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TIMCO ENGINEERING, Inc.

An IIA Company

FCC PART 15.247 & IC RSS-247 2.4 GHz DTS Test Report

APPLICANT	RENOVIA INC.
ADDRESS	263 SUMMER STREET, 5TH FLOOR BOSTON, MA 02210
FCC ID	2AT3A-LEVA-02B
MODEL NUMBER	leva-02
PRODUCT DESCRIPTION	Pelvic Digital Health System - BLE Relay/Case
DATE SAMPLE RECEIVED	5/31/2019
FINAL TEST DATE	6/3/2019
TESTED BY	Tim Royer
TEST RESULTS	☒ PASS ☐ FAIL

Report Number	Report Version	Description	Issue Date
811BUT20_2400 MHZ DTS TestReport_	Rev1	Initial Issue	6/3/2019
811BUT20_2400 MHZ DTS TestReport_	Rev2	Updated Product Description, Corrected peak power output, Added Colocation section on page 2	5/18/2020

THE ATTACHED REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL WITHOUT THE WRITTEN APPROVAL OF TIMCO ENGINEERING, INC.

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GENERAL REMARKS

Summary

The device under test does:

☒ Fulfill the general approval requirements as identified in this test report and was selected by the customer.

☐ Not fulfill the general approval requirements as identified in this test report

Attestations

This equipment has been tested in accordance with the standards identified in this test report. To the best of my knowledge and belief, these tests were performed using the measurement procedures described in this report.

All instrumentation and accessories used to test products for compliance to the indicated standards are calibrated regularly in accordance with ISO 17025 requirements.

I attest that the necessary measurements were made at:

Timco Engineering Inc.
849 NW State Road 45
Newberry, FL 32669
Designation #: US1070

Tested by:

Name and Title	Tim Royer, Project Manager / EMC Testing Engineer
Date	06/5/2019

GENERAL INFORMATION

EUT Information

EUT Description	Pelvic Digital Health System - BLE Relay/Case		
FCC ID	2AT3A-LEVA-02B		
Model Number	leva-02		
EUT Power Source	☐110–120Vac, 50–60Hz	☐ DC Power	☒ Battery Operated
Test Item	☐ Prototype	☒ Pre-Production	☐ Production
Type of Equipment	☐ Fixed	☐ Mobile	☒ Portable
Antenna Connector	SMA		
Test Conditions	The temperature was 26ºC Relative humidity of 50%.		
Test Configuration	Operational		
Colocation:	900MHz and 2400MHz radios do not function simultaneously in normal operation.		
Modification to the EUT	No Modification to EUT.		
Applicable Standards	FCC CFR 47 Part 2, Part 15, RSS-GEN Issue 5, RSS-247, Issue 2, Referring to ANSI C63.10-2013 for Test Procedures		
Test Facility	Timco Engineering Inc. at 849 NW State Road 45 Newberry, FL 32669 USA. Designation #: US1070 ISED Test Site Registration: 2056-A		

Peripherals Used in Testing

Description	Type	Connector	Length
n/a	n/a	n/a	n/a

Test Results Summary

FCC Rule Part No.	IC Rule Part No.	Requirement	Test Item	Result
15.215(c)	RSS-GEN 6.6	Occupied Bandwidth	99% Bandwidth	**Pass**
15.247(a), (e)	RSS-247 § 5.2	Digital Transmission Systems	6 dB Bandwidth	**Pass**
			Power Spectral Density	**Pass**
15.247(b)	RSS-247 § 5.4	Transmitter Output Power and Equivalent Isotropically Radiated Power	Peak Power Output (ERP)	**Pass**
			Antenna Gain (EIRP)	**Pass**
15.247(d)	RSS-247 § 5.5	Unwanted Emissions	Bandedge	**Pass**
			Radiated Spurious	**Pass**
			AC Powerline Conducted Emissions	**n/a**

Frequency Range(s) of EUT

Operating Frequency Band 1	2400 – 2483.5 MHz

Test Frequencies	2402, 2442, 2480 MHz

Definition of EUT

RULE PART NO.: FCC PART 15.3

(i) *Class B digital device.* A digital device that is marketed for use in a residential environment notwithstanding use in commercial, business and industrial environments. Examples of such devices include, but are not limited to, personal computers, calculators, and similar electronic devices that are marketed for use by the general public.

NOTE: The responsible party may also qualify a device intended to be marketed in a commercial, business or industrial environment as a Class B device, and in fact is encouraged to do so, provided the device complies with the technical specifications for a Class B digital device. In the event that a particular type of device has been found to repeatedly cause harmful interference to radio communications, the Commission may classify such a digital device as a Class B digital device, regardless of its intended use.

(k) *Digital device.* (Previously defined as a computing device). An unintentional radiator (device or system) that generates and uses timing signals or pulses at a rate in excess of 9,000 pulses (cycles) per second and uses digital techniques; inclusive of telephone equipment that uses digital techniques or any device or system that generates and uses radio frequency energy for the purpose of performing data processing functions, such as electronic computations, operations, transformations, recording, filing, sorting, storage, retrieval, or transfer. A radio frequency device that is specifically subject to an emanation requirement in any other FCC Rule part or an intentional radiator subject to subpart C of this part that contains a digital device is not subject to the standards for digital devices, provided the digital device is used only to enable operation of the radio frequency device and the digital device does not control additional functions or capabilities.

NOTE: Computer terminals and peripherals that are intended to be connected to a computer are digital devices.

(o) *Intentional radiator.* A device that intentionally generates and emits radio frequency energy by radiation or induction.

MEASUREMENT STANDARDS

RULE PART NO.: FCC PART 15.31

(a) The following measurement procedures are used by the Commission to determine compliance with the technical requirements in this part. Except where noted, copies of these procedures are available from the Commission's current duplicating contractor whose name and address are available from the Commission's Consumer and Governmental Affairs Bureau at 1-888-CALL-FCC (1-888-225-5322).

(2) Unlicensed Personal Communications Service (UPCS) devices are to be measured for compliance using ANSI C63.17-2013: "American National Standard Methods of Measurement of the Electromagnetic and Operational Compatibility of Unlicensed Personal Communications Services (UPCS) Devices" (incorporated by reference, see §15.38).

(3) Other intentional radiators are to be measured for compliance using the following procedure: ANSI C63.10-2013 (incorporated by reference, see §15.38).

(e) For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

(l) Measurements of radio frequency emissions conducted to the public utility power lines shall be performed using a 50 ohm/50 uH line-impedance stabilization network (LISN).

(m) Measurements on intentional radiators or receivers, other than TV broadcast receivers, shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table:

Frequency range over which device operates	Number of frequencies	Location in the range of operation
1 MHz or less	1	Middle.
1 to 10 MHz	2	1 near top and 1 near bottom.
More than 10 MHz	3	1 near top, 1 near middle and 1 near bottom.

(o) The amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

FREQUENCY RANGE OF RADIATED MEASUREMENTS

RULE PART NO.: FCC PART 15.33

§15.33 Frequency range of radiated measurements.

(a) For an intentional radiator, the spectrum shall be investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to at least the frequency shown in this paragraph:

(1) If the intentional radiator operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

(2) If the intentional radiator operates at or above 10 GHz and below 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 100 GHz, whichever is lower.

(3) If the intentional radiator operates at or above 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 200 GHz, whichever is lower, unless specified otherwise elsewhere in the rules.

(4) If the intentional radiator contains a digital device, regardless of whether this digital device controls the functions of the intentional radiator or the digital device is used for additional control or function purposes other than to enable the operation of the intentional radiator, the frequency range shall be investigated up to the range specified in paragraphs (a)(1) through (a)(3) of this section or the range applicable to the digital device, as shown in paragraph (b)(1) of this section, whichever is the higher frequency range of investigation.

METHOD OF MEASUREMENT

RULE PART NO.: FCC PART 15.35

§15.35 Measurement detector functions and bandwidths.

The conducted and radiated emission limits shown in this part are based on the following, unless otherwise specified in this part:

(a) On any frequency or frequencies below or equal to 1000 MHz, the limits shown are based on measuring equipment employing a CISPR quasi-peak detector function and related measurement bandwidths, unless otherwise specified. The specifications for the measuring instrumentation using the CISPR quasi-peak detector can be found in ANSI C63.4-2014, clause 4 (incorporated by reference, see §15.38). As an alternative to CISPR quasi-peak measurements, the responsible party, at its option, may demonstrate compliance with the emission limits using measuring equipment employing a peak detector function as long at the same bandwidth as indicated for CISPR quasi-peak measurements are employed.

(b) Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz. When average radiated emission measurements are specified in this part, including average emission measurements below 1000 MHz, there also is a limit on the peak level of the radio frequency emissions. Unless otherwise specified, *e.g.,* see §§15.250, 15.252, 15.253(d), 15.255, 15.256, and 15.509 through 15.519, the limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device, *e.g.,* the total peak power level. Note that the use of a pulse desensitization correction factor may be needed to determine the total peak emission level. The instruction manual or application note for the measurement instrument should be consulted for determining pulse desensitization factors, as necessary.

(c) Unless otherwise specified, *e.g.,* §§15.255(b), and 15.256(l)(5), when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to Supplier's Declaration of Conformity.

DTS BANDWIDTH

Rules Part No.: FCC 15.247 (a)(2), IC RSS 247 Section 5.2, a

Requirements:

§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

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

RSS 247, Section 5.2:

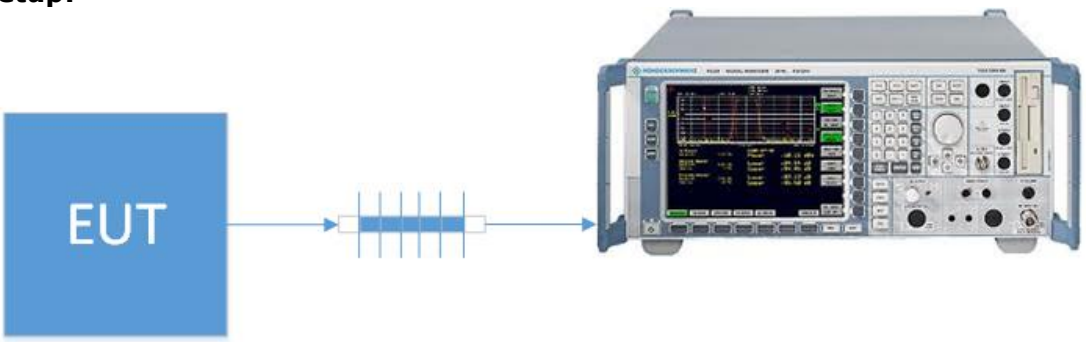
DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400-2483.5 MHz: [1]

a. The minimum 6 dB bandwidth shall be 500 kHz.

b. The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of section 5.4(d), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

Test Method: ANSI C63.10 § 11.8.1 DTS Bandwidth Option 1
ANSI C63.10 § 6.3 Radiated Emissions testing- Common

Test Setup:



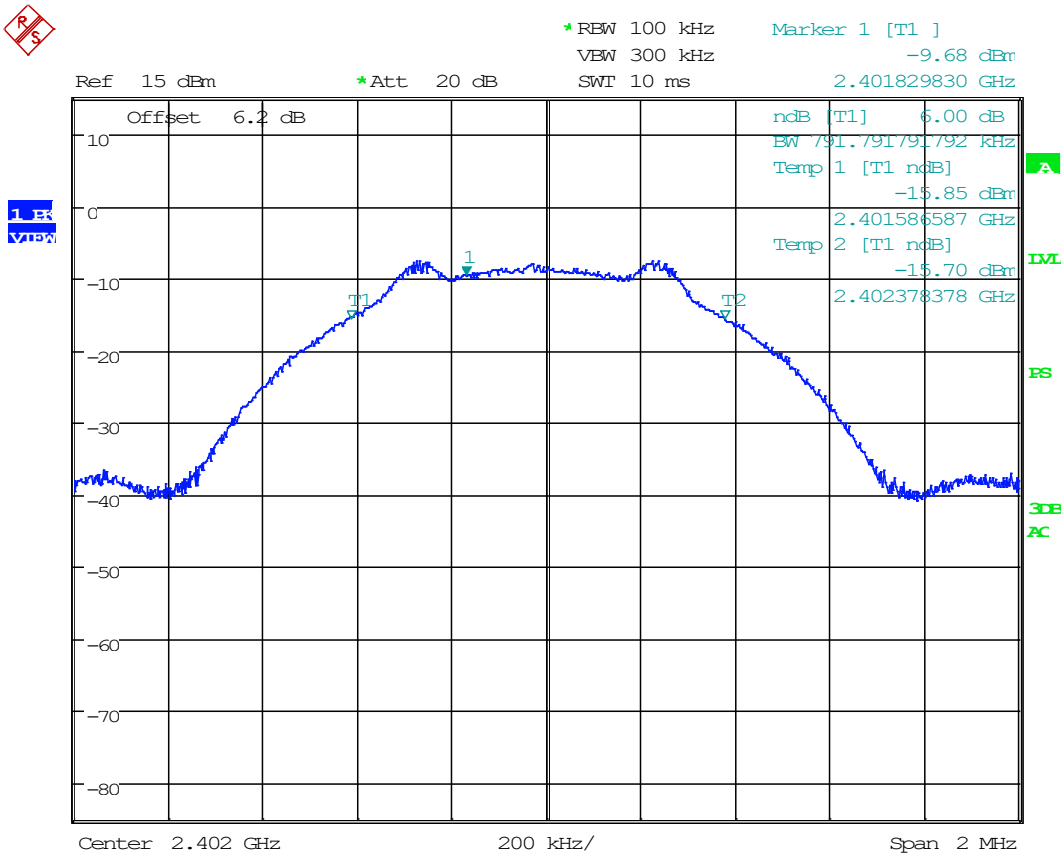
Test Data: **DTS Bandwidth Measurement Table**

Tuned Frequency (MHz)	6 dB BW (KHz)	Limit (KHz)	Margin (KHz)
2402	751.7	≥ 500	251.7
2442	685.6	≥ 500	185.6
2480	689.6	≥ 500	189.6

RESULT: Meets Requirements

DTS BANDWIDTH

Test Data: DTS Bandwidth Plot Low End of Band

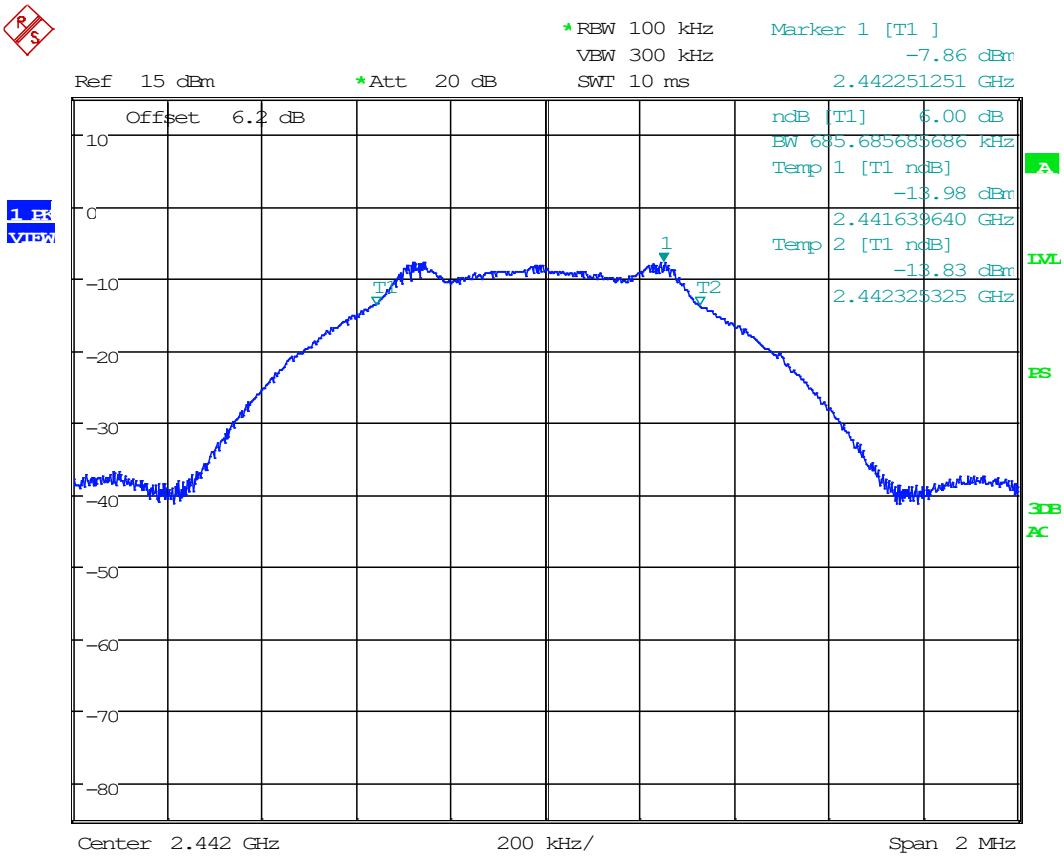


Date: 3.JUN.2019 17:00:00

RESULT: 6 dB BW = 751.7kHz

DTS BANDWIDTH

Test Data: DTS Bandwidth Plot Middle of Band

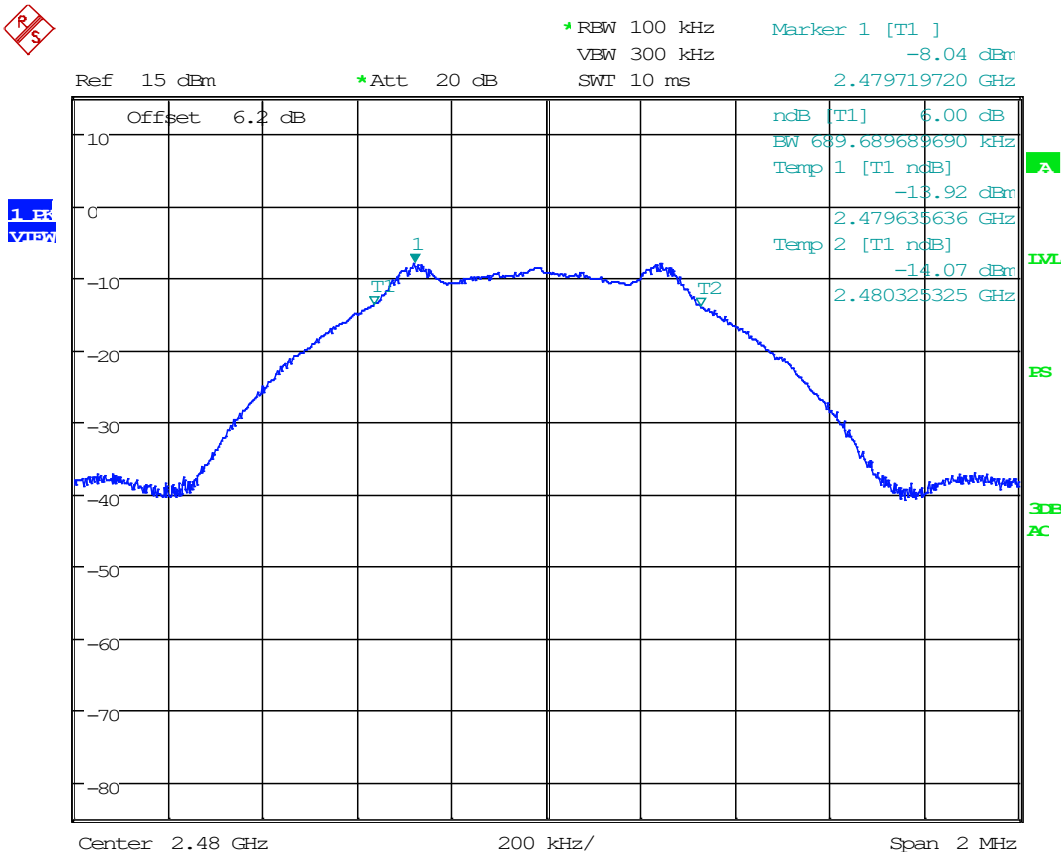


Date: 3.JUN.2019 17:02:31

RESULT: 6 dB BW = 685.6 kHz

DTS BANDWIDTH

Test Data: DTS Bandwidth Plot High End of Band



Date: 3.JUN.2019 17:01:48

RESULT: 6 dB BW = 689.6 kHz

PEAK POWER OUTPUT

Rules Part No.: FCC 15.247(b) (3) (4), IC RSS 247 Section 5.4, d

Requirements:

§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

(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.

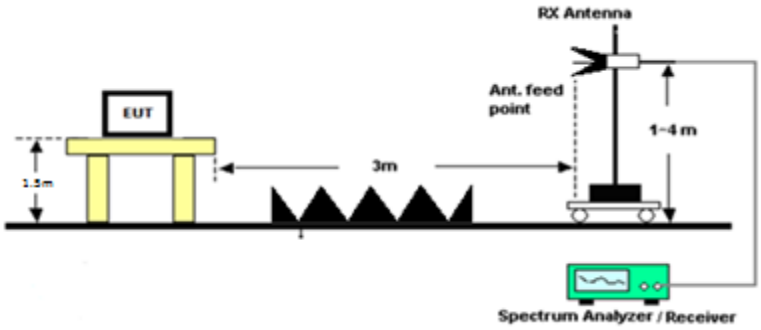
(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output 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 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

Test Method: ANSI C63.10 § 11.2 Power Limits, definitions, and device configuration
ANSI C63.10 § 11.9.1.1 Fundamental Output Power RBW ≥ DTS Bandwidth
ANSI C63.10 § Annex G Relationship among Field Strength and ERP/EIRP

Test Setup:



PEAK POWER OUTPUT

Test Data: **Peak Power Output Measurement Table**

Peak Conducted Power Output Measurement				
Tuned Frequency (MHz)	PConducted (dBm)	PConducted (W)	15.247 Limit (W)	Margin (W)
2402	-9.00	0.00013	1.00	0.99987
2442	0.87	0.00122	1.00	0.99878
2480	-8.55	0.00014	1.00	0.99986
ERP to EIRP Conversion formula: EIRP = ERP + 2.15 dB				

Peak EIRP Power Output Calculation				
Tuned Frequency (MHz)	PConducted (dBm)	EIRP (W)	RSS-247 Limit (W)	Margin (W)
2402	-9.00	0.00021	4.00	3.99979
2442	0.87	0.00201	4.00	3.99799
2480	-8.55	0.00023	4.00	3.99977

RESULT: Meets Requirements

POWER SPECTRAL DENSITY

Rules Part No.: FCC 15.247(e), IC RSS 247 Section 5.2, b

Requirements:

§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

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

RSS 247, Section 5.2:

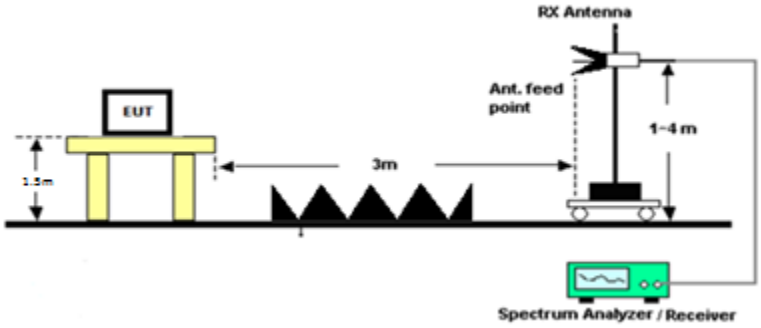
DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400-2483.5 MHz: 1

a. The minimum 6 dB bandwidth shall be 500 kHz.

b. The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of section 5.4(d), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

Test Method: ANSI C63.10 § 11.2 Power Limits, definitions, and device configuration
ANSI C63.10 § 11.10.2 Maximum PSD in the fundamental- Method PKPSD
ANSI C63.10 § 6.3 Radiated Emissions testing- Common
ANSI C63.10 § Annex G Relationship among Field Strength and ERP/EIRP

Setup:



POWER SPECTRAL DENSITY

Test Data: **Power Spectral Density Measurement Table**

Tuned Frequency (MHz)	PSD (dBm/3KHz)	Limit (dBm/3KHz)	Margin (dB)
2402	-7.86	8.00	15.86
2442	-1.40	8.00	9.40
2480	-9.87	8.00	17.87

RESULT: Meets Requirements

OCCUPIED BANDWIDTH

Rules Part No.: FCC 15.215(c), IC RSS GEN Section 6.6

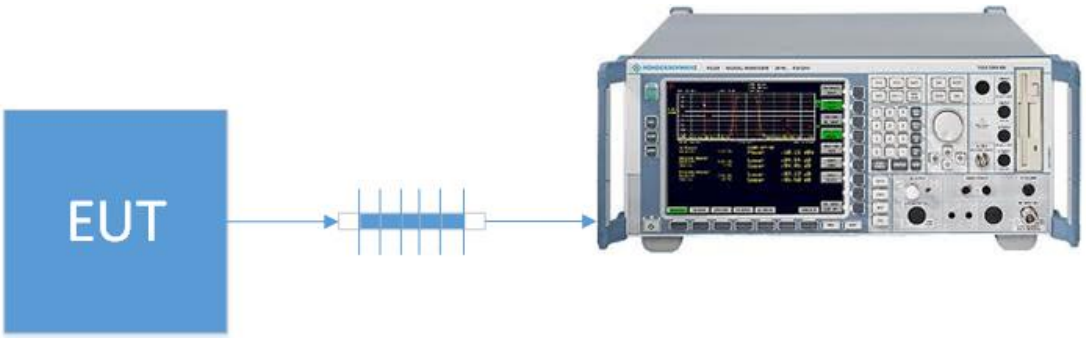
Requirements: The 99% Bandwidth is for reporting only.

§15.215 Additional provisions to the general radiated emission limitations.

(c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. In the case of intentional radiators operating under the provisions of subpart E, the emission bandwidth may span across multiple contiguous frequency bands identified in that subpart. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

Test Method: ANSI C63.10 § 6.9.2 Occupied Bandwidth- Relative procedure
ANSI C63.10 § 6.9.3 Occupied Bandwidth- 99% Power Bandwidth procedure
ANSI C63.10 § 6.3 Radiated Emissions testing- Common

Setup:



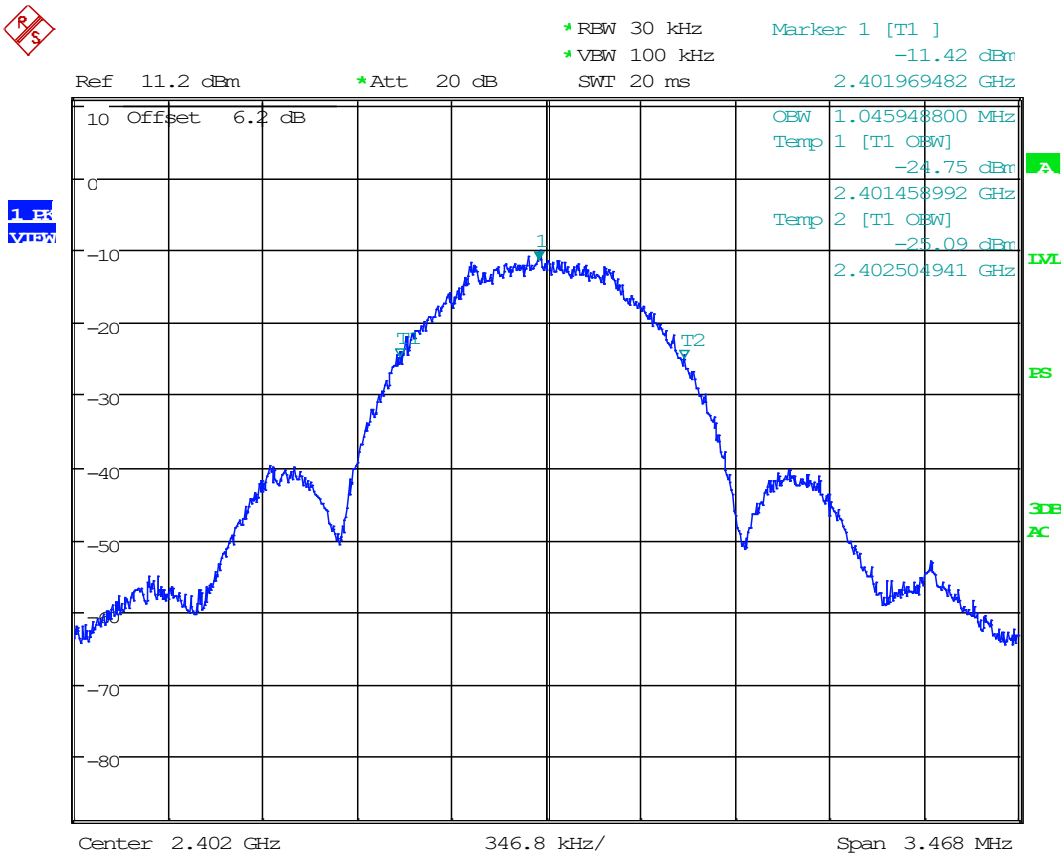
Test Data: **Occupied Bandwidth Measurement Table**

Tuned Frequency (MHz)	99% BW (MHz)
2402	1.045
2442	1.05
2480	1.05

RESULT: Meets Requirements

OCCUPIED BANDWIDTH

Test Data: 99% Bandwidth Low End of Band

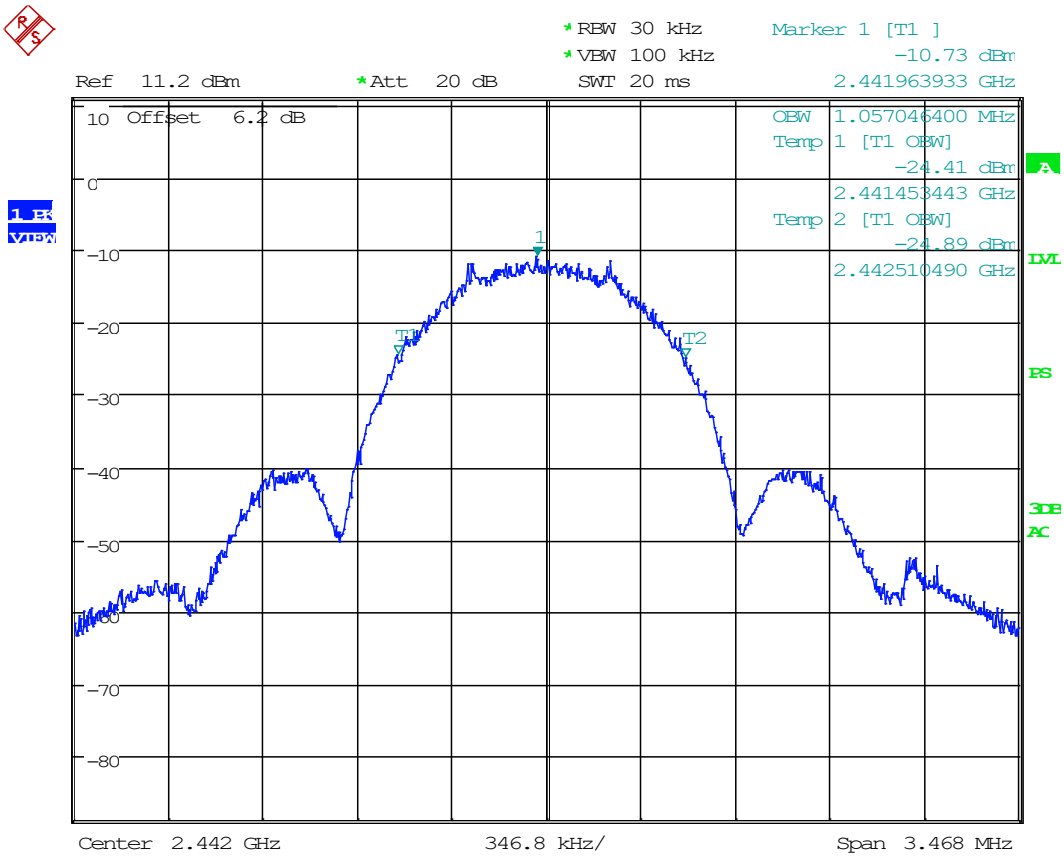


Date: 3.JUN.2019 17:06:06

RESULT: 99% OBW = 1.045 MHz

OCCUPIED BANDWIDTH

Test Data: 99% Bandwidth Middle of Band

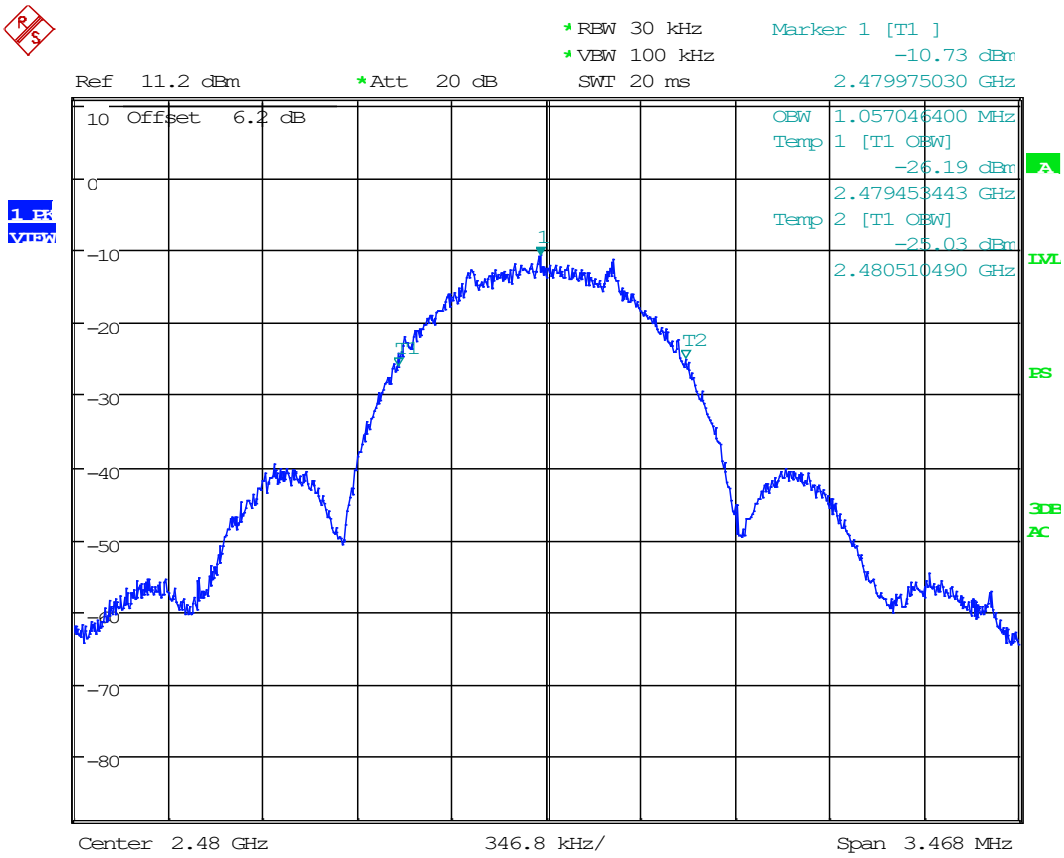


Date: 3.JUN.2019 17:04:12

RESULT: 99% OBW = 1.05 MHz

OCCUPIED BANDWIDTH

Test Data: 99% Bandwidth High end of Band



Date: 3.JUN.2019 17:05:22

RESULT: 99% OBW = 1.05 MHz

BANDEDGE

Rule Part No.: FCC 15.247(d), IC RSS 247 Section 5.5

Requirements:

§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

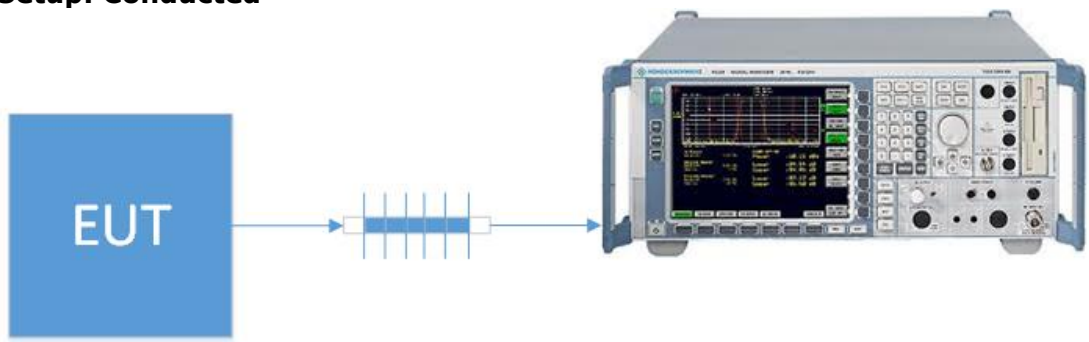
(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains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

RSS 247, Section 5.5:

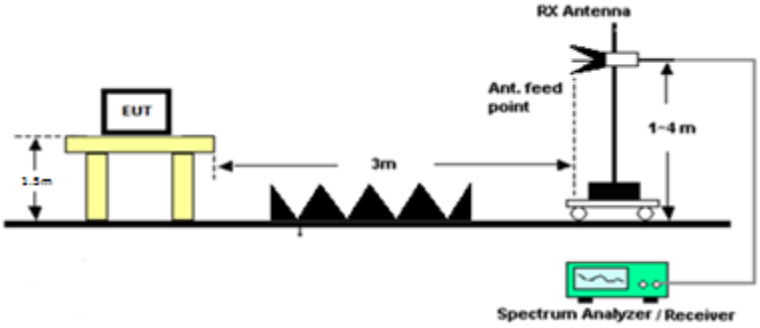
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

Test Method: ANSI C63.10 § 6.10.4 Authorized band-edge relative method (non-restricted
ANSI C63.10 § 6.10.6 Marker Delta Method (restricted band edge)
ANSI C63.10 § 6.3 Radiated Emissions testing- Common

Setup: Conducted



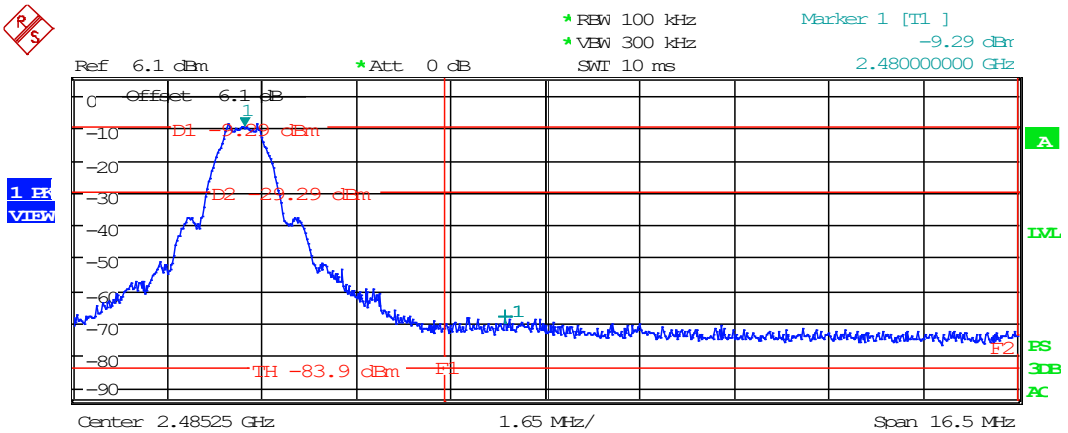
Setup: Radiated



BANDEDGE

Test Data: Upper Band Edge Plot Conventional Method

Tuned Frequency (MHz)	Emission Frequency (MHz)	Detector	Field Strength (dBµV/m)	Margin (dB)
2480.00	2484.55	Peak	20.31	53.69
2480.00	2484.55	Average	16.01	37.99



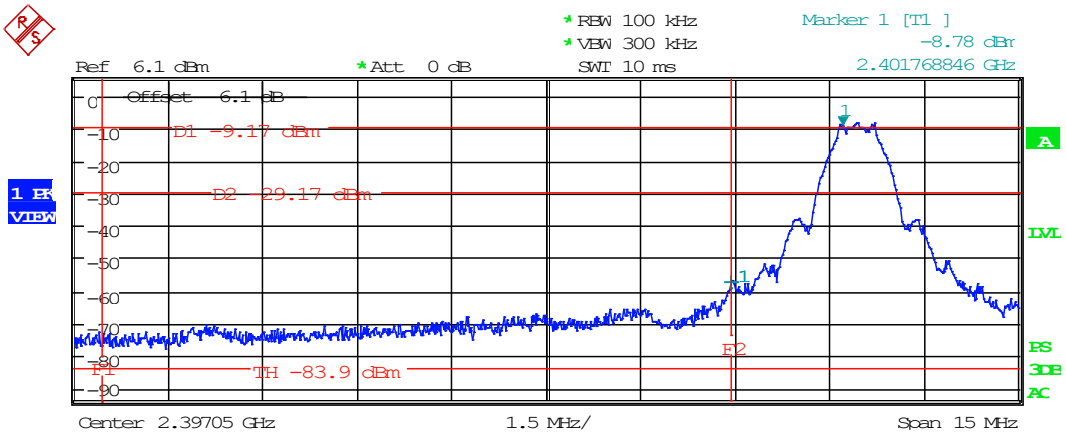
#	Frequency	Level
1	2.484550 GHz	-68.51 dBm

Date: 3.JUN.2019 16:58:37

RESULT: Meets Requirements

BANDEDGE

Test Data: **Lower Band Edge Plot**



#	Frequency	Level
1	2.399990 GHz	-57.65 dBm

Date: 3.JUN.2019 16:56:38

RESULT: Meets Requirements

RADIATED SPURIOUS EMISSIONS

RULE PART NO.: FCC part 15.247 (d) & 15.209, IC RSS 247 Section 5.5 & RSS GEN Section 8.9

Requirements:

§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

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

§15.209 Radiated emission limits; general requirements.

(a) Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency (MHz)	Limit (µV/m)	Limit (dBµV/m)
0.009 – 0.490	2400/F(in kHz) @ 300m	-
0.490 – 1.705	24000/F(in kHz) @ 30m	-
1.705 kHz – 30	30.0 @ 30 m	29.54 @ 30m
30 – 88	100.0	40.0
88 – 216	150.0	43.5
216 – 960	200.0	46.0
Above 960	500.0	54.0

§15.35 Measurement detector functions and bandwidths.

(b) Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz. When average radiated emission measurements are specified in this part, including average emission measurements below 1000 MHz, there also is a limit on the peak level of the radio frequency emissions. Unless otherwise specified, *e.g.,* see §§15.250, 15.252, 15.253(d), 15.255, 15.256, and 15.509 through 15.519, the limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device, *e.g.,* the total peak power level. Note that the use of a pulse desensitization correction factor may be needed to determine the total peak emission level. The instruction manual or application note for the measurement instrument should be consulted for determining pulse desensitization factors, as necessary.

RADIATED SPURIOUS EMISSIONS

RSS 247, Section 5.5:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

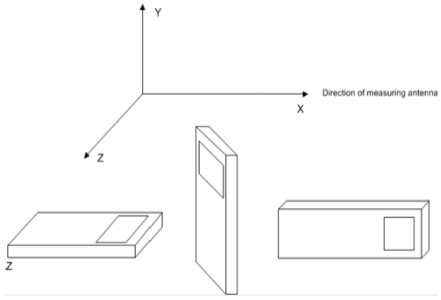
Test Procedure: ANSI C63.4 § Annex D Validation of radiated emissions standard test sites
ANSI C63.10 § 6.3 Common requirements radiated emissions
ANSI C63.10 § 6.4 Emissions below 30 MHz
ANSI C63.10 § 6.5 Emissions between 30 & 1000 MHz
ANSI C63.10 § 6.6 Emissions above 1 GHz

Radiated Emissions Test Setup:

EUT setup and arrangement was completed as described in ANSI C63.4. Exploratory measurements were taken following different peripheral placement and cable manipulations as described in ANSI C63.4. A photo is provided of the Test setup to record the exact peripheral equipment and cable manipulation arrangement found to produce the highest possible level of radiated emissions.
The test procedure used for radiated emissions is described ANSI C63.4 using a spectrum analyzer. The resolution bandwidth used was 100 kHz with an appropriate sweep speed. The analyzer was calibrated in dB above a microvolt at the output of the antenna. All cable loss and antenna factors were calibrated to provide plots with correction factors applied to results using the formula and example described below. The video bandwidth of the analyzer was always greater than or equal to the resolution bandwidth, and a peak detector with max hold was used.

The unit under test was placed on a table 80 cm high and with dimensions of 1m by 1.5m. The table used for radiated measurements is capable of continuous rotation. When an emission was found, the table was rotated to produce the maximum signal strength. At this point, the antenna was raised and lowered from 1m to 4m. The antenna was placed in both the horizontal and verticals planes. The frequency was scanned from 30 MHz to 1.0 GHz. The EUT was measured in three parts of the tunable band of EUT and (3) orthogonal planes when necessary.

EUT Orientation(s):



RADIATED SPURIOUS EMISSIONS

Formula of Conversion Factors:

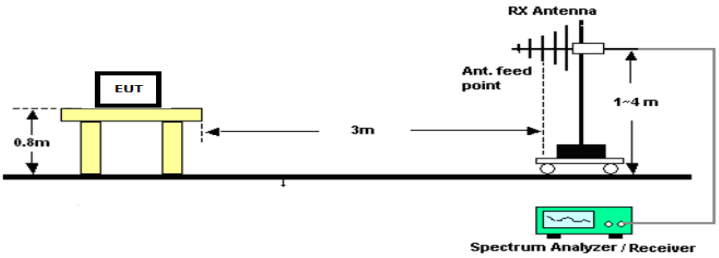
The field strength at 3m was established by adding the meter reading of the spectrum analyzer (which is set to read in units of dBµV) to the antenna correction factor supplied by the antenna manufacturer plus the coax loss. The antenna correction factors are stated in terms of dB. The gain of the preselector was accounted for in the spectrum analyzer meter reading.

Field Strength Correction Factor Conversion Example:

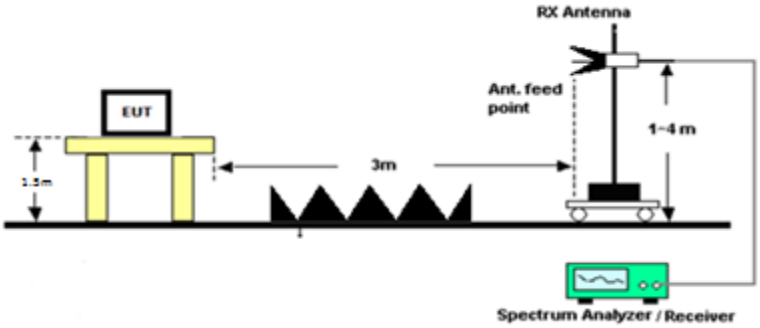
Freq (MHz)	Meter Reading	+ ACF	+CL	= FS
33	20 dBµV	+ 10.36 dB/m	+0.40 dB	=30.76 dBµV/m @ 3m

Test Setup:

Emissions 30 – 1000 MHz



Emissions above 1 GHz



RADIATED SPURIOUS EMISSIONS

Notes: The spectrum was measured from 9 KHz to 25 GHz. Six or more of the Spurious Emissions equal to or less than 20 dB from the limits are required to be reported, therefore the worst case data rate and output power which produced emissions within 30 dB of the limit are reported below.

Yellow Highlighted Emission Frequencies indicate Restricted Bands, per 15.209(a). The measurement of restricted bands were taken in Peak Hold, and shown to comply with the average limit of 15.209. In cases where the Peak measurement does not meet or exceed the Average limit of 15.209, the Average detector was used, and the peak is to then meet the level of 15.35(b), 20 dB higher that the limit of 15.209.

For all other emissions (in non-restricted bands) they are shown to comply with the limit of 15.247(d). The Radiated Fundamental Power Output is taken below, using a Peak detector.

Test Data: Field Strength of the Fundamental

Tuned Frequency (MHz)	Emission Frequency (MHz)	Meter Reading (dBµV)	Antenna Polarity	Coax Loss (dB)	Correction Factor (dB/m)	Field Strength (dBµV/m)	15.247 (d) Limit (dBc)	15.247 (d) Limit (dBuV/m)
2402.00	2402.00	52.02	H	5.62	31.88	89.52	20.000	69.52
2442.00	2442.00	58.52	V	5.62	31.84	95.98	20.000	75.98
2480.00	2480.00	49.79	V	5.62	32.10	87.51	20.000	67.51

Test Data: 2402 MHz Field Strength table

Tuned Freq MHz	Emission Frequency MHz	Detector	Meter Reading dBu V	Antenna Polarity	Coax Loss Db	Correction Factor dB/M	Field Strength dBu V/M	Margin	Limit
2402.00	4804.00	PK	11.56	V	7.08	33.93	52.57	21.43	74.00
2402.00	4804.00	PK	10.52	H	7.08	33.93	51.53	22.47	74.00
2402.00	4804.00	AV	0.70	V	7.08	33.93	41.71	12.29	54.00
2402.00	4804.00	AV	0.80	H	7.08	33.93	41.81	12.19	54.00
2402.00	7206.00	PK	5.18	H	9.47	36.39	51.04	18.46	69.50
2402.00	7206.00	PK	6.64	V	9.47	36.39	52.50	17.00	69.50
2402.00	9608.00	PK	-0.48	H	10.72	36.62	46.86	22.64	69.50
2402.00	9608.00	PK	-0.84	V	10.72	36.62	46.50	23.00	69.50
2402.00	12010.00	PK	-3.30	H	12.45	39.08	48.23	25.77	74.00
2402.00	12010.00	PK	1.84	V	12.45	39.08	53.37	20.63	74.00
2402.00	12010.00	AV	-8.40	V	12.45	39.08	43.13	10.87	54.00
2402.00	12010.00	AV	-7.40	H	12.45	39.08	44.13	9.87	54.00
2402.00	14412.00	PK	-2.45	H	13.49	39.75	50.79	18.71	69.50
2402.00	14412.00	PK	-0.84	V	13.49	39.75	52.40	17.10	69.50
2402.00	16814.00	PK	-1.41	H	14.53	42.34	55.46	14.04	69.50
2402.00	16814.00	PK	-7.40	H	14.53	42.34	49.47	20.03	69.50
2402.00	16814.00	PK	-7.40	V	14.53	42.34	49.47	20.03	69.50

RADIATED SPURIOUS EMISSIONS

Test Data: 2442 MHz Field Strength table

Tuned Freq MHz	Emission Frequency MHz	Detector	Meter Reading dBu V	Antenna Polarity	Coax Loss Db	Correction Factor dB/M	Field Strength dBu V/M	Margin	Limit
2442.00	4884.00	PK	11.60	V	7.30	33.92	52.82	21.18	74.00
2442.00	4884.00	AV	5.50	V	7.30	33.92	46.72	7.28	54.00
2442.00	4884.00	PK	7.97	H	7.30	33.92	49.19	24.81	74.00
2442.00	4884.00	AV	-1.70	H	7.30	33.92	39.52	14.48	54.00
2442.00	7326.00	PK	4.15	V	9.46	36.23	49.84	24.16	74.00
2442.00	7326.00	AV	-5.00	V	9.46	36.23	40.69	13.31	54.00
2442.00	7326.00	PK	4.51	H	9.46	36.23	50.20	23.80	74.00
2442.00	7326.00	AV	-5.00	H	9.46	36.23	40.69	13.31	54.00
2442.00	9768.00	PK	-0.90	V	10.96	36.84	46.90	29.00	75.90
2442.00	9768.00	PK	-3.31	H	10.96	36.84	44.49	31.41	75.90
2442.00	12210.00	PK	-3.08	V	12.35	39.24	48.51	25.49	74.00
2442.00	12210.00	AV	-9.00	V	12.35	39.24	42.59	11.41	54.00
2442.00	12210.00	PK	-2.50	H	12.35	39.24	49.09	24.91	74.00
2442.00	12210.00	AV	-9.00	H	12.35	39.24	42.59	11.41	54.00
2442.00	14652.00	PK	-4.30	V	13.70	40.27	49.67	26.23	75.90
2442.00	14652.00	PK	-3.79	H	13.70	40.27	50.18	25.72	75.90
2442.00	17094.00	PK	0.24	V	14.80	42.42	57.46	18.44	75.90
2442.00	17094.00	PK	-1.19	H	14.80	42.42	56.03	19.87	75.90

Test Data: 2480 MHz Field Strength table

Tuned Freq MHz	Emission Frequency MHz	Detector	Meter Reading dBu V	Antenna Polarity	Coax Loss Db	Correction Factor dB/M	Field Strength dBu V/M	Margin	Limit
2480.00	4960.00	PK	11.32	V	7.49	33.96	52.77	21.23	74.00
2480.00	4960.00	AV	0.60	V	7.49	33.96	42.05	11.95	54.00
2480.00	4960.00	PK	12.50	H	7.49	33.96	53.95	20.05	74.00
2480.00	4960.00	AV	-0.10	H	7.49	33.96	41.35	12.65	54.00
2480.00	7440.00	PK	4.25	V	9.56	36.01	49.82	24.18	74.00
2480.00	7440.00	AV	-4.80	V	9.56	36.01	40.77	13.23	54.00
2480.00	7440.00	PK	4.29	H	9.56	36.01	49.86	24.14	74.00
2480.00	7440.00	AV	-7.10	H	9.56	36.01	38.47	15.53	54.00
2480.00	9920.00	PK	0.55	V	11.12	37.08	48.75	18.75	67.50
2480.00	9920.00	PK	-2.86	H	11.12	37.08	45.34	22.16	67.50
2480.00	12400.00	PK	-0.79	V	12.42	39.23	50.86	23.14	74.00
2480.00	12400.00	AV	-8.20	V	12.42	39.23	43.45	10.55	54.00
2480.00	12400.00	PK	-3.33	H	12.42	39.23	48.32	25.68	74.00
2480.00	12400.00	AV	-9.00	H	12.42	39.23	42.65	11.35	54.00
2480.00	14880.00	PK	-2.41	V	13.68	40.29	51.56	15.94	67.50
2480.00	14880.00	PK	-2.25	H	13.68	40.29	51.72	15.78	67.50
2480.00	17360.00	PK	-1.56	V	14.97	42.52	55.93	11.57	67.50
2480.00	17360.00	PK	-1.68	H	14.97	42.52	55.81	11.69	67.50

Result: Meets Requirements

POWER LINE CONDUCTED INTERFERENCE

Rule Part No.: FCC Part 15.107 & ICES-003 § 6.1

Requirements:

§15.107 Conducted limits.

(a) Except for Class A digital devices, for equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the band edges.

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

*Decreases with the logarithm of the frequency.

(d) Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provision for, the use of battery chargers which permit operating while charging, AC adaptors or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

Method of Measurement:

The procedure used was ANSI C63.4 using a 50uH LISN. Both lines were observed. The bandwidth of the spectrum analyzer was 10 kHz with an appropriate sweep speed. The spectrum was scanned from 0.15 to 30 MHz.

The following plots represent the emissions for power line conducted. Both lines were observed.

Test Data: n/a

NOTE: This device is battery operated only.

TEST EQUIPMENT LIST

Device	Manufacturer	Model	Serial Number	Cal/Char Date	Due Date
Antenna: Active Loop	ETS-Lindgren	6502	62529	12/11/2017	12/11/2019
Antenna: Biconical 1057	Eaton	94455-1	1057	12/13/2017	12/13/2019
Antenna: Log-Periodic 1122	Electro-Metrics	LPA-25	1122	7/26/2017	7/26/2019
CHAMBER	Panashield	3M	N/A	3/15/2019	3/15/2021
EMI Test Receiver R & S ESU 40 Chamber	Rohde & Schwarz	ESU 40	100320	08/28/18	08/28/2021
Software: Field Strength Program	Timco	N/A	Version 4.10.7.0	N/A	N/A
Antenna: Double-Ridged Horn/ETS Horn 2	ETS-Lindgren	3117	41534	3/1/2017	3/1/2020
Bore-sight Antenna Positioning Tower	Sunol Sciences	TLT2	N/A	N/A	N/A
Coaxial Cable #103 - KMKM-0180-01 Aqua	Micro-Coax	UFB142A-0-0720-200200	225363-002 (#103)	4/12/2019	4/12/2021
Coaxial Cable - Chamber 3 cable set (Primary)	Micro-Coax	Chamber 3 cable set (Primary)	KMKM-0244-01 KMKM-0670-00 KFKF-0198-01	4/12/2019	4/12/2021
Band Reject Filter 2.4 GHz	Micro-Tronics	BRM50702-02	0	4/12/2019	4/12/2021
Pre-amp	RF-LAMBDA	RLNA00M45GA	N/A	2/27/2019	2/27/2021
Antenna: Double-Ridged Horn 18-40 GHz	EMCO	3116	9011-2145	12/8/2017	12/8/2019
Attenuator SMA 30dB 5W DC-18G	Pasternack	PE7013-30	#23	11/19/2017	11/19/2019
LISN (Primary)	Electro-Metrics	ANS-25/2	225363	08/26/17	08/26/19

***EMI RECEIVER SOFTWARE VERSION**

The receiver firmware used was version 4.43 Service Pack 3

STATE OF THE MEASUREMENT UNCERTAINTY

The data and results referenced in this document are true and accurate. The measurement uncertainty was calculated for all measurements listed in this test report according To CISPR 16–4 or ENTR 100-028 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: "Uncertainty in EMC Measurements" and is documented in the Timco Engineering, Inc. quality system according to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.
Hereafter the best measurement capability for Timco Engineering, Inc. is reported:

Test Items	Measurement Uncertainty	Notes
RF Frequency Accuracy	± 49.5 Hz	(1)
RF Conducted Power	±0.93dB	(1)
Conducted spurious emission of transmitter valid up to 40GHz	±1.86dB	
Occupied Bandwidth	±2.65%	
Audio Frequency Response	±1.86dB	
Modulation limiting	±1.88%	
Radiated RF Power	±1.4dB	
Maximum frequency deviation: Within 300 Hz and 6kHz of audio freq. Within 6kHz and 25kHz of audio Freq.	 ±1.88% ±2.04%	
Rad Emissions Sub Meth up to 26.5GHz	±2.14dB	
Adjacent channel power	±1.47dB	(1)
Transient Frequency Response	±1.88%	
Temperature	±1.0°C	(1)
Humidity	±5.0%	

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=1.96.

END OF REPORT