FCC RF Test Report
As per

RSS-247 Issue 2

FCC Part 15.247 Subpart C
&
ICES 003 Issue 6
on the

WX DB Thermostat

IC: 8410A-WXDB; FCC ID: XEYWX – DB

Prepared to:

Verdant. Environmental Technologies, Inc.

1850 – 55th Avenue, Lachine, Quebec, H8T 3J5
CANADA

Product Service

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RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Test Specialist	Abdoulaye Ndiaye	22-09-2020	
Authorised Signatory	Scott Drysdale	22-09-2020	

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD Product Service document control rules.

EXECUTIVE SUMMARY
A sample of this product was tested and found to be in compliance with FCC Part 15 Subpart 15.247/ ICES 003 Issue 6, RSS-247 Issue 2.

A2LA Cert. No. 2955.20

TÜV SÜD Product Service
is a trading name of TUV SUD Ltd
2972 Joseph-A-Bombardier
Laval, QC H7P 6E3 Canada

TUV SUD Ltd is a
TÜV SÜD Group Company

Phone: +450-687-4976
www.tuv-sud.ca

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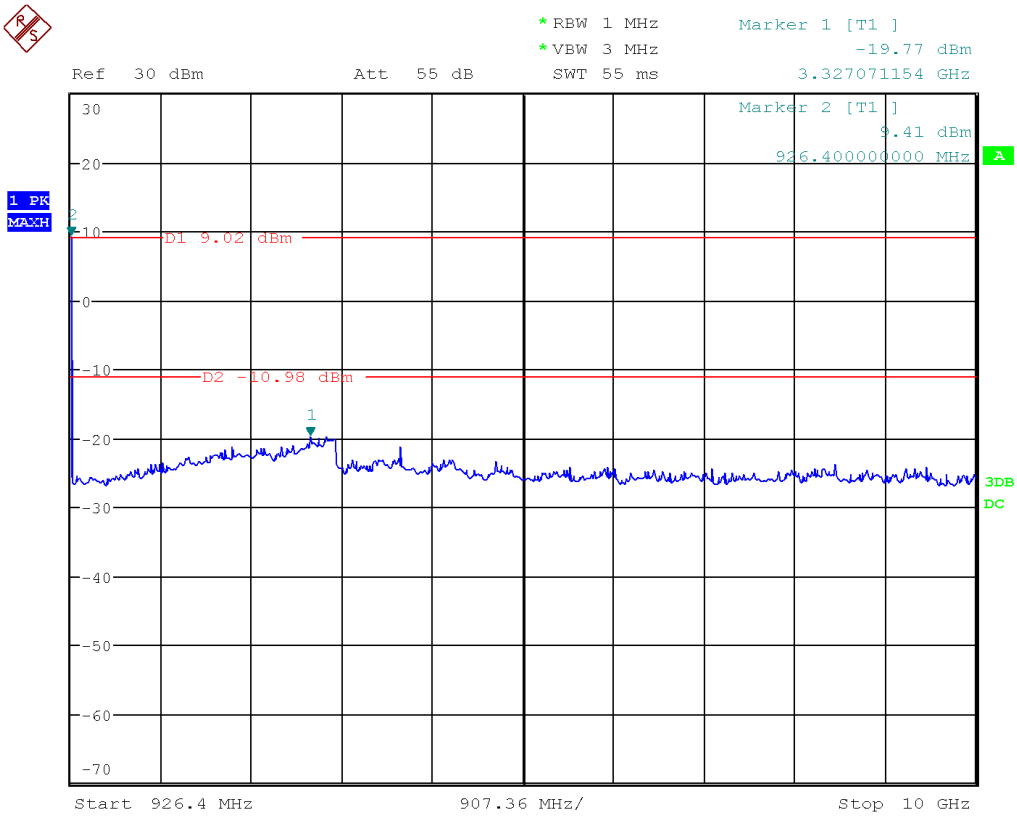


1 Report Summary

Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	April 17TH, 2020
2	Appendix A updated. Section 6,9, 10, 11, 12, 13, 14, 15 updated.	September 22, 2020

Table 1 – Modification Records

Acronyms & Definitions

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

Acronyms

AM	Amplitude Modulation
ASCE	Antenna Spurious Conducted Emissions
DTS	Digital Transmission System
EIRP	Equivalent Isotropical Radiated Power
ETSI	European Telecommunications Standards Institute
EUT	Equipment Under Test
FHSS	Frequency Hopping Spread Spectrum
OOB	Out of Band
PKPSD	Peak Power Spectrum Density
RBW	Resolution Bandwidth
RF	Radio Frequency of oscillation rate of electromagnetic fields (e.g. radio waves: 9kHz to 300GHz)
RMS	Root mean square, i.e., $V_p/\sqrt{2}$
Rx	Referred as antennae for receiving RF signals
SD	Spurious Domain
TR	Technical Report
Tx	Referred as antenna for transmitting RF signals
VBW	Video Bandwidth
Vp	Peak Voltage

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.

2 Introduction

Applicant:	Verdant Environmental Technologies, Inc.
Manufacturer:	Verdant Environmental Technologies, Inc.
Number of Samples Tested:	2
Test Specification/Issue/Date:	RSS-247 Issue 2: February 2017 FCC Part 15 Subpart C.247:2016 ICES 003 Issue 6:2019
Test Plan/Issue/Date:	N/A
Project Number:	7169007677
Date:	2020-02-26
Date of Receipt of EUT:	2020-03-09
Start of Test:	2020-03-12
Finish of Test:	2020-03-17
Name of Tester(s):	Abdoulaye Ndiaye Jose Martinez-Ortega
Related Documents:	ANSI C63.10:2013 FCC 15. Subpart C/RSS-247 RSS.GEN Issue 5: 2019

Brief Summary of Results

A brief summary of the tests carried out in accordance with RSS-247 Issue 2, FCC Part 15 Subpart 15.247, FCC Part 15 Subpart 15.207 & FCC Part 15 Subpart 15.209 is summarized in Table 2.

Report Section	FCC Rule	IC Rule	Description	Class/Limit	Result
6	15.247(a)(1)	RSS-GEN5 Clause.6.7	99% Bandwidth DTS+FHSS	Refer to RSS GEN 5 Clause.6.7	Pass
	15.247(a)(1)(i)	RSS-247.5.1	99% Bandwidth Hopping System	≤500kHz	Pass
7	15.247(a)(2)	RSS-247.5.2(a)	6 dB Bandwidth	>500kHz	Pass
8	15.247(a)(1)(i)	RSS 247 5.1 (c)	Hopping Channels	>=50	Pass
9	15.247(a)(1)	RSS 247 5.1 (2)	Channel Separation	> 25 kHz or 20 dB BW	Pass
10	15.247(a)(1)(i)	RSS 247 5.1 (c)	Time of occupancy	<0.4 s in 20s period	Pass
11	§15.247(b)(3)	RSS-247.5.4(d)	Maximum Peak Output Power (DTS)	< 1W	Pass
	15.247(b)(2)	RSS-247.5.4(a)	Maximum Peak Output Power (FHSS)	< 1W	
12	15.247(f)	RSS-247 5.2(b)	Power Spectral Density	<8dBm in any 3kHz Band	Pass
13	§15.247(d)	RSS-247 5.5	Antenna conducted spurious 9k to 10th Harmonic Emission	≤ 20dBc	Pass

14	§15.209(a)	RSS-247 5.5	Tx Spurious Radiated Emission	Quasi-Peak Average	Pass
15	15.207(a)	RSS GEN 8.8	Conducted Emission	Quasi-Peak Average	Pass
	15.247(h)	RSS 247 5.1	FHSS Intelligence	Note 3	Pass
	15.247 (i)	RSS-102	RF Exposure	Note 4	Pass
	15.247(b)(4)	RSS 247 5.4 (3)	Antenna Gain	<6dBi <Note 2>	Pass
	15.203 & 15.247(b)	RSS-210	Antenna Requirement	Note 1	Not Applicable

Note 1: Manufacture uses a SMA antenna connector for unique coupling to the intentional radiator
Note 2: For the Antenna requirement specified in FCC 15.203 (RSS-247 section 5.5), the unit uses a trace antenna with a gain of less than 6 dBi.
Note 3: The EUT does not coordinate transmission with any other FHSS to avoid simultaneous occupation of hopping frequencies
Note 4: For maximum permissible exposure, this device operates at less than 1 Watt at 902 - 928MHz and at 2.4GHz – 2.48GHz. It 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

Table 2 – Test Summary Table

Declaration of Build Status

This report addresses the EMC verification testing and test results of the WX DB Thermostat 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
FCC Part 15 Subpart C 15.247:2016
ICES 003 Issue 6:2019

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

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.

For a more detailed list of the standards and the revision used, see the "Applicable Standards, Specifications and Methods" section of this report.

Notes, Justification

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 2 traces antenna with a gain of less than 6 dBi which is 0 dBi.for each antenna.

For the Restricted Bands of operation, the EUT is designed to only operate between 902 – 926.4 MHz and 2.402 – 2.48GHz.

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

For maximum permissible exposure, this device operates at less than 1 Watt at 902 - 928MHz and 2.4GHz – 2.48GHz. It 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.

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

3 EUT: WX DB Thermostat

3.1 Specifications:

PRODUCT NAME:	WX DB Thermostat
MANUFACTURER:	Verdant Environmental Technologies, Inc
MODEL	2.4GHz
TUV NUMBER:	479418
PART NUMBER:	N/A
SERIAL NUMBER	WX_DB Rev.0.1
SOFTWARE VERSION	1.51
HARDWARE VERSION	0.1
FREQUENCY RANGE (MHz)	2402-2480
CHANNEL NUMBER	0-39 [40]
DATA RATE	1Mbps
CHANNEL BANDWIDTH	2MHz
MODULATION TYPE	GFSK
VOLTAGE RATING:	24 Vac & 3.3 Vdc

Table 3 – EUT – WX DB – Specifications for 2.4GHz

PRODUCT NAME:	WX DB Thermostat
MANUFACTURER:	Verdant Environmental Technologies, Inc
MODEL	900 MHz
TUV NUMBER:	479419
PART NUMBER:	N/A
SERIAL NUMBER	WX_DB Rev.0.1
SOFTWARE VERSION	1.51
HARDWARE VERSION	0.1
FREQUENCY RANGE (MHz)	902 – 927.54
CHANNEL NUMBER	0-66 [67]
DATA RATE	100kbps
CHANNEL BANDWIDTH	380kHz
MODULATION TYPE	GFSK
VOLTAGE RATING:	24 Vac & 3.3 Vdc

Table 4 – EUT – WX DB – Specifications for 900 MHz

Channels	Frequency (GHz)	Channels	Frequency (GHz)
Channel #0	2.402GHz	Channel #20	2.442GHz
Channel #1	2.404GHz	Channel #21	2.444GHz
Channel #2	2.406GHz	Channel #22	2.446GHz
Channel #3	2.408GHz	Channel #23	2.448GHz
Channel #4	2.410GHz	Channel #24	2.450GHz
Channel #5	2.412GHz	Channel #25	2.452GHz
Channel #6	2.414GHz	Channel #26	2.454GHz
Channel #7	2.416GHz	Channel #27	2.456GHz
Channel #8	2.418GHz	Channel #28	2.458GHz
Channel #9	2.420GHz	Channel #29	2.460GHz
Channel #10	2.422GHz	Channel #30	2.462GHz
Channel #11	2.424GHz	Channel #31	2.464GHz
Channel #12	2.426GHz	Channel #32	2.466GHz
Channel #13	2.428GHz	Channel #33	2.468GHz
Channel #14	2.430GHz	Channel #34	2.470GHz
Channel #15	2.432GHz	Channel #35	2.472GHz
Channel #16	2.434GHz	Channel #36	2.474GHz
Channel #17	2.436GHz	Channel #37	2.476GHz
Channel #18	2.438GHz	Channel #38	2.478GHz
Channel #19	2.440GHz	Channel #39	2.480GHz

Table 5 List of Channels for WX DB 2.4 GHz

Channels	Frequency (MHz)	Channels	Frequency (MHz)	Channels	Frequency (MHz)	Channels	Frequency (MHz)
Channel #0	902.46	Channel #20	910.06	Channel #40	917.66	Channel #60	925.26
Channel #1	902.84	Channel #21	910.44	Channel #41	918.04	Channel #61	925.64
Channel #2	903.22	Channel #22	910.82	Channel #42	918.42	Channel #62	926.02
Channel #3	903.6	Channel #23	911.2	Channel #43	918.8	Channel #63	926.4
Channel #4	903.98	Channel #24	911.58	Channel #44	919.18		
Channel #5	904.36	Channel #25	911.96	Channel #45	919.56		
Channel #6	904.74	Channel #26	912.34	Channel #46	919.94		
Channel #7	905.12	Channel #27	912.72	Channel #47	920.32		
Channel #8	905.5	Channel #28	913.1	Channel #48	920.7		
Channel #9	905.88	Channel #29	913.48	Channel #49	921.08		
Channel #10	906.26	Channel #30	913.86	Channel #50	921.46		
Channel #11	906.64	Channel #31	914.24	Channel #51	921.84		
Channel #12	907.02	Channel #32	914.62	Channel #52	922.22		
Channel #13	907.4	Channel #33	915	Channel #53	922.6		
Channel #14	907.78	Channel #34	915.38	Channel #54	922.98		
Channel #15	908.16	Channel #35	915.76	Channel #55	923.36		
Channel #16	908.54	Channel #36	916.14	Channel #56	923.74		
Channel #17	908.92	Channel #37	916.52	Channel #57	924.12		
Channel #18	909.3	Channel #38	916.90	Channel #58	924.5		
Channel #19	909.68	Channel #39	917.28	Channel #59	924.88		

Table 6 List of Channels for WX DB 900MHz

3.2 Modes of Operation

The WX DB thermostat is operating in the 2.4 GHz and 915 MHz bands. For operation it uses the GFSK modulation as the following:

- 1Mbit/s GFSK at 2.4 GHz
- 600bps GFSK at 915 MHz

The EUT was configured to continuously transmit during transmitter testing by an interval of 1s. To parse commands to the EUT, the operator has to change to an equivalent RF mode using the Wireless Gecko DTM Application
For more details please refer to Zx_DUTs test Setup in Appendix B

3.3 Setup Diagram

During the EUT was exercised by powering to the rated voltage and connecting according to Figure 1.

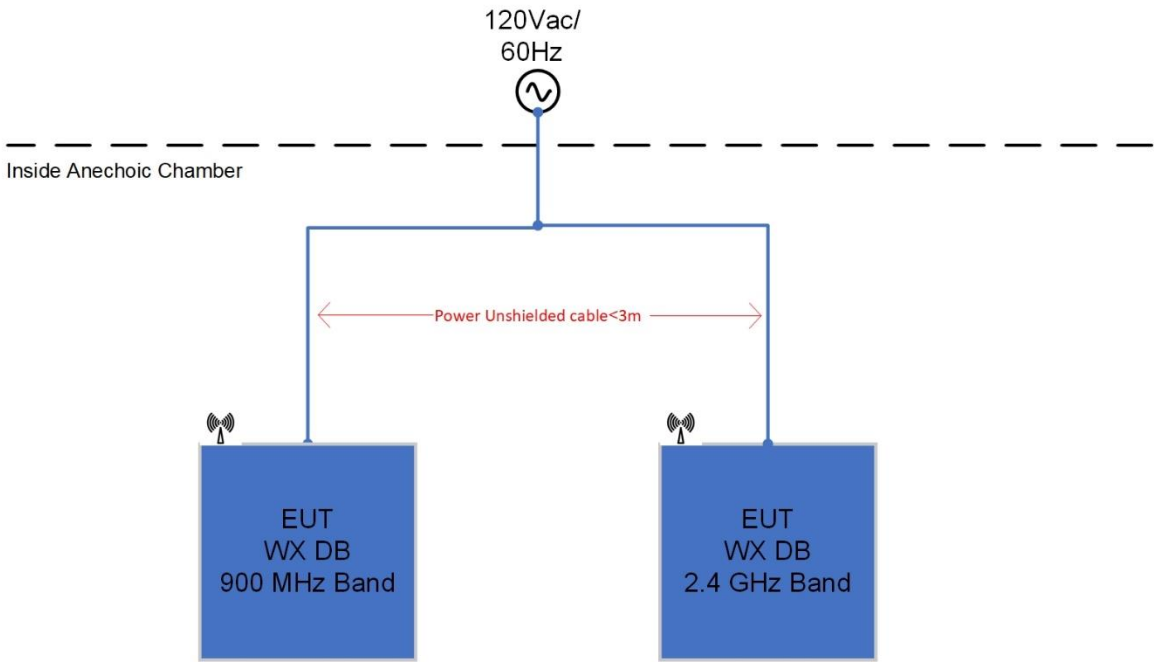


Figure 1: EUT Setup Diagram – WX DB thermostat – Spurious emissions

4 Deviations from the Standard

No deviations from the applicable test standard were made during testing.

5 Measurement Uncertainty

The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2. For instance, for the range of 0.15MHz-30MHz, 30MHz – 1GHz and 1GHz – 18GHz is ±3.3 dB, ±4.25dB and ±4.93dB, respectively with a 'k=2' coverage factor and a 95% confidence level.

Parameter	Uncertainty
Occupied channel Bandwidth	± 5%
RF output power, conducted	± 1.5dB
Power Spectral Density, conducted	± 3dB
Unwanted Emission, conducted	± 3dB
All emission, radiated	± 6dB
Temperature	± 3°C
Time Occupancy	± 3%

Table 7 Acceptable Uncertainties

6 99% Bandwidth

6.1 Purpose & Methods

The Purpose & Methods of this test is to ensure that the bandwidth occupied exceeds a stated minimum. This helps ensure the utilization of the frequency allocation is sufficiently wide. This also helps prevent corruption of data by ensuring adequate data separation to distinguish the reception of the intended information. The test method is a defined in ANSI C63.10.

6.2 Test Specifications

REFERENCE STANDARD	FCC 15.247(a)(1) ANSI C63.10-2013 Clause 6.9 RSS-247.5.1 RSS GEN 5 Clause 6.7	
SPECIFICATIONS		
Limit – % Bandwidth	99	
Frequency range (MHz)	2402 2440 2480	902.46 915 926.4
Data rate	1Mbps	100kbps
RBW (kHz):	Set to 1% to 3% of the 99% bandwidth	
VBW (kHz)	3xRBW	
EUT		
Identification	WX DB Thermostat(2.4GHz/900MHz)	
Voltage Input	24 Vac & 3.3 Vdc	
ENVIROMENTAL & TEST INFO		
Test Date (YYYY-MM-DD)	2020-03-16	2020-09-15
Temperature (°C)	22.6 ± 2	21.3 ± 2
Humidity (%)	23.4 ± 5	22.24 ± 5
Atmospheric Pressure kPa (For Info Only)	103.34	101.33
Tester	Abdoulaye Ndiaye Jose Martinez-Ortega	
Client Witness	No Witness	

6.3 Test Setup

The setup for conducted measurements is depicted in photo 1

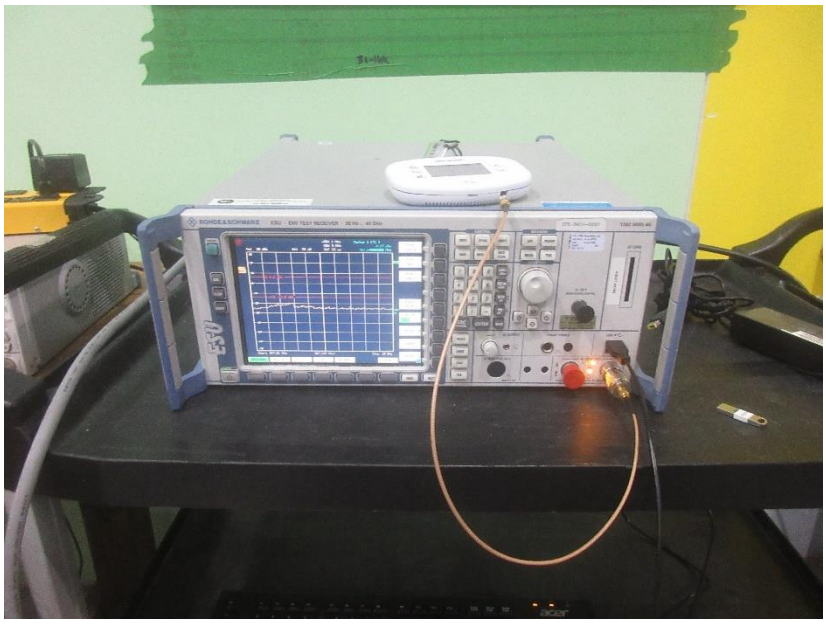


Photo 1: – WX DB (900MHz/2.4GHz)

6.4 Test Results

WX DB (2.4GHz)

The Channel #19 and Channel # 39 gave a maximum of 1.2 MHz for 99% BW. Details are depicted in Table 8

Channel	Frequency (MHz)	99% Bandwidth (MHz)	Results
Low channel: #0	2402	1.15	Pass
Middle Channel: #19	2442	1.2	Pass
Highest Channel: #39	2480	1.2	Pass
Note 1: No Limit is applicable, but according to RSS GEN 5 the RBW has to be set to 1% to 3% of the 99% bandwidth			

Table 8 – 99% Bandwidth Results

WX DB (900MHz)

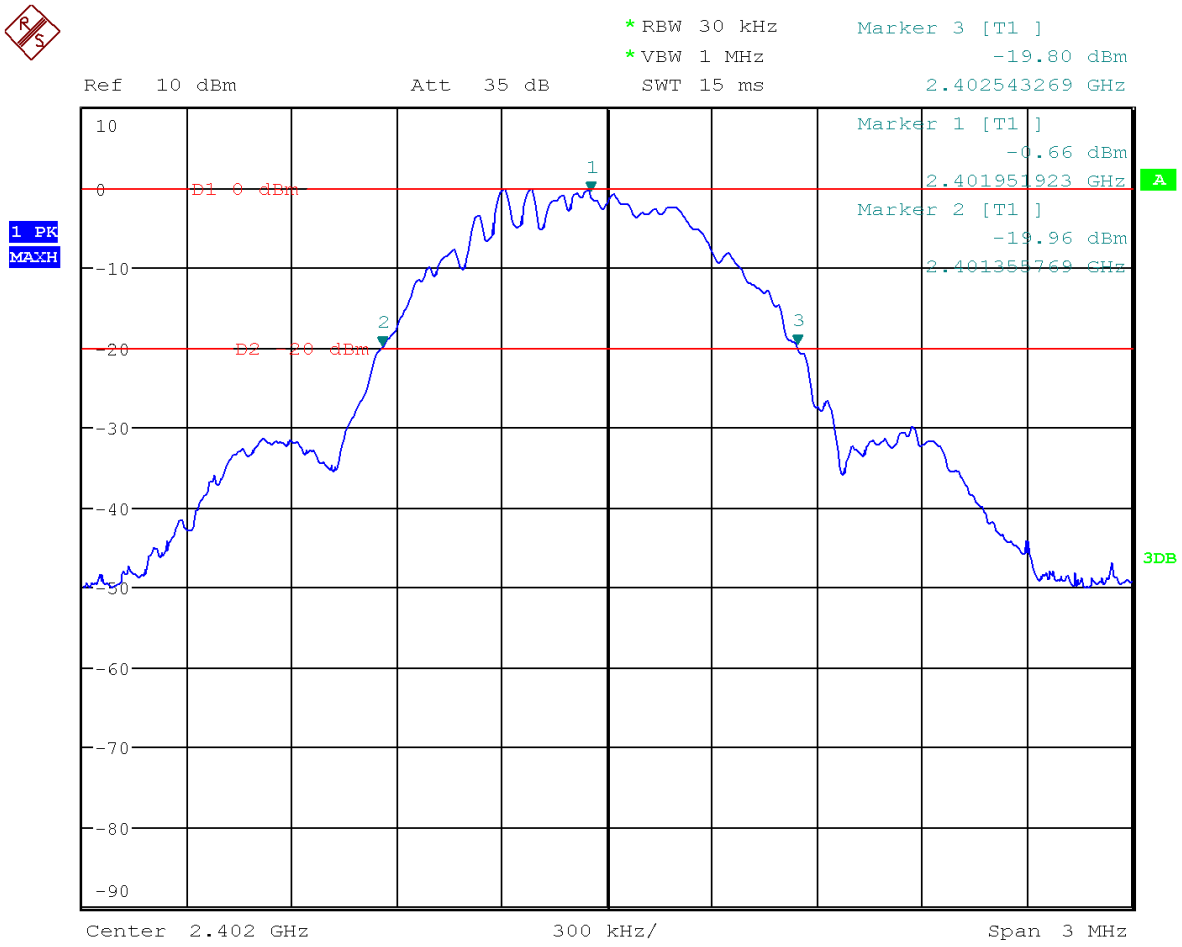
Channel 63 gave a maximum of 218.75 kHz for 99% BW. Details are depicted in Table 9

Channel	Frequency (MHz)	99% Bandwidth (kHz)	Limit (kHz)	Results
Low channel: #0	902.46	215.544	>25	Pass
Middle Channel: #32	915	217.147	>25	Pass
Highest Channel: #63	926.4	218.75	>25	Pass

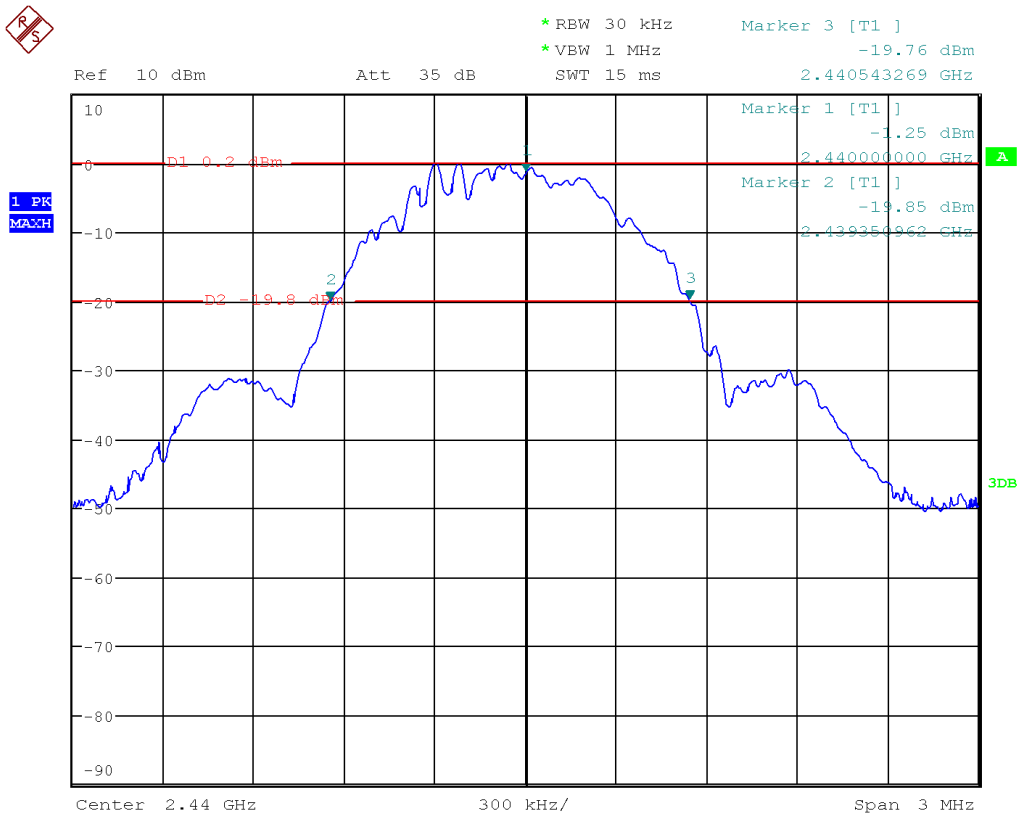
Table 9 – 99% Bandwidth Results

6.5 Graphs

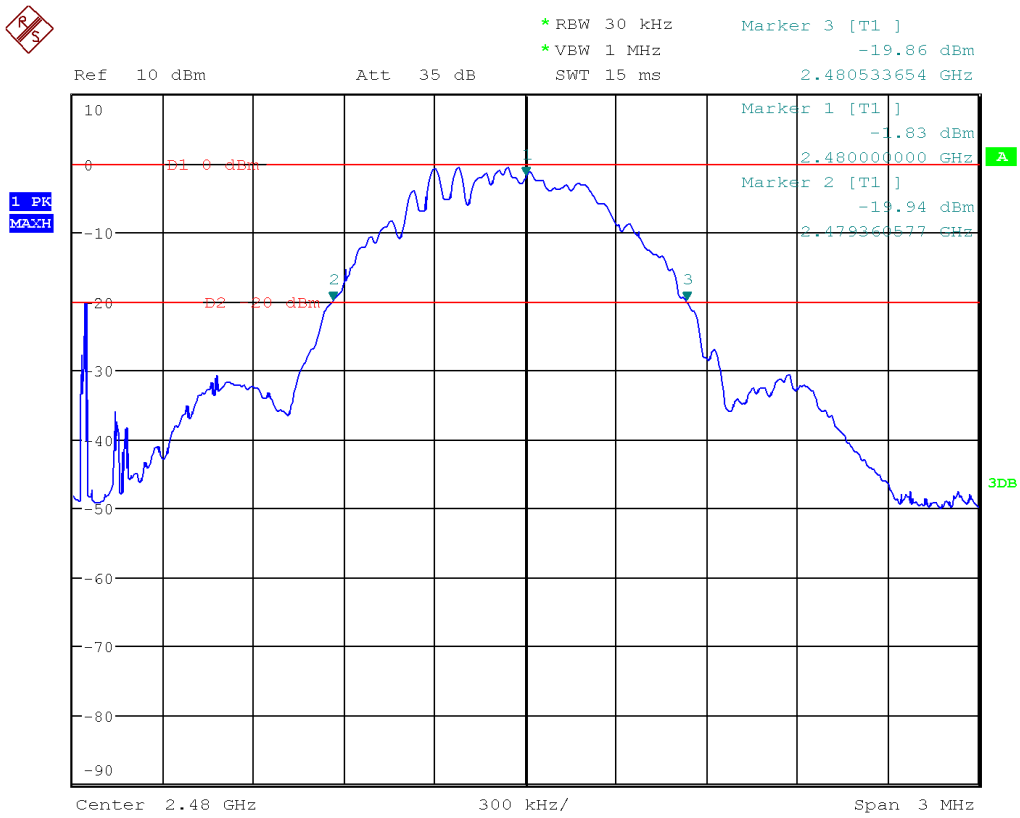
The graphs showed below show the OBW during the operation of the device. This is measured by a max hold on the spectrum analyzer and the highest resolution bandwidth that is sufficiently low to exhibit the 99% bandwidth of a channel during operation of the EUT. Max hold is performed for a duration of not less than 1 minute. No attenuator was used between the EUT and the Spectrum Analyzer.



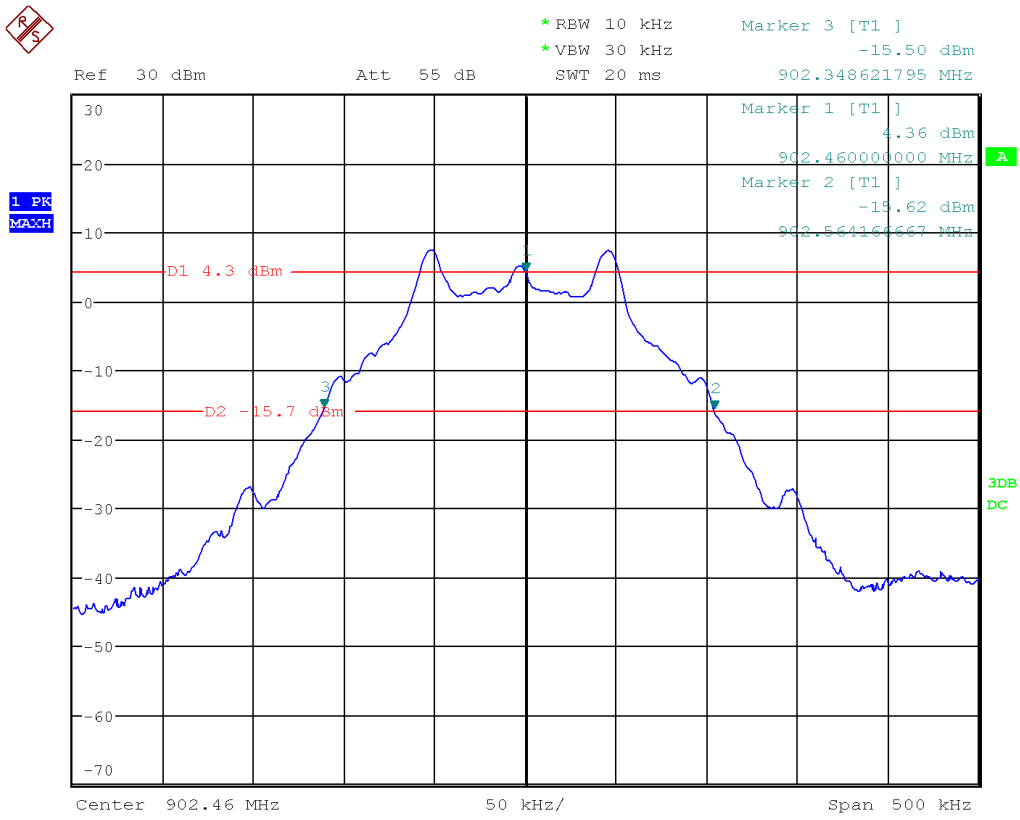
Graph 1 Test Results – 99% Bandwidth Results – Lower Channel (#0) WX DB(2.4GHz)



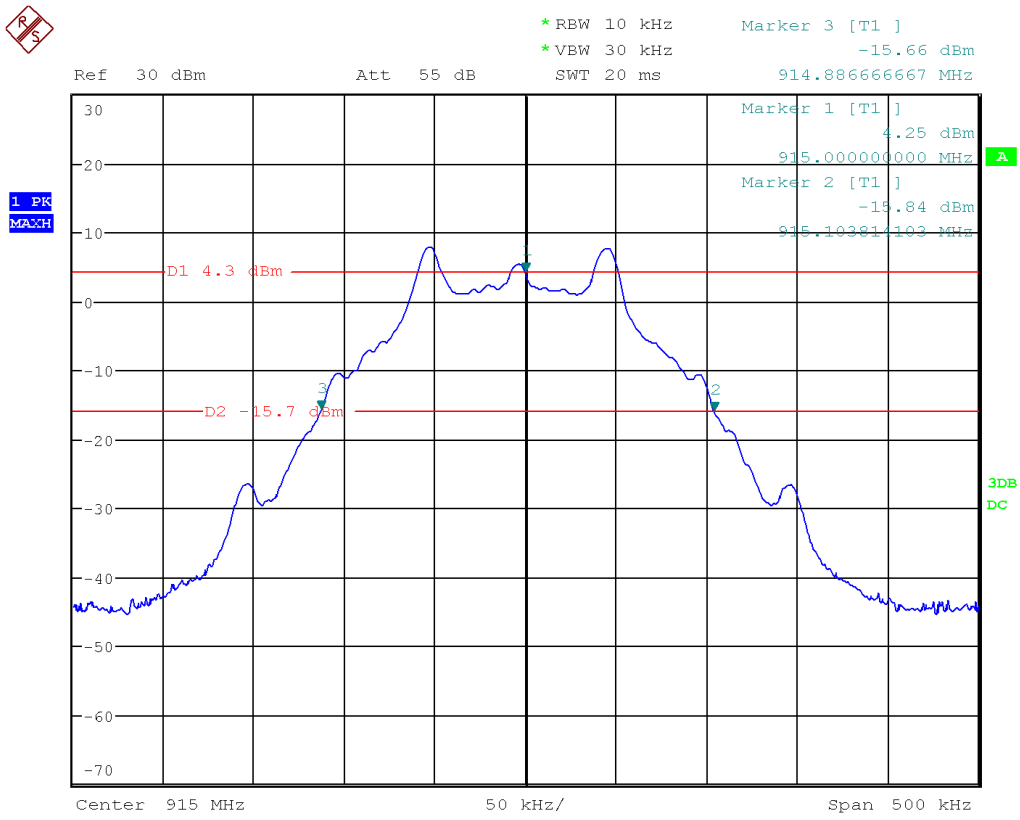
Graph 2 Test Results – 99% Bandwidth Results – Middle Channel (#19) WX DB(2.4GHz)



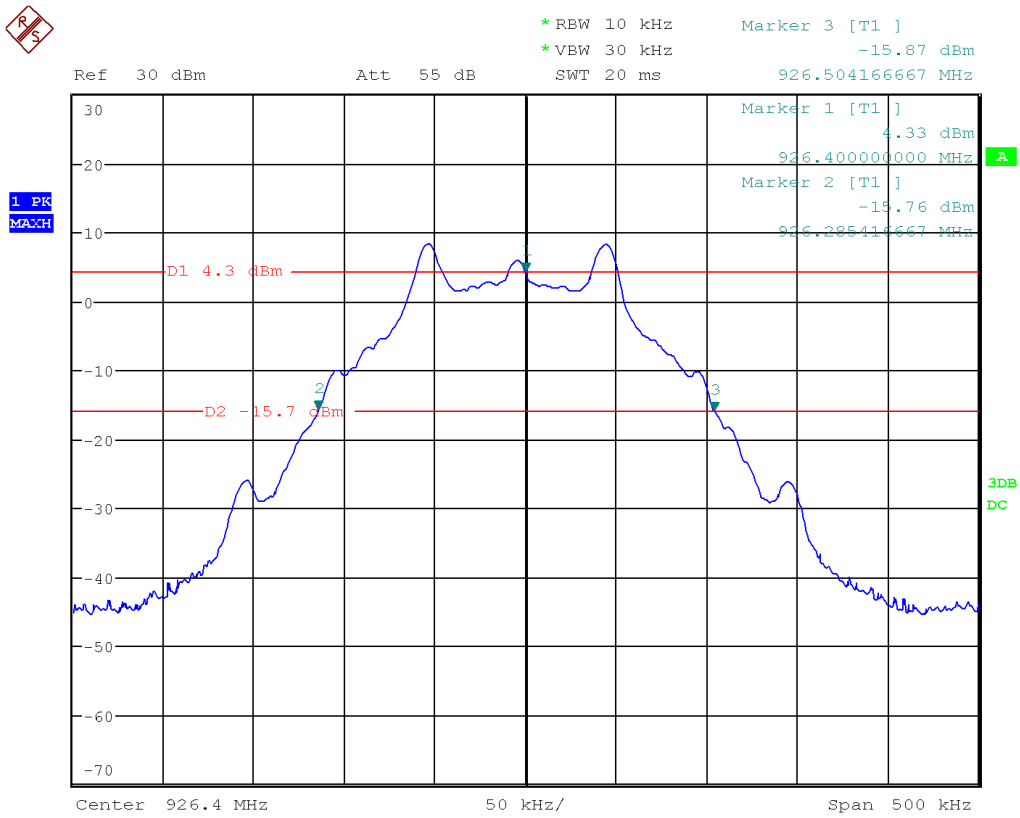
Graph 3 Test Results – 99% Bandwidth Results – Highest Channel (#39) WX DB(2.4GHz)



Graph 4 Test Results – 99% Bandwidth Results – Low Channel (#0) WX DB (900MHz)



Graph 5 Test Results – 99% Bandwidth Results – Mid Channel (#32) WX DB (900MHz)



Graph 6 Test Results – 99% Bandwidth Results – Highest Channel (#63) WX DB (900MHz)

6.6 Test Instruments

This test was carried out in Laval test location

Equipment	Model No.	Manufacturer	Calibration Period (months)	Calibration Due (YYY-MM-DD)	Asset No: LAVE
Spectrum Analyzer	ESU-40	Rohde & Schwarz	12	2021-07-17	4092
Attenuator 10 dB	4779-10	Narda	NCR	NCR	4096
Cable 254mm SMA	Minibend-10	Huber+ Suhner	NCR	NCR	4080
Signal generator	SMU100A	Rohde & Schwarz	24	2020-08-23	4135
Signal generator	FSL 6	Rohde & Schwarz	24	2020-09-02	4095

Table 10: 99% dB Bandwidth Test Equipment

7 6dB Bandwidth of Digitally Modulated Systems

7.1 Purpose & Methods

The Purpose & Methods of this test is to ensure that the bandwidth occupied exceeds a stated minimum. This helps ensure the utilization of the frequency allocation is sufficiently wide. This also helps prevent corruption of data by ensuring adequate data separation to distinguish the reception of the intended information. The test method is a defined in ANSI C63.10.

7.2 Test Specifications

REFERENCE STANDARD	FCC Part 15.247(a)2 RSS-247 5.2(a)
SPECIFICATIONS	
Limit – 6dB Bandwidth	≥500kHz
Frequency range (MHz)	2402 2440 2480
Data rate	1Mbps
RBW (kHz):	100
VBW (kHz)	300
EUT	
Identification	WX DB Thermostat (2.4GHz)
Voltage Input	24 Vac & 3.3 Vdc
ENVIROMENTAL & TEST INFO	
Test Date (YYYY-MM-DD)	2020-03-16
Temperature (°C)	22.6 ± 2
Humidity (%)	20.3 ± 5
Atmospheric Pressure kPa (For Info Only)	100.7
Tester	Abdoulaye Ndiaye Jose Martinez-Ortega
Client Witness	No Witness

7.3 Test Setup

The Setup for the 6dB Bandwidth testing is identical to the 99% Bandwidth setup.

For more details refer to photo 1

7.4 Test Results

WX DB (2.4GHz)

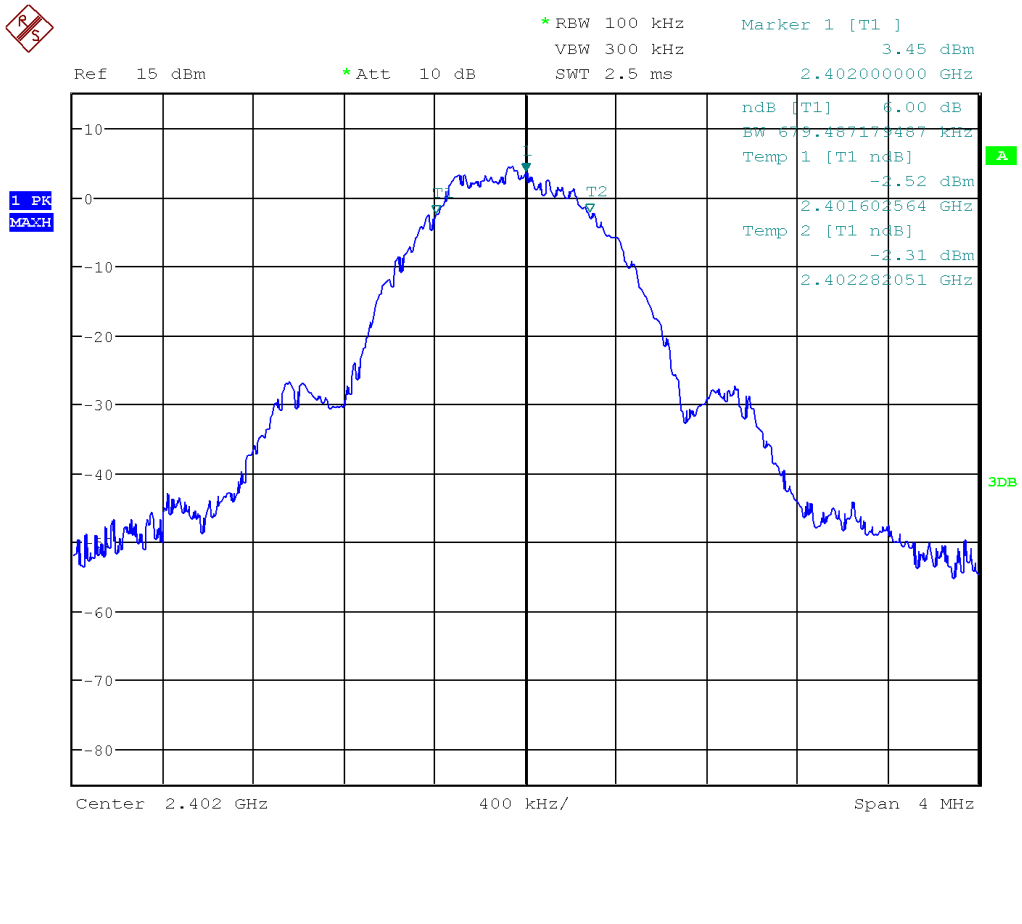
The Channel #19 gave a maximum of 756.41 kHz for 6dB BW. Details are depicted in Table 11

Channel	Frequency (MHz)	6dB Bandwidth (kHz)	Limit (kHz)	Results
Low channel: #0	2402	679.48	500	Pass
Middle Channel: #19	2442	756.41	500	Pass
Highest Channel: #39	2480	711.53	500	Pass

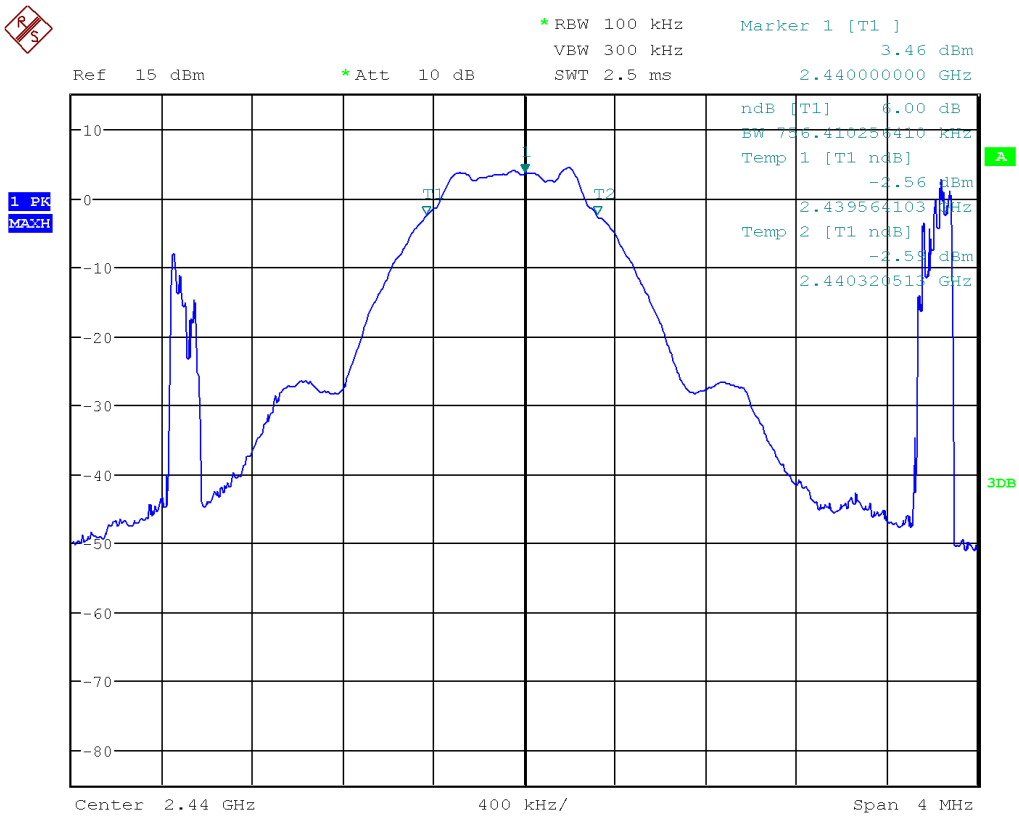
Table 11 – 6dB Bandwidth Results

7.5 Graphs

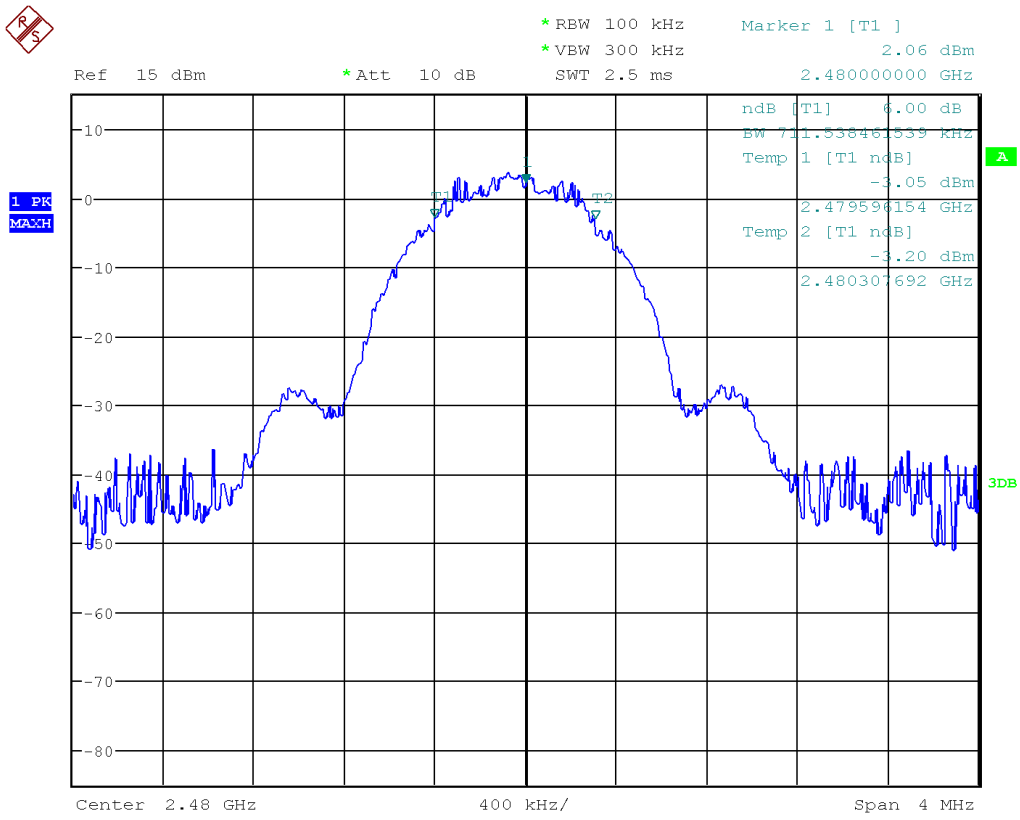
The graphs showed below show the OBW during the operation of the device. This is measured by a max hold on the spectrum analyzer and the highest resolution bandwidth that is sufficiently low to exhibit the 6dB of the 99% bandwidth of a channel during operation of the EUT. Max hold is performed for a duration of not less than 1 minute. No attenuator was used between the EUT and the Spectrum Analyzer.



Graph 7 Test Results – 6dB Bandwidth Results – Lower Channel (#0) WX DB(2.4GHz)



Graph 8 Test Results – 6dB Bandwidth Results – Middle Channel (#19) WX DB(2.4GHz)



Graph 9 Test Results – 6dB Bandwidth Results – Highest Channel (#39) WX DB(2.4GHz)

7.6 Test Instruments

This test was carried out in Laval test location

Equipment	Model No.	Manufacturer	Calibration Period (months)	Calibration Due (YYY-MM-DD)	Asset No: LAVE
Spectrum Analyzer	ESU-40	Rohde & Schwarz	12	2021-07-17	4092
Attenuator 10 dB	4779-10	Narda	NCR	NCR	4096
Cable 254mm SMA	Minibend-10	Huber+ Suhner	NCR	NCR	4080
Spectrum Analyzer	FSL 6	Rohde & Schwarz	24	2020-09-02	4095

Table 12: 6 dB OBW Test Equipment

8 Hopping Channel

8.1 Purpose & Methods

The Purpose & Methods 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. The test method is a defined in ANSI C63.10.

8.2 Test Specifications

REFERENCE STANDARD	FCC Part 15.247(a)(1)(i) RSS 247 5.1 (c)
SPECIFICATIONS	
Limits	See Section 15.247(a)(1)
Test Frequency (MHz):	902.46 915 926.4
RBW (MHz)	0.12
VBW (MHz)	1
EUT	
Identification	WX DB Thermostat (900MHz)
Voltage Input	24 Vac & 3.3 Vdc
Environmental	**Normal Conditions**
Test Date (YYYY-MM-DD)	2020-07-10
Temperature (°C)	22.4 ± 1
Humidity (%)	33.4 ± 5
Atmospheric Pressure kPa (For Info Only)	101.95
Tester(s)	Jose Martinez-Ortega Abdoulaye Ndiaye
Client Witness	No witness

8.3 Limits

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

Frequency Band	20 dB Bandwidth of the hopping channel	Hopping Number
902 - 928	≤250kHz	≥ 50 channels
	≥250 kHz	≥ 25 channels
2400 - 2483.5	≤250kHz	≥ 15 channels
	≥250 kHz	≥15 channels
5275 - 5850	≤250kHz	≥ 75 channels
	≥250 kHz	≥ 75 channels

8.4 Test Setup

The Setup for the Hopping Channel testing is identical to the 99% Bandwidth setup. For more details refer to photo 1

8.5 Test Results

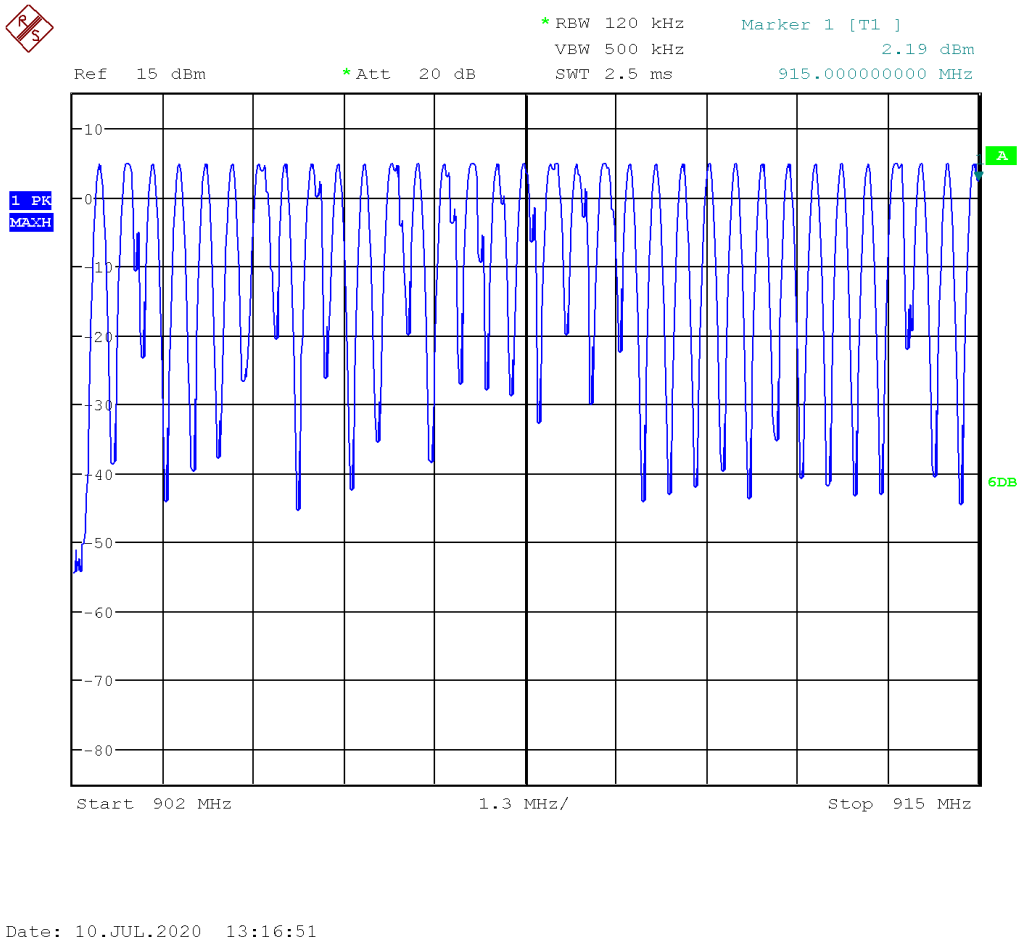
The EUT passed the requirements of the number of channels. The number of channels occupied by the EUT is 64 channels in the allocation band of 902 MHz to 928 MHz

Channel	Range (MHz)	Number of Hopping Measured	Limits	Results
Middle Channel: #33	902 - 928	64	≥50 channels	Pass

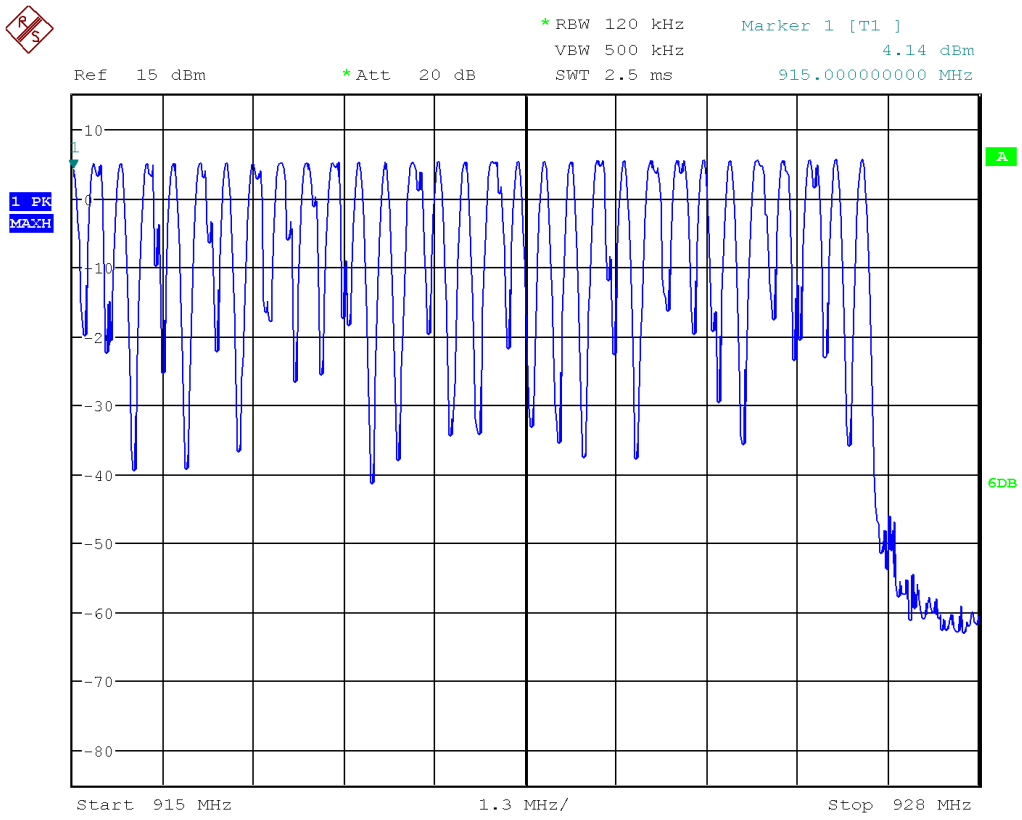
Table 13 – Hopping Channel Results

8.6 Graphs

The graphs below show the number of occupied channels during the operation of the device. This is measured by a max hold on the spectrum analyser 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 10: Hopping Channel – WX DB (900MHz) – 902MHz – 915MHz



Graph 11: Hopping Channel – WX DB (900MHz) – 915MHz – 928MHz

8.7 Test Instruments

This test was carried out in Laval test location

Equipment	Model No.	Manufacturer	Calibration Period (months)	Calibration Due (YYY-MM-DD)	Asset No: LAVE
Spectrum Analyzer	ESU-40	Rohde & Schwarz	12	2021-07-17	4092
Cable 254mm SMA	Minibend-10	Huber+ Suhner	NCR	NCR	4080
Spectrum Analyzer	FSL 6	Rohde & Schwarz	24	2020-09-02	4095

Table 14: Hopping Channel Test Equipment

9 Channel Separation

9.1 Purpose & Methods

The Purpose & Methods 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. The test method is a defined in ANSI C63.10.

9.2 Test Specifications

REFERENCE STANDARD	FCC Part 15.247(a)(1). RSS 247 5.1 (2)
SPECIFICATIONS	
Limit	≥20 dB Bandwidth
Frequency range (MHz)	902.46 915 926.4
RBW (kHz):	120
VBW (kHz)	500
EUT	
Identification	WX DB thermostat (900MHz)
Voltage Input	24 Vac & 3.3 Vdc
ENVIROMENTAL & TEST INFO	
Test Date (YYYY-MM-DD)	2020-09-17
Temperature (°C)	23.5 ± 1
Humidity (%)	23.7 ± 5
Atmospheric Pressure kPa (For Info Only)	100.85
Tester	Jose Martinez-Ortega Abdoulaye Ndiaye
Client Witness	No Witness

9.3 Limits

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

Frequency Band	20 dB Bandwidth of the hopping channel	Limits <Note 1>
902 - 928	≤250kHz	25kHz or 20dB BW
2400 - 2483.5	≤250kHz	25kHz or 20dB BW
	≤125mW	25 kHz or 2/3 of 20 dB BW[1]
5275 - 5850	≤250kHz	25kHz or 20dB BW
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 218.75 kHz. Thus, a channel separation limit of 218.75kHz applies.		

9.4 Test Setup

The Setup for the Channel Separation testing is identical to the 20dB Bandwidth setup. For more details refer to photo 1

9.5 Test Results

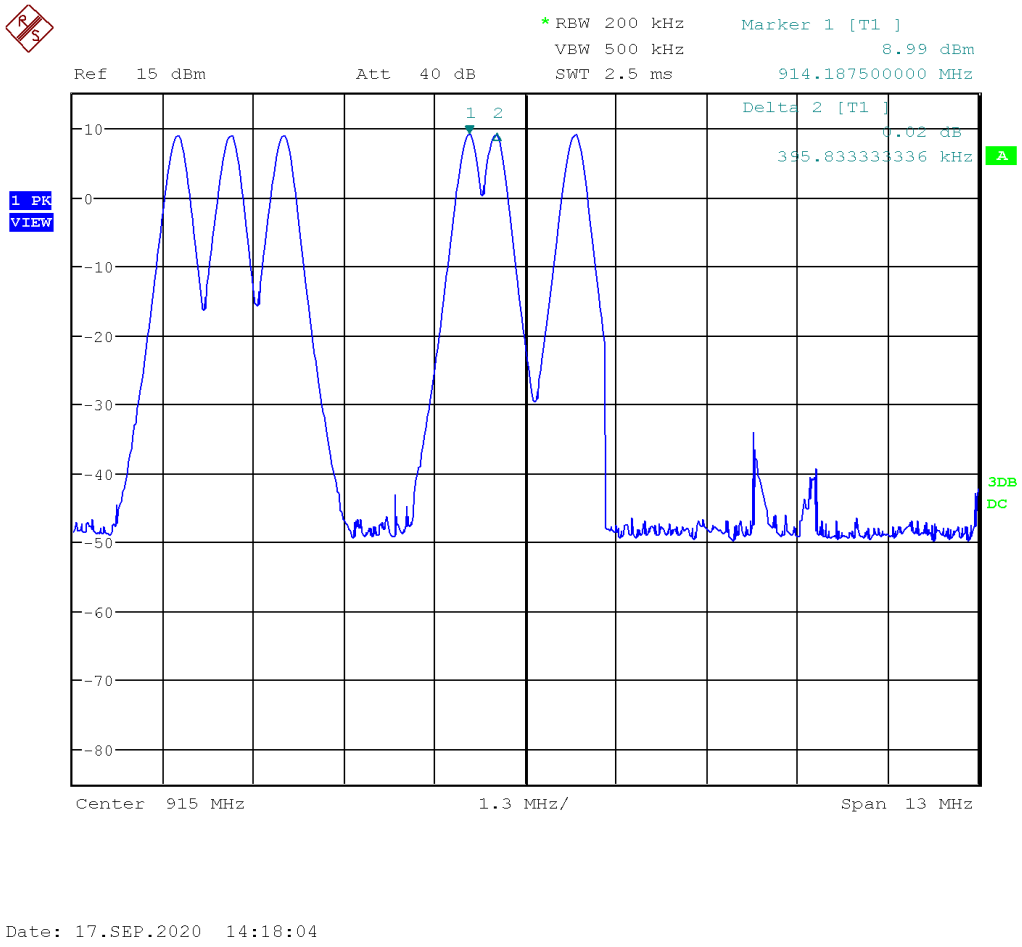
The results of the EUT are detailed in Table 15

Channel	Range (MHz)	Channel Separation Measured <kHz>	Limits < kHz>	Results
Middle Channel: #33	902 - 915	395.83	≥218.75	Pass

Table 15 – Channel Separation Results

9.6 Graphs

The graphs shown below shows the channel spacing during the operation of the device. This is measured by a max hold on the spectrum analyser 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.



Graph 12: Channel Separation – WX DB (900MHz)

9.7 Test Instruments

This test was carried out in Laval test location

Equipment	Model No.	Manufacturer	Calibration Period (months)	Calibration Due (YYY-MM-DD)	Asset No: LAVE
Spectrum Analyzer	ESU-40	Rohde & Schwarz	12	2021-07-17	4092
Cable 254mm SMA	Minibend-10	Huber+ Suhner	NCR	NCR	4080
Spectrum Analyzer	FSL 6	Rohde & Schwarz	24	2020-09-02	4095

Table 16: Channel Separation Test Equipment

10 Time of Occupancy

10.1 Purpose & Methods

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.

10.2 Test Specifications

REFERENCE STANDARD	FCC Part 15.247(a)(1). RSS 247 5.1 (2)
SPECIFICATIONS	
Limit	See FCC 15.247(a)(1)(i).
Frequency range (MHz)	902.46 915 926.4
Data Rate	100kbps
RBW (MHz):	1
VBW (MHz)	3
EUT	
Identification	WX DB Thermostat (900MHz)
Voltage Input	24 Vac & 3.3 Vdc
ENVIROMENTAL & TEST INFO	
Test Date (YYYY-MM-DD)	2020-09-17
Temperature (°C)	23.5 ± 1
Humidity (%)	23.7 ± 5
Atmospheric Pressure kPa (For Info Only)	100.85
Tester	Jose Martinez-Ortega Abdoulaye Ndiaye
Client Witness	No Witness

10.3 Limits

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.

10.4 Test Setup

The Setup for the Time Occupancy testing is identical to the 99% Bandwidth setup. For more details refer to photo 1

10.5 Test Results

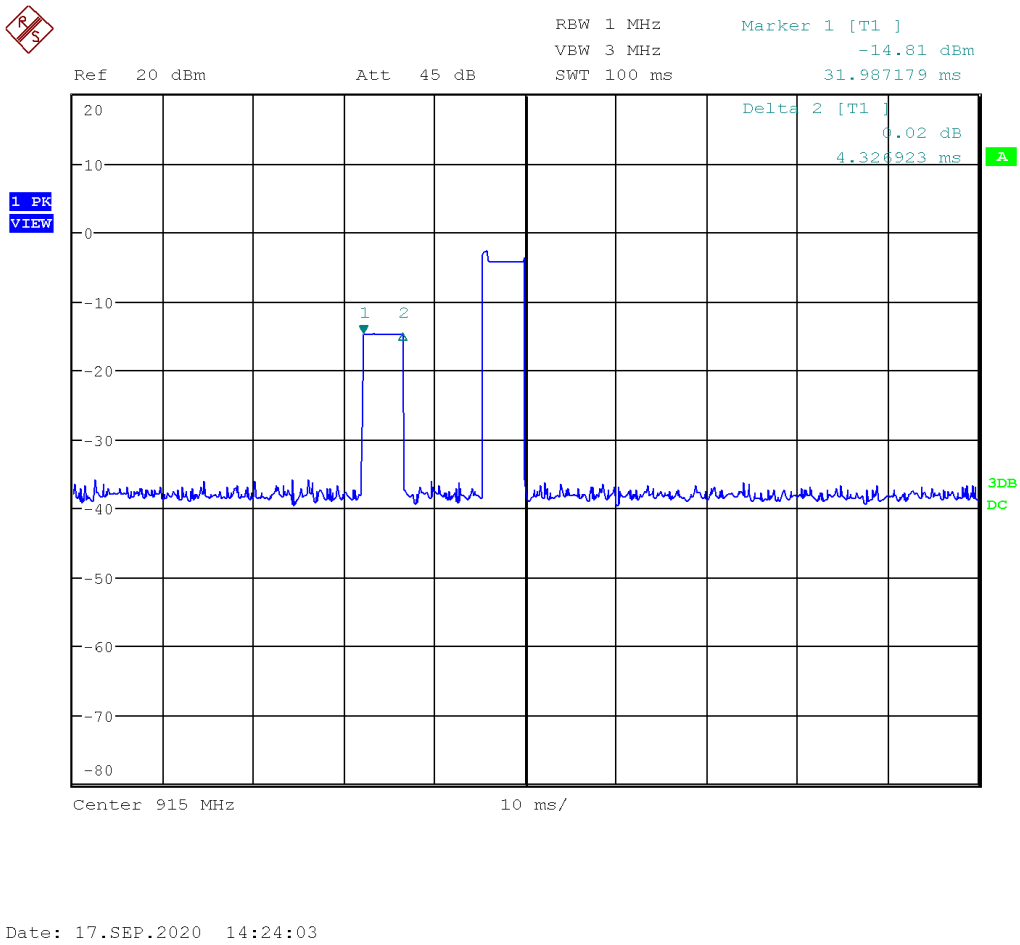
The EUT cycles through its pseudo-random generated list of hopping frequencies. There are 64 channels occupied in total. The average transmit time is 4.32 ms per channel and each channel is repeated approximately every 1 s.

Channel	Range (MHz)	Average Transmit Time/ Channel (ms)	Number of Hops in 20s	Average Time of Occupancy (ms)	Limit (ms)	Results
Middle Channel: #33	902 - 915	4.32	20	86.4	≤400	Pass

Table 17 – Time Occupancy Results

10.6 Graphs

The graphs shown below shows the Time of Occupancy during the operation of the device. This is measured by a max hold on the spectrum analyser and the highest resolution bandwidth that is sufficiently low to exhibit the Time of Occupancy of the signal being measured. This measurement is a peak measurement.



Graph 13: Time of Occupancy – WX DB (900MHz)

10.7 Test Instruments

This test was carried out in Laval test location

Equipment	Model No.	Manufacturer	Calibration Period (months)	Calibration Due (YYY-MM-DD)	Asset No: LAVE
Spectrum Analyzer	ESU-40	Rohde & Schwarz	12	2021-07-17	4092
Cable 254mm SMA	Minibend-10	Huber+ Suhner	NCR	NCR	4080
Spectrum Analyzer	FSL 6	Rohde & Schwarz	24	2020-09-02	4095

Table 18: Time of Occupancy Test Equipment

11 Maximum Peak Envelope Conducted Power – Digital Modulated

11.1 Purpose & Methods

The purpose of this test is to ensure that the maximum power conducted to the radiating element does not exceed the limits specified. The test method is a defined in ANSI C63.10.

This Test must be performed on normal temperature (23°C - 35°C)

11.2 Test Specifications

REFERENCE STANDARD	FCC Part 15.247(b)(3) FCC Part 15.247(b)(2) RSS-247.5.4(d) ANSI C63.10. Clause 11.9.1		
SPECIFICATIONS			
Limit – Power (W)	<1		
Frequencies (MHz)	2402 2440 2480	902.46 915 926.4	
RBW (MHz):	3	0.3	
VBW (MHz)	10	1	
Span (MHz)	10	10	
EUT			
Identification	WX DB Thermostat (2.4GHz/900MHz)		
Voltage Input	24 Vac & 3.3 Vdc		
ENVIROMENTAL	**Normal Conditions**		
Test Date (YYYY-MM-DD)	2020-03-16	2020-03-17	2020-09-15
Temperature (°C)	23.4 ± 2	23.6 ± 2	21.3 ± 2
Humidity (%)	23.4±	18.8	22.24 ± 5
Atmospheric Pressure kPa (For Info Only)	99.95	100.85	101.33
Tester	Abdoulaye Ndiaye Jose Martinez-Ortega		
Client Witness	No Witness		

11.3 Limits

The limits are defined in 15.247(b)(2) and 15.247(b)(3).

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.

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.

11.4 Test Setup

The Setup for the Maximum Peak Power testing is identical to the 99% Bandwidth setup. For more details refer to photo 1

11.5 Tests Results

WX DB (2.4GHz)

The Channel # 0 gave a maximum Peak Power of 4.21mW. The peak power measurements of channels tested are depicted in Table 19.

Channel	Frequency (MHz)	Measured Peak Power (dBm)	External Attenuation +Cable (dB) <Note 1>	Peak Power (mW)	Limit (W)	Result
Low: #0	2402	6.25	0	4.21	1	Pass
Middle: #19	2440	5.81	0	3.81	1	Pass
High: #39	2480	6.19	0	4.15	1	Pass
Note 1: The 2.4 GHz model was tested with direct connexion to the antenna without cable.						

Table 19 – Test Results Peak-Power Measurements WX DB (2.4GHz)

WX DB (900MHz)

The Channel # 63 gave a maximum Peak Power of 8.53 mW. The peak power measurements of channels tested are depicted in Table 20.

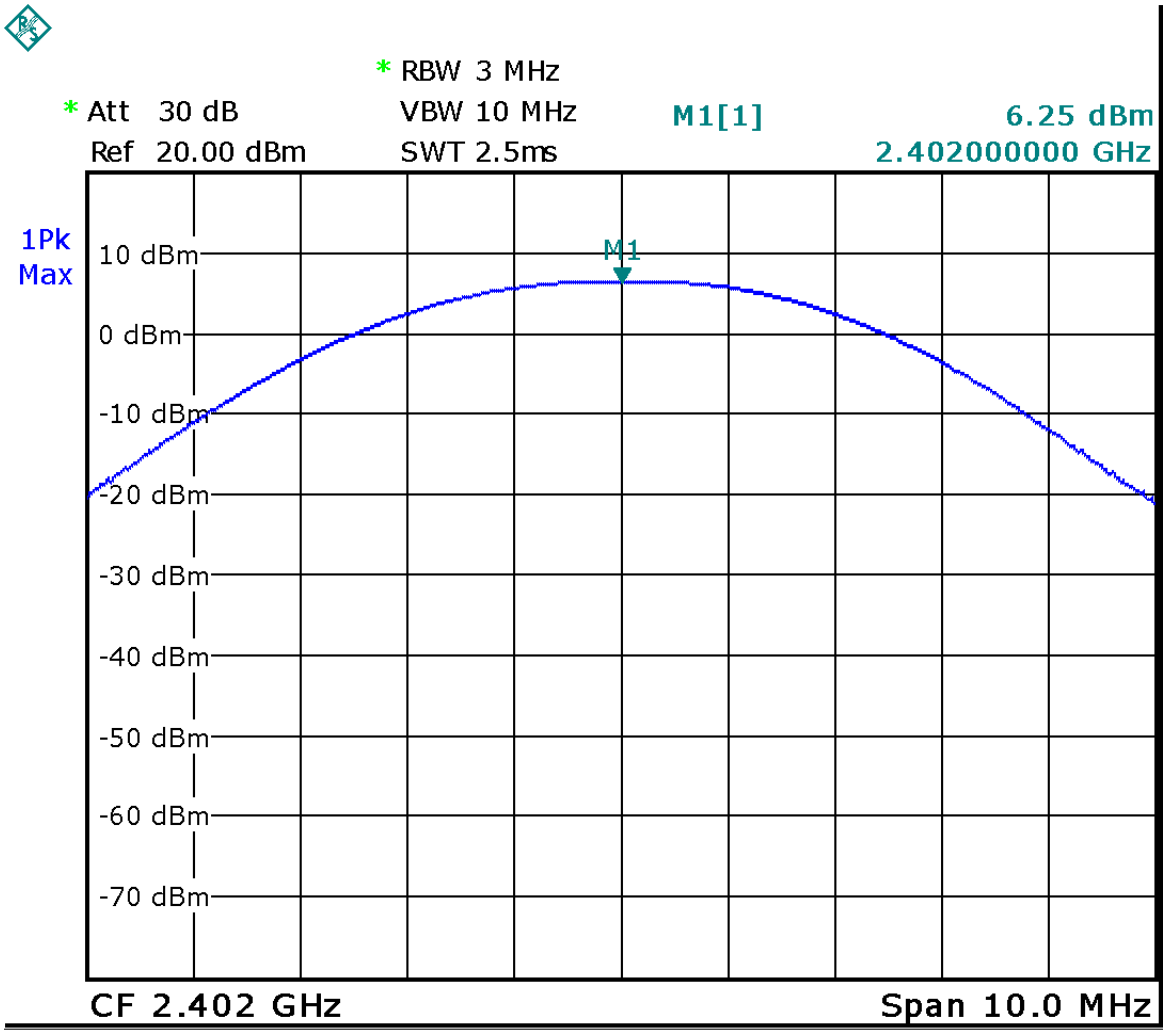
Channel	Frequency (MHz)	Measured Peak Power (dBm)	External Attenuation +Cable (dB)	Peak Power (mW)	Limit (W)	Result
Low: #0	902.46	8.87	0	7.70	1	Pass
Middle: #33	915	8.83	0	7.63	1	Pass
High: #63	926.4	9.31	0	8.53	1	Pass

Table 20 – Test Results Peak-Power Measurements WX DB (900MHz)

11.6 Graphs

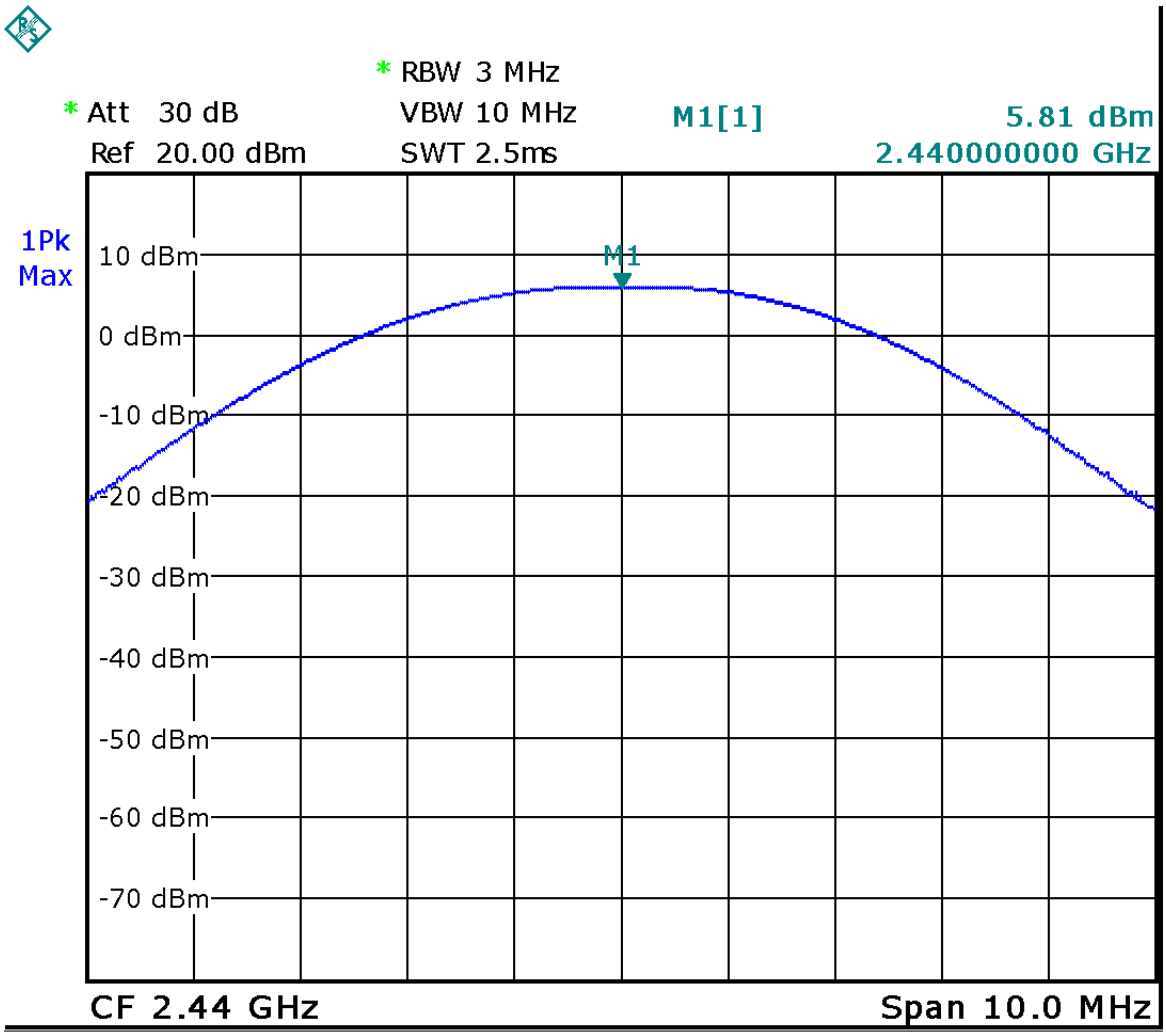
The plots shown below show the Peak Power Output of the device during the antenna conducted measurements during transmit operation of the EUT. Note that no attenuator was used between the EUT and the Spectrum Analyzer.

WX DB (2.4GHz)



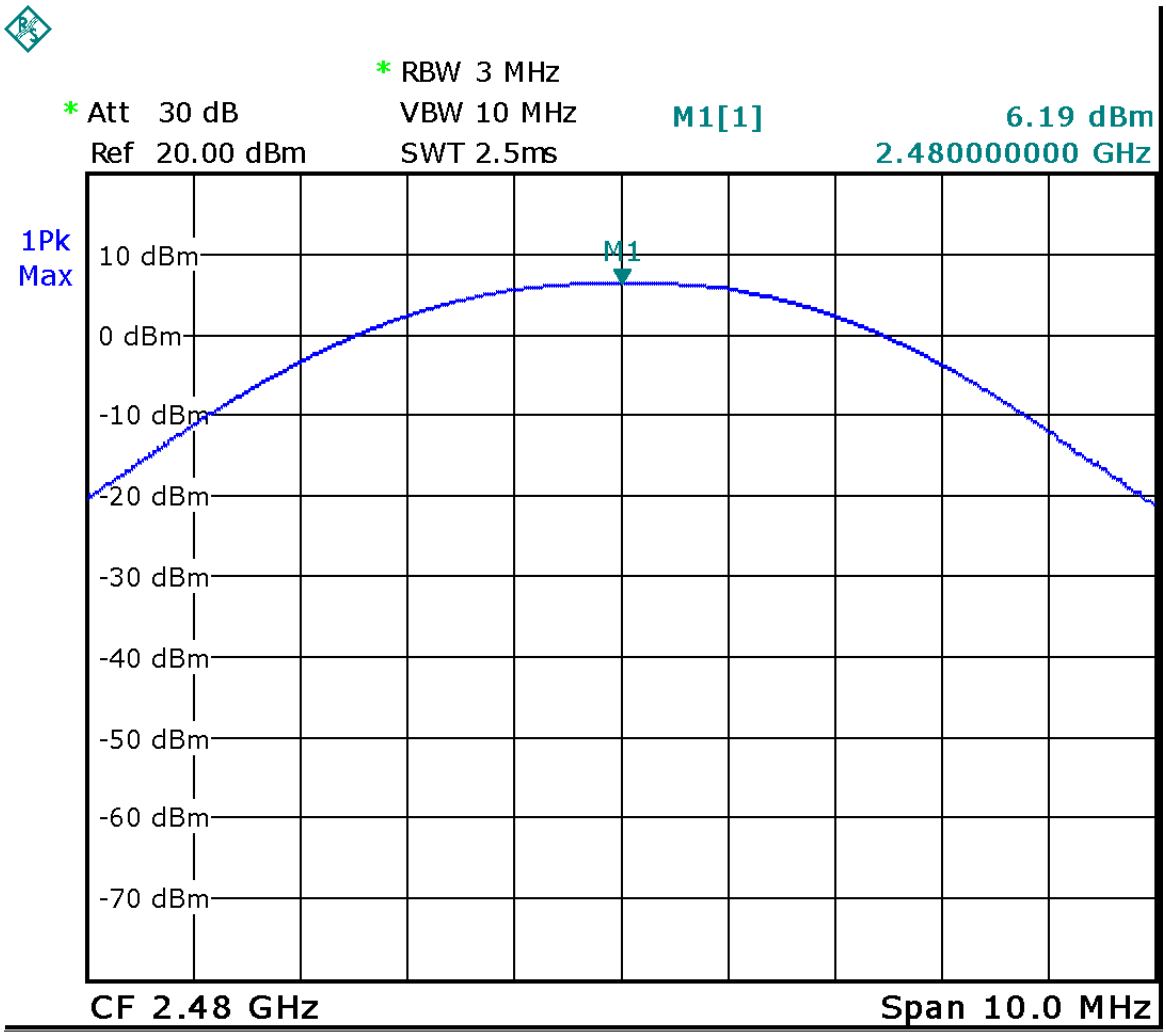
Date: 16.MAR.2020 09:34:31

Graph 14 Test Results – Conducted Peak Power Measurements – Channel #0



Date: 16.MAR.2020 09:38:07

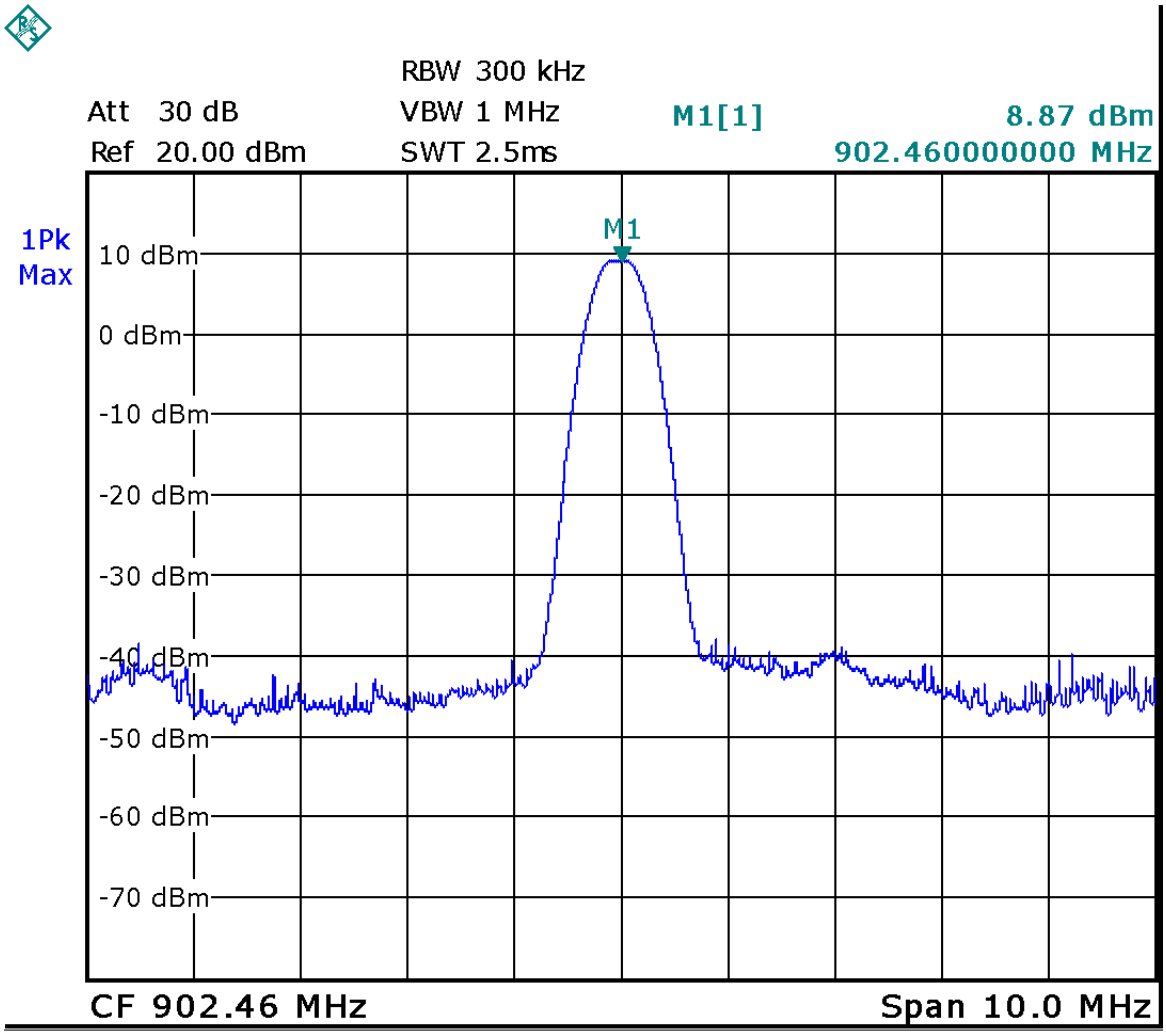
Graph 15 Test Results – Conducted Peak Power Measurements – Channel #19



Date: 16.MAR.2020 09:43:04

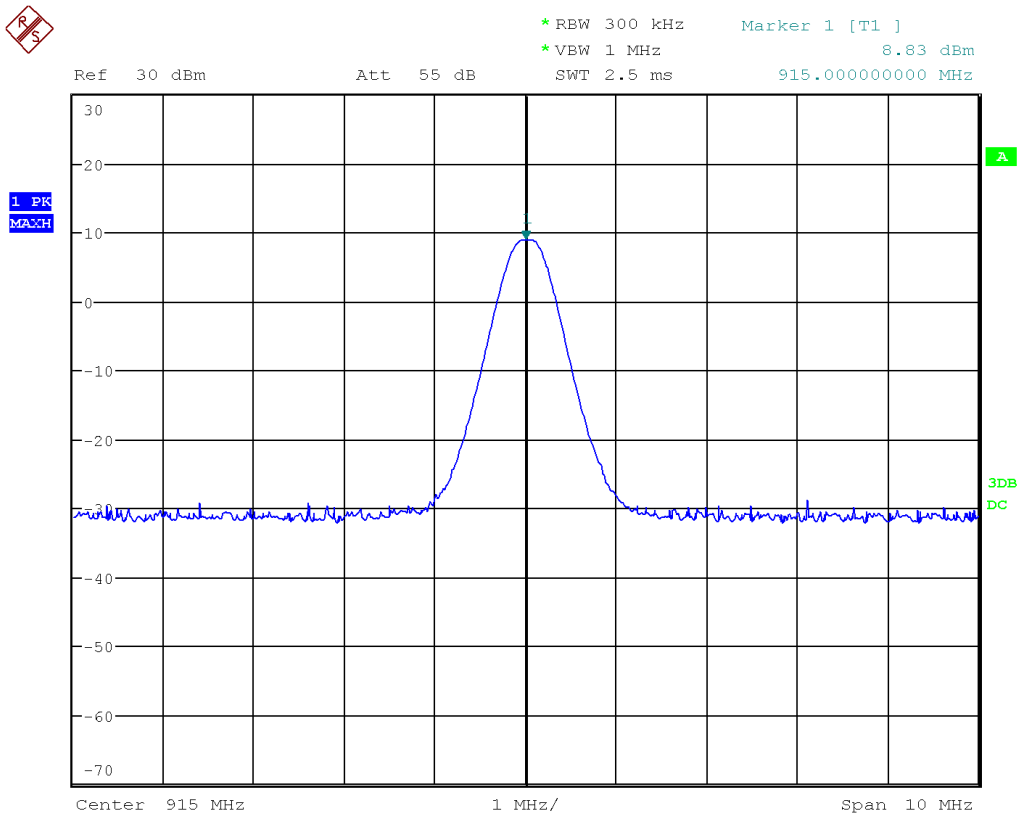
Graph 16 Test Results – Conducted Peak Power Measurements – Channel #39

WX DB (900MHz)

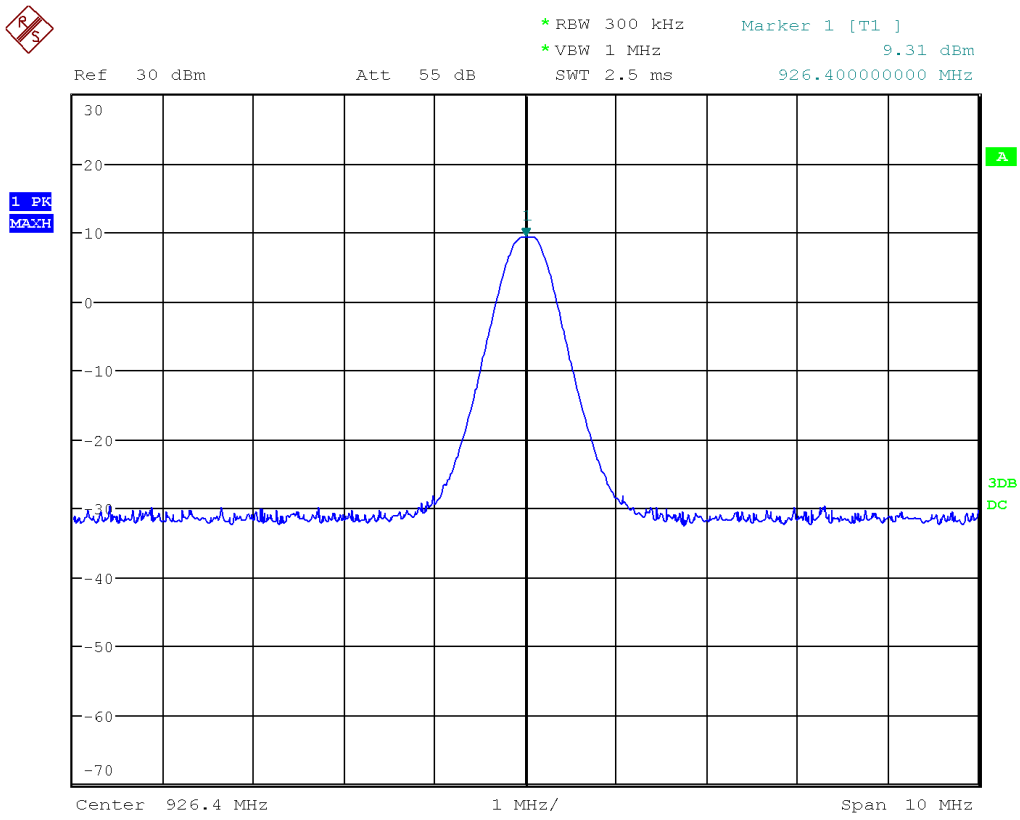


Date: 17.MAR.2020 10:36:49

Graph 17 Test Results – Conducted Peak Power Measurements – Channel #0



Graph 18 Test Results – Conducted Peak Power Measurements – Channel #33



Graph 19 Test Results – Conducted Peak Power Measurements – Channel #63

11.7 Test Instruments

This test was carried out in Laval test location

Equipment	Model No.	Manufacturer	Calibration Period (months)	Calibration Due (YYY-MM-DD)	Asset No: LAVE
Spectrum Analyzer	ESU-40	Rohde & Schwarz	12	2021-07-17	4092
Spectrum Analyzer	FSL 6	Rohde & Schwarz	24	2020-09-02	4095

Table 21: Conducted Peak Power Test Equipment

12 Peak Power Spectral Density

12.1 Purpose & Methods

The Purpose & Methods of this test is to ensure that the maximum power spectral density to the radiating element does not exceed the limits specified. This ensures that the modulation is significantly wide enough, or low enough in power that it will allow for co-operation of other wireless devices operating within this frequency allocation. The method applied is the PKPSD described in ANSI C63.10-2013 in Clause 11.10.

12.2 Test Specifications

REFERENCE STANDARD	FCC Part 15.247(F) RSS-247 5.2(b) ANSI C63.10. Clause 11.10		
SPECIFICATIONS			
Limit (dBm)	<8		
Frequencies (MHz)	2402 2442 2480	902.46 915 926.4	
RBW (kHz):	3 & 100	3	
VBW (kHz)	10 & 300	10	
Span (MHz)	4	4	
EUT			
Identification	WX DB Thermostat(2.4GHz/900MHz)		
Voltage Input	24 Vac & 3.3 Vdc		
ENVIROMENTAL & TEST INFO			
Test Date (YYYY-MM-DD)	2020-03-13	2020-03-16	2020-09-15
Temperature (°C)	23.9 ± 2	23.4 ± 2	21.3 ± 2
Humidity (%)	23.4 ± 5	23.4 ± 5	22.24 ± 5
Atmospheric Pressure kPa (For Info Only)	99.95	103.34	101.33
Tester	Abdoulaye Ndiaye Jose Martinez-Ortega		
Client Witness	No Witness		

12.3 Limits

The limits are defined in 15.247(f)

The power spectral density conducted from the intentional radiator to the antenna due to the digital modulation operation of the hybrid system, with the frequency hopping operation turned off, shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

12.4 Test Setup

The Setup for the Maximum Peak Power testing is identical to the 99% Bandwidth setup. For more details refer to photo 1

12.5 Test Results

WX DB (2.4GHz)

The EUT was tested on: Low, medium, and high bands. The worst-case value is -11.25 dBm as measured on the middle channel #0. The results of the peak power of channels tested are depicted in Table 22

Channel	Frequency (MHz)	Measured PSD (dBm)	External Attenuation +Cable (dB)	Corrected Peak Power (dBm)	Result
Low: #0	2402	-11.25	0	-11.25	Pass
Middle: #19	2440	-12.28	0	-12.28	Pass
High: #39	2480	-11.30	0	-11.30	Pass

Table 22- Results – PKPSD

WX DB (900MHz)

The EUT was tested on: Low, medium, and high bands. The worst-case value is –1.24 dBm as measured with a 3 kHz resolution bandwidth (peak power) on the high channel #63. The results of the peak power of channels tested are depicted in Table 23

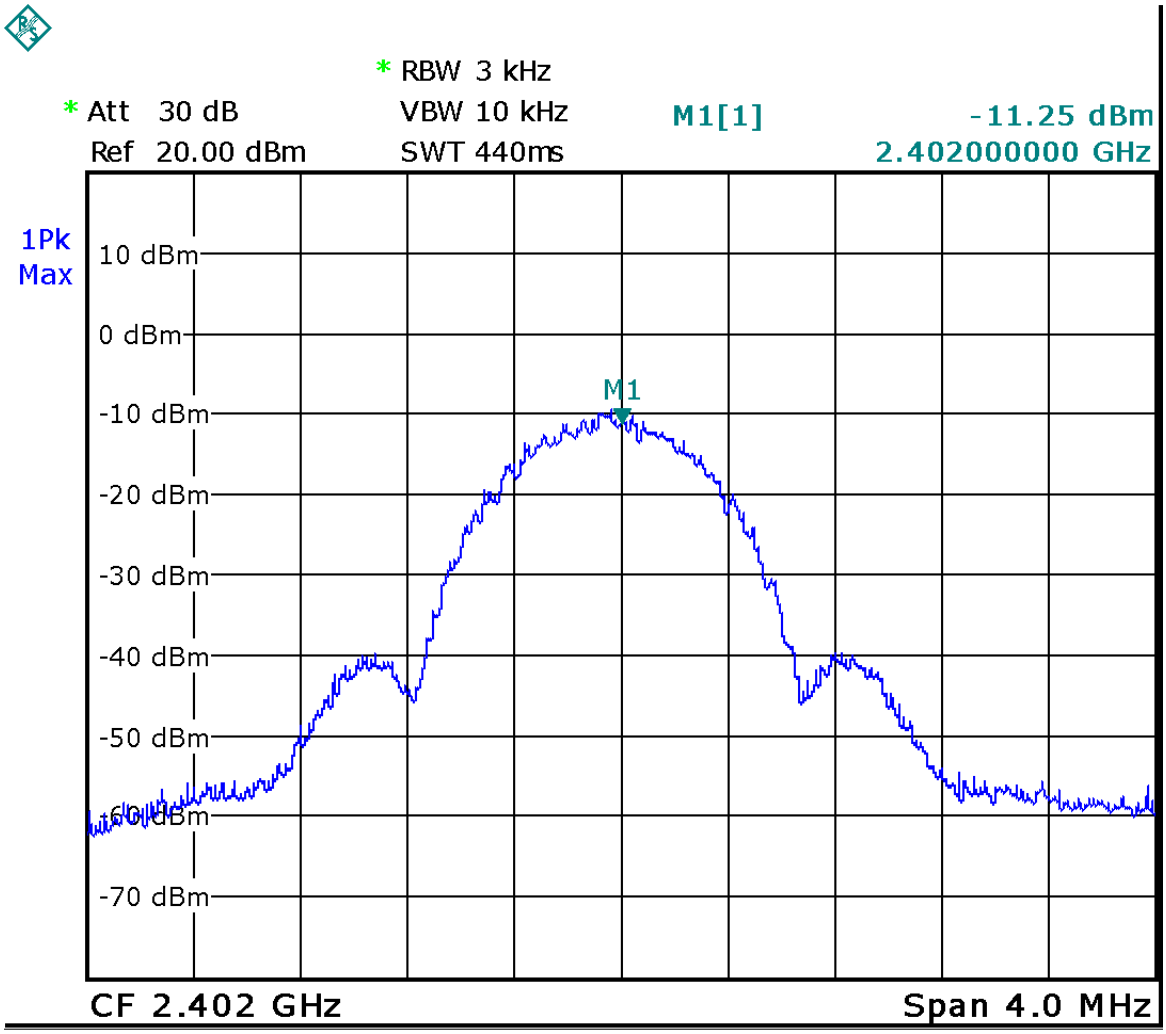
Channel	Frequency (MHz)	Measured PSD (dBm)	External Attenuation +Cable (dB)	Corrected Peak Power (dBm)	Result
Low: #0	902.46	-1.96	0	-1.96	Pass
Middle: #33	915	-1.89	0	-1.89	Pass
High: #63	926.4	-1.24	0	-1.24	Pass

Table 23- Results – PKPSD

12.6 Graphs

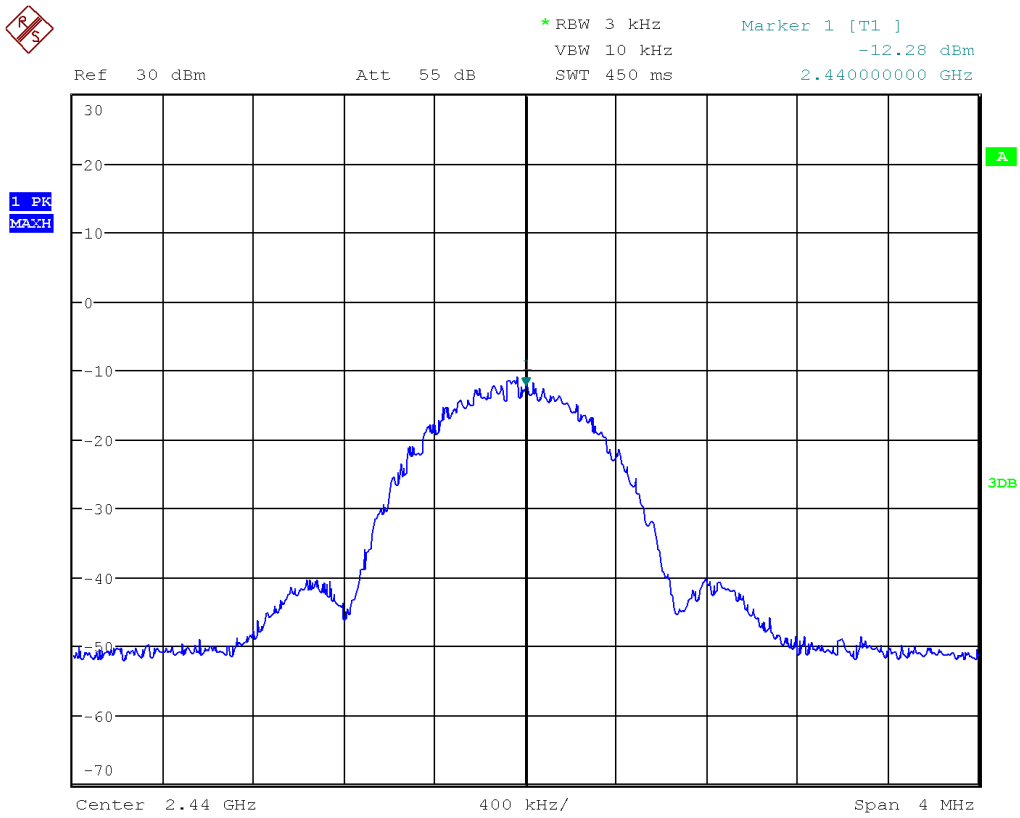
The graphs shown below show the power spectral density of the device during the conducted measurement operation of the EUT. Low, middle, and high channel was investigated. No attenuator was used between the EUT and the Spectrum Analyzer

WX DB (2.4GHz)

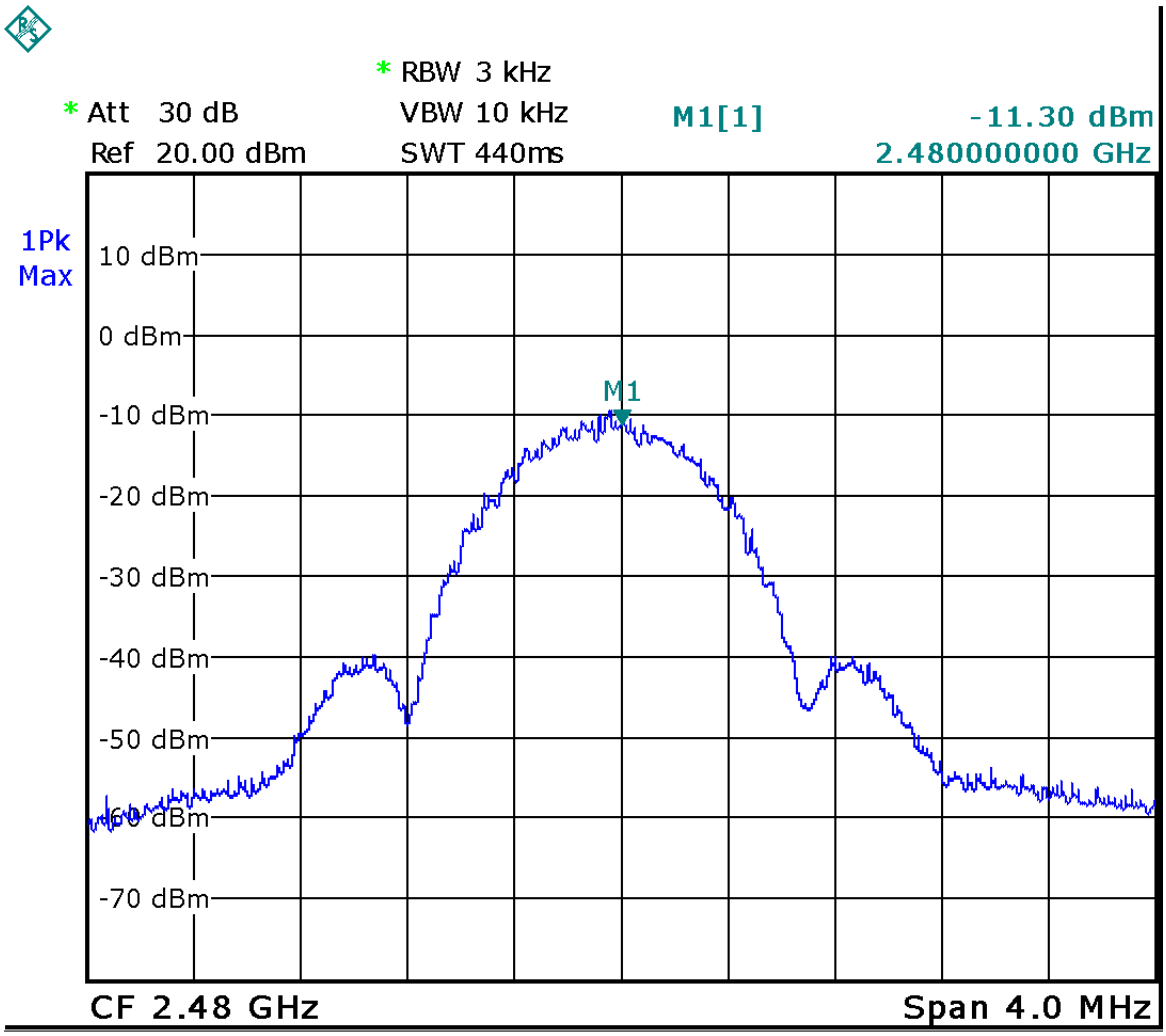


Date: 16.MAR.2020 09:26:43

Graph 20 Test Results – PKPSD – Channel #0



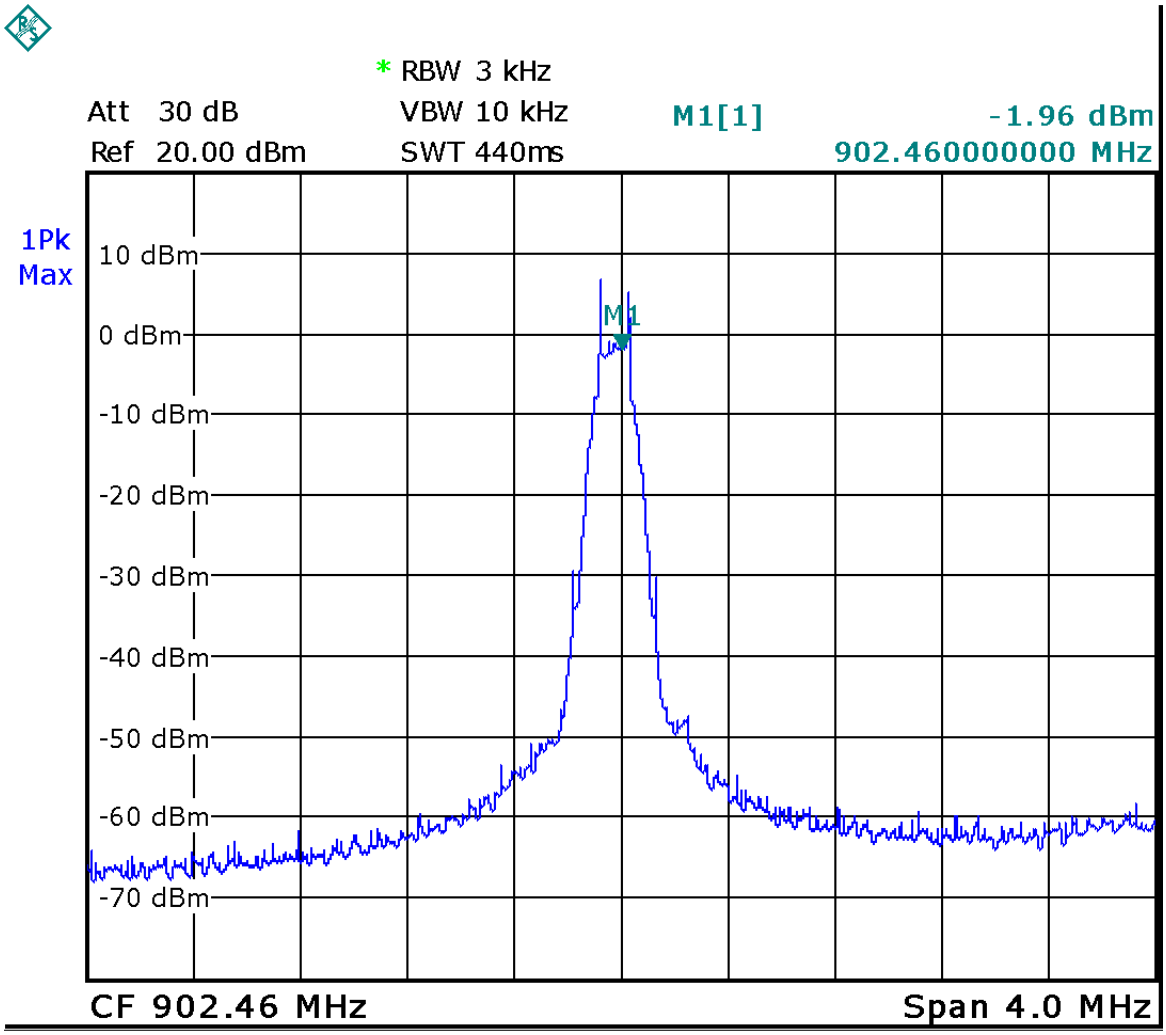
Graph 21 Test Results – PKPSD – Channel #19



Date: 16.MAR.2020 09:24:08

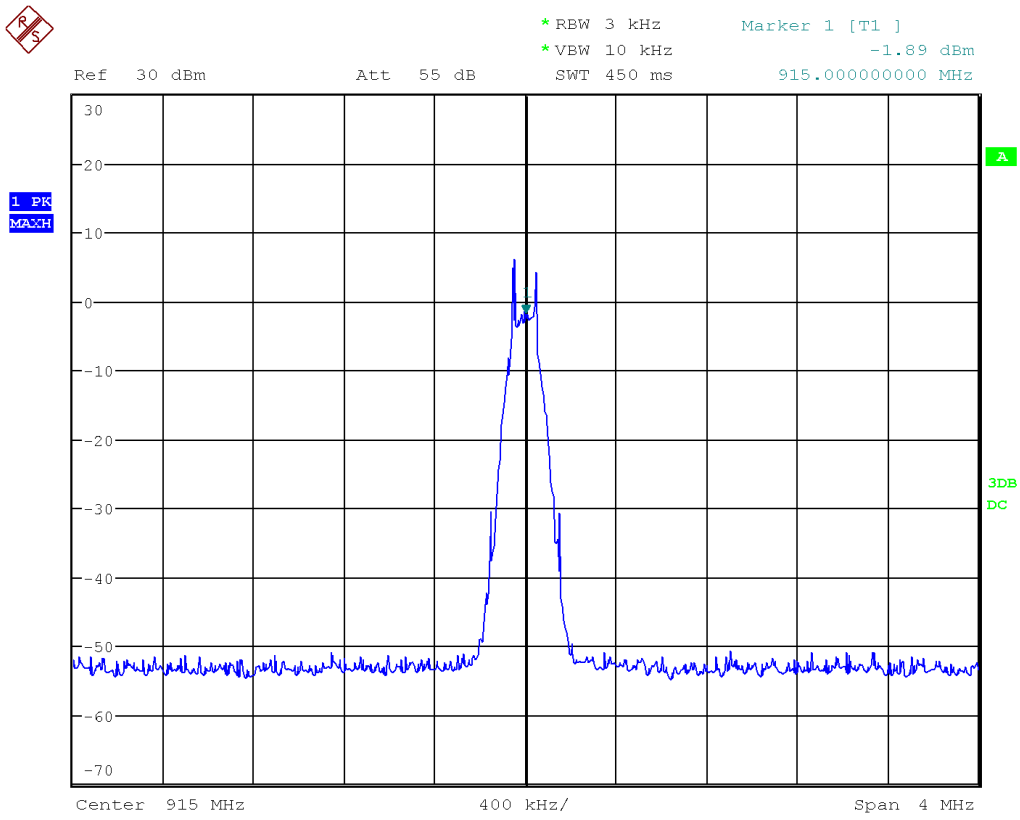
Graph 22 Test Results – PKPSD – Channel #39

WX DB (900MHz)

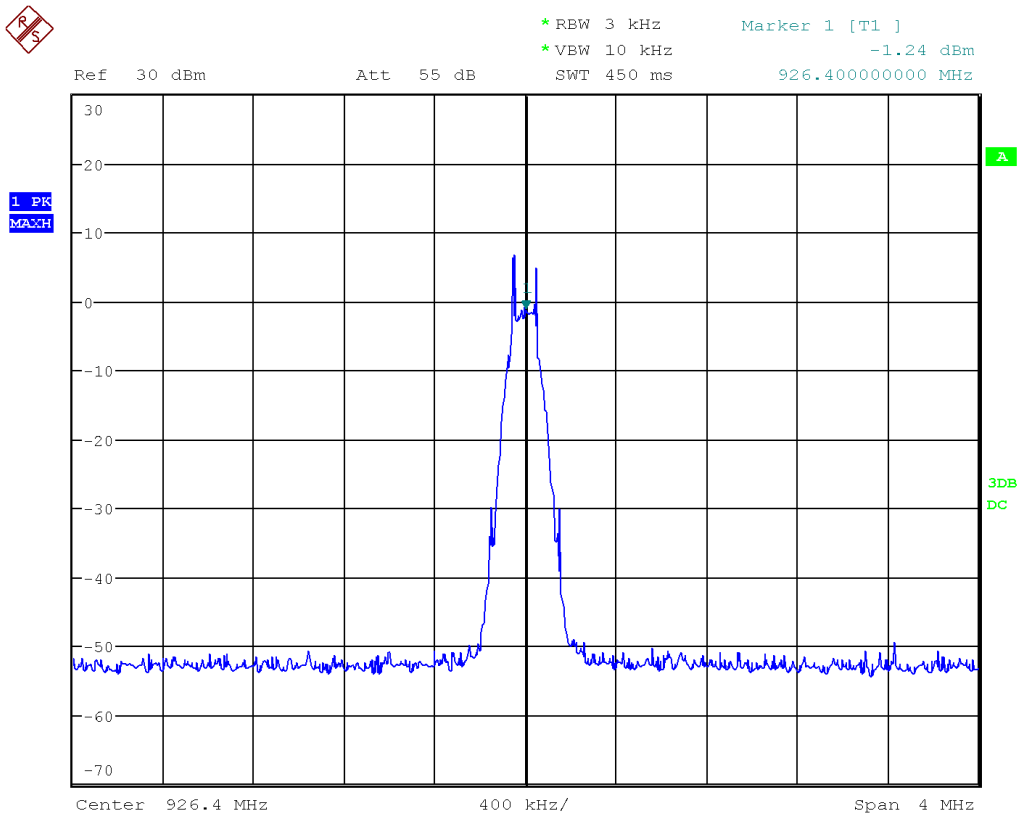


Date: 16.MAR.2020 17:19:51

Graph 23 Test Results – PKPSD – Channel #0



Graph 24 Test Results – PKPSD – Channel #33



Graph 25 Test Results – PKPSD – Channel #63

12.7 Test Instruments

This test was carried out in Laval test location

Equipment	Model No.	Manufacturer	Calibration Period (months)	Calibration Due (YYY-MM-DD)	Asset No: LAVE
Spectrum Analyzer	ESU-40	Rohde & Schwarz	12	2021-07-17	4092
Spectrum Analyzer	FSL 6	Rohde & Schwarz	24	2020-09-02	4095

Table 24 – Test Instrumentation – Power Spectral Density

13 Band Edge (-20 dBc Requirement)

13.1 Purpose & Methods

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. The method applied is described in ANSI C63.10-2013 in Clause 11.11.1

13.2 Test Specifications

REFERENCE STANDARD	FCC Part 15.247(d) RSS-247 5.5 ANSI C63.10 Clause 11.11.1			
SPECIFICATIONS				
Limit (dBc)	<20			
Frequencies (MHz)	2402 2440 2483.5	902.46 915 926.4		
EUT				
Identification	WX DB Thermostat (900MHz/2.4GHz)			
Voltage Input	24 Vac & 3.3 Vdc			
ENVIROMENTAL & TEST INFO				
Test Date (YYYY-MM-DD)	2020-03-16	2020-03-17	2020-06-08	2020-09-15
Temperature (°C)	23.4 ± 2	23.6 ± 2	22	21.3 ± 2
Humidity (%)	23.4 ± 5	18.8 ± 5	23	22.24 ± 5
Atmospheric Pressure kPa (For Info Only)	103.34	100.85	101.4	101.33
Tester	Abdoulaye Ndiaye Jose Martinez-Ortega			
Client Witness	No Witness			

13.3 Limits

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. Band Edge is to be evaluated up to the 10th harmonic. This -20 dBc requirement also applies at the 'band edge' of 2.4 GHz and 2.4835 GHz.

13.4 Test Setup

The Setup for the Maximum Peak Power testing is identical to the 99% Bandwidth setup. For more details refer to photo 1

13.5 Test Results

WX DB (2.4GHz)

The EUT was tested on: Low, medium, and high bands. The worst-case value is -26.35 dBm with 9.48 dB margin on channel #39. The peak power of channels tested are depicted in Table 25.

Channel	Frequency (MHz)	Measured Spurious Conducted (dBm)	-20dbc Limit (dBm) <Note 2>	Margin from the Limit (dBm)	Results <Note 2>
Low: #0	0.009-0.15	-61.8	-50.75	11.05	Pass
Low: #0	0.15-30	-67.18	-50.75	16.43	Pass
Low: #0	30-2400	-80.46	-50.75	29.71	Pass
Low: #0	2400--2402	-62.41	-50.75	11.66	Pass
Middle: #19	2402-2483.5	-63.16	-35.5	27.66	Pass
High: #39	2480-2483.5	-26.35	-16.87	9.48	Pass
High: #39	2483.5-25000	-30	-16.3	13.7	Pass
Note 1: Note 1: 20 dB Attenuator Removed Note 2. The highest level of the fundamental is 6.25 dBm based on RF output Power results (Table 19)					

Table 25- Results – Band Edge

WX DB (900MHz)

The EUT was tested on: Low, medium, and high bands. The worst-case value is -19.77 dBm with 8.79 dB margin on channel 63. The peak power of channels tested are depicted in Table 26.

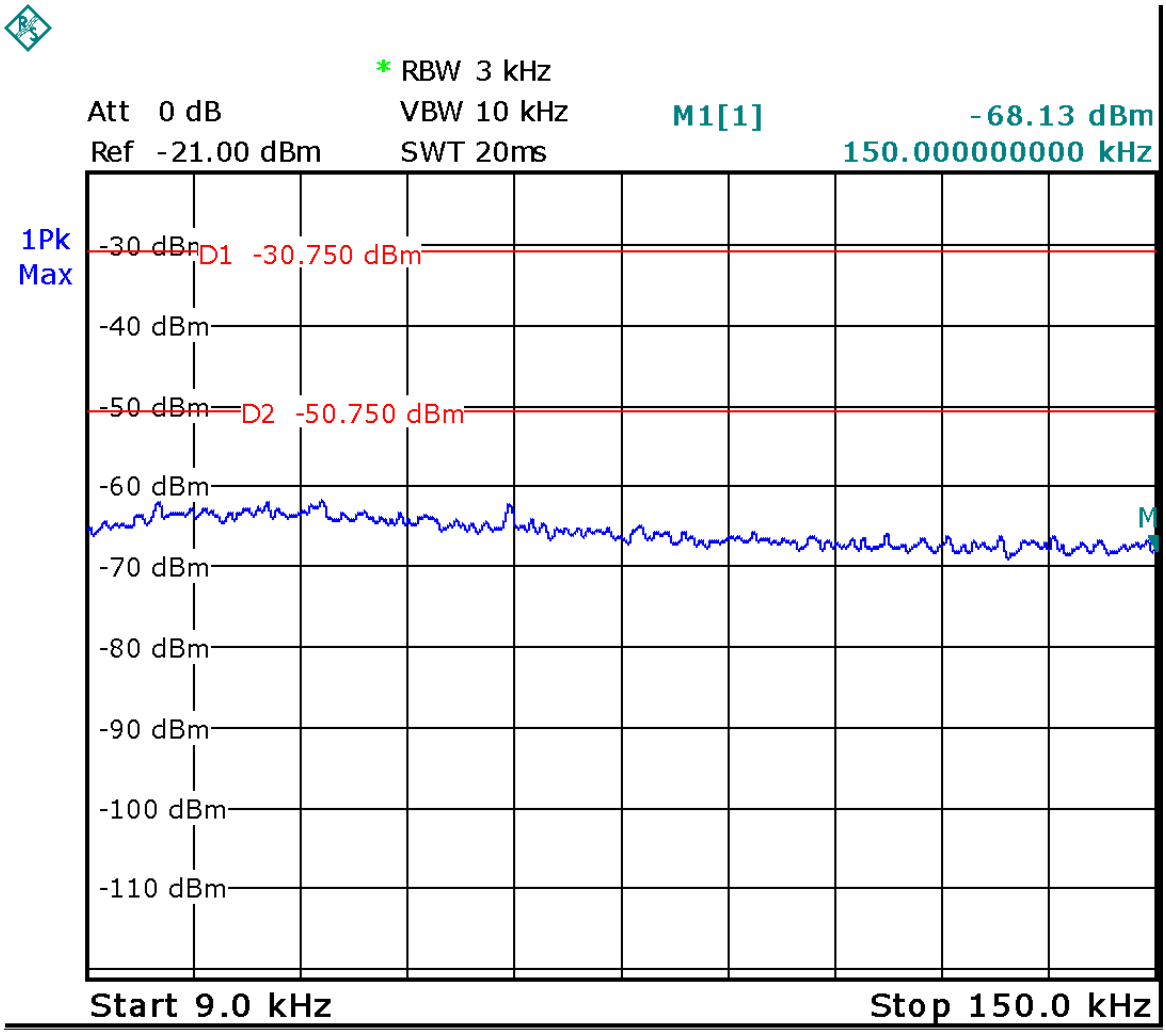
Channel	Frequency (MHz)	Measured Spurious Conducted (dBm)	-20dbc Limit (dBm) <Note 1>	Margin (dBm)	Results <Note 2>
Low: #0	0.009-0.15	-30.5	-11	19.5	Pass
Low: #0	0.15-30	-34.38	-11	23.38	Pass
Low: #0	30-902.46	-46	-11	35	Pass
Low: #0	902 – 902.46	-28.13	-12.11	16.02	Pass
Middle # 33: No Hopping	900 - 915	-31.38	-12.28	19.1	Pass
Middle#33: Hopping	900 - 915	-47	-15.16	31.54	Pass
Middle: #33	900 - 930	-42	-10	32	Pass
High: #63 No Hopping	915- 930	-32.13	-10.98	21.15	Pass
High: #63	926.4 - 930	-32.31	-10.98	21.33	Pass
High: #63	926.4 - 10000	-19.77	-10.98	8.79	Pass
Note 1: 20 dB Attenuator Removed					

Table 26 - Results – Band Edge – 900MHz Band

13.6 Graphs

The graphs below show the worst-case peak power output of the device with conducted measurement during transmit operation of the EUT. No attenuator was used between the EUT and the Spectrum Analyzer

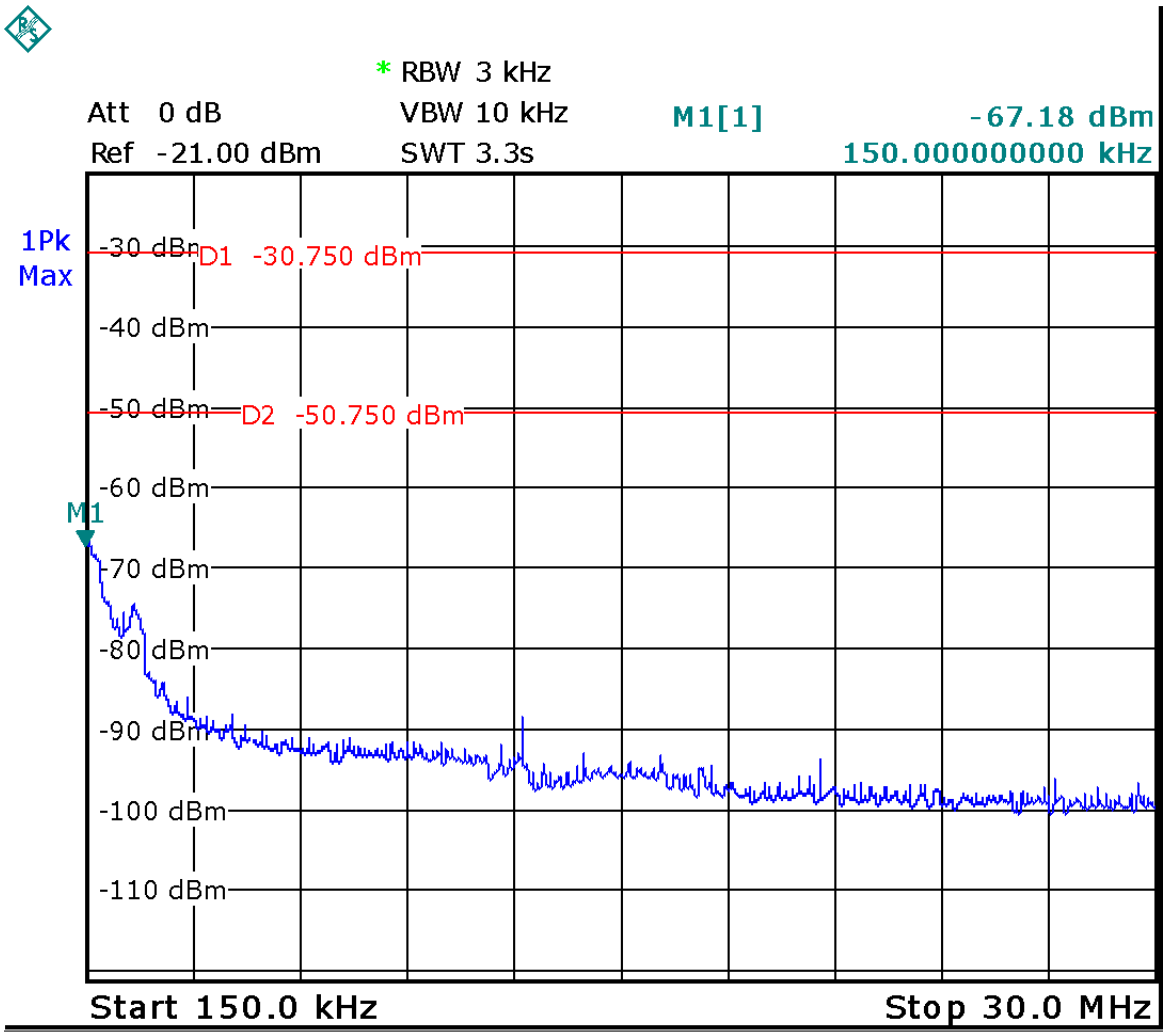
WX DB (2.4GHz)



D1=Fondamental level; D2= 20dB limit

Date: 16.MAR.2020 11:37:36

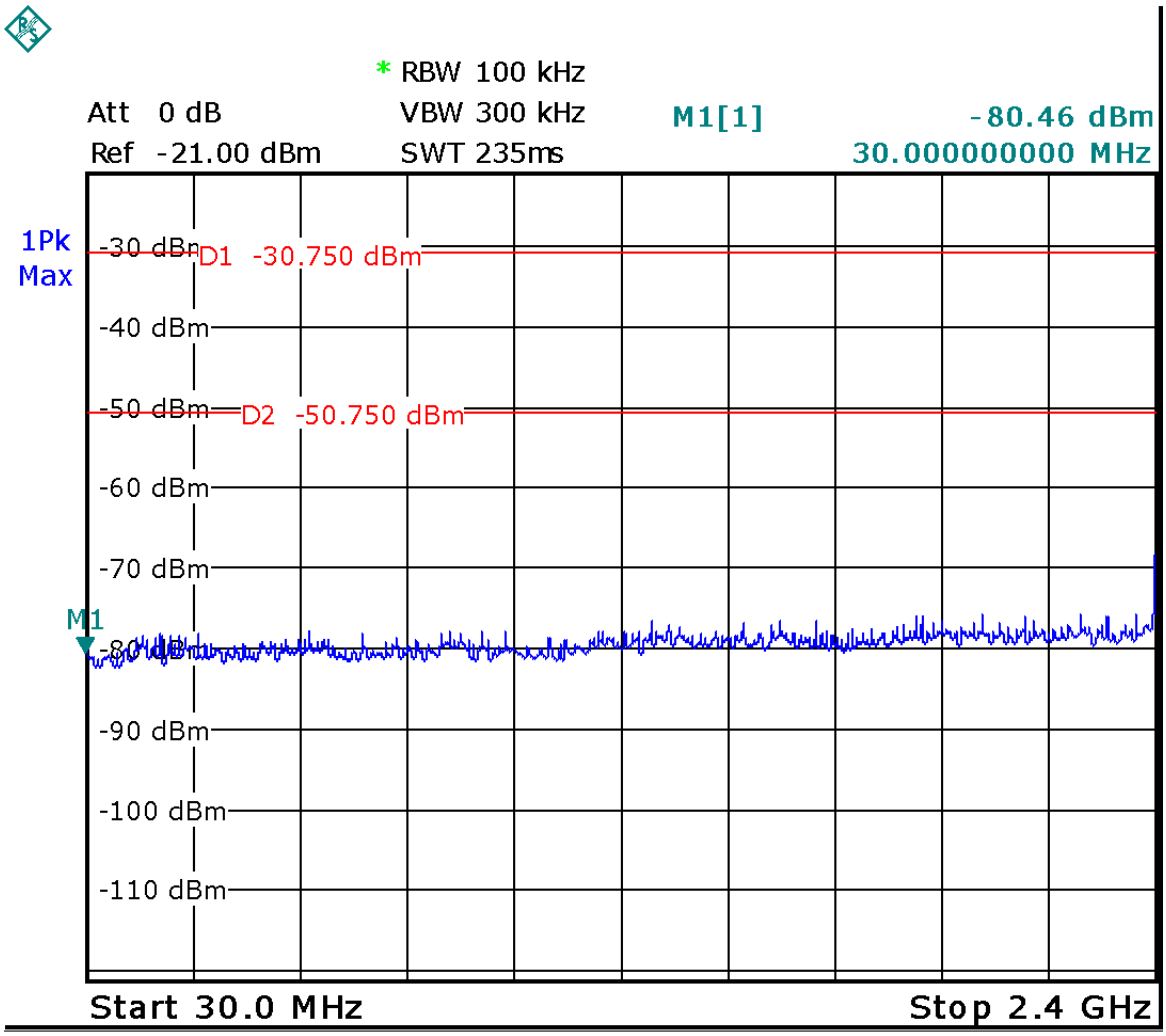
Graph 26 Test Results – Band Edge – 9kHz to 150kHz –Channel #0



D1=Fondamental level; D2= 20dB limit

Date: 16.MAR.2020 11:39:04

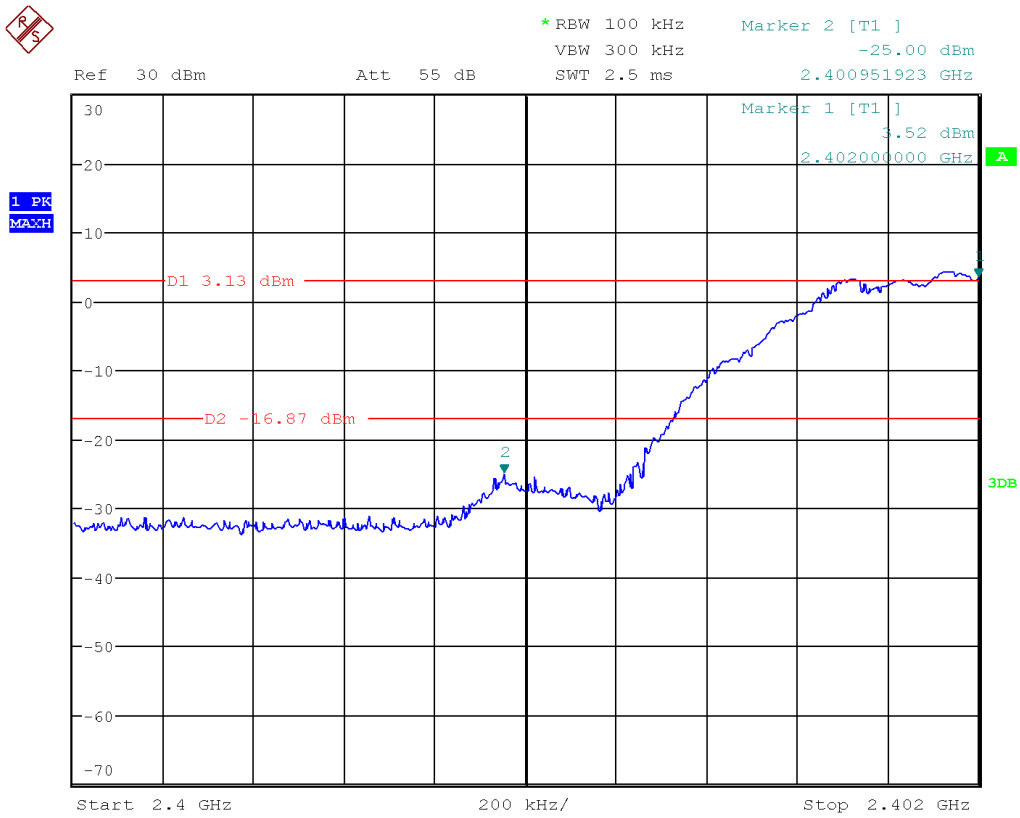
Graph 27 Test Results – Band Edge –150kHz to 30MHz – Channel #0



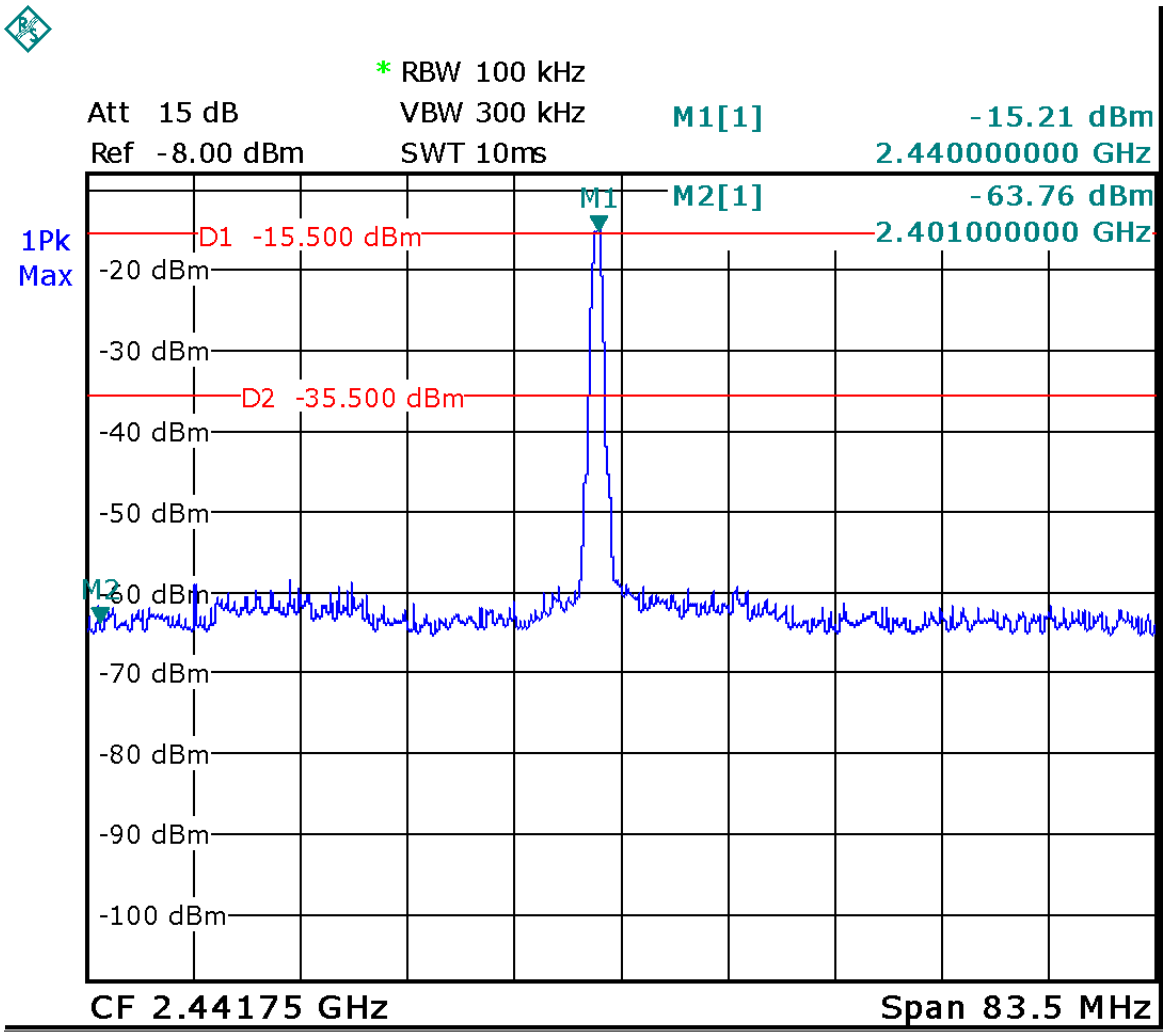
D1=Fondamental level; D2= 20dB limit

Date: 16.MAR.2020 11:41:28

Graph 28 Test Results – Band Edge –30MHz to 2.4GHz– Channel #0



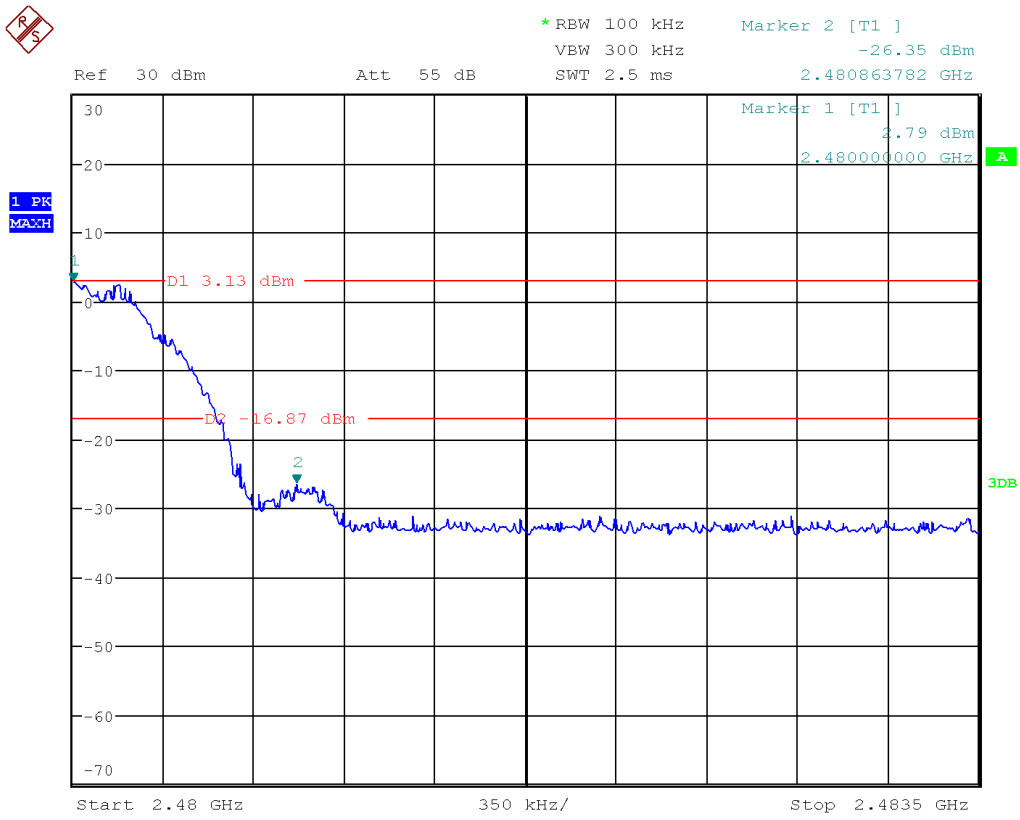
Graph 29 Test Results – Band Edge –2.4GHz to 2.402GHz– Channel #0



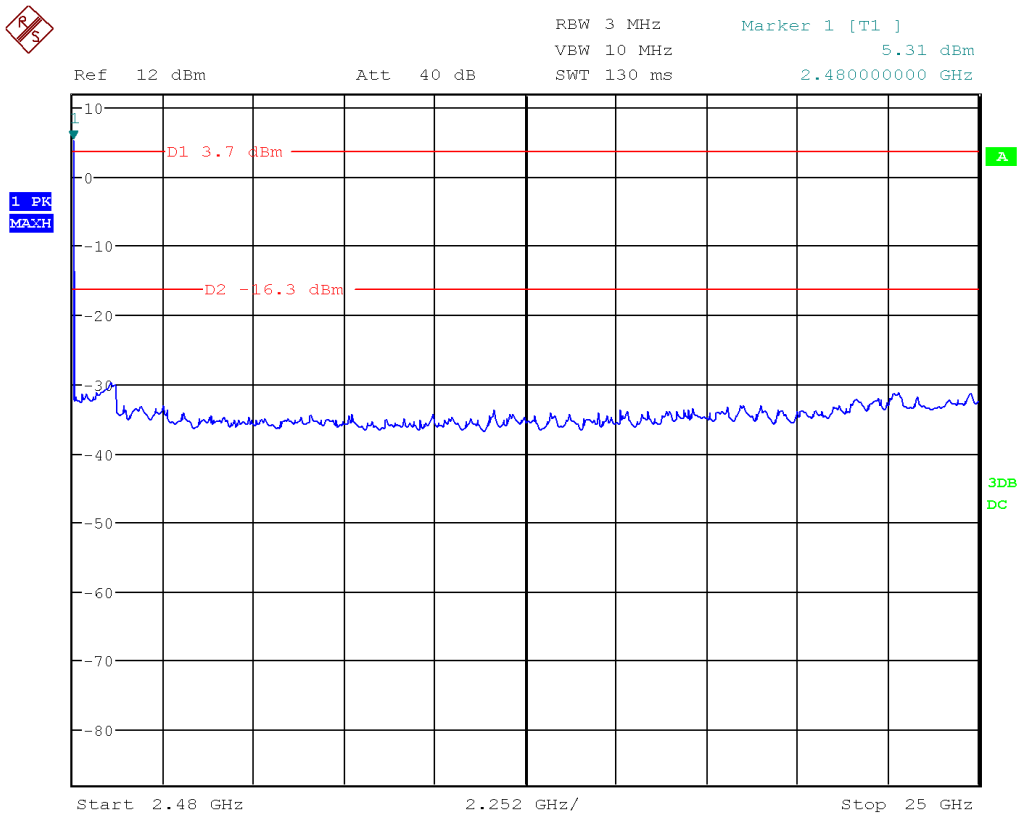
D1=Fondamental level; D2= 20dB limit

Date: 16.MAR.2020 11:59:49

Graph 30 Test Results – Band Edge –2.402GHz to 2.4835GHz– Channel #19



Graph 31 Test Results – Band Edge –2.48GHz to 2.4835GHz– Channel #19

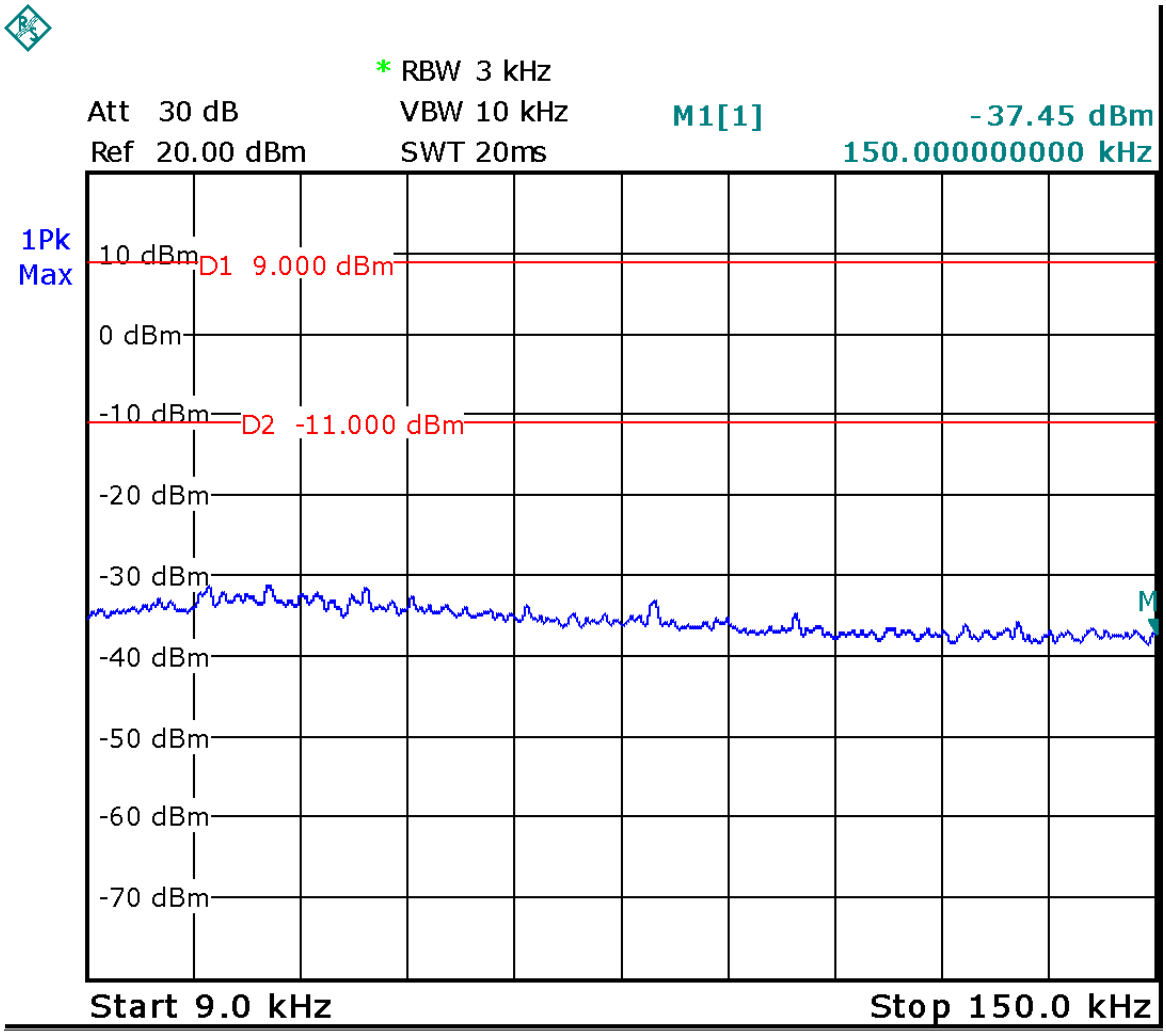


D1= Harmonic Level; D2= 20dB Limit

Date: 17.MAR.2020 15:11:49

Graph 32 Test Results – Band Edge –2.4835GHz to 25GHz– Channel #39

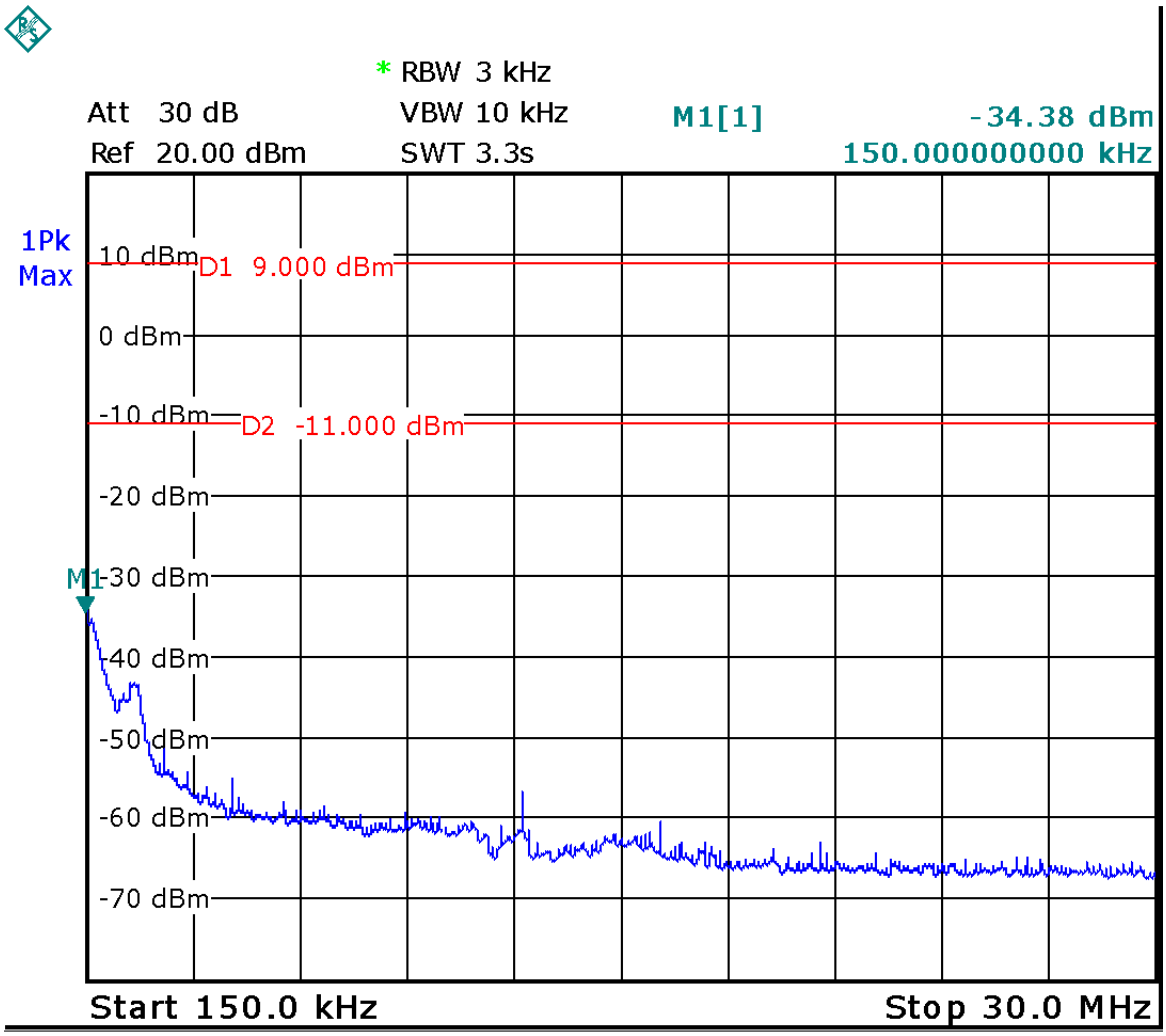
WX DB (900MHz)



D1= Fondamental Level; D2= 20dB Limit

Date: 17.MAR.2020 09:04:16

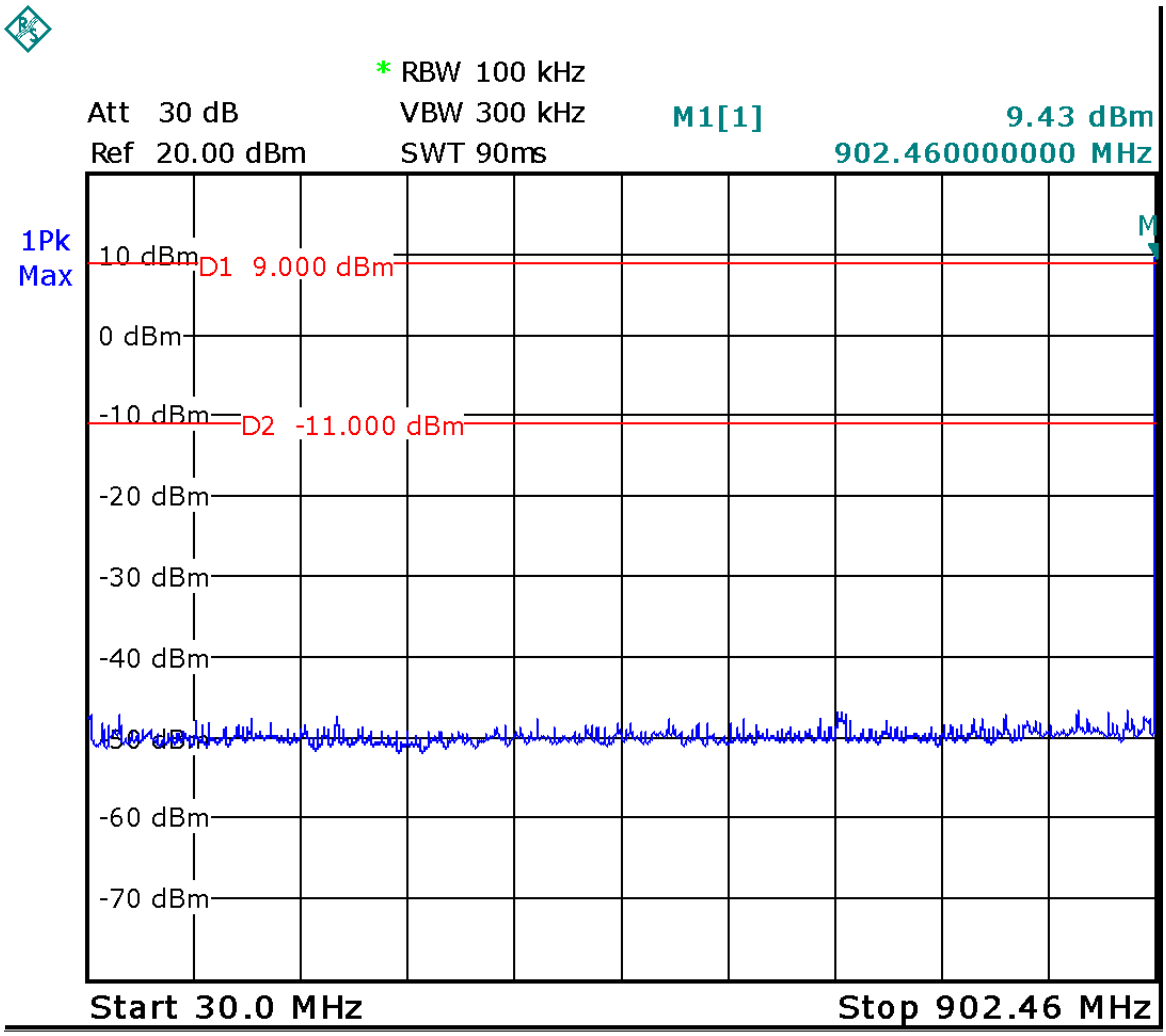
Graph 33 Test Results – Band Edge – 9kHz to 150kHz –Channel #0



D1= Fondamental Level; D2= 20dB Limit

Date: 17.MAR.2020 10:01:24

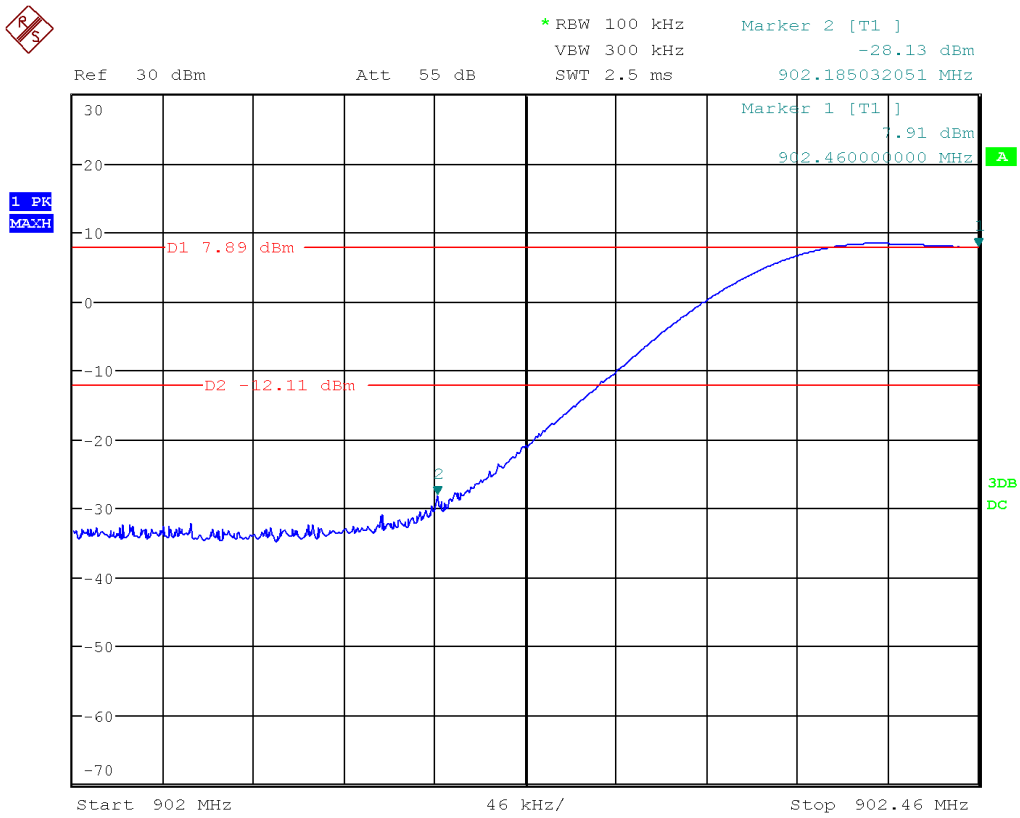
Graph 34 Test Results – Band Edge –150kHz to 30MHz – Channel #0



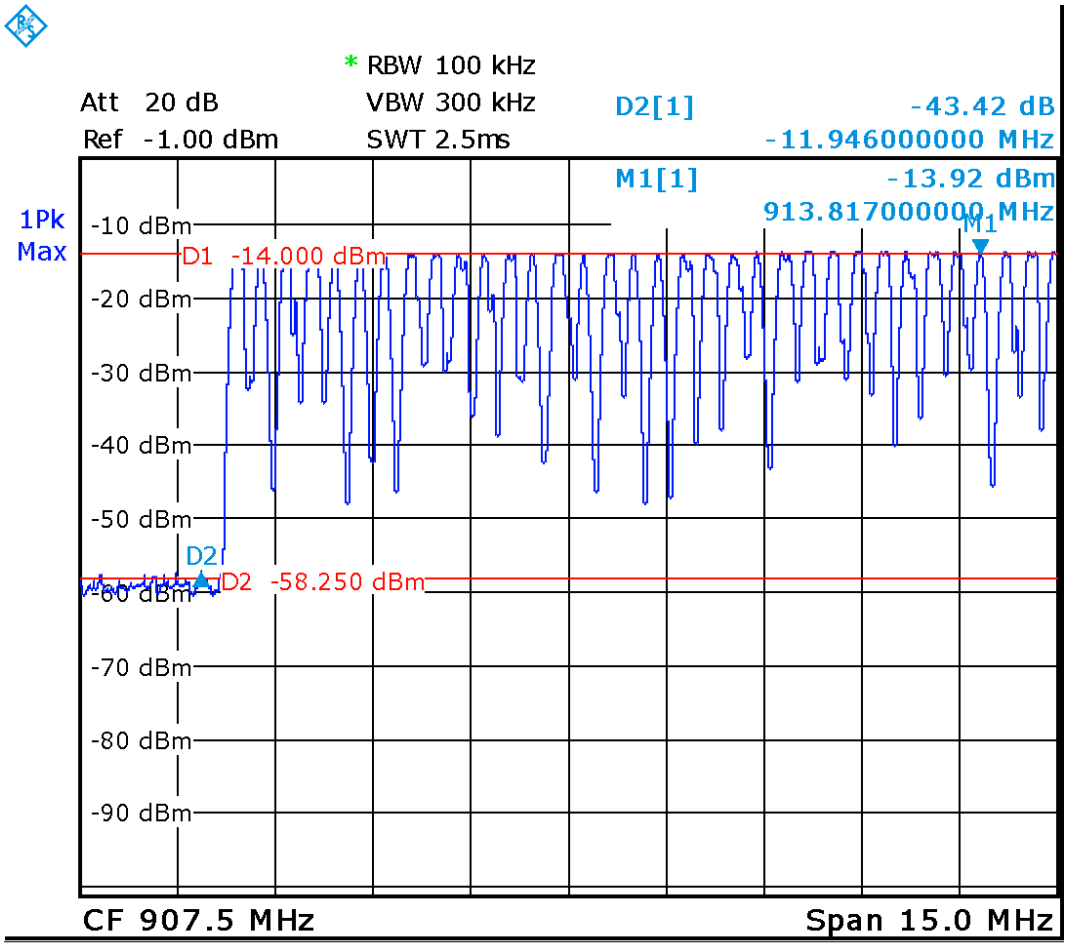
D1= Fondamental Level; D2= 20dB Limit

Date: 17.MAR.2020 10:07:55

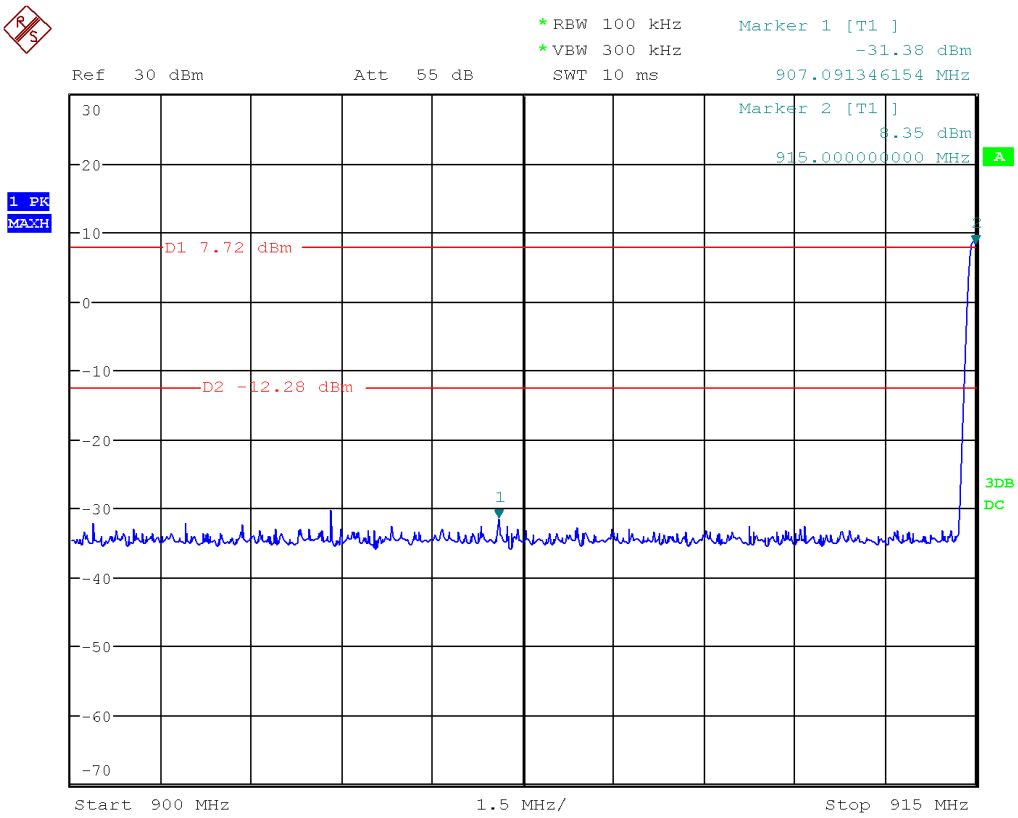
Graph 35 Test Results – Band Edge –30MHz to 902.46MHz – Channel #0



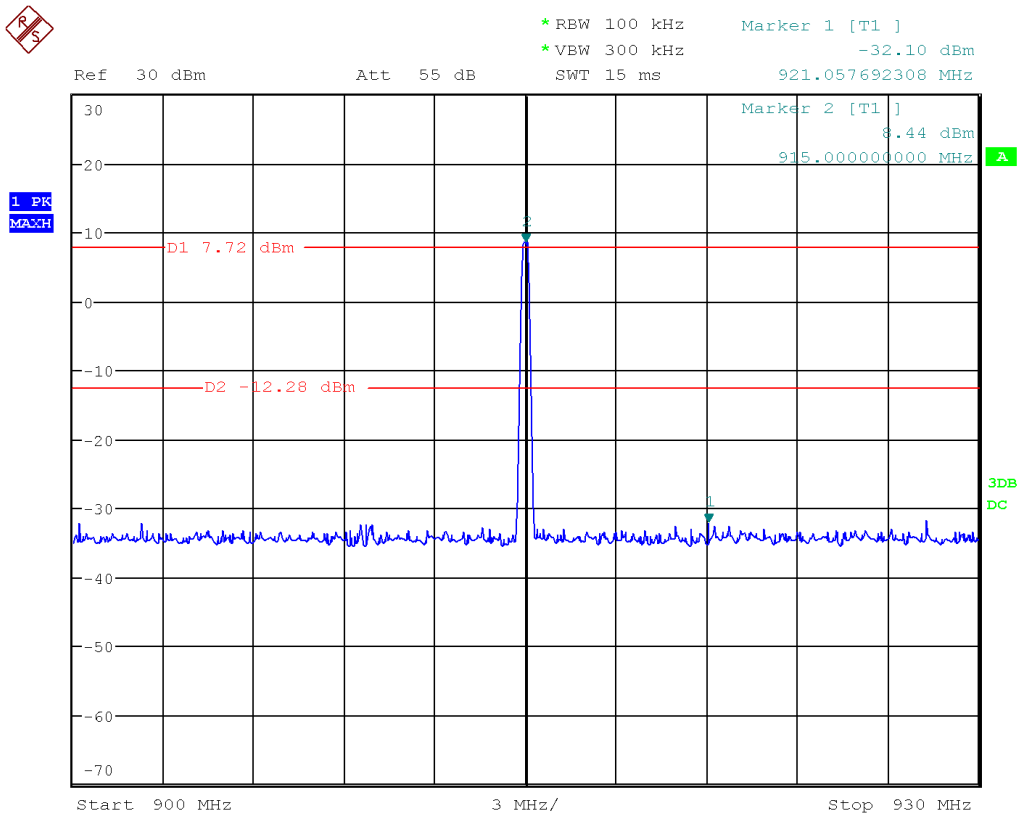
Graph 36 Test Results – Band Edge –902 MHz to 902.46MHz – No Hopping



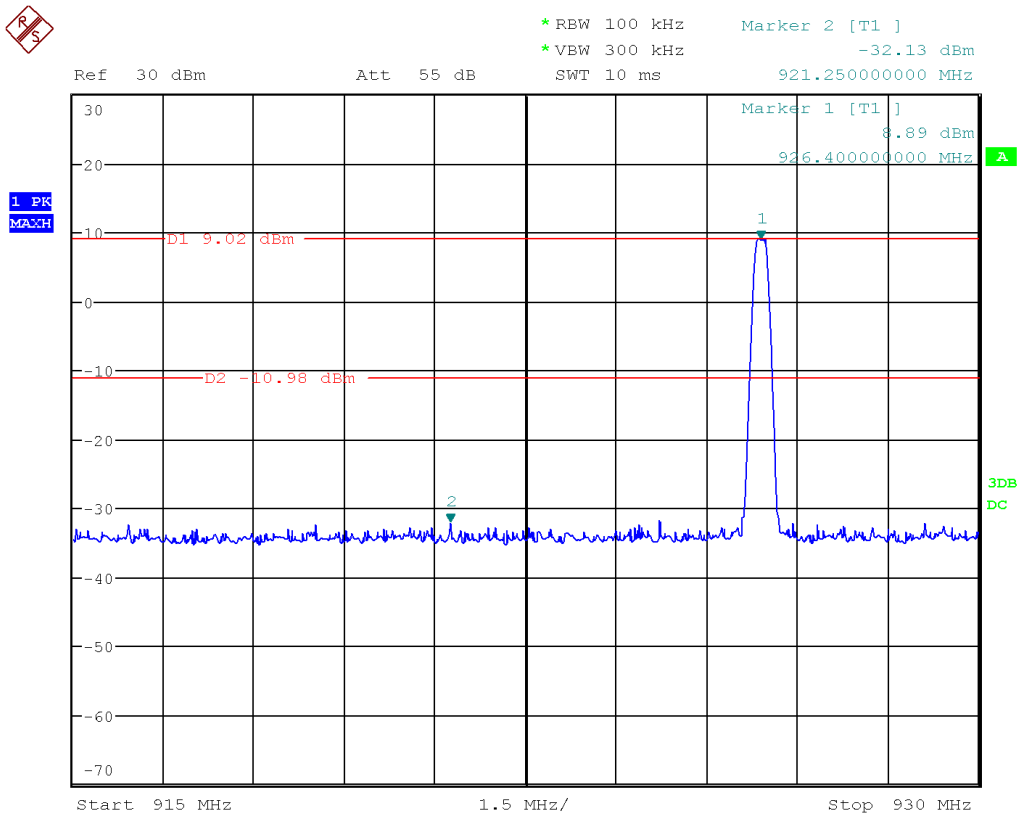
Graph 37 Test Results – Band Edge –900MHz to 915MHz – Hopping



Graph 38 Test Results – Band Edge –900 MHz to 915 MHz – No Hopping

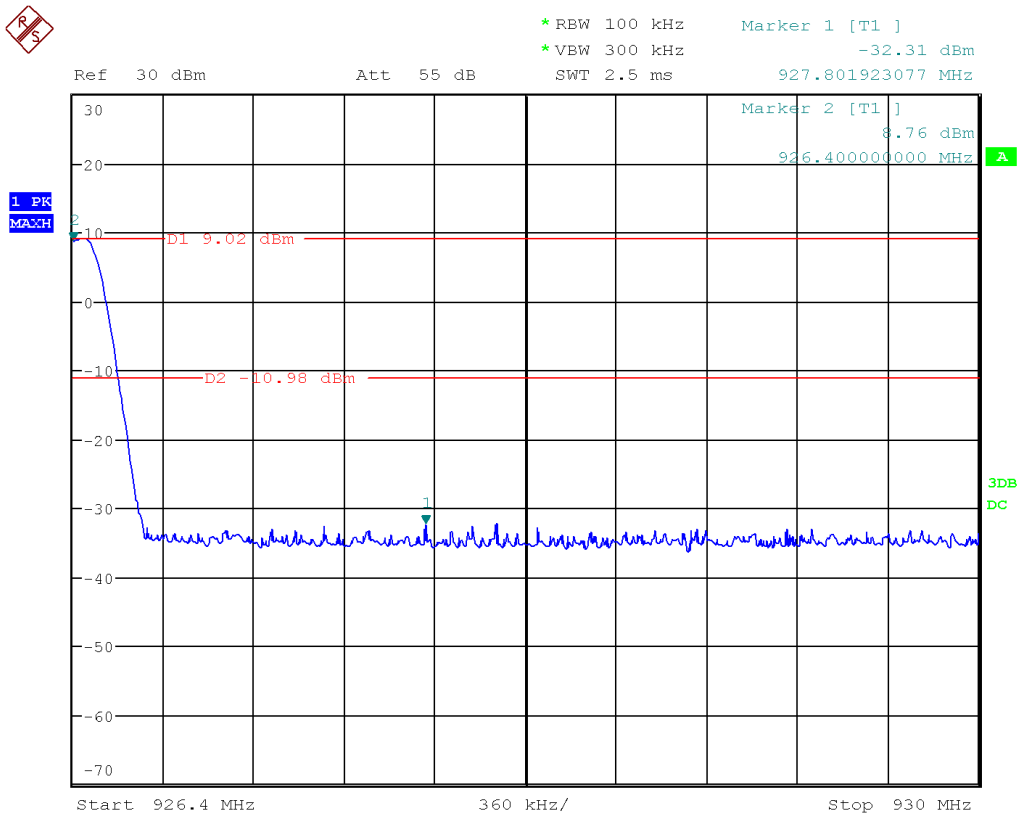


Graph 39 Test Results – Band Edge –900 MHz to 930 MHz – Channel #32

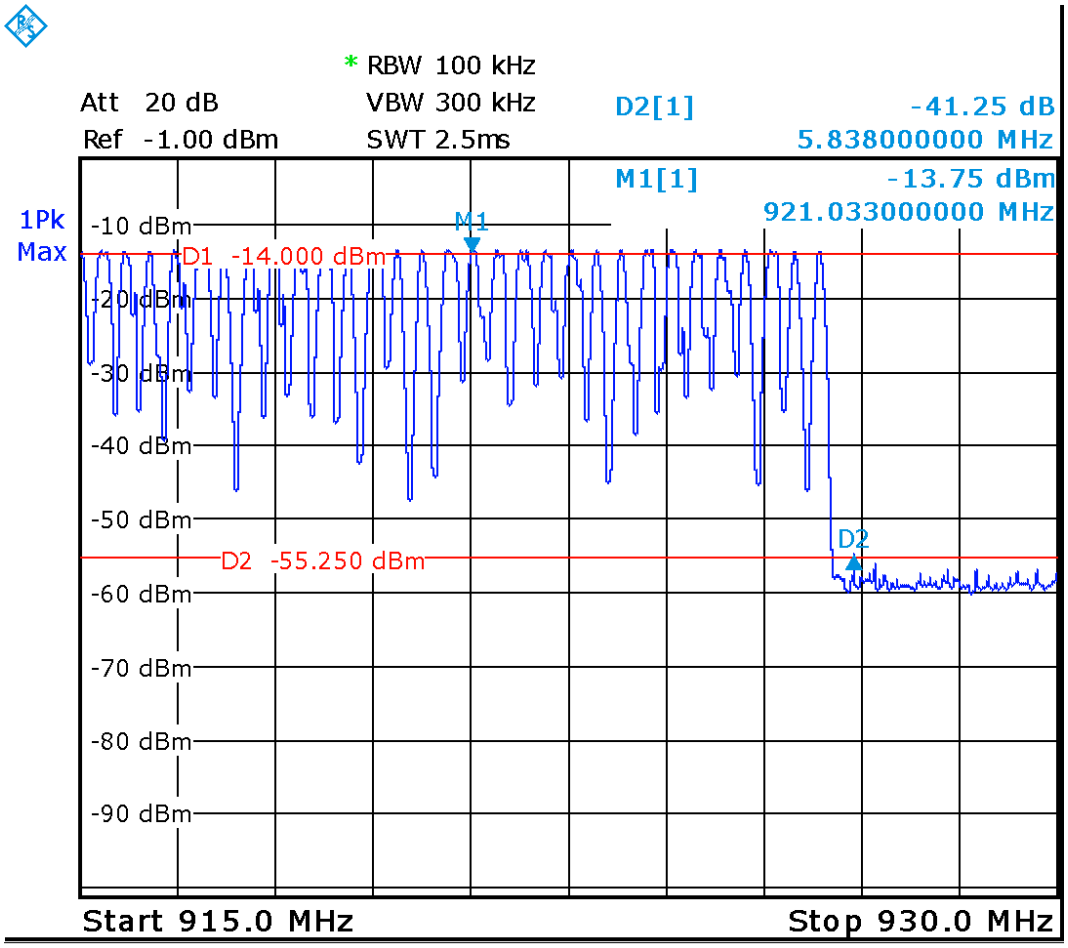


Date: 15.SEP.2020 13:29:39

Graph 40 Test Results – Band Edge –915 MHz to 930 MHz – No Hopping Channel #63

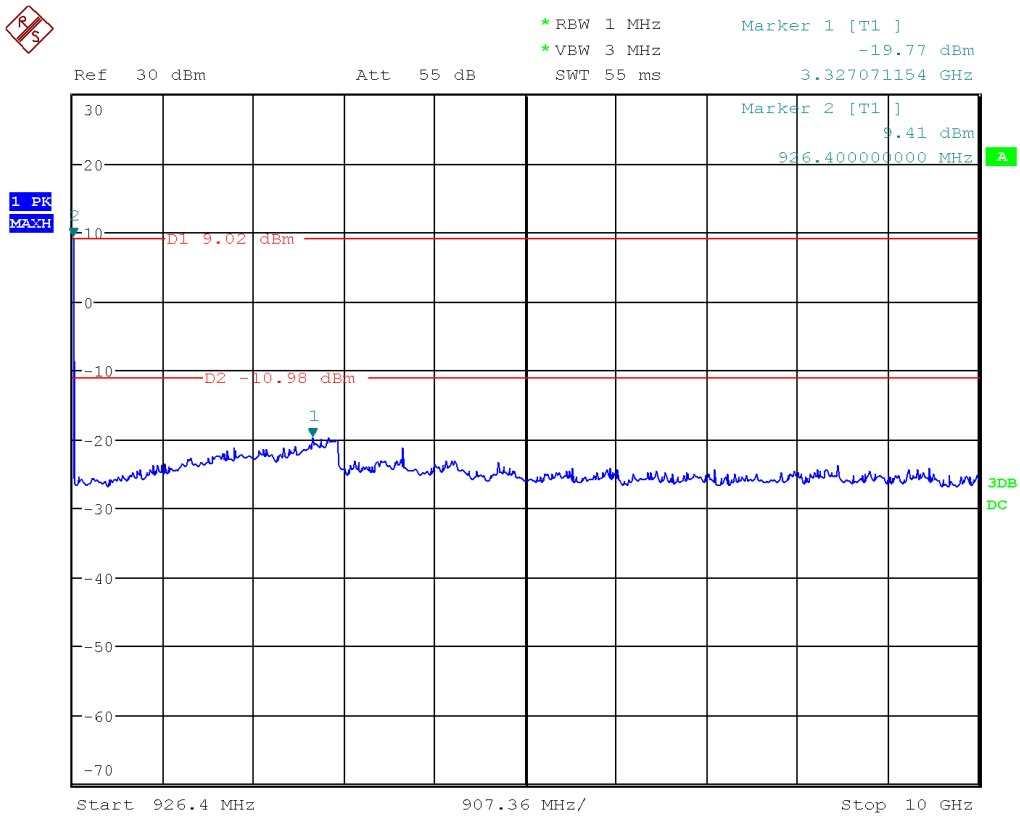


Graph 41 Test Results – Band Edge –926.4 MHz to 930 MHz – No Hopping Channel #63



Date: 1.JUN.2020 18:11:39

Graph 42 Test Results – Band Edge –926.4 MHz to 930 MHz – Hopping



Graph 44 Test Results – Band Edge –927.54 MHz to 10 GHz – Channel #63

13.7 Test Instruments

This test was carried out in Laval test location

Equipment	Model No.	Manufacturer	Calibration Period (months)	Calibration Due (YYY-MM-DD)	Asset No: LAVE
Spectrum Analyzer	ESU-40	Rohde & Schwarz	12	2021-07-17	4092
Cable 254mm SMA	Minibend-10	Huber+ Suhner	NCR	NCR	4080
Spectrum Analyzer	FSL 6	Rohde & Schwarz	24	2020-09-02	4095

Table 27 – Test Instrumentation – Band Edge

14 Tx Spurious Radiated Emissions

14.1 Purpose & Methods

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. The method is as defined in Section 12.1 of FCC KDB 558074 and ANSI C63.10.

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

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

Table 28 Limits – Tx Spurious

Based on ANSI C63.4 Section 4.2, if the Peak detector measurements do not exceed the Quasi-Peak limits, where defined, then the EUT is deemed to have passed the requirements.

14.2 Test Specifications

REFERENCE STANDARD	FCC Part 15.209(a) RSS-247 5.5 ANSI C63.10 Clause 5.5			
SPECIFICATIONS				
Limit (dBuV/m)	See table 28			
Frequencies (MHz)	2402 2440 2480	902.46 915 926.4		
EUT				
Identification	WX DB Thermostat (900MHz/ 2.4GHz)			
Voltage Input	24 Vac & 3.3 Vdc			
ENVIROMENTAL & TEST INFO				
Test Date (YYYY-MM-DD)	2020-03-12	2020-03-13	2020-09-15	2020-09-16
Temperature (°C)	22.3 ± 2	23.9 ± 2	21.3 ± 2	20.3 ± 2
Humidity (%)	21.2 ± 5	23.4 ± 5	22.24 ± 5	19.4 ± 5
Atmospheric Pressure kPa (For Info Only)	99.8	99.95	101.33	101.08
Tester	Abdoulaye Ndiaye Jose Martinez-Ortega			
Client Witness	No Witness			

14.3 Limits

The limits, as defined in 15.247(d) for intentional 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).

14.4 Test Setup

As per ANSI C63.10 Clause 6.3.1, below 1GHz, the height of the EUT was set to 80cm. And above 1GHz, the height was set to 1.5m.

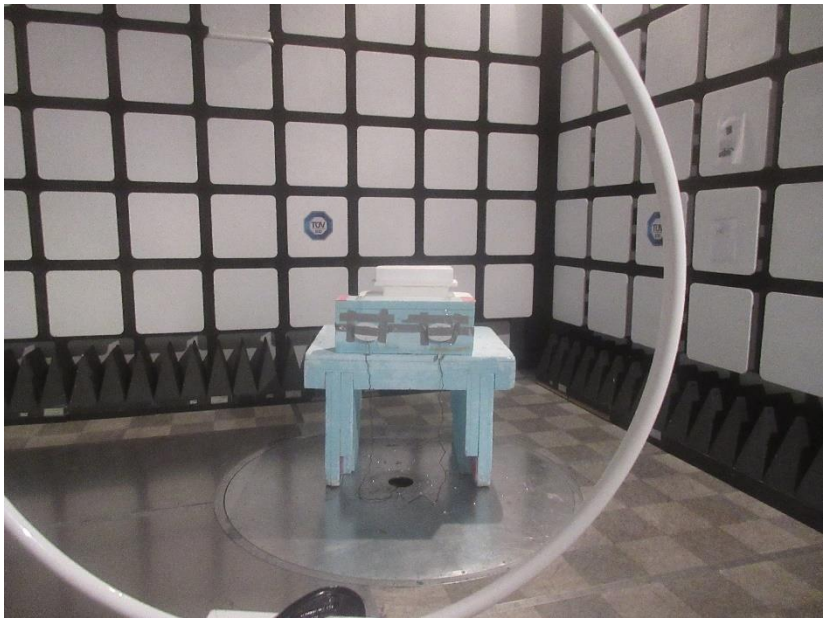


Photo 2: – Test Setup – 9kHz to 30MHz (2.4GHz/915MHz)

Photo 3: – Test Setup – 30MHz to 1GHz – Vertical Polarization(2.4GHz/915MHz)

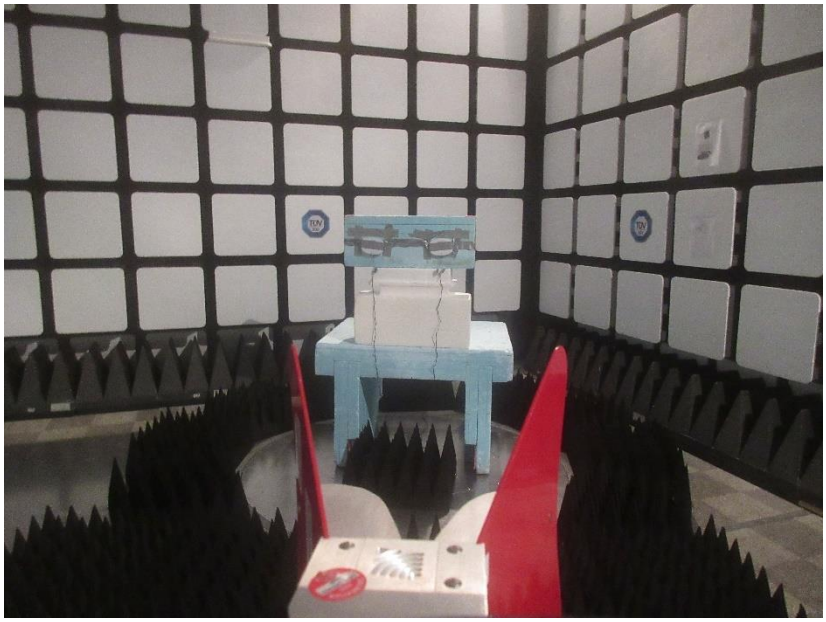


Photo 4: – Test Setup >1GHz – Horizontal Polarization(2.4GHz/915MHz)

14.5 Results

Only middle channel was tested as worst case. The worst-case are only presented and final measurements are given in Appendix A.

Channel	Frequency Range (MHz)	Frequency (MHz)	Polarization	Detector	Limit	Margin	Results <Note 2>
#0	0.009 – 0.015	-	-	-	See Table 28	Note 1	
	0.015 – 30					Note 1	
	30 – 1000	-	-	-		-	Pass
	>1000	-	-	-		-	Pass
#19	0.009 – 0.015	-	-	-		Note 1	Pass
	0.015 – 30			-		Note 1	Pass
	30 – 1000	-	-	-		Note 1	Pass
	>1000	4880.18	Vertical	Average		9.9	Pass
#39	0.009 – 0.015	-	-	-		Note 1	
	0.015 – 30					Note 1	
	30 – 1000	-	-	-		-	Pass
	>1000	17992.3	Horizontal	Average		12.9	Pass
Note 1: No significant emission, i.e., 10dB below the limit was noted Note 2: For Worst cases final measurement please refer to Appendix A: Table A3, A6, A7, A8, A9, A10 and A11							

Table 29 – Test Results for Tx Spurious Emission – Worst Cases(2.4GHz)

Channel	Frequency Range (MHz)	Frequency (MHz)	Polarization	Detector	Limit	Margin	Results <Note 2>
#0	0.009 – 0.015	-	-	-	See Table 28	Note 1	Pass
	0.015 – 30					Note 1	Pass
	30 – 1000	-	-	-		Note 1	Pass
	>1000	-	-	-		Note 1	Pass
#33	0.009 – 0.015	-	-	-		Note 1	Pass
	0.015 – 30			-		Note 1	Pass
	30 – 1000	695.309	Horizontal	Quasi-Peak		19.4	Pass
	>1000	2754.33	Vertical	Average		9.8	Pass
#63	0.009 – 0.015	-	-	-		Note 1	Pass
	0.015 – 30					Note 1	Pass
	30 – 1000	-	-	-		Note 1	Pass
	>1000	-	-	-		Note 1	Pass

Note 1: No significant emission, i.e., 10dB below the limit was noted
Note 2: For Worst cases final measurement please refer to Appendix A: Table A1, A2, A4, A5 & A12

Table 30 – Test Results for Tx Spurious Emission – Worst Cases(900MHz)

14.6 Graphs

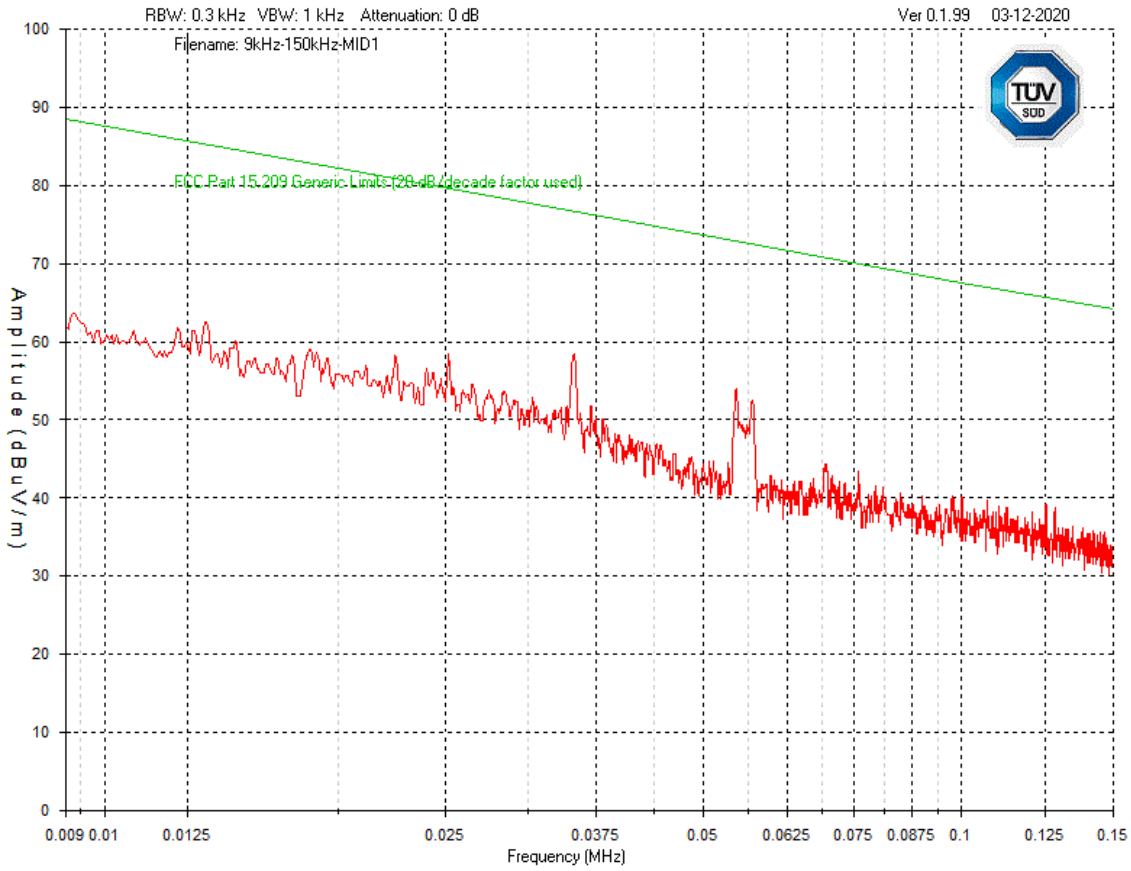
The graphs shown below are maximized peak measurement graphs measured with a resolution bandwidth greater than or equal to the final required detector over a full 0-360°. This peaking process is done as a worst-case measurement and enables the detection of frequencies of concern for final measurement. For final measurements with the appropriate detector, where applicable, please refer to the tables under Final Measurements.

In accordance with FCC Part 15, Subpart A, Section 15.33, the device was scanned to the 10th harmonic (a minimum of 24.835 GHz).

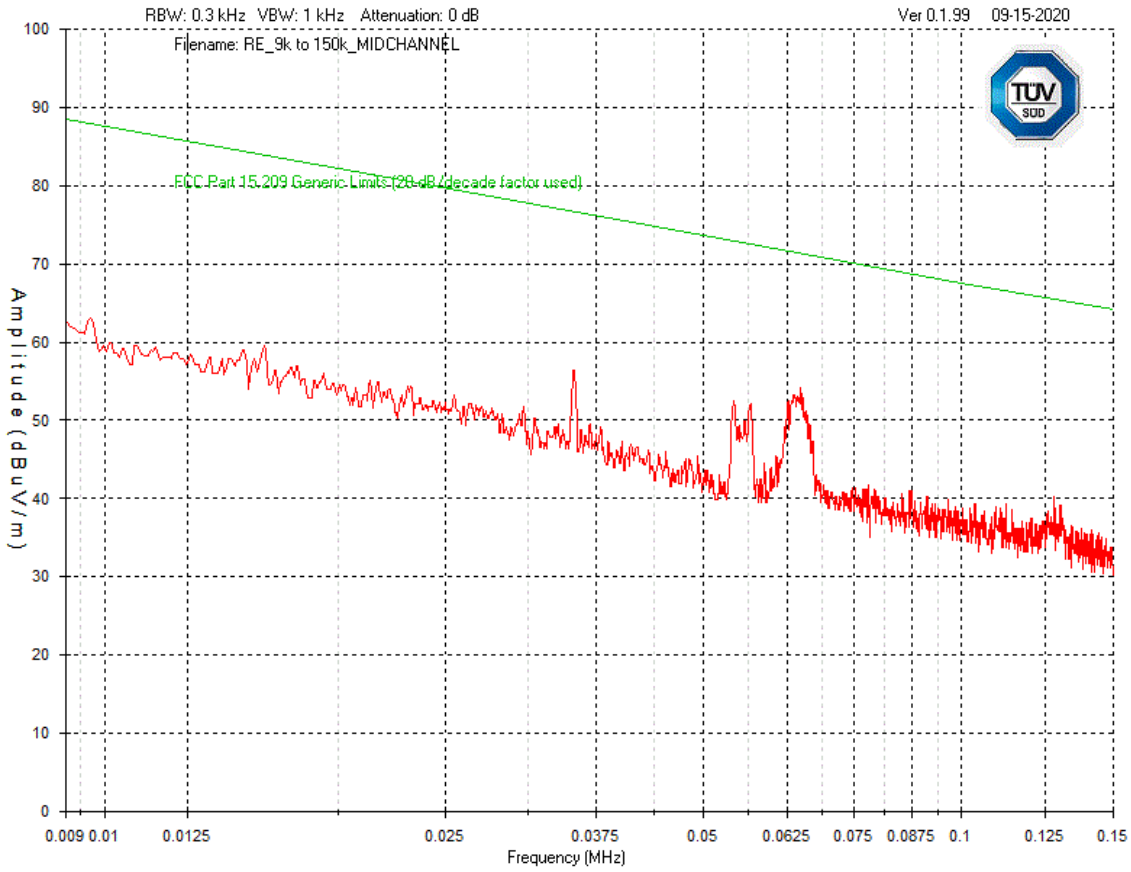
Devices scanned may be scanned at alternate test distances and in accordance with FCC Part 15, Subpart A, Section 15.31, an extrapolation factor of 20 dB/decade was used above 30 MHz and 40 dB/decade below 30 MHz for example, for 1-meter measurements, an extrapolation factor 9.5 dB from 20 Log (1m /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

Only worst-case of Middle and High Channels graphs are presented.

Frequency range from 9kHz to 150kHz

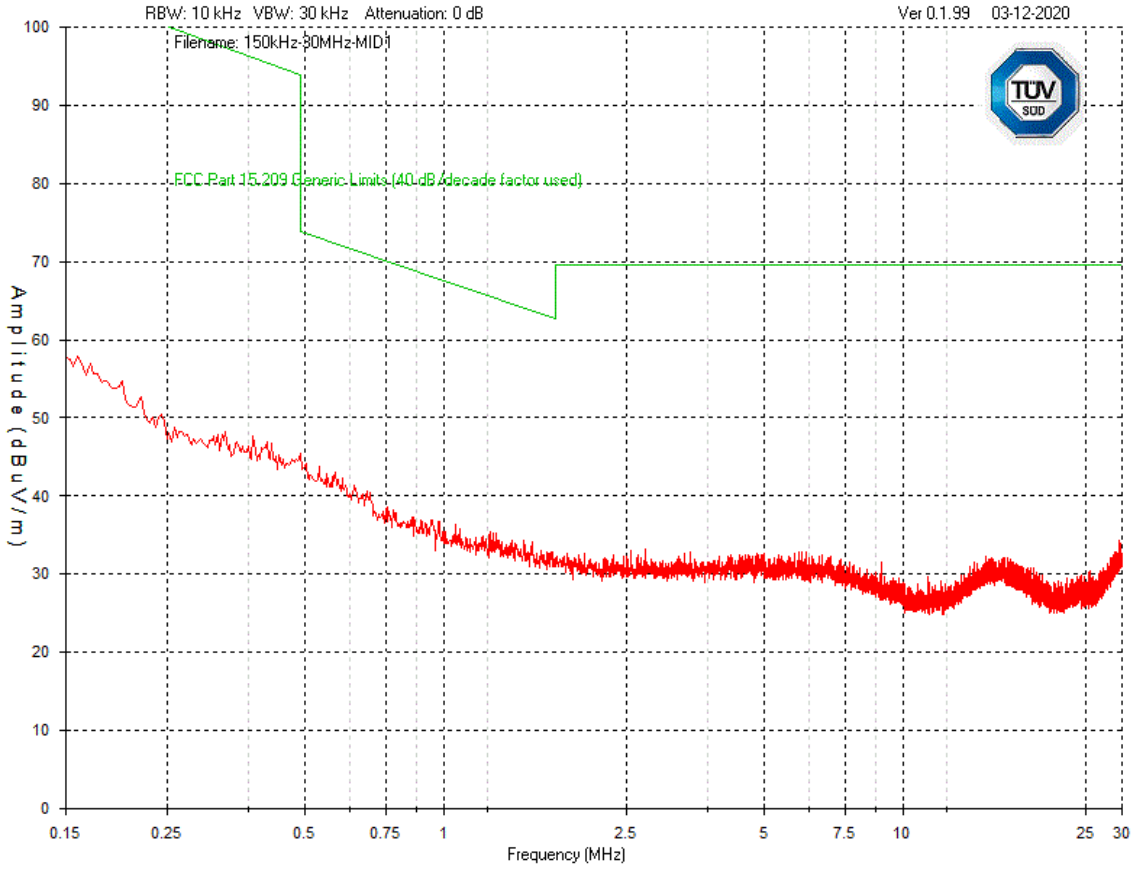


Graph 45 Test Results – Tx Spurious emission 9kHz – 150kHz: Channel #19

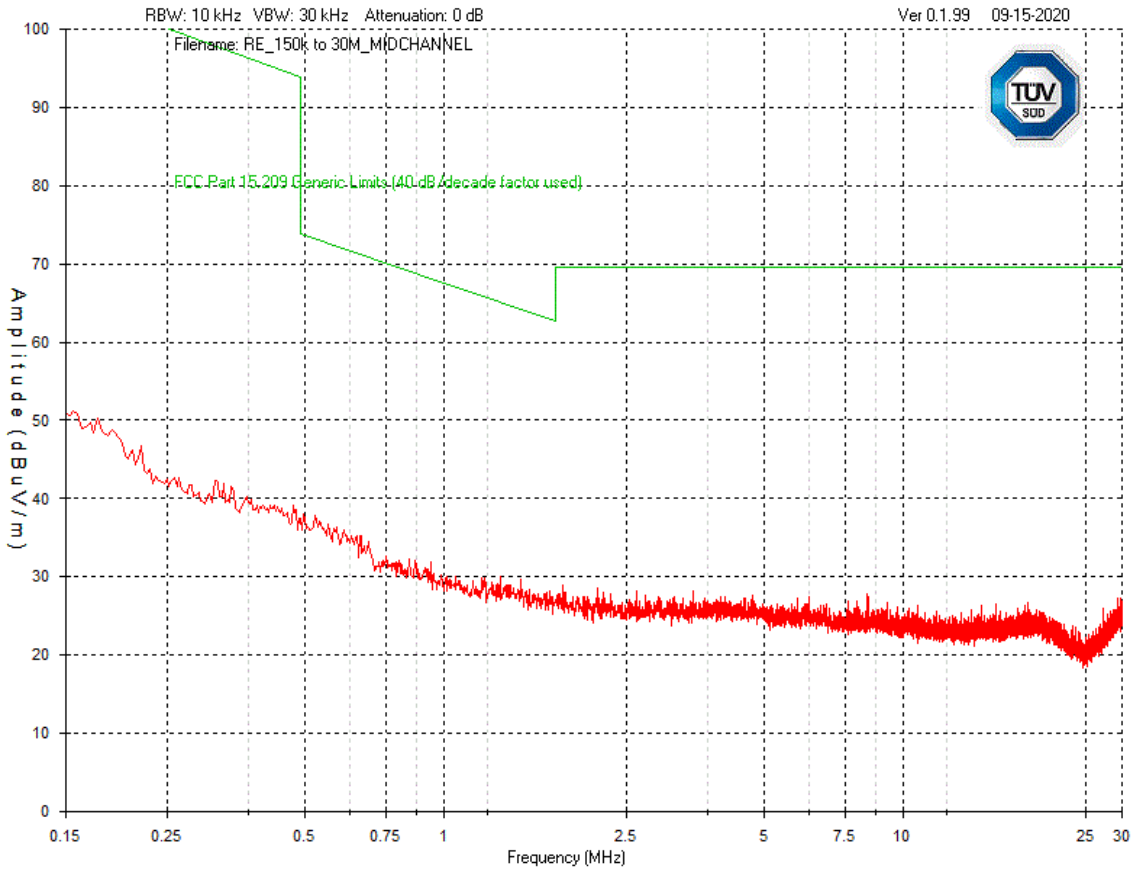


Graph 46 Test Results – Tx Spurious emission 9kHz – 150kHz: Channel #33

Frequency range from 150kHz to 30MHz

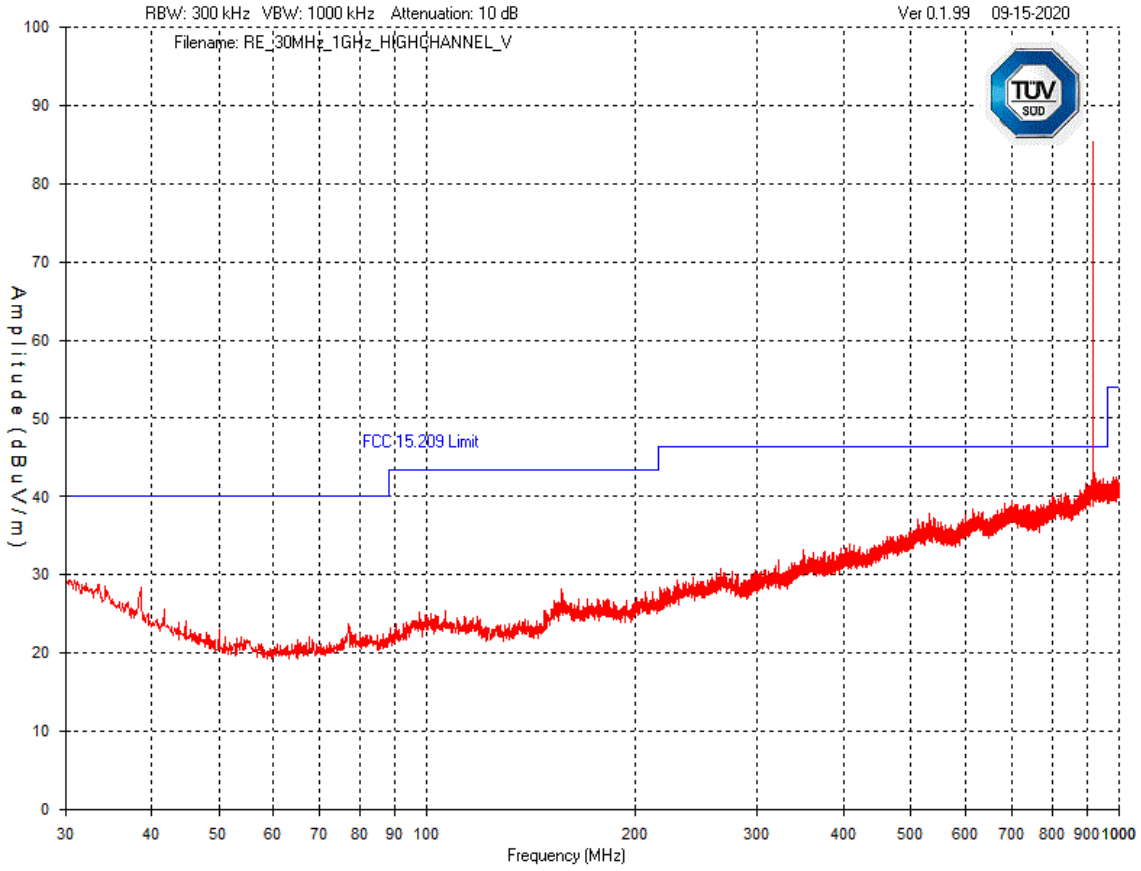


Graph 47 Test Results – Tx Spurious emission 150kHz – 30MHz: Channel #19

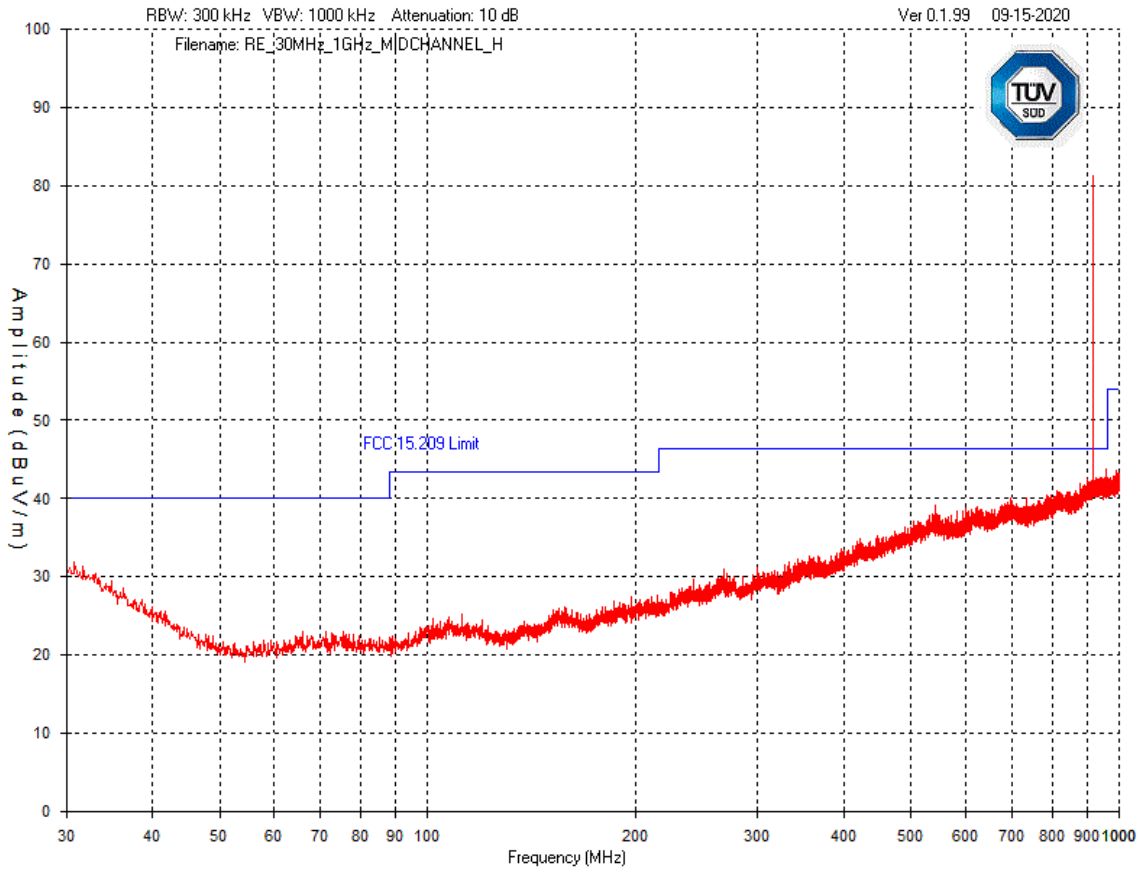


Graph 48 Test Results – Tx Spurious emission 150kHz – 30MHz: Channel #33

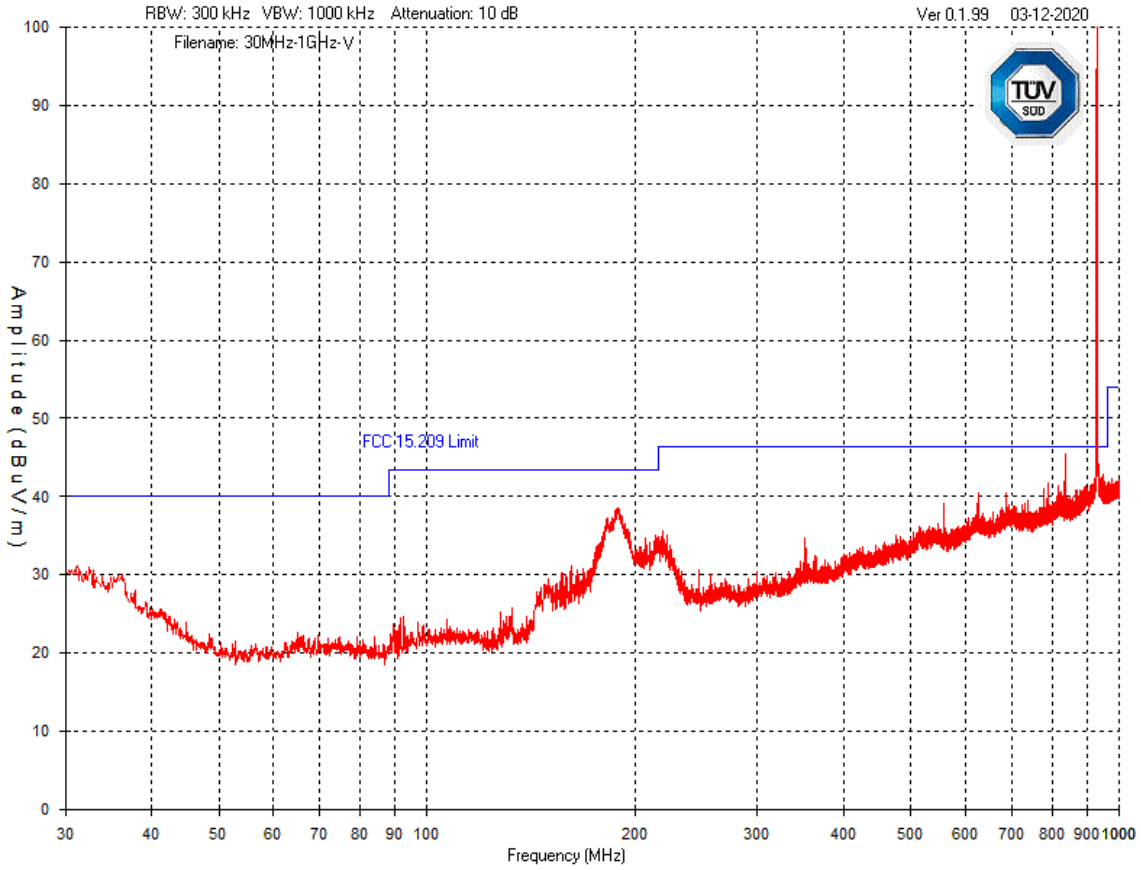
Frequency Range from 30MHz to 1GHz – Worst case – Channel #33 & Channel #39



Graph 49 Test Results – Tx Spurious emission 30MHz – 1GHz-(Vertical polarisation): Channel #33

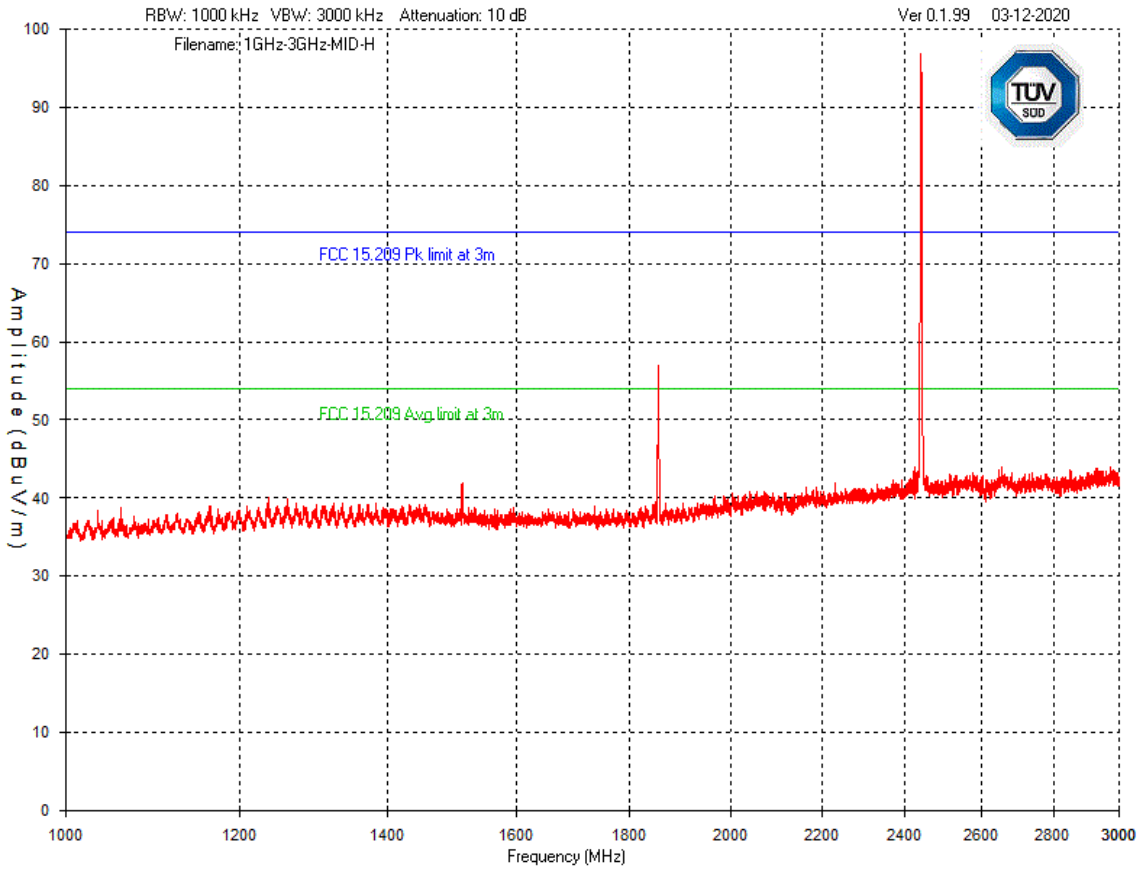


Graph 50 Test Results – Tx Spurious emission 30MHz – 1GHz-(Horizontal polarisation): Channel #33

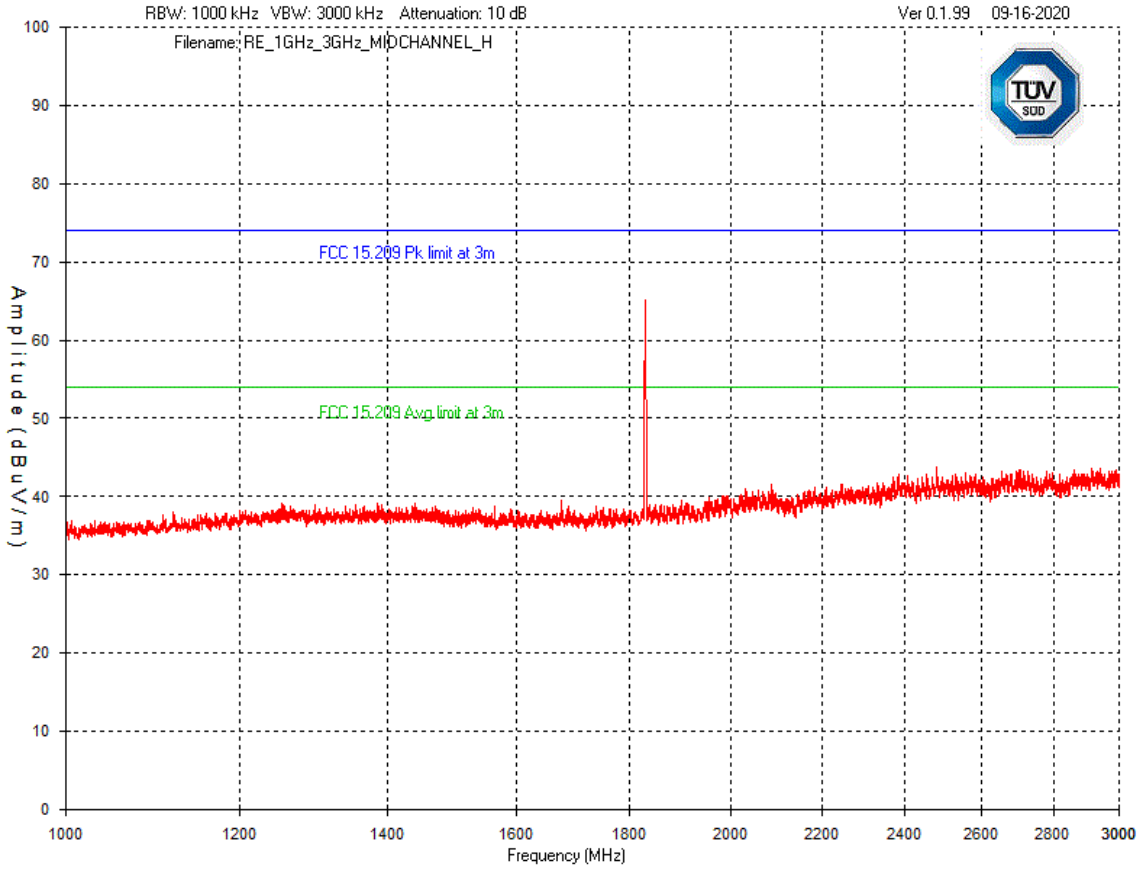


Graph 51 Test Results – Tx Spurious emission 30MHz – 1GHz-(vertical polarisation): Channel #39

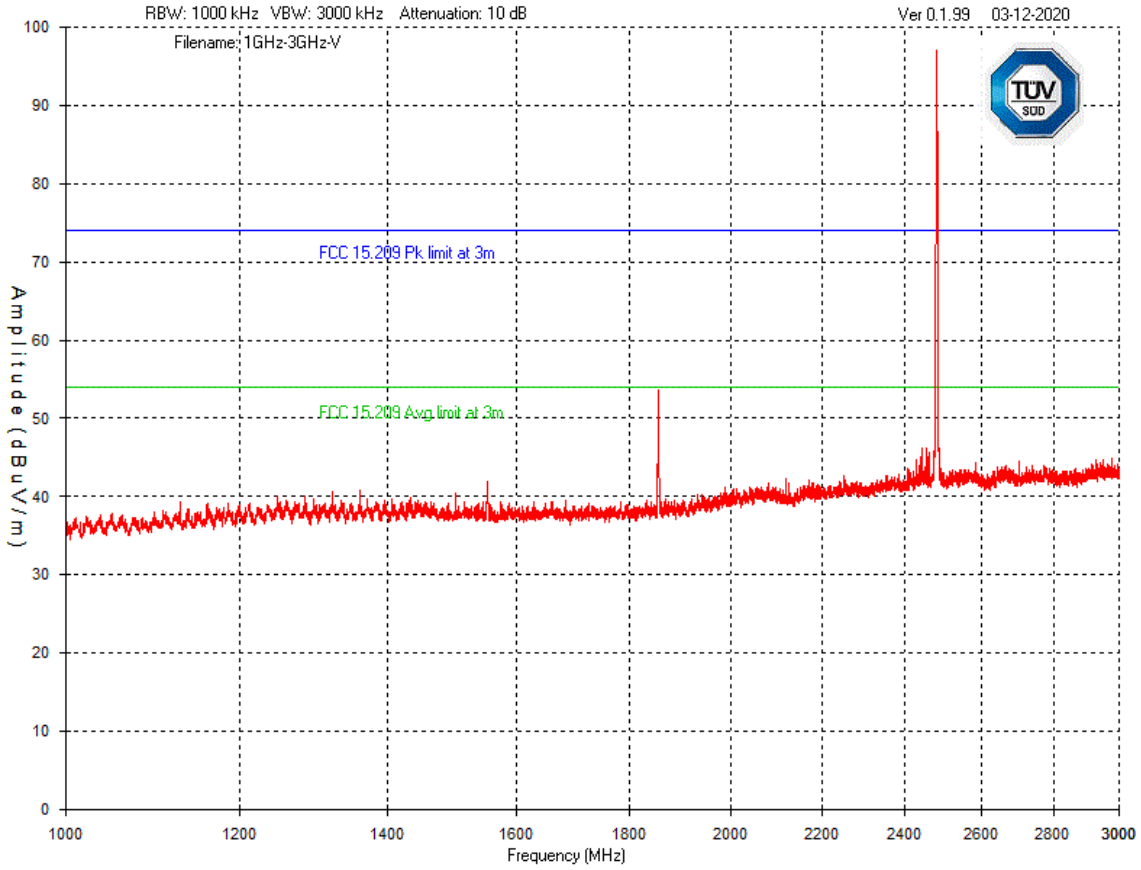
Frequency Range from 1GHz to 3GHz – Worst case – Channel #19, channel #33 & Channel #39



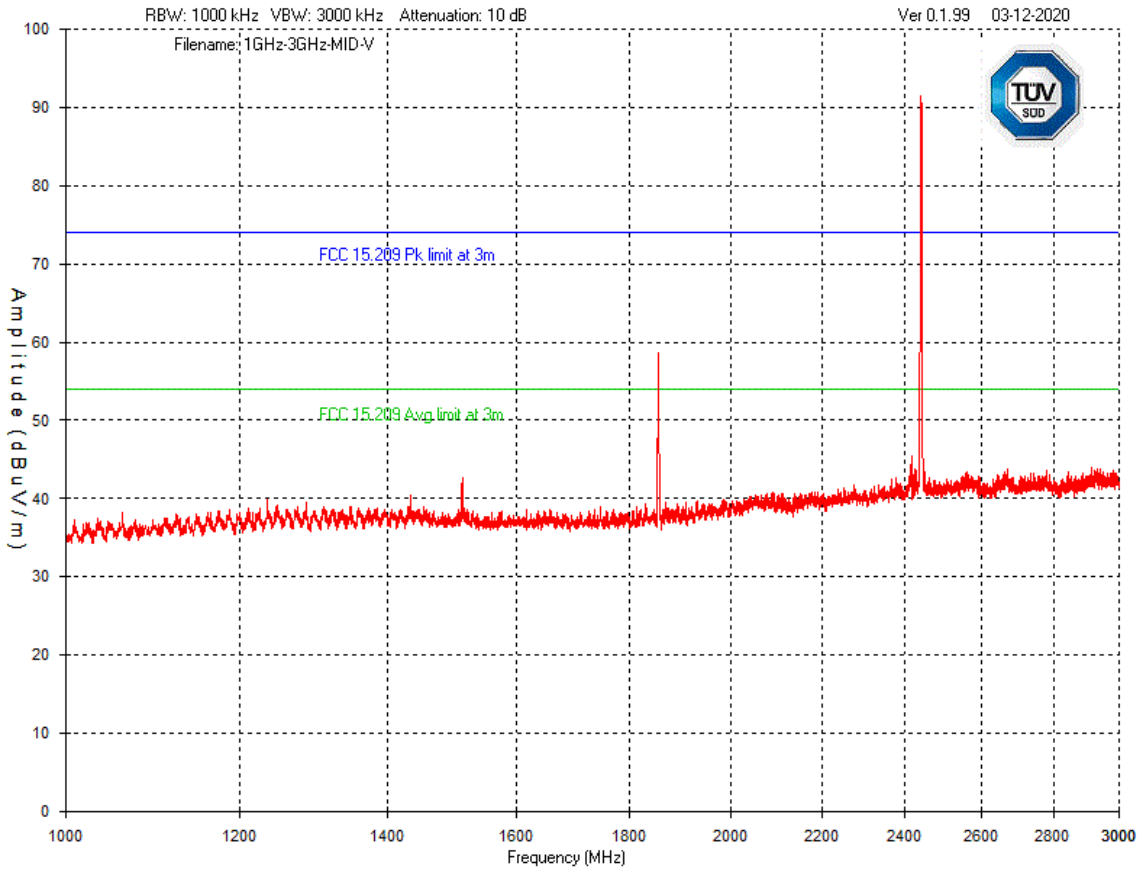
Graph 52 Test Results – Tx Spurious emission 1GHz – 3GHz-(Horizontal polarisation): Channel #19



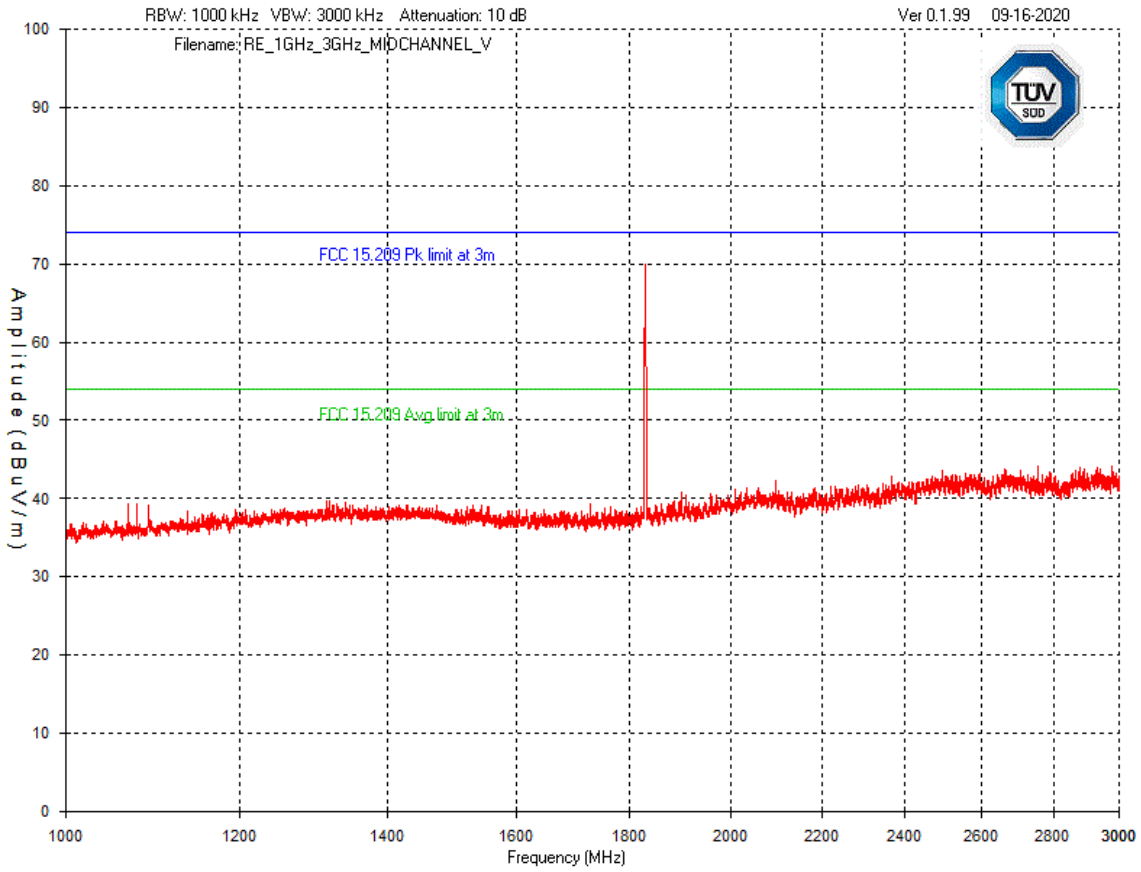
Graph 53 Test Results – Tx Spurious emission 1GHz – 3GHz-(Horizontal polarisation): Channel #33



Graph 54 Test Results – Tx Spurious emission 1GHz – 3GHz-(Vertical polarisation): Channel #39

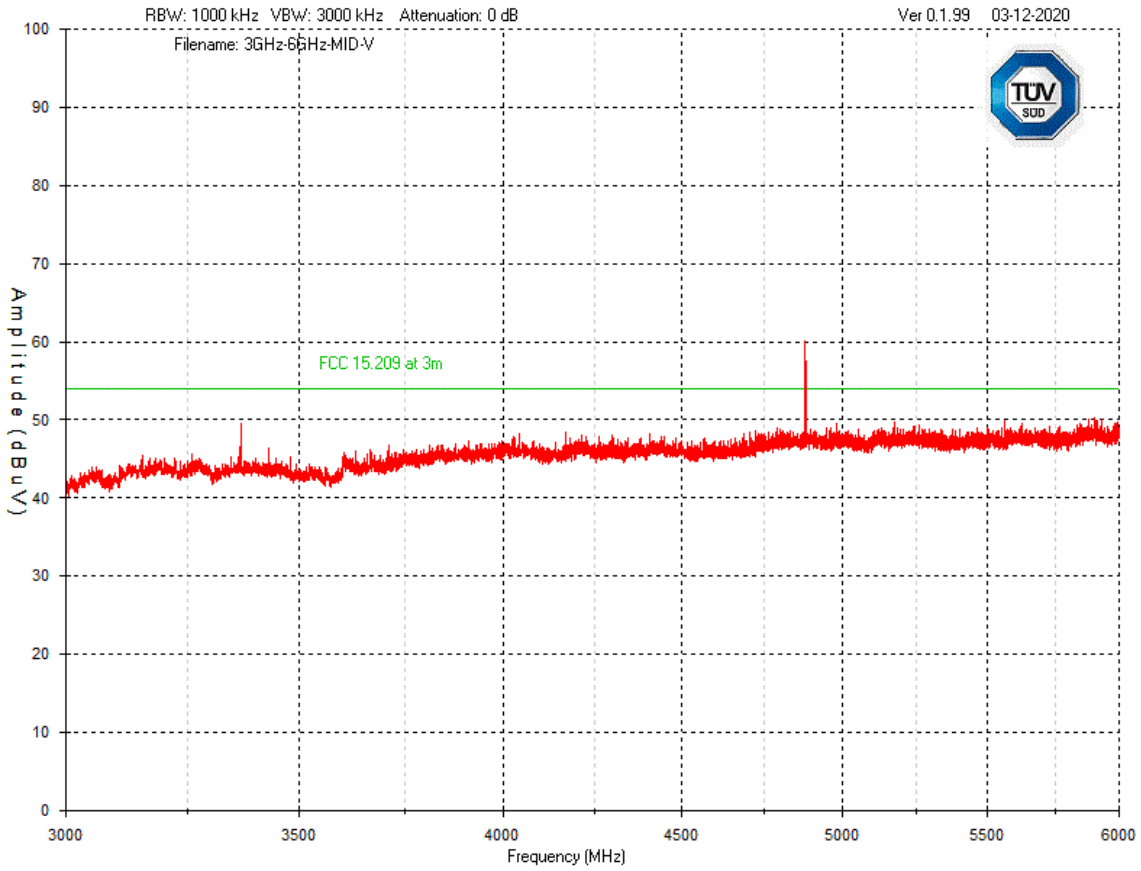


Graph 55 Test Results – Tx Spurious emission 1GHz – 3GHz-(Vertical polarisation): Channel #19

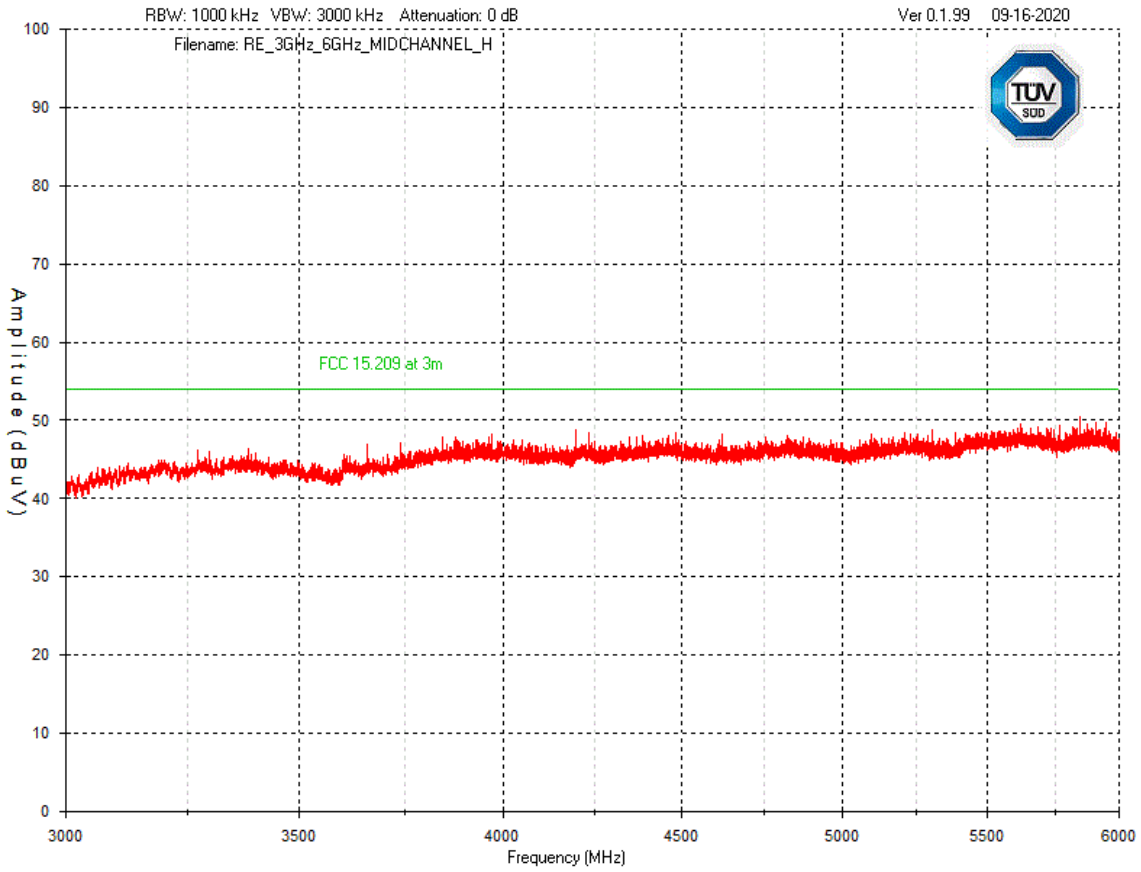


Graph 56 Test Results – Tx Spurious emission 1GHz – 3GHz-(Vertical polarisation): Channel #33

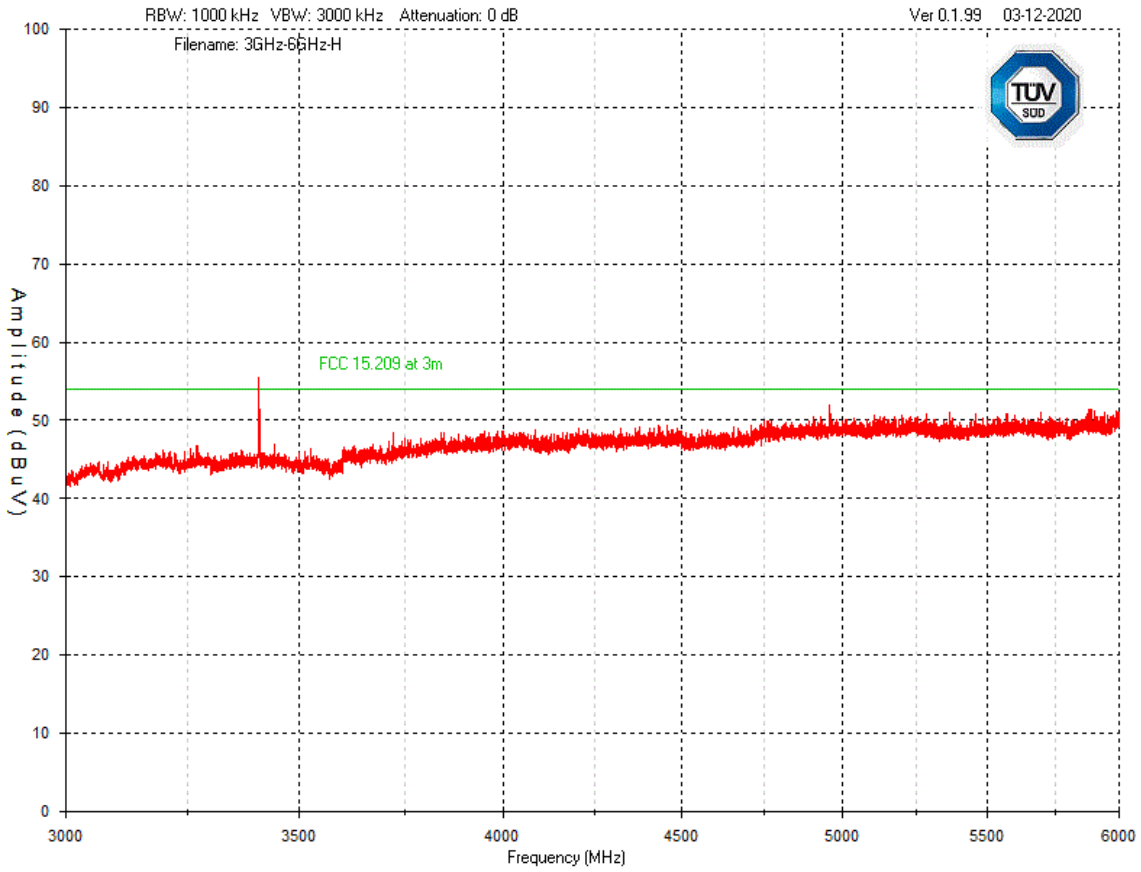
Frequency Range from 3GHz to 6GHz – Worst case – Channel #19, Channel #33 and Channel #39



Graph 57 Test Results – Tx Spurious emission 3GHz – 6GHz-(Vertical polarisation): Channel #19

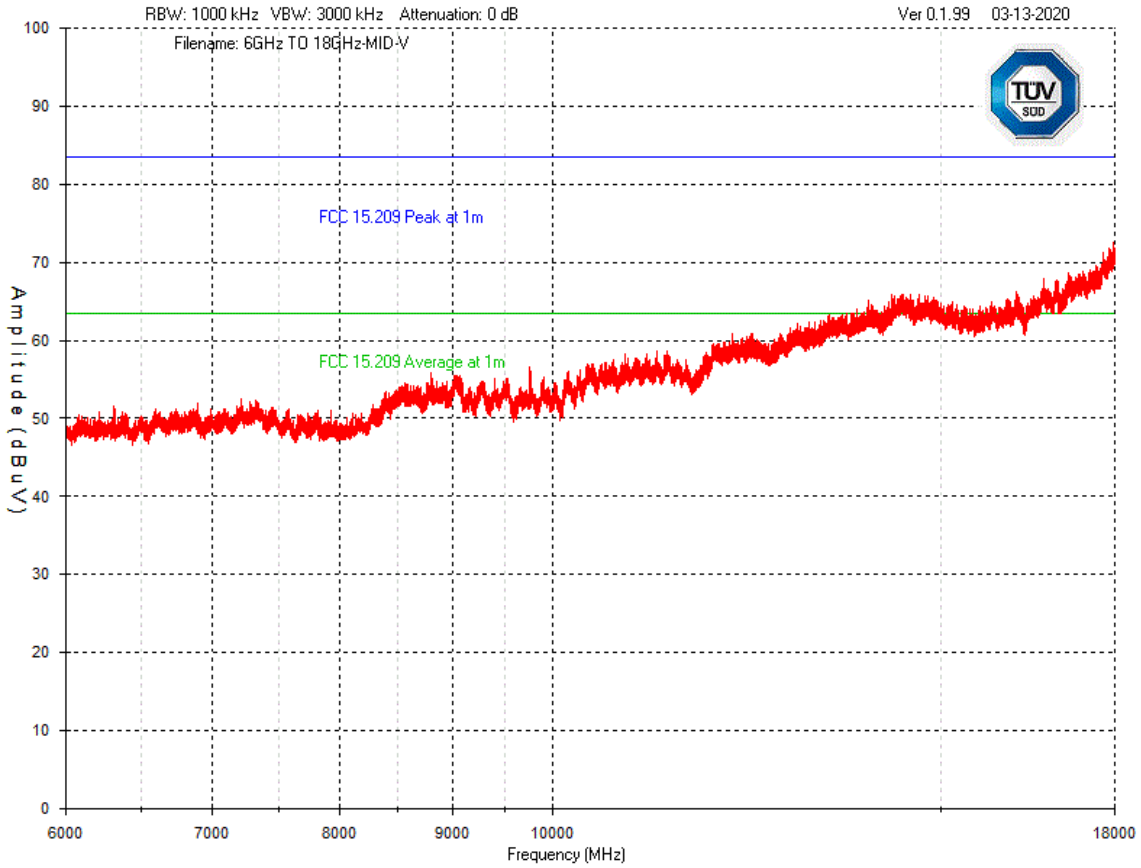


Graph 58 Test Results – Tx Spurious emission 3GHz – 6GHz-(Horizontal polarisation): Channel #33

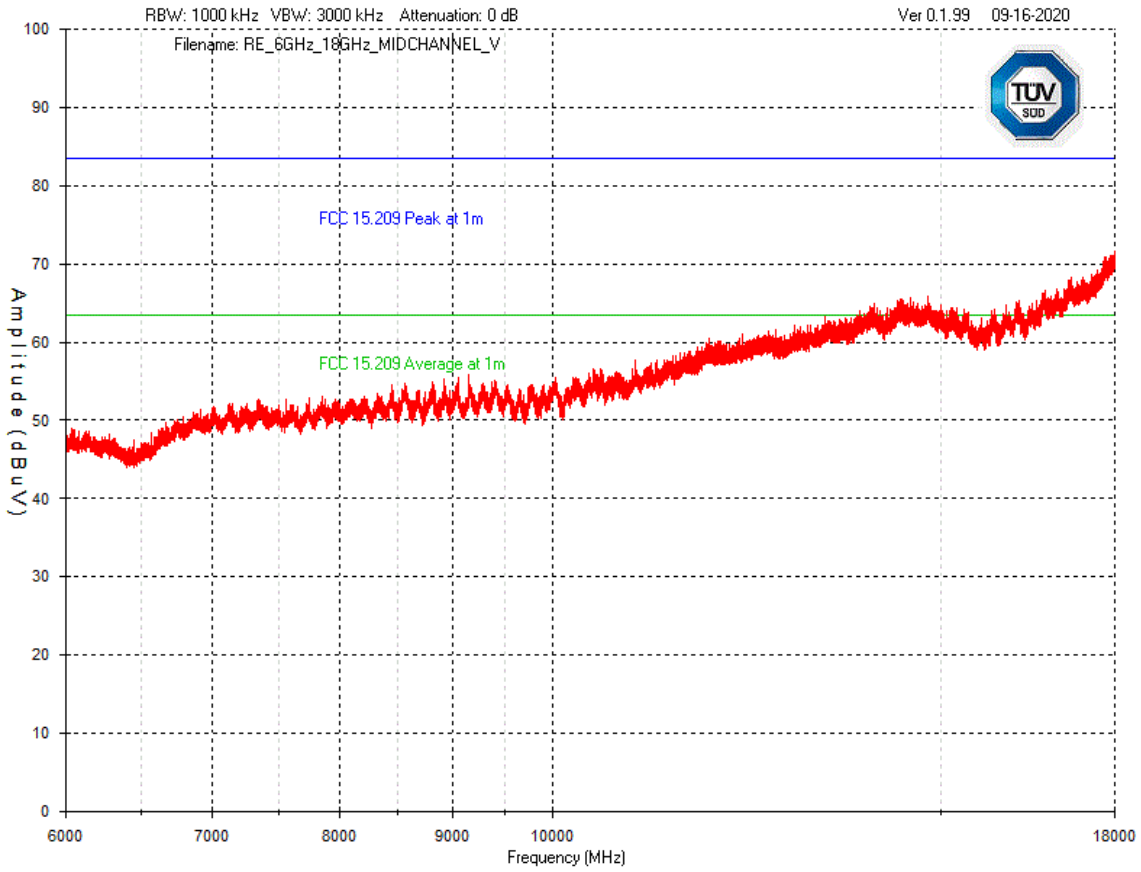


Graph 59 Test Results – Tx Spurious emission 3GHz – 6GHz-(Horizontal polarisation): Channel #39

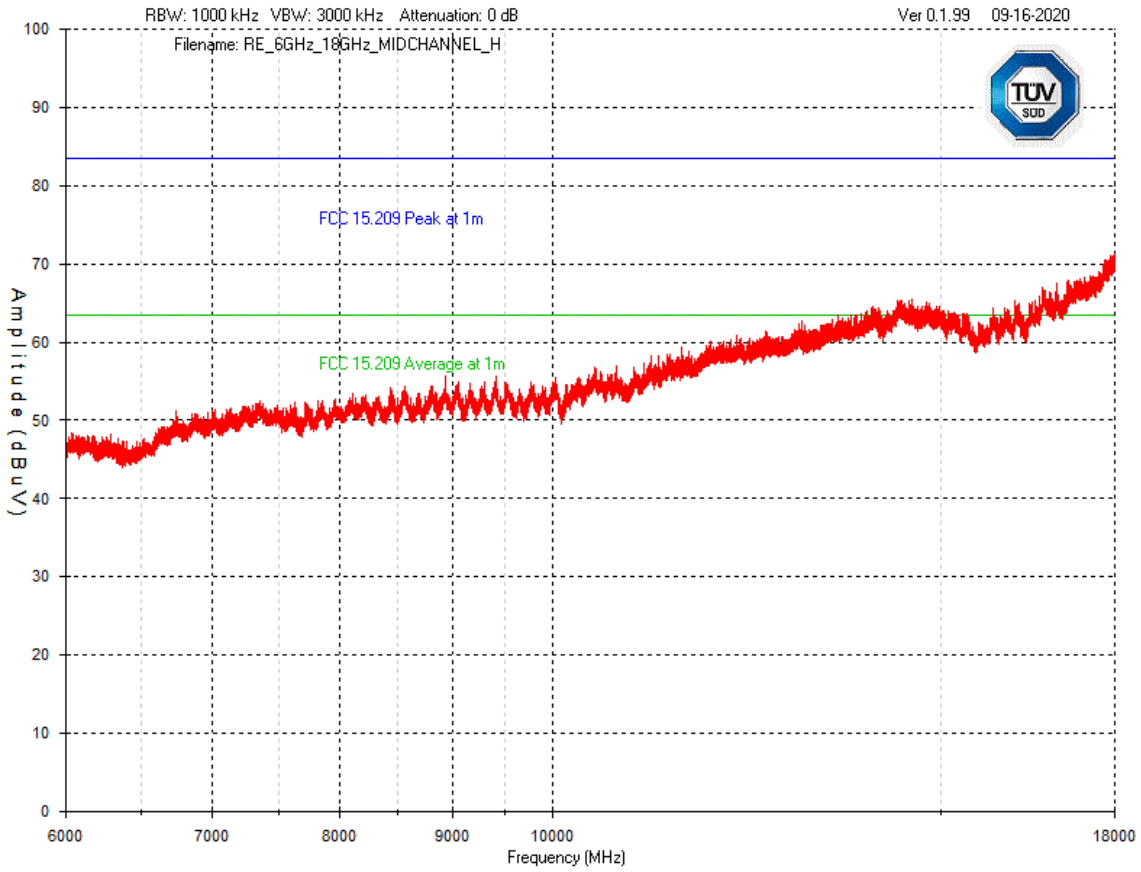
Frequency Range from 6GHz to 18GHz– Worst case – Channel #19, Channel #33, Channel #39



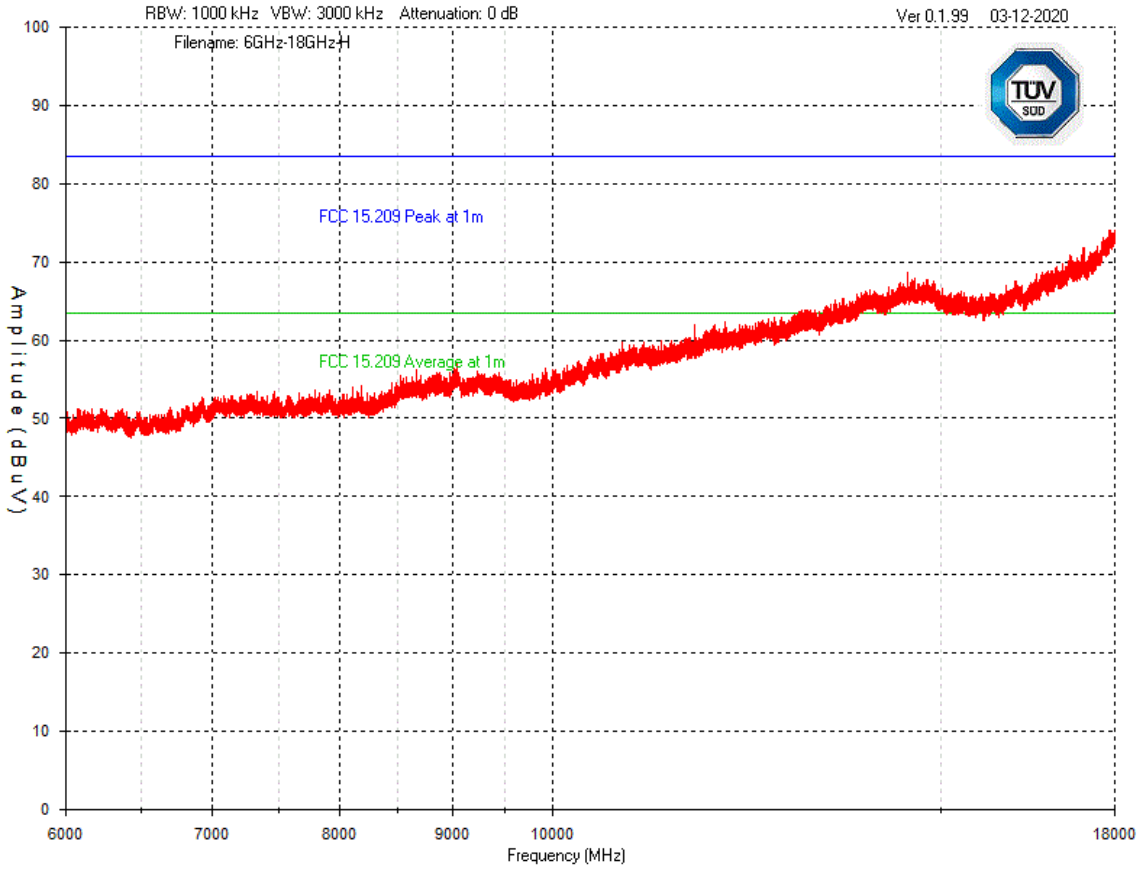
Graph 60 Test Results – Tx Spurious emission 6GHz – 18GHz-(Vertical polarisation): Channel #19



Graph 61 Test Results – Tx Spurious emission 6GHz – 18GHz-(Vertical polarisation): Channel #33



Graph 62 Test Results – Tx Spurious emission 6GHz – 18GHz-(Horizontal polarisation): Channel #33



Graph 63 Test Results – Tx Spurious emission 6GHz – 18GHz-(Horizontal polarisation): Channel #39

14.7 Test Instruments

This test was carried out in Laval test location.

Equipment	Model No.	Manufacturer	Calibration Period (months)	Calibration Due (YYY-MM-DD)	Asset No LAV0
Spectrum Analyzer	ESU-40	Rohde & Schwarz	12	2021-07-17	4092
BiLog Antenna	3142-E	ETS	24	2021-11-29	4002
Attenuator 4 dB	20181128A	KLP	24	2021-11-29	4300
Horn Antenna	ATH1G18G	AR	24	2021-04-25	4005
Attenuator 6 dB	FP-50-3	Trilithic	NCR	NCR	4125
LPA pre-amp	Keysight	LPA-10-20	24	2021-02-28	244
1-26.5GHz preamp	Agilent	8449B	NCR	NCR	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	0.1.94	Global EMC	NCR	NCR	4058

Table 31 – Test Instrumentation – Tx Spurious Emission

15 Conducted Emissions

15.1 Purpose & Methods

The Purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT trough conducted lines does not exceed the limits listed below as defined in the applicable test standard, as measured from a LISN. This helps protect broadcast radio services such as television, FM radio, pagers, cellular telephones, emergency services, and so on, from unwanted interference. The method is as defined in ANSI C63.10 Section 6.2.

Frequency (MHz)	Average Limit	Quasi-Peak Limit
0.15 MHz – 0.5 MHz	56 to 46*	66 to 56*
0.5 MHz – 5 MHz	56	46
5 MHz – 30 MHz	60	50
*Decrease with the Logarithm of the frequency		

Table 32 Limits – Conducted Emissions

15.2 Test Specifications

REFERENCE STANDARD	FCC Part 15.207(a) RSS-247 GEN 8.8 ANSI C63.10 Clause 6.2	
SPECIFICATIONS		
Limit (dBuV/m)	See Table 32	
Frequencies (MHz)	2402 2440 2480	902.46 915 926.4
EUT		
Identification	WX DB Thermostat (900MHz/ 2.4GHz)	
Voltage Input	24 Vac	
ENVIROMENTAL & TEST INFO		
Test Date (YYYY-MM-DD)	2020-03-17	2020-09-17
Temperature (°C)	23.6 ± 2	23.4 ± 2
Humidity (%)	18.8 ± 5	40.5 ± 5
Atmospheric Pressure kPa (For Info Only)	100.85	101.4
Tester	Abdoulaye Ndiaye Jose Martinez-Ortega	
Client Witness	Jie Zhou	

15.3 Limits

The limits, as defined in 15.207(a) for conducted emissions. These emissions must comply with the conducted emission limits specified in Section 15.207(a).

15.4 Test Setup

As per ANSI C63.10 Clause 6.2.2, the EUT was set to 80cm from the LISN. and 40cm from the VCP

Photo 5: – Test Setup – Conducted Emission WX DB (2.4GHz/915MHz)

15.5 Results

This test is performed in accordance with the method defined in FCC 15 207 Subpart C and results are depicted in Table 33

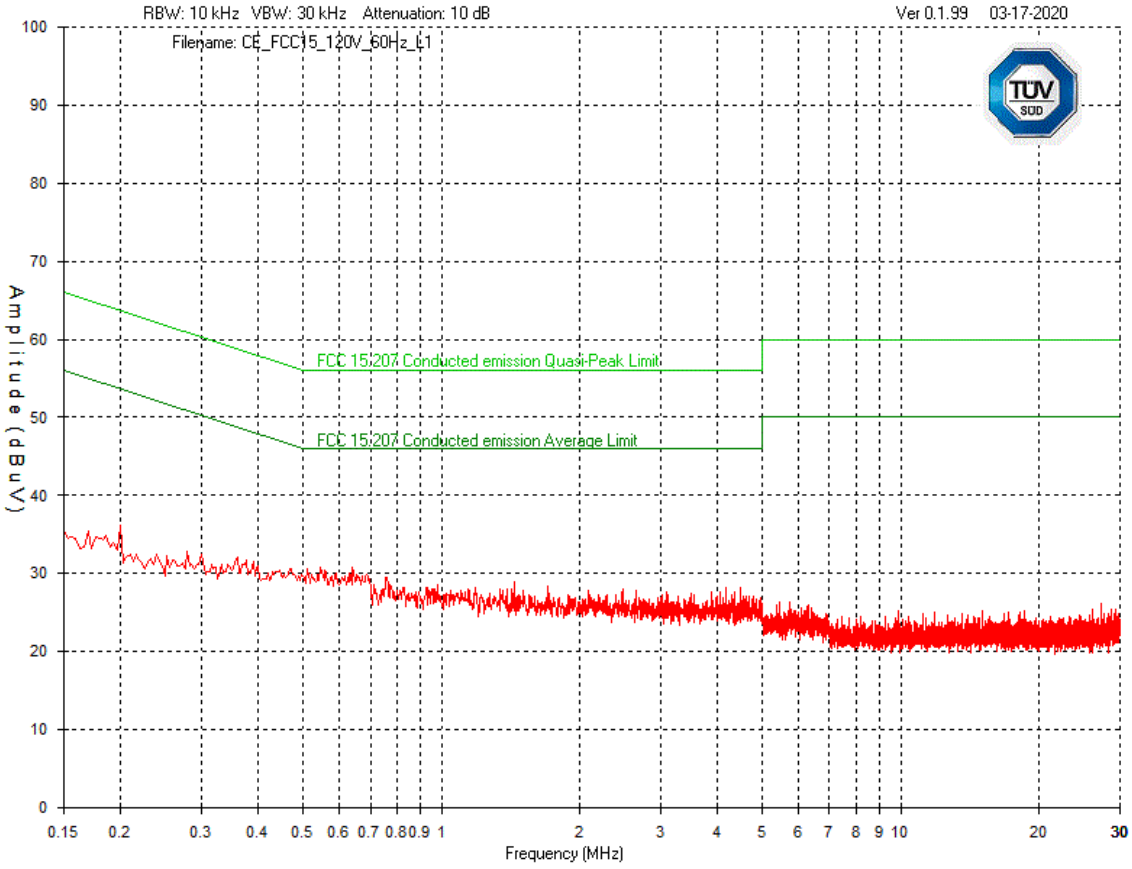
Tested Line	Frequency (MHz)	Quasi-Peak Limit dB(µV)	Average Limit dB(µV)	Results <Note 2>
Power – Phase (120V/60Hz)	0.150 – 0.50 <Note 1>	66 - 56	56 - 46	Pass
	0.50 – 5	56	46	Pass
	5 - 30	60	50	Pass
Power – Neutral (120V/60Hz)	0.150 – 0.50 <Note 1>	66 - 56	56 - 46	Pass
	0.5 – 5	56	46	Pass
	5 - 30	60	50	Pass
Note 1. The lower limit shall apply at the transition frequency Note 2: Only High channel was used for that test since he has the highest Rf Output level				

Table 33 – Test Results for Conducted Emission –WX DB (2.4GHz/900MHz)

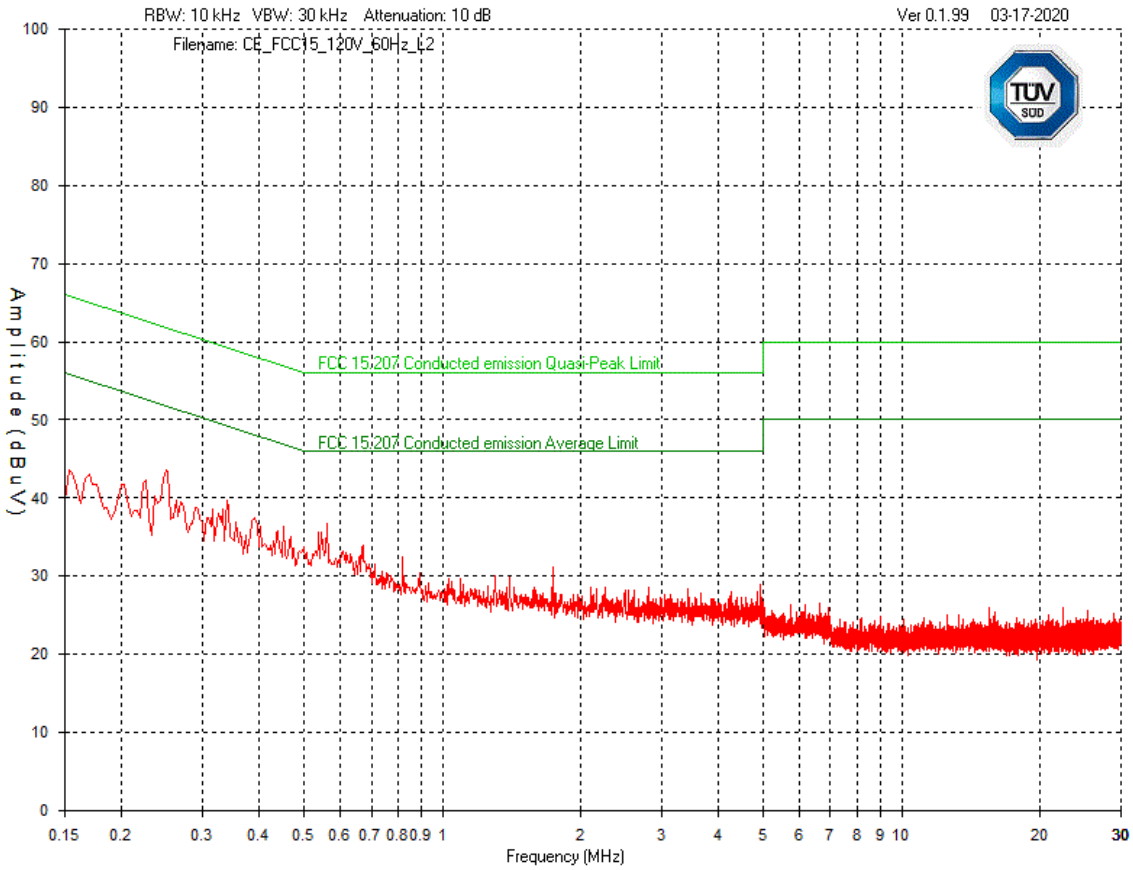
15.6 Graphs

The graphs shown below are maximized peak measurement graphs measured with a resolution bandwidth greater than or equal to the final required detector. This peaking process is done as a worst-case measurement and enables the detection of frequencies of concern for final measurement. For final measurements with the appropriate detector, where applicable, please refer to the tables under Final Measurements.

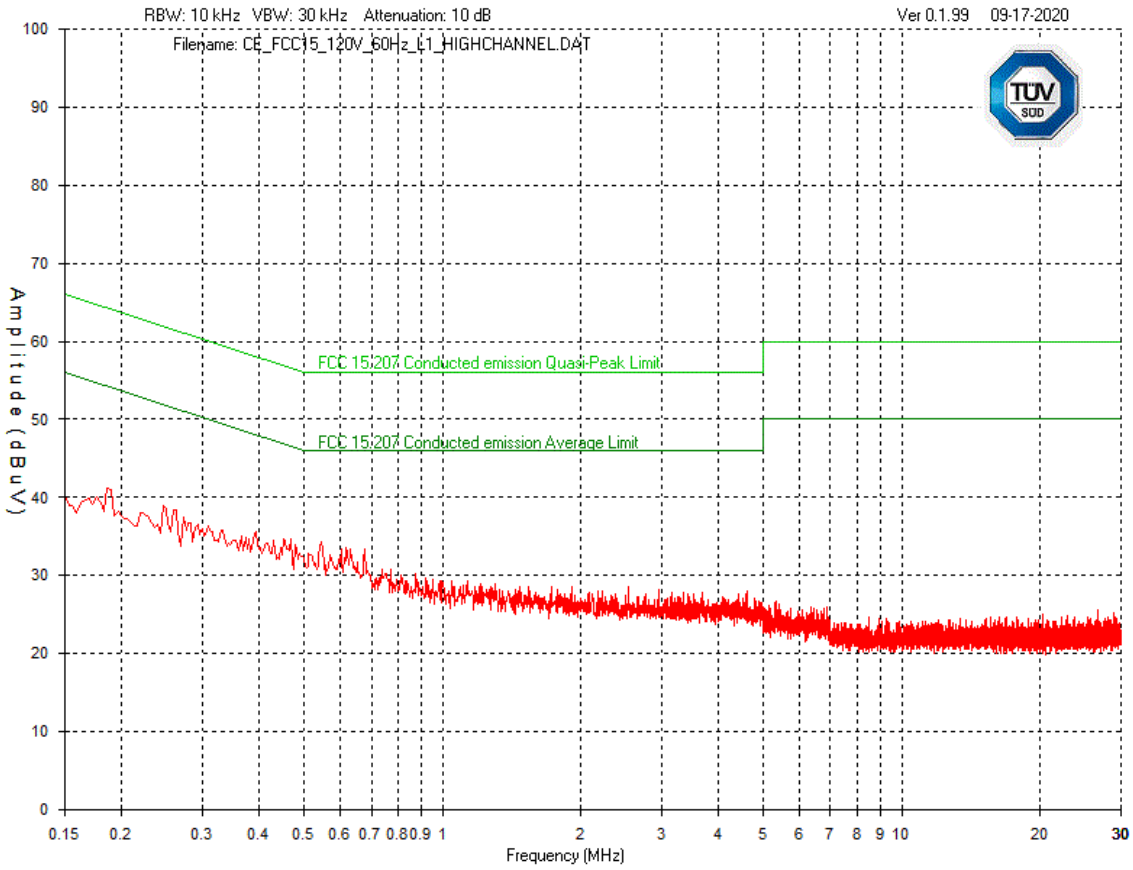
Only middle channel was tested as worst case. However, the worst-case graphs are presented.



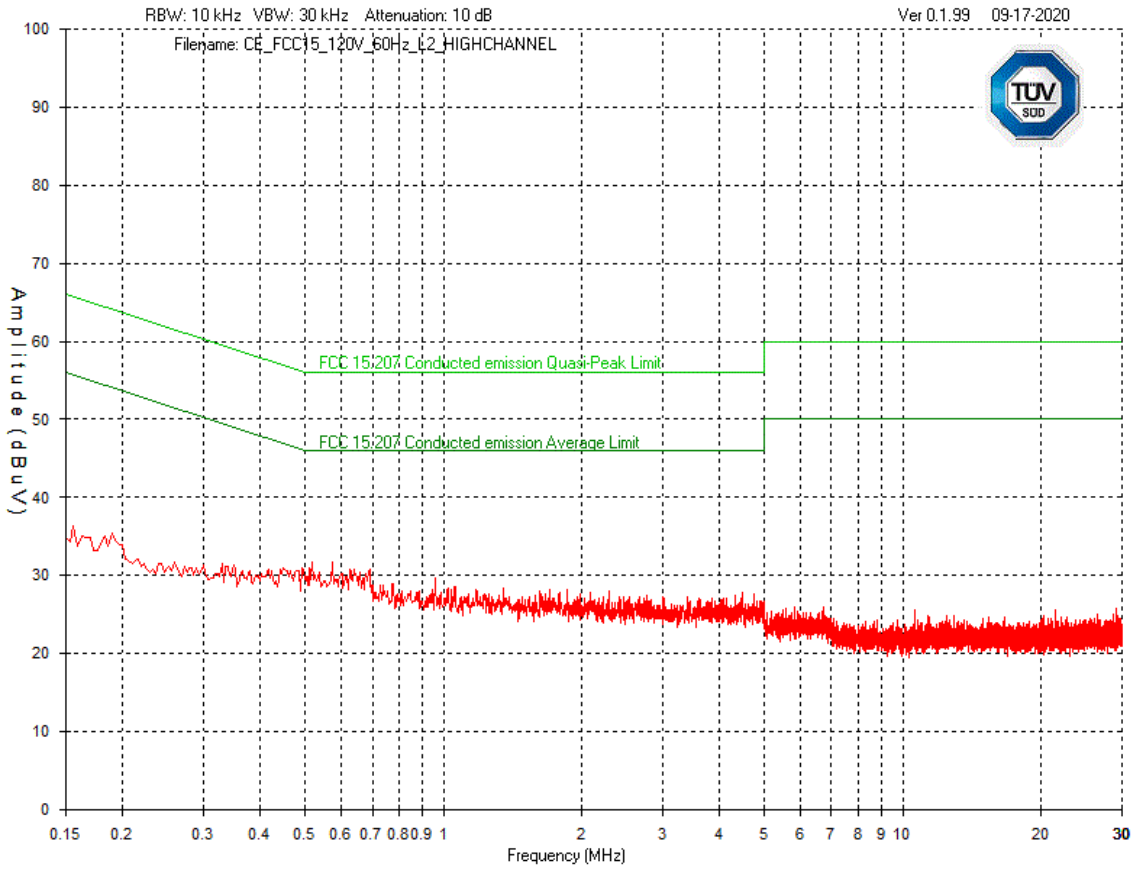
Graph 64: Conducted Emissions Power – Phase – WX DB(2.4GHz)



Graph 65: Conducted Emissions Power – Neutral – WX DB(2.4GHz)



Graph 66: Conducted Emissions Power – Phase – WX DB (900MHz)



Graph 67: Conducted Emissions Power – Neutral – WX DB (900MHz)

Tested Line	Frequency (MHz)	Detector	Limit dB(µV)	Level (dBµV)	Bandwidth (kHz)	Measurement Time (s)	Margin
Power – Phase (120V/60Hz)	-	-	-	-	9 kHz	15	Note 1
Power – Neutral (120V/60Hz)	-	-	-	-	9 kHz	15	Note 1
Conducted emission level (dBµV) = Value reading at the EMI receiver (dBµV) + Correction factor (dB) Correction factor (dB) = LISN attenuation (dB) + cable loss (dB) – amplifier gain (dB) + attenuator (dB) Note 1: No significant emission was noted.							

Table 34: Test Results Lowest Margin according to FCC 15.207

15.7 Test instruments

This test was carried out in Laval test location.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due (YYY-MM-DD)
Spectrum Analyzer	ESU-40	Rohde & Schwarz	4092	12	2021-07-17
LISN	FCC-LISN-50/250-16-2-01	FCC	4005	12	2021-02-27
RF Cable 2.5m	LMR-400-1M-50OHM-MN-MN	LexTec	4039	NCR	NCR
Attenuator 10 dB	FP-50-10	Trilithic	4027	NCR	NCR
Emission software	0.1.95	Global EMC	58	NCR	NCR

Table 35: Conducted Emission Test Equipment

APPENDIX A: Tx Spurious Emissions – Worst Cases

Frequency (MHz)	Detector	Raw Reading	Antenna Factor (dB/m	Atten Factor (dB	Cable 27 - 10m LMR400 Factor	Cable 28 - 7m LMR400 Factor	Cable 30 - 0.5m LMR400 Factor	Preamp-LNA1450 Factor	Level	FCC 15.209 Limit	FCC 15.209 Limit Margin
914.943	PEAK	72.6	28.3	10	1.4	1	0.2	-32.3	81.2	46.4	-34.8 <Note 1>
735.605	QP	21.4	26	10	1.2	0.9	0.2	-33	26.7	46.4	19.7
695.309	QP	21.5	26.4	10	1.2	0.8	0.2	-33.1	27	46.4	19.4
541.216	QP	23	24.5	10	1	0.7	0.2	-33.2	26.2	46.4	20.2
30.8739	QP	20.1	20.9	10	0.3	0.2	0	-32.4	19.1	40	20.9
30	QP	20	21.4	10	0.3	0.2	0	-32.4	19.5	40	20.5
Note 1. Transmitter Frequency excluded from FCC limits.											

Table A.1 Tx Spurious Emission Channel #33 – 30MHz - 1GHz: Horizontal Polarization

Frequency (MHz)	Detector	Raw Reading	Antenna Factor (dB/m	Atten Factor (dB	Cable 27 - 10m LMR400 Factor	Cable 28 - 7m LMR400 Factor	Cable 30 - 0.5m LMR400 Factor	Preamp-LNA1450 Factor	Level	FCC 15.209 Limit	FCC 15.209 Limit Margin
915.04	PEAK	77.6	27.5	10	1.4	1	0.2	-32.3	85.4	46.4	-39 <Note 1>
698.805	QP	21.6	25.8	10	1.2	0.8	0.2	-33.1	26.5	46.4	19.9
532.38	QP	21.9	23.8	10	1	0.7	0.2	-33.2	24.4	46.4	22
30	PEAK	32.5	19.2	10	0.3	0.2	0	-32.4	29.8	40	10.2
30.5826	PEAK	32.4	18.9	10	0.3	0.2	0	-32.4	29.4	40	10.6
156.615	PEAK	35.2	15.3	10	0.6	0.4	0.1	-33.4	28.2	43.5	15.3
Note 1. Transmitter Frequency excluded from FCC limits.											

Table A.2 Tx Spurious Emission Channel #33 – 30MHz - 1GHz: Vertical Polarization

Frequency (MHz)	Detector	Raw Reading	Antenna Factor (dB/m	Atten Factor (dB	Cable 27 - 10m LMR400 Factor	Cable 28 - 7m LMR400 Factor	Cable 30 - 0.5m LMR400 Factor	Preamp-LNA1450 Factor	Level	FCC 15.209 Limit	FCC 15.209 Limit Margin
926.466	PEAK	95.7	28.2	10	1.4	1	0.2	-32.2	104.3	46.4	-57.9 <Note 1>
837.362	QP	20.4	26.8	10	1.3	0.9	0.2	-32.7	26.9	46.4	19.5
188.268	QP	32.7	14.6	10	0.6	0.4	0.1	-33.3	25.1	43.5	18.4
557.334	PEAK	36.3	24.1	10	1.1	0.8	0.2	-33.2	39.3	46.4	7.1
31.2623	PEAK	32.5	20.6	10	0.3	0.2	0	-32.4	31.2	40	8.8
743.567	PEAK	32.3	26	10	1.2	0.9	0.2	-33	37.6	46.4	8.8
Note 1. Transmitter Frequency excluded from FCC limits.											

Table A.3 Tx Spurious Emission Channel #39 – 30MHz - 1GHz: Vertical Polarization

Frequency	Detector	Raw Reading	Antenna Factor (dB/m	Cable 27 - 10m LMR400 Factor	Cable 28 - 7m LMR400 Factor	Cable 30 - 0.5m LMR400 Factor	Preamp - HP 8449B 4006 Factor	Level	FCC 15.209 Average at 3m Limit	FCC 15.209 Average at 3m Margin
1830.26	AVE	30.1	24.9	2	1.4	0.3	-33.1	25.6	54	28.4
2754.33	PEAK	43.8	28.7	2.5	1.9	0.4	-33.1	44.2	54	9.8
2098.24	PEAK	44.3	27	2.1	1.5	0.3	-33	42.2	54	11.8
1316.6	PEAK	45	25.3	1.7	1.2	0.3	-33.7	39.8	54	14.2

Table A.4 Tx Spurious Emission Channel #33 – 1GHz - 3GHz: Vertical Polarization

Frequency	Detector	Raw Reading	Antenna Factor (dB/m	Cable 27 - 10m LMR400 Factor	Cable 28 - 7m LMR400 Factor	Cable 30 - 0.5m LMR400 Factor	Preamp - HP 8449B 4006 Factor	Level	FCC 15.209 Average at 3m Limit	FCC 15.209 Average at 3m Margin
1830.54	AVE	28.7	24.9	2	1.4	0.3	-33.1	24.2	54	29.8
2481.2	PEAK	43.8	28.5	2.3	1.8	0.4	-33.1	43.7	54	10.3
2086.52	PEAK	43.6	27.1	2.1	1.5	0.3	-33.1	41.5	54	12.5
1678.11	PEAK	44.6	24.7	1.9	1.3	0.4	-33.2	39.7	54	14.3

Table A.5 Tx Spurious Emission Channel #33 – 1GHz - 3GHz: Horizontal Polarization

Frequency (MHz)	Detector	Raw Reading	Antenna Factor (dB/m	Cable 27 - 10m LMR400 Factor	Cable 28 - 7m LMR400 Factor	Cable 30 - 0.5m LMR400 Factor	Pre-Amp (dB)	Level	FCC 15.209 Limit	FCC 15.209 Limit Margin
2439.73	Peak	91.8	28.3	2.3	1.8	0.4	-33.1	91.5	54	-37.5 <Note 1>
1855.43	AVE	19.7	25.1	2	1.4	0.3	-33.1	15.4	54	38.6
2416.56	AVE	20.1	28.2	2.3	1.8	0.4	-33.1	19.7	54	34.3
1512.8	Peak	47.7	25	1.8	1.3	0.4	-33.4	42.8	54	11.2
1433.58	Peak	45.3	25.4	1.7	1.2	0.4	-33.5	40.5	54	13.5
Note 1. Transmitter Frequency excluded from FCC limits.										

Table A.6 Tx Spurious Emission Mid Channel#19 (2.4GHz) –1GHz – 3GHz: Vertical Polarization

Frequency (MHz)	Detector	Raw Reading	Antenna Factor (dB/m	Cable 27 - 10m LMR400 Factor	Cable 28 - 7m LMR400 Factor	Cable 30 - 0.5m LMR400 Factor	Pre-Amp (dB)	Level	FCC 15.209 Limit	FCC 15.209 Limit Margin
2440.3	Peak	97	28.3	2.3	1.8	0.4	-33.1	96.7	54	-42.7 <Note 1>
1855.43	AVE	19.7	25.1	2	1.4	0.3	-33.1	15.4	54	38.6
2655.37	AVE	19	29.1	2.4	1.9	0.4	-33.1	19.7	54	34.3
1512.8	Peak	47	25	1.8	1.3	0.4	-33.4	42.1	54	11.9
1879.74	Peak	42.2	25.2	2	1.4	0.3	-33.1	38	54	16
Note 1. Transmitter Frequency excluded from FCC limits.										

Table A.7 Tx Spurious Emission Mid Channel#19 (2.4GHz) –1GHz – 3GHz: Horizontal Polarization

Frequency (MHz)	Detector	Raw Reading	Antenna Factor (dB/m	Cable 27 - 10m LMR400 Factor	Cable 28 - 7m LMR400 Factor	Cable 30 - 0.5m LMR400 Factor	Pre-Amp (dB)	Level	FCC 15.209 Limit	FCC 15.209 Limit Margin
2479.87	PEAK	87	28.5	2.3	1.8	0.4	-33.1	86.9	N/A	N/A
2483.5	PEAK	40.7	28.5	2.3	1.8	0.4	-33.1	40.6	54	13.4 <Note 1>
1855.49	AVE	19.6	25.1	2	1.4	0.3	-33.1	15.3	54	38.7
2442.71	AVE	19.7	28.3	2.3	1.8	0.4	-33.1	19.4	54	34.6
2455.17	PEAK	46.4	28.3	2.3	1.8	0.4	-33.1	46.1	54	7.9
1552.84	PEAK	47	24.9	1.8	1.3	0.4	-33.4	42	54	12
Note 1. The peak reading was compared with the average limit and found in compliance. Therefore, the average reading was not necessary.										

Table A.8 Tx Spurious emission 1GHz – 3GHz-(Vertical polarisation): Channel #39

Frequency	Detector	Raw Reading	Antenna Factor (dB/m	Cable 27 - 10m LMR400 Factor	Cable 28 - 7m LMR400 Factor	Cable 30 - 0.5m LMR400 Factor	Preamp - HP 8449B 4006 Factor	Level	FCC 15.209 Average at 3m Limit	FCC 15.209 Average at 3m Margin
4880.18	AVE	37.2	33.2	3.4	2.5	0.6	-32.8	44.1	54	9.9
5900.9	AVE	19.2	33.6	4.1	2.7	0.7	-32.8	27.5	54	26.5
5174.77	AVE	19.5	33.4	3.6	2.5	0.6	-32.7	26.9	54	27.1
3367.87	AVE	26.6	30.3	2.9	2.2	0.5	-33	29.5	54	24.5

Table A.9 Tx Spurious Emission Channel #19 (2.4GHz) –3GHz - 6GHz: Vertical Polarization

Frequency	Detector	Raw Reading	Antenna Factor (dB/m	Cable 27 - 10m LMR400 Factor	Cable 28 - 7m LMR400 Factor	Cable 30 - 0.5m LMR400 Factor	Preamp - HP 8449B 4006 Factor	Level	FCC 15.209 Average at 3m Limit	FCC 15.209 Average at 3m Margin
3407.81	AVE	35.8	30.2	2.9	2.2	0.5	-33	38.6	54	15.4
4960.36	AVE	30.5	33.4	3.4	2.5	0.6	-32.8	37.6	54	16.4
5892.79	AVE	18.9	33.6	4.1	2.7	0.7	-32.8	27.2	54	26.8
3721.92	AVE	22.9	30.4	3	2.3	0.5	-32.9	26.2	54	27.8

Table A.10 Tx Spurious Emission Channel #39 (2.4GHz) –3GHz - 6GHz: Horizontal Polarization

Frequency	Detector	Raw Reading	Antenna Factor (dB/m	Cable 27 - 10m LMR400 Factor	Cable 28 - 7m LMR400 Factor	Preamp - HP 8449B 4006 Factor	Level	FCC 15.209 Average at 1m Limit	FCC 15.209 Average at 1m Margin
17976.4	AVE	17.6	45	10	10	-32.3	50.3	63.5	13.2
16764.7	AVE	17.7	40.9	9.2	9.2	-32.6	44.4	63.5	19.1
11270.6	AVE	18.2	39.3	5.7	5.5	-32.8	35.9	63.5	27.6
9760.92	AVE	20.5	38.8	4.8	4.5	-33.6	35	63.5	28.5
8794.54	AVE	18.5	38.3	4.6	3.9	-33.3	32	63.5	31.5

Table A.11 Tx Spurious Emission Channel #19 (2.4GHz) –6GHz - 18GHz: Vertical Polarization

Frequency	Detector	Raw Reading	Antenna Factor (dB/m	Cable 27 - 10m LMR400 Factor	Cable 28 - 7m LMR400 Factor	Preamp - HP 8449B 4006 Factor	Level	FCC 15.209 Average at 1m Limit	FCC 15.209 Average at 1m Margin
17986.8	AVE	17.2	45.1	10	10	-32.3	50	63.5	83.5
14809.1	AVE	18	41.5	8	7.9	-32.3	43.1	63.5	83.5
9155.67	AVE	18.2	38.8	4.7	4.2	-33.5	32.4	63.5	83.5
9059.96	AVE	17.9	38.7	4.7	4.1	-33.4	32	63.5	83.5
10025.6	AVE	18.4	38.7	4.9	4.7	-33.6	33.1	63.5	83.5
8925.12	AVE	18.5	38.5	4.6	4	-33.4	32.2	63.5	83.5
8814.3	AVE	18.5	38.3	4.6	3.9	-33.3	32	63.5	83.5
8561.66	AVE	19	37.9	4.5	3.7	-33.3	31.8	63.5	83.5

Table A.12 Tx Spurious Emission Channel #33 (900MHz) –6GHz - 18GHz: Vertical Polarization

Frequency	Detector	Raw Reading	Antenna Factor (dB/m	Cable 27 - 10m LMR400 Factor	Cable 28 - 7m LMR400 Factor	Preamp - HP 8449B 4006 Factor	Level	FCC 15.209 Average at 1m Limit	FCC 15.209 Average at 1m Margin
17992.3	AVE	17.8	45.1	10	10	-32.3	50.6	63.5	12.9
14479.7	AVE	17.9	41.9	7.8	7.6	-31.9	43.3	63.5	20.2
16239.3	AVE	18.8	40	8.9	8.8	-33.2	43.3	63.5	20.2
11588.3	AVE	17.9	39.4	5.9	5.7	-32.8	36.1	63.5	27.4
10745.9	AVE	10.6	39.4	5.4	5.1	-33	27.5	63.5	36

Table A.12 Tx Spurious Emission Channel #39 (2.4GHz) –6GHz - 18GHz: Horizontal Polarization

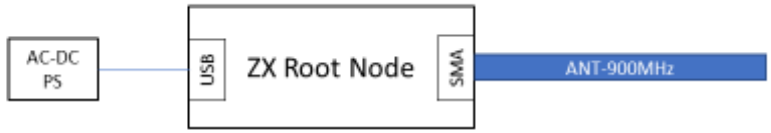
APPENDIX B: Zx DUTs Test Setup

ZX Root Node – 915MHz Band FCC test setup

Radiated

Test Code:

- *3 frequencies, modulated, 100% duty, power cycle to change frequency*
- *frequency sweep, modulated*



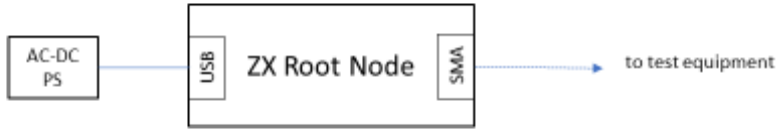
Comments:

- same DUT used for both radiated and conducted test;
- total 2 units required:
  1 programmed with 3 frequencies code;
  1 programmed with frequency sweep code;

Conducted

Test Code:

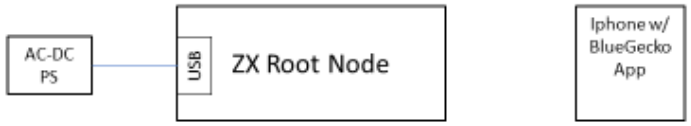
- *3 frequencies, modulated, 100% duty, power cycle to change frequency*
- *frequency sweep, modulated*



ZX Root Node – 2.4GHz Band BLE FCC test setup

Radiated

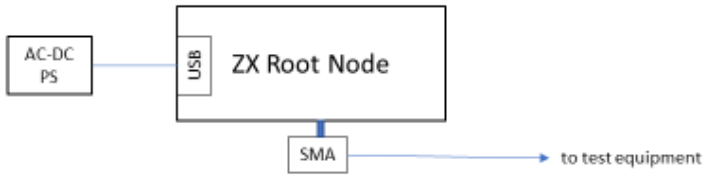
Test Code:
- *3 frequencies, modulated, 100% duty, use BlueGecko DTM set the frquencies*



Comments:
- total 1 unit required:
  use DTM test code to set to the carrier required for the test;

Conducted

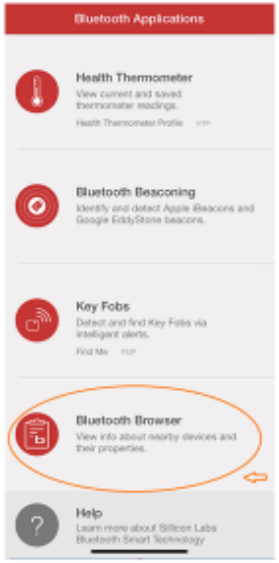
Test Code: need to verify the DUT can receive the command from the phone without antenna????
- *3 frequencies, modulated, 100% duty, power cycle to change frequency*
- *frequency sweep, modulated*



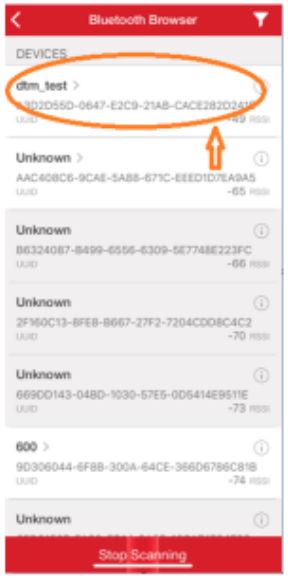
Appendix:

How to set up BlueGecko DTM in Transimit Mode

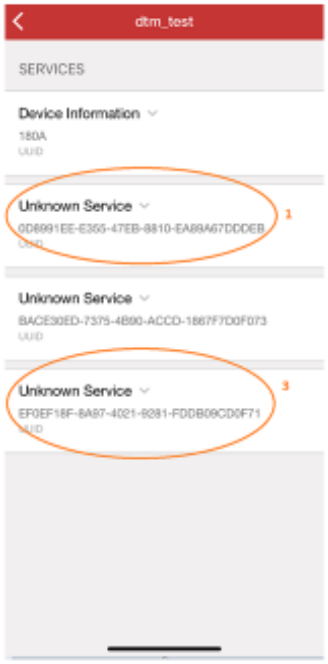
Step 1: start "BlueGecko" app on my phone, and selected " Bluetooth Brower"



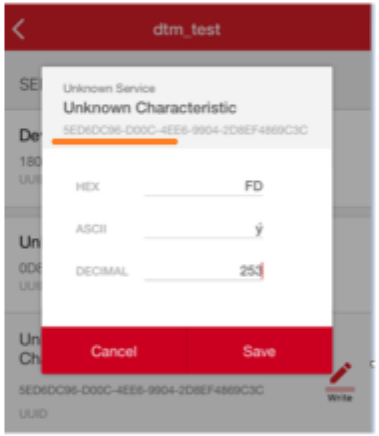
Step 2: Select DEVICES "dtm_test"



Step 3: enter info to "Unknown Service" 1 and 3



Step 4: in first "Service", press the down arrow sign next to the test, when that expand, you see editable "Characteristic" identified as "5ED6DC96" , an valid timer value needs to be entered here and press "Save". The timer unit is seconds.



Step 5: in third "Service", press the down arrow sign next to the test, when that expand, you see editable "Characteristic" identified as "31D511A9", a packet type needs to be entered here and press "Save". The timer unit is seconds.

Packet type settings:

Value	Name	Description
0	test_pkt_prbs9	PRBS9 packet payload
1	test_pkt_11110000	11110000 packet payload
2	test_pkt_10101010	10101010 packet payload
3	test_pkt_carrier_deprecated	Unmodulated carrier - deprecated
4	test_pkt_11111111	11111111 packet payload
5	test_pkt_00000000	00000000 packet payload
6	test_pkt_00001111	00001111 packet payload
7	test_pkt_01010101	01010101 packet payload
253	test_pkt_pn9	PN9 continuously modulated output
254	test_pkt_carrier	Unmodulated carrier

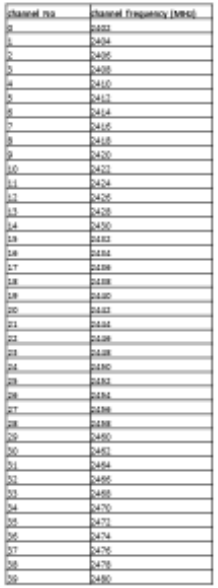
other special packet type named `test_pkt_pn9` (enumerating to a value of 253) that can be used to transmit a continuous modulated carrier instead, by mean of a PN9 stream offering a 100% duty cycle.

In general, for the regulatory testing PRBS9 (packet_type of 0) and/or the continuous modulated carrier are used, whereas the other two packet payloads (packet_type of 1 or 2) are used when testing for the Bluetooth qualification.

Step 6: in third "Service", enter data for the rest of 3 characteristics.

E4A01204 → Packet length (0~255), for Verdant 255 shall be used.

1928CD35 → Tx channel. (Channel = (F-2402)/2) where F is in MHz) →

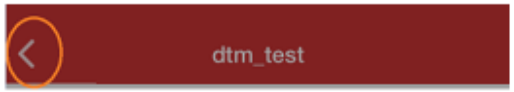


D559D164 → PHY. Decimal is "1".

PHY settings :

Value	Name	Description
1	test_phy_1m	1M phy
2	test_phy_2m	2M phy
3	test_phy_125k	125k Coded PHY
4	test_phy_500k	500k Coded PHY

Step 7: After entering all the required data, press the arrow button on the top panel "dtm_test", this will trigger DUT to transmit set carrier.

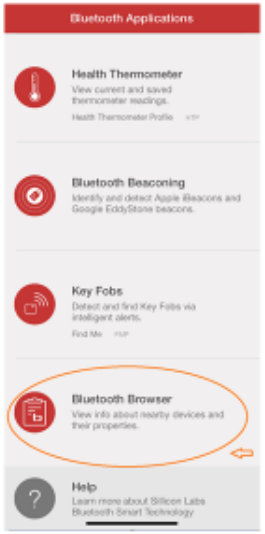


Step 8: Reconnect and read out the result in the timer service (the first one) with UUID starts with 0D8991EE and then the first characteristic UUID starts with 84D0E28A. The result corresponds to the number of packets transmitted by the DUT.

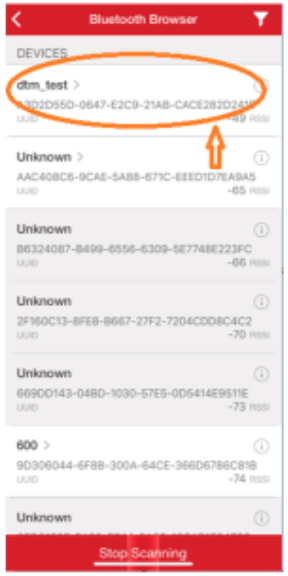
Appendix:

How to set up BlueGecko DTM in Receive Mode

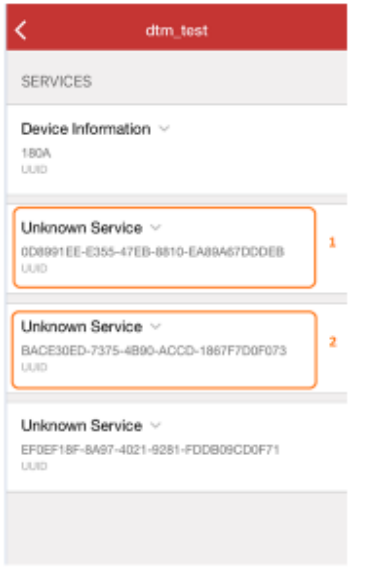
Step 1: start "BlueGecko" app on my phone, and selected " Bluetooth Brower"



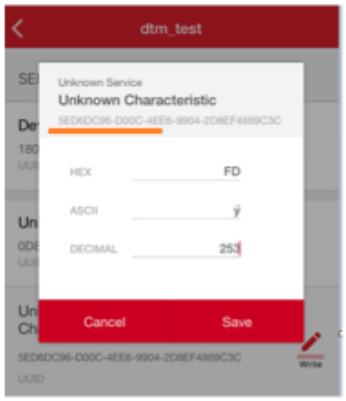
Step 2: Select DEVICES "dtm_test"



Step 3: enter info to "Unknown Service" 1 and 2

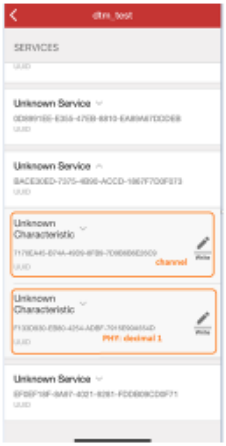


Step 4: in first "Service", press the down arrow sign next to the test, when that expand, you see editable "Characteristic" identified as "5ED6DC96" , an valid timer value needs to be entered here and press "Save". The timer unit is seconds.



Step 4: in second "Service", press the down arrow sign next to the test, when that expand, you see two editable "Characteristic"s.

- *first → channel*
- *second → PHY layer, enter "1" at decimal line*



Step 7: After entering all the required data, press the arrow button on the top panel "dtm_test", this will trigger DUT to receive mode.

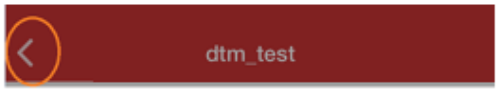


Table 2. Comparison of Classic Bluetooth and BLE Technical Specifications

Technical Specification	Classic Bluetooth	Bluetooth Low Energy
Frequency	2400 to 2483.5 MHz	2400 to 2483.5 MHz
Modulation Technique	Frequency Hopping	Frequency Hopping
Modulation Scheme	GFSK	GFSK
Modulation Index	0.35	0.5
Number of Channels	79	40
Channel Bandwidth	1 MHz	2 MHz
Nominal Data Rate	1 - 3 Mbps	1 Mbps
Application Throughput	0.7 - 2.1 Mbps	< 0.3 Mbps
Nodes / Active Slaves	7	Unlimited
Security	56 to 128 bit	128-bit AES
Robustness	FHSS	FHSS
Voice	Capable	Not capable

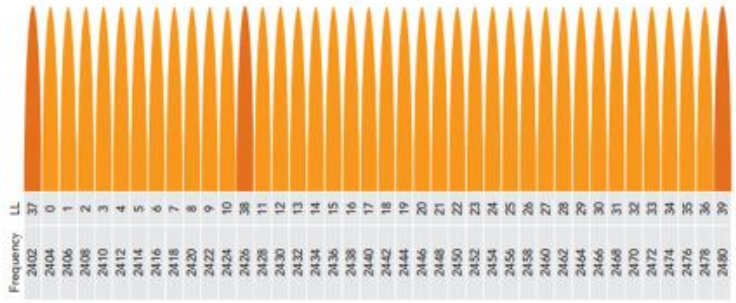


Figure 6. BLE Channels. Shown in dark green color are the three "advertising" channels