Amber Helm Development L.C.
92723 Michigan Hwy-152
Sister Lakes, Michigan 49047 USA
Tel: 888-847-8027

EMC Test Report

GC1902314TX
Issued: **June 7, 2019**

regarding

USA: CFR Title 47, Part 15.247 (Emissions)
Canada: IC RSS-247/GENe (Emissions)

for

PHOTOS HELD CONFIDENTIAL

CS-IWO

Category: Remote Control Receptacle

Judgments:
FCC 15.247, ISED RSS-247 Compliant
Testing Completed: April 17, 2019

TESTING
NVLAP LAB CODE 200129-0

Prepared for:

GridConnect, Inc.

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Date of Issue: June 7, 2019

Revision History

Rev. No.	Date	Details	Revised By
r0	June 7, 2019	Initial Release.	J. Brunett
r1	September 3, 2019	Correct typographical errors and update customer info.	J. Brunett
r2	October 17, 2019	Correct typographical errors.	G. Helm
r3	November 5, 2019	Photos removed for STC	J. Brunett

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1 Test Report Scope and Limitations

1.1 Laboratory Authorization

Test Facility description and attenuation characteristics are on file with the FCC Laboratory, Columbia, Maryland (FCC Reg. No: US5348 and US5356) and with ISED Canada, Ottawa, ON (File Ref. No: 3161A and 24249). Amber Helm Development L.C. holds accreditation under NVLAP Lab Code 200129-0.

1.2 Report Retention

For equipment verified to comply with the regulations herein, the manufacturer is obliged to retain this report with the product records for the life of the product, and no less than ten years. A copy of this Report will remain on file with this laboratory until July 2029.

1.3 Subcontracted Testing

This report does not contain data produced under subcontract.

1.4 Test Data

This test report contains data included within the laboratories scope of accreditation.

1.5 Limitation of Results

The test results contained in this report relate only to the item(s) tested. Any electrical or mechanical modification made to the test item subsequent to the test date shall invalidate the data presented in this report. Any electrical or mechanical modification made to the test item subsequent to this test date shall require reevaluation.

1.6 Copyright

1.7 Endorsements

This report shall not be used to claim product endorsement by any accrediting, regulatory, or governmental agency.

1.8 Test Location

The EUT was fully tested by **Amber Helm Development L.C.**, headquartered at 92723 Michigan Hwy-152, Sister Lakes, Michigan 49047 USA. Table 1 lists all sites employed herein. Specific test sites utilized are also listed in the test results sections of this report where needed.

Table 1: Test Site List.

Description	Location	Quality Num.
OATS (3m & 10m)	92723 Michigan Hwy-152, Sister Lakes, Michigan 49047 USA	OATSA

1.9 Traceability and Equipment Used

Pertinent test equipment used for measurements at this facility is listed in Table 2. The quality system employed at Amber Helm Development L.C. has been established to ensure all equipment has a clearly identifiable classification, calibration expiry date, and that all calibrations are traceable to the SI through NIST, other recognized national laboratories, accepted fundamental or natural physical constants, ratio type of calibration, or by comparison to consensus standards.

Table 2: Equipment List.

Description	Manufacturer/Model	SN	Quality Num.	Last Cal By / Date Due
Spectrum Analyzer	R & S / FSV30	101660	RSFSV30001	RS / Apr-2021
EMI Receiver	HP / 85460A/85462A	3704A00422, 3807A00465	HP8546A	Std and Cal / May-2020
LISN	Solar / 8012-50-R-24-BNC	962138	LISN7	AHD / April-2021
BiconiLog Antenna	EMCO / 3142	1169	BILO3142	Lib.Labs / May-2020
(3m) LMR-400 Coax	AHD / LMR400	C090804	LMR400	AHD / Jan-2020
(LCI) DS Coax	AHD / RG58/U	920809	RG58U	AHD / Jul-2020
Double Ridged Horn	EMCO / 3115	2788	RH3115	Lib.Labs. / July-2020
K-Band Horn	JEF / NRL Std.	001	HRNK01	AHD / Jul-2020

2 Test Specifications and Procedures

2.1 Test Specification and General Procedures

The goal of GridConnect, Inc. is to demonstrate that the Equipment Under Test (EUT) complies with the Rules and/or Directives below. Detailed in this report are the results of testing the GridConnect, Inc. CS-IWO for compliance to:

Country/Region	**Rules or Directive**	**Referenced Section(s)**
United States	Code of Federal Regulations	CFR Title 47, Part 15.247
Canada	ISED Canada	IC RSS-247/GENe

It has been determined that the equipment under test is subject to the rules and directives above at the date of this testing. In conjunction with these rules and directives, the following specifications and procedures are followed herein to demonstrate compliance (in whole or in part) with these regulations.

ANSI C63.4:2014	"Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz"
ANSI C63.10:2013	"American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices"
TP0102RA	"AHD Internal Document TP0102 - Radiated Emissions Test Procedure"
TP0106RC	"AHD Internal Document TP0106 - Emissions Measurement Procedures (above 40 GHz)"
ISED Canada	"The Measurement of Occupied Bandwidth"
ICES-003; Issue 6 (2016)	"Information Technology Equipment (ITE) - Limits and methods of measurement"

3 Configuration and Identification of the Equipment Under Test

3.1 Description and Declarations

The EUT is wireless controlled electronic wall socket. The EUT is approximately 10 x 7 x 5 cm in dimension, and is depicted in Figure 1. It is powered by 115 VAC mains power. This product is used as an relay activated wall socket controlled via WLAN and BLE interfaces. Table 3 outlines provider declared EUT specifications.

Figure 1: Photos of EUT.

Table 3: EUT Declarations.

General Declarations	
Equipment Type:	Remote Control Receptacle
Country of Origin:	USA
Nominal Supply:	115 VAC
Oper. Temp Range:	not declared
Frequency Range:	2402 – 2480 MHz
Antenna Dimension:	Integral
Antenna Type:	Integral
Antenna Gain:	Not Declared
Number of Channels:	40(BLE),11(WLAN)
Channel Spacing:	2 MHz(BLE), 5 MHz(WLAN)
Alignment Range:	Not Declared
Type of Modulation:	GFSK, OFDM
United States	
FCC ID Number:	2AFC3-CSIWO
Classification:	DTS
Canada	
IC Number:	22503-CSIWO
Classification:	Spread Spectrum (24002483.5 MHz)

3.1.1 EUT Configuration

The EUT is configured for testing as depicted in Figure 2.

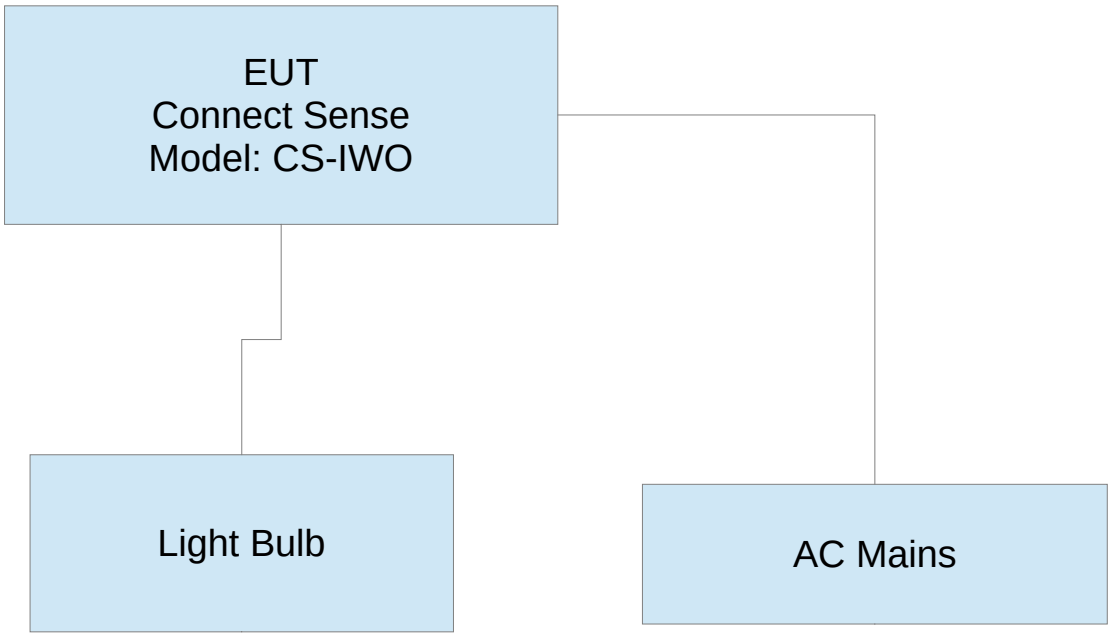


Figure 2: EUT Test Configuration Diagram.

3.1.2 Modes of Operation

The EUT is capable of operating in BLE (1Mbps) or in 802.11 b, g, or n(20) modes. Test samples were placed into worst-case operating modes (highest data rate, highest operating power that may be employed) using a PC serial UART interface that could be attached and detached from the EUT. In the BLE mode the EUT could not be placed into full continuous modulated transmission, so duty cycle within each transmitted pulse was measured and applied to peak measured data. For 802.11b/g/n modes continuous modulated transmission mode was tested. Additionally, CW mode was employed with the EUT in order to determine integral antenna gain.

3.1.3 Variants

There is only a single electrical version and PCB design of the EUT, but there are two variants of the external housing front plastic that may be populated on the unit.

3.1.4 Test Samples

Two samples of the EUT were provided for emissions testing, one radiated sample and one sample for conducted measurements.

3.1.5 Functional Exerciser

EUT functionality was con
rmed by measurement of transmitted signals. Outlet unit functionality was verified by connecting the EUT to an incondecent 75W light.

3.1.6 Modifications Made

There were no modifications made to the EUT by this laboratory. However, in order to bring the device into compliance with line conducted emissions the manufacturer chose to have the input resistance increased of the standby power supply.

3.1.7 Production Intent

The EUT appears to be a production ready sample.

3.1.8 Declared Exemptions and Additional Product Notes

None.

4 Emissions

4.1 General Test Procedures

4.1.1 Radiated Test Setup and Procedures

Radiated electromagnetic emissions from the EUT are first pre-scanned in our screen room. Spectrum and modulation characteristics of all emissions are recorded. Instrumentation, including spectrum analyzers and other test equipment as detailed in Section 1.8 are employed. After pre-scan, emission measurements are made on the test site of record. If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in relevant test standards are followed. Alternatively, a layout closest to normal use (as declared by the provider) is employed if the resulting emissions appear to be worst-case in such a configuration. See Figure 3. All intentionally radiating elements that are not fixed-mounted in use are placed on the test table lying flat, on their side, and on their end (3-axes) and the resulting worst case emissions are recorded. If the EUT is fixed-mounted in use, measurements are made with the device oriented in the manner consistent with installation and then emissions are recorded. If the EUT exhibits spurious emissions due to internal receiver circuitry, such emissions are measured with an appropriate carrier signal applied.

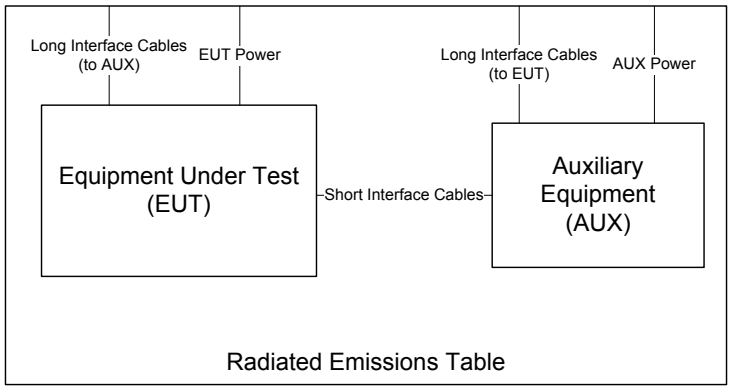


Figure 3: Radiated Emissions Diagram of the EUT.

For devices with intentional emissions below 30 MHz, a shielded loop antenna and/or E-field and H-Field broadband probes are used depending on the regulations. Shielded loops are placed at a 1 meter receive height at the desired measurement distance. For exposure in this band, the broadband probes employed are 10cm diameter single-axis shielded transducers and measurements are repeated and summed over three axes.

Emissions between 30 MHz and 1 GHz are measured using calibrated broadband antennas. For both horizontal and vertical polarizations, the test antenna is raised and lowered from 1 to 4 m in height until a maximum emission level is detected. The EUT is then rotated through 360^o in azimuth until the highest emission is detected. The test antenna is then raised and lowered one last time from 1 to 4 m and the worst case value is recorded. Emissions above 1 GHz are characterized using standard gain or broadband ridge-horn antennas on our OATS with a 4×5 m rectangle of ECCOSORB absorber covering the OATS ground screen and a 1.5m table height. Care is taken to ensure that test receiver resolution and video bandwidths meet the regulatory requirements, and that the emission bandwidth of the EUT is not reduced. Photographs of the test setup employed are depicted in Figure 4.

Where regulations allow for direct measurement of field strength, power values (dBm) measured on the test receiver / analyzer are converted to dBμV/m at the regulatory distance, using

$$E_{dist} = 107 + P_R + K_A - K_G + K_E - C_F$$

where P_R is the power recorded on spectrum analyzer, in dBm, K_A is the test antenna factor in dB/m, K_G is the combined pre-amplifier gain and cable loss in dB, K_E is duty correction factor (when applicable) in dB, and C_F is a distance conversion (employed only if limits are specified at alternate distance) in dB. This field strength value is then compared with the regulatory limit. If effective isotropic radiated power (EIRP) is computed, it is computed as

$$EIRP(dBm) = E_{3m}(dB\mu V/m) - 95.2.$$

When presenting data at each frequency, the highest measured emission under all possible EUT orientations (3-axes) is reported.

Where regulations call for substitution method measurements, the EUT is replaced by a substitution antenna if field strength measurements indicate the emission is close to the regulatory limit. This antenna is co-polarized with the test antenna and tuned (when necessary) to the emission frequency, after which the test antenna height is again optimized. The substitution antenna's signal level is adjusted such that its emission is equal to the level measured from the EUT. The signal level applied to the substitution antenna is then recorded. Effective isotropic radiated power (EIRP) and effective radiated power (ERP) in dBm are formulated from

$$EIRP = P_T - G_A = ERP + 2.16, \tag{1}$$

where P_T is the power applied to substitution antenna in dBm, including correction for cable loss, and G_A is the substitution antenna gain, in dBi.

Figure 4: Radiated Emissions Test Setup Photograph(s).

4.1.2 Conducted Emissions Test Setup and Procedures

Transmit Antenna Port Conducted Emissions At least one sample EUT supplied for testing was provided with a 50Ω antenna port. Conducted transmit chain emissions measurements (where applicable) are made by connecting the EUT antenna port directly to the test receiver port. Photographs of the test setup employed are depicted in Figure 5.

Figure 5: Conducted RF Test Setup Photograph(s).

AC Port Conducted Spurious For this device, AC power line conducted emissions are measured in our screen room. If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.4 / CISPR 22 are employed. Alternatively, an on-table layout more representative of actual use may be employed if the resulting emissions appear to be worst-case in such a configuration. See Figure 6.

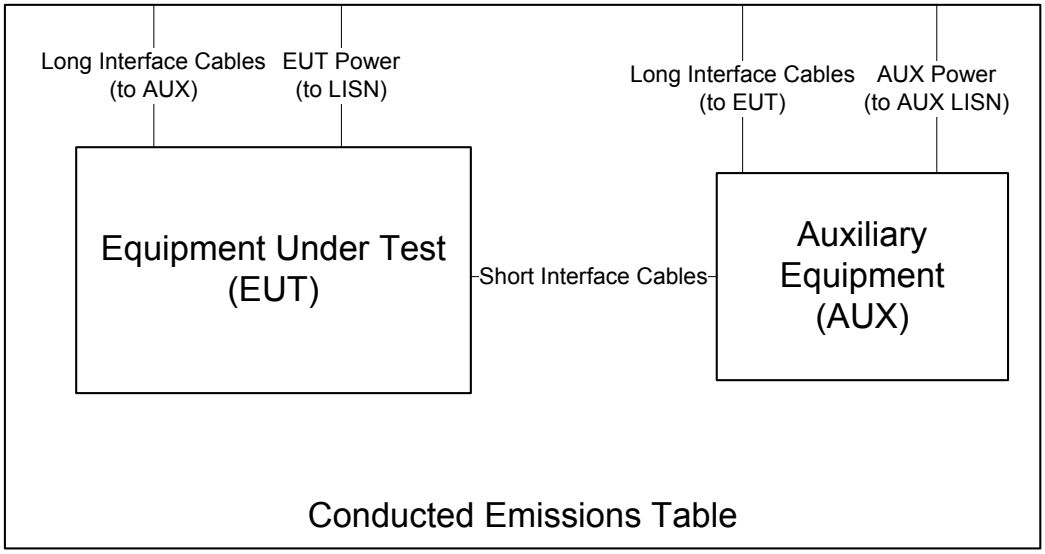


Figure 6: Conducted Emissions Setup Diagram of the EUT.

Conducted emissions are measured and recorded for each AC mains power source over the spectrum 0.15 MHz to 30 MHz for both the ungrounded (HI/PHASE) and grounded (LO/GND) conductors with the EUT placed in its highest current draw operating mode(s). The test receiver is set to peak-hold mode in order to record the peak emissions throughout the course of functional operation. Only if an emission exceeds or is near the limit are quasi-peak and average detection applied. Photographs of the test setup employed are depicted in Figure 7.

Figure 7: Conducted Emissions Test Setup Photograph(s).

4.1.3 Power Supply Variation

Tests at extreme supply voltages are made if required by the procedures specified in the test standard, and results of this testing are detailed in this report.

In the case of this EUT, measurements of the worst-case radiated emissions are performed with the supply voltage varied by no less than 85% and 115% of the nominal rated value for devices connecting to AC power mains.

4.2 Intentional Emissions

4.2.1 Duty and Transmission Cycle, Pulsed Operation

The details and results of testing the EUT for pulsed operation are summarized in Table 4. Plots showing the measurements made to obtain these values are provided in Figure 8.

Table 4: Pulsed Emission Characteristics (Duty Cycle).

Frequency Range	**Det**	**IFBW**	**VBW**
f > 1 000 MHz	Pk	1 MHz	28 MHz
f > 1 000 MHz	Pk	28 MHz	28 MHz

Test Date:	17-Apr-19
Test Engineer:	Gordon Helm
EUT	CS-IWO
Meas. Distance:	Conducted

Pulsed Operation / Duty Cycle						
Transmit Mode	Data Rate (Mbps)	Voltage (V)	Oper. Freq (MHz)	1 MHz RBW Duty Within Pulse (dB)	RBW > OBW Duty Within Pulse (dB)	Worst Case Duty Factor (dB)
BLE	1.0	115.0	2440.0	-1.5	-1.5	-1.5
802.11b	1.0	115.0	2437.0	0.0	0.0	0.0
802.11g	6.0	115.0	2437.0	0.0	0.0	0.0
802.11n(20)	20.0	115.0	2437.0	0.0	0.0	0.0

* Duty Cycle is measured in line with DTS procedures section 12.2.5.2 for averaging only over full-power transmission pulses.

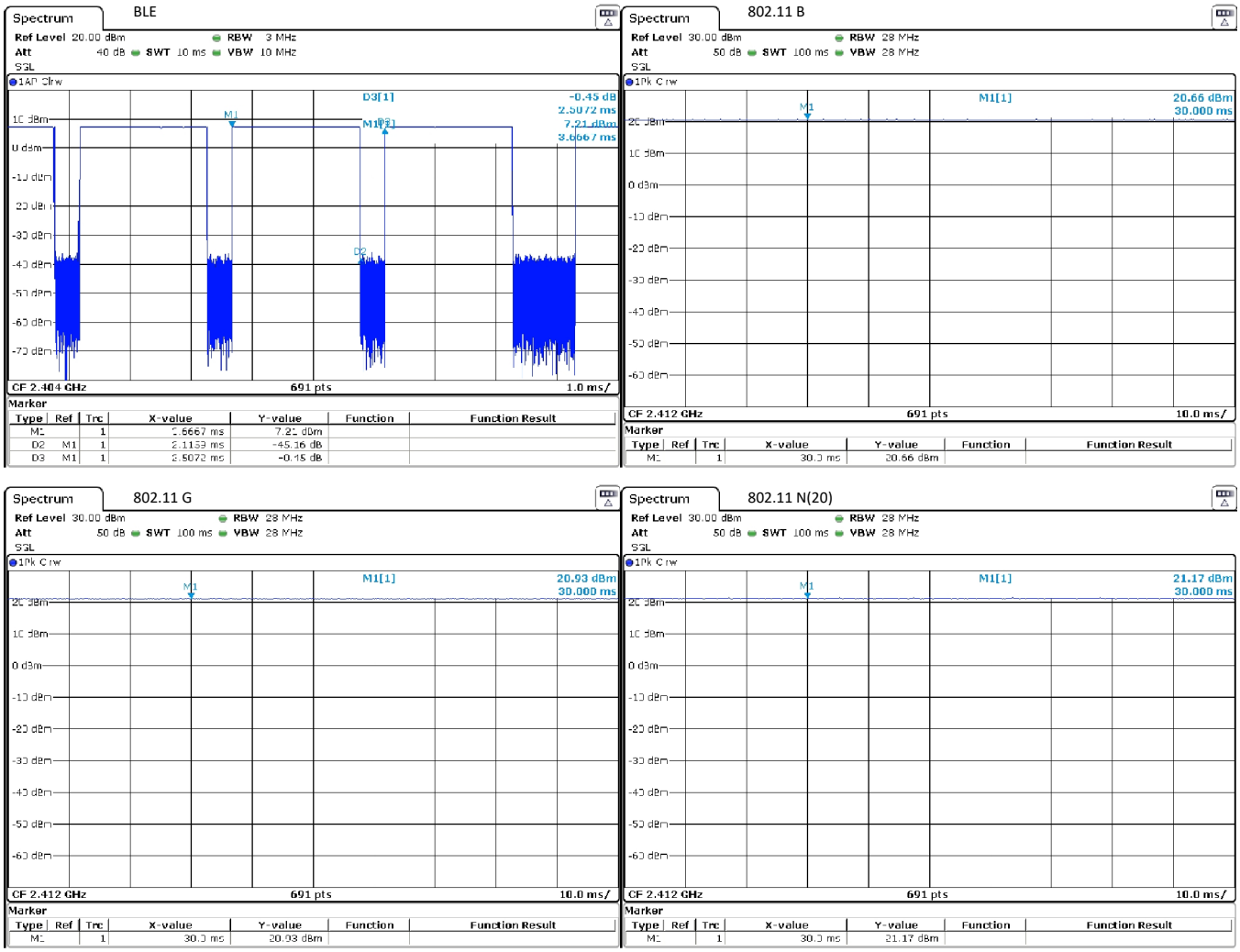


Figure 8: Pulsed Emission Characteristics (Duty Cycle).

4.2.2 Fundamental Emission Bandwidth

Emission bandwidth (EBW) of the EUT is measured with the device placed in the test mode(s) with the shortest available packet length and minimum packet spacing. Radiated emissions are recorded following the test procedures listed in Section 2.1. The 6 dB bandwidth is measured for the lowest, middle, and highest channels available. The 99% emission bandwidth per IC test procedures is also reported. The results of this testing are summarized in Table 5. Plots showing measurements employed obtain the emission bandwidths reported are provided in Figure 9.

Table 5: Intentional Emission Bandwidth.

Frequency Range	**Det**	**IFBW**	**VBW**	**Test Date:**	17-Apr-19
f > 1 000 MHz	Pk	30 kHz	100 kHz	**Test Engineer:**	Gordon Helm
				EUT	CS-IWO
				Meas. Distance:	Conducted

Occupied Bandwidth								
Transmit Mode	Data Rate* (Mbps)	Voltage (V)	Oper. Freq (MHz)	6 dB BW (MHz)	6 dB BW Limit (MHz)	99% OBW (MHz)	20 dB BW (MHz)	Pass/Fail
BLE	1.0	115.0	2402.0	0.61	0.50	1.01	0.57	Pass
			2440.0	0.60	0.50	1.02	0.60	Pass
			2480.0	0.59	0.50	1.02	0.59	Pass
802.11b	1.0	115.0	2412.0	11.50	0.50	13.00	15.20	Pass
			2437.0	10.20	0.50	13.00	15.20	Pass
			2462.0	9.50	0.50	12.90	15.30	Pass
802.11g	11.0	115.0	2412.0	11.50	0.50	13.00	15.20	Pass
			2437.0	10.30	0.50	13.00	15.20	Pass
			2462.0	9.53	0.50	12.90	15.30	Pass
802.11n(20)	20.0	115.0	2412.0	17.70	0.50	17.80	19.80	Pass
			2437.0	17.60	0.50	17.80	19.70	Pass
			2462.0	17.70	0.50	17.80	19.70	Pass

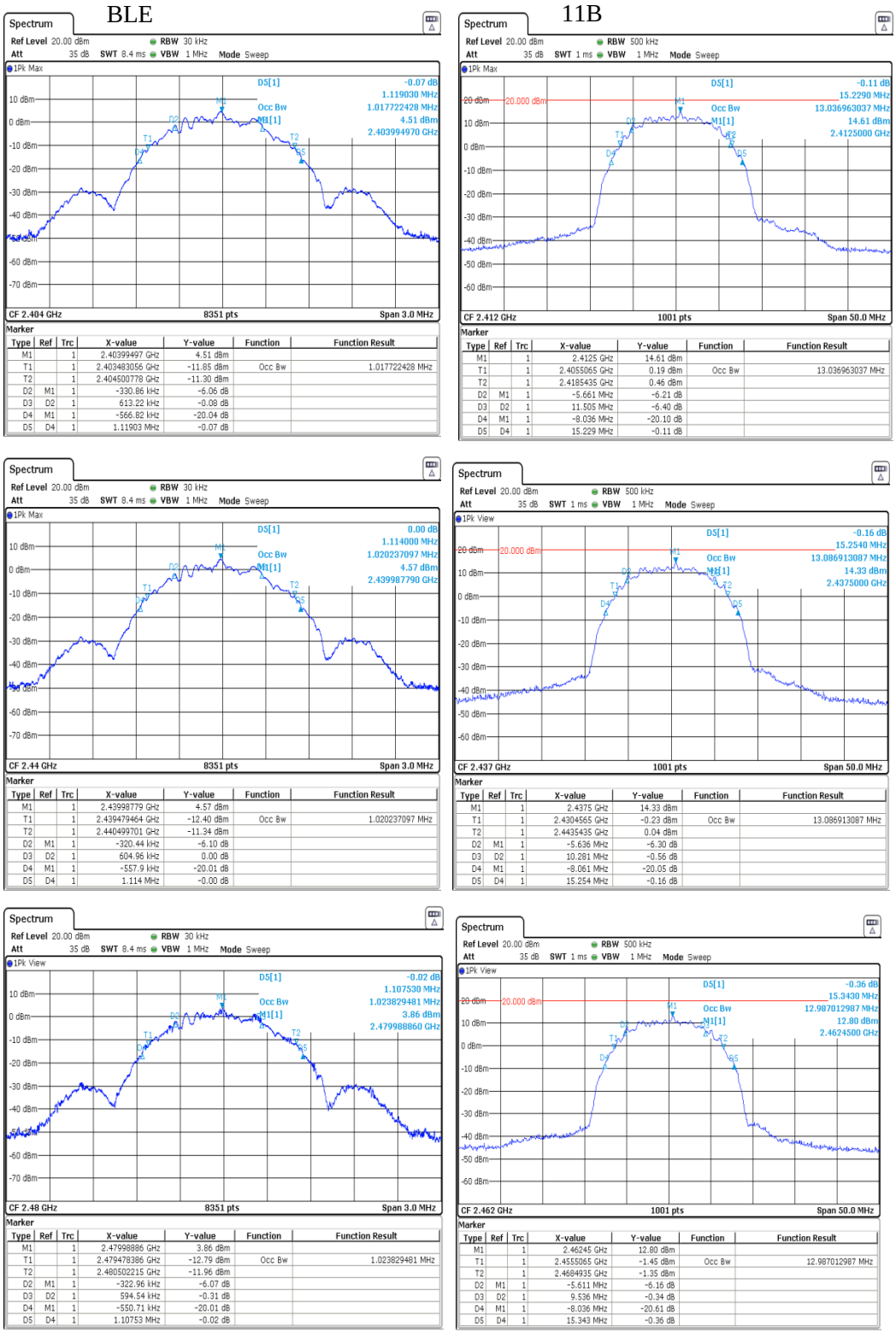


Figure 9(a): Intentional Emission Bandwidth.

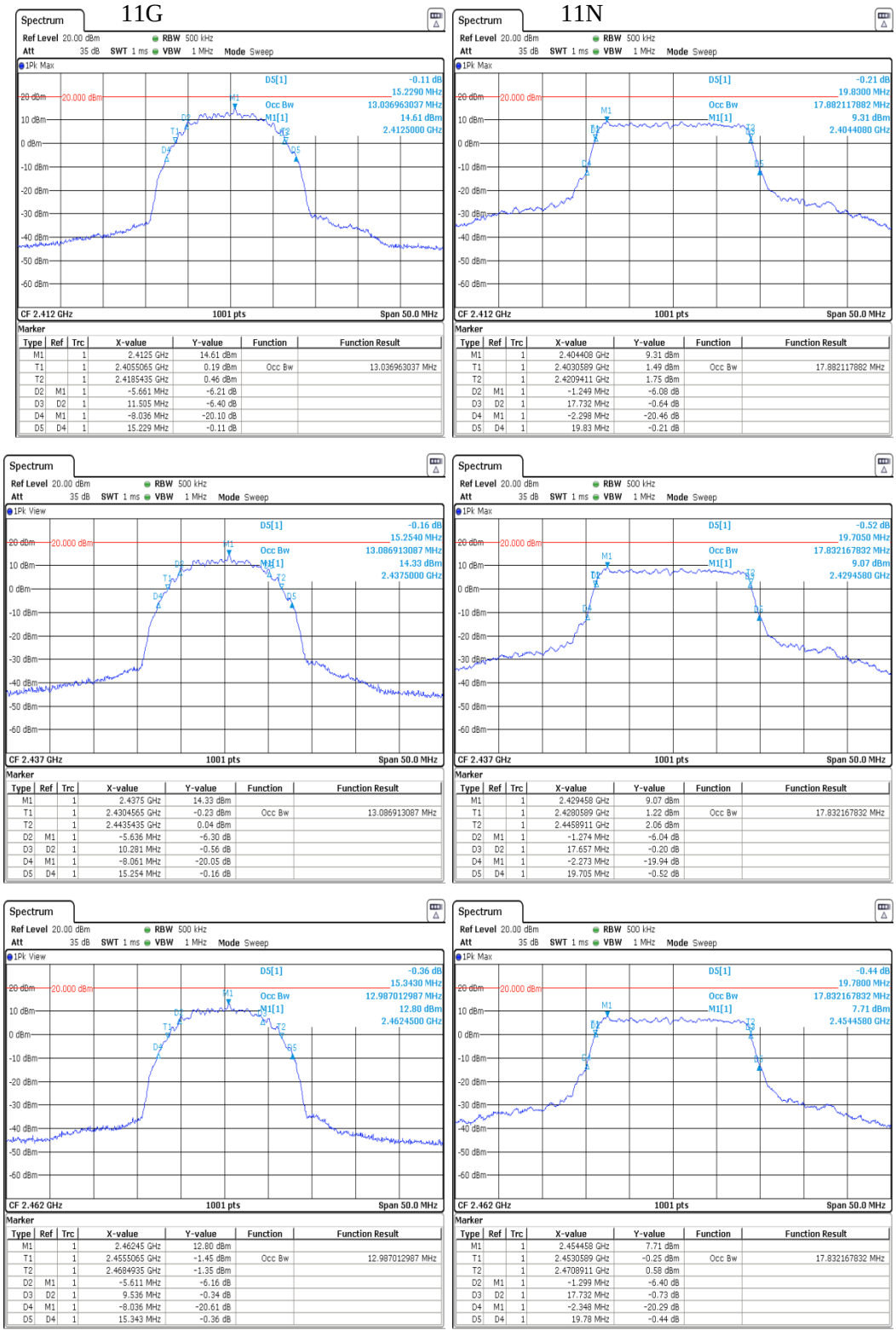


Figure 9(b): Intentional Emission Bandwidth.

4.2.3 Effective Isotropic Radiated Power

The EUT's radiated power is computed from antenna port conducted power measurements and the gain of the EUT antenna(s). Where the EUT is not sold with an antenna connector, a modified product has been provided including such. Peak conducted output power was measured directly from the EUT at the port where the antenna attaches. The test receiver bandwidth was set to be greater than the measured emission bandwidth of the EUT to capture the true peak. Antenna gain is either provided directly by the antenna manufacturer or measured by comparison between calculated EIRP and conducted output power. Table 6 details the results of these measurements. Plots showing conducted measurements made are depicted in Figure 10.

Table 6: Radiated Power Results.

Frequency Range	Det	IF Bandwidth	Video Bandwidth	Mode		
f > 1 000 MHz	Pk/Avg	3 MHz	10 MHz	BLE	**Test Date:**	17-Apr-19
f > 1 000 MHz	Pk/Avg	28 MHz	28 MHz	WLAN	**Test Engineer:**	Gordon Helm
					EUT:	Connect Sense
					Meas. Distance:	3m

FCC/IC

#	Mode	Channel	Freq. MHz	Ant. Used	Ant. Pol.	Table Azim. deg	Ant Height m	Ka dB/m	Kg dB	E3(Pk)** dBµV/m	EIRP (Pk) dBm	Pout* (Pk) dBm	Ant Gain dBi	EIRP (Avg) Limit dBm	Pass dB
1	BLE (CW)	L	2402.0	RH3115	H/V	30.0	2.0	28.9	-2.3	92.5	-2.7	**3.9**	-6.6		
2		M	2440.0	RH3115	H/V	30.0	2.0	29.0	-2.4	94.6	-.6	-0.6	**0.0**		
3		H	2480.0	RH3115	H/V	30.0	2.0	29.1	-2.4	93.8	-1.4	-1.1	-0.3		
7	WLAN (CW)	L	2412.0	RH3115	H/V	290.0	2.0	28.9	-2.4	114.6	19.4	20.0	**-0.6**		
8		M	2437.0	RH3115	H/V	290.0	2.0	29.0	-2.4	112.7	17.5	**20.2**	-2.7		
9		H	2462.0	RH3115	H/V	290.0	2.0	29.1	-2.4	111.1	15.9	20.0	-4.1		
#	Mode	Channel	Freq. MHz	Ant. Used	Ant. Pol.	Table Azim. deg	Ant Height m	Ka dB/m	Kg dB	E3(Pk) dBµV/m	EIRP (Pk) dBm	Pout* (Pk) dBm	Ant Gain dBi	EIRP (Avg) Limit dBm	Pass dB
13	BLE (1MBPS) MODULATED	L	2402.0	RH3115	H/V	30.0	2.0	28.9	-2.3		1.4	8.0	-6.6	30.0	28.6
14		M	2440.0	RH3115	H/V	30.0	2.0	29.0	-2.4		7.7	7.8	0.0	30.0	22.3
15		H	2480.0	RH3115	H/V	30.0	2.0	29.1	-2.4		7.0	7.3	-0.3	30.0	23.1
16	WLAN 11B MODULATED	L	2412.0	RH3115	H/V	290.0	2.0	28.9	-2.4		20.3	20.9	-0.6	30.0	**9.7**
17		M	2437.0	RH3115	H/V	290.0	2.0	29.0	-2.4		12.7	15.4	-2.7	30.0	17.4
18		H	2462.0	RH3115	H/V	290.0	2.0	29.1	-2.4		11.1	15.2	-4.1	30.0	18.9
19	WLAN 11G MODULATED	L	2412.0	RH3115	H/V	290.0	2.0	28.9	-2.4		18.4	19.0	-0.6	30.0	11.6
20		M	2437.0	RH3115	H/V	290.0	2.0	29.0	-2.4		17.0	19.7	-2.7	30.0	13.0
21		H	2462.0	RH3115	H/V	290.0	2.0	29.1	-2.4		15.0	19.1	-4.1	30.0	15.0
22	WLAN 11N MODULATED	L	2412.0	RH3115	H/V	290.0	2.0	28.9	-2.4		17.7	18.3	-0.6	30.0	12.3
23		M	2437.0	RH3115	H/V	290.0	2.0	29.0	-2.4		16.4	19.1	-2.7	30.0	13.6
24		H	2462.0	RH3115	H/V	290.0	2.0	29.1	-2.4		15.0	19.1	-4.1	30.0	15.0

* Measured conducted from the radio using conducted test sample. Peak power measured with IFBW > OBW in line with DTS Meas. Procedures Section 9.1.1 (ANSI C63.10 11.9.1.1).
(Note: IFBW & VBW maximum bandwidth of 28 MHz >> OBW available on Spectrum Analyzer only in zero span mode.) VBW = IFBW gives accurate results as IFBW >> OBW.
** Measured radiated at 3 meter distance.

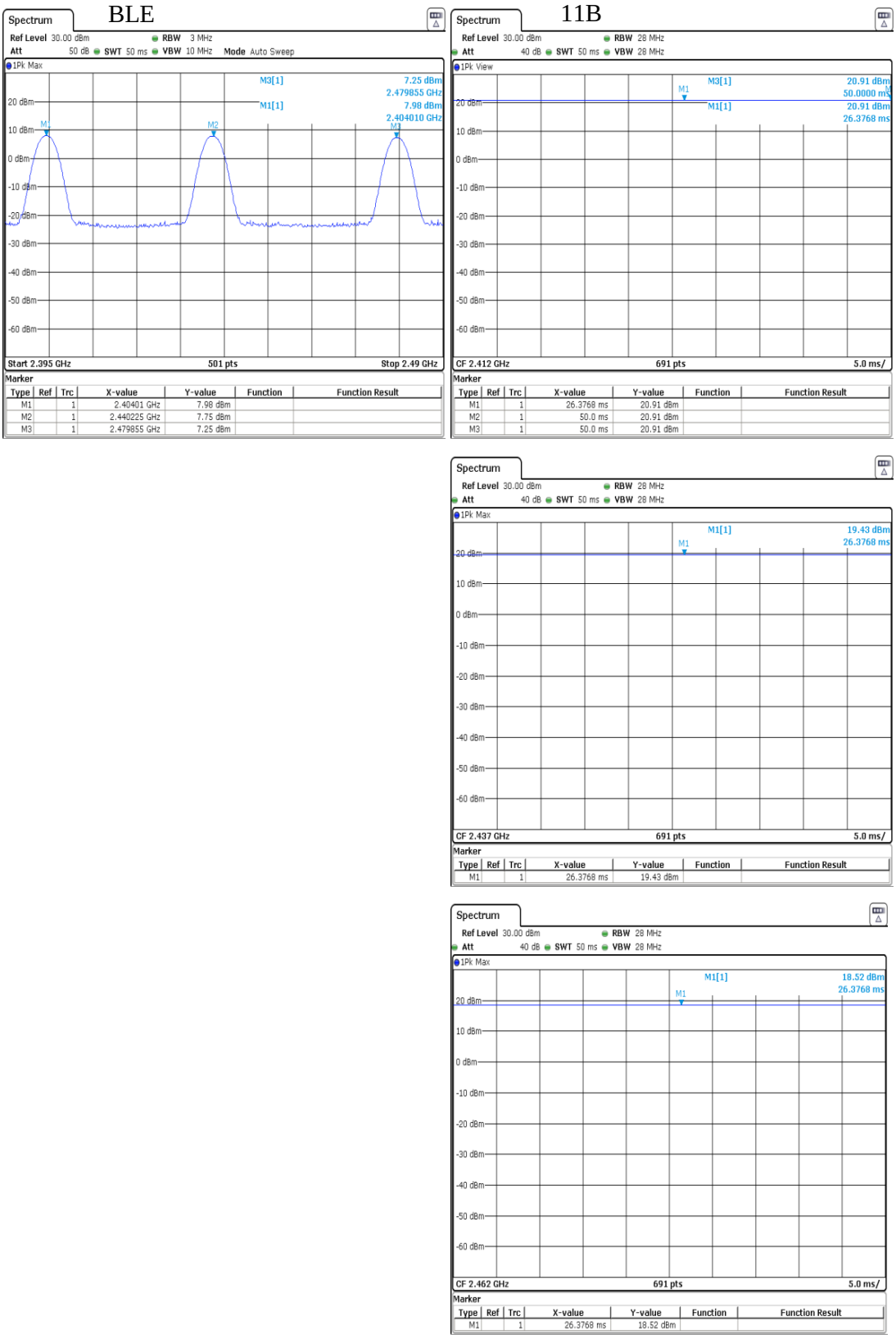


Figure 10(a): Conducted RF Power Plots

Figure 10(b): Conducted RF Power Plots

4.2.4 Power Spectral Density

For this test, the EUT was attached directly to the test receiver. Following FCC DTS measurement procedures, the emission spectrum is first scanned for maximum spectral peaks, the span and receiver bandwidth are then reduced until the power spectral density is measured in the prescribed receiver bandwidth. The results of this testing are summarized in Table 7. Plots showing how these measurements were made are depicted in Figure 11.

Table 7: Power Spectral Density Results.

Frequency Range	**Detector**	**IF Bandwidth**	**Video Bandwidth**	**Test Date:**	17-Apr-19
2400-2483.5	Pk	3 kHz	10 kHz	**Test Engineer:**	Gordon Helm
				EUT:	CS-IWO
				Meas. Distance:	Conducted

						FCC/IC
Mode	Channel	Frequency (MHz)	Ant. Used	PSDcond (meas)* (dBm/3kHz)	PSD Limit (dBm/3kHz)	Pass By (dB)
BLE	L	2402.0	Cond.	-9.1	8.00	17.1
	M	2441.0	Cond.	-8.4	8.00	16.4
	H	2480.0	Cond.	-10.2	8.00	18.2
802.11b	L	2402.0	Cond.	-6.8	8.00	**14.8**
	M	2441.0	Cond.	-7.5	8.00	15.5
	H	2480.0	Cond.	-8.2	8.00	16.2
802.11g	L	2402.0	Cond.	-12.1	8.00	20.1
	M	2441.0	Cond.	-13.2	8.00	21.2
	H	2480.0	Cond.	-14.3	8.00	22.3
802.11n(20)	L	2402.0	Cond.	-10.4	8.00	18.4
	M	2441.0	Cond.	-12.2	8.00	20.2
	H	2480.0	Cond.	-13.3	8.00	21.3

* PSD measured conducted out the the EUT antenna port following FCC DTS PKPSD procedure.

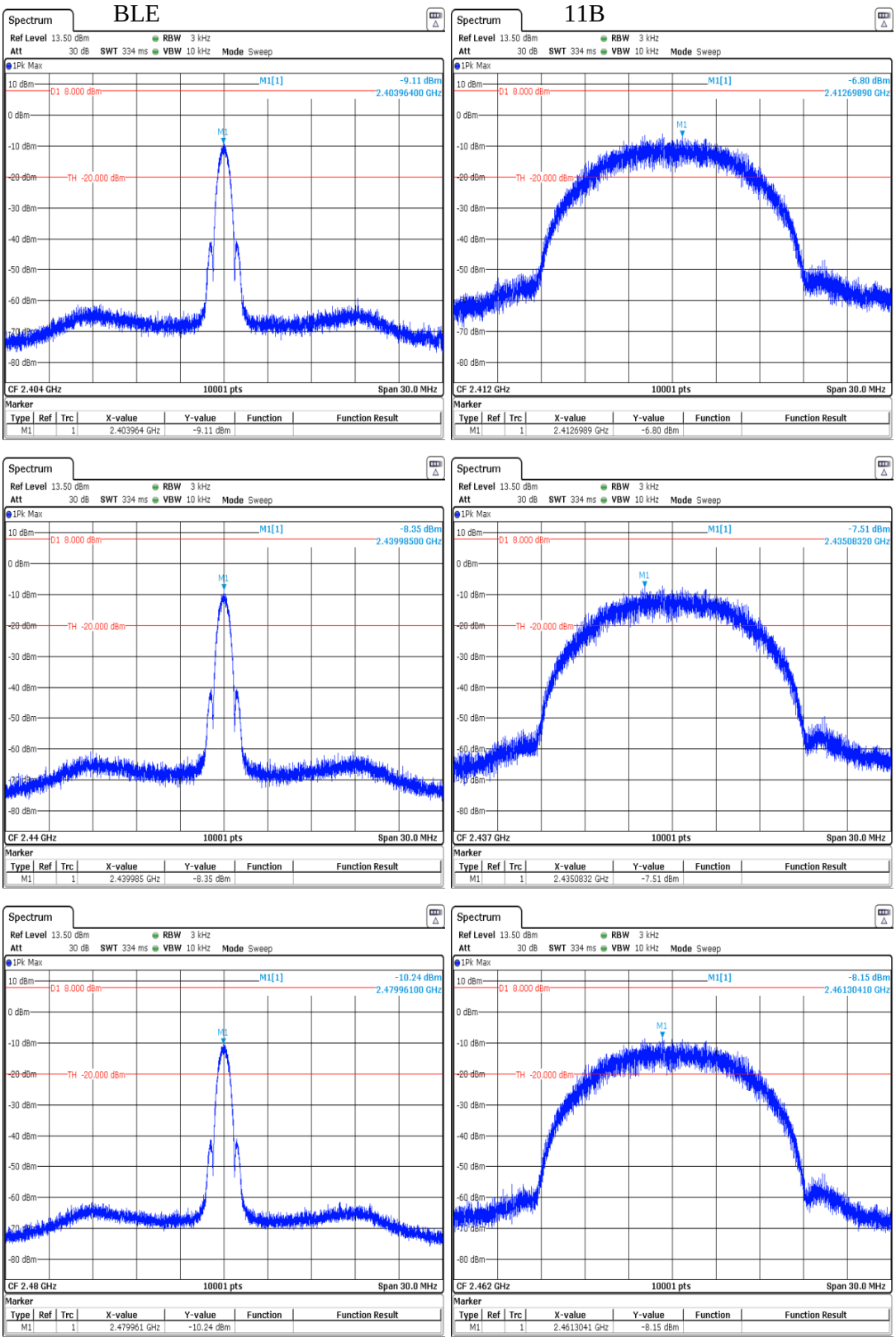


Figure 11(a): Power Spectral Density Plots.

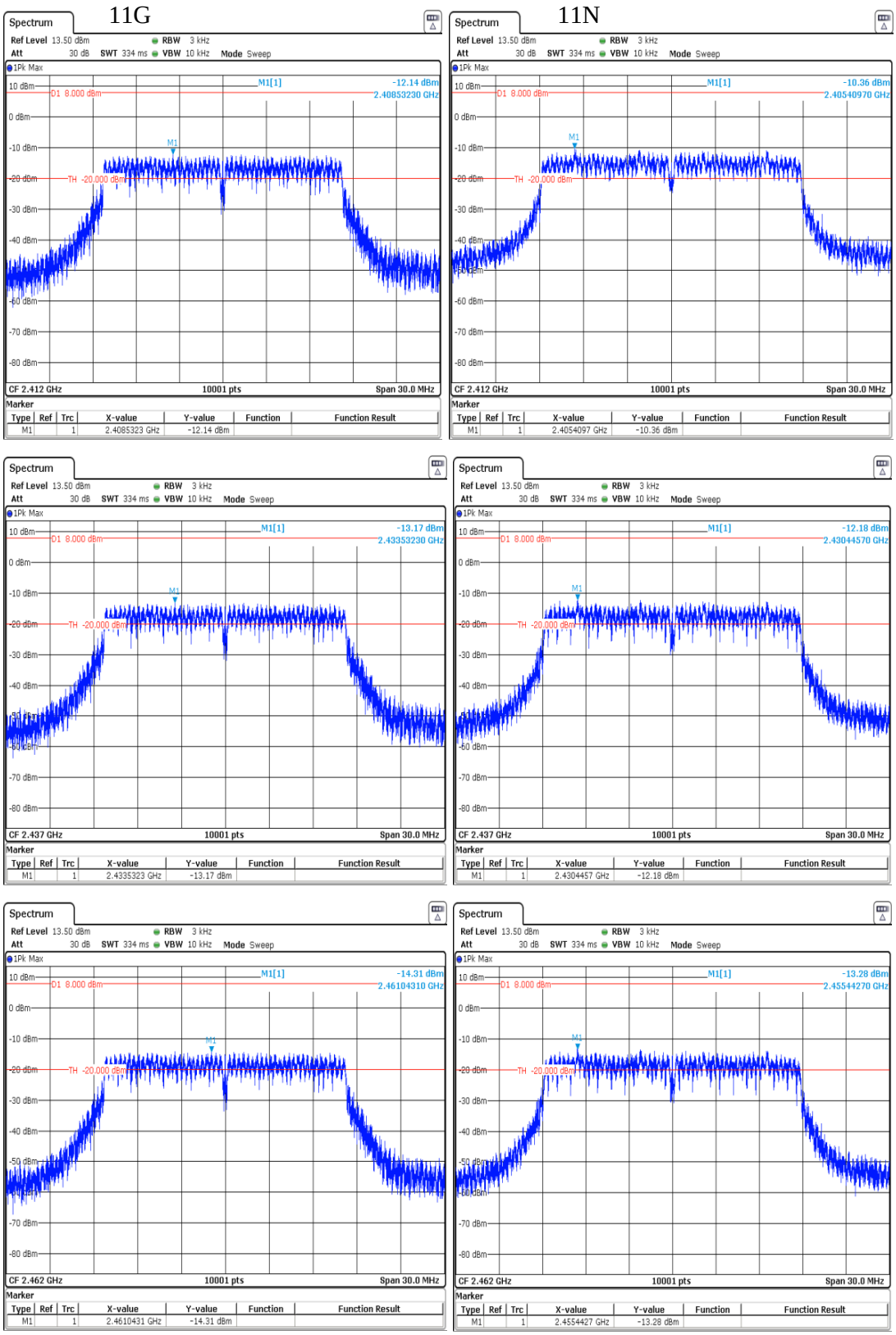


Figure 11(b): Power Spectral Density Plots.

4.3 Unintentional Emissions

4.3.1 Transmit Chain Spurious Emissions

The results for the measurement of transmit chain spurious emissions at the nominal voltage and temperature are provided in Table 8. Measurements are performed to 10 times the highest fundamental operating frequency.

Table 8(a): Transmit Chain Spurious Emissions.

Frequency Range	Det	IF Bandwidth	Video Bandwidth		
25 MHz ≤ f ≤ 1 000 MHz	Pk/QPk	120 kHz	300 kHz	**Test Date:**	17-Apr-19
f > 1 000 MHz	Pk/Avg	1 MHz	3 MHz	**Test Engineer:**	Gordon Helm
				EUT:	Connect Sense
				Mode:	BLE
				Meas. Distance:	3m

															FCC/IC
#	Mode	Freq. Start MHz	Freq. Stop MHz	Ant. Used	Ant. Pol.	Table Azim. deg	Ant Height m	Ka dB/m	Kg dB	E3(Pk) dBµV/m	E3 Pk Lim dBµV/m	E3(Avg) dBµV/m	E3 Avg Lim dBµV/m	Pass dB	Comments
1	Fundamental Restricted Band Edge (Low Side)														
2	CW	2390.0	2390.0	RH3115	H/V	10	2.2	28.9	-2.3	40.9	74.0	40.6	54.0	13.4	max L,M,H channels; all orientations
3	Fundamental Restricted Band Edge (High Side)														
4	CW	2483.5	2483.5	RH3115	H/V	30	2.2	29.1	-2.4	51.8	74.0	51.5	54.0	**2.5**	max L,M,H channels; all orientations
5	Harmonic Emissions														
6	CW	4804.0	4804.0	RH3115	H/V	280	2.0	33.1	-3.5	39.0	74.0	38.7	54.0	15.3	CH Low; all orientations
7	CW	4882.0	4805.0	RH3115	H/V	280	2.0	33.1	-3.6	39.0	74.0	38.7	54.0	15.3	CH Low; all orientations
8	CW	4960.0	4806.0	RH3115	H/V	280	2.0	33.1	-3.6	40.0	74.0	39.7	54.0	14.3	CH High; all orientations
9	CW	4000.0	6000.0	RH3115	H/V	280	2.0	35.0	-3.1	40.0	74.0	39.7	54.0	14.3	max L,M,H channels; all orientations
10	CW	6000.0	8400.0	RH3115	H/V	all	all	37.6	-4.1	41.8	74.0	41.5	54.0	12.5	max all
11	CW	8400.0	12500.0	RH3115	H/V	all	all	40.5	-4.9	38.8	74.0	38.5	54.0	15.5	max all, noise
12	CW	12500.0	18000.0	RH3115	H/V	all	all	45.2	-6.1	41.1	74.0	40.8	54.0	13.2	max all, noise
13	CW	18000.0	26000.0	RHCOB1840	H/V	all	all	53.0	-7.4	37.3	74.0	37.0	54.0	17.0	max all, noise
14															
15															

*Avg band edge and harmonic levels computed from Pk measurement minus duty cycle.

Table 8(b): Transmit Chain Spurious Emissions.

Frequency Range	Det	IF Bandwidth	Video Bandwidth		
25 MHz ≤ f ≤ 1 000 MHz	Pk/QPk	120 kHz	300 kHz	**Test Date:**	17-Apr-19
f > 1 000 MHz	Pk/Avg	1 MHz	3 MHz	**Test Engineer:**	Gordon Helm
				EUT:	Connect Sense
				Mode:	BLE
				Meas. Distance:	3m

																FCC/IC
#	Mode	Freq. Start MHz	Freq. Stop MHz	Ant. Used	Ant. Pol.	Table Azim. deg	Ant Height m	Ka dB/m	Kg dB	E3(Pk) dBµV/m	E3 Pk Lim dBµV/m	E3(Avg)* dBµV/m	E3 Avg Lim dBµV/m	Pass dB	Comments
1	Fundamental Restricted Band Edge (Low Side)														
2	11B	2390.0	2390.0	RH3115	H/V	290	2.2	28.9	-2.3	52.3	74.0	52.3	54.0	1.7	max L,M,H channels; all orientations
3	11G	2390.0	2390.0	RH3115	H/V	250	2.4	28.9	-2.3	52.7	74.0	52.7	54.0	1.3	max L,M,H channels; all orientations
4	11N	2390.0	2390.0	RH3115	H/V	250	2.4	28.9	-2.3	51.7	74.0	51.7	54.0	2.3	max L,M,H channels; all orientations
5															
6	Fundamental Restricted Band Edge (High Side)														
7	11B	2483.5	2483.5	RH3115	H/V	290	2.2	29.1	-2.4	53.2	74.0	53.2	54.0	0.8	max L,M,H channels; all orientations
8	11G	2483.5	2483.5	RH3115	H/V	290	2.2	29.1	-2.4	50.8	74.0	50.8	54.0	3.2	max L,M,H channels; all orientations
9	11N	2483.5	2483.5	RH3115	H/V	40	2.7	29.1	-2.4	53.9	74.0	53.9	54.0	**0.1**	max L,M,H channels; all orientations
10															
11	Harmonic Emissions														
12		4824.0	4804.0	RH3115	H/V	280	2.0	33.1	-3.5	49.9	74.0	49.9	54.0	4.1	CH Low, max all modes, all orientations
13		4874.0	4805.0	RH3115	H/V	280	2.0	33.1	-3.6	51.2	74.0	51.2	54.0	2.8	CH Mid, max all modes, all orientations
14		4924.0	4806.0	RH3115	H/V	280	2.0	33.1	-3.6	50.3	74.0	50.3	54.0	3.7	CH High, max all modes, all orientations
15		4000.0	6000.0	RH3115	H/V	all	all	35.0	-3.1	51.2	74.0	51.2	54.0	**2.8**	
16	All	7236.0	7236.0	RH3115	H/V	all	all	36.8	-4.5	45.9	74.0	45.9	54.0	8.1	CH Low, max all modes, all orientations
17		6000.0	8400.0	RH3115	H/V	all	all	37.6	-4.1	45.9	74.0	45.9	54.0	8.1	all channels; max all modulations
18		8400.0	12500.0	RH3115	H/V	all	all	40.5	-4.9	48.9	74.0	48.9	54.0	5.1	max all, noise
19		12500.0	18000.0	RH3115	H/V	all	all	45.2	-6.1	50.1	74.0	50.1	54.0	3.9	max all, noise
20		18000.0	26000.0	RHCOB1840	H/V	all	all	53.0	-7.4	50.0	74.0	50.0	54.0	4.0	max all, noise
21															
22															

*Avg band edge and harmonic levels computed from Pk measurement minus duty cycle.

4.3.2 Relative Transmit Chain Spurious Emissions

The results for the measurement of transmit chain spurious emissions relative to the fundamental in a 100 kHz receiver bandwidth (at the nominal voltage and temperature) are provided in Figure 12 below.

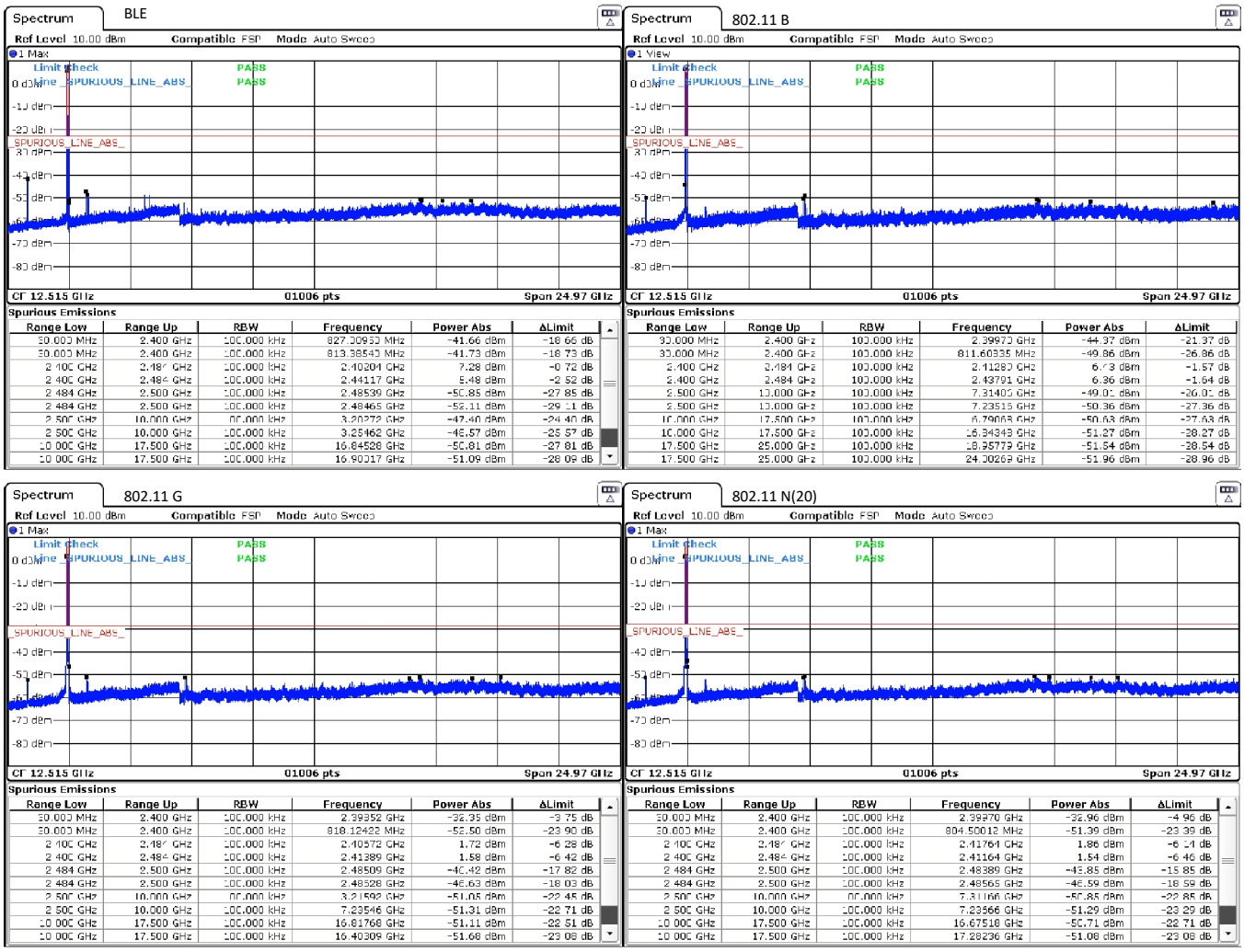


Figure 12: Conducted Transmitter Emissions Measured.

4.3.3 General Radiated Spurious

The results for the measurement of general spurious emissions (emissions arising from digital circuitry) at the nominal voltage and temperature are provided in Table 9. Radiation from digital components are measured up to 1000 MHz or to the highest frequency required by the applied standards, whichever is greater.

Table 9: Radiated Digital Spurious Emissions.

Frequency Range	Det	IF Bandwidth	Video Bandwidth
25 MHz ≤ f ≤ 1 000 MHz	Pk/QPk	120 kHz	300 kHz
f > 1 000 MHz	Pk	1 MHz	3 MHz

Test Date:	17-Apr-19
Test Engineer:	Gordon Helm
EUT:	CS-IWO
EUT Mode:	Active
Meas. Distance:	3 meters

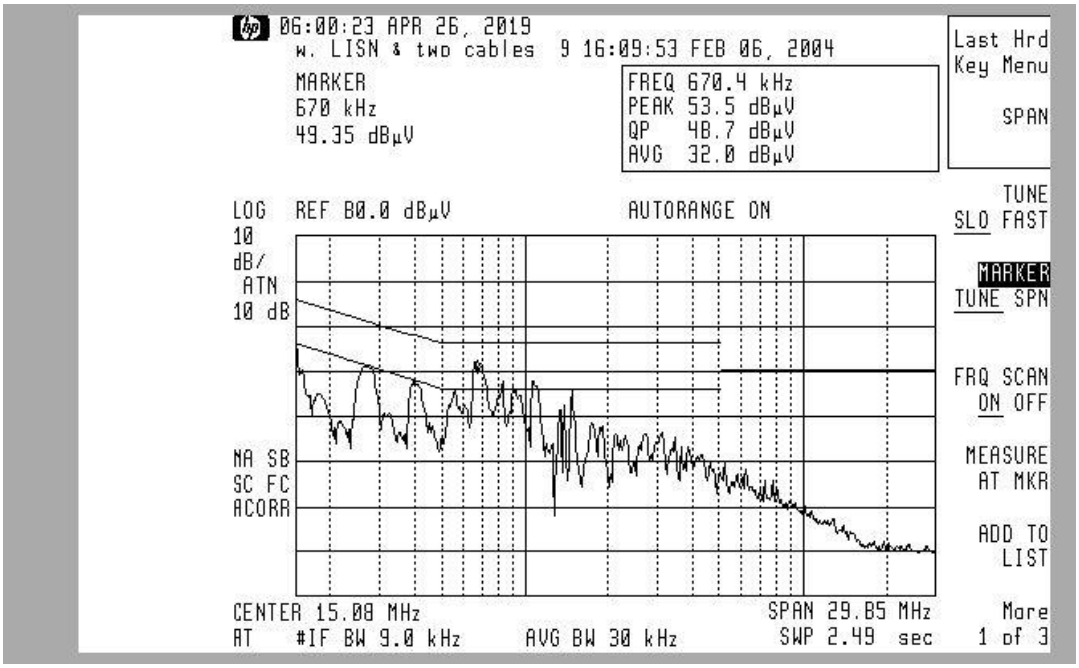
Digital Spurious Emissions FCC/IC

#	Freq. MHz	Ant. Used	Ant. Pol.	Table Azim. deg	Ant Height m	Ka dB/m	Kg dB	E3(Pk) dBµV/m	E3(QPk/Avg) dBµV/m	FCC/IC E3lim (Pk) dBµV/m	FCC/IC E3lim (Qpk/Avg) dBµV/m	Pass dB	Comments
1	79.0	BILO3142	H	10.0	1.7	8.0	-.5	37.1	31.7	60.0	40.0	**8.3**	background
2	81.0	BILO3142	V	250.0	1.0	7.9	-.5	33.5	28.1	60.0	40.0	11.9	background
3	109.0	BILO3142	H	10.0	1.7	7.2	-.6	25.8	19.2	63.5	43.5	24.3	
4	109.0	BILO3142	V	10.0	1.7	7.2	-.6	23.4	16.8	63.5	43.5	26.7	
5	257.0	BILO3142	V	240.0	1.0	15.6	-1.0	19.6	12.6	66.0	46.0	33.4	
6	260.0	BILO3142	H	230.0	1.8	15.8	-1.0	17.2	12.2	66.0	46.0	33.8	
7													
8	No other spurious emissions observed within 20 dB of the regulatory limit.												
9													

4.3.4 Conducted Emissions Test Results - AC Power Port(s)

The results of emissions from the EUT's AC mains power port(s) are reported in Table 10.

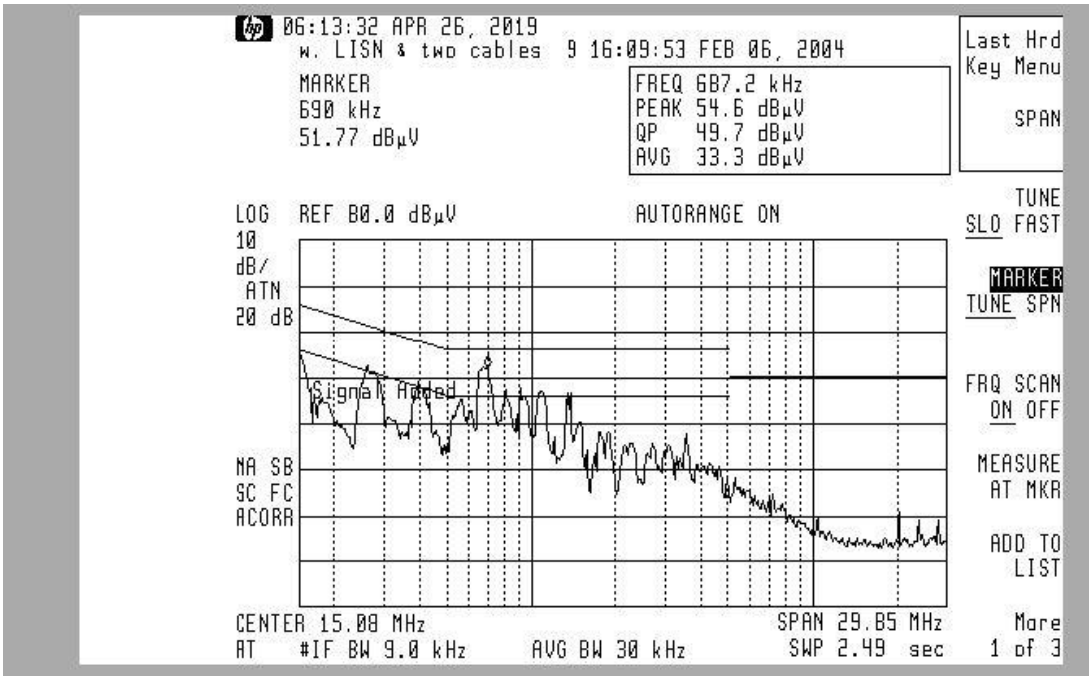
Table 10(a): AC Mains Power Conducted Emissions Results.



Neutral Data

Frequency	dBuV Reading		FCC / EN55032 dBuV Class B Limit		dB Margin	
MHz	QP	Avg	QP	Avg	QP	Avg
0.15	**54.60**	**39.10**	66.00	56.00	11.40	16.90
0.40	**45.00**	**28.00**	57.85	47.85	12.85	19.85
0.56	**41.00**	**23.00**	56.00	46.00	15.00	23.00
0.67	**48.70**	**32.00**	56.00	46.00	7.30	14.00
0.90	**40.00**	**19.00**	56.00	46.00	16.00	27.00
1.09	**44.00**	**27.00**	56.00	46.00	12.00	19.00

Table 10(b): AC Mains Power Conducted Emissions Results.



Phase Data

Frequency	dBuV Reading		FCC / EN55032 dBuV Class B Limit		dB Margin	
MHz	QP	Avg	QP	Avg	QP	Avg
0.15	**54.70**	**38.70**	65.77	55.77	11.07	17.07
0.20	**48.00**	**32.00**	63.61	53.61	15.61	21.61
0.41	**45.00**	**28.00**	57.65	47.65	12.65	19.65
0.68	**49.00**	**33.00**	56.00	46.00	7.00	13.00
1.10	**43.00**	**26.00**	56.00	46.00	13.00	20.00
1.30	**40.00**	**20.00**	56.00	46.00	16.00	26.00

5 Measurement Uncertainty and Accreditation Documents

The maximum values of measurement uncertainty for the laboratory test equipment and facilities associated with each test are given in the table below. This uncertainty is computed for a 95.45% confidence level based on a coverage factor of $k = 2$.

Table 11: Measurement Uncertainty.

Measured Parameter	Measurement Uncertainty†
Radio Frequency	$\pm(f_{Mkr}/10^7 + RBW/10 + (SPN/(PTS-1))/2 + 1\,\text{Hz})$
Conducted Emm. Amplitude	$\pm 1.9\,\text{dB}$
Radiated Emm. Amplitude $(30 - 200\,\text{MHz})$	$\pm 4.0\,\text{dB}$
Radiated Emm. Amplitude $(200 - 1000\,\text{MHz})$	$\pm 5.2\,\text{dB}$
Radiated Emm. Amplitude $(f > 1000\,\text{MHz})$	$\pm 3.7\,\text{dB}$

†Ref: CISPR 16-4-2:2011+A1:2014


United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

Certificate of Accreditation to ISO/IEC 17025:2005

NVLAP LAB CODE: 200129-0

AHD (Amber Helm Development, L.C.)
Sister Lakes, MI

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

Electromagnetic Compatibility & Telecommunications

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).

2019-06-28 through 2020-06-30
Effective Dates

For the National Voluntary Laboratory Accreditation Program

Figure 13: Accreditation Documents