



PCTEST ENGINEERING LABORATORY, INC.

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MEASUREMENT REPORT FCC Part 15.247 900MHz ISM Band

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

Date of Testing:
8/27 - 9/17/15
Test Site/Location:
PCTEST Lab, Columbia, MD, USA
Test Report Serial No.:
0Y1508261695.OXW

FCC ID:	OXW-PA0022
APPLICANT:	Device Solutions Inc.

Application Type: Certification
Model(s): PA0022
EUT Type: Sensor II – LoRa Module
Max. RF Output Power: 29.478 mW (14.7 dBm) Peak Conducted
Frequency Range: 907 – 923MHz
Type of Modulation: GFSK
FCC Classification: Digital Transmission System (DTS)
FCC Rule Part(s): Part 15 Subpart C (15.247)
Test Procedure(s): KDB 558074 v03r03

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 v03r03. 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







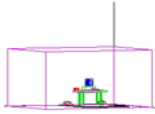
FCC ID: OXW-PA0022		FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)		Reviewed by: Quality Manager
Test Report S/N: 0Y1508261695.OXW	Test Dates: 8/27 - 9/17/15	EUT Type: Sensor II – LoRa Module		Page 1 of 37

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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: PA0022

FCC ID: OXW-PA0022

FCC CLASSIFICATION: Digital Transmission System (DTS)

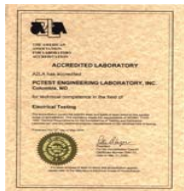
Test Device Serial No.: DUT1 Production Pre-Production Engineering

DATE(S) OF TEST: 8/27 - 9/17/15



TEST REPORT S/N: 0Y1508261695.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.

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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, the Baltimore-Washington Intern'tl (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.

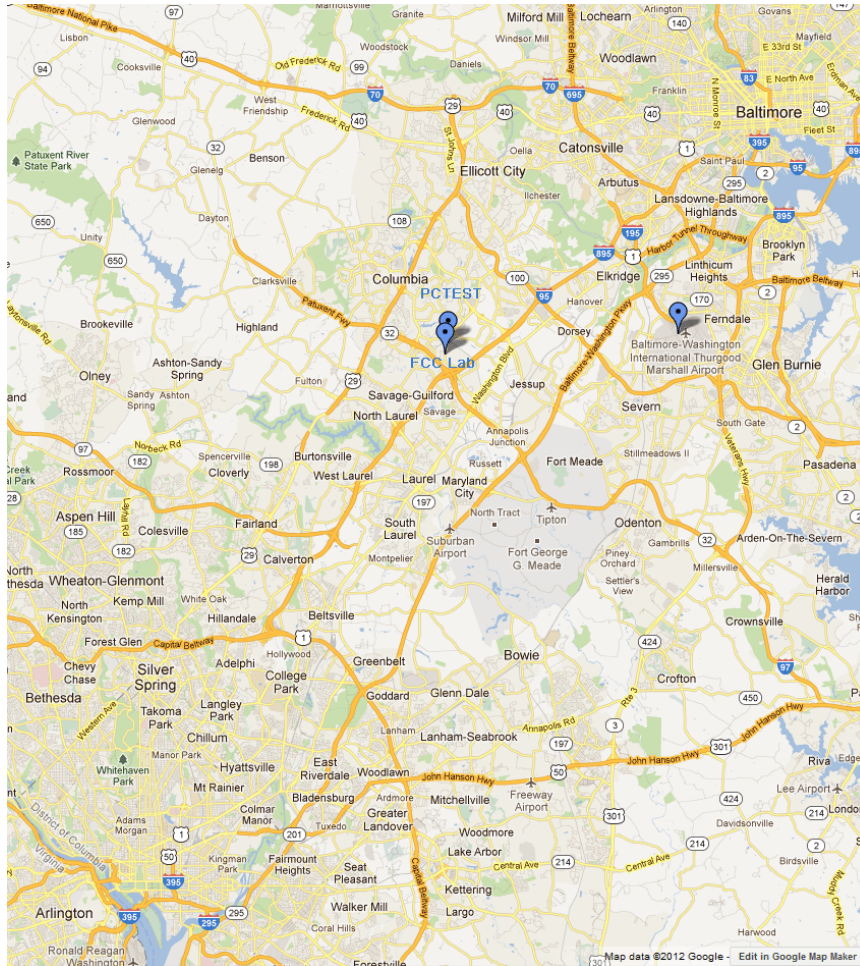




Figure 1-1. Map of the Greater Baltimore and Metropolitan Washington, D.C. area

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2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Device Solutions Sensor II – LoRa Module FCC ID: OXW-PA0022**. The test data contained in this report pertains only to the emissions due to the EUT’s ISM (DTS) transmitter.

2.2 Device Capabilities

This device contains the following capabilities:



900MHz ISM

2.3 Test Configuration

The Device Solutions Sensor II – LoRa Module FCC ID: OXW-PA0022 was tested per the guidance of KDB 558074 v03r03. ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing. See Section 3.2 for radiated emissions test setups, and 6.2, 6.3, 6.4, 6.5, and 6.6 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 TEST

3.1 Evaluation Procedure

The measurement procedures described in the American National Standard for Testing Unlicensed Wireless Devices (ANSI C63.10-2013), and the guidance provided in KDB 558074 v03r03 were used in the measurement of the **Device Solutions Sensor II – LoRa Module FCC ID: OXW-PA0022**.

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. For measurements above 1GHz 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 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 below 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 0.8 meter high, 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, clock speed, mode of operation or video resolution, if applicable, 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 antennas of the Sensor II – LoRa Module are **permanently attached**.
- There are no provisions for connections to an external antenna.

Conclusion:

The **Device Solutions Sensor II – LoRa Module FCC ID: OXW-PA0022** unit complies with the requirement of §15.203.

Ch.	Frequency (MHz)
Low	904.8
:	:
Mid	914.8
:	:
High	924.8

Table 4-1. Frequency/ Channel Operations



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5.0 TEST EQUIPMENT CALIBRATION DATA

Test Equipment Calibration is traceable to the National Institute of Standards and Technology (NIST).

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
-	RE1	Radiated Emissions Cable Set (UHF/EHF)	4/28/2015	Annual	4/28/2016	N/A
-	WL25-1	Conducted Cable Set (25GHz)	4/8/2015	Annual	4/8/2016	N/A
Agilent	N9020A	MXA Signal Analyzer	10/27/2014	Annual	10/27/2015	US46470561
Com-Power	AL-130	9kHz - 30MHz Loop Antenna	7/30/2015	Biennial	7/30/2017	121034
Com-Power	PAM-118A	Pre-Amplifier	4/10/2015	Annual	4/10/2016	551042
ETS Lindgren	3117	1-18 GHz DRG Horn (Medium)	4/8/2014	Biennial	4/8/2016	125518
K & L	13SH10-1000/U1000	N Type High Pass Filter	12/1/2014	Annual	12/1/2015	1
Rhode & Schwarz	TS-PR18	Pre-Amplifier	3/5/2015	Annual	3/5/2016	101622
Rohde & Schwarz	ESU40	EMI Test Receiver (40GHz)	7/17/2015	Annual	7/17/2016	100348
Seekonk	NC-100	Torque Wrench 5/16", 8" lbs	3/18/2014	Biennial	3/18/2016	N/A
Sunol	JB5	Bi-Log Antenna (30M - 5GHz)	1/28/2014	Biennial	1/28/2016	A051107
VWR	62344-734	Thermometer with Clock	2/20/2014	Biennial	2/20/2016	140140336

Table 5-1. Annual Test Equipment Calibration Schedule

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6.0 TEST RESULTS

6.1 Summary



Company Name: Device Solutions Inc.
 FCC ID: OXW-PA0022
 FCC Classification: Digital Transmission System (DTS)

FCC Part Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
TRANSMITTER MODE (TX)					
15.247(a)(2)	6dB Bandwidth	> 500kHz	CONDUCTED	PASS	Section 6.2
15.247(b)(3)	Transmitter Output Power	< 1 Watt		PASS	Sections 6.3
15.247(e)	Transmitter Power Spectral Density	< 8dBm / 3kHz Band		PASS	Section 6.4
15.247(d)	Band Edge / Out-of-Band Emissions	Conducted \geq 20dBc		PASS	Sections 6.5, 6.6
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 6.7, 6.8

Table 6-1. Summary of Test Results

Notes:

- 1) All modes of operation and data rates were investigated. The test results shown in the following sections represent the worst case emissions.
- 2) 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.
- 3) 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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6.2 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 its maximum duty cycle (>98%), at maximum power, and at the appropriate frequencies. All data rates 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 v03r03 – Section 8.2 Option 2

Test Settings

1. The signal analyzer's automatic bandwidth measurement capability 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.

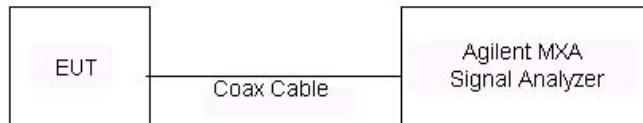




Figure 6-1. Test Instrument & Measurement Setup

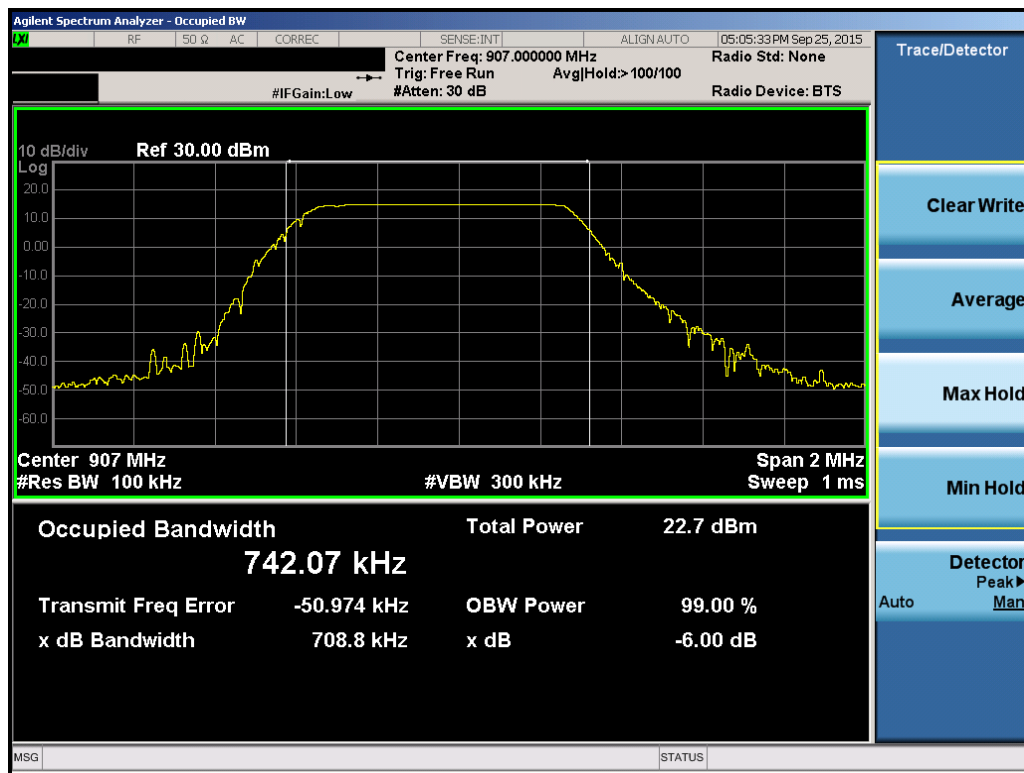
Test Notes

None

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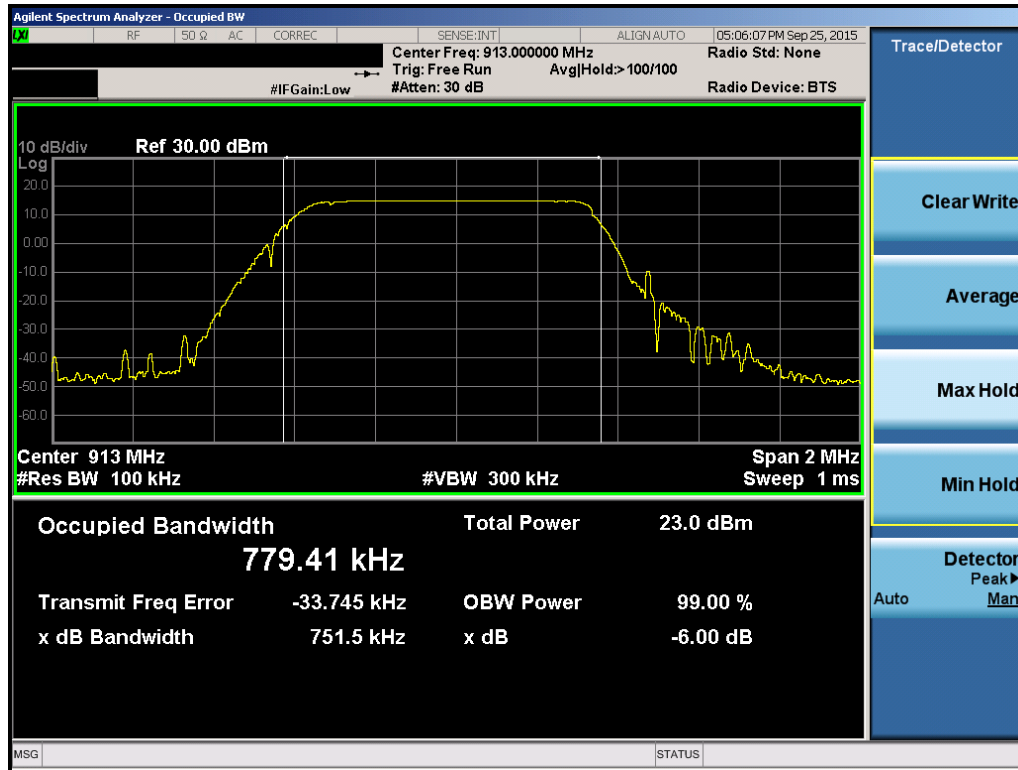
Frequency [MHz]	Channel No.	6dB Bandwidth Test Results	
		Measured Bandwidth [kHz]	Pass/Fail
907	Low	708.80	Pass
913	Mid	751.50	Pass
923	High	704.30	Pass

Table 6-2. Conducted Bandwidth Measurements

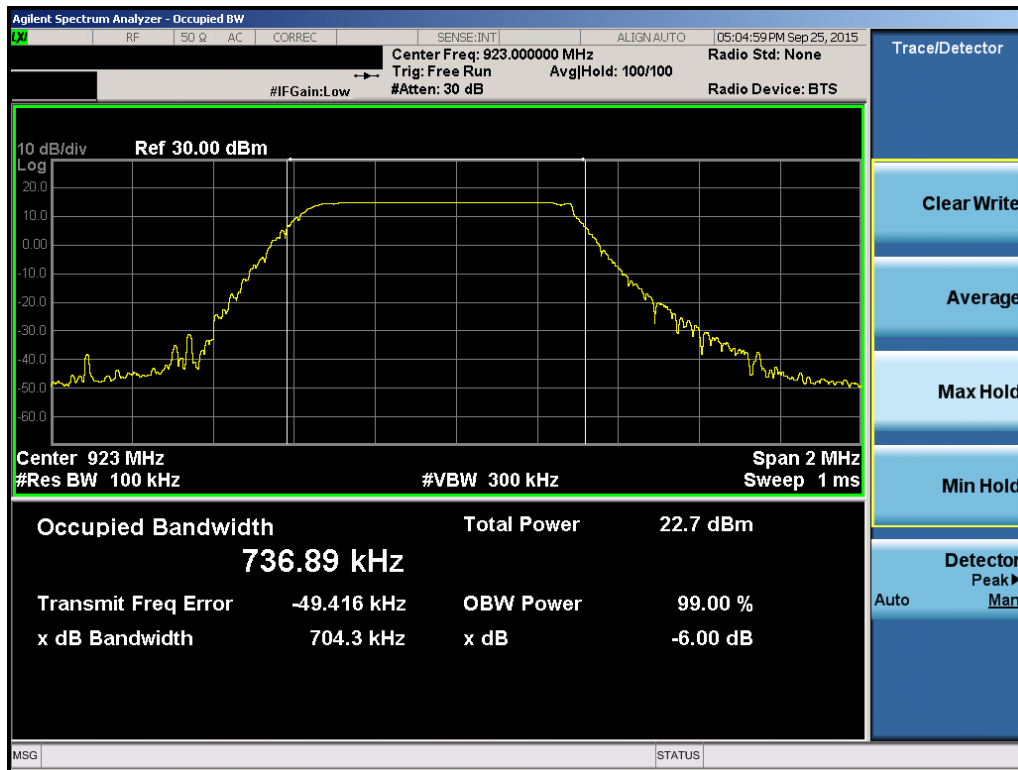


Plot 6-1. 6dB Bandwidth Plot (Low Channel)

FCC ID: OXW-PA0022		FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)		Reviewed by: Quality Manager
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Plot 6-2. 6dB Bandwidth Plot (Mid Channel)



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

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6.3 Output Power Measurement

§15.247(b.3)

Test Overview and Limits

A transmitter antenna terminal of EUT is connected to the input of an RF power sensor. Measurement is made using a broadband power meter capable of making peak and average measurements while the EUT is operating at its maximum duty cycle (>98%), at maximum power, and at the appropriate frequencies.

The maximum permissible conducted output power is 1 Watt.

Test Procedure Used

KDB 558074 v03r03 – 9.1.1 RBW ≥ DTS bandwidth

Test Settings

Peak Power Measurement

1. Peak power measurements were performed only when the EUT was transmitting at its maximum power control level using a measurement instrument that has available a resolution bandwidth that is greater than the DTS bandwidth.
2. Set the RBW ≥ DTS bandwidth.
3. Set VBW ≥ 3 x RBW.
4. Set span ≥ 3 x RBW
5. Sweep time = auto couple.
6. Detector = peak.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use peak marker function to determine the peak amplitude level.

Test Setup

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

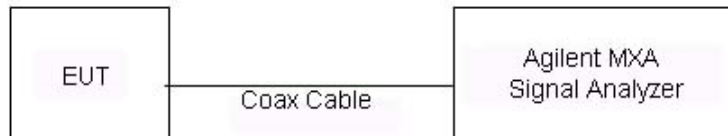




Figure 6-2. Test Instrument & Measurement Setup for Power Meter Measurements

Test Notes

None

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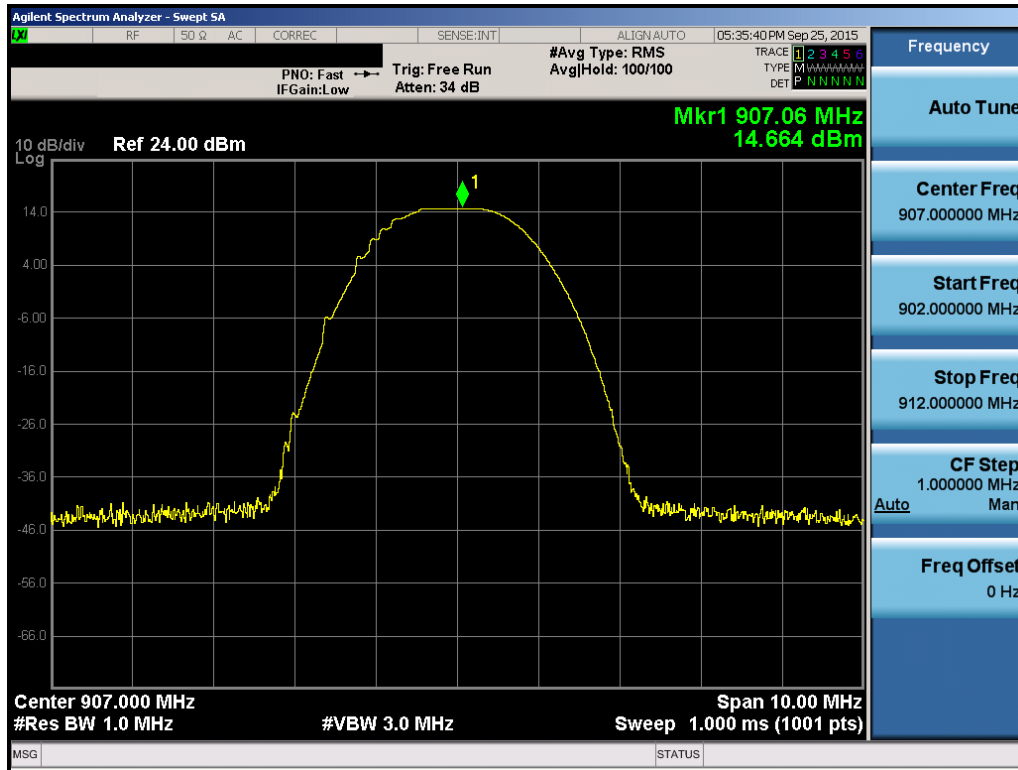


Table 6-3. Conducted Output Power Measurements (Low Channel)

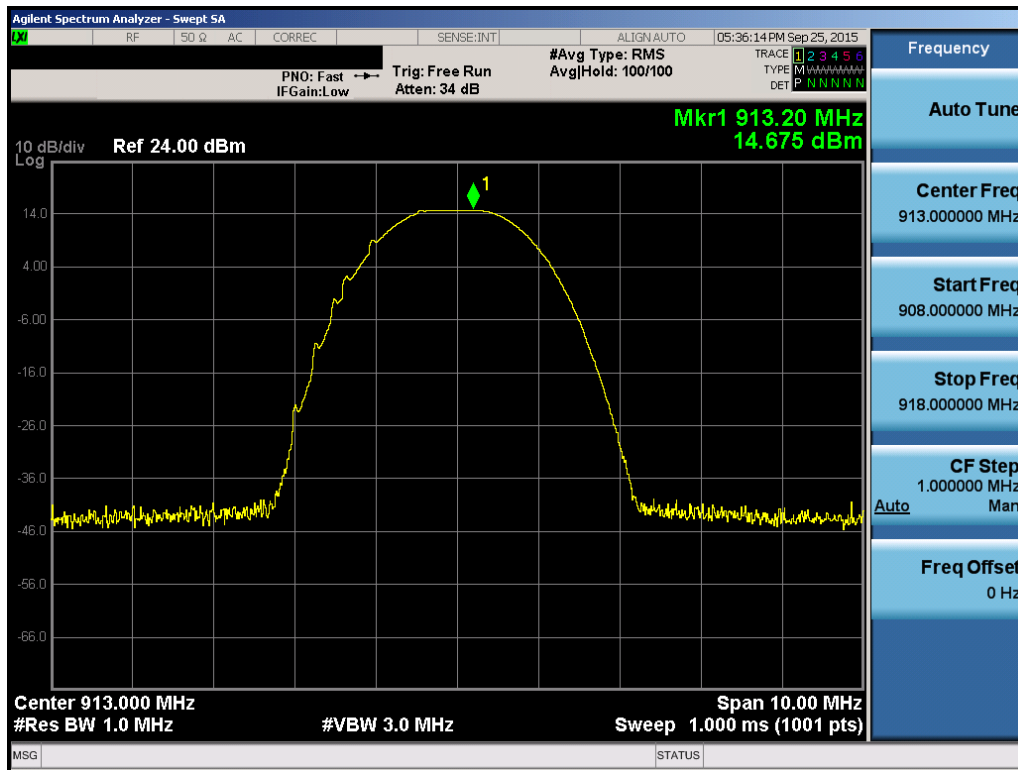


Table 6-4. Conducted Output Power Measurements (Mid Channel)

FCC ID: OXW-PA0022	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)	DeviceSolutions Incorporated, Ireland	Reviewed by: Quality Manager
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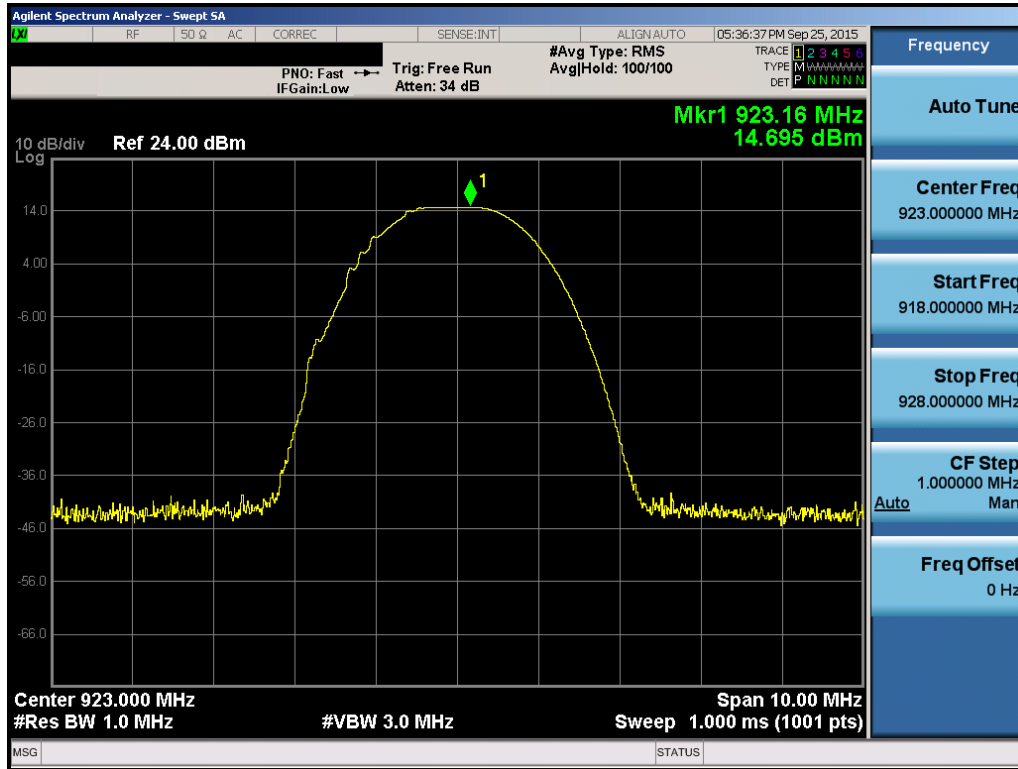


Table 6-5. Conducted Output Power Measurements (High Channel)

FCC ID: OXW-PA0022	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)	DeviceSolutions Innovations. Partnered.	Reviewed by: Quality Manager
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6.4 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 its maximum duty cycle (>98%), at maximum power, and at the appropriate frequencies. All data rates were investigated and the worst case configuration results are reported in this section.

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

Test Procedure Used

KDB 558074 v03r03 – 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 = 3kHz
4. VBW = 10kHz
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.

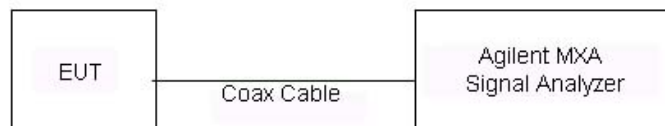




Figure 6-3. Test Instrument & Measurement Setup

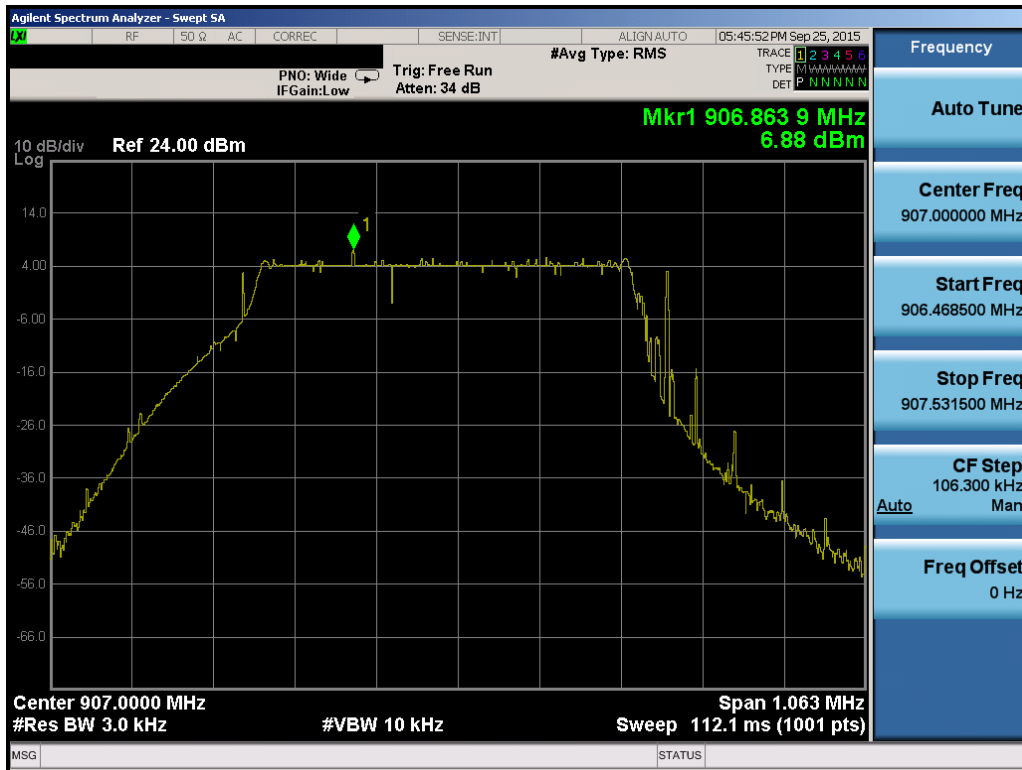
Test Notes

None

FCC ID: OXW-PA0022		FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)		Reviewed by: Quality Manager
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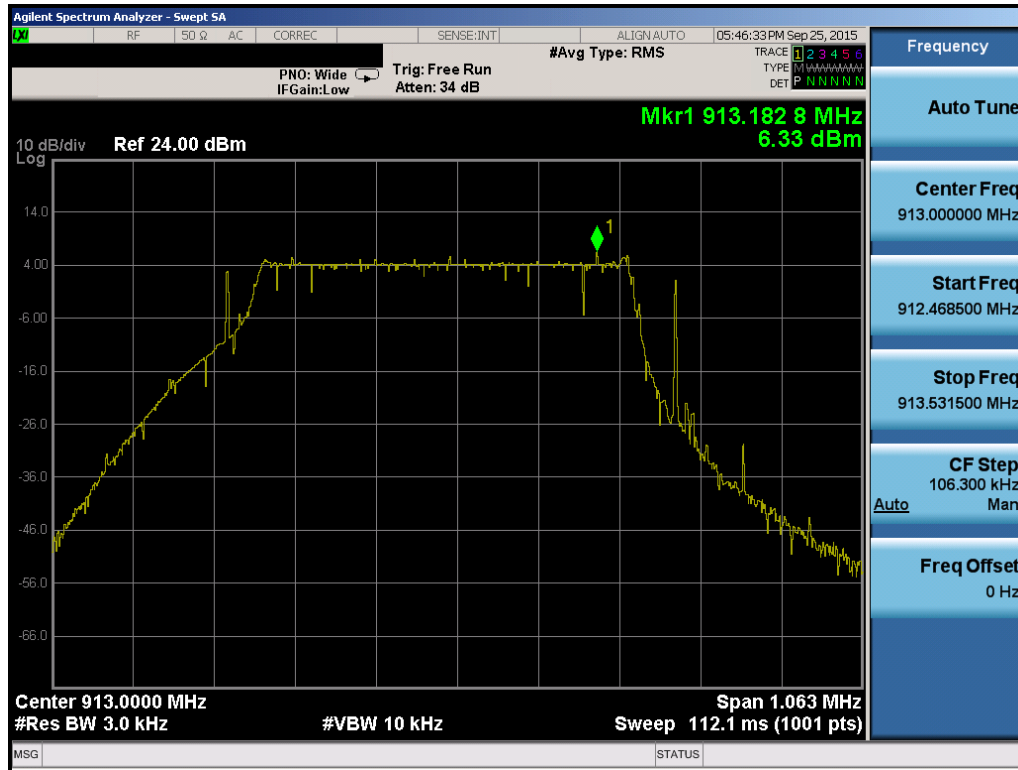
Frequency [MHz]	Channel No.	Measured Power Spectral Density [dBm]	Maximum Permissible Power Density [dBm / 3kHz]	Margin [dB]	Pass / Fail
907	Low	6.88	8.00	-1.12	Pass
913	Mid	6.33	8.00	-1.67	Pass
923	High	7.21	8.00	-0.79	Pass

Table 6-6. Conducted Power Density Measurements

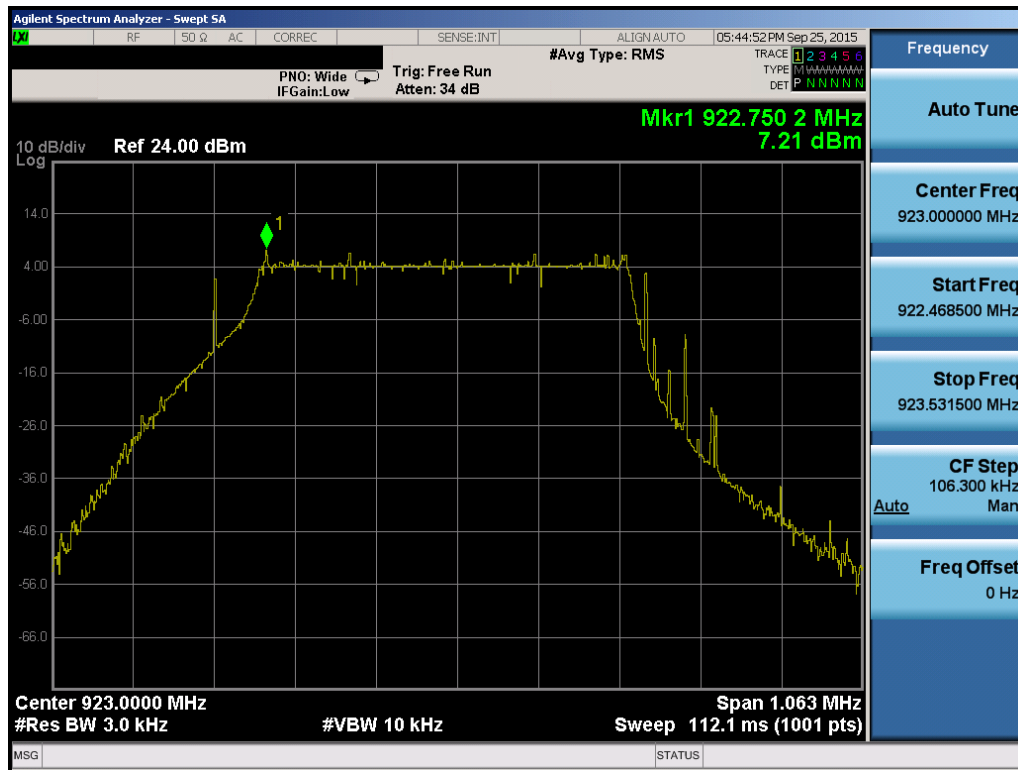


Plot 6-4. Power Spectral Density Plot (Low Channel)

FCC ID: OXW-PA0022	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)	DeviceSolutions Innovations. Partnered.	Reviewed by: Quality Manager
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Plot 6-5. Power Spectral Density Plot (Mid Channel)



Plot 6-6. Power Spectral Density Plot (High Channel)

FCC ID: OXW-PA0022	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)	DeviceSolutions Innovations. Partnered.	Reviewed by: Quality Manager
Test Report S/N: 0Y1508261695.OXW	Test Dates: 8/27 - 9/17/15	EUT Type: Sensor II - LoRa Module		Page 18 of 37

6.5 Conducted Emissions at the Band Edge

§15.247(d)

Test Overview and Limit

All out of band emissions are measured with a spectrum analyzer connected to the antenna terminal of the EUT while the EUT is operating at its maximum duty cycle (>98%), at maximum power, and at the appropriate frequencies. All data rates were investigated to determine the worst case 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 PSD procedure (Section 9.1).

Test Procedure Used

KDB 558074 v03r03 – 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.

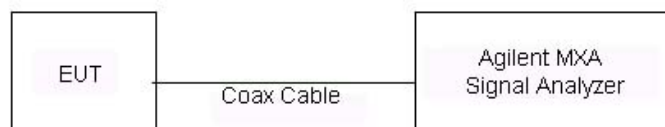


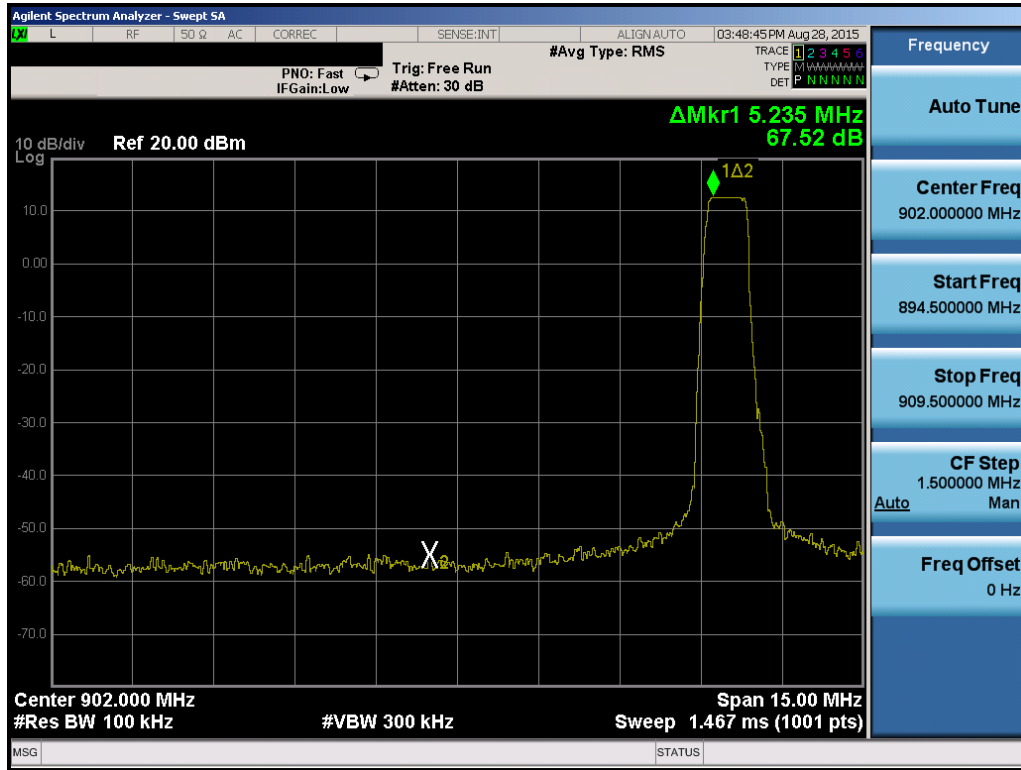


Figure 6-4. Test Instrument & Measurement Setup

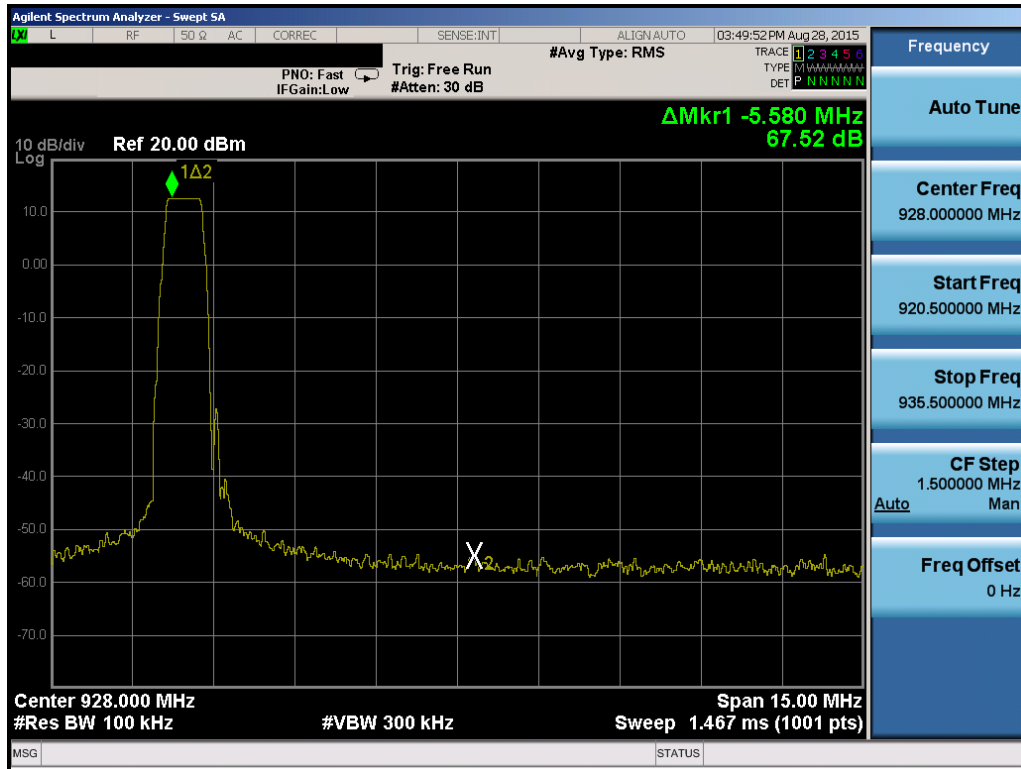
Test Notes

None

FCC ID: OXW-PA0022		FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)		Reviewed by: Quality Manager
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Plot 6-7. Lower Band Edge Plot



Plot 6-8. Upper Band Edge Plot

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Test Report S/N: 0Y1508261695.OXW	Test Dates: 8/27 - 9/17/15	EUT Type: Sensor II – LoRa Module		Page 20 of 37

6.6 Conducted Spurious Emissions

§15.247(d)

Test Overview and Limit

All out of band emissions are measured with a spectrum analyzer connected to the antenna terminal of the EUT while the EUT is operating at its maximum duty cycle (>98%), at maximum power, and at the appropriate frequencies. All data rates were investigated to determine the worst case configuration.

The limit for out-of-band spurious emissions at the band edge is 30dB 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 v03r03.

Test Procedure Used

KDB 558074 v03r03 – Section 11.3

Test Settings

1. Start frequency was set to 30MHz and stop frequency was set to 10GHz (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.

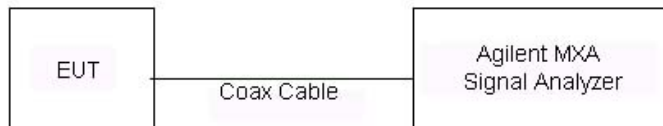






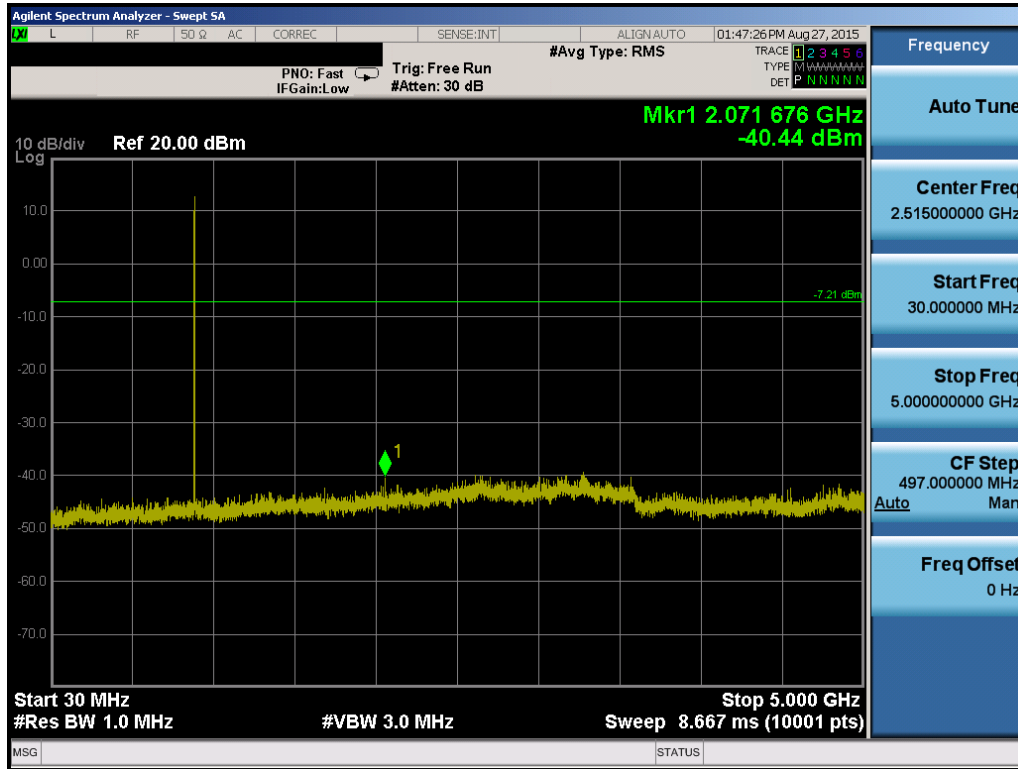
Figure 6-5. Test Instrument & Measurement Setup

FCC ID: OXW-PA0022		FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)		Reviewed by: Quality Manager
Test Report S/N: 0Y1508261695.OXW	Test Dates: 8/27 - 9/17/15	EUT Type: Sensor II – LoRa Module		Page 21 of 37

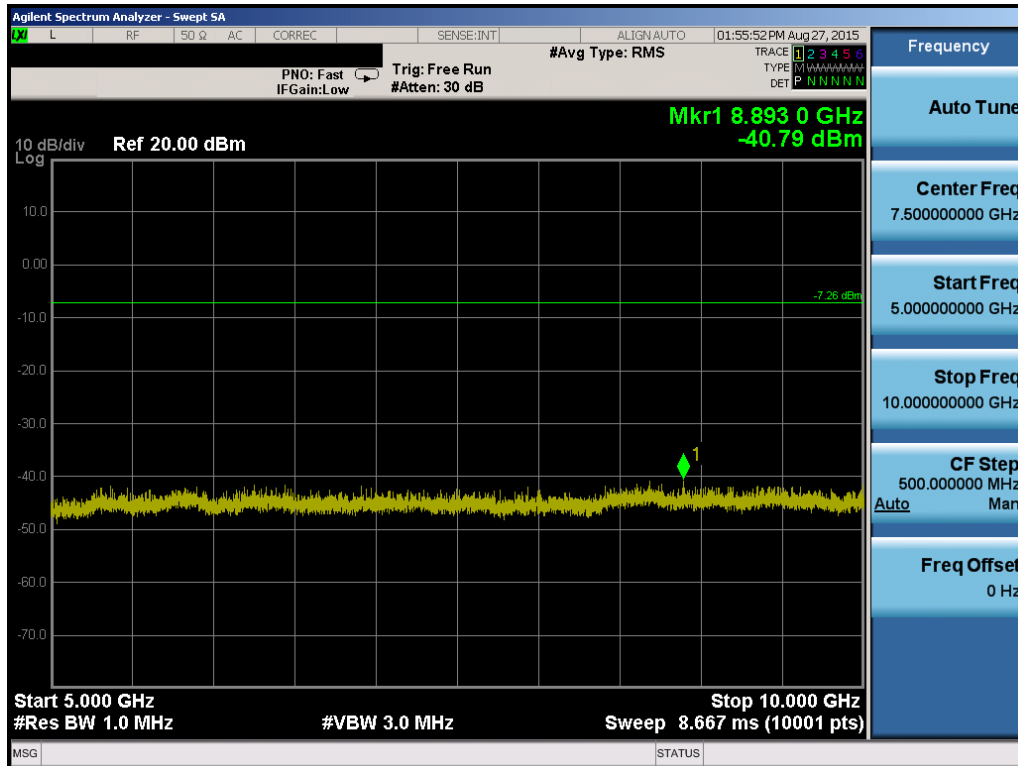
Test Notes

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-PA0022		FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)		Reviewed by: Quality Manager
Test Report S/N: 0Y1508261695.OXW	Test Dates: 8/27 - 9/17/15	EUT Type: Sensor II – LoRa Module	Page 22 of 37	

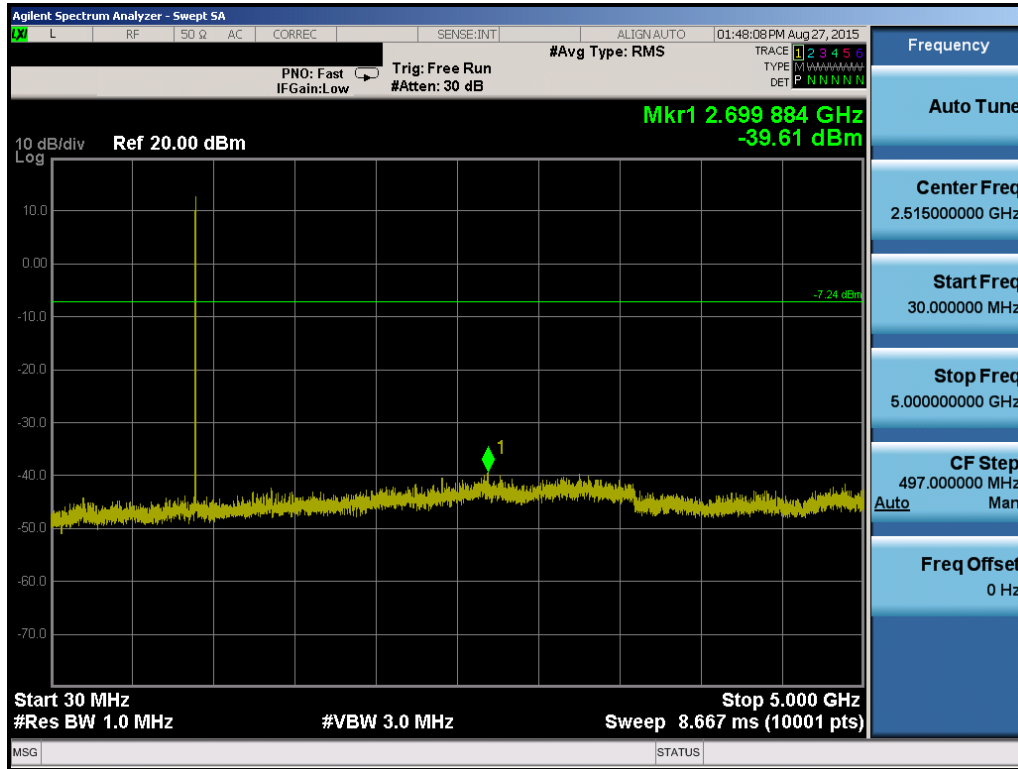


Plot 6-9. Conducted Spurious Plot (Low Channel)

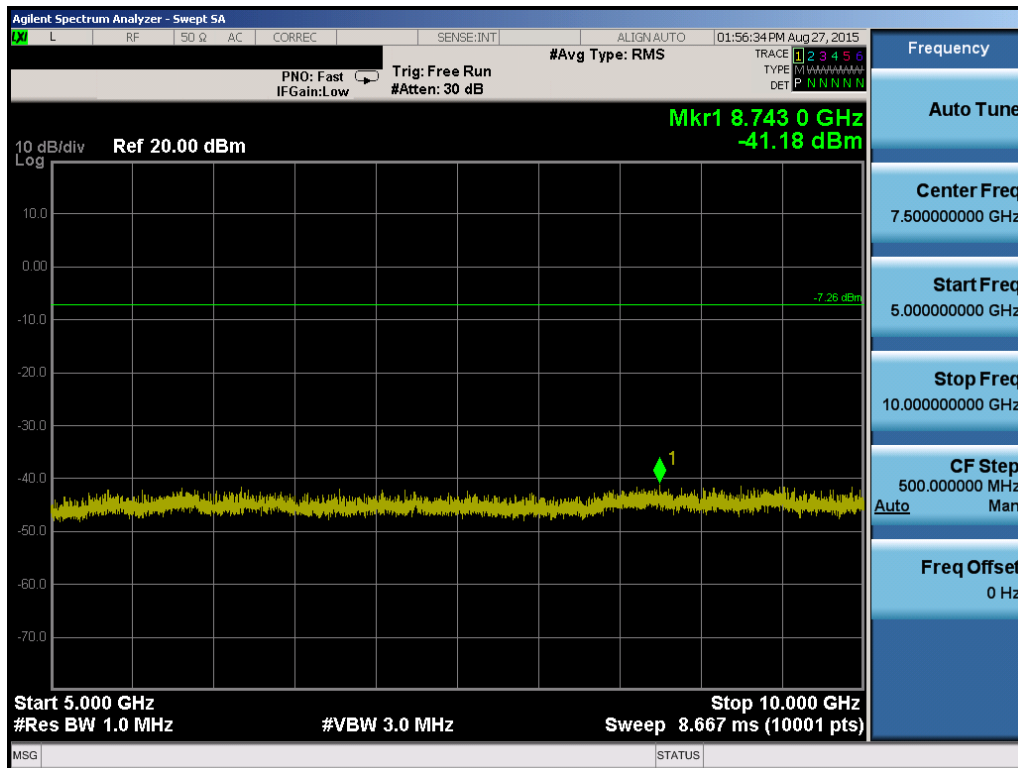


Plot 6-10. Conducted Spurious Plot (Low Channel)

FCC ID: OXW-PA0022		FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)		Reviewed by: Quality Manager
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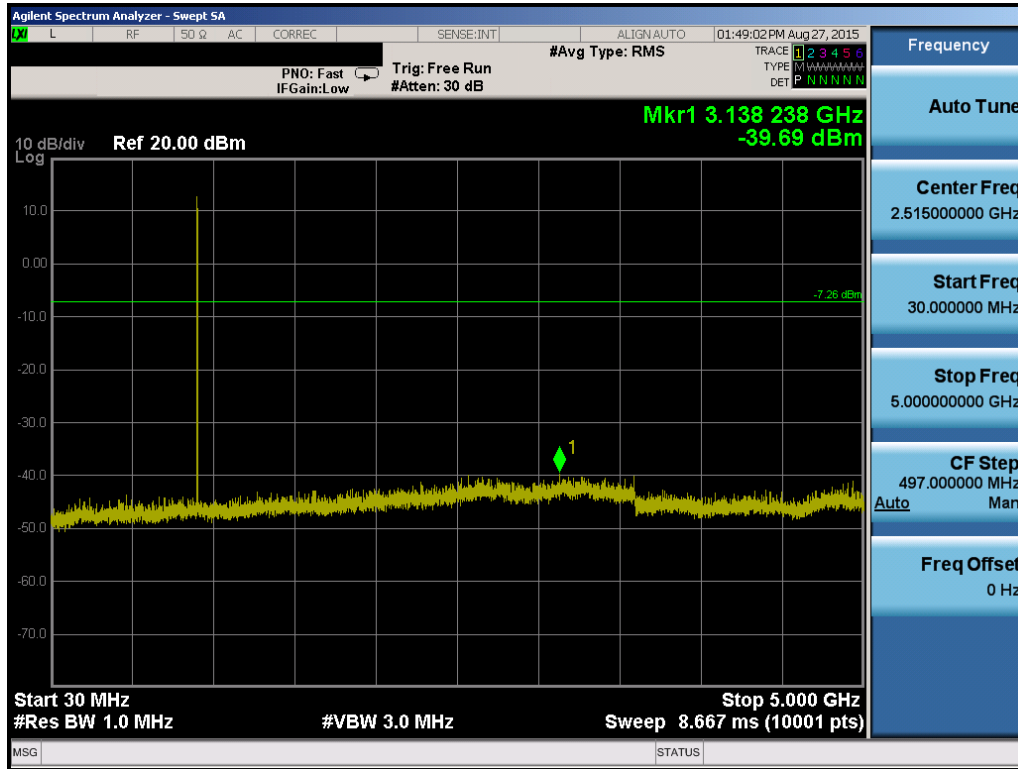


Plot 6-11. Conducted Spurious Plot (Mid Channel)

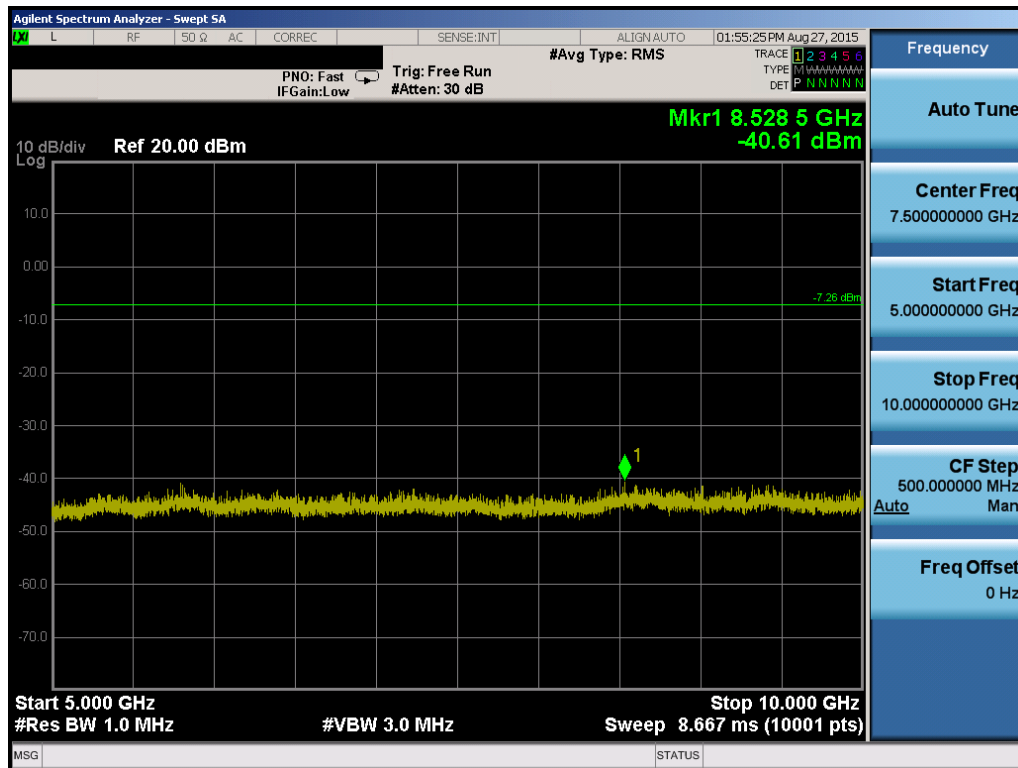


Plot 6-12. Conducted Spurious Plot (Mid Channel)

FCC ID: OXW-PA0022	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)	DeviceSolutions Innovations. Partnered.	Reviewed by: Quality Manager
Test Report S/N: 0Y1508261695.OXW	Test Dates: 8/27 - 9/17/15	EUT Type: Sensor II – LoRa Module		Page 24 of 37



Plot 6-13. Conducted Spurious Plot (High Channel)



Plot 6-14. Conducted Spurious Plot (High Channel)

FCC ID: OXW-PA0022	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)	DeviceSolutions	Reviewed by: Quality Manager
Test Report S/N: 0Y1508261695.OXW	Test Dates: 8/27 - 9/17/15	EUT Type: Sensor II - LoRa Module		Page 25 of 37

6.7 Radiated Spurious Emission Measurements – Above 1GHz §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 its maximum duty cycle (>98%), 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 6-7 per Section 15.209.

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

Table 6-7. Radiated Limits

Test Procedures Used

KDB 558074 v03r03 – Section 12.1, 12.2.7



Test Settings

Average Field Strength Measurements per Section 12.2.5.1 of KDB 558074 v03r03

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 average (RMS)
5. Number of measurement points = 1001 (Number of points must be $\geq 2 \times \text{span}/\text{RBW}$)
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 v03r03

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

FCC ID: OXW-PA0022		FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)		Reviewed by: Quality Manager
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Test Setup

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

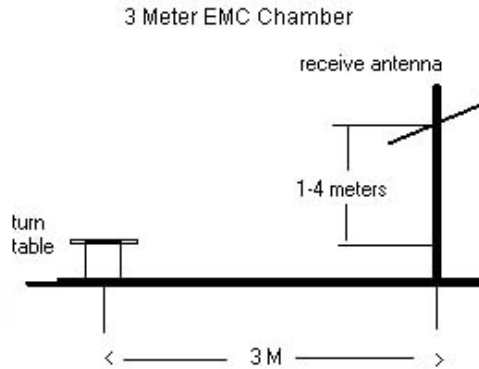


Figure 6-6. Test Instrument & Measurement Setup



Test Notes

1. All emissions lying in restricted bands specified in §15.205 are below the limit shown in Table 6-7.
2. Average measurements > 1GHz using RBW = 1MHz, VBW = 3MHz, and RMS detector.
3. Peak measurements > 1GHz using RBW = 1MHz, VBW = 3MHz, and peak detector.
4. The antenna is manipulated through typical positions, polarity and length during the tests. The EUT is manipulated through three orthogonal planes.
5. This unit was tested while powered by a 9V battery.
6. The spectrum is measured from 9kHz to the 10th harmonic and the worst-case emissions are reported.

Sample Calculations

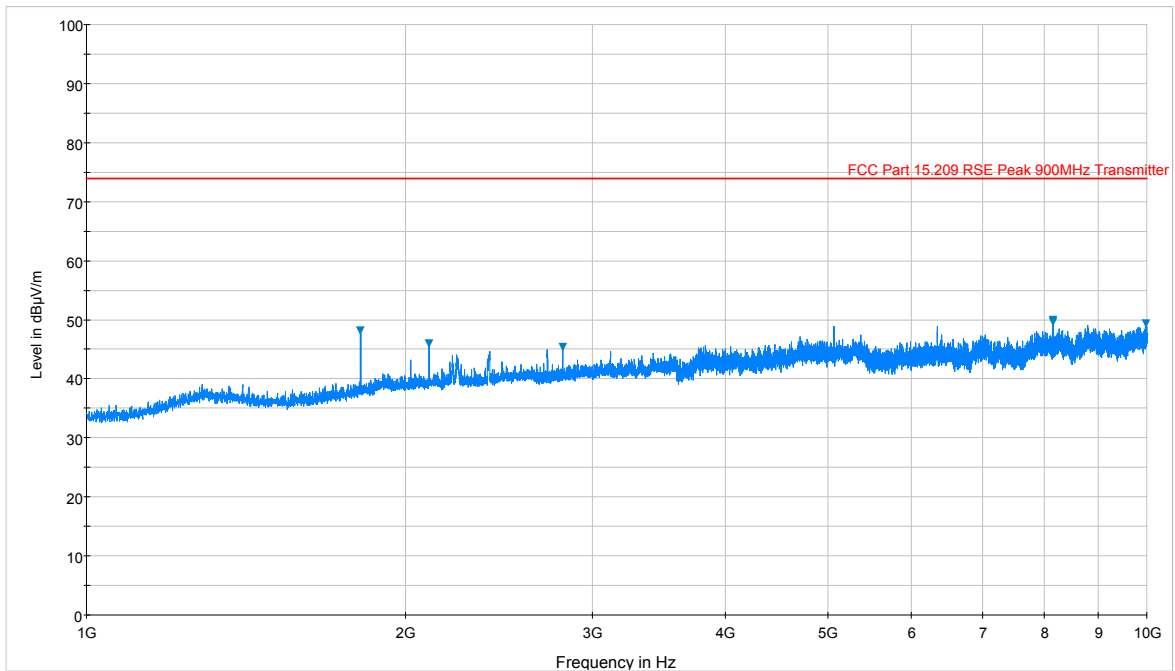
Determining Spurious Emissions Levels

- Field Strength Level $_{[dB_{\mu V/m}]}$ = Analyzer Level $_{[dBm]}$ + 107 + AFCL $_{[dB/m]}$ + Duty Cycle Correction $_{[dB]}$
- AFCL $_{[dB/m]}$ = Antenna Factor $_{[dB/m]}$ + Cable Loss $_{[dB]}$
- Margin $_{[dB]}$ = Field Strength Level $_{[dB_{\mu V/m}]}$ – Limit $_{[dB_{\mu V/m}]}$

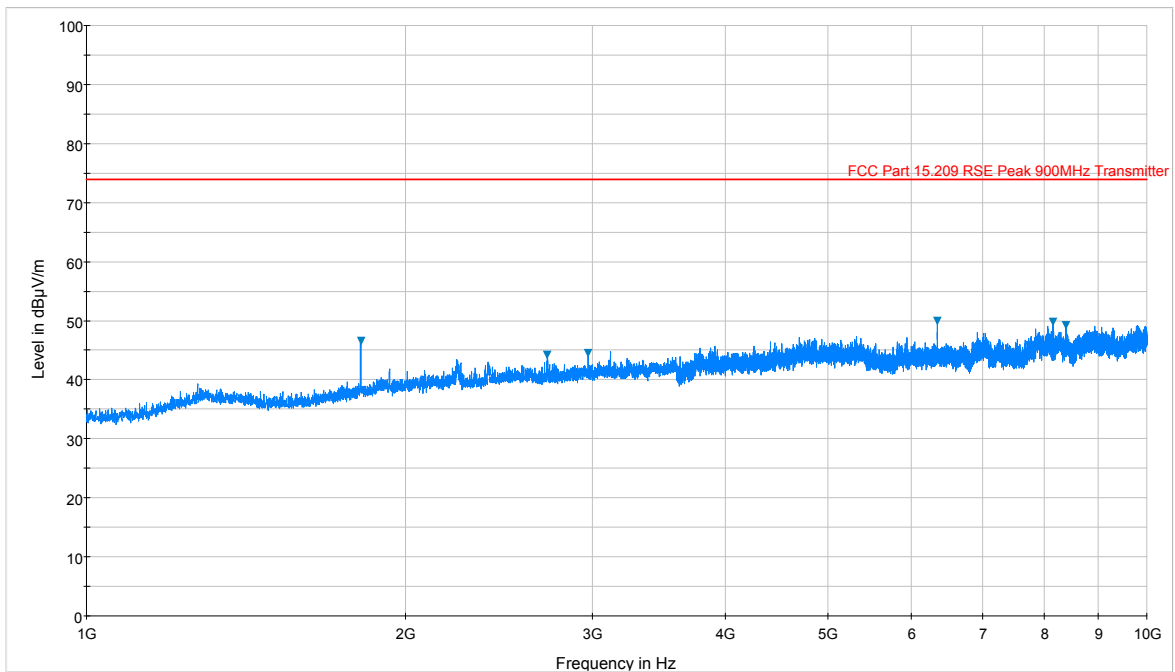
FCC ID: OXW-PA0022		FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)		Reviewed by: Quality Manager
Test Report S/N: 0Y1508261695.OXW	Test Dates: 8/27 - 9/17/15	EUT Type: Sensor II – LoRa Module		Page 27 of 37

Radiated Spurious Emission Measurements



§15.205 §15.209 §15.247 (d)

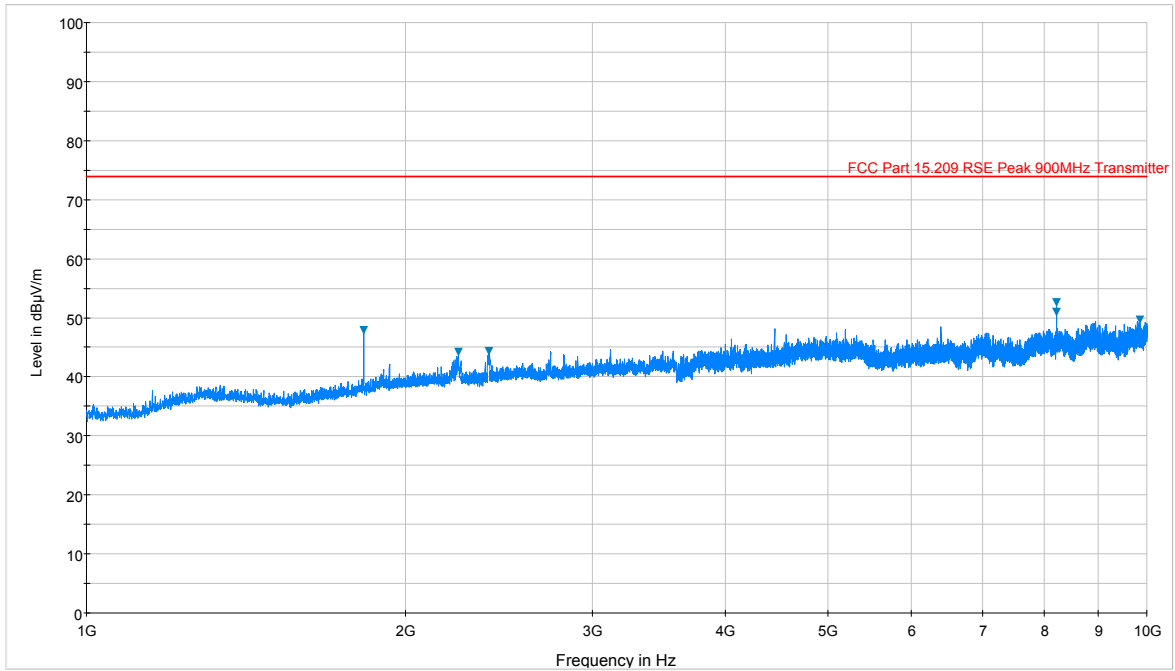


Plot 6-15. Radiated Spurious Plot above 1GHz (Low Channel) (Pol. H)

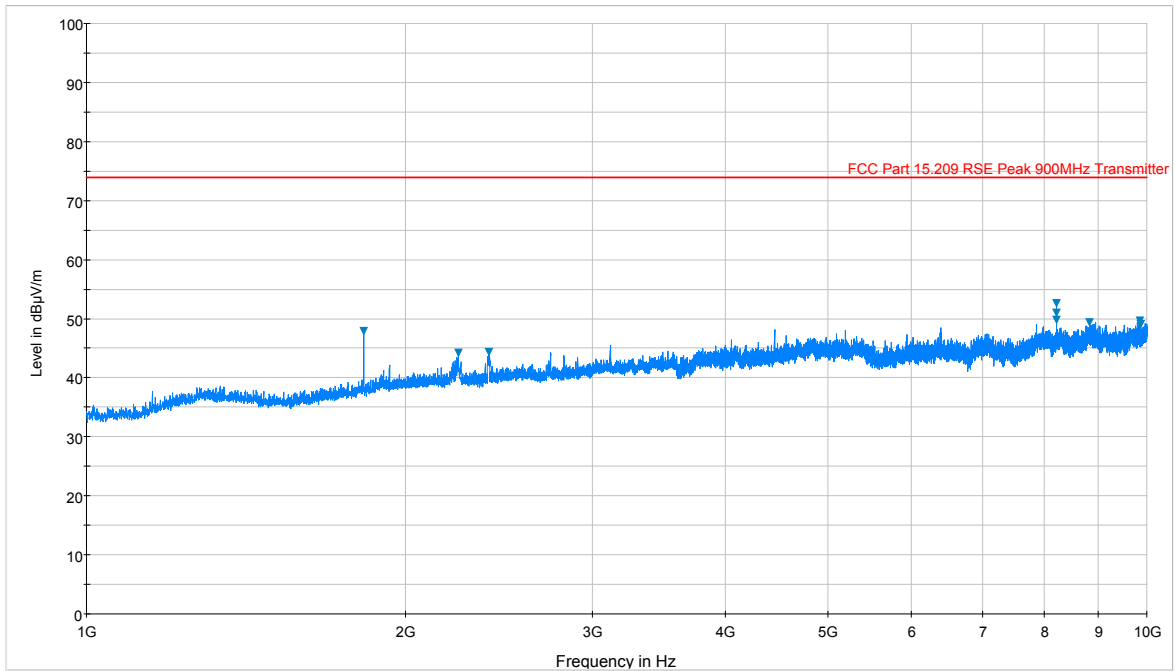


Plot 6-16. Radiated Spurious Plot above 1GHz (Low Channel) (Pol. V)



FCC ID: OXW-PA0022		FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)	 Reviewed by: Quality Manager
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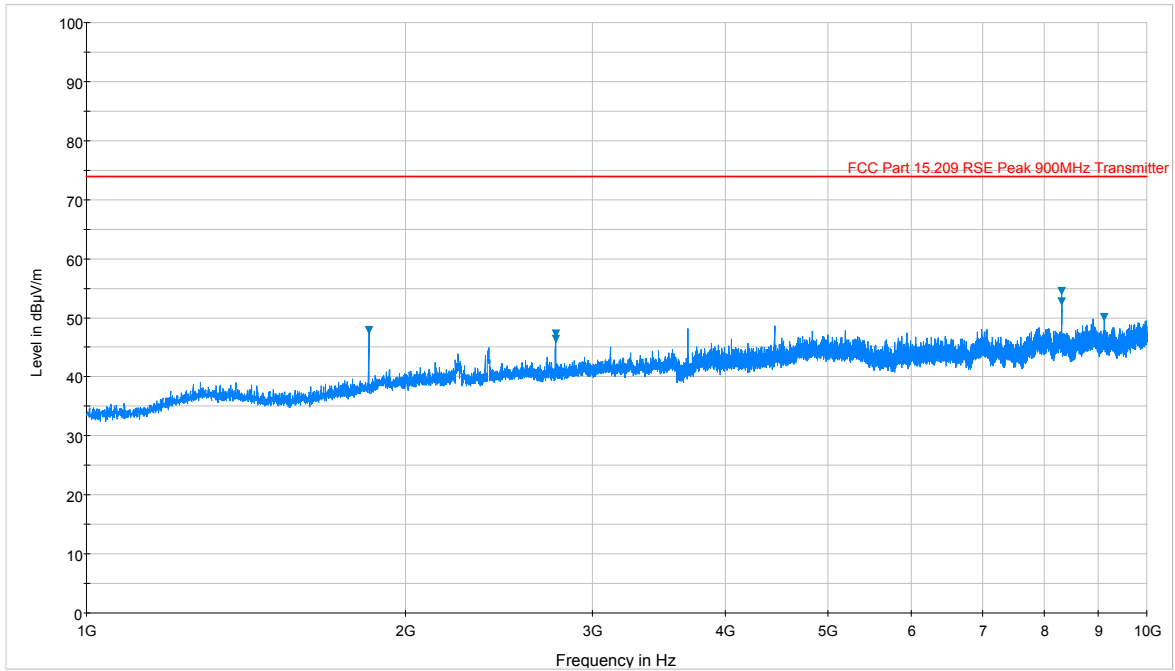


Plot 6-17. Radiated Spurious Plot above 1GHz (Mid Channel) (Pol. H)

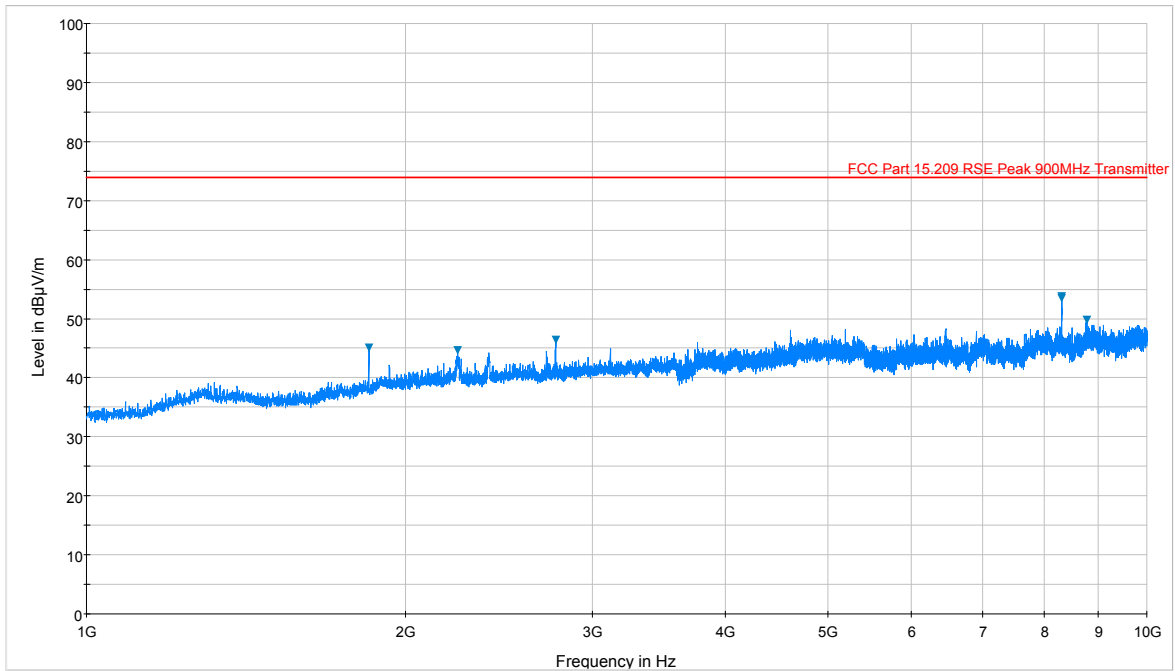


Plot 6-18. Radiated Spurious Plot above 1GHz (Mid Channel) (Pol. V)



FCC ID: OXW-PA0022		FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)	 Reviewed by: Quality Manager
Test Report S/N: 0Y1508261695.OXW	Test Dates: 8/27 - 9/17/15	EUT Type: Sensor II – LoRa Module	Page 29 of 37



Plot 6-19. Radiated Spurious Plot above 1GHz (High Channel) (Pol. H)



Plot 6-20. Radiated Spurious Plot above 1GHz (High Channel) (Pol. V)

FCC ID: OXW-PA0022		FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)	 Reviewed by: Quality Manager
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Radiated Spurious Emission Measurements

§15.205 §15.209 §15.247 (d)

Measurement Distance: 3 Meters
 Operating Frequency: 907MHz

Frequency [MHz]	Analyzer Level [dBm]	Detector	Ant. Pol. [H/V]	AFCL [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
* 2721.00	-102.52	Avg	H	36.93	41.42	53.98	-12.56
* 2721.00	-97.88	Peak	H	36.93	46.06	73.98	-27.92
* 3628.00	-104.88	Avg	H	38.87	41.00	53.98	-12.98
* 3628.00	-97.81	Peak	H	38.87	48.07	73.98	-25.91
* 4535.00	-107.53	Avg	H	41.59	41.06	53.98	-12.92
* 4535.00	-100.21	Peak	H	41.59	48.38	73.98	-25.60
* 5442.00	-108.51	Avg	H	41.94	40.43	53.98	-13.55
* 5442.00	-98.93	Peak	H	41.94	50.01	73.98	-23.97
* 7256.00	-108.19	Avg	H	43.99	42.80	53.98	-11.18
* 7256.00	-99.27	Peak	H	43.99	51.72	73.98	-22.26
* 8163.00	-103.43	Avg	H	44.65	48.22	53.98	-5.76
* 8163.00	-97.39	Peak	H	44.65	54.26	73.98	-19.72
* 9070.00	-108.02	Avg	H	45.83	44.81	53.98	-9.17
* 9070.00	-97.48	Peak	H	45.83	55.35	73.98	-18.63



Table 6-8. Radiated Measurements

FCC ID: OXW-PA0022		FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)		Reviewed by: Quality Manager
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Measurement Distance: 3 Meters
 Operating Frequency: 913MHz

Frequency [MHz]	Analyzer Level [dBm]	Detector	Ant. Pol. [H/V]	AFCL [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
* 2739.00	-98.80	Avg	H	36.69	44.89	53.98	-9.09
* 2739.00	-96.03	Peak	H	36.69	47.66	73.98	-26.32
* 3652.00	-104.68	Avg	H	38.95	41.28	53.98	-12.70
* 3652.00	-97.70	Peak	H	38.95	48.26	73.98	-25.72
* 4565.00	-107.90	Avg	H	41.62	40.72	53.98	-13.26
* 4565.00	-99.23	Peak	H	41.62	49.39	73.98	-24.59
* 7304.00	-108.26	Avg	H	44.21	42.94	53.98	-11.04
* 7304.00	-100.09	Peak	H	44.21	51.11	73.98	-22.87
* 8217.00	-101.05	Avg	H	44.52	50.48	53.98	-3.50
* 8217.00	-97.07	Peak	H	44.52	54.46	73.98	-19.52
* 9130.00	-108.01	Avg	H	45.88	44.86	53.98	-9.11
* 9130.00	-100.28	Peak	H	45.88	52.59	73.98	-21.38

Table 6-9. Radiated Measurements

FCC ID: OXW-PA0022		FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)		Reviewed by: Quality Manager
Test Report S/N: 0Y1508261695.OXW	Test Dates: 8/27 - 9/17/15	EUT Type: Sensor II – LoRa Module	Page 32 of 37	



Radiated Spurious Emission Measurements

§15.205 §15.209 §15.247 (d)

Measurement Distance: 3 Meters
 Operating Frequency: 923MHz

	Frequency [MHz]	Analyzer Level [dBm]	Detector	Ant. Pol. [H/V]	AFCL [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	2769.00	-95.94	Avg	H	36.78	47.84	53.98	-6.14
*	2769.00	-93.81	Peak	H	36.78	49.97	73.98	-24.01
*	3692.00	-103.24	Avg	H	39.09	42.85	53.98	-11.13
*	3692.00	-97.04	Peak	H	39.09	49.05	73.98	-24.93
*	4615.00	-104.99	Avg	H	41.55	43.56	53.98	-10.42
*	4615.00	-97.46	Peak	H	41.55	51.09	73.98	-22.89
*	7384.00	-105.81	Avg	H	44.26	45.45	53.98	-8.53
*	7384.00	-98.75	Peak	H	44.26	52.51	73.98	-21.47
*	8307.00	-100.46	Avg	H	44.46	51.00	53.98	-2.98
*	8307.00	-96.10	Peak	H	44.46	55.36	73.98	-18.62

Table 6-10. Radiated Measurements

FCC ID: OXW-PA0022		FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)			Reviewed by: Quality Manager
Test Report S/N: 0Y1508261695.OXW	Test Dates: 8/27 - 9/17/15	EUT Type: Sensor II – LoRa Module			Page 33 of 37

6.8 Radiated Spurious Emissions 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 6-9 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 6-11. Radiated Limits



Test Procedures Used

ANSI C63.4-2014

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-PA0022		FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)		Reviewed by: Quality Manager
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Test Setup

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

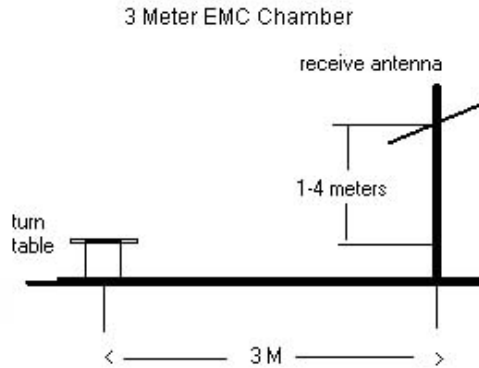




Figure 6-7. Test Instrument & Measurement Setup

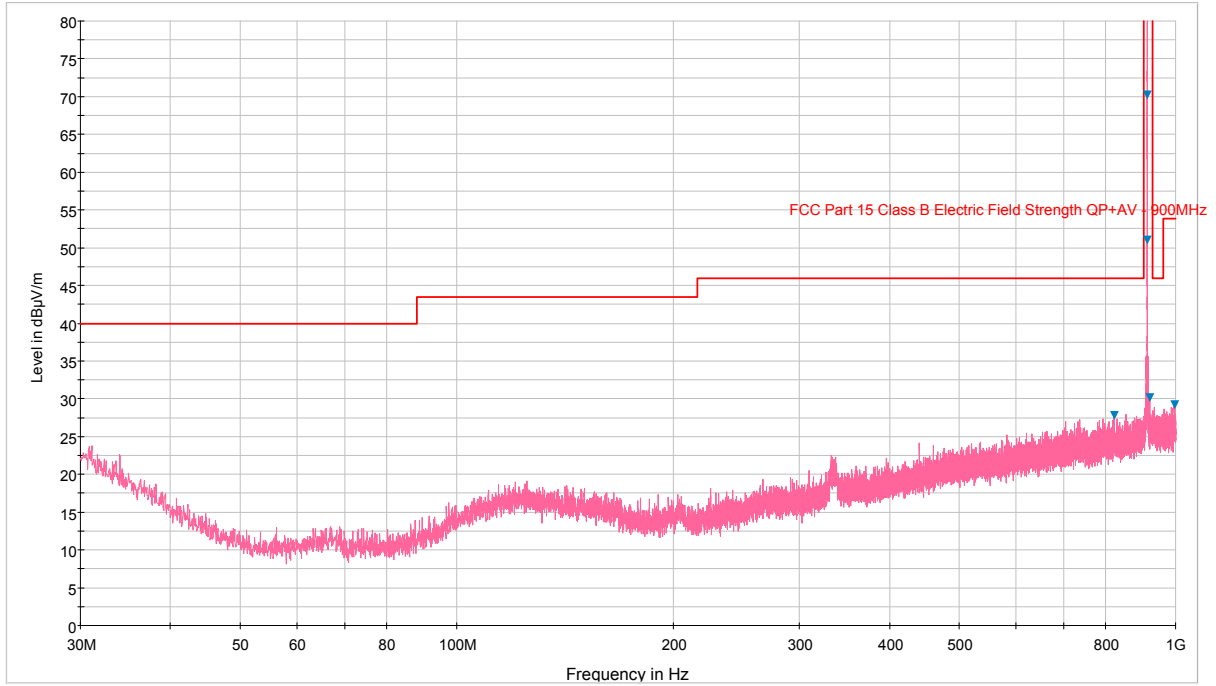
Test Notes

1. All emissions lying in restricted bands specified in §15.205 are below the limit shown in Table 6-11.
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 a 9V battery.
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.

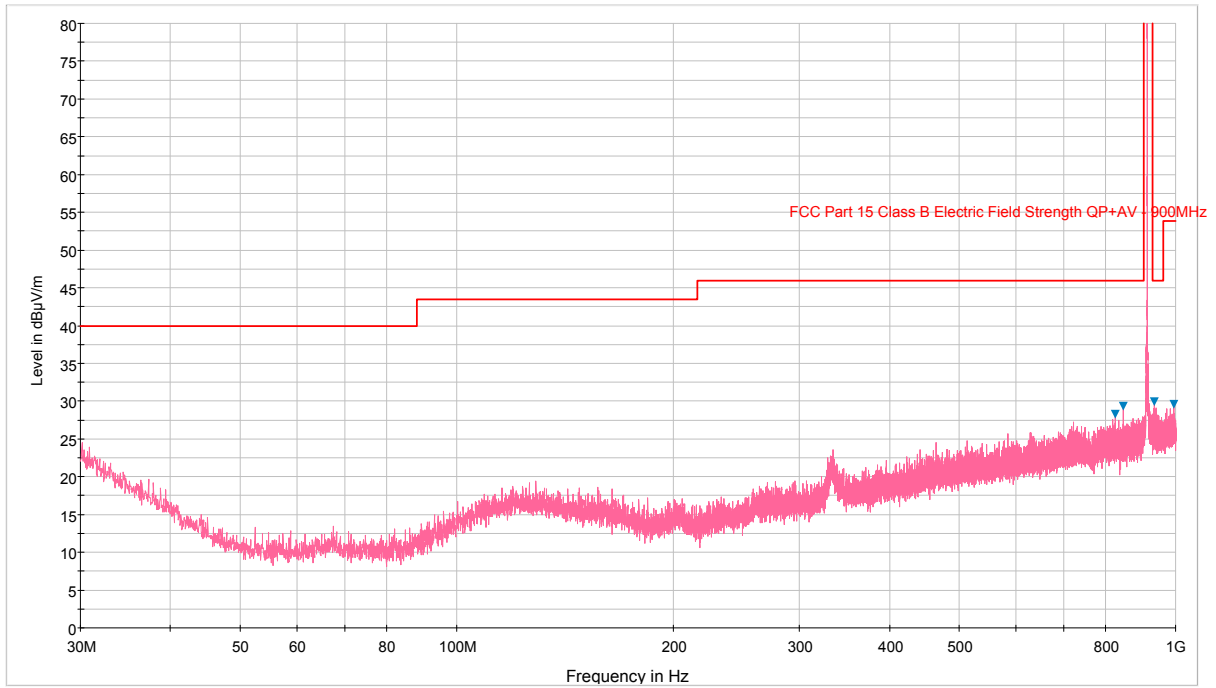
FCC ID: OXW-PA0022		FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)	 Reviewed by: Quality Manager
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Radiated Spurious Emissions Measurements (Below 1GHz)



§15.209



Plot 6-21. Radiated Spurious Plot below 1GHz (Pol. H)





Plot 6-22. Radiated Spurious Plot below 1GHz (Pol. V)

FCC ID: OXW-PA0022		FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)		Reviewed by: Quality Manager
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7.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **Device Solutions Sensor II – LoRa Module FCC ID: OXW-PA0022** is in compliance with Part 15 Subpart C (15.247) of the FCC Rules.

FCC ID: OXW-PA0022		FCC Pt. 15.247 900MHz ISM MEASUREMENT REPORT (CERTIFICATION)		Reviewed by: Quality Manager
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