4740 Discovery Drive | Lincoln, NE 68521
tel- 402.323.6233 | tel -888.657.6860 | fax - 402.323.6238
info@nceelabs.com | http://nceelabs.com

FDS Test Report

Client:	**Garmin International Inc.**
EUT:	**1200 E. 151st Street Olathe, Kansas, 66062, USA**
Product:	**A04540**
Test Report No.:	**R20221213-20-E3B**

Approved By:

Fox Lane,
EMC Test Engineer

Date: **16 February 2023**

Total Pages: **44**

ACCREDITED
TESTING LABORATORY
CERTIFICATE NO. 1953.01

Revision Page

Rev. No.	Date	Description
Original	2/8/2023	Issued by FLane Prepared by KVepuri/FLane
A	2/9/2023	Corrected Operating Range - FL
B	2/16/2023	Edited Table names - FL

Table of Contents

1 Summary of Test Results

1.1 Emissions Test Results

The EUT has been tested according to the following specifications:

(1) US Code of Federal Regulations, Title 47, Part 15
(2) ISED RSS-210, Issue 10

Testing was performance in accordance with the methods published in ANSI C63.10-2013

Table 1 - Emissions Test Results

Emissions Tests	Test Method and Limits	Result
Fundamental, Harmonics and Band Edges	FCC Part 15.249 RSS-210, Issue 10, Annex B.10	Complies

2 EUT Description

2.1 Equipment under Test (EUT)

Table 2 - Equipment under Test (EUT)

EUT	A04540
IC	1792A-04540
FCC ID	IPH-04540
EUT Received	1 December 2022
EUT Tested	1 December 2022- 9 January 2023
Serial No.	3419589455 (Radiated Measurements) 3419589465 (Conducted Measurements)
Operating Band	24000 MHz -24250 MHz
Device Type	Field Disturbance Sensor
Power Supply / Voltage	12VDC Marine battery Representative power supply used for Conducted AC Emissions: Garmin MN: PSAI05R-050Q PN: 362-00072-00

2.2 Laboratory Description

All testing was performed at the following Facility:

The Nebraska Center for Excellence in Electronics (NCEE Labs)
4740 Discovery Drive
Lincoln, NE 68521

A2LA Certificate Number:	1953.01
FCC Accredited Test Site Designation No:	US1060
Industry Canada Test Site Registration No:	4294A-1
NCC CAB Identification No:	US0177

Environmental conditions varied slightly throughout the tests:

Relative humidity of 32 ± 4%
Temperature of 22 ± 3° Celsius

2.3 EUT Setup

The EUT was powered by 12 VDC unless specified and set to transmit continuously on the selected frequency channel.

3 Test Results

3.1 Fundamental Emissions

Test: FCC Part 15.245, RSS-210, Issue 10

Test Result: Complies

3.1.1 Test Description

Measurements distances can be seen in section 3.1.6 Table 3. The results were compared against the limits published in FCC Part 15.245.

3.1.2 Test Results

No radiated emissions measurements were found in excess of the limits. Test result data can be seen below.

3.1.3 Test Environment

Testing was performed at the NCEE Labs Lincoln facility. Laboratory environmental conditions varied slightly throughout the test:

Relative humidity of 33 ± 5%
Temperature of 22 ±2^{o} C

3.1.4 Test Setup

See Section 2.3 for further details.

3.1.5 Test Pictures and/or Figures

Fundamental Peak 15.249									
Channel	**Frequency**	**SA Reading (Peak) (SAR)**	**Antenna Factor (AF)**	**Cable loss (CL)**	**FS Level (Peak) (FSL)**	**Test Distance (TD)**	**FS level @ 3m (FSL 3)**	**Peak Limit (Part 15.249)**	**Margin**
	GHz	**dBmV**	**dB**	**dB**	**dBmV/m**	**m**	**dBmV/m**	**dBmv/m**	**dB**
Low	24.022000	16.94	45.564	0	62.504	1	52.96157	67.9588	14.99723
Mid	24.139000	15.685	45.502	0	61.187	1	51.64457	67.9588	16.31423
High	24.217000	15.811	45.454	0	61.265	1	51.72257	67.9588	16.23623
FSL=SAR+AF+CL; FSL 3=FSL+20*log(TD/3); Margin=Limit-FSL 3									

Table 3 - Fundamental Data, Peak
Measurements made at 1m for fundamental. Measurements were extrapolated to 3m.

Fundamental Average 15.249										
Channel	**Frequency**	**SA Reading (Peak) (SAR)**	**Antenna Factor (AF)**	**Cable loss (CL)**	**DCCF**	**FS Level (Peak) (FSL)**	**Test Distance (TD)**	**FS level @ 3m (FSL 3)**	**Avg Limit (Part 15.249)**	**Margin**
	GHz	**dBmV**	**dB**	**dB**	**dB**	**dBmV/m**	**m**	**dBmV/m**	**dBmv/m**	**dB**
Low	24.022000	16.94	45.564	0	-19.0309	43.4731	1	33.93068	47.9588	14.02813
Mid	24.139000	15.685	45.502	0	-19.0309	42.1561	1	32.61368	47.9588	15.34513
High	24.217000	15.811	45.454	0	-19.0309	42.2341	1	32.69168	47.9588	15.26713
FSL=SAR+AF+CL; FSL 3=FSL+20*log(TD/3); Margin=Limit-FSL 3										

Table 4 - Fundamental Data, Average
Measurements made at 1m for fundamental. Measurements were extrapolated to 3m.

Harmonics - Peak Limit, FCC 15.249											
Channel	**Harmonic**	**Frequency**	**SA reading (Peak Detector) (SAR)**	**Test Distance (TD)**	**Cable loss (CL)**	**Mixer Factor (MF)**	**Antenna Factor (AF)**	**Field Strength Level (FSL)**	**FS extrapolated to 3m (FSL 3)**	**Avg Limit (at 3m FCC Part 15.249)**	**Margin**
		GHz	**dBmV/m**	**m**	**dB**	**dB**	**dB**	**dBmV/m**	**dBmV/m**	**dBmV/m**	
Low	*2nd*	48.044000	-30.377	0.5	1.3	21.9	40.90	**34.22**	**18.66**	27.9588	9.30
Mid	*2nd*	48.278000	-34.173	0.5	1.3	22	40.94	**30.57**	**15.00**	27.9588	12.96
High	*2nd*	48.434000	-29.745	0.5	1.3	22.1	40.97	**35.12**	**19.56**	27.9588	8.40
Low	*3rd*	72.066000	-2.315	0.5	0	0	43.42	**41.60**	**26.04**	27.9588	1.92
Mid	***3rd***	**72.417000**	**-2.14**	**0.5**	**0**	**0**	**43.46**	**41.82**	**26.26**	**27.9588**	**1.70**
High	*3rd*	72.651000	-3.11	0.5	0	0	43.49	**40.88**	**25.32**	27.9588	2.64
Low	*4th*	96.088000	-21.683	0.5	0	0	45.92	**24.74**	**9.17**	27.9588	18.78
Mid	*4th*	96.556000	-20.081	0.5	0	0	45.96	**26.38**	**10.82**	27.9588	17.14
High	*4th*	96.868000	-21.099	0.5	0	0	45.99	**25.39**	**9.83**	27.9588	18.13
FSL=SAR+MF+AF+CL+DCCF; FSL 3=FSL+20*log(TD/3); Margin=Limit-FSL 3; MF=0 if its accounted for in the plot.											

Table 5 - Harmonic Emissions Data, Peak

0.5m for 2nd and 3rd Harmonics respectively. Measurements were extrapolated to 3m.

Harmonics - Avg Limit, FCC 15.249												
Channel	**Harmonic**	**Frequency**	**SA reading (Peak Detector) (SAR)**	**Test Distance (TD)**	**Cable loss (CL)**	**Mixer Factor (MF)**	**Antenna Factor (AF)**	**DCCF**	**Field Strength Level (FSL)**	**FS extrapolated to 3m (FSL 3)**	**Avg Limit (at 3m FCC Part 15.249)**	**Margin**
		GHz	**dBmV/m**	**m**	**dB**	**dB**	**dB**	**dB**	**dBmV/m**	**dBmV/m**	**dBmV/m**	
Low	*2nd*	48.044000	-30.377	0.5	1.3	21.9	40.90	-38.06	**-4.34**	**-19.91**	7.9588	27.86
Mid	*2nd*	48.278000	-34.173	0.5	1.3	22	40.94	-38.06	**-8.00**	**-23.56**	7.9588	31.52
High	*2nd*	48.434000	-29.745	0.5	1.3	22.1	40.97	-38.06	**-3.44**	**-19.00**	7.9588	26.96
Low	*3rd*	72.066000	-2.315	0.5	0	0	43.42	-38.06	**3.04**	**-12.52**	7.9588	20.48
Mid	*3rd*	72.417000	-2.14	0.5	0	0	43.46	-38.06	**3.26**	**-12.30**	7.9588	20.26
High	*3rd*	72.651000	-3.11	0.5	0	0	43.49	-38.06	**2.32**	**-13.25**	7.9588	21.21
Low	*4th*	96.088000	-21.683	0.5	0	0	45.92	-38.06	**-13.82**	**-29.39**	7.9588	37.34
Mid	*4th*	96.556000	-20.081	0.5	0	0	45.96	-38.06	**-12.18**	**-27.74**	7.9588	35.70
High	*4th*	96.868000	-21.099	0.5	0	0	45.99	-38.06	**-13.17**	**-28.73**	7.9588	36.69
FSL=SAR+MF+AF+CL+DCCF; FSL 3=FSL+20*log(TD/3); Margin=Limit-FSL 3; MF=0 if its accounted for in the plot.												

Table 6 - Harmonic Emissions Data, Average

0.5m for 2nd and 3rd Harmonics respectively. Measurements were extrapolated to 3m.

Remarks relating to 5 cm and 50 cm measurements of 2nd and 3rd harmonics:

Per FCC Part 15.31 (f) the distance is defined as:

To the extent practicable, the device under test shall be measured at the distance specified in the appropriate rule section. The distance specified corresponds to the horizontal distance between the measurement antenna and the closest point of the equipment under test, support equipment or interconnecting cables as determined by the boundary defined by an imaginary straight-line periphery describing a simple geometric configuration enclosing the system containing the equipment under test. The equipment under test, support equipment and any interconnecting cables shall be included within this boundary.

Per FCC Part 15.31(f)(1)

(1) At frequencies at or above 30 MHz, measurements may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment. Measurements shall not be performed at a distance greater than 30 meters unless it can be further demonstrated that measurements at a distance of 30 meters or less are impractical. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

The measurements presented for 2nd and 3rd harmonics in this report meet both of the criteria for allowing near-field measurements

1. it can be shown that near field measurements are appropriate due to the characteristics of the device - (better signal to noise ratio when measuring an extremely narrow beam width.)

2. it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment. (yes it can)

Since the 20 dB/decade extrapolation is explicitly specified in the CFR, this takes precedence over the addition of the linear distance attenuation factor specified in C63.10, Section 9.1.

Plots:

Note:

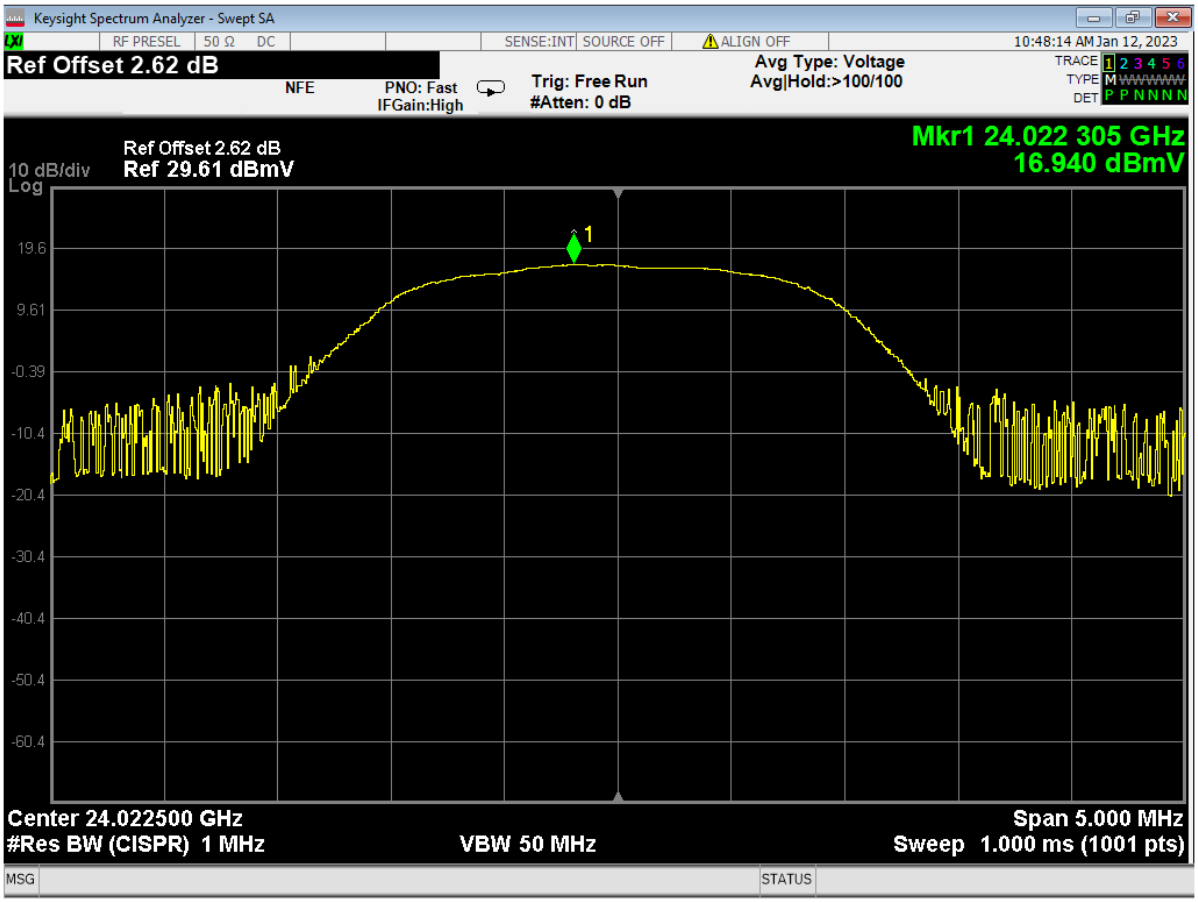


Figure 1 - Analyzer Measurement – Fundamental, Low Channel

Uncorrected measurement as recorded on spectrum analyzer

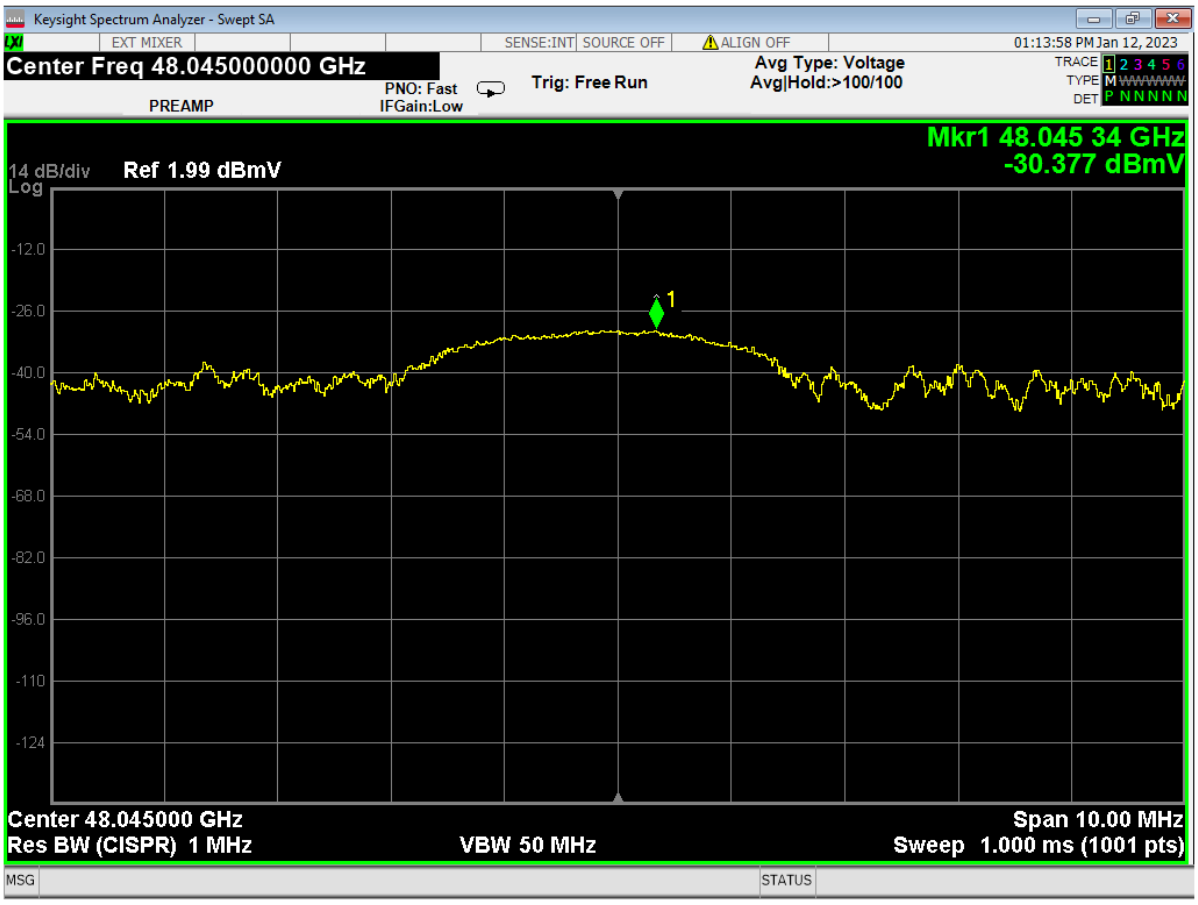


Figure 2 - Analyzer Measurement – 2nd Harmonic, Low Channel, Peak

Uncorrected measurement as recorded on spectrum analyzer

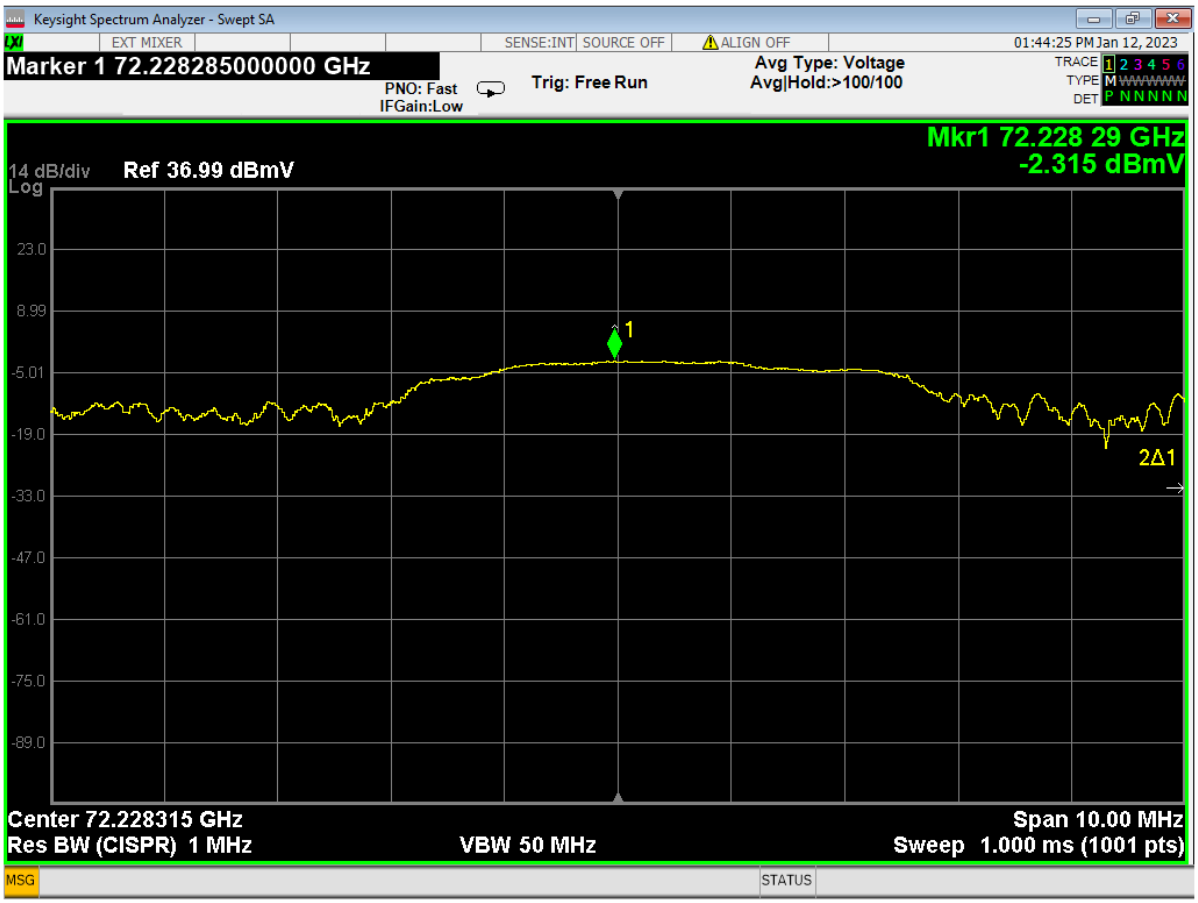


Figure 3 - Analyzer Measurement – 3rd Harmonic, Low Channel, Peak

Uncorrected measurement as recorded on spectrum analyzer

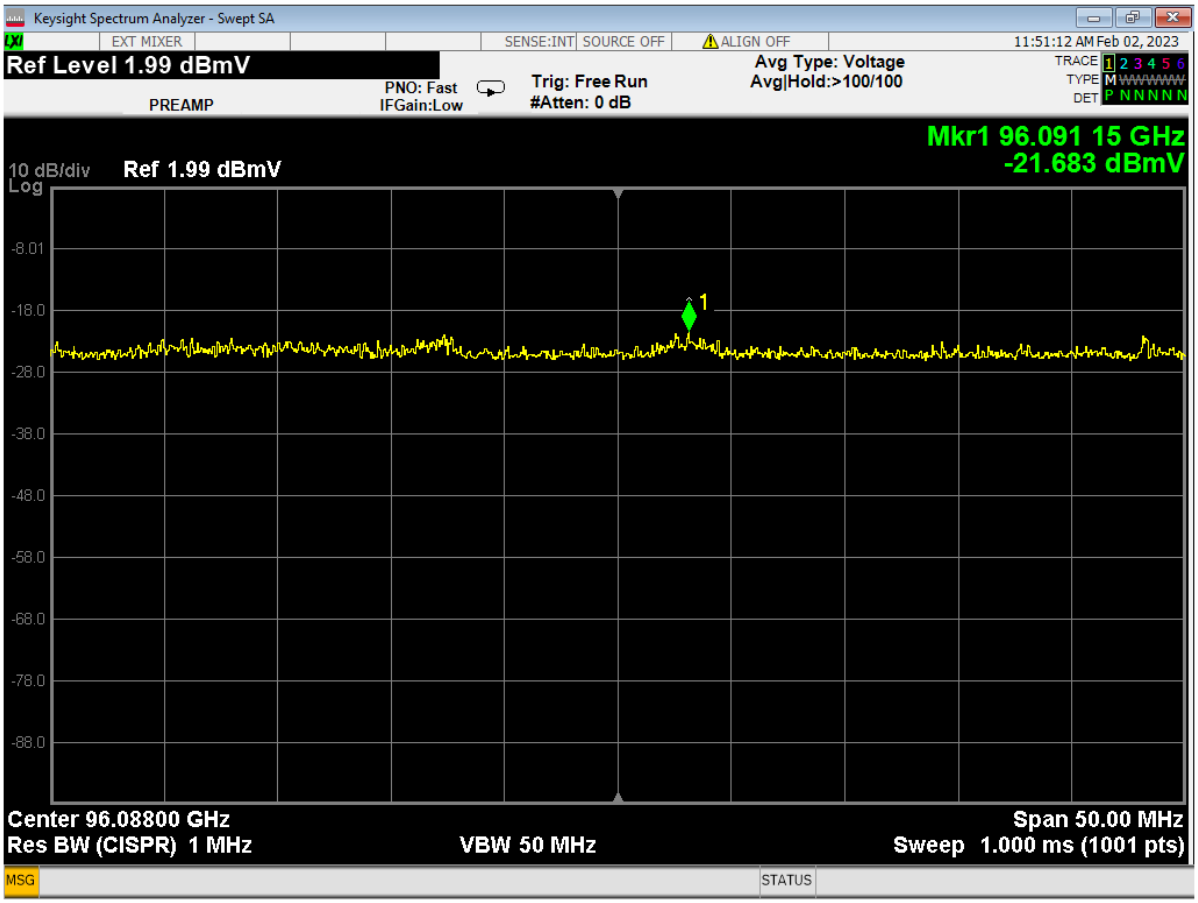


Figure 4 - Analyzer Measurement – 4th Harmonic, Low Channel, Peak

Uncorrected measurement as recorded on spectrum analyzer.

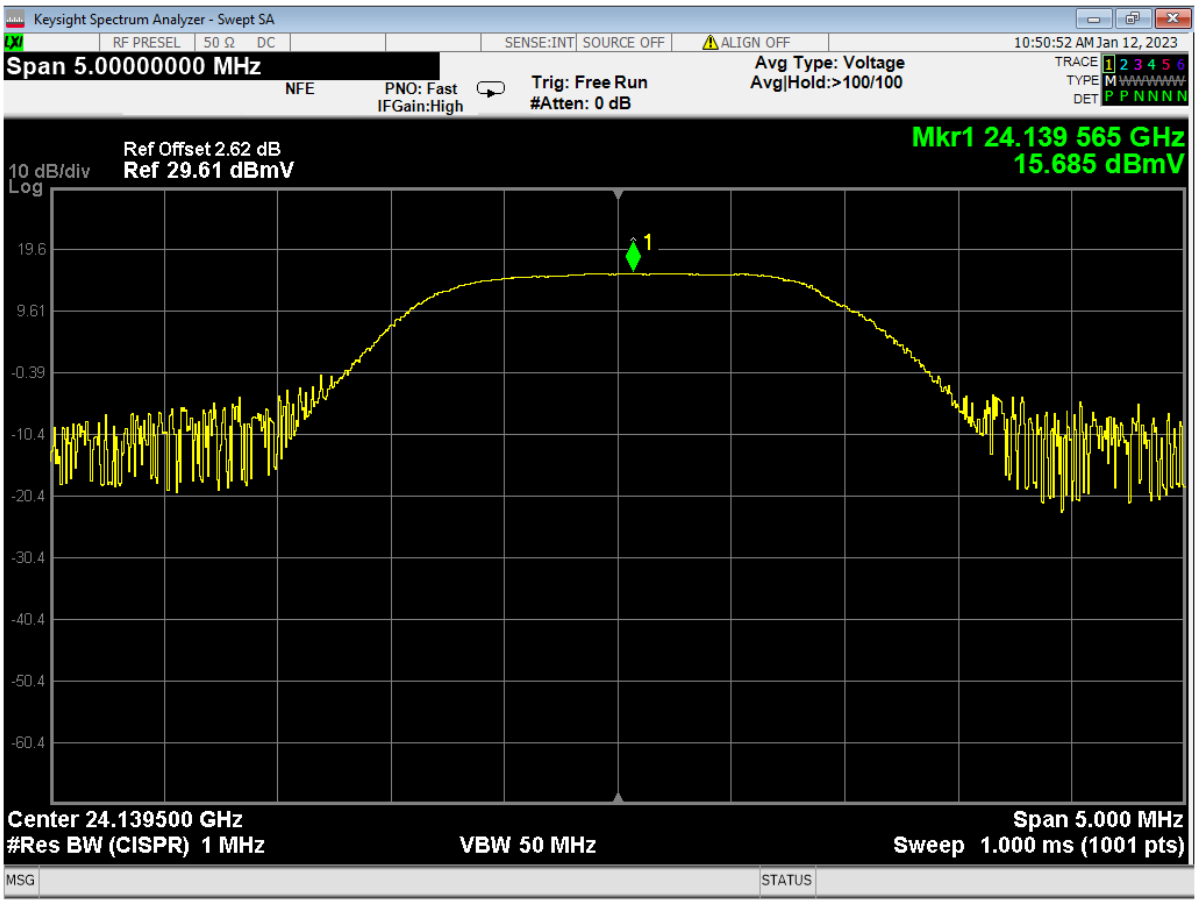


Figure 5 - Analyzer Measurement – Fundamental, Mid Channel

Uncorrected measurement as recorded on spectrum analyzer

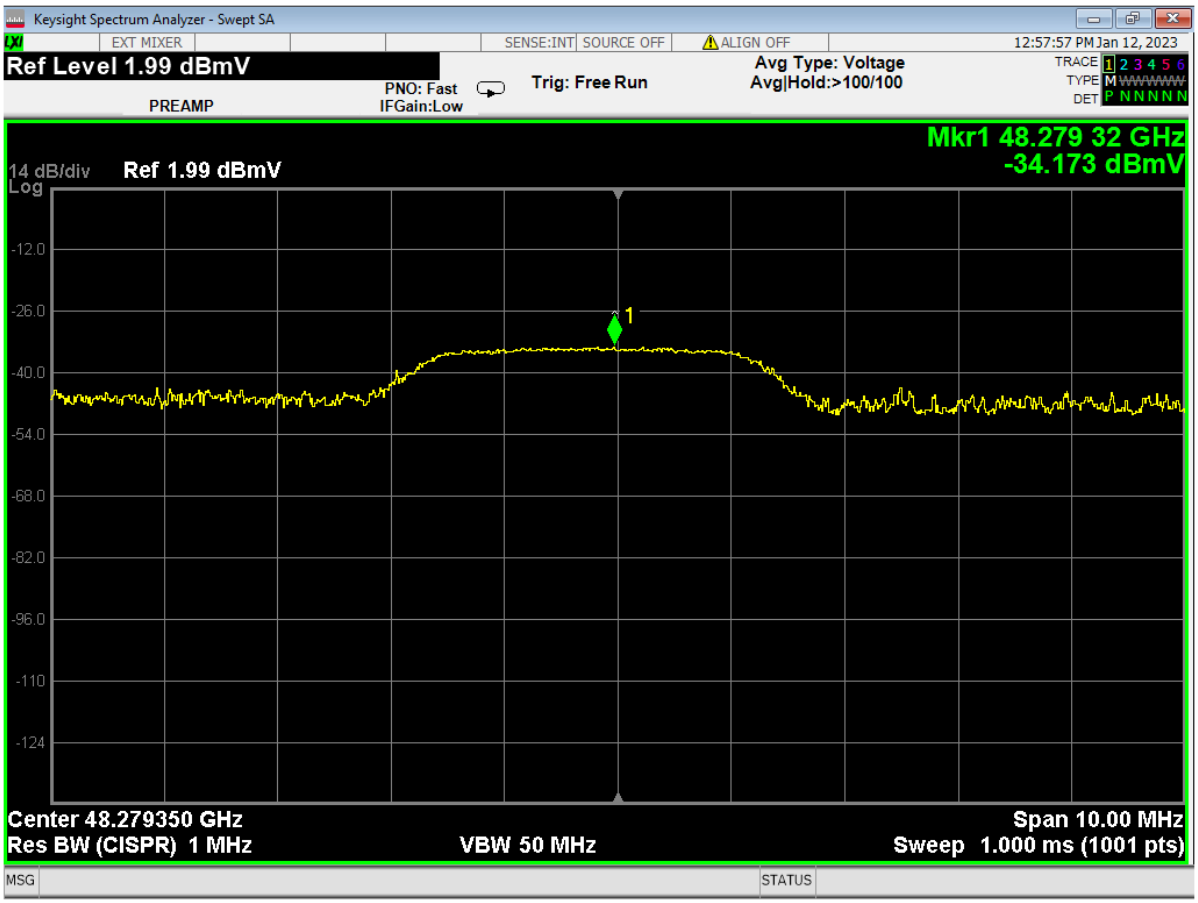


Figure 6 - Analyzer Measurement – 2nd Harmonic, Mid Channel, Peak

Uncorrected measurement as recorded on spectrum analyzer

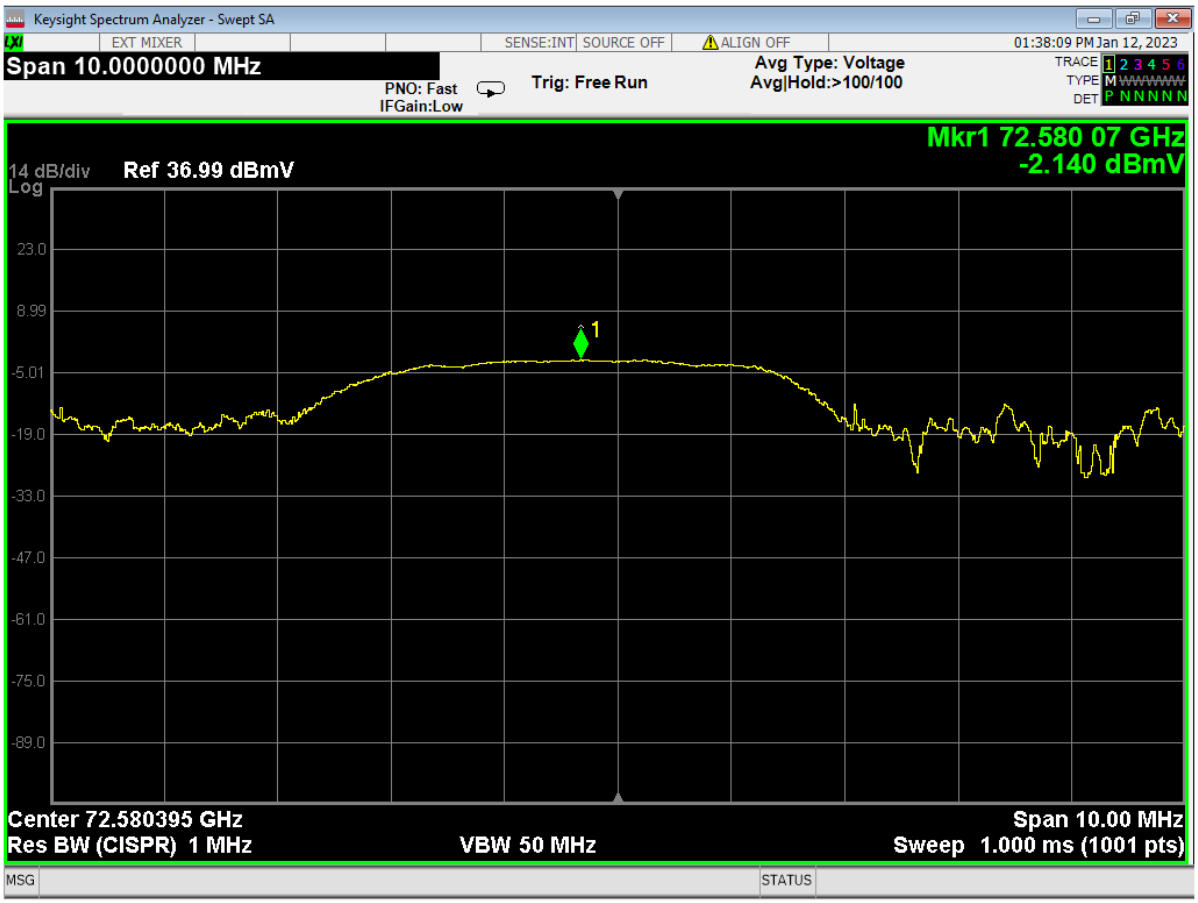


Figure 7 - Analyzer Measurement – 3rd Harmonic, Mid Channel, Peak

Uncorrected measurement as recorded on spectrum analyzer

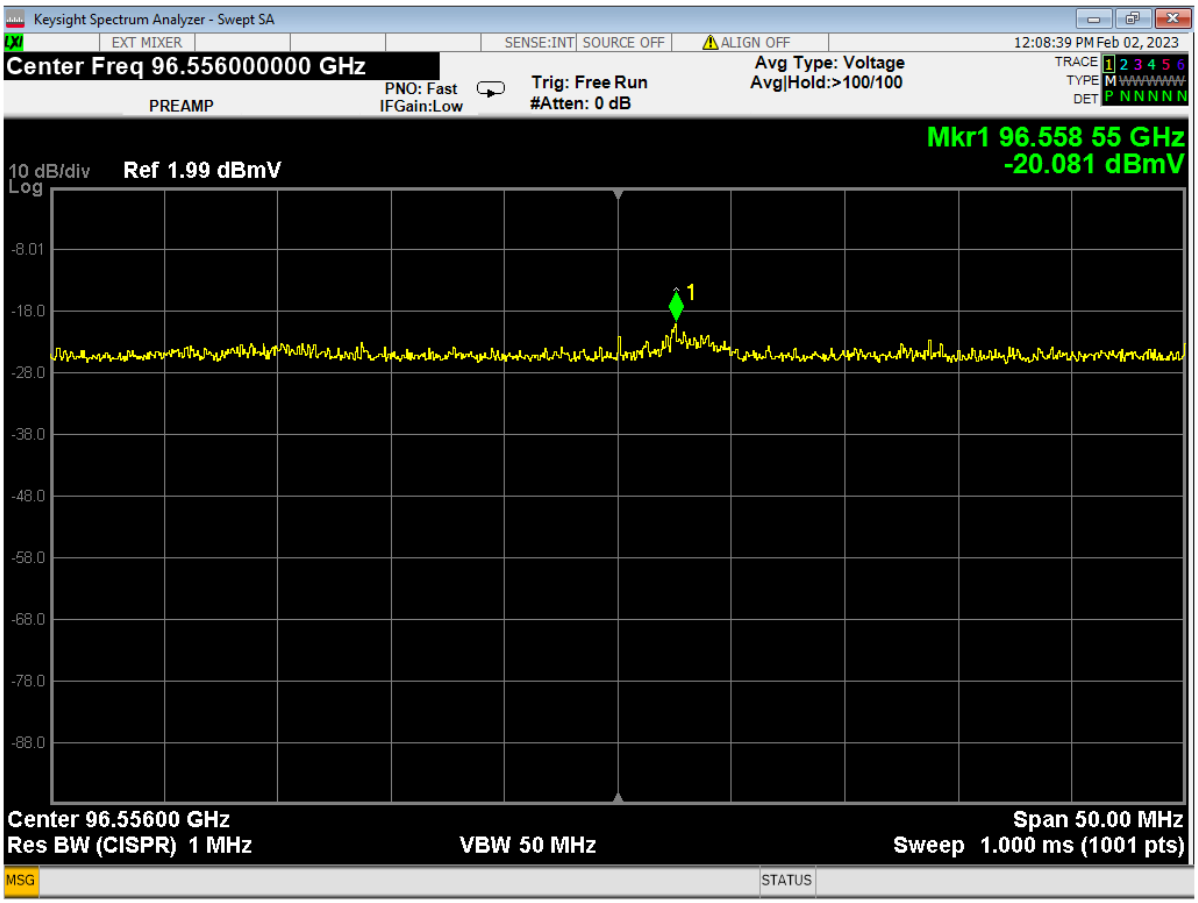


Figure 8 - Analyzer Measurement – 4th Harmonic, Mid Channel, Peak

Uncorrected measurement as recorded on spectrum analyzer

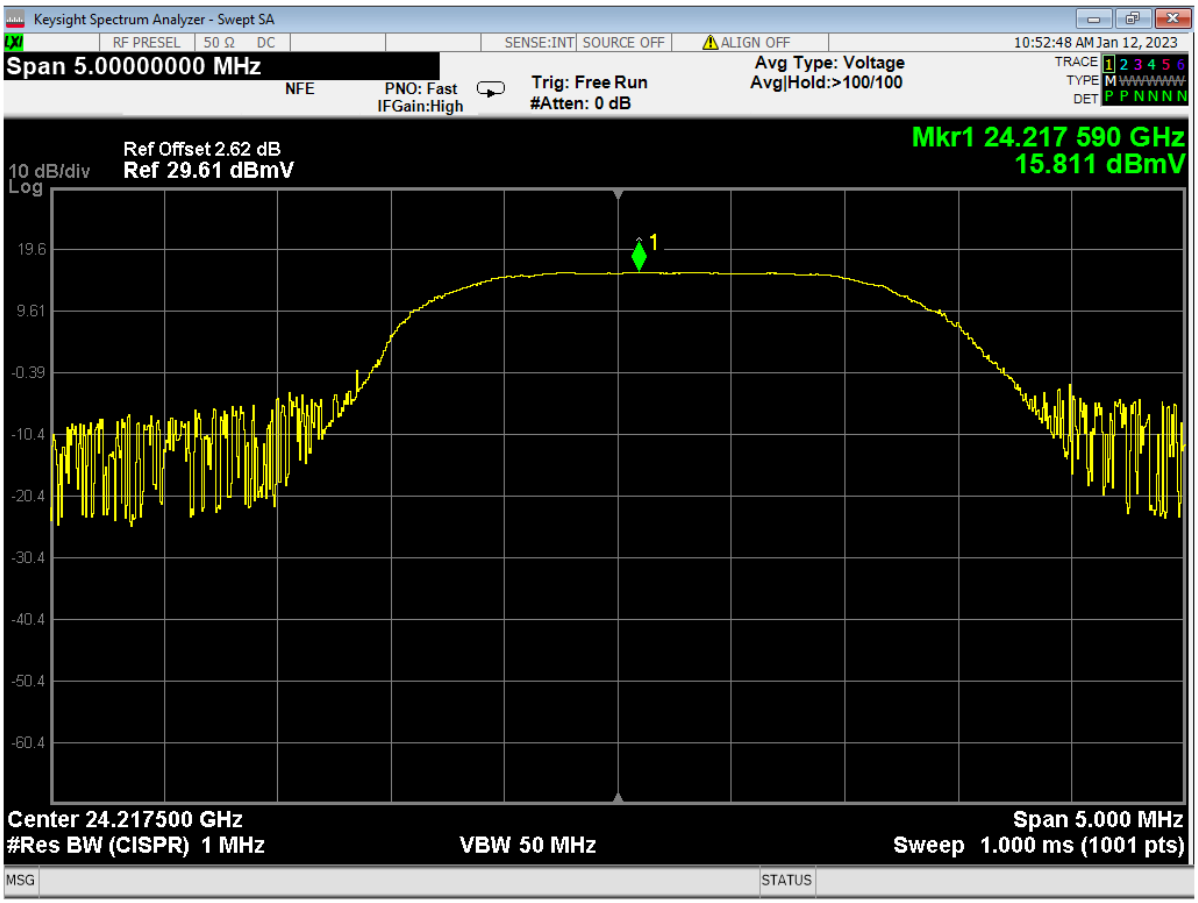


Figure 9 - Analyzer Measurement – Fundamental, High Channel

Uncorrected measurement as recorded on spectrum analyzer

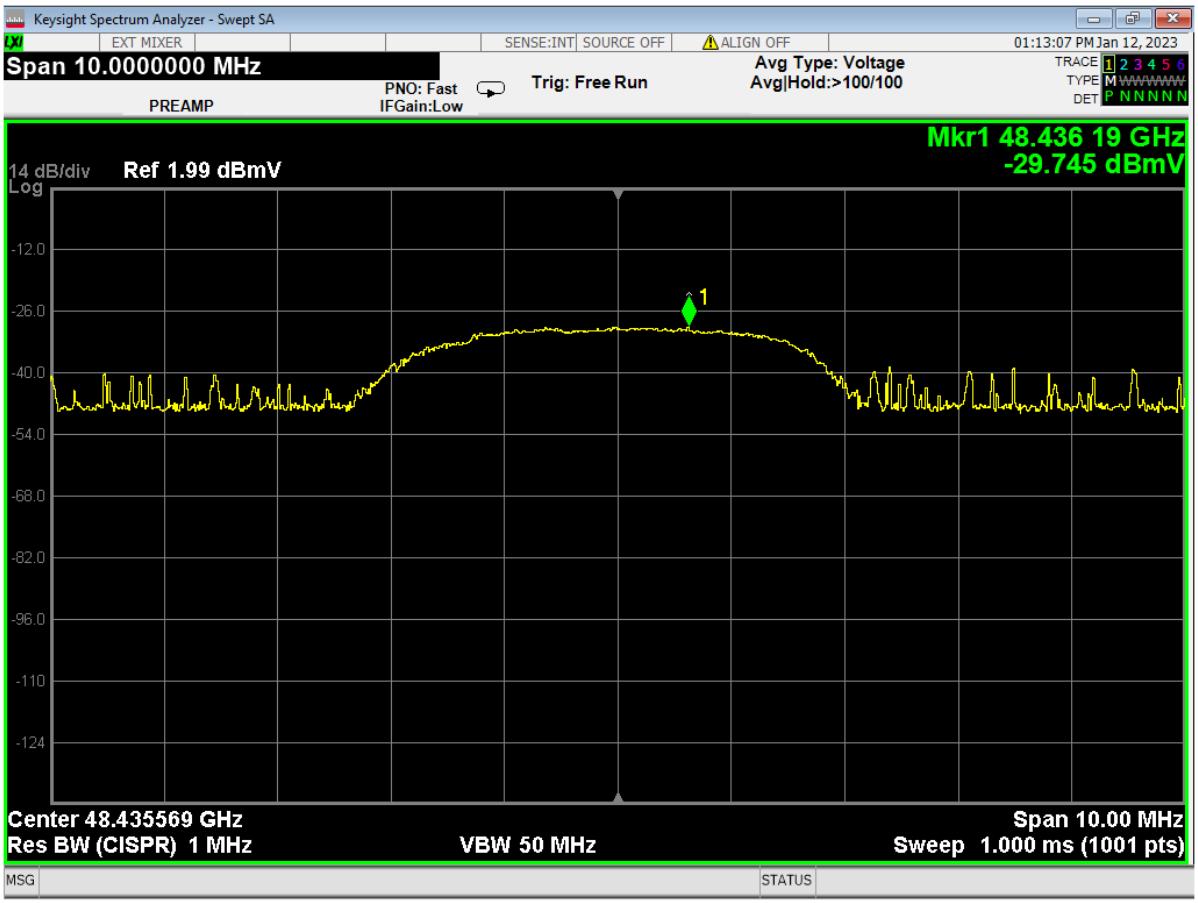


Figure 10 - Analyzer Measurement – 2nd Harmonic, High Channel, Peak

Uncorrected measurement as recorded on spectrum analyzer

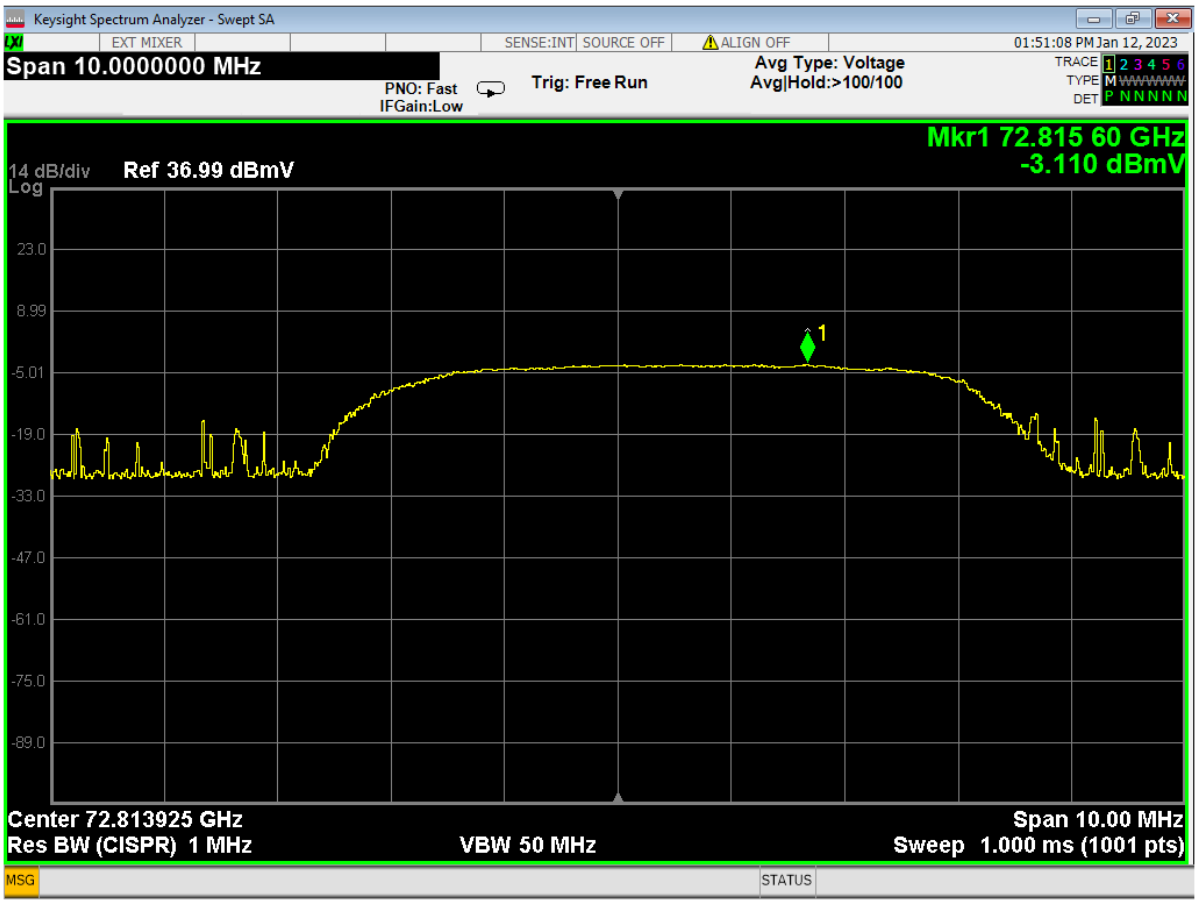


Figure 11 - Analyzer Measurement – 3rd Harmonic, High Channel, Peak

Uncorrected measurement as recorded on spectrum analyzer.

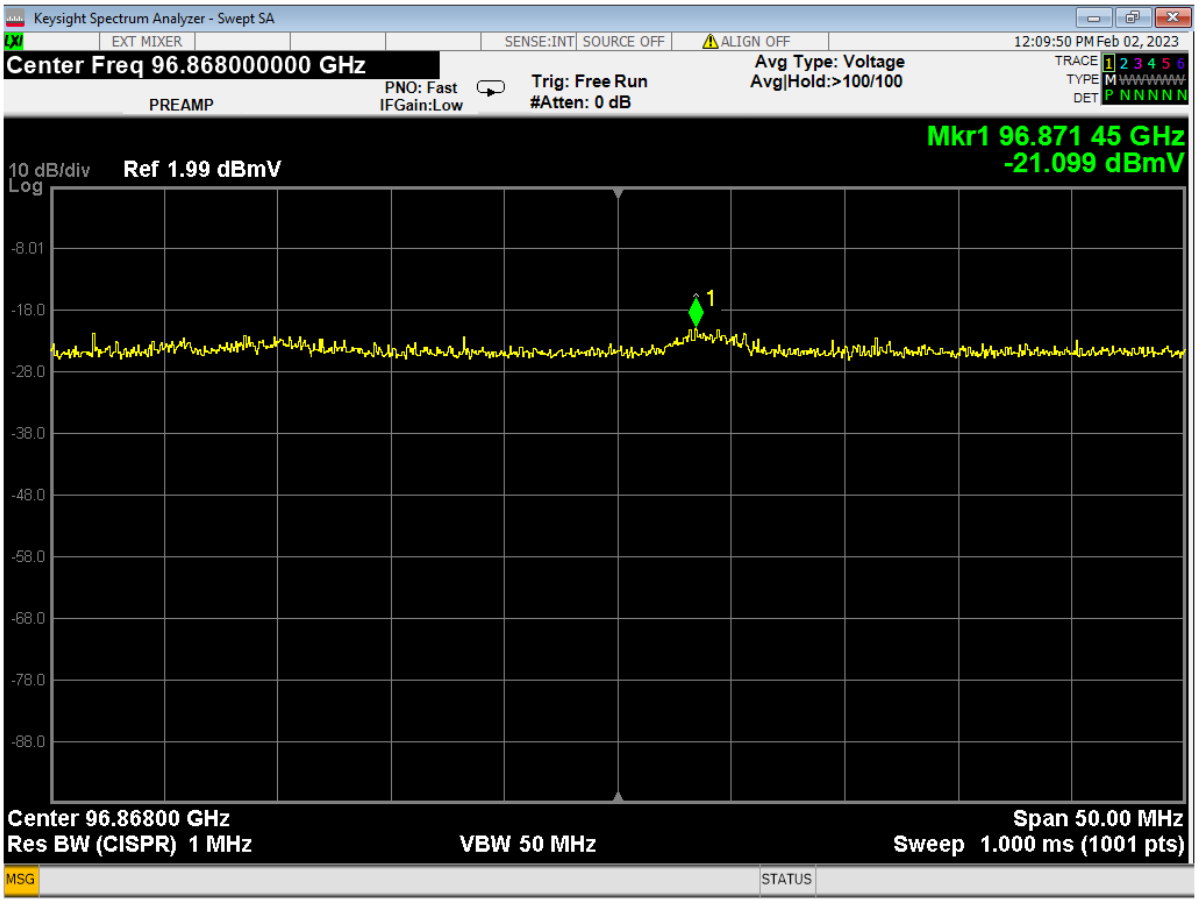


Figure 12 - Analyzer Measurement – 4th Harmonic, Mid Channel, Peak

Uncorrected measurement as recorded on spectrum analyzer.

3.2 Band edges

Test Method: ANSI C63.10-2013, Section(s) 6.10.5, 6.10.6

3.2.1 Limits of bandedge measurements:

For emissions outside of the allowed band of operation, the emission level needs to be 50dB under the maximum fundamental field strength. However, if the emissions fall within one of the restricted bands from 15.205 the field strength levels need to be under that of the limits in 15.209.

The limit from FCC Part 15.209 for all frequencies above 960 MHz is 500 µV/m at 3m.

500 µV/m = 20log (500) = 54 dBµV/m at 3m average

Peak limit = average limit + 20 dB = 74 dBµV/m at 3m peak

Restricted Bands:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
[1]0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	([2])
13.36-13.41			

3.2.2 Test procedures:

The EUT was oriented as to produce the maximum emission levels. The resolution bandwidth was set to 1MHz. The highest emissions level beyond the band edge was measured and recorded. All band edge measurements were evaluated to the general limits in Part 15.209.

Measurements were performed as radiated measurements in the same manner as Section 3.1 of this report.

The bandwidth of the fundamental frequency was measured by spectrum analyzer with 100 kHz RBW and 300 kHz VBW. The occupied bandwidth was measured using the spectrum analyzers 99% occupied bandwidth setting.

3.2.3 Deviations from test standard:

No deviation.

3.2.4 Test setup:

All the measurements were done at 1m test distance.

3.2.5 EUT operating conditions:

The EUT was set to transmit continuously on the lowest frequency channel, and the highest frequency channel.

3.2.6 Band Edges

Test results:

Peak Restricted Band Edge												
Channel	Band Edge	Band Frequency	Peak SA reading (SAR)	Antenna Factor (AF)	DCCF	Cable loss (CL)	Test Distance	FS level @ Test Distance	FS level @ 3m (FS 3 dBmV)	FS level @ 3m (FS 3 dBuV)	Peak Limit Part 15.209	Margin
GHz		GHz	dBmV	dB	dB	dB	m	dBmV/m	dBmV/m	dBµv/m	dBµv/m	
Low	*LBE*	24.022000	-26.59	45.56	0.00	0.00	1.00	18.98	9.44	69.44	74	4.56
High	*HBE*	24.139000	-26.55	45.50	0.00	0.00	1.00	18.95	9.41	69.41	74	4.59
FS = SAR 1+AF+LC; FS 3= FS TD +20*log(TD/3); SAR Detector type= Average												
(3) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.												

Average Restricted Band Edge												
Channel	Band Edge	Band Frequency	SA reading (SAR)	Antenna Factor (AF)	DCCF	Cable loss (CL)	Test Distance	FS level @ Test Distance	FS level @ 3m (FS 3 dBmV)	FS level @ 3m (FS 3 dBuV)	Avg Limit Part 15.209	Margin
GHz		GHz	dBmV	dB	dB	dB	m	dBmV/m	dBmV/m	dBµv/m	dBµv/m	
Low	*LBE*	24.022000	-26.59	45.56	-38.06	0.00	1.00	-19.08	-28.63	31.37	54	22.63
High	*HBE*	24.139000	-26.55	45.50	-38.06	0.00	1.00	-19.11	-28.65	31.35	54	22.65
FS = SAR 1+AF+LC; FS 3= FS TD +20*log(TD/3); SAR Detector type= Peak												
(3) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.												

Peak Spurious Measurements >18GHz												
Ch.	Detector / Trace	Frequency	SA reading (SAR)	Antenna Factor (AF)	Cable loss (CL)	Test Distance	FS level @ Test Distance	FS level @ 3m (FS 3 dBmV)	FS level @ 3m (FS 3 dBuV)	Limit Part 15.209	Delta to fund.	Margin to 15.209
		GHz	dBmV	dB	dB	m	dBmV/m	dBmV/m	dBµv/m	dBµV/m (15.209)	dB	dB
Low	Peak/Maxhold	19.2860	-36.04	45.06	0.00	1.00	9.02	-0.52	59.48	74	NA	14.52
Low	Peak/Maxhold	21.5768	-28.14	45.13	0.00	1.00	17.00	7.45	67.45	74	NA	6.55
Low	Peak/Maxhold	26.4685	-28.62	45.28	0.00	1.00	16.66	7.11	67.11	74	NA	6.89
Low	Peak/Maxhold	27.0700	-32.47	46.06	0.00	1.00	13.60	4.05	64.05	74	NA	9.95
Low	Peak/Maxhold	28.9792	-29.89	45.87	0.00	1.00	15.98	6.44	66.44	74	NA	7.56

Average Spurious Measurements >18GHz													
Ch.	Detector / Trace	Frequency	SA reading (SAR)	Antenna Factor (AF)	DCCF	Cable loss (CL)	Test Distance	FS level @ Test Distance	FS level @ 3m (FS 3 dBmV)	FS level @ 3m (FS 3 dBuV)	Limit Part 15.209	Delta to fund.	Margin to 15.209
		GHz	dBmV	dB	dB	dB	m	dBmV/m	dBmV/m	dBµv/m	dBµV/m (15.209)	dB	dB
Low	Peak/Maxhold	19.2860	-36.04	45.06	-38.06	0	1	-29.04	-38.58	21.42	54	NA	32.58
Low	Peak/Maxhold	21.5768	-28.14	45.13	-38.06	0	1	-21.06	-30.61	29.39	54	NA	24.61
Low	Peak/Maxhold	26.4685	-28.62	45.28	-38.06	0	1	-21.40	-30.95	29.05	54	NA	24.95
Low	Peak/Maxhold	27.0700	-32.47	46.06	-38.06	0	1	-24.46	-34.01	25.99	54	NA	28.01
Low	Peak/Maxhold	28.9792	-29.89	45.87	-38.06	0	1	-22.08	-31.62	28.38	54	NA	25.62

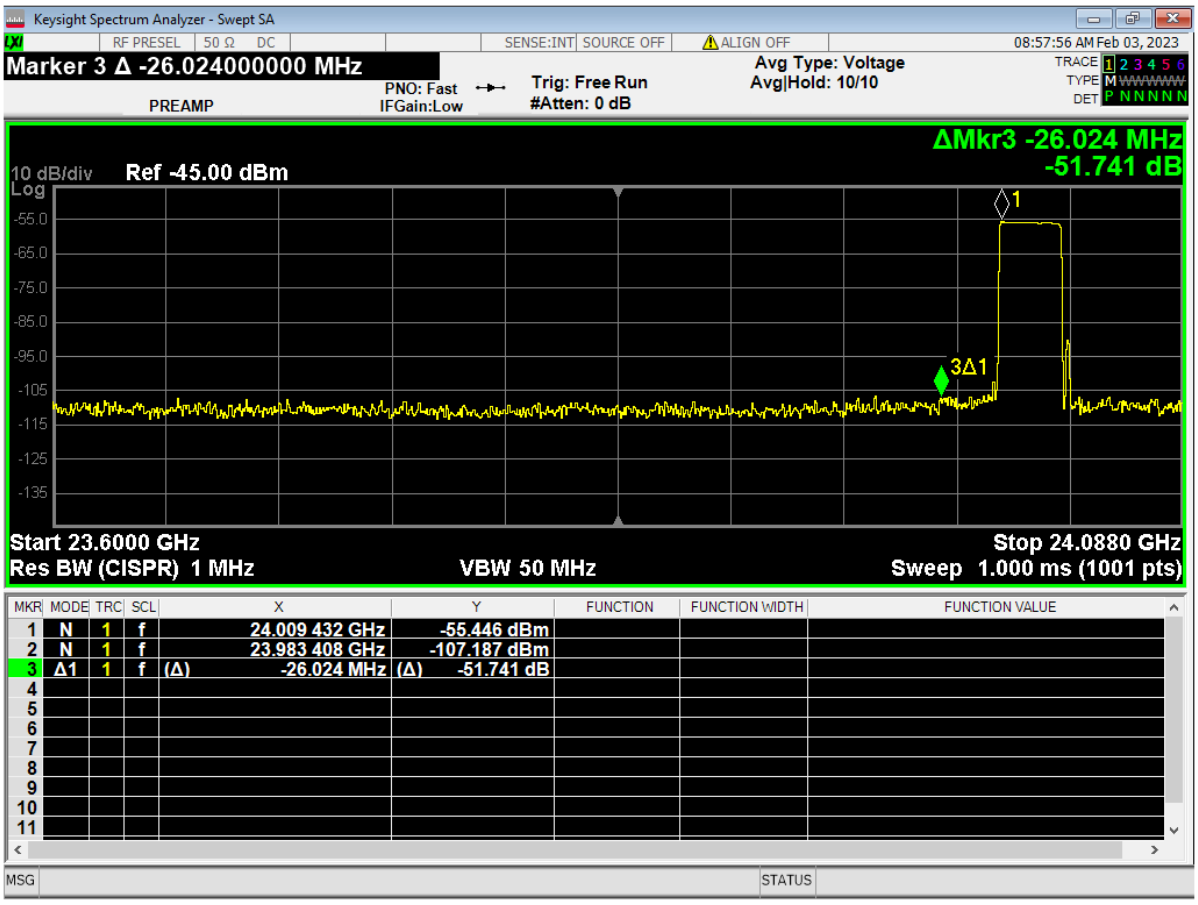


Figure 13 – Unrestricted Lower Band Edge, 24 Mhz

***Delta is greater than 50 dB as required by FCC Part 15.249- Pass**

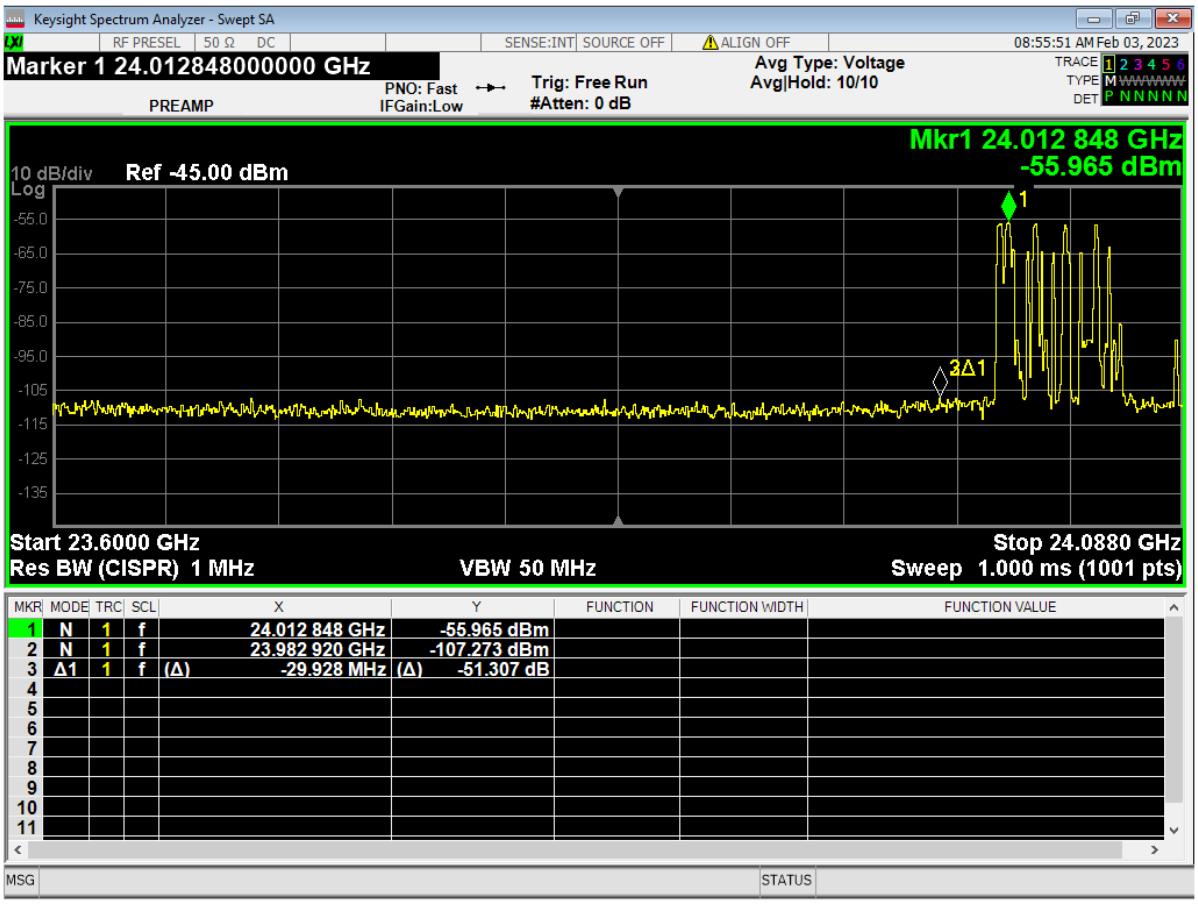


Figure 14 – Unrestricted Lower Band Edge, 48 MHz

***Delta is greater than 50 dB as required by FCC Part 15.249- Pass**

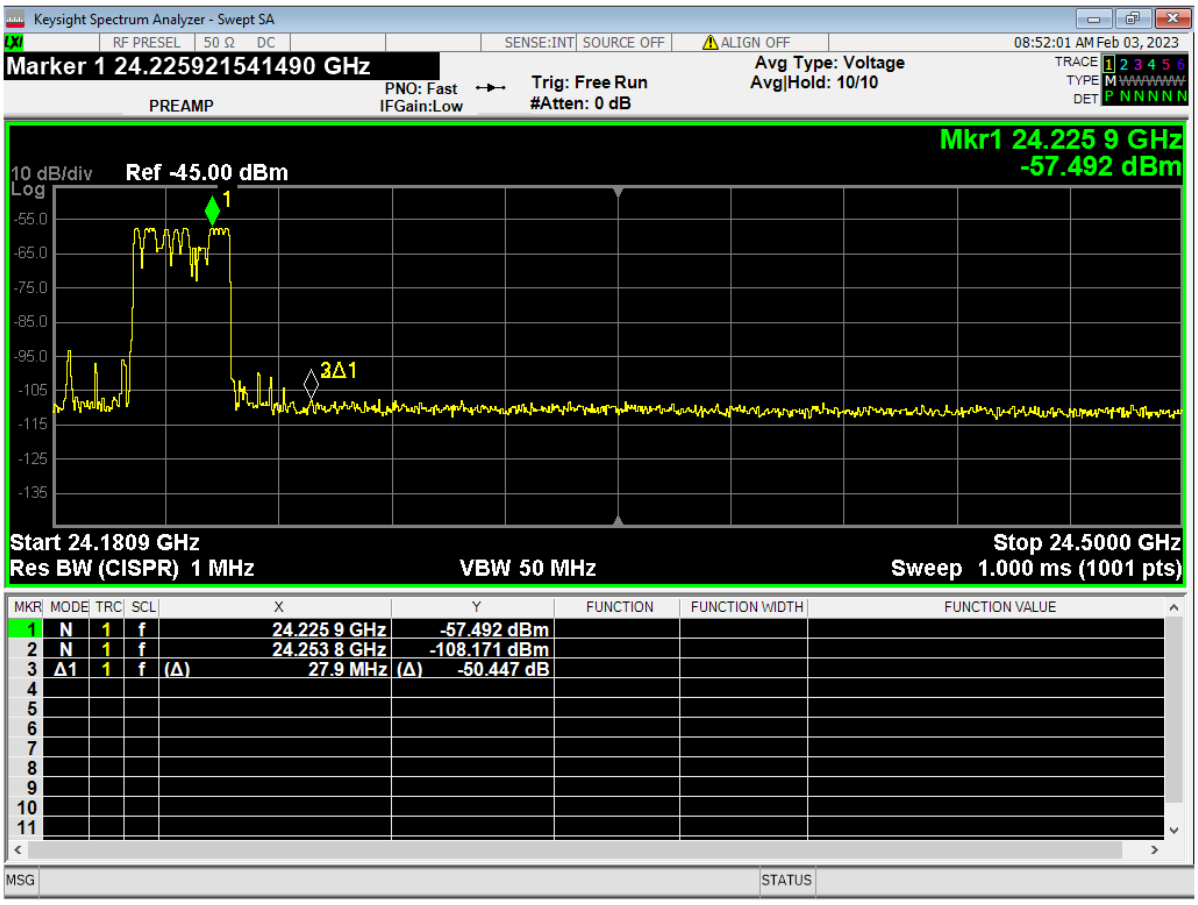


Figure 15 – Unrestricted Higher Band Edge, 24 Mhz

***Delta is greater than 50 dB as required by FCC Part 15.249- Pass**

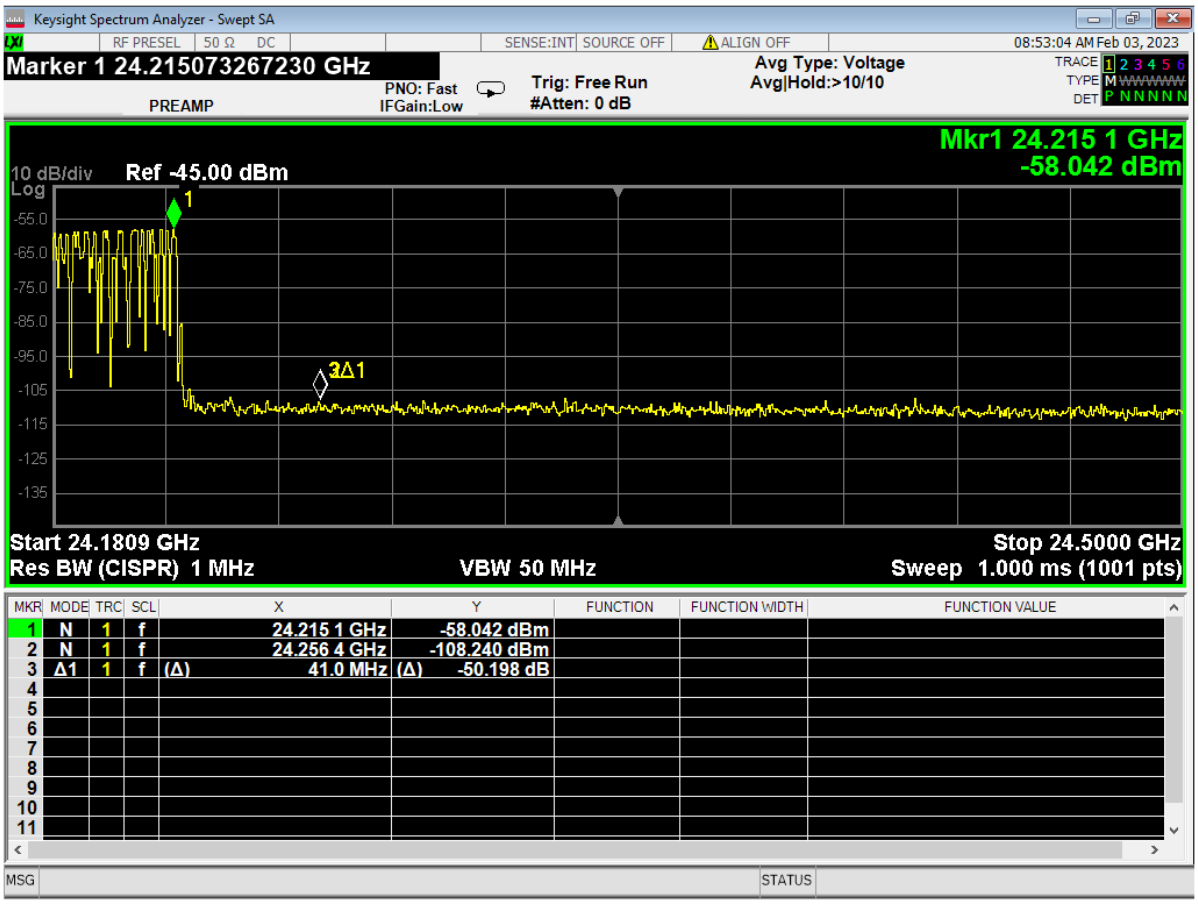


Figure 16 – Unrestricted Higher Band Edge, 48 MHz

***Delta is greater than 50 dB as required by FCC Part 15.249- Pass**

3.3 Radiated emissions

Test Method: ANSI C63.10-2013, Section 6.5, 6.6

Limits for radiated emissions measurements:

Emissions radiated outside of the specified bands shall be applied to the limits in 15.209 as followed:

FREQUENCIES (MHz)	FIELD STRENGTH (μV/m)	MEASUREMENT DISTANCE (m)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	3
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

NOTE:
1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 * log * Emission level (μV/m).
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20dB under any condition of modulation.
4. The EUT was tested for spurious emissions while running off of battery power and external USB power. The worse-case emissions were produced while running off of USB power, so results from this mode are presented.

Test procedures:

a. The EUT was placed on the top of a rotating table above the ground plane in a 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation. The table was 0.8m high for measurements from 30MHz-1Ghz and 1.5m for measurements from 1GHz and higher.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The antenna was a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are used to make the measurement.

d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height was varied from 1 meter to 4 meters and the rotating table was turned from 0 degrees to 360 degrees to find the maximum emission reading.

e. The test-receiver system was set to use a peak detector with a specified resolution bandwidth. For spectrum analyzer measurements, the composite maximum of several analyzer sweeps was used for final measurements.

f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise, the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

g. The EUT was maximized in all 3 orthogonal positions. The results are presented for the axis that had the highest emissions.

h. For the preview scans, the EUT was tested with all radios transmitting simultaneously and independently to identify the highest peaks.

Test setup:

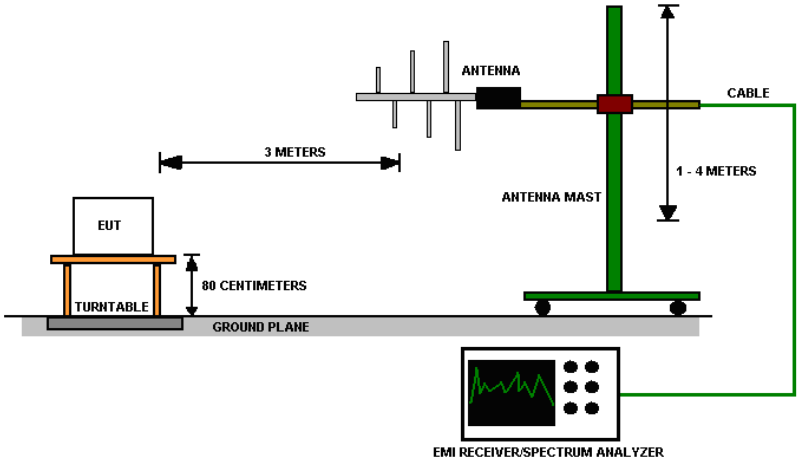


Figure 17 - Radiated Emissions Test Setup

NOTE:
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequencies below 1GHz.

2. The resolution bandwidth 1 MHz for all measurements and at frequencies above 1GHz, A peak detector was used for all measurements above 1GHz. Measurements were made with an EMI Receiver.

Deviations from test standard:

No deviation.

EUT operating conditions
Details can be found in section 2.1 of this report.

Test results:

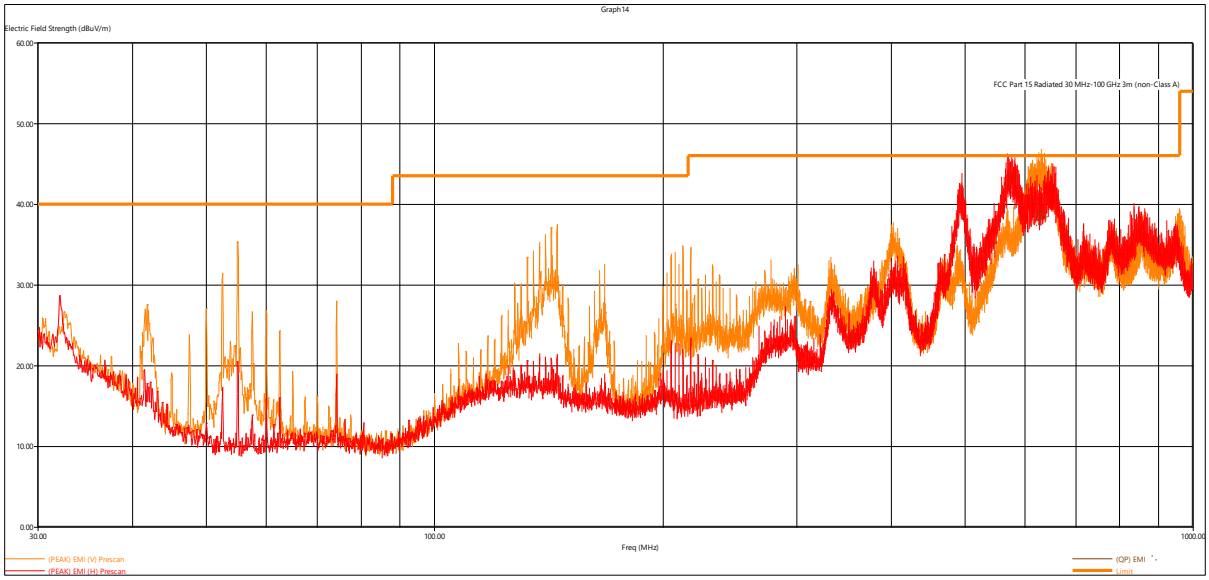


Figure 18 - Radiated Emissions Plot, Low Channel

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Limit value - Emission level

Quasi-Peak Measurements, 30MHz – 1GHz, Radar, Low							
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol.**	**Channel**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm**	**deg**		
568.875360	42.37	46.02	3.65	131.00	176.00	H	Low
576.261840	**43.35**	**46.02**	**2.67**	**134.00**	**182.00**	**H**	**Low**
621.815520	37.64	46.02	8.38	222.00	52.00	V	Low
626.211840	38.26	46.02	7.76	106.00	54.00	V	Low
629.145840	38.67	46.02	7.35	105.00	52.00	V	Low
631.121040	38.60	46.02	7.42	105.00	52.00	V	Low
637.020000	38.56	46.02	7.46	104.00	50.00	V	Low

The EUT was maximized in all 3 orthogonal axis and on the low, middle and high channels. The worst-case axis and channel are shown in the plot and table above.

Harmonics of fundamental frequency are shown in Section 3.1.

Peak Measurements, 1GHz – 100 GHz							
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol.**	**Channel**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm**	**deg**		
1724.232000	35.21	73.98	38.77	209.00	336.00	V	Low
16182.134000	53.10	73.98	20.88	470.00	1.00	H	Low
11822.212000	51.27	73.98	22.71	136.00	74.00	V	Low

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

Average Measurements, 1GHz – 100 GHz							
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol.**	**Channel**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm**	**deg**		
1724.232000	21.98	53.98	32.00	209.00	336.00	V	Low
16182.134000	38.87	53.98	15.11	470.00	1.00	H	Low
11822.212000	37.05	53.98	16.93	136.00	74.00	V	Low

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

3.4 Conducted AC Mains Emissions

Test Method: ANSI C63.10-2013, Section(s) 6.2

Limits for conducted emissions measurements:

FREQUENCY OF EMISSION (MHz)	CONDUCTED LIMIT (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56	56 to 46
0.5-5	56	46
5-30	60	50

Notes:
1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz
3. All emanations from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

Test Procedures:

a. The EUT was placed 0.8m above a ground reference plane and 0.4 meters from the conducting wall of a shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). The LISN provides 50 ohm/ 50uH of coupling impedance for the measuring instrument.
b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference as well as the ground.
c. The frequency range from 150 kHz to 30 MHz was searched. Emission levels over 10dB under the prescribed limits are not reported.
d. Results were compared to the 15.207 limits.

Deviation from the test standard:
No deviation

EUT operating conditions:
The EUT was set to transmit continuously on the middle channel.

Test Results: PASS

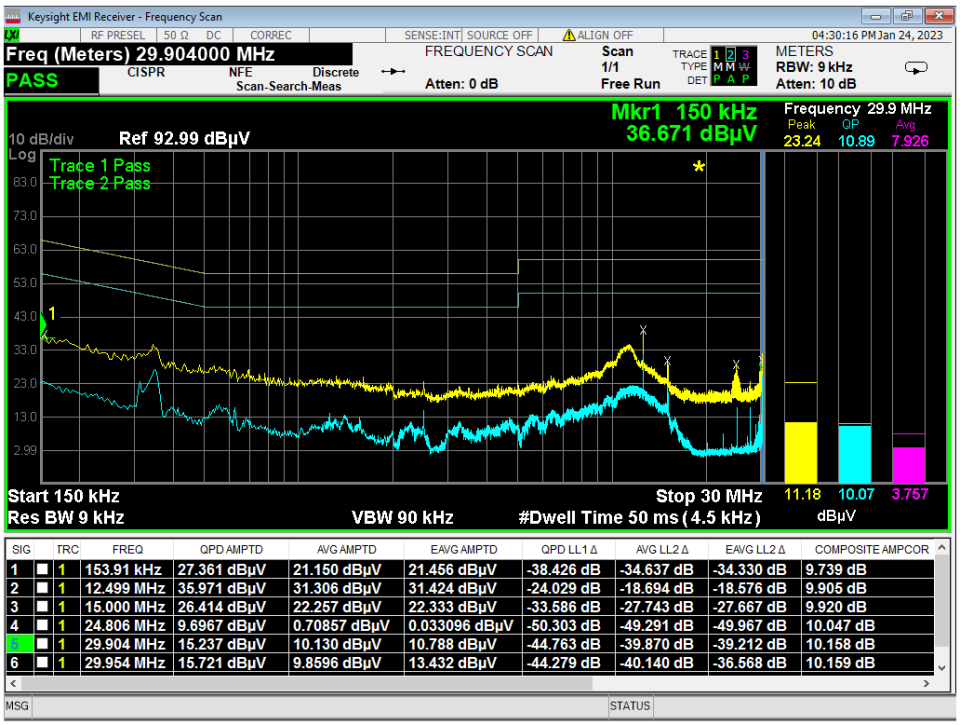


Figure 19 - Conducted Emissions Plot, Tx, Line

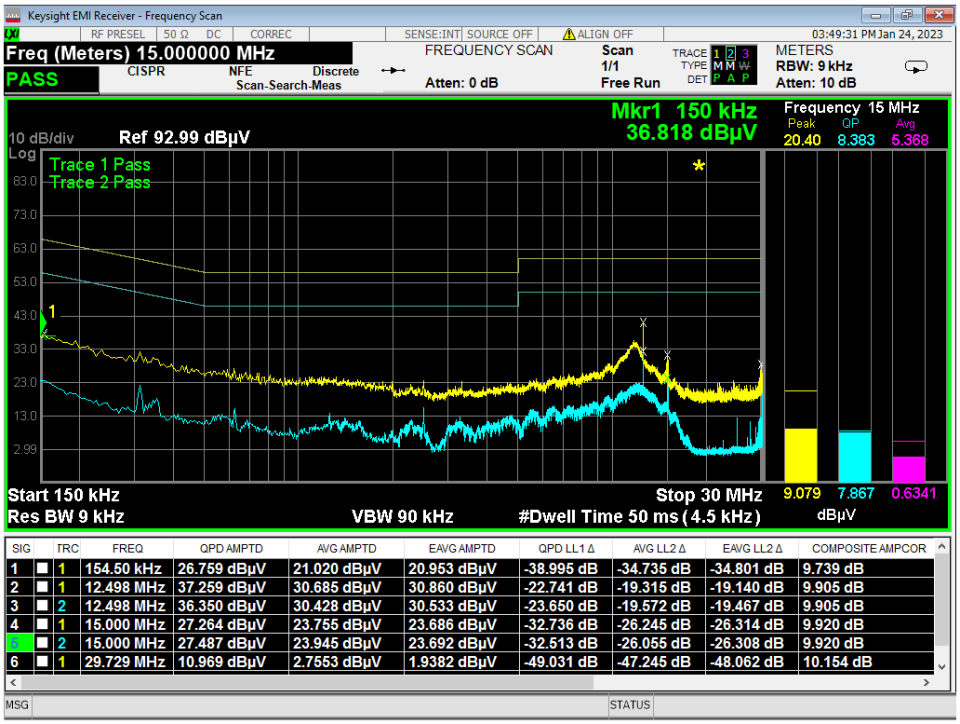
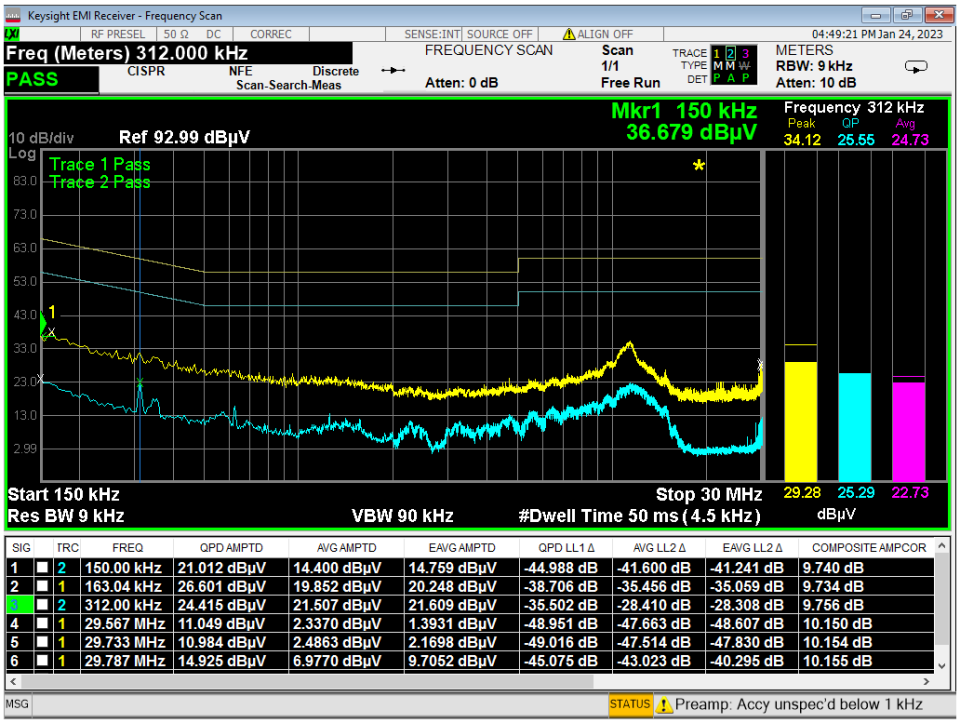
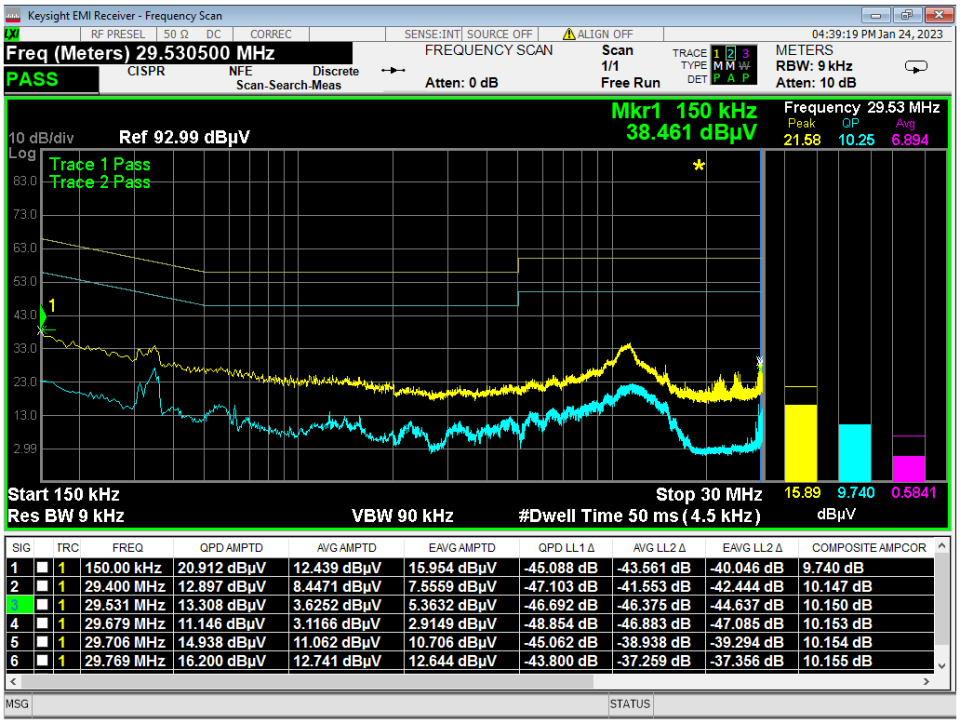


Figure 20 - Conducted Emissions Plot, Tx, Neutral



SIG	TRC	FREQ	QPD AMPTD	AVG AMPTD	EAVG AMPTD	QPD LL1 Δ	AVG LL2 Δ	EAVG LL2 Δ	COMPOSITE AMPCOR
1	2	150.00 kHz	21.012 dBµV	14.400 dBµV	14.759 dBµV	-44.988 dB	-41.600 dB	-41.241 dB	9.740 dB
2	1	163.04 kHz	26.601 dBµV	19.852 dBµV	20.248 dBµV	-38.706 dB	-35.456 dB	-35.059 dB	9.734 dB
3	2	312.00 kHz	24.415 dBµV	21.507 dBµV	21.609 dBµV	-35.502 dB	-28.410 dB	-28.308 dB	9.756 dB
4	1	29.567 MHz	11.049 dBµV	2.3370 dBµV	1.3931 dBµV	-48.951 dB	-47.663 dB	-48.607 dB	10.150 dB
5	1	29.733 MHz	10.984 dBµV	2.4863 dBµV	2.1698 dBµV	-49.016 dB	-47.514 dB	-47.830 dB	10.154 dB
6	1	29.787 MHz	14.925 dBµV	6.9770 dBµV	9.7052 dBµV	-45.075 dB	-43.023 dB	-40.295 dB	10.155 dB

Figure 21 - Conducted Emissions Plot, Rx, Line



SIG	TRC	FREQ	QPD AMPTD	AVG AMPTD	EAVG AMPTD	QPD LL1 Δ	AVG LL2 Δ	EAVG LL2 Δ	COMPOSITE AMPCOR
1	1	150.00 kHz	20.912 dBµV	12.439 dBµV	15.954 dBµV	-45.088 dB	-43.561 dB	-40.046 dB	9.740 dB
2	1	29.400 MHz	12.897 dBµV	8.4471 dBµV	7.5559 dBµV	-47.103 dB	-41.553 dB	-42.444 dB	10.147 dB
3	1	29.531 MHz	13.308 dBµV	3.6252 dBµV	5.3632 dBµV	-46.692 dB	-46.375 dB	-44.637 dB	10.150 dB
4	1	29.679 MHz	11.146 dBµV	3.1166 dBµV	2.9149 dBµV	-48.854 dB	-46.883 dB	-47.085 dB	10.153 dB
5	1	29.706 MHz	14.938 dBµV	11.062 dBµV	10.706 dBµV	-45.062 dB	-38.938 dB	-39.294 dB	10.154 dB
6	1	29.769 MHz	16.200 dBµV	12.741 dBµV	12.644 dBµV	-43.800 dB	-37.259 dB	-37.356 dB	10.155 dB

Figure 22 - Conducted Emissions Plot, Rx, Neutral

3.5 Duty Cycle

1.1.1 Test Results

The following duty cycle correction factors (DCCF) were used where applicable.

Manufacturer declares worst case duty cycle for Radar is 30% over the smallest bandwidth of 24MHz.

DCCF is based over the span of 1MHz
Duty Cycle / 1MHz steps = 0.3 / 24 = 0.0125 = 1.25%

DCCF (For Emissions) = 20 * log(0.0125) = -38.0618

DCCF (For Power) = 10 * log(0.0125) = -19.0309

Annex A - Sample Calculations

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:
FS = RA + AF – (-CF + AG) + AV

where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dBμV is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dBμV/m.

FS = 55 + 12 – (-1.1 + 20) + 0 = 48.1 dBμV/m

The 48.1 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20]= 254.1 μV/m

AV is calculated by the taking the 20*log(T_{on}/100) where T_{on} is the maximum transmission time in any 100ms window.

EIRP Calculations

In cases where direct antenna port measurement is not possible or would be inaccurate, output power is measured in EIRP. The maximum field strength is measured at a specified distance and the EIRP is calculated using the following equation;

EIRP (Watts) = [Field Strength (V/m) x antenna distance (m)]^2 / [30 x Gain (numeric)]

Power (watts) = 10^[Power (dBm)/10] x 1000

Field Strength (dBµV/m) = Field Strength (dBm) + 107 (for 50Ω measurement systems)

Field Strength (V/m) = 10^[Field Strength (dBµV/m) / 20] / 10^6

Gain = 1 (numeric gain for isotropic radiator)

Conversion from 3m field strength to EIRP (d=3):

EIRP = (FS x d^2)/30 = FS [(d^2)/30] = FS [0.3}

EIRP(dBm) = FS(dBµV/m) – 10(log 10^9)+ 10log[0.3] = -95.23

10log(10^) is the conversion from micro to milli

Annex B – Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been for tests performed in this test report:

Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	3.82
Radiated Emissions, 3m	1GHz - 18GHz	4.44
Emissions limits, conducted	150kHz – 18GHz	3.30

Expanded uncertainty values are calculated to a confidence level of 95%.

CISPR 16-4-2:2011 was used to calculate the above values.

Annex C – Test Equipment

Serial No.	Manufacturer	Model	Description	Last Cal.	Calibration due
A082918-1	SunAR RF Motion	JB1	Bicon Antenna	July 26, 2022	July 26, 2023
00218655	EMCO-ETS	3115	DRG Horn	July 21, 2022	July 21, 2023
2576	ETS	3116	Horn Antenna	9 Mar 2020	9 Mar 2024
MY59050109	Keysight	N9038A	Keysight MXE Signal Analyzer (44GHz)**	July 19, 2022	July 19, 2024
MY51391050	Keysight	M1970V-002	Mixer, 50 – 80 GHz	13 Apr 2019	13 Apr 2024
MY56390145	Keysight	M1971W	Mixer, 75 – 110 GHz	12 Apr 2019	12 Apr 2024
700307	V11.25	700307	TDK Emissions Lab S/W	NA	NA
32/2016	Pasternack	PE9881-24	WR-15 Horn Antenna	CNR***	CNR***
16434-01	Sage Millimeter	SAZ-2410-10-S1	WR-10 Horn Antenna	CNR***	CNR***
3903A03916	Agilent	11970Q	Mixer, 33 – 50 GHz	CNR**	CNR**
Ncee1	Pasternack	SH122-23	WR-22 Horn Antenna	CNR***	CNR***
181004-2	OML	DPL313B	Diplexer	CNR**	CNR**
200707-1	OML	M08HWDX	Mixer, 90 – 140 GHz	07 July 2020	07 July 2025
20070701	OML	M08RH	WR-8 Horn Antenna	CNR***	CNR***
200707-1	OML	M05HWDX	Mixer, 140 – 220 GHz	07 July 2020	07 July 2025
20070701	OML	MR05RH	WR-5 Horn Antenna	CNR***	CNR***

All mixers and pre-amplifiers were calibrated with associated cables.

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE	CALIBRATION DUE DATE
Trilithic High Pass Filter*	6HC330	23042	March 21, 2022	March 21, 2024
RF Cable (preamplifier to antenna)*	MFR-57500	90-195-040	August 22, 2022	August 22, 2024
RF Cable (antenna to 10m chamber bulkhead)*	FSCM 64639	01E3872	September 24, 2021	September 24, 2023
RF Cable (10m chamber bulkhead to control room bulkhead)*	FSCM 64639	01E3864	September 24, 2021	September 24, 2023
RF Cable (control room bulkhead to test receiver)*	FSCM 64639	01F1206	September 24, 2021	September 24, 2023
N connector bulkhead (10m chamber)*	PE9128	NCEEBH1	September 24, 2021	September 24, 2023
N connector bulkhead (control room)*	PE9128	NCEEBH2	September 24, 2021	September 24, 2023

*Internal Characterization ** Extended Cal

REPORT END