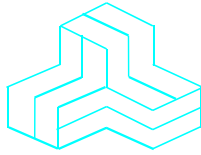


ENGINEERING TEST REPORT



Battery Powered Dimming Light Switch/Battery Powered Light Switch

Model(s): 32120001 and 32120002

FCC ID: 2AUCQ-32120001

Applicant:

Katerra Inc

2115 S service road W

Oakville, ON L6L 5W2

Canada

In Accordance With

Federal Communications Commission (FCC) Part 15, Subpart C, Section 15.247

Digital Modulation Systems (DTS) Operating in 2400 – 2483.5 MHz Band

& ISSED, RSS-247, Issue 2

Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and

Licence-Exempt Local Area Network (LE-LAN) Devices

UltraTech's File No.: 19KATE003_FCCRSS247

This Test report is Issued under the Authority of

Tri M. Luu

Vice President of Engineering

UltraTech Group of Labs

Date: October 1, 2019

Report Prepared by: Santhosh Fernandez

Tested by: Hung Trinh

Date: October 1, 2019

Test Dates: July 2- July 5, 2019

- The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.
- This report must not be used by the client to claim product endorsement by any agency of the US Government.
- This test report shall not be reproduced, except in full, without a written approval from UltraTech

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Website: www.ultratech-labs.com, Email: vic@ultratech-labs.com, Email: tri@ultratech-labs.com



91038



1309



46390-2049



AT-1945



SL2-IN-E-1119R



CA2049

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EXHIBIT 1. INTRODUCTION

1.1. SCOPE

Reference:	FCC Part 15, Subpart C, Section 15.247 Industry Canada RSS-247, Issue 2
Title:	Code of Federal Regulations (CFR), Title 47 – Telecommunication, Part 15 – Radio Frequency Devices Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
Purpose of Test:	Equipment Certification for Digital Modulation Systems (DTS) Operating Under §15.247 and Technical Acceptance Certificate (TAC) under Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment
Test Procedures:	- ANSI C63.4 - ANSI C63.10 - FCC KDB Publication No. 558074 D01 DTS Meas Guidance v05 - RSS-247, Issue 2; RSS-Gen, Issue 5
Environmental Classification:	☒ Commercial, industrial or business environment ☒ Residential environment

1.2. RELATED SUBMITTAL(S)/GRANT(S)

None.

1.3. NORMATIVE REFERENCES

Publication	Year	Title
47 CFR Parts 0-19	2018	Code of Federal Regulations (CFR), Title 47 – Telecommunication
ANSI C63.4	2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 KHz to 40 GHz
ANSI C63.10	2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
FCC, KDB Publication No. 558074 D01 DTS Meas Guidance v05	2019	Guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum system, and hybrid system devices operating under section 15.247 of the FCC rules
RSS-247, Issue 2	2017	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
RSS-102, Issue 5	2015	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
SPR-002	2016	Supplementary Procedure for Assessing Compliance with RSS-102 Nerve Stimulation Exposure Limits
ICES-003, Issue 6	2016	Information Technology Equipment (Including Digital Apparatus) - Limits and Methods of Measurement
RSS-Gen, Issue 5	2018	General Requirements for Compliance of Radio Apparatus

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EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1. CLIENT INFORMATION

Applicant	
Name:	Katerra Inc
Address:	2115 S service road W Oakville, Ontario L6L 5W2, Canada
Contact Person:	Mr Paul Reeves Phone #: 6504223572 Email: paul.reeves@katerra.com

Manufacturer	
Name:	Intretech
Address:	588, Jiahe road, Xiamen, Fujian, China Postal code:361006
Contact Person:	Peter Li
Telephone No.:	+86-592-5797666-8719
Fax No.:	+86-592-5701337

2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

Brand Name:	Kova
Product Name:	Battery Powered Dimming Light Switch Battery Powered Light Switch
Model Name or Number: <i>(Hardware Version Identification Number- HVIN)</i>	Battery Powered Dimming Light Switch Battery Powered Light Switch
Serial Number:	32120001 32120002
Type of Equipment:	Digital Transmission System (DTS)
Input Power Supply Type:	3.3 Vdc, ~15 mA (max).
Primary User Functions of EUT:	Battery powered Bluetooth Mesh light switch for on/off, and on/off/dim control of remote Bluetooth Mesh lighting devices.

Note: Pre-scans were performed on both models and the unit with the dimmer feature was tested to represent both models.

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2.3. EUT'S TECHNICAL SPECIFICATIONS

Transmitter	
Equipment Type:	Mobile Base station (fixed use)
Intended Operating Environment:	Commercial, industrial or business environment Residential environment
Power Supply Requirement:	3.3 VDC, 3x CR2032 batteries
RF Output Power Rating:	8.9 dBm conducted
Operating Frequency Range:	2402 – 2480 MHz
Channel Spacing (if applicable):	2 MHz
RF Output Impedance:	50 Ω
Modulation Type:	2-GFSK
Emission Designator(s)	F7D
Antenna Connector Types:	PCB Integral antenna

2.4. ASSOCIATED ANTENNA DESCRIPTIONS

Antenna Type	Manufacturer	Model	Maximum Gain (dBi)
Inverted-F metal stamped	Pulse	SZ12443	3.63

2.5. LIST OF EUT'S PORTS

None

2.6. ANCILLARY EQUIPMENT

None

EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21 to 23 °C
Humidity:	45 to 58%
Pressure:	102 kPa
Power Input Source:	3.3 VDC

3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	The transmitter was operated in a continuous transmission mode with the carrier modulated as specified in the Test Data.
Special Test Software:	Test software provided by the Applicant to operate the EUT at each channel frequency continuously and in the range of typical modes of operation.
Special Test Hardware:	Program Board
Transmitter Test Antenna:	The EUT is tested with the antenna fitted in a manner typical of normal intended use as integral / non-integral antenna equipment as described with the test results.

Transmitter Test Signals	
Frequency Band(s):	2402 - 2480 MHz
Frequency(ies) Tested:	2402 MHz, 2404, 2440 MHz, 2478 MHz, 2480 MHz
RF Power Output: (measured maximum output power at antenna terminals)	8.9 dBm Peak
Normal Test Modulation:	2-GFSK
Modulating Signal Source:	Internal

EXHIBIT 4. SUMMARY OF TEST RESULTS

4.1. LOCATION OF TESTS

All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

- Radiated Emissions were performed at the Ultratech's 3-10 TDK Semi-Anechoic Chamber situated in the Town of Oakville, province of Ontario. This test site been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville 3-10 TDK Semi-Anechoic Chamber has been filed with ANAB File No.: AT-1945.

4.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Compliance (Yes/No)
15.203 RSS-Gen, Section 6.8	Antenna requirements	Yes*
15.207(a) RSS-Gen, Section 8.8	AC Power Line Conducted Emissions	N/A(battery operated)
15.247(a)(2) RSS-247, Section 5.2(a)	6 dB Bandwidth	Yes
15.247(b)(3) RSS-247, Section 5.4	Peak Conducted Output Power	Yes
15.247(d) RSS-247, Section 5.5	Band-Edge and RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
15.247(d), 15.209 & 15.205	Transmitter Spurious Radiated Emissions	Yes
15.247(e) RSS-247, Section 5.2(b)	Power Spectral Density	Yes
15.247(i), 1.1307, 1.1310, 2.1091 RSS-Gen, Section 3.4 & RSS-102	RF Exposure	Yes
RSS-Gen, Section 7.3	Receiver Spurious Emissions (Radiated)	N/A
RSS-Gen, Section 7.4	Receiver Spurious Emissions (Antenna Conducted)	N/A
ICES-003, Issue 6	Information Technology Equipment (Including Digital Apparatus) - Limits and Methods of Measurement	Yes

* The EUT complies with the requirement; it employs an integral antenna.

4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None.

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EXHIBIT 5. TEST DATA

5.1. OCCUPIED BANDWIDTH [§ 15.247(a)(2)] [RSS-247, SECTION 5.2(a)]

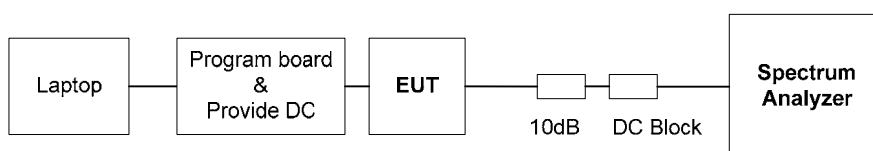
5.1.1. Limit(s)

The minimum 6 dB bandwidth shall be at least 500 kHz.

5.1.2. Method of Measurements

KDB 558074 D01 DTS Meas Guidance v05, Section 8.2 Option 2.

5.1.3. Test Arrangement



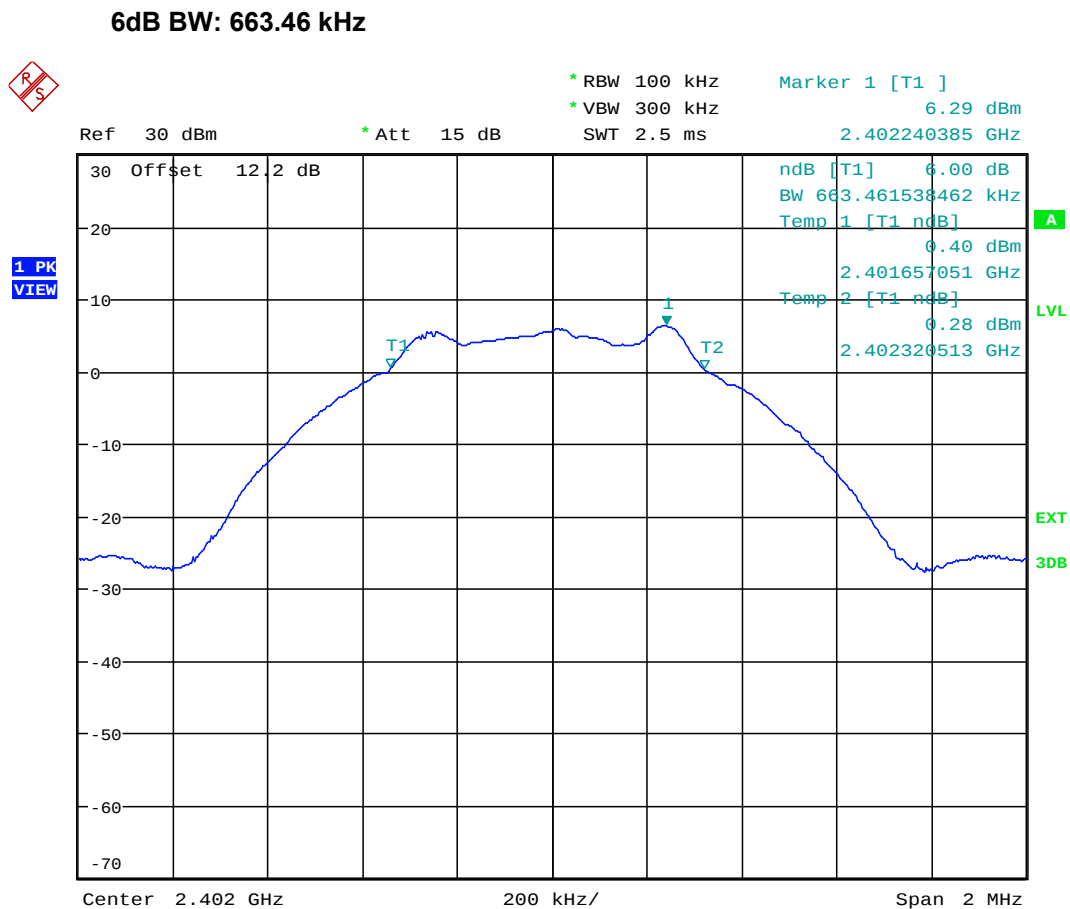
5.1.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range	Calibration Due Date
Spectrum Analyzer	Rohde & Schwarz	FSU26	200946	20Hz–26.5 GHz	Jul 25, 2020
Attenuator	Hewlett Packard	8493C	0465	DC–18 GHz	Cal on use
DC Block	Hewlett Packard	11742A	12460	0.045 – 26.5 GHz	Cal on use
Laptop	Lenovo	ThinkPad Edge 0578	IS057882 ULRBXKBG	---	---

5.1.5. Test Data

Modulation	Power Setting	Channel	Frequency (MHz)	6dB BW (kHz)	Min. Limit (kHz)
1M	100	37	2402	663.46	500
	100	17	2440	663.46	500
	100	39	2480	663.46	500
2M	100	0	2404	1160	500
	100	17	2440	1150	500
	100	36	2478	1150	500

5.1.6. Channel 37, 2402 MHz, 1M, Power setting 100 (10dBm)



Date: 3.JUL.2019 11:44:01

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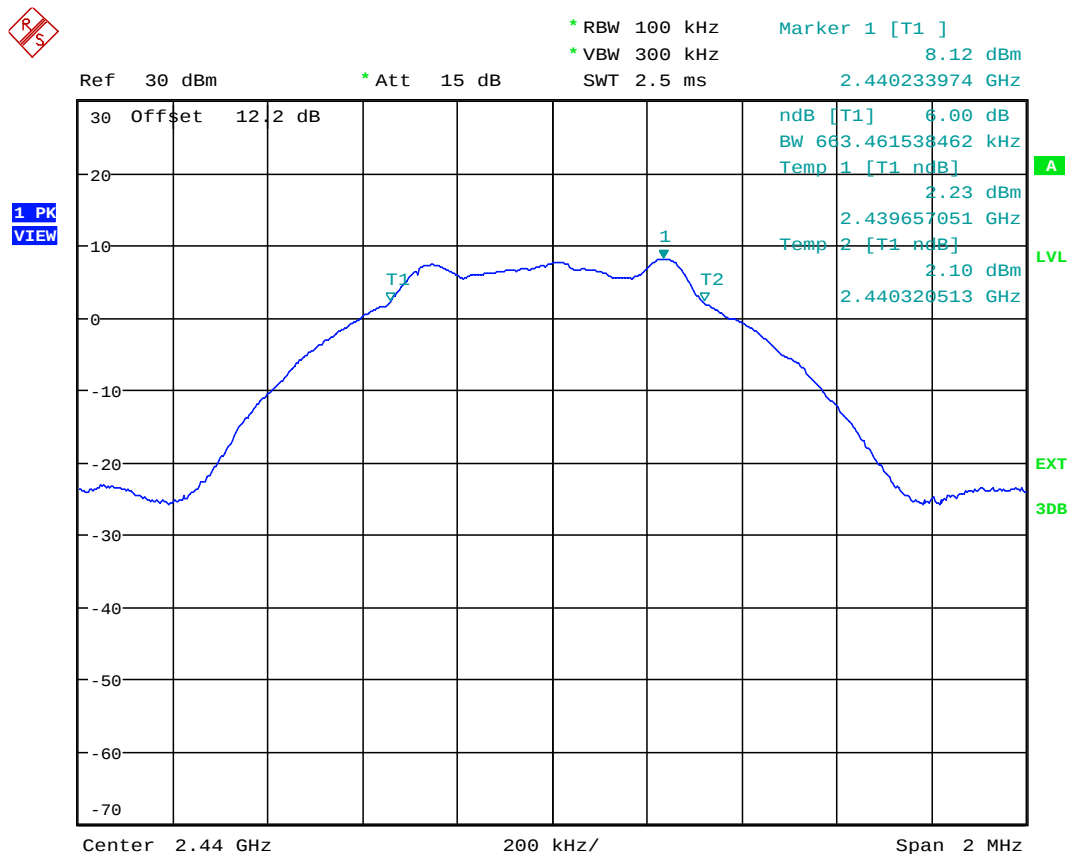
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
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5.1.7. Channel 17, 2440 MHz, 1M, Power setting 100 (10dBm)

6dB BW: 663.46 kHz



Date: 3.JUL.2019 11:51:31

ULTRATECH GROUP OF LABS

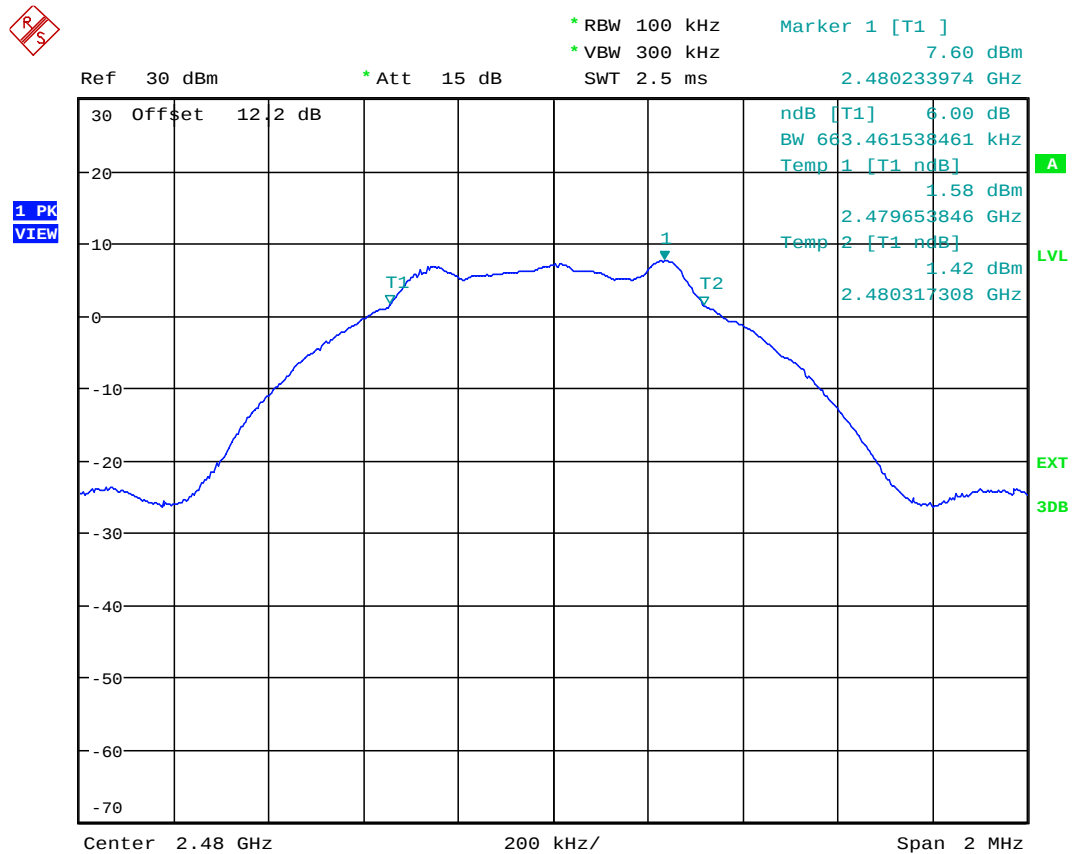
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
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5.1.8. Channel 39, 2480 MHz, 1M, Power setting 100 (10dBm)

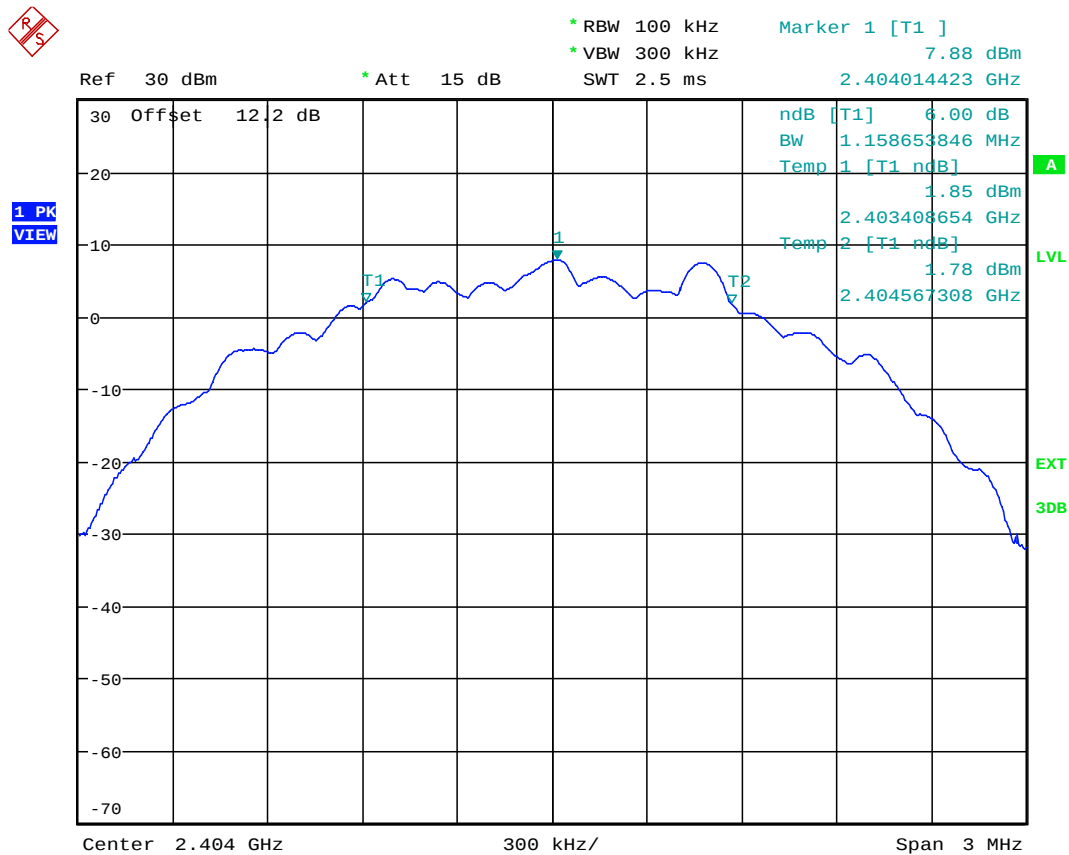
6dB BW: 663.46 kHz



Date: 3.JUL.2019 11:55:08

5.1.9. Channel 0, 2404 MHz, 2M, Power setting 100 (10dBm)

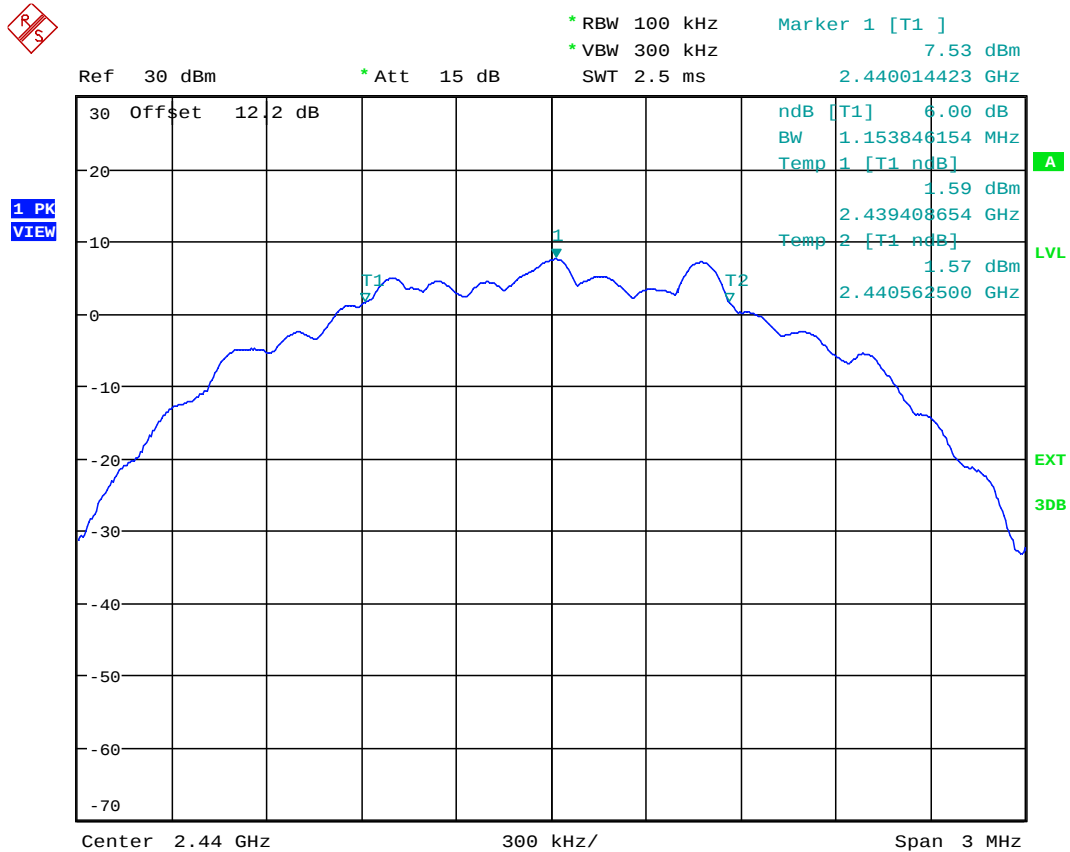
6dB BW: 1.16 MHz



Date: 3.JUL.2019 11:58:47

5.1.10. Channel 17, 2440 MHz, 2M, Power setting 100 (10dBm)

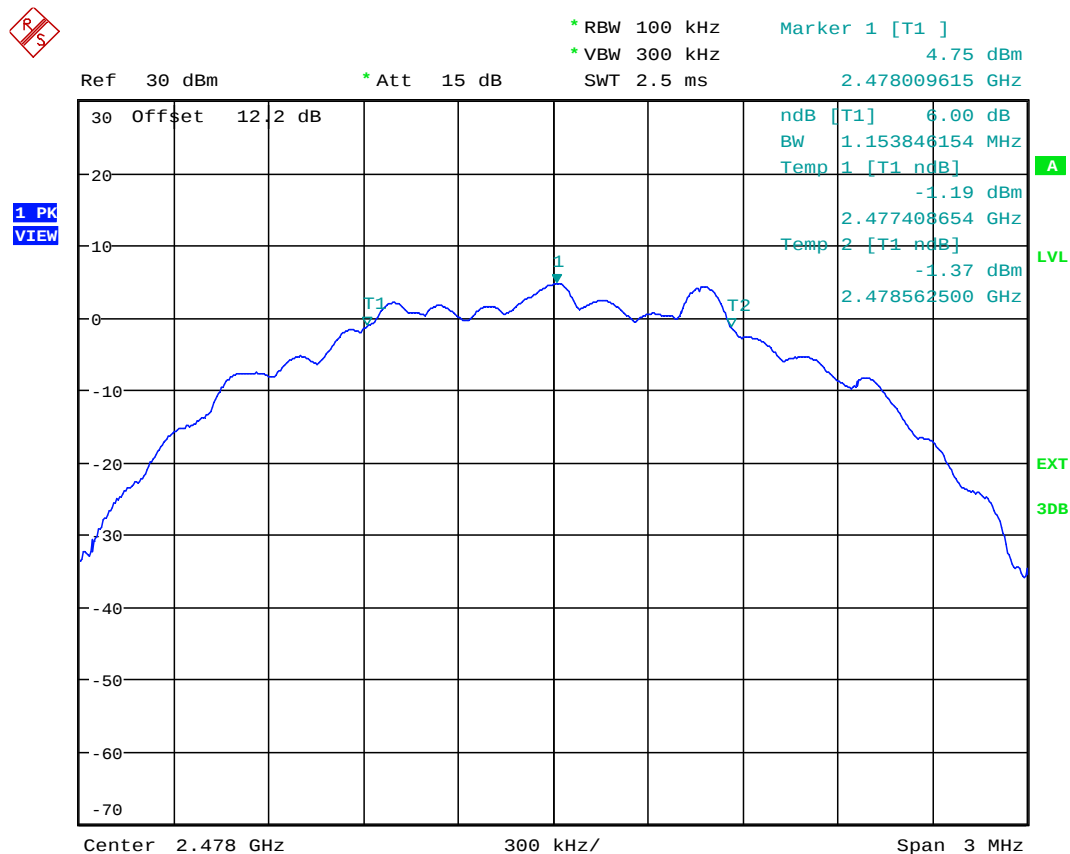
6dB BW: 1.15 MHz



Date: 3.JUL.2019 12:01:20

5.1.11. Channel 36, 2478 MHz, 2M, Power setting 100 (10dBm)

6dB BW: 1.15 MHz



Date: 3.JUL.2019 12:03:43

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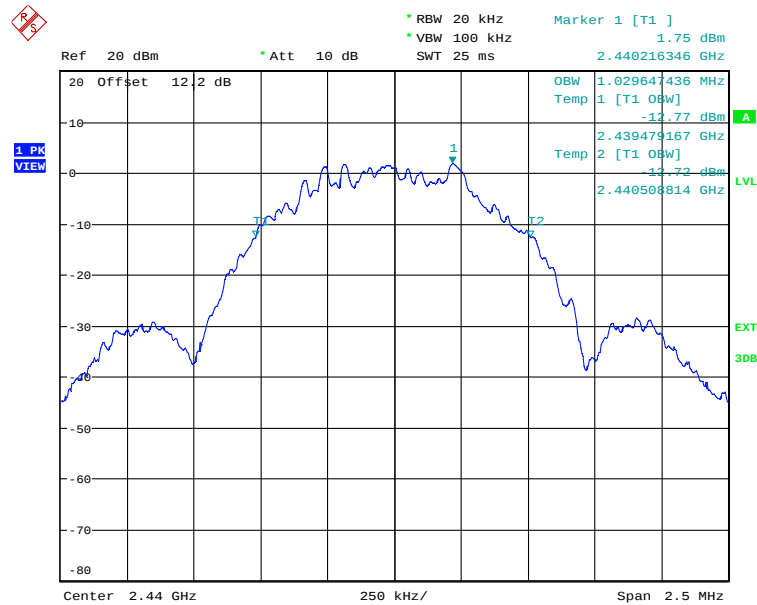
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
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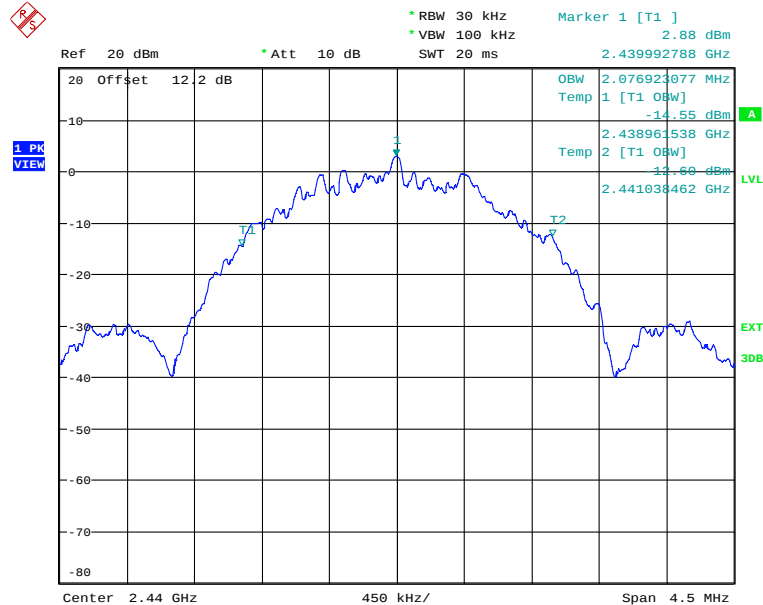
5.1.11.1. 99% Occupied bandwidth ISED Emission Designator

99% OBW: 1.03 MHz @ 1M



Date: 3.JUL.2019 13:35:31

99% OBW: 2.07 MHz @ 2M



Date: 3.JUL.2019 13:58:16

Not for FCC, the highest bandwidth plots for 1M and 2M reported above

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5.2. PEAK CONDUCTED OUTPUT POWER - DTS [§ 15.247(b)(3)] and EIRP[RSS-247, SECTION 5.4]

5.2.1. Limit(s)

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

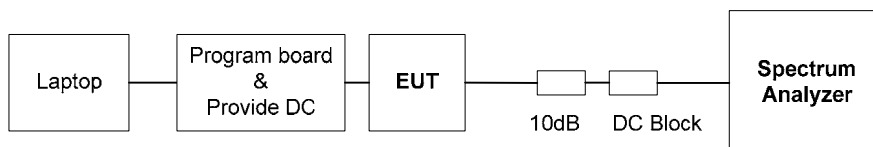
§ 15.247(b)(4): The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

RSS 247 Section 5.4(d): For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

5.2.2. Method of Measurements & Test Arrangement

KDB 558074 D01 15.247 Meas Guidance v05r02, Section 8.3.1.1 RBW ≥ DTS bandwidth, Sub clause 11.9.1.1 of ANSI C63.10

5.2.3. Test Arrangement



5.2.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range	Calibration Due Date
Spectrum Analyzer	Rohde & Schwarz	FSU26	200946	20Hz–26.5 GHz	Jul 25, 2020
DC Block	Hewlett Packard	11742A	12460	0.045 – 26.5 GHz	Cal on use
Attenuator	Hewlett Packard	8493C	0461	DC - 26.5 GHz	---
Laptop	Lenovo	ThinkPad Edge 0578	IS057882 ULRBCKBG	---	---

5.2.5. Test Data

PCB Antenna with 3.63 dBi gain

BLE Channel	BLE Frequency (MHz)	Power Setting	1M Power (dBm)	1M EIRP (dBm)
37	2402	100	8.86	12.49
17	2440	100	8.49	11.85
39	2480	100	8.04	11.67

BLE Channel	BLE Frequency (MHz)	Power Setting	2M Power (dBm)	2M EIRP (dBm)
0	2404	100	8.90	12.53
17	2440	100	8.48	12.11
36	2478	100	5.77	9.40

BLE Channel	BLE Frequency (MHz)	Power Setting	1M Power (dBm)	1M EIRP (dBm)
37	2402	1	-2.43	1.20
17	2440	1	-2.84	0.79
39	2480	1	-3.59	0.04

BLE Channel	BLE Frequency (MHz)	Power Setting	2M Power (dBm)	2M EIRP (dBm)
0	2404	1	-2.49	1.14
17	2440	1	-2.91	0.72
36	2478	1	-3.35	0.28

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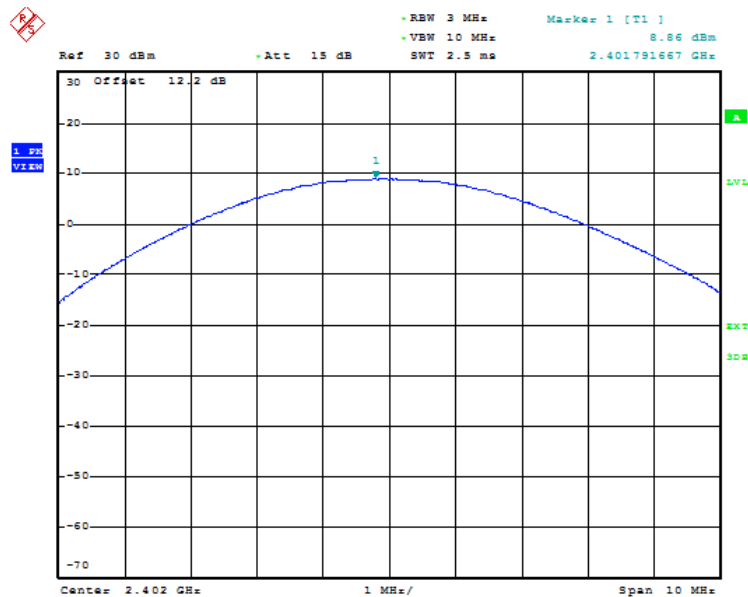
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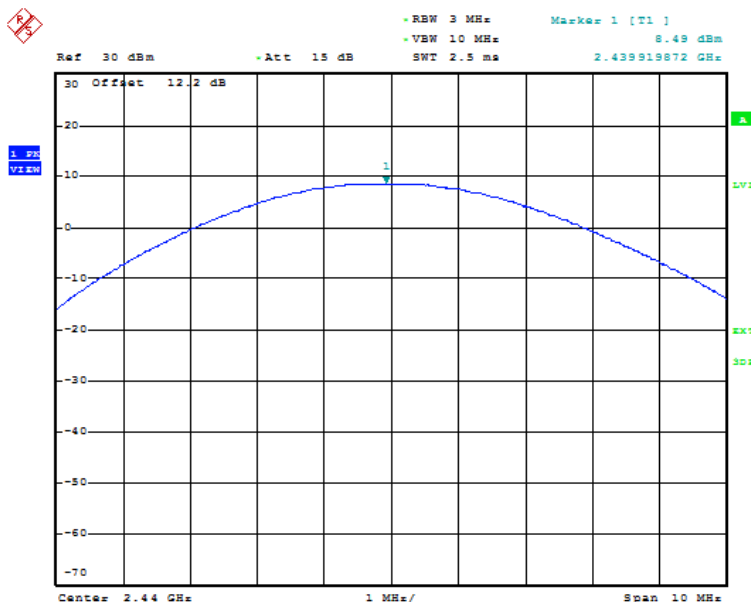
5.2.6. Plots

5.2.6.1. Channel 37, 2402 MHz, 1M, Power setting 100 (10dBm)



Date: 3.JUL.2019 14:20:04

5.2.6.2. Channel 17, 2440 MHz, 1M, Power setting 100 (10dBm)



Date: 3.JUL.2019 14:21:43

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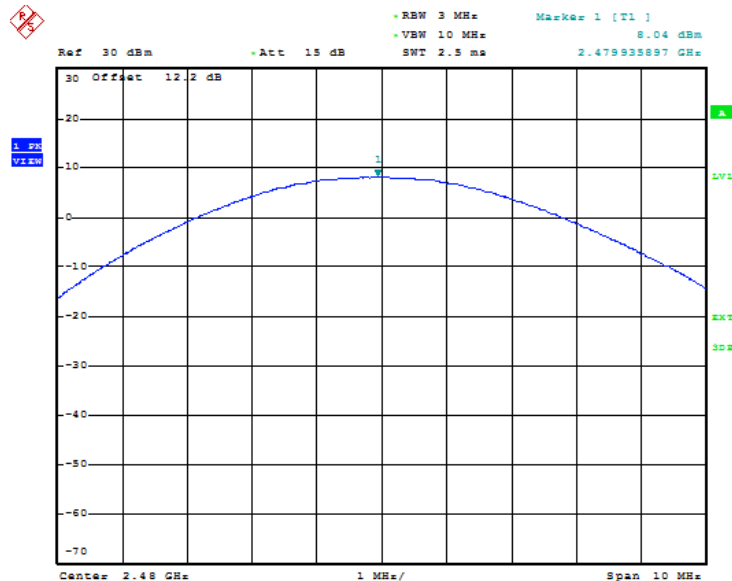
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

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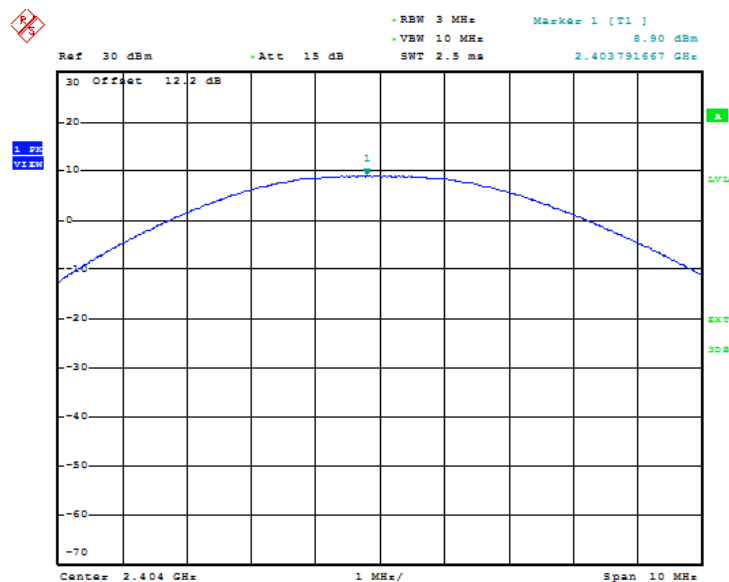
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

5.2.6.3. Channel 39, 2480 MHz, 1M, Power setting 100 (10dBm)



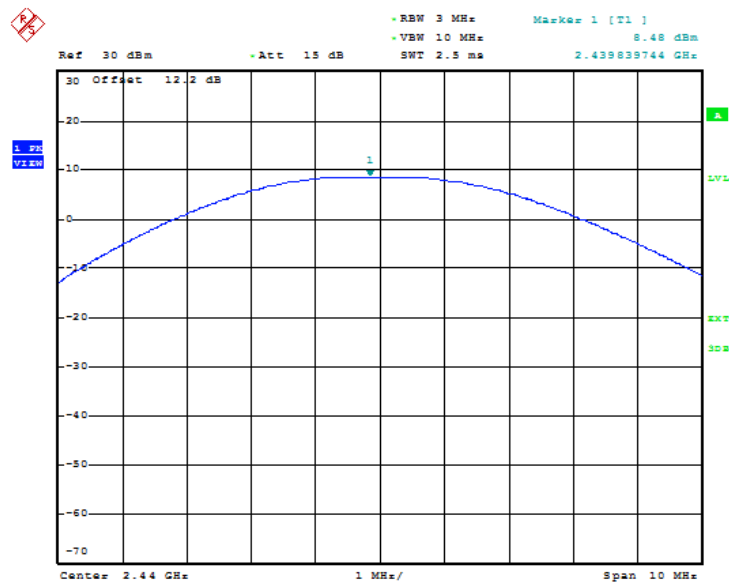
Date: 3.JUL.2019 14:24:11

5.2.6.4. Channel 0, 2404 MHz, 2M, Power setting 100 (10dBm)



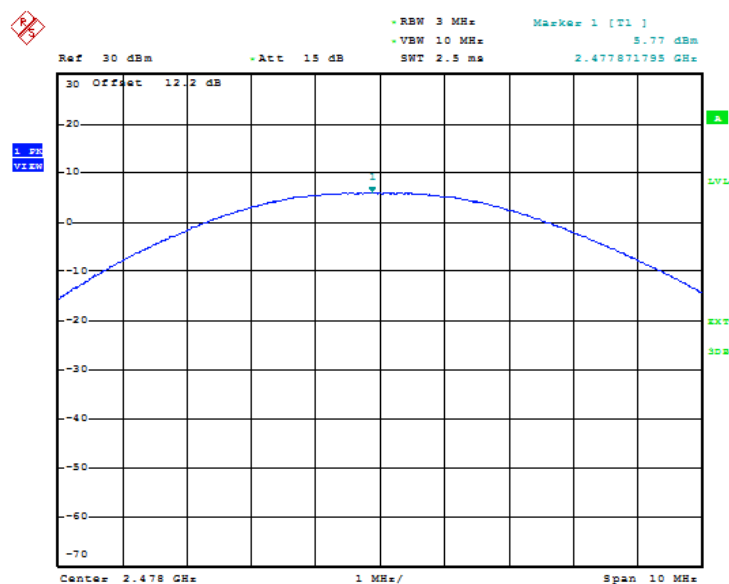
Date: 2.JUL.2019 13:54:57

5.2.6.5. Channel 17, 2440 MHz, 2M, Power setting 100 (10dBm)



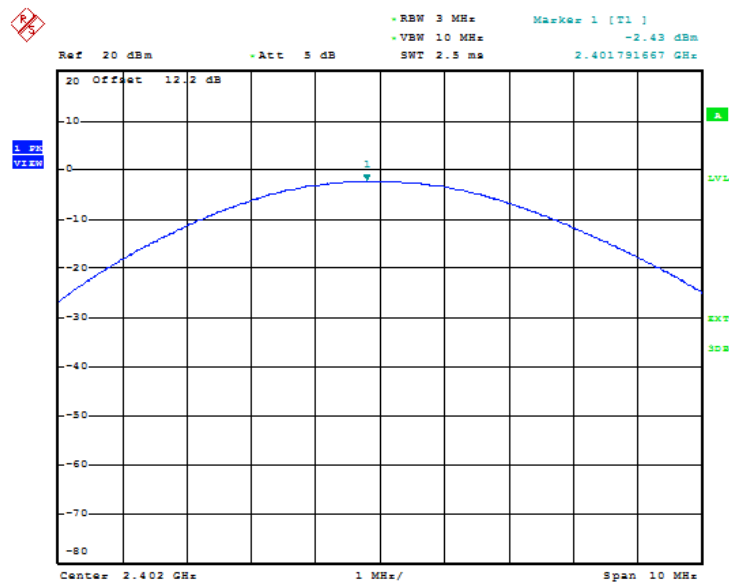
Date: 2.JUL.2019 13:56:53

5.2.6.6. Channel 36, 2478 MHz, 2M, Power setting 100 (10dBm)



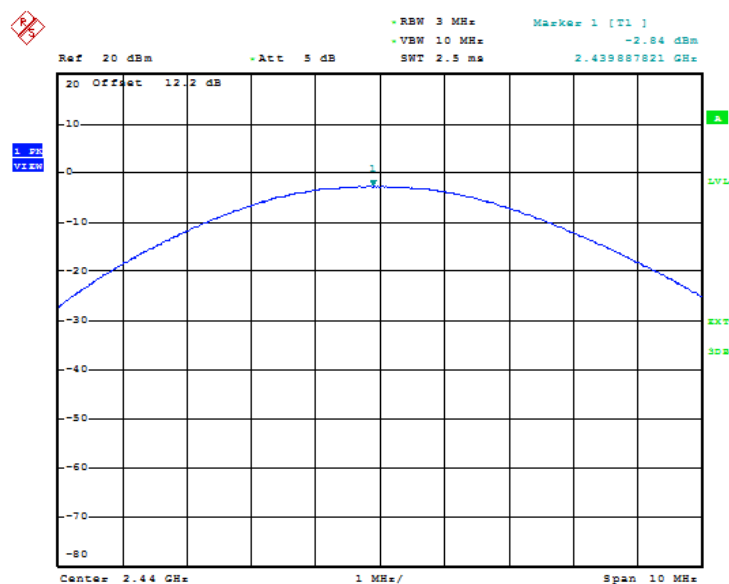
Date: 2.JUL.2019 13:51:13

5.2.6.7. Channel 37, 2402 MHz, 1M, Power setting 1



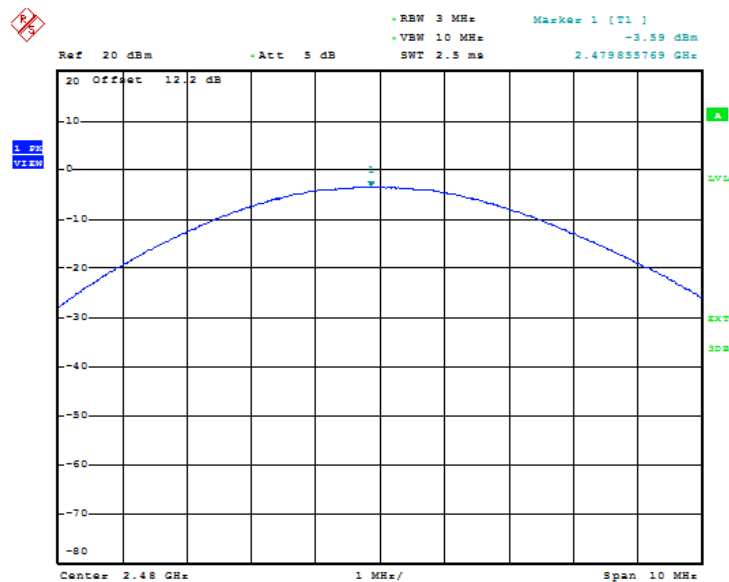
Date: 5. JUL. 2019 14:23:41

5.2.6.8. Channel 19, 2440 MHz, 1M, Power setting 1



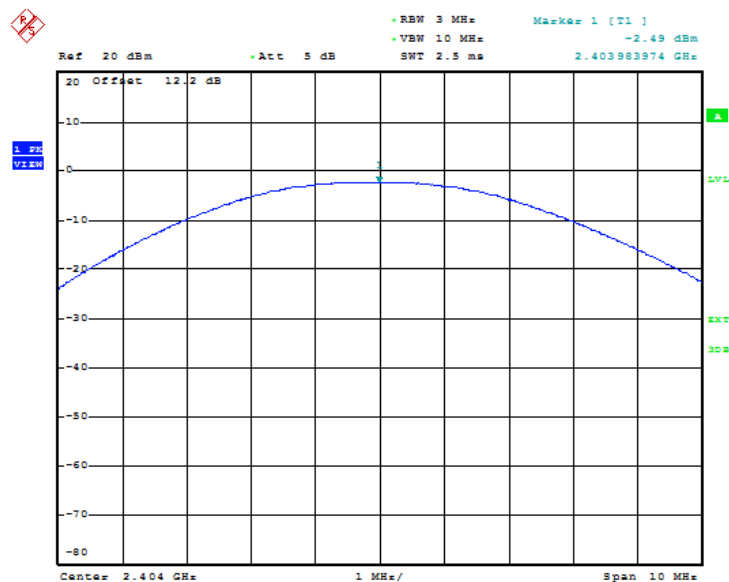
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5.2.6.9. Channel 39, 2480 MHz, 1M, Power setting 1



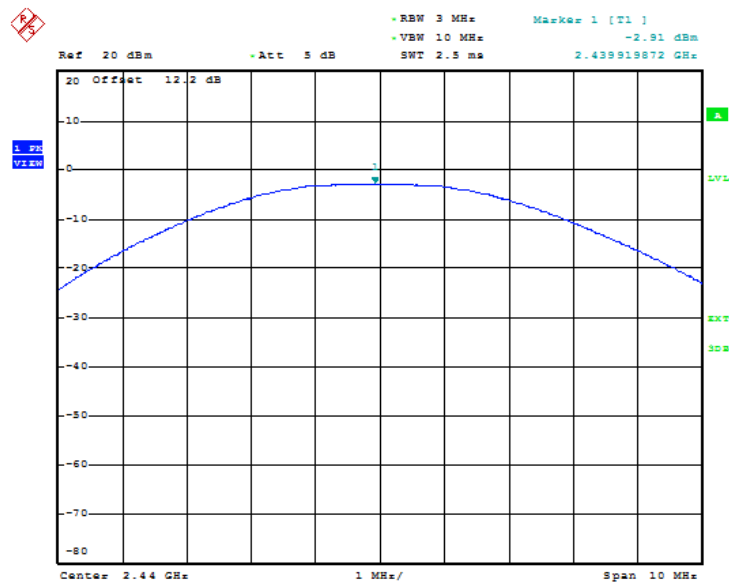
Date: 5. JUL. 2019 14:28:39

5.2.6.10. Channel 0, 2404 MHz, 2M, Power setting 1



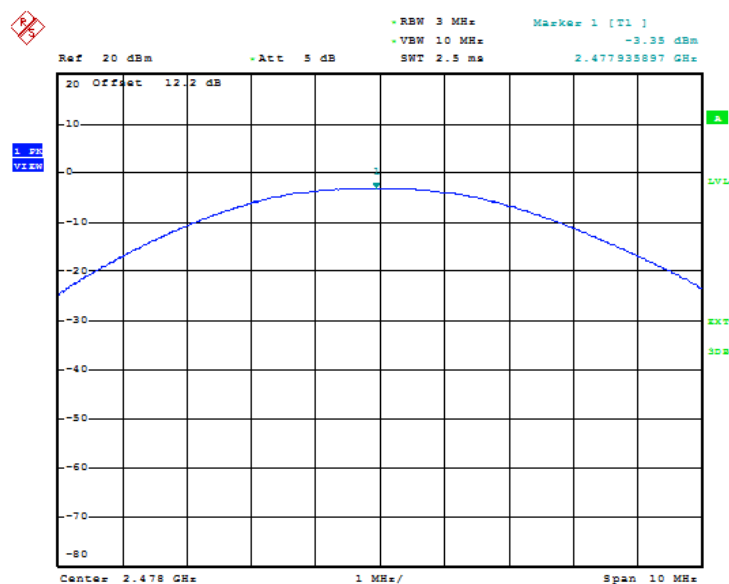
Date: 5. JUL. 2019 14:57:53

5.2.6.11. Channel 17, 2440 MHz, 2M, Power setting 1



Date: 5. JUL. 2019 14:50:19

5.2.6.12. Channel 36, 2478 MHz, 2M, Power setting 1



Date: 5. JUL. 2019 14:35:00

5.3. TRANSMITTER SPURIOUS RADIATED EMISSIONS AT 3 METERS [§§ 15.247(d), 15.209 & 15.205] [RSS-247, SECTION 5.5]

5.3.1. Limit(s)

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

Section 15.205(a) - Restricted Bands of Operation

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
¹ 0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	(²)
13.36–13.41.			

¹ Until February 1, 1999, this restricted band shall be 0.490–0.510 MHz.

² Above 38.6

Section 15.209(a) - Field Strength Limits within Restricted Frequency Bands

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2,400 / F (kHz)	300
0.490 - 1.705	24,000 / F (kHz)	30
1.705 - 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3

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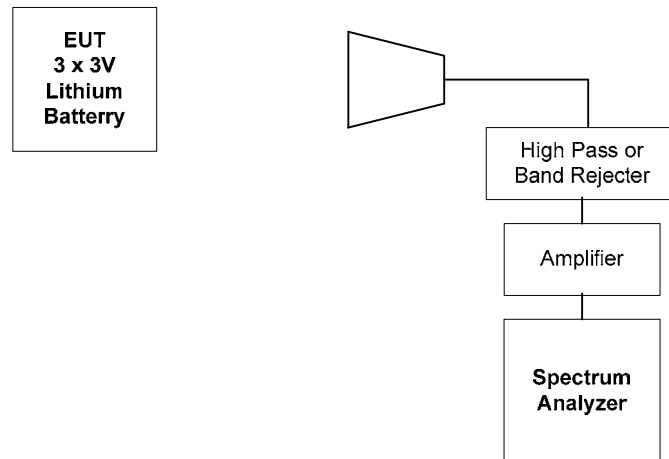
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

5.3.2. Method of Measurements

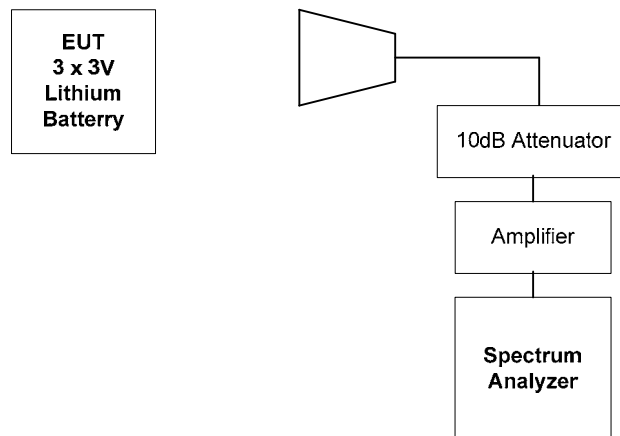
KDB 558074 D01 15.247 Meas Guidance v05r02 and ANSI C63.10.

5.3.3. Test Arrangement

Radiated Emissions



Band-Edge Radiated Emissions



5.3.4. Test Equipment List

Radiated Emissions

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range	Calibration Due Date
EMI Receiver	Rohde & Schwarz	ESU40	100037	20Hz–40 GHz	Mar 15, 2020
Spectrum Analyzer	Rohde & Schwarz	FSU26	200946	20Hz–26.5 GHz	Jul 25, 2020
RF Amplifier	Com-Power	PAM-0118A	551052	0.5 – 18 GHz	Jul 26, 2019
RF Amplifier	Hewlett Packard	84498	3008A00769	1 – 26.5 GHz	May 15, 2020
Biconilog	Emco	3142B	1575	26-2000 MHz	May 10, 2020
Horn Antenna	Emco	3155	5061	1 – 18 GHz	Apr 30, 2020
Horn Antenna	ETS-Lindgren	3160-09	001183858	18 – 26.5 GHz	Oct 11, 2019
High Pass Filter	K & L	11SH10-4000/T12000	4	Cut off 2.4 GHz	Cal on use
Band Reject Filter	Micro-Tronics	BRM50701	105	Cut off 2.4-2.483 GHz	Cal on use
Laptop	Lenovo	ThinkPad Edge 0578	IS057882 ULRBXKGB	---	---

Band-Edge Radiated Emissions

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range	Calibration Due Date
Spectrum Analyzer	Rohde & Schwarz	FSU26	200946	20Hz–26.5 GHz	Jul 25, 2020
RF Amplifier	Hewlett Packard	84498	3008A00769	1 – 26.5 GHz	May 15, 2020
Attenuator	Hewlett Packard	8493C	0465	DC–26.5 GHz	Cal on use
Horn Antenna	Emco	3155	6570	1 – 18 GHz	Oct 11, 2020
Laptop	Lenovo	ThinkPad Edge 0578	IS057882 ULRBXKGB	---	---

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5.3.5. Test Data

Remark(s):

- All spurious emissions that are in excess of 20 dB below the specified limit shall be recorded.
- EUT shall be tested in three orthogonal positions.
- Exploratory tests performed to determined worst-case test configurations, the following test results at high power setting represent the worst-case.

5.3.5.1. Test Configuration 1: 1M transmit

Fundamental Frequency:		2402 MHz					
Frequency Test Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
2402	108.16	--	V	--	--	--	--
2402	109.28	--	H	--	--	--	--
4804	53.62	43.56	V	54.0	88.1	-10.4	Pass*
4804	59.28	50.83	H	54.0	88.1	-3.17	Pass*

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

Fundamental Frequency:		2440 MHz					
Frequency Test Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
2440	106.1	--	V	--	--	--	--
2440	108.01	--	H	--	--	--	--
4880	51.12	41.94	V	54.0	86.1	-12.06	Pass*
4880	57.93	48.95	H	54.0	86.1	-5.05	Pass*
7320	52.88	39.21	V	54.0	86.1	-14.79	Pass*
7320	52.76	39.58	H	54.0	86.1	-14.42	Pass*

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

Fundamental Frequency:		2480 MHz					
Frequency Test Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
2480	105.84	--	V	--	--	--	--
2480	107.18	--	H	--	--	--	--
4960	51.43	41.26	V	54.0	85.8	-12.74	Pass*
4960	53.80	43.97	H	54.0	85.8	-10.03	Pass*
7440	52.41	39.06	V	54.0	85.8	-14.94	Pass*
7440	52.77	39.22	H	54.0	85.8	-14.78	Pass*

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

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5.3.5.2. Test Configuration 2: 2M transmit

Fundamental Frequency:		2404 MHz					
Frequency Test Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
2404	106.22	--	V	--	--	--	--
2404	109.63	--	H	--	--	--	--
4808	51.07	37.62	V	54.0	86.2	-16.38	Pass*
4808	58.41	42.09	H	54.0	86.2	-11.91	Pass*

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

Fundamental Frequency:		2440 MHz					
Frequency Test Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
2440	105.59	--	V	--	--	--	--
2440	108.53	--	H	--	--	--	--
4880	49.98	36.66	V	54.0	85.5	-17.34	Pass*
4880	56.13	41.16	H	54.0	85.5	-12.84	Pass*

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

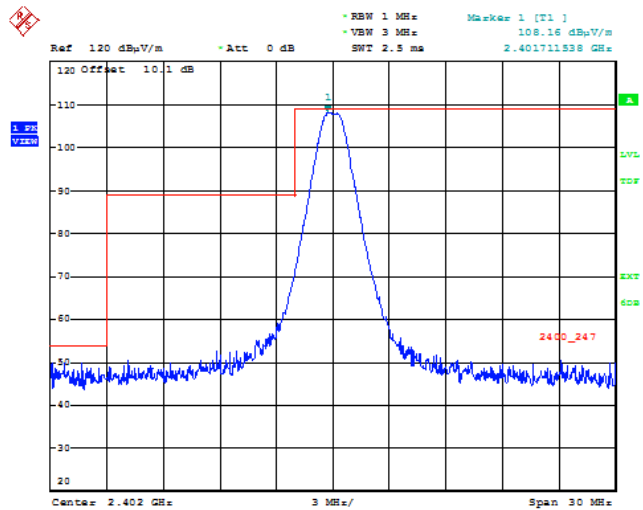
Fundamental Frequency:		2478 MHz					
Frequency Test Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
2478	103.16	--	V	--	--	--	--
2478	104.46	--	H	--	--	--	--
4956	51.37	36.55	V	54.0	83.1	-17.45	Pass*
4956	53.32	38.04	H	54.0	83.1	-15.96	Pass*

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

5.3.5.3. Band-Edge Radiated Emissions

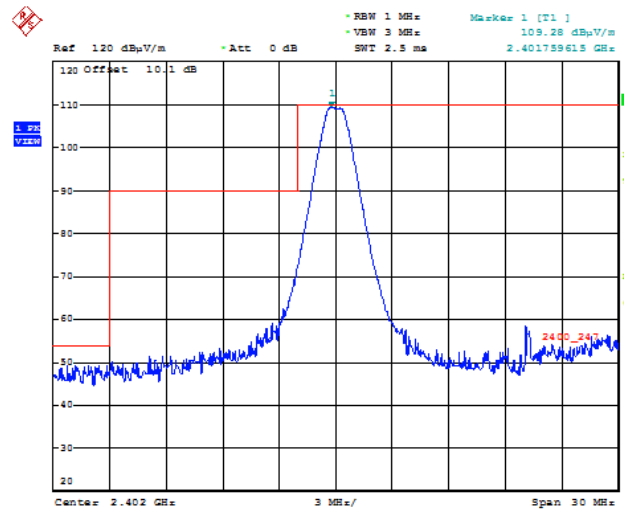
5.3.5.3.1. 2402 MHz @ Tx 1M

Vertical Polarization



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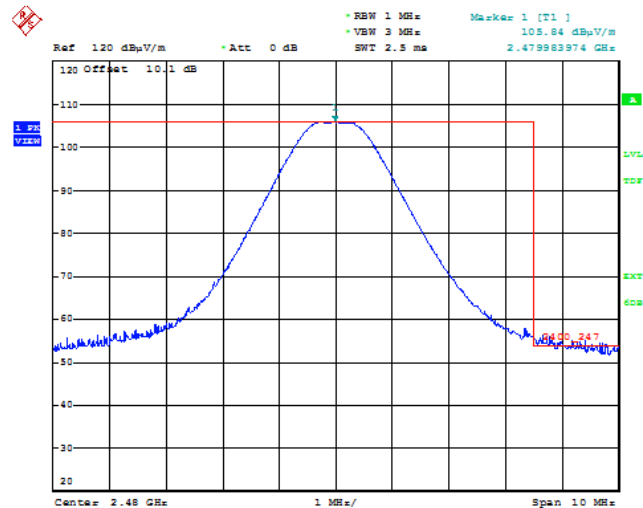
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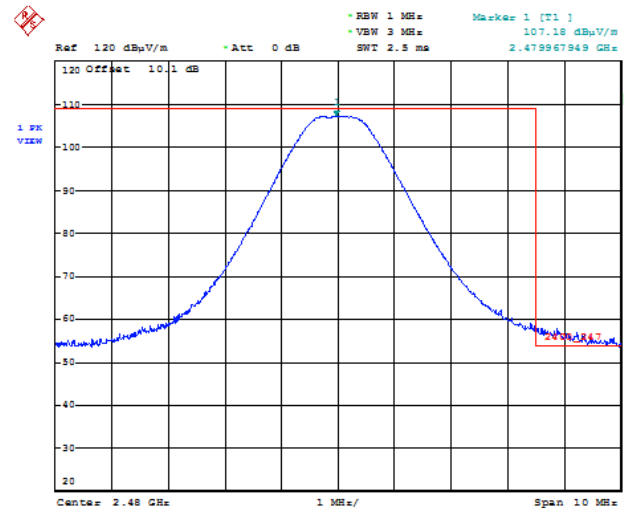
5.3.5.3.2. 2480 MHz @ Tx 1M

Vertical Polarization



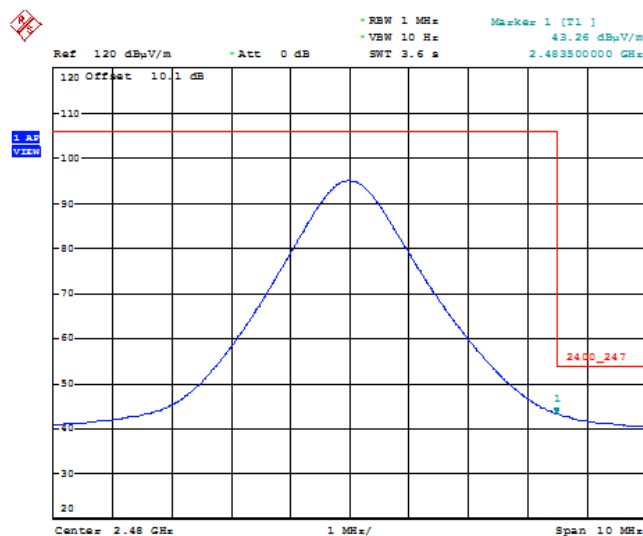
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Horizontal Polarization



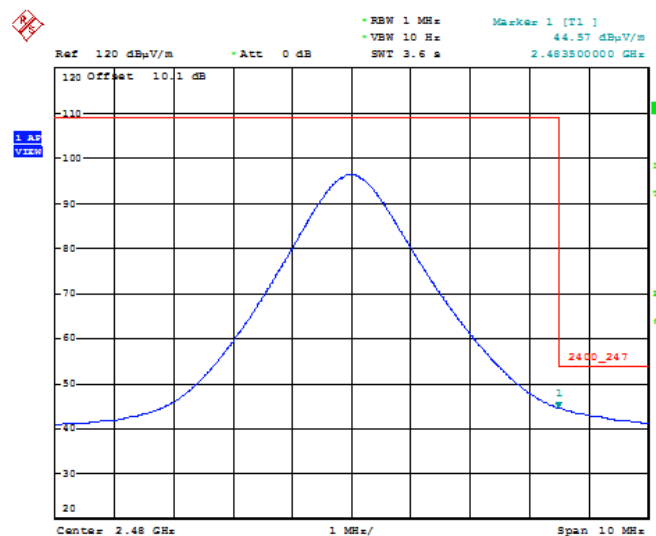
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Vertical Polarization



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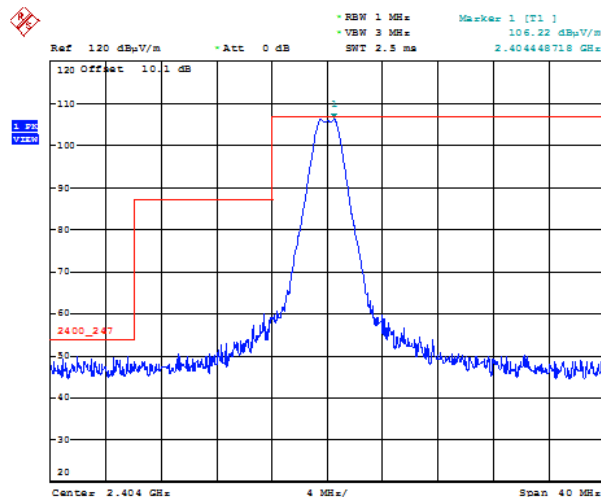
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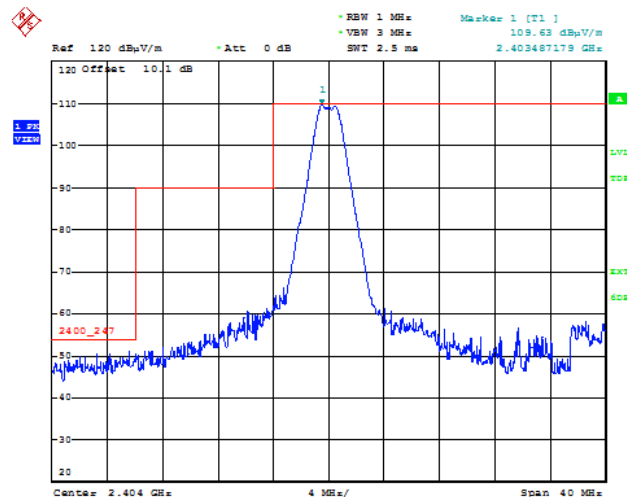
5.3.5.3.3. 2404 MHz @ Tx 2M

Vertical Polarization



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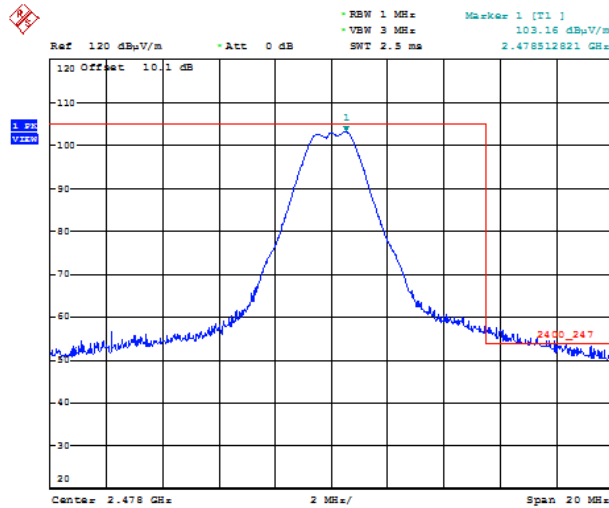
Horizontal Polarization



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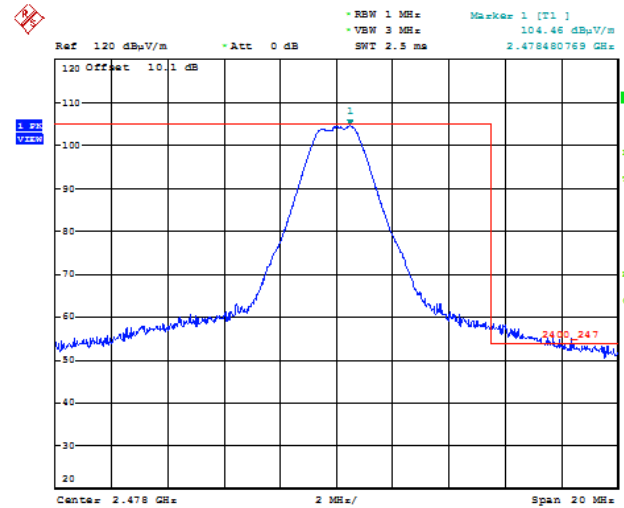
5.3.5.3.4. 2478 MHz @ Tx 2M

Vertical Polarization



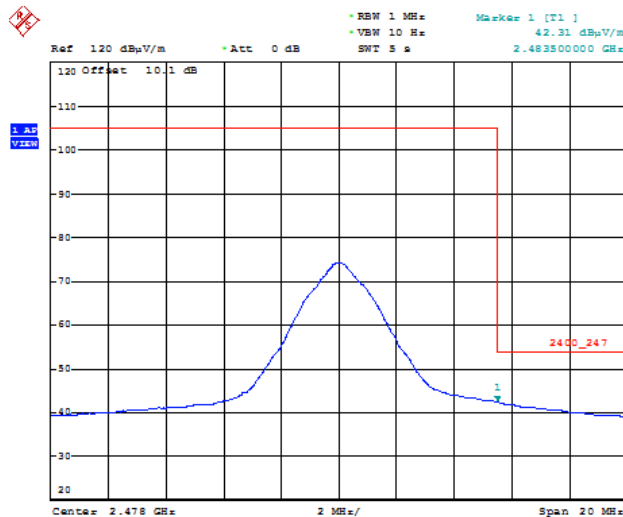
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Horizontal Polarization



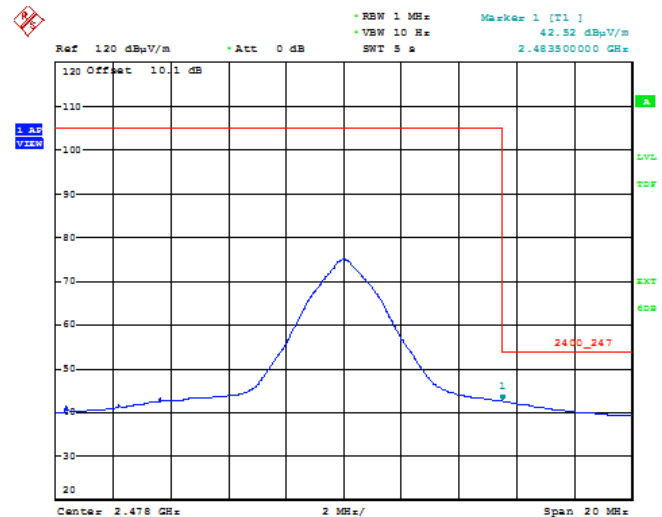
Date: 4.JUL.2019 13:56:24

Vertical Polarization



Date: 4.JUL.2019 14:03:34

Horizontal Polarization



Date: 4.JUL.2019 13:58:43

5.4. POWER SPECTRAL DENSITY [§ 15.247(e)] [RSS-247, SECTION 5.2(b)]

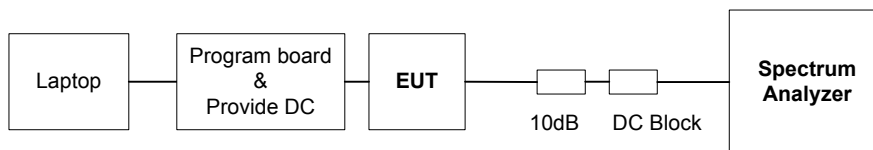
5.4.1. Limit(s)

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

5.4.2. Method of Measurements

KDB 558074 D01 15.247 Meas Guidance v05r02, Section 8.4 DTS Power Spectral Density, refer to section 11.10.2 PKPSD of ANSI C63.10

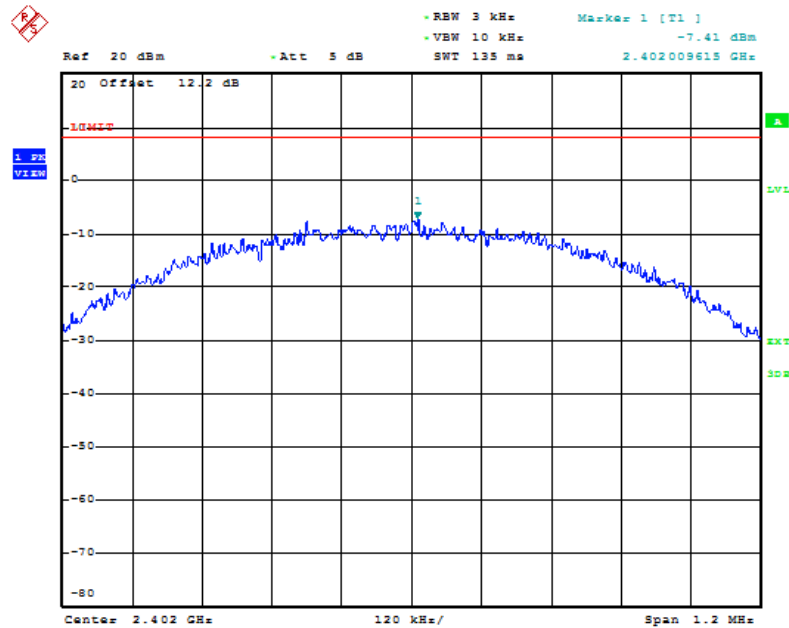
5.4.3. Test Arrangement



5.4.4. Test Data

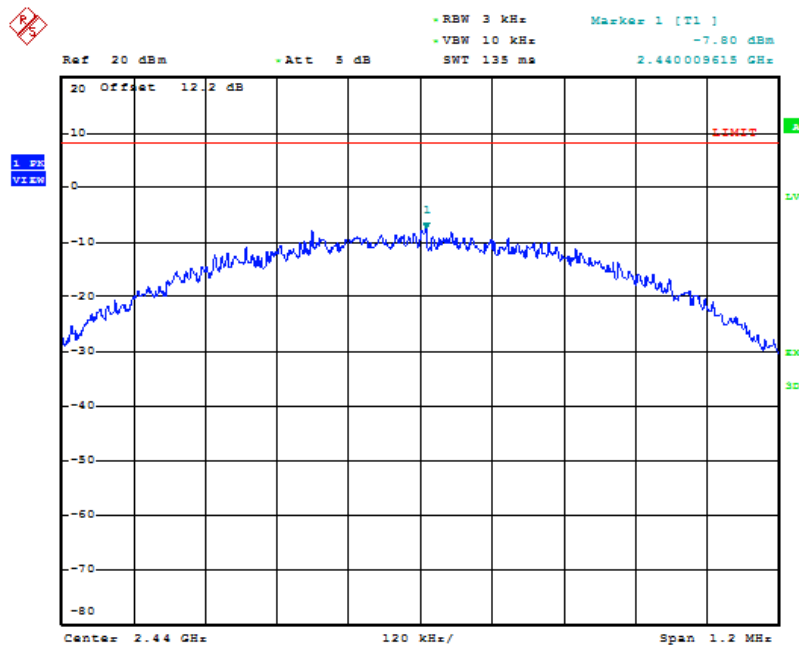
Configurati on	Power Setting	Channel	Frequency (MHz)	PSD (dBm)	Max. Limit (dBm)	Margin (dBm)
1M	High(100)	37	2402	-7.41	8	-15.41
		17	2440	-7.80	8	-15.8
		39	2480	-8.24	8	-16.24
2M	High(100)	0	2404	-10.55	8	-18.55
		17	2440	-10.94	8	-11.02
		36	2478	-13.66	8	-21.66

5.4.4.1. 1M 2402 MHz PSD



Date: 3.JUL.2019 11:04:49

5.4.4.2. 1M 2440 MHz PSD



Date: 3.JUL.2019 11:07:03

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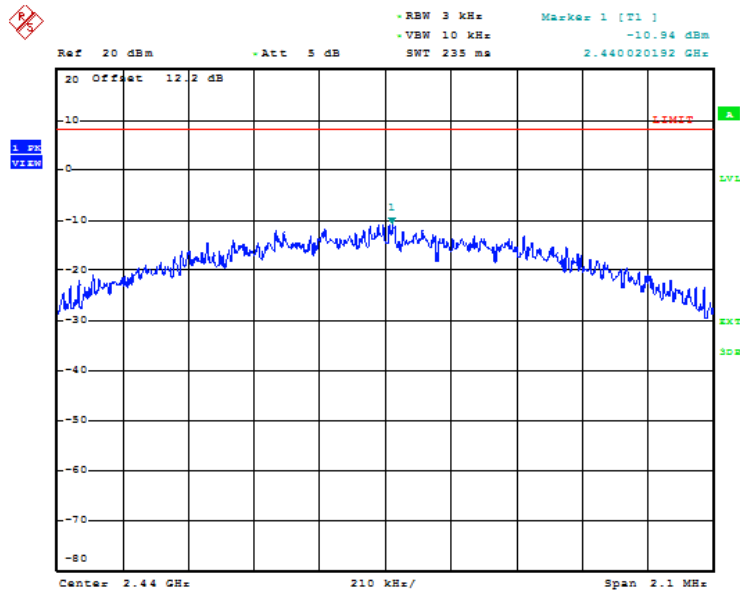
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

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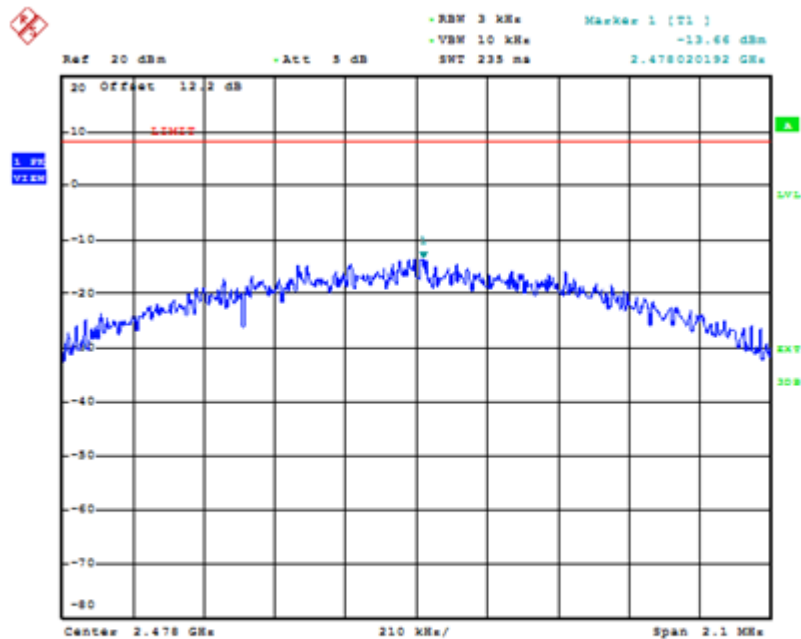
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

5.4.4.5. 2M 2440 MHz PSD



Date: 3 JUL 2019 11:27:28

5.4.4.6. 2M 2478 MHz PSD



Date: 3 JUL 2019 11:29:30

5.5. RF EXPOSURE REQUIRMENTS [§§ 15.247(i), 1.1310 & 2.1091] [RSS-Gen, SECTION 3.4 & RSS-102]

5.5.1. Limits

§ 1.1310: The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3-3.0	614	1.63	*(100)	6
3.0-30	1842/f	4.89/f	*(900/f ²)	6
30-300	61.4	0.163	1.0	6
300-1500			f/300	6
1500-100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500			f/1500	30
1500-100,000			1.0	30

f = frequency in MHz

* = Plane-wave equivalent power density

Note 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

Note 2: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in RSS-102

RSS 102

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Reference Period (minutes)
0.003-10 ²¹	83	90	-	Instantaneous*
0.1-10	-	0.73/ <i>f</i>	-	6**
1.1-10	87/ <i>f</i> ^{0.5}	-	-	6**
20-Oct	27.46	0.0728	2	6
20-48	58.07/ <i>f</i> ^{0.25}	0.1540/ <i>f</i> ^{0.25}	8.944/ <i>f</i> ^{0.5}	6
48-300	22.06	0.05852	1.291	6
300-6000	3.142 <i>f</i> ^{0.3417}	0.008335 <i>f</i> ^{0.3417}	0.02619 <i>f</i> ^{0.6834}	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ <i>f</i> ^{1.2}
150000-300000	0.158 <i>f</i> ^{0.5}	4.21 x 10 ⁻⁴ <i>f</i> ^{0.5}	6.67 x 10 ⁻⁵ <i>f</i>	616000/ <i>f</i> ^{1.2}

Note: *f* is frequency in MHz.
 *Based on nerve stimulation (NS).
 ** Based on specific absorption rate (SAR).

5.5.2. Method of Measurements

Calculation Method of Power Density/RF Safety Distance:

$$S = \frac{PG}{4\pi \cdot r^2} = \frac{EIRP}{4\pi \cdot r^2}$$

Where,
 P: power input to the antenna in mW
 EIRP: Equivalent (effective) isotropic radiated power.
 S: power density mW/cm²
 G: numeric gain of antenna relative to isotropic radiator
 r: distance to centre of radiation in cm

5.5.3. RF Evaluation

FCC

Frequency (MHz)	EIRP (dBm)	EIRP (mW)	Evaluation Distance, r (cm)	Power Density, S (mW/cm ²)	MPE Limit (mW/cm ²)	Margin (mW/cm ²)
2402	12.53	17.91	20	0.0035	1.0	-0.996

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Frequency (MHz)	EIRP (dBm)	EIRP (mW)	Evaluation Distance, r (cm)	Power Density, S (W/m ²)	MPE Limit (W/m ²)	Margin (W/m ²)
2402	12.53	17.91	20	0.035	5.35	-5.31

5.6. DIGITAL APPARATUS EMISSIONS (RADIATED) [ICES-003, ISSUE 6]

5.6.1. Limit(s)

The equipment shall meet the limits of the following tables determined at a distance of 3 metres:

Class B Radiated Limits Below 1 GHz

Frequency (MHz)	Class B Radiated Limit (dB μ V/m)
	Quasi-peak
30 - 88	40.0
88 - 216	43.5
216 - 960	46.0
960 - 1000	54.0

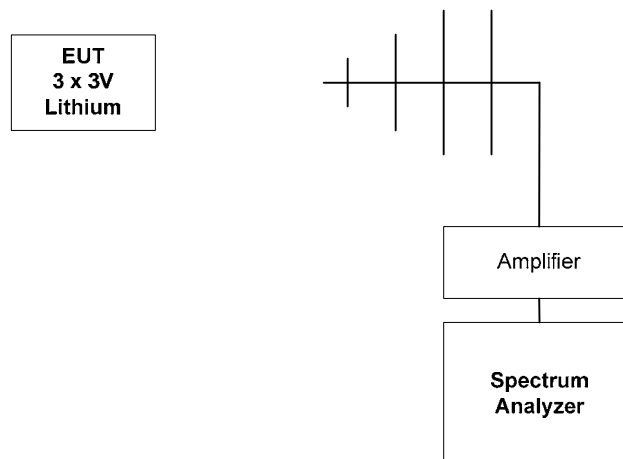
Class B Radiated Limits Above 1 GHz

Frequency (MHz)	Class B Radiated Limit (dB μ V/m)	
	Linear Average Detector	Peak Detector
> 1000	54	74

5.6.2. Method of Measurements

RSS-Gen and ANSI C63.4

5.6.3. Test Arrangement



5.6.5. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range	Calibration Due Date
EMI Receiver	Rohde & Schwarz	ESU40	100037	20Hz–40 GHz	Mar 15, 2020
RF Amplifier	Com-Power	PAM-0118A	551052	0.5 – 18 GHz	Jul 26, 2019
Biconilog	Emco	3142B	1575	26-2000 MHz	May 10, 2020
Horn Antenna	Emco	3155	5061	1 – 18 GHz	Apr 30, 2020

5.6.6. Test Data

Remarks: - The measuring receiver shall be tuned over the frequency range 30 MHz to 12.5 GHz. - All spurious emissions that are in excess of 20 dB below the specified limit shall be recorded.					
Frequency (MHz)	RF Level (dB μ V/m)	Detector Used (Peak/QP/Avg)	Antenna Plane (H/V)	Limit at 3 m (dB μ V/m)	Margin (dB)
All signals measured were below 20dB below the limit					

EXHIBIT 6. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of CISPR 16-4-2 @ IEC:2003 and JCGM 100:2008 (GUM 1995) – Guide to the Expression of Uncertainty in Measurement.

6.1. LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY

	Line Conducted Emission Measurement Uncertainty (9 kHz – 30 MHz):	Measured	Limit
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)}$	± 1.44	± 1.8
U	Expanded uncertainty U: $U = 2u_c(y)$	± 2.89	± 3.6

6.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY

	Radiated Emission Measurement Uncertainty @ 3m, Horizontal (30-1000 MHz):	Measured (dB)	Limit (dB)
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)}$	± 2.39	± 2.6
U	Expanded uncertainty U: $U = 2u_c(y)$	± 4.79	± 5.2

	Radiated Emission Measurement Uncertainty @ 3m, Vertical (30-1000 MHz):	Measured (dB)	Limit (dB)
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)}$	± 2.39	± 2.6
U	Expanded uncertainty U: $U = 2u_c(y)$	± 4.78	± 5.2

	Radiated Emission Measurement Uncertainty @ 3 m, Horizontal & Vertical (1 – 18 GHz):	Measured (dB)	Limit (dB)
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)}$	± 1.87	Under consideration
U	Expanded uncertainty U: $U = 2u_c(y)$	± 3.75	Under consideration