

Annex 1: Measurement diagrams 23-1-0144201T001a-A1

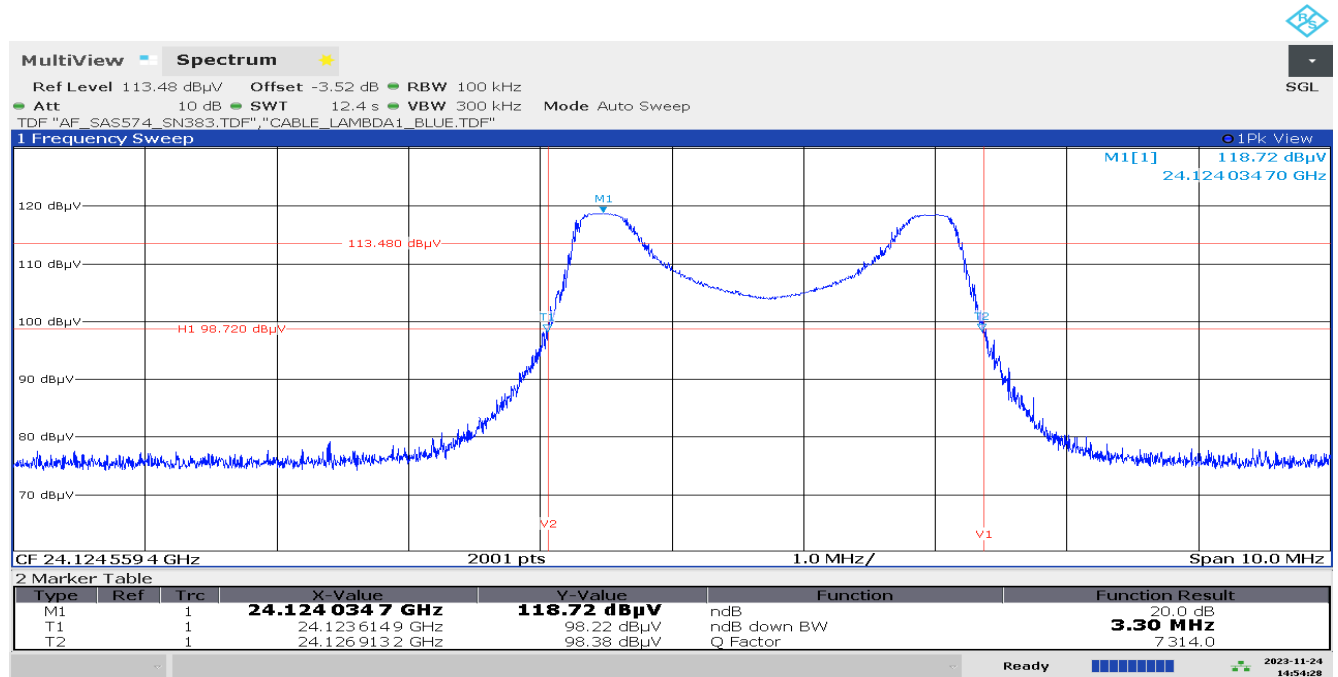
Number of pages:	40	Date of Report:	2024-Jun-13
Testing company:	cetecom advanced GmbH Untertuerkheimer Str. 6-10 66117 Saarbruecken GERMANY	Applicant:	RTB GmbH & Co. KG
Product:	Radar unit (IVS-179/ Radarboard)		
Model:	Radarbased vehicle classification		
FCC ID:	2BDLJ-RU-IVS179		--
Testing has been carried out in accordance with:	FCC Regulations Title 47 CFR, Chapter I, Subchapter A, Part 15 Subpart C Intentional Radiators § 15.245 operating within the Band 24.075G to 24.175GHz § 15.215(c), § 15.245(b), § 15.207(a) § 15.205 Restricted bands of operation. § 15.209 Radiated emission limits; general requirements		

1 Measurement results

20dB bandwidth at normal condition, Normal Mode

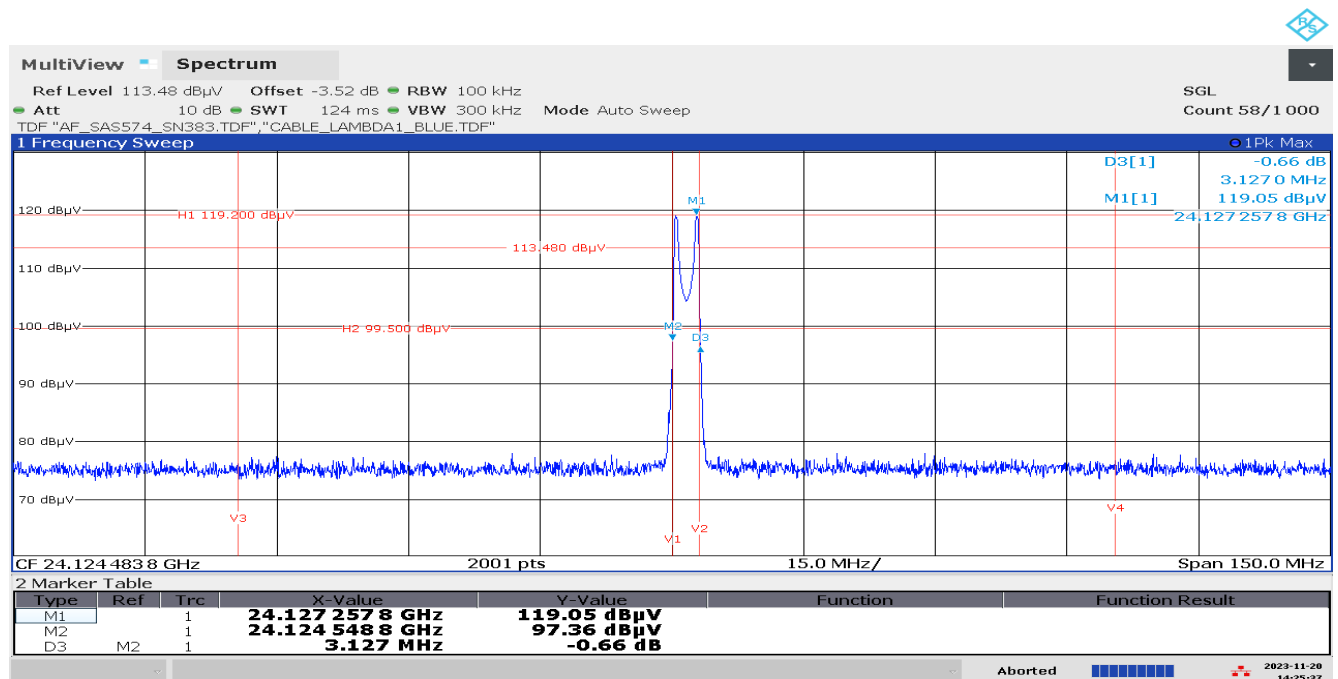
Note: Worst-case has found at measurement Antenna Vertical Polarization, therefore all measurements have performed with Vertical Polarization.

D506_20dB_OBW_3.30MHz_12V_T20°C_ndB



02:54:29 PM 11/24/2023

D204_20dB_OBW_3.13MHz_span_150MHz

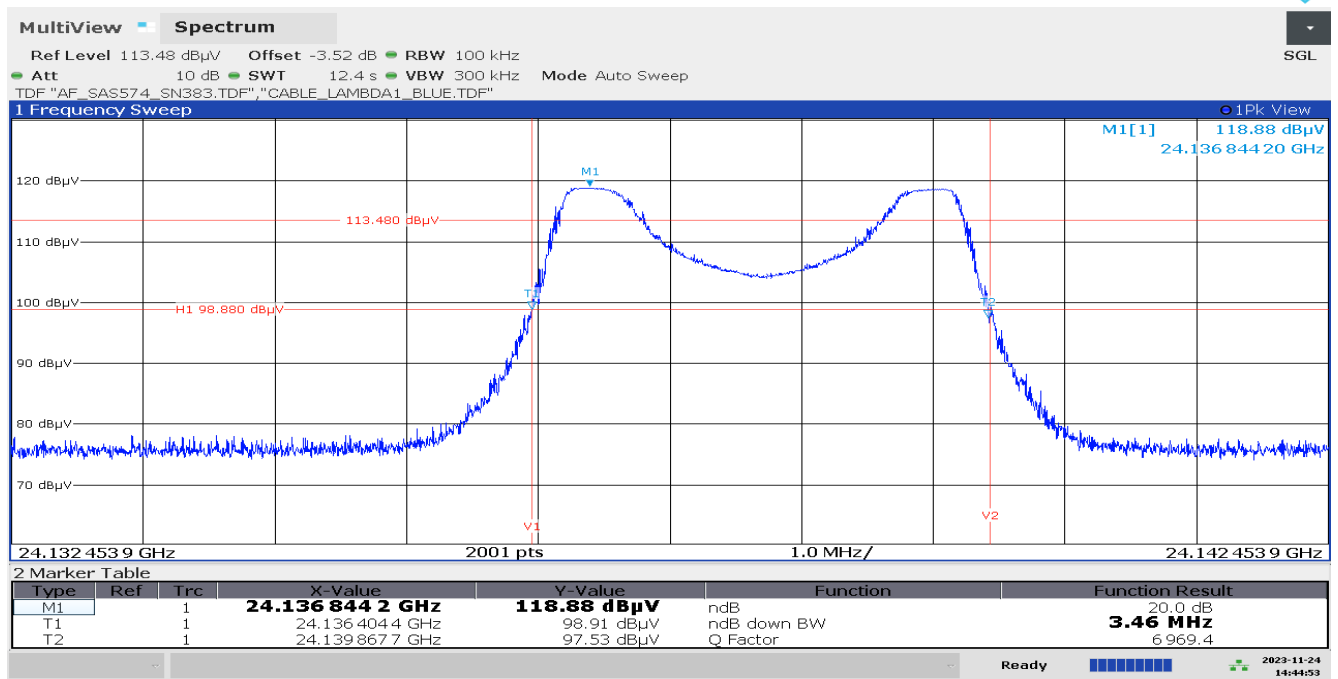


02:25:37 PM 11/20/2023

Only for information, not for assessment. With large span (150MHz) V3 = 24.075GHz, V4 = 24.175GHz

Frequency stability tests, bandwidth at -20 °C / V_{nom}

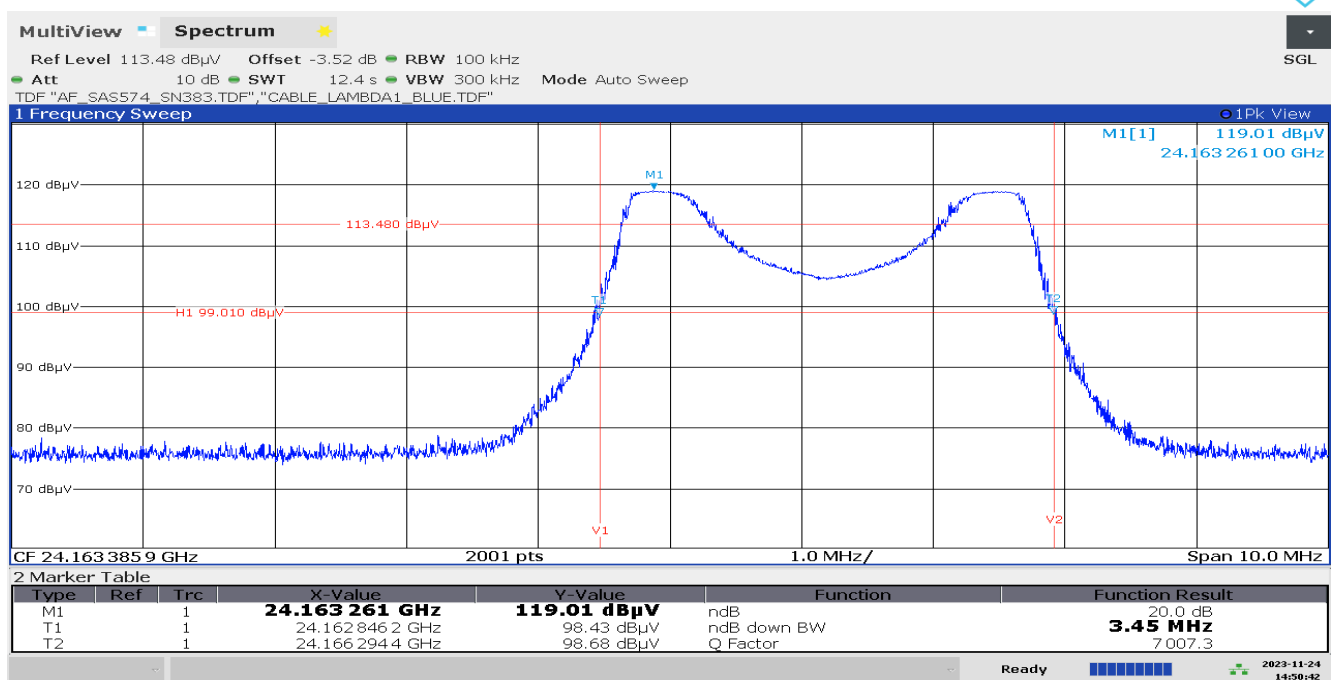
D500_20dB_OBW_3.46MHz_12V_T-20°C_ndB



02:44:53 PM 11/24/2023

Frequency stability tests, bandwidth at -10 °C / V_{nom}

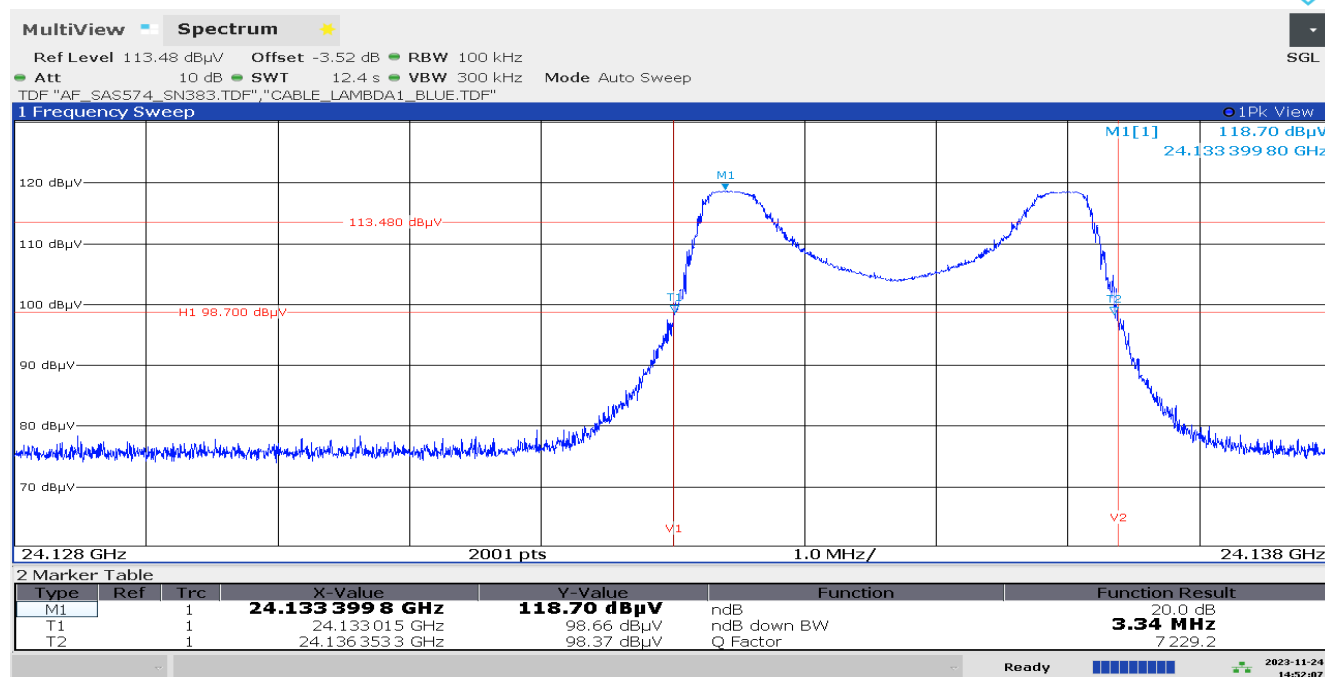
D503_20dB_OBW_3.45MHz_12V_T-10°C_ndB



02:50:43 PM 11/24/2023

Frequency stability tests, bandwidth at 0 °C / V_{nom}

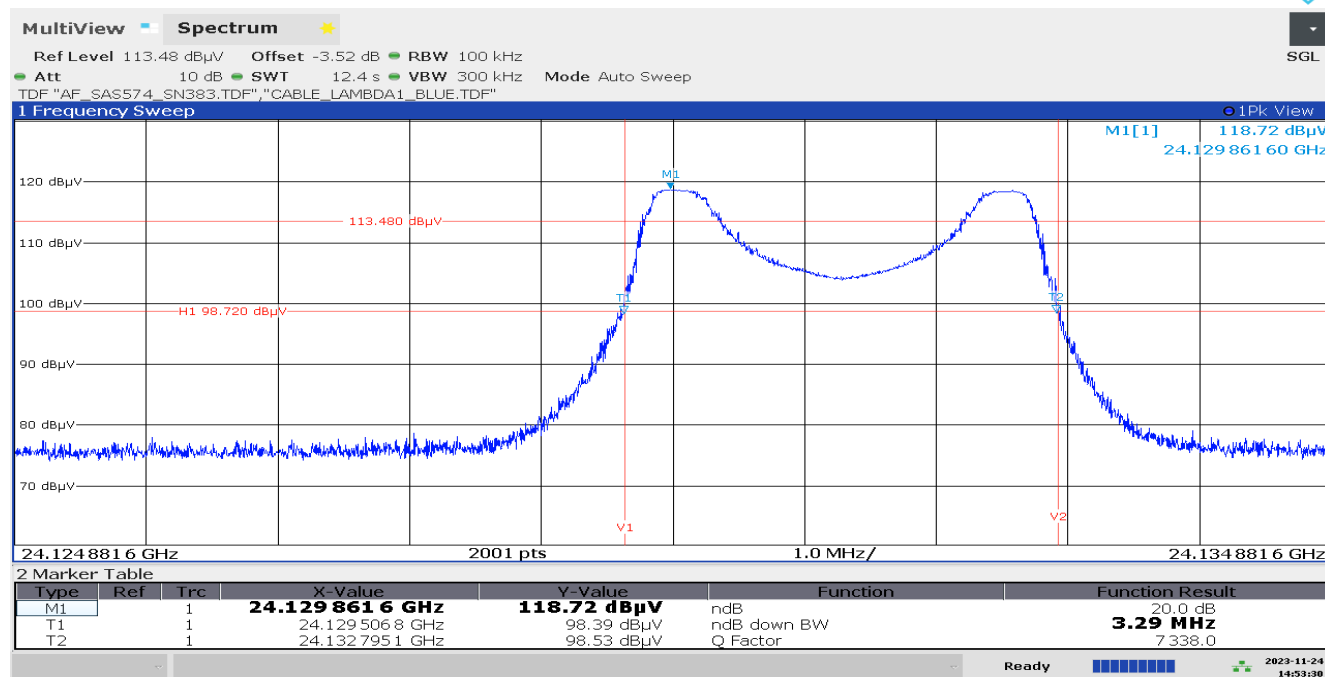
D504_20dB_OBW_3.34MHz_12V_T0°C_ndB



02:52:07 PM 11/24/2023

Frequency stability tests, bandwidth at 10 °C / V_{nom}

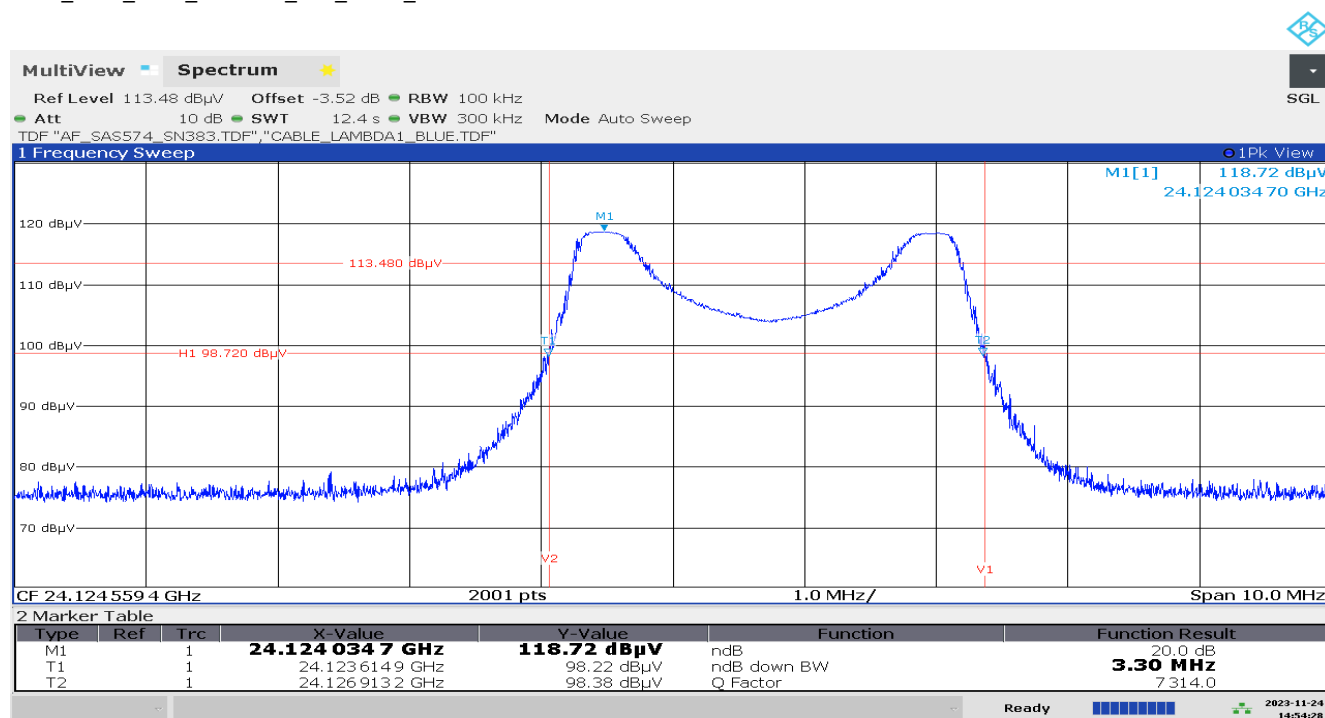
D505_20dB_OBW_3.29MHz_12V_T10°C_ndB



02:53:30 PM 11/24/2023

Frequency stability tests, bandwidth at 20 °C / V_{nom}

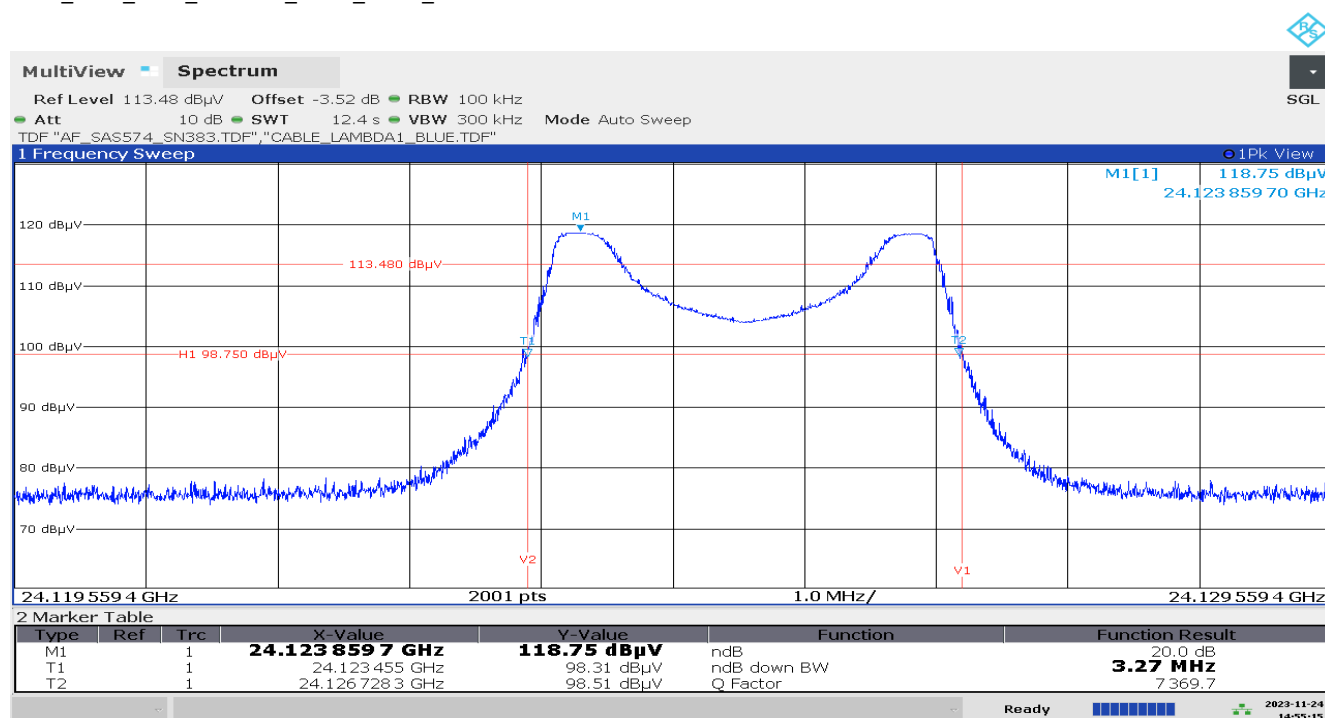
D506_20dB_OBW_3.30MHz_12V_T20°C_ndB



02:54:29 PM 11/24/2023

Frequency stability tests, bandwidth at 20 °C / V_{max}

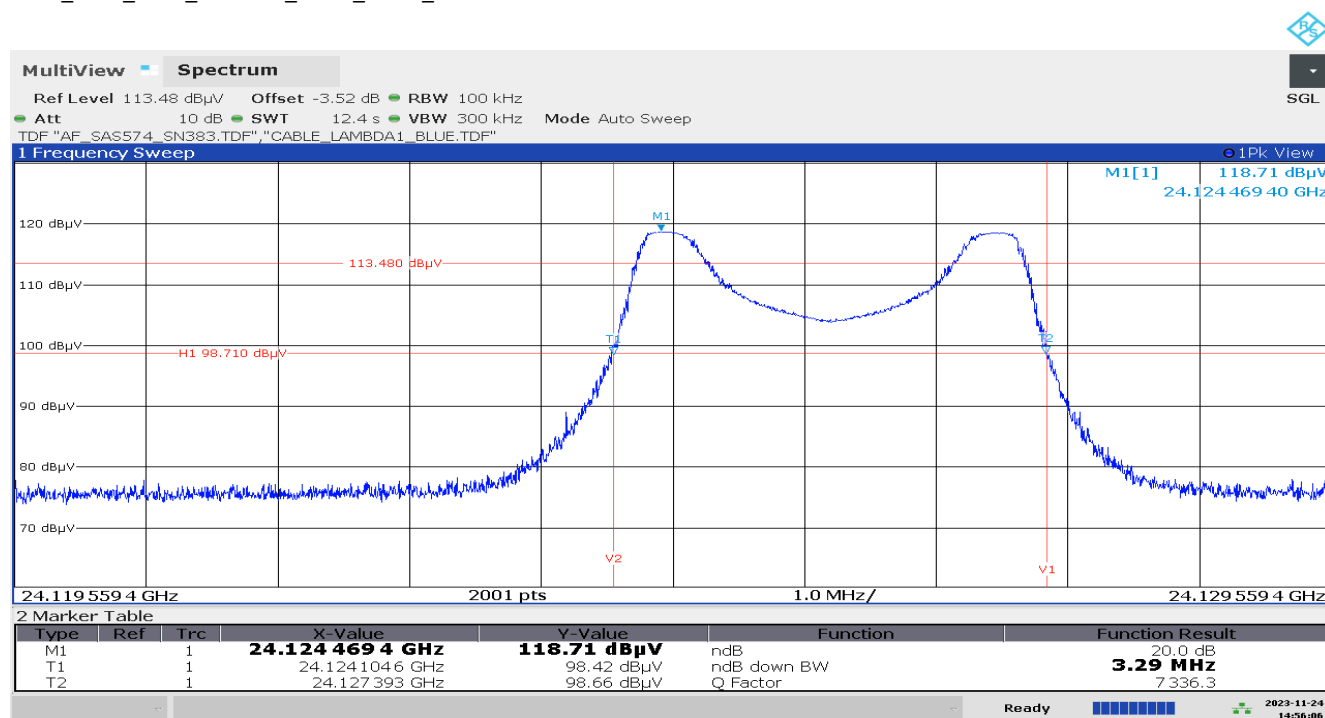
D507_20dB_OBW_3.27MHz_14.5V_T20°C_ndB



02:55:16 PM 11/24/2023

Frequency stability tests, bandwidth at 20 °C / V_{min}

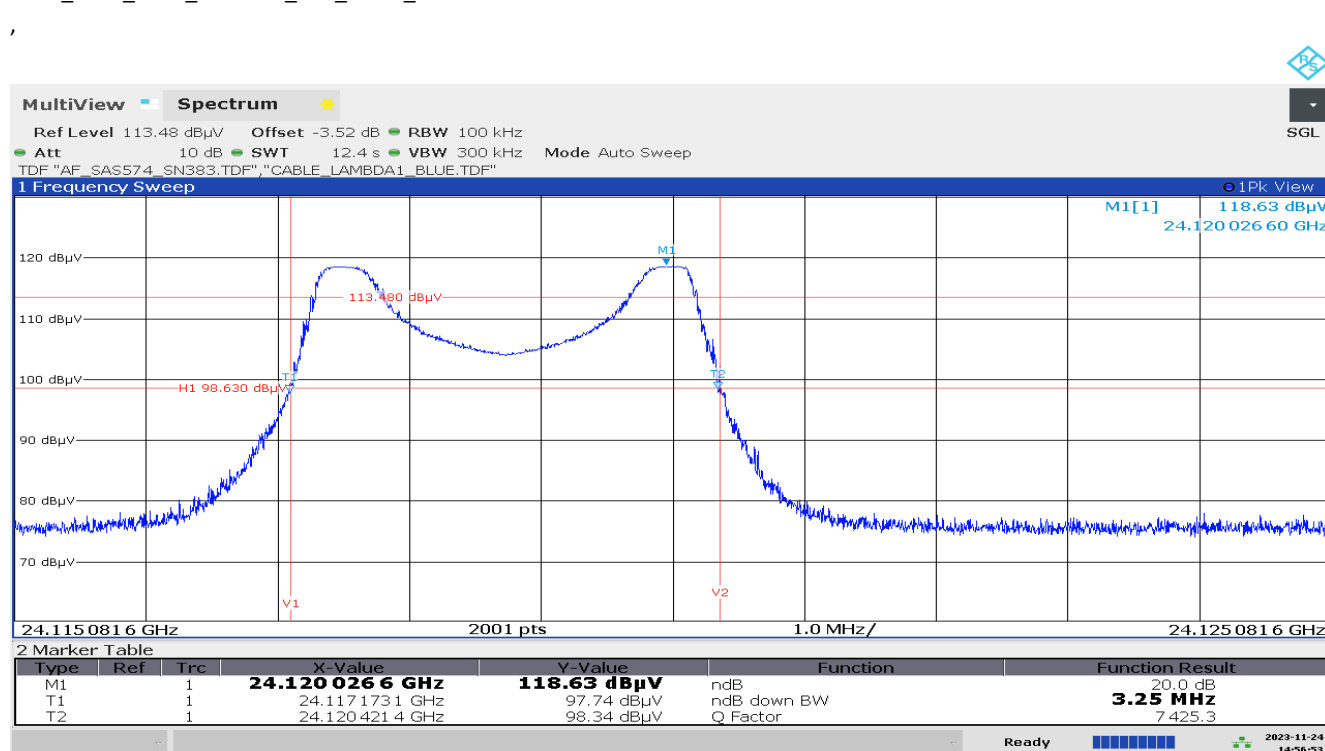
D508_20dB_OBW_3.29MHz_10.9V_T20°C_ndB



02:56:06 PM 11/24/2023

Frequency stability tests, bandwidth at 30 °C / V_{nom}

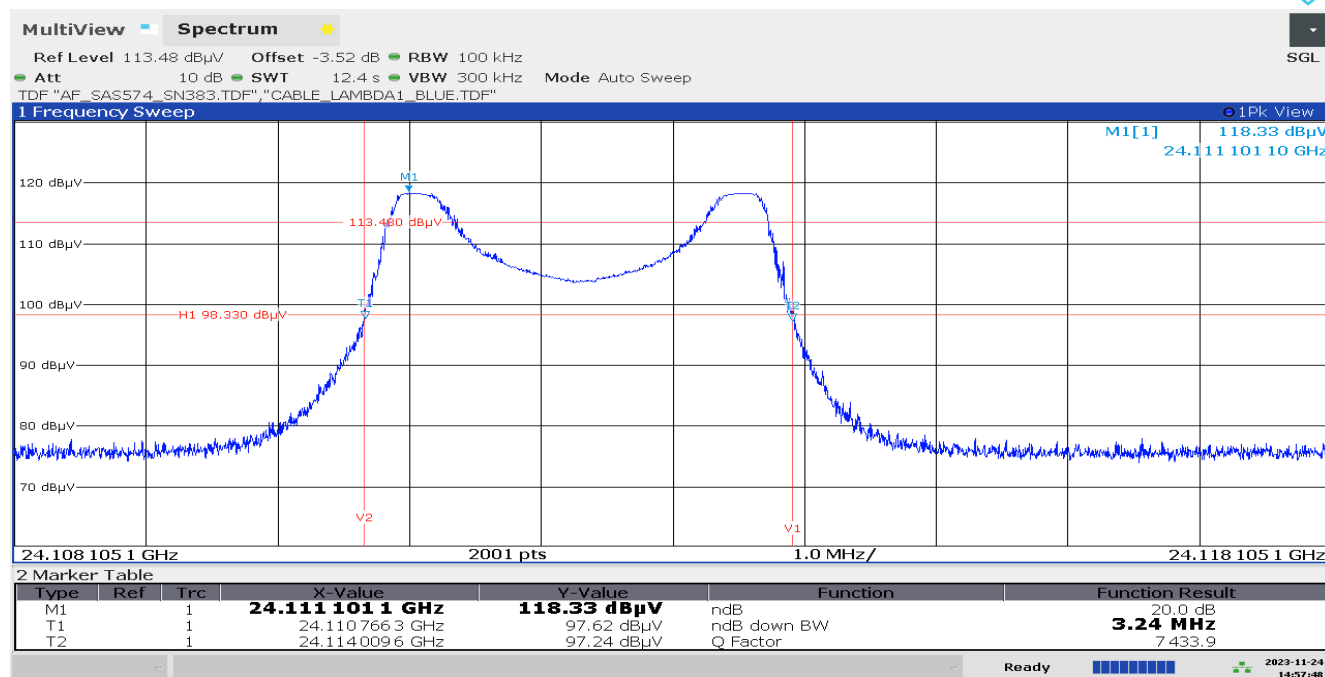
D509_20dB_OBW_3.25MHz_12V_T30°C_ndB



02:56:53 PM 11/24/2023

Frequency stability tests, bandwidth at 40 °C / V_{nom}

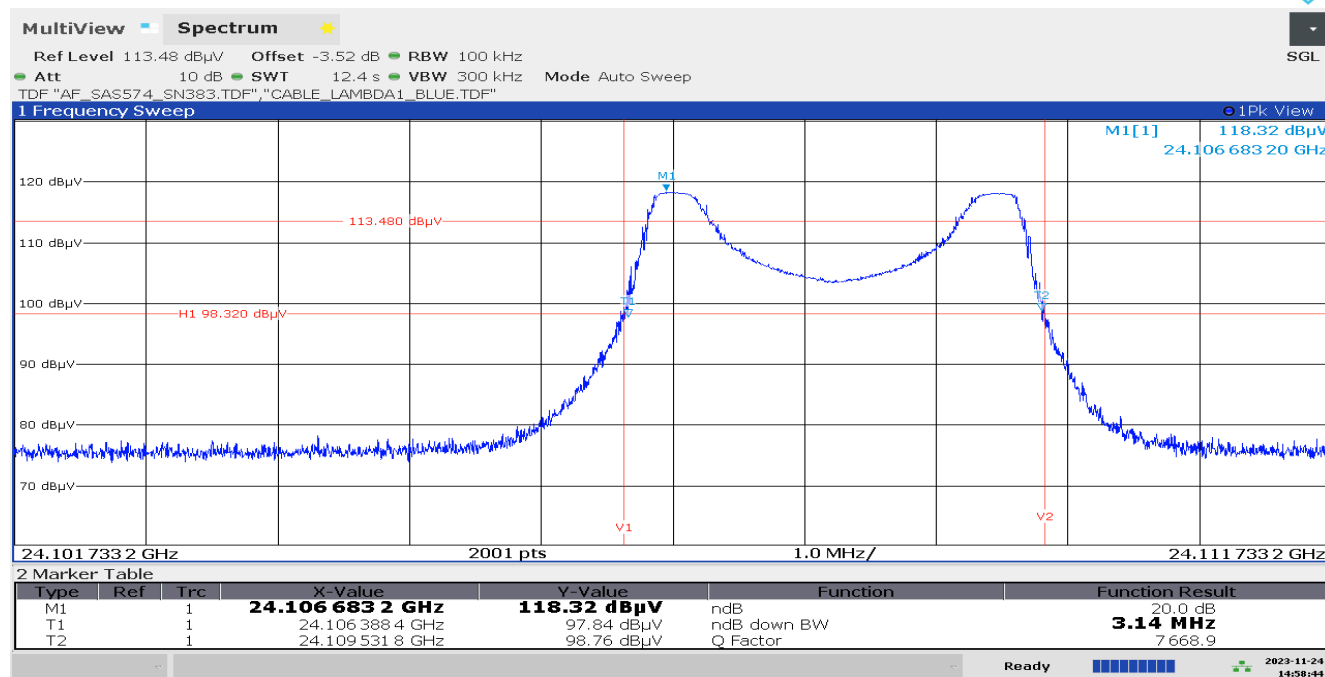
D510_20dB_OBW_3.24MHz_12V_T40°C_ndB



02:57:48 PM 11/24/2023

Frequency stability tests, bandwidth at 50 °C / V_{nom}

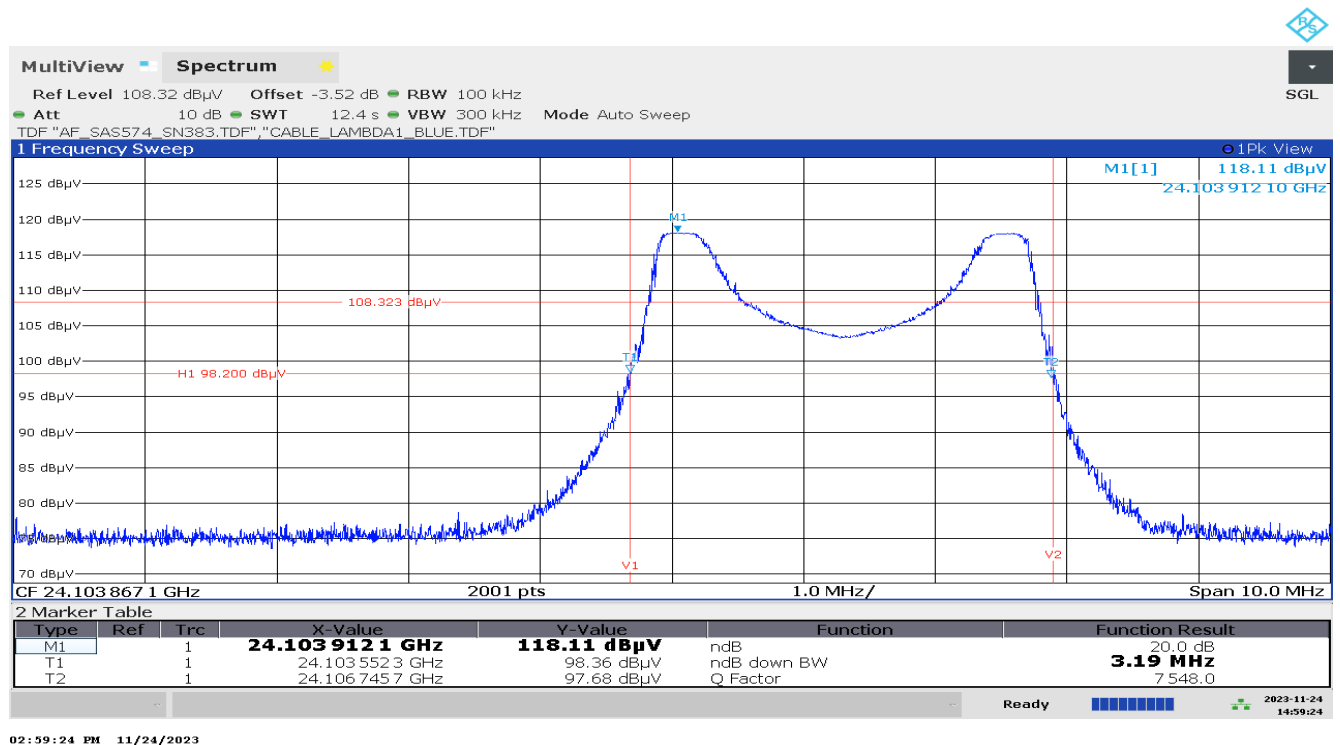
D511_20dB_OBW_3.14MHz_12V_T50°C_ndB



02:58:44 PM 11/24/2023

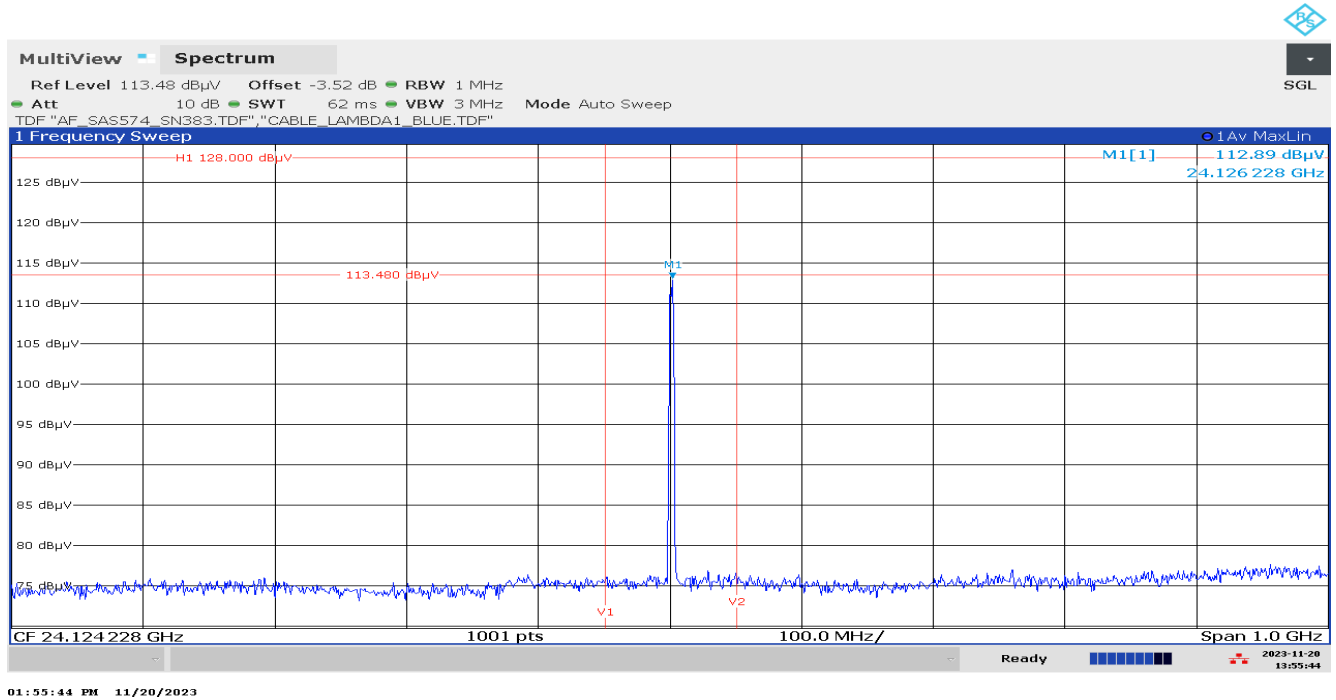
Frequency stability tests, bandwidth at 60 °C / V_{nom}

D512_20dB_OBW_3.19MHz_12V_T60°C_ndB



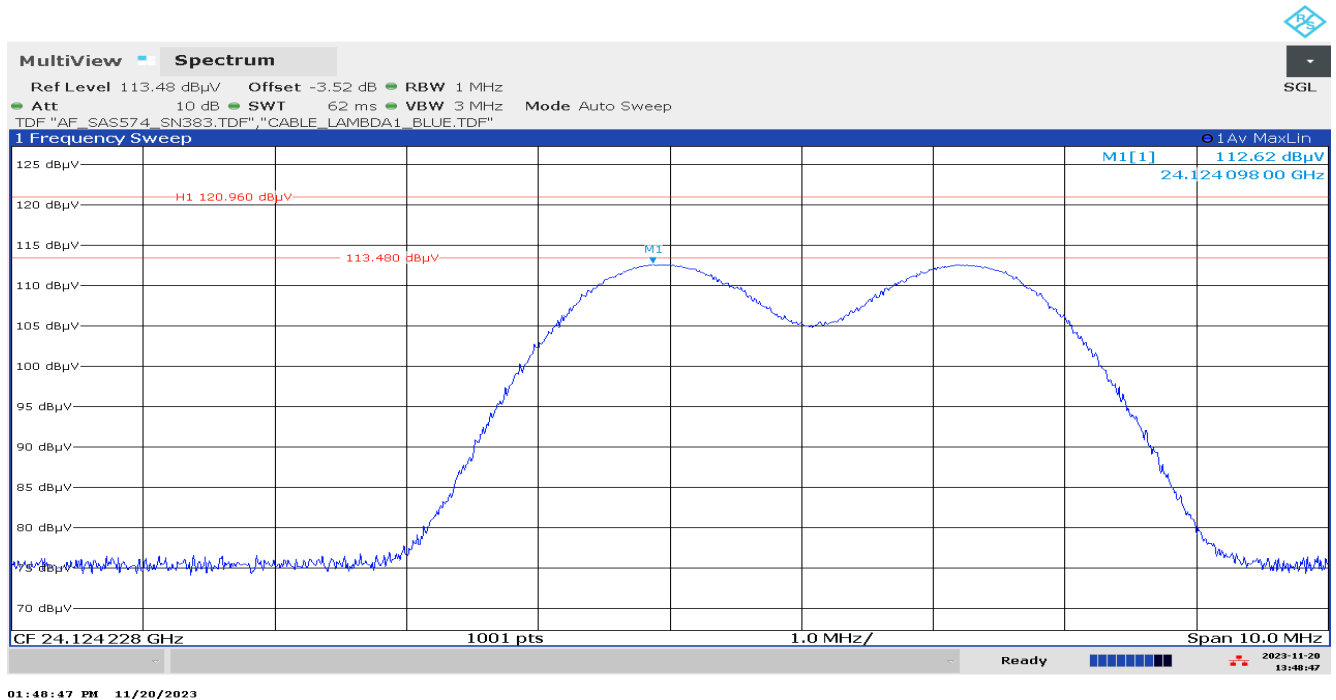
1.1 Field strength of fundamental emission

D100_Max_Avg_Field_Strength_Span_1GHz



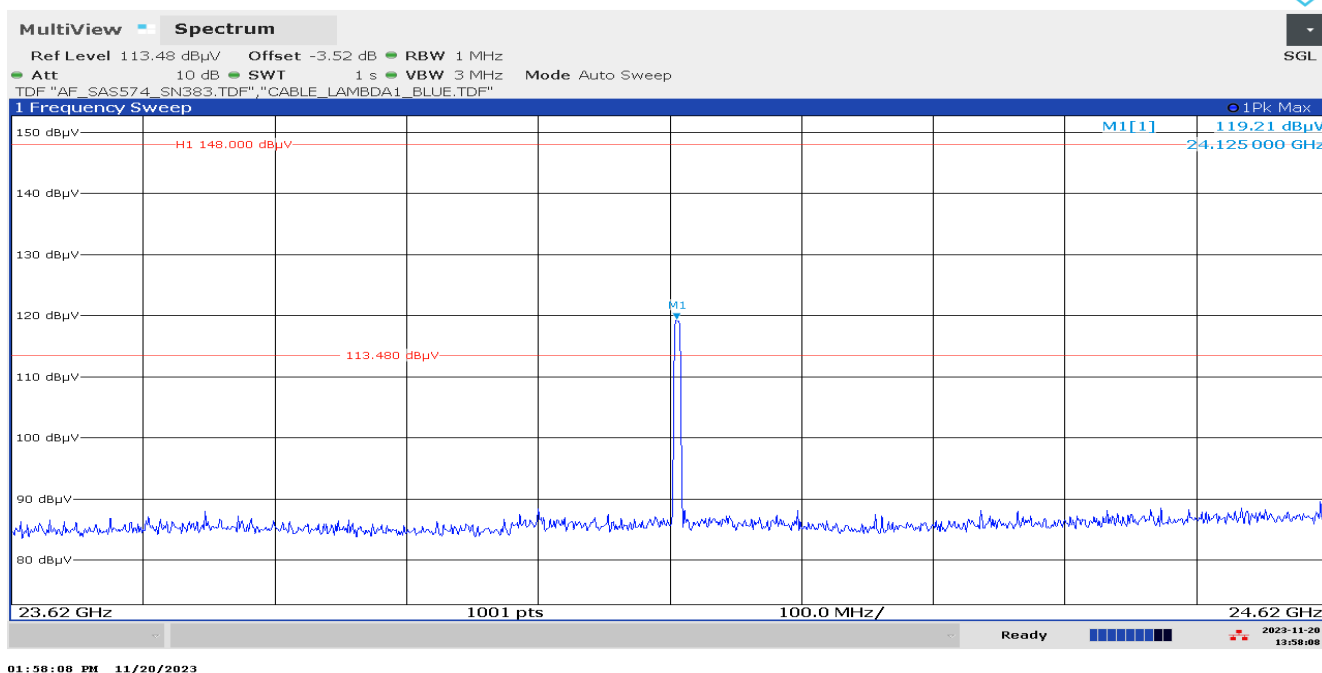
Note: Maximum Average Field strength of Fundamental Emission with larger span is 112.89dBμV,
Only for information, not for assessment, for Final test check below Diagram D100_01.

D100_01_Max_Avg_Field_Strength_small_Span_10MHz



Note: Maximum Average Field strength of Fundamental Emission with smaller span is 112.62dBμV, Limit: 128dBμV,
Result: Pass

D101_Max_Peak_Power_119.21 dBμV

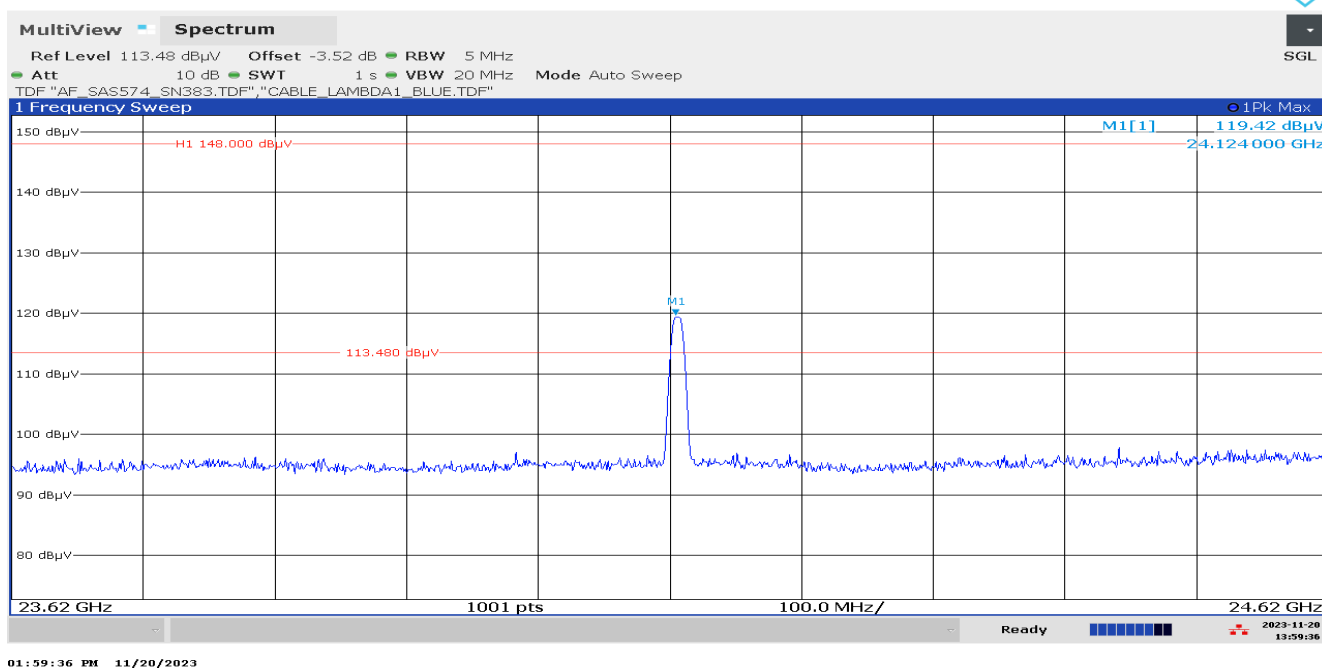


Note-1: Note: Maximum Peak Field strength of Fundamental Emission with RBW 1MHz is 119.21dBμV, Limit: 148dBμV, Result: Pass.

Note-2: Use different RBW to get a stable Peak Field strength of Fundamental Emission.

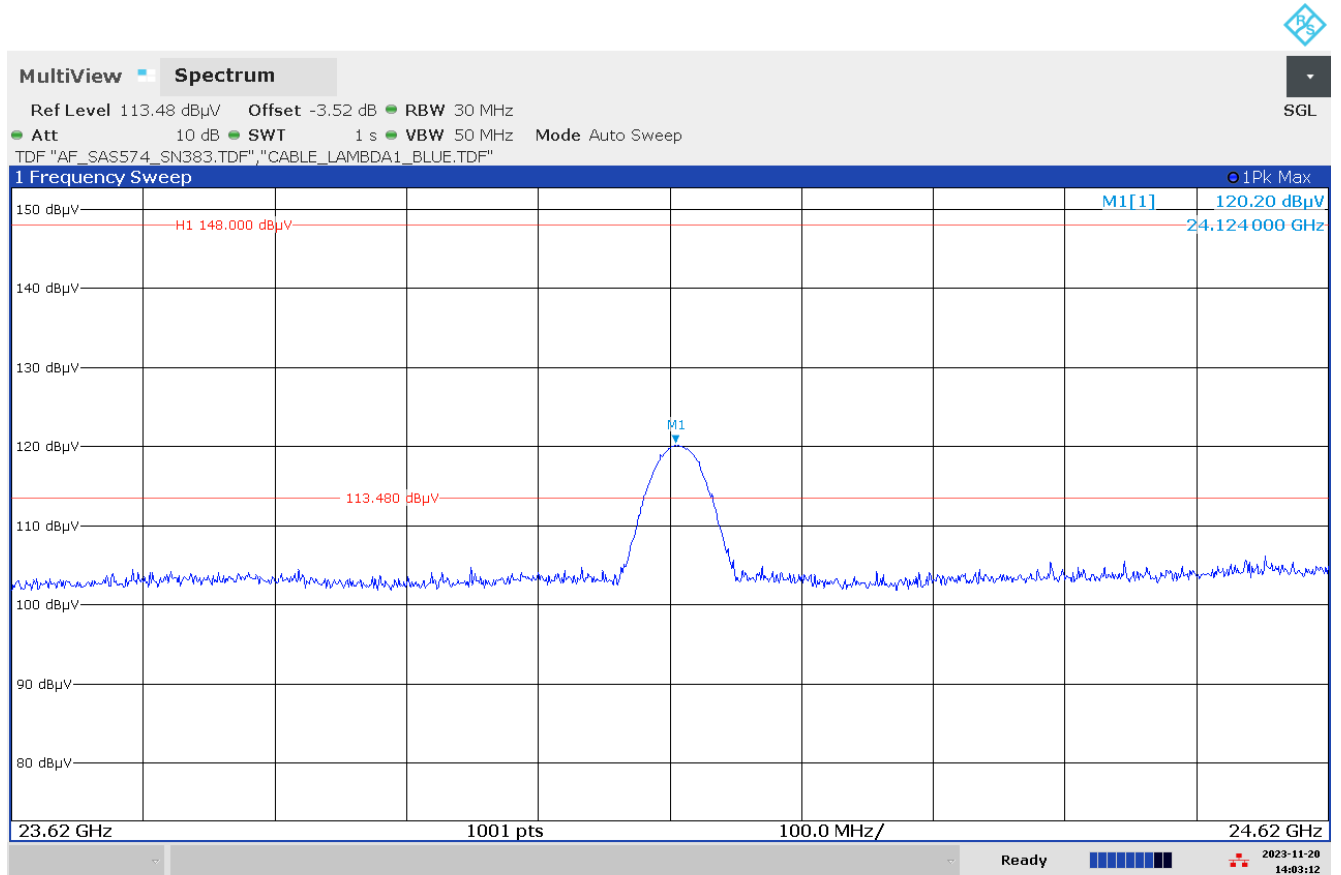
Note-3: With RBW 1MHz, maximum Field Strength is stable, therefore RBW 1MHz has taken as Final test, Check below Diagram D102 and D103 with different RBW, Only for information, not for assessment.

D102_Max_Peak_Power_119.42 dBμV



Note: Note: Maximum Peak Field strength of Fundamental Emission with RBW 5MHz is 119.21dBμV, Only for information, not for assessment.

D103_Max_Peak_Power_120.20 dBμV



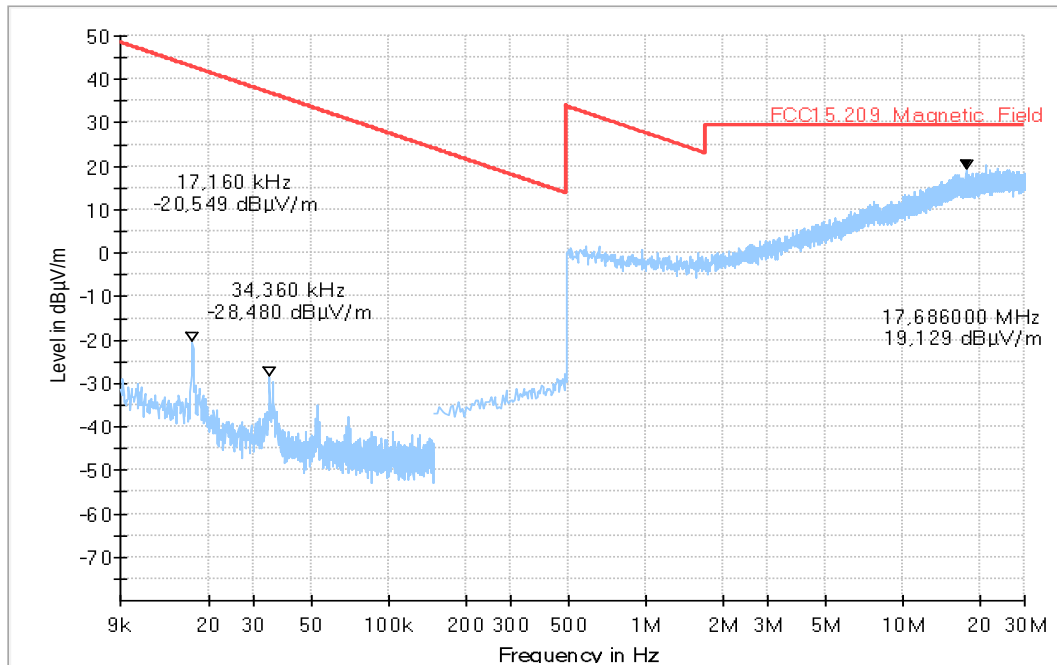
02:03:12 PM 11/20/2023

Note: Maximum Peak Field strength of Fundamental Emission with RBW 30MHz is 120.20dBμV, Only for information, not for assessment.

1.2 Field strength of emissions (radiated outside of the specified frequency bands)

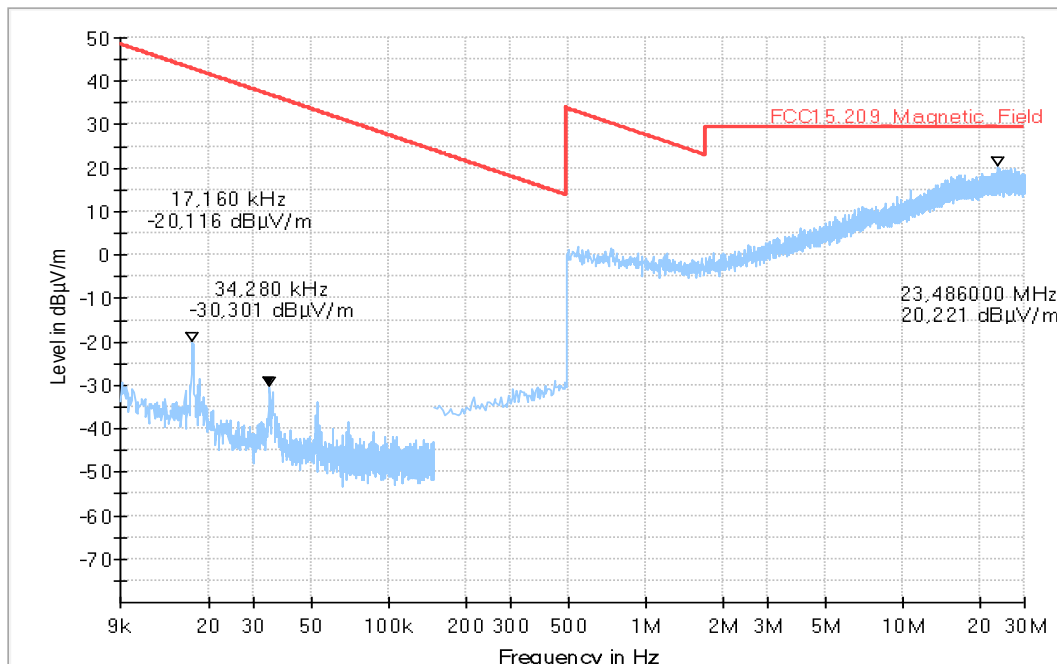
D290_H_Field_9kHz_30MHz_RADAR_active_EUT_ele_0°

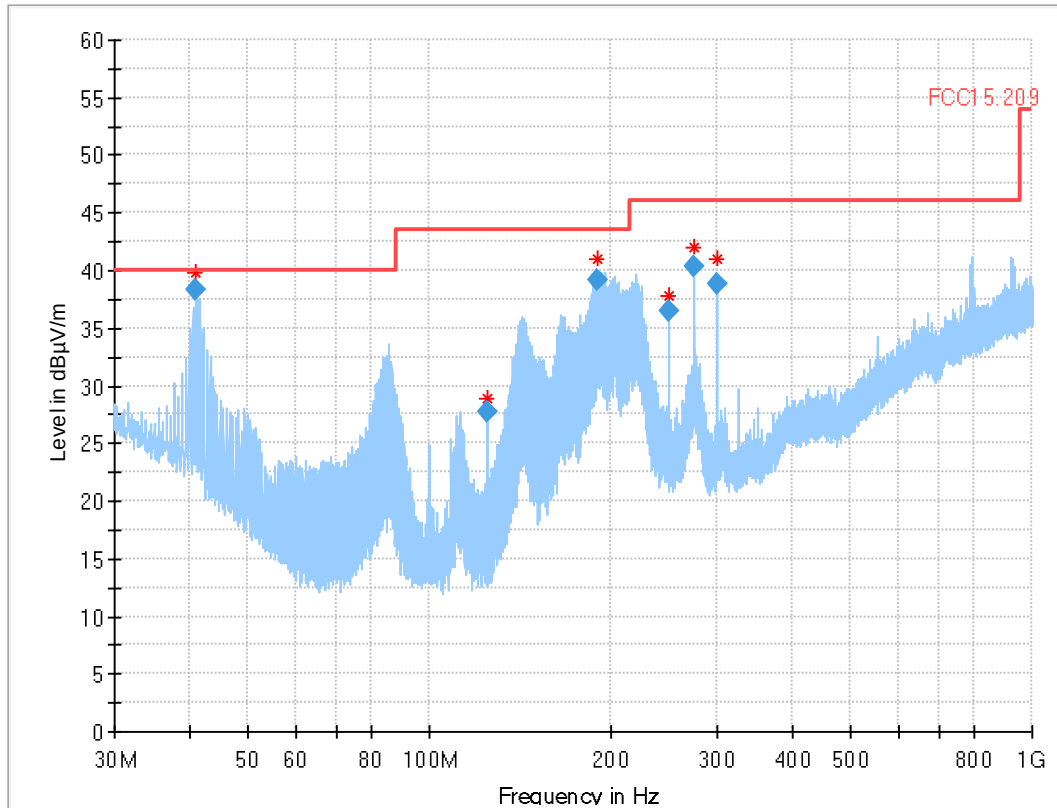
Full Spectrum



D291_H_Field_9kHz_30MHz_RADAR_active_EUT_ele_90°

Full Spectrum

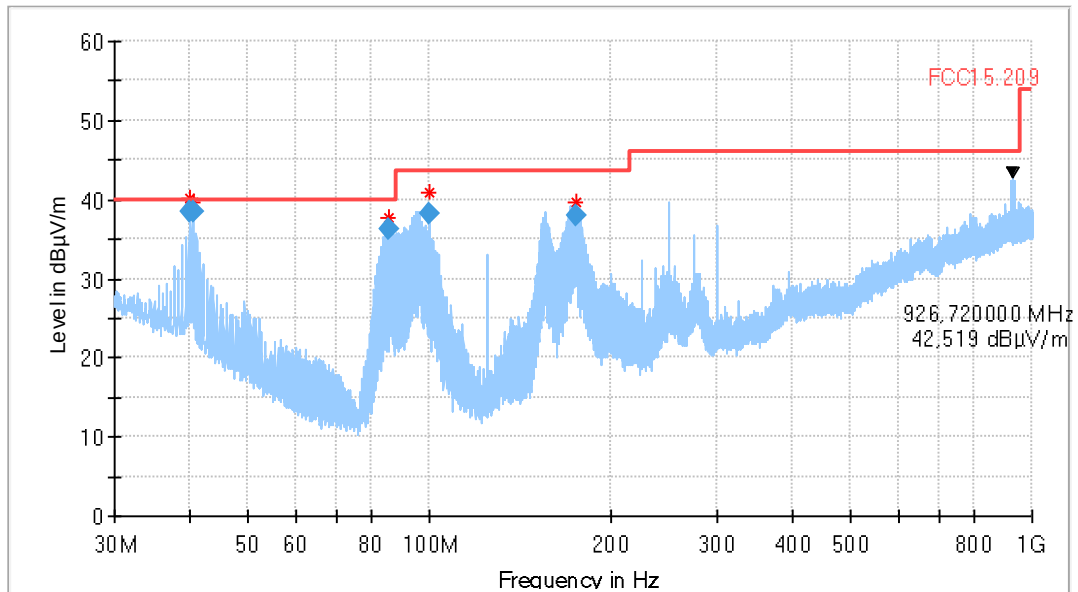


D292_01_E_Field_30MHz_1GHz_RADAR_active_EUT_ele_0°

Final_Result

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
41.030000	38.27	40.00	1.73	1000.0	120.000	232.0	H	172.0	16.0
124.990000	27.66	43.50	15.84	1000.0	120.000	277.0	H	330.0	7.6
190.250000	39.13	43.50	4.37	1000.0	120.000	178.0	H	334.0	11.0
249.990000	36.40	46.00	9.60	1000.0	120.000	154.0	H	312.0	13.0
274.990000	40.40	46.00	5.60	1000.0	120.000	114.0	H	174.0	14.4
299.990000	38.77	46.00	7.23	1000.0	120.000	107.0	H	3.0	15.1

(continuation of the "Final_Result" table from column 16 ...)

Frequency (MHz)	Sig Path (dB)	Preamp (dB)	Trd Corr. (dB/m)	Raw Rec (dBμV)	Comment
41.030000	0.0	0.6	15.4	22.2	16:13:08 - 23.11.2023
124.990000	0.0	1.1	6.5	20.1	16:07:44 - 23.11.2023
190.250000	0.0	1.3	9.7	28.1	16:02:49 - 23.11.2023
249.990000	0.0	1.6	11.4	23.4	16:18:33 - 23.11.2023
274.990000	0.0	1.6	12.8	26.0	15:58:05 - 23.11.2023
299.990000	0.0	1.7	13.4	23.7	15:52:50 - 23.11.2023

D293_E_Field_30MHz_1GHz_RADAR_active_EUT_90°


Note: Emission at 926.72MHz is outside from the chamber, not related to assessment.

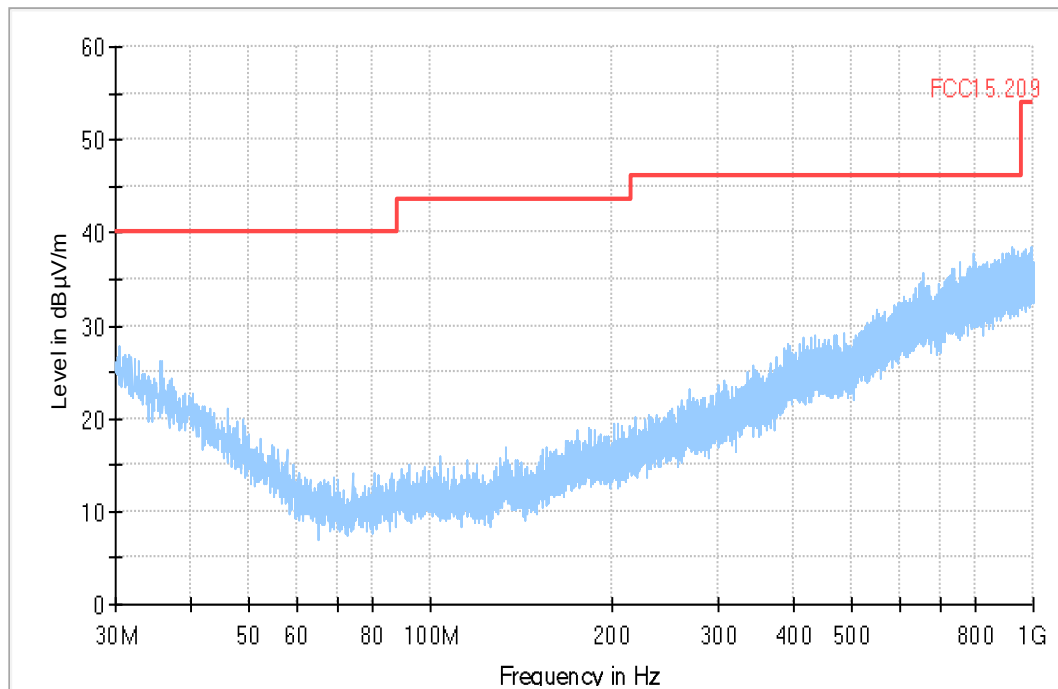
Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Sig Path (dB)	Preamp (dB)
39.950000	38.39	40.00	1.61	120.000	233.0	H	135.0	16.5	0.0	0.6
40.470000	38.33	40.00	1.67	120.000	279.0	H	112.0	16.3	0.0	0.6
85.390000	36.20	40.00	3.80	120.000	124.0	V	237.0	7.6	0.0	0.9
99.990000	38.12	43.50	5.38	120.000	154.0	V	202.0	7.7	0.0	0.9
174.790000	38.06	43.50	5.44	120.000	191.0	V	136.0	10.2	0.0	1.2

(continuation of the "Final_Result" table from column 18 ...)

Frequency (MHz)	Trd Corr. (dB/m)	Raw Rec (dBµV)	Comment
39.950000	15.9	21.9	11:14:39 - 23.11.2023
40.470000	15.7	22.0	11:19:33 - 23.11.2023
85.390000	6.7	28.6	11:24:56 - 23.11.2023
99.990000	6.8	30.5	11:30:04 - 23.11.2023
174.790000	9.0	27.8	11:35:07 - 23.11.2023

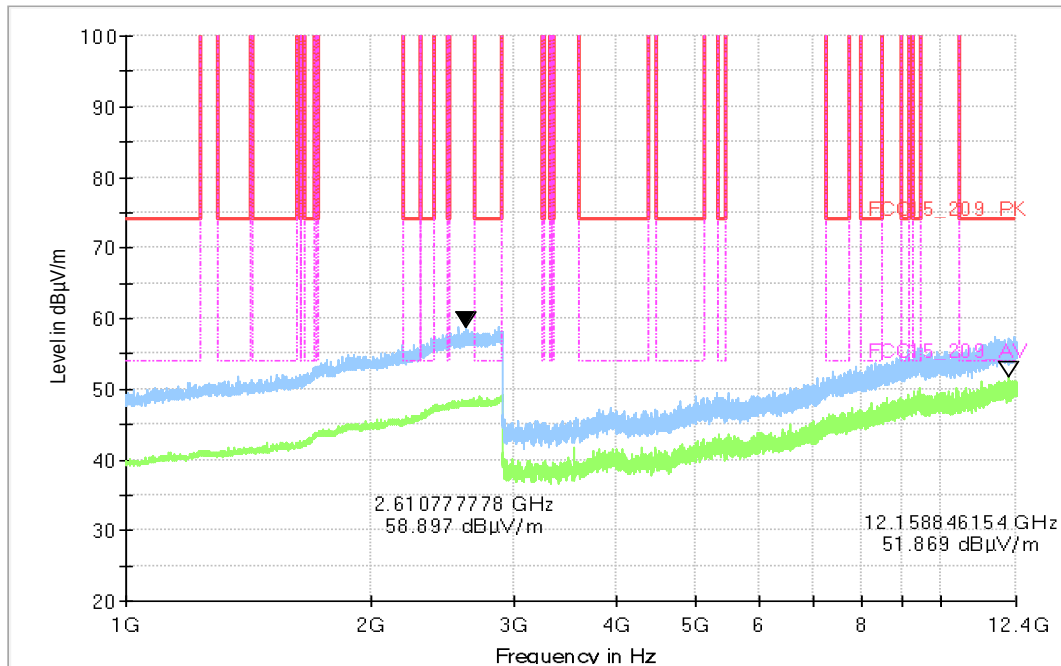
Ambient_EUT_Power-off_Test_System_Power-on



Note: Ambient Test: EUT Power Off, Test System Power on
Only for information, not for assessment.

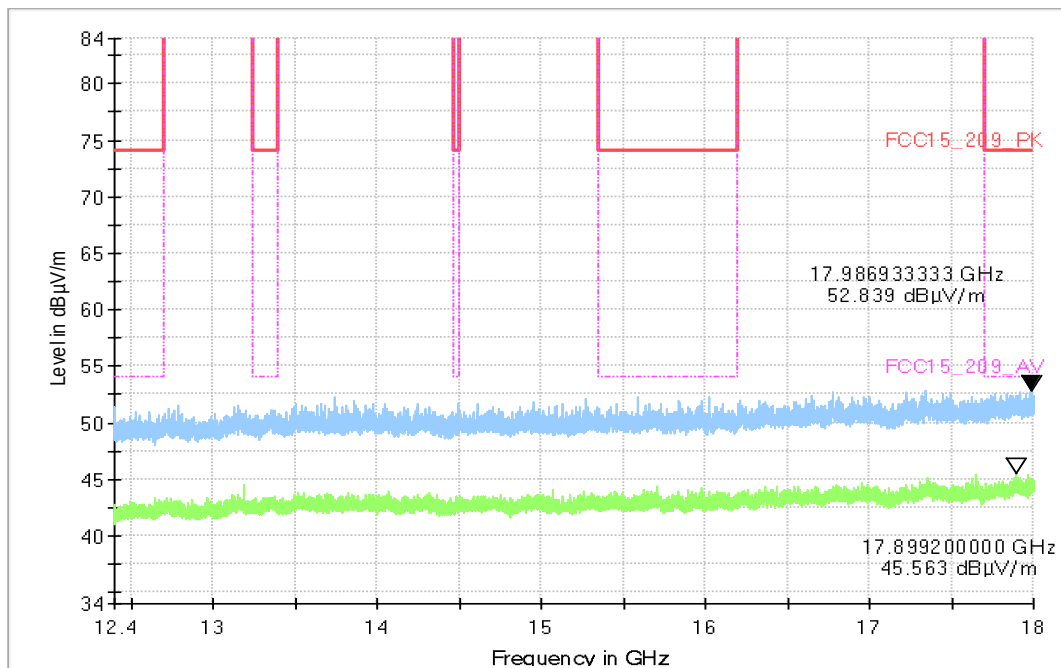
D294_RSE_1G_12.4GHz_RADAR_24GHz_active_Antenna_H+V

Full Spectrum



D295_RSE_12.4G_18GHz_RADAR_24GHz_active_Antenna_H+V

Full Spectrum

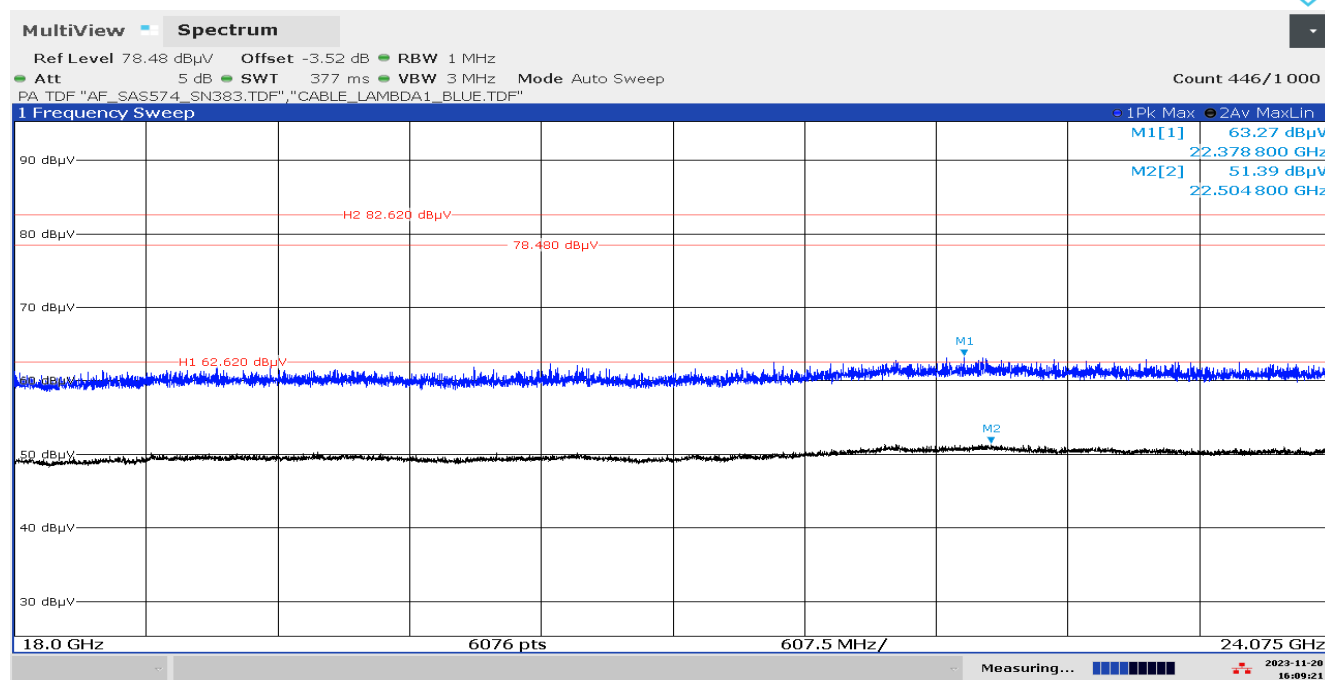




SGL



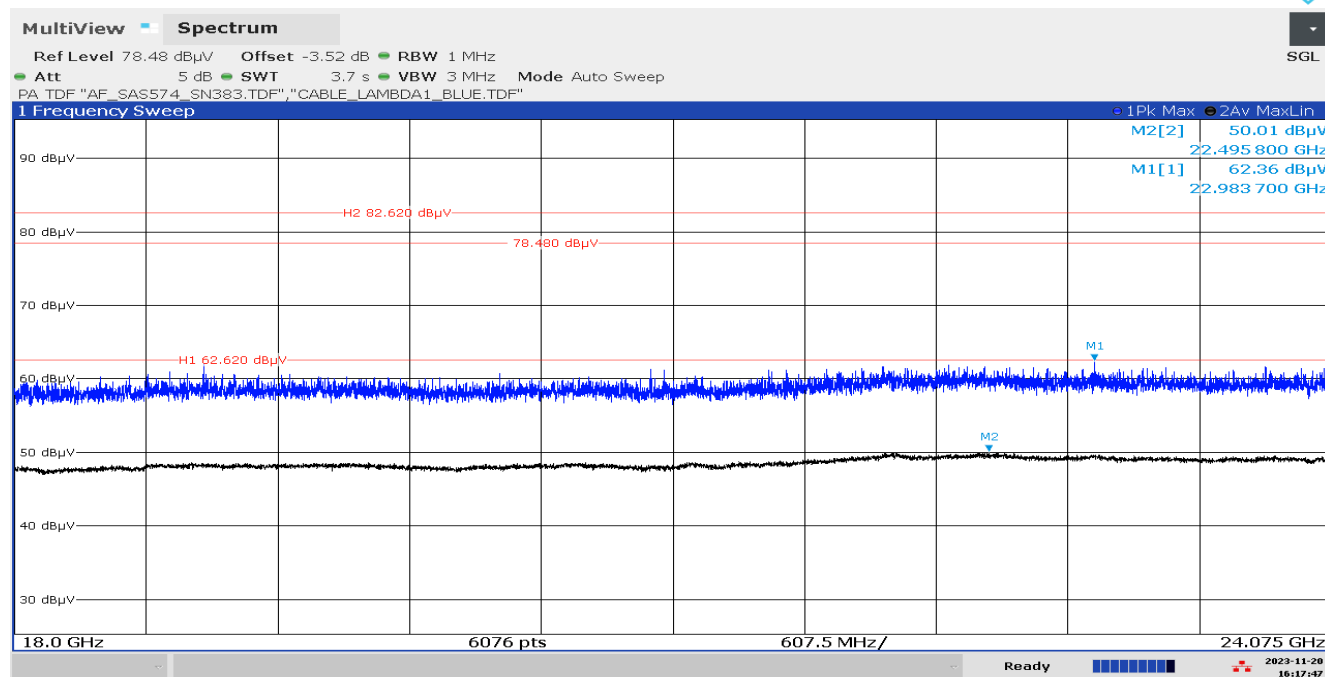
D298_OOB_18GHz_24.075GHz_peak_avg_full_scan_TT0°-360°_EUT90°, Antenna Horizontal



04:09:21 PM 11/20/2023

Note: Turn Table Movement from 0° to 360° + Continuous sweep to find out worst-case position of EUT.

D299_OOB_18GHz_24.075GHz_peak_avg_single_scan_TT-45°_EUT90°, Antenna Horizontal

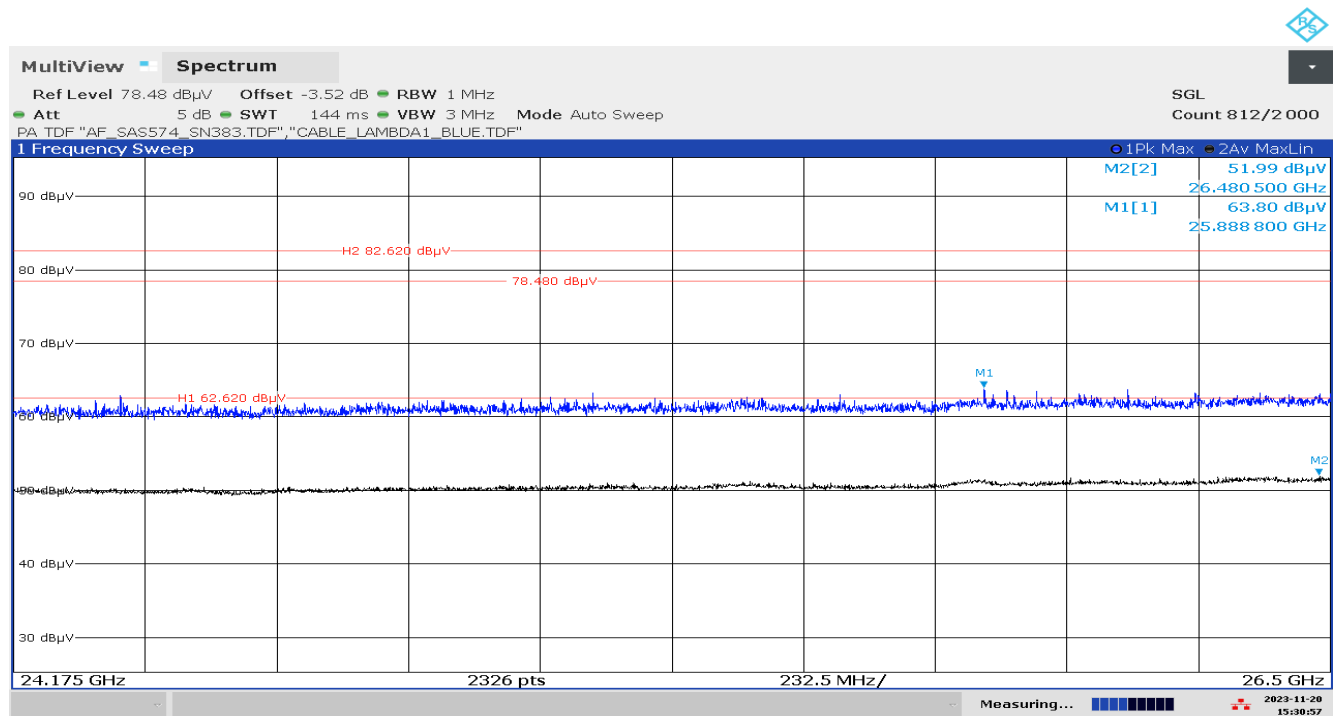


04:17:47 PM 11/20/2023

Note: EUT RADAR Antenna positioned (worst-case position) to the Measurement Antenna.

No critical Emission found, Result: Pass.

D300_OOB_24.175GHz_26.5GHz_peak_avg_full_scan_TT0°-360°_EUT90°, Antenna Vertical

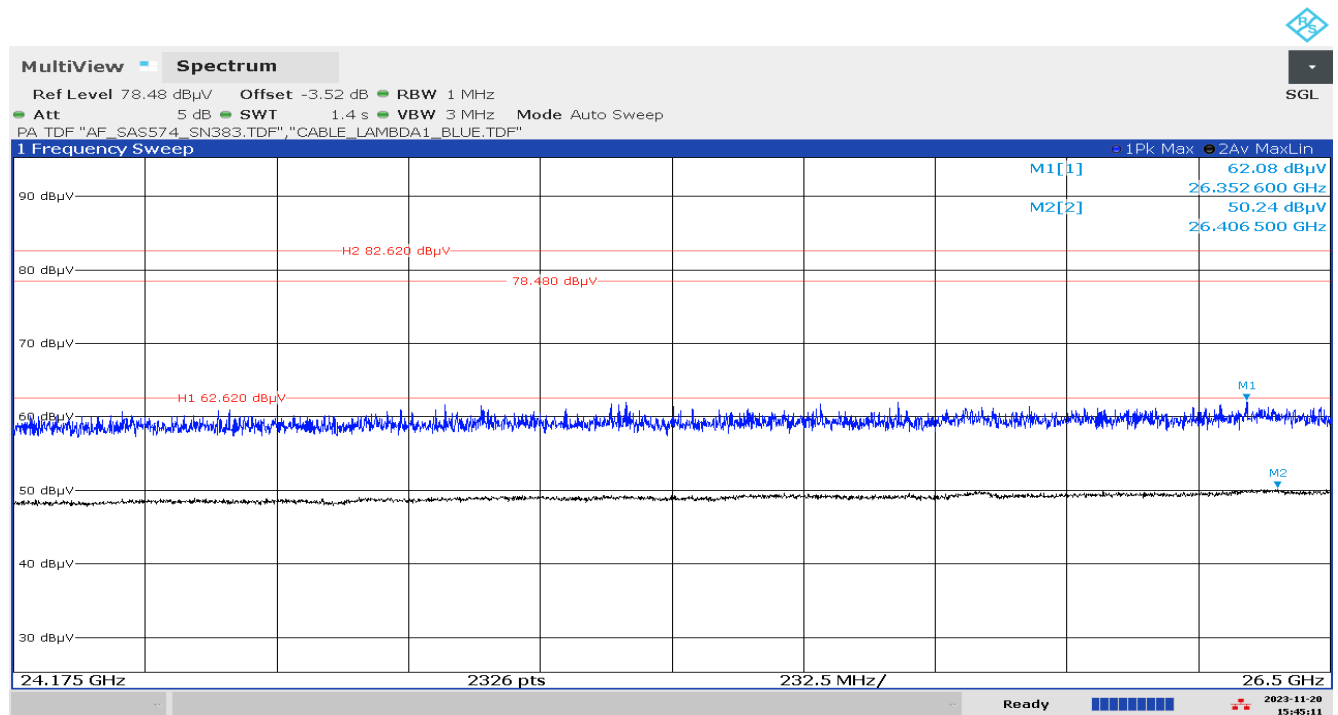


03:30:57 PM 11/20/2023

Note: Turn Table Movement from 0° to 360° + Continuous sweep, to find out worst-case position of EUT.

For Final test check below Diagram.

D301_OOB_24.175GHz_26.5GHz_peak_avg_single_scan_TT-45°_EUT90°, Antenna Vertical



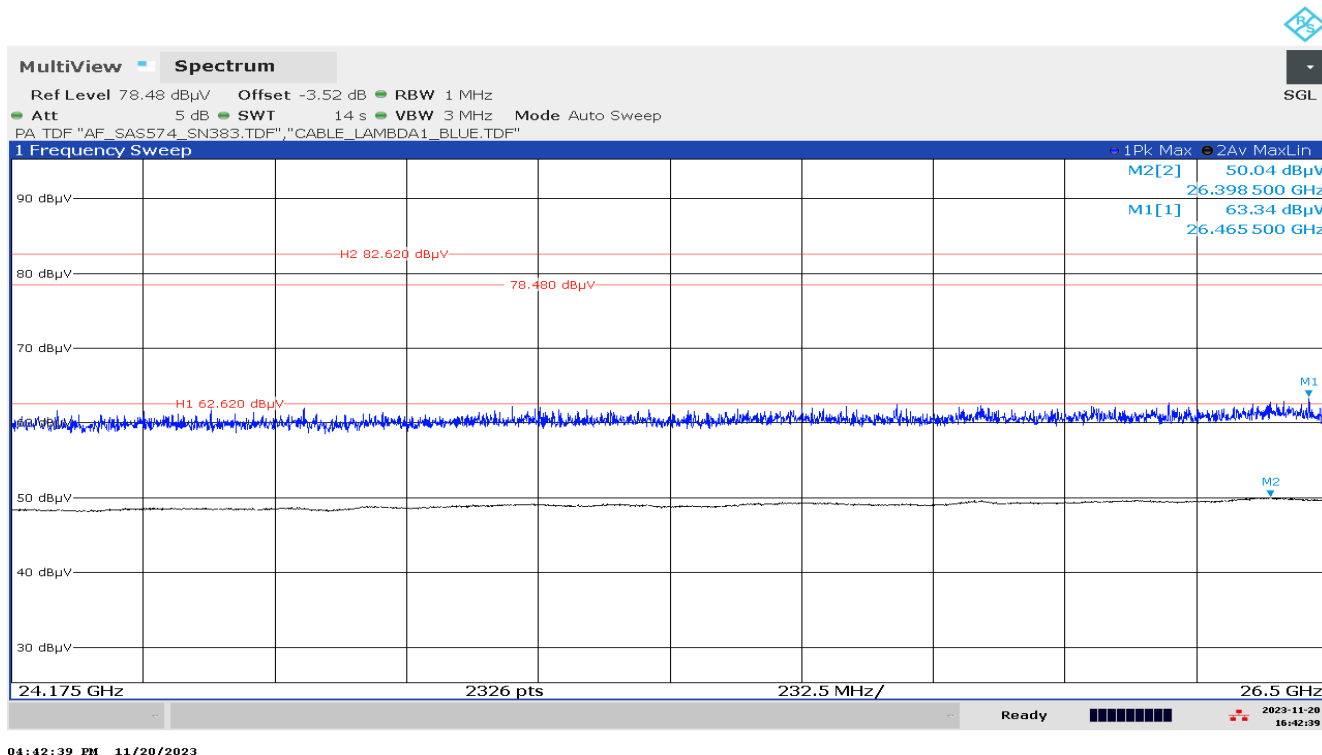
03:45:11 PM 11/20/2023

Note: No critical Emission found, Result: Pass.

Limit Line: Average: 62.62dBμV, Peak: 82.62dBμV, Result: Average: Pass, Peak: Pass.

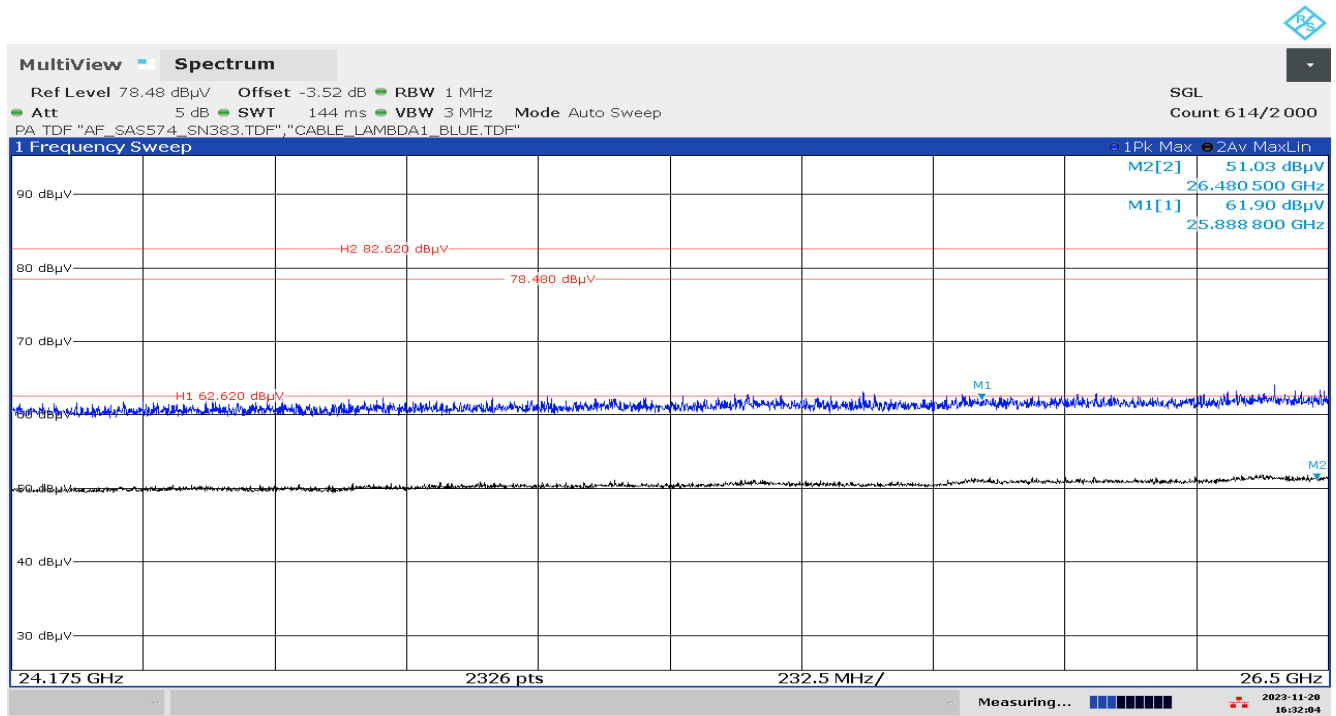
Peak Field Strength: Blue Color, Average Field Strength: Black Color.

D301_01_RSE_24.175GHz_26.5GHz_peak_avg_single_scan_TT-45°_EUT90°_14s, Antenna Vertical



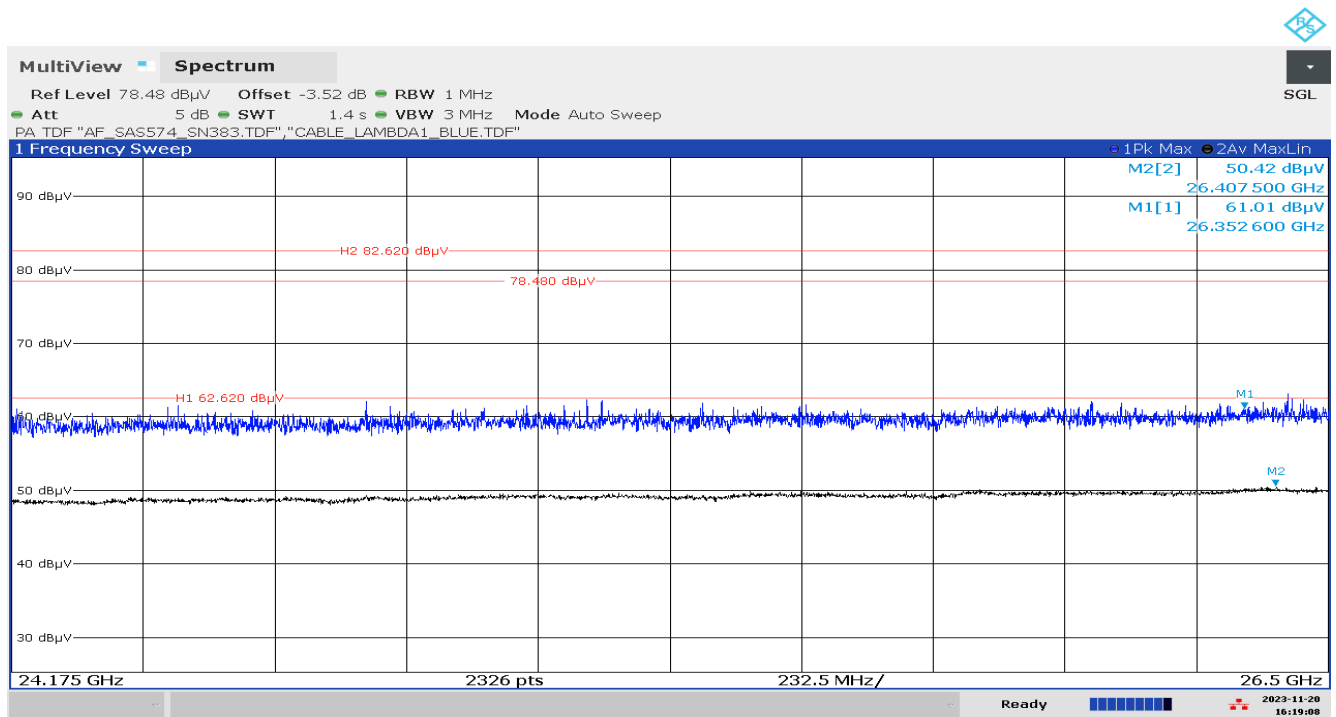
Note: With more measurement time, no critical Emission found, only for information not for assessment.

Limit Line: Average: 62.62dBμV, Peak: 82.62dBμV.

D302_OOB_24.175GHz_26.5GHz_peak_avg_full_scan_TT0°-360°_EUT90°, Antenna Horizontal


Note: Turn Table Movement from 0° to 360° + Continuous sweep, to find out worst-case position of EUT.

For Final test check below Diagram.

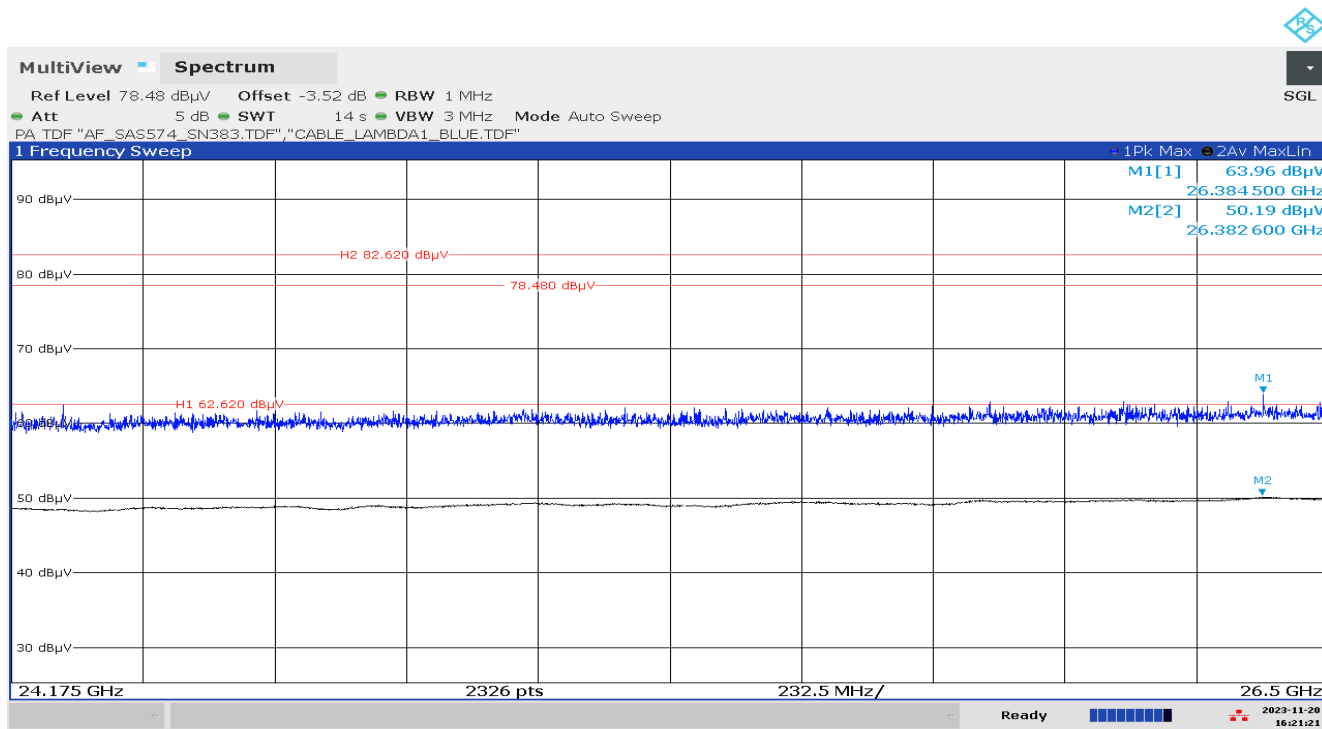
D303_RSE_24.175GHz_26.5GHz_peak_avg_single_scan_TT-45°_EUT90°, Antenna Horizontal


Note: No critical Emission found, Result: Pass.

Limit Line: Average: 62.62dBμV, Peak: 82.62dBμV, Result: Average: Pass, Peak: Pass.

Peak Field Strength: Blue Color, Average Field Strength: Black Color.

D303_01_RSE_24.175GHz_26.5GHz_peak_avg_single_scan_TT-45°_EUT90°_14s, Antenna Horizontal

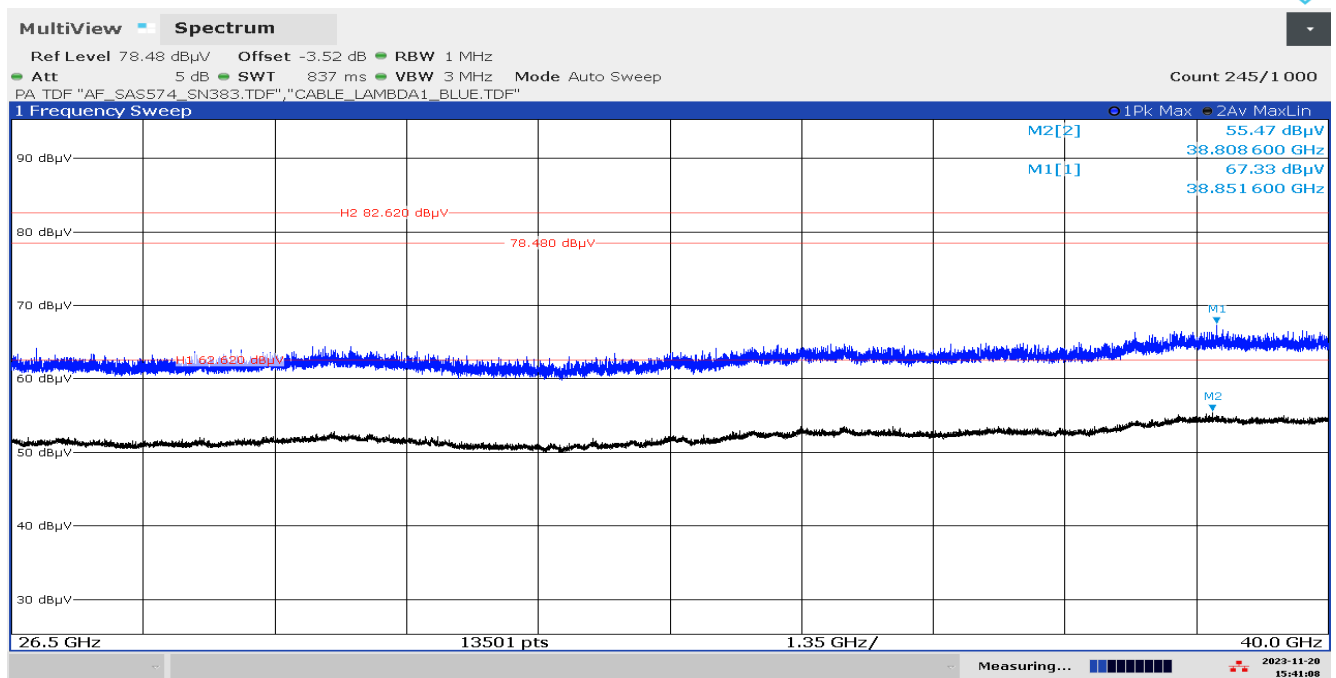


04:21:21 PM 11/20/2023

Note: With more measurement time, no critical Emission found, only for information not for assessment.

Limit Line: Average: 62.62dBμV, Peak: 82.62dBμV.

D304_RSE_26.5GHz_40GHz_peak_avg_full_scan_TT0°-360°_EUT90°, Antenna Vertical

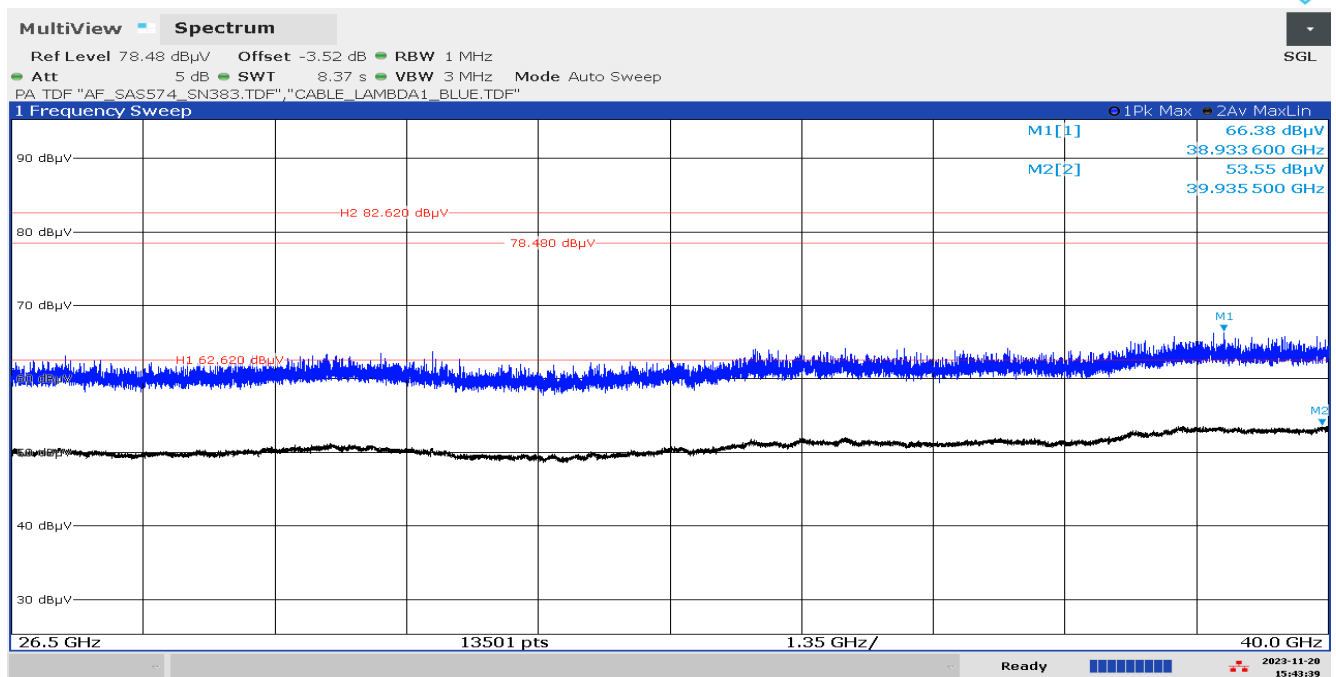


03:41:09 PM 11/20/2023

Note: Turn Table Movement from 0° to 360° + Continuous sweep, to find out worst-case position of EUT.

For Final test check below Diagram.

D305_RSE_26.5GHz_40GHz_peak_avg_single_scan_TT-45°_EUT90°, Antenna Vertical



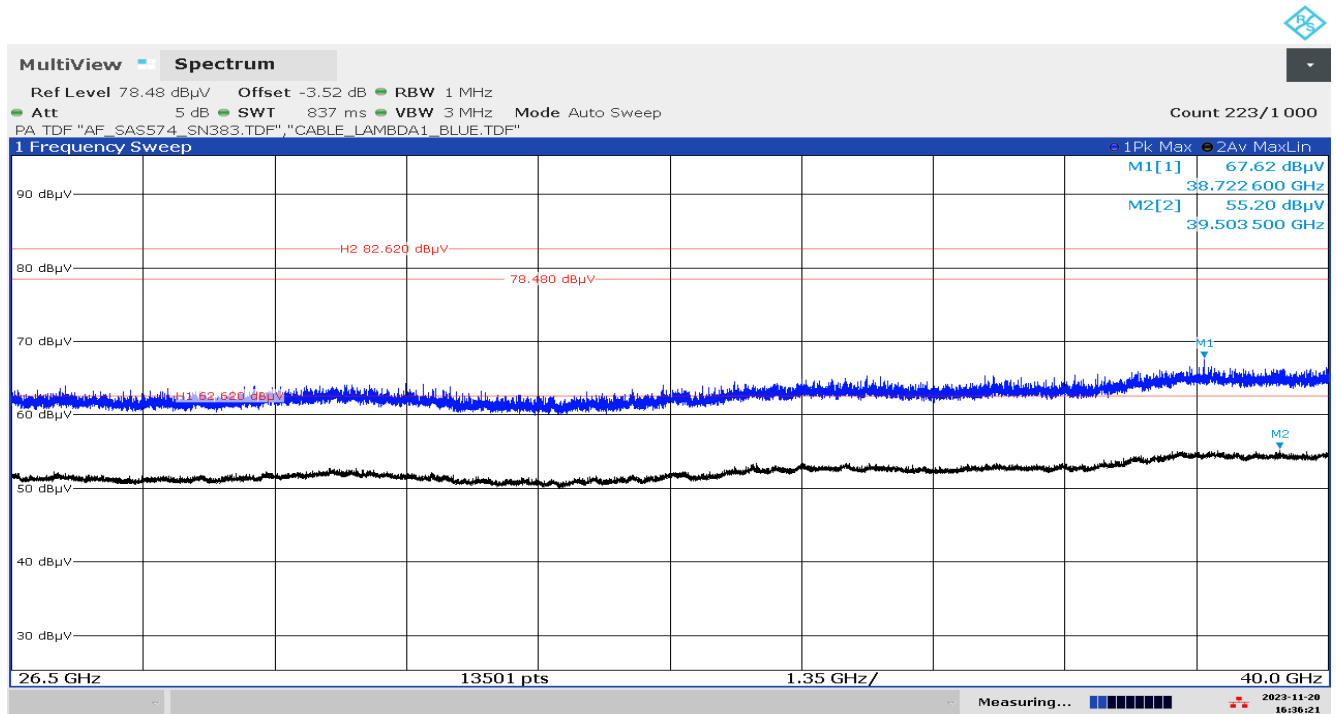
03:43:39 PM 11/20/2023

Note: No critical Emission found, Result: Pass.

Limit Line: Average: 62.62dBμV, Peak: 82.62dBμV, Result: Average: Pass, Peak: Pass.

Peak Field Strength: Blue Color, Average Field Strength: Black Color.

D306_RSE_26.5GHz_40GHz_peak_avg_full_scan_TT0°-360°_EUT90°, Antenna Horizontal

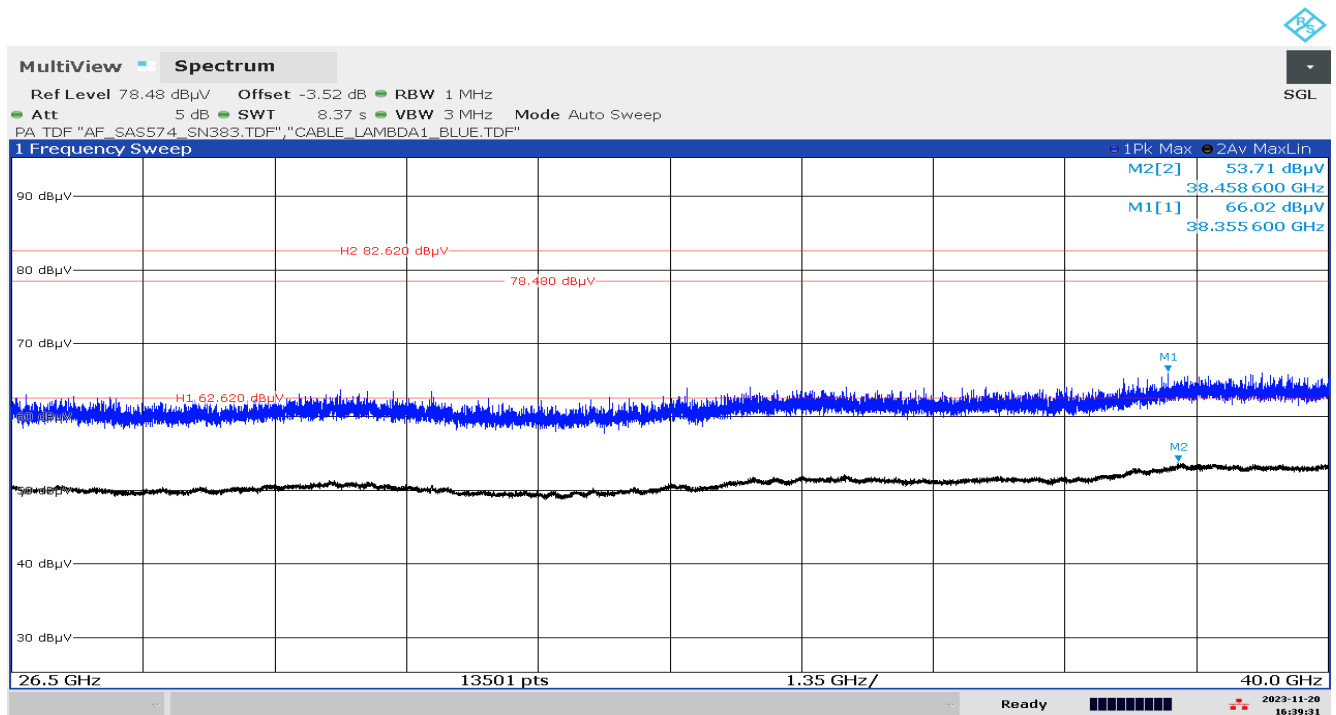


04:36:22 PM 11/20/2023

Note: Turn Table Movement from 0° to 360° + Continuous sweep, to find out worst-case position of EUT.

For Final test check below Diagram.

D307_RSE_26.5GHz_40GHz_peak_avg_single_scan_TT-45°_EUT90°, Antenna Horizontal



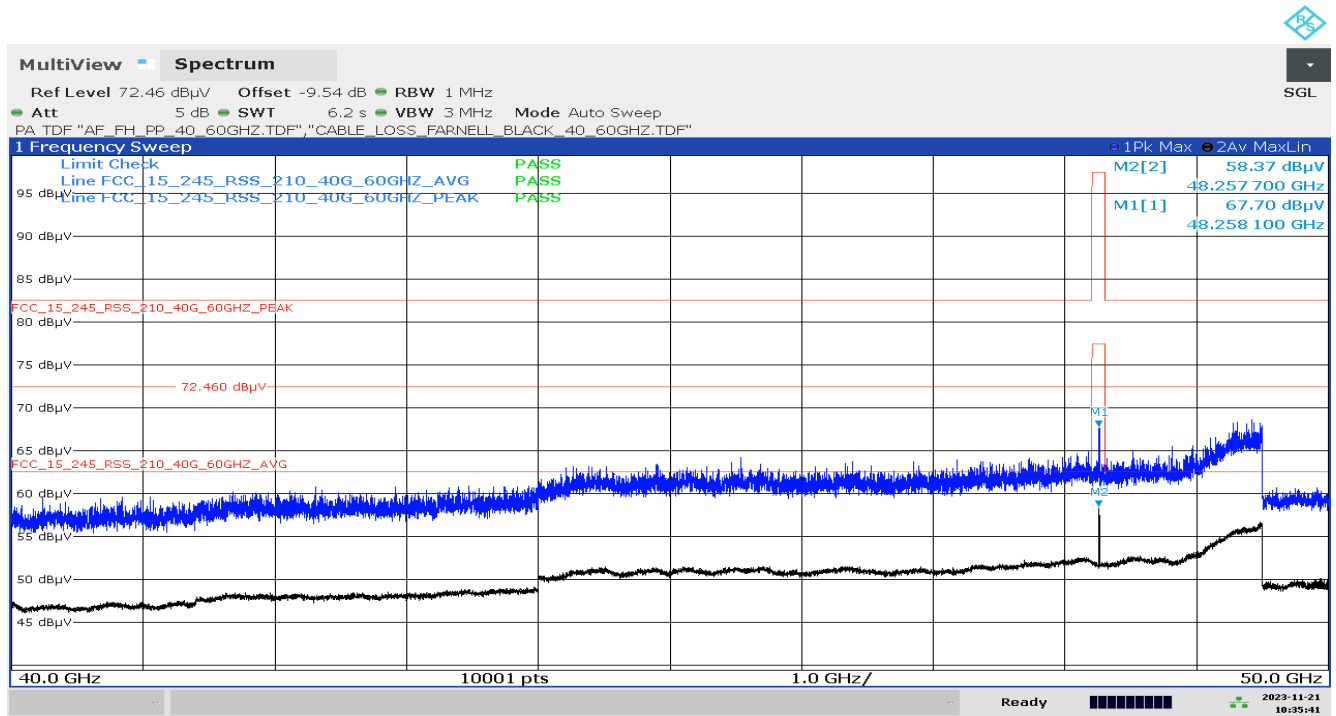
04:39:32 PM 11/20/2023

Note: No critical Emission found, Result: Pass.

Limit Line: Average: 62.62dBμV, Peak: 82.62dBμV, Result: Average: Pass, Peak: Pass.

Peak Field Strength: Blue Color, Average Field Strength: Black Color.

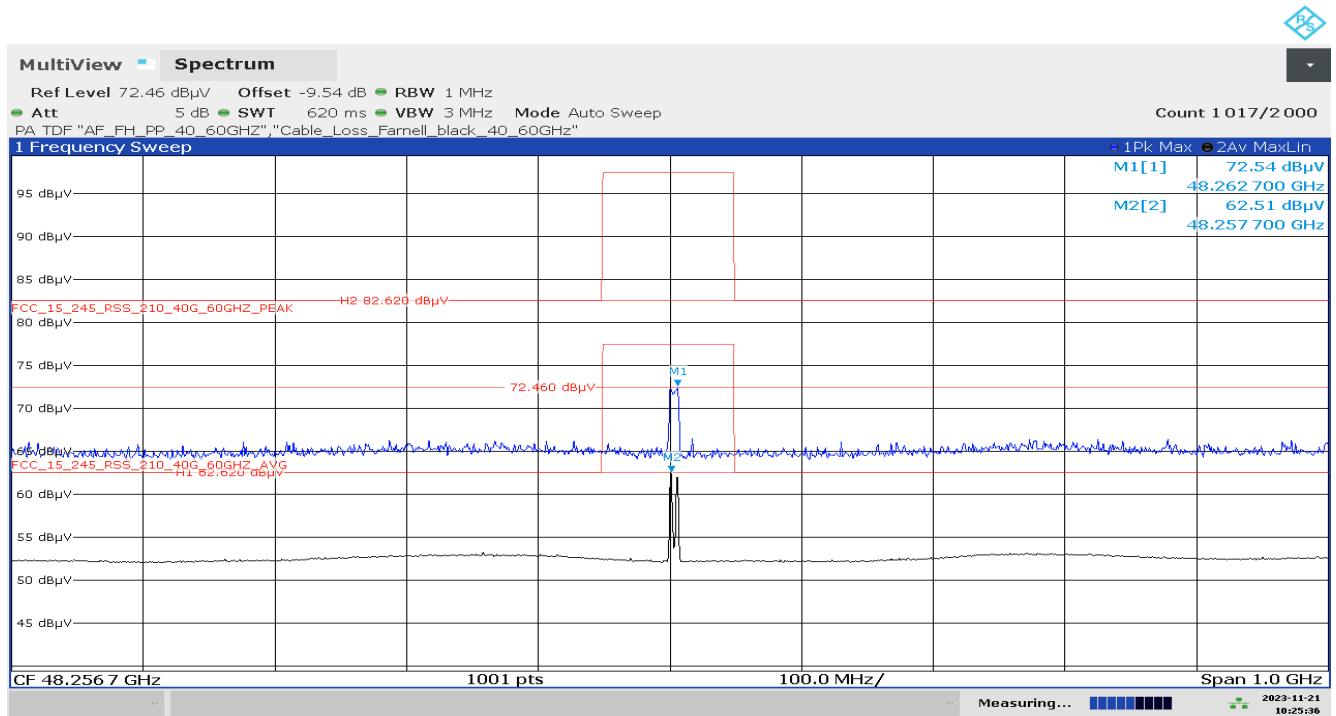
D308_RSE_40GHz_50GHz_peak_avg_single_scan_TT-45°_EUT90°_2nd_run_with_pass_limit, Antenna Vertical



10:35:41 AM 11/21/2023

Note: Maximum Emission found at 48.258GHz, check below Diagrams D308_01 and D308_02 for Final test,

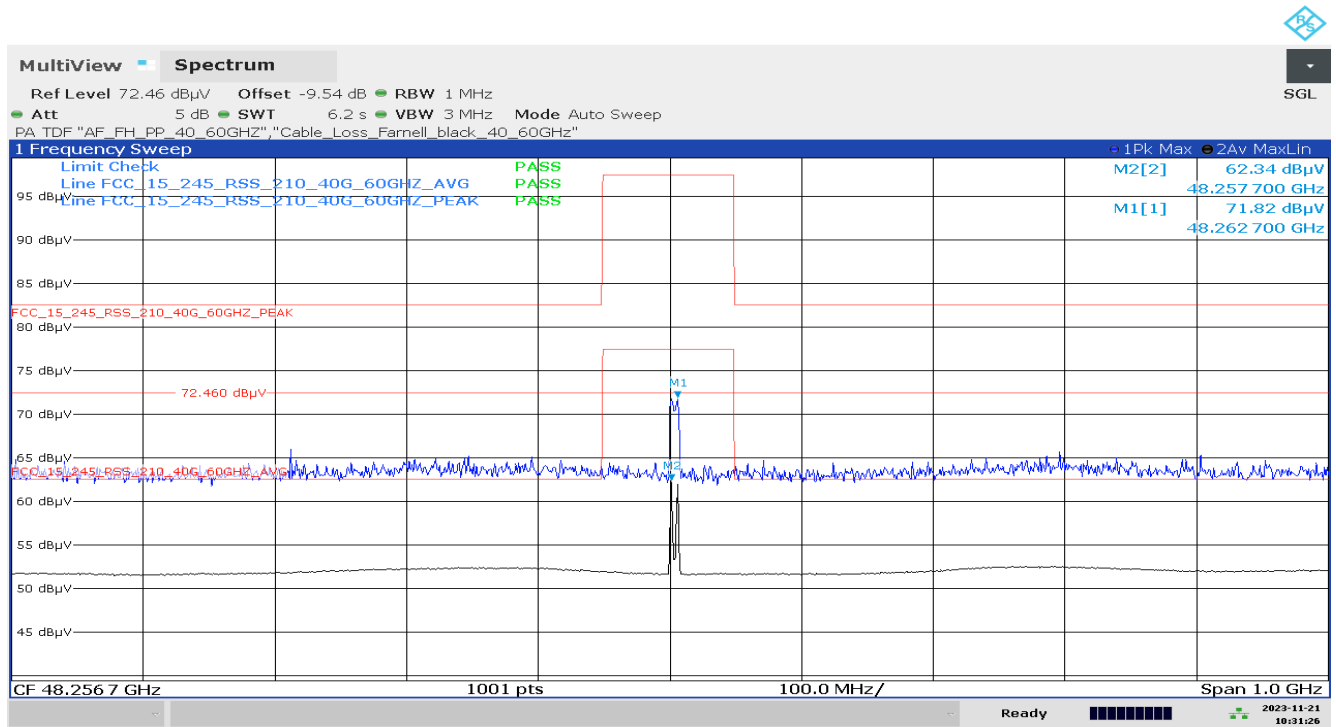
D308_01_RSE_48.258GHz_span_1GHz_peak_avg_full_scan_TT0°-360°_EUT90°, Antenna Vertical



10:25:36 AM 11/21/2023

Note: Turn Table Movement from 0° to 360° + Continuous sweep, to find out worst-case position of EUT.

D308_02_RSE_48.258GHz_span_1GHz_peak_avg_final_test_TT12°_EUT90°, Antenna Vertical



10:31:27 AM 11/21/2023

Note:

Final Test: EUT RADAR Antenna positioned (worst-case position) to the Measurement Antenna.

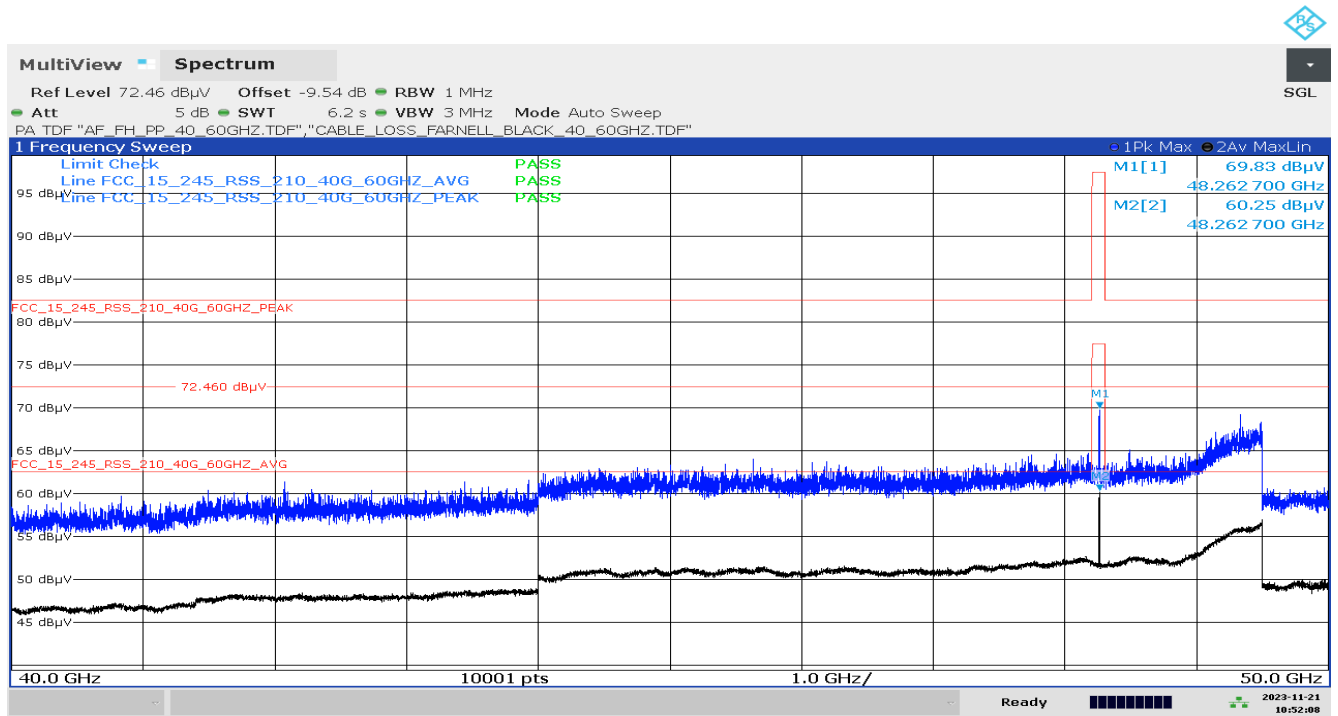
Maximum Average Field Strength found 62.34dBμV at 48.258GHz, Limit Line: Average: 77.50dBμV

Maximum Peak Field Strength found 71.82dBμV at 48.258GHz, Limit Line: Peak: 97.50dBμV

Result: Average: Pass, Peak: Pass,

Peak Field Strength: Blue Color, Average Field Strength: Black Color.

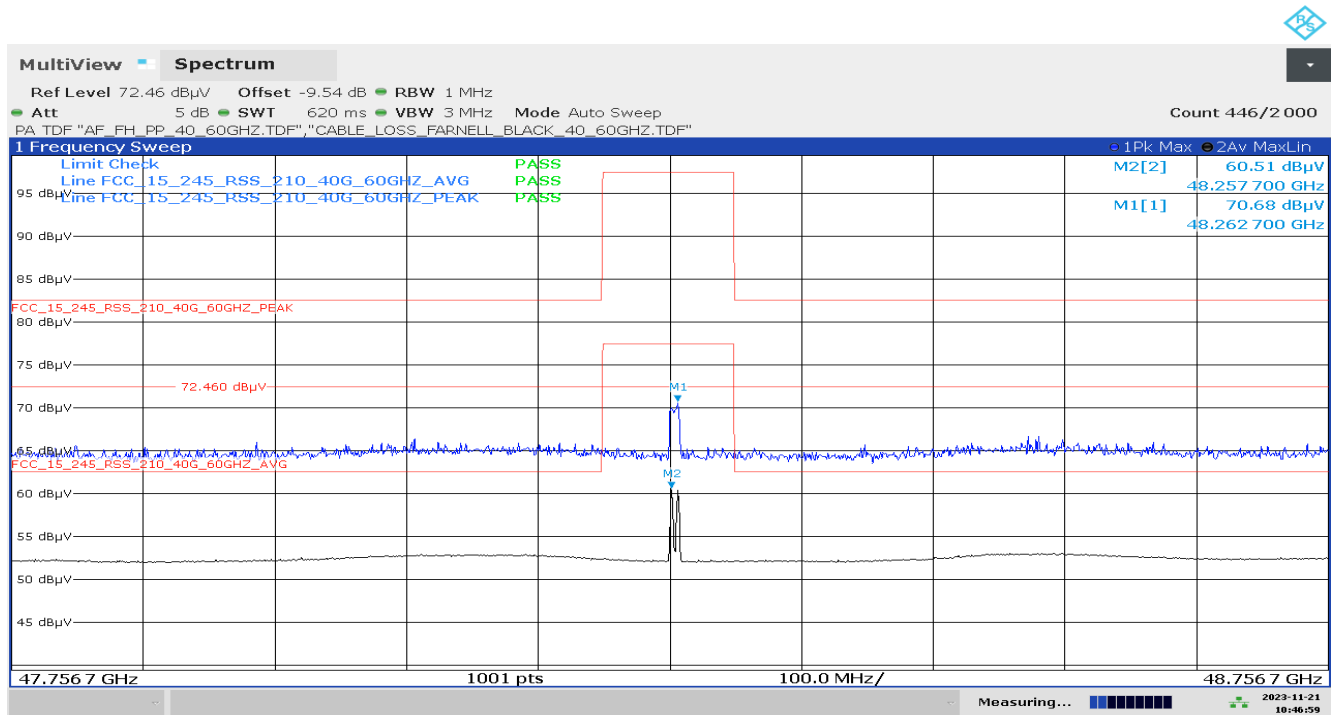
D309_RSE_40GHz_50GHz_peak_avg_single_scan_TT-45°_EUT90°, Antenna Horizontal



10:52:08 AM 11/21/2023

Note: Maximum Emission found at 48.263GHz, check below Diagrams D309_01 and D309_02 for Final test,

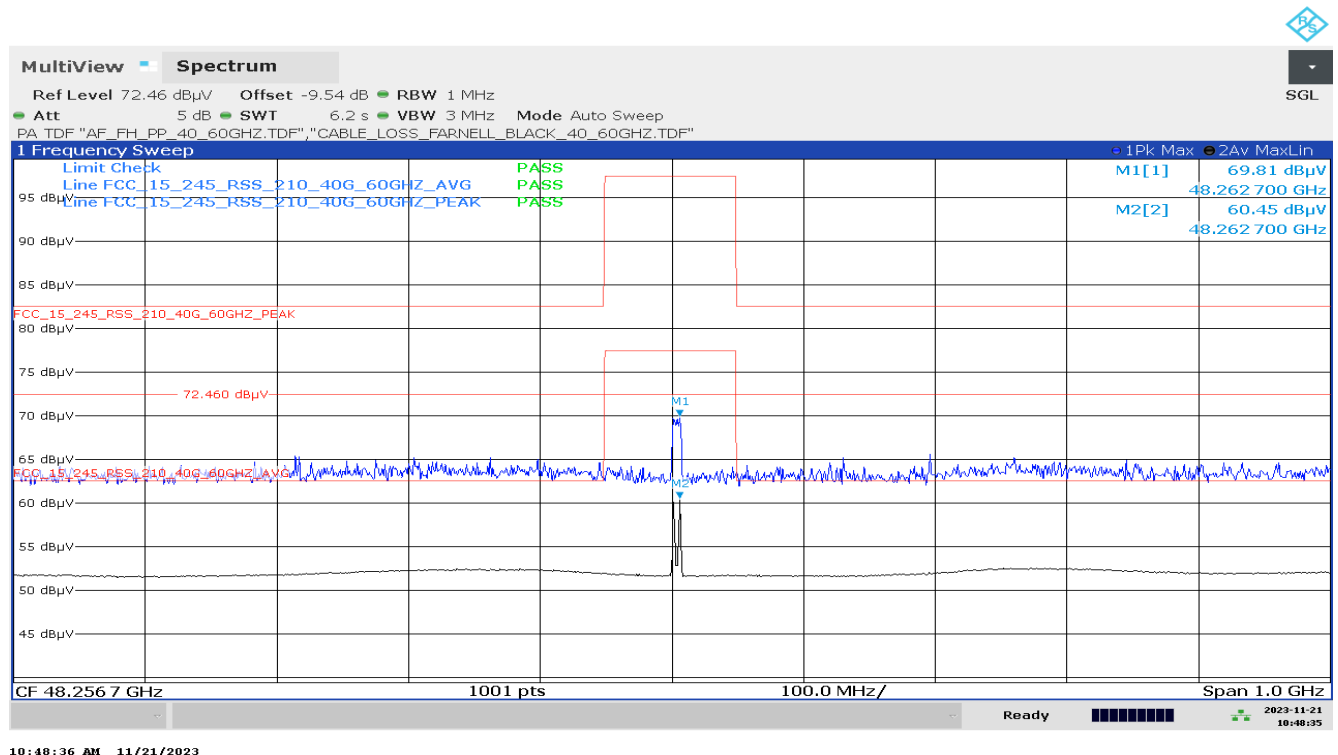
D309_01_RSE_48.258GHz_span_1GHz_peak_avg_full_scan_TT0°-360°_EUT90°, Antenna Horizontal



10:46:59 AM 11/21/2023

Note: Turn Table Movement from 0° to 360° + Continuous sweep, to find out worst-case position of EUT.

D309_02_RSE_48.263GHz_span_1GHz_peak_avg_final_test_TT-45°_EUT90°, Antenna Horizontal



Note:

Final Test: EUT RADAR Antenna positioned (worst-case position) to the Measurement Antenna.

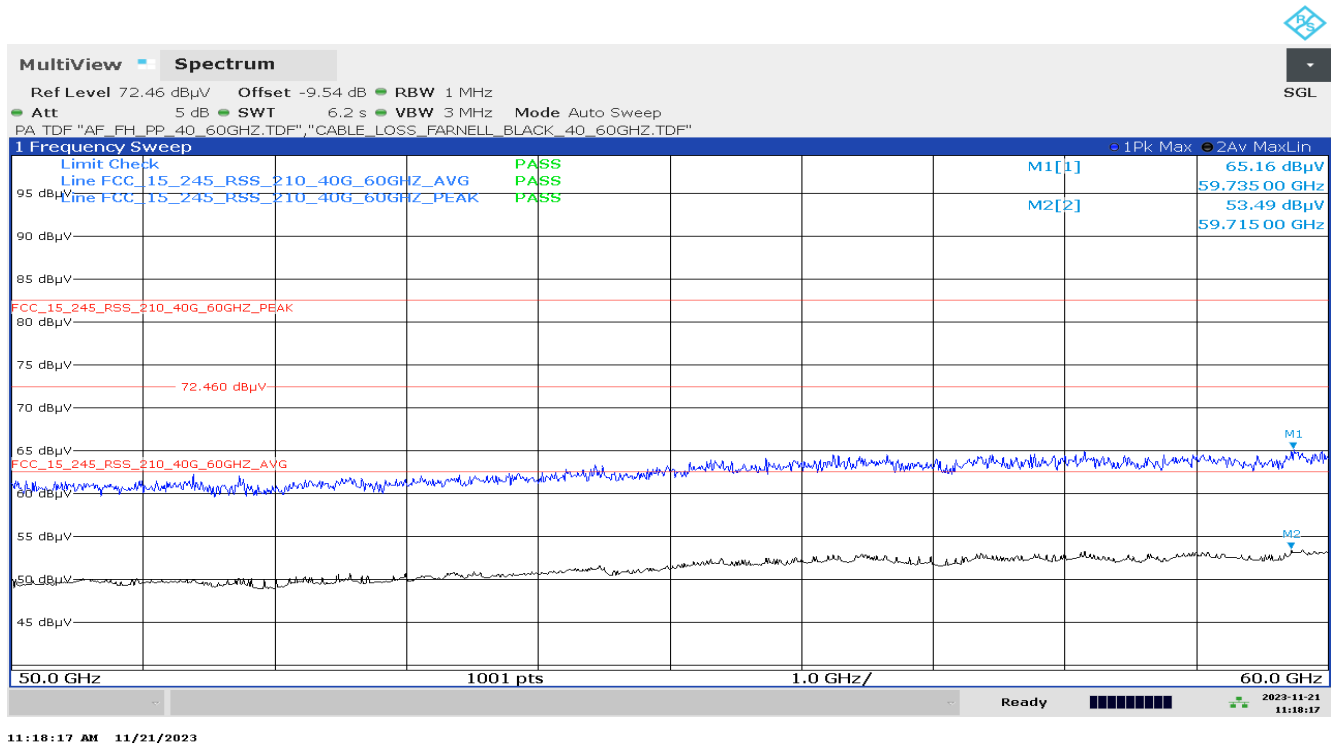
Maximum Average Field Strength found 60.51dBμV at 48.263GHz, Limit Line: Average: 77.50dBμV

Maximum Peak Field Strength found 69.81dBμV at 48.263GHz, Limit Line: Peak: 97.50dBμV

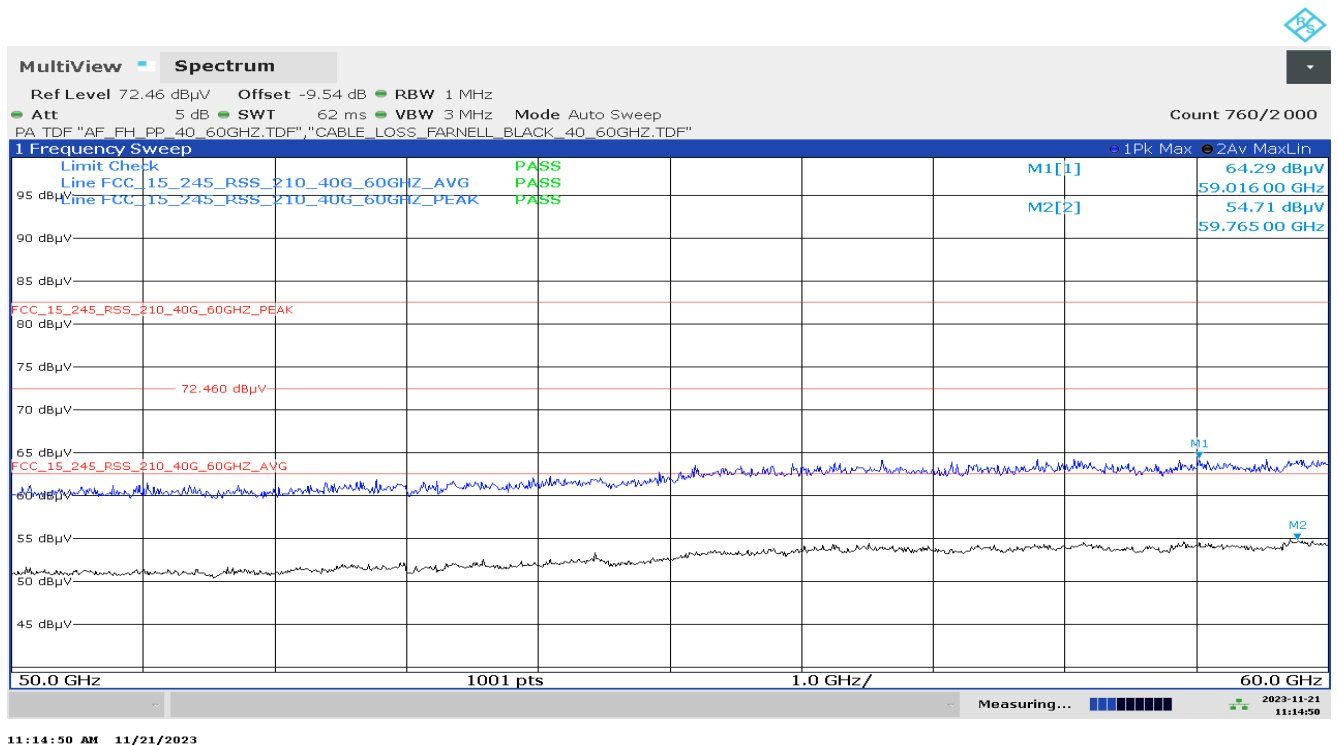
Result: Average: Pass, Peak: Pass,

Peak Field Strength: Blue Color, Average Field Strength: Black Color.

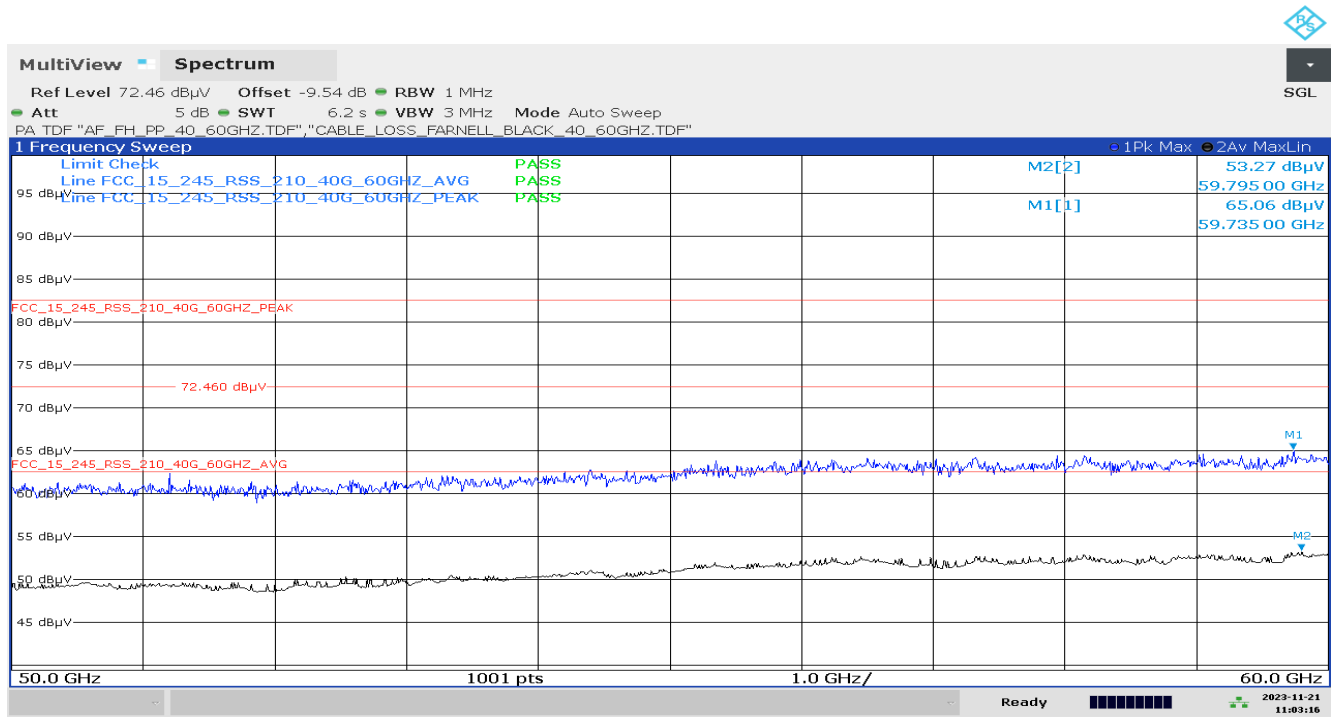
D310_RSE_50GHz_60GHz_peak_avg_single_scan_TT-45°_EUT90°, Antenna Vertical



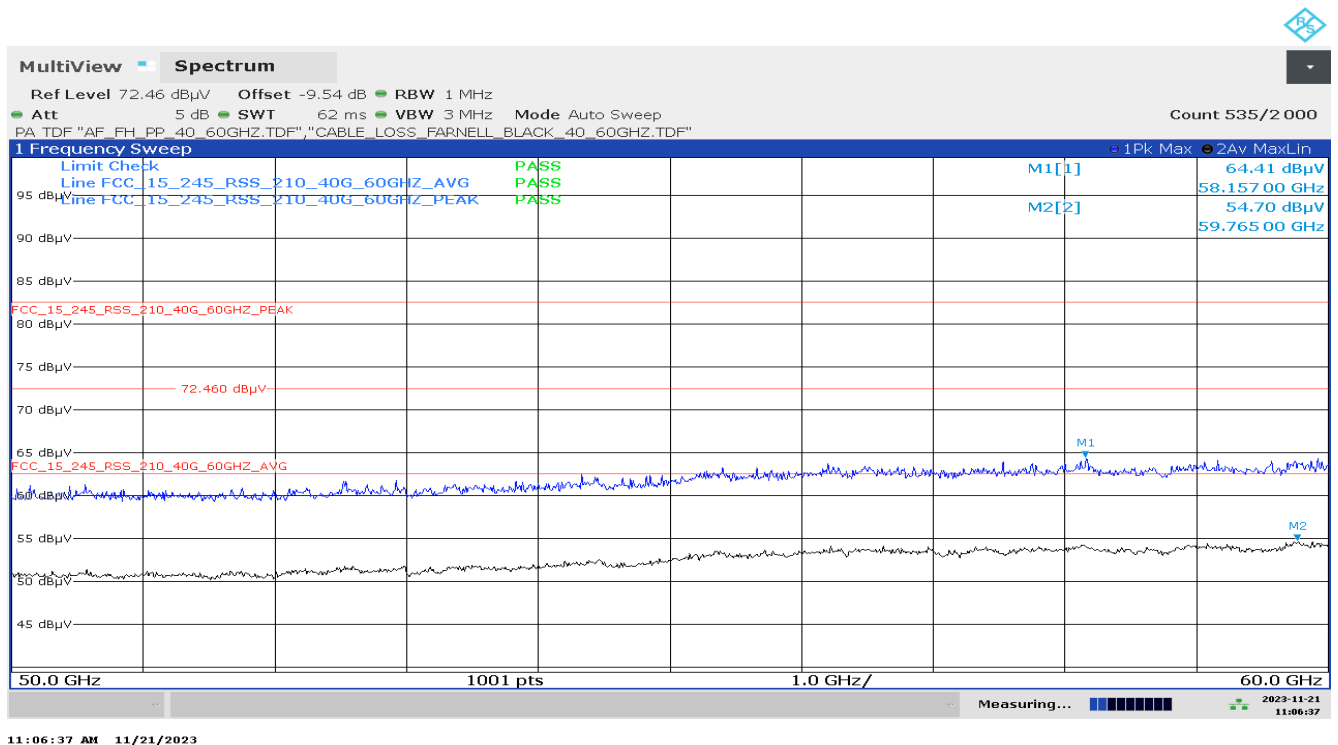
D311_RSE_50GHz_60GHz_peak_avg_full_scan_TT0°-360°_EUT90°, Antenna Vertical

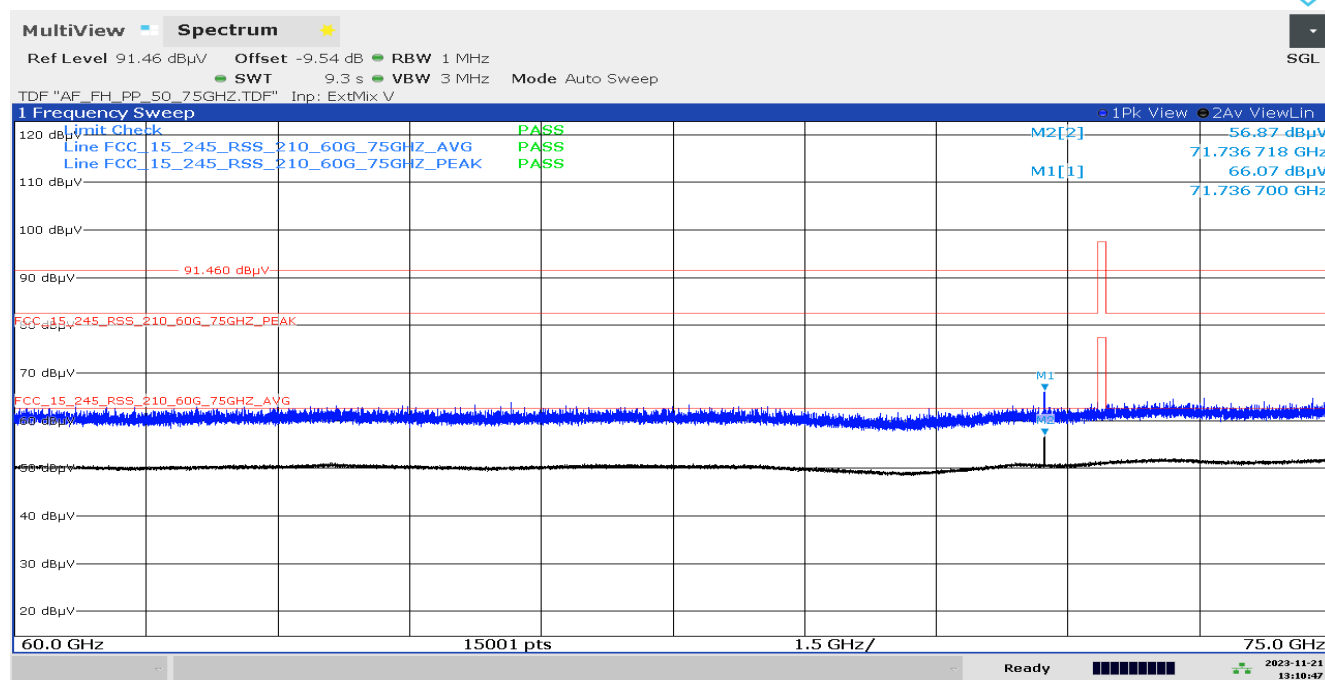


D312_RSE_50GHz_60GHz_peak_avg_single_scan_TT-45°_EUT90°, Antenna Horizontal



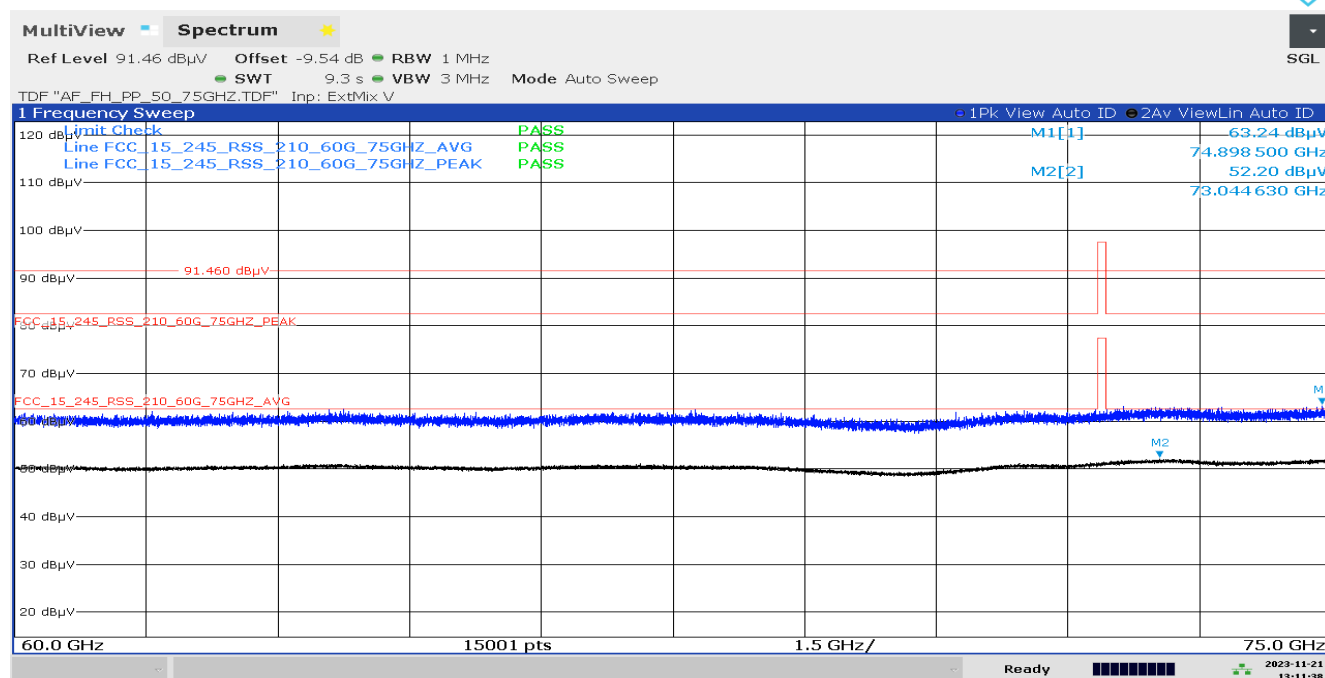
D313_RSE_50GHz_60GHz_peak_avg_full_scan_TT0°-360°_EUT90°, Antenna Horizontal



D314_RSE_60GHz_75GHz_peak_avg_single_scan_TT-45°_EUT90°, Antenna Vertical


01:10:47 PM 11/21/2023

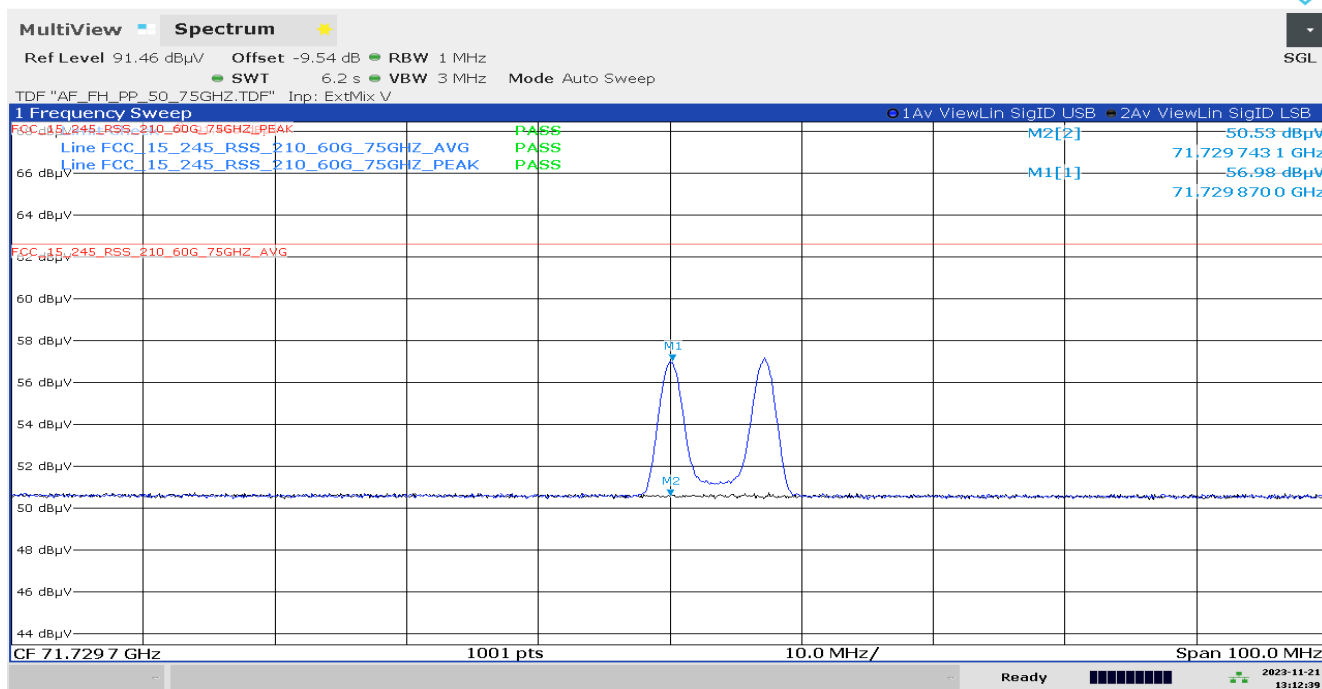
Note: No Critical Emission found, Only Ghost/Image signal, not related to assessment, check below Diagram D314_01

D314_01_RSE_60GHz_75GHz_peak_avg_single_scan_TT-45°_EUT90°_auto_id, Antenna Vertical


01:11:38 PM 11/21/2023

Note: No critical Emission found, Result: Pass.

D314_02_RSE_71.730GHz_avg_single_scan_TT-45°_EUT90°_ghost_signal, Antenna Vertical



01:12:39 PM 11/21/2023

Note: with small span to verify Ghost/Image signal.

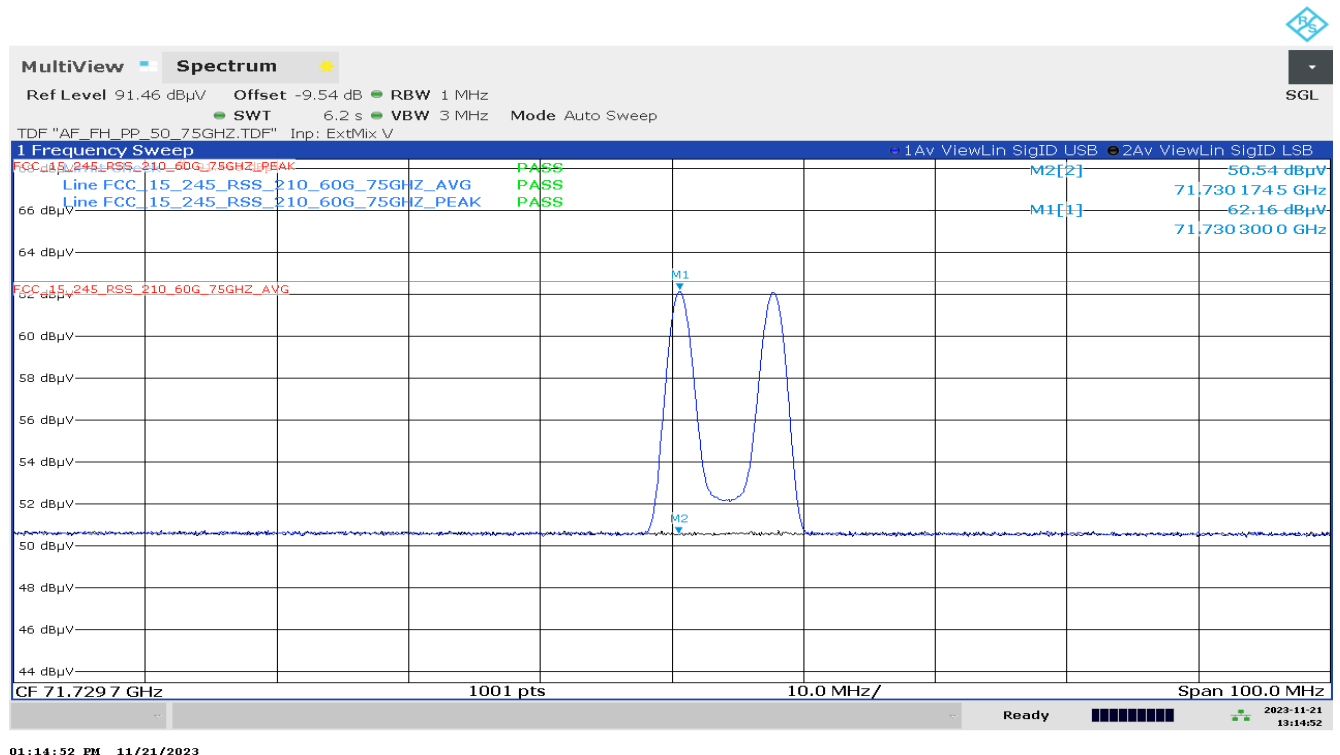
Signals, which are not overlapping, are Ghost/Image signal,

Signals, which are overlapping, are Real signal,



Note: No critical Emission found, Result: Pass.

D315_02_RSE_71.730GHz_avg_single_scan_TT-45°_EUT90°_ghost_signal, Antenna Horizontal

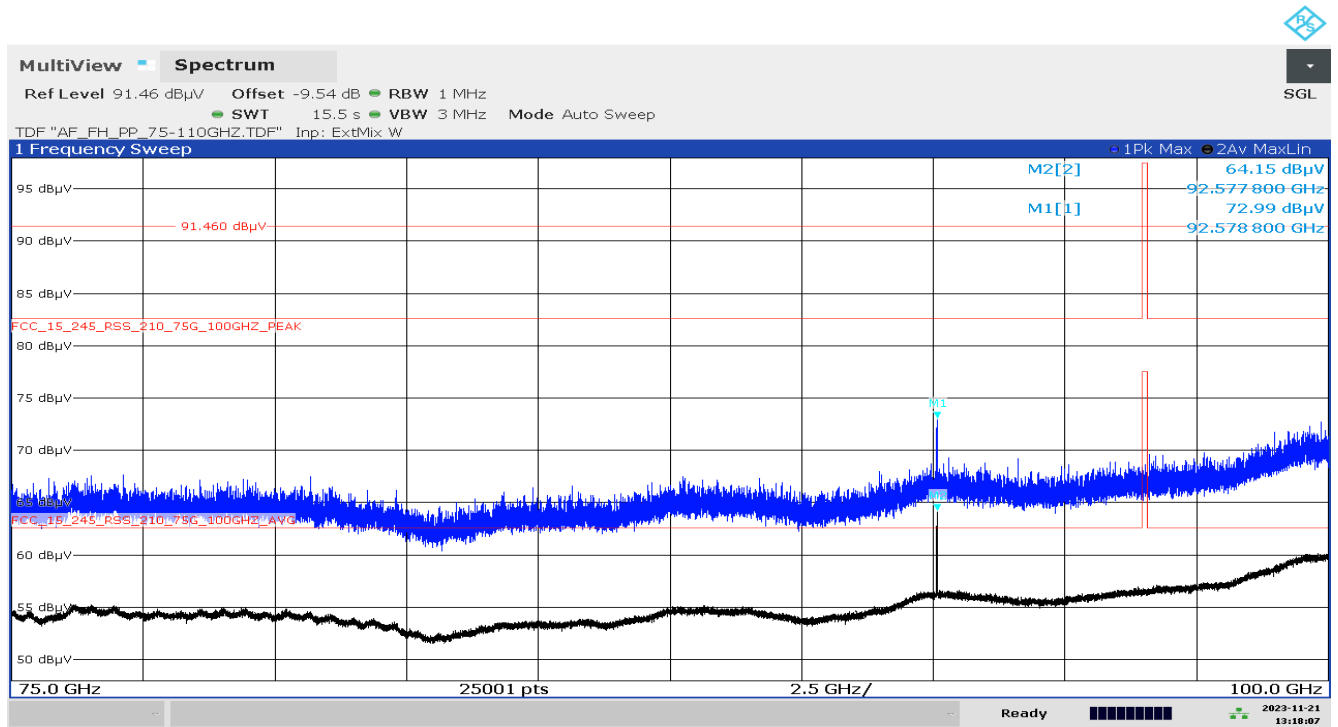


Note: with small span to verify Ghost/Image signal.

Signals, which are not overlapping, are Ghost/Image signal,

Signals, which are overlapping, are Real signal,

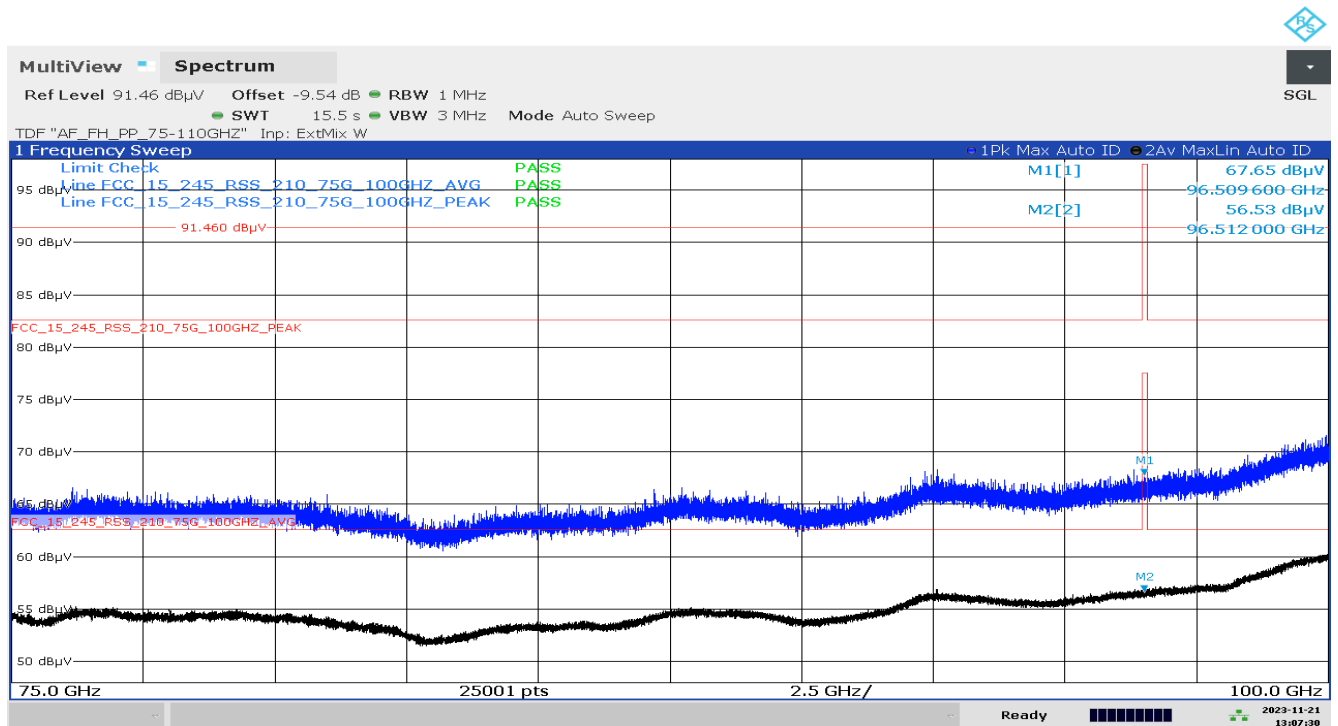
D316_RSE_75GHz_100GHz_peak_avg_single_scan_TT-45°_EUT90°_signal_id, Antenna Horizontal



01:18:08 PM 11/21/2023

Note: No Critical Emission found, Only Ghost/Image signal, not related to assessment, check below Diagram D316_01, D316_02

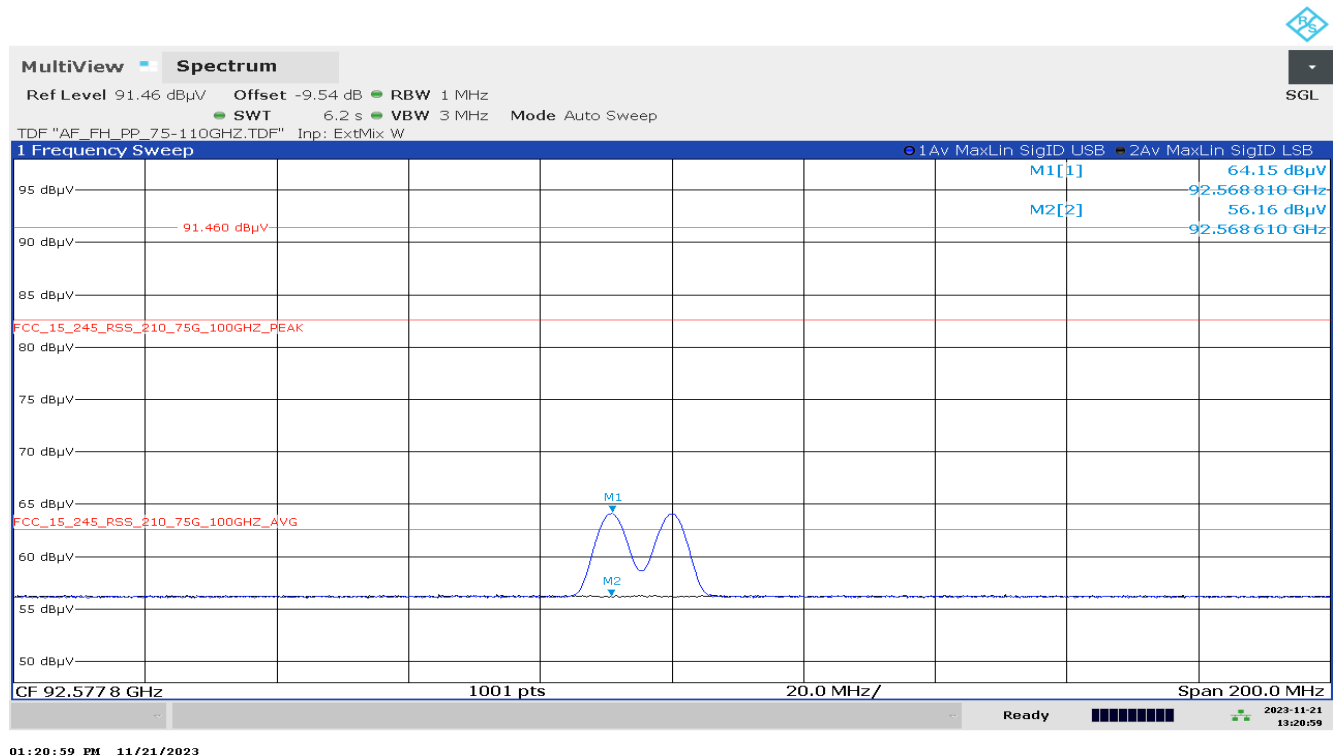
D316_01_RSE_75GHz_100GHz_peak_avg_single_scan_TT-45°_EUT90°_auto_id, Antenna Horizontal



01:07:30 PM 11/21/2023

Note: No critical Emission found, Result: Pass.

D316_02_RSE_92.578GHz_avg_single_scan_TT-45°_EUT90°_ghost_signal, Antenna Horizontal

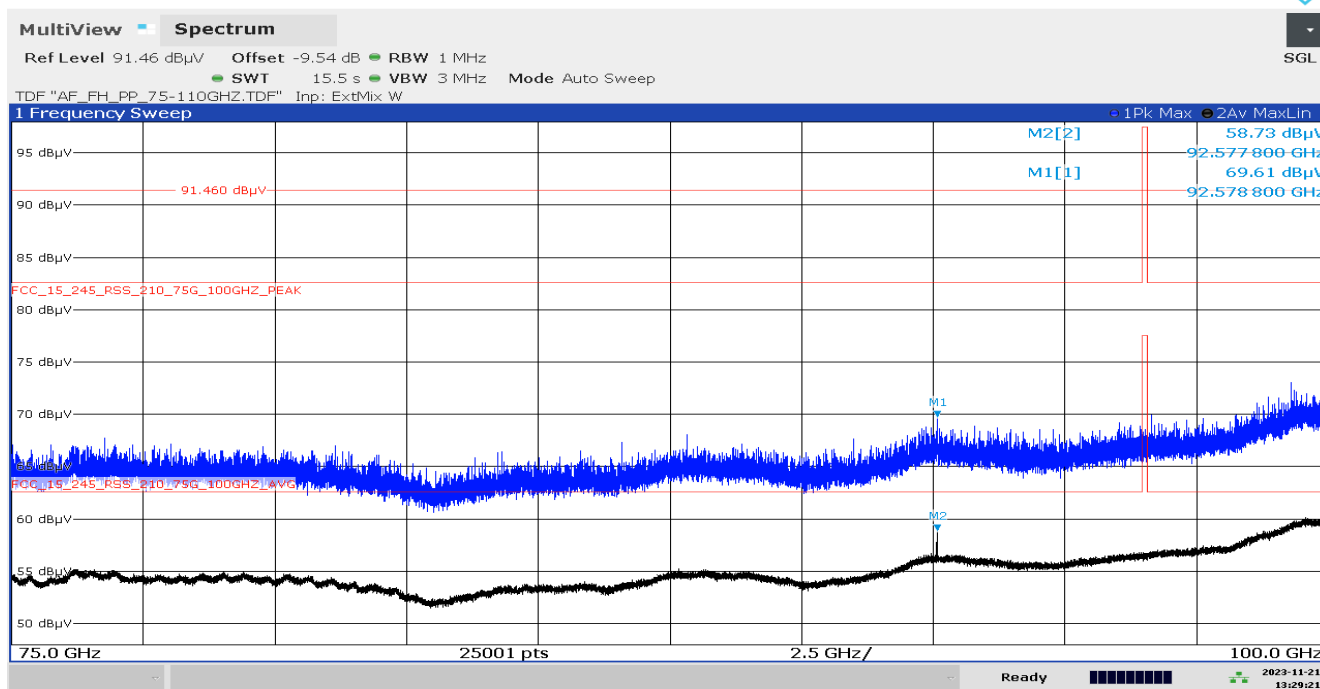


Note: with small span to verify Ghost/Image signal.

Signals, which are not overlapping, are Ghost/Image signal,

Signals, which are overlapping, are Real signal,

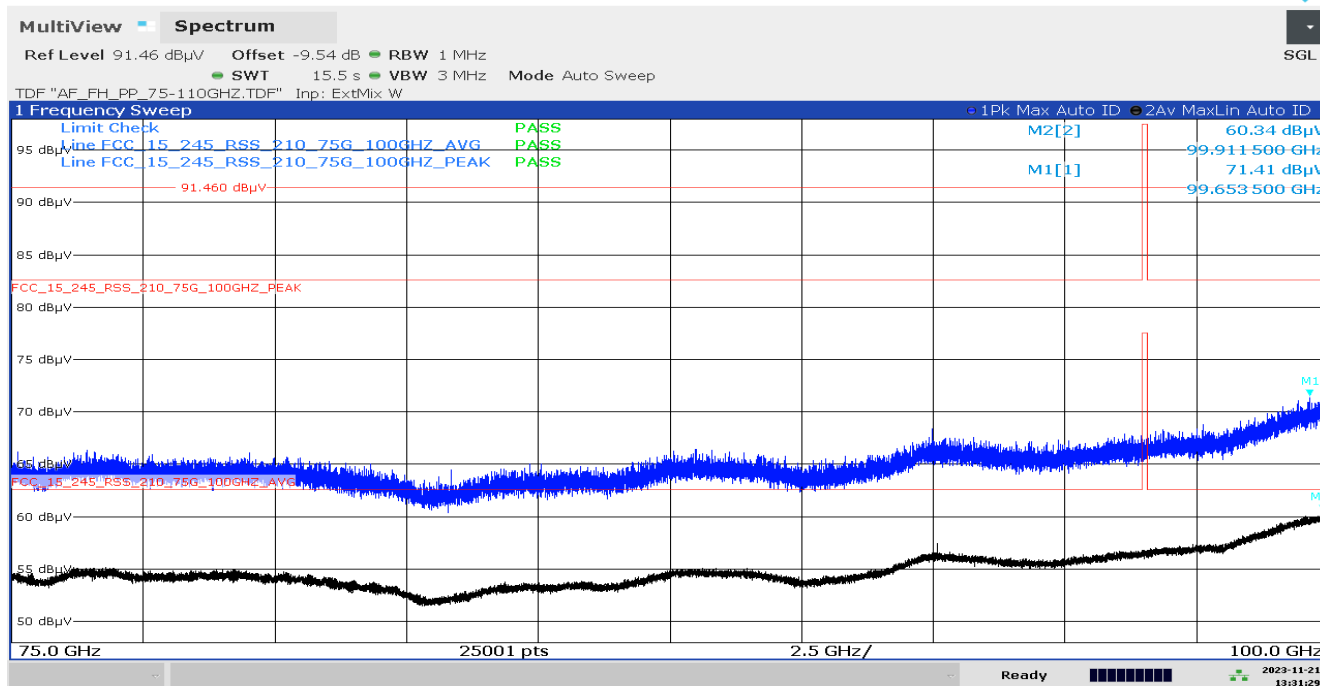
D317_RSE_75GHz_100GHz_peak_avg_single_scan_TT-45°_EUT90°_signal_id, Antenna Vertical



01:29:22 PM 11/21/2023

Note: No Critical Emission found, Only Ghost/Image signal, not related to assessment, check below Diagram D317_01, D317_02

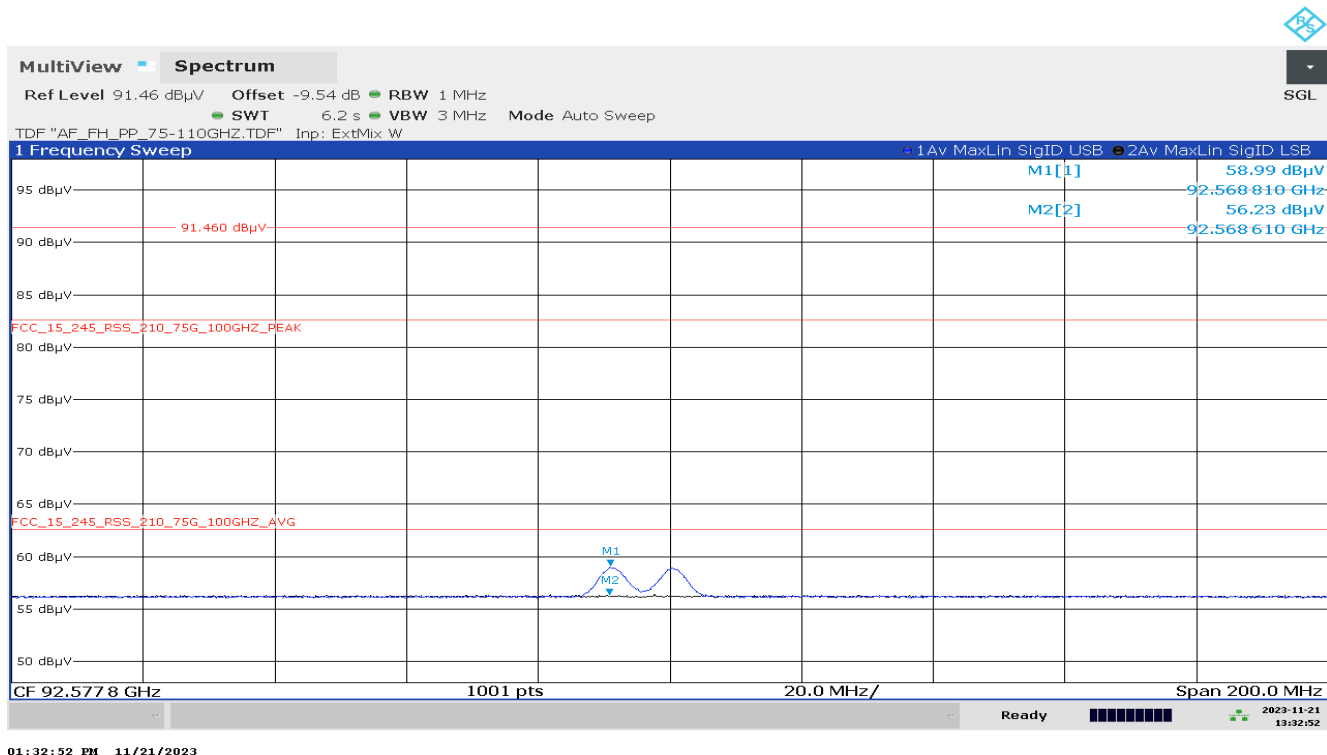
D317_01_RSE_75GHz_100GHz_peak_avg_single_scan_TT-45°_EUT90°_auto_id, Antenna Vertical



01:31:29 PM 11/21/2023

Note: No critical Emission found, Result: Pass.

D317_02_RSE_92.578GHz_avg_single_scan_TT-45°_EUT90°_ghost_signal, Antenna Vertical



Note: with small span to verify Ghost/Image signal.

Signals, which are not overlapping, are Ghost/Image signal,

Signals, which are overlapping, are Real signal,

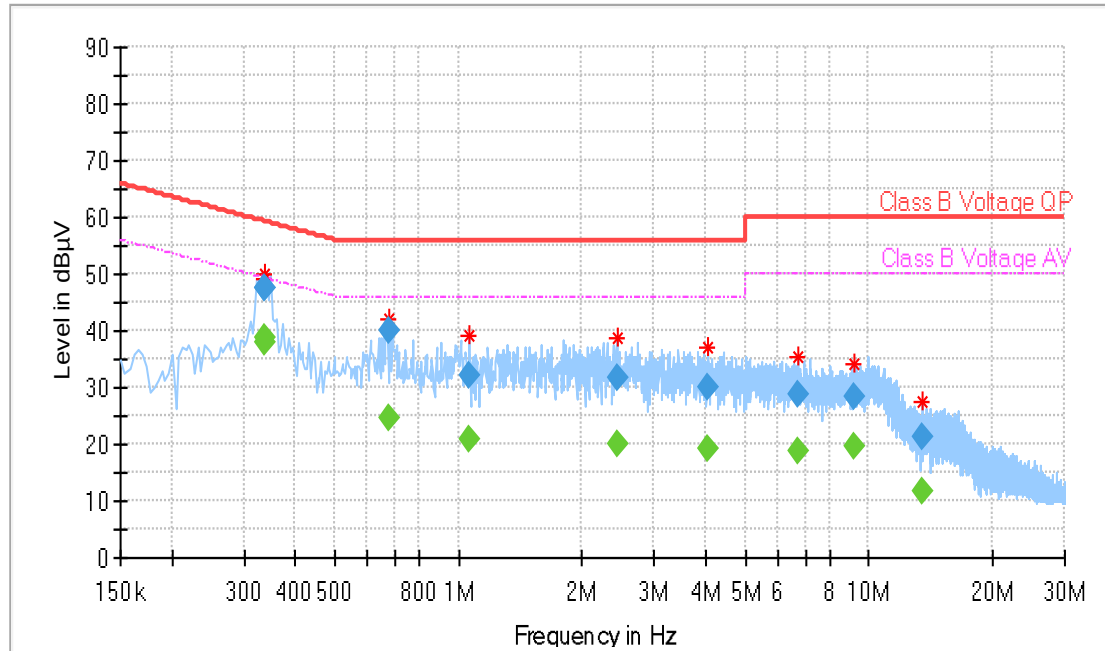
1.3 Conducted emissions < 30MHz (AC power line)

Measurement results:

Phase line + Neutral line

D252_Conducted_Emission_RADAR_Active_with_ac_dc_adapter

Full Spectrum



Final_Result

Frequency (MHz)	QuasiPeak (dBμV)	CAverage (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Correction (dB)
0.336719	---	38.79	49.28	10.49	1000.	9.000	N	GN	0.1
0.336719	47.56	---	59.28	11.72	1000.	9.000	N	GN	0.1
0.338281	47.40	---	59.25	11.85	1000.	9.000	L1	GN	0.1
0.338281	---	37.97	49.25	11.28	1000.	9.000	L1	GN	0.1
0.674844	39.85	---	56.00	16.15	1000.	9.000	N	GN	0.2
0.674844	---	24.63	46.00	21.37	1000.	9.000	N	GN	0.2
1.062656	32.19	---	56.00	23.81	1000.	9.000	L1	GN	0.2
1.062656	---	20.97	46.00	25.03	1000.	9.000	L1	GN	0.2
2.448750	31.49	---	56.00	24.51	1000.	9.000	L1	GN	0.2
2.448750	---	20.19	46.00	25.81	1000.	9.000	L1	GN	0.2
4.057656	---	19.27	46.00	26.73	1000.	9.000	L1	GN	0.3
4.057656	30.19	---	56.00	25.81	1000.	9.000	L1	GN	0.3
6.693281	28.55	---	60.00	31.45	1000.	9.000	N	GN	0.4
6.693281	---	18.80	50.00	31.20	1000.	9.000	N	GN	0.4
9.182188	---	19.48	50.00	30.52	1000.	9.000	N	GN	0.4
9.182188	28.51	---	60.00	31.49	1000.	9.000	N	GN	0.4
13.551406	21.13	---	60.00	38.87	1000.	9.000	L1	GN	0.8
13.551406	---	11.53	50.00	38.47	1000.	9.000	L1	GN	0.8

Verdict: Compliant

End Of Annex 1