

9.6 Conducted Spurious Emissions

9.6.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (d)

ISED RSS-247 [5.5]

9.6.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V05 and ANSI C63.10: 2013.

Spectrum Analyzer settings:

Identification of Reference Level:

RBW= 100 kHz

VBW $\geq 3 \times$ RBW

Trace Mode= Peak Detector (Max Hold)

Sweep time= Auto Couple

Span >1.5 times DTS Bandwidth

Peak Marker function to determine the max PSD level.

Conducted Spurious Emissions:

RBW= 1 MHz

VBW $\geq 3 \times$ RBW = 3 MHz

Trace Mode = Peak Detector (Max Hold)

Sweep time = Auto Couple

Span= 30 MHz- 12 GHz; 12 GHz – 25 GHz

Sweep Points = 30000

9.6.3 Limits:

All spurious emissions at least 20 dBc.

9.6.4 Sample Calculations:

Emissions Amplitude (dBm/MHz): Amplitude (Analyzer level) + Correction Factor (Cable loss) = -12.26dBm + 8dB = -4.26dBm/MHz.

9.6.5 Test Result:

Channel	Carrier Frequency (MHz)	Emission Frequency (MHz)	Emissions Amplitude (dBm/MHz)	Limit (dBm)	Margin (dB)	Result
0	2402	4803.20	-47.37	-24.26	-23.11	Pass
0	2402	7205.60	-49.90	-24.26	-25.64	Pass
0	2402	14410.80	-54.35	-24.26	-30.09	Pass
19	2440	4879.600	-47.79	-24.16	-23.63	Pass

19	2440	7321.300	-50.98	-24.16	-26.82	Pass
19	2440	14641.700	-53.90	-24.16	-29.74	Pass
39	2480	4960.600	-46.73	-24.37	-22.36	Pass
39	2480	7441.000	-52.06	-24.37	-27.69	Pass
39	2480	14878.300	-52.90	-24.37	-28.53	Pass

9.6.6 Test Data:

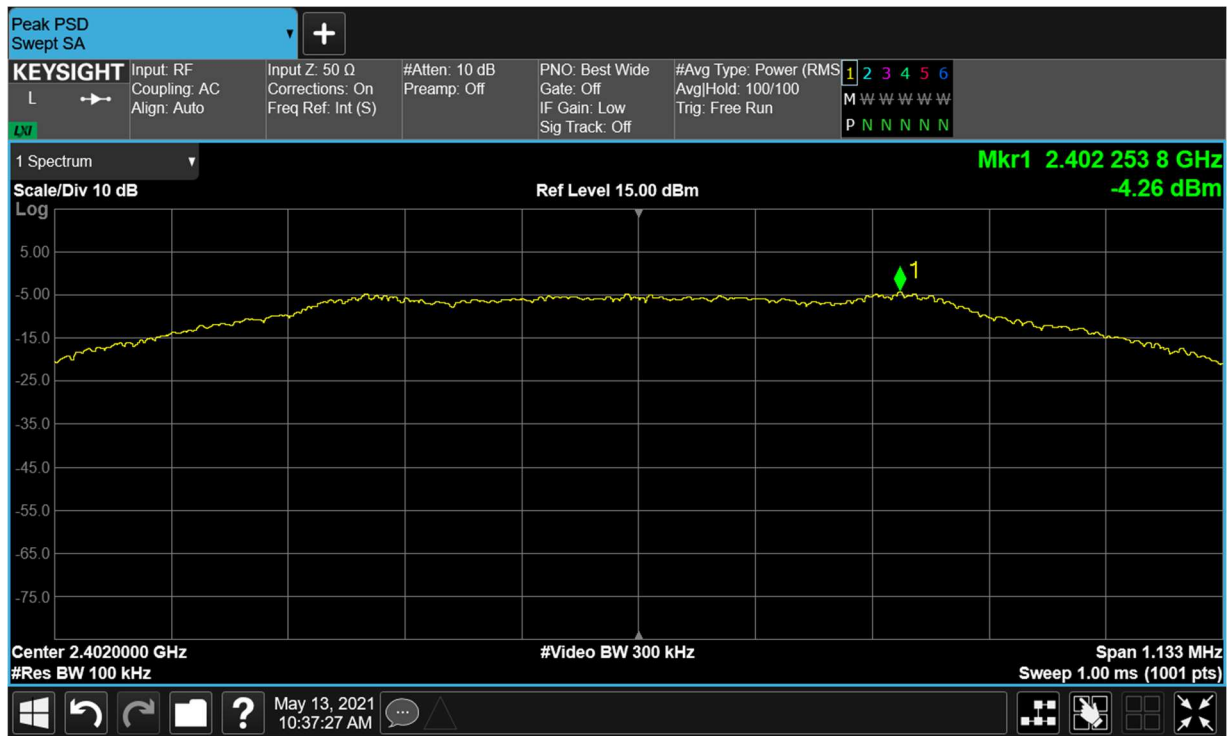


Figure 9-14 Reference Level Measurement (Ch.0)



Figure 9-15 Conducted Spurious Emissions 30-12000 MHz (Ch. 0)

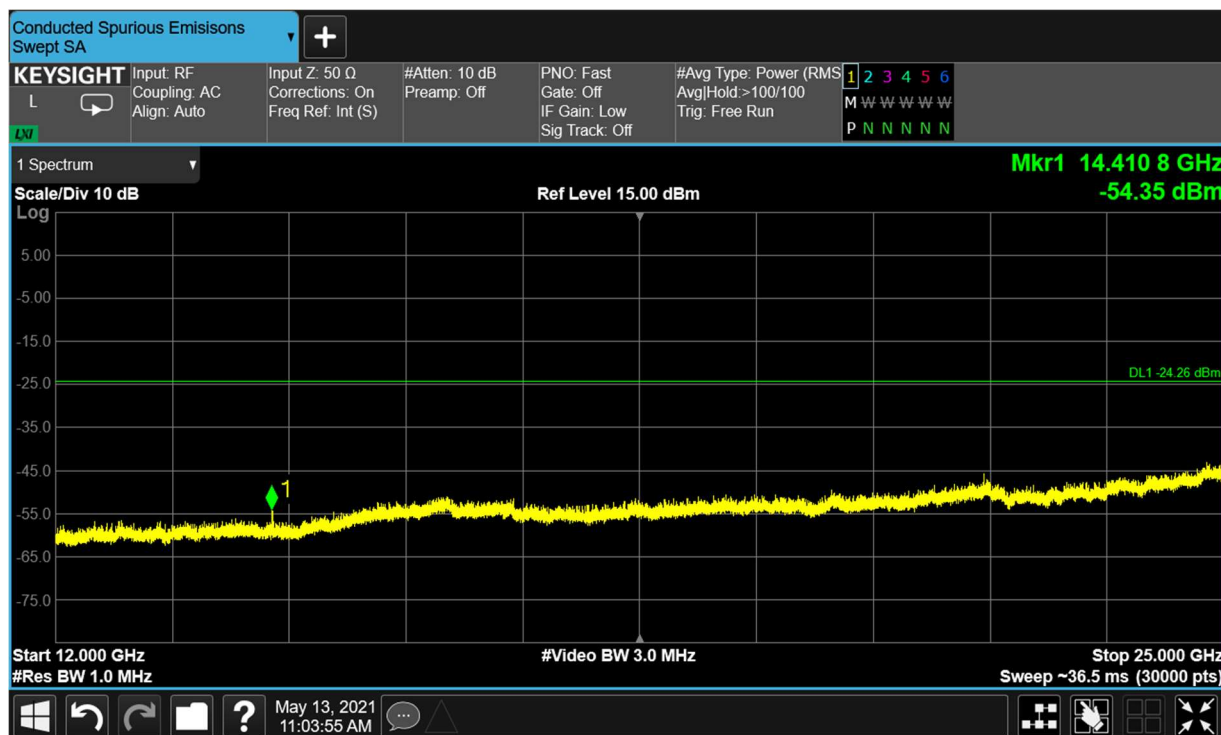


Figure 9-16 Conducted Spurious Emissions 12-25 GHz (Ch.0)



Figure 9-17 Reference Level Measurement (Ch.19)



Figure 9-18 Conducted Spurious Emissions 30-12000 MHz (Ch. 19)

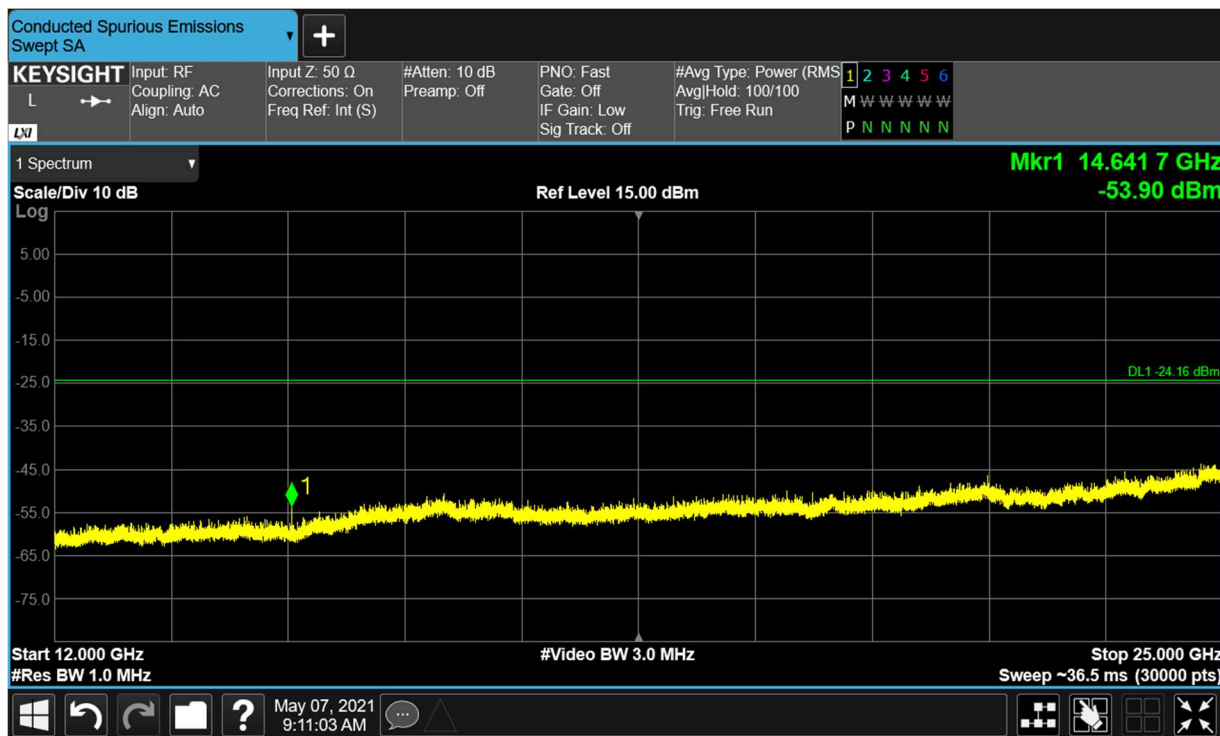


Figure 9-19 Conducted Spurious Emissions 12-25 GHz (Ch. 19)

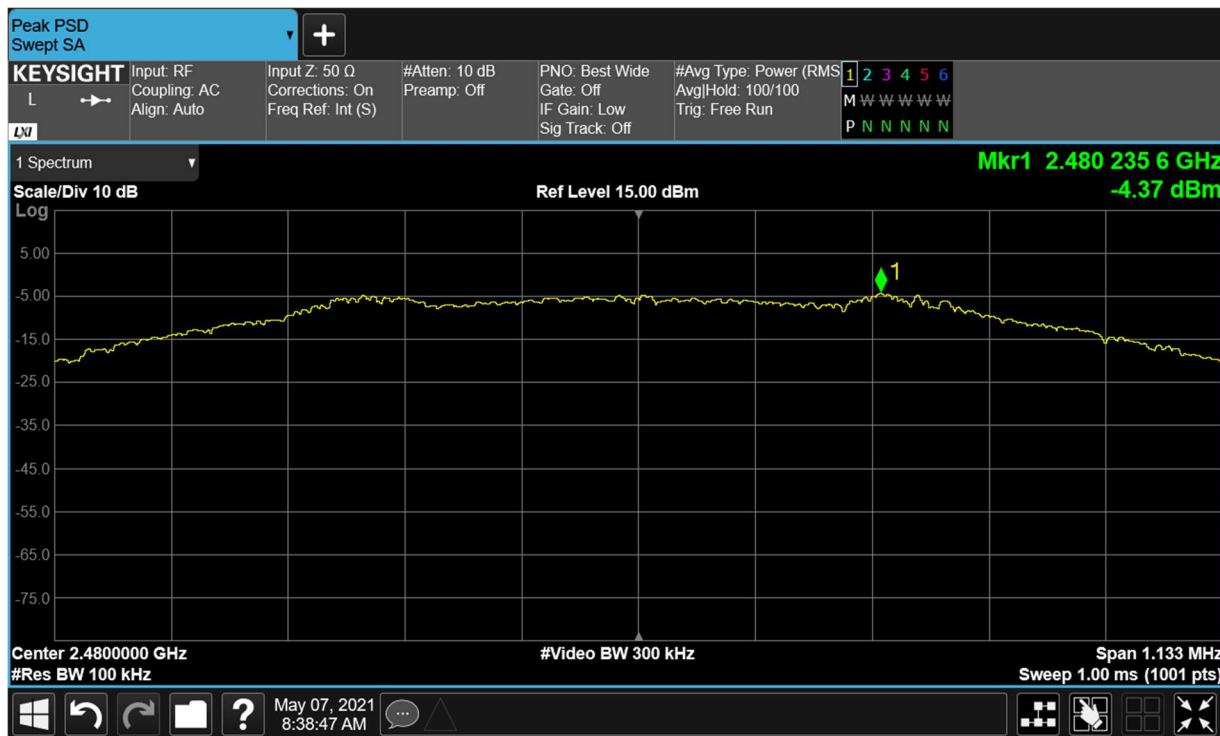


Figure 9-20 Reference Level Measurement (Ch.39)



Figure 9-21 Conducted Spurious Emissions 30-12000 MHz (Ch.39)

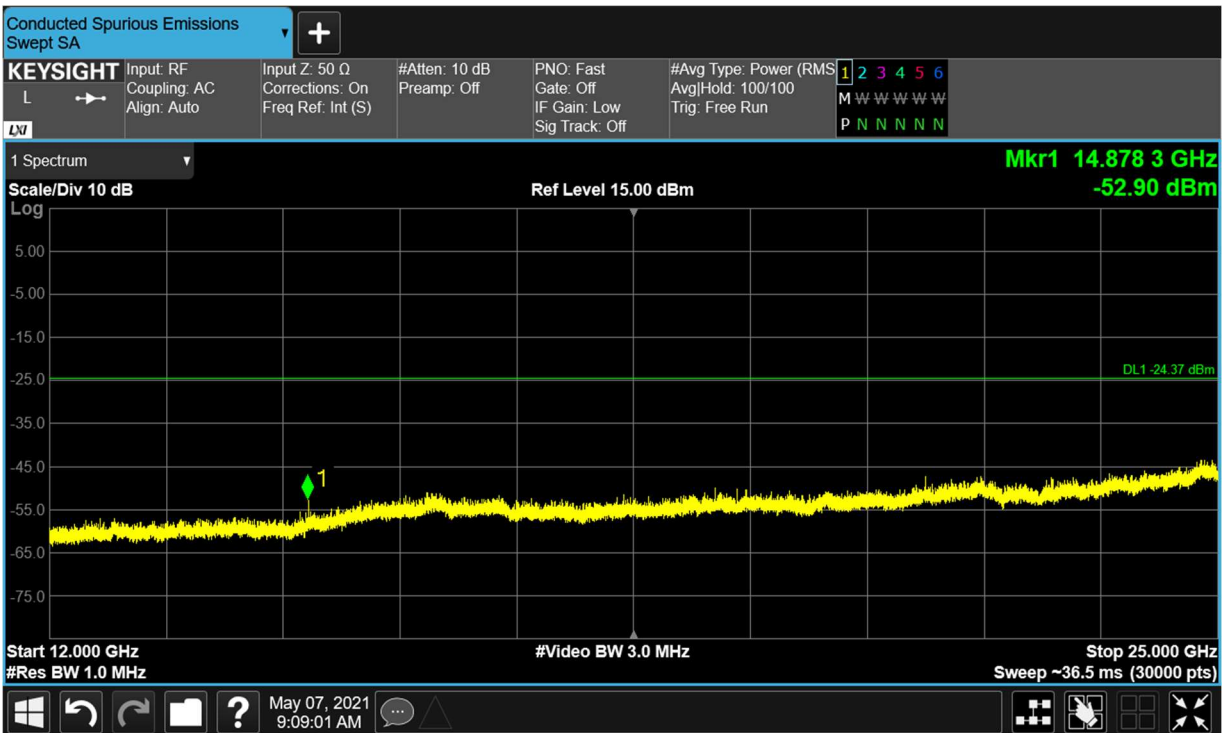


Figure 9-22 Conducted Spurious Emissions 12-25GHz (Ch.39)

9.7 Conducted Band Edge Emissions

9.7.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (d)

ISED RSS-247 [5.5]

9.7.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V05 and ANSI C63.10: 2013.

Spectrum analyzer settings:

Span = wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation

RBW = 100 kHz

VBW = 300 kHz

Sweep = Auto Couple

Detector function = Peak

Trace = Max Hold

The trace was allowed to stabilize. The marker was set on the emission at the band edge, or on the highest modulation product outside of the band if this level is greater than that at the band edge. The delta marker function was set, and the marker-to-peak function moved to the peak of the in-band emission.

9.7.3 Limits:

All spurious emissions at least 20dBc.

9.7.4 Sample Calculations:

Emissions Amplitude (dBm/MHz): Amplitude (Analyzer level) + Correction Factor (Cable loss) = -12.26dBm + 8dB = -4.26dBm.

9.7.5 Test Result:

Pass.

9.7.6 Test Data:

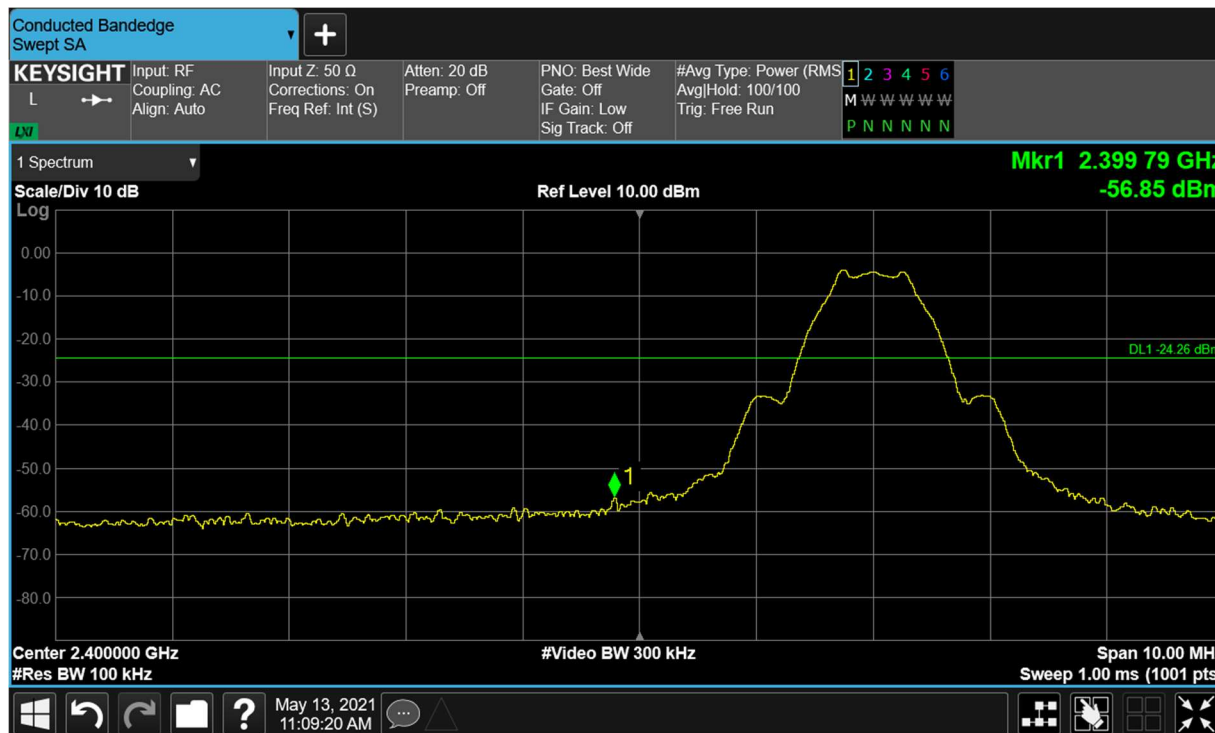


Figure 9-23 Conducted-Low Band Edge (Ch. 0)

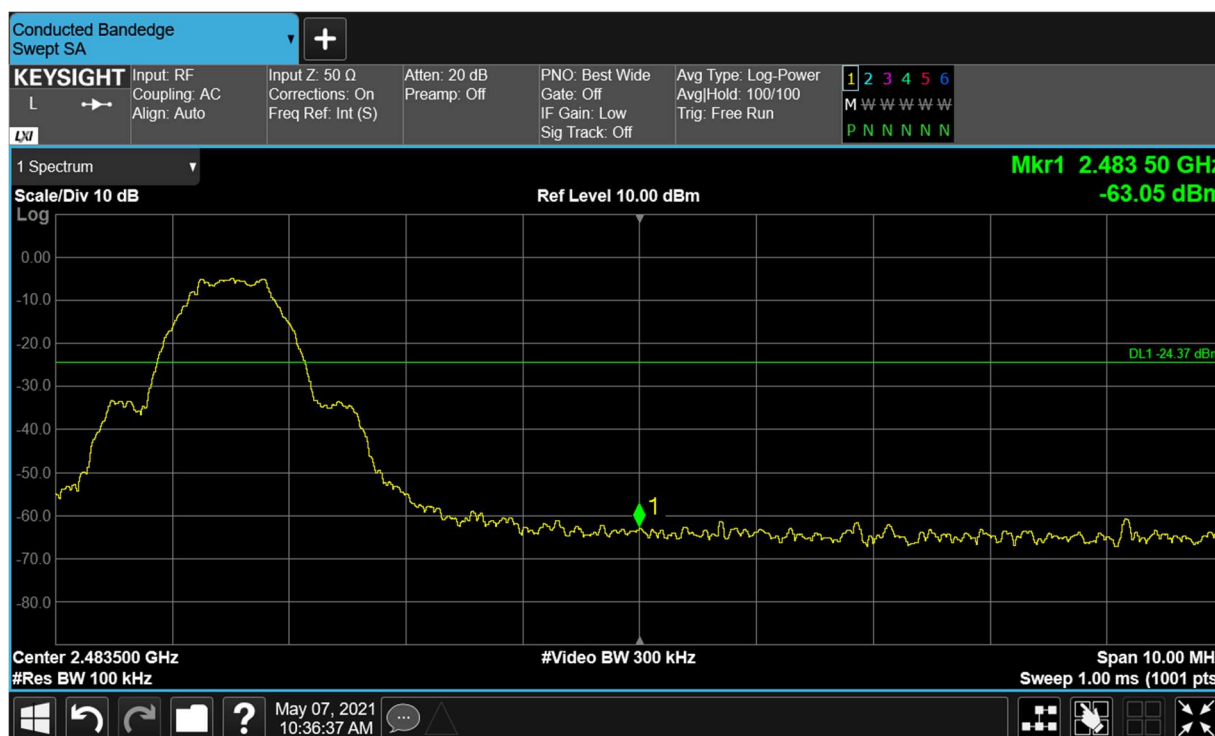


Figure 9-24 Conducted- High Band Edge (Ch. 39)

9.8 Radiated Spurious and Band Edge Emissions

9.8.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (d)

ISED RSS-247 [5.5] and RSS GEN [8.9]

9.8.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V05 and ANSI C63.10: 2013.

Radiated spurious measurements are made from 9kHz to the 10th harmonic of the fundamental frequency of the transmitter. The limit for radiated spurious emissions is per 15.209 and RSS-247 [5.5]. Additionally, emissions found in the restricted bands listed in 15.205 and RSS-Gen were tested for compliance per limits in 15.209 and RSS-Gen.

The EUT was tested near the low, middle and high channels of operation. Guidelines in ANSI C63.10:2013 were followed with respect to maximizing the emissions.

A pre-amp and a high pass filter were required for this test, to provide the measuring system with sufficient sensitivity. The peak reading of the emission, after being corrected by the antenna factor, cable loss, pre-amp gain, etc., is the peak field strength.

Both horizontal and vertical antenna polarizations were investigated. Worst-case maximized data for both polarizations is shown in this test report.

Radiated Spurious Emissions**Spectrum Analyzer Settings:****9 kHz- 30 MHz:**

RBW= 1 kHz | 10kHz

VBW \geq 3 X RBW

Trace Mode: Peak Detector (Max Hold). Final measurements performed using QP Detector and RBW's as defined in ANSI C63.2.

Span= 9 kHz – 150 kHz and 150 kHz- 30 MHz

Sweep time= Auto

30 MHz- 1 GHz:

RBW = 120 kHz

VBW \geq 3 X RBW

Trace Mode: Peak Detector (Max Hold). Final measurements performed using QP Detector.

Span= 30 MHz - 1 GHz

Sweep time= Auto

Sweep points \geq 2 x Span/RBW**Above 1 GHz:**

RBW= 1 MHz

VBW= 3 MHz

Trace Mode: Peak Detector (Max Hold) and RMS Average Detector (Max Hold)

Span= 1 - 18 GHz and 18 - 26.5 GHz.

Sweep time= Auto

Sweep points \geq 2 x Span/RBW**Final Measurements above 1 GHz****Peak Measurements****Spectrum Analyzer Settings:**

RBW= 1 MHz

VBW= 3 MHz

Trace Mode: Peak Detector (Max Hold)

Span= wide enough to encompass the emission

Sweep Points \geq 2 × Span/RBW

Sweep Time = Auto

RMS Average Measurements**Spectrum Analyzer Settings:**

RBW = 1 MHz

VBW \geq 3 × RBW

Detector = RMS

Span = wide enough to encompass the emission

Sweep points \geq 2 × Span/RBW

Sweep time = auto

Trace = Average at least 100 traces

Trace Averaging Type= power (RMS)

The duty cycle correction factor is added to the emission level.

Restricted Band-Edge Emissions**Peak Measurements****Spectrum Analyzer Settings:**

RBW = 1 MHz

VBW = 3 MHz

Trace Mode: Peak Detector (Max Hold)

Span = 2310 – 2500 MHz

Sweep Points = 401

Sweep Time = Auto

Average Measurements**Spectrum Analyzer Settings:**

RBW= 1 MHz

VBW= 3 MHz

VBW Mode = Linear

Trace Mode: RMS Detector (Average)

Span= 2310 – 2500 MHz

Sweep Points = 401

Sweep Time = Auto

Sweep Count = 200

Sample Calculation:

Field Strength Level: Amplitude (Analyzer level) + AFCL (Antenna Factor and Cable losses) –
Amplifier Gain = 50dBuV + 33 dB/m – 25 dB = 58dB μ V/m

9.8.3 Limits:

Frequency (MHz)	Field Strength ($\mu\text{V/m}$)	Measurement Distance (meters)	Corrected Field Strength for 3m measurement distance ($\text{dB}\mu\text{V/m}$)
0.009-0.490	2400/F (kHz)	300	48.5 - 13.8
0.490-1.705	24000/F (kHz)	30	33.8- 23.0
1.705-30	30	30	29.5
30-88	100	3	40
88-216	150	3	43.5
216-960	200	3	46
960-1000	500	3	54
Above 1000 (Restricted Frequency Bands)	500	3	54 (Average) 74 (Peak)

9.8.4 Test Result:

Pass.

9.8.5 Test Data:

9.8.5.1 Radiated Restricted Band-edge emissions

Radiated Band Edge Average Data							
Carrier Frequency (MHz)	Frequency (MHz)	Raw Avg. Amplitude (dB μ V)	Correction Factor (dB)	DC Correction Factor (dB)	Corrected Avg. Field Strength (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)
2402	2390	30.33	13.10	0	43.43	54	-10.57
2480	2483.5	30.47	13.80	0	44.27	54	-9.73

Radiated Band Edge Peak Data						
Carrier Frequency (MHz)	Frequency (MHz)	Raw Peak Amplitude (dB μ V)	Correction Factor (dB)	Corrected Peak Field Strength (dB μ V/m)	Peak Limit (dB μ V/m)	Margin (dB)
2402	2386.76	56.24	-	56.24	74	-17.76
2480	2484.04	56.19	-	56.19	74	-17.81

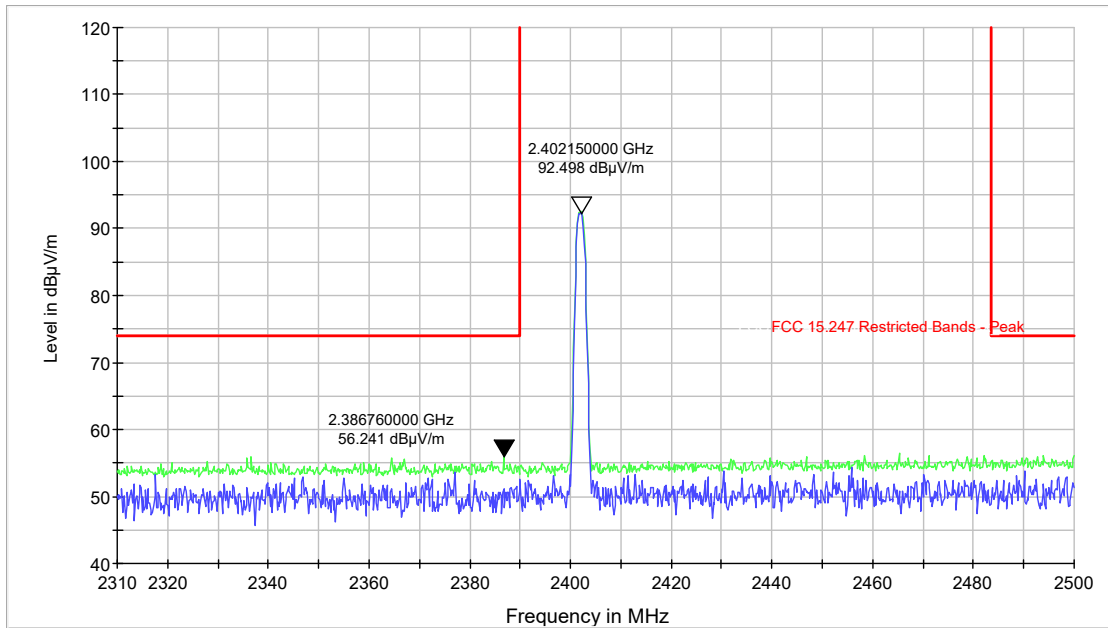
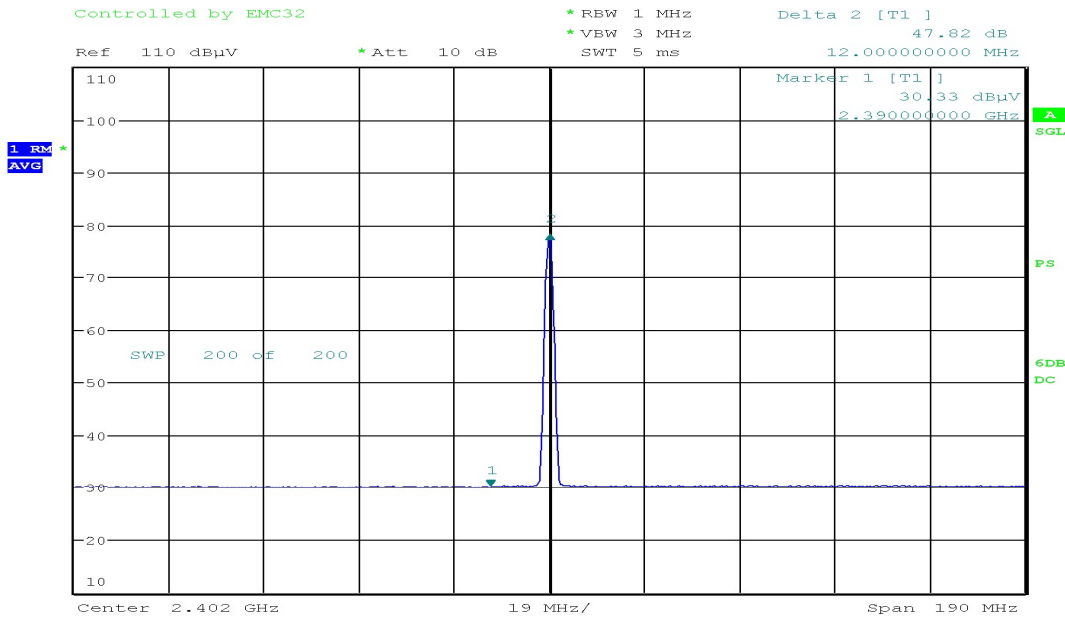
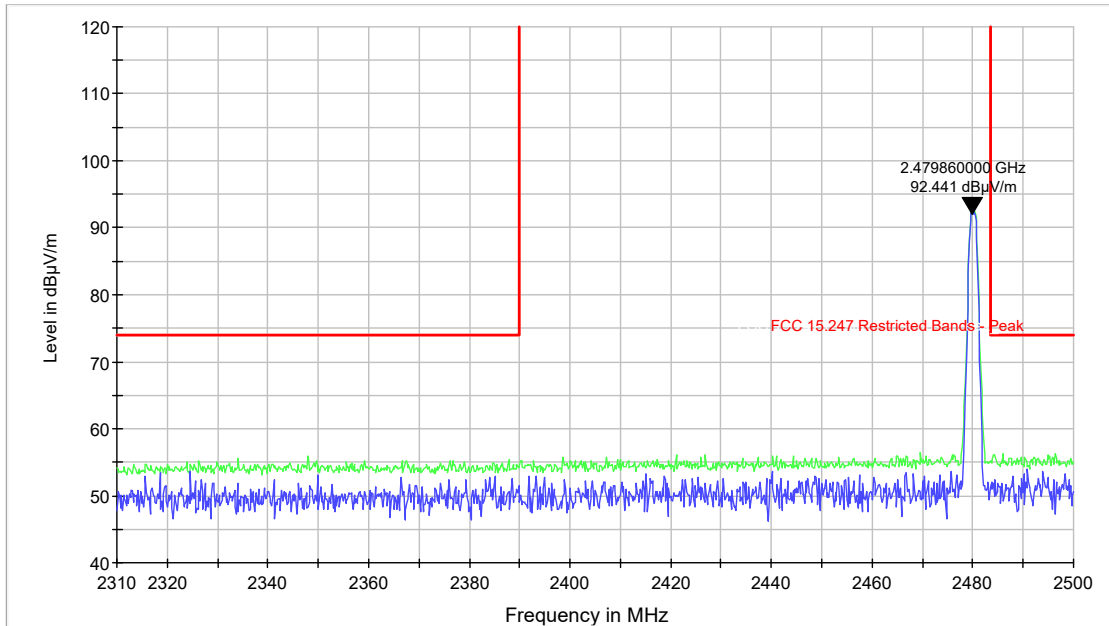


Figure 9-25 Radiated Restricted Band Edge (Ch. 0) Peak



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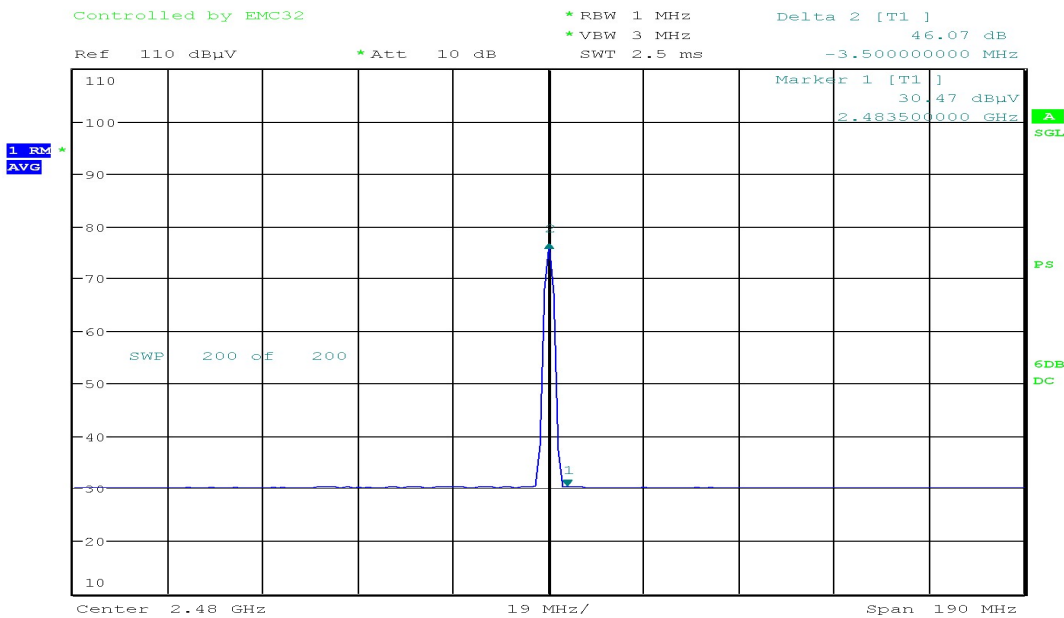
Figure 9-26 Radiated Restricted Band Edge (Ch. 0) Average



PK+_MAXH
FCC 15.247 Restricted Bands - Peak_inv

PK+_CLRWR
FCC 15.247 Restricted Bands - Peak

Figure 9-27 Radiated Restricted Band Edge (Ch. 39) Peak



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Figure 9-28 Radiated Restricted Band Edge (Ch. 39) Average

9.8.5.2 Emissions in 9 kHz- 30 MHz range

All channels and polarization were tested and worst case results from Channel 19 with ground parallel orientation is shown here.

RSE 9kHz-3000 MHz						
Carrier Frequency (MHz)	Emission Frequency (MHz)	Raw Quasi-Peak Amplitude (dBµV/m)	Correction Factor (dB)	Corrected Quasi-Peak Field Strength (dBµV/m)	Quasi-Peak Limit (dBµV/m)	Quasi-Peak Margin (dB)
2440	7.92	-1.65	-4.8	-6.45	29.54	-35.99
2440	8.71	-5.46	-4.9	-10.36	29.54	-39.90
2440	23.13	-2.84	-5.4	-8.24	29.54	-37.78
2440	29.23	-3.31	-6.1	-9.41	29.54	-38.95

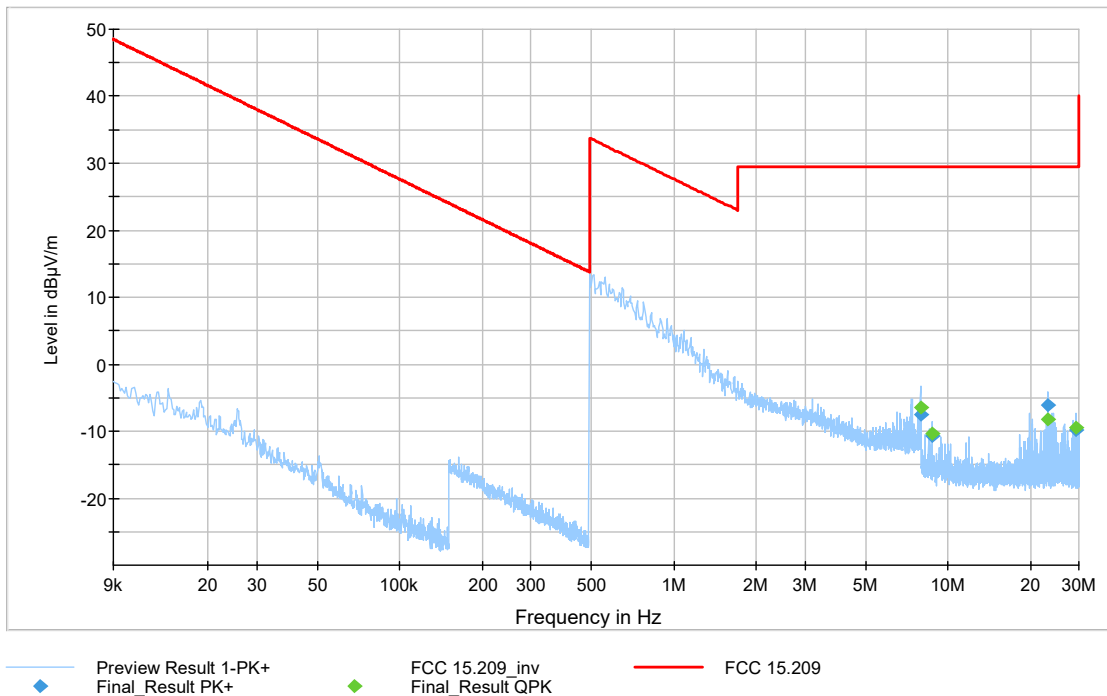


Figure 9-29 Radiated Spurious Emissions (Ch. 39) 2440 (9kHz – 30MHz)

9.8.5.3 Emissions in 30 MHz- 1 GHz range

All channels were tested and worst case results from channel 19 shown here.

RSE 30-1000 MHz						
Carrier Frequency (MHz)	Emission Frequency (MHz)	Raw Quasi-Peak Amplitude (dBµV/m)	Correction Factor (dB)	Corrected Quasi-Peak Field Strength (dBµV/m)	Quasi-Peak Limit (dBµV/m)	Quasi-Peak Margin (dB)
2440	958.82	-0.96	31.9	30.94	46	-15.06

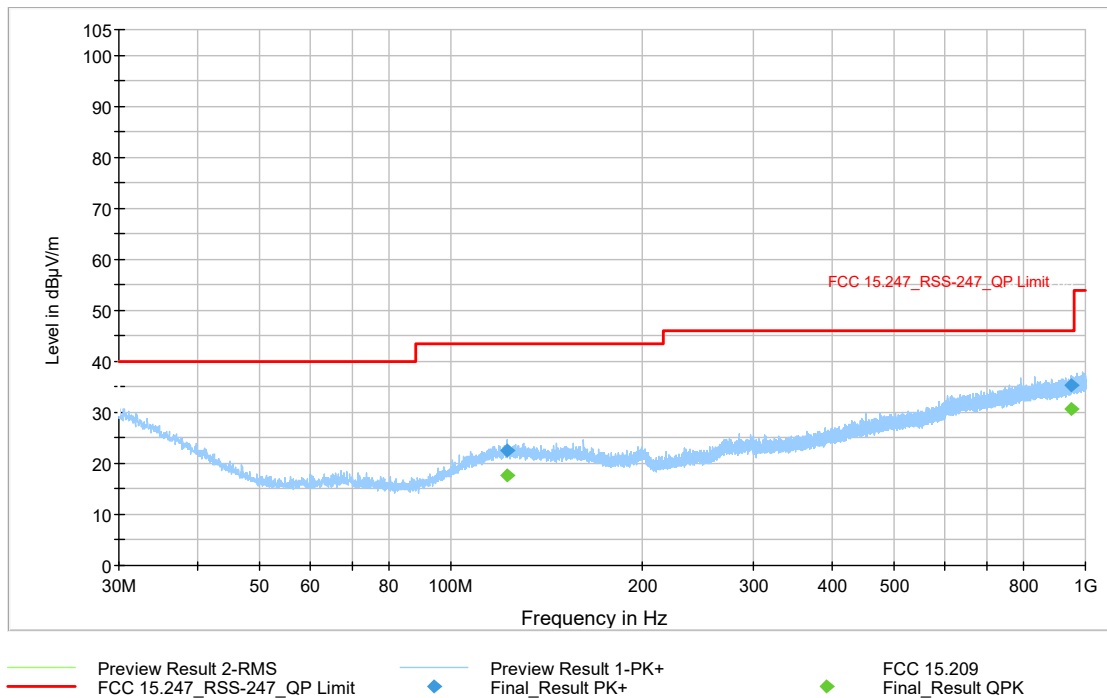


Figure 9-30 Radiated Spurious Emissions (30MHz - 1GHz) - Ambient

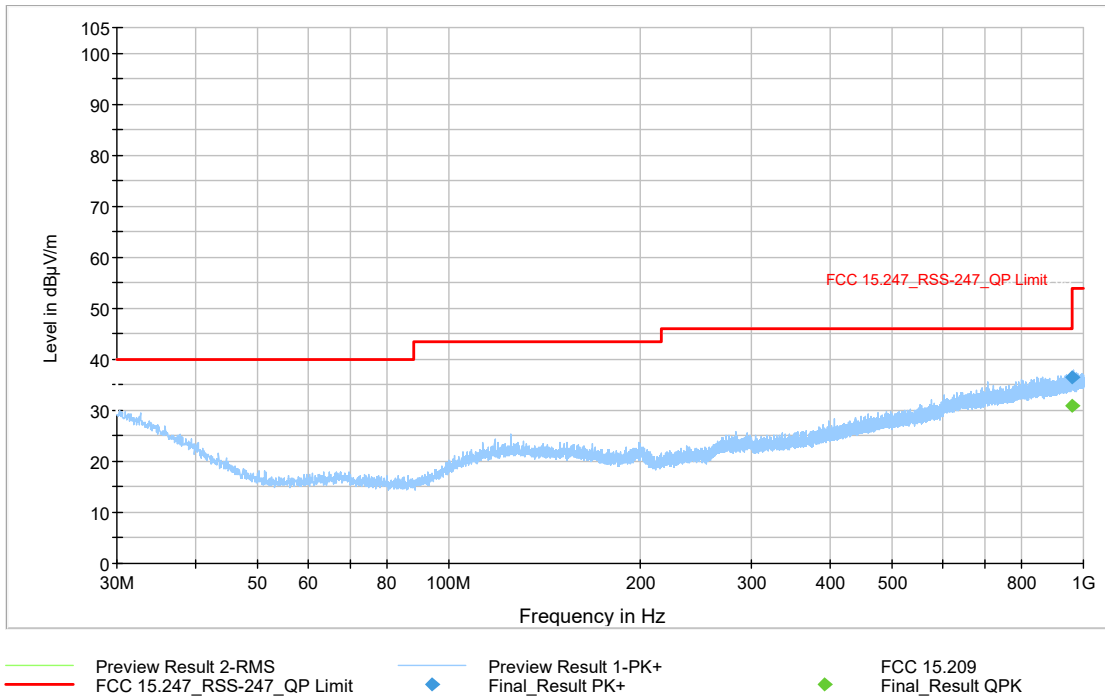


Figure 9-31 Radiated Spurious Emissions (Ch. 19) 2440 (30MHz - 1GHz)

9.8.5.4 Emissions in 1-18 GHz range

RSE 1 - 18GHz Average Data							
Carrier Frequency (MHz)	Frequency (MHz)	Raw Avg. Amplitude (dB μ V)	Correction Factor (dB)	DC Correction Factor (dB)	Corrected Avg. Field Strength (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)
2402	7206.6	36.94	12.4	0	49.34	54	-4.66
2402	17863.5	19.91	24	0	43.91	54	-10.09
2440	7319.4	34.21	11.9	0	46.11	54	-7.89
2440	17915.5	19.75	24.6	0	44.35	54	-9.65
2480	7439.3	27.87	12.3	0	40.17	54	-13.83
2480	17924.9	19.82	24.6	0	44.42	54	-9.58

RSE 1 - 18GHz Peak Data						
Carrier Frequency (MHz)	Frequency (MHz)	Raw Peak Amplitude (dB μ V)	Correction Factor (dB)	Corrected Peak Field Strength (dB μ V/m)	Peak Limit (dB μ V/m)	Margin (dB)
2402	7206.7	57.96	-	57.96	74	-16.04
2402	17850.0	56.02	-	56.02	74	-17.98
2440	7319.4	53.98	-	53.98	74	-20.02
2440	17908.3	56.27	-	56.27	74	-17.73
2480	7439.2	49.20	-	49.20	74	-24.80
2480	17875.3	55.63	-	55.63	74	-18.37

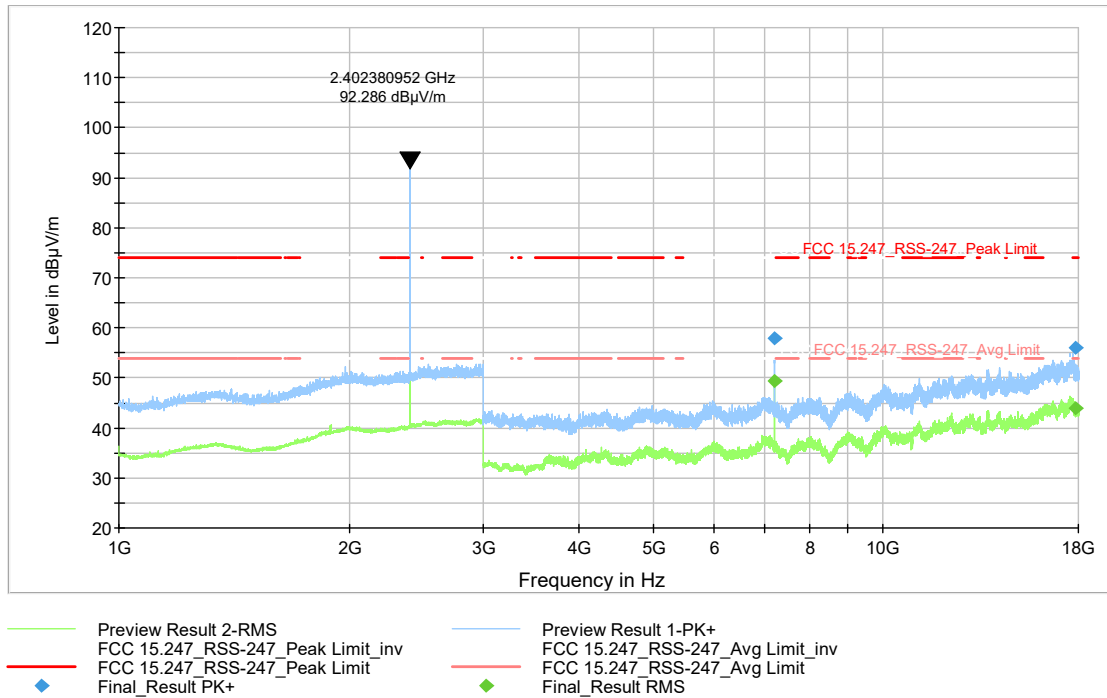


Figure 9-32 Radiated Spurious Emissions 1-18 GHz (Ch. 0)

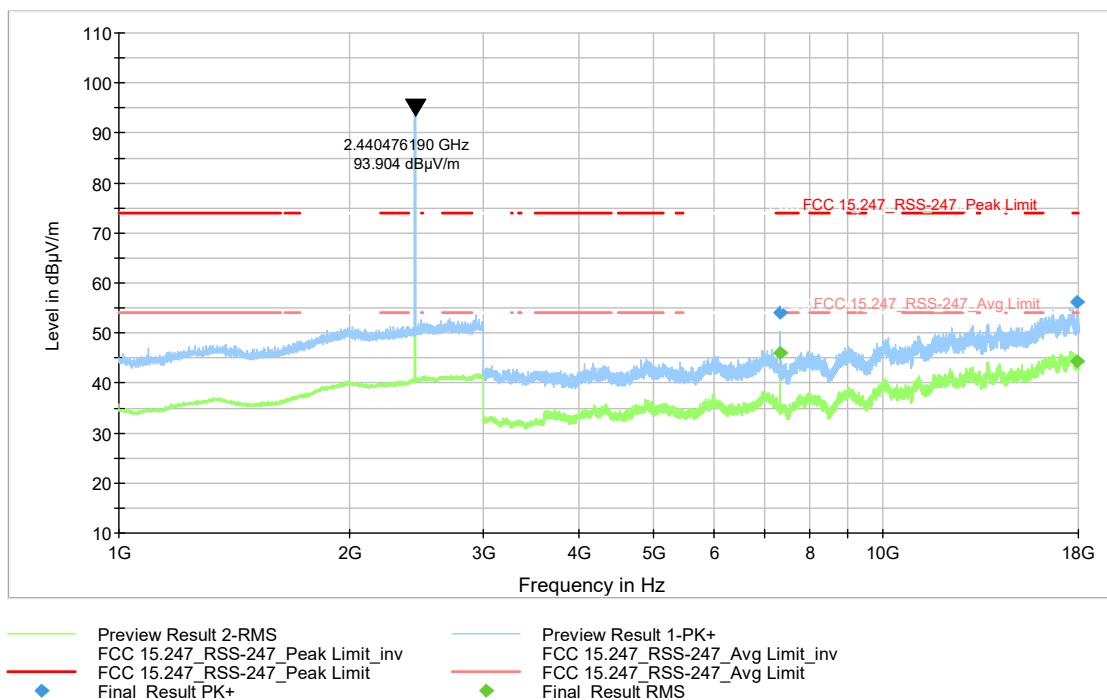
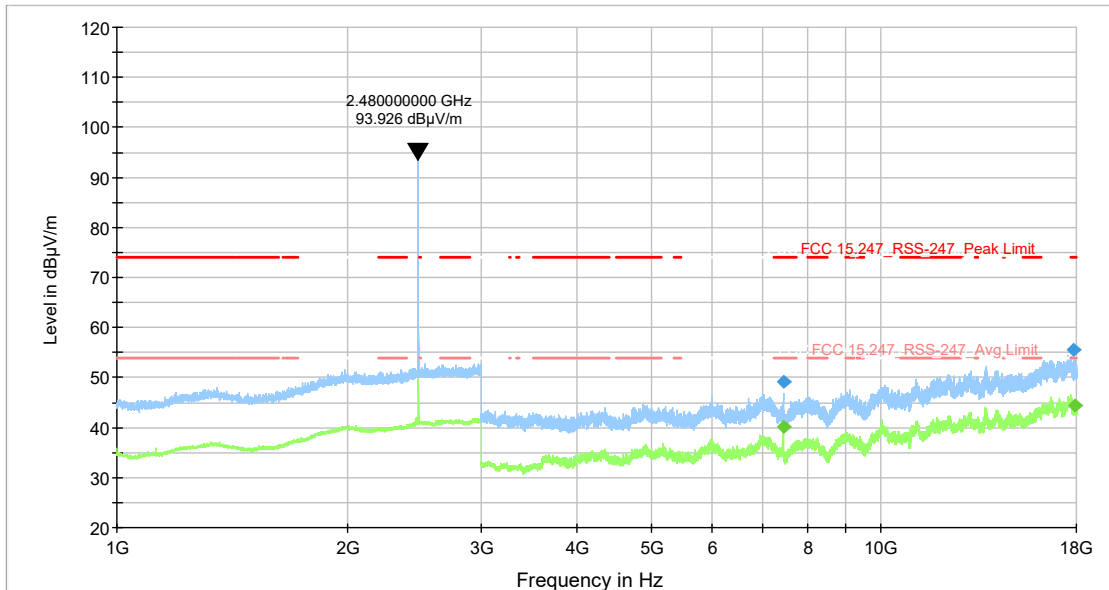


Figure 9-33 Radiated Spurious Emissions 1-18 GHz (Ch. 19)



- Preview Result 2-RMS
- FCC 15.247_RSS-247_Peak Limit_inv
- Preview Result 1-PK+
- FCC 15.247_RSS-247_Avg Limit_inv
- ◆ Final_Result PK+
- ◆ Final_Result RMS

Figure 9-34 Radiated Spurious Emissions 1-18 GHz (Ch. 39)

9.8.5.5 Emissions in 18-26.5 GHz range

All channels were tested and worst-case results from channel 0 (2402 MHz) shown here. No significant emissions to report above noise floor.

RSE 18-26.5 GHz Average Data							
Carrier Frequency (MHz)	Frequency (MHz)	Raw Avg. Amplitude (dBμV)	Correction Factor (dB)	DC Correction Factor (dB)	Corrected Avg. Field Strength (dBμV/m)	Average Limit (dBμV/m)	Margin (dB)
2402	23850.98	33.68	13.8	0	47.48	54	-6.52

RSE 18-26.5 GHz Peak Data						
Carrier Frequency (MHz)	Frequency (MHz)	Raw Peak Amplitude (dBμV)	Correction Factor (dB)	Corrected Peak Field Strength (dBμV/m)	Peak Limit (dBμV/m)	Margin (dB)
2402	23849.28	56.94	-	57.96	74	-17.06

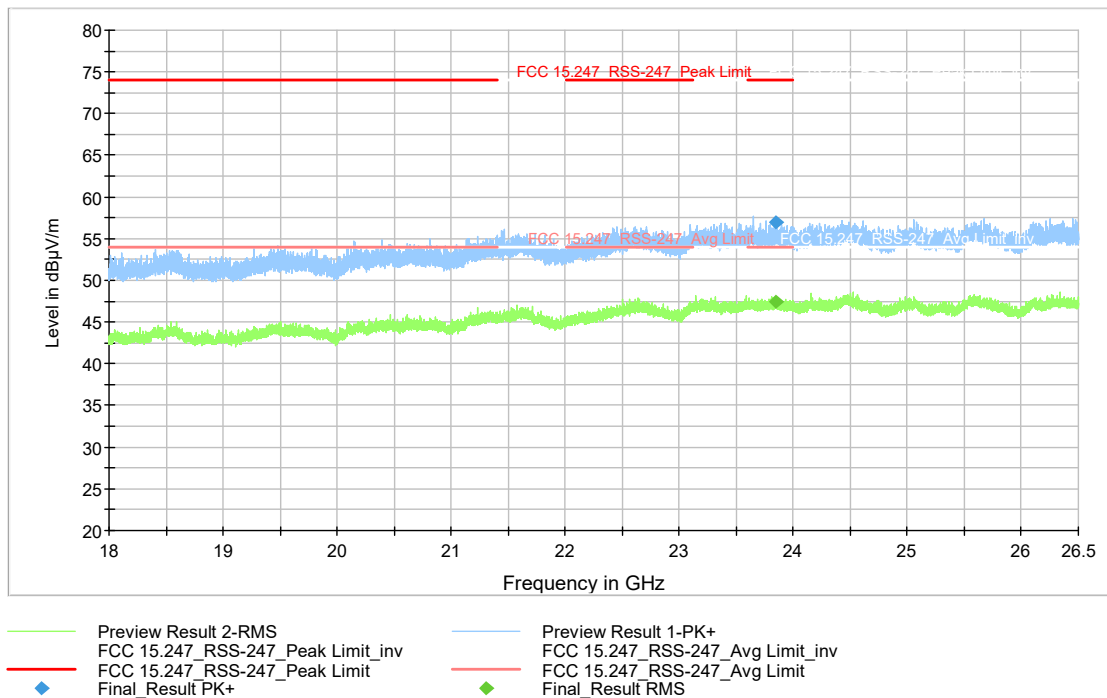


Figure 9-35 Radiated Spurious Emissions (Ch. 0) (18 – 26.5 GHz)

9.9 AC Line Conducted Emissions

9.9.1 Test Requirements

FCC CFR 47 Rule Part 15.207 (a)

ISED RSS Gen [8.8]

9.9.2 Test Method

Conducted power line measurements are made, unless otherwise specified, over the frequency range from 150 kHz to 30 MHz to determine the unsymmetric radio-noise voltage that is conducted from the EUT power-input terminals that are directly (or indirectly via separate transformer or power supplies) connected to a public power network. Equipment is tested with the power cords that are used under normal operating conditions. These measurements are made using a LISN (Line Impedance Stabilization Network). AC powered peripherals are attached to a second LISN with the 50 ohm measuring port terminated by a 50 ohm resistive load.

The EUT is set to continuously transmit on Ch.39 at 4dBm power setting.

EMI Receiver Settings:

150 kHz – 30 MHz:

RBW= 9 kHz

VBW \geq 3 X RBW

Trace Mode: Peak Detector (Max Hold).

Final measurements were performed using Quasi-Peak and Average Detectors.

Span= 150 kHz – 30 MHz

Sweep time= Auto

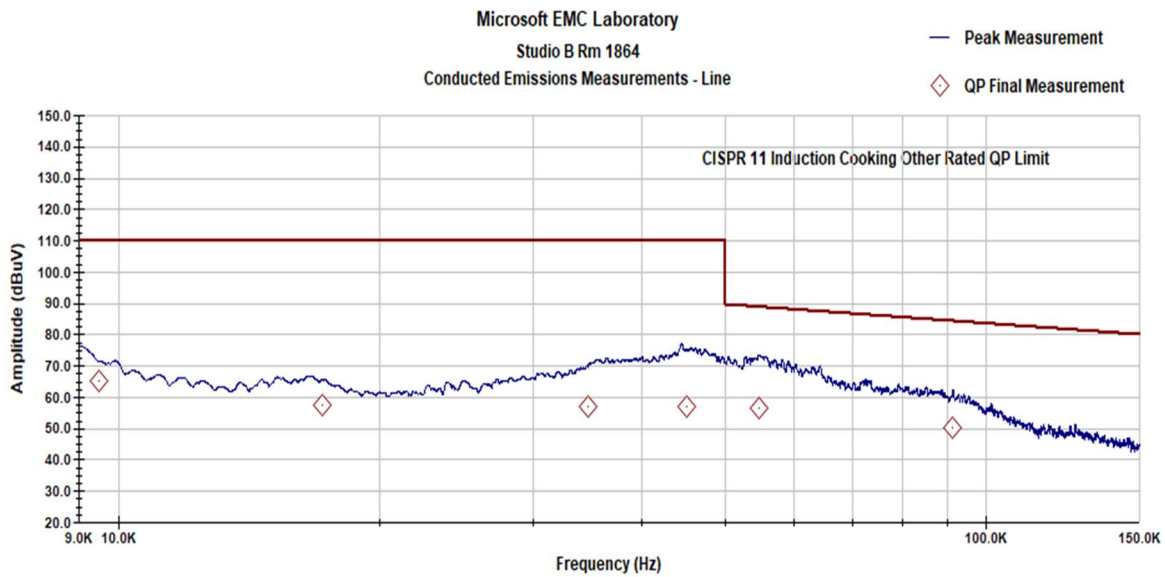
9.9.3 Limit

Frequency of emission (MHz)	Conducted limit (dB μ V)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

9.9.4 Test Result:

Pass

9.9.5 Test Data:

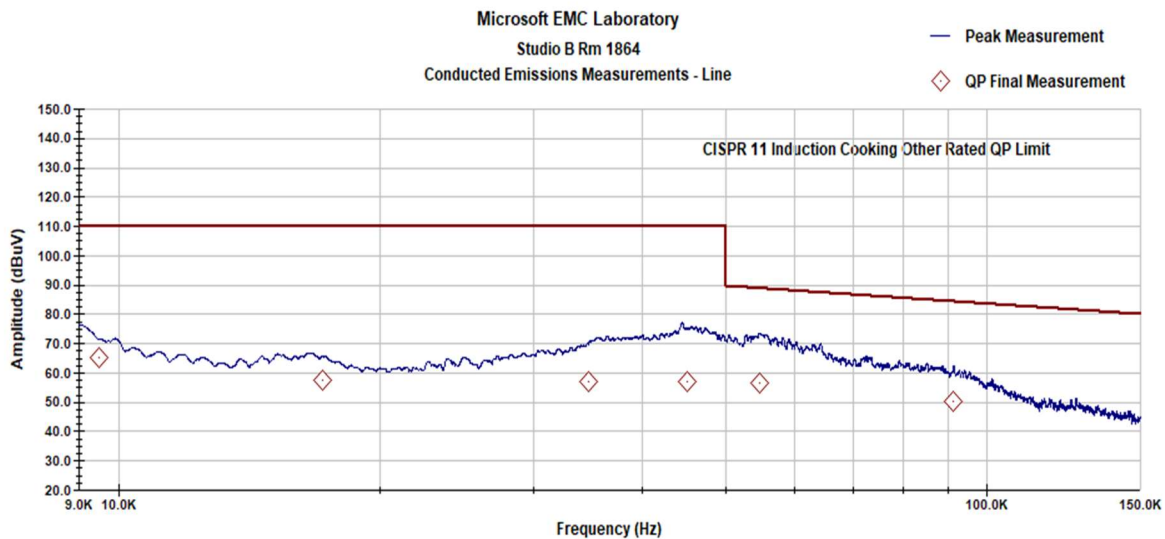


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Last Data Update 09:53:13 AM, Thursday, May 13, 2021

CE Profile V3.0

Figure 9-36 AC Line Conducted Emissions- Line (9kHz - 150 kHz) – Charger Rear

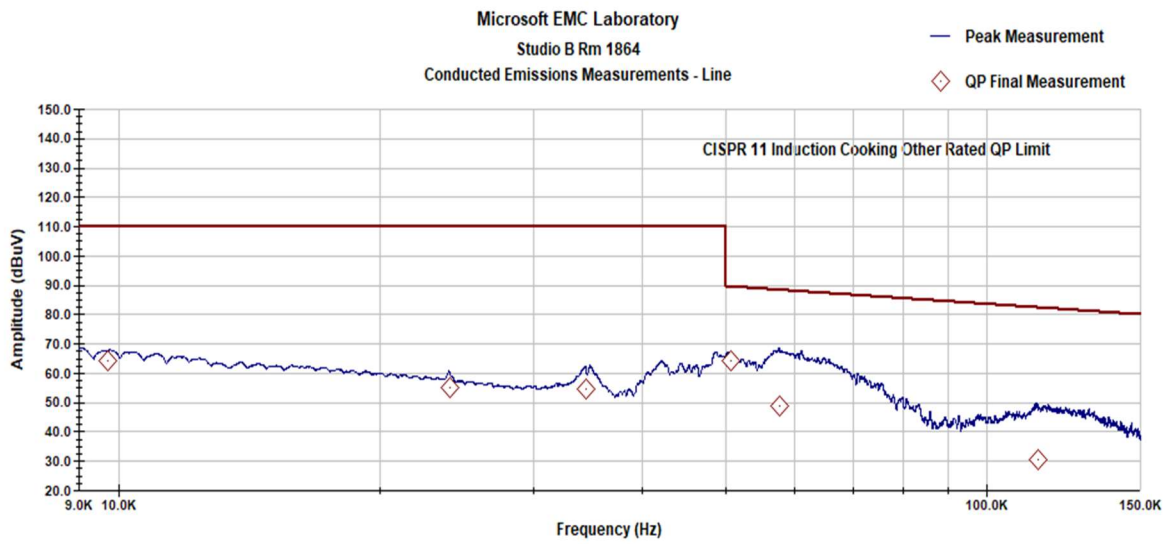


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Last Data Update 09:53:13 AM, Thursday, May 13, 2021

CE Profile V3.0

Figure 9-37 AC Line Conducted Emissions- Neutral (9kHz - 150 kHz) – Charger Rear

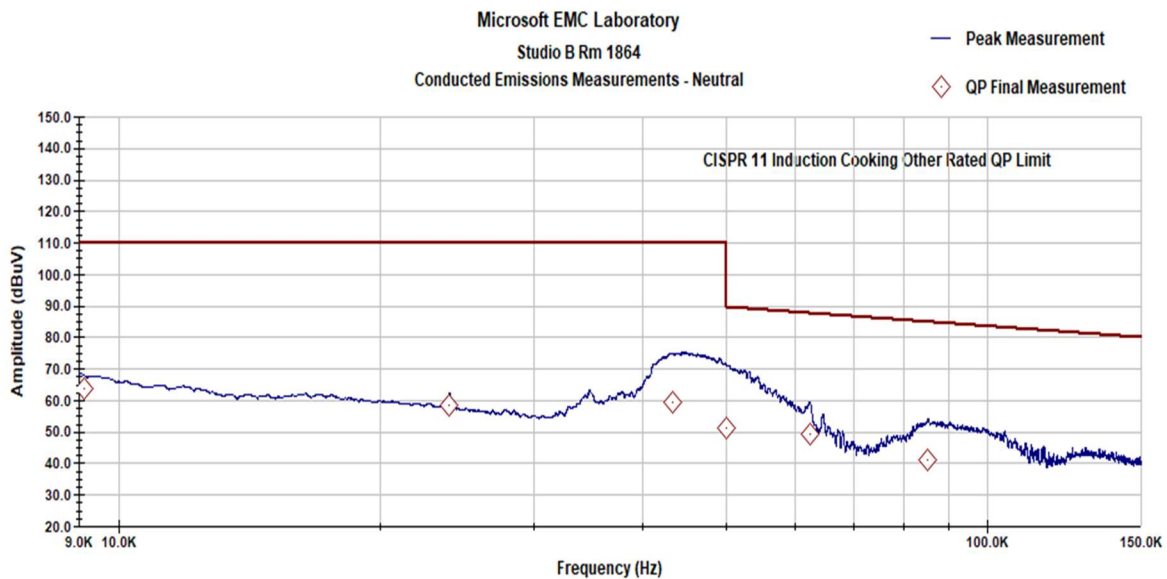


Operator: Benjamin Atsu

Last Data Update 10:42:34 AM, Thursday, May 13, 2021

CE Profile V3.0

Figure 9-38 AC Line Conducted Emissions- Line (9kHz - 150 kHz) – Keyboard Charger Left.



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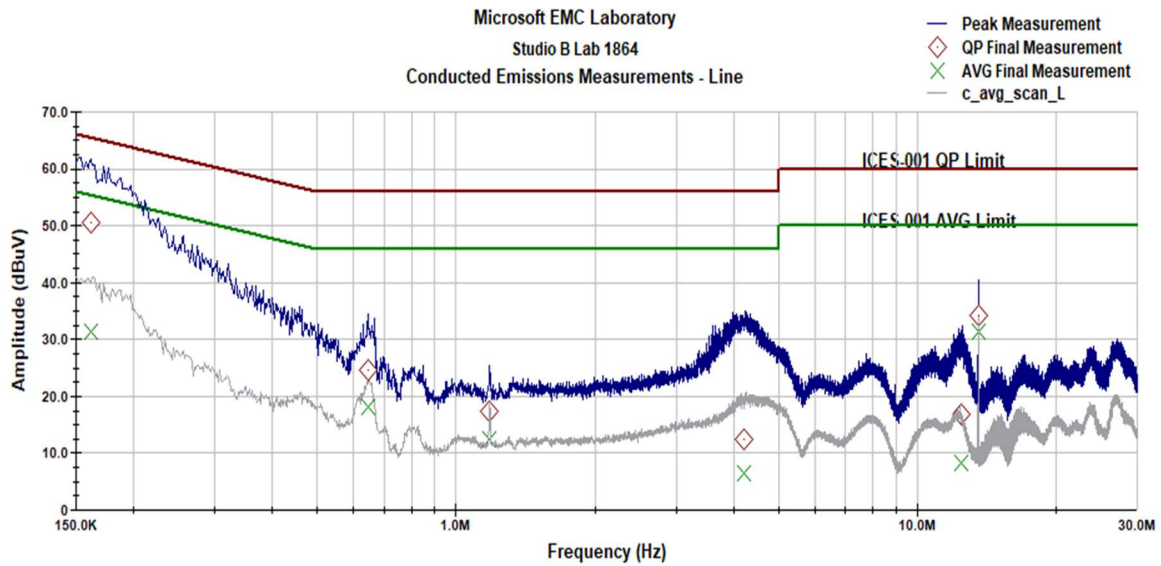
Last Data Update 10:49:43 AM, Thursday, May 13, 2021

CE Profile V3.0

Figure 9-39 AC Line Conducted Emissions- Neutral (9kHz - 150 kHz) – Keyboard Charger Left.

9kHz-150kHz Charger Rear						
Frequency (MHz)	Raw QP Amplitude (dBuV)	System Factors (dB)	QP Amplitude (dBuV)	Quasi-Peak Limit (dBμV)	Line Tested (L or N)	Quasi-Peak Margin (dB)
0.058	50.10	9.92	60.01	88.65	L	-28.63
0.068	42.46	9.83	52.29	87.23	L	-34.94
0.115	28.01	9.83	37.84	82.42	L	-44.58
0.010	53.28	11.46	64.74	110.00	L	-45.26
0.024	46.24	10.64	56.88	110.00	L	-53.12
0.035	45.88	10.25	56.13	110.00	L	-53.87
0.058	49.79	9.91	59.71	88.70	N	-28.99
0.065	46.13	9.86	55.98	87.62	N	-31.63
0.010	53.48	11.43	64.90	110.00	N	-45.10
0.114	26.84	9.83	36.67	82.51	N	-45.84
0.024	48.69	10.62	59.30	110.00	N	-50.70
0.034	47.22	10.25	57.47	110.00	N	-52.53

9kHz-150kHz Charger Keyboard Left						
Frequency (MHz)	Raw QP Amplitude (dBuV)	System Factors (dB)	QP Amplitude (dBuV)	Quasi-Peak Limit (dBμV)	Line Tested (L or N)	Quasi-Peak Margin (dB)
0.051	54.12	9.99	64.11	89.88	L	-25.77
0.058	38.92	9.92	48.85	88.72	L	-39.88
0.010	52.76	11.45	64.21	110.00	L	-45.79
0.114	20.75	9.83	30.58	82.46	L	-51.87
0.024	44.60	10.63	55.23	110.00	L	-54.77
0.034	44.60	10.27	54.87	110.00	L	-55.13
0.062	39.61	9.88	49.49	87.98	N	-38.49
0.050	41.09	10.00	51.08	90.00	N	-38.92
0.085	31.47	9.83	41.30	85.16	N	-43.86
0.009	52.46	11.31	63.76	110.00	N	-46.24
0.043	49.19	10.08	59.27	110.00	N	-50.73
0.024	48.07	10.61	58.69	110.00	N	-51.31

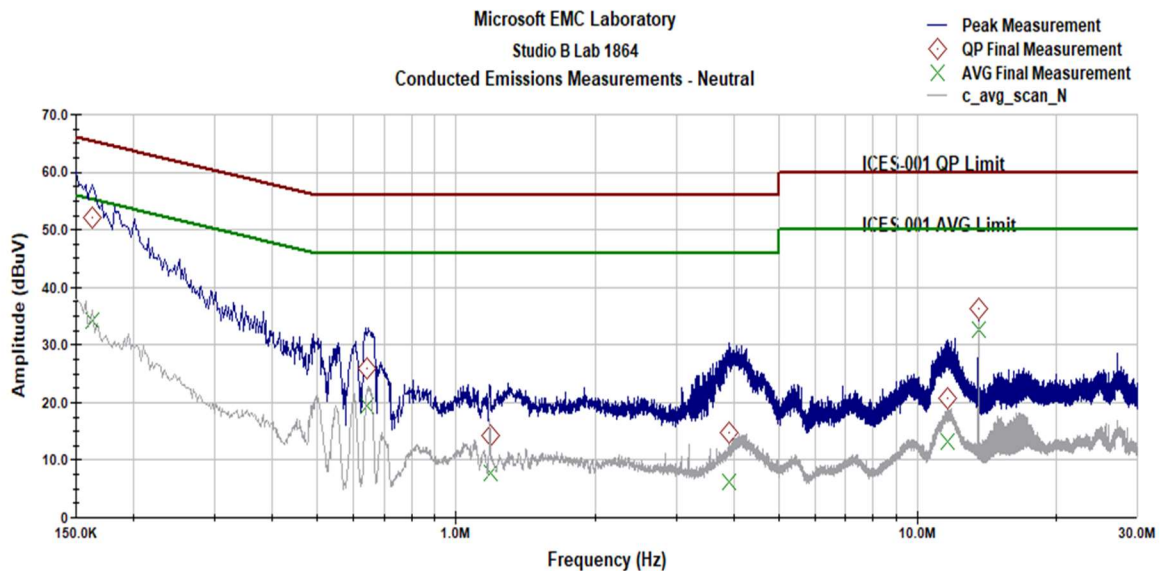


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Last Data Update 03:32:28 PM, Thursday, May 13, 2021

CE Profile V2.2

Figure 9-40 AC Line Conducted Emissions- Line (150 kHz – 30MHz) – Charger – Front

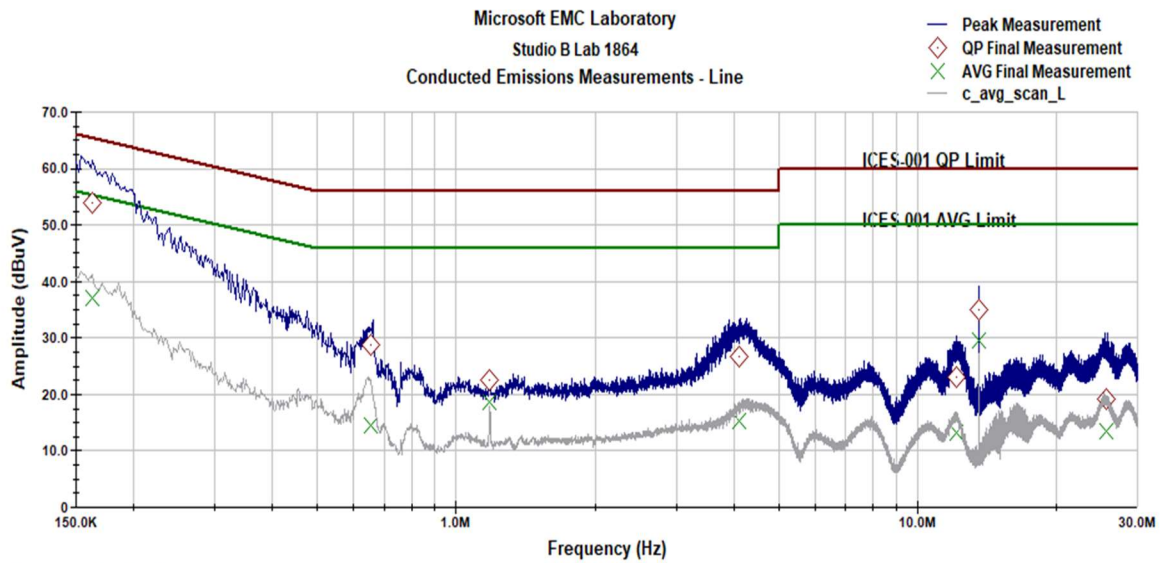


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Last Data Update 03:24:17 PM, Thursday, May 13, 2021

CE Profile V2.2

Figure 9-41 AC Line Conducted Emissions- Neutral (150 kHz – 30MHz) - Charger - Front

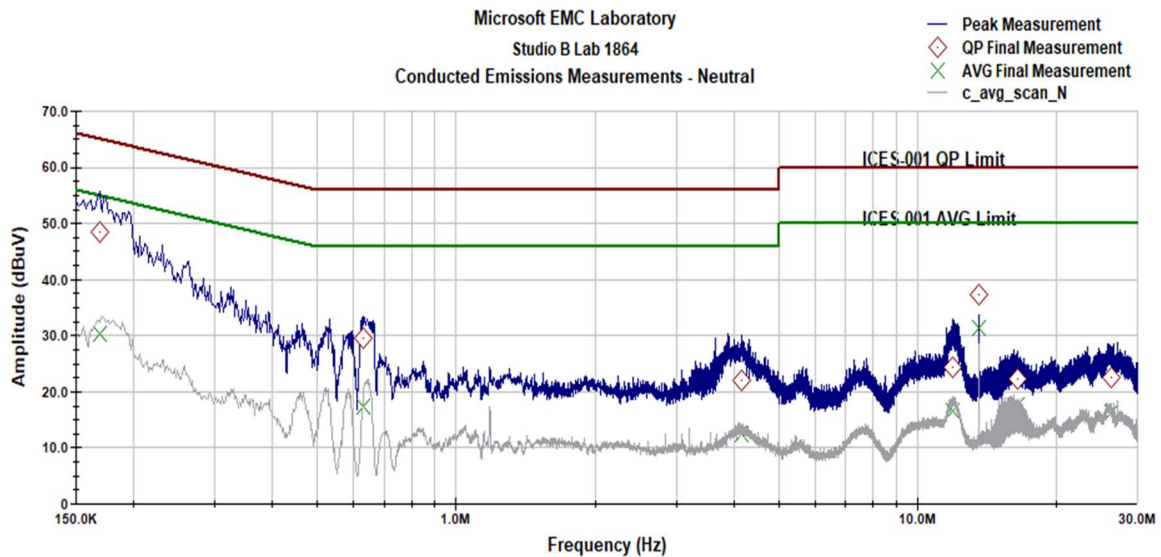


Operator: Benjamin Atsu

Last Data Update 09:39:51 AM, Friday, May 14, 2021

CE Profile V2.2

Figure 9-42 AC Line Conducted Emissions- Line (150 kHz – 30MHz) – Keyboard – Left



Operator: Benjamin Atsu

Last Data Update 10:01:35 AM, Friday, May 14, 2021

CE Profile V2.2

Figure 9-43 AC Line Conducted Emissions- Neutral (150 kHz – 30MHz) – Keyboard - Left

150kHz - 30MHz Charger Front							
Frequency (MHz)	AVG Amplitude (dBuV)	QP Amplitude (dBuV)	AVG Limit (dBuV)	QP Limit (dBuV)	Line Tested (L or N)	AVG Margin (dB)	QP Margin (dB)
0.16	31.33	50.56	55.40	65.40	L	-24.07	-14.84
13.56	31.36	34.31	50.00	60.00	L	-18.65	-25.69
0.65	18.16	24.57	46.00	56.00	L	-27.84	-31.43
1.18	12.37	17.29	46.00	56.00	L	-33.63	-38.71
12.49	8.34	16.82	50.00	60.00	L	-41.67	-43.18
4.22	6.41	12.51	46.00	56.00	L	-39.59	-43.49
0.16	34.23	52.04	55.30	65.30	N	-21.07	-13.27
13.56	32.67	36.16	50.00	60.00	N	-17.33	-23.84
0.64	19.33	25.88	46.00	56.00	N	-26.67	-30.12
11.65	13.23	20.62	50.00	60.00	N	-36.78	-39.38
3.91	6.12	14.75	46.00	56.00	N	-39.88	-41.25
1.19	7.81	14.33	46.00	56.00	N	-38.19	-41.67

150kHz - 30MHz Keyboard Left							
Frequency (MHz)	AVG Amplitude (dBuV)	QP Amplitude (dBuV)	AVG Limit (dBuV)	QP Limit (dBuV)	Line Tested (L or N)	AVG Margin (dB)	QP Margin (dB)
0.16	37.04	53.98	55.30	65.30	L	-18.26	-11.33
13.56	29.47	35.12	50.00	60.00	L	-20.53	-24.88
0.65	14.59	28.72	46.00	56.00	L	-31.41	-27.28
4.10	15.16	26.62	46.00	56.00	L	-30.84	-29.39
1.18	18.78	22.46	46.00	56.00	L	-27.22	-33.54
12.15	13.11	23.11	50.00	60.00	L	-36.89	-36.89
25.60	13.50	19.28	50.00	60.00	L	-36.50	-40.72
0.17	30.32	48.56	55.02	65.02	N	-24.70	-16.46
13.56	31.39	37.32	50.00	60.00	N	-18.61	-22.68
0.63	17.44	29.43	46.00	56.00	N	-28.56	-26.57
4.15	12.46	22.05	46.00	56.00	N	-33.54	-33.95
11.92	16.59	24.33	50.00	60.00	N	-33.41	-35.68
26.40	16.40	22.51	50.00	60.00	N	-33.60	-37.49
16.49	17.68	22.20	50.00	60.00	N	-32.32	-37.80

End of Report