HEADQUARTERS: 914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230 • PHONE (410) 354-3300 • FAX (410) 354-3313

November 1, 2022

Lumin
Ethan Bush
501 Locust Ave,
Floor 1, Ste 2,
Charlottesville, VA, 22902

Dear Ethan Bush,

Enclosed is the EMC Wireless test report for compliance testing of the Lumin Smart Panel, LSP-12 as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Part 15 Subpart C for Intentional Radiators.

Thank you for using the services of Eurofins Electrical and Electronic Testing NA, Inc. If you have any questions regarding these results or if Eurofins Electrical and Electronic Testing NA, Inc. can be of further service to you, please feel free to contact me.

Sincerely yours,
EUROFINS ELECTRICAL AND ELECTRONIC TESTING NA, INC.

Michelle Tawmging
Documentation Department

Reference: (\Lumin \WIR117048-FCC247 DTS Rev. 2)

ACCREDITED
TESTING CERT #0591.01

Electromagnetic Compatibility Criteria Test Report

for the

Lumin Smart Panel
LSP-12

Tested under
the FCC Certification Rules
contained in
15.247 Subpart C for Intentional Radiators

Report: WIR117048-FCC247 DTS Rev. 2

November 1, 2022

Prepared For:

Lumin
501 Locust Ave,
Floor 1, Ste 2,
Charlottesville, VA, 22902

Prepared By:
Eurofins Electrical and Electronic Testing NA, Inc.
914 W. Patapsco Avenue
Baltimore MD 21230

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Donald Salguero, Project Engineer
Wireless Lab

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC Rules Part 15.247 under normal use and maintenance.

Michael Griffiths
Manager, Wireless Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	August 26, 2022	Initial Issue.
1	October 7, 2022	Transmitter Parameters Overview Table Updated
2	November 1, 2022	Updated customer address; Updated EUT name

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Executive Summary

A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Lumin LSP-12, with the requirements of Part 15, §15.247. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the Lumin Smart Panel, LSP-12. Lumin should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Lumin Smart Panel, LSP-12, has been **permanently** discontinued.

B. Executive Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, §15.247, in accordance with Lumin, purchase order number 220105-E1. All tests were conducted using measurement procedure ANSI C63.10-2013.

FCC Reference 47 CFR Part 15.247:2005	Description	Compliance
Title 47 of the CFR, Part 15 §15.203	Antenna Requirement	Compliant
Title 47 of the CFR, Part 15 §15.207(a)	Conducted Emission Limits	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(2)	6dB Occupied Bandwidth	Compliant
Title 47 of the CFR, Part 15 §15.247(b)(3)	Peak Power Output	Compliant
Title 47 of the CFR, Part 15 §15.247(c)	Spurious Emissions in Non-restricted Bands	Compliant
Title 47 of the CFR, Part 15 §15.247(d); §15.209; §15.205	Radiated Spurious Emissions Requirements	Compliant
Title 47 of the CFR, Part 15; §15.247(e)	Peak Power Spectral Density	Compliant
Title 47 of the CFR, Part 15 §15.247(i)	Maximum Permissible Exposure (MPE)	Compliant

Table 1. Executive Summary of EMC Part 15.247 ComplianceTesting

Equipment Configuration

A. Overview

Eurofins Electrical and Electronic Testing NA, Inc. was contracted by Lumin to perform testing on the LSP-12, under Lumin's purchase order number 220105-E1.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Lumin Smart Panel, LSP-12.

The results obtained relate only to the item(s) tested.

Model(s) Tested:	LSP-12	
Model(s) Covered:	LSP-12	
EUT Specifications:	Primary Power: 120/240 VAC	
	FCC: 2AY52-LSP12W	
	Type of Modulations:	CCK, OFDM
	Equipment Code:	DTS
	Peak RF Output Power:	16.11 dBm; 0.041W
	EUT Frequency Ranges:	2412-2462 MHz; 2422-2452 MHz
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35º C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Evaluated by:	Donald Salguero	
Report Date(s):	November 1, 2022	

Table 2. EUT Summary Table

B. References

CFR 47, Part 15, Subpart C	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: General Rules and Regulations, Allocation, Assignment, and Use of Radio Frequencies
ANSI C63.4:2014	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
ISO/IEC 17025:2017	General Requirements for the Competence of Testing and Calibration Laboratories
ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices
KDB 558074 v05r02	Guidance For Performing Compliance Measurements On Digital Transmission Systems (DTS) Operating Under Section 15.247

Table 3. References

C. Test Site

All testing was performed at Eurofins Electrical and Electronic Testing NA, Inc., 914 W. Patapsco Avenue, Baltimore, MD 21230. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology. Eurofins Electrical and Electronic Testing NA, Inc. has been accredited by the American Association for Laboratory Accreditation (A2LA) (Certificate #: 0591.01) in accordance with ISO/IEC 17025:2017.

Radiated Emissions measurements were performed in a 3 meter semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at Eurofins Electrical and Electronic Testing NA, Inc.

D. Measurement Uncertainty

Test Method	Typical Expanded Uncertainty	K	Confidence Level
Radiated Emissions, (30 MHz – 1 GHz)	±3.20	2	95%
Radiated Emissions, (1 GHz – 6 GHz)	±2.52	2	95%
Conducted Emission Voltage	±2.03	2	95%
RF Frequencies	±4.52 Hz	2	95%
RF Power Conducted Emissions	±2.32 dB	2	95%
RF Power Conducted Spurious Emissions	±2.25 dB	2	95%
RF Power Radiated Emissions	±3.01 dB	2	95%

Table 4. Uncertainty Calculations Summary

E. Equipment Details

Name of EUT/Model:	LSP-12
Description of EUT and Intended Use:	Sample Lumin Smart Panel — residential electrical load management device — with support equipment (primarily a breaker panel) to simplify setup to connection with a 120/240 VAC power source and provide representative conditions. Breakers and wiring are included to simulate completed installation; load simulation current draw is not relevant to EMC testing. Test mode drivers have been configured for the wireless radio to support EMC testing operation modes. Note that the wireless transceiver is a third-party module without any agency certifications granted to the original manufacturer.
Selected Operation Mode(s):	Online Operation Mode: The device operates with a continuous network connection. The provided EUT setup shall be powered and connected to the local network via Ethernet while simultaneously broadcasting test mode data across 2.4 GHz Wi-Fi bands. Lumin will provide an operating manual for directly controlling the Wi-Fi radio.
Rational for the selection of the Operation Mode(s):	The device operates with a continuous network connection when installed. The device supports Ethernet and 2.4 GHz Wi-Fi, typically with data transfer only occurring over one or the other protocol (Bluetooth and 5 GHz Wi-Fi radios in the transceiver module are disabled in the factory-installed and -managed software, and can not be enabled by the end user). However, it is possible for momentary transition states in which both Ethernet and Wi-Fi transmitters are active, so this is selected as the peak emission operation mode. The physical EUT assembly provides a representative radiofrequency environment with respect to dead metal and 60 Hz AC power conductors.
Monitoring Method(s):	System operation for the EUT is verified by navigating to http://lumin-C43A35C500E3.local/ in a Web Browser once the EUT is connected to the local network via Ethernet. Refresh the site to check for continued operation. If the site reloads successfully, the device is operating properly. If the site fails to reload, the device has lost power, been improperly configured, or malfunctioned.
Emissions Class Declaration:	Class B
Configurations:	See the block diagram of the EUT assembly (LS-100693). Remove the outer product cover by unlatching the pair of clasps, pulling the bottom of the cover out, and lifting up. Remove the bag of hardware from the exposed interface compartment. Install an Ethernet cable between a router and the RJ45 port in the product labelled "Ethernet," utilizing the 3/4" knockout in the bottom of the enclosure to route the cable. Replace the product outer cover by hooking over the top and latching. Mount the EUT vertically (the Lumin logo on the smart panel oriented upright). Install the included external antenna on the RP-SMA jack of the product. Orient the installed antenna to point up.
EUT Power Requirement	
Voltage:	120/240
AC or DC:	AC
Voltage Frequency:	60
Number of Phases:	1

Current:	0.5
Physical Description	
EUT Arrangement:	Floor Standing
System with Multiple Chassis?	False
Size (HxWxD) inches:	48x31x6
Weight (lbs.):	60
Highest Internal Frequency (MHz):	2500
Other Info	
EUT Software (Internal to EUT):	QCMBR
Support Software (used by support PC to exercise EUT):	Web Browser
Transmitter Parameters	
Description of your unit:	DTS
Modulation Type:	CCK, OFDM
Number of Channels:	11 (20MHz width), 7 (40MHz width)
Frequency Range (MHz):	2412-2462 MHz; 2422-2452 MHz
Antenna Type:	External dipole
Antenna Gain (dB):	2
PMN:	Lumin Smart
HVIN:	8274B-SR
FVIN:	1.0
Data Rates:	600 Mbps
Expected Power Level:	16 dBm
Number of Antenna:	1
Number of Intentional Transmitters:	1
Number of Certified Intentional Transmitter Modules:	0
FCC ID:	2AY52-LSP12W

Table 5. Equipment Details

Ref. ID	Slot#	Name/Description	Model Number	Part Number	Serial Number	Rev. #
	1	UFB 6AWG 2C 7STR CU BLK WHT, 10AWG SOLID CU BARE, GRY JACKET		21469203		
	2	UFB 10AWG 2C SOLID CU BLK WHT, 10AWG SOLID CU BARE, GRY JACKET		13056717		
	3	NM B, 6/3 STRANDED CU BLK WHT RED, 12/1 SOLID CU BARE, BLK JACKET		63950045		
LS-100501	4	LOAD CENTER, 2 PHASE, 6 SPACES, 12 CIRCUITS, 125A		BR612L125RP		
	5	5 TERMINAL GALVANIZED GROUND BAR KIT		GBK5CS		
	6	CIRCUIT BREAKER, 15A, 1 POLE, STANDARD TRIP		BR115		
	7	CIRCUIT BREAKER, 20A, 2 POLE, STANDARD TRIP		BR220		
	8	CIRCUIT BREAKER, 40A, 1 POLE, STANDARD TRIP		BR140		
	9	CIRCUIT BREAKER, 70A, 2 POLE, STANDARD TRIP		BR270		
	10	3/8 IN CLAMP ON TYPE SERVICE ENTRANCE CONNECTOR CONDUIT FITTINGS		49650		
	11	3/4 IN CLAMP ON TYPE SERVICE ENTRANCE CONNECTOR CONDUIT FITTINGS		49660		
	12	BLACK INSULATED MULTI CABLE CONNECTOR DUAL ENTRY 2 PORTS 4 14		97102		
LS-100687	13	LSP 12 OR.1.7 TOP LEVEL		LS-100687		
LS-100417	14	LSP 12 OR.2.0 BRACKET		LS-100417		
LS-100419	15	LSP 12 OR.2.0 SPACER		LS-100419		
LS-100007	16	200A CT ASSEMBLY A		LS-100007		
LS-100009	17	200A CT ASSEMBLY B		LS-100009		
LS-100546	18	STAINLESS 1/4" 20 LOCKNUT		96278A511		
LS-100158	19	FLAT WASHER FOR 1/4" SCREW		90107A029		
LS-100164	20	1/4" WOOD SCREW HEX HEAD 2" LONG		91478A550		

Table 6. Equipment Configuration

Ref. ID	Port Name on EUT	Cable Desc. or reason for none	QTY	Length as tested (m)	Max Length (m)	Shielded?	Termination Box ID & Port Name
	RP-SMA JACK	NONE: DIRECT CXN FOR EXTERNAL ANTENNA	1			No	
	ETHER NET	CAT 5+ ETHERNET	1		30	Yes	
	USB	NONE: NOT USED IN END APPLICATIONS	2			No	
	RS-485	NONE: NOT USED IN END APPLICATION	1			No	

Table 7. Ports and Cabling

F. Modifications

a) Modifications to EUT

No modifications were made to the EUT.

b) Modifications to Test Standard

No modifications were made to the test standard.

G. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Lumin upon completion of testing.

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.203 Antenna Requirement

Test Requirement: **§ 15.203:** An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

The structure and application of the EUT were analyzed to determine compliance with Section 15.203 of the Rules. Section 15.203 states that the subject device must meet at least one of the following criteria:

a.) Antenna must be permanently attached to the unit.

b.) Antenna must use a unique type of connector to attach to the EUT.

c.) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

Test Results: The EUT as tested is **compliant** the criteria of §15.203. EUT uses unique connector.
Antenna Type: Whip Dipole
Antenna Gain: 2dBi

Test Engineer(s): Donald Salguero

Test Date(s): July 29, 2022

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.207(a) Conducted Emissions Limits

Test Requirement(s): **§ 15.207 (a):** For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency range (MHz)	§ 15.207(a), Conducted Limit (dBµV)	
	Quasi-Peak	Average
* 0.15- 0.5	66 - 56	56 - 46
0.5 - 5	56	46
5 - 30	60	50

Table 8. Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)

Test Procedure: The EUT was placed on a 0.8 m-high wooden table inside a screen room. The EUT was situated such that the back of the EUT was 0.4 m from one wall of the vertical ground plane, and the remaining sides of the EUT were no closer than 0.8 m from any other conductive surface. The EUT was powered from a 50 Ω/50 µH Line Impedance Stabilization Network (LISN). The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. Conducted Emissions measurements were made in accordance with *ANSI C63.10-2013*. The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω/50 µH LISN as the input transducer to an EMC/field intensity meter.

Test Results: The EUT was **compliant** with requirements of this section. Measured emissions were below the applicable limits.

Test Engineer(s): Donald Salguero

Test Date(s): August 18, 2022

§ 15.207(a) Conducted Emissions Limits

	Frequency	Quasi-Peak Measurement	Correction Factor	Corrected Measurement	Quasi-Peak Limit	Margin	Result	Average Measurement	Correction Factor	Corrected Measurement	Average Limit	Margin	Result
	MHz	dBuV	dB	dBuV	dBuV	dB	Pass/Fail	dBuV	dB	dBuV	dBuV	dB	Pass/Fail
Line 1	0.1500	46.88	10.36	57.23	65.99	-8.76	PASS	24.32	10.36	34.68	55.99	-21.31	PASS
	0.1970	43.11	10.18	53.29	64.67	-11.38	PASS	13.75	10.18	23.92	54.67	-30.75	PASS
	0.7730	34.97	9.99	44.96	56.00	-11.04	PASS	13.84	9.99	23.83	46.00	-22.17	PASS
	5.3660	43.45	10.00	53.45	60.00	-6.55	PASS	38.17	10.00	48.18	50.00	-1.82	PASS
	7.0930	43.98	10.02	54.00	60.00	-6.00	PASS	38.05	10.02	48.07	50.00	-1.93	PASS
	7.3080	43.32	10.02	53.34	60.00	-6.66	PASS	37.98	10.02	48.00	50.00	-2.00	PASS
Line 2	5.3990	24.61	10.00	34.61	60.00	-25.39	PASS	13.92	10.00	23.92	50.00	-26.08	PASS
	8.4340	32.68	10.04	42.72	60.00	-17.28	PASS	13.94	10.04	23.98	50.00	-26.02	PASS
	9.4020	27.52	10.05	37.57	60.00	-22.43	PASS	13.94	10.05	23.99	50.00	-26.01	PASS
	13.9560	25.32	10.10	35.43	60.00	-24.57	PASS	13.97	10.10	24.07	50.00	-25.93	PASS
	17.2310	21.92	10.14	32.06	60.00	-27.94	PASS	13.98	10.14	24.12	50.00	-25.88	PASS
	24.1820	19.20	10.31	29.51	60.00	-30.49	PASS	12.32	10.31	22.63	50.00	-27.37	PASS
Neutral	2.8410	20.58	9.98	30.57	56.00	-25.43	PASS	13.73	9.98	23.71	46.00	-22.29	PASS
	4.8160	35.20	10.00	45.20	56.00	-10.80	PASS	26.67	10.00	36.67	46.00	-9.33	PASS
	5.3560	38.21	10.00	48.21	60.00	-11.79	PASS	34.97	10.00	44.97	50.00	-5.03	PASS
	7.0540	40.22	10.02	50.24	60.00	-9.76	PASS	36.33	10.02	46.35	50.00	-3.65	PASS
	7.5170	38.79	10.02	48.81	60.00	-11.19	PASS	35.21	10.02	45.24	50.00	-4.76	PASS
	14.0500	20.49	10.10	30.59	60.00	-29.41	PASS	13.78	10.10	23.88	50.00	-26.12	PASS

Table 9. CEV, Data

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a)(2) 6 dB Bandwidth

Test Requirements: **§ 15.247(a)(2):** Operation under the provisions of this section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

For systems using digital modulation techniques, the EUT may operate in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands. The minimum 6dB bandwidth shall be at least 500 kHz.

Test Procedure: The EUT was connected to a spectrum analyzer through a cable and an attenuator. Measurements were taken with the EUT set to transmit continuously on its low, mid, and high channels for all its bandwidths. The 6dB bandwidth was measured according to measurement method 11.8.2 Option 2 of ANSI C63.10-2013.

Test Results The EUT was **compliant** with § 15.247 (a)(2).

The 6 dB Bandwidth was determined from the plots on the following pages.

Test Engineer(s): Donald Salguero

Test Date(s): July 29, 2022

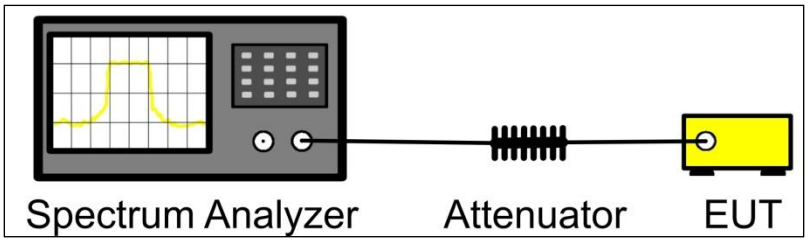

Figure 1. Block Diagram, Occupied Bandwidth Test Setup

6dB Occupied Bandwidth Test Results

Mode	Frequency (MHz)	Measured -6dB Bandwidth (MHz)	Measured 99% Bandwidth (MHz)
802.11b	2412	7.319	13.0095
	2437	8.163	13.0681
	2462	8.149	13.0691
802.11g	2412	16.35	16.6666
	2437	16.46	16.6148
	2462	16.134	16.6784
802.11n 20	2412	16.914	17.7585
	2437	16.938	17.8295
	2462	16.653	17.8214
802.11n 40	2422	35.227	36.4812
	2437	35.536	36.5079
	2452	35.437	36.5248

Table 10. 6dB Occupied Bandwidth Test Results

Electromagnetic Compatibility Criteria for Intentional Radiators

Duty Cycle

Test Procedure: The EUT was connected to a spectrum analyzer and was ran at the maximum achievable duty cycle for all modes. The duty cycle was measured in accordance with section 11.6 of ANSI C63.10-2013.

Test Results: The EUT was **compliant** with the duty cycle limits of **RSS-247 (6.2.4.1)**. No anomalies noted.

Test Engineer(s): Donald Salguero

Test Date(s): July 29, 2022

Duty Cycle

Mode	On Time (ms)	Period (ms)	Duty Cycle (%)	DCCF (dB)	VBW (Hz)
802.11b	N/A	N/A	100.00	0	N/A
802.11g	2.05	2.175	94.25	0.26	460
802.11n 20	1.917	2.033	94.29	0.26	492
802.11n 40	0.9083	1.05	86.5	0.63	952

Table 11. Duty Cycle, Test Results

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(b) Conducted Power Output

Test Requirements: **§15.247(b):** The maximum peak output power of the intentional radiator shall not exceed the following:

§15.247(b)(3): For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

§15.247(c)(4): The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Test Procedure: The EUT was connected to a spectrum analyzer through a cable and an attenuator. Measurements were taken with the EUT set to transmit continuously on its low, mid, and high channels for all its bandwidths at maximum power. Power was measured according to measurement method RBW ≥ DTS Bandwidth, as described in ANSI C63.10-2013, section 11.9.1.1. Attenuator and cable loss were programmed into the spectrum analyzer.

Test Results: The EUT was **compliant** with the Peak Power Output limits of **§15.247(b)**. No anomalies noted.

Test Engineer(s): Donald Salguero

Test Date(s): July 29, 2022

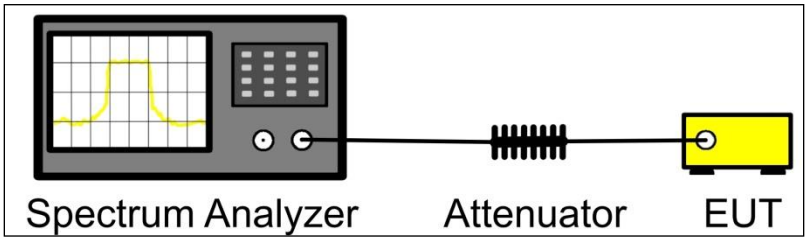

Figure 2. Power Output Test Setup

Maximum Conducted Power Output Test Results

Mode	Frequency (MHz)	Measured Conducted Power (dBm)	DCCF (dB)	Limit (dBm)	Margin (dB)	Antenna Gain (dBi)	EIRP (dBm)	Limit EIRP (dBm)	Margin (dB)
802.11b	2412	15.93	0	30	-14.07	2	17.93	36	-18.07
	2437	15.58	0	30	-14.42	2	17.58	36	-18.42
	2462	16.11	0	30	-13.89	2	18.11	36	-17.89
802.11g	2412	15.1	0.26	30	-14.64	2	17.36	36	-18.64
	2437	15.22	0.26	30	-14.52	2	17.48	36	-18.52
	2462	15.31	0.26	30	-14.43	2	17.57	36	-18.43
802.11n 20	2412	14.99	0.26	30	-14.75	2	17.25	36	-18.75
	2437	14.78	0.26	30	-14.96	2	17.04	36	-18.96
	2462	15.09	0.26	30	-14.65	2	17.35	36	-18.65
802.11n 40	2422	14.6	0.63	30	-14.77	2	17.23	36	-18.77
	2437	14.73	0.63	30	-14.64	2	17.36	36	-18.64
	2452	14.18	0.63	30	-15.19	2	16.81	36	-19.19

Table 12. Maximum Conducted Power Output Test Results

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.209 Radiated Spurious Emissions Requirements

Test Requirements: **§15.247(d); §15.205:** Emissions outside the frequency band.

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

MHz	MHz	MHz	GHz
0.090–0.110----------	16.42–16.423	399.9–410	4.5–5.15
[1] 0.495–0.505----------	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905----------	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128----------	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775----------	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775----------	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218----------	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825----------	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225----------	123–138	2200–2300	14.47–14.5
8.291–8.294----------	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366----------	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675----------	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475----------	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293----------	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025----------	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725----------	322–335.4	3600–4400	([2])
13.36-13.41			

Table 13. Restricted Bands of Operation

[1] Until February 1, 1999, this restricted band shall be 0.490 – 0.510 MHz.
[2] Above 38.6

Test Requirement(s): **§ 15.209 (a):** Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in Table 14.

Frequency (MHz)	§ 15.209(a),Radiated Emission Limits (dBµV) @ 3m
30 - 88	40.00
88 - 216	43.50
216 - 960	46.00
Above 960	54.00

Table 14. Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a)

Test Procedures: The transmitter was turned on. Measurements were performed of the low, mid and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line. Radiated emissions were investigated up to 25 GHz

Test Results: The EUT was **compliant** with the Radiated Spurious Emission limits of **§ 15.247(d) and § 15.209**. Measured emissions were below the applicable limits.

Test Engineer(s): Donald Salguero

Test Date(s): August 5, 2022

Mode	Channel	Frequency	Polarity	Antenna Height	Turntable Position	Measured	Correction Factor	Corrected Reading	Limit	Margin	Results
		MHz	Horizontal/Vertical	cm	Degrees	dBuV	dB	dBuV/m	dBuV/m	dB	Pass/Fail
802.11b (Worst-Case)	2412	56.16	H	402.21	0.60	18.36	12.52	30.88	40.00	-9.12	PASS
		36.36	V	114.34	15.90	13.38	20.66	34.04	40.00	-5.96	PASS
		55.95	V	276.34	186.40	23.56	12.04	35.60	40.00	-4.40	PASS
		70.24	V	106.52	-0.20	21.25	12.36	33.61	40.00	-6.39	PASS
		785.53	V	338.52	3.00	5.95	28.43	34.37	46.00	-11.63	PASS
	2437	55.95	H	393.95	114.20	21.55	12.54	34.09	40.00	-5.91	PASS
		782.85	H	152.52	279.40	-4.20	28.92	24.72	46.00	-21.28	PASS
		36.69	V	103.17	19.90	14.62	20.40	35.02	40.00	-4.98	PASS
		51.19	V	104.73	-1.20	21.10	12.36	33.46	40.00	-6.54	PASS
		58.62	V	107.82	24.70	22.84	11.86	34.70	40.00	-5.30	PASS
		69.68	V	162.43	21.30	23.01	12.39	35.40	40.00	-4.60	PASS
		780.37	V	332.34	92.30	5.95	28.32	34.26	46.00	-11.74	PASS
	2462	61.78	H	388.69	289.30	22.63	12.59	35.22	40.00	-4.78	PASS
		776.58	H	112.39	50.80	-4.28	28.72	24.45	46.00	-21.55	PASS
		36.69	V	104.00	0.20	15.17	20.40	35.57	40.00	-4.43	PASS
		48.05	V	188.65	75.00	18.79	13.48	32.27	40.00	-7.73	PASS
		53.58	V	222.47	244.50	23.20	12.12	35.32	40.00	-4.68	PASS

Table 15. Cabinet Radiated Emissions, Test Results below 1GHz

Mode	Frequency (MHz)	Frequency	Polarity	Antenna Height	Turntable Position	Measured	Correction Factor	Corrected Reading	Limit	Margin	Results
		MHz	Horizontal/Vertical	cm	Degrees	dBuV	dB	dBuV/m	dBuV/m	dB	Pass/Fail
802.11b	2412	1.92	H	286.39	23.50	48.80	-29.33	19.48	54.00	-34.52	PASS
		14.13	H	111.60	154.90	36.96	-0.83	36.13	54.00	-17.87	PASS
		1.92	H	286.39	23.50	59.62	-29.33	30.29	74.00	-43.71	PASS
		14.13	H	111.60	154.90	48.12	-0.83	47.29	74.00	-26.71	PASS
		7.74	V	103.78	114.80	41.60	-14.54	27.06	54.00	-26.94	PASS
		14.15	V	106.04	244.50	37.00	-1.41	35.59	54.00	-18.41	PASS
		7.74	V	103.78	114.80	52.35	-14.54	37.81	74.00	-36.19	PASS
		14.15	V	106.04	244.50	48.49	-1.41	47.08	74.00	-26.92	PASS
	2437	5.89	H	107.69	25.50	44.87	-20.96	23.91	54.00	-30.09	PASS
		14.10	H	106.04	26.70	35.83	-0.90	34.92	54.00	-19.08	PASS
		5.89	H	107.69	25.50	56.23	-20.96	35.27	74.00	-38.73	PASS
		14.10	H	106.04	26.70	46.09	-0.90	45.19	74.00	-28.81	PASS
		4.39	V	294.47	202.00	48.29	-25.84	22.45	54.00	-31.55	PASS
		14.21	V	106.56	202.10	36.12	-1.32	34.80	54.00	-19.20	PASS
		4.39	V	294.47	202.00	58.33	-25.84	32.49	74.00	-41.51	PASS
		14.21	V	106.56	202.10	45.69	-1.32	44.37	74.00	-29.63	PASS
	2462	7.00	H	102.69	114.00	42.37	-15.40	26.97	54.00	-27.03	PASS
		14.18	H	109.26	244.60	36.38	-0.70	35.68	54.00	-18.32	PASS
		7.00	H	102.69	114.00	53.86	-15.40	38.46	74.00	-35.54	PASS
		14.18	H	109.26	244.60	46.98	-0.70	46.28	74.00	-27.72	PASS
		6.99	V	102.39	114.90	42.71	-15.61	27.10	54.00	-26.90	PASS
		14.13	V	103.82	115.30	36.36	-1.46	34.90	54.00	-19.10	PASS
		6.99	V	102.39	114.90	53.54	-15.61	37.93	74.00	-36.07	PASS
		14.13	V	103.82	115.30	47.25	-1.46	45.79	74.00	-28.21	PASS

Table 16. Cabinet Radiated Emissions, Test Results above 1GHz – 802.11b

Mode	Frequency (MHz)	Frequency	Polarity	Antenna Height	Turntable Position	Measured	Correction Factor	Corrected Reading	Limit	Margin	Results
		MHz	Horizontal/Vertical	cm	Degrees	dBuV	dB	dBuV/m	dBuV/m	dB	Pass/Fail
802.11g	2412	3.36	H	296.30	113.60	49.40	-28.91	20.48	54.00	-33.52	PASS
		14.16	H	107.30	24.80	36.44	-0.75	35.69	54.00	-18.31	PASS
		3.36	H	296.30	113.60	59.84	-28.91	30.93	74.00	-43.07	PASS
		14.16	H	107.30	24.80	48.13	-0.75	47.37	74.00	-26.63	PASS
		6.98	V	103.13	22.30	42.50	-15.73	26.77	54.00	-27.23	PASS
		14.13	V	104.65	65.20	36.48	-1.46	35.02	54.00	-18.98	PASS
		6.98	V	103.13	22.30	52.98	-15.73	37.25	74.00	-36.75	PASS
		14.13	V	104.65	65.20	46.77	-1.46	45.31	74.00	-28.69	PASS
	2437	10.78	H	103.47	25.20	40.56	-11.16	29.40	54.00	-24.60	PASS
		14.10	H	104.69	243.60	36.42	-0.91	35.51	54.00	-18.49	PASS
		10.78	H	103.47	25.20	51.37	-11.16	40.22	74.00	-33.78	PASS
		14.10	H	104.69	243.60	46.86	-0.91	45.95	74.00	-28.05	PASS
		7.03	V	102.56	201.60	42.70	-15.49	27.21	54.00	-26.79	PASS
		14.18	V	104.04	202.10	36.83	-1.31	35.51	54.00	-18.49	PASS
		7.03	V	102.56	201.60	54.18	-15.49	38.69	74.00	-35.31	PASS
		14.18	V	104.04	202.10	46.87	-1.31	45.55	74.00	-28.45	PASS
	2462	7.05	H	102.34	114.10	42.39	-15.22	27.17	54.00	-26.83	PASS
		14.20	H	103.52	243.60	35.78	-0.68	35.10	54.00	-18.90	PASS
		7.05	H	102.34	114.10	53.14	-15.22	37.92	74.00	-36.08	PASS
		14.20	H	103.52	243.60	45.69	-0.68	45.01	74.00	-28.99	PASS
		7.76	V	103.78	360.10	41.28	-14.50	26.78	54.00	-27.22	PASS
		14.16	V	104.82	114.50	36.83	-1.37	35.46	54.00	-18.54	PASS
		7.76	V	103.78	360.10	51.48	-14.50	36.98	74.00	-37.02	PASS
		14.16	V	104.82	114.50	48.22	-1.37	46.85	74.00	-27.15	PASS

Table 17. Cabinet Radiated Emissions, Test Results above 1GHz – 802.11g

Mode	Frequency (MHz)	Frequency	Polarity	Antenna Height	Turntable Position	Measured	Correction Factor	Corrected Reading	Limit	Margin	Results
		MHz	Horizontal/Vertical	cm	Degrees	dBuV	dB	dBuV/m	dBuV/m	dB	Pass/Fail
802.11n 20	2412	6.38	H	102.78	113.80	44.09	-20.12	23.97	54.00	-30.03	PASS
		14.21	H	104.91	243.80	36.55	-0.74	35.81	54.00	-18.19	PASS
		6.38	H	102.78	113.80	54.59	-20.12	34.47	74.00	-39.53	PASS
		14.21	H	104.91	243.80	46.79	-0.74	46.06	74.00	-27.94	PASS
		6.93	V	102.91	290.60	42.50	-16.27	26.23	54.00	-27.77	PASS
		14.13	V	104.39	115.30	36.83	-1.46	35.37	54.00	-18.63	PASS
		6.93	V	102.91	290.60	53.41	-16.27	37.14	74.00	-36.86	PASS
		14.13	V	104.39	115.30	47.09	-1.46	45.62	74.00	-28.38	PASS
	2437	7.07	H	183.08	201.20	42.87	-15.15	27.73	54.00	-26.27	PASS
		14.21	H	107.26	201.70	36.45	-0.71	35.74	54.00	-18.26	PASS
		7.07	H	183.08	201.20	54.20	-15.15	39.05	74.00	-34.95	PASS
		14.21	H	107.26	201.70	46.97	-0.71	46.26	74.00	-27.74	PASS
		12.02	V	102.47	359.60	38.49	-6.26	32.23	54.00	-21.77	PASS
		14.18	V	104.13	115.40	36.71	-1.33	35.39	54.00	-18.61	PASS
		12.02	V	102.47	359.60	49.59	-6.26	43.33	74.00	-30.67	PASS
		14.18	V	104.13	115.40	48.33	-1.33	47.00	74.00	-27.00	PASS
	2462	10.79	H	104.56	113.70	41.09	-11.07	30.03	54.00	-23.97	PASS
		14.15	H	105.73	23.30	36.92	-0.79	36.13	54.00	-17.87	PASS
		10.79	H	104.56	113.70	51.70	-11.07	40.63	74.00	-33.37	PASS
		14.15	H	105.73	23.30	47.69	-0.79	46.90	74.00	-27.10	PASS
		7.75	V	103.08	200.00	41.72	-14.52	27.20	54.00	-26.80	PASS
		14.20	V	104.30	22.90	36.90	-1.27	35.63	54.00	-18.37	PASS
		7.75	V	103.08	200.00	52.30	-14.52	37.78	74.00	-36.22	PASS
		14.20	V	104.30	22.90	48.58	-1.27	47.32	74.00	-26.69	PASS

Table 18. Cabinet Radiated Emissions, Test Results above 1GHz – 802.11n HT20

Mode	Frequency (MHz)	Frequency	Polarity	Antenna Height	Turntable Position	Measured	Correction Factor	Corrected Reading	Limit	Margin	Results
		MHz	Horizontal/Vertical	cm	Degrees	dBuV	dB	dBuV/m	dBuV/m	dB	Pass/Fail
802.11n 20	2422	10.80	H	243.43	113.70	41.16	-11.03	30.13	54.00	-23.87	PASS
		14.18	H	106.30	32.40	37.47	-0.71	36.76	54.00	-17.24	PASS
		10.80	H	243.43	113.70	52.51	-11.03	41.48	74.00	-32.52	PASS
		14.18	H	106.30	32.40	48.24	-0.71	47.54	74.00	-26.46	PASS
		12.07	V	102.47	290.70	39.19	-6.55	32.64	54.00	-21.36	PASS
		14.17	V	104.73	291.20	36.93	-1.34	35.59	54.00	-18.41	PASS
		12.07	V	102.47	290.70	49.09	-6.55	42.54	74.00	-31.46	PASS
		14.17	V	104.73	291.20	48.27	-1.34	46.93	74.00	-27.07	PASS
	2437	12.04	H	103.17	293.00	39.43	-6.41	33.03	54.00	-20.97	PASS
		14.10	H	104.34	202.90	37.29	-0.92	36.37	54.00	-17.63	PASS
		12.04	H	103.17	293.00	49.18	-6.41	42.77	74.00	-31.23	PASS
		14.10	H	104.34	202.90	47.52	-0.92	46.60	74.00	-27.40	PASS
		10.80	V	103.95	292.90	41.28	-11.34	29.93	54.00	-24.07	PASS
		14.12	V	107.30	201.60	37.28	-1.51	35.77	54.00	-18.23	PASS
		10.80	V	103.95	292.90	51.60	-11.34	40.26	74.00	-33.74	PASS
		14.12	V	107.30	201.60	48.04	-1.51	46.53	74.00	-27.47	PASS
	2452	7.02	H	104.17	114.80	43.03	-15.33	27.70	54.00	-26.30	PASS
		14.21	H	105.39	244.70	37.25	-0.72	36.54	54.00	-17.46	PASS
		7.02	H	104.17	114.80	53.64	-15.33	38.30	74.00	-35.70	PASS
		14.21	H	105.39	244.70	47.76	-0.72	47.04	74.00	-26.96	PASS
		11.91	V	102.52	26.10	38.02	-6.70	31.32	54.00	-22.68	PASS
		14.17	V	103.73	64.40	37.29	-1.35	35.94	54.00	-18.06	PASS
		11.91	V	102.52	26.10	47.76	-6.70	41.06	74.00	-32.94	PASS
		14.17	V	103.73	64.40	48.23	-1.35	46.87	74.00	-27.13	PASS

Table 19. Cabinet Radiated Emissions, Test Results above 1GHz – 802.11n HT40

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d) Spurious Emissions in Non-restricted Bands

Test Requirement: **15.247(d)** In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

Test Procedure: For intentional radiators with a digital device portion which operates below 10 GHz, the spectrum was investigated as per §15.33(a)(1) and §15.33(a)(4); i.e., the lowest RF signal generated or used in the device up to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

The EUT was connected to a spectrum analyzer through a cable and an attenuator. Measurements were taken with the EUT set to transmit continuously on its low, mid, and high channels for all its bandwidths at maximum power. Conducted spurious emissions were measured according to sections 11.11.2 and 11.11.3 of ANSI C63.10-2013.

Test Results: The EUT was **compliant** with the Spurious Emission limits of **§15.247(d)**. Measured emissions were below the applicable limits.

Test Engineer(s): Donald Salguero

Test Date(s): July 29, 2022

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(e) Power Spectral Density

Test Requirements: **§15.247(e):** For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

Test Procedure: The EUT was connected to a spectrum analyzer through a cable and an attenuator. Measurements were taken with the EUT set to transmit continuously on its low, mid, and high channels for all its bandwidths at maximum power. Power spectral density was measured according to measurement method PKPSD, as described in ANSI C63.10-2013, section 11.10.2. Attenuator and cable loss were programmed into the spectrum analyzer.

Test Results: The EUT was **compliant** with the peak power spectral density limits of **§ 15.247 (e)**. No anomalies noted.

The peak power spectral density was determined from plots on the following page(s).

Test Engineer(s): Donald Salguero

Test Date(s): July 29, 2022

Peak Power Spectral Density Test Results

Mode	Frequency (MHz)	Measured Conducted PSD (dBm)	Limit (dBm)	Margin (dB)
802.11b	2412	-3.43	8	-11.43
	2437	-9.22	8	-17.22
	2462	0.15	8	-7.85
802.11g	2412	-4.8	8	-12.8
	2437	-6.42	8	-14.42
	2462	-6.34	8	-14.34
802.11n 20	2412	-6.52	8	-14.52
	2437	-5.11	8	-13.11
	2462	-6.16	8	-14.16
802.11n 40	2422	-9.8	8	-17.8
	2437	-8.74	8	-16.74
	2452	-7.22	8	-15.22

Table 20. Peak Power Spectral Density Test Results

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(i) Maximum Permissible Exposure

RF Exposure Requirements: **§1.1307(b)(1) and §1.1307(b)(2):** Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

RF Radiation Exposure Limit: **§1.1310:** As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.

Test Results:

Maximum Permissible Exposure Test Results

FCC									
Frequency (MHz)	**Con. Pwr. (dBm)**	**Con. Pwr. (mW)**	**Ant. Gain (dBi)**	**Ant. Gain numeric**	**Pwr. Density (mW/cm^2)**	**Limit (mW/cm^2)**	**Margin**	**Distance (cm)**	**Result**
2462	16.11	40.832	2	1.585	0.01287	1	0.98713	20	Pass

Table 21. Maximum Permissible Exposure Test Results

Test Equipment List

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2017.

Asset	Equipment	Manufacturer	Model	Calibration Date	Calibration Due Date
1T4681	Spectrum Analyzer (PSA)	Agilent Technologies	E4448A	10/15/2021	4/15/2023
1T4409	EMI Receiver	Rohde & Schwarz	ESIB7	2/16/2022	8/31/2023
1T6658	Spectrum Analyzer	Agilent Technologies	E4407B	9/7/2021	3/7/2023
1T4751	Antenna - Bilog	Sunol Sciences	JB6	6/1/2022	12/1/2023
1T4576	Antenna, Active Horn	Com-Power	AHA-118	7/8/2022	1/31/2024
1T4744	Antenna, Horn	ETS-Lindgren	3116	3/4/2021	9/4/2022
1T4752	Pre-Amplifier	Miteq	JS44-18004000-35-8P	Func Verify	Func Verify
1T8743	Preamplifier	A.H. Systems, Inc.	PAM-0118P	Func Verify	Func Verify
1T4300B	Semi-Anechoic 3m Chamber sVSWR	EMC TEST SYSTEMS	NONE	9/30/2021	9/30/2023
1T4300	SEMI-ANECHOIC CHAMBER (NSA)	EMC TEST SYSTEMS	NONE	8/19/2021	8/31/2023
1T8909	LISN	Com-Power	LI-150C	4/12/2021	10/12/2022
1T8908	LISN	Com-Power	LI-150C	4/12/2021	10/12/2022
1T8907	LISN	Com-Power	LI-150C	4/12/2021	10/12/2022
1T7450	Transient Limiter	Com-Power	LIT-153A	Not Required	Not Required

Table 22. Equipment List

Note: Functionally verified test equipment is verified using calibrated instrumentation at time of testing.

End of Report