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TIMCO ENGINEERING, Inc.

An IIA Company

FCC PART 15.247
2.4 GHz DSS Test Report

APPLICANT	LOEN ENGINEERING INC.
ADDRESS	846 CARRIE STREET VICTORIA BC V9A 5R4
FCC ID	2AVOA-SSM1
MODEL NUMBER	SSM1
PRODUCT DESCRIPTION	DTS/DSS MODULE
DATE SAMPLE RECEIVED	10/07/2019
FINAL TEST DATE	11/12/2019
TESTED BY	Franklin Rose
APPROVED BY	Tim Royer
TEST RESULTS	☒ PASS ☐ FAIL

Report Number	Report Version	Description	Issue Date
2685AUT19_PT 15.247 DSS TX_	Rev1	Initial Issue	11/20/2019

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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	Franklin Rose, Project Manager / EMC Specialist
Date	11/20/2019

Reviewed and Approved by:

Name and Title	Tim Royer, Project Manager / EMC Testing Engineer
Date	11/20/2019

GENERAL INFORMATION

EUT Information

EUT Description	DTS/DSS MODULE		
FCC ID	2AVOA-SSM1		
Model Number	SSM1		
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(s)	None		
Antenna(s)	Trace/Wafer antenna		
Normal Duty Cycle	2.87 % (= 15.42 dB correction factor)		
Test Conditions	The temperature was 26ºC Relative humidity of 50%.		
Test Configuration	Normal use.		
Modification to the EUT	EUT was fitted with UFL to SMA connector for testing. EUT was set to transmit at a 100% duty cycle for testing.		
Applicable Standards	FCC CFR 47 Part 2, Part 15, 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		

Peripherals Used in Testing

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

EUT Modes of Operation

Description	Modulation Type
Mode 1	GFSK

Test Results Summary

FCC 47 CFR Part 15.247 Compliance Summary				
Aspect		**FCC Governing Rule(s)**	**Description**	**Compliance**
Device Profile	731 Rule Part	FCC 47 CFR Part 15	15.247	**PASS**
	731 Equipment Class	n/a	DSS	
	Frequency Band	15.247, 15.37(h)	902-928 MHz	
	Type of Device	n/a	Digital Spread Spectrum Device	n/a
	Test Setup	n/a	Applicant must provide ≥ 2 samples with the following capabilities: Sample #1: 1 antenna connector per transmit antenna; Sample #2: normally radiating with antennas. Means to 1)Toggle DSS operation (hopping), 2)Select Frequency, 3)Select Mode(s), 4)Continuously Transmit	n/a
Power Output	Antenna	15.247(b)(4)	Antenna Gain < 6 dBi	**Complies**
	Output Power	15.247(b)(2)	Devices using ≥ 50 hopping frequencies may use 1 W. Otherwise, 0.25 W.	**Complies**
	Duty Cycle	KDB 558074 D01 v05r02 s. 9 b)	The Duty Cycle Correction Factor (DCCF) shall be the worst-case duty cycle within a 100 ms period. All spurious emissions measured using an RMS or Peak detector may be corrected using a DCCF.	n/a
	Power Spectral Density	n/a	n/a	n/a
	Unwanted Emissions at the Bandedge	KDB 558074 D01 v05r02 s. 8.1 c) 1), ANSI C63.10 s. 7.8.6	Marker-Delta Method if Emission falls within 2 MHz of Bandedge. Otherwise, use Integrated Average Power measurement. 15.247 or KDB 558074 do not specifically state DSS devices shall meet band edge requirements, but it is given in the normative reference, ANSI C63.10 section 7.8.6.	**Complies**
	Unwanted Emissions Out of Band	15.247(d)	In any 100 kHz BW unwanted emissions must be > 20 dB below Peak Power, or > 30 dB below RMS Power. RMS Emissions within restricted bands of operation (15.205(a) shall be below the limits of 15.209(a), and Peak Emissions above 1 GHz shall be below the limits of 15.209(a) + 20 dB per 15.35(b).	**Complies**
Frequencies & Bandwidth	Channel Scheme	n/a	Device frequency hops	n/a
	Channel Selection	15.247(a)(1)(i), KDB 558074 D01 v05r02 s. 9. c)	Channel frequencies must be chosen pseudo-randomly. Pseudo-random algorithm must be supplied in application, with specific items found in KDB 558074 9. c)	**Complies**
	Occupied Bandwidth	15.247(a)(1)(i)	20 dB Occupied BW must be ≤ 500 kHz	**Complies**
	Number of Channels	15.247(a)(1)(i)	If 20 dB BW < 250 kHz, then must use ≥ 50 frequencies. Otherwise must use ≥ 25 frequencies.	**Complies**
	Channels Dwell Time	15.247(a)(1)(i)	If 20 dB BW < 250 kHz, then avg. occupancy ≤ 400 ms in a 20 s period. Otherwise, avg. occupancy ≤ 400 ms in a 10 s period.	**Complies**
	Channel Separation	15.247(a)(1)	Hopping Channel Separation of greatest of 25 kHz and 20 dB BW.	**Complies**

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.

Frequency Range(s) of EUT

DSS	910.5-920.5 MHz

Testing Frequencies for EUT

DSS	910.5, 915.5, 920.5 MHz

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.

20 dB OCCUPIED BANDWIDTH

Rule Part No.: FCC 2.1049(h), 15.215(c), FCC 15.247 (a)(1)(i)

Requirements:

§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.

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

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

Test Method: ANSI C63.10 § 7.8.7

7.8.7 Occupied bandwidth

For occupied bandwidth measurements, use the procedure in 6.9.2.

OCCUPIED BANDWIDTH

Test Method: ANSI C63.10 § 6.9.2

6.9.2 Occupied bandwidth—relative measurement procedure

The occupied bandwidth is measured as the width of the spectral envelope of the modulated signal, at an amplitude level reduced from a reference value by a specified ratio (or in decibels, a specified number of dB down from the reference value). Typical ratios, expressed in dB, are –6 dB, –20 dB, and –26 dB, corresponding to 6 dB BW, 20 dB BW, and 26 dB BW, respectively. In this subclause, the ratio is designated by "–xx dB." The reference value is either the level of the unmodulated carrier or the highest level of the spectral envelope of the modulated signal, as stated by the applicable requirement. Some requirements might specify a specific maximum or minimum value for the "–xx dB" bandwidth; other requirements might specify that the "–xx dB" bandwidth be entirely contained within the authorized or designated frequency band.[53]

a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The span range for the EMI receiver or spectrum analyzer shall be between two times and five times the OBW.

b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW and video bandwidth (VBW) shall be approximately three times RBW, unless otherwise specified by the applicable requirement.

c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.

d) Steps a) through c) might require iteration to adjust within the specified tolerances.

e) The dynamic range of the instrument at the selected RBW shall be more than 10 dB below the target "–xx dB down" requirement; that is, if the requirement calls for measuring the –20 dB OBW, the instrument noise floor at the selected RBW shall be at least 30 dB below the reference value.

f) Set detection mode to peak and trace mode to max hold.

g) Determine the reference value: Set the EUT to transmit an unmodulated carrier or modulated signal, as applicable. Allow the trace to stabilize. Set the spectrum analyzer marker to the highest level of the displayed trace (this is the reference value).

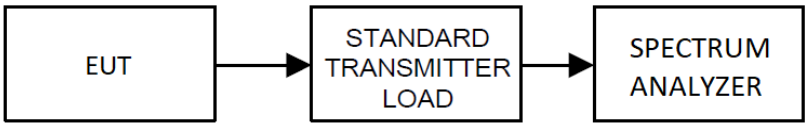
h) Determine the "–xx dB down amplitude" using [(reference value) – xx]. Alternatively, this calculation may be made by using the marker-delta function of the instrument.

i) If the reference value is determined by an unmodulated carrier, then turn the EUT modulation ON, and either clear the existing trace or start a new trace on the spectrum analyzer and allow the new trace to stabilize. Otherwise, the trace from step g) shall be used for step j).

j) Place two markers, one at the lowest frequency and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the "–xx dB down amplitude" determined in step h). If a marker is below this "–xx dB down amplitude" value, then it shall be as close as possible to this value. The occupied bandwidth is the frequency difference between the two markers. Alternatively, set a marker at the lowest frequency of the envelope of the spectral display, such that the marker is at or slightly below the "–xx dB down amplitude" determined in step h). Reset the marker-delta function and move the marker to the other side of the emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth.

k) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

Test Setup:



OCCUPIED BANDWIDTH

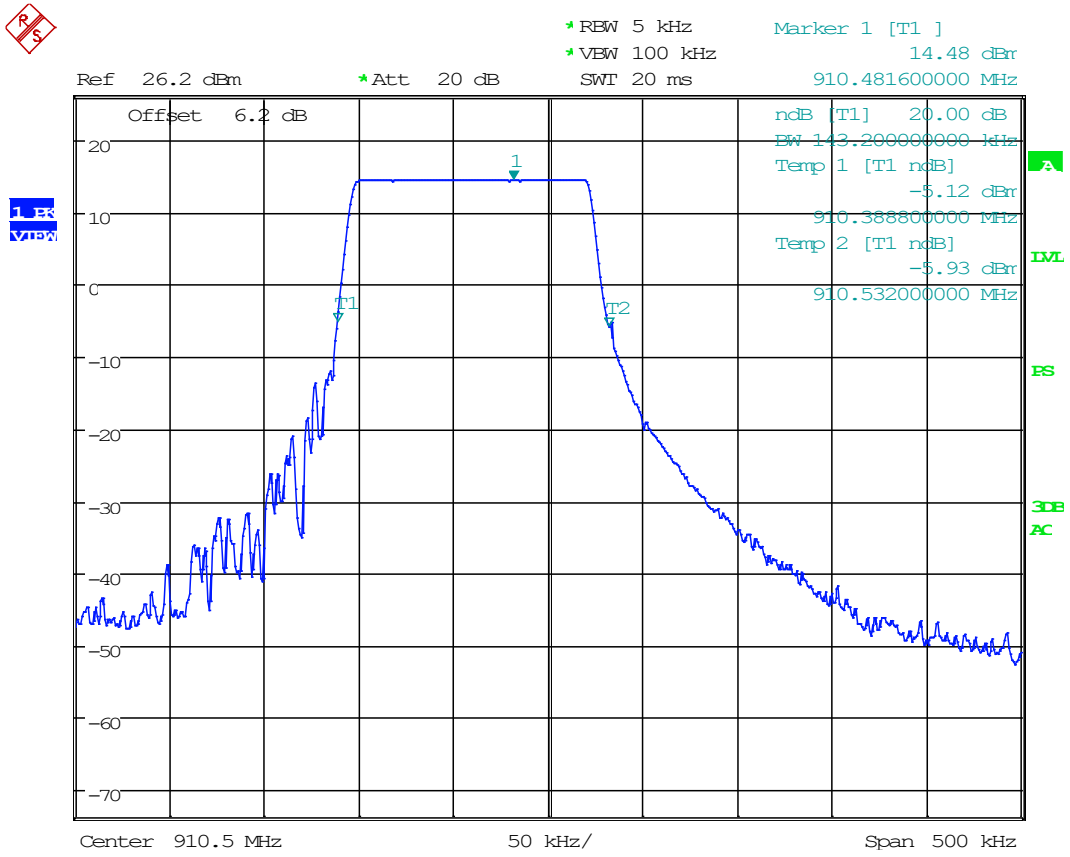
Test Data: Occupied Bandwidth Measurement Table

Tuned Frequency (MHz)	20 dB BW (MHz)
910.5	143.2
915.5	144.8
920.5	144.0

RESULT: Complies.

OCCUPIED BANDWIDTH

Test Data: 20 dB Bandwidth , 910.5 MHz

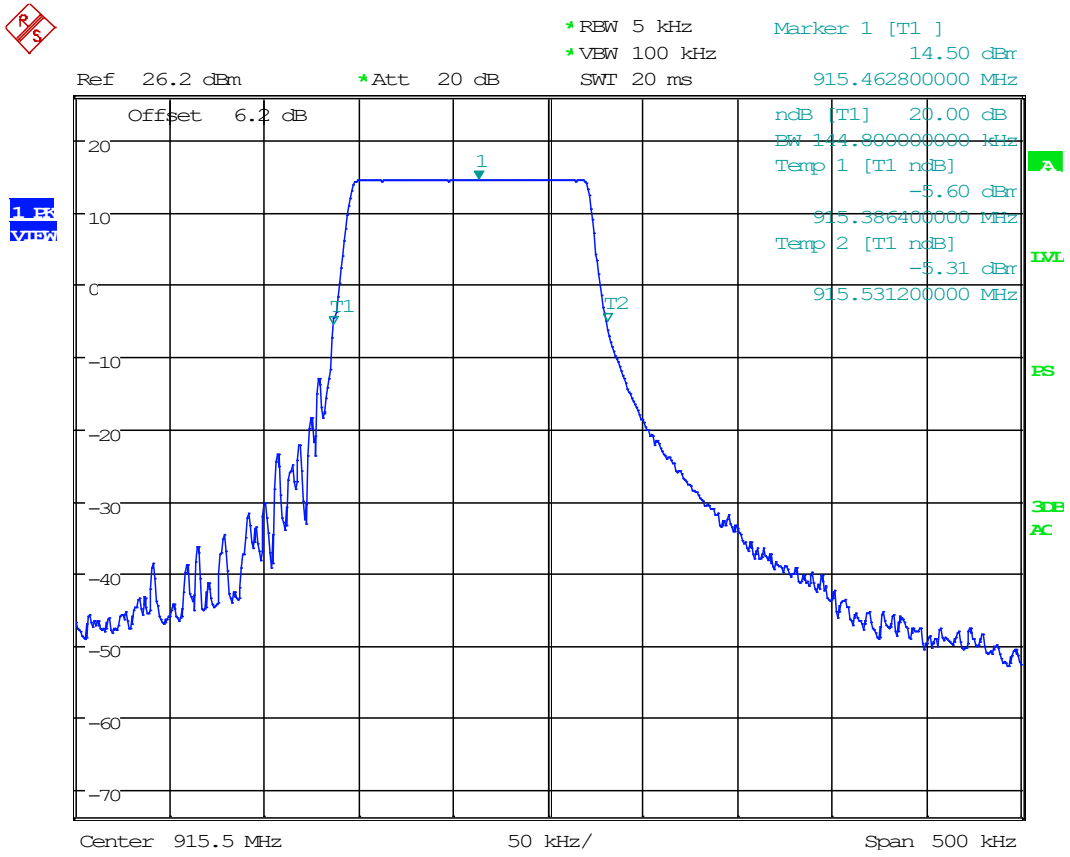


Date: 19.NOV.2019 12:26:13

RESULT: Complies.

OCCUPIED BANDWIDTH

Test Data: 20 dB Bandwidth , 915.5 MHz

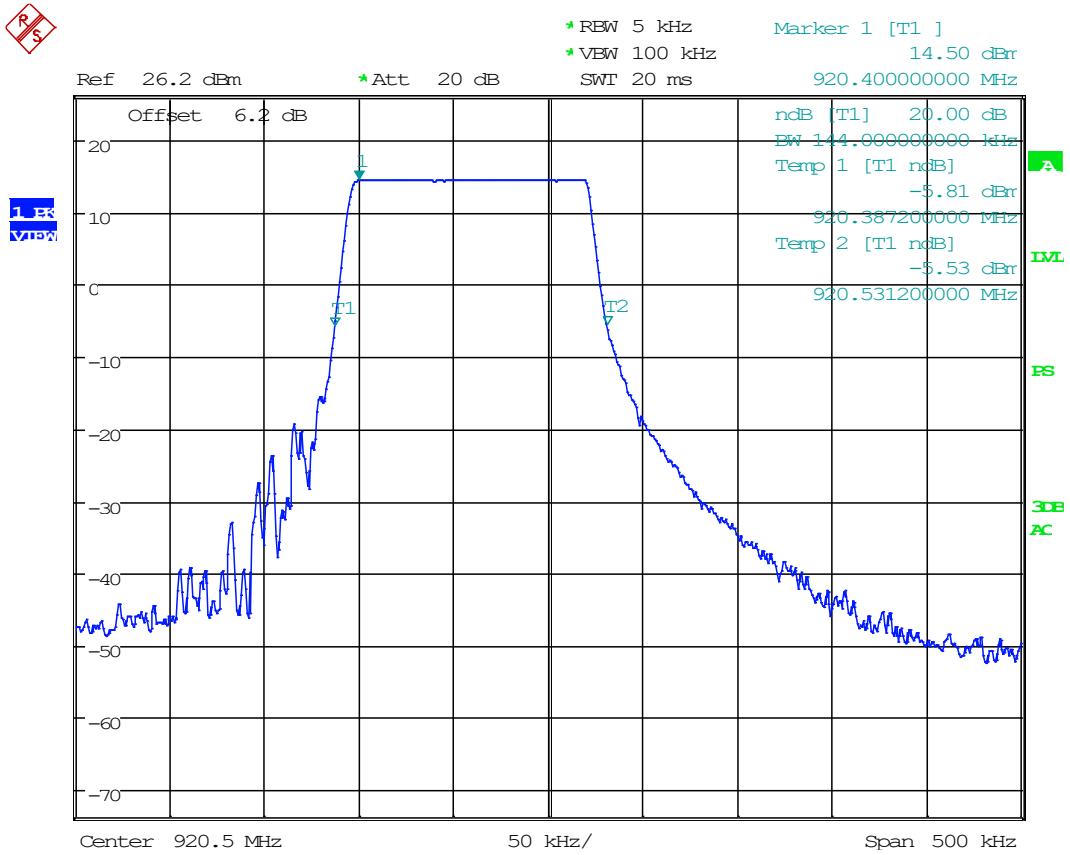


Date: 19.NOV.2019 12:28:27

RESULT: Complies.

OCCUPIED BANDWIDTH

Test Data: 20 dB Bandwidth , 920.5 MHz



Date: 19.NOV.2019 12:29:19

RESULT: Complies.

PEAK POWER OUTPUT

Rules Part No.: FCC 15.247(b)(1)-(2)

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:

(1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

(2) 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.

Test Method: ANSI C63.10 § 7.8.5

7.8.5 Output power test procedure for frequency-hopping spread-spectrum (FHSS) devices[73]

This is an RF-conducted test to evaluate maximum peak output power. Use a direct connection between the antenna port of the unlicensed wireless device and the spectrum analyzer, through suitable attenuation. The hopping shall be disabled for this test:

a) Use the following spectrum analyzer settings:
   1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
   2) RBW > 20 dB bandwidth of the emission being measured.
   3) VBW ≥ RBW.
   4) Sweep: Auto.
   5) Detector function: Peak.
   6) Trace: Max hold.

b) Allow trace to stabilize.

c) Use the marker-to-peak function to set the marker to the peak of the emission.

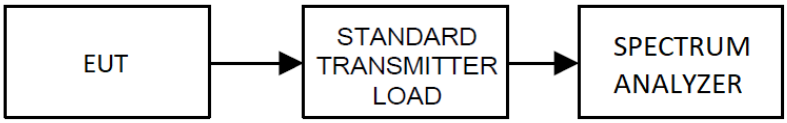
d) The indicated level is the peak output power, after any corrections for external attenuators and cables.

e) A plot of the test results and setup description shall be included in the test report.

NOTE—A peak responding power meter may be used, where the power meter and sensor system video bandwidth is greater than the occupied bandwidth of the unlicensed wireless device, rather than a spectrum analyzer.

POWER OUTPUT

Test Setup:



Test Data: Power Output Measurement Table

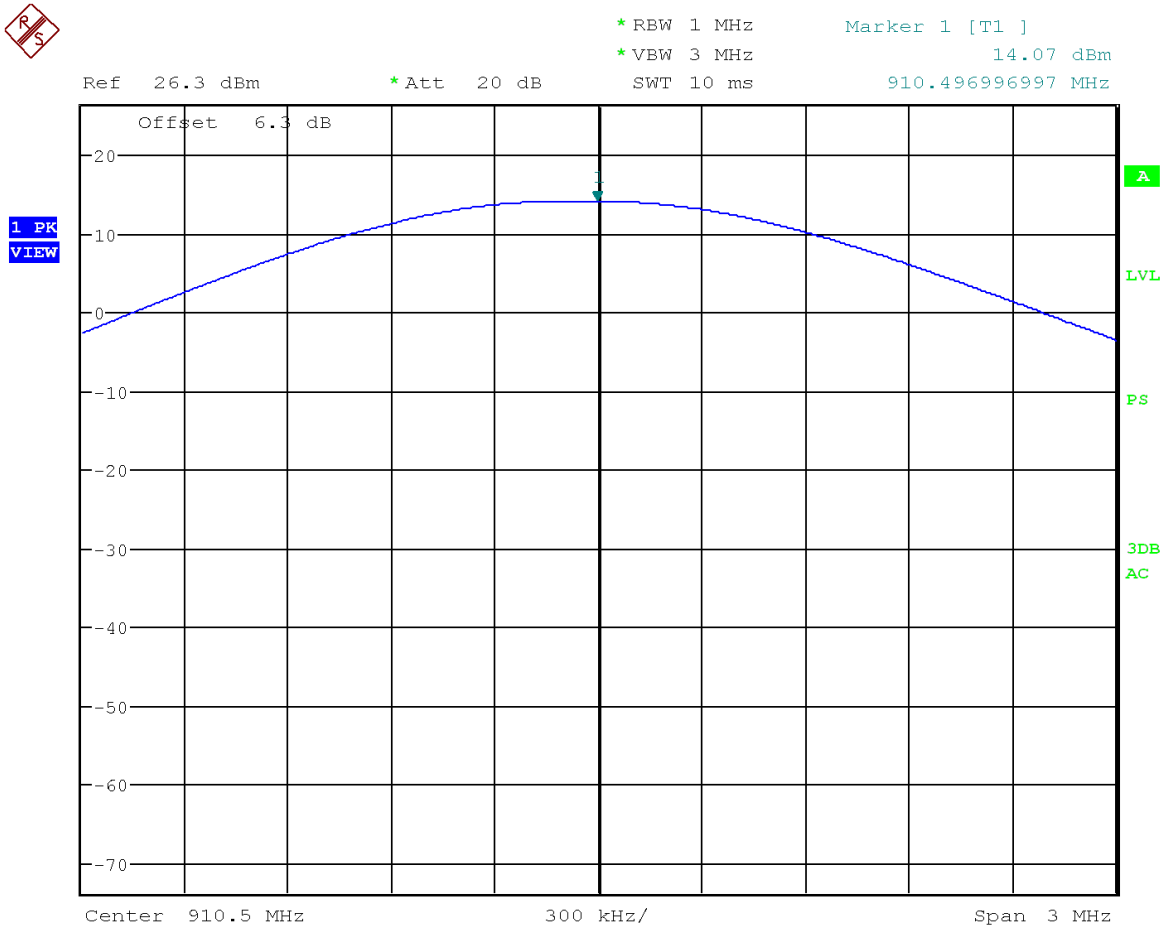
Tuned Frequency (MHz)	Power Output (dBm)
910.5	14.07
915.5	14.10
920.5	14.11

Result: Complies.

Maximum Power Output: 14.11 dBm

POWER OUTPUT

Test Data: **Power Output , 910.5 MHz**

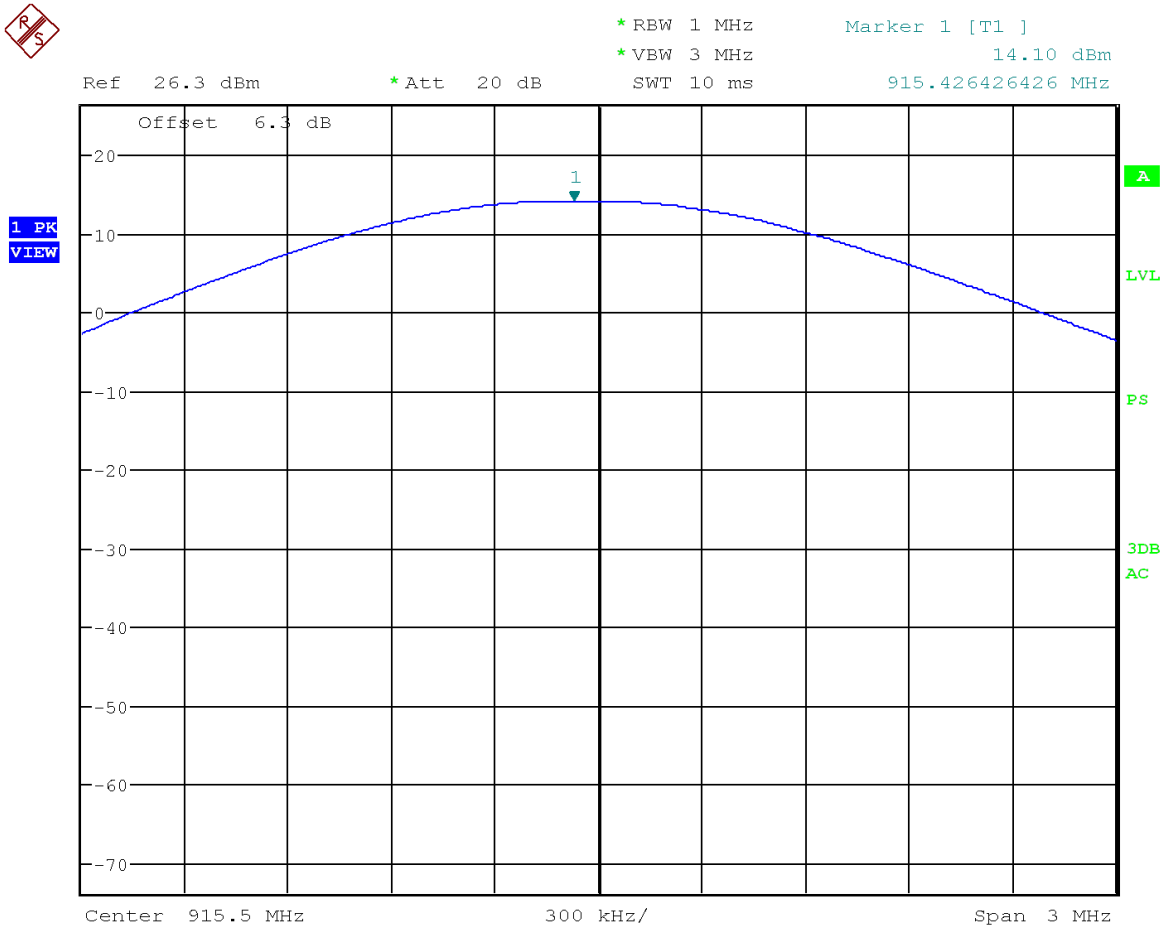


Date: 24.OCT.2019 16:56:29

RESULT: Power Output = 27.71 dBm

POWER OUTPUT

Test Data: **Power Output , 915.5 MHz**

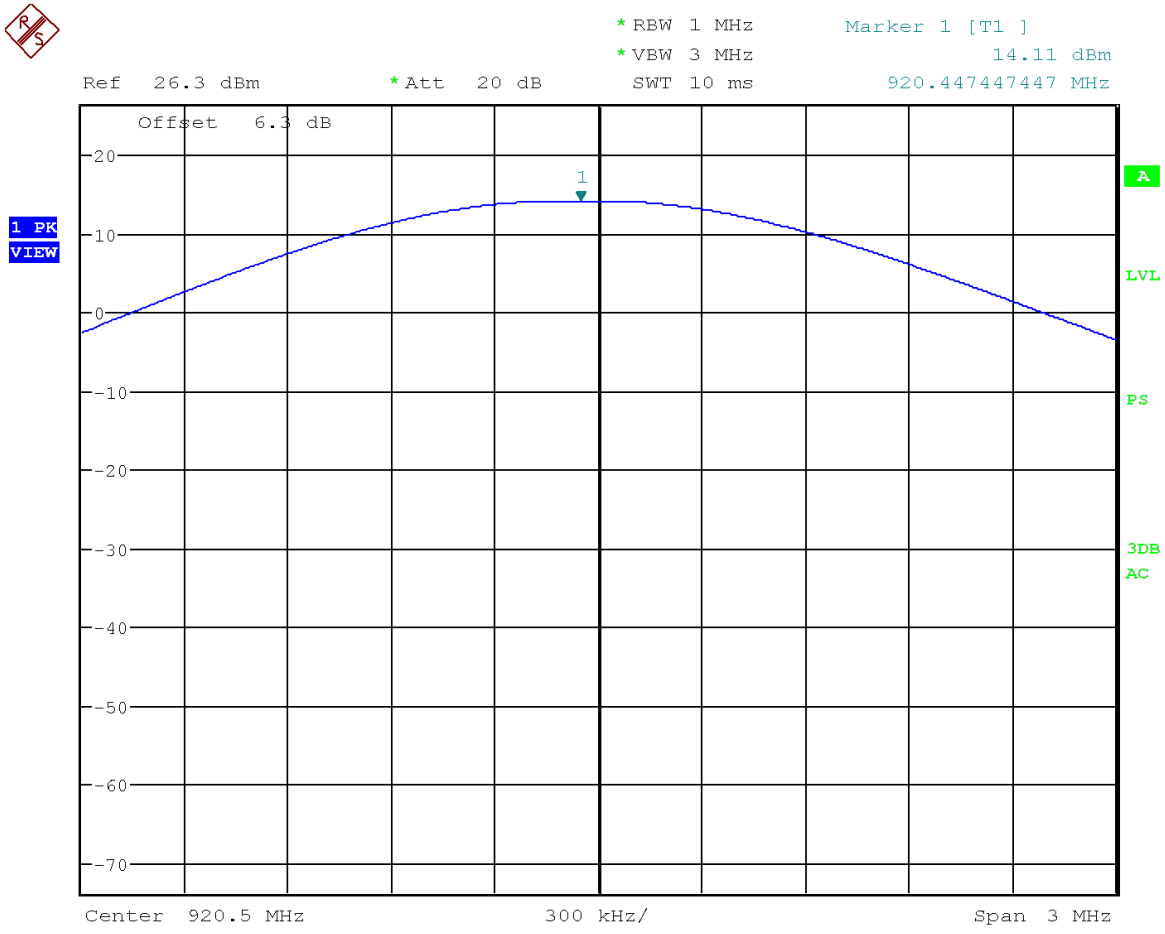


Date: 24.OCT.2019 16:55:36

RESULT: Power Output = 27.95 dBm

POWER OUTPUT

Test Data: Power Output , 920.5 MHz



Date: 24.OCT.2019 16:55:00

RESULT: Power Output = 28.08 dBm

HOPPING CHARACTERISTICS

Rules Part No.: FCC 15.247(a)(1)(i)

Requirements:

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

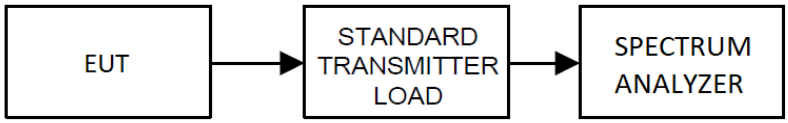
(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

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

Test Method: ANSI C63.10 § 7.8

Test Setup:



HOPPING CHARACTERISTICS

Carrier Frequency Separation

7.8.2 Carrier frequency separation

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

a) Span: Wide enough to capture the peaks of two adjacent channels.

b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.

c) Video (or average) bandwidth (VBW) ≥ RBW.

d) Sweep: Auto.

e) Detector function: Peak.

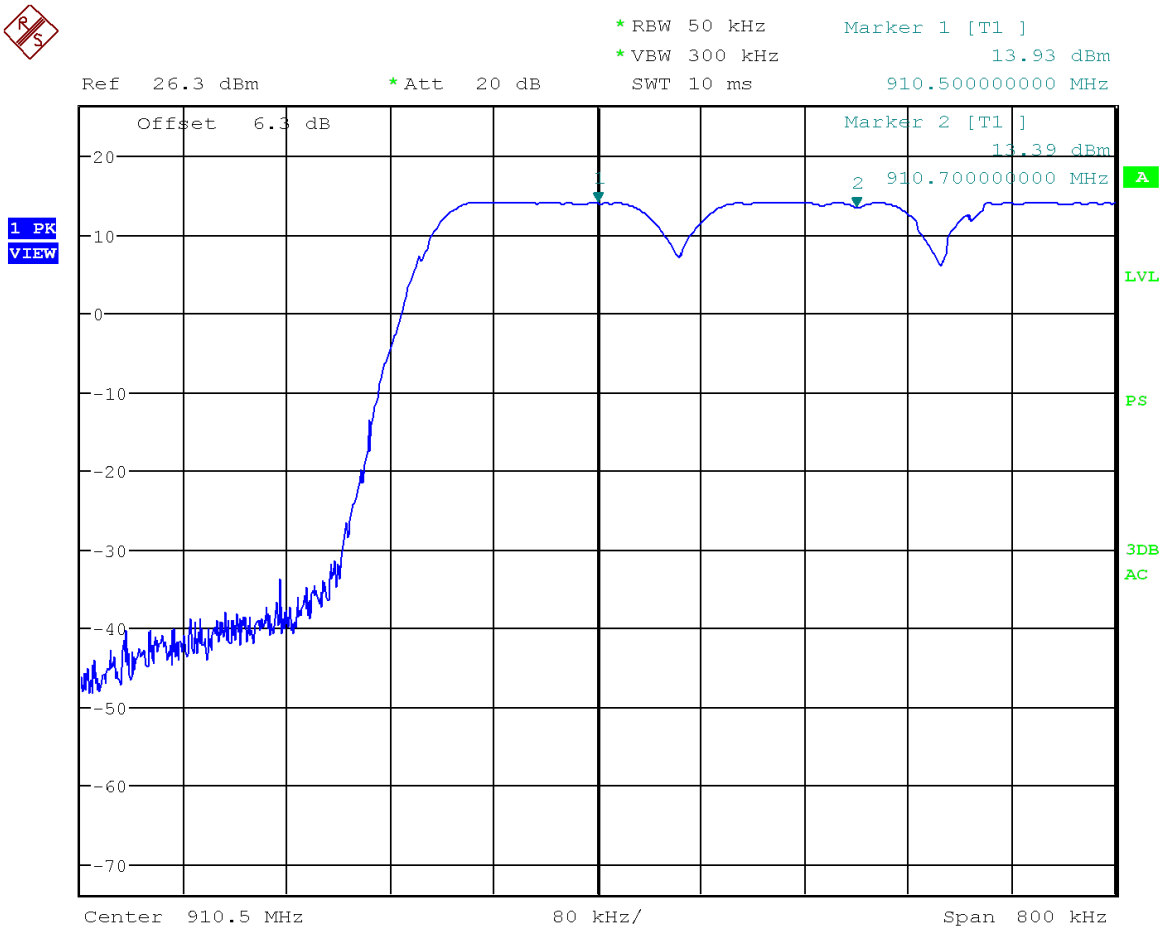
f) Trace: Max hold.

g) Allow the trace to stabilize.

Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Compliance of an EUT with the appropriate regulatory limit shall be determined. A plot of the data shall be included in the test report.

HOPPING CHARACTERISTICS

Test Data: Carrier Frequency Separation Plot



Date: 24.OCT.2019 17:40:54

Result: Complies.

HOPPING CHARACTERISTICS

Number of Hopping Frequencies

7.8.3 Number of hopping frequencies

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.

b) RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.

c) VBW ≥ RBW.

d) Sweep: Auto.

e) Detector function: Peak.

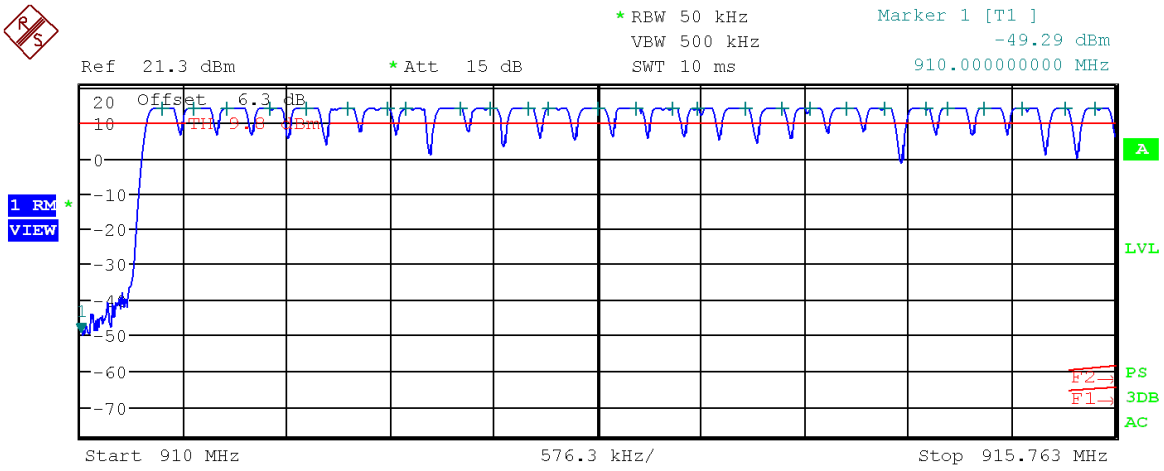
f) Trace: Max hold.

g) Allow the trace to stabilize.

It might prove necessary to break the span up into subranges to show clearly all of the hopping frequencies. Compliance of an EUT with the appropriate regulatory limit shall be determined for the number of hopping channels. A plot of the data shall be included in the test report.

HOPPING CHARACTERISTICS

Test Data: Number of Hopping Frequencies Plot 1



#	Frequency	Level	#	Frequency	Level
1	910.456430 MHz	13.86 dBm	13	912.890721 MHz	13.87 dBm
2	910.631625 MHz	13.86 dBm	14	913.102799 MHz	13.87 dBm
3	910.816041 MHz	13.86 dBm	15	913.301046 MHz	13.88 dBm
4	911.055782 MHz	13.86 dBm	16	913.439358 MHz	13.88 dBm
5	911.258639 MHz	13.86 dBm	17	913.706762 MHz	13.88 dBm
6	911.493770 MHz	13.86 dBm	18	913.909619 MHz	13.88 dBm
7	911.715069 MHz	13.86 dBm	19	914.070983 MHz	13.88 dBm
8	911.811887 MHz	13.86 dBm	20	914.269230 MHz	13.88 dBm
9	912.116174 MHz	13.87 dBm	21	914.485919 MHz	13.89 dBm
10	912.282148 MHz	13.87 dBm	22	914.716439 MHz	13.89 dBm
11	912.498837 MHz	13.87 dBm	23	914.831699 MHz	13.88 dBm
12	912.609486 MHz	13.87 dBm	24	915.034557 MHz	13.89 dBm

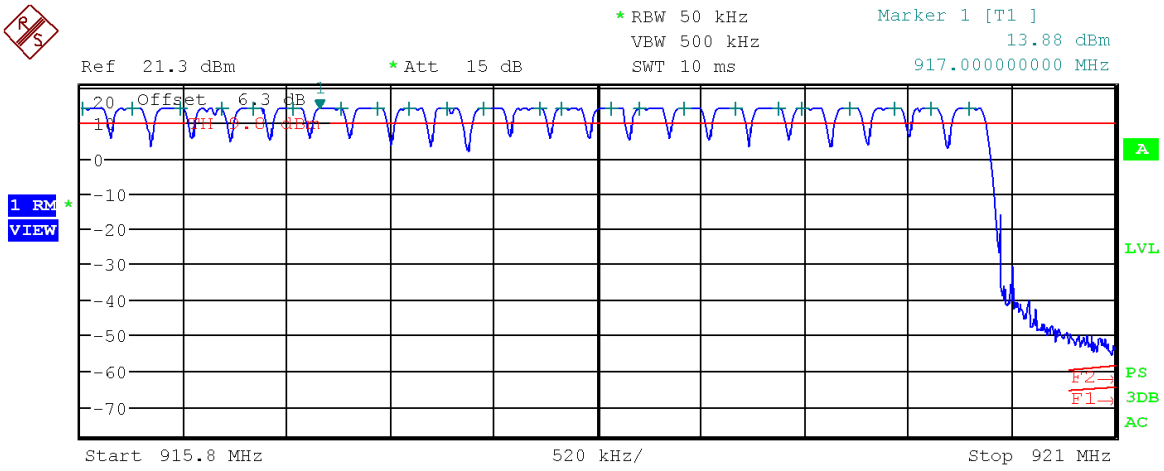
Date: 24.OCT.2019 18:07:26

Note: Analyzer cannot list more than 24 frequencies on the output window.

Result: 27 Frequencies in Plot 1.

HOPPING CHARACTERISTICS

Test Data: Number of Hopping Frequencies Plot 2



#	Frequency	Level	#	Frequency	Level
1	915.812480 MHz	13.90 dBm	13	918.221120 MHz	13.91 dBm
2	916.066240 MHz	13.91 dBm	14	918.470720 MHz	13.91 dBm
3	916.307520 MHz	13.89 dBm	15	918.616320 MHz	13.91 dBm
4	916.511360 MHz	13.88 dBm	16	918.836800 MHz	13.92 dBm
5	916.673600 MHz	13.90 dBm	17	919.098880 MHz	13.92 dBm
6	916.869120 MHz	13.90 dBm	18	919.315200 MHz	13.92 dBm
7	917.110400 MHz	13.90 dBm	19	919.431680 MHz	13.92 dBm
8	917.297600 MHz	13.90 dBm	20	919.668800 MHz	13.93 dBm
9	917.455680 MHz	13.90 dBm	21	919.897600 MHz	13.93 dBm
10	917.647040 MHz	13.91 dBm	22	920.076480 MHz	13.92 dBm
11	917.830080 MHz	13.91 dBm	23	920.272000 MHz	13.93 dBm
12	918.108800 MHz	13.90 dBm			

Date: 24.OCT.2019 18:00:20

Result: **23 Frequencies in Plot 2.**

Total Hopping Channels: 50

HOPPING CHARACTERISTICS

Time of Occupancy

7.8.4 Time of occupancy (dwell time)

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

a) Span: Zero span, centered on a hopping channel.

b) RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.

c) Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.

d) Detector function: Peak.

e) Trace: Max hold.

Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time.

Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation:

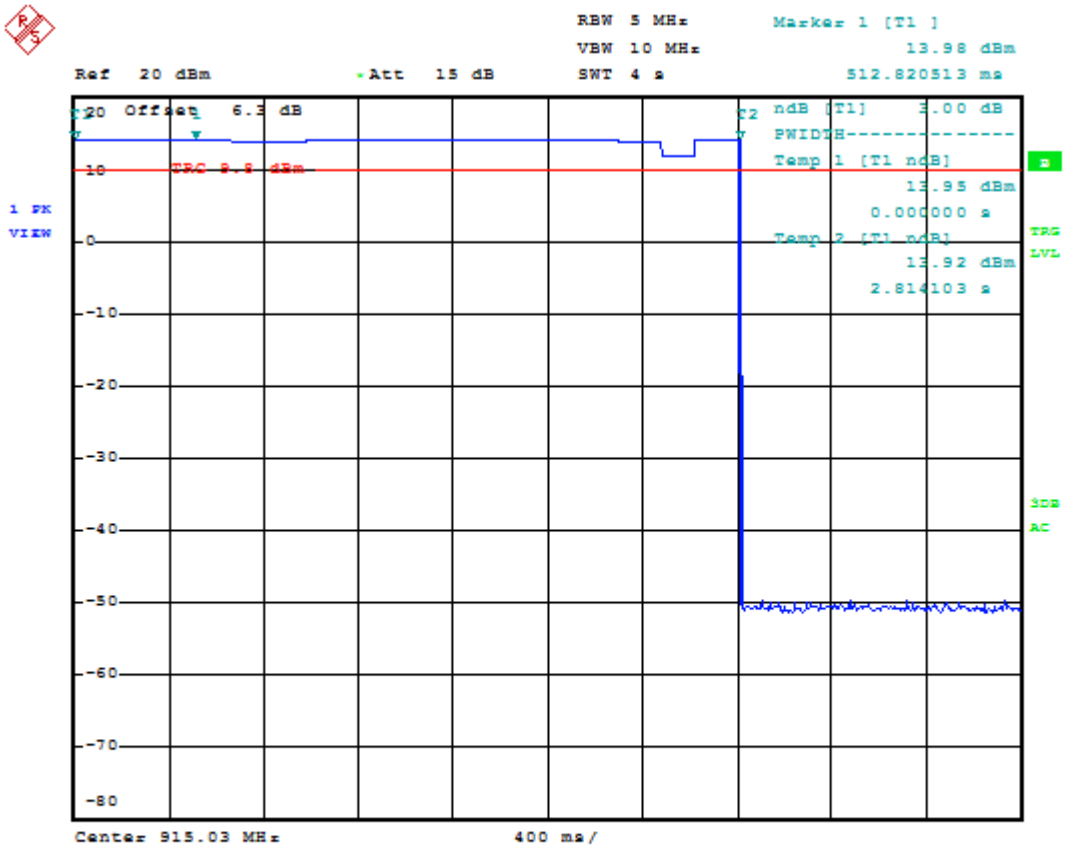
(Number of hops in the period specified in the requirements) =
(number of hops on spectrum analyzer) × (period specified in the requirements / analyzer sweep time)

The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements. If the number of hops in a specific time varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation.

The measured transmit time and time between hops shall be consistent with the values described in the operational description for the EUT.

HOPPING CHARACTERISTICS

Test Data: Time of Occupancy Plot

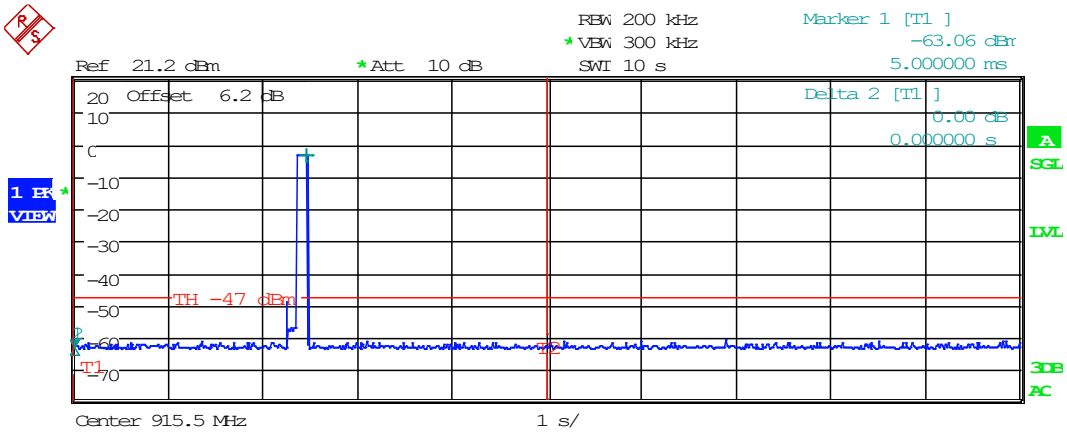


Date: 25.OCT.2019 16:27:47

Result: Time of Occupancy: 2.814 s

HOPPING CHARACTERISTICS

Test Data: Hops in 10 s Plot



#	Time	Level
1	2.456000 s	-3.23 dBm

Date: 19.NOV.2019 12:43:07

Result: Hops in 10 s: 1

AUTHORIZED BANDEDGE EMISSIONS

Rule Part No.: FCC 15.247(d)

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)).

Test Method: ANSI C63.10 § 7.8.6

7.8.6 Band-edge measurements for RF conducted emissions

For band-edge measurements, use the band-edge procedure in 6.10. Band-edge measurements shall be tested both on single channels, and with the EUT hopping.

6.10.4 Authorized-band band-edge measurements (relative method)

These procedures are applicable for determining compliance at authorized-band band-edges where the requirements are expressed as a value relative to the in-band signal level. Procedures for determining compliance with field strength limits at or close to the band-edges are given in 6.10.6 (see also Table A.2).

Band-edge tests are typically performed as a conducted test but may be performed as radiated measurements on a test site meeting the specifications in 5.2, at the measurement distances specified in 5.3. The instrumentation shall meet the requirements in 4.1.1 using the bandwidths and detectors specified in 4.1.4.2.

When performing radiated measurements, the measurement antenna(s) shall meet the specifications in 4.3. The EUT shall be connected to an antenna and operated at the highest power settings following procedures in 6.3.

For other than frequency-hopping devices, this test sequence shall be performed once.

AUTHORIZED BANDEDGE EMISSIONS

a) Connect the EMI receiver or spectrum analyzer to the EUT using an appropriate RF cable connected to the EUT output. Configure the spectrum analyzer settings as described in step e) (be sure to enter all losses between the unlicensed wireless device output and the spectrum analyzer).

b) Set the EUT to the lowest frequency channel (for the hopping on test, the hopping sequence shall include the lowest frequency channel).

c) Set the EUT to operate at maximum output power and 100% duty cycle, or equivalent "normal mode of operation" as specified in 6.10.3.

d) If using the radiated method, then use the applicable procedure(s) of 6.4, 6.5, or 6.6, and orient the EUT and measurement antenna positions to produce the highest emission level.

e) Perform the test as follows:

   1) Span: Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products that fall outside of the authorized band of operation.

   2) Reference level: As required to keep the signal from exceeding the maximum instrument input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.

   3) Attenuation: Auto (at least 10 dB preferred).

   4) Sweep time: Coupled.

   5) Resolution bandwidth: 100 kHz.[56]

   6) Video bandwidth: 300 kHz.[56]

   7) Detector: Peak.[56]

   8) Trace: Max hold.[56]

f) Allow the trace to stabilize. For the test with the hopping function turned ON, this can take several minutes to achieve a reasonable probability of intercepting any emissions due to oscillator overshoot.

g) Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission.

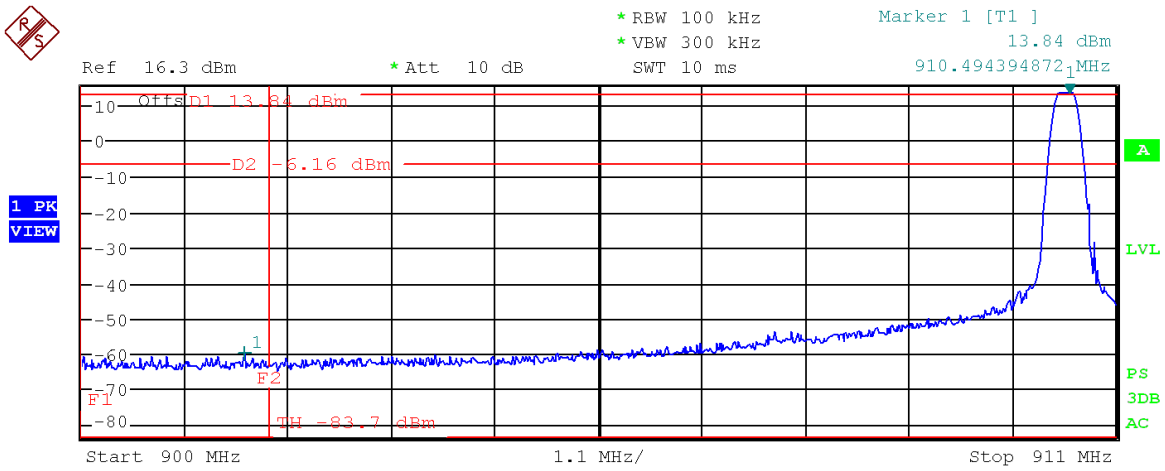
h) Repeat step c) through step e) for every applicable modulation.

i) Set the EUT to the highest frequency channel (for the hopping on test, the hopping sequence shall include the highest frequency channel) and repeat step c) through step d).

j) The band-edge measurement shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

BANDEDGE EMISSIONS

Test Data: Lower Band Edge Plot, Stopped



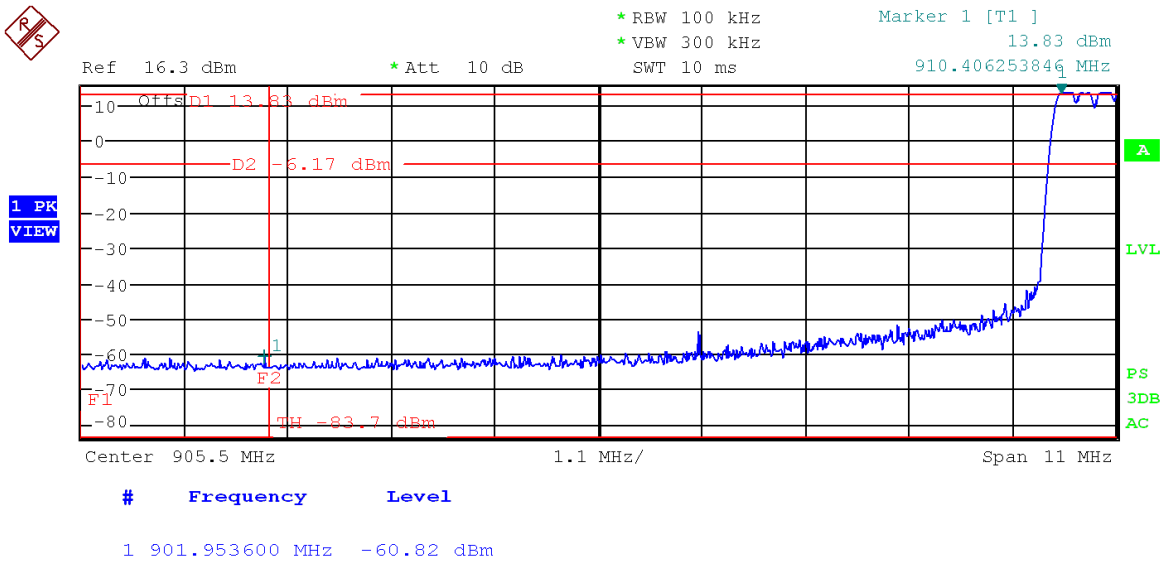
#	Frequency	Level
1	901.742400 MHz	-59.95 dBm

Date: 24.OCT.2019 18:44:40

RESULT: Meets Requirements

BANDEDGE EMISSIONS

Test Data: Lower Band Edge Plot, Hopping



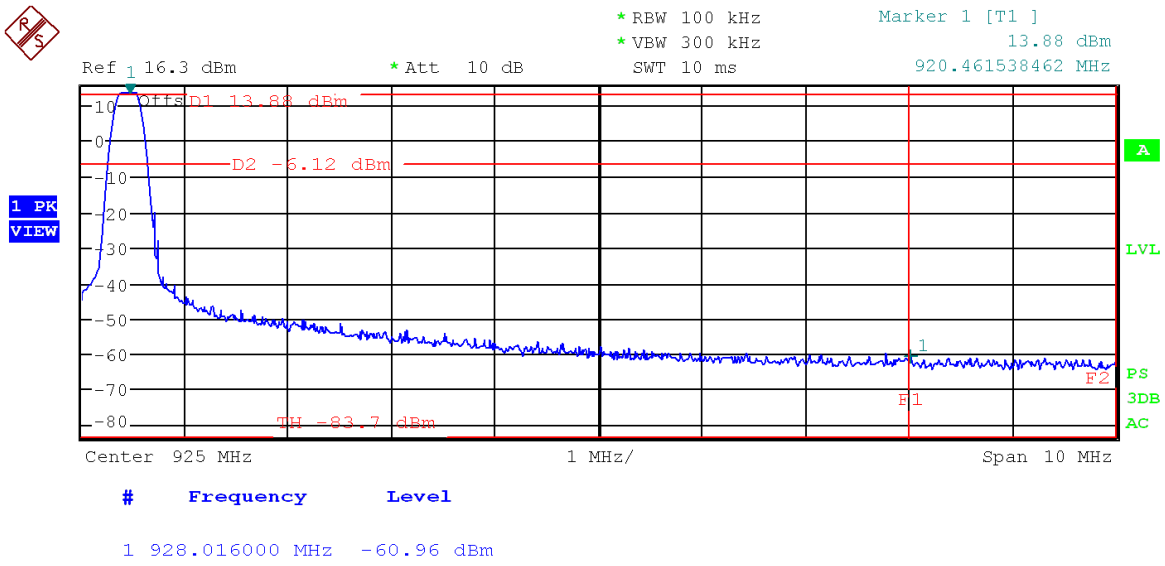
#	Frequency	Level
1	901.953600 MHz	-60.82 dBm

Date: 24.OCT.2019 18:47:09

RESULT: Meets Requirements

BANDEDGE EMISSIONS

Test Data: Upper Band Edge Plot, Stopped



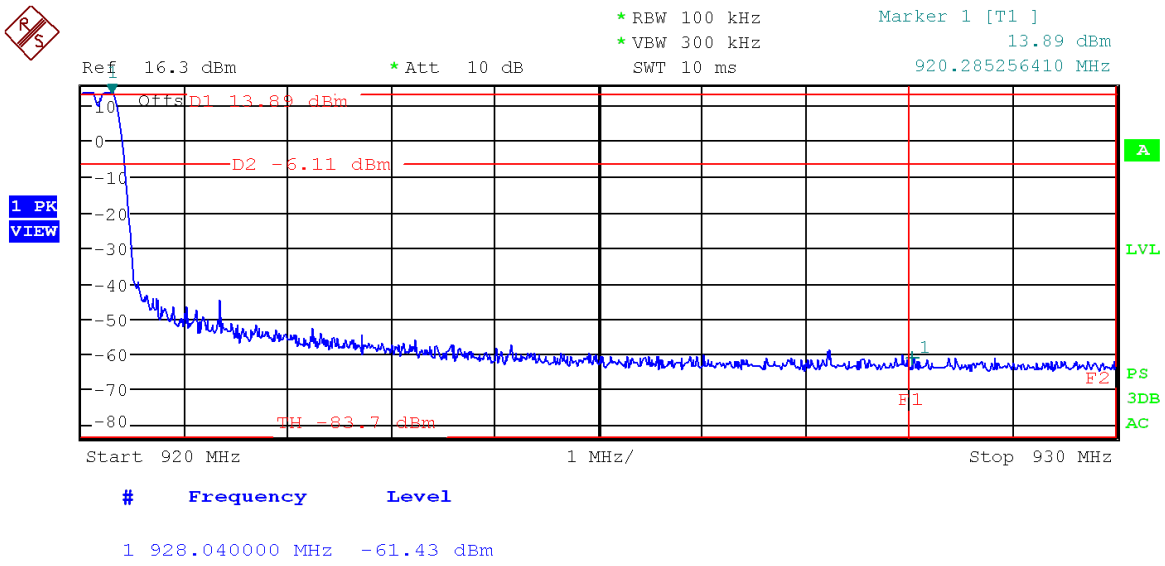
#	Frequency	Level
1	928.016000 MHz	-60.96 dBm

Date: 24.OCT.2019 18:55:11

RESULT: Meets Requirements

BANDEDGE EMISSIONS

Test Data: Upper Band Edge Plot, Hopping



#	Frequency	Level
1	928.040000 MHz	-61.43 dBm

Date: 24.OCT.2019 18:53:58

RESULT: Meets Requirements

RESTRICTED BANDEDGE EMISSIONS

Rule Part No.: FCC 15.247(d), KDB 558074 D01 v05r02 c) 1)

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)).

Test Method: ANSI C63.10 § 7.8.6

7.8.6 Band-edge measurements for RF conducted emissions

For band-edge measurements, use the band-edge procedure in 6.10. Band-edge measurements shall be tested both on single channels, and with the EUT hopping.

6.10.5.1 Test setup

Restricted-band band-edge tests shall be performed as radiated measurements, on a test site meeting the specifications in 5.2 at the measurement distances specified in 5.3.[57]

The instrumentation shall meet the requirements in 4.1.1 using the bandwidths and detectors specified in 4.1.4.2. Considering the requirements of 5.8, the antenna(s) shall be connected to the antenna ports. When performing radiated measurements, the measurement antenna(s) shall meet the specifications in 4.3. The EUT shall be connected to an antenna and operated at the highest power settings following procedures in 6.3, and the relevant procedure in 6.4, 6.5, or 6.6.

6.10.5.2 Test methodology

The following test methodology shall be used for the restricted-band band-edge measurements:

a) For frequency-hopping systems, the hopping shall be turned OFF during this test.

b) Configure the spectrum analyzer settings as described in step e) (be sure to enter all losses between the unlicensed wireless device output and the spectrum analyzer).

c) Set the unlicensed wireless device to the lowest frequency channel.

d) Set the unlicensed wireless device to operate at maximum output power and 100% duty cycle, or equivalent "normal mode of operation" as specified in 6.10.3.

e) Perform the test as follows:

1) Span: Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products that fall outside of the authorized band of operation.

2) Reference level offset: Corrected for gains and losses of test antenna factor, preamp gain and cable loss, so as to indicate field strength, in units of dBμV/m at 3 m, directly on the instrument display. Alternatively, the reference level offset may be set to zero and calculations shall be provided showing the conversion of raw measured data to the field strength in dBμV/m at 3 m.

3) Reference level: As required to keep the signal from exceeding the maximum spectrum analyzer input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.

4) Attenuation: Auto (at least 10 dB preferred).

5) Sweep time: Coupled.

RESTRICTED BANDEDGE EMISSIONS

6.10.5.2 Con't.

6) Resolution bandwidth:

   i) Below 150 kHz: 300 Hz or CISPR 200 Hz (CISPR 200 Hz required if using QP detector)

   ii) 150 kHz to 30 MHz: 10 kHz or CISPR 9 kHz, (CISPR 9 kHz required if using QP detector)

   iii) 30 MHz to 1000 MHz: 100 kHz or CISPR 120 kHz, (CISPR 120 kHz required if using QP detector)

   iv) Above 1 GHz: 1 MHz

7) Video bandwidth:

   i) VBW for Peak, Quasi-peak, or Average Detector Function: 3 × RBW

   ii) VBW for alternative average measurements using peak detector function; refer to 4.1.4.2.3

8) Detector (unless specified otherwise):

   i) QP below 1 GHz (however, peak detector measurements may be used to determine compliance with QP requirements).

   ii) Peak and average above 1 GHz

9) Trace: Max hold for final measurement; a combination of two traces, clear-write and max hold, is recommended for maximizing the emission.

f) Using the applicable procedure(s) of 6.4, 6.5, or 6.6, orient the EUT and measurement antenna positions to produce the highest emission level.

g) Set the marker on the emission at the restricted band edge, or on the highest modulation product within the restricted band, if this level is greater than that at the band edge.

h) Repeat step d) through step g) for every applicable modulation.

i) Repeat step d) through step h) for the highest gain of each type of antenna to be used with the EUT.

j) Set the EUT to the highest frequency channel and repeat step d) through step i).

k) The band-edge measurement shall be reported by providing plot(s) of the measuring instrument display; the axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

RESTRICTED BANDEDGE EMISSIONS

KDB 558074 D01 v05r02 c) 1)

c) Test procedures for DTS device EMC and radio parameters, such as power, OBW, radiated and band-edge measurements, are described in the following subclauses, including cross-references to Clause 11 of ANSI C63.10.

In addition the following clarifications relative to ANSI C63.10 are also applicable.

1) Concerning 11.13 (Band-edge measurements) of ANSI C63.10:

The requirement in 11.13.1 that the DTS bandwidth (or EBW) edge falls within 2 MHz of the band edge applies only for use of the marker-delta method; use of the integration method is not subject to the same limitation.

ANSI C63.10 s.11.13

11.13.1 General

Emissions within a restricted band and within 2 MHz of an authorized band edge may be measured using either the marker-delta method or the integration method, which is described in 11.13.3, provided that the DTS bandwidth (or EBW) edge falls within 2 MHz of the band edge. Otherwise, all unwanted emissions measurements shall be performed using the standard methods.

RESTRICTED BANDEDGE EMISSIONS

11.13.2 Marker-delta method

The marker-delta method, as described in 6.10.6, can be used to perform measurements of the unwanted emissions level at the band edges.

6.10.6 Marker-delta method

6.10.6.1 General requirements

In making radiated band-edge measurements, there can be a problem obtaining meaningful data because a measurement instrument that is tuned to a band-edge frequency might also capture some in-band signals when using the specified RBW. In an effort to compensate for this problem, the following technique has been developed for determining band-edge compliance.

This method may be used only when the edge of the occupied bandwidth of the emission falls within two "standard bandwidths" of the restricted-band band-edge frequency, where "standard bandwidth" is the RBW required by the measurement procedure (generally, the "standard bandwidth," i.e., reference bandwidth, is 10 kHz for measurements below 30 MHz, 100 kHz for measurements between 30 MHz and 1000 MHz, and 1 MHz for measurements above 1 GHz). For this purpose, the occupied bandwidth is based on the 99% power bandwidth. Detailed explanations and examples of these constraints are given subsequently.

For example, for band-edge measurements in the restricted band that begins at 2483.5 MHz, a measurement bandwidth of 1 MHz is required. Therefore the "delta" technique may be used if the upper frequency edge of the occupied bandwidth of the fundamental emission is greater than or equal to 2481.5 MHz (2 MHz removed from the band edge). If the upper frequency edge of the occupied bandwidth is less than 2481.5 MHz, then radiated emissions within the restricted band shall be measured in the conventional manner. The report shall include photographs or plots of the measuring instrument display, with the lower and/or upper frequency limit(s), as applicable, clearly labeled.

Additionally this method may be used only when the emission being measured falls within two "standard bandwidths" of the restricted band band-edge frequency. For example, for band-edge measurements in the restricted band that begins at 2483.5 MHz, a measurement bandwidth of 1 MHz is required. Therefore the "delta" technique may be used if the restricted-band emission is between 2483.5 MHz and 2485.5 MHz. If the restricted-band emission is at a frequency greater than 2485.5 MHz, then radiated emissions within the restricted band shall be measured in the conventional manner.

6.10.6.2 Marker-delta procedure

The following procedure shall be used for the marker-delta method:

a) Perform an in-band field strength measurement of the fundamental emission using the RBW and detector function required for the frequency being measured. For example, for a device operating in the 902 MHz to 928 MHz band,[56] use a 120 kHz RBW with a CISPR QP detector (a peak detector with 100 kHz RBW alternatively may be used). For transmitters operating above 1 GHz, use a 1 MHz RBW, a 3 MHz VBW, and a peak detector, as required.[58] Repeat the measurement with an average detector (or alternatively, a peak detector and reduced VBW). For pulsed emissions, other factors shall be included; see 4.1.4.2.6.

b) Choose an EMI receiver or spectrum analyzer span that encompasses both the peak of the fundamental emission and the band-edge emission under investigation. Set the instrument RBW to 1% of the total span (but never less than 30 kHz), with a VBW equal to or greater than three times the RBW. Record the peak levels of the fundamental emission and the relevant band-edge emission (i.e., run several sweeps in peak hold mode). Observe the stored trace and measure the amplitude delta between the peak of the fundamental and the peak of the band-edge emission. This is not an absolute field strength measurement; it is only a relative measurement to determine the amount by which the emission drops at the band edge relative to the highest fundamental emission level.

c) Subtract the delta measured in step b) from the field strengths measured in step a). The resulting field strengths (CISPR QP, average, or peak, as appropriate) are then used to determine band-edge emissions compliance, where required.[59]

[57] Conducted testing may be an acceptable alternative to radiated testing for devices operating under certain regulatory requirements: examples include 47 CFR 15.247 and 47 CFR 15.407, as well as Annex 8 and Annex 9 of IC RSS-210. See FCC/KDB-789033 [B28] and FCC/KDB-558074 [B26].

[58] See 47 CFR 15.35.

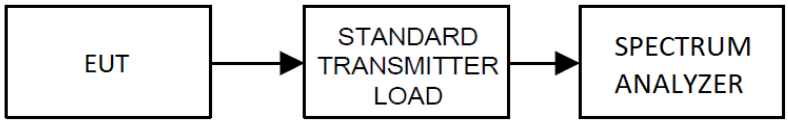
[59] See 47 CFR 15.205 or RSS-Gen.

11.13.3 Integration method

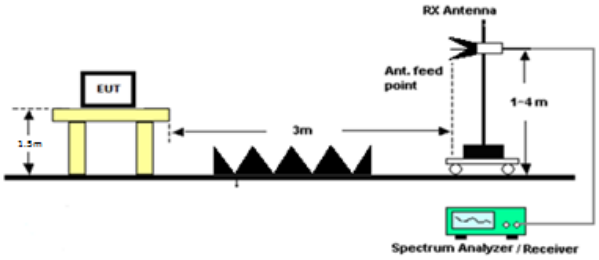
11.13.3.1 General

The following procedures may be used to determine the peak or average field strength or power of an unwanted emission that is within 2 MHz of the authorized band edge. If a peak detector is used, then use the procedure described in 11.13.3.2. Use the procedure described in 11.13.3.3 when using an average detector and the EUT can be configured to transmit continuously (i.e., $D \geq 98\%$). Use the procedure described in 11.13.3.4 when using an average detector and the EUT cannot be configured to transmit continuously but the duty cycle is constant (i.e., duty cycle variations are less than ±2%). Use the procedure described in 11.13.3.5 when using an average detector for those cases where the EUT cannot be configured to transmit continuously and the duty cycle is not constant (duty cycle variations equal or exceed 2%).

Test Setup: (conducted)



Test Setup: (radiated)



Test Data: N/A

Note: EUT does not border a Restricted Band.

CONDUCTED SPURIOUS EMISSIONS

RULE PART NO.: FCC part 15.247(d)

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)).

Test Procedure: ANSI C63.10 7.8.8

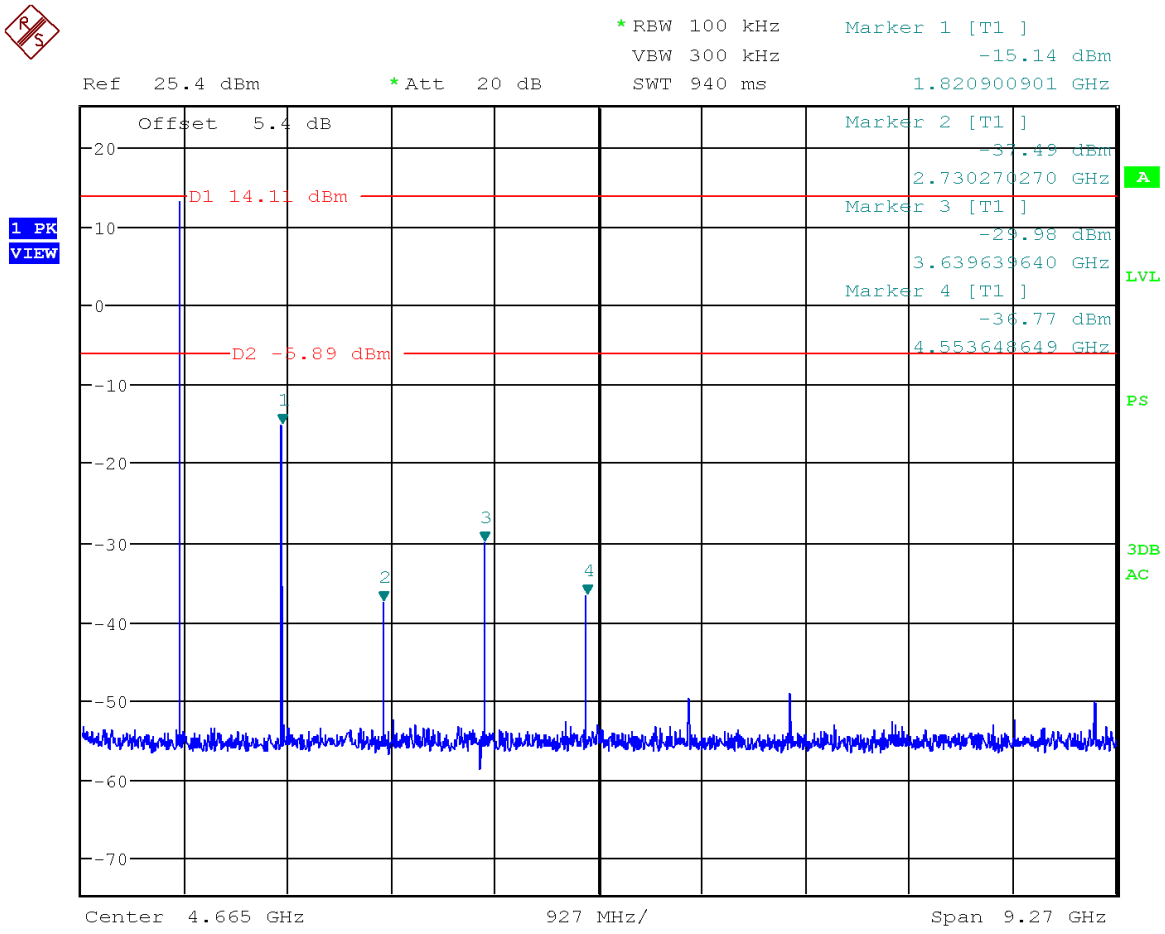
7.8.8 Conducted spurious emissions test methodology

Conducted spurious emissions shall be measured for the transmit frequency, per 5.5 and 5.6, and at the maximum transmit powers.

Connect the primary antenna port through an attenuator to the spectrum analyzer input; in the results, account for all losses between the unlicensed wireless device output and the spectrum analyzer. The instrument shall span 30 MHz to 10 times the operating frequency in GHz, with a resolution bandwidth of 100 kHz, video bandwidth of 300 kHz, and a coupled sweep time with a peak detector. The band 30 MHz to the highest frequency may be split into smaller spans, as long as the entire spectrum is covered.

CONDUCTED SPURIOUS EMISSIONS

Test Data: 910.5 MHz

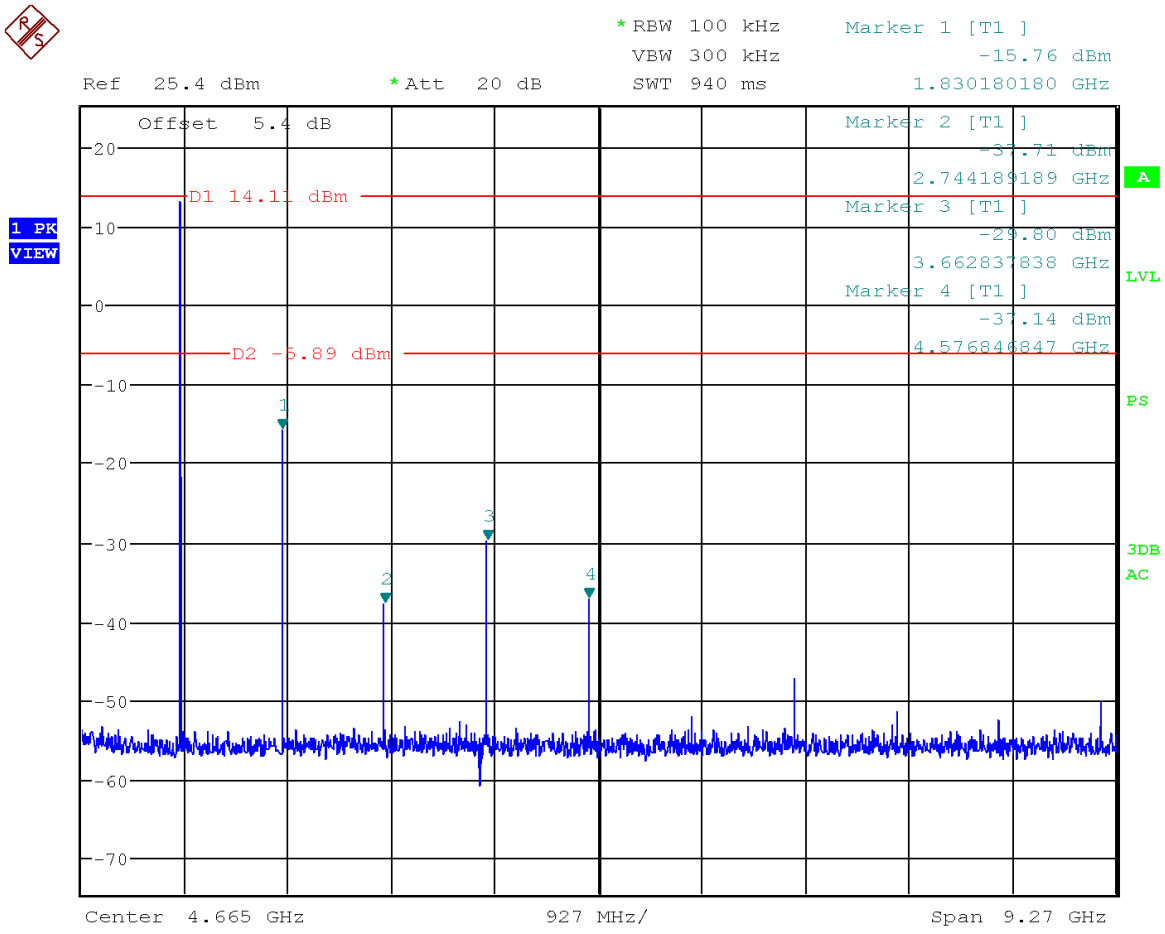


Date: 24.OCT.2019 19:20:28

RESULT: Complies.

CONDUCTED SPURIOUS EMISSIONS

Test Data: 915.5 MHz

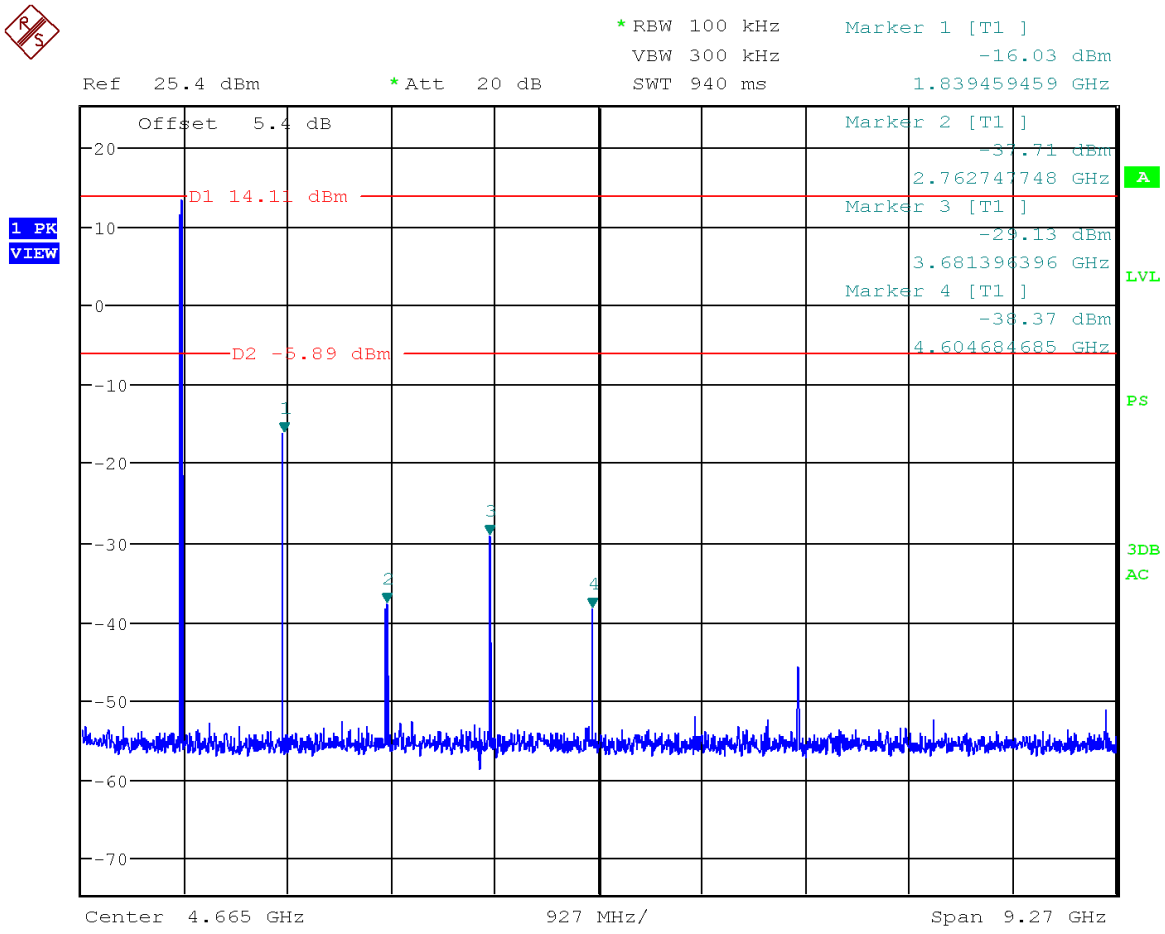


Date: 24.OCT.2019 19:21:22

RESULT: Complies.

CONDUCTED SPURIOUS EMISSIONS

Test Data: 920.5 MHz



Date: 24.OCT.2019 19:22:21

RESULT: Complies.

RADIATED SPURIOUS EMISSIONS

RULE PART NO.: FCC part 15.247(b)(4), (d), 15.205, 15.209

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:

(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.

(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)).

§15.205 Restricted bands of operation.

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

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	2690-2900	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			

RADIATED SPURIOUS EMISSIONS

§15.31 Measurement standards.

(f) To the extent practicable, the device under test shall be measured at the distance specified in the appropriate rule section. The distance specified corresponds to the horizontal distance between the measurement antenna and the closest point of the equipment under test, support equipment or interconnecting cables as determined by the boundary defined by an imaginary straight line periphery describing a simple geometric configuration enclosing the system containing the equipment under test. The equipment under test, support equipment and any interconnecting cables shall be included within this boundary.

(2) At frequencies below 30 MHz, measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field. Pending the development of an appropriate measurement procedure for measurements performed below 30 MHz, when performing measurements at a closer distance than specified, the results shall be extrapolated to the specified distance by either making measurements at a minimum of two distances on at least one radial to determine the proper extrapolation factor or by using the square of an inverse linear distance extrapolation factor (40 dB/decade). This paragraph (f) shall not apply to Access BPL devices operating below 30 MHz.

§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	Limit (μV/m)	15.31 Extrapolation factor (dB)	3m Limit (dBμV/m)
9 kHz – 30 kHz	2400/F(in kHz) @ 300m	80 dB	-31.48 to -41.94
30 kHz – 300 kHz	2400/F(in kHz) @ 300m	80 dB	-41.94 to -61.94
300 kHz – 490 kHz	2400/F(in kHz) @ 300m	80 dB	-61.94 to -66.2
490 kHz – 1.705 MHz	24000/F(in kHz) @ 30m	40 dB	-6.2 to -17.03
1.705 MHz – 3 MHz	30.0 @ 30 m	40 dB	-10.46
3 MHz – 30 MHz	30.0 @ 30 m	40 dB	-10.46

RADIATED SPURIOUS EMISSIONS

(1) At frequencies at or above 30 MHz, measurements may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment. Measurements shall not be performed at a distance greater than 30 meters unless it can be further demonstrated that measurements at a distance of 30 meters or less are impractical. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

§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)	3m Limit (dBμV/m)
30 – 88	100.0	40.00
88 – 216	150.0	43.52
216 – 960	200.0	46.02
Above 960	500.0	53.98

§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

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

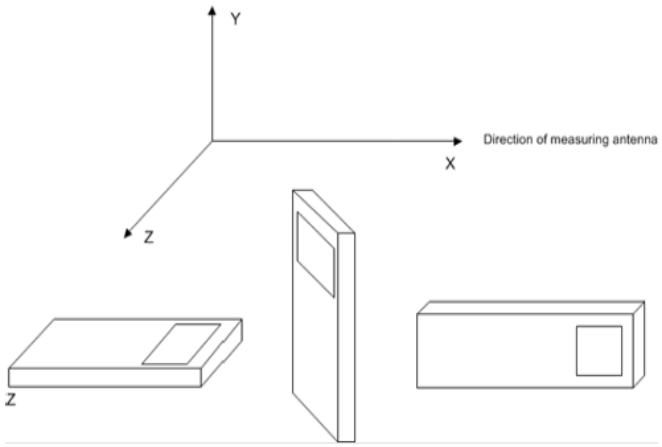
Radiated Emissions Test Setup:

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 C63.10 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:

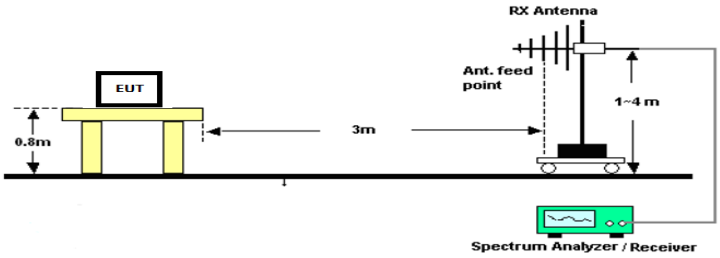
The field strength at 3m was established by adding the meter reading of the spectrum analyzer (which is set to read in units of dBµV) to the antenna correction factor supplied by the antenna manufacturer plus the coax loss. The antenna correction factors are stated in terms of dB. The gain of the preselector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

Field Strength Correction Factor Conversion Example:

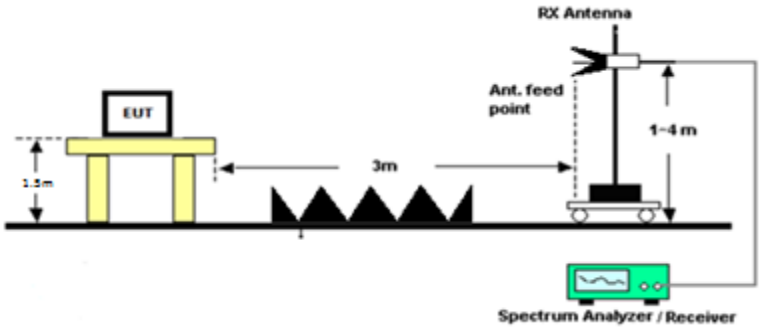
Freq (MHz)	Meter Reading	+ ACF	+CL	= FS
33	20 dBµV	+ 10.36 dB/m	+0.40 dB	=30.76 dBµV/m @ 3m

Test Setup:

Emissions 30 – 1000 MHz



Emissions above 1 GHz



RADIATED SPURIOUS EMISSIONS

Test Data: Field Strength of the Fundamental

Tuned Frequency (MHz)	Detector	Meter Reading (dBµV)	Antenna Polarity	Coax Loss (dB)	Antenna Correction Factor (dB/m)	Distance (m)	Field Strength (dBµV/m)
910.50	PK	78.46	H	3.55	22.60	3.00	104.61
910.50	PK	86.69	V	3.55	22.60	3.00	112.84
915.50	PK	77.62	H	3.57	22.57	3.00	103.76
915.50	PK	85.49	V	3.57	22.57	3.00	111.63
920.50	PK	78.55	H	3.58	22.29	3.00	104.42
920.50	PK	86.62	V	3.58	22.29	3.00	112.49

Test Data: Low End of Band

Tuned Frequency (MHz)	Emission Frequency (MHz)	15.205 Restricted Band	15.247(d) Detector	Meter Reading (dBµV)	Antenna Polarity	Coax Loss (dB)	Duty Cycle Correction (dB)	Antenna Correction Factor (dB/m)	Distance (m)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dBm)
910.50	103.71		PK	5.44	H	1.17	15.42	10.63	3.00	1.82	92.84	91.02
910.50	57.61		PK	1.67	H	0.89	15.42	8.46	3.00	-4.41	92.84	97.25
910.50	182.86		PK	1.87	H	1.57	15.42	13.50	3.00	1.52	92.84	91.32
910.50	900.73		PK	32.35	H	3.54	15.42	21.77	3.00	42.24	92.84	50.60
910.50	407.36	X	PK	21.52	H	2.30	15.42	14.70	3.00	23.10	46.02	22.92
910.50	81.00		PK	8.37	V	1.09	15.42	8.80	3.00	2.83	92.84	90.01
910.50	103.71		PK	8.25	V	1.17	15.42	10.63	3.00	4.63	92.84	88.21
910.50	162.06	X	PK	4.41	V	1.46	15.42	16.39	3.00	6.85	43.52	36.67
910.50	43.87		PK	4.25	V	0.75	15.42	12.73	3.00	2.30	92.84	90.54
910.50	901.17		PK	32.17	V	3.54	15.42	21.82	3.00	42.11	92.84	50.73
910.50	564.80		PK	21.29	V	2.85	15.42	18.30	3.00	27.02	92.84	65.82

Tuned Frequency (MHz)	Emission Frequency (MHz)	15.205 Restricted Band	15.205, 15.35, 15.247(d) Detector	Meter Reading (dBµV)	Antenna Polarity	Coax Loss (dB)	Duty Cycle Correction (dB)	Antenna Correction Factor (dB/m)	Distance (m)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dBm)
910.50	1821.00		PK	49.90	H	4.92	15.42	30.54	3.00	69.94	92.84	22.90
910.50	1821.00		PK	42.70	V	4.92	15.42	30.54	3.00	62.74	92.84	30.10
910.50	2731.50	X	PK	20.70	H	6.05	15.42	32.43	3.00	43.76	73.98	30.22
910.50	2731.50	X	AVG	16.40	H	6.05	15.42	32.43	3.00	39.46	53.98	14.52
910.50	2731.50	X	PK	19.70	V	6.05	15.42	32.43	3.00	42.76	73.98	31.22
910.50	2731.50	X	AVG	15.20	V	6.05	15.42	32.43	3.00	38.26	53.98	15.72
910.50	3642.00	X	PK	31.20	H	6.62	15.42	33.18	3.00	55.58	73.98	18.40
910.50	3642.00	X	AVG	25.70	H	6.62	15.42	33.18	3.00	50.08	53.98	3.90
910.50	3642.00	X	PK	35.00	V	6.62	15.42	33.18	3.00	59.38	73.98	14.60
910.50	3642.00	X	AVG	27.90	V	6.62	15.42	33.18	3.00	52.28	53.98	1.70
910.50	4552.50	X	PK	28.50	H	7.49	15.42	34.00	3.00	54.56	73.98	19.41
910.50	4552.50	X	AVG	26.00	H	7.49	15.42	34.00	3.00	52.06	53.98	1.91
910.50	4552.50	X	PK	27.50	V	7.49	15.42	34.00	3.00	53.56	73.98	20.41
910.50	4552.50	X	AVG	24.90	V	7.49	15.42	34.00	3.00	50.96	53.98	3.01
910.50	5463.00		PK	23.80	H	8.11	15.42	34.48	3.00	50.96	92.84	41.88
910.50	5463.00		PK	25.10	V	8.11	15.42	34.48	3.00	52.26	92.84	40.58
910.50	6373.50		PK	19.20	H	8.95	15.42	35.42	3.00	48.15	92.84	44.69
910.50	6373.50		PK	17.90	V	8.95	15.42	35.42	3.00	46.85	92.84	45.99
910.50	7284.00	X	PK	18.10	H	9.57	15.42	36.30	3.00	48.55	73.98	25.43
910.50	7284.00	X	AVG	11.40	H	9.57	15.42	36.30	3.00	41.85	53.98	12.13
910.50	7284.00	X	PK	18.50	V	9.57	15.42	36.30	3.00	48.95	73.98	25.03
910.50	7284.00	X	AVG	11.50	V	9.57	15.42	36.30	3.00	41.95	53.98	12.03
910.50	8194.50	X	PK	15.10	H	9.86	15.42	35.80	3.00	45.34	73.98	28.64
910.50	8194.50	X	AVG	6.70	H	9.86	15.42	35.80	3.00	36.94	53.98	17.04
910.50	8194.50	X	PK	15.60	V	9.86	15.42	35.80	3.00	45.84	73.98	28.14
910.50	8194.50	X	AVG	7.10	V	9.86	15.42	35.80	3.00	37.34	53.98	16.64
910.50	9105.00	X	PK	14.90	H	10.74	15.42	36.12	3.00	46.34	73.98	27.63
910.50	9105.00	X	AVG	4.20	H	10.74	15.42	36.12	3.00	35.64	53.98	18.33
910.50	9105.00	X	PK	14.70	V	10.74	15.42	36.12	3.00	46.14	73.98	27.83
910.50	9105.00	X	AVG	4.50	V	10.74	15.42	36.12	3.00	35.94	53.98	18.03

RADIATED SPURIOUS EMISSIONS

Test Data: Middle of Band

Tuned Frequency (MHz)	Emission Frequency (MHz)	15.205 Restricted Band	15.247(d) Detector	Meter Reading (dBµV)	Antenna Polarity	Coax Loss (dB)	Duty Cycle Correction (dB)	Antenna Correction Factor (dB/m)	Distance (m)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dBm)
915.50	103.71		PK	3.48	H	1.17	15.42	10.63	3.00	-0.14	92.84	92.98
915.50	48.77		PK	2.52	H	0.81	15.42	11.57	3.00	-0.53	92.84	93.37
915.50	188.98		PK	2.35	H	1.59	15.42	13.70	3.00	2.21	92.84	90.63
915.50	749.12		PK	21.63	H	3.22	15.42	20.85	3.00	30.27	92.84	62.57
915.50	81.00		PK	8.04	V	1.09	15.42	8.80	3.00	2.50	92.84	90.34
915.50	103.58		PK	7.96	V	1.17	15.42	10.64	3.00	4.36	92.84	88.49
915.50	43.87		PK	4.33	V	0.75	15.42	12.73	3.00	2.38	92.84	90.46
915.50	189.12		PK	3.81	V	1.59	15.42	13.72	3.00	3.70	92.84	89.14
915.50	511.68		PK	21.55	V	2.69	15.42	17.77	3.00	26.58	92.84	66.26

Tuned Frequency (MHz)	Emission Frequency (MHz)	15.205 Restricted Band	15.205, 15.35, 15.247(d) Detector	Meter Reading (dBµV)	Antenna Polarity	Coax Loss (dB)	Duty Cycle Correction (dB)	Antenna Correction Factor (dB/m)	Distance (m)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dBm)
915.50	1831.00		PK	50.70	H	4.94	15.42	30.66	3.00	70.88	92.84	21.96
915.50	1831.00		PK	36.50	V	4.94	15.42	30.66	3.00	56.68	92.84	36.16
915.50	2746.50	X	PK	20.20	H	6.09	15.42	32.39	3.00	43.26	73.98	30.72
915.50	2746.50	X	AVG	15.90	H	6.09	15.42	32.39	3.00	38.96	53.98	15.02
915.50	2746.50	X	PK	18.20	V	6.09	15.42	32.39	3.00	41.26	73.98	32.72
915.50	2746.50	X	AVG	12.40	V	6.09	15.42	32.39	3.00	35.46	53.98	18.52
915.50	3662.00	X	PK	30.40	H	6.62	15.42	33.20	3.00	54.80	73.98	19.18
915.50	3662.00	X	AVG	16.00	H	6.62	15.42	33.20	3.00	40.40	53.98	13.58
915.50	3662.00	X	PK	34.90	V	6.62	15.42	33.20	3.00	59.30	73.98	14.68
915.50	3662.00	X	AVG	16.60	V	6.62	15.42	33.20	3.00	41.00	53.98	12.98
915.50	4577.50	X	PK	29.80	H	7.53	15.42	34.03	3.00	55.94	73.98	18.04
915.50	4577.50	X	AVG	18.80	H	7.53	15.42	34.03	3.00	44.94	53.98	9.04
915.50	4577.50	X	PK	29.50	V	7.53	15.42	34.03	3.00	55.64	73.98	18.34
915.50	4577.50	X	AVG	13.40	V	7.53	15.42	34.03	3.00	39.54	53.98	14.44
915.50	5493.00		PK	24.20	H	8.07	15.42	34.47	3.00	51.32	92.84	41.52
915.50	5493.00		PK	24.30	V	8.07	15.42	34.47	3.00	51.42	92.84	41.42
915.50	6408.50		PK	18.50	H	8.95	15.42	35.46	3.00	47.50	92.84	45.35
915.50	6408.50		PK	18.80	V	8.95	15.42	35.46	3.00	47.80	92.84	45.05
915.50	7324.00	X	PK	16.90	H	9.59	15.42	36.23	3.00	47.30	73.98	26.68
915.50	7324.00	X	AVG	9.70	H	9.59	15.42	36.23	3.00	40.10	53.98	13.88
915.50	7324.00	X	PK	19.20	V	9.59	15.42	36.23	3.00	49.60	73.98	24.38
915.50	7324.00	X	AVG	12.80	V	9.59	15.42	36.23	3.00	43.20	53.98	10.78
915.50	8239.50	X	PK	16.20	H	10.01	15.42	35.80	3.00	46.59	73.98	27.39
915.50	8239.50	X	AVG	8.60	H	10.01	15.42	35.80	3.00	38.99	53.98	14.99
915.50	8239.50	X	PK	15.20	V	10.01	15.42	35.80	3.00	45.59	73.98	28.39
915.50	8239.50	X	AVG	6.90	V	10.01	15.42	35.80	3.00	37.29	53.98	16.69
915.50	9155.00	X	PK	15.10	H	10.83	15.42	36.19	3.00	46.70	73.98	27.28
915.50	9155.00	X	AVG	5.30	H	10.83	15.42	36.19	3.00	36.90	53.98	17.08
915.50	9155.00	X	PK	15.10	V	10.83	15.42	36.19	3.00	46.70	73.98	27.28
915.50	9155.00	X	AVG	5.60	V	10.83	15.42	36.19	3.00	37.20	53.98	16.78

RADIATED SPURIOUS EMISSIONS

Test Data: High End of Band

Tuned Frequency (MHz)	Emission Frequency (MHz)	15.205 Restricted Band	15.247(d) Detector	Meter Reading (dBµV)	Antenna Polarity	Coax Loss (dB)	Duty Cycle Correction (dB)	Antenna Correction Factor (dB/m)	Distance (m)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dBm)
920.50	103.71		PK	3.93	H	1.17	15.42	10.63	3.00	0.31	92.84	92.53
920.50	40.34		PK	2.32	H	0.70	15.42	13.27	3.00	0.87	92.84	91.97
920.50	189.12		PK	3.40	H	1.59	15.42	13.72	3.00	3.29	92.84	89.55
920.50	928.69		PK	21.78	H	3.58	15.42	22.27	3.00	32.21	92.84	60.63
920.50	279.36	X	PK	21.70	H	2.05	15.42	12.86	3.00	21.19	46.02	24.83
920.50	81.00		PK	8.71	V	1.09	15.42	8.80	3.00	3.17	92.84	89.67
920.50	103.71		PK	7.33	V	1.17	15.42	10.63	3.00	3.71	92.84	89.13
920.50	43.87		PK	3.85	V	0.75	15.42	12.73	3.00	1.90	92.84	90.94
920.50	162.06	X	PK	3.78	V	1.46	15.42	16.39	3.00	6.22	43.52	37.30
920.50	929.22		PK	21.99	V	3.58	15.42	22.28	3.00	32.43	92.84	60.41
920.50	672.96		PK	21.81	V	3.04	15.42	20.60	3.00	30.02	92.84	62.82

Tuned Frequency (MHz)	Emission Frequency (MHz)	15.205 Restricted Band	15.205, 15.35, 15.247(d) Detector	Meter Reading (dBµV)	Antenna Polarity	Coax Loss (dB)	Duty Cycle Correction (dB)	Antenna Correction Factor (dB/m)	Distance (m)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dBm)
920.50	1841.00		PK	50.40	H	4.96	15.42	30.78	3.00	70.72	92.84	22.13
920.50	1841.00		PK	42.30	V	4.96	15.42	30.78	3.00	62.62	92.84	30.23
920.50	2761.50	X	PK	18.00	H	6.12	15.42	32.41	3.00	41.11	73.98	32.87
920.50	2761.50	X	AVG	12.00	H	6.12	15.42	32.41	3.00	35.11	53.98	18.87
920.50	2761.50	X	PK	15.80	V	6.12	15.42	32.41	3.00	38.91	73.98	35.07
920.50	2761.50	X	AVG	6.90	V	6.12	15.42	32.41	3.00	30.01	53.98	23.97
920.50	3682.00	X	PK	31.60	H	6.63	15.42	33.19	3.00	56.00	73.98	17.98
920.50	3682.00	X	AVG	28.00	H	6.63	15.42	33.19	3.00	52.40	53.98	1.58
920.50	3682.00	X	PK	34.10	V	6.63	15.42	33.19	3.00	58.50	73.98	15.48
920.50	3682.00	X	AVG	27.10	V	6.63	15.42	33.19	3.00	51.50	53.98	2.48
920.50	4602.50	X	PK	32.60	H	7.55	15.42	34.05	3.00	58.78	73.98	15.20
920.50	4602.50	X	AVG	22.80	H	7.55	15.42	34.05	3.00	48.98	53.98	5.00
920.50	4602.50	X	PK	30.80	V	7.55	15.42	34.05	3.00	56.98	73.98	17.00
920.50	4602.50	X	AVG	22.10	V	7.55	15.42	34.05	3.00	48.28	53.98	5.70
920.50	5523.00		PK	24.00	H	8.06	15.42	34.44	3.00	51.08	92.84	41.76
920.50	5523.00		PK	25.90	V	8.06	15.42	34.44	3.00	52.98	92.84	39.86
920.50	6443.50		PK	20.30	H	8.96	15.42	35.51	3.00	49.36	92.84	43.49
920.50	6443.50		PK	20.40	V	8.96	15.42	35.51	3.00	49.46	92.84	43.39
920.50	7364.00	X	PK	18.30	H	9.47	15.42	36.14	3.00	48.49	73.98	25.49
920.50	7364.00	X	AVG	11.60	H	9.47	15.42	36.14	3.00	41.79	53.98	12.19
920.50	7364.00	X	PK	20.50	V	9.47	15.42	36.14	3.00	50.69	73.98	23.29
920.50	7364.00	X	AVG	14.70	V	9.47	15.42	36.14	3.00	44.89	53.98	9.09
920.50	8284.50	X	PK	13.60	H	10.08	15.42	35.82	3.00	44.09	73.98	29.89
920.50	8284.50	X	AVG	3.20	H	10.08	15.42	35.82	3.00	33.69	53.98	20.29
920.50	8284.50	X	PK	13.40	V	10.08	15.42	35.82	3.00	43.89	73.98	30.09
920.50	8284.50	X	AVG	3.30	V	10.08	15.42	35.82	3.00	33.79	53.98	20.19
920.50	9205.00		PK	15.60	H	10.93	15.42	36.27	3.00	47.38	92.84	45.46
920.50	9205.00		PK	14.80	V	10.93	15.42	36.27	3.00	46.58	92.84	46.26

RADIATED SPURIOUS EMISSIONS

Test Data: Hopping

Tuned Frequency (MHz)	Emission Frequency (MHz)	15.205 Restricted Band	15.247(d) Detector	Meter Reading (dBµV)	Antenna Polarity	Coax Loss (dB)	Duty Cycle Correction (dB)	Antenna Correction Factor (dB/m)	Distance (m)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dBm)
910.50	103.71		PK	4.28	H	1.17	0.00	10.63	3.00	16.08	92.84	76.76
910.50	45.78		PK	1.58	H	0.77	0.00	12.37	3.00	14.72	92.84	78.13
910.50	151.45		PK	2.59	H	1.41	0.00	16.50	3.00	20.50	92.84	72.34
910.50	901.95		PK	21.88	H	3.54	0.00	21.90	3.00	47.32	92.84	45.52
910.50	929.48		PK	23.32	H	3.58	0.00	22.29	3.00	49.19	92.84	43.65
910.50	424.64		PK	22.20	H	2.36	0.00	15.77	3.00	40.33	92.84	52.51
910.50	103.58		PK	7.95	V	1.17	0.00	10.64	3.00	19.77	92.84	73.08
910.50	81.00		PK	7.66	V	1.09	0.00	8.80	3.00	17.55	92.84	75.30
910.50	43.87		PK	3.75	V	0.75	0.00	12.73	3.00	17.22	92.84	75.62
910.50	189.12		PK	3.50	V	1.59	0.00	13.72	3.00	18.81	92.84	74.03
910.50	767.04		PK	21.91	V	3.26	0.00	21.16	3.00	46.33	92.84	46.51
910.50	900.13		PK	21.88	V	3.54	0.00	21.71	3.00	47.13	92.84	45.71
910.50	929.96		PK	21.66	V	3.58	0.00	22.30	3.00	47.54	92.84	45.30

Tuned Frequency (MHz)	Emission Frequency (MHz)	15.205 Restricted Band	15.205, 15.35, 15.247(d) Detector	Meter Reading (dBµV)	Antenna Polarity	Coax Loss (dB)	Duty Cycle Correction (dB)	Antenna Correction Factor (dB/m)	Distance (m)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dBm)
920.50	1833.60		PK	31.22	V	4.95	0.00	30.69	3.00	66.85	92.84	25.99
920.50	1840.20		PK	39.36	H	4.96	0.00	30.77	3.00	75.08	92.84	17.76
920.50	2732.90	X	PK	4.73	V	6.06	0.00	32.43	3.00	43.21	73.98	30.77
920.50	2732.90	X	AVG	-10.69	V	6.06	0.00	32.43	3.00	27.79	53.98	26.19
920.50	2734.30	X	PK	6.42	H	6.06	0.00	32.42	3.00	44.90	73.98	29.08
920.50	2734.30	X	AVG	-3.59	H	6.06	0.00	32.42	3.00	34.89	53.98	19.09
920.50	3658.40	X	PK	23.04	V	6.62	0.00	33.20	3.00	62.85	73.98	11.13
920.50	3658.40	X	AVG	11.50	V	6.62	0.00	33.20	3.00	51.32	53.98	2.66
920.50	3678.10	X	PK	21.07	H	6.62	0.00	33.19	3.00	60.88	73.98	13.09
920.50	3678.10	X	AVG	-1.49	H	6.62	0.00	33.19	3.00	38.32	53.98	15.65
920.50	4577.40	X	PK	15.90	V	7.53	0.00	34.03	3.00	57.46	73.98	16.52
920.50	4577.40	X	AVG	10.31	V	7.53	0.00	34.03	3.00	51.87	53.98	2.11
920.50	4597.10	X	PK	19.12	H	7.54	0.00	34.05	3.00	60.71	73.98	13.26
920.50	4597.10	X	AVG	-4.29	H	7.54	0.00	34.05	3.00	37.30	53.98	16.67
920.50	5509.50		PK	11.65	H	8.06	0.00	34.46	3.00	54.16	92.84	38.68
920.50	5516.00		PK	13.44	V	8.06	0.00	34.45	3.00	55.94	92.84	36.90
920.50	6402.20		PK	5.53	H	8.95	0.00	35.46	3.00	49.93	92.84	42.91
920.50	6408.70		PK	5.82	V	8.95	0.00	35.46	3.00	50.23	92.84	42.61
920.50	7327.70	X	PK	6.40	V	9.58	0.00	36.22	3.00	52.20	73.98	21.78
920.50	7327.70	X	AVG	-10.59	V	9.58	0.00	36.22	3.00	35.21	53.98	18.77
920.50	7360.50	X	PK	6.55	H	9.48	0.00	36.14	3.00	52.17	73.98	21.81
920.50	7360.50	X	AVG	-11.09	H	9.48	0.00	36.14	3.00	34.53	53.98	19.45
920.50	8213.80	X	PK	1.18	H	9.92	0.00	35.80	3.00	46.90	73.98	27.08
920.50	8213.80	X	AVG	-13.49	H	9.92	0.00	35.80	3.00	32.23	53.98	21.75
920.50	8213.80	X	PK	2.66	V	9.92	0.00	35.80	3.00	48.38	73.98	25.60
920.50	8213.80	X	AVG	-10.59	V	9.92	0.00	35.80	3.00	35.13	53.98	18.85
920.50	9145.90	X	PK	0.74	H	10.80	0.00	36.18	3.00	47.71	73.98	26.27
920.50	9145.90	X	AVG	-13.49	H	10.80	0.00	36.18	3.00	33.48	53.98	20.50
920.50	9159.10	X	PK	1.05	V	10.85	0.00	36.20	3.00	48.09	73.98	25.89
920.50	9159.10	X	AVG	-13.49	V	10.85	0.00	36.20	3.00	33.55	53.98	20.43

POWER LINE CONDUCTED INTERFERENCE

FCC Rule Part No.: FCC Part 15.207(a)

Requirements:

§15.207 Conducted limits.

(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator 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 boundary between the frequency ranges.

	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.

(c) 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 provisions for, the use of battery chargers which permit operating while charging, AC adapters or battery eliminators or that connect to the AC power lines indirectly, obtainig 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

The EUT does not connect to an external powerline.

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	7/26/2020
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

***EMI RECEIVER SOFTWARE VERSION**

The receiver firmware used was version 4.43 Service Pack 3

STATEMENT OF 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%	
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%	
Radiated Emissions up to 26.5GHz	±2.14dB	
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