

June 2, 2021

Span.IO, Inc.
1436 Howard St #201
San Francisco, CA 94103

Dear Cole Ashman,

Enclosed is the EMC Wireless test report for compliance testing of the Span.IO, Inc., Span Smart Panel (PN 01-00800-xx) as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Title 47 of the CFR, Part 15.407, Subpart E (UNII 3).

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.



Jennifer Warnell
Documentation Department

Reference: (\Span.IO, Inc.\ WIRS112102-FCC407 UNII 3)



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Electromagnetic Compatibility Criteria Test Report

for the

**Span.IO, Inc.
Model Span Smart Panel (PN 01-00800-xx)**

Tested under
The FCC Certification Rules
contained in
Title 47 of the CFR
15.407 Subpart E

Report: WIRS112102-FCC407 UNII 3

June 2, 2021

Prepared For:

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San Francisco, CA 94103**

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Arsalan Hasan
Manager, Wireless Laboratory

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 Part 15.407, of the FCC Rules under normal use and maintenance.



Eleazar Zuniga, PhD.
Director, Wireless Technologies

Report Status Sheet

Revision	Report Date	Reason for Revision
Ø	June 2, 2021	Initial Issue.

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Executive Summary

A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Span.IO, Inc. Span Smart Panel (PN 01-00800-xx), with the requirements of Part 15, §15.407. 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 Span Smart Panel (PN 01-00800-xx). Span.IO, Inc. should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Span Smart Panel (PN 01-00800-xx), 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, §15.407, in accordance with Span.IO, Inc., purchase order number PO00303. All tests were conducted using measurement procedure ANSI C63.4-2014.

FCC Reference	Description	Results
§15.203	Antenna Requirement	Compliant
§15.403(i)	26 dB Occupied Bandwidth	Data valid from module original certification FCC ID: N6C-SDPAC
§15.407 (a)(2)	Maximum Conducted Output Power	Data valid from module original certification FCC ID: N6C-SDPAC
§15.407 (a)(2)	Maximum Power Spectral Density	Data valid from module original certification FCC ID: N6C-SDPAC
§15.407 (b)(4)& (6 - 7)	Undesirable Emissions	Compliant
§15.407(b)(6)	Conducted Emission	Compliant

Table 1. Executive Summary of EMC Part 15.407 Compliance Testing

Rationale: Per KDB KDB 996369 D04 “Modular Transmitter Integration Guide – Guidance for Host Product Manufacturers” only worst-case radiated measurements are reported in this filing.

Equipment Configuration

A. Overview

Eurofins Electrical and Electronic Testing NA, Inc. was contracted by Span.IO, Inc. to perform testing on the Span Smart Panel (PN 01-00800-xx), under Span.IO, Inc.'s purchase order number PO00303.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Span.IO, Inc. Span Smart Panel (PN 01-00800-xx).

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

Model(s) Tested:	Span Smart Panel (PN 01-00800-xx)	
Model(s) Covered:	Span Smart Panel (PN 01-00800-xx)	
EUT Specifications:	Primary Power: 120/240VAC	
	FCC ID: 2AWJ7-MW	
	Type of Modulations:	DSSS, OFDM
	Equipment Code:	NII
	EUT Frequency Ranges:	5725 MHz – 5850 MHz
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35° C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Type of Filing:	Original	
Evaluated by:	Arsalan Hasan	
Report Date(s):	June 2, 2021	

Table 2. EUT Summary

B. References

CFR 47, Part 15, Subpart E	Unlicensed National Information Infrastructure Devices (UNII)
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
789033 D02 General UNII Test Procedures New Rules v01	Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices Part 15, Subpart E

Table 3. References

C. Test Site

All testing was performed at Eurofins Electrical and Electronic Testing NA, Inc., 3162 Belick St. Santa Clara, CA 95054. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed in a 10 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)	±3.24	2	95%
Radiated Emissions, (1 GHz – 6 GHz)	±3.92	2	95%
Conducted Emission Voltage	±2.44	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. Description of Test Sample

<p>Name of EUT/Model:</p>	<p>Span Smart Panel (PN 01-00800-xx)</p>
<p>Description of EUT and its intended use:</p>	<p>The Span Panel is a 120/240Vac panelboard, housing circuit breakers for overcurrent protection and embedded electronics for the homeowner to meter and control (via embedded relays) loads within their home, as divided into circuits. Solar PV and battery storage may be connected into the Span Panel via the inverter’s AC output. The Span Panel communicates energy data to the Span cloud via multiple internet connection routes (2.4 GHz WiFi, wired Ethernet, cellular LTE) and hosts local connections for setup (Bluetooth, 2.4 GHz WiFi) and communication with other onsite devices such as solar inverters (wired modbus RTU, 2.4 GHz WiFi, Bluetooth, wired Ethernet). The panelboard is intended for the residential and light commercial markets in North America, where it is wall-mounted either indoors or outdoors.</p>
<p>Selected Operation Mode(s):</p>	<p>Normal Operation:</p> <p>In normal operation the Span Panel is connected to WiFi, Ethernet, and Cellular LTE. It is installed in a user’s home as their primary panelboard with each circuit in their home connected to it. It continuously monitors the voltage of the electrical grid as well as each of the user’s 32 circuits and sends periodic status and log information over its network interfaces.</p> <p>If it notices the electrical grid AC RMS voltage has dropped below a certain threshold, or the user makes a request over the network, the Span Panel will open the single relay which connects it to the electrical grid, and actuate each of the 32 relays connecting each circuit in the user’s home to its internal bussing. The intent is to connect circuits the user wishes to back up with battery, and disconnect all others.</p> <p>A test tool will be provided which will periodically cause the panel to simulate an “on grid” or “off grid” transition as if the grid was “going down” or the user was periodically requesting it to connect and disconnect from the grid. The panel will be configured to periodically download files over the network.</p>
<p>Rationale for the selection of the Operation Mode(s):</p>	<p>The Span Panel will be running production firmware, and so by default will operate normally. There will be frequent communication along all wire harnesses. In most installations we expected “on grid” and “off grid” transitions to be infrequent (as infrequent as the attached electrical grid is reliable), but the test script will artificially trigger these conditions to create more electrical activity in the panel.</p>
<p>Monitoring Method(s):</p>	<p>Feedback for the test engineer will be provided solely through the associated test laptop, as all other indicators are hidden when the product is in its typical operation configuration.</p> <p>There will be commands via the “panel_cli” tool which can be used to confirm it is operating as intended, or not.</p>
<p>Emissions Class Declaration:</p>	<p>Span.IO declares that this device is:</p> <p>Class B ITE where the device is intended primarily for use in an environment where the use of broadcast radio and television receivers may be expected within a distance of 10 m</p>

<p>Configuration(s):</p>	<p>The “Grid AC input” is connected to 240Vac 60Hz power to power the EUT.</p> <p>The EUT will be connected to an external test computer via an Ethernet cable to facilitate running tests.</p>
<p>EUT Power Requirement:</p>	<p>Voltage: 120/240V split phase AC or DC: AC Frequency: 50 Hz Number of phases: 1 Amperage: to power the unit for testing, >5A AC is required. The max possible AC current is 200A. Uses an external AC/DC adapter: Yes 0</p>
<p>Physical Description: (If the EUT has multiple possible orientations, specify the orientation to be tested.)</p>	<p>EUT Arrangement (table top, floor standing or both): Table top</p> <p>System w/Multiple Chassis? (Yes/No): No</p> <p>Size: (HxWxD): 51x17.25x9 inches</p> <p>Weight: 150 lbs</p>
<p>Other info:</p>	<p>Highest frequency used in device (non-transmitting): 168MHz (main microcontroller clock speed)</p> <p>EUT Software (internal to EUT):</p> <ul style="list-style-type: none"> - Main Microcontroller: RootMicro.bin built from git SHA YYY - Gateway Computer: “20200408-nitrogen8mm-4.14.x_2.0.1_ga-bionic-en_US-console-weston_aarch64” Ubuntu 18.04 modified to include Span software built from git SHA XXX - Column Board Microcontrollers: Firmware built from git SHA 6e136c222042d089b702c96ffd8ee1ee6bec3e9f <p>Support Software (used by support PC to exercise EUT): minicom. “panel_cli” tool built from git SHA ZZZ</p>

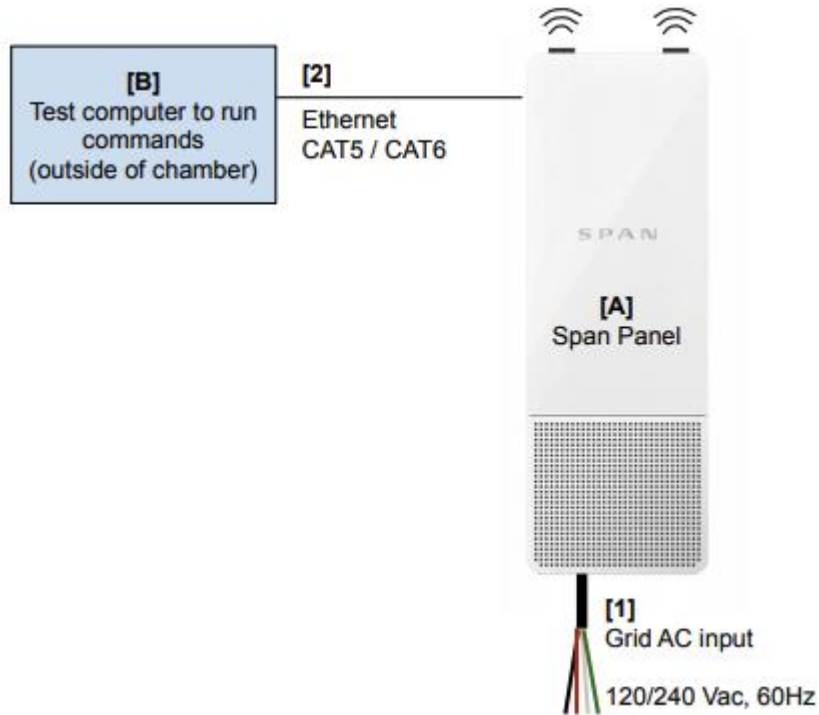


Figure 1. Block Diagram of Test Configuration

F. Equipment Configuration

The EUT was set up as outlined in Figure 1, Block Diagram of Test Setup. All cards, racks, etc., incorporated as part of the EUT is included in the following list.

Ref. ID	Slot #	Name / Description	Model Number	Part Number	Serial Number	Revision
A		Span Panel	Span Smart Panel	01-00800	--	01

Table 5. Equipment Configuration

G. Support Equipment

Support equipment necessary for the operation and testing of the EUT is included in the following list.

Ref. ID	Name / Description	Manufacturer	Model Number	Customer Supplied Calibration Data
B	MET Lab test Windows laptop	--	--	--

Table 6. Support Equipment

H. Ports and Cabling Information

Ref. ID	Port name on EUT	Cable Description or reason for no cable	Qty	Length as tested (m)	Max Length (m)	Shielded? (Y/N)	Termination Box ID & Port Name
1	AC Input	4 conductor, minimum 6 AWG	1	n/a	n/a	No	Grid input (120/240Vac/60Hz)
2	Ethernet	CAT5 / CAT6	1	2 m	100 m	Yes	Router: Ethernet

Table 7. Ports and Cabling Information

I. 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.

J. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Span.IO, Inc. 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.

Results: The EUT as tested is compliant the criteria of §15.203.

Test Engineer(s): Arsalan Hasan

Test Date(s): 05/19/2021

Electromagnetic Compatibility Criteria for Intentional Radiators

§15.407(b)(4) & (6 – 7) Undesirable Emissions

Test Requirements: § 15.407(b)(4): For transmitters operating in the 5.725-5.85 GHz band: All emissions within the frequency range from the band edge to 10 MHz above or below the band edge shall not exceed an e.i.r.p. of -17 dBm/MHz; for frequencies 10 MHz or greater above or below the band edge, emissions shall not exceed an e.i.r.p. of -27 dBm/MHz.

§ 15.407(b)(6): Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in Section 15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in Section 15.207.

§ 15.407(b)(7): The provisions of Section 15.205 of this part apply to intentional radiators operating under this section.

Test Procedure: The EUT was placed on a non-conducting stand on a turntable in a chamber. To find the maximum emission the EUT was set to transmit on low, mid, and high channels. Additionally, the turntable was rotated 360 degrees, the EUT was oriented through its three orthogonal axes, and the receive antenna height was varied in order to maximize emissions.

For frequencies from 30 MHz to 1 GHz, measurements were first made using a peak detector with a 100 kHz resolution bandwidth. Emissions which exceeded the limits were re-measured using a quasi-peak detector with a 120 kHz resolution bandwidth.

Above 1 GHz, measurements were made pursuant the method described in FCC KDB 789033 D02 General UNII Test Procedure New Rules v01. The equation, $EIRP = E + 20 \log D - 104.8$ was used to convert field strength to EIRP (E = field strength (dB μ V/m) and D = Reference measurement distance).

For emissions above 1 GHz and in restricted bands, measurements of the field strength were made with a peak detector and an average detector and compared with the limits of 15.209.

As an alternative, according to FCC KDB 789033 D02 General UNII Test Procedure New Rules v01, all emissions above 1 GHz that comply with the peak and average limits of 15.209 satisfy the requirements of unwanted emissions in 15.407.

Test Results: For below 1 GHz, the EUT was compliant with the requirements of this section. Refer to UNII 3 Appendix for plots.

For above 1 GHz, the EUT was compliant with the requirements of this section. Refer to UNII 3 Appendix for plots.

Test Engineer(s): Arsalan Hasan

Test Date(s): 05/19/2021

Test Equipment

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	Last Cal Date	Cal Due Date
1S4075	RADIO COMMUNICATION TESTER	ROHDE & SCHWARZ	CMW500	09/20/2020	09/20/2022
1S2399	TURNTABLE/MAST CONTROLLER	SUNOL SCIENCES	SC99V	SEE NOTE 1	
1S2600	BILOG ANTENNA	TESEQ	CBL6112D	03/19/2021	06/19/2022
1S2733	BILOG ANTENNA	TESEQ	CBL6112D	06/05/2019	06/05/2021
1S3826	DRG HORN ANTENNA	ETS-LINDGREN	3117	12/03/2020	12/03/2022
1S2198	DRG HORN ANTENNA	ETS-LINDGREN	3117	10/07/2019	10/07/2021
1S2003	PXA Signal Analyzer	Keysight	N9030B	09/15/2020	09/15/2021
1S2587	PRE AMPLIFIER	AML COMMUNICATIONS	AML0126L3801	SEE NOTE 1	
1S2653	AMPLIFIER	SONOMA INSTRUMENT	310 N	SEE NOTE 1	
1S2486	5 METER CHAMBER	PANASHIELD - ETS	5M	SEE NOTE 2	
1S3824	SIGNAL GENERATOR	ROHDE & SCHWARZ	SMA100B	11/06/2019	05/06/2021

Table 8. Test Equipment List

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

End of Report