5 Input/Output Power and Amplifier/Booster Gain

Governing Doc	FCC Part 90.219	Room Temperature (°C)	20.5
Test Procedure	ANSI/TIA-603- E-2016; KDB 935210 D05, v01r04	Relative Humidity (%)	38.6
Test Location	Richmond	Barometric Pressure (kPa)	101.8
Test Engineer	Jack Qin	Date	August 29,2023
EUT Voltage	☒ +48VDC	☐ 120VAC @ 60Hz	

Test Equipment Used	Manufacturer	Model	Serial Number	Calibration date	Calibration due
Signal Generator	Keysight	N5172B	MY53050270	Oct 9, 2021	Oct 9, 2023
Spectrum Analyzer	Keysight	N9010A	MY50520285	Oct 11, 2021	Oct 11, 2023

Span:	☒ Max Gain Frequency ± 1500kHz
Detector:	☒ Peak
RBW/VBW:	☒100k Hz/ 300 kHz
Type of Facility:	☒ Tabletop
Distance:	☒ Direct

Maximum booster gain is 95.5 dB.

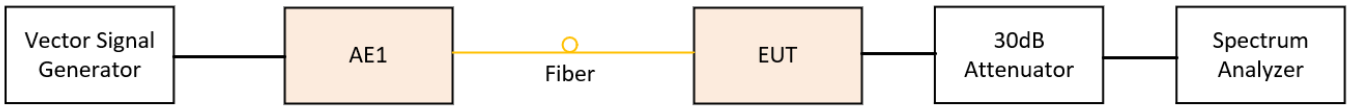
Compliant ☒ Non-Compliant ☐ Not Applicable ☐

Test Setup

Description of test set-up:

The procedure used was ANSI/TIA-603-E-2016 and FCC KDB 935210 D05 Indus Booster Basic Meas v01r02:. A CW tone was input at the frequency where the system gain is the maximum in the pass band, with the nominal input power level. The spectrum analyzer was connected to the output RF port via a 50 Ohm 30 dB attenuator. The maximum hold trace and peak detector was used to capture the output power. The output power minus the input power equals to the booster gain in dB.

The EUT was set to **Operation Mode #1 with configuration Mode #1.**



Test Data

Test Band	Frequency (MHz)	Input Power (dBm)	Output Power (dBm)	Gain (dB)
800PS	860	-58.6	36.92	95.5
VHF PS	163	-55.8	37.08	92.9

6 Out-Of-Band / Out-Of-Block Intermodulation and Spurious Emissions

Governing Doc	FCC Part 90.219	Room Temperature (°C)	20.5
Test Procedure	ANSI/TIA-603- E-2016; KDB 935210 D05, v01r04	Relative Humidity (%)	38.6
Test Location	Richmond	Barometric Pressure (kPa)	101.8
Test Engineer	Jack Qin	Date	August 29,2023
EUT Voltage	☒ +48VDC	☐ 120VAC @ 60Hz	

Test Equipment Used	Manufacturer	Model	Serial Number	Calibration date	Calibration due
Signal Generator	Keysight	N5172B	MY53050270	Oct 9, 2021	Oct 9, 2023
Spectrum Analyzer	Keysight	N9010A	MY50520285	Oct 11, 2021	Oct 11, 2023

Frequency Range:	☒ Max Gain Frequency ± 50kHz
Detector:	☒ Average
RBW/VBW:	☒100/910Hz
Type of Facility:	☒ Tabletop
Distance:	☒ Direct

On 800 band and UHF band: The intermodulation product of 2 tone is below the -13dBm emission limit with input power
0.5 dB below AGC threshold
2 dB AGC threshold
3 dB above AGC threshold

Compliant ☒ Non-Compliant ☐ Not Applicable ☐

Test Setup

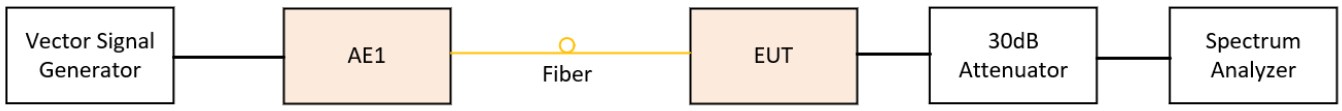
Description of test set-up:

The procedure used was ANSI/TIA-603-E-2016. Two tones (CW) method was used. The input power to the amplifier was set at maximum drive level by combining the two tones. The two tones were chosen in such a way (1) the third order intermodulation product frequencies are located within the pass band of the DUT and (2) they produce the worst-case emissions out of band.

Based on KDB 935210 D05 Indus Booster Basic Meas v01r04: 2019, the two tone was located on either side of the maximum gain frequence in the passing band, and separated with the available spacing, which is 12.5kHz.

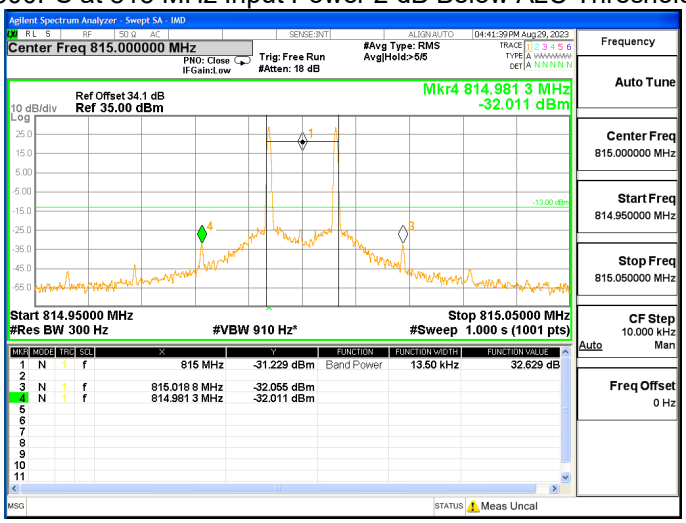
Measurements were performed with modulated -tone at identical input amplitude which produced integrated maximum rated output power.

The EUT was set to **Operation Mode #1 with configuration Mode #1.**

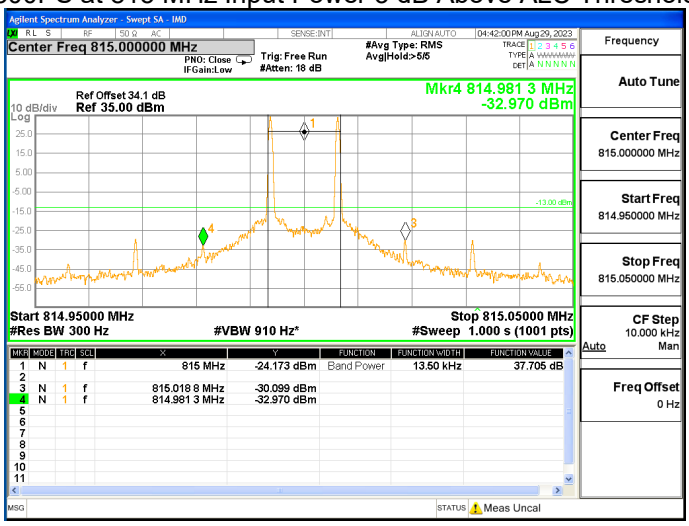


Test Data

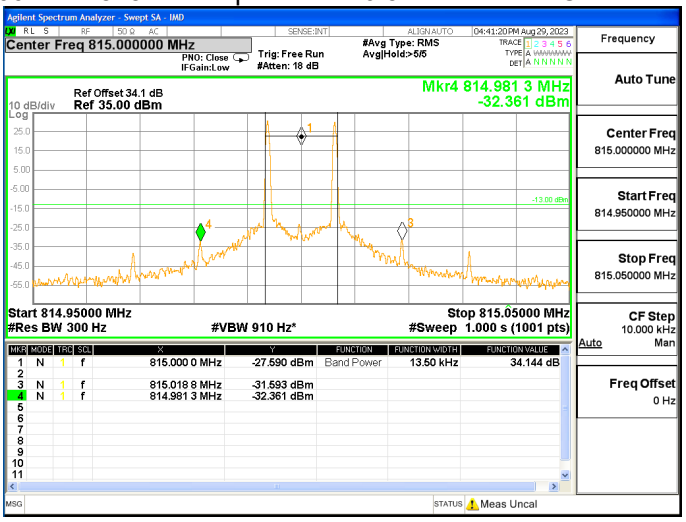
800PS at 815 MHz Input Power 2 dB Below ALC Threshold



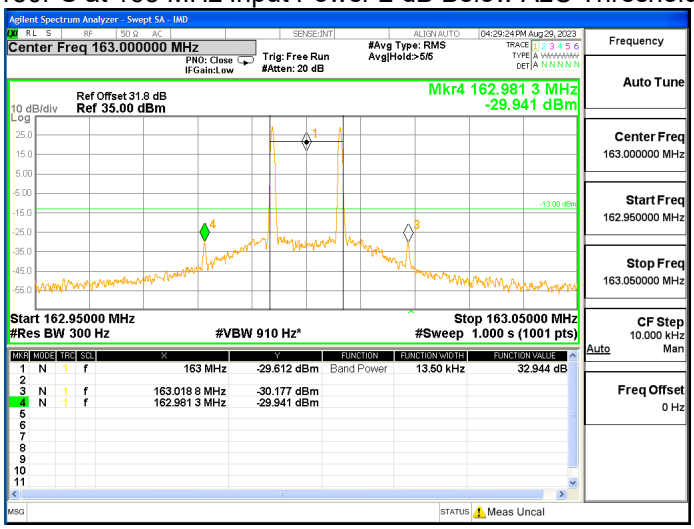
800PS at 815 MHz Input Power 3 dB Above ALC Threshold



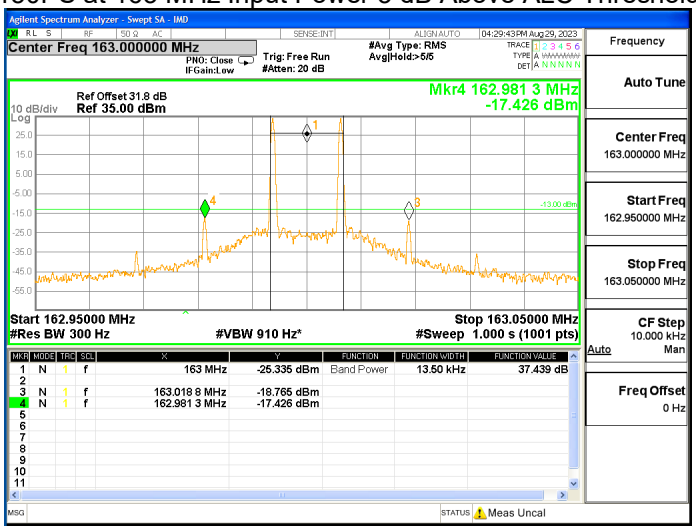
800PS at 815 MHz Input Power 0.5 dB Below ALC Threshold



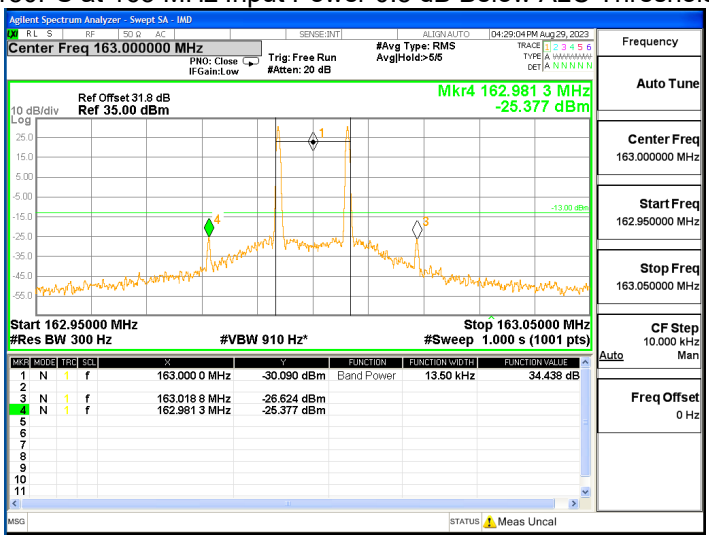
150PS at 163 MHz Input Power 2 dB Below ALC Threshold



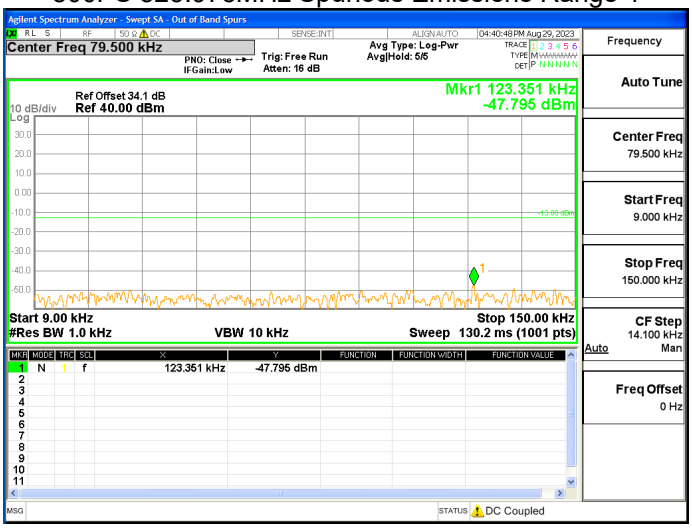
150PS at 163 MHz Input Power 3 dB Above ALC Threshold



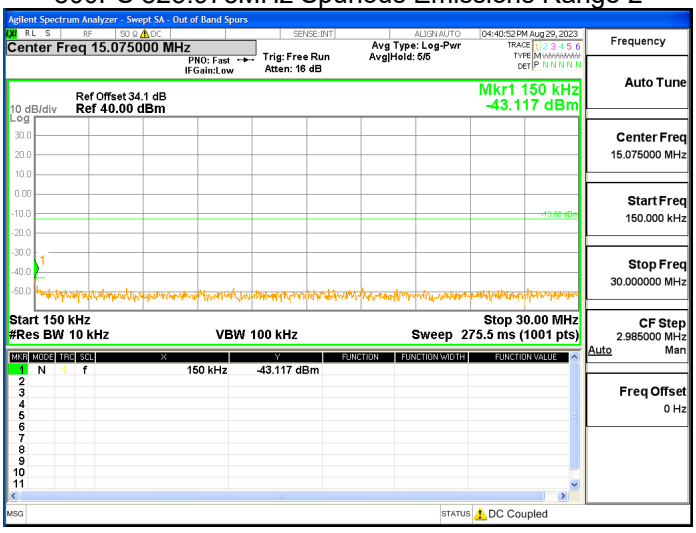
150PS at 163 MHz Input Power 0.5 dB Below ALC Threshold



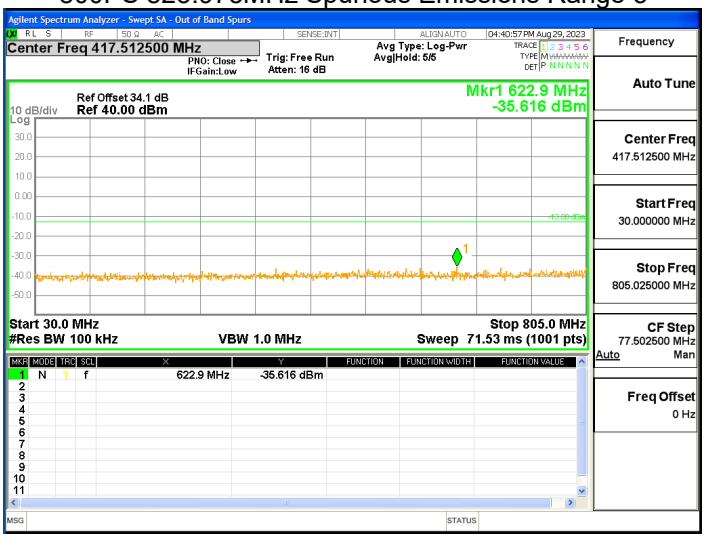
800PS 823.975MHz Spurious Emissions Range 1



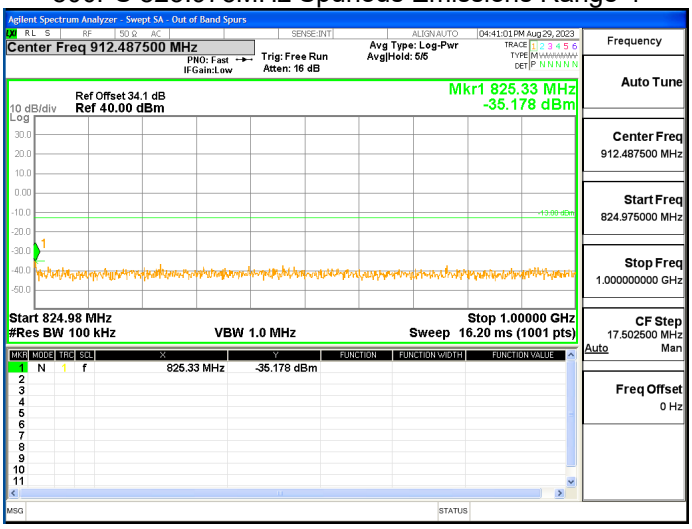
800PS 823.975MHz Spurious Emissions Range 2



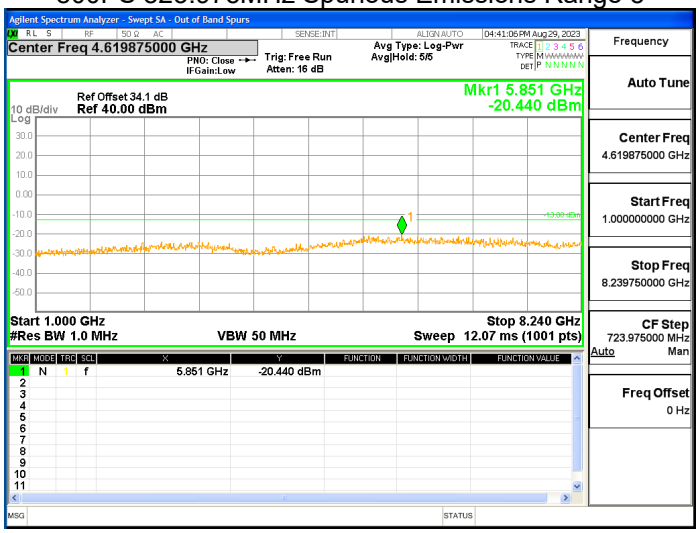
800PS 823.975MHz Spurious Emissions Range 3



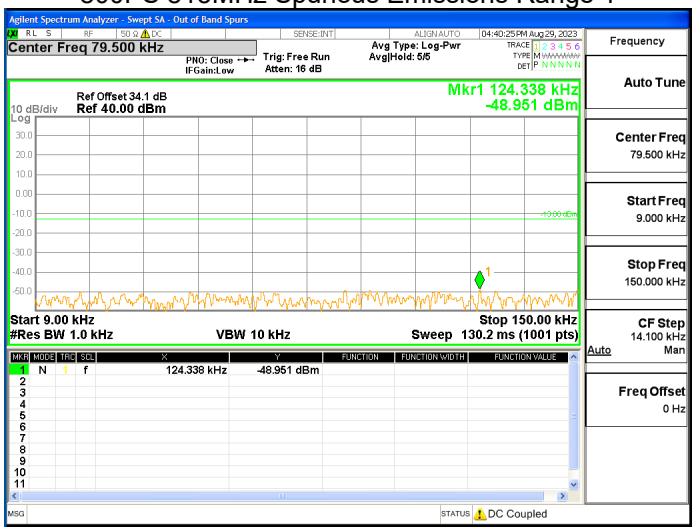
800PS 823.975MHz Spurious Emissions Range 4



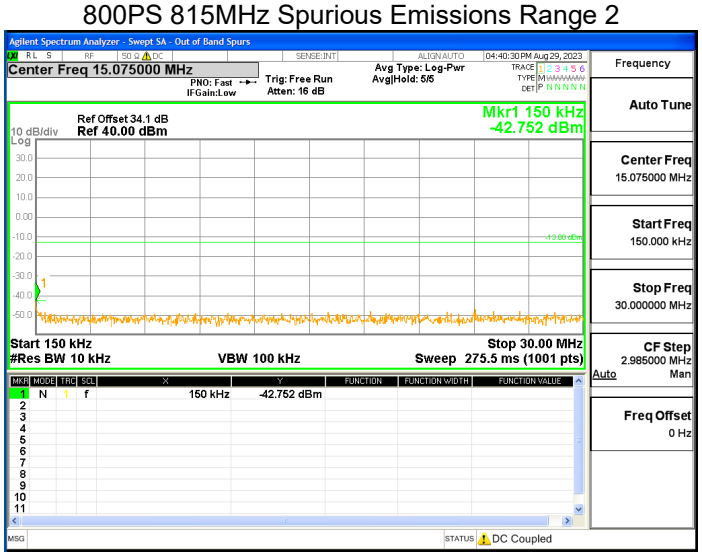
800PS 823.975MHz Spurious Emissions Range 5



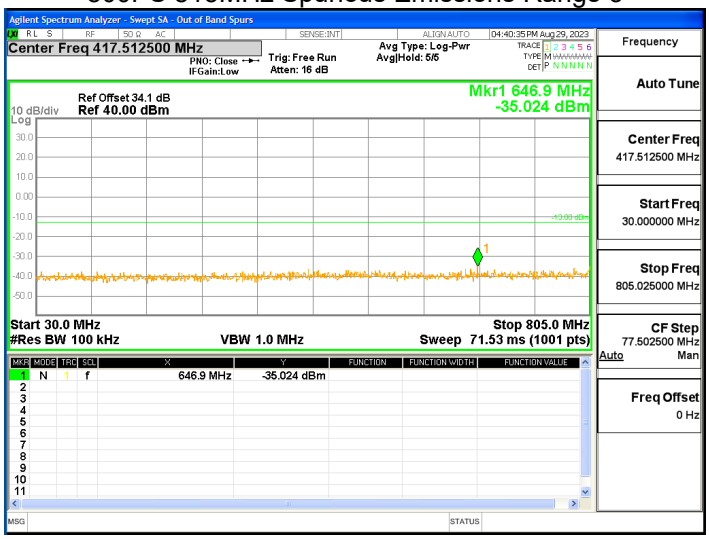
800PS 815MHz Spurious Emissions Range 1



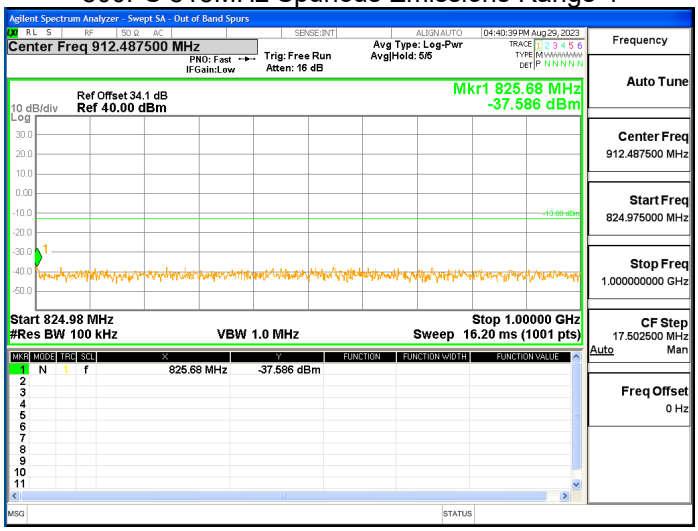
800PS 815MHz Spurious Emissions Range 2



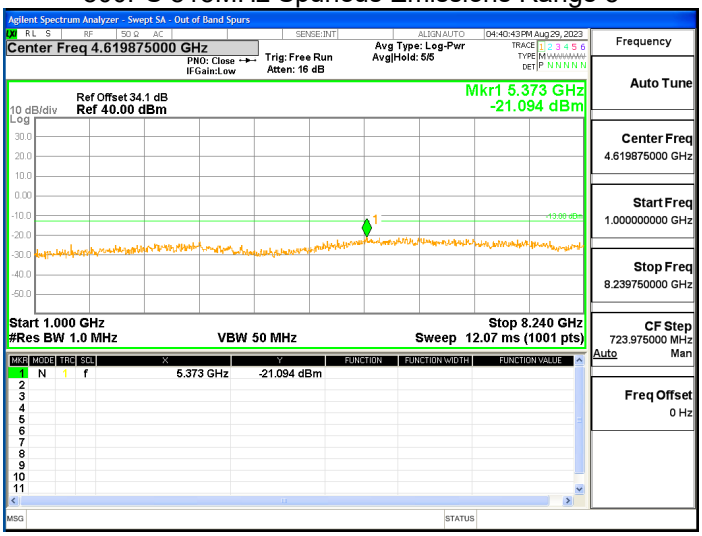
800PS 815MHz Spurious Emissions Range 3



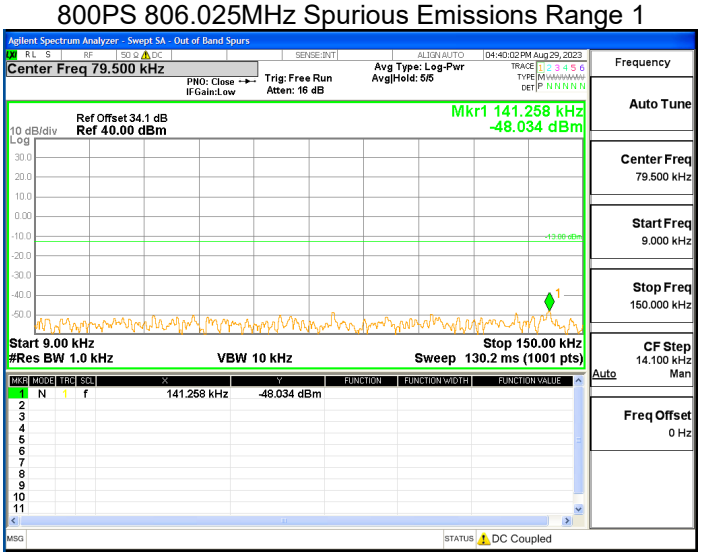
800PS 815MHz Spurious Emissions Range 4



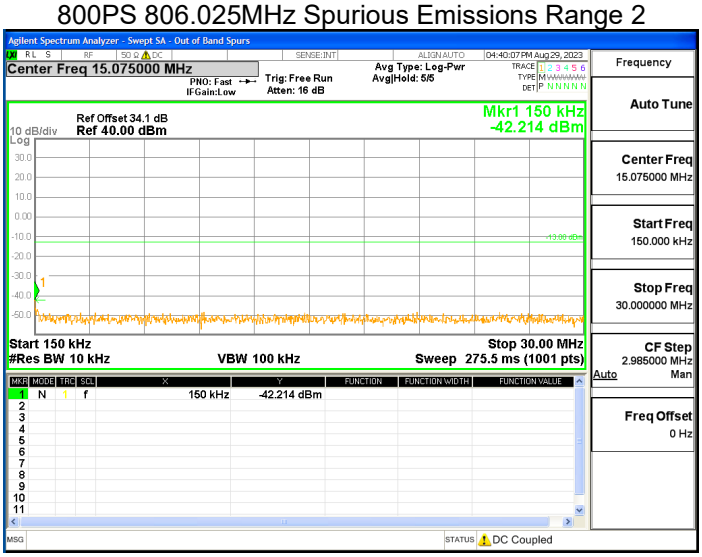
800PS 815MHz Spurious Emissions Range 5



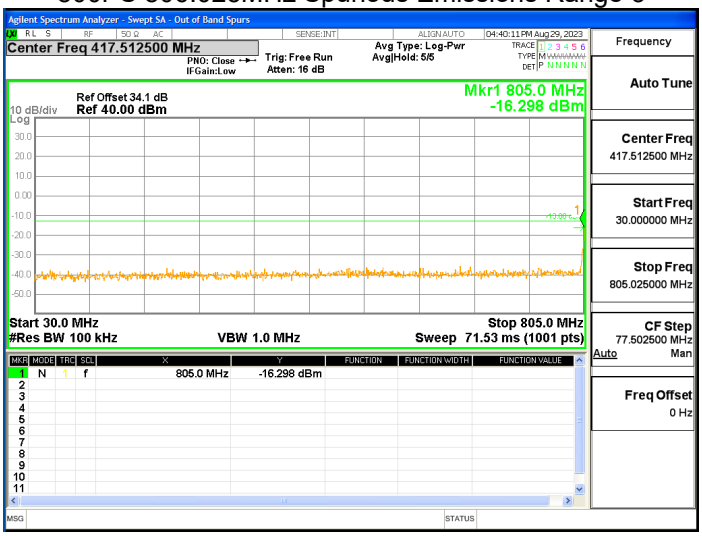
800PS 806.025MHz Spurious Emissions Range 1



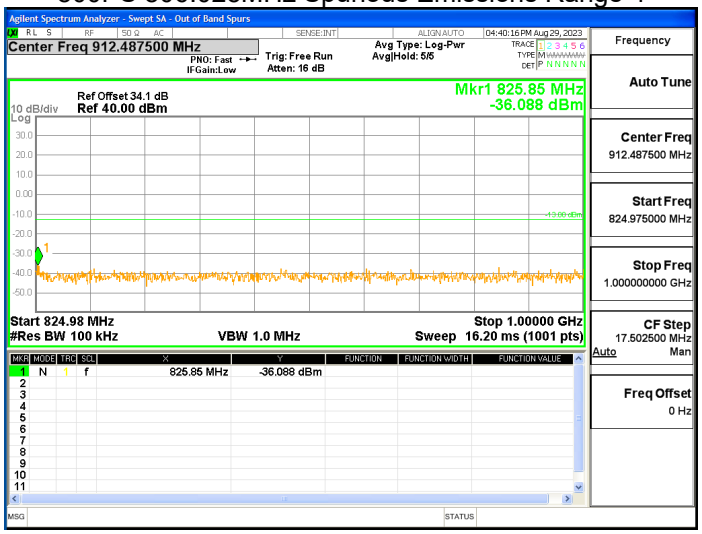
800PS 806.025MHz Spurious Emissions Range 2



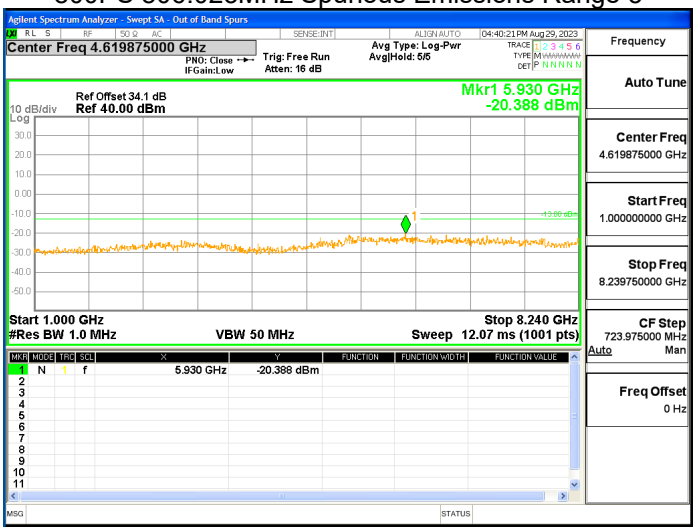
800PS 806.025MHz Spurious Emissions Range 3



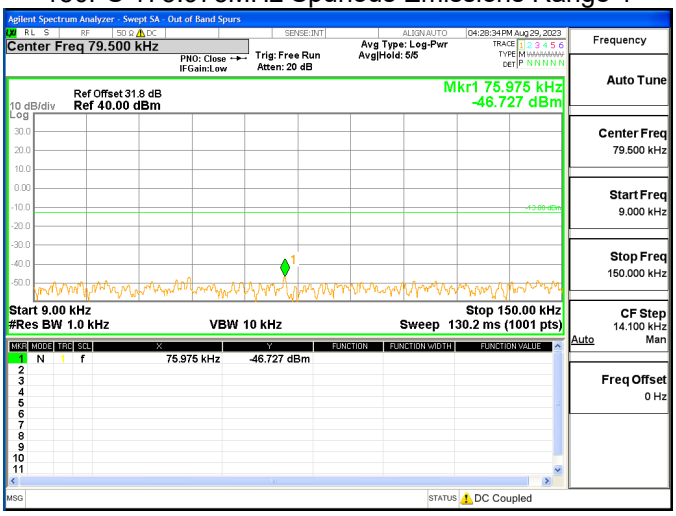
800PS 806.025MHz Spurious Emissions Range 4



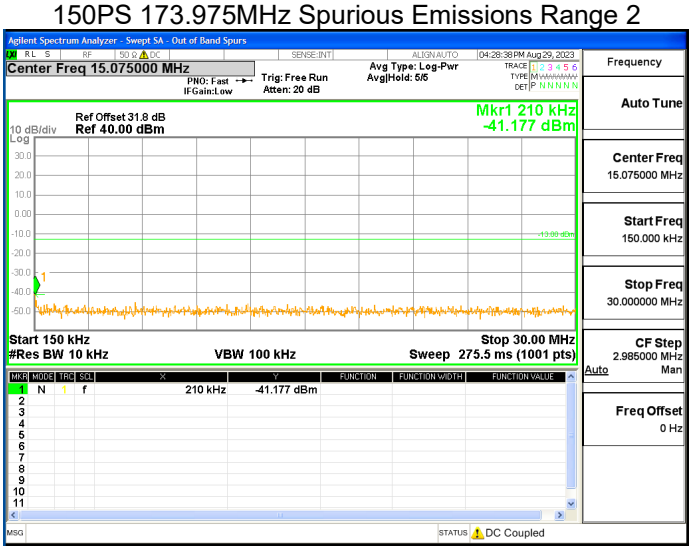
800PS 806.025MHz Spurious Emissions Range 5



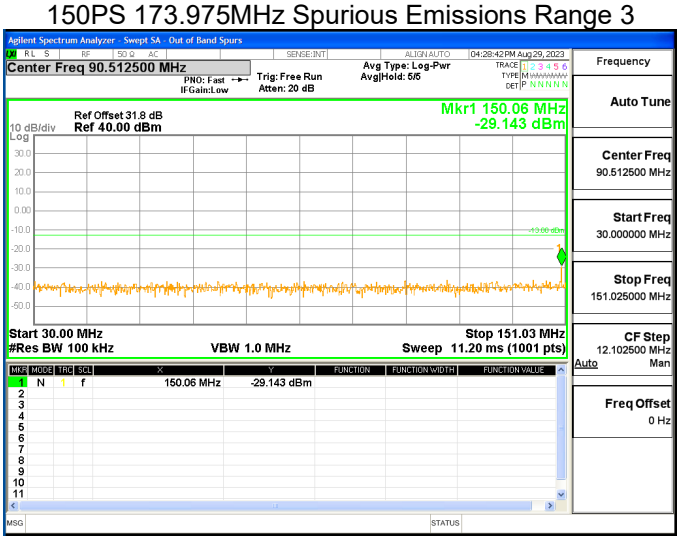
150PS 173.975MHz Spurious Emissions Range 1



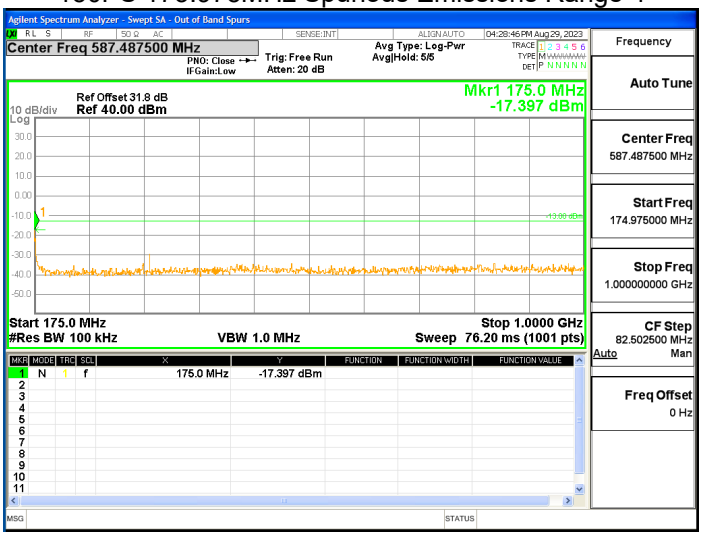
150PS 173.975MHz Spurious Emissions Range 2



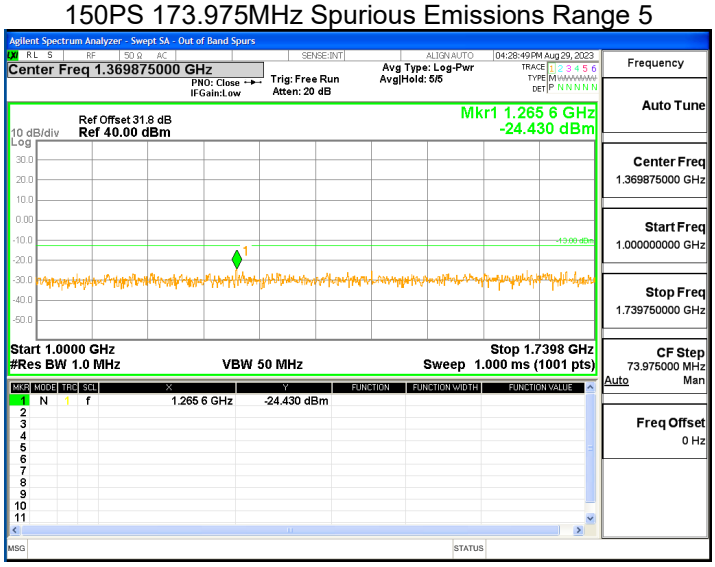
150PS 173.975MHz Spurious Emissions Range 3



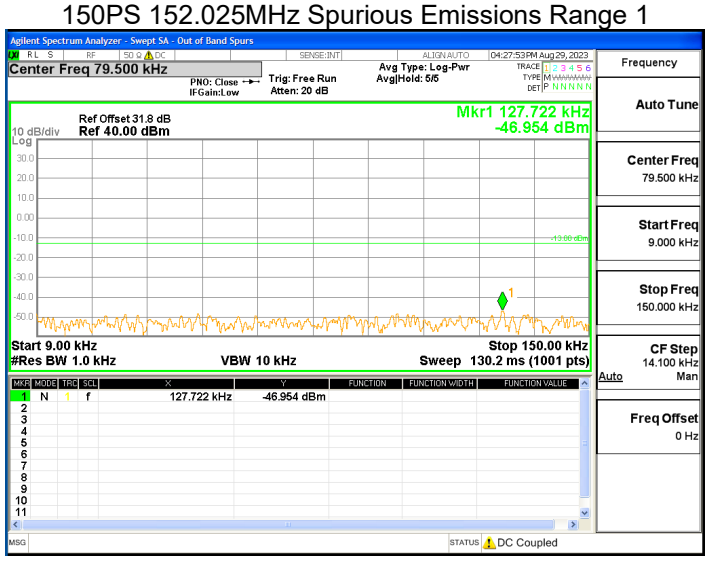
150PS 173.975MHz Spurious Emissions Range 4



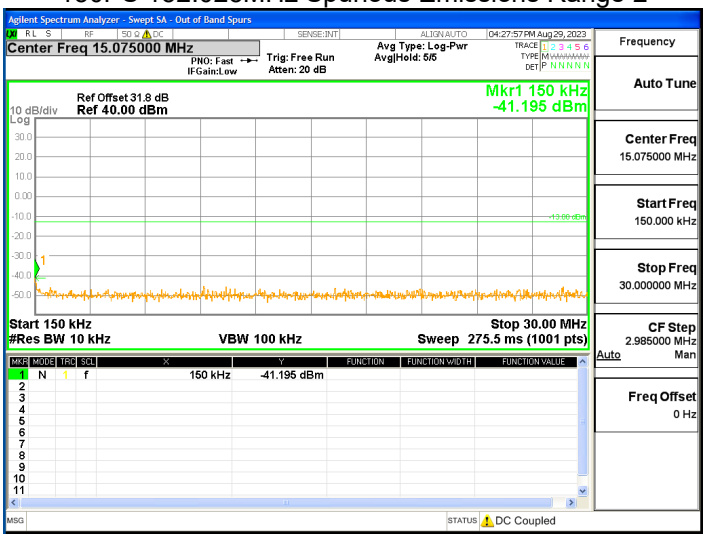
150PS 173.975MHz Spurious Emissions Range 5



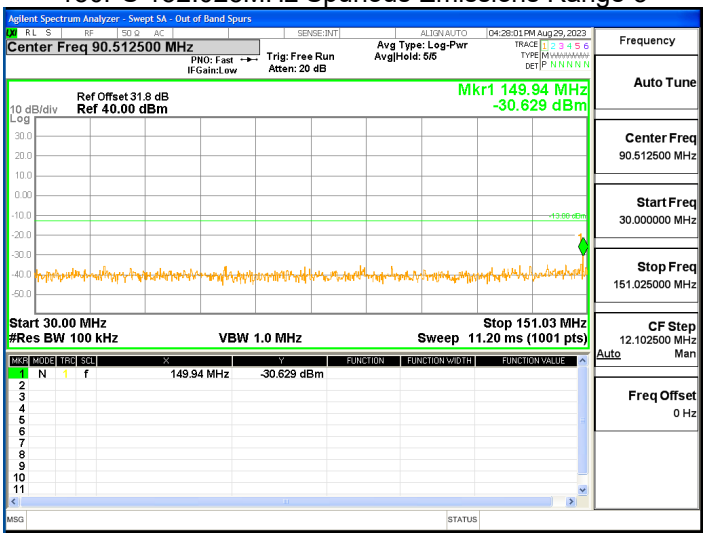
150PS 152.025MHz Spurious Emissions Range 1



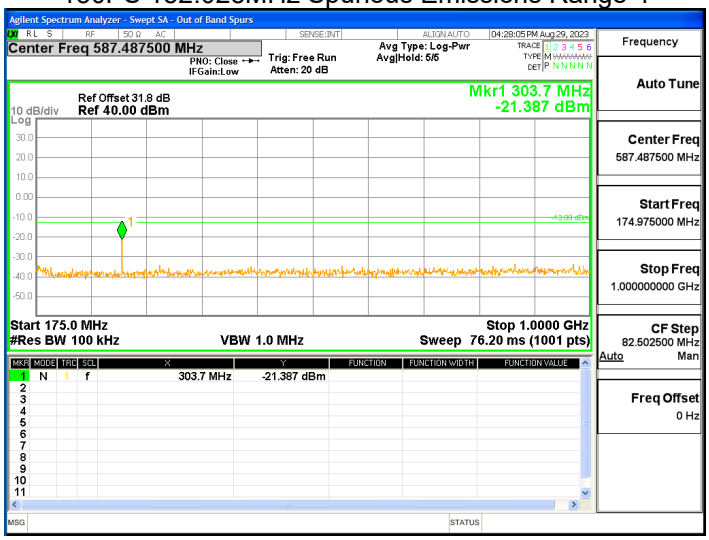
150PS 152.025MHz Spurious Emissions Range 2



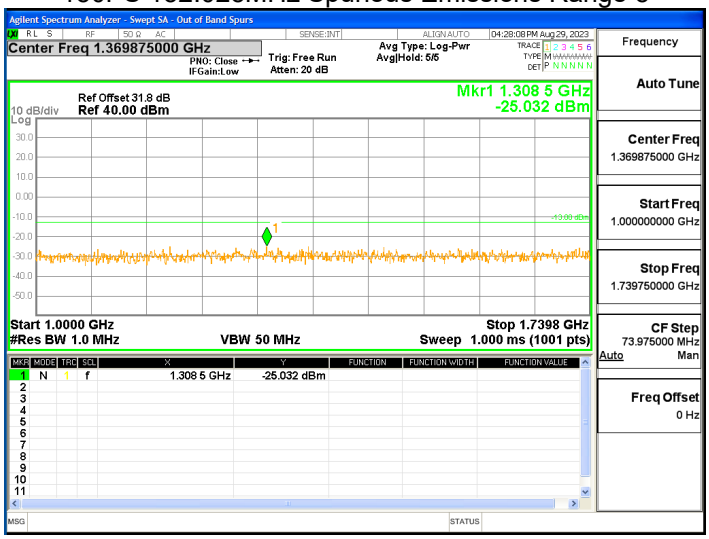
150PS 152.025MHz Spurious Emissions Range 3



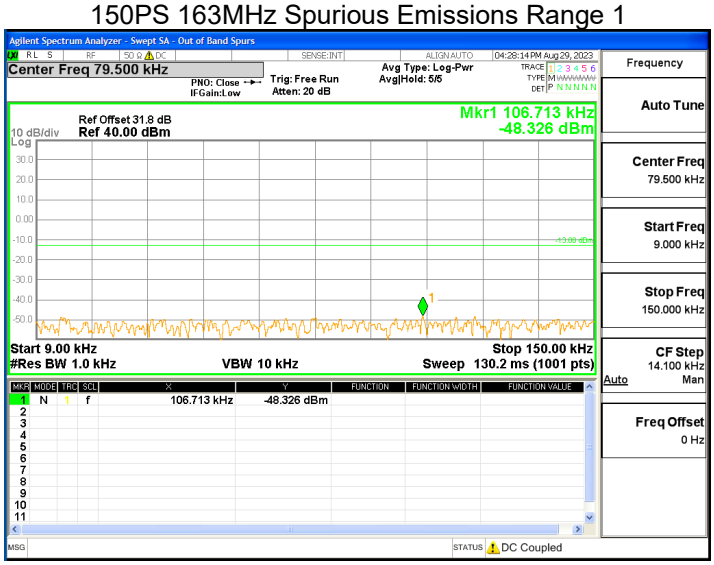
150PS 152.025MHz Spurious Emissions Range 4



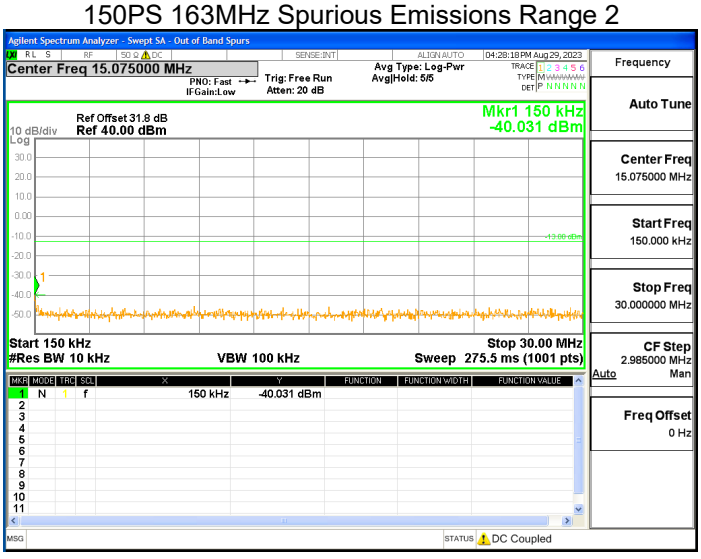
150PS 152.025MHz Spurious Emissions Range 5



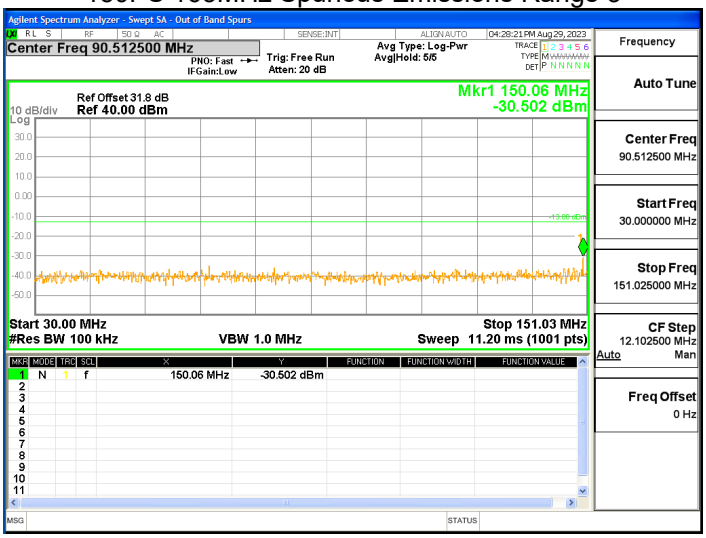
150PS 163MHz Spurious Emissions Range 1



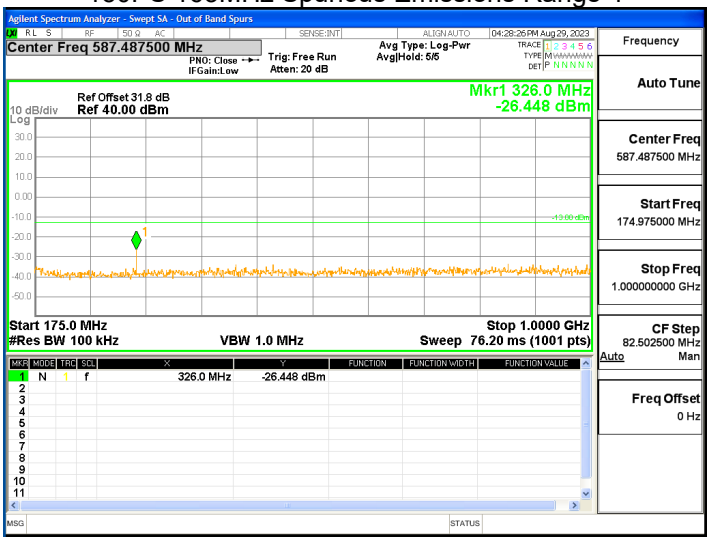
150PS 163MHz Spurious Emissions Range 2



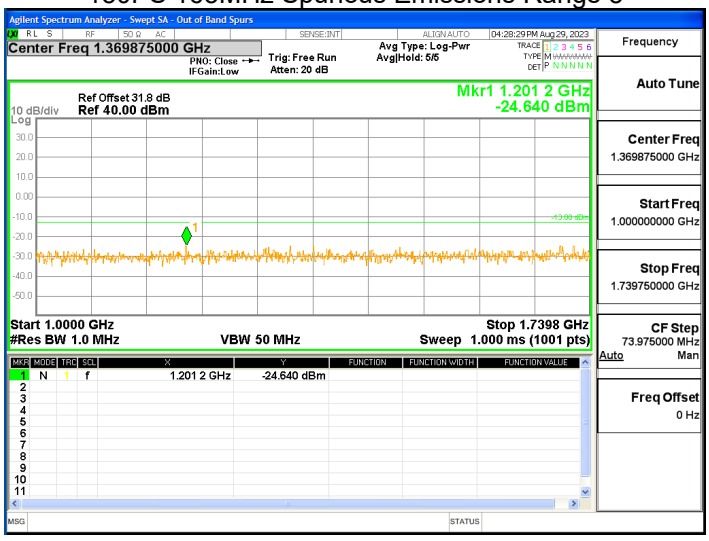
150PS 163MHz Spurious Emissions Range 3



150PS 163MHz Spurious Emissions Range 4



150PS 163MHz Spurious Emissions Range 5



7 Noise Figure

Governing Doc	FCC Part 90.219	Room Temperature (°C)	20.5
Test Procedure	ANSI/TIA-603- E; KDB 935210 D05, v01r04	Relative Humidity (%)	38.6
Test Location	Richmond	Barometric Pressure (kPa)	101.8
Test Engineer	Jack Qin	Date	August 29,2023
EUT Voltage	☒ +48VDC	☐ 120VAC @ 60Hz	

Test Equipment Used	Manufacturer	Model	Serial Number	Calibration date	Calibration due
Signal Generator	Keysight	N5172B	MY53050270	Oct 9, 2021	Oct 9, 2023
Spectrum Analyzer	Keysight	N9010A	MY50520285	Oct 11, 2021	Oct 11, 2023

Frequency Range:	☒ 2 times of the passband on each band
Detector:	☒ Average
RBW:	☒910 kHz
Type of Facility:	☒ Tabletop
Distance:	☒ Direct

Noise Figure on each band is less than the 9 dB required.

Compliant ☒ Non-Compliant ☐ Not Applicable ☐

Test Setup

Description of test set-up:

Based on FCC KDB 935210 D05 Indus Booster Basic Meas v01r04: 2019, the system maximum gain and the noise density is measured.Measurements were performed within the EUT's passband.

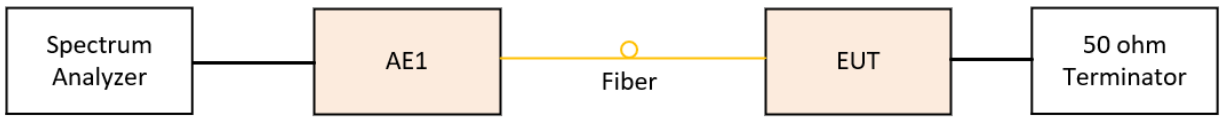
The noise figure is then calculated by NF = NP – Gain + KTB Noise; where

NP is in band noise power per Herz,

Gain is measured at the maximum noise frequence with -55 dBm input signal in UL.

KTB Noise is 174dBm/Hz.

The EUT was set to **Operation Mode #1 with configuration Mode #1.**



Test Data

Test Band	Gain (dB)	kTB (dBm/Hz)	Measured Value (dBm/Hz)	Noise Figure (dB)
800PS	95.5	174	-70.5	8.04
VHF PS	92.9	174	-74.4	6.72

8 Frequency Stability

The AMU37 and RU37 are sychronized to the same reference clock. Therefore there is no frequency error after down and up frequency conversion are performed.

The frequency stability check is not applicable to the EUT.

9 Radiated Emissions – Enclosure

9.1 Radiated Emissions 30 MHz – 1 GHz

Standard	FCC Part 15 Subpart B				
Basic Standard(s)	ANSI C63.4, CISPR 16-2-1				
Tested by	Jack Qin				
Test date	2023-08-30				
Test location	in SAC, Richmond				
Test Equipment	Manufacturer	Model	LabTest ID	Calibration date	Calibration due
EMC Analyzer	Keysight Technologies	N9038A	702	02-Nov-2022	01-Nov-2023
Broadband Antenna	Sunol	JB1	371	24-Oct-2022	24-Oct-2024

Applied limit

Radiated Emission FCC Class A Limit at 3 Meters	
Frequency (MHz)	**Quasi-peak (dB µV/m)**
30 – 88	50
88 – 216	54
216 - 960	57
960 – 1000	60
Note 1. The lower limit shall apply at the transition frequency Note 2. Additional provisions may be required for cases where interference occurs	

Test set-up description	☒	Equipment on a table of 80 cm height
	☐	Equipment on the floor (insulated from ground plane)
	☐	Other:
Test method applied	☒	OATS or SAC with measurement distance [m]: ☒3 ☐10
	☐	FAR CISPR 16-2-3 with measurement distance [m]: 3
	☐	FAR IEC 61000-4-22 with measurement distance [m]: 3
	☐	TEM Waveguide according to IEC 61000-4-20
Supplementary test set-up	☒	Measurements were made in semi-anechoic chamber that complies to CISPR 16. Preliminary (peak) measurements. The EUT was rotated 360° about its azimuth with the receive antenna located at various heights in horizontal and vertical polarities. Final measurements (quasi-peak detector below 1GHz and average detector above 1GHz) were then performed by rotating the EUT 360° and adjusting the receive antenna height from 1 to 4 m. All frequencies were investigated in both horizontal and vertical antenna polarity, where applicable.

Supplementary information	• If the highest internal frequency of the EUT is less than 108 MHz, the measurement shall only be made up to 1 GHz. • If the highest internal frequency of the EUT is between 108 MHz and 500 MHz, the measurement shall only be made up to 2 GHz. • If the highest internal frequency of the EUT is between 500 MHz and 1 GHz, the measurement shall only be made up to 5 GHz. • If the highest internal frequency of the EUT is above 1 GHz, the measurement shall be made up to 6 GHz. • Where the highest internal frequency is not known, tests shall be performed up to 6 GHz.

VERDICT: PASS

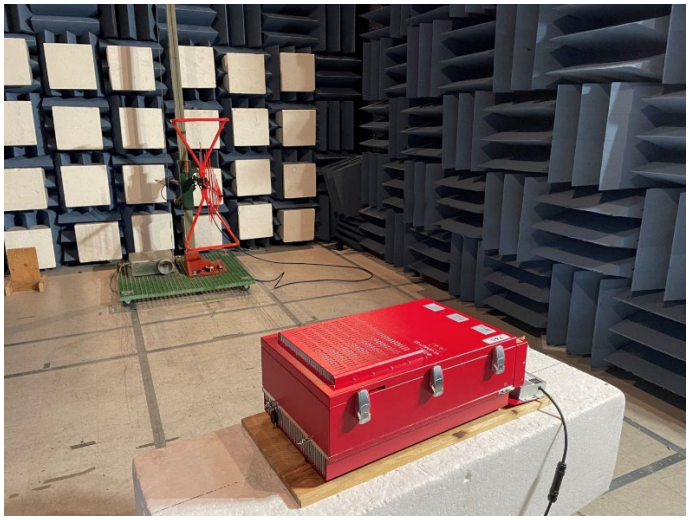
Test Method

This test measures the radiating levels from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices. Testing was performed in accordance with the test standard(s) referenced in the test summary section of this report. The Equipment Under Test (EUT) was configured based upon the requirements of the applicable test standard. Initially, the primary emission frequencies are identified by positioning a broadband receive antenna three meter from the EUT.

A scan was made with an EMC Analyzer, controlled by EMC Test Software, Tile7! with the receiver in the peak mode. The receiver IF bandwidth was 120 kHz and scan step was less than 30kHz. To ensure that the maximum emission at each discrete frequency of interest is observed, the receive antenna is varied in height from one to four meters and rotated to produce horizontal and vertical polarities while the turntable is rotated to determine the worst emitting configuration. Measurements were then made using CISPR quasi peak when the peak readings were within 10dB of the limit line. The numerical results are included herein to demonstrate compliance.

Test Setup

The EUT was placed on a 0.8m non-conducting table above a ground reference plane (GRP).

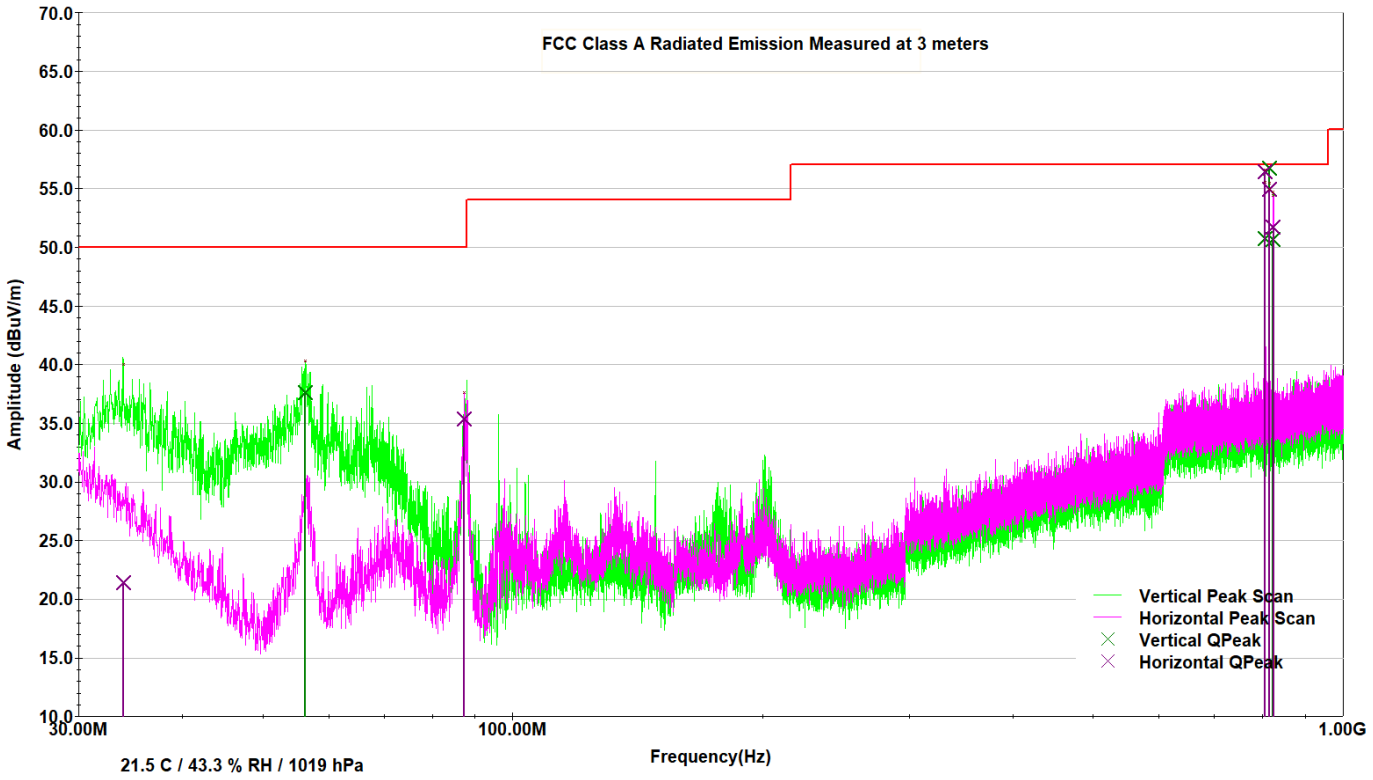


Measurement data and Plot

Note:

Quasi-peak (dBuV/m) = Raw Quasi-peak (dBuV) + Antenna Factor (dB/m) + Correction Factor (dB)
Correction Factor (dB) = Cable loss(dB)

Radiated Emission 30 MHz - 1000MHz, 120V/60Hz, FCC Class A Limit



Frequency	Antenna Polarization	Raw QPeak	Antenna Factor	Correction Factor	QPeak	Margin	Limit
MHz	V/H	dBuV	dB/m	dB	dBuV/m	dB	dBuV/m
33.98275	H	-2.7	23.4	0.7	21.4	28.6	50
87.364	H	22.7	11.7	0.9	35.4	14.6	50
806.02425	H	27.5	26.1	2.8	56.4	0.6	57
814.99675	H	25.9	26.2	2.8	55	2	57
823.97925	H	22.7	26.2	2.8	51.7	5.3	57
56.1785	V	25.7	11.2	0.8	37.6	12.4	50
806.01425	V	22.5	25.4	2.8	50.7	6.3	57
815.00675	V	28.4	25.5	2.8	56.7	0.3	57
823.96925	V	22.2	25.6	2.8	50.7	6.3	57

9.2 Radiated Emissions above 1 GHz

Standard	FCC Part 15 Subpart B				
Basic Standard(s)	ANSI C63.4, CISPR 16-2-1				
Tested by	Jack Qin				
Test date	2023-08-30				
Test location	in SAC, Richmond				
Test Equipment	Manufacturer	Model	LabTest	Calibration date	Calibration due
EMC Analyzer	Keysight Technologies	N9038A	702	02-Nov-2022	01-Nov-2023
Horn Antenna	A.H Systems	SAS-571	227C	13-Sept-2022	13-Sept-2024
RF Preamplifier	Agilent	8449B	273	In House Calibration	In House Calibration
RF Cable	A.H. Systems	SAC-26G-3	227D	In House Calibration	In House Calibration

Applied limit

Radiated Emission FCC Class B Limit at 3 Meters		
Frequency (GHz)	**Average (dBμV/m)**	**Peak (dBμV/m)**
> 1	54	74

Test set-up description	☒	Equipment on a table of 80 cm height
	☐	Equipment on the floor (insulated from ground plane)
	☐	Other:
Operating modes of EUT	The EUT is configured as “Dive Mode”, the wireless charger is powered by 120V/60Hz or 230V/50Hz.	
Test method applied	☐	OATS or SAC with measurement distance [m]: ☒3 ☐10
	☒	FAR CISPR 16-2-3 with measurement distance [m]: 3
	☐	FAR IEC 61000-4-22 with measurement distance [m]: 3
	☐	TEM Waveguide according to IEC 61000-4-20
Supplementary test set-up	☒	Measurements were made in FAR chamber that complies to CISPR 16. Preliminary (peak) measurements. The EUT was rotated 360° about its azimuth with the receive antenna located at various heights in horizontal and vertical polarities. Final measurements (quasi-peak detector below 1GHz and average detector above 1GHz) were then performed by rotating the EUT 360° and adjusting the receive antenna height from 1 to 4 m. All frequencies were investigated in both horizontal and vertical antenna polarity, where applicable.

Supplementary information	• If the highest internal frequency of the EUT is less than 108 MHz, the measurement shall only be made up to 1 GHz. • If the highest internal frequency of the EUT is between 108 MHz and 500 MHz, the measurement shall only be made up to 2 GHz. • If the highest internal frequency of the EUT is between 500 MHz and 1 GHz, the measurement shall only be made up to 5 GHz. • If the highest internal frequency of the EUT is above 1 GHz, the measurement shall be made up to 6 GHz. • Where the highest internal frequency is not known, tests shall be performed up to 6 GHz.
VERDICT: PASS	

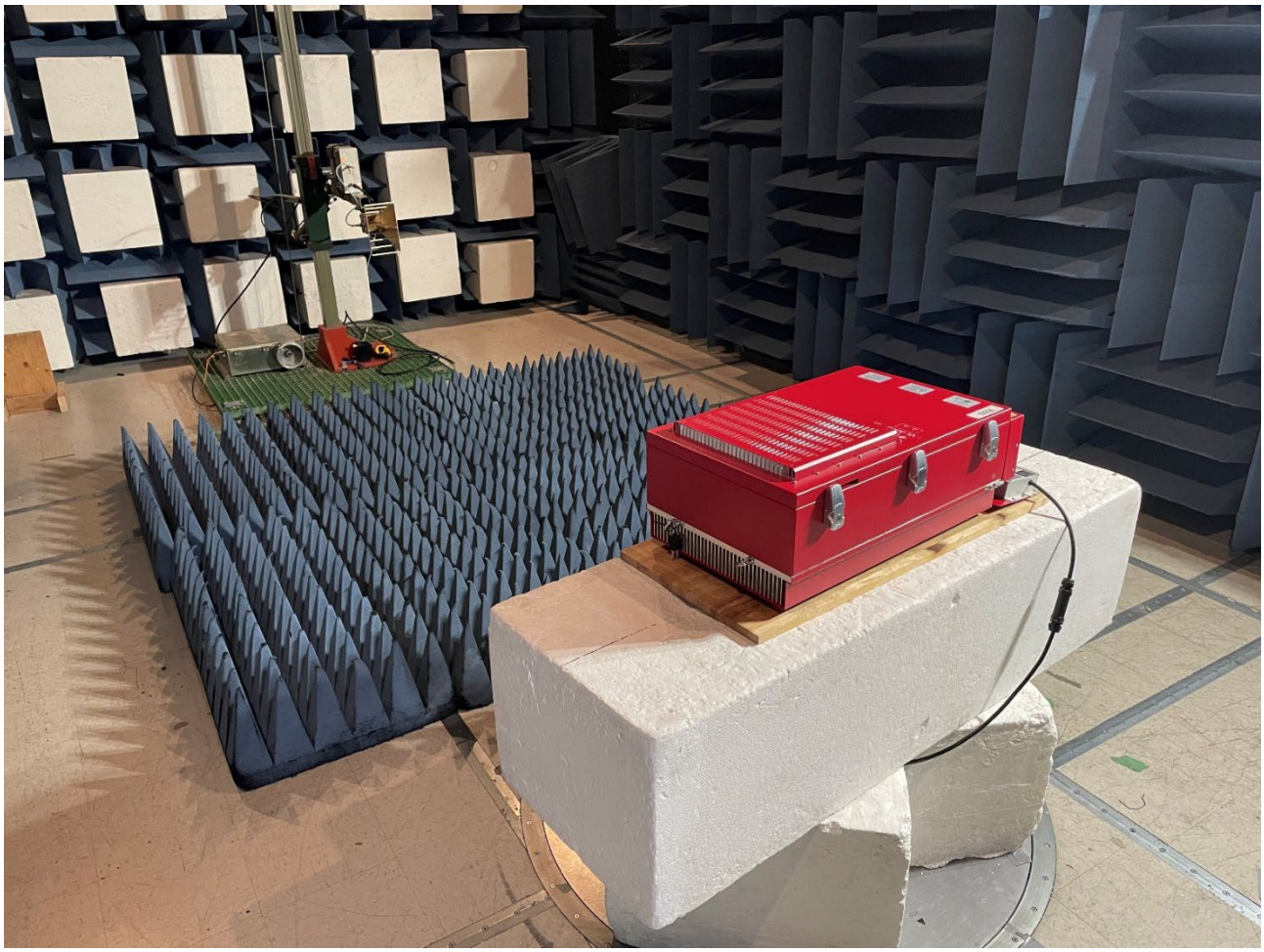
Test Method

This test measures the radiating levels from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices. Testing was performed in accordance with the test standard(s) referenced in the test summary section of this report. The Equipment Under Test (EUT) was configured based upon the requirements of the applicable test standard. Initially, the primary emission frequencies are identified by positioning a broadband receive antenna three meter from the EUT.

A scan was made with an EMC Analyzer, controlled by EMC Test Software, Tile7!, with the receiver in the peak mode. The receiver IF bandwidth was 1000 kHz and scan step was less than 300 kHz. To ensure that the maximum emission at each discrete frequency of interest is observed, the receive antenna is varied in height from one to four meters and rotated to produce horizontal and vertical polarities while the turntable is rotated to determine the worst emitting configuration. Measurements were then made using CISPR quasi peak when the peak readings were within 10dB of the limit line. The numerical results are included herein to demonstrate compliance.

Test Setup

The EUT was placed on an 80 cm non-conducting table above a ground reference plane (GRP).

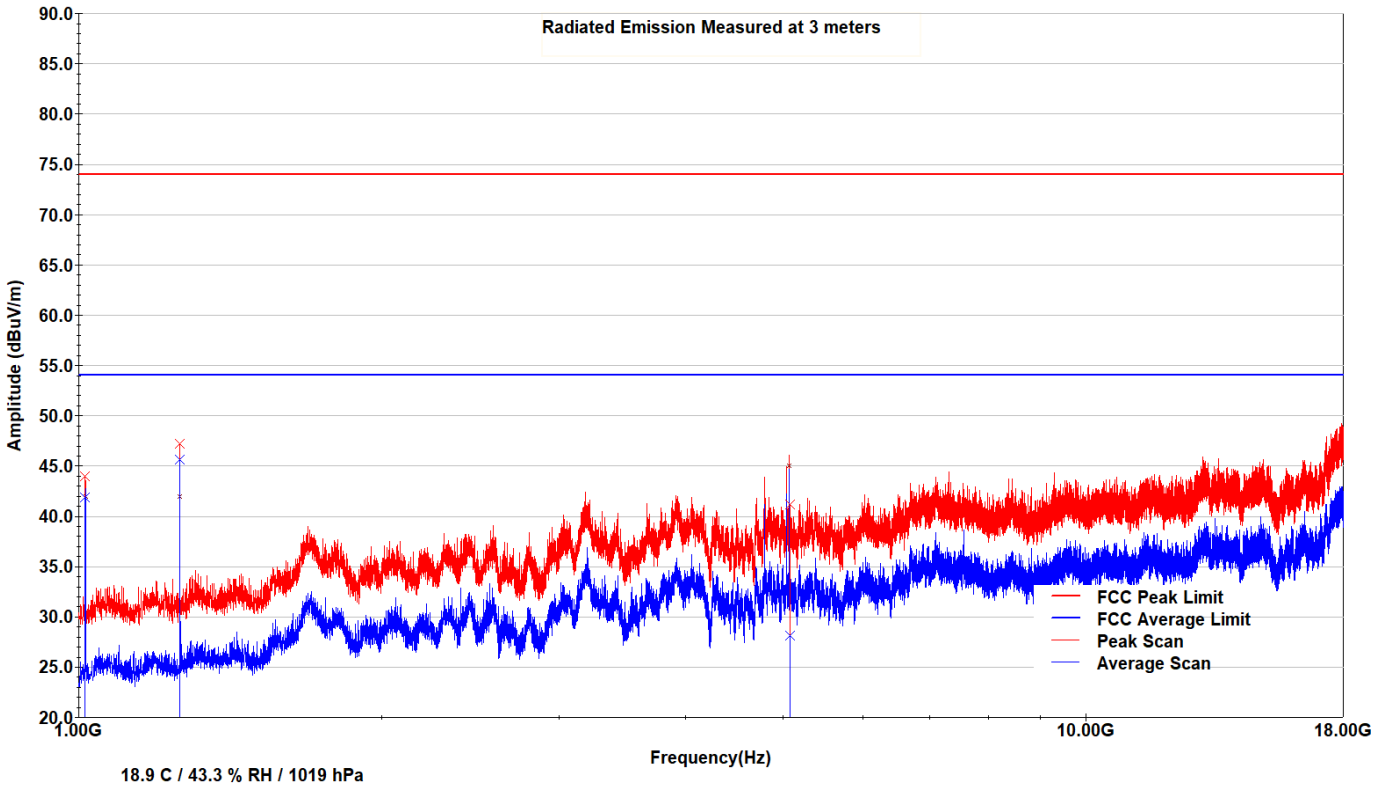


Measurement data and Plot

Note:

1) The test results below show that the EUT (Equipment Under Test) passes the tests with the Class B limit. Since the Class B limit is more restrictive than the Class A limit, it follows that the EUT also passes the tests with the Class A limit.
2) Quasi-peak (dBuV/m) = Raw Quasi-peak (dBuV) + Antenna Factor (dB/m) + Correction Factor (dB)
   Correction Factor (dB) = Cable loss(dB) + Preamp Gain(dB)

Radiated Emission 1 GHz – 18 GHz, 120V/60Hz, FCC Class B Limit



Frequency	Antenna Polarization	Antenna Factor	Correction Factor	Raw Average	Average	Aveg Margin	Avg Limit	RAW Peak	Peak	Peak Margin	Peak Limit
MHz	V/H	dB/m	dB	dBuV	dBuV/m	dB	dBuV/m	dBuV	dBuV/m	dB	dBuv/m
1014.8	V	23.3	-30.5	49.1	41.9	12.1	54	51.136	43.95	30.05	74
1259.9	V	24.7	-29.7	50.6	45.6	8.4	54	52.202	47.236	26.764	74
5079.8	V	34.1	-23.4	17.4	28.1	25.9	54	30.436	41.198	32.802	74

10 Conducted Emissions at AC Power Port

Standard	FCC Part 15 Subpart B				
Basic Standard(s)	ANSI C63.4, CISPR 16-2-1				
Tested by	Jack Qin				
Test date	2023-08-30				
Test location	in SAC, Richmond				
Test Equipment	Manufacturer	Model	LabTest ID	Calibration date	Calibration due
EMC Analyzer	Keysight Technologies	N9038A	702	02-Nov-2022	01-Nov-2023
LISN	Com-Power	LI-150A	1527	13-Apr-23	13-Apr-25
LISN	Com-Power	LI-150A	1528	13-Apr-23	13-Apr-25

Applied limit

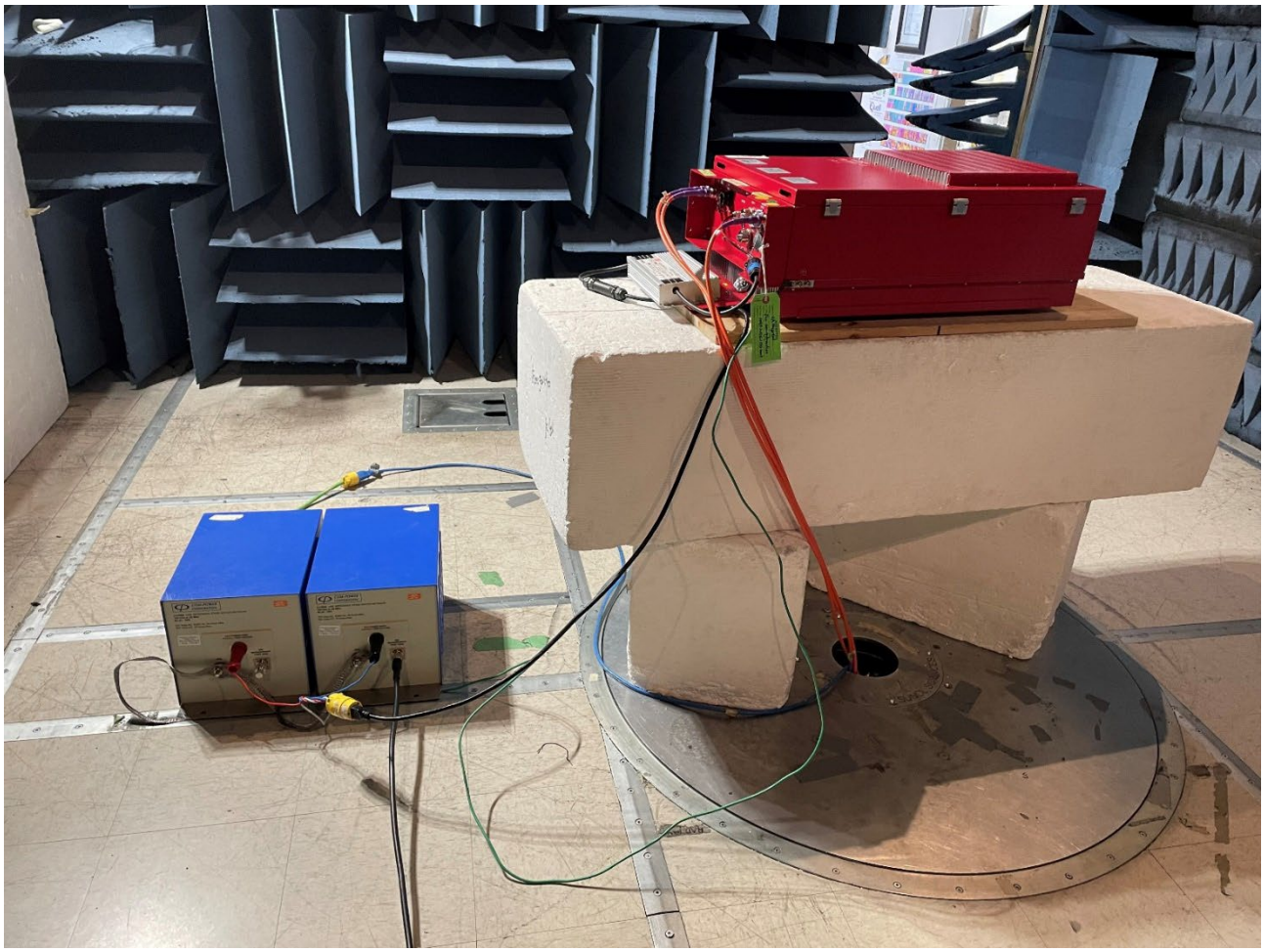
Conducted emissions Class A limits (AC mains power terminals)		
Frequency (MHz)	Quasi-Peak (dBμV)	Average (dBμV)
0.15 - 0.50	79	66
0.5 - 30	73	60
Note 1 The lower limit shall apply at the transition frequencies		

Test set-up description	☒	Set-up Type A (40 cm distance to vertical ground plane, 80 cm over ground plane)
	☐	Set-up Type B (40 cm distance to horizontal ground plane)
	☐	Floor standing equipment set-up (10 cm over ground plane)
	☐	Other:
Test method applied	☒	Artificial mains network (AMN)
	☐	Voltage Probe

VERDICT: PASS

Test method
This test measures the levels emanating from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices. Testing was performed in accordance with the test standard(s) referenced in the test summary section of this report. The Equipment Under Test (EUT) was configured based upon the requirements of the applicable test standard. Initially a scan was made with an EMC Analyzer, controlled by EMC Test Software, Tile7!, from 150 kHz to 30 MHz on each phase with the receiver in the peak mode. The measuring bandwidth was set up 9 kHz. Measurements were then made using CISPR16-1 quasi peak and averaging detectors when the peak readings were within 10dB of the Quasi-peak limit line.

Test setup
The EUT was placed on a 0.8m non-conducting table above GRP.

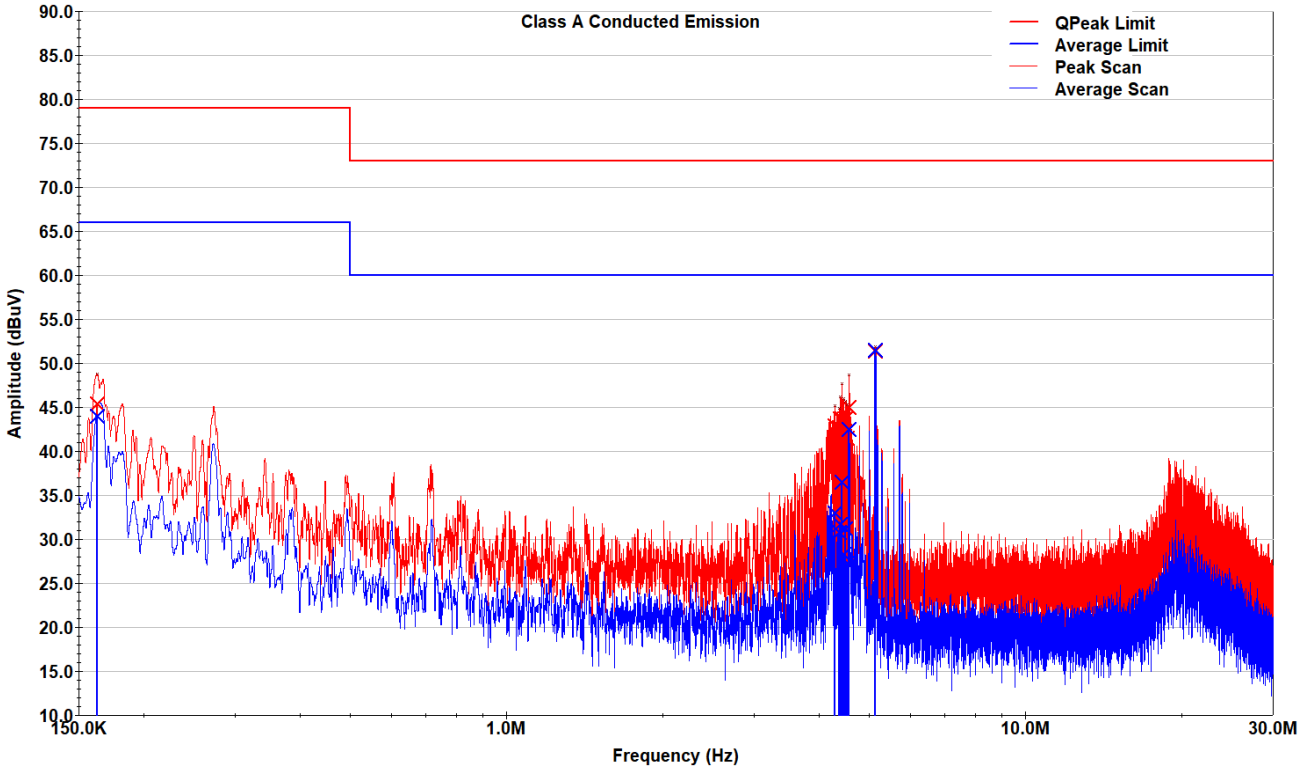


Measurement data and plot

Note:

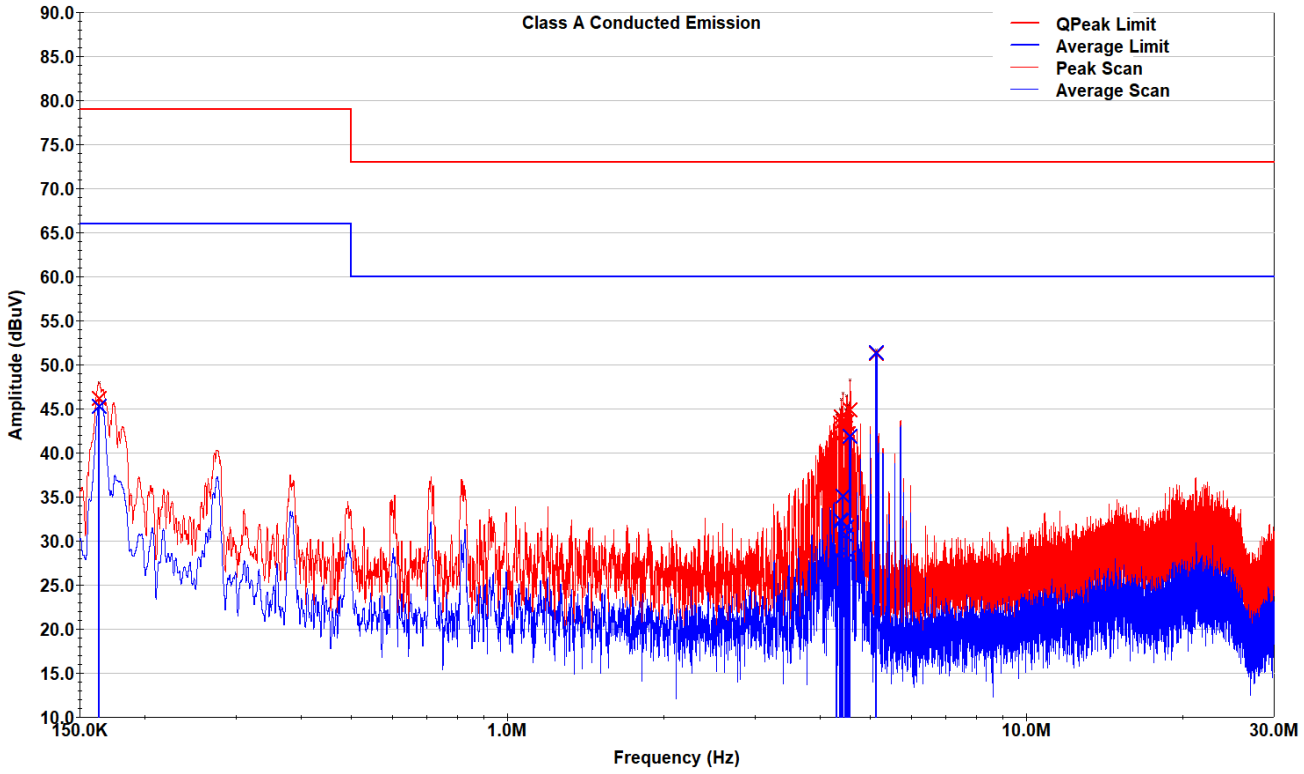
Conducted Emission (dBuV) = Measured Emission (dBuV) + Correction Factor (dB)
Correction Factor (dB) = LISN Transduce Factor (dB) + Cable loss(dB) + 20 dB limiter(dB)

Conducted Emission 150 kHz - 30MHz Class A, 120V/60Hz AC Main L1



Frequency	Correction Factor	QPeak	QPeak Margin	QPeak Limit	Average	Average Margin	Average Limit
MHz	dB	dBuV	dB	dBuV	dBuV	dB	dBuV
0.163	20.627	45.4	33.6	79	44.042	21.96	66
4.288	20.653	42.93	30.07	73	33.016	26.98	60
4.377	20.647	42.71	30.29	73	30.759	29.24	60
4.4	20.646	43.7	29.3	73	31.722	28.28	60
4.43	20.644	43.65	29.35	73	36.462	23.54	60
4.457	20.643	42.44	30.56	73	28.348	31.65	60
4.504	20.642	43.71	29.29	73	31.182	28.82	60
4.542	20.641	41.48	31.52	73	27.319	32.68	60
4.577	20.64	45.01	27.99	73	42.506	17.49	60
5.146	20.66	51.44	21.56	73	51.538	8.46	60

Conducted Emission 150 kHz - 30MHz Class A, 120V/60Hz AC Main L2



Frequency	Correction Factor	QPeak	QPeak Margin	QPeak Limit	Average	Average Margin	Average Limit
MHz	dB	dBuV	dB	dBuV	dBuV	dB	dBuV
0.163	20.627	46.16	32.84	79	45.281	20.72	66
4.306	20.652	41.74	31.26	73	28.423	31.58	60
4.372	20.647	43.39	29.61	73	32.364	27.64	60
4.396	20.646	44.1	28.9	73	32.313	27.69	60
4.429	20.644	43.56	29.44	73	35.091	24.91	60
4.487	20.642	42.83	30.17	73	30.717	29.28	60
4.508	20.642	43.53	29.47	73	31.58	28.42	60
4.532	20.641	42.24	30.76	73	28.111	31.89	60
4.577	20.64	44.9	28.1	73	41.942	18.06	60
5.147	20.66	51.34	21.66	73	51.383	8.62	60

Annex

Annex 1 – Measurement Uncertainties

Where relevant, the following measurement uncertainty levels have been estimated for tests:

Parameter	Uncertainty
Radio Frequency	± 1 ppm
Total RF Power: Conducted	± 1 dB
RF Power Density: Conducted	± 2.75 dB
Spurious Emissions: Conducted	± 3.0 dB
Temperature	± 1.0 °C
Humidity	± 5.0 %
DC and Low Frequency Voltages	± 3.0 %
Radiated Emission, 30 to 6,000MHz	± 4.93 dB
Conducted Measurements, 0.15 to 30MHz	± 3.52 dB

Uncertainty figures are valid to a confidence level of 95%.

Annex 2 - ISO 17025 ACCREDITATION CERTIFICATE

For complete scope of certification use

https://labtestcert.com/wp-content/uploads/2023/07/LabTestCertificationCertScope-V017.pdf

END OF REPORT

205 – 8291 92 Street, Delta, BC
V4G 0A4, Canada
Phone: 604-247-0444
Fax: 604-247-0442
www.labtestcert.com