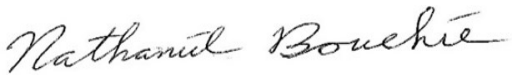
Engineering Test Report No. 2400542-01		
Report Date	March 19, 2024	
Manufacturer Name	Milwaukee Electric Tool Corporation	
Manufacturer Address	13135 West Lisbon Road Brookfield, WI 53005	
Product Name Model No.	Sander Tool 2837-20	
Date Received	March 14, 2024	
Test Dates	March 14, 2024	
Specifications	FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247 Innovation, Science, and Economic Development Canada, RSS-GEN Innovation, Science, and Economic Development Canada, RSS-247	
Test Facility	Elite Electronic Engineering, Inc. 1516 Centre Circle, Downers Grove, IL 60515	FCC Reg. Number: 269750 IC Reg. Number: 2987A CAB Identifier: US0107
Signature		
Tested by	Nathaniel Bouchie	
Signature		
Approved by	Raymond J. Klouda, Registered Professional Engineer of Illinois – 44894	
PO Number	MF-1445026	

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 "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247, Innovation, Science, and Economic Development Canada, RSS-GEN, and Innovation, Science, and Economic Development Canada, RSS-247 test specifications. The data presented in this test report pertains to the EUT on the test dates 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

Revision	Date	Description
–	26 MAR 2024	Initial Release of Engineering Test Report No. 2400542-01

2. Introduction

2.1. Scope of Tests

This document presents the results of a series of RF emissions tests that were performed on the Milwaukee Electric Tool Corporation, Model No. 2837-20 Sander Tool (hereinafter referred to as the Equipment Under Test (EUT)). The EUTs were manufactured and submitted for testing by Milwaukee Electric Tool Corporation located in Brookfield, WI.

2.2. Purpose

The test series was performed to determine if the EUT meets the RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, §15.247 for a Digital Modulation intentional radiator operating within the 2400 – 2483.5MHz band.

The test series was also performed to determine if the EUT meets the RF emission requirements of the Innovation, Science, and Economic Development Canada Radio Standards Specification RSS-247 for a Digital Modulation intentional radiator operating within the 2400 – 2483.5MHz band.

Testing was performed in accordance with ANSI C63.10-2013.

2.3. Identification of the EUT

The EUTs were identified as follows:

EUT Identification	
EUT #1	
Product Description	Sander Tool (Radiated Sample)
Model/Part No.	2837-20
Serial No.	3010092D
Size of EUT	7 in x 6 in x 5.5 in
Software/Firmware Version	Tool Firmware: 1.1.0.0
Device Type	Digitally Modulated Transmission Device
Band of Operation	2400 – 2483.5MHz
Modulation Type	FSK
Antenna Type	Trace
Rated Output Power	6dBm
6dB Bandwidth	800kHz
Occupied Bandwidth (99% CBW)	1.033MHz
EUT #2	
Product Description	Sander Tool (Conducted Sample)
Model/Part No.	2837-20
Serial No.	3010102D
Size of EUT	7 in x 6 in x 5.5 in
Software/Firmware Version	Tool Firmware: 2.1.2
Device Type	Digitally Modulated Transmission Device
Band of Operation	2400 – 2483.5MHz
Modulation Type	FSK
Antenna Type	Trace
Rated Output Power	6dBm
6dB Bandwidth	800kHz
Occupied Bandwidth (99% CBW)	1.033MHz

The EUTs listed above were used throughout the test series.

3. Power Input

The EUTs were powered by 18V interchangeable batteries.

4. Grounding

The EUTs were connected to ground through the third wire of the input power cord.

5. Support Equipment

No support equipment was used during the tests.

6. Interconnect Leads

No interconnect leads were used during the tests.

7. Modifications Made to the EUT

No modifications were made to the EUTs during the testing.

8. Modes of Operation

The EUTs and all peripheral equipment were energized. The EUTs were programmed to transmit in one of the following modes:

Mode	Description
BLE @ 2402MHz	Power Setting = 6dBm
BLE @ 2442MHz	Power Setting = 6dBm
BLE @ 2480MHz	Power Setting = 6dBm

9. Test Specifications

The tests were performed to selected portions of, and in accordance with the test specifications.

- Federal Communications Commission "Code of Federal Regulations", Title 47, Chapter I, Subchapter A, Part 15, Subpart C
- 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 Systems, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating Under Section 15.247 April 2, 2019 KDB 558074 D01v05r02
- RSS-Gen Issue 5, February 2020, Amendment 2, Innovation, Science, and Economic Development Canada, “General Requirements for Compliance of Radio Apparatus”
- RSS-247 Issue 2, February 2017, “Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices”

10. Test Plan

No test plan was provided. Instructions were provided by personnel from Milwaukee Electric Tool Corporation and used in conjunction with the FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247, Innovation, Science, and Economic Development Canada, RSS-247, Innovation, Science, and Economic Development Canada, RSS-GEN, and ANSI C63.4-2014 specifications.

11. Deviation, Additions to, or Exclusions from Test Specifications

There were no deviations, additions to, or exclusions from the test specifications during this test series.

12. Laboratory Conditions

The ambient parameters of the laboratory during testing were as follows:

Ambient Parameters	Value
Temperature	23.5°C
Relative Humidity	23%
Atmospheric Pressure	1018mb

13. Summary

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

Test Description	Requirements	Test Method	S/N	Results
6dB Bandwidth	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	3010102D	Conforms
99% Bandwidth	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	3010102D	Conforms
Output Power	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	3010102D	Conforms
Power Spectral Density	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	3010102D	Conforms
Low Band Edge	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	3010102D	Conforms
High Band Edge	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	3010102D	Conforms
EIRP	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	3010092D	Conforms
Spurious Radiated Emissions	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	3010092D	Conforms

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).

Formula 1: VL (dBµV) = MTR (dBµV) + 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 preamplifier is used, the total is reduced by its gain (-PA). If a distance correction (DC) is required, it is added to the total.

Formula 1: FS (dBµV/m) = MTR (dBµV) + AF (dB/m) + CF (dB) + (- PA (dB)) + DC (dB)

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

Formula 2: FS (µV/m) = AntiLog [(FS (dBµV/m))/20]

15. Statement of Conformity

The following Milwaukee Electric Tool Corporation EUTs did fully conform to the selected requirements of FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247, Innovation, Science, and Economic Development Canada, RSS-GEN, and Innovation, Science, and Economic Development Canada, RSS-247.

EUT	Model No.	Serial No.
Sander Tool	2837-20	3010092D
Sander Tool	2837-20	3010102D

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 "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247, Innovation, Science, and Economic Development Canada, RSS-GEN, and Innovation, Science, and Economic Development Canada, RSS-247 test specifications. The data presented in this test report pertains to the EUTs as received by the customer on the test date specified. Any electrical or mechanical modifications made to the EUTs subsequent to the specified test date will serve to invalidate the data and void this certification.

17. Photographs of EUT

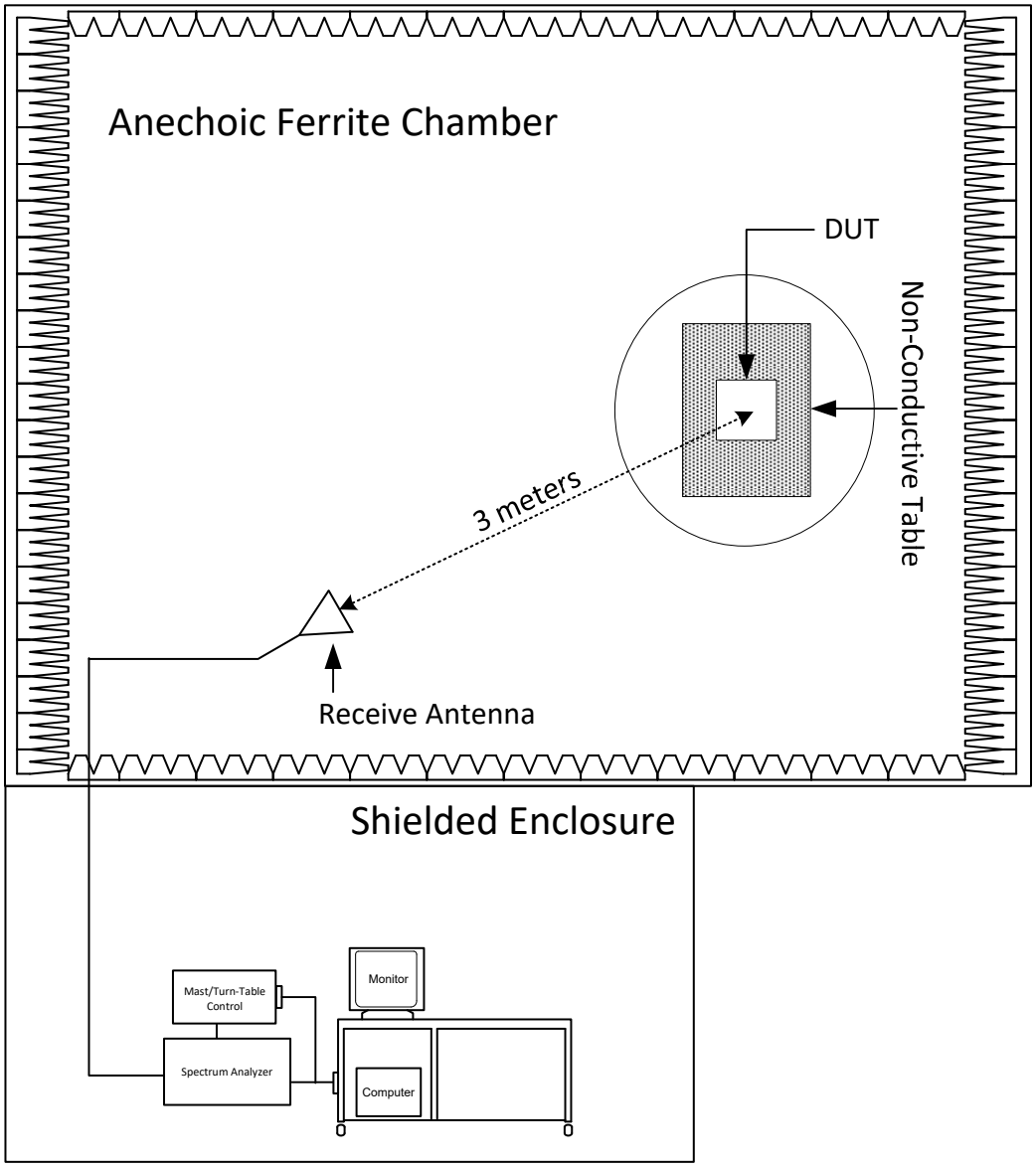

Milwaukee
REDLITHIUM

18. Equipment List

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
APW10	PREAMPLIFIER	PMI	PE2-35-120-5R0-10-12-SFF	PL11685/1241	1GHZ-20GHZ	3/13/2024	3/13/2025
APW18	PREAMPLIFER	PLANAR	PE2-30-20G20R6G-3R0-10-12-SFF	PL34312/2148	18-26.5GHZ	2/23/2024	2/23/2025
CDZ3	LAB WORKSTATION	ELITE	LWS-10		WINDOWS 10	CNR	
GCM0	SFC COMPACT MODULATOR	ROHDE & SCHWARZ	2115.3510K02	100552	---	3/30/2023	4/7/2025
GSE1	SIGNAL GENERATOR (40GHZ)	ROHDE & SCHWARZ	SMB100A	183099	100KHZ-40GHZ	1/25/2023	1/25/2025
GSE3	SIGNAL GENERATOR (40GHZ)	ROHDE & SCHWARZ	SMB100A	183294	100KHZ-40GHZ	1/30/2023	1/30/2025
GSF0	VECTOR SIGNAL GENERATOR	ROHDE & SCHWARZ	SMBV100A	260452	9kHz to 6GHz	9/2/2022	9/2/2024
GSFB	OSP120 BASE UNIT	ROHDE & SCHWARZ	OSP120	101071	---	3/30/2023	3/30/2025
GSFE	OSP120	ROHDE & SCHWARZ	OSP120	101288	.01-40GHZ	4/4/2023	4/4/2025
GURB	ATTENUATOR FOR PEFT.1	HAEFELY	50R	54.3DB	1HZ-1MHZ	10/3/2023	10/3/2024
NHG1	STANDARD GAIN HORN ANTENNA	NARDA	638	---	18-26.5GHZ	NOTE 1	
NSDS1	UNIVERSAL SPHERICAL DIPOLE SOURCE	AET	USDS-H	AET-1116		NOTE 1	
NTA3	BILOG ANTENNA	TESEQ	6112D	32853	25-1000MHz	11/17/2022	11/17/2024
NWN0	DOUBLE RIDGED GUIDE ANTENNA	ETS-LINDGREN	3116	00026778	18 - 40 GHZ	12/16/2022	12/16/2024
NWQ2	DOUBLE RIDGED WAVEGUIDE ANTENNA	ETS LINDGREN	3117	66659	1GHZ-18GHZ	4/27/2022	4/27/2024
PLF2	CISPR16 50UH LISN	ELITE	CISPR16/70A	002	.15-30MHz	4/10/2023	4/10/2024
PLF4	CISPR16 50UH LISN	ELITE	CISPR16/70A	003	.15-30MHz	4/10/2023	4/10/2024
R29F	3M ANECHOIC CHAMBER NSA	EMC TEST SYSTEMS	3M ANECHOIC		30MHZ-18GHZ	6/12/2023	6/12/2024
RBG2	EMI ANALYZER	ROHDE & SCHWARZ	ESW44	101591	2HZ-44GHZ	4/10/2023	4/10/2024
RBH6	EMI ANALYZER	ROHDE & SCHWARZ	ESW26	103067	2HZ-26GHZ	2/17/2024	2/17/2025
SES0	24VDC POWER SUPPLY	P-TRANS	FS-32024-1M	001	18-27VDC	NOTE 1	
T1EM	10DB 25W ATTENUATOR	WEINSCHEL	46-10-34	CD6796	DC-18GHZ	4/4/2022	4/4/2024
XPQ4	HIGH PASS FILTER	K&L MICROWAVE	11SH10-4800/X20000-O/O	1	4.8-20GHZ	9/14/2023	9/14/2025

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. Block Diagram of Test Setup



Radiated Measurements Test Setup

20. Antenna Port Conducted Emissions Tests

Test Information	
Manufacturer	Milwaukee Electric Tool Corporation
Product	Sander Tool (Conducted Sample)
Model No.	2837-20
Serial No.	3010102D
Mode	BLE @ 2402MHz BLE @ 2442MHz BLE @ 2480MHz

Test Setup Details	
Setup Format	Tabletop
Type of Test Site	EMC Bench
Note	None

Measurement Uncertainty	
Measurement Type	Expanded Measurement Uncertainty
Occupied Channel Bandwidth	± 224kHz
Power Spectral Density	± 0.372Hz
RF Output Power, Conducted	± 0.349 dB
Unwanted Emissions, Conducted	± 1.39 dB
All Emissions Radiated Below 1GHz	± 2.629 dB
All Emissions Radiated Above 1GHz	± 2.710 dB
Temperature	± 0.165˚C
Humidity	± 1.7% RH
DC and Low Frequency Voltages	± 0.115 Volts
Time	± 0.05%

Requirements
6dB Bandwidth (DTS Bandwidth): Per FCC 15.247, Section (a)(2), and ISED RSS-247, Section 5.2(a), the minimum 6dB bandwidth shall be at least 500kHz for all systems using digital modulation techniques.
99% Bandwidth: RSS-Gen requires the measurement of the 99% bandwidth (Occupied Bandwidth). If measuring the maximum conducted (average) output power for FCC 15.247, the 99% bandwidth is used as the reference for power integration.
Peak Conducted Output Power Per FCC 15.247, Section (b)(3) and ISED RSS-247, Section 5.4(d), for systems using digital modulation, the maximum peak conducted output power shall not exceed 1 watt.
Peak Power Spectral Density Per FCC 15.247, Section (e), and ISED RSS-247, Section 5.2(b), for digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. If peak conducted output power was measured, the same method must be used to measure the power spectral density.
Low Band Edge Per FCC 15.247, Section (d) and ISED RSS-247, Section 5.5, in any 100 kHz bandwidth outside the frequency band in which the 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. Attenuation below the general limits specified in FCC 15.209, Section (a) and ISED RSS-Gen is not required.

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:

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. Detector Mode = Max Peak
6. Trace Mode = Max Hold

b) Allow the trace to stabilize.

c) Use the 99% power bandwidth function of the EMI receiver.

Peak Conducted Output Power:

C63.10-2013 section 11.9.1.1:

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

1. Center Frequency = Transmit Frequency of the EUT
2. RBW = ≥ DTS Bandwidth
3. VBW = ≥ 3 x RBW
4. Span = ≥ 3 x RBW
5. Sweep Time = Auto couple
6. Detector Mode = Max Peak
7. Trace Mode = Max Hold

b) Allow the trace to stabilize.

c) Use the peak marker function to determine the peak amplitude level.

Peak Power Spectral Density:

C63.10-2013 section 11.10.2:

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 = 3kHz ≤ RBW ≤ 100kHz
4. VBW = ≥ 3 x RBW
5. Detector Mode = Max Peak
6. Sweep Time = Auto Couple
7. Trace Mode = Max Hold

b) Allow the trace to stabilize.

c) Use the peak marker function to determine the maximum amplitude level within the RBW.

d) If measured value exceeds requirement, then reduce RBW (but no less than 3kHz) 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 = ≥ 3 x RBW
5. Detector Mode = Max Peak
6. Trace Mode = Max Hold
7. Sweep Time = Auto

b) Allow the trace to stabilize and use the peak marker function to determine the maximum level.

c) Emission Level Measurement

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

d) Allow the trace to stabilize and use the peak marker function to determine the maximum level.

e) The two sweeps were combined and plotted.

Ensure that the amplitude of all unwanted emissions are attenuated by at least 20dB.

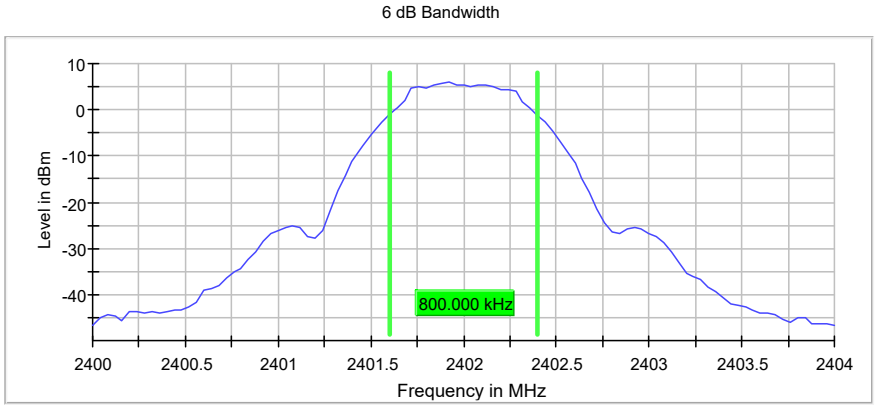
Minimum Emission Bandwidth 6 dB

6 dB Bandwidth

DUT Frequency (MHz)	Bandwidth (MHz)	Limit Min (MHz)	Limit Max (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)
2402.000000	0.800000	0.500000	---	2401.600000	2402.400000

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

DUT Frequency (MHz)	Max Level (dBm)	Result
2402.000000	5.9	PASS



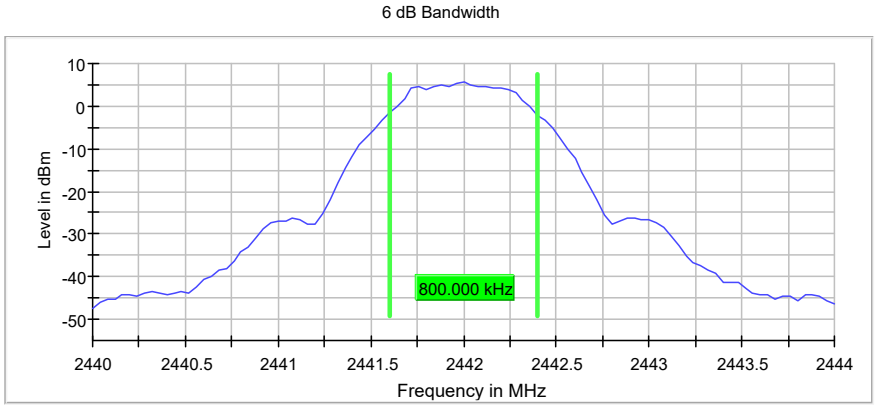
Minimum Emission Bandwidth 6 dB

6 dB Bandwidth

DUT Frequency (MHz)	Bandwidth (MHz)	Limit Min (MHz)	Limit Max (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)
2442.000000	0.800000	0.500000	---	2441.600000	2442.400000

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

DUT Frequency (MHz)	Max Level (dBm)	Result
2442.000000	5.6	PASS



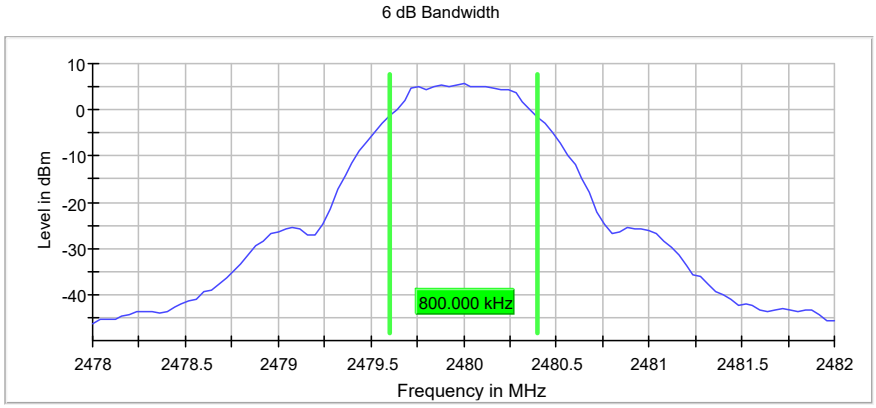
Minimum Emission Bandwidth 6 dB

6 dB Bandwidth

DUT Frequency (MHz)	Bandwidth (MHz)	Limit Min (MHz)	Limit Max (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)
2480.000000	0.800000	0.500000	---	2479.600000	2480.400000

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

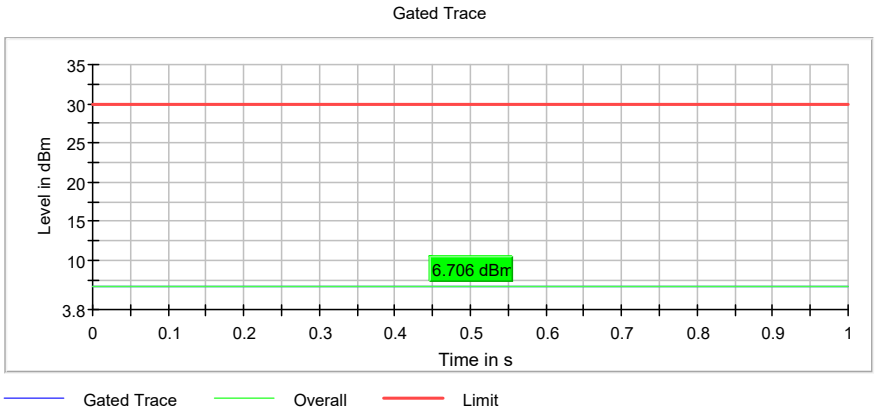
DUT Frequency (MHz)	Max Level (dBm)	Result
2480.000000	5.6	PASS



RF output power

Result

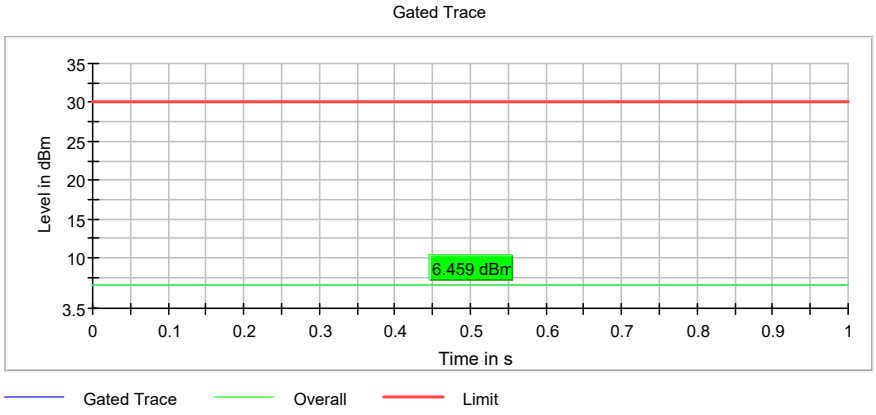
DUT Frequency (MHz)	Gated RMS (dBm)	Limit Max (dBm)	Gated EIRP (dBm)	Duty Cycle	Result
2402.000000	6.7	30.0	9.0	100.000	PASS



RF output power

Result

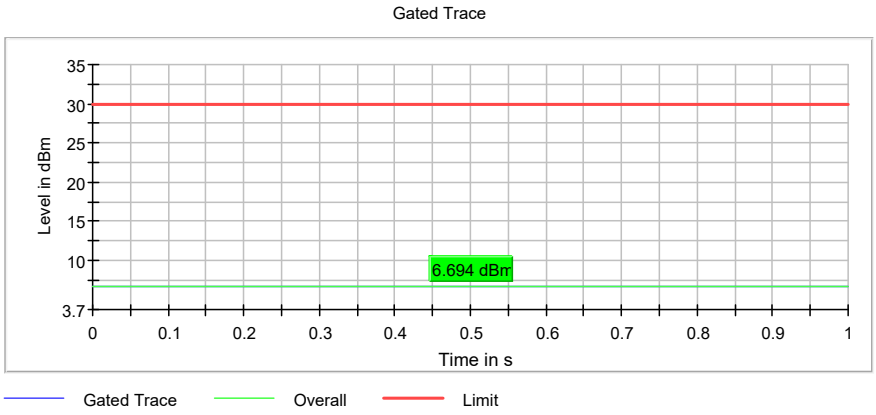
DUT Frequency (MHz)	Gated RMS (dBm)	Limit Max (dBm)	Gated EIRP (dBm)	Duty Cycle	Result
2442.000000	6.5	30.0	8.8	100.000	PASS



RF output power

Result

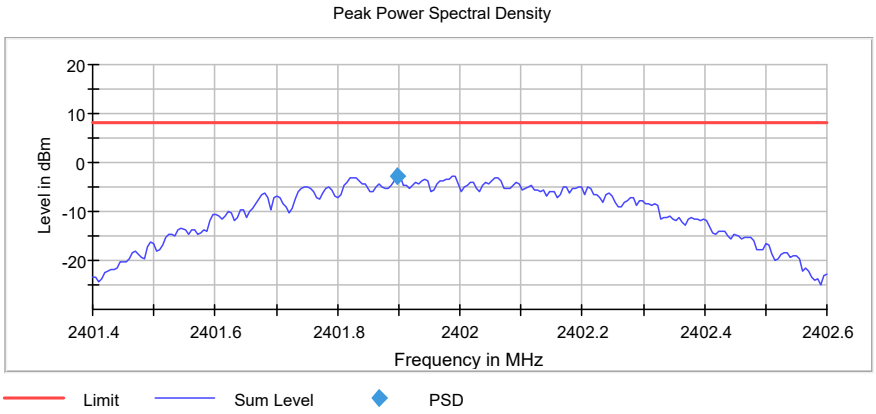
DUT Frequency (MHz)	Gated RMS (dBm)	Limit Max (dBm)	Gated EIRP (dBm)	Duty Cycle	Result
2480.000000	6.7	30.0	9.0	100.000	PASS



Peak Power Spectral Density

Result

DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
2402.000000	2401.897071	-2.734	8.0	PASS



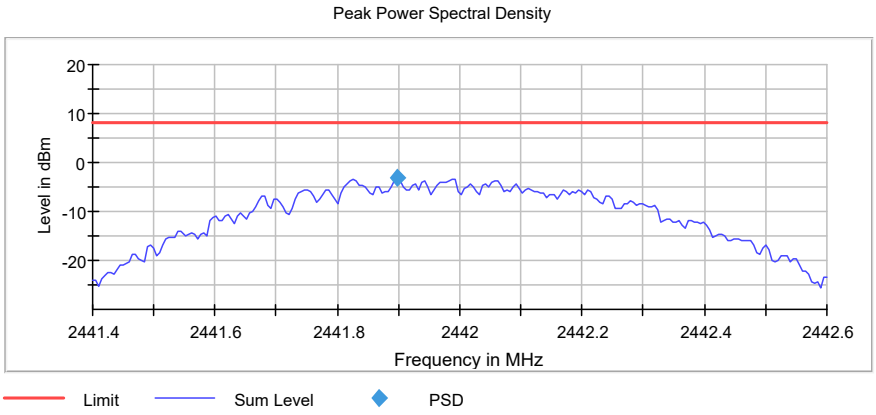
Peak Power Spectral Density

Result

DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
2442.000000	2441.897071	-3.276	8.0	PASS

Ports

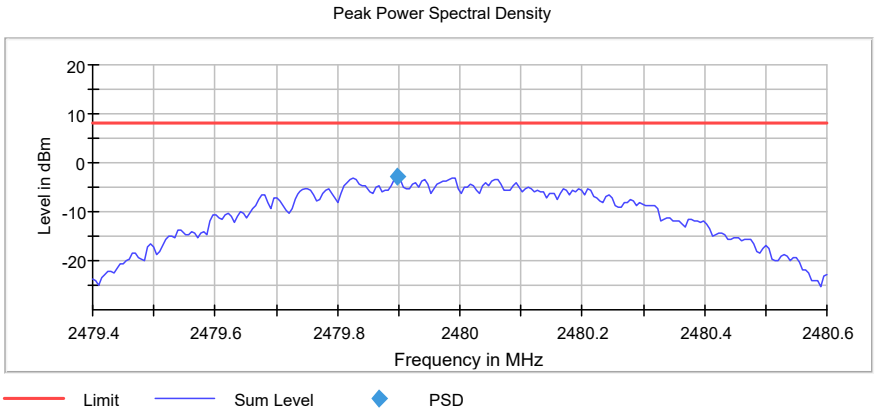
Port	State
1	used



Peak Power Spectral Density

Result

DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
2480.000000	2479.897071	-2.956	8.0	PASS

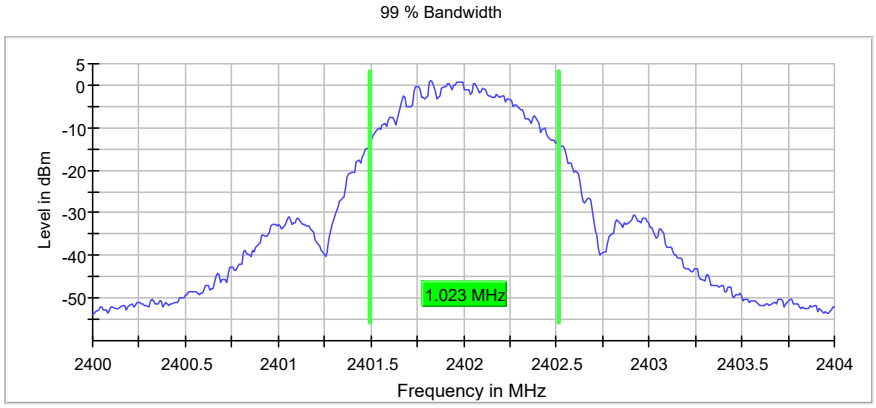


Occupied Channel Bandwidth 99%

99 % Bandwidth

DUT Frequency (MHz)	Bandwidth (MHz)	Limit Min (MHz)	Limit Max (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)
2402.000000	1.022557	---	---	2401.493734	2402.516291

DUT Frequency (MHz)	Result
2402.000000	PASS

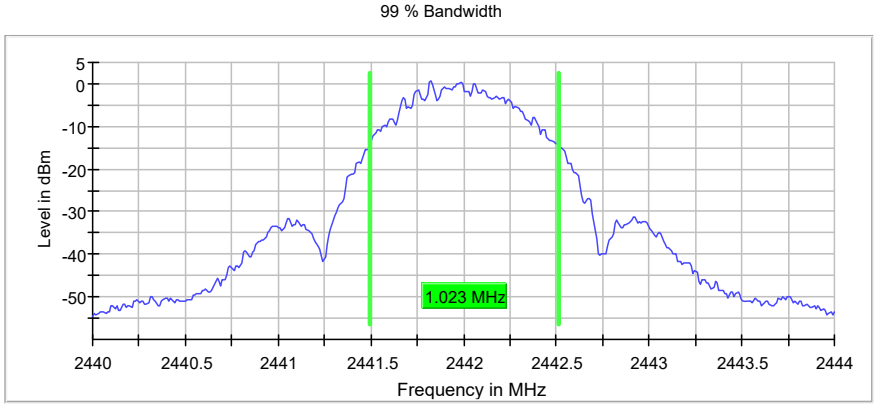


Occupied Channel Bandwidth 99%

99 % Bandwidth

DUT Frequency (MHz)	Bandwidth (MHz)	Limit Min (MHz)	Limit Max (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)
2442.000000	1.022557	---	---	2441.493734	2442.516291

DUT Frequency (MHz)	Result
2442.000000	PASS

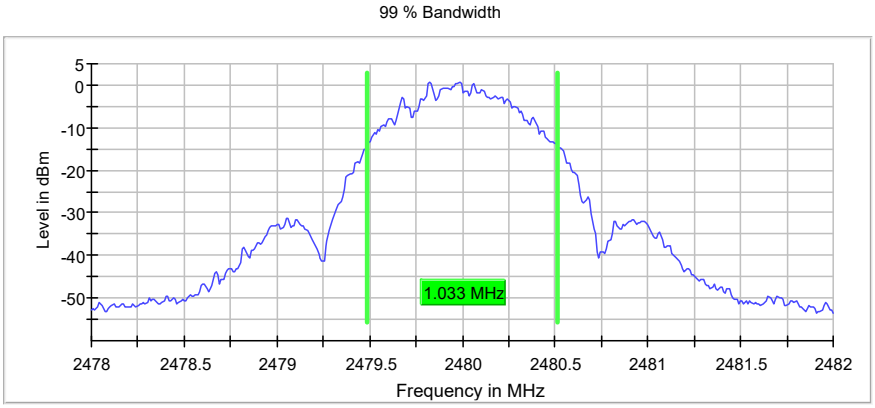


Occupied Channel Bandwidth 99%

99 % Bandwidth

DUT Frequency (MHz)	Bandwidth (MHz)	Limit Min (MHz)	Limit Max (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)
2480.000000	1.032582	---	---	2479.483709	2480.516291

DUT Frequency (MHz)	Result
2480.000000	PASS



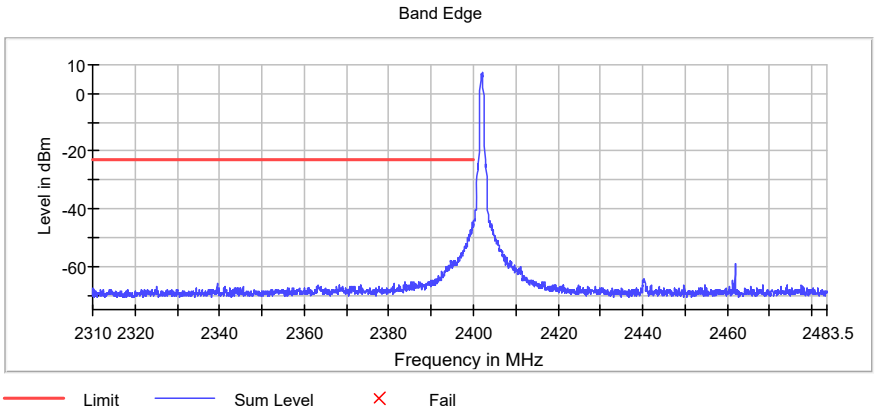
Band Edge low

Result

DUT Frequency (MHz)	Result
2402.000000	PASS

Measurements

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.799889	-44.7	21.8	-22.9	PASS
2399.849917	-44.8	21.8	-22.9	PASS
2399.899944	-45.4	22.5	-22.9	PASS
2399.749861	-46.1	23.2	-22.9	PASS
2399.949972	-46.5	23.6	-22.9	PASS
2399.599778	-47.0	24.1	-22.9	PASS
2399.699833	-47.1	24.2	-22.9	PASS
2399.549750	-47.4	24.5	-22.9	PASS
2399.499722	-47.5	24.6	-22.9	PASS
2399.349639	-47.5	24.6	-22.9	PASS
2399.649805	-47.6	24.7	-22.9	PASS
2399.299611	-47.7	24.8	-22.9	PASS
2399.449694	-48.3	25.3	-22.9	PASS
2399.249583	-48.3	25.4	-22.9	PASS
2398.799333	-48.8	25.9	-22.9	PASS



21. Radiated Emissions Tests

EUT Information	
Manufacturer	Milwaukee Electric Tool Corporation
Product	Sander Tool (Radiated Sample)
Model No.	2837-20
Serial No.	3010092D
Mode	BLE @ 2402MHz BLE @ 2442MHz BLE @ 2480MHz

Test Setup Details	
Setup Format	Tabletop
Type of Test Site	Semi-Anechoic Chamber
Test Site Used	Room 29
Type of Antennas Used	Below 1GHz: Bilog (or equivalent) 1 – 18GHz: Double-Ridged Waveguide (or equivalent) Above 18GHz: Horn (or equivalent)
Notes	N/a

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

Requirements
Per FCC 15.247, Section (b)(3) and ISED RSS-247, Section 5.4(d), for systems using digital modulation, the maximum peak conducted output power shall not exceed 1 watt. Per FCC 15.247, Section (b)(4), and ISED RSS-247, Section 5.4(d), the conducted output power limit is based on the use of antennas with directional gains that do not exceed 6dBi. If transmitting antennas of directional gain greater than 6dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values, by the amount in dB that the directional gain of the antenna exceeds 6dBi.
Per FCC 15.247, Section (d), and ISED RSS-247, Section 5.5, in any 100kHz 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 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated emissions measurement. Attenuation below the general limits specified in §15.209(a) is not required. Radiated Emissions in Restricted Bands: Per 15.247, Section (d), radiated emissions which fall in the restricted bands, as defined in FCC 15.205, Section (a), must comply with the radiated emission limits specified in FCC 15.209, Section (a). Per ISED RSS-247, Section 3.3, radiated emissions which fall in the restricted bands, as defined in ISED RSS-Gen, Section 8.10, must comply with the radiated emission limits specified in RSS-Gen, Section 8.9.
High Band Edge: Per 15.247, Section (d), radiated emissions which fall in the restricted band beginning at 2483.5MHz, as defined in FCC 15.205, Section (a), must comply with the radiated emission limits specified in FCC 15.209, Section (a). Per ISED RSS-247, Section 3.3, radiated emissions which fall in the restricted band beginning at 2483.5MHz, as defined in ISED RSS-Gen, Section 8.10, must comply with the radiated emission limits specified in RSS-Gen, Section 8.9.

Procedures
C63.10 Annex G and Section 11.9.1.1: 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. a) The following settings were employed on the EMI Test Receiver: 1) Center Frequency = Transmit frequency of EUT 2) Span = ≥ 3 x RBW 3) RBW = ≥ DTS Bandwidth 4) VBW = ≥ 3 x RBW 5) Number of points in sweep = ≥ (2 x span /RBW) 6) Sweep time = Auto 7) Detector = Peak 8) Trace = Max hold

b) Allow trace to stabilize and use peak marker function to determine the peak amplitude level.

c) The equivalent power was determined using equation G.1 in C63.10 to convert field intensity levels measured at 3 meters into EIRP readings.

C63.10-2013 Section 11.11

Radiated measurements were performed in a 32ft. x 20ft. x 14ft. high shielded enclosure. The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All powerlines and signal lines entering the enclosure pass through filters on the enclosure wall. The powerline filters prevent extraneous signals from entering the enclosure on these leads.

Preliminary radiated emissions tests were performed to determine the emission characteristics of the EUT. For the preliminary test, a broadband measuring antenna was positioned at a 3 meter distance from the EUT. The entire frequency range from 30MHz to 25GHz was investigated using a peak detector function.

The final radiated emission tests were then manually performed over the frequency range of 30MHz to 25GHz.

1) The field strength of the fundamental was measured using a double ridged waveguide antenna. The waveguide antenna was positioned at a 3 meter distance from the EUT. The EUT was placed on a 1.5 meter high non-conductive stand and set to transmit. A peak detector with a resolution bandwidth of 100kHz was used on the spectrum analyzer.

2) The field strengths of all of the harmonics not in the restricted band were then measured using a double-ridged waveguide antenna. The waveguide antenna was positioned at a 3 meter distance from the EUT. The EUT was placed on a 1.5 meter high non-conductive stand and set to transmit. A peak detector with a resolution bandwidth of 100kHz was used on the spectrum analyzer.

3) To ensure that maximum or worst case emission levels at the fundamental and harmonics were measured, the following steps were taken when measuring the fundamental emissions and the spurious emissions:

    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 for each antenna polarization to maximize the readings.

    d) In instances where it was necessary to use a shortened cable between the measuring antenna and the spectrum analyzer, the measuring antenna was not raised or lowered to ensure maximized readings. Instead, the EUT was rotated through all axis to ensure the maximum readings were recorded for the EUT.

4) All harmonics not in the restricted bands must be at least 20dB below levels measured at the fundamental. However, attenuation below the general limits specified in §15.209(a) is not required.

<u>Radiated Emissions in Restricted Bands:</u>

C63.10-2013 Section 11.12

1) The field strengths of all emissions below 1 GHz were measured using a bi-log antenna. The bi-log antenna was positioned at a 3 meter distance from the EUT. The EUT was placed on an 80 cm high non-conductive stand and set to transmit. A peak detector with a resolution bandwidth of 100 kHz was used on the spectrum analyzer.

2) The field strengths of all emissions above 1 GHz were measured using a double-ridged waveguide antenna. The waveguide antenna was positioned at a 3 meter distance from the EUT. The EUT

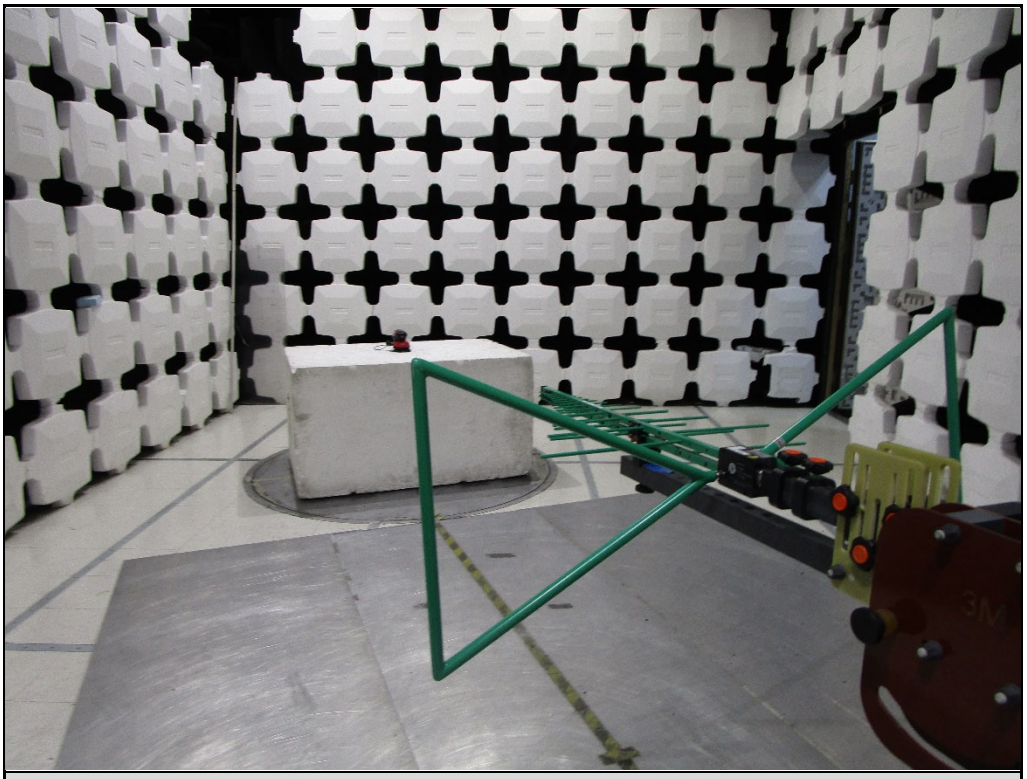
was placed on a 1.5 meter high non-conductive stand and set to transmit. A peak detector with a resolution bandwidth of 1 MHz was used on the spectrum analyzer.

3) To ensure that maximum or worst case emission levels were measured, the following steps were taken when taking all measurements:
    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 for each antenna polarization to maximize the readings.
    d) In instances where it was necessary to use a shortened cable between the measuring antenna and the spectrum analyzer, the measuring antenna was not raised or lowered to ensure maximized readings. Instead, the EUT was rotated through all axis to ensure the maximum readings were recorded for the EUT.
4) For all radiated emissions measurements below 1GHz, if the peak reading is below the limits listed in 15.209(a), no further measurements are required. If, however, the peak readings exceed the limits listed in 15.209(a), then the emissions are remeasured using a quasi-peak detector.
5) For all radiated emissions measurements above 1GHz, the peak readings must comply with the 15.35(b) limits. 15.35(b) states that when average radiated emissions measurements are specified, there also is a limit on the peak level of the radiated emissions. The limit on the peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. Therefore, all peak readings above 1GHz must be no greater than 20dB above the limits specified in 15.209(a).
6) Next, for all radiated emissions measurements above 1GHz, the resolution bandwidth was set to 1MHz. The analyzer was set to linear mode with a 10Hz video bandwidth in order to simulate an average detector. An average reading was taken.

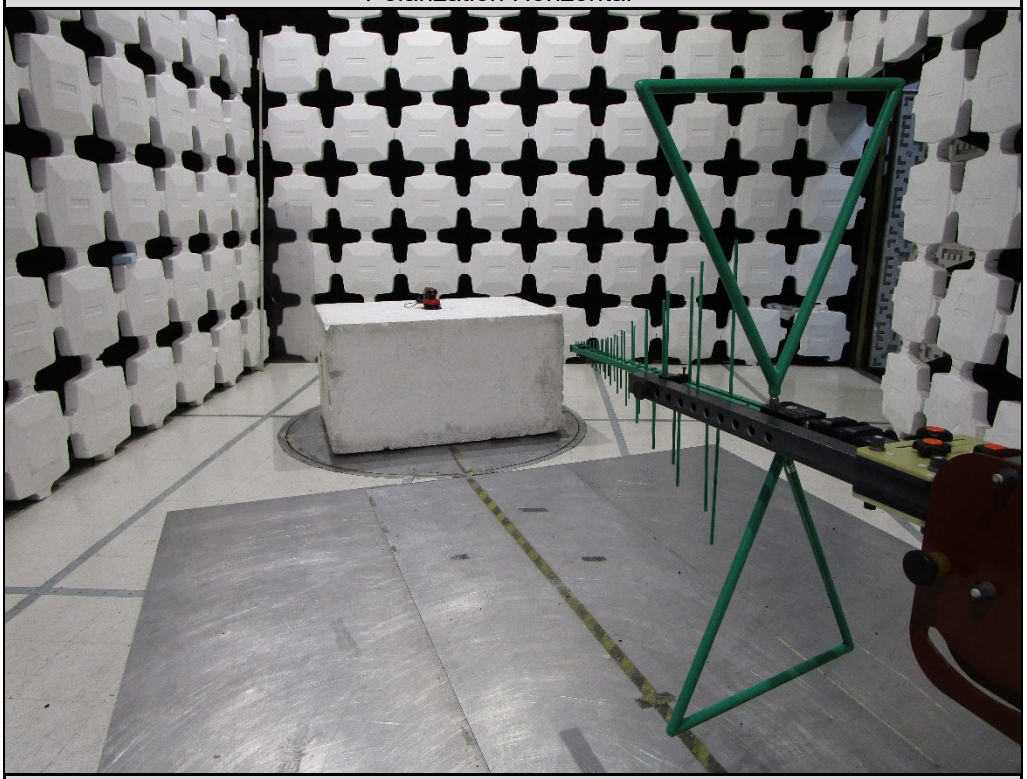
<u>High Band Edge:</u>

C63.10-2013 section 6.10.5:

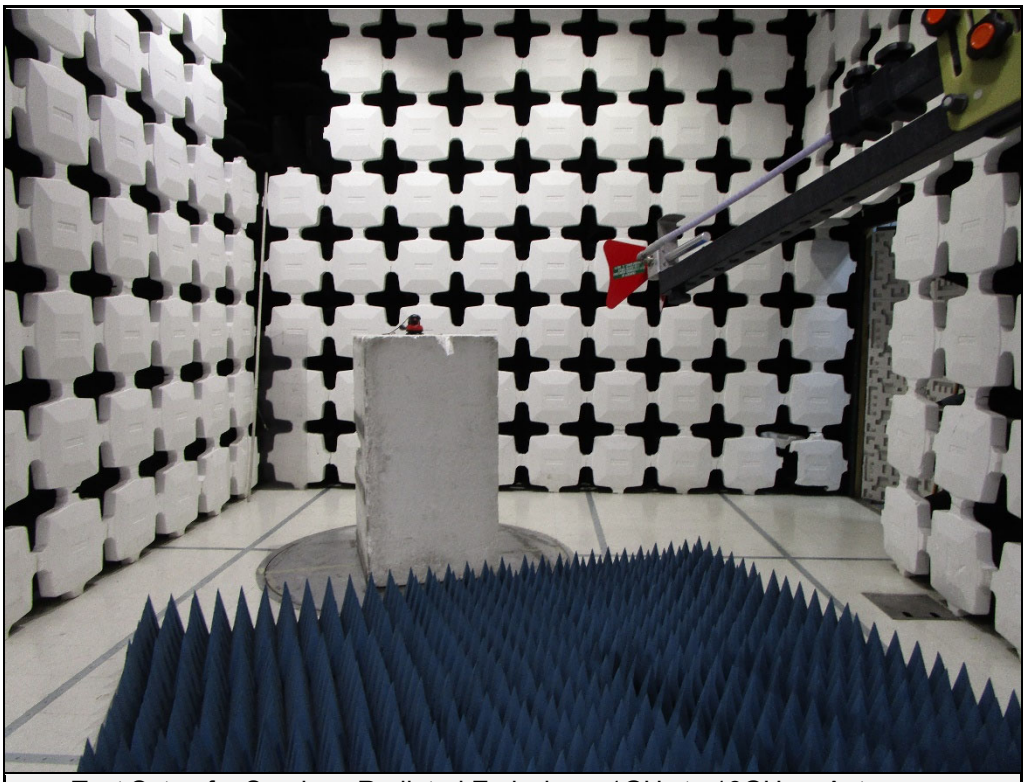
1) The EUT was set to transmit continuously at the channel closest to the high band-edge.
2) The waveguide antenna was positioned at a 3 meter distance from the EUT. The EUT was placed on a 1.5 meter high non-conductive stand and set to transmit. A peak detector with a resolution bandwidth of 1 MHz was used on the spectrum analyzer.
3) To ensure that maximum or worst case emission levels were measured, the following steps were taken when taking all measurements:
    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 for each antenna polarization to maximize the readings.
4) The peak readings must comply with the 15.35(b) limits. 15.35(b) states that when average radiated emissions measurements are specified, there also is a limit on the peak level of the radiated emissions. The limit on the peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test. Therefore, all peak readings above 1 GHz must be no greater than 20 dB above the limits specified in 15.209(a).
5) Next, the resolution bandwidth was set to 1MHz. The analyzer was set to linear mode with a 10Hz video bandwidth in order to simulate an average detector. An average reading was taken.



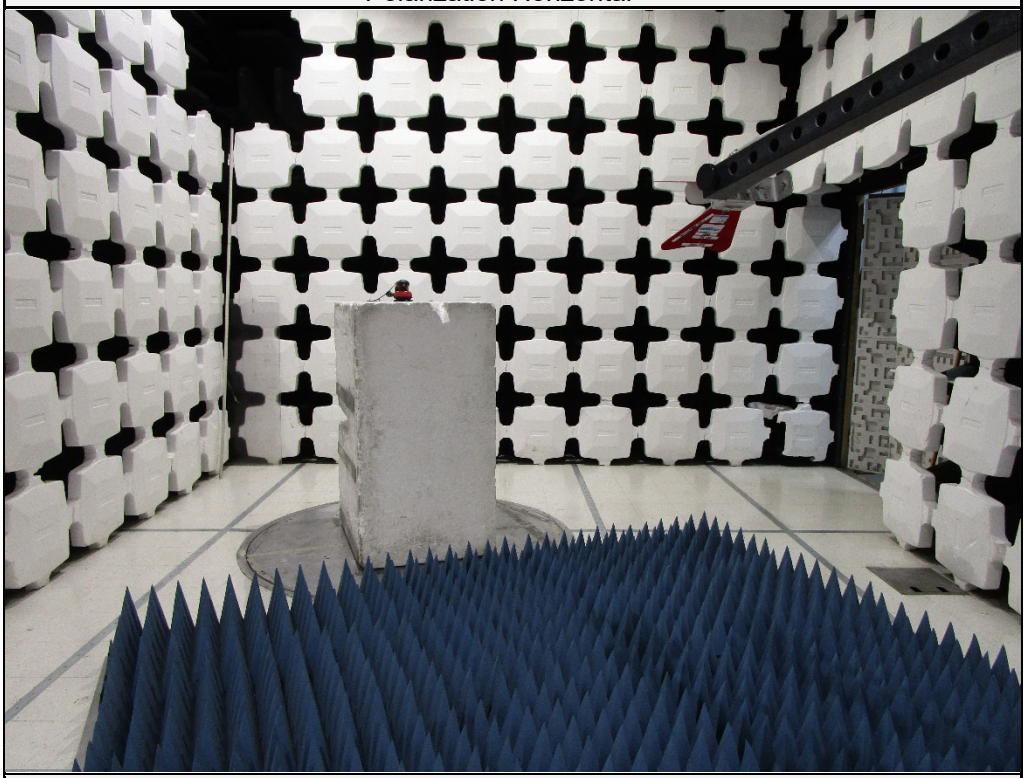
Test Setup for Spurious Radiated Emissions, 30MHz – 1GHz – Antenna Polarization Horizontal



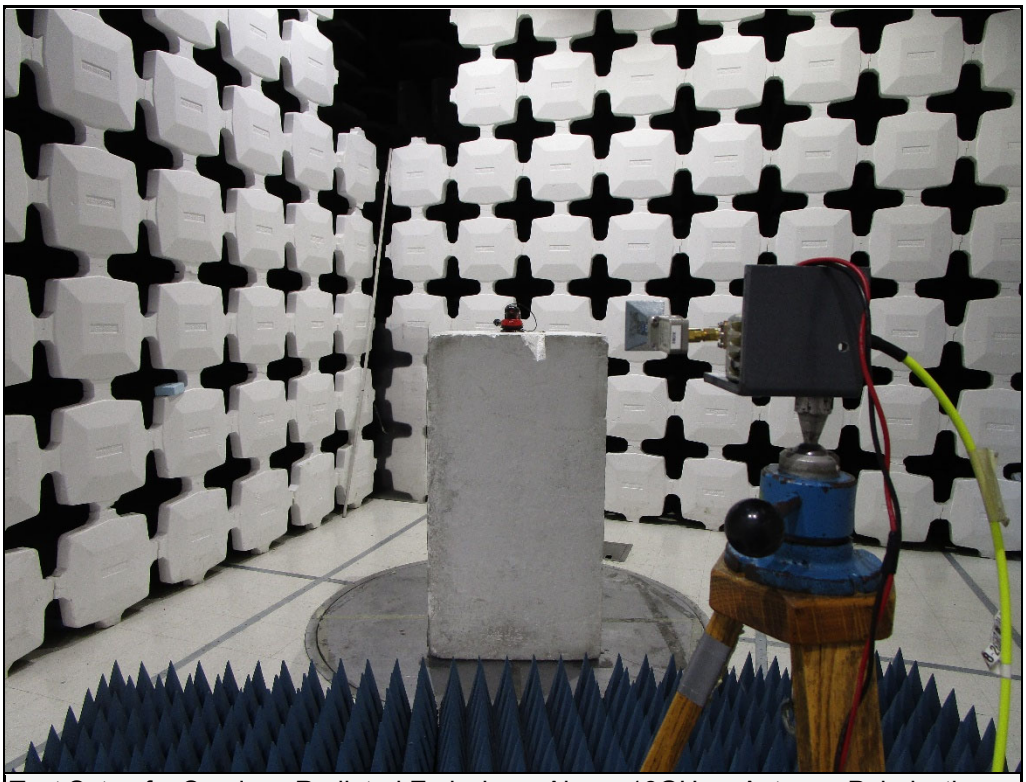
Test Setup for Spurious Radiated Emissions, 30MHz – 1GHz – Antenna Polarization Vertical



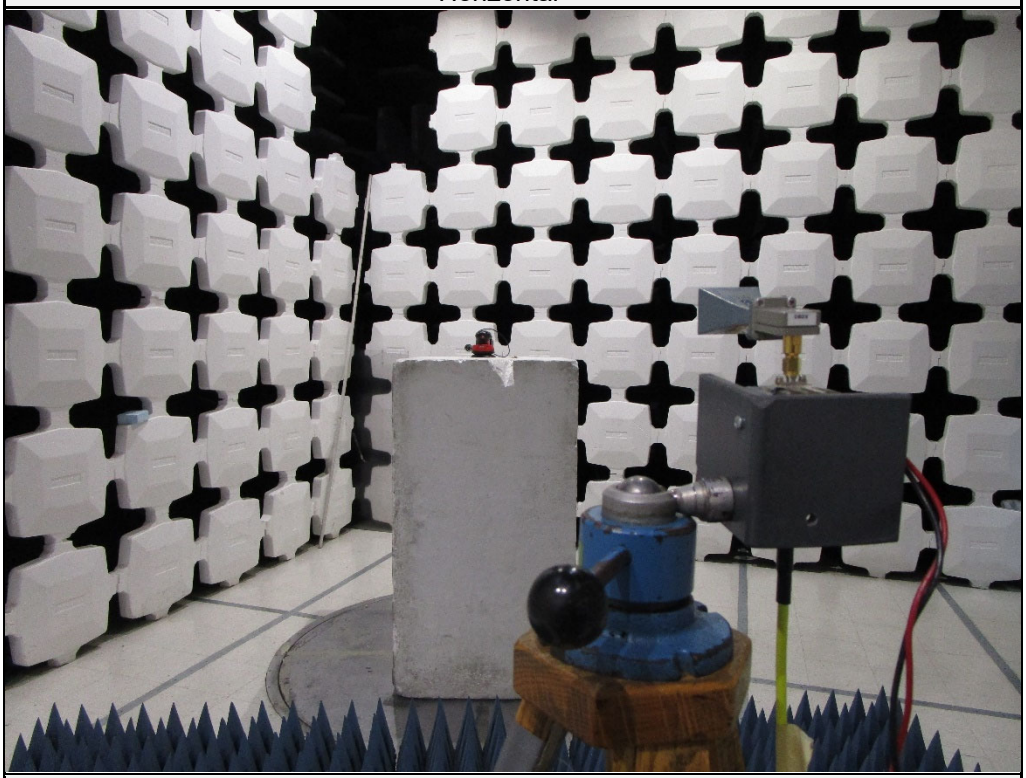
Test Setup for Spurious Radiated Emissions, 1GHz to 18GHz – Antenna Polarization Horizontal



Test Setup for Spurious Radiated Emissions, 1GHz to 18GHz – Antenna Polarization Vertical



Test Setup for Spurious Radiated Emissions, Above 18GHz – Antenna Polarization Horizontal



Test Setup for Spurious Radiated Emissions, Above 18GHz – Antenna Polarization Vertical

Test Details	
Manufacturer	Milwaukee Electric Tool Corporation
EUT	Sander Tool
Model No.	2837-20
Serial No.	3010092D
Mode	BLE @ 2402MHz BLE @ 2442MHz BLE @ 2480MHz
Result	Max EIRP = 7.24mW (8.6dBm)
Notes	None

Freq (MHz)	Ant Pol	Wide BW Meter Reading (dBµV)	Cable Factor (dB)	Antenna Factor (dB/m)	Pre Amp (dB)	Peak Total (dBµV/m)	EIRP (dBm)	Limit (dBm)	Margin (dB)
2402.00	H	68.3	2.6	32.6	0.0	103.5	8.2	36.0	-27.8
	V	66.4	2.6	32.6	0.0	101.6	6.3	36.0	-29.7
2442.00	H	68.6	2.6	32.6	0.0	103.9	8.6	36.0	-27.4
	V	64.3	2.6	32.6	0.0	99.6	4.3	36.0	-31.7
2480.00	H	66.2	2.7	32.7	0.0	101.6	6.3	36.0	-29.7
	V	62.7	2.7	32.7	0.0	98.1	2.8	36.0	-33.2

Peak Total (dBµV/m) = Meter Reading (dBµV) + CBL Fac (dB) + Ant Fac (dB/m) + Pre Amp (dB)

EIRP (dBm) = Peak Total (dBµV/m) – 95dB

Test Details	
Manufacturer	Milwaukee Electric Tool Corporation
EUT	Sander Tool
Model No.	2837-20
Serial No.	3010092D
Test	Peak Measurements in the Restricted Bands
Mode	BLE @ 2402MHz
Frequency Tested	2402MHz
Notes	None

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	Cable Factor (dB)	Antenna Factor (dB/m)	Pre Amp (dB)	Peak Total at 3m (dBµV/m)	Peak Total at 3m (µV/m)	Peak Limit at 3m (µV/m)	Margin (dB)
4804.00	H	52.2		3.7	34.3	-39.3	50.9	348.8	5000.0	-23.1
	V	50.3		3.7	34.3	-39.3	49.0	281.3	5000.0	-25.0
12010.00	H	49.8	*	6.1	38.8	-39.2	55.5	597.3	5000.0	-18.5
	V	50.2	*	6.1	38.8	-39.2	56.0	630.5	5000.0	-18.0
19216.00	H	38.2	*	2.0	40.4	-27.6	52.9	441.3	5000.0	-21.1
	V	38.3	*	2.0	40.4	-27.6	53.0	448.9	5000.0	-20.9

Test Details	
Manufacturer	Milwaukee Electric Tool Corporation
EUT	Sander Tool
Model No.	2837-20
Serial No.	3010092D
Test	Average Measurements in the Restricted Bands
Mode	BLE @ 2402MHz
Frequency Tested	2402MHz
Notes	None

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Duty Cycle Factor (dB)	Average Total at 3m (dBµV/m)	Average Total at 3m (µV/m)	Average Limit at 3m (µV/m)	Margin (dB)
4804.00	H	42.90		3.7	34.3	-39.3	0.0	41.6	120.0	500.0	-12.4
	V	38.51		3.7	34.3	-39.3	0.0	37.2	72.4	500.0	-16.8
12010.00	H	34.68	*	6.1	38.8	-39.2	0.0	40.4	105.1	500.0	-13.5
	V	34.70	*	6.1	38.8	-39.2	0.0	40.5	105.4	500.0	-13.5
19216.00	H	23.15	*	2.0	40.4	-27.6	0.0	37.9	78.2	500.0	-16.1
	V	23.24	*	2.0	40.4	-27.6	0.0	38.0	79.0	500.0	-16.0

Test Details	
Manufacturer	Milwaukee Electric Tool Corporation
EUT	Sander Tool
Model No.	2837-20
Serial No.	3010092D
Test	Peak Measurements in the Non-Restricted Bands
Mode	BLE @ 2402MHz
Frequency Tested	2402MHz
Notes	None

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	Cable Factor (dB)	Antenna Factor (dB/m)	Pre Amp (dB)	Peak Total at 3m (dBµV/m)	Peak Total at 3m (µV/m)	Peak Limit at 3m (µV/m)	Margin (dB)
7206.00	H	38.56	*	4.6	36.3	-39.4	40.1	100.8	13207.0	-42.3
	V	38.78	*	4.6	36.3	-39.4	40.3	103.4	13207.0	-42.1
9608.00	H	38.85	*	5.2	37.1	-39.3	41.9	124.4	13207.0	-40.5
	V	38.78	*	5.2	37.1	-39.3	41.8	123.4	13207.0	-40.6
14412.00	H	39.61	*	6.6	39.4	-38.3	47.4	233.2	13207.0	-35.1
	V	38.61	*	6.6	39.4	-38.3	46.4	207.8	13207.0	-36.1
16814.00	H	38.18	*	7.2	42.2	-37.5	50.1	319.4	13207.0	-32.3
	V	38.10	*	7.2	42.2	-37.5	50.0	316.5	13207.0	-32.4
21618.00	H	27.55	*	2.1	40.6	-25.3	45.0	177.5	13207.0	-37.4
	V	26.72	*	2.1	40.6	-25.3	44.2	161.3	13207.0	-38.3
24020.00	H	27.35	*	2.3	40.6	-25.2	45.0	178.5	13207.0	-37.4
	V	27.31	*	2.3	40.6	-25.2	45.0	177.6	13207.0	-37.4

Test Details	
Manufacturer	Milwaukee Electric Tool Corporation
EUT	Sander Tool
Model No.	2837-20
Serial No.	3010092D
Test	Peak Measurements in the Restricted Bands
Mode	BLE @ 2442MHz
Frequency Tested	2442MHz
Notes	None

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	Cable Factor (dB)	Antenna Factor (dB/m)	Pre Amp (dB)	Peak Total at 3m (dBµV/m)	Peak Total at 3m (µV/m)	Peak Limit at 3m (µV/m)	Margin (dB)
4884.00	H	53.4		3.7	34.2	-39.3	52.0	397.3	5000.0	-22.0
	V	50.9		3.7	34.2	-39.3	49.4	296.6	5000.0	-24.5
7326.00	H	55.7		4.7	36.3	-39.4	57.3	729.9	5000.0	-16.7
	V	54.8		4.7	36.3	-39.4	56.3	655.8	5000.0	-17.6
12210.00	H	50.1	*	6.1	38.9	-39.1	55.9	625.9	5000.0	-18.0
	V	49.3	*	6.1	38.9	-39.1	55.1	570.8	5000.0	-18.8
19536.00	H	37.9	*	2.0	40.4	-26.7	53.5	475.1	5000.0	-20.4
	V	37.9	*	2.0	40.4	-26.7	53.6	476.2	5000.0	-20.4

Test Details	
Manufacturer	Milwaukee Electric Tool Corporation
EUT	Sander Tool
Model No.	2837-20
Serial No.	3010092D
Test	Average Measurements in the Restricted Bands
Mode	BLE @ 2442MHz
Frequency Tested	2442MHz
Notes	None

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Duty Cycle Factor (dB)	Average Total at 3m (dBµV/m)	Average Total at 3m (µV/m)	Average Limit at 3m (µV/m)	Margin (dB)
4884.00	H	46.55		3.7	34.2	-39.3	0.0	45.1	180.4	500.0	-8.9
	V	40.24		3.7	34.2	-39.3	0.0	38.8	87.2	500.0	-15.2
7326.00	H	48.41		4.7	36.3	-39.4	0.0	49.9	314.2	500.0	-4.0
	V	46.56		4.7	36.3	-39.4	0.0	48.1	253.9	500.0	-5.9
12210.00	H	34.41	*	6.1	38.9	-39.1	0.0	40.3	103.0	500.0	-13.7
	V	34.46	*	6.1	38.9	-39.1	0.0	40.3	103.6	500.0	-13.7
19536.00	H	22.45	*	2.0	40.4	-26.7	0.0	38.1	80.6	500.0	-15.9
	V	22.70	*	2.0	40.4	-26.7	0.0	38.4	82.9	500.0	-15.6

Test Details	
Manufacturer	Milwaukee Electric Tool Corporation
EUT	Sander Tool
Model No.	2837-20
Serial No.	3010092D
Test	Peak Measurements in the Non-Restricted Bands
Mode	BLE @ 2442MHz
Frequency Tested	2442MHz
Notes	None

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	Cable Factor (dB)	Antenna Factor (dB/m)	Pre Amp (dB)	Peak Total at 3m (dBµV/m)	Peak Total at 3m (µV/m)	Peak Limit at 3m (µV/m)	Margin (dB)
9768.00	H	39.24	*	5.2	37.2	-39.3	42.4	132.5	13946.2	-40.4
	V	38.26	*	5.2	37.2	-39.3	41.5	118.4	13946.2	-41.4
14652.00	H	38.66	*	6.7	39.5	-38.2	46.7	215.4	13946.2	-36.2
	V	38.04	*	6.7	39.5	-38.2	46.0	200.6	13946.2	-36.8
17094.00	H	38.71	*	7.3	42.4	-37.6	50.8	348.6	13946.2	-32.0
	V	38.13	*	7.3	42.4	-37.6	50.3	326.1	13946.2	-32.6
21978.00	H	26.47	*	2.1	40.6	-25.9	43.3	146.4	13946.2	-39.6
	V	27.06	*	2.1	40.6	-25.9	43.9	156.7	13946.2	-39.0
24420.00	H	26.30	*	2.2	40.6	-25.6	43.5	149.6	13946.2	-39.4
	V	27.41	*	2.2	40.6	-25.6	44.6	170.0	13946.2	-38.3

Test Details	
Manufacturer	Milwaukee Electric Tool Corporation
EUT	Sander Tool
Model No.	2837-20
Serial No.	3010092D
Test	Peak Measurements in the Restricted Bands
Mode	BLE @ 2480MHz
Frequency Tested	2480MHz
Notes	None

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	Cable Factor (dB)	Antenna Factor (dB/m)	Pre Amp (dB)	Peak Total at 3m (dBµV/m)	Peak Total at 3m (µV/m)	Peak Limit at 3m (µV/m)	Margin (dB)
4960.00	H	55.1		3.7	34.1	-39.3	53.6	478.2	5000.0	-20.4
	V	53.1		3.7	34.1	-39.3	51.6	381.6	5000.0	-22.3
7440.00	H	54.6		4.7	36.3	-39.4	56.3	649.7	5000.0	-17.7
	V	53.8		4.7	36.3	-39.4	55.4	586.5	5000.0	-18.6
12400.00	H	48.6	*	6.1	38.9	-39.0	54.6	536.7	5000.0	-19.4
	V	48.6	*	6.1	38.9	-39.0	54.5	533.0	5000.0	-19.4
19840.00	H	37.9	*	1.9	40.4	-26.8	53.5	473.4	5000.0	-20.5
	V	37.8	*	1.9	40.4	-26.8	53.4	466.9	5000.0	-20.6
22320.00	H	37.3	*	1.9	40.6	-26.0	53.9	493.1	5000.0	-20.1
	V	37.6	*	1.9	40.6	-26.0	54.1	508.1	5000.0	-19.9

Test Details	
Manufacturer	Milwaukee Electric Tool Corporation
EUT	Sander Tool
Model No.	2837-20
Serial No.	3010092D
Test	Average Measurements in the Restricted Bands
Mode	BLE @ 2480MHz
Frequency Tested	2480MHz
Notes	None

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Duty Cycle Factor (dB)	Average Total at 3m (dBµV/m)	Average Total at 3m (µV/m)	Average Limit at 3m (µV/m)	Margin (dB)
4960.00	H	48.82		3.7	34.1	-39.3	0.0	47.3	232.9	500.0	-6.6
	V	45.28		3.7	34.1	-39.3	0.0	43.8	154.9	500.0	-10.2
7440.00	H	45.80		4.7	36.3	-39.4	0.0	47.4	234.8	500.0	-6.6
	V	45.16		4.7	36.3	-39.4	0.0	46.8	218.1	500.0	-7.2
12400.00	H	33.82	*	6.1	38.9	-39.0	0.0	39.8	97.4	500.0	-14.2
	V	33.66	*	6.1	38.9	-39.0	0.0	39.6	95.7	500.0	-14.4
19840.00	H	22.99	*	1.9	40.4	-26.8	0.0	38.6	84.9	500.0	-15.4
	V	22.74	*	1.9	40.4	-26.8	0.0	38.3	82.5	500.0	-15.7
22320.00	H	22.84	*	1.9	40.6	-26.0	0.0	39.4	93.1	500.0	-14.6
	V	23.14	*	1.9	40.6	-26.0	0.0	39.7	96.4	500.0	-14.3

Test Details	
Manufacturer	Milwaukee Electric Tool Corporation
EUT	Sander Tool
Model No.	2837-20
Serial No.	3010092D
Test	Peak Measurements in the Non-Restricted Bands
Mode	BLE @ 2480MHz
Frequency Tested	2480MHz
Notes	None

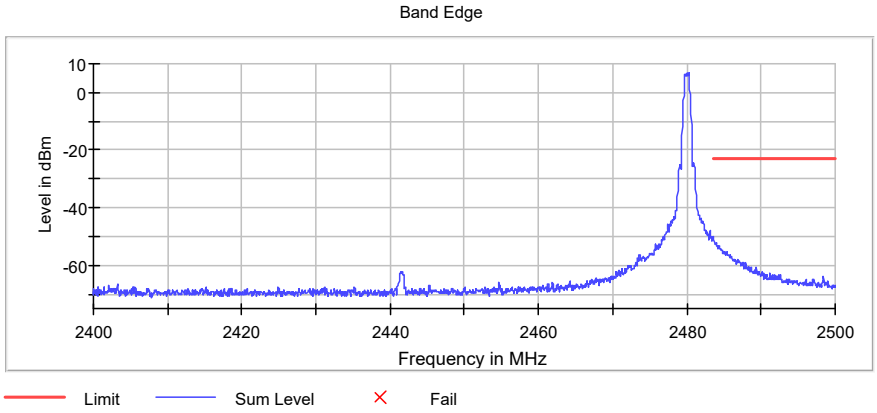
Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	Cable Factor (dB)	Antenna Factor (dB/m)	Pre Amp (dB)	Peak Total at 3m (dBµV/m)	Peak Total at 3m (µV/m)	Peak Limit at 3m (µV/m)	Margin (dB)
9920.00	H	39.59	*	5.3	37.2	-39.2	42.8	138.2	10774.7	-37.8
	V	38.07	*	5.3	37.2	-39.2	41.3	116.0	10774.7	-39.4
14880.00	H	39.35	*	6.8	39.9	-38.2	47.9	247.3	10774.7	-32.8
	V	38.92	*	6.8	39.9	-38.2	47.4	235.3	10774.7	-33.2
17360.00	H	39.18	*	7.4	42.5	-37.7	51.3	367.6	10774.7	-29.3
	V	39.01	*	7.4	42.5	-37.7	51.1	360.5	10774.7	-29.5
24800.00	H	27.35	*	2.3	40.6	-25.0	45.3	183.9	10774.7	-35.4
	V	27.29	*	2.3	40.6	-25.0	45.2	182.6	10774.7	-35.4

Test Details	
Manufacturer	Milwaukee Electric Tool Corporation
EUT	Sander Tool
Model No.	2837-20
Serial No.	3010092D
Test	High band edge Measurements
Mode	BLE @ 2480MHz
Frequency Tested	2480MHz
Notes	None

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	Cable Factor (dB)	Antenna Factor (dB/m)	Pre Amp (dB)	Peak Total at 3m (dBµV/m)	Peak Total at 3m (µV/m)	Peak Limit at 3m (µV/m)	Margin (dB)
2483.50	H	27.1		2.7	32.7	0.0	62.5	1336.2	5000.0	-11.5
	V	23.6		2.7	32.7	0.0	59.0	893.1	5000.0	-15.0

Test Details	
Manufacturer	Milwaukee Electric Tool Corporation
EUT	Sander Tool
Model No.	2837-20
Serial No.	3010092D
Test	High Band-Edge – Average Readings
Mode	BLE @ 2480MHz
Frequency Tested	2480MHz
Notes	None

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Duty Cycle Factor (dB)	Average Total at 3m (dBµV/m)	Average Total at 3m (µV/m)	Average Limit at 3m (µV/m)	Margin (dB)
2483.50	H	12.56		2.7	32.7	0.0	0.0	47.9	249.4	500.0	-6.0
	V	10.17		2.7	32.7	0.0	0.0	45.5	189.4	500.0	-8.4



22. Scope of Accreditation

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

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ELECTRICAL

Valid To: June 30, 2025 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 *(Max Voltage 60V/Max current 100A)*	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; ECE Regulation 10.06 Annex 10
Electrostatic Discharge (ESD) *(Up to +/-25kV)*	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, CE 430, CE440)

Test Technology:	Test Method(s)[1]:
Radiated Emissions Anechoic *(Up to 6GHz)*	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, RE320);
Vehicle Radiated Emissions	CISPR 12; CISPR 36; ICES-002; ECE Regulation 10.06 Annex 5
Bulk Current Injection (BCI) *(1 to 400MHz 500mA)*	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); ECE Regulation 10.06 Annex 9
Radiated Immunity Anechoic *(Up to 6GHz and 200V/m)* *(Including Radar Pulse 600V/m)*	ISO 11452-2; 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; ECE Regulation 10.06 Annex 9
Radiated Immunity Magnetic Field	ISO 11452-8; FMC 1278 (RI140)
Radiated Immunity Reverb *(360MHz to 6GHz and 100V/m)*	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)* *(Up to 6GHz and 20W)*	ISO 11452-9; EMC-CS-2009.1 (RI115); FMC1278 (RI115); GMW 3097, Sec 3.4.4
Vehicle Radiated Immunity (ALSE)	ISO 11451-2; ECE Regulation 10.06 Annex 6
Vehicle Product Specific EMC Standards	EN 14982; EN ISO 13309; ISO 13766; EN 50498; EC Regulation No. 2015/208; EN 55012
Electrical Loads	ISO 16750-2
Stripline	ISO 11452-5
Transverse Electromagnetic (TEM) Cell	ISO 11452-3

Test Technology:	Test Method(s)[1]:
Emissions	
Radiated and Conducted (3m Semi-anechoic chamber, up to 40 GHz)	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; KS C 9811; CNS 13803 (1997, 2003); CISPR 14-1; EN 55014-1; AS/NZS CISPR 14.1; CISPR 16-2-1 (2008); CISPR 16-2-1; KS C 9814-1; 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; KS C 9832; KN 32; ECE Regulation 10.06 Annex 7 (Broadband); ECE Regulation 10.06 Annex 8 (Narrowband); ECE Regulation 10.06 Annex 14 (Conducted)
Cellular Radiated Spurious Emissions	ETSI TS 151 010-1 GSM; 3GPP TS 51.010-1, Sec 12; ETSI TS 134 124 UMTS; 3GPP TS 34.124; ETSI TS 136 124 LTE; E-UTRA; 3GPP TS 36.124
Current Harmonics	IEC 61000-3-2; IEC 61000-3-12; EN 61000-3-2; KN 61000-3-2; KS C 9610-3-2; ECE Regulation 10.06 Annex 11
Flicker and Fluctuations	IEC 61000-3-3; IEC 61000-3-11; EN 61000-3-3; KN 61000-3-3; KS C 9610-3-3; ECE Regulation 10.06 Annex 12
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; KS C 9610-4-2; 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; KS C 9610-4-3; IEEE C37.90.2 2004

Test Technology:	Test Method(s)[1]:
Immunity (cont'd)	
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; KS C 9610-4-4; ECE Regulation 10.06 Annex 15
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; KS C 9610-4-5; IEEE C37.90.1 2012; IEEE STD C62.41.2 2002; ECE Regulation 10.06 Annex 16
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; KS C 9610-4-6
Power Frequency Magnetic Field Immunity (*Down to 3 A/m*)	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; KS C 9610-4-8
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; KS C 9610-4-11
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; IEEE STD C62.41.2 2002

Test Technology:	Test Method(s)[1]:
Generic and Product Specific EMC Standards	IEC/EN 61000-6-1; AS/NZS 61000-6-1; KN 61000-6-1; KS C 9610-6-1; IEC/EN 61000-6-2; AS/NZS 61000-6-2; KN 61000-6-2; KS C 9610-6-2; IEC/EN 61000-6-3; AS/NZS 61000-6-3; KN 61000-6-3; KS C 9610-6-3; IEC/EN 61000-6-4; AS/NZS 61000-6-4; KN 61000-6-4; KS C 9610-6-4; EN 50130-4; EN 61326-1; EN 50121-3-2; EN 12895; EN 50270; EN 50491-1; EN 50491-2; EN 50491-3; EN 55015; EN 60730-1; EN 60945; IEC 60533; EN 61326-2-6; EN 61800-3; IEC/CISPR 14-2; EN 55014-2; AS/NZS CISPR 14.2; KN 14-2; KS C 9814-2; IEC/CISPR 24; AS/NZS CISPR 24; EN 55024; KN 24; IEC/CISPR 35; AS/NZS CISPR 35; EN 55035; KN 35; KS C 9835; 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 301 489-20
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 300 220-3-1; ETSI EN 300 220-3-2; 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 303 413; ETSI EN 302 502; EN 303 340; EN 303 345-2; EN 303 345-3; EN 303 345-4
Canadian Radio Tests	RSS-102 measurement (RF Exposure Evaluation); RSS-102 measurement (Nerve Stimulation); SPR-002; 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-247; RSS-248; RSS-251; RSS-252; RSS-287; RSS-288; RSS-310; RSS-GEN
Mexico Radio Tests	IFT-008-2015; NOM-208-SCFI-2016
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 (July 15, 2020)

Test Technology:	Test Method(s)[1]:
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; KS X 3124; KS X 3125; KS X 3130; KS X 3126; KS X 3129
Vietnam Radio Test Standards	QCVN 47:2015/BTTTT; QCVN 54:2020/BTTTT; QCVN 55:2011/BTTTT; QCVN 65:2013/BTTTT; QCVN 73:2013/BTTTT; QCVN 74:2020/BTTTT; QCVN 112:2017/BTTTT; QCVN 117:2020//BTTTT
Vietnam EMC Test Standards	QCVN 18:2014/BTTTT; QCVN 86:2019/BTTTT; QCVN 96:2015/BTTTT; QCVN 118:2018/BTTTT
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 (using ANSI/TIA-603-E, TIA-102.CAAA-E, ANSI C63.26:2015)
OTA (Over the Air) Performance GSM, GPRS, EGPRS UMTS (W-CDMA) LTE including CAT M1 A-GPS for UMTS/GSM LTS A-GPS, A-GLONASS, SIB8/SIB16 Large Device/Laptop/Tablet Testing Integrated Device Testing WiFi 802.11 a/b/g/n/a	CTIA Test Plan for Wireless Device Over-the-Air Performance (Method for Measurement for Radiated Power and Receiver Performance) V3.8.2; CTIA Test Plan for RF Performance Evaluation of WiFi Mobile Converged Devices V2.1.0

Test Technology:	Test Method(s)[1]:
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	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;
DC Voltage / Current (1mV to 15 kV) / (1µA to 10A)	FAA EB 67D
Power Factor / Efficiency / Crest Factor (Power to 30kW)	
Resistance (1mΩ to 4000MΩ)	
Surge (Up to 10 kV / 5 kA) (Combination Wave and Ring Wave)	

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, edition, version, etc. is not identified in the scope of accreditation, laboratories may use the version that immediately precedes the current version for a period of one year from the date of publication of the standard measurement method, per part C., Section 1 of A2LA *R101 - General Requirements - Accreditation of ISO-IEC 17025 Laboratories*.

Testing Activities Performed in Support of FCC Certification in Accordance with 47 Code of Federal Regulations and FCC KDB 974614, Appendix A, Table A.1[2]

Rule Subpart/Technology	Test Method	Maximum Frequency (MHz)
Unintentional Radiators Part 15B	ANSI C63.4:2014	40000
Industrial, Scientific, and Medical Equipment Part 18	FCC MP-5 (February 1986)	40000
Intentional Radiators Part 15C	ANSI C63.10:2013	40000

Testing Activities Performed in Support of FCC Certification in Accordance with 47 Code of Federal Regulations and FCC KDB 974614, Appendix A, Table A.1[2]

Rule Subpart/Technology	Test Method	Maximum Frequency (MHz)
Unlicensed Personal Communication Systems Devices Part 15D	ANSI C63.17:2013	40000
U-NII without DFS Intentional Radiators Part 15E	ANSI C63.10:2013	40000
U-NII with DFS Intentional Radiators Part 15E	FCC KDB 905462 D02 (v02)	40000
UWB Intentional Radiators Part 15F	ANSI C63.10:2013	40000
BPL Intentional Radiators Part 15G	ANSI C63.10:2013	40000
White Space Device Intentional Radiators Part 15H	ANSI C63.10:2013	40000
Commercial Mobile Services (FCC Licensed Radio Service Equipment) Parts 22 (cellular), 24, 25 (below 3 GHz), and 27	ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015	40000
General Mobile Radio Services (FCC Licensed Radio Service Equipment) 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
Citizens Broadband Radio Services (FCC Licensed Radio Service Equipment) Part 96	ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015	40000
Maritime and Aviation Radio Services Parts 80 and 87	ANSI/TIA-603-E; ANSI C63.26:2015	40000
Microwave and Millimeter Bands Radio Services 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

Testing Activities Performed in Support of FCC Certification in Accordance with 47 Code of Federal Regulations and FCC KDB 974614, Appendix A, Table A.1[2]

Rule Subpart/Technology	Test Method	Maximum Frequency (MHz)
Broadcast Radio Services		
Parts 73 and 74 (below 3 GHz)	ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015	40000
Signal Boosters		
Part 20 (Wideband Consumer Signal Boosters, Provider-specific signal boosters, and Industrial Signal Boosters) Section 90.219	ANSI C63.26:2015	40000

[2] Accreditation 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 15th day of August 2023.

Mr. Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 1786.01
Valid to June 30, 2025

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