FCC/ISED RF Test Report
As per

RSS-247 Issue 2

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

ZX Low Voltage Thermostat

IC:8410A-ZXLV; FCC ID: XEY-ZX-LV

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	Jose Martinez	12-09-2019	
Authorised Signatory	Scott Drysdale	12-09-2019	

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 15.247 Subpart C/ ICES 003 Issue 6 and RSS-247 Issue 2.

A2LA Cert. No. 2955.20

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Contents

TABLE OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF GRAPHS

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	May 5th, 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
DTS	Digital Transmission System
EIRP	Equivalent Isotropical Radiated Power
ETSI	European Telecommunications Standards Institute
EUT	Equipment Under Test
FVIN	Firmware Version Identification Number
HVIN	Hardware Version Identification Number(s)
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

2 Introduction

Applicant:	Verdant Environmental Technologies, Inc.
Manufacturer:	Verdant Environmental Technologies, Inc.
Number of Samples Tested:	1
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:	7169005571
Date:	2019-02-26
Date of Receipt of EUT:	2019-02-10
Start of Test:	2019-02-26
Finish of Test:	2019-04-09
Name of Tester(s):	Abderrahmane Ferhat
Related Documents:	ANSI C63.10:2013 FCC 15. Subpart 15 Subpart C/RSS-247

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-GEN.6.7	99% Bandwidth DTS+FHSS	Refer to RSS GEN.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	Band-Edge Spurious Conducted 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 2	Pass
-	15.247 (i)	RSS-102	RF Exposure	Note 3	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: Antenna permanently to the circuit board, with a gain of 0dBi, in accordance with 15.203 a) i).
Note 2: The EUT does not coordinate transmission with any other FHSS to avoid simultaneous occupation of hopping frequencies
Note 3: 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 ZX LOW VOLTAGE Thermostat as 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 an antenna permanently to the circuit board, with a gain of 0dBi, in accordance with 15.203 a) i).

For the Restricted Bands of operation, the EUT is designed to only operate between 902 – 907.6 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: ZX LOW VOLTAGE THERMOSTAT

3.1 Specifications:

PRODUCT NAME:	ZX LOW VOLTAGE THERMOSTAT
MANUFACTURER:	Verdant Environmental Technologies, Inc
MODEL	2.4G
FREQUENCY RANGE (MHz)	2402-2480
VOLTAGE RATING:	5Vdc
HVIN	LV
FVIN	V1.00

Table 3 – EUT – ZX LOW VOLTAGE THERMOSTAT– Specifications for 2.4GHz

PRODUCT NAME:	ZX LOW VOLTAGE THERMOSTAT
MANUFACTURER:	Verdant Environmental Technologies, Inc
MODEL	900 MHz
FREQUENCY RANGE (MHz)	902-928
VOLTAGE RATING:	5Vdc
HVIN	LV
FVIN	V1.00

Table 4 – EUT – ZX LOW VOLTAGE THERMOSTAT– Specifications for 900MHz

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

Table 5 List of Channels for ZX Low Voltage Thermostat2.4 GHz

Channels	Frequency (MHz)
#0	902.46
#1	902.84
#2	903.22
#3	903.6
#4	903.98
#5	904.36
#6	904.74
#7	905.12
#8	905.5
#9	905.88
#10	906.26
#11	906.64
#12	907.02
#13	907.4
#14	907.78
#15	908.16
#16	908.54
#17	908.92
#18	909.3
#19	909.68
#20	910.06
#21	910.44
#22	910.82
#23	911.2
#24	911.58
#25	911.96
#26	912.34
#27	912.72
#28	913.1
#29	913.48
#30	913.86
#31	914.24
#32	914.62

Channels	Frequency (MHz)
#33	915
#34	915.38
#35	915.76
#36	916.14
#37	916.52
#38	916.90
#39	917.28
#40	917.66
#41	918.04
#42	918.42
#43	918.8
#44	919.18
#45	919.56
#46	919.94
#47	920.32
#48	920.7
#49	921.08
#50	921.46
#51	921.84
#52	922.22
#53	922.6
#54	922.98
#55	923.36
#56	923.74
#57	924.12
#58	924.5
#59	924.88
#60	925.26
#61	925.64
#62	926.02
#63	926.4
#64	926.78
#65	927.16

Channels	Frequency (MHz)
#66	927.54
#67	927.92

Table 6 List of Channels for ZX Low Voltage Thermostat900 MHz

3.2 Modes of Operation

The ZX LOW VOLTAGE THERMOSTAT is operating in the 2.4 GHz and 915 MHz bands. For operation, Low Voltage was 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.

3.3 Setup Diagram

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

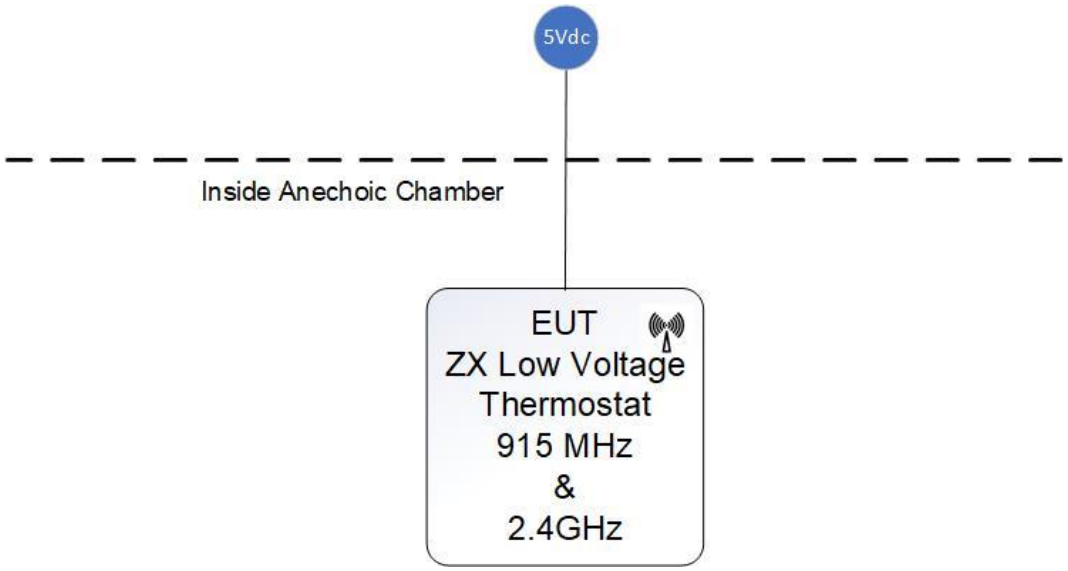


Figure 1: EUT Setup Diagram – ZX LOW VOLTAGE THERMOSTAT– Spurious Emissions

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	
SPECIFICATIONS		
Limit – Bandwidth (kHz)	≤500	
Frequency range (MHz)	2402 2442 2480	902.46 915 927.52
RBW (kHz):	Set to 1% to 3% of the 99% bandwidth	
VBW (kHz)	3xRBW	
EUT		
Identification	ZX Low Voltage Thermostat(2.4GHz) ZX Low Voltage Thermostat(915MHz)	
Voltage Input	5Vdc	
ENVIROMENTAL & TEST INFO		
Test Date (YYYY-MM-DD)	2019-04-09	
Temperature (°C)	21.4± 2	
Humidity (%)	26.3 ± 5	
Atmospheric Pressure kPa (For Info Only)	101.1	
Tester	Abderrahmane Ferhat	
Client Witness	No Witness	

6.3 Test Results

ZX Low Voltage Thermostat(2.4GHz)

All the Channels gave a maximum of 1.193MHz for 99% BW. Details are depicted in Table 8.

Channel	Frequency (MHz)	99% Bandwidth (MHz)	Results
Low channel	2402	1.046	Pass
Middle Channel	2442		Pass
Highest Channel	2480	1.050	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 – 2.4GHz Band

ZX Low Voltage Thermostat(900MHz)

The Channel #0 gave a maximum of 182.7 kHz for 99% BW. Details are depicted in Table 9.

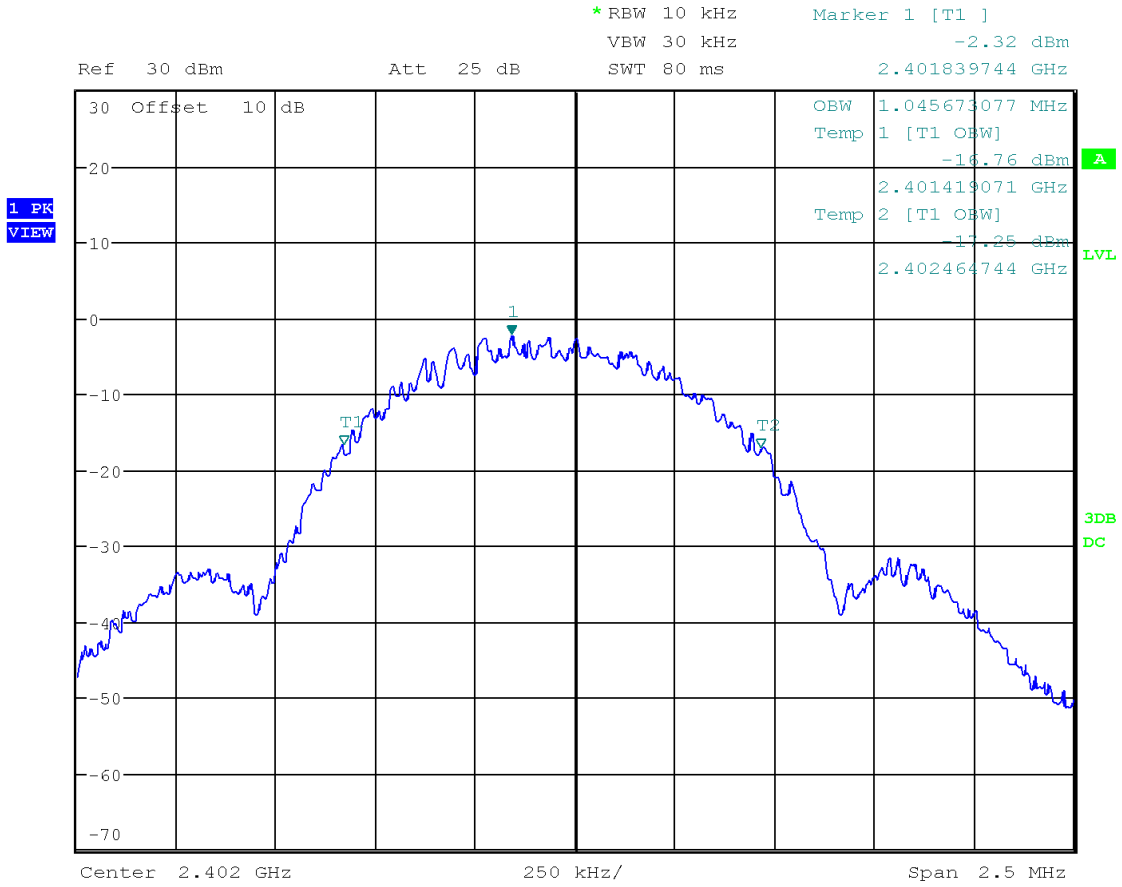
Channel	Frequency (MHz)	20 dB Bandwidth (kHz)	Limits (kHz)	Results
Low channel	902.46	182.69	≤500	Pass
Middle Channel	915	181.090	≤500	Pass
Highest Channel	927.52	182.692	≤500	Pass

Table 9 – 99% Bandwidth Results – 900MHz Band

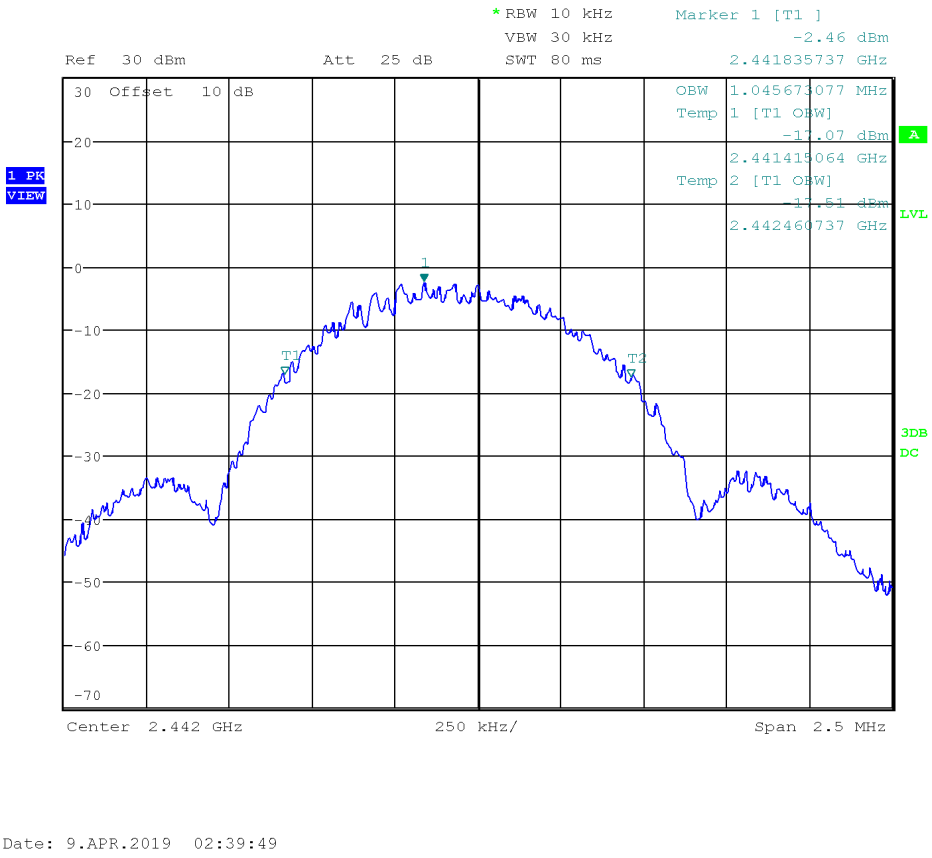
6.4 Graphs

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.

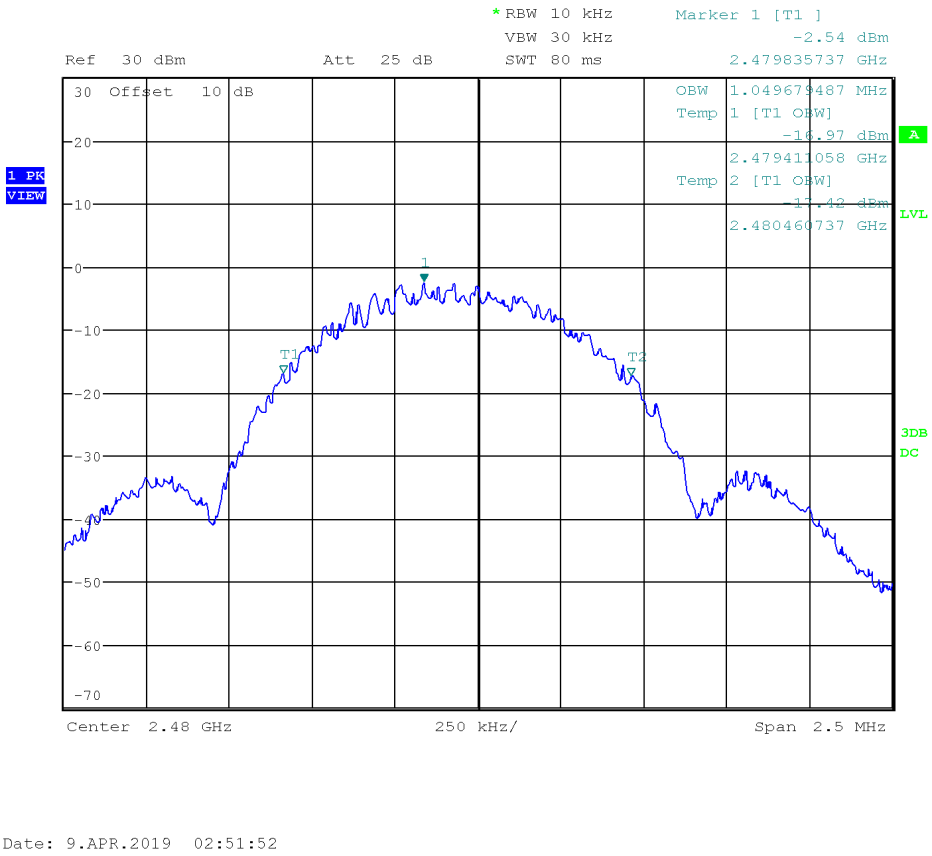
ZX Low Voltage Thermostat(2.4GHz)



Graph 1 Test Results – 99% Bandwidth Results – Lower Channel (#0) ZX LOW VOLTAGE Thermostat(2.4GHz)

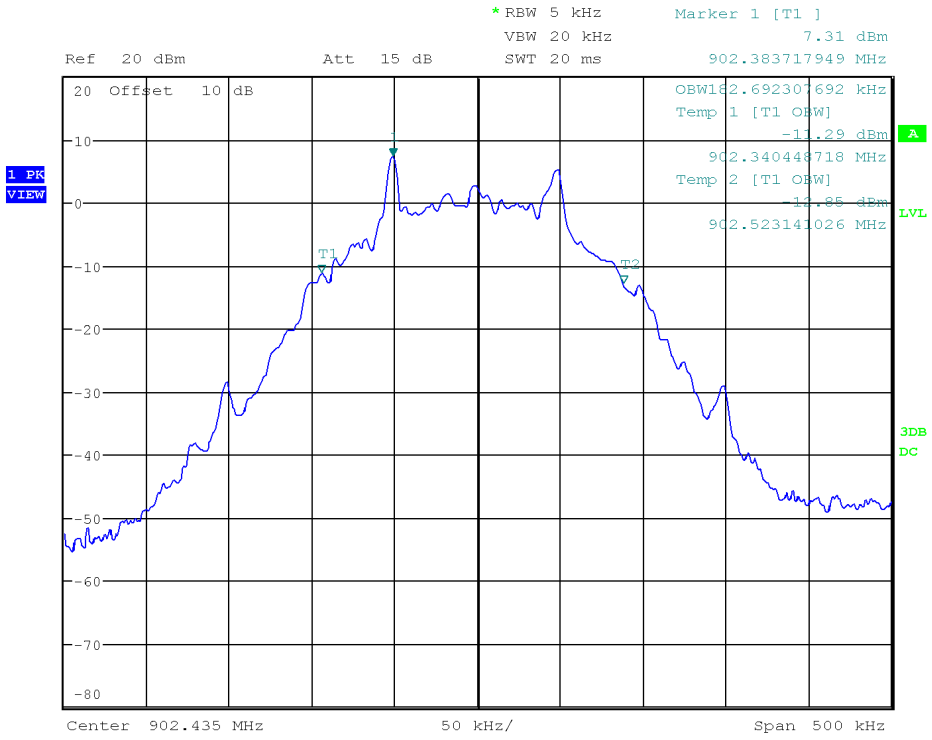


Graph 2 Test Results – 99% Bandwidth Results – Middle Channel (#19) ZX LOW VOLTAGE Thermostat(2.4GHz)

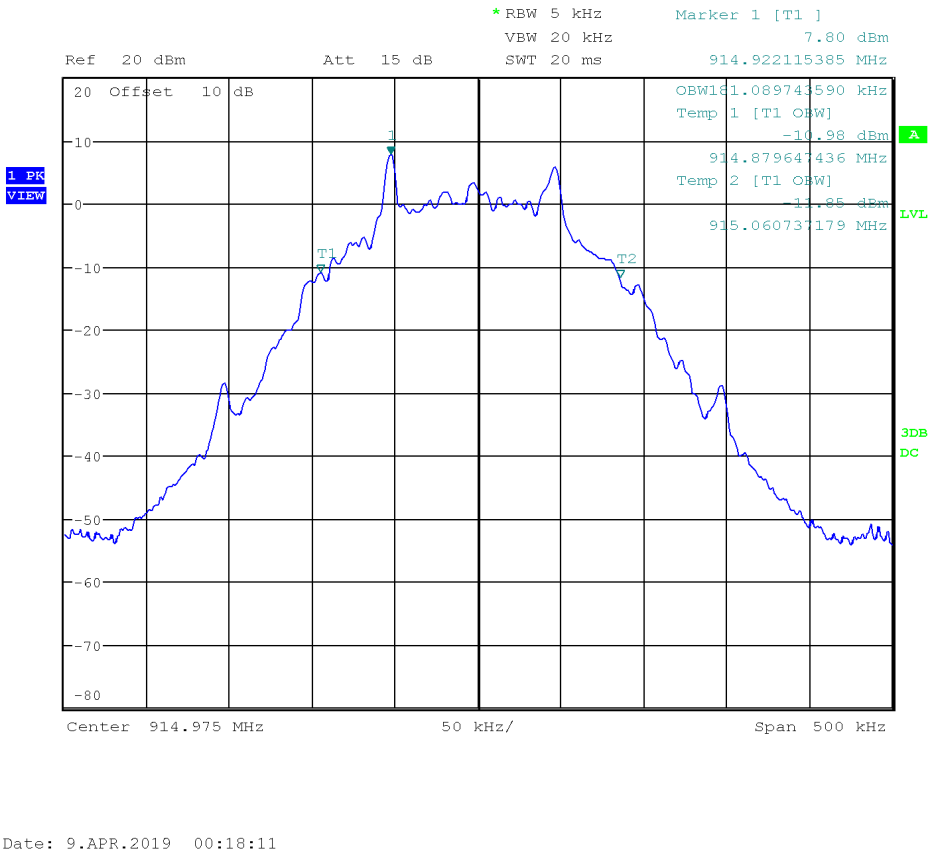


Graph 3 Test Results – 99% Bandwidth Results – Highest Channel (#39) ZX LOW VOLTAGE Thermostat(2.4GHz)

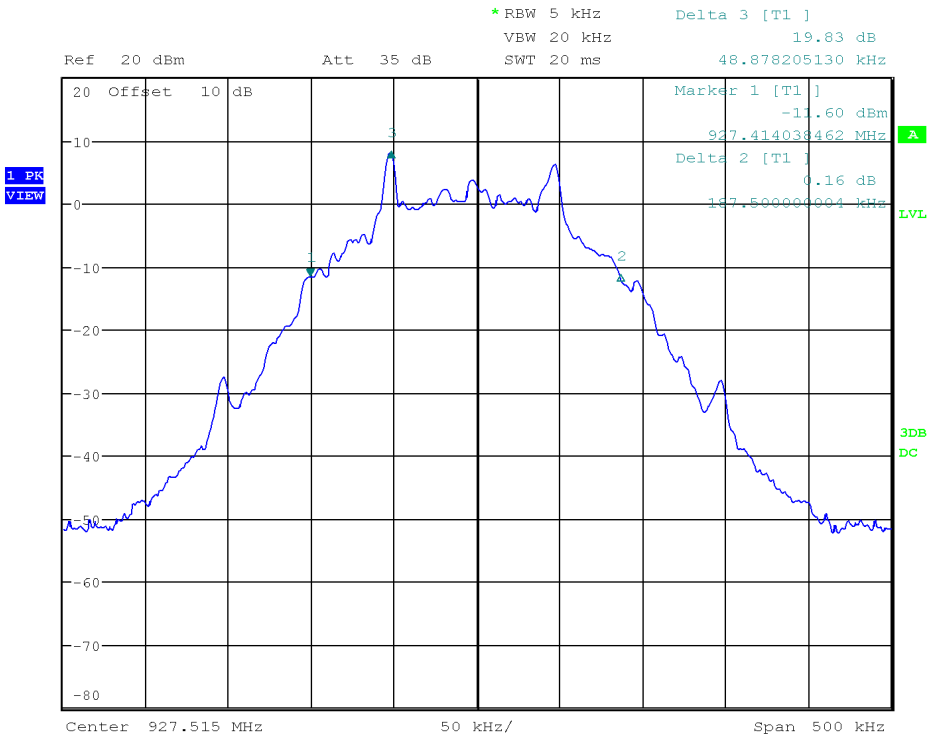
ZX Low Voltage Thermostat(900MHz)



Graph 4 Test Results – 99% Bandwidth Results – Low Channel ZX Low Voltage Thermostat(900MHz)



Graph 5 Test Results – 99% Bandwidth Results – Mid Channel ZX Low Voltage Thermostat(900MHz)



Graph 6 Test Results – 99% Bandwidth Results – High Channel ZX LOW VOLTAGE Thermostat(900MHz)

6.5 Test Instruments

This test was carried out in Laval test location. Instrumentation used is depicted in Table 10.

Equipment	Model No.	Manufacturer	Calibration Period (months)	Calibration Due (YYY-MM-DD)	Asset No: LAVE
Spectrum Analyzer	ESU-40	Rohde & Schwarz	24	2019-04-20	4092
Attenuator 10 dB	4779-10	Narda	NCR	NCR	4096

Table 10: 99%BW 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(kHz)	≥500kHz
Test Frequency (MHz):	2402 2442 2480
RBW (kHz)	10
VBW (kHz)	30
EUT	
Identification	ZX Low Voltage Thermostat(2.4GHz)
Voltage Input	5Vdc
Environmental	Normal Conditions
Test Date (YYYY-MM-DD)	2019-04-09
Temperature (°C)	21.4± 2
Humidity (%)	26.3 ± 5
Atmospheric Pressure kPa (For Info Only)	101.1
Tester(s)	Abderrahmane Ferhat
Client Witness	No Witness

7.3 Test Results

ZX Low Voltage Thermostat(2.4GHz)

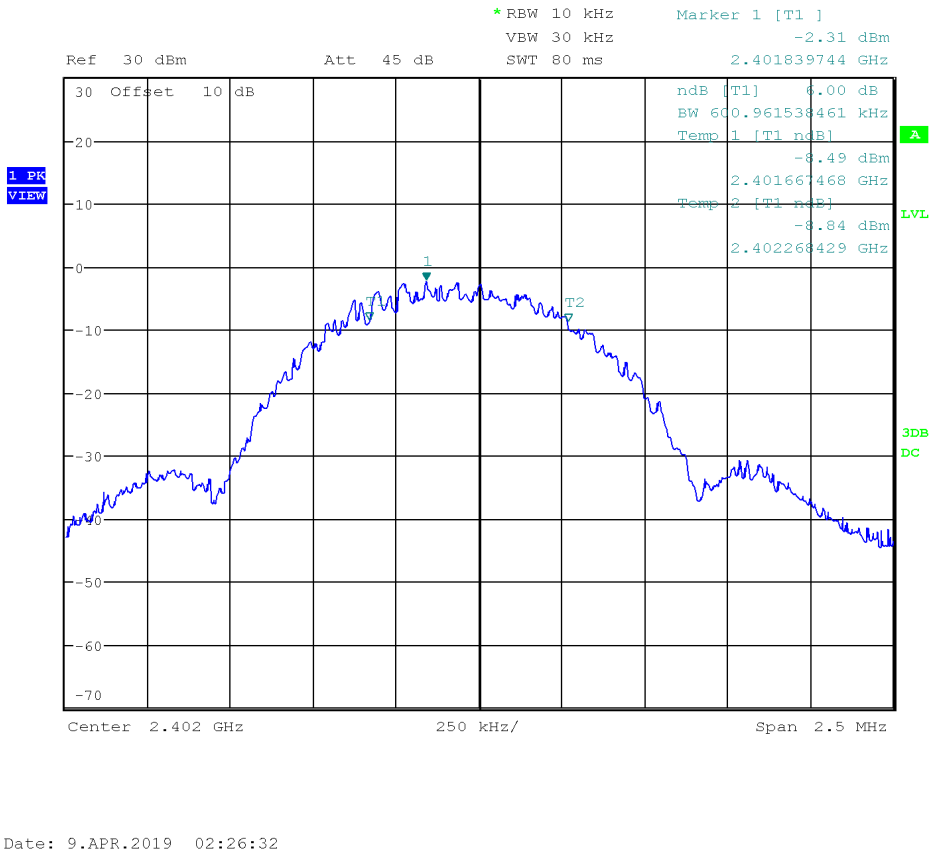
The Channel #0 and Channel #19 gave a maximum of 596.955kHz for 6dB BW. Details are depicted in Table 11

Channel	Frequency (MHz)	6dB Bandwidth (kHz)	Limit (kHz)	Results
Low channel:	2402	601	≥500	Pass
Middle Channel	2442	597	≥500	Pass
Highest Channel	2480	561	≥500	Pass

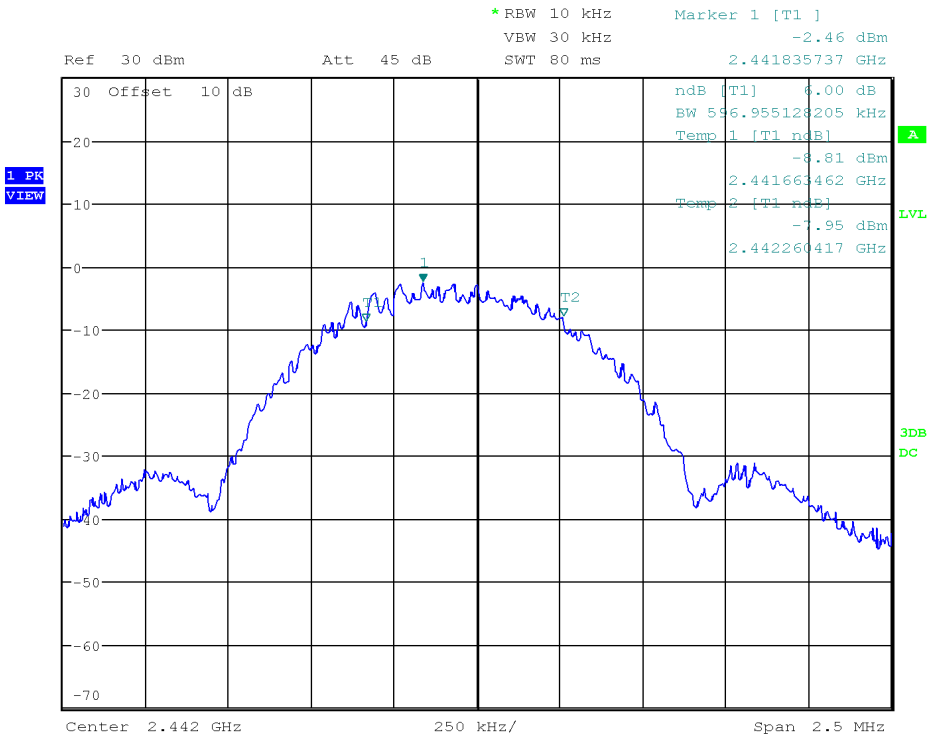
Table 11 – 6dB Bandwidth Results

7.4 Graphs

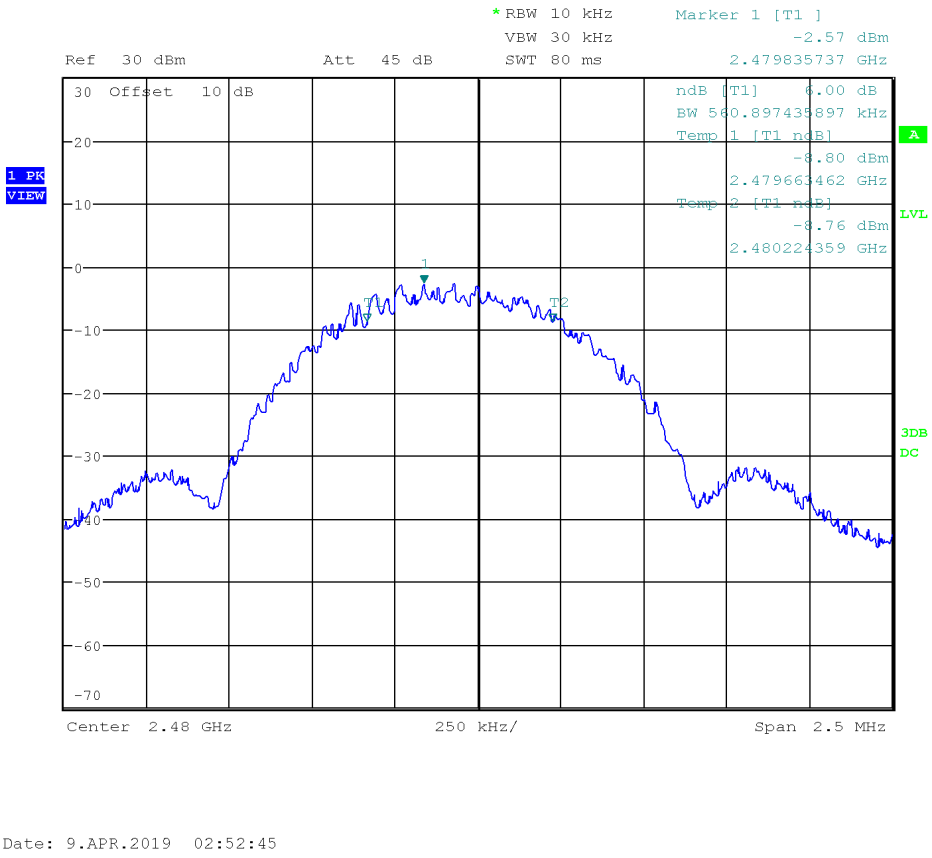
The graphs showed below show the OBW during the operation of the device. This is measured by a max hold on the spectrum analyzer and the highest resolution bandwidth that is sufficiently low to exhibit the 99% bandwidth of a channel during operation of the EUT. Max hold is performed for a duration of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



Graph 7 Test Results – 6dB Bandwidth Results – Low Channel ZX LOW VOLTAGE Thermostat(2.4GHz)



Graph 8 Test Results – 6dB Bandwidth Results – Mid Channel ZX LOW VOLTAGE Thermostat(2.4GHz)



Graph 9 Test Results – 6dB Bandwidth Results – High Channel ZX LOW VOLTAGE Thermostat(2.4GHz)

7.5 Test Instruments

This test was carried out in Laval test location. Instrumentation used are depicted in Table 12.

Equipment	Model No.	Manufacturer	Calibration Period (months)	Calibration Due (YYY-MM-DD)	Asset No: LAVE
Spectrum Analyzer	ESU-40	Rohde & Schwarz	24	2019-04-20	4092
Attenuator 10 dB	4779-10	Narda	NCR	NCR	4096

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):	902.46 915 927.52
RBW (kHz)	200
VBW (kHz)	500
EUT	
Identification	ZX Low Voltage Thermostat(900MHz)
Voltage Input	5Vdc
Environmental	Normal Conditions
Test Date (YYYY-MM-DD)	2019-04-09
Temperature (°C)	21.4± 2
Humidity (%)	26.3 ± 5
Atmospheric Pressure kPa (For Info Only)	101.1
Tester(s)	Abderrahmane Ferhat
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
	≥250 kHz	≥ 75 channels

8.4 Test Results

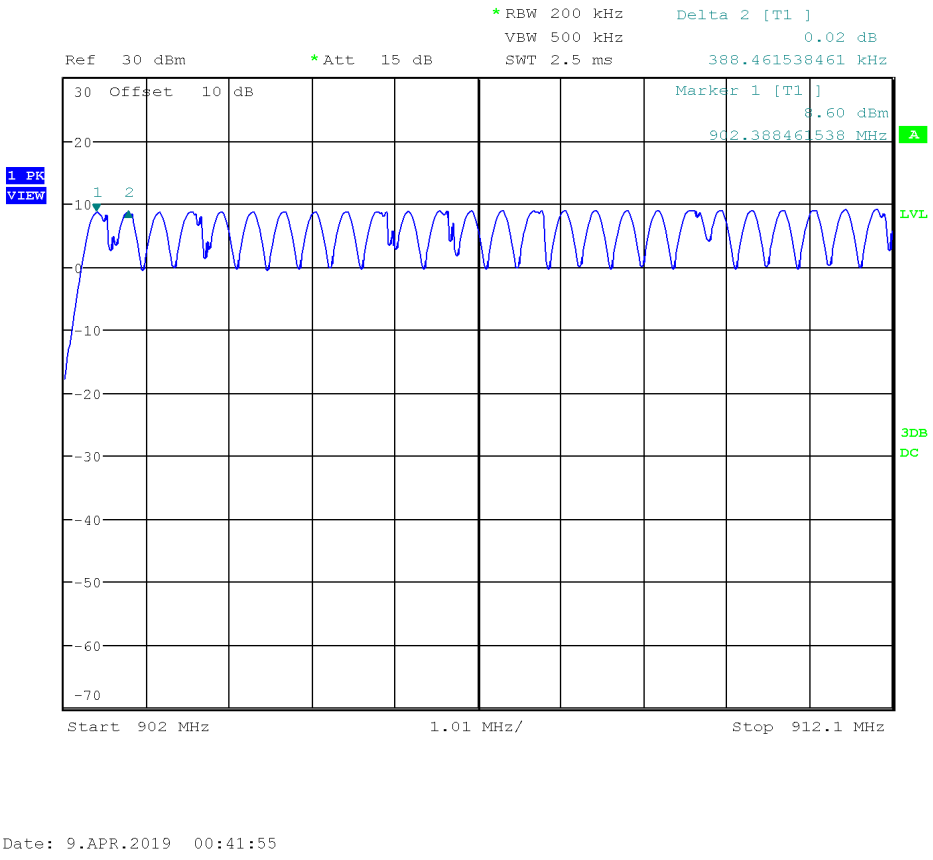
The EUT passed the requirements of the number of channels. The number of channels occupied by the EUT and 64 channels in the allocation band of 902 MHz to 928 MHz. The results are depicted in Table 13.

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

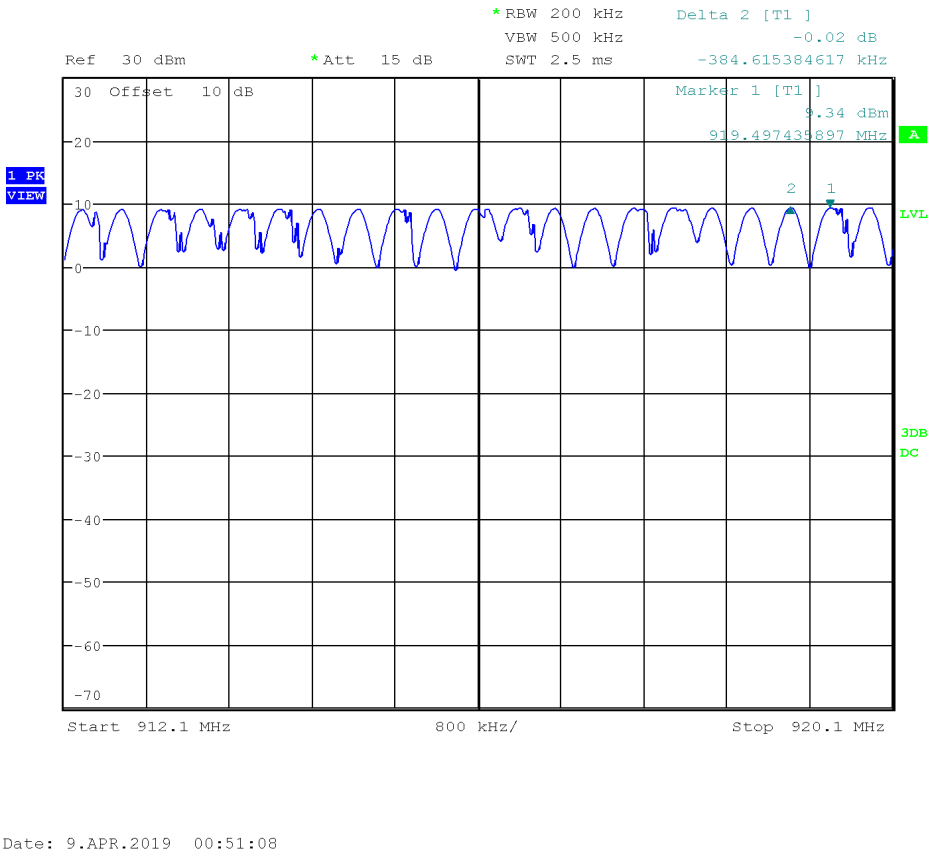
Table 13 – Hopping Channel Results

8.5 Graphs

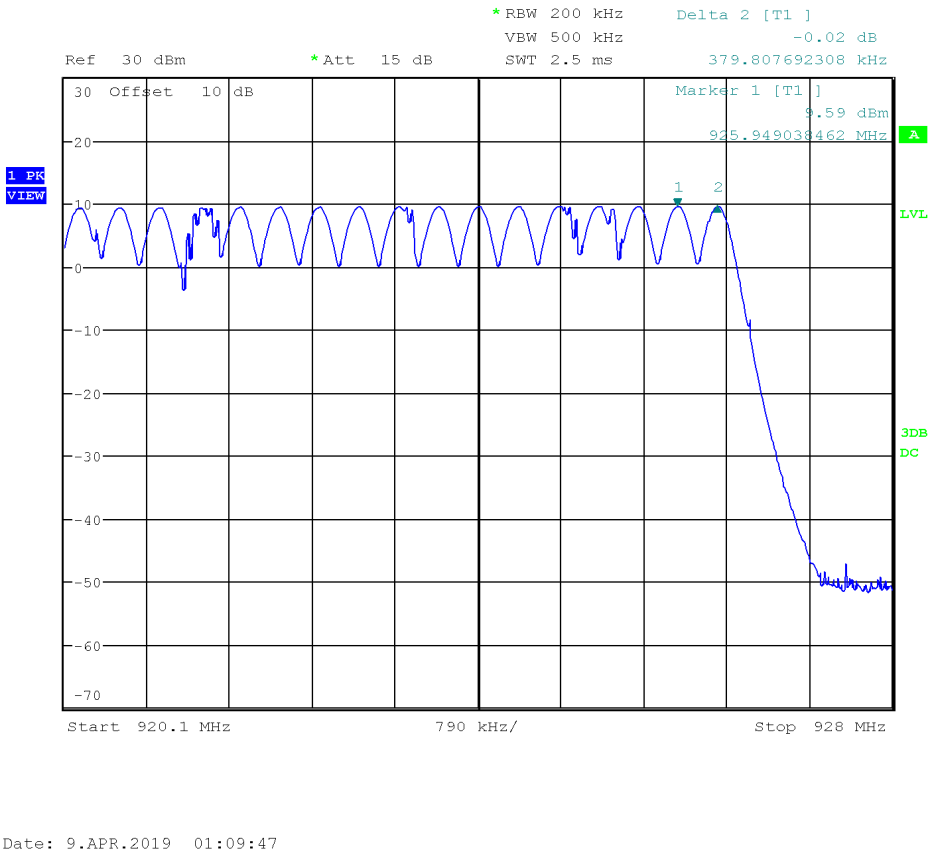
The graphs below show the number of occupied channels during the operation of the device. This is measured by a max hold on the spectrum analyser and the highest resolution bandwidth that is sufficiently low to exhibit the channel spacing of the signal being measured. This measurement is a peak measurement. 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 – ZX Low Voltage Thermostat(900MHz) – 902MHz – 912.1MHz



Graph 11: Hopping Channel – ZX Low Voltage Thermostat(900MHz) – 912.1MHz – 920.1MHz



Graph 12: Hopping Channel – ZX Low Voltage Thermostat(900MHz) – 920.1MHz – 928MHz

8.6 Test Instruments

This test was carried out in Laval test location. Instrumentation used is depicted in Table 14.

Equipment	Model No.	Manufacturer	Calibration Period (months)	Calibration Due (YYY-MM-DD)	Asset No: LAVE
Spectrum Analyzer	ESU-40	Rohde & Schwarz	24	2019-04-20	4092
Attenuator 10 dB	4779-10	Narda	NCR	NCR	4096

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)	902.46 915 927.52
RBW (kHz):	100
VBW (kHz)	300
EUT	
Identification	ZX LOW VOLTAGE THERMOSTAT (900MHz)
Voltage Input	5Vdc
ENVIROMENTAL & TEST INFO	
Test Date (YYYY-MM-DD)	2019-04-09
Temperature (°C)	21.4± 2
Humidity (%)	26.3 ± 5
Atmospheric Pressure kPa (For Info Only)	101.1
Tester	Abderrahmane Ferhat
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 as shown in the Table below

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]
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 184.63 kHz. Thus, a channel separation limit of 182.7kHz applies.		

9.4 Test Results

The results of the EUT are detailed in Table 15. Results are depicted in Table 15.

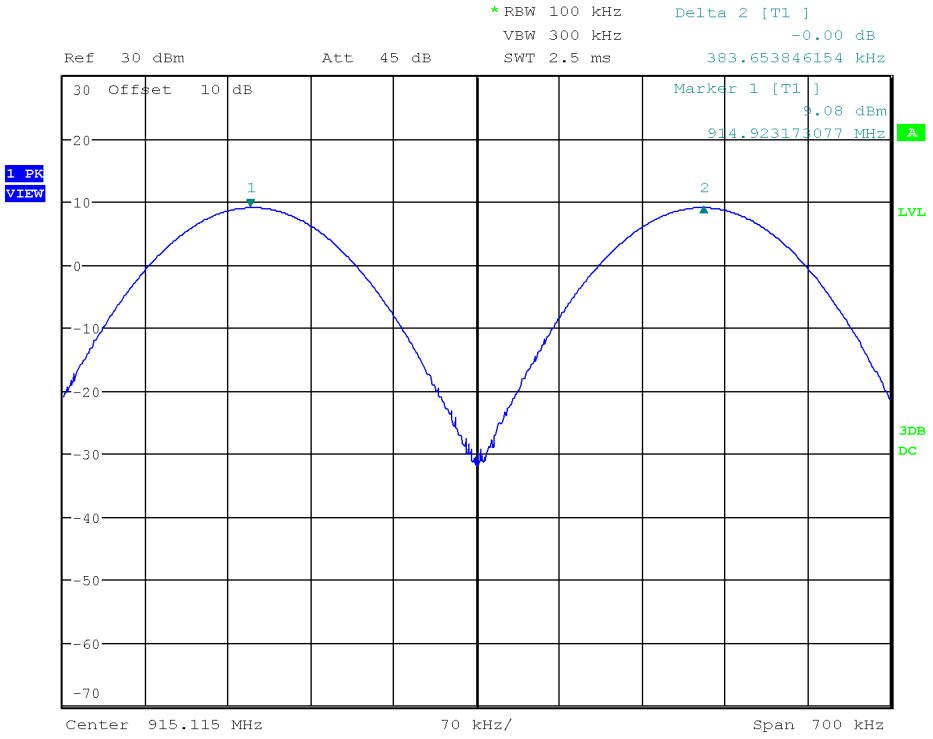
Channel	Range (MHz)	Channel Separation Measured <kHz>	Limits < kHz>	Results
Middle Channel:	902 - 915	382.65	≥182.7	Pass

Table 15 – Channel Separation Results

9.5 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 13: Channel Separation – ZX



Low Voltage Thermostat(900MHz)

9.6 Test Instruments

This test was carried out in Laval test location. Instrumentation used is depicted in Table 16.

Equipment	Model No.	Manufacturer	Calibration Period (months)	Calibration Due (YYY-MM-DD)	Asset No: LAVE
Spectrum Analyzer	ESU-40	Rohde & Schwarz	24	2019-04-20	4092
Attenuator 10 dB	4779-10	Narda	NCR	NCR	4096

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)	902.46 915 927.52
RBW (kHz):	200
VBW (kHz)	500
EUT	
Identification	ZX LOW VOLTAGE THERMOSTAT (900MHz)
Voltage Input	5Vdc
ENVIROMENTAL & TEST INFO	
Test Date (YYYY-MM-DD)	2019-04-09
Temperature (°C)	21.4± 2
Humidity (%)	26.3 ± 5
Atmospheric Pressure kPa (For Info Only)	101.1
Tester	Abderrahmane Ferhat
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. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

10.4 Test Results

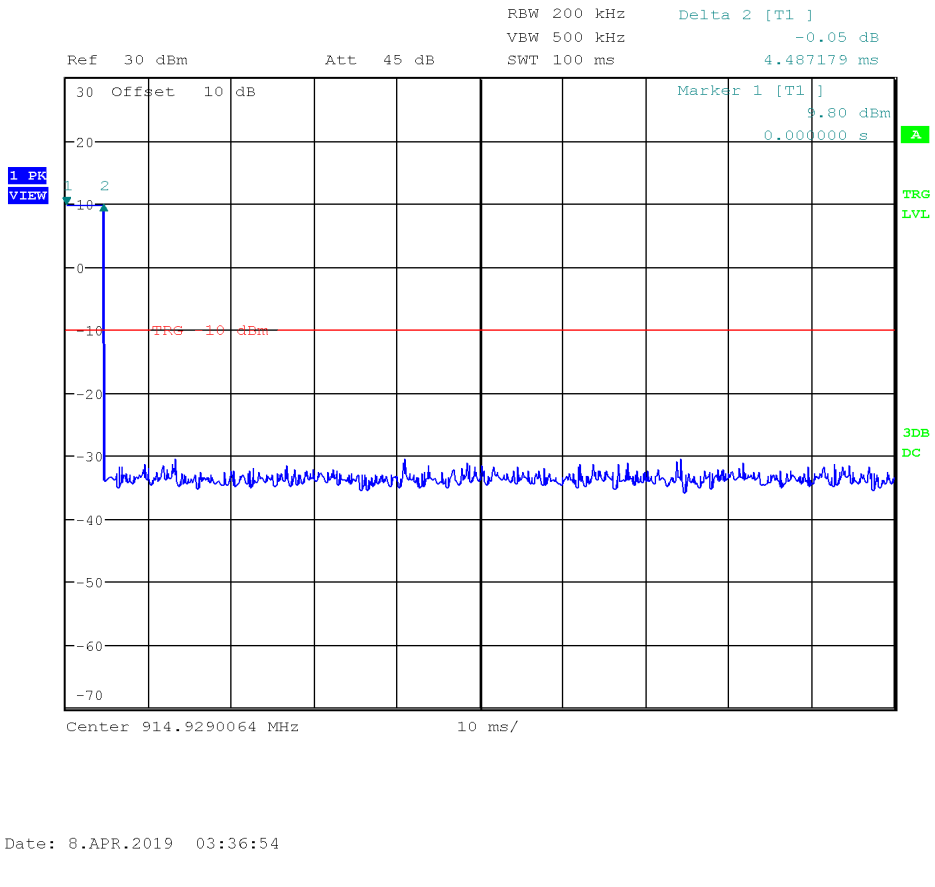
The EUT cycles through its pseudo-random generated list of hopping frequencies. There are 64 channels occupied in total. The average transmit time is 4.5ms per channel and each channel is repeated approximately every 1s. Results are depicted in Table 17.

Channel	Range (MHz)	Average Transmit Time/ Channel (ms)	Number of Hops in 20s	Average Time of Occupancy (ms)	Limit (ms)	Results
Middle Channel: #34	902 - 915	4.5	20	90	≤400	Pass

Table 17 – Time Occupancy Results

10.5 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 14: Time of Occupancy – ZX Low Voltage Thermostat(900MHz)

10.6 Test Instruments

This test was carried out in Laval test location. Instrumentation used is depicted in Table 18.

Equipment	Model No.	Manufacturer	Calibration Period (months)	Calibration Due (YYY-MM-DD)	Asset No: LAVE
Spectrum Analyzer	ESU-40	Rohde & Schwarz	24	2019-04-20	4092
Attenuator 10 dB	4779-10	Narda	NCR	NCR	4096

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.

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 2442 2480	902.46 915 927.52
RBW (MHz):	2	0.2
VBW (MHz)	10	0.5
Span (MHz)	10	1.5
EUT		
Identification	ZX LOW VOLTAGE THERMOSTAT	
Voltage Input	5Vdc	
ENVIROMENTAL	**Normal Conditions**	
Test Date (YYYY-MM-DD)	2019-04-09	
Temperature (°C)	23.4 ± 2	
Humidity (%)	36.3± 5	
Atmospheric Pressure kPa (For Info Only)	109.7	
Tester	Abderrahmane Ferhat	
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 Tests Results

ZX Low Voltage Thermostat(2.4GHz)

The Low Channel gave a maximum Peak Power of 8.03dBm(6.4mW). Results of the peak power measurements of channels tested are depicted in Table 19.

Channel	Frequency (MHz)	Measured Peak Power (dBm)	Peak Power (mW)	Limit (W)	Result
Low	2402	8.03	6.4	1	Pass
Middle	2442	7.81	6.0	1	Pass
High	2480	7.68	5.9	1	Pass

Table 19 – Test Results Peak-Power Measurements ZX Low Voltage Thermostat(2.4GHz)

ZX Low Voltage Thermostat(900MHz)

The High Channel gave a maximum Peak Power of 9.94dBm (9.9mW). The peak power measurements of channels tested are depicted in Table 20.

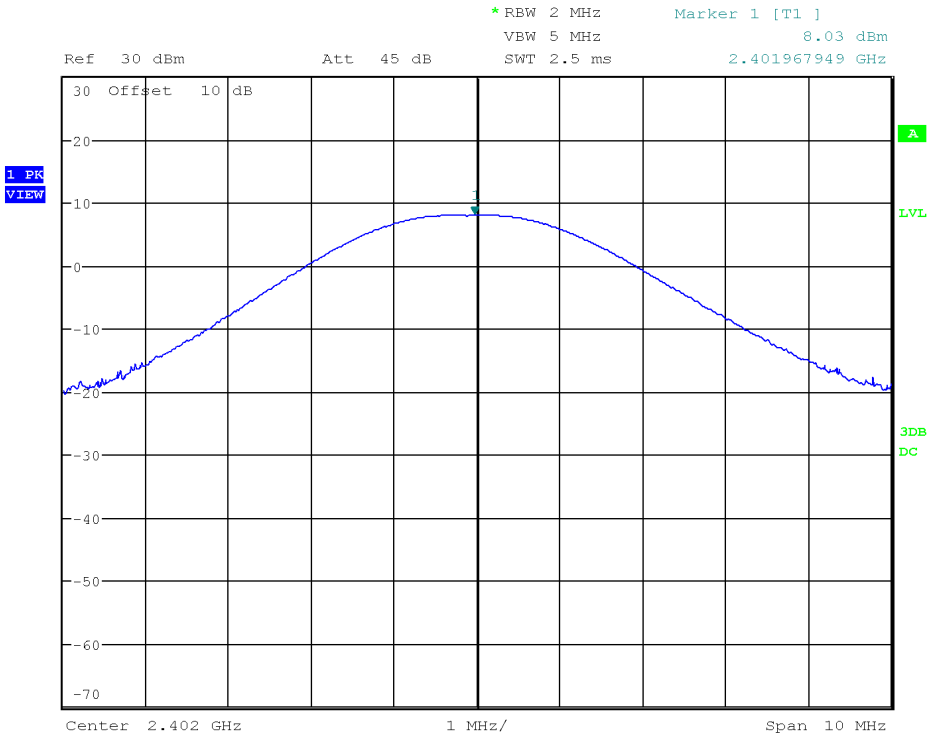
Channel	Frequency (MHz)	Measured Peak Power (dBm)	Peak Power (mW)	Limit (mW)	Result
Low	902.46	8.96	7.9	1000	Pass
Middle	915	9.48	8.9	1000	Pass
High	927.52	9.94	9.9	1000	Pass

Table 20 – Test Results Peak-Power Measurements ZX Low Voltage Thermostat(900MHz)

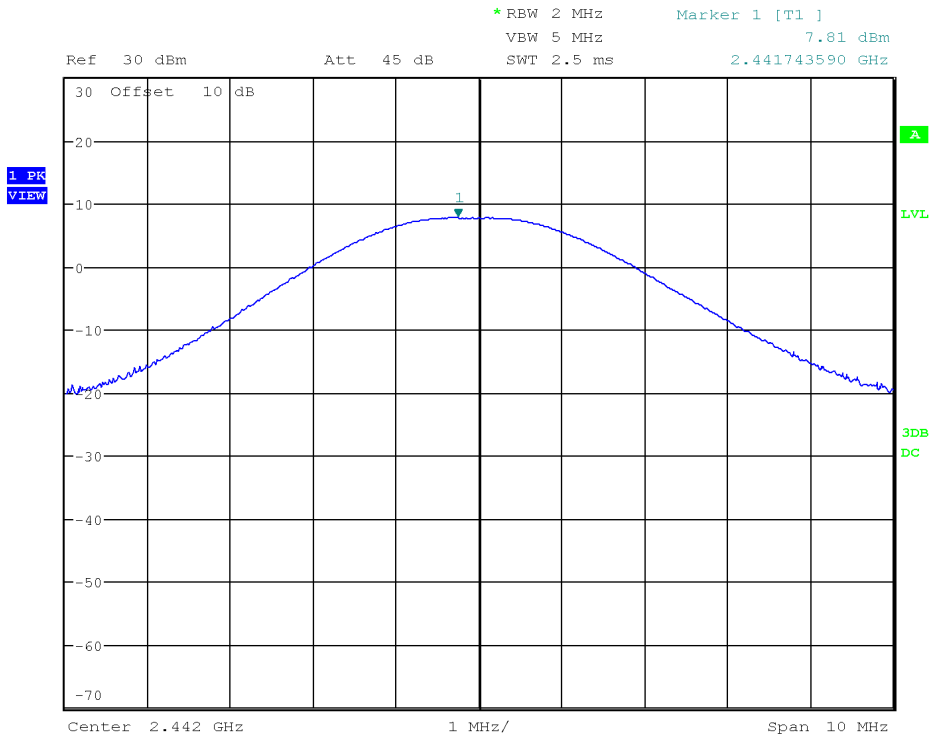
11.5 Graphs

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.

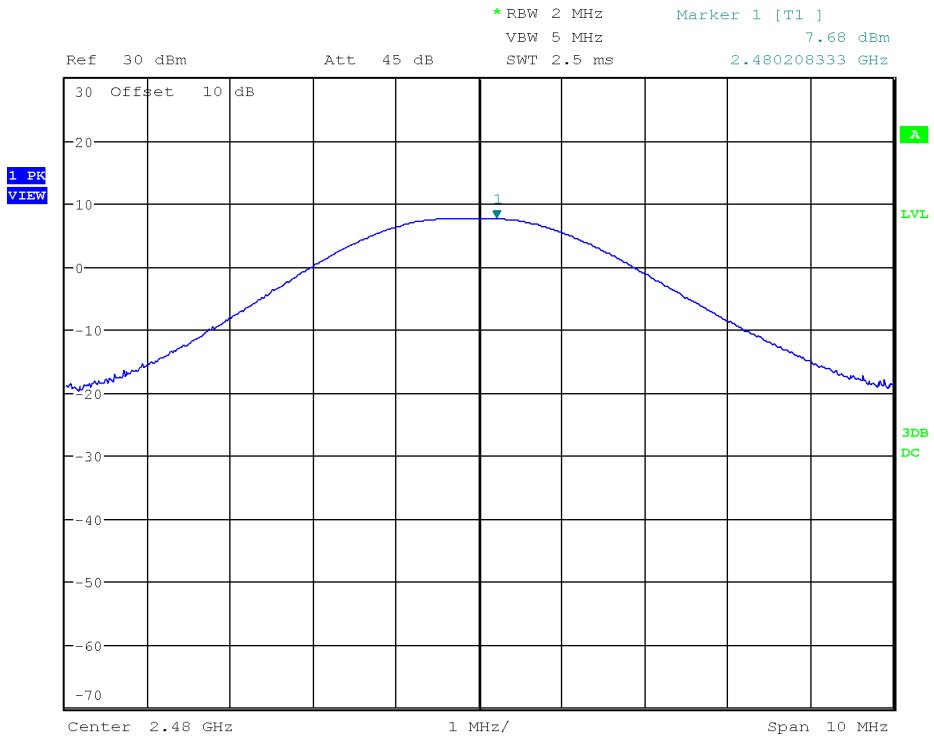
ZX Low Voltage Thermostat(2.4GHz)



Graph 15 Test Results – Conducted Peak Power Measurements – Low Channel

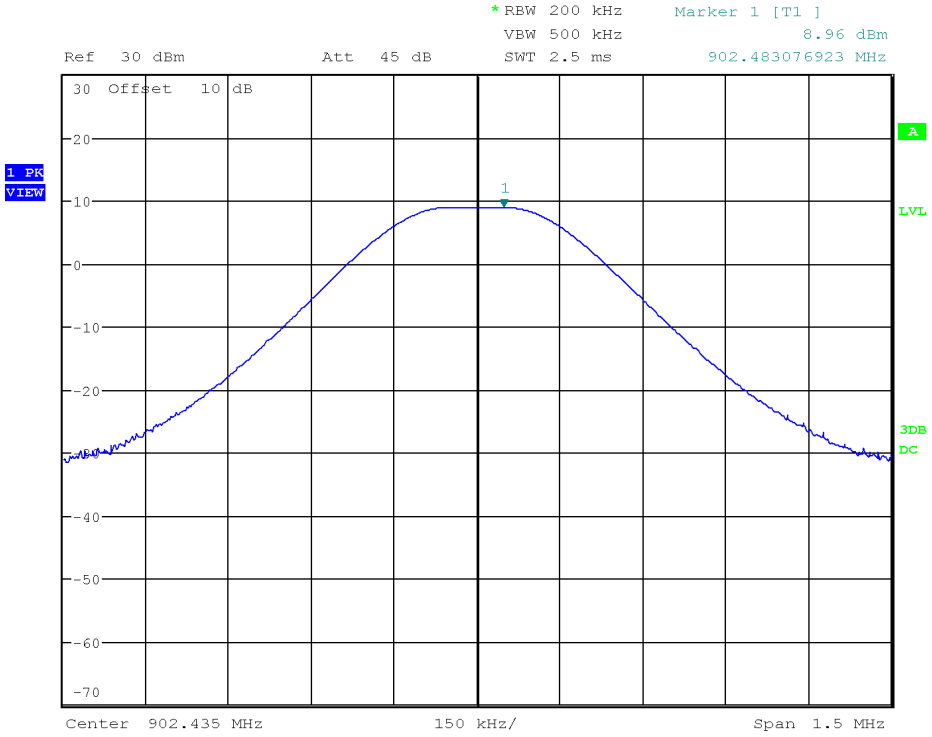


Graph 16 Test Results – Conducted Peak Power Measurements – Mid Channel

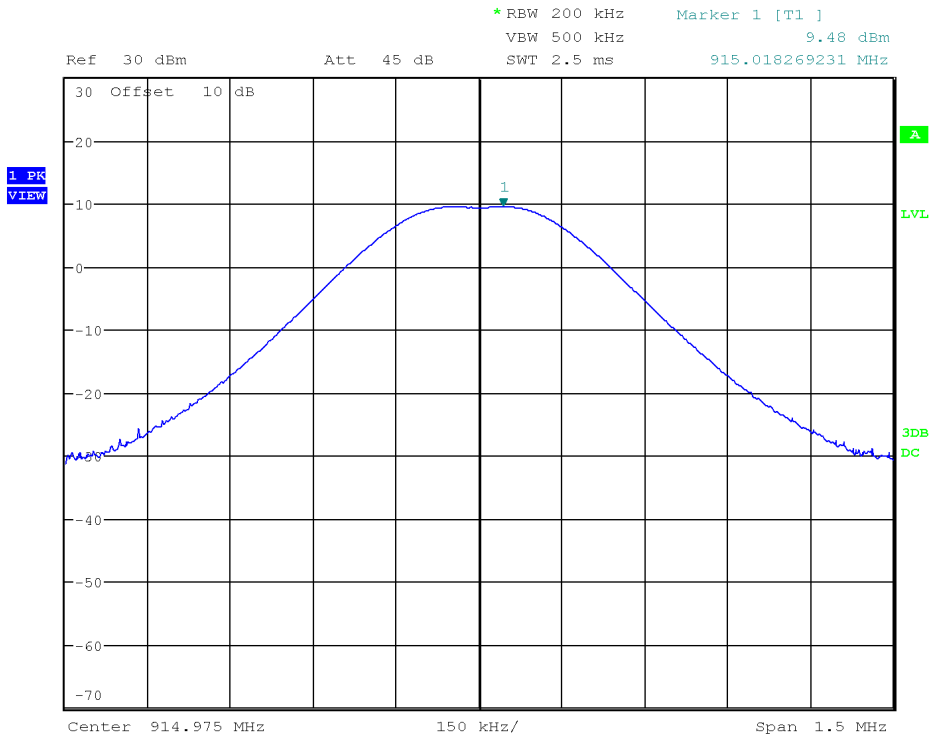


Graph 17 Test Results – Conducted Peak Power Measurements – High Channel

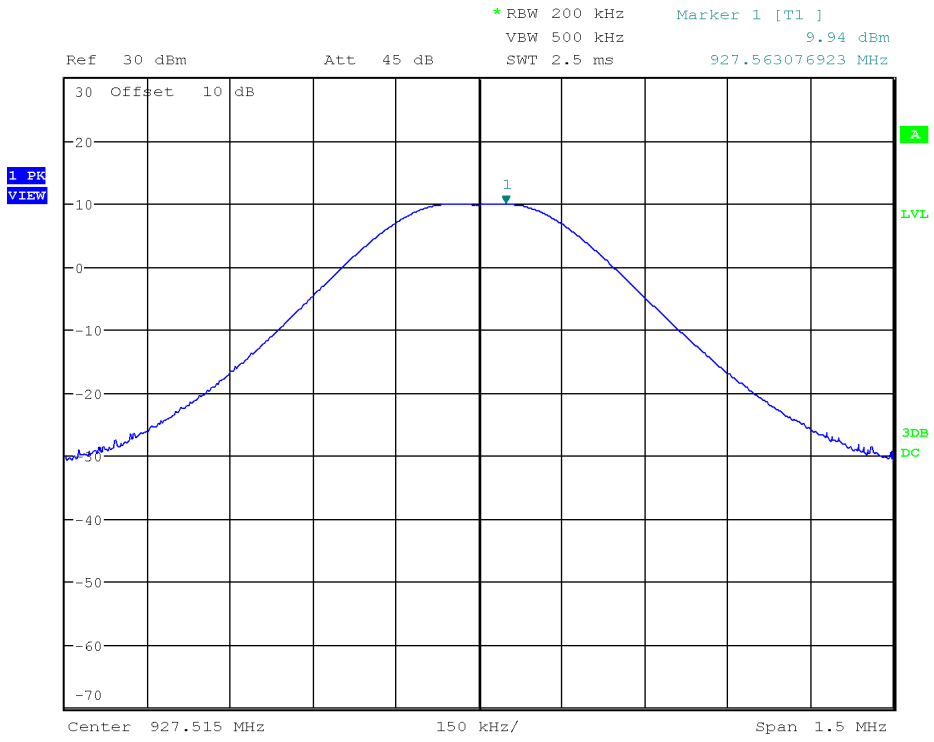
ZX Low Voltage Thermostat(900MHz)



Graph 18 Test Results – Conducted Peak Power Measurements – Low Channel



Graph 19 Test Results – Conducted Peak Power Measurements – Mid Channel



Graph 20 Test Results – Conducted Peak Power Measurements – High Channel

11.6 Test Instruments

This test was carried out in Laval test location. Instrumentation used is depicted in Table 21.

Equipment	Model No.	Manufacturer	Calibration Period (months)	Calibration Due (YYY-MM-DD)	Asset No: LAVE
Spectrum Analyzer	ESU-40	Rohde & Schwarz	24	2019-04-20	4092
Attenuator 10 dB	4779-10	Narda	NCR	NCR	4096

Table 21: Conducted Peak Power Test Equipment

12 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 Low Voltage 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
RBW (kHz):	3
VBW (kHz)	10
Span (MHz)	2
EUT	
Identification	ZX LOW VOLTAGE Thermostat
Voltage Input	5Vdc
ENVIROMENTAL & TEST INFO	
Test Date (YYYY-MM-DD)	2019-04-09
Temperature (°C)	21.4± 2
Humidity (%)	26.3 ± 5
Atmospheric Pressure kPa (For Info Only)	101.1
Tester	Abderrahmane Ferhat
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 Results

ZX Low Voltage Thermostat(2.4GHz)

The EUT was tested on: Low, medium, and high bands. The worst-case value is the High Channel with -8.18dBm as measured with a 3 kHz resolution bandwidth (peak power) on the higher channel #39. The results of the peak power of channels tested are depicted in Table 22.

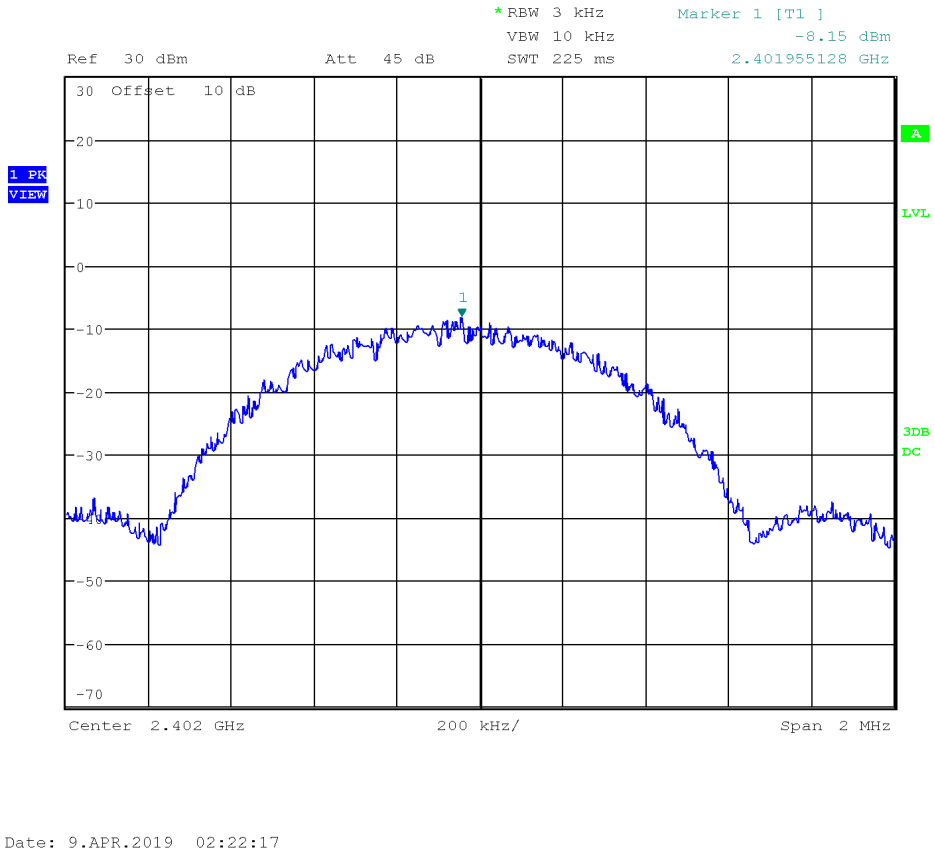
Channel	Frequency (MHz)	Measured PSD (dBm)	Limit (dBm)	Results
Low	2402	-8.15	<8	Pass
Middle	2442	-8.26	<8	Pass
High	2480	-8.38	<8	Pass

Table 22- Results – PKPSD

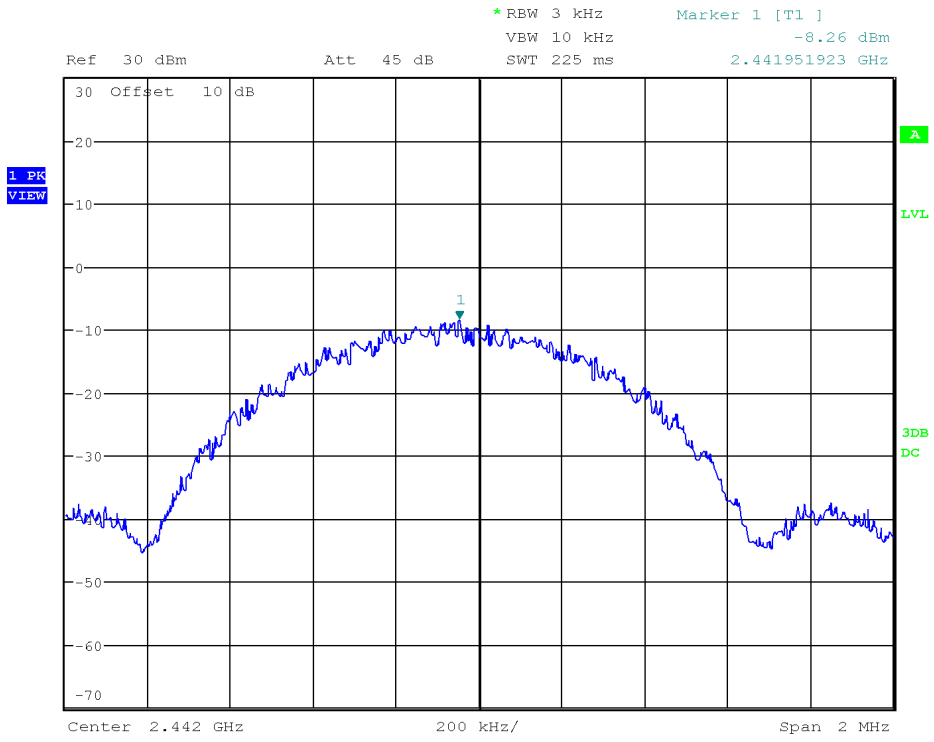
12.5 Graphs

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.

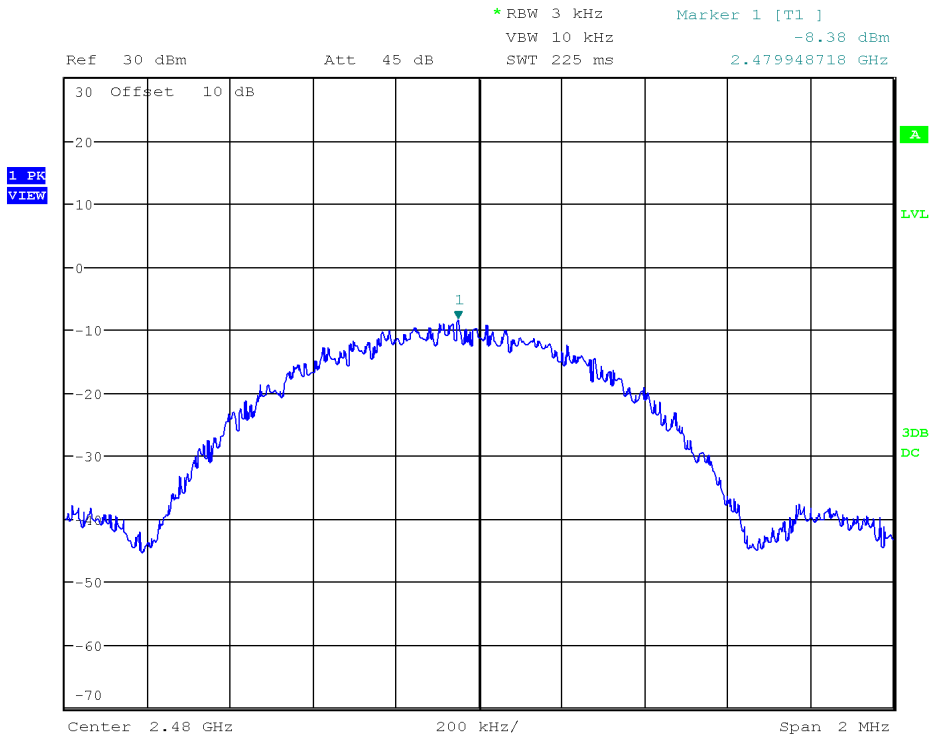
ZX Low Voltage Thermostat(2.4GHz)



Graph 21 Test Results – PKPSD – Low Channel



Graph 22 Test Results – PKPSD – Mid Channel



Graph 23 Test Results – PKPSD – High Channel

12.6 Test Instruments

This test was carried out in Laval test location. Instrumentation used is depicted in Table 23.

Equipment	Model No.	Manufacturer	Calibration Period (months)	Calibration Due (YYY-MM-DD)	Asset No: LAVE
Spectrum Analyzer	ESU-40	Rohde & Schwarz	24	2019-04-20	4092
Attenuator 10 dB	4779-10	Narda	NCR	NCR	4096

Table 23 – Test Instrumentation – PKPS

13 Band Edge Spurious Emission (-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 2442 2483.5	902.46 915 927.52
EUT		
Identification	ZX LOW VOLTAGE THERMOSTAT	
Voltage Input	24 Vdc	
ENVIROMENTAL & TEST INFO		
Test Date (YYYY-MM-DD)	2019-04-09	
Temperature (°C)	21.4± 2	
Humidity (%)	26.3 ± 5	
Atmospheric Pressure kPa (For Info Only)	101.1	
Tester	Abderrahmane Ferhat	
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.

13.5 Test Results

ZX Low Voltage Thermostat(2.4GHz)

The EUT was tested on: Low, medium, and high bands. The worst-case value is -28.88 dBm and on High Channel. The peak power of channels tested are depicted in Table 24.

Frequency Band (MHz)	Channel	Frequency (MHz)	**Measured Spurious Conducted (dBm)**	Results <Note 1>**)**
2402 – 2480	Low	0.009-0.15	-70.54	Pass
	Low	0.15-30	-38.85	Pass
	Low	30-2400	-29.95	Pass
	Low	2400-2402	-40.39	Pass
	Middle	2402-2483.5	-38.85	Pass
	High	2483.5-26000	-29.27	Pass
Note 1. The highest level of the fundamental frequency is 9.94dBm according to RF output Power results (see Table 19).				

Table 24- Results Band Edge – 2.4GHz Band

ZX LOW VOLTAGE THERMOSTAT (900MHz)

The EUT was tested on: Low, medium, and high bands. The worst-case value is -34.65 dBm on Middle channel. The peak power of channels tested are depicted in Table 25.

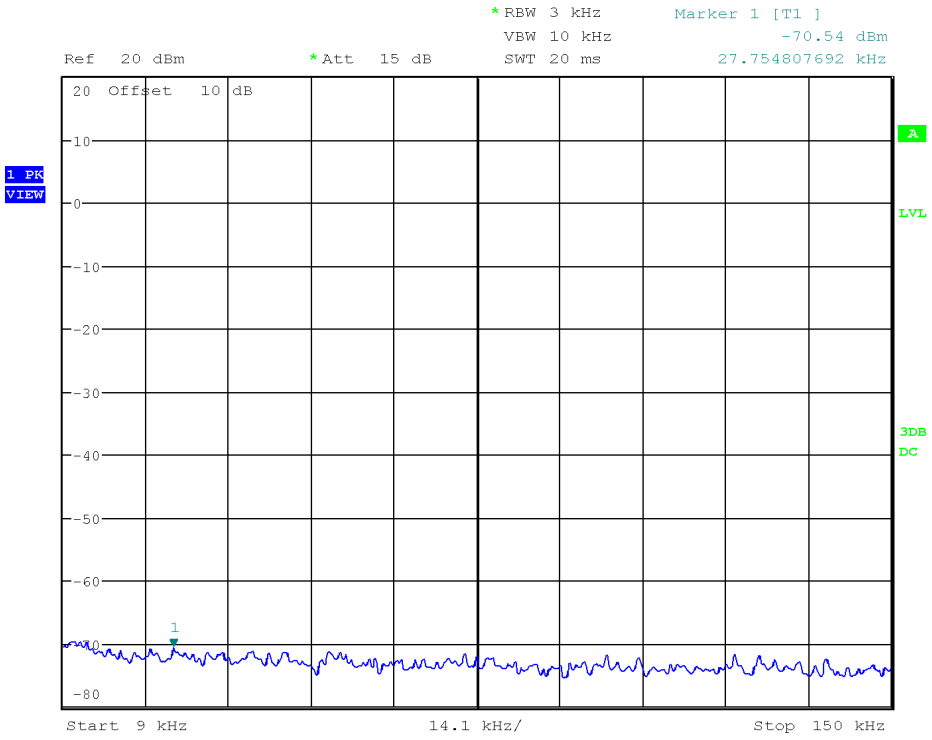
Frequency Band (MHz)	Channel	Frequency (MHz)	**Measured Spurious Conducted (dBm)**	Results <Note 1>**)**
902 – 907.6	Low	0.009-0.15	-70.54	Pass
	Low	0.15-30	-67.31	Pass
	Low	30-1000	-60.0	Pass
	Low	900-902.46	-49.1	Pass
	Middle	902 - 928	-54.82	Pass
	Hight	1000 - 10000	-44.25	Pass
Note 1. The highest level of the fundamental is 9.94dBm based on RF output Power results (see Table 20)				

Table 25- Results – Band Edge – 900GHz Band

13.6 Graphs

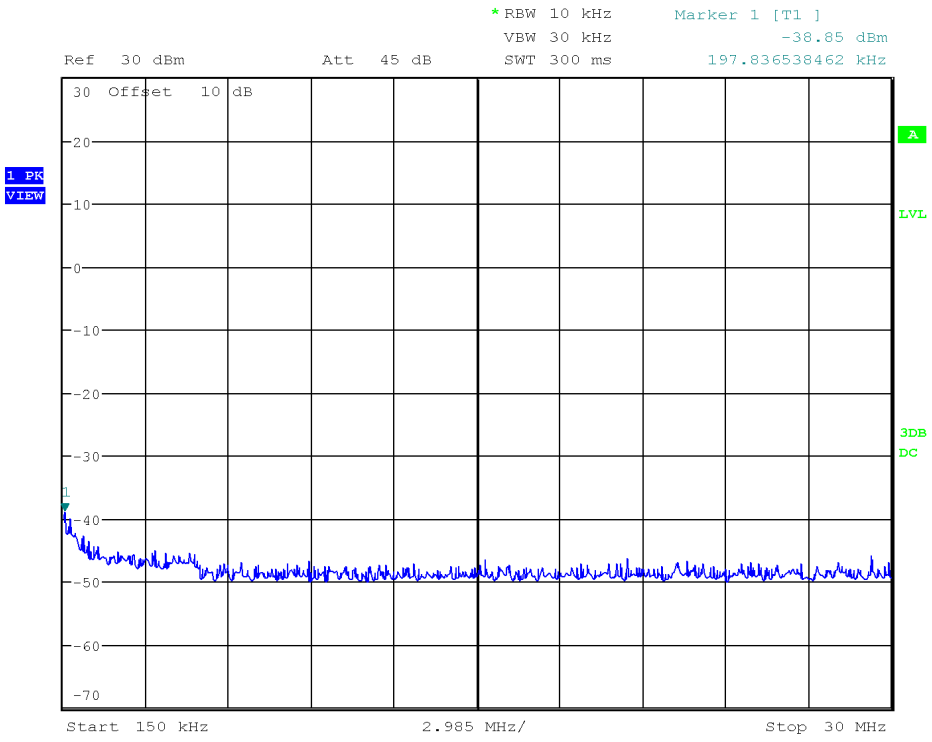
The graphs shown below show the worst-case peak power output of the device during the antenna conducted measurement during transmit operation of the EUT. No attenuator was used between the EUT and the Spectrum Analyzer.

ZX Low Voltage Thermostat(2.4GHz)

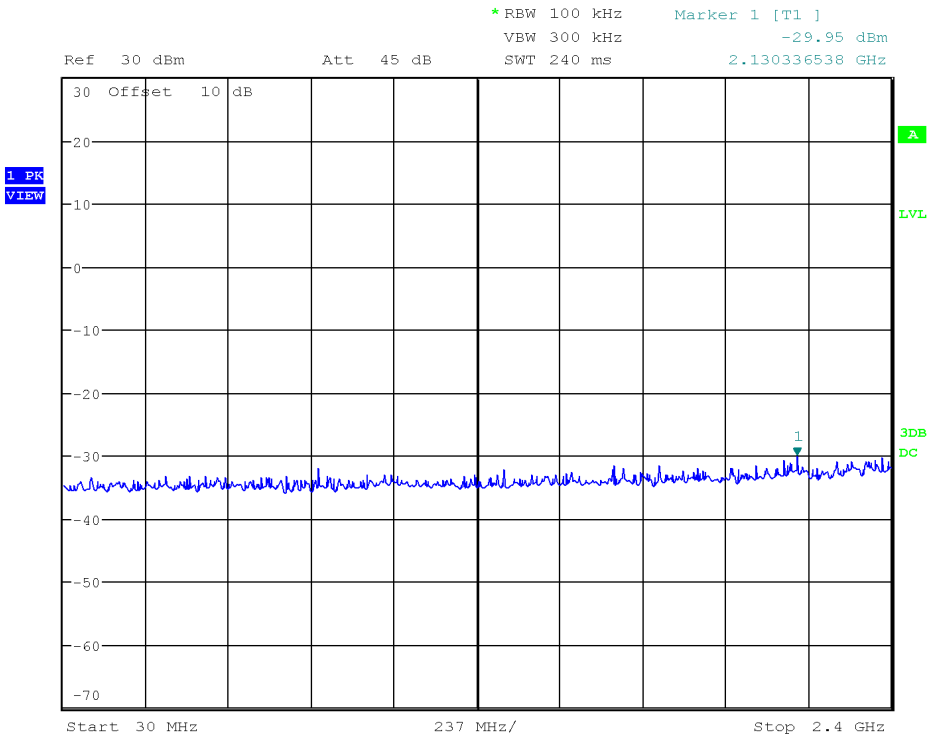


Date: 9.APR.2019 00:07:57

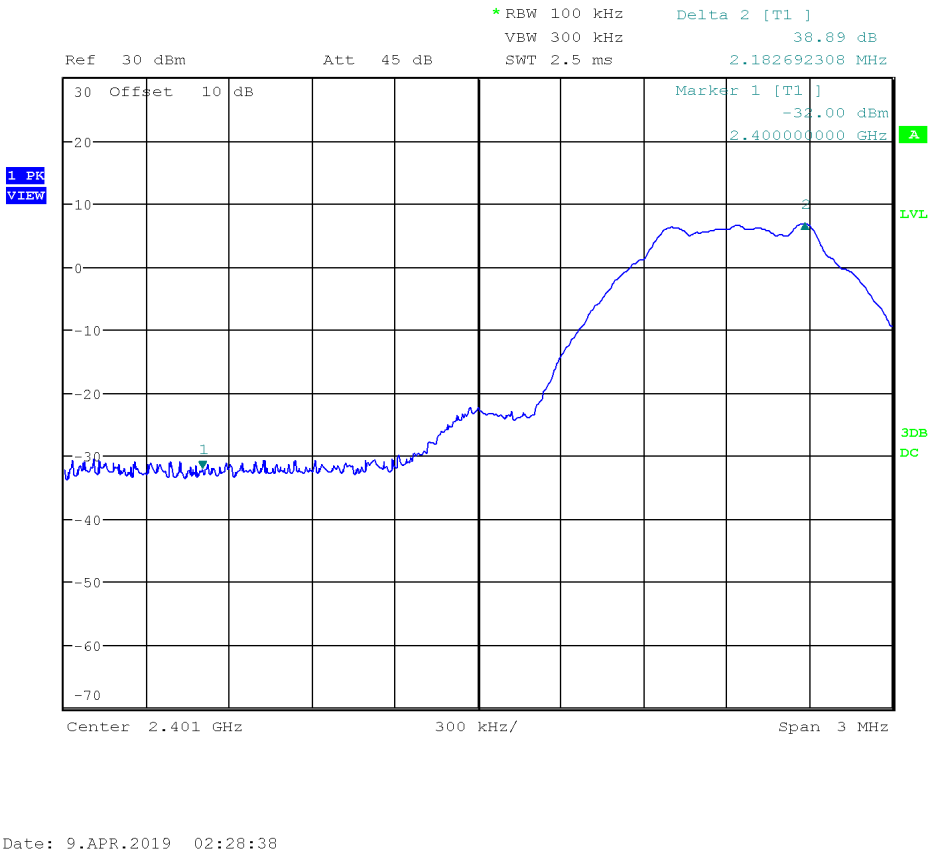
Graph 24 Test Results – Low Band Edge – 9kHz to 150kHz – Low Channel



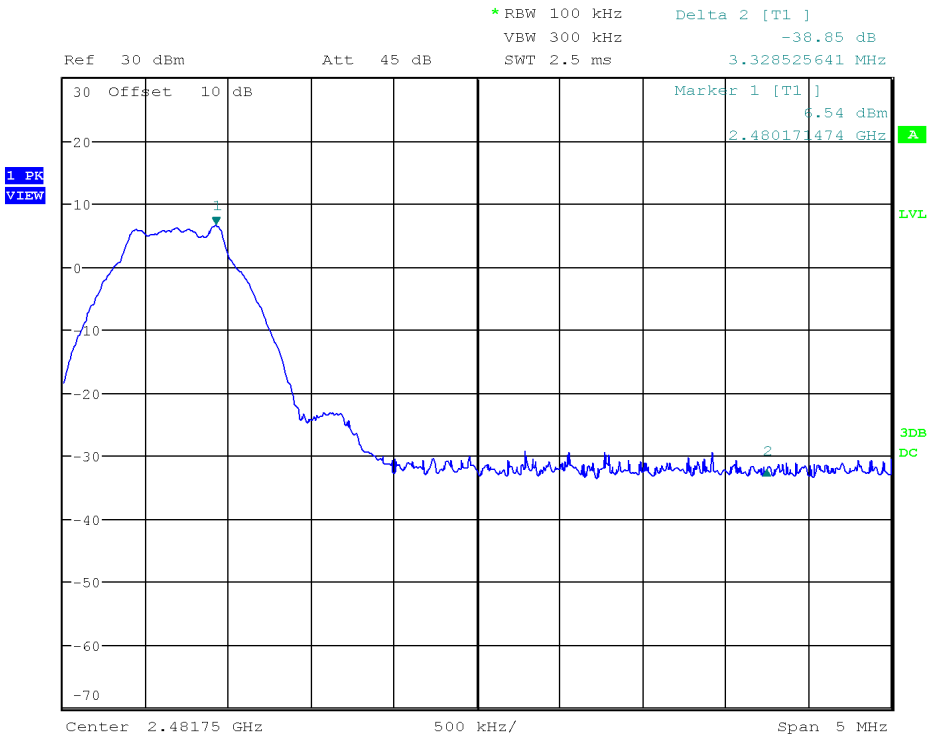
Graph 25 Test Results – Band Edge –150kHz to 30MHz – Low Channel



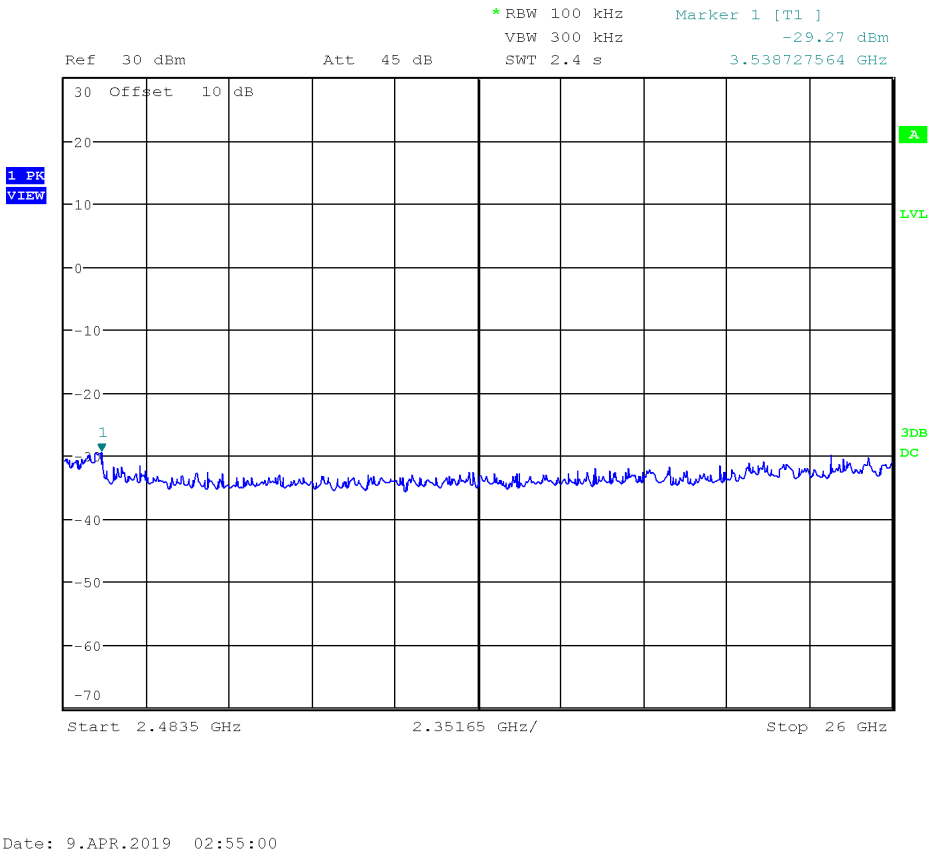
Graph 26 Test Results – Band Edge –30MHz to 2.4GHz– Low Channel



Graph 27 Test Results – Band Edge –2.4GHz to 2.402GHz– Mid Channel

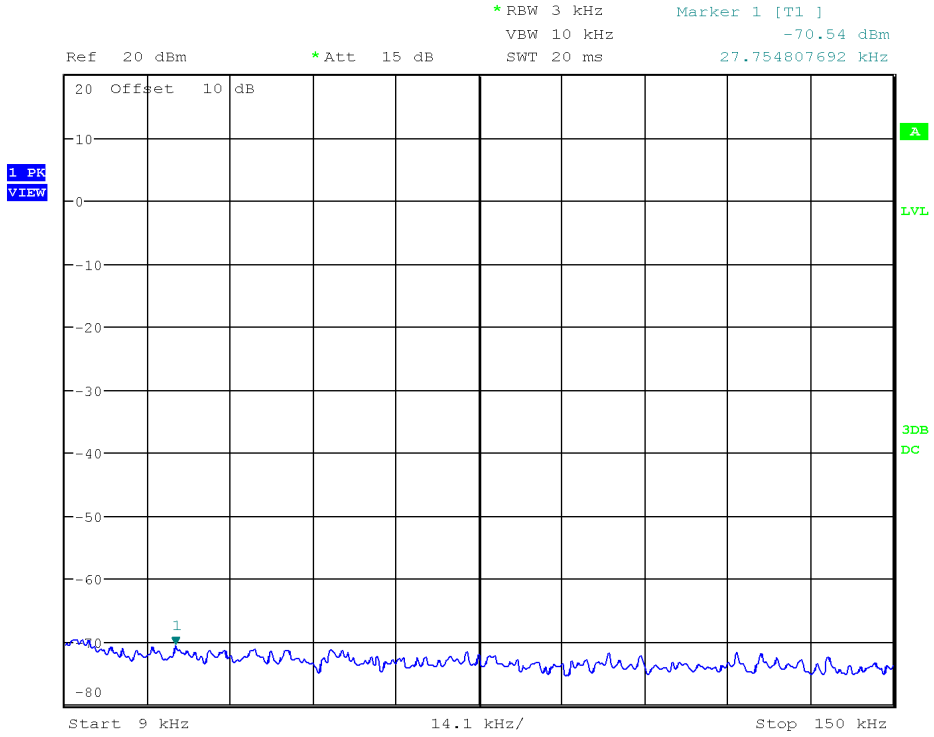


Graph 28 Test Results – Band Edge –2.402GHz to 2.4835GHz– Mid Channel

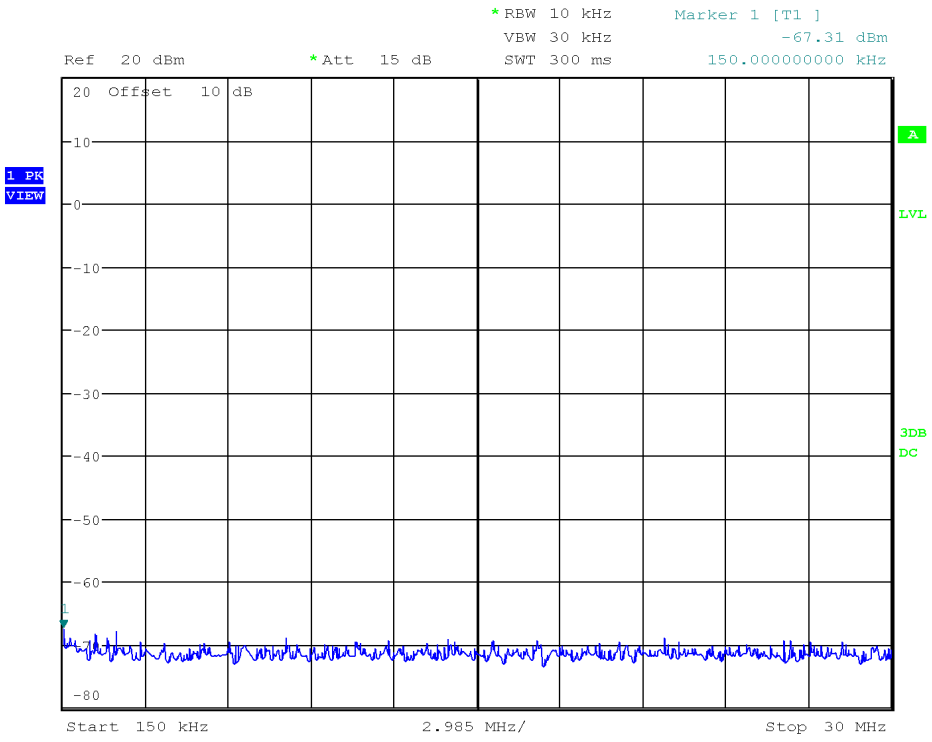


Graph 29 Test Results – Band Edge –2.4835GHz to 26GHz– High Channel

ZX Low Voltage Thermostat(900MHz)

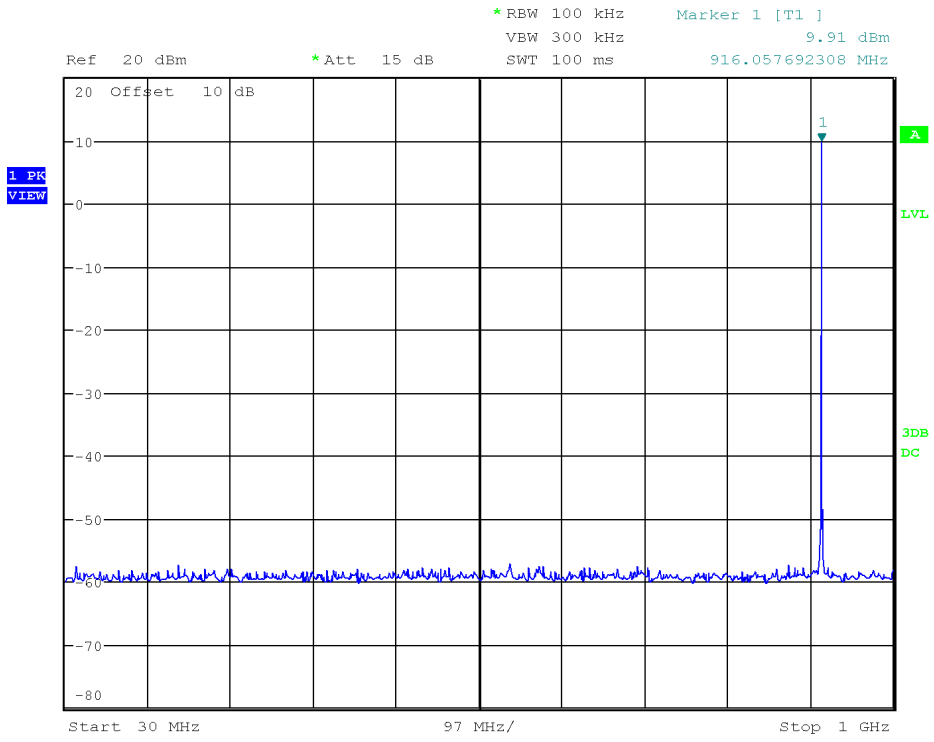


Graph 30 Test Results – Band Edge – 9kHz to 150kHz – Low Channel

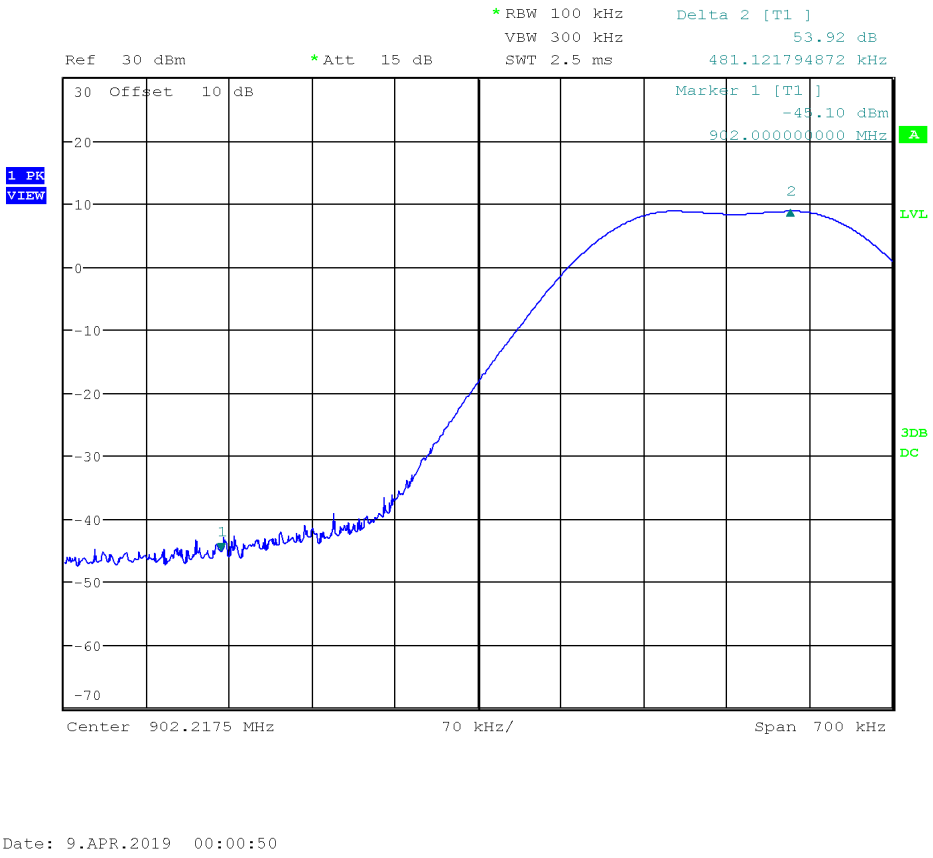


Date: 9.APR.2019 00:10:45

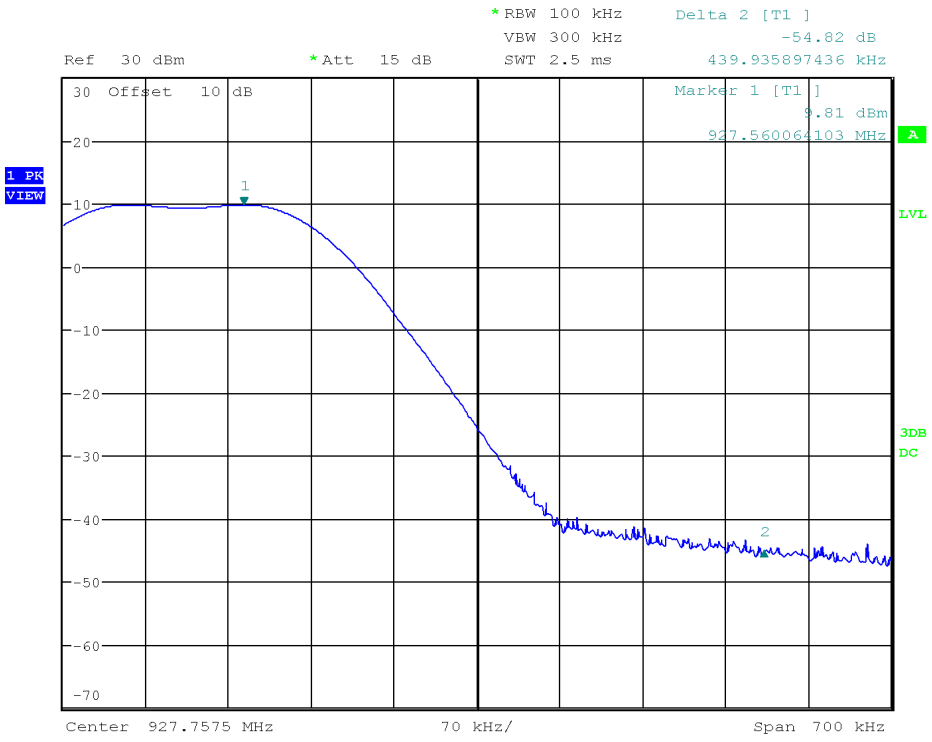
Graph 31 Test Results – Band Edge –150kHz to 30MHz – Low Channel



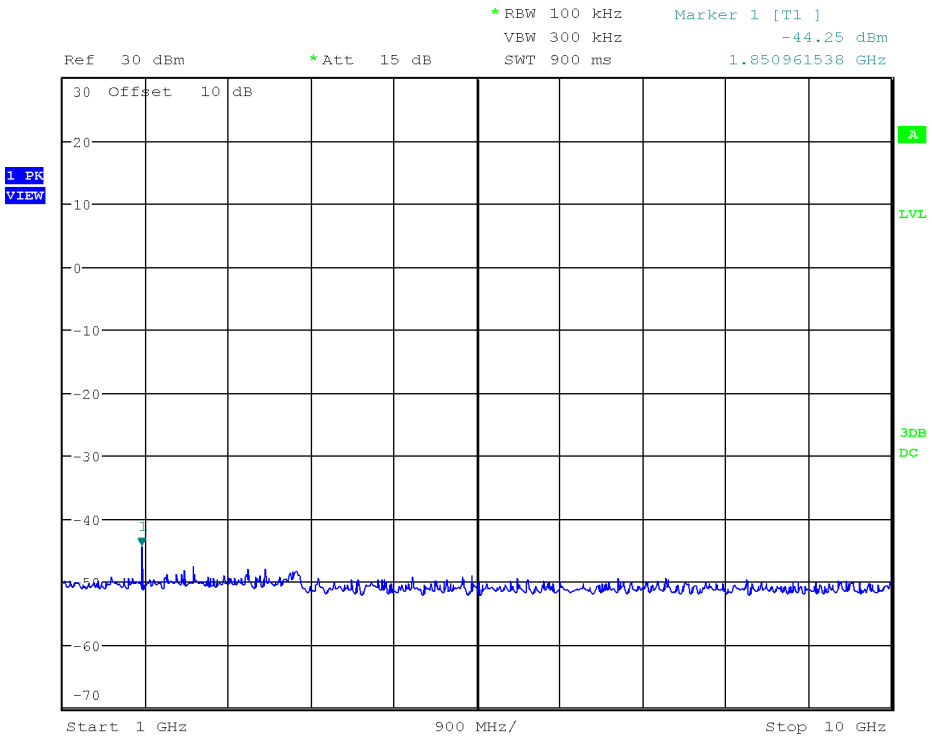
Graph 32 Test Results – Band Edge –30MHz to 1GHz – Mid Channel



Graph 33 Test Results – Band Edge – 900MHz to 902.46 MHz– Mid Channel



Graph 34 Test Results – Band Edge – 902 to 928MHz– Mid Channel



Graph 35 Test Results – Band Edge –1GHz to 10 GHz – High Channel

13.7 Test Instruments

This test was carried out in Laval test location. Instrumentation used is depicted in Table 26.

Equipment	Model No.	Manufacturer	Calibration Period (months)	Calibration Due (YYY-MM-DD)	Asset No: LAVE
Spectrum Analyzer	ESU-40	Rohde & Schwarz	24	2019-04-20	4092
Attenuator 10 dB	4779-10	Narda	NCR	NCR	4096

Table 26 – 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. Limits are depicted in Table 27.

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 27 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 2442 2480	902.46 915 927.52			
EUT					
Identification	ZX LOW VOLTAGE THERMOSTAT				
Voltage Input	5Vdc				
ENVIROMENTAL & TEST INFO					
Test Date (YYYY-MM-DD)	2019-02-26	2019-03-15	2019-03-19	2019-04-04	2019-04-05
Temperature (°C)	24 ± 2	21 ± 2	23 ± 2	21 ± 2	21 ± 2
Humidity (%)	15 ± 5	18 ± 5	20 ± 5	19 ± 5	15 ± 5
Atmospheric Pressure kPa (For Info Only)	102.6	101	101	100.6	103.2
Tester	Abderrahmane Ferhat				
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 Results

The EUT passed. Low, medium, and high bands were tested. 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
Low	0.009 – 0.015	-	-	-	See Table 27	Note 1	Pass
	0.015 – 30						Pass
	30 – 1000						Pass
	>1000						Pass
Mid	0.009 – 0.015	-	-	-		Note 1	Pass
	0.015 – 30						Pass
	30 – 1000	67.1	Vertical	Quasi-Peak		1.2 <Note 2>	Pass
	>1000	1830.26	Horizontal	Average		0.2 <Note 3>	Pass
High	0.009 – 0.015	-	-	-		Note 1	Pass
	0.015 – 30						Pass
	30 – 1000						Pass
	>1000						Pass

Note 1: No significant emission was measured (< 10dB below the limit).
Note 2: Refer to Appendix A: Table A.1.
Note 3. Refer to Appendix A: Table A.3

Table 28 – Test Results for Tx Spurious Emission – Worst Cases (900MHz)

Channel	Frequency Range (MHz)	Frequency (MHz)	Polarization	Detector	Limit	Margin	Results <Note 2>
Low	0.009 – 0.015	-	-	-	See Table 27	Note 1	Pass
	0.015 – 30						Pass
	30 – 1000						Pass
	>1000						Pass
Mid	0.009 – 0.015	-	-	-		Note 1	Pass
	0.015 – 30						Pass
	30 – 1000	68.16	Vertical	Quasi-Peak		9.2 <Note 2>	Pass
	>1000	2483.5	Horizontal	Average		15.8 <Note 3>	Pass
High	0.009 – 0.015	-	-	-		Note 1	Pass
	0.015 – 30						Pass
	30 – 1000						Pass
	>1000						Pass

Note 1: No significant emission was measured (< 10dB below the limit).
Note 2: Refer to Appendix A: Table A.4.
Note 3. Refer to Appendix A: Table A.5.

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

14.5 Graphs

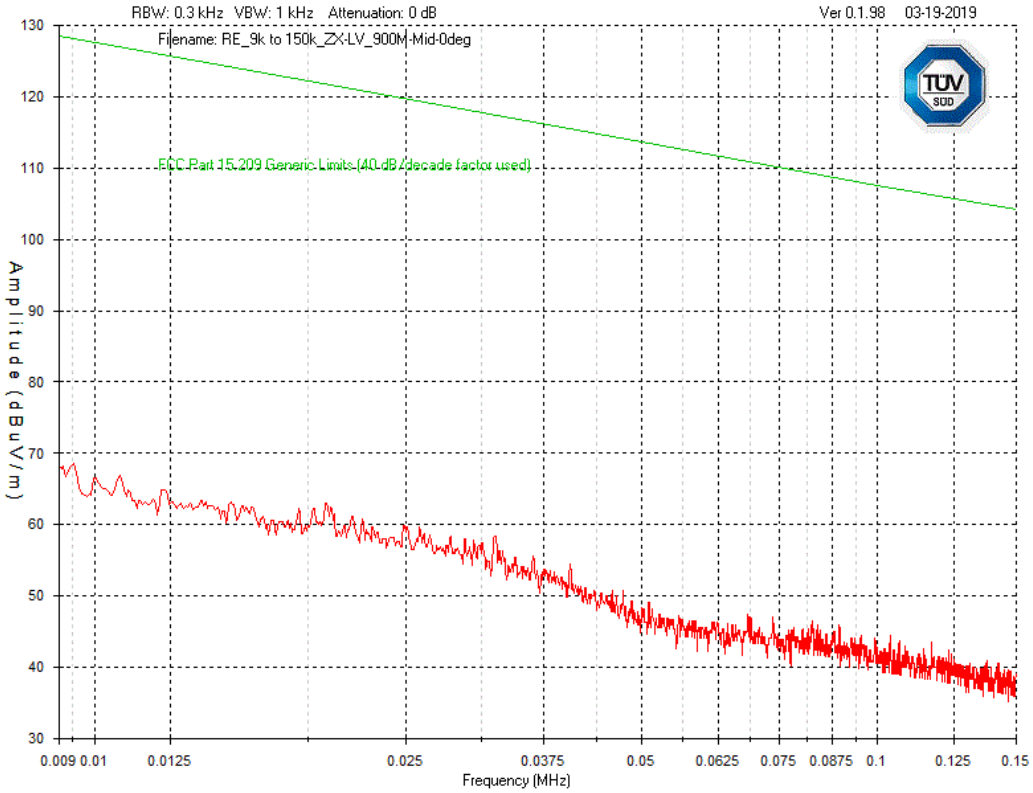
The graphs shown below are maximized peak measurement graphs measured with a resolution bandwidth greater than or equal to the final required detector over a full 0-360°. This peaking process is done as a worst-case measurement and enables the detection of frequencies of concern for final measurement. 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).

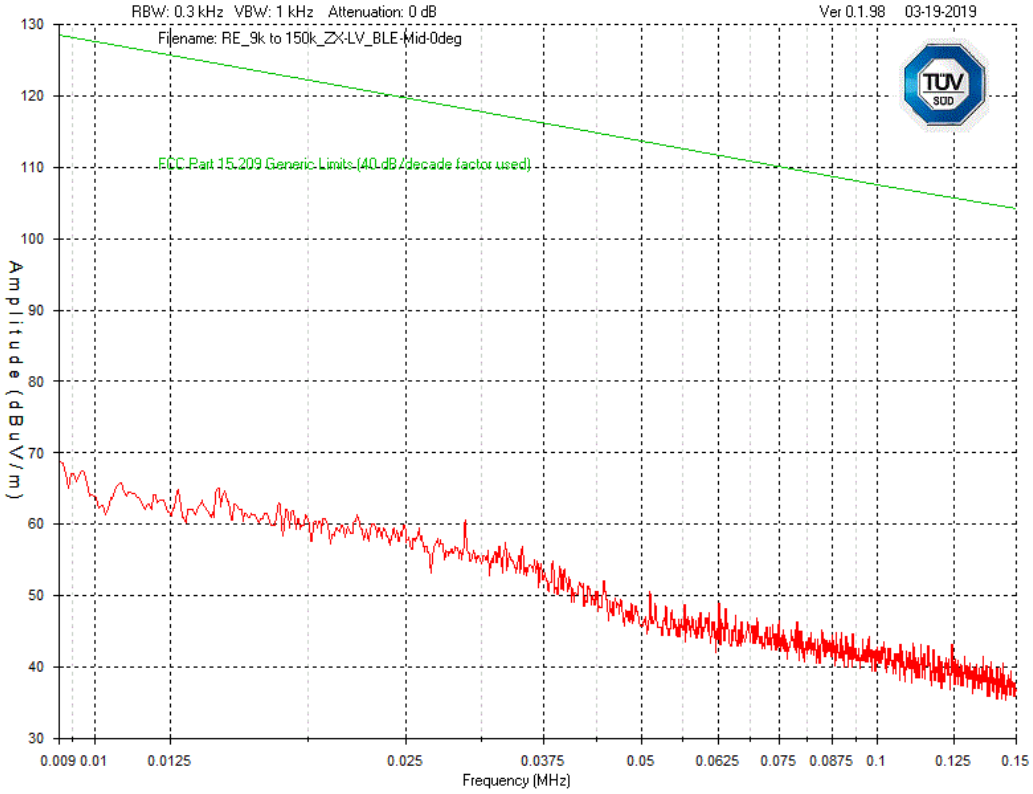
Devices scanned may be scanned at alternate test distances and in accordance with FCC Part 15, Subpart A, Section 15.31, an extrapolation factor of 20 dB/decade was used above 30 MHz and 40 dB/decade below 30 MHz for example, for 1-meter measurements, an extrapolation factor 9.5 dB from 20 Log (1m /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

Low, middle and high channels. However, the worst-case graphs are presented.

Frequency range from 9kHz to 150kHz

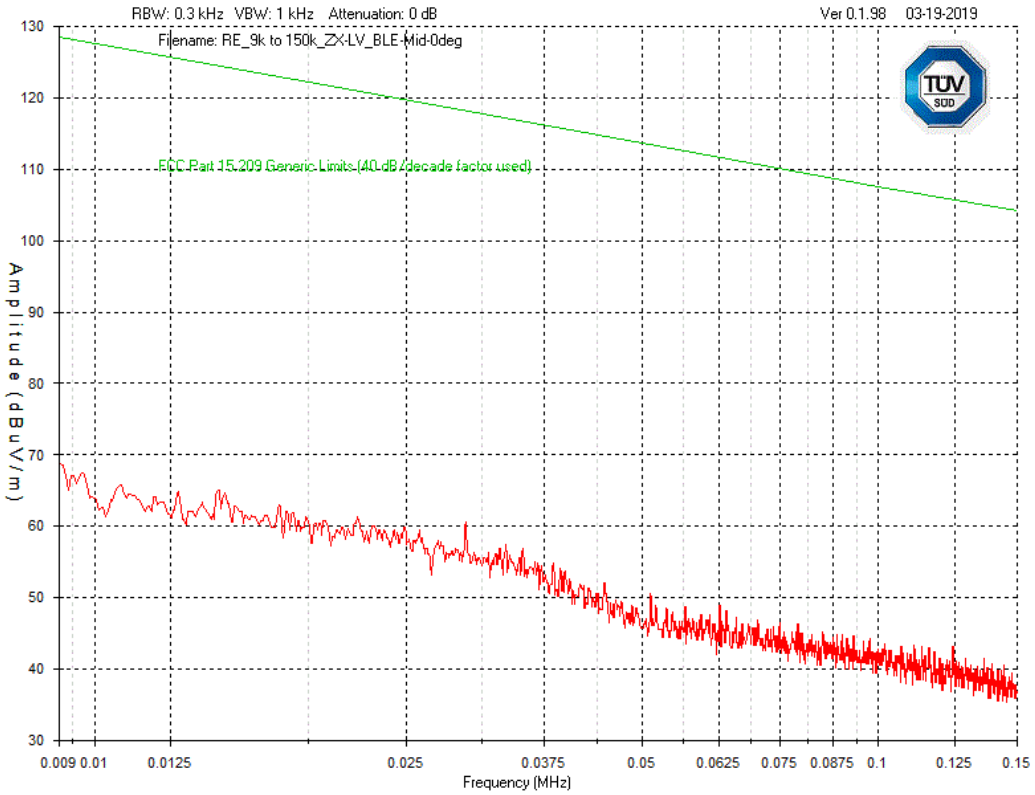


Graph 36 Test Results – Tx Spurious emission 9kHz – 150kHz: Mid Channel ZX Low Voltage Thermostat (900MHz)

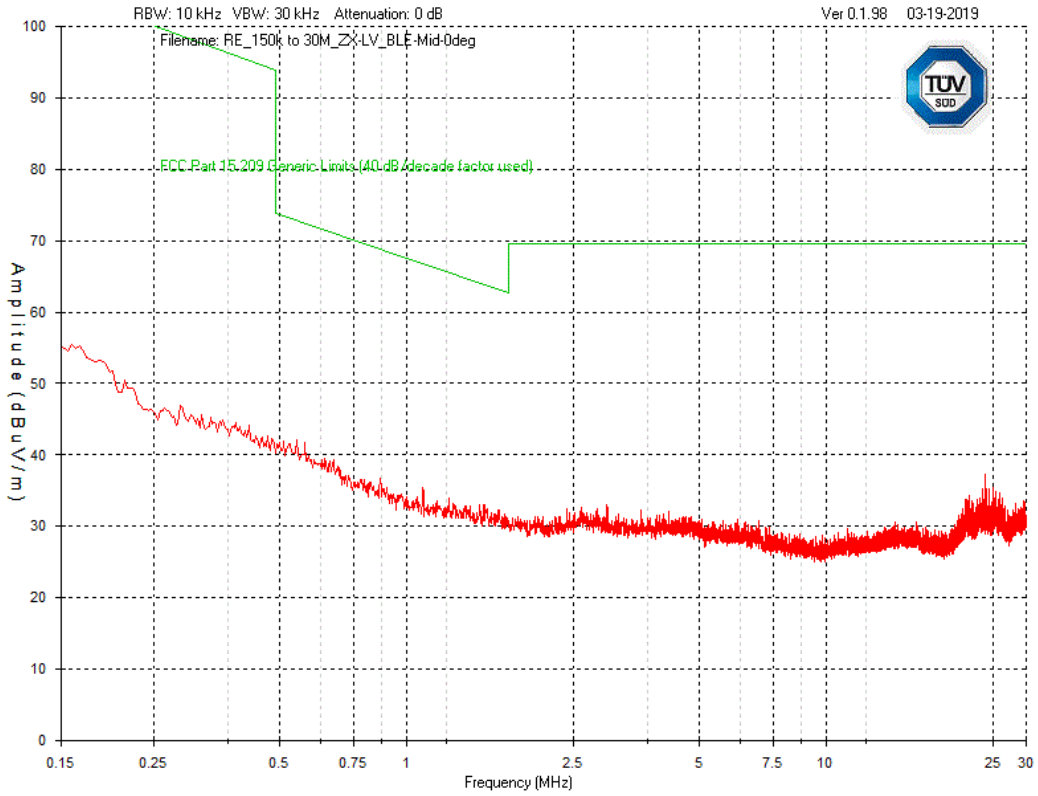


Graph 37 Test Results – Tx Spurious emission 9kHz – 150kHz: Mid Channel ZX Low Voltage Thermostat (2.4GHz)

Frequency range from 150kHz to 30MHz

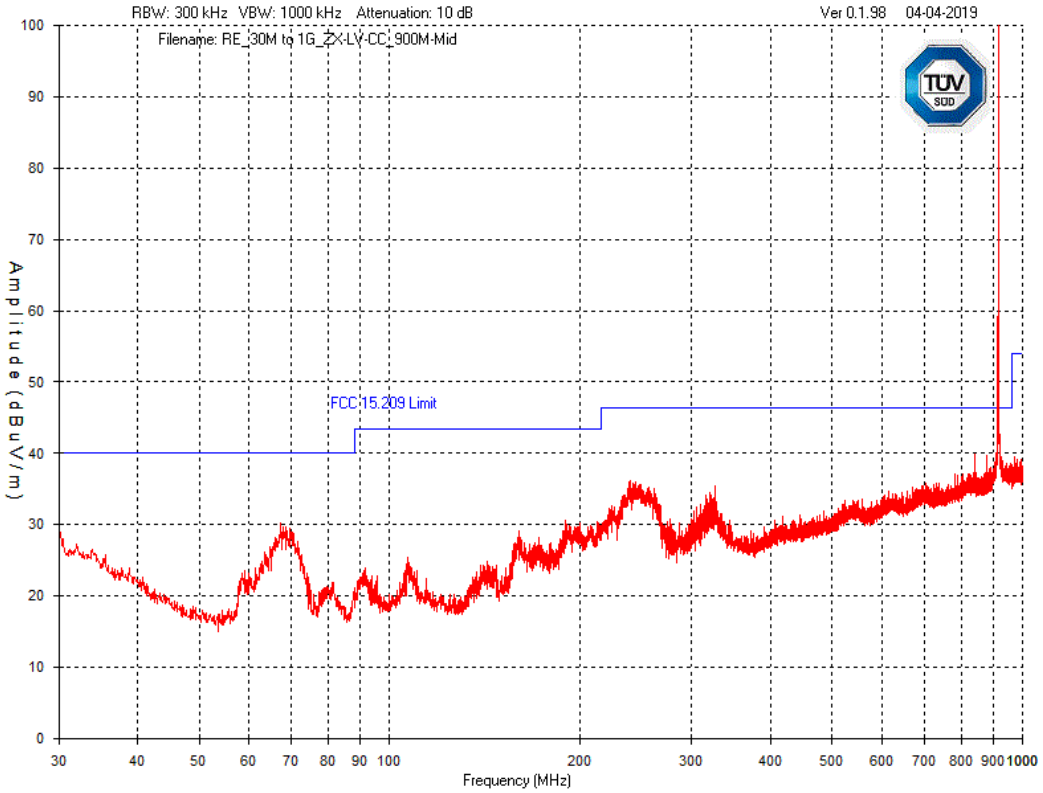


Graph 38 Test Results – Tx Spurious emission 150kHz – 30MHz: Mid Channel ZX Low Voltage Thermostat (900MHz)

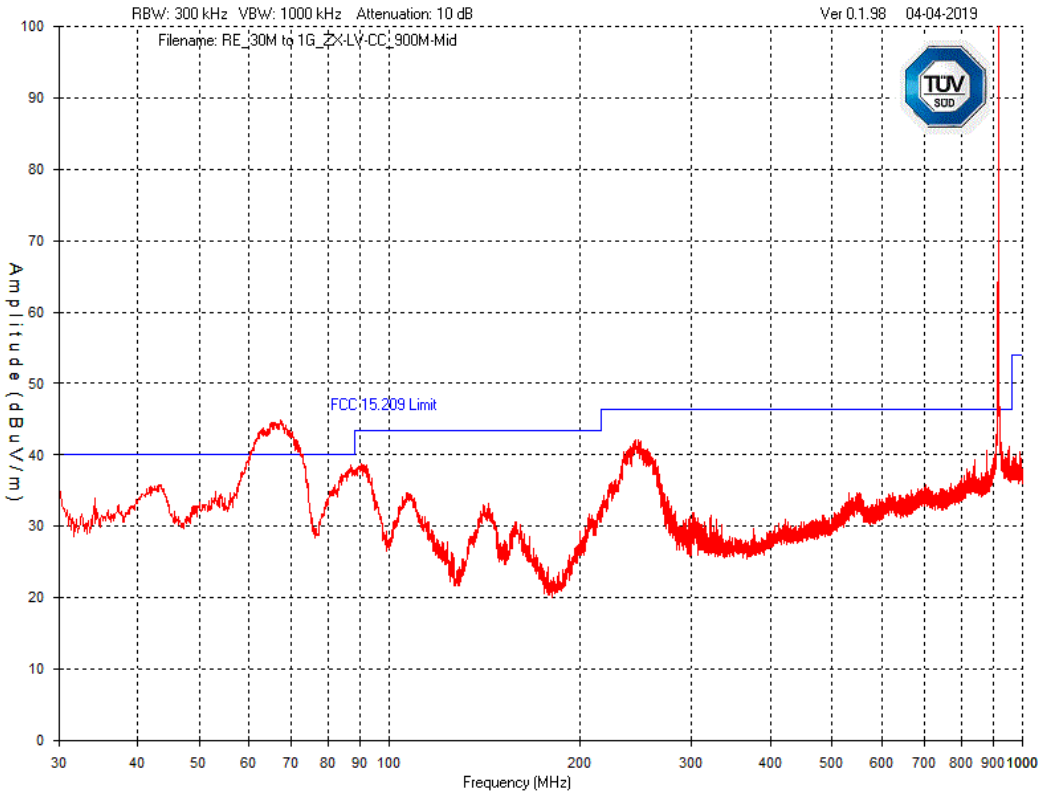


Graph 39 Test Results – Tx Spurious emission 150kHz – 30MHz: Mid Channel ZX Low Voltage Thermostat (2.4GHz)

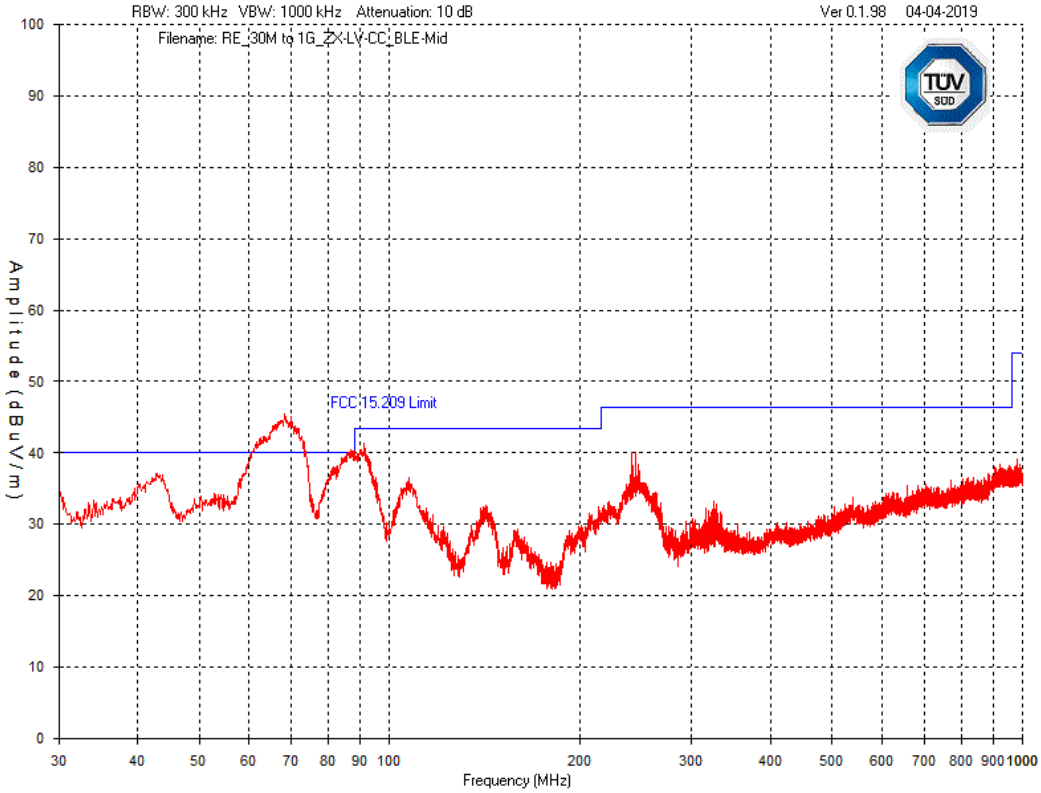
Frequency Range from 30MHz to 1GHz – Worst case – Mid Channel



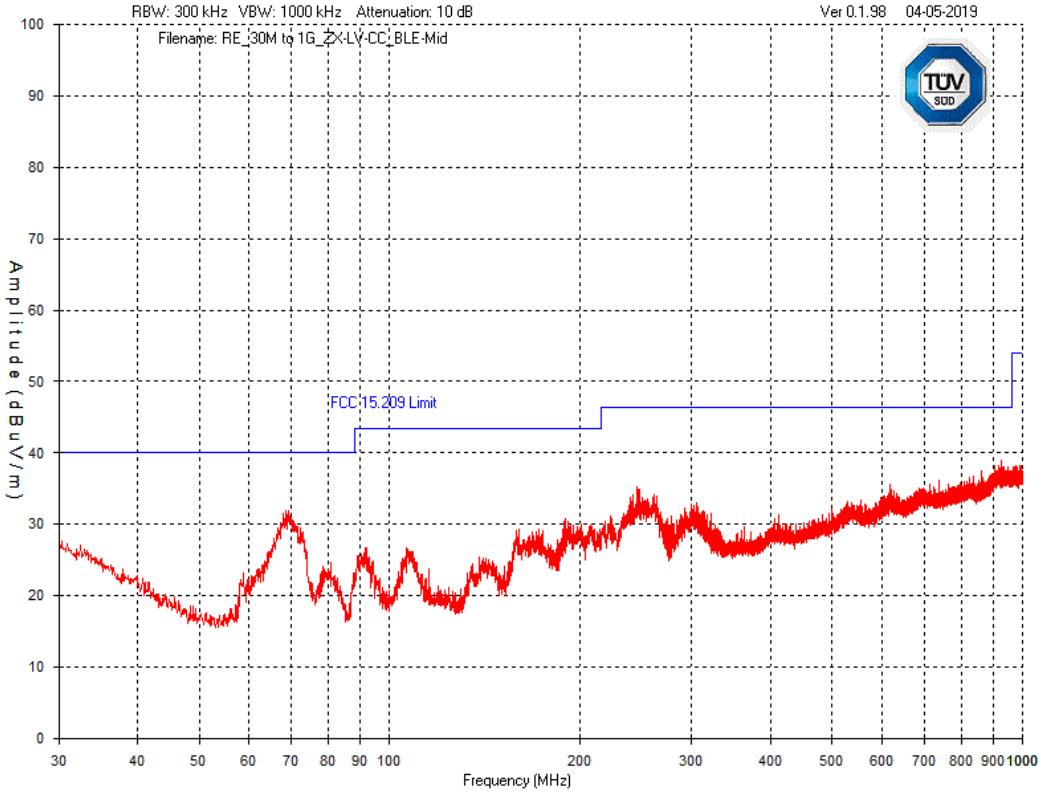
Graph 40 Test Results – Tx Spurious emission 30MHz – 1GHz: Mid Channel ZX Low Voltage Thermostat (900MHz) – Horizontal Polarization



Graph 41 Test Results – Tx Spurious emission 30MHz – 1GHz: Mid Channel ZX Low Voltage Thermostat (900MHz) – Vertical Polarization

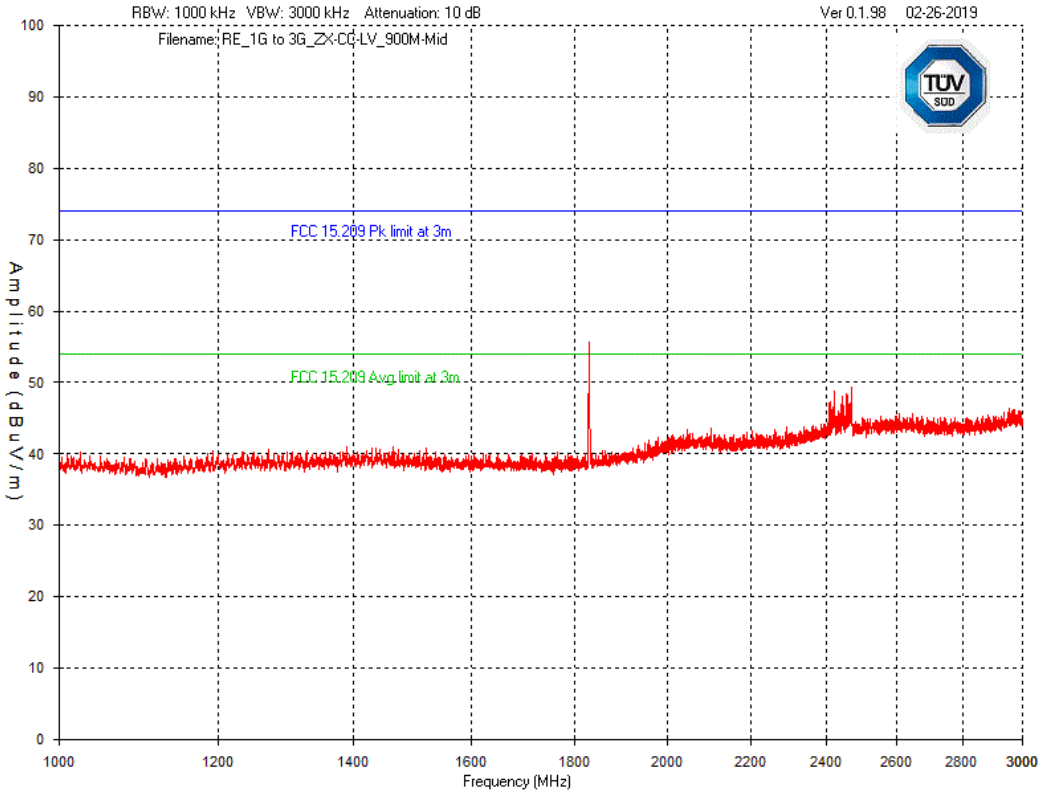


Graph 42 Test Results – Tx Spurious emission 30MHz – 1GHz: Mid Channel ZX Low Voltage Thermostat(2.4GHz) – Vertical Polarization

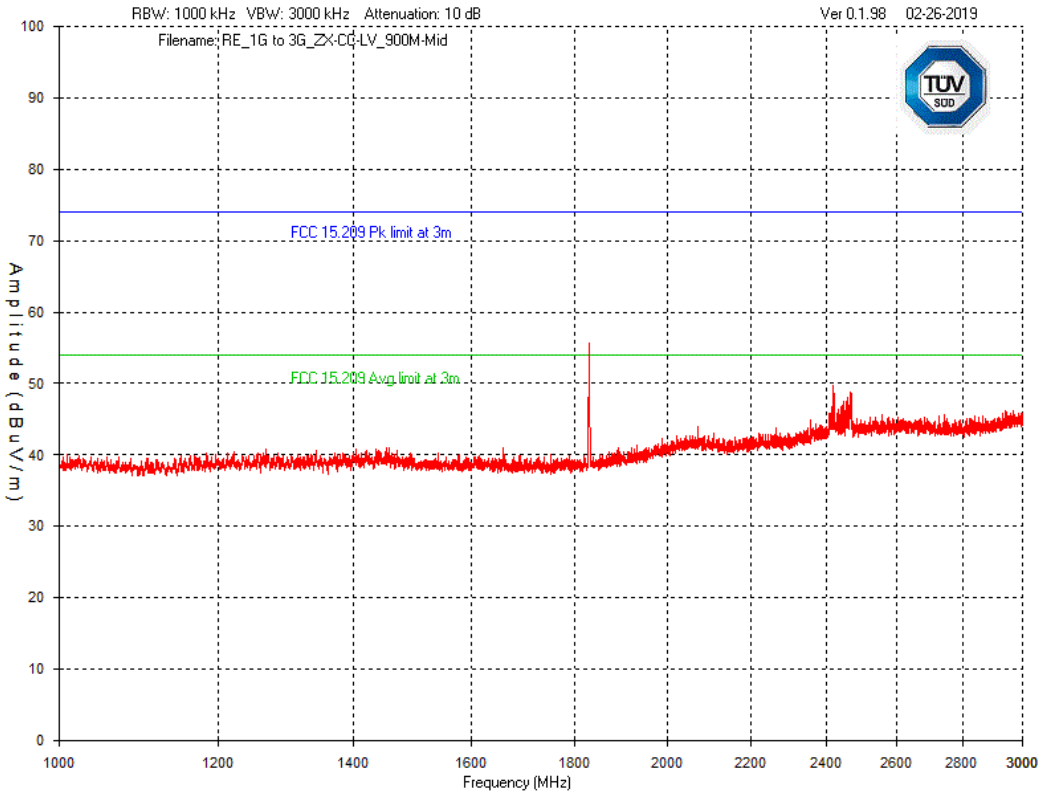


Graph 43 Test Results – Tx Spurious emission 30MHz – 1GHz: Mid Channel ZX Low Voltage Thermostat(2.4GHz) – Horizontal Polarization

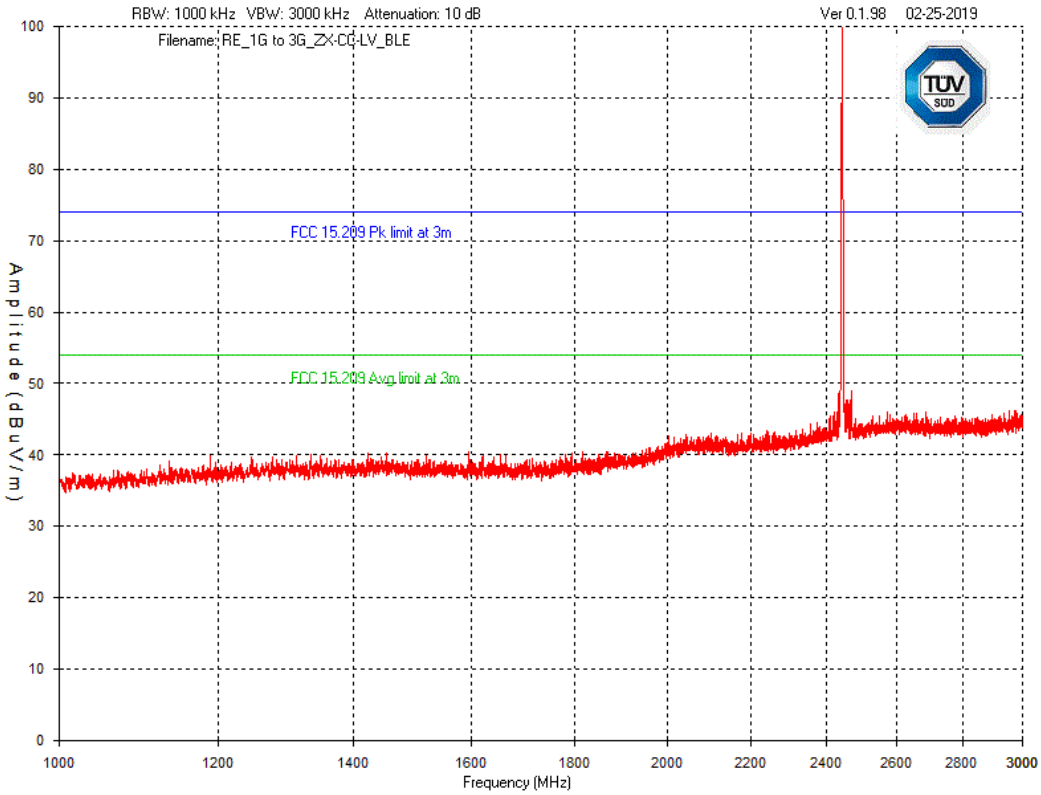
Frequency Range from 1GHz to 3GHz – Worst case – Mid Channel



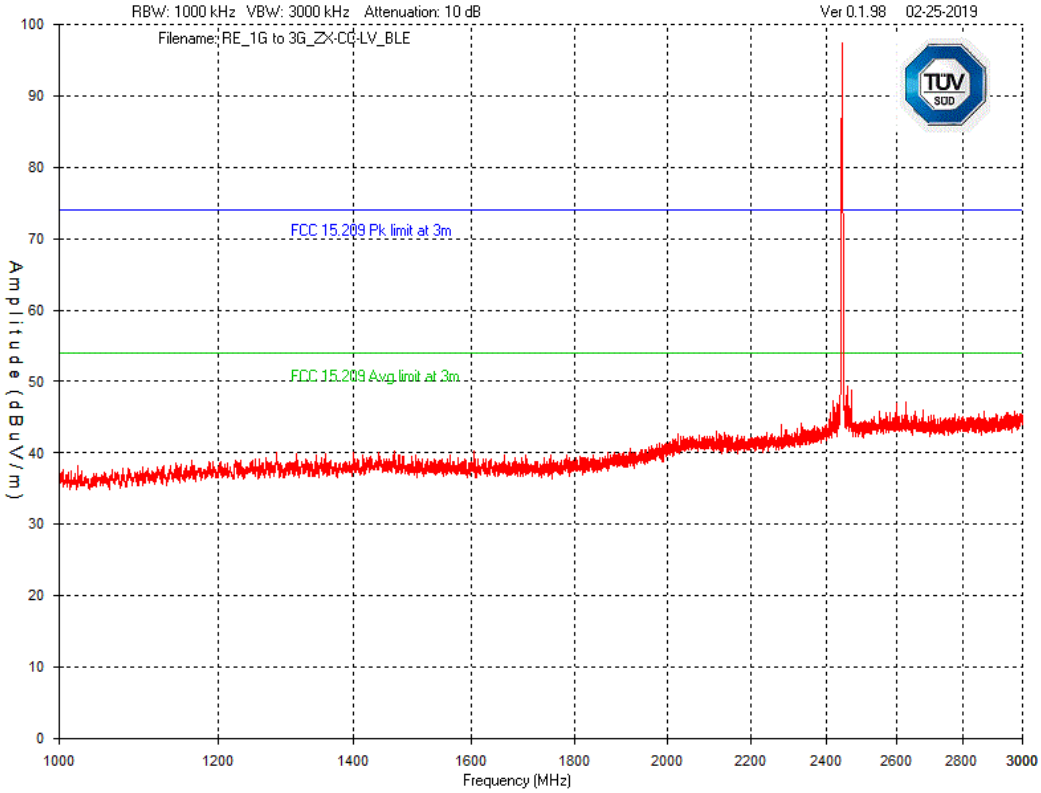
Graph 44 Test Results – Tx Spurious emission 1GHz – 3GHz: Mid Channel ZX Low Voltage Thermostat (900MHz) – Horizontal Polarization



Graph 45 Test Results – Tx Spurious emission 1GHz – 3GHz: Mid Channel ZX Low Voltage Thermostat (900MHz) – Vertical Polarization

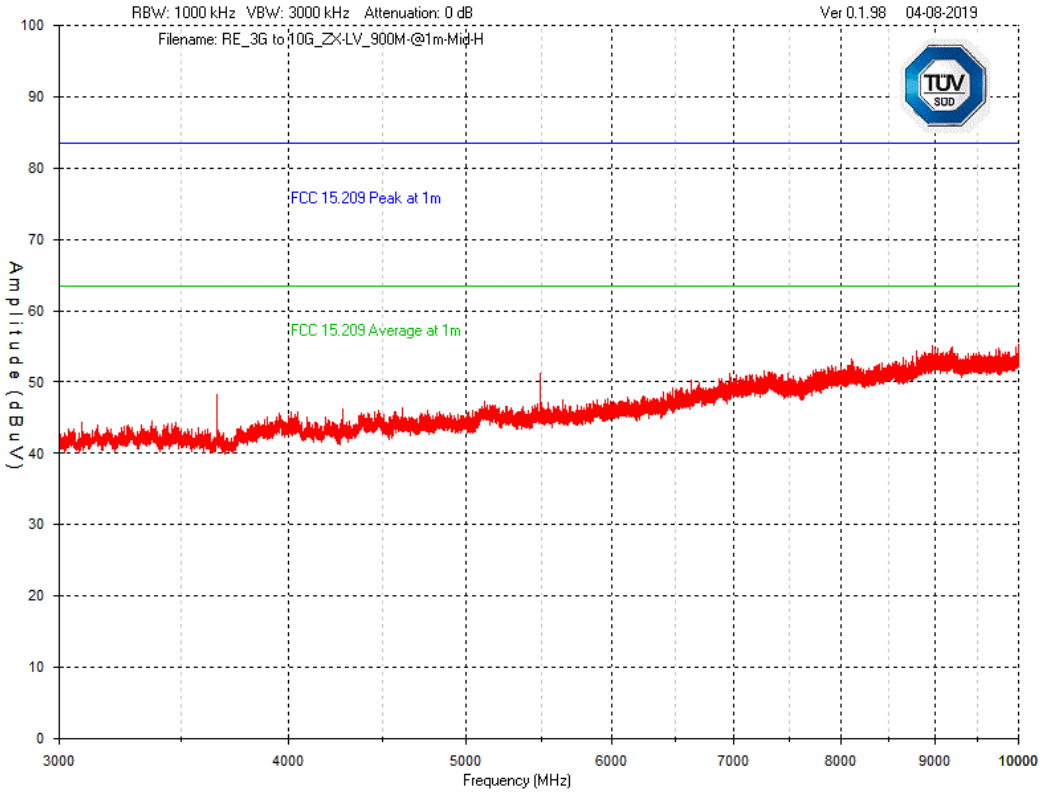


Graph 46 Test Results – Tx Spurious emission 1GHz – 3GHz: Mid Channel ZX Low Voltage Thermostat (2.4GHz) – Horizontal Polarization

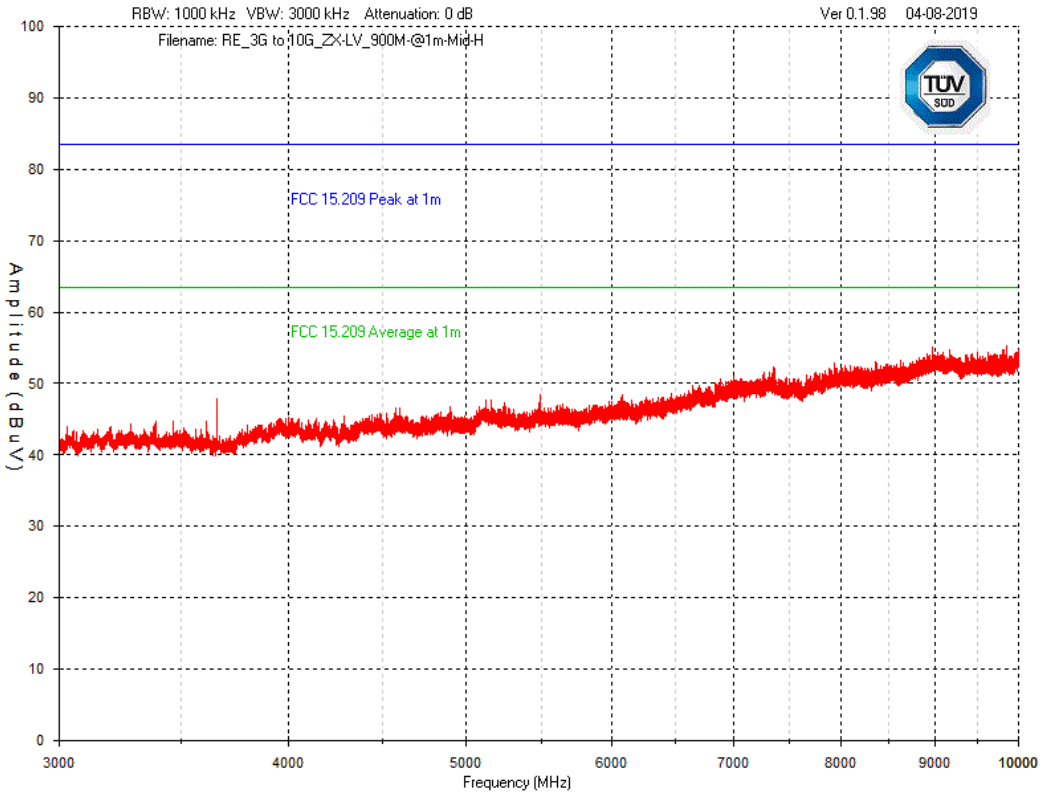


Graph 47 Test Results – Tx Spurious emission 1GHz – 3GHz: Mid Channel ZX Low Voltage Thermostat (2.4GHz) – Vertical Polarization

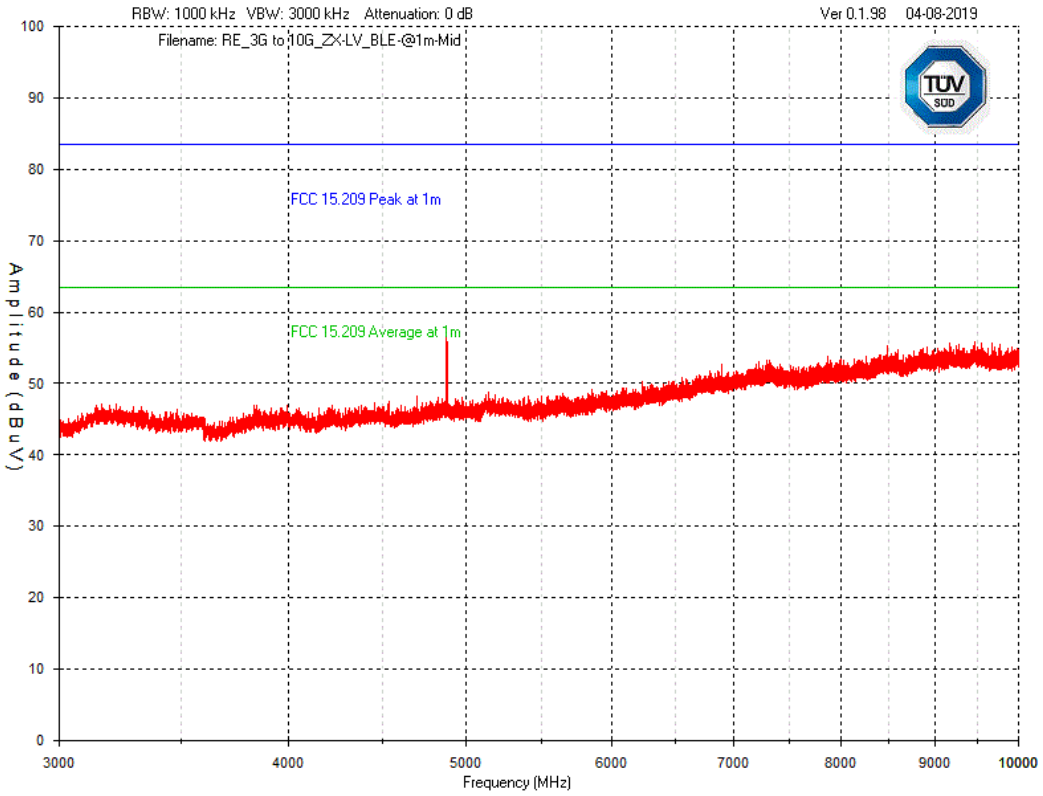
Frequency Range from 3GHz – 10GHz – Worst case – Mid Channel



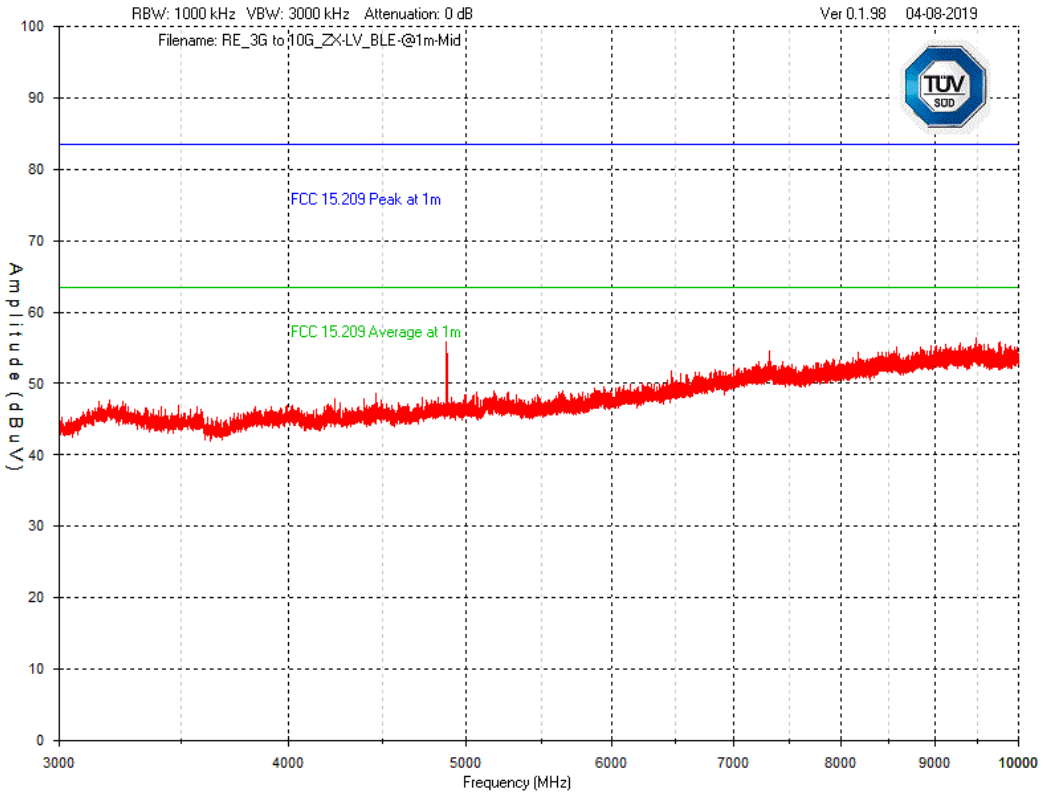
Graph 48 Test Results – Tx Spurious emission 3GHz – 10GHz: Mid Channel ZX Low Voltage Thermostat (900MHz) – Horizontal Polarization



Graph 49 Test Results – Tx Spurious emission 3GHz – 10GHz: Mid Channel ZX Low Voltage Thermostat (900MHz) – Vertical Polarization

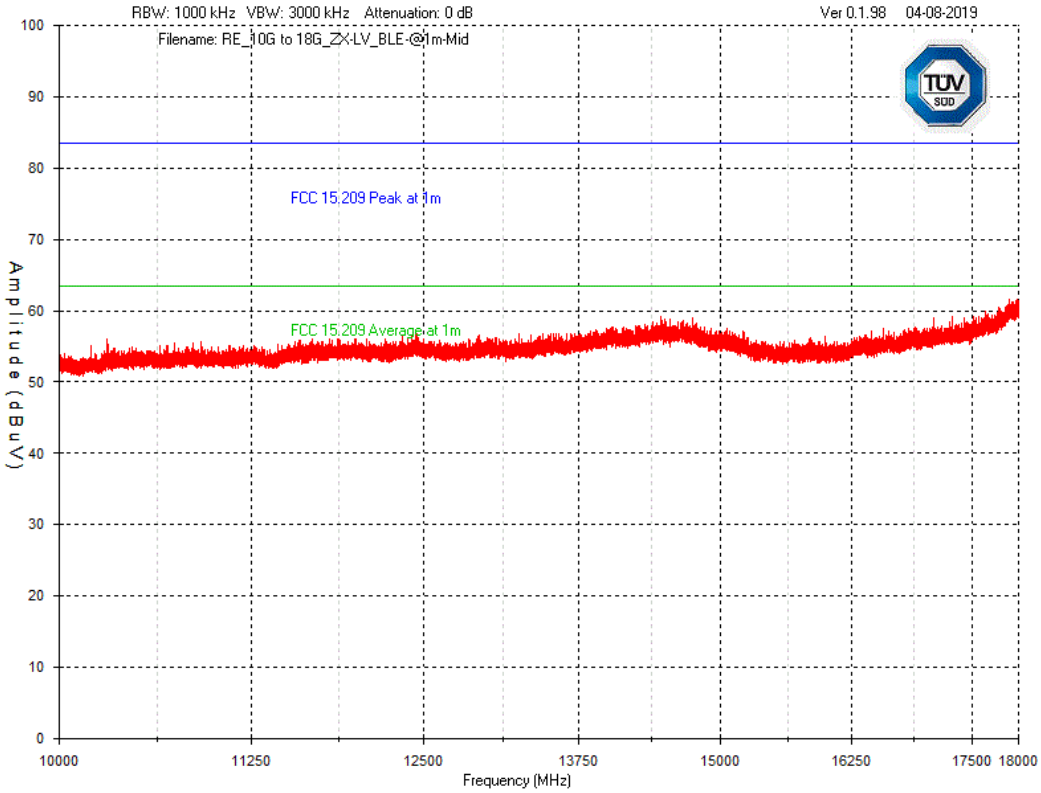


Graph 50 Test Results – Tx Spurious emission 3GHz – 10GHz: Mid Channel ZX Low Voltage Thermostat (2.4GHz) – Horizontal Polarization

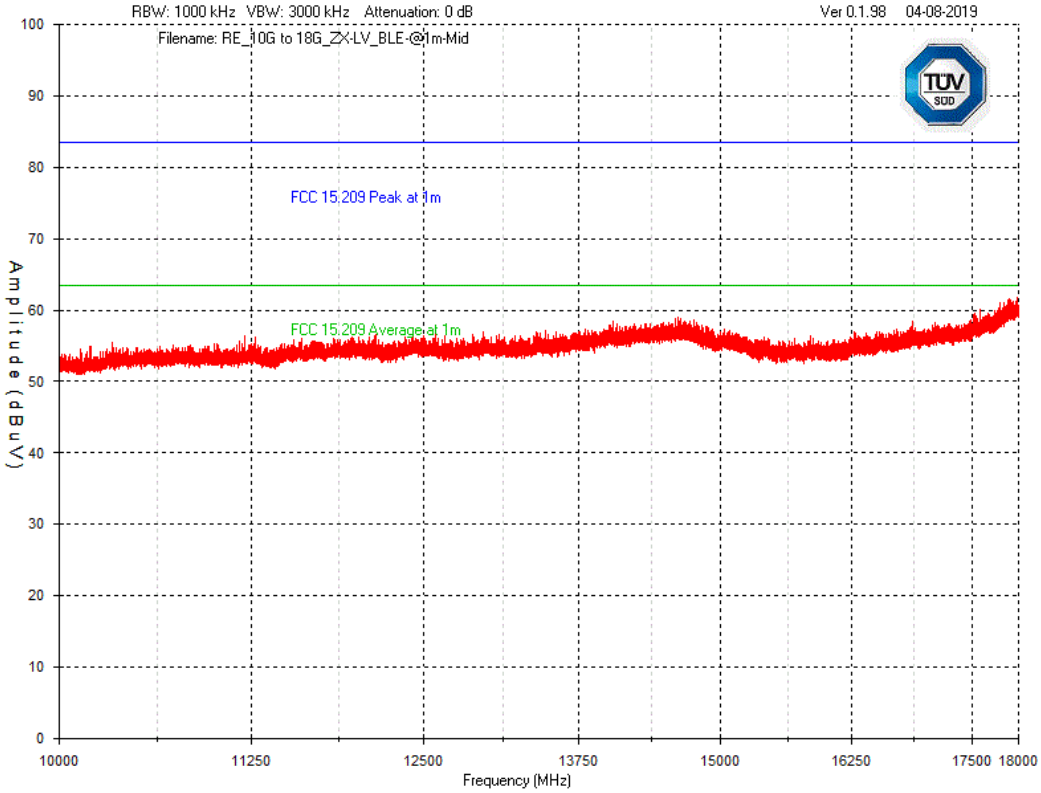


Graph 51 Test Results – Tx Spurious emission 3GHz – 10GHz: Mid Channel ZX Low Voltage Thermostat (2.4GHz) – Vertical Polarization

Frequency Range from 10GHz – 18GHz – Worst case – Mid Channel

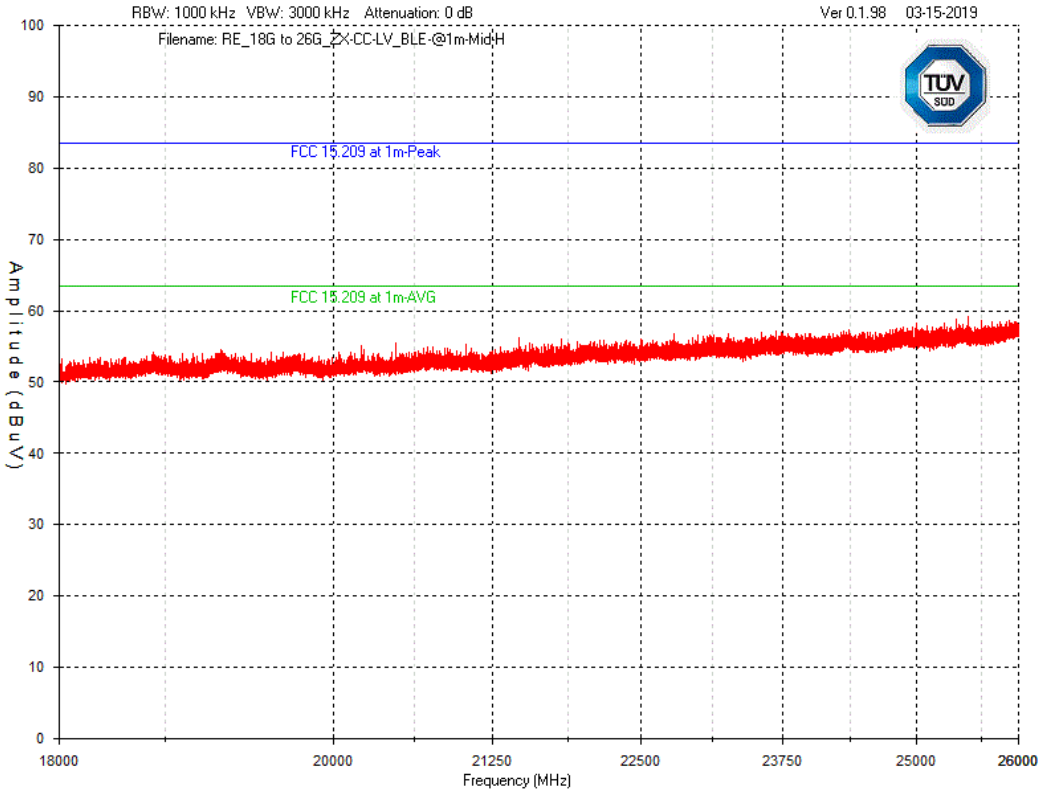


Graph 52 Test Results – Tx Spurious emission 10GHz – 18GHz: Mid Channel ZX Low Voltage Thermostat (2.4GHz) – Horizontal Polarization

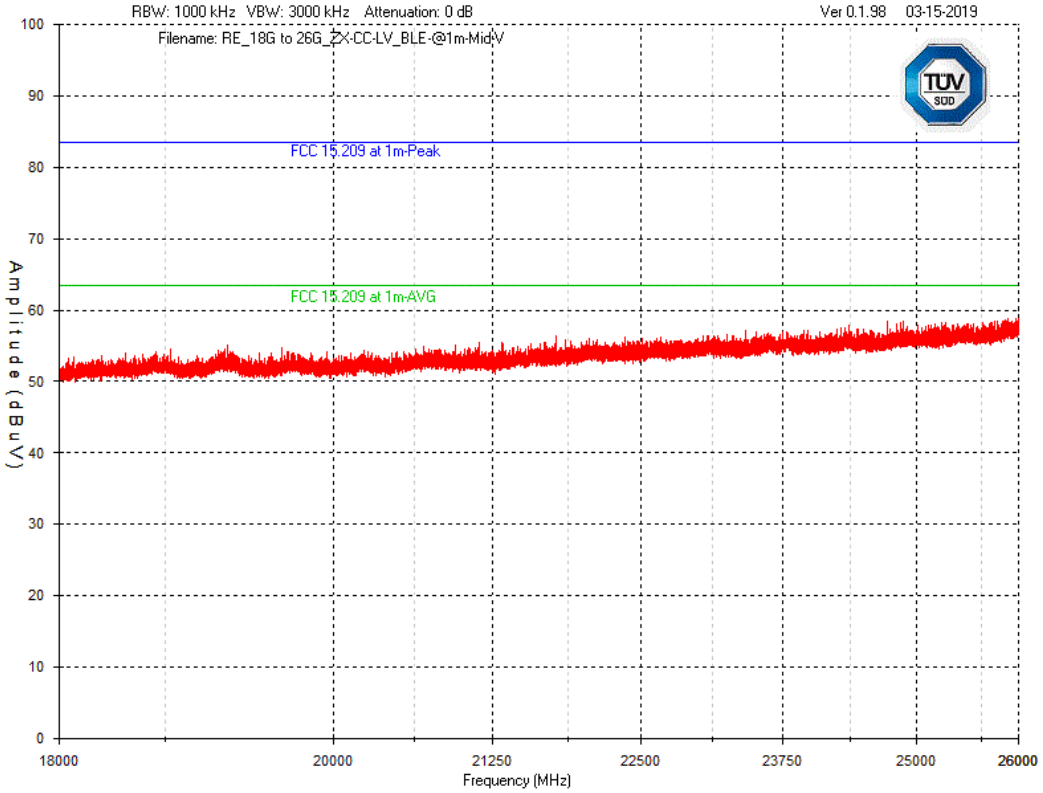


Graph 53 Test Results – Tx Spurious emission 10GHz – 18GHz: Mid Channel ZX Low Voltage Thermostat (2.4GHz) – Vertical Polarization

Frequency Range from 18GHz – 26GHz – Worst case – Mid Channel



Graph 54 Test Results – Tx Spurious emission 18GHz – 26GHz: Mid Channel ZX Low Voltage Thermostat (2.4GHz) – Horizontal Polarization



Graph 55 Test Results – Tx Spurious emission 18GHz – 26GHz: Mid Channel ZX Low Voltage Thermostat (2.4GHz) – Vertical Polarization

14.6 Test Instruments

This test was carried out in Laval test location. Instrumentation used is depicted in Table 30.

Equipment	Model No.	Manufacturer	Calibration Period (months)	Calibration Due (YYY-MM-DD)	Asset No LAV0
Spectrum Analyzer	ESU-40	Rohde & Schwarz	24	2019-04-20	4092
BiLog Antenna	3142-E	ETS	24	2020-11-29	4002
Horn Antenna	ATH1G18G	AR	24	2019-04-25	4003
Biconical Antenna	EM-6913	Electro-Metrics	24	2019-05-02	4060
Log Periodic Antenna	LPA-25	Electro-Metrics	24	2019-04-20	4087
Loop Antenna	EM 6879	Electro-Metrics	24	2019-04-19	4040
Attenuator 3 dB	FP-50-3	Trilithic	NCR	NCR	4028
LNA pre-amp	LNA-1450	RF Bay Inc.	24	2019-07-22	4089
1-26.5GHz preamp	8449B	Agilent	24	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

Table 30 – Test Instrumentation – Tx Spurious Emission

APPENDIX A: Tx Spurious Emissions – Worst Cases

Frequency (MHz)	Detector	Raw Reading	Antenna Factor (dB/m	Atten Factor (dB	Cable Factor (dB)	Pre-Amp (dB)	Level	FCC 15.209 Limit	FCC 15.209 Limit Margin
914.943	Peak	101.2	28.3	4	2.3	-32.3	103.5	46.4	-57.1 <Note 1>
67.0911	QP	56	11.5	4	0.7	-33.4	38.8	40	1.2
43.2052	PEAK	50.5	13.7	4	0.6	-33	35.8	40	4.2
244.876	PEAK	53.9	16.4	4	1.2	-33.3	42.2	46.4	4.2
90.006	PEAK	56.3	11.2	4	0.8	-33.5	38.8	43.5	4.7
Note 1. Transmitter Frequency excluded from FCC limits.									

Table A.1 Tx Spurious Emission Mid Channel (900MHz) – 30MHz- 1GHz – Vertical Polarization-QP

Frequency (MHz)	Detector	Raw Reading	Antenna Factor (dB/m)	Atten Factor (dB)	Cable Factor (dB)	Pre-Amp (dB)	Level	FCC 15.209 Limit	FCC 15.209 Limit Margin
915.04	PEAK	100	28.3	4	2.3	-32.3	102.3	46.4	-55.9 <Note 1>
67.3824	PEAK	47.5	11.5	4	0.7	-33.4	30.3	40	9.7
240.215	PEAK	47.8	16.5	4	1.2	-33.3	36.2	46.4	10.2
327.02	PEAK	44.9	18.4	4	1.4	-33.3	35.4	46.4	11
Note 1. Transmitter Frequency excluded from FCC limits.									

Table A.2 Tx Spurious Emission Mid Channel (900MHz) – 30MHz – 1GHz – Horizontal Polarization- QP

Frequency (MHz)	Detector	Raw Reading	Antenna Factor (dB/m	Atten Factor (dB	Cable Factor (dB)	Pre-Amp (dB)	Level	FCC 15.209 Limit	FCC 15.209 Limit Margin
1830.26	AVG	58.6	24.9	3.3	0.2	-33.1	53.9	54	0.1
2468.9	PEAK	49.4	28.4	4.2	0.3	-33.1	49.2	54	4.8
2421.14	PEAK	49.2	28.2	4.1	0.3	-33.1	48.7	54	5.3
2440.87	PEAK	48.3	28.3	4.1	0.3	-33.1	47.9	54	6.1
2407.69	PEAK	47.7	28.2	4.1	0.3	-33.1	47.2	54	6.8
1000	PEAK	42.9	23.5	2.4	3.1	-34.4	37.5	54	16.5

Table A.3 Tx Spurious Emission Mid Channel(900MHz) –1GHz –3GHz: Horizontal Polarization

Frequency (MHz)	Detector	Raw Reading	Antenna Factor (dB/m	Atten (dB)	Cable Factor (dB)	Pre-Amp (dB)	Level	FCC 15.209 Limit	FCC 15.209 Limit Margin
68.1592	QP	47.9	11.6	4	0.7	-33.4	30.8	40	9.2
90.977	QP	43.6	11.3	4	0.8	-33.5	26.2	43.5	17.3
42.8168	QP	38.2	13.9	4	0.6	-33	23.7	40	16.3
30.0971	QP	28.3	21.3	4	0.5	-32.4	21.7	40	18.3
244.876	QP	32.8	16.4	4	1.2	-33.3	21.1	46.4	25.3
241.575	QP	32.3	16.4	4	1.2	-33.3	20.6	46.4	25.8

Table A.4 Tx Spurious Emission Mid Channel (2.4GHz) –30MHz – 1GHz: Vertical Polarization

Frequency (MHz)	Detector	Antenna Polarity	Raw Signal	Antenna Factor (dB/m)	Cable Factor (dB)	Atten (dB)	Pre-Amp (dB)	Level	FCC 15.209 Limit	FCC 15.209 Limit Margin
2480	Peak	Horz	99.4	28.5	4.2	0.0	33.1	99.0	74/54	Note 1
2483.5	Peak	Horz	51.3	28.5	4.2	0.0	33.1	50.9	74.0	23.1
2483.5	Avg	Horz	38.6	28.5	4.2	0.0	33.1	38.2	54.0	15.8
2483.5	Peak	Vert	50.0	28.5	4.2	0.0	33.1	49.6	74.0	24.4
2483.5	Avg	Vert	36.6	28.5	4.2	0.0	33.1	36.2	54.0	17.8
2483.5	Peak	Horz	51.3	28.5	4.2	0.0	33.1	50.9	74.0	23.1
2483.5	Avg	Horz	38.6	28.5	4.2	0.0	33.1	38.2	54.0	15.8
Note 1. 3.8dBm after applying 99dB(µV) -95.2 (conversion factor). See RF Exposure Report for details.										

Table A.5 Tx Spurious Emission Mid Channel (2.4GHz) –30MHz – 1GHz: Vertical Polarization – High Channel