

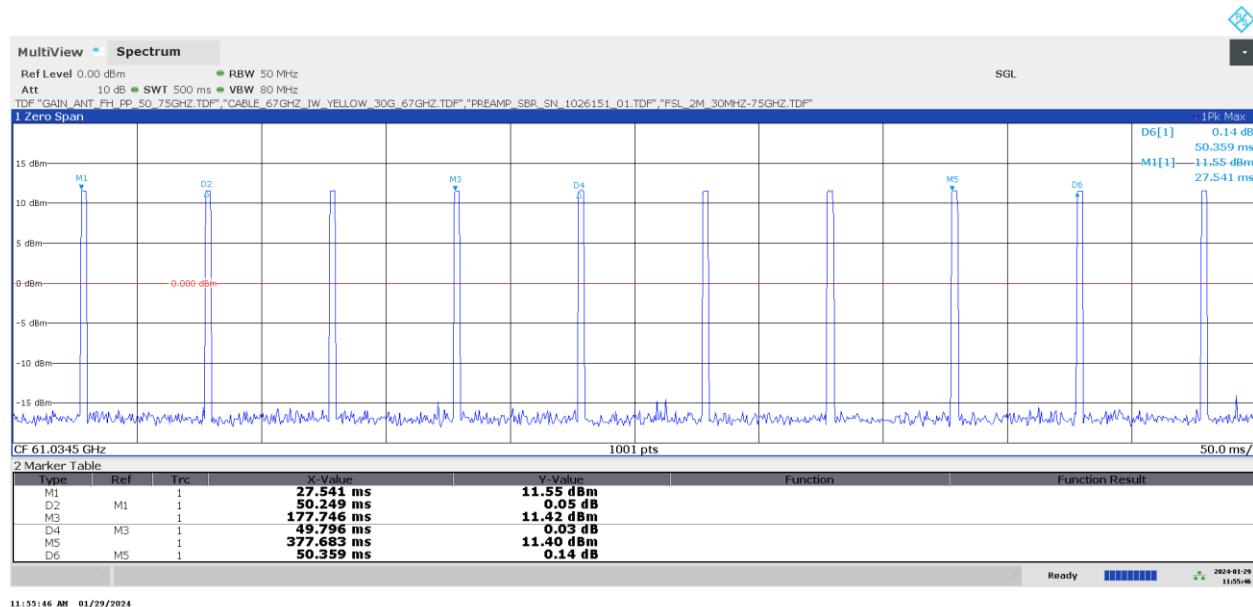
Annex 1: Measurement diagrams 22-1-0043303T008a-A1

Number of pages:	41	Date of Report:	2024-Jul-04
Testing company:	cetecom advanced GmbH Untertuerkheimer Str. 6-10 66117 Saarbruecken GERMANY	Applicant:	Hans Turck GmbH & Co. KG
Product:	Radar Sensor		
Model:	MR15-Q80-IOLCJ-H1141		
Testing has been carried out in accordance with:	FCC Regulations Title 47 CFR The 57-71 GHz Band Radar Service § 15.255 Operating within band 57 – 64 GHz 47 CFR 15.255(c)(2)(iii) (A)		

1 Measurement diagrams

1.1 EUT Cycle Time:

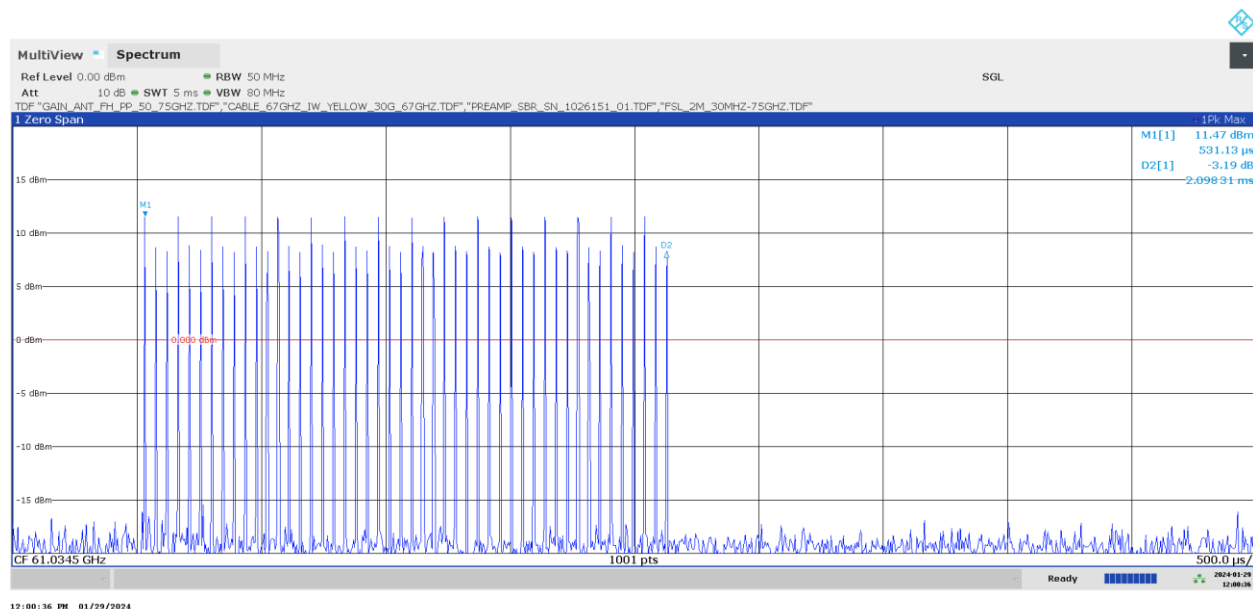
TID002_Ess_OR03_T004_EUT_Cycle_Time_50ms



Note: only for information,

EUT cycle time: 50ms. Measurement Performed with Spectrum Analyzer.

TID002_01_Ess_OR03_T004_single_Burst_Time_2.1ms



Note: only for information,

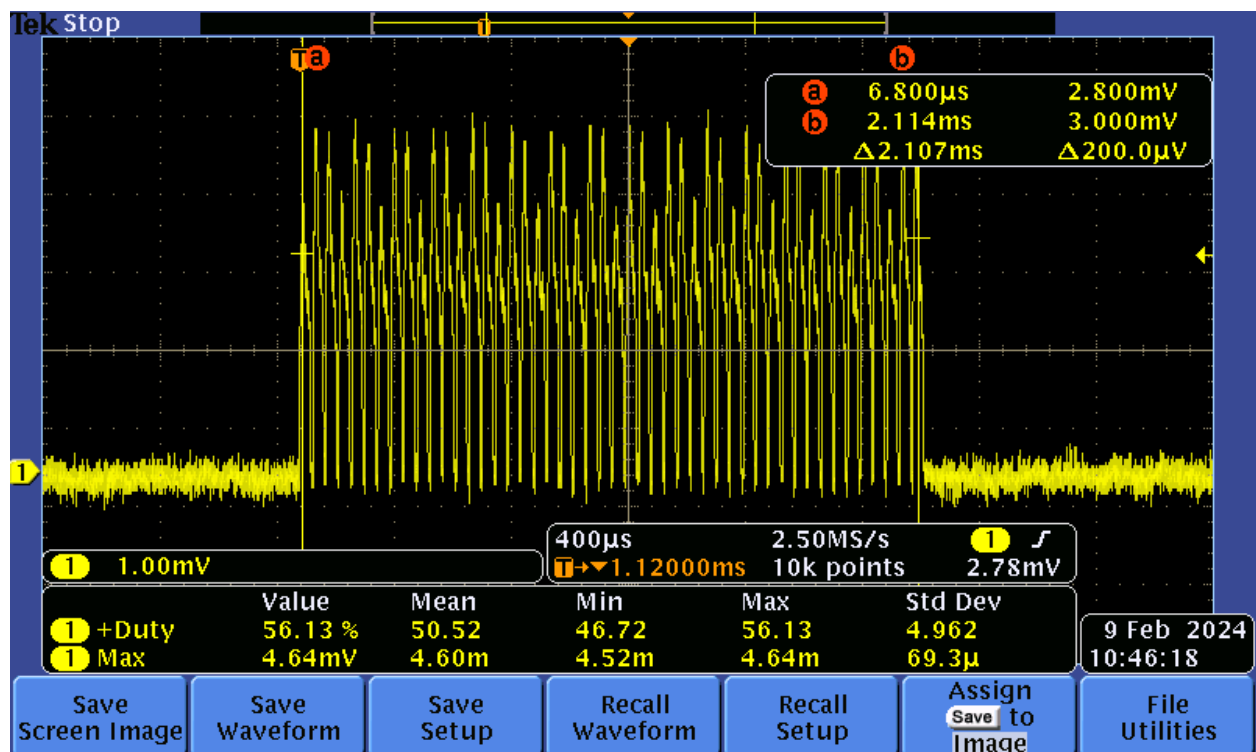
Burst time: 2.1ms. Measurement Performed with Spectrum Analyzer.

1.2 Time domain requirements: Continuous transmitter off-times & transmit duty cycle. Requirement to be fulfilled according to §15.255(c) (2) (iii)

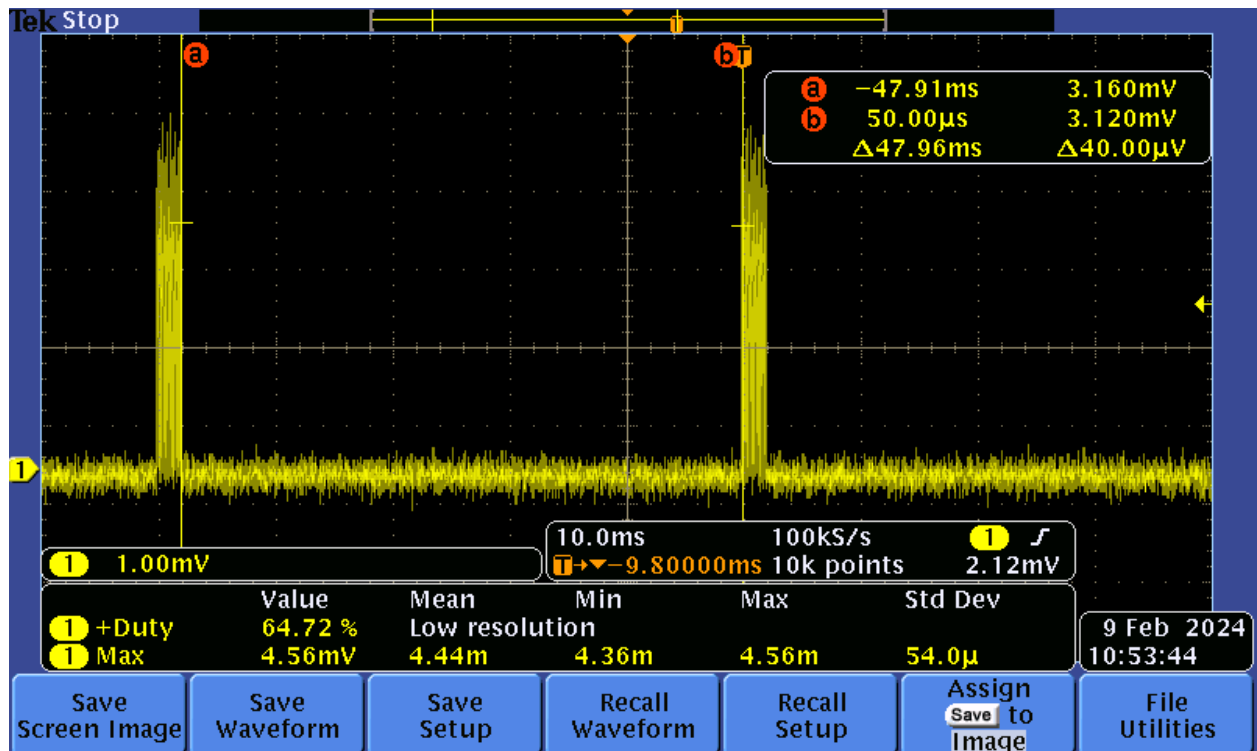
Off time $\geq 2\text{ms}$ (continuous) and $\geq 25.5\text{ms}$ within 33ms

57.0–64.0 GHz:

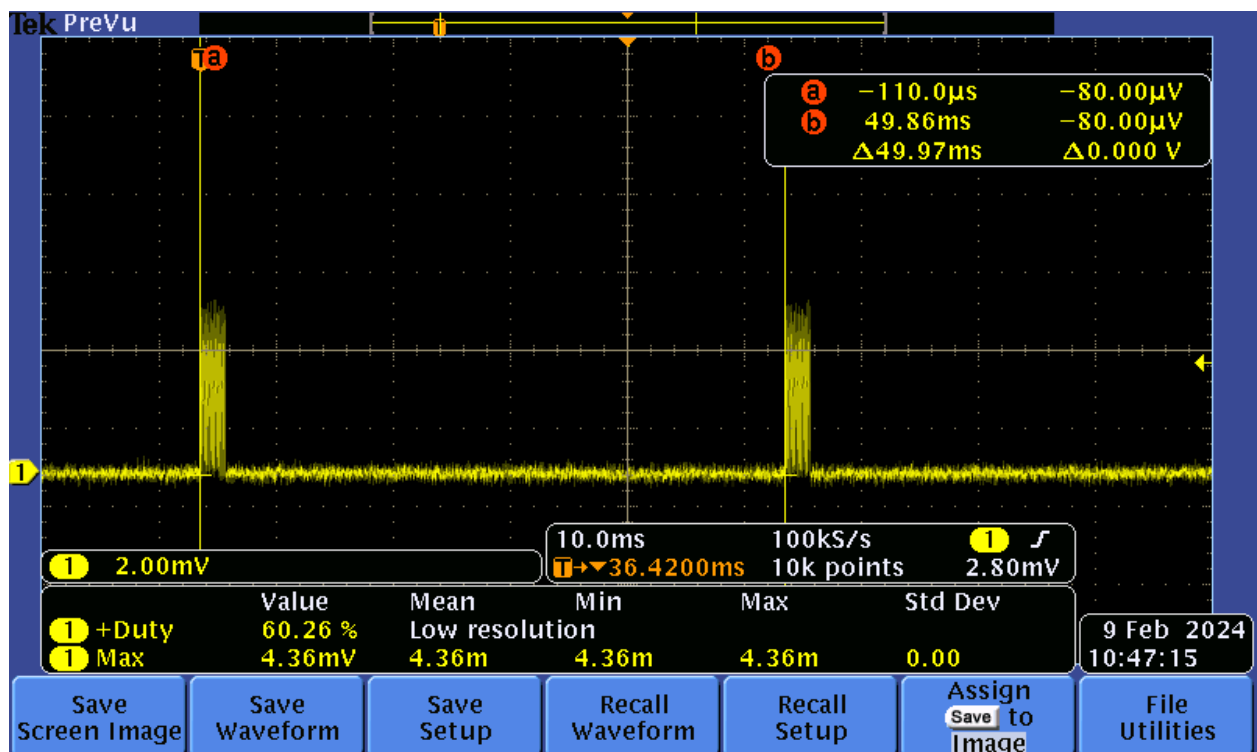
(A) The peak EIRP shall not exceed 14 dBm, and the sum of continuous transmitter off-times of at least two milliseconds shall equal at least 25.5 milliseconds within any contiguous interval of 33 milliseconds.



Note: Transmitter on time = 2.107ms



Note: Transmitter off time = 47.96ms



Note-1: EUT cycle time = 50ms

Note-2: One Pulse Train within 33ms period.

1.3 Peak Power / Peak EIRP (Reference Clause No: §15.255(c)):

TID012_Ess_OR03_T008_PEAK_EIRP_RBW_50MHz_FSW_ref_level_verified

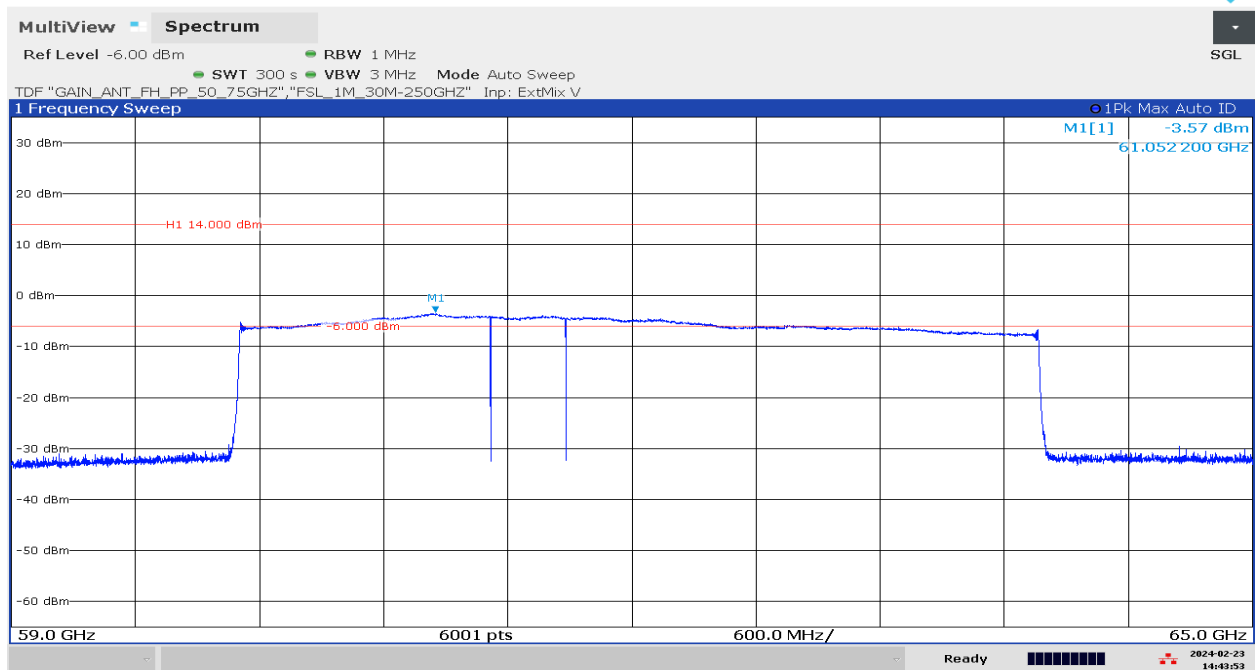


03:07:41 PM 02/23/2024

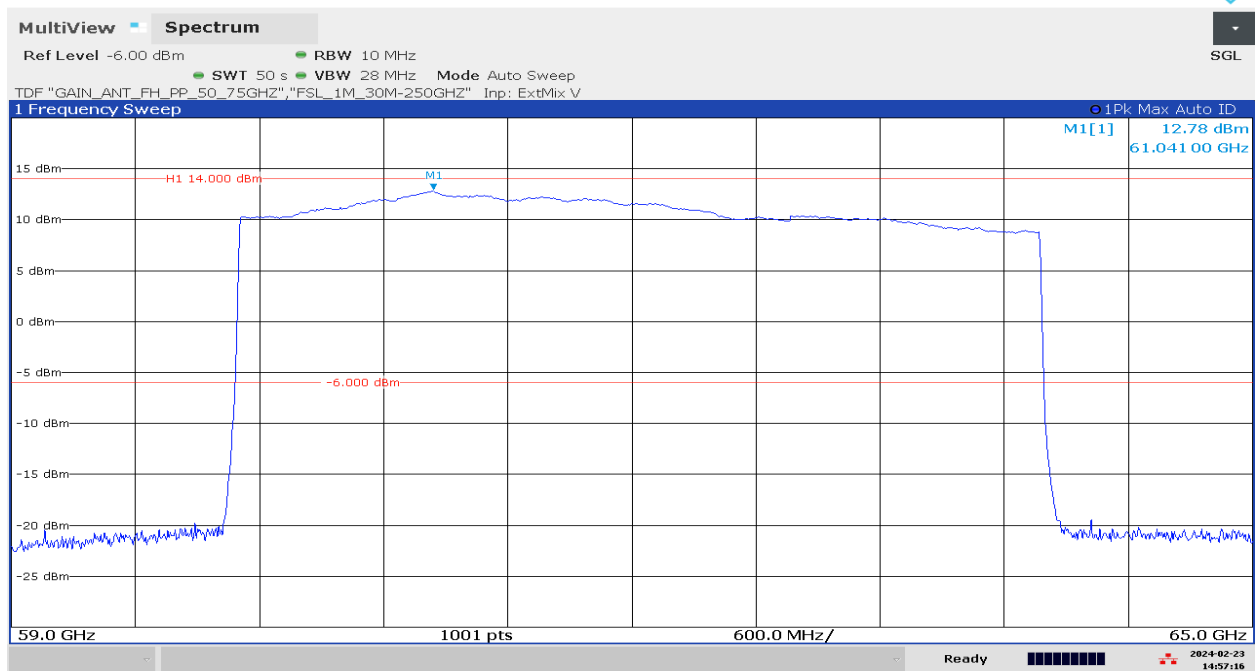
Note: only for information, not for assessment.

Spectrum Analyzer Ref Level verified.

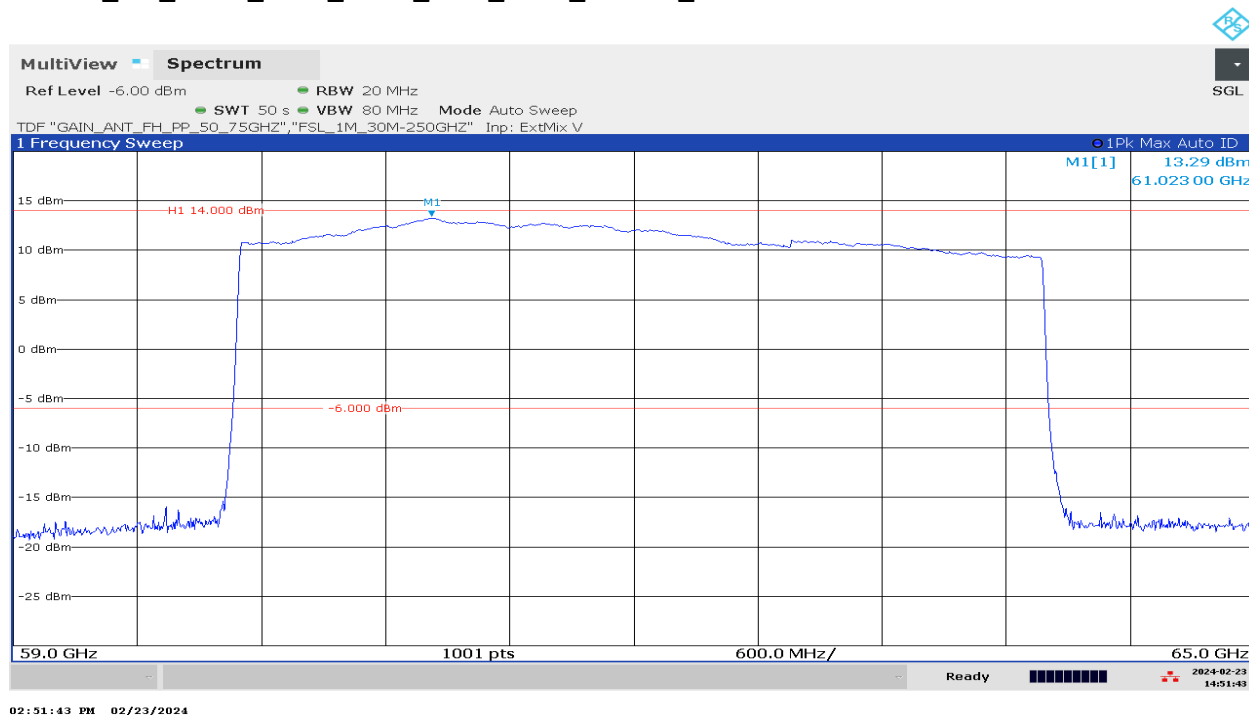
TID007_Ess_OR03_T008_PEAK_EIRP_RBW_1MHz



TID008_Ess_OR03_T008_PEAK_EIRP_RBW_10MHz_12.78dBm

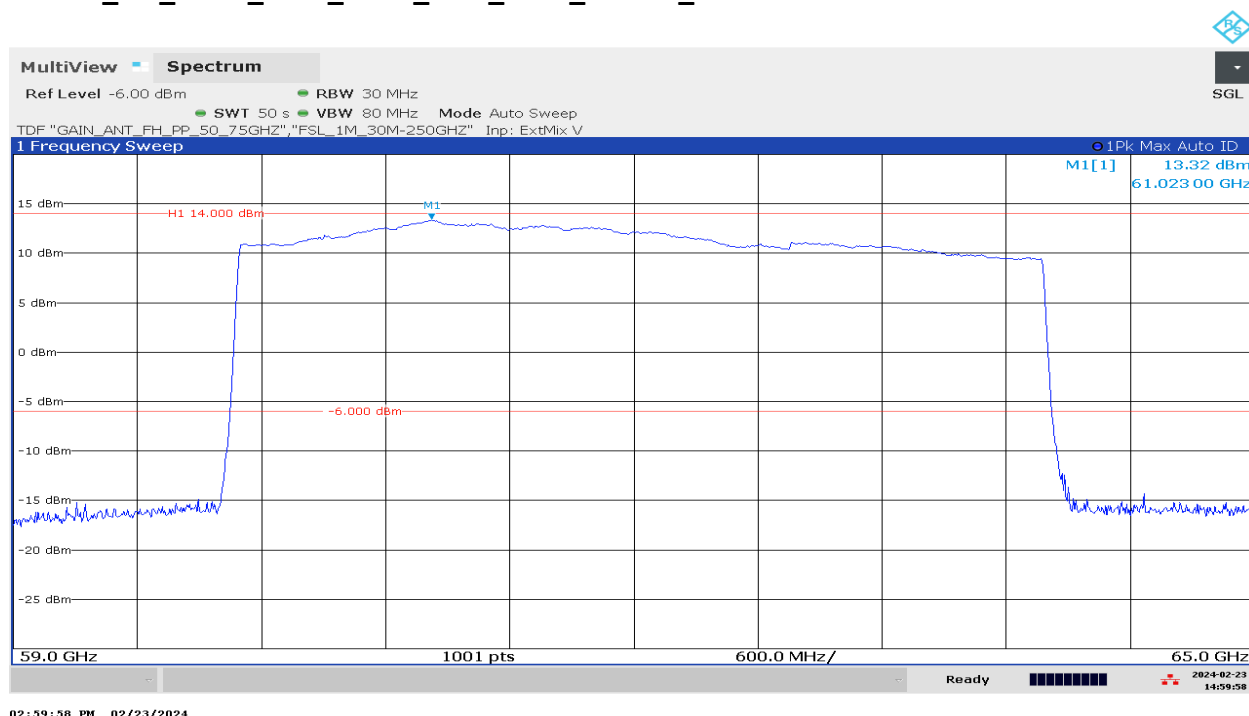


TID009_Ess_OR03_T008_PEAK_EIRP_RBW_20MHz_13.29dBm



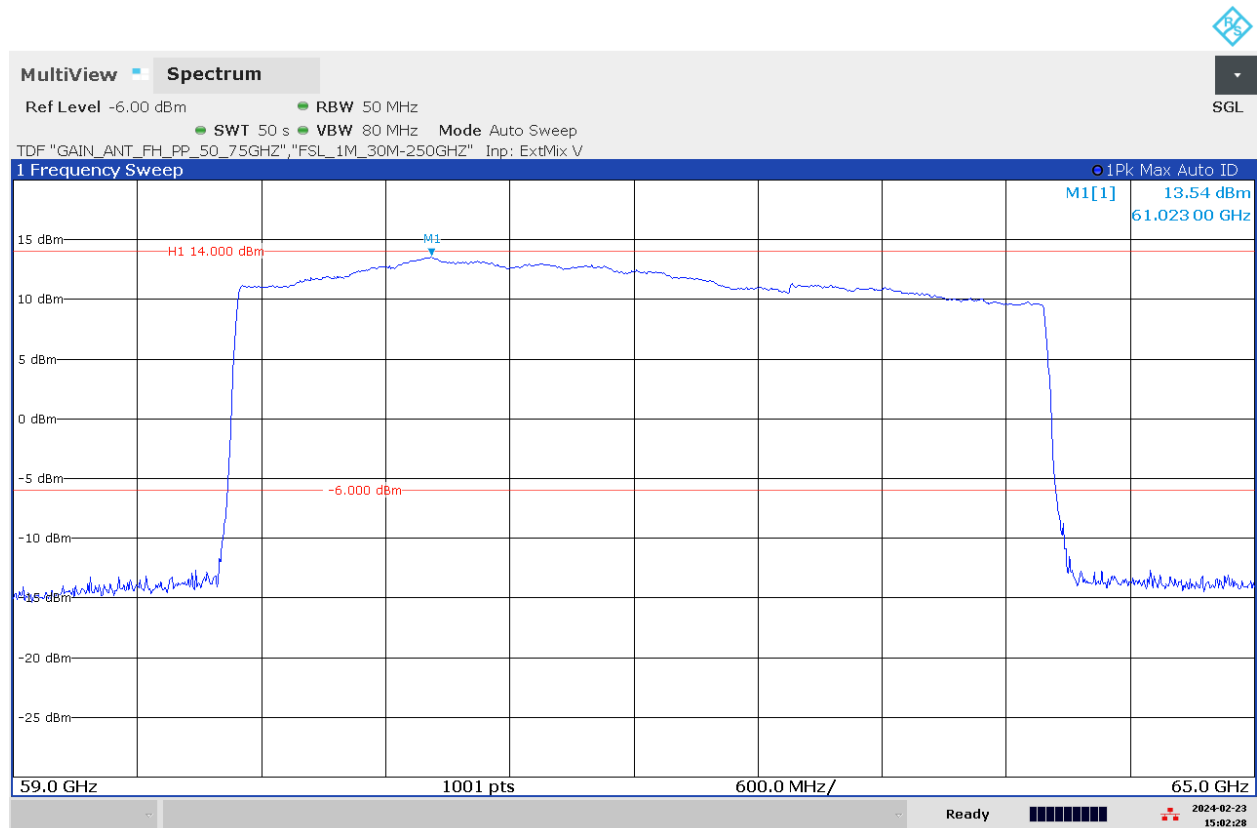
Note: Different RBW has been used to avoid desensitization factor and to get a stable Peak power.
Only for information, not for assessment.

TID010_Ess_OR03_T008_PEAK_EIRP_RBW_30MHz_13.32dBm



Note: Different RBW has been used to avoid desensitization factor and to get a stable Peak power.
Only for information, not for assessment.

TID011_Ess_OR03_T008_PEAK_EIRP_RBW_50MHz_13.54dBm



03:02:28 PM 02/23/2024

Note: Different RBW has been used to avoid desensitization factor and to get a stable Peak power.

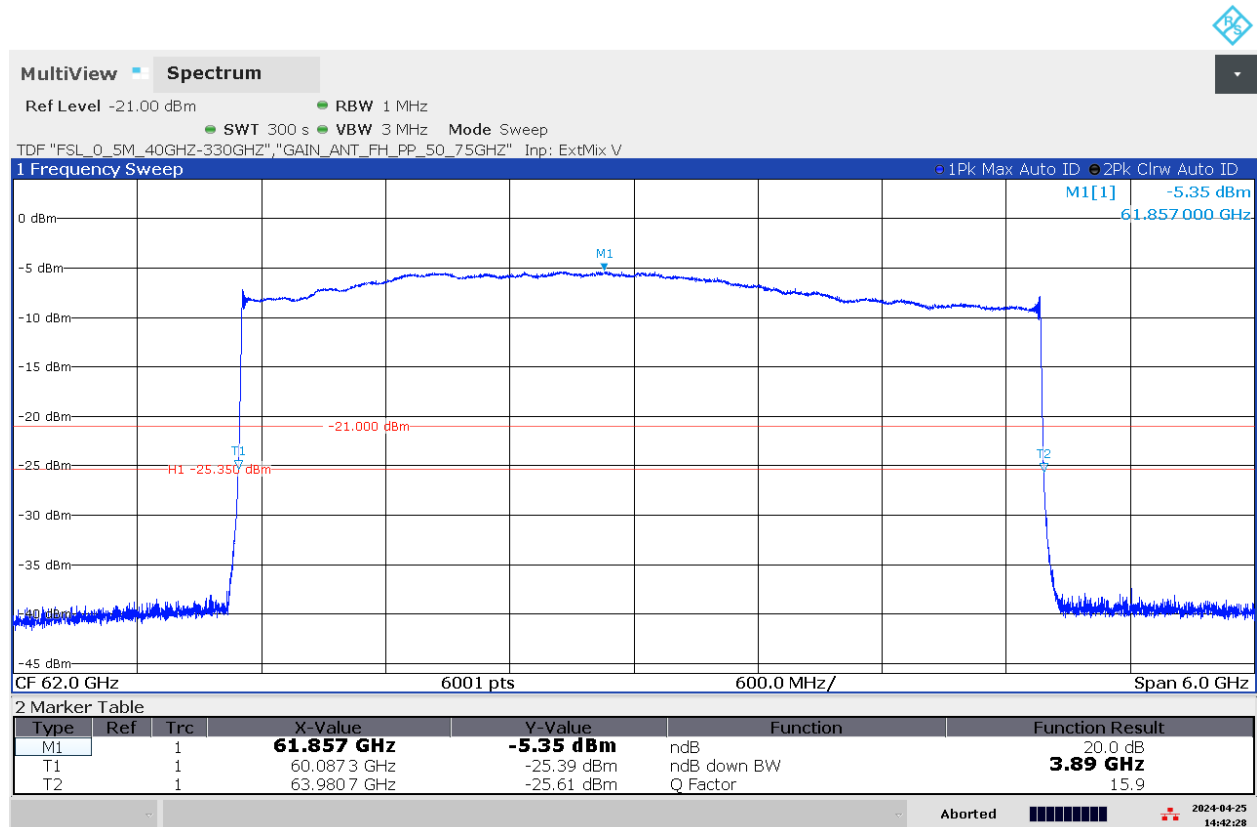
As worst case scenario 50MHz RBW has been taken for maximum Peak Power/EIRP.

Maximum EIRP = 13.54dBm, Limit: 14dBm, Result: Pass.

1.4 20 dB Bandwidth (Reference Clause No: §15.215(c)):

1.4.1 Tnom Vnom,

TID100_Ess_OR03_T008_PEAK_EIRP_RBW_1MHz_Vnom_Tnom_pass



02:42:28 PM 04/25/2024

Note:

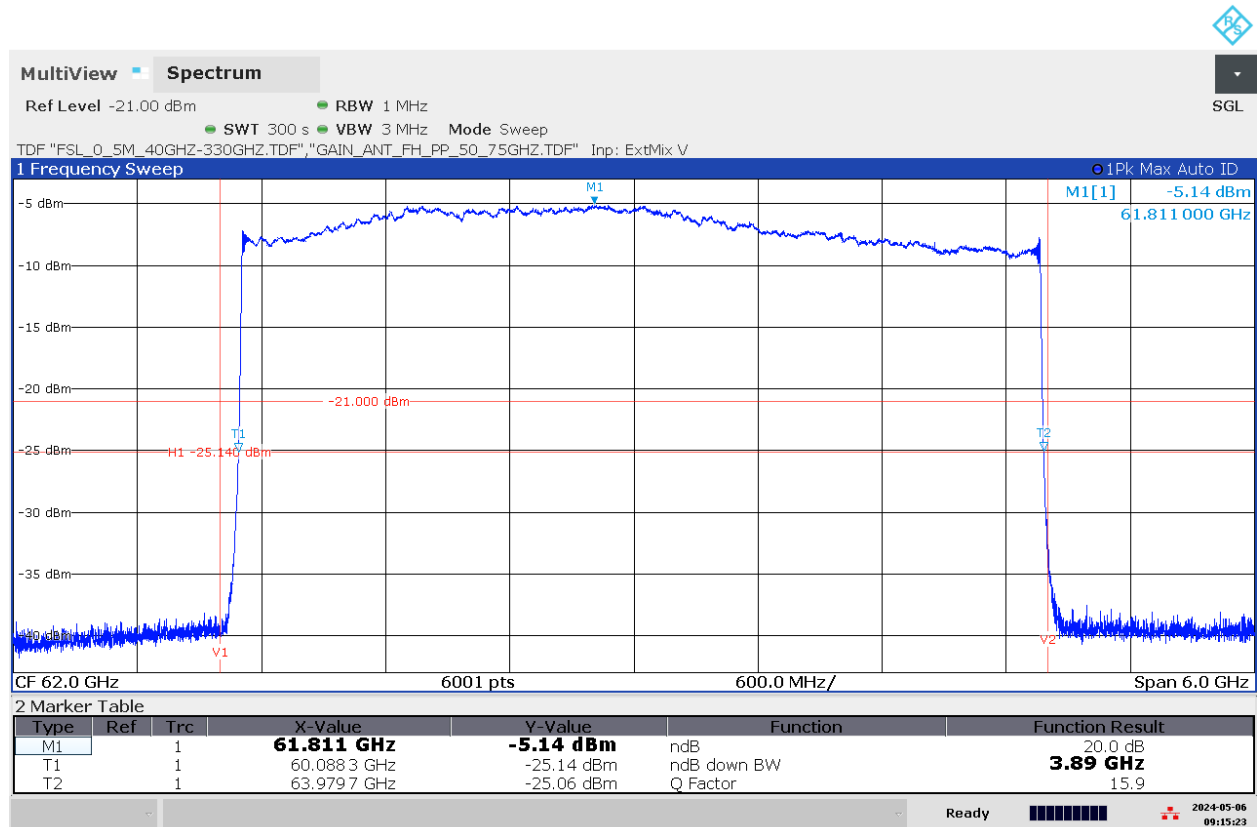
Limit: fLow>57GHz, fHigh<64GHz.

fLow = T1 , fHigh = T2.

Result: fLow: Pass, fHigh: Pass.

1.4.2 Tnom Vmin,

TID101_Ess_OR03_T008_PEAK_EIRP_RBW_1MHz_Vmin_Tnom_pass



09:15:24 AM 05/06/2024

Note:

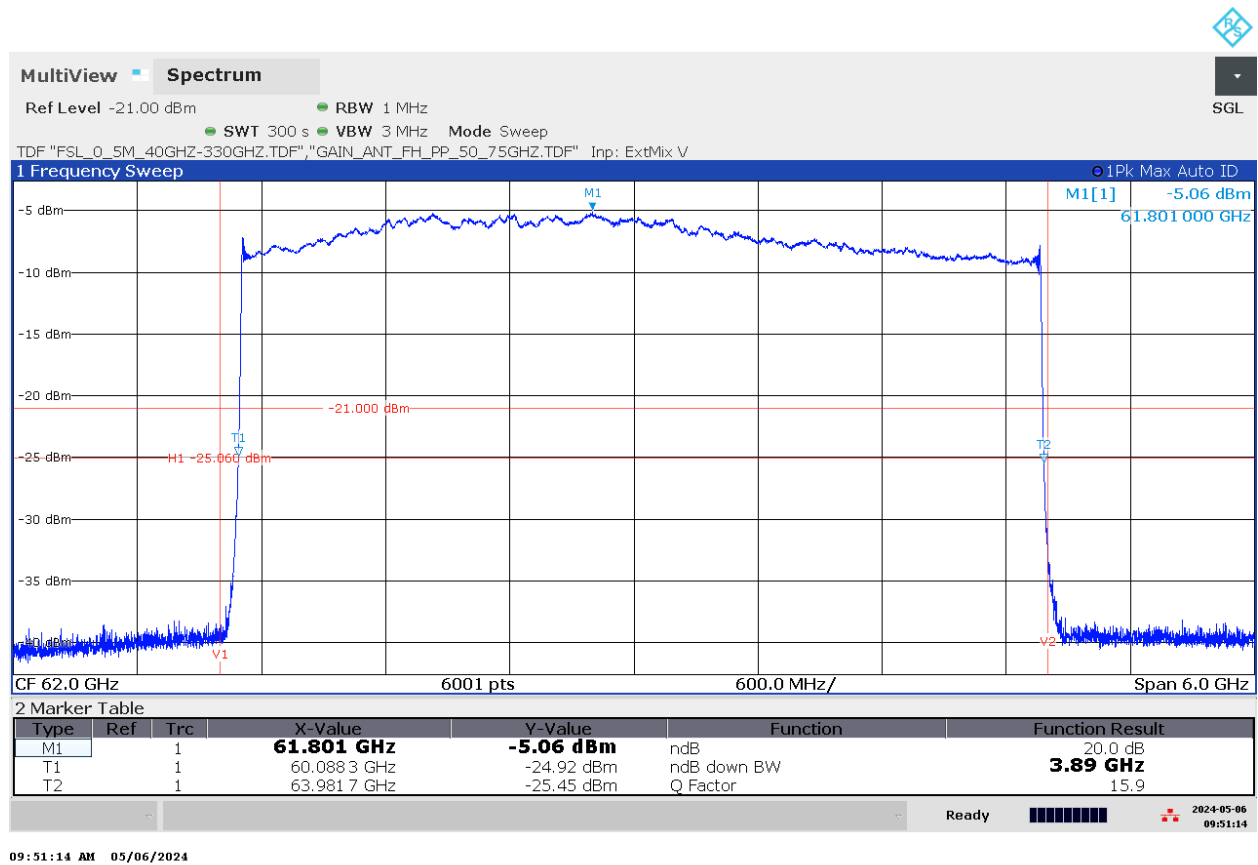
Limit: fLow>57GHz, fHigh<64GHz.

fLow = T1 , fHigh = T2.

Result: fLow: Pass, fHigh: Pass.

1.4.3 Tnom Vmax,

TID102_Ess_OR03_T008_PEAK_EIRP_RBW_1MHz_Vmax_Tnom_pass



Note:

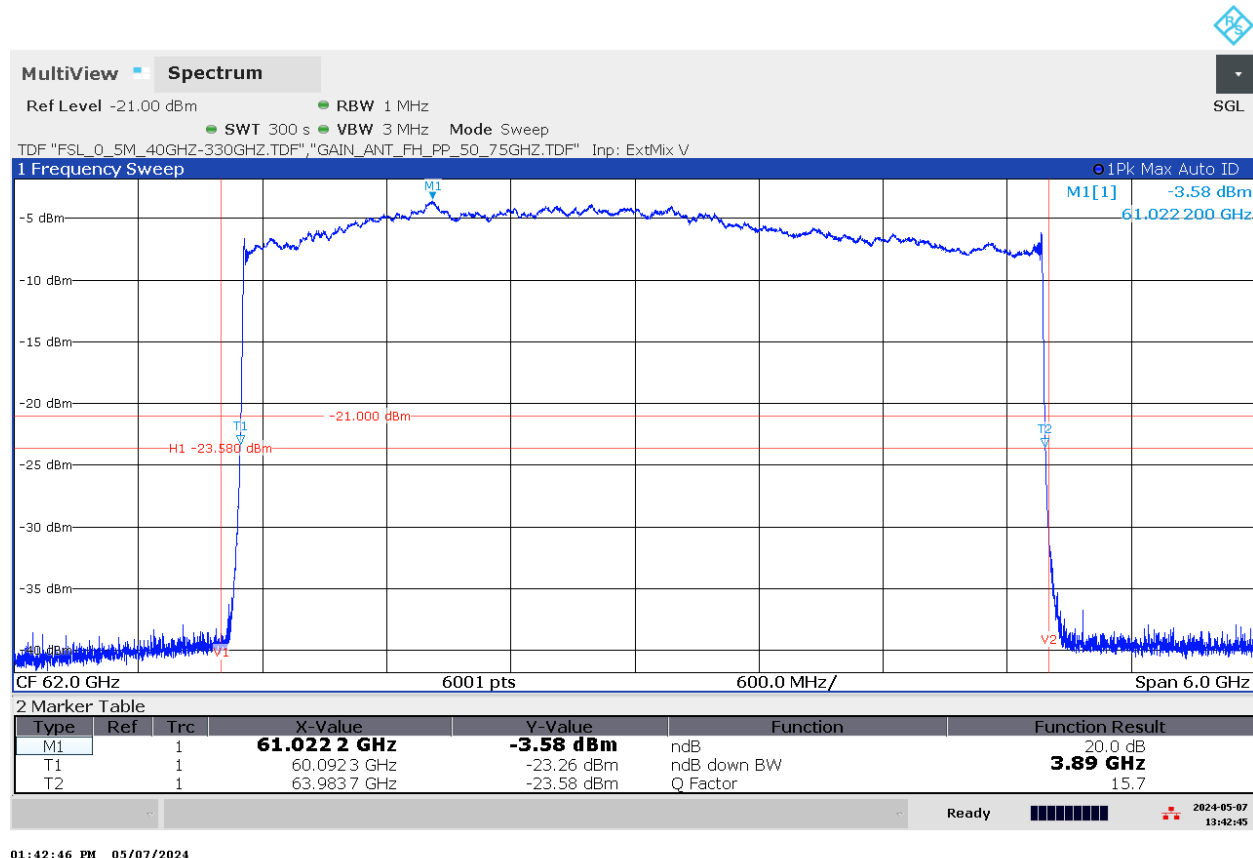
Limit: fLow>57GHz, fHigh<64GHz.

fLow = T1 , fHigh = T2.

Result: fLow: Pass, fHigh: Pass.

1.4.4 Vnom T -20°C:

TID104_Ess_OR03_T008_PEAK_EIRP_RBW_1MHz_Vnom_T-20°C



01:42:46 PM 05/07/2024

Note:

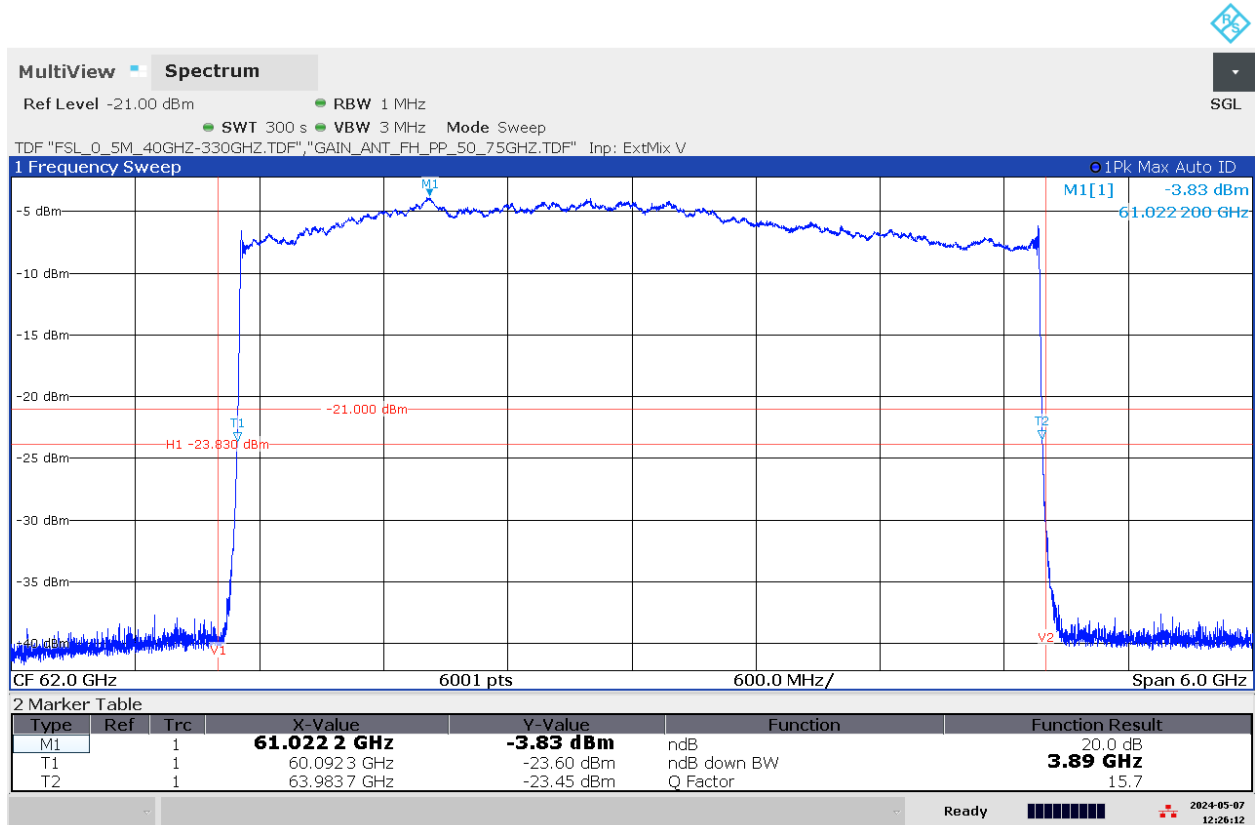
Limit: fLow>57GHz, fHigh<64GHz.

fLow = T1 , fHigh = T2.

Result: fLow: Pass, fHigh: Pass.

1.4.5 Vnom T -10°C:

TID105_Ess_OR03_T008_PEAK_EIRP_RBW_1MHz_Vnom_T-10°C



12:26:13 PM 05/07/2024

Note:

Limit: fLow>57GHz, fHigh<64GHz.

fLow = T1 , fHigh = T2.

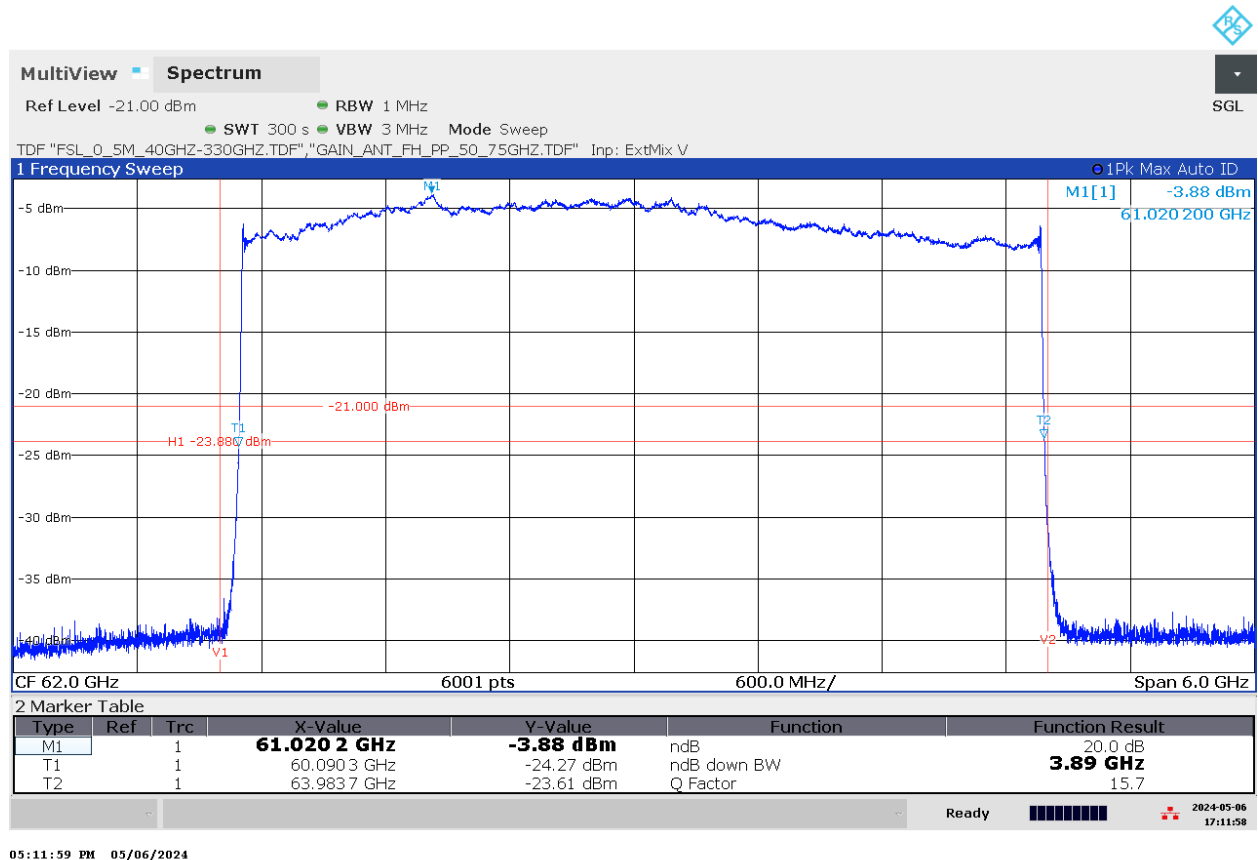
Result: fLow: Pass, fHigh: Pass.



14 / 41

1.4.6 Vnom T 0°C:

TID106_Ess_OR03_T008_PEAK_EIRP_RBW_1MHz_Vnom_T0°C



Note:

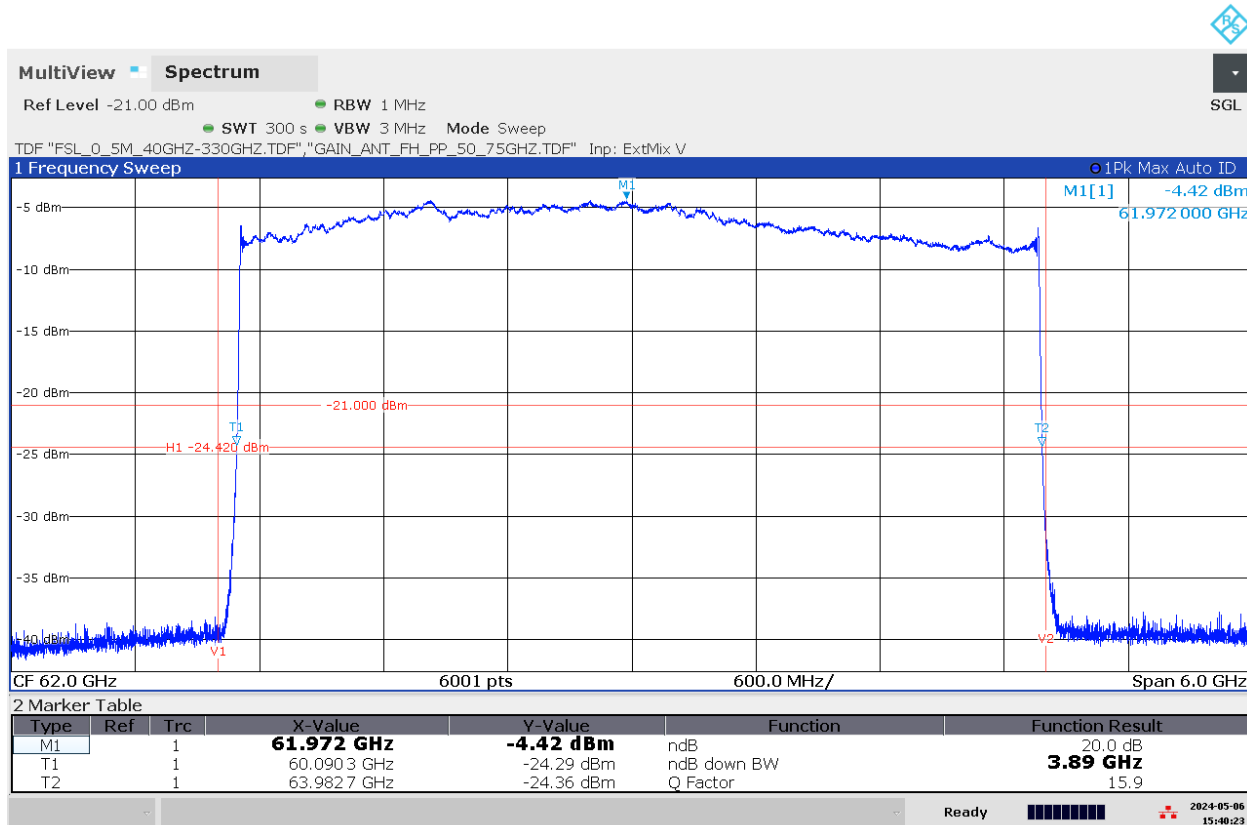
Limit: fLow>57GHz, fHigh<64GHz.

fLow = T1 , fHigh = T2.

Result: fLow: Pass, fHigh: Pass.

1.4.7 Vnom T +10°C:

TID107_Ess_OR03_T008_PEAK_EIRP_RBW_1MHz_Vnom_T10°C



03:40:24 PM 05/06/2024

Note:

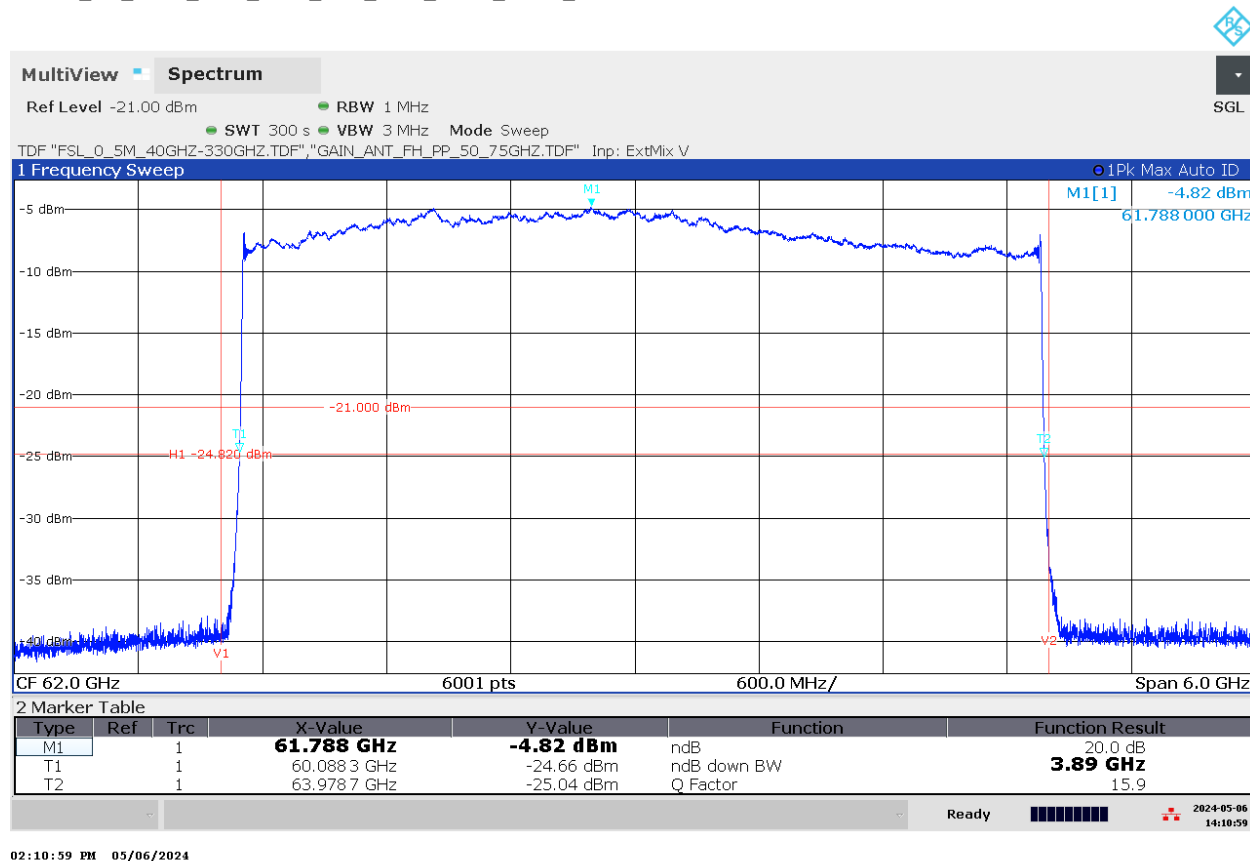
Limit: fLow>57GHz, fHigh<64GHz.

fLow = T1 , fHigh = T2.

Result: fLow: Pass, fHigh: Pass.

1.4.8 Vnom T +20°C:

TID108_Ess_OR03_T008_PEAK_EIRP_RBW_1MHz_Vnom_T20°C



02:10:59 PM 05/06/2024

Note:

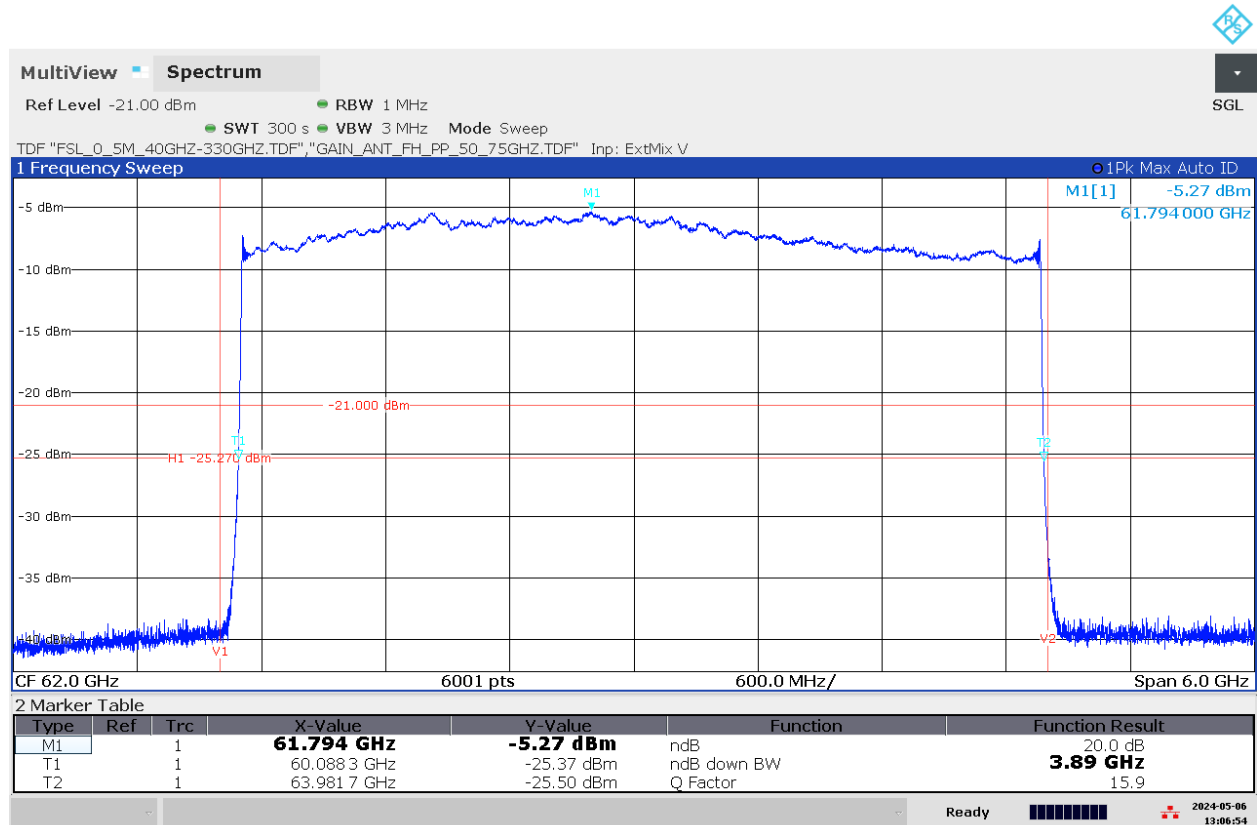
Limit: fLow>57GHz, fHigh<64GHz.

fLow = T1 , fHigh = T2.

Result: fLow: Pass, fHigh: Pass.

1.4.9 Vnom T +30°C:

TID109_Ess_OR03_T008_PEAK_EIRP_RBW_1MHz_Vnom_T30°C



01:06:54 PM 05/06/2024

Note:

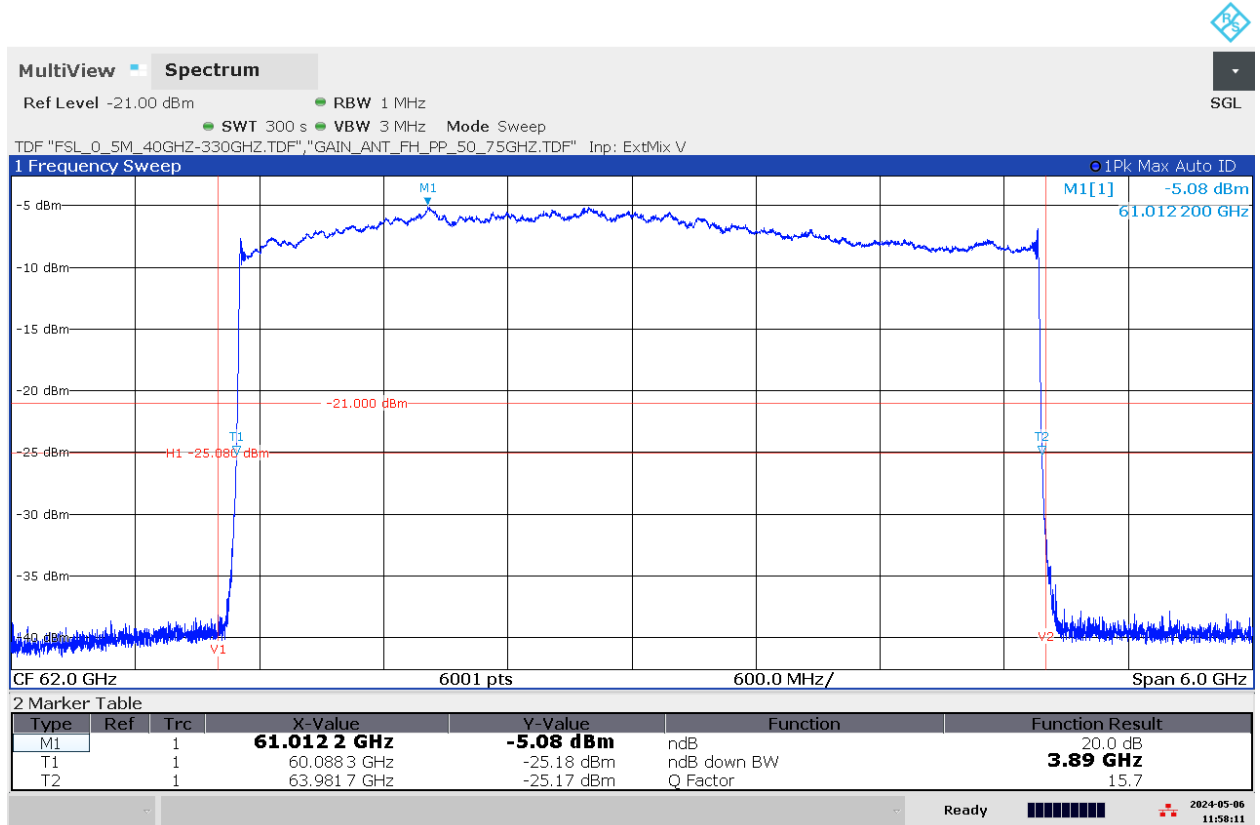
Limit: fLow>57GHz, fHigh<64GHz.

fLow = T1 , fHigh = T2.

Result: fLow: Pass, fHigh: Pass.

1.4.10 Vnom T +40°C:

TID110_Ess_OR03_T008_PEAK_EIRP_RBW_1MHz_Vnom_T40°C



11:58:11 AM 05/06/2024

Note:

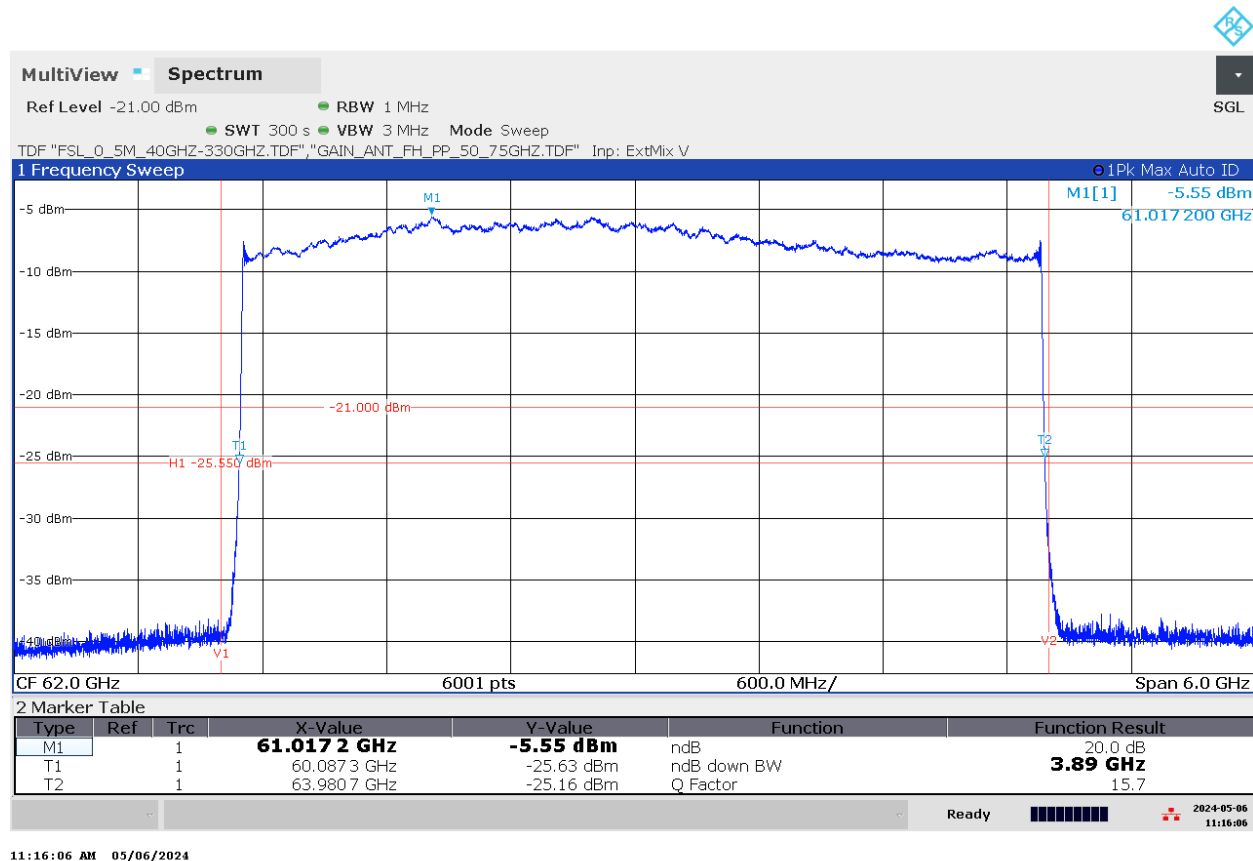
Limit: fLow>57GHz, fHigh<64GHz.

fLow = T1 , fHigh = T2.

Result: fLow: Pass, fHigh: Pass.

1.4.11 Vnom T +50°C:

TID111_Ess_OR03_T008_PEAK_EIRP_RBW_1MHz_Vnom_T50°C



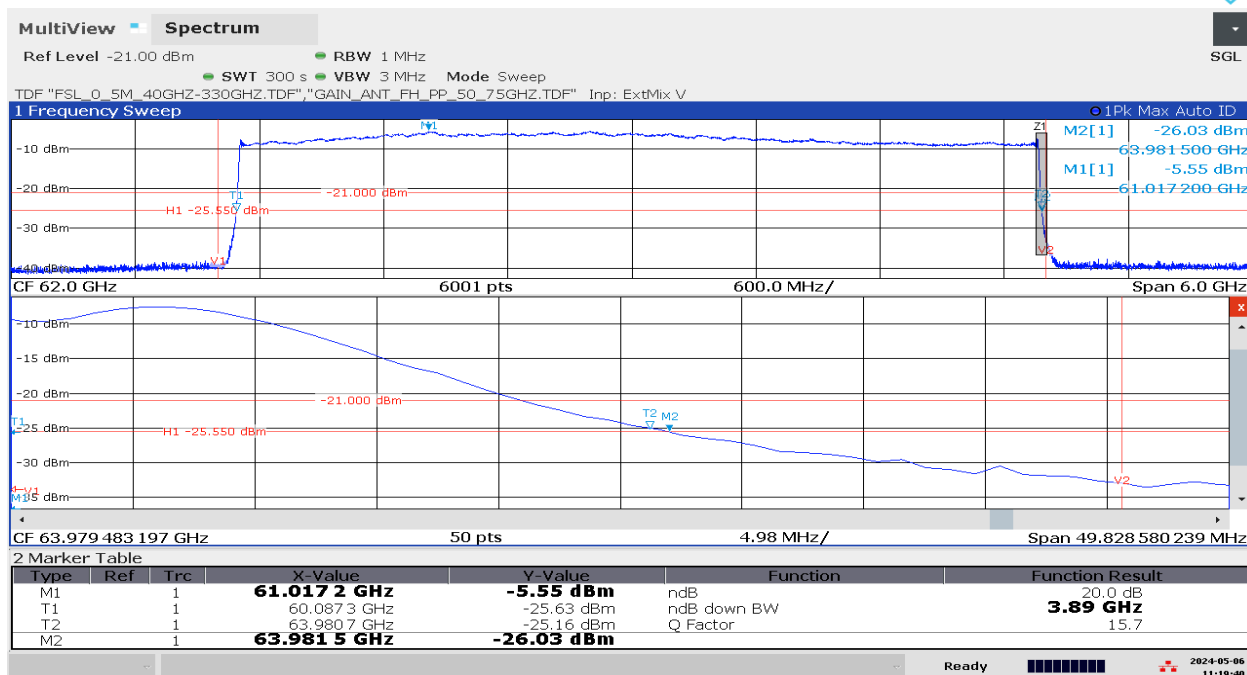
Note:

Limit: fLow>57GHz, fHigh<64GHz.

fLow = T1 , fHigh = T2.

Result: fLow: Pass, fHigh: Pass.

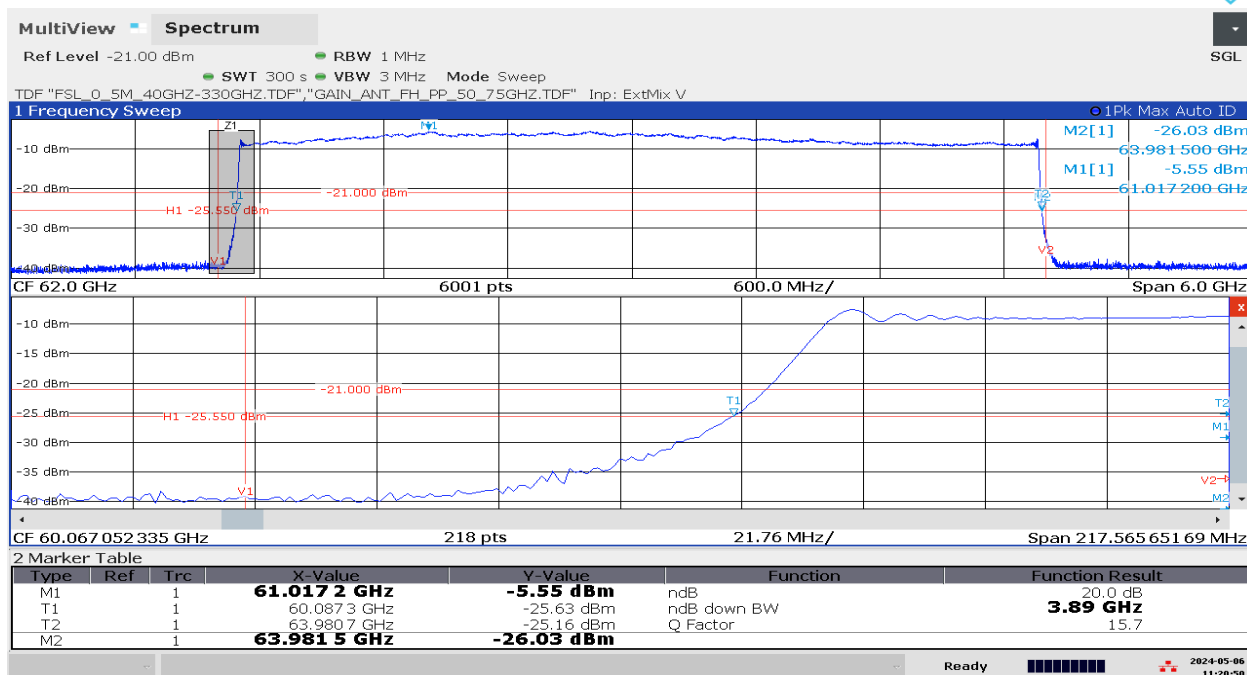
TID111_01_Ess_OR03_T008_PEAK_EIRP_RBW_1MHz_Vnom_T50°C_T2_zoom



11:19:40 AM 05/06/2024

Note: only for information zoom in to T2 to verify, no critical issue found.

TID111_02_Ess_OR03_T008_PEAK_EIRP_RBW_1MHz_Vnom_T50°C_T1_zoom



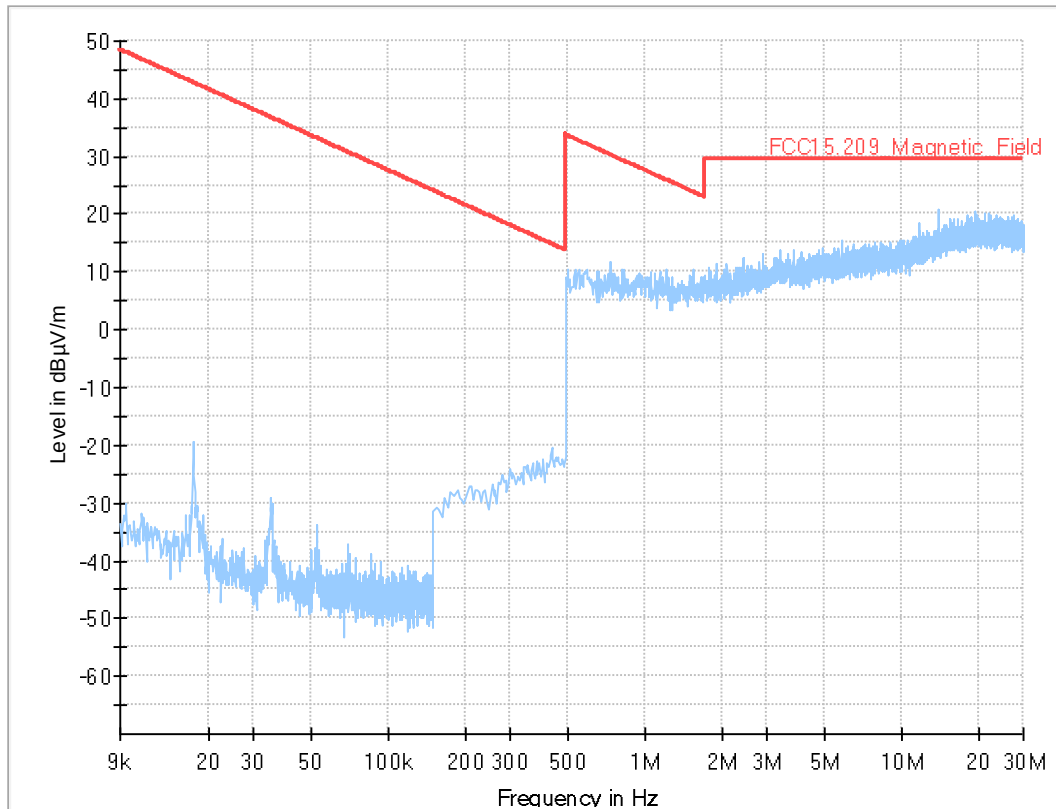
11:20:50 AM 05/06/2024

Note: only for information zoom in to T1 to verify, no critical issue found.

1.5 Spurious Emission 9k – 200GHz (Reference Clause No: §15.255(d)):

1.6 9k – 30MHz

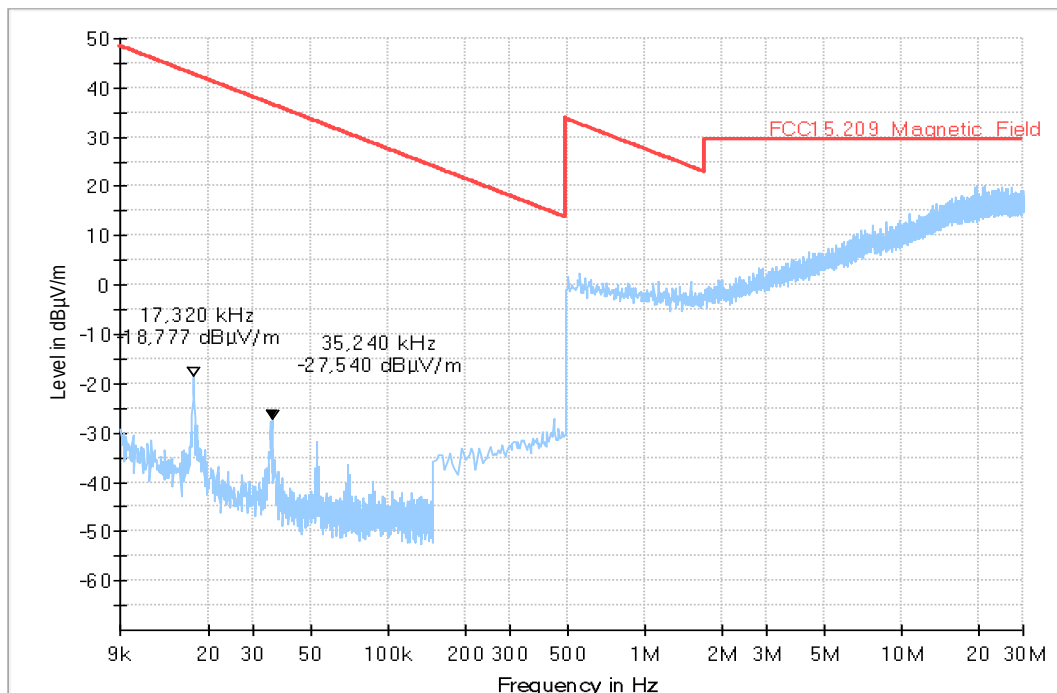
Ambient Test: Chamber / Test System verification, EUT Power off



Note: Ambient Test has been performed to verify the test system.

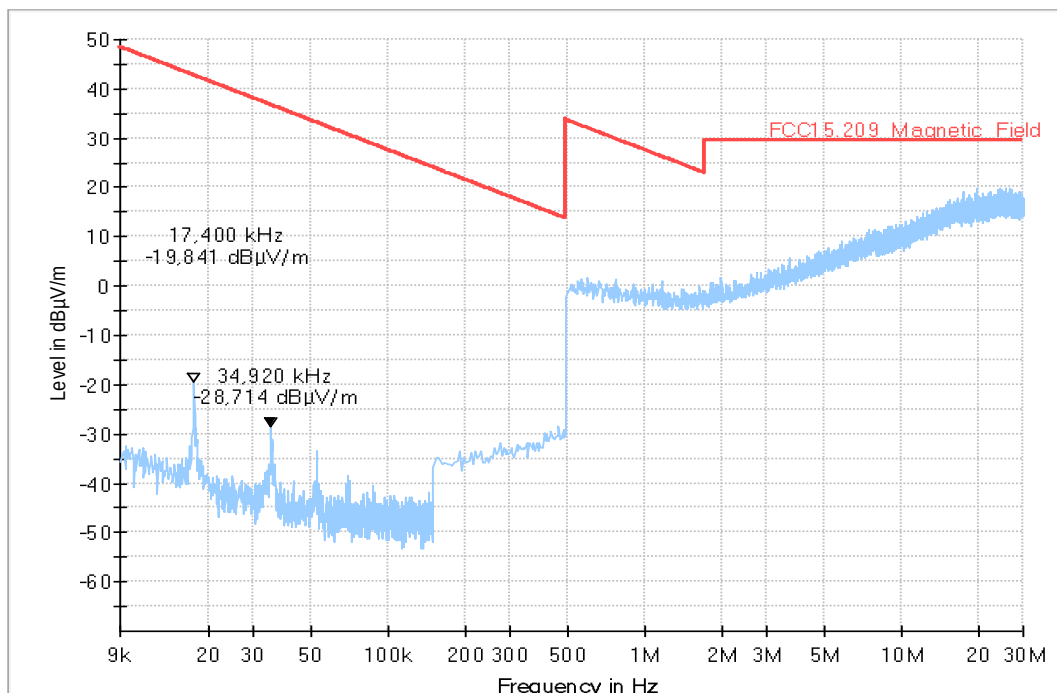
Ambient Test: EUT power off + Test System Power on. Only for information not for assessment.

TID020_RSE_9k-30MHz_RADAR_Active



Note: EUT orientation Standing (front + rear + left + right)

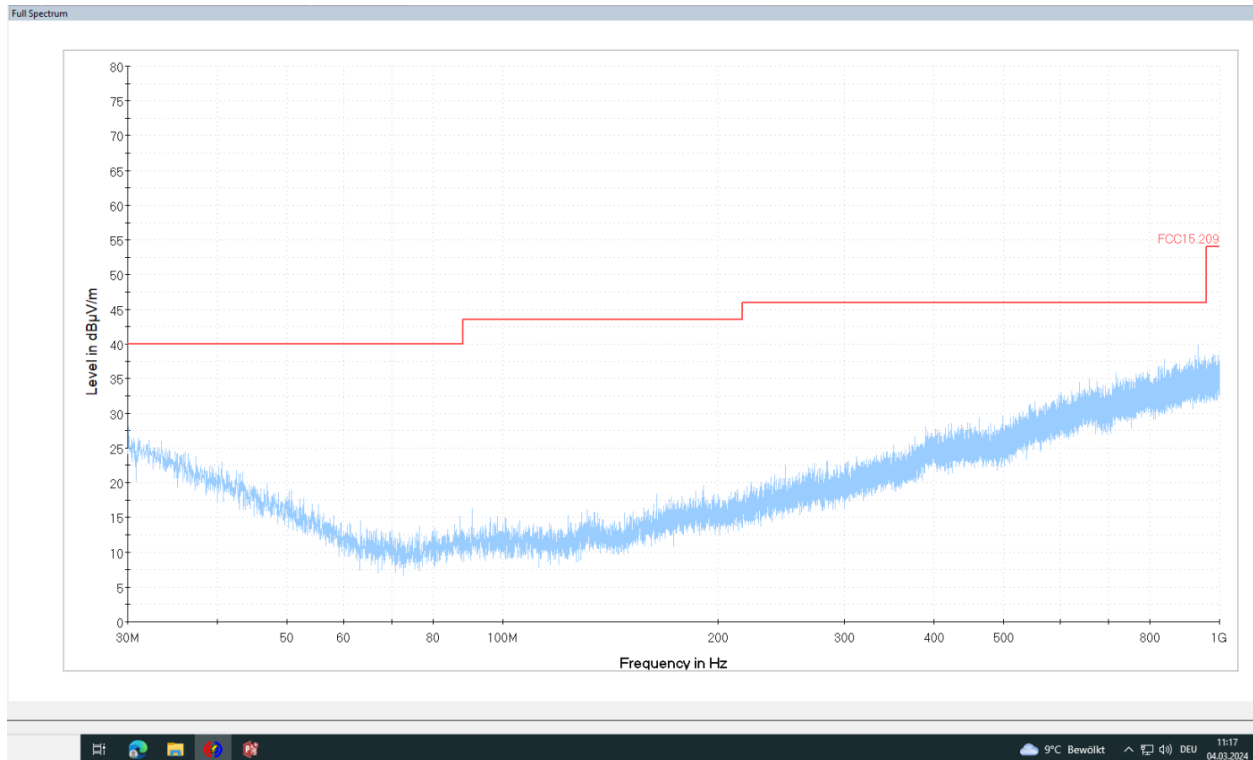
TID020_01_RSE_9k-30MHz_RADAR_Active



Note: EUT orientation Laying (top + bottom + left + right)

1.7 30M – 1GHz

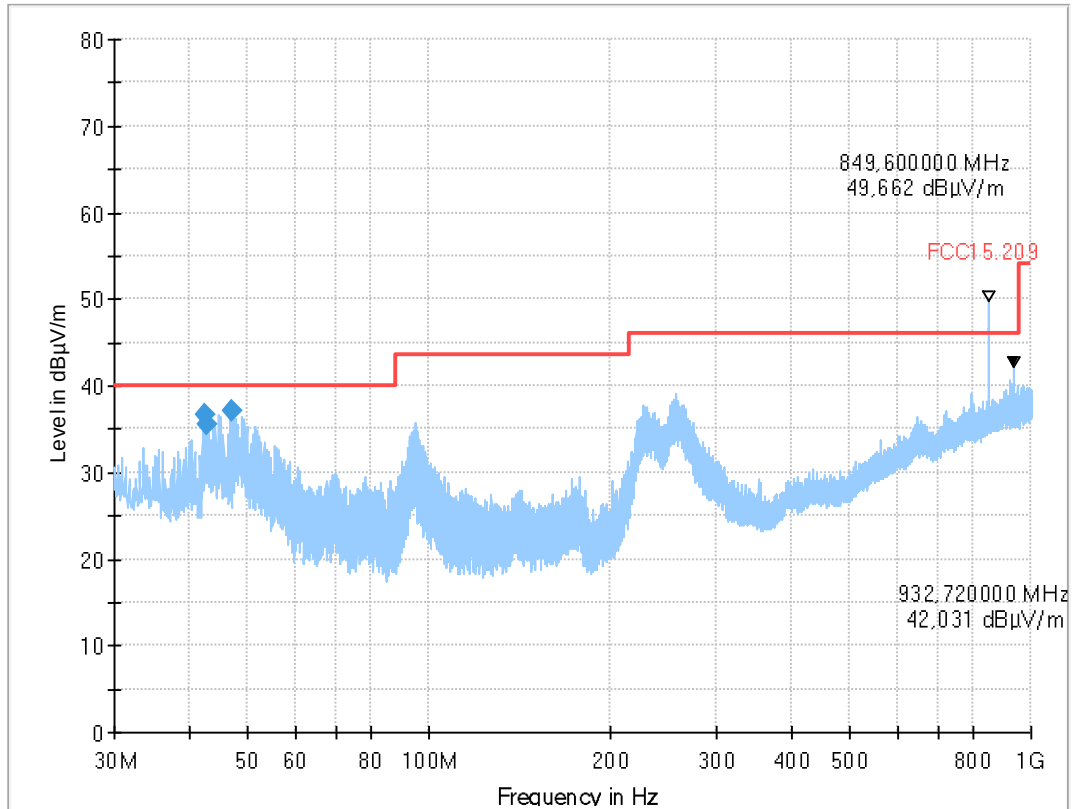
Ambient Test: Chamber / Test System verification, EUT Power off



Note: Ambient Test has been performed to verify the test system.

Ambient Test: EUT power off + Test System Power on. Only for information not for assessment.

TID021_RSE_30M-1GHz_RADAR_Active



Note-1: EUT orientation standing (front + rear + left + right)

Note-2: Emission at 849.60MHz and 932.72MHz are outside from the chamber, not related to assessment.

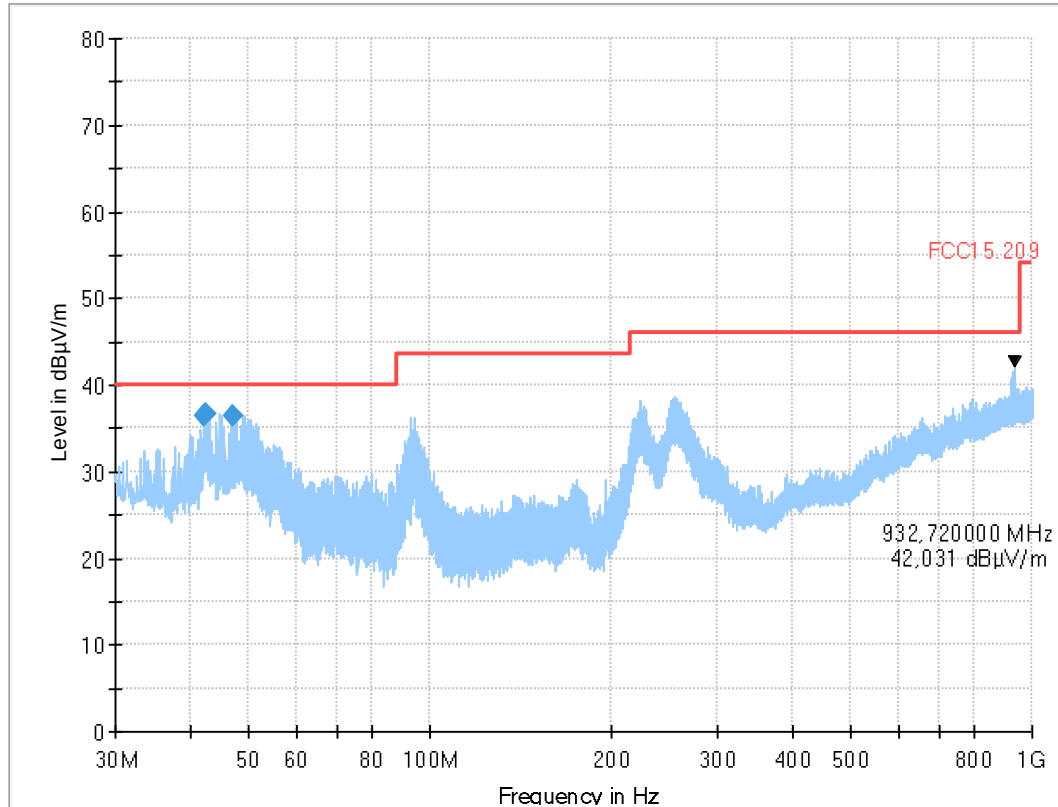
Final_Result

Frequency (MHz)	Quasi Peak (dB μ V /m)	Limit (dB μ V /m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Sig Path (dB)
42.470000	36.59	40.00	3.41	120.000	105.0	V	81.0	15.4	0.0
42.910000	35.62	40.00	4.38	120.000	105.0	V	71.0	15.2	0.0
47.190000	37.17	40.00	2.83	120.000	105.0	V	94.0	13.3	0.0

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

Frequency (MHz)	Preamp (dB)	Trd Corr. (dB/m)	Raw Rec (dB μ V)	Comment
42.470000	0.6	14.8	21.2	11:59:59 - 04.03.2024
42.910000	0.6	14.6	20.4	12:04:27 - 04.03.2024
47.190000	0.6	12.7	23.9	12:08:50 - 04.03.2024

TID021_01_RSE_30M-1GHz_RADAR_Active



Note-1: EUT orientation Laying (top + bottom + left + right)

Note-2: Emission at 932.72MHz is outside from the chamber, not related to assessment.

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)
42.030000	36.36	40.00	3.64	120.000	105.0	V	93.0	15.6	0.0
42.470000	36.64	40.00	3.36	120.000	109.0	V	78.0	15.4	0.0
47.190000	36.42	40.00	3.58	120.000	105.0	V	70.0	13.3	0.0

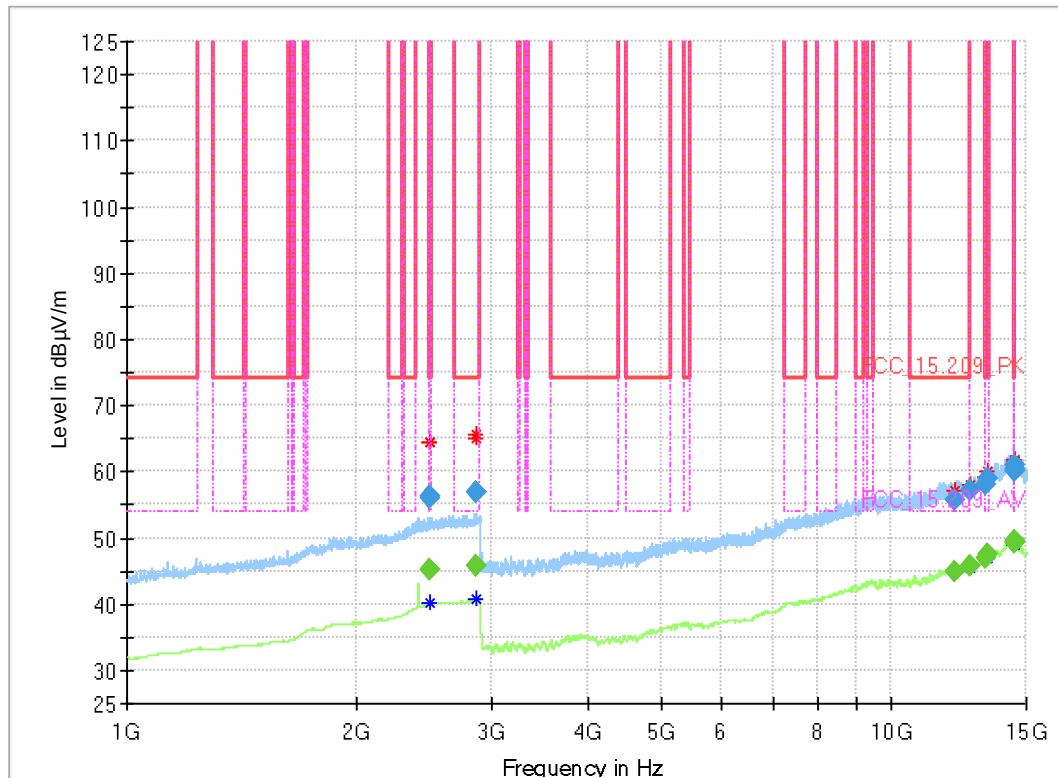
(continuation of the "Final_Result" table from column 17 ...)

Frequency (MHz)	Preamp (dB)	Trd Corr. (dB/m)	Raw Rec (dBμV)	Comment
42.030000	0.6	15.0	20.8	12:49:25 - 04.03.2024
42.470000	0.6	14.8	21.3	12:53:46 - 04.03.2024
47.190000	0.6	12.7	23.2	12:58:22 - 04.03.2024

1.8 1G – 15GHz

TID022_01_RSE_1G_15GHz

Full Spectrum



Final_Result_PK+

Frequency (MHz)	MaxPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)
2483.536667	55.98	74.00	18.02	1000.000	155.0	H	120.0	0.0	33.7
2483.590000	56.27	74.00	17.73	1000.000	155.0	V	118.0	90.0	33.7
2860.185000	56.93	74.00	17.07	1000.000	155.0	H	115.0	0.0	34.8
2866.829897	57.00	74.00	17.00	1000.000	155.0	V	-4.0	90.0	34.8
12096.733214	55.67	74.00	18.33	1000.000	155.0	V	19.0	90.0	9.2
12688.163036	57.21	74.00	16.79	1000.000	155.0	H	-4.0	0.0	10.8
13267.143571	57.95	74.00	16.05	1000.000	155.0	V	-28.0	90.0	11.7
13375.702143	59.06	74.00	14.94	1000.000	155.0	H	5.0	0.0	12.0
14474.112679	60.11	74.00	13.89	1000.000	155.0	H	-12.0	0.0	12.6
14480.295893	60.97	74.00	13.03	1000.000	155.0	H	155.0	90.0	12.6
14491.520179	60.32	74.00	13.68	1000.000	155.0	H	-19.0	0.0	12.6
14494.093393	60.22	74.00	13.78	1000.000	155.0	H	207.0	90.0	12.6

(continuation of the "Final_Result_PK+" table from column 12 ...)

Frequency (MHz)	Preamp (dB)	Trd Corr. (dB/m)	Raw Rec (dBμV)	Comment
2483.536667	0.0	28.7	22.3	7:52:40 AM - 22-Feb-24
2483.590000	0.0	28.7	22.6	7:57:36 AM - 22-Feb-24

2860.185000	0.0	29.4	22.2	7:54:26 AM - 22-Feb-24
2866.829897	0.0	29.4	22.2	7:56:11 AM - 22-Feb-24
12096.73321 4	0.0	38.5	46.4	11:22:12 AM - 22-Feb-24
12688.16303 6	0.0	38.6	46.4	11:12:11 AM - 22-Feb-24
13267.14357 1	0.0	39.8	46.2	11:23:46 AM - 22-Feb-24
13375.70214 3	0.0	40.1	47.1	11:13:41 AM - 22-Feb-24
14474.11267 9	0.0	41.4	47.5	11:15:11 AM - 22-Feb-24
14480.29589 3	0.0	41.3	48.3	11:18:46 AM - 22-Feb-24
14491.52017 9	0.0	41.3	47.7	11:16:45 AM - 22-Feb-24
14494.09339 3	0.0	41.3	47.7	11:20:15 AM - 22-Feb-24

Final_Result_RMS

Frequency (MHz)	RMS (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)
2483.536667	45.12	54.00	8.88	1000.000	155.0	H	120.0	0.0	33.7
2483.590000	45.16	54.00	8.84	1000.000	155.0	V	118.0	90.0	33.7
2860.185000	45.86	54.00	8.14	1000.000	155.0	H	115.0	0.0	34.8
2866.829897	45.88	54.00	8.12	1000.000	155.0	V	-4.0	90.0	34.8
12096.73321 4	44.75	54.00	9.25	1000.000	155.0	V	19.0	90.0	9.2
12688.16303 6	45.88	54.00	8.12	1000.000	155.0	H	-4.0	0.0	10.8
13267.14357 1	47.04	54.00	6.96	1000.000	155.0	V	-28.0	90.0	11.7
13375.70214 3	47.54	54.00	6.46	1000.000	155.0	H	5.0	0.0	12.0
14474.11267 9	49.34	54.00	4.66	1000.000	155.0	H	-12.0	0.0	12.6
14480.29589 3	49.39	54.00	4.61	1000.000	155.0	H	155.0	90.0	12.6
14491.52017 9	49.51	54.00	4.49	1000.000	155.0	H	-19.0	0.0	12.6
14494.09339 3	49.39	54.00	4.61	1000.000	155.0	H	207.0	90.0	12.6

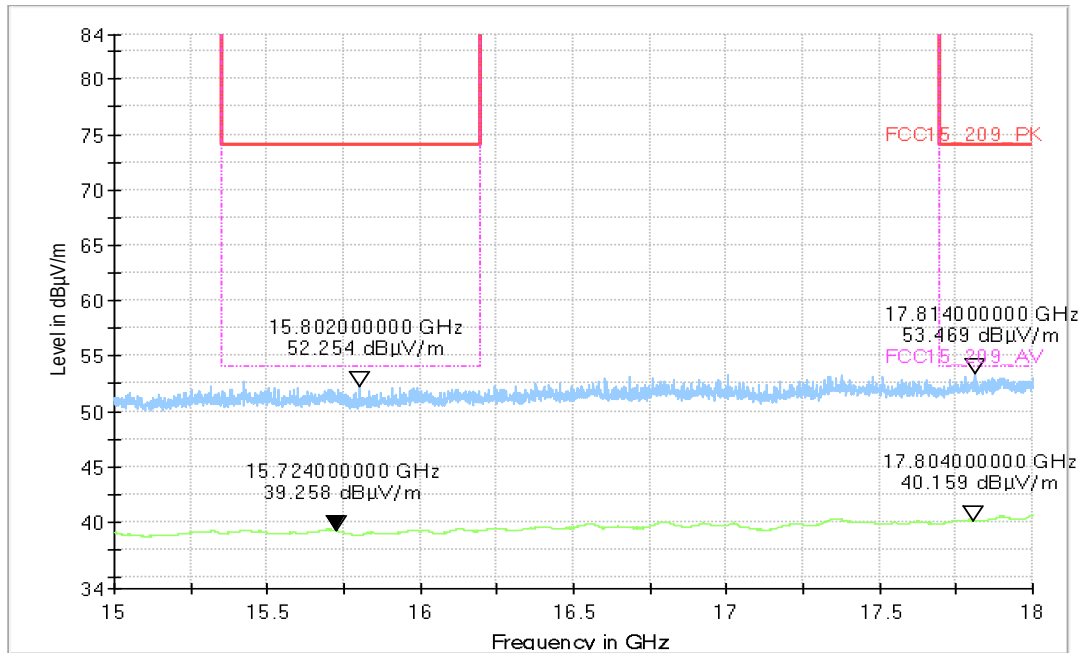
(continuation of the "Final_Result_RMS" table from column 12 ...)

Frequency (MHz)	Preamp (dB)	Trd Corr. (dB/m)	Raw Rec (dBμV)	Comment
2483.536667	0.0	28.7	11.4	7:52:41 AM - 22-Feb-24
2483.590000	0.0	28.7	11.4	7:57:36 AM - 22-Feb-24
2860.185000	0.0	29.4	11.1	7:54:26 AM - 22-Feb-24
2866.829897	0.0	29.4	11.1	7:56:11 AM - 22-Feb-24
12096.73321 4	0.0	38.5	35.5	11:22:12 AM - 22-Feb-24
12688.16303 6	0.0	38.6	35.1	11:12:12 AM - 22-Feb-24
13267.14357 1	0.0	39.8	35.3	11:23:46 AM - 22-Feb-24
13375.70214 3	0.0	40.1	35.5	11:13:41 AM - 22-Feb-24
14474.11267 9	0.0	41.4	36.7	11:15:11 AM - 22-Feb-24
14480.29589 3	0.0	41.3	36.8	11:18:46 AM - 22-Feb-24
14491.52017 9	0.0	41.3	36.9	11:16:45 AM - 22-Feb-24
14494.09339 3	0.0	41.3	36.8	11:20:15 AM - 22-Feb-24

1.9 15G – 18GHz

TID022_02_RSE_15G_18GHz

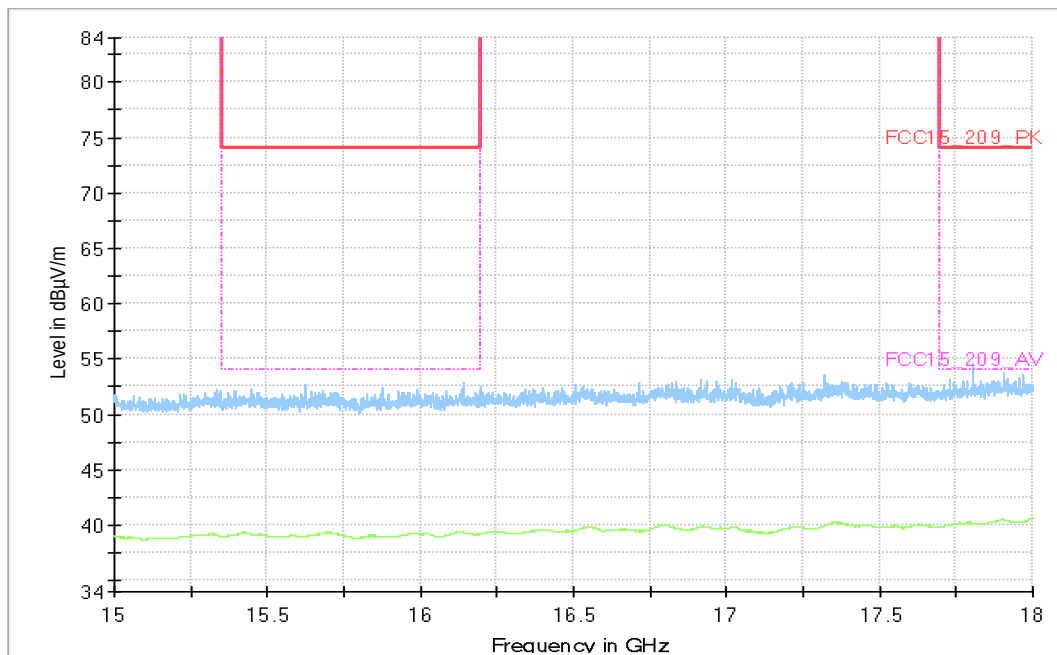
Full Spectrum



Note: No critical frequency found, Result: Pass.

TID022_03_RSE_15G_18GHz_Ant_H

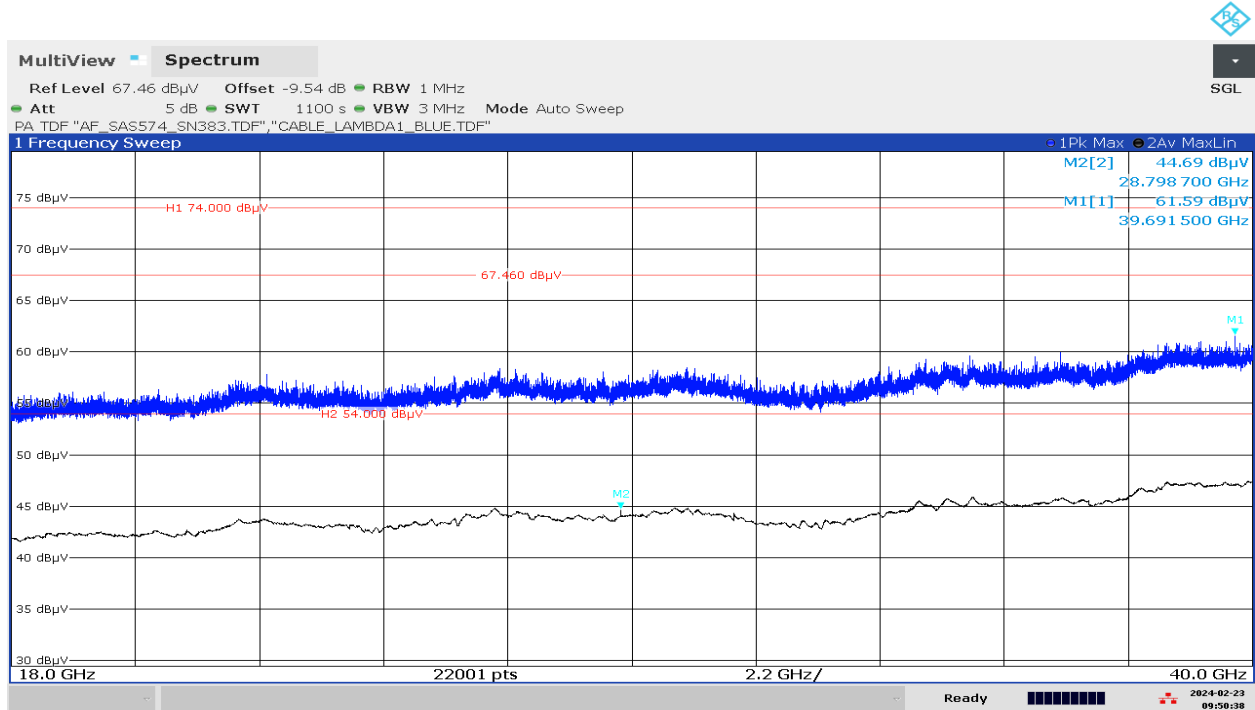
Full Spectrum



Note: No critical frequency found, Result: Pass.

1.10 18G – 40GHz

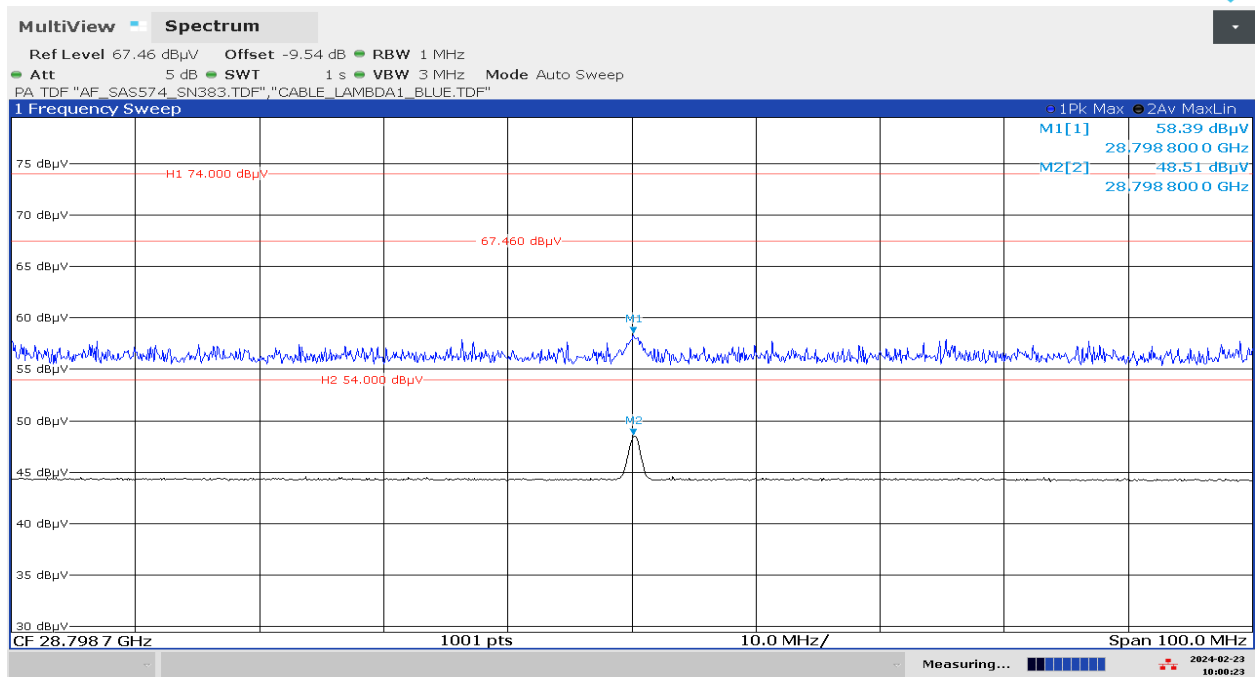
TID024_Ess_OR03_T008_RSE_18G_40GHz_Ant_H_FCC_ISED



09:50:38 AM 02/23/2024

Note: Maximum Emission found at 28.7987GHz, for Final test check below diagram TID024_02 and TID023_03

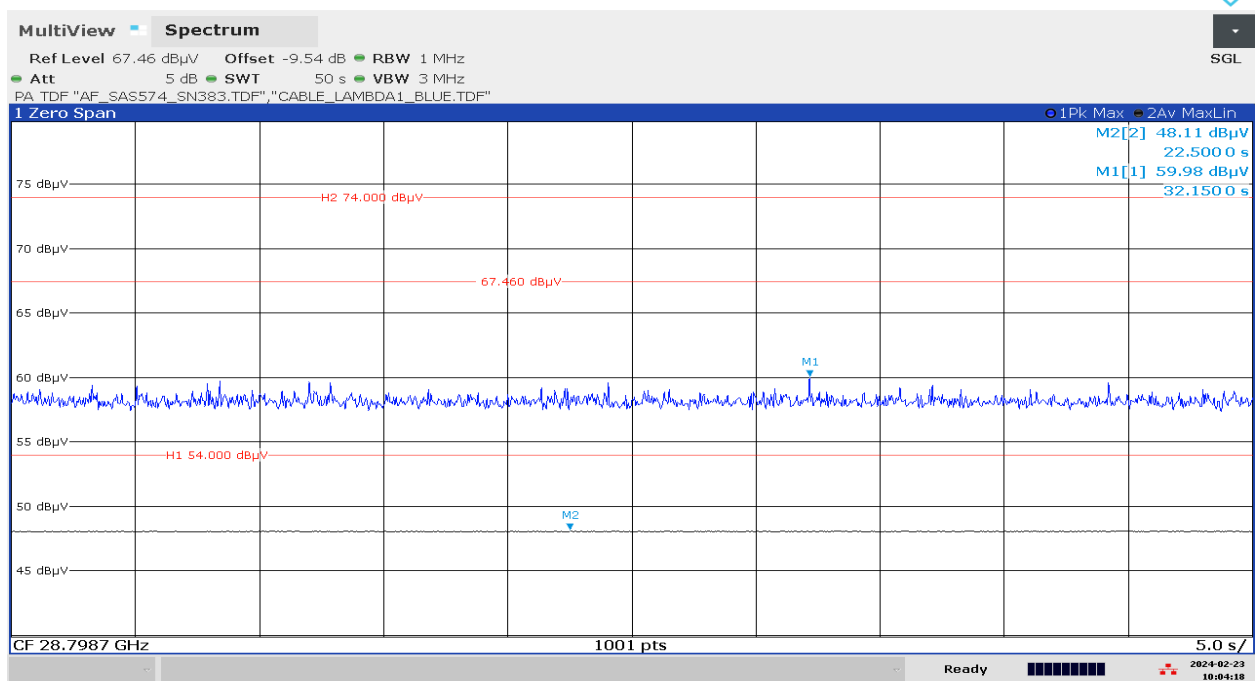
TID024_01_Ess_OR03_T008_RSE_28.80GHz_Ant_H_FCC_ISED_worst_case_pos_verified



10:00:23 AM 02/23/2024

Note: Worst case position of EUT verified, Antenna Polarization: H, TT: 40°, TD: 98°

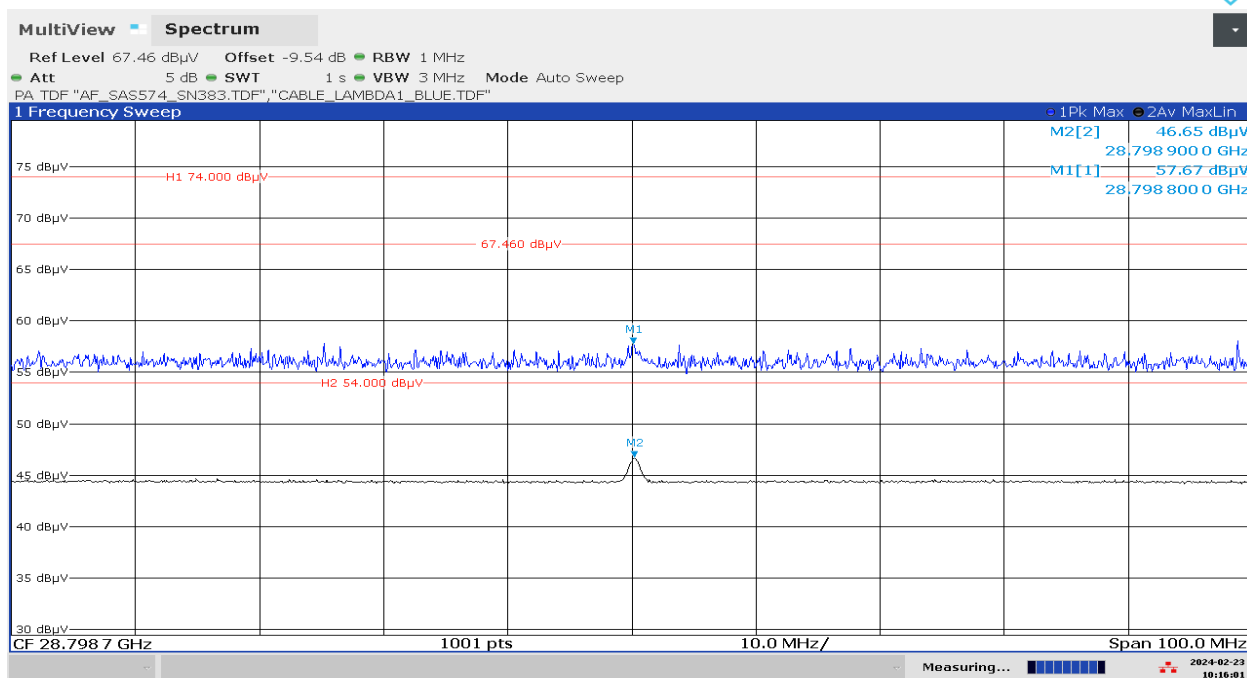
TID024_02_Ess_OR03_T008_RSE_28.80GHz_Ant_H_FCC_ISED_Zero_Span



10:04:18 AM 02/23/2024

Note: Final Test with Zero Span,
Max Peak level: 59.98 dBμV/m, Limit: 74 dBμV/m, Result: Pass.
Max Avg Level: 48.11 dBμV/m, Limit: 54 dBμV/m, Result: Pass.

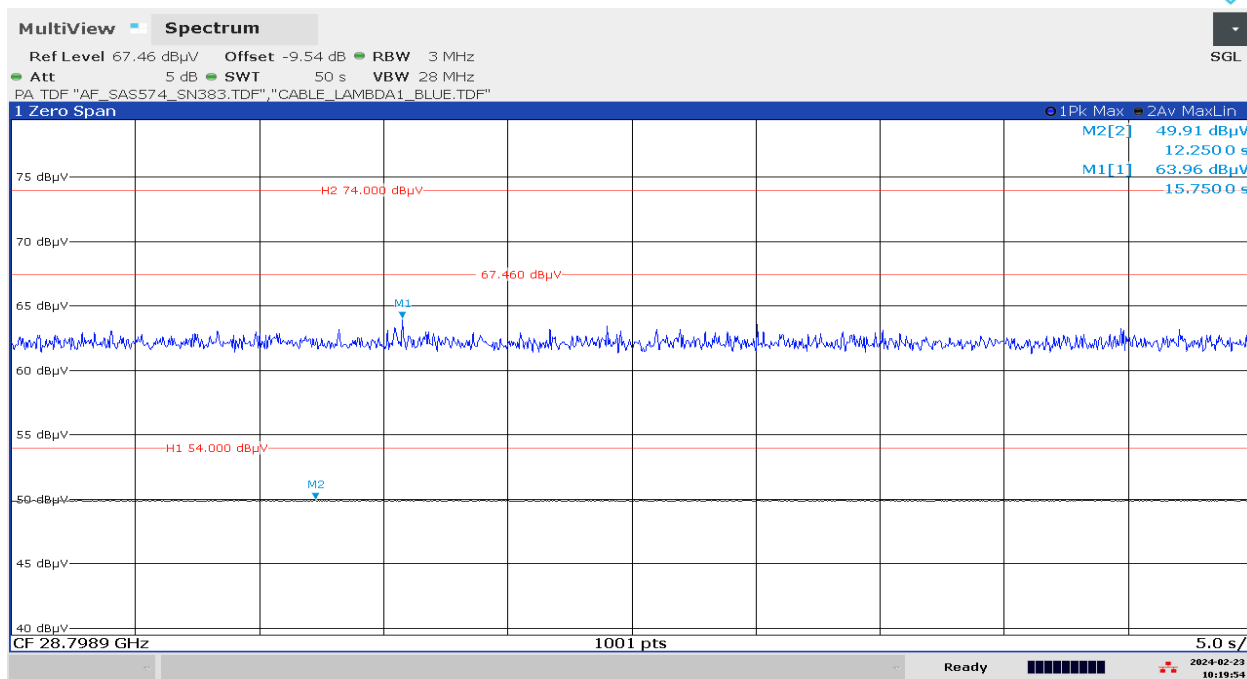
TID023_01_Ess_OR03_T008_RSE_28.80GHz_Ant_V_FCC_ISED_worst_case_pos_verified



10:16:01 AM 02/23/2024

Note: Worst case position of EUT verified, Antenna Polarization: V, TT: 340°, TD: 98°

TID023_03_Ess_OR03_T008_RSE_28.80GHz_Ant_V_FCC_ISED_Zero_Span_50s

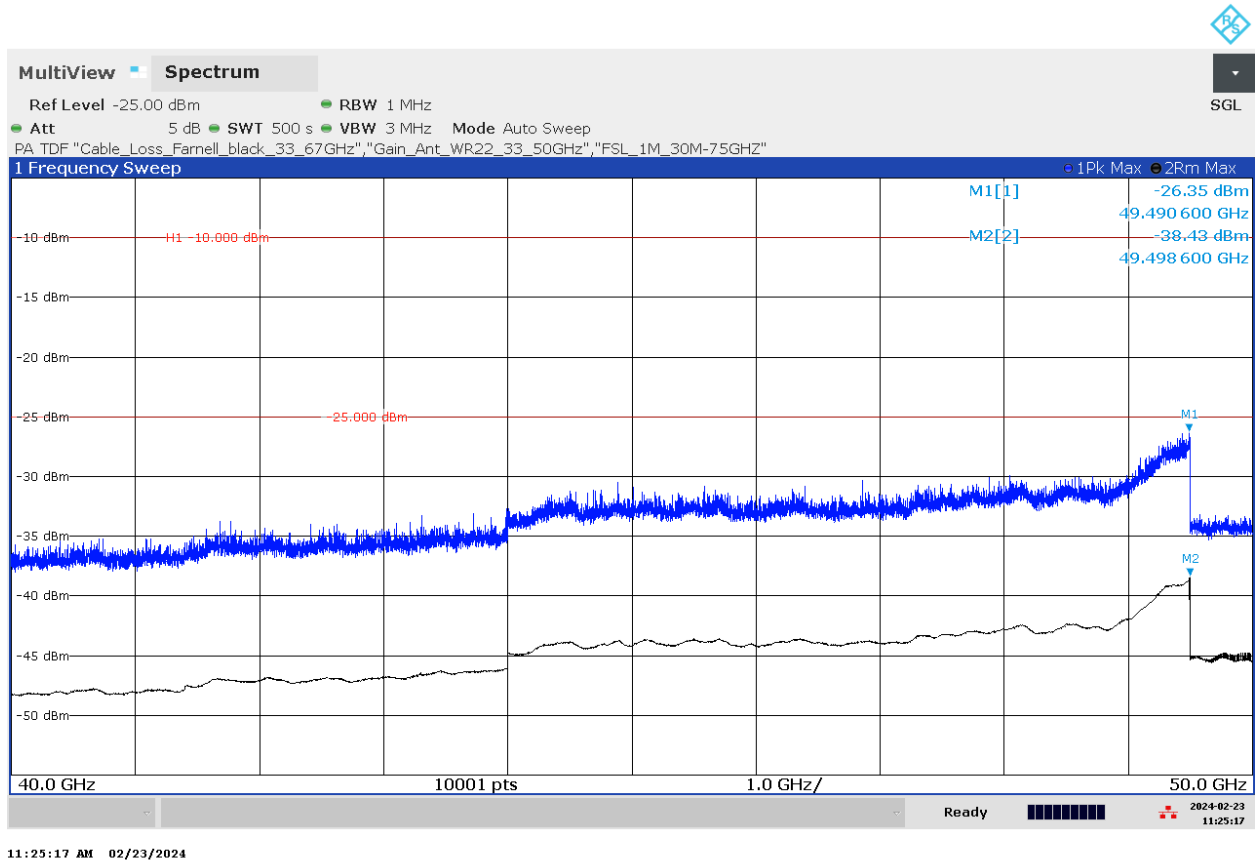


10:19:54 AM 02/23/2024

Note: Final Test with Zero Span,
Max Peak level: 63.96 dBμV, Limit: 74 dBμV, Result: Pass.
Max Avg Level: 49.91 dBμV, Limit: 54 dBμV, Result: Pass.

1.11 40G – 50GHz

TID026_Ess_OR03_T008_RSE_40G_50GHz_Ant_H_FCC_ISED

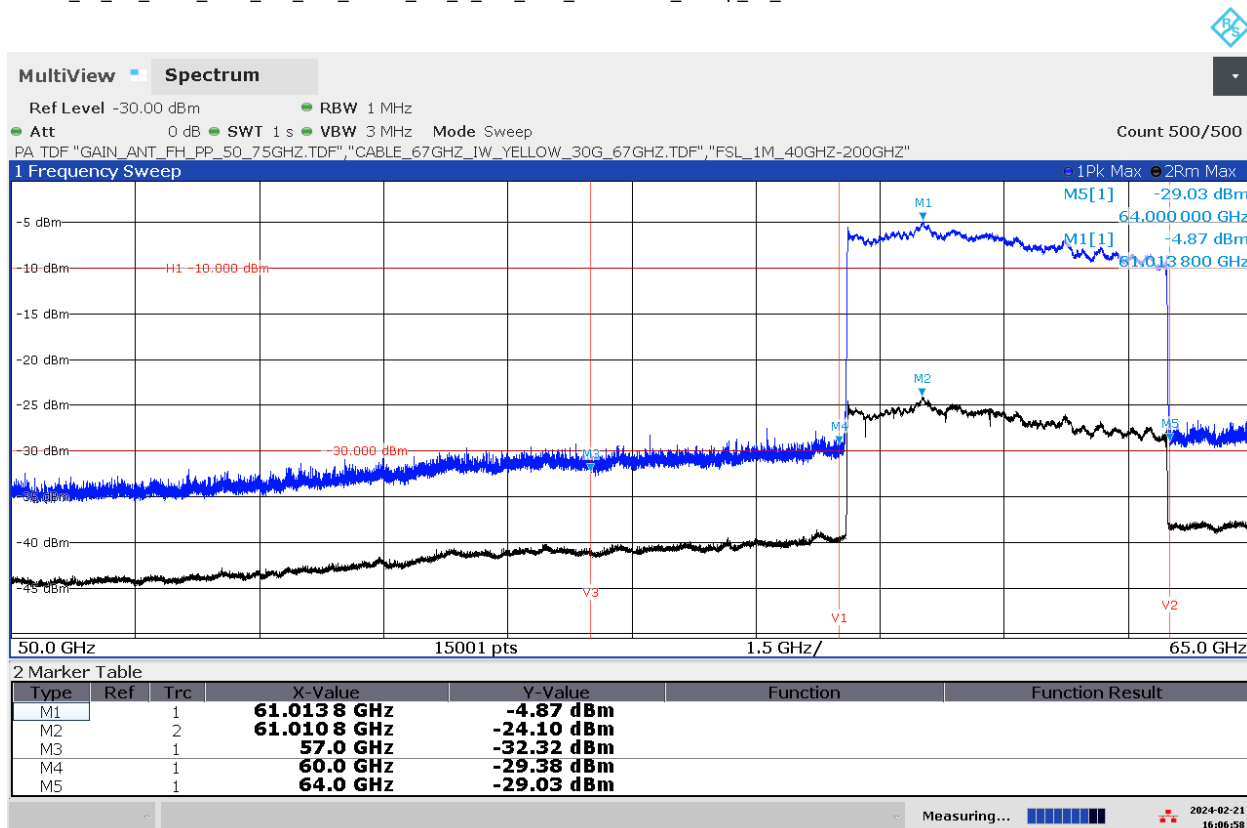


11:25:17 AM 02/23/2024

Note: No critical Emission found, Limit line: -10dBm, Result: Pass.

1.12 50G – 65GHz, Out-of-band domain + spurious emissions:

TID027_02_Ess_OR03_T008_RSE_50G_65GHz_Ant_H_FCC_ISED_continuous_sweep_PK_RMS

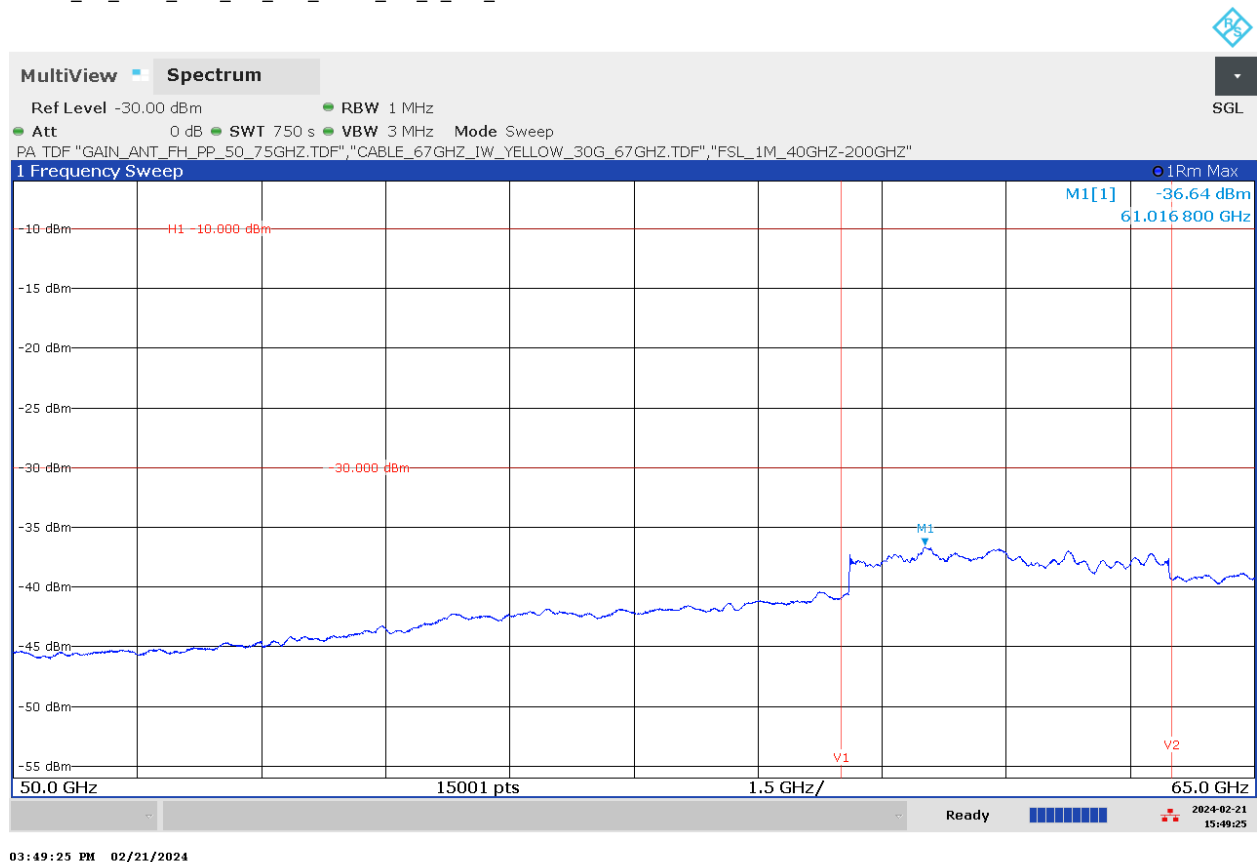


04:06:58 PM 02/21/2024

Note: Pretest with Peak and RMS detector, only for information not for assessment.

For Final test check below Diagram TID027

TID027_Ess_OR03_T008_RSE_50G_65GHz_Ant_H_FCC_ISED



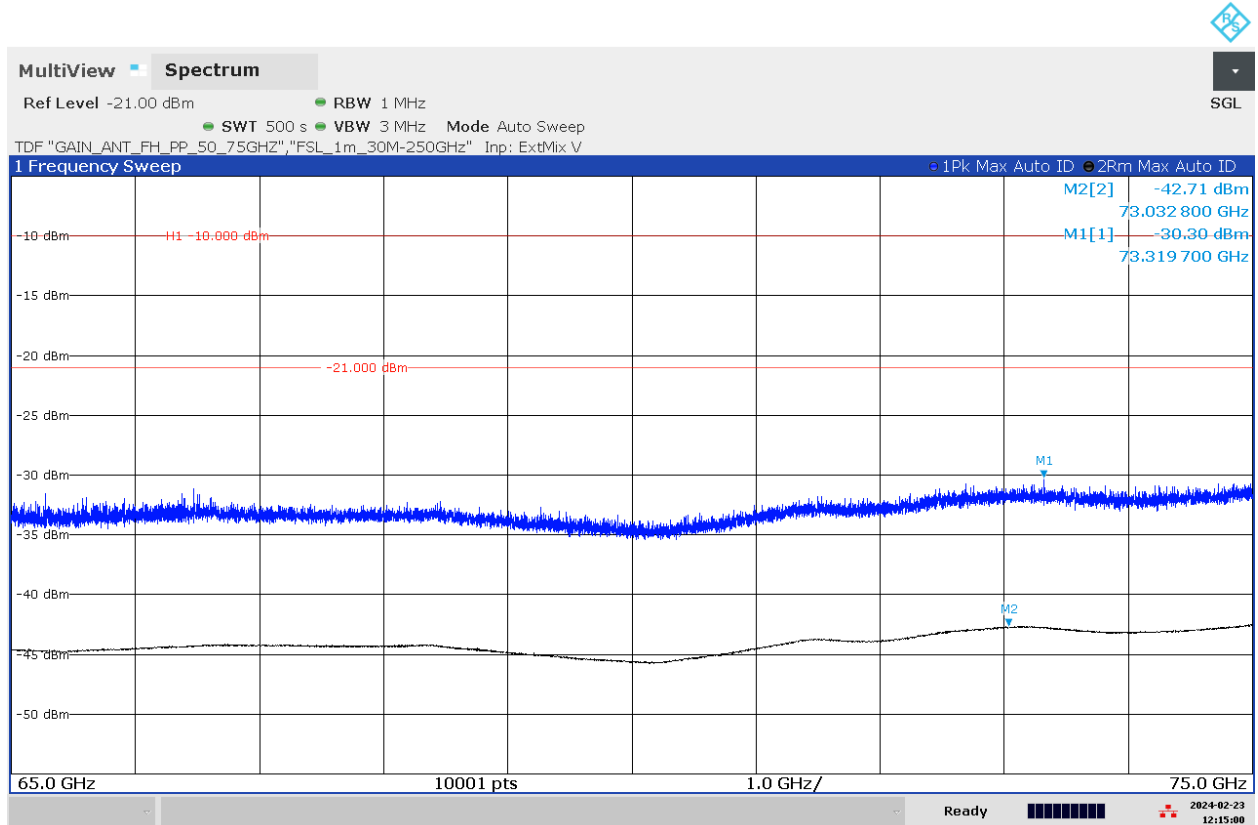
03:49:25 PM 02/21/2024

Note: Final Test.
No critical frequency found,
Limit Line: -10dBm, Result: Pass.

RADAR Active: 60G – 64GHz, therefore no assessment in Band.

1.13 65G – 75GHz

TID028_02_Ess_OR03_T008_RSE_65G_75GHz_Ant_H_FCC_ISED_auto_id

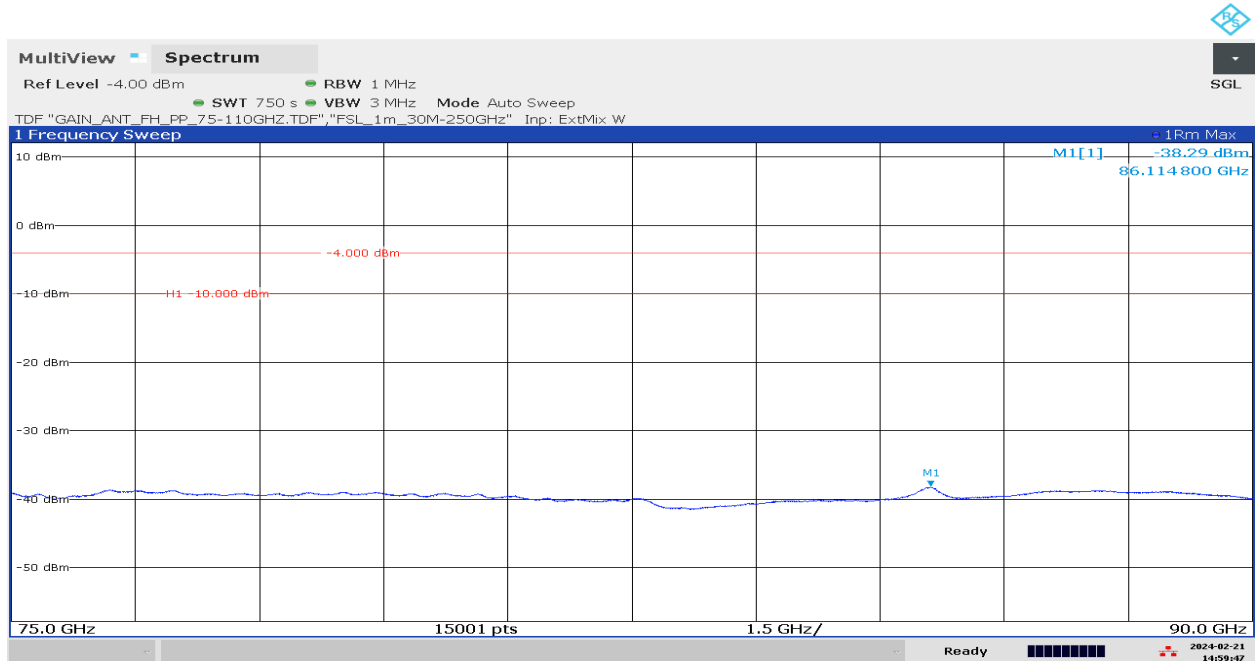


12:15:01 PM 02/23/2024

Note: No Critical Frequency found, Peak detector is only for information not for information.
Limit Line: -10dBm, Result: Pass.

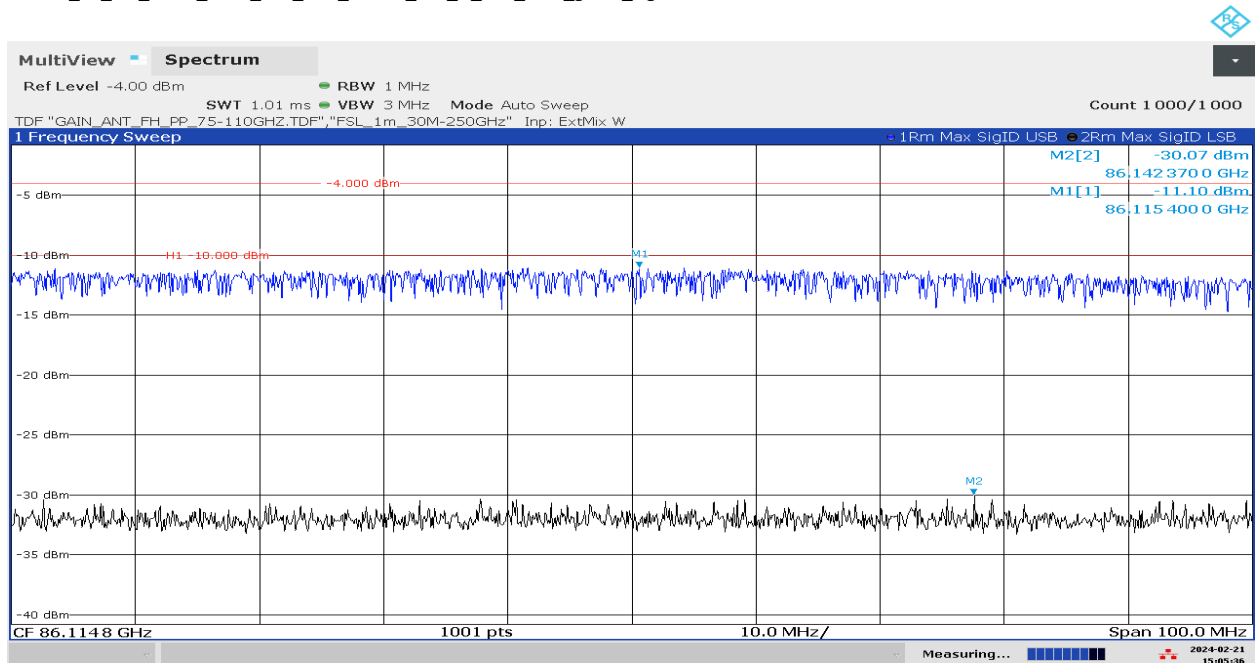
1.14 75G – 90GHz

TID029_Ess_OR03_T008_RSE_75G_90GHz_Ant_H_FCC_ISD



Note: No critical frequency found, Emission at 86.1148GHz is ghost/image signal not related to assessment,
For more information, check Diagram TID029_01 below,
No Critical frequency found, Limit Line: -10dBm, Result: Pass.

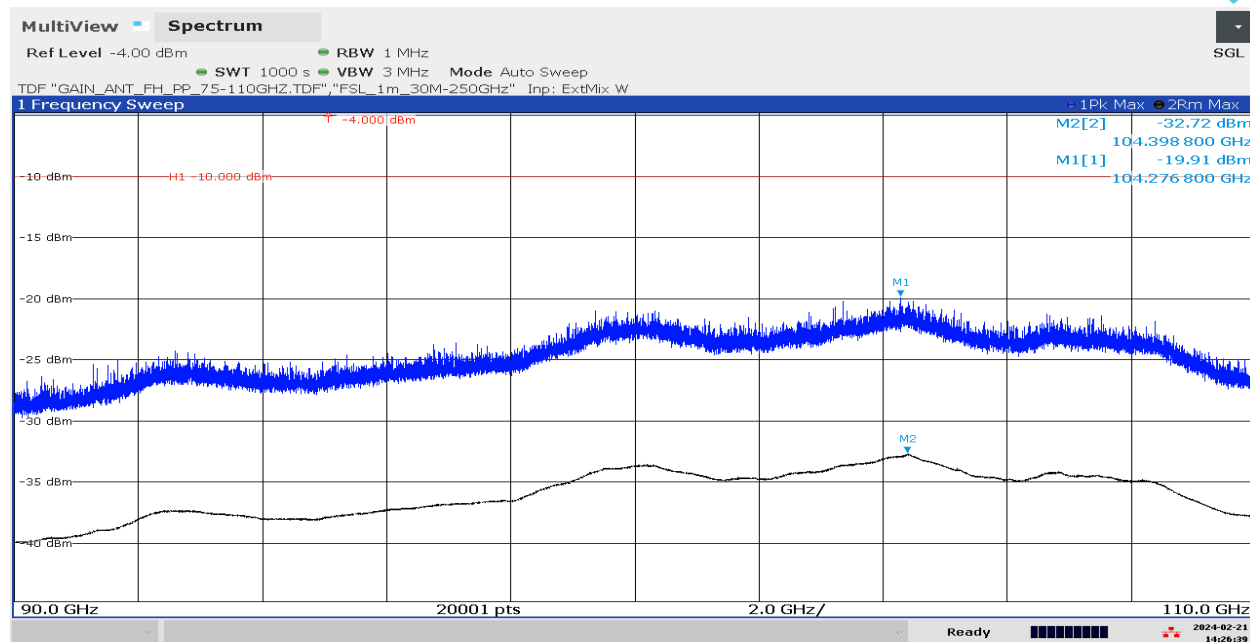
TID029_01_Ess_OR03_T008_RSE_75G_90GHz_Ant_H_FCC_ISD_ghost_signal



Note: Signal ID functions are activated to verify ghost/image signal.
Mixer product are used, therefore ghost/image signals are there.
Ghost/Image Signal: Signals which are not overlapping,
Real Signal: Signals which are not overlapping.

1.15 90G – 140GHz

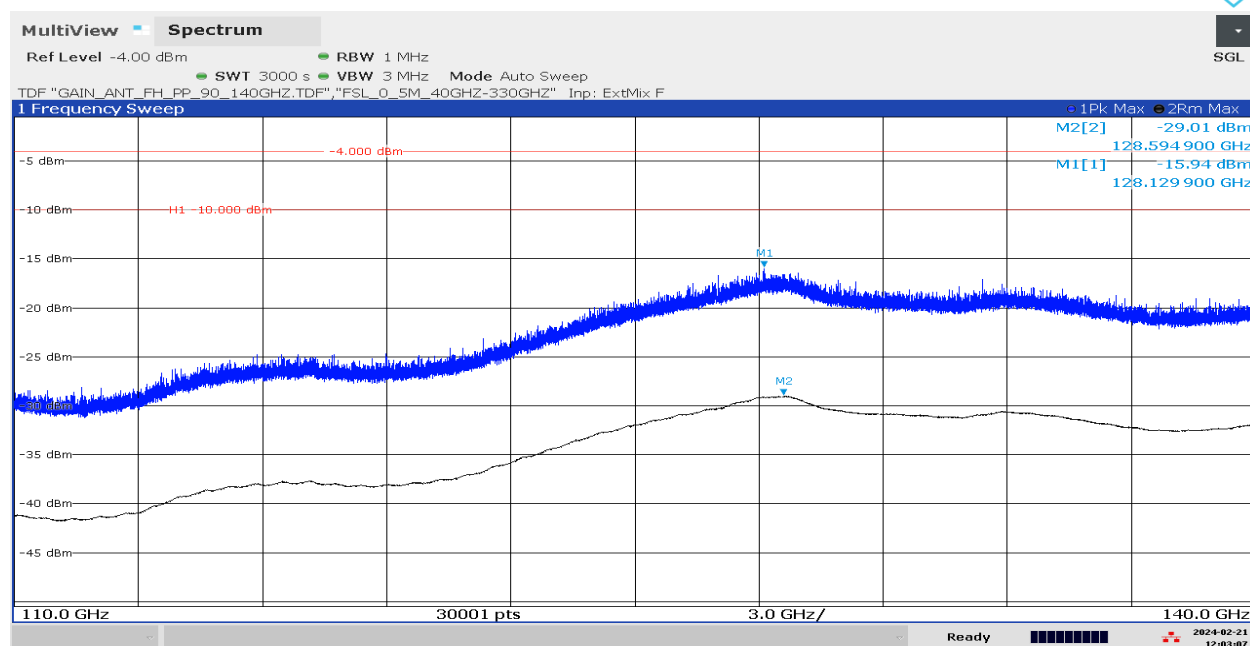
TID030_Ess_OR03_T008_RSE_90G_110GHz_Ant_H_FCC_ISED



02:26:40 PM 02/21/2024

Note: No Critical frequency found, Limit line: -10dBm, Detector: RMS, Result: Pass.
Peak detector is only for information not for assessment.

TID032_Ess_OR03_T008_RSE_110G_140GHz_Ant_H_FCC_ISED

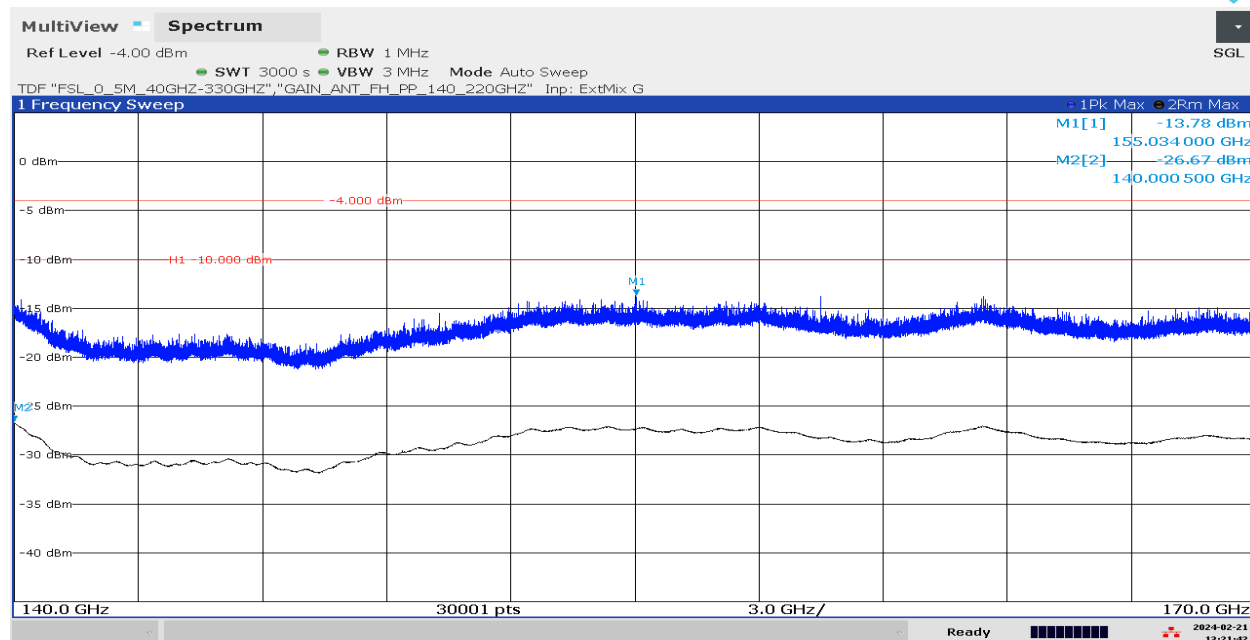


12:03:07 PM 02/21/2024

Note: No Critical frequency found, Limit line: -10dBm, Detector: RMS, Result: Pass.
Peak detector is only for information not for assessment.

1.16 140M – 200GHz

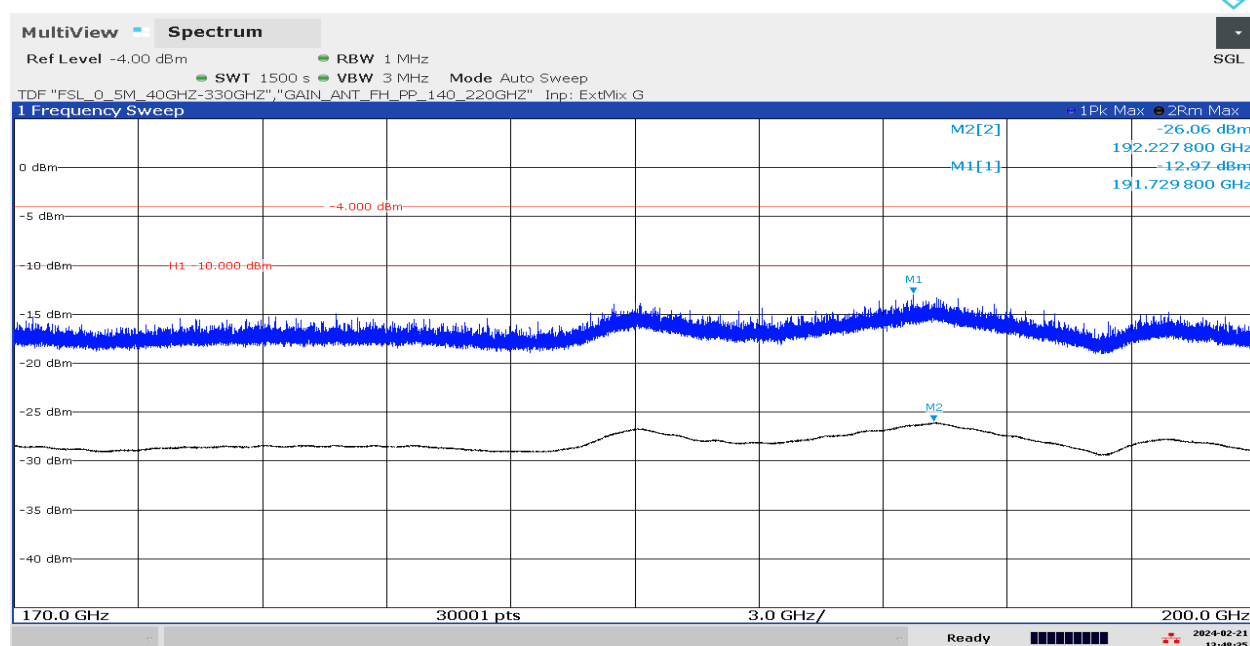
TID033_Ess_OR03_T008_RSE_140G_170GHz_Ant_H_FCC_ISED



01:21:42 PM 02/21/2024

Note: No Critical frequency found, Limit line: -10dBm, Detector: RMS, Result: Pass.
Peak detector is only for information not for assessment.

TID034_Ess_OR03_T008_RSE_170G_200GHz_Ant_H_FCC_ISED



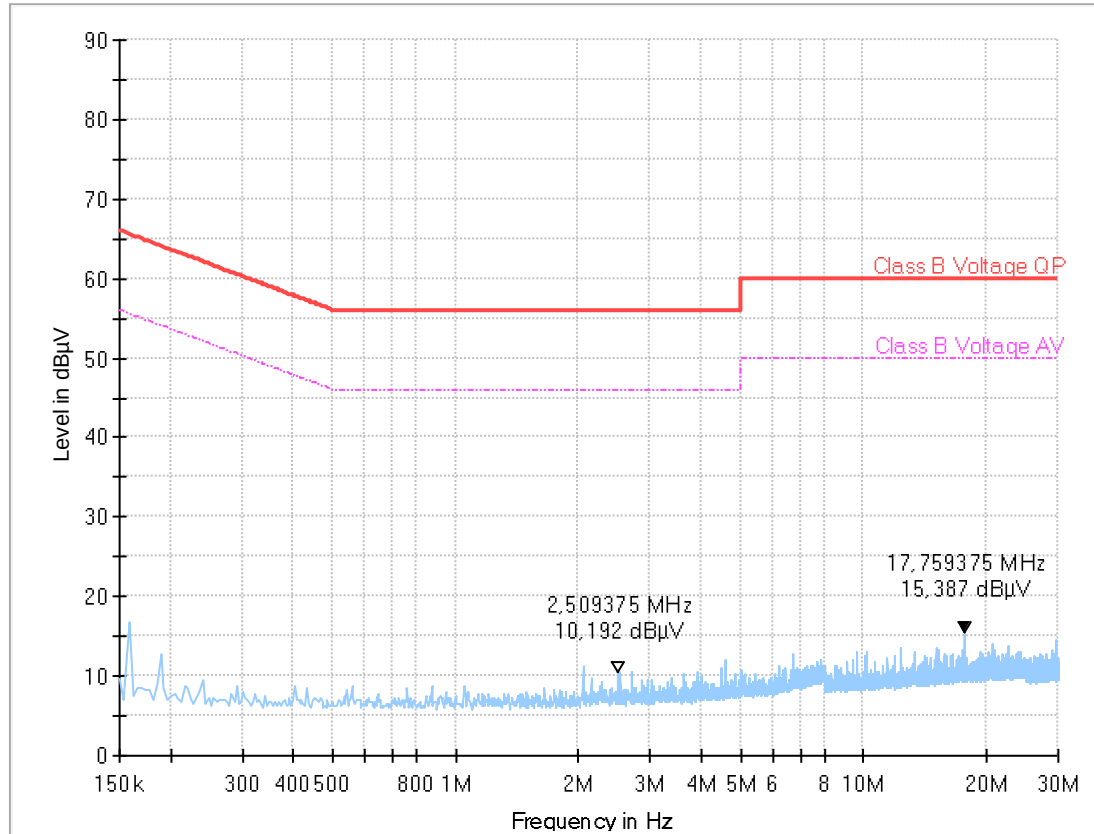
01:48:35 PM 02/21/2024

Note: No Critical frequency found, Limit line: -10dBm, Detector: RMS, Result: Pass.
Peak detector is only for information not for assessment.

1.17 Conducted Emission <30MHz (AC power line) (Reference Clause No: §15.207(a)):

Test System Check/verification: EUT disconnected

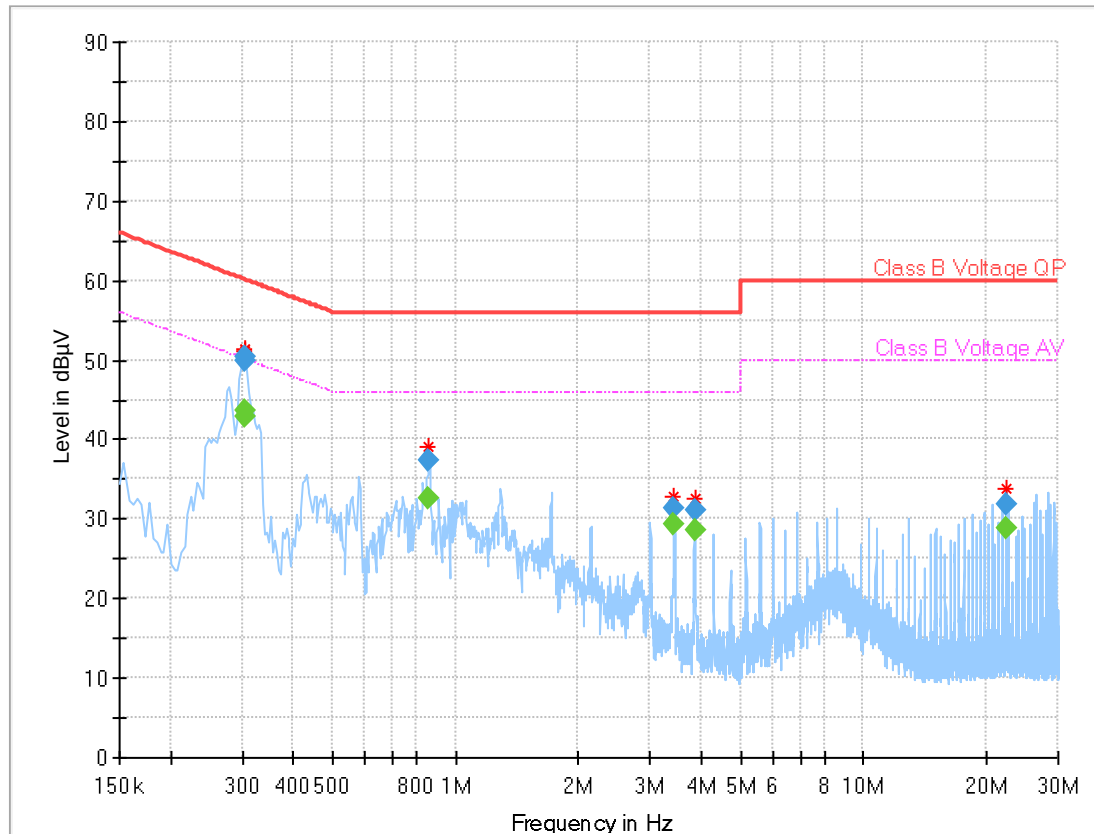
Full Spectrum



Note: Test system verified, EUT Disconnected, only for information not for assessment.

TID018_EMI_Conducted_150k-30MHz

Full Spectrum



Note: This test has been carried out with a AC/DC Adapter + 120V input.
Adapter Output = EUT Power supply = 24V DC.

Final Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.303750	50.28	---	60.14	9.86	1000.0	9.000	N	GND	0.1
0.303750	---	43.62	50.14	6.52	1000.0	9.000	N	GND	0.1
0.304844	49.82	---	60.11	10.29	1000.0	9.000	N	GND	0.1
0.304844	---	42.85	50.11	7.26	1000.0	9.000	N	GND	0.1
0.859531	---	32.60	46.00	13.40	1000.0	9.000	L1	GND	0.2
0.859531	37.37	---	56.00	18.63	1000.0	9.000	L1	GND	0.2
3.432656	---	29.22	46.00	16.78	1000.0	9.000	L1	GND	0.3
3.432656	31.40	---	56.00	24.60	1000.0	9.000	L1	GND	0.3
3.863438	---	28.59	46.00	17.41	1000.0	9.000	N	GND	0.3
3.863438	31.10	---	56.00	24.90	1000.0	9.000	N	GND	0.3
22.311563	---	28.90	50.00	21.10	1000.0	9.000	N	GND	0.9
22.311563	31.75	---	60.00	28.25	1000.0	9.000	N	GND	0.9

End of Annex 1