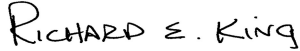


**Engineering Test Report No. 1900757-02**

Report Date	January 23, 2020
Manufacturer Name	Caterpillar Inc.
Manufacturer Address	Route 29 & Rensch Road Oak Brook, IL 61552
Product Name Brand/Model/Part Number No.	580-2222-01
Date Received	October 30 th 2019
Test Dates	October 30 th , 2019 through January 9 th , 2020
Specifications	FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.207 and 15.247 for Digital Modulation Intentional Radiators Operating within the band 2400-2483.5MHz FCC "Code of Federal Regulations" Title 47, Part 15, Subpart 15B, Section 15.107 and 15.109 for Receivers Innovation, Science, and Economic Development Canada RSS-247 Innovation, Science, and Economic Development Canada RSS-GEN
Test Facility	Elite Electronic Engineering, Inc. 1516 Centre Circle, Downers Grove, IL 60515
Signature	
Tested by	John Peters
Signature	
Approved by	Richard King For Raymond J. Klouda, Registered Professional Engineer of Illinois – 44894

This report is for your exclusive use. Any copying or replication of this report to or for any other person or entity, or use of our name or trademark, is permitted only with our prior written permission. This report sets forth our findings solely with respect to the test samples identified herein. The results set forth in this report are not indicative or representative of the quality or characteristics of the lot from which a test sample was taken or any similar or identical product unless specifically and expressly noted. Our report includes all of the tests requested by you and the results thereof based upon the information that you provided to us. You have 60 days from date of issuance of this report to notify us of any material error or omission caused by our negligence, provided, however, that such notice shall be in writing and shall specifically address the issue you wish to raise. A failure to raise such issue within the prescribed time shall constitute your unqualified acceptance of the completeness of this report, the tests conducted and the correctness of the report contents.

This report shall not be reproduced, except in full, without the written approval of Elite Electronic Engineering Inc.

Elite Electronic Engineering Incorporated certifies that the information contained in this report was obtained under conditions which meet or exceed those specified in the FCC 15.247 for transceivers and RSS-247 For Transceivers test specification(s). The data presented in this test report pertains to the EUT on the test date(s) specified. Any electrical or mechanical modifications made to the EUT subsequent to the specified test date will serve to invalidate the data and void this certification. This report must not be used to claim product certification, approval, or endorsement by A2LA, NIST, or any agency of the Federal Government.

Table of Contents

1.	Report Revision History	3
2.	Introduction	4
3.	Technical Information	4
4.	Test Specification(s)	4
5.	Laboratory Conditions	5
6.	Summary	5
7.	Test Plan	5
8.	Grounding	5
9.	Firmware/Software	5
10.	Modifications Made to EUT	5
11.	Deviations from Specification(s)	5
12.	Modes of Operation	6
12.1.	Transmit	6
13.	Test Method	6
14.	Sample Calculations	6
15.	Statement of Conformity	6
16.	Certification	6
17.	Photographs of EUT	7
18.	Equipment List	8
19.	Antenna Port Conducted Emissions Tests	10
20.	Scope of Accreditation	47

**This report shall not be reproduced, except in full,
without the written approval of Elite Electronic Engineering Inc.**

1. Report Revision History

Revision	Date	Description
–	11 MAR 2020	Initial Release of Engineering Test Report No. 1900757-02

2. Introduction

This document presents the results of a series of electromagnetic compatibility (EMC) tests that were performed on one (1) Trackwear Sensor model/part number 580-2222-01 (hereinafter referred to as the Equipment Under Test (EUT)). Two samples were submitted. One sample was modified with an antenna port in place of the PCB trace antenna to perform antenna conducted measurements. One sample was left with the PCB trace antenna intact for all radiated testing. All EUTs were modified with external connections to apply a DC voltage for powering the device.

The EUT submitted was identified as follows:

Description	Part #	S/N	
Trackwear Sensor	580-2222-01	None given	Used for antenna conducted measurements
Trackwear Sensor	580-2222-01	None given	Used with the Track for radiated measurements
Track	CAT 524-1973	None given	

The EUT listed above was used throughout the test series.

3. Technical Information

This document presents the technical information of the EUT as tested to a series of electromagnetic compatibility (EMC) tests. This information is listed as follows:

Applicant FCC FRN Company number (If known)	0022872246
Applicant IC company number (If known)	4071A
FCC ID Number (If known)	Undecided
IC UPN number (If Known)	Undecided
FCC test site(s) Reg. number	2987-1
IC test site(s) Reg. number	2987A
FCC Test Speciation	FCC 15.247
RSS number and Issue number	RSS-247 Issue 2, Feb 2017
Frequency band	2400–2480 MHz
Frequency Min (MHz)	2402
Frequency Max (MHz)	2480
RF power Max (W), Conducted	0.00123 (0.9 dBm)
Field strength, Units @ distance	N/A
Measured BW (kHz)	1070.0
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	$\pi/4$ DQPSK
Transmitter spurious, dB μ V/m @ 3 m	44.5 dB μ V/m @ 3Meters
Emission classification (F1D, G1D, D1D)	F1D
Power requirements	3.3VDC

4. Test Specification(s)

The tests were performed to selected portions of, and in accordance with the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.207 and 15.247 for Intentional Radiators Operating within the 2400-2483.5 MHz band test specification(s):

Federal Communications Commission "Code of Federal Regulations", Title 47, Part 15, Subpart C
ANSI C63.4-2014, "American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz"
ANSI C63.10-2013 "American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices"
"Federal Communications Commission Office of Engineering and Technology Laboratory Division, Guidance

For Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating Under Section 15.247 of the FCC Rules"

April 2, 2019, KDB 558074 D01 DTS Meas Guidance v05

RSS-Gen Issue 5, March 2019, Amendment 1, Innovation, Science, and Economic Development Canada, "Spectrum Management and Telecommunications, Radio Standards Specification, General Requirements for Compliance of Radio Apparatus"

RSS-247 Issue 2, February 2017, Innovation, Science, and Economic Development Canada, "Spectrum Management and Telecommunications, Radio Standards Specification, Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices"

5. Laboratory Conditions

The temperature at the time of the test was 22.6°C, and the relative humidity was 17%.

6. Summary

The following EMC tests were performed, and the results are shown below:

Test Specification	Test Description	Results
FCC 15.247 RSS 247	Transmitter RF Conducted Emissions Test (AC Mains)	Conforms
	Transmitter 6dB Bandwidth Test	Conforms
	Transmitter 99% Bandwidth Test	Conforms
	Transmitter Average Conducted Output Power Test	Conforms
	Transmitter Power Spectral Density Test	Conforms
	Transmitter Low Band Edge Test	Conforms
	Transmitter EIRP Test	Conforms
	Transmitter Duty Cycle Correction Factor Test	N/A
	Transmitter Spurious Radiated Emissions Test	Conforms
	Transmitter High Band Edge Test	Conforms

7. Test Plan

No test plan was provided. Instructions were provided by personnel from Caterpillar Inc. and used in conjunction with the FCC 15.247 for transceivers and RSS-247 For Transceivers specification(s).

8. Grounding

The EUT was ungrounded during the test.

9. Firmware/Software

For all tests, the EUT had Firmware Version 6.2 loaded onto the device to provide correct load characteristics. The EUT requires Software RTLBTAPP Version 5.22.40 to control the device during testing.

10. Modifications Made to EUT

No modifications were made to the EUT during the testing.

11. Deviations from Specification(s)

No deviations from the specification(s) were made during the testing.

12. Modes of Operation

The EMC tests were performed with the EUT(s) operating in one or more of the test modes described below. See the specific test section for the applicable test modes.

12.1. Transmit

The EUT was energized. The EUT was programmed to continuously transmit separately at each of the following channels:

- Transmit at 2402MHz; +4dBm
- Transmit at 2437MHz; +4dBm
- Transmit at 2480MHz; +4dBm

13. Test Method

The tests were performed using the referenced methods described in the FCC 15.247 for transceivers and RSS-247 For Transceivers test specification(s). The specific test sections and specification references are called out in the individual test sections.

14. Sample Calculations

For Powerline Conducted Emissions:

The resultant voltage level (VL) is a summation in decibels (dB) of the receiver meter reading (MTR) and the cable loss factor (CF).

$$\text{Formula 1: VL (dBuV) = MTR (dBuV) + CF (dB)}$$

For Radiated Emissions:

The resultant field strength (FS) is a summation in decibels (dB) of the receiver meter reading (MTR), the antenna correction factor (AF), and the cable loss factor (CF). If an external pre-amplifier is used, the total is reduced by its gain (-PA). If a distance correction (DC) is required, it is added to the total.

$$\text{Formula 1: FS (dBuV/m) = MTR (dBuV) + AF (dB/m) + CF (dB) + (- PA (dB)) + DC (dB)}$$

To convert the Field Strength dBuV/m term to uV/m, the dBuV/m is first divided by 20. The Base 10 AntiLog is taken of this quotient. The result is the Field Strength value in uV/m terms.

$$\text{Formula 2: FS (uV/m) = AntiLog [(FS (dBuV/m))/20]}$$

15. Statement of Conformity

The Caterpillar Inc. Trackwear Sensor, Model/Part Number No. 580-2222-01, No Serial No. assigned, did fully conform to the selected requirements of FCC 15.247 for transceivers and RSS-247 For Transceivers.

16. Certification

Elite Electronic Engineering Incorporated certifies that the information contained in this report was obtained under conditions which meet or exceed those specified in the FCC 15.247 for transceivers and RSS-247 For Transceivers test specification(s). The data presented in this test report pertains to the EUT on the test date specified. Any electrical or mechanical modifications made to the EUT subsequent to the specified test date will serve to invalidate the data and void this certification.

18. Equipment List

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
ACU2	BROADBAND POWER AMPLIFIER	AMPLIFIER RESEARCH	500W1000A	29209	80-1000MHZ	NOTE 1	
APW0	PREAMPLIFIER	PLANAR ELECTRONICS	PE2-30-20G20R6G	PL2926/0646	20GHZ-26.5GHZ	10/2/2019	10/2/2020
APW14	PREAMPLIFIER	PLANAR	PE2-35-120-5R0-10-12-SFF	PL22671	1-20GHZ	9/25/2019	9/25/2020
APW3	PREAMPLIFIER	PLANAR ELECTRONICS	PE2-35-120-5R0-10-12	PL2924	1GHZ-20GHZ	4/8/2019	4/8/2020
AWC0	HIGH POWER TWT AMPLIFIER 500watt	IFI	T251-500A	L521-0208	1.0-2.5GHz	NOTE 1	
AWD0	500 W TWT Amplifier	IFI, Inc.	GT7525-500	L569-0308	2.5 to 7.5 GHz	NOTE 1	
CDW4	DESKTOP COMPUTER	ELITE	PENTIUM 4	005	3.8GHZ	N/A	
CDX6	COMPUTER	ELITE	WORKSTATION			N/A	
CDY0	WORKSTATION	ELITE	WORKSTATION		WINDOWS 7	N/A	
CLT25	COMPUTER	HP	HP 450 G2	5CD6174H0L			
EMCE01	TEMPERATURE CHAMBER	THERMOTRON	S-4	34537	-70C to 180C	5/24/2019	5/24/2020
GRE0	SIGNAL GENERATOR	AGILENT TECHNOLOGIES	E4438C	MY42083127	250KHZ-6GHZ	5/2/2019	5/2/2020
GSE0	SIGNAL GENERATOR (40GHZ)	ROHDE & SCHWARZ	SMB100A	175137	100KHZ-40GHZ	8/21/2019	8/21/2020
GSFB	OSP120 BASE UNIT	ROHDE & SCHWARZ	OSP120	101246	---	4/1/2019	4/1/2020
GSFE	OSP120	ROHDE & SCHWARZ	OSP120	101288	.01-40GHZ	5/2/2019	5/2/2020
MMLO	ELECTROMETER/MULTIMETER	KEITHLEY	619	220024	V/A/R	9/16/2019	9/16/2020
MPE0	DUAL POWER METER	AGILENT	E4419B	GB39511351	0.1MHZ-50GHZ	8/27/2019	8/27/2020
MPI2	POWER SENSOR	KEYSIGHT	E9304WA	MY55420009	9KHZ-6GHZ	5/3/2018	5/3/2020
MRJ0	TEMPERATURE-HUMIDITY THERMOMETER	EXTECH	445703	---	---	8/22/2018	8/22/2020
NHG0	STANDARD GAIN HORN ANTENNA	NARDA	638	---	18-26.5GHZ	NOTE 1	
NSA7	LOG PERIODIC ANTENNA	AMPLIFIER RESEARCH	AT1080	14239	80-1000MHZ	NOTE 1	
NTA2	BILOG ANTENNA	TESEQ	6112D	28040	25-1000MHz	2/6/2020	2/6/2021
NWQ0	DOUBLE RIDGED WAVEGUIDE ANTENNA	ETS LINDGREN	3117	66657	1GHZ-18GHZ	5/31/2018	5/31/2020
NWQ2	DOUBLE RIDGED WAVEGUIDE ANTENNA	ETS LINDGREN	3117	66659	1GHZ-18GHZ	3/22/2018	3/22/2020
NWV0	DOUBLE RIDGED WAVEGUIDE ANTENNA	ETS LINDGREN	3119	164466	400MHZ-6GHZ	7/15/2018	7/15/2020
PMF1	HIGH VOLTAGE PROBE	KEITHLEY	6103C	---	0-30KV	10/4/2019	10/4/2020
RBG0	EMI ANALYZER	ROHDE & SCHWARZ	ESW44	101533	10HZ-44GHZ	2/19/2020	2/19/2021
RBG3	EMI ANALYZER	ROHDE & SCHWARZ	ESW44	101592	2HZ-44GHZ	2/20/2019	3/20/2020
SHC2	Power Supplies	HENGFU	HF60W-SL-24	A11372702	24V	NOTE 1	
SMAF	POWER SUPPLY	MASTECH	HY3020EX	1012	30 Volt, 20 Amp	NOTE 1	
VBV2	CISPR EN FCC ICES RE.EXE	ELITE	CISPR EN FCC ICES RE.EXE	---	---	N/A	
WKA1	SOFTWARE, UNIVERSAL RCV EMI	ELITE	UNIV_RCV_EMI	1	---	I/O	
WOJ0	SOFTWARE, BSI61000-4-3 RS	ELITE	BSI_610004_3_RS	1	80-2000MHZ	I/O	
XDBB0	DUAL DIRECTIONAL COUPLER (700W)	WERLATONE	C10996-20	115548	700-6000MHZ	2/5/2020	2/5/2021
XDW6	DUAL DIRECTIONAL COUPLER (50DB)	AMPLIFIER RESEARCH	DC6180M6	338070	80-1000MHZ (600W)	9/13/2019	9/13/2020



XPQ4	HIGH PASS FILTER	K&L MICROWAVE	11SH10-4800/X20000-O/O	1	4.8-20GHZ	9/6/2019	9/6/2021
XTR6	ESD SIMULATOR	NOISEKEN	ESS-S3011	ESS15Y2245	---	4/13/2019	4/13/2020
XTRV	ESD GUN	NOISEKEN	GT-30RA	ESS1766229	---	5/31/2019	5/31/2020

N/A: Not Applicable

I/O: Initial Only

CNR: Calibration Not Required

NOTE 1: For the purpose of this test, the equipment was calibrated over the specified frequency range, pulse rate, or modulation prior to the test or monitored by a calibrated instrument.

19. Antenna Port Conducted Emissions Tests

Manufacturer	Caterpillar Inc.
Product	Trackwear Sensor
Model/Part Number	580-2222-01
Mode	Transmit per Paragraph 11.1

Information	
Setup Format	Tabletop
Height of Support (radiated spurious emissions)	80cm below 1GHz; 1.5M above 1GHz
Type of Test Site	Semi-anechoic chamber
Type of Antennas Used	Below 1GHz: Bilog (or equivalent) Above 1GHz: Double-ridged waveguide (or equivalent)
Highest Internal Frequency of the EUT:	2.4 GHz BLE transmitter and 2.4GHz WiFi transmitter
Highest Measurement Frequency:	25GHz
Notes	The cables were manually maximized during the preliminary emissions sweeps. The cable arrangement which resulted in the worst-case emissions was utilized.

Measurement Type	Expanded Measurement Uncertainty
Conducted disturbance (mains port) (150 kHz – 30 MHz)	2.7
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz)	4.3
Radiated disturbance (electric field strength on an open area test site or alternative test site) (1 GHz – 6 GHz)	3.1
Radiated disturbance (electric field strength on an open area test site or alternative test site) (6 GHz – 18 GHz)	3.2

Measurement Uncertainty	
Measurement Type	Expanded Measurement Uncertainty
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz)	4.3
Radiated disturbance (electric field strength on an open area test site or alternative test site) (1 GHz – 6 GHz)	3.1
Radiated disturbance (electric field strength on an open area test site or alternative test site) (6 GHz – 18 GHz)	3.2
Radiated disturbance (electric field strength on an open area test site or alternative test site) (18 GHz – 26.5 GHz)	3.3
Radiated disturbance (electric field strength on an open area test site or alternative test site) (26.5 GHz – 40 GHz)	3.4

Procedures

6dB Bandwidth (DTS Bandwidth)

C63.10-2013 section 11.8 Option 1:

- a) The following settings were employed on the EMI Test Receiver:
 1. Center Frequency = Transmit Frequency of the EUT
 2. Frequency Span = 2 x Occupied Channel Bandwidth
 3. RBW = 100kHz
 4. VBW = 3 x RBW
 5. Detector Mode = Max Peak
 6. Trace Mode = Max Hold
- b) Allow the trace to stabilize.
- c) Set the spectrum analyzer marker to the highest level of the displayed trace (this is the reference value).
- d) Determine the 6dB down amplitude.
- e) Place two markers, one at the lowest frequency and the other at the highest frequency of the envelope trace, such that each marker is at or slightly below the 6dB down amplitude determined in step d). If a marker is below this 6dB 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.

99% Bandwidth (OBW)

C63.10-2013 section 6.9.3:

- a) The following settings were employed on the EMI Test Receiver:
 1. Center Frequency = Transmit Frequency of the EUT
 2. Frequency Span = Between 1.5 and 5 times the OBW
 3. RBW = Between 1% to 5% of the OBW
 4. VBW = Approximately 3 x RBW
 5. Steps 1) through 4) might require iterations to adjust within the specified range
 6. Detector Mode = Max Peak
 7. Trace Mode = Max Hold
- b) Allow the trace to stabilize.
- c) Use the 99% power bandwidth function of the EMI receiver.

Average Conducted Output Power

C63.10-2013 section 11.9.2.3.2:

- a) The antenna port of the EUT was connected to the input of a gated RF average power meter. The gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level.
- b) The average conducted output power was recorded.

Average Power Spectral Density (Duty Cycle $\geq$ 98%)

C63.10-2013 section 11.10.3

- a) The following settings were employed on the EMI Test Receiver:
 1. Center Frequency = Transmit Frequency of the EUT
 2. Frequency Span = At least 1.5 times the OBW
 3. RBW = $3\text{kHz} \leq \text{RBW} \leq 100\text{kHz}$
 4. VBW $\geq 3 \times \text{RBW}$
 5. Detector Mode = RMS
 6. Number of Measurement Points $\geq 2 \times \text{span/RBW}$

7. Sweep Time = Auto Couple
8. Employ RMS mode over a minimum of 100 traces

- b) Use the peak marker function to determine the maximum amplitude level within the RBW.
- c) If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat.

Low Band Edge

C63.10-2013 section 11.11:

a) Reference Level Measurement

1. Start Frequency = 2400MHz
2. Stop Frequency = 2483.5MHz
3. RBW = 100kHz
4. VBW $\geq 3 \times$ RBW
5. Detector Mode = Max Peak
6. Trace Mode = Max Hold
7. Sweep Time = Auto

- b) Allow the trace to stabilize
- c) Use the peak marker function to determine the maximum level

d) Emission Level Measurement

1. Start Frequency = 2310MHz
2. Stop Frequency = 2400MHz
3. RBW = 100kHz
4. VBW $\geq 3 \times$ RBW
5. Detector Mode = Max Peak
6. Trace Mode = Max Hold
7. Sweep Time = Auto

- e) Allow the trace to stabilize
- f) Use the peak marker function to determine the maximum level
- g) The two sweeps were combined and plotted.
- h) Ensure that the amplitude of all unwanted emissions is attenuated by at least the minimum requirements.

High Band Edge

- 1) The EUT was set to transmit continuously at the channel closest to the high band-edge.
- 2) A double ridged waveguide was placed 3 meters away from the EUT. The antenna was connected to the input of a spectrum analyzer.
- 3) The center frequency of the analyzer was set to the high band edge (2483.5MHz)
- 4) The resolution bandwidth was set to 1MHz.
- 5) To ensure that the maximum or worst case emission level was measured, the following steps were taken:
 - a. The EUT was rotated so that all of its sides were exposed to the receiving antenna.
 - b. Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.
 - c. The measuring antenna was raised and lowered from 1 to 4 meters for each antenna polarization to maximize the readings.
- 6) The highest measured peak reading was recorded.

The highest measured average reading was recorded.

Duty Cycle Correction Factor

C63.10-2013 section 11.6

a) The following settings were employed on the EMI Test Receiver:

1. Center Frequency = Transmit Frequency of the EUT
2. Frequency Span = 0Hz
3. RBW $\geq$ OBW if possible; otherwise set RBW as large as possible
4. VBW $\geq$ RBW
5. Detector Mode = Peak or RMS
6. Number of Measurement Points $\geq 2 \times \text{span/RBW}$

b) Measure the ON and OFF times of the transmitted signal

c) Duty Cycle (D) = ((ON TIME)/((ON TIME) + (OFF TIME)))

EIRP

The EUT was placed on a 1.5 meter high non-conductive stand and set to transmit. A double ridged waveguide antenna was placed at a test distance of 3 meters from the EUT. The resolution bandwidth (RBW) of the spectrum analyzer was set to greater than the 6dB bandwidth. The EUT was maximized for worst case emissions (or maximum output power) at the measuring antenna. The maximum meter reading was recorded.

The equivalent power was determined from the field intensity levels measured at 3 meters using the substitution method. To determine the emission power, a double ridged waveguide antenna was then set in place of the EUT and connected to a calibrated signal generator. The output of the signal generator was adjusted to match the received level at the spectrum analyzer. The signal level was recorded. The reading was then corrected to compensate for cable loss and antenna gain.

Since a quasi-peak detector and an average detector requires a long integration times, it is not practical to automatically sweep through the quasi-peak and average levels. Therefore, radiated emissions from the EUT were first scanned using a peak detector and automatically plotted. The frequencies where significant emission levels were noted were then re-measured using the quasi-peak detector or average detector.

The broadband measuring antenna was positioned at a 3 meter distance from the EUT. The frequency range from 30MHz to 1GHz was investigated using a peak detector function with the bilog antenna at several heights, horizontal and vertical polarization, and with several different orientations of the EUT with respect to the antenna. The frequency range from 1GHz to 25GHz was investigated using a peak detector function with the double ridged waveguide antenna at several heights, horizontal and vertical polarization, and with several different orientations of the EUT with respect to the antenna. The maximum levels for each antenna polarization were plotted.

Final radiated emissions were performed on all significant broadband and narrowband emissions found in the exploratory sweeps using the following methods:

- 1) Measurements from 30MHz to 1GHz were made using a quasi-peak detector and a broadband bilog antenna. Measurements above 1GHz were made using an average detector and a broadband double ridged waveguide antenna.
- 2) To ensure that maximum or worst case, emission levels were measured, the following steps were taken:
 - a) The EUT was rotated so that all sides were exposed to the receiving antenna.
 - b) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.
 - c) The measuring antenna was raised and lowered from 1 to 4 meters for each antenna polarization to maximize the readings.
 - d) For hand-held or body-worn devices, the EUT was rotated through three orthogonal axes to determine which orientation produces the highest emission relative to the limit.

FCC Part 47 §15.247 2400-2483.5 MHz 2018

DUT Information

DUT Name:	Trackwear Sensor; Part Number: 580-2222-01
Manufacturer:	Caterpillar Inc.
Serial Number:	None Given
Hardware Rev:	None Given
Software Rev:	None Given
Comment:	

Frequencies

BLE Low Channel (2402 MHz)	BLE Mid Channel (2440 MHz)	BLE High Channel (2480 MHz)
----------------------------	----------------------------	-----------------------------

Bandwidths

2 MHz (2 MHz)

Power

0.000 dBm (4 dBm)

Beamforming Gain

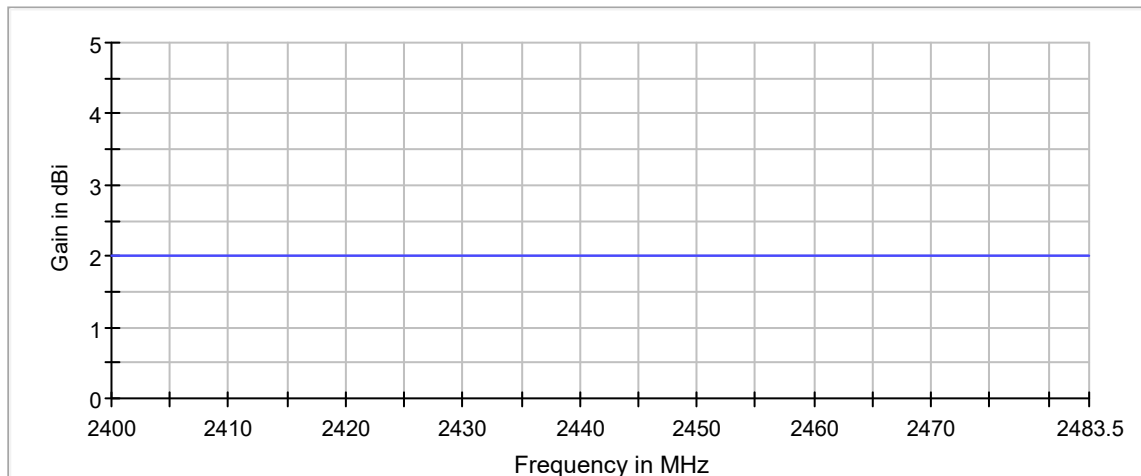
0.000 dBm (4 dBm) ---

Gain Tables

0.000 dBm (4 dBm) Port 1: Track Wear Antenna Gain;

DUT Settings

No. of transmission chains	1
Equipment Type	Other
Digital Modulation	Yes
Frequency Hopping	No



— Gaintable: Track Wear Antenna Gain — Gaintable: Track Wear Antenna Gain

Hardware Setup: WMS Measurements\TS8997

Spectrum Analyzer: SA ESW 44 (SA ESW 44) @ VISA (ADR
TCPIP::192.168.48.148::inst0::instr), SN 1328.4100K44/101533, FW
1.50 SP1

Vector Generator: VG SMBV100A (VG SMBV100A) @ VISA (ADR
TCPIP::192.168.48.149::inst0::instr), SN 260452, FW 3.1.18.2-
3.01.130.48.1

Generator: SMB100A (SMB100A) @ VISA (ADR
TCPIP::192.168.48.150::inst0::instr)

OSP: OSP-B157W (OSP-B157W) @ VISA (ADR
TCPIP::192.168.48.157::inst0::instr), SN 1527.1144. /, FW 1.24.0.10

Summary

Test	Frequency (MHz)	Nominal Power (dBm)	Nominal Bandwidth (MHz)	Result
Emission Bandwidth 20 dB	2402.000	4.0	2.000000	PASS
Minimum Emission Bandwidth 6 dB	2402.000	4.0	2.000000	PASS
Peak output power (Sweep)	2402.000	4.0	2.000000	PASS
Peak output power (ZeroSpan)	2402.000	4.0	2.000000	PASS
RF output power	2402.000	4.0	2.000000	PASS
Peak Power Spectral Density	2402.000	4.0	2.000000	PASS
Power Spectral Density	2402.000	4.0	2.000000	PASS
Occupied Channel Bandwidth 99%	2402.000	4.0	2.000000	PASS
Band Edge low	2402.000	4.0	2.000000	PASS
Emission Bandwidth 20 dB	2440.000	4.0	2.000000	PASS
Minimum Emission Bandwidth 6 dB	2440.000	4.0	2.000000	PASS
Peak output power (Sweep)	2440.000	4.0	2.000000	PASS
Peak output power (ZeroSpan)	2440.000	4.0	2.000000	PASS
RF output power	2440.000	4.0	2.000000	PASS
Peak Power Spectral Density	2440.000	4.0	2.000000	PASS
Power Spectral Density	2440.000	4.0	2.000000	PASS
Occupied Channel Bandwidth 99%	2440.000	4.0	2.000000	PASS
Emission Bandwidth 20 dB	2480.000	4.0	2.000000	PASS
Minimum Emission Bandwidth 6 dB	2480.000	4.0	2.000000	PASS
Peak output power (Sweep)	2480.000	4.0	2.000000	PASS
Peak output power (ZeroSpan)	2480.000	4.0	2.000000	PASS
RF output power	2480.000	4.0	2.000000	PASS
Peak Power Spectral Density	2480.000	4.0	2.000000	PASS
Power Spectral Density	2480.000	4.0	2.000000	PASS
Occupied Channel Bandwidth 99%	2480.000	4.0	2.000000	PASS
Band Edge high	2480.000	4.0	2.000000	PASS

Emission Bandwidth 20 dB (2402 MHz; 0.000 dBm; 2 MHz)

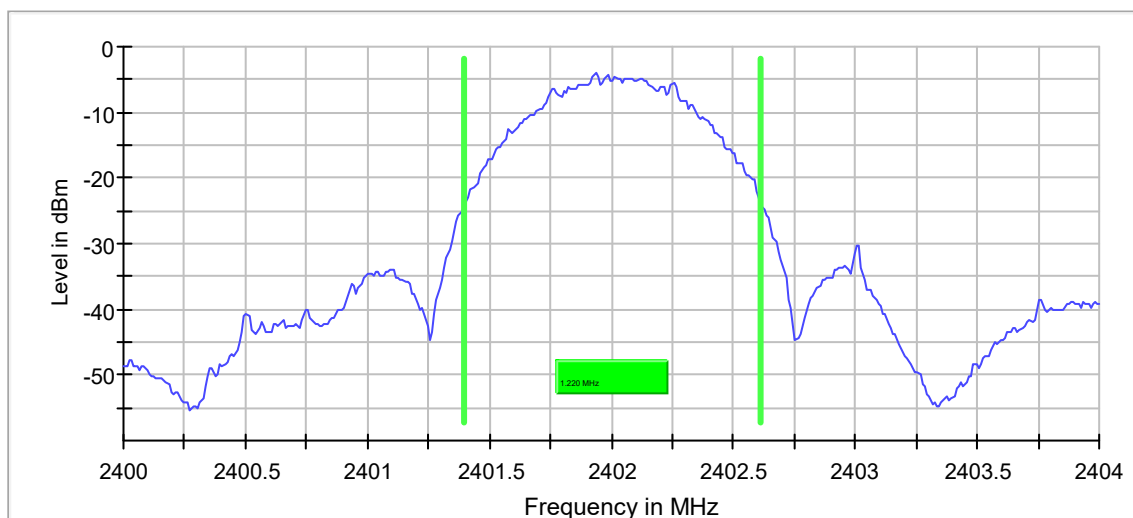
Test according to FCC title 47 part 15 §15.247(a), KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.8.1

20 dB Bandwidth

DUT Frequency (MHz)	Bandwidth (MHz)	Limit Min (MHz)	Limit Max (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)
2402.000000	1.220000	---	---	2401.395000	2402.615000

(continuation of the "20 dB Bandwidth" table from column 6 ...)

DUT Frequency (MHz)	Max Level (dBm)	Result
2402.000000	-4.0	PASS



Measurement

Setting	Instrument Value	Target Value
Start Frequency	2.40000 GHz	2.40000 GHz
Stop Frequency	2.40400 GHz	2.40400 GHz
Span	4.000 MHz	4.000 MHz
RBW	20.000 kHz	>= 20.000 kHz
VBW	100.000 kHz	>= 60.000 kHz
Sweep Points	400	~ 400
Sweep time	210.000 μ s	AUTO
Reference Level	0.000 dBm	0.000 dBm
Attenuation	15.000 dB	AUTO
Detector	MaxPeak	MaxPeak
Sweep Count	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweep type	FFT	AUTO
Preamp	off	off
Stable mode	Trace	Trace
Stable value	0.50 dB	0.50 dB
Run	49 / max. 150	max. 150
Stable	5 / 5	5
Max Stable Difference	0.09 dB	0.50 dB

Minimum Emission Bandwidth 6 dB (2402 MHz; 0.000 dBm; 2 MHz)

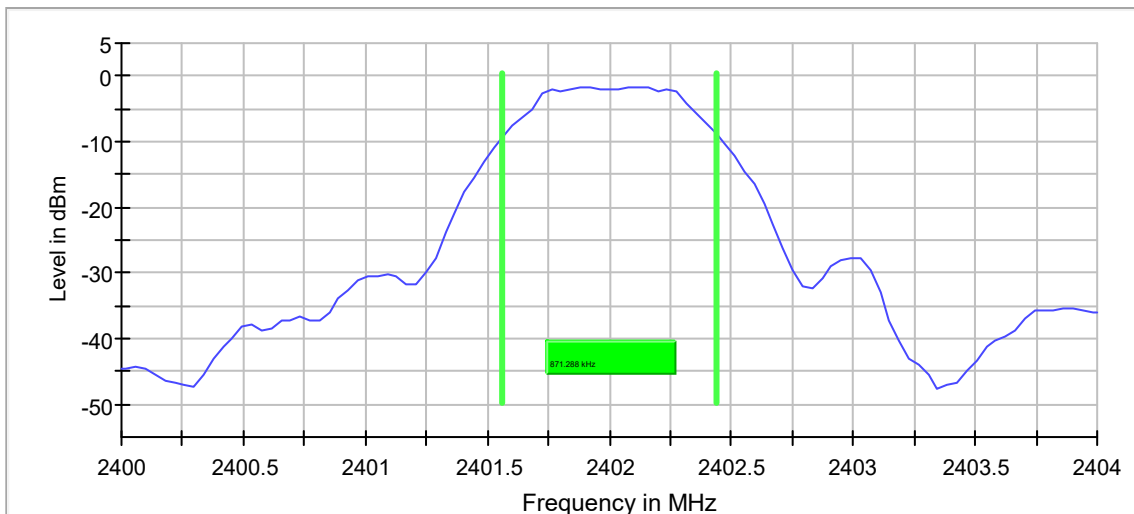
Test according to FCC title 47 part 15 §15.247(a), KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.8.1

6 dB Bandwidth

DUT Frequency (MHz)	Bandwidth (MHz)	Limit Min (MHz)	Limit Max (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)
2402.000000	0.871288	0.500000	---	2401.564356	2402.435644

(continuation of the "6 dB Bandwidth" table from column 6 ...)

DUT Frequency (MHz)	Max Level (dBm)	Result
2402.000000	-1.6	PASS



Measurement

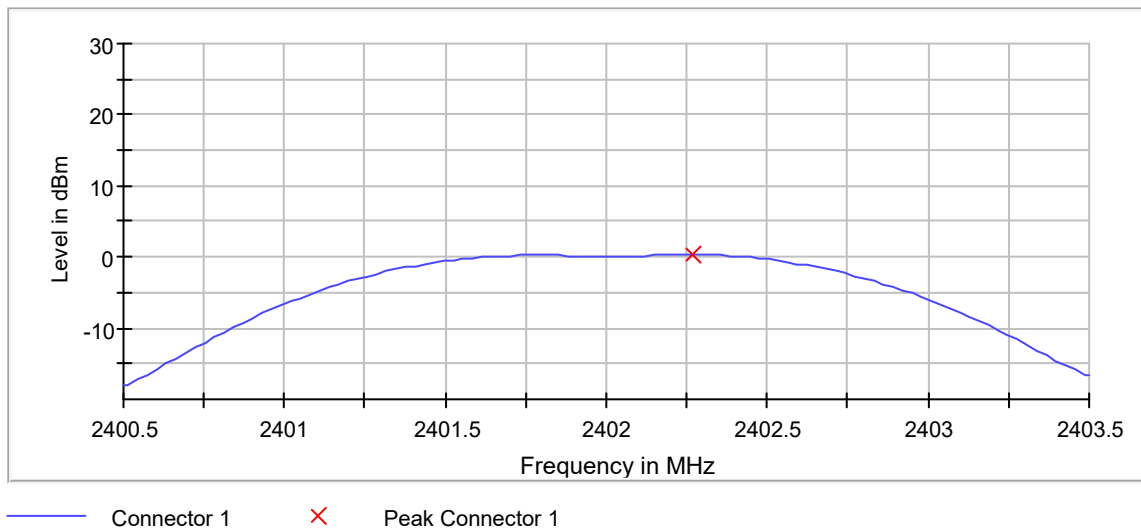
Setting	Instrument Value	Target Value
Start Frequency	2.40000 GHz	2.40000 GHz
Stop Frequency	2.40400 GHz	2.40400 GHz
Span	4.000 MHz	4.000 MHz
RBW	100.000 kHz	~ 100.000 kHz
VBW	300.000 kHz	~ 300.000 kHz
Sweep Points	101	~ 80
Sweep time	41.830 µs	AUTO
Reference Level	0.000 dBm	0.000 dBm
Attenuation	15.000 dB	AUTO
Detector	MaxPeak	MaxPeak
Sweep Count	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweep type	FFT	AUTO
Preamp	off	off
Stable mode	Trace	Trace
Stable value	0.50 dB	0.50 dB
Run	9 / max. 150	max. 150
Stable	5 / 5	5
Max Stable Difference	0.17 dB	0.50 dB

Peak output power (Sweep) (2402 MHz; 0.000 dBm; 2 MHz)

Test according to FCC title 47 part 15 §15.247(b), KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.9.1.1

Result

DUT Frequency (MHz)	Peak Power (dBm)	Limit Max (dBm)	Result
2402.000000	0.3	30.0	PASS



Measurement

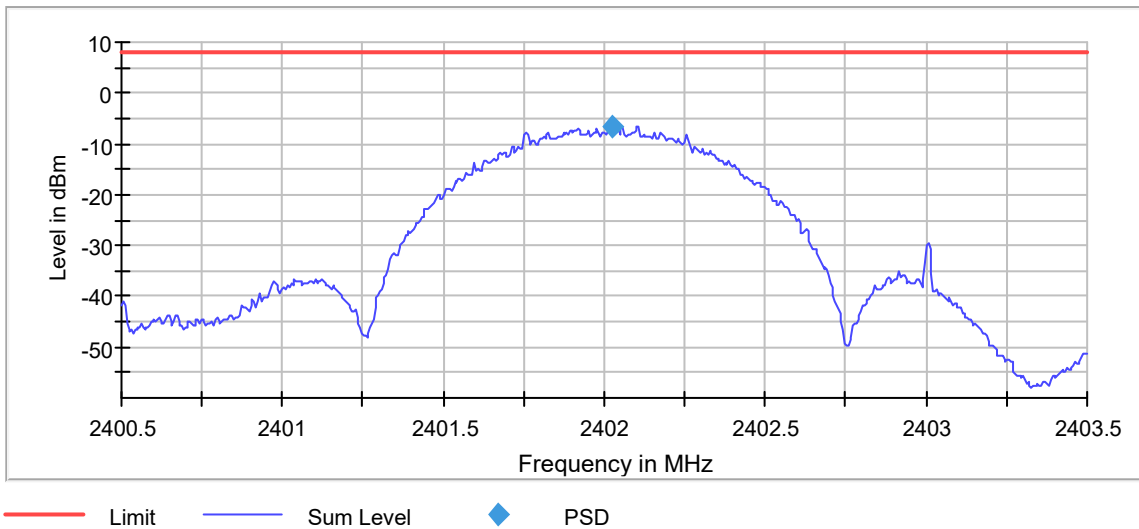
Setting	Instrument Value	Target Value
Start Frequency	2.40050 GHz	2.40050 GHz
Stop Frequency	2.40350 GHz	2.40350 GHz
Span	3.000 MHz	3.000 MHz
RBW	1.000 MHz	>= 871.289 kHz
VBW	3.000 MHz	>= 3.000 MHz
Sweep Points	101	~ 101
Sweep time	4.210 µs	AUTO
Reference Level	10.000 dBm	10.000 dBm
Attenuation	25.000 dB	AUTO
Detector	MaxPeak	MaxPeak
Sweep Count	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweep type	FFT	AUTO
Preamp	off	off
Stable mode	Trace	Trace
Stable value	0.50 dB	0.50 dB
Run	4 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.01 dB	0.50 dB

Peak Power Spectral Density (2402 MHz; 0.000 dBm; 2 MHz)

Test according to FCC title 47 part 15 §15.247(a),(e), KDB 558074 D01 DTS Meas Guidance v05 F and ANSI C63.10-2013

Result

DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
2402.000000	2402.027500	-6.656	8.0	PASS

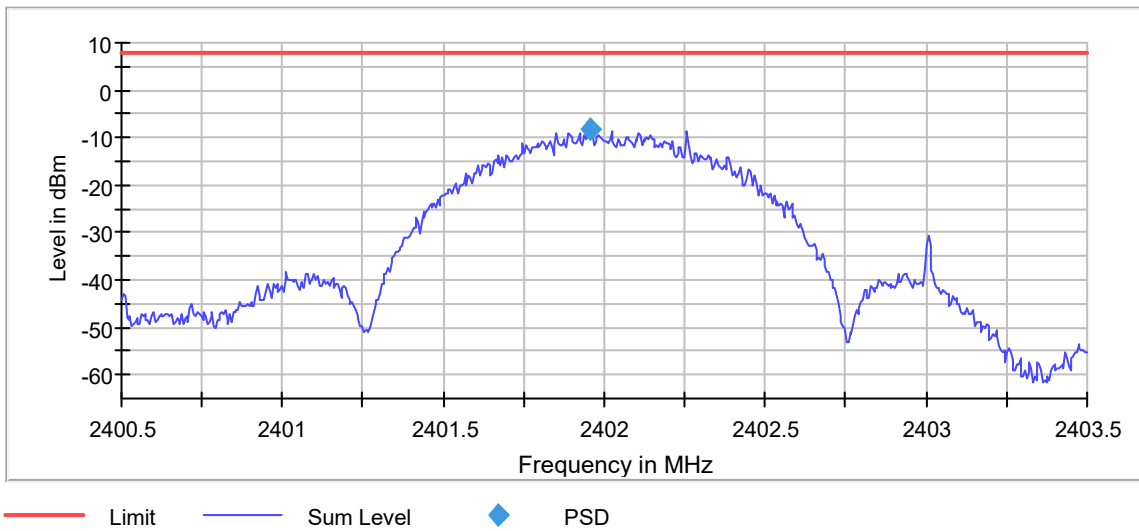


Power Spectral Density (2402 MHz; 0.000 dBm; 2 MHz)

Test according to FCC title 47 part 15 §15.247(a),(e), KDB 558074 D01 DTS Meas Guidance v05 F and ANSI C63.10-2013

Result

DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
2402.000000	2401.957500	-8.175	8.0	PASS



Measurement

Setting	Instrument Value	Target Value
Start Frequency	2.40050 GHz	2.40050 GHz
Stop Frequency	2.40350 GHz	2.40350 GHz
Span	3.000 MHz	3.000 MHz
RBW	10.000 kHz	<= 10.000 kHz
VBW	30.000 kHz	>= 30.000 kHz
Sweep Points	600	~ 600
Sweep time	12.000 ms	12.000 ms
Reference Level	-10.000 dBm	-10.000 dBm
Attenuation	5.000 dB	AUTO
Detector	RMS	RMS
Sweep Count	1	1
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweep type	Sweep	Sweep
Preamplifier	off	off
Stable mode	Trace	Trace
Stable value	0.50 dB	0.50 dB
Run	94 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.50 dB

Occupied Channel Bandwidth 99% (2402 MHz; 0.000 dBm; 2 MHz)

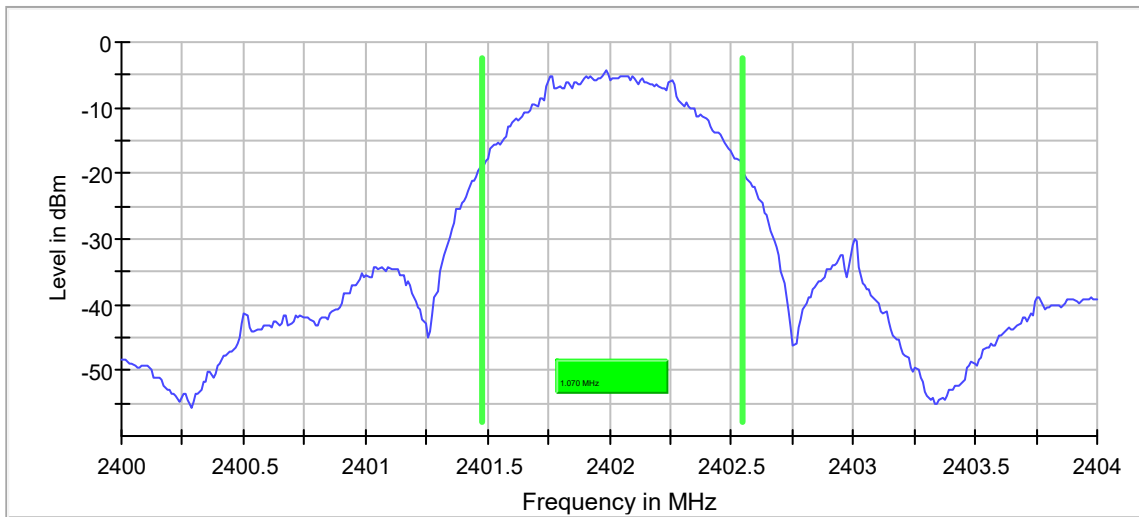
Test according to FCC title 47 part 15 §15.247(a), KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.8.1

99 % Bandwidth

DUT Frequency (MHz)	Bandwidth (MHz)	Limit Min (MHz)	Limit Max (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)
2402.000000	1.070000	---	---	2401.475000	2402.545000

(continuation of the "99 % Bandwidth" table from column 6 ...)

DUT Frequency (MHz)	Result
2402.000000	PASS



Measurement

Setting	Instrument Value	Target Value
Start Frequency	2.40000 GHz	2.40000 GHz
Stop Frequency	2.40400 GHz	2.40400 GHz
Span	4.000 MHz	4.000 MHz
RBW	20.000 kHz	≥ 20.000 kHz
VBW	100.000 kHz	≥ 60.000 kHz
Sweep Points	400	~ 400
Sweep time	210.000 μ s	AUTO
Reference Level	-10.000 dBm	-10.000 dBm
Attenuation	5.000 dB	AUTO
Detector	MaxPeak	MaxPeak
Sweep Count	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweep type	FFT	AUTO
Preamp	off	off
Stable mode	Trace	Trace
Stable value	0.30 dB	0.30 dB
Run	34 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.10 dB	0.30 dB

Band Edge low (2402 MHz; 0.000 dBm; 2 MHz)

Test according to FCC title 47 part 15 §15.247(d), KDB 558074 D01 DTS Meas Guidance v05 8.7 and ANSI C63.10-2013

Result

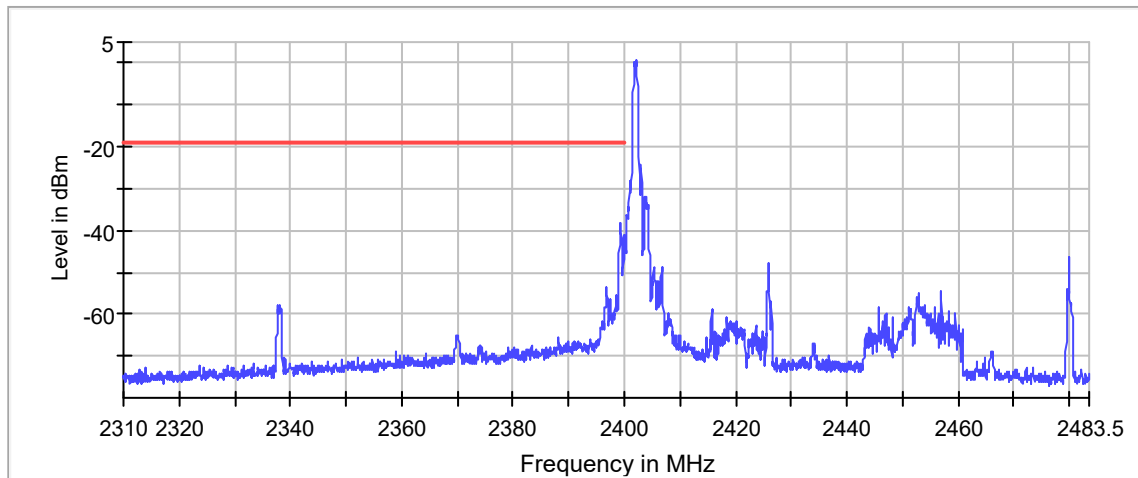
DUT Frequency (MHz)	Result
2402.000000	PASS

Inband Peak

Frequency (MHz)	Level (dBm)
2402.225000	0.8

Measurements

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.225000	-38.2	19.0	-19.2	PASS
2399.275000	-38.3	19.1	-19.2	PASS
2399.325000	-39.9	20.7	-19.2	PASS
2399.375000	-40.2	21.0	-19.2	PASS
2399.425000	-40.9	21.6	-19.2	PASS
2399.175000	-40.9	21.7	-19.2	PASS
2399.975000	-41.0	21.8	-19.2	PASS
2399.475000	-42.1	22.8	-19.2	PASS
2399.925000	-42.2	22.9	-19.2	PASS
2399.525000	-42.5	23.2	-19.2	PASS
2399.125000	-43.6	24.3	-19.2	PASS
2399.875000	-44.3	25.1	-19.2	PASS
2399.575000	-44.3	25.1	-19.2	PASS
2399.075000	-45.3	26.0	-19.2	PASS
2399.625000	-46.3	27.0	-19.2	PASS



— Limit — Sum Level × Fail

Measurement 1

Setting	Instrument Value	Target Value
Start Frequency	2.31000 GHz	2.31000 GHz
Stop Frequency	2.40000 GHz	2.40000 GHz
Span	90.000 MHz	90.000 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
Sweep Points	1800	~ 1800
Sweep time	1.800 ms	AUTO
Reference Level	0.000 dBm	0.000 dBm
Attenuation	15.000 dB	AUTO
Detector	MaxPeak	MaxPeak
Sweep Count	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweep type	Sweep	AUTO
Preamp	off	off
Stable mode	Trace	Trace
Stable value	0.50 dB	0.50 dB
Run	7 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.50 dB

Measurement 2

Setting	Instrument Value	Target Value
Start Frequency	2.40000 GHz	2.40000 GHz
Stop Frequency	2.48350 GHz	2.48350 GHz
Span	83.500 MHz	83.500 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
Sweep Points	1670	~ 1670
Sweep time	1.670 ms	AUTO
Reference Level	0.000 dBm	0.000 dBm
Attenuation	15.000 dB	AUTO
Detector	MaxPeak	MaxPeak
Sweep Count	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweep type	Sweep	AUTO
Preamp	off	off
Stable mode	Trace	Trace
Stable value	0.50 dB	0.50 dB
Run	5 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.39 dB	0.50 dB

Emission Bandwidth 20 dB (2440 MHz; 0.000 dBm; 2 MHz)

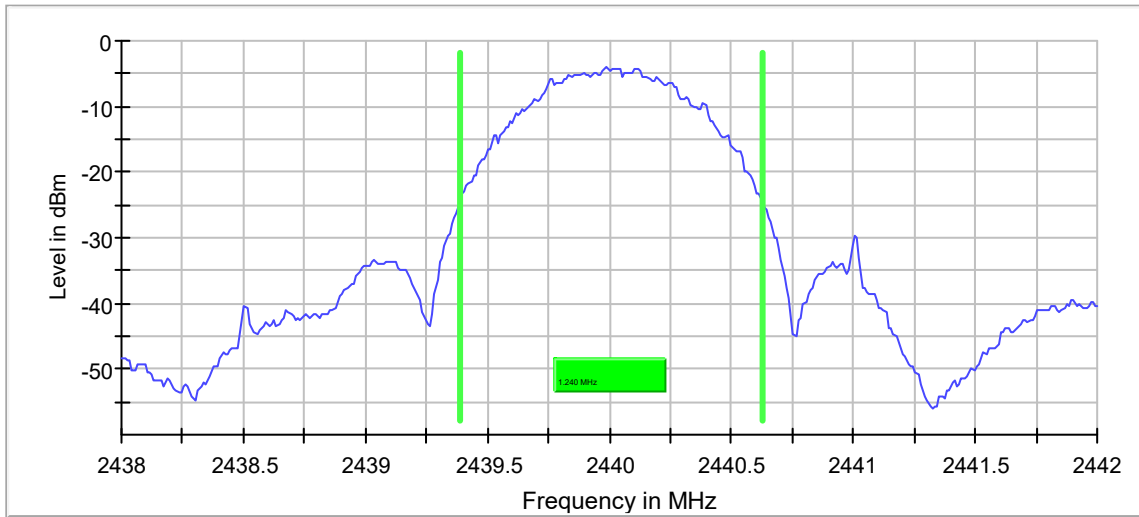
Test according to FCC title 47 part 15 §15.247(a), KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.8.1

20 dB Bandwidth

DUT Frequency (MHz)	Bandwidth (MHz)	Limit Min (MHz)	Limit Max (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)
2440.000000	1.240000	---	---	2439.385000	2440.625000

(continuation of the "20 dB Bandwidth" table from column 6 ...)

DUT Frequency (MHz)	Max Level (dBm)	Result
2440.000000	-3.8	PASS



Measurement

Setting	Instrument Value	Target Value
Start Frequency	2.43800 GHz	2.43800 GHz
Stop Frequency	2.44200 GHz	2.44200 GHz
Span	4.000 MHz	4.000 MHz
RBW	20.000 kHz	>= 20.000 kHz
VBW	100.000 kHz	>= 60.000 kHz
Sweep Points	400	~ 400
Sweep time	210.000 μ s	AUTO
Reference Level	-10.000 dBm	-10.000 dBm
Attenuation	5.000 dB	AUTO
Detector	MaxPeak	MaxPeak
Sweep Count	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweep type	FFT	AUTO
Preamplifier	off	off
Stable mode	Trace	Trace
Stable value	0.50 dB	0.50 dB
Run	28 / max. 150	max. 150
Stable	5 / 5	5
Max Stable Difference	0.19 dB	0.50 dB

Minimum Emission Bandwidth 6 dB (2440 MHz; 0.000 dBm; 2 MHz)

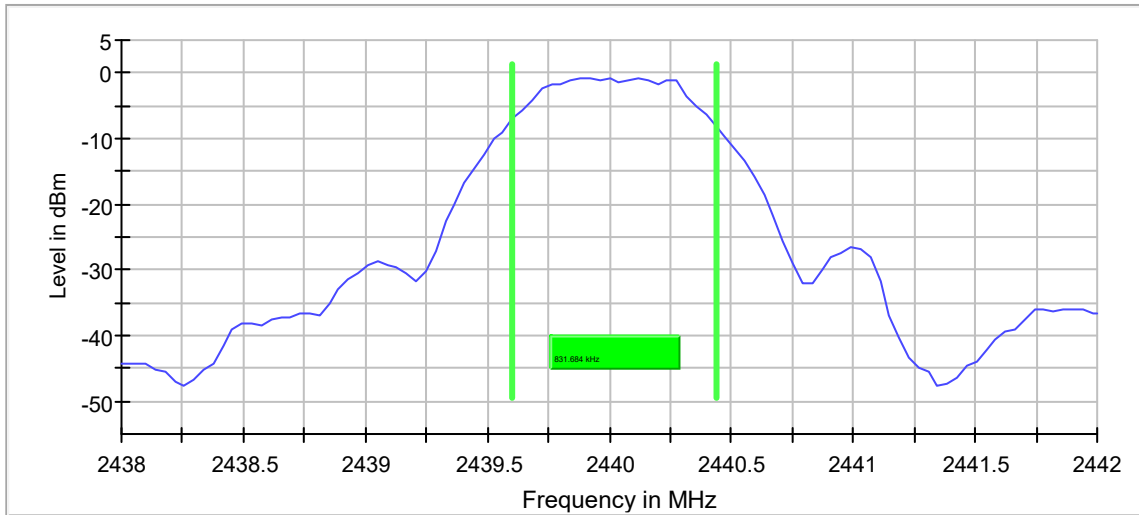
Test according to FCC title 47 part 15 §15.247(a), KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.8.1

6 dB Bandwidth

DUT Frequency (MHz)	Bandwidth (MHz)	Limit Min (MHz)	Limit Max (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)
2440.000000	0.831684	0.500000	---	2439.603960	2440.435644

(continuation of the "6 dB Bandwidth" table from column 6 ...)

DUT Frequency (MHz)	Max Level (dBm)	Result
2440.000000	-0.7	PASS



Measurement

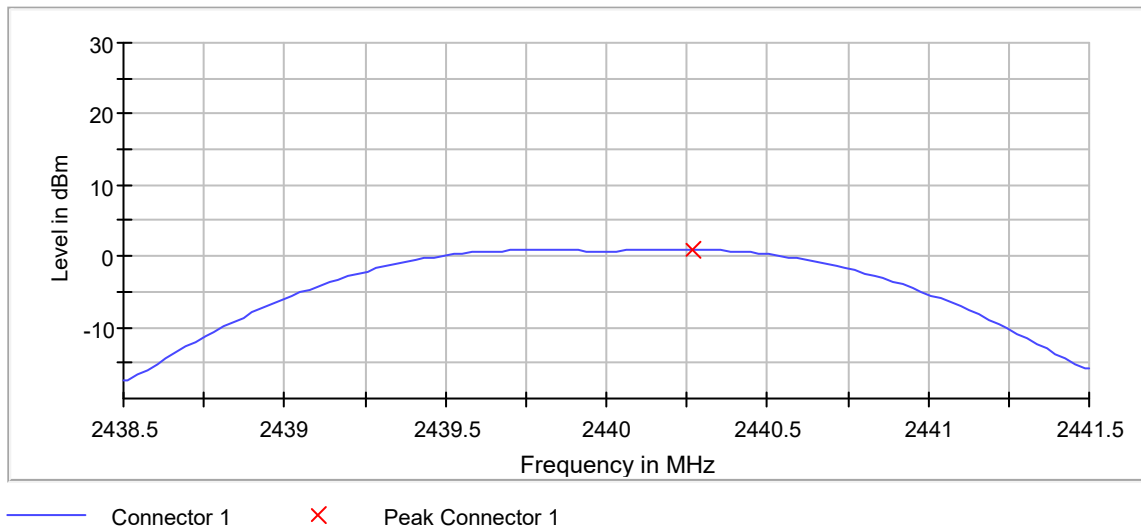
Setting	Instrument Value	Target Value
Start Frequency	2.43800 GHz	2.43800 GHz
Stop Frequency	2.44200 GHz	2.44200 GHz
Span	4.000 MHz	4.000 MHz
RBW	100.000 kHz	~ 100.000 kHz
VBW	300.000 kHz	~ 300.000 kHz
Sweep Points	101	~ 80
Sweep time	41.830 μ s	AUTO
Reference Level	-10.000 dBm	-10.000 dBm
Attenuation	5.000 dB	AUTO
Detector	MaxPeak	MaxPeak
Sweep Count	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweep type	FFT	AUTO
Preamp	off	off
Stable mode	Trace	Trace
Stable value	0.50 dB	0.50 dB
Run	15 / max. 150	max. 150
Stable	5 / 5	5
Max Stable Difference	0.02 dB	0.50 dB

Peak output power (Sweep) (2440 MHz; 0.000 dBm; 2 MHz)

Test according to FCC title 47 part 15 §15.247(b), KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.9.1.1

Result

DUT Frequency (MHz)	Peak Power (dBm)	Limit Max (dBm)	Result
2440.000000	0.9	30.0	PASS



Measurement

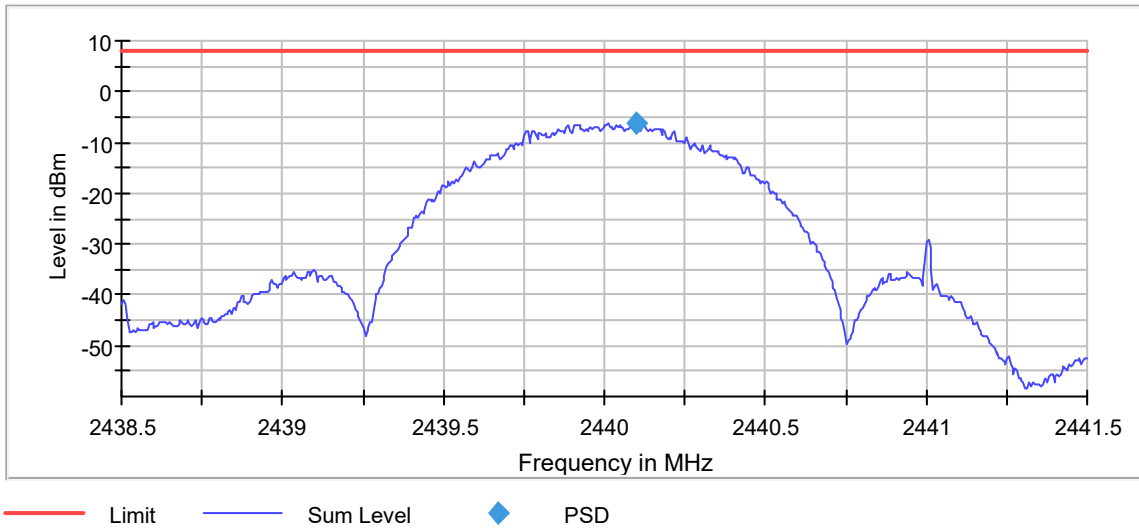
Setting	Instrument Value	Target Value
Start Frequency	2.43850 GHz	2.43850 GHz
Stop Frequency	2.44150 GHz	2.44150 GHz
Span	3.000 MHz	3.000 MHz
RBW	1.000 MHz	≥ 831.685 kHz
VBW	3.000 MHz	≥ 3.000 MHz
Sweep Points	101	~ 101
Sweep time	4.210 μ s	AUTO
Reference Level	10.000 dBm	10.000 dBm
Attenuation	25.000 dB	AUTO
Detector	MaxPeak	MaxPeak
Sweep Count	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweep type	FFT	AUTO
Preamplifier	off	off
Stable mode	Trace	Trace
Stable value	0.50 dB	0.50 dB
Run	4 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.01 dB	0.50 dB

Peak Power Spectral Density (2440 MHz; 0.000 dBm; 2 MHz)

Test according to FCC title 47 part 15 §15.247(a),(e), KDB 558074 D01 DTS Meas Guidance v05 F and ANSI C63.10-2013

Result

DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
2440.000000	2440.102500	-6.103	8.0	PASS



Occupied Channel Bandwidth 99% (2440 MHz; 0.000 dBm; 2 MHz)

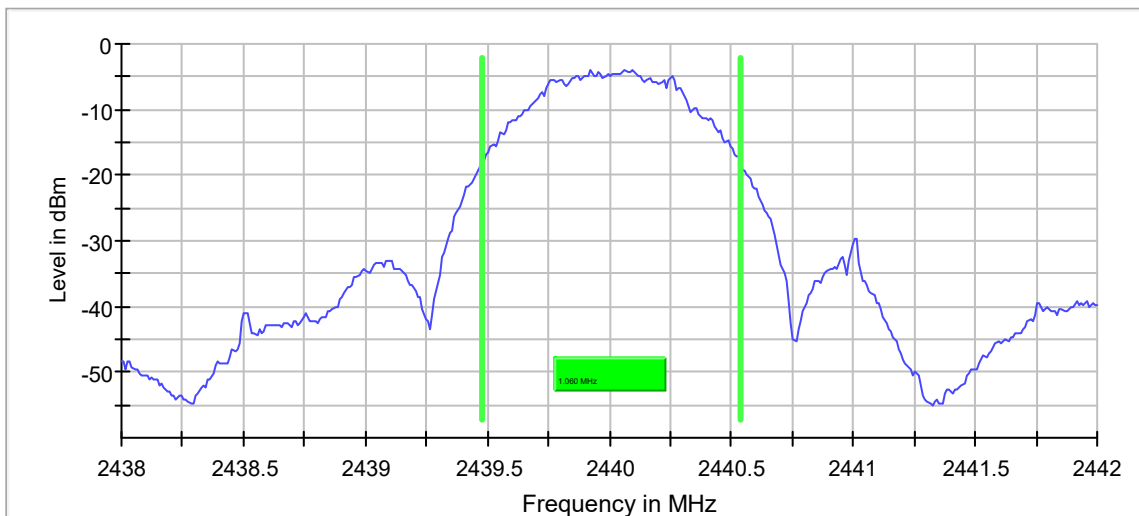
Test according to FCC title 47 part 15 §15.247(a), KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.8.1

99 % Bandwidth

DUT Frequency (MHz)	Bandwidth (MHz)	Limit Min (MHz)	Limit Max (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)
2440.000000	1.060000	---	---	2439.475000	2440.535000

(continuation of the "99 % Bandwidth" table from column 6 ...)

DUT Frequency (MHz)	Result
2440.000000	PASS



Measurement

Setting	Instrument Value	Target Value
Start Frequency	2.43800 GHz	2.43800 GHz
Stop Frequency	2.44200 GHz	2.44200 GHz
Span	4.000 MHz	4.000 MHz
RBW	20.000 kHz	>= 20.000 kHz
VBW	100.000 kHz	>= 60.000 kHz
Sweep Points	400	~ 400
Sweep time	210.000 μ s	AUTO
Reference Level	-10.000 dBm	-10.000 dBm
Attenuation	5.000 dB	AUTO
Detector	MaxPeak	MaxPeak
Sweep Count	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweep type	FFT	AUTO
Preamp	off	off
Stable mode	Trace	Trace
Stable value	0.30 dB	0.30 dB
Run	39 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.30 dB

Emission Bandwidth 20 dB (2480 MHz; 0.000 dBm; 2 MHz)

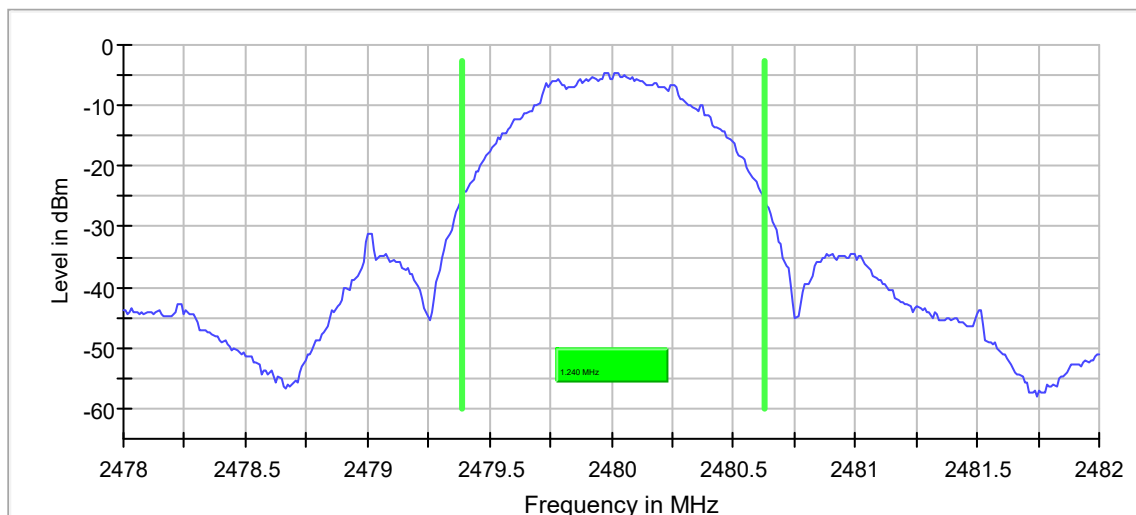
Test according to FCC title 47 part 15 §15.247(a), KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.8.1

20 dB Bandwidth

DUT Frequency (MHz)	Bandwidth (MHz)	Limit Min (MHz)	Limit Max (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)
2480.000000	1.240000	---	---	2479.385000	2480.625000

(continuation of the "20 dB Bandwidth" table from column 6 ...)

DUT Frequency (MHz)	Max Level (dBm)	Result
2480.000000	-4.6	PASS



Measurement

Setting	Instrument Value	Target Value
Start Frequency	2.47800 GHz	2.47800 GHz
Stop Frequency	2.48200 GHz	2.48200 GHz
Span	4.000 MHz	4.000 MHz
RBW	20.000 kHz	>= 20.000 kHz
VBW	100.000 kHz	>= 60.000 kHz
Sweep Points	400	~ 400
Sweep time	210.000 μ s	AUTO
Reference Level	-10.000 dBm	-10.000 dBm
Attenuation	5.000 dB	AUTO
Detector	MaxPeak	MaxPeak
Sweep Count	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweep type	FFT	AUTO
Preamplifier	off	off
Stable mode	Trace	Trace
Stable value	0.50 dB	0.50 dB
Run	35 / max. 150	max. 150
Stable	5 / 5	5
Max Stable Difference	0.00 dB	0.50 dB

Minimum Emission Bandwidth 6 dB (2480 MHz; 0.000 dBm; 2 MHz)

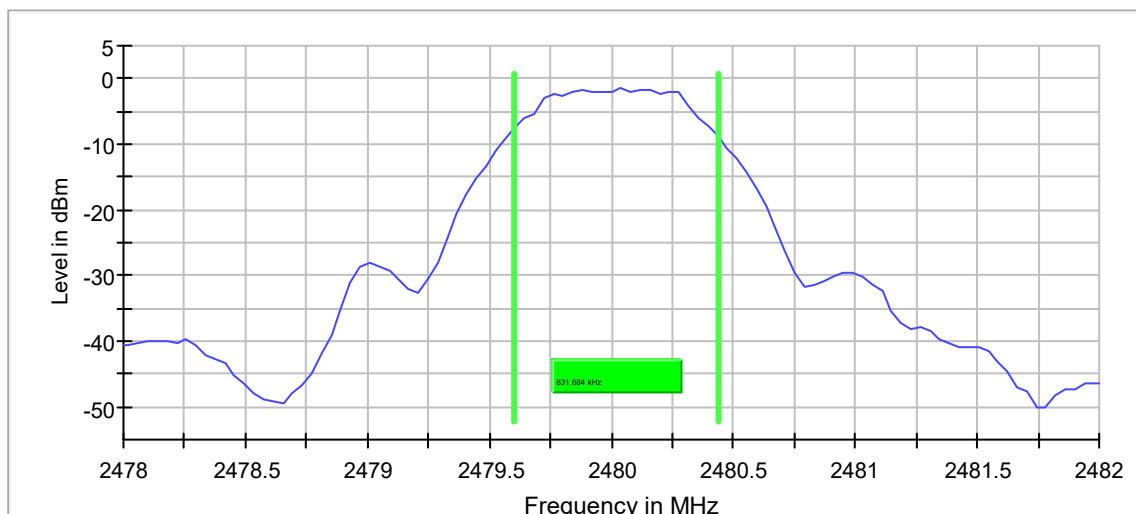
Test according to FCC title 47 part 15 §15.247(a), KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.8.1

6 dB Bandwidth

DUT Frequency (MHz)	Bandwidth (MHz)	Limit Min (MHz)	Limit Max (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)
2480.000000	0.831684	0.500000	---	2479.603960	2480.435644

(continuation of the "6 dB Bandwidth" table from column 6 ...)

DUT Frequency (MHz)	Max Level (dBm)	Result
2480.000000	-1.4	PASS



Measurement

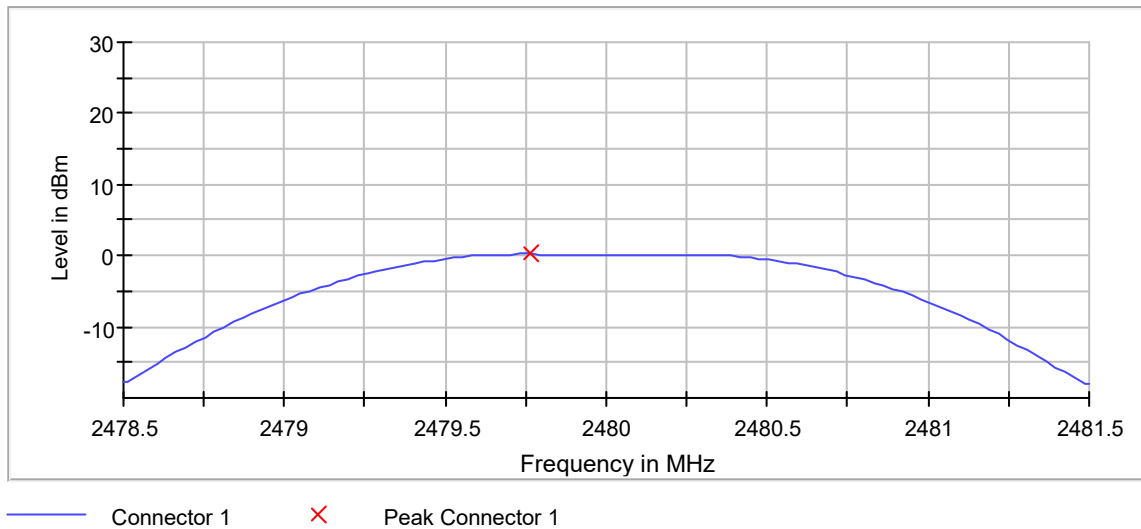
Setting	Instrument Value	Target Value
Start Frequency	2.47800 GHz	2.47800 GHz
Stop Frequency	2.48200 GHz	2.48200 GHz
Span	4.000 MHz	4.000 MHz
RBW	100.000 kHz	~ 100.000 kHz
VBW	300.000 kHz	~ 300.000 kHz
Sweep Points	101	~ 80
Sweep time	41.830 μ s	AUTO
Reference Level	-10.000 dBm	-10.000 dBm
Attenuation	5.000 dB	AUTO
Detector	MaxPeak	MaxPeak
Sweep Count	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweep type	FFT	AUTO
Preamplifier	off	off
Stable mode	Trace	Trace
Stable value	0.50 dB	0.50 dB
Run	12 / max. 150	max. 150
Stable	5 / 5	5
Max Stable Difference	0.19 dB	0.50 dB

Peak output power (Sweep) (2480 MHz; 0.000 dBm; 2 MHz)

Test according to FCC title 47 part 15 §15.247(b), KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.9.1.1

Result

DUT Frequency (MHz)	Peak Power (dBm)	Limit Max (dBm)	Result
2480.000000	0.2	30.0	PASS



Measurement

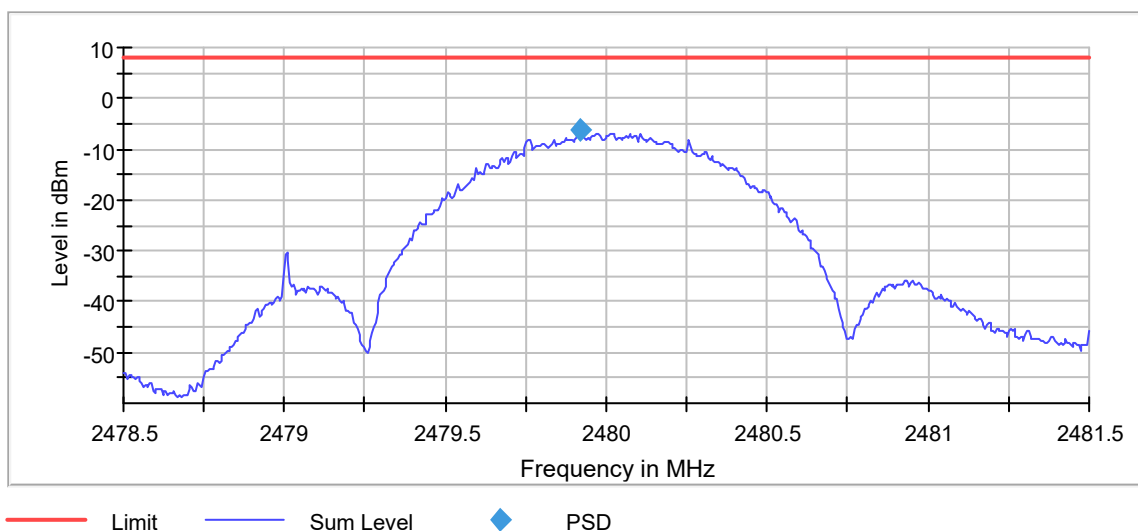
Setting	Instrument Value	Target Value
Start Frequency	2.47850 GHz	2.47850 GHz
Stop Frequency	2.48150 GHz	2.48150 GHz
Span	3.000 MHz	3.000 MHz
RBW	1.000 MHz	≥ 831.685 kHz
VBW	3.000 MHz	≥ 3.000 MHz
Sweep Points	101	~ 101
Sweep time	4.210 μ s	AUTO
Reference Level	10.000 dBm	10.000 dBm
Attenuation	25.000 dB	AUTO
Detector	MaxPeak	MaxPeak
Sweep Count	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweep type	FFT	AUTO
Preamp	off	off
Stable mode	Trace	Trace
Stable value	0.50 dB	0.50 dB
Run	4 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.23 dB	0.50 dB

Peak Power Spectral Density (2480 MHz; 0.000 dBm; 2 MHz)

Test according to FCC title 47 part 15 §15.247(a),(e), KDB 558074 D01 DTS Meas Guidance v05 F and ANSI C63.10-2013

Result

DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
2480.000000	2479.917500	-6.178	8.0	PASS

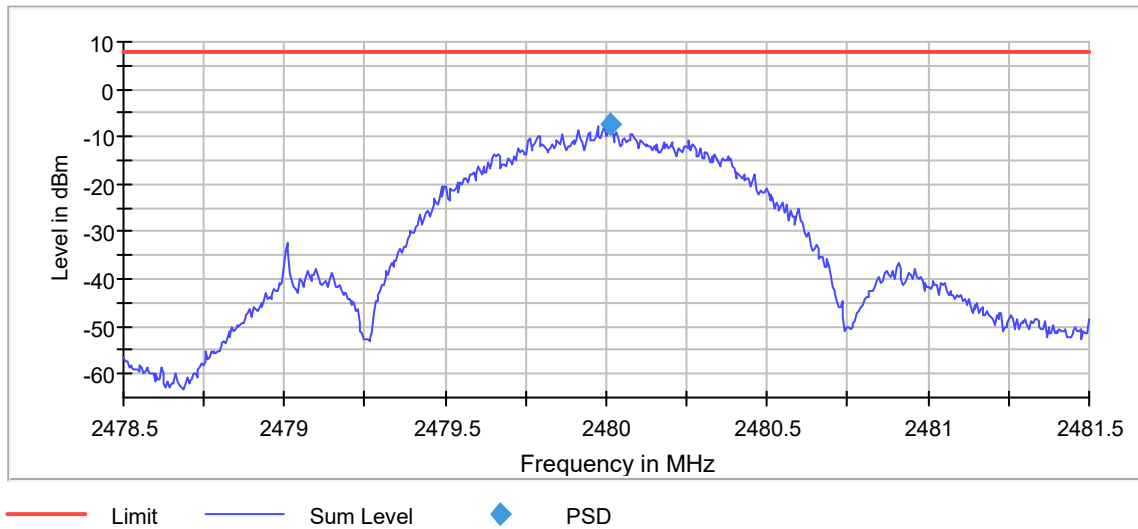


Power Spectral Density (2480 MHz; 0.000 dBm; 2 MHz)

Test according to FCC title 47 part 15 §15.247(a),(e), KDB 558074 D01 DTS Meas Guidance v05 F and ANSI C63.10-2013

Result

DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
2480.000000	2480.012500	-7.485	8.0	PASS



Measurement

Setting	Instrument Value	Target Value
Start Frequency	2.47850 GHz	2.47850 GHz
Stop Frequency	2.48150 GHz	2.48150 GHz
Span	3.000 MHz	3.000 MHz
RBW	10.000 kHz	<= 10.000 kHz
VBW	30.000 kHz	>= 30.000 kHz
Sweep Points	600	~ 600
Sweep time	12.000 ms	12.000 ms
Reference Level	-10.000 dBm	-10.000 dBm
Attenuation	5.000 dB	AUTO
Detector	RMS	RMS
Sweep Count	1	1
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweep type	Sweep	Sweep
Preamp	off	off
Stable mode	Trace	Trace
Stable value	0.50 dB	0.50 dB
Run	88 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.50 dB

Occupied Channel Bandwidth 99% (2480 MHz; 0.000 dBm; 2 MHz)

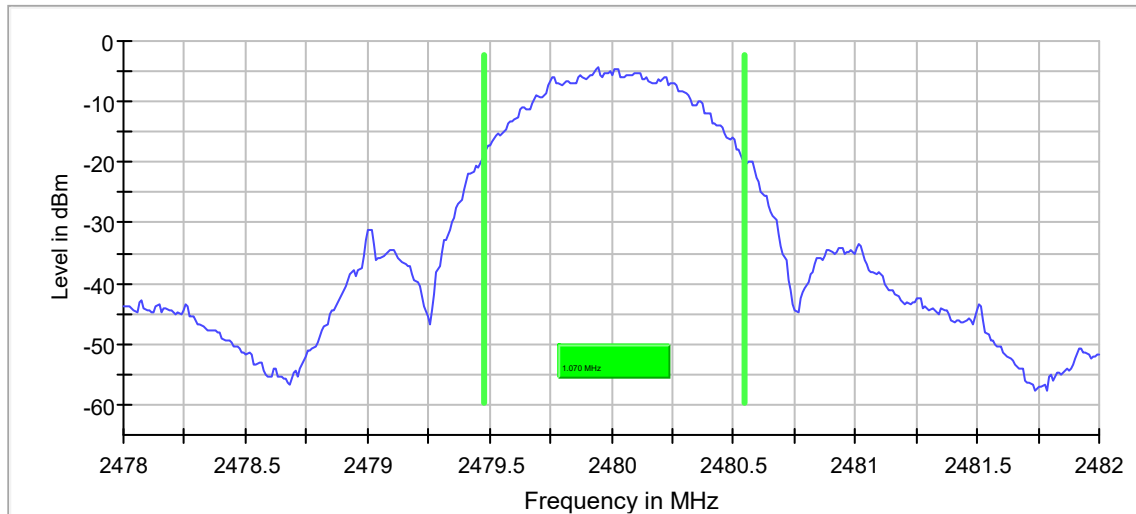
Test according to FCC title 47 part 15 §15.247(a), KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.8.1

99 % Bandwidth

DUT Frequency (MHz)	Bandwidth (MHz)	Limit Min (MHz)	Limit Max (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)
2480.000000	1.070000	---	---	2479.475000	2480.545000

(continuation of the "99 % Bandwidth" table from column 6 ...)

DUT Frequency (MHz)	Result
2480.000000	PASS



Measurement

Setting	Instrument Value	Target Value
Start Frequency	2.47800 GHz	2.47800 GHz
Stop Frequency	2.48200 GHz	2.48200 GHz
Span	4.000 MHz	4.000 MHz
RBW	20.000 kHz	>= 20.000 kHz
VBW	100.000 kHz	>= 60.000 kHz
Sweep Points	400	~ 400
Sweep time	210.000 µs	AUTO
Reference Level	-10.000 dBm	-10.000 dBm
Attenuation	5.000 dB	AUTO
Detector	MaxPeak	MaxPeak
Sweep Count	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweep type	FFT	AUTO
Preamp	off	off
Stable mode	Trace	Trace
Stable value	0.30 dB	0.30 dB
Run	30 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.30 dB

Manufacturer : Caterpillar Inc.
 Test Item : Trackwear Sensor
 Model/Part Number No. : 580-2222-01
 Mode : Transmit at 2402MHz
 Test Specification : FCC-15.247, RSS-247 Peak Radiated Emissions in Restricted Bands
 Date : December 17, 2019
 Test Distance : 3 meters
 Notes : Peak Detector with 1MHz Resolution Bandwidth

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dBuV/m at 3m	Peak Total uV/m at 3 m	Peak Limit uV/m at 3 m	Margin (dB)
4804.00	H	50.1	Ambient	5.7	34.2	-40.2	49.7	306.2	5000.0	-24.3
4804.00	V	49.9	Ambient	5.7	34.2	-40.2	49.5	298.2	5000.0	-24.5
12010.00	H	52.1	Ambient	8.6	38.7	-39.7	59.7	961.5	5000.0	-14.3
12010.00	V	50.7	Ambient	8.6	38.7	-39.7	58.3	822.1	5000.0	-15.7
19216.00	H	35.8	Ambient	2.2	40.4	-28.8	49.6	302.1	5000.0	-24.4
19216.00	V	36.0	Ambient	2.2	40.4	-28.8	49.8	307.8	5000.0	-24.2

Total (dBuV/m) = Meter Reading + CBL FAC + Ant Fac + Pre Amp

Manufacturer : Caterpillar Inc.
 Test Item : Trackwear Sensor
 Model/Part Number No. : 580-2222-01
 Mode : Transmit at 2402MHz
 Test Specification : FCC-15.247, RSS-247 Average Radiated Emissions in Restricted Bands
 Date : December 17, 2019
 Test Distance : 3 meters
 Notes : Average Detector with 1MHz Resolution Bandwidth

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Average Total dBuV/m at 3m	Average Total uV/m at 3 m	Average Limit uV/m at 3 m	Margin (dB)
4804.00	H	35.9		5.7	34.2	-40.2	35.5	59.5	500.0	-18.5
4804.00	V	35.9		5.7	34.2	-40.2	35.5	59.8	500.0	-18.4
12010.00	H	36.6	Ambient	8.6	38.7	-39.7	44.2	161.6	500.0	-9.8
12010.00	V	36.5	Ambient	8.6	38.7	-39.7	44.1	160.5	500.0	-9.9
19216.00	H	20.9	Ambient	2.2	40.4	-28.8	34.7	54.4	500.0	-19.3
19216.00	V	21.1	Ambient	2.2	40.4	-28.8	34.9	55.3	500.0	-19.1

Total (dBuV/m) = Meter Reading + CBL FAC + Ant Fac + Pre Amp

Manufacturer : Caterpillar Inc.
 Test Item : Trackwear Sensor
 Model/Part Number No. : 580-2222-01
 Mode : Transmit at 2402MHz
 Test Specification : FCC-15.247, RSS-247 Peak Radiated Emissions not in Restricted Bands
 Date : December 17, 2019
 Test Distance : 3 meters
 Notes : Peak Detector with 100kHz Resolution Bandwidth

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dBuV/m at 3m	Peak Total uV/m at 3 m	Peak Limit uV/m at 3 m	Margin (dB)
2402.00	H	51.1		4.3	32.2	0.0	87.6	23920.4		
2402.00	V	54.2		4.3	32.2	0.0	90.6	33983.6		
7206.00	H	38.9	Ambient	6.9	35.9	-40.1	41.6	120.6	3398.4	-29.0
7206.00	V	40.4		6.9	35.9	-40.1	43.1	142.7	3398.4	-27.5
9608.00	H	40.5	Ambient	8.2	36.8	-39.6	45.9	197.8	3398.4	-24.7
9608.00	V	40.9	Ambient	8.2	36.8	-39.6	46.4	207.8	3398.4	-24.3
14412.00	H	40.2	Ambient	9.6	39.6	-40.0	49.4	293.7	3398.4	-21.3
14412.00	V	40.6	Ambient	9.6	39.6	-40.0	49.7	305.4	3398.4	-20.9
16814.00	H	39.7	Ambient	10.9	42.0	-38.9	53.7	485.5	3398.4	-16.9
16814.00	V	40.0	Ambient	10.9	42.0	-38.9	54.0	502.5	3398.4	-16.6
21618.00	H	26.1	Ambient	2.2	40.6	-28.9	40.0	100.5	3398.4	-30.6
21618.00	V	25.2	Ambient	2.2	40.6	-28.9	39.1	90.1	3398.4	-31.5

Total (dBuV/m) = Meter Reading + CBL FAC + Ant Fac + Pre Amp

Manufacturer : Caterpillar Inc.
 Test Item : Trackwear Sensor
 Model/Part Number No. : 580-2222-01
 Mode : Transmit at 2440MHz
 Test Specification : FCC-15.247, RSS-247 Peak Radiated Emissions in Restricted Bands
 Date : December 17, 2019
 Test Distance : 3 meters
 Notes : Peak Detector with 1MHz Resolution Bandwidth

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dBuV/m at 3m	Peak Total uV/m at 3 m	Peak Limit uV/m at 3 m	Margin (dB)
4880.00	H	50.3	Ambient	5.7	34.1	-40.3	50.0	314.6	5000.0	-24.0
4880.00	V	50.1	Ambient	5.7	34.1	-40.3	49.7	304.3	5000.0	-24.3
7320.00	H	48.5	Ambient	6.9	35.9	-40.1	51.2	361.4	5000.0	-22.8
7320.00	V	48.8	Ambient	6.9	35.9	-40.1	51.5	375.9	5000.0	-22.5
12200.00	H	50.7	Ambient	8.9	38.7	-39.6	58.7	858.6	5000.0	-15.3
12200.00	V	50.3	Ambient	8.9	38.7	-39.6	58.3	824.7	5000.0	-15.7
19520.00	H	36.3	Ambient	2.2	40.4	-28.7	50.1	321.1	5000.0	-23.8
19520.00	V	36.4	Ambient	2.2	40.4	-28.7	50.3	327.4	5000.0	-23.7

Total (dBuV/m) = Meter Reading + CBL FAC + Ant Fac + Pre Amp

Manufacturer : Caterpillar Inc.
 Test Item : Trackwear Sensor
 Model/Part Number No. : 580-2222-01
 Mode : Transmit at 2440MHz
 Test Specification : FCC-15.247, RSS-247 Average Radiated Emissions in Restricted Bands
 Date : December 17, 2019
 Test Distance : 3 meters
 Notes : Average Detector with 1MHz Resolution Bandwidth

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Average Total dBuV/m at 3m	Average Total uV/m at 3 m	Average Limit uV/m at 3 m	Margin (dB)
4880.00	H	34.8	Ambient	5.7	34.1	-40.3	34.4	52.7	500.0	-19.5
4880.00	V	34.8	Ambient	5.7	34.1	-40.3	34.4	52.5	500.0	-19.6
7320.00	H	33.42	Ambient	6.9	35.9	-40.1	36.1	64.1	500.0	-17.8
7320.00	V	33.4	Ambient	6.9	35.9	-40.1	36.1	64.1	500.0	-17.8
12200.00	H	35.9	Ambient	8.9	38.7	-39.6	43.9	157.0	500.0	-10.1
12200.00	V	35.9	Ambient	8.9	38.7	-39.6	43.9	155.9	500.0	-10.1
19520.00	H	20.6	Ambient	2.2	40.4	-28.7	34.5	53.0	500.0	-19.5
19520.00	V	21.2	Ambient	2.2	40.4	-28.7	35.1	57.0	500.0	-18.9

Total (dBuV/m) = Meter Reading + CBL FAC + Ant Fac + Pre Amp

Manufacturer : Caterpillar Inc.
 Test Item : Trackwear Sensor
 Model/Part Number No. : 580-2222-01
 Mode : Transmit at 2440MHz
 Test Specification : FCC-15.247, RSS-247 Peak Radiated Emissions not in Restricted Bands
 Date : December 17, 2019
 Test Distance : 3 meters
 Notes : Peak Detector with 100kHz Resolution Bandwidth

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dBuV/m at 3m	Peak Total uV/m at 3 m	Peak Limit uV/m at 3 m	Margin (dB)
2440.00	H	55.7		4.3	32.3	0.0	92.2	40898.1		
2440.00	V	50.4		4.3	32.3	0.0	87.0	22320.4		
9760.00	H	40.5	Ambient	8.2	37.0	-39.6	46.2	204.7	4089.8	-26.0
9760.00	V	40.3	Ambient	8.2	37.0	-39.6	45.9	198.2	4089.8	-26.3
14640.00	H	40.4	Ambient	9.7	39.7	-40.2	49.6	301.7	4089.8	-22.6
14640.00	V	40.7	Ambient	9.7	39.7	-40.2	49.9	313.4	4089.8	-22.3
17080.00	H	40.4	Ambient	11.0	41.8	-38.8	54.4	524.3	4089.8	-17.8
17080.00	V	41.4	Ambient	11.0	41.8	-38.8	55.4	589.6	4089.8	-16.8
21960.00	H	26.6	Ambient	2.2	40.6	-29.4	40.0	100.2	4089.8	-32.2
21960.00	V	26.4	Ambient	2.2	40.6	-29.4	39.8	97.4	4089.8	-32.5
24400.00	H	27.3	Ambient	2.2	40.6	-30.4	39.7	97.0	4089.8	-32.5
24400.00	V	26.1	Ambient	2.2	40.6	-30.4	38.5	84.5	4089.8	-33.7

Total (dBuV/m) = Meter Reading + CBL FAC + Ant Fac + Pre Amp

Manufacturer : Caterpillar Inc.
 Test Item : Trackwear Sensor
 Model/Part Number No. : 580-2222-01
 Mode : Transmit at 2480MHz
 Test Specification : FCC-15.247, RSS-247 Peak Radiated Emissions in Restricted Bands
 Date : December 17, 2019
 Test Distance : 3 meters
 Notes : Peak Detector with 1MHz Resolution Bandwidth

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dBuV/m at 3m	Peak Total uV/m at 3 m	Peak Limit uV/m at 3 m	Margin (dB)
4960.00	H	49.9	Ambient	5.8	34.1	-40.3	49.5	299.8	5000.0	-24.4
4960.00	V	49.8	Ambient	5.8	34.1	-40.3	49.4	295.7	5000.0	-24.6
7440.00	H	49.4	Ambient	6.9	35.8	-40.0	52.1	401.7	5000.0	-21.9
7440.00	V	48.4	Ambient	6.9	35.8	-40.0	51.0	356.8	5000.0	-22.9
12400.00	H	50.5	Ambient	9.4	38.6	-39.5	59.0	889.2	5000.0	-15.0
12400.00	V	50.5	Ambient	9.4	38.6	-39.5	59.0	888.2	5000.0	-15.0
19840.00	H	35.6	Ambient	2.2	40.4	-28.4	49.9	311.6	5000.0	-24.1
19840.00	V	36.2	Ambient	2.2	40.4	-28.4	50.4	330.9	5000.0	-23.6
22320.00	H	36.1	Ambient	2.2	40.6	-29.3	49.7	304.0	5000.0	-24.3
22320.00	V	36.5	Ambient	2.2	40.6	-29.3	50.1	318.4	5000.0	-23.9

Total (dBuV/m) = Meter Reading + CBL FAC + Ant Fac + Pre Amp

Manufacturer : Caterpillar Inc.
 Test Item : Trackwear Sensor
 Model/Part Number No. : 580-2222-01
 Mode : Transmit at 2480MHz
 Test Specification : FCC-15.247, RSS-247 Average Radiated Emissions in Restricted Bands
 Date : December 17, 2019
 Test Distance : 3 meters
 Notes : Average Detector with 1MHz Resolution Bandwidth

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Average Total dBuV/m at 3m	Average Total uV/m at 3 m	Average Limit uV/m at 3 m	Margin (dB)
4960.00	H	34.1	Ambient	5.8	34.1	-40.3	33.8	48.7	500.0	-20.2
4960.00	V	34.4	Ambient	5.8	34.1	-40.3	34.0	50.3	500.0	-20.0
7440.00	H	33.72	Ambient	6.9	35.8	-40.0	36.4	65.9	500.0	-17.6
7440.00	V	33.7	Ambient	6.9	35.8	-40.0	36.4	65.9	500.0	-17.6
12400.00	H	35.9	Ambient	9.4	38.6	-39.5	44.4	166.0	500.0	-9.6
12400.00	V	36.0	Ambient	9.4	38.6	-39.5	44.5	168.5	500.0	-9.4
19840.00	H	20.7	Ambient	2.2	40.4	-28.4	35.0	56.1	500.0	-19.0
19840.00	V	21.1	Ambient	2.2	40.4	-28.4	35.4	58.6	500.0	-18.6
22320.00	H	21.7	Ambient	2.2	40.6	-29.3	35.2	57.6	500.0	-18.8
22320.00	V	21.3	Ambient	2.2	40.6	-29.3	34.8	55.3	500.0	-19.1

Total (dBuV/m) = Meter Reading + CBL FAC + Ant Fac + Pre Amp

Manufacturer : Caterpillar Inc.
 Test Item : Trackwear Sensor
 Model/Part Number No. : 580-2222-01
 Mode : Transmit at 2480MHz
 Test Specification : FCC-15.247, RSS-247 Peak Radiated Emissions not in Restricted Bands
 Date : December 17, 2019
 Test Distance : 3 meters
 Notes : Peak Detector with 100kHz Resolution Bandwidth

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dBuV/m at 3m	Peak Total uV/m at 3 m	Peak Limit uV/m at 3 m	Margin (dB)
2480.00	H	51.4		4.3	32.3	0.0	88.1	25284.1		
2480.00	V	53.8		4.3	32.3	0.0	90.4	33216.0		
9920.00	H	40.3	Ambient	8.3	37.1	-39.5	46.2	203.4	3321.6	-24.3
9920.00	V	41.4	Ambient	8.3	37.1	-39.5	47.3	232.4	3321.6	-23.1
14880.00	H	40.6	Ambient	9.8	39.8	-40.4	49.8	308.3	3321.6	-20.6
14880.00	V	40.5	Ambient	9.8	39.8	-40.4	49.7	306.8	3321.6	-20.7
17360.00	H	39.6	Ambient	11.0	41.7	-39.1	53.2	455.8	3321.6	-17.3
17360.00	V	39.4	Ambient	11.0	41.7	-39.1	52.9	442.9	3321.6	-17.5
24800.00	H	26.2	Ambient	2.2	40.6	-31.2	37.9	78.1	3321.6	-32.6
24800.00	V	26.2	Ambient	2.2	40.6	-31.2	37.9	78.2	3321.6	-32.6

Total (dBuV/m) = Meter Reading + CBL FAC + Ant Fac + Pre Amp

Manufacturer : Caterpillar Inc.
 Test Item : Trackwear Sensor
 Model/Part Number No. : 580-2222-01
 Mode : Tx High Channel - 2480MHz
 Test Specification : FCC-15.247, RSS-247 Band-Edge Compliance
 Date : December 17th, 2019
 Test Distance : 3 Meters
 Notes : Peak Detector with 1MHzHz Resolution Bandwidth

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dBuV/m at 3m	Peak Total uV/m at 3 m	Peak Limit uV/m at 3 m	Margin (dB)
2483.50	H	22.9		4.3	32.3	0.0	59.6	954.4	5000.0	-14.4
2483.50	V	22.1		4.3	32.3	0.0	58.8	867.4	5000.0	-15.2

Manufacturer : Caterpillar Inc.
 Test Item : Trackwear Sensor
 Model/Part Number No. : 580-2222-01
 Mode : Tx High Channel - 2480MHz
 Test Specification : FCC-15.247, RSS-247 Band-Edge Compliance
 Date : December 17th, 2019
 Test Distance : 3 Meters
 Notes : Average Detector with 1MHzHz Resolution Bandwidth

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Average Total dBuV/m at 3m	Average Total uV/m at 3 m	Average Limit uV/m at 3 m	Margin (dB)
2483.50	H	8.4		4.3	32.3	0.0	45.1	180.0	500.0	-8.9
2483.50	V	8.4		4.3	32.3	0.0	45.1	179.8	500.0	-8.9

20. Scope of Accreditation

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

ELITE ELECTRONIC ENGINEERING, INC.
1516 Centre Circle
Downers Grove, IL 60515
Robert Bugielski (QA Manager) Phone: 630 495 9770 ext. 168
Email: rbugielski@elitetest.com
Craig Fanning (EMC Lab Manager) Phone: 630 495 9770 ext. 112
Email: cfanning@elitetest.com
Stanley Dolecki (Automotive Team Leader) Phone: 630 495 9770 ext. 103
Email: sdolecki@elitetest.com
Website: www.elitetest.com

ELECTRICAL

Valid to: June 30, 2021

Certificate Number: 1786.01

In recognition of the successful completion of the A2LA Accreditation Program evaluation process, accreditation is granted to this laboratory to perform the following automotive electromagnetic compatibility and other electrical tests:

Test Technology:**Test Method(s) ¹:*****Transient Immunity***

ISO 7637-2 (including emissions); ISO 7637-3;
ISO 16750-2:2012, Sections 4.6.3 and 4.6.4;
CS-11979, Section 6.4; CS.00054, Section 5.9;
EMC-CS-2009.1 (CI220); FMC1278 (CI220, CI221, CI222);
GMW 3097, Section 3.5;
SAE J1113-11; SAE J1113-12

Electrostatic Discharge (ESD)

ISO 10605 (2001, 2008);
CS-11979 Section 7.0; CS.00054, Section 5.10;
EMC-CS-2009.1 (CI 280); FMC1278 (CI280); SAE J1113-13;
GMW 3097 Section 3.6

Conducted Emissions

CISPR 25 (2002, 2008), Sections 6.2 and 6.3;
CISPR 25 (2016), Sections 6.3 and 6.4;
CS-11979, Section 5.1; CS.00054, Sections 5.6.1 and 5.6.2;
GMW 3097, Section 3.3.2;
EMC-CS-2009.1 (CE 420); FMC1278 (CE420, CE421)

Radiated Emissions Anechoic

CISPR 25 (2002, 2008), Section 6.4;
CISPR 25 (2016), Section 6.5;
CS-11979, Section 5.3; CS.00054, Section 5.6.3;
GMW 3097, Section 3.3.1;
EMC-CS-2009.1 (RE 310); FMC1278 (RE310)

Vehicle Radiated Emissions

CISPR 12; ICES-002

(A2LA Cert. No. 1786.01) 08/08/2019



Page 1 of 7

5202 Presidents Court, Suite 220 | Frederick, MD 21703-8515 | Phone: 301 644 3248 | Fax: 240 454 9449 | www.A2LA.org

Test Technology:
Test Method(s) ¹:
Bulk Current Injection (BCI)

ISO 11452-4;
CS-11979, Section 6.1; CS.00054, Section 5.8.1;
GMW 3097, Section 3.4.1;
SAE J1113-4;
EMC-CS-2009.1 (RI112); FMC1278 (RI112)

***Bulk Current Injections (BCI)
(Closed Loop Method)***

ISO 11452-4; SAE J1113-4

***Radiated Immunity Anechoic
(Including Radar Pulse)***

ISO 11452-2; ISO 11452-5;
CS-11979, Section 6.2; CS.00054, Section 5.8.2;
GMW 3097, Section 3.4.2;
EMC-CS-2009.1 (RI114); FMC1278 (RI114); SAE J1113-21

Radiated Immunity Magnetic Field

ISO 11452-8

Radiated Immunity Reverb

ISO/IEC 61000-4-21;
GMW 3097, Section 3.4.3;
EMC-CS-2009.1 (RI114); FMC1278 (RI114);
ISO 11452-11

***Radiated Immunity
(Portable Transmitters)***

ISO 11452-9;
EMC-CS-2009.1 (RI115); FMC1278 (RI115)

Vehicle Radiated Immunity (ALSE)

ISO 11451-2

Electrical Loads

ISO 16750-2, Sections 4.2, 4.3, 4.4, 4.5, 4.6, 4.7,
4.8, 4.9, 4.11, and 4.12

Dielectric Withstand Voltage

MIL-STD-202, Method 301;
EIA-364-20D

Insulation Resistance

MIL-STD-202, Method 302;
SAE/USCAR-2, Revision 6, Section 5.5.1;
EIA-364-21D

Contact Resistance

MIL-STD-202, Method 307;
SAE/USCAR-2, Revision 6, Section 5.3.1;
EIA/ECA-364-23C;
USCAR21-3 Section 4.5.3

DC Resistance

MIL-STD-202, Method 303

Contact Chatter

MIL-STD-202, Method 310;
SAE/USCAR-2, Revision 6, Section 5.1.9

Voltage Drop

SAE/USCAR-2, Revision 6, Section 5.3.2;
USCAR21-3 Section 4.5.6

Test Technology:
Emissions

Radiated and Conducted
(3m Semi-anechoic chamber,
up to 40 GHz)

Test Method(s) ¹:

47 CFR, FCC Part 15 B (using ANSI C63.4:2014);
47 CFR, FCC Part 18 (using FCC MP-5:1986);
ICES-001; ICES-003; ICES-005;
IEC/CISPR 11, Ed. 4.1 (2004-06); AS/NZS CISPR 11 (2004);
IEC/CISPR 11 Ed 5 (2009-05) + A1 (2010);
KN 11 (2008-5) with RRL Notice No. 2008-3 (May 20, 2008);
CISPR 11; EN 55011; KN 11; CNS 13803 (1997, 2003);
CISPR 14-1; EN 55014-1; AS/NZS CISPR 14.1; KN 14-1;
IEC/CISPR 22 (1997); EN 55022 (1998) + A1(2000);
EN 55022 (1998) + A1(2000) + A2(2003); EN 55022 (2006);
IEC/CISPR 22 (2008-09); AS/NZS CISPR 22 (2004);
AS/NZS CISPR 22, 3rd Edition (2006); KN 22 (up to 6 GHz);
CNS 13438 (up to 6 GHz); VCCI V-3 (up to 6 GHz);
CISPR 32; EN 55032; KN 32

Current Harmonics

IEC 61000-3-2; EN 61000-3-2; KN 61000-3-2

Flicker and Fluctuations

IEC 61000-3-3; EN 61000-3-3; KN 61000-3-3

Immunity

Electrostatic Discharge

IEC 61000-4-2, Ed. 1.2 (2001);
IEC 61000-4-2 (1995) + A1(1998) + A2(2000);
EN 61000-4-2 (1995); EN 61000-4-2 (2009-05);
KN 61000-4-2 (2008-5); RRL Notice No. 2008-4 (May 20, 2008);
IEC 61000-4-2; EN 61000-4-2; KN 61000-4-2;
IEEE C37.90.3 2001

Radiated Immunity

IEC 61000-4-3 (1995) + A1(1998) + A2(2000);
IEC 61000-4-3, Ed. 3.0 (2006-02);
IEC 61000-4-3, Ed. 3.2 (2010);
KN 61000-4-3 (2008-5); RRL Notice No. 2008-4 (May 20, 2008);
IEC 61000-4-3; EN 61000-4-3; KN 61000-4-3;
IEEE C37.90.2 2004

Electrical Fast Transient/Burst

IEC 61000-4-4, Ed. 2.0 (2004-07); IEC 61000-4-4, Ed. 2.1 (2011);
IEC 61000-4-4 (1995) + A1(2000) + A2(2001);
KN 61000-4-4 (2008-5); RRL Notice No. 2008-5 (May 20, 2008);
IEC 61000-4-4; EN 61000-4-4; KN 61000-4-4

Surge

IEC 61000-4-5 (1995) + A1(2000);
IEC 61000-4-5, Ed 1.1 (2005-11);
EN 61000-4-5 (1995) + A1(2001);
KN 61000-4-5 (2008-5); RRL Notice No. 2008-4 (May 20, 2008);
IEC 61000-4-5; EN 61000-4-5; KN 61000-4-5;
IEEE C37.90.1 2012

Test Technology:
Test Method(s) ¹:
Immunity (cont'd)

Conducted Immunity

IEC 61000-4-6 (1996) + A1(2000);
IEC 61000-4-6, Ed 2.0 (2006-05);
IEC 61000-4-6 Ed. 3.0 (2008);
KN 61000-4-6 (2008-5); RRL Notice No. 2008-4 (May 20, 2008);
EN 61000-4-6 (1996) + A1(2001); IEC 61000-4-6; EN 61000-4-6;
KN 61000-4-6

Power Frequency Magnetic Field
Immunity

IEC 61000-4-8 (1993) + A1(2000); IEC 61000-4-8 (2009);
EN 61000-4-8 (1994) + A1(2000);
KN 61000-4-8 (2008-5); RRL Notice No. 2008-4 (May 20, 2008);
IEC 61000-4-8; EN 61000-4-8; KN 61000-4-8

Voltage Dips, Short Interrupts, and Line
Voltage Variations

IEC 61000-4-11, Ed. 2 (2004-03);
KN 61000-4-11 (2008-5);
RRL Notice No. 2008-4 (May 20, 2008);
IEC 61000-4-11; EN 61000-4-11; KN 61000-4-11

Ring Wave

IEC 61000-4-12, Ed. 2 (2006-09);
EN 61000-4-12:2006;
IEC 61000-4-12; EN 61000-4-12; KN 61000-4-12

Generic and Product Specific EMC
Standards

IEC/EN 61000-6-1; AS/NZS 61000-6-1; KN 61000-6-1;
IEC/EN 61000-6-2; AS/NZS 61000-6-2; KN 61000-6-2;
IEC/EN 61000-6-3; AS/NZS 61000-6-3; KN 61000-6-3;
IEC/EN 61000-6-4; AS/NZS 61000-6-4; KN 61000-6-4;
EN 50130-4; IEC 61326-1;
IEC/CISPR 14-2; EN 55014-2; AS/NZS CISPR 14.2; KN 14-2;
IEC/CISPR 24; AS/NZS CISPR 24; EN 55024; KN 24;
IEC 60601-1-2; JIS T0601-1-2

TxRx EMC Requirements

EN 301 489-1; EN 301 489-3; EN 301 489-9; EN 301 489-17;
EN 301 489-19; EN 301 489-52;

European Radio Test Standards

ETSI EN 300 086-1; ETSI EN 300 086-2;
ETSI EN 300 113-1; ETSI EN 300 113-2;
ETSI EN 300 220-1; ETSI EN 300 220-2;
ETSI EN 300 330-1; ETSI EN 300 330-2;
ETSI EN 300 440-1; ETSI EN 300 440-2;
ETSI EN 300 422-1; ETSI EN 300 422-2;
ETSI EN 300 328; ETSI EN 301 893;
ETSI EN 301 511; ETSI EN 301 908-1;
ETSI EN 908-2; ETSI EN 908-13;
ETSI EN 301 413;
ETSI EN 302 502

Test Technology:
Test Method(s) ¹:
Canadian Radio Tests

RSS-102 (RF Exposure Evaluation only); RSS-111; RSS-112; RSS-117; RSS-119; RSS-123; RSS-125; RSS-127; RSS-130; RSS-131; RSS-132; RSS-133; RSS-134; RSS-135; RSS-137; RSS-139; RSS-140; RSS-141; RSS-142; RSS-170; RSS-181; RSS-182; RSS-191; RSS-192; RSS-194; RSS-195; RSS-196; RSS-197; RSS-199; RSS-210; RSS-211; RSS-213; RSS-215; RSS-216; RSS-220; RSS-222; RSS-236; RSS-238; RSS-243; RSS-244; RSS-246; RSS-247; RSS-251; RSS-252; RSS-287; RSS-288; RSS-310; RSS-GEN

Mexico Radio Tests

IFT-008; NOM-208-SCFI

Japan Radio Tests

Radio Law No. 131, Ordinance of MPT No. 37, 1981, MIC Notification No. 88:2004, Table No. 22-11; ARIB STD-T66, Regulation 18

Taiwan Radio Tests

LP-0002

Australia/New Zealand Radio Tests

AS/NZS 4268; Radiocommunications (Short Range Devices) Standard (2014)

Hong Kong Radio Tests

HKCA 1039 Issue 6; HKCA 1042; HKCA 1033 Issue 7; HKCA 1061; HKCA 1008; HKCA 1043; HKCA 1057; HKCA 1073

Korean Radio Test Standards

KN 301 489-1; KN 301 489-3; KN 301 489-9; KN 301 489-17; KN 301 489-52

***Unlicensed Radio Frequency Devices
(3 Meter Semi-Anechoic Room)***

47 CFR FCC Part 15C, 15D, 15E, 15F, 15G, 15H (using ANSI C63.10:2013, ANSI C63.17:2013 and FCC KDB 905462 D02 (v02))

Licensed Radio Service Equipment

47 CFR FCC Parts 20, 22, 24, 25, 27, 30, 73, 74, 80, 87, 90, 95, 96, 97, 101; ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015;

***Electrical Measurements and
Simulation***
AC Voltage / Current

(1mV to 5kV) 60 Hz
(0.1V to 250V) up to 500 MHz
(1μA to 150A) 60 Hz

DC Voltage / Current

(1mV to 15-kV) / (1μA to 10A)

Power Factor / Efficiency / Crest Factor

(Power to 30kW)

Resistance

(1mΩ to 4000MΩ)

Surge

(Up to 10 kV / 5 kA) (Combination Wave and Ring Wave)

FAA AC 150/5345-10H
FAA AC 150/5345-43J
FAA AC 150/5345-44K
FAA AC 150/5345-46E
FAA AC 150/5345-47C
FAA EB 67D

(A2LA Cert. No. 1786.01) 08/08/2019



Page 5 of 7

On the following products and materials:

Telecommunications Terminal Equipment (TTE), Radio Equipment, Network Equipment, Information Technology Equipment (ITE), Automotive Electronic Equipment, Automotive Hybrid Electronic Devices, Maritime Navigation and Radio Communication Equipment and Systems, Vehicles, Boats and Internal Combustion Engine Driven Devices, Automotive, Aviation, and General Lighting Products, Medical Electrical Equipment, Motors, Industrial, Scientific and Medical (ISM) Radio-Frequency Equipment, Household Appliances, Electric Tools, Low-voltage Switchgear and Control gear, Programmable Controllers, Electrical Equipment for Measurement, Control and Laboratory Use, Base Materials, Power and Data Transmission Cables and Connectors

¹ When the date, revision or edition of a test method standard is not identified on the scope of accreditation, the laboratory is expected to be using the current version within one year of the date of publication, per part C., Section 1 of A2LA R101 - General Requirements - Accreditation of ISO-IEC 17025 Laboratories.

Testing Activities Performed in Support of FCC Declaration of Conformity and Certification in Accordance with 47 Code of Federal Regulations and FCC KDB 974614, Appendix A, Table A.1²

Rule Subpart/Technology	Test Method	Maximum Frequency (MHz)
<u>Unintentional Radiators</u>		
Part 15B	ANSI C63.4:2014	40000
<u>Industrial, Scientific, and Medical Equipment</u>		
Part 18	FCC MP-5 (February 1986)	40000
<u>Intentional Radiators</u>		
Part 15C	ANSI C63.10:2013	40000
<u>Unlicensed Personal Communication Systems Devices</u>		
Part 15D	ANSI C63.17:2013	40000
<u>U-NII without DFS Intentional Radiators</u>		
Part 15E	ANSI C63.10:2013	40000
<u>U-NII with DFS Intentional Radiators</u>		
Part 15E	FCC KDB 905462 D02 (v02)	40000
<u>UWB Intentional Radiators</u>		
Part 15F	ANSI C63.10:2013	40000
<u>BPL Intentional Radiators</u>		
Part 15G	ANSI C63.10:2013	40000
<u>White Space Device Intentional Radiators</u>		
Part 15H	ANSI C63.10:2013	40000

Testing Activities Performed in Support of FCC Declaration of Conformity and Certification in Accordance with 47 Code of Federal Regulations and FCC KDB 974614, Appendix A, Table A.1²

Rule Subpart/Technology	Test Method	Maximum Frequency (MHz)
<u>Commercial Mobile Services (FCC Licensed Radio Service Equipment)</u> Parts 22 (cellular), 24, 25 (below 3 GHz), and 27	ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015	40000
<u>General Mobile Radio Services (FCC Licensed Radio Service Equipment)</u> Parts 22 (non-cellular), 90 (below 3 GHz), 95, 97, and 101 (below 3 GHz)	ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015	40000
<u>Citizens Broadband Radio Services (FCC Licensed Radio Service Equipment)</u> Part 96	ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015	40000
<u>Maritime and Aviation Radio Services</u> Parts 80 and 87	ANSI/TIA-603-E; ANSI C63.26:2015	40000
<u>Microwave and Millimeter Bands Radio Services</u> Parts 25, 30, 74, 90 (above 3 GHz), 97 (above 3 GHz), and 101	ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015	40000
<u>Broadcast Radio Services</u> Parts 73 and 74 (below 3 GHz)	ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015	40000
<u>Signal Boosters</u> Part 20 (Wideband Consumer Signal Boosters, Provider-specific signal boosters, and Industrial Signal Boosters) Section 90.219	ANSI C63.26:2015	40000

²Accreditation does not imply acceptance to the FCC equipment authorization program. Please see the FCC website (<https://apps.fcc.gov/oetcf/eas/>) for a listing of FCC approved laboratories.



Accredited Laboratory

A2LA has accredited

ELITE ELECTRONIC ENGINEERING INC.

Downers Grove, IL

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *General requirements for the competence of testing and calibration laboratories*. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).



Presented this 8th day of August 2019.



Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 1786.01
Valid to June 30, 2021

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.