

TEST REPORT

Test report no.: 23-1-0144001T007_TR1-R02



Deutsche
Akkreditierungsstelle
D-PL-12047-01-00

Testing laboratory

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Accredited Testing Laboratory:

The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2018-03) by the Deutsche Akkreditierungsstelle GmbH (DAkkS).

The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number:

D-PL-12047-01-00.

ISED Testing Laboratory Recognized Listing Number: DE0001

FCC designation number: DE0002

Applicant

Brose Fahrzeugteile SE & Co. KG, Bamberg

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96052 Bamberg, GERMANY

Phone: +49 9517474-0

Contact: Bertram Bopp

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Manufacturer

Brose Fahrzeugteile SE & Co. KG, Bamberg

Berliner Ring 1

96052 Bamberg, GERMANY

Test standard/s

FCC - Title 47 CFR Part 95 FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 95 - Personal Radio Services

For further applied test standards please refer to section 3 of this test report.

Test Item

Kind of test item: Kick Sensor (HfA)

Model name: R-HFA GEN2

FCC ID: 2AHV8-G69634

IC: 29958-G69634

Frequency: 77 – 79 GHz

Technology tested: RADAR

Antenna: Integrated antenna

Power supply: 8 V to 16 V DC

Temperature range: -40°C to 105°C

This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

Test report authorized:



Christian Lorenz
Lab Manager
Radio Communications

Test performed:



Al-Amin Hossain
Testing Manager
Radio Communications

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2 General information

2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. cetecom advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.

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This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

2.2 Application details

Date of receipt of order:	2024-02-27
Date of receipt of test item:	2024-08-15
Start of test:*	2024-08-20
End of test:*	2024-09-11
Person(s) present during the test:	-/-

*Date of each measurement, if not shown in the plot, can be requested. Dates are stored in the measurement software.

2.3 Involved test locations

Saarbruecken lab		Essen lab	
☐	Untertuerkheimer Str. 6-10 66117 Saarbruecken Germany	☒	Im Teelbruch 116 45219 Essen Germany

2.4 Test laboratories sub-contracted

None

2.5 Laboratory listings and recognitions

	Saarbruecken	Essen
FCC	DE0002	DE0003
ISED	DE0001 3462C	DE0001 3462D

3 Test standard/s, references and accreditations

Test standard	Date	Description
FCC - Title 47 CFR Part 95	2017-09-20	FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 95 - Personal Radio Services

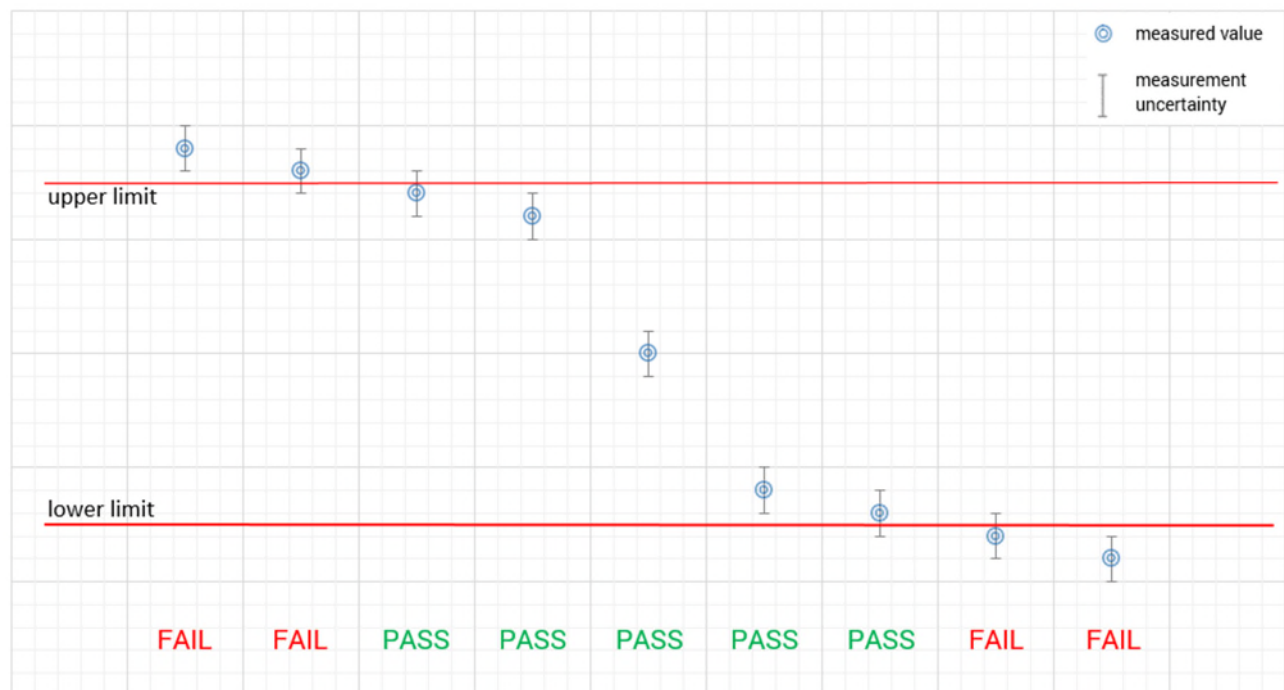
Guidance	Version	Description
ANSI C63.4-2014	-/-	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10-2020	-/-	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
ANSI C63.26-2015	-/-	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
76-81 GHz Radars KDB	v01r02	653005 D01 76-81 GHz Radars v01r02: EQUIPMENT AUTHORIZATION GUIDANCE FOR 76-81 GHz RADAR DEVICES

4 Reporting statements of conformity – decision rule

Only the measured values related to their corresponding limits will be used to decide whether the equipment under test meets the requirements of the test standards listed in chapter 3.

The measurement uncertainty is mentioned in this test report, see chapter 9, but is not taken into account - neither to the limits nor to the measurement results. Measurement results with a smaller margin to the corresponding limits than the measurement uncertainty have a potential risk of more than 5% that the decision might be wrong.

measured value, measurement uncertainty, verdict



5 Test environment

Temperature	:	T_{nom} 20 °C during room temperature tests T_{max} 50 °C during high temperature tests T_{min} -20 °C during low temperature tests
Relative humidity content	:	55 % - 65 %
Barometric pressure	:	985 hPa
Power supply	:	V_{nom} 12 V DC V_{max} 13.8 V DC (115% V_{nom}) V_{min} 10.2 V DC (85% V_{nom})

6 Test item

6.1 General description

Kind of test item	:	Kick Sensor (HfA)
Model name	:	AWRL 1422
PMN	:	R-HFA GEN2
HVIN	:	R-HFA GEN2
FVIN	:	G8C574-000
S/N serial number	:	Engineering Sample / 23-1-01440S11_C01 (PMT Sample No.)
Hardware status	:	G69634-100
Software status	:	B013
Firmware status	:	G8C574-000
Frequency band	:	77 – 79 GHz
Type of modulation	:	FMCW
Number of modes	:	1
Antenna	:	Integrated antenna
Power supply	:	8.0 V to 16.0 V DC (Powered by Vehicular Battery)
Temperature range	:	-40°C to 105°C

6.2 Additional information

The content of the following annexes is defined in the QA. It may be that not all of the listed annexes are necessary for this report, thus some values in between may be missing.

Test setup and EUT photos are included in test report:

- 23-1-0144001T007_TR1-A101-R01 (External photographs of EUT)
- 23-1-0144001T007_TR1-A102-R01 (Internal photographs of EUT)
- 23-1-0144001T007_TR1-A103-R01 (Test set-up photographs)
- Note: The referenced photos show EUT delivered by the customer in this project, not necessarily the exact one used for the specific tests. EUT identification shown in the photos may differ.

Additional measurement reports:

- 23-1-0144001T007_TR1-A201-R01

Additional declarations (manufacturer's declarations, declarations of conformity, etc.):

7 Description of the test setup

Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements with other calibrated test systems or effective verifications. Weekly chamber inspections and range calibrations are performed. Where possible, RF generating and signaling equipment as well as measuring receivers and analyzers are connected to an external high-precision 10 MHz reference (GPS-based or rubidium frequency standard).

In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

Agenda: Kind of Calibration

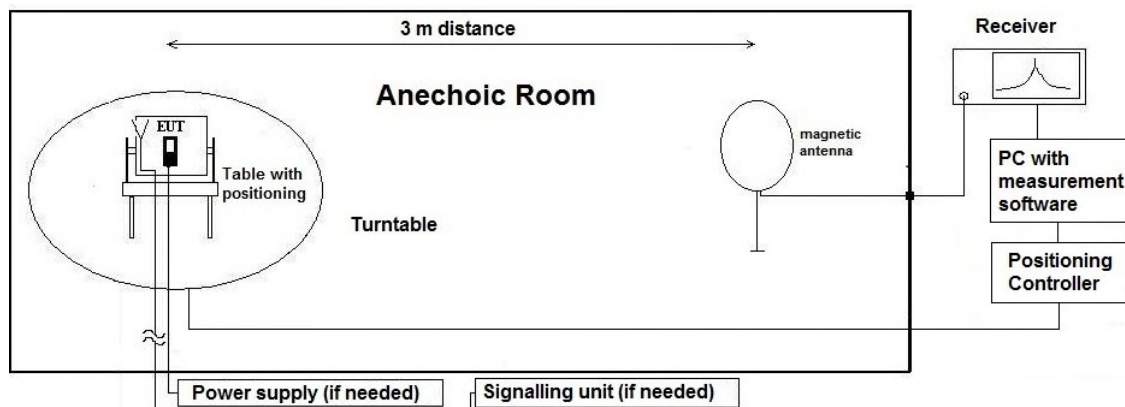
K	calibration / calibrated	EK	limited calibration
(cal)			
Ne	not required (k, ev, izw, zw not required)	zw	cyclical maintenance (external cyclical maintenance)
(cnn)		izw	internal cyclical maintenance
Ev	periodic self verification		
(chk)			
Ve	long-term stability recognized	g	blocked for accredited testing
vkl!	Attention: extended calibration interval	cpu	Verification before usage
NK!	Attention: not calibrated	*)	next calibration ordered / currently in progress

7.1 Shielded semi anechoic chamber

Evaluating the radiated field emissions are done first by an exploratory emission measurement and a final measurement for most critical frequencies determined.

The loop antenna was placed at 1 m height above ground plane and 3 m measurement distance from set-up for investigations. Because of reduced measurement distance, correction data were applied, as stated in chapter 9.2.1. The tests are performed in the semi anechoic room recognized by the regulatory commission.

Schematic:



Testing method:

The measurement is made according to relevant reference clauses:
(See Tables *Summary of Test Results* and *Summary of Test Methods* on page 5)

Exploratory, preliminary measurements

The EUT and its associated accessories are placed on a non-conductive position manipulator (tipping device) of 0.8 m height which is placed on the turntable. By rotating the turntable (step 90°, range 0° to 360°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT), the emission spectrum was recorded.

The loop antenna was moved at least to 2-perpendicular axes (antenna vector in direction of EUT and parallel to EUT) in order to maximize the emissions. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a data reduction table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

Final measurement on critical frequencies

Based on the exploratory measurements, the most critical frequencies are re-measured by maintaining the EUT's worst-case operation mode, cable position, etc.

First a frequency zoom around the critical frequency is done to locate the frequency more precisely. After this step, for all identified critical frequencies, the maximum peak was determined.

Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself either over 3-orthogonal axis (not defined usage position) or 2-orthogonal axis (defined usage position).

On the determined worst-case position, a final measurement with necessary bandwidth and detector according standard has been carried out.

Formula:

$$E_C = E_R + AF + C_L + D_F - G_A$$

$$M = L_T - E_C$$

AF = Antenna factor

C_L = Cable lossD_F = Distance correction factor (if used)E_C = Electrical field – corrected valueE_R = Receiver readingG_A = Gain of pre-amplifier (if used)L_T = Limit

M = Margin

All units are dB-units, positive margin means value is below limit.

7.1.1 Sample calculation

Raw-Value [dBuV/m]	Antenna factor	Distance Correction [dB]	Cable Loss	Preamplifier	Resulting correction value [dB]	Final result [dBuV/m]	Remarks
19.83	18.9	-70.75	0.18	--	-51.67	-31.83	30 to 3 m correction used according ANSI C63.10-2020

Remark: This calculation is based on an example value at 458 kHz

7.1.2 Correction factors due to reduced meas. distance ($f < 30$ MHz):

The used correction factors when the measurement distance is reduced compared to regulatory measurement distance, are calculated according Extrapolation formulas valid for EUT's with maximum dimension of $0.625 \times \text{Lambda}$. Formula 2+3+4 as presented in ANSI C63.10, Chapter 6.4.4 are used for the calculations of proper extrapolation factors

Frequency Range	f [kHz/MHz]	Lambda [m]	Far-Field Point [m]	Distance Limit accord. 15.209 [m]	1st Condition (dmeas < Dnear-field)	2nd Condition (Limit distance bigger dnear-field)	Distance Correction accord. Formula
kHz	9	33333.33	5305.17	300	fullfilled	not fullfilled	-80.00
	10	30000.00	4774.65		fullfilled	not fullfilled	-80.00
	20	15000.00	2387.33		fullfilled	not fullfilled	-80.00
	30	10000.00	1591.55		fullfilled	not fullfilled	-80.00
	40	7500.00	1193.66		fullfilled	not fullfilled	-80.00
	50	6000.00	954.93		fullfilled	not fullfilled	-80.00
	60	5000.00	795.78		fullfilled	not fullfilled	-80.00
	70	4285.71	682.09		fullfilled	not fullfilled	-80.00
	80	3750.00	596.83		fullfilled	not fullfilled	-80.00
	90	3333.33	530.52		fullfilled	not fullfilled	-80.00
	100	3000.00	477.47		fullfilled	not fullfilled	-80.00
	125	2400.00	381.97		fullfilled	not fullfilled	-80.00
	200	1500.00	238.73		fullfilled	fullfilled	-78.02
	300	1000.00	159.16		fullfilled	fullfilled	-74.49
	400	750.00	119.37		fullfilled	fullfilled	-72.00
	490	612.24	97.44		fullfilled	fullfilled	-70.23
	500	600.00	95.49		fullfilled	not fullfilled	-40.00
	600	500.00	79.58		fullfilled	not fullfilled	-40.00
	700	428.57	68.21		fullfilled	not fullfilled	-40.00
	800	375.00	59.68		fullfilled	not fullfilled	-40.00
	900	333.33	53.05		fullfilled	not fullfilled	-40.00
MHz	1.00	300.00	47.75	30	fullfilled	not fullfilled	-40.00
	1.59	188.50	30.00		fullfilled	not fullfilled	-40.00
	2.00	150.00	23.87		fullfilled	fullfilled	-38.02
	3.00	100.00	15.92		fullfilled	fullfilled	-34.49
	4.00	75.00	11.94		fullfilled	fullfilled	-32.00
	5.00	60.00	9.55		fullfilled	fullfilled	-30.06
	6.00	50.00	7.96		fullfilled	fullfilled	-28.47
	7.00	42.86	6.82		fullfilled	fullfilled	-27.13
	8.00	37.50	5.97		fullfilled	fullfilled	-25.97
	9.00	33.33	5.31		fullfilled	fullfilled	-24.95
	10.00	30.00	4.77		fullfilled	fullfilled	-24.04
	10.60	28.30	4.50		fullfilled	fullfilled	-23.53
	11.00	27.27	4.34		fullfilled	fullfilled	-23.21
	12.00	25.00	3.98		fullfilled	fullfilled	-22.45
	13.56	22.12	3.52		fullfilled	fullfilled	-21.39
	15.00	20.00	3.18		fullfilled	fullfilled	-20.51
	15.92	18.85	3.00		fullfilled	fullfilled	-20.00
	17.00	17.65	2.81		not fullfilled	fullfilled	-20.00
	18.00	16.67	2.65		not fullfilled	fullfilled	-20.00
	20.00	15.00	2.39		not fullfilled	fullfilled	-20.00
	21.00	14.29	2.27		not fullfilled	fullfilled	-20.00
	23.00	13.04	2.08		not fullfilled	fullfilled	-20.00
	25.00	12.00	1.91		not fullfilled	fullfilled	-20.00
	27.00	11.11	1.77		not fullfilled	fullfilled	-20.00
	29.00	10.34	1.65		not fullfilled	fullfilled	-20.00
	30.00	10.00	1.59		not fullfilled	fullfilled	-20.00

7.1.3 Measurement Location

Test site	SAC 3
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7.1.4 Limit

Radiated emissions limits (3 meters)					
Frequency Range [MHz]	Limit [$\mu\text{V}/\text{m}$]	Limit [$\text{dB}\mu\text{V}/\text{m}$]	Distance [m]	Detector	RBW [kHz]
0.009 – 0.09	2400 / f [kHz]	67.6 – 20Log(f) (kHz)	300	Pk & Avg	0.2
0.09 – 0.11	2400 / f [kHz]	67.6 – 20Log(f) (kHz)	300	Quasi peak	0.2
0.11 – 0.15	2400 / f [kHz]	67.6 – 20Log(f) (kHz)	300	Pk & Avg	0.2
0.15 – 0.49	2400 / f [kHz]	67.6 – 20Log(f) (kHz)	300	Pk & Avg	9
0.49 – 1.705	24000 / f [kHz]	87.6 – 20Log(f) (kHz)	30	Quasi peak	9
1.705 - 30	30	29.5	30	Quasi peak	9

*Remark: In Canada same limits apply, just unit reference is different

7.1.5 Result

Note: For more information Check Chapter 12.5

Equipment table:

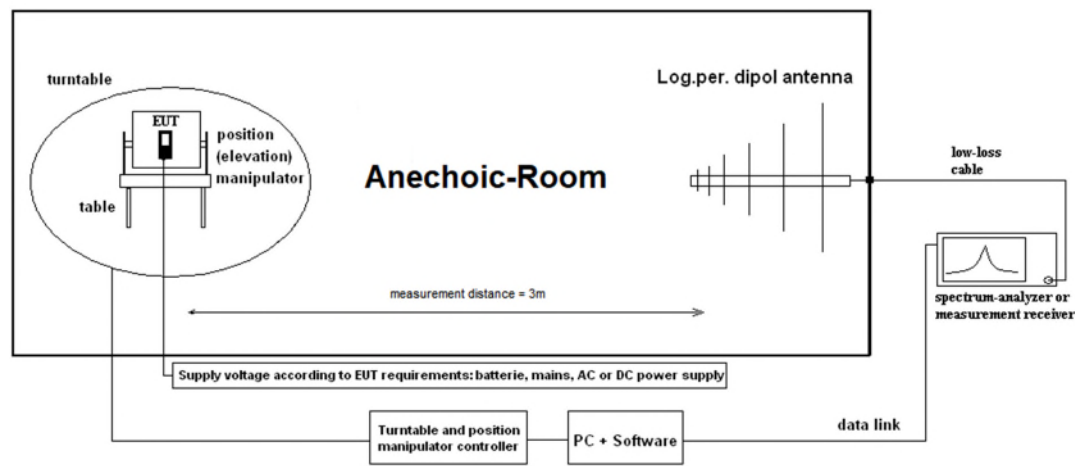
No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	20341	Digital Multimeter	Digital Multimeter Fluke 112	Fluke Deutschland GmbH / Glottertal	81650455	–	cal	13.05.2024	13.05.2026
2	20442	Semi Anechoic Chamber	Semi Anechoic Chamber SAC3	ETS-Lindgren GmbH / Taufkirchen	without	–	cnn	02.08.2013	-/-
3	20482	Filter Matrix	Filter Matrix SAC3	cetecom advanced GmbH / Essen	without	–	cnn	-/-	-/-
4	20574	Biconilog Hybrid Antenna	Biconilog Hybrid Antenna BTA-L	Frankonia GmbH / Heideck	980026L	–	cal	15.06.2022	15.06.2025
5	20620	EMI Test Receiver	EMI Test Receiver ESU26	Rohde & Schwarz Messgerätebau GmbH / Memmingen	100362	–	cal	15.05.2024	15.05.2025
6	20885	Power Supply EA3632A	Power Supply EA3632A	Agilent Technologies Deutschland GmbH	75305850	–	cnn	-/-	-/-
7	25038	Loop Antenna	Loop Antenna HFH2-Z2	Rohde & Schwarz Messgerätebau GmbH / Memmingen	879824/13	–	cal	04.07.2022	04.07.2025

7.2 Radiated field strength emissions 30 MHz – 1000 MHz (Chamber: SAC 3)

7.2.1 Description of the general test setup and methodology, see below example:

Evaluating the emissions have to be done first by an exploratory emissions measurement and a final measurement for most critical frequencies. The tests are performed in a CISPR 16-1-4:2010 compliant Semi anechoic Chamber (SAC) recognized by the regulatory commission. The measurement distance was set to 3 meter for frequencies up to 1 GHz. A logarithmic periodic antenna is used for the frequency range 30 MHz to 1 GHz.

Schematic:



Testing method:

The measurement is made according to relevant reference clauses:
(See Tables *Summary of Test Results* and *Summary of Test Methods* on page 5)

Exploratory, preliminary measurements

The EUT and its associated accessories are placed on a non-conductive position manipulator (tipping device) of 0.8 m height which is placed on the turntable. By rotating the turntable (range 0° to 360°, step 90°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT) the emission spectrum and its characteristics was recorded with an EMI-receiver, broadband antenna and software.

Measurement antenna: horizontal and vertical, heights: 1,0 m and 1,82 m as worst-case determined by an exploratory emission measurements. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case of them. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

Final measurement on critical frequencies

Based on the exploratory measurements, the most critical frequencies are re-measured by maintaining the EUT's worst-case operation mode, cable position, etc. either on 10m OATS or 3m semi-anechoic room.

First a frequency zoom around the critical frequency is done to locate the frequency more precisely. After this step, for all identified critical frequencies, the maximum peak was determined.

Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself either over 3-orthogonal axis (not defined usage position) or 2-orthogonal axis (defined usage position). The measurement antenna height between 1 m and 4 m.

On the determined worst-case position, a final measurement with necessary bandwidth and detector according standard has been carried out

Formula:

$$E_C = E_R + AF + C_L + D_F - G_A \quad (1)$$

$$M = L_T - E_C \quad (2)$$

AF = Antenna factor

C_L = Cable lossD_F = Distance correction factor (if used)E_C = Electrical field – corrected valueE_R = Receiver readingG_A = Gain of pre-amplifier (if used)L_T = Limit

M = Margin

All units are dB-units, positive margin means value is below limit.

7.2.2 Sample calculation

Raw-Value [dBuV/m]	Antenna factor	Distance Correction [dB]	Cable Loss	Preamplifier	Resulting correction value [dB]	Final result [dBuV/m]	Remarks
32.7	22.25	--	3.1	--	25.35	58.05	--

Remark: This calculation is based on an example value at 800.4 MHz

7.2.3 Measurement Location

Test site	SAC 3
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7.2.4 Limit

Radiated emissions limits (3 meters)				
Frequency Range [MHz]	Limit [μV/m]	Limit [dBμV/m]	Detector	RBW / VBW [kHz]
30 - 88	100	40.0	Quasi peak	100 / 300
88 - 216	150	43.5	Quasi peak	100 / 300
216 - 960	200	46.0	Quasi peak	100 / 300
960 - 1000	500	54.0	Quasi peak	100 / 300

7.2.5 Result

Note: For more information Check Chapter 12.5

Equipment table:

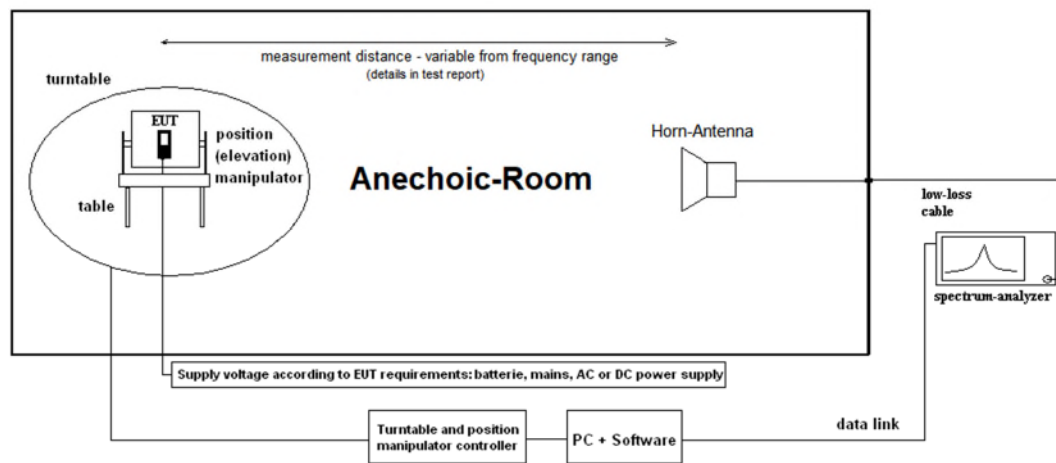
No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	Kind of Calibration	Last Calibration	Next Calibration
1	20341	Digital Multimeter	Digital Multimeter Fluke 112	Fluke Deutschland GmbH / Glottertal	81650455	cal	13.05.2024	13.05.2026
2	20442	Semi Anechoic Chamber	Semi Anechoic Chamber SAC3	ETS-Lindgren GmbH / Taufkirchen	without	cnn	24.10.2024	24.10.2025
3	20482	Filter Matrix	Filter Matrix SAC3	cetecom advanced GmbH / Essen	without	cnn	-/-	-/-
4	20574	Biconilog Hybrid Antenna	Biconilog Hybrid Antenna BTA-L	Frankonia GmbH / Heideck	980026L	cal	15.06.2022	15.06.2025
5	20620	EMI Test Receiver	EMI Test Receiver ESU26	Rohde & Schwarz Messgerätebau GmbH / Memmingen	100362	cal	15.05.2024	15.05.2025
6	20885	Power Supply EA3632A	Power Supply EA3632A	Agilent Technologies Deutschland GmbH	75305850	cnn	-/-	-/-

7.3 Shielded fully anechoic chamber (1 GHz – 18 GHz / Chamber: FAC 2)

7.3.1 Description of the general test setup and methodology, see below example:

Evaluating the emissions have to be done first by an exploratory emissions measurement and a final measurement for most critical frequencies. The tests are performed in a CISPR 18-1-4:2010 compliant fully anechoic room (FAR) recognized by the regulatory commission. The measurement distance was set to 3 meter for frequencies up to 12.4 GHz and 2 meter up to 18 GHz. Horn antennas are used for frequency range 1 GHz to 65 GHz.

Schematic:



Testing method:

The measurement is made according to relevant reference clauses:
(See Tables *Summary of Test Results* and *Summary of Test Methods* on page 5)

Exploratory, preliminary measurements

The EUT and its associated accessories are placed on a non-conductive position manipulator (tipping device) of 1.55 m height which is placed on the turntable. By rotating the turntable (range 0° to 360°, step 15°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT) the emission spectrum and its characteristics was recorded with an EMI-receiver, broadband antenna and software.

The measurements are performed in horizontal and vertical polarization of the measurement antennas. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case of them. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

Final measurement on critical frequencies

Based on the exploratory measurements, the most critical frequencies are re-measured by maintaining the EUT's worst-case operation mode, cable position, etc.

First a frequency zoom around the critical frequency is done to locate the frequency more precisely. After this step, for all identified critical frequencies, the maximum peak was determined.

Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself over 3-orthogonal axis and the height for EUT with large dimensions or three axis scan for portable/small equipment.

On the determined worst-case position, a final measurement with necessary bandwidth and detector according standard has been carried out.

Formula:

$$P_{EIRP} = P_{MEAS} + C_L + FSL - G_A \quad (1)$$

 P_{MEAS} = measured power at instrument

M = Margin

 L_T = Limit

FSL = Free Space loss = Function(frequency, measurement distance)

$$M = L_T - P_{EIRP}$$

 C_L = cable loss G_A = Gain of pre-amplifier (if used)

All units are dB-units, positive margin means value is below limit.

7.3.2 Sample calculation

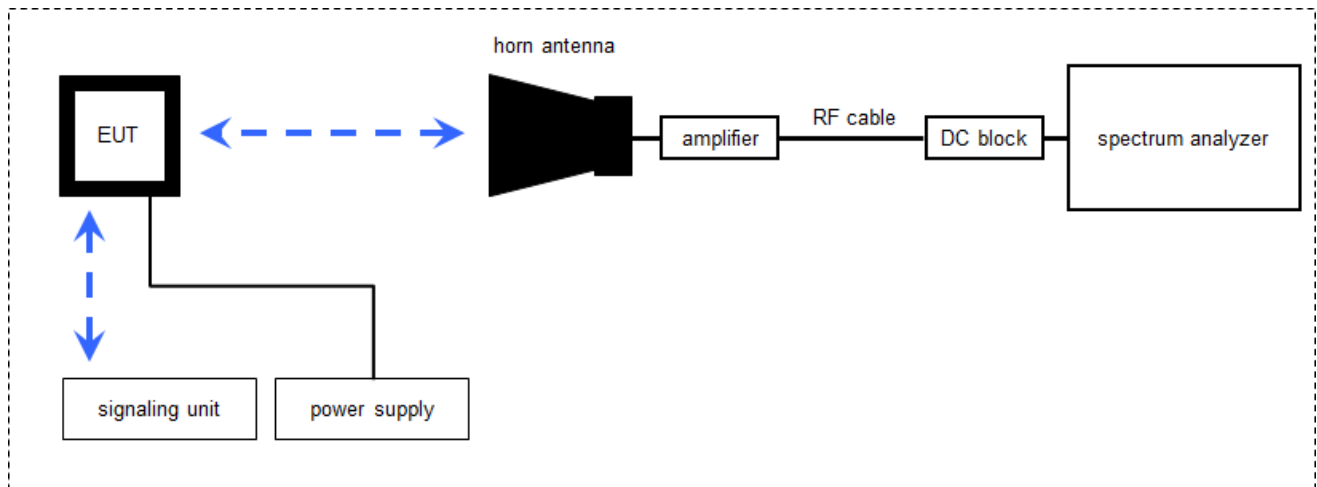
Raw-Value [dBuV/m]	Antenna factor	Distance Correction [dB]	Cable Loss + Preamplifier	Resulting correction value [dB]	Final result [dBuV/m]	Remarks
29.37	41.20	–	24.28	16.92	46.3	CableLoss and PreAmp data in one data correction file

Remark: This calculation is based on an example value at 10 GHz

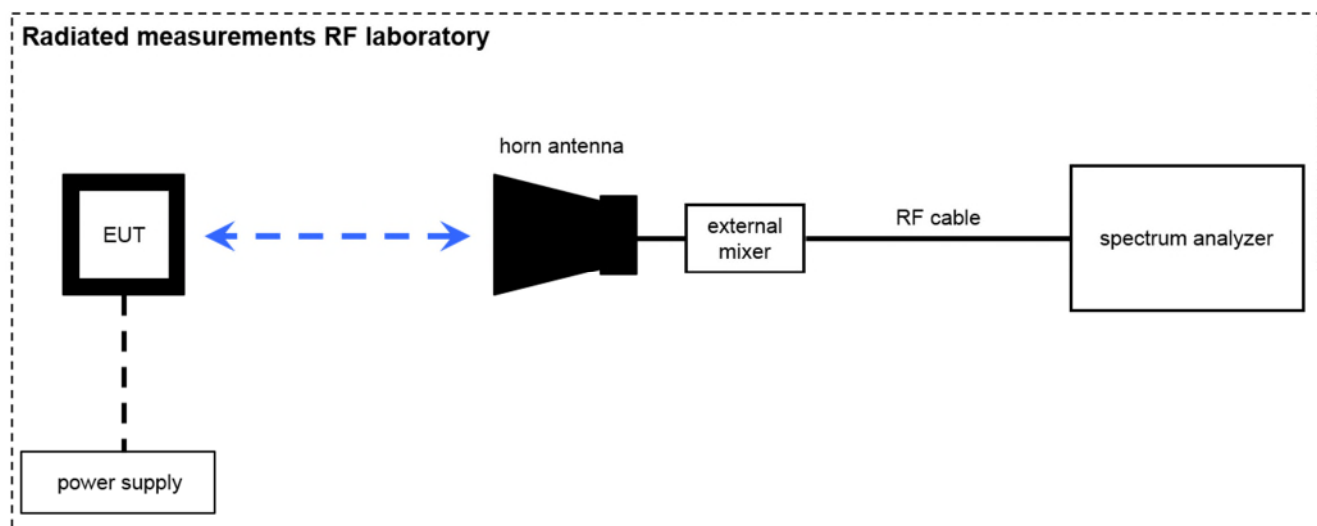
7.3.3 Equipment table

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	Kind of Calibration	Last Calibration	Next Calibration
1	20133	Double-Ridged Waveguide Horn Antenna	Double-Ridged Waveguide Horn Antenna 3115 (Meas 1)	EMCO Elektronik GmbH / Gilching	9012-3629	cal	22.05.2023	22.05.2026
2	20354	DC - Power Supply 40A	DC - Power Supply 40A NGPE 40/40		448	cpu	05.03.2008	-/-
3	20412	Fully Anechoic Chamber	Fully Anechoic Chamber 2	ETS-Lindgren GmbH / Taufkirchen	without	chk	15.03.2024	15.03.2025
4	20972	Signal- and Spectrum Analyzer	Signal- and Spectrum Analyzer FSW50	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101929	cal	05.01.2024	05.01.2025
5	20811	Horn Antenna	Horn Antenna ASY- SGH-124-SMA	Antenna Systems Solutions S.L / Santander	29F14182337	chk	20.10.2021	07.10.2025
6	20816	SGH Antenna	SGH Antenna SGH-26- WR10	Antenal S.L.	1144	cnn	-/-	-/-
7	20817	Waveguide Rectangular Horn Antenna	Waveguide Rectangular Horn Antenna SAR-2309-22- S2	ERAVANT / Torrance	13254-01	chk	16.10.2024	20.10.2026
8	20836	Amplifier	1-18 GHz Amplifier	Wright Technologies, Inc., Inc. / Roseville	0001	chk	18.10.2024	18.10.2026
9	20912	Low noise Amplifier Module 0.5-4GHz	Low noise Amplifier Module 0.5-4GHz	RF-Lambda Europe GmbH / Rüsselsheim	19041200083	cpu	18.10.2024	18.10.2025
10	20913	Phase Amplitude Stable Cable Assembly	Phase Amplitude Stable Cable Assembly DC-40GHz	RF-Lambda Europe GmbH	AC19040001	cnn	-/-	-/-
11	25457	DRG Horn Antenna	DRG Horn Antenna SAS-574	A.H. Systems, Inc. / Chatsworth	383	cal	28.03.2022	28.03.2025

7.4 Radiated measurements > 18 GHz



7.5 Radiated measurements > 50/85 GHz



Measurement distance: horn antenna e.g. 75 cm

$$FS = UR + CA + AF$$

(FS-field strength; UR-voltage at the receiver; CA-loss signal path & distance correction; AF-antenna factor)

Example calculation:

$$FS \text{ [dB}\mu\text{V/m]} = 40.0 \text{ [dB}\mu\text{V/m]} + (-60.1) \text{ [dB]} + 36.74 \text{ [dB/m]} = 16.64 \text{ [dB}\mu\text{V/m]} \text{ (} 6.79 \text{ }\mu\text{V/m)}$$

$$OP = AV + D - G + CA$$

(OP-radiated output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain+amplifier gain; CA-loss signal path)

Example calculation:

$$OP \text{ [dBm]} = -59.0 \text{ [dBm]} + 44.0 \text{ [dB]} - 20.0 \text{ [dBi]} + 5.0 \text{ [dB]} = -30 \text{ [dBm]} \text{ (} 1 \text{ }\mu\text{W)}$$

Note: conversion loss of mixer is already included in analyzer value.

7.5.1 Equipment table

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	Kind of Calibration	Last Calibration	Next Calibration
1	20133	Double-Ridged Waveguide Horn Antenna	Double-Ridged Waveguide Horn Antenna 3115 (Meas 1)	EMCO Elektronik GmbH / Gilching	9012-3629	cal	22.05.2023	22.05.2026
2	20354	DC - Power Supply 40A	DC - Power Supply 40A NGPE 40/40		448	cpu	05.03.2008	-/-
3	20412	Fully Anechoic Chamber	Fully Anechoic Chamber 2	ETS-Lindgren GmbH / Taufkirchen	without	chk	15.03.2024	15.03.2025
4	20729	Harmonic Mixer	FS-Z140	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101004	cal	16.06.2023	16.06.2026
5	20730	Harmonic Mixer	FS-Z110	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101468	cal	02.06.2023	02.06.2026
6	20731	Harmonic Mixer	FS-Z75	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101022	cal	18.05.2022	18.05.2025
7	20732	Signal- and Spectrum Analyzer	Signal- and Spectrum Analyzer FSW67	Rohde & Schwarz Messgerätebau GmbH / Memmingen	104023	cal	30.07.2024	30.07.2025
8	20733	Harmonic Mixer	Harmonic Mixer FS-Z220	RPG-Radiometer Physics GmbH / Meckenheim	101009	cal	24.05.2024	24.05.2027
9	20734	Harmonic Mixer	Harmonic Mixer FS-Z325	RPG-Radiometer Physics GmbH / Meckenheim	101005	cal	24.05.2024	24.05.2027
10	20765	Pickett-Potter Horn Antenna	Pickett-Potter Horn Antenna FH-PP 40-60	RPG-Radiometer Physics GmbH / Meckenheim	010001	chk	16.10.2024	16.10.2026
11	20767	Pickett-Potter Horn Antenna	Pickett-Potter Horn Antenna FH-PP 140-220	RPG-Radiometer Physics GmbH / Meckenheim	010011	chk	09.10.2024	09.10.2026
12	20811	Horn Antenna	Horn Antenna ASY-SGH-124-SMA	Antenna Systems Solutions S.L / Santander	29F14182337	cal	08.10.2024	08.10.2027
13	20813	Pickett-Potter Horn Antenna	Pickett-Potter Horn Antenna FH-PP 075	RPG-Radiometer Physics GmbH / Meckenheim	10006	chk	16.10.2024	16.10.2026
14	20814	Pickett-Potter Horn Antenna	Pickett-Potter Horn Antenna FH-PP 140	RPG-Radiometer Physics GmbH / Meckenheim	10008	chk	09.10.2024	09.10.2026
15	20815	Pickett-Potter Horn Antenna	Pickett-Potter Horn Antenna FH-PP 110	RPG-Radiometer Physics GmbH / Meckenheim	10014	chk	22.03.2024	22.03.2026
16	20817	Waveguide Rectangular Horn Antenna	Waveguide Rectangular Horn Antenna SAR-2309-22-S2	ERAVANT / Torrance	13254-01	chk	16.10.2024	16.10.2026
17	20836	Amplifier	1-18 GHz Amplifier	Wright Technologies, Inc., Inc. / Roseville	0001	chk	18.10.2024	18.10.2026
18	20912	Low noise Amplifier Module 0.5-4GHz	Low noise Amplifier Module 0.5-4GHz	RF-Lambda Europe GmbH / Rüsselsheim	19041200083	cpu	18.10.2024	18.10.2025
19	20913	Phase Amplitude Stable Cable Assembly	Phase Amplitude Stable Cable Assembly DC-40GHz	RF-Lambda Europe GmbH	AC19040001	cnn	-/-	-/-
20	25457	DRG Horn Antenna	DRG Horn Antenna SAS-574	A.H. Systems, Inc. / Chatsworth	383	cal	28.03.2022	28.03.2025

8 Sequence of testing

8.1 Sequence of testing radiated spurious 9 kHz to 30 MHz

Setup

Note: Check Chapter 7.1

Premeasurement*

Note: Check Chapter 7.1

Final measurement

Note: Check Chapter 7.1

*)Note: The sequence will be repeated two times with different EUT orientations.

8.2 Sequence of testing radiated spurious 30 MHz to 1 GHz

Setup

Note: Check Chapter 7.2

Premeasurement

Note: Check Chapter 7.2

Final measurement

Note: Check Chapter 7.2

8.3 Sequence of testing radiated spurious 1 GHz to 18 GHz

Setup

Note: Check Chapter 7.3

Premeasurement

Note: Check Chapter 7.3

Final measurement

Note: Check Chapter 7.3

8.4 Sequence of testing radiated spurious above 18 GHz up to 50 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The DC power port of the EUT is connected to a power outlet.
- The measurement distance is specified in chapter 10.
- The EUT is set into operation.

Premeasurement

- The test antenna is handheld and moved carefully over the EUT to cover the EUT's whole sphere and different polarizations of the antenna.

Final measurement

- The final measurement is performed at the position and antenna orientation causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement and the limit is stored.

8.5 Sequence of testing radiated spurious above 50 GHz with external mixers

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The DC power port of the EUT is connected to a power outlet.
- The measurement distance is specified in chapter 10.
- The EUT is set into operation.

Premeasurement

- The test antenna with external mixer is handheld and moved carefully over the EUT to cover the EUT's whole sphere and different polarizations of the antenna.
- Caution is taken to reduce the possible overloading of the external mixer.

Final measurement

- The final measurement is performed at the position and antenna orientation causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- As external mixers may generate false images care is taken to ensure that any emission measured by the spectrum analyzer does indeed originate in the EUT. Signal identification feature of spectrum analyzer is used to eliminate false mixer images (i.e., it is not the fundamental emission or a harmonic falling precisely at the measured frequency).
- Final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement and the limit is stored.

9 Measurement uncertainty

The reported uncertainties are calculated based on the standard uncertainty multiplied with the appropriate coverage factor k, such that a confidence level of approximately 95% is achieved. For uncertainty determination, each component used in the concrete measurement set-up was taken in account and its contribution to the overall uncertainty according its statistical distribution calculated.

Issue No.	Measurement type	Reference	Frequency range of measurement		Calculated Uncertainty based on confidence level of 95.54%	Remarks
			Start [MHz]	Stop [MHz]		
1	Magnetic Field Strength	EN ,FCC, JP, IC	0.009	30	4.86	Magnetic loop antenna, Pre-Amp on
2	RF-Output Power (EIRP) Unwanted emissions (EIRP) [dB]	EN, FCC, JP, IC	30	100	4.57	without Pre-Amp
			30	100	4.91	with Pre-Amp
			100	1000	4.02	without Pre-Amp
			100	1000	4.26	with Pre-Amp
			1000	18000	4.36	without Pre-Amp
			1000	18000	5.23	with Pre-Amp
			18000	33000	4.92	Schwarzbeck BBHA9170 (#20302) Antenna set-up non-waveguide antenna)
			33000	50000	4.17	Set-up for Q-Band (WR-22), non-wave guide antenna
			40000	60000	4.69	Set-up U-Band (WR-19), non-waveguide antenna
			50000	75000	4.06	External Mixer set-up V-Band (WR-15)
			75000	110000	4.17	External Mixer set-up W-Band (WR-6)
			90000	140000	5.49	External Mixer set-up F-Band (WR-8)
			140000	225000	6.22	External Mixer set-up G-Band (WR-5)
			225000	325000	7.04	External Mixer set-up (WR-3)
			325000	500000	8.84	External Mixer set-up (WR-2.2)
3	Radiated Blocking [dB]	EN	1000	18000	2.85	Typical set-up with microwave generator and antenna, value for 7 GHz calculated
			18000	33000	4.66	Typical set-up with microwave generator and antenna
			33000	50000	3.48	WR-22 set-up
			50000	75000	3.73	WR-15 set-up
			75000	110000	4.26	WR-6 set-up
4	Frequency Error / UWB+FMCW [kHz]	EN, FCC, JP, ISED	40000	77000	276.19	calculated for 77 GHz (FMCW) carrier
	Frequency Error / NFC [Hz]	EN, FCC, JP, ISED	6000	7000	33.92	calculated for 6.5 GHz UWB Ch.5
			11.00	14.00	20.76	calculated for 13.56 MHz NFC carrier
5	TS 8997 Conducted Parameters	FCC15/18 / ISED	30	6000	1.11	1. Power measurement with Fast-sampling-detector
			30	6000	1.20	2. Power measurement with Spectrum-Analyzer
			30	6000	1.20	3. Power Spectrum-Density measurement
			30	7500	1.20	4. Conducted Spurious emissions
			0.009	30	2.56	5. Conducted Spurious emissions
			2.4	2.48	1.95 ppm	6a. Bandwidth / 2-Marker Method for 2.4 GHz ISM
			5.18	5.825	7.180 ppm	6b. Bandwidth / 2-Marker Method for 5 GHz WLAN
			5.18	5.825	1.099 ppm	7. Frequency (Marker method) for 5 GHz WLAN
			30	6000	0.11561 µs	8. Medium-Utilization factor / Timing
			30	6000	1.85	9a. Blocking-Level of companion device
			30	6000	1.62	9b. Blocking Generator level
6	Conducted Emissions	EN, FCC	0.009	30	3.57	general EMI-measurements on AC/DC ports

10 Far field consideration for measurements above 18 GHz

Far field distance calculation:

$$D_{ff} = 2 \times D^2 / \lambda$$

with

D_{ff} Far field distance
 D Antenna dimension
 λ wavelength

Spurious emission measurements:

Antenna frequency range in GHz	Highest measured frequency in GHz	D in m	λ in m	D_{ff} in m
18 – 40	40	0.0450	0.00749481	0.54
40-55	55	0.0384	0.005450772	0.54
55-75	73.5	0.03072	0.004078810	0.46
55-75	74.5	0.03072	0.004024060	0.47
55-75	75	0.03072	0.003997233	0.47
75-110	76	0.020757	0.003944640	0.22
75-110	78.5	0.020757	0.003819010	0.23
75-110	79.5	0.020757	0.003770974	0.23
75-110	81	0.020757	0.003701141	0.23
75-110	90	0.020757	0.003331027	0.26
75-110	98	0.020757	0.003059107	0.28
75-110	110	0.020757	0.002725386	0.32
90-140	122	0.016696	0.002457315	0.23
90-140	130	0.016696	0.002306100	0.24
140-220	220	0.010700	0.001362693	0.17
220-325	250	0.007050	0.001199170	0.08

Measurement distance used during measurements:

Measurement frequency range, [GHz]:	Measurement distance, [m]	Boundary for near/far field, [m]
18 - 40	1	0.54
40 - 50	1.5	0.49
50 - 55	1	0.54
55 - 65	0.5	0.41
65 - 75	0.5	0.47
75 - 95	0.5	0.27
95 - 110	0.5	0.32
110 - 120	0.5	0.22
120 - 140	0.5	0.26
140 - 150	0.5	0.11
150 - 160	0.5	0.12
160 - 170	0.5	0.13
170 - 180	0.5	0.14
180 - 190	0.17	0.15
190 - 200	0.17	0.15
200 - 220	0.17	0.17
220 - 243	0.17	0.08

11 Summary of measurement results

11.1 Summary

☒	No deviations from the technical specifications were ascertained
☐	There were deviations from the technical specifications ascertained
☐	This test report is only a partial test report. The content and verdict of the performed test cases are listed below.

TC Identifier	Description	Verdict	Date	Remark
RF-Testing	47 CFR Part 95 Subpart M	see below	2025-02-14	-/-

Test specification clause	Test case	Temperature conditions	Power source voltages	Pass	Fail	NA	NP	Remark
§2.1046 §95.3367 (a) / (b)	Radiated power	Nominal	Nominal	☒	☐	☐	☐	complies
§2.1047	Modulation characteristics	-/-	-/-	☐	☐	☐	☒	Provided by customer, see chapter 12.2
§2.1049	Occupied bandwidth (99% bandwidth)	Nominal	Nominal	☒	☐	☐	☐	complies
§2.1051	Spurious emissions at antenna terminals	Nominal	Nominal	☐	☐	☒	☐	see note 2, DUT has integral antenna
§2.1053 §95.3379 (a)(1) §95.3379 (a)(2) §95.3379 (a)(3)	Unwanted emissions (radiated spurious)	Nominal	Nominal	☒	☐	☐	☐	complies
§2.1055 §95.3379 (b)	Frequency stability	Nominal and Extreme	Nominal and Extreme	☒	☐	☐	☐	complies

Note:

- 1) C = Compliant; NC = Not compliant; NA = Not applicable; NP = Not performed
- 2) ANSI C63.26-2015, chapter 5.5.1:
 "...many contemporary portable transmitters utilize integral antennas, precluding access to an antenna output port from which to perform conducted compliance measurements. For these types of transmitters, all of the data necessary to demonstrate compliance must be measured in a radiated test configuration..."

11.2 Additional comments

Reference documents: None

Special test descriptions: AWRI1422_ Manual Switch-Cable Certification.docx

Configuration descriptions: None

12 Measurement results

12.1 Radiated power

Description:

§95.3367:

The fundamental radiated emission limits within the 76-81 GHz band are expressed in terms of Equivalent Isotropically Radiated Power (EIRP) and are as shown below.

Limits:

FCC §95.3367 (a) (b)

Frequency	Limit (eirp)
76.0 - 81.0 GHz	50 dBm/MHz (Average)
76.0 - 81.0 GHz	55 dBm/MHz (PEAK)

Measurement: Average Power

Measurement parameter	
Detector:	RMS
Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Trace-Mode:	Max Hold

Measurement: Peak Power

Measurement parameter	
Detector:	Pos-Peak
Resolution bandwidth:	50 MHz
Video bandwidth:	80 MHz
Trace-Mode:	Max Hold

Note: KDB 653005 4.(c)(1)

Peak power measurements of swept frequency radar implementations (e.g., high sweep rate FMCW) may require a desensitization correction factor to be applied to the measurement results.

Consequence:

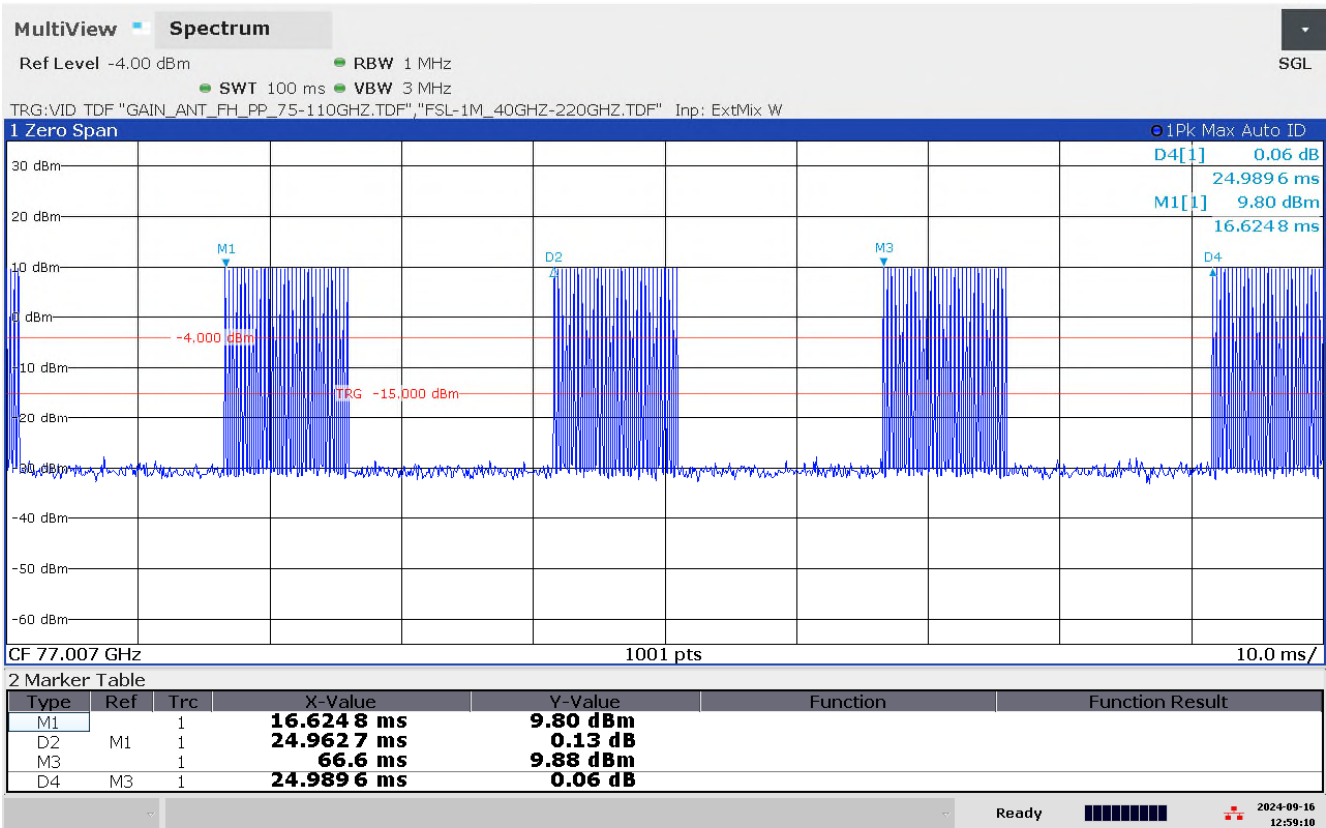
Worst case measurement, the peak power measurement is performed with a greater resolution bandwidth to solve the problem with the desensitization.

Measurement results:

EUT	Mode	Test condition	Radiated peak power (eirp)	Radiated Mean Power (eirp)
1	1	T_{nom} / V_{nom}	13.86	4.07

Verdict: Complies

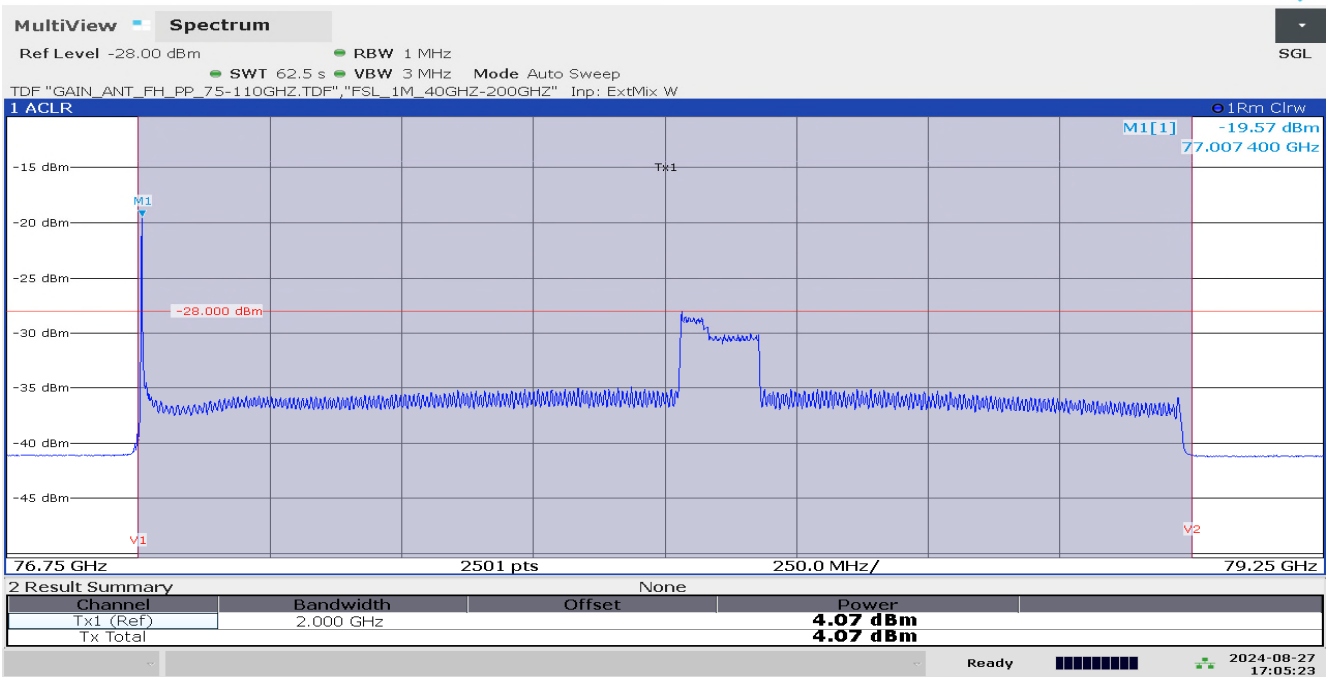
TID100_23-1-0144001T007_EUT_Cycle_Time_AnthH_25ms



12:59:10 PM 09/16/2024

Note: EUT Cycle time has been verified according to customer declaration, EUT cycle Time = 25 ms.

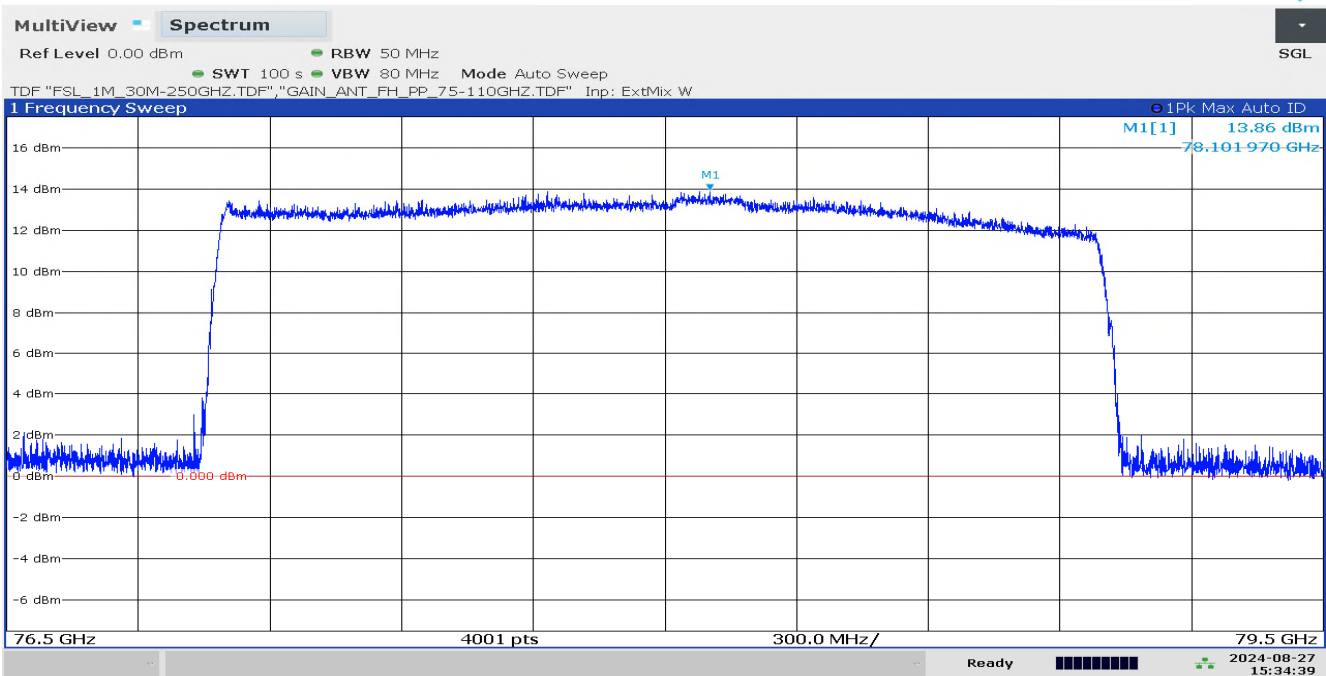
TID113_02_23-1-0144001T007_Mean_Power_AntH_single_sweep



05:05:23 08/27/2024

Note:

TID106_23-1-0144001T007_Peak_Power_AntH_RBW_50MHz_auto_id

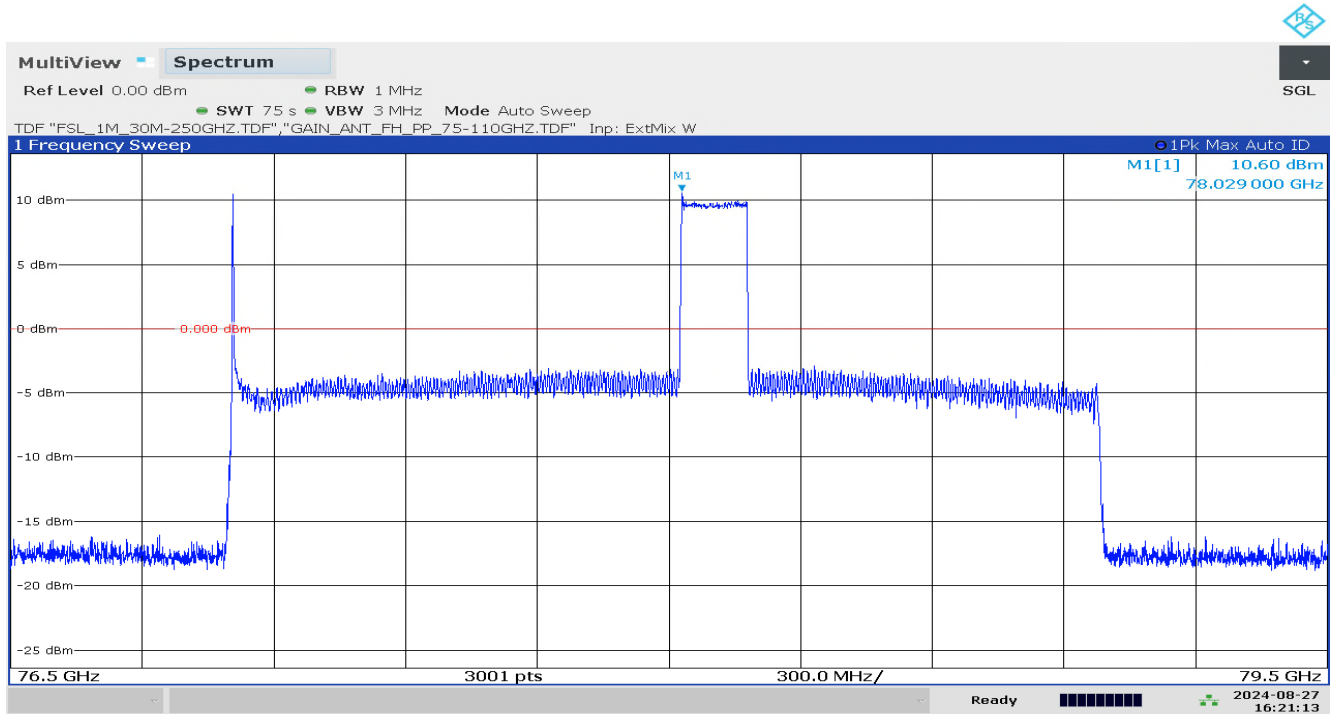


03:34:39 08/27/2024

Note: Antenna Polarization Horizontal,
RBW 50 MHz has been used to avoid desensitization factor. Maximum Peak EIRP = 13.86 dBm

Note: Different RBW are used to avoid desensitization factor and to get a stable Peak EIRP, TID106 is the Final test result but the below TIDs are only for information,

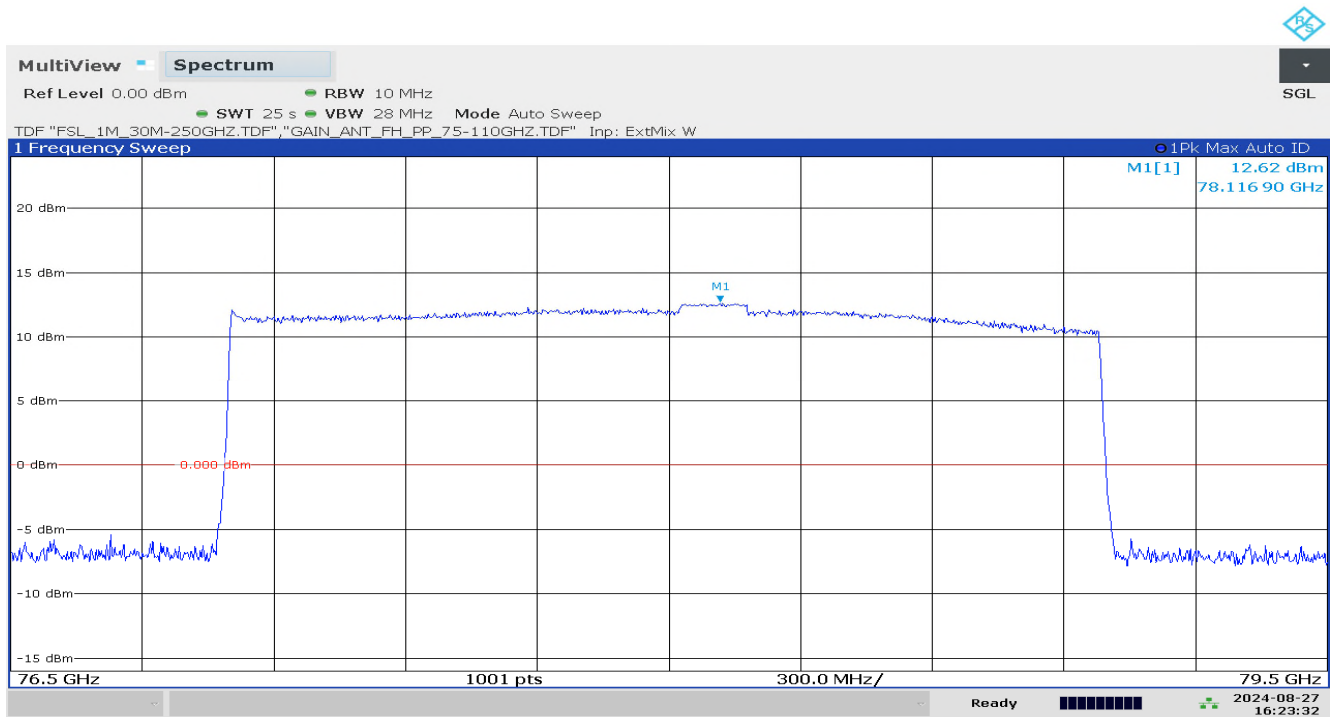
TID101_23-1-0144001T007_Peak_Power_AntH_RBW_1MHz



04:21:13 08/27/2024

Note: Only for information, for final result check TID106.

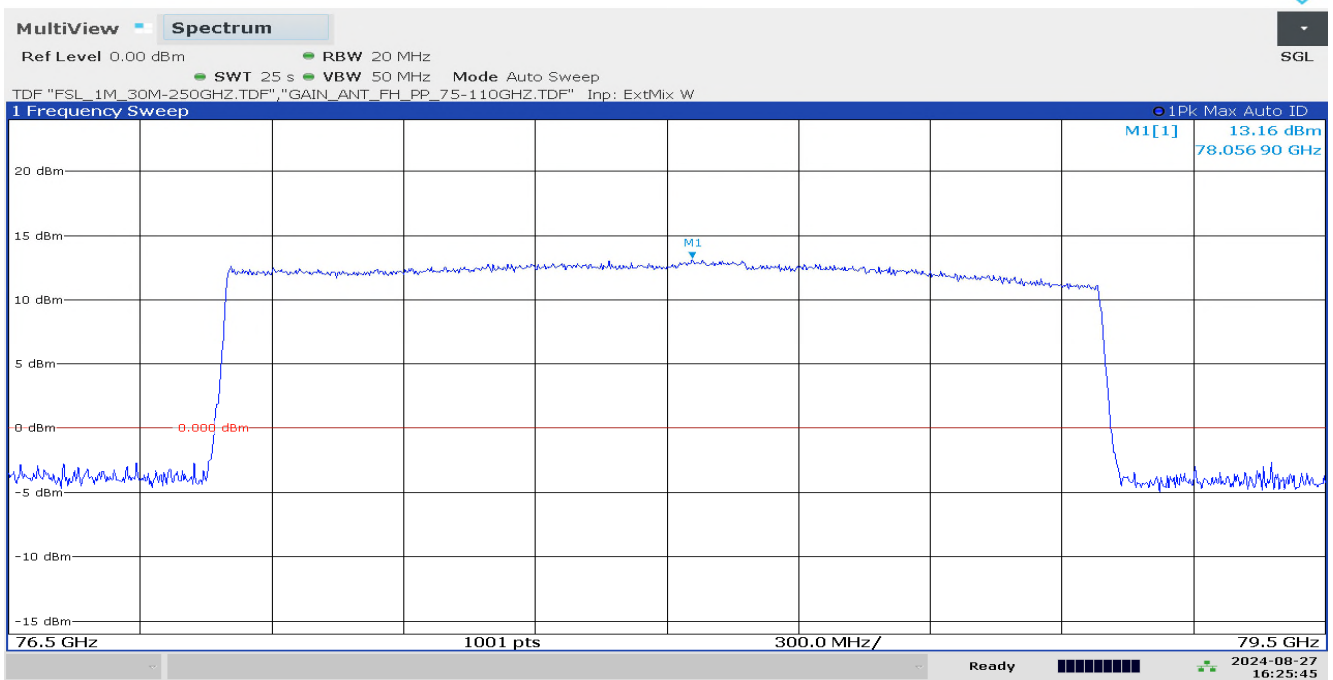
TID102_23-1-0144001T007_Peak_Power_AntH_RBW_10MHz



04:23:32 08/27/2024

Note: Only for information, for final result check TID106.

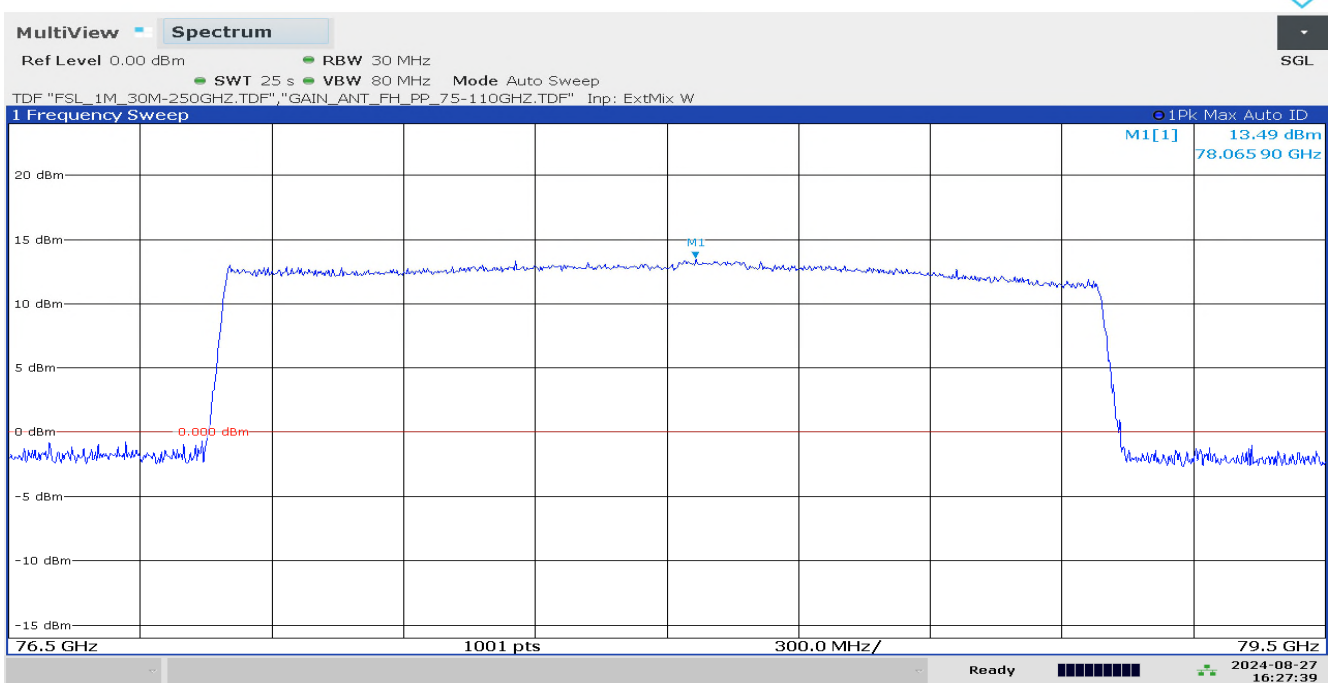
TID103_23-1-0144001T007_Peak_Power_AntH_RBW_20MHz



04:25:45 08/27/2024

Note: Only for information, for final result check TID106.

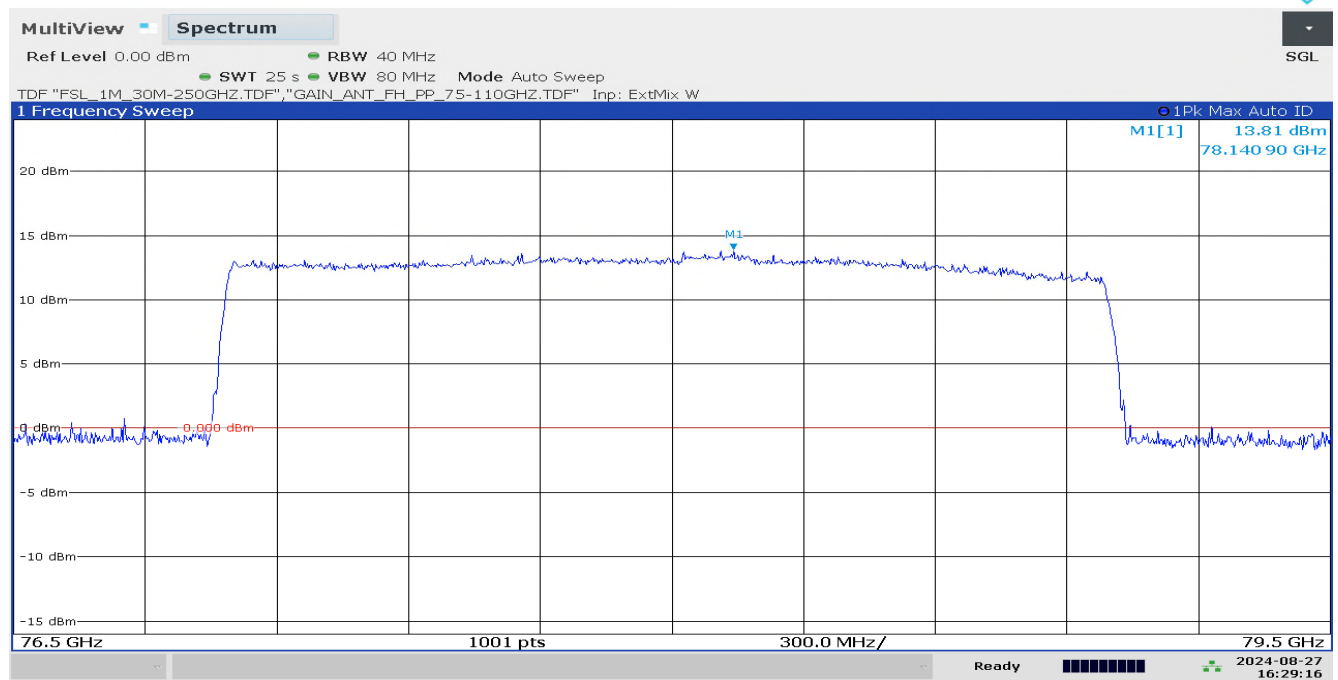
TID104_23-1-0144001T007_Peak_Power_AntH_RBW_30MHz



04:27:39 08/27/2024

Note: Only for information, for final result check TID106.

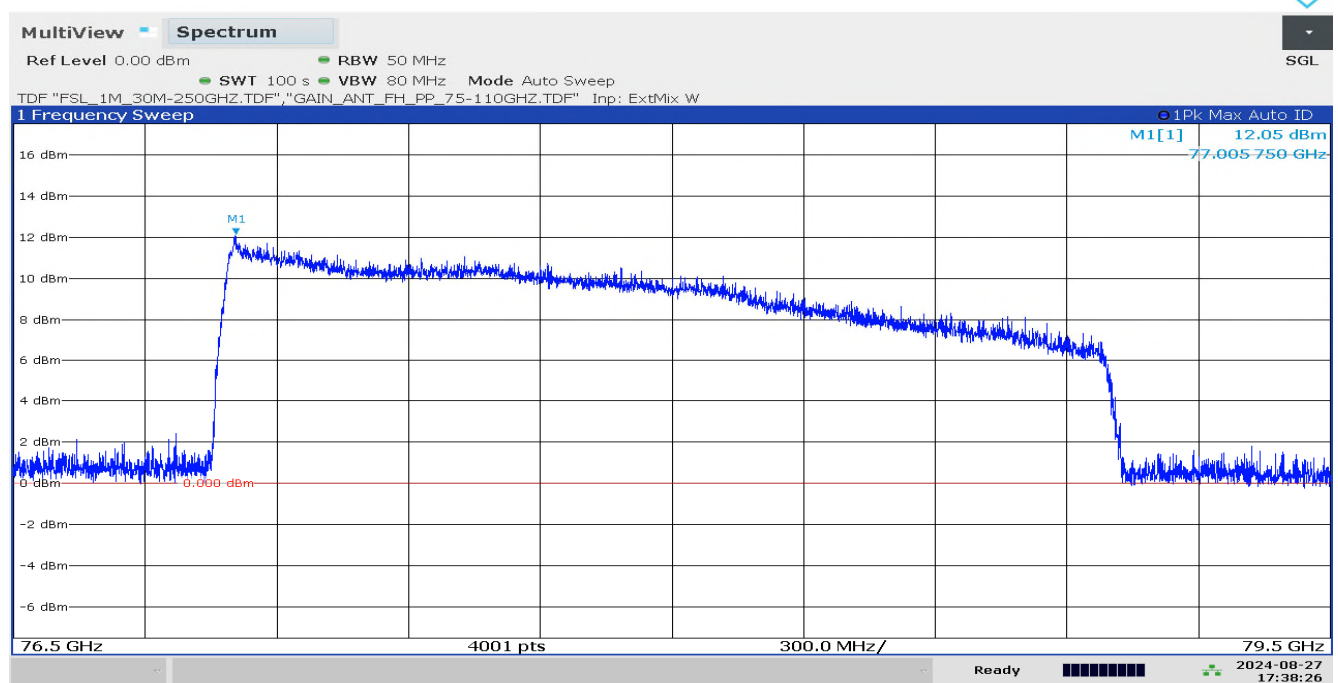
TID105_23-1-0144001T007_Peak_Power_AntH_RBW_40MHz



04:29:17 08/27/2024

Note: Only for information, for final result check TID106.

TID108_03_23-1-0144001T007_Peak_Power_AntV_RBW_50MHz_auto_id



05:38:27 08/27/2024

Note: Antenna polarization Vertical.

Only for information, for final result check TID106.

12.2 Modulation characteristics

Description:

§2.1047 (d) *Other types of equipment.* A curve or equivalent data which shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed.

KDB 653005 D01 76-81 GHz Radars v01r02, section 3 (g)

Concerning the Section 2.1047 modulation characteristics requirement, the following information should be provided:

- 1) Pulsed radar: pulse width and pulse repetition frequency (if PRF is variable, then report maximum and minimum values).
- 2) Non-pulsed radar (e.g., FMCW): modulation type (i.e., sawtooth, sinusoid, triangle, or square wave) and sweep characteristics (sweep bandwidth, sweep rate, sweep time).

Information from manufacturer on modulation characteristics:

Modulation Type	FMCW
Modulation characteristics:	
Sweep bandwidth	➤ Sweep bandwidth = 1989.9MHz ➤ Sweep rate = 111.79 MHz/us ➤ Sweep time = 17.8us
Sweep rate	
Sweep time	

12.3 Occupied bandwidth

Description:

§2.1049 The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission.

Limits:

FCC	IC
FCC §95.3379 (b)	RSS-251 chapter 7.2:
The occupied bandwidth from intentional radiators operated within the specified frequency band shall comply with the following:	
Frequency range	
76 GHz – 81 GHz	

Measurement:

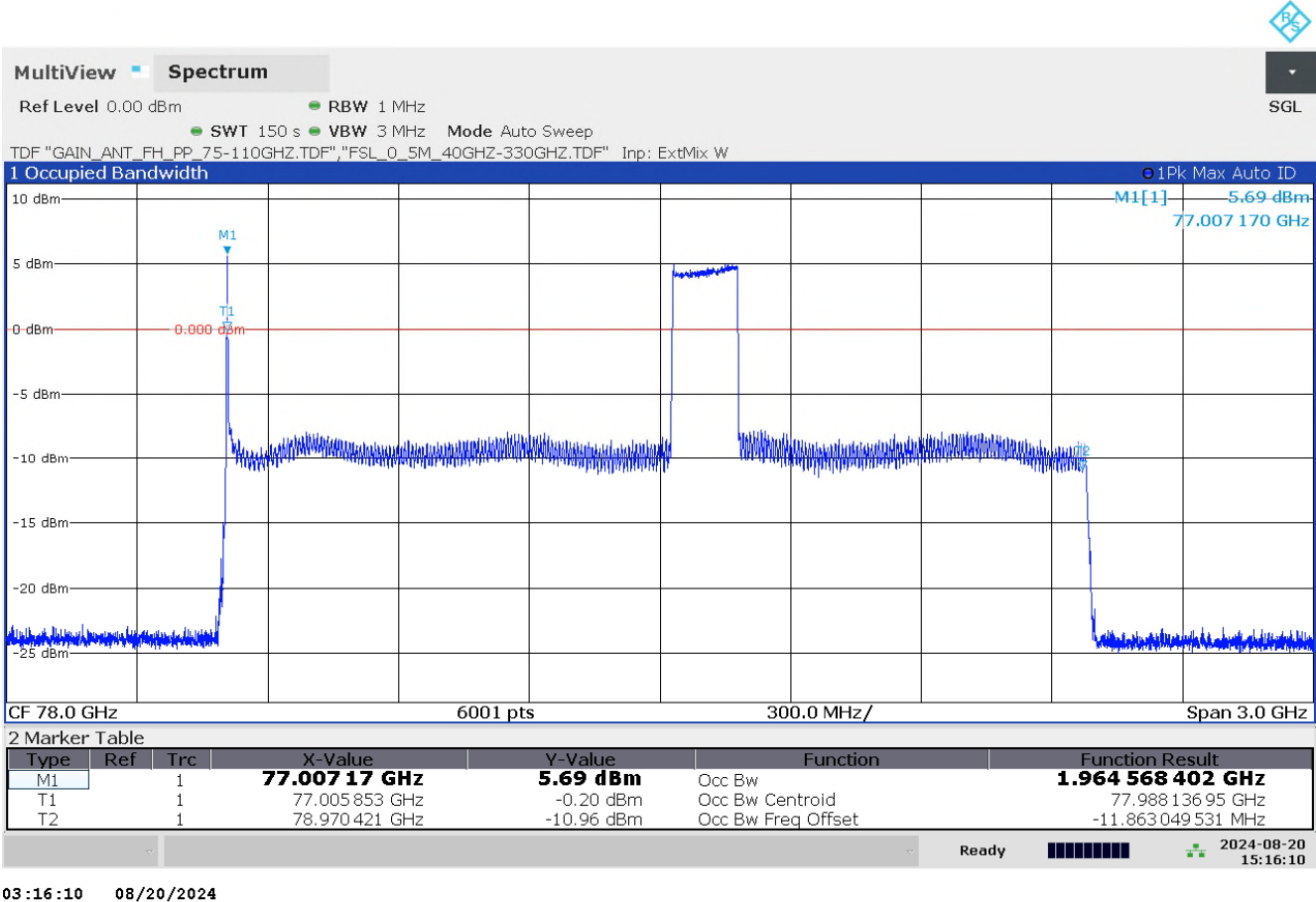
Parameters	
Detector:	Pos-Peak
Resolution bandwidth:	50 MHz
Video bandwidth:	80 MHz
Trace-Mode:	Max Hold

Results:

EUT	TEST CONDITIONS	f_L in GHz	f_H in GHz	Occupied Bandwidth (99%) in GHz	Plot
EUT 1	T_{nom} / V_{nom}	77.005853	78.970421	1.964568	TID111

Verdict: Complies

Plot:
TID111_23-1-0144001T007_99%OBW_AntH_Peak_RBW_1MHz



03:16:10 08/20/2024

12.4 Band edge compliance

Description:

Investigation of the emission limits at the band edge.

Limits:

FCC §95.3379 (a) (2) (i) + (ii) / ANSI C63.10-2020 / 6.10

Frequency Range [GHz]	Measurement distance	Power Density
40 – 76 and 81 – 200	3.0 m	600 pW/cm ² → -1.7 dBm

FCC §95.3367 (a) (b)

Frequency Range [GHz]	Power Density
76 - 81	50 dBm/MHz (e.i.r.p)

Measurement:

Parameters	
Detector:	RMS
Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Trace-Mode:	Max Hold

Measurement results:

- Results are part of chapter 12.5

Verdict: **Complies**

12.5 Unwanted emissions

Description:

Measurement of the radiated unwanted emissions.

Limits:

FCC §95.3379

(a) The power density of any emissions outside the 76-81 GHz band shall consist solely of spurious emissions and shall not exceed the following:

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

FCC		
CFR Part 95.3379 (a) (1) / CFR Part 95.3379 (a) (3)		
Radiated unwanted emissions		
Frequency (MHz)	Field Strength (μV/m)	Measurement distance (m)
0.009 – 0.490	2400/F[kHz]	300
0.490 – 1.705	24000/F[kHz]	30
1.705 – 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
960 – 40 000	500	3

- (i) In the emissions table in paragraph (a)(1) of this section, the tighter limit applies at the band edges.
 - (ii) The limits in the table in paragraph (a)(1) of this section are based on the frequency of the unwanted emissions and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
 - (iii) The emissions limits shown in the table in paragraph (a)(1) of this section are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9.0-90.0 kHz, 110.0-490.0 kHz, and above 1000 MHz. Radiated emissions limits in these three bands are based on measurements employing an average detector with a 1 MHz RBW
- (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/cm² at a distance of 3 meters from the exterior surface of the radiating structure.

- (ii) For radiated emissions above 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 1000 pW/cm² at a distance of 3 meters from the exterior surface of the radiating structure.

Frequency Range (GHz)	Power Density	EIRP
40 – 200	600 pW/cm ² @ 3m	-1.7 dBm
200 – 231	1000 pW/cm ² @ 3m	+0.5 dBm

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

Limit conversion (ANSI C63.10-2020 9.2.3):

$$\text{EIRP[dBm]} = 10 \times \log(4 \times \pi \times d^2 \times \text{PD[W/m}^2])$$

- Power density at the distance specified by the limit: PD [W/m²]
- Equivalent isotropically radiated power: EIRP [dBm]
- Distance at which the power density limit is specified: d [m]

According to this formula, an emission limit of PD = 600 pW/cm² at a distance of d = 3 m corresponds to an equivalent isotropically radiated power of EIRP = -1.7 dBm.

Measurement:

Measurement parameter	
Detector:	Quasi Peak / Pos-Peak / LinAV / RMS
Resolution bandwidth:	F < 1 GHz: 100 kHz F > 1 GHz: 1 MHz
Video bandwidth:	F < 1 GHz: 300 kHz F > 1 GHz: 3 MHz
Trace-Mode:	Max Hold

Measurement results:

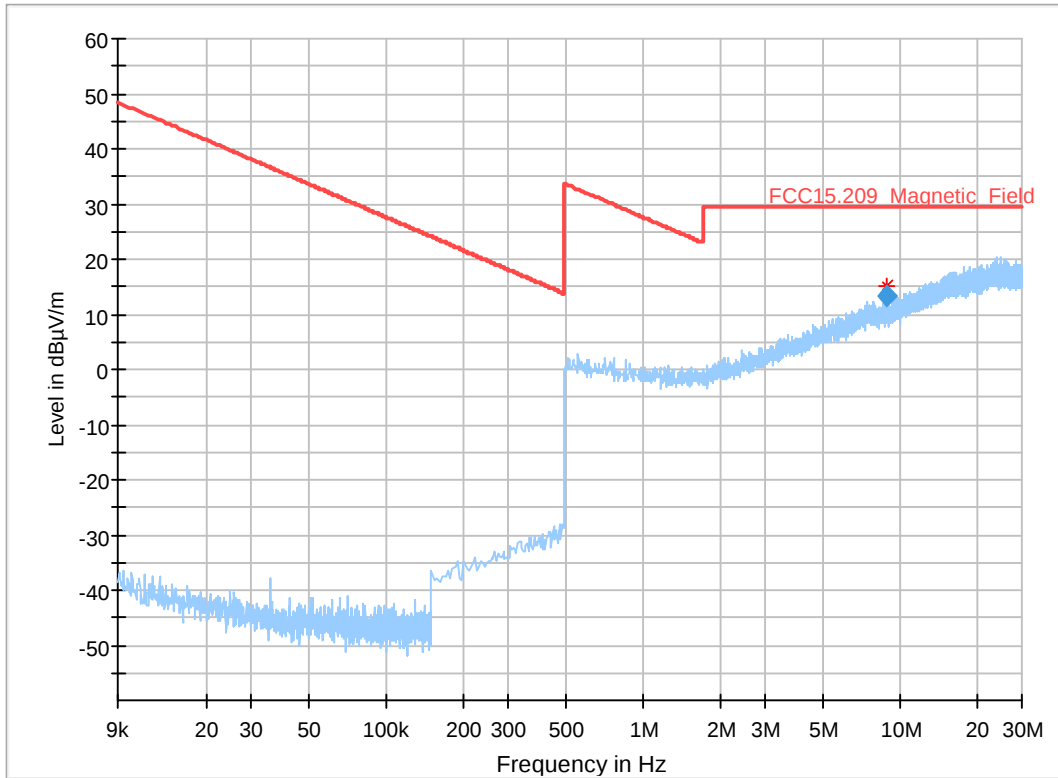
Frequency [GHz]	Detector	Bandwidth [MHz]	Level	Limit	Margin [dB]
0.000009 - 0.03	Max Peak	0.009	13.32 dBμV	29.54 dBμV	16.22
0.03 - 1	Quasi Peak	0.12	41.31 dBμV	46 dBμV	4.69
1 - 12.4	Max Peak LinAV	1	61.87 dBμV 46.98 dBμV	74 dBμV 54 dBμV	12.13 7.02
12.4 - 18	Max Peak LinAV	1	57.65 dBμV 51.60 dBμV	74 dBμV 54 dBμV	16.35 2.40
18 - 40	Max Peak LinAV	1	63.41 dBμV 48.10 dBμV	74 dBμV 54 dBμV	10.59 5.90
40 - 50	RMS	1	*No critical Emission found	-1.7 dBm	Only noise level
50 - 55	RMS	1	*No critical Emission found	-1.7 dBm	Only noise level
55 - 65	RMS	1	*No critical Emission found	-1.7 dBm	Only noise level
65 - 75	RMS	1	*No critical Emission found	-1.7 dBm	Only noise level
75 - 95	RMS	1	*No critical Emission found	-1.7 dBm	Only noise level
95 - 110	RMS	1	*No critical Emission found	-1.7 dBm	Only noise level
110 - 120	RMS	1	*No critical Emission found	-1.7 dBm	Only noise level
120 - 140	RMS	1	*No critical Emission found	-1.7 dBm	Only noise level
140 - 150	RMS	1	*No critical Emission found	-1.7 dBm	Only noise level
150 - 160	RMS	1	*No critical Emission found	-1.7 dBm	Only noise level
160 - 170	RMS	1	*No critical Emission found	-1.7 dBm	Only noise level
170 - 180	RMS	1	*No critical Emission found	-1.7 dBm	Only noise level
180 - 190	RMS	1	*No critical Emission found	-1.7 dBm	Only noise level
190 - 200	RMS	1	*No critical Emission found	-1.7 dBm	Only noise level
200 - 220	RMS	1	*No critical Emission found	0.5 dBm	Only noise level
220 - 243	RMS	1	*No critical Emission found	0.5 dBm	Only noise level
Please refer to the following plots for more information on the level of spurious emissions					

Note: *No critical Emission found = more than 20 dB from Limit line has considered as no critical emission.
Only worst-case result stated in this Table.

Verdict: Complies

TID117_RSE_MgField_S12_9kHz-30MHz

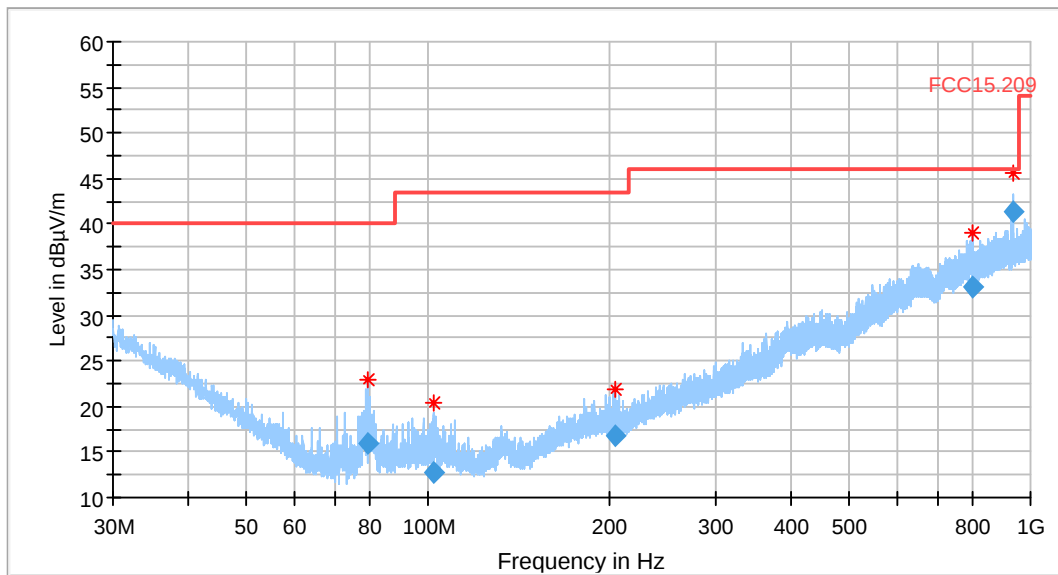
Full Spectrum



Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
8.870000	13.32	29.54	16.22	9.000	H	216.0	-5.7	18:19:05 - 23.08.2024

TID118_RSE_E-Field_S12_30-1GHz



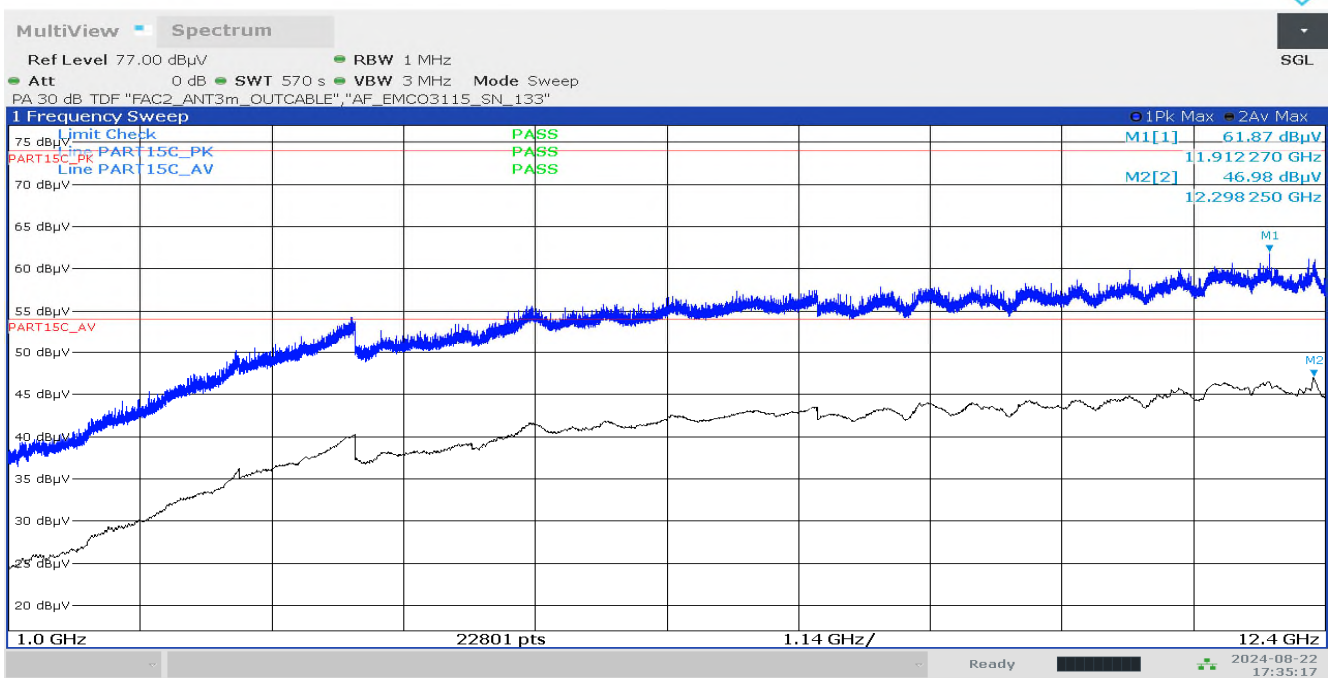
Final_Result

Frequency (MHz)	Quasi Peak (dBµV /m)	Limit (dBµV /m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Sig Path (dB)
79.723000	15.99	40.00	24.01	120.000	137.0	V	60.0	6.9	0.0
101.843000	12.66	43.50	30.84	120.000	121.0	V	252.0	7.7	0.0
204.315000	16.78	43.50	26.72	120.000	109.0	V	70.0	11.1	0.0
798.635000	33.08	46.00	12.92	120.000	163.0	H	92.0	25.5	0.0
934.805000	41.31	46.00	4.69	120.000	264.0	V	0.0	27.1	0.0

(continuation of the "Final_Result" table from column 17 ...)

Frequency (MHz)	Preamp (dB)	Trd Corr. (dB/m)	Raw Rec (dBµV)	Comment
79.723000	0.9	6.0	9.1	19:17:17 - 23.08.2024
101.843000	0.9	6.8	4.9	19:22:16 - 23.08.2024
204.315000	1.4	9.7	5.7	19:12:41 - 23.08.2024
798.635000	3.1	22.4	7.6	19:07:47 - 23.08.2024
934.805000	3.4	23.7	14.2	19:27:26 - 23.08.2024

TID119a_RSE_TX_S12_1-12.4GHz_AntH

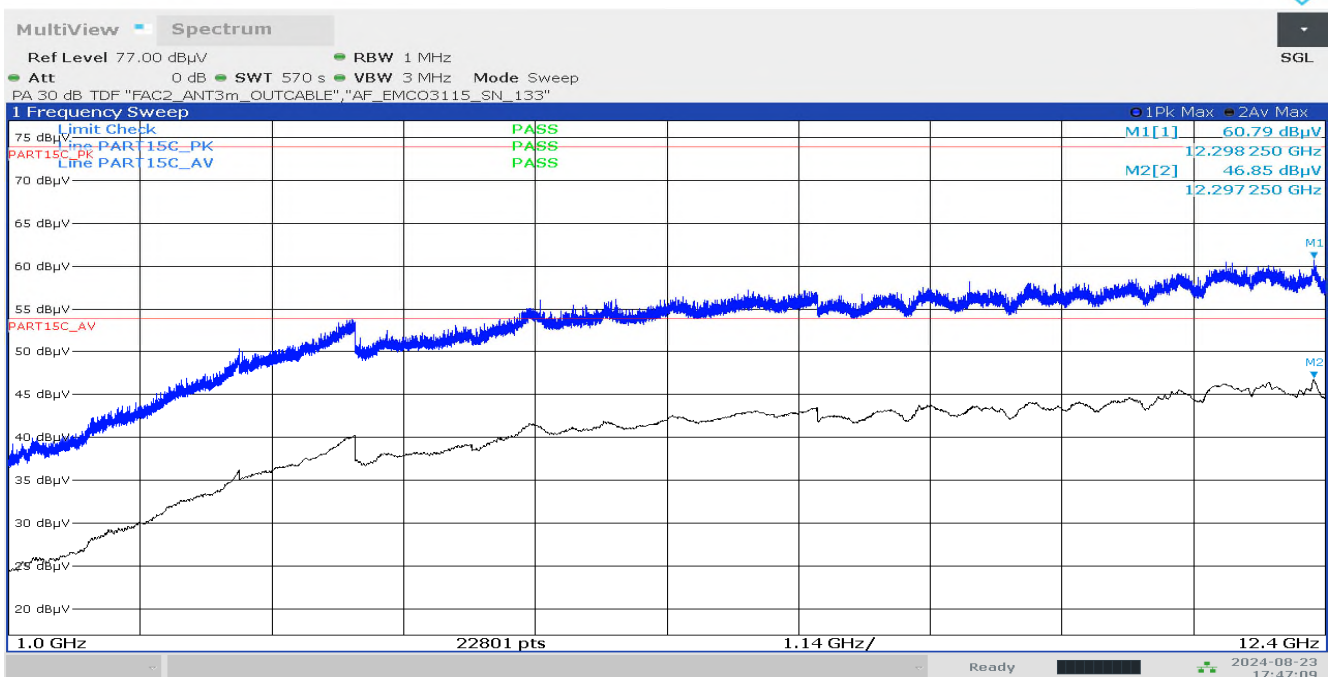


05:35:17 08/22/2024

Note:

Limit Line: Peak: 74 dBμV, Average: 54 dBμV,
Result: Peak: Pass, Average: Pass.

TID119b_RSE_TX_S12_1-12.4GHz_AntV

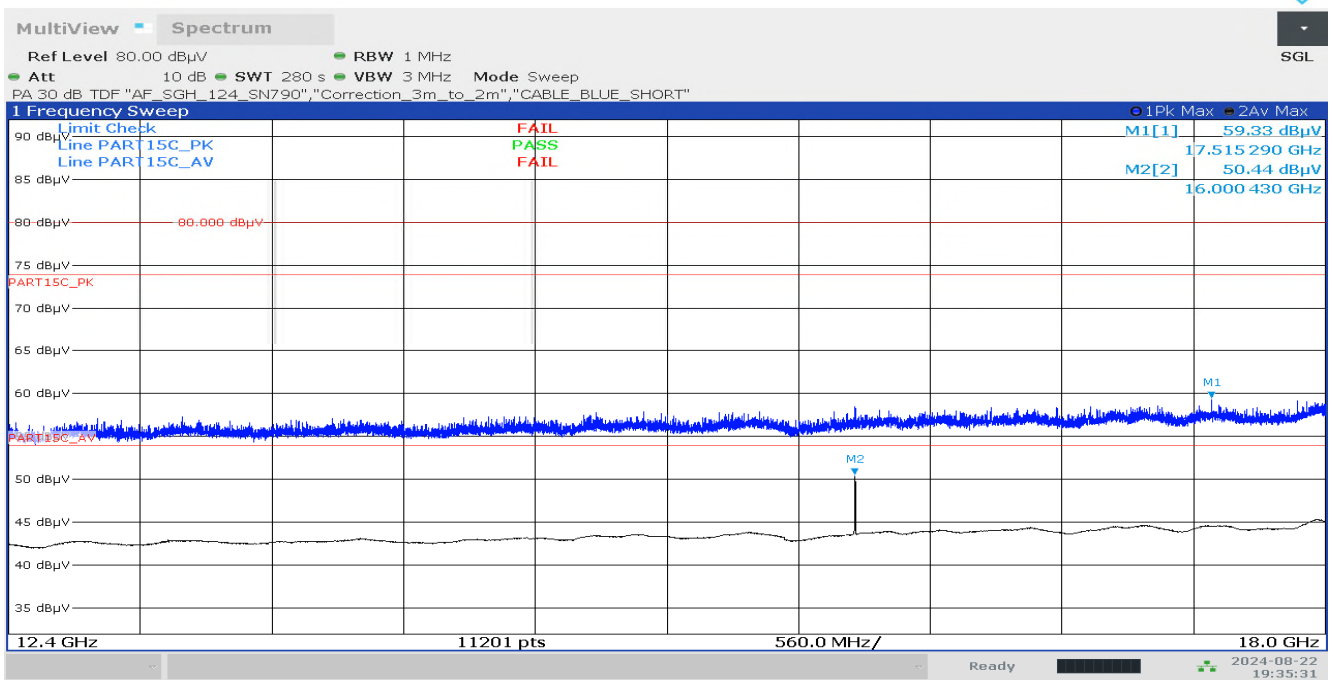


05:47:09 08/23/2024

Note:

Limit Line: Peak: 74 dBμV, Average: 54 dBμV,
Result: Peak: Pass, Average: Pass.

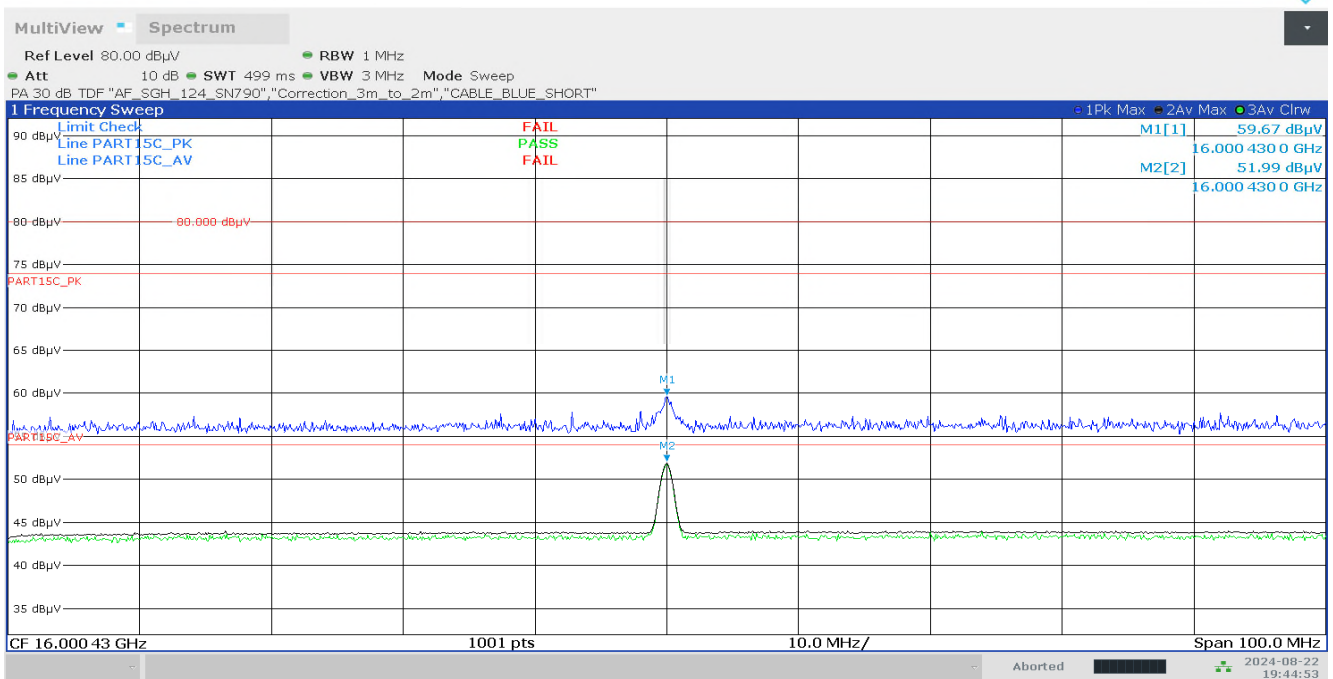
TID120a_RSE_TX_S12_12.4-18GHz_AntH



07:35:32 08/22/2024

Note: Maximum Emission found at 16.000430 GHz (M2) with average detector, for Final test check below test TID120a_02 with Zero span, Limit line: Peak: 74 dBμV, Average: 54 dBμV.

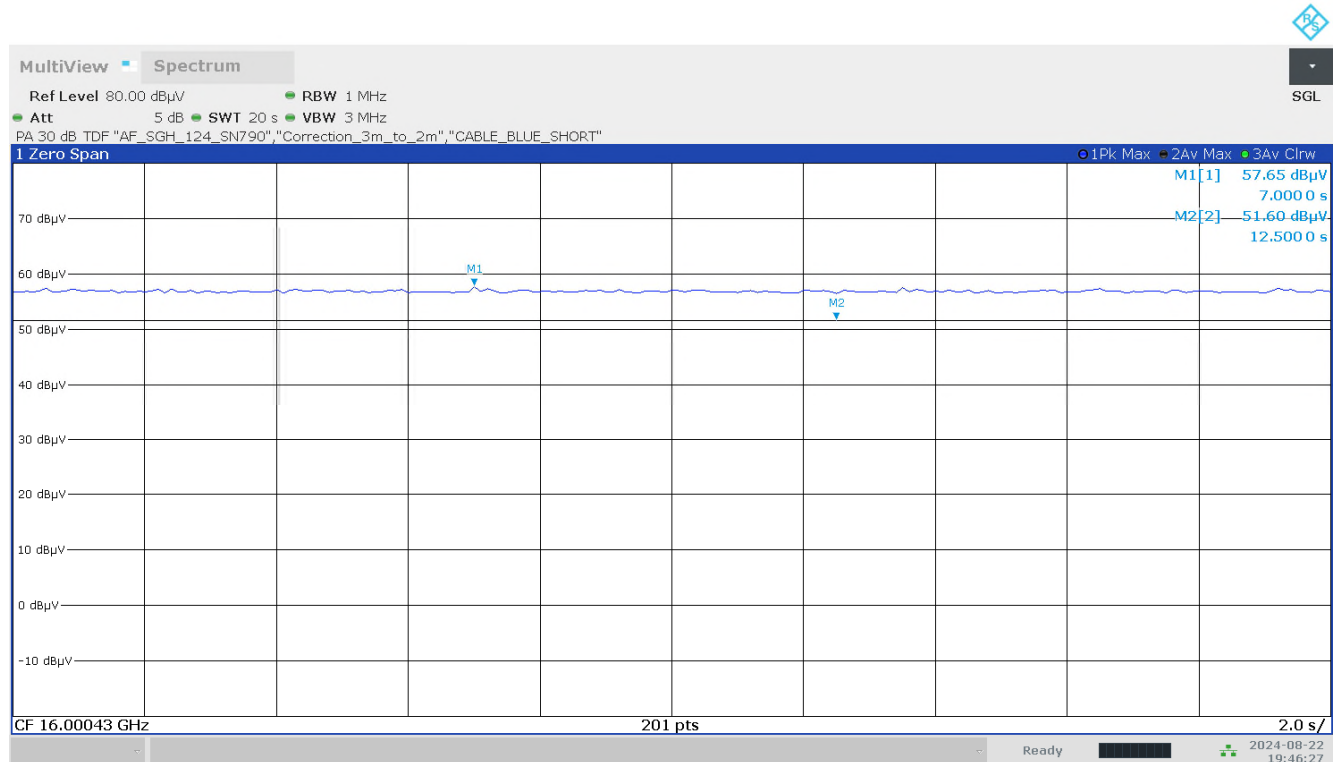
TID120a_01_S12_f1_16GHz_A138deg_E95deg_AntH



07:44:53 08/22/2024

Note: Maximum Emission search and found at TT138°, TD95°

TID120a_02_S12_f1_16GHz_ZeroSpan_100ms_A138deg_E95deg__AntH



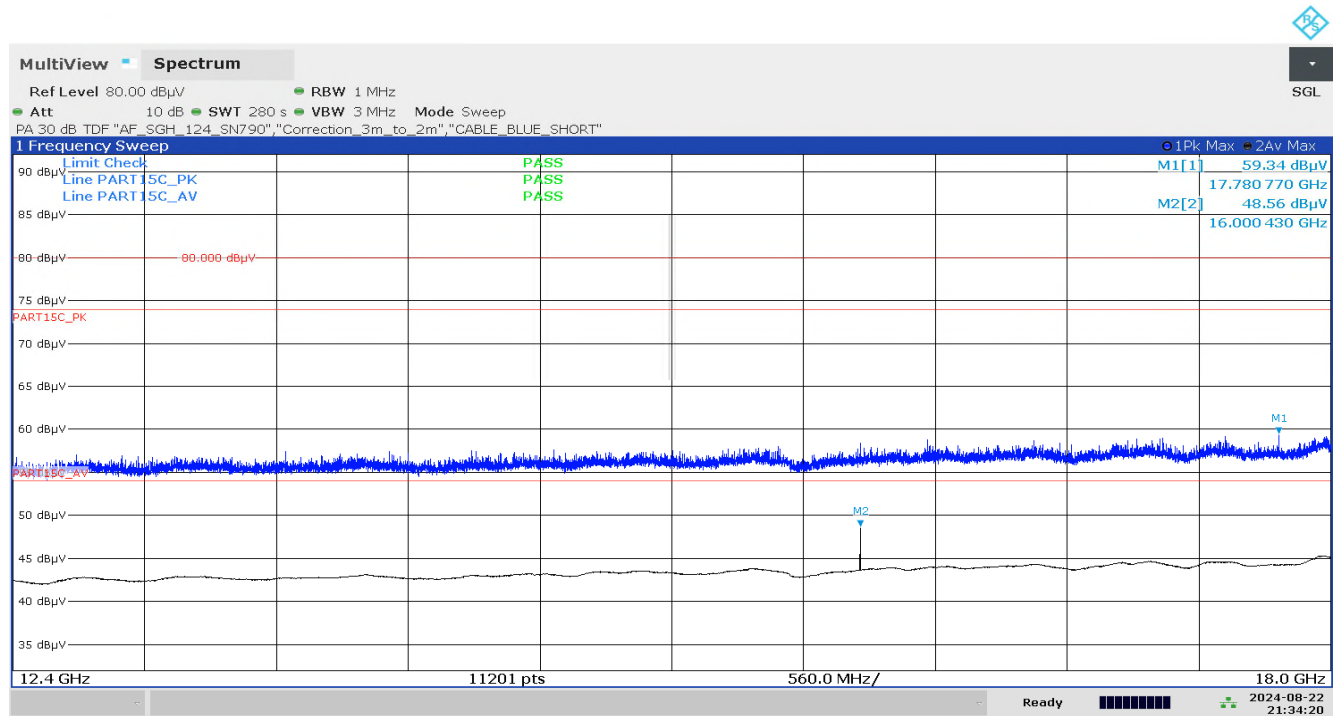
07:46:27 08/22/2024

Note:

Maximum Emission found with Average Detector: 51.60 dBμV, Limit Line: 54 dBμV, Result: Pass.

Maximum Emission found with Peak Detector: 57.65 dBμV, Limit Line: 74 dBμV, Result: Pass.

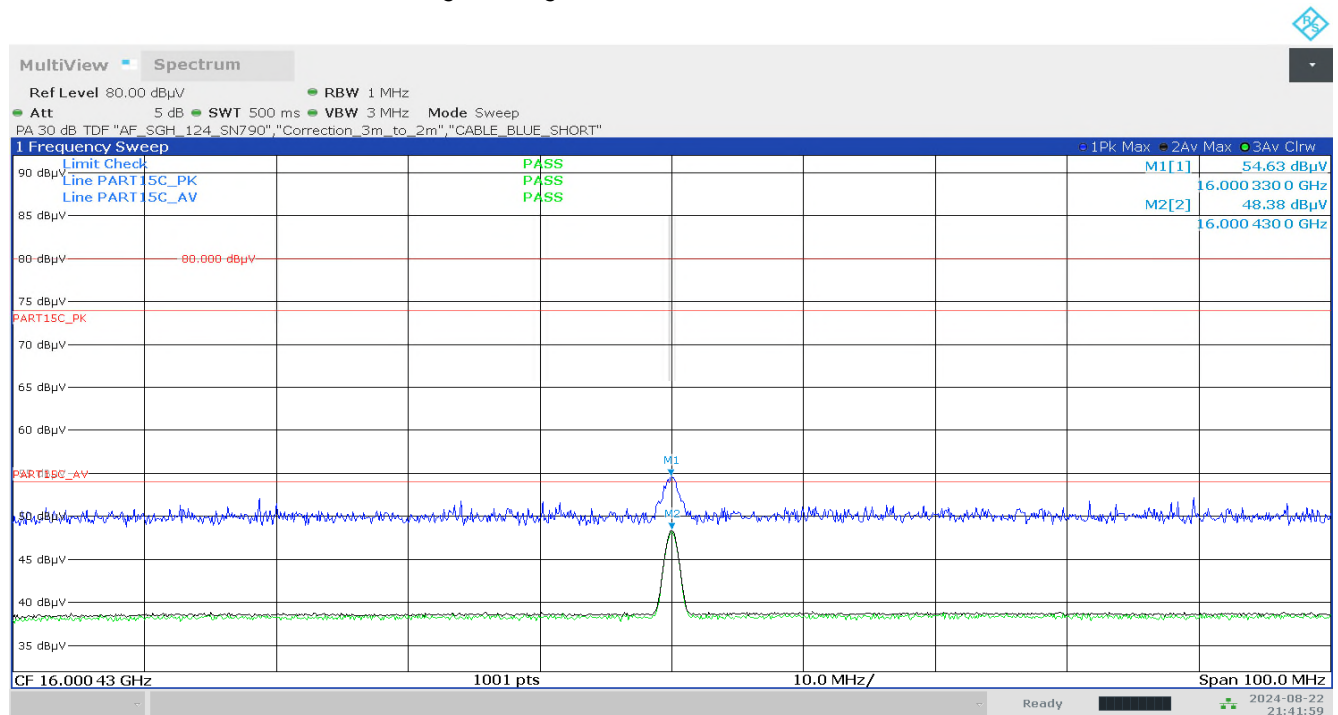
TID120b__RSE_TX_S12_12.4-18GHz__AntV



09:34:20 08/22/2024

Note: Maximum Emission found at 16.000430 GHz (M2) with average detector, for Final test check below test TID120a_02 with Zero span, Limit line: Peak: 74 dBμV, Average: 54 dBμV.

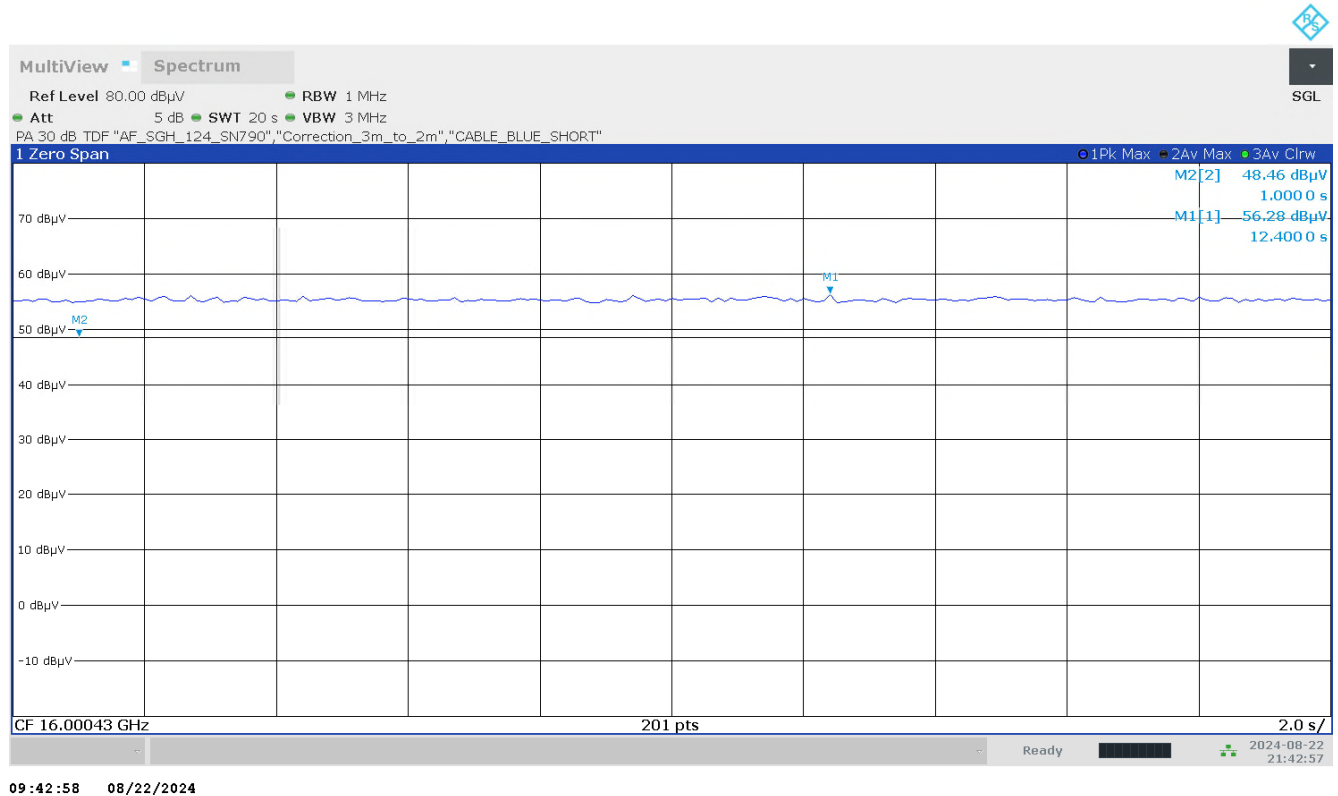
TID120b_01_S12_f1_16GHz_A329deg_E11deg__AntV



09:41:59 08/22/2024

Note: Maximum Emission search and found at TT329°, TD11°

TID120b_02_S12_f1_16GHz_ZeroSpan_100ms_A329deg_E11deg_AntV



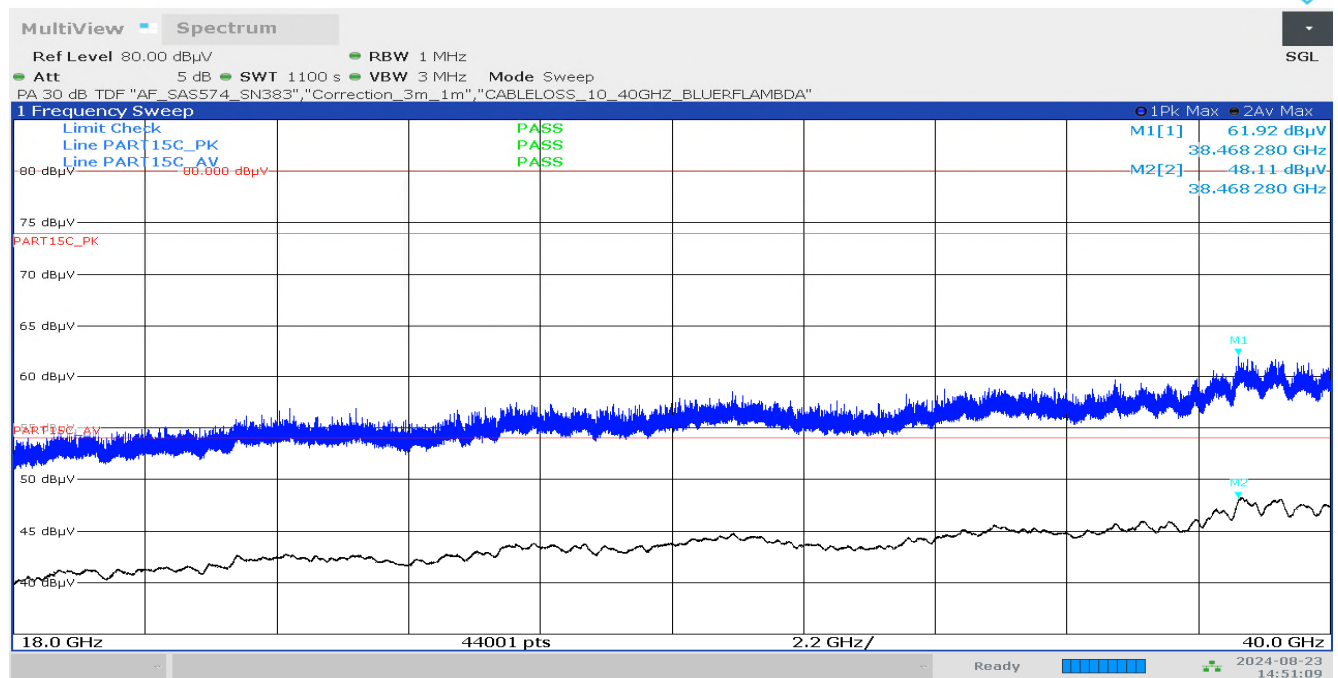
09:42:58 08/22/2024

Note:

Maximum Emission found with Average Detector: 48.46 dBμV, Limit Line: 54 dBμV, Result: Pass.

Maximum Emission found with Peak Detector: 56.28 dBμV, Limit Line: 74 dBμV, Result: Pass.

TID121a_RSE_TX_S12_18-40GHz_AntH



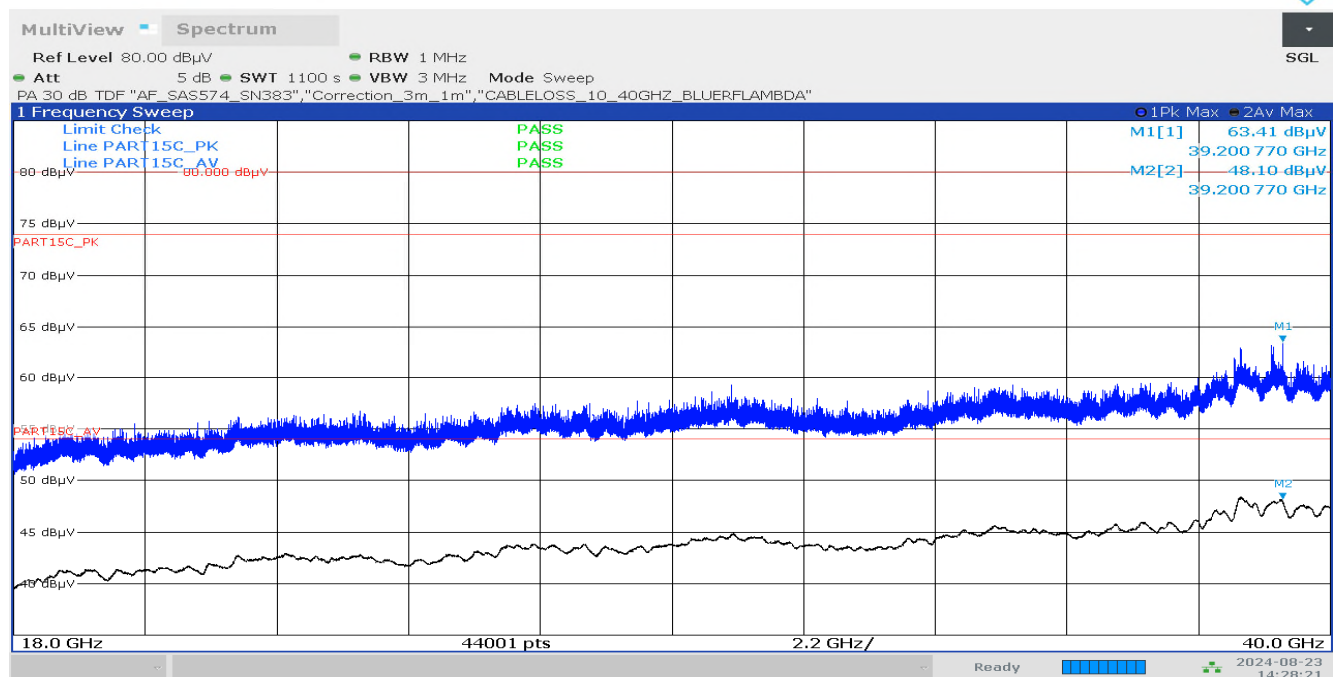
02:51:10 08/23/2024

Note:

Limit Line: Peak: 74 dBμV, Average: 54 dBμV,

Result: Peak: Pass, Average: Pass.

TID121b_RSE_TX_S12_18-40GHz_AntV



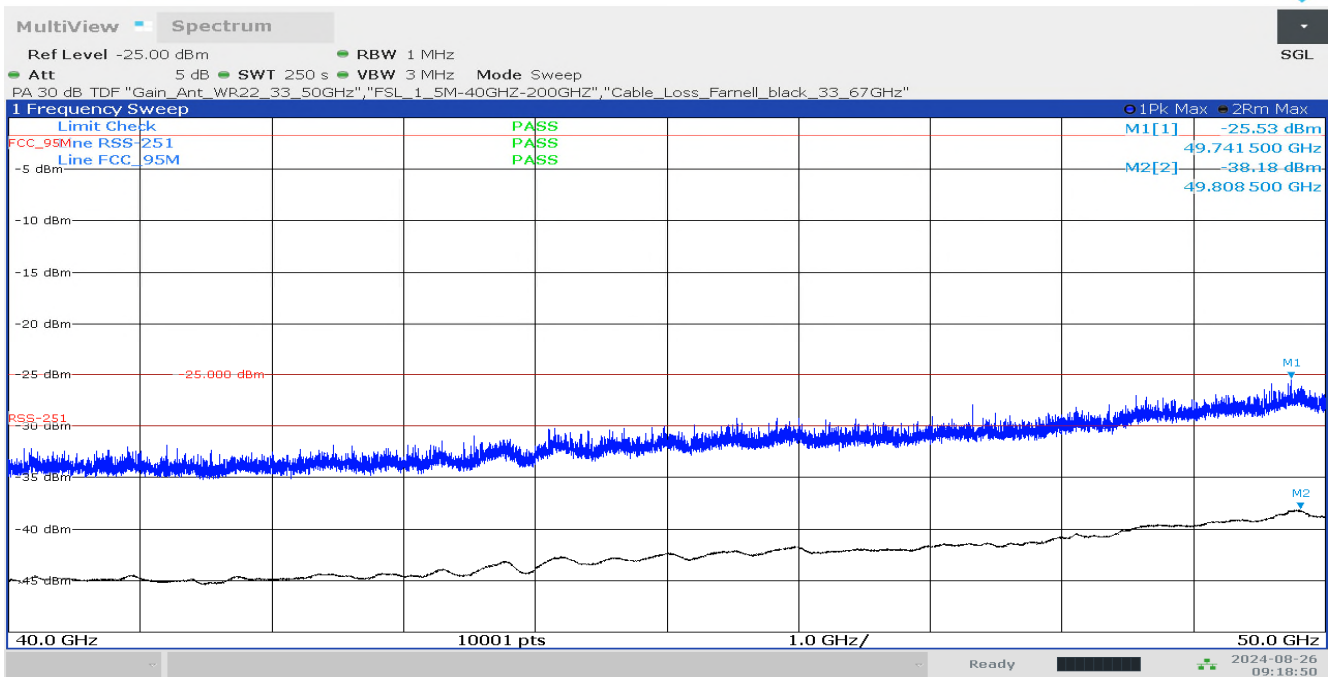
02:28:22 08/23/2024

Note:

Limit Line: Peak: 74 dBμV, Average: 54 dBμV,

Result: Peak: Pass, Average: Pass.

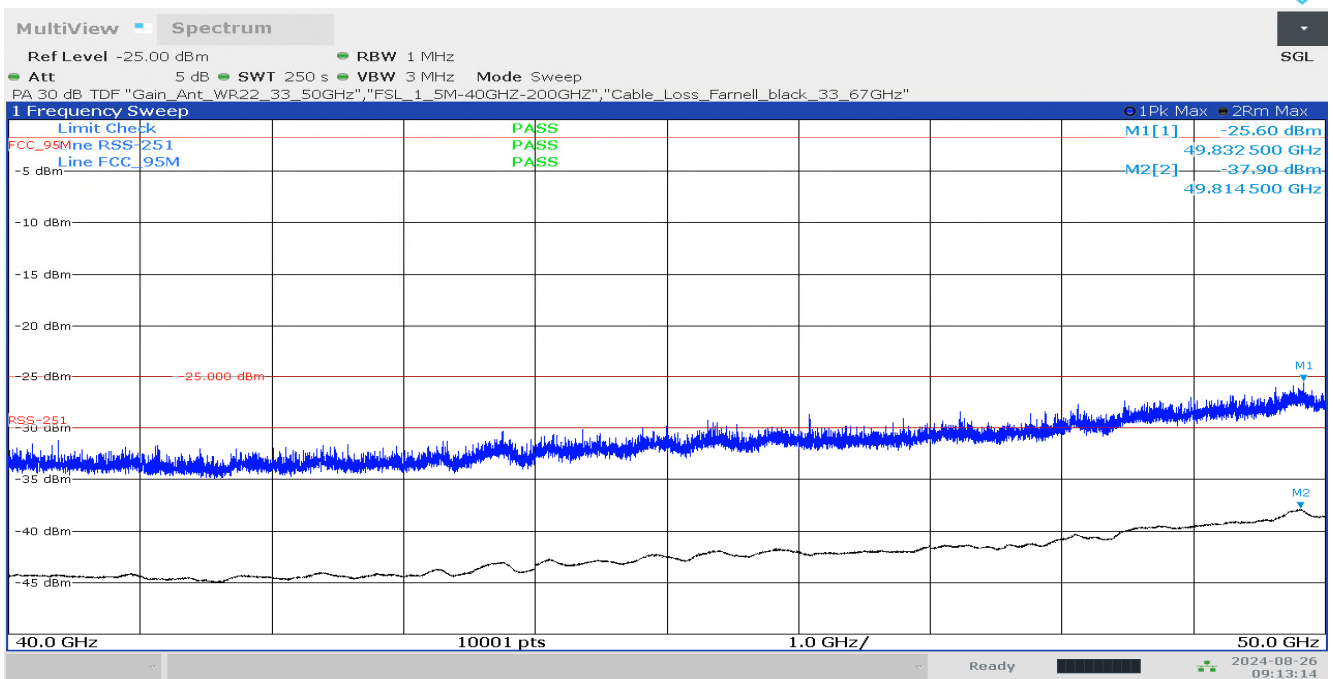
TID122a__RSE_TX_S12_40G-50GHz__AntH



09:18:51 08/26/2024

Note: No Critical Emission found, Only Noise Level from Spectrum Analyzer.

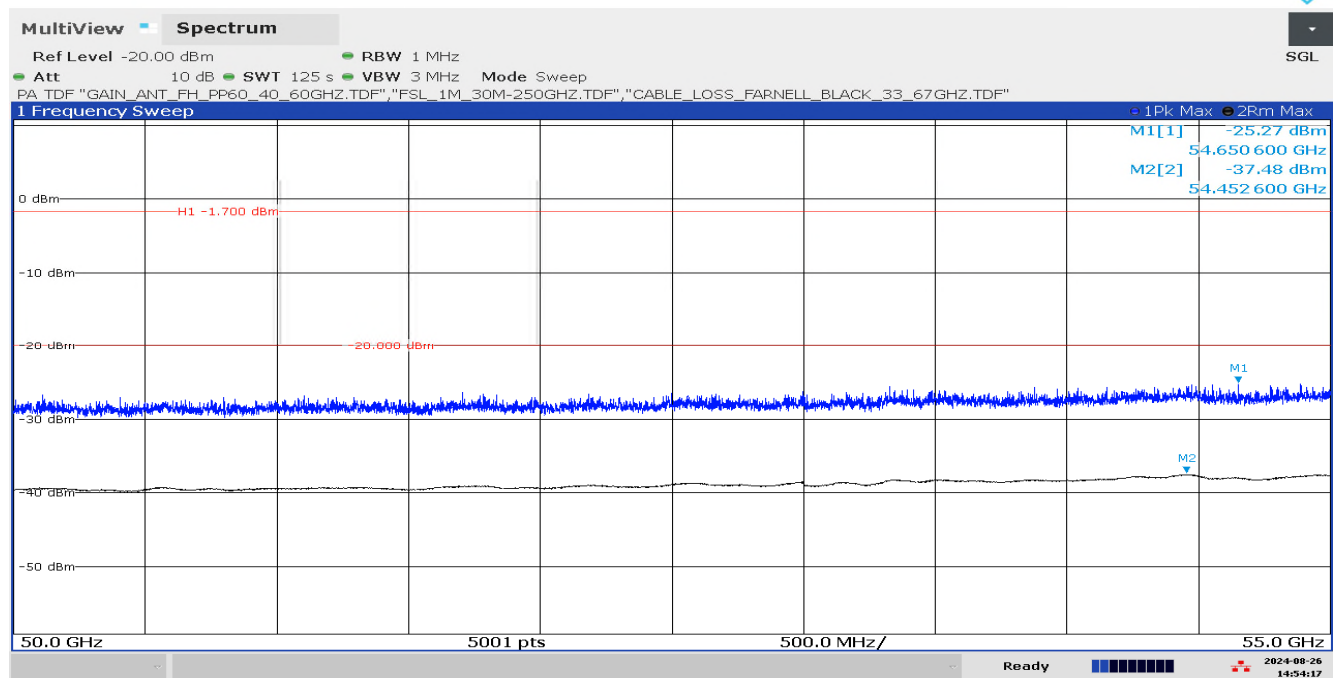
TID122b__RSE_TX_S12_40G-50GHz__AntV



09:13:14 08/26/2024

Note: No Critical Emission found, Only Noise Level from Spectrum Analyzer.

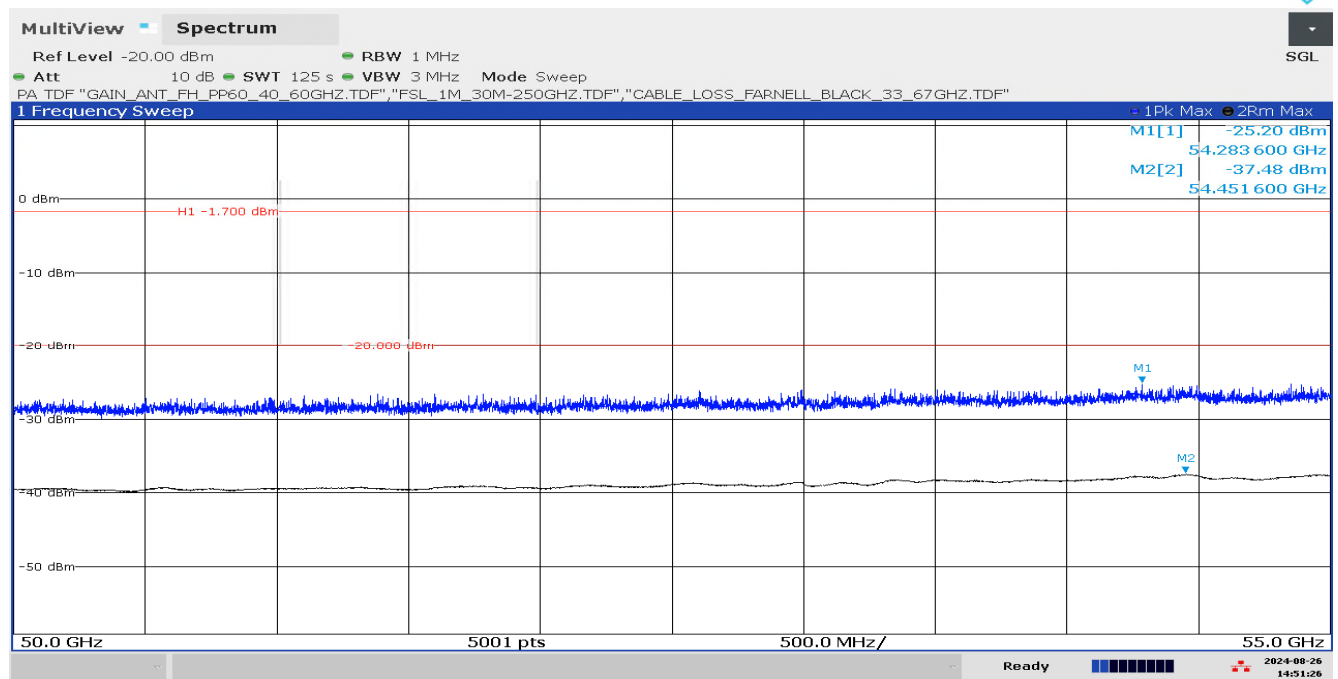
TID223a_23-1-0144001T007_RSE_50 G - 55 GHz_FCC_AntH



02:54:17 PM 08/26/2024

Note: No Critical Emission found, Only Noise Level from Spectrum Analyzer.

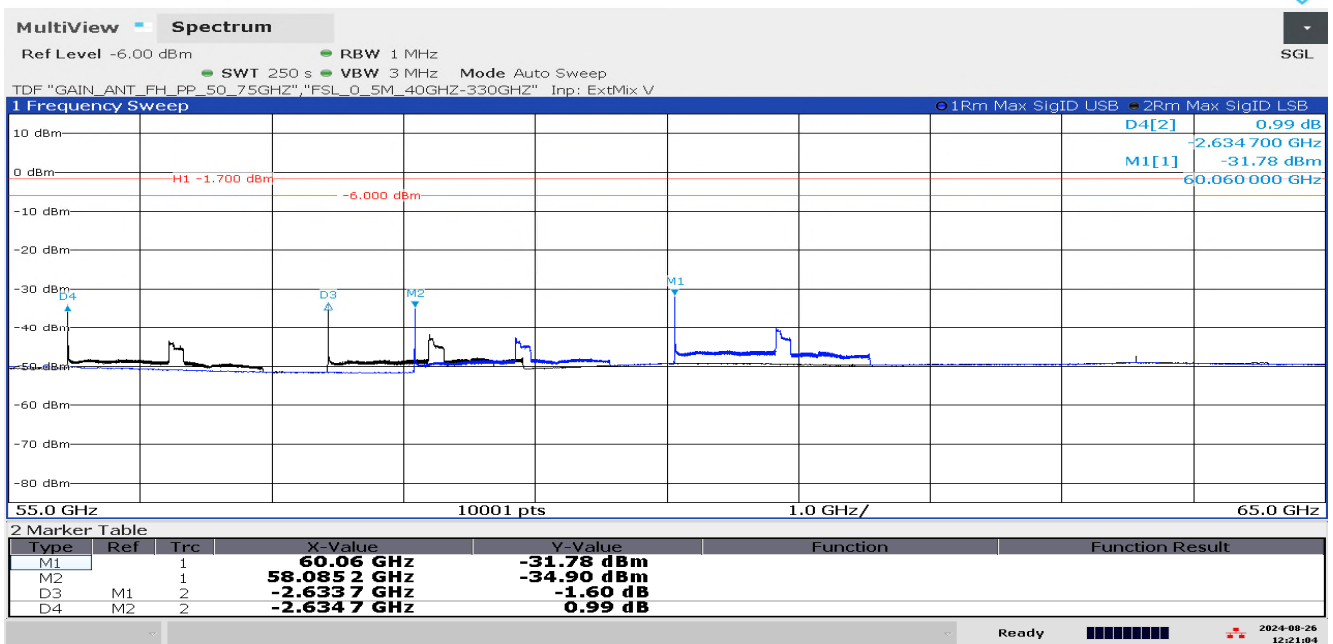
TID223b_23-1-0144001T007_RSE_50 G - 55 GHz_FCC_AntV



02:51:26 PM 08/26/2024

Note: No Critical Emission found, Only Noise Level from Spectrum Analyzer.

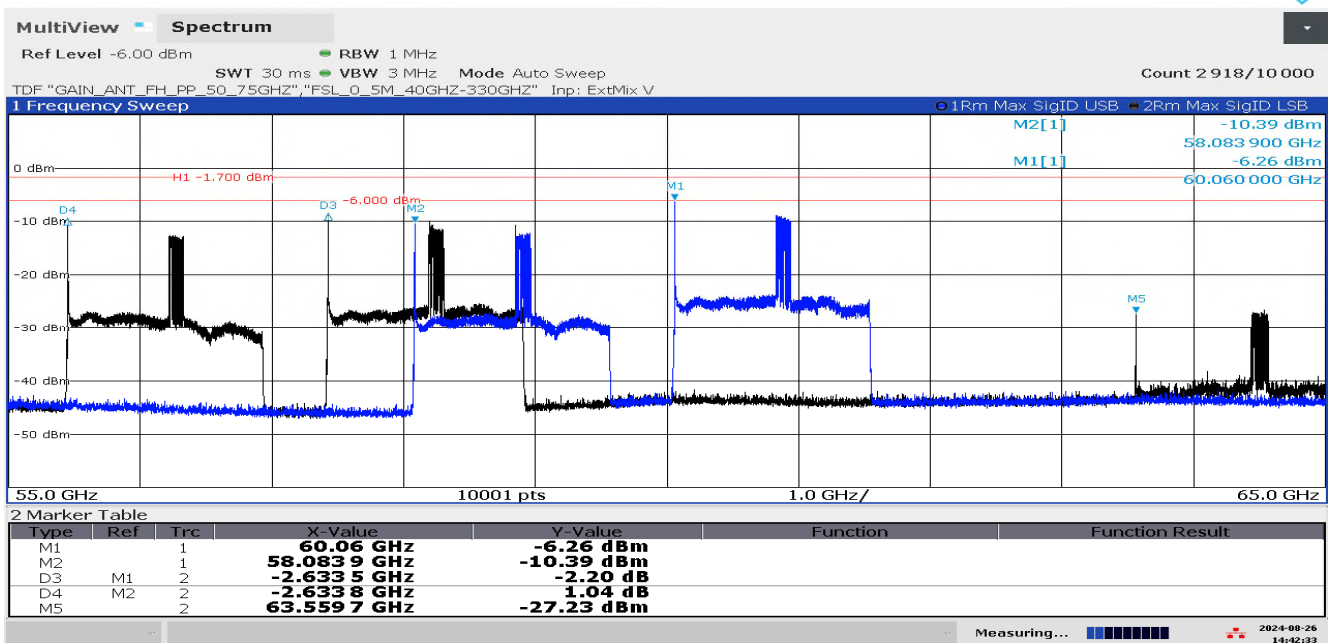
TID224a_23-1-0144001T007_RSE_55 G - 65 GHz_FCC_AntH



12:21:04 PM 08/26/2024

Note: No Critical emission found, only image signal, check below TID224a_01 for more information.

TID224a_01_23-1-0144001T007_RSE_55 G - 65 GHz_FCC_AntH_signal_id



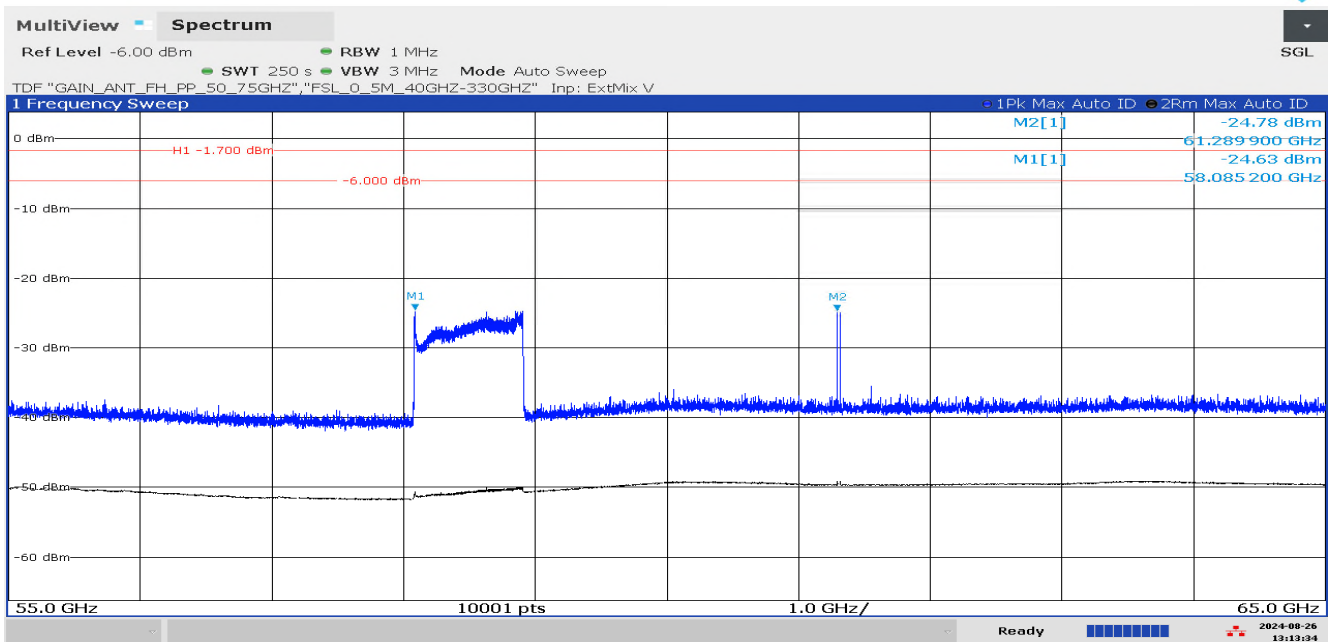
02:42:33 PM 08/26/2024

Note: Continuous Sweep with auto sweep time to verify image/ghost signals, only for information.

All are Image/Ghost Signals, since Mixer products are used.

Image/Ghost Signal: Signals, which are not overlapping(USB+LSB), Real Signal: Signals, which are overlapping(USB+LSB).

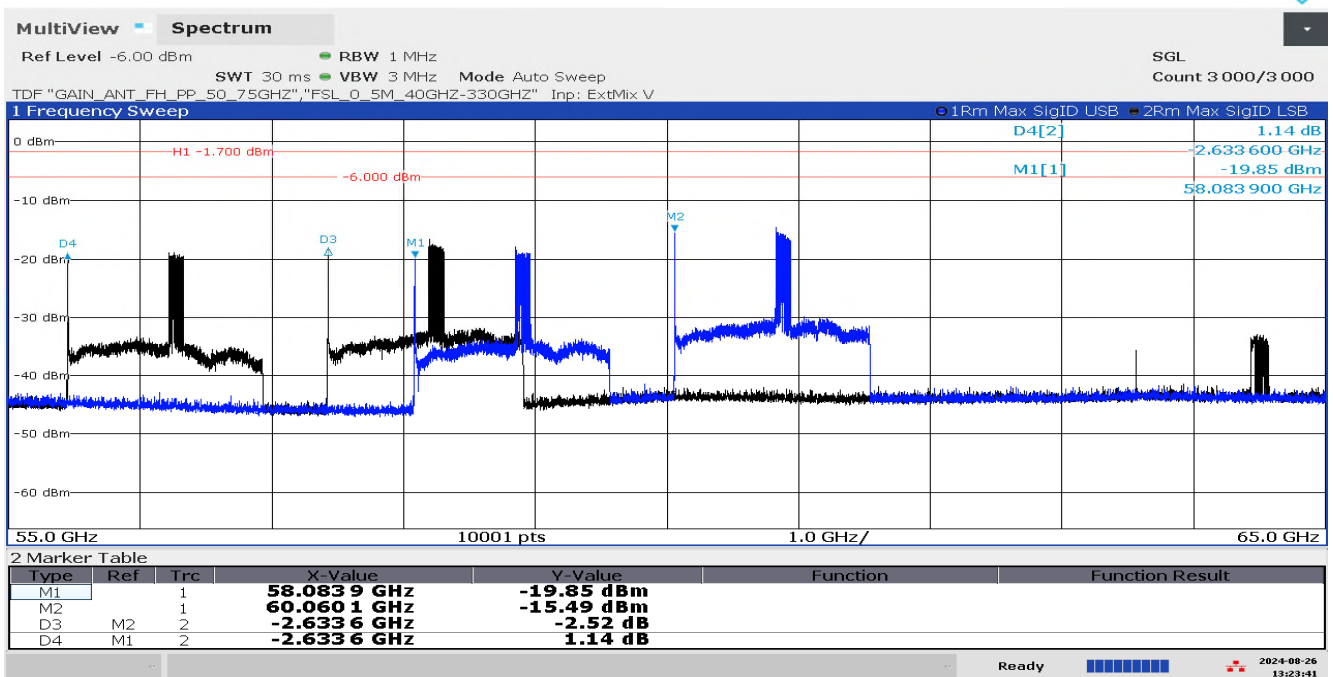
TID224b_23-1-0144001T007_RSE_55 G - 65 GHz_FCC_AntV_auto_id



01:13:34 PM 08/26/2024

Note: No critical Emission found, only image/ghost signals, for more information check below TID224b_01

TID224b_01_23-1-0144001T007_RSE_55 G - 65 GHz_FCC_AntV_signal_id



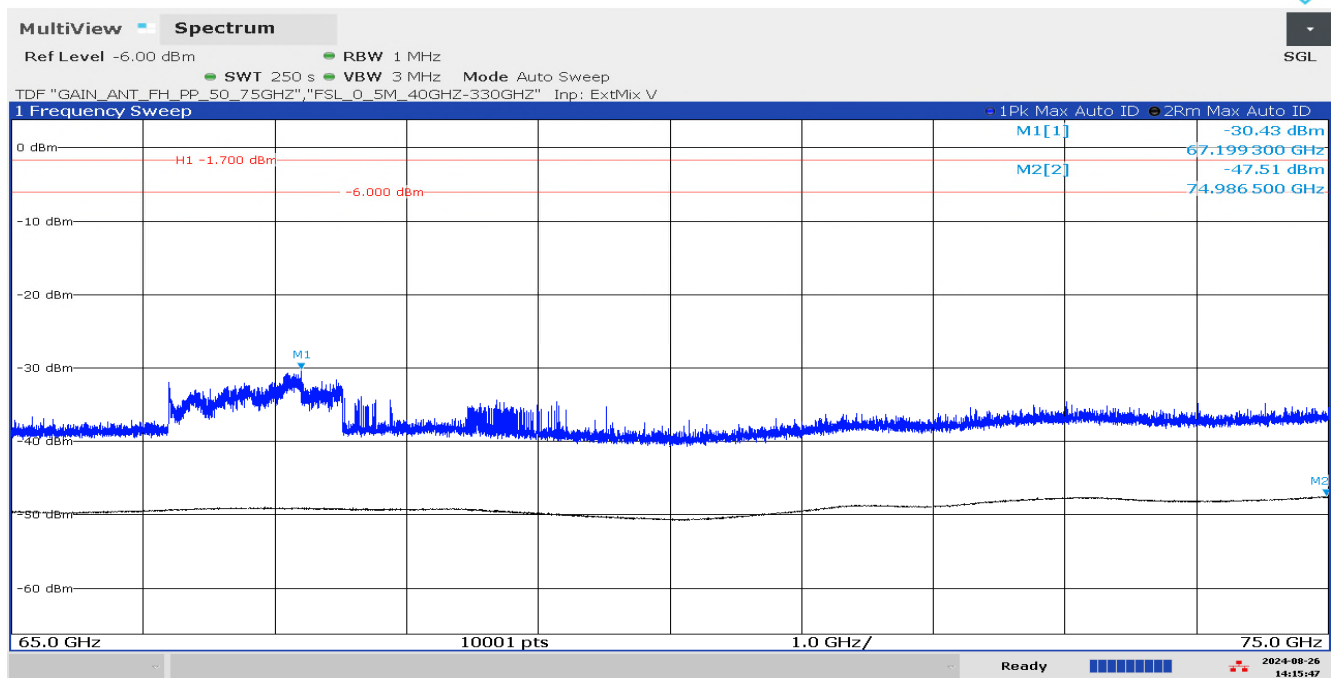
01:23:41 PM 08/26/2024

Note: Continuous Sweep with auto sweep time to verify image/ghost signals, only for information.

All are Image/Ghost Signals, since Mixer products are used.

Image/Ghost Signal: Signals, which are not overlapping(USB+LSB), Real Signal: Signals, which are overlapping(USB+LSB).

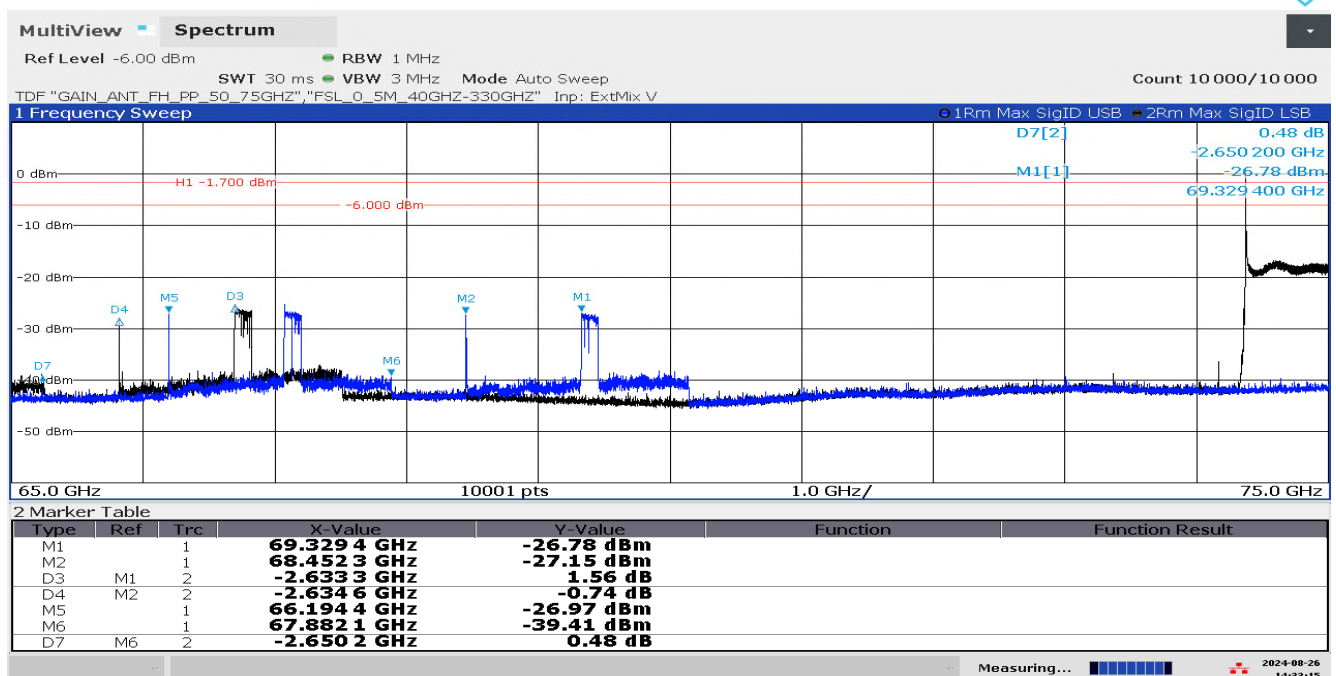
TID225a_23-1-0144001T007_RSE_65 G - 75 GHz_FCC_AntH



02:13:47 PM 08/26/2024

Note: No Critical Emission found, only image signal, check TID225a_02 below for more information.

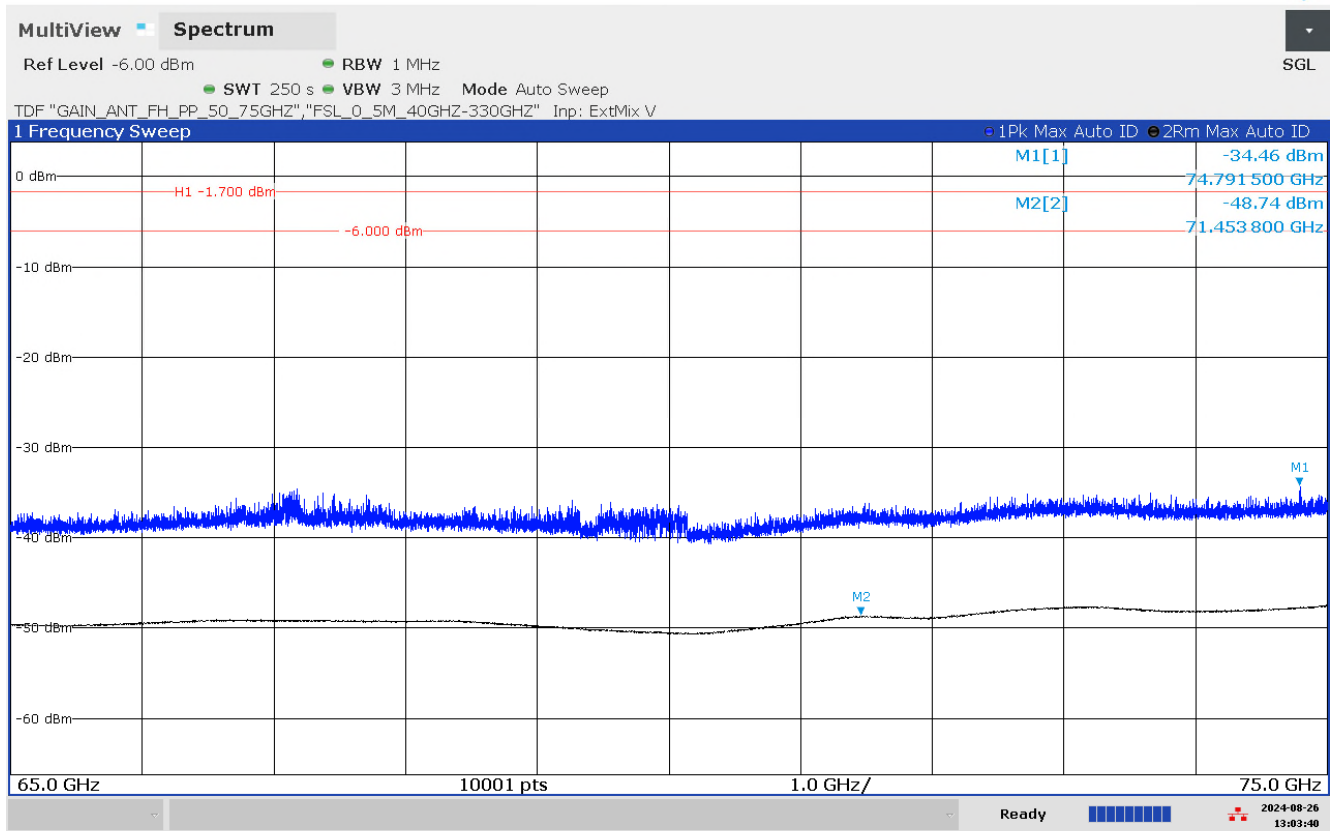
TID225a_02_23-1-0144001T007_RSE_65 G - 75 GHz_FCC_AntH_signal_id



02:33:15 PM 08/26/2024

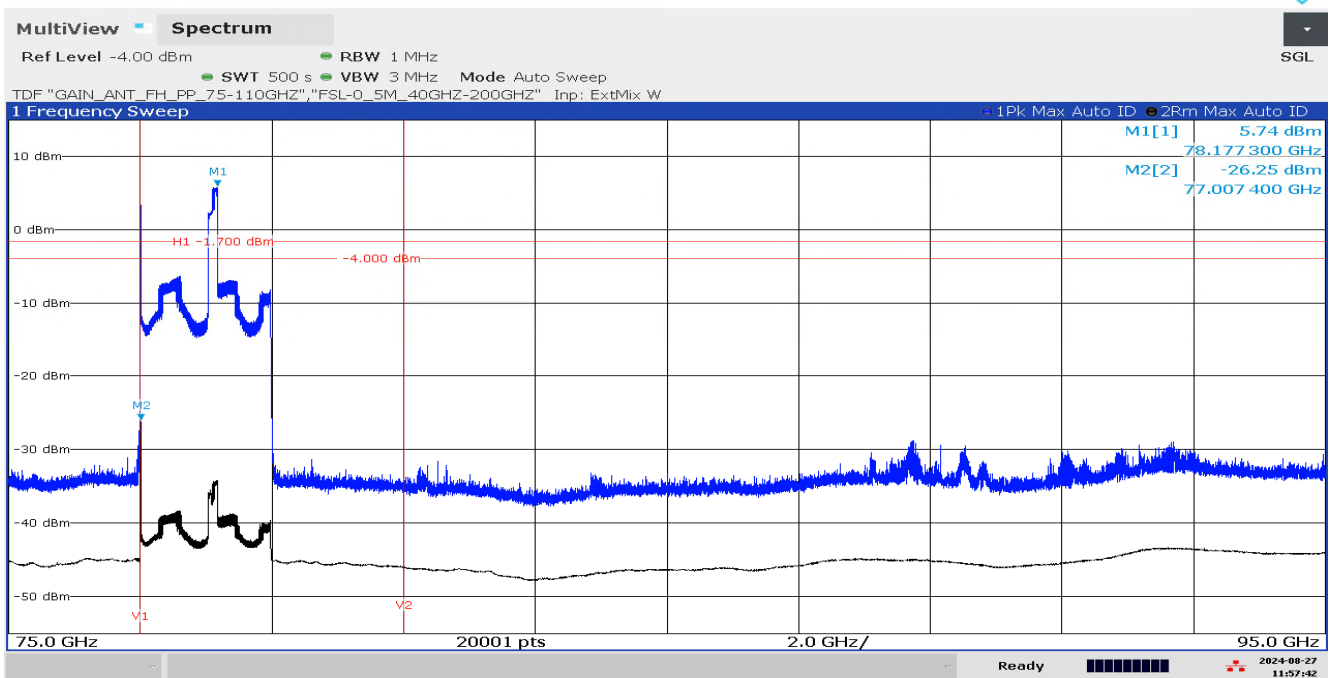
Note: Signal ID functions are activated to verify image / ghost signals. No critical Emission found, only image signal.

TID225b_23-1-0144001T007_RSE_65 G - 75 GHz_FCC_AntV



01:03:40 PM 08/26/2024

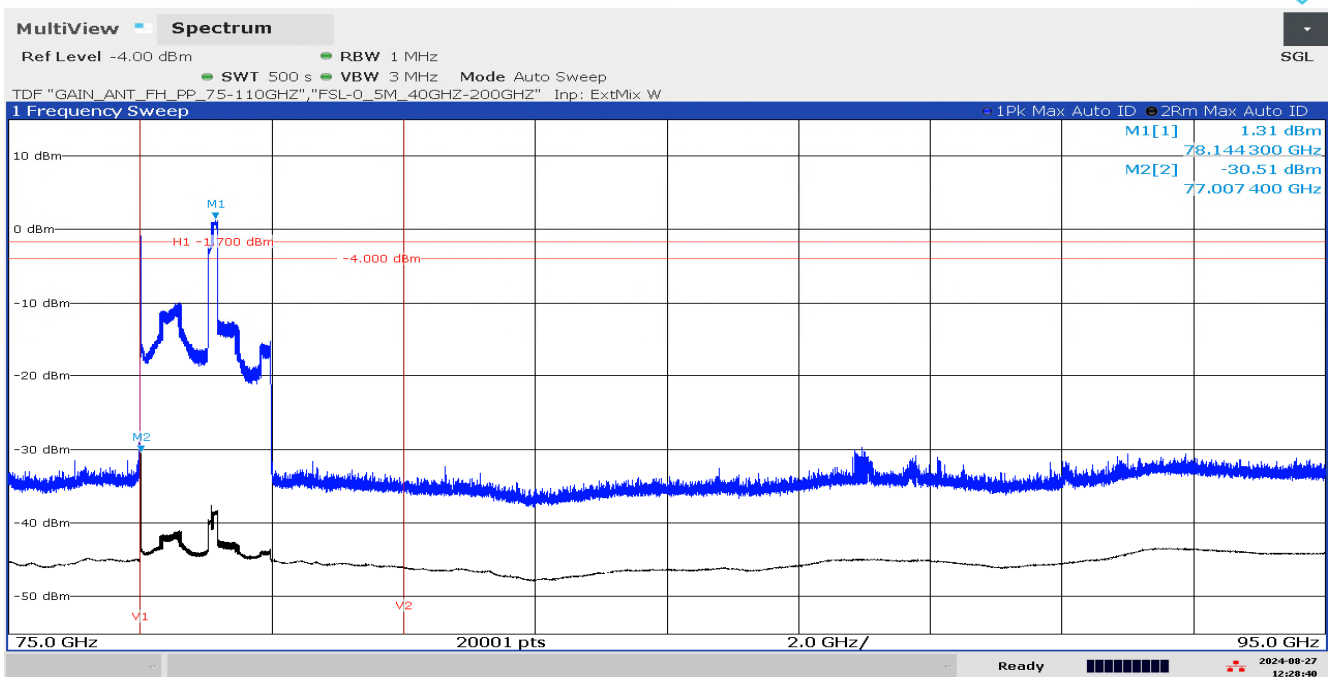
TID226a_23-1-0144001T007_RSE_75 G - 95 GHz_FCC_AntH



11:57:42 AM 08/27/2024

Note: In this Plot, V1 = 77 GHz, V2 = 81 GHz, RADAR active from 77 – 79 GHz. No critical Emission found.

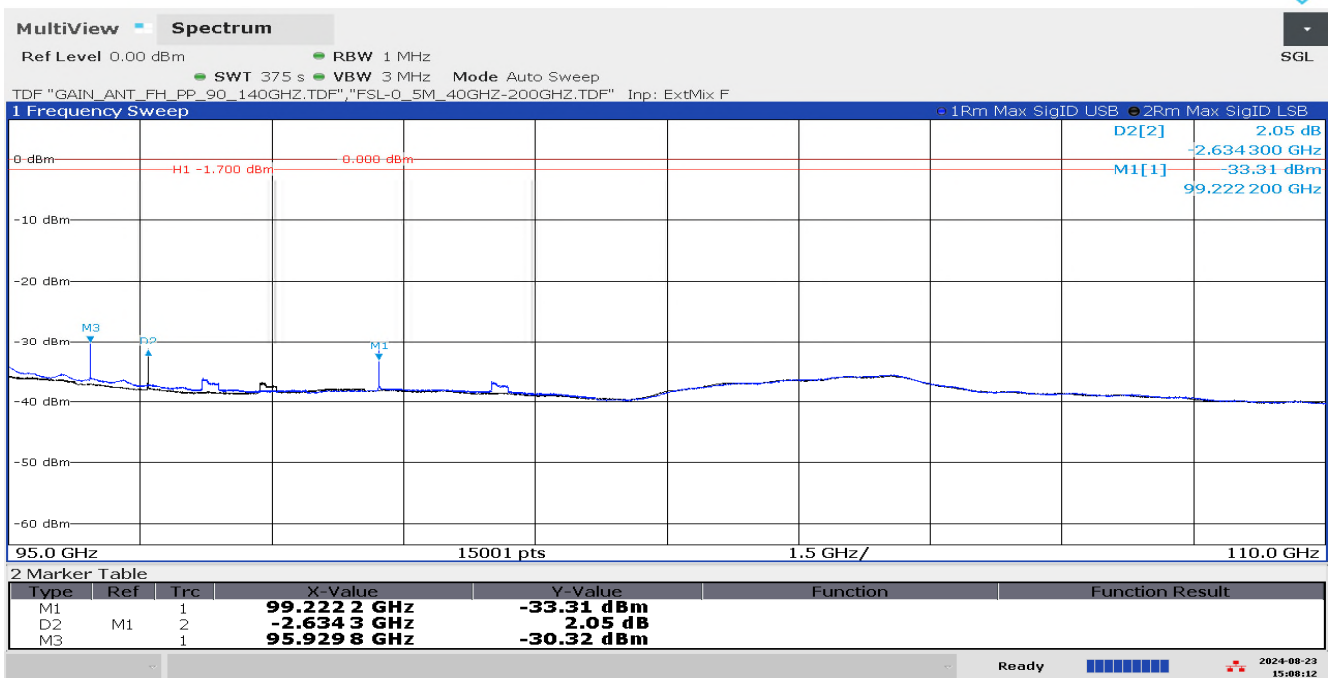
TID226b_23-1-0144001T007_RSE_75 G - 95 GHz_FCC_AntV



12:28:40 PM 08/27/2024

Note: In this Plot, V1 = 77 GHz, V2 = 81 GHz, RADAR active from 77 – 79 GHz. No critical Emission found.

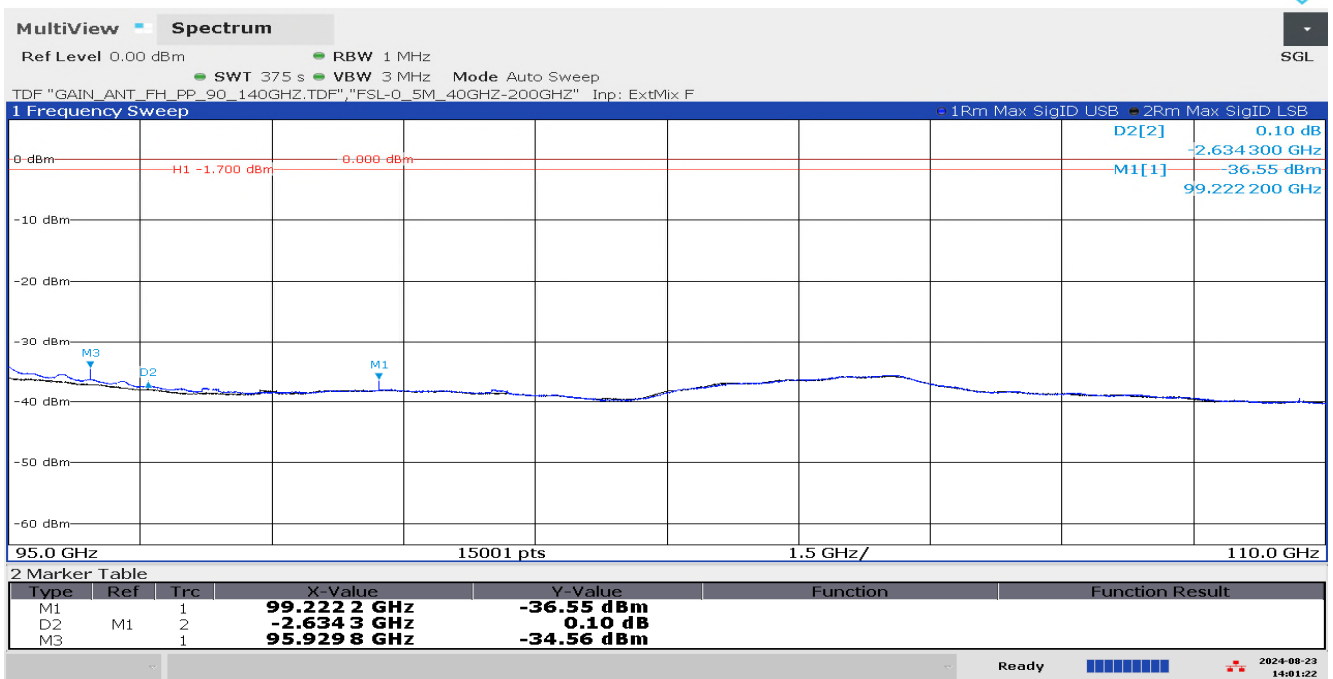
TID227_01a_23-1-0144001T007_RSE_95 G - 110 GHz_FCC_AntH



03:08:12 PM 08/23/2024

Note: Signal ID functions are activated to verify image / ghost signals. No critical Emission found, only image signal.

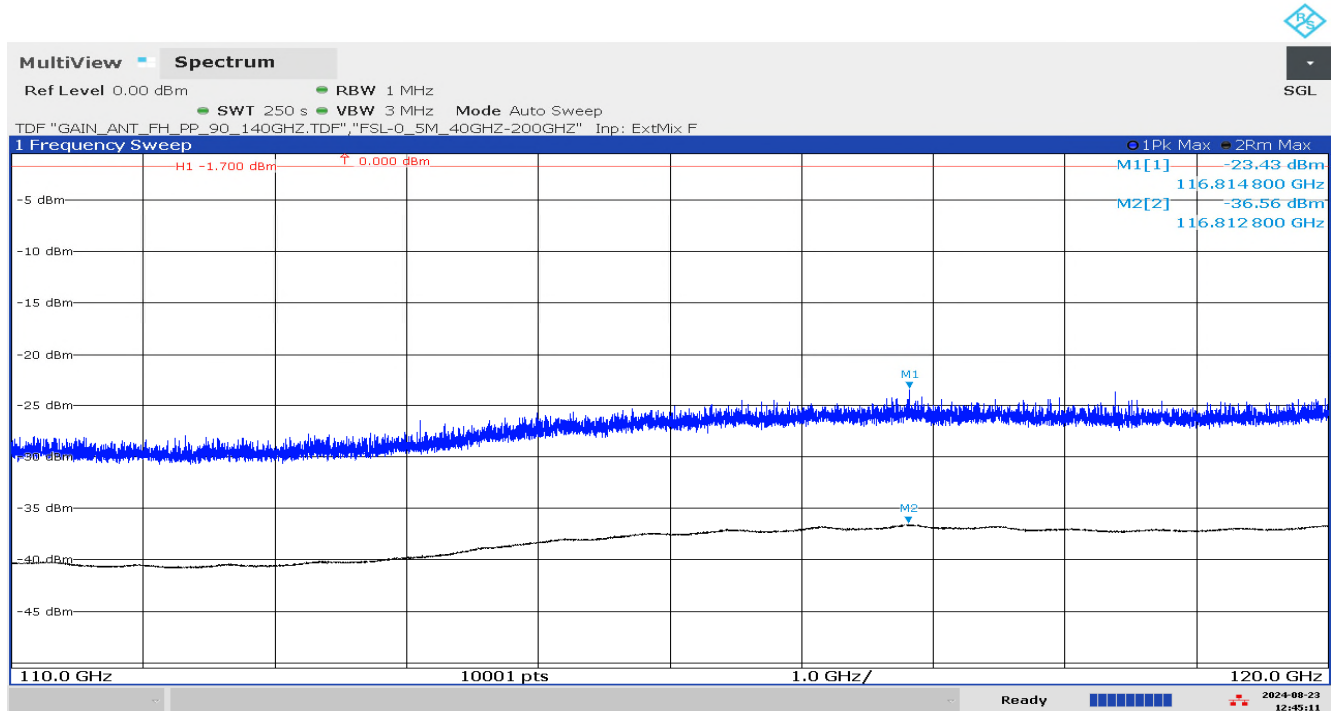
TID227_01b_23-1-0144001T007_RSE_95 G - 110 GHz_FCC_AntV



02:01:23 PM 08/23/2024

Note: Signal ID functions are activated to verify image / ghost signals. No critical Emission found, only image signal.

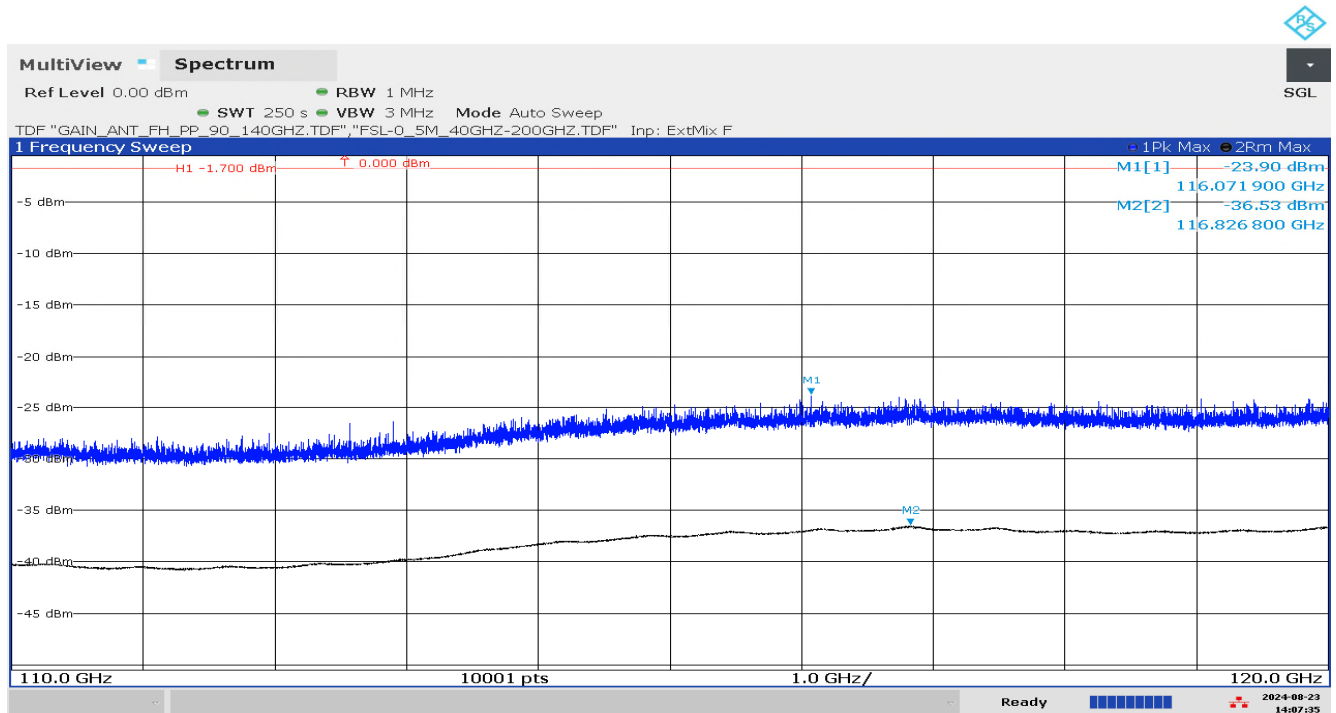
TID227_02a_23-1-0144001T007_RSE_110 G - 120 GHz_FCC_AntH



12:45:11 PM 08/23/2024

Note: No critical Emission found, only noise level from Spectrum Analyzer.

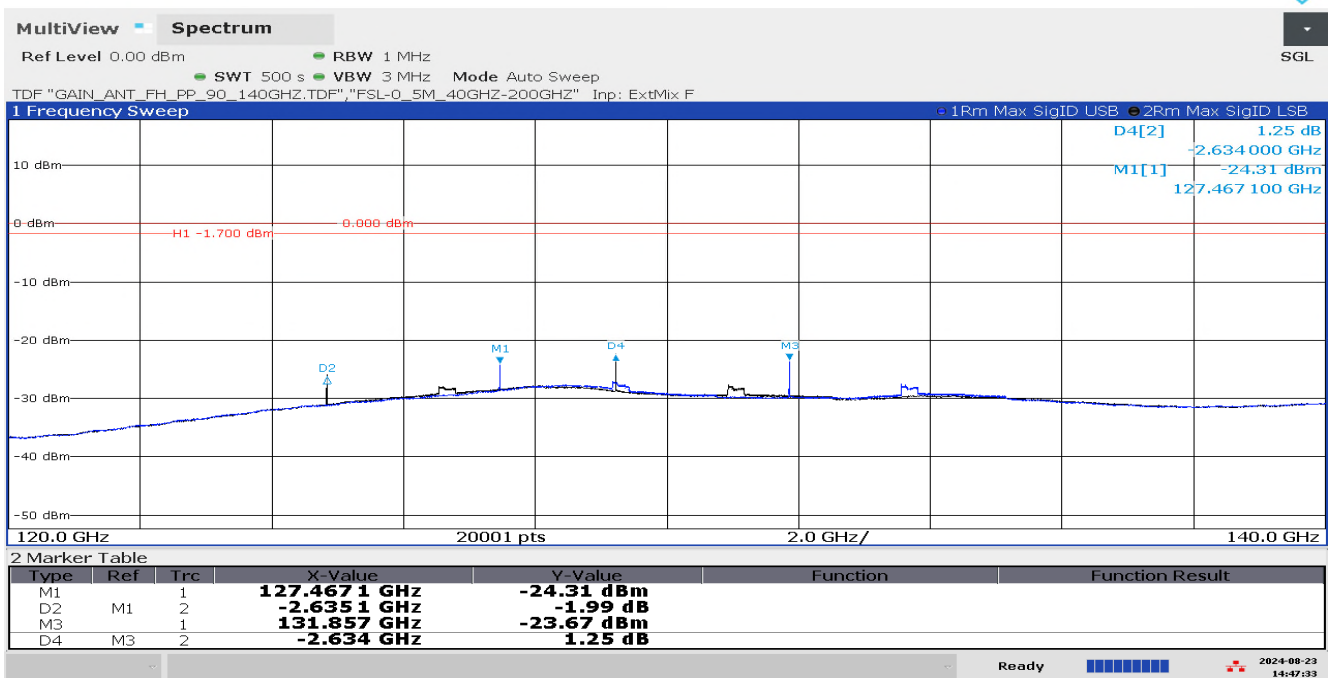
TID227_02b_23-1-0144001T007_RSE_110 G - 120 GHz_FCC_AntV



02:07:36 PM 08/23/2024

Note: No critical Emission found, only noise level from Spectrum Analyzer.

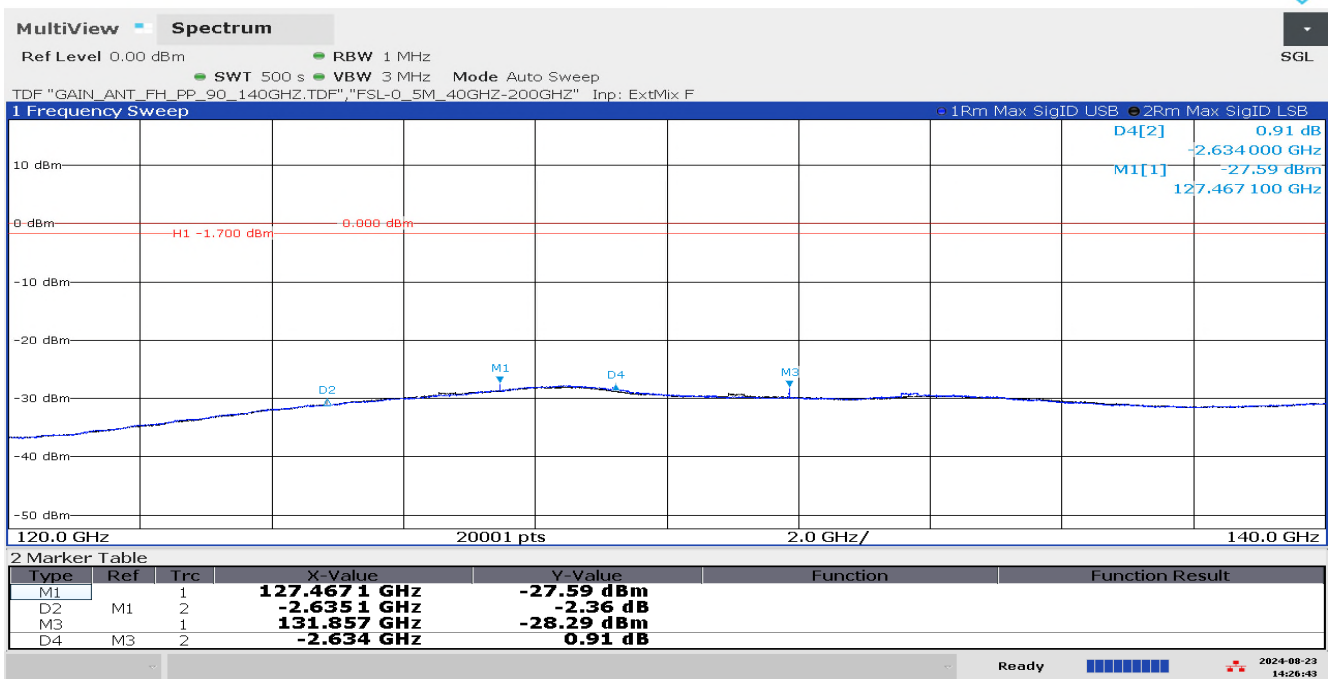
TID227_03a_23-1-0144001T007_RSE_120 G - 140 GHz_FCC_AntH



02:47:33 PM 08/23/2024

Note: Signal ID functions are activated to verify image / ghost signals. No critical Emission found, only image signal

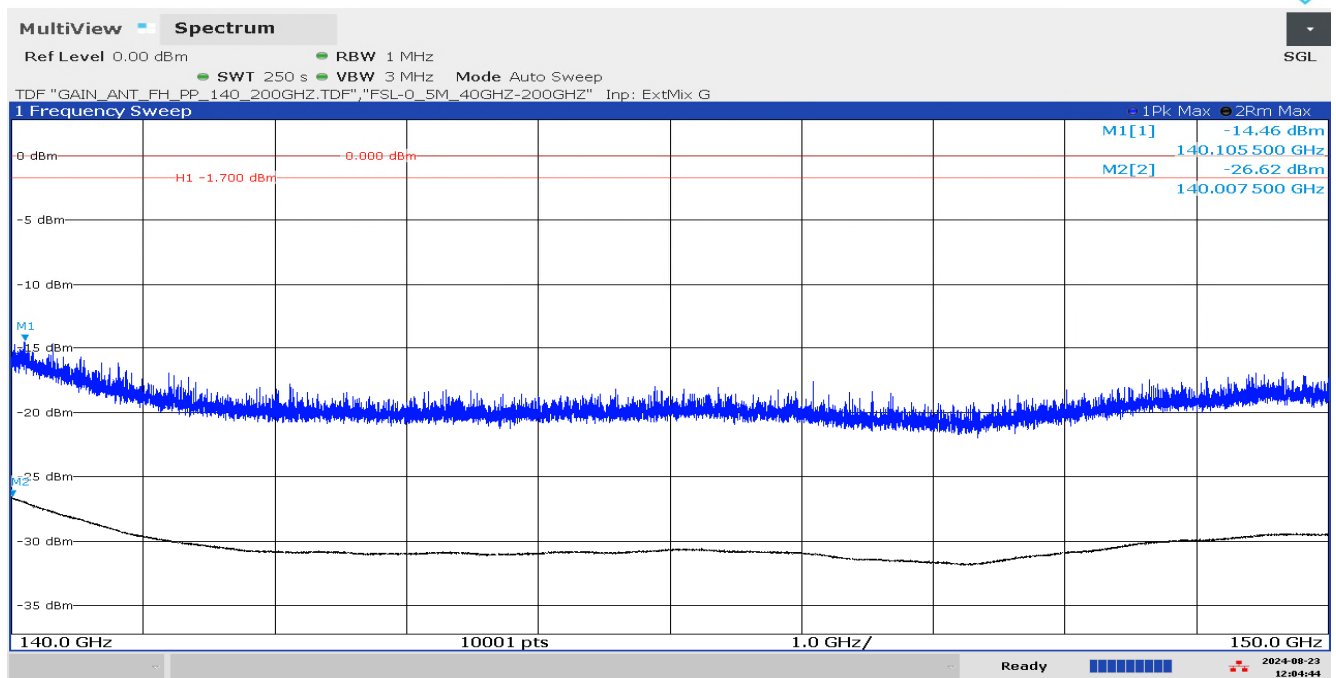
TID227_03b_23-1-0144001T007_RSE_120 G - 140 GHz_FCC_AntV



02:26:43 PM 08/23/2024

Note: Signal ID functions are activated to verify image / ghost signals. No critical Emission found, only image signal

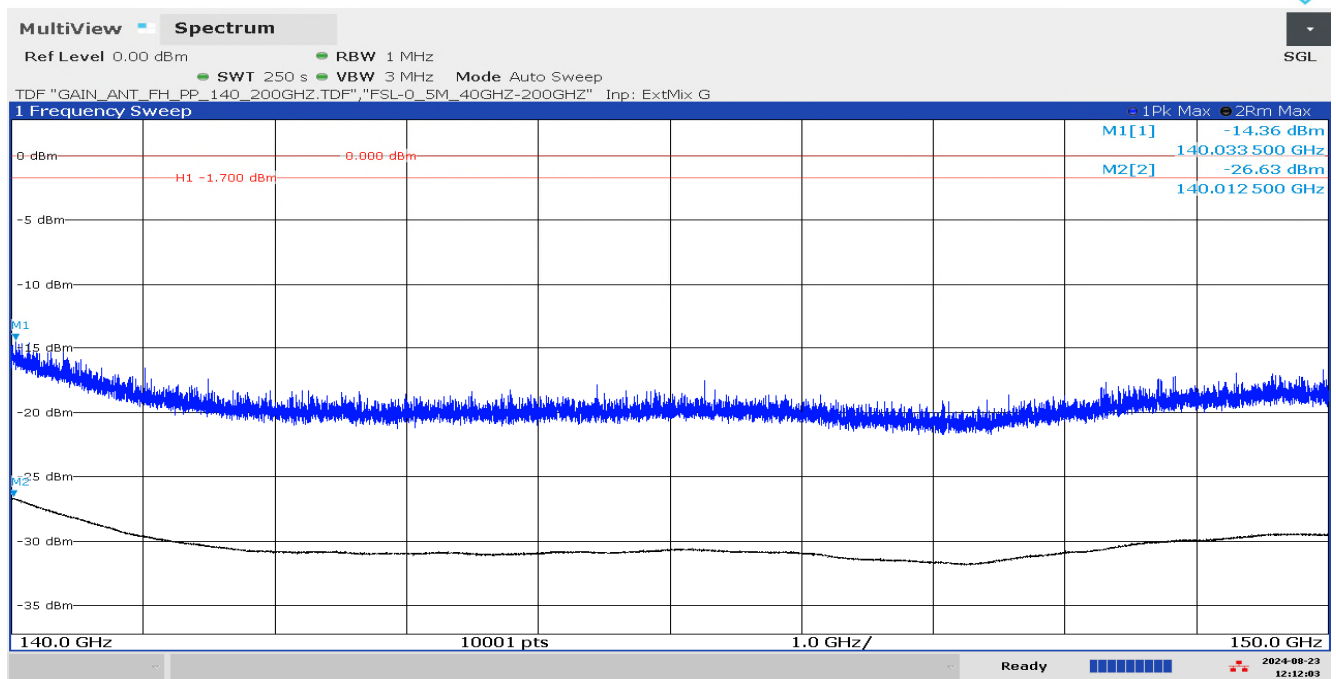
TID227_04a_23-1-0144001T007_RSE_140 G - 150 GHz_FCC_AntH



12:04:45 PM 08/23/2024

Note: No critical Emission found, only noise level from Spectrum Analyzer.

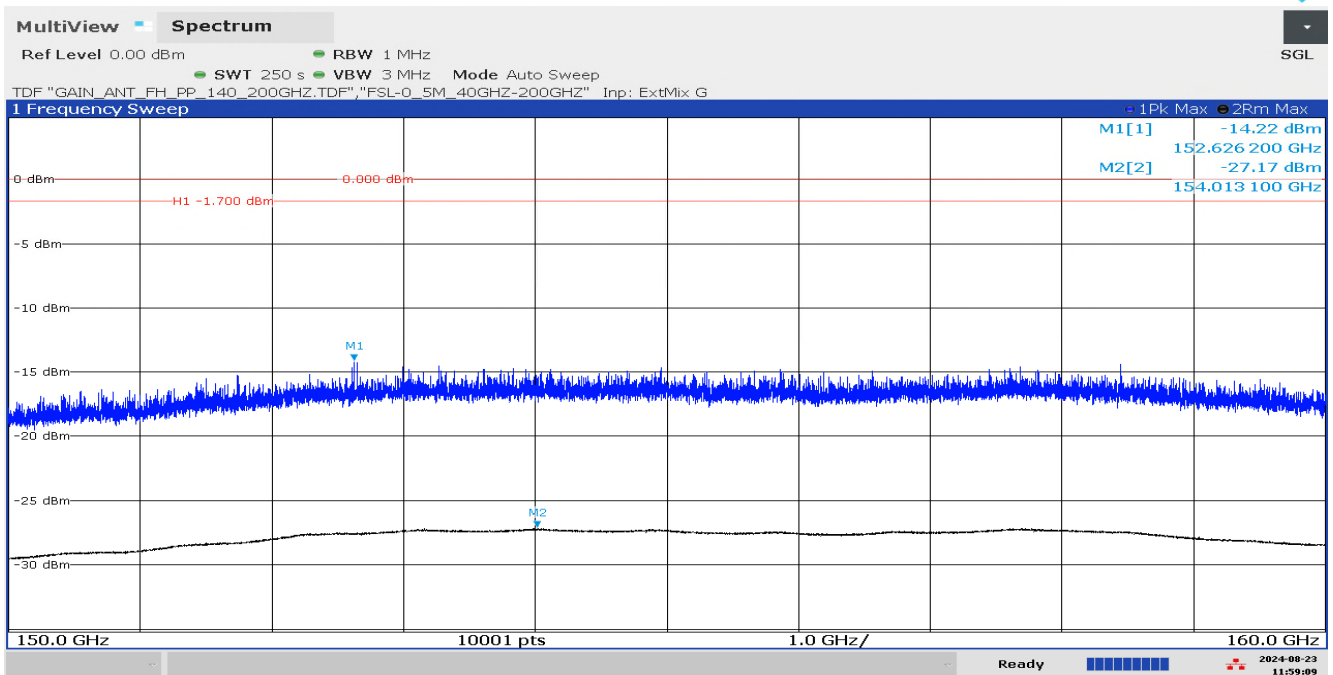
TID227_04b_23-1-0144001T007_RSE_140 G - 150 GHz_FCC_AntV



12:12:04 PM 08/23/2024

Note: No critical Emission found, only noise level from Spectrum Analyzer.

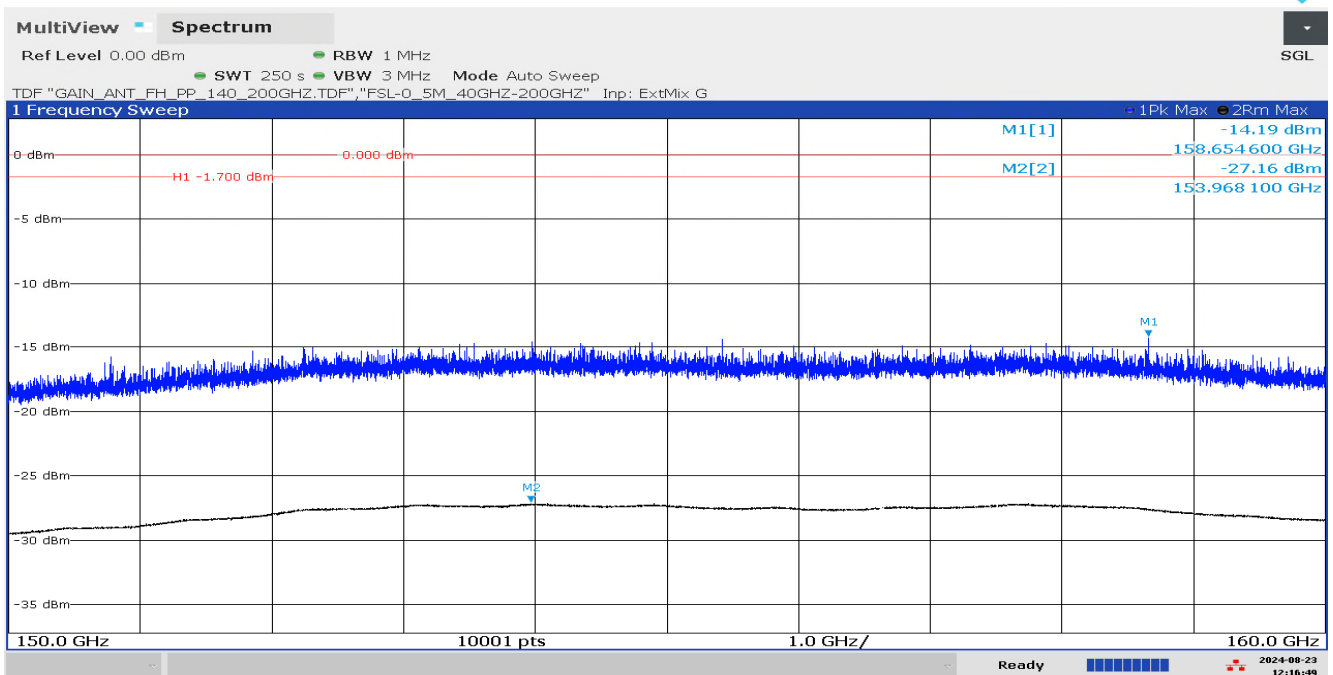
TID227_05a_23-1-0144001T007_RSE_150 G - 160 GHz_FCC_AntH



11:59:09 AM 08/23/2024

Note: No critical Emission found, only noise level from Spectrum Analyzer.

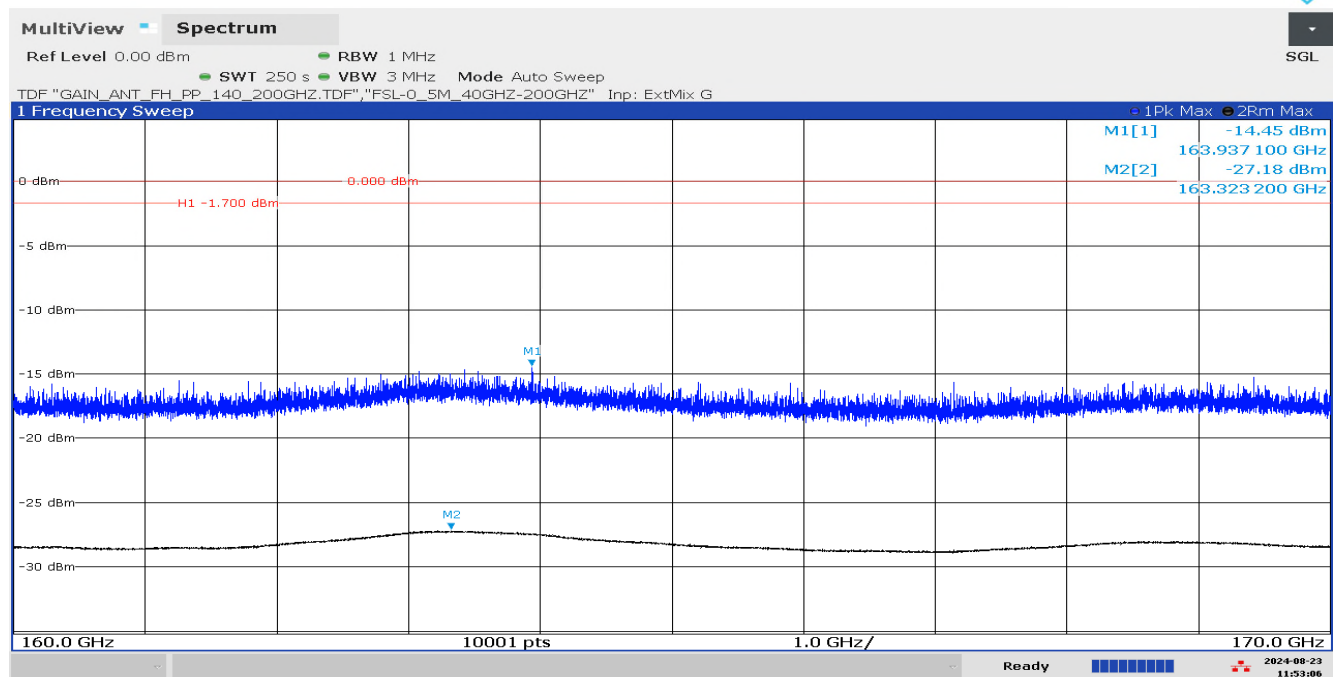
TID227_05b_23-1-0144001T007_RSE_150 G - 160 GHz_FCC_AntV



12:16:49 PM 08/23/2024

Note: No critical Emission found, only noise level from Spectrum Analyzer.

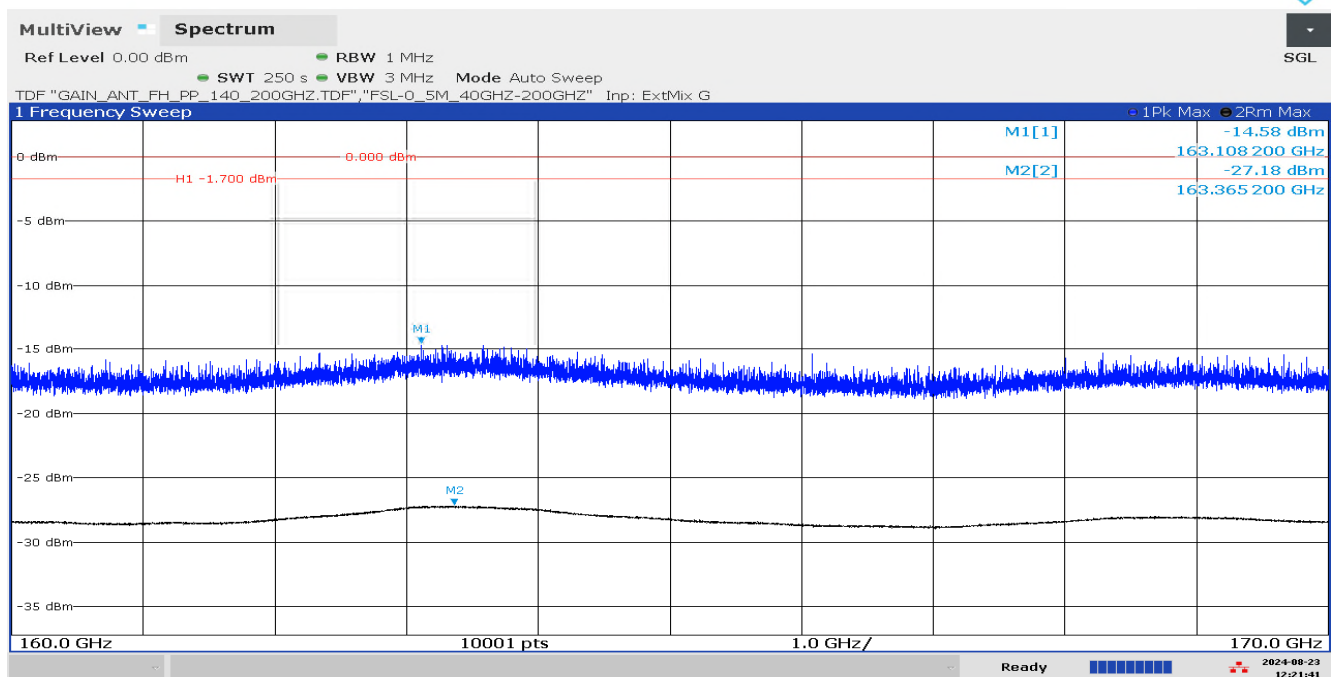
TID227_06a_23-1-0144001T007_RSE_160 G - 170 GHz_FCC_AntH



11:53:07 AM 08/23/2024

Note: No critical Emission found, only noise level from Spectrum Analyzer.

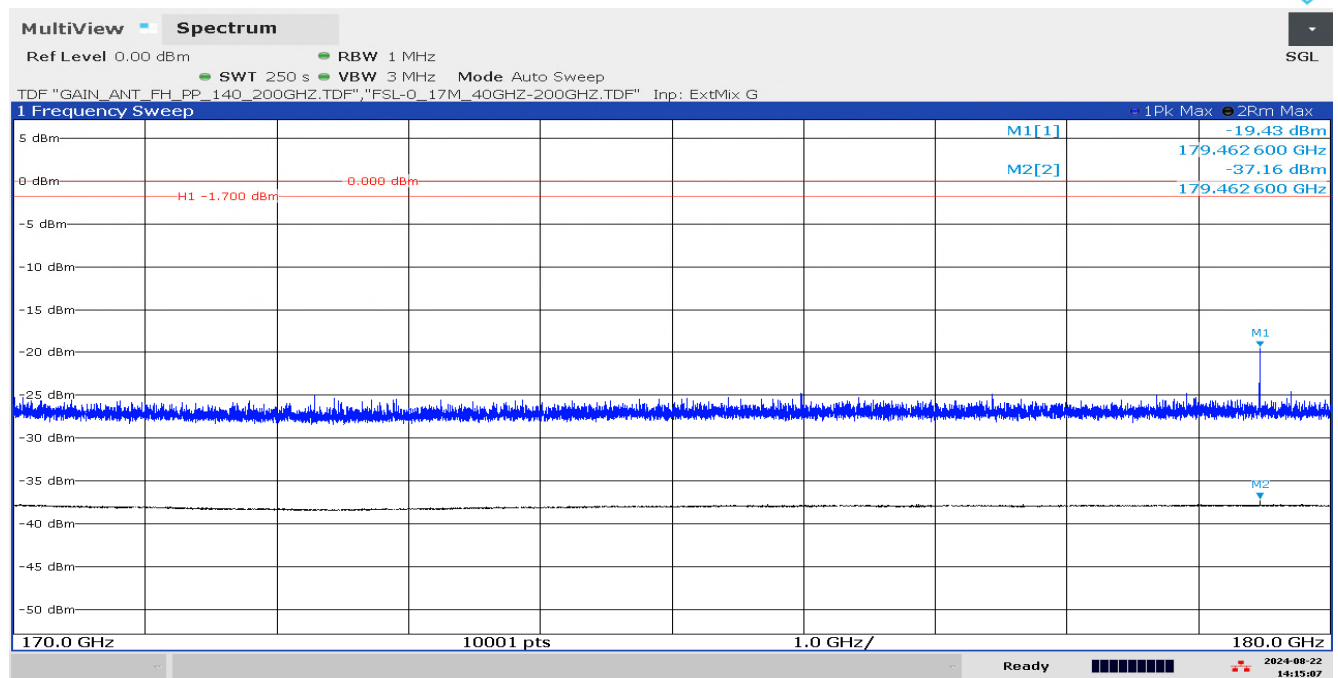
TID227_06b_23-1-0144001T007_RSE_160 G - 170 GHz_FCC_AntV



12:21:41 PM 08/23/2024

Note: No critical Emission found, only noise level from Spectrum Analyzer.

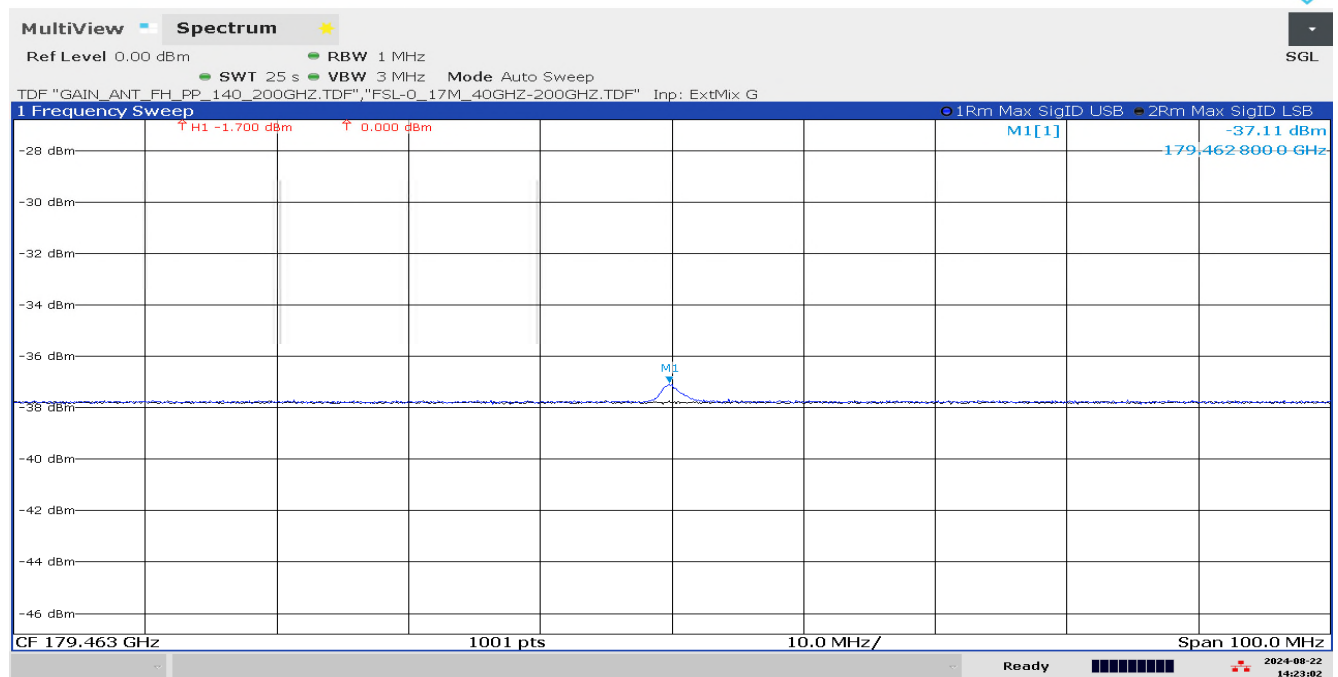
TID228_23-1-0144001T007_RSE_170 G - 180 GHz_AntH_FCC



02:13:07 PM 08/22/2024

Note: Emission at 179.4626 GHz is image signal, no critical emission, for more information, check below TID228_01

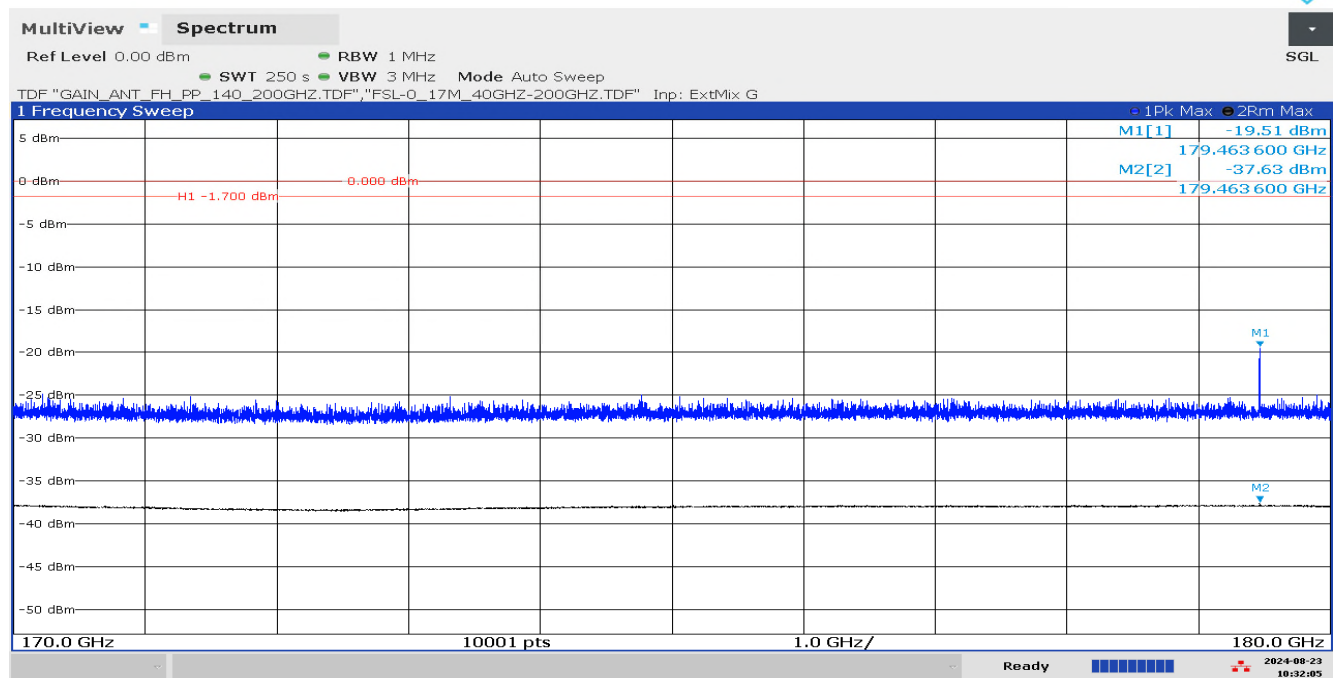
TID228_01_23-1-0144001T007_RSE_179.46 GHz_AntH_FCC_image_signal



02:23:02 PM 08/22/2024

Note: Signal ID function are activated to verify image / ghost signal, Emission at 179.46 GHz is image signal. No critical emission. Signal which are not overlapping(USB+LSB)(USB+LSB) is image / ghost signal.

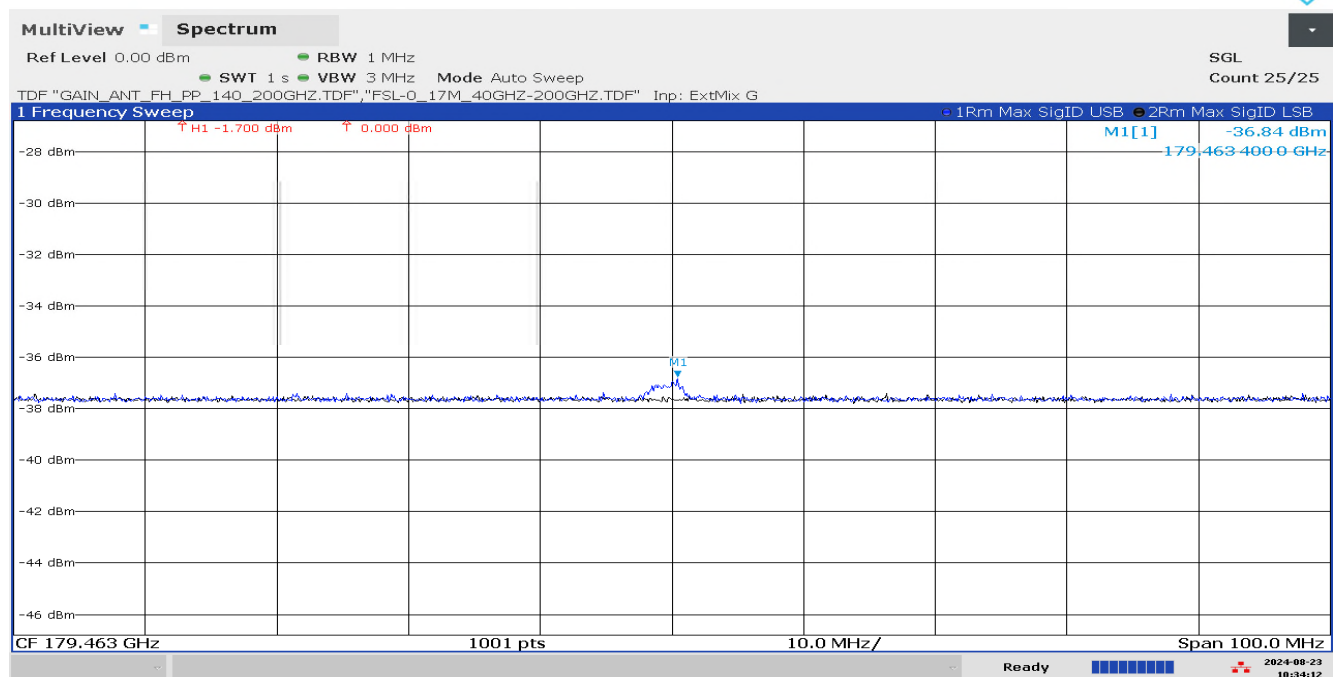
TID229_23-1-0144001T007_RSE_170 G - 180 GHz_AntV_FCC



10:32:05 AM 08/23/2024

Note: Emission at 179.4626 GHz is image signal, no critical emission, for more information, check below TID229_01

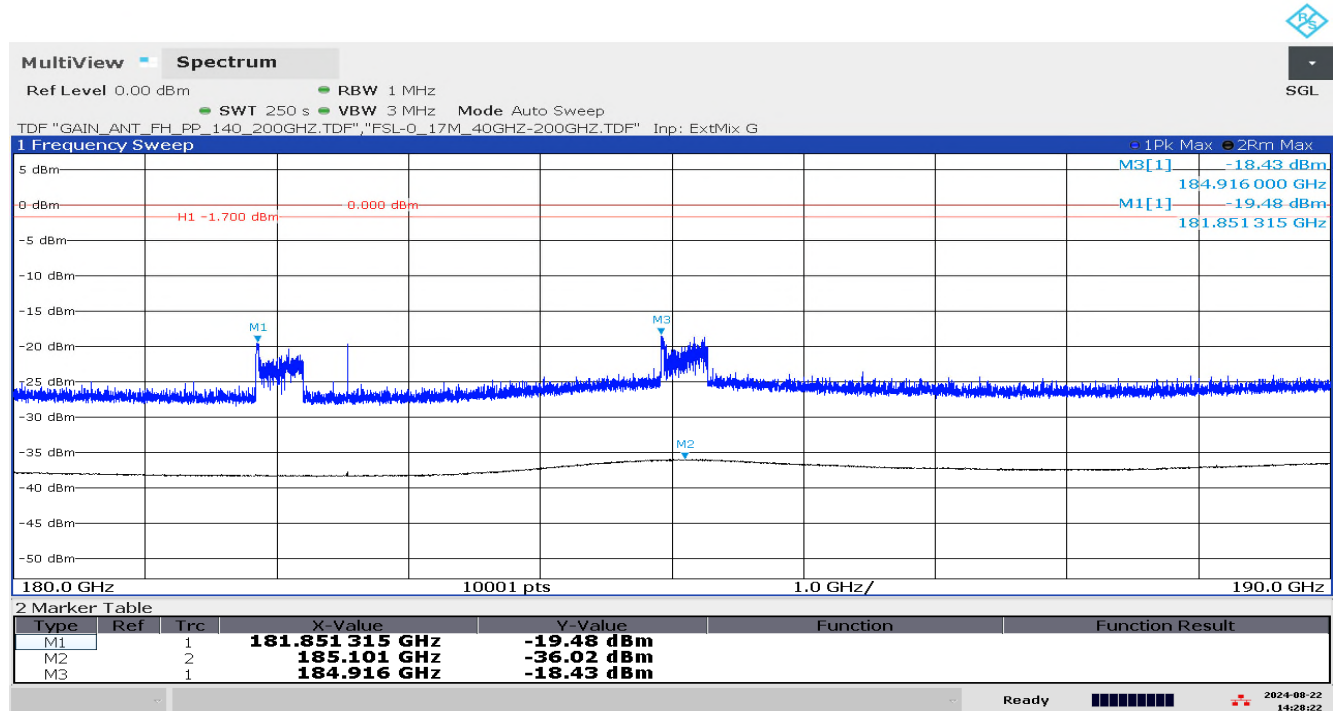
TID229_01_23-1-0144001T007_RSE_179.46 GHz_AntH_FCC_image_signal



10:34:12 AM 08/23/2024

Note: Signal ID function are activated to verify image / ghost signal, Emission at 179.46 GHz is image signal. No critical emission. Signal which are not overlapping(USB+LSB)(USB+LSB) is image / ghost signal.

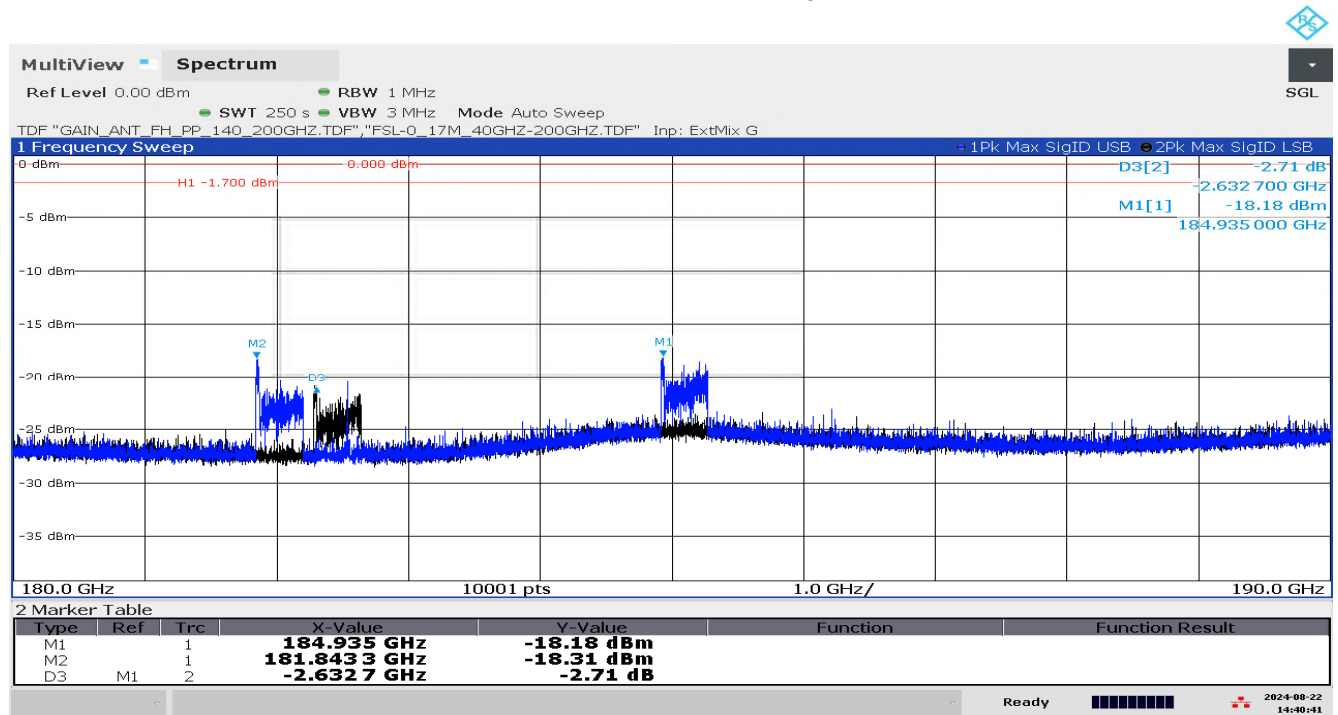
TID230_23-1-0144001T007_RSE_180 G - 190 GHz_AntH_FCC



02:28:22 PM 08/22/2024

Note: Emission at Marker-1 and Marker-2 are image signals, check below TID230_01 for more information.

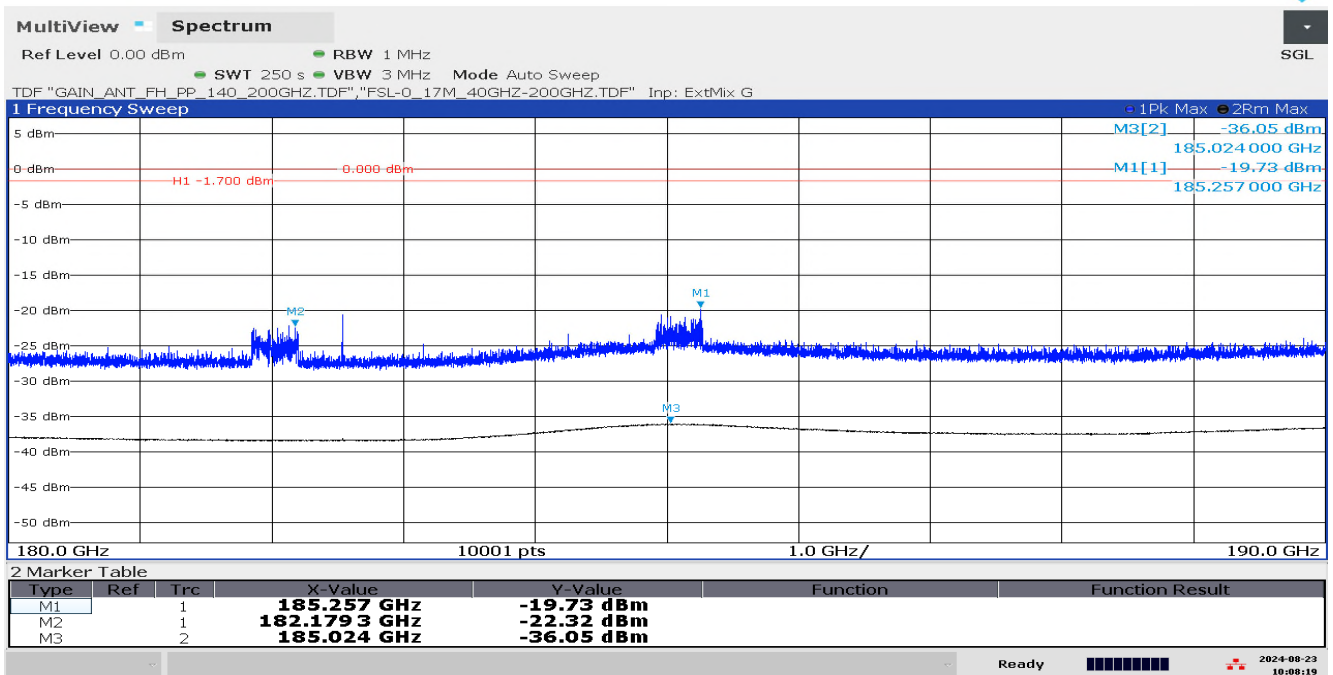
TID230_01_23-1-0144001T007_RSE_180 G - 190 GHz_AntH_FCC_signal_id



02:40:41 PM 08/22/2024

Note: Signal ID function are activated to verify image / ghost signal, in this plot all are image signal.
No critical emission. Signal which are not overlapping(USB+LSB)(USB+LSB) is image / ghost signal.

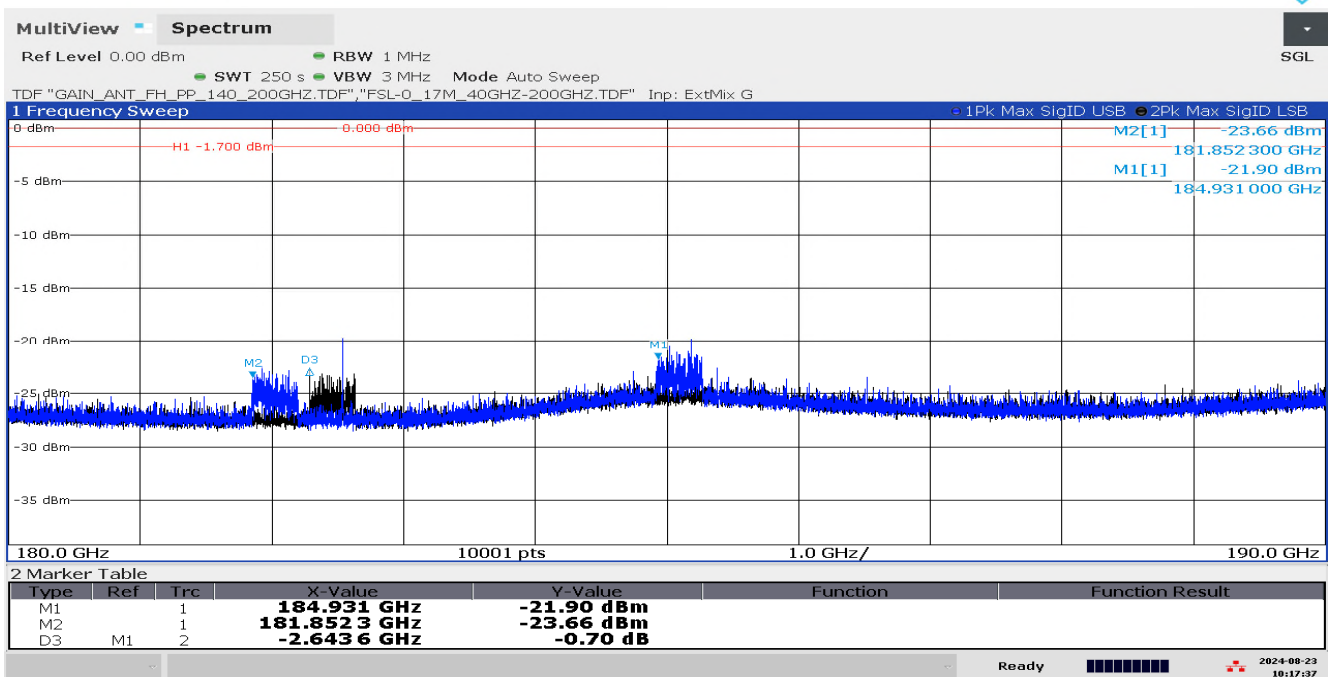
TID231_23-1-0144001T007_RSE_180 G - 190 GHz_AntV_FCC



10:08:19 AM 08/23/2024

Note: Emission at Marker-1 and Marker-2 are image signals, check below TID231_01 for more information.

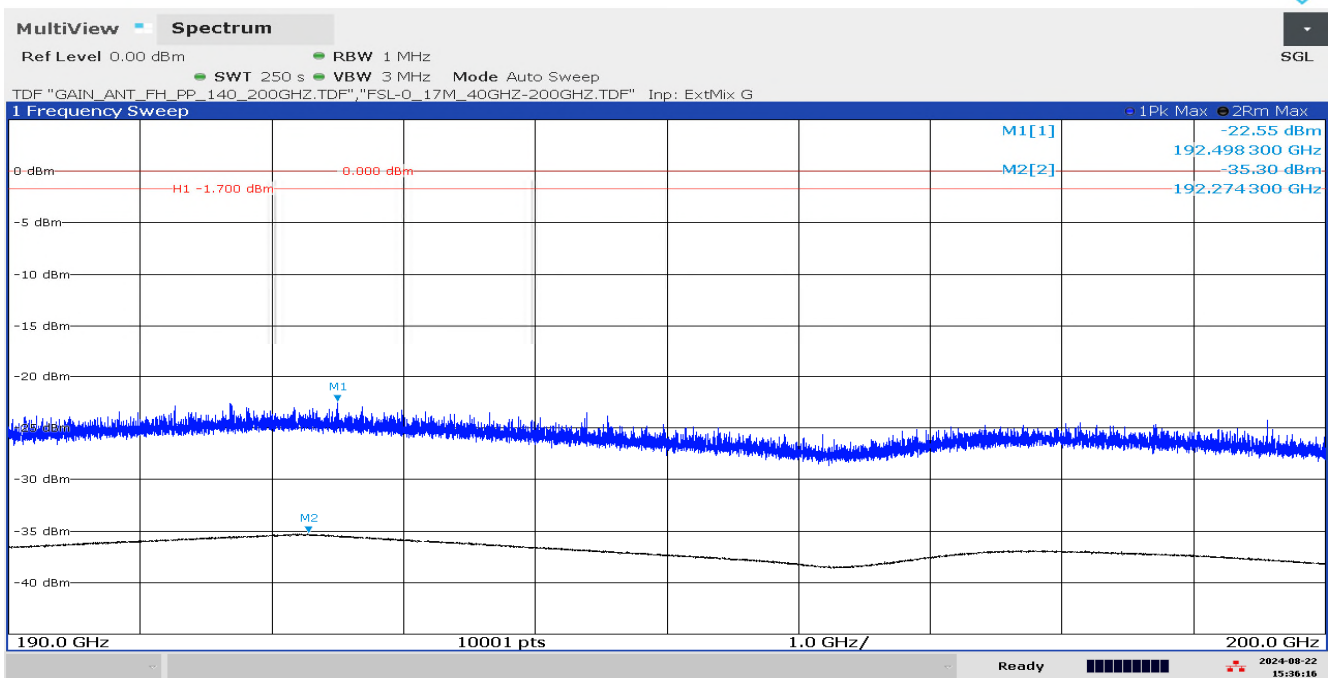
TID231_01_23-1-0144001T007_RSE_180 G - 190 GHz_AntV_FCC_signal_id



10:17:37 AM 08/23/2024

Note: Signal ID function are activated to verify image / ghost signal, in this plot all are image signal. No critical emission. Signal which are not overlapping(USB+LSB) (USB+LSB) is image / ghost signal.

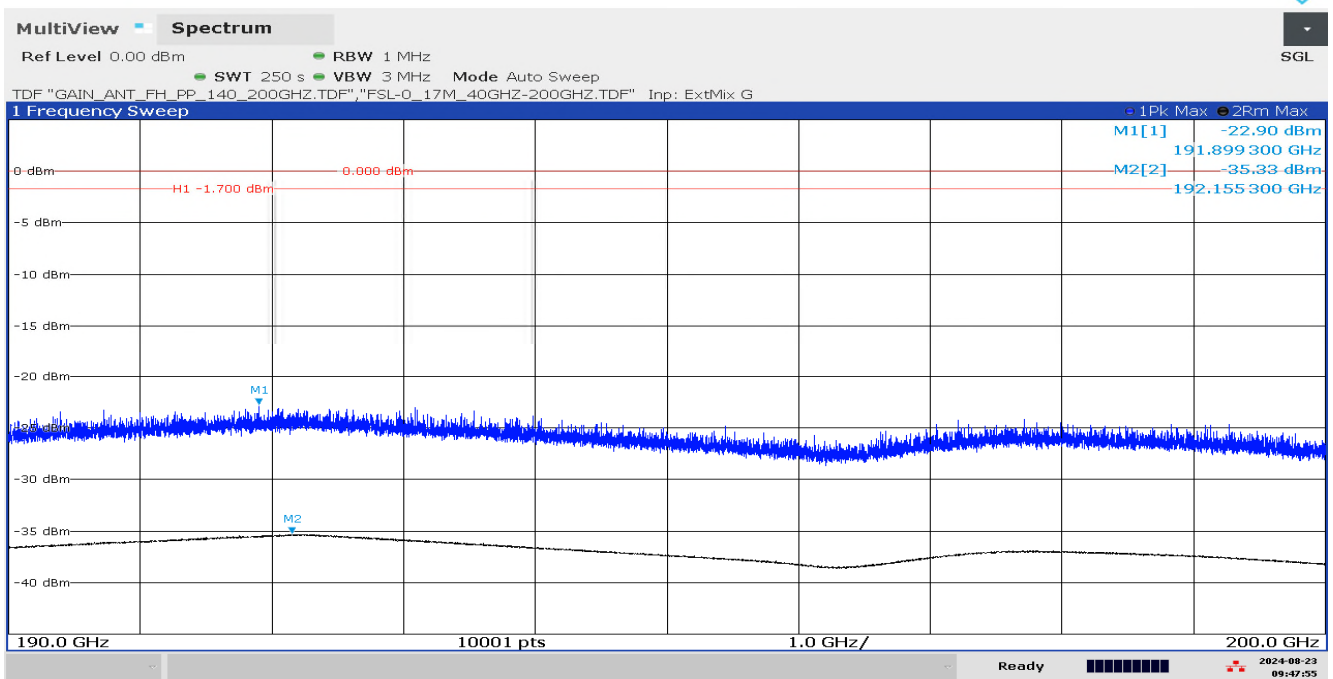
TID232_23-1-0144001T007_RSE_190 G - 200 GHz_AntH_FCC



03:36:16 PM 08/22/2024

Note: No critical Emission found, only noise level from Spectrum Analyzer.

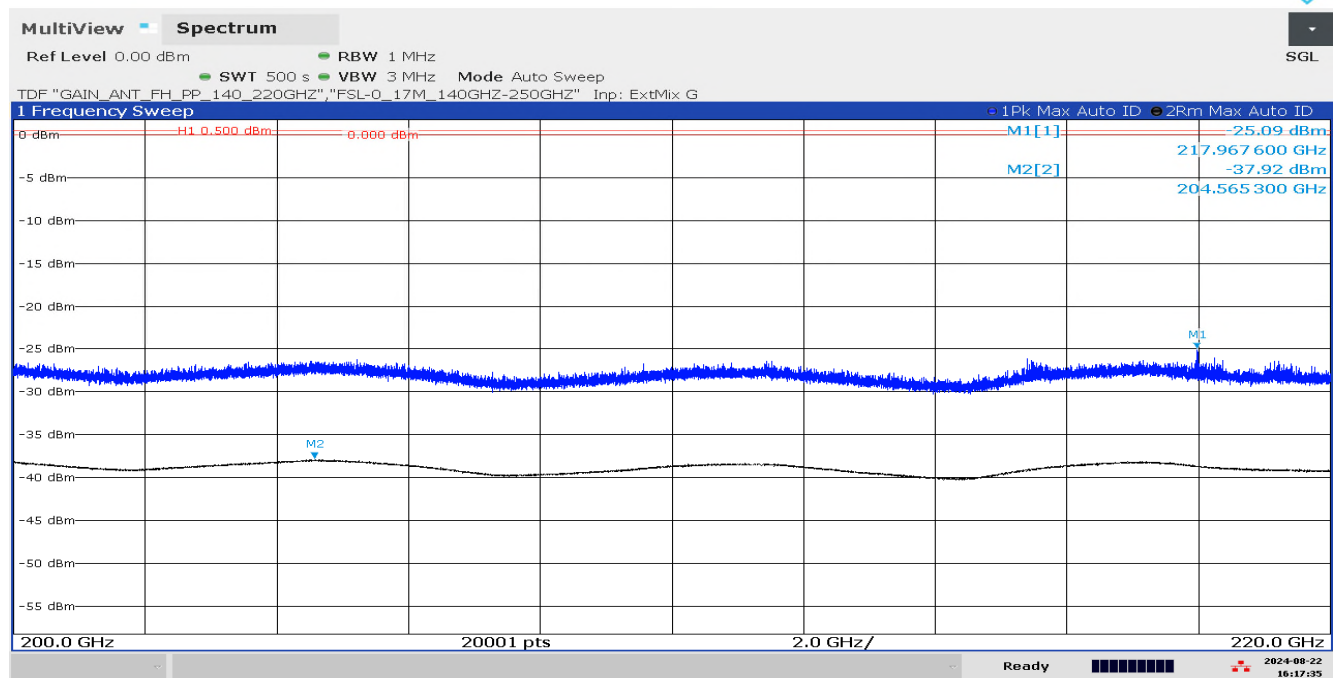
TID233_23-1-0144001T007_RSE_190 G - 200 GHz_AntV_FCC



09:47:55 AM 08/23/2024

Note: No critical Emission found, only noise level from Spectrum Analyzer.

TID234_23-1-0144001T007_RSE_200 G - 220 GHz_AntH_FCC

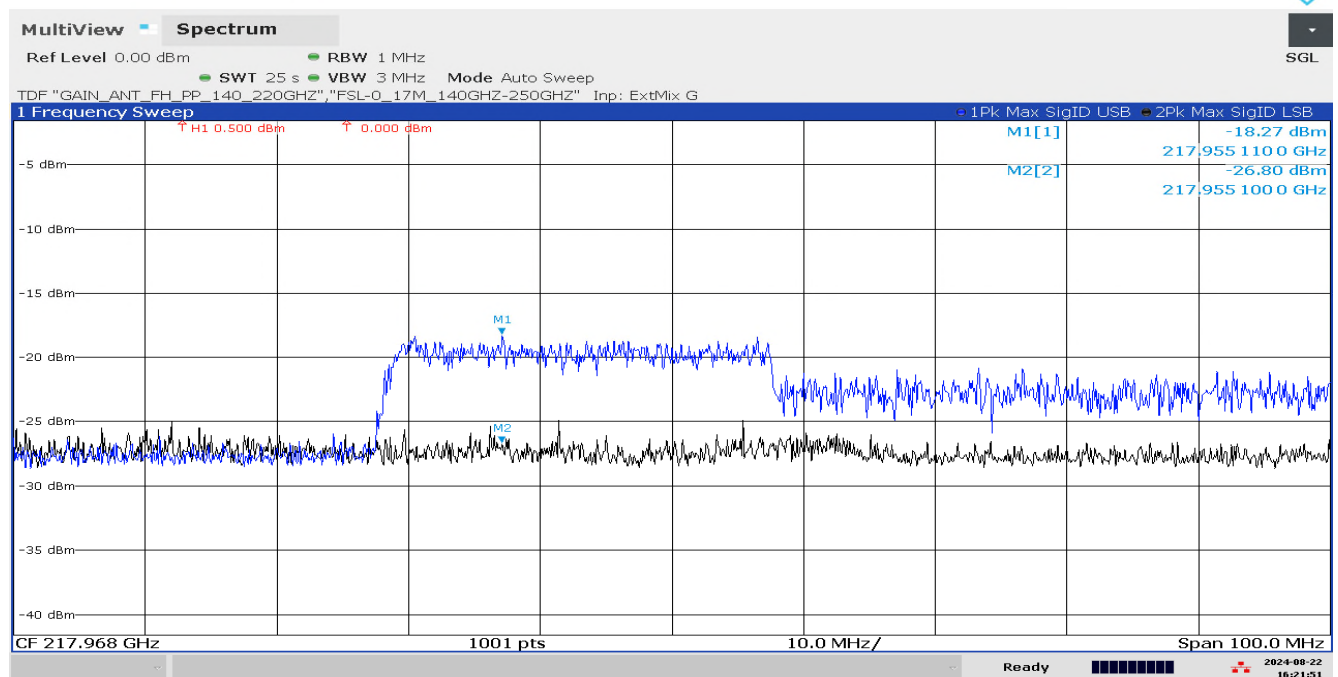


04:17:35 PM 08/22/2024

Note: Peak Detector is only for information, No Critical frequency found. Emission at M1 (217.9676 GHz is image signal)

Limit Line: 0.5 dBm, Result: Pass

TID234_01_23-1-0144001T007_RSE_200 G - 220 GHz_AntH_FCC_signal_id

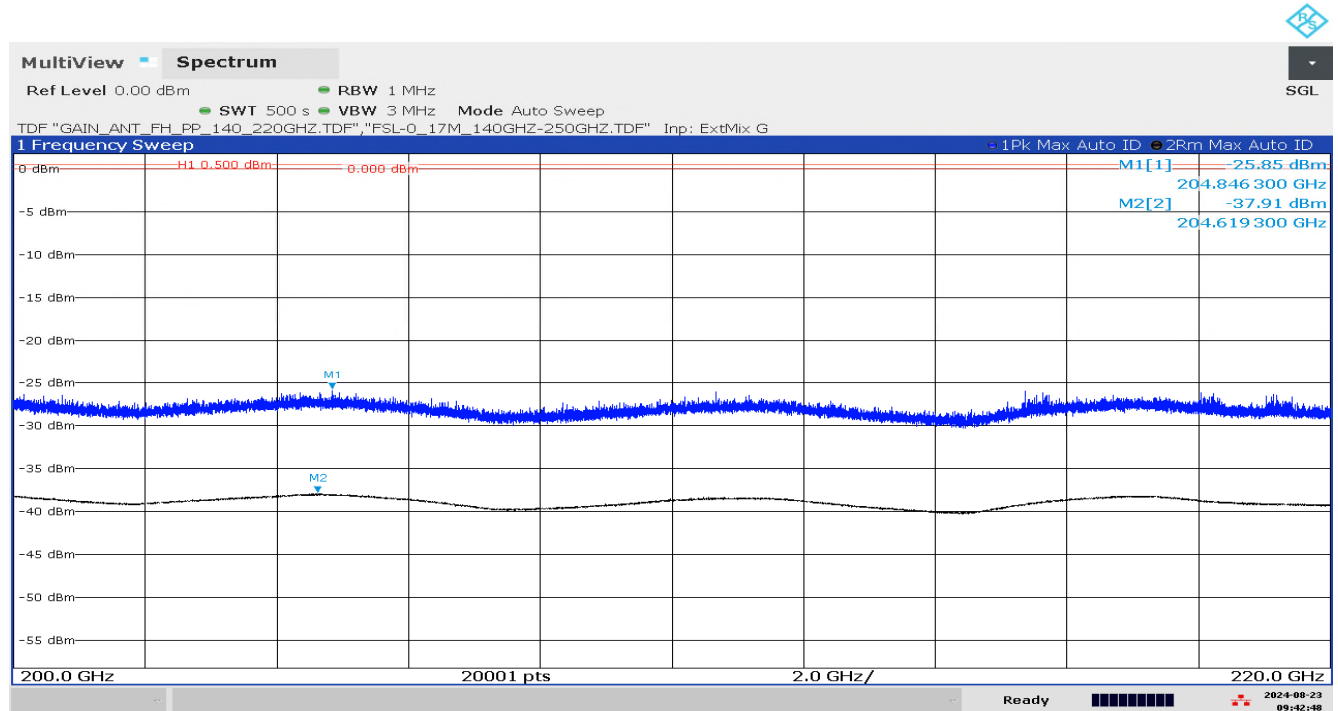


04:21:51 PM 08/22/2024

Note: Since Mixer Products are used, there are some image/ghost signal.

Signals, which are overlapping (USB+LSB), are real signal, in this plot there is only image signal not related to assessment.

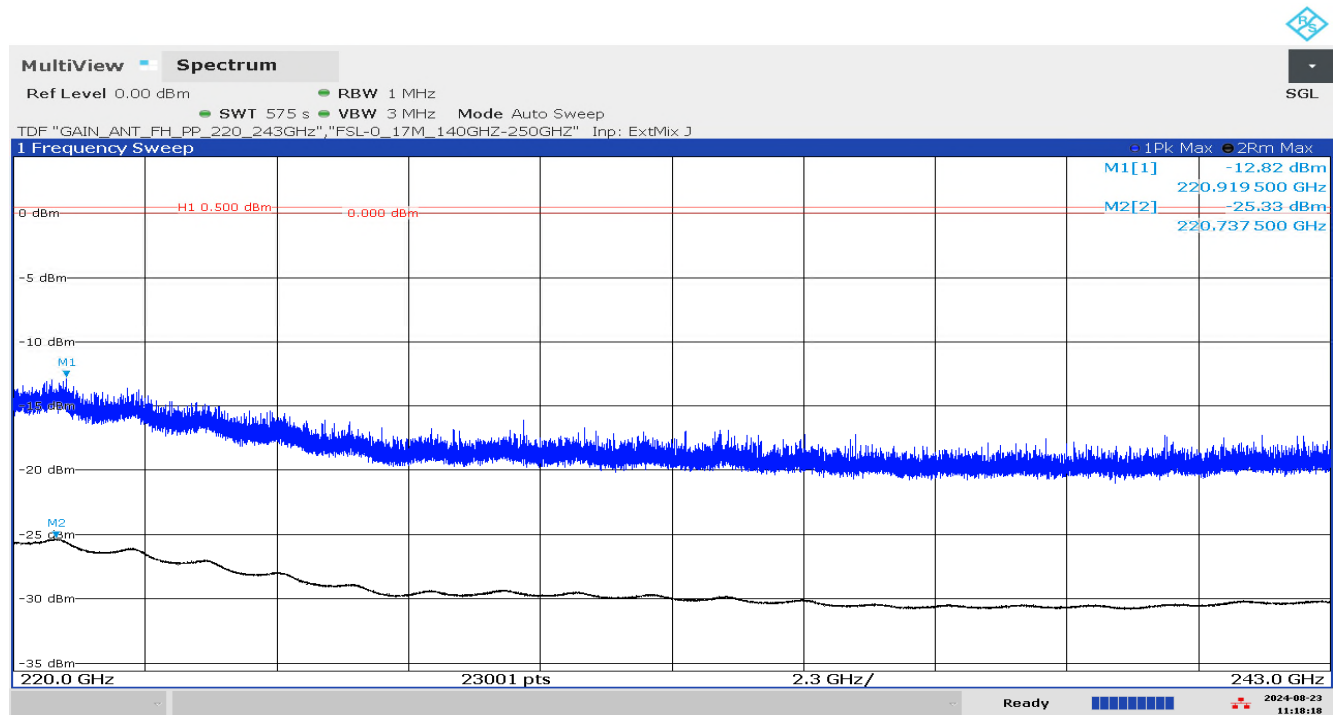
TID235_23-1-0144001T007_RSE_200 G - 220 GHz_AntV_FCC



09:42:48 AM 08/23/2024

Note: Peak Detector is only for information, No Critical frequency found.
Limit Line: 0.5 dBm, Result: Pass

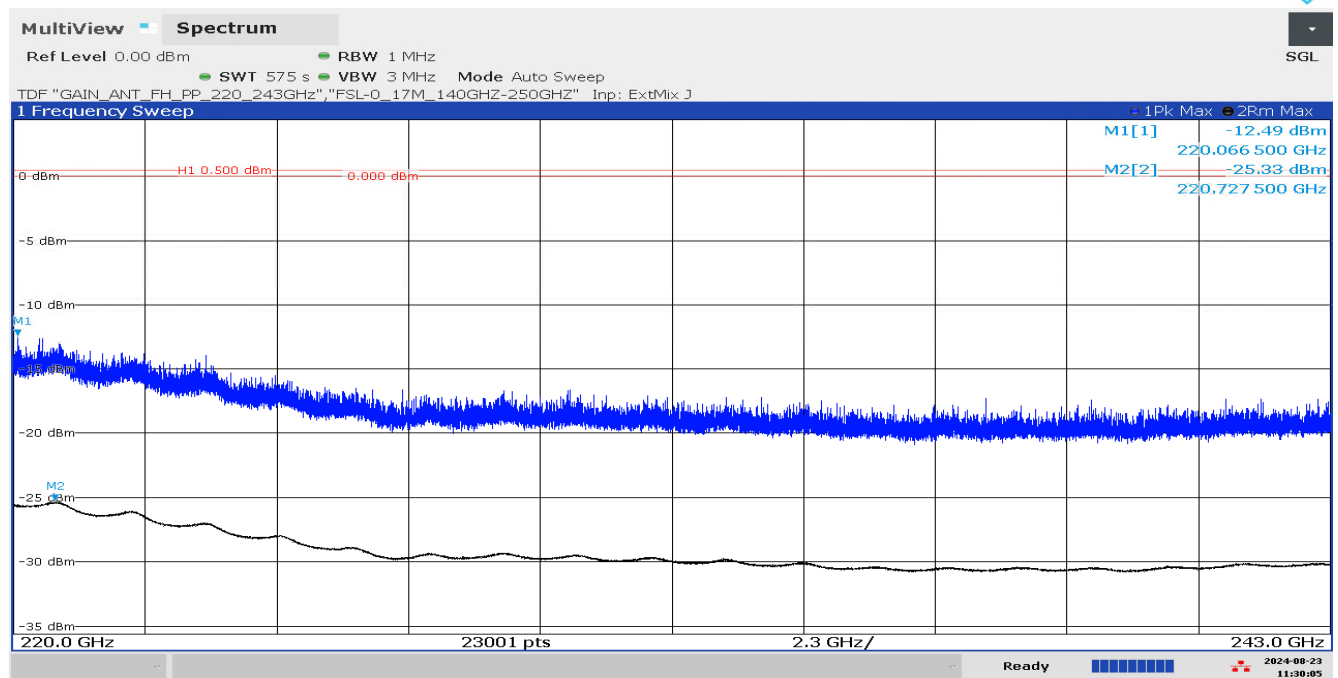
TID236_23-1-0144001T007_RSE_220 G - 243 GHz_AntH_FCC



11:18:18 AM 08/23/2024

Note: Peak Detector is only for information, No Critical frequency found.
Limit Line: 0.5 dBm, Result: Pass

TID237_23-1-0144001T007_RSE_220 G - 243 GHz_AntV_FCC



11:30:05 AM 08/23/2024

Note: Peak Detector is only for information, No Critical frequency found.
Limit Line: 0.5 dBm, Result: Pass

12.6 Frequency stability

Description:

§95.3379 (b) 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 -20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

Limits:

FCC
FCC §95.3379 (b)
The occupied bandwidth from intentional radiators operated within the specified frequency band shall comply with the following:
Frequency range
76 GHz – 81 GHz

Measurement:

Parameters	
Detector:	Pos-Peak
Resolution bandwidth:	50 MHz
Video bandwidth:	80 MHz
Trace-Mode:	Max Hold

Measurement results:

Test condition	Frequency f_L [GHz]	Frequency f_H [GHz]	Bandwidth [GHz]
-20 °C / V_{nom}	77.008053	78.942130	1.934077
-10 °C / V_{nom}	77.007406	78.945789	1.938378
0 °C / V_{nom}	77.006951	78.956179	1.949228
10 °C / V_{nom}	77.006337	78.962884	1.956547
20 °C / V_{nom}	77.005933	78.966823	1.960890
20 °C / V_{min}	77.005837	78.965884	1.960051
20 °C / V_{max}	77.005801	78.965736	1.959934
30 °C / V_{nom}	77.005328	78.968232	1.962904
40 °C / V_{nom}	77.005369	78.971956	1.966587
50 °C / V_{nom}	77.004802	78.972297	1.967495

Note:

- The EUT is measured in the temperature range from -20°C to 50°C specified by §95.3379 (b) and RSS Gen 6.11.
- If the operating temperature range of the device specified by the manufacturer exceeds the test temperature range (-20°C to +50°C), the customer is responsible for ensuring the frequency stability and proper functioning of the device within the extended operating temperature range.

Verdict: Complies

Note: For measurement diagrams, check another document "23-1-0144001T007_TR1-A201-R1.pdf"

13 Glossary

EUT	Equipment under test
DUT	Device under test
UUT	Unit under test
GUE	GNSS User Equipment
ETSI	European Telecommunications Standards Institute
EN	European Standard
FCC	Federal Communications Commission
FCC ID	Company Identifier at FCC
IC	Industry Canada
PMN	Product marketing name
HMN	Host marketing name
HVIN	Hardware version identification number
FVIN	Firmware version identification number
EMC	Electromagnetic Compatibility
HW	Hardware
SW	Software
Inv. No.	Inventory number
S/N or SN	Serial number
C	Compliant
NC	Not compliant
NA	Not applicable
NP	Not performed
PP	Positive peak
QP	Quasi peak
AVG	Average
OC	Operating channel
OCW	Operating channel bandwidth
OBW	Occupied bandwidth
OOB	Out of band
DFS	Dynamic frequency selection
CAC	Channel availability check
OP	Occupancy period
NOP	Non occupancy period
DC	Duty cycle
PER	Packet error rate
CW	Clean wave
MC	Modulated carrier
WLAN	Wireless local area network
RLAN	Radio local area network
DSSS	Dynamic sequence spread spectrum
OFDM	Orthogonal frequency division multiplexing
FHSS	Frequency hopping spread spectrum
GNSS	Global Navigation Satellite System
C/N₀	Carrier to noise-density ratio, expressed in dB-Hz

14 Document history

Version	Applied changes	Date of release
R01	Initial release	2024-11-20
R02	Frequency band corrected. R01 of the report is replaced and not valid anymore.	2025-02-14

END OF TEST REPORT