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Report On

Application for Grant of Equipment Authorization of the
Occammd, LLC
MPCIe Smart Gateway Card– Model SG9001 & SG9002

FCC Part 15 Subpart C §15.247
IC RSS-247 Issue 2 February 2017

Report No. TP72132175.102 **November 2018**

REPORT ON	Radio Testing of the Occammd, LLC Model SG9001 & SG9002
TEST REPORT NUMBER	TP72132175.102
PREPARED FOR	Occammd, LLC PO Box 172548 Tampa, FL 33672-0548
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PREPARED BY	**Steve Hoke** Authorized Signatory Senior EMC Engineer
APPROVED BY	**Pete Walsh** Authorized Signatory Tampa Service Line Manager
DATED	08. November 2018

TÜV SÜD AMERICA INC 5610 W. Sligh Ave., Tampa, FL 33634 Phone: 813 284 2715 FAX: 813 413 3813

Revision History

TP72132175.102 Occammd, LLC Model SG9001-2					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
08. November 2018	Initial Release				Pete Walsh
27. November 2018	TP72132175.100	TP72132175.101	Update RSS Issue Date and change IC number from IC 23319-SG9001-2 to IC 23319-SG90012	all	S. Hoke
30. November 2018	TP72132175.101	TP72132175.102	Updated model numbers		S. Hoke

CONTENTS

Section		Page No
1	**REPORT SUMMARY**	**5**
1.1	Introduction	6
1.2	Brief Summary of Results	7
1.3	Product Information	8
1.4	EUT Test Configuration	9
1.5	Deviations from the Standard	11
1.6	Modification Record	11
1.7	Test Methodology	11
1.8	Test Facility Location	11
2	**TEST DETAILS**	**12**
2.1	Peak Output Power	13
2.2	Conducted Emissions	17
2.3	99% Emission Bandwidth	19
2.4	Minimum 6 dB RF Bandwidth	24
2.5	Out-Of-Band Emissions - Conducted	28
2.6	Band-Edge Compliance of RF Conducted Emissions	32
2.7	Spurious Radiated Emissions	35
2.8	Power Spectral Density	41
3	**TEST EQUIPMENT USED**	**46**
3.1	Test Equipment Used	47
3.2	Measurement Uncertainty	48
4	**DIAGRAM OF TEST SETUP**	**49**
4.1	Test Setup Diagram	50
5	**ACCREDITATION, DISCLAIMERS AND COPYRIGHT**	**52**
5.1	Accreditation, Disclaimers and Copyright	53

SECTION 1

1REPORT SUMMARY

Radio Testing of the
Occammd, LLC
Model SG9001-2

1.1 INTRODUCTION

The information contained in this report is intended to show compliance of Occammd, LLC., Model SG9001-2 to the requirements of FCC Part 15 Subpart C §15.247 and IC RSS-247 Issue 1 May 2015.

Objective	To perform Radio Testing to determine the Equipment Under Test's (EUT's) compliance with the Test Specification, for the series of tests carried out.
Manufacturer	Occammd, LLC
Model Number(s)	SG9001 & SG9002
FCC ID Number	2ANX6-SG9001-2
IC Number	23319-SG90012
Serial Number(s)	None
Number of Samples Tested	1
Test Specification/Issue/Date	• FCC Part 15 Subpart C §15.247 • IC RSS-247 Issue 1 February 2017. Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices. • IC RSS-GEN Issue 4 November 2018. General Requirements for Compliance of Radio Apparatus. • 558074 D01 DTS Meas Guidance v04, (April 05, 2017) Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247.
Start of Test	29. November, 2016
Finish of Test	03. January 2017
Name of Engineer(s)	David Foerstner / Steven Hoke
Related Document(s)	None. Supporting documents for EUT certification are separate exhibits.

1.2 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out in accordance with FCC Part 15 Subpart C §15.247 with cross-reference to the corresponding IC RSS standard is shown below.

Section	§15.247 Spec Clause	RSS	Test Description	Result	Comments/ Base Standard
2.1	§15.247(b)(3)	RSS-247 5.4(4)	Peak Output Power	Compliant	
2.2	§15.207(a)	RSS-Gen 8.8	Conducted Emissions	N/A	
2.3		RSS-Gen 6.6	99% Emission Bandwidth	Compliant	
2.4	§15.247(a)(2)	RSS-247 5.2(1)	Minimum 6 dB RF Bandwidth	Compliant	
2.5	§15.247(d)	RSS-247 5.5	Out-of-Band Emissions - Conducted	Compliant	
2.6	§15.247(d)	RSS-247 5.5	Band-edge Compliance of RF Conducted Emissions	Compliant	
2.7	§15.247(d)	RSS-Gen 8.9 and 8.10	Spurious Radiated Emissions	Compliant	
2.7		RSS-Gen 7.1	Receiver Spurious Emissions	Compliant	
2.8	§15.247(e)	RSS-247 5.2(2)	Power Spectral Density for Digitally Modulated Device	Compliant	

N/A Not performed. EUT is an RF Module.

1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) was a Occammd, LLC Model SG9001 & SG9002. It was mounted and tested on the provided Occam Technology Group host as detailed in this filing.

1.3.2 EUT General Description

EUT Description	PCIE Radio Card (915 MHz version)
Model Number(s)	SG9001-2
Rated Voltage	3.3 to 5VDC
Mode Verified	LoRa
Capability	LoRa
Primary Unit (EUT)	☐ Production
	☒ Pre-Production
	☐ Engineering
Antenna Manufacturer	SHENZHEN TUKO TECHNOLOGY CO.LTD
Antenna Part Number	TG 03-0930
Antenna Type	Omni-Directional
Antenna Gain	5.0 dBi
Host Brand	Occam Technology Group
Host Model Name	none
Host Model Number	LoRa-Adapter-01

1.3.3 Maximum Conducted Output Power (Peak)

Mode	Frequency Range (MHz)	Output Power (dBm)	Output Power (mW)
LoRa	903 – 927.4	25.64	366.4

1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

Test Configuration	Description
A	Antenna conducted port test configuration. Direct connection of the antenna port to a spectrum analyzer.
B	Radiated emissions test configuration. EUT transmitting through the integral antenna (mounted on the development board).
C	Radiated emissions test configuration. Antenna port terminated.

1.4.2 EUT Exercise Software

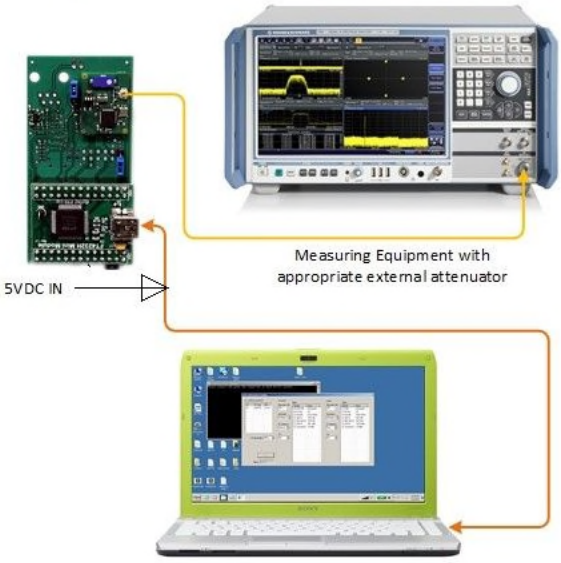
The manufacturer provided an application (Gateway Serial Tool) to configure EUT RF settings.

1.4.3 Support Equipment and I/O cables

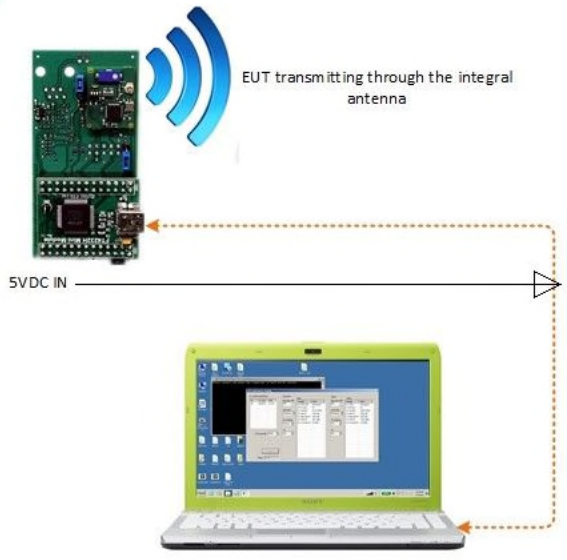
Manufacturer	Equipment/Cable	Description
Escort, Inc.	Host Board	LoRa-Adapter-01
Lenovo	Support Laptop for programming EUT	Model B570
-	RF Cable Assembly (EUT antenna port to Spectrum Analyzer)	0.2 meter, SMA Female (Bulkhead) to U.FL

1.4.4 Simplified Test Configuration Diagram

Antenna Conducted Port Test Setup



Radiated Emission Test Setup



For Illustration Purpose Only
Image presented may not represent the actual EUT, display or support equipment

Configuration not presented is when the EUT is installed inside a representative host. Radiated emissions were performed on the host while the EUT is in Rx and TX mode (worst case).

1.5 DEVIATIONS FROM THE STANDARD

No deviations from the applicable test standards or test plan were made during testing.

1.6 MODIFICATION RECORD

Description of Modification	Modification Fitted By	Date Modification Fitted
Serial Number		
None.		

The table above details modifications made to the EUT during the test programme. The modifications incorporated during each test (if relevant) are recorded on the appropriate test pages.

1.7 TEST METHODOLOGY

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

For conducted and radiated emissions, the equipment under test (EUT) was configured to measure its highest possible emission level. The test modes were adapted according to the Operating Instructions provided by the manufacturer/client.

1.8 TEST FACILITY LOCATION

1.8.1 FCC – Site Registration

The TUV SUD America Inc. (Tampa), test facility has been registered with the Federal Communication Commission as an ISO/IEC 17025 accredited test laboratory and assigned the designation number US1063.

1.8.2 Canadian ISED Site Registration

The TUV SUD America Inc. (Tampa), test facility has been registered with Innovation, Science and Economic Development Canada and assigned the site number 2087A-2.

1.8.3 VCCI Site Registration

The TUV SUD America Inc. (Tampa), test facility has been registered with the VCCI and assigned the registration number A-0256.

SECTION 2

2TEST DETAILS

Radio Testing of the
Occammd, LLC
Model SG9001-2

2.1 PEAK OUTPUT POWER

2.1.1 Specification Reference

Part 15 Subpart C §15.247(b)(3)

2.1.2 Standard Applicable

(3) For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

2.1.3 Equipment Under Test and Modification State

Serial No: none / Test Configuration A

2.1.4 Date of Test/Initial of test personnel who performed the test

08. February 2018 / DF

2.1.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.1.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Tampa facility

Ambient Temperature	24 - 26 °C
Relative Humidity	48 - 52 %

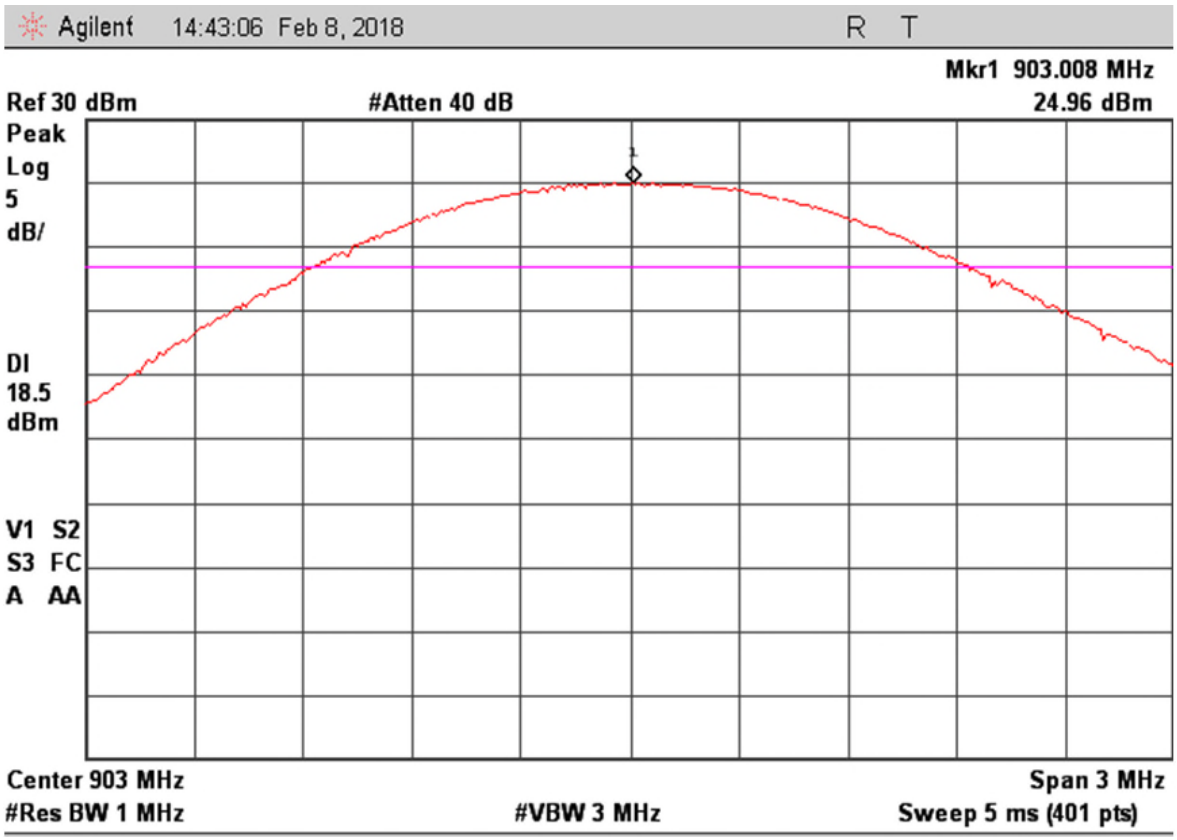
2.1.7 Additional Observations

- This is a conducted test (Maximum Peak Conducted Output Power) using direct connection to a spectrum analyzer.
- The cable loss of (0.64) dB was added to the measured value.
- Test methodology is per Clause 9.1.1 of KDB 558074 D01 (DTS Meas Guidance v03r05, April 08, 2016). All conditions under this Clause were satisfied.

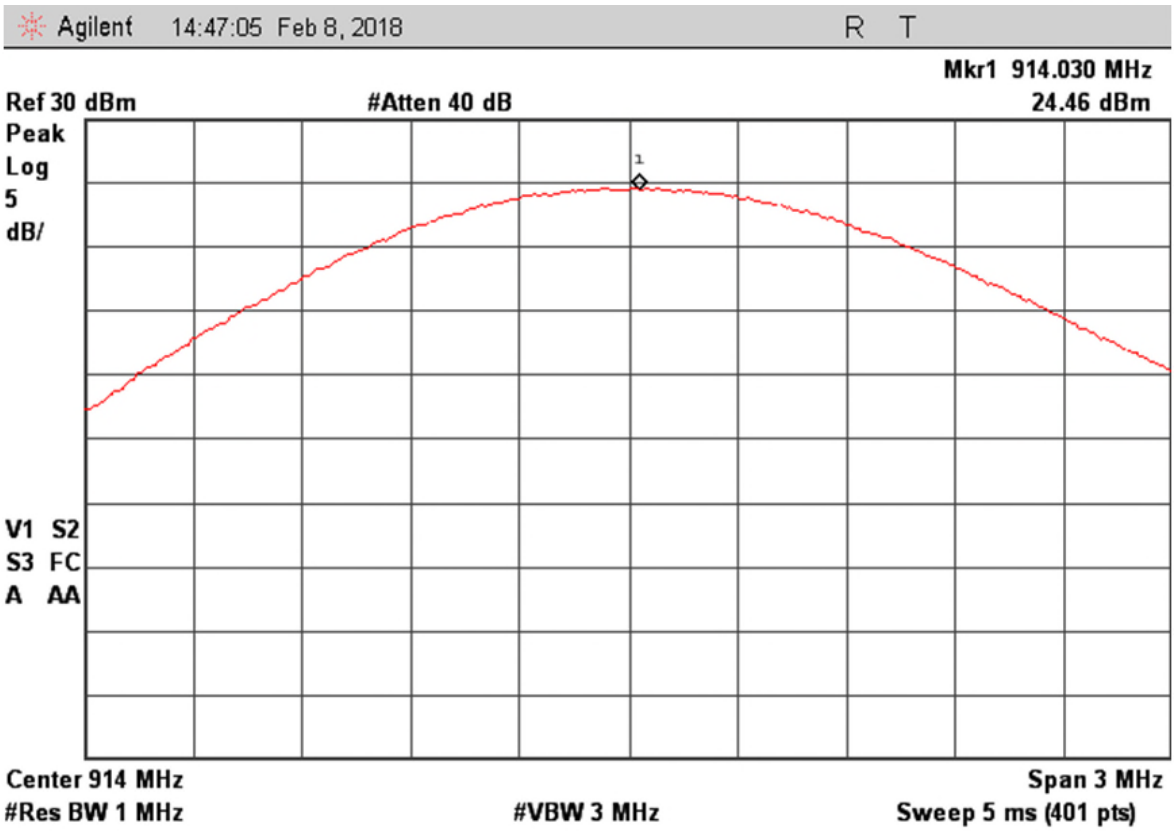
2.1.8 Test Results

Channel	Modulation	Measured Peak Power (dBm)	Cable loss (dB)	Actual Peak Power (dBm)	Actual Peak Power (mW)
903 MHz	LoRa SF 12	25.0	0.64	25.64	366.4
914 MHz		24.5	0.64	25.14	326.6
927.5 MHz		24.3	0.64	24.94	311.9

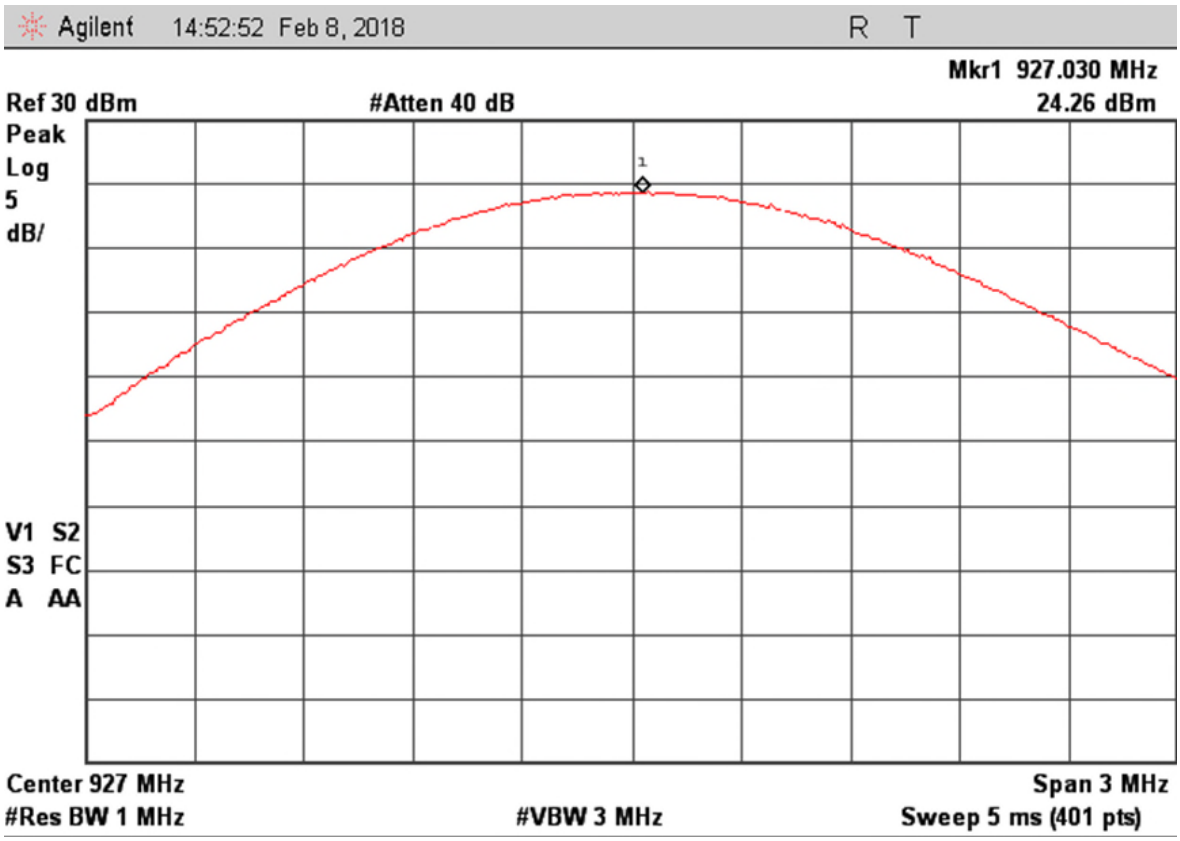
2.1.9 Test Plots



Low Channel Peak Power



Mid Channel Peak Power



High Channel Peak Power

2.2 CONDUCTED EMISSIONS

2.2.1 Specification Reference

Part 15 Subpart C §15.207(a)

2.2.2 Standard Applicable

An intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN).

Frequency of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

**Decreases with the logarithm of the frequency.*

2.2.3 Equipment Under Test and Modification State

Serial No: 001 /Test Configuration B

2.2.4 Date of Test/Initial of test personnel who performed the test

Not applicable – battery operated

2.2.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.2.6 Environmental Conditions

Not applicable as the test was not performed.

2.2.7 Additional Observations

Not applicable as the test was not performed.

2.2.1 Sample Computation (Conducted Emission – Quasi Peak)

Measuring equipment raw measurement (dBµV) @ 150kHz			30.0
Correction Factor (dB)	TEMC00002 - LISN	0.03	0.11
	Cable 1	0.08	
Reported QuasiPeak Final Measurement (dbµV) @ 150kHz			**30.11**

2.2.2 Test Results

Not applicable – battery operated

2.3 99% Emission Bandwidth

2.3.1 Specification Reference

RSS-Gen Clause 6.6

2.3.2 Standard Applicable

The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth.
When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- • The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.
- • The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3x RBW.

Note: Video averaging is not permitted.
A peak, or peak hold, may be used in place of the sampling detector as this may produce a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold may be necessary to determine the occupied bandwidth if the device is not transmitting continuously.
The trace data points are recovered and are directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded.
The difference between the two recorded frequencies is the 99% occupied bandwidth.

2.3.3 Equipment Under Test and Modification State

Serial No: none / Test Configuration A

2.3.4 Date of Test/Initial of test personnel who performed the test

09. February 2018 / SH

2.3.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.3.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Tampa facility

Ambient Temperature	24 - 26 °C
Relative Humidity	48 - 52 %

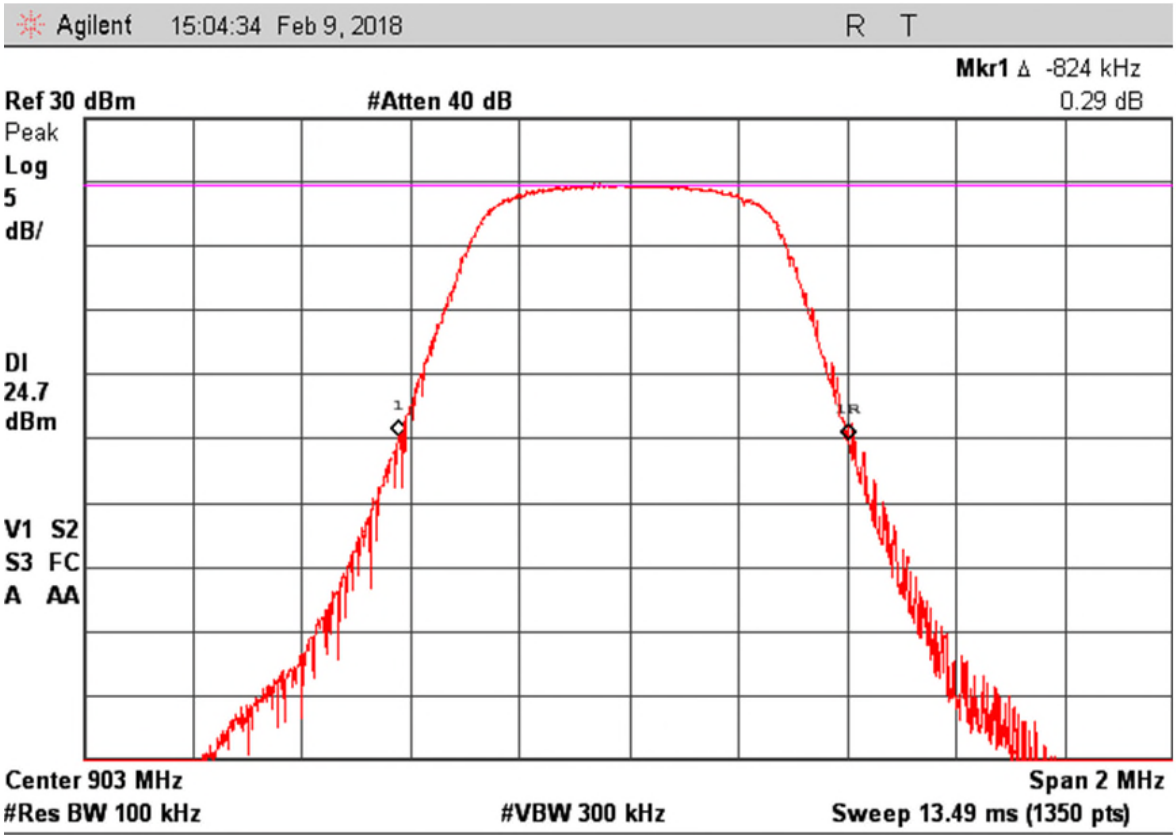
2.3.7 Additional Observations

- This is a conducted test. EUT on normal test mode.
- Span is wide enough to capture the channel transmission.
- RBW is 1% to 5% of the span.
- VBW is 3X RBW.
- Sweep is auto.
- Detector is peak.

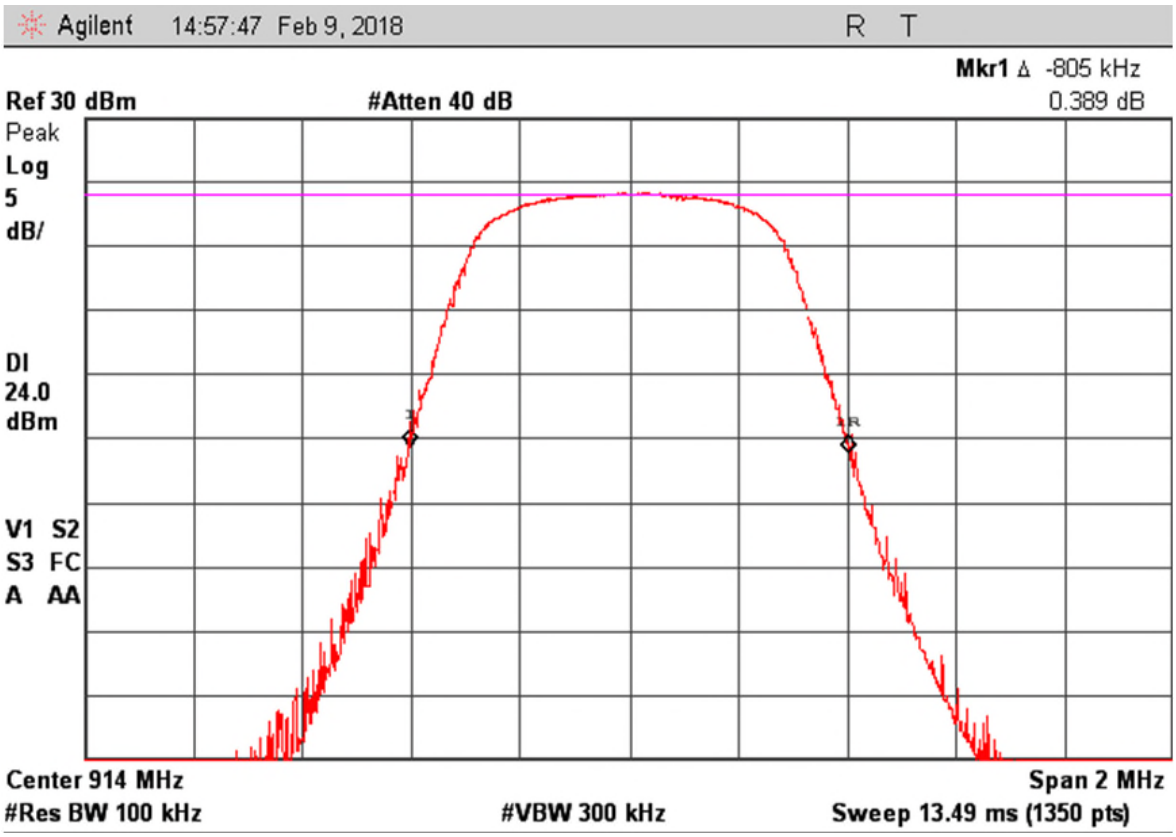
2.3.8 Test Results (For reporting purposes only)

Mode	Channel	Measured 99% Bandwidth (kHz)
LoRa	903 MHz	824
	914 MHz	805
	927 MHz	805

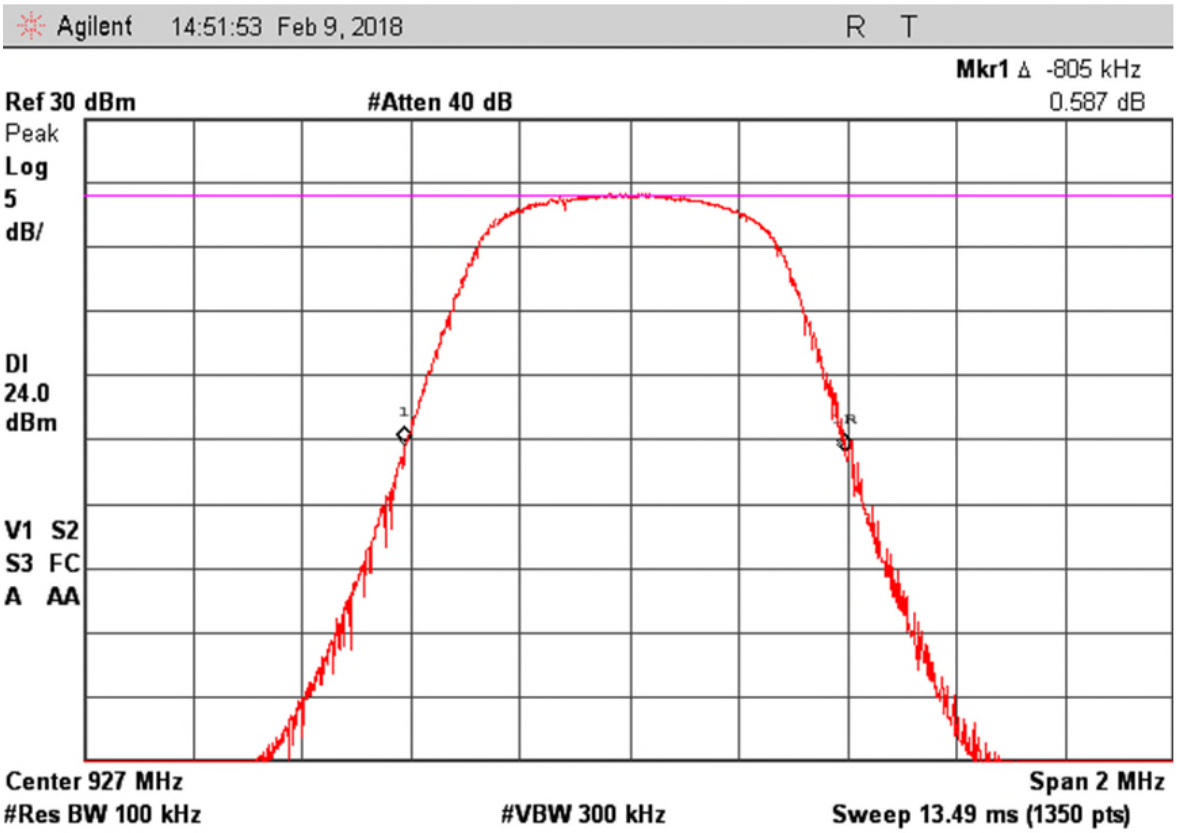
2.3.9 Test Plots



LoRa Low Channel



LoRa Mid Channel



LoRa High Channel

2.4 MINIMUM 6 dB RF BANDWIDTH

2.4.1 Specification Reference

Part 15 Subpart C §15.247(a)(2)

2.4.2 Standard Applicable

(2) Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

2.4.3 Equipment Under Test and Modification State

Serial No: none/ Test Configuration A

2.4.4 Date of Test/Initial of test personnel who performed the test

08. February 2018 / DF

2.4.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.4.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Tampa facility

Ambient Temperature	24 - 26 °C
Relative Humidity	48 - 52 %

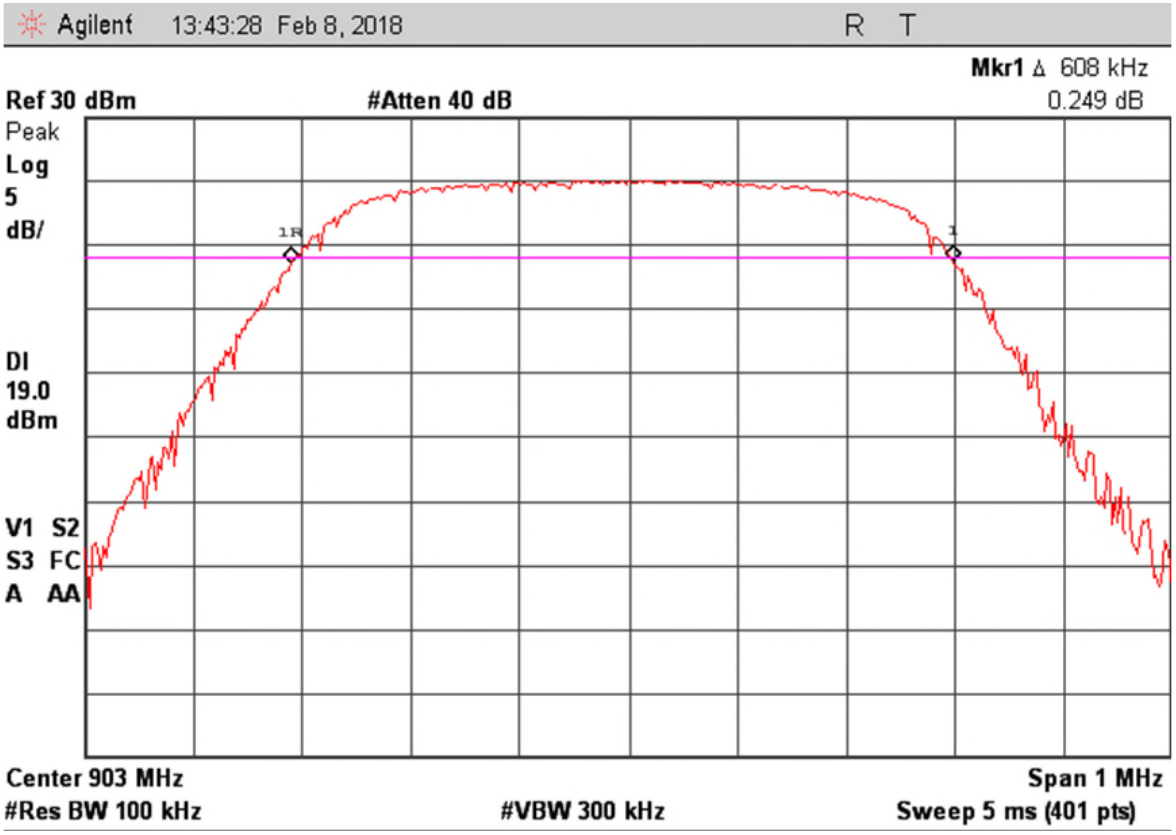
2.4.7 Additional Observations

- This is a conducted test.
- Span is wide enough to capture the channel transmission.
- RBW is set to 100 kHz.
- VBW is ≥3X RBW.
- Sweep is auto.
- Detector is peak.

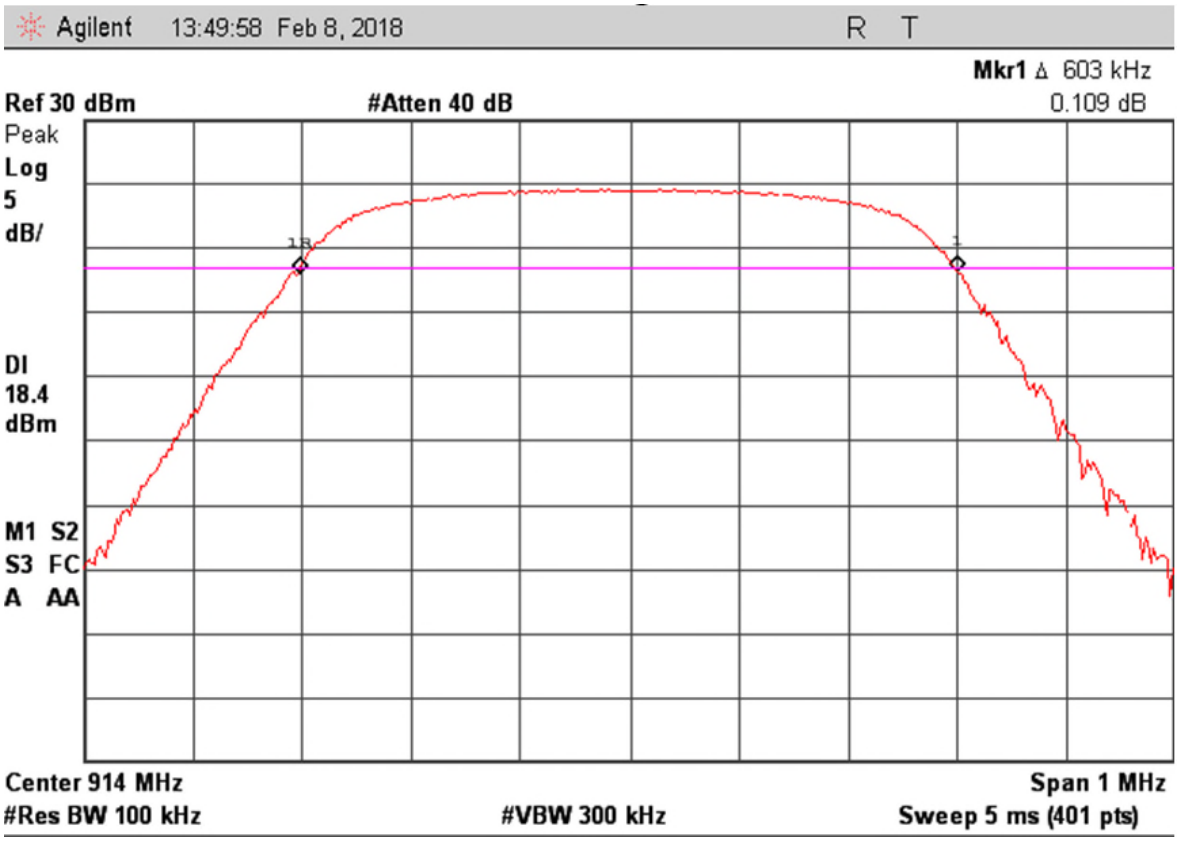
2.4.8 Test Results

Mode	Channel	Measured Bandwidth (MHz)	Minimum Bandwidth (MHz)	Compliance
LoRa	903 MHz	0.608	0.500	Complies
	914 MHz	0.603	0.500	Complies
	927 MHz	0.600	0.500	Complies

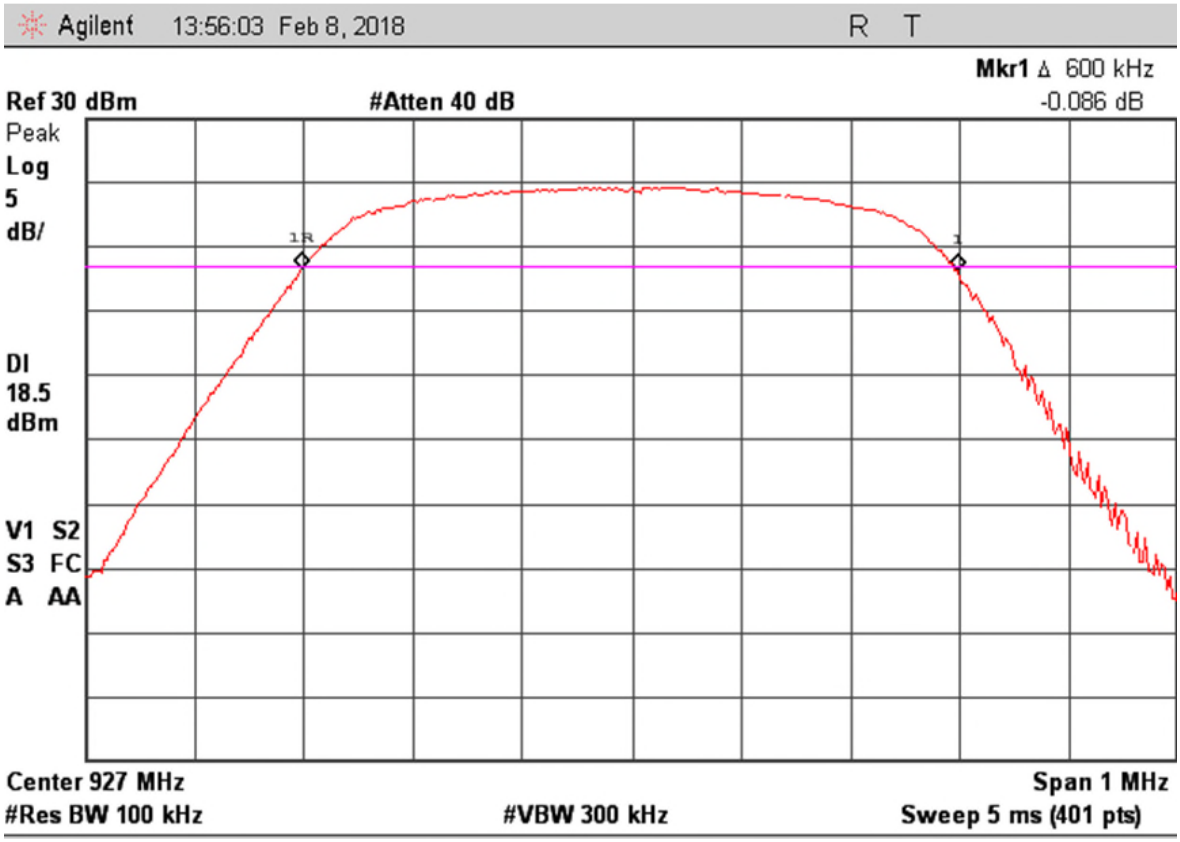
2.4.9 Test Results Plots



LoRa Low Channel



LoRa Mid Channel



LoRa High Channel

2.5 OUT-OF-BAND EMISSIONS - CONDUCTED

2.5.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.5.2 Standard Applicable

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

2.5.3 Equipment Under Test and Modification State

Serial No: none/ Test Configuration A

2.5.4 Date of Test/Initial of test personnel who performed the test

08. February 2018 / DF

2.5.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.5.6 Environmental Conditions

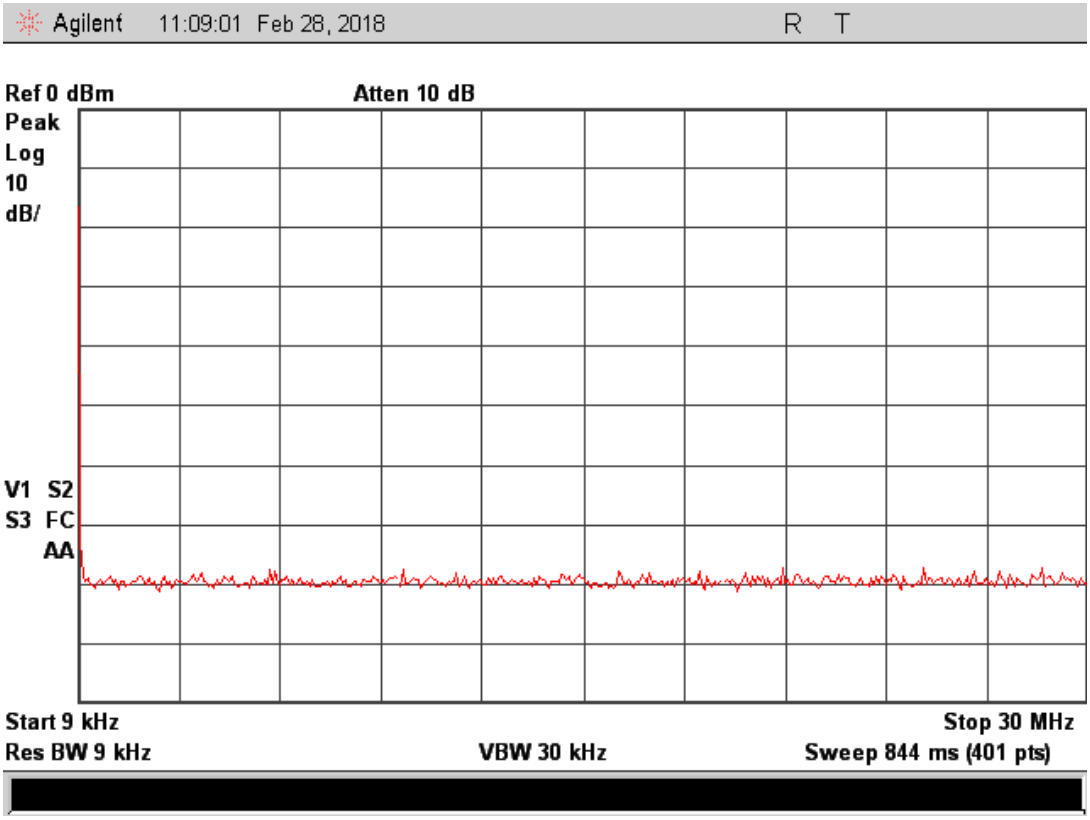
Test performed at TÜV SÜD America Inc. Tampa facility

Ambient Temperature	22 – 24 °C
Relative Humidity	48 – 52%

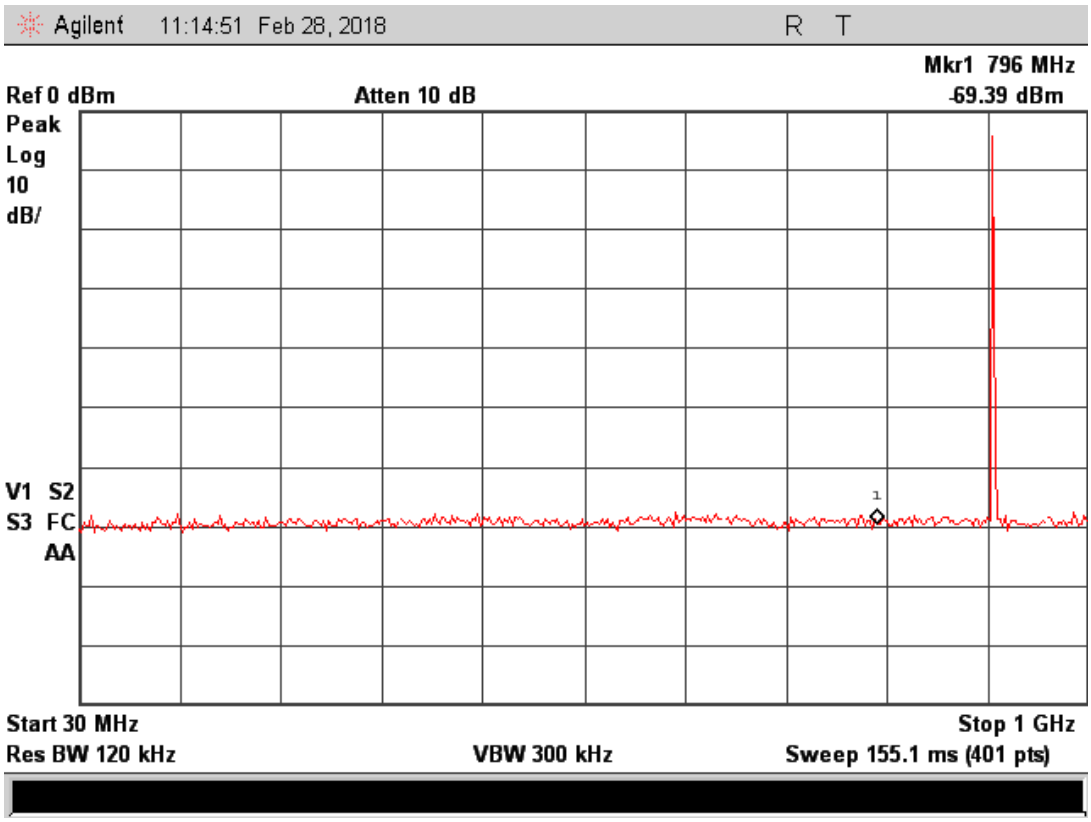
2.5.7 Additional Observations

- This is a conducted test.
- RBW is 100kHz.VBW is 3X RBW.
- Sweep is auto. Detector is peak. Trace is max hold. Sweep points set to maximum.
- Initial scan was performed to determine the highest level of the desired power within the band. Limit (display line) was drawn 20dB below this level.
- Spectrum was searched from 9 kHz up to 26.5GHz.

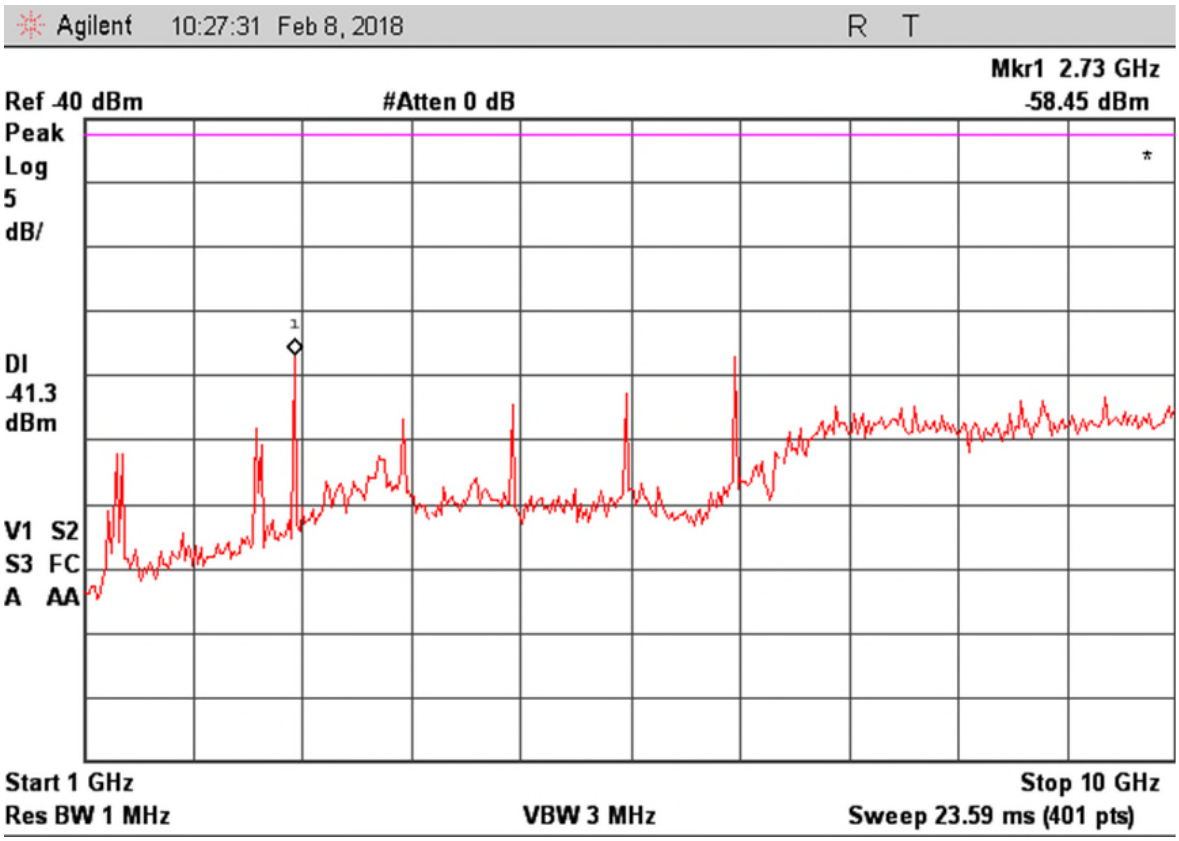
2.5.8 Test Results Plots



Conducted Emissions (9 kHz to 30 MHz)



Conducted Emissions (30 MHz to 1 GHz)



Conducted Emissions (1 to 10 GHz)

72132175 EM OCCAMMD (915 MHz Radio), 1 to 10 GHz Restricted Bands evaluation. All Harmonics are greater than 20 dB below the "Restricted Band" limit

TX Power Setting in Software is set = +27 dBm for All Plots
Gateway Serial Tool, LORA Packets constant

A conducted output power level of -41.3 dBm equates to an electric field strength level of 54 dBuV/M.

(E=EIRP – 20 log D + 104.8), D=3M, E=54dBuV/M
Therefore E=EIRP+95.3 and therefore EIRP=E-95.3=54-95.3= -41.3

Therefore an EIRP measurement of -41.3 dBm would equate to Field Strength of
54 dBuV/M (The Restricted Band Limit @3Meters Distance)

Direct into SA:
These graph levels are already corrected to present EIRP, added are the EUT antenna Gain of 5.0 dBi, cable loss involved with setup and insertion loss (2.5 dB) of high pass filter used to block the 908 MHz

Conducted Output power (dBm)
Emissions in RESTRICTED Frequency Bands
Out of Band Emissions, FCC Part 15.247 (d)

2.6 BAND-EDGE COMPLIANCE OF RF CONDUCTED EMISSIONS

2.6.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.6.2 Standard Applicable

See previous test.

2.6.3 Equipment Under Test and Modification State

Serial No: none / Test Configuration A

2.6.4 Date of Test/Initial of test personnel who performed the test

09. February 2018 / SH

2.6.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.6.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Tampa facility

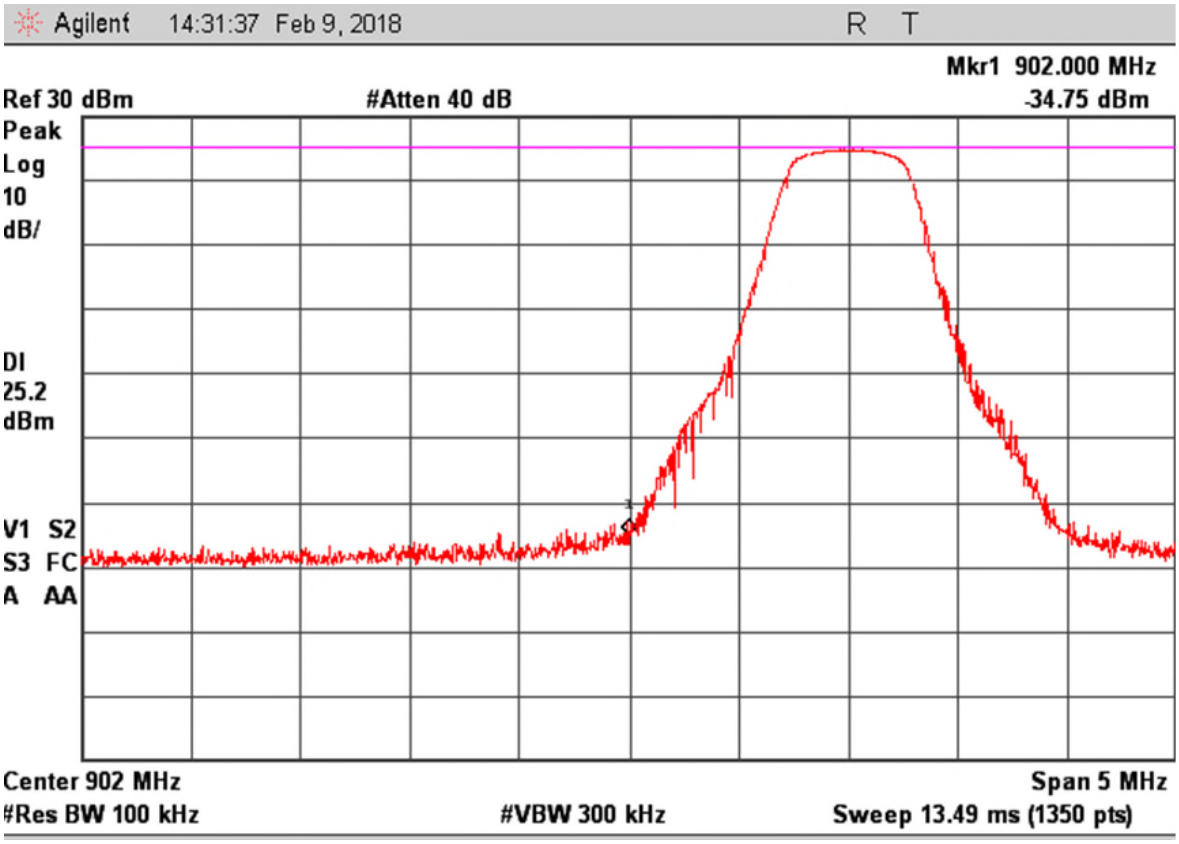
Ambient Temperature	24 - 26 °C
Relative Humidity	48 - 52 %

2.6.7 Additional Observations

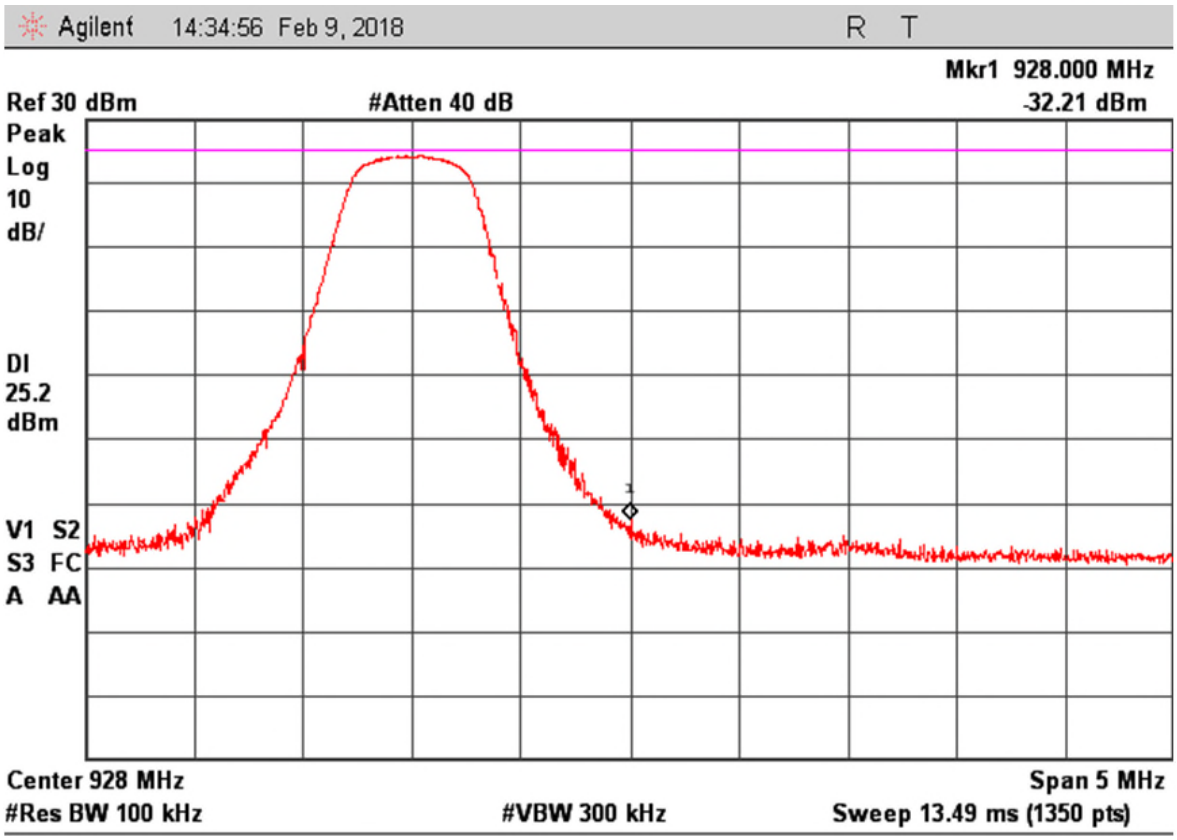
- This is a conducted test.
- RBW is 100kHz.VBW is 3X RBW.
- Sweep is auto. Detector is peak. Trace is max hold.
- Trace was centred on the band-edge frequency.
- Span was set to encompass the band-edge frequency and the peak of the emission.
- Using Marker function, peak of the emission was determined and the delta to the band-edge frequency measured.
- Band-edges were verified ≤ 30 dBc.

2.6.8 Test Results

Complies. See attached plots.



LoRa Low Channel (903 MHz)



LoRa High Channel (927.5 MHz)

2.7 SPURIOUS RADIATED EMISSIONS

2.7.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.7.2 Standard Applicable

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

2.7.3 Equipment Under Test and Modification State

Serial No: none / Test Configuration B and C

2.7.4 Date of Test/Initial of test personnel who performed the test

06. February 2018 / DF

2.7.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.7.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Tampa facility

Ambient Temperature	24 - 26 °C
Relative Humidity	48 - 52 %

2.7.7 Additional Observations

- This is a radiated test. The spectrum was searched from 30MHz to the 10th harmonic.
- There are no emissions found that do not comply to the restricted bands defined in FCC Part 15 Subpart C, 15.205 or Part 15.247(d).
- Verification of the EUT while inside a representative host were also performed.
- Measurement was done using EMC32 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.6.8 for sample computation.
- No additional emissions were observed because of EUT being placed in receive mode.

2.7.1 Sample Computation (Radiated Emission)

Measuring equipment raw measurement (dBµV) @ 30 MHz			20.0
Correction Factor (dB)	Cable 2	0.24	18.94
	TEMC00011 (antenna)	18.70	
Reported QuasiPeak Final Measurement (dBµV/m) @ 30MHz			**38.94**

2.7.2 Test Results

See attached plots.

2.7.3 Test Results Below 1GHz

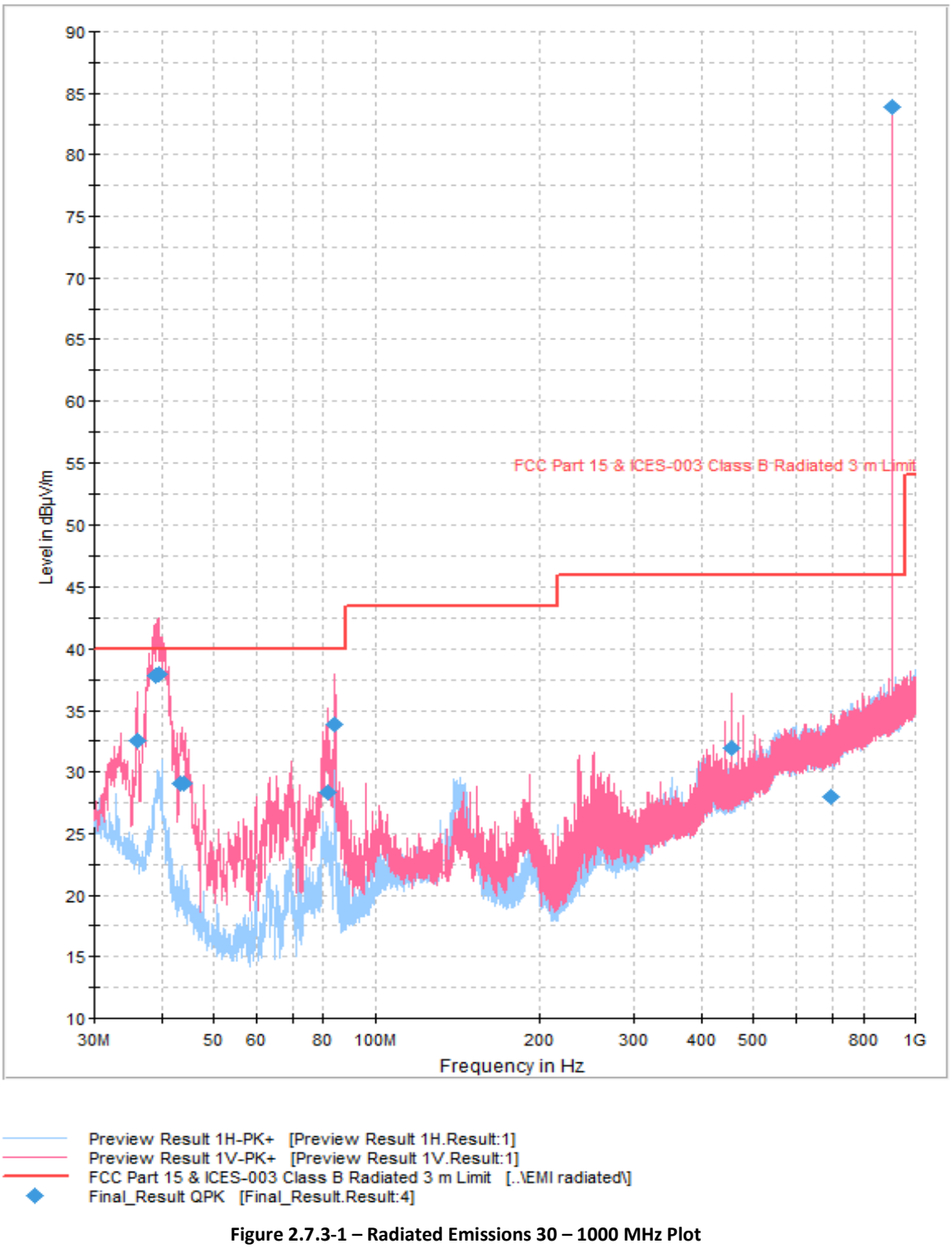


Figure 2.7.3-1 – Radiated Emissions 30 – 1000 MHz Plot

Table 2.7.3-1 – Quasi-Peak Detector Data 30 – 1000 MHz

Frequency (MHz)	Quasi-Peak (dBµV/m)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
36.00	32.5	100.0	V	241.0	22.1	7.5	40.0
39.04	37.8	101.0	V	46.0	20.4	2.2	40.0
39.48	37.9	103.0	V	354.0	20.1	2.1	40.0
43.40	29.1	104.0	V	45.0	17.9	10.9	40.0
43.96	29.1	100.0	V	12.0	17.6	10.9	40.0
81.36	28.4	130.0	V	203.0	14.3	11.6	40.0
83.96	33.9	133.0	V	45.0	14.8	6.1	40.0
456.00	31.9	104.0	V	160.0	25.5	14.1	46.0
698.00	27.9	328.0	V	315.0	28.4	18.1	46.0
698.44	27.9	266.0	V	39.0	28.4	18.1	46.0
908.00	83.9	100.0	H	230.0	30.5	N/A	N/A

2.7.4 Test Results Above 1GHz

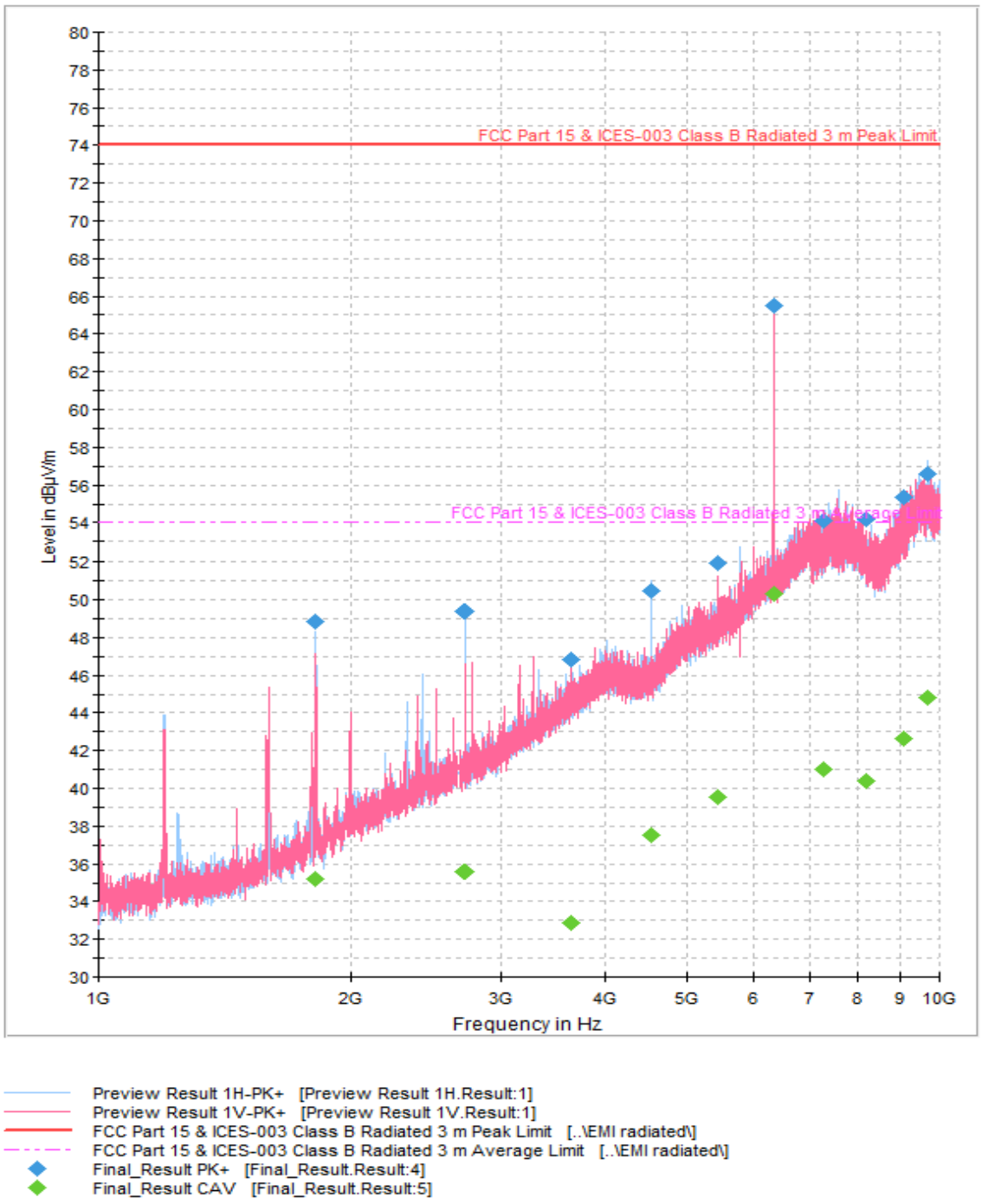


Figure 2.7.4-1 – Radiated Emissions 1 – 10 GHz Plot

Table 2.7.4-1 –-Peak Detector Data 1 – 10 GHz

Frequency (MHz)	Peak (dBµV/m)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1816.00	48.8	157.0	H	276.0	-3.9	25.2	74.0
2724.00	49.4	378.0	H	256.0	-0.2	24.6	74.0
3632.00	46.8	346.0	H	80.0	3.6	27.2	74.0
4540.00	50.4	100.0	H	138.0	5.3	23.6	74.0
5448.00	51.9	141.0	V	29.0	7.7	22.1	74.0
6356.00	65.5	164.0	V	319.0	9.0	8.5	74.0
7264.00	54.1	314.0	V	0.0	11.8	19.9	74.0
8172.00	54.2	163.0	V	228.0	14.0	19.8	74.0
9080.00	55.4	150.0	H	189.0	13.5	16.6	74.0
9660.00	56.6	239.0	H	71.0	14.1	17.4	74.0

Table 2.7.4-2 –-Average Detector Data 1 – 10 GHz

Frequency (MHz)	CAverage (dBµV/m)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1816.00	35.2	157.0	H	276.0	-3.9	18.8	54.0
2724.00	35.6	378.0	H	256.0	-0.2	18.4	54.0
3632.00	32.9	346.0	H	80.0	3.6	21.1	54.0
4540.00	37.5	100.0	H	138.0	5.3	16.5	54.0
5448.00	39.5	141.0	V	29.0	7.7	14.5	54.0
6356.00	50.3	164.0	V	319.0	9.0	3.7	54.0
7264.00	41.0	314.0	V	0.0	11.8	13.0	54.0
8172.00	40.4	163.0	V	228.0	14.0	13.6	54.0
9080.00	42.6	150.0	H	189.0	13.5	11.4	54.0
9660.00	44.8	239.0	H	71.0	14.1	9.2	54.0

2.8 POWER SPECTRAL DENSITY

2.8.1 Specification Reference

Part 15 Subpart C §15.247(e)

2.8.2 Standard Applicable

(e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

2.8.3 Equipment Under Test and Modification State

Serial No: None / Test Configuration A

2.8.4 Date of Test/Initial of test personnel who performed the test

08. – 09. February 2018 / DF

2.8.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.8.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Tampa facility

Ambient Temperature	24 - 26 °C
Relative Humidity	48 - 52 %

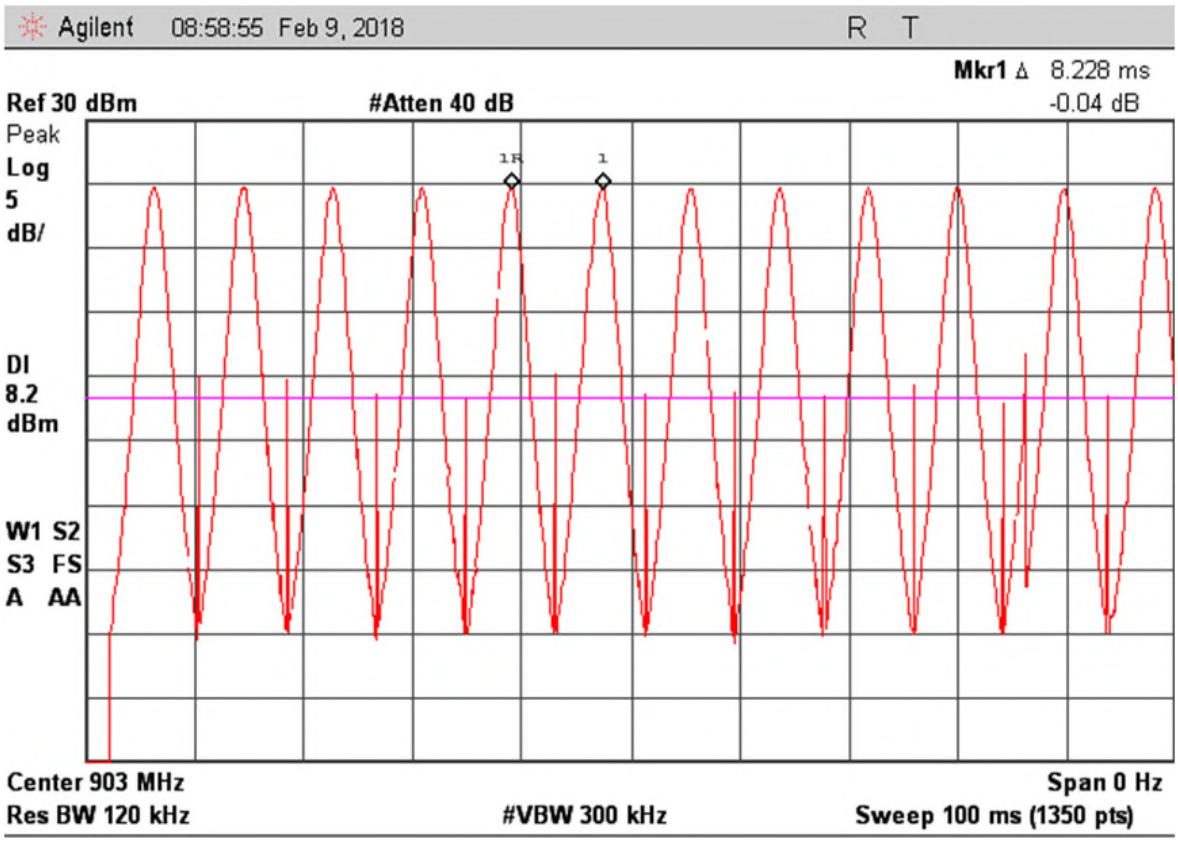
2.8.7 Additional Observations

- This is a conducted test.
- Test procedure is per Section 10.8 of KDB 558074 v03r05, (April 08, 2016).
- Detector is Peak.
- Trace Mode is Max hold.
- Sweep time is Auto Couple.
- EUT complies with 3 kHz RBW.
- T= 8.3 mSec (VBW ≥ 1/T) (1/T=120 Hz) (VBW set to 300 Hz)
- Number of points in sweep ≥ 2 Span / RBW (4,000,000/3,000) =1,333
- Display mode is set to linear

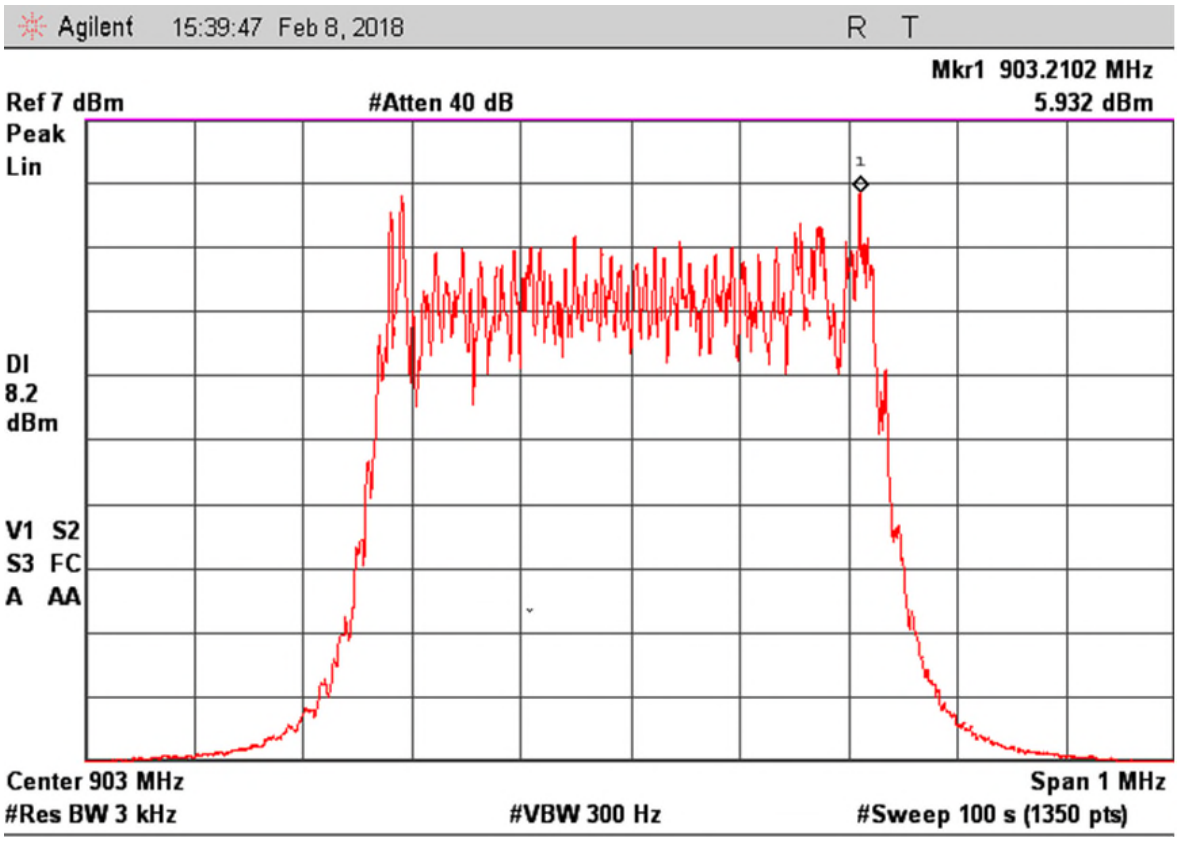
2.8.8 Test Results Summary (PKPSD Method)

Mode	Channel	Marker Reading using 3 kHz RBW (dBm)	Cable loss dB	Linear mode Correction dB	PSD dB	PSD Limit (dBm)	Compliance
LoRa	903 MHz	5.9	0.64	1.0	7.54	8	Complies
	914 MHz	5.2	0.64	1.0	6.84	8	Complies
	927 MHz	5.4	0.64	1.0	7.04	8	Complies

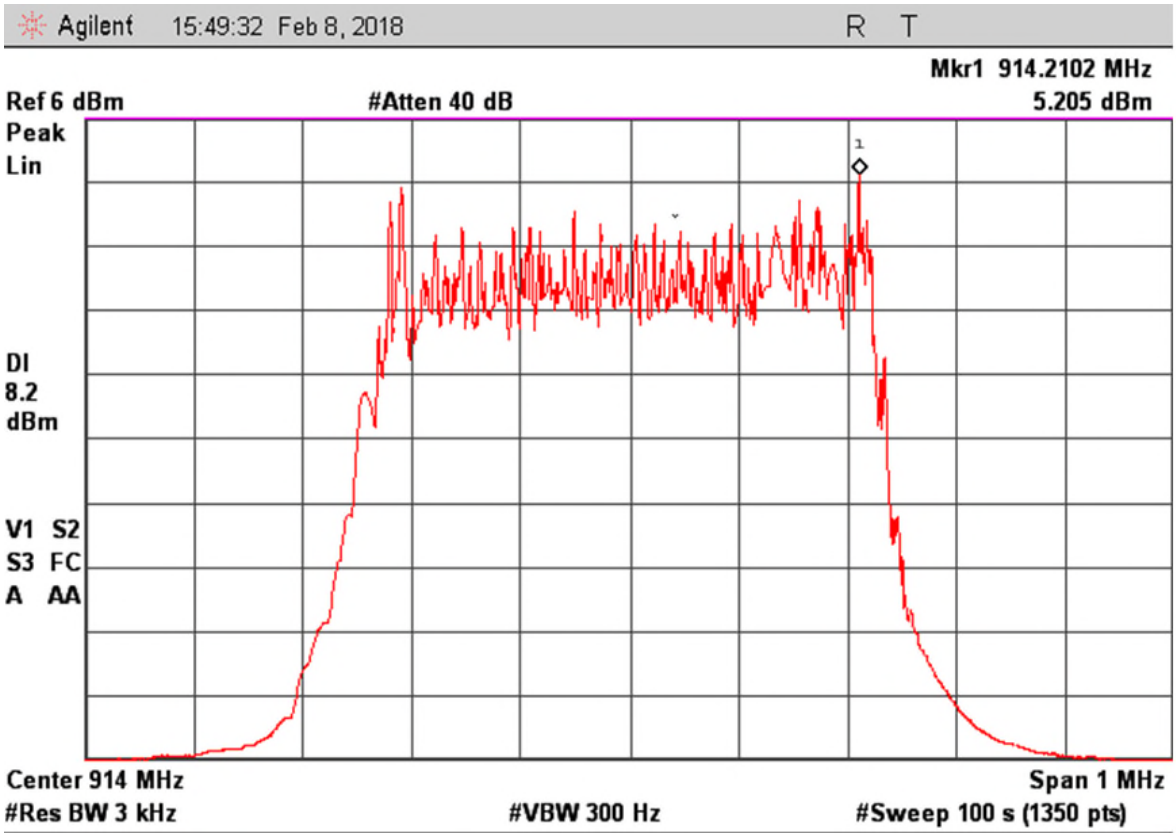
2.8.9 Test Results Plots



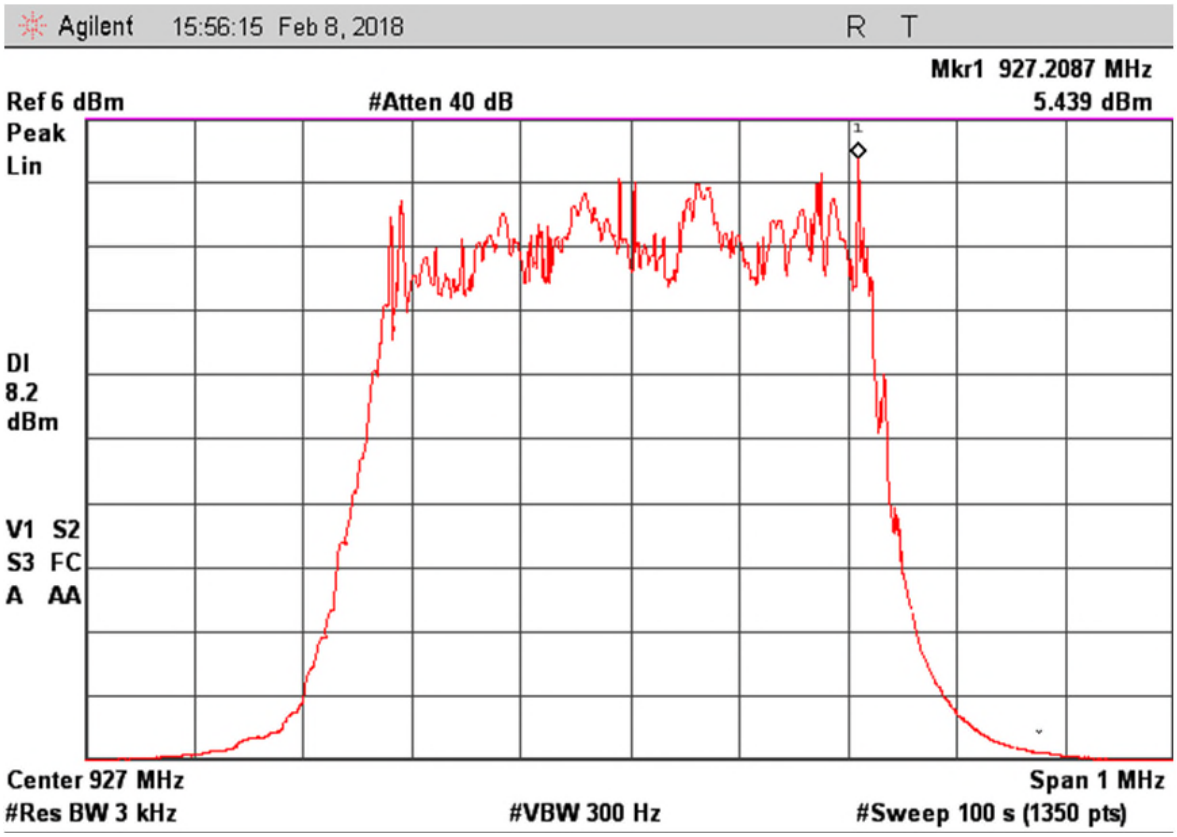
Zero Span (T=8.23 mSec)



LoRa Low Channel



LoRa Mid Channel



LoRa High Channel

SECTION 3

3TEST EQUIPMENT USED

3.1 TEST EQUIPMENT USED

List of absolute measuring and other principal items of test equipment.

ID Number	Test Equipment	Type	Serial Number	Manufacturer	Cal Date	Cal Due Date
Conducted Port Measurement						
NA	High-frequency cable	SMA to N (12) inch	NA	NA	Validated 10/21/2106	
TAME01005	Thermometer	51		Fluke	4/22/2015	4/22/2017
TEMC00093	DVM	87	5920853	Fluke	11/14/2017	11/14/2018
TAME01064	DC Power Supply	HPD 60-5	NA	XANTREX	NCR	
TEMC00091	Spectrum Analyzer	E7402A	US39150137	Agilent	2/22/2018	2/22/2020
NA	Temperature Chamber	EC127	EC0152	Sun Electronics	NCR	
Radiated Emissions						
TEMC00005	Bilog Antenna	6112B	2579	Chase EMC	12/19/2017	12/19/2019
TEMC00061	Double-ridged waveguide horn antenna	3117	00109296	ETS Lindgren	2/13/2018	2/13/2020
	High-frequency cable					
	High-frequency cable					
TEMC00011	EMI Test Receiver	ESCS30	825788/002	Rhode & Schwarz	11/17/2017	11/17/2019
TEMC00012	Spectrum Analyzer	E7404A	MY42000055	Agilent	3/31/2017	3/31/2018
TEMC00013	Pre-amplifier	PA-122	181925	Compower	3/1/2017	3/1/2018
Blocking						
TEMC00091	Spectrum Analyzer	E7402A	US39150137	Agilent	2/22/2018	2/22/2020
TEMC00092	Signal Generator	8648C	3619U	Agilent	1/13/2017	1/13/2019
Miscellaneous						
N/A	Test Software	EMC32	V8.54	Rhode & Schwarz	N/A	

3.2 MEASUREMENT UNCERTAINTY

For a 95% confidence level, the measurement uncertainties for defined systems are:

Table 3-1 - Values of U_{cispr} and U_{Lab}

Measurement	U_{cispr}	U_{Lab}
Conducted disturbance (mains port) (9 kHz – 150 kHz) (150 kHz – 30 MHz)	 3.8 dB 3.4 dB	 3.71 dB 3.31 dB
Conducted disturbance (telecom port) (150 kHz – 30 MHz 55 dB LCL) (150 kHz – 30 MHz 65 dB LCL) (150 kHz – 30 MHz 75 dB LCL)	 5.0 dB 5.0 dB 5.0 dB	 4.11 dB 4.50 dB 4.94 dB
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1 000 MHz) (1 – 6 GHz) (6-18 GHz)	 6.3 dB 5.2 dB 5.5 dB	 5.85 dB 4.48 dB 4.48 dB

Notes:

U_{cispr} resembles a value of measurement uncertainty for a specific test, which was determined by considering uncertainties associated with the quantities listed in CISPR 16-4-2:2011.

Compliance or non-compliance with a disturbance limit shall be determined in the following manner.

If U_{Lab} is less than or equal to U_{cispr} in Table 5.0-1, then:
- 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.

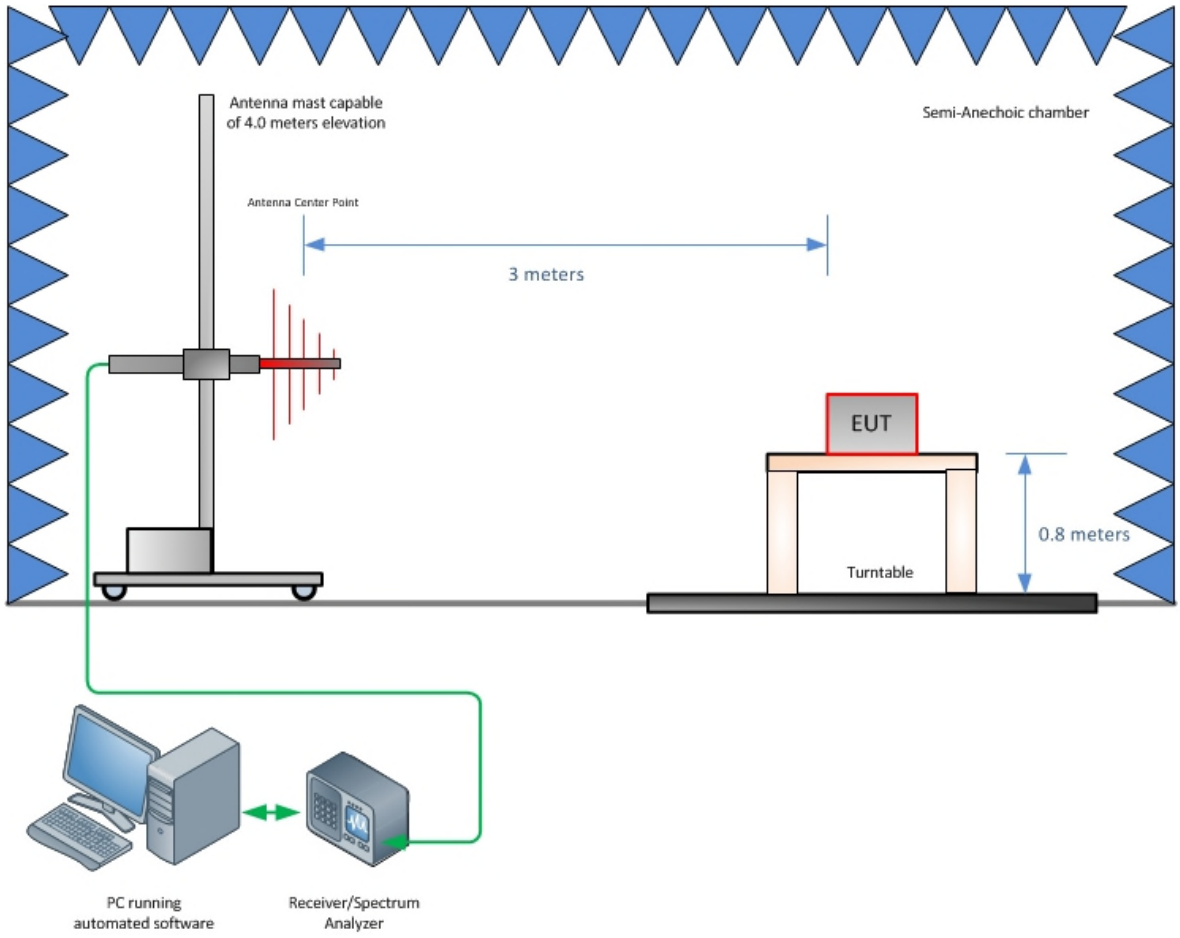
If U_{Lab} is greater than U_{cispr}, then:
- compliance is deemed to occur if no measured disturbance, increased by ($U_{Lab} - U_{cispr}$), exceeds the disturbance limit;
- non-compliance is deemed to occur if any measured disturbance, increased by ($U_{Lab} - U_{cispr}$), exceeds the disturbance limit.

The TÜV SÜD AMERICA, Inc. calculated MU is less than the internationally accepted MU, therefore an adjustment to the measured result as mentioned above is not necessary.

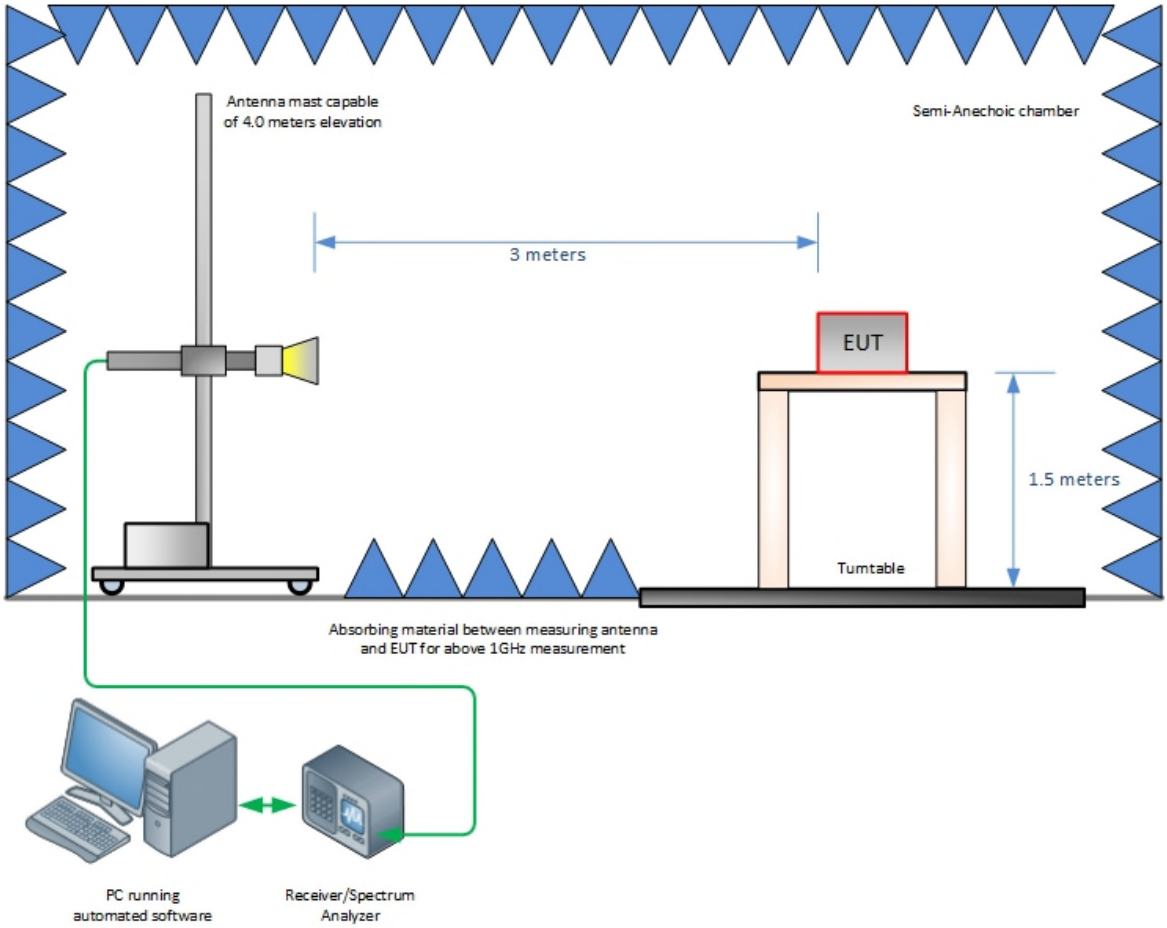
SECTION 4

4DIAGRAM OF TEST SETUP

4.1 TEST SETUP DIAGRAM



Radiated Emission Test Setup (Below 1GHz)



Radiated Emission Test Setup (Above 1GHz)

SECTION 5

5ACCREDITATION, DISCLAIMERS AND COPYRIGHT

5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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