

### 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.

**Test Date:** 11-Jun-18  
**Test Engineer:** J. Brunett  
**EUT:** GridConnect ESP32  
**Meas. Distance:** 3m

FCC/IC

#	Mode	Channel	Freq. MHz	Pout* dBm	Duty dB	Pout + Duty dBm	Ant Gain** dBi	EIRP (Avg) dBm	EIRP (Avg) Limit dBm	Pass dB
1	BLE (1MBPS)	0	2402.0	-3.0	6.8	3.8	3.8	7.6	30.0	22.4
2		19	2440.0	-2.3	6.8	4.5	3.8	8.3	30.0	21.7
3		39	2480.0	-1.3	6.8	5.5	3.8	9.3	30.0	20.7
4	802.11B	1	2412.0	12.2	0.6	12.8	3.8	<b>16.6</b>	30.0	<b>13.4</b>
5		6	2437.0	11.9	0.6	12.5	3.8	16.3	30.0	13.7
6		11	2462.0	11.7	0.6	12.3	3.8	16.1	30.0	13.9
7	802.11G	1	2412.0	7.9	0.9	8.8	3.8	12.6	30.0	17.4
8		6	2437.0	<b>7.9</b>	0.9	8.8	3.8	12.6	30.0	17.4
9		11	2462.0	7.6	0.9	8.5	3.8	12.3	30.0	17.7
10	802.11N(20)	1	2412.0	5.9	0.9	6.8	3.8	10.6	30.0	19.4
11		6	2437.0	6.2	0.9	7.1	3.8	10.9	30.0	19.1
12		11	2462.0	6.0	0.9	6.9	3.8	10.7	30.0	19.3
10	802.11N(40)	3	2422.0	6.0	0.9	6.9	3.8	10.7	30.0	19.3
11		6	2437.0	6.1	0.9	7.0	3.8	10.8	30.0	19.2
12		9	2452.0	6.0	0.9	6.9	3.8	10.7	30.0	19.3

\* Measured conducted from the radio using conducted test sample. Avg Power measured following DTS Meas. Procedures Section 9.2.2.4 (AVGSA-2)

\*\* Worst Case Antenna Gain as declared by Manufacturer (antenna data sheet)

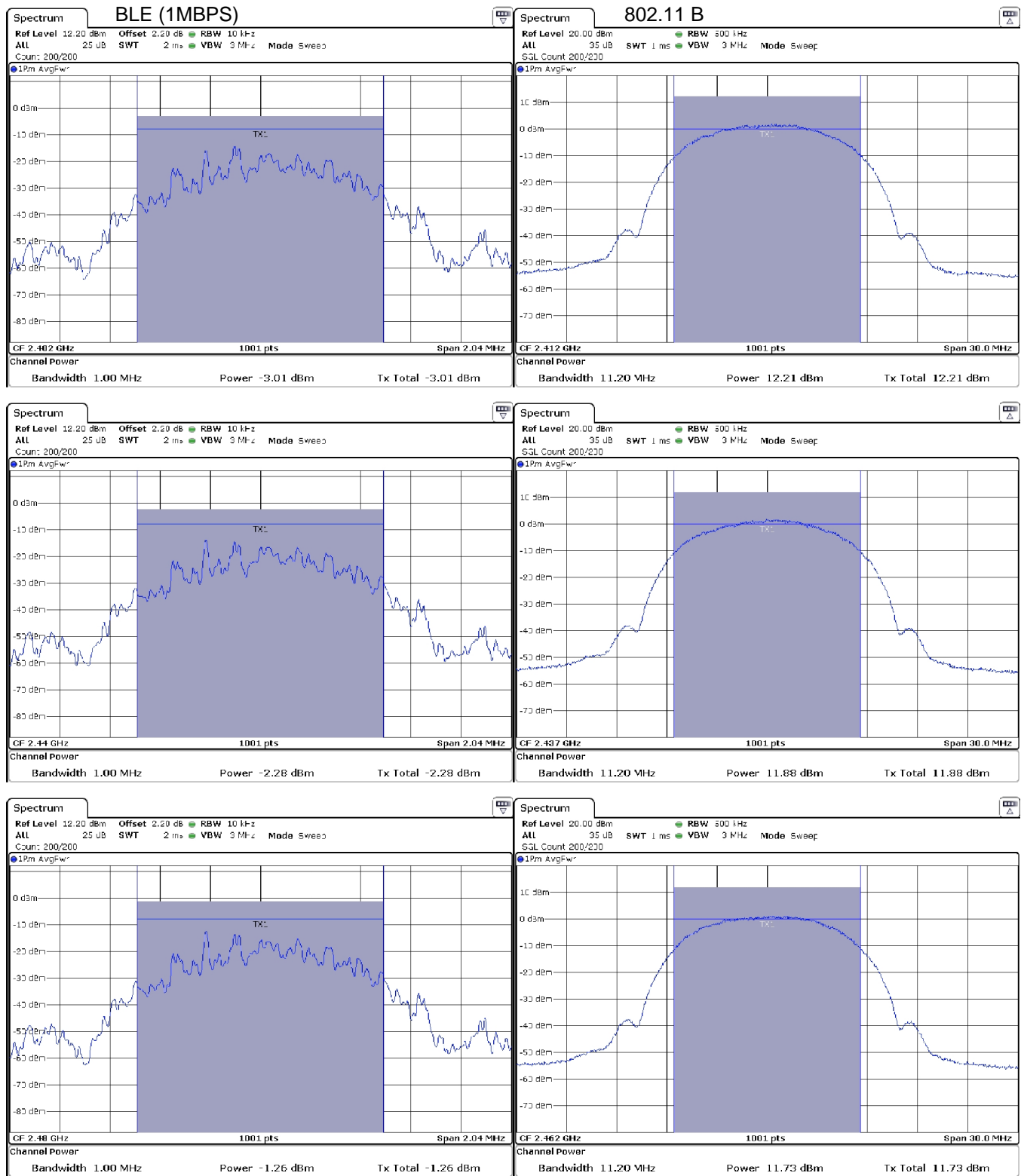


Figure 10(a): Conducted RF Power Plots

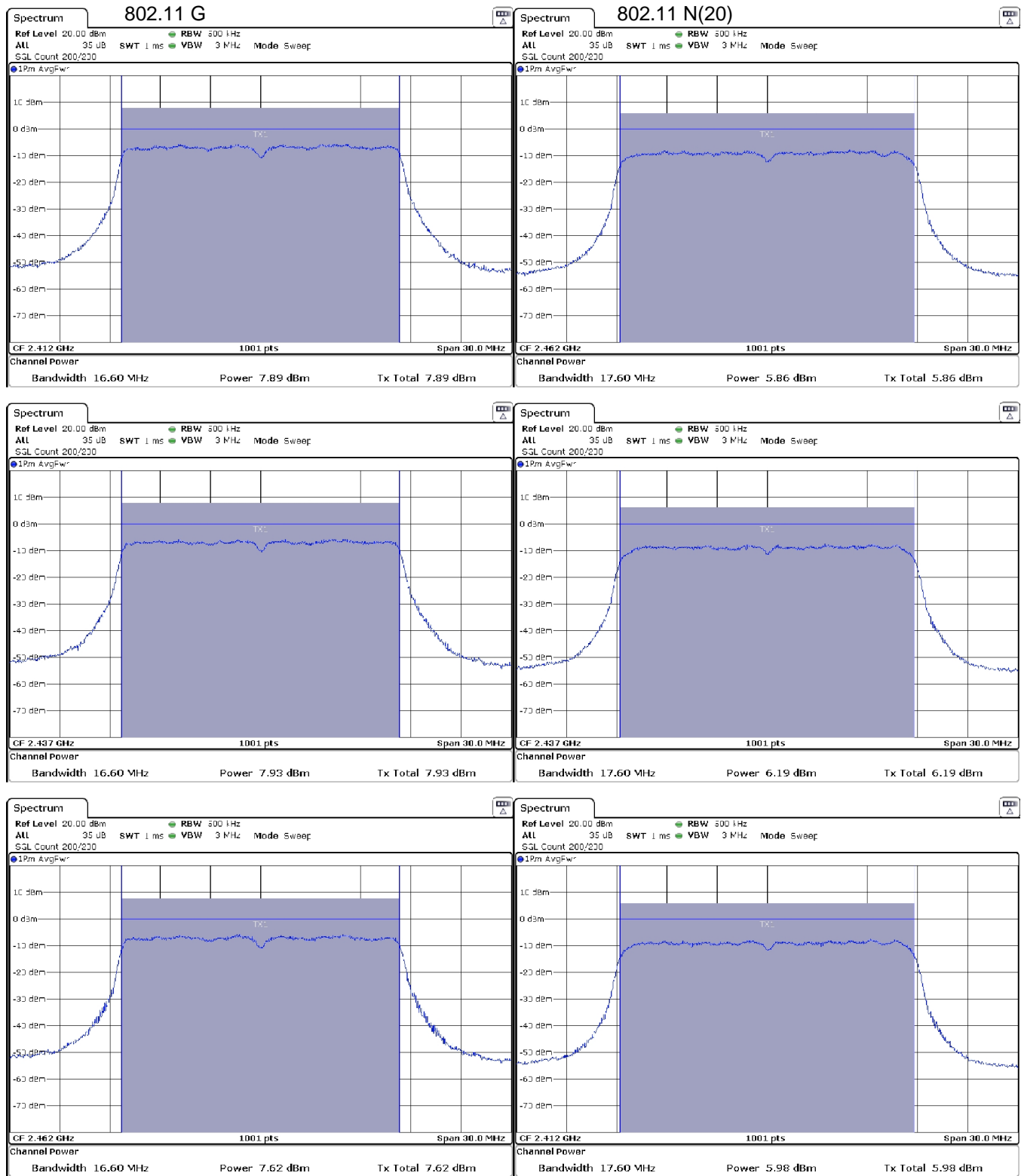


Figure 10(b): Conducted RF Power Plots

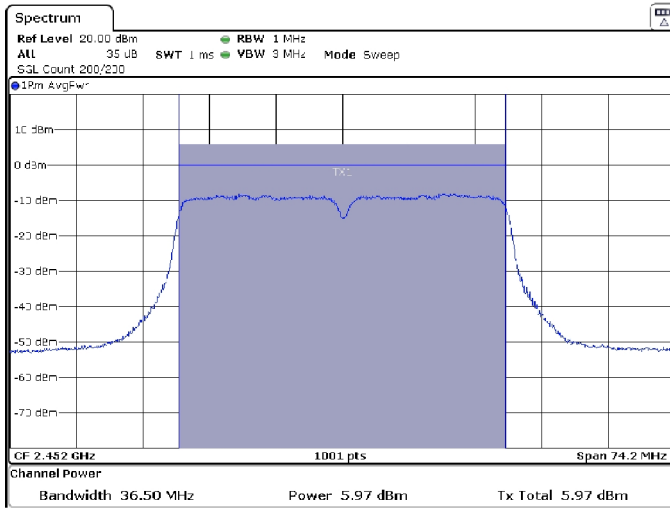
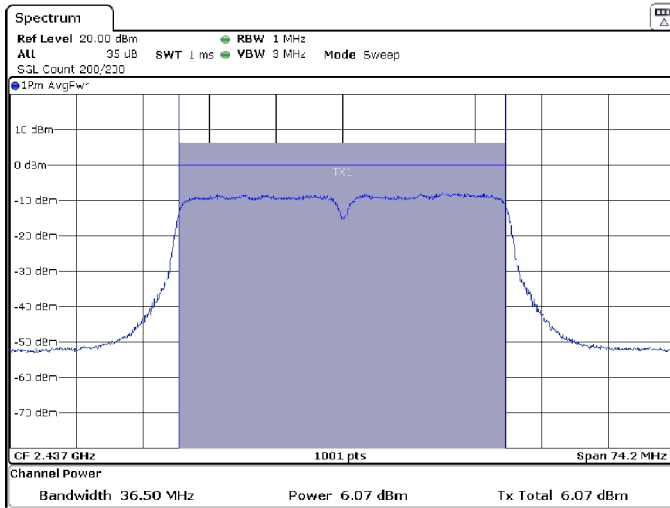
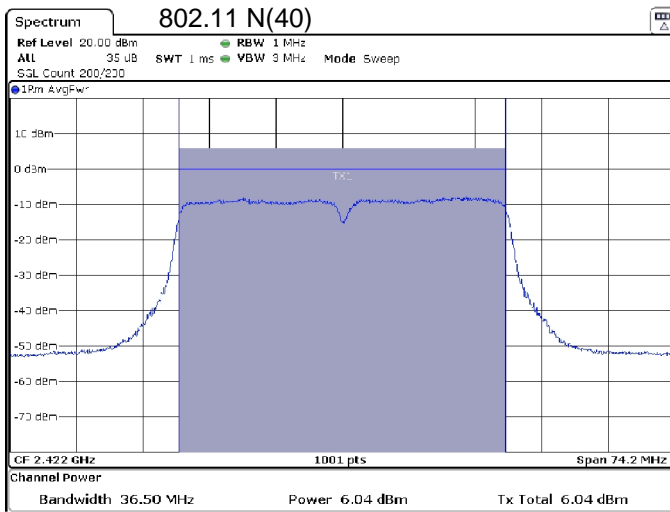


Figure 10(c): Conducted RF Power Plots

**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** 2400-2483.5    **Detector** Pk    **IF Bandwidth** 3 kHz    **Video Bandwidth** 10 kHz    **Test Date:** 11-Jun-18  
**Test Engineer:** Joseph Brunett  
**EUT:** GridConnect ESP32  
**Meas. Distance:** Conducted

							FCC/IC
#	Mode	Channel	Frequency (MHz)	Ant. Used	PSDcond (meas)* (dBm/3kHz)	PSD Limit (dBm/3kHz)	Pass By (dB)
1	BLE	0	2402.0	Cond.	-15.4	8.00	23.4
2		19	2440.0	Cond.	-14.3	8.00	22.3
3		39	2480.0	Cond.	-13.0	8.00	21.0
4	802.11b	1	2412.0	Cond.	-10.9	8.00	18.9
5		6	2437.0	Cond.	-11.3	8.00	19.3
6		11	2462.0	Cond.	-12.3	8.00	20.3
7	802.11g	1	2412.0	Cond.	-17.9	8.00	25.9
8		6	2437.0	Cond.	-18.1	8.00	26.1
9		11	2462.0	Cond.	-18.0	8.00	26.0
10	802.11n(20)	1	2412.0	Cond.	-19.3	8.00	27.3
11		6	2437.0	Cond.	-19.8	8.00	27.8
12		11	2462.0	Cond.	-19.7	8.00	27.7
13	802.11n(40)	3	2422.0	Cond.	-21.7	8.00	29.7
14		6	2437.0	Cond.	-21.8	8.00	29.8
15		9	2452.0	Cond.	-21.8	8.00	29.8

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

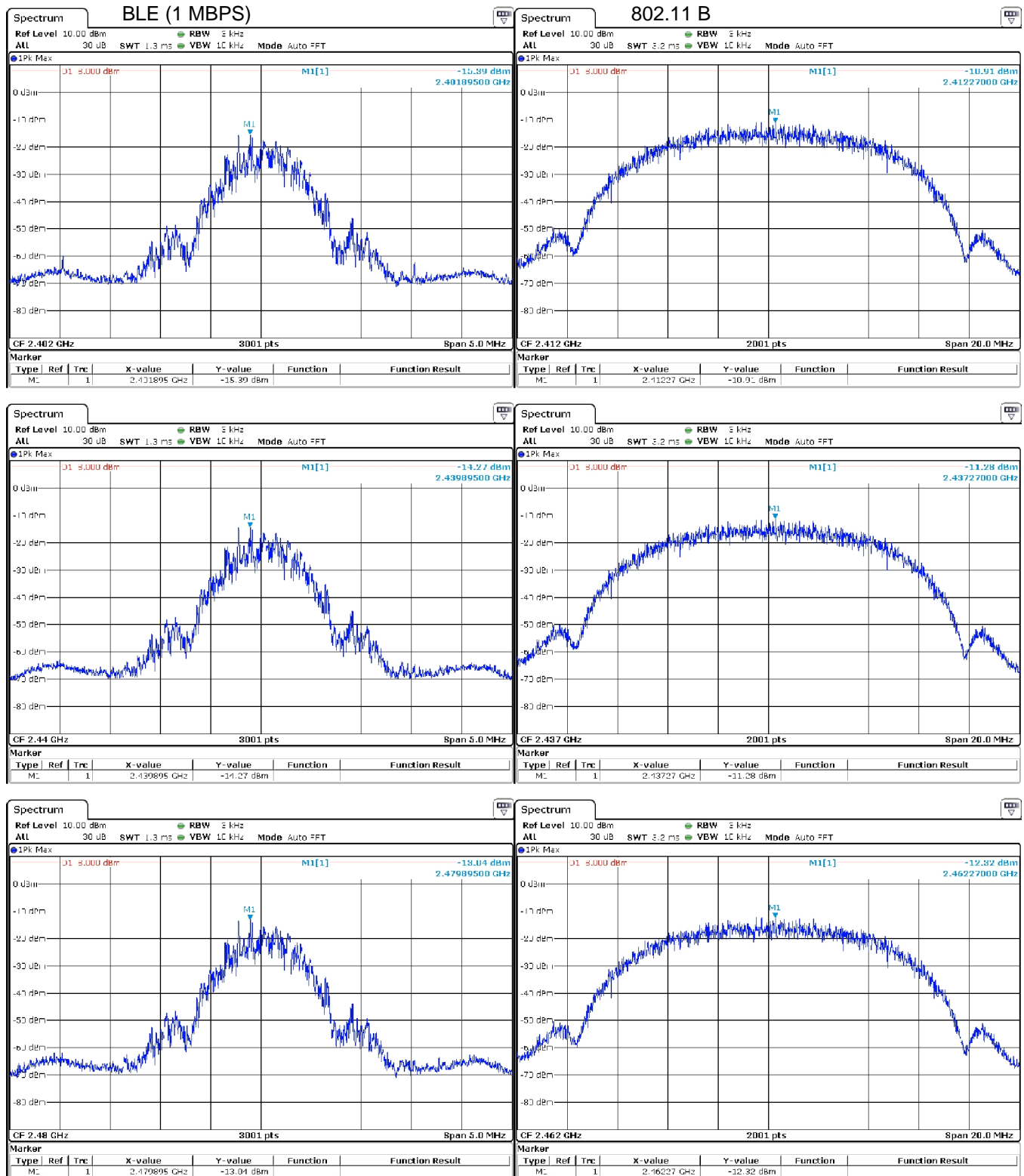


Figure 11(a): Power Spectral Density Plots.

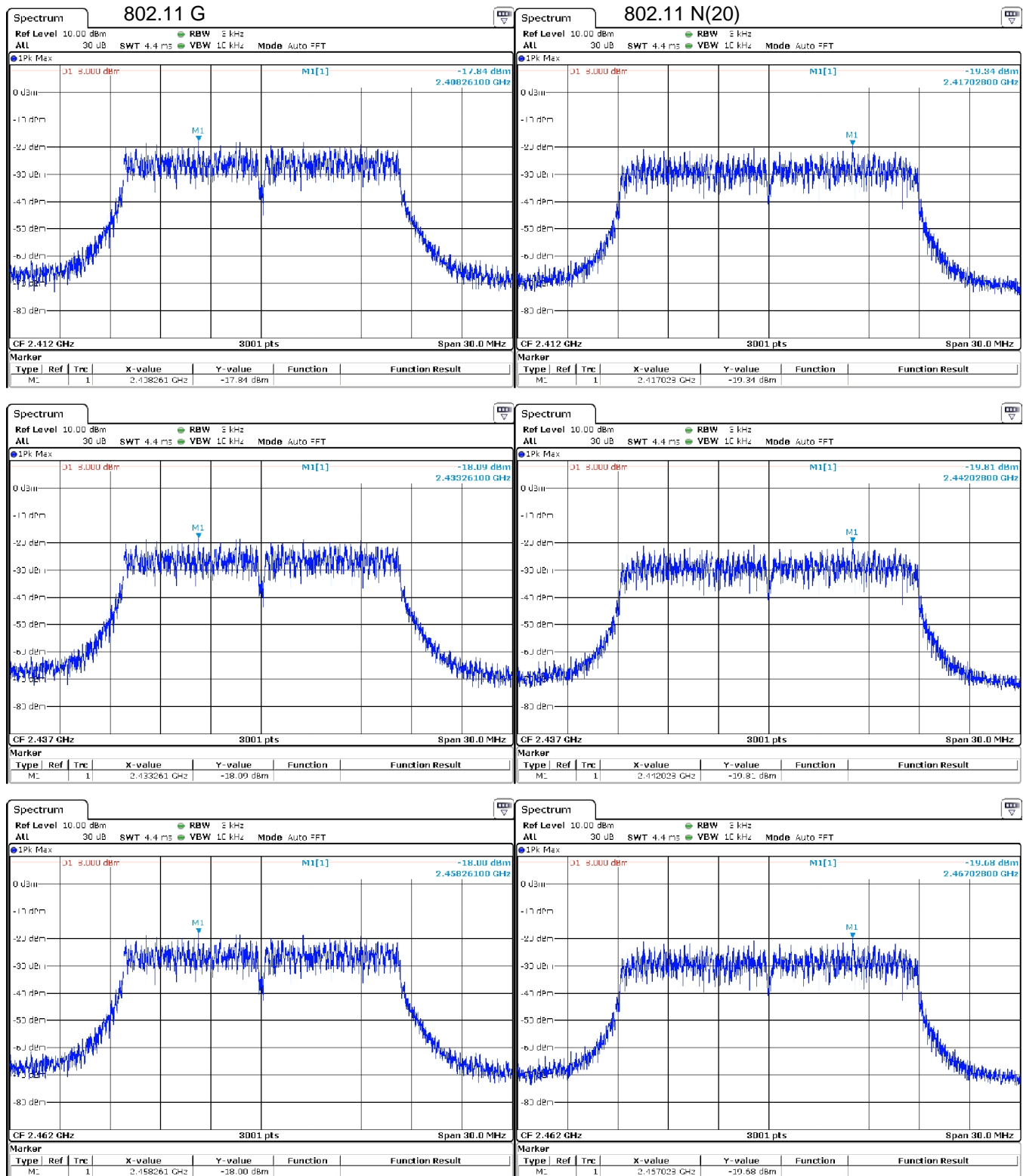


Figure 11(b): Power Spectral Density Plots.

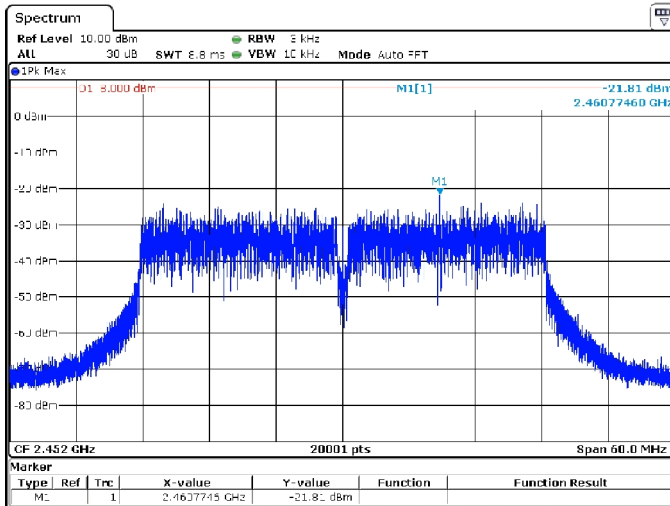
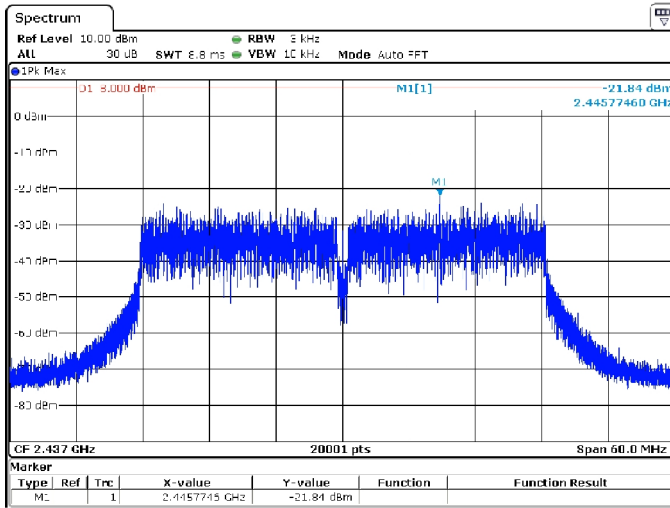
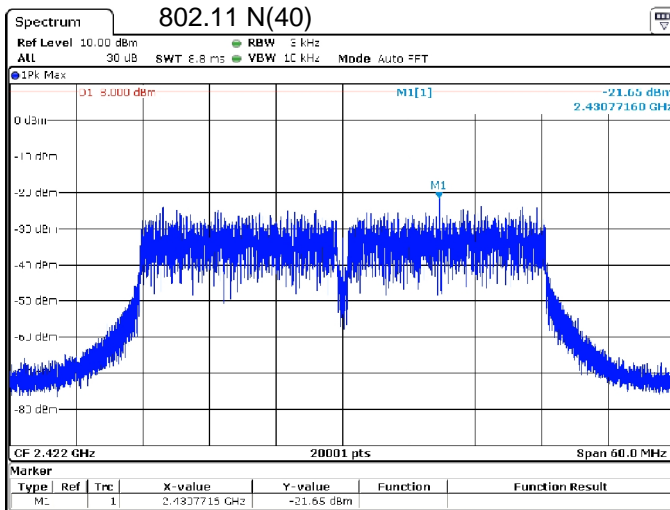


Figure 11(c): Power Spectral Density Plots.



### 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.

<b>Frequency Range</b> f > 1 000 MHz	<b>Det</b> Pk/Avg	<b>IF Bandwidth</b> 1 MHz	<b>Video Bandwidth</b> 3 MHz	<b>Test Date:</b> 5/30/2018, 6/12/2018
				<b>Test Engineer:</b> G. Helm, J. Brunett
				<b>EUT:</b> GridConnect ESP32
				<b>Mode:</b> BLE
				<b>Meas. Distance:</b> 3m

															FCC/IC	
#	Mode	Freq. Start MHz	Freq. Stop MHz	Ant. Used	Ant. Pol.	Table Angle deg	Ant Height m	Ka dB/m	Kg dB	E3 Pk dBµV/m	E3 Pk Lim dBµV/m	E3(Avg) meas. dBµV/m	E3 (Avg) + Duty dBµV/m	E3 Avg Lim dBµV/m	Pass dB	Comments
1	Trace Antenna (N2420)															
2	Fundamental Restricted Band Edge (Low Side)															
3	BLE	2390.0	2390.0	RH3115	H/V	300	2.5	28.9	-2.3	39.5	74.0			54.0	14.5	max L,M,H channels; all orientations
4	Fundamental Restricted Band Edge (High Side)															
5	BLE	2483.5	2483.5	RH3115	H/V	300	2.5	29.1	-2.4	52.3	74.0			54.0	1.7	max L,M,H channels; all orientations
6	Harmonic Emissions															
7	BLE	4804.0	4804.0	RH3115	H/V	0	2.7	33.1	-3.5	56.3	74.0	31.8	38.6	54.0	15.4	CH Low; all orientations
8	BLE	4880.0	4805.0	RH3115	H/V	0	2.7	33.1	-3.6	56.0	74.0	31.5	38.3	54.0	15.8	CH Low; all orientations
9	BLE	4960.0	4806.0	RH3115	H/V	0	2.7	33.1	-3.6	53.2	74.0	28.7	35.5	54.0	18.5	CH High; all orientations
10	BLE	4000.0	6000.0	RH3115	H/V	all	all	35.0	-3.1	56.3	74.0	31.8	38.6	54.0	15.4	max L,M,H channels; all orientations
11	BLE	6000.0	8400.0	HQR2TO18S01	H/V	all	all	37.6	-4.1	58.7	74.0	34.2	41.0	54.0	13.0	max all
12	BLE	8400.0	12500.0	HQR2TO18S01	H/V	all	all	40.5	-4.9	58.1	74.0	33.6	40.4	54.0	13.6	max all, noise
13	BLE	12500.0	18000.0	HQR2TO18S01	H/V	all	all	45.2	-6.1	46.0	74.0	21.5	28.3	54.0	25.7	max all, noise
14	BLE	18000.0	26000.0	RHCOB1840	H/V	all	all	53.0	-7.4	39.2	74.0	14.7	21.5	54.0	32.5	max all, noise
15																
16	Whip Antenna (VTWFA-3)															
17	Fundamental Restricted Band Edge (Low Side)															
18	BLE	2390.0	2390.0	RH3115	H/V	310	2.6	28.9	-2.3	44.6	74.0	44.3		54.0	9.4	max L,M,H channels; all orientations
19	Fundamental Restricted Band Edge (High Side)															
20	BLE	2483.5	2483.5	RH3115	H/V	310	2.6	29.1	-2.4	51.8	74.0	51.5		54.0	2.2	max L,M,H channels; all orientations
21	Harmonic Emissions															
22	BLE	4804.0	4804.0	RH3115	H/V	10	1.8	33.1	-3.5	50.7	74.0	26.2	33.0	54.0	21.0	CH Low; all orientations
23	BLE	4882.0	4805.0	RH3115	H/V	10	1.8	33.1	-3.6	59.4	74.0	34.9	41.7	54.0	12.3	CH Low; all orientations
24	BLE	4960.0	4806.0	RH3115	H/V	10	1.8	33.1	-3.6	58.7	74.0	34.2	41.0	54.0	13.0	CH High; all orientations
25	BLE	4000.0	6000.0	RH3115	H/V	all	all	35.0	-3.1	59.4	74.0	34.9	41.7	54.0	12.3	max L,M,H channels; all orientations
26	BLE	6000.0	8400.0	HQR2TO18S01	H/V	all	all	37.6	-4.1	51.7	74.0	27.2	34.0	54.0	20.0	max all
27	BLE	8400.0	12500.0	HQR2TO18S01	H/V	all	all	40.5	-4.9	47.7	74.0	23.2	30.0	54.0	24.0	max all, noise
28	BLE	12500.0	18000.0	HQR2TO18S01	H/V	all	all	45.2	-6.1	48.5	74.0	24.0	30.8	54.0	23.2	max all, noise
29	BLE	18000.0	26000.0	RHCOB1840	H/V	all	all	53.0	-7.4	40.1	74.0	15.6	22.4	54.0	31.6	max all, noise
30																

Table 8(b): Transmit Chain Spurious Emissions.

<b>Frequency Range</b> f > 1 000 MHz	<b>Det</b> Pk/Avg	<b>IF Bandwidth</b> 1 MHz	<b>Video Bandwidth</b> 3 MHz	<b>Test Date:</b> 5/30/2018, 6/12/2018
				<b>Test Engineer:</b> G. Helm, J. Brunett
				<b>EUT:</b> GridConnect ESP32
				<b>Mode:</b> 802.11B
				<b>Meas. Distance:</b> 3m

Raven

															FCC/IC	
#	Mode	Freq. Start MHz	Freq. Stop MHz	Ant. Used	Ant. Pol.	Table Angle deg	Ant Height m	Ka dB/m	Kg dB	E3 Pk dBµV/m	E3 Pk Lim dBµV/m	E3(Avg) meas. dBµV/m	E3 (Avg) + Duty dBµV/m	E3 Avg Lim dBµV/m	Pass dB	Comments
1	Trace Antenna (N2420)															
2	Fundamental Restricted Band Edge (Low Side)															
3	802.11B	2390.0	2390.0	RH3115	H/V	300	2.5	28.9	-2.3	41.0	74.0			54.0	13.0	max L,M,H channels; all orientations
4	Fundamental Restricted Band Edge (High Side)															
5	802.11B	2483.5	2483.5	RH3115	H/V	300	2.5	29.1	-2.4	46.0	74.0			54.0	8.0	max L,M,H channels; all orientations
6	Harmonic Emissions															
7	802.11B	4804.0	4804.0	RH3115	H/V	10	1.8	33.1	-3.5	65.2	74.0	40.7	41.3	54.0	8.8	CH Low; all orientations
8	802.11B	4880.0	4805.0	RH3115	H/V	10	1.8	33.1	-3.6	63.0	74.0	38.5	39.1	54.0	11.0	CH Low; all orientations
9	802.11B	4960.0	4806.0	RH3115	H/V	10	1.8	33.1	-3.6	62.0	74.0	37.5	38.1	54.0	12.0	CH High; all orientations
10	802.11B	4000.0	6000.0	RH3115	H/V	all	all	35.0	-3.1	65.2	74.0	40.7	41.3	54.0	8.8	max L,M,H channels; all orientations
11	802.11B	6000.0	8400.0	HQR2TO18S01	H/V	all	all	37.6	-4.1	66.9	74.0	42.4	43.0	54.0	7.1	max all
12	802.11B	8400.0	12500.0	HQR2TO18S01	H/V	all	all	40.5	-4.9	66.0	74.0	41.5	42.1	54.0	8.0	max all, noise
13	802.11B	12500.0	18000.0	HQR2TO18S01	H/V	all	all	45.2	-6.1	50.0	74.0	35.2	35.8	54.0	18.2	max all, noise
14	802.11B	18000.0	26000.0	RHCOB1840	H/V	all	all	53.0	-7.4	41.0	74.0	39.2	39.8	54.0	14.2	max all, noise
15																
16	Whip Antenna (VTWFA-3)															
17	Fundamental Restricted Band Edge (Low Side)															
18	802.11B	2390.0	2390.0	RH3115	H/V	310	2.6	28.9	-2.3	46.4	74.0	46.1		54.0	7.6	max L,M,H channels; all orientations
19	Fundamental Restricted Band Edge (High Side)															
20	802.11B	2483.5	2483.5	RH3115	H/V	310	2.6	29.1	-2.4	47.1	74.0	46.8		54.0	6.9	max L,M,H channels; all orientations
21	Harmonic Emissions															
22	802.11B	4804.0	4804.0	RH3115	H/V	100	2.0	33.1	-3.5	62.5	74.0	38.0	44.8	54.0	9.2	CH Low; all orientations
23	802.11B	4882.0	4805.0	RH3115	H/V	100	2.0	33.1	-3.6	62.3	74.0	37.8	44.6	54.0	9.4	CH Low; all orientations
24	802.11B	4960.0	4806.0	RH3115	H/V	100	2.0	33.1	-3.6	61.9	74.0	37.4	44.2	54.0	9.8	CH High; all orientations
25	802.11B	4000.0	6000.0	RH3115	H/V	all	all	35.0	-3.1	62.5	74.0	38.0	44.8	54.0	9.2	max L,M,H channels; all orientations
26	802.11B	6000.0	8400.0	HQR2TO18S01	H/V	all	all	37.6	-4.1	66.5	74.0	42.0	48.8	54.0	5.2	max all
27	802.11B	8400.0	12500.0	HQR2TO18S01	H/V	all	all	40.5	-4.9	54.3	74.0	29.8	36.6	54.0	17.4	max all, noise
28	802.11B	12500.0	18000.0	HQR2TO18S01	H/V	all	all	45.2	-6.1	49.8	74.0	25.3	33.9	54.0	20.1	max all, noise
29	802.11B	18000.0	26000.0	RHCOB1840	H/V	all	all	53.0	-7.4	39.9	74.0	15.4	40.1	54.0	13.9	max all, noise
30																

Duty  
0.3

Table 8(c): Transmit Chain Spurious Emissions.

**Frequency Range**  
 f > 1 000 MHz  
**Det**  
 Pk/Avg  
**IF Bandwidth**  
 1 MHz  
**Video Bandwidth**  
 3 MHz  
**Test Date:** 5/30/2018, 6/12/2018  
**Test Engineer:** G. Helm, J. Brunett  
**EUT:** GridConnect ESP32  
**Mode:** 802.11G  
**Meas. Distance:** 3m

															FCC/IC	
#	Mode	Freq. Start MHz	Freq. Stop MHz	Ant. Used	Ant. Pol.	Table Angle deg	Ant Height m	Ka dB/m	Kg dB	E3 Pk dBµV/m	E3 Pk Lim dBµV/m	E3(Avg) meas. dBµV/m	E3 (Avg) + Duty dBµV/m	E3 Avg Lim dBµV/m	Pass dB	Comments
1	Trace Antenna (N2420)															
2	Fundamental Restricted Band Edge (Low Side)															
3	802.11G	2390.0	2390.0	RH3115	H/V	300	2.5	28.9	-2.3	47.0	74.0			54.0	7.0	max L,M,H channels; all orientations
4	Fundamental Restricted Band Edge (High Side)															
5	802.11G	2483.5	2483.5	RH3115	H/V	300	2.5	29.1	-2.4	52.4	74.0			54.0	1.6	max L,M,H channels; all orientations
6	Harmonic Emissions															
7	802.11G	4804.0	4804.0	RH3115	H/V	10	1.8	33.1	-3.5	59.3	74.0	34.8	35.7	54.0	14.7	CH Low; all orientations
8	802.11G	4880.0	4805.0	RH3115	H/V	10	1.8	33.1	-3.6	57.9	74.0	33.4	34.3	54.0	16.1	CH Low; all orientations
9	802.11G	4960.0	4806.0	RH3115	H/V	10	1.8	33.1	-3.6	56.0	74.0	31.5	32.4	54.0	18.0	CH High; all orientations
10	802.11G	4000.0	6000.0	RH3115	H/V	all	all	35.0	-3.1	59.3	74.0	34.8	35.7	54.0	14.7	max L,M,H channels; all orientations
11	802.11G	6000.0	8400.0	HQR2TO18S01	H/V	all	all	37.6	-4.1	61.2	74.0	36.7	37.6	54.0	12.8	max all
12	802.11G	8400.0	12500.0	HQR2TO18S01	H/V	all	all	40.5	-4.9	60.3	74.0	35.8	36.7	54.0	13.7	max all, noise
13	802.11G	12500.0	18000.0	HQR2TO18S01	H/V	all	all	45.2	-6.1	44.9	74.0	35.2	36.1	54.0	17.9	max all, noise
14	802.11G	18000.0	26000.0	RHCOB1840	H/V	all	all	53.0	-7.4	35.1	74.0	39.2	40.1	54.0	13.9	max all, noise
15																
16	Whip Antenna (VTWFA-3)															
17	Fundamental Restricted Band Edge (Low Side)															
18	802.11G	2390.0	2390.0	RH3115	H/V	310	2.6	28.9	-2.3	52.8	74.0	52.5		54.0	1.2	max L,M,H channels; all orientations
19	Fundamental Restricted Band Edge (High Side)															
20	802.11G	2483.5	2483.5	RH3115	H/V	310	2.6	29.1	-2.4	52.9	74.0	52.6		54.0	1.1	max L,M,H channels; all orientations
21	Harmonic Emissions															
22	802.11G	4804.0	4804.0	RH3115	H/V	100	2.0	33.1	-3.5	57.0	74.0	32.5	33.4	54.0	17.0	CH Low; all orientations
23	802.11G	4882.0	4805.0	RH3115	H/V	100	2.0	33.1	-3.6	56.6	74.0	32.1	33.0	54.0	17.4	max all
24	802.11G	4960.0	4806.0	RH3115	H/V	100	2.0	33.1	-3.6	56.7	74.0	32.2	33.1	54.0	17.3	CH High; all orientations
25	802.11G	4000.0	6000.0	RH3115	H/V	all	all	35.0	-3.1	57.0	74.0	32.5	33.4	54.0	17.0	max L,M,H channels; all orientations
26	802.11G	6000.0	8400.0	HQR2TO18S01	H/V	all	all	37.6	-4.1	61.2	74.0	36.7	37.6	54.0	12.8	max all
27	802.11G	8400.0	12500.0	HQR2TO18S01	H/V	all	all	40.5	-4.9	48.8	74.0	24.3	25.2	54.0	25.2	max all, noise
28	802.11G	12500.0	18000.0	HQR2TO18S01	H/V	all	all	45.2	-6.1	44.6	74.0	20.1	21.0	54.0	29.4	max all, noise
29	802.11G	18000.0	26000.0	RHCOB1840	H/V	all	all	53.0	-7.4	34.9	74.0	10.4	11.3	54.0	39.1	max all, noise
30																

Table 8(d): Transmit Chain Spurious Emissions.

**Frequency Range** f > 1 000 MHz  
**Det** Pk/Avg  
**IF Bandwidth** 1 MHz  
**Video Bandwidth** 3 MHz  
**Test Date:** 5/30/2018, 6/12/2018  
**Test Engineer:** G. Helm, J. Brunett  
**EUT:** GridConnect ESP32  
**Mode:** 802.11N20  
**Meas. Distance:** 3m

															FCC/IC	
#	Mode	Freq. Start MHz	Freq. Stop MHz	Ant. Used	Ant. Pol.	Table Angle deg	Ant Height m	Ka dB/m	Kg dB	E3 Pk dBμV/m	E3 Pk Lim dBμV/m	E3(Avg) meas. dBμV/m	E3 (Avg) + Duty dBμV/m	E3 Avg Lim dBμV/m	Pass	Comments
1	Trace Antenna (N2420)															
2	Fundamental Restricted Band Edge (Low Side)															
3	802.11N20	2390.0	2390.0	RH3115	H/V	300	2.5	28.9	-2.3	42.0	74.0			54.0	12.0	max L,M,H channels; all orientations
4	Fundamental Restricted Band Edge (High Side)															
5	802.11N20	2483.5	2483.5	RH3115	H/V	300	2.5	29.1	-2.4	48.0	74.0			54.0	6.0	max L,M,H channels; all orientations
6	Harmonic Emissions															
7	802.11N20	4804.0	4804.0	RH3115	H/V	10	1.8	33.1	-3.5	58.2	74.0	33.7	34.6	54.0	15.8	CH Low; all orientations
8	802.11N20	4880.0	4805.0	RH3115	H/V	10	1.8	33.1	-3.6	56.8	74.0	32.3	33.2	54.0	17.2	CH Low; all orientations
9	802.11N20	4960.0	4806.0	RH3115	H/V	10	1.8	33.1	-3.6	54.8	74.0	30.3	31.2	54.0	19.2	CH High; all orientations
10	802.11N20	4000.0	6000.0	RH3115	H/V	all	all	35.0	-3.1	58.2	74.0	33.7	34.6	54.0	15.8	max L,M,H channels; all orientations
11	802.11N20	6000.0	8400.0	HQR2TO18S01	H/V	all	all	37.6	-4.1	59.3	74.0	34.8	35.7	54.0	14.7	max all
12	802.11N20	8400.0	12500.0	HQR2TO18S01	H/V	all	all	40.5	-4.9	58.5	74.0	34.0	34.9	54.0	15.5	max all, noise
13	802.11N20	12500.0	18000.0	HQR2TO18S01	H/V	all	all	45.2	-6.1	44.0	74.0	35.2	36.1	54.0	17.9	max all, noise
14	802.11N20	18000.0	26000.0	RHCOB1840	H/V	all	all	53.0	-7.4	37.9	74.0	39.2	40.1	54.0	13.9	max all, noise
15																
16	Whip Antenna (VTWEA-3)															
17	Fundamental Restricted Band Edge (Low Side)															
18	802.11N20	2390.0	2390.0	RH3115	H/V	310	2.6	28.9	-2.3	49.3	74.0	49.0		54.0	4.7	max L,M,H channels; all orientations
19	Fundamental Restricted Band Edge (High Side)															
20	802.11N20	2483.5	2483.5	RH3115	H/V	310	2.6	29.1	-2.4	52.8	74.0	52.5		54.0	1.2	max L,M,H channels; all orientations
21	Harmonic Emissions															
22	802.11N20	4804.0	4804.0	RH3115	H/V	100	2.0	33.1	-3.5	55.1	74.0	30.6	31.5	54.0	18.9	CH Low; all orientations
23	802.11N20	4882.0	4805.0	RH3115	H/V	100	2.0	33.1	-3.6	54.8	74.0	30.3	31.2	54.0	19.2	CH Low; all orientations
24	802.11N20	4960.0	4806.0	RH3115	H/V	100	2.0	33.1	-3.6	55.0	74.0	30.5	31.4	54.0	19.0	CH High; all orientations
25	802.11N20	4000.0	6000.0	RH3115	H/V	all	all	35.0	-3.1	55.1	74.0	30.6	31.5	54.0	18.9	max L,M,H channels; all orientations
26	802.11N20	6000.0	8400.0	HQR2TO18S01	H/V	all	all	37.6	-4.1	59.3	74.0	34.8	35.7	54.0	14.7	max all
27	802.11N20	8400.0	12500.0	HQR2TO18S01	H/V	all	all	40.5	-4.9	47.0	74.0	33.1	34.0	54.0	20.0	max all, noise
28	802.11N20	12500.0	18000.0	HQR2TO18S01	H/V	all	all	45.2	-6.1	45.1	74.0	34.5	35.4	54.0	18.6	max all, noise
29	802.11N20	18000.0	26000.0	RHCOB1840	H/V	all	all	53.0	-7.4	37.9	74.0	37.1	38.0	54.0	16.0	max all, noise
30																

Table 8(e): Transmit Chain Spurious Emissions.

Frequency Range: f > 1 000 MHz  
 Det: Pk/Avg  
 IF Bandwidth: 1 MHz  
 Video Bandwidth: 3 MHz  
 Test Date: 5/30/2018, 6/12/2018  
 Test Engineer: G. Helm, J. Brunett  
 EUT: GridConnect ESP32  
 Mode: 802.11N40  
 Meas. Distance: 3m

															FCC/IC	
#	Mode	Freq. Start MHz	Freq. Stop MHz	Ant. Used	Ant. Pol.	Table Angle deg	Ant Height m	Ka dB/m	Kg dB	E3 Pk dBμV/m	E3 Pk Lim dBμV/m	E3(Avg) meas. dBμV/m	E3 (Avg) + Duty dBμV/m	E3 Avg Lim dBμV/m	Pass dB	Comments
1	Trace Antenna (N2420)															
2	Fundamental Restricted Band Edge (Low Side)															
3	802.11N40	2390.0	2390.0	RH3115	H/V	300	2.5	28.9	-2.3	43.0	74.0			54.0	11.0	max L,M,H channels; all orientations
4	Fundamental Restricted Band Edge (High Side)															
5	802.11N40	2483.5	2483.5	RH3115	H/V	300	2.5	29.1	-2.4	51.0	74.0			54.0	3.0	max L,M,H channels; all orientations
6	Harmonic Emissions															
7	802.11N40	4804.0	4804.0	RH3115	H/V	10	1.8	33.1	-3.5	55.7	74.0	31.2	32.1	54.0	18.3	CH Low; all orientations
8	802.11N40	4880.0	4805.0	RH3115	H/V	10	1.8	33.1	-3.6	54.0	74.0	29.5	30.4	54.0	20.0	CH Low; all orientations
9	802.11N40	4960.0	4806.0	RH3115	H/V	10	1.8	33.1	-3.6	52.3	74.0	27.8	28.7	54.0	21.7	CH High; all orientations
10	802.11N40	4000.0	6000.0	RH3115	H/V	all	all	35.0	-3.1	55.7	74.0	31.2	32.1	54.0	18.3	max L,M,H channels; all orientations
11	802.11N40	6000.0	8400.0	HQR2TO18S01	H/V	all	all	37.6	-4.1	56.6	74.0	32.1	33.0	54.0	17.4	max all
12	802.11N40	8400.0	12500.0	HQR2TO18S01	H/V	all	all	40.5	-4.9	56.0	74.0	31.5	32.4	54.0	18.0	max all, noise
13	802.11N40	12500.0	18000.0	HQR2TO18S01	H/V	all	all	45.2	-6.1	44.0	74.0	35.2	36.1	54.0	17.9	max all, noise
14	802.11N40	18000.0	26000.0	RHCOB1840	H/V	all	all	53.0	-7.4	37.9	74.0	39.2	40.1	54.0	13.9	max all, noise
15																
16	Whip Antenna (VTWEA-3)															
17	Fundamental Restricted Band Edge (Low Side)															
18	802.11N40	2390.0	2390.0	RH3115	H/V	310	2.6	28.9	-2.3	48.6	74.0	48.3		54.0	5.4	max L,M,H channels; all orientations
19	Fundamental Restricted Band Edge (High Side)															
20	802.11N40	2483.5	2483.5	RH3115	H/V	310	2.6	29.1	-2.4	52.1	74.0	51.8		54.0	1.9	max L,M,H channels; all orientations
21	Harmonic Emissions															
22	802.11N40	4804.0	4804.0	RH3115	H/V	100	2.0	33.1	-3.5	52.2	74.0	27.7	28.6	54.0	21.8	CH Low; all orientations
23	802.11N40	4882.0	4805.0	RH3115	H/V	100	2.0	33.1	-3.6	51.9	74.0	27.4	28.3	54.0	22.1	CH Low; all orientations
24	802.11N40	4960.0	4806.0	RH3115	H/V	100	2.0	33.1	-3.6	52.2	74.0	27.7	28.6	54.0	21.8	CH High; all orientations
25	802.11N40	4000.0	6000.0	RH3115	H/V	all	all	35.0	-3.1	52.2	74.0	27.7	28.6	54.0	21.8	max L,M,H channels; all orientations
26	802.11N40	6000.0	8400.0	HQR2TO18S01	H/V	all	all	37.6	-4.1	56.8	74.0	32.3	33.2	54.0	17.2	max all
27	802.11N40	8400.0	12500.0	HQR2TO18S01	H/V	all	all	40.5	-4.9	44.7	74.0	20.2	34.4	54.0	19.6	max all, noise
28	802.11N40	12500.0	18000.0	HQR2TO18S01	H/V	all	all	45.2	-6.1	45.1	74.0	20.6	35.9	54.0	18.1	max all, noise
29	802.11N40	18000.0	26000.0	RHCOB1840	H/V	all	all	53.0	-7.4	37.9	74.0	13.4	39.0	54.0	15.0	max all, noise
30																

### 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.

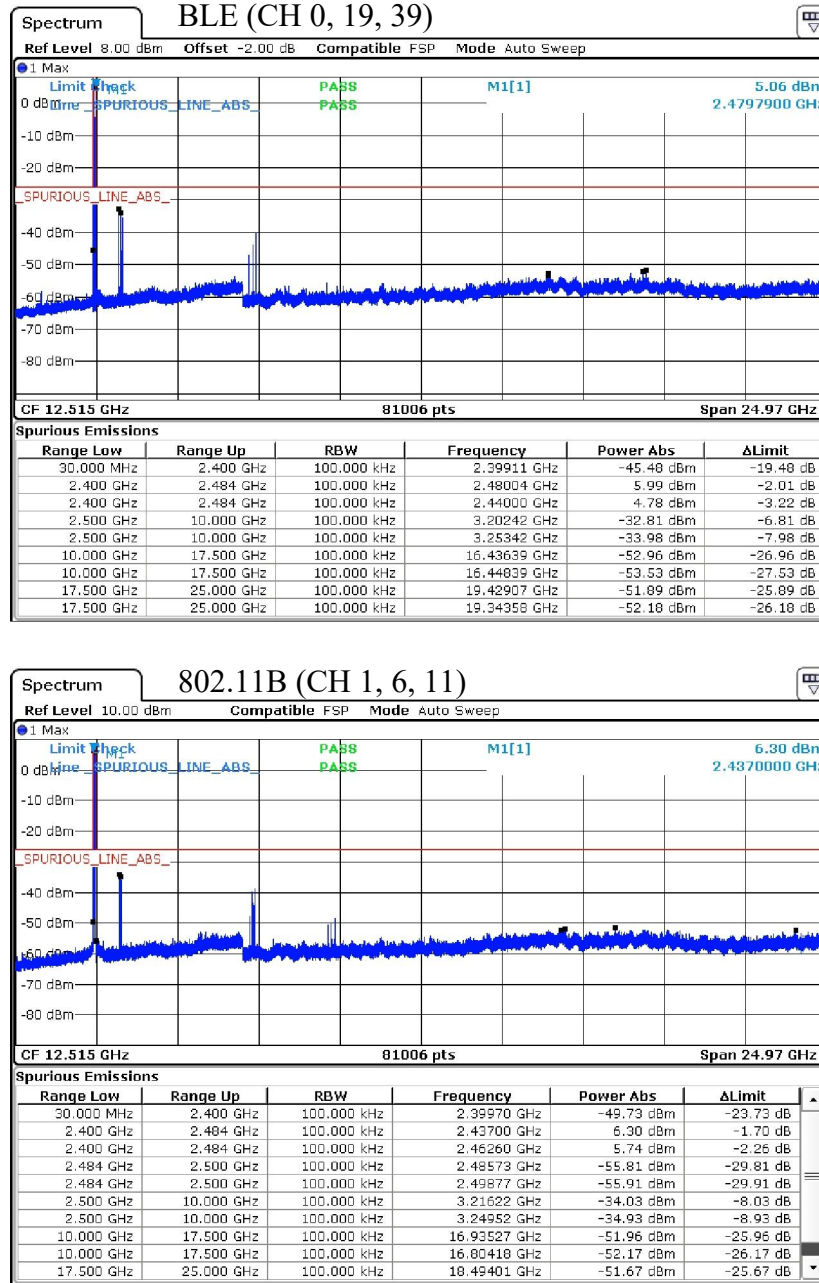


Figure 12(a): Conducted Transmitter Emissions Measured.

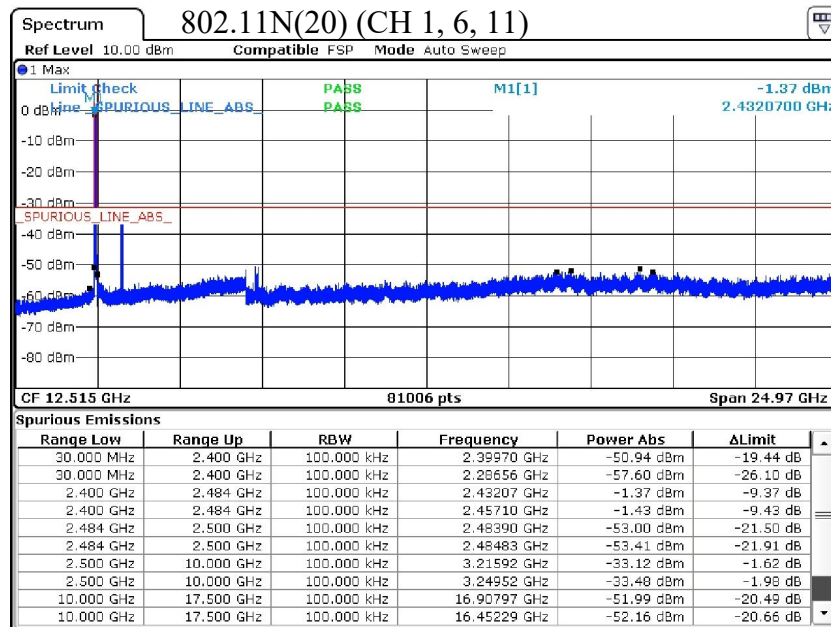
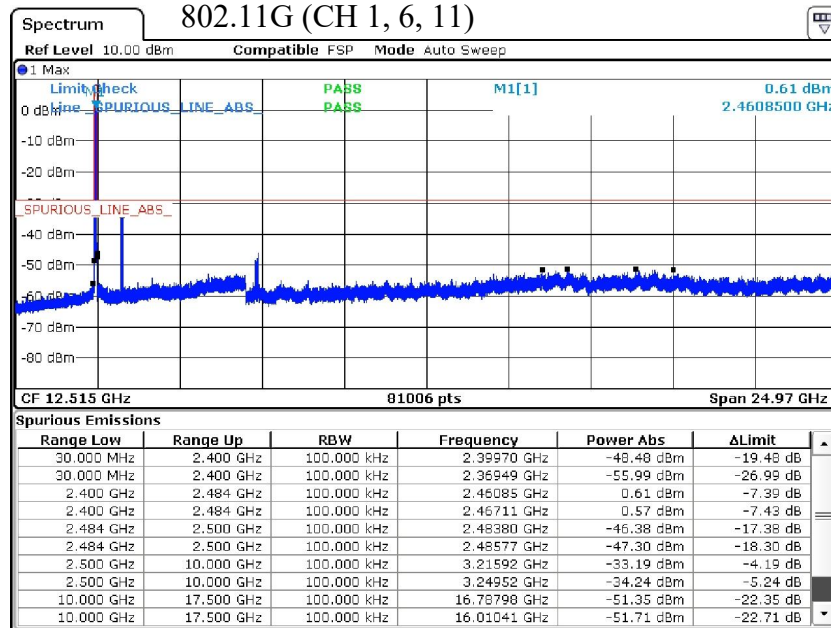


Figure 12(b): Conducted Transmitter Emissions Measured.

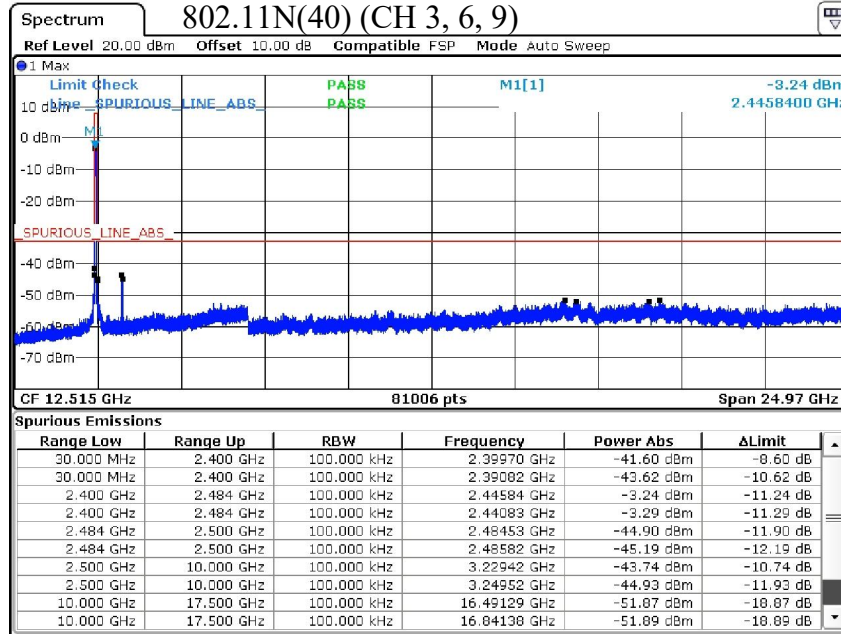


Figure 12(c): Conducted Transmitter Emissions Measured.



### 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.

<b>Frequency Range</b>	<b>Det</b>	<b>IF Bandwidth</b>	<b>Video Bandwidth</b>	<b>Test Date:</b>	29-Jun-18
25 MHz f 1 000 MHz	Pk/QPk	120 kHz	300 kHz	<b>Test Engineer:</b>	J. Brunett
f > 1 000 MHz	Pk	1 MHz	3 MHz	<b>EUT:</b>	GridConnect ESP32
				<b>EUT Mode:</b>	Active
				<b>Meas. Distance:</b>	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) dBµV/m		FCC/IC E3lim (Qpk) dBµV/m	Pass dB	Comments
1	144.1	BICEMCO01	H	0.0	1.0	12.4	-0.7	37.0	36.5		43.5	7.0	AUX PC spurious
2	144.1	BICEMCO01	V	280.0	2.0	12.4	-0.7	41.0	40.2		43.5	3.3	AUX PC spurious
3	192.2	BICEMCO01	H	10.0	1.0	15.0	-0.8	39.0	38.8		43.5	4.7	AUX PC spurious
4	192.2	BICEMCO01	V	200.0	1.3	15.0	-0.8	40.0	39.7		43.5	3.8	AUX PC spurious
5	233.4	LOGEMCO01	H	0.0	1.0	11.9	-0.9	41.0	40.8		46.0	5.2	AUX PC spurious
6	233.4	LOGEMCO01	V	200.0	1.0	11.9	-0.9	39.0	39.0		46.0	7.0	AUX PC spurious
7	240.0	LOGEMCO01	H	20.0	1.2	12.1	-1.0	37.0	36.1		46.0	9.9	AUX PC spurious
8	240.0	LOGEMCO01	V	200.0	1.0	12.1	-1.0	40.0	39.8		46.0	6.2	AUX PC spurious
9	320.0	LOGEMCO01	H	33.0	1.3	14.2	-1.2	35.0	34.1		46.0	11.9	
10	320.0	LOGEMCO01	V	25.0	1.0	14.2	-1.2	22.0	21.2		46.0	24.8	
11	400.0	LOGEMCO01	H	33.0	1.3	15.7	-1.4	38.0	37.4		46.0	8.6	
12	400.0	LOGEMCO01	V	25.0	1.0	15.7	-1.4	19.0	18.6		46.0	27.4	
13													
14	No other spurious emissions observed within 20 dB of the regulatory limit.												
15													

### 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.



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



## 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 <sup>†</sup>
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 MHz)	$\pm 4.0 \text{ dB}$
Radiated Emm. Amplitude (200 – 1000 MHz)	$\pm 5.2 \text{ dB}$
Radiated Emm. Amplitude ( $f > 1000 \text{ MHz}$ )	$\pm 3.7 \text{ dB}$

<sup>†</sup>Ref: CISPR 16-4-2:2011+A1:2014



**FEDERAL COMMUNICATIONS COMMISSION**  
 Laboratory Division  
 7435 Oakland Mills Road  
 Columbia, MD 21046  
 July 06, 2018

National Voluntary Laboratory Accreditation Program  
 100 Bureau Drive  
 Gaithersburg, MD 20899-2140

Attention: Timothy Rasinski

Re: Accreditation of AHD (Amber Helm Development, L.C.)  
 Designation Number: US5348  
 Test Firm Registration #: 639064

Dear Sir or Madam:

We have been notified by National Voluntary Laboratory Accreditation Program that AHD (Amber Helm Development, L.C.) has been accredited as a testing laboratory.

At this time AHD (Amber Helm Development, L.C.) is hereby recognized to perform compliance testing on equipment subject to Declaration of Conformity (DOC) and Certification of the Commission's Rules.

This recognition will expire upon expiration of the accreditation or notification of withdrawal of recognition.

Any questions about this recognition should be submitted as an inquiry to the FCC Knowledge Database at [www.fcc.gov/kdb](http://www.fcc.gov/kdb).

Sincerely,

George Tanshill  
 Electronics Engineer



Figure 13: Accreditation Documents