.049
923	High	12.85	19.280

Table 7-3. Conducted Output Power Measurements

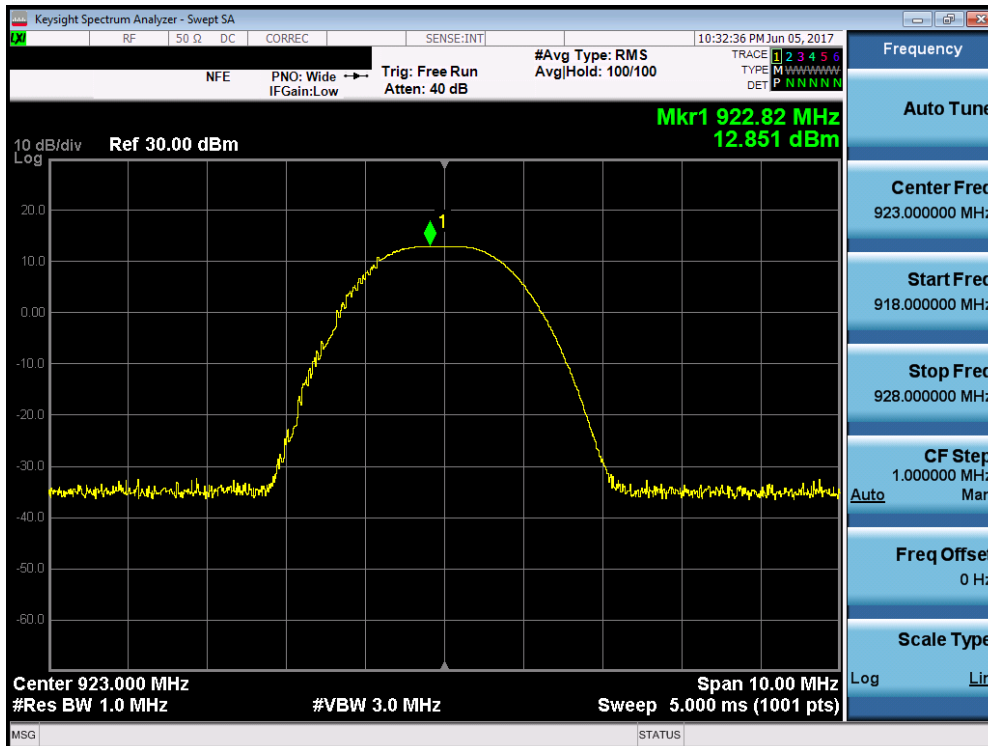


Plot 7-4. Peak Power Plot (Low Channel)

FCC ID: OXW-PA0053		FCC Pt. 15.247 900MHz ISM TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
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Plot 7-5. Peak Power Plot (Mid Channel)



Plot 7-6. Peak Power Plot (High Channel)

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## 7.4 Power Spectral Density

### §15.247(e)

#### Test Overview and Limit

The peak power density is measured with a spectrum analyzer connected to the antenna terminal of the EUT while the EUT is operating at maximum power and at the appropriate frequencies.

***The maximum permissible power spectral density is 8 dBm in any 3 kHz band.***

#### Test Procedure Used

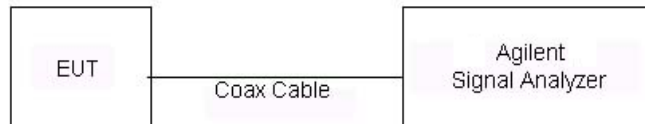
KDB 558074 D01 v04 – Section 10.2 Method PKPSD

#### Test Settings

1. Analyzer was set to the center frequency of the DTS channel under investigation
2. Span = 1.5 times the DTS channel bandwidth
3. RBW = 10kHz
4. VBW = 1MHz
5. Detector = peak
6. Sweep time = auto couple
7. Trace mode = max hold
8. Trace was allowed to stabilize

#### Test Setup



The EUT and measurement equipment were set up as shown in the diagram below.



**Figure 7-3. Test Instrument & Measurement Setup**

#### Test Notes

None

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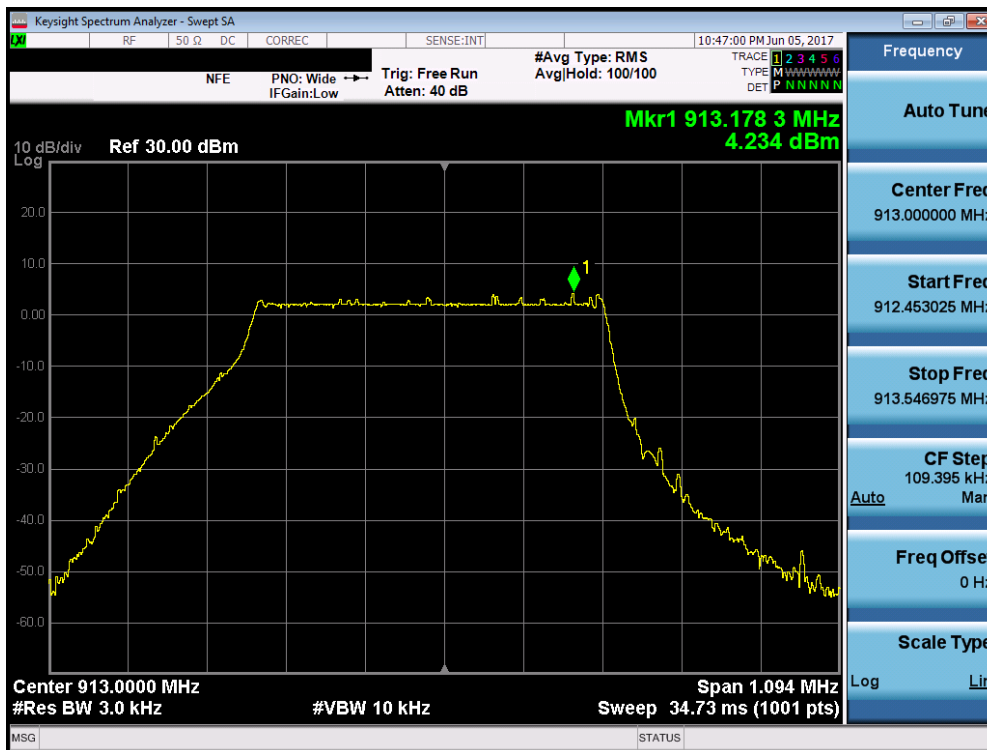
Frequency [MHz]	Channel No.	Measured Power Spectral Density [dBm]	Maximum Permissible Power Density [dBm / 3kHz]	Margin [dB]
907	Low	4.85	8.0	-3.15
913	Mid	4.23	8.0	-3.77
923	High	3.72	8.0	-4.28

**Table 7-4. Conducted Power Density Measurements**

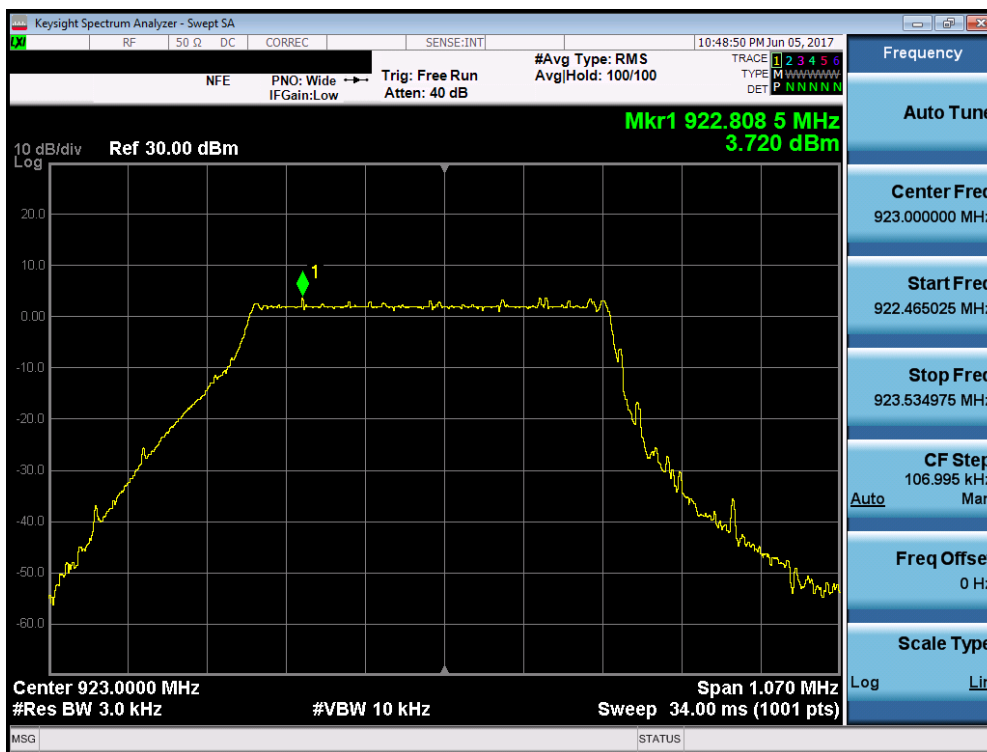


**Plot 7-7. Power Spectral Density Plot (Low Channel)**

FCC ID: OXW-PA0053		FCC Pt. 15.247 900MHz ISM TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1706070191-02.OXW	Test Dates: 6/6-6/14/2017	EUT Type: LoRa2 Radio Module		Page 18 of 38



Plot 7-8. Power Spectral Density Plot (Mid Channel)



Plot 7-9. Power Spectral Density Plot (High Channel)

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## 7.5 Conducted Emissions at the Band Edge §15.247(d)

### Test Overview and Limit

For the following out of band conducted spurious emissions plots at the band edge, the EUT was set to transmit at maximum power with the largest packet size available. These settings produced the worst-case emissions.

***The limit for out-of-band spurious emissions at the band edge is 20dB below the fundamental emission level, as determined from the in-band power measurement of the DTS channel performed in a 100kHz bandwidth.***

### Test Procedure Used

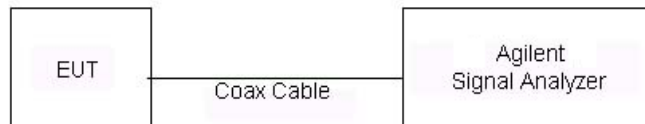
KDB 558074 D01 v04 – Section 11.3

### Test Settings

1. Start and stop frequency were set such that the band edge would be placed in the center of the plot
2. Span was set large enough so as to capture all out of band emissions near the band edge
3. RBW = 100kHz
4. VBW = 300kHz
5. Detector = Peak
6. Number of sweep points  $\geq 2 \times \text{Span/RBW}$
7. Trace mode = max hold
8. Sweep time = auto couple
9. The trace was allowed to stabilize

### Test Setup



The EUT and measurement equipment were set up as shown in the diagram below.

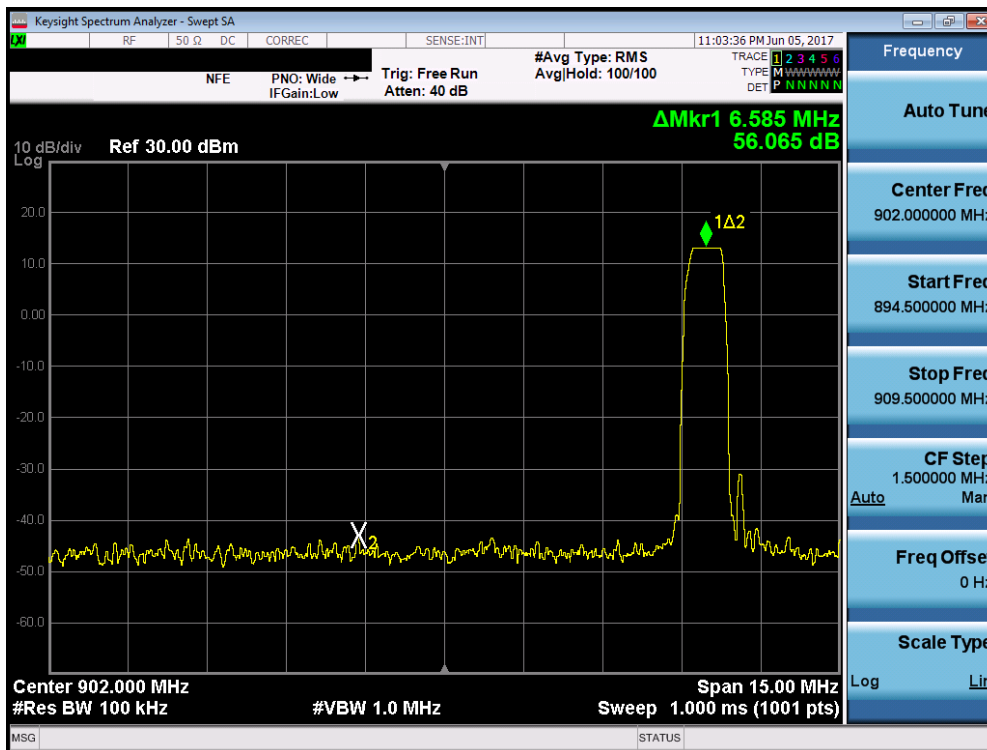


**Figure 7-4. Test Instrument & Measurement Setup**

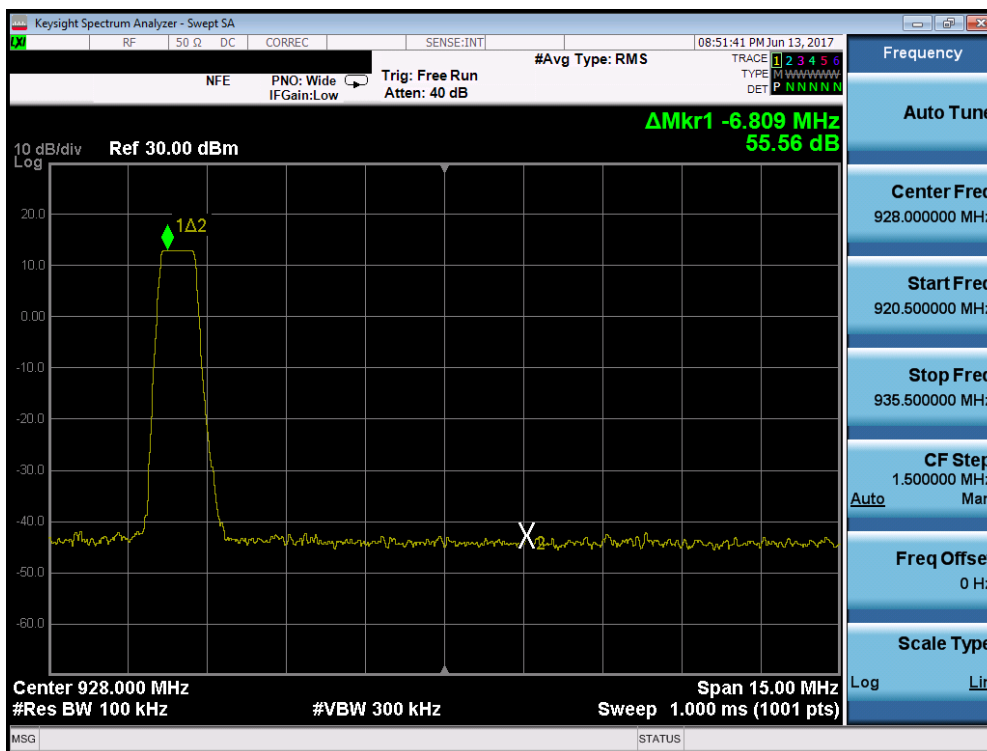
### Test Notes

None

FCC ID: OXW-PA0053		FCC Pt. 15.247 900MHz ISM TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
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Plot 7-10. Band Edge Plot (Low Channel)



Plot 7-11. Band Edge Plot (High channel)

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Test Report S/N: 1M1706070191-02.OXW	Test Dates: 6/6-6/14/2017	EUT Type: LoRa2 Radio Module		Page 21 of 38

## 7.6 Conducted Spurious Emissions §15.247(d)

### Test Overview and Limit

For the following out of band conducted spurious emissions plots, the EUT was set to transmit at maximum power with the largest packet size available. The worst case spurious emissions were found in this configuration.

***The limit for out-of-band spurious emissions at the band edge is 20dB below the fundamental emission level, as determined from the in-band power measurement of the DTS channel performed in a 100kHz bandwidth per the procedure in Section 11.1 of KDB 558074 D01 v04.***

### Test Procedure Used

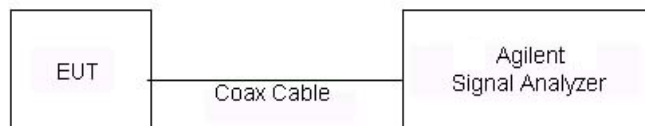
KDB 558074 D01 v04 – Section 11.3

### Test Settings

1. Start frequency was set to 30MHz and stop frequency was set to 25GHz (separated into two plots per channel)
2. RBW = 1MHz
3. VBW = 3MHz
4. Detector = Peak
5. Trace mode = max hold
6. Sweep time = auto couple
7. The trace was allowed to stabilize

### Test Setup



The EUT and measurement equipment were set up as shown in the diagram below.

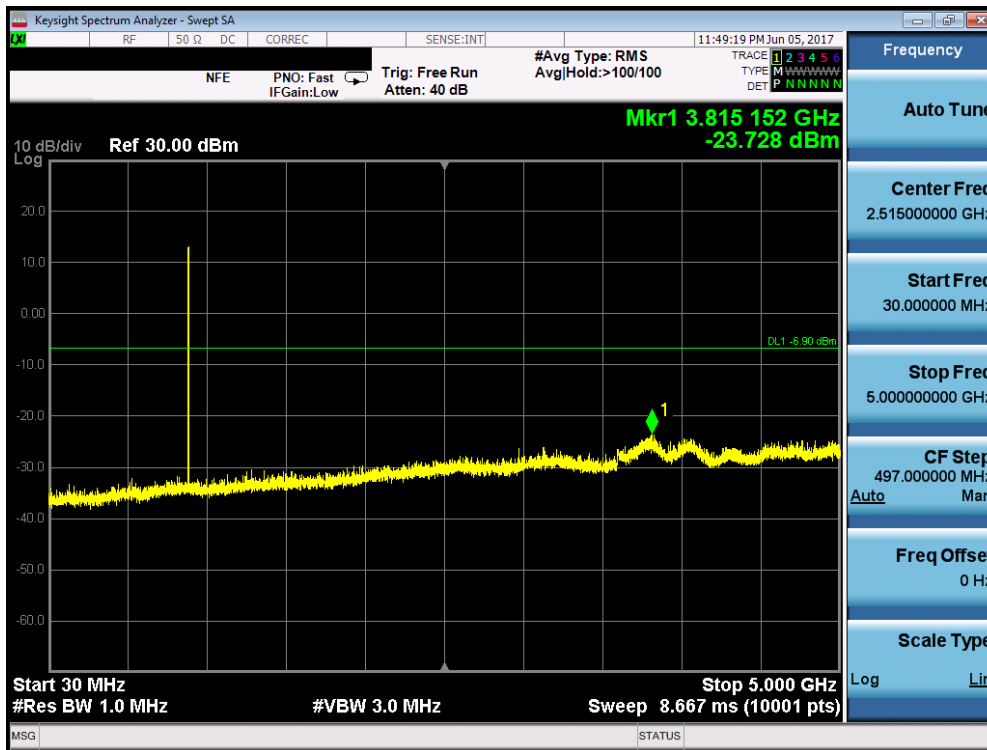


**Figure 7-5. Test Instrument & Measurement Setup**

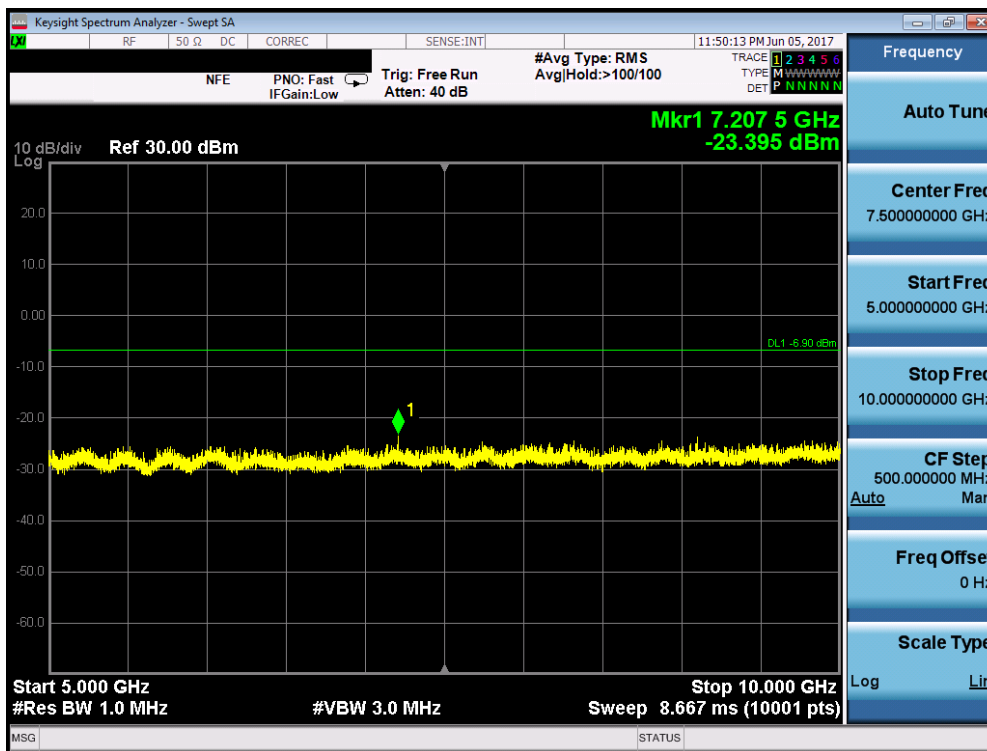
### Test Notes

1. RBW was set to 1MHz rather than 100kHz in order to increase the measurement speed.
2. The display line shown in the following plots denotes the limit at 20dB below the fundamental emission level measured in a 100kHz bandwidth. However, since the traces in the following plots are measured with a 1MHz RBW, the display line may not necessarily appear to be 20dB below the level of the fundamental in a 1MHz bandwidth.

FCC ID: OXW-PA0053		FCC Pt. 15.247 900MHz ISM TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1706070191-02.OXW	Test Dates: 6/6-6/14/2017	EUT Type: LoRa2 Radio Module	Page 22 of 38	

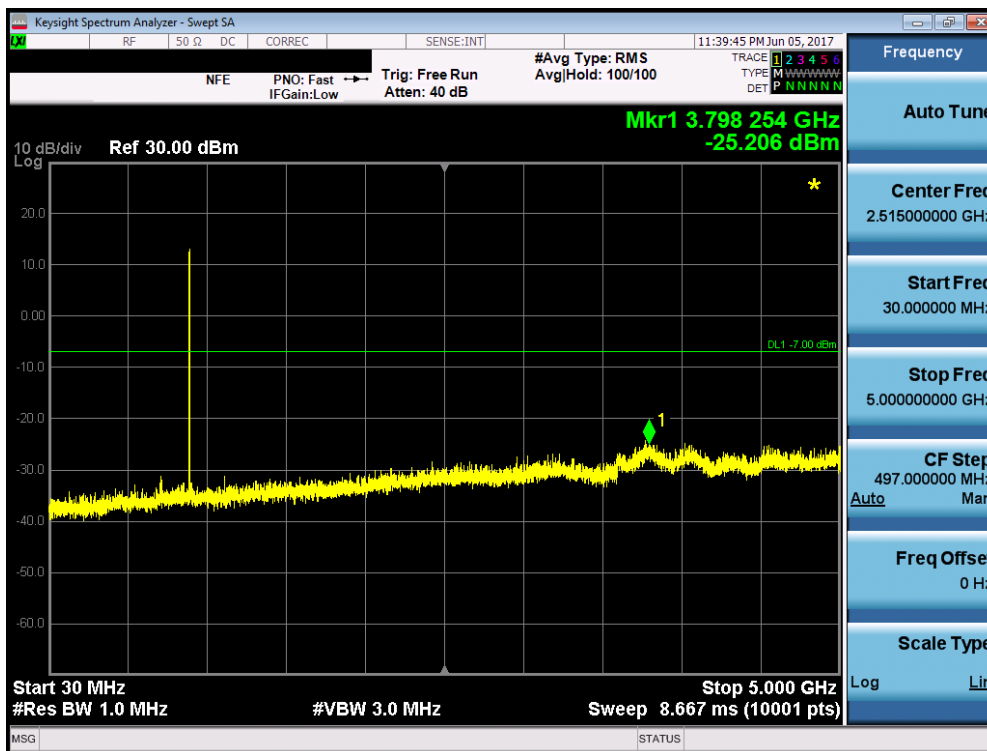


Plot 7-12. Conducted Spurious Plot (Low Channel)

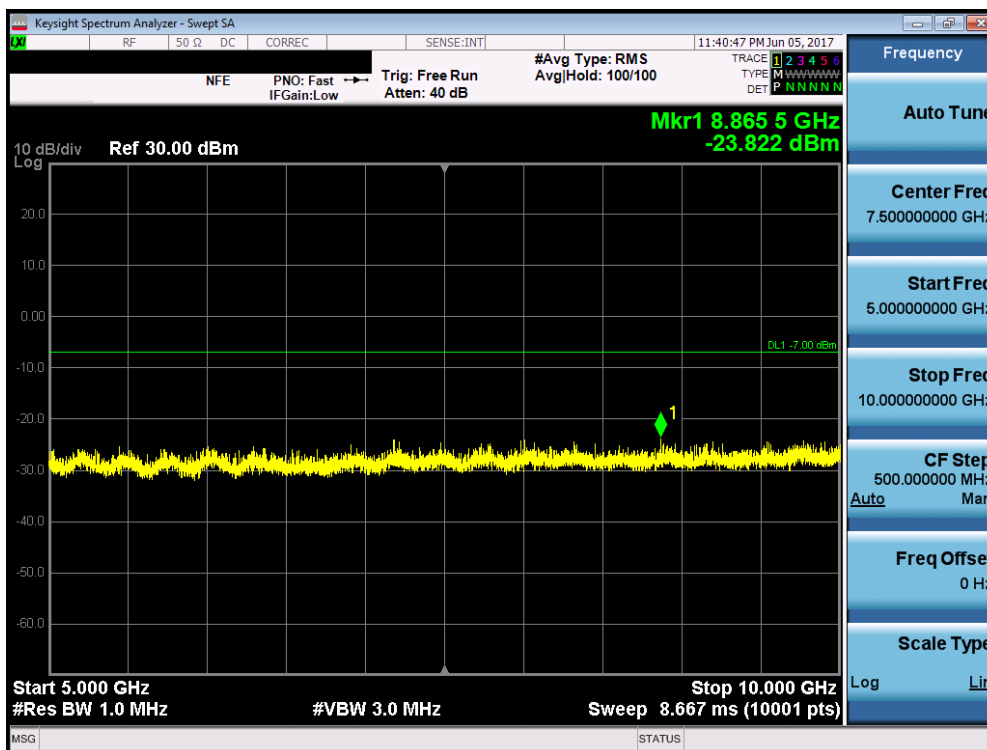


Plot 7-13. Conducted Spurious Plot (Low Channel)

FCC ID: OXW-PA0053		FCC Pt. 15.247 900MHz ISM TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
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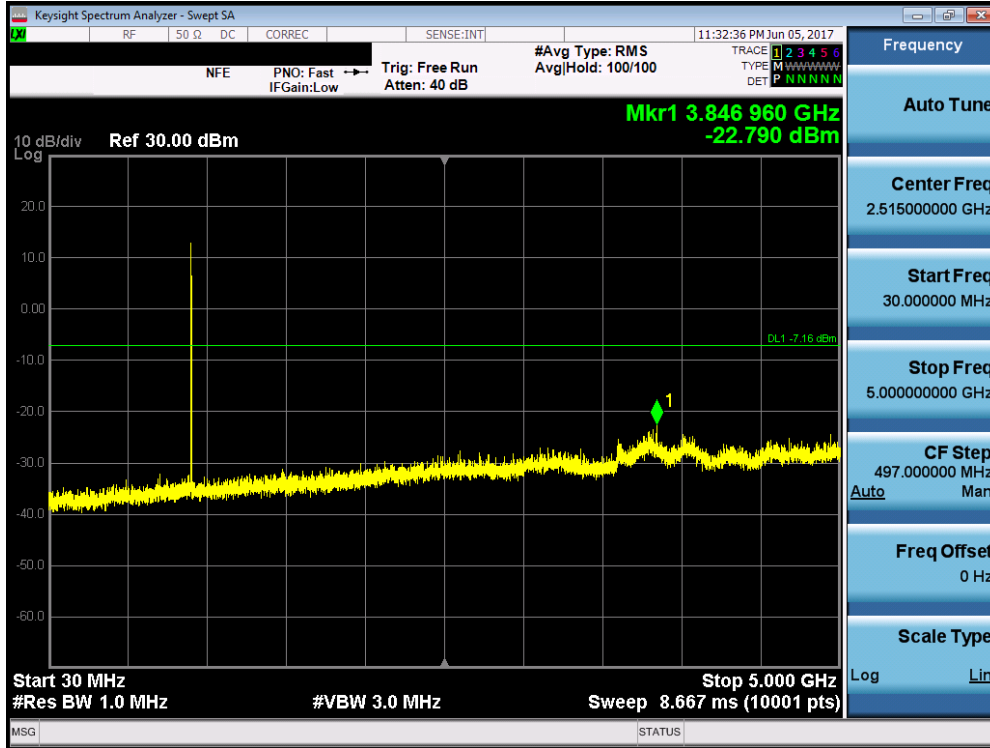
Plot 7-14. Conducted Spurious Plot (Mid Channel)



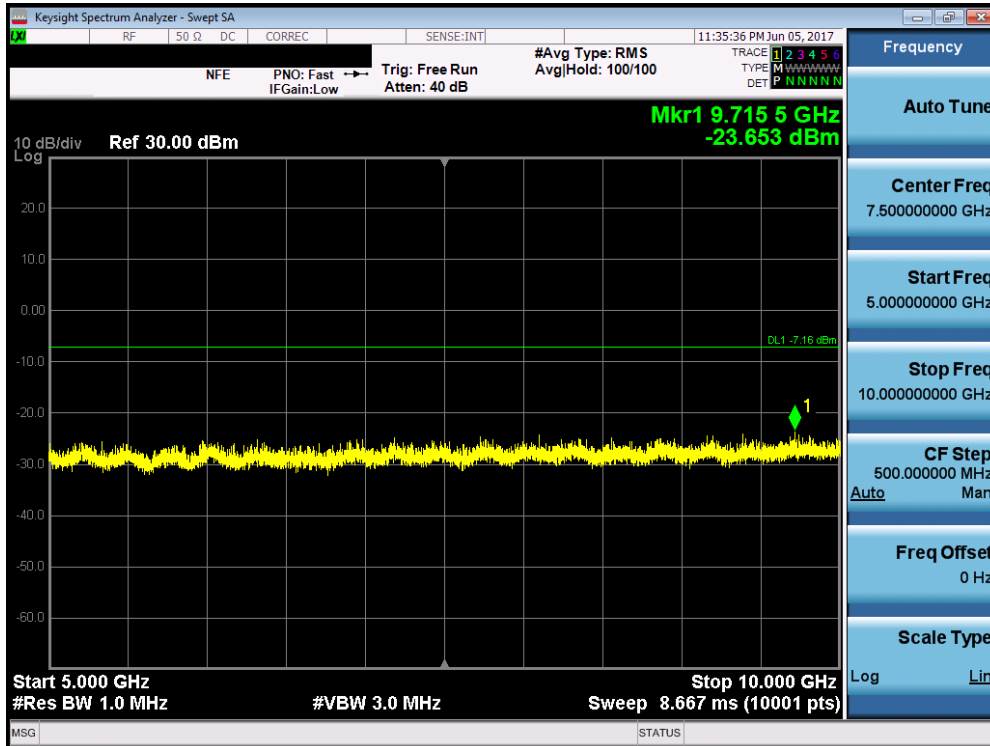
Plot 7-15. Conducted Spurious Plot (Mid Channel)

FCC ID: OXW-PA0053		FCC Pt. 15.247 900MHz ISM TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1706070191-02.OXW	Test Dates: 6/6-6/14/2017	EUT Type: LoRa2 Radio Module		Page 24 of 38





Plot 7-16. Conducted Spurious Plot (High Channel)



Plot 7-17. Conducted Spurious Plot (High Channel)

FCC ID: OXW-PA0053		FCC Pt. 15.247 900MHz ISM TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1706070191-02.OXW	Test Dates: 6/6-6/14/2017	EUT Type: LoRa2 Radio Module		Page 25 of 38



## 7.7 Radiated Spurious Emission Measurements

§15.205 §15.209 §15.247(d)

### Test Overview and Limit

All out of band radiated spurious emissions are measured with a spectrum analyzer connected to a receive antenna while the EUT is operating at maximum power and at the appropriate frequencies. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

**All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR must not exceed the limits shown in Table 7-5 per Section 15.209.**

Frequency	Field Strength [ $\mu\text{V/m}$ ]	Measured Distance [Meters]
Above 960.0 MHz	500	3

**Table 7-5. Radiated Limits**

### Test Procedures Used

KDB 558074 D01 v04 – Section 12.1, 12.2.7



### Test Settings

#### **Average Field Strength Measurements per Section 12.2.5.3 of KDB 558074 D01 v04**

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW = 3MHz
4. Detector = power averaging (RMS)
5. Number of measurement points = 1001 (Number of points must be  $\geq 2 \times \text{span/RBW}$ )
6. Sweep time = auto
7. Trace (RMS) averaging was performed over at least 100 traces

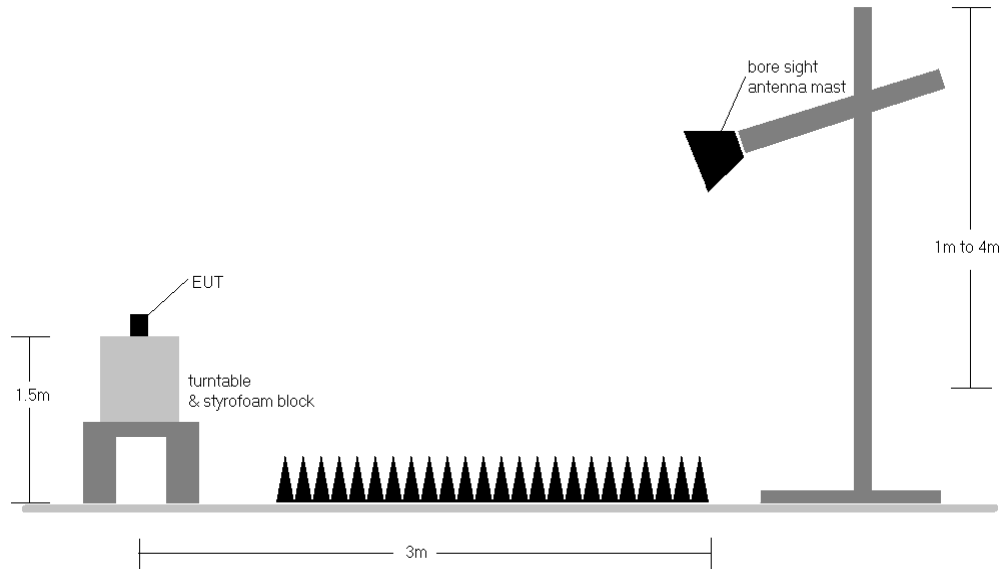
#### **Peak Field Strength Measurements per Section 12.2.4 of KDB 558074 D01 v04**

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW = 3MHz
4. Detector = peak
5. Sweep time = auto couple
6. Trace mode = max hold
7. Trace was allowed to stabilize

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## Test Setup



The EUT and measurement equipment were set up as shown in the diagram below.



**Figure 7-6. Radiated Test Setup >1GHz**

## Test Notes



1. The optional test procedures for antenna port conducted measurements of unwanted emissions per the guidance of KDB 558074 D01 v04 were not used to evaluate this device for compliance to radiated limits. All radiated spurious emissions levels were measured in a radiated test setup.
2. All emissions lying in restricted bands specified in §15.205 are below the limit shown in Table 7-5.
3. The antenna is manipulated through typical positions, polarity and length during the tests. The EUT is manipulated through three orthogonal planes.
4. This unit was tested while powered by an DC power source.
5. The spectrum is measured from 9kHz to the 10th harmonic of the fundamental frequency of the transmitter using CISPR quasi peak detector below 1GHz. Above 1 GHz, average and peak measurements were taken using linearly polarized horn antennas. The worst-case emissions are reported however emissions whose levels were not within 20dB of the respective limits were not reported.
6. The wide spectrum spurious emissions plots shown on the following pages are used only for the purpose of emission identification. Any emissions found to be within 20dB of the limit are fully investigated and the results are shown in this section. Rohde & Schwarz EMC32, Version 9.15.00 automated test software was used to perform the Radiated Spurious Emissions Pre-Scan testing.
7. The "-" shown in the following RSE tables are used to denote a noise floor measurement.

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## Sample Calculations

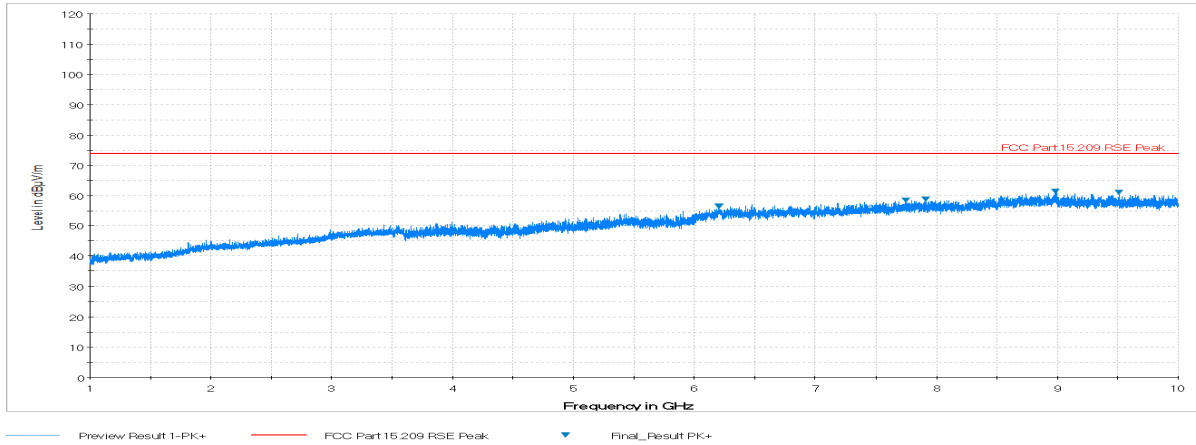
### Determining Spurious Emissions Levels

- Field Strength Level [dB $\mu$ V/m] = Analyzer Level [dBm] + 107 + AFCL [dB/m]
- AFCL [dB/m] = Antenna Factor [dB/m] + Cable Loss [dB]
- Margin [dB] = Field Strength Level [dB $\mu$ V/m] – Limit [dB $\mu$ V/m]

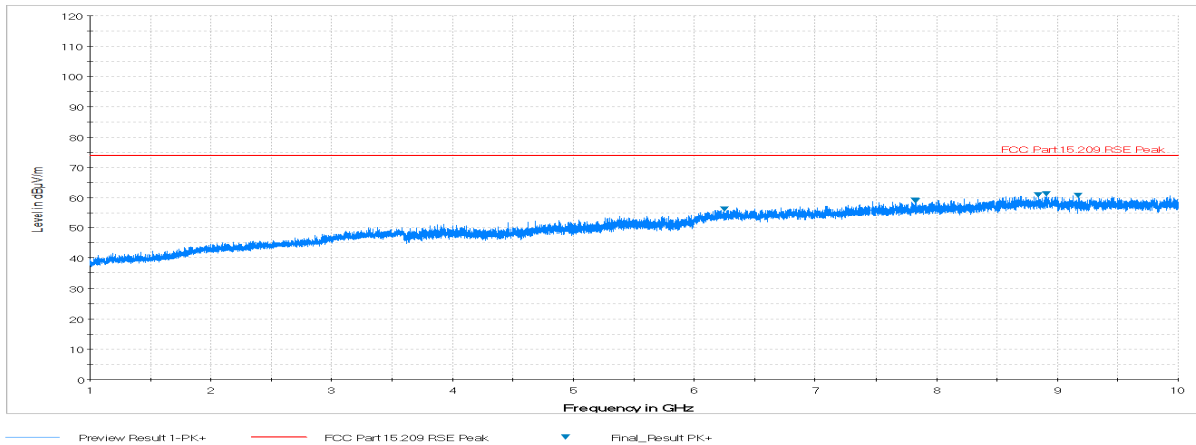
FCC ID: OXW-PA0053	 <b>FCC Pt. 15.247 900MHz ISM TEST REPORT (CERTIFICATION)</b>			<b>Approved by:</b> Quality Manager
<b>Test Report S/N:</b> 1M1706070191-02.OXW	<b>Test Dates:</b> 6/6-6/14/2017	<b>EUT Type:</b> LoRa2 Radio Module		Page 28 of 38

# Antenna-1 Radiated Spurious Emission Measurements

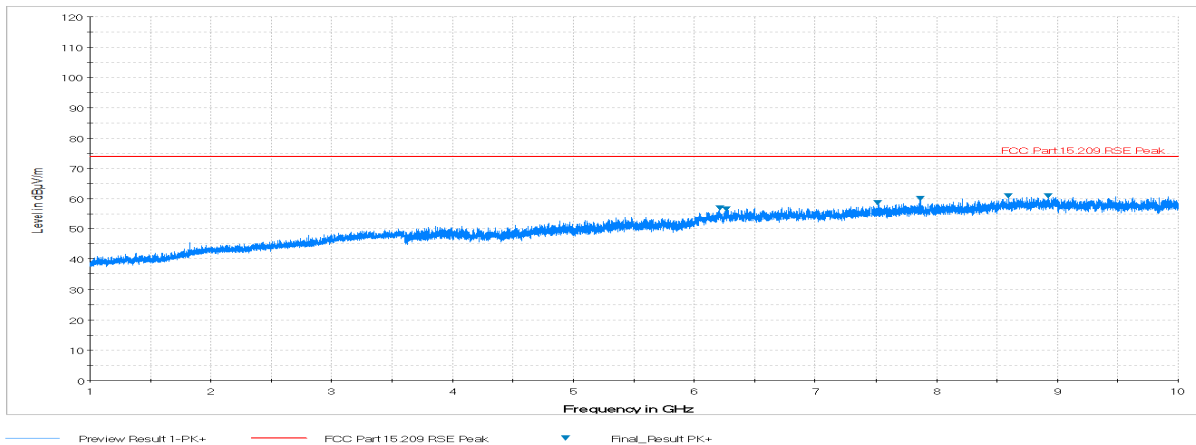
§15.247(d) §15.205 & §15.209



**Plot 7-18. Radiated Spurious Plot above 1GHz (Low Channel, Ant. Pol. H)**

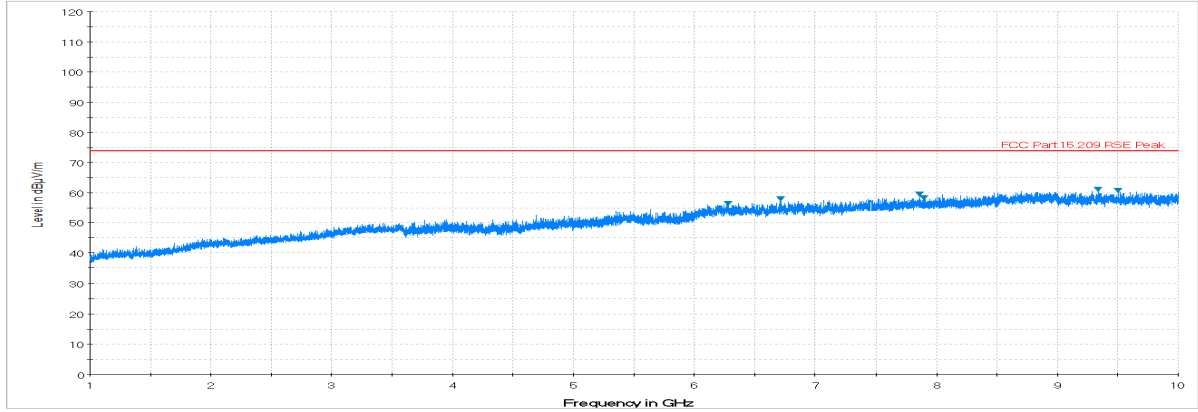


**Plot 7-19. Radiated Spurious Plot above 1GHz (Low Channel, Ant. Pol. V)**

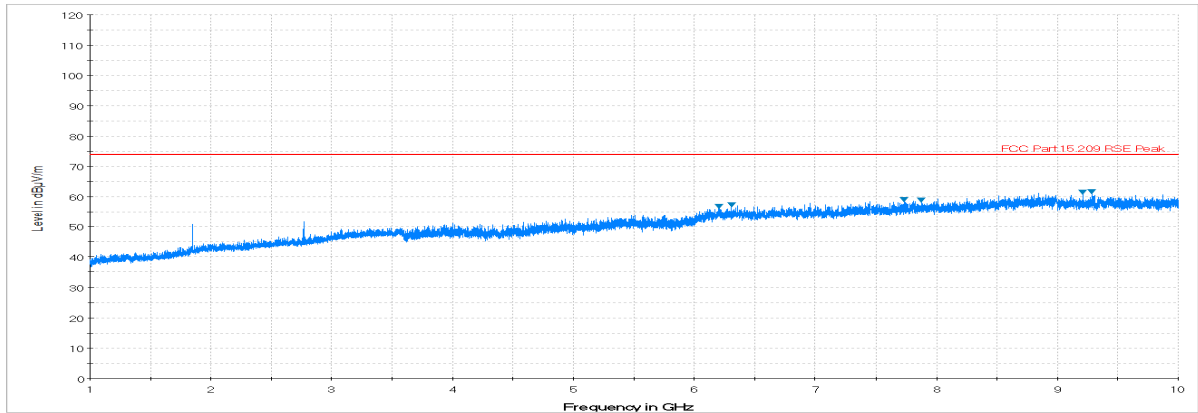


**Plot 7-20. Radiated Spurious Plot above 1GHz (Mid Channel, Ant. Pol. H)**

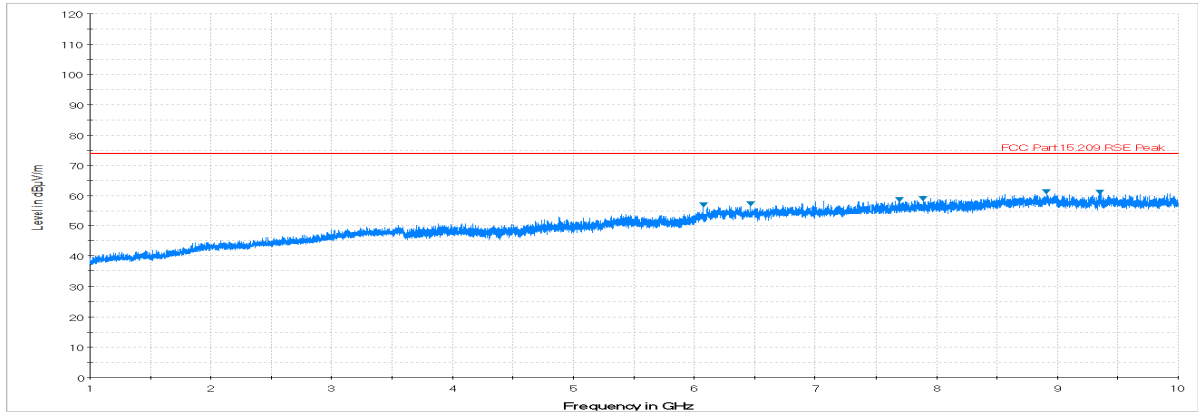
FCC ID: OXW-PA0053		FCC Pt. 15.247 900MHz ISM TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
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**Plot 7-21. Radiated Spurious Plot above 1GHz (Mid Channel, Ant. Pol. V)**



**Plot 7-22. Radiated Spurious Plot above 1GHz (High Channel, Ant. Pol. H)**



**Plot 7-23. Radiated Spurious Plot above 1GHz (High Channel, Ant. Pol. V)**

FCC ID: OXW-PA0053		FCC Pt. 15.247 900MHz ISM TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
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## Radiated Spurious Emission Measurements

§15.205 §15.209 §15.247(d)

Distance of Measurements: 3 Meters  
 Operating Frequency: 907MHz

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
2721.00	Avg	H	110	206	-65.82	-5.43	35.75	53.98	-18.23
2721.00	Peak	H	110	206	-56.63	-5.43	44.94	73.98	-29.04
3628.00	Avg	H	-	-	-68.32	-2.21	36.47	53.98	-17.51
3628.00	Peak	H	-	-	-56.62	-2.21	48.17	73.98	-25.81
4535.00	Avg	H	-	-	-68.15	-0.20	38.65	53.98	-15.33
4535.00	Peak	H	-	-	-57.31	-0.20	49.49	73.98	-24.49
5442.00	Avg	H	-	-	-69.47	2.67	40.20	53.98	-13.78
5442.00	Peak	H	-	-	-57.47	2.67	52.20	73.98	-21.78
7256.00	Avg	H	-	-	-69.68	10.31	47.63	53.98	-6.35
7256.00	Peak	H	-	-	-57.85	10.31	59.46	73.98	-14.52
8163.00	Avg	H	-	-	-70.23	11.45	48.22	53.98	-5.76
8163.00	Peak	H	-	-	-58.68	11.45	59.77	73.98	-14.21
9070.00	Avg	H	-	-	-69.96	11.91	48.95	53.98	-5.03
9070.00	Peak	H	-	-	-58.11	11.91	60.80	73.98	-13.18

Table 7-6. Radiated Measurements @ 3 meters

FCC ID: OXW-PA0053		FCC Pt. 15.247 900MHz ISM TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
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## Radiated Spurious Emission Measurements

§15.205 §15.209 §15.247(d)

Distance of Measurements: 3 Meters  
 Operating Frequency: 913MHz

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
2739.00	Avg	H	114	211	-65.84	-5.35	35.81	53.98	-18.17
2739.00	Peak	H	114	211	-56.22	-5.35	45.43	73.98	-28.55
3652.00	Avg	H	-	-	-68.39	-2.28	36.33	53.98	-17.65
3652.00	Peak	H	-	-	-55.69	-2.28	49.03	73.98	-24.95
4565.00	Avg	H	-	-	-69.42	-0.15	37.43	53.98	-16.55
4565.00	Peak	H	-	-	-57.91	-0.15	48.94	73.98	-25.04
7304.00	Avg	H	-	-	-69.89	10.24	47.35	53.98	-6.63
7304.00	Peak	H	-	-	-58.20	10.24	59.04	73.98	-14.94
8217.00	Avg	H	-	-	-70.28	11.16	47.88	53.98	-6.09
8217.00	Peak	H	-	-	-59.03	11.16	59.13	73.98	-14.84
9130.00	Avg	H	-	-	-69.91	12.78	49.87	53.98	-4.11
9130.00	Peak	H	-	-	-57.83	12.78	61.95	73.98	-12.03

Table 7-7. Radiated Measurements @ 3 meters

FCC ID: OXW-PA0053		FCC Pt. 15.247 900MHz ISM TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
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**Radiated Spurious Emission Measurements**  
§15.205 §15.209 §15.247(d)

Distance of Measurements: 3 Meters  
 Operating Frequency: 923MHz

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
2769.00	Avg	H	171	136	-62.77	-5.21	39.02	53.98	-14.96
2769.00	Peak	H	171	136	-56.02	-5.21	45.77	73.98	-28.21
3692.00	Avg	H	-	-	-68.73	-1.63	36.64	53.98	-17.34
3692.00	Peak	H	-	-	-56.58	-1.63	48.79	73.98	-25.19
4615.00	Avg	H	-	-	-69.63	-0.21	37.16	53.98	-16.82
4615.00	Peak	H	-	-	-57.75	-0.21	49.04	73.98	-24.94
7384.00	Avg	H	-	-	-70.50	10.64	47.14	53.98	-6.84
7384.00	Peak	H	-	-	-58.37	10.64	59.27	73.98	-14.71
8307.00	Avg	H	-	-	-71.57	11.67	47.10	53.98	-6.88
8307.00	Peak	H	-	-	-59.59	11.67	59.08	73.98	-14.90

**Table 7-8. Radiated Measurements @ 3 meters**

FCC ID: OXW-PA0053		FCC Pt. 15.247 900MHz ISM TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1706070191-02.OXW	Test Dates: 6/6-6/14/2017	EUT Type: LoRa2 Radio Module	Page 33 of 38	

## 7.8 Radiated Spurious Emission Measurements – Below 1GHz

### §15.209

#### Test Overview and Limit

All out of band radiated spurious emissions are measured with a spectrum analyzer connected to a receive antenna while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates and modes were investigated for radiated spurious emissions. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

**All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR must not exceed the limits shown in Table 7-9 per Section 15.209.**

Frequency	Field Strength [ $\mu\text{V/m}$ ]	Measured Distance [Meters]
0.009 – 0.490 MHz	2400/F (kHz)	300
0.490 – 1.705 MHz	24000/F (kHz)	30
1.705 – 30.00 MHz	30	30
30.00 – 88.00 MHz	100	3
88.00 – 216.0 MHz	150	3
216.0 – 960.0 MHz	200	3
Above 960.0 MHz	500	3

**Table 7-9. Radiated Limits**



#### Test Procedures Used

ANSI C63.10-2013

#### Test Settings

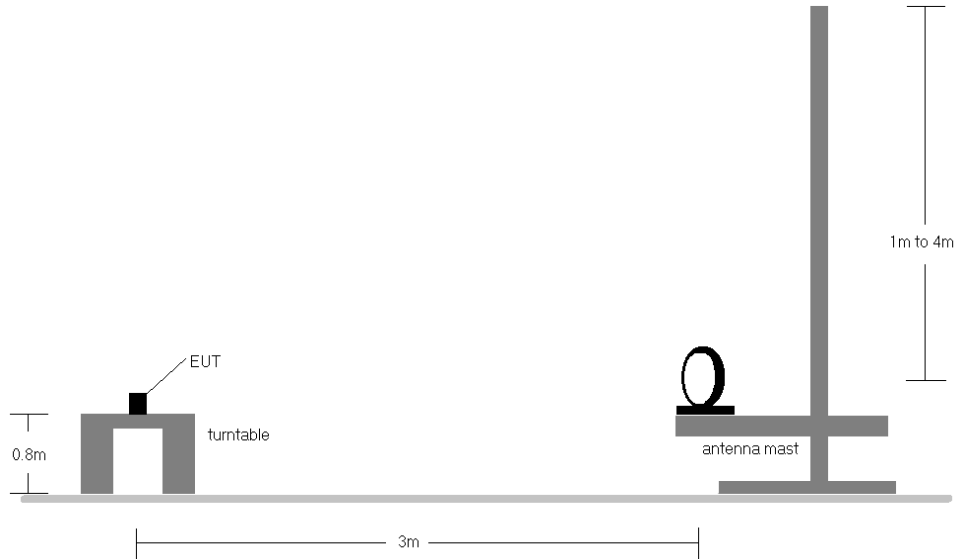
##### Quasi-Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 120kHz (for emissions from 30MHz – 1GHz)
3. Detector = quasi-peak
4. Sweep time = auto couple
5. Trace mode = max hold
6. Trace was allowed to stabilize

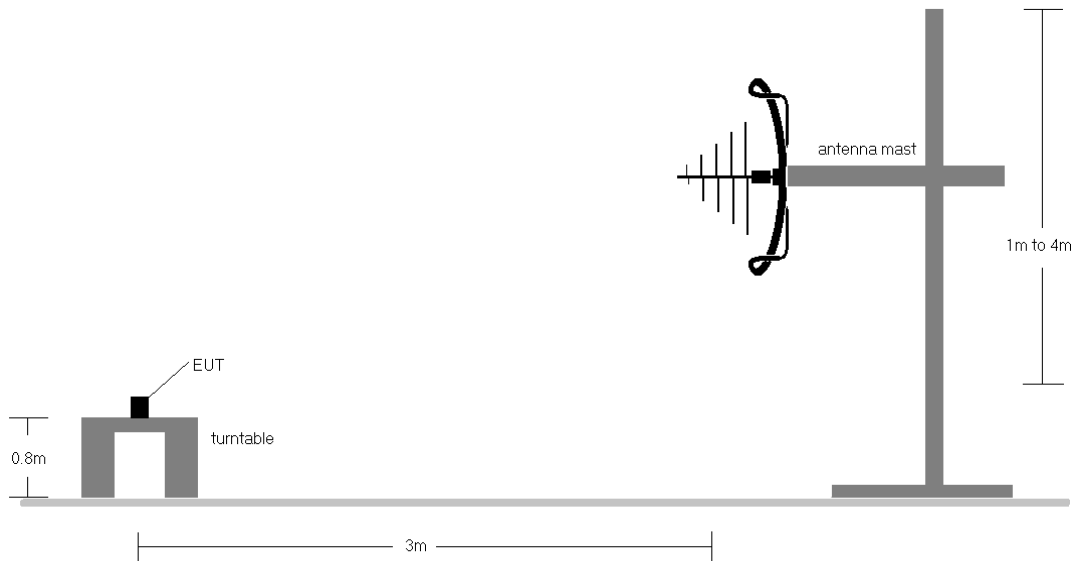
FCC ID: OXW-PA0053		FCC Pt. 15.247 900MHz ISM TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1706070191-02.OXW	Test Dates: 6/6-6/14/2017	EUT Type: LoRa2 Radio Module	Page 34 of 38	

### Test Setup

The EUT and measurement equipment were set up as shown in the diagrams below.



**Figure 7-7. Radiated Test Setup < 30Mhz**





**Figure 7-8. Radiated Test Setup < 1GHz**

FCC ID: OXW-PA0053		FCC Pt. 15.247 900MHz ISM TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
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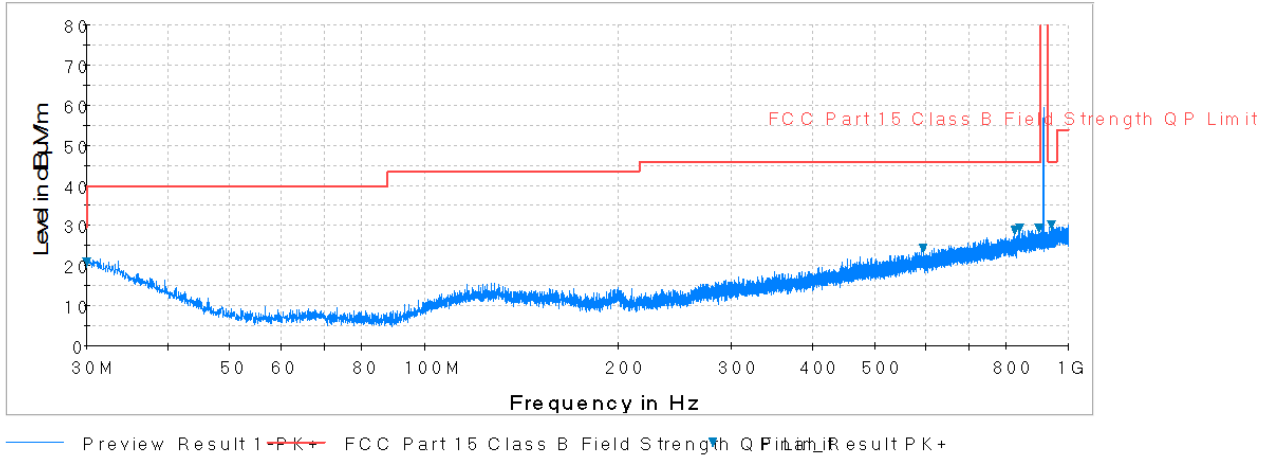
**Test Notes**

1. All emissions lying in restricted bands specified in §15.205 are below the limit shown in Table 7-9.
2. The broadband receive antenna is manipulated through vertical and horizontal polarizations during the tests. The EUT is manipulated through three orthogonal planes.
3. This unit was tested while powered by an DC power source.
4. The spectrum is investigated using a peak detector and final measurements are recorded using CISPR quasi peak detector. The worst-case emissions are reported however emissions whose levels were not within 20dB of the respective limits were not reported.
5. Emissions were measured at a 3 meter test distance.
6. Emissions are investigated while operating on the center channel of the mode, band, and modulation that produced the worst case results during the transmitter spurious emissions testing.
7. No spurious emissions were detected within 20dB of the limit below 30MHz.
8. The results recorded using the broadband antenna is known to correlate with the results obtained by using a tuned dipole with an acceptable degree of accuracy. The VSWR for the measurement antenna was found to be less than 2:1.
9. The wide spectrum spurious emissions plots shown on the following pages are used only for the purpose of emission identification. There were no emissions detected in the 30MHz – 1GHz frequency range, as shown in the subsequent plots.

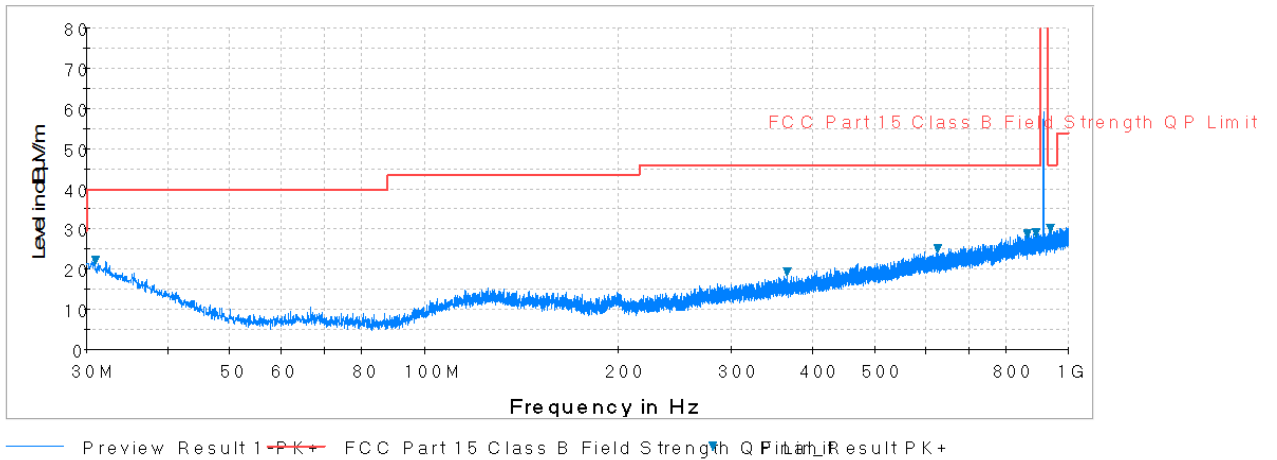
FCC ID: OXW-PA0053	 <b>FCC Pt. 15.247 900MHz ISM TEST REPORT (CERTIFICATION)</b>			<b>Approved by:</b> Quality Manager
<b>Test Report S/N:</b> 1M1706070191-02.OXW	<b>Test Dates:</b> 6/6-6/14/2017	<b>EUT Type:</b> LoRa2 Radio Module		Page 36 of 38

# Antenna-1 Radiated Spurious Emissions Measurements (Below 1GHz)

§15.209



**Plot 7-24. Radiated Spurious Plot below 1GHz (Pol. H)**





**Plot 7-25. Radiated Spurious Plot below 1GHz (Pol. V)**

FCC ID: OXW-PA0053		FCC Pt. 15.247 900MHz ISM TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1M1706070191-02.OXW	Test Dates: 6/6-6/14/2017	EUT Type: LoRa2 Radio Module		Page 37 of 38

## 8.0 CONCLUSION

The data collected relate only the item(s) tested and show that the **Device Solutions LoRa2 Radio Module FCC ID: OXW-PA0053** is in compliance with Part 15C of the FCC Rules.

<b>FCC ID:</b> OXW-PA0053		<b>FCC Pt. 15.247 900MHz ISM TEST REPORT (CERTIFICATION)</b>		<b>Approved by:</b> Quality Manager
<b>Test Report S/N:</b> 1M1706070191-02.OXW	<b>Test Dates:</b> 6/6-6/14/2017	<b>EUT Type:</b> LoRa2 Radio Module	Page 38 of 38	