

Testing Tomorrow's Technology

**CFR 47 Part 18 Industrial Scientific and Medical Equipment
Subpart C Technical Standards,
Part 18.305, Field Strength Limits and Part 18.307, Conducted limits
Permissive Change Report**

for the

Sharp Corporation

**Microwave Oven Drawer
Model: SMD2480CSC**

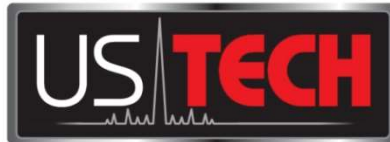
FCC ID: APYDMR0173

**Test Dates: January 23-26, 2018
Issue Date: February 7, 2018**

UST Project No: 17-0457

Total Number of Pages Contained Within this report: 24

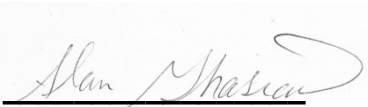
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Testing Tomorrow's Technology

I certify that I am authorized to sign for the manufacturer and that all of the statements in this report and in the exhibits attached hereto are true and correct to the best of my knowledge and belief:

US Tech (Agent responsible for test):

By: 

Name: Alan Ghasiani

Title: President – Consulting Engineer

Date: February 7, 2018



TESTING
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Exhibits (Supplied Separately)

FCC Application Forms
Agency Agreement
Permissive Change Letter
Internal Photos
Test Configuration Photos
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1 General Information

1.1 Purpose of the Report

The purpose of the test report is to file a permissive change request for the Sharp Corporation Model: SMD2480CSC Microwave Oven Drawer with FCC ID: APYDMR0173 for the following reason:

- An alternate magnetron is being certified for use with the product. The alternate magnetron is Sharp model: 2M303H(L).

1.2 Product Description

The Equipment Under Test (EUT) is the Sharp Corporation SMD2480CSC Microwave Oven Drawer. The EUT is rated to be 950 Watts. The input power is rated at 120 VAC, 60Hz.

The EUT was tested at 100% microwave power setting.

1.3 Related Submittal(s)/Grant(s)

The original Grant for this EUT was issued on January 16, 2009.

1.4 Test Methodology

The EUT was configured as shown in the block diagram and photographs herein. The sample was tested per FCC measurement Procedure MP-5, "Methods of Measurement of Radio Noise Emissions from Industrial, Scientific and Medical Equipment" (1986) as well as per CFR 47 part 18. Conducted and radiated emissions data were taken with the Test Receiver or Spectrum Analyzer's resolution bandwidth adjusted to 9 kHz and 120 kHz, respectively. At frequencies above 1 GHz, the resolution bandwidth was increased to 1 MHz. The video bandwidth was three times more than resolution bandwidth on the spectrum analyzer. All measurements are peak unless stated otherwise. Interconnecting cables were manipulated as necessary to maximize emissions.

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1.5 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA. This site has been fully described and registered with the FCC under site designation number US5301. Additionally this site has also been fully described and submitted to Industry Canada (IC), and has been approved under IC site number 9900A-1.

US Tech currently is Accredited by the NIST NVLAP organization, Lab Code: 200162-0 and FCC Part 18 is in our Scope of Accreditation.

1.6 Test Equipment

The following table details the test equipment used in the evaluation of this product.

Table 1. Test Equipment

INSTRUMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	CALIBRATION DUE DATE
SPECTRUM ANALYZER	E4407B	AGILENT	US41442935	06/22/2018
SPECTRUM ANALYZER	DSA815	RIGOL	DSA8A18030138	10/11/2019 2 yr.
PREAMPLIFIER	8449B	HEWLETT-PACKARD	3008A00480	12/01/2018
PREAMPLIFIER	8447D	HEWLETT-PACKARD	1937A02980	03/07/2018
BICONICAL ANTENNA	3110B	EMCO	9307-1431	10/23/2019 2 yr.
HORN ANTENNA	3115	EMCO	9107-3723	9/22/2018 2 yr.
LOG PERIODIC ANTENNA	3146	EMCO	9305-3600	9/22/2018 2 yr.
LISN (x2)	9028-50-TS24-BNC	SOLAR ELECTRONICS	910494 & 910496	06/22/2018
Fluke Data logger	Hydra Series II	FLUKE	8821014/ 8822004	02/28/2018
CALCULATION PROGRAM	N/A	N/A	N/A	N/A

Note: The calibration interval of the above test instruments is 12 months unless stated otherwise and all calibrations are traceable to NIST/USA.

2 System Test Configuration

2.1 Characterization of Sample Tested

The samples used for test were received on January 22, 2018 in good condition.

2.2 EUT Exercise Software

No software was exercised while the EUT was being tested. The EUT was programmed to perform at 100% power level. The test was performed using 950 ml of tap water in a 150 mm diameter cylindrical glass vessel placed in the center of the oven.

2.3 Special Accessories

There were not special accessories required for this product testing.

2.4 Test Rationale

The EUT, cable and wiring arrangement, and mode of operation that produced the emissions with the highest levels relative to the applicable limits was selected for final measurements.

The interconnect cable(s) and/or power cord(s) were moved into various positions of the most likely configurations to maximize the emissions. In this case the placement of the cables had negligible effects. The test configuration photographs represent the final configuration used for testing.

2.5 Tested System Details

Table 2. EUT and Peripherals

PERIPHERAL/ MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC ID	CABLES P/D
Microwave Oven Drawer (EUT)/ Sharp	SMD2480CSC	Engineering Sample	APYDMR0173	N/A

U= unshielded S= shielded P= Power D= Data

Table 3. Detail of I/O Cables Attached to EUT

DESCRIPTION OF CABLE	DETAILS OF CABLE			CABLE LENGTH
Power Cable	Manufacturer and Part Number			1.5 m
	CND			
	Shield Type	Shield Termination	Type of Backshell	
	NA	NA	NA	

Shield Type

N/A = None
 F = Foil
 B = Braided
 2B = Double Braided
 CND = Could Not Determine
 C = Conduit

Shield Termination

N/A = None
 360 = 360°
 P = Pigtail/Drain Wire
 CND = Could Not Determine

Type of Backshell

N/A = Not Applicable
 PS = Plastic Shielded
 PU = Plastic Unshielded
 MS = Metal Shielded
 MU = Metal Unshielded

2.6 Configuration of Tested System



Figure 1. Block Diagram of Test Configuration

2.7 Equipment Modifications

No modifications were made to the EUT in order for it to meet the requirements.

2.8 Test Results

Line conducted emissions testing was conducted and compared to 18.307(b) limits. The worst case line conducted emission was 7.6 dB below the limit at 0.8330 MHz on the Phase line. All other conducted emissions were at least 8.4 dB below the limit.

Radiated emissions testing was conducted and compared to 18.305 (a) and (b) limits. The worst case radiated emission in the frequency range 30 MHz to 25 GHz was 13.4 dB below the limit at 14.760 GHz. All other radiated emissions were at least 12.9 dB below the limit.

2.9 Measurement Uncertainty

Conducted Emissions:

Measurement Uncertainty (within a 95% confidence level) for this test was ± 2.8 dB.

- ☐ - The data listed in this test report may exceed the test limit because it does not have enough margin (more than 2.8 dB) to meet the measurement uncertainty interval. The EUT conditionally passes this test.
- ☒ - The data listed in this test report has enough margin, more than 2.8, dB to meet the measurement uncertainty interval. The EUT unconditionally passes this test.

Radiated Emissions:

Measurement Distance of 10 m:

The measurement uncertainty (with a 95% confidence level) for this test using a Biconnical Antenna is ± 5.21 dB.

The measurement uncertainty (with a 95% confidence level) for this test using a Log Periodic Antenna is ± 4.99 dB.

Measurement Distance of 3 m:

The measurement uncertainty (with a 95% confidence level) for this test using a double ridge horn antenna is ± 5.08 dB.

- ☐ - The data listed in this test report may exceed the test limit because it does not have enough margins to meet the measurement uncertainty interval. The EUT conditionally passes this test.
- ☒ - The data listed in this test report has enough margins to meet the measurement uncertainty interval. The EUT unconditionally passes this test.

3 Power Line Conducted Emissions Data (47 CFR 18.307)

3.1 Test Site Description

The mains terminal interference measurement facility is a shielded room (Lectro Magnetics, Inc., Type LDC6-0812-8-2793) 4.0 m deep x 2.5 m wide x 2.5 m high. Power for the shielded room is filtered (Lectroline, EMX-1020-2, rated 125/250 V, 20 A, 50/60 Hz).

The artificial mains networks are Solar Electronics models 8028. A nonconductive table 1.5 m deep x 1.0 m wide x 0.8 m high is used for tabletop equipment. All grounded conducting surfaces including the case or cases of one or more artificial mains networks is at least 0.8 m from any surface of the EUT. The EUT is a floor standing unit; therefore the unit was placed on the floor 50cm away from all vertical coupling surfaces.

The load used for this measurement was with 700 to 1000 ml of water located in the center of the oven.

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Table 4. Power Line Conducted Emissions

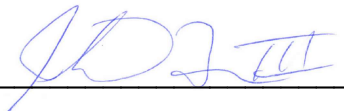
Conducted Emissions 120 VAC						
Tested By:	Test: Part 18.307 DoC			Client: Sharp Corporation		
JF	Project: 17-0457		Class: B	Model: SMD2480CSC		
Frequency (MHz)	Test Data (dBuV)	AF+CA-AMP (dB)	Peak Results (dBuV)	Average Limits (dBuV)	Margin (dB)	Detector Used
PHASE						
0.1529	45.68	0.42	46.10	65.8	19.7	QP
0.8330	38.32	0.11	38.43	46.0	7.6	PK
2.6130	37.46	0.16	37.62	46.0	8.4	PK
7.3750	31.56	0.34	31.90	50.0	18.1	PK
14.5830	37.05	1.41	38.46	50.0	11.5	PK
21.1500	31.51	0.75	32.26	60.0	27.7	QP
NEUTRAL						
0.1506	45.13	0.52	45.65	66.0	20.3	QP
0.8825	35.57	0.26	35.83	46.0	10.2	PK
1.5533	22.13	0.31	22.44	56.0	33.6	QP
7.4333	30.64	0.48	31.12	50.0	18.9	PK
14.4667	37.93	1.52	39.45	50.0	10.5	PK
22.0667	31.51	0.85	32.36	60.0	27.6	QP

“*” denotes Quasi-peak limit used.

Sample Calculation at 0.1529 MHz:

Magnitude of Measured Frequency	45.68 dBuV
+Correction Factors	0.42 dB
Corrected Result	46.10 dBuV

Test Date: January 26, 2017

Tested by
 Signature: 

Name: John Freeman

4 Radiated Emissions Data (47 CFR 18.301, 18.303, 18.305)

4.1 Test Site Description

The radiated emissions disturbance measurement facility consists of a 8.5m meters long by 5.5 meter wide and 5.6 meter high shielded semi anechoic EMC Chamber. The chamber is lined with ferrite core and RF absorbers. The quiet zone is 2.0 meters.

The test facility layout is shown in the figure below. A remotely controlled 2.0 m diameter flush-mounted turntable is provided for rotating (through at least 360 degrees) the EUT. A nonconductive table, 1.5 m long by 1.0 m wide by 0.8 m high is used in conjunction with the turntable for tabletop equipment. Electrical service for the EUT is provided through openings at the center of the turntable.

Provision for receiving antenna power and data wires is provided by junction boxes place at the parameter of the chamber. The receive antenna mast is remotely controlled and can be varied in height from 1 m to 4 m.

Power and data cables for the radiated disturbance measurement facility are run through PVC tubing under the raised floor or are laid directly upon the ground plane.

Radiated emissions were evaluated based on 47 CFR 18.309 and MP-5 (1986). During testing the EUT was tested up to the 10th harmonic or the highest detectable emission.

The load used for frequency measurement was 1000 ml of water in the beaker located in the center of the oven. For radiation on second and third harmonic two loads, one of 700 ml and one of 300 ml of water was used. Each load was tested both with the beaker located in the center of the oven and with it in the right front corner.

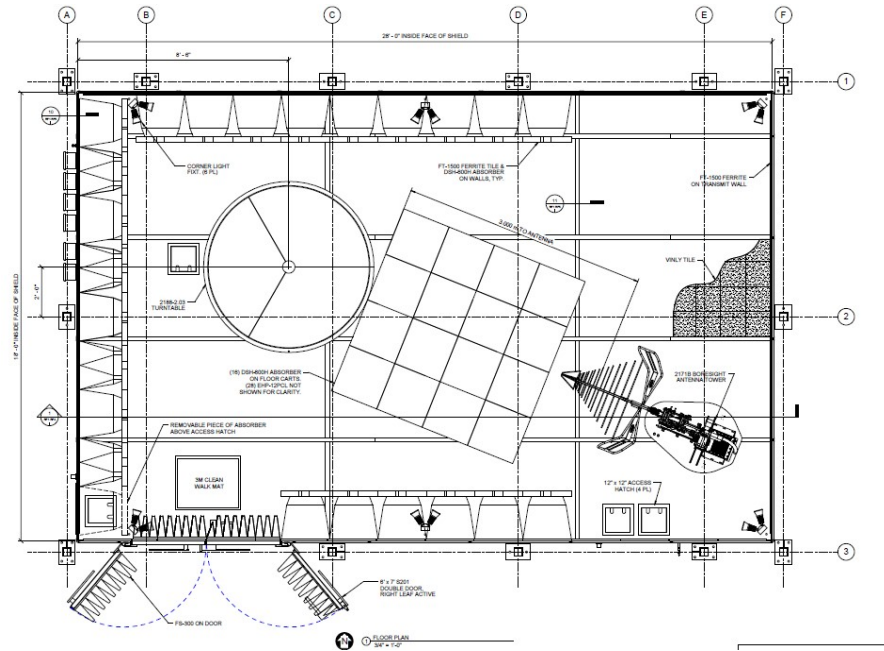


Figure 2. Radiated Emissions Disturbance Measurement Facility Diagram

4.2 Test Limits/Calculations

4.2.1 Part 18 ISM Test Limits

Per 47 CFR 18.301 the ISM equipment may be operated on any frequency above 9 kHz except as indicated in 47 CFR 18.303. The field strength limit per 47 CFR 18.305 for ISM equipment operating on a frequency specified in 47 CFR 18.301 is permitted unlimited radiated energy in the band specified for that frequency. The field strength levels of emissions which lie outside the bands specified in 47 CFR 18.301 must not exceed the limits detailed in CFR 18.305, unless otherwise indicated.

Per the table in 18.301, the frequency 2450 MHz $\pm$ 50MHz is allowed unlimited radiated energy. The EUT fundamental frequency is stated to be 2450 MHz.

The field strength levels of emissions which lie outside the bands specified in 18.301, unless otherwise indicated, shall not exceed the following:

Any type of equipment unless otherwise specified that operate above 500 watts: 25 uV/m X SQRT (power/500) at the distance of 300m.

Therefore the limit converted to dBuV/m is: $20 \log [(25) * \sqrt{(EUT \text{ power}/500)}] = \text{dBuV/m} + 20 \log(300/\text{test distance used}) = \text{XX.X dBuV/m}$

The measured EUT power P, is 950 Watts as rated and tested by the manufacturer. This value was used in the calculation of the limit for this test.

Limit at 10 meters is $20 \log [(25) * \sqrt{(950/500)}] = 30.74 + 20 \log(300/10) = 60.28 \text{ dBuV/m}$.

Limit at 3 meters is $20 \log [(25) * \sqrt{(950/500)}] = 30.74 + 20 \log(300/3) = 70.74 \text{ dBuV/m}$.

4.2.2 General Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + CF - AG$$

where

- FS = Field Strength
- RA = Receiver Amplitude (dBuV)
- CF = Correction Factor (Antenna Factor & Cable Loss) (dB/m)
- AG = Amplifier Gain

Assuming a receiver reading of 100 dBuV and a correction factor of 11.8 dB/m, the following calculation would apply:

$$FS \text{ (dBuV/m)} = 100 \text{ dBuV} + 11.8 \text{ dB/m} = 111.8 \text{ dBuV/m}$$

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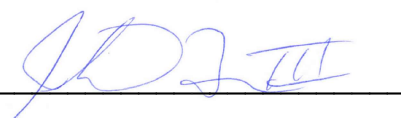
Table 5. Radiated Emissions Data 30 MHz to 1 GHz

Radiated Emissions							
Test By: JF	Test: Radiated	Client: Sharp Corporation					
	Project: 17-0457	Limits Based on: FCC 18.305	Model: SMD2480CSC				
Frequency (MHz)	Test Data (dBuV)	AF+CA-AMP (dB/m)	Results (dBuV/m)	Average Limits (dBuV/m)	Application Test Distance/ Polarization	Margin (dB)	Detector Used
35.38	44.22	-14.52	29.70	70.7	3m./VERT	41.0	PK
67.99	33.26	-17.60	15.66	70.7	3m./HORZ	55.1	PK
111.80	42.93	-15.75	27.18	70.7	3m./VERT	43.6	PK
132.50	47.20	-14.94	32.26	70.7	3m./HORZ	38.5	PK
200.88	33.22	-14.32	18.90	70.7	3m./VERT	51.8	PK
209.28	38.61	-14.47	24.14	70.7	3m./HORZ	46.6	PK
260.08	51.57	-12.60	38.97	70.7	3m./HORZ	31.8	PK
325.10	45.87	-11.45	34.42	70.7	3m./VERT	36.3	PK
960.60	48.65	-3.30	45.35	70.7	3m./VERT	25.4	PK
962.52	44.17	-2.70	41.47	70.7	3m./HORZ	29.3	PK
Measurements were made over the frequency range of 30 MHz – 1000 MHz All other emissions were more than 20 dB from the limit.							

Sample Calculation at 35.38 MHz:

Magnitude of Measured Frequency	44.22 dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-14.52 dB/m
Corrected Results	29.70 dBuV/m

Test Date: January 23, 2018

Tested by
 Signature: 

Name: John Freeman

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Table 6. Radiated Emissions Data 1 GHz to 25 GHz

Radiated Emissions								
Test By: JF	Test: Radiated		Client: Sharp Corporation					
	Project: 17-0457		Limits Based on: FCC18.305	Model: SMD2480CSC				
Frequency (MHz)	Test Data (dBuV)	Additional Factor	AF+CA-AMP (dB/m)	Results (dBuV/m)	Average Limits (dBuV/m)	Application Test Distance/ Polarization	Margin (dB)	Detector Used
4928.50	45.46	0.00	6.14	51.60	70.7	3.0m./HORZ	19.1	AVG
7402.50	52.99	-9.50	13.86	57.35	70.7	1.0m./VERT	13.4	AVG
9817.00	47.80	-9.50	14.41	52.71	70.7	1.0m./VERT	18.0	AVG
9862.00	46.58	-9.50	15.47	52.55	70.7	1.0m./HORZ	18.2	AVG
14760.00	44.16	-9.50	23.22	57.88	70.7	1.0m./VERT	12.9	AVG
14850.00	43.48	-9.50	22.72	56.70	70.7	1.0m./HORZ	14.0	AVG
Measurements were made over the frequency range of 1 GHz to 25 GHz. All other emissions were more than 20 dB from the limit.								

Note: For measurements made at test distance of 1 meter an extrapolation factor of -9.5 dB was applied to correct the data for a 3 meter test distance.

Sample Calculation at 4928.50 MHz:

Magnitude of Measured Frequency	45.46 dBuV
+Additional Factor	0.00 dB
+Antenna Factor + Cable Loss+ Amplifier Gain	6.14 dB/m
Corrected Result	51.60 dBuV/m

Test Date: January 23, 2018

Tested by
 Signature: 

Name: John Freeman

5 Variation in Operating Frequency

Frequency variation testing was performed per MP-5 section 4.5. The EUT was set up inside the EMC Chamber, and a double ridge horn antenna and spectrum analyzer were used to measure the fundamental frequency of the EUT. The test results are presented below.

5.1 Variation in Operating Frequency Over Time

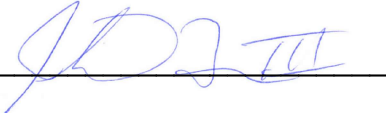
The operating frequency was measured using a spectrum analyzer. Starting with the EUT at room temperature, a 950 mL water load was placed in the center of the oven and the oven was operated at maximum output power. The fundamental operating frequency was monitored over the length of time taken for the water level to reduce to 20 percent of the original level. In this case it took 18 mins for the water level to reach 20% or 760 ml.

During the test the fundamental frequency of the EUT must remain within the ISM frequency band of 2450 MHz $\pm$ 50 MHz, 2400 MHz to 2500 MHz. The results of this test are presented below.

Table 7. Measured Frequency Variation

Low Frequency (MHz)	High Frequency (MHz)
2400.00	2461.70

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Signature: 

Name: John Freeman

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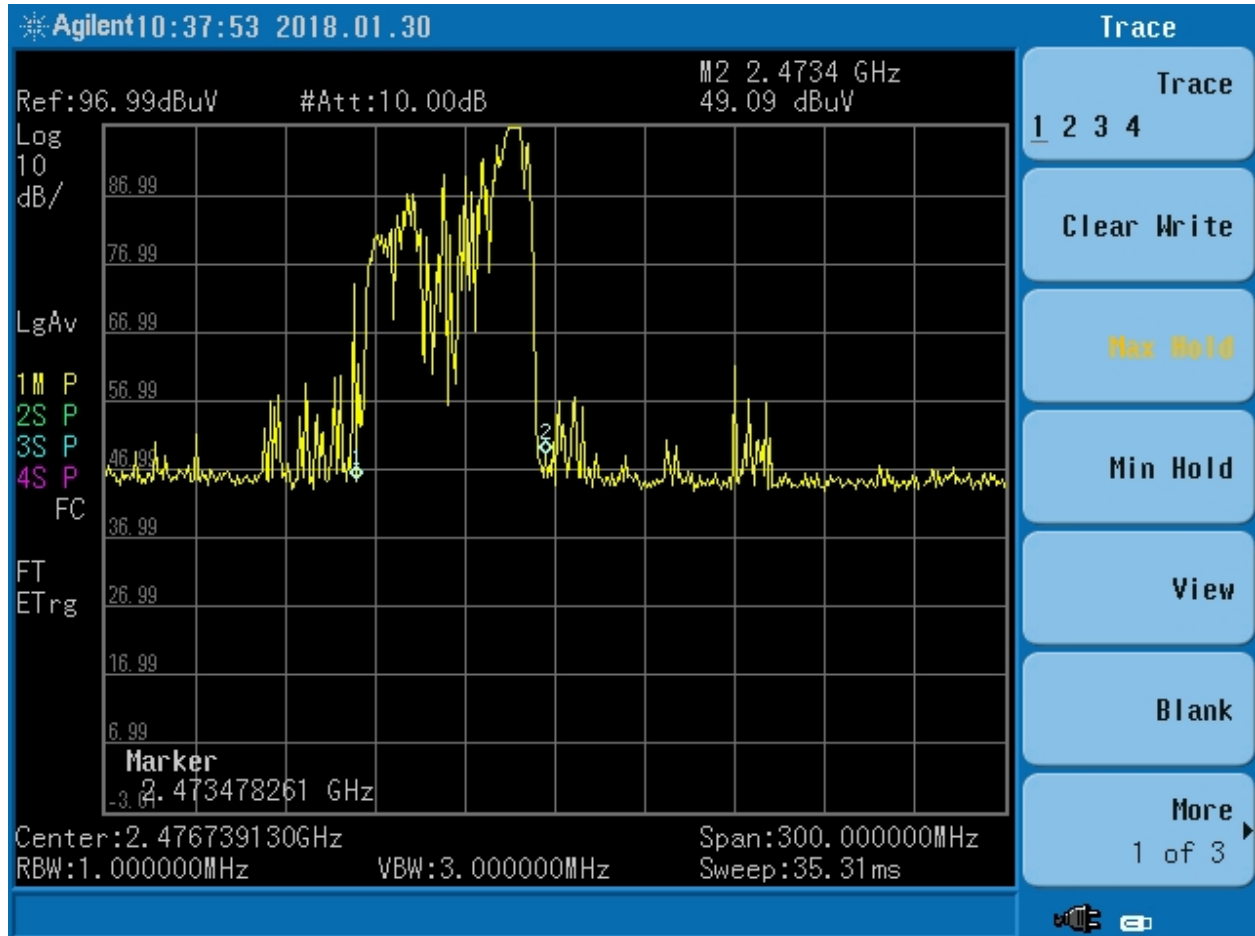


Figure 3. Frequency Variation at Nominal Voltage

5.2 Variation in Operating Frequency with Line Voltage

The EUT was operated/warmed up for at least 10 minutes of use with a 950 mL water load at room temperature at the beginning of the test. Then the operating frequency was monitored as the input voltage was varied between 80 and 125 percent of the nominal rating. At each varied voltage level, the EUT was allowed to operate for at least 5 minutes.

During the test, the fundamental frequency of the EUT must remain within the ISM frequency band of 2450 MHz $\pm$ 50 MHz, or 2400 - 2500 MHz. The results of this test are presented below.

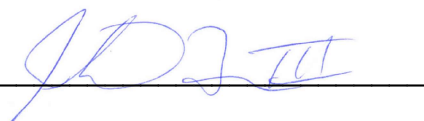
Line voltage varied from 96 VAC to 150 VAC.

Table 8. Measured Supply Voltage Variation

%	Supply Voltage (V) at 60 Hz	Measured Frequency (MHz)	
		Low Frequency	High Frequency
80%	96	2400.00	2464.00
125%	150	2400.00	2463.25

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Tested by
Signature:



Name: John Freeman

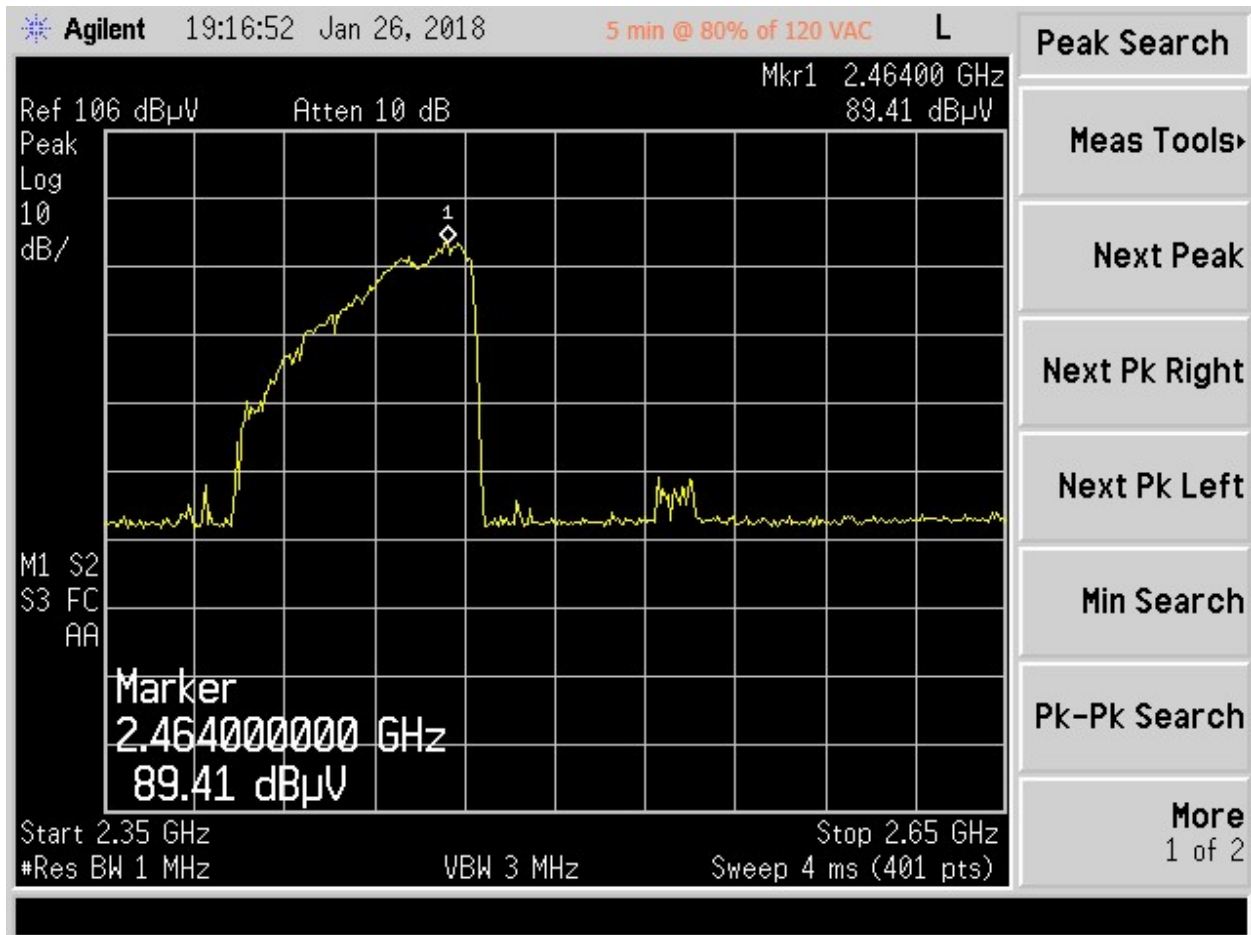


Figure 4. Frequency Variation at Low Voltage

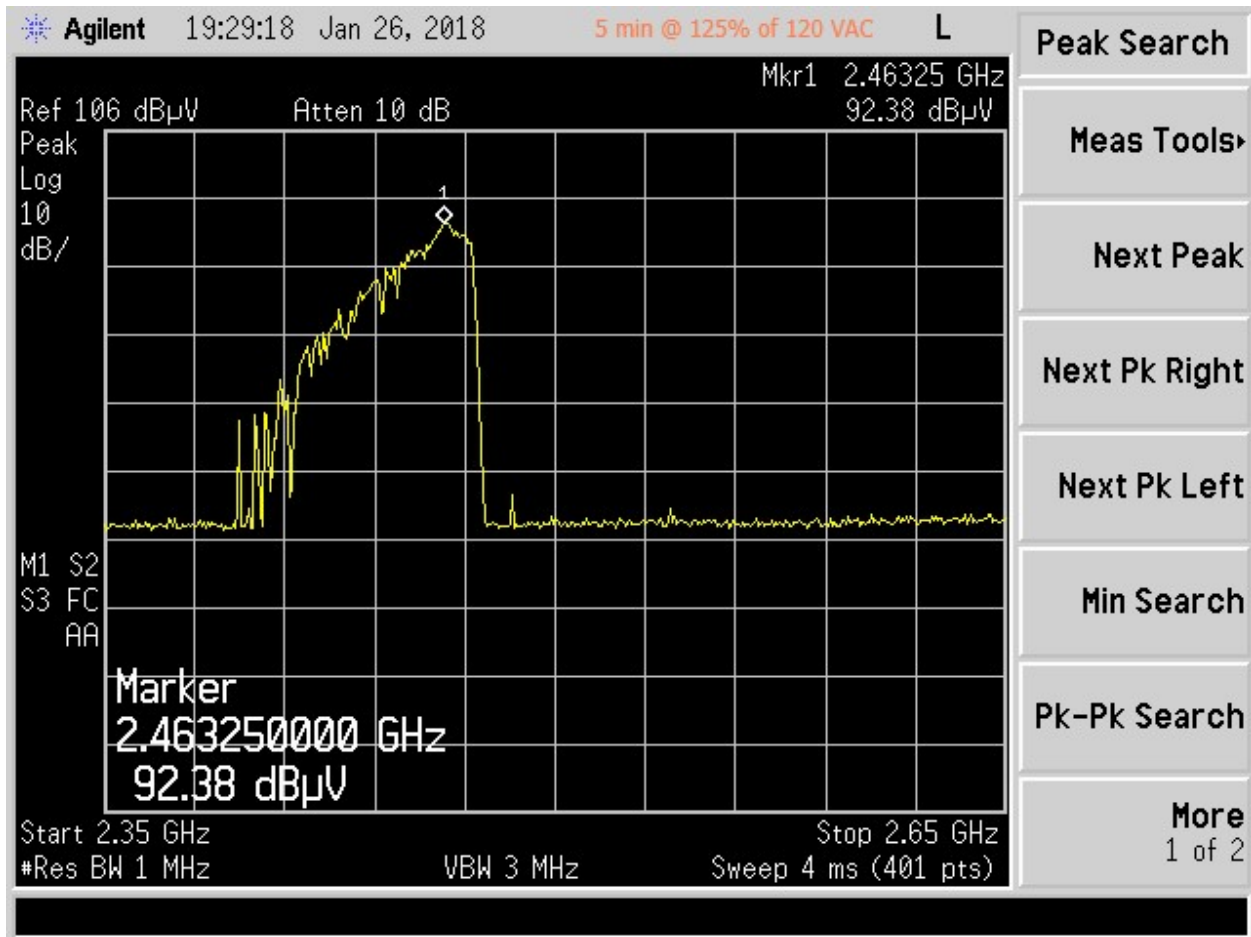


Figure 5. Frequency Variation at High Voltage

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6 Output Power

The Caloric Method was used to determine maximum output power. The initial temperature of a 1000 ml water load was measured for ovens rated at 1000 watts or less power output. For ovens more than 1000 watts output rating, additional beakers by fraction thereof are used if necessary.

The water load was placed in the center of the oven. The oven was operated at maximum output power for 120 seconds, then the temperature of the water was re-measured.

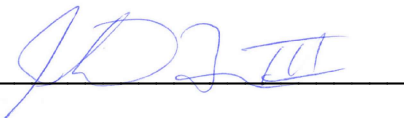
Three trials were performed and then the results calculated using the following formula:
$$\text{Output Power} = ((4.2 \text{ Joules/Cal}) * (\text{Volume in ml}) * (\text{Temp Rise})) / (\text{Time in seconds})$$

Table 9. Output Power Results

Start Temperature (°C)	Final Temperature (°C)	Temperature Rise	Elapsed Time (seconds)	Water Volume (ml)	RF Power (Watts)
20.7	46.2	25.5	120	950	847.875
21.6	46.3	24.7	120	950	821.275
21.6	47.5	25.9	120	950	861.175

Average from the three trials: 843.44 Watts

Test Date: January 26, 2018

Tested by
Signature: 

Name: John Freeman