EMC & RF Test Report

As per

RSS-247 Issue 2:2017
&
FCC Part 15 Subpart 15.247:2016

Unlicensed Intentional Radiators
(FHSS)

on the

ZX Root Node

(FCC ID: XEY-ZX-RN; IC: 8410A-ZXRN)

Issued by: **TÜV SÜD Canada Inc.**
2972 Joseph-A-Bombardier
Laval, QC, H7P 6E3
Canada
Ph: (450) 687-4976

Completed by:
Abderrahmane Ferhat, Project Engineer

Reviewed by:
Scott Drysdale, Canada Wireless Manager

Testing produced for

verdant

See Appendix A for full client & EUT details.

Industry Canada
Registration # 6844B-1

Registration # CA6845

Testing Laboratory
Certificate #2955.20

Table of Contents

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Report Scope

This report addresses the EMC verification testing and test results of the **ZX Root Node** and is herein referred to as EUT (Equipment Under Test). The EUT was tested for compliance against the following standards:

RSS-247 Issue 2:2017
RSS GEN Issue 5: 2019-03

FCC Part 15 Subpart C 15.247:2016

Test procedures, results, justifications, and engineering considerations, if any, follow later in this report.

The results contained in this report relate only to the item(s) tested.

This report does not imply product endorsement by any government, accreditation agency, or TÜV SÜD Canada Inc.

Opinions or interpretations expressed in this report, if any, are outside the scope of TÜV SÜD Canada Inc. accreditations. Any opinions expressed do not necessarily reflect the opinions of TÜV SÜD Canada Inc., unless otherwise stated.

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Summary

The results contained in this report relate only to the item(s) tested.

EUT:	ZX Root Node
FCC Certification #, FCC ID:	XEY-ZX-RN
Industry Canada Certification #, IC:	8410A-ZXRN
Hardware Version Identification Number(s) (HVIN):	RN
EUT passed all tests performed	Yes
Tests conducted by	Abderrahmane Ferhat

For testing dates, see "Testing Environmental Conditions and Dates".

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Test Results Summary

Standard/Method	Description	Class/Limit	Result
FCC 15.203 KDB 353028	Antenna Requirement	Unique	Pass See Justification
FCC 15.205 RSS GEN 5	Restricted Bands for intentional operation	None within band	Pass See description
FCC 15.207 RSS GEN 5	Power line conducted emissions	QuasiPeak Average	N/A See Justification
FCC 15.209 RSS GEN 5	Radiated emissions	QuasiPeak Average	Pass
FCC 15.247(a)(1) RSS 247 5.1 (2)	Channel Separation	> 25 kHz or 20 dB BW	Pass
FCC 15.247(a)(1)(i) RSS 247 5.1 (3)	Number of channels	> 50	Pass
FCC 15.247(a)(1)(i) RSS 247 5.1 (3)	Time of occupancy	< 0.4 sec in 20 sec period	Pass
FCC 15.247(b) RSS 247 5.4(1)	Max output power	< 1 Watt	Pass
FCC 15.247(b)(4) RSS 247 5.4 (3)	Antenna Gain	< 6 dBi	Pass See Justification
FCC 15.247(d) RSS 247 5.5	Band Edge <Antenna conducted spurious>	> 20 dBc	Pass
FCC 15.247(h) RSS GEN 247 5.1	FHSS Intelligence	No coordination	Pass See Justification
FCC 15.247(i) RSS-102	RF Exposure	—	Pass See justification and SAR report
		Overall Result	**PASS**

If the product as tested or otherwise complies with the specification, the EUT is deemed to comply with the requirement and is deemed a 'PASS' grade. If not 'FAIL' grade will be issued. Note that 'PASS' / 'FAIL' grade is independent of any measurement uncertainties. A 'PASS' / 'FAIL' grade within measurement uncertainty is marked with a '*'.

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Notes, Justifications, or Deviations

The following notes, justifications for tests not performed or deviations from the above listed specifications apply:

For the Antenna requirement specified in FCC 15.203 (RSS-247 section 5.5), the unit uses an whip, tilt sma antenna with a gain of 1.2 dBi which is less than 6 dBi.

For the Restricted Bands of operation, the EUT is designed to only operate between 902 – 928 MHz.

The EUT is not a hybrid system and FCC 15.247 (f) does not apply to it.

The EUT does not coordinate transmission with any other FHSS to avoid simultaneous occupation of hopping frequencies.

For the scope of this test report, the EUT was mounted in three orthogonal axis to maximize emissions. Worst case results are presented.

For antenna requirements, the antenna is permanently glue with epoxy to a standard connector. See for instance external photos. Thus, complies with section 15.203 2a (ii).

For maximum permissible exposure, this device operates at less than 1 Watt at 902 - 928MHz and is designed to operate less than 20 cm from any personnel during normal operation. No testing is required; however it complies with SAR exemption evaluation as determined the RF Exposure exhibits.

Power line conducted emissions was not applicable since the EUT is a 5Vdc powered through USB port.

Sample Calculation(s)

Radiated Emission Test

Margin = Limit – (Received Signal + Antenna Factor + Cable Loss – Pre-Amp Gain)
Margin = 50.5dBµV/m – (50dBµV + 10dB + 2.5dB – 20dB)
Margin = 8.0 dB (pass)

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Applicable Standards, Specifications and Methods

ANSI C63.4:2014 Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

ANSI C63.10:2013 American National Standard For Testing Unlicensed Wireless Devices

CFR 47 FCC 15 Code of Federal Regulations – Radio Frequency Devices, Subpart C:

- Oct 1, 2018: Rule Parts 20-39, 80+
- Oct 1, 2019: Rule Parts 0-19, 40-69, 70-79

CISPR 22:2008 Information Technology Equipment - Radio Disturbance Characteristics - Limits and Methods of Measurement

ICES-003 Issue 6 2016 Digital Apparatus - Spectrum Management and Telecommunications Policy Interference-Causing Equipment Standard

RSS-GEN Issue 4 2014 General Requirements and Information for the Certification of Radio Apparatus

RSS-247 Issue 2:2017 Issue 2: Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

RSS 102 Issue 5 2015 Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

FCC KDB 447498 RF Exposure Procedures And Equipment Authorization Policies v06 For Mobile And Portable Devices

ISO 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories

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Document Revision Status

Revision 0 - September 12, 2019. Initial Release

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Definitions and Acronyms

The following definitions and acronyms are applicable in this report.
See also ANSI C63.14.

AE – Auxiliary Equipment. A digital accessory that feeds data into or receives data from another device (host) that in turn, controls its operation.

BW - Bandwidth. Unless otherwise stated, this is refers to the 6 dB bandwidth.

EMC – Electro-Magnetic Compatibility. The ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment.

EMI – Electro-Magnetic Immunity. The ability to maintain a specified performance when the equipment is subjected to disturbance (unwanted) signals of specified levels.

EUT – Equipment Under Test. A device or system being evaluated for compliance that is representative of a product to be marketed.

ITE - Information Technology Equipment with a primary function(s) of entry, storage, display, retrieval, transmission, processing, switching, or control, of data.

LISN – Line Impedance Stabilization Network

NCR – No Calibration Required

RF – Radio Frequency

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Testing Facility

Testing for EMC on the EUT was carried out at TÜV SÜD Canada testing lab in Laval, near Montréal, Québec, Canada. The testing lab has a calibrated 3m semi-anechoic chamber which allows measurements on an EUT that has a maximum width or length of up to 2m and a height of up to 3m. The chamber is equipped with a turntable that is capable of testing devices up to 3300lb in weight. This facility is capable of testing products that are rated for 120Vac and 240Vac single phase, or devices that are rated for a 208 Vac 3 phase input. DC capability is also available for testing. The chamber is equipped with a mast that controls the polarization and height of the antenna. Control of the mast occurs in the control room adjoining the shielded chamber. Radiated emission measurements are performed using a BiLog antenna and a Horn antenna where applicable. Conducted emissions, unless otherwise stated, are performed using a LISN and using the Vertical Ground plane if applicable. For ESD testing, the HCP is 1.6m x 0.8m and the VCP is 0.5m x 0.5m. The reference ground plane, when applicable, is 1.6m x 1.6m.

Calibrations and Accreditations

The 3m semi-anechoic chamber is registered with Federal Communications Commission (FCC, CA6845) and Industry Canada (IC, 6844B-1). This chamber was calibrated for Normalized Site Attenuation (NSA) using test procedures outlined in ANSI C63.4 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". The chamber is lined with ferrite tiles and absorption cones to minimize any undesired reflections. The NSA data is kept on file at TÜV SÜD Canada. For radiated susceptibility testing, a 16-point field calibration has been performed on the chamber. The field uniformity data is kept on file at TÜV SÜD Canada. TÜV SÜD Canada Inc is accredited to ISO 17025 by A2LA with Testing Certificate #2955.02. The laboratory's current scope of accreditation listing can be found as listed on the A2LA website. All measuring equipment is calibrated on an annual or biannual basis as listed for each respective test.

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Testing Environmental Conditions and Dates

Following environmental conditions were recorded in the facility during time of testing

Date	Test	Initials	Temperature (°C)	Humidity (%)	Pressure (kPa)
2019-02-25 to 2019-03-18	Radiated Emissions	AF	23.1 – 25	36.0 – 51	98.0 – 102.0
2019-03-19 to 2019-03-20	Antenna Conducted Emissions/ Measurements	AF	23.1 – 25	36.0 – 51	98.0 – 102.0

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Detailed Test Results Section

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Channel Carrier Bandwidth

Purpose

The purpose of this test is to allow for results that is used to help establish other limits. Although there is not specific limit for this requirement, the derived limits dependent on this information helps allow for other spread spectrum devices to co-exist in the same frequency spectrum. This also helps prevent corruption of data by ensuring adequate channel separation to distinguish the reception of the intended information.

Limits and Methods

The limits are as defined in 47 CFR FCC Part 15 Section 15.247(a)(1). The test method is a defined in ANSI C63.10.

The maximum allowed 20 dB bandwidth for frequency hopping system operating in the 902 to 928 MHz band is 500 kHz.

Results

The EUT passed. The maximum OBW measured was 181.1 kHz.

Channel	Frequency (MHz)	99% BW (kHz)	20 dB BW Limit (kHz)	Pass/Fail
Low	902.46	181.1	500	Pass
Mid	915.00	181.1	500	Pass
High	927.52	181.1	500	Pass

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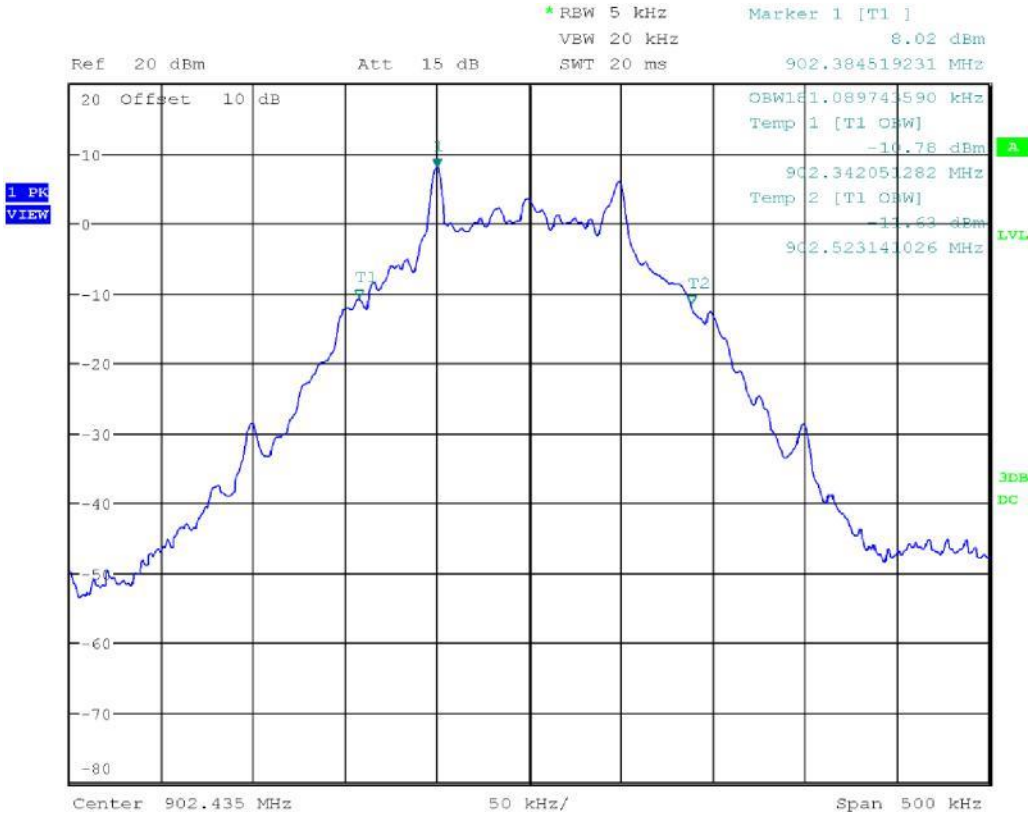
Graph(s)

The graphs shown below shows the 20dB bandwidth during the operation of the device. This is measured by a max hold on the spectrum analyzer and the highest resolution bandwidth that is sufficiently low to exhibit the 20dB bandwidth of a channel during operation of the EUT. This measurement is a peak measurement. Max hold is performed for a duration of not less than 1 minute.

20 dB Bandwidth: Low Channel



Date: 19.MAR.2019 15:53:10

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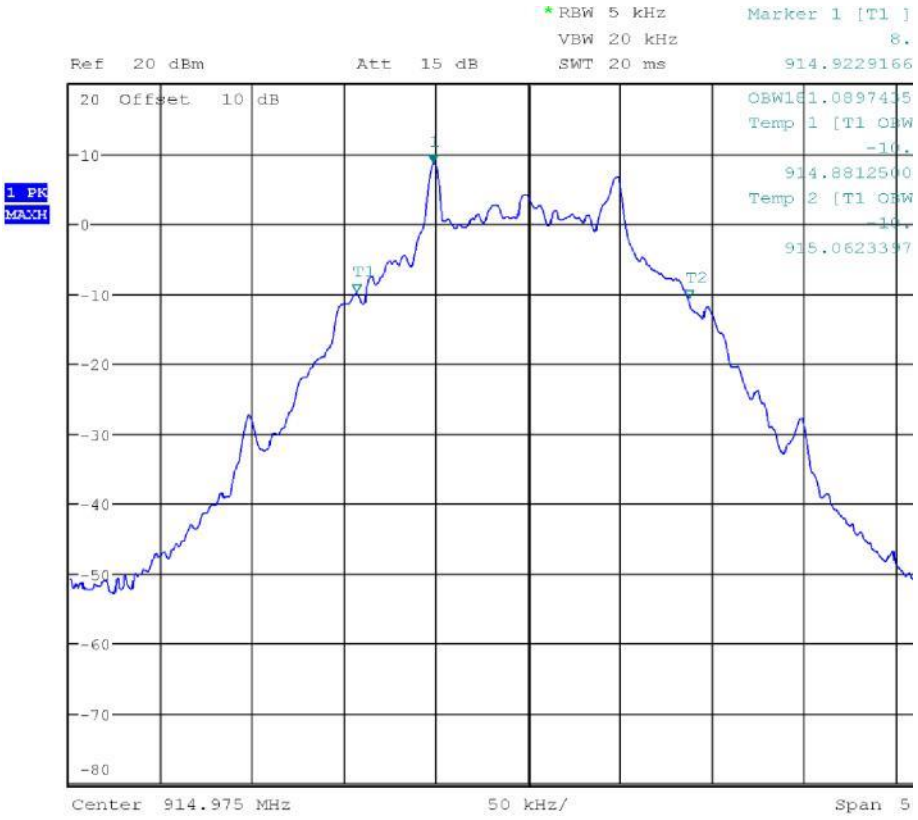
20 dB Bandwidth: Mid Channel



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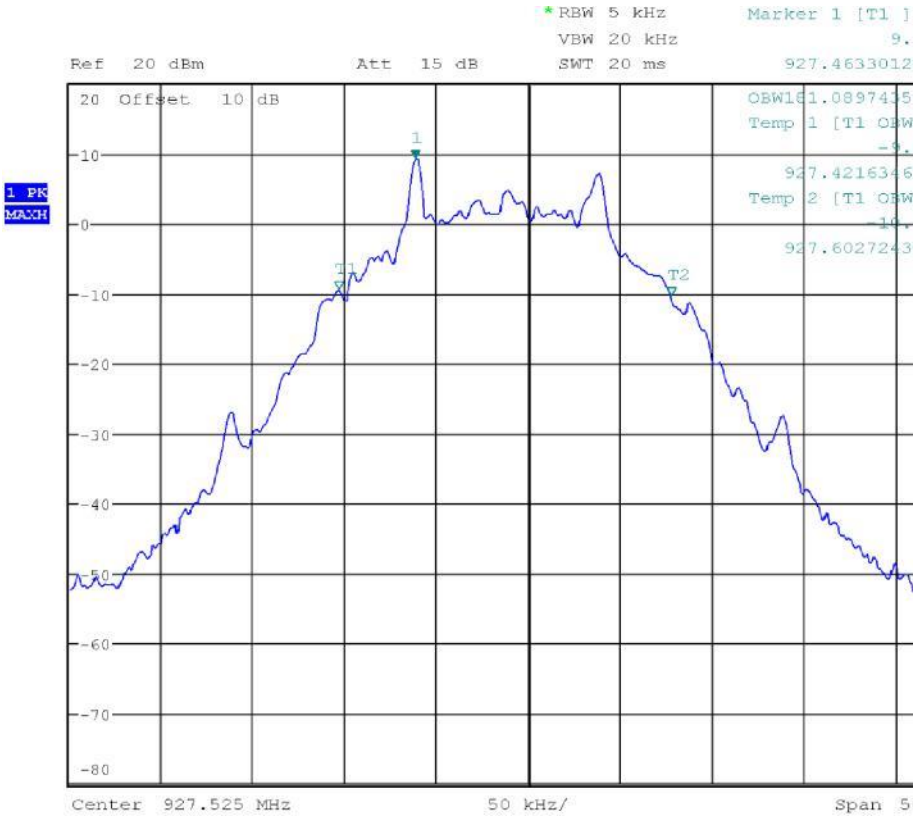
20 dB Bandwidth: High Channel



Note: Please refer to Test Setup exhibit for EUT and Test Setup photos of the unit.

Test Equipment List

Equipment	Model No.	Manufacturer	Calibration date	Calibration due date	Asset #
Spectrum Analyzer	ESU-40	Rohde & Schwarz	2017-04-20	2019-04-20	4092
10 dB attenuator (SMA)	4779-10	narda	NCR	NCR	4096

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Carrier Frequency Separation

Purpose

The purpose of this test is to ensure that the RF energy of frequency hopping systems is sufficiently spread over a spectrum and that the radio energy is not overly dense. This limit helps allow for other spread spectrum devices to co-exist in the same frequency spectrum. This also helps prevent corruption of data by ensuring adequate channel separation to distinguish the reception of the intended information.

Limits and method

The limits are as defined in 47 CFR FCC Part 15 Section 15.247(a)(1). The test method is a defined in ANSI C63.10.

	902 to 928 MHz	2400 to 2483.5 MHz	5275 to 5850 MHz
No conditions	25 kHz or 20 dB BW[1]	25 kHz or 20 dB BW[1]	25 kHz or 20 dB BW[1]
< 125 mW	--	25 kHz or 2/3 of 20 dB BW[1]	--

Note 1: The minimum channel separation is given by the greater of 25 kHz or 20 dB BW for unconditional operation. The 20 dB BW of the system was measured to be 181.1 kHz, so a channel separation limit of 181.1 kHz applies.

Results

The EUT passed the requirements of channel carrier spacing exceeding the measured 20dB BW of the EUT. The 20 dB BW previously measured was 181.1 kHz and the device had a minimum channel spacing of 381.4 kHz.

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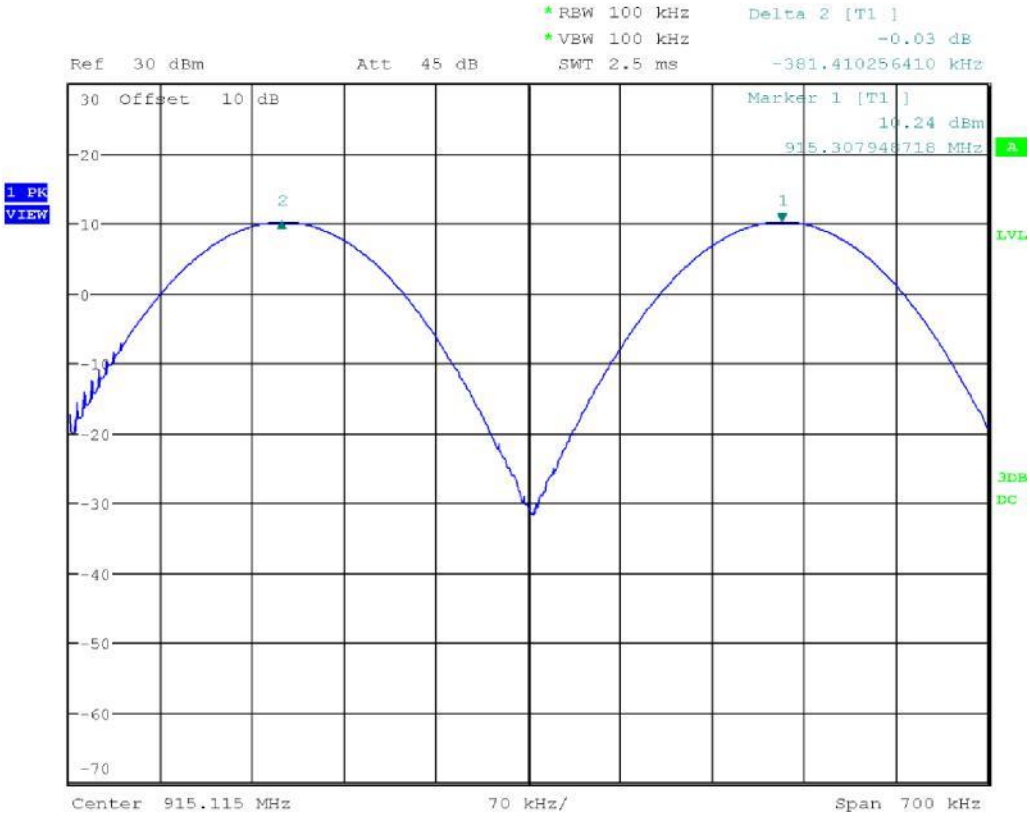
Graph(s)

The graphs shown below shows the channel spacing during the operation of the device. This is measured by a max hold on the spectrum analyzer and the highest resolution bandwidth that is sufficiently low to exhibit the channel spacing of the signal being measured. This measurement is a peak measurement. Max hold is performed for a duration of not less than 1 minute, as the device is stepping through its hopping table.

Channel Separation



Note: Please refer to Test Setup exhibit for EUT and Test Setup photos of the unit.

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Test Equipment List

Equipment	Model No.	Manufacturer	Calibration date	Calibration due date	Asset #
Spectrum Analyzer	ESU-40	Rohde & Schwarz	2017-04-20	2019-04-20	4092
10 dB attenuator (SMA)	4779-10	narda	NCR	NCR	4096

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Number of Hopping Frequencies

Purpose

The purpose of this test is to ensure that the RF energy of frequency hopping systems is sufficiently spread over a spectrum and that the radio energy is not overly dense. This limit helps allow for other spread spectrum devices to co-exist in the same frequency spectrum. This also helps prevent corruption of data by ensuring adequate channel separation to distinguish the reception of the intended information.

Limits and method

The limits are as defined in 47 CFR FCC Part 15 Section 15.247(a)(1). The test method is a defined in ANSI C63.10.

	902 to 928 MHz	2400 to 2483.5 MHz	5275 to 5850 MHz
No conditions	≥ 50 channels	≥ 15 channels	≥ 75 channels
20 dB BW exceeds 250 kHz	≥ 25 channels	≥15 channels	≥ 75 channels

Results

The EUT passed the requirements of the number of channels. The number of channels the device occupies is 64 channels in the allocation band of 902 to 928 MHz.

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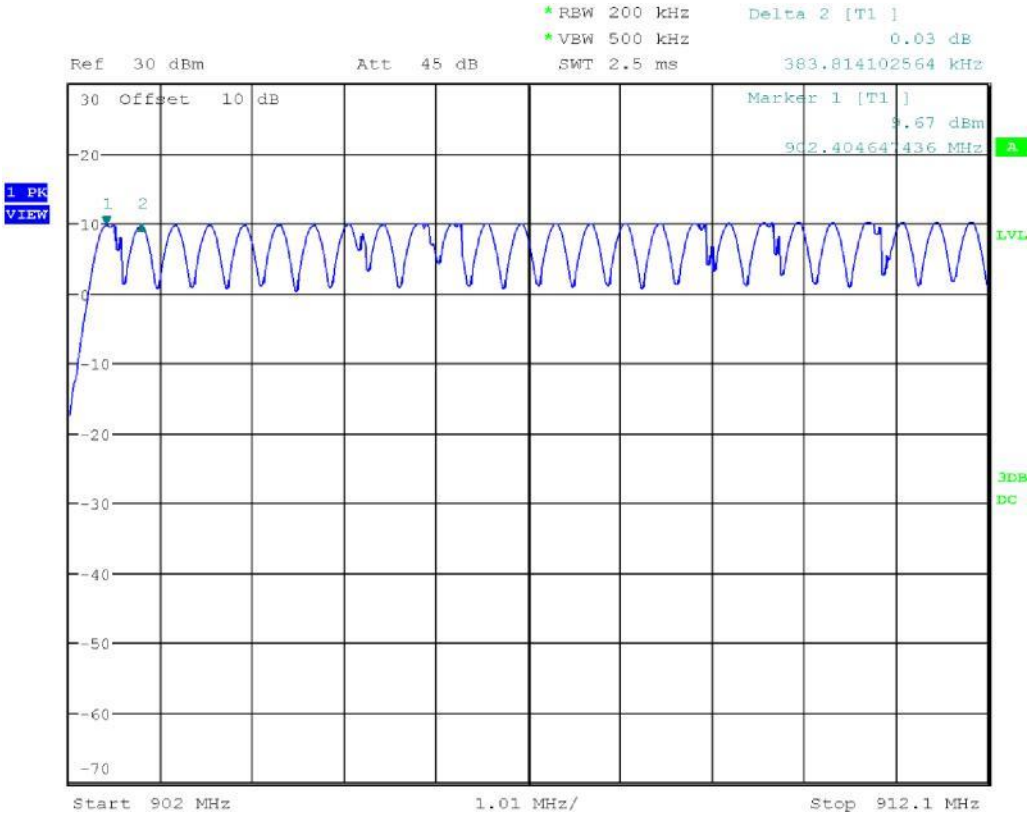
Graph(s)

The graphs shown below shows the number of occupied channels during the operation of the device. This is measured by a max hold on the spectrum analyzer and the highest resolution bandwidth that is sufficiently low to exhibit the channel spacing of the signal being measured. This measurement is a peak measurement. Max hold is performed for a duration of not less than 10 minutes, or as sufficient to capture the channels occupied.

Graph 1 of 3 (26 channels)



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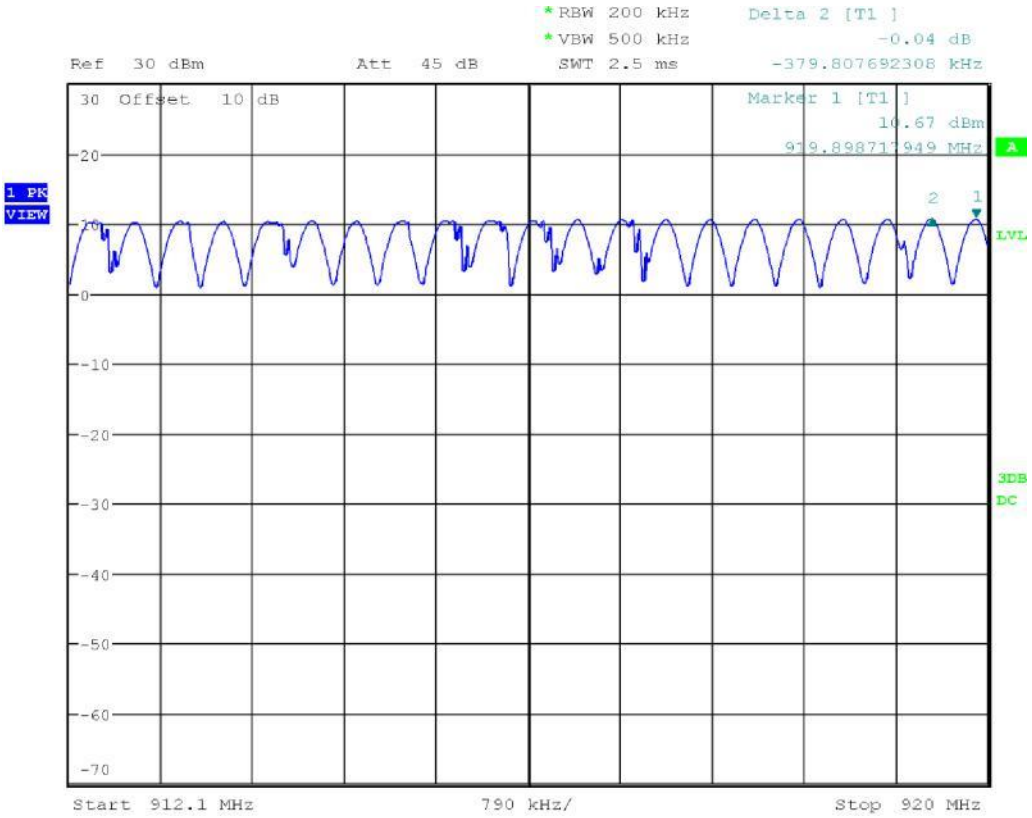
Graph 2 of 3 (21 channels)



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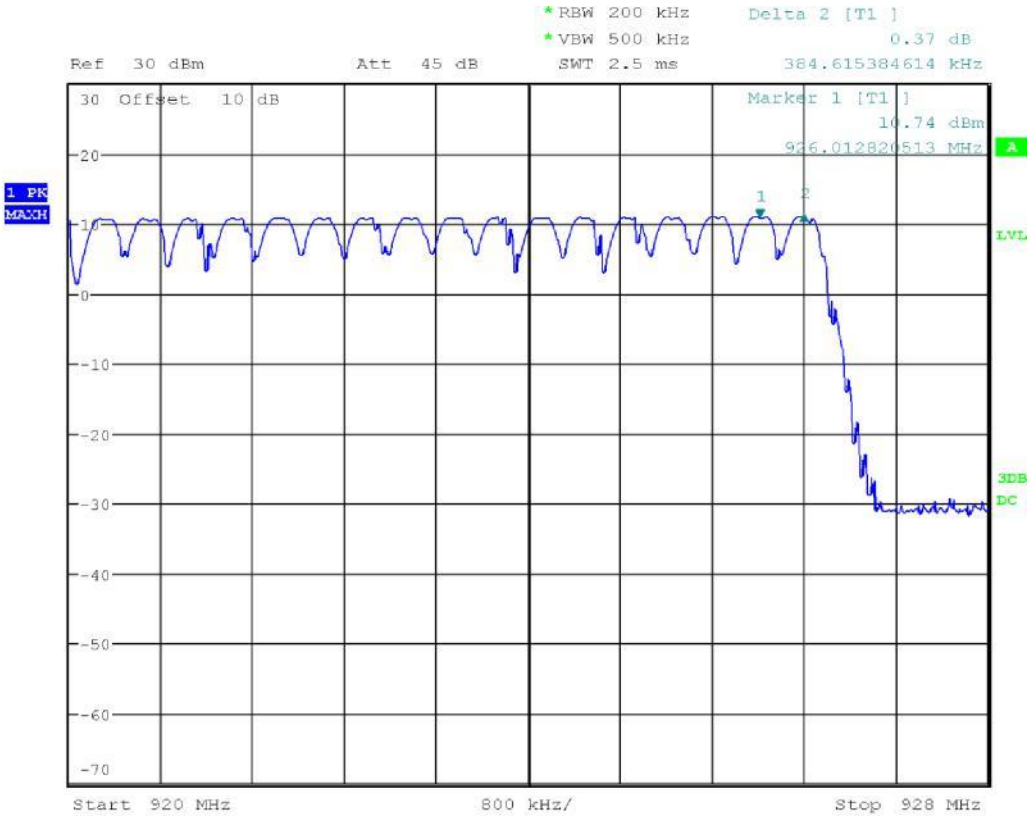
Graph 3 of 3 (17 channels)



Note: Please refer to Test Setup exhibit for EUT and Test Setup photos of the unit. **Test Equipment List**

Equipment	Model No.	Manufacturer	Calibration date	Calibration due date	Asset #
Spectrum Analyzer	ESU-40	Rohde & Schwarz	2017-04-20	2019-04-20	4092
10 dB attenuator (SMA)	4779-10	narda	NCR	NCR	4096

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Time of Occupancy

Purpose

The purpose of this test is to ensure that the RF energy of frequency hopping systems is hopping at a minimum defined rate. This helps ensure sufficient time off to enable other frequency hopping devices to co-operate within this allocated band.

Limits

For 902 to 928 MHz systems, the limits are as defined in 47 CFR FCC Part 15 Section 15.247(a)(1)(i).

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

The 20 dB bandwidth of the system is less than 250 kHz and have more than 50 channels; therefore the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.

Results

The EUT passed the requirements. The maximum average time of occupancy is 0.09 seconds.

The EUT cycles through its pseudo-random generated list of hopping frequencies. There are 64 channels occupied in total. The average transmit time is 4.5 ms per channel and each channel is repeated every 1 s.

Number of hops in 20 s is 20.

Average time of occupancy = 20 × 4.5 ms = 90 ms

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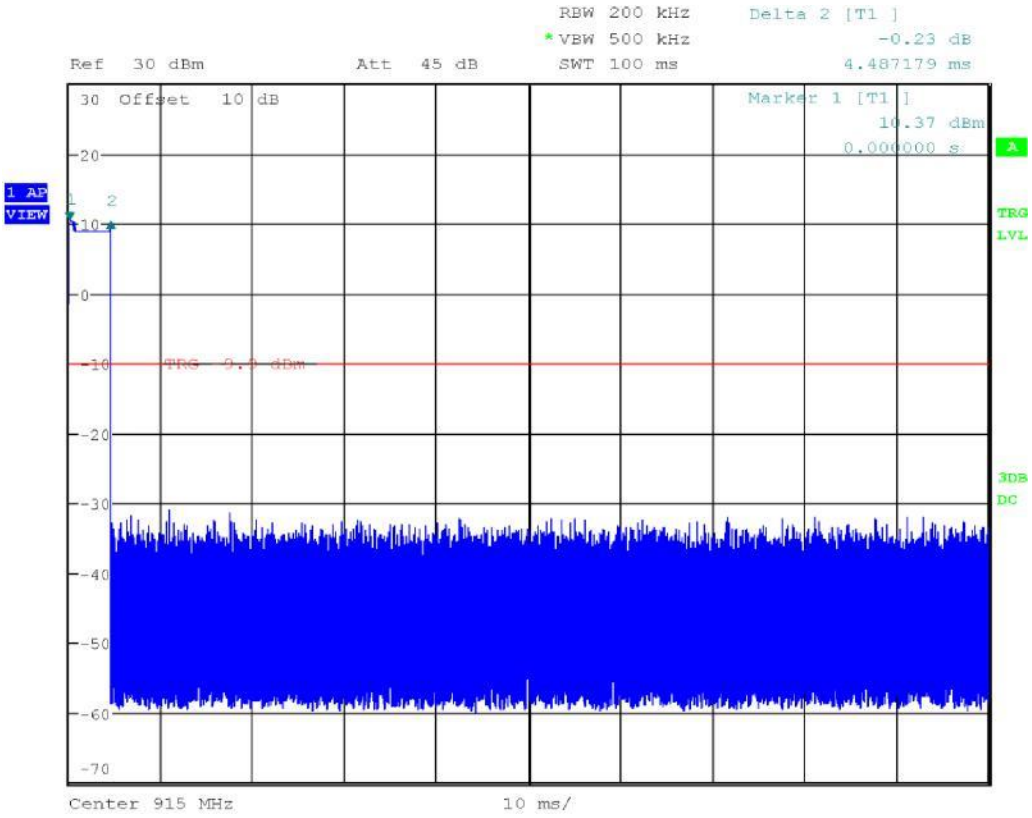
Graph(s)

Transmit time per hop



Note: Please refer to Test Setup exhibit for EUT and Test Setup photos of the unit. **Test Equipment List**

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10 dB attenuator (SMA)	4779-10	narda	NCR	NCR	4096

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Maximum Peak Envelope Conducted Power - FHSS

Purpose

The purpose of this test is to ensure that the maximum power conducted to the radiating element does not exceed the limits specified.

Limits and methods

The limits are defined in 15.247(b).

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

The test method is a defined in ANSI C63.10.

Results

The EUT passed. The peak power measured was 10.89 dBm (12.3 mW).

Channel	Frequency (MHz)	Power (dBm) <Note 1>	Power (mW)	Limit (mW)	Pass/Fail
Low	902.46	09.72	9.4	1000	Pass
Mid	914.98	10.32	10.8	1000	Pass
High	927.525	10.89	12.3	1000	Pass
Note 1. Measures account for the antenna gain of 1.2dBi					

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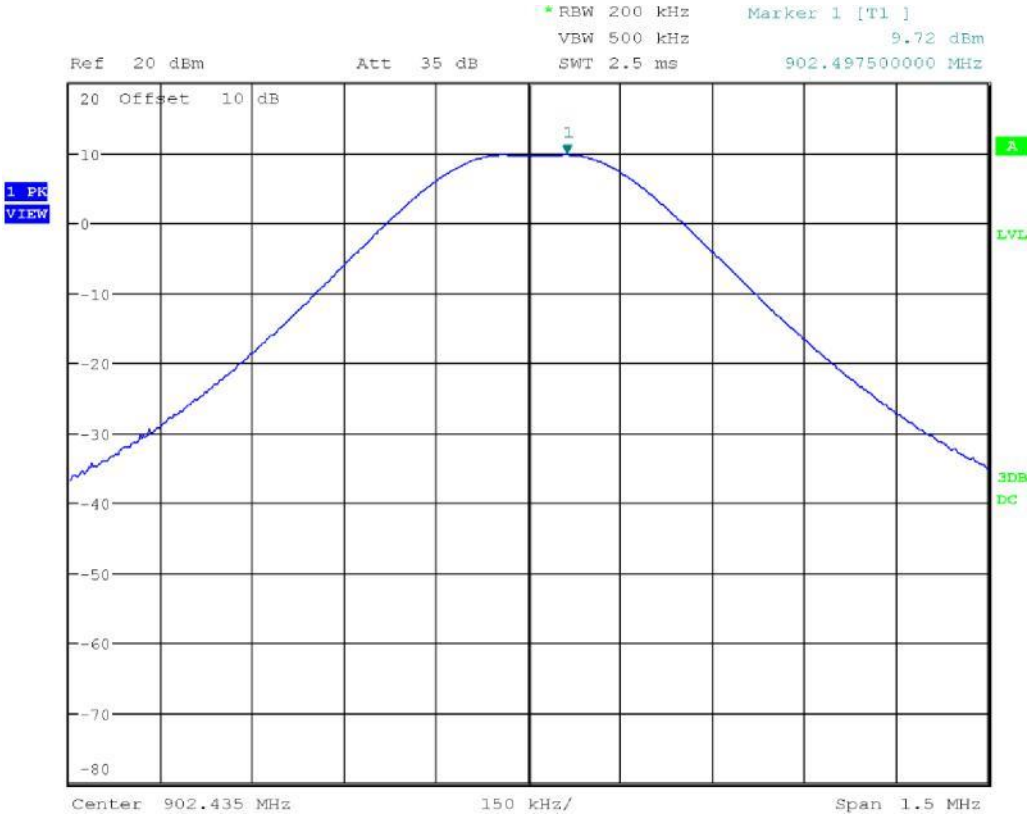
Measurement(s)

The graphs shown below shows the peak power output of the device during the antenna conducted measurement during transmit operation of the EUT.

Antenna Conducted Power: Low Channel



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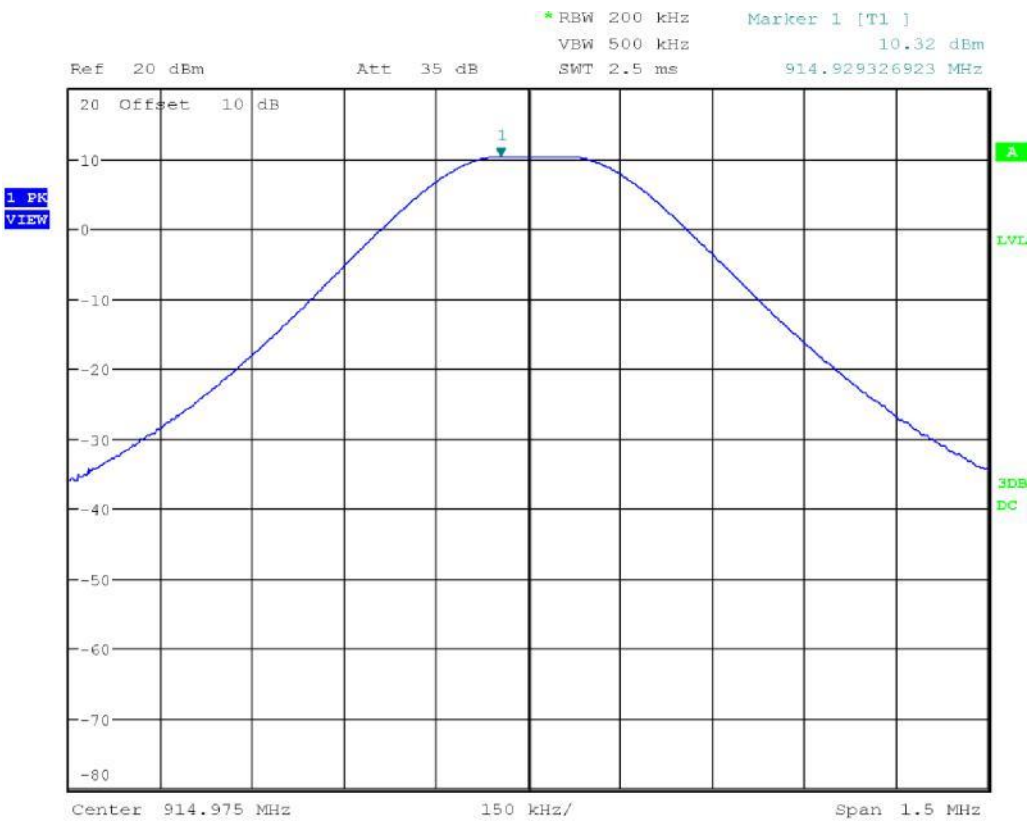
Antenna Conducted Power: Mid Channel



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Antenna Conducted Power: High Channel

Note: Please refer to Test Setup exhibit for EUT and Test Setup photos of the unit.

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Test Equipment List

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10 dB attenuator (SMA)	4779-10	narda	NCR	NCR	4096

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Antenna Spurious Conducted Emissions (-20 dBc Requirement) – 15.247

Purpose

The purpose of this test is to ensure that the maximum power conducted to the radiating element at frequencies outside of the authorized spectrum does not exceed the limits specified. This ensures that the only the intended signal is delivered to the radiating element.

Limits and Methods

The limits are defined in 15.247(d). In any 100 kHz band, the peak spurious harmonics emissions must be at least 20 dB below the fundamental. Spurious Conducted emissions are to be evaluated up to the 10^{th} harmonic. This -20 dBc requirement also applies at the 'band edge'. Band edge testing shall be performed with the EUT in hopping and in single channel modes.

The method is given in and ANSI C63.10

Results

The EUT passed the limits. Low, middle and high channels were measured. The worst case was presented as a graph for the spectrum. The -20 dBc requirement is shown for the lower band edge at 902 MHz in the low band. The -20 dBc requirement is also shown for the higher band edge at 928 MHz in the high band.

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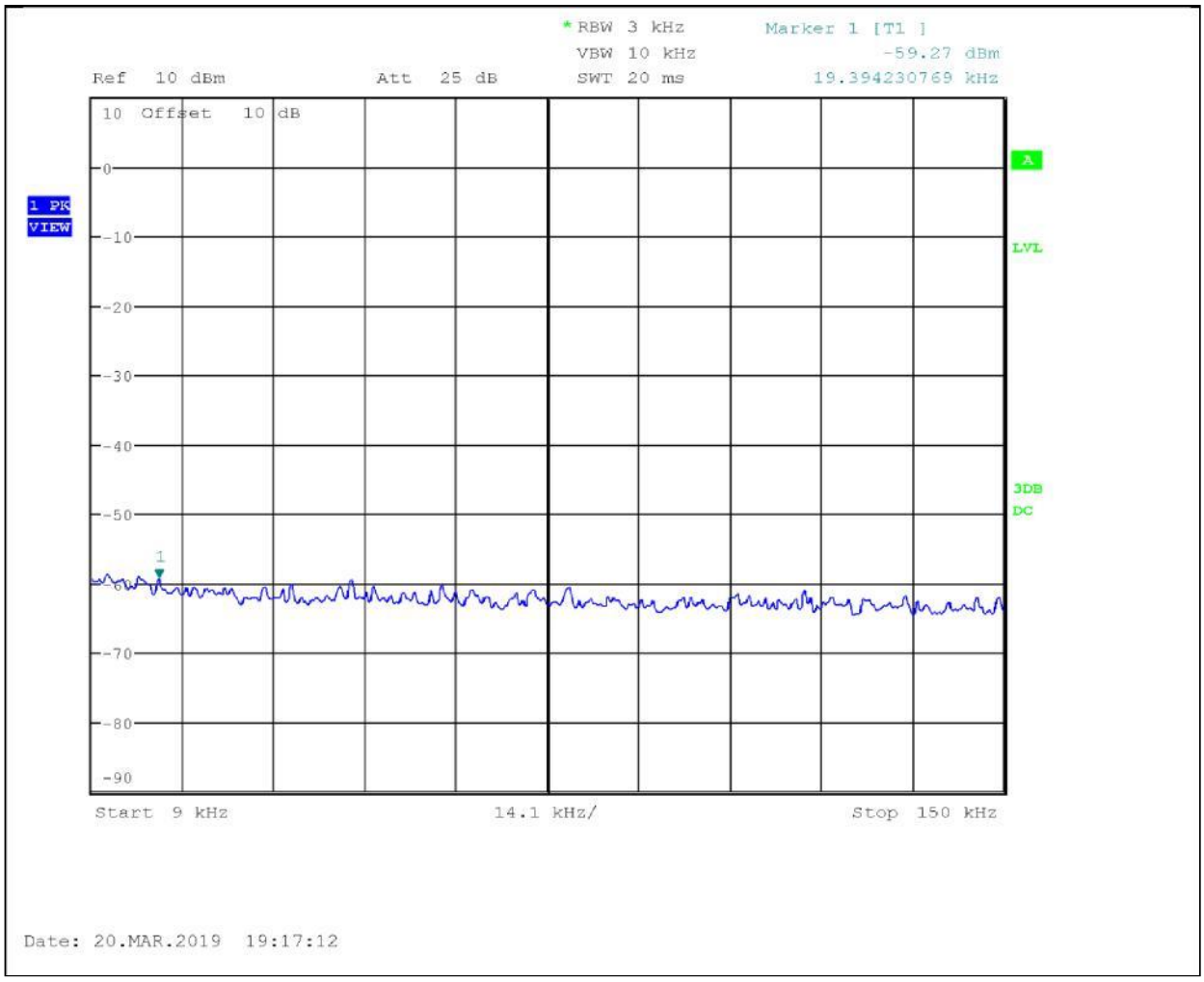
Graph(s)

The graphs shown below shows the peak power output of the device during the antenna conducted measurement during transmit operation of the EUT.

-20 dBc



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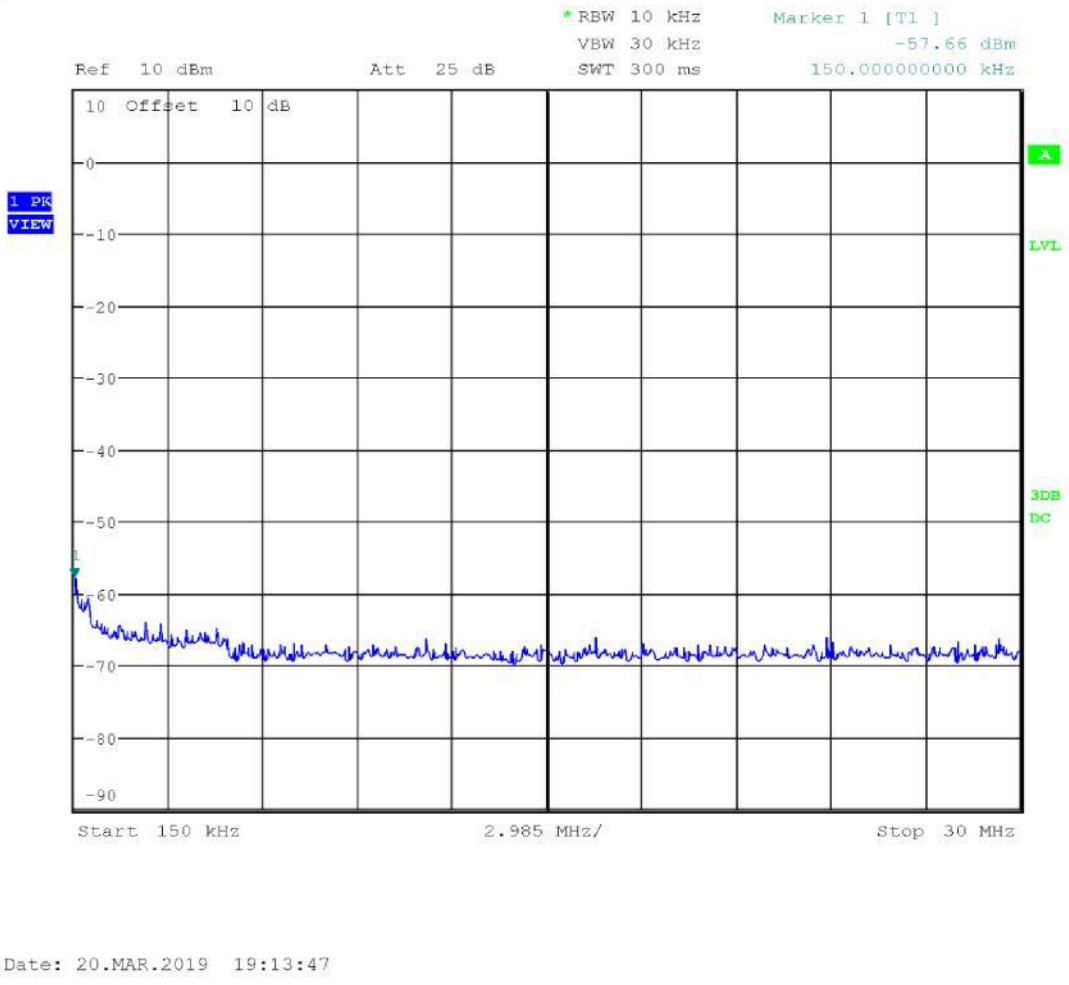
-20 dBc

150 kHz – 30 MHz



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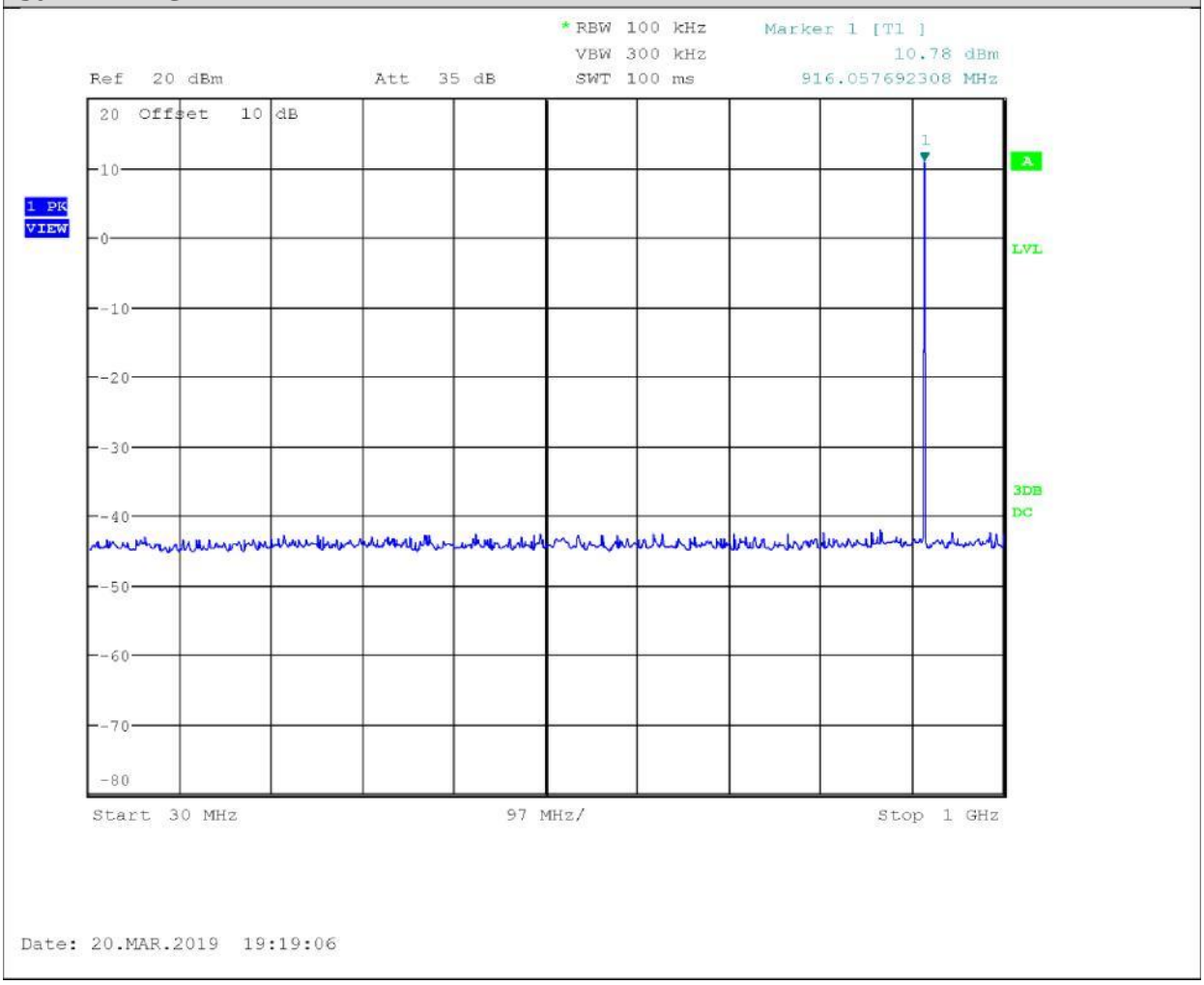
-20 dBc

30 MHz – 1 GHz



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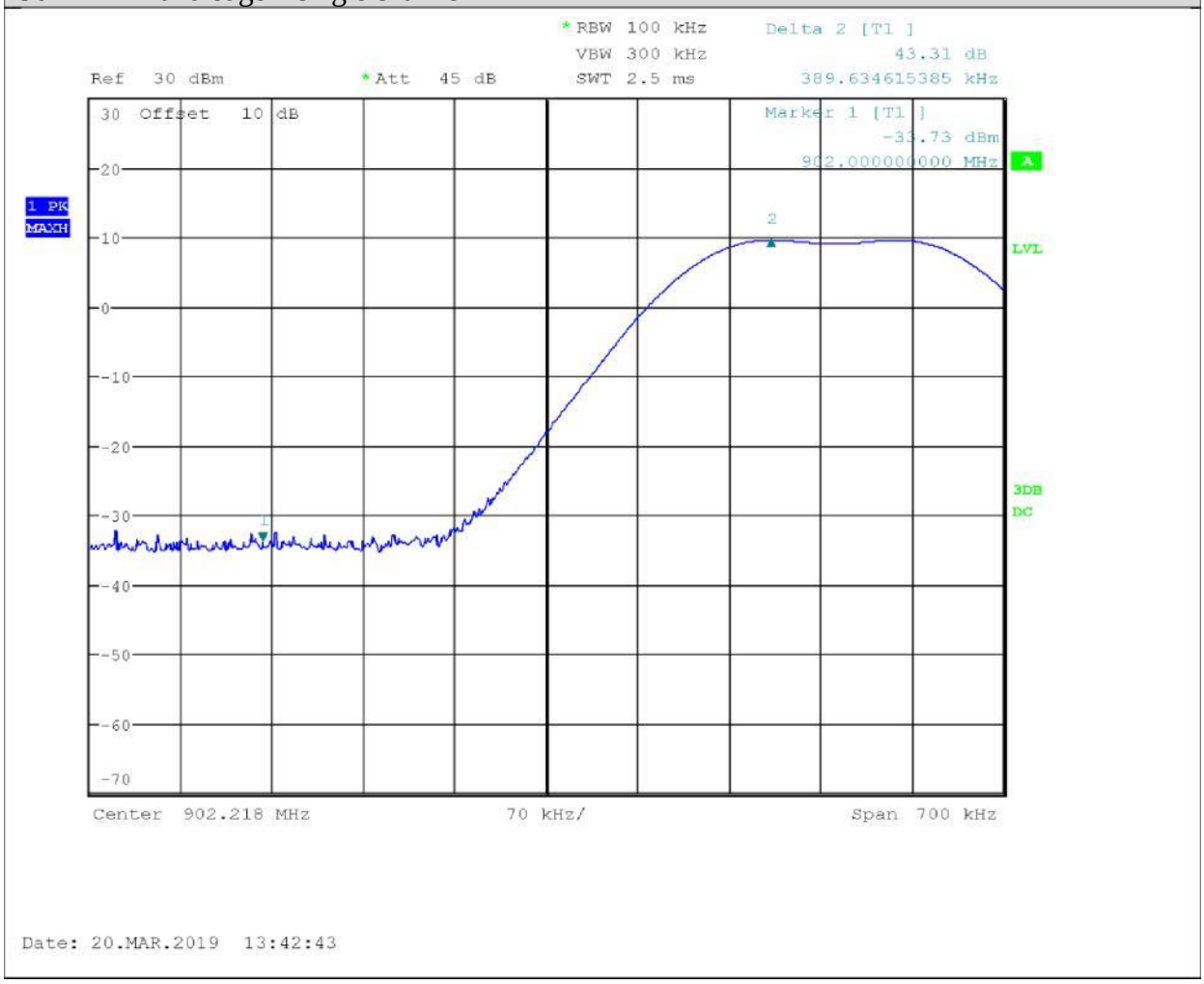
-20 dBc

902 MHz Band edge – single channel



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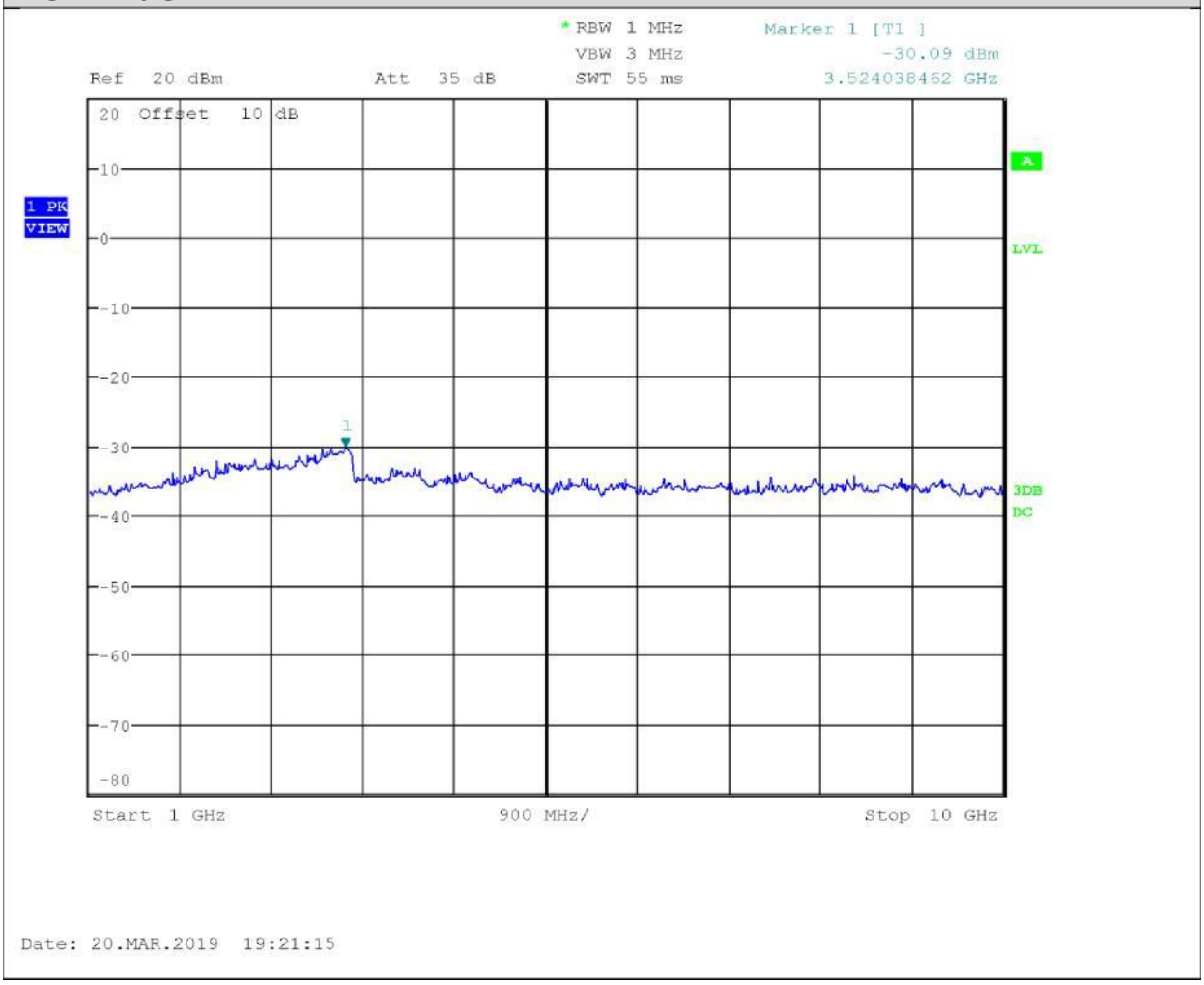
-20 dBc

1 GHz – 10 GHz



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Test Equipment List

Equipment	Model No.	Manufacturer	Calibration date	Calibration due date	Asset #
Spectrum Analyzer	ESU-40	Rohde & Schwarz	2017-04-20	2019-04-20	4092
10 dB attenuator (SMA)	4779-10	narda	NCR	NCR	4096

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Radiated Emissions – 15.247

Purpose

The purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT does not exceed the limits listed below as defined in the applicable test standard, as measured from a receiving antenna. This helps protect broadcast radio services such as television, FM radio, pagers, cellular telephones, emergency services, and so on, from unwanted interference.

Limit and Method

The method is given in Section 12.1 of FCC KDB 558074 and ANSI C 63.10
The limits are as defined in FCC Part 15, Section 15.209:

The limits, as defined in 15.247(d) for unintentional radiated emissions apply for those emissions that fall in the restricted bands, as defined in Section 15.205(a). These emissions must comply with the radiated emission limits specified in Section 15.209(a).

All unintentional emissions must also meet the 'Spurious Conducted Emissions' requirements of -20 dBc or greater. See also 'Spurious Conducted Emissions' for further details.

0.009 MHz – 0.490 MHz, 2400/F (kHz) uV/m at 300 m[1]
0.490 MHz – 1.705 MHz, 24000/F (kHz) uV/m at 30 m[1]
1.705 MHz – 30 MHz, 30 uV/m at 30 m[1]
30 MHz – 88 MHz, 100 uV/m (40.0 dBuV/m[1]) at 3 m
88 MHz – 216 MHz, 150 uV/m (43.5 dBuV/m[1]) at 3 m
216 MHz – 960 MHz, 200 uV/m (46.0 dBuV/m[1]) at 3 m
Above 960 MHz, 500 uV/m (54.0 dBuV/m[1]) at 3 m
Above 1000 MHz, 500 uV/m (54 dBuV/m[2]) at 3m
Above 1000 MHz, 500 uV/m (74 dBuV/m[3]) at 3m

[1]Limit is with Quasi Peak detector with bandwidths as defined in CISPR-16-1-1
[2]Limit is with 1 MHz measurement bandwidth and using an Average detector
[3]Limit is with 1 MHz measurement bandwidth and using a Peak detector

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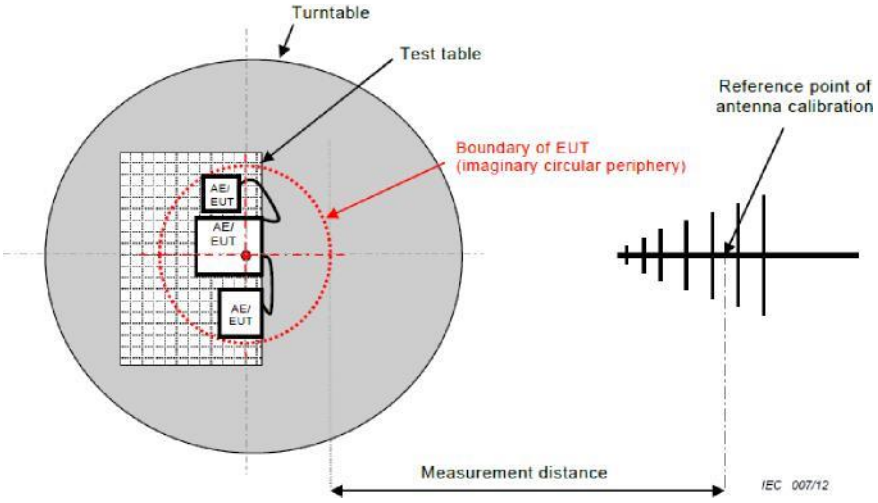
Typical Radiated Emissions Setup



Measurement Uncertainty

The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is +/-4.4 dB with a 'k=2' coverage factor and a 95% confidence level.

Preliminary Graphs

Note the graphs shown below are for graphical illustration only. For final measurements with the appropriate detector, please refer to the final measurement table where applicable. The graph shown below is a maximized peak measurement graph, measured with a resolution bandwidth greater than the final required detector and over a full 0-360 rotation. This peaking process is done as a worst case measurement. This process enables the detection of frequencies of concern for final measurement, and provides considerable time savings.

In accordance with FCC Part 15, Subpart A, Section 15.33, the device was scanned to the 10^{th} harmonic.

Devices scanned may be scanned at alternate test distances, and in accordance with FCC Part 15, Subpart A, Section 15.31, an extrapolation factor of 20 dB/decade was used above 30 MHz and 40 dB/decade below 30 MHz. For example for 1 meter measurements, an extrapolation factor 9.5 dB from 20 Log (1m / 3m) is applied.

Low, middle and high channels were measured, each in three orthogonal axes were checked; however the worst case graphs are presented.

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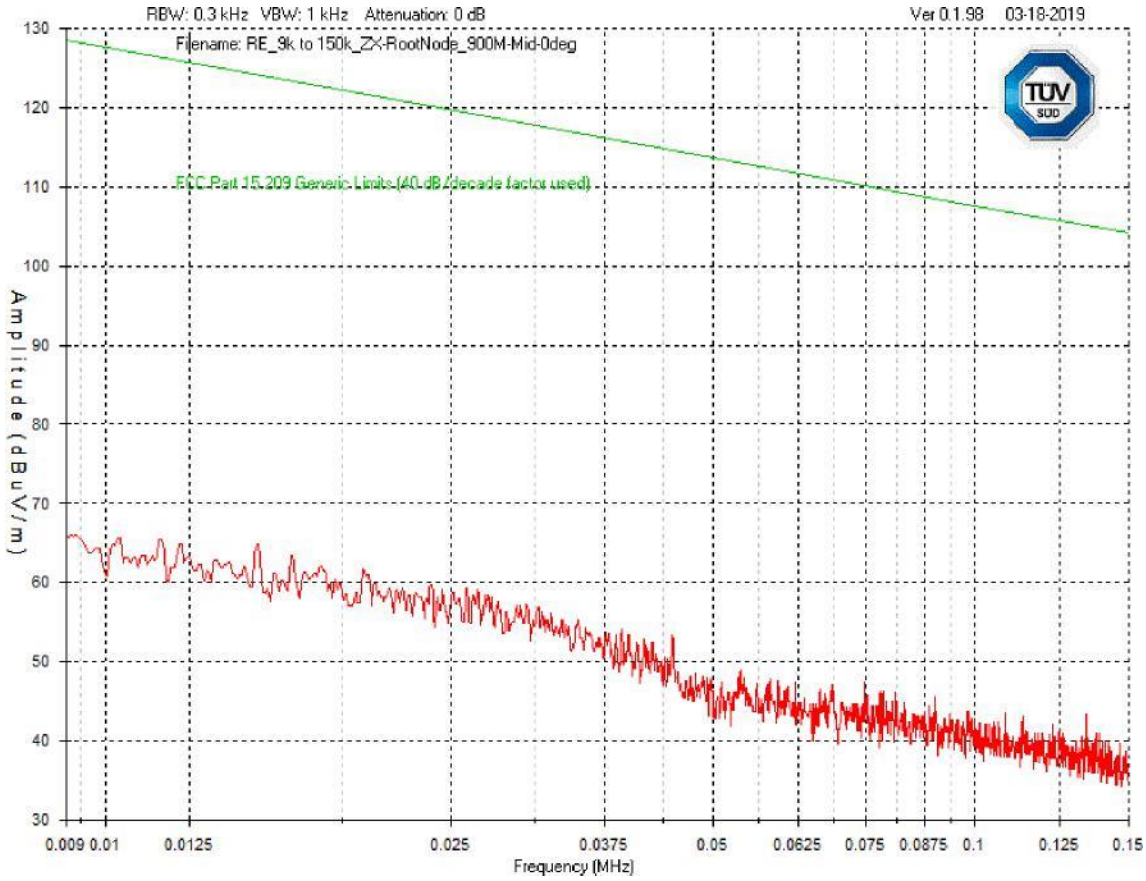
Band edge measure graphs were shown for illustrations purpose. See final measurement section for all measurements.

9 kHz – 150 kHz



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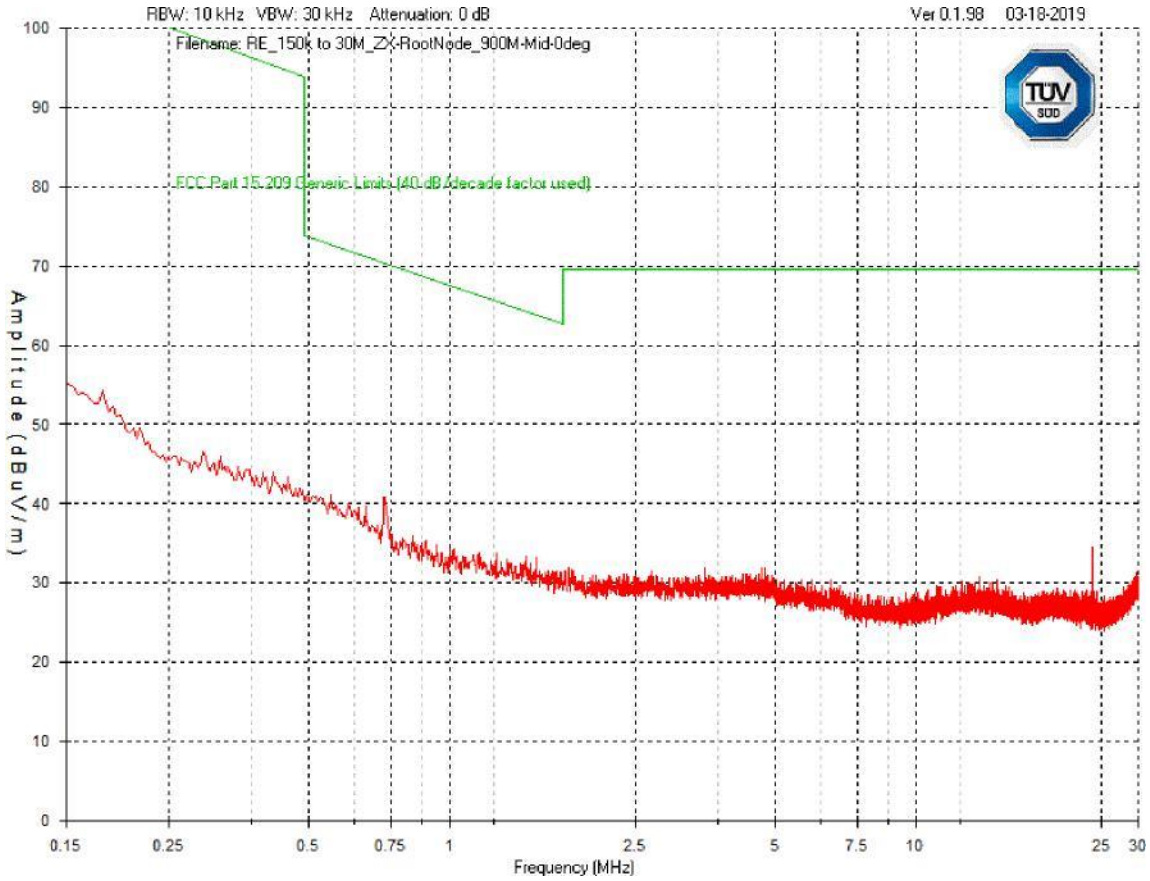
150 kHz – 30 MHz



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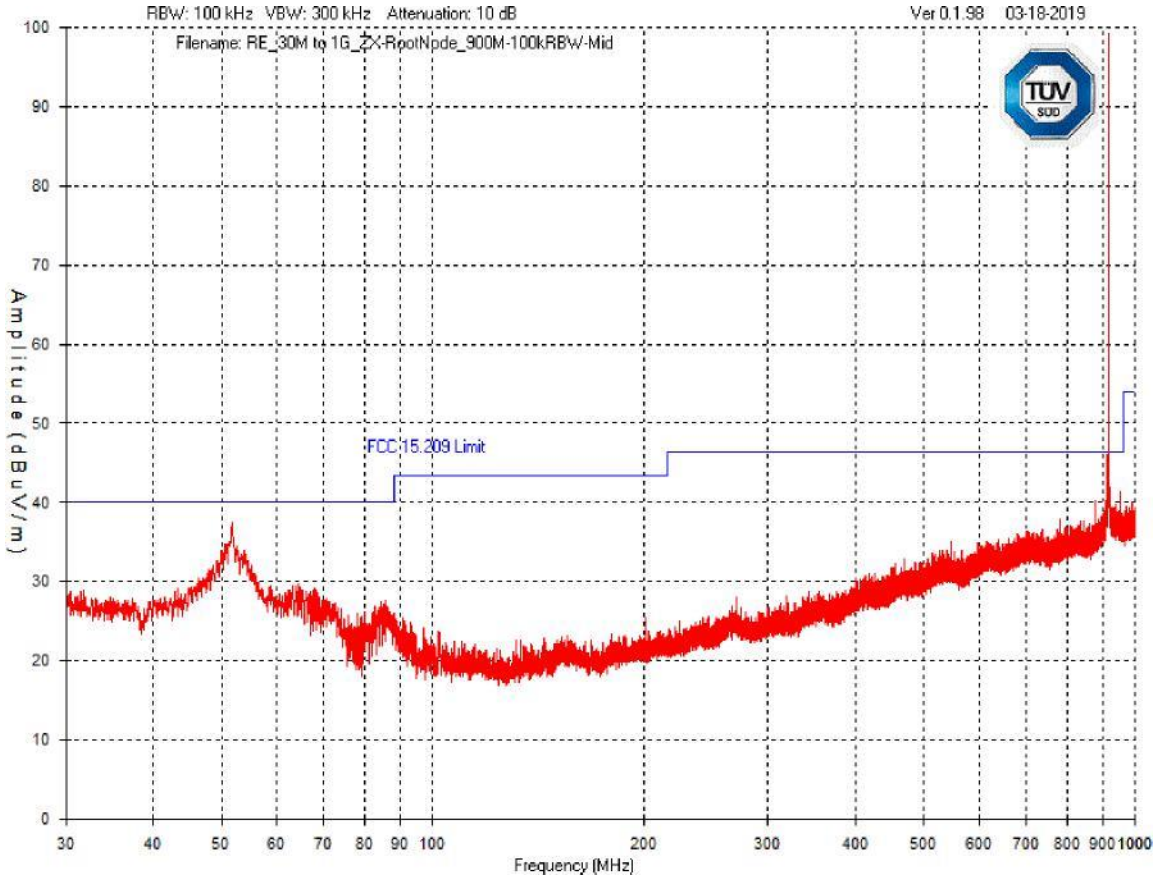
Mid Channel - 30 MHz – 1 GHz
Vertical – Peak Emission Graph



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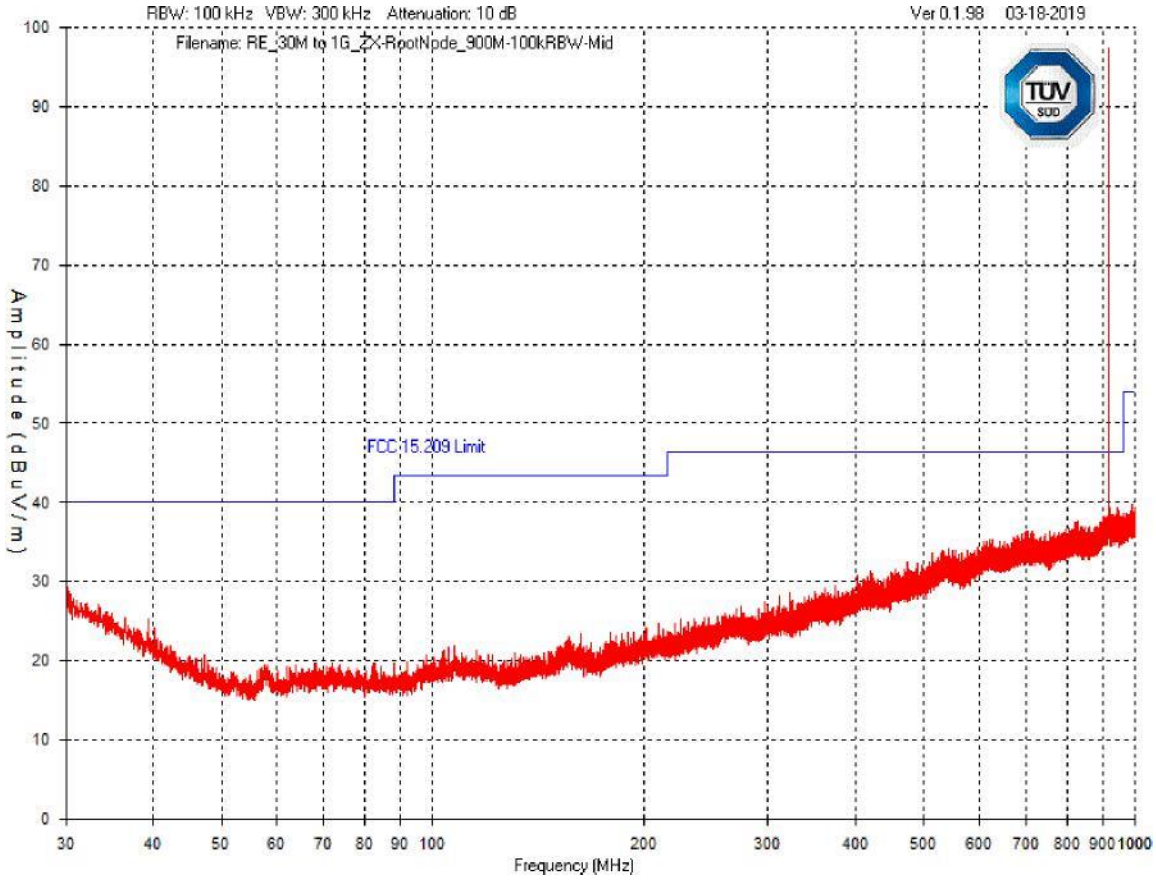
Mid Channel – 30 MHz – 1 GHz
Horizontal - Peak Emission Graph



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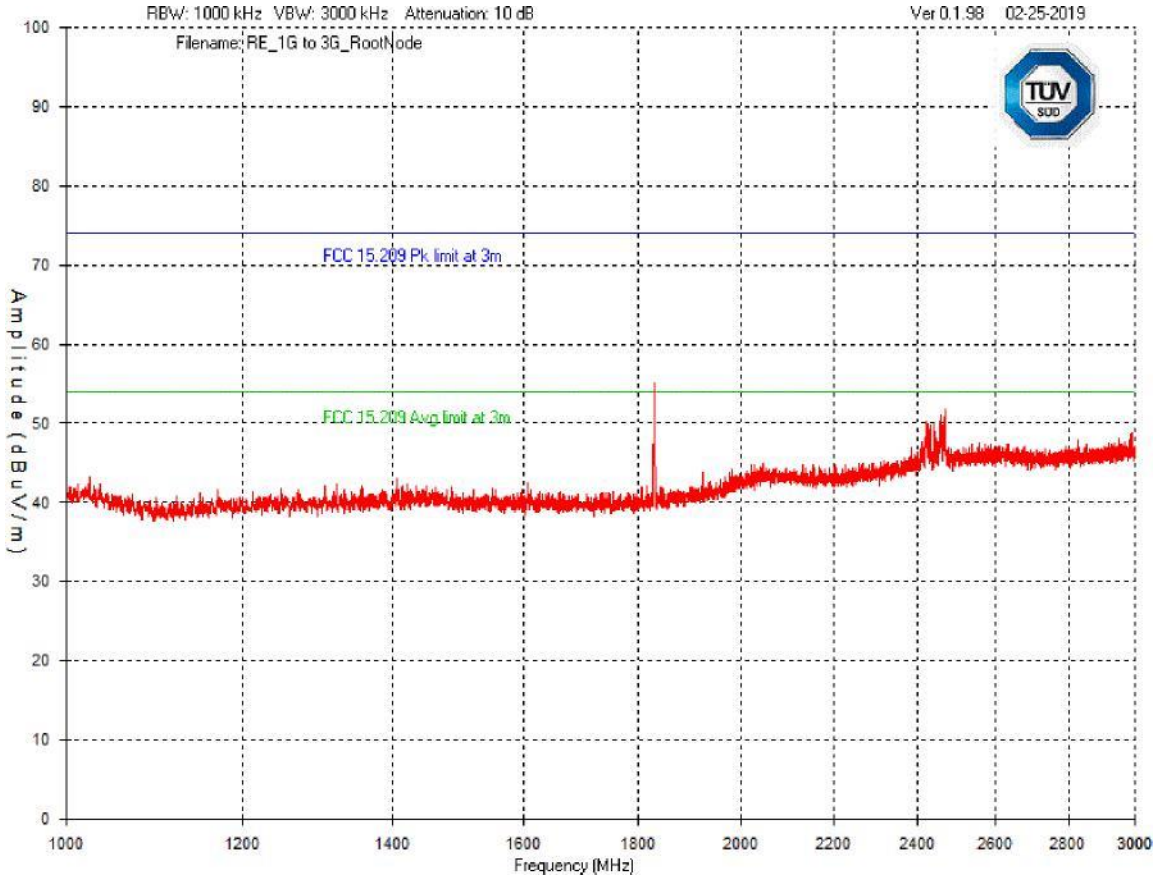
Mid Channel – 1 GHz – 3 GHz
Vertical - Peak Emission Graph



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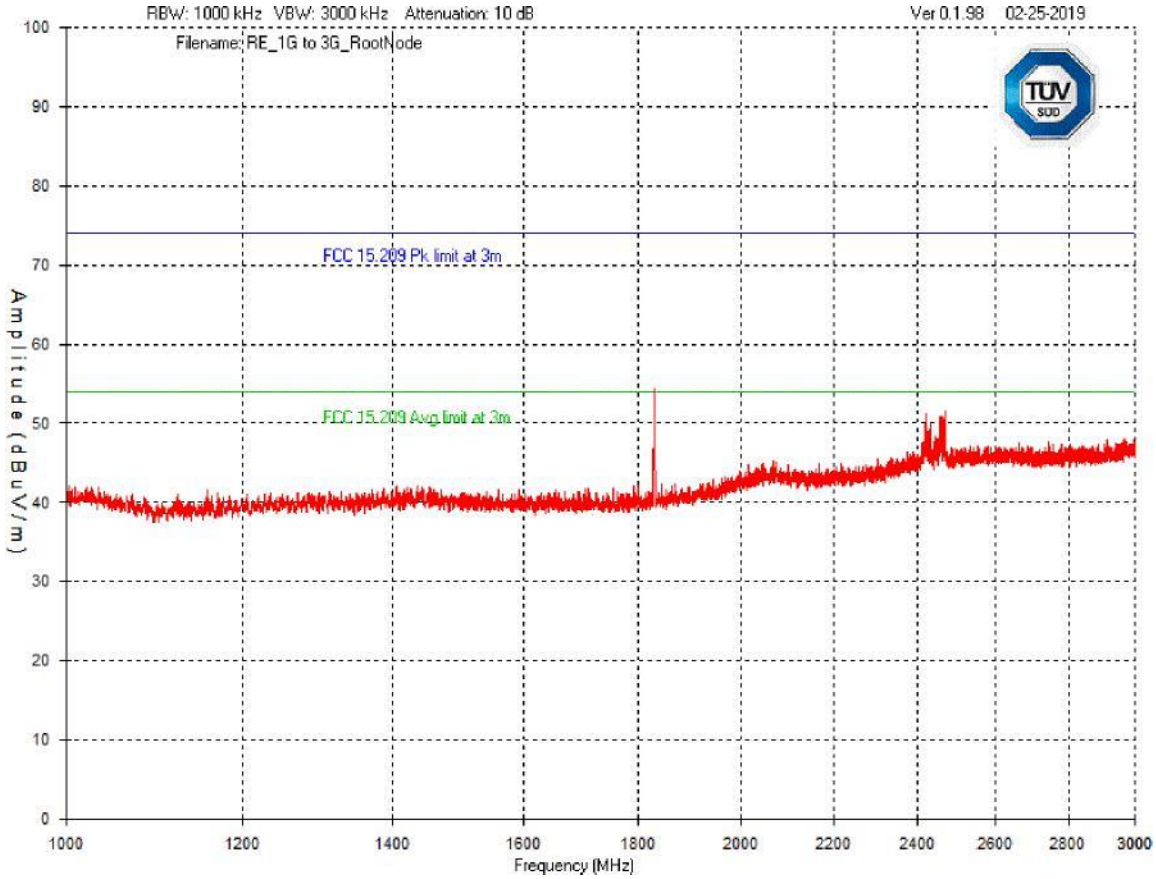
Mid Channel – 1 GHz – 3 GHz
Horizontal - Peak Emission Graph



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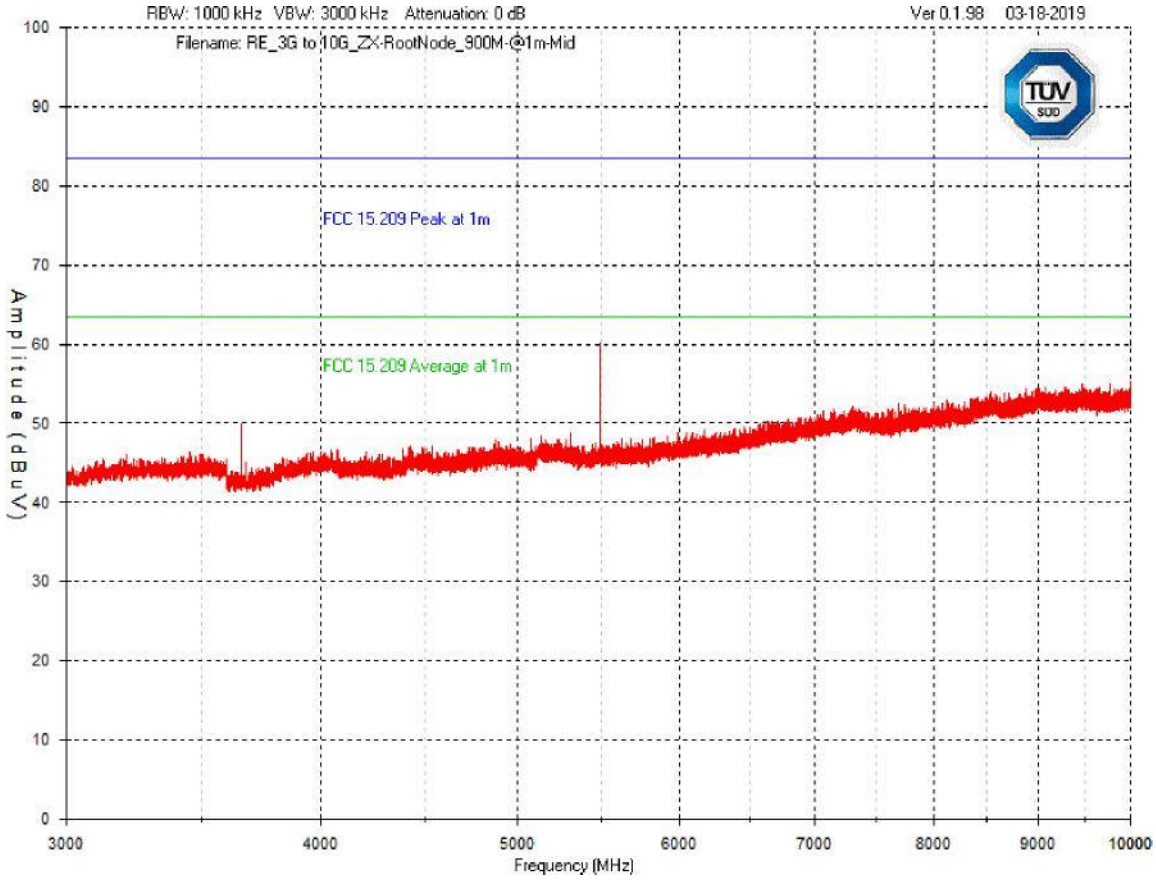
Mid Channel – 3 GHz – 10 GHz
Vertical - Peak Emission Graph



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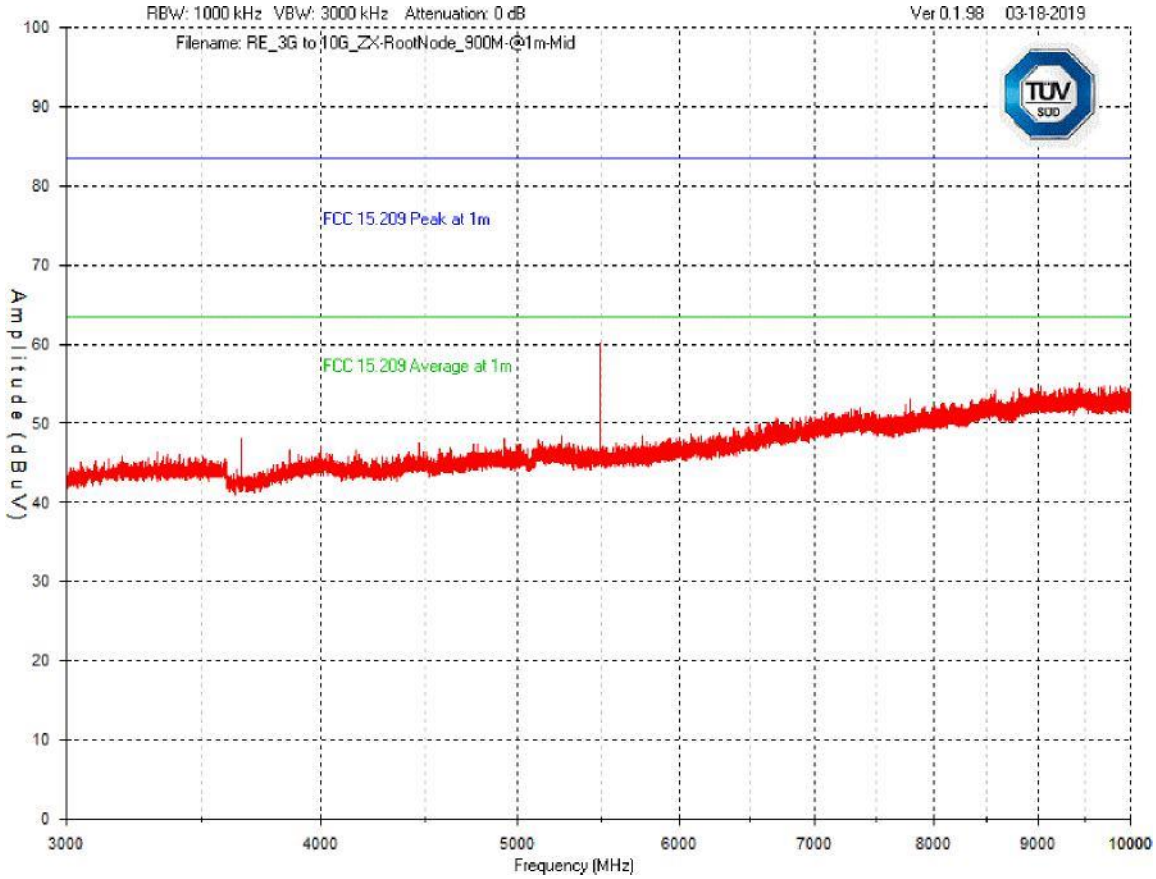
Mid Channel – 3 GHz – 10 GHz
Horizontal - Peak Emission Graph



Note: See Final Measurements and Results section for measurements.

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Final Measurements and Results

The EUT passed the limits. Low, middle and high channels were measured.

In accordance with 15.247(d), only frequencies exceeding the 15.209 limit that occur within the bands listed in 15.205, need to be verified with a final detector. Emission outside the restricted bands were measured for information purpose.

The measurements were maximized by rotating the turn table over a full 0-360 rotation and the antenna height was varied from 1 m to 4 m.

Quasi-Peak Emissions Table

Supply			5 Vdc							
Freq. (MHz)	**Detector Peak/ QP**	**Received Signal (dBi.tV)**	**Antenna Factor (dB/m)**	**Atten Factor (dB)**	**Cable Factor (dB)**	**Pre-Amp (dB)**	**Level (dBi.tV/m)**	**QP Limit (dB)**	**QP Margin (dB)**	**Pass / Fail**
Vertical Antenna Polarization										
30.2266	Peak	29.9	21.3	10	0.5	-32.4	29.3	40	10.7	Pass
542.964	Peak	31.1	24.5	10	1.7	-33.2	34.1	46.4	12.3	Pass
30	Peak	27.4	21.4	10	0.5	-32.4	26.9	40	13.1	Pass
420.46	Peak	31.4	21.7	10	1.5	-33.3	31.3	46.4	15.1	Pass
373.044	Peak	31.4	20	10	1.5	-33.3	29.6	46.4	16.8	Pass
322.003	Peak	32.4	18.2	10	1.4	-33.3	28.7	46.4	17.7	Pass
Horizontal Antenna Polarization										
51.7821	Peak	49.2	10.9	10	0.7	-33.3	37.5	40	2.5	Pass
953.329	Peak	33.1	28.1	10	2.3	-32.1	41.4	46.4	5	Pass
876.525	Peak	33.8	26.8	10	2.2	-32.5	40.3	46.4	6.1	Pass
547.333	Peak	32.3	24.4	10	1.7	-33.2	35.2	46.4	11.2	Pass
85.5719	Peak	39.1	11.1	10	0.8	-33.4	27.6	40	12.4	Pass
82.7561	Peak	38.3	11.2	10	0.8	-33.4	26.9	40	13.1	Pass

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Average Emissions Table

Supply			5 Vdc							
Freq. (MHz)	**Detector Peak/ AVG/ QP**	**Received Signal (dBi.tV)**	**Antenna Factor (dB/m)**	**Cable Factor (dB)**	**HP Filter (dB)**	**Pre-Amp (dB)**	**Level (dBi.tV)**	**AVG Limit (dB)**	**AVG Margin (dB)**	**Pass / Fail**
Vertical Antenna Polarization										
1830	AVG	56	24.9	3.3	1.9	-33.1	53	54	1	Pass
2466.9	Peak	50.1	28.4	4.2	1.9	-33.1	51.5	54	2.5	Pass
2420.28	Peak	50	28.2	4.1	1.9	-33.1	51.1	54	2.9	Pass
2458.89	Peak	49.6	28.4	4.1	1.9	-33.1	50.9	54	3.1	Pass
1000	Peak	42.6	23.5	2.4	6	-34.4	40.1	54	13.9	Pass
1551.41	Peak	43.3	24.9	3	2	-33.4	39.8	54	14.2	Pass
Horizontal Antenna Polarization										
1830.54	AVG	56.7	24.9	3.3	1.9	-33.1	53.7	54	0.3	Pass
2466.61	Peak	50.4	28.4	4.2	1.9	-33.1	51.8	54	2.2	Pass
2456.03	Peak	49.8	28.3	4.1	1.9	-33.1	51	54	3	Pass
2420.56	Peak	49.1	28.2	4.1	1.9	-33.1	50.2	54	3.8	Pass
2407.69	Peak	46.7	28.2	4.1	1.9	-33.1	47.8	54	6.2	Pass
1000	Peak	43.4	23.5	2.4	6	-34.4	40.9	54	13.1	Pass

Note:

Peak = Peak measurement
QP = Quasi-Peak measurement
AVG = Average measurement

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Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration Date	Next Calibration Date	Asset #
Spectrum Analyzer	ESU-40	Rohde & Schwarz	2017-04-20	2019-04-20	4092
BiLog Antenna	3142-E	ETS	2018-11-29	2020-11-29	4002
Horn Antenna	ATH1G18G	AR	2017-04-25	2019-04-25	4003
Biconical Antenna	EM-6913	Electro-Metrics	2017-05-02	2019-05-02	4060
Log Periodic Antenna	LPA-25	Electro-Metrics	2017-04-20	2019-04-20	4087
Loop Antenna	EM 6879	Electro-Metrics	2017-04-19	2019-04-19	4040
Attenuator 3 dB	FP-50-3	Trilithic	NCR	NCR	4028
LNA pre-amp	LNA-1450	RF Bay Inc.	2017-07-22	2019-07-22	4089
1-26.5GHz preamp	8449B	Agilent	2017-09-09	2019-09-09	4006
RF Cable 10m	LMR-400-10M-50OHM-MN-MN	LexTec	NCR	NCR	4025
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	4026
Emission software	0.1.97	Global EMC	NCR	NCR	58

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Appendix A – EUT Summary

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For further details for filing purposes, refer to filing package.

General EUT Description

Client	
Organization / Address	VERDANT ENVIRONMENTAL TECHNOLOGIES, 1850 55E AVENUE,
Contact	Andrew Co
Phone	1.514.344.4448
Email	andrew@verdant.info
EUT Details	
EUT Name	ZX Root Node
FCC ID	XEYZX-RN
Industry Canada #	8410A-ZXRN
Hardware Version Identification Number(s) (HVIN):	ZX-RN
Equipment Category	Unlicensed transmitter
Basic EUT Functionality	EUT is a 902 – 928 MHz FHSS transmitter.
Input Voltage and Frequency	5 VDC

Note the EUT is considered to have been received the date of the commencement of the first test, unless otherwise stated.

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EUT Configuration

Please refer to Test Setup exhibit for EUT and Test Setup photos of the unit.

- Wireless were configured to transmit at maximum possible duty cycle
- The transmitter was provided in 2 different settings:
    - A configuration with special test firmware was installed on the EUT to control hopping through its pseudo random sequence and single channel
    - A configuration with low, medium and high channels transmitting continuously at a 100% duty cycle.

Operational Setup

These devices are required to be attached to the EUT for its normal operation.

- None.

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