TEST REPORT

Report Number	:	14841575-E1V2
Applicant	:	Waymo LLC 1600 Amphitheatre Parkway Mountain View, CA 94043
Model	:	RADE8C
FCC ID	:	2AZKTRADE8C
EUT Description	:	E-Band Automotive Radar Sensor
Test Standard	:	FCC CFR 47 PART 95 SUBPART M

Date Of Issue:
March 29, 2024

Prepared by:
UL Verification Services Inc.
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ACCREDITED
CERT #0751.06

REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	11/17/2023	Initial Issue	GP Chin
V2	03/29/2024	Update Pg. 7 & Pg. 34 Per TCB Feedback	GP Chin

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TABLE OF CONTENTS

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME:	Waymo LLC 1600 Amphitheatre Parkway Mountain View, CA 94043
EUT DESCRIPTION:	E-Band Automotive Radar Sensor
MODEL:	RADE8C
SERIAL NUMBER:	WNT012311000445
SAMPLE RECEIVE DATE:	July 19th, 2023
DATE TESTED:	July 21st - August 24th, 2023

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
FCC PART 95 SUBPART M	Complies

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by A2LA, NIST, any agency of the Federal Government, or any agency of the U.S. government.

Approved & Released For
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Tested By:

Haowen Lin
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2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with the following methods.

1. FCC CFR 47 Part 2
2. FCC CFR 47 Part 95M
4. ANSI C63.10-2020
5. ANSI C63.26-2015
6. KDB 653005 D01 76-81 GHz Radars v01r02
7. KDB 971168 D01 Power Meas. License Digital Systems v03r01

3. FACILITIES AND ACCREDITATION

UL LLC is accredited by A2LA, certification #0751.05, for all testing performed within the scope of this report. Testing was performed at the locations noted below.

	Address	ISED CABID	ISED Company No.	FCC Registration
☒	Building 1: 47173 Benicia Street, Fremont, California, USA	US0104	2324A	208313
☒	Building 2: 47266 Benicia Street, Fremont, California, USA	US0104	22541	208313
☒	Building 4: 47658 Kato Rd, Fremont, California, USA	US0104	2324B	208313

4. CALIBRATION AND UNCERTAINTY

4.1. METROLOGICAL TRACEABILITY

All test and measuring equipment utilized to perform the tests documented in this report are calibrated on a regular basis, with a maximum time between calibrations of one year or the manufacturers' recommendation, whichever is less, and where applicable is traceable to recognized national standards.

4.2. DECISION RULES

The Decision Rule is based on Simple Acceptance in accordance with ISO Guide 98-4:2012 Clause 8.2. (Measurement uncertainty is not taken into account when stating conformity with a specified requirement.)

4.3. MEASUREMENT UNCERTAINTY

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

PARAMETER	U_{LAB}
Worst Case Radiated Disturbance, 9 KHz to 30 MHz	2.87 dB
Worst Case Radiated Disturbance, 30 to 1000 MHz	6.01 dB
Worst Case Radiated Disturbance, 1000 to 18000 MHz	4.73 dB
Worst Case Radiated Disturbance, 18000 to 26000 MHz	4.51 dB
Worst Case TRP, 18000 to 26000 MHz	4.10 dB
Worst Case Radiated Disturbance, 26000 to 40000 MHz	5.29 dB
Worst Case Radiated Disturbance, > 40000 MHz	2.89 dB
Temperature	±0.9 °C
Voltages	±0.45 %
Time	±0.02 %

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

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5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is a radar sensor, operating in 76 - 81 GHz band, with a digital beam-forming scanning antenna. Four modes in FMCW modulation of each range for operation are available as shown.

Mode	Frequency Band (GHz)
LRES W6	79.036 – 80.978
LRES W4	79.036 – 80.978
MRES	79.046 – 80.968
HRES	79.044 – 80.950

The EUT is powered by an external power supply (car battery) with a nominal voltage of 12 VDC at test.

5.2. SOFTWARE AND FIRMWARE

The Software/Firmware version used on the test is cl@549997726.

5.3. MAXIMUM OUTPUT POWERS

Mode	Max. Avg EIRP (dBm)	Max. Peak EIRP (dBm)
LRES W6	33.10	34.98
LRES W4	33.39	36.67
MRES	32.85	41.25
HRES	33.45	43.98

5.4. DESCRIPTION OF AVAILABLE ANTENNA

The EUT utilizes four sets of integral patch antenna array. A single set of antenna array has 16 dBi gain and its dimension is 25 mm x 2 mm x 1 mm. At operation, the fundamental emissions are sequentially radiating from each antenna array.

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5.5. MODULATION FORMAT

Modulation is FMCW and parameters are as follows:

Mode	Chirp Width (MHz)	Waveform Chirp Sweep Time (us)
LRES W6	90	31.4
LRES W4	90	29.4
MRES	361	29.4
HRES	615	29.4

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

PERIPHERAL SUPPORT EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
KFC Tester	Waymo	N/A	N/A	NA
Shield Test Enclosure	Ramsey	STE4500	1540	NA
Laptop PS	HP	744481-002	F225081409021726	NA
Laptop	HP	Elitebook 840	QLF-00572	PD97260H

I/O CABLES

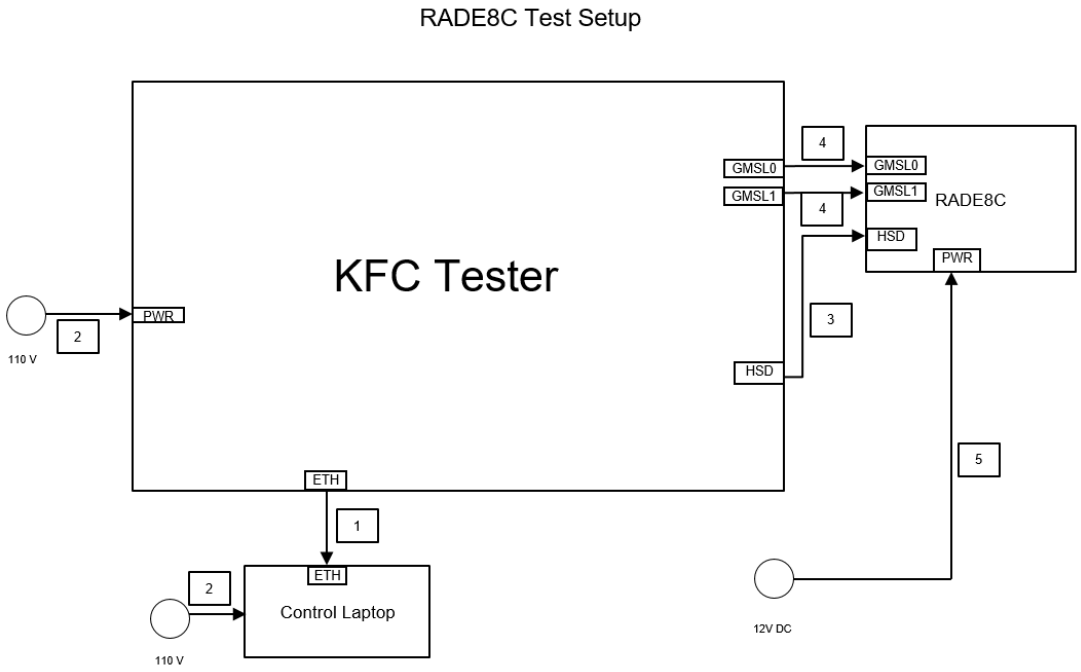
I/O Cable List						
Cable No.	**Port**	**# of identical ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	Ethernet	1	RJ45	Ethernet	> 1	NA
2	AC Power	2	IEC320 C13	Stranded Wire	> 1	NA
3	HSD	1	Wire to Board	HSD	> 1	NA
4	Mini Fakra Quad	2	Fakra	GMSL	> 1	NA
5	DC Power	1	Banana	Stranded Wire	1	NA

TEST SETUP

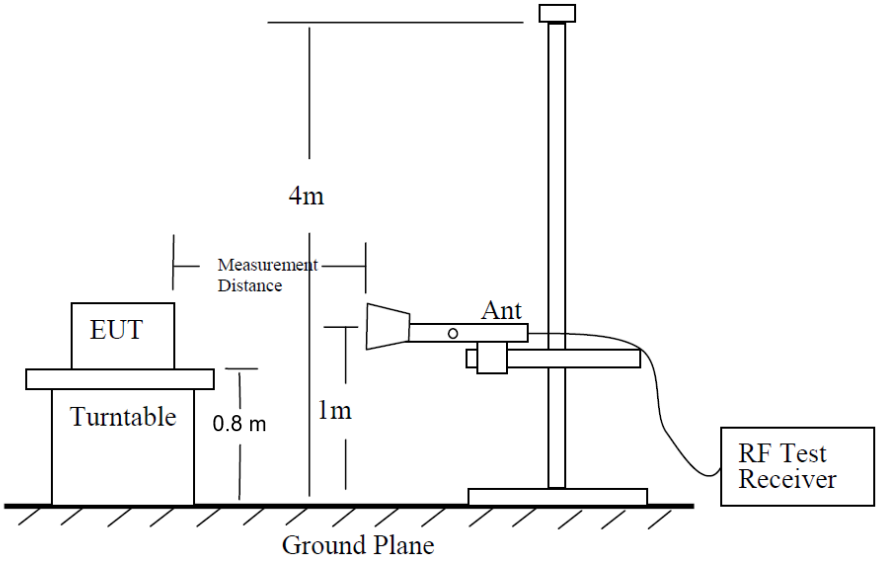
The EUT was connected to a laptop computer. All testing was performed using customer-provided software that was utilized to enable continuous Tx modulated operation.

SETUP DIAGRAM FOR TESTS

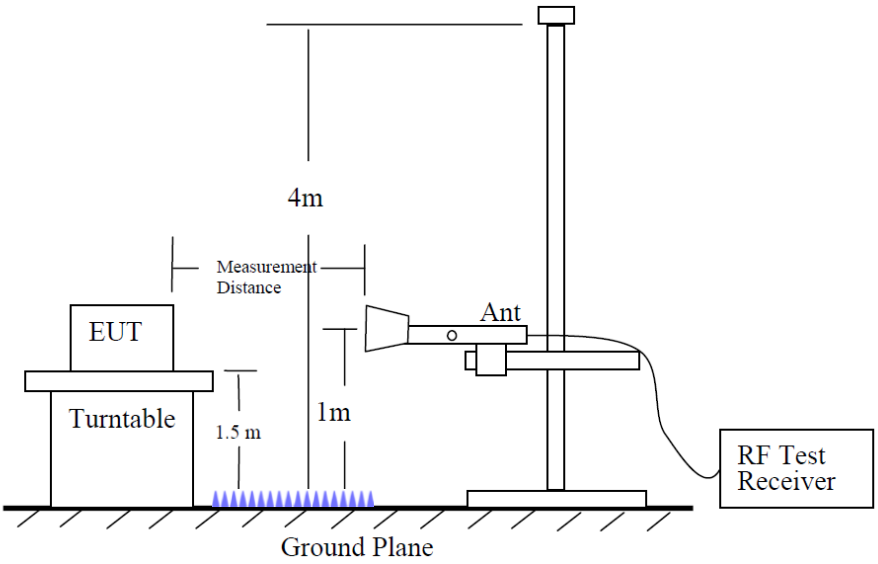
EUT TEST CONFIGURATION



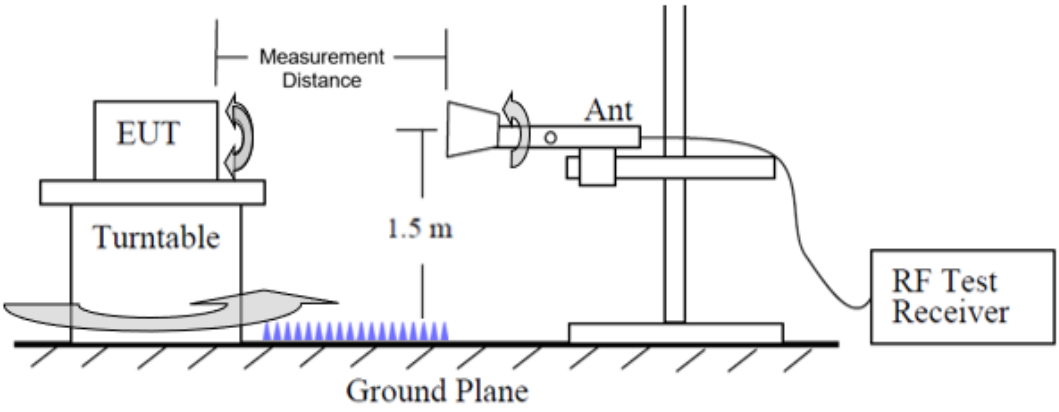
TEST SITE DIAGRAM – Below 1 GHz



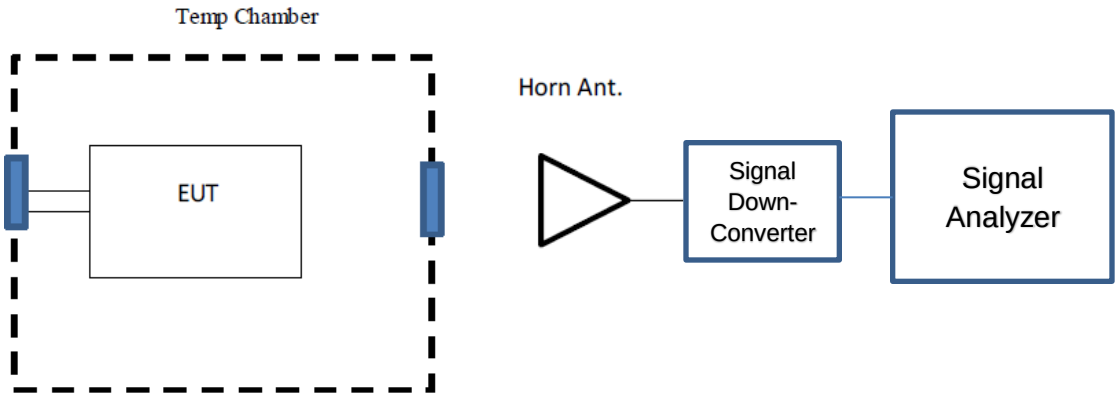
TEST SITE DIAGRAM – 1-18 GHz



TEST SITE DIAGRAM – Above 18 GHz & mmWave



FREQUENCY STABILITY



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FAR-FIELD DISTANCE AND MEASUREMENT DISTANCE

The equipment under test was transmitting while connected to its integral antenna and placed on a turntable.

The measurement distance is in the far field, per formula $2D^2/\lambda$, where D is the largest dimension of the antenna.

For fundamental / band edge emissions, the largest far-field distance of either the EUT antenna or measurement antenna shall be used. For above 18 GHz spurious emissions, the far-field distance will be based on the measurement antenna. In this case, the measurement antenna has the largest far-field distance. The EUT is manipulated through all orthogonal planes representative of its typical use to achieve the highest EIRP reading on the receiving spectrum analyzer.

Frequency Range (GHz)	Wavelength (m)	Rx Antenna Diagonal dim. (m)	Far Field Distance (m)	Measurement Distance Used (m)
40-50	0.0060	0.069	1.61	3.00
50-75	0.0040	0.046	1.05	3.00
75-110	0.0027	0.031	0.70	3.00
110-170	0.0018	0.02	0.46	3.00
170-243	0.0012	0.013	0.31	0.50

Radiated spurious emissions limits above 40 GHz are based on a 3-meter measurement distance. As such, testing from 40 - 170 GHz was performed at 3-meters. Above 170 GHz, testing was performed at a 0.5-meter distance and the data was corrected, accordingly, to the 3-meter limit.

In-band testing was performed at a 4-meter distance, still in the far-field based on the maximum EUT and measurement antenna dimension.

Radiated power levels are investigated while the receiving antenna was rotated through all angles to determine the worst-case polarization/positioning.

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6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

Test Equipment List					
Description	**Manufacturer**	**Model**	**Local ID**	**Last Cal**	**Cal Due**
Spectrum Analyzer, 2 Hz to 50 GHz	Rohde & Schwarz	FSW50	215756	01/30/2023	01/30/2024
EMI Test Receiver, 1 Hz to 44 GHz	Rohde & Schwarz	ESW44	191429	02/15/2023	02/29/2024
Antenna, Horn 18-26.5 GHz	Com-Power	AH-826	222326	9/26/2022	9/26/2023
Antenna, Horn 26.5-40 GHz	Com-Power	AH-640	222328	8/24/2022	8/24/2023
Antenna, Double Ridge Guide Horn 1 to 18 GHz	ETS	3117	206806	10/7/2022	10/7/2023
Active Loop Antenna 30 Hz to 1 MHz	ETS	EM-6871	170013	7/28/2022	7/31/2024
Active Loop Antenna 100 KHz to 30 MHz	ETS	EM-6872	170015	7/28/2022	7/31/2024
Amplifier, 100 KHz to 1 GHz, 32dB	Keysight Technologies	8447D	29654	7/31/2023	7/31/2024
Antenna, Broadband Hybrid, 30 MHz to 3 GHz	Sunol Sciences Corp.	JB3	174374	4/5/2023	4/5/2024
RF Filter Box, 1-18 GHz	UL-FR1	NA	171013	10/31/2022	10/31/2023
Environmental Chamber	Cincinnati Sub Zero	ZPHS-8-3.5-SCT/WC	82472	6/8/23	1/31/2024
Digital Multimeter	Fluke	87V	59154	1/24/2023	1/24/2024
50V/3A Adj. DC Power Supply	Rigol	DP712	T1746	CNR	CNR
Horn antenna, 35-50 GHz	CMI	HO22R	201517	4/1/2023	4/1/2024
LNA, 40-50 GHz	Evarant	SBL-3335033040-2222-E1	199504	8/1/2022	8/1/2023
Waveguide BandPass Filter, 40-50 GHz	Evarant	SWF-46308340-22-B1	222195	10/13/2022	10/13/2023
50-75 GHz Horn	CMI	HO15R	210519	4/13/2023	4/13/2024
LNA, 50-75 GHz	VIVA TECH	VTLNA-15-6018-FB	202496	8/29/2022	8/29/2023
50 – 75 GHz Downconverter	VDI	WR15SAX-F	198529	10/18/2022	10/18/2023
75-110 GHz Horn	CMI	HO10R	201524	7/6/2023	7/6/2024
75 – 110 GHz Downconverter	VDI	WR10SAX-F	223987	10/18/2022	10/18/2023
110-170 GHz Horn	CMI	HO6R	201528	4/14/2023	4/14/2024
LNA 110-170 GHz	SAGE Millimeter, Inc.	SBL-1141741860-0606-EI	199832	10/3/2022	10/3/2023
110-170 GHz Downconverter	VDI	WR6.5SAX-F	223773	10/3/2022	10/3/2023
170-260 GHz Horn	CMI	HO4R	201525	4/13/2023	4/13/2024
170-260 GHz Downconverter	VDI	WR4.3SAX-F	223771	09/30/2022	09/30/2023
Amplifier, 18 to 26.5GHz	Amplical	AMP18G26-35-7-MI	196113	7/28/2023	7/28/2024
Amplifier, 26.5 to 40GHz	Amplical	AMP26G40-34-10-MI	196397	7/28/2023	7/28/2024
60-90 GHz Horn	CMI	HO12R	201521	8/2/2023	8/2/2024
60-90 GHz Downconverter	OML	C12H1DC01	220522	7/1/2023	7/1/2024
Signal Generator	Keysight	E8257D	156340	1/25/2023	1/31/2024
UL EMC Radiated Software	Version	Rev.9.5 01 May 2023			
mmWave LabView Software	Version	V2021.8.18			

*Equipment was used to perform tests prior to the calibration due date.

All horn antennas at and above the 33-50 GHz band are standard gain horns. In accordance with ANSI C63.10 clause 4.4.3 (a) Standard gain horns need not be periodically recalibrated unless damage or deterioration is suspected or known to have occurred. If a standard gain horn is not periodically recalibrated, then its critical dimensions (see IEEE Std 1309-2005) shall be verified and documented on an annual basis.

UL measures the critical dimensions on an annual basis and checks for damage and deterioration before each test.

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7. SUMMARY TABLE

FCC Part Section	Test Description	Test Limit	Test Condition	Test Result
2.1049	Occupied Bandwidth	N/A	Radiated	Compliant
2.1046 95.3367	Equivalent Isotropic Radiated Power (EIRP)	+50 dBm (Average) +55 dBm (Peak)	Radiated	Compliant
2.1051 95.3379	Spurious Emissions < 40 GHz	See Table 95.3379 (1)	Radiated	Compliant
2.1051 95.3379	Spurious Emissions 40 – 200 GHz	600 pW/cm^2 (-1.68 dBm)	Radiated	Compliant
2.1051 95.3379	Spurious Emissions > 200 GHz	1000 pW/cm^2 (+0.53 dBm)	Radiated	Compliant
2.1055 95.3379	Frequency Stability	See 95.3379 (b)	Radiated	Compliant

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8. APPLICABLE LIMITS AND TEST RESULTS

8.1. DUTY CYCLE

LIMIT

None; for reporting purposes only.

TEST PROCEDURE

The fundamental is measured using a Standard Gain Horn Antenna and a Harmonic Mixer connected to a Signal Analyzer. Pulse widths, burst lengths, and periods are measured, from which the duty cycle is calculated.

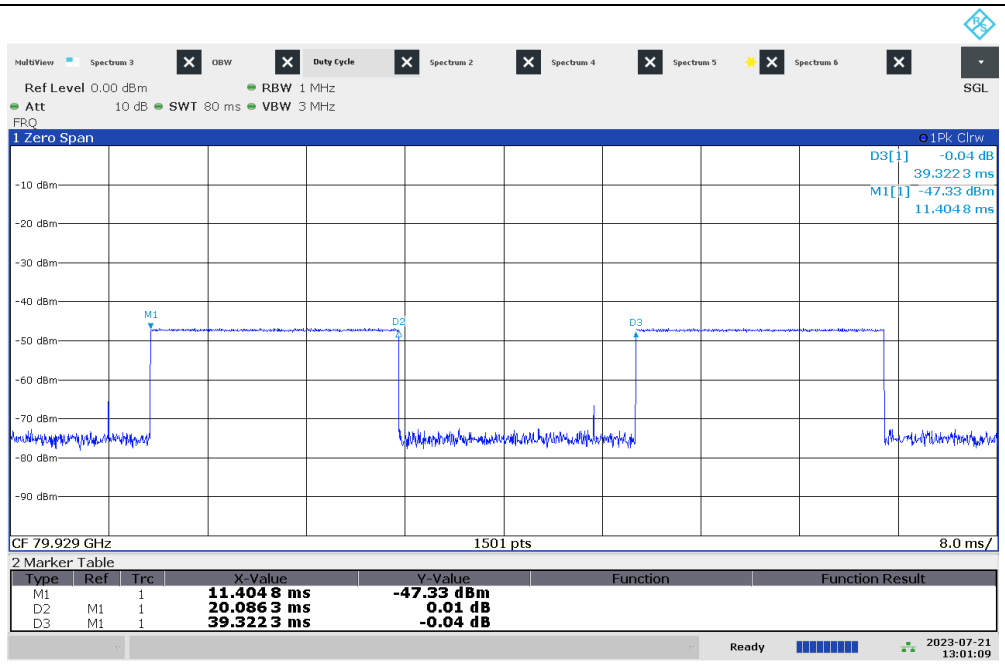
RESULTS

Employee ID: 27446, 27818
Location: 01-mmW-A
Date: 7/21/2023

Duty cycle linear = on/off time
Duty cycle % = Duty cycle linear * 100

Mode	Frame On Time (mS)	Frame Period (mS)	Duty Cycle (linear)	Duty Cycle (%)
LRES W6	20.09	39.32	0.51	51.09
LRES W4	18.7	37.04	0.50	50.49
MRES	18.69	38.78	0.48	48.19
HRES	18.67	38.7	0.48	48.24

LRES W6 MODE



Frame On Time + Frame Period

LRES W4 MODE

Frame On Time + Frame Period

MRES MODE

Frame On Time + Frame Period

HRES MODE

Frame On Time + Frame Period

8.2. OCCUPIED BANDWITH

RULE PART(S)

FCC: §2.1049, §95.3379 (b)

LIMIT

The occupied bandwidth (99% emission bandwidth) shall be contained in the 76 – 81 GHz frequency band.

TEST PROCEDURES

99% bandwidth measurement function of the signal analyzer was used to measure 99% occupied bandwidth.

- RBW = 1 – 5% of OBW
- VBW ≥ 3 x RBW
- Span = Wide enough to capture all modulation products including the emission skirts
- Detector = Peak
- Trace mode = max hold
- Sweep = auto couple
- The trace was allowed to stabilize

ANSI C63.26-2015 Clause 5.4.3

Low, Mid and High channels of all modes of operations were investigated and results are reported in this section.

The OBW plots of Mid Channel on each mode are provided to demonstrate the test parameter setting on signal analyzer. The tabular data includes data for Low, Mid and High channels of all modes.

RESULTS

See the following pages.

Employee ID: 27446, 27818
Location: 01-mmW-A
Date: 7/21/2023 - 7/28/2023

OCCUPIED BANDWIDTHS

Mode	Channel	Center Freq. (GHz)	99% BW (MHz)	FL Min Limit (GHz)	Meas. FL (GHz)	Pass or Fail	Meas. FH (GHz)	FH Max Limit (GHz)	Pass or Fail
LRES W6	L	79.083	117.42	76	79.024	Pass	79.142	81	Pass
LRES W6	M	79.923	116.84	76	79.864	Pass	79.981	81	Pass
LRES W6	H	80.924	114.99	76	80.866	Pass	80.981	81	Pass
LRES W4	L	79.087	109.45	76	79.032	Pass	79.142	81	Pass
LRES W4	M	79.926	110.66	76	79.871	Pass	79.982	81	Pass
LRES W4	H	80.926	110.43	76	80.871	Pass	80.981	81	Pass
MRES	L	79.243	423.93	76	79.031	Pass	79.455	81	Pass
MRES	M	80.122	421.42	76	79.912	Pass	80.333	81	Pass
MRES	H	80.762	422.36	76	80.551	Pass	80.973	81	Pass
HRES	L	79.398	725.15	76	79.035	Pass	79.760	81	Pass
HRES	M	79.955	728.35	76	79.591	Pass	80.319	81	Pass
HRES	H	80.637	720.20	76	80.277	Pass	80.998	81	Pass

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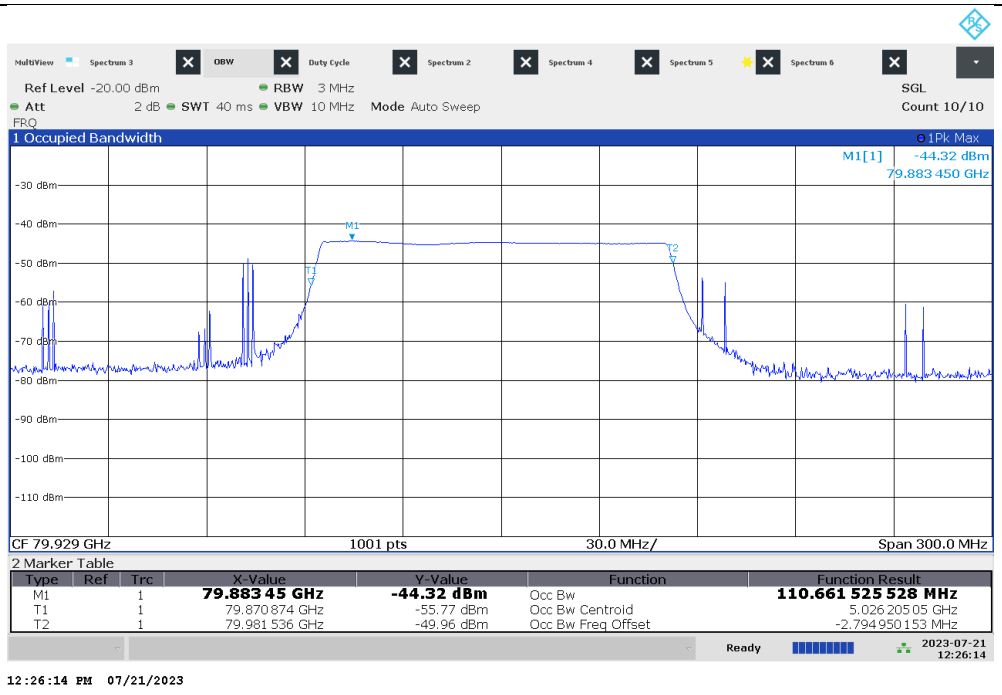
LRES W6 MODE

Mid Channel

LRES W4 MODE



Mid Channel

MRES MODE

Mid Channel

HRES MODE

Mid Channel

8.3. AVERAGE AND PEAK RADIATED POWERS

RULE PART(S)

FCC: §2.1046, §95.3367 (a) (b)

LIMIT

FCC §95.3367 - The fundamental radiated emission limits within the 76-81 GHz band are expressed in terms of Equivalent Isotropic Radiated Power (EIRP) and are as follows:

(a) The maximum power (EIRP) within the 76-81 GHz band shall not exceed 50 dBm based on measurements employing a power averaging detector with a 1 MHz Resolution Bandwidth (RBW).

(b) The maximum peak power (EIRP) within the 76-81 GHz band shall not exceed 55 dBm based on measurements employing a peak detector with a 1 MHz RBW.

TEST PROCEDURES

Average EIRP

Radiated power measurements are performed using the signal analyzer's "channel power" measurement capability for signals with continuous operation.

- RBW = 1 – 5% of the OBW, not to exceed 1 MHz
- VBW ≥ 3 x RBW
- Span = 2x to 3x the OBW
- Number of measurement points in sweep > 2 x span / RBW
- Sweep time = 5 x (Signal Period) x (Span)
- Detector = RMS
- Power shall be integrated over the OBW

Worse-case Signal Period of all modes is 39.32 ms, thus sweep times are:

Mode	Span (MHz)	RBW (MHz)	Swp Time (ms)	Swp Time (s)	Swp Time Used (s)
LRES W6	200	1	34826	34.83	250
LRES W4	200	1	32873	32.87	250
MRES	800	1	123873	123.87	250
HRES	1200	1	214748	214.75	300

Peak EIRP

Radiated power measurements are performed with the signal analyzer's set to spectrum analyzer mode.

- RBW = 1 MHz
- VBW ≥ 3 x RBW
- Span = 2x to 3x the OBW
- Number of measurement points in sweep > 2 x span / RBW
- Sweep time = 2 x (Signal Period) x (Span)
- Detector = Peak
- Trace mode = Max Hold
- Set reference level as required
- Set marker on the signal peak after trace has stabilized

Worse-case Signal Period of all modes is 39.32 ms, thus sweep times are:

Mode	Span (MHz)	RBW (MHz)	Swp Time (ms)	Swp Time (s)	Swp Time Used (s)
LRES W6	200	1	13930	13.93	100
LRES W4	200	1	13149	13.15	100
MRES	800	1	49549	49.55	100
HRES	1200	1	85899	85.90	120

KDB 653005 D01 76-81 GHz Radars v01r01 Section 4 a) b) c)
ANSI C63.26-2015 Clause 5.2, Clause 5.5, Clause 6.4, and Annex C.5.2
ANSI C63.10-2020 Clause 9, Annex C, Annex L

Measurements are made at a distance greater than or equal to the far field boundary distance. The measured power level is converted to EIRP based on the following:

$EIRP = P_R + L_P$

where,

P_R is the adjusted received power, after corrections
L_P is the basic free space propagation path loss

EIRP was calculated using the equations of ANSI C63.26-2015 Annex C.5.2. The total correction factors from 76-81 GHz range of far-field path loss, horn antenna gain, waveguide extension/cable losses, downconverter loss were calculated using equations C.8 and C.9, and pre-loaded into spectrum analyzer.

Sample calculation of EIRP:

Total Correction Factor = Path Loss @ 80 GHz (dB) – Horn Ant Gain (dBi) + WG Ext. Loss (dB) + Downconverter Loss (dB) + Cable Loss (dB)
= 80 – 23 + 3 + 10 + 1
= 71 dB

EIRP = $P_{measured}$(dBm), where Total Correction Factor preloaded.

In order to properly display of signal level on the plots, the pre-loaded correction factors were intentional lowered by 50 dB and an offset factor of 50 dB was applied on spectrum analyzer to compensate the true correction factors across frequency range of measurement.

Radiated power levels are investigated while the receive antenna was rotated through all angles to determine the worst-case polarization/positioning.

FAR FIELD BOUNDARY CALCULATION

The far-field boundary is given as:

$R_{far\text{-}field} = (2 * D^2) / \lambda$

where,

D = Largest Antenna Dimension, including the reflector, in meters
λ = wavelength in meters

The largest dimension (diagonally) of the integral TX array antenna is 25.08 mm, which is smaller than the maximum dimension of the measurement antenna (31 mm). As such, 31 mm is the dimension that is used in determining the far-field boundary.

Frequency (GHz)	D (m)	Lambda (m)	R (Far Field) (m)
79	0.031	0.0038	0.51
81	0.031	0.0037	0.52

Radiated power measurements are performed at a 4-meter test distance, to prevent damage to the test system.

FMCW CORRECTION FACTOR FOR PEAK DETECTION

Keysight Technologies Application Note 5952-1039 “Spectrum and Signal Analysis Pulsed RF” provides the derivation of the FMCW Desensitization Factor for Gaussian-shaped Resolution Bandwidth Filters in Appendix B “IF Amplifier Response and Distortion”.

Equation B-10 is excerpted:

$$\alpha = \frac{1}{\sqrt[4]{1+\left(\frac{2\ln(2)}{\pi}\right)^2\left(\frac{F_s}{T_s B^2}\right)^2}} \qquad \text{(B-10)}$$

Where

α is the reduction in amplitude
F_s= FMCW Chirp Bandwidth
T_s = FMCW Chirp Time
B= 3 dB IF Bandwidth = RBW

Mode	FMCW Width (MHz)	Ramp Time (uS)	RBW (MHz)	Amplitude Loss (lin)	Amplitude Loss (dB)
LRES W6	117.42	31.4	1	0.720	2.86
LRES W6	116.84	31.4	1	0.721	2.84
LRES W6	114.99	31.4	1	0.725	2.79
LRES W4	109.45	29.4	1	0.721	2.84
LRES W4	110.11	29.4	1	0.719	2.86
LRES W4	110.43	29.4	1	0.719	2.87
MRES	418.60	29.4	1	0.396	8.04
MRES	418.31	29.4	1	0.396	8.04
MRES	419.36	29.4	1	0.396	8.05
HRES	724.63	29.4	1	0.303	10.39
HRES	720.71	29.4	1	0.303	10.36
HRES	723.92	29.4	1	0.303	10.38

The EIRP plots of Mid Channel on each mode are provided to demonstrate the test parameter setting on signal analyzer. The tabular data includes data for Low, Mid and High channels of all modes.

RESULTS

See the following pages.

Employee ID: 27446, 27818
Location: 01-mmW-A
Date: 7/21/2023 - 7/28/2023

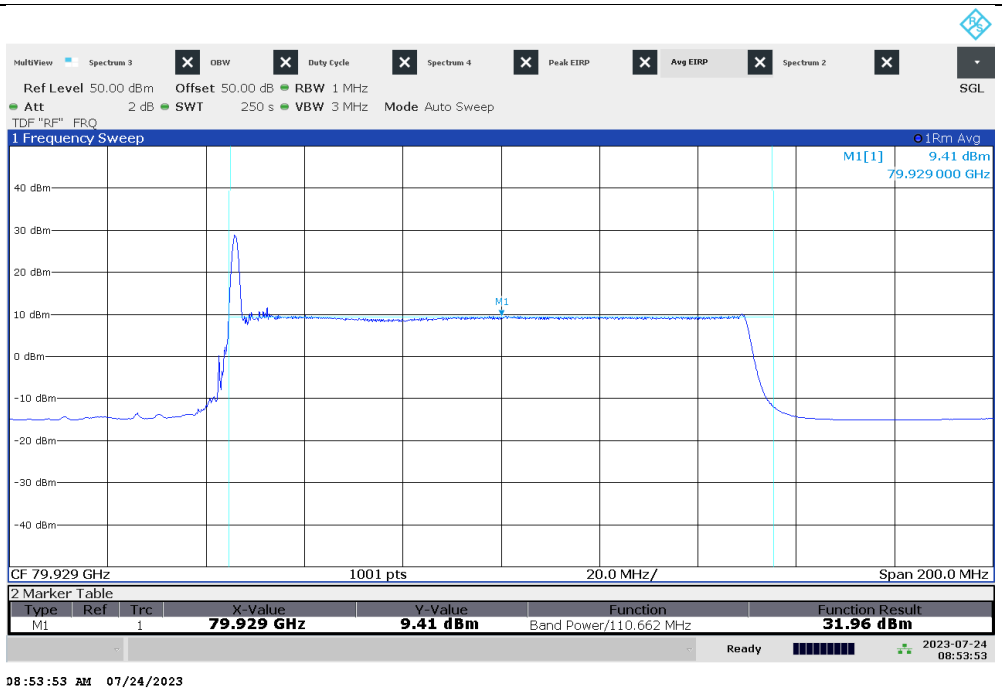
8.3.1. AVERAGE EIRP

Mode	Channel	Measured OBW (GHz)	Measured Distance (m)	RBW (MHz)	Avg EIRP over OBW (dBm)	Avg EIRP Limit (dBm)	Limit Margin (dB)	Pass or Fail
LRES W6	L	117.42	4	1	30.90	50	-19.10	Pass
LRES W6	M	116.84	4	1	30.24	50	-19.76	Pass
LRES W6	H	114.99	4	1	33.10	50	-16.90	Pass
LRES W4	L	109.45	4	1	30.35	50	-19.65	Pass
LRES W4	M	110.66	4	1	31.96	50	-18.04	Pass
LRES W4	H	110.43	4	1	33.39	50	-16.61	Pass
MRES	L	423.93	4	1	30.90	50	-19.10	Pass
MRES	M	421.42	4	1	32.85	50	-17.15	Pass
MRES	H	422.36	4	1	29.98	50	-20.02	Pass
HRES	L	725.15	4	1	32.04	50	-17.96	Pass
HRES	M	728.35	4	1	32.90	50	-17.10	Pass
HRES	H	720.20	4	1	33.45	50	-16.55	Pass

AVERAGE EIRP - LRES W6 MODE

Mid Channel

AVERAGE EIRP - LRES W4 MODE



Mid Channel

AVERAGE EIRP - MRES MODE

Mid Channel

AVERAGE EIRP - HRES MODE

Mid Channel

8.3.2. PEAK EIRP

Mode	Channel	Peak Freq. (GHz)	Meas. Distance (m)	RBW (MHz)	Meas. Pwr (dBm)	FMCW Corr Fact (dB)	Adj. Peak EIRP (dBm/MHz)	Peak EIRP Limit (dBm/MHz)	Limit Margin (dB)	Pass or Fail
LRES W6	L	79.028	4	1	30.93	2.86	33.79	55	-21.21	Pass
LRES W6	M	79.873	4	1	31.18	2.84	34.02	55	-20.98	Pass
LRES W6	H	80.868	4	1	32.19	2.79	34.98	55	-20.02	Pass
LRES W4	L	79.041	4	1	29.93	2.84	32.77	55	-22.23	Pass
LRES W4	M	79.880	4	1	32.31	2.86	35.17	55	-19.83	Pass
LRES W4	H	80.882	4	1	33.80	2.87	36.67	55	-18.33	Pass
MRES	L	79.514	4	1	32.16	8.04	40.20	55	-14.80	Pass
MRES	M	79.194	4	1	31.90	8.04	39.94	55	-15.06	Pass
MRES	H	80.058	4	1	33.20	8.05	41.25	55	-13.75	Pass
HRES	L	79.418	4	1	32.70	10.39	43.09	55	-11.91	Pass
HRES	M	80.243	4	1	33.38	10.36	43.74	55	-11.26	Pass
HRES	H	80.923	4	1	33.60	10.38	43.98	55	-11.02	Pass

PEAK EIRP - LRES W6 MODE

Mid Channel

PEAK EIRP - LRES W4 MODE

Mid Channel

PEAK EIRP - MRES MODE

Mid Channel

PEAK EIRP - HRES MODE

Mid Channel

8.4. RADIATED SPURIOUS EMISSIONS

RULE PART

FCC: §95.3379

LIMIT

95.3379 - (a)(1) Radiated emissions below 40 GHz shall not exceed the field strength as shown in the following emissions table

Frequency (MHz)	Field Strength (uV/m)	Field Strength (dBuV/m)	Measurement Distance (meters)
0.009-0.490	2400/F (kHz)	48.5-13.8	300
0.490-1.705	24000/F (kHz)	49.0-23.0	30
1.705-30.0	30	29.5	30
30-88	100	40.0	3
88-216	150	43.5	3
216-960	200	46.0	3
Above 960	500	54.0	3

*Limit: 54 dBuV/m at 3 m = -41.3 dBm

90.3379 - (a)(2) The power density of radiated emissions outside the 76-81 GHz band above 40.0 GHz shall not exceed the following, based on measurements employing an average detector with a 1 MHz RBW:

(i) For radiated emissions outside the 76-81 GHz band between 40 GHz and 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 600 pW/cm^2 at a distance of 3 meters from the exterior surface of the radiating structure.

*Limit: 600 pW/cm^2 at 3 m = -1.68 dBm

(ii) For radiated emissions above 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 1000 pW/cm^2 at a distance of 3 meters from the exterior surface of the radiating structure.

*Limits: 1000 pW/cm^2 at 3 m = 0.53 dBm

(iii) For field disturbance sensors and radar systems operating in the 76-81 GHz band, the spectrum shall be investigated up to 231.0 GHz.

Testing was performed up to 243 GHz (3rd hormonic of 81 GHz) per the recommendation of KDB 653005.

TEST PROCEDURE

KDB 653005 D01 76-81 GHz v01r01 Section 4 (e)
ANSI C63.26-2015 Clause 5.5.4 and Annex C.5.2.

RSE was investigated from 9 kHz – 243 GHz for FCC.

Testing below 18 GHz

The EUT is placed on a non-conducting table 80 cm above the ground plane for measurement below 1 GHz; 1.5 m above the ground plane for measurement above 1 GHz. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.26 and set to transmit in a continuous mode.

For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements in the 30-1000 MHz range, 9 kHz for peak and/or quasi-peak detection measurements in the 0.15 – 30 MHz range and 200 Hz for peak and/or quasi-peak detection measurements in the 9 to 150 kHz range. Peak detection is used unless otherwise noted as quasi-peak or average (9 – 90 kHz and 110 – 490 kHz).

For pre-scans above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 3 MHz for peak measurements.

For final measurements above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 3 MHz for peak measurements; as applicable for linear voltage averaging measurements.

The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

3D antenna use - For below 30 MHz testing, investigation was done on three antenna orientations (parallel “face on”, perpendicular “face off”, and ground-parallel “face down”).

Based on FCC 15.31 (f) (2): measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field.

KDB 414788 Open Field Site(OFS) and Chamber Correlation Justification

OFS and chamber correlation testing had been performed and chamber measured test result is the worst-case test result.

Testing above 18 GHz

All radiated spurious emissions were measured as EIRP to compare with the limits as defined above.

RSEs above 18 GHz were measured at the appropriate far field distances listed on Section 5.6 on this report (FAR-FIELD DISTANCE AND MEASUREMENT DISTANCE). RSEs from 18 – 50 GHz were measured using a spectrum analyzer or EMI receiver with an internal preamplifier when applicable. Emissions above 50 GHz were measured using a downconverter with spectrum analyzer, while an external LNA was used when applicable.

EIRP of RSE was calculated using the equations on ANSI C63.26-2015 Annex C.5.2. The total correction factor of cable/waveguide extension loss, horn antenna gain, downconverter loss, LNA gain and far-field path loss were calculated using equations C.8 and C.9, and pre-loaded into spectrum analyzer.

Sample calculation of EIRP:

Total Correction Factor = Cable Loss (dB) – Horn Ant Gain (dBi) – LNA Gain (dB)
+ Downconverter Loss (dB) + Path Loss (dB)
= 4 – 23 – 30 + 8 + 71
= 30 dB

EIRP = $P_{measured}$(dBm), where Total Correction Factor preloaded.

Worse-Case Configuration

All RSEs were measured for the configuration with the highest EIRP on each mode as representing the worst case.

RESULTS

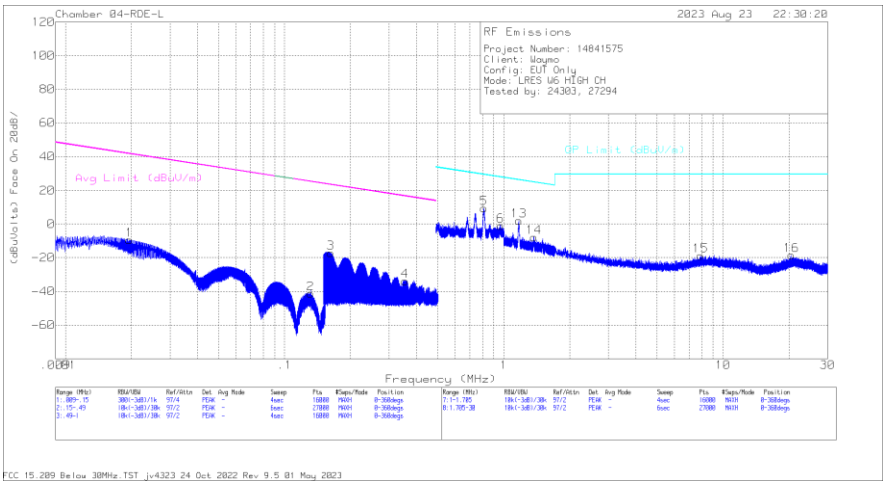
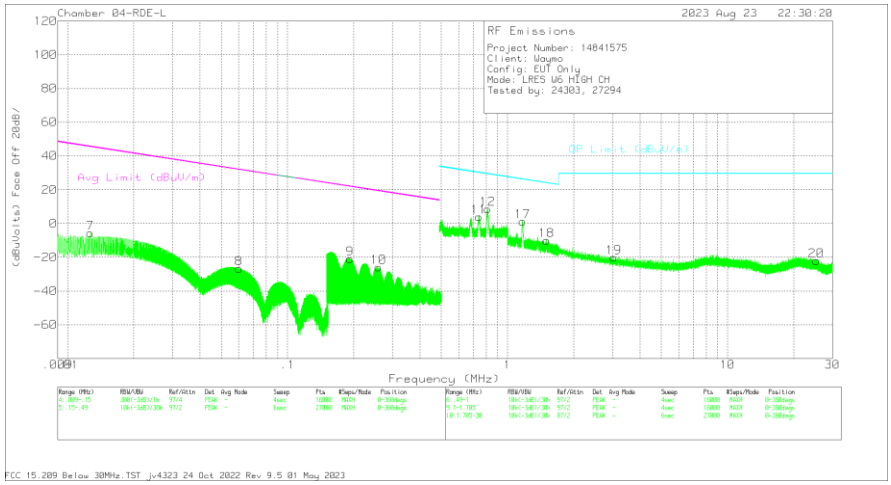
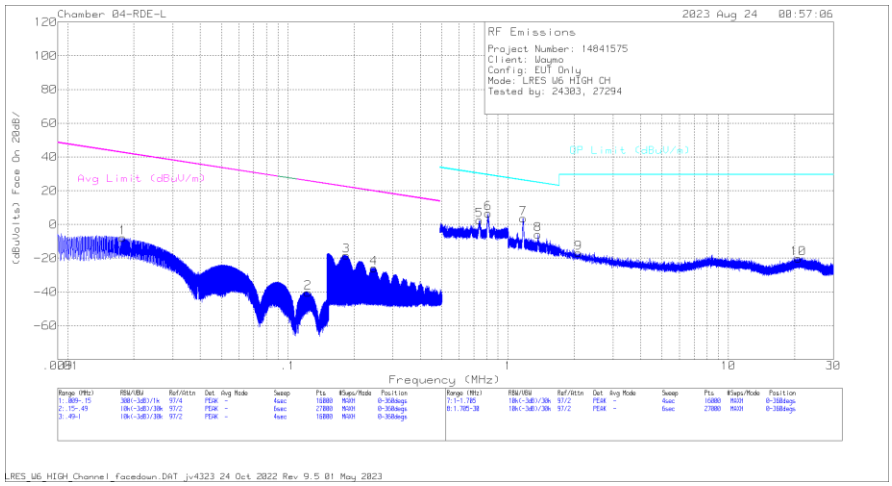
See the following pages.

TESTED BY

Below 18 GHz Test Site: 04-RDE-L
Employee IDs: 27818, 27446
Date: 8/23/2023 - 8/24/2023

Above 18 GHz Test Site: 01-mmW-A
Employee IDs: 27818, 27446, 24303, 27294
Date: 7/27/2023 - 8/1/2023

8.4.1. RADIATED EMISSIONS, 9 kHz - 30 MHz

Face On	
Face Off	
Face Down	
LRES W6 MODE	

Antenna Face On Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 300m	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
1	.0195	42.19	Pk	59.2	-30.9	-80	-9.51	41.76	-51.27	0-360
2	.1312	14.79	Pk	55.9	-32	-80	-41.31	25.27	-66.58	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 300m	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
3	.1621	38.69	Pk	56.1	-32	-80	-17.21	23.43	-40.64	0-360
4	.3541	21.73	Pk	56.3	-31.9	-80	-33.87	16.63	-50.5	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
5	.8111	25	Pk	56.4	-31.9	-40	9.5	29.43	-19.93	0-360
6	.9636	14.46	Pk	56.4	-31.8	-40	-.94	27.94	-28.88	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
13	1.1694	27.91	Pk	45.9	-31.8	-40	2.01	26.27	-24.26	0-360
14	1.3708	18.97	Pk	44.9	-31.8	-40	-7.93	24.89	-32.82	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
15	7.9018	18.14	Pk	34.7	-31.5	-40	-18.66	29.5	-48.16	0-360
16	20.5439	18.46	Pk	34.3	-31.3	-40	-18.54	29.5	-48.04	0-360

Antenna Face Off Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 300m	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
7	.0127	43.83	Pk	60	-29.5	-80	-5.67	45.5	-51.17	0-360
8	.0602	28.91	Pk	56.3	-31.9	-80	-26.69	32	-58.69	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 300m	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
9	.1925	34.72	Pk	56.3	-32	-80	-20.98	21.93	-42.91	0-360
10	.2596	29.84	Pk	56.3	-32	-80	-25.86	19.33	-45.19	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
11	.7425	19.48	Pk	56.3	-31.9	-40	3.88	30.2	-26.32	0-360
12	.8114	23.94	Pk	56.4	-31.9	-40	8.44	29.43	-20.99	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
17	1.173	27.06	Pk	45.9	-31.8	-40	1.16	26.24	-25.08	0-360
18	1.5027	17.57	Pk	44.2	-31.8	-40	-10.03	24.09	-34.12	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
19	3.0433	12.93	Pk	38.7	-31.7	-40	-20.07	29.5	-49.57	0-360
20	25.2913	15.67	Pk	33.5	-31.2	-40	-22.03	29.5	-51.53	0-360

Pk - Peak detector

Antenna Face Down Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
1	.0178	43.25	Pk	59.4	-30.6	-80	-7.95	42.44	-50.39	0-360
2	.1234	15.83	Pk	55.9	-32	-80	-40.27	25.8	-66.07	0-360

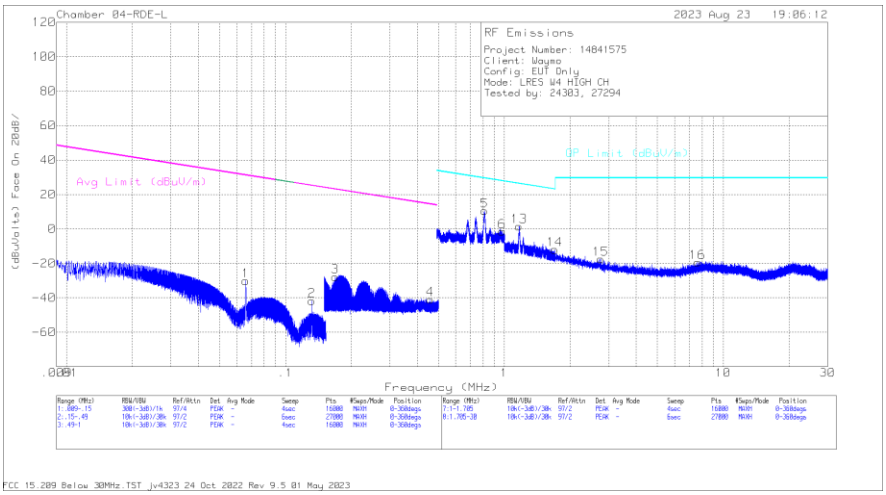
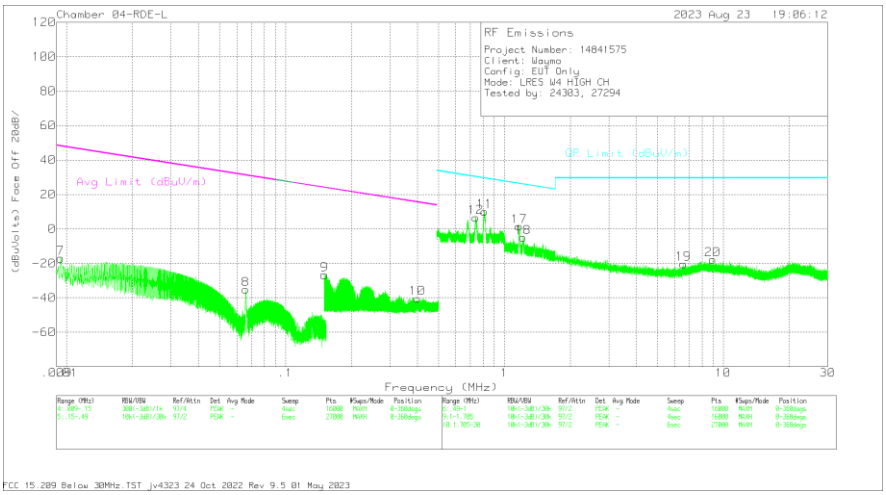
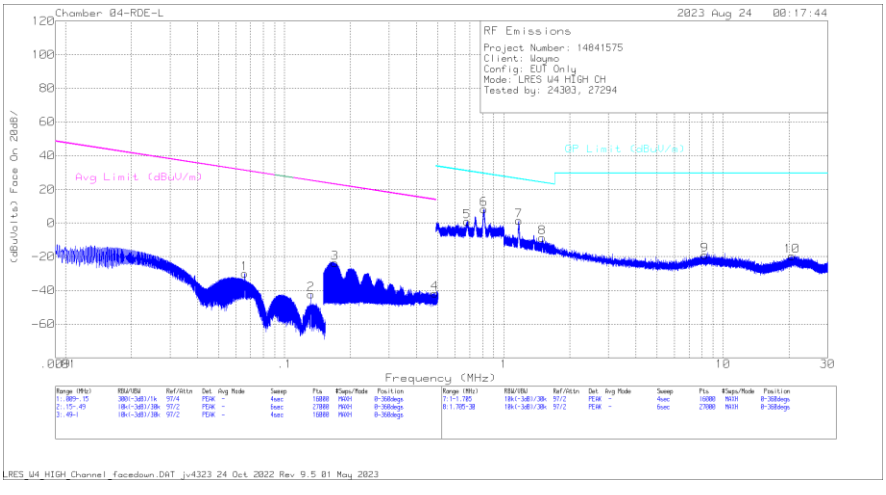
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
3	.1837	37.34	Pk	56.3	-32	-80	-18.36	22.34	-40.7	0-360
4	.246	29.88	Pk	56.3	-32	-80	-25.82	19.8	-45.62	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
5	.7419	18.18	Pk	56.3	-31.9	-40	2.58	30.21	-27.63	0-360
6	.812	22.18	Pk	56.4	-31.9	-40	6.68	29.43	-22.75	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
7	1.1703	29.47	Pk	45.9	-31.8	-40	3.57	26.26	-22.69	0-360
8	1.3689	21.05	Pk	44.9	-31.8	-40	-5.85	24.9	-30.75	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
9	2.0875	13.76	Pk	41.3	-31.8	-40	-16.74	29.5	-46.24	0-360
10	20.8289	16.76	Pk	34.3	-31.3	-40	-20.24	29.5	-49.74	0-360

Pk - Peak detector

Face On	
Face Off	
Face Down	
LRES W4 MODE	

Face On Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
1	.0659	25.53	Pk	56.2	-31.9	-80	-30.17	31.21	-61.38	0-360
2	.132	14.38	Pk	55.9	-32	-80	-41.72	25.22	-66.94	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
3	.1689	28	Pk	56.2	-32	-80	-27.8	23.07	-50.87	0-360
4	.4586	14.76	Pk	56.2	-31.9	-80	-40.94	14.38	-55.32	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
5	.8115	25.96	Pk	56.4	-31.9	-40	10.46	29.43	-18.97	0-360
6	.9774	13.88	Pk	56.4	-31.8	-40	-1.52	27.82	-29.34	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
13	1.1684	27.35	Pk	45.9	-31.8	-40	1.45	26.27	-24.82	0-360
14	1.6989	16.57	Pk	43.2	-31.8	-40	-12.03	23.03	-35.06	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
15	2.753	14.73	Pk	39.4	-31.7	-40	-17.57	29.5	-47.07	0-360
16	7.6273	17.3	Pk	34.8	-31.5	-40	-19.4	29.5	-48.9	0-360

Face Off Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
7	.0094	30.64	Pk	61	-28.7	-80	-17.06	48.12	-65.18	0-360
8	.0659	20.51	Pk	56.2	-31.9	-80	-35.19	31.21	-66.4	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
9	.1507	29.21	Pk	56.1	-32	-80	-26.69	24.06	-50.75	0-360
10	.4003	15.36	Pk	56.2	-31.9	-80	-40.34	15.56	-55.9	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
11	.8125	25.56	Pk	56.4	-31.9	-40	10.06	29.42	-19.36	0-360
12	.7408	22.24	Pk	56.3	-31.9	-40	6.64	30.22	-23.58	0-360
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
17	1.17	27.28	Pk	45.9	-31.8	-40	1.38	26.26	-24.88	0-360
18	1.2184	21.08	Pk	45.7	-31.8	-40	-5.02	25.91	-30.93	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
19	6.5761	16.24	Pk	35	-31.6	-40	-20.36	29.5	-49.86	0-360
20	8.9593	18.95	Pk	34.7	-31.5	-40	-17.85	29.5	-47.35	0-360

Pk - Peak detector

Antenna Face Down Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
1	.0658	25.72	Pk	56.2	-31.9	-80	-29.98	31.22	-61.2	0-360
2	.132	13.94	Pk	55.9	-32	-80	-42.16	25.22	-68.38	0-360

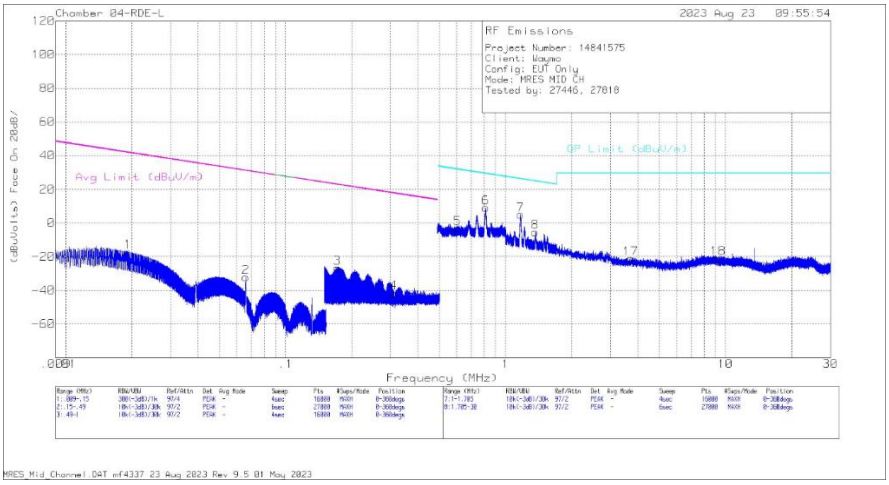
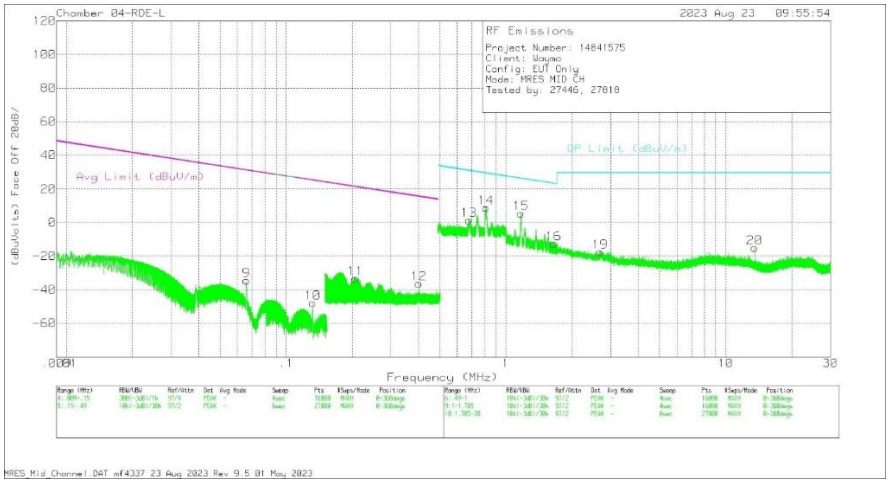
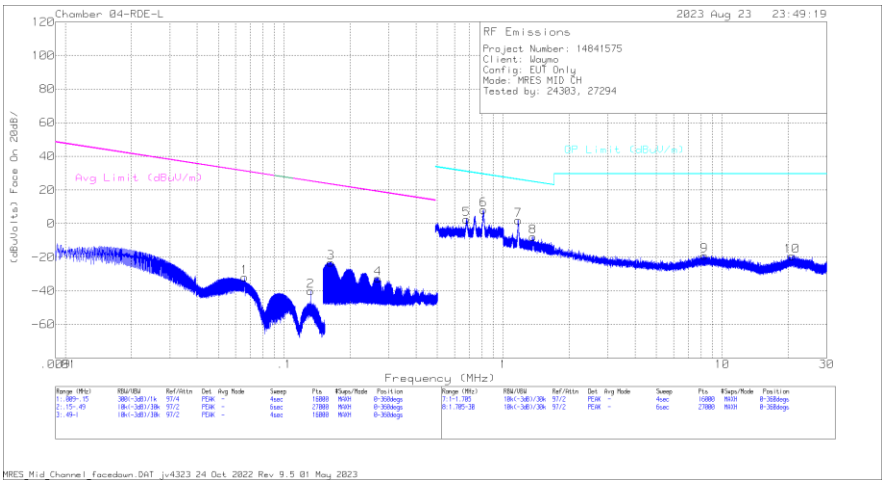
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
3	.1694	32.22	Pk	56.2	-32	-80	-23.58	23.04	-46.62	0-360
4	.4837	14.09	Pk	56.2	-31.9	-80	-41.61	13.91	-55.52	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
5	.6801	16.4	Pk	56.3	-31.9	-40	.8	30.96	-30.16	0-360
6	.8123	23.82	Pk	56.4	-31.9	-40	8.32	29.42	-21.1	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
7	1.1695	27.22	Pk	45.9	-31.8	-40	1.32	26.27	-24.95	0-360
8	1.499	19.02	Pk	44.2	-31.8	-40	-8.58	24.12	-32.7	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
9	8.234	17.77	Pk	34.7	-31.5	-40	-19.03	29.5	-48.53	0-360
10	20.6141	17.37	Pk	34.3	-31.3	-40	-19.63	29.5	-49.13	0-360

Pk - Peak detector

Face On	
Face Off	
Face Down	
MRES MODE	

Face On Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
1	.0193	34.64	Pk	59.2	-30.9	-80	-17.06	41.9	-58.96	0-360
2	.0659	23.65	Pk	59.2	-31.9	-80	-32.05	31.21	-63.26	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
3	.1772	30.35	Pk	56.2	-32	-80	-26.78	22.9	-49.68	0-360
4	.3097	25.09	Pk	56.3	-31.9	-80	-41.4	17.79	-59.19	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
5	.6049	22.34	Pk	56.3	-31.9	-40	-3.21	31.97	-35.18	0-360
6	.1318	24.49	Pk	56.4	-31.9	-40	9.05	29.44	-20.39	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
7	1.1721	24.43	Pk	45.9	-31.8	-40	5.05	26.25	-21.2	0-360
8	1.3682	17.94	Pk	44.9	-31.8	-40	-5.39	24.91	-30.3	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
17	3.7014	15.82	Pk	37.7	-31.7	-40	-21.09	29.5	-50.59	0-360
18	9.2338	12.67	Pk	34.7	-31.5	-40	-20.87	29.5	-50.37	0-360

Face On Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
9	.066	35.64	Pk	56.2	-31.9	-80	-34.23	31.19	-65.42	0-360
10	.1318	9.29	Pk	55.9	-32	-80	-47.83	25.23	-73.06	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
11	.2062	29.6	Pk	56.4	-32	-80	-33.35	21.33	-54.68	0-360
12	.4026	18.03	Pk	56.2	-31.9	-80	-36.32	15.51	-51.83	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
13	.6793	23.92	Pk	56.3	-31.9	-40	1.5	30.97	-29.47	0-360
14	.8106	15.44	Pk	56.4	-31.9	-40	8.77	29.44	-20.67	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
15	1.1698	24.92	Pk	45.9	-31.8	-40	5.67	26.26	-20.59	0-360
16	1.652	18.18	Pk	43.4	-31.8	-40	-12.38	23.27	-35.65	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
19	2.6807	15.05	Pk	39.7	-31.7	-40	-17.36	29.5	-46.86	0-360
20	13.5579	18	Pk	39.7	-31.4	-40	-15.04	29.5	-44.54	0-360

Pk - Peak detector

Face Down Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
1	.0659	23.71	Pk	56.2	-31.9	-80	-31.99	31.21	-63.2	0-360
2	.132	15.98	Pk	55.9	-32	-80	-40.12	25.21	-65.33	0-360

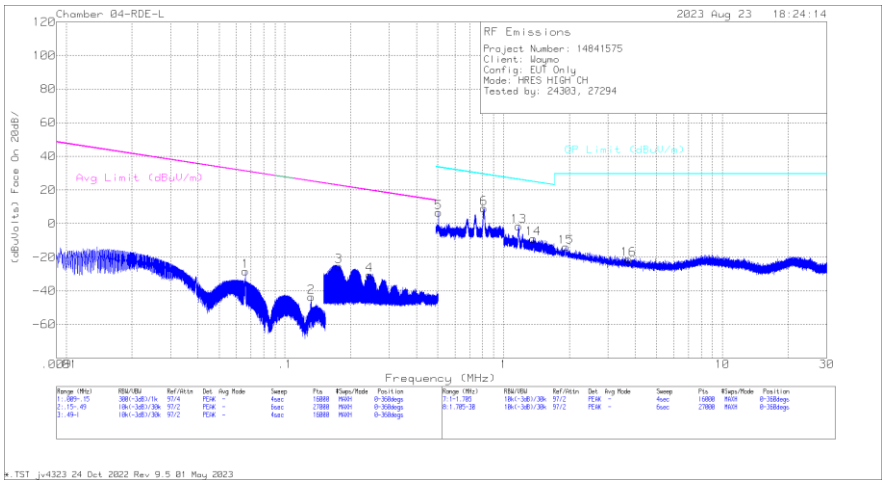
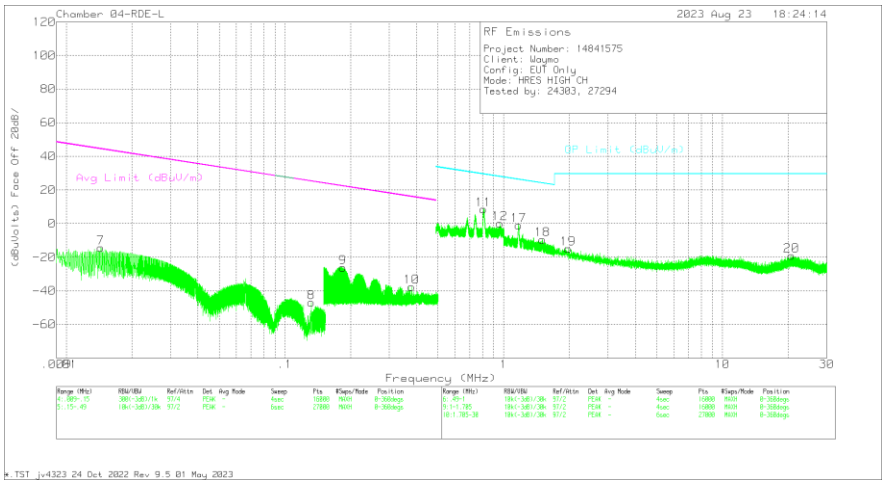
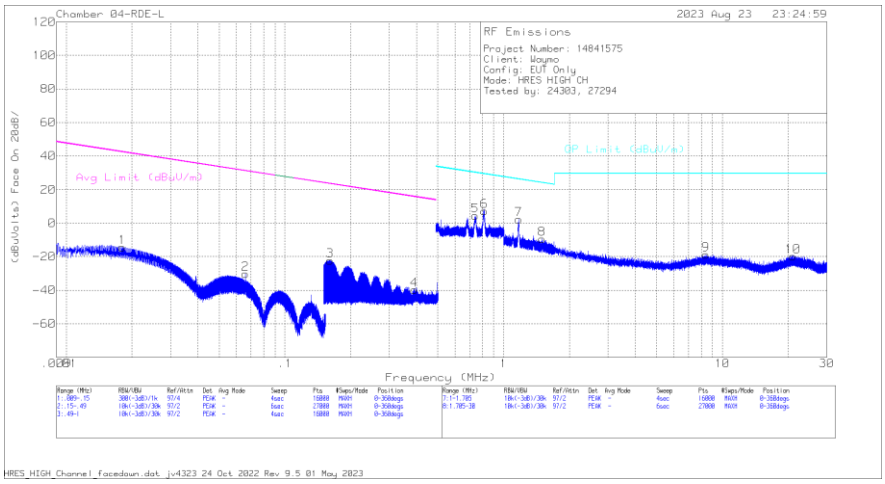
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
3	.1633	32.64	Pk	56.1	-32	-80	-23.26	23.36	-46.62	0-360
4	.2675	22.97	Pk	56.3	-32	-80	-32.73	19.07	-51.8	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
5	.6805	18.1	Pk	56.3	-31.9	-40	2.5	30.96	-28.46	0-360
6	.8109	23.66	Pk	56.4	-31.9	-40	8.16	29.44	-21.28	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
7	1.1688	27.88	Pk	45.9	-31.8	-40	1.98	26.27	-24.29	0-360
8	1.3679	19.14	Pk	44.9	-31.8	-40	-7.76	24.91	-32.67	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
9	8.2864	17.7	Pk	34.7	-31.5	-40	-19.1	29.5	-48.6	0-360
10	20.8341	17.68	Pk	34.3	-31.3	-40	-19.32	29.5	-48.82	0-360

Pk - Peak detector

Face On	
Face Off	
Face Down	
HRES MODE	

Face On Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
1	.0658	27.44	Pk	56.2	-31.9	-80	-28.26	31.21	-59.47	0-360
2	.1318	12.53	Pk	55.9	-32	-80	-43.57	25.23	-68.8	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
3	.1759	30.35	Pk	56.2	-32	-80	-25.45	22.72	-48.17	0-360
4	.2438	25.09	Pk	56.3	-32	-80	-30.61	19.87	-50.48	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
5	.5031	22.34	Pk	56.2	-31.9	-40	6.64	33.57	-26.93	0-360
6	.8119	24.49	Pk	56.4	-31.9	-40	8.99	29.43	-20.44	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
13	1.1706	24.43	Pk	45.9	-31.8	-40	-1.47	26.26	-27.73	0-360
14	1.3676	17.94	Pk	44.9	-31.8	-40	-8.96	24.91	-33.87	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
15	1.9209	15.82	Pk	42	-31.8	-40	-13.98	29.5	-43.48	0-360
16	3.7276	12.67	Pk	37.7	-31.7	-40	-21.33	29.5	-50.83	0-360

Face Off Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
7	.0144	35.64	Pk	59.8	-29.9	-80	-14.46	44.41	-58.87	0-360
8	.1318	9.29	Pk	55.9	-32	-80	-46.81	25.23	-72.04	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
9	.1836	29.6	Pk	56.3	-32	-80	-26.1	22.34	-48.44	0-360
10	.3784	18.03	Pk	56.3	-31.9	-80	-37.57	16.05	-53.62	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
11	.809	23.92	Pk	56.4	-31.9	-40	8.42	29.46	-21.04	0-360
12	.9592	15.44	Pk	56.4	-31.8	-40	.04	27.98	-27.94	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
17	1.1728	24.92	Pk	45.9	-31.8	-40	-.98	26.24	-27.22	0-360
18	1.5034	18.18	Pk	44.2	-31.8	-40	-9.42	24.09	-33.51	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
19	1.9733	15.05	Pk	41.7	-31.8	-40	-15.05	29.5	-44.55	0-360
20	20.7241	18	Pk	34.3	-31.3	-40	-19	29.5	-48.5	0-360

Pk - Peak detector

UL VERIFICATION SERVICES INC
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 319-4000 FAX: (510) 661-0888

Face Down Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
1	.0181	36.99	Pk	59.3	-30.6	-80	-14.31	42.44	-56.75	0-360
2	.0659	25.37	Pk	56.2	-31.9	-80	-30.33	31.21	-61.54	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
3	.1607	33.61	Pk	56.1	-32	-80	-22.29	23.5	-45.79	0-360
4	.3906	15.79	Pk	56.3	-31.9	-80	-39.81	15.77	-55.58	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
5	.7406	20.08	Pk	56.3	-31.9	-40	4.48	30.22	-25.74	0-360
6	.8146	22.58	Pk	56.4	-31.9	-40	7.08	29.4	-22.32	0-360

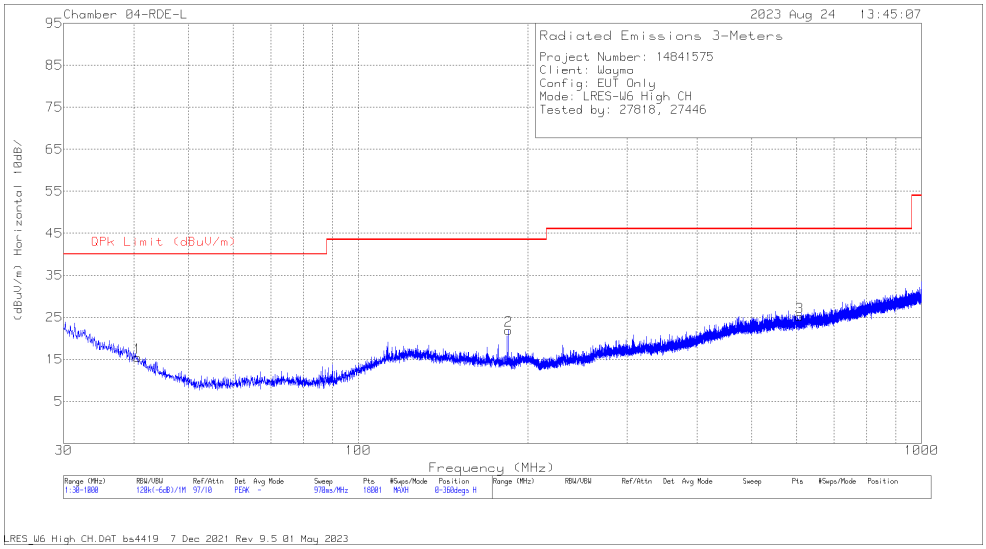
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
7	1.1698	28.27	Pk	45.9	-31.8	-40	2.37	26.26	-23.89	0-360
8	1.5	18.18	Pk	44.2	-31.8	-40	-9.42	24.11	-33.53	0-360

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna E (ACF)	CBL/AMP	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
9	8.3881	17.92	Pk	34.7	-31.5	-40	-18.88	29.5	-48.38	0-360
10	20.9641	17.24	Pk	34.2	-31.3	-40	-19.86	29.5	-49.36	0-360

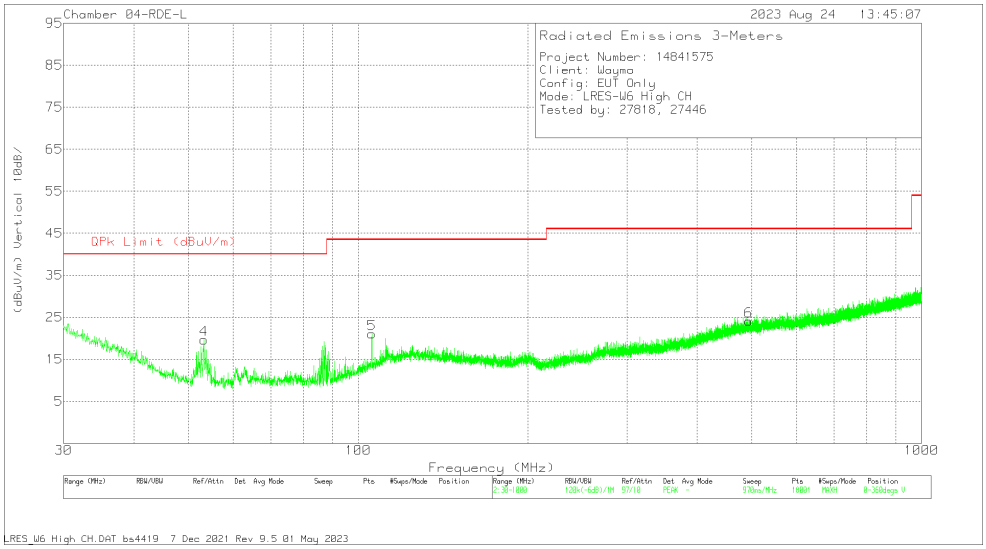
Pk - Peak detector

8.4.2. RADIATED EMISSIONS, 30 MHz - 1 GHz

Horizontal



Vertical



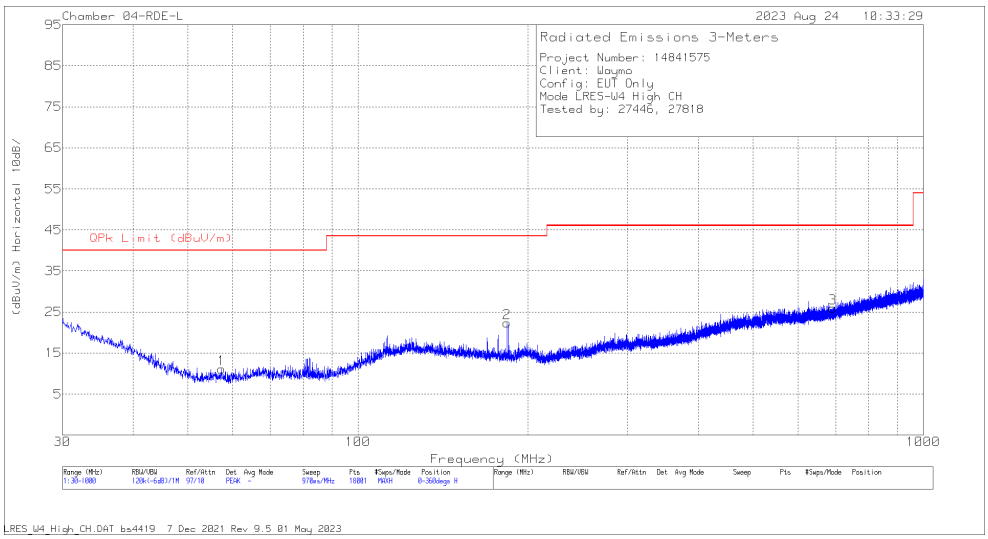
LRES W6 MODE

Range 1: Horizontal 30 - 1000MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	174374 ANSI ACF 10 m H UL_	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	40.5622	27.16	Pk	19.3	-31	15.46	40	-24.54	0-360	199	H
2	184.877	34.41	Pk	17.1	-29.6	21.91	43.52	-21.61	0-360	299	H
3	607.582	28.69	Pk	24.6	-28.1	25.19	46.02	-20.83	0-360	199	H

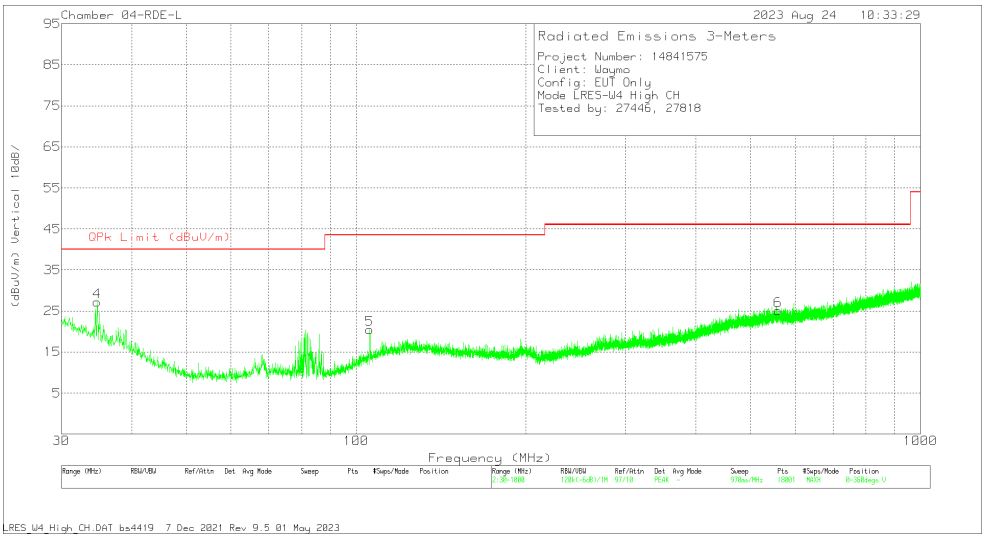
Range 2: Vertical 30 - 1000MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	174374 ANSI ACF 10 m H UL_	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
4	53.2262	37.26	Pk	13.3	-30.9	19.66	40	-20.34	0-360	99	V
5	105.768	33.85	Pk	17.6	-30.4	21.05	43.52	-22.47	0-360	99	V
6	493.823	28.67	Pk	23.7	-28.3	24.07	46.02	-21.95	0-360	399	V

Pk - Peak detector

Horizontal



Vertical



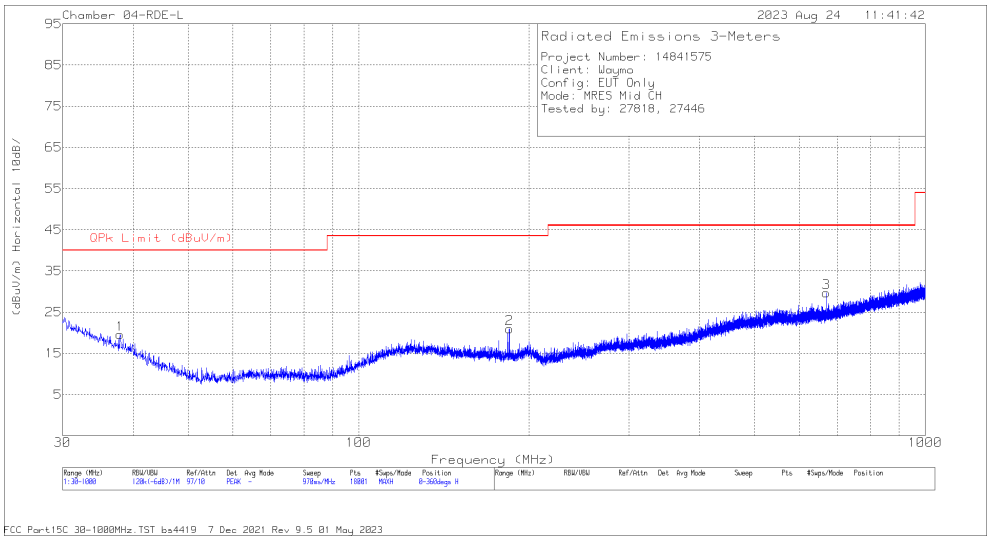
LRES W4 MODE

Range 1: Horizontal 30 - 1000MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	174374 ANSI ACF 10 m H UL_	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	57.4295	28.67	Pk	13.2	-30.8	11.07	40	-28.93	0-360	399	H
2	183.422	34.83	Pk	17.1	-29.6	22.33	43.52	-21.19	0-360	299	H
3	691.272	27.8	Pk	25.9	-27.8	25.9	46.02	-20.12	0-360	101	H

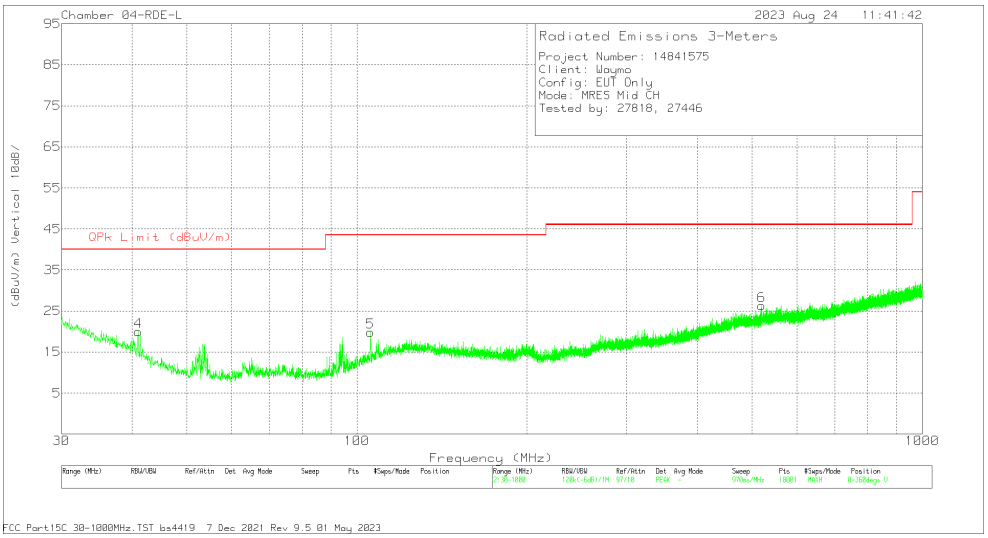
Range 2: Vertical 30 - 1000MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	174374 ANSI ACF 10 m H UL_	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
4	34.7422	35.07	Pk	23.2	-31.1	27.17	40	-12.83	0-360	99	V
5	105.66	33.39	Pk	17.5	-30.4	20.49	43.52	-23.03	0-360	99	V
6	559.567	29.06	Pk	24.4	-28.4	25.06	46.02	-20.96	0-360	99	V

Pk - Peak detector

Horizontal



Vertical



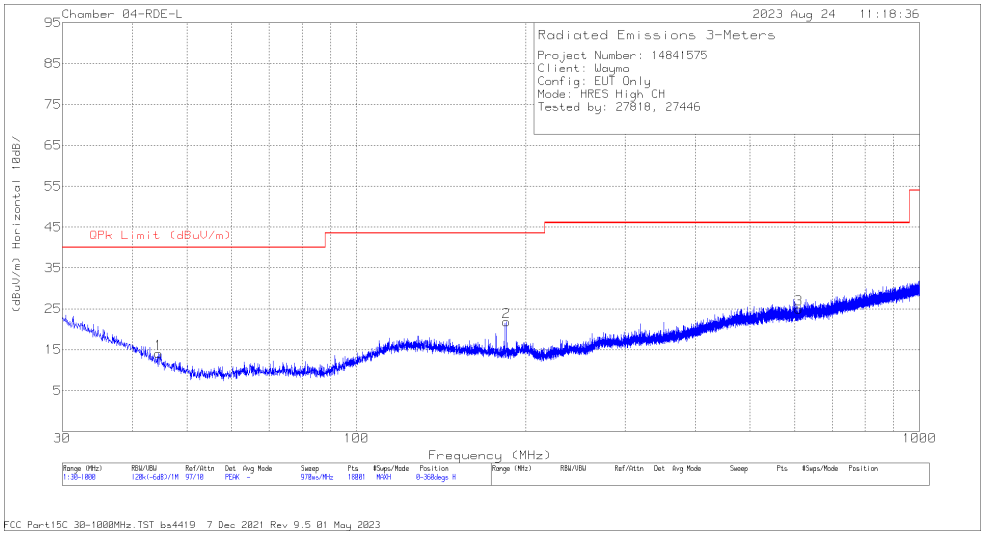
MRES MODE

Range 1: Horizontal 30 - 1000MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	174374 ANSI ACF 10 m H UL_	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	37.9217	29.34	Pk	21.2	-31	19.54	40	-20.46	0-360	399	H
2	184.446	33.46	Pk	17.1	-29.6	20.96	43.52	-22.56	0-360	299	H
3	668.531	32.08	Pk	25.6	-28	29.68	46.02	-16.34	0-360	299	H

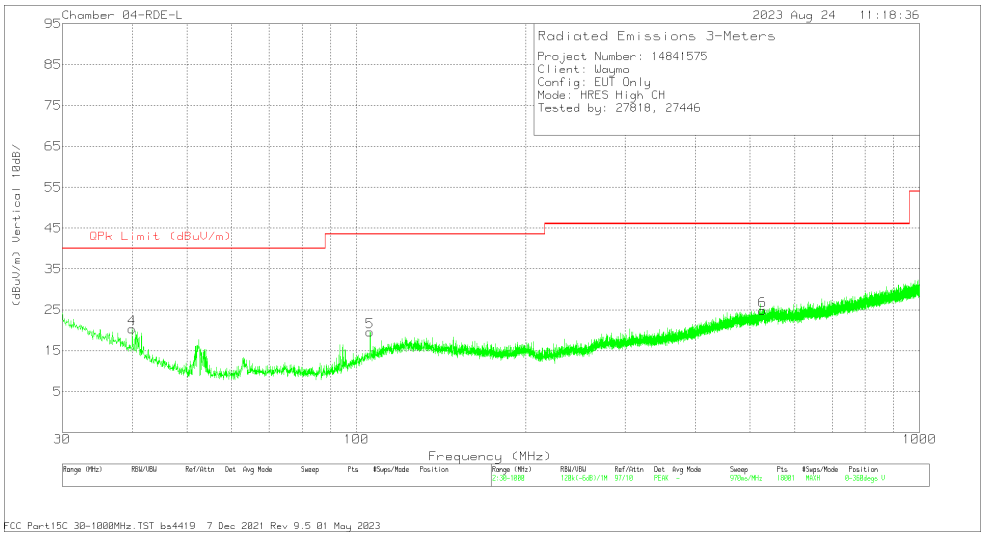
Range 2: Vertical 30 - 1000MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	174374 ANSI ACF 10 m H UL_	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
4	40.9934	32.03	Pk	19	-31	20.03	40	-19.97	0-360	100	V
5	105.714	32.73	Pk	17.5	-30.4	19.83	43.52	-23.69	0-360	100	V
6	519.635	30.79	Pk	23.7	-28.1	26.39	46.02	-19.63	0-360	399	V

Pk - Peak detector

Horizontal



Vertical



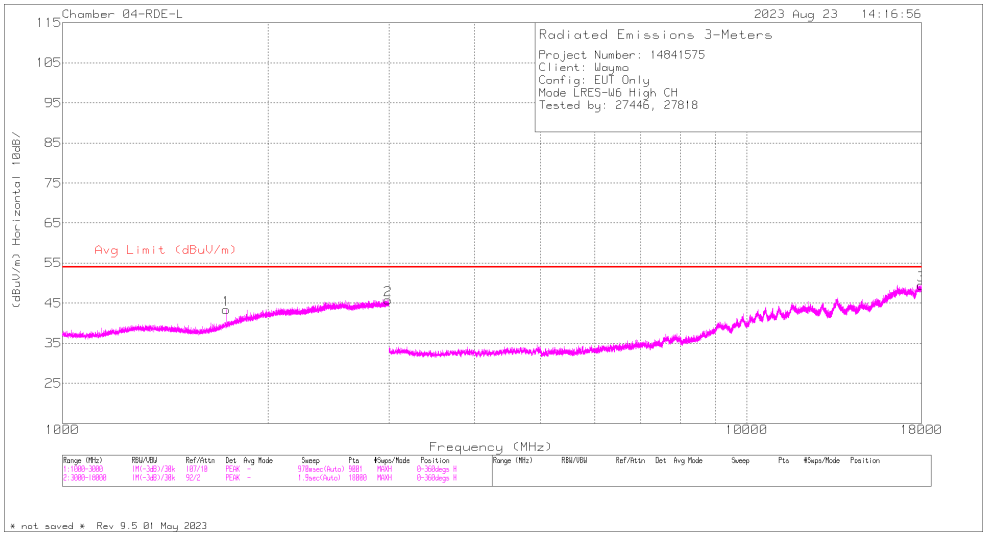
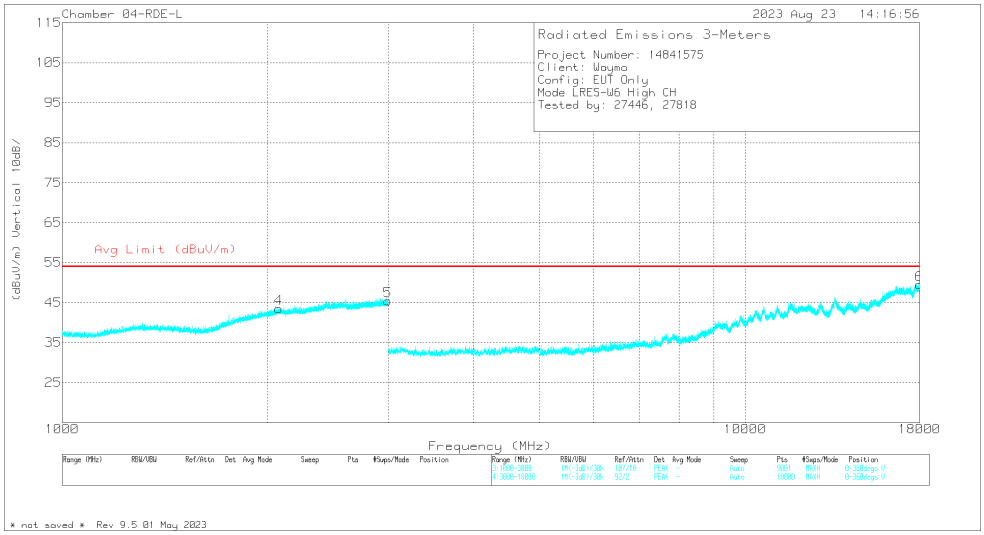
HRES MODE

Range 1: Horizontal 30 - 1000MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	174374 ANSI ACF 10 m H UL_	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	44.4961	28.42	Pk	16.6	-30.9	14.12	40	-25.88	0-360	399	H
2	184.581	34.33	Pk	17.1	-29.6	21.83	43.52	-21.69	0-360	299	H
3	610.816	28.17	Pk	24.7	-27.9	24.97	46.02	-21.05	0-360	199	H

Range 2: Vertical 30 - 1000MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	174374 ANSI ACF 10 m H UL_	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
4	39.9695	31.65	Pk	19.7	-31	20.35	40	-19.65	0-360	99	V
5	105.714	32.45	Pk	17.5	-30.4	19.55	43.52	-23.97	0-360	99	V
6	526.695	28.89	Pk	23.9	-28	24.79	46.02	-21.23	0-360	99	V

Pk - Peak detector

8.4.3. RADIATED EMISSIONS, 1 - 18 GHz

Horizontal	
Vertical	
LRES W6 MODE	

Range 1: Horizontal 1000 - 3000MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	206806 ACF (dB) 3mH	AMP/CBL	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	1737.11	34.78	Pk	29.2	-20.6	43.38	54	-10.62	0-360	200	H
2	2992.665	30.95	Pk	32.7	-17.8	45.85	54	-8.15	0-360	101	H

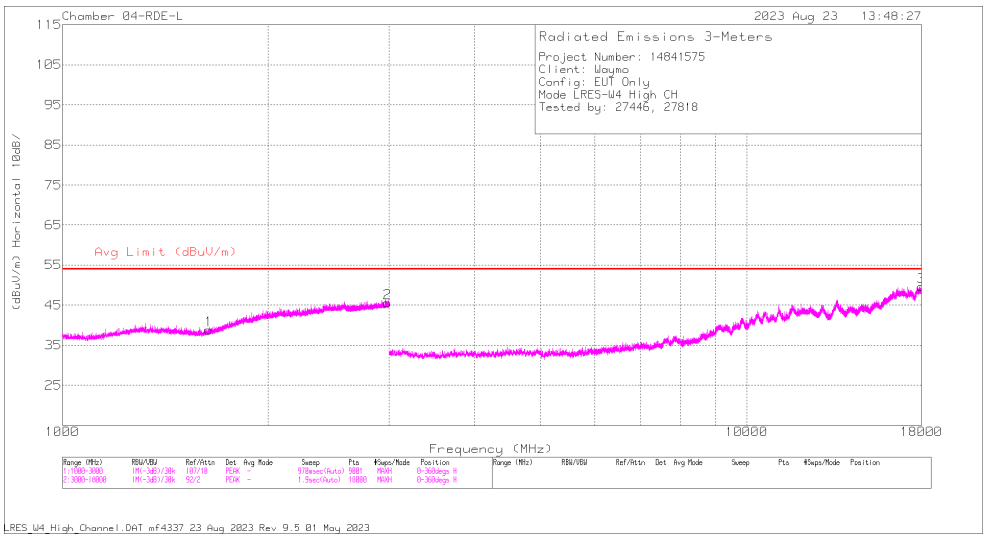
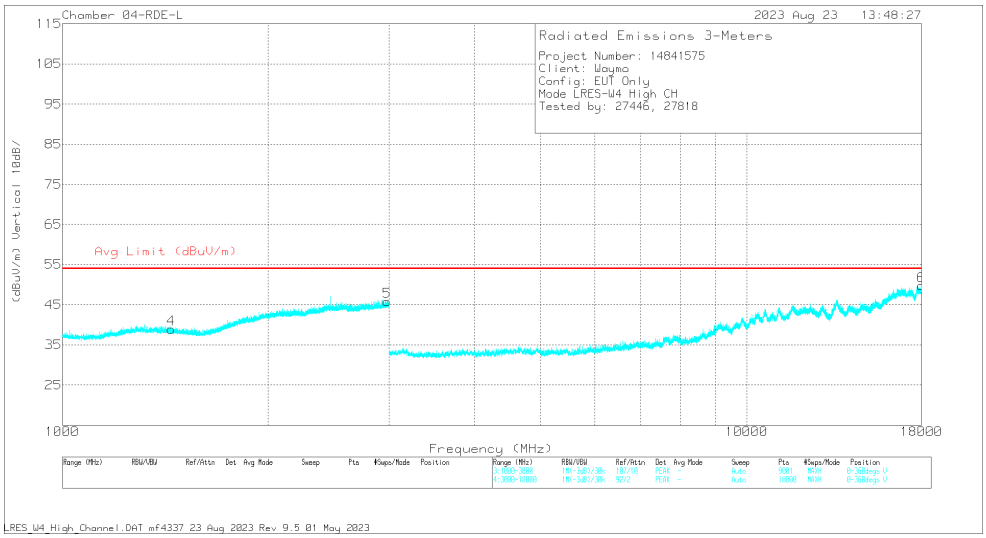
Range 2: Horizontal 3000 - 18000MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	206806 ACF (dB) 3mH	AMP/CBL	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
3	17984.172	21.42	Pk	41.6	-13.5	49.52	54	-4.48	0-360	101	H

Range 3: Vertical 1000 - 3000MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	206806 ACF (dB) 3mH	AMP/CBL	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
4	2075.554	31.36	Pk	31.7	-19.5	43.56	54	-10.44	0-360	101	V
5	2997.776	30.35	Pk	32.8	-17.7	45.45	54	-8.55	0-360	101	V

Range 4: Vertical 3000 - 18000MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	206806 ACF (dB) 3mH	AMP/CBL	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
6	17992.506	21.35	Pk	41.6	-13.4	49.55	54	-4.45	0-360	200	V

Pk - Peak detector

UL VERIFICATION SERVICES INC
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 319-4000 FAX: (510) 661-0888

Horizontal	
Vertical	
LRES W4 MODE	

Range 1: Horizontal 1000 - 3000MHz											
Marker	**Frequency (MHz)**	**Meter Reading (dBuV)**	**Det**	**206806 ACF (dB) 3mH**	**AMP/CBL**	**Corrected Reading (dBuV/m)**	**Avg Limit (dBuV/m)**	**Margin (dB)**	**Azimuth (Degs)**	**Height (cm)**	**Polarity**
1	1638.222	31.66	Pk	28	-20.9	38.76	54	-15.24	0-360	101	H
2	2986.665	30.59	Pk	32.7	-17.7	45.59	54	-8.41	0-360	101	H

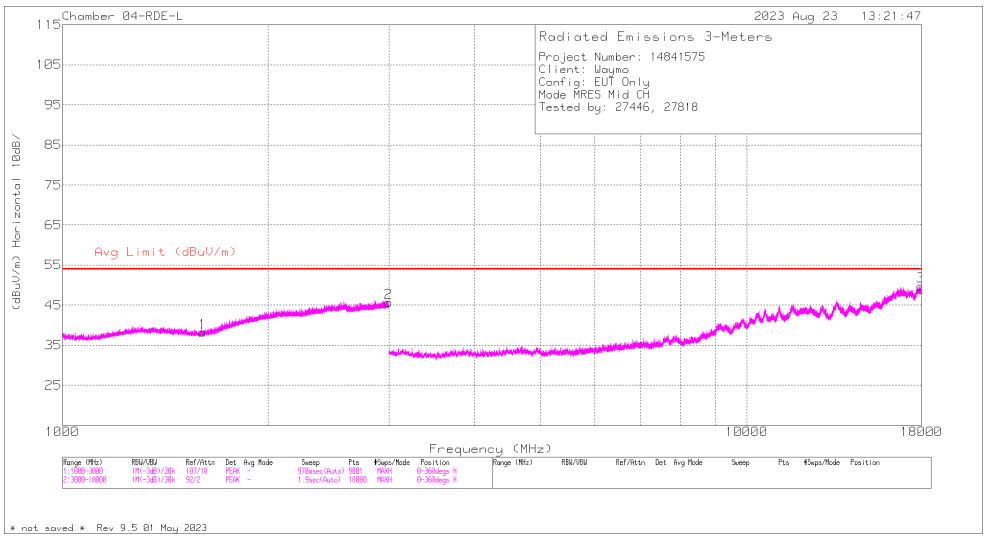
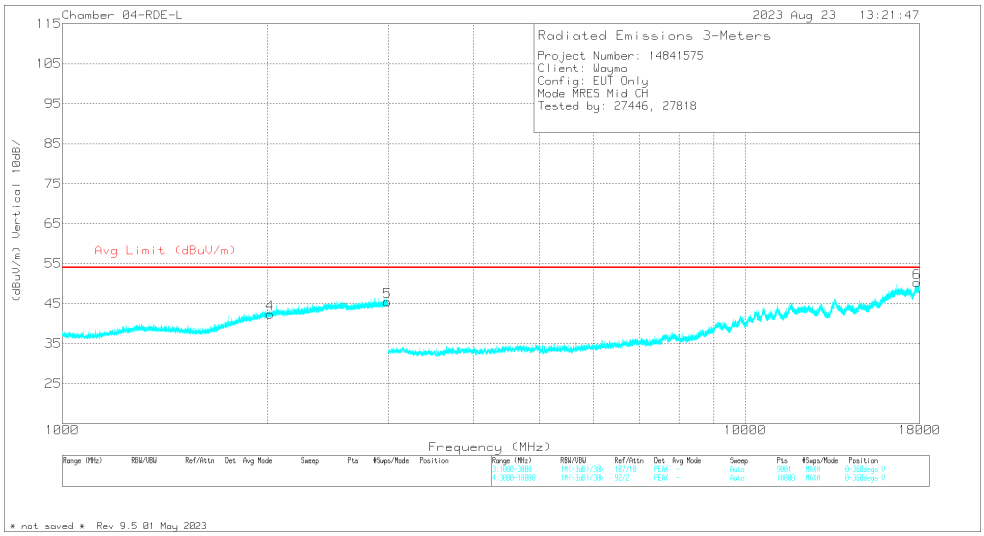
Range 2: Horizontal 3000 - 18000MHz											
Marker	**Frequency (MHz)**	**Meter Reading (dBuV)**	**Det**	**206806 ACF (dB) 3mH**	**AMP/CBL**	**Corrected Reading (dBuV/m)**	**Avg Limit (dBuV/m)**	**Margin (dB)**	**Azimuth (Degs)**	**Height (cm)**	**Polarity**
3	17990.423	21.43	Pk	41.6	-13.4	49.63	54	-4.37	0-360	200	H

Range 3: Vertical 1000 - 3000MHz											
Marker	**Frequency (MHz)**	**Meter Reading (dBuV)**	**Det**	**206806 ACF (dB) 3mH**	**AMP/CBL**	**Corrected Reading (dBuV/m)**	**Avg Limit (dBuV/m)**	**Margin (dB)**	**Azimuth (Degs)**	**Height (cm)**	**Polarity**
4	1441.555	31.87	Pk	28.5	-21.4	38.97	54	-15.03	0-360	200	V
5	2983.331	30.88	Pk	32.7	-17.8	45.78	54	-8.22	0-360	101	V

Range 4: Vertical 3000 - 18000MHz											
Marker	**Frequency (MHz)**	**Meter Reading (dBuV)**	**Det**	**206806 ACF (dB) 3mH**	**AMP/CBL**	**Corrected Reading (dBuV/m)**	**Avg Limit (dBuV/m)**	**Margin (dB)**	**Azimuth (Degs)**	**Height (cm)**	**Polarity**
6	17993.34	21.61	Pk	41.6	-13.4	49.81	54	-4.19	0-360	101	V

Pk - Peak detector

UL VERIFICATION SERVICES INC
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 319-4000 FAX: (510) 661-0888

Horizontal	
Vertical	
MRES MODE	

Range 1: Horizontal 1000 - 3000MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	206806 ACF (dB) 3mH	AMP/CBL	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	1603.555	31.43	Pk	27.8	-21	38.23	54	-15.77	0-360	101	H
2	2995.776	30.82	Pk	32.7	-17.8	45.72	54	-8.28	0-360	101	H

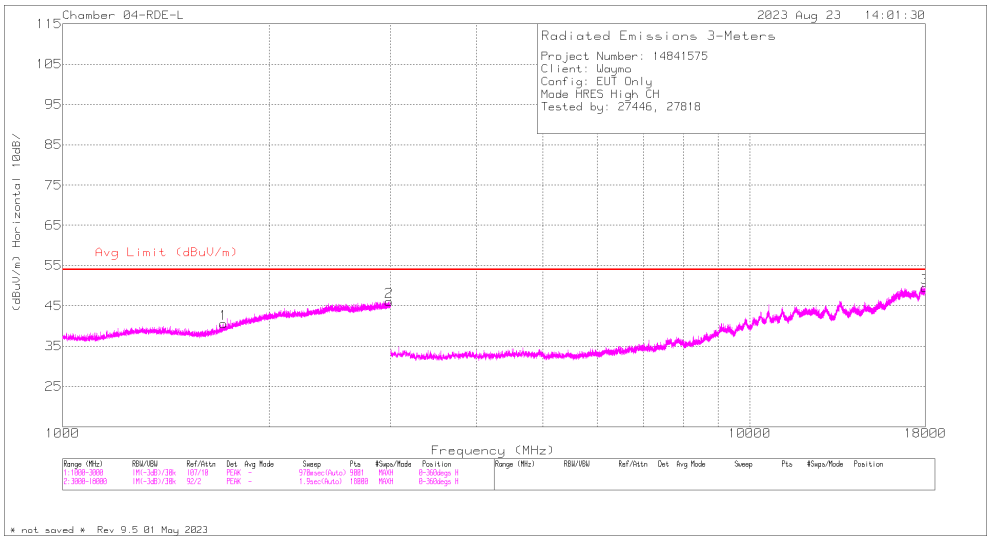
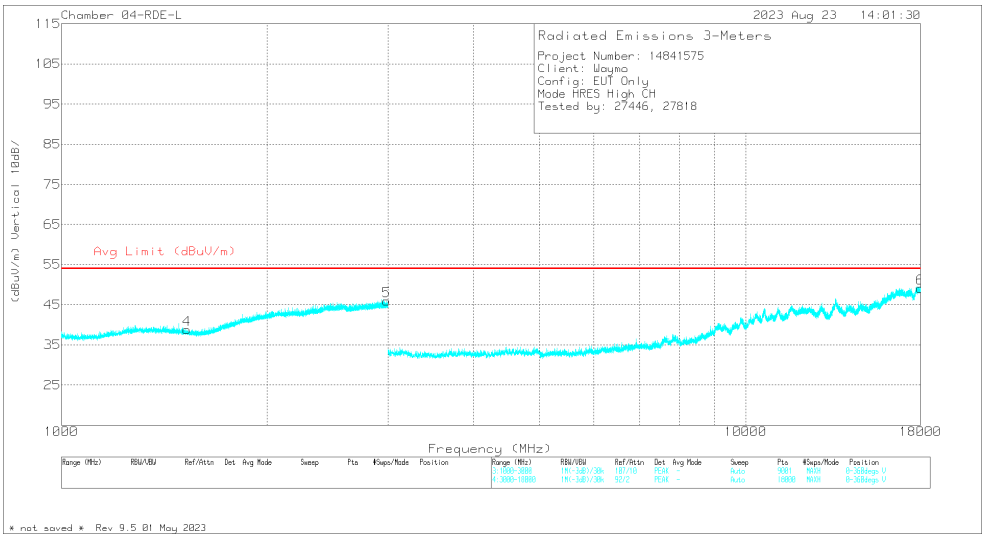
Range 2: Horizontal 3000 - 18000MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	206806 ACF (dB) 3mH	AMP/CBL	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
3	17980.006	21.69	Pk	41.6	-13.5	49.79	54	-4.21	0-360	101	H

Range 3: Vertical 1000 - 3000MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	206806 ACF (dB) 3mH	AMP/CBL	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
4	2015.11	30.62	Pk	31.4	-19.7	42.32	54	-11.68	0-360	101	V
5	2991.554	30.46	Pk	32.7	-17.7	45.46	54	-8.54	0-360	101	V

Range 4: Vertical 3000 - 18000MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	206806 ACF (dB) 3mH	AMP/CBL	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
6	17839.164	23.3	Pk	41.2	-14.2	50.3	54	-3.7	0-360	101	V

Pk - Peak detector

UL VERIFICATION SERVICES INC
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 319-4000 FAX: (510) 661-0888

Horizontal	
Vertical	

HRES MODE

Range 1: Horizontal 1000 - 3000MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	206806 ACF (dB) 3mH	AMP/CBL	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	1715.777	32.26	Pk	28.9	-20.6	40.56	54	-13.44	0-360	199	H
2	2984.665	31.12	Pk	32.7	-17.7	46.12	54	-7.88	0-360	101	H

Range 2: Horizontal 3000 - 18000MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	206806 ACF (dB) 3mH	AMP/CBL	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
3	17997.506	21.37	Pk	41.6	-13.4	49.57	54	-4.43	0-360	101	H

Range 3: Vertical 1000 - 3000MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	206806 ACF (dB) 3mH	AMP/CBL	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
4	1526.888	31.95	Pk	28	-21.2	38.75	54	-15.25	0-360	101	V
5	2986.665	30.92	Pk	32.7	-17.7	45.92	54	-8.08	0-360	200	V

Range 4: Vertical 3000 - 18000MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	206806 ACF (dB) 3mH	AMP/CBL	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
6	17994.173	20.97	Pk	41.6	-13.4	49.17	54	-4.83	0-360	101	V

Pk - Peak detector

UL VERIFICATION SERVICES INC
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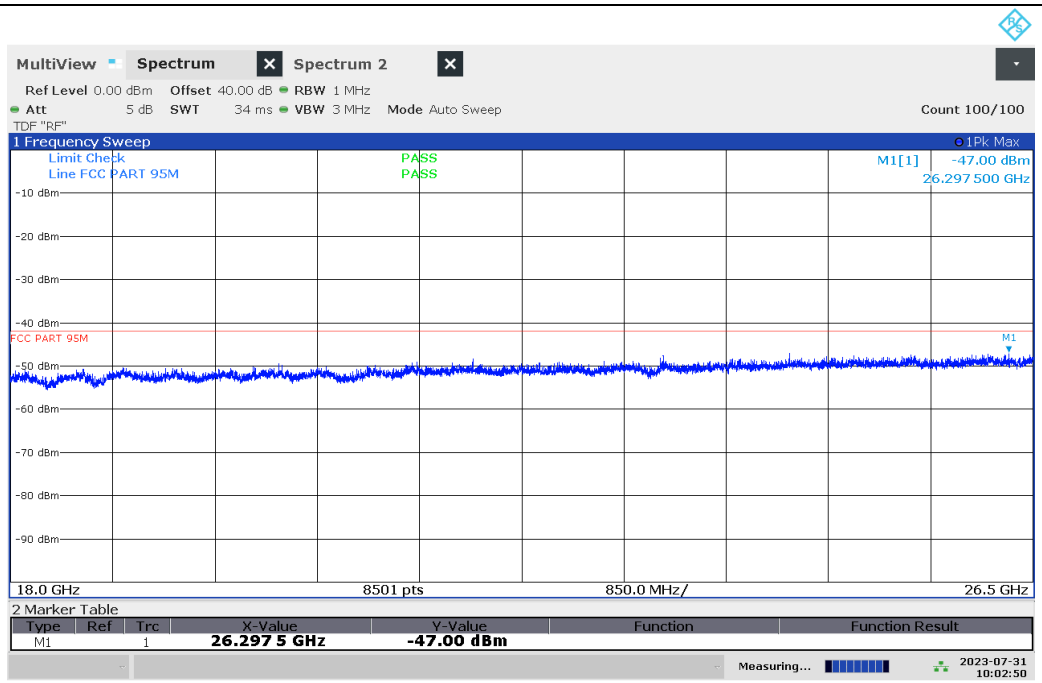
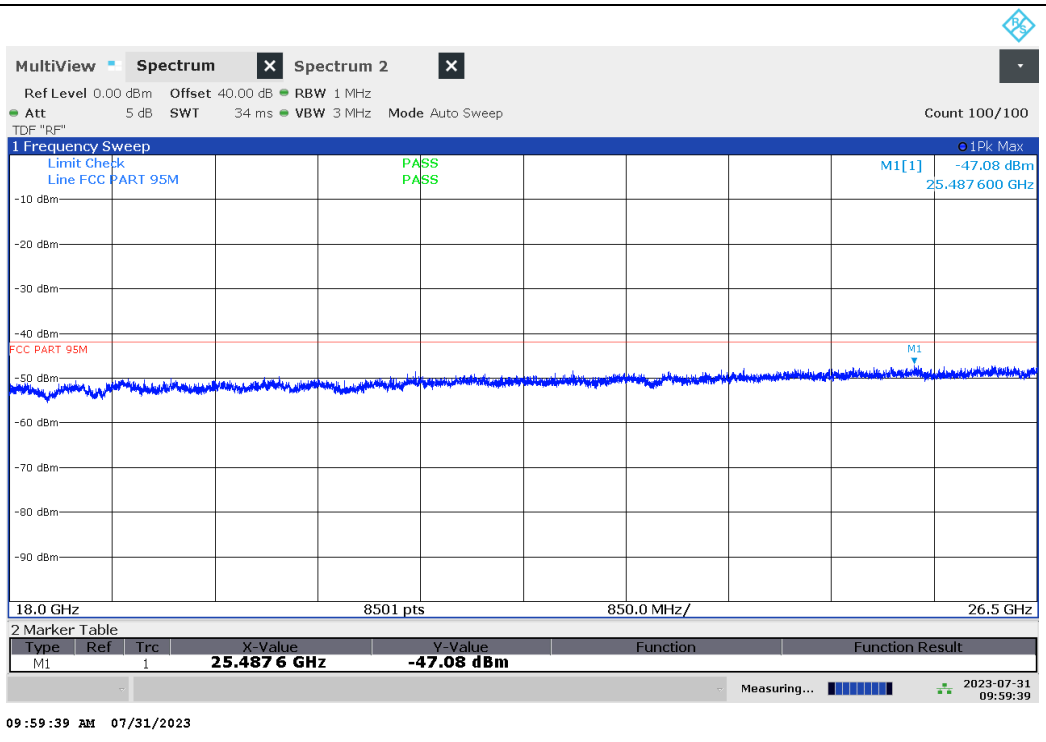
8.4.4. RADIATED EMISSIONS, 18 - 26.5 GHz

Horizontal

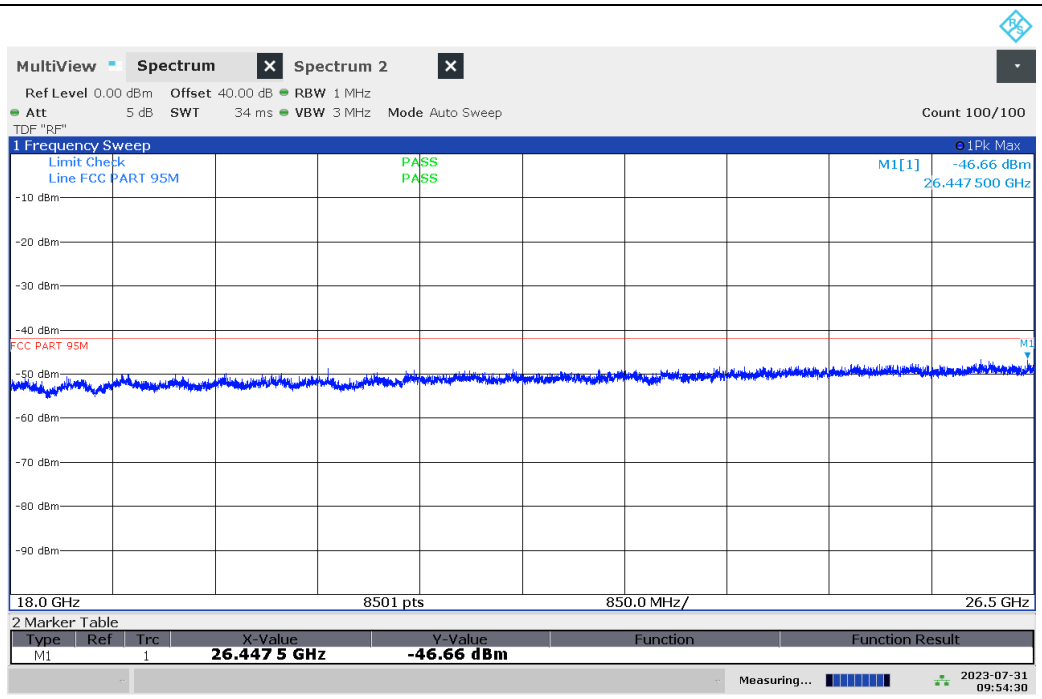
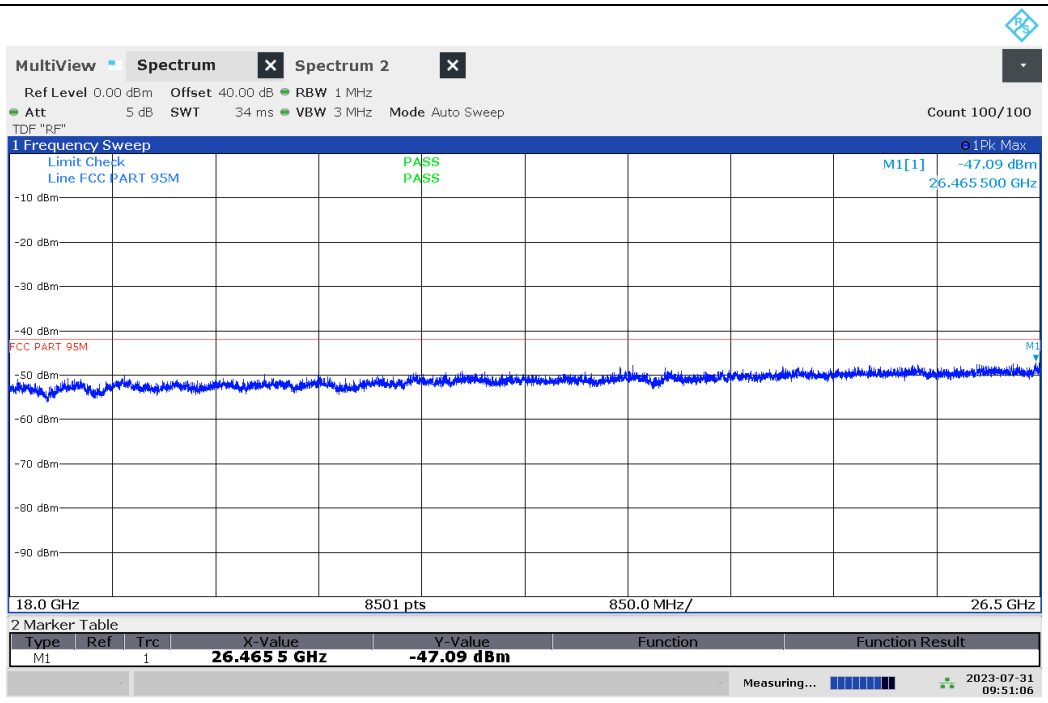


Vertical



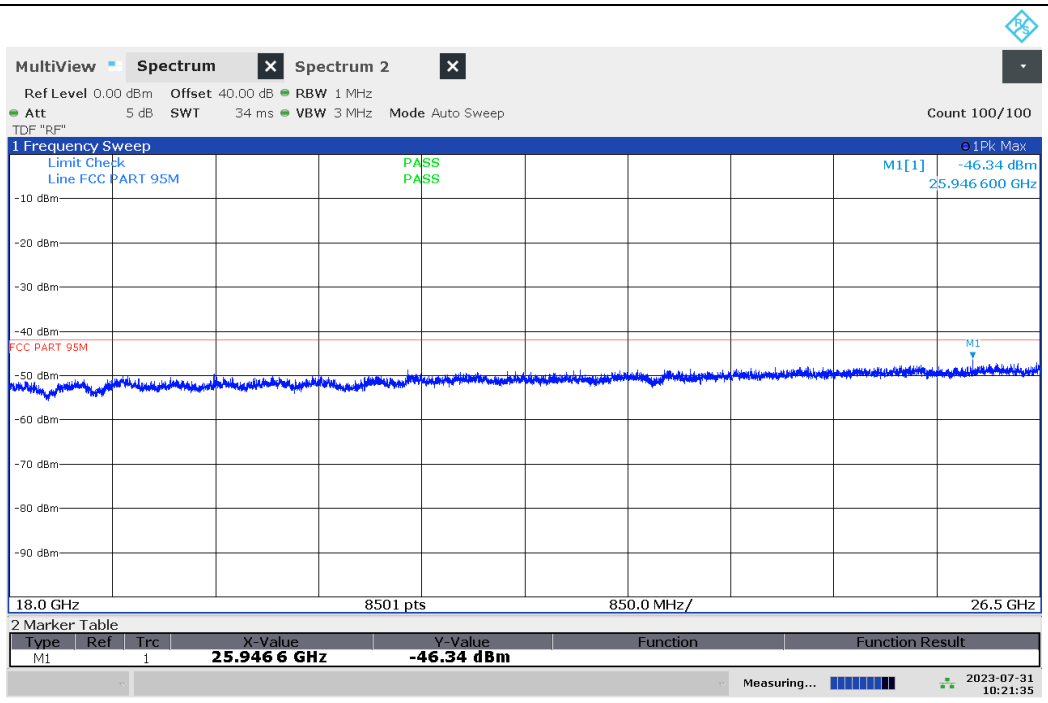
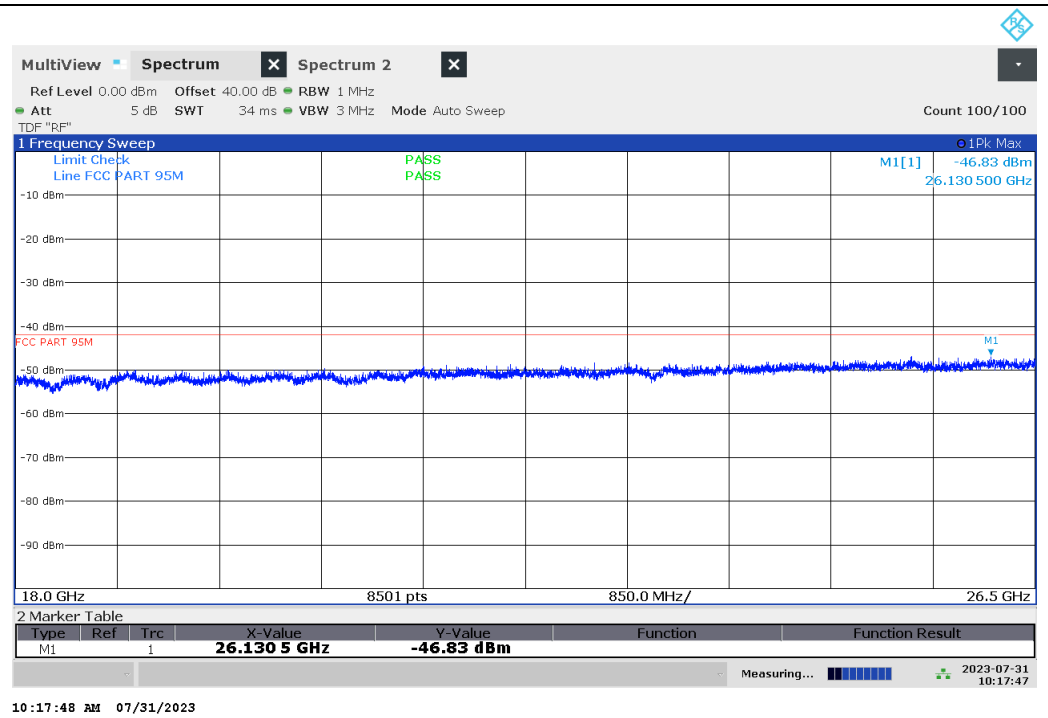
LRES W6 MODE

No emission detected using Peak Detection.

Horizontal	
Vertical	

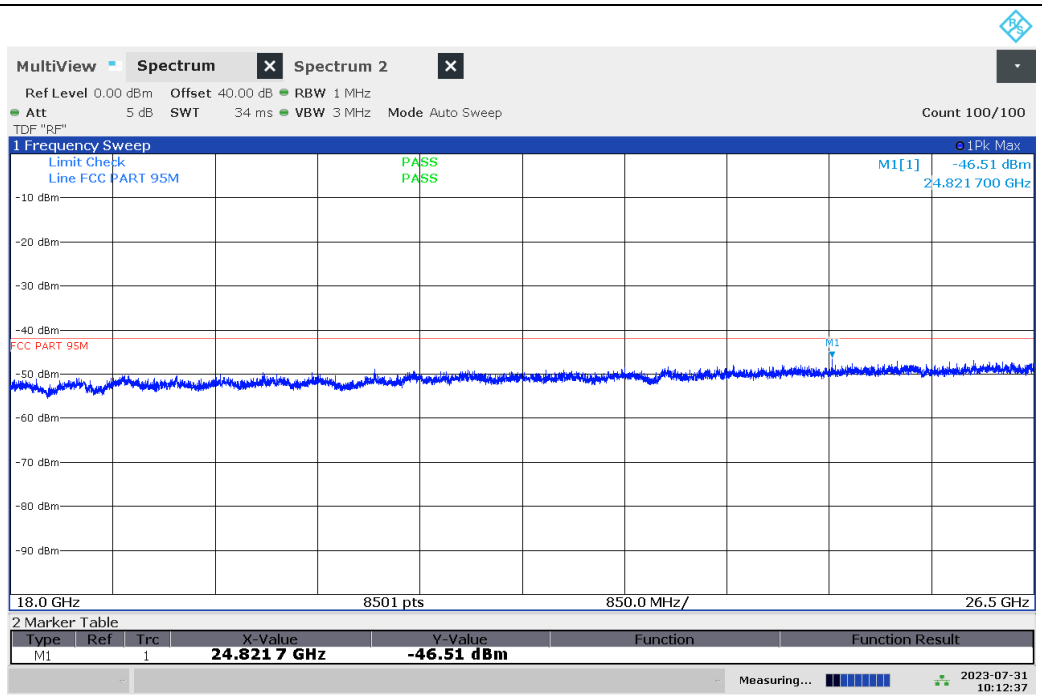
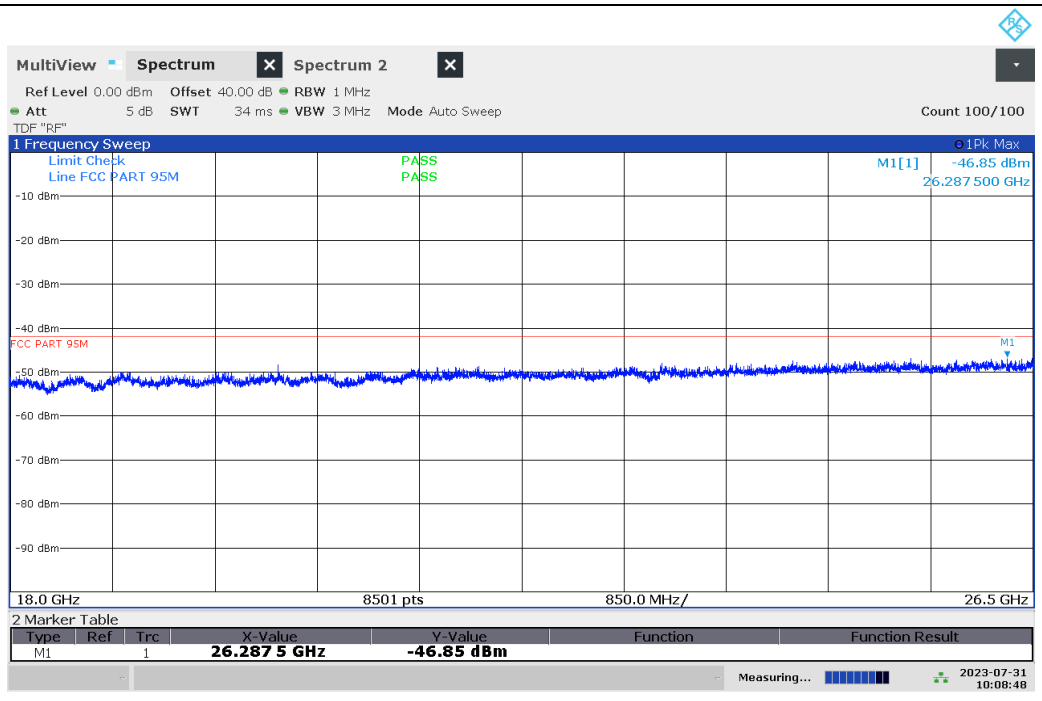
LRES W4 MODE

No emission detected using Peak Detection.

Horizontal	
Vertical	

MRES MODE

No emission detected using Peak Detection.

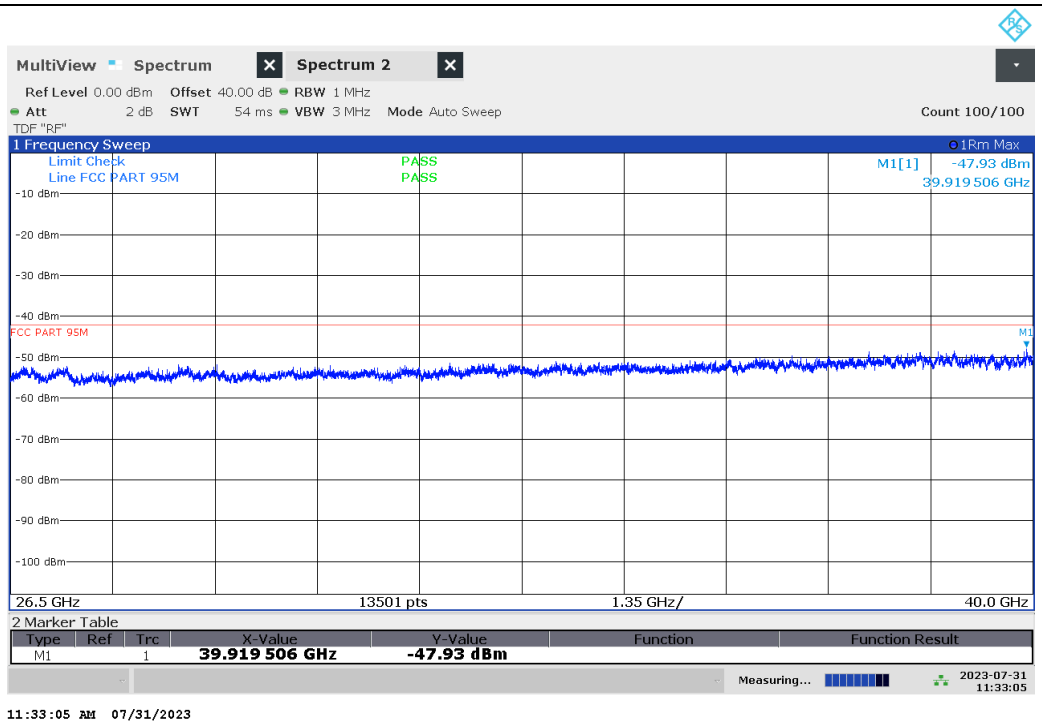
Horizontal	
Vertical	

HRES MODE

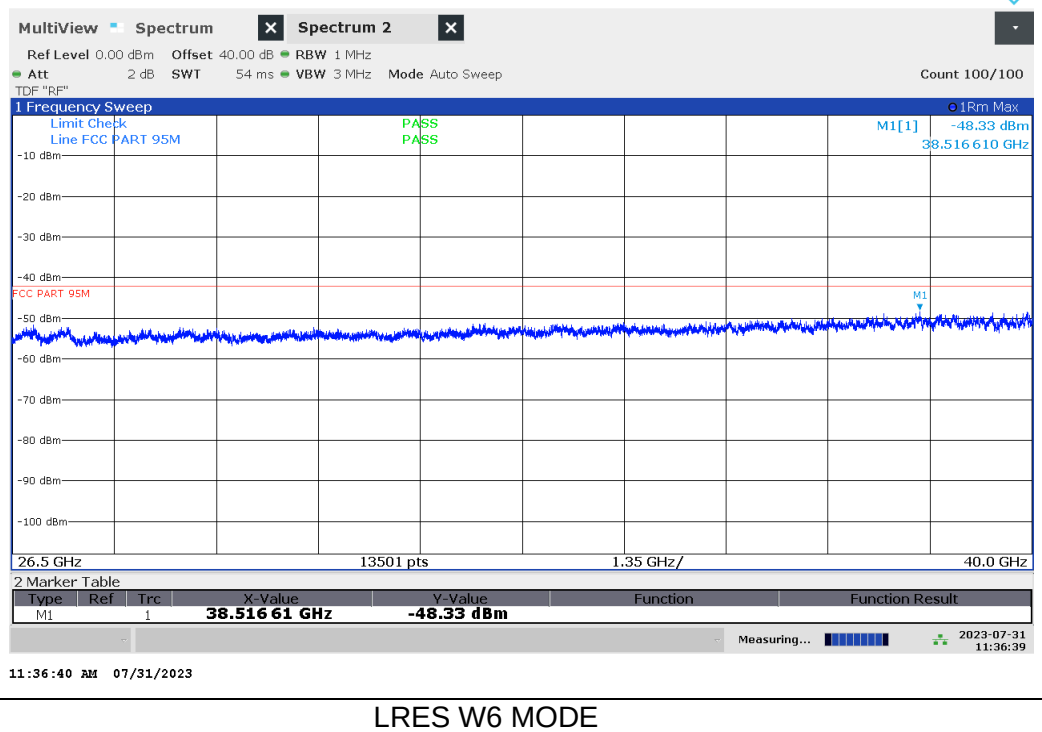
No emission detected using Peak Detection.

8.4.5. RADIATED EMISSIONS, 26.5 - 40 GHz

Horizontal

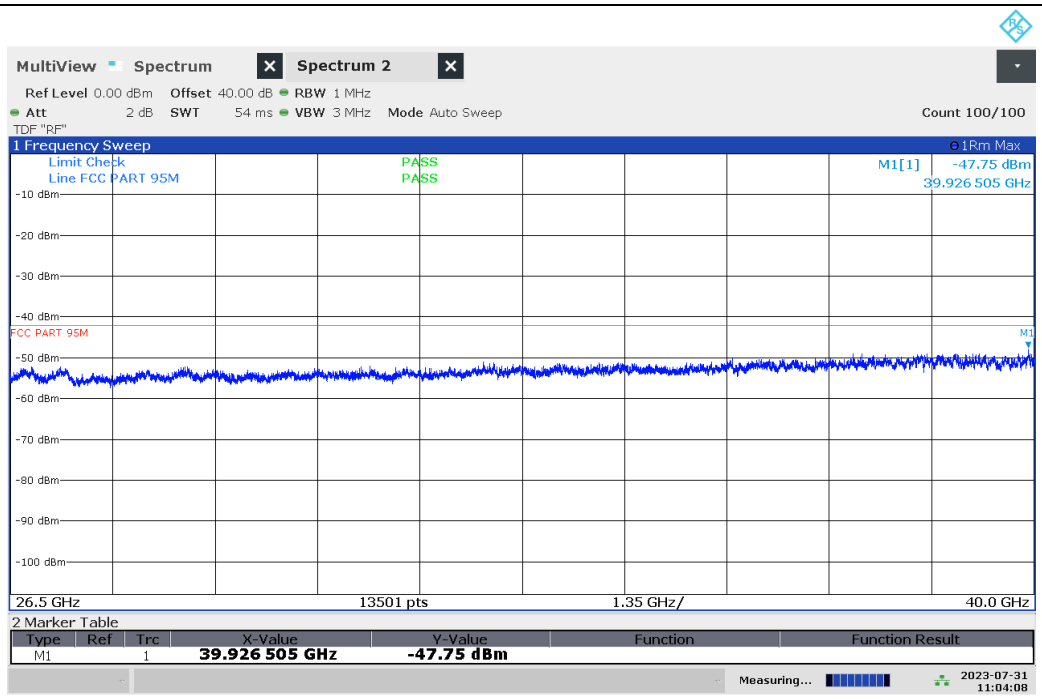
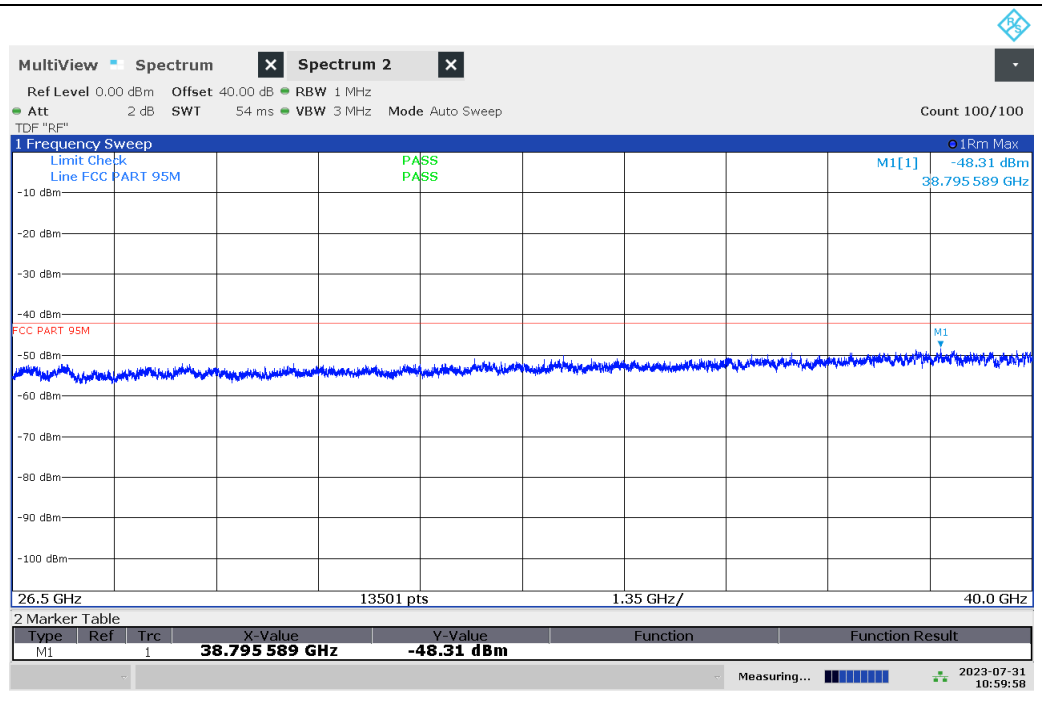


Vertical



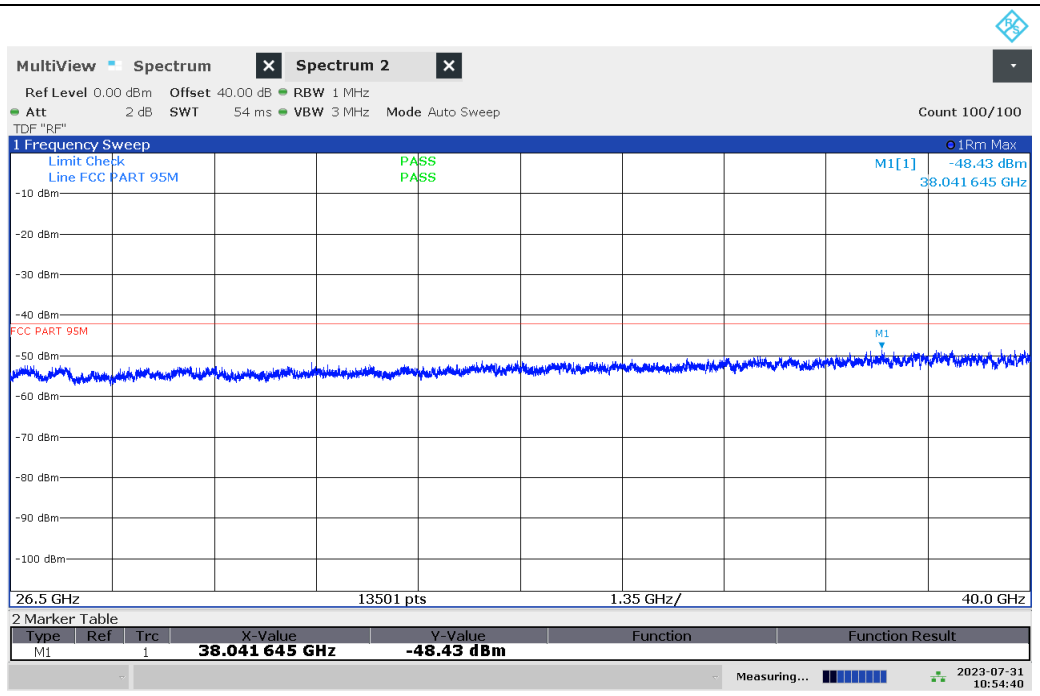
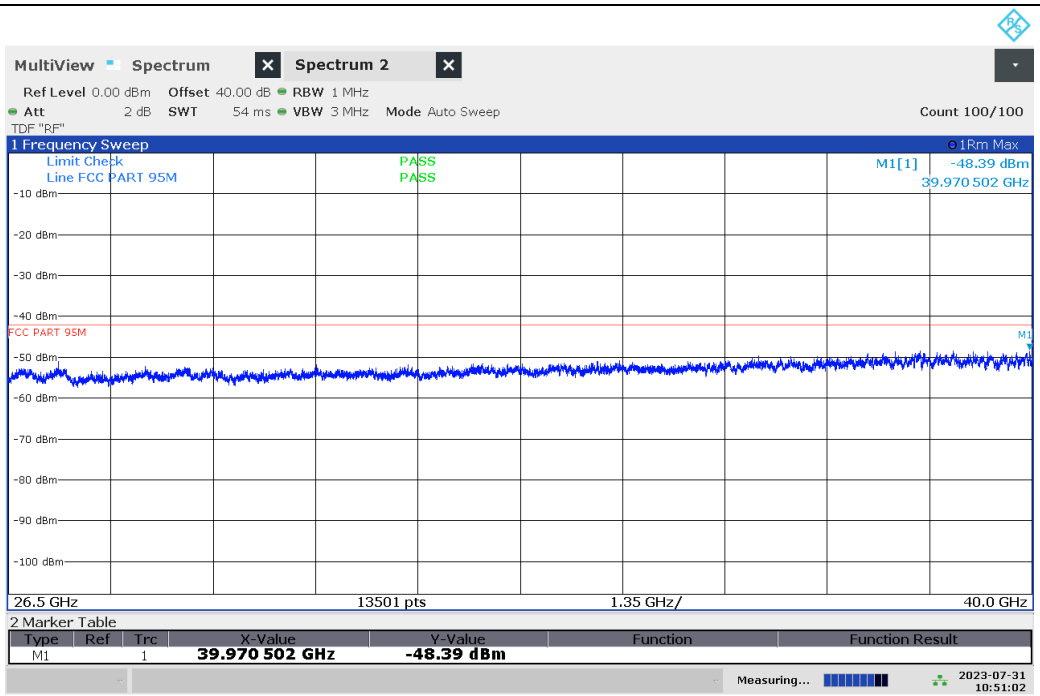
LRES W6 MODE

No emission detected using Peak Detection.

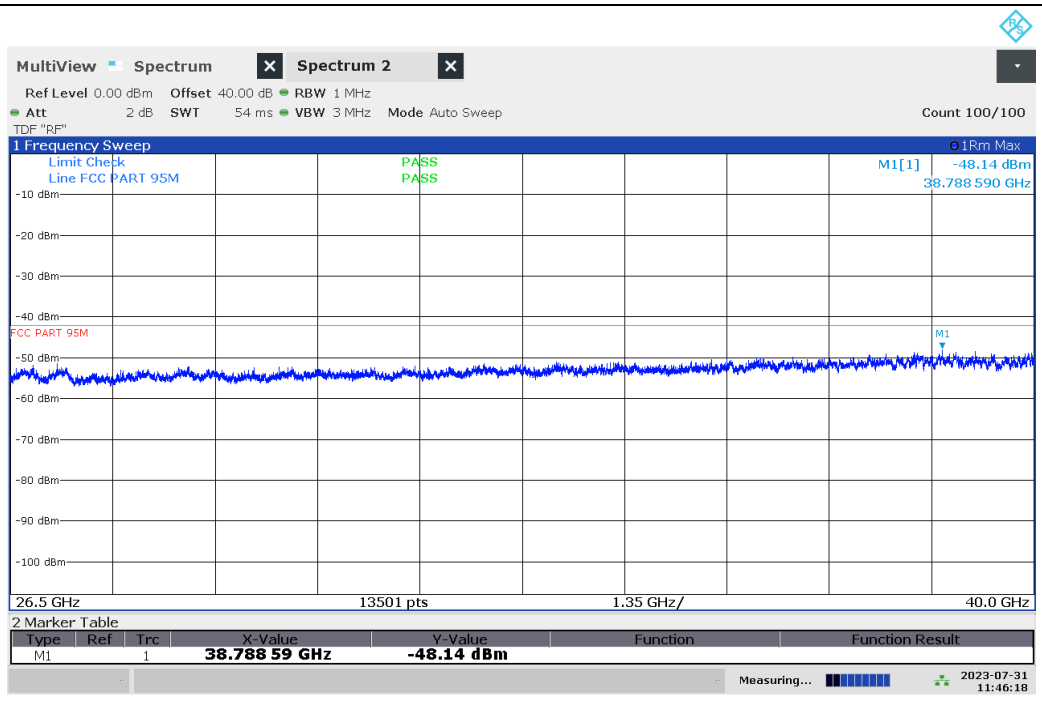
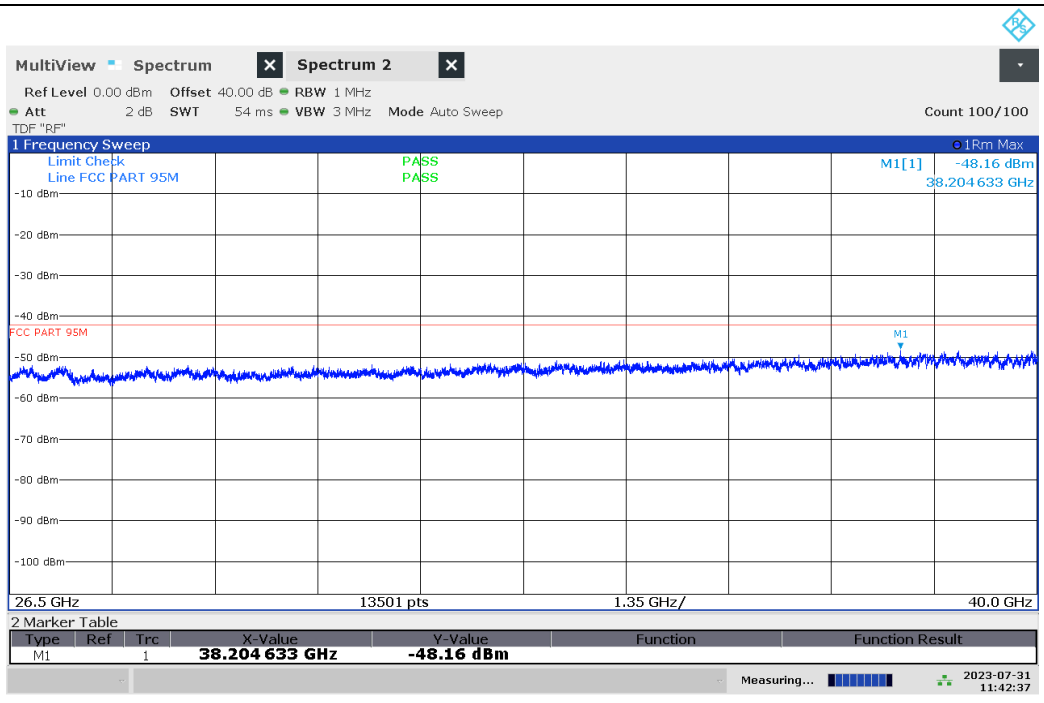
Horizontal	
Vertical	

LRES W4 MODE

No emission detected using Peak Detection.

Horizontal	
Vertical	
MRES MODE	

No emission detected using Peak Detection.

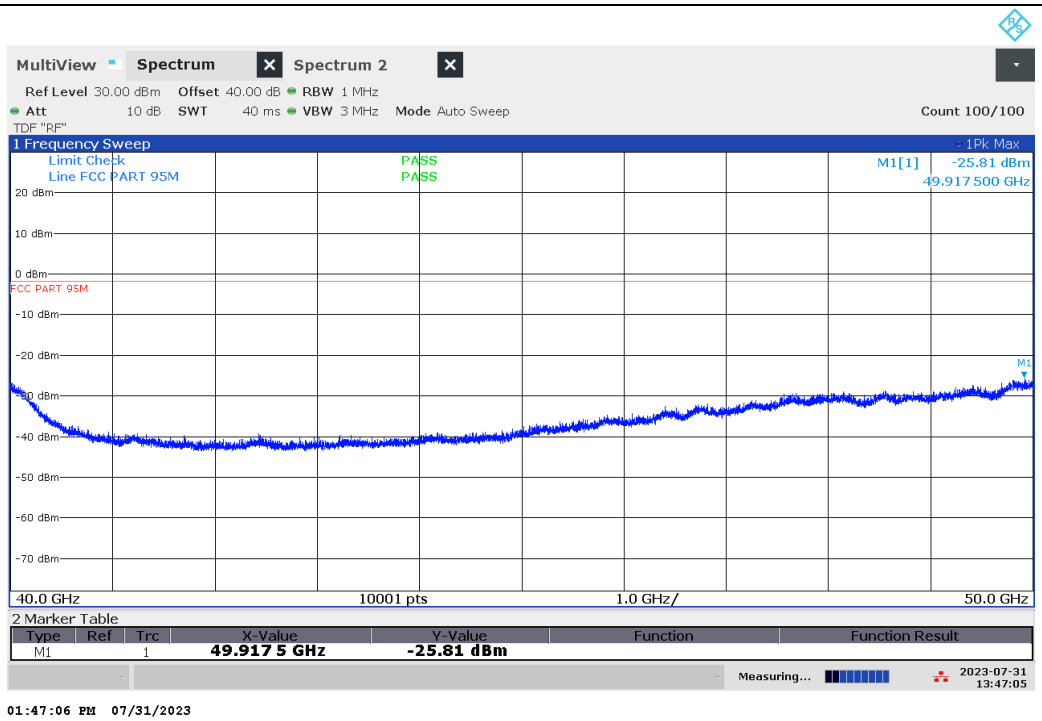
Horizontal	
Vertical	

HRES MODE

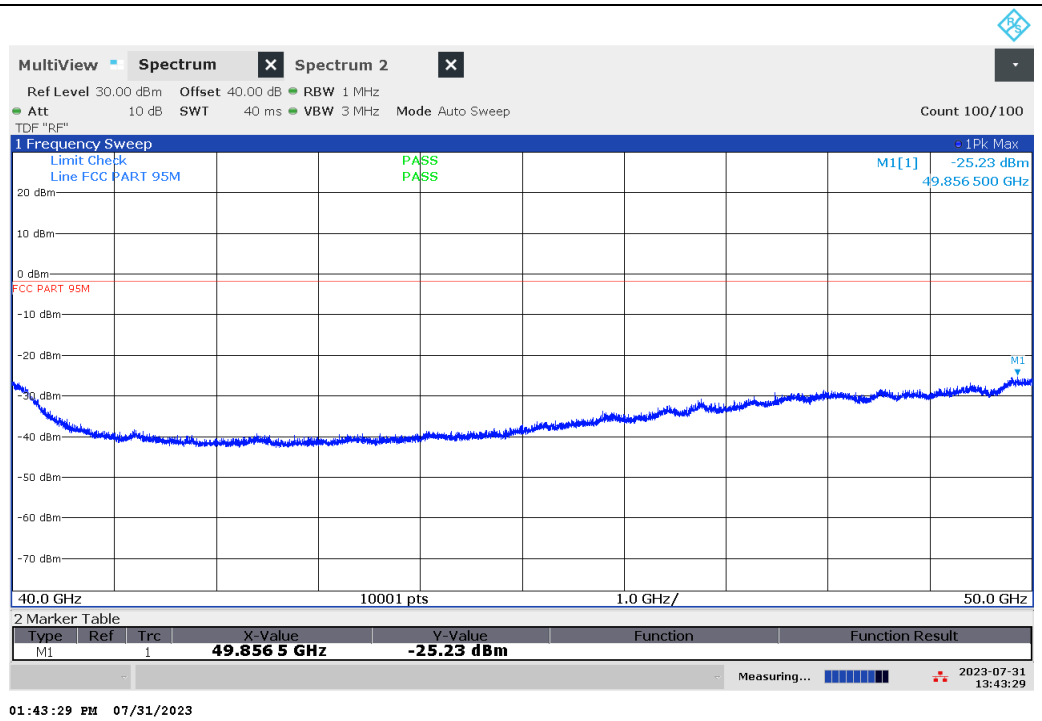
No emission detected using Peak Detection.

8.4.6. RADIATED EMISSIONS, 40 - 50 GHz

Horizontal

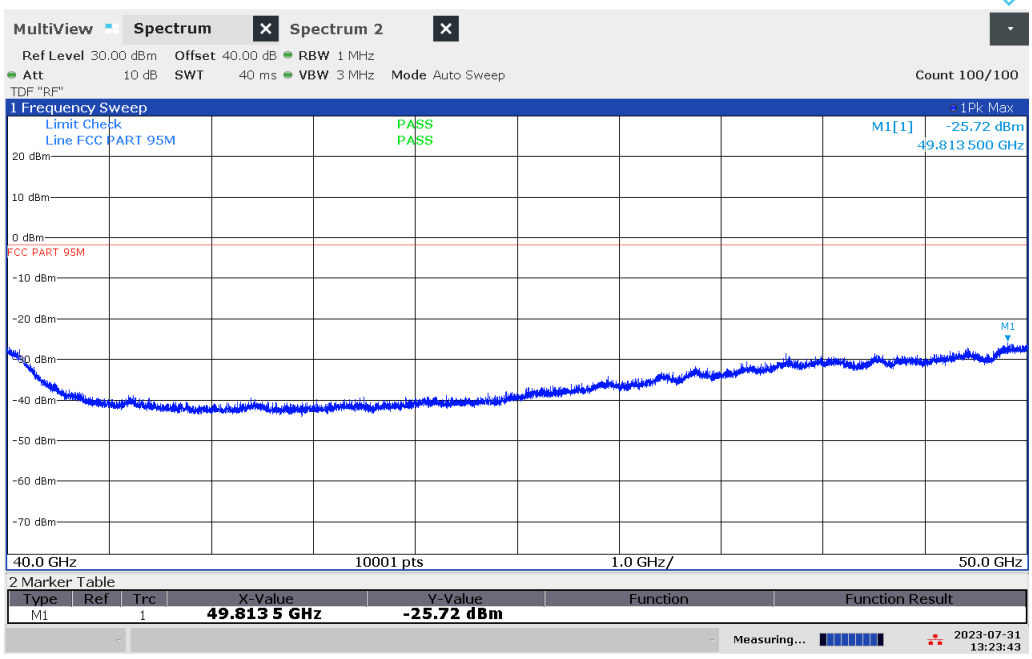
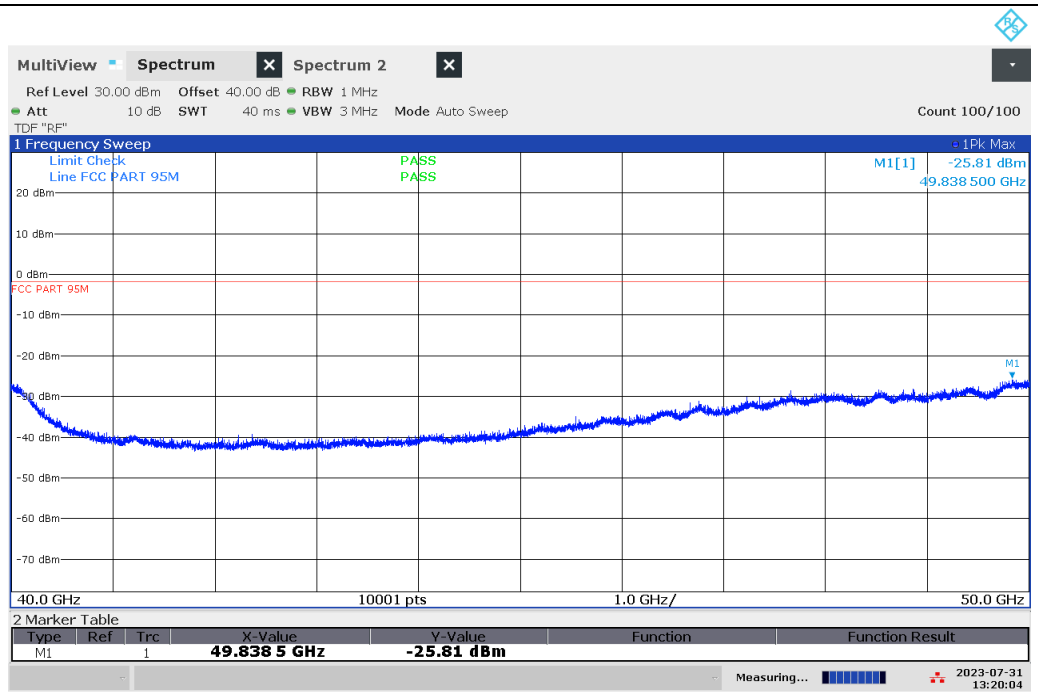


Vertical



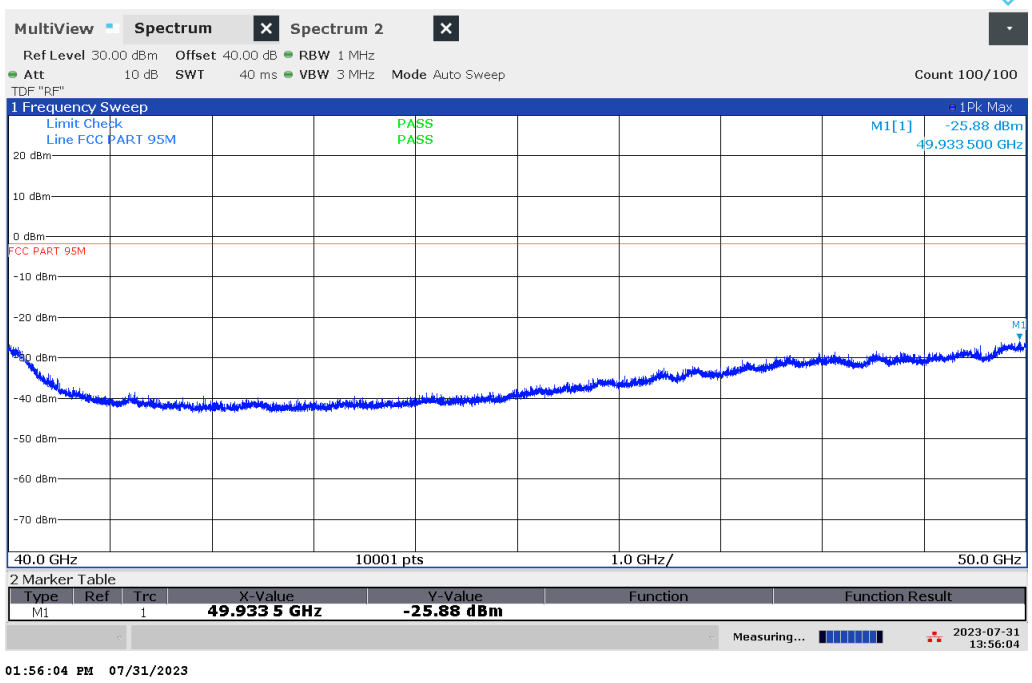
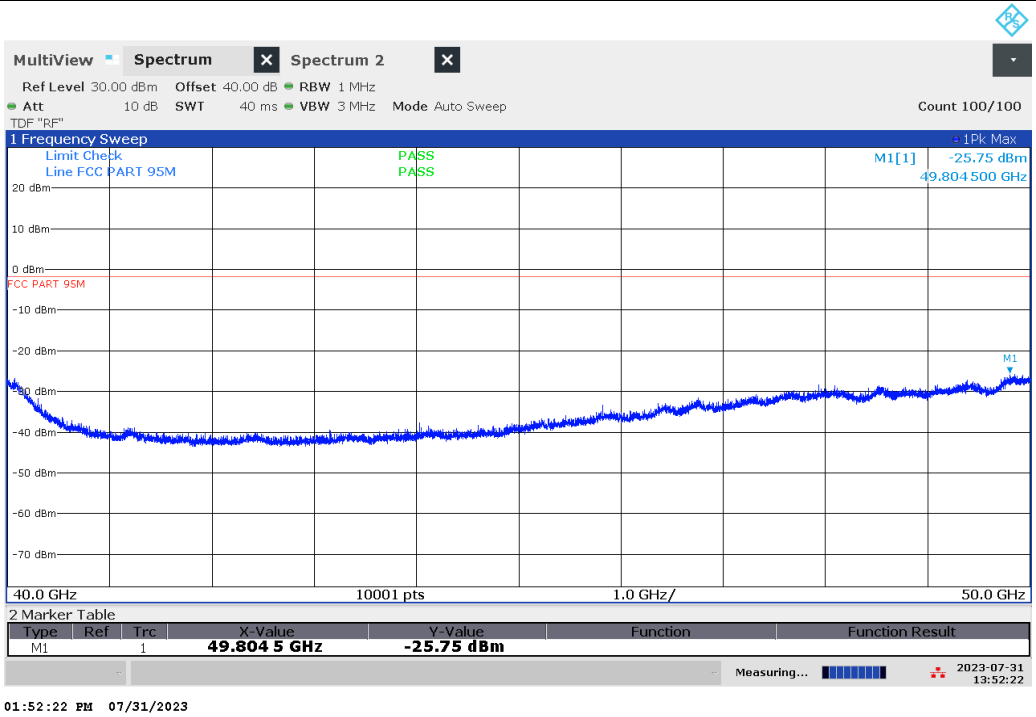
LRES W6 MODE

No emission detected using Peak Detection.

Horizontal	
Vertical	

LRES W4 MODE

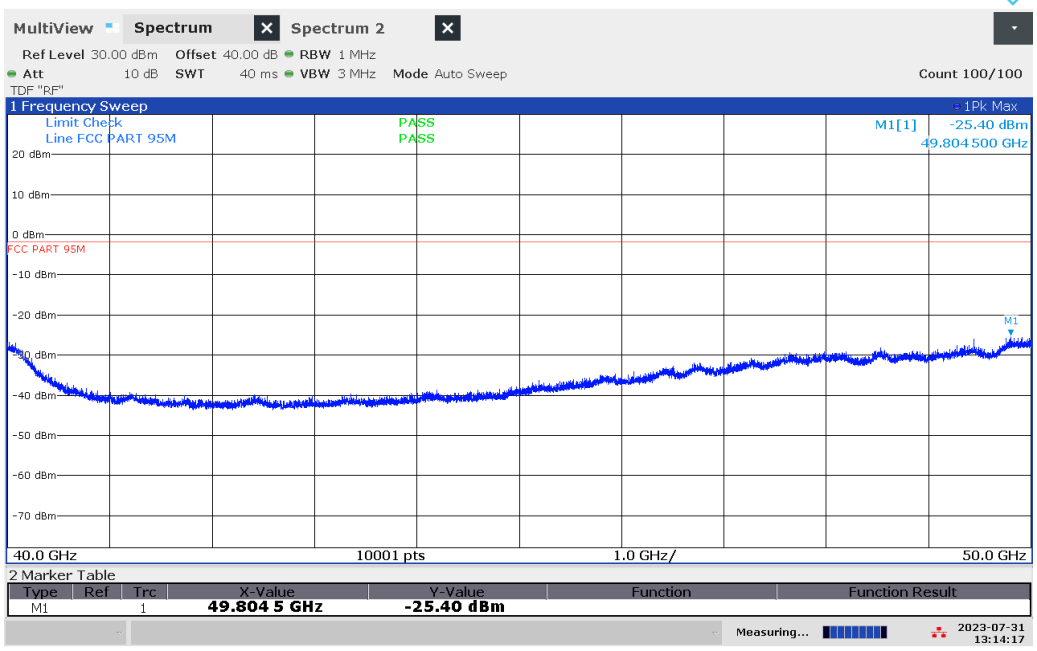
No emission detected using Peak Detection.

Horizontal	
Vertical	

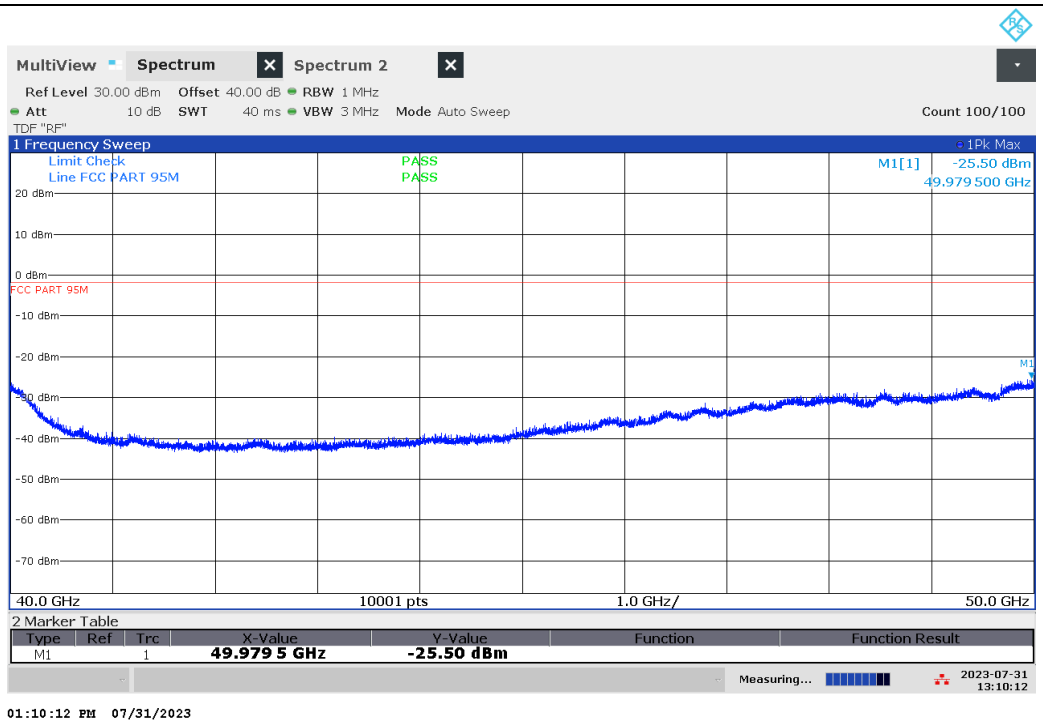
MRES MODE

No emission detected using Peak Detection.

Horizontal



Vertical

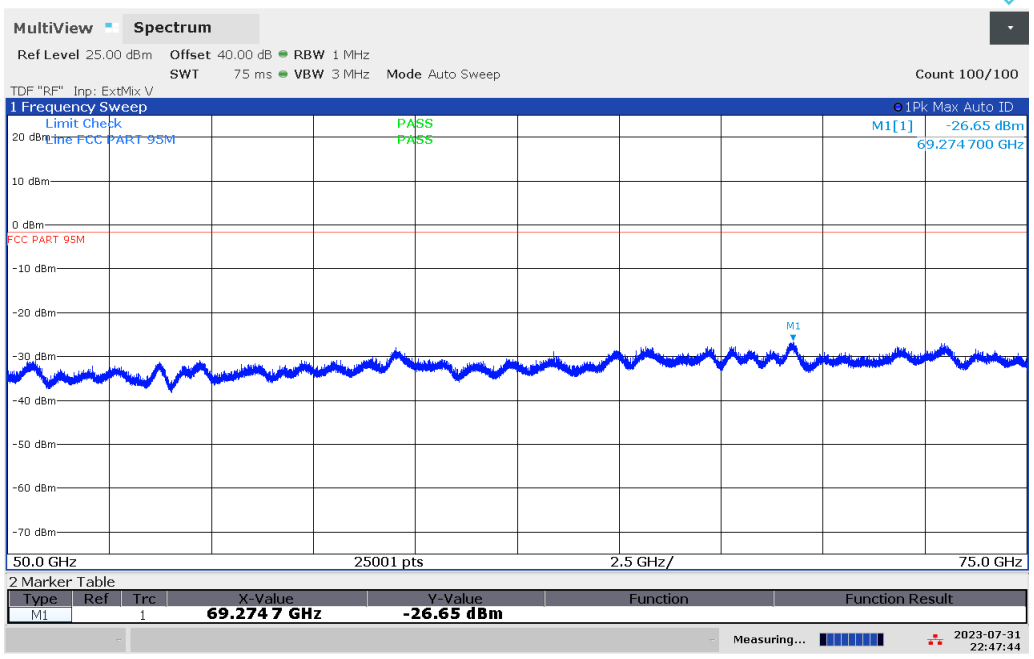


HRES MODE

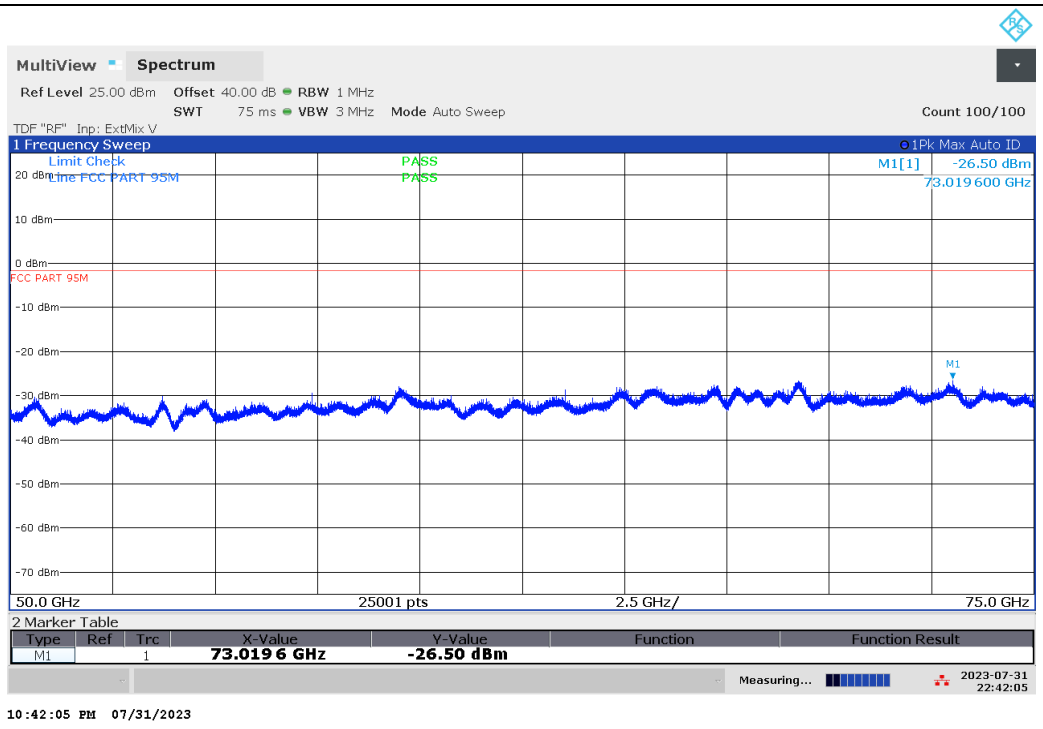
No emission detected using Peak Detection.

8.4.7. RADIATED EMISSIONS, 50 - 75 GHz

Horizontal

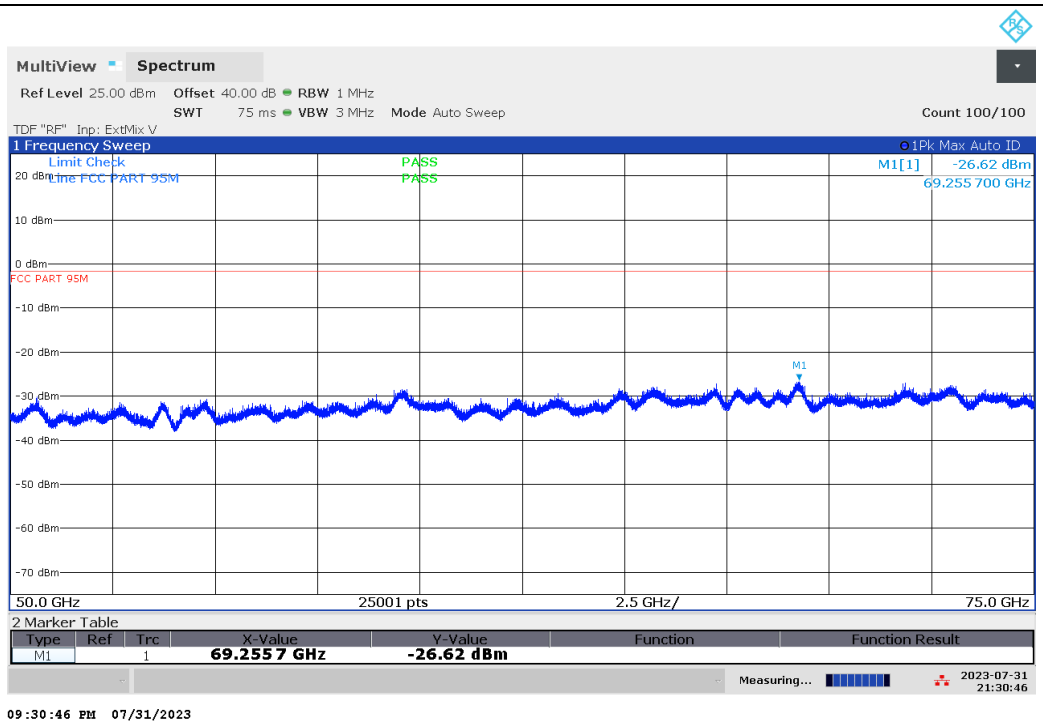
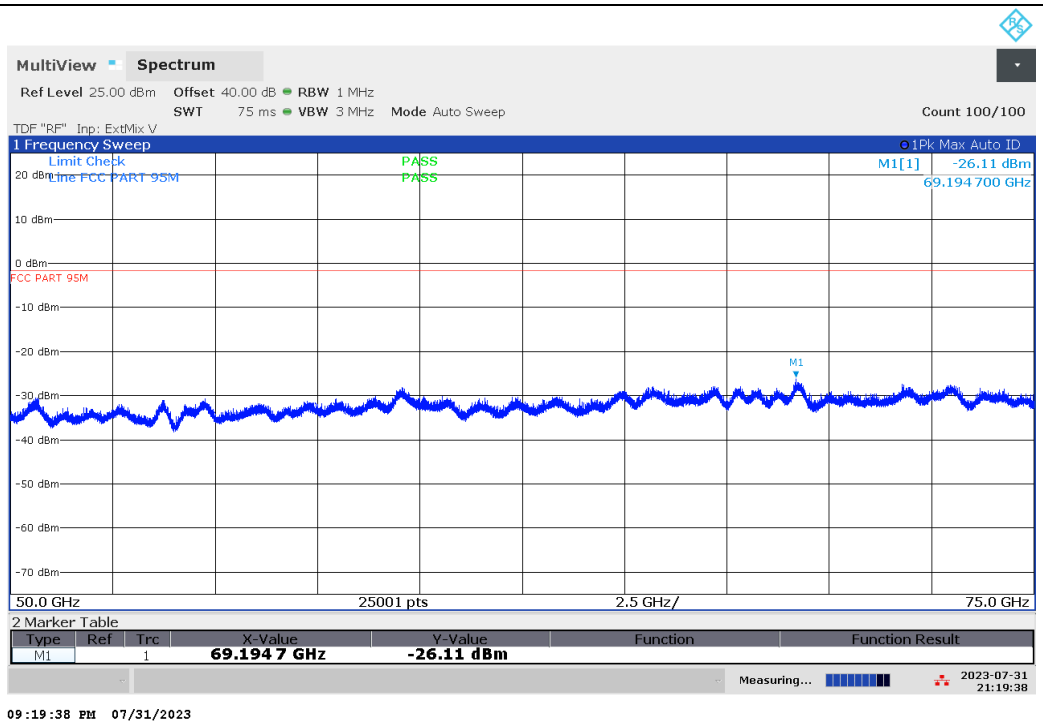


Vertical



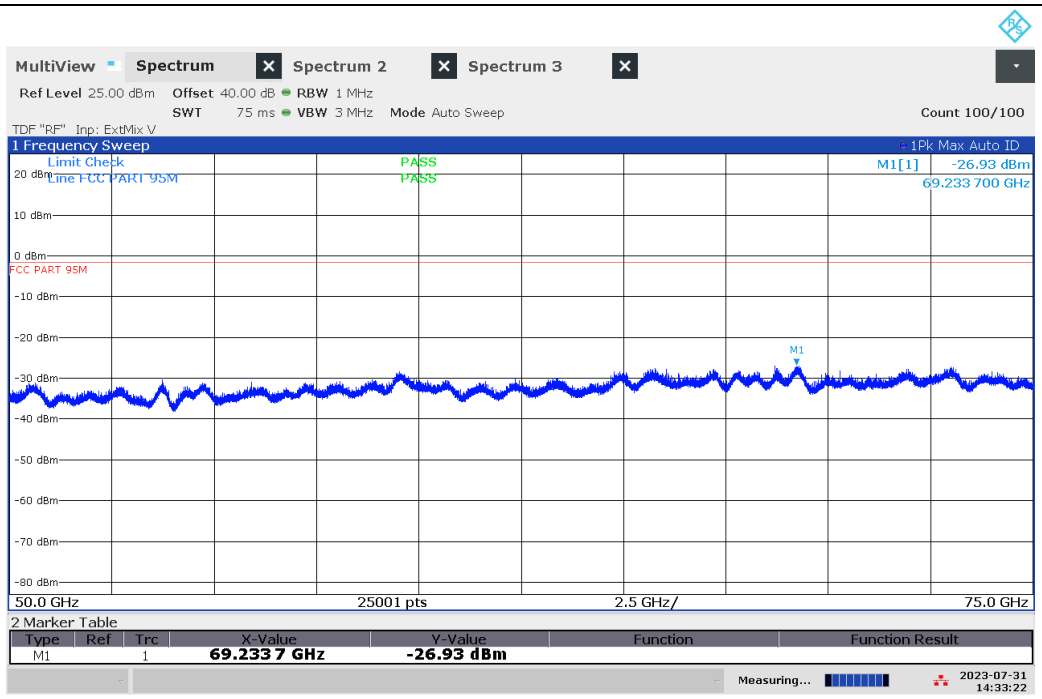
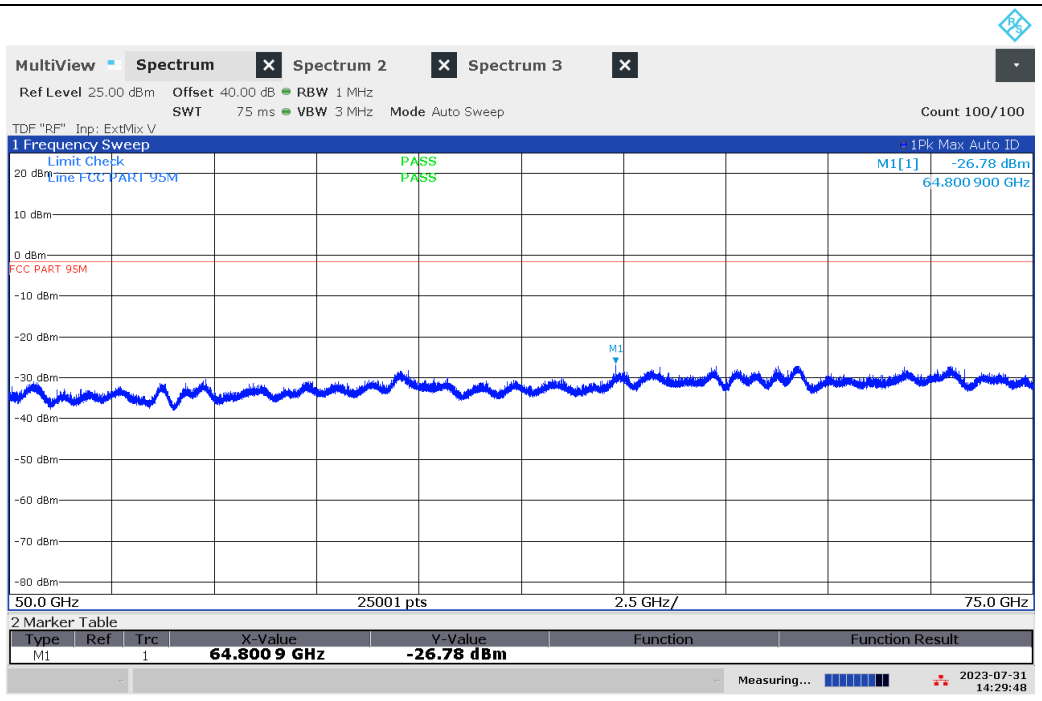
LRES W6 MODE

No emission detected using Peak Detection.

Horizontal	
Vertical	

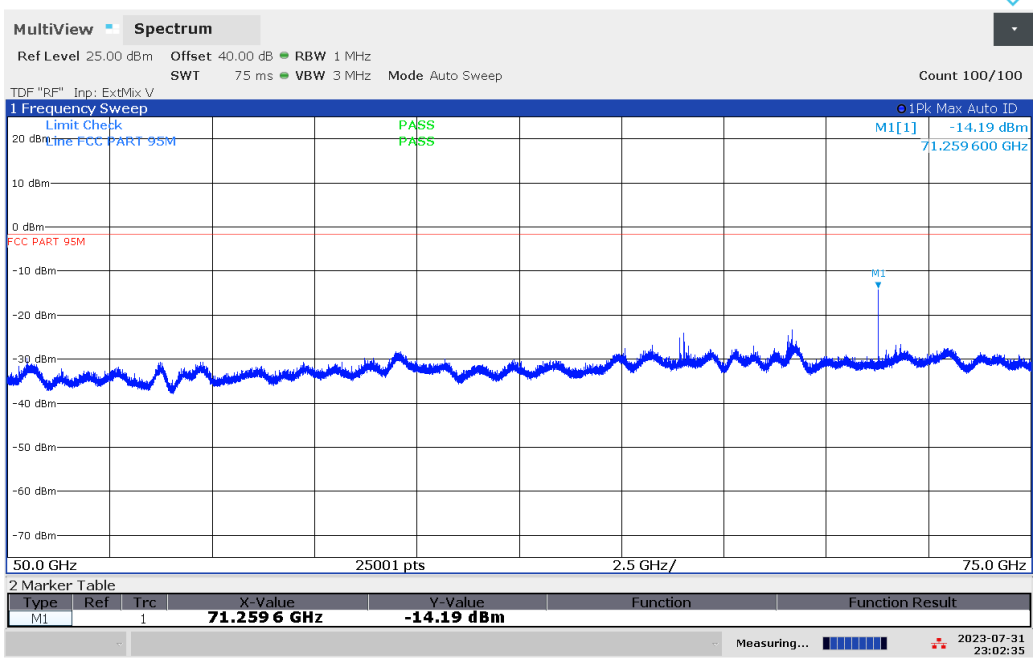
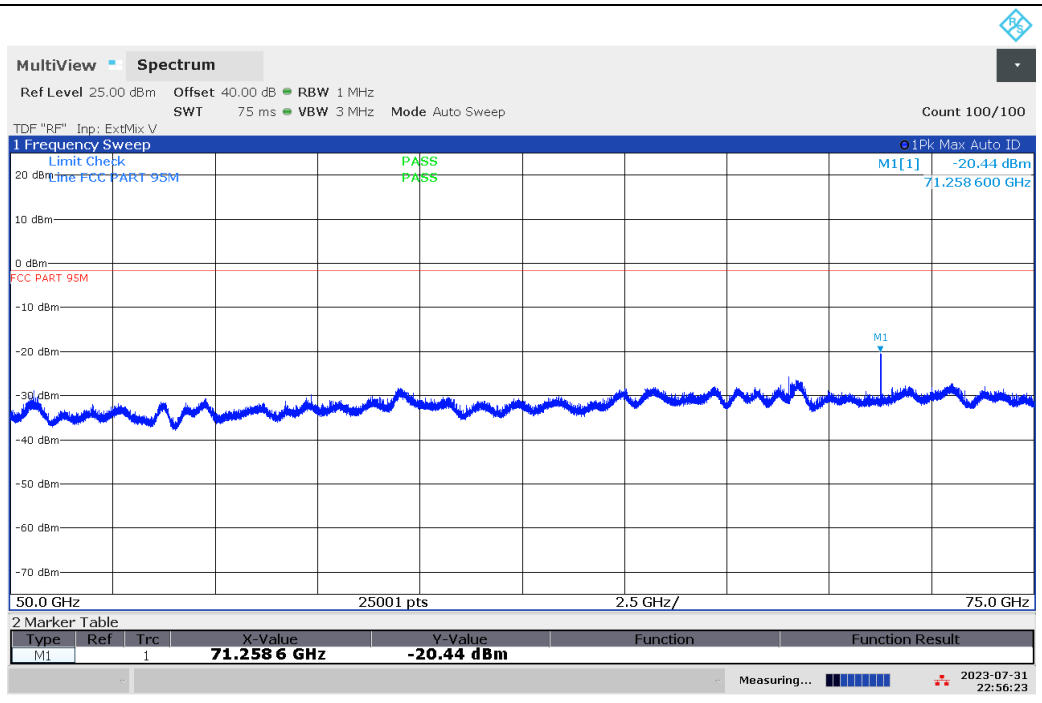
LRES W4 MODE

No emission detected using Peak Detection.

Horizontal	
Vertical	

MRES MODE

No emission detected using Peak Detection.

Horizontal	
Vertical	

HRES MODE

Emissions detected using Peak Detection at pre-scan. Avg EIRP was measured.

Freq.	Meas. Distance	Rx Ant. Polarity	Meas. Avg EIRP	FCC Part 95M Avg EIRP Limit	Margin
(GHz)	(m)	H/V	(dBm)	(dBm)	(dB)
71.259	3	H	-39.51	-1.68	-37.83
71.259	3	V	-38.70	-1.68	-37.02

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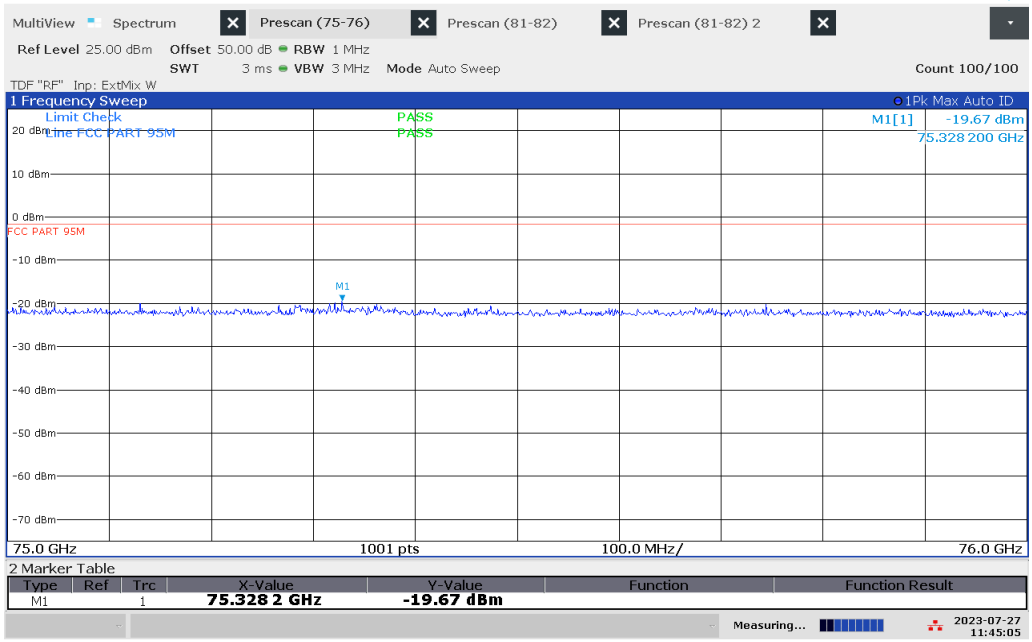
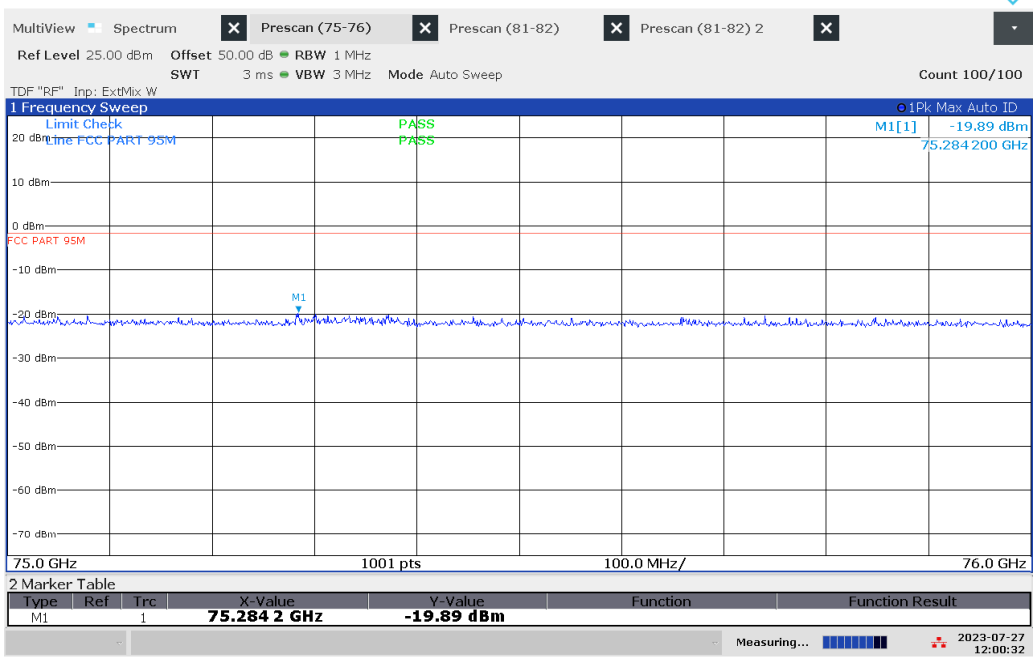
8.4.8. RADIATED EMISSIONS, 75 - 76 GHz

Horizontal

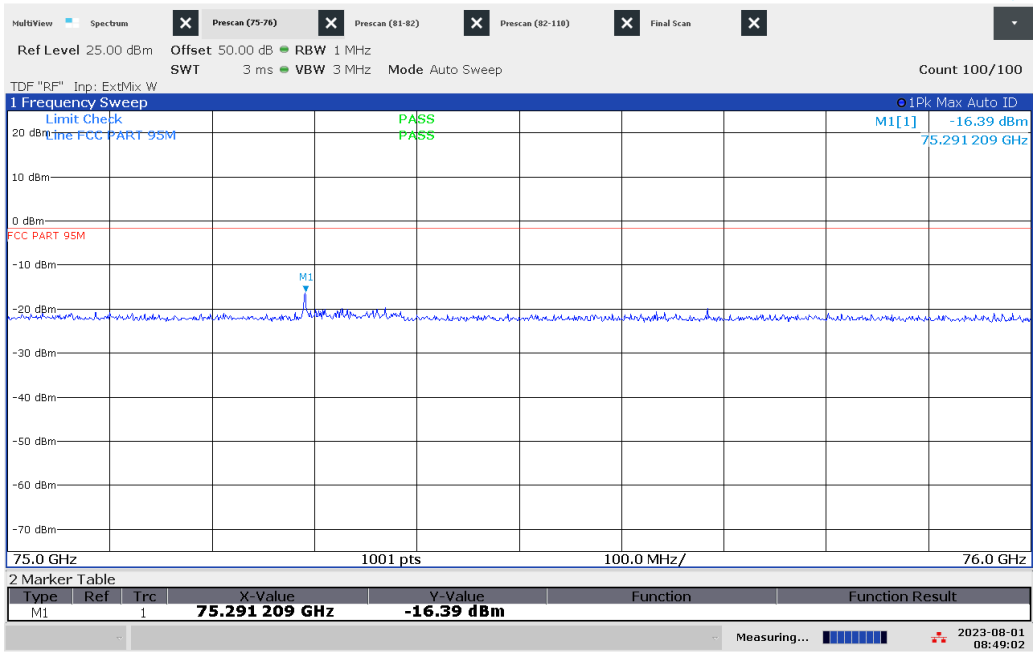
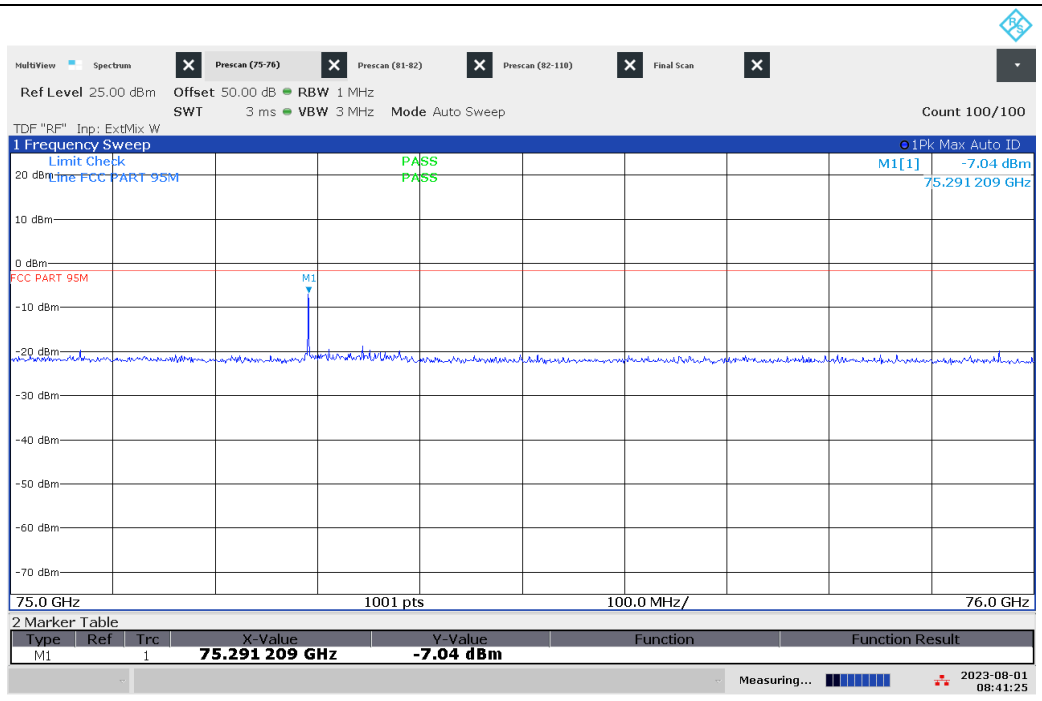


Vertical



LRES W6 MODE

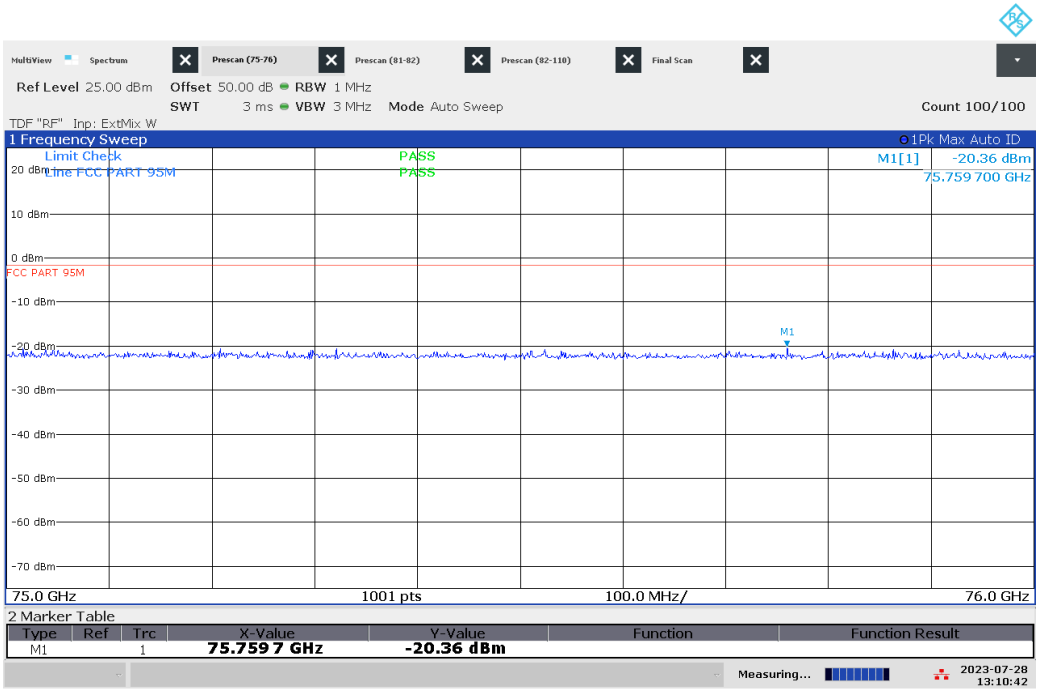
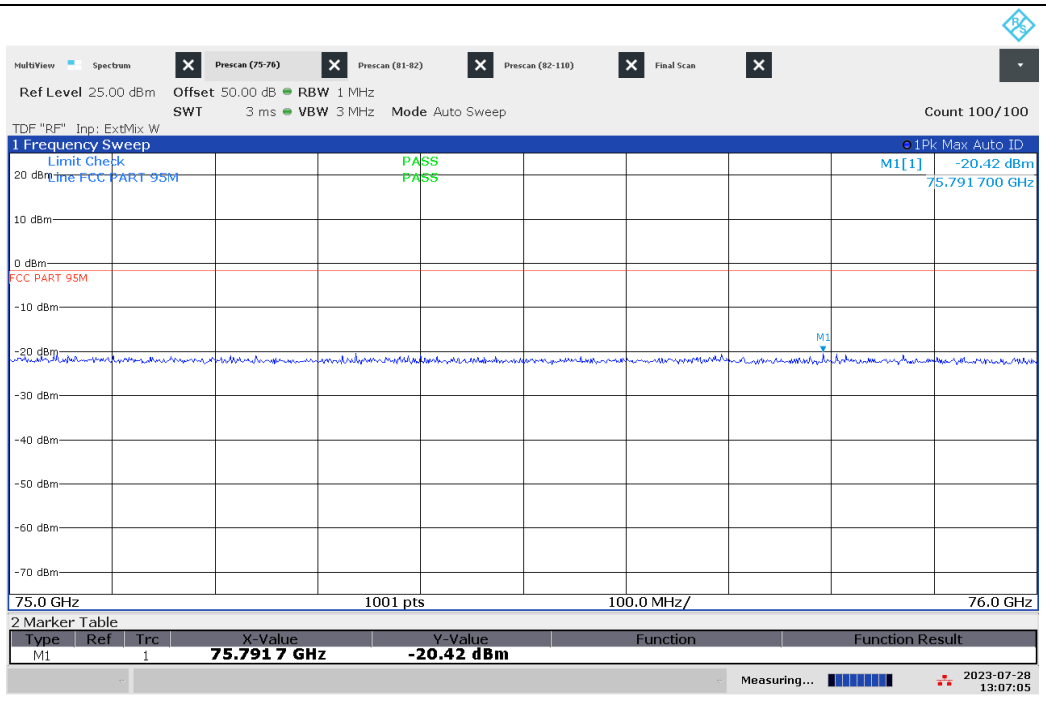
No emission detected using Peak Detection.

Horizontal	
Vertical	

LRES W4 MODE

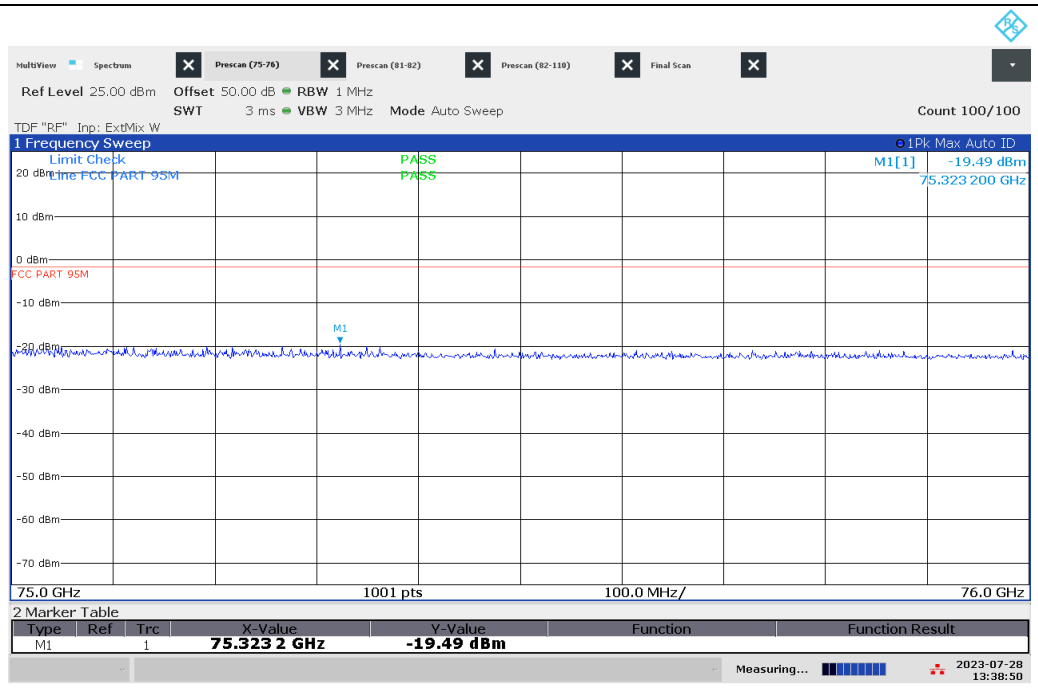
Emissions detected using Peak Detection at pre-scan. Avg EIRP was measured.

Freq.	Meas. Distance	Rx Ant. Polarity	Meas. Avg EIRP	FCC Part 95M Avg EIRP Limit	Margin
(GHz)	(m)	H/V	(dBm)	(dBm)	(dB)
75.291	3	H	-30.94	-1.68	-29.26
75.291	3	V	-28.91	-1.68	-27.23

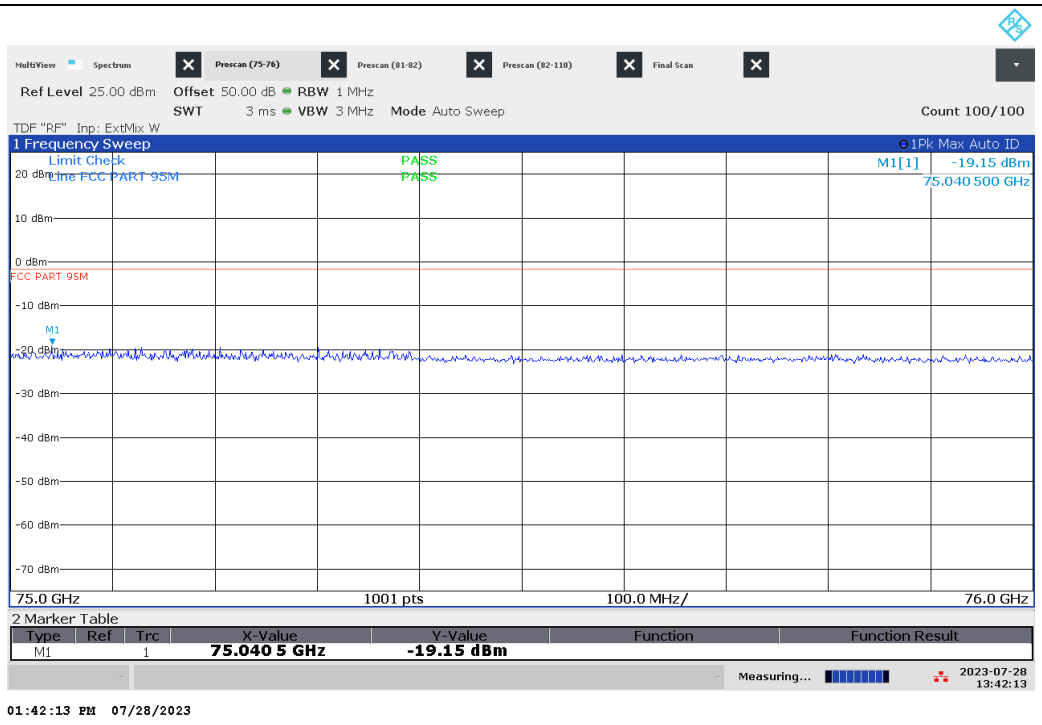
Horizontal	
Vertical	
MRES MODE	

No emission detected using Peak Detection.

Horizontal



Vertical

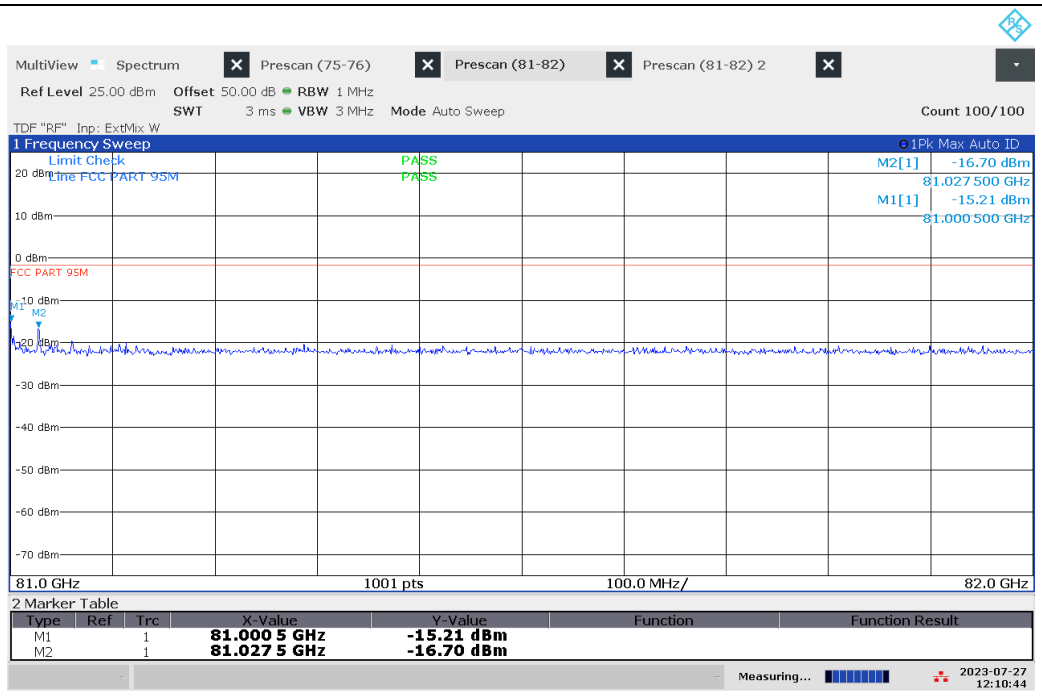


HRES MODE

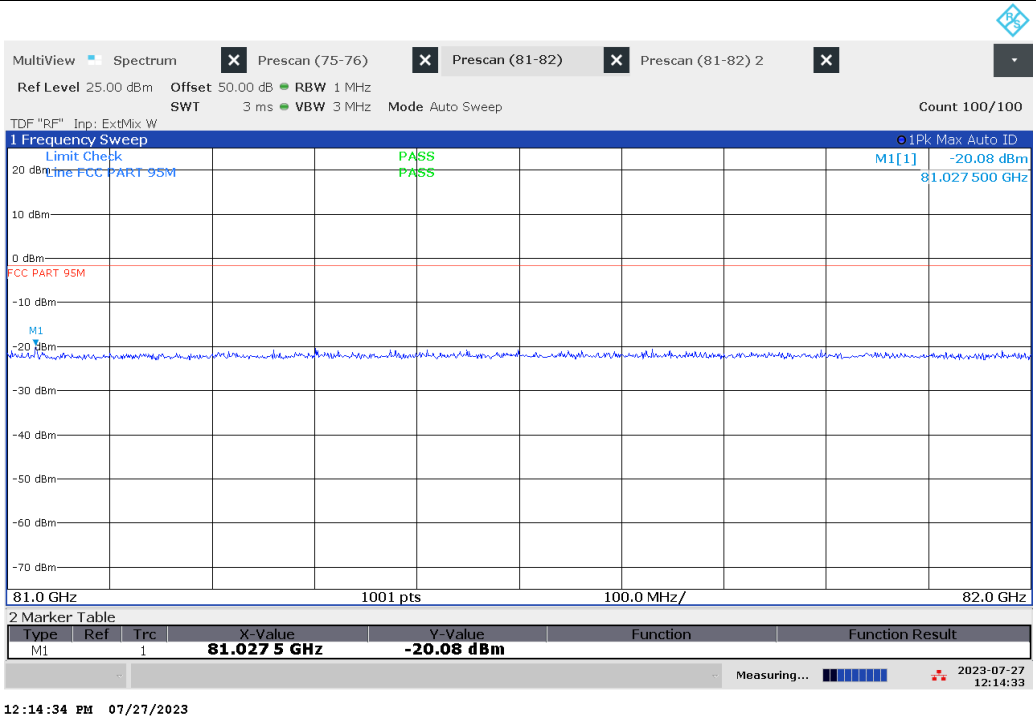
No emission detected using Peak Detection.

8.4.9. RADIATED EMISSIONS, 81 - 82 GHz

Horizontal



Vertical



LRES W6 MODE

Emissions detected using Peak Detection at pre-scan. Avg EIRP was measured.

Freq.	Meas. Distance	Rx Ant. Polarity	Meas. Avg EIRP	FCC Part 95M Avg EIRP Limit	Margin
(GHz)	(m)	H/V	(dBm)	(dBm)	(dB)
81.001	3	H	-29.48	-1.68	-27.80
81.001	3	V	-29.79	-1.68	-28.11
81.028	3	H	-24.35	-1.68	-22.67
81.028	3	V	-27.73	-1.68	-26.05

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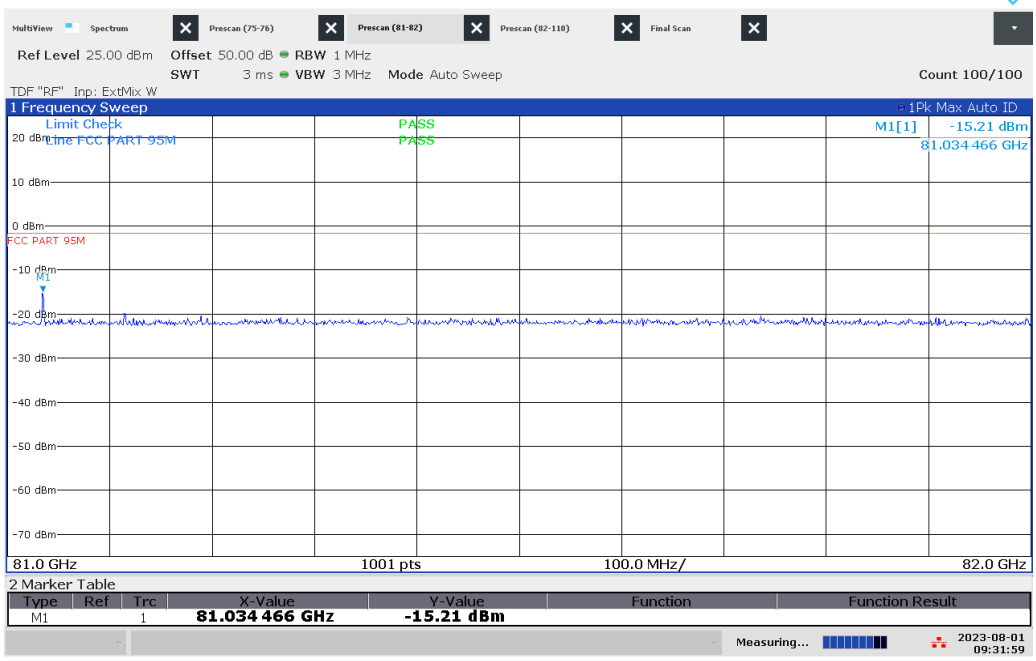
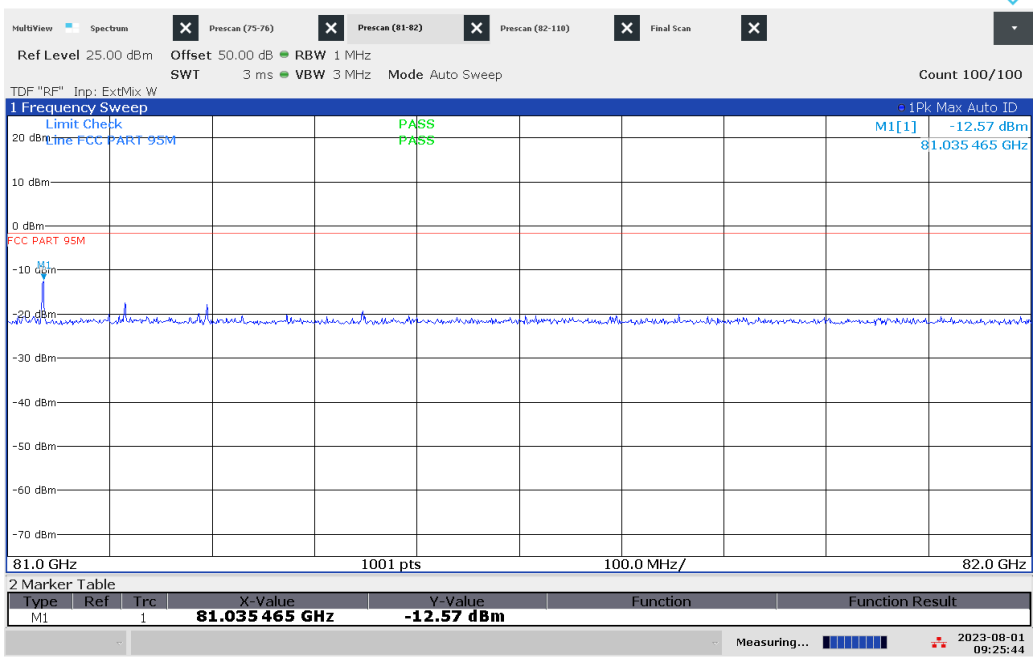
Horizontal



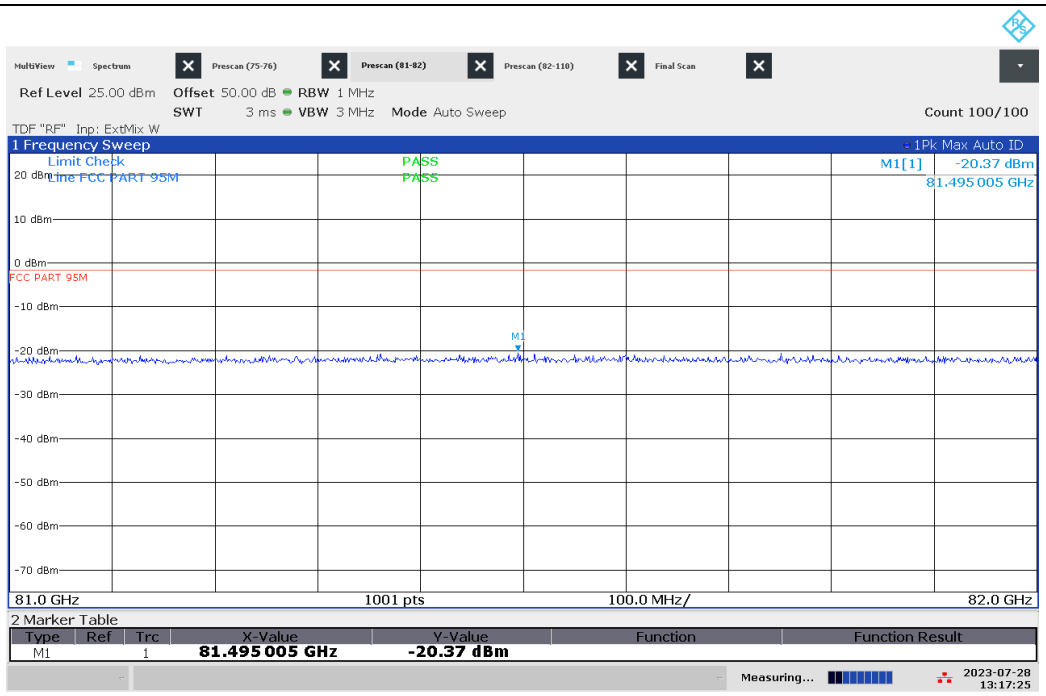
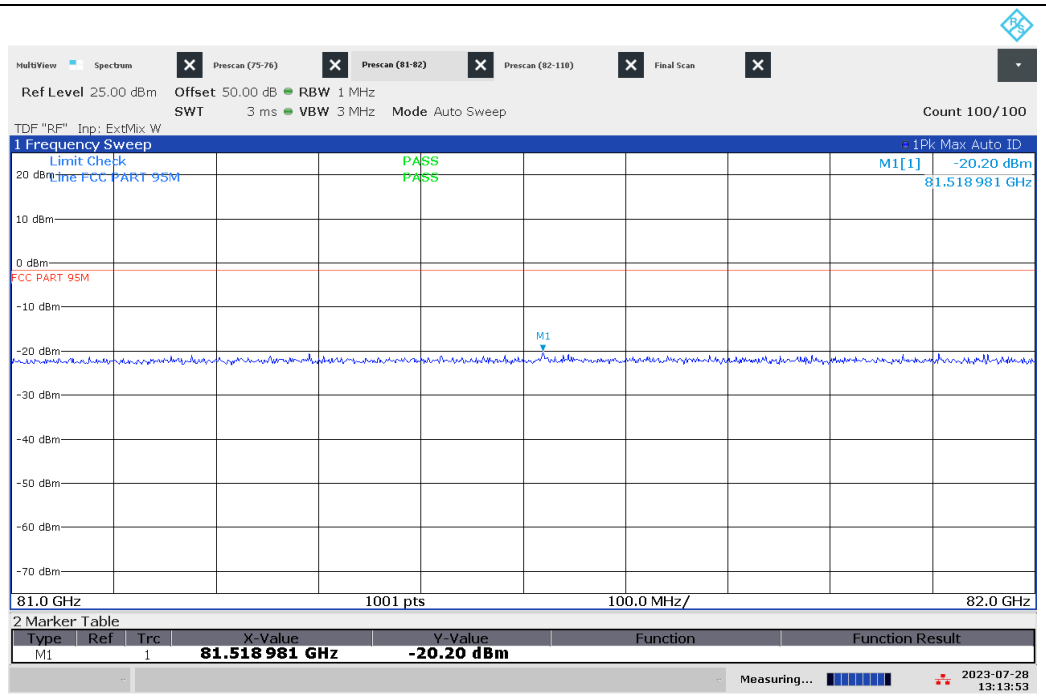
Vertical



LRES W4 MODE

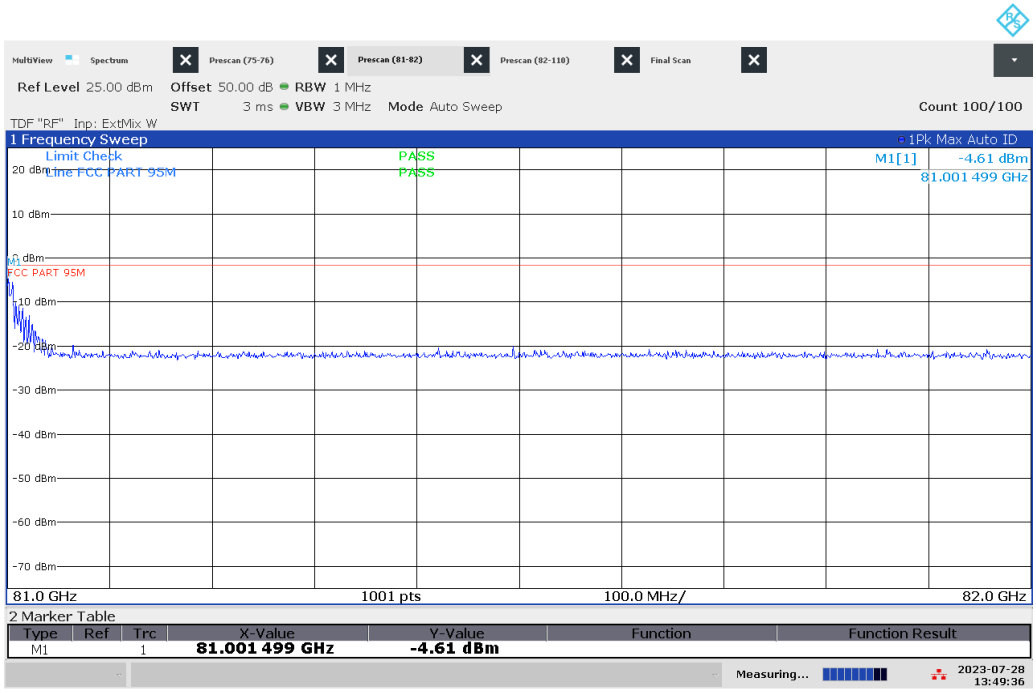
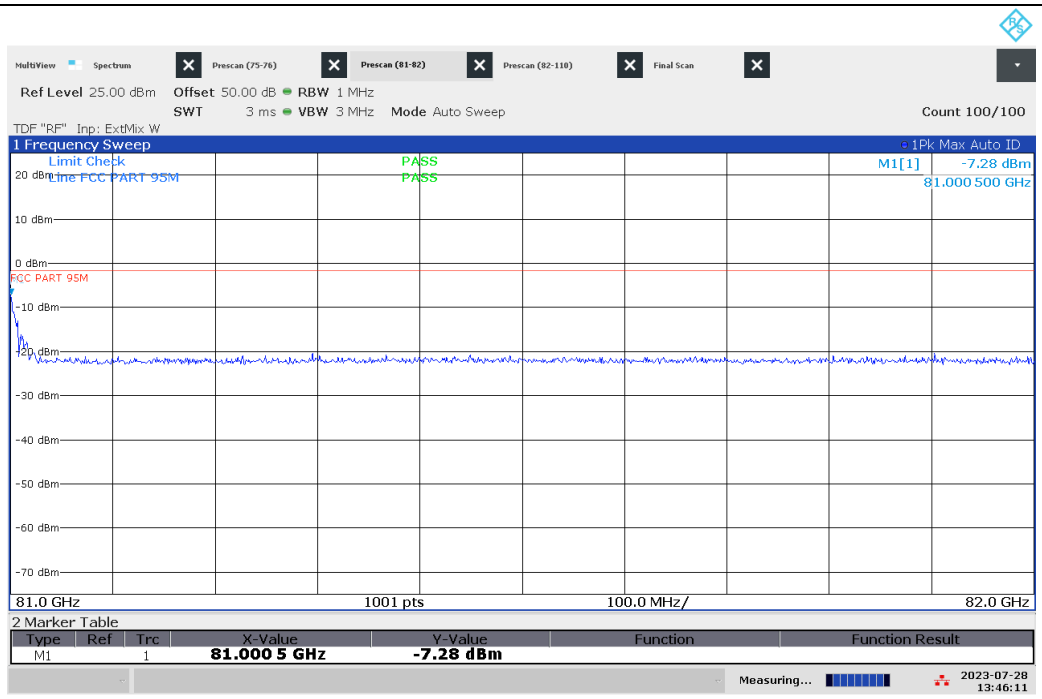
Emissions detected using Peak Detection at pre-scan. Avg EIRP was measured.

Freq.	Meas. Distance	Rx Ant. Polarity	Corrected Avg EIRP	FCC Part 95M Avg EIRP Limit	Margin
(GHz)	(m)	H/V	(dBm)	(dBm)	(dB)
81.035	3	H	-18.92	-1.68	-17.24
81.035	3	V	-30.89	-1.68	-29.21

Horizontal	
Vertical	

MRES MODE

No emission detected using Peak Detection.

Horizontal	
Vertical	

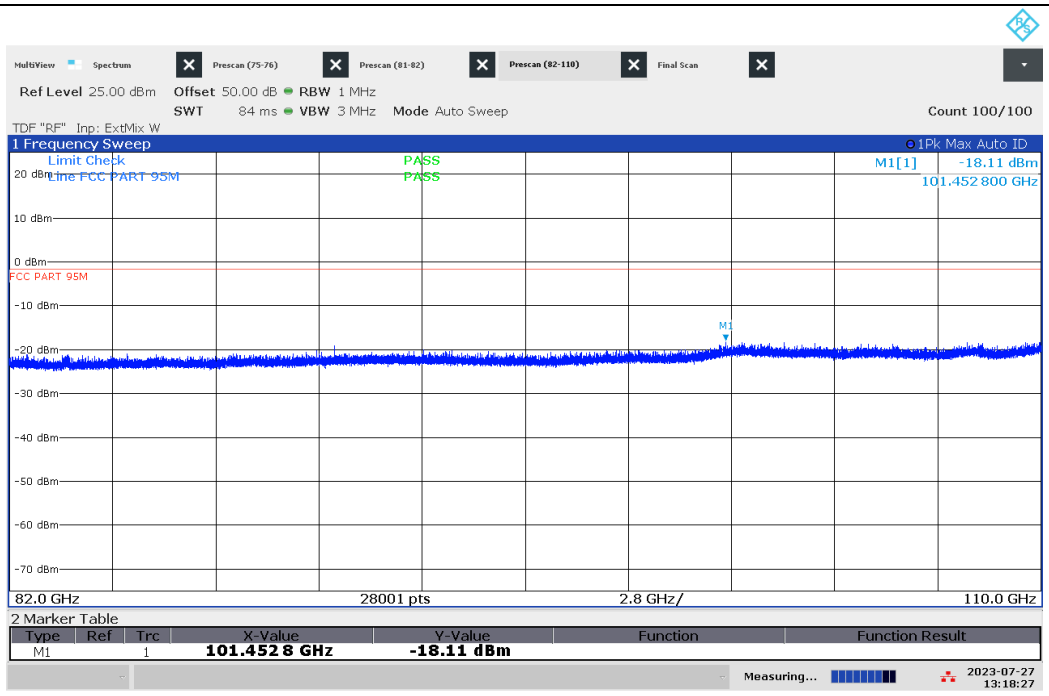
HRES MODE

Emissions detected using Peak Detection at pre-scan. Avg EIRP was measured.

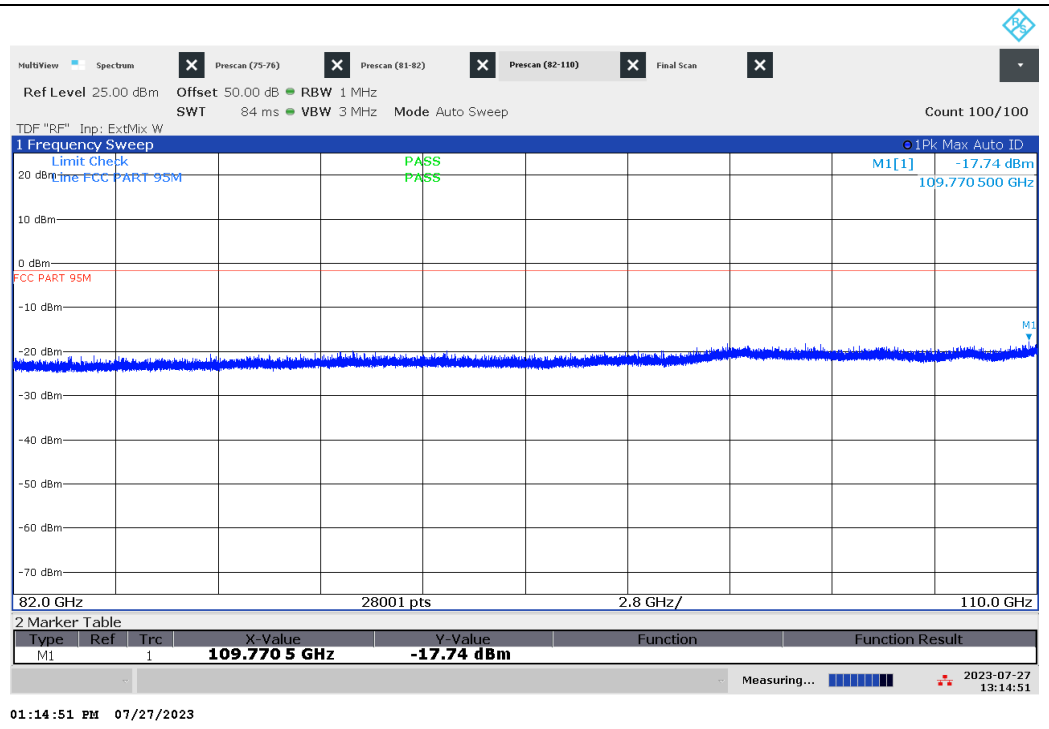
Freq.	Meas. Distance	Rx Ant. Polarity	Corrected Avg EIRP	FCC Part 95M Avg EIRP Limit	Margin
(GHz)	(m)	H/V	(dBm)	(dBm)	(dB)
81.001	3	H	-29.18	-1.68	-27.50
81.001	3	V	-29.04	-1.68	-27.36

8.4.10. RADIATED EMISSIONS, 82 - 110 GHz

Horizontal

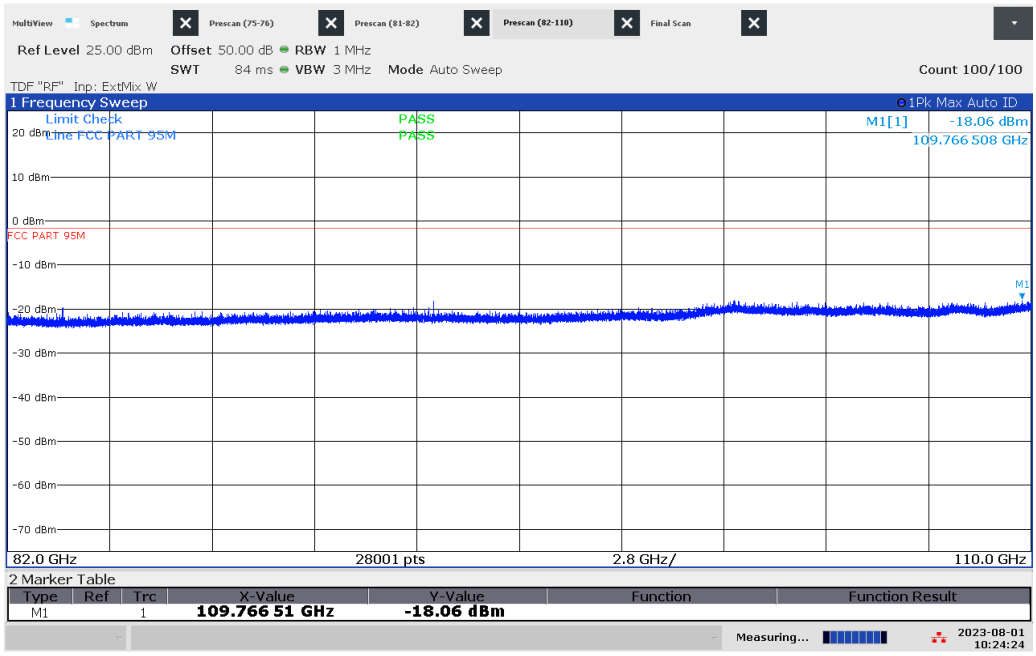
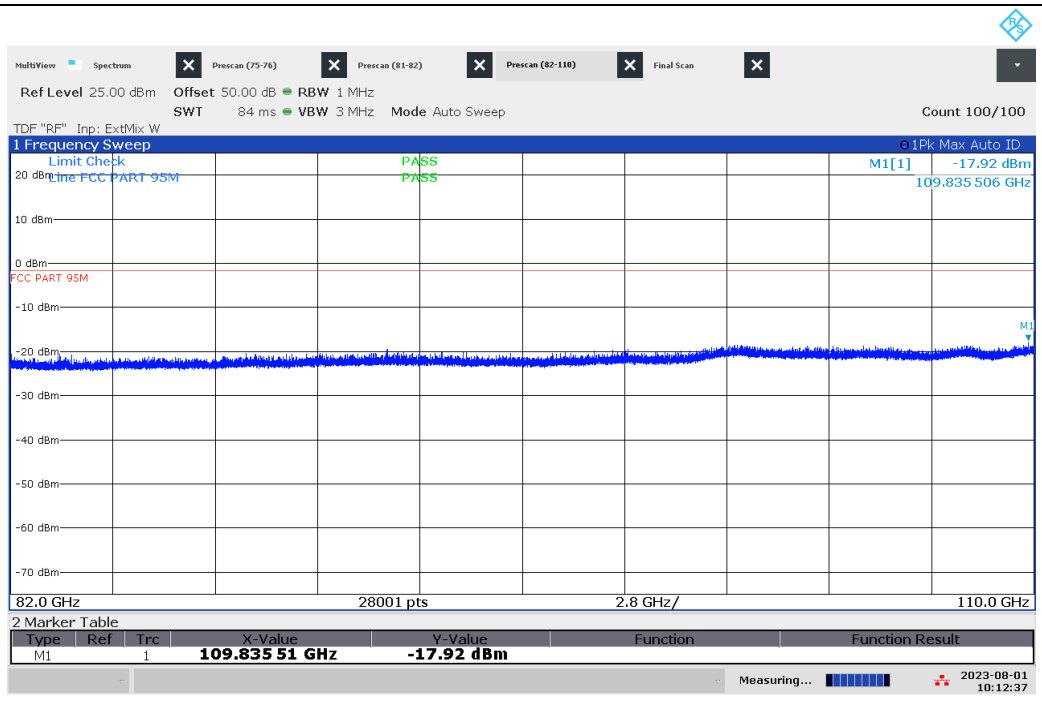


Vertical



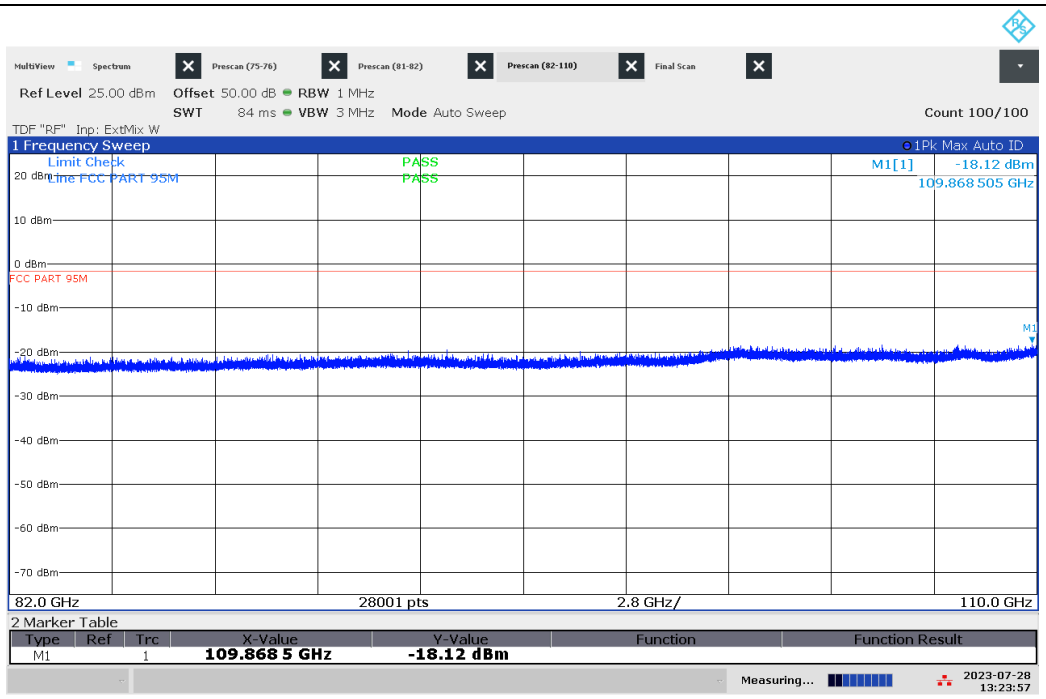
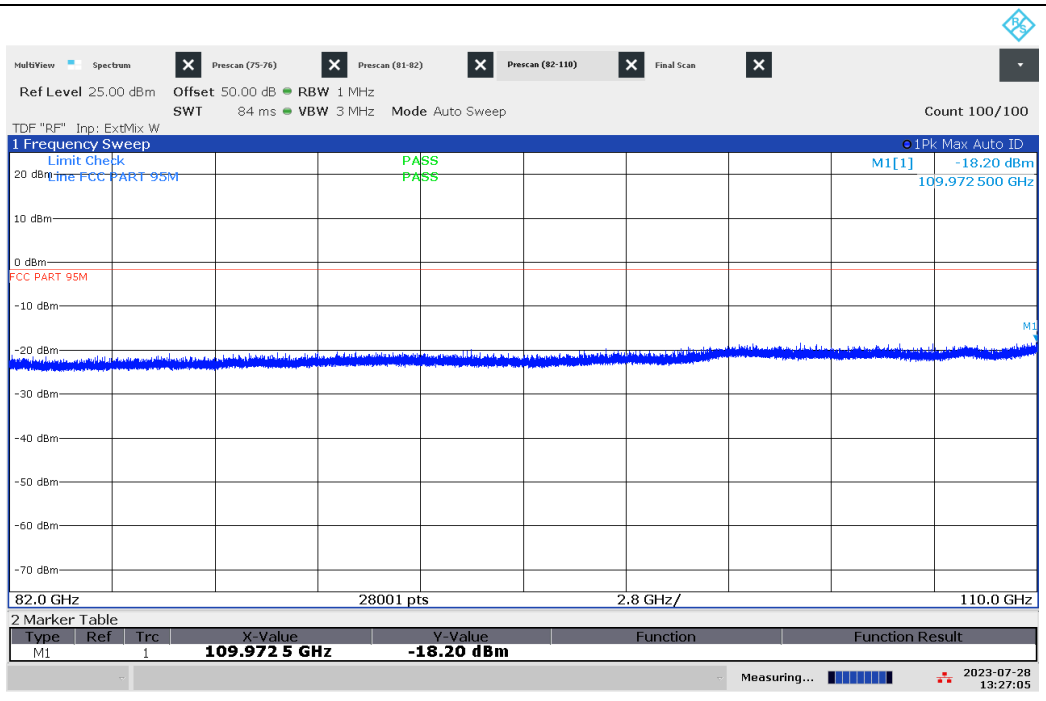
LRES W6 MODE

No emission detected using Peak Detection.

Horizontal	
Vertical	

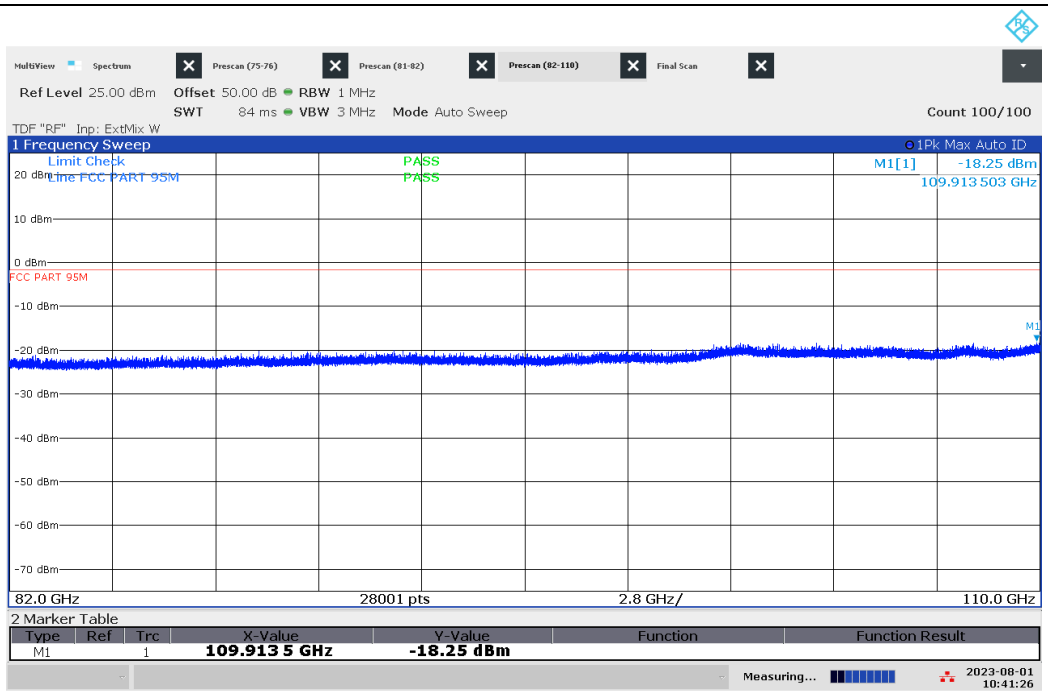
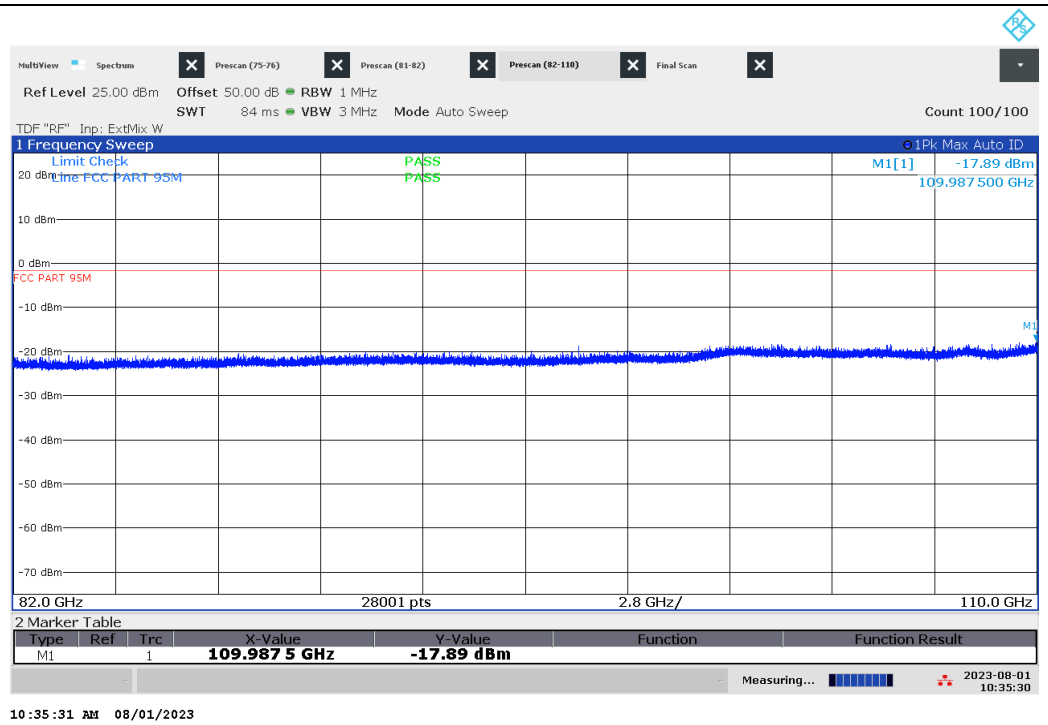
LRES W4 MODE

No emission detected using Peak Detection.

Horizontal	
Vertical	

MRES MODE

No emission detected using Peak Detection.

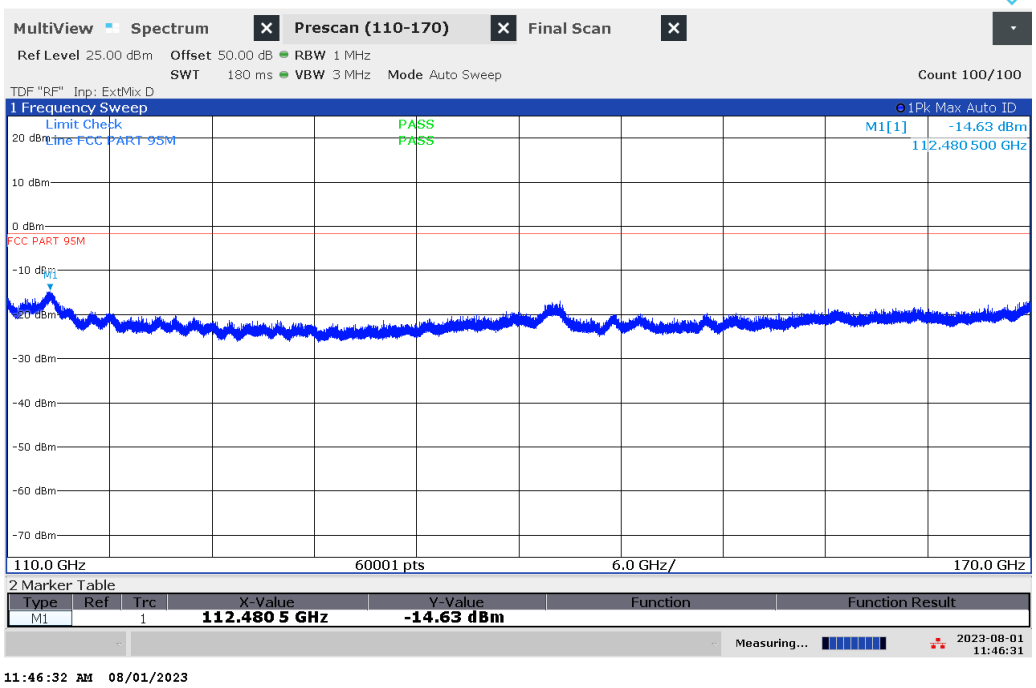
Horizontal	
Vertical	

HRES MODE

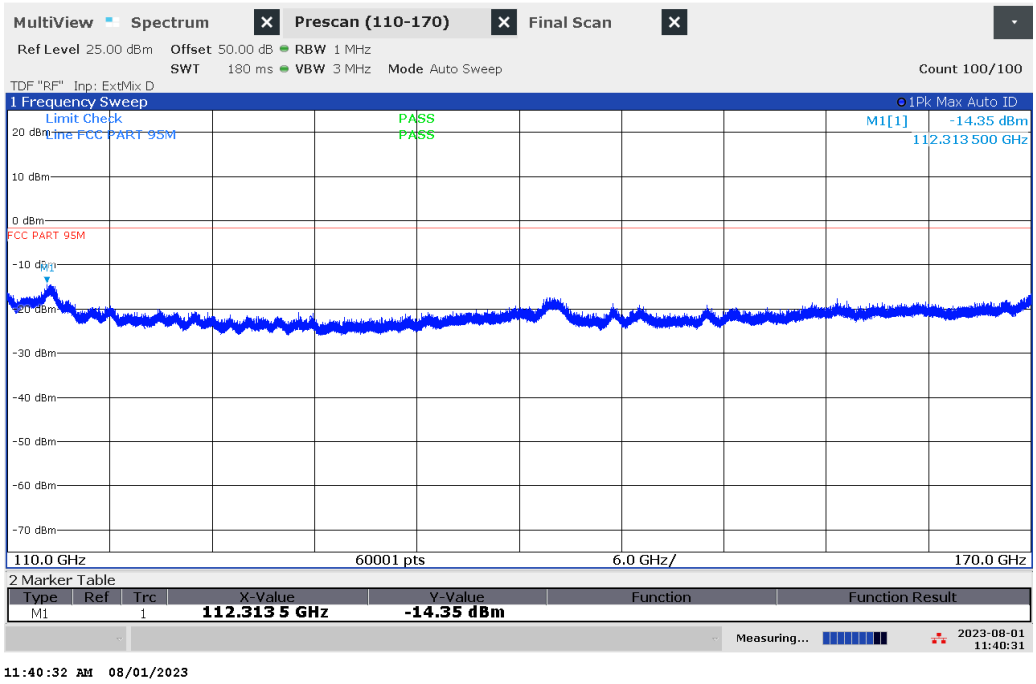
No emission detected using Peak Detection.

8.4.11. RADIATED EMISSIONS, 110 - 170 GHz

Horizontal

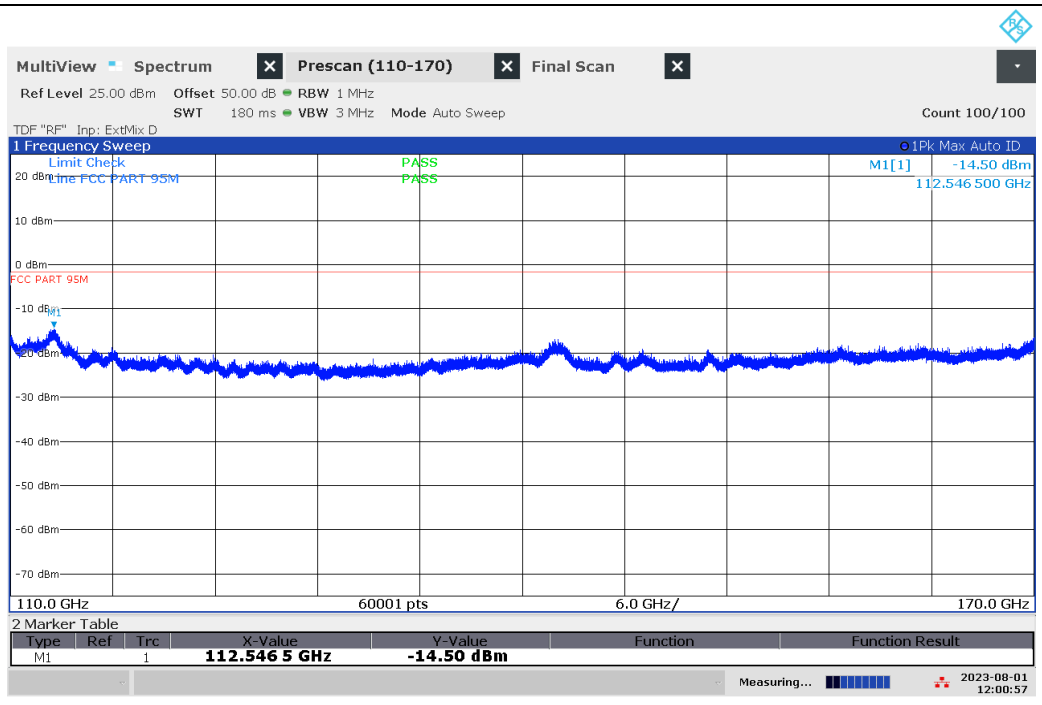
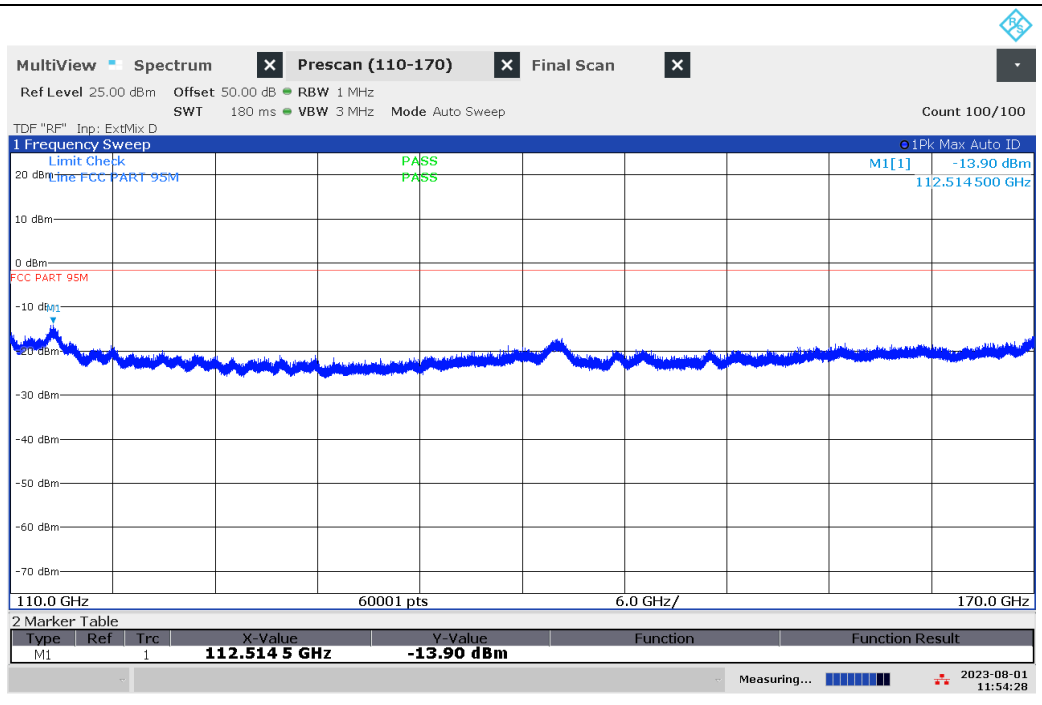


Vertical



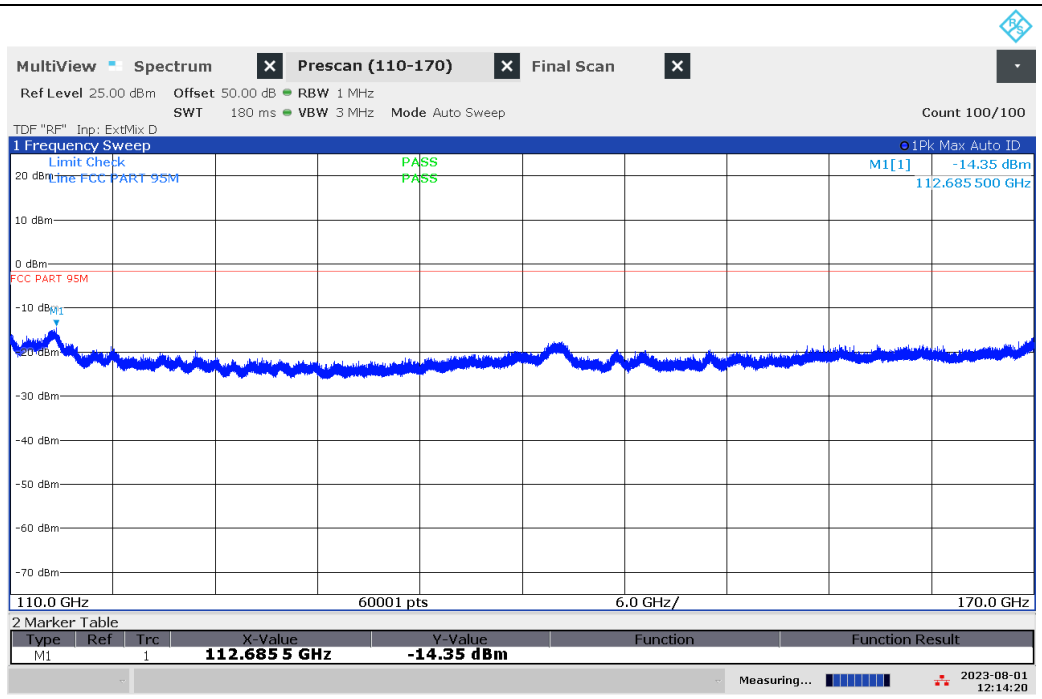
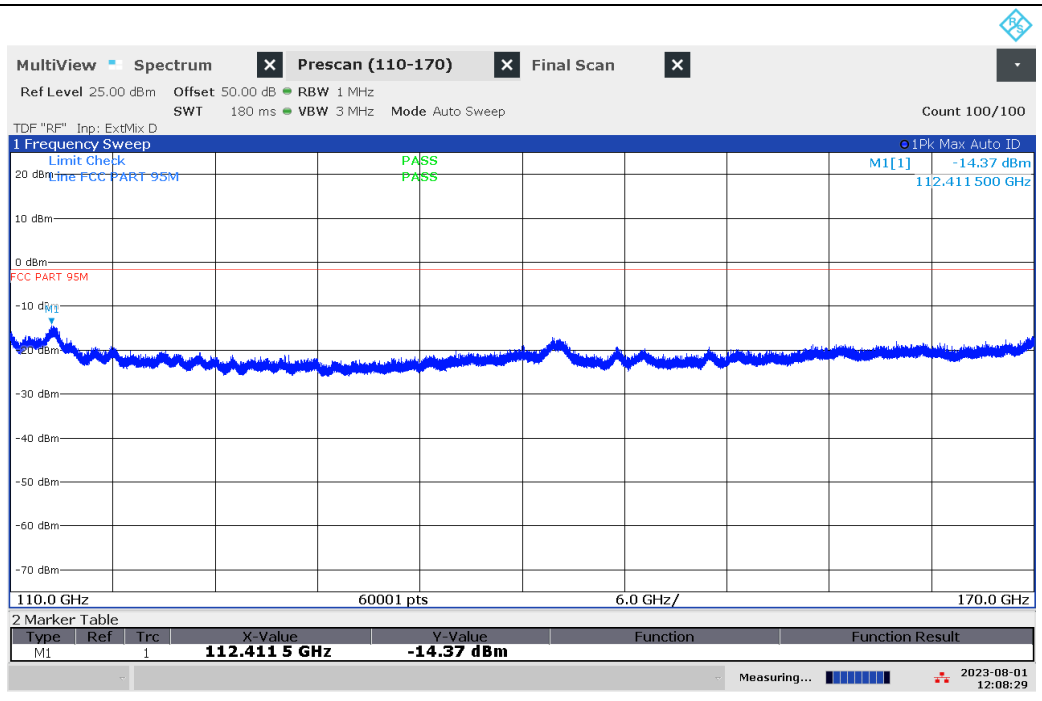
LRES W6 MODE

No emission detected using Peak Detection.

Horizontal	
Vertical	

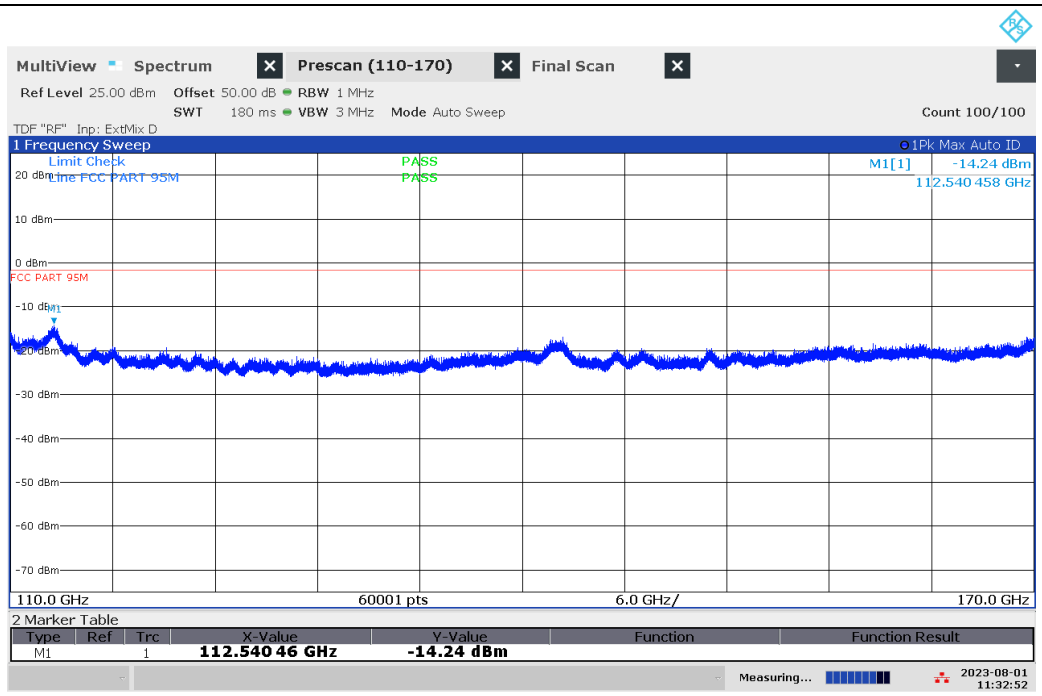
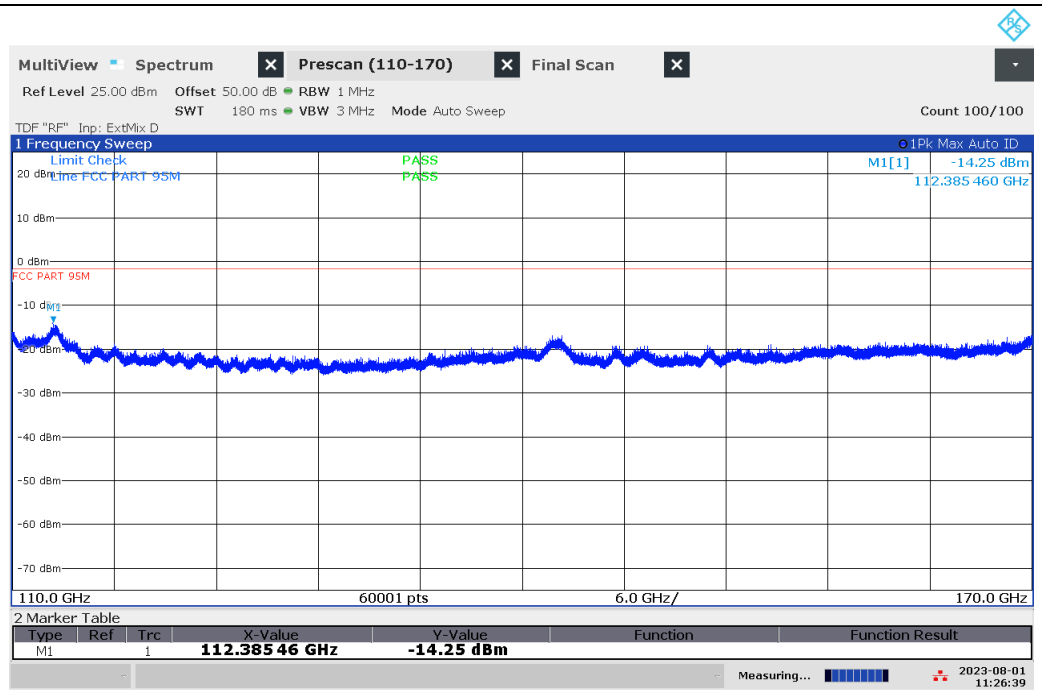
LRES W4 MODE

No emission detected using Peak Detection.

Horizontal	
Vertical	

MRES MODE

No emission detected using Peak Detection.

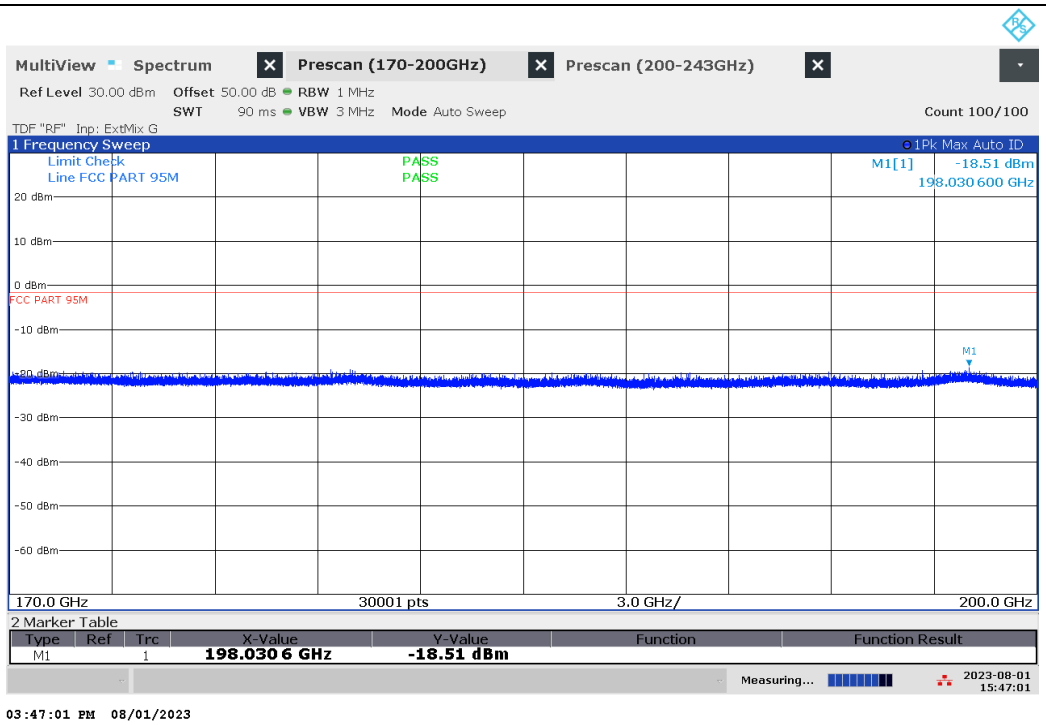
Horizontal	
Vertical	

HRES MODE

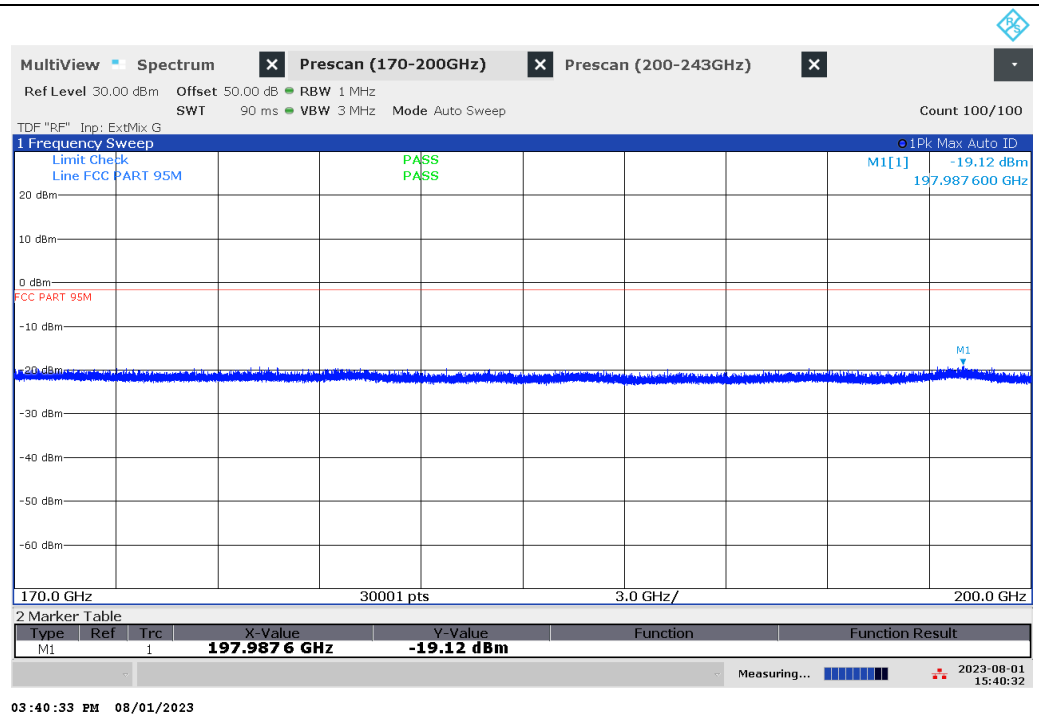
No emission detected using Peak Detection.

8.4.12. RADIATED EMISSIONS, 170 - 200 GHz

Horizontal

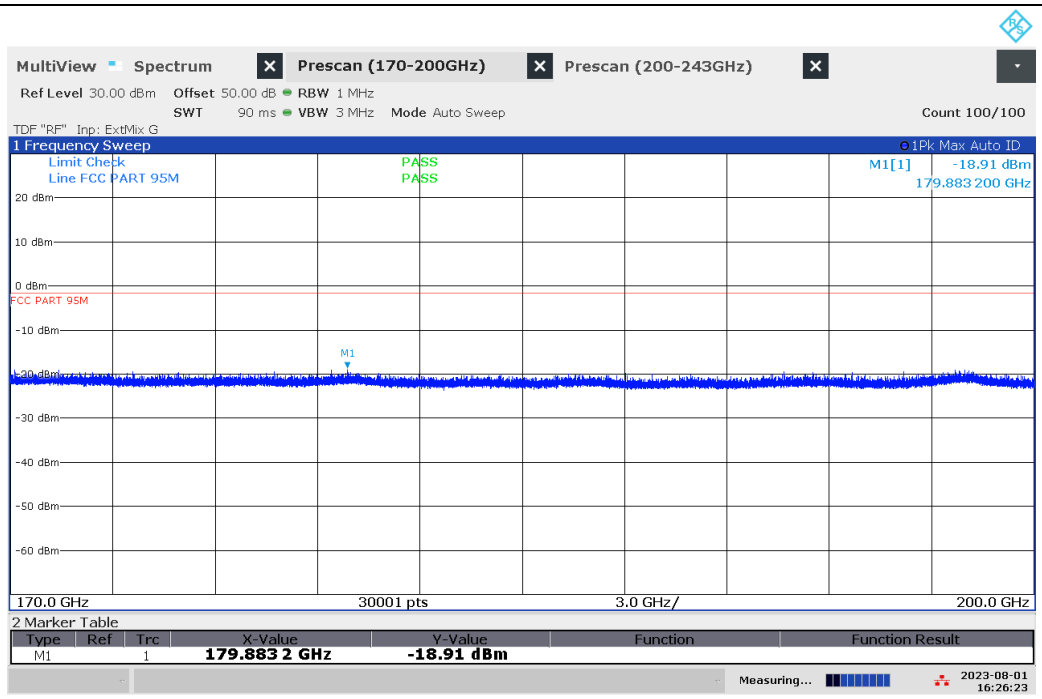
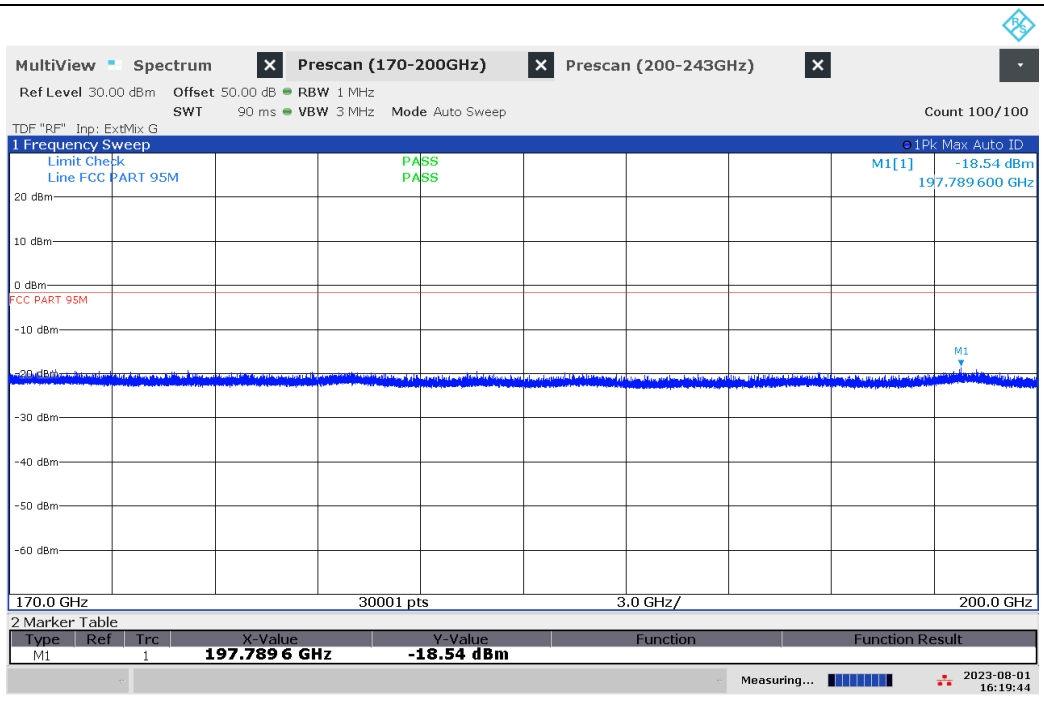


Vertical



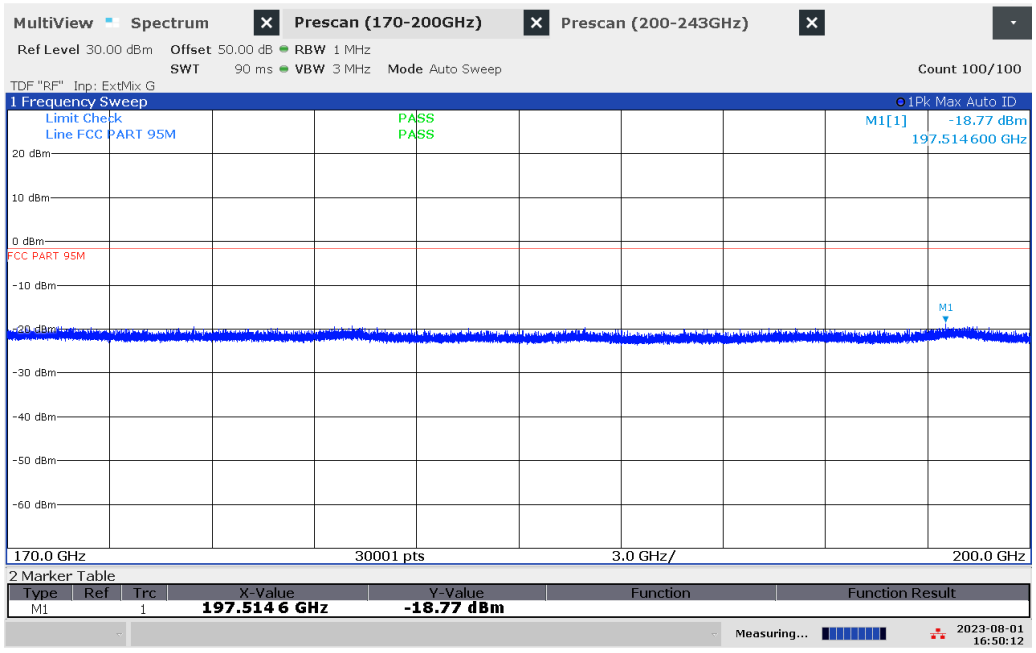
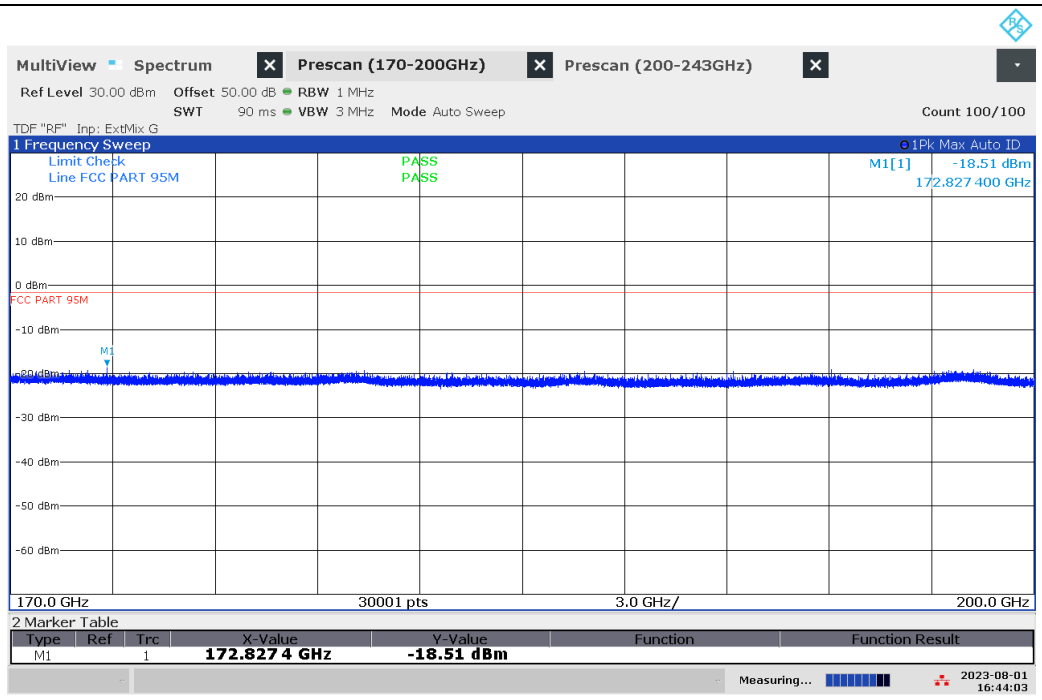
LRES W6 MODE

No emission detected using Peak Detection.

Horizontal	
Vertical	

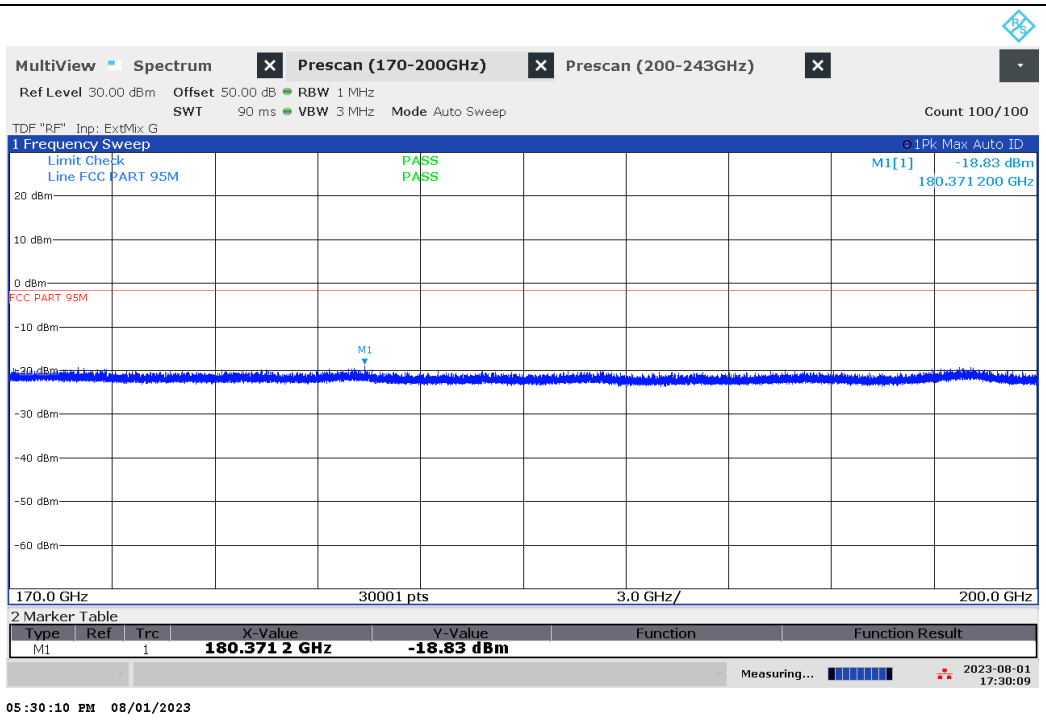
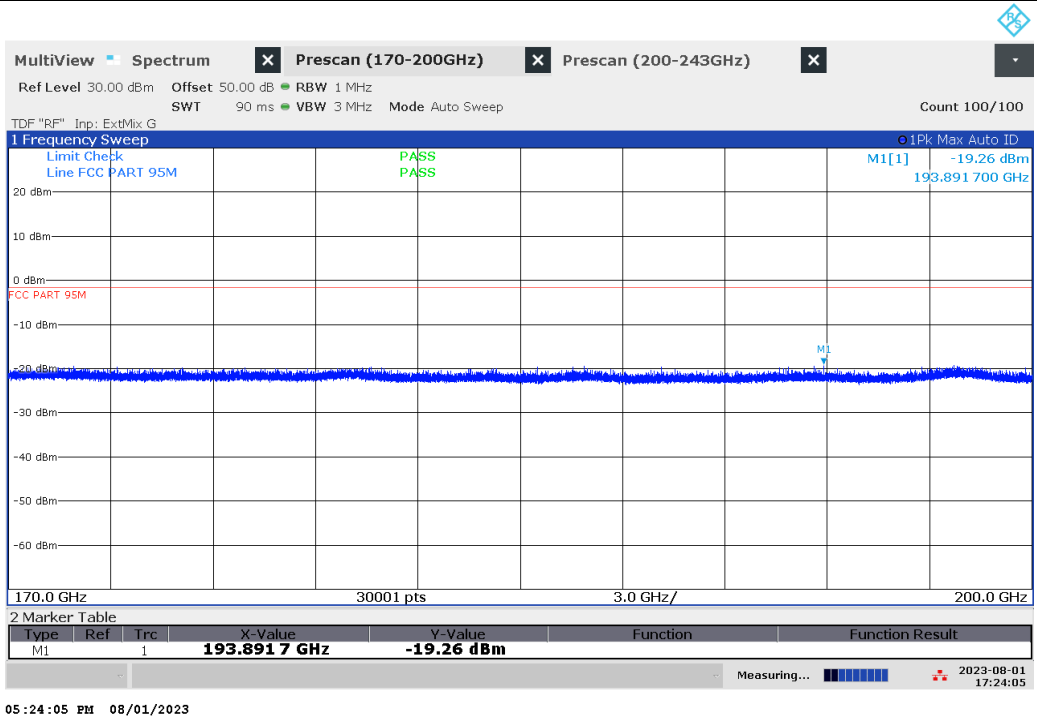
LRES W4 MODE

No emission detected using Peak Detection.

Horizontal	
Vertical	

MRES MODE

No emission detected using Peak Detection.

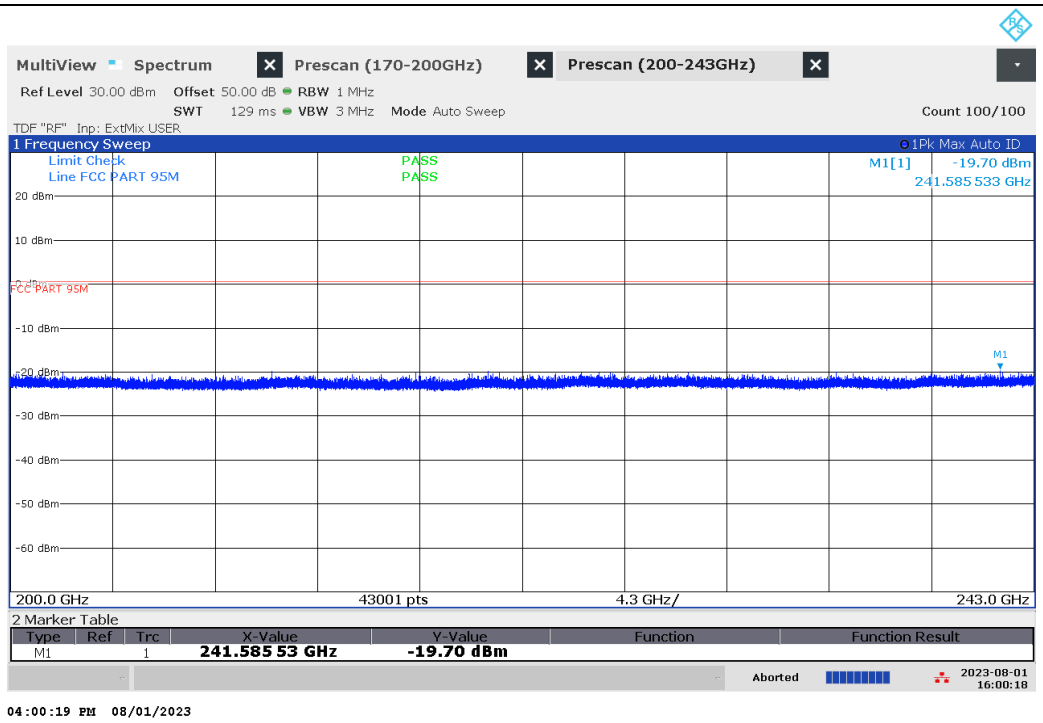
Horizontal	
Vertical	

HRES MODE

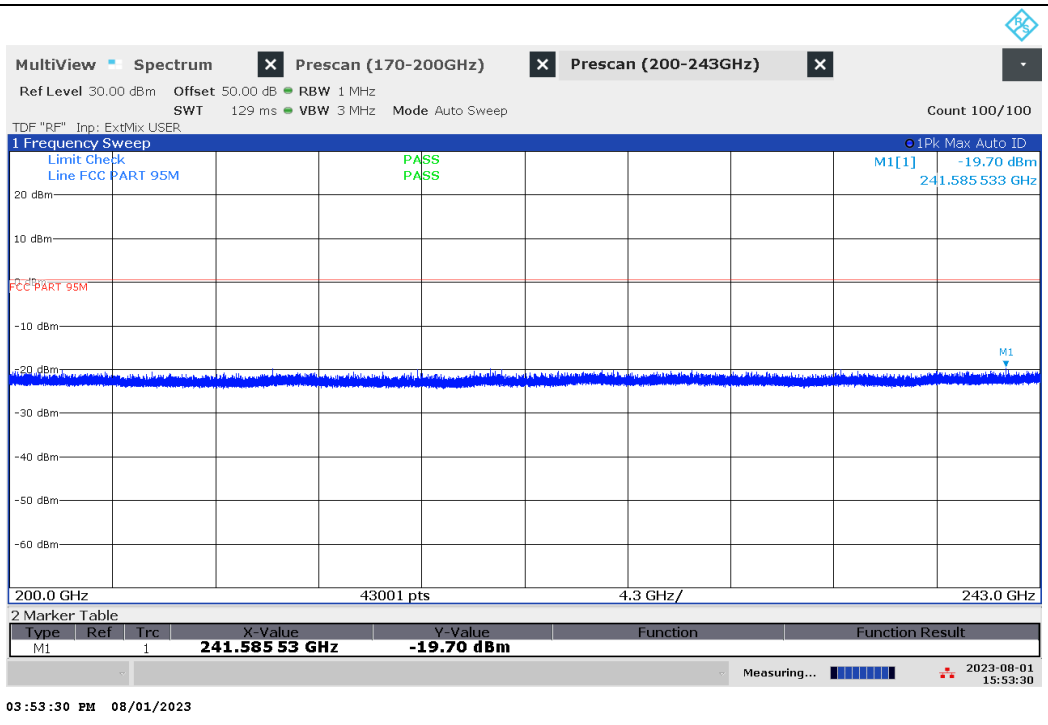
No emission detected using Peak Detection.

8.4.13. RADIATED EMISSIONS, 200 - 243 GHz

Horizontal

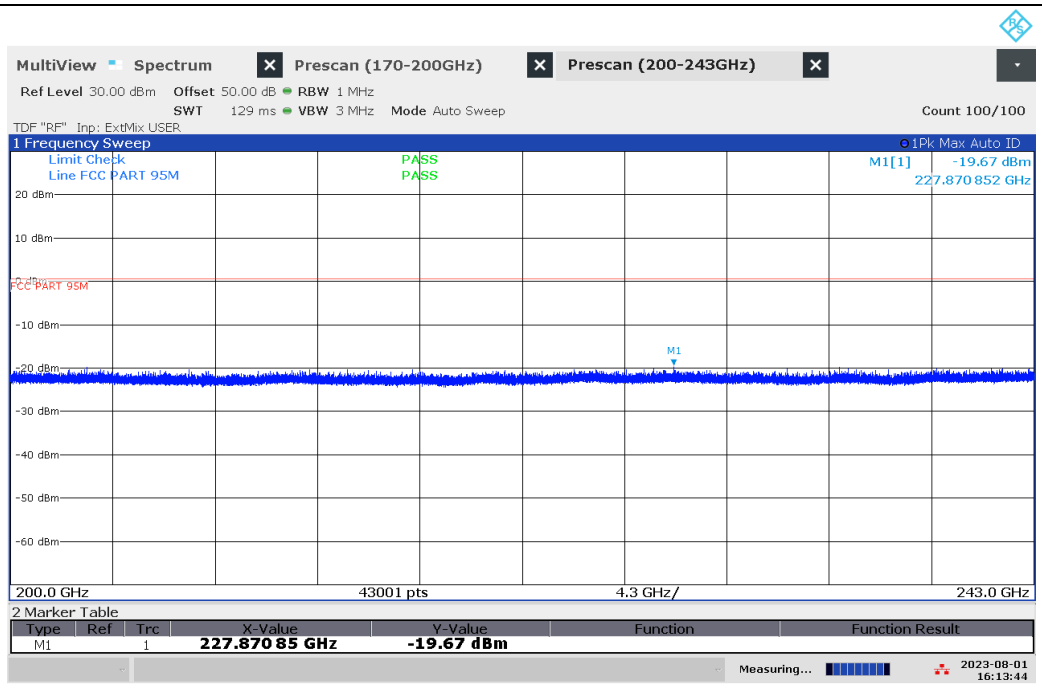
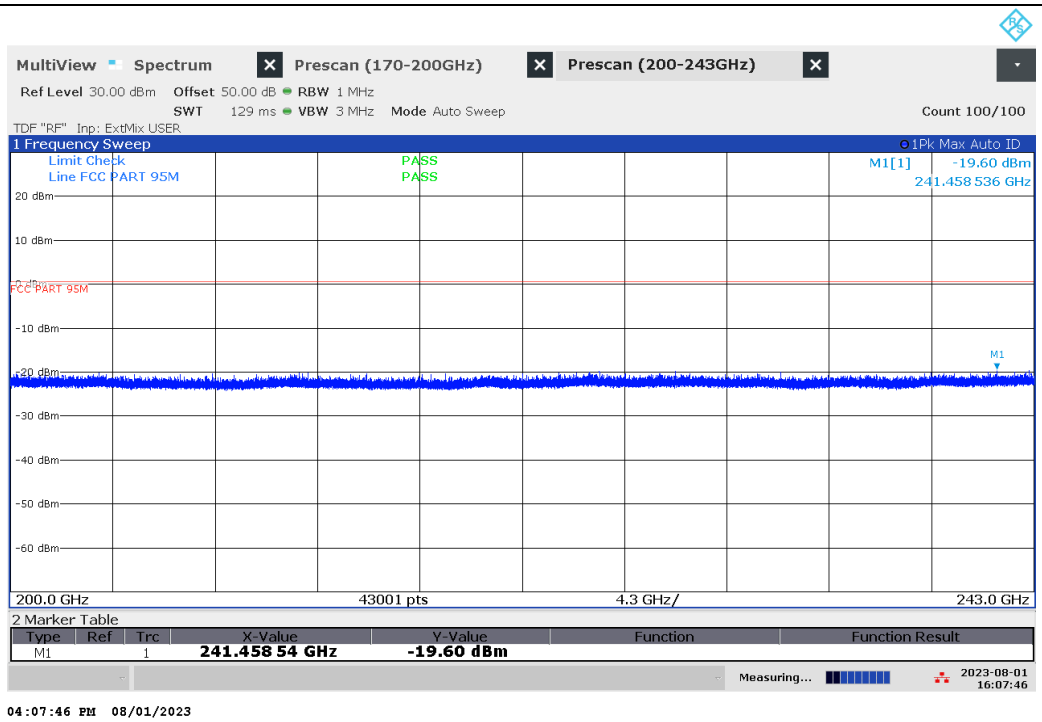


Vertical



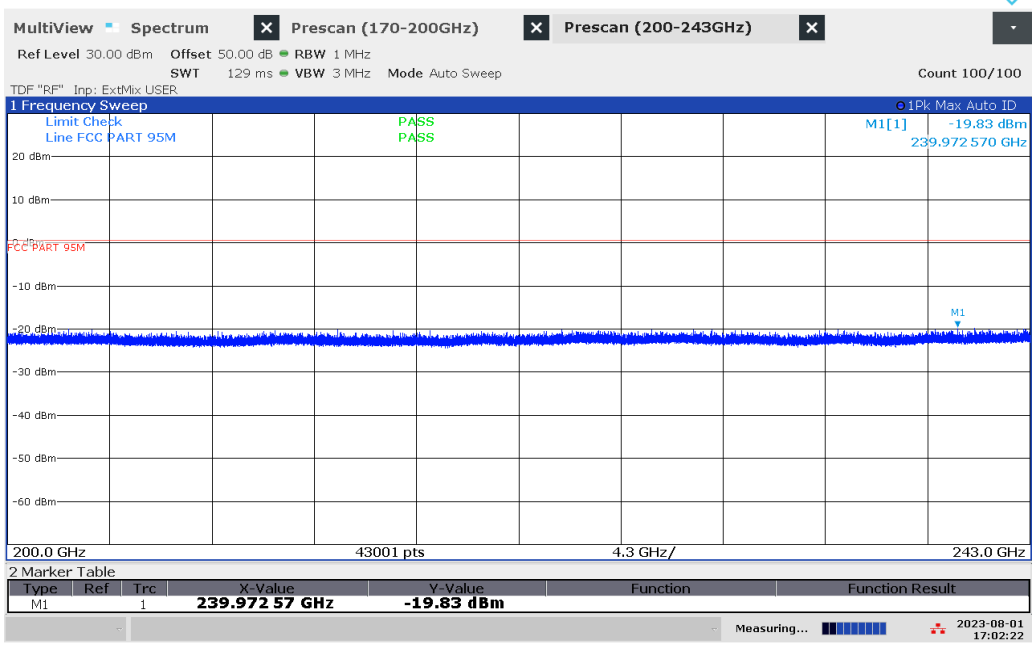
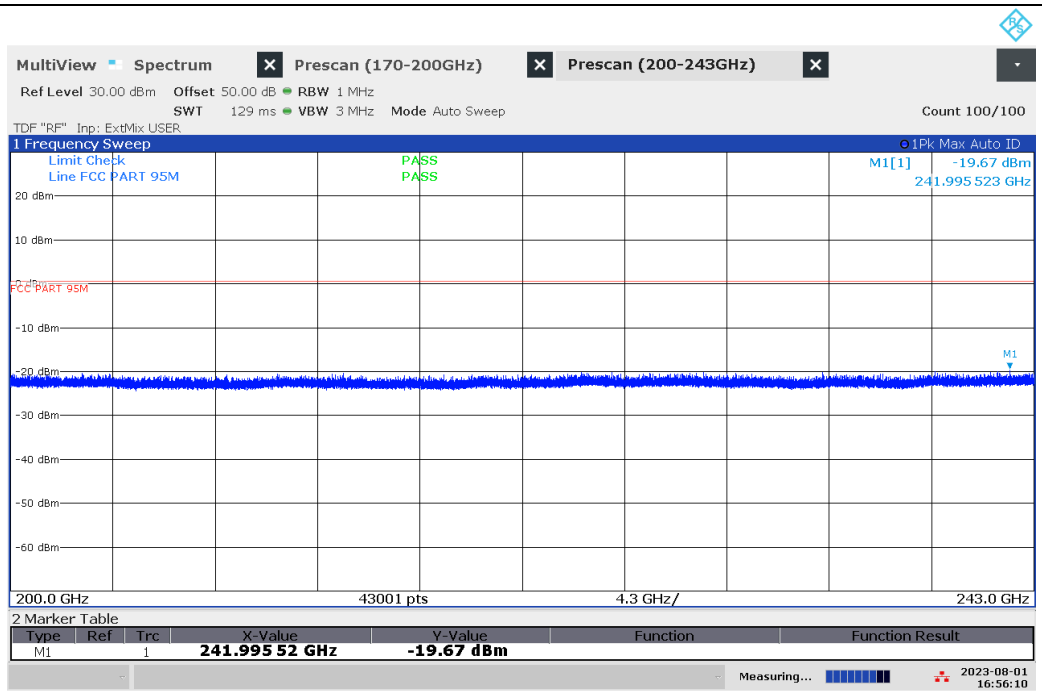
LRES W6 MODE

No emission detected using Peak Detection.

Horizontal	
Vertical	

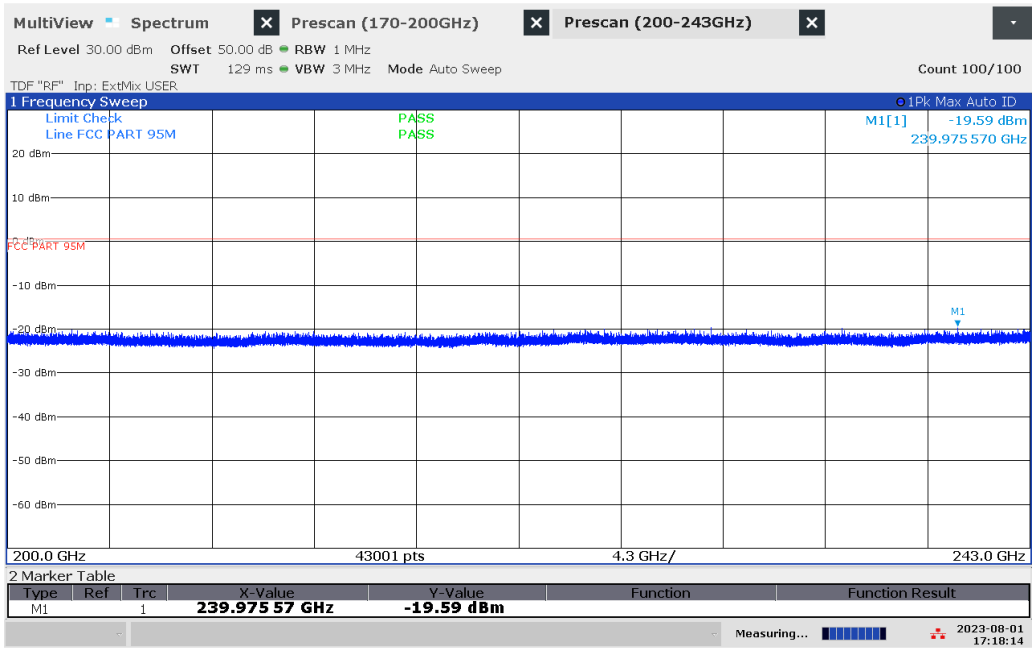
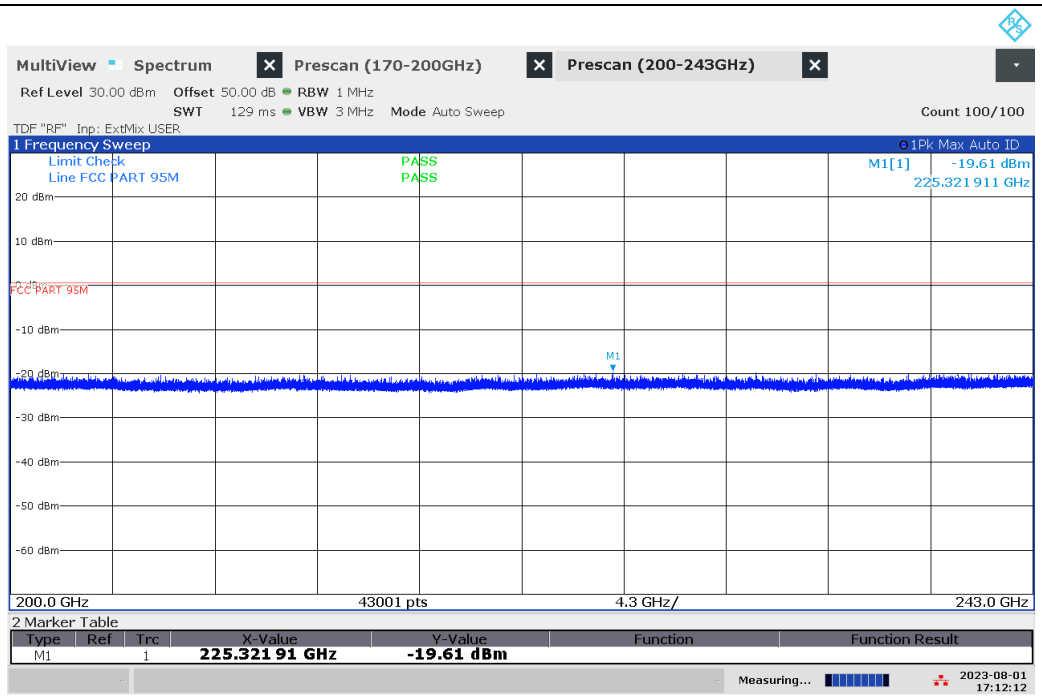
LRES W4 MODE

No emission detected using Peak Detection.

Horizontal	
Vertical	

MRES MODE

No emission detected using Peak Detection.

Horizontal	
Vertical	

HRES MODE

No emission detected using Peak Detection.

8.4.14. BANDEDGE

8.4.14.1. LOW SIDE

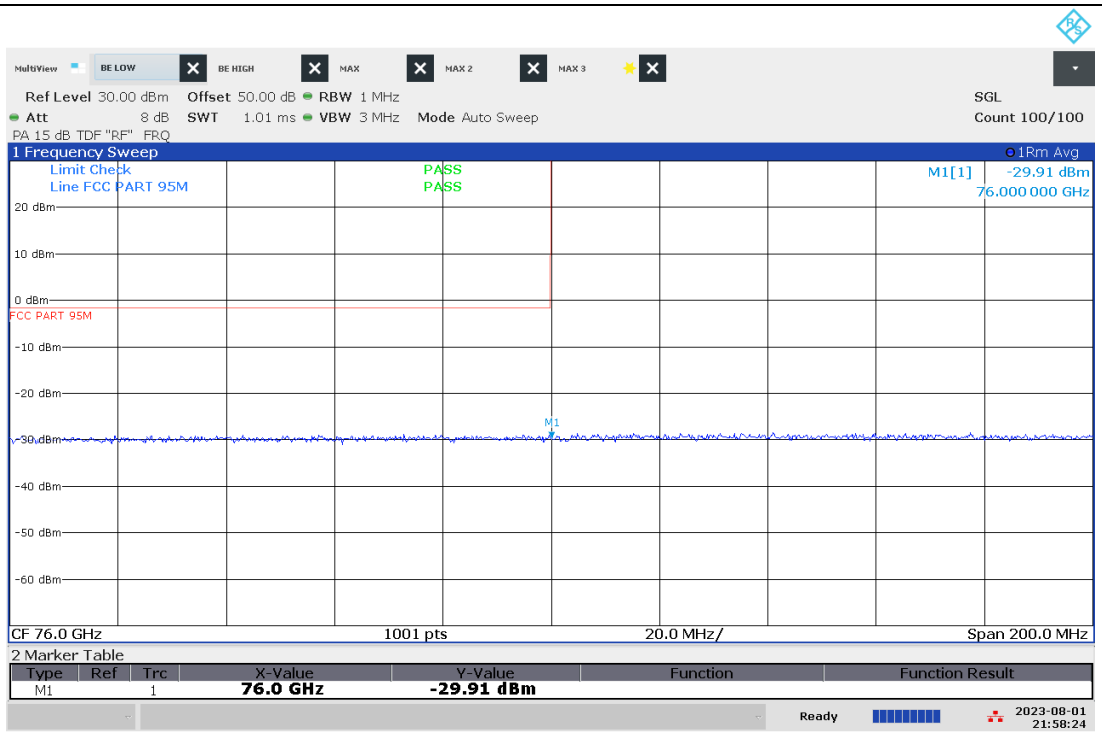
Worst case of horizontal / vertical measurement was reported.

LRES W6 Low CH

LRES W4 Low CH

MRES Low CH

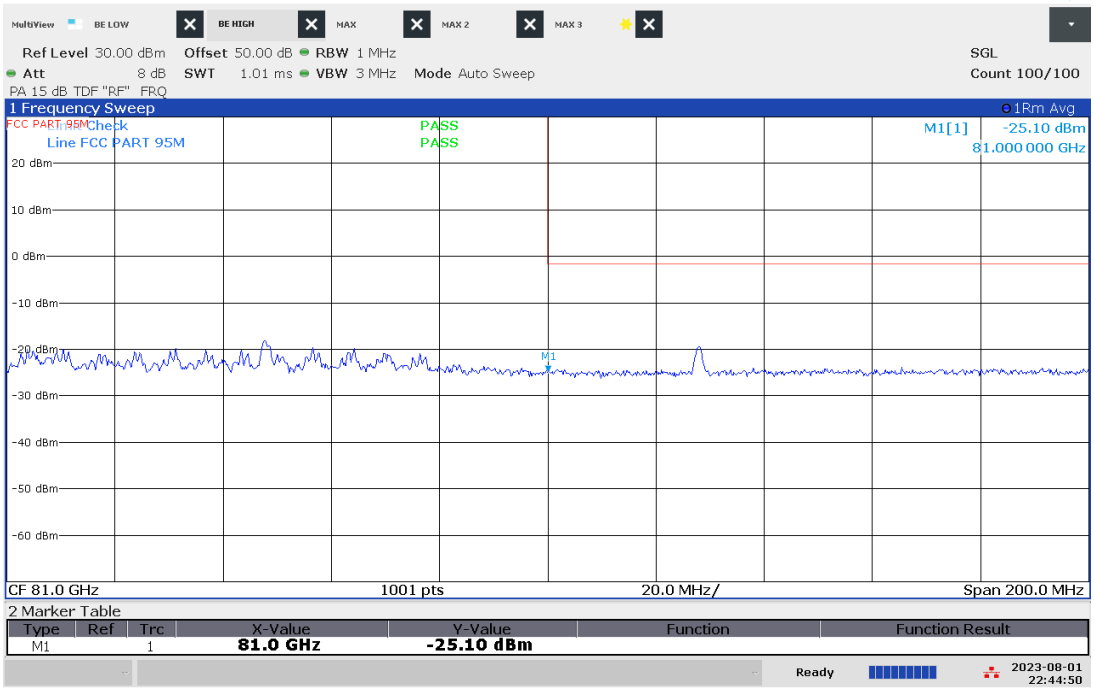
HRES Low CH



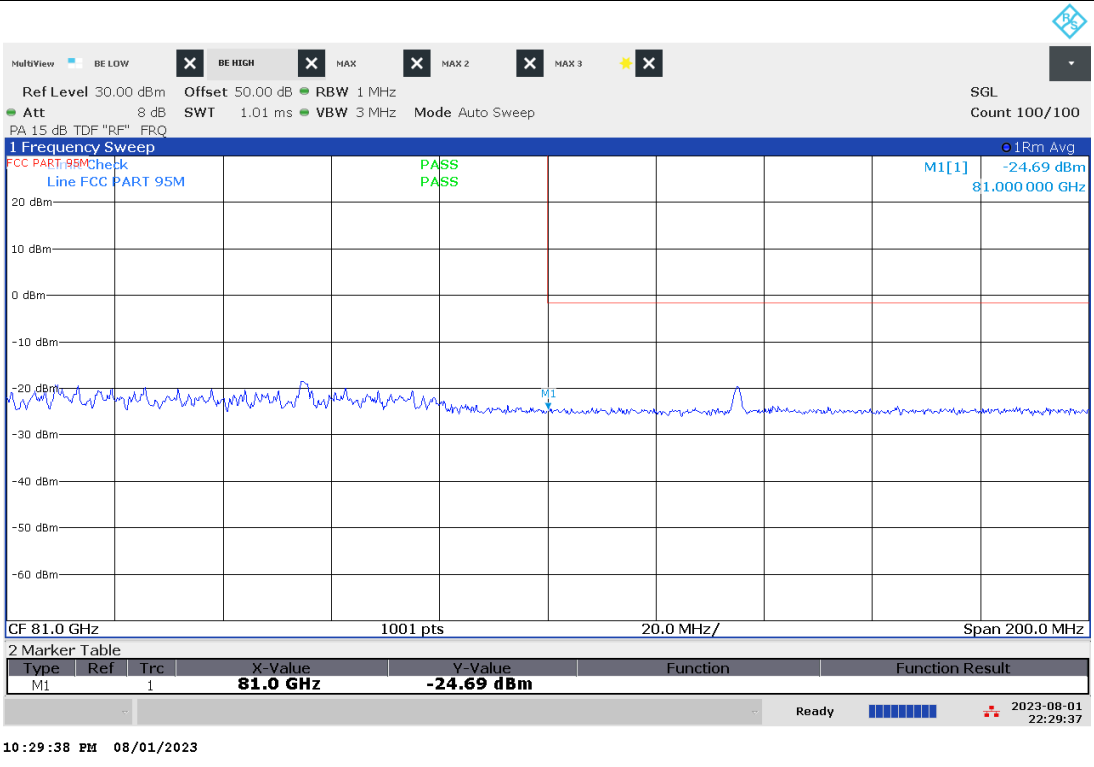
8.4.14.2. HIGH SIDE

Worst case of horizontal / vertical measurement was reported.

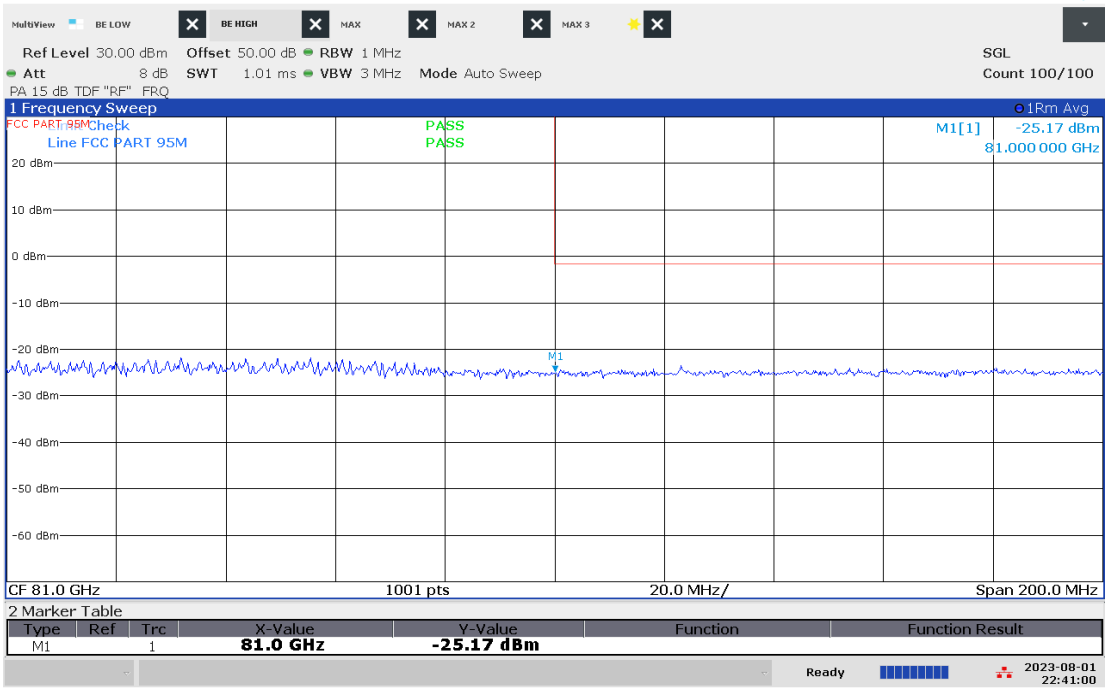
LRES W6 High CH



LRES W4 High CH



MRES High CH



10:41:00 PM 08/01/2023

HRES High CH

10:33:47 PM 08/01/2023

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8.5. FREQUENCY STABILITY

RULE PART(S)

FCC: §2.1055

FCC §95.3379 (b) – F (low) > 76.0 GHz; F (high) < 81 GHz
Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range −30 to +50 degrees Celsius with an input voltage variation of 85% to 115% of the rated input voltage (12V), unless justification is presented to demonstrate otherwise.

TEST PROCEDURES

ANSI C63.26-2015 Section 5.6

Test procedures for temperature variation:

The measurements were performed with the CW signal of the center frequency of each mode.

a. Position the EUT in temperature/humidity chamber with power off.
b. Set chamber temperature to 50°C and stabilize the EUT for at least 30 minutes.
c. Record maximum change in frequency within one minute after powering the EUT.
d. Power off the EUT and decrease chamber temperature at 10°C intervals from 50°C to -30°C. Power the EUT and record maximum change in frequency at each temperature.
e. A period of at least 30 minutes is provided to allow stabilization of the equipment at each temperature level.

- Temp. = −30°C to +50°C

Test procedures for voltage variation:

a. Position the EUT in temperature/humidity chamber with power off.
b. Set chamber temperature to 20°C.
c. Record maximum frequency change within one minute after powering the EUT.
d. The primary supply voltage is varied from 85% to 115% of the nominal value. Primary supply voltage is reduced to the battery operating end point which shall be specified by the manufacturer.

- Voltage = (85% - 115%)
- Nominal: 12 VDC; Low: 10.2 VDC; High: 13.8 VDC

The measurements were performed with the CW signal of center frequency of mid channel on each mode. Testing of LRES W6 represents the performance of both LRES W6 and W4 modes.

RESULTS

Employee ID: 27818, 27446, 24303
Location: Temperature Chamber B
Date: 8/8/2023

LRES - Mid Channel - 79.929 GHz			
Voltage	**Environment**	**Frequency**	**Delta**
	Temp (ºC)	**(GHz)**	**(MHz)**
Normal	50	79928.7932	0.1259
Normal	40	79928.7074	0.0401
Normal	30	79928.7003	0.0330
Normal	**20**	**79928.6673**	**Reference**
Normal	10	79928.7003	0.0330
Normal	0	79928.7543	0.0869
Normal	-10	79928.6883	0.0210
Normal	-20	79928.6934	0.0261
Normal	-30	79928.7632	0.0959
85%	20	79928.7123	0.0450
115%	20	79928.6970	0.0297

MRES - Mid Channel - 80.129 GHz			
Voltage	**Environment**	**Frequency**	**Delta**
	Temp (ºC)	**(GHz)**	**(MHz)**
Normal	50	80128.6643	-0.0929
Normal	40	80128.6853	-0.0719
Normal	30	80128.6314	-0.1258
Normal	**20**	**80128.7572**	**Reference**
Normal	10	80128.6224	-0.1348
Normal	0	80128.7213	-0.0359
Normal	-10	80128.6643	-0.0929
Normal	-20	80128.5774	-0.1798
Normal	-30	80128.7662	0.0090
85%	20	80128.6630	-0.0942
115%	20	80128.6553	-0.1019

HRES - Mid Channel - 79.969 GHz			
Voltage	**Environment**	**Frequency**	**Delta**
	Temp (ºC)	**(MHz)**	**(MHz)**
Normal	50	79968.6370	-0.0753
Normal	40	79968.7662	0.0539
Normal	30	79968.6913	-0.0210
Normal	**20**	**79968.7123**	**Reference**
Normal	10	79968.7273	0.0150
Normal	0	79968.7333	0.0210
Normal	-10	79968.6613	-0.0510
Normal	-20	79968.7003	-0.0120
Normal	-30	79968.7123	0.0000
85%	20	79968.8172	0.1049
115%	20	79968.6703	-0.0420

The F_L and F_H of occupied bandwidths (Section 8.2) are at least 2 MHz from either edge of the channel for all operation modes. As the channels are fully contained within the FCC-allocated bands, and the frequency stability is significantly less than 2 MHz, with maximum frequency shift of 0.1798 MHz over the test conditions (MRES Mid Channel at -20ºC). The signal is always contained within the allocated channel, therefore, always contained within the allocated band.

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9. SETUP PHOTOS

Please refer to report 14841575-EP1 for setup photos.

END OF REPORT