



# element

**Glowforge Incorporated**

**GFD-100**

**FCC 15.247:2024, RSS-247 Issue 3:2023  
RSS-Gen Issue 5:2018+A1:2019+A2:2021**

**Wi-Fi 802.11 b/g/n SISO radio**

**Report: GLOW0052.0 Rev. 0, Issue Date: February 13, 2024**



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# CERTIFICATE OF TEST

**Last Date of Test: January 25, 2024**  
**Glowforge Incorporated**  
**EUT: GFD-100**

## Radio Equipment Testing

### Standards

Specification	Method
FCC 15.247:2024	ANSI C63.10:2013
RSS-247 Issue 3:2023	
RSS-Gen Issue 5:2018+A1:2019+A2:2021	

### Guidance

FCC KDB 558074 v05r02:2019
Notice 2021 - CEB0001

### Results

Test Description	Result	Specification Section(s)	Method Section(s)	Comments
Powerline Conducted Emissions	N/A	15.207	6.2	Not required to show compliance of the module in the host.
Duty Cycle	N/A	KDB 558074 -6.0	11.6	Not required to show compliance of the module in the host.
DTS Bandwidth	N/A	15.247(a)(2), KDB 558074 -8.2	11.8.2	Not required to show compliance of the module in the host.
Occupied Bandwidth	N/A	KDB 558074 -2.1	6.9.3	Not required to show compliance of the module in the host.
Output Power	Pass	15.247(b)(3), KDB 558074 -8.3.2	11.9.2.2.4	
Equivalent Isotropic Radiated Power (EIRP)	N/A	15.247(b)(3), KDB 558074 -8.3.2	11.9.2.2.4	Not required to show compliance of the module in the host.
Power Spectral Density	N/A	15.247(e), KDB 558074 -8.4	11.10.5	Not required to show compliance of the module in the host.
Band Edge Compliance	N/A	15.247(d), KDB 558074 -8.5	11.11	Not required to show compliance of the module in the host.
Spurious Conducted Emissions	N/A	15.247(d), KDB 558074 -8.5	11.11	Not required to show compliance of the module in the host.
Spurious Radiated Emissions - Spot Checks	Pass	15.247(d), KDB 558074 - 8.6, 8.7	11.12.1, 11.13.2, 6.5, 6.6	

### Deviations From Test Standards

None

### Approved By:



Cole Ghizzone, Operations Manager

*Product compliance is the responsibility of the client; therefore, the tests and equipment modes of operation represented in this report were agreed upon by the client, prior to testing. The results of this test pertain only to the sample(s) tested. The specific description is noted in each of the individual sections of the test report supporting this certificate of test. This report reflects only those tests from the referenced standards shown in the certificate of test. It does not include inspection or verification of labels, identification, marking or user information. As indicated in the Statement of Work sent with the quotation, Element's standard process is to always use the latest published version of the test methods even when earlier versions are cited in the test specification. Issuance of a purchase order was de facto acceptance of this approach. Otherwise, the client would have advised Element in writing of the specific version of the test methods they wanted applied to the subject testing.*

# REVISION HISTORY



Revision Number	Description	Date (yyyy-mm-dd)	Page Number
00	None		

# ACCREDITATIONS AND AUTHORIZATIONS



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## United States

**FCC** - Designated by the FCC as a Telecommunications Certification Body (TCB). Certification chambers, Open Area Test Sites, and conducted measurement facilities are listed with the FCC.

**A2LA** - Each laboratory is accredited by A2LA to ISO / IEC 17025, and as a product certifier to ISO / IEC 17065 which allows Element to certify transmitters to FCC and IC specifications.

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## Canada

**ISED** - Recognized by Innovation, Science and Economic Development Canada as a Certification Body (CB) and as a CAB for the acceptance of test data.

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## European Union

**European Commission** – Recognized as an EU Notified Body validated for the EMCD and RED Directives.

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## United Kingdom

**BEIS** – Recognized by the UK as an Approved Body under the UK Radio Equipment and UK EMC Regulations.

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## Australia/New Zealand

**ACMA** - Recognized by ACMA as a CAB for the acceptance of test data.

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## Korea

**MSIT / RRA** - Recognized by KCC's RRA as a CAB for the acceptance of test data.

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## Japan

**VCCI** - Associate Member of the VCCI. Conducted and radiated measurement facilities are registered.

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## Taiwan

**BSMI** – Recognized by BSMI as a CAB for the acceptance of test data.

**NCC** - Recognized by NCC as a CAB for the acceptance of test data.

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## Singapore

**IDA** – Recognized by IDA as a CAB for the acceptance of test data.

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## Israel

**MOC** – Recognized by MOC as a CAB for the acceptance of test data.

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## Hong Kong

**OFCA** – Recognized by OFCA as a CAB for the acceptance of test data.

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## Vietnam

**MIC** – Recognized by MIC as a CAB for the acceptance of test data.

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## SCOPE

For details on the Scopes of our Accreditations, please visit:

[California](#)

[Minnesota](#)

[Oregon](#)

[Texas](#)

[Washington](#)

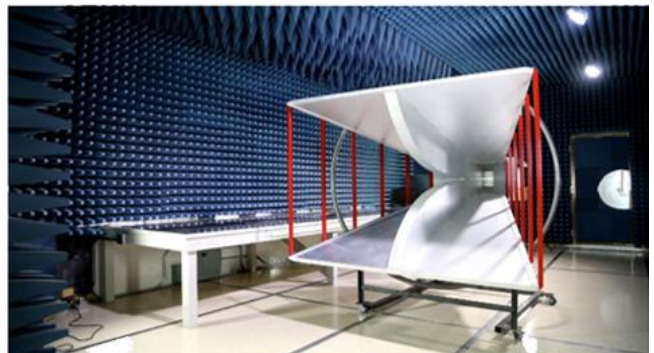
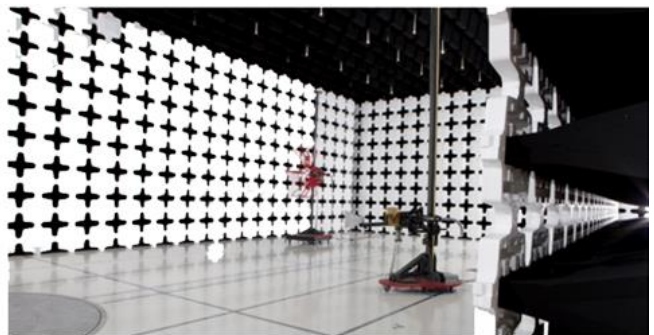
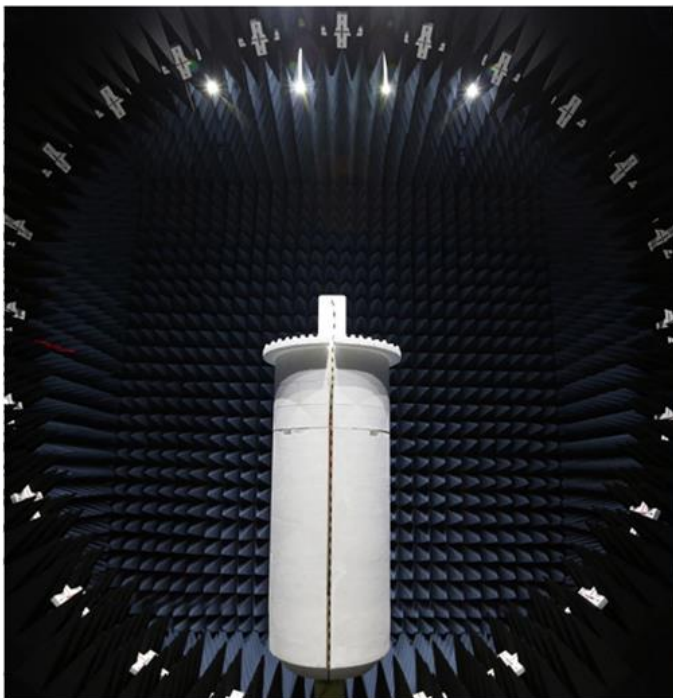
# FACILITIES

Testing was performed at the following location(s)

Location	Labs <sup>(1)</sup>	Address	A2LA <sup>(2)</sup>	ISED <sup>(3)</sup>	BSMI <sup>(4)</sup>	VCCI <sup>(5)</sup>	CAB <sup>(6)</sup>	FDA <sup>(7)</sup>
<input type="checkbox"/> California	OC01-17	41 Tesla Irvine, CA 92618 (949) 861-8918	3310.04	2834B	SL2-IN-E-1154R	A-0029	US0158	TL-55
<input type="checkbox"/> Minnesota	MN01-11	9349 W Broadway Ave. Brooklyn Park, MN 55445 (612) 638-5136	3310.05	2834E	SL2-IN-E-1152R	A-0109	US0175	TL-57
<input type="checkbox"/> Oregon	EV01-12	6775 NE Evergreen Pkwy #400 Hillsboro, OR 97124 (503) 844-4066	3310.02	2834D	SL2-IN-E-1017	A-0108	US0017	TL-56
<input type="checkbox"/> Texas	TX01-09	3801 E Plano Pkwy Plano, TX 75074 (469) 304-5255	3310.03	2834G	SL2-IN-E-1158R	A-0201	US0191	TL-54
<input checked="" type="checkbox"/> Washington	NC01-05	19201 120th Ave NE Bothell, WA 98011 (425) 984-6600	3310.06	2834F	SL2-IN-E-1153R	A-0110	US0157	TL-67
<input type="checkbox"/> Offsite	N/A	See Product Description	N/A	N/A	N/A	N/A	N/A	N/A

See data sheets for specific labs

- (1) The lab designations denote individual rooms within each location. (OC01, OC02, OC03, etc.)
- (2) A2LA Certificate No.
- (3) ISED Company No.
- (4) BSMI No.
- (5) VCCI Site Filing No.
- (6) CAB Identifier. Recognized Phase I CAB for ISED, ACMA, BSMI, IDA, KCC/RRA, MIC, MOC, NCC, OFCA
- (7) FDA ASCA No.



# MEASUREMENT UNCERTAINTY



## Measurement Uncertainty

When a measurement is made, the result will be different from the true or theoretically correct value. The difference is the result of tolerances in the measurement system that cannot be completely eliminated. To the extent that technology allows us, it has been our aim to minimize this error. Measurement uncertainty is a statistical expression of measurement error qualified by a probability distribution.

A measurement uncertainty estimation has been performed for each test per our internal quality document QM205.4.6. The estimation is used to compare the measured result with its "true" or theoretically correct value. The expanded measurement uncertainty (K=2) can be found in the table below. A lab specific value may also be found in the applicable test description section. Our measurement data meets or exceeds the measurement uncertainty requirements of the applicable specification; therefore, the test data can be compared directly to the specification limit to determine compliance. The calculations for estimating measurement uncertainty are based upon ETSI TR 100 028 (or CISPR 16-4-2 as applicable), and are available upon request.

The following table represents the Measurement Uncertainty (MU) budgets for each of the tests that may be contained in this report.

<b>Test</b>	<b>+ MU</b>	<b>- MU</b>
Frequency Accuracy	0.0007%	-0.0007%
Amplitude Accuracy (dB)	1.2 dB	-1.2 dB
Conducted Power (dB)	1.2 dB	-1.2 dB
Radiated Power via Substitution (dB)	0.7 dB	-0.7 dB
Temperature (degrees C)	0.7°C	-0.7°C
Humidity (% RH)	2.5% RH	-2.5% RH
Voltage (AC)	1.0%	-1.0%
Voltage (DC)	0.7%	-0.7%
Field Strength (dB)	5.2 dB	-5.2 dB
AC Powerline Conducted Emissions (dB)	3.1 dB	-3.1 dB

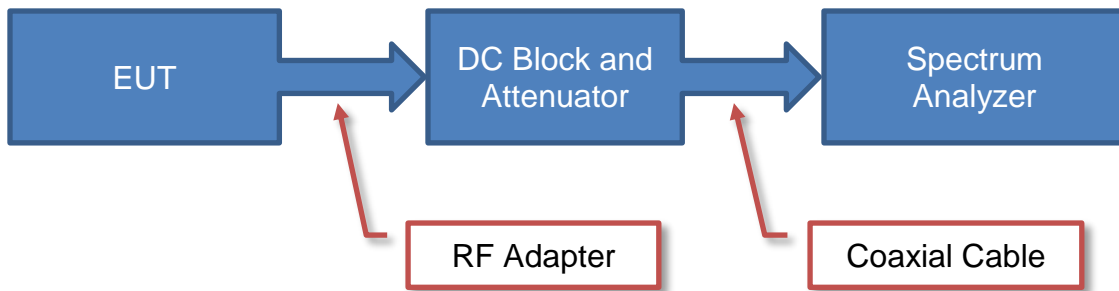
# TEST SETUP BLOCK DIAGRAMS

## Measurement Bandwidths

Frequency Range (MHz)	Peak Data (kHz)	Quasi-Peak Data (kHz)	Average Data (kHz)
0.01 - 0.15	1.0	0.2	0.2
0.15 - 30.0	10.0	9.0	9.0
30.0 - 1000	100.0	120.0	120.0
Above 1000	1000.0	N/A	1000.0

Unless otherwise stated, measurements were made using the bandwidths and detectors specified. No video filter was used.

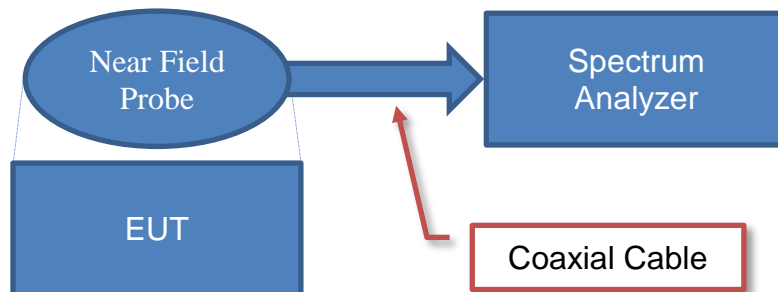
## Antenna Port Conducted Measurements



### Sample Calculation (logarithmic units)

$$\begin{array}{r}
 \text{Measured Value} \\
 71.2
 \end{array}
 =
 \begin{array}{r}
 \text{Measured Level} \\
 42.6
 \end{array}
 +
 \begin{array}{r}
 \text{Reference Level Offset} \\
 28.6
 \end{array}$$

## Near Field Test Fixture Measurements



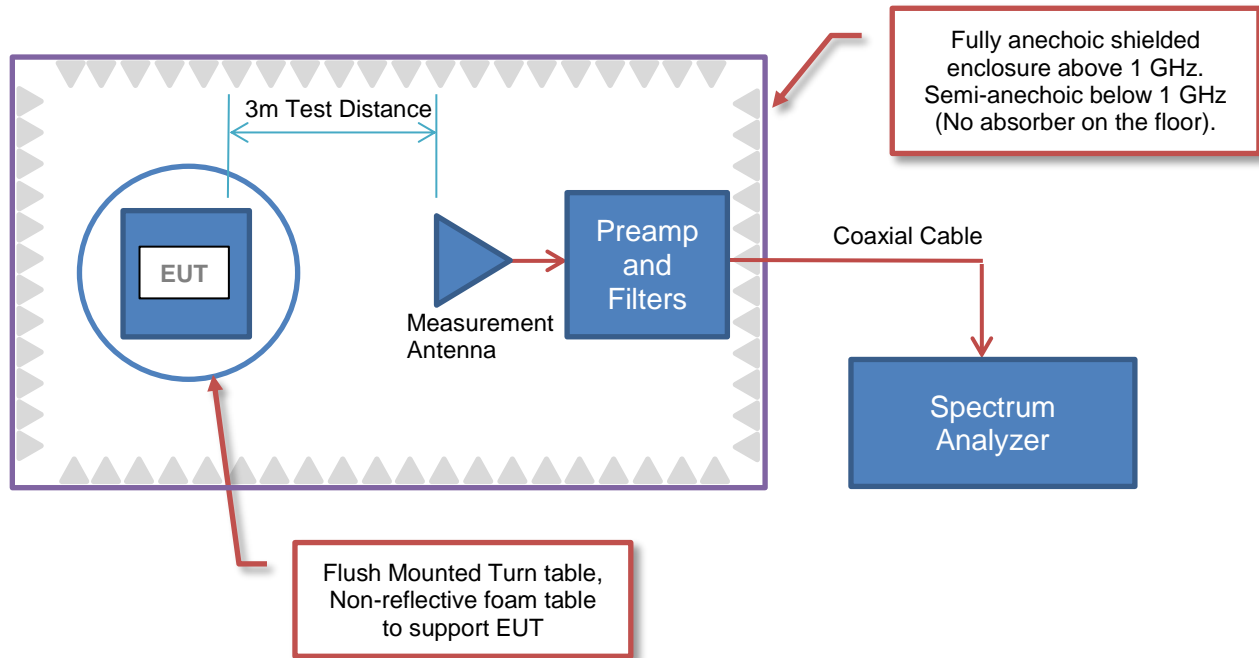
### Sample Calculation (logarithmic units)

$$\begin{array}{r}
 \text{Measured Value} \\
 71.2
 \end{array}
 =
 \begin{array}{r}
 \text{Measured Level} \\
 42.6
 \end{array}
 +
 \begin{array}{r}
 \text{Reference Level Offset} \\
 28.6
 \end{array}$$



# TEST SETUP BLOCK DIAGRAMS

## Emissions Measurements



## Sample Calculation (logarithmic units)

### Radiated Emissions:

Measured Level (Amplitude)	Factor			Distance Adjustment Factor	External Attenuation	Field Strength
	Antenna Factor	Cable Factor	Amplifier Gain			
42.6	28.6	3.1	40.8	0.0	0.0	33.5

42.6 + 28.6 + 3.1 - 40.8 + 0.0 + 0.0 = 33.5

### Conducted Emissions:

Measured Level (Amplitude)	Factor		External Attenuation	Adjusted Level
	Transducer Factor	Cable Factor		
26.7	0.3	0.1	20.0	47.1

26.7 + 0.3 + 0.1 + 20.0 = 47.1

### Radiated Power (ERP/EIRP) – Substitution Method:

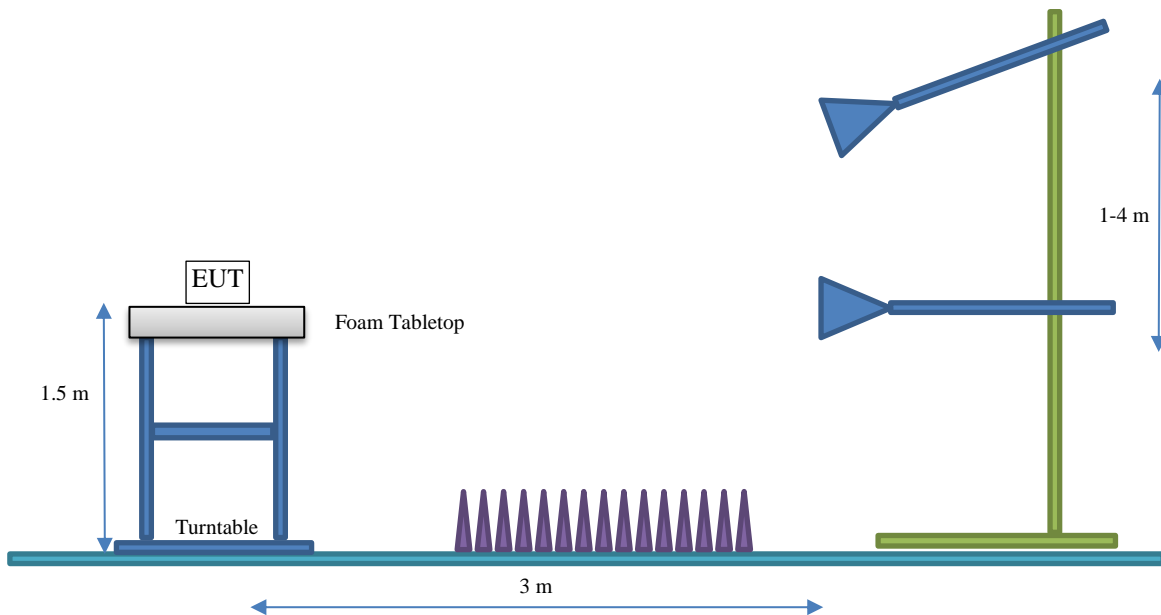
Measured Level into Substitution Antenna (Amplitude dBm)	Substitution Antenna Factor (dBi)	EIRP to ERP (if applicable)	Measured power (dBm ERP/EIRP)
10.0	6.0	2.15	13.9/16.0

10.0 + 6.0 - 2.15 = 13.9/16.0

# TEST SETUP BLOCK DIAGRAMS

## Bore Sighting (>1GHz)

The diameter of the illumination area is the dimension of the line tangent to the EUT formed by 3 dB beamwidth of the measurement antenna at the measurement distance. At a 3 meter test distance, the diameter of the illumination area was 3.8 meters at 1 GHz and greater than 2.1 meters up to 6 GHz. Above 1 GHz, when required by the measurement standard, the antenna is pointed for both azimuth and elevation to maintain the receive antenna within the cone of radiation from the EUT. The specified measurement detectors were used for comparison of the emissions to the peak and average specification limits.



# PRODUCT DESCRIPTION

## Client and Equipment under Test (EUT) Information

<b>Company Name:</b>	Glowforge Incorporated
<b>Address:</b>	1938 Occidental Avenue S Suite C
<b>City, State, Zip:</b>	Seattle, WA 98134
<b>Test Requested By:</b>	Nick Woolger
<b>EUT:</b>	GFD-100
<b>First Date of Test:</b>	January 24, 2024
<b>Last Date of Test:</b>	January 25, 2024
<b>Receipt Date of Samples:</b>	January 24, 2024
<b>Equipment Design Stage:</b>	Production
<b>Equipment Condition:</b>	No Damage
<b>Purchase Authorization:</b>	Verified

## Information Provided by the Party Requesting the Test

### Functional Description of the EUT:

Craft laser cutter and engraver

### Testing Objective:

To demonstrate compliance of the module in the host per KDB 996369 for the Wi-Fi 802.11 b/g/n SISO radio under FCC 15.247 for operation in the 2.4 GHz band.

# POWER SETTINGS AND ANTENNAS



The power settings, antenna gain value(s) and cable loss (if applicable) used for the testing contained in this report were provided by the customer and will affect the validity of the results. Element assumes no responsibility for the accuracy of this information. The power settings below reflect the maximum power that the EUT is allowed to transmit at during normal operation.

## ANTENNA GAIN (dBi)

Type	Provided by:	Frequency Range (MHz)	Gain (dBi)
PIFA	ProAnt	2400 – 2500	4.9

The EUT was tested using the power settings provided by the manufacturer which were based upon:

- Test software settings      Test software/firmware installed on EUT: 1.0.1-219  
 Rated power settings

## SETTINGS FOR ALL TESTS IN THIS REPORT

Modulation Types	Channel Bandwidths (MHz)	20 MHz Channels	Channel Position*	Frequency Range (MHz)	Power Setting
1 Mbps	20	1, 6, 11	Low, Mid, High	2400-2483.5	38
11 Mbps	20	1, 6, 11	Low, Mid, High	2400-2483.5	38
6 Mbps	20	1, 6, 11	Low, Mid, High	2400-2483.5	38
36 Mbps	20	1, 6, 11	Low, Mid, High	2400-2483.5	38
54 Mbps	20	1, 6, 11	Low, Mid, High	2400-2483.5	38
MCS0	20, 40	1, 6, 11	Low, Mid, High	2400-2483.5	38
MCS7	20, 40	1, 6, 11	Low, Mid, High	2400-2483.5	38

# CONFIGURATIONS



## Configuration GLOW0052-1

Software/Firmware Running During Test	
Description	Version
Firmware provided by manufacturer	v1.0.1-219

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
Laser Printer	Glowforge, Inc.	GFD-100	D4D-T28

Cables					
Cable Type	Shield	Length (m)	Ferrite	Connection 1	Connection 2
AC Power	None	2 m	None	EUT	AC Mains

## Configuration GLOW0052-2

Software/Firmware Running During Test	
Description	Version
Firmware provided by manufacturer	v1.0.1-219

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
Laser Printer	Glowforge, Inc.	GFD-100	XB2-839

Cables					
Cable Type	Shield	Length (m)	Ferrite	Connection 1	Connection 2
AC Power	None	2 m	None	EUT	AC Mains

# MODIFICATIONS



## Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2024-01-24	Spurious Radiated Emissions - Spot Checks	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
2	2024-01-25	Output Power	Tested as delivered to test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

# OUTPUT POWER

## TEST DESCRIPTION

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

The fundamental emission output power (maximum average conducted output power) was measured using the channels and modes as called out on the following data sheets. The transmit power was set to its default maximum.

Prior to measuring output power; the emission bandwidth (B) and the transmission pulse duration (T) were measured. Both are required to determine the method of measuring Maximum Conducted Output Power. The transmission pulse duration (T) was measured using a zero span on the spectrum analyzer to see the pulses in the time domain.

The method AVGSA-2 in section 11.9.2.2.4 of ANSI C63.10:2013 was used to make the measurement. This method uses trace averaging across ON and OFF times of the EUT transmissions in the spectrum analyzer channel power function using an RMS detector. Following the measurement a duty cycle correction was applied by adding  $[10 \log (1 / D)]$ , where D is the duty cycle, to the measured power to compute the average power during the actual transmission times.

## TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Analyzer - Spectrum Analyzer	Agilent	E4440A	AAX	2023-12-14	2024-12-14
Generator - Signal	Agilent	N5183A	TIA	2022-06-25	2024-06-25
Block - DC	Weinschel Corp.	7006	AMS	2024-01-24	2025-01-24
Cable	Micro-Coax	UFD150A-1-0720-200200	NCW	2024-01-24	2025-01-24
Attenuator	S.M. Electronics	SA18H-20	REK	2023-03-08	2024-03-08

# OUTPUT POWER



EUT:	GFD-100	Work Order:	GLOW0052
Serial Number:	XB2-839	Date:	2024-01-25
Customer:	Glowforge Incorporated	Temperature:	21.2°C
Attendees:	Nathan Hills	Relative Humidity:	42%
Customer Project:	None	Bar. Pressure (PMSL):	1015 mbar
Tested By:	Harry Zhao	Job Site:	NC06
Power:	120VAC/60Hz	Configuration:	GLOW0052-2

## TEST SPECIFICATIONS

Specification:	Method:
FCC 15.247:2024	ANSI C63.10:2013
RSS-247 Issue 3:2023	ANSI C63.10:2013
RSS-Gen Issue 5:2018+A1:2019+A2:2021	ANSI C63.10:2013

## COMMENTS

Reference level offset includes measurement cable, attenuator, DC block, and customer's patch cable.

## DEVIATIONS FROM TEST STANDARD

None

## CONCLUSION

Pass

Tested By

## TEST RESULTS

		Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result
20 MHz	2400 MHz - 2483.5 MHz Band					
	802.11(b) 1 Mbps					
	Low Channel 1, 2412 MHz	12.73	0	12.7	30	Pass
	Mid Channel 6, 2437 MHz	13.231	0	13.2	30	Pass
	High Channel 11, 2462 MHz	13.585	0	13.6	30	Pass
	802.11(b) 11 Mbps					
	Low Channel 1, 2412 MHz	12.634	0	12.6	30	Pass
	Mid Channel 6, 2437 MHz	13.099	0	13.1	30	Pass
	High Channel 11, 2462 MHz	13.472	0	13.5	30	Pass
	802.11(g) 6 Mbps					
	Low Channel 1, 2412 MHz	7.938	0	7.9	30	Pass
	Mid Channel 6, 2437 MHz	8.443	0	8.4	30	Pass
	High Channel 11, 2462 MHz	8.845	0	8.8	30	Pass
	802.11(g) 36 Mbps					
	Low Channel 1, 2412 MHz	7.897	0	7.9	30	Pass
	Mid Channel 6, 2437 MHz	8.348	0	8.3	30	Pass
	High Channel 11, 2462 MHz	8.704	0	8.7	30	Pass
	802.11(g) 54 Mbps					
	Low Channel 1, 2412 MHz	7.833	0	7.8	30	Pass
	Mid Channel 6, 2437 MHz	8.309	0	8.3	30	Pass
	High Channel 11, 2462 MHz	8.758	0	8.8	30	Pass
	802.11(n) MCS0					
	Low Channel 1, 2412 MHz	7.847	0	7.8	30	Pass

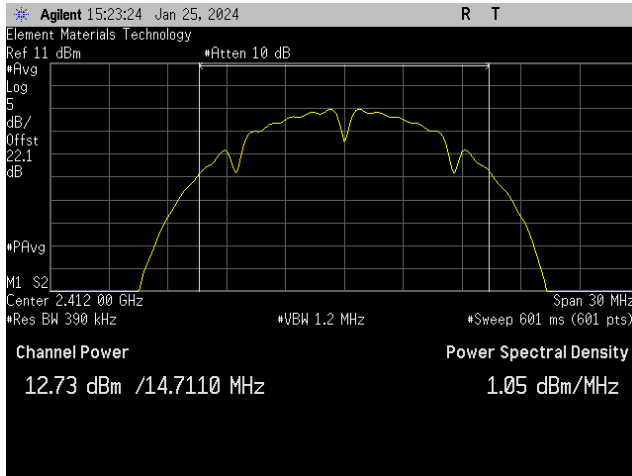


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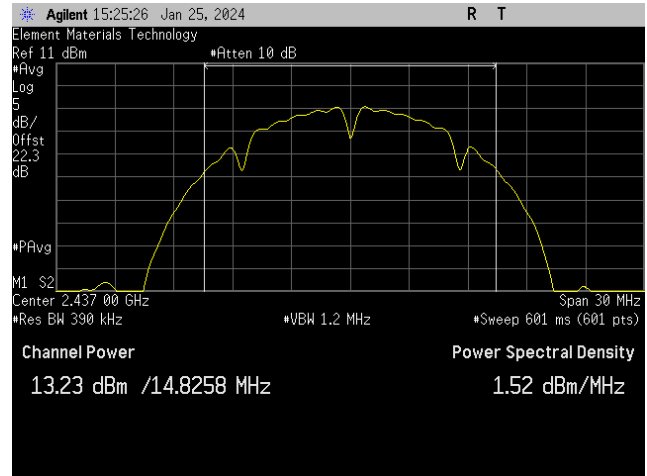


		Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result
Mid Channel 6, 2437 MHz		8.331	0	8.3	30	Pass
High Channel 11, 2462 MHz		8.723	0	8.7	30	Pass
802.11(n) MCS7						
Low Channel 1, 2412 MHz		7.754	0	7.8	30	Pass
Mid Channel 6, 2437 MHz		8.292	0	8.3	30	Pass
High Channel 11, 2462 MHz		8.673	0	8.7	30	Pass
40 MHz						
	2400 MHz - 2483.5 MHz Band					
	802.11(n) MCS0					
	Low Channel 1/5, 2422 MHz	7.978	0	8	30	Pass
	Mid Channel 4/8, 2437 MHz	8.435	0	8.4	30	Pass
	High Channel 7/11, 2452 MHz	8.745	0	8.7	30	Pass
	802.11(n) MCS7					
	Low Channel 1/5, 2422 MHz	7.914	0	7.9	30	Pass
	Mid Channel 4/8, 2437 MHz	8.31	0	8.3	30	Pass
	High Channel 7/11, 2452 MHz	8.599	0	8.6	30	Pass

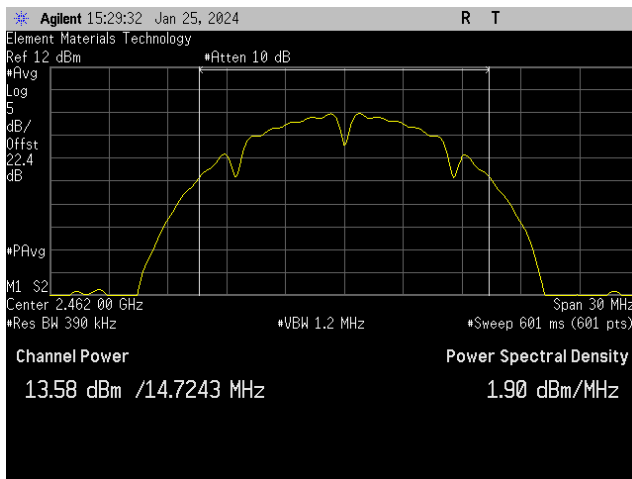
# OUTPUT POWER



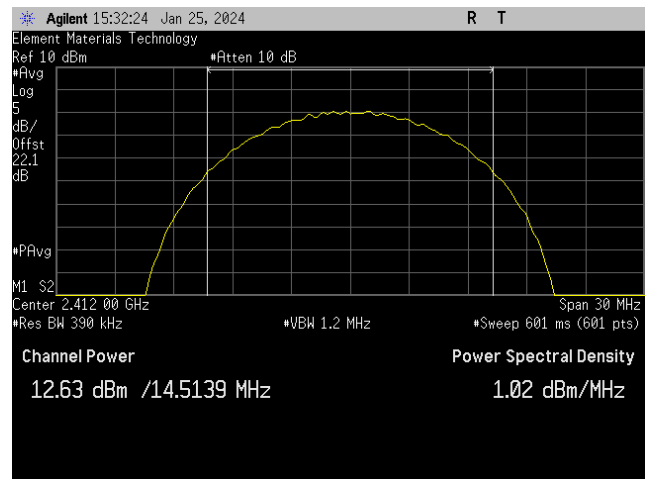
**20 MHz**  
**2400 MHz - 2483.5 MHz Band**  
**802.11(b) 1 Mbps**  
**Low Channel 1, 2412 MHz**



**20 MHz**  
**2400 MHz - 2483.5 MHz Band**  
**802.11(b) 1 Mbps**  
**Mid Channel 6, 2437 MHz**

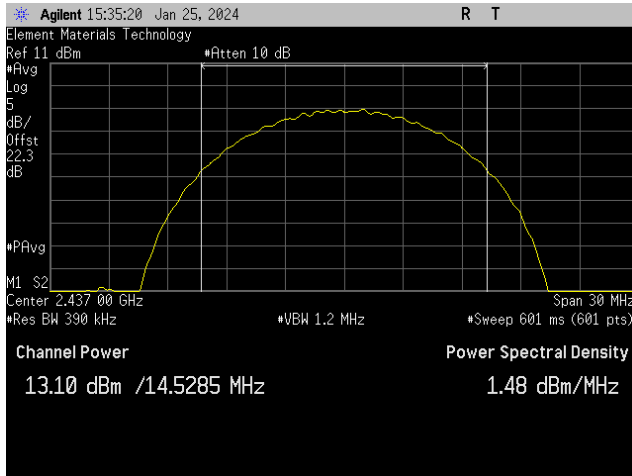


**20 MHz**  
**2400 MHz - 2483.5 MHz Band**  
**802.11(b) 1 Mbps**  
**High Channel 11, 2462 MHz**

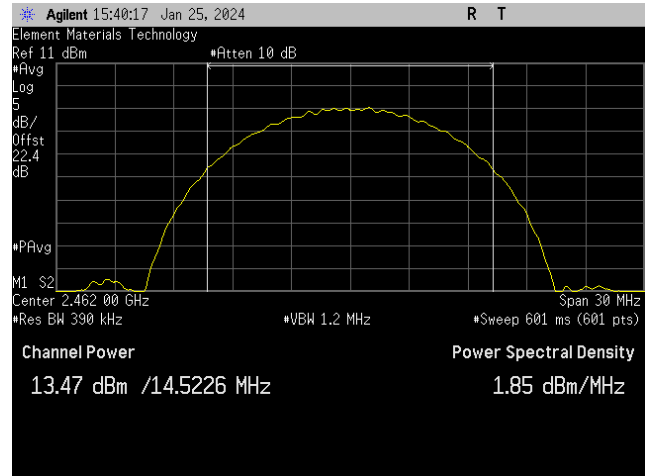


**20 MHz**  
**2400 MHz - 2483.5 MHz Band**  
**802.11(b) 11 Mbps**  
**Low Channel 1, 2412 MHz**

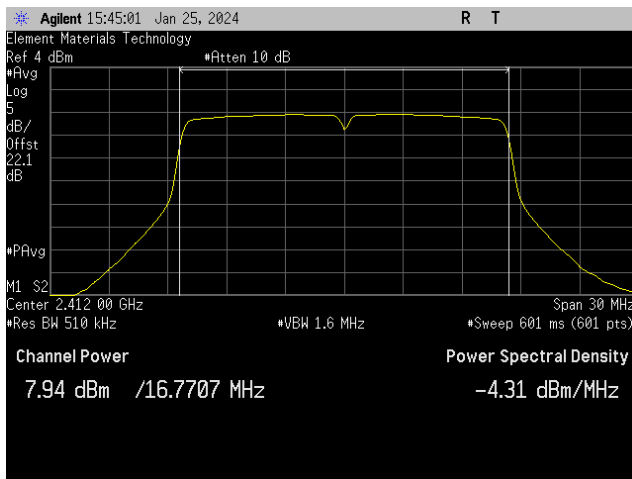
# OUTPUT POWER



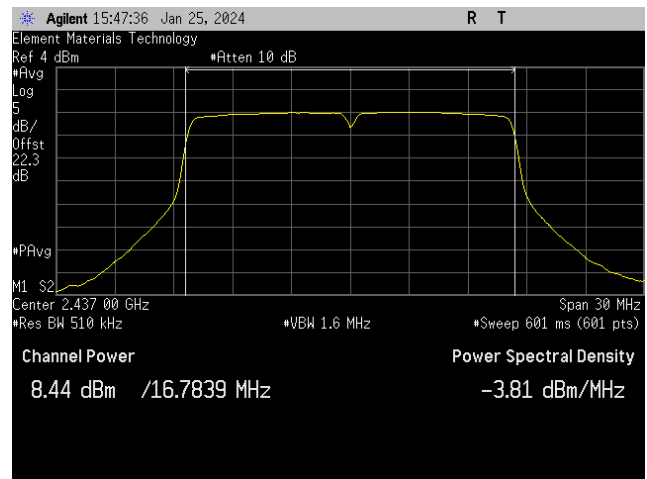
20 MHz  
2400 MHz - 2483.5 MHz Band  
802.11(b) 11 Mbps  
Mid Channel 6, 2437 MHz



20 MHz  
2400 MHz - 2483.5 MHz Band  
802.11(b) 11 Mbps  
High Channel 11, 2462 MHz

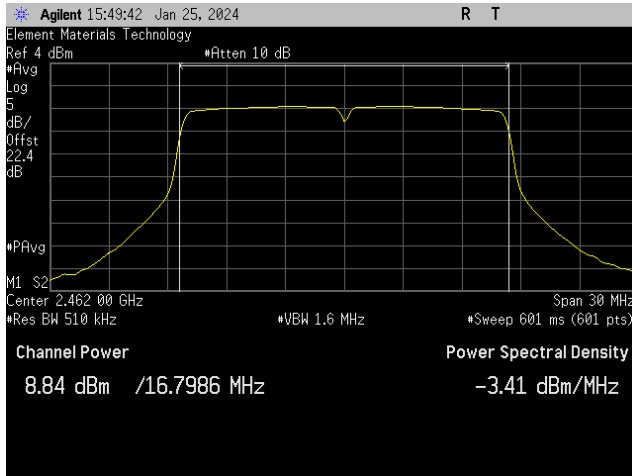


20 MHz  
2400 MHz - 2483.5 MHz Band  
802.11(g) 6 Mbps  
Low Channel 1, 2412 MHz

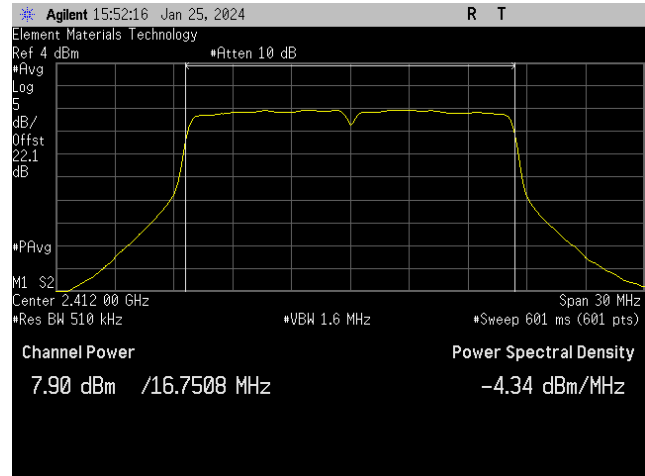


20 MHz  
2400 MHz - 2483.5 MHz Band  
802.11(g) 6 Mbps  
Mid Channel 6, 2437 MHz

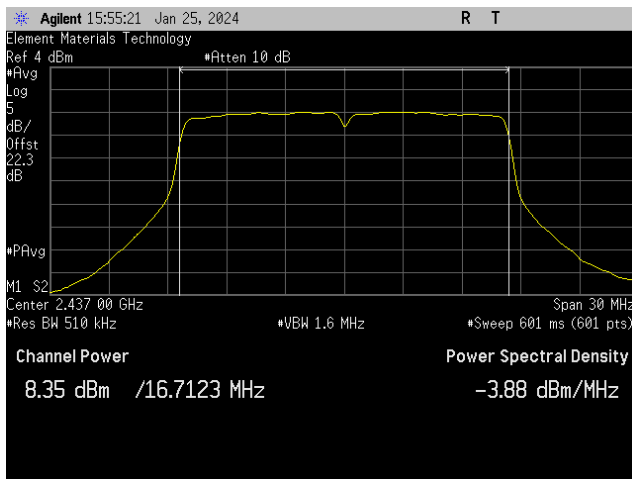
# OUTPUT POWER



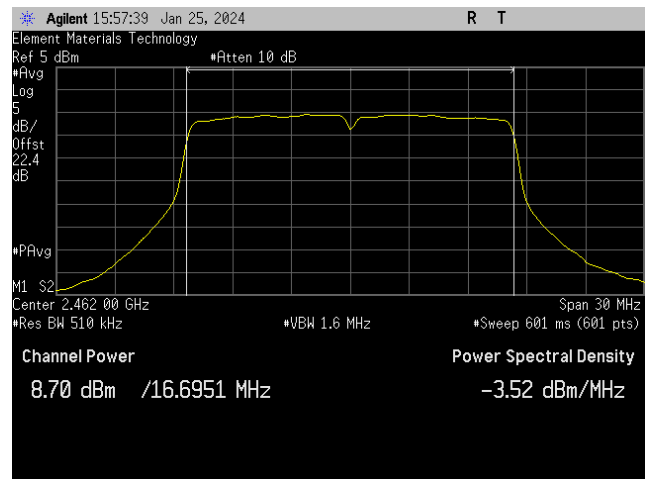
**20 MHz**  
**2400 MHz - 2483.5 MHz Band**  
**802.11(g) 6 Mbps**  
**High Channel 11, 2462 MHz**



**20 MHz**  
**2400 MHz - 2483.5 MHz Band**  
**802.11(g) 36 Mbps**  
**Low Channel 1, 2412 MHz**

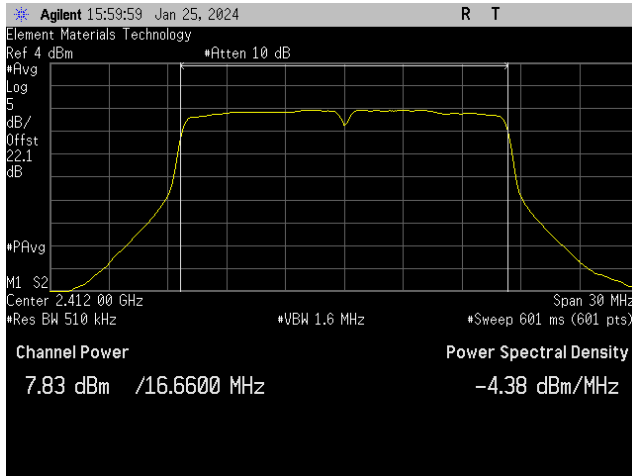


**20 MHz**  
**2400 MHz - 2483.5 MHz Band**  
**802.11(g) 36 Mbps**  
**Mid Channel 6, 2437 MHz**

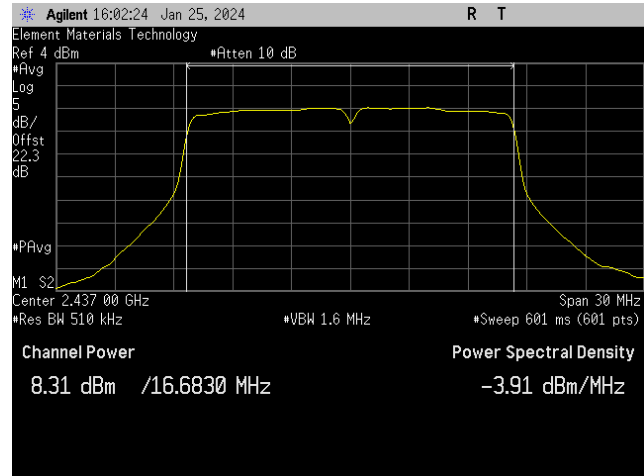


**20 MHz**  
**2400 MHz - 2483.5 MHz Band**  
**802.11(g) 36 Mbps**  
**High Channel 11, 2462 MHz**

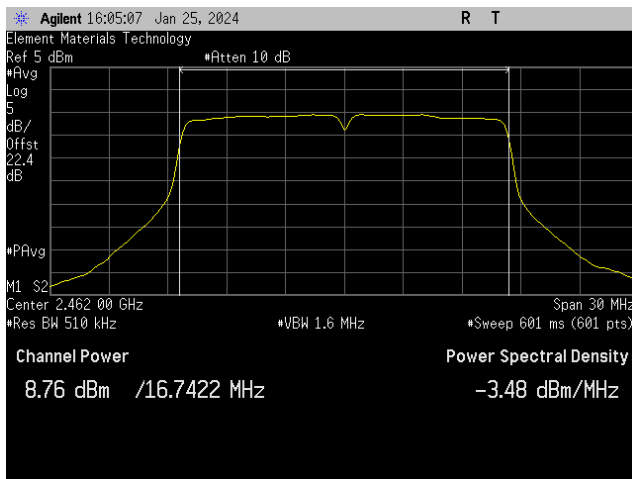
# OUTPUT POWER



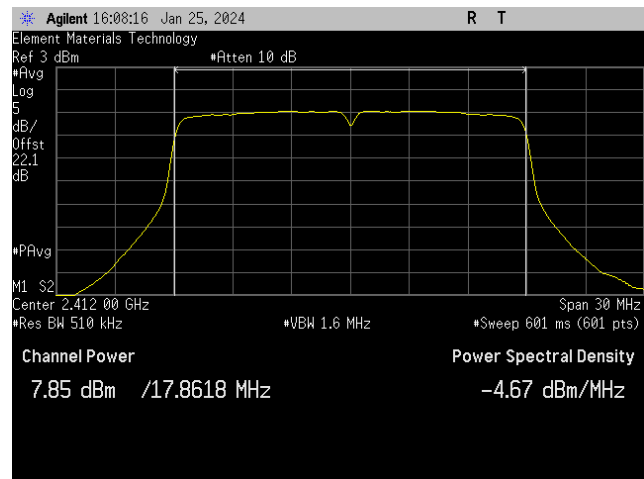
**20 MHz**  
**2400 MHz - 2483.5 MHz Band**  
**802.11(g) 54 Mbps**  
**Low Channel 1, 2412 MHz**



**20 MHz**  
**2400 MHz - 2483.5 MHz Band**  
**802.11(g) 54 Mbps**  
**Mid Channel 6, 2437 MHz**

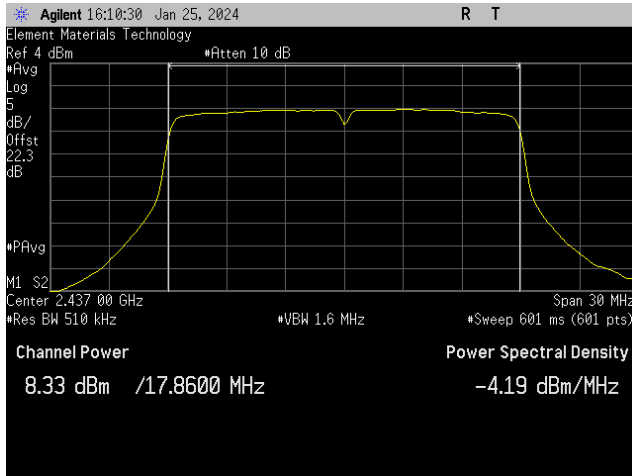


**20 MHz**  
**2400 MHz - 2483.5 MHz Band**  
**802.11(g) 54 Mbps**  
**High Channel 11, 2462 MHz**

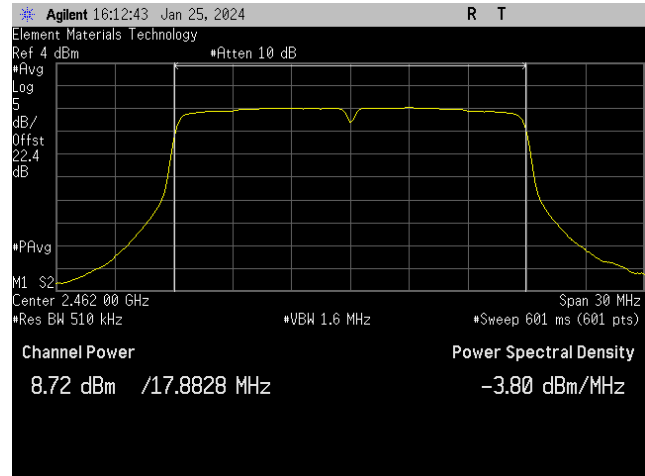


**20 MHz**  
**2400 MHz - 2483.5 MHz Band**  
**802.11(n) MCSO**  
**Low Channel 1, 2412 MHz**

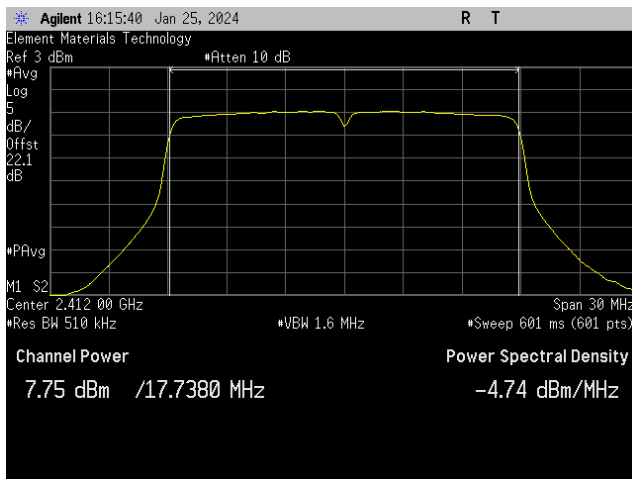
# OUTPUT POWER



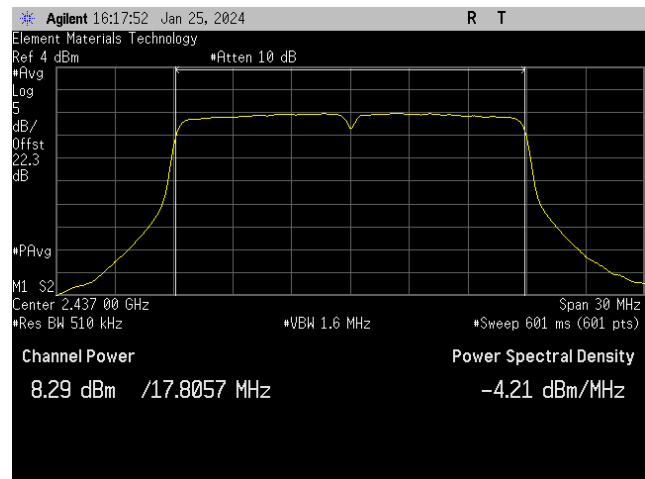
20 MHz  
2400 MHz - 2483.5 MHz Band  
802.11(n) MCS0  
Mid Channel 6, 2437 MHz



20 MHz  
2400 MHz - 2483.5 MHz Band  
802.11(n) MCS0  
High Channel 11, 2462 MHz

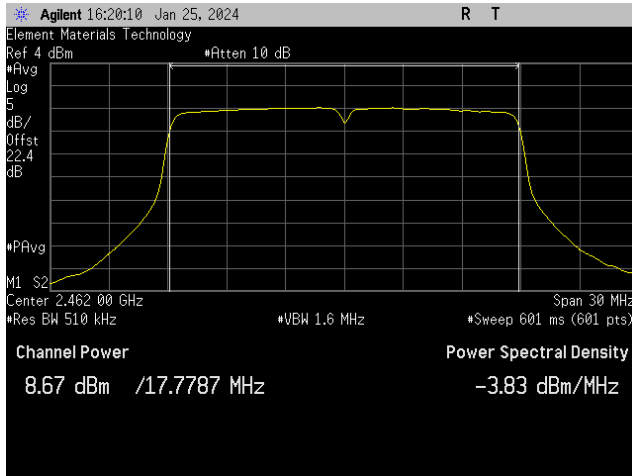


20 MHz  
2400 MHz - 2483.5 MHz Band  
802.11(n) MCS7  
Low Channel 1, 2412 MHz

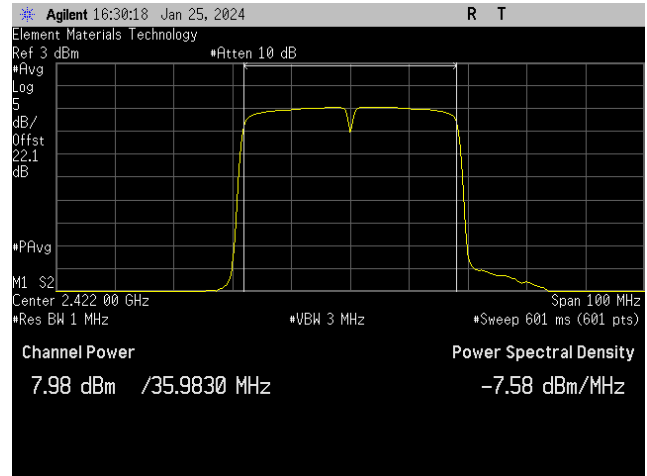


20 MHz  
2400 MHz - 2483.5 MHz Band  
802.11(n) MCS7  
Mid Channel 6, 2437 MHz

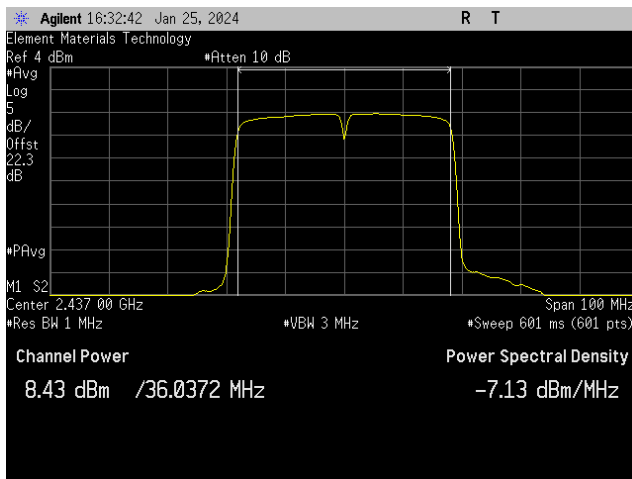
# OUTPUT POWER



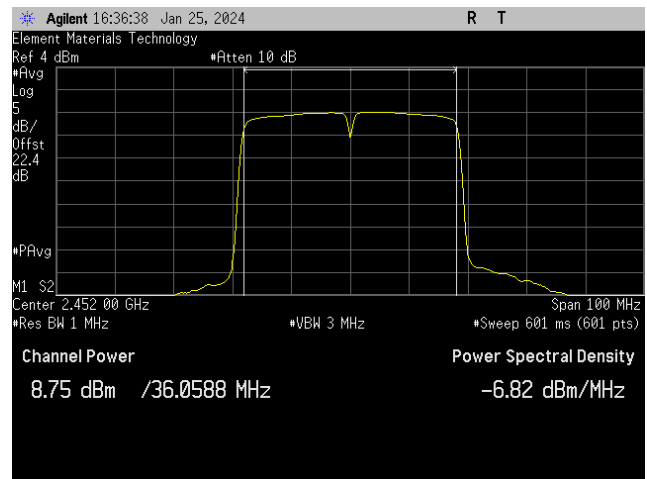
**20 MHz**  
**2400 MHz - 2483.5 MHz Band**  
**802.11(n) MCS7**  
**High Channel 11, 2462 MHz**



**40 MHz**  
**2400 MHz - 2483.5 MHz Band**  
**802.11(n) MCS0**  
**Low Channel 1/5, 2422 MHz**

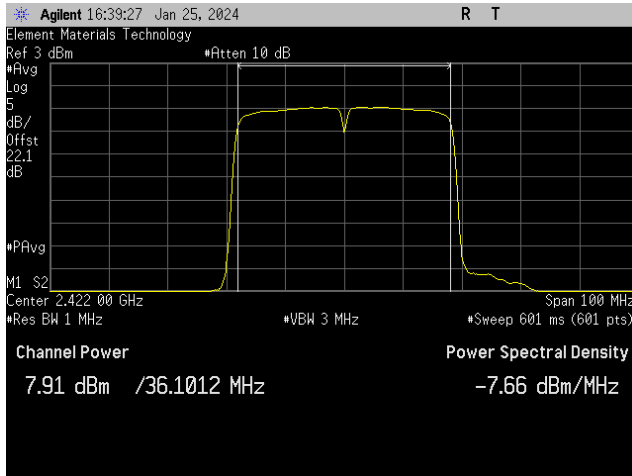


**40 MHz**  
**2400 MHz - 2483.5 MHz Band**  
**802.11(n) MCS0**  
**Mid Channel 4/8, 2437 MHz**

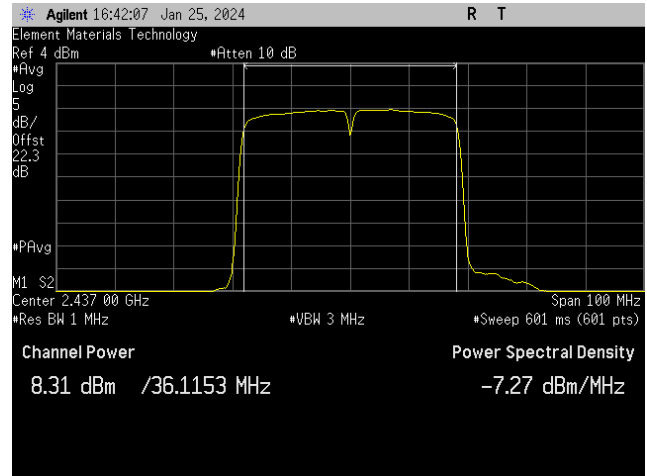


**40 MHz**  
**2400 MHz - 2483.5 MHz Band**  
**802.11(n) MCS0**  
**High Channel 7/11, 2452 MHz**

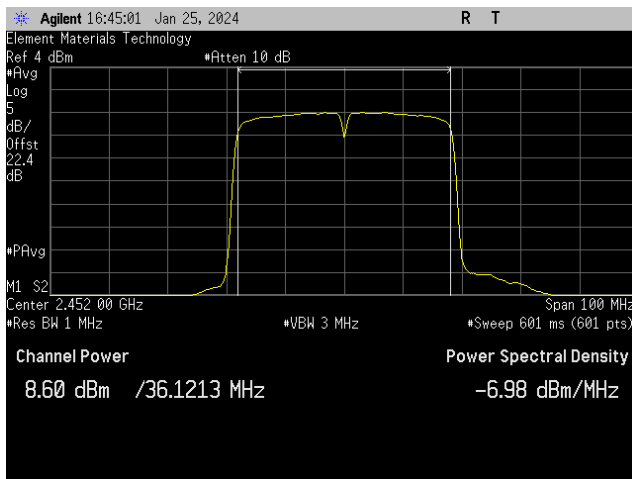
# OUTPUT POWER



**40 MHz**  
**2400 MHz - 2483.5 MHz Band**  
**802.11(n) MCS7**  
**Low Channel 1/5, 2422 MHz**



**40 MHz**  
**2400 MHz - 2483.5 MHz Band**  
**802.11(n) MCS7**  
**Mid Channel 4/8, 2437 MHz**



**40 MHz**  
**2400 MHz - 2483.5 MHz Band**  
**802.11(n) MCS7**  
**High Channel 7/11, 2452 MHz**



# SPURIOUS RADIATED EMISSIONS – SPOT CHECKS



## TEST DESCRIPTION

The highest gain antenna of each type to be used with the EUT was tested. The EUT was configured for the required transmit frequencies and the modes as showed in the data sheets.

For each configuration, the spectrum was scanned throughout the specified range as part of the exploratory investigation of the emissions. These “pre-scans” are not included in the report. Final measurements on individual emissions were then made and included in this test report.

The individual emissions from the EUT were maximized by rotating the EUT on a turntable, adjusting the position of the EUT and EUT antenna in three orthogonal axis if required, and adjusting the measurement antenna height and polarization (per ANSI C63.10). A preamp and high pass filter (and notch filter) were used for this test in order to provide sufficient measurement sensitivity.

Measurements were made with the required detectors and annotated on the data for each individual point using the following annotation:

- QP = Quasi-Peak Detector
- PK = Peak Detector
- AV = RMS Detector

Measurements were made to satisfy the specific requirements of the test specification for out of band emissions as well as the restricted band requirements.

If there are no detectable emissions above the noise floor, the data included may show noise floor measurements for reference only.

Measurements within 2 MHz of the allowable band may have been taken using the integration method from ANSI C63.10 clause 11.13.3. This procedure uses the channel power feature of the spectrum analyzer to integrate the power of the emission within a 1 MHz bandwidth.

Where the radio test software does not provide for a duty cycle at continuous transmit conditions (> 98%) and the RMS (power average) measurements were made across the on and off times of the EUT transmissions, a duty cycle correction is added to the measurements using the formula of  $10 \cdot \log(1/dc)$ .

## TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Antenna - Double Ridge	EMCO	3115	AHM	2022-07-13	2024-07-13
Cable	Northwest EMC	3115 Horn Cable	NC2	2023-04-25	2024-04-25
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	AVZ	2023-04-25	2024-04-25
Analyzer - Spectrum Analyzer	Agilent	N9010A	AFI	2023-08-29	2024-08-29
Antenna - Standard Gain	EMCO	3160-07	AHP	NCR	NCR
Cable	High Speed Interconnects	EW292A-NGNG-300	NC3	2023-09-01	2024-09-01
Amplifier - Pre-Amplifier	Miteq	AMF-6F-08001200-30-10P	AOK	2023-08-09	2024-08-09
Antenna - Standard Gain	EMCO	3160-08	AHO	NCR	NCR
Amplifier - Pre-Amplifier	Miteq	AMF-6F-12001800-30-10P	AOJ	2023-08-09	2024-08-09
Filter - High Pass	Micro-Tronics	HPM50111	HHI	2023-10-09	2024-10-09
Attenuator	Fairview Microwave	SA18E-20	AQV	2023-07-31	2024-07-31

## MEASUREMENT UNCERTAINTY

Description		
Expanded k=2	5.2 dB	-5.2 dB

## FREQUENCY RANGE INVESTIGATED

1 GHz TO 18 GHz

# SPURIOUS RADIATED EMISSIONS – SPOT CHECKS



## POWER INVESTIGATED

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120VAC/60Hz

---

## CONFIGURATIONS INVESTIGATED

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GLOW0052-1

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## MODES INVESTIGATED

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Transmitting WiFi 802.11. Low Channel 1 = 2412 MHz, Middle Channel 6 = 2437 MHz, High Channel 11 = 2462 MHz,  
Power setting = 38

---

# SPURIOUS RADIATED EMISSIONS – SPOT CHECKS



EUT:	GFD-100	Work Order:	GLOW0052
Serial Number:	D4D-T28	Date:	2024-01-24
Customer:	Glowforge Incorporated	Temperature:	22°C
Attendees:	Nathan Hills	Relative Humidity:	40.6%
Customer Project:	None	Bar. Pressure (PMSL):	1008 mb
Tested By:	Harry Zhao	Job Site:	NC01
Power:	120VAC/60Hz	Configuration:	GLOW0052-1

## TEST SPECIFICATIONS

Specification:	Method:
FCC 15.247:2024	ANSI C63.10:2013
RSS-247 Issue 3:2023	ANSI C63.10:2013
RSS-Gen Issue 5:2018+A1:2019+A2:2021	ANSI C63.10:2013

## TEST PARAMETERS

Run #:	21	Test Distance (m):	3	Ant. Height(s) (m):	1 to 4(m)
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## COMMENTS

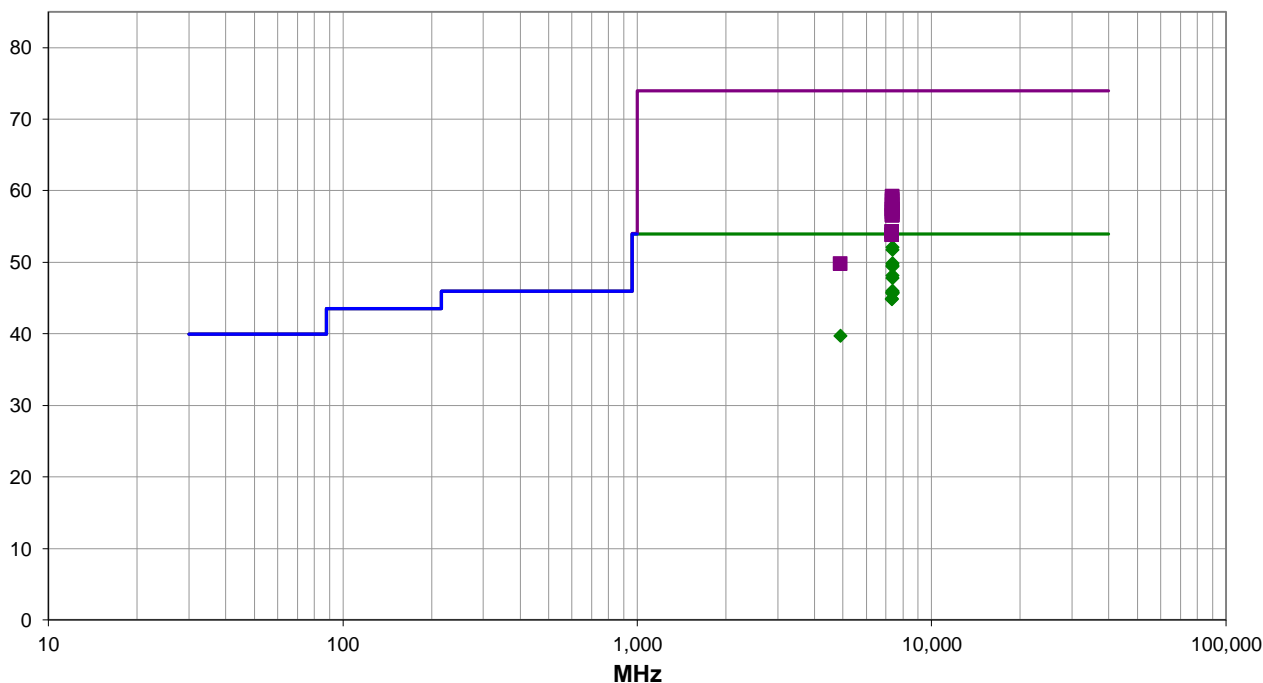
The test mode operates at various duty cycle (DC) . The lowest duty cycle of 54.7% was used for the duty cycle correction factor (DCCF). The upward duty cycle correction factor of  $10 \cdot \log(1/0.547) = 2.62$  dB was applied to the average measurements except for the 1 Mbps data rate which operates at >98% duty cycle. See data comments below for EUT orientation, data rates, and channel.

## EUT OPERATING MODES

Transmitting WiFi 802.11. Low Channel 1 = 2412 MHz, Middle Channel 6 = 2437 MHz, High Channel 11 = 2462 MHz, Power setting = 38

## DEVIATIONS FROM TEST STANDARD

None



Run #: 21

PK AV QP

# SPURIOUS RADIATED EMISSIONS – SPOT CHECKS



## RESULTS - Run #21

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor (dB)	External Attenuation (dB)	Polarity/Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
7387.183	37.1	15.0	2.5	116.0	0.0	0.0	Vert	AV	0.0	52.1	54.0	-1.9	Ch. 11, EUT Horizontal, 1 Mbps
7387.108	36.7	15.0	3.5	322.0	0.0	0.0	Horz	AV	0.0	51.7	54.0	-2.3	Ch. 11, EUT on side, 1 Mbps
7387.017	34.8	15.0	4.0	57.0	0.0	0.0	Horz	AV	0.0	49.8	54.0	-4.2	Ch. 11, EUT front facing down, 1 Mbps
7387.175	34.6	15.0	1.8	14.0	0.0	0.0	Vert	AV	0.0	49.6	54.0	-4.4	Ch. 11, EUT front facing down, 1 Mbps
7387.117	34.4	15.0	1.0	302.0	0.0	0.0	Vert	AV	0.0	49.4	54.0	-4.6	Ch. 11, EUT on side, 1 Mbps
7387.642	30.5	15.0	2.5	116.0	2.6	0.0	Vert	AV	0.0	48.1	54.0	-5.9	Ch. 11, EUT Horizontal, 11 Mbps
7385.167	32.8	15.0	4.0	221.0	0.0	0.0	Horz	AV	0.0	47.8	54.0	-6.2	Ch. 11, EUT Horizontal, 1 Mbps
7383.700	28.4	15.0	2.5	116.0	2.6	0.0	Vert	AV	0.0	46.0	54.0	-8.0	Ch. 11, EUT Horizontal, 6 Mbps
7386.717	28.2	15.0	2.5	116.0	2.6	0.0	Vert	AV	0.0	45.8	54.0	-8.2	Ch. 11, EUT Horizontal, 36 Mbps
7383.508	28.2	15.0	2.5	116.0	2.6	0.0	Vert	AV	0.0	45.8	54.0	-8.2	Ch. 11, EUT Horizontal, 54 Mbps
7384.733	28.1	15.0	2.5	116.0	2.6	0.0	Vert	AV	0.0	45.7	54.0	-8.3	Ch. 11, EUT Horizontal, HT20 MCS0
7383.708	28.0	15.0	2.5	116.0	2.6	0.0	Vert	AV	0.0	45.6	54.0	-8.4	Ch. 11, EUT Horizontal, HT20 MCS7
7353.858	27.8	14.5	2.5	116.0	2.6	0.0	Vert	AV	0.0	44.9	54.0	-9.1	Ch. 7/11, EUT Horizontal, HT40 MCS0
7354.258	27.7	14.5	2.5	116.0	2.6	0.0	Vert	AV	0.0	44.8	54.0	-9.2	Ch. 7/11, EUT Horizontal, HT40 MCS7
4924.108	29.4	10.3	1.5	165.0	0.0	0.0	Vert	AV	0.0	39.7	54.0	-14.3	Ch. 11, EUT Horizontal, 1 Mbps
7386.033	44.2	15.0	2.5	116.0	0.0	0.0	Vert	PK	0.0	59.2	74.0	-14.8	Ch. 11, EUT Horizontal, 1 Mbps
7385.967	43.8	15.0	3.5	322.0	0.0	0.0	Horz	PK	0.0	58.8	74.0	-15.2	Ch. 11, EUT on side, 1 Mbps
7385.183	43.5	15.0	2.5	116.0	0.0	0.0	Vert	PK	0.0	58.5	74.0	-15.5	Ch. 11, EUT Horizontal, HT20 MCS0
7387.658	43.0	15.0	1.8	14.0	0.0	0.0	Vert	PK	0.0	58.0	74.0	-16.0	Ch. 11, EUT front facing down, 1 Mbps
7387.467	42.4	15.0	2.5	116.0	0.0	0.0	Vert	PK	0.0	57.4	74.0	-16.6	Ch. 11, EUT Horizontal, 54 Mbps
7385.725	42.4	15.0	4.0	57.0	0.0	0.0	Horz	PK	0.0	57.4	74.0	-16.6	Ch. 11, EUT front facing down, 1 Mbps
7386.058	42.3	15.0	1.0	302.0	0.0	0.0	Vert	PK	0.0	57.3	74.0	-16.7	Ch. 11, EUT on side, 1 Mbps
7387.225	42.0	15.0	2.5	116.0	0.0	0.0	Vert	PK	0.0	57.0	74.0	-17.0	Ch. 11, EUT Horizontal, 11 Mbps
7387.558	41.9	15.0	2.5	116.0	0.0	0.0	Vert	PK	0.0	56.9	74.0	-17.1	Ch. 11, EUT Horizontal, 6 Mbps
7384.700	41.6	15.0	2.5	116.0	0.0	0.0	Vert	PK	0.0	56.6	74.0	-17.4	Ch. 11, EUT Horizontal, HT20 MCS7
7385.117	41.6	15.0	4.0	221.0	0.0	0.0	Horz	PK	0.0	56.6	74.0	-17.4	Ch. 11, EUT Horizontal, 1 Mbps
7384.450	41.5	15.0	2.5	116.0	0.0	0.0	Vert	PK	0.0	56.5	74.0	-17.5	Ch. 11, EUT Horizontal, 36 Mbps
7357.200	39.6	14.6	2.5	116.0	0.0	0.0	Vert	PK	0.0	54.2	74.0	-19.8	Ch. 7/11, EUT Horizontal, HT40 MCS7
7356.917	39.2	14.6	2.5	116.0	0.0	0.0	Vert	PK	0.0	53.8	74.0	-20.2	Ch. 7/11, EUT Horizontal, HT40 MCS0
4924.175	39.4	10.3	1.5	165.0	0.0	0.0	Vert	PK	0.0	49.7	74.0	-24.3	Ch. 11, EUT Horizontal, 1 Mbps

## CONCLUSION

Pass

Tested By

# SPURIOUS RADIATED EMISSIONS – SPOT CHECKS



EUT:	GFD-100	Work Order:	GLOW0052
Serial Number:	D4D-T28	Date:	2024-01-24
Customer:	Glowforge Incorporated	Temperature:	22°C
Attendees:	Nathan Hills	Relative Humidity:	40.6%
Customer Project:	None	Bar. Pressure (PMSL):	1008 mb
Tested By:	Harry Zhao	Job Site:	NC01
Power:	120VAC/60Hz	Configuration:	GLOW0052-1

## TEST SPECIFICATIONS

Specification:	Method:
FCC 15.247:2024	ANSI C63.10:2013
RSS-247 Issue 3:2023	ANSI C63.10:2013
RSS-Gen Issue 5:2018+A1:2019+A2:2021	ANSI C63.10:2013

## TEST PARAMETERS

Run #:	22	Test Distance (m):	3	Ant. Height(s) (m):	1 to 4(m)
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## COMMENTS

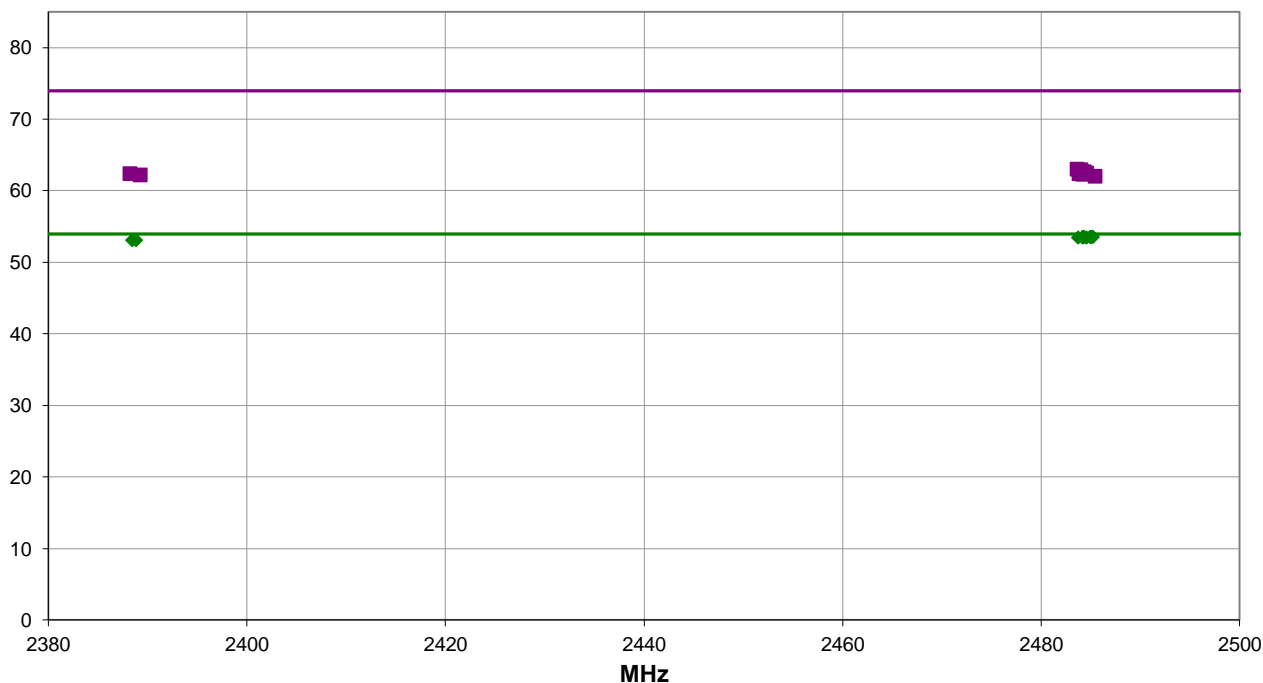
The test mode operates at various duty cycle (DC) . The lowest duty cycle of 54.7% was used for the duty cycle correction factor (DCCF). The upward duty cycle correction factor of  $10 \cdot \log(1/0.6265) = 2.62$  dB was applied to the average measurements except for the 1 Mbps data rate which operates at >98% duty cycle. See data comments below for EUT orientation, data rates, and channel.

## EUT OPERATING MODES

Transmitting WiFi 802.11. Low Channel 1 = 2412 MHz, Middle Channel 6 = 2437 MHz, High Channel 11 = 2462 MHz, Power setting = 38

## DEVIATIONS FROM TEST STANDARD

None



Run #: 22

■ PK    ◆ AV    ● QP

# SPURIOUS RADIATED EMISSIONS – SPOT CHECKS

## RESULTS - Run #22

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor	External Attenuation (dB)	Polarity/Transducer	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
2484.290	29.6	1.3	1.1	356.0	2.6	20.0	Horz	AV	0.0	53.5	54.0	-0.5	Ch. 11, EUT Horizontal, 1 Mbps
2484.980	29.6	1.3	1.5	327.0	2.6	20.0	Vert	AV	0.0	53.5	54.0	-0.5	Ch. 11, EUT Horizontal, 1 Mbps
2484.197	29.6	1.3	1.1	356.0	2.6	20.0	Horz	AV	0.0	53.5	54.0	-0.5	Ch. 11, EUT Horizontal, 11 Mbps
2485.250	29.6	1.3	1.1	356.0	2.6	20.0	Horz	AV	0.0	53.5	54.0	-0.5	Ch. 11, EUT Horizontal, 36 Mbps
2484.997	29.6	1.3	1.1	356.0	2.6	20.0	Horz	AV	0.0	53.5	54.0	-0.5	Ch. 11, EUT Horizontal, HT20 MCS0
2485.080	29.6	1.3	1.1	356.0	2.6	20.0	Horz	AV	0.0	53.5	54.0	-0.5	Ch. 11, EUT Horizontal, HT20 MCS7
2484.370	29.6	1.3	1.1	355.0	2.6	20.0	Horz	AV	0.0	53.5	54.0	-0.5	Ch. 7/11, EUT Horizontal, HT40 MCS7
2484.577	29.5	1.3	1.1	356.0	2.6	20.0	Horz	AV	0.0	53.4	54.0	-0.6	Ch. 11, EUT Horizontal, 6 Mbps
2484.197	29.5	1.3	1.1	356.0	2.6	20.0	Horz	AV	0.0	53.4	54.0	-0.6	Ch. 11, EUT Horizontal, 54 Mbps
2483.733	29.5	1.3	1.1	356.0	2.6	20.0	Horz	AV	0.0	53.4	54.0	-0.6	Ch. 7/11, EUT Horizontal, HT40 MCS0
2388.833	29.4	1.1	3.3	317.0	2.6	20.0	Horz	AV	0.0	53.1	54.0	-0.9	Ch. 1, EUT Horizontal, 1 Mbps
2388.433	29.4	1.1	1.5	82.0	2.6	20.0	Vert	AV	0.0	53.1	54.0	-0.9	Ch. 1, EUT Horizontal, 1 Mbps
2483.710	41.6	1.3	1.1	355.0	0.0	20.0	Horz	PK	0.0	62.9	74.0	-11.1	Ch. 7/11, EUT Horizontal, HT40 MCS7
2484.083	41.5	1.3	1.1	356.0	0.0	20.0	Horz	PK	0.0	62.8	74.0	-11.2	Ch. 11, EUT Horizontal, 54 Mbps
2484.390	41.3	1.3	1.1	356.0	0.0	20.0	Horz	PK	0.0	62.6	74.0	-11.4	Ch. 11, EUT Horizontal, 6 Mbps
2483.977	41.2	1.3	1.1	356.0	0.0	20.0	Horz	PK	0.0	62.5	74.0	-11.5	Ch. 11, EUT Horizontal, 1 Mbps
2483.977	41.1	1.3	1.1	356.0	0.0	20.0	Horz	PK	0.0	62.4	74.0	-11.6	Ch. 11, EUT Horizontal, 11 Mbps
2484.357	41.1	1.3	1.1	356.0	0.0	20.0	Horz	PK	0.0	62.4	74.0	-11.6	Ch. 11, EUT Horizontal, HT20 MCS7
2484.677	41.1	1.3	1.1	356.0	0.0	20.0	Horz	PK	0.0	62.4	74.0	-11.6	Ch. 7/11, EUT Horizontal, HT40 MCS0
2483.867	41.0	1.3	1.1	356.0	0.0	20.0	Horz	PK	0.0	62.3	74.0	-11.7	Ch. 11, EUT Horizontal, HT20 MCS0
2388.287	41.2	1.1	3.3	317.0	0.0	20.0	Horz	PK	0.0	62.3	74.0	-11.7	Ch. 1, EUT Horizontal, 1 Mbps
2484.277	40.9	1.3	1.1	356.0	0.0	20.0	Horz	PK	0.0	62.2	74.0	-11.8	Ch. 11, EUT Horizontal, 36 Mbps
2389.297	41.0	1.1	1.5	82.0	0.0	20.0	Vert	PK	0.0	62.1	74.0	-11.9	Ch. 1, EUT Horizontal, 1 Mbps
2485.487	40.6	1.3	1.5	327.0	0.0	20.0	Vert	PK	0.0	61.9	74.0	-12.1	Ch. 11, EUT Horizontal, 1 Mbps

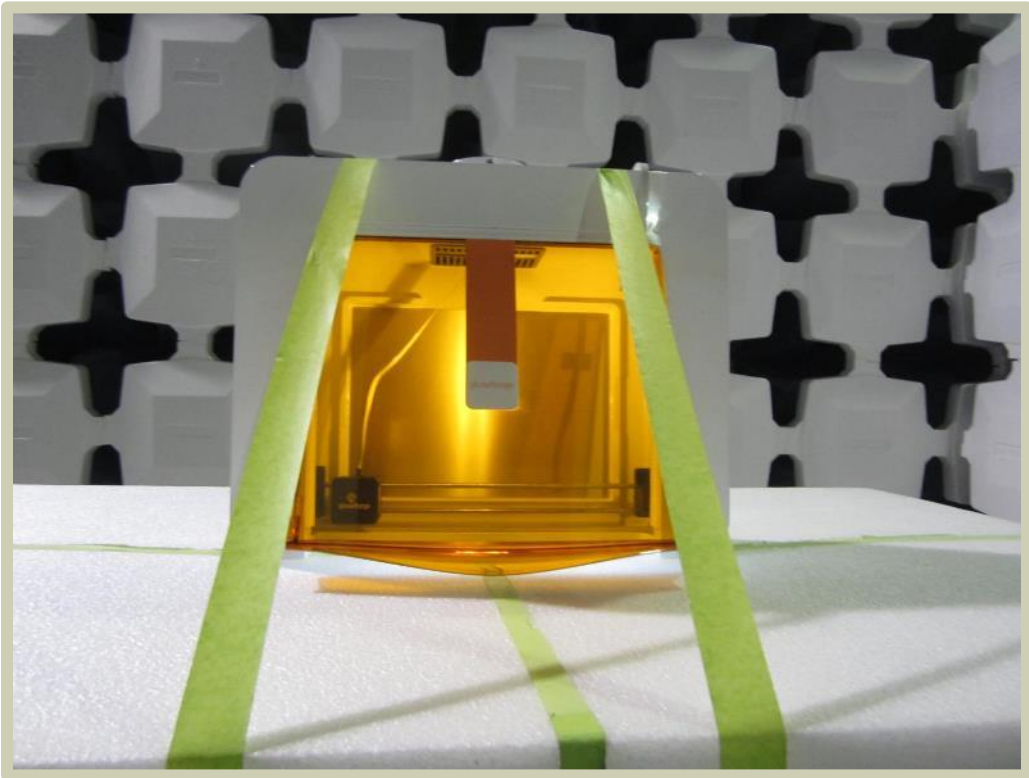
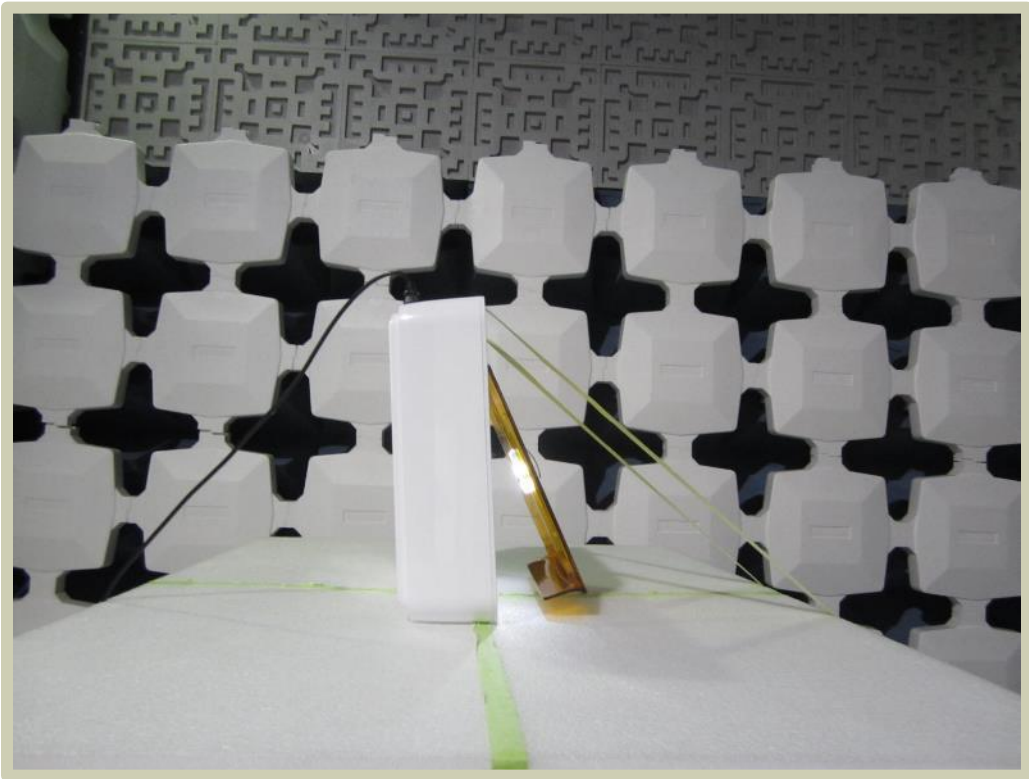
## CONCLUSION

Pass



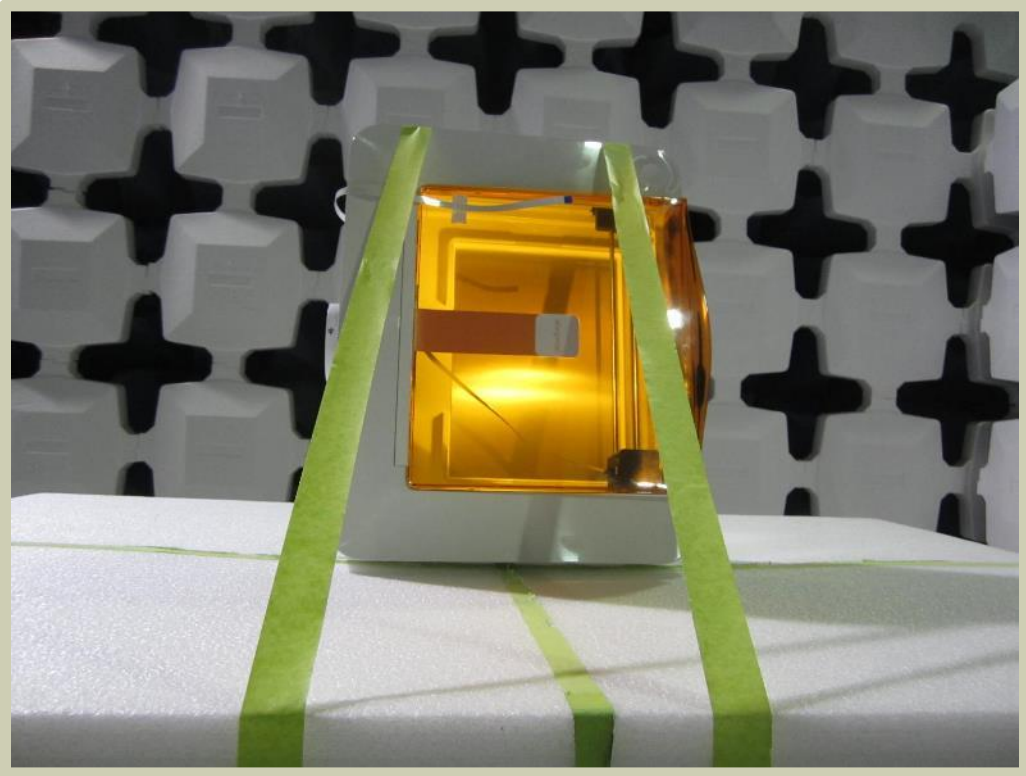
Tested By

# SPURIOUS RADIATED EMISSIONS – SPOT CHECKS



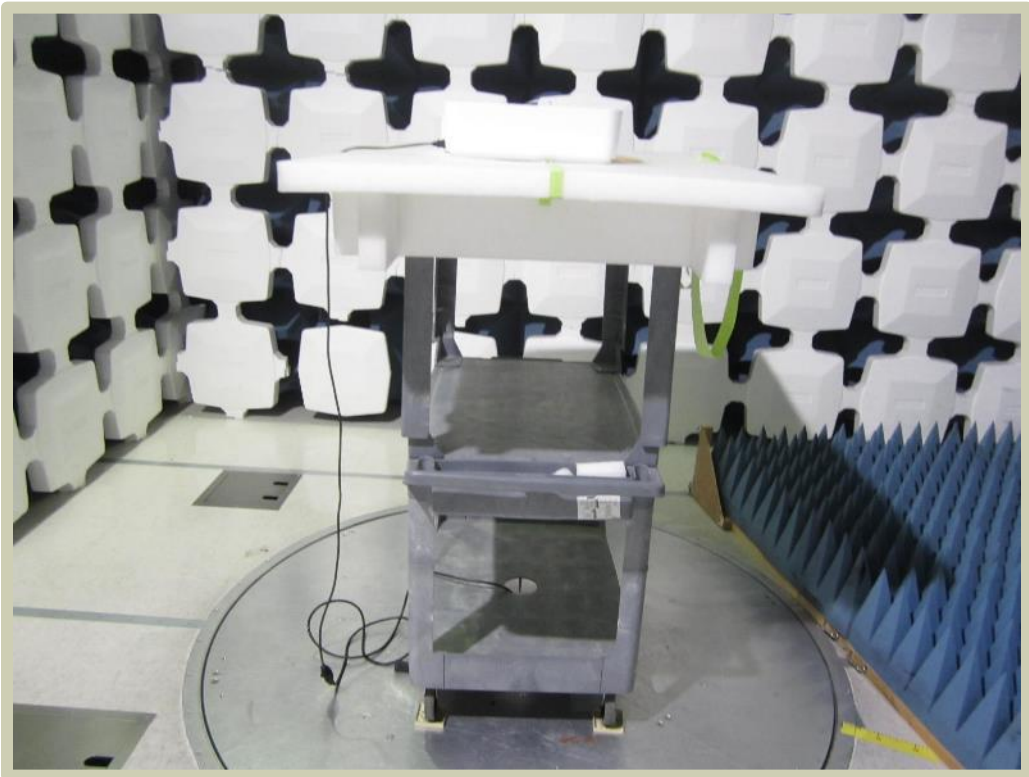


# SPURIOUS RADIATED EMISSIONS – SPOT CHECKS

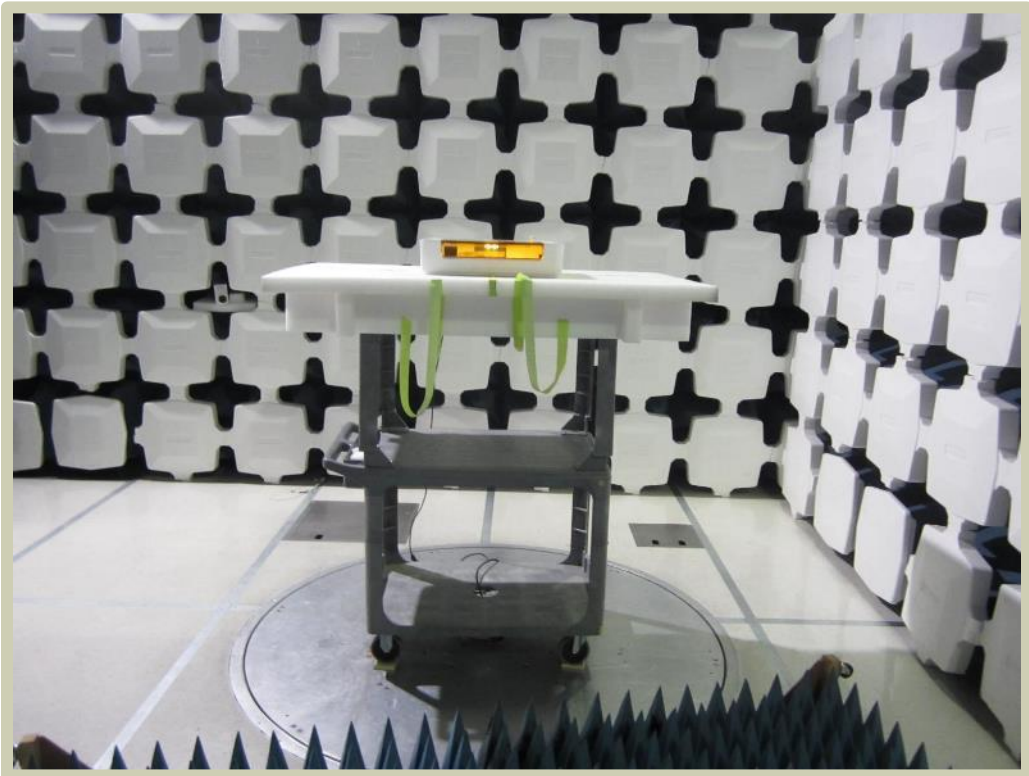
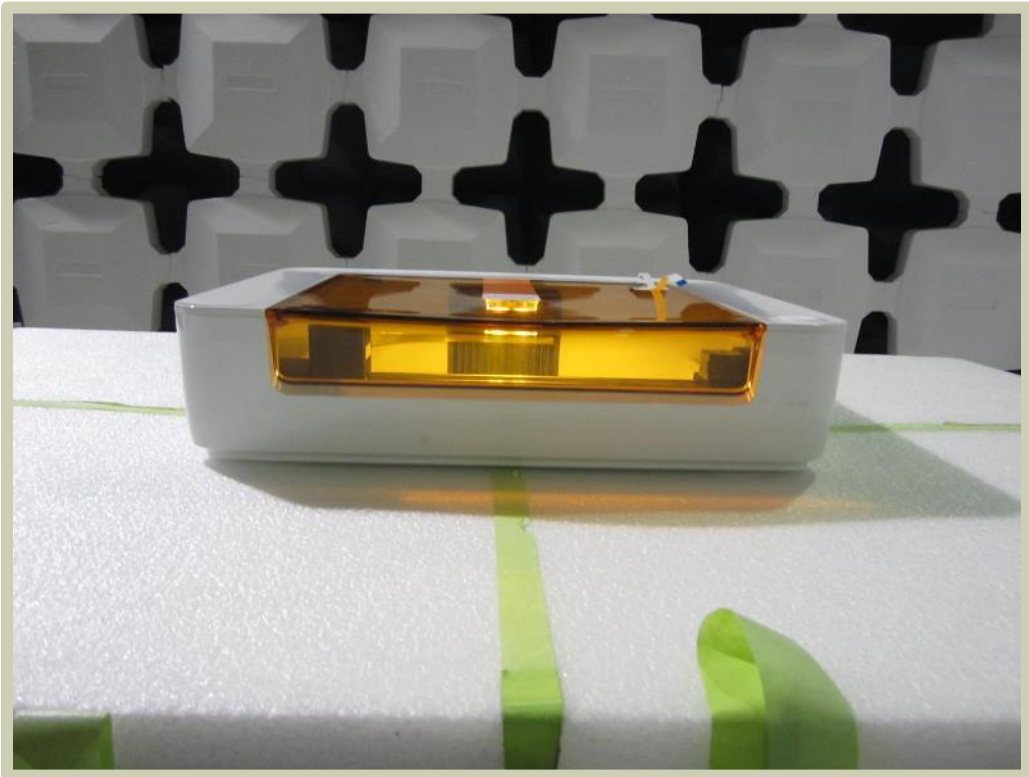




# SPURIOUS RADIATED EMISSIONS – SPOT CHECKS



# SPURIOUS RADIATED EMISSIONS – SPOT CHECKS



End of Test Report